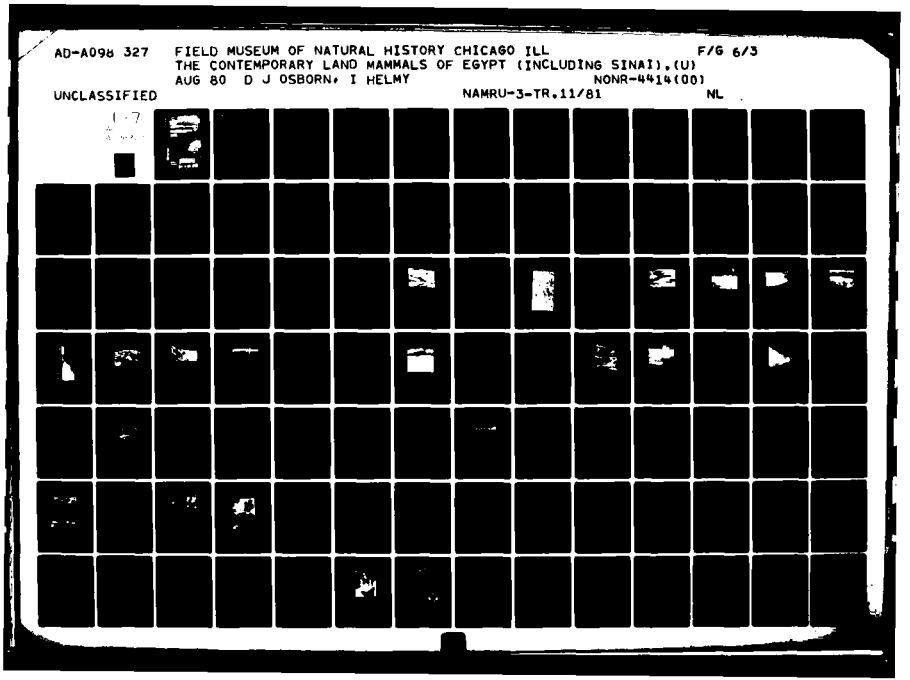
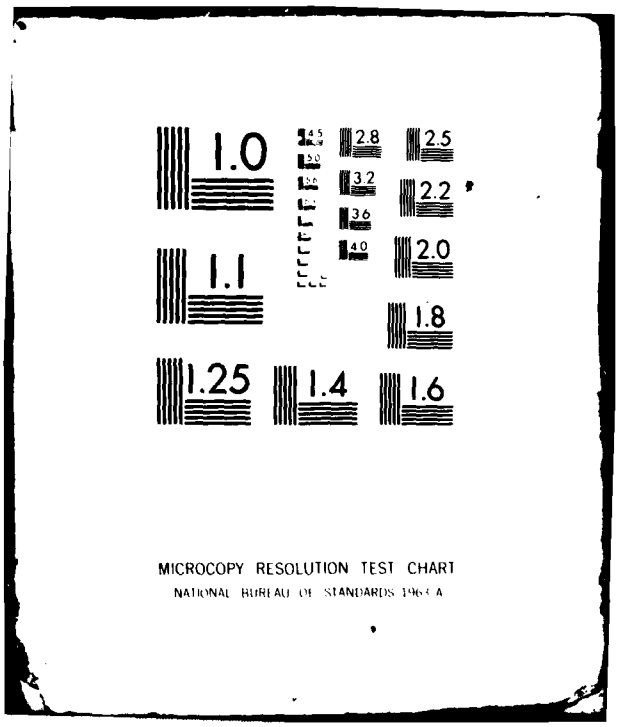
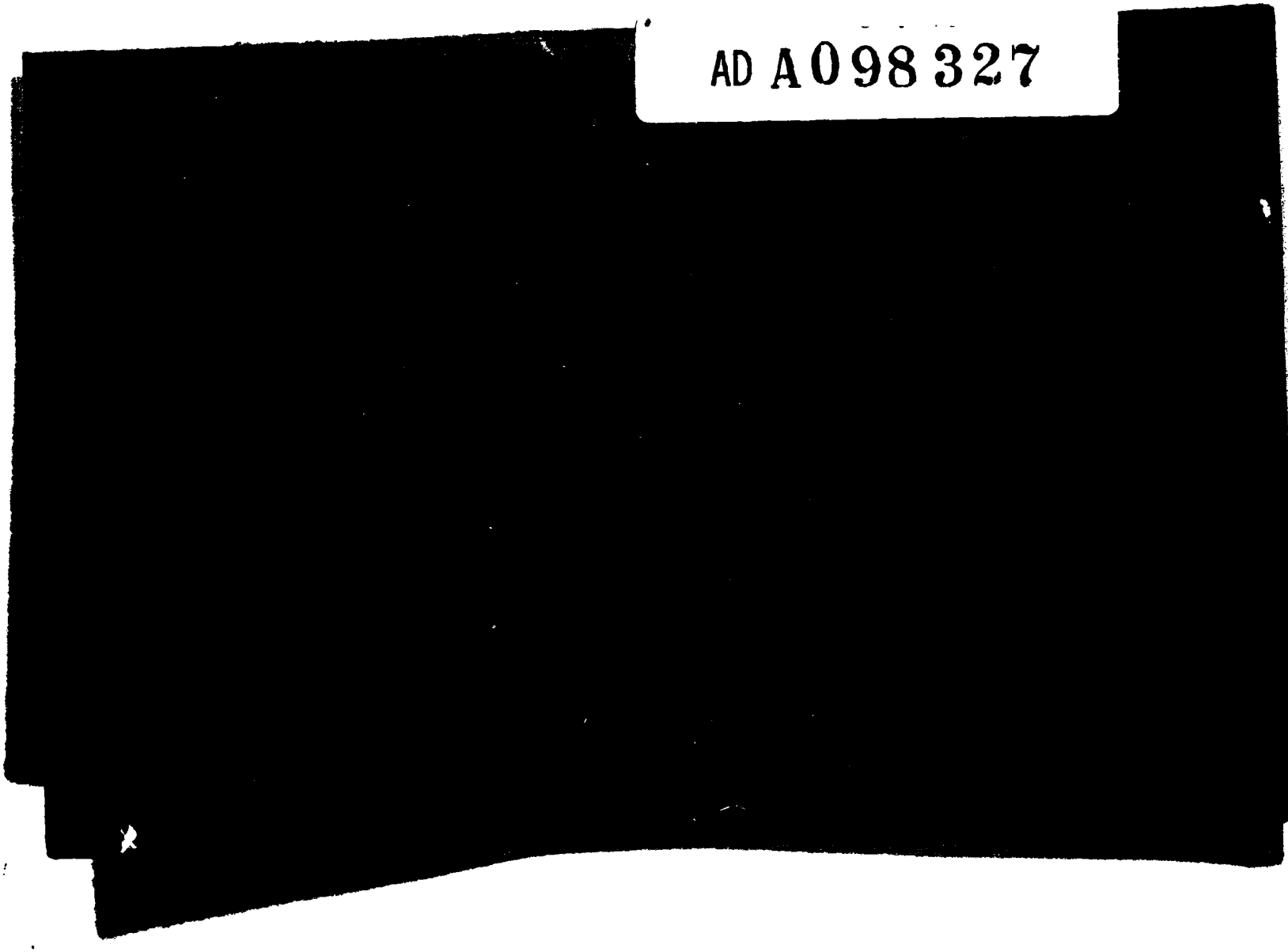
AD-A098 327 FIELD MUSEUM OF NATURAL HISTORY CHICAGO ILL F/G 6/3
THE CONTEMPORARY LAND MAMMALS OF EGYPT (INCLUDING SINAI),(U)
AUG 80 D J OSBORN, I HELMY NONR-4414(00)
UNCLASSIFIED NAMRU-3-TR.11/81 NL




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A


AD A098327

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: NAMRU-3 TR.11/81 ✓	2. GOVT ACCESSION NO.: AD-A098 324
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): THE CONTEMPORARY LAND MAMMALS OF EGYPT (INCLUDING SINAI)	5. TYPE OF REPORT & PERIOD COVERED: Technical/Scientific Report
	6. PERFORMING ORG. REPORT NUMBER: Acc. 1222
7. AUTHOR(s): Dale J. Osborn, Ibrahim Helmy	8. CONTRACT OR GRANT NUMBER(s): NIH Grant #LM02765; ONR Grant Nonr 4414(00)NR 107-806
9. PERFORMING ORGANIZATION NAME AND ADDRESS: U.S. Naval Medical Research Unit No.3, FPO New York 09527/0007	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: MR041.09.01-0152
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Medical Research and Development Command, National Naval Medical Center, Bethesda, Maryland 20014	12. REPORT DATE: 15 August 1980; 13. NUMBER OF PAGES: 579
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): Navy-4414(00), NIH-LM02765	15. SECURITY CLASS. (of this report): Unclassified; 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution of this report is unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Distribution is unlimited

18. SUPPLEMENTARY NOTES

Published by Field Museum of Natural History
Fieldiana: Zoology, New Series, No.5

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Land mammals
Review of literature
Desert features
Study area
Synopses of Representatives in Orders of recent land mammals
Orders Insectivora; Lagomorpha; Rodentia; Carnivora Hyracoidea; Perissodactyla; Artiodactyla;

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This volume is a cooperative effort involving persons of many professions and personal interests. Accurate identification of mammalian host species and knowledge of ecologic factors and geographical distribution was of immediate importance in this project. A modern treatise on the mammals of Egypt with workable keys, accurate descriptions, and fundamental biological information has been the goal of this work.

403520

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

THE CONTEMPORARY LAND MAMMALS OF EGYPT (INCLUDING SINAI)

FIELDIANA
Zoology

Published by Field Museum of Natural History

New Series, No. 5

THE CONTEMPORARY LAND MAMMALS OF EGYPT (INCLUDING SINAI)

DALE J. OSBORN
Research Associate
Field Museum of Natural History
and
Mammalogist
Department of Medical Zoology
U.S. Naval Medical Research Unit No. 3
American Embassy
Cairo, Arab Republic of Egypt

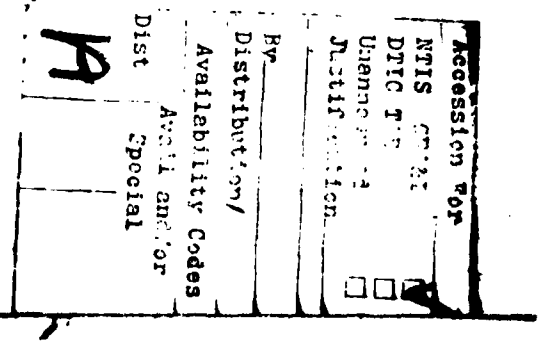
IBRAHIM HELMY
Field Research Supervisor
Department of Medical Zoology
U.S. Naval Medical Research Unit No. 3
American Embassy
Cairo, Arab Republic of Egypt

From Research Project MR041.09.01-0152, Naval Medical Research and Development Command, National Naval Medical Center, Bethesda, Maryland. The opinions and assertions contained herein are the private ones of the authors and are not to be construed as official or as reflecting the views of the Department of the Navy or of the naval service at large.

Dr. Osborn's present address is Ladova 7, 12800 Praha 2, Czechoslovakia, S.R. Dr. Osborn's employment at NAMRU-3 was supported by Office of Naval Research grant Nonr 4414(00)NR 107-806.

This publication was supported in part by NIH Grant #LM02765 from The National Library of Medicine.

August 15, 1980
Publication 1309



Library of Congress Catalog Number: 79-51549

US ISSN: 0015-0754

PRINTED IN THE UNITED STATES OF AMERICA

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS x
LIST OF TABLES xv
PREFACE xviii
INTRODUCTION 1
Review of Literature 1
Materials and Methods 3
STUDY AREA 6
TOPOGRAPHY 9
Sinai Peninsula 9
Eastern Desert 10
Nile Valley and Delta 14
Western Mediterranean Coastal Desert 16
Western Desert 18
DESERT FEATURES 24
Raml 24
Serir 24
Hamada 25
Balata 25
Nafash 26
Sebakha 26
THE WADI 27
CLIMATIC FACTORS 30
Temperature 30
Wind 33
Rainfall 33
Dew 36
Water and Desert Life 37
VEGETATION 39
Sinai Peninsula 40
Red Sea Coastal Desert 41
Eastern Desert 42
Gebel Elba 45
Nile Valley and Delta 45
Western Mediterranean Coastal Desert 46
Western Desert 48
Zoogeography 51
Special Adaptations of Desert Mammals 53
SYNOPSES OF REPRESENTATIVES IN ORDERS OF RECENT EGYPTIAN LAND MAMMALS 55
ORDER INSECTIVORA 57
Key to Families of Egyptian Insectivores 57

Family 1. Erinaceidae 57
Key to Egyptian Genera of Erinaceidae 57
Genus *Hemiechinus* Fitzinger, 1866 57
Hemiechinus auritus (Gmelin, 1770) 57
Key to Egyptian Subspecies of *Hemiechinus auritus* 62
Hemiechinus auritus aegyptius (Fischer, 1829) 62
Hemiechinus auritus libycus (Ehrenberg, 1833) 63
Genus *Paraechinus* Trouessart, 1879 64
Key to Egyptian Species of *Paraechinus* 64
Paraechinus deserti (Loche, 1858) 64
Paraechinus deserti deserti (Loche, 1858) 65
Paraechinus aethiopicus (Ehrenberg, 1833) 68
Paraechinus aethiopicus aethiopicus (Ehrenberg, 1833) 69
Paraechinus dorsalis (Anderson and De Winton, 1901) 70
Paraechinus dorsalis dorsalis (Anderson and De Winton, 1901) 70
Family 2. Soricidae 71
Key to Egyptian Genera of Soricidae 71
Genus *Crocidura* Wagler, 1832 71
Key to Egyptian Species of *Crocidura* 71
Crocidura flavescens (I. Geoffroy St.-Hilaire, 1827) 73
Crocidura flavescens deltae Heim de Balsac and Barloy, 1966 73
Crocidura floweri Dollman, 1916 76
Crocidura nana Dobson, 1890 77
Crocidura suaveolens (Pallas, 1811) 78
Egyptian Subspecies of *Crocidura suaveolens* 79
Crocidura suaveolens portali (Thomas, 1920) 79
Crocidura suaveolens matruhensis Setzer, 1960 80
Genus *Suncus* Ehrenberg, 1833 80
Key to Egyptian Species of *Suncus* 80
Suncus murinus Linnaeus, 1766 81
Suncus murinus sacer (Ehrenberg, 1833) 81
Suncus etruscus Savi, 1822 82
ORDER LAGOMORPHA 84
Family Leporidae 84
Genus *Lepus* Linnaeus, 1758 84
Lepus capensis Linnaeus, 1758 84
Key to Egyptian Subspecies of *Lepus capensis* 90
Lepus capensis sinaiticus (Ehrenberg, 1833) 90
Lepus capensis aegyptius (Demarest, 1822) 91
Lepus capensis isabellinus (Cretzschmar, 1826) 92
Lepus capensis rothschildi (De Winton, 1902) 92
ORDER RODENTIA 94
Key to Egyptian Families of Rodentia 94
Family 1. Cricetidae (Subfamily Gerbillinae) 95
Keys to Egyptian Genera of Gerbillinae (External Characters and Cranial and Dental Characters) 95
Genus *Gerbillus* Desmarest, 1804 96
Key to Egyptian Species of *Gerbillus* 96
Gerbillus pyramidum I. Geoffroy St. Hilaire, 1825 96
Key to Egyptian Subspecies of *Gerbillus pyramidum* 111

Gerbillus pyramidum pyramidum I. Geoffroy St. Hilaire, 1825.....111
Gerbillus pyramidum floweri (Thomas, 1919).....113
Gerbillus pyramidum gedeedus ssp. nov. Osborn and Helmy.....114
Gerbillus pyramidum elbaensis Setzer, 1958.....116
Gerbillus perpallidus Setzer, 1958.....117
Gerbillus andersoni De Winton, 1902.....119
Key to Egyptian Subspecies of *Gerbillus andersoni*.....127
Gerbillus andersoni andersoni De Winton, 1902.....128
Gerbillus andersoni inflatus (Ranck, 1968).....128
Gerbillus andersoni bonhotei (Thomas, 1919).....129
Gerbillus gerbillus (Olivier, 1801).....130
Key to Egyptian Subspecies of *Gerbillus gerbillus*.....136
Gerbillus gerbillus asyutensis Setzer, 1960.....136
Gerbillus gerbillus sudanensis Setzer, 1956.....138
Gerbillus gerbillus gerbillus (Olivier, 1801).....139
Genus *Dipodillus* Lataste, 1881.....140
Keys to Egyptian Species of *Dipodillus* (External Characters and Cranial Characters).....141
Dipodillus campestris (Levaillant, 1857).....141
Egyptian Subspecies of *Dipodillus campestris*.....152
Dipodillus campestris wassifi (Setzer, 1958).....152
Dipodillus campestris haymani (Setzer, 1958).....153
Dipodillus campestris patrizii (de Beaux, 1932).....154
Dipodillus campestris venustus (Sundevall, 1843).....154
Dipodillus dasyurus (Wagner, 1842).....155
Dipodillus dasyurus dasyurus (Wagner, 1842).....155
Dipodillus mackilligini Thomas, 1904.....159
Dipodillus simoni (Lataste, 1881).....161
Dipodillus simoni kaiseri (Setzer, 1958).....161
Dipodillus amoenus De Winton, 1902.....167
Dipodillus amoenus amoenus De Winton, 1902.....168
Dipodillus henleyi De Winton, 1903.....174
Key to Egyptian Subspecies of *Dipodillus henleyi*.....179
Dipodillus henleyi henleyi De Winton, 1903.....179
Dipodillus henleyi mariae (Bonhote, 1909).....180
Genus *Sekeetamys* Ellerman, 1947.....181
Sekeetamys calurus (Thomas, 1892).....181
Key to Egyptian Subspecies of *Sekeetamys calurus*.....188
Sekeetamys calurus calurus (Thomas, 1892).....188
Sekeetamys calurus makrami (Setzer, 1961).....189
Genus *Meriones* Illiger, 1811.....190
Key to Egyptian Species of *Meriones*.....190
Meriones crassus Sundevall, 1842.....191
Key to Egyptian Subspecies of *Meriones crassus*.....201
Meriones crassus crassus Sundevall, 1842.....201
Meriones crassus perpallidus Setzer, 1961.....202
Meriones crassus pallidus Bonhote, 1912.....203
Meriones sacramenti Thomas, 1922.....204
Meriones libycus (Lichtenstein, 1823).....207
Meriones libycus libycus (Lichtenstein, 1823).....208

Meriones shawi Rozet, 1833. . . . 214
Meriones shawi isis (Thomas, 1919). . . . 215
Meriones tristrami Thomas, 1892. . . . 218
Meriones tristrami tristrami Thomas, 1892. . . . 218
Genus *Pachyuromys* Lataste, 1880. . . . 220
Pachyuromys duprasi Lataste, 1880. . . . 220
Pachyuromys duprasi natronensis De Winton, 1903. . . . 221
Genus *Psammomys* Cretzschmar, 1828. . . . 226
Psammomys obesus Cretzschmar, 1828. . . . 227
Key to Egyptian Subspecies of *Psammomys obesus*. . . . 242
Psammomys obesus obesus Cretzschmar, 1828. . . . 242
Psammomys obesus nicolli Thomas, 1908. . . . 243
Psammomys obesus terraesanctae Thomas, 1902. . . . 244
Family 2. Spalacidae. . . . 245
Genus *Spalax* Güldenstaedt, 1770. . . . 245
Spalax ehrenbergi Nehring, 1898. . . . 246
Spalax ehrenbergi aegyptiacus (Nehring, 1898). . . . 246
Family 3. Muridae. . . . 253
Key to Egyptian Genera of Muridae. . . . 254
Genus *Arvicanthis* Lesson, 1842. . . . 254
Arvicanthis niloticus (Desmarest, 1822). . . . 254
Arvicanthis niloticus niloticus (Desmarest, 1822). . . . 255
Genus *Rattus* Fischer, 1803. . . . 263
Key to Egyptian Species of *Rattus*. . . . 264
Rattus rattus (Linnaeus, 1758). . . . 264
Rattus norvegicus (Berkenhout, 1769). . . . 269
Genus *Mus* Linnaeus, 1758. . . . 273
Mus musculus Linnaeus, 1758. . . . 274
Mus musculus praetextus (Brants, 1827). . . . 274
Genus *Acomys* I. Geoffroy St. Hilaire, 1838. . . . 285
Key to Egyptian Species of *Acomys*. . . . 285
Acomys russatus (Wagner, 1840). . . . 286
Key to Egyptian Subspecies of *Acomys russatus*. . . . 292
Acomys russatus russatus (Wagner, 1840). . . . 292
Acomys russatus aegyptiacus Bonhote, 1912. . . . 293
Acomys cahirinus (Desmarest, 1819). . . . 293
Key to Egyptian Subspecies of *Acomys cahirinus*. . . . 303
Acomys cahirinus cahirinus (Desmarest, 1819). . . . 303
Acomys cahirinus viator (Thomas, 1902). . . . 305
Acomys cahirinus hunteri (De Winton, 1901). . . . 305
Acomys cahirinus dimidiatus (Cretzschmar, 1826). . . . 306
Acomys cahirinus megalodus (Setzer, 1959). . . . 307
Acomys cahirinus helmyi ssp. nov. Osborn. . . . 308
Genus *Nesokia* Gray, 1842. . . . 309
Nesokia indica (Gray and Hardwicke, 1832). . . . 309
Nesokia ind[illegible] suilla (Thomas, 1907). . . . 309
Family 4. Muscardinidae. . . . 315
Genus *Eliomys* Wagner, 1840. . . . 315
Eliomys quercinus (Linnaeus, 1766). . . . 316
Key to Egyptian Subspecies of *Eliomys quercinus*. . . . 321

Eliomys quercinus melanurus (Wagner, 1840)..... 321
Eliomys quercinus cyrenaicus (Festa, 1921)..... 322
Family 5. Dipodidae..... 322
Key to Egyptian Genera of Dipodidae..... 323
Genus *Allactaga* Cuvier, 1836..... 323
Allactaga tetradactyla (Lichtenstein, 1823)..... 327
Genus *Jaculus* Erxleben, 1777..... 333
Key to Egyptian Species of *Jaculus*..... 333
Jaculus orientalis Erxleben, 1777..... 334
Jaculus orientalis orientalis Erxleben, 1777..... 334
Jaculus jaculus (Linnaeus, 1758)..... 339
Key to Egyptian Subspecies of *Jaculus jaculus*..... 352
Jaculus jaculus schlueteri (Nehring, 1901)..... 352
Jaculus jaculus flavillus Setzer, 1955..... 353
Jaculus jaculus butleri Thomas, 1922..... 355
Jaculus jaculus jaculus (Linnaeus, 1758)..... 356
Family 6. Hystricidae..... 357
Genus *Hystrix* Linnaeus, 1758..... 357
Hystrix cristata Linnaeus, 1758..... 357
ORDER CARNIVORA..... 359
Key to Egyptian Families of Carnivora (Cranial and Dental Characters and External Characters)..... 359
Family 1. Canidae..... 359
Key to Egyptian Genera of Canidae..... 360
Genus *Canis* Linnaeus, 1758..... 360
Canis aureus Linnaeus, 1758..... 360
Canis aureus lupaster (Hemprich and Ehrenberg, 1833)..... 361
Genus *Vulpes* Oken, 1816..... 371
Key to Egyptian Species of *Vulpes*..... 371
Vulpes vulpes (Linnaeus, 1758)..... 371
Vulpes vulpes aegyptiaca (Sonnini, 1816)..... 372
Vulpes rueppelli (Schinz, 1825)..... 379
Vulpes rueppelli rueppelli (Schinz, 1825)..... 380
Genus *Fennecus* Desmarest, 1804..... 387
Fennecus zerda (Zimmermann, 1780)..... 387
Family 2. Mustelidae..... 395
Key to Egyptian Genera of Mustelidae..... 395
Genus *Poecilictis* Thomas and Hinton, 1920..... 395
Poecilictis libyca (Hemprich and Ehrenberg, 1833)..... 395
Poecilictis libyca libyca (Hemprich and Ehrenberg, 1833)..... 396
Genus *Ictonyx* Kaup, 1835..... 403
Ictonyx striatus (Perry, 1810)..... 404
Ictonyx striatus erythreae De Winton, 1898..... 404
Genus *Mustela* Linnaeus, 1758..... 405
Mustela nivalis Linnaeus, 1766..... 406
Mustela nivalis subpalmata (Hemprich and Ehrenberg, 1833)..... 406
Family 3. Viverridae..... 410
Key to Egyptian Genera of Viverridae..... 410
Genus *Genetta* Oken, 1816..... 410
Genetta genetta (Linnaeus, 1758)..... 410

Genetta genetta senegalensis (Fischer, 1829) 411
Genus *Herpestes* Illiger, 1811 415
Herpestes ichneumon (Linnaeus, 1758) 416
Herpestes ichneumon ichneumon (Linnaeus, 1758) 416
Family 4. Hyaenidae 422
Key to Egyptian Genera of Hyaenidae 422
Genus *Hyaena* Brisson, 1762 422
Hyaena hyaena (Linnaeus, 1758) 423
Hyaena hyaena dubbah (Meyer, 1793) 423
Genus *Proteles* I. Geoffroy St.-Hilaire, 1824 432
Proteles cristatus (Sparrmann, 1783) 432
Proteles cristatus pallidior Cabrera, 1910 432
Family 5. Felidae 434
Key to Egyptian Genera of Felidae 434
Genus *Felis* Linnaeus, 1758 434
Key to Egyptian Species of Genus *Felis* 435
Felis chaus Güldenstaedt, 1776 435
Felis chaus nilotica De Winton, 1898 435
Felis sylvestris Schreber, 1777 440
Felis sylvestris libyca (Forster, 1780) 443
Felis sylvestris tristrami (Pocock, 1944) 443
Felis margarita Loche, 1858 444
Felis margarita margarita Loche, 1858 444
Genus *Caracal* Gray, 1843 447
Caracal caracal (Schreber, 1776) 447
Caracal caracal schmitzi (Matschie, 1912) 448
Genus *Panthera* Oken, 1816 451
Panthera pardus (Linnaeus, 1758) 451
Panthera pardus jarvisi Pocock, 1932 454
Panthera pardus pardus (Linnaeus, 1758) 455
Genus *Acinonyx* Brookes, 1828 455
Acinonyx jubatus (Schreber, 1776) 455
ORDER HYRACOIDEA 460
Family Procaviidae 460
Genus *Procavia* Storr, 1780 460
Procavia capensis (Pallas, 1766) 460
Key to Egyptian Subspecies of *Procavia capensis* 468
Procavia capensis syriaca (Schreber, 1784) 468
Procavia capensis ruficeps (Hemprich and Ehrenberg, 1832) 468
ORDER PERISSODACTYLA 470
Family Equidae 470
Genus *Equus* Linnaeus, 1758 470
Equus asinus Linnaeus, 1758 470
Equus asinus africanus (Fitzinger, 1857) 470
ORDER ARTIODACTYLA 475
Family 1. Suidae 475
Genus *Sus* Linnaeus, 1758 475
Sus scrofa Linnaeus, 1758 475
Family 2. Hippopotamidae 477
Genus *Hippopotamus* Linnaeus, 1758 477

Hippopotamus amphibius Linnaeus, 1758. . . . 477
Family 3. Bovidae. . . . 479
Key to Egyptian Genera of Bovidae. . . . 479
Genus *Oryx* Blainville, 1816. . . . 480
Oryx dammah (Cretzschmar, 1826). . . . 480
Genus *Addax* Rafinesque, 1815. . . . 482
Addax nasomaculatus (Blainville, 1816). . . . 482
Genus *Alcelaphus* Blainville, 1816. . . . 484
Alcelaphus buselaphus (Pallas, 1766). . . . 484
Genus *Gazella* Blainville, 1816. . . . 486
Key to Egyptian Species of *Gazella*. . . . 486
Gazella leptoceros (F. Cuvier, 1842). . . . 487
Gazella leptoceros leptoceros (F. Cuvier, 1842). . . . 487
Gazella dorcas (Linnaeus, 1758). . . . 501
Key to Egyptian Subspecies of *Gazella dorcas*. . . . 507
Gazella dorcas littoralis (Blaine, 1913). . . . 508
Gazella dorcas dorcas (Linnaeus, 1758). . . . 509
Gazella dorcas saudiya (Carruthers and Schwarz, 1935). . . . 512
Gazella gazella (Pallas, 1766). . . . 513
Gazella gazella arabica (Lichtenstein, 1827). . . . 513
Genus *Capra* Linnaeus, 1758. . . . 514
Capra ibex Linnaeus, 1758. . . . 515
Capra ibex nubiana (F. Cuvier, 1825). . . . 515
Genus *Ammotragus* Blyth, 1840. . . . 521
Ammotragus lervia (Pallas, 1777). . . . 521
Ammotragus lervia ornatus (I. Geoffroy St. Hilaire, 1827). . . . 521
APPENDIX 1. Explanation of abbreviations. . . . 526
APPENDIX 2. The auditory bulla. . . . 528
APPENDIX 3. Gerbillinae tooth terminology. . . . 530
APPENDIX 4. The governorates of Egypt. . . . 532
APPENDIX 5. Gazetteer of localities mentioned in the text. . . . 533
APPENDIX 6. Definitions of terms used in the text. . . . 553
REFERENCES. . . . 554

LIST OF ILLUSTRATIONS

1. Geography of Egypt..... 6
2. Rainfall map of Egypt..... 7
3. Eastern Desert. Red Sea Hills..... 11
4. Eastern Desert. Wadi Garawi in Helwan Plateau..... 13
5. Eastern Desert. Wadi Gindali south of Cairo-Suez Road..... 15
6. Nile valley near Giza..... 16
7. Western Mediterranean Coastal Desert near Burg el Arab..... 17
8. Western Mediterranean Coastal Desert 4.8 km. E of Abu Mena..... 18
9. Western Desert. *Serir* (pebble desert) and sand sheet..... 19
10. Western Desert. Meandering sand sheet in area between Wadi el Natroun and Bir Victoria..... 20
11. Western Mediterranean Coastal Desert. Limestone cliffs near Salum..... 21
12. Western Desert. Wadi Labaq in northeastern part of Qattara Depression.. 22
13. Western Desert. Wadi Muwellih..... 25
14. Eastern Desert. Wadi Hof..... 28
15. Eastern Desert. Wadi el Qreiya at km. 77 on Qena-Safaga road..... 29
16. Eastern Desert. Bir Qiseib in Wadi Qiseib..... 31
17. Western Desert. El Maghra..... 34
18. Western Desert. *Acacia raddiana* grove 120 km. S of El Maghra..... 40
19. Western Mediterranean Coastal Desert 34 km. S of Bahig..... 47
20. Western Mediterranean Coastal Desert near area in Figure 19..... 47
21. Western Desert. Bahariya Oasis, Bir Wigaba..... 49
22. Western Desert. Bahrein..... 50
23. Collection localities of *Hemiechinus auritus aegyptius* and *H. a. lybicus*... 58
24. Skull of *Hemiechinus auritus*..... 60
25. Collection localities of *Paraechinus deserti deserti, P. aethiopicus aethiopicus*, and *P. dorsalis dorsalis*..... 65
26. Ventral view of *Paraechinus aethiopicus aethiopicus*..... 66
27. Skull of *Paraechinus deserti deserti*..... 67
28. Collection localities of *Crocidura flavescens deltae, C. floweri, C. nana, C. suaveolens portali*, and *C. s. matruhensis*..... 72
29. Skull of *Crocidura flavescens deltae*..... 74
30. Collection localities of *Lepus capensis sinaiticus, L. c. aegyptius, L. c. isabellinus, L. c. rothschildi*, and sight records..... 85
31. Skull of *Lepus capensis*..... 87
32. Collection localities of *Gerbillus pyramidum pyramidum, G. p. floweri, G. p. gedeedus, G. p. elbaensis*, and *G. perpallidus*..... 97
33. Palatal ridges of *Gerbillus gerbillus, G. andersoni, G. pyramidum, Dipodillus campestris, D. simoni, D. amoenus, Sekeetamys calurus, Meriones crassus*, and *Psammomys obesus*..... 99

34. Palms and soles of *Dipodillus campestris, D. dasyurus, D. simoni, D. amoenus, D. henleyi, Gerbillus gerbillus, Sekeetamys calurus, Meriones crassus,* and *Psammomys obesus*.....101
35. Skull of adult *Gerbillus pyramidum floweri*.....102
36. Mastoid bulla variations in *Gerbillus pyramidum* and *G. perpallidus*.....103
37. Posterior margins of nasals and interparietal outlines of *Gerbillus pyramidum pyramidum, G. p. floweri,* and *G. perpallidus*.....104
38. Crown views of right upper and left lower molars of mature and immature of species of *Dipodillus* and *Gerbillus*.....105
39. Collection localities of *Gerbillus andersoni andersoni, G. a. inflatus,* and *G. a. bonhotei*.....120
40. Comparison of auditory bullae in lateral and dorsal view and skull shape in *Gerbillus andersoni inflatus, G. a. andersoni,* and *G. gerbillus gerbillus*.....122
41. Posterior margins of nasals and incisive and posterior palatal foramina of *Gerbillus andersoni* and *G. gerbillus*.....123
42. Scatter diagram of incisive foramina length versus occipitonasal length in *Gerbillus andersoni* and *G. gerbillus*.....127
43. Collection localities of *Gerbillus gerbillus gerbillus, G. g. asyutensis,* and *G. g. sudanensis*.....131
44. Cadaver of *Gerbillus gerbillus*.....132
45. Collection localities of *Dipodillus campestris wassifi, D. c. haymani, D. c. patrizii, D. c. venustus, D. dasyurus dasyurus,* and *D. mackilligini*.....142
46. Live specimen of *Dipodillus campestris wassifi*.....144
47. Auditory bullae in lateral view and outlines of skulls in dorsal view of species of *Dipodillus*.....145
48. Western Mediterranean Coastal Desert. Ras el Hekma.....166
49. Scatter diagram of tail length versus head and body length in Eastern Desert and Sinai Peninsula samples of *Dipodillus dasyurus*.....167
50. Collection localities of *Dipodillus simoni kaiseri* and *D. amoenus amoenus*.168
51. Skull of *Dipodillus simoni kaiseri*.....169
52. Crown view of upper first molars of *Dipodillus henleyi, D. simoni,* and *D. amoenus*.....171
53. Cadaver of *Dipodillus amoenus amoenus*.....172
54. Collection localities of *Dipodillus henleyi henleyi* and *D. h. mariae*.....175
55. Cadaver of *Dipodillus henleyi mariae*.....176
56. Collection localities of *Sekeetamys calurus calurus* and *S. c. makrami* and sight records.....182
57. Live specimen of *Sekeetamys calurus makrami*.....183
58. Skull of *Sekeetamys calurus makrami*.....184
59. Crown views of right upper and left lower molars of mature and immature *Sekeetamys calurus, Meriones crassus, Psammomys obesus,* and *Pachyuromys duprasi*.....187
60. Auditory bullae in lateral and dorsal views, interparietal shapes, and exposure of infraorbital foramina in lateral view in species of *Meriones*.. 192
61. Skull of *Meriones sacramenti*.....193
62. Collection localities of *Meriones crassus crassus, M. c. perpallidus,* and *M. c. pallidus*.....194
63. Live specimen of *Meriones crassus*.....195
64. Western Desert. About 7 km. SE of km. 208 on Cairo-Bahariya road.....199

65. Collection localities of *Meriones sacramenti, M. libycus libycus, M. shawi isis,* and *M. tristrami*.....205
66. Collection localities of *Pachyuromys duprasi natronensis*.....222
67. Live specimen of *Pachyuromys duprasi natronensis*.....223
68. Skull of *Pachyuromys duprasi natronensis*.....225
69. Collection localities of *Psammomys obesus obesus, P. o. nicolli,* and *P. o. terraesanctae*.....228
70. Cadaver of *Psammomys obesus obesus*.....229
71. Diagrams of middorsal hairs from subspecies of *Psammomys obesus*.....231
72. Skull of *Psammomys obesus*.....232
73. Lateral view of right upper molars of adult and immature *Psammomys obesus*.....233
74. Anterior and posterior position of posterior margin of nasals in subspecies of *Psammomys obesus*.....236
75. Burrow and toilet of *Psammomys obesus*.....238
76. Collection localities of *Spalax ehrenbergi aegyptiacus* and sight record.....247
77. Live specimen of *Spalax ehrenbergi aegyptiacus*.....248
78. Skull of *Spalax ehrenbergi aegyptiacus*.....249
79. Crown views of right upper and left lower molars of Egyptian Muridae and *Spalax ehrenbergi*.....250
80. Collection localities of *Arvicanthis niloticus niloticus*.....256
81. Dorsal views of *Arvicanthis niloticus niloticus, Rattus rattus, R. norvegicus,* and *Nesokia indica*.....257
82. Skull of *Arvicanthis niloticus niloticus*.....258
83. Collection localities of *Rattus rattus* and *R. norvegicus*.....265
84. Skull of *Rattus rattus*.....266
85. Skull of *Rattus norvegicus*.....271
86. Collection localities of *Mus musculus praetextus*.....275
87. Skull of *Mus musculus praetextus*.....277
88. Collection localities of *Acomys russatus russatus* and *A. r. aegyptiacus*.....287
89. Live specimen of *Acomys russatus*.....288
90. Collection localities of *Acomys cahirinus cahirinus, A. c. megalodus, A. c. dimidiatus, A. c. hunteri, A. c. helmyi,* and *A. c. viator*.....294
91. Skull of *Acomys cahirinus*.....296
92. Shells of snails (*Eremica desertorum*) gnawed by a captive *Acomys cahirinus*.....301
93. Collection localities of *Nesokia indica suilla* and sites of Paleolithic remains.....310
94. Skull of *Nesokia indica suilla*.....312
95. Collection localities of *Eliomys quercinus melanurus* and *E. q. cyrenaicus*.....317
96. Live specimen of *Eliomys quercinus cyrenaicus*.....318
97. Skull of *Eliomys quercinus*.....319
98. Crown views of right upper and left lower molars of mature *Allactaga tetradactyla, Jaculus orientalis,* and *J. jaculus*.....323
99. Collection localities of *Allactaga tetradactyla* and *Jaculus orientalis orientalis*.....328
100. Live specimen of *Allactaga tetradactyla*.....329
101. Skull of *Allactaga tetradactyla*.....330
102. Posterior margins of nasals of *Allactaga tetradactyla, Jaculus orientalis,* and *J. jaculus*.....331

103. Skull of *Jaculus orientalis orientalis*.....335
104. Collection localities of *Jaculus jaculus jaculus, J. j. flavillus, J. j. schlueteri, J. j. butleri,* and *Hystrix cristata*.....340
105. Live specimen of *Jaculus jaculus jaculus*.....341
106. Lower jaw and posteriors of lower jaws in ventral view of *Jaculus jaculus*..343
107. Frequency diagrams of ear length and hind foot length of subspecies of *Jaculus jaculus*.....347
108. Western Desert 3 km. SSE of Camel Pass Dune. Solitary specimen of *Cornulaca monocantha,* an important browse plant of *Gazella* sp. and a food source for *Jaculus jaculus*.....349
109. Collection localities of *Canis aureus lupaster* and sight records.....362
110. Skull of *Canis aureus lupaster*.....363
111. Left mandibular teeth of jackal and dog.....368
112. Comparison of nasomaxillary contact and shape of posterior margins of nasals in *Vulpes vulpes* and *V. rueppelli*.....372
113. Collection localities of *Vulpes vulpes aegyptiaca*.....373
114. Skull of *Vulpes vulpes aegyptiaca*.....375
115. Collection localities of *Vulpes rueppelli rueppelli* and sight record.....380
116. Live specimen of *Vulpes rueppelli rueppelli*.....381
117. Skull of *Vulpes rueppelli rueppelli*.....383
118. Collection localities of *Fennecus zerda* and sight record.....388
119. Young *Fennecus zerda*.....389
120. Skull of *Fennecus zerda*.....391
121. Collection localities of *Poecilictis libyca libyca* and records of tracks, *Ictonyx striatus erythreae, Mustela nivalis subpalmata* and sight records, and *Genetta genetta senegalensis*.....396
122. Mustelidae. Dorsal and ventral views of *Mustela nivalis subpalmata;* two dorsal views and a ventral view of *Poecilictis libyca libyca;* dorsal and ventral views of *Ictonyx striatus erythreae*.....397
123. Skull of *Poecilictis libyca libyca*.....398
124. Skull of *Mustela nivalis subpalmata*.....407
125. Museum specimen of *Genetta genetta senegalensis*.....412
126. Skull of *Genetta genetta senegalensis*.....413
127. Collection localities of *Herpestes ichneumon ichneumon* and sight record..417
128. Cadavers of *Herpestes ichneumon ichneumon*.....418
129. Skull of *Herpestes ichneumon ichneumon*.....419
130. Collection localities of *Hyaena hyaena dubbah,* sight records and tracks; and *Proteles cristata*.....424
131. Cadaver of *Hyaena hyaena dubbah*.....425
132. Skull of *Hyaena hyaena dubbah*.....426
133. Collection localities of *Felis chaus nilotica, F. sylvestris libyca, F. s. tristrami,* and *F. margarita*.....436
134. Skull of *Felis chaus nilotica*.....438
135. Skull of *Felis sylvestris libyca*.....442
136. Skull of *Felis margarita*.....446
137. Collection localities of *Caracal caracal schmitzi*.....448
138. Skull of *Caracal caracal schmitzi*.....449
139. Collection localities of *Panthera pardus pardus* and *P. p. jarvisi*.....452
140. Skull of *Panthera pardus*.....453
141. Collection localities, sight records, tracks, and verbal reports of *Acinonyx*

jubatus. 456
142. Skull of *Acinonyx jubatus*. 458
143. Collection localities of *Procavia capensis syriaca*, *P. c. ruficeps*, and sight records. 461
144. Skull of *Procavia capensis*. 462
145. Comparison of position of anterior end of malar relative to lacrimal in *Procavia capensis ruficeps* and *P. c. syriacus*. 463
146. Habitat of *Procavia capensis* in Wadi Nagib. 466
147. Localities of observations of *Equus asinus africanus* in 1800's and from 1950 to date; paleolithic and prehistoric remains. 471
148. Previous distribution of *Sus scrofa*. 476
149. Previous distribution of *Hippopotamus amphibius*. 478
150. Previous distribution of *Oryx damah* and recent sight record. 481
151. Previous distribution of *Addax nasomaculatus*. 483
152. Previous distribution of *Alcelaphus buselaphus*. 485
153. Collection localities of *Gazella leptoceros leptoceros*; sight records; skulls and horns. 488
154. Skull of *Gazella leptoceros leptoceros*. 492
155. Lateral views of anterior part of skulls of *Gazella leptoceros* and *G. dorcas*. 494, 495
156. Nasal bones, interparietals, and lower second and third molars of *Gazella leptoceros* and *G. dorcas*. 496
157. Frontal views of horns of *Gazella dorcas* and *G. leptoceros*. 498
158. Cross-sections of bases of left horn cores of adult males and females of *Gazella dorcas* and *G. leptoceros*. 499
159. *Acacia ehrenbergiana* browsed by *Gazella dorcas*. 506
160. Collection localities of *Gazella dorcas dorcas*, *G. d. littoralis*, *G. d. saudiya*, and *G. gazella arabica*; sight records and skulls and horns. 508
161. Skull of *Gazella dorcas*. 510
162. Collection localities of *Capra ibex nubiana*, undated and prior to 1932 and 1948 to date; horns or skulls; and sight records. 516
163. Skull of *Capra ibex nubiana*. 517
164. Collection localities of *Ammotragus lervia ornatus*, undated and prior to 1932, 1932-1948, and 1949 to date; and horns and skulls; and sight records 1932 to date. 522
165. Auditory bullae of *Dipodillus campestris*. 529
166. Terminology used in describing molars of Gerbillinae. 531
167. Governorates of Egypt. 532

LIST OF TABLES

1. Monthly means (and ranges) in temperature in Egypt 32
2. Means (and ranges) of measurements of adult *Hemiechinus auritus* 61
3. Means (and ranges) of measurements and weight of *Paraechinus deserti*, *P. aethiopicus*, and *P. dorsalis* 61
4. Means (and ranges) of measurements and ratios of species of *Crocidura* 75
5. Means (and ranges) of measurements and ratios of adult *Lepus capensis* 88
6. Means (and ranges) of measurements, ratios, and weight of adult *Gerbillus pyramidum* and *G. perpallidus* 106
7. Characters of *Gerbillus pyramidum* and *G. perpallidus* 108
8. Means (and ranges) of measurements, ratios, and weight of adult *Gerbillus andersoni* 110
9. Comparison of inflation in mastoid chambers of bulla in *Gerbillus andersoni* 124
10. Means (and ranges) of measurements, ratios, and weight of adult *Gerbillus gerbillus* 124
11. Comparison of characters of *Gerbillus andersoni* and *G. gerbillus* 125
12. Means (and ranges) of measurements, ratios, and weight of adult *Dipodillus campestris* 147
13. Means (and ranges) of measurements, ratios, and weight of adult *Dipodillus dasyurus* and *D. mackilligini* 148
14. Characters of species of *Dipodillus* 149
15. Means (and ranges) of measurements, ratios, and weight of adult *Dipodillus simoni* 164
16. Means (and ranges) of measurements, ratios, and weight of adult *Dipodillus a. amoenus* 165
17. Means (and ranges) of measurements, ratios, and weight of adult *Dipodillus henleyi* 178
18. Means (and ranges) of measurements, ratios, and weight of adult *Sekeetamys calurus* 187
19. Means (and ranges) of measurements, ratios, and weight of adult *Meriones crassus* 197
20. Color and cranial variations in *Meriones crassus* 197
21. Means (and ranges) of head and body and occipitonasal lengths of adult *Meriones crassus* from Sinai Peninsula and northern to southern localities in Eastern and Western Deserts 198
22. Means (and ranges) of measurements, ratios, and weight of adults of species of *Meriones* 209
23. Characters of species of *Meriones* 210
24. Means (and ranges) of measurements, ratios, and weight of adult *Pachyuromys duprasi natronensis* 224
25. Means (and ranges) of measurements, ratios, and weight of adult *Psammomys obesus* 234

26. Color patterns of *Psammomys obesus*.... 235
27. Variation in position of posterior margins of nasals in *Psammomys obesus*.. 235
28. Numbers of burrow systems and occupation; numbers and distribution of sexes within age classes of *Psammomys obesus*.... 240
29. Number and per cent of males and females in three age classes of museum samples of *Psammomys obesus*.... 242
30. Means (and ranges) of measurements and weight of adult *Spalax ehrenbergi aegyptiacus*.... 251
31. Means (and ranges) of measurements, ratios, and weight of adult *Rattus rattus, R. norvegicus,* and *Arvicanthis niloticus*.... 259
32. Characters of *Rattus rattus, R. norvegicus,* and *Arvicanthis niloticus*.... 260
33. Color phases of *Mus musculus praetextus*.... 276
34. Means (and ranges) of measurements, ratios, and weight of adult *Mus musculus praetextus*.... 278
35. Means (and ranges) and ratios of head and body length and tail length of *Mus musculus praetextus*.... 279
36. Means (and ranges) or measurements, ratios, and weight of adult *Acomys russatus*.... 289
37. Means (and ranges) of measurements, ratios, and weight of adult *Acomys cahirinus*.... 290
38. Means (and ranges) of measurements, ratios, and weight of adult *Nesokia indica suilla*.... 311
39. Means (and ranges) of measurements, ratios, and weight of adult *Eliomys quercinus*.... 321
40. Characters of Egyptian jerboas.... 324
41. Means (and ranges) of measurements, ratios, and weight of adult *Allactaga tetradactyla* and *Jaculus orientalis*.... 332
42. Color and cranial variations in *Jaculus jaculus*.... 342
43. Means (and ranges) of measurements, ratios, and weight of adult *Jaculus jaculus*.... 345
44. Means (and ranges) of measurements, ratios, and weight of adult *Canis aureus lupaster*.... 364
45. Means (and ranges) of measurements, ratios, and weight of adult male and female *Vulpes vulpes nilotica*.... 366
46. Means (and ranges) of measurements, ratios, and weight of adult male and female *Vulpes r. rueppelli*.... 367
47. Means (and ranges) of measurements, ratios, and weight of adult *Fennecus zerda*.... 390
48. Means (and ranges) of measurements and ratios of adult *Poecilictis l. libyca* and adult male and female *Ictonyx striatus erythreae*.... 400
49. Variation in median lumbar stripe in samples of *Poecilictis libyca*.... 403
50. Means (and ranges) of measurements and ratios of adult male and female *Mustela nivalis subpalmata*.... 408
51. Means (and ranges) of measurements and ratios of *Genetta genetta* and *Herpestes ichneumon*.... 415
52. Means (and ranges) of measurements, ratios, and weight of adult *Hyaena h. dubbah*.... 427
53. Means (and ranges) of measurements, ratios, and weight of *Felis sylvestris* and *F. chaus*.... 437
54. Means (and ranges) of measurements of *Procavia capensis*.... 464

55. Hind hoof length (and ranges) in subadult and adult gazelles from hard and sandy desert. 489
56. Cranial and horn characters of *Gazella leptoceros*, *G. dorcas*, and *G. gazella*. 490
57. Means (and ranges) of measurements and weight of adult male and female *Gazella dorcas* and *G. leptoceros*. 493
58. Measurements of two specimens of *Capra ibex nubiana*. 518

PREFACE

A volume of this kind is never the work or the inspiration of its authors alone. It is a co-operative effort involving persons of many professions and personal interests.

Dr. Harry Hoogstraal, Head, Medical Zoology Department, United States Naval Medical Research Unit Number Three (NAMRU-3), laid the foundation in 1950 by beginning a research program on the ecologic factors of arthropod-borne diseases. The necessity for accurate identification of mammalian host species and knowledge of ecologic factors and geographical distribution was of immediate importance in this project (Hoogstraal, 1960). His goal, a modern treatise on the mammals of Egypt with workable keys, accurate descriptions, and fundamental biological information, has been our goal as well.

For the loan of study materials, we are indebted to Dr. G. B. Corbet, British Museum (Natural History), London; Dr. Jean Dorst, Museum National d'Histoire Naturelle, Paris; Dr. H. Felten, Natur-Museum und Forschungs Institute Senckenberg, Frankfurt; Dr. Kamal Wassif, Ain Shams University, Cairo; Dr. A. M. Monaiery, Giza Zoological Gardens, Giza; Drs. Joseph Curtis Moore and Luis de la Torre, Field Museum of Natural History, Chicago; Dr. Oliver Pearson, Museum of Vertebrate Zoology, Berkeley; and Dr. Henry W. Setzer, United States National Museum, Washington, D.C.

For identifying plants, we are indebted to late Dr. Vivi Tackholm, Cairo University; snails, late Dr. William J. Clench, Museum of Vertebrate Zoology, Cambridge; and arthropod remains from stomach samples, late Mr. Anastase Alfieri, Entomological Institute, Cairo.

For figures other than those of the co-author (I. H.), we appreciate the help of Mr. Samuel H. Grove of Field Museum and Miss Marian Moon of Cairo.

Almost every employee of NAMRU-3 was involved in some way

with the collecting phase of our work, albeit administrative, ordering and issuing supplies, maintaining vehicles, and constructing or repairing equipment.

Our greatest debt of appreciation is to the devoted persons of the Medical Zoology Department who over the years spent countless hours in the field amassing the bulk of the collection which made this publication possible — Drs. Harry Hoogstraal and Makram N. Kaiser, and Messrs. Sobhy Gaber, Sayed Metwally, Hassan Touhamy, Ibrahim Khedr, and Kasim Hadad.

Mr. Abd el Aziz Salah, Manager, Administrative Liaison, was indispensible in his ability to secure travel permits and special privileges from Egyptian government agencies.

We also thank the representatives of the Ministry of Public Health who accompanied us on field trips and assumed responsibility for our welfare.

Representatives of the Department of Antiquities, Department of Locust Control, and the Governors of El Wadi El Gedeed and Matruh Governorates were especially helpful in securing guides, rest houses, and collecting permits.

Field assistants recruited from various localities participated in the collecting effort. These men dug rodents and foxes from burrows, set out and retrieved traps, and chased jerboas with nets.

Lastly, we are grateful to the professional guides who led us without map or compass into the most remote regions of the desert.

The NAMRU-3 collections reported herein are deposited in the Smithsonian Institution and in Field Museum of Natural History.

INTRODUCTION

Review of Literature.—Egyptian mammals were first recorded in rock engravings and cave paintings mainly in the areas of Gebel Uweinat and the southern Eastern Desert, especially around Gebel Elba. Elephant, giraffe, hartebeest, oryx, addax, wild cattle, hippopotamus, and lion, which are no longer part of the fauna, and ibex, gazelle, Barbary sheep, wild ass, leopard, and other cats were known to prehistoric man in Egypt (Newbold, 1928; Sandford and Arkell, 1933, 1939; Winkler, 1938; Dunbar, 1941). Pre-dynastic men made the wheel trap with pointed pieces of *markh* wood (*Leptadenia pyrotechnica*) and captured wild ass, ibex, gazelle (Winkler, 1938), and probably other species. This same device, made with the spines of date palms, was used by the ancient Egyptians and is still used by Bedouins to capture gazelle (Harding-King, 1925; Khairat, 1954; Osborn, 1968b). Extensive stone walls were constructed by Paleolithic men which enabled them to drive game into small enclosures for slaughter (Reed et al., 1967), and these same traps were doubtlessly utilized by the Pharaohs in their "hunts." The walls still stand in Nubia (Giegengack, 1968).

Lion, oryx, addax, hartebeest, hippopotamus, gazelle, ibex, and Barbary sheep appear in paintings and reliefs on the walls of Pharaonic tombs and temples. Animal motifs of the V and VI Dynasties at Saqqara are particularly well preserved. In addition to these, there are carvings of shrew, hedgehog, mongoose, otter, hyena, hare, fox, wild cats, striped weasel, porcupine, and aardvark (Paton, 1925; Keimer, 1942, 1944, 1949, 1955; Brunner, 1969). Numerous species were worshipped and mummified (Gaillard and Daressy, 1905; Morrison-Scott, 1952). Two shrews, *Crocidura olivieri* (*C. flavescens*) and *Sorex religiosus* (*C. nana*), were each described from mummified specimens (Geoffroy St.-Hilaire, 1827).

The Pharaohs hunted and tamed most of the larger animals, including hyenas and lions, and also kept mongooses as pets (Wilkinson, 1878; Newbold, 1928; Khairat, 1954). During the Greek occupa-

tion from the time of Alexander (332 B.C.) until the Arab invasion of 639 A.D., gazelle were plentiful, the Nile abounded with hippopotamus, and lions were hunted near Alexandria (Lindsay, 1965). Herodotus (fifth century B.C.) can be credited with the first accounts of Egyptian mammals, and some correlation seemed to have existed between the known fauna and Herodotus' compilations (Keimer, 1955). Natural history written by Pliny the Elder in the first century A.D. was supposedly influenced by the Egyptians. His statement that mice were spontaneously generated from Nile mud after each annual flood was reported by Dawson (1924) to have been currently believed in Egypt.

Alpini (1735) wrote the first book on Egyptian mammals, Forskal (1775) followed with descriptions of wild and domesticated animals, and Bruce (1790) listed a few Egyptian species in his "Travels." A large number of publications on natural history and the mammalian fauna (E. Geoffroy St.-Hilaire, 1818; I. Geoffroy St.-Hilaire, 1827; Audouin, 1829; E. Geoffroy St.-Hilaire and Audouin, 1829) were based on the collections of the French zoologist, Étienne Geoffroy Saint-Hilaire, who accompanied Napoleon's abortive military expedition to Egypt during 1798 and 1799 (Fagan, 1975) and remained there until 1801. Both he and his son, Isidore (previously cited herein in reference to a shrew) described numerous additions to the vertebrate fauna. Isidore completed his father's work on the reptiles of Egypt, wrote his biography (Geoffroy St.-Hilaire, 1847), and published on the fishes of the Nile and the Red Sea. Further notes on this era of Egyptian natural history are in Sherborn (1897). The great explorer, Rüppell (1826, 1829, 1842), added many new forms to the list of Egyptian mammals.

Anderson's (1898) introduction in Volume I of *Zoology of Egypt* is a source of considerable historical data compiled from the writings of early explorers. Publications of the nineteenth century usually mentioned the observable mammals, such as leopard, hyena, jackal, fox, gazelle, ibex, Barbary sheep, wild donkey, hippopotamus, hyrax, and hare; and some folklore was often included (Sonnini, 1807; Russell, 1831; Wilkinson, 1832; Adams, 1870; Klunzinger, 1878; Flower, 1887, 1893).

Hart (1891) published the first annotated list of the mammals of Sinai, but the first modern treatment of the Egyptian mammal fauna was Anderson's (1902) monumental work. Numerous publications followed which dealt with local collections and descriptions of new forms, and these were summarized by Flower (1932). In the

same year, Innes (1932), compiled a résumé of the rodents of Egypt. Information on the larger mammals continued to appear in geological survey reports and miscellaneous books and papers (Barron and Hume, 1902; Hume, 1906, 1921; Barron, 1907a; Stuart, 1910; Murray, 1912). An interesting list appears in Budge's (1926), *The Dwellers on the Nile*.

Wassif (1944 et seq.) began a series of papers on bats, rodents, and local faunal lists. Setzer (1952 et seq.) started a trend in more strictly taxonomic treatments of the mammals. Negumi (1952) compiled a semi-popular account (in Arabic). Sandborn and Hoogstraal (1955) brought information on bats up to date, and Hoogstraal (1962, 1963, 1964) reviewed most of the work that had been done since Flower (1932). Papers continue to be published on this fauna (Bauer, 1963; Osborn, 1968a; Hoogstraal et al., 1968; Lay and Nadler, 1969, 1972; Wassif et al., 1969; Osborn and Krombein, 1969; Missone, 1969, 1970; Pelikán et al., 1971; DeBlase, 1972; Gaisler et al., 1972, 1973; Haim and Tchernov, 1974; Lay et al., 1975). Numerous references to Egyptian forms are in the works of Ranck (1968), Harrison (1964, 1968, 1972), and Meester and Setzer (1971).

The first recorded observation of decline in Egypt's fauna was by Floyer (1893). In reference to the paucity of animal life in the Eastern Desert, he (Floyer, 1893, p. 411) remarked, "The horse, cow, ostrich and wild donkey have disappeared from this country, not, however, by a diminished rainfall, but perhaps expelled by the camel." Concern over the slaughter of Egypt's game mammals and threatened species of wildlife has been expressed by too few individuals (Dumreicher, 1931; Russell, 1949ab, 1951; Monaiery, 1955; Hoogstraal, 1964; Hoogstraal et al., 1968). Prince Kemal el Din, a renowned trophy hunter, established an ibex sanctuary in Wadi Rishrash in 1900 which was maintained for approximately 40 years (Halton, 1935; Talbot, 1960). According to Dumreicher (1931), good, strict game laws had been introduced by the government, and a short period of enforcement resulted in an apparent increase in hare, gazelle, and cheetah. In 1953, new game laws were established, and hope was expressed for the development of more reserves (Monaiery, 1955). Game laws, however, are not enforced, and animals are killed in all seasons (Hartert, 1913; Wellard, 1965, p. 28).

Materials and Methods.—Field parties from NAMRU-3 have explored all of Egypt except for some parts of Sinai. Collections were

made during all seasons at numerous localities. Areas in which the most extensive collections were obtained are northern Red Sea Hills, Nile Delta, Western Mediterranean Coastal Desert, and El Maghra.

Various means of obtaining specimens were used: trapping, digging out of burrows, and shooting or netting at night under a spotlight. Our rodent live trap is shown in Figure 108. Bait was usually peanut butter and bread, but vegetables, dates, and other fruits were sometimes used. Snap traps were not used, because dead specimens become damaged by ants (Pelikán et al., 1971) and lose ectoparasites, particularly fleas. Digging rodents and small carnivores out of burrows, although laborious and time consuming, has its rewards—specimens have most of their ectoparasites, nests can be examined if present, and commensals may be found. There is always an extra bit of biological knowledge to be gained from a burrow.

Commercial live traps were used for capturing carnivores. Sardine bait was used successfully for most species. Steel traps were resorted to when other techniques failed to get specimens. Hunting at night with a light was an efficient way to obtain cats, hyena, red fox, and jackals. Jerboas were often captured at night with nets. Various other species of rodents and hedgehogs were captured by hand under a spotlight. Small dipodils were pulled from the protection of spiny bushes with long forceps. Methods of collection are further discussed under individual species.

Ectoparasites were removed from specimens as soon as possible after collection and were sent to various specialists.

Standard techniques were followed in preparation of specimens (Corbet, 1966; Harrison, 1972; DeBlase and Martin, 1974). Unless otherwise indicated, tables of measurements and weights are of adult males and females combined. In most rodents, average weight of males is slightly greater than that of females of the same age category. Explanation of abbreviations for measurements and methods of taking same are given in Appendix 1. In systematic work on the Gerbillinae, useful characters were variations in chamber sizes of the auditory bulla (Appendix 2, fig. 165), swellings of the lip of the external auditory meatus, and shapes of associated bones, such as basisphenoid, basioccipital, and interparietal and presence or absence of the accessory tympanum. Terminology used in describing rodent molars is given in Appendix 3, Figure 166.

Synonymy in the taxonomic sections is, for the most part, that of Allen (1939), Ellerman (1941, 1948, 1949), and Ellerman and Morrison-Scott (1951). Recent controversies and taxonomic changes are listed and explained in the text.

Plant names have been revised to agree with Täckholm's (1974) new edition of *Student's Flora of Egypt*.

Localities of collections are listed by Governorate, District, or other political subdivision (in capitals) followed by the name of a town or place. Localities in countries other than Egypt are preceded by the name of the country (e.g., Sudan. KASSALA: Wadi Onib). Names of small villages are sometimes preceded by the name of a township or oasis.

Maps showing Governorates of Egypt are in Appendix 4, Figure 167. All localities mentioned in the text are listed in the Gazeteer in Appendix 5. Definitions of various local terms used in the text are in Appendix 6.

STUDY AREA

Egypt (fig. 1) occupies a 1,000,000-km.^{2} (386,000-mile^2) area of the northeastern corner of Africa north of parallel 22° N lat. and east of parallel 25° E long. About 3.6 per cent of the country is considered habitable, the rest is desert. High, naked mountains, bold plateaus, sterile, stony plains, fields of sinuous dunes, lush oases,

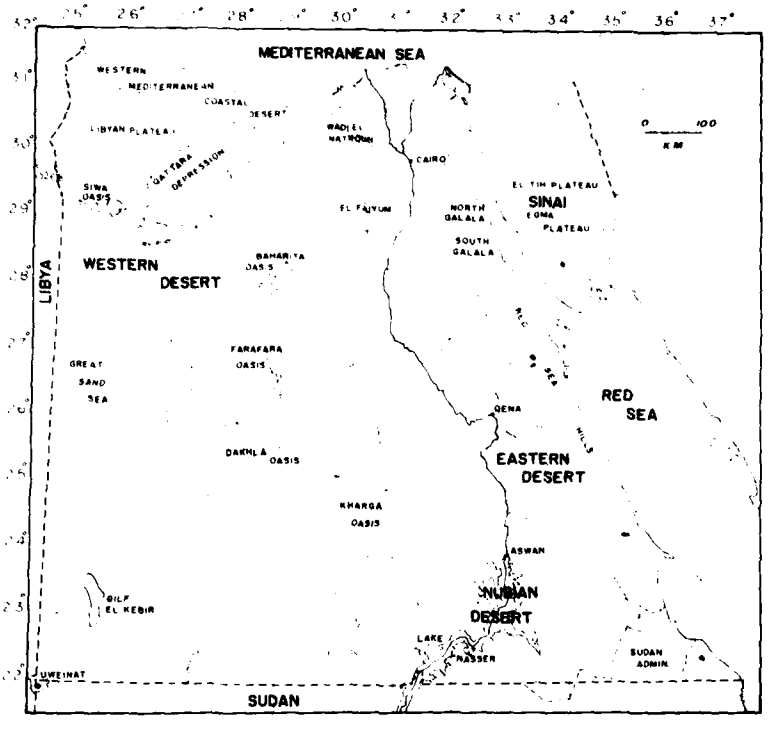


FIG 1. Geography of Egypt. Stippled areas are sand dunes. Black areas are mountains above 1,200 m.

and the green Nile Valley make it a land of striking geographical contrasts.

Egypt is a land of sunshine and intense, dry heat. Were it not for the Nile River, which receives no water-bearing tributaries in its lower 2,750 km., cultivable land would be limited to the deltas of a few wadis, narrow strips bordering the Mediterranean coast, and a few oases in the Western Desert. The Nile Valley, deserts west and east of the Nile, and the Sinai Peninsula are practically rainless (fig. 2).

Egypt is bounded on the north by the Mediterranean Sea and on the east by a 200-km. Israeli frontier, the Gulf of Aqaba, and the Red Sea. Western and southern political boundaries separate Egypt from Libya and Sudan, respectively. The Sudan Government Administration Area (SUDAN ADMIN.) boundary in the southeast

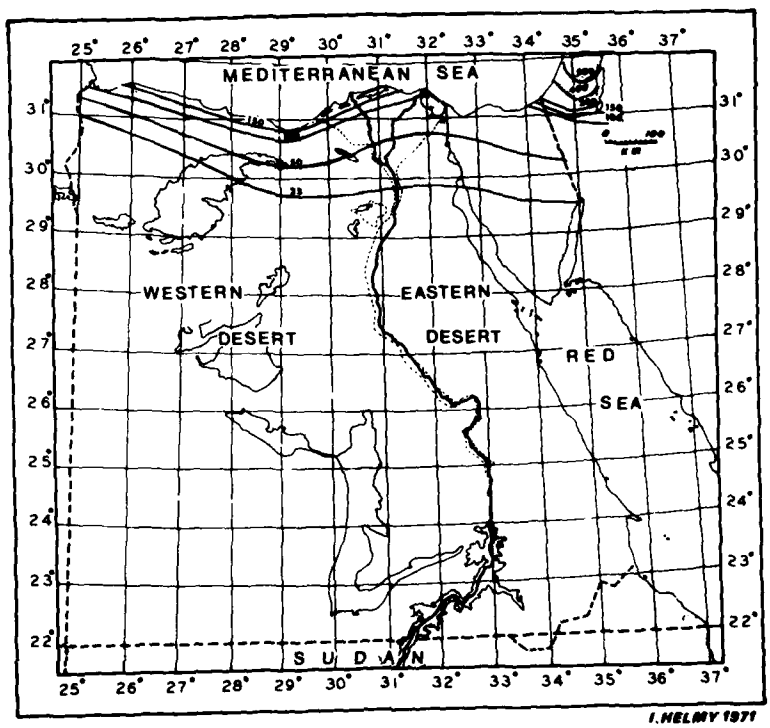


Fig. 2. Rainfall map of Egypt. Isohyets are in millimeters.

(fig. 1) zigzags between Gebel Muqsim and Bir Shalatein, separating the Ababda tribe, which is under Egyptian authority, from the Bisharin who are Sudanese (Ball, 1912; Henderson, 1965).

Certain geopolitical terms of Pharaonic origin still in use today are Lower Egypt, referring to the Nile "Delta" (a term invented by the Greeks), and Upper Egypt (including El Faiyum) from the apex of the Delta south to the first cataract at Aswan. South of Aswan is Nubia (fig. 1), a once-settled area, which as a result of the Aswan High Dam, has been inundated by Lake Nasser.

The major geographical provinces of Egypt are: Sinai Peninsula; Isthmus of Suez; Eastern Desert (Arabian Desert), including the Red Sea Hills (Northern Etbai Range), the Gebel Elba region within the Sudan Administrative Area, and the Nubian Desert (the southern section, which includes the last two, is also known as Bisharin Desert); Nile Valley and Delta; Western Desert (Libyan Desert) and oases; and Western Mediterranean Coastal Desert (fig. 1). Political subdivisions of Egypt (Governorates) are in Appendix 4.

One of the most readable accounts of Egyptian terrain is in Anderson's (1898) *Zoology of Egypt* which, incidentally, included Suakin, Berber, and Dongola provinces of Sudan as part of Egypt. Additional sources dealing with all parts of the country are Hume (1921), Gautier (1935), Jarvis (1937), Ball (1939), Murray (1951), Mitwally (1954), Said (1962), and Abu Al-Izz (1971). The majority of references concern specific localities or sections.

TOPOGRAPHY

Sinai Peninsula.—The Sinai Peninsula (fig. 1) is a triangular area of desert 61,000 km.^{2} (23,200 miles^2) linking Africa with Asia and usually considered as part of Asia.

Steep mountains of igneous and metamorphic rock skirted on the north and west with remnants of Cretaceous or Nubian sandstone form the southern third of the peninsula or Sinai proper. Prominent peaks of this region are Gebels Serbal (2,070 m.), Umm Shomer (2,586 m.), Musa (2,228 m.), and Catherine (2,637 m.), the highest mountain in Egypt. Rocky wadis drain these mountains eastward, abruptly into the Gulf of Aqaba, and westward, gradually over the broad, sandy plain of Qaa into the Gulf of Suez. Wadis Isla, Hebron, Feiran, and Sidri are the most extensive of the western drainage systems.

A high plateau of Cretaceous, Eocene, and Miocene limestones dominates central and part of northern Sinai. Gebel Egma (1,620 m.), a plateau itself, forms the southern extremity of northward dipping Badiet el Tih (Desert of the Wanderings) Plateau which averages between 700- and 900-m. elevation. The 500-m. high sandstone cliffs of Gebel Dhulal (1,570 m.) form the southern scarp of El Tih. Tributaries of northward flowing Wadi el Arish drain most of the surface of El Tih. Incidentally, the outwash plain of this great wadi, prior to the Israeli occupation, was the only site of agriculture in Sinai. Northern limits of the plateau are marked by a series of prominent mesas, ranging from 370- to 1,094-m. elevation, between which extend dunes and plains of the northern desert. These sand and gravel plains and belts of northwest-southeast oriented dunes, 80 to 100 m. in height, cover a triangular area from the Isthmus of Suez eastward to Rafa. This area, together with the plateau to the south, is called El Tih or, in combination with the region north of Wadi Tumilat, Isthmic Desert (Hassib, 1951; Tackholm, 1974).

The Mediterranean coastal desert of Sinai, or Nile-Sinai Mediter-

ranean Littoral (Meigs, 1966), is not as distinctive a region as is the Western Mediterranean Coastal Desert discussed below. In contrast, the former desert receives less rainfall, is more sparsely vegetated (Zohary, 1944), and is low, featureless, and slowly subsiding. Two shallow saline lakes, Sebakha el Bardawil and Birket Serbonis (Sea of Reeds) enclosed by offshore bars, occupy the central sector of the coast.

Further notes on Sinai are found in Holland (1868), Hart (1891), Barron (1907a), Hume (1906, 1921, 1925), Kassas (1952, 1955), Zohary (1954), Haim and Tchernov (1974), and general references to Egypt.

The Isthmus of Suez, a low, sandy, and scantily vegetated neck of land connecting Egypt with Sinai, contains Lake Timsah and Great and Little Bitter Lakes which are connected and traversed by the Suez Canal. The isthmus lies in the northwest branch of the Great Rift Valley and has, in times past, fluctuated in elevation and separated the adjoining land masses. Thus, a partial barrier exists here to the interchange of African and Asian faunas.

Eastern Desert.—Comparable geologically with the Sinai Peninsula, the Eastern Desert also has mountains of igneous and metamorphic rock skirted on the north and west with remnants of sandstone, northwestward-dipping limestone plateaus in the north and northwest, and a northern plains section.

The Red Sea Hills, or Northern Etbai Range, occupy nearly one-third of the area of the Eastern Desert. These mountains of great topographical complexity, with no single dominating ridge, parallel the Red Sea and southern part of the Gulf of Suez from Gebel Shellal (1,409 m.) north to Gebel Umm Tenassib (1,110 m.). Disintegrated by the rock splitting forces of heat and cold and eroded by water, these ancient peaks have become buried in their own rubble (fig. 3). In the Sudan Government Administrative Area, 11 peaks rise above 1,200 m. elevation and four above 1,500 m. The Prominent Gebel Elba is 1,437 m. above sea level. Thirteen peaks north of the Sudan Administrative Area are above 1,200 m. elevation, and eight are higher than 1,500 m. Gebel Shayeb, the second highest mountain in Egypt, rises 2,187 m. above sea level.

East of the mountains, broad gravel plains, averaging 15 to 20 km. in width, slope down to the sea and are occasionally intersected by narrow series of low hills. Wadis draining into the sea are relatively short, straight, and often deep compared with those

FIG. 3. Eastern Desert. Red Sea Hills. View eastward from summit of Gebel Abu Kharif. Gebel Ras el Barud (1,439 m.) in background.

draining westward into the Nile Valley. Exceptions are the long, winding, and complicated Wadis Diib and Hodein ending at the southern and northern ends of El Wadah coastal plain (fig. 1).

The Nubian Desert west of the Gebel Elba area, south and southeast of Aswan, is a country of sandy plains, low granite hills, and sandstone cones and buttes. This desert extends eastward into the Red Sea Hills and a short distance west of the Nile Valley into the bordering limestone scarps and sandstone pinnacles. The two largest drainage systems crossing the Nubian Desert are Wadi Dihmit, with affluents in the Red Sea Hills, and Wadi Allaqi, with eastern tributaries in the Elba Mountains and a great northward flowing branch, Wadi Gabgaba, originating in Sudan. A source book of extensive information on Nubia is Butzer and Hansen (1968). Portions of Nubia west of the Nile were described by Butzer (1965).

North and east of Aswan on the Nile side of the Red Sea Hills successive belts of sandstone form a rough, broken terrain known as the Ababda Plateau. Adjacent to the Nile are two broad plains: Kom Ombo from 30 km. north of Aswan to Gebel Silsila and

Lakeitah between Luxor and Qena. Four major drainage systems between Aswan and Qena are those of Wadis Kharit, Shait, Abad, and Zeidun running out of the Red Sea Hills and crossing the plateau. North of the Red Sea Hills are two vast tablelands, with eastern faces of sandstone on the Gulf of Suez overlain to the north and west by limestones: Gebel Galala el Qibliya or South Galala Plateau (1,464 m.) and Galala el Bahariya or North Galala Plateau (1,247 m.). These tablelands are separated by Wadi Araba which is 30 km. at its widest, penetrates halfway from the Gulf of Suez to the Nile, and was a bay in Upper Mesozoic (Said, 1962).

Incidentally, there is no geological evidence to support Ranck's (1968, p. 52) theory that tectonic disturbances during Pliocene-Quaternary might have so altered the course of the Nile that it flowed into the Red Sea via Wadi Araba or Wadi Ghuweiba further north.

West and southwest of the Galalas lies another series of plateaus which border the Nile Valley from Qena north to Wadi el Digla and dominate two-thirds of the northern part of the Eastern Desert (fig. 1). Cliffs of limestone also intermittently occur west of the Nile between Luxor and Gebel Deshesha, at the level of el Faiyum.

Southernmost of the aforementioned eastern plateaus is Maaza Plateau (Hume, 1921), with elevations of over 500 m. This plateau is drained toward the Nile by steep walled Wadis Qasab, Umm Dud, and Asyuti and its tributary, Wadi Habeeb. Wadi Gurdi and Wadi Umm Omeyid are two of the larger systems draining this plateau eastward into Wadi Qena. Plateaus to the north and their major wadi systems are El Saff, drained by Wadis Tarfa and Rishrash, and Helwan Plateau, drained by Wadis Garawi (figs. 1, 4), Rished, Hof, and El Digla. The last separates Helwan Plateau, with its highest point at Gebel Hof (317 m.), from Gebel Mokattam (205 m.). The tops of these tablelands are severely eroded to form large areas of barren rock fragments or *hamada.* According to Hume (1925), *serir* plains have also developed on the higher summits.

Wadi Qena (fig. 1), mentioned earlier, has its northernmost tributary west of Gebel Gharib in the Red Sea Hills and flows southwards about 320 km. to Qena, receiving tributaries from a vast part of the western slopes of these mountains and eastern parts of the plateaus. Important tributaries from the Red Sea Hills are Wadi el Atrash, Wadi Fatira, Wadi Merkh, and Wadi Hammad. The main part of Wadi Qena is a broad, sterile plain of sand, clay, and stone.

FIG. 4. Eastern Desert. Wadi Garawi in Helwan Plateau. Vegetation is mainly *Zilla spinosa*, *Zygophyllum coccineum*, and *Lavendula stricta*.

The northern limits of the plateau country are marked by a chain of low mesas between the Nile Valley and Suez. Between these outlying mesas and the main plateaus is a rubble-covered stretch of hillocks and hollows of Oligocene Nile fluviatile. This formation also occupies a large area west of the Nile (Hume, 1921; Davis, 1953; Said, 1962). The presence of soft Oligocene beds is indicated by the numerous burrows of rodents as opposed to compact Miocene rocks where burrows are lacking (Barron, 1907b). The Wadi el Gafra–Wadi Iseili–Wadi Gindali system (figs. 1, 5) drains the central and northern parts of the Eastern Desert plateaus, cutting across the fluviatile and between the outlying mesas to debauch in a broad, sandy area on the eastern margin of the Delta. Wadi el Baharri drains northeastward from the plateau into the northern end of the Gulf of Suez. Wadi Ghuweiba, with tributaries cutting over 70 km. inland from the Gulf of Suez, separates Gebel Ataqa (871 m.) and Akheider Ridge (367 m.) from the main plateau with an outwash plain 25 km. wide. A limited agriculture is practiced by Bedouins in this area.

The northern section of the Eastern Desert consists of low, featureless hills and plains of *serir* interspersed with sandy wadis and depressions (Tortonese, 1948) lying mainly south of Wadi Tumilat, an ancient course of the Nile which is now a cultivated area along the Cairo–Ismailia canal. Similar terrain occurs west of the Nile Delta (see under Western Desert).

The Eastern Desert as a whole has a system of external drainage. Water is the most obvious agent of erosion and has carved the vast and intricately complex wadi systems. Wind erosion and deposition are negligible and, other than local sand shadows and drifts, has created only three areas of true dunes — El Khanka near Cairo, the deltaic plain of Wadi el Laqeita, and a range in the southwestern end of El Waddah, the coastal plain north of Gebel Elba.

Nile Valley and Delta.—For about 300 km. from Wadi Halfa to Aswan, prior to inundation by Lake Nasser (fig. 1), the Nile Valley in Nubia extended between cliffs of sandstone and granite, intermittent outwash plains and narrow benches covered with acacias, groves of date palms, and gardens. From Aswan to Cairo, a distance of about 800 km., the Nile Valley stretches like an elongated oasis from 1 to 23 km. wide, separating Egypt into two quite different halves.

The Nile Valley is bordered by cliffs of sandstone from Aswan

FIG. 5. Eastern Desert, Wadi Gindali south of Cairo-Suez Road. Dominant shrubs are *Anabasis articulata* and *Hammada elegans*.

North to Esna and by limestone from Esna to Cairo. North of Asyut, the western cliffs are considerably lower than those to the east. The river runs closest to the eastern cliff boundaries and, in the great bend at Qena, nearly washes the feet of 300 m. walls. In wider stretches of the Valley, ancient terraces bearing traces of prehistoric man rise high above the present alluvial level.

Near Cairo, the river divides into two branches which flow into the Mediterranean at Rosetta (Rashid) and Damietta (Dumyat). The Delta is about 166 km. long and 250 km. wide and is intensively cultivated, being likened to a vast market garden by Russell (1949a). The basin system of cultivation and irrigation prevails throughout, and the entire Valley and Delta are interlaced with irrigation and drainage canals (fig. 6). Islands of sand and saline soil occur here and there. Ard el Barari (The Barrens) is an area of poorly drained, salty wasteland (Hassan, 1953) of marsh and swamp along the inner borders of the Delta Lakes (Manzalah, Burullus, Idku, and Maryut). Barrier beaches of sand occur on the outer shores of these lagoons. Near Baltim and on the northern edge of Lake Burullus are

FIG. 6. Nile Valley near Giza.

fields of anchored crescentric dunes (Drar, 1955; Meigs, 1966) between which are date palm groves and gardens.

Western Mediterranean Coastal Desert.—The Western Mediterranean Coastal Desert (fig. 1) is a distinct northern part of the Western Desert (discussed below). This desert extends from Alexandria westward about 600 km. to Salum and varies in width from 15 to 30 km. in the eastern and central sections to a few kilometers in the west, south of the cliffs at Salum.

Various names applied to this region are: Marmarica (Hassib, 1951), Mareotis District (Kassas, 1955), Western Mediterranean Coastal Region (Tackholm, 1956), and Qattara Littoral (Meigs, 1966).

This coastal desert differs from the Sinai Littoral in the fact that it is calcareous rather than siliceous, has a higher rainfall, and has the richest flora in Egypt other than that of the Gebel Elba area (Tadros, 1953). At various intervals west of Alexandria, dunes of white oolitic sand form the coastline. Usually paralleling the sandy

FIG. 7. Western Mediterranean Coastal Desert near Burg el Arab. Coastal sand dune, salt marsh, and limestone ridge. Vegetation: foreground, *Juncus* sp. and *Limonium delicatulum;* sand dune at right, *Ficus* sp. planted by Bedouins; salt marsh, a variety consisting mainly of *Halocnemon strobilaceum, Arthrocnemon glaucum,* and *Limoniastrum monopetalum. Suaeda fruticosa* occurs on limestone slopes in the background.

coast is a series of two valleys containing salt marshes alternating with limestone ridges (fig. 7) (Shata, 1955). The latter were probably offshore bars in the Pleistocene (Said, 1962). At Ras el Hekma, Ageeba, and Salum, sheer cliffs border the sea. Inland of the cliffs, ridges, and salt marshes lies a relatively flat strip of sand and clay soils (fig. 8) interspersed with *hamada.*

A few relatively short wadis drain the annual runoff from the coastal desert. During heavy rains, they become torrents carrying large quantities of soil into the sea.

Figs are cultivated in a semi-wild state on the coastal dunes (fig. 7); and dates, along the margins of salt marshes and, together with olives, in inland valleys. Barley, the chief crop of the semi-nomadic Bedouins, is grown on the more level clay and loam soils (fig. 8), where earlier, the Romans also practiced dry-farming. Sandy soils, particularly of the Sidi Barrani area, are also the site of fig trees and, in addition, produce annual crops of watermelons.

With the introduction of irrigation water via canals from the Nile

FIG. 8. Western Mediterranean Coastal Desert 4.8 km. E of Abu Mena. Soil is clay. Vegetation: *Lycium* sp. in foreground and *Anabasis articulata* in background. This area was previously Bedouin barley fields. Note burrow of *Meriones shawi isis* under *Lycium*. Rod is divided into 10-cm. units.

Delta, the coastal area as far west as El Hammam is rapidly being changed. As a result, the Nile rat (*Arvicanthis niloticus*) and the mongoose (*Herpestes ichneumon*) have become part of the fauna.

Western Desert.—In contrast with Sinai and the Eastern Desert, the Western Desert lacks extensive areas of high relief. Gebel Uweinat (1,892 m.), with its highest point in Sudan, is an isolated sandstone and igneous massive where the borders of Egypt, Libya, and Sudan intersect (Osborn and Krombein, 1969). Gilf el Kebir (The Great Cliff) of Nubian sandstone, 100 km. N of Gebel Uweinat, rises 1,000 m. above sea level at its southern margin. The northern limestone plateaus are no more than 500 m. in elevation.

The landscape of the Western Desert is wind-dominated (fig. 9). Erosion by water is not as obvious as it is in the Eastern Desert and Sinai, except for the long, winding wadis of Gebel Uweinat and Gilf el Kebir. High plateaus around oases have been dissected to about the same extent as plateaus in the Eastern Desert (Murray, 1950); otherwise, wind has removed much of the relief.

The northeastern part of the Western Desert, which is traversed

FIG. 9. Western Desert. *Serir* (pebble desert) and sand sheet. Camel Pass Dune (Ghard el Qattaniya) in background. View west. Note sand drifts southeast of shrubs (*Calligonum comosum*).

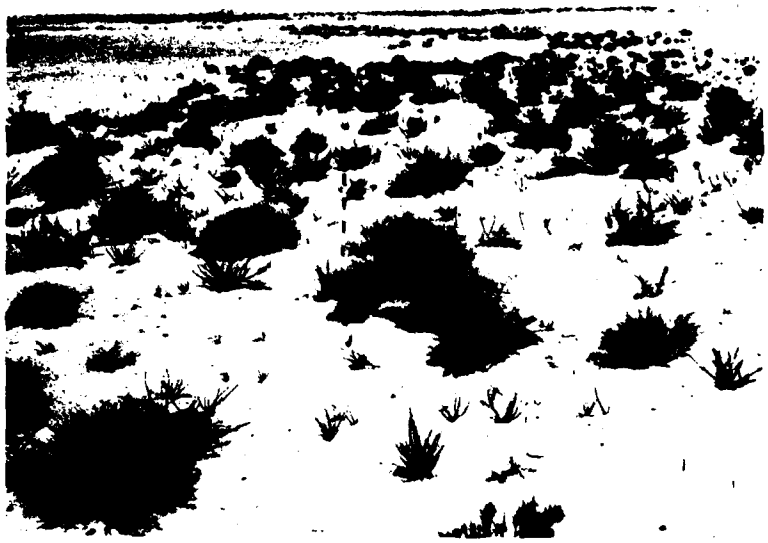


FIG. 10. Western Desert. Meandering sand sheet in area between Wadi el Natroun and Bir Victoria. Vegetation: *Artemisia monosperma* and *Pituranthos tortuosus*.

by the Cairo–Alexandria desert road, is a monotony of low, rolling hills and plains of Pleistocene and recent material interspersed with small sand sheets and narrow, sinuous sandy depressions or meanders of sand (fig. 10) sporadically interrupted by low ridges capped with weathered Pliocene limestone (Shata, 1955). Similar low hills and sandy depressions were described by Tortonese (1948) in the Eastern Desert south of Wadi Tumilat.

El Daffa (Marmarican or Libyan Plateau) in the northwest (fig. 1), is a vast pebble-covered plain with a scattering of mud pans and large areas of *hamada*. This is the Miocene limestone that forms cliffs along the Mediterranean coast (fig. 11), 200 m. promontories on the north of Qattara Depression (fig. 12), and scarps bordering Siwa Oasis and smaller depressions west of Siwa. A narrow tongue of this formation protrudes eastward south of Wadi el Natroun and the aforementioned rolling plains to the Nile Valley (Shata, 1955), ending in prominent Gebel Ghigiga (197 m.) near Abu Rawash. South of the broken limestone hills is the previously mentioned

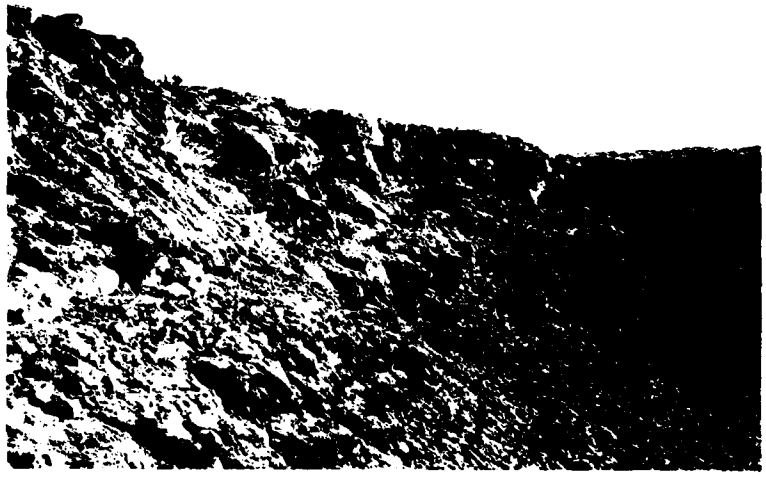


FIG. 11. Western Mediterranean Coastal Desert. Limestone cliffs near Salum. Vegetation: *Rhus tripartita, Limoniastrum monopetalum, Limonium pruinosum, Pancratium maritimum, Moricandia nitens, Asparagus stipularis, Noaea mucronata, Pituranthos tortuosus, Rumex cyprius,* and *Euphorbia dendroides.*

broad area of Oligocene Nile fluviatile that extends some 200 km. SW of Cairo.

Deep depressions or oases in the Western Desert are a result of initial erosive action of water on folds and fractures in the limestone formations during pre- and Pleistocene pluvial periods. During subsequent dry phases of Pleistocene and Recent Periods, wind action completed the excavations to ground water level. Smaller depressions, such as Wadi el Natroun and Wadi el Farigh, where soft sediments were exposed, are considered to have been excavated entirely by wind (Abu Al-Izz, 1971, p. 197). Opinions on the formation of these depressions vary slightly (Hume, 1925; Ball, 1927; Caton-Thompson and Gardner, 1932; Mitwally, 1953b). Most depressions have spectacular northern escarpments, but are open to the south and rise gradually to the level of the desert floor. Exceptions are El Faiyum and Bahariya Oasis which are completely surrounded by cliffs. Within the latter are isolated cones and buttes. Depressions east from Giarabub through Siwa Oasis and Qattara Depression follow the Eocene-Miocene boundary. Other oases are in Paleocene and Eocene deposits. Depression floors are close to or

FIG. 12. Western Desert. Wadi Labaq in northeastern part of Qattara Depression. Minqar Abu Dweis in distant background. Shrubs in background are *Hammada elegans*. Small, cushiony plants are *Convolvulus lanatus* which, if unmolested, grow to a height of 50 to 60 cm. The area is browsed continuously by gazelles and periodically by camels.

below sea level. The lowest point (-137 m.) is in Qattara. Springs, artesian wells, and cultivable land have permitted conversion of parts of some hollows into habitable oases (e.g., Siwa, Qara, Farafara, Bahariya, Dakhla, and Kharga Oases; and Wadi el Natroun and El Faiyum). The last borders Birket Qarun (-45 m.), the remains of prehistoric Lake Moeris, and has been supplied with Nile River water for 3,000 years by the 435 km. Canal of Joseph or Bahr Yusuf (Whitehouse, 1887). Wadi el Rayan (-64 m.) and Wadi Muwellih (+25 m.) to the west and southwest of El Faiyum are undeveloped depressions with springs of potable water. Between these hollows and Bahariya Oasis is El Bahr (The Sea), a belt of confused or broken country consisting of cones and table hills.

Lakes within depressions are usually salty, due to high rate of evaporation, and partly surrounded by *sebakha* (salt pan) and/or marsh (fig. 13).

Winds of excavation are also winds of deposition, and material from the depressions is distributed over the Western Desert in the form of dunes and sheets of sand. Conflicting north and northwest

winds formed the parallel ranges of longitudinal *seif* dunes overlying the *serir* or pebble desert between Qattara Depression and Camel Pass Dune about 100 km. W of Cairo (figs. 1, 9). Ghard el Moharik, a dune range 6 to 8 km. wide and 450 km. long, runs from north and east of Bahariya Oasis southward into Kharga Oasis. Irregular accumulations of dunes occur southwest of El Faiyum and in the depressions of Gharak, Wadi el Rayan, and Wadi Muwellih. North of Giza Pyramids and between El Bahnassa and Mallawi, sand encroaches on the Nile Valley. The Great Sand Sea or Libyan Erg, a vast waterless and almost impassable area of high complicated dunes, some of which are over 100 m. high (Murray, 1967), lies west of Farafara Oasis and stretches about 800 km. south of the Siwa-Giarabub depressions where it inundates the lower levels of the northward-dipping sandstone of Gilf el Kebir.

South from the latitude of Kharga Oasis, north winds continually deposit sand in shallow depressions and also form ranges of crescent-shaped or barchan dunes which move slowly over the plains. Within Kharga Oasis, marching dunes temporarily inundate fields and villages. Sand dunes of the Western Desert were first described in detail by Beadnell (1910) and have received considerable attention since then by various desert explorers (Kemal el Din, 1928; Bagnold, 1931, 1933, 1935, 1936, 1942; Mason, 1936; and Jarvis, 1937).

DESERT FEATURES

Bedouins have more than 20 names for the various land forms in the desert (Dumreicher, 1931). Many terms refer to local phenomena, such as *batikh*, or watermelon-shaped rocks east of Kharga Oasis, and *kharafish*, grooved and ridged limestone south of the dune lines. Surfaces most frequently traversed will be described.

Raml.—*Raml* or sand occupies far less total area than does bare rock in the Egyptian deserts (Mitwally, 1954; Said, 1962). Sand, unless moving as over the surface of a dune, supports most of the vegetation in the Western Desert (figs. 9, 10). According to Davis (1953, p. 160), "Sand drift enables areas to support vegetation that would otherwise be quite bare, the sand acting as a mulch and preventing drying out of the substratum." Sand is a substrate to which hairy-footed mammals such as *Meriones* sp., *Gerbillus* sp., *Jaculus jaculus*, *Fennecus zerda*, and *Felis margarita* have become adapted.

Serir.—*Serir* or pebble desert (fig. 9), a pavement of small to large stones or even cobbles, is the main surface formation in the Western Desert and northern plains of the Eastern Desert and Sinai. Temperature extremes cause fracturing of solid materials from which all the finer dust and sand has been swept away, leaving a stone veneer overlying hard packed sand (Hume, 1921; Harding-King, 1925; Tortonese, 1948; Kassas, 1952; Mitwally, 1953). Some authors (Zohary, 1944; Ranck, 1968) classify *serir* as *hamada*. A mature *serir* consists of angular, faceted pebbles polished smooth by wind and sand. *Serir* plains remain barren in spite of rain, because plants cannot become established. Travel on *serir* is easy and rapid, and wheel tracks and camel tracks remain visible for many years on this surface.

Incidentally, the jerboa (*Jaculus jaculus*) burrows under *serir*. Wind carries away the excavated sand, making its burrows hard to find.

FIG. 13. Western Desert. Wadi Muwellih. *Sebakha* (salt crust) in foreground. Behind this is a strip of *Juncus rigidus* in shallow, salty water. *Tamarix nilotica* covers the sand mound in the background.

Hamada.—*Hamada* or rocky desert occurs on limestone and sandstone tablelands. *Hamada* is rock surface directly covered with a layer of rock fragments. Formation is by weathering and deflation (removal by wind of small particles). Vegetation occurs where rainfall is sufficient and soil has formed in basins or cracks. Intact or jointed rock surfaces on plateaus and granite mountains and barren mountain slopes with loose rock are comparable to *hamada*.

Balata.—*Balata* or mud pans are smooth, flat deposits of silt in shallow depressions (Mitwally, 1953a). They are common on the Libyan Plateau and vary in area from a few square meters to several acres (Omer-Cooper, 1947). *Balata* support plants such as *Capparis*

deserti (= *C. spinosa*), *Acacia raddiana*, *Zygophyllum coccineum*, and *Anastatica hierochuntica*.

Nafash.—*Nafash* is powdery limestone or gypsum with a covering of pebbles or limestone fragments or, in some areas, coin-like nummilites (e.g., Bahrein and an area between El Faiyum and Wadi Muwellih). *Nafash* is rarely vegetated and can be most difficult to traverse.

Sebakha.—*Sebakha* or salt pan (fig. 13) is a mixture of sand, salt, and varying amounts of water upon which a solid or semi-solid crust forms due to evaporation. The latter condition is usually impassable. *Sebakha* may overlie solid ground or salty sludge. The crust is usually brownish and may be hard or soft, smooth or rough. Depressions and oases have extensive areas of *sebakha* that are supplied by underground water. It may also border salty lakes and lowlying seacoasts. According to Ball (1933), the area of *sebakha* in Qattara Depression is about 5,800 km.^{2} Sandy hillocks supporting date palm (*Phoenix dactylifera*), *Tamarix* sp., *Nitraria retusa*, and *Juncus* sp. occur within *sebakha*.

THE WADI

Wadi (Karkur in Gebel Uweinat, Khor in Nubia) refers to a gully, canyon, valley, or any dry stream bed that conveys water at irregular intervals. A wadi is the result of periodic erosion and deposition by water. Some closed-in depressions are erroneously called wadis (e.g., Wadi el Rayan, Wadi Muwellih, and Wadi el Natroun). The mature wadi "has a main channel which is wide, deep, and well defined" (Kassas, 1952), side terraces and alluvial deposits, and is connected with numerous small to large tributaries or runnels. Young and immature wadis lack deposits and terraces.

In igneous mountains, runnels may be shallow but precipitous and covered by massive blocks and boulders. These runnels debauch into drainage lines at the feet of the mountains (fig. 3). In plateaus, shallow runnels may traverse the surfaces and cut the slope or cliff of the plateau edge or the wall of the mature wadi (fig. 4). Waterfall-like cliffs and shelf-like ledges also develop (fig. 14) in wadis of plateau country. In limestone plateaus, wadis are generally narrow and canyon-like (fig. 4). In Nubian sandstone, running water produces broad, open wadis (Abu Al-Izz, 1971).

The wadi bed is at lower levels than the surrounding terrain and receives soil and water via complexly branched tributaries from an extensive drainage area (Kassas, 1953). Its water supply is thus many times the recorded rainfall (Hassib, 1951). As little as 1 cm. of rain is enough to cause flooding (Davis, 1953). Because of the torrential nature of this water supply, main channels within mountains or plateaus are generally devoid of plants. Vegetation is usually established on terraces bordering the channel or on islands within broad channels (fig. 15). On plains, where the rate of stream flow is negligible, plants may be established in the wadi bed or sometimes on relicts of old terraces (fig. 5). Rodent burrows are usually found in these structures.

Most deposits in wadis are alluvial, but wind-blown sand may accumulate within the mountains or plateaus, usually in the

FIG. 14. Eastern Desert. Wadi Hof. Dry waterfall and ledges in Miocene limestone.

FIG. 15. Eastern Desert. Wadi el Qreiya at km. 77 on Qena-Safaga road. Hills are granitic. Vegetation: *Citrullus colocynthis*, prostrate plant in foreground; *Zilla spinosa*, low, white shrub; and *Leptadenia pyrotechnica*, tall, woody shrub.

downstream parts. Transported materials (silt, sand, gravel), if deep enough, usually support some vegetation (Kassas, 1966).

Flash floods disrupt the wadi ecosystem both by building up and removing soil and by destroying vegetation and the habitats of animals, if not the animals themselves. Erratic floods sometimes uproot trees, move large boulders and masses of soil; totally changing long sections of wadis (Kemal el Din, 1928; Kassas and Imam, 1954; Hoogstraal et al., 1967; Kassas and Girgis, 1970). Flood waters or *seyal* may or may not reach the mouth of a wadi, depending upon the amount and locality of rainfall.

CLIMATIC FACTORS

The Pleistocene is considered to have been a time of heavy rainfall in Egypt, during which the desert wadis were running streams (Sandford and Arkell, 1939). Pleistocene terraces carved by recent rains are common in the Eastern Desert (fig. 16), and "mud sphinxes" or wind-carved remnants of ancient lake sediments occur in some parts of the Western Desert (e.g., Kharga Oasis).

The present, arid, Mediterranean climate of Egypt, except for a slight reduction in rainfall from 1910-1940 and increases in moisture about 2,350 B.C. and 5,500 B.C., dates back to about 8,000 B.C. (Butzer and Twidale, 1966). Contemporary changes that have been wrought on vegetation, with consequent reduction or disappearance of animal species, are not due to climatic change, as proposed by Russell (1949a), but are due solely to actions of man and livestock (Hassib, 1951; Long, 1955; Pearse, 1955).

In Egypt, rains can be expected from November to April, with maximums in December and January (table 1), the coolest months of the year. Annual precipitation varies from zero or a trace to a series of cloudbursts. Years of low rainfall are usually followed by several seasons of higher rainfall (El Danasori, 1957).

The Egyptian deserts are among the most arid regions in the world and have the highest air temperatures and lowest rainfall and relative humidity of most African and Asian deserts (Migahid and Abd el Rahman, 1953a). In combination with the seasonality, irregularity, and meagerness of rainfall (fig. 2), low atmospheric moisture, and high temperatures (table 1), winds are strong and dessicating. These factors, except for wind, become more pronounced with increasing distance from the Mediterranean coast in Sinai and Egypt (Kassas, 1952; Migahid et al., 1955), westward into the middle of the Sahara (Perret, 1935), and eastward into the Middle Eastern and Southwest Asian Deserts (Zohary, 1954).

Temperature.—Prevailing high temperatures (table 1) in combination with low rainfall increases aridity and imposes additional hard-

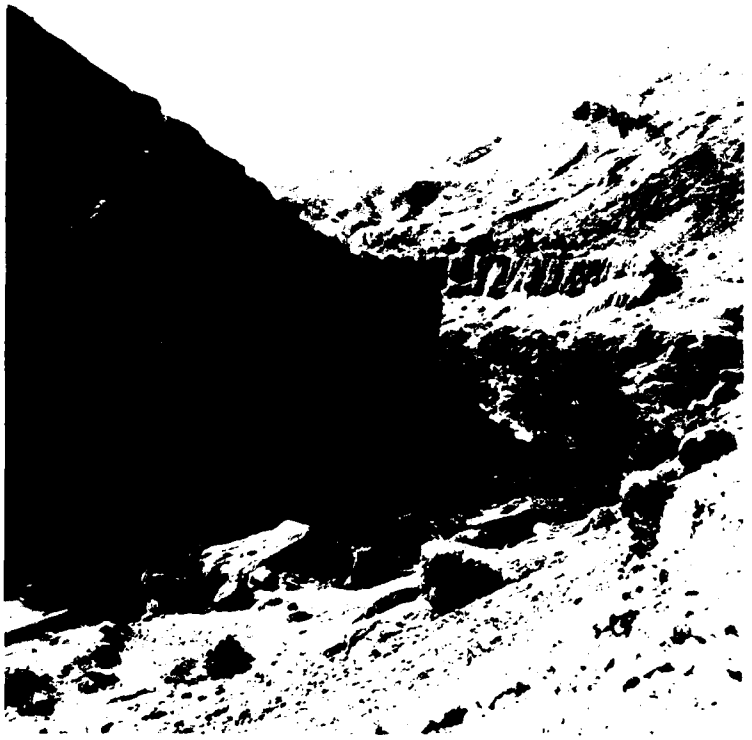


FIG. 16. Eastern Desert. Bir Qiseib in Wadi Qiseib. Note Pleistocene mud flows. Vegetation: date palms (*Phoenix dactylifera*), reeds (*Phragmites australis*), *Imperata cylindrica*, *Juncus rigidus*, *Tamarix nilotica*, *Lycium arabicum*, and *Nitraria retusa*.

ships on desert life. Areas of low relief, plateaus, and south-facing cliffs and slopes are the surfaces most exposed to solar radiation and evaporation and the least likely to support life. North-facing slopes of otherwise barren mountains may support a lichen flora simply because of subtle microclimatic differences (Abd el Rahman and Batanouy, 1966).

According to Hefny (1953), Egyptian deserts are mostly temperate (i.e., mean temperature of coldest month is below 18° C.). The Red Sea coast south of Quseir is considered Tropical Desert, since it has a hot desert climate (i.e., mean temperature of coldest

TABLE 1. — Monthly means (and ranges) in temperature (in centigrade) in Egypt (after El Danasori, 1957).

Month	Alexandria	Tanta	Cairo	Minya	Luxor
Jan.	13.7 (10.6-18.5)	11.6 (6.3-19.9)	11.6 (7.1-18.5)	12.2 (6.2-20.0)	13.0 (5.4-23.4)
Feb.	14.1 (11.0-19.1)	12.3 (6.6-12.3)	13.1 (8.2-20.3)	14.1 (7.3-21.8)	15.4 (6.7-26.1)
March	15.8 (12.8-21.2)	14.6 (8.3-23.8)	16.0 (10.4-23.8)	17.1 (9.8-25.6)	19.4 (10.2-29.9)
April	18.1 (15.0-23.5)	18.7 (11.0-28.2)	19.8 (13.4-28.2)	21.4 (13.5-30.6)	25.0 (15.2-35.2)
May	21.0 (18.0-26.2)	22.9 (14.9-32.3)	23.3 (16.4-31.9)	26.1 (17.5-34.3)	30.2 (20.5-40.0)
June	23.6 (20.8-28.2)	25.4 (17.5-34.3)	26.1 (19.3-34.7)	28.0 (20.0-36.3)	31.4 (21.3-41.0)
July	25.4 (23.0-29.6)	26.5 (19.3-34.8)	27.2 (21.0-35.5)	29.0 (21.4-36.6)	32.3 (22.5-41.4)
Aug.	26.2 (23.6-30.4)	26.4 (19.5-34.7)	27.1 (21.4-34.8)	28.7 (21.6-36.0)	32.1 (22.8-41.2)
Sept.	25.2 (22.6-29.9)	24.4 (17.7-32.8)	24.5 (19.4-31.8)	26.1 (19.7-32.7)	29.7 (21.4-38.2)
Oct.	23.3 (20.2-28.4)	22.1 (15.7-30.4)	22.1 (17.0-29.3)	23.8 (17.5-30.2)	26.8 (18.6-36.8)
Nov.	19.9 (16.9-25.0)	18.3 (12.7-26.2)	17.8 (13.2-24.8)	19.2 (13.3-26.1)	20.5 (12.3-30.6)
Dec.	15.7 (12.6-20.6)	13.6 (8.4-21.5)	13.3 (9.0-19.9)	14.0 (9.2-21.1)	15.1 (7.4-25.4)
Total Mean	20.2 (17.3-25.0)	19.8 (13.2-28.3)	20.2 (14.6-27.8)	21.6 (14.7-29.3)	24.2 (15.4-34.2)

Month	Aswan	Qena	Quseir	Dakhla	Suez
Jan.	15.5 (10.1-23.5)	13.2 (6.9-22.7)	17.8 (13.9-22.7)	12.3 (4.8-21.5)	13.8 (9.4-19.9)
Feb.	17.2 (11.2-25.5)	15.0 (7.8-25.3)	18.4 (14.4-23.1)	14.1 (6.3-24.0)	14.6 (10.0-21.0)
March	21.3 (14.5-30.4)	19.4 (11.4-30.5)	20.7 (16.6-24.9)	18.1 (9.9-28.2)	17.1 (12.1-24.0)
April	26.2 (19.1-35.4)	24.6 (16.1-25.3)	23.4 (19.6-27.5)	23.4 (14.3-33.4)	20.5 (14.8-28.3)
May	30.5 (23.5-39.4)	29.8 (20.8-38.8)	26.8 (23.4-31.0)	28.2 (19.3-37.6)	24.4 (18.6-32.5)
June	32.9 (25.8-41.7)	31.7 (23.2-41.0)	28.9 (25.7-32.8)	30.4 (22.4-39.3)	26.9 (20.9-34.9)
July	33.2 (26.4-41.3)	32.0 (24.1-41.0)	29.8 (26.4-33.6)	30.8 (23.1-39.2)	28.4 (22.7-36.3)
Aug.	33.0 (26.4-41.1)	32.1 (24.2-40.7)	30.3 (27.0-34.1)	30.5 (23.0-38.9)	28.5 (23.1-36.2)
Sept.	30.9 (24.0-39.4)	29.1 (22.0-38.1)	28.7 (25.6-32.5)	28.1 (20.8-36.3)	26.3 (21.3-33.5)
Oct.	28.3 (21.6-36.8)	26.0 (18.8-35.1)	26.7 (23.3-30.6)	24.9 (17.5-33.5)	24.0 (19.2-31.0)
Nov.	22.6 (16.5-30.6)	20.3 (13.6-30.1)	23.4 (19.8-27.7)	19.2 (12.3-28.4)	20.0 (15.5-26.5)
Dec.	17.4 (11.8-25.3)	15.0 (8.9-24.4)	19.6 (16.0-24.4)	13.8 (6.7-22.9)	15.4 (10.8-21.7)
Total Mean	25.8 (19.2-34.2)	24.0 (16.5-33.6)	24.5 (21.0-28.7)	22.8 (15.0-31.9)	21.7 (16.5-28.8)

month is above 18° C.). In contrast with intense daily heat in summer, desert nights are often very chilly, and cloudy winter days are penetratingly cold (table 1).

In order to escape dessication, small desert animals either retire into sand, under stones, or in burrows during the day and become active at night. Studies of burrow microclimates of Egyptian rodents by Williams (1954), Briscoe (1956), and Yunker and Guirgis (1969) will be discussed under appropriate species. Larger mammals and men seek the shade of trees or cliffs during the hottest part of the day. Gazelles in treeless areas scratch hollows in the mounds beneath shrubs in order to obtain shelter from the sun.

Wind.—Prevailing winds over most of Egypt are from the northwest. In the Western Desert south of Kharga Oasis, winds are northerly. In the southeastern coastal and mountain section (Gebel Elba) south of Ras Banas, prevailing winds come from the southeast (Abu Al-Izz, 1971).

From March to May, strong, hot winds known as *Khamsin* (Fifty-Day Winds) or Pentecost Winds veering from south to northwest, produce severe sand and dust storms. These winds tend to scatter sand, but do not affect the stability of dunes (Ball, 1927). Duration is usually two to three days, sometimes recurring every two to three days (Hume, 1925). After a rain, such winds are extremely desiccative. Khamsin are common to the greater part of Egypt, but are most severe in the non-mountainous areas, particularly the coastal deserts.

Wind velocity is greater on the coast than inland, especially in winter (Migahid et al., 1955) and, along with salt spray, is a major limiting factor suppressing development of vegetation on exposed ridges and cliffs near the seacoast (fig. 11).

Strong winds dry the upper soil layer, destroy seedlings, shorten leaf and flowering periods by increasing transpiration, and suppress animal activity (Abd el Rahman and Hadidy, 1959; Abd el Rahman and Batanouy, 1959; Migahid and Ayyad, 1959a). Wind and sand produce abrasive action that is damaging to plants. Wind-deposited materials sometimes cover plants (Montasir, 1954), although species such as *Calligonum comosum*, *Nitraria retusa*, *Zygophyllum album*, *Stipagrostis vulnerans* (= *Aristida vulnerans*) and *Tamarix* sp. (figs. 9, 17), together with wind-blown sand, form hillocks which, incidentally, are burrow sites for animals such as rodents and foxes.

Rainfall.—The Western Mediterranean Coastal Desert from

FIG. 17. Western Desert, El Maghra. Hillocks with *Nitraria retusa* and *Tamarix tetragyna* interspersed with sand and *Juncus subulatus*. Background is salt marsh.

Salum to the Nile Delta receives an average winter rainfall of 70 to 200 mm. each year. Alexandria receives an average of 188 mm. per year. The amount of rainfall decreases to about 80 mm. at Port Said (Hefny, 1953) and to about half that of Alexandria at El Arish in Sinai (Migahid et al., 1955). Ali (1952) suggested that west to east differences in precipitation were caused by local orientation of the coastlines to direction of moisture-bearing northwesterly winds (fig. 2).

Inland, the amount of rainfall decreases sharply. Cairo, 170 km. from the sea, has an annual average of 34 mm.; Helwan, 200 km. inland, 31 mm.; El Faiyum, 230 km. inland, 16 mm.; and Siwa, 390 km. inland, less than 1 mm.

Omer-Cooper (1947) remarked on the snail belt in El Daffa between 31° 00′ and 30° 30′ N lat. and noted that, south of it, the country was barren and almost devoid of plants. Note also that this belt is slightly beyond the southernmost cistern that was dug in this area, indicating how far south effective rainfall penetrates.

Kassas (1955) reported the average annual minimum and maximum rainfall for Alexandria during a 50-year period to have been 59 and 387 mm., respectively. From 1900–1947, these figures were 83

and 287 mm., respectively. For Helwan, minimum and maximum from 1904–1947 were 2 and 25 mm., respectively; Siwa, 0 and 44 mm. for the same period. South of 29° N lat., the average annual rainfall is 0 to less than 25 mm. Dakhla Oasis receives an annual increment of 1 mm. or less of rain. The southern two-thirds of the Western Desert is practically rainless (table 1, fig. 2, and Perret, 1935).

Missone (1970) thought that no rain had fallen on Gilf el Kebir for 30 years. Nevertheless, there are green trees in the wadis (*Maerua crassifolia, Acacia* sp., and *Balanites aegyptiaca*). The exception in this sterile desert area is Gebel Uweinat which receives orographic rain in some part every 7 to 10 years (Peel, 1939; Williams and Hall, 1965) and supports a flora in the wadis similar to that in wadis of the Red Sea Hills (Osborn and Krombein, 1969) and some species high up on the cliffs (Shaw, 1931). The only natural sources of permanent water in the Western Desert are in the pot holes and springs of Gebel Uweinat and springs of oases. In the latter, numerous artesian wells have been bored for land reclamation.

The northern part of the Eastern Desert south to the latitudes of Cairo and Suez receives an average annual rainfall of between 27 and 30 mm. The limestone and sandstone plateaus further south to about 29° N lat. receive less precipitation, but annual rains can be expected. Cloudbursts are not infrequent. Natural water sources are Bir Qiseib, Bir Abu Sanduq, Bir Zafarana, and several springs along the cliffs bordering Wadi Araba.

Between 29° and 26° N lat., there is seldom any Mediterranean climatic influence. Rainfall is scanty and variable and usually comes in irregular cloudbursts at intervals of 10 years or more.

Asyut receives an average of about 7 mm. of rain per year; Minya, 2 mm.; Hurghada on the Red Sea coast, about 3 mm. (Kassas and Zahran, 1962; Kassas and Girgis, 1965). Higher mountains, probably those of 1,500-m. elevation or higher, receive orographic rains (Kassas, 1953). Permanent pools of water occur near the summits of Gebel Shayeb and Gebel Abu Harba. A few other natural sources of water occur in the area, such as Bir Qattar, Bir Sheitun, Bir Mellaha, and Bir Ambagi. The last two are brackish. A few pot holes (e.g., Qalt Umm Disi) and numerous dug wells occur in this section of desert, as indicated on topographical maps. Some wells have been in use since Pharaonic times.

The middle part of the Eastern Desert from 26° N lat. to 24° N lat. receives erratic rainfall in the form of cloudbursts. The mean an-

nual precipitation at Qena is 4 mm.; Quseir, 5 mm.; and Aswan, 3 mm.

The southern part or Nubian Desert from Aswan south to Wadi Halfa is part of the rainless midland of the Sahara and transitional between tropical desert to the south and east and the temperate or Mediterranean desert to the north. The rare incidents of rain in this area may occur in winter (Mediterranean affinity) or in summer (tropical affinity). Devastating floods have been recorded in Wadi Allaqi in 1830 (Ball, 1912) and 1902. High-water marks of the latter are still visible in Wadi Umm Karayiet (Osborn, 1968a). Another flood reached the mouth of Wadi Or in 1962 (Giegengack, 1968). The Gebel Elba region, east of the dry Nubian Desert, lies within the hot desert (tropical desert) of Hefny (1953) which extends along the Red Sea coastal area from Quseir southward. Southeasterly winds predominate along the Red Sea coast and eastern slopes of the mountains as far north as Ras Banas.

The average rainfall in the Gebel Elba region is 25 mm. per year; during 1904-1912, it varied from 5 to 91 mm. Orographic rainfall may reach 400 mm. Precipitation generally falls in winter, but occasional summer showers occur, although the northern limits of monsoon rains is 18° to 19° N lat.

Bir Abraq, north of Gebel Elba, is a well-known source of fresh water. There are few springs in the Gebel Elba region, and in the dry season, naturally occurring water is available from multitudinous pot holes (*Qulut*) in steep and sheltered canyons.

Inland Sinai is practically rainless, although it has a greater rainfall than much of the Eastern Desert (fig. 2, table 1). Higher mountains in the south receive orographic precipitation, possibly amounting to 300 mm. annually (Zohary, 1944). Snow falls occasionally above 1,000-m. elevation and may remain for several months. One meter of snow was measured at St. Catherine Monastery in February 1937 (Drar, 1955). This area, Feiran Oasis, and a few more localities, such as Ain el Gedeirat, Ain el Furtaga, Ain el Senned, Ain Abu Nateigina, and Ain Sudr, are natural, continuous sources of fresh water in Sinai. Water at Hammam Musa and Ayun Musa is brackish, although the presence of date palms (*Phoenix dactylifera*) indicates a "fresh water layer among the underground water layers" (Zahran, 1969, p. 244).

Dew.—Fog and dew are common to all parts of the desert (Russell, 1949a). Dense fogs were reported to have occurred during October

and November in the northern part of the Eastern Desert (Tortonese, 1948). Dew occurs in the mountains of the Eastern Desert (Ball, 1912) and in the spring in the Gebel Elba area (Hoogstraal et al., 1957a). In the Western Desert, heavy dew was recorded during July 2 to 5, 1935, at Qara, and thick fog and dew occurred in late July at 30° 26′ N lat., 26° 27′ E long., and 29° 57′ N lat., 25° 56′ E long. Water dripped from cars, formed puddles, and saturated the soil to a depth of one-fourth inch (Omer-Cooper, 1947). We experienced comparable fog at Bir Shaqqa on August 20, 1964. Northwest of Cairo near Abu Rawash, early morning mists and occasionally fogs were common throughout the year, except during April, May, and June, and indicated high nocturnal relative humidity. Fog usually disappeared before 8 or 9 A.M. and generally occurred in the lower cultivated areas and semi-desert; rarely in the desert (Yunker and Guirgis, 1969).

A considerable amount of dew is precipitated on the Western Mediterranean Coastal Desert during the rainless part of the year and is reported to be of significance to shallow rooted plants (Migahid and Ayyad, 1959a). During the rainless season, some perennials produce ephemeral rootlets close to the soil surface (Kassas, 1953). There is a possibility that the greater amount of dew in the mountains and coastal desert keeps certain perennials alive. Dew is known to be absorbed by the leaves of some desert plants (Waisel, 1958), and it is undoubtedly the water source of algae and lichens which grow on pebbles and which are a food source of desert beetles. The Bedouin belief that the beetles live upon pebbles (MacDougal, 1913) is therefore a truism.

Dew is thought to be a source of water for some birds (Edney, 1966), and it may also be used by small desert mammals such as *Jaculus jaculus* (Bagnold, 1954). The importance of fog and dew in temporarily relieving the physiological pressures of evaporation in desert animals and plants appears to be a subject worthy of consideration. Tortonese (1948, p. 156) noted that dew had a "remarkable effect on the vegetation in the first hours of the morning," but was unable to clarify the biological importance of dew in the desert.

Water and Desert Life.—Water is singularly the most important factor for desert life. Desert plants have evolved numerous adaptations for conserving water and reducing transpiration (Migahid and Abd el Rahman, 1953abc; Zohary, 1954, 1962).

"Scarcity and irregularity of water supplies in the desert make the ability of a desert animal to resist drought a matter of life or death" (Shehata and Kawashti, 1966, p. 181). Desert animals reduce water loss and escape from heat by burrowing underground, seeking shade, or being active only at night. Water must either be extracted from animal or plant tissues, metabolized from dry food, or obtained directly from natural sources. Those animals that must drink can usually endure long waterless periods and/or travel long distances to obtain water (Adolph et al., 1947). A large amount of literature is available on water regulation in desert animals (Schmidt-Nielsen, 1964; Schmidt-Nielsen and Schmidt-Nielsen, 1949 et seq.). Summaries are available in Harrison (1964) and Vaughan (1972). Further remarks on water are given under individual mammal species.

VEGETATION

In the greater part of the Sinai Peninsula, Eastern Desert, and Western Desert, perennial vegetation is confined mainly in channels and catchments of the drainage systems. These are "run-off" deserts, in contrast with "rain deserts" which receive enough rainfall to maintain a continuous vegetative cover (Zohary, 1962) as in the Sinai Coastal Desert, Western Mediterranean Coastal Desert, and the Gebel Elba region.

Plateaus and mountain slopes are the most exposed to wind, sun, and evaporation and are the least vegetated. Exceptions are the higher peaks of Sinai and some mountain tops of the Red Sea Hills south of Gebel Gharib which are above 1,500-m. elevation and receive additional orographic rainfall (Kassas and Zahran, 1965, 1971). Wadi beds receive a lower wind velocity, collect and contain run-off water (Abd el Rahman and Batanouy, 1966), have more favorable substrates, and therefore, have the greatest concentrations of plant life (fig. 4). Likewise, sand sheets and soils of depressions, if sufficiently deep, support vegetation in otherwise barren country (figs. 9, 10, 18).

Desert vegetation has been classified into three basic subdivisions: accidental, ephemeral, and perennial. These subdivisions are associated with three water sources: accidental, ephemeral, and perennial (sub-surface storage) (Kassas, 1966; Kassas and Girgis, 1970). An occasional or accidental rainstorm "will bring up patches of vegetation from seed in the most unlikely parts of the . . . desert" (Shaw, 1931, p. 535). Sporadic rainfall, however, limits species numbers in both plants and animals and has produced in both, including man, shifting and tenuous populations.

Ephemerals, although they may be germinated accidentally, are more abundant where annual rainfall is a certainty (e.g., Western Mediterranean Coastal Desert, northern part of the Eastern Desert and Sinai, and Gebel Elba region). Perennials are found wherever there is the meagerest amount of moisture, providing there are

FIG. 18. Western Desert. *Acacia raddiana* grove 120 km. S of El Maghra.

suitable soils in rock crevices, basins, or wadis where water can accumulate. Acacia trees are known to grow in catchment basins where there is only 1 mm. of effective rain every 15 years (Bagnold, 1954).

In general, areas with the deepest soil will have the largest number of perennials, regardless of the amount of precipitation. Shallow soils support ephemerals or accidentals only. Soils deep enough to have a permanently wet soil layer underlying a dessicated upper layer in the dry season form a suitable habitat for perennials. Climax vegetation in such situations is woody shrubs and trees (Kassas, 1952). There are, however, exceptions to every rule. Soils, no matter how deep, if covered with a layer of desert armor or *serir*, especially if the stones are cemented together with capillary salts, are usually absolutely barren.

Sinai Peninsula.—The littoral zone or coast of Sinai studied by Zohary (1935, 1944) and Kassas (1955) is 10 to 15 km. wide and consists of dunes alternating with sand plains and *serir*.

Typical perennial coastal dune plants of 50 to 100 per cent fre-

quency are: *Ammophila arenaria*, *Polygonum equisetiforme*, *Lotus creticus*, and *Moltkiopsis ciliata* (=*Moltkea callosa*). Plants predominating on the sand plains are: *Artemisia monosperma*, *Haplophyllum tuberculatum* (=*H. longifolium*), *Panicum turgidum*, *Pituranthos tortuosus*, *Urginea maritima*, and *Cynodon dactylon*. Inland dunes and slope-piled dunes on mountains are vegetated with *Panicum turgidum*, *Stipagrostis scoparia* (=*Aristida scoparia*), *Thymelaea hirsuta*, *Convolvulus lanatus*, and *Noaea mucronata*. *Lygos raetam* (=*Retama raetam*) also occurs on these dunes. Dominant plants on *serir*, where enough moisture accumulates, are *Anabasis articulata* or *Hammada elegens* (=*Haloxylon salicornicum*). These two species, incidentally, extend from sea level to 1,000-m. elevation. Haim and Tchernov (1974) listed *Anabasis articulata*, *Gymocarpus decandrum*, and *Zygophyllum dumosum* as the characteristic plants of northern and central Sinai without consideration of site variations. They did not consult the works of Kassas and Zohary. Vegetation in plateaus and mountain areas is confined chiefly to the wadis, although higher peaks in southern Sinai are vegetated because of orographic moisture.

Haim and Tchernov (1974) listed *Artemisia inculta* (= *A. herba-alba*), *Hammada elegans* (*H. articulata* in their text), and *Anabasis articulata* as dominants on the southern El Tih-Gebel Egma area, which, in their opinion, is a transition zone. On the higher mountains above 1,500 m., *Artemisia inculta* was noted as being the dominant plant. With the exception of a few shrubs, the vegetation of Sinai mountains and wadis is essentially the same as that in comparable situations in the Eastern Desert described below. Further coverage of the vegetation of Sinai is by Zohary (1935, 1944, 1954) who considered the Peninsula on the whole to be in Saharo-Sindian territory on the basis of the large number of plant species belonging to this element.

Saline areas around brackish springs and wells (e.g., Ayun Musa, Wadi Sudr, Bir Hassana, and Bir Kussaima) are distinguished by mound-forming *Tamarix nilotica* (= *T. mannifera*), *Nitraria retusa*, and *Zygophyllum album*, together with *Alhagi mannifera* (= *A. maurorum*) and clusters of date palms (Zohary, 1944). The same plants occur at similar sites in Egypt.

Red Sea Coastal Vegetation.—At Ain Sukhna, a warm water spring at the foot of Khashm el Galala, there are dense stands of *Juncus rigidus* (= *J. arabicus*), *Tammarix nilotica*, *Phragmites australis* (= *P. communis*), scattered date palms, and various salt

marsh species (Täckholm, 1956). Salt marsh communities form an intermittent fringe along the Mediterranean coasts, the Sinai and Egyptian coasts of the Gulf of Suez, and the coast of the Red Sea. In the wet saline or tidal zone and littoral *sebakha*, which is separated from the shoreline by sandbars, common species are *Halocnemon strobilaceum*, *Arthrocnemon glaucum*, *Halopeplis perfoliata*, *Limonium pruinosum*, *Juncus rigidus*, and *Cressa cretica*. The drier inland zone is dominated by mound-forming *Tamarix nilotica*, *Nitraria retusa*, *Zygophyllum album*, and in a few localities, *Aeluropus massauensis* (= *A. brevifolius*). South of Mersa el Alem, *Suaeda monoica* replaces *N. retusa*. Along the Gulf of Suez and Red Sea coasts, mounds and small dunes stabilized by these plants are havens for *Meriones crassus* and *Gerbillus gerbillus*. *Gazella dorcas* browses *N. retusa* and other shrubs, and *Vulpes rueppelli* hunts throughout these areas.

Mangrove (*Avicennia marina*) swamps occur on the southern tip of Sinai at Ras Muhammed and at various localities along the Red Sea coast of Egypt from 22 km. N of Hurghada south to Marsa Halaib (Zahran, 1965, 1969).

Eastern Desert.—The open or *serir* desert south of Wadi Tumilat between the margin of the Delta and the Isthmus of Suez contains sand sheets plus a few broad, shallow wadis which originate in the limestone plateau. Although an annual rainfall is predictable in this area, the amount varies considerably (Kassas and Imam, 1959). There is usually enough rain to germinate a few species of ephemerals such as *Mesembryanthemum forsskalei*, *Malva parviflora*, *Erodium pulverulentum*, and *Melilotus* sp. A typical dominant, *Zilla spinosa*, forms thickets in deep sand and shelters other species (Tortonese, 1948). Large drainage systems, such as Wadi Gafra, support stands of *Lygos raetam* and *Panicum turgidum* in sandy areas.

In sections of wadis devoid of sand, plant communities are dominated by *Hammada elegans* (fig. 5). This species also occurs on slopes of cobble hills, Oligocene gravels, and the Khanka sand dunes. Relict specimens of *Acacia raddiana* occur in some of the wadis. More thorough analyses of plant communities of this area are in Davis (1953), Kassas (1953), and Kassas and Imam (1959).

Vegetation in the area adjacent to Cairo and suburbs is suppressed due to grazing and cutting. The bitter *Zygophyllum coccineum* is dominant in Wadi Liblab and *Cassia italica* (= *C. obovata*) is common, but overgrazed. Further south, *Z. coccineum* is replaced by

Anabasis setifera and other species (Kassas and Imam, 1954). The well-vegetated Wadi Garawi is shown in Figure 4.

On the northernmost plateaus where pockets develop to form rain pools, soil accumulates, and *Zygophyllum decumbens, Fagonia tristis, Limonium pruinosum, Reaumuria hirtella,* and *Stachys aegyptiaca* have become established. Vegetation of most wadis in this region is continuous and extends to the sea in the east and to the Nile Valley in the west. A few ephemerals occur as far south as Wadi Araba. Common shrubs in the wadis east and west are *Lycium shawii* (= *arabicum*), *Atriplex halimus,* and *Zilla spinosa. Lygos raetam, Tamarix nilotica,* and *Acacia raddiana* are rare in the northwest due to cutting and browsing. Important reports dealing with the plants of this area are Davis (1953), Kassas and Imam (1954), Täckholm (1956), Kassas and Zahran (1962), and Kassas and Girgis (1964).

South of Wadi Araba to Ras Banas, there is a barren coastal plain that widens to 15 or 20 km. inland from the thin band of coastal salt marsh vegetation discussed above.

Few wadis, except Wadi Abu Haad, in which there is an *Acacia raddiana* climax, are vegetated on the downstream or coastal section. Around brackish Bir Mellaha, there are clusters of date palms (*Phoenix dactylifera*), *Tamarix nilotica,* and mats of *Imperata cylindrica* and *Juncus rigidus.* The last, together with *T. nilotica,* choke the salty stream bed of Wadi Mellaha. Bir Ambagi, another salty spring, produces a short stream with dense growths of *T. nilotica* and *J. rigidus.*

Vegetation is otherwise limited to the shelter of the mountains and foothills (Kassas and Zahran, 1965). On the Nile side of the mountains, vegetation is also limited to upstream sections of wadis and to deltas along the Nile Valley which receive lateral seepage of water. Floods in these wadis rarely reach the Nile Valley. Flood waters can more easily traverse the shorter and steeper sloping wadis debauching into the Red Sea.

Three subdivisions of the Eastern Desert recognized by Kassas and Girgis (1970) were: (A) Northern, 30° to 26° N lat.; (B) Middle, 26° to 24° N lat.; and (C) Southern or Nubian Desert south of 24° N lat.

Eighteen communities were described from these areas. Dominant plants and their areas of distribution are as follows: *Leptadenia pyrotechnica* (fig. 15) and *Acacia raddiana* occur on sand

and gravel deposits of large tributaries throughout the Eastern Desert. *Acacia ehrenbergiana* occurs south of 27° N lat. *Acacia tortilis* is found in the eastern part of the Nubian Desert. *Zygophyllum coccineum* and *Calligonum comosum* are in the northern part only. *Aerva javanica* (=*A. persica*) (fig. 15) is found in the northern and southern parts. *Zilla spinosa* and *Crotalaria aegyptiaca* are northern and middle in distribution. *Cassia italica* is central, and *C. senna*, central and southern. *Francoeuria crispa* (=*Pulicaria crispa*) is widespread in the middle section and extends into the northern part as well. *Salsola baryosma* is central and southern in distribution. *Indigofera argentea* is southern. *Salvadora persica* is found in the eastern parts only of the central and southern sections. Extensive stands of *Tamarix* sp. occur in the deltaic parts of Wadi Araba, Wadi Qena, Wadi Zeidun, Wadi el Asyuti, and in Wadi Haimur (Kassas and Zahran, 1965; Kassas and Girgis, 1970, 1972).

In the rocky talus and boulder-strewn gorges at the bases of mountains higher than 1,300- to 1,500-m. elevation, *Moringa peregrina*, the *yassar* tree, lives in small groves (Kassas and Zahran, 1971). According to Kassas and Zahran (1965), the demand for the valuable Ben oil produced in the seeds have saved this tree from being cut for fuel. *Rhus tripartita* (=*R. oxycantha*) and *Pistacia khinjuk* occur on some of the higher mountain tops which receive orographic rain, but not on dry slopes or in wadis (Tregenza, 1958). Kassas and Zahran (1971) have compiled estimates of abundance of selected species in different habitats within coastal mountain groups—Shayeb, Nugrus, Samiuki, and Elba. Unfortunately, these higher mountains have not been explored for their zoogeographical affinities.

Wadi Qena which flows southward between the Maaza limestone plateau and northern Red Sea Hills deserves mention. The main part of this great southward-flowing wadi is a broad, sterile plain of clay, sand, and stone with a few islands of acacia and thin bands of shrub along the bordering terraces (Barron and Hume, 1902). Kassas and Girgis (1972) showed that the dominant shrubs in Wadi Qena are *Zilla spinosa*, *Calligonum comosum*, *Crotalaria aegyptiaca*, *Zygophyllum coccineum*, *Acacia ehrenbergiana*, *Leptadenia pyrotechnica*, *Tamarix aphylla*, and *T. nilotica*. The last form large hillocks; particularly in the broader channels and deltaic parts of large wadis. Wadis el Asyuti, Zeidun, and el Laqeita were found to have approximately the same vegetation as Wadi Qena.

On the eastern slope of the Red Sea Hills, southward from Ras

Banas, the variety and frequency of plants increases noticeably and is continuous in the wadis from the mountains to the sea. In years of plentiful rainfall, plains and foothills are covered with vegetation, a very different sight indeed from the barren mountain slopes further north and west.

Gebel Elba.—The Gebel Elba region in the Sudan Government Administrative Area has the richest flora in Egypt (Fahmy, 1936), with a type of tropical forest (Tadros, 1953) mostly of Ethiopian species. Vegetation of wadis draining seawards in this area is luxurious in comparison with those draining toward the Nile (Ball, 1912). Rainfall is variable, yet may come in winter and in summer (monsoon affinity). Fahmy (1936), in reference to G. Schweinfurth, mentioned 40 days of continuous rain in the spring of 1864, during the season when no rain falls in the rest of Egypt. Kassas (1966) considers the area to be a "mist oasis" similar in many respects to Erkwit, Sudan (Kassas, 1956). The two areas share a number of tropical plant species, one of the most obvious of which is *Dracaena ombet*.

Acacia etbaica, *A. mellifera*, *A. nubica*, and *A. tortilis* occur in the wadis, and *A. laeta*, *A. raddiana*, and *A. tortilis*, on the plains. The beautiful *Delonix elata* (=*Poinciana elata*) grows in rocky, inaccessible wadis. Several ornamental flowering shrubs of this area are *Abutilon fruticosum*, *Hibiscus micranthus*, and *Pavonia triloba*. In the big acacia forests, trees are entwined with lianas such as *Cocculus pendulus*, *Ochradenus baccatus*, and *Ephedra ciliata* (=*E. foliata*). Hassib (1951) published on the vertical distribution of plant species on Gebel Elba by numbers. Kassas and Zahran (1971) distinguished four main altitudinal zones on the north- and east-facing slopes of Elba which varied somewhat in height due to combination of altitude, degree of slope, and other factors. These zones are (1) a base zone of *Euphorbia cuneata* scrub, (2) a zone of *E. nubica* scrub, (3) a zone of *Acacia etbaica* scrub, and (4) a top and wettest zone with patches of *Dracaena ombet*, *Euclea schimperi*, *Dodonaea viscosa*, *Jasminum sp.*, *Rhus abyssinica*, *R. tripartita*, and a variety of ferns, mosses, and liverworts. Vegetation on south-facing slopes is confined mainly to runnels and is dominated by *Commiphora opobalsamum* at upper levels and *Acacia tortilis* scrub at the mountain base.

Nile Valley and Delta.—According to El Hadidi and Ghabbour (1968, p. 394), the Nile Valley was "among the least explored phytogeographical regions in Egypt." In an intensively cultivated

area such as this (fig. 6), the weed population consists of a great number of species (Boulos 1966b, 1967). Cultivated plants, especially date palms, dominate the scene. Roads and canals are lined with *Eucalyptus camaldulensis* and *Casuarina stricta*. Dense growths of halfa grasses (*Desmostachya bipinnata* and *Imperata cylindrica*) occur along the canal banks. Marshy areas are dominated by *Juncus rigidus* and *Phragmites australis*. *Alhagi mannifera* occurs around the sandy edges of such areas.

In the Nile Delta, few patches of wild land remain. Sandy islands support coarse grasses; low, poorly drained areas usually have a salt marsh type of vegetation. The ecotone between Nile Valley and Delta and the true desert east and west is very narrow and occurs as intermittent stands of *Panicum turgidum*, *Stipagrostis plumosa* (=*Aristida plumosa*), *S. pungens* (=*A. pungens*), *Calligonum comosum*, and other less abundant species (Thomas, 1921) on sand sheets and as *Anabasis articulata* and *Hammada elegans* in sand-filled cracks of rocky areas (Davis, 1953).

Western Mediterranean Coastal Desert.—Four phytogeographical zones have been defined by Kassas (1955) and others for this littoral semi-desert, as follows:

1. Littoral oolitic sand dunes (*Euphorbia paralias*, *Pancratium maritimum*, *Ammophila arenaria*, *Ononis vaginalis*, etc., and cultivated figs).

2. Sub-littoral and inland oolitic limestone ridges 3 km. apart (*Globularia arabica*, *Thymus capitatus*, *Helianthemum lippii*, *Asphodelus microcarpus*, lichen growth, etc.).

3. Salt marsh between the two rocky ridges (*Halocnemon strobilaceum*, *Limoniastrum monopetalum*, *Arthrocnemon glaucum*, etc.).

4. Inland plains (barley fields, olive groves, *Thymelaea hirsuta*, *Anabasis articulata*, and a variety of annuals including *Papaver dubium*, *Chrysanthemum coronarium*, and *Carthamus tenuis*).

These zones are covered with a continuous vegetation (figs. 7, 8, 19), except as noted below, which changes to discontinuous patches inland on sand sheets (figs. 9, 20). The latter represents the transition between coastal desert and the interior barren desert, which has only isolated patches of vegetation or solitary plants (figs. 9, 12, 17, 18). This transitional zone appears to be comparable with what Ranck (1968) called the Saharan steppe in Libya.

Grazing and cutting for fuel have completely removed the vegetation from extensive areas around coastal towns and villages and

FIG. 19. Western Mediterranean Coastal Desert 34 km. S of Bahig. Vegetation is primarily *Thymelaea hirsuta* and *Anabasis articulata*. Soil is sand and clay.

FIG. 20. Western Mediterranean Coastal Desert. *Artemisia monosperma* and *Panicum turgidum* on sand sheet near area in Figure 19.

affected it elsewhere. In areas devoted to agriculture, native plants have been reduced to a few species.

Numerous studies have been made of the coastal desert vegetation, particularly on Ras el Hekma (Tadros, 1953, 1956; Montasir, 1954; Long, 1955; Pearse, 1955; Migahid et al., 1955; Tadros and Berlanta, 1958ab; Migahid and Ayyad, 1959abc; Tadros and Sharkawi, 1960ab).

Western Desert.—The northeastern plains of the Western Desert between Wadi el Natroun and the Nile Delta receive 50 to 100 mm. of rain per year. Shallow catchment basins of Bir Victoria and a nearby *Acacia raddiana* grove in this area support the following plants: *Carduncellus mareoticus* (=*Carthamus mareoticus*), *Panicum turgidum*, *Alhagi mannifera*, *Artemisia monosperma*, *Zilla spinosa*, *Pituranthos tortuosus*, and *Hyoscyamus muticus*. Similar associations occur on sand sheets and meanders of sand (fig. 10).

To the west of Qattara Depression, El Daffa is a sterile plateau with scattered mud pans (*balata*) that support a few species of plants: *Capparis deserti*, *Acacia raddiana*, *Zygophyllum coccineum*, and *Anastatica hierochuntica*.

Sand dunes in the Western Desert are rarely vegetated, except for occasional clumps of *Stipagrostis scoparia*, *S. vulnerans*, and *Cornulaca monacantha*. Sand sheets in the dune areas are usually vegetated (fig. 9).

Groves of *Acacia raddiana* occur in shallow basins scattered throughout the north central section (fig. 18). Omer-Cooper (1947) mentioned groves in the western part of Siwa Depression. There are other small stands between Siwa and El Bahrein, at Talh el Fawakhir north of Qara, near Minqar Abu Dweiss, west of El Maghra about 16 km., and a few kilometers north of El Maghra at Hatiyet el Maghra. To the east, isolated groves occur at 28° 55′ N lat., 29° 31′ E long. and at Hatiyet el Sunt (28° 26′ N lat., 29° 42′ E long.). The largest groves, which are now almost completely dead (personal observation of D. Osborn, April, 1977), are near the southeastern end of the Depression in the vicinity of 29° 37′ N lat., 27° 32′ E long. and are marked on topographic maps as "numerous groves of trees in shallow depressions." These trees survive in an area that receives an annual rainfall of 0 to 5 mm., with larger increments about every 10 years. In such basins where sand or mud have collected, other plants may occur, such as *Francoeria crispa*, *Astragulus trigonus*, *Conyza linifolia* (=*Erigeron crispus*),

FIG. 21. Western Desert. Bahariya Oasis, Bir Wigaba. Vegetation: *Typha domingensis* in foreground and smaller marsh plants such as *Juncus rigidus*, *Epilobium hirsutum*, *Centaurium spicatum*, and *C. pulchellum*; dense stand of *Panicum repens*; and *Salix subserrata*.

Hyoscyamus muticus, *Stipagrostis plumosa*, *Fagonia arabica*, *Monsonia nivea*, *Capparis deserti*, *Zygophyllum coccineum*, and *Anastatica hierochuntica*. The southern one-half of the Western Desert, except for Gebel Uweinat, the oases, and an elongate hollow south of Kharga Oasis, is almost barren (Ascherson, 1874; MacDougal, 1913; Shaw, 1931, 1934; Shaw and Hutchinson, 1931). Often, the only plant to be seen over vast areas is *Stipagrostis plumosa* on sand sheets and in shallow, sandy runnels.

In oases, great numbers of plants grow around non-saline springs and cultivated areas (fig. 21). Lakes within oases are usually salty, partly surrounded by *sebakha* and/or marsh (figs. 13, 22) with *Phragmites australis*, *Typha domingensis*, *Juncus* sp., and *Phoenix dactylifera*. Outside the damp, salty zone there are usually hillocks of sand covered with *Nitraria retusa* (fig. 17), *Tamarix* sp., or *Zygophyllum album*. Patches of *Alhagi mannifera* and stands of *Panicum turgidum*, *Imperata cylindrica*, and *Desmostachya bipinnata* occur on the deeper sand sheets. Trees (*Maerua crassifolia*, *Acacia* sp., and *Balanites aegyptiaca*) in the wadis of Gilf el Kebir

FIG. 22. Western Desert. Bahrein. Palm-rush-reed salt marsh association (*Phoenix dactylifera, Phragmites australis,* and *Juncus rigidus*). Habitat of *Mus musculus.*

north of Gebel Uweinat were mentioned previously (Missone, 1970). Gebel Uweinat in the southwestern corner of Egypt (fig. 1) has a flora of at least 55 species which is comparable with that of the Red Sea Hills (Shaw, 1931; Osborn and Krombein, 1969). Common species in the wadis of this area are *Acacia ehrenbergiana, A. raddiana,* and *Panicum turgidum.*

In the huge, elongated hollows of El Wadi el Gedeed between Kharga Oasis and the Sudanese border, islands of vegetation mark the presence of water, oftentimes brackish, a meter or so below the surface. There are clusters of dom (*Hyphaene thebaica*) and date palms (*Phoenix dactylifera*); areas of hummock-forming grasses (*Stipagrostis vulnerans, Sporobolus spicatus,* and *Cynodon dactylon*) and mound-forming *Cornulaca monacantha, Tamarix amplexicaulis, Acacia ehrenbergiana,* and *Ziziphus spina-christi;* some extensive tracts covered with *Alhagi mannifera, Imperata cylindrica,* and *Phragmites australis*; and occasional solitary specimens of *Capparis decidua.* Cattails, *Typha domingensis* (=*T. australis*), were found in a shallow well at Bir Qiseiba.

A large, solitary specimen of *Salvadora persica,* visible for 20 km., is noted on topographic sheets at 23° 09′ N lat., 29° 44′ E long. Tamarisc and acacia mounds, together with patches of grass (*Stipagrostis* sp.), occur in the areas of Bir Terfawi and Bir Safsaf which are west of the area under discussion (Beadnell, 1931).

On the Nile side of this area, in Nubia, several small oases occur (Kurkur, Dunqul, and Dineigil) which have high underground water supplies. Vegetation in Dunqul Oasis and Wadi Dunqul consists of *Imperata cylindrica, Salsola baryosma, Tamarix amplexicaulis, T. aphylla,* and *Stipagrostis vulnerans.* In Dineigil, there are patches of *Alhagi mannifera, Juncus rigidus,* and *Imperata cylindrica* (Zahran, 1966). Kurkur Oasis and Wadi Kurkur (Reed, 1964) support these and many additional plants, including dom and date palms, *Acacia ehrenbergiana, A. raddiana* (Boulos, 1966a), and the rare *Medemia argun* (Boulos, 1968).

Zoogeography.—Due to striking taxonomic similarities of floras, the almost continuous deserts extending from the Sahara through the Middle East to Sind in Northwestern India became known as the North African-Indian Desert Province (Muschler, 1912) or the Saharo-Sindian Phytogeographic Region (Shaw, 1931; Zohary, 1935, 1944, 1954). Likewise, the mammal fauna that is adapted to these deserts has been referred to as Saharo-Sindian (Harrison, 1964; Ranck, 1968). From a more strictly zoogeographical point of

view, the area should be called the Saharo-Sindian Sub-Region of the Palearctic.

Saharo-Sindian species of mammals which are widely distributed in North African and Southwest Asian deserts are *Vulpes rueppelli*, *Fennecus zerda*, *Felis margarita*, *Gazella dorcas*, *Jaculus jaculus*, *Meriones libycus*, *M. crassus*, and *Psammomys obesus*. The latter is the more restricted ecologically.

Most desert species are indigenous to either North African or Southwest Asian deserts. Penetration east and west has been restricted either by the Isthmus of Suez or the Nile Valley and Delta. Most of the faunal interchange between these deserts and subsequent isolation, at least in rodents, took place during the Upper Pleistocene (Zahavi and Wahram, 1957; Tchernov, 1968).

Species endemic to Egypt are *Crocidura floweri* in the Nile Valley, *Dipodillus mackilligini* in the southern Eastern Desert, and *Gerbillus perpallidus* in the northern Western Desert. The ranges of a few North African species extend through Egypt into Sinai or as far east as southern Israel or Jordan, e.g., *Jaculus orientalis*, *Gerbillus gerbillus*, *G. pyramidum*, and *G. andersoni*. *Dipodillus henleyi* is known from northern Yemen (Bahmanyar and Lay, 1975). Two species, closely related to *G. andersoni* and *G. gerbillus*, and which occur in similar habitats in Israel and Southwest Asia, are *G. allenbyi* and *G. cheesmani*, respectively. Note that *J. orientalis* belongs to the Dipodidae, a family of Asian origin. North African species that range into the Eastern Desert of Egypt are *Paraechinus aethiopicus*, *Ammotragus lervia*, and *Dipodillus amoenus*. North African species in Egypt which are not known to occur east of the Nile Valley and Delta are *Paraechinus deserti*, *Gazella leptoceros*, *Poecilictis libyca*, *Dipodillus simoni*, *D. campestris*, and *Meriones shawi*. In addition, *Pachyuromys duprasi* and *Allactaga tetradactyla* have limited distributions in the northern limits of the Sahara. *Allactaga euphratica*, a species similar to *A. tetradactyla*, is widely distributed in Southwest Asia.

Saharo-Sindian species of limited distribution that occur in Egypt and/or Sinai are *Meriones sacramenti* in Sinai, Israel, and Jordan; *Sekeetamys calurus* in the Eastern Desert, Sinai, southeastern Israel, and Jordan; and *Acomys russatus* in the Eastern Desert, Sinai, Israel, and parts of western Saudi Arabia.

Species of Southwest Asian origin which have penetrated into North Africa are: *Spalax ehrenbergi*, which occurs as relict popula-

tions in the Western Mediterranean Coastal Desert of Egypt and the Cyrenaican Plateau and Coastal Plain of Libya, and *Dipodillus dasyurus*, which occurs in Sinai and the northern part of the Eastern Desert. *Paraechinus dorsalis* is known from Sinai.

Although the Saharo-Sindian Deserts are a barrier between Ethiopian and Palearctic faunas, numerous wide-ranging species of Oriental, Palearctic, or Ethiopian origin contain desert-adapted subspecies in this Sub-Region. Those that occur in Egypt are *Hemiechinus auritus, Canis aureus, Vulpes vulpes, Hyaena hyaena, Caracal caracal, Felis sylvestris, F. chaus, Panthera pardus, Genetta genetta, Procavia capensis, Lepus capensis, Eliomys quercinus, Acomys cahirinus*, and *Hystrix indica*. Some species in this category, such as *Herpestes ichneuman* and *Mustela nivalis*, are restricted to river valleys or other areas where water is available.

A few species of known Ethiopian origin have penetrated Egypt via the Nile Valley: *Crocidura flavescens, C. nana*, and *Arvicanthus niloticus*. Two desert-adapted species of Ethiopian origin, *Ictonyx striatus* and *Proteles cristatus*, have been collected in southeastern Egypt.

A few relicts of Palearctic origin are *Crocidura suaveolens* in Sinai and the Western Mediterranean Coastal Desert and *Suncus etruscus* in the Nile Delta. *Nesokia indica*, of Oriental or Indian origin, occurs sporadically in Egypt and the Arabian Peninsula. *Suncus murinus*, another Oriental form and a commensal of man, is known from the port city of Suez. Its distribution in the Arabian Peninsula (Harrison, 1964) indicates transportation by man. *Mus musculus, Rattus rattus*, and *R. norvegicus* no doubt arrived in Egypt and other parts of the Saharo-Sindian Region via man.

Special Adaptations of Desert Mammals.—The enlarged tympanic and mastoid chambers of the middle ear of certain desert rodents, foxes, cats, and weasels, and probably the swollen pterygoids in hedgehogs, increase their ability to hear low-frequency sounds in warm dry air, which has poor sound-carrying qualities (Legouix et al., 1954; Wisner et al., 1954; Vaughan, 1972; Harrison, 1972), or vibrations in densely packed sand. Lay's (1972) data show a high correlation between specialization in audio-sensitivity and environmental aridity. Beecher (1969) suggested that, in addition to promoting better hearing, air trapped in the sinuses of the middle ear provided an accessory motion sense in saltatorial forms.

Soles of the feet of sand-dwelling mammals are usually covered with hair. This characteristic is thought to be advantageous for movement on sand. Hairy-footed rodents never penetrate the soft, salty, clinging soils of salt marshes, as do the bare-footed dipodils; nor do they climb rock walls and leap from boulder to boulder, like the latter and the agile spiny mice. However, bare-footed dipodils and gerbils with partially furred soles (e.g., *Dipodillus campestris*, *D. henleyi*, *D. amoenus*, *Meriones* sp., and *Psammomys obesus*) are commonly found on sandy substrates.

The paleness of desert mammals appears not to be primarily protective, but a result of the physiological effect of dry heat on the development of pigments (Bodenheimer, 1935).

The physical, behavioral, and physiological adaptations of desert mammals which enable them to avoid dehydration and the ability of some rodents to metabolize water are well known (Schmidt-Nielsen and Schmidt-Nielsen 1949 et seq.; Cloudsley-Thompson, 1954; Cloudsley-Thompson and Chadwick, 1964; Schmidt-Nielsen, K., 1964; Harrison, 1964; Mountfort, 1965; Hills, 1966; McGinnies et al., 1968; Vaughan, 1972; Prakash and Ghosh, 1975). Further discussion herein on the subject are in sections on climate, dew, water and desert life, and under individual mammal species.

SYNOPSES OF REPRESENTATIVES IN ORDERS OF RECENT EGYPTIAN LAND MAMMALS

Order I. Insectivora.—Hedgehogs and Shrews. Pelage spinous or soft. Muzzle forming flexible snout beyond mouth. Feet plantigrade, palm and sole naked, toes usually five. Tympanic bone annular, not fused to skull. First upper and lower incisors protruding, canines unmodified, molars tuberculosectorial (crushing-piercing). Two families in Egypt, p. 57.

Order II. Chiroptera.—Bats and Flying Mammals. Membranes extending between elongated fingers, fore limbs and body, legs and tail. The most recent treatments of this group in Egypt are Sanborn and Hoogstraal (1955), Hoogstraal (1962), and Zein el Din and Hafez (1959). Additional references are Wassif (1946b, 1948, 1949, 1950, 1951, 1953b, 1960ab, 1962, 1971), Wassif and Madkour (1963, 1969a, 1969b, 1972abc), Madkour (1961), De Blase (1972), and Gaisler et al. (1972, 1973).

Order III. Lagomorpha.—Hares. Pelage very soft. Ear extremely long, lower margin of external opening above level of crown of head. Hind limb considerably longer than fore limb in Egyptian forms. Tail short. Feet digitigrade, four functional toes, one vestigial. Claws, palm, and sole concealed by fur. Skull rodent-like, except for fenestrated facial portion of maxilla. Incisive foramina extremely long, bony palate very short, postorbital process broad and triangular in outline. Incisors continuously growing; two upper pairs and one lower. Canines absent, long diastema between incisors and premolars. Check teeth six above, five below; occlusal surfaces elliptical. One family and one genus in Egypt, p. 84.

Order IV. Rodentia.—Mice, Rats, Jerboas, Jirds, Gerbils, etc. Pelage usually soft, spinous in two genera (*Acomys* and *Hystrix*). Feet plantigrade to unguiculate; toes usually five, number reduced in Dipodidae; palm and sole naked or haired. One pair only of upper and lower continuously growing, chisel-shaped incisors. Canines absent. Long diastema between incisors and molariform teeth.

Check teeth three-four, upper and lower; cusp pattern variable, Six families in Egypt, p. 94.

Order V. Carnivora.—Foxes, Jackals, Cats, Hyenas, Weasels, Civets, etc. Great diversity of external form. Feet plantigrade to digitigrade, toes four or five. Mandible with condyle transversely elongate. Three pairs of upper and lower incisors. Canines long, slightly recurved, pointed; p^4 and m_1 modified as carnassials or flesh-cutting teeth. Five families in Egypt, p. 359.

Order VI. Hyracoidea.—Hyraxes. Size and appearance hare-like except for small ear and absence of tail. Feet broad, plantigrade; fore foot four-toed, hind foot three-toed; nails flat except for curved claw on inner hind toe. One pair of tusk-like continuously growing upper incisors separated by a gap, triangular in cross section, tips pointed. Two pairs of rooted lower incisors, chisel-shaped with edges pectinate. Canines absent. Long diastema between upper incisors and premolars. Premolars and molars dissimilar. Check teeth seven, crushing-type with low cusps and ridges. One family and one genus in Egypt, p. 460.

Order VII. Perissodactyla.—Asses. Feet unguligrade with single functional toe-bearing hoof. Remnants of metacarpals and metatarsals two and four as splint bones. Preorbital part of skull and diastema elongate. Upper canine small and in diastema between incisors and premolars. Lower canine incisiform. Premolars and molars alike, hypsodont, crowns squarish, complexly ridged. One family and one genus in Egypt, p. 470.

Order VIII. Artiodactyla.—Pigs, Hippopotamuses, Oryxes, Addaxes, Hartebeests, Gazelles, Ibex, and Barbary Sheep. Feet unguligrade, usually with two functional and two lateral rudimentary digits bearing hoofs; sometimes with four functional toes. Horns present in both sexes in family Bovidae. Upper incisors and canines absent in Bovidae. Lower canines usually incisor-like; upper canines may be modified. Diastema usually present between lower canines and premolars. Premolars simpler than molars. Cheek teeth five-seven, bunodont to selenodont, brachydont to hypsodont. Three families known to have occurred in Egypt, p. 475.

ORDER INSECTIVORA

KEY TO FAMILIES OF EGYPTIAN INSECTIVORES

1. Size large, head and body length average 200 mm. Pelage spinous. Ear large. Zygomatic arch complete..... Family 1. Erinaceidae, p. 57.
2. Size smaller, head and body length 44-118 mm. Pelage soft. Ear small. Zygomatic arch incomplete..... Family 2. Soricidae, p. 71.

Family 1. Erinaceidae

Hedgehogs. Large insectivores, head and body length average 200 mm. Pelage spinous. Ear large. Zygomatic arch complete, parapterygoid plate and fossa present, tympanic bulla partially developed, mandible with one condylar articulation. First upper incisor caniniform, m^1 and m^2 with four subequal cusps. Dental formula: $\frac{3}{2}, \frac{1}{1}, \frac{2-3}{2}, \frac{3}{3} \times 2 = 34$ or 36.

KEY TO EGYPTIAN GENERA OF ERINACEIDAE

1. Spines on forehead not parted. Belly white. Pterygoid and bulla normal..... *Hemiechinus*, p. 57.
2. Spines on forehead parted. Belly not all white. Pterygoid inflated, cavity communicating with bulla..... *Paraechinus*, p. 64.

Genus **Hemiechinus** Fitzinger, 1866

Ears proportionately large. Forehead without bare gap in spines. Tips of dorsal spines pale. Face pale brown, belly and feet whitish. Pterygoid fossa not invaded by tympanic cavity. First upper incisors proodont. Dental formula: $\frac{3}{2}, \frac{1}{1}, \frac{3}{2}, \frac{3}{3} \times 2 = 36$.

Hemiechinus auritus (Gmelin, 1770)

Erinaceus auritus Gmelin, 1770, Nov. Comment. Acad. Sci. Petropoli, 14, p. 519.

Type locality.—U.S.S.R.: ASTRAKHAN.

General distribution.—Mongolia, Chinese Turkestan, India, Afghanistan, Iran, Iraq, Ukranian S.S.R., Transcaspia, Transcaucasia, southern U.S.S.R., Asian Turkey, Cyprus, northern parts

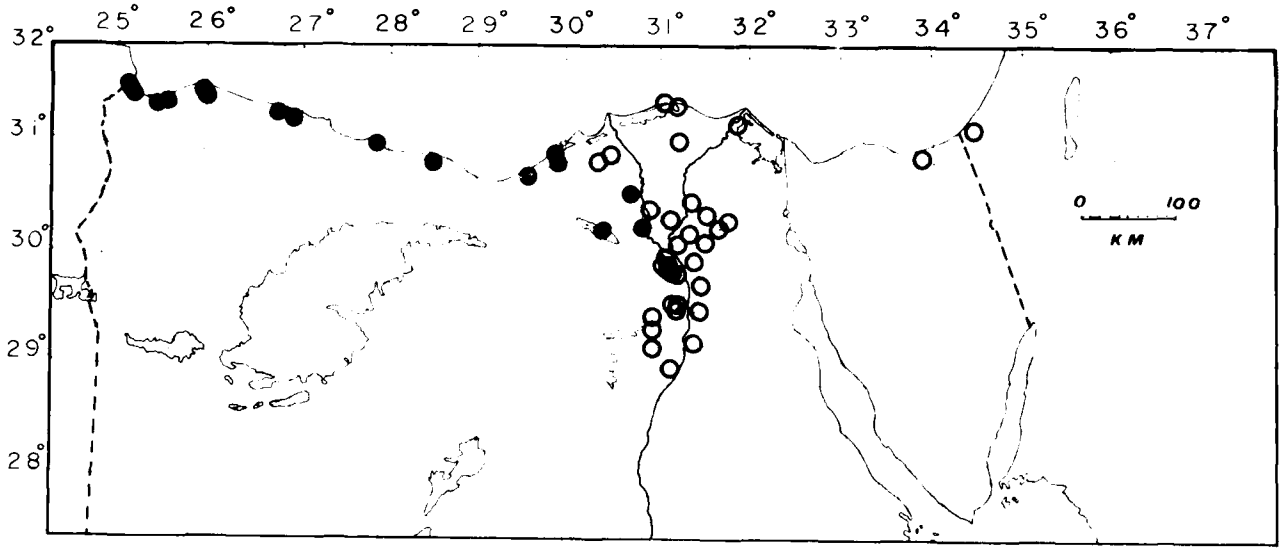


FIG. 23. Collection localities of *Hemiechinus auritus aegyptius* (circles) and *H. a. lybicus* (dots).

of Arabian Peninsula, Syria, Jordan, Israel, Sinai Peninsula, Egypt, Libya.

Common names.—Long Eared Hedgehog, *Qunfid, Abu Ghunfis.*

Distribution of subspecies in Egypt.—Figure 23. *Hemiechinus auritus aegyptius:* Northern Sinai Peninsula, northern part of Eastern Desert, Nile Delta, Nile Valley south to Samalut, and El Faiyum; *Hemiechinus auritus libycus:* Wadi el Natroun and Western Mediterranean Coastal Desert.

Diagnosis.—Small hedgehog with long ears. Face pale brown, belly white. Tips of dorsal spines white. Gap in spines of forehead lacking. Pterygoid not inflated nor communicating with tympanic cavity. First upper incisors proodont.

Adult head and body length average 181 mm., tail 24 mm., foot 35 mm., ear 41 mm., skull length 44.7 mm.

External characters.—Dorsal spines white tipped, with buffy terminal band, and brownish bases. Face and forehead pale brown. Venter white. Feet whitish to pale brown. Ear large, whitish. Gap in forehead spines lacking.

Cranial characters.—Figure 24. Premaxillary and frontal bones never in contact. Postpalatal bridge straight. Pterygoid not inflated. Post-glenoid process of squamosal and mastoid process subequal, not inflated.

Dental characters.—First upper incisors proodont. Last lower premolar lacking medial tubercle, but with posterior accessory cusp present in 62 per cent of specimens examined.

Measurements.—Table 2. Male and female dimensions are subequal. Flower (1932) gave the weights of two specimens as 0.4 and 0.5 kg.

Comparisons.—*Hemiechinus auritus* is distinguishable from other Egyptian hedgehogs by smaller dimensions (tables 2, 3), paler color, lack of a gap in forehead spines, proodont first upper incisors, and pterygoid inflation nil.

Variation.—Specimens from the Nile Delta and Valley and El Faiyum are generally darker than those from desert localities. A specimen from northern Sinai is paler than any from the Eastern Desert. Specimens from the Western Mediterranean Coastal Desert have the auditory bulla slightly more inflated. An accessory

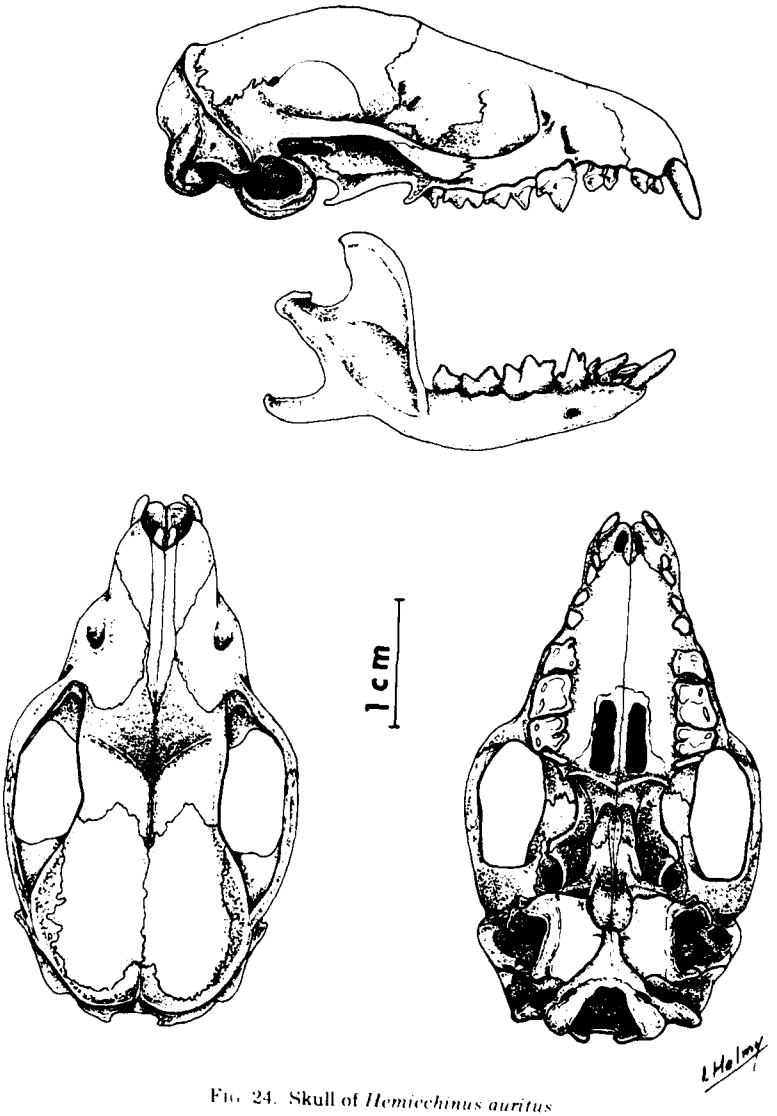


FIG. 24. Skull of *Hemiechinus auritus*

TABLE 2. — Means (and ranges) of measurements followed by number of specimens of adult *Hemiechinus auritus*.

	H. a. aegyptius	*H. a. libycus*
HBL	179.1 (156-206) 35	182.6 (136-206) 19
TL	24.6 (18-39) 36	21.8 (15-26) 19
FL	35.9 (28-39) 37	34.2 (32-38) 19
EL	41.0 (34-45) 37	41.0 (38-45) 19
CBL	44.6 (42.5-46.7) 32	45.0 (42.2-47.5) 19
ZW	26.5 (24.1-29.7) 32	25.9 (24.7-27.8) 18
POW	11.0 (10.2-11.7) 33	11.3 (10.5-11.8) 19
RW	9.8 (9.1-10.7) 33	10.0 (9.4-10.7) 19
BCW	21.3 (20.1-22.8) 33	21.2 (20.2-22.5) 19
NL	14.8 (12.4-16.3) 33	15.9 (14.1-17.5) 18
PPF	6.2 (5.0-6.8) 33	6.6 (5.5-7.2) 19
SH	11.6 (10.6-12.5) 32	11.8 (10.8-12.4) 19

TABLE 3. — Means (and ranges) of measurements and weight of *Paraechinus deserti*, *P. aethiopicus*, and *P. dorsalis*.

	P. d. deserti	*P. a. aethiopicus*	*P. d. dorsalis*
HBL	215.0 (192-226) 5	196.1 (169-217) 7	199.0 (182-228) 10
TL	21.6 (19-29) 5	19.1 (15-22) 7	20.6 (13-30) 9
FL	33.4 (31-35) 5	32.8 (30-37) 7	34.4 (32-36) 10
EL	50.8 (45-58) 5	43.6 (41-45) 7	49.8 (44-55) 7
Wt	285, 380	500	— —
CBL	50.2 (49.0-52.2) 3	47.0 (46.3-48.1) 3	49.8 (48.1-53.3) 10
ZW	30.4 (30.1-30.6) 3	26.8, 29.3	28.9 (27.9-30.0) 9
POW	11.8 (11.5-12.1) 3	10.3 (10.0-10.5) 4	11.3 (10.9-12.1) 10
BCW	27.5 (26.9-27.9) 3	25.6 (24.7-26.8) 3	24.9 (23.7-26.2) 10
RW	11.5 (11.2-12.0) 3	10.8 (10.3-11.4) 4	10.8 (10.1-11.9) 10
NL	14.0, 15.7	16.5 (14.4-17.8) 4	17.1 (15.9-18.2) 9
PPF	6.4 (6.2-6.6) 3	5.8 (5.4-6.1) 4	6.0 (5.0-7.1) 10
SH	13.5 (13.0-14.2) 3	12.0 (11.5-12.4) 4	12.4 (11.7-13.3) 10

posterior cusp on pm_3 occurred in 28 (70 per cent) of 40 specimens of *H. a. libycus* and in 18 (52 per cent) of 34 *H. a. aegyptius*.

Collection.—Dug occasionally from shallow burrows, but usually found in buildings, crevices in walls, brick and stone piles, small caves (Hoogstraal, 1962), graveyards, and burrows of fat sand rats (*Psammomys obesus*) in salt marsh habitat.

Habitats.—Gardens, olive groves, cultivated areas, and more densely vegetated areas of the Coastal Desert (fig. 7). As noted above, this hedgehog is everywhere associated with human activities. It is never found in scantily vegetated desert (Hoogstraal,

1962) and is not a true desert hedgehog (Harrison, 1964) like species of *Paraechinus*.

Reasons for lack of hedgehogs in the Nile Valley south of Samalut, as mentioned by Hoogstraal (1962), remain obscure.

Habits.—Nocturnal. According to Flower (1932), it is very noisy when fighting and "growls" when alarmed or angry.

Food.—Said to eat grapes in some parts of the Nile Delta (Wassif, 1953a), thought to be mainly insectivorous (Harrison, 1964) or omnivorous (Hoogstraal, 1962). Laboratory specimens kill and eat adult white mice.

Reproduction.—Flower (1932) listed litters of one and two young found in May and five in August.

Sex ratio.—A museum sample of 90 specimens contained 50 (55.5 per cent) males and 40 females.

Remarks.—Two species of hedgehogs, *H. auritus* and *Paraechinus aethiopicus*, have been distinguished from illustrations in tombs of Giza Pyramid area, Abu Sir, and Sakkara (Anderson, 1902; Wassif, 1954b).

KEY TO EGYPTIAN SUBSPECIES OF *Hemiechinus auritus*

1. Color darker, average tail length longer, bulla smaller, mesopterygoid space deeper. . . . . *aegyptius*, p. 62.
2. Color paler, average tail length shorter, bulla larger, mesopterygoid space shallower. . . . . *libycus*, p. 63.

Hemiechinus auritus aegyptius (Fischer, 1829)

Hemiechinus aegyptius Fischer, 1829, Synopsis Mammalia, p. 262.

Type locality.—CAIRO: Cairo area.

Distribution in Egypt.—Figure 23. Northern Sinai Peninsula, northern part of Eastern Desert, Nile Delta, Nile Valley south to Samalut, and El Faiyum. Listing of southern Sinai by Flower (1932) was without documentation.

External characters.—Dorsal color variable but generally darker than in *libycus*. Tail averages longer and postpalatal foramen shorter than in the latter (table 2).

Cranial characters.—Bulla slightly less inflated and mesopterygoid space slightly deeper than in *libycus*.

Dental characters.—Accessory posterior cusp on pm_2 was found in 52 per cent of *aegyptius* and 70 per cent of *libycus*.

Remarks.—Characters listed by Setzer (1957b) as diagnostic of *H. a. metwallyi* ssp. nov. are considered to be too obscure, and all such specimens are placed in subspecies *aegyptius*.

Material from Sinai Peninsula is considered tentatively to be *aegyptius*.

Specimens examined.—Total 48.

SINAI: El Arish (1).
CAIRO: Cairo 10 km. E (1), Maadi (1).
DAQAHLIYA: Mit Ghamr (1).
DAMIETTA: Damietta (1).
SHARQIYA: Tel el Kebir (1), Tel Basta (6), Bilbeis (1), Abu Hammad (1).
KAFR EL SHEIKH: Baltim (2).
MINUFIYA: Quweisna (1), Dinshawi (1).
QALYUBIYA: El Barada (1), Kafr Abu Sir (1), Kafr el Shobak (1), El Marq (1).
BEHEIRA: Damanhour (3), Hafs (1).
GIZA: Abu Rawash (3), El Kuraimat (3), Mit Riheina (1), Sakkara (2), Minshat el Bakkari (1), El Badr Shein (1), Giza Pyramid area (1), El Mansuriya (1), Cairo-Alexandria desert road km. 4 (1), Beni Yusef (4).
BENI SUEF: Beni Suef (1).
MINYA: Samalut, Qulugan (1).
EL FAIYUM: Qasr Rashwan (1), Seila (1).

Published records.—Records are from Flower (1932), Wassif (1953b), Setzer (1957b), and Bodenheimer (1958).

SINAI: Gaza, El Arish.
SHARQIYA: Tel Basta, Tel el Kebir, Abu Hammad.
QALYUBIYA: Kafr el Shobak, Kafr Abu Sir, El Barada, El Marq.
KAFR EL SHEIKH: El Burg N of Baltim, Baltim, Biyala.
MINUFIYA: Quweisna, Dinshawi.
DAQAHLIYA: Mit Ghamr.
CAIRO: Cairo 10 km. E, Maadi, Helwan.
GIZA: Kafr Ammar, Giza Pyramid area, Sakkara, El Kuraimat, Kafret el Gabel, El Badrshein, Minshat el Bakkari, Minyet el Sultan, Mit Riheina, Abu Rawash.
EL FAIYUM: Qasr Rashwan, Kom O Shim, Seila.
BENI SUEF: Beni Suef.

Hemichinus auritus libycus (Ehrenberg, 1833).

Erinaceus libycus Ehrenberg in Hemprich and Ehrenberg, 1833, Symbolae Physical Mamm., Dec. 2, sheet k (footnote).

Type locality.—Desert near Alexandria.

Distribution in Egypt.—Figure 23. Wadi el Natroun and Western Mediterranean Coastal Desert.

External characters.—Dorsal color generally paler than in *aegyptius*. Tail averages shorter than in the latter and postpalatal foramen longer (table 2).

Cranial characters.—Bulla slightly more inflated and mesopterygoid space slightly shallower than in *aegyptius*.

Dental characters.—See under *H. a. aegyptius*.

Specimens examined.—Total 46.

ALEXANDRIA: Ramleh 40 km. W (1), Amiriya (3).
BEHEIRA: Kom Hamada (1), Wadi el Natroun (2).
MATRUH: Burg el Arab (14); El Daba (1); Ras el Hekma (1); Mersa Matruh (6), 1.6 km. E (4), 60 km. W (1); Ageeba (1); Sidi Barrani (7), 1.6 km. S (1), 55 km. W (1); Salum 4.8 km. E (2).

Published records.—Records are from Setzer (1957b) and Hoogstraal (1962).

ALEXANDRIA: Ramleh 40 km. W.
BEHEIRA: El Birigat 1 km. W, Wadi el Natroun.
MATRUH: El Amiriya; Bahig; Burg el Arab; El Daba; Ras el Hekma; Mersa Matruh, 1.6 km. E, 60 km. W; Sidi Barrani, 55 km. W, 1.6 km. S; Salum 66 km. E, 50 km. E.

Genus **Paraechinus** Trouessart, 1879

Forehead spines divided by bare gap. First upper incisor not proodont. Tympanic bulla large, cavity communicating with pterygoid. Dental formula: $\frac{3}{3}, \frac{1}{1}, \frac{2-3}{2}, \frac{3}{3} \times 2 = 34$ or 36.

KEY TO EGYPTIAN SPECIES OF *Paraechinus*

1. Belly dark medially only. Face partly white. Postpalatal bridge straight.
   a. Tips of dorsal spines pale. Premaxilla contacting frontal. Posterior lower premolar with small medial cusp or metaconid. (Western Mediterranean Coastal Desert) ..... *deserti*, p. 64.
   b. Tips of dorsal spines dark. Premaxilla not contacting frontal. Posterior lower premolar lacking medial cusp. (Southern part of Eastern Desert) ..... *aethiopicus*, p. 68.
2. Belly black. Face blackish. Tips of dorsal spines dark. Postpalatal bridge V-shaped (Sinai Peninsula) ..... *dorsalis*, p. 70.

Paraechinus deserti (Loche, 1858)

Erinaceus deserti Loche, 1858, Cat. Mamm. Oiseaux Algerie, p. 20.

Type locality.—Algeria: Oases of Beni Mzab, Ouargla, and Tuggurt.

General distribution.—Egypt, Libya, Tunisia, Algeria, and Morocco.

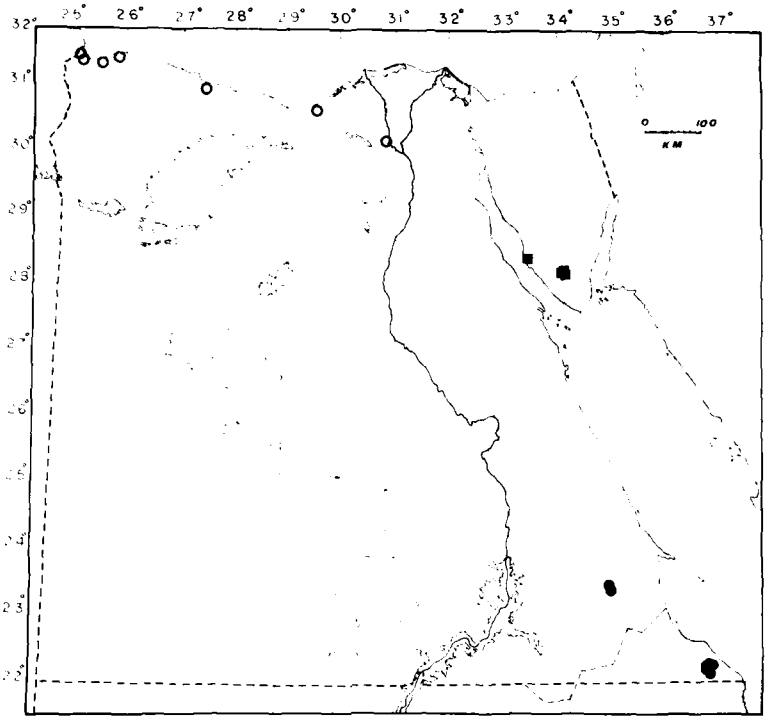


FIG. 25. Collection localities of *Paraechinus deserti deserti* (circles), *P. aethiopicus aethiopicus* (dots), and *P. dorsalis dorsalis* (squares).

Common name.—Desert Hedgehog.

Subspecies in Egypt.—

Paraechinus deserti deserti (Loche, 1858)

Type locality.—See under species.

Distribution in Egypt.—Figure 25. Northwestern margin of Nile Delta and Western Mediterranean Coastal Desert.

Diagnosis.—Tips of dorsal spines pale. Face partly white. Large brown area on belly. Parapterygoid slightly inflated, fossa deep. Posterior lower premolar with small medial cusp.

Head and body length average 215 mm., tail 22 mm., foot 33 mm., ear 50 mm., skull length 50.2 mm.

FIG. 26. Ventral view of *Paraechinus aethiopicus aethiopicus*.

External characters.—Dorsal spines with terminal band white (3 to 4 mm.), subterminal band blackish (4 to 5 mm.), basal bands white (4 to 6 mm.) and grayish (5 to 7 mm.) (Setzer, 1957b). Face brownish anteriorly, frontal area whitish. Chin and throat white, belly white with brown patches. Ear, legs, and feet brownish.

Cranial characters.—Figure 27. Nasal processes of frontal and premaxilla usually in contact. Postpalatal bridge straight to slightly wing-shaped. Bulla moderately inflated, parapterygoid slightly swollen; cavities in communication. Parapterygoid fossa deep.

Teeth.—Posterior lower premolar (p_2) with small medial cusp.

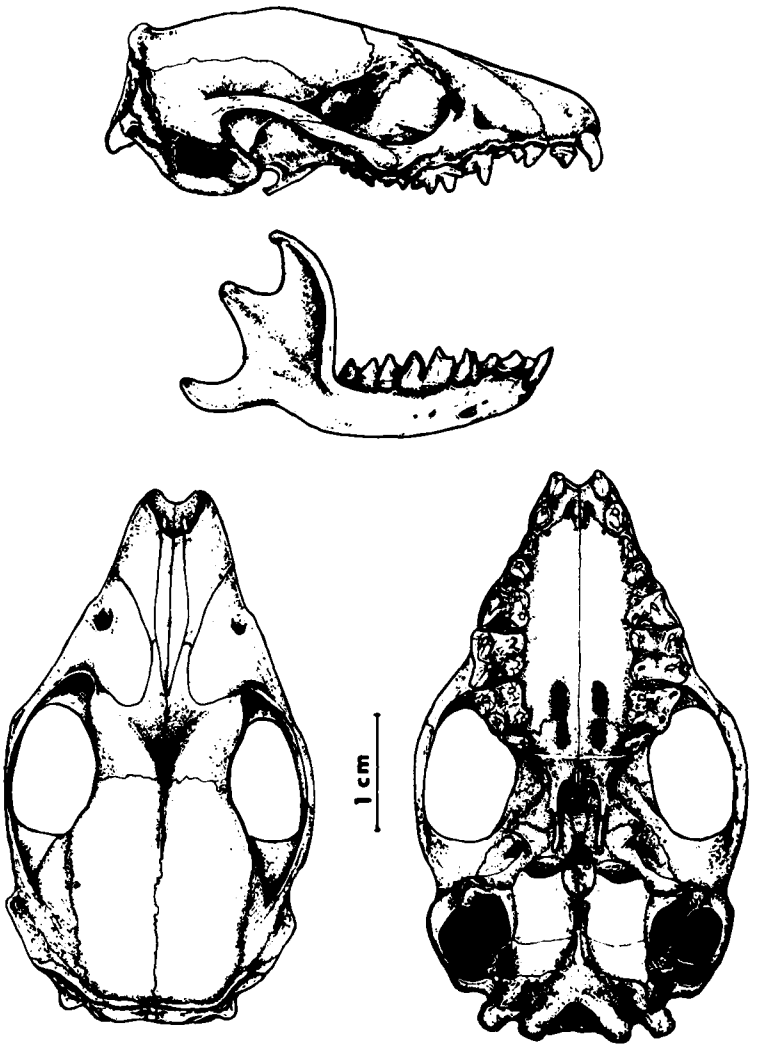


FIG. 27. Skull of *Paraechinus deserti deserti*.

Measurements.—Table 3. Male and female dimensions appear to be subequal.

Variation.—Considerable variation with age occurs in the swelling of bulla and parapterygoid.

Remarks.—Smaller dimensions, together with less inflation of parapterygoid and auditory bulla were used as characters by Setzer (1957b) in describing *P. d. wassifi* subsp. nov. Unfortunately, he was unaware of the fact that inflation in these structures increases with age. Further comparison between specimens of comparable ages indicated that all specimens previously recorded as *P. d. wassifi* (Setzer, 1957b; Hoogstraal, 1962) are *P. d. deserti.*

Paraechinus d. deserti is rare and localized in Egypt (Hoogstraal, 1962).

Comparisons.—*Paraechinus d. deserti* differs from other Egyptian paraechine hedgehogs in having dorsal spines with whitish tips instead of brown, nasal processes of frontal and premaxilla in contact, less inflated pterygoids, smaller bulla, and a medial cusp on p_2.

Specimens examined.—Total eight.

BEHEIRA: El Birigat 3 km. W (2).
MATRUH: El Hammam 20 km. S (1); Qara road E of Mersa Matruh (1); Sidi Barrani 33 km. W (1); Salum (1), 66 km. E (1), 6.6 km. E (1).

Published records.—Records are from Wassif (1954b), Setzer (1957b), and Hoogstraal (1962).

BEHEIRA: El Birigat 3 km. W.
MATRUH: Sidi Barrani 33 km. W; Salum, 66 km. E, 6.6 km. E.

Habitats.—Collected from a burrow in barren sandy-clay hills and barren desert west of El Birigat (Wassif, 1953a), vegetated areas of the Western Mediterranean Coastal Desert (fig. 7), and a garden in Salum.

Habits.—Nocturnal. Very little is known about this hedgehog.

Reproduction.—Wassif (1953a) found a lactating female in June.

Paraechinus aethiopicus (Ehrenberg, 1833)

Erinaceus aethiopicus Ehrenberg *in* Hemprich and Ehrenberg, 1833, Symbolae Physical Mamm., Dec. 2, sheet k (footnote).

Type locality.—Sudan. NORTHERN: Dongola Desert.

General distribution.—Egypt, Sudan, Eritrea, Somalia, Asben, Algeria, Morocco, and Mauretania.

Common name.—Ethiopian Hedgehog.

Subspecies in Egypt.—

Paraechinus aethiopicus aethiopicus (Ehrenberg, 1833)

Type locality.—See under species.

Distribution in Egypt.—Figure 25. Southern part of Eastern desert.

Diagnosis.—Tips of dorsal spines dark. Face partly white. Central part of belly dark brown. Feet and legs dark brown. Parapterygoid strongly inflated, fossa obliterated.

Head and body length average 196 mm., tail 19 mm., foot 32 mm., ear 44 mm., skull length 47.0 mm.

External characters.—Figure 26. Dorsal spines blackish-brown with light brown tips. Anterior of face, lower lip, chin, large area on throat and center of belly, genital region, legs, and outside of ear dark brown. Frontal area of head and most of throat and belly white. Inside of ear white in some individuals.

Cranial characters.—Nasal processes of frontal and premaxillary widely separated. Postpalatal bridge straight. Bulla enormously inflated, alisphenoid and parapterygoid hollow and inflated. Parapterygoid fossa obliterated.

Teeth.—Posterior lower molar without small medial cusp.

Measurements.—Table 3. Male and female dimensions are subequal.

Comparisons.—*Paraechinus aethiopicus* differs from other Egyptian paraechine hedgehogs in having generally smaller average dimensions, particularly ear length (table 3). In color, *aethiopicus* is darker than *deserti*, paler than *dorsalis*. The postpalatal margin is straight in *aethiopicus*, V-shaped in *dorsalis*. Comparisons with *deserti* are under the latter.

Specimens examined.—Total nine.

RED SEA: Wadi Naam (1).
SUDAN ADMINISTRATIVE: Wadi Akwamtra (1); Bir Kansisrob (2), 1.6 km. N (1), 5 km. N (2); Wadi Kansisrob (1); Wadi Allaqi, about 22° N lat., 35° E long. (1).

Published records.—Records are from Setzer (1957b), Hoogstraal et al. (1957b), and Hoogstraal (1962).

RED SEA: Wadi Naam near Bir Abraq.

SUDAN ADMINISTRATIVE: Bir Kansisrob 1.6 to 5 km. N, Wadi Abu Saala (remains), summit of Gebel Elba (remains).

Habitats.—Collected in burrows under dense stands of vegetation or large shrubs on coastal plain and in rocky wadis.

Habits.—Nocturnal. Very little is known about this species, particularly in Egypt.

Paraechinus dorsalis (Anderson and De Winton, 1901)

Erinaceus dorsalis Anderson and De Winton, 1901, Ann. Mag. Nat. Hist., (ser. 7), 7, p. 42.

Type locality.—Saudi Arabia: Hadramaut.

General distribution.—Iraq, Saudi Arabia, Lebanon, Jordan, Israel, and Sinai Peninsula.

Common name.—Desert Hedgehog.

Subspecies in Egypt.—

Paraechinus dorsalis dorsalis (Anderson and De Winton, 1901)

Type locality.—See under species.

Distribution in Egypt.—Figure 25. Sinai Peninsula.

Diagnosis.—Dorsal spines blackish. Face, belly, and limbs blackish. White mark on throat. Postpalatal bridge V-shaped. Parapterygoid inflated, fossa obliterated.

Head and body length average 199 mm., tail 20 mm., foot 34 mm., ear 50 mm., skull length 49.8 mm.

External characters.—Dorsal spines blackish, flank spines with brownish tips. Face and forehead all black. Chin and throat black, latter with white band sometimes extending to base of ear. Venter and limbs black.

Cranial characters.—Nasal processes of premaxilla and frontal sometimes in contact. Postpalatal bridge V-shaped. Bulla greatly inflated, alisphenoid and parapterygoid hollow and inflated. Parapterygoid fossa obliterated by inflation.

Teeth.—Posterior lower molar with vestigial medial cusp. Second upper premolar reduced or absent.

Measurements.—Table 3. Male and female dimensions are subequal.

Comparisons.—*Paraechinus dorsalis* differs from other Egyptian

hedgehogs in having color generally darker, white areas smaller, postpalatal margin V-shaped, bulla more inflated. Pterygoids are, incidentally, slightly less inflated than those in *P. aethiopicus*.

Specimens examined.—Total 10.

SINAI: Wadi el Sheikh (2), St. Catherine Monastery area (5), Wadi Raha (2), Feiran Oasis 1.6 km. N (1).

Published records.—Records are from Wassif and Hoogstraal (1954), Setzer (1957b), and Hoogstraal (1962).

SINAI: St. Catherine Monastery and vicinity, Wadi Raha, Feiran Oasis 1.6 km. N.

Habitats.—Occurs from lowland to high elevations in Sinai Peninsula and in gardens near St. Catherine Monastery.

Habits.—Nocturnal. Information on this species is meager.

Family 2. Soricidae

Shrews. Small to large insectivores, head and body length averaging 44 to 118 mm. Pelage soft. Ear small. Zygomatic arch incomplete, parapterygoid plate and fossa absent, tympanic bulla absent, mandible with two condylar articulations. First upper incisor two cusped, m^1 and m^2 with cusps of unequal height. Dental formula: $\frac{3}{2}, \frac{1}{0}, \frac{1-2}{1}, \frac{3}{3} \times 2 = 28$ or 30.

KEY TO EGYPTIAN GENERA OF SORICIDAE

1. Upper unicuspids 3-3 ..... *Crocidura*, p. 71.
2. Upper unicuspids usually 4-4 ..... *Suncus*, p. 80.

Genus **Crocidura** Wagler, 1832

White toothed shrews. Fur short, dense. Ear scarcely protruding beyond fur. Tail with conspicuous and scattered bristle hairs. Teeth unpigmented. Anterior upper incisor with main cusp long, slender, and hooked downward; basal lobe less than one-half height of anterior lobe. Anterior lower incisor without lobes on cutting edge, proodont. Upper unicuspid teeth three. Dental formula: $\frac{3}{2}, \frac{1}{0}, \frac{1}{1}, \frac{3}{3} \times 2 = 28$.

KEY TO EGYPTIAN SPECIES OF *Crocidura*

1. Larger shrews. Head and body length 70 mm. or more, condyloincisive length 15 mm. or more.
   a. Bristle hairs on proximal two-thirds of tail. Venter dark gray. Hind foot 18 mm. or more ..... *flavescens*, p. 73.
   b. Bristle hairs along entire length of tail. Venter whitish. Hind foot less than 13 mm. ..... *suaveolens*, p. 78.

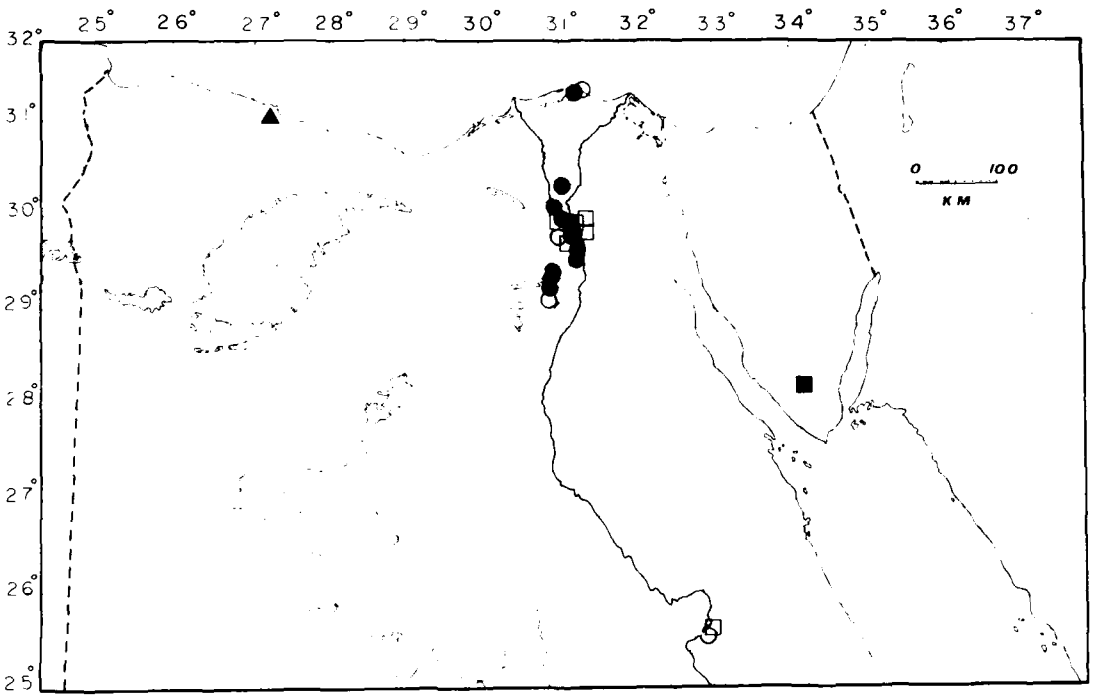


FIG. 28. Collection localities of *Crocidura flavescens deltae* (dots), *C. floweri* (circles), *C. nana* (open squares), *C. suaveolens portali* (solid square), and *C. s. matruhensis* (triangle).

2. Smaller shrews. Head and body length 72 mm. or less, condyloincisive length 20 mm. or less.
   a. Bristle hairs of tail inconspicuous, sparse, limited to proximal one-half. Dorsum brownish. Cranium convex. Hind foot length 12 mm. or more . . . . *floweri*, p. 76.
   b. Bristle hairs of tail conspicuous, numerous. Dorsum grayish. Cranium flat, very small. Hind foot length 10 mm. or less . . . . . *nana*, p. 77.

Crocidura flavescens (I. Geoffroy St.-Hilaire, 1827)

Sorex flavescens I. Geoffroy St.-Hilaire, 1827, Dict. Class. Hist. Nat., p. 324.
Crocidura olivieri Lesson, 1827, Man. Mamm., p. 127.

Type locality.—South Africa, "Le Cafrérie et le pays des Hottentots" (I. Geoffroy St.-Hilaire, 1827), Eastern CAPE PROVINCE: King Williams Town (Roberts, 1951).

General distribution.—Egypt, Sudan, Ethiopia, and the rest of Africa south into South Africa; west Africa north to Sierra Leone.

Common names:—Giant Musk Shrew, *Far, Ersa.*

Subspecies in Egypt.—

Crocidura flavescens deltae Heim de Balsac and Barloy, 1966

Crocidura flavescens deltae Heim de Balsac and Barloy, 1966, Mammalia, **30**, p. 631.

Type locality.—Egypt. No exact locality.

Distribution in Egypt.—Figure 28. Nile Delta and Valley as far south as Dahshur and in El Faiyum.

Diagnosis.—Largest of Egyptian species of *Crocidura*. Dorsum dark brown, venter grayish. Tail slightly darker than dorsum, unicolored; bristles on proximal two-thirds.

Third upper unicuspid larger in transverse section than second.

Adult head and body length average 118 mm.; tail 71 mm., 60 per cent of head and body length; foot 20 mm.; ear 12 mm.; condyloincisive length 28 mm.

External characters.—Dorsum uniform dark brown with silvery sheen shading on lower side to dark gray venter. Some individuals with brownish throat patch. Feet grayish to brown. Tail dark brown, unicolored; bristles on proximal two-thirds. Scent gland on side with whitish hairs. Ear large, almost naked, with pronounced ventral fold.

Cranial characters.—Figure 29. Cranium normal, much larger and heavier than in other Egyptian shrews.

Teeth.—Third upper unicuspid larger in transverse section than

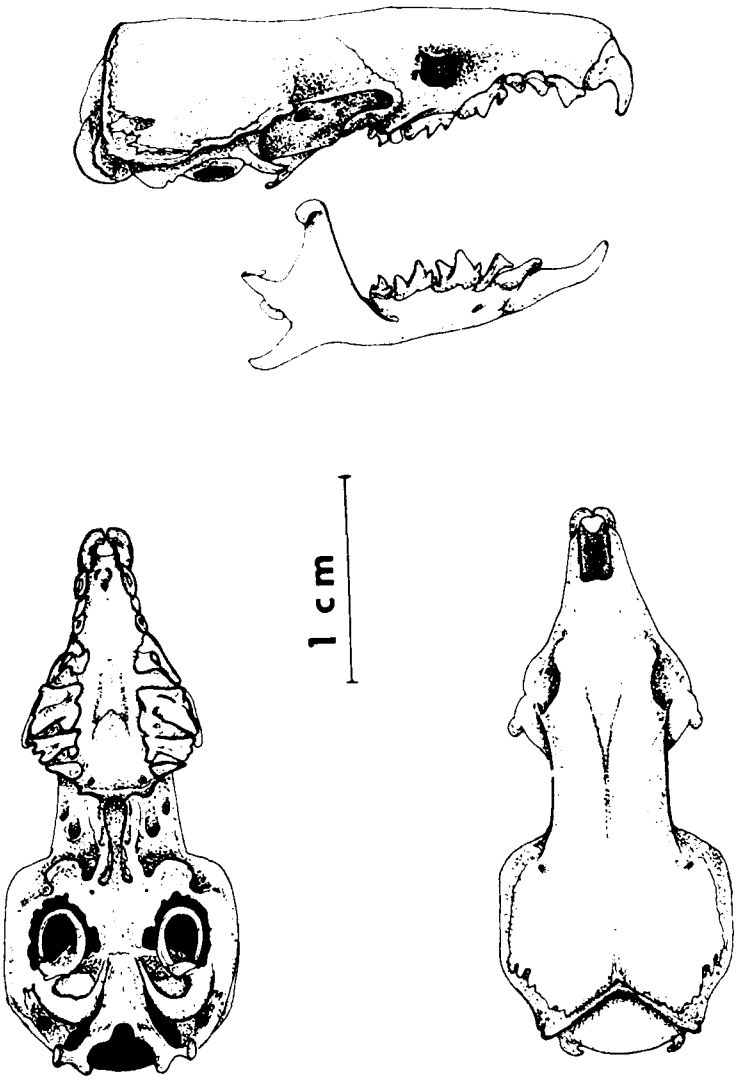
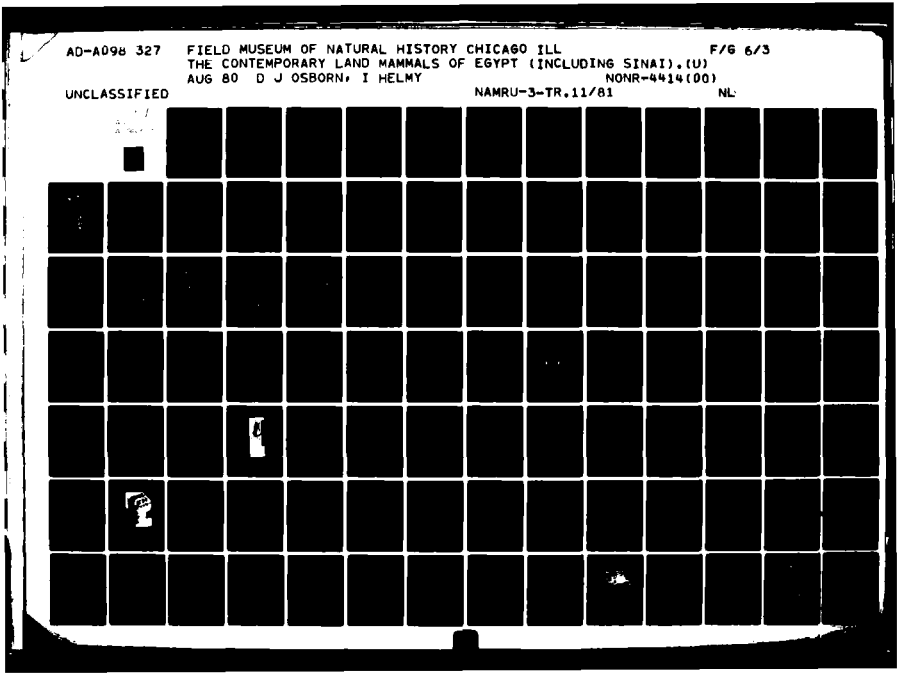


FIG. 29. Skull of *Crocidura flavescens deltae*

AD-A098 327 FIELD MUSEUM OF NATURAL HISTORY CHICAGO ILL F/G 6/3
THE CONTEMPORARY LAND MAMMALS OF EGYPT (INCLUDING SINAI).(U)
AUG 80 D J OSBORN, I HELMY NONR-4414(00)
UNCLASSIFIED NAMRU-3-TR.11/81 NL



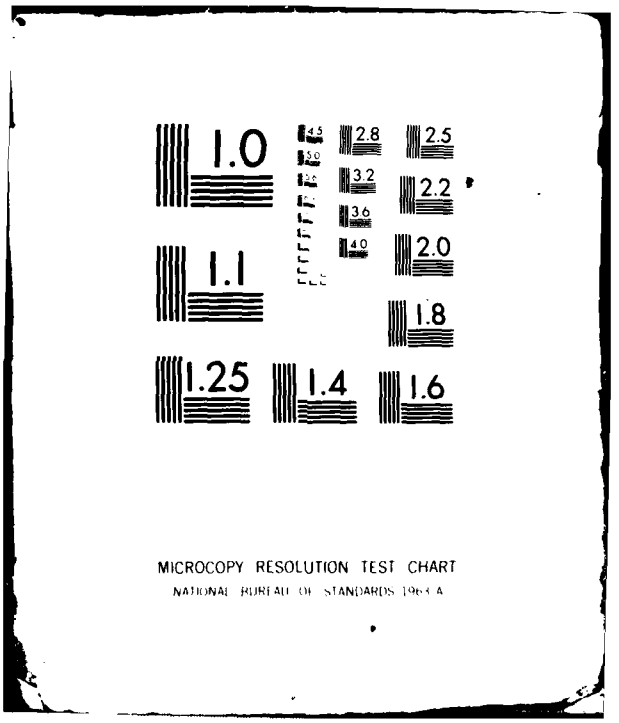

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

TABLE 4. — Means (and ranges) of measurements and ratios of species of *Crocidura*.

	C. floweri	*C. flavescens*	*C. nana*
HBL	(57-71)*	117.8 (106-135) 27	53.8 (48-62) 8
TL	(55-58)*	71.2 (57-84) 27	34.8 (28-40) 8
TL/HBL%	75*	60.6 (45.6-69.0) 27	65.2 (61.0-75.0) 8
FL	(12-13.5)*	20.4 (18-22) 27	9.4 (8.5-10.0) 8
EL	8*	12.8 (11-14) 25	7.0 (5.5-9.0) 7
CIL	18.4 (18.0-19.2) 4	27.9 (26.0-29.6) 26	15.3 (14.4-16.1) 8
RW	5.4 (5.2-5.6) 4	8.8 (8.3-9.3) 28	4.5 (4.3-4.8) 13
BCW	8.0 (7.8-8.4) 4	11.9 (11.2-12.4) 26	6.8 (6.6-7.1) 12
POW	3.8 (3.7-4.0) 4	5.2 (5.1-5.5) 24	3.2 (3.0-3.5) 13
TRL	7.8 (7.6-8.1) 4	12.4 (11.3-13.2) 28	6.2 (5.5-6.7) 12
PL	7.4 (7.3-7.5) 4	12.0 (10.8-12.5) 18	6.4 (5.8-7.2) 9
SH	4.2 (4.1-4.3) 4	6.6 (6.0-7.5) 24	3.4 (3.2-3.7) 6

*Data from Flower (1932).

second. Basal cusp of anterior upper incisor very small. Setzer (1957a) discovered a supernumerary molariform tooth in a specimen from Abu Ghalib.

Measurements.—Table 4.

Comparisons.—*Crocidura flavescens* is the largest of Egyptian shrews. The subspecies *deltae* averages longer in head and body length and shorter in tail length than most other African races.

Remarks.—Ellerman et al. (1953) tentatively united all the larger forms of southern and eastern Africa under *C. flavescens* and included *olivieri* as an outlying race. Setzer (1957b) doubted the correctness of these assignments. Heim de Balsac and Barloy (1966) substantiated the conclusions of Ellerman et al., but proposed the Egyptian form be called *C. f. deltae*, as *olivieri* was inappropriate due to having been applied to a diversity of mummified specimens of unknown origin.

Specimens examined.—Total 104.

DAMIETTA: Damietta (3).

KAFR EL SHEIKH: Baltim (1), 1 km. S (1).

MINUFIYA: Mit Faris (1).

GIZA: Mena House area (6), Tanash (6), El Baragil (4), Abu Rawash (18), Abu Ghalib (9), Nahya (11), Wardan (8), Kirdasa (4), Giza Pyramid area (1), Minshat el Bakkari (1), Kafr Hakim (1), El Mansuriya (10), Manshiyet Radwan (1), Talbia (1), Saft el Laban (3), El Qatta (1), Birqash (1), El Badrshein (1), Dahshur (2).

EL FAIYUM: Minshat Beni Osman (3), Kom O Shim (2), Royal Shooting Club (4).

Published records.—Records are from Anderson (1902), Bonhote (1909), Flower (1932), Setzer (1952, 1957b).

GIZA: Mena House area (6), Tanash (6), El Baragil (4), Abu Rawash (18), Abu Ghalib (9), Nahya (11), Wardan (8), Kirdasa (4), Giza Pyramid area (1), Minshat el Bakkari (1), Kafr Hakim (1), El Mansuriya (10), Manshiyet Radwan (1), Talbia (1), Saft el Laban (3), El Qatta (1), Birqash (1), El Badrshein (1), Dahshur (2).

EL FAIYUM: Minshat Beni Osman (3), Kom O Shim (2), Royal Shooting Club (4).

Habitats.—"Richly weeded canal margins in Nile Delta and Valley" (Hoogstraal, 1962, p. 150); dry wells in summer. A specimen from Zagazig "fell from the talons of an eagle owl shot at by Dr. Walter Innes" (Anderson, 1902, p. 167). Many have been collected in cultivated fields (fig. 6).

Nests.—Nests are balls of grass and always moist (Hoogstraal, 1962).

Food.—Nests sometimes contain insect remains and broken snail shells (Hoogstraal, 1962). Captive shrews kill and eat adult albino *Mus musculus.*

Crocidura floweri Dollman, 1915

Crocidura floweri, Dollman, 1915, Ann. Mag. Nat. Hist., (ser. 8), 15, p. 515 (Actual description in 1916 ibid., (ser. 8), 17, p. 192).

Type locality.—Egypt. GIZA: Giza.

Distribution.—Figure 28. Nile Delta and El Faiyum.

Common name.—Flower's shrew.

Diagnosis.—Small shrew. Dorsum pale cinnamon brown. Venter whitish. Tail bicolored, bristles scattered along proximal one-half. Skull convex. Second and third unicuspids subequal; third overlapping second. Head and body length ranges from 57 to 71 mm.; tail 55 to 58 mm., 75 per cent or more of head and body length; foot 12 to 13.5 mm., ear 8 mm.; and condyloincisive length 17.1 to 19.2 mm.

External characters.—Dorsum and side light cinnamon brown, flank and belly whitish. Tips of belly hairs whitish, bases gray. Feet dirty whitish. Tail bicolored, color of back above, whitish below; thinly haired; bristle hairs grayish white, inconspicuous, scattered, and confined to proximal one-half.

Cranial characters.—Skull normal except slightly more convex than in other Egyptian shrews.

Teeth.—Second and third unicuspids subequal, third overlapping second. According to Heim de Balsac and Mein (1971, p. 238), the molars have a "protometacone union, that is of a metaloph and equally that of a metaconule."

Measurements.—Table 4.

Comparisons.—*Crocidura floweri* is distinguishable from other species of Egyptian *Crocidura* by lack of bristles on distal one-half of tail, and second and third unicuspids subequal.

Remarks.—Practically nothing is known about this shrew. It is rare (Setzer, 1957b) and possibly extinct (Hoogstraal, 1962). Specimens have been collected in fields. One was from the stomach of a cattle egret (Flower, 1932).

Specimens examined.—Total five.

GIZA: Giza (Type, 3).
EL FAIYUM: Faiyum (1).

Published records.—Records are from Flower (1932) and Heim de Balsac and Mein (1971).

KAFR EL SHEIKH: Baltim.
GIZA: Giza.
QENA: Thebes (mummified).

Crocidura nana Dobson, 1890

Crocidura nana Dobson, 1890, Ann. Mag. Nat. Hist., (ser. 6), 5, p. 225.
Sorex religiosus I. Geoffroy St.-Hilaire, 1827, Mem. Mus. Hist. Nat., Paris, 15, p. 128.

Type locality.—Somalia: Dollo.

General distribution.—Egypt and Eastern Africa from Sudan south to Rhodesia.

Common name.—Dwarf Shrew.

Distribution in Egypt.—Figure 28. Nile Delta and possibly Nile Valley.

Diagnosis.—Size very small. Dorsum grayish with tinge of brown. Venter light gray. Tail bicolored, bristles numerous.

Head and body length average 54 mm.; tail 35 mm., 64 per cent of head and body length; foot 10 mm.; ear 7 mm.; condyloincisive length 15.4 mm.

External characters.—Dorsum dull gray with brownish tinge. Flank paler. Venter light gray due to hairs with whitish tips and gray bases. Chin and throat paler than belly. Feet whitish, almost hairless. Tail gray above, whitish below; bristle hairs numerous, whitish.

Cranial characters.—Skull very small, delicate and "flat."

Measurements.—Table 4.

Comparisons.—*Crocidura nana* is distinguishable from other species of Egyptian *Crocidura* on the bases of smaller size, paler color, and flatness of skull.

Remarks.—According to Heim de Balsac and Mein (1971, p. 243), *C. nana* is synonymous with *C. religiosa*, and the latter name should be suppressed because it "did not designate any exact species." *Crocidura religiosa* (I. Geoffroy St.-Hilaire, 1827) was described from mummified material.

Specimens examined.—Total 18.

QALYUBIYA: Qalyub (1).
GIZA: Kafr Hakim (1), Nahya (2), Minshat el Bakkari (1), Abu Rawash (7), Giza (2).
CAIRO: Cairo (4).

Published records.—Records are from Flower (1932), Setzer (1957b), and Heim de Balsac and Mein (1971).

GIZA: Abu Rawash, Kafr Hakim, Nahya.
QENA: Thebes (mummified).

Remarks.—Found "under stones, bricks, and clumps of earth in moist cultivated fields" (Hoogstraal, 1962, p. 150), in canal banks, in dry wells, and under piles of grass, cotton, and corn stalks. A nest of cotton bolls and small sticks was noted on a label.

Crocidura suaveolens (Pallas, 1811)

Sorex suaveolens Pallas, 1811, Zoographia Rosso Asiatica, 1, pl. 9, fig. 2, p. 139.

Type locality.—Southern Russia. Crimea: Khersomes.

General distribution.—Korea, Japan, Mongolia, Siberia, China, Central and Southern U.S.S.R., Europe, Iran, Iraq, Russian Turkestan, Armenian S.S.R., Asian Turkey, Lebanon, Israel, Egypt, Algeria, and Morocco.

Common name.—Lesser White Toothed Shrew.

Distribution of subspecies in Egypt.—Figure 28. *Crocidura suaveolens portali:* Sinai Peninsula; *Crocidura suaveolens matruhensis:* Western Mediterranean Coastal Desert.

Diagnosis.—Small shrew, tail about one-half length of head and body. Dorsum dull brownish gray. Venter and feet whitish. Tail bicolored, bristles scattered along entire length.

Skull lacking distinctive features. Second upper unicuspid smaller than third.

Head and body length ranges from 55 to 72 mm., tail 25 to 40 mm., 38 to 60 per cent of head and body length; foot 10 to 12.5 mm.; condyloincisive length 16.0 to 17.6 mm.

External characters.—Dorsum and side dull brownish gray. Hairs gray with minute brownish tips. Venter and feet whitish. Tail indistinctly bicolored, grayish or brownish above, paler below.

Cranial characters.—No distinctive features.

Teeth.—Large upper premolar with prominent cutting blade and paracone well developed. Second upper unicuspid smaller in crown area than third.

Measurements.—See under diagnosis and subspecies.

Comparisons.—*Crocidura suaveolens* differs from *C. nana* in larger size. From other Egyptian shrews, it differs in having bristles extending along the entire length of tail and the second upper unicuspid smaller than third.

Collection.—*Crocidura suaveolens* has been found in two localities: inside El Arbaein Monastery near St. Catherine Monastery, Sinai Peninsula; and in burrows of fat sand rat (*Psammomys obesus*) in coastal salt marsh near Mersa Matruh (Wassif and Hoogstraal, 1953; Setzer, 1957b, 1960b; Hoogstraal, 1962).

Habits.—This species appears to be adapted to semidesert conditions. It is rare and little known (Harrison, 1964).

EGYPTIAN SUBSPECIES OF *Crocidura suaveolens*

Crocidura suaveolens portali (Thomas, 1920)

Crocidura portali Thomas, 1920, Ann. Mag. Nat. Hist., (ser. 9), 5, p. 119.

Type locality.—Israel: Ramleh.

Distribution in Egypt.—Figure 28. Sinai Peninsula.

Comparison.—*Crocidura s. portali* differs from *C. s. matruhensis* in larger body size and longer tail (Setzer, 1960b).

Collection.—Trapped in old El Arbaein Monastery near St. Catherine Monastery, Sinai.

Measurements.—Measurements from Wassif and Hoogstral (1954) of a female specimen are: head and body length 56 mm.; tail

37 mm., about 66 per cent of head and body; foot 10.5 mm.; ear 7 mm.; occipitonasal length 16.5 mm.

Specimen examined.—Total one.

SINAI: El Arbaein Monastery 9 km. W of St. Catherine Monastery (1).

Published records.—Above-mentioned single specimen is referred to in Wassif and Hoogstraal (1953), Setzer (1957b), Hoogstraal (1962), and Harrison (1964).

Crocidura suaveolens matruhensis Setzer, 1960

Crocidura suaveolens matruhensis Setzer, 1960, J. Egypt. Publ. Health Assn., 35, p. 2.

Type locality.—MATRUH: Mersa Matruh 4.8 km. W.

Distribution in Egypt.—Known only from type locality 4.8 and 1.6 km. W of Mersa Matruh (fig. 28).

Comparisons.—*Crocidura s. matruhensis* differs from *C. s. portali* of Sinai in smaller body size and shorter tail and from *C. s. whitakeri* of Morocco in proportionately shorter tail, 45 per cent of head and body in *whitakeri* and 38 per cent in *matruhensis* (Setzer, 1960b).

Collection.—"Taken in burrows of fat sand-rat, *Psammomys obesus*, in damp, saline depressions just behind the sea" (Setzer, 1960b, p. 3).

Measurements.—Measurements of type, an adult male, are: head and body length 63 mm.; tail 25 mm., 38 per cent of head and body; foot 11 mm.; ear 9.5 mm.; condyloincisive length 17.1 mm. (Setzer, 1960b).

Specimen examined.—Total one.

MATRUH: Mersa Matruh 4.8 km. W (1).

Published records.—Records of above-mentioned specimen and another 1.6 km. W of Mersa Matruh are in Setzer (1960b) and Hoogstraal (1962).

Genus Suncus Ehrenberg, 1833

White-toothed shrews of the genus *Suncus* are distinguishable from *Crocidura* by presence of small fourth upper unicuspid. Body size is minute or very large. Dental formula: $\frac{3}{2}, \frac{1}{0}, \frac{2}{1}, \frac{3}{3} \times 2 = 30$.

KEY TO EGYPTIAN SPECIES OF *Suncus*

1. Size large, head and body length 108-135 mm. Tail thick at base, tapering; not bicolored..... *murinus*, p. 81.

2. Size small, head and body length 40-54 mm. Tail slender, bicolored ..... *etruscus*, p. 82.

Suncus murinus Linnaeus, 1766

Suncus murinus Linnaeus, 1766, Syst. Nat., 12th ed., p. 74.

Type locality.—Java.

General distribution.—New Guinea, Java, Sumatra, Borneo, Celebes, Philippines, Japan, Taiwan, Southeast China, Indochina, Burma, Malay States, Bali, Ceylon, and India; and seaports in Iran, Iraq, Oman, Aden, Yemen, Saudi Arabia, Egypt (Suez), Sudan (Suakin), and possibly Ethiopia.

Common name.—House Shrew.

Subspecies in Egypt.—

Suncus murinus sacer (Ehrenberg, 1833)

Suncus sacer Ehrenberg, 1833, *in* Hemprich and Ehrenberg, Symbolae Physicae Mamm., Dec. 2, folio k.

Type locality.—SUEZ: Suez.

Distribution in Egypt.—A single specimen was captured in a house in Suez.

Diagnosis.—Very large shrew. Tail about one-half length of head and body. Dorsum brown, venter grayish, tail color of back with silvery bristles along entire length.

Skull massive in comparison with other shrews and strongly ridged.

Head and body length average 118 mm.; tail 70 mm., 58 per cent of head and body length; foot 20 mm.; ear 14 mm.; skull length 32.2 mm. (data from Harrison, 1964).

External characters.—Large, rat-sized shrew. Tail thick at base, tapering; slightly more than one-half length of head and body. Dorsum grayish brown, hairs brown-tipped with gray base. Venter grayish white. Line of demarcation between side and belly indistinct. Feet whitish.

Cranial characters.—Skull massive compared with that of other shrews and heavily ridged.

Teeth.—Chief characteristics are large size and presence of four instead of three upper unicuspids as in *Crocidura*..

Comparisons.—*Suncus murinus* is distinguishable from all other

Egyptian shrews by its much larger size, tail being shorter than one-half head and body length and thick at base.

Remarks.—Setzer (1952, p. 345) thought that individual specimens of this shrew from North Africa were "merely fortuitous travelers come ashore from some trading vessel." He omitted discussion of the species (Setzer, 1957b, p. 2), because it is "apparently only infrequently imported from the Indian region and is not a member of the native Egyptian mammal fauna." We are inclined to agree with these conclusions and so does Harrison (1964) with regard to *S. murinus* in the Arabian Peninsula.

Further notes on characters of *S. m. sacer* are in Harrison (1964).

Specimens examined.—None from Egypt. One from Saudi Arabia.

Collection.—Easily trapped with a variety of baits (Sanborn and Hoogstraal, 1953).

Habitats.—Houses and buildings in this area; probably not occurring in nature.

Habits.—Commensal, at least in the Arabian Peninsula, and active at any time of day or night (Sanborn and Hoogstraal, 1953; Harrison, 1964).

Suncus etruscus Savi, 1822

Suncus etruscus Savi, 1822, *Nuovo Giorn de Letterati*, Pisa, 1, p. 60.

Type locality.—Italy: Pisa.

General distribution.—Spain, France, Corsica, Sicily, Sardinia, Italy, Yugoslavia, Hungary, Albania, Greece, Crete, Turkey, Rhodes, Tiflis, Azerbaijan S.S.R., Turkmen S.S.R., Uzbek, Iran, Irak, Israel, Aden, and Egypt (Harrison, 1964; Spitzenberger, 1970).

Common names.—Savi's Dwarf Shrew, Pygmy White Toothed Shrew.

Distribution in Egypt.—Nile Delta.

Diagnosis.—Very tiny shrew. Tail about two-thirds of head and body length. Dorsum grayish to light brown, venter whitish. Tail bicolored with bristles along entire length. Skull minute, flattened, and fragile.

Head and body length average 46 mm.; tail 26 mm., 64 per cent of head and body length; foot 7 mm.; skull length 13.0 mm. (data from Harrison, 1964).

External characters.—One of the smallest shrews. Resembles a dwarf *Crocidura suaveolens.* Tail thin, not tapering, and about two-thirds of head and body length; bicolored, brown above, whitish below. Dorsum light brown to grayish, and hairs with brown tips and gray bases. Venter whitish, hairs with white tips and gray bases. Line of demarcation between side and belly indistinct. Feet whitish.

Cranial characters.—Skull very small and fragile, lacking ridges, and dorsoventrally flattened relative to width.

Teeth.—Chief characteristic is the presence of four instead of three upper unicuspids as in *Crocidura.*

Comparisons.—*Suncus etruscus* is distinguishable from most Egyptian shrews by its small size. It is distinguishable from *Crocidura nana* by having four instead of three upper unicuspids.

Remarks.—Further notes on characters of *S. etruscus* are in Harrison (1964).

Specimens examined.—None from Egypt. One from Israel.

Published records.—Heim de Balsac and Lamotte (1957) discovered a single specimen from the Nile Delta in the Paris Museum.

Habitats.—Known to live in houses in the Mediterranean region, also found in gardens, under stones, and in old walls (Corbet, 1966).

ORDER LAGOMORPHA

Family Leporidae

Genus **Lepus** Linnaeus, 1758

Hares. Ear long, prominent. Hind foot long, slender; sole densely haired. Tail short, black above, white below. Pelage soft, woolly, yellowish to buffy gray.

Skull elongate, convex dorsally. Palate very short, posterior margin opposite PM^3. Mesopterygoid space wider than length of palatine bridge. Incisive foramen very long, broadened posteriorly. Palatal foramen minute. Postorbital process broad and triangular with distinct anterior and posterior projections. Two pairs of continuously growing upper incisors. Upper tooth rows further apart than lower. Dental formula: $\frac{2}{1}, \frac{0}{0}, \frac{3}{2}, \frac{3}{3} \times 2 = 28$.

Lepus capensis Linnaeus, 1758

Lepus capensis Linnaeus, 1758, Syst. Nat., 10th ed., p. 58.

Type locality.—Union of South Africa: Cape of Good Hope.

General distribution.—Britain; Europe eastward through U.S.S.R. into Siberia, Mongolia, and China; Afghanistan, Iran, Iraq, Syria, Turkey, Lebanon, Israel, Jordan, Sinai Peninsula, and Egypt; Sudan west to Río de Oro and south into eastern and southern Africa.

Common names.—Hare, *Arnab.*

Distribution of subspecies in Egypt.—Figure 30. *Lepus capensis sinaiticus:* Sinai Peninsula; *Lepus capensis aegyptius:* northern two-thirds of Eastern Desert; *Lepus capensis isabellinus:* southern one-third of Eastern Desert; *Lepus capensis rothschildi:* Western Desert.

Diagnosis.—Ear and hind foot long, tail relatively short. Pelage soft, yellowish or buffy gray; tail black above, white below. Skull elongate, arched in profile; palate very short; incisive foramen very

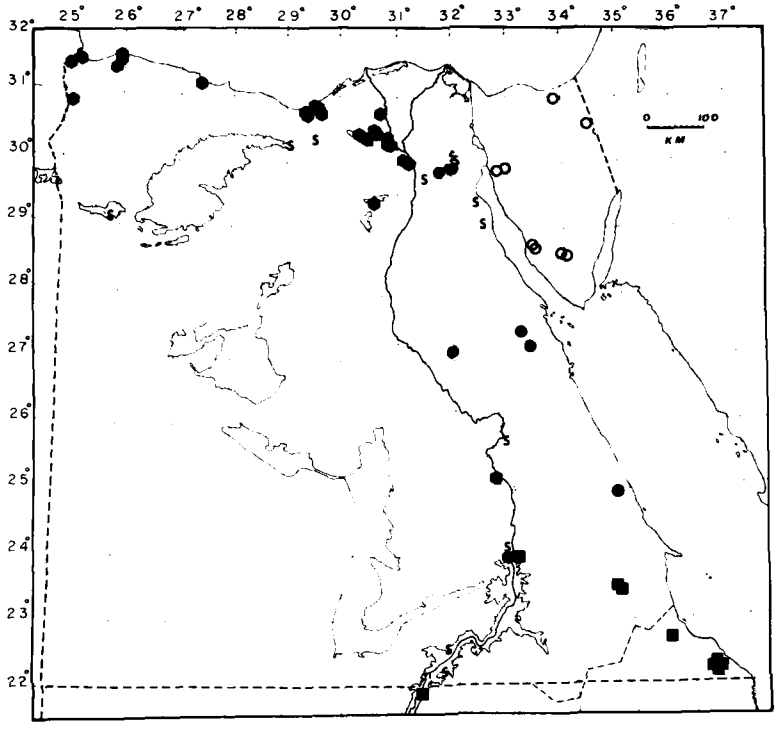


FIG. 30. Collection localities of *Lepus capensis sinaiticus* (circles), *L. c. aegyptius* (dots), *L. c. isabellinus* (solid squares), *L. c. rothschildi* (hexagons), and sight records (S).

long; maxilla and posterior parts of cranium fenestrated. Upper incisors two pairs, continuously growing; diastema very long; cheek-teeth hypsodont, six above, five below. Occlusal surfaces are elliptical. Adult head and body length average 400 mm.; tail 76 mm., 19 per cent of head and body length; foot 105 mm; ear 116 mm.

External characters.—Pelage soft, woolly, yellowish to buffy gray. Dorsal hairs with blackish tips, subterminal bands yellowish to buffy, and basal bands grading from dark gray to pale gray or whitish. Narrow stripe on side and flank of buff-tipped hairs with white bases. Venter hairs are pure white except for buff-tipped hair of groin. Throat buffy. Circumorbital area whitish. Nape buffy to rufous. Ear covered with short hair; outer side brownish, tip blackish, base color of nape; inner side whitish, margin cream

colored, with long hair on inner margin; anterior tip sometimes blackish or brownish. Tail black above, white below. Legs and feet with outer surface buffy, inner white. Hair of palm and sole brownish, long, nearly concealing claws.

Cranial characters.—Figure 31. Skull elongate, convex dorsally. Nasals long, broadened posteriorly, and separated by a deep, U-shaped frontal extension. Postorbital processes are prominent and have anterior and posterior extensions. Supraoccipital sloping caudad; external occipital protuberance posterior to level of occipital condyle and auditory bulla and bearing superior nuchal crest. There is a deep groove between the occipital protuberance and petromastoid. The interparietal is sometimes absent. Exoccipital is wide and flaring. Paroccipital process long, adnate to bulla. Lateral part of maxilla, posterior part of parietal, interparietal, supraoccipital, temporal process of parietal, temporal, alisphenoid, parts of petromastoid and parapterygoid are fenestrated. Auditory bulla conspicuously inflated. External auditory meatus tube-like, extending dorsocaudad. Malar long, deep, thin, and with prominent posterior projection. Diastema very long. Incisive foramen also long, broadened posteriorly. Palatine foramen minute. Palatal bridge shorter than width of mesopterygoid space, posterior margin opposite pm^3. Parapterygoid process long, hook-shaped. Angle and condyloid process of lower jaw broad, thin; coronoid process vestigial.

Teeth.—Figure 31. Two pairs of continuously growing upper incisors. Anterior pair with groove nearer medial than lateral border. Cheekteeth hypsodont. Pm^1 and pm_1 with reentrant angles on anterior surface. Pm^1 with one deep and two shallow reentrant angles, remaining upper cheekteeth with one lingual reentrant angle. Crowns elliptical in outline, divided by single transverse lamina.

Measurements.—Table 5. Male and female measurements subequal. Means and ranges of condyloincisive length (in millimeters) of sixteen adult males and eight adult females are 78.8 (75.3 to 82.3) and 76.8 (74.9 to 78.9), respectively.

Age determination.—Adults have all cheekteeth slightly worn, basioccipital-basisphenoid suture closed.

Variation.—*Lepus c. rothschildi* specimens from the desert edge of Giza Governorate are more reddish than those from elsewhere in Egypt (Setzer, 1958b). White forehead spots are common in

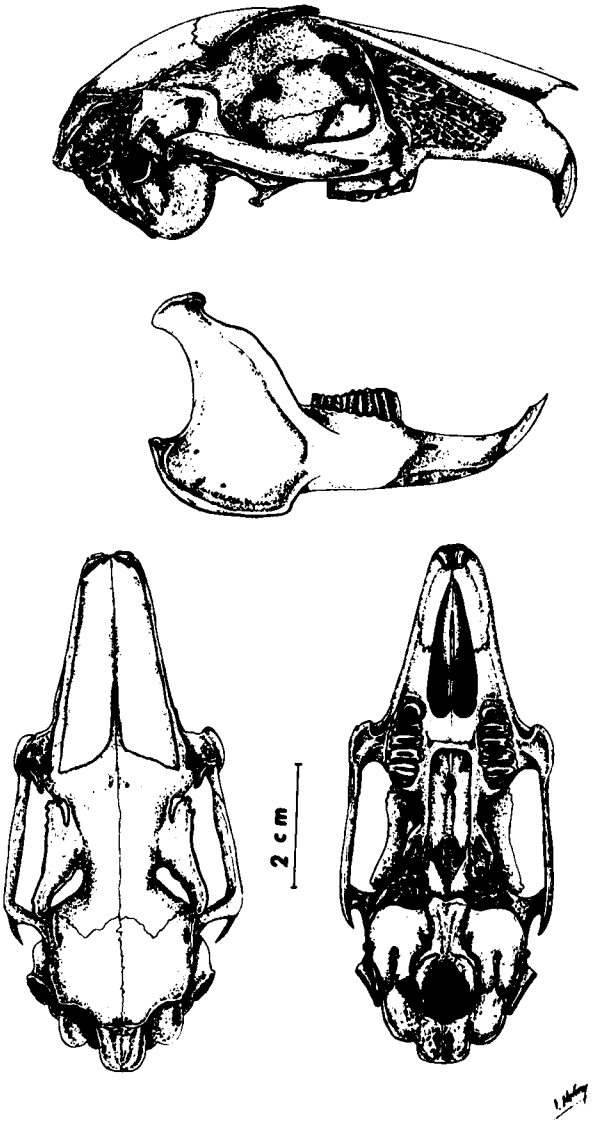


FIG. 31. Skull of *Lepus capensis*.

TABLE 5. — Means (and ranges) of measurements and ratios of adult *Lepus capensis*.

	Sinai Peninsula	N Eastern Desert	S Eastern Desert	Western Desert
	L. c. sinaiticus	*L. c. aegyptius*	*L. c. isabellinus*	*L. c. rothschildi*
HBL	388.7 (369-405) 4	416.2 (422-426) 4	390.0 (371-416) 5	387.0 (300-447) 40
TL	69.5 (61-76) 4	72.5 (60-83) 4	91.0 (81-97) 5	72.5 (49-102) 40
TL/HBL%	17.9 (16.5-19.1) 4	17.5 (14.4-20.5) 4	23.4 (21.8-25.5) 5	18.8 (21.9-26.0) 40
FL	107.5 (102-113) 4	109.8 (106-116) 4	103.8 (102-111) 5	101.2 (90-114) 41
EL	126.8 (123-135) 4	115.0 (112-120) 4	119.8 (110-126) 5	106.3 (92-135) 41
SL	79.3 (76.7-81.8) 4	82.9 (81.4-85.3) 4	85.1 (81.1-89.7) 7	78.8 (74.9-88.0) 35
ZW	37.8 (36.9-39.4) 4	38.6 (37.0-40.2) 4	38.6 (36.8-40.0) 6	36.9 (33.4-42.4) 34
POW	11.6 (10.5-13.8) 4	10.6 (9.6-11.1) 4	11.4 (9.6-12.9) 7	11.5 (9.4-14.2) 35
BCW	27.8 (26.1-29.3) 3	28.3 (27.8-28.8) 4	27.5 (26.3-28.5) 7	26.2 (24.8-31.0) 35
NL	33.3 (30.3-35.0) 4	33.2 (32.2-35.0) 4	34.3 (32.1-38.4) 7	31.0 (28.3-34.9) 34
RW	18.9 (16.8-19.9) 4	20.2 (19.7-20.8) 4	21.3 (19.2-23.0) 7	19.5 (16.1-23.9) 35
PW	10.7 (10.2-11.4) 4	10.4 (10.2-10.6) 4	9.9 (9.3-10.8) 7	9.6 (8.8-10.5) 33
BL	13.6 (12.5-14.2) 4	13.7 (13.1-14.2) 4	13.1 (12.6-13.9) 7	12.2 (11.2-13.7) 32
AL	14.1 (13.5-14.5) 4	14.8 (14.2-15.6) 4	15.2 (14.4-16.2) 7	13.8 (13.0-15.5) 35
SH	33.1 (31.4-34.2) 3	33.4 (33.0-33.7) 4	34.3 (32.6-36.2) 6	32.4 (30.1-36.7) 32

rothschildi, but occur in other Egyptian subspecies. Color in general varies from slightly more grayish Sinai specimens through yellowish and pale brownish gray in Eastern Desert specimens to brownish and reddish gray in the Western Desert. Black anterior ear tip predominates in subspecies *sinaiticus* and *aegyptius*, appears on intergrades between *aegyptius* and *isabellinus*, but is an occasional individual variation in Western Desert *rothschildi*. The latter averages smaller in most dimensions than other Egyptian subspecies (table 5). Other variations in measurements are discussed under comparisons of subspecies.

Comparisons.—*Lepus capensis* differs externally from all other Egyptian mammals by the combination of long ear, long hind foot, and short tail which is black above, white below. Cranially, *L. capensis* differs in the marked fenestration of maxilla and posterior parts of skull, short palate, two pairs of upper incisors, and upper tooth row wider than lower.

The Western Desert subspecies, *L. c. rothschildi*, differs from other Egyptian subspecies by slightly more brownish to reddish color of dorsum, lack of black anterior border on ear tip, and smaller average dimensions (table 5). *Lepus c. sinaiticus* is distinguishable from other subspecies by slightly more grayish color, due to length of black terminal bands on dorsum hairs, and greater average ear length.

Lepus c. aegyptius in comparison with *sinaiticus* and *isabellinus* appears to have a higher frequency of specimens with anterior border of ear tip black, but shows intergradation with those two subspecies in this character. *Lepus c. aegyptius* averages intermediate in measurements between *sinaiticus* and *isabellinus*. *Lepus c. isabellinus* differs little in color from *aegyptius*, but has a considerably longer tail (table 5).

Remarks.—Setzer (1958b) declined applying a subspecific name to 12 specimens from the Western Desert, chiefly from the desert area adjacent to the Nile Delta. We consider them to be *rothschildi* on geographic grounds. Due to the fact that this area represents a habitat limit, different phenotypic expressions are to be expected.

Collection.—Shooting from a vehicle is the most efficient means of collecting desert hares. Coni-bear traps set at 1-meter intervals on both sides of a net have taken hares in areas impassable for vehicles. Bedouins near Khatatba "trap large numbers in weir-type nets set in the desert and baited with clover" (Hoogstraal, 1963, p. 5).

Habitats.—Vegetated desert and wadi mouths along the Red Sea, Gulf of Suez, and Western Mediterranean coast. In the area of Bir Abraq, hares were found hiding in rock crevices (Hoogstraal et al., 1957ab). In the Western Mediterranean Coastal Desert (fig. 8), hares spend the day in clumps of *Lycium* sp. At Zeitun, Siwa Oasis, hares were frightened from clumps of *Tamarix* sp. in *sebakha*. South of Qena hares were seen in stands of *Zygophyllum coccineum*. Near Bir Zafarana in the Eastern Desert, one was flushed from a patch of *Juncus* sp. Wassif (1953b) reported hares from stands of *Panicum turgidum* in wadis in the Risan Eineiza area of north Sinai Peninsula.

Food.—Little is known of plants eaten by hares in Egypt. The variety is doubtlessly great. We have observed that *Zygophyllum coccineum* was nibbled by hares and were told by a Bedouin that they eat fallen acacia blossoms. Gnawed bark of *yassar* trees (*Moringa peregrina*) was noted by Tregenza (1958).

Reproduction.—Records of reproduction are from three females with two, two, and three fetuses from Wadi Ibib in March.

Sex ratio.—A sample of 71 museum specimens of *L. capensis* contained 38 (54 per cent) males and 33 females.

KEY TO EGYPTIAN SUBSPECIES OF *Lepus capensis*

1. Ear tip usually black anteriorly.
   a. Ear length more than 120 mm., average 126 mm. (Sinai Peninsula) ..... *sinaiticus*, p. 90.
   b. Ear length 120 mm. or less, average 115 mm. (Northern two-thirds of Eastern Desert) ..... *aegyptius*, p. 91.
2. Ear tip usually not black anteriorly.
   a. Tail long, average about 90 mm. (Southern one-third of Eastern Desert) ..... *isabellinus*, p. 92.
   b. Tail shorter, average about 70 mm. (Western Desert) ..... *rothschildi*, p. 92.

Lepus capensis sinaiticus (Ehrenberg, 1833)

Lepus sinaiticus Ehrenberg, 1833, *in* Hemprich and Ehrenberg, Symbolae Physicae, Mamm., Dec. 2, pl. 14, fig. 1.

Type locality.—SINAI: Gebel Musa.

Distribution in Egypt.—Figure 30. Sinai Peninsula.

External characters.—See species description. Dorsum grayish. Anterior border of ear tip usually blackish.

Cranial characters.—See species description and Figure 31.

Measurements.—Table 5.

Comparisons.—Slightly more grayish than other subspecies. Ear length averaging longer than in other Egyptian subspecies.

Specimens examined.—Total six.

SINAI: El Quseima (1), Wadi Raha (1), Feiran Oasis (1), Wadi Ain el Gefeef (1), Wadi el Sheikh (1), St. Catherine Monastery (1).

Published records.—Records are from Murray (1912), Flower (1932), Wassif (1953b), Setzer (1958b).

SINAI: Mount Sinai (Type); Ayun Musa E of; Wadi Feiran, 16 km. W Feiran Oasis; El Quseima; Wadi el Sheikh, near St. Catherine Monastery; St. Catherine Monastery, Wadi Raha.

SINAI: Risan Eineza area south of El Arish (sight record), southwest Sinai (sight record).

Lepus capensis aegyptius (Demarest, 1822)

Lepus aegyptius Demarest, 1822, Encyclop. Methodique, Mammalogie, suppl., p. 350.

Type locality.—QENA: between Luxor and Karnak.

Distribution in Egypt.—Figure 30. Northern two-thirds of Eastern Desert.

External characters.—See species description. Dorsum yellowish to brownish gray. Anterior border of ear tip blackish.

Cranial characters.—See species description and Figure 31.

Measurements.—Table 5.

Comparisons.—*Lepus c. aegyptius* differs from other Egyptian subspecies in having a larger proportion of individuals with anterior border of ear tip black, from *sinaiticus* in more yellowish or brownish dorsum and shorter ear, from *isabellinus* in having a shorter tail, and from *rothschildi* in paler color and generally larger dimensions.

Specimens examined.—Total five.

SUEZ: Wadi Katamiya mouth (1), Wadi Gindali (1), Wadi Iseili (1).
RED SEA: Wadi Abu Qarayia (1), Ezzeit (1).

Sight records of I. Helmy and D. Osborn.—

CAIRO: Wadi Garawi.
SUEZ: Wadi Qiseib, Cairo-Suez road km. 77, El Dar el Beida.
RED SEA: Bir Zafarana.
QENA: Qena 30 km. S.

Published sight records.—Records are from Bedan (1928) and Tregenza (1955, 1958).

RED SEA: Wadi Habeeb, Wadi Umm Sidri, Wadi Shawak.

Lepus capensis isabellinus (Cretzchmar, 1826)

Lepus isabellinus Cretzschmar, 1826, *in* Ruppell, Atlas zu der Reise im nordliche Afrika von Ruppell, Saugeth., pl. 20, p. 52.

Type locality.—Sudan. NORTHERN: Ambukol, deserts south of.

Distribution in Egypt.—Figure 30. Southern one-third of Eastern Desert.

External characters.—See species description. Dorsum yellowish to brownish gray. Ear tip usually not black on anterior border.

Cranial characters.—See species description and Figure 31.

Measurements.—Table 5.

Comparisons.—*Lepus c. isabellinus* is about the same color as *L. c. aegyptius*, less grayish than *L. c. sinaiticus*, and markedly paler than *L. c. rothschildi*. Coloration is rather uniform in *isabellinus* except for black inner tip of ear in about one-third of specimens examined. Tail length is longer in *isabellinus* than in other Egyptian subspecies. Ear length is less in *isabellinus* than in *sinaiticus*. In comparison with *rothschildi*, *isabellinus* averages larger in most dimensions, except head and body length and postorbital width.

Specimens examined.—Total 14.

RED SEA: Bir Abraq (1), Wadi Naam (1).
ASWAN: Near Aswan (1), Gebel Ain (1).
SUDAN ADMINISTRATIVE: Wadi Ibib (2), Wadi Darawena (2), Wadi Adeib 3.2 km. N of Bir Kansisrob (2), Wadi Adeib (1), Wadi Kansisrob (2).
Sudan. NORTHERN: Wadi Halfa (1)

Sight record of I. Helmy.—

ASWAN: Qustul East.

Published records.—Records are from Hoogstraal et al. (1957b) and Setzer (1956, 1958b).

RED SEA: Bir Abraq, Wadi Naam.
ASWAN: Naikhala.
SUDAN ADMINISTRATIVE: Wadi Adeib; 3.2 km. N of Bir Kansisrob; 4.8 km. N of Bir Kansisrob, 6.4 km. N of Bir Kansisrob; Wadi Darawena.

Lepus capensis rothschildi (De Winton, 1902)

Lepus rothschildi De Winton, 1902, Nov. Zool., 9, p. 444.

Type locality.—GIZA: Giza.

Distribution in Egypt.—Figure 30. Western Desert.

External characters.—See species description. Dorsum

brownish to reddish gray. Ear tip usually entirely yellowish white on anterior border.

Cranial characters.—See species description and Figure 31.

Measurements.—Table 5. *Lepus c. rothschildi* averages smaller in most dimensions than all other Egyptian subspecies.

Variation.—Setzer (1958b) noted reddish coloration in specimens from near Abu Rawash.

Comparisons.—In comparison with other Egyptian subspecies, *rothschildi* is generally darker and more brownish, lacks black on anterior margin of ear tip, and averages smaller in most dimensions.

Remarks.—Three specimens from Wadi Nassim, west side of Nile Valley, were considered "virtual topotypes of *L. c. aegyptius*" (Setzer, 1958b, p. 147; Hoogstraal, 1963). Note that the type locality of *L. c. aegyptius* has been fixed as between Luxor and Karnak on the eastern side of the Nile Valley. On a geographical basis, these specimens belong to *rothschildi*. Their chief similarity to *aegyptius* is the brownish anterior border of ear tip.

Specimens examined.—Total 69.

BEHEIRA: El Khatatba (6); Kom Hamada (3); Zaghig (6); Bir Victoria (7), 8 km. S (4); Wadi el Natroun (1).
GIZA: Wardan (3), Beni Salami (2), Giza (1).
QENA: Isna, Wadi Nassim (3).
MATRUH: Bahig (1), 8 km. S (2), 16 km. S (3), 18 km. S (1), 20 km. S (2); Abu Mena (2); Burg el Arab (1); El Hammam 10 km. S (2), 17 km. SW (2); Sidi Barrani (1), 4.8 km. S (1), 32 km. W (2); Salum 6.4 km. E (1); Bir Wair area (2); Bir Shaqqa 4.8 km. N (1); Marsaba (1); El Ferinat E of El Maghra (1); El Malfa 110 km. W of Siwa (2); Siwa Oasis, Abu Shuruf (2); El Zeitun (2).
ASWAN: Near Aswan West (1).

Sight records of I. Helmy and D. Osborn.—

ASWAN: Aswan West, Nag Farqanda West.
MATRUH: El Maghra; Qaret el Mashruka W of; Siwa Oasis, El Zeitun.

Published records.—Records are from Anderson (1902), De Winton (1902b, 1903), Kasim (1912), and Setzer (1958b).

GIZA: Wardan, Abu Rawash 1 km. S.
EL FAIYUM: Gattah, Birket Qarun.
BEHEIRA: Bir Victoria; Bir Victoria 8 km. S; Wadi el Natroun; Wadi el Natroun, Zaghig: between El Khatatba and Wadi el Natroun.
MATRUH: Burg el Arab, Wadi el Ghazal S of Sidi Barrani (sight record).

ORDER RODENTIA

KEY TO EGYPTIAN FAMILIES OF RODENTIA

1. Pelage soft, harsh, or spinous. Head and body length not exceeding 260 mm. Nasofrontal region normal. Angular process of lower jaw arising ventral to alveoli.
   a. External ear and tail present. Eyes normal. Supraoccipital normal, except in *genus Nesokia*. Median sagittal ridge absent. Interparietal present. Molar patterns variable, never S-shaped.
      i. Hind limbs elongate, tibia and fibula fused. Functional hind toes three. Tail length averages 150 per cent of head and body. Tail tip feathered black and white. Infraorbital foramen greatly enlarged, with upper root of zygomatic process posterior to lower. Maxillary plate minute. Cheek teeth $\frac{3-3}{3}$, enamel patterns E- and Z-shaped. . . . . **Family 5. Dipodidae, p. 322.**
      ii. Hind limbs normal. Functional hind toes five. Tail length averages less than 150 per cent of head and body. Tail tip not feathered black and white. Infraorbital foramen not greatly enlarged. Upper root of zygomatic process anterior to lower. Maxillary plate normal, except in Muscardinidae. Cheek teeth $\frac{3-4}{3-4}$, crowns transversely ridged, tuberculate, prismatic, or laminate.
         (a) Tail bushy nearly to base. Black facial markings present. Skull smooth. Tympanic bulla with three septa. Cheek teeth $\frac{4}{4}$, crowns concave, transversely ridged. . . . . **Family 4. Muscardinidae, p. 315.**
         (b) Tail not bushy, except in genus *Sekeetamys*. Black facial markings absent. Skull ridged. Tympanic bulla with no more than two septa. Cheek teeth $\frac{3}{3}$, crowns not as above.
            (1) Pelage soft. Tail hair concealing annulations. Tail tip usually tufted. Supraorbital ridge present, tempoparietal ridge usually absent. Incisive and palatal foramina large. Bulla conspicuously inflated. Molars with tubercles or prisms in two longitudinal rows, laminate in genus *Pachyuromys*. . . . . **Family 1. Cricetidae, p. 95.**
            (2) Pelage soft, harsh, or spinous. Tail hair not concealing annulations. Tail never tufted. Supraorbital and tempoparietal ridges present, except in genus *Mus*. Incisive foramen large, except in genus *Nesokia;* palatal foramen minute. Bulla not conspicuously inflated. Molars with cusps in two longitudinal rows, laminate in genus *Nesokia*. . . . . **Family 3. Muridae, p. 253.**
   b. External ear absent. Tail not visible externally. Eyes small, covered with hairy skin. Supraoccipital large, sloping forward to level of zygomatic process of temporal. Median sagittal ridge present. Interparietal absent. Enamel pattern of molars S-shaped. . . . . **Family 2. Spalacidae, p. 245.**
2. Pelage of dorsum and tail of long, round, hollow quills. Head and body length

average 600 mm. Nasofrontal region inflated. Angular process of mandible arising lateral to alveoli. Crowns of cheek teeth flat, complexly folded.....
.....Family 6. Hystricidae, p. 357.

Family 1. Cricetidae
(Subfamily Gerbillinae)

Small to relatively large rodents. Head and body length average 66 to 120 mm. Fur soft. Supraorbital spots usually prominent. Tail annulations concealed by hair, apical brush usually present. Supraorbital ridge present, tempoparietal ridge usually not conspicuously developed; infraorbital foramen relatively small and incisive and palatine foramina long. Tympanic and mastoid bullae conspicuously inflated. Upper incisor with anterior surface grooved, except in genus *Psammomys*. Cheek teeth tuberculate (tubercles in two longitudinal rows), laminate, or prismatic. Dental formula: $\frac{1}{1}, \frac{0}{0}, \frac{0}{0}, \frac{3}{3} \times 2 = 16$.

Keys to Egyptian Genera of Gerbillinae

External Characters

1. Tail slender, usually longer than head and body length (95 per cent or more).
   a. Sole partly or completely haired, with a single lobed subdigital pad and a subhallucal tubercle (fig. 34).
      i. Sole partly haired. Belly hairs usually with gray bases.....*Meriones*, p. 190.
      ii. Sole completely haired. Belly hairs never with gray bases.. *Gerbillus*, p. 96.
   b. Sole naked, with six tubercles (three subdigital, one subhallucal, and two plantar) (fig. 34).
      i. Tail bushy..... *Sekeetamys*, p. 181.
      ii. Tail not bushy.....*Dipodillus*, p. 140.
2. Tail thick, always shorter than head and body length (90 per cent or less).
   a. Tail normal, with black tip. Belly hairs yellowish.....*Psammomys*, p. 226.
   b. Tail clavate (club-shaped), without black tip. Belly hairs white.....
   .....*Pachyuromys*, p. 220.

Cranial and Dental Characters

1. Anterior surface of upper incisor grooved.
   a. Molars tuberculate in immatures, laminate in adults. Supraoccipital swollen, posterior margin beyond level of occipital condyles.
      i. First labial and lingual cusps of m^1 opposite. Mastoid bulla never inflated posterior to level of supraoccipital..... *Gerbillus*, p. 96.
      ii. First labial and lingual cusps of m^1 alternate, at least in immatures. Mastoid bulla sometimes inflated posterior to level of supraoccipital.
         (a) Mastoid bulla always inflated beyond level of supraoccipital. Superior wall of parapterygoid perforated..... *Sekeetamys*, p. 181.
         (b) Mastoid bulla inflated beyond level of supraoccipital in some species. Superior wall of parapterygoid fossa not perforated....*Dipodillus*, p. 140.
   b. Molars laminate or prismatic in all ages. Supraoccipital not swollen, posterior margin at or slightly beyond level of occipital condyles.

i. Supraoccipital slightly constricted by swelling of bullae. Palatine foramen narrow, inconspicuous. . . . . *Meriones*, p. 190.
ii. Supraoccipital narrowly constricted by swelling of bullae. Palatine foramen broad, conspicuous. . . . . *Pachyuromys*, p. 220.
2. Anterior surface of upper incisor smooth. . . . . *Psammomys*, p. 226.

Genus **Gerbillus** Desmarest, 1804

Orangish to brownish rodents of varying size. Tail longer than head and body in all species. Tail brush variable. Palm and sole haired. Hand with large palmar pad bearing appendix. Foot with single, lobed subdigital pad and subhallucal tubercle, no plantar tubercles (fig. 34).

Brain case usually inflated and supraoccipital swollen beyond level of occipital condyle. Cranial ridges developed in larger species, supraorbital ridges in all species. Lip of auditory meatus never modified or swollen. Accessory tympanum present. Some variation among species in size of tympanic bulla and chambers of mastoid bulla. Subarcuate fossa small, never separating anterior and lateral superior posterior mastoid chambers as in some species of *Dipodillus* (figs. 36, 47).

Upper incisors with single groove on anterior surface. Molars tuberculate, becoming laminate with wear. First labial and lingual cusps of m^1 opposite (fig. 38).

KEY TO EGYPTIAN SPECIES OF *Gerbillus*

1. Larger species, hind foot length 30-36 mm., occipitonasal length 30-38 mm.
   a. Dorsum dark to pale. Posterior margin of nasals broadly to narrowly truncate. Interparietal usually deep and narrow (table 7, fig. 37. . . . . *pyramidum*, p. 96.
   b. Dorsum very pale. Posterior portion of nasals tapering and narrow, "bottle-shaped." Interparietal shallow and broad (table 7, fig. 37) . . *perpallidus*, p. 117.
2. Smaller species, hind foot length 25-32 mm., occipitonasal length 25 to 31 mm.
   a. Dorsum dark, brownish orange. Ear and sole pigmented. Posterior margin of nasals truncate (table 11, fig. 41). . . . . *andersoni*, p. 119.
   b. Dorsum orangish. Ear and sole not pigmented. Posterior margin of nasals round or pointed (table 11, fig. 41). . . . . *gerbillus*, p. 130.

Gerbillus pyramidum I. Geoffroy St. Hilaire, 1825

Gerbillus pyramidum I. Geoffroy St. Hilaire, 1825, Dict. Class. Hist. Nat., Vol. VII, p. 321.

Type locality.—Egypt. GIZA: Giza Pyramids area.

General distribution.—Israel, Sinai Peninsula, Egypt, Sudan, Libya, Tunisia, Algeria, Morocco, Northern Chad, Niger, and Mauritania.

Common names.—Greater Gerbil, *Demsy.*

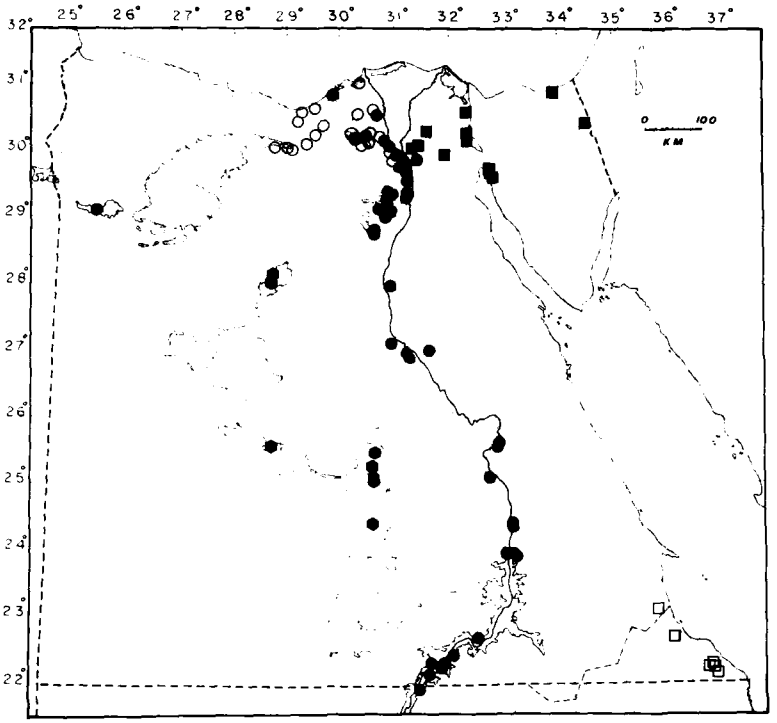


FIG. 32. Collection localities of *Gerbillus pyramidum pyramidum* (dots), *G. p. floweri* (solid squares), *G. p. gedeedus* (hexagons), *G. p. elbaensis* (open squares), and *G. perpallidus* (circles).

Distribution of subspecies in Egypt.—Figure 32. *Gerbillus pyramidum floweri:* northern Sinai and northern part of Eastern Desert; *Gerbillus pyramidum pyramidum:* Nile Delta and Valley, Wadi el Natroun, El Faiyum, Wadi Muwellih, and Siwa Oasis; *Gerbillus pyramidum gedeedus* ssp. nov.: Bahariya, Kharga, and Dakhla Oases and probably Farafara Oasis; *Gerbillus pyramidum elbaensis:* southeastern part of Eastern Desert.

Diagnosis.—Large gerbil with orangish to tawny and brownish upper parts. Dorsal stripe dark and usually distinct from sides. Tail long; brush brownish, usually conspicuous. Ears pigmented in nominate subspecies. Eye prominent. Skull large, heavily ridged. Nasals broadly to narrowly truncate posteriorly. Bulla extending or not extending posteriorly slightly beyond paroccipital.

Largest of Egyptian species of *Gerbillus*. Adult head and body length average 120 mm.; tail 158 mm., 134 per cent of head and body length; hind foot 36 mm.; ear 17 mm.; occipitonasal length 33.4 mm.; weight 60 gm.

External characters.—Upper parts varying through orangish cinnamon, cinnamon, and tawny to brownish. Dorsal stripe, if distinct, broad and dark. All hairs of dorsum and side, except for narrow ventrolateral strip, with gray bases. Widths of agouti bands and brownish tips of dorsal hairs variable. Hairs of underparts and feet white to base. Upper surface of tail either as dorsum (with brownish tipped hairs) or side (lacking brownish tipped hairs). Tail brush one-third or more of tail length, brownish or fuscous. Under surface of tail either entirely white or with buffy base. Rump patch of white hairs, hairs with white bands, or lacking. Mystacial and circumorbital areas pale in desert populations, darker and less conspicuous in Nile Delta and Valley populations.

Palatal ridges.—Figure 33. Palatal ridges of two or three specimens of species of Gerbillinae were examined, with the exception of *Gerbillus perpallidus*, *Dipodillus mackilligini*, *Meriones sacramenti*, and *M. tristrami*. They appear to be of taxonomic value in this group. Eisentraut (1969) recognized the usefulness of palatal ridges in the Muridae, but noted that extra ridges and abnormalities may occur.

In *G. pyramidum*, the first diastemal or antemolar ridge is broadly U-shaped, the second is transverse. The first to fourth intermolar ridges reach the midline and are recurved; the fourth is slenderest; the fifth is thickest, reaches midline, but is not recurved.

Glans penis and baculum.—Slight differences in shape of the penis among species of the family Gerbillinae were illustrated by Wassif et al. (1969, p. 84). In *Gerbillus* and *Dipodillus*, the surface of the penis is covered with minute spines in small, circular pockets. The baculum consists of a basal plate distinguished from the bony shaft, except in *G. andersoni*, with "three separate cartilaginous digitigrade processes."

Feet.—Palm and sole haired, pads and tubercles comparable with *G. gerbillus* (fig. 34).

Cranial characters.—Figures 35-37. Skull largest and most heavily developed of Egyptian species of *Gerbillus*. Supraorbital ridge thick and prominent, parietal ridge variable. Zygomatic plate large, anterior margin usually reaching level of premaxillary-maxillary

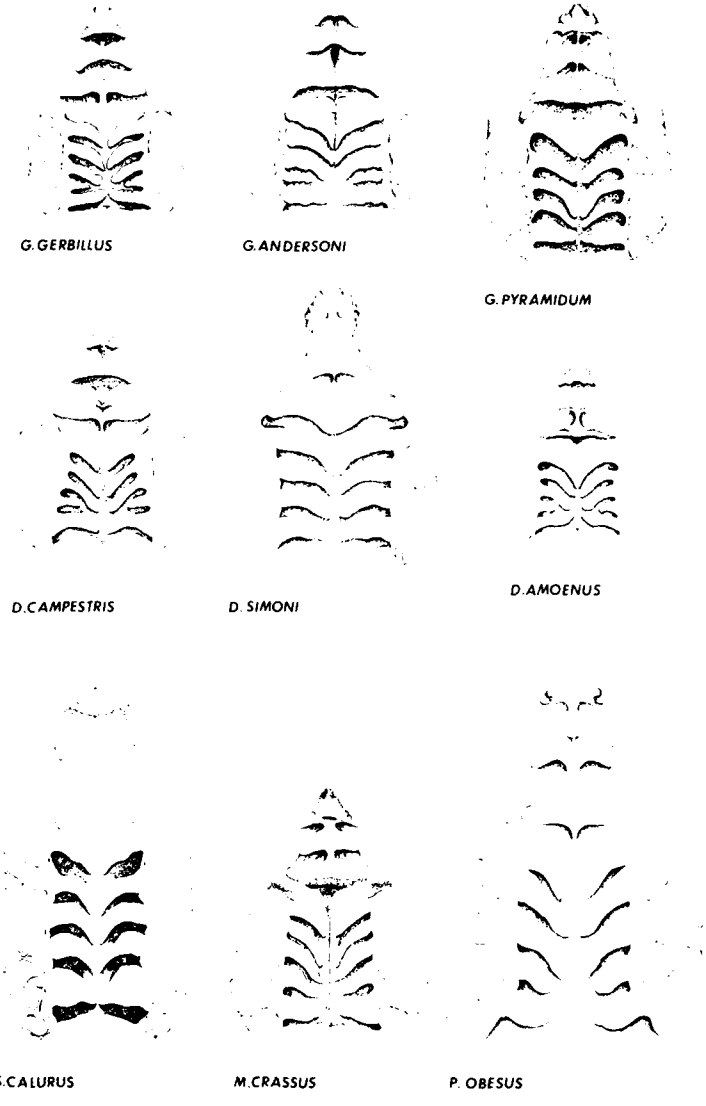


FIG. 33. Palatal ridges of *Gerbillus gerbillus*, *G. andersoni*, *G. pyramidum*, *Dipodillus campestris*, *D. simoni*, *D. amoenus*, *Sekeetamys calurus*, *Meriones crassus*, and *Psammomys obesus*. Not drawn to same scale.

suture. Posterior margin of nasals broadly to narrowly truncate. Interparietal shape varies between subspecies, as shown in Figure 37. Anterior surface of tympanic bulla reaching level of posterior margin of foramen ovale. Posterior surface of mastoid bulla exceeding or not exceeding level of paroccipital process. Partition between anterior mastoid chamber and posterior superior mastoid chamber at level of or slightly behind level of posterior margin of hamular (suprameatal) process of temporal (fig. 36).

Teeth.—Figure 38. Upper incisor grooved. First labial and lingual cusps of m^1 opposite. Molars tuberculate in immatures, becoming fused into laminae with rounded margins. Confluency of cusps begins between anterior and first lingual cusps in m^1, anterior and first labial cusps in m_1, and is completed earliest in m_1. M^2 and m_2 become laminated prior to confluency of cusps of m^1, m_1, but anteroposterior union is limited. M^3 small, with three transient cusps.

Measurements.—Table 6. Male dimensions average slightly larger than female. Means (and ranges) of occipitonasal length (in millimeters) of 21 adult males and 13 adult females, respectively, are 35.9 (34.6 to 38.1) and 34.8 (33.2 to 37.3).

Age determination.—Individuals are considered adult when anterior and first lingual cusps of m^1 become confluent or almost confluent and/or the basioccipital-basisphenoid suture closes.

Variation.—The greatest amount of variation is between *G. p. pyramidum* of the Nile Valley and Delta and *G. p. floweri* of the northern Eastern Desert and Sinai Peninsula.

Intergradation between *G. p. pyramidum* and *G. p. floweri* extends a few kilometers east of the Nile Delta where *floweri* becomes considerably paler than *pyramidum;* ear tip loses pigmentation; tail becomes completely bicolored; upper surface of tail loses blackish hairs; tail brush becomes smaller and paler; rump patch increases in size and whiteness; mystacial, suborbital, postorbital, and postauricular areas become lighter or white; white of underside extends onto shoulders and over whole of limbs; and dorsal stripe becomes less distinct or lacking. The anterior mastoid chamber is slightly more expanded in desert populations (fig. 36), posterior margin of nasals narrower, interparietal less deep (fig. 37), and means of most dimensions smaller.

Differences between *G. p. pyramidum* and other subspecies are

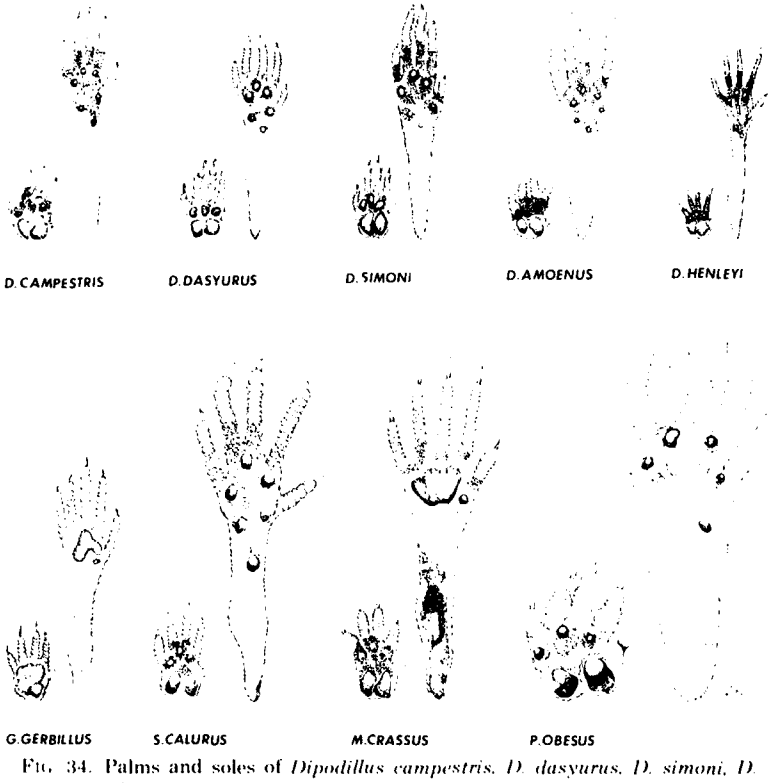


FIG. 34. Palms and soles of *Dipodillus campestris, D. dasyurus, D. simoni, D. amoenus, D. henleyi, Gerbillus gerbillus, Sekeetamys calurus, Meriones crassus,* and *Psammomys obesus*. Not drawn to same scale.

considerably less striking. Tail brush is larger in *G. p. gedeedus* ssp. nov. (table 7), dorsal stripe indistinct, skull more heavily ridged, and bulla inflation slightly greater.

Gerbillus p. elbaensis is slightly paler than *G. p. pyramidum*, tail proportionally longer (table 6), posterior margin of nasals narrower, and anterior mastoid chamber of bulla more swollen in about 50 per cent of the samples.

The statement of Innes (1932, p. 22) that ear length is longer than one-half hind foot length in *G. pyramidum* is true only for samples from the Nile Delta.

Comparisons.—*Gerbillus pyramidum* differs from related species,

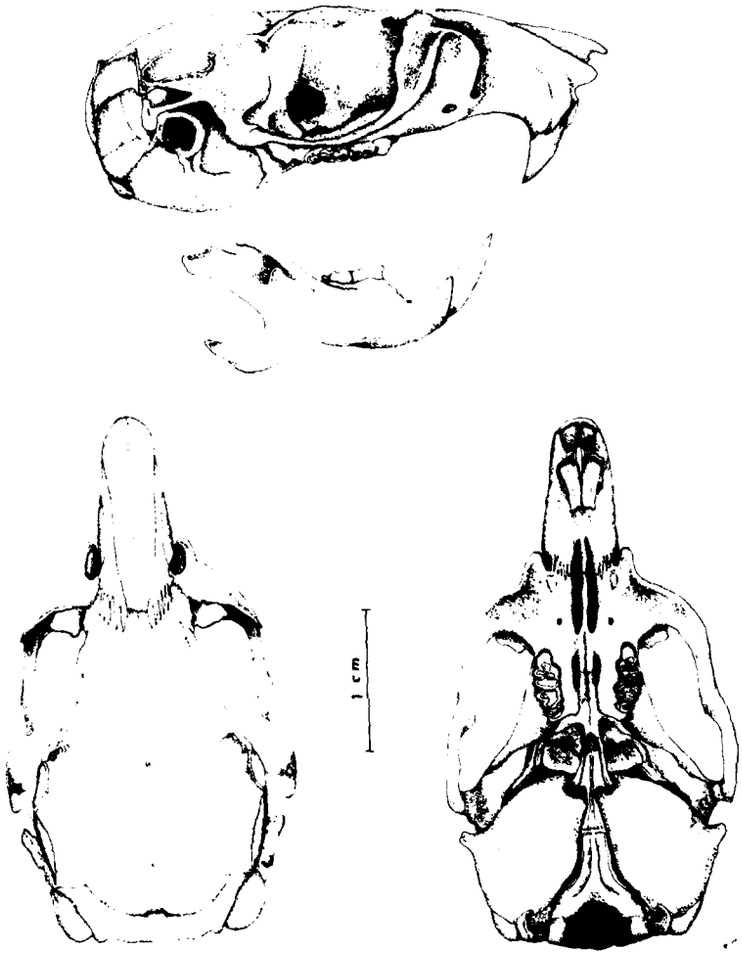


FIG. 35. Skull of adult *Gerbillus pyramidum flowcri*

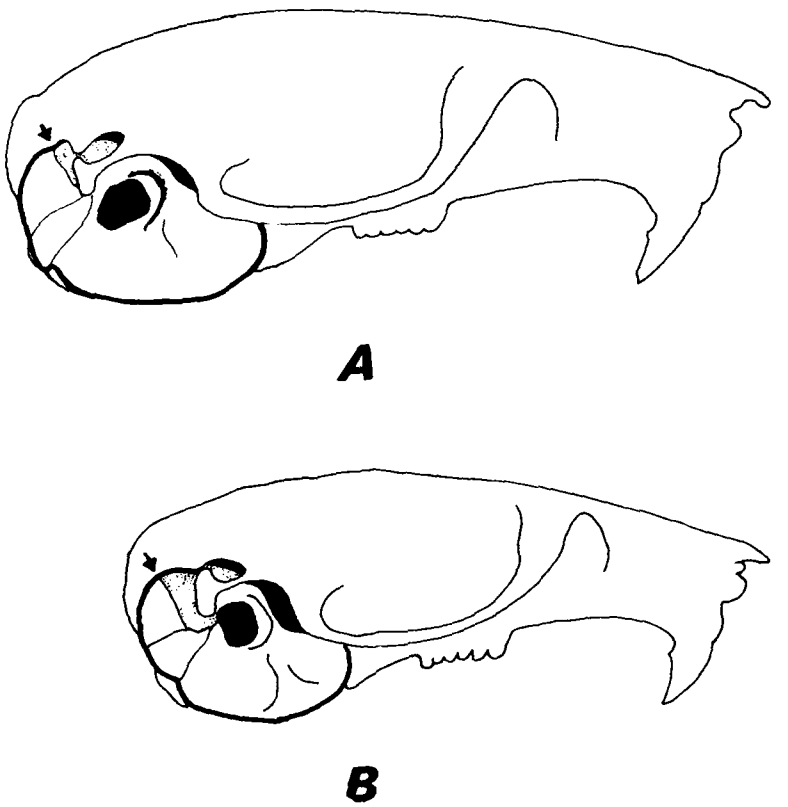


FIG. 36. Mastoid bulla variations in *Gerbillus pyramidum* and *G. perpallidus*. (A) Anterior position of partition (at arrow) between anterior mastoid (shaded) and superior posterior lateral mastoid chambers as in *G. pyramidum pyramidum*. (B) Posterior position of partition (at arrow) as in desert subspecies of *G. pyramidum* and in *G. perpallidus*.

G. perpallidus, in much darker color, presence of a broad dorsal stripe, white rump patch smaller or absent, nasals truncate posteriorly instead of tapering narrowly, narrower and deeper interparietal, thicker and longer supraorbital ridge, less inflated mastoid bulla, and significantly larger dimensions. Characters of larger gerbils are summarized in Table 7, and shown in Figures 36, 37.

From *G. gerbillus* and *G. andersoni*, *G. pyramidum* differs in much larger dimensions (tables 6, 8, 10), relatively smaller bulla,

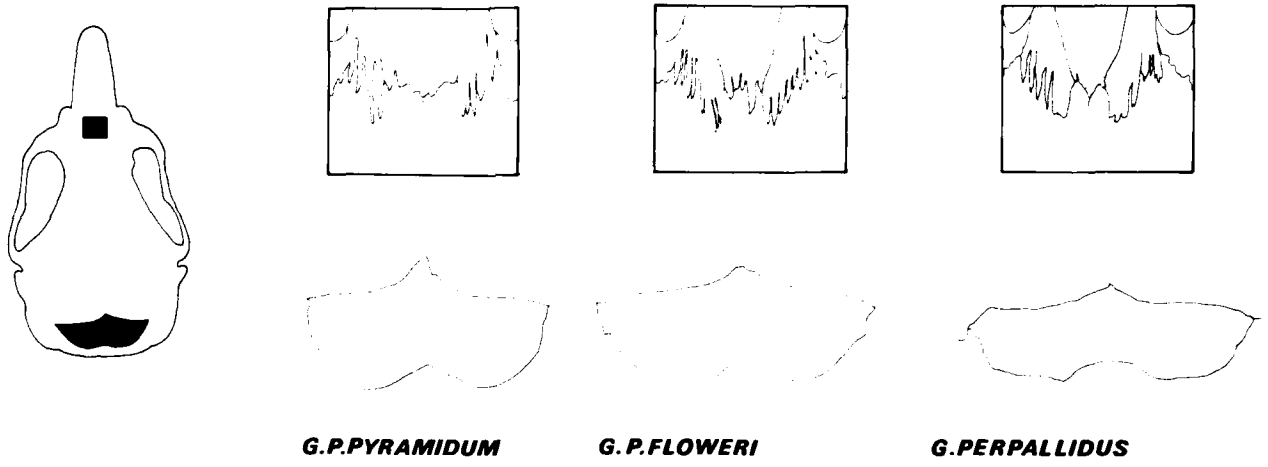


FIG. 37. Posterior margins of nasals (above) and interparietal outlines (below) of *Gerbillus pyramidum pyramidum*, *G. p. floweri*, and *G. perpallidus*.

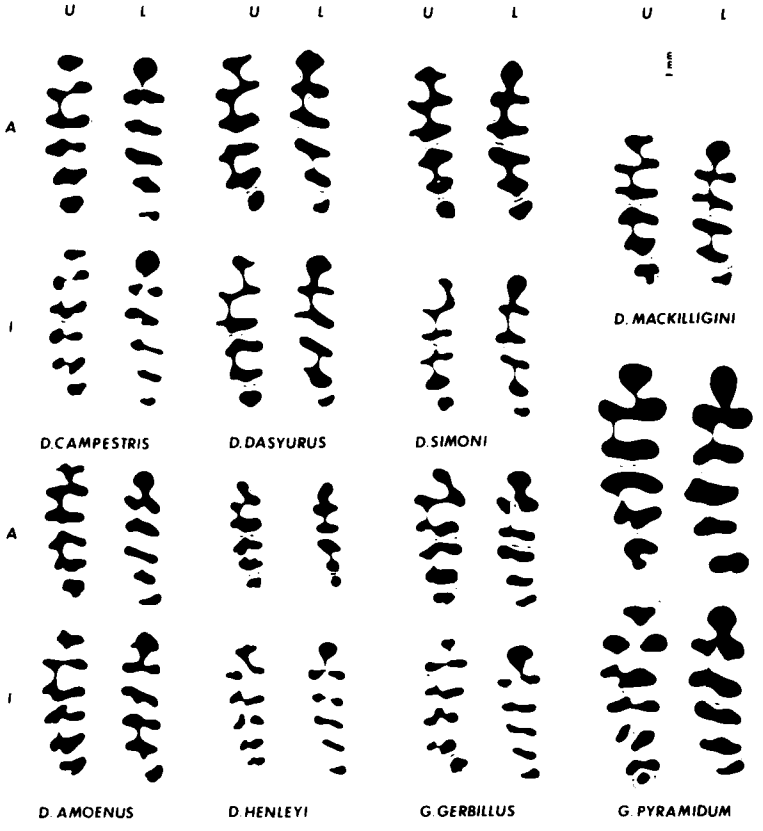


FIG. 38. Crown views of right upper (U) and left lower (L) molars of mature (A) and immature (I) of species of *Dipodillus* and *Gerbillus*. Mature only of *D. mackilligini* shown.

longer and more prominent tail brush; from *G. gerbillus*, in darker coloration and presence of dorsal stripe.

Wassif et al. (1969) reported the diploid chromosome numbers of *G. pyramidum*, *G. andersoni*, and *G. gerbillus* to be 38, 40, and 42 (43 in males), respectively. Lay et al. (1975) found that *G. perpallidus* exhibited a 2N=40. Zahavi and Wahrman (1957) listed two Israeli forms of *G. pyramidum*, from the Negev and Coastal plain, as having diploid numbers of 66 and 52.

TABLE 6. — Means (and ranges) of measurements, ratios, and weight of adult *Gerbillus pyramidum* and *G. perpallidus*.

	G. p. pyramidum	*G. p. floweri*	*G. p. gedeedus* ssp. nov.	*G. p. elbaensis*	*G. perpallidus*
HBL	121.9 (109-135) 47	117.0 (111-213) 21	116.3 (107-131) 16	106.4 (102-111) 5	107.4 (95-117) 27
TL	153.1 (128-173) 39	149.1 (140-158) 21	163.2 (150-180) 16	157.0 (142-170) 5	137.2 (128-150) 26
TL/HBL%	126.0 (113.2-138.2) 39	127.4 (120.2-133.3) 21	140.1 (124.8-151.3) 16	147.7 (133.9-166.6) 5	129.5 (119.0-142.3) 26
FL	35.2 (33-38) 49	34.9 (33-36) 21	35.3 (33-39) 16	32.5 (30.5-35.0) 5	33.8 (32-36) 21
EL	18.1 (15-20) 48	16.2 (15-17) 21	16.4 (15-18) 16	16.0 (14-17) 5	15.9 (14-18) 21
Wt	—	54.1 (48.9-63.0) 21	53.2 (37.2-67.2) 16	—	36.3 (26.2-48.4) 20
ONL	35.5 (33.2-38.1) 46	34.0 (32.6-35.4) 18	34.7 (33.0-37.6) 14	33.3 (32.5-34.2) 7	32.3 (30.1-33.8) 27
ZW	19.0 (17.9-20.8) 37	18.7 (18.1-19.4) 17	18.3 (17.0-19.7) 15	17.2 (16.8-17.6) 5	17.4 (16.5-18.5) 25
IOW	6.7 (6.1-7.4) 50	6.6 (6.2-7.3) 18	6.5 (6.0-7.2) 16	6.5 (6.2-6.9) 7	6.2 (5.8-6.7) 31
BCW	15.3 (14.7-16.3) 50	15.6 (15.2-16.5) 18	15.1 (14.5-15.5) 16	14.9 (14.5-15.4) 7	15.0 (14.4-15.7) 31
NL	14.2 (12.7-15.5) 46	14.5 (13.2-15.7) 18	13.8 (12.5-15.3) 14	13.5 (12.6-14.1) 7	13.5 (12.4-14.4) 27
IFL	5.9 (5.4-6.4) 37	6.0 (5.8-6.4) 17	5.8 (5.2-6.4) 16	5.6 (5.2-5.8) 7	5.6 (5.0-6.0) 33
AL	4.9 (4.5-5.5) 37	4.9 (4.8-5.1) 18	4.9 (4.6-5.5) 16	4.6 (4.5-4.8) 7	4.8 (4.4-5.9) 33
RW	4.7 (4.4-5.1) 50	4.8 (4.5-5.2) 18	4.7 (4.5-5.3) 16	4.4 (4.1-4.6) 7	4.5 (4.3-4.8) 27
BL	10.0 (9.2-11.5) 50	10.0 (9.5-10.5) 18	10.3 (9.7-11.1) 16	9.9 (9.3-10.3) 7	9.4 (8.9-10.0) 28
SH	13.7 (12.9-14.8) 48	13.2 (12.9-13.8) 18	13.5 (12.8-14.0) 15	13.0 (12.8-13.3) 7	12.7 (12.3-13.1) 28

Collection.—Dug from burrows in sand and trapped alive near burrows and where tracks are obvious.

Habitats.—Sinai Peninsula: *Gerbillus p. floweri* was collected in palm groves and near cultivation (Hoogstraal, 1963) and in sandy dunes of the northern section (Wassif, 1953b), but not in dunes of southern Sinai (Haim and Tchernov, 1974). The last authors gave the southern limit at Wadi Wardan.

Eastern Desert: *Gerbillus p. floweri* was collected in Wadi el Gafra in sand beneath *Lygos raetum.* Hoogstraal (1963, p. 12) listed it from "palm groves and near cultivation" in Suez and "from around old army barracks" in Qalyubiya Governorate. *Gerbillus p. elbaensis* is from "grassy valleys in Gebel Elba," sandy coastal plain (Hoogstraal, 1963, p. 11), and lower reaches of Wadi Ibib beneath close stands of *Panicum turgidum.*

Nile Delta: Sandy areas near cultivation, palm groves, and sandy canal banks supporting *halfa* grasses (*Desmostachya bipinnata* and *Imperata cylindrica*); desert edge areas in stands of *Panicum turgidum* and other bunch grasses; and barren sand and gravel around tents and houses south of Giza Pyramids.

Nile Valley: East and west banks in situations described above and inside larger tributary wadis, such as Wadi Asyuti, where vegetation is scattered *Acacia raddiana, Leptadenia pyrotechnica,* and *Zilla spinosa;* dry cracked mud beside the Nile; and palm groves with patches of *halfa* grass.

Wadi el Natroun: Sand sheets vegetated with *Panicum turgidum* and small shrubs.

El Faiyum: Under *Tamarix* sp. in sandy areas at desert edge.

Wadi Muwellih: Sand mounds supporting *Nitraria retusa* and *Desmostachya bipinnata.*

Oases: Sandy areas with cover of *halfa* grasses and other vegetation in palm groves; sand sheets supporting camel thorn (*Alhagi mannifera*) and bunch grasses (*Sporobolus spicatus* and *Stipagrostis vulnerans*); heavily vegetated areas around walls, springs, and leaking aqueducts (fig. 21); beneath *Acacia* sp. and *Lagonychium farctum;* under date palms and *Tamarix* sp.; and in drifted sand in uninhabited buildings.

Behavior.—Nocturnal. Extremely nervous and highly sensitive to slightest noise and movement. Difficult to handle and bites readily.

TABLE 7. — Characters of *Gerbillus pyramidum* and *G. perpallidus*.

Character	*G. p. pyramidum*	*G. p. gedeedus*	*G. p. floweri*	*G. p. elbaensis*	*G. perpallidus*
Color	dark	dark-pale	pale		
Dorsal stripe	present	present-absent	absent		
White rump patch	small-absent		large		
Dorsal tail surface	with black hairs to base	with-without black hairs to base	no black hairs to base		
Ventral tail surface	white, proximal ⅓ buffy	white, bicolored			
Tail brush	blackish, ½ tail length	black, more than ½ tail length	fuscous, less than ½ tail length		

TABLE 7. — *continued.*

Character	*G. p. pyramidum*	*G. p. gedeedus*	*G. p. flowcri*	*G. p. elbaensis*	*G. perpallidus*
Ear	pigmented		not pigmented		
Position of bulla partition (Fig. 36)	anterior		posterior	50% posterior	posterior
Posterior nasal margin	broadly truncate		narrowly truncate		"bottle-shaped"
Interparietal shape (Fig. 37)	deep, narrow		shallow, broad	70% deep, narrow	very shallow, broad
Anterior margin of zygomatic plate	usually reaching level of premaxillary-maxillary suture				almost reaching level of suture

TABLE 8. — Means (and ranges) of measurements, ratios, and weight of adult *Gerbillus andersoni*.

	G. a. inflatus	*G. a. andersoni*	*G. a. bonhotei*
HBL	96.0 (83-112) 38	92.2 (90-115) 26	96.2 (95-98) 4
TL	128.0 (118-140) 31	124.0 (110-150) 26	120.5 (117-125) 4
TL/HBL%	134.3 (118.2-159.0) 32	125.4 (115.5-139.6) 25	125.2 (119.4-131.6) 4
FL	28.4 (25-30) 38	29.4 (27-32) 27	27.8 (26-31) 4
EL	15.2 (15-18) 39	16.0 (15-19) 25	15.5 (14-16) 4
Wt	28.6 (15.9-38.4) 31	30.0 (27.7-33.2) 9	— —
ONL	28.4 (27.5-30.3) 32	29.2 (27.7-31.0) 26	28.9 (28.3-30.0) 5
ZW	16.0 (14.8-16.6) 27	16.4 (14.9-17.6) 17	15.8, 16.0
IOW	6.0 (5.1-6.2) 34	6.0 (5.4-6.0) 28	5.6 (5.4-5.8) 5
BCW	14.0 (13.4-14.4) 31	14.0 (13.0-15.6) 25	14.0 (13.7-14.3) 5
NL	11.2 (10.4-12.0) 32	12.0 (10.5-14.0) 27	10.9 (10.5-11.3) 5
IFL	5.2 (4.6-5.6) 35	5.0 (4.8-5.6) 27	5.1 (4.8-5.4) 5
AL	4.2 (4.0-4.4) 34	4.0 (3.6-4.8) 28	4.6 (4.2-5.4) 5
RW	4.0 (3.6-4.4) 34	4.0 (3.6-4.5) 28	3.8, 4.1, 4.2
BL	9.0 (8.4-9.5) 31	8.5 (7.8-9.1) 27	9.1 (8.9-9.3) 5
SH	12.2 (11.7-12.8) 27	12.0 (11.1-12.5) 22	12.0 (11.9-12.2) 4

Burrows.—The similarity between *G. pyramidum* and *G. gerbillus* burrows was noted by Yunker and Guirgis (1969) (see p. 135).

Food.—See *G. gerbillus*. In northern Sinai, Wassif (1953b) found camel dung and seeds of *Citrullus* (=*Colocynthis*) in burrows of *G. p. floweri* and assumed they were part of the animal's food ration.

Reproduction.—Data available only from January through March on three males with testes descended and two females, one with three fetal scars, and one with five fetuses.

Sex ratio.—In a sample of 74 museum specimens, there were 38 (51 per cent) males and 36 females.

Associates.—*Gerbillus pyramidum* shares habitats with *G. gerbillus*, *G. andersoni*, *G. perpallidus*, *Arvicanthis niloticus*, *Rattus rattus*, *Meriones libycus*, and *M. crassus*. Commensal inhabitants of burrows are listed by Yunker and Guirgis (1969) and discussed under *G. gerbillus*.

Remarks.—Happold (1967a) considered *G. pyramidum* to be better adapted to desert environment of the Sudan than *Jaculus jaculus*, owing to its ability to breed during a longer period of the year and lose less weight when fed on whole barley for four weeks at 30°C. (Schmidt-Nielsen, 1964, p. 182). Nevertheless, *G. pyramidum* is never found in isolated, barren desert situations where *J. jaculus* survives.

KEY TO EGYPTIAN SUBSPECIES OF *Gerbillus pyramidum*

1. Dorsum dark to pale. Tail with conspicuous black brush extending one-third or more of tail length. Nasals broadly truncate on posterior margin.
   a. Dorsum darker, stripe distinct. Brush extending up to one-third of tail length. Underside of tail base buffy. (Nile Delta, Nile Valley, El Faiyum). . . . . *pyramidum*, p. 111.
   b. Dorsum paler, stripe indistinct. Brush extending more than one-third of tail length. Underside of tail base white. (Western Desert oases). . *gedeedus*, p. 114.
2. Dorsum pale, dorsal stripe indistinct to lacking. Tail with inconspicuous, fuscous, or grayish brush extending less than one-third of tail length. Nasals usually narrowly truncate posteriorly.
   a. Interparietal shallow, broad. Partition between mastoid bulla chambers in posterior position. (Sinai Peninsula and northern part of Eastern Desert). . . . . *floweri*, p. 113.
   b. Interparietal deep, narrow. Partition between mastoid bulla chambers in posterior position in 50 per cent of sample. (Southeastern part of Eastern Desert). . . . . *elbaensis*, p. 116.

Gerbillus pyramidum pyramidum I. Geoffroy St. Hilaire, 1825

Type locality.—Egypt. GIZA: Giza Pyramids area.

Distribution in Egypt.—Figure 32. Nile Delta and Nile Valley.

External characters.—Upper parts tawny to brownish, dorsal stripe broad, dark brown. Side tawny to pale brownish. Some individuals almost completely brown on back and side. Venter and feet white. Broad pigmented band extending from mystacial area below ear and continuous with color of sides. Circumorbital area pigmented. Postauricular spot white. Rump patch small or lacking. Upper surface of tail with blackish tipped hairs to base. Tail brush prominent. Under surface of tail white with buffy base. Ear pigmented.

Cranial characters.—Figure 35. Skull large, angular, prominently ridged. Posterior margin of nasals broadly truncate. Partition between anterior and posterior superior mastoid chambers in anterior position (fig. 36). Posterior margin of mastoid bulla not inflated beyond level of paroccipital. Interparietal deep and narrow (fig. 37).

Measurements.—Table 6. Except for tail length, dimensions of *G. p. pyramidum* differ slightly from those of other subspecies. Ear length is obviously longer in Nile Delta samples only.

Variation.—Samples of *G. p. pyramidum* from dark soils are darker and have a less clearly defined dorsal stripe than those from pallid soils. Ear length decreases from north to south in Nile Delta and Nile Valley populations. Tail length increases slightly from

north to south along the Nile Valley. Albinistic specimens have been collected from near Abu Rawash.

Comparisons.—The subspecies *pyramidum* can be distinguished from others by darker color, more clearly defined dorsal stripes, blackish hairs along entire length of tail, and buffy underside of tail base. Ears are pigmented in *pyramidum* and *gedeedus*, but not in other subspecies (table 7).

From the desert-inhabiting subspecies, *floweri* and *elbaensis*, *pyramidum* can be distinguished by less inflated bulla (fig. 36), deeper and narrower interparietal (fig. 37), partition between mastoid chambers in anterior position, and broadly truncate posterior nasal margin (fig. 37). From *gedeedus*, *pyramidum* differs in having average tail length 10 per cent shorter and having a less conspicuous tail brush. From *elbaensis*, *pyramidum* differs in having average tail length about 20 per cent shorter, but more conspicuous brush.

Remarks.—Two specimens (skulls only) of *G. pyramidum* were obtained in 1974 from beneath date palms at El Zeitun and El Maragi which are in the Siwa depression. They could have arrived accidentally via camel pack or they could be relicts of a formerly continuous distribution. This species is found in western Libya and far to the east in Egypt (fig. 32). All we can suggest at this time is the old *cliché*: "Further investigation is obviously necessary."

Specimens examined.—Total 193.

ALEXANDRIA: Near Alexandria (3).

BEHEIRA: El Khatatba (3), El Birigat 2 km. W (1), Kom Hamada (1), Wadi el Natroun (2), Ezbet Beni Salami (2).

GIZA: Giza (8); Abu Ghalib (13); Abu Rawash (19), 3 km. N (1); Gebel el Ghigiga (5); Giza Pyramids area (1), 3.6 km. W (1), 1 km. S (1); Cairo-Alexandria desert road km. 10 (2); Kafr Hakim (2).

CAIRO: Cairo (4).

MATRUH: El Maragi (1), El Zeitun (1).

EL FAIYUM: Faiyum (3), 4.8 km. N (2); Kom O Shim (2); Kom Ashmun (2); Shooting Club (4); Ezbet Ayub Ali (2); Sinnurus (3); Fanus (2); Minshat el Amir (Mohamed Ali Pasha) (2); Wadi Muwellih, Bir Dakaar (2).

ASYUT: Asyut 4.8 km. SW (1), Beni Adi (24), Durunka (2), Wadi Asyuti (2).

QENA: Luxor (1), 4.8 km. N (1); Wadi Nassim (11).

ASWAN: Aswan (2), 1.6 km. SE (1), 16 km. N (1), West Aswan (6); Kom Ombo (19), El Kagug Cave (2), Muneiha (3); El Biyara (10); Kom Ombo Temple 0.8 km. E (1); West Armina (4), Adindan (2), El Dirr, Amada (4), Abu Simbil (1).

Published records.—Records are from Anderson (1902), Flower (1932), Setzer (1952, 1958d), and Bauer (1963).

QALYUBIYA: Kafr Abu Sir.
SHARQIYA: Tel el Kebir.
KAFR EL SHEIKH: Baltim, El Burg.
BEHEIRA: Wadi el Natroun; Bir Hooker; Kafr Dawud; El Khatatba; Kom Hamada, Talha Station.
GIZA: Abu Rawash, 3 km. N, 1.6 km. N; Gebel Abu Rawash 4.8 km. NE, 1.6 km. NE; Giza Pyramids 3.2 km. W; Abu Ghalib; El Aiyat; Mit Riheina; Atfih; El Mansuriya; Zawyet Abu Mussalam; Birqash; Mena suburbs; Kafr Hakim; El Lisht Pyramid; Cairo-Alexandria desert road km. 10.
CAIRO: Abassia Fever Hospital.
EL FAIYUM: Faiyum, El Nassariya, Ezbet Ayub Ali, Idwa, Ezbet el Asfar, Fanus, Minshat Tantawi, Ezbet Abu Zeid, Kom O Shim 3.6 km. NE.
MINYA: Tel el Amarna.
QENA: Luxor, Wadi Nassim.
ASWAN: Aswan; West Faras 4 km. S; El Dirr, Amada; Abu Simbil.
Sudan. NORTHERN: Wadi Halfa.

Gerbillus pyramidum floweri (Thomas, 1919)

Gerbillus floweri Thomas, 1919, Ann. Mag. Nat. Hist., (ser. 9), 3, p. 559.

Type locality.—Egypt. SINAI: Wadi Hareidin 22.4 km. S of El Arish.

Distribution in Egypt.—Figure 32. Northern parts of Sinai Peninsula and Eastern Desert.

External characters.—Pale cinnamon to tawny above with indistinct dorsal stripe. Mystacial area with white hairs only, area below eye very pale to whitish. Preorbital, postorbital, and postauricular areas and rump patch white and prominent. Ear usually not pigmented. Tail usually without brownish or blackish hairs dorsally, brush relatively inconspicuous, fuscous.

Cranial characters.—Figures 35, 37. Skull with pronounced supraorbital ridge, posterior margin of nasals narrowly truncate, anterior margin of zygomatic plate usually reaching level of premaxillary-maxillary suture, posterior margin of mastoid bulla usually not inflated beyond level of paroccipital. Partition between anterior and posterior superior mastoid chambers usually in the posterior position (fig. 36). Interparietal a little less deep than in *pyramidum* (fig. 37).

Measurements.—Table 6. Slightly smaller than *G. p. pyramidum* in some measurements. Ear length appears to be the only significantly smaller measurement.

Variation.—Samples from eastern edge of the Nile Delta and Wadi el Gafra have a more distinct dorsal stripe than those from vicinities

of Suez Canal and northern Sinai. Other variations are described under the species.

Comparisons.—The subspecies *floweri* is distinguishable from *pyramidum* in decidedly paler color, less distinct dorsal stripe and tail brush, narrower posterior margin of nasals, and posterior position of partition between anterior and posterior superior lateral mastoid chambers (fig. 36). Intergradation in color, nasal shape, and bulla conformation exist between *G. pyramidum floweri* and *G. p. pyramidum.* From *gedeedus, floweri* differs in the same details, and tail length averages 10 per cent shorter. Color markings in *floweri* differ slightly from those of *elbaensis,* but body size is larger, tail length shorter, posterior nasal margin narrower, interparietal shallower, and mastoid partition is posterior in position (table 7). Intergradation in characters between *floweri* and *elbaensis* is evident.

Gerbillus p. floweri and G. perpallidus are strikingly similar in color, and bulla shape and, in some individuals, posterior margin of nasals.

Remarks.—Haim and Tchernov (1974) considered the Sinai form to be *G. p. negev* without recourse to substantiative data.

Specimens examined.—Total 81.

SINAI: El Arish (32), Wadi Hareidin (Type), El Ras el Ahmar (2), El Quseima (1), Ain Sudr (1), Ayun Musa (1).
ISMAILIA: Abu Sultan (1), Lake Timsah west side (1), El Ballah (1).
SHARQIYA: Bilbeis (6).
QALYUBIYA: Kafr Abu Sir (6).
SUEZ: Wadi el Gafra (28), el Kubri (1).

Published records.—Records are from Flower (1932), Wassif (1954c), Setzer (1958d), and Haim and Tchernov (1974).

SINAI: El Arish, Wadi Hareidin, El Quseima, Wadi Wardan near Ras el Sudr (Sidr).
ISMAILIA: Abu Sultan.
QALYUBIYA: Kafr Abu Sir, Mazaret el Gebel el Asfar, El Khanka.

Gerbillus pyramidum gedeedus ssp. nov. Osborn and Helmy

Type.—Adult male, skin and skull, Field Museum of Natural History number 106213; original number 17230 in H. Hoogstraal catalog. Collected December 6, 1966, by Ibrahim Helmy.

Type locality.—Egypt. EL WADI EL GEDEED: Dakhla Oasis, El Mawhoub.

External characters.—Tawny to light brown dorsally. Most without distinct dorsal stripe. Usually no black hairs on upper surface of tail except for long, distinctive black brush.

Circumorbital markings indistinct. Postauricular patch white, prominent. White rump patch small when present. Belly, inside of legs, and underside of tail white. Ear pigmented.

Cranial characters.—Skull similar to *G. p. pyramidum*, but more massive. Posterior margin of nasals broadly truncate. Partition between anterior and posterior superior mastoid chambers in anterior position (fig. 36). Interparietal as in *pyramidum* (fig. 37).

Measurements.—Tables 6, 7. Type head and body length 121 mm.; tail 180 mm., 148 per cent of head and body length; hind foot 37 mm.; ear 17 mm.; occipitonasal length 35.9 mm.; weight 54.2 gm. Ear length is less than one-half hind foot length.

Comparisons.—Subspecies *gedeedus* differs from *pyramidum* in paler color; lack of or less distinct dorsal stripe; completely white underside of tail; lack of blackish hairs on upper side of tail; larger, more conspicuous tail brush; longer tail; slightly more inflated mastoid bulla; and slightly more angular and strongly ridged skull. Measurements other than tail length are about equal in the two subspecies (tables 6, 7).

Gerbillus p. gedeedus cannot be confused with *G. p. floweri*, *G. p. elbaensis*, or *G. perpallidus* because of its larger size, darker color, and longer tail brush. The tail is relatively and actually longer than in other subspecies except *elbaensis*.

Habitat.—See Oases under *G. pyramidum* and Figure 21.

Specimens examined.—Total 101.

GIZA: Bahariya Oasis, Bir Qasr No. 1 (7), Bir Qasr No. 3 (2); El Aguz (9); Bir Wigaba (3); Ain Marun (7); Mandisha (3); Bawiti (1); Ain el Qht (7); El Hara (9); Ain el Beilda (1); Wadi Ghorabi (2).

EL WADI EL GEDEED: Dakhla Oasis, El Mawhoub (10, Type), Mut (2); Kharga Oasis (1), El Kharga 14 km. E (3), 3 km. S (3), 4 km. S (1); Bulaq (3); Nasser Village (3); Baris (2); El Gezira (11); El Farag (2); Ain Eede 8 km. E (1); Ginah (7).

Published records.—Records are from Flower (1932) and Wassif (1960ab, as *G. p. pyramidum*).

GIZA: Bahariya Oasis, Mandisha.

EL WADI EL GEDEED: Kharga Oasis; Kharga Oasis, El Mahariq, Baris.

Gerbillus pyramidum elbaensis Setzer, 1958

Gerbillus pyramidum elbaensis Setzer, 1959, J. Egypt. Publ. Health Assn., 33, p. 223.

Type locality.—Egypt. SUDAN ADMINISTRATIVE AREA: Wadi Adeib, 3.2 km. N of Bir Kansisrob.

Distribution in Egypt.—Figure 32. Southeastern part of Eastern Desert.

External characters.—Dorsum pale cinnamon to tawny, dorsal stripe inconspicuous to absent. Color and markings very similar to *G. p. floweri*. Tail indistinctly bicolored, upper surface without brownish or blackish hairs; brush about one-third of tail length, fuscous, less conspicuous than in *G. p. pyramidum* or *G. p. gedeedus*.

Cranial characters.—Nasal with posterior margin tapering and narrowly truncate or rounded in about 70 per cent of specimens examined, broadly truncate in 30 per cent. Partition between anterior and superior posterior mastoid chambers in posterior position (fig. 36) in about 50 per cent of specimens examined, posterior margin of mastoid bulla posterior to level of paroccipital in about 80 per cent, and interparietal deep and narrow, as in *pyramidum*, in about 70 per cent. Interparietal shape similar to that of *floweri* in about 30 per cent.

Measurements.—Table 6. *Gerbillus p. elbaensis* averages smaller in most dimensions, except tail length, than other subspecies; however, the sample is much smaller than others. Anterior palatine (incisive) foramen is not as "long and narrow" (table 6) as one would assume from the comment of Setzer (1958d, p. 223).

Comparisons.—*Gerbillus p. elbaensis* is distinguishable from *floweri* and other subspecies by smaller dimensions, except tail length. From *pyramidum* and *gedeedus* it differs in lack of a dorsal stripe, less conspicuous tail brush, relatively larger bulla, and narrower posterior nasal margins.

Similarities between this subspecies, *G. p. floweri*, and *G. perpallidus* in color and bulla conformation may be correlated with adaptation to desert habitat.

Specimens examined.—Total 18.

SUDAN ADMINISTRATIVE: Wadi Kansisrob (8); Bir Kansisrob 4.8 km. N (1); Wadi Adeib, 3.2 km. N of Bir Kansisrob (2); Wadi Serimtai, 16 km. N of Halaib (4); Halaib 20 km. N (1), Wadi Hodein (1); Wadi Ibib (1).

Published records.—Records are from Hoogstraal et al. (1957b) and Setzer (1958d).

SUDAN ADMINISTRATIVE: Halaib 20 km. N; Wadi Serimtai; Bir Kansisrob 4.8 km. N, 3.2 km. N; Wadi Kansisrob.

Gerbillus perpallidus Setzer, 1958

Gerbillus perpallidus Setzer, 1958, J. Egypt. Publ. Health Assn., **33**, p. 221.

Type locality.—Egypt. BEHEIRA: Bir Victoria.

Common name.—Pallid Gerbil.

Distribution in Egypt.—Figure 32. Western Desert between the western part of Nile Delta, Qattara Depression, and Western Mediterranean Coastal Desert environs of El Hamman.

Diagnosis.—Medium size gerbil with pale orangish upper parts lacking dorsal stripe. Tail brush relatively inconspicuous, fuscous. Ears not pigmented. Skull not strongly developed, supraorbital ridges not heavy. Nasals tapering and narrow or "bottle shaped" posteriorly. Interparietal shallow and broad. Bulla extending posteriorly beyond paroccipital.

Adult head and body length average 107 mm.; tail 137 mm., 129 per cent of head and body length; hind foot 34 mm.; ear 16 mm.; occipitonasal length 32.3 mm.; weight 36.3 gm.

External characters.—Dorsal color pale yellowish orange to light reddish orange with no dorsal stripe, but dark-tipped hairs on rump. Hairs of dorsum and part of side have gray bases. Underparts, feet, and underside of tail white. Mystacial and suborbital areas without pigmented hairs. Postorbital and postauricular spots and rump patch white, conspicuous. Dorsal tail color as back, lacking brownish tipped hairs; brush about one-third of tail length, fuscous. Ears not pigmented.

Palatal ridges.—Pattern similar to *G. andersoni* (fig. 33).

Glans penis and baculum.—Not observed.

Cranial characters.—Figures 36, 37. Skull without strongly developed supraorbital ridge. Posterior portion of nasals tapering narrowly or "bottle shaped." Anterior margin of zygomatic plate slightly posterior to or reaching level of premaxillary-maxillary suture. Anterior margin of tympanic bulla reaching level of foramen ovale or beyond. Posterior margin of mastoid bulla beyond margin of paroccipital. Partition between anterior mastoid and superior

posterior mastoid chambers clearly posterior to margin of hamular process of temporal. Interparietal shallow and broad.

Teeth.—Upper incisor grooved. Cusp pattern of molars as in other *Gerbillus* species (fig. 38).

Feet.—Palm and sole haired, pads and tubercles as in *G. gerbillus* (fig. 34).

Measurements.—Table 6. Males slightly larger than females. Ear length averages less than one-half hind foot length.

Age determination.—Adults are separated from immatures as in other species of *Gerbillus* on bases of tooth wear and suture closure.

Variation.—Color varies from pale yellowish orange in the Wadi el Natroun area to light reddish orange in El Maghra.

Comparisons.—*Gerbillus perpallidus* differs from *G. gerbillus* and *G. andersoni* in larger size and from the last in paler color and lack of dorsal stripe. Skins of young *G. perpallidus* can be distinguished from *G. g. gerbillus* by comparing the size of the white pygal area which is comparatively larger and extends further forward on the hip of the latter. It also differs in color from *G. p. pyramidum*, but not from all individuals of *G. p. floweri.* It differs from *G. pyramidum* subspecies in less strongly ridged skull and greater inflation of mastoid chambers, and markedly from other *Gerbillus* species in shape of interparietal and posterior nasal shape (fig. 37). Anterior margin of zygomatic plate does not extend over the premaxillary-maxillary suture in *G. perpallidus* as in most *G. pyramidum.* The similarity between *G. perpallidus* and *G. p. floweri* is noted under the latter form, and characters of larger gerbils are summarized in Table 7. The validity of taxon *G. perpallidus* was tentatively confirmed by chromosomal studies of Lay et al. (1975), who reported a 2N=40 and FN=76 for the latter and a 2N=38 and FN=76 for *G. pyramidum* from Egypt.

Collection.—Dug from burrows in sand and trapped alive beside open burrows or with lines of traps in habitat.

Habitats.—Idku: Coastal sand dunes.

Western Mediterranean Coastal Desert: Coastal dunes of white, nummilitic sand (fig. 7); sandy areas in stands of *Thymelaea hirsuta* and *Artemisia monosperma* in the southern limits of vegetation (figs. 19, 20).

Wadi el Natroun: Lake shore areas of mud and salty sand support-

ing *Typha* sp. and *Desmostachya bipinnata*; almost barren sand slopes with dry, ephemeral *Mesembryanthemum* sp.; soft sand sheets supporting stands of *Panicum turgidum*; dunes under exotic *Prosopis juliflora*; sandy slopes near clover fields, but not within the fields.

Bir Victoria: Sand sheets and meanders with dominants of *Artemisia monosperma*, *Panicum turgidum*, and *Pityranthus tortuosa* (fig. 10).

El Maghra: Sand mounds around *Nitraria retusa* and *Zygophyllum album*, barren sand and gravel slopes, and 15 km. W in soft sand in scattered *Acacia raddiana*.

Reproduction.—One record of five fetuses in April.

Associates.—*Gerbillus gerbillus*, *G. andersoni*, *G. pyramidum*, *Jaculus jaculus*, *Meriones libycus*, and *M. shawi* and, probably, *M. crassus*.

Specimens examined.—Total 218.

GIZA: Abu Ghalib (1), Abu Rawash (1).

EL FAIYUM: Ezbet el Asfar (1).

ALEXANDRIA: Idku (4).

EL TAHREER: Cairo-Alexandria desert road km. 102 (3), km. 143 (1).

BEHEIRA: Bir Victoria (27); wadi el Natroun (45); Wadi el Natroun ½ to 1 km. E (9), Bir Hooker (5); Gebel Muluk (3), Zaghig (17); El Birigat 2 km. W (4), Kom Hamada (1).

MATRUH: Burg el Arab (2); El Hawa 20 km. S of El Hamman (1); Qasr el Qatagi (1); Nakhlat el Barraq (1); El Maghra (72), 15 km. W (5); Bir Nahid (7); Qur el Hilab (7).

Published records.—Records are from De Winton (1903 as *G. tarabuli*) and Setzer (1958d).

BEHEIRA: Bir Victoria; Wadi el Natroun; Wadi el Natroun, Gebel Muluk, and Zaghig.

Gerbillus andersoni De Winton, 1902

Gerbillus andersoni De Winton, 1902, Ann. Mag. Nat. Hist., (ser. 7), 9, p. 45.

Gerbillus eatoni Thomas, 1902, Proc. Zool. Soc., London, 2, pt. 1, p. 6.

Gerbillus bonhotei Thomas 1919, Ann. Mag. Nat. Hist., (ser. 9), 3, p. 5.

Type locality.—Egypt. ALEXANDRIA: Alexandria, El Mandara.

General distribution.—Jordan, Northern Sinai Peninsula, Egypt, Libya, and Tunisia.

Common names.—Anderson's Gerbil, *Bayoudi*.

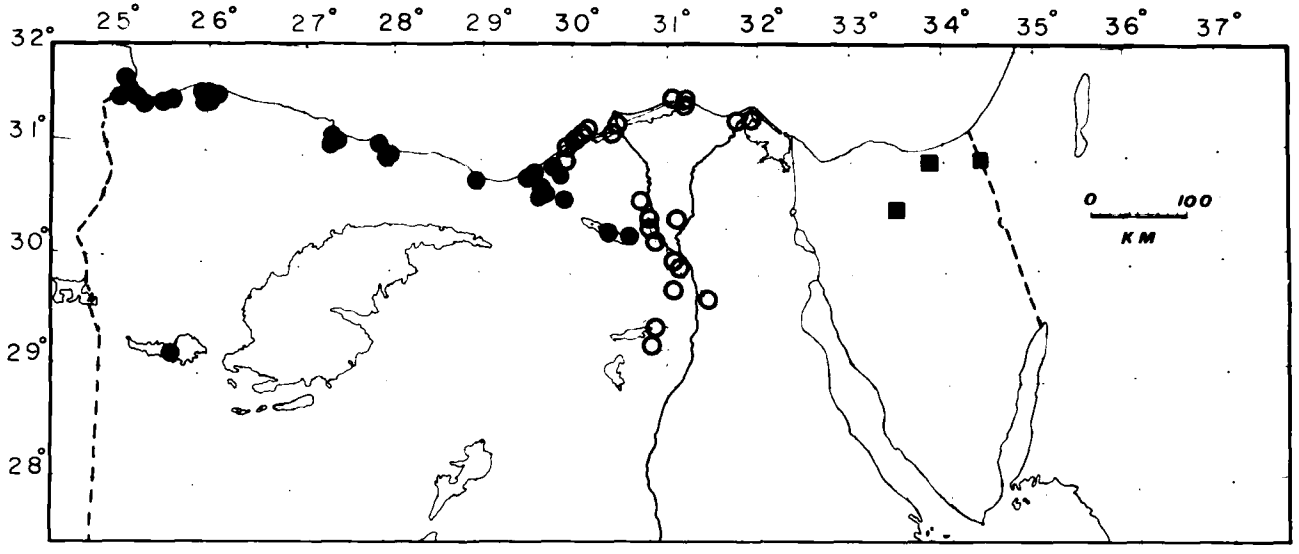


FIG. 39. Collection localities of *Gerbillus andersoni andersoni* (circles), *G. a. inflatus* (dots), and *G. a. bonhotei* (squares).

Distribution of subspecies in Egypt.—Figure 39. *Gerbillus andersoni bonhotei*: Northern Sinai Peninsula; *Gerbillus andersoni andersoni*: Nile Delta and El Faiyum; *Gerbillus andersoni inflatus*: Northern Western Desert and Siwa Oasis.

Diagnosis.—Brownish orange gerbil slightly larger than *G. gerbillus*, with ear and sole pigmented. Tail not bicolored at base; brush small, brownish. Whitish supraorbital, postauricular markings, and rump patch inconspicuous. Ear length equal to or greater than one-half of hind foot length. Bulla large. Incisive foramina relatively long, palatine foramina relatively short. Posterior margin of nasals truncate.

Adult head and body length average 97 mm.; tail 126 130 per cent of head and body length; foot 28 mm.; ear 15 mm.; occipitonasal length 28.8 mm.; weight 28 gm.

External characters.—Dorsum brownish orange, darkest on rump. Side clear orange. Color of side extending onto upper foreleg and heel. Hairs of dorsum and portion of sides with gray bases. Underparts, feet, and distal portion of underside of tail white. Underside of tail base buffy. Broad, conspicuous band of dark-tipped hairs extending from mystacial area beneath eye to base of ear. Whitish postorbital and postauricular areas small, inconspicuous. White rump patch small. Dorsal tail color as back and with blackish hairs; brush fuscous or brownish, not conspicuous, and about one-fourth tail length. Ear and sole pigmented.

Palatal ridges.—Figure 33. Pattern similar to *G. gerbillus*, but intermolar ridges somewhat thicker, with tips of first to third more medial and recurving.

Glans penis and baculum.—These structures as described in Wassif et al. (1969) show little difference between species of Gerbillinae, except that the bacular shaft in *G. andersoni* broadens gradually into a wide, thickened base.

Feet.—Palm and sole almost completely haired as in *G. gerbillus* (fig. 34). Sole pigmented.

Cranial characters.—Figures 40, 41. Skull slightly larger than *G. gerbillus*, supraorbital ridge not well developed, not extending anterior to level of posterior plane of lacrimal bone. Posterior margin of nasals truncate. Incisive foramina relatively long and palatine foramina relatively short. Anterior margin of zygomatic plate never reaching level of premaxillary-maxillary suture. Parapterygoid

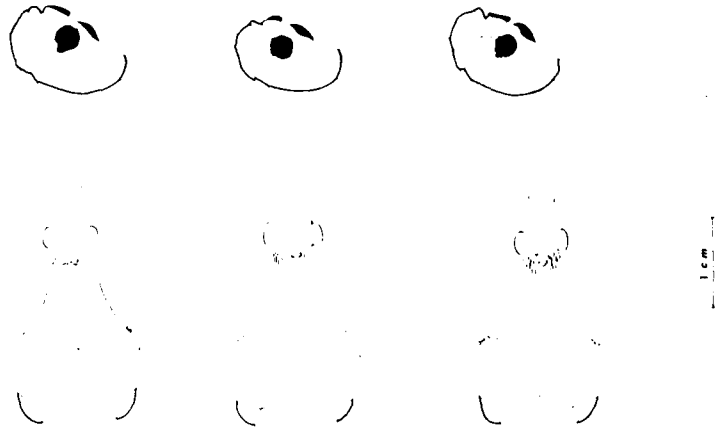


FIG. 40. Comparison of auditory bullae in lateral and dorsal view (heavy lines) and skull shape in *Gerbillus andersoni inflatus*, *G. a. andersoni*, and *G. gerbillus gerbillus*. Lateral superior posterior mastoid chambers are shaded. *G. a. bonhotei* (not shown) is identical with *G. a. inflatus*.

fossa deep and partly closed. Anterior margin of tympanic bulla reaching level of anterior margin of foramen ovale. Posterior margin of mastoid chambers extending to and sometimes beyond level of occipital condyle, but not to level of supraoccipital. Posterior superior mastoid chamber (app. 2, fig. 165) more inflated than inferior chamber (fig. 40). Lip of external auditory meatus slightly thickened in adults.

Teeth.—As in other species of *Gerbillus* (fig. 38).

Measurements.—Table 8. Male and female dimensions subequal. Means (and ranges) of occipitonasal length (in millimeters) of 11 adult males and 10 adult females, respectively: 29.4 (28.2 to 31.0) and 29.0 (27.7 to 29.8). Note that ear length averages half or greater than half of hind foot length.

Age determination.—Adults are determined by tooth wear and suture closure as in *G. pyramidum*.

Variation.—Color varies slightly from dark *G. a. andersoni* of the Nile Delta area through paler forms of *G. a. inflatus* inhabiting light-colored beach sand near Burg el Arab and pallid soils of Ras el

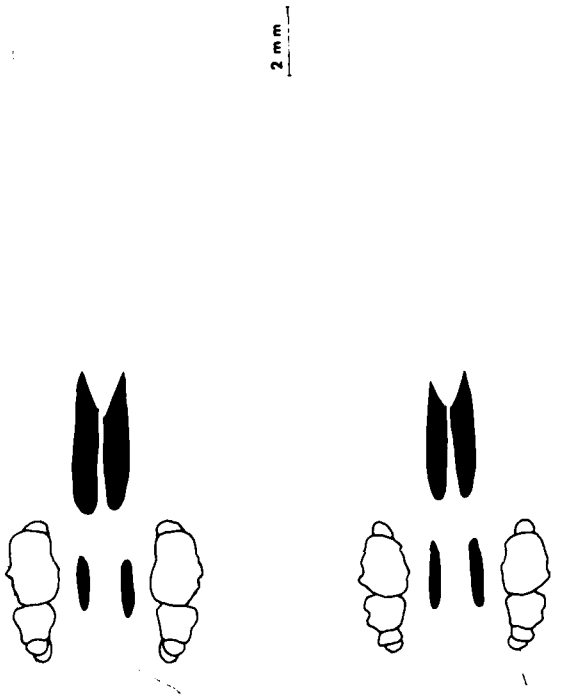


FIG. 41. Posterior margins of nasals (upper) and incisive and posterior palatal foramina (lower) of *Gerbillus andersoni* and *G. gerbillus*.

Hekma, to darker individuals of that subspecies from more western localities. Specimens from northern Sinai are paler than those from the Nile Delta.

Superior posterior mastoid and anterior mastoid chambers show more inflation in *inflatus* west of the Nile Delta and in *bonhotei* of northeastern Sinai (fig. 40, table 9).

TABLE 9. — Comparison of inflation in mastoid chambers of bulla in *Gerbillus andersoni*.

Subspecies	Locality	Number examined	Number with degree of inflation Maximum	Medium	Minimum
G. a. andersoni	Baltim, Idku, other Delta localities	26	—	—	26
G. a. inflatus	Cairo-Alexandria desert road km. 164	3	3	—	—
	Burg el Arab	16	10	3	3
	Ras el Hekma, Mersa Matruh	21	16	5	—
	Buq Buq	18	12	6	—
	Salum	25	14	4	7
G. a. bonhotei	Northeastern Sinai	5	5	—	—

TABLE 10. — Means (and ranges) of measurements, ratios, and weight of adult *Gerbillus gerbillus*.

	G. g. gerbillus	*G. g. asyutensis*	*G. g. sudanensis*
HBL	90.0 (77-104) 164	88.4 (76-97) 108	84.0 (79-93) 30
TL	124.0 (107-137) 161	124.0 (100-143) 104	117.4 (91-128) 29
TL/HBL%	138.0 (118.0-161.5) 159	134.9 (125.8-167.1) 108	140.0 (109.6-151.2) 29
FL	30.2 (28-32) 175	29.4 (26-32) 109	28.0 (25-30) 30
EL	13.2 (12.0-15.0) 171	12.9 (12.0-14.5) 109	12.3 (11.0-14.0) 30
Wt	24.2 (15.0-34.7) 112	22.1 (16.0-33.0) 49	19.2 (13.6-24.2) 17
ONL	28.0 (25.8-30.0) 142	28.0 (25.6-29.5) 99	26.8 (26.4-28.4) 23
ZW	15.2 (13.7-16.2) 122	15.1 (14.1-16.0) 79	14.5 (13.9-15.1) 17
IOW	5.6 (5.0-6.4) 159	5.5 (4.9-6.1) 110	5.2 (4.7-5.7) 19
BCW	13.5 (12.9-14.2) 156	13.4 (12.8-13.9) 109	13.0 (12.7-13.5) 24
NL	10.4 (9.2-11.4) 132	10.3 (9.5-11.4) 95	9.9 (9.3-10.7) 23
IFL	4.4 (3.7-4.9) 156	4.3 (3.8-4.8) 100	4.1 (3.8-4.6) 27
AL	3.9 (3.4-4.6) 155	3.7 (3.2-4.2) 101	3.6 (3.2-4.1) 27
RW	3.8 (3.6-4.2) 158	3.8 (3.5-4.3) 109	3.6 (3.4-3.9) 20
BL	8.5 (7.9-9.3) 154	8.4 (7.4-9.2) 103	8.3 (7.8-8.8) 22
SH	11.2 (10.6-12.0) 142	11.2 (10.5-11.9) 99	10.9 (10.5-11.9) 20

Dimensions given in Table 8 indicate negligible differences between subspecies except in alveolar and bulla lengths.

Comparisons.—*Gerbillus andersoni* is distinguishable from *G. gerbillus* by darker coloration, smaller white rump patch, pigmented ear and sole, base of tail usually not bicolored, longer ear length relative to hind foot length, posterior margin of nasals truncate rather than round or pointed, longer incisive foramina, shorter palatine foramina, shaft of baculum not distinct from base (Wassif et al., 1969), and other characters listed in Table 11 and shown in Figures 40-42. From *Dipodillus campestris*, which it resembles superficially, *G. andersoni* differs in having palm and sole hairy rather than bare, smaller tail brush, greater amount of white hair on rump, larger auditory bulla, opposite rather than alternate arrangement of first lingual and labial cusps of first upper molar, narrower basioccipital.

TABLE 11. – Comparison of characters of *Gerbillus andersoni* and *G. gerbillus*

Character	*G. andersoni*	*G. gerbillus*
Dorsum	darker (brownish orange)	lighter (orange)
Ear	pigmented	not pigmented
Sole	pigmented	not pigmented
Mystacial and suborbital areas	with pigmented hairs	without pigmented hairs
Supraorbital areas	inconspicuous	conspicuous
White rump patch	half size of *gerbillus*	twice size of *andersoni*
Tail	not bicolored at base brush small, dark	bicolored brush large, pale
Posterior margin of nasals	truncate	round or pointed
Mastoid bulla	superior posterior chamber more inflated	inferior posterior chamber more inflated
Incisive (anterior palatine) foramina	longer	shorter
Posterior palatine foramina	shorter	longer
Supraorbital ridge	not anterior to posterior plane of lacrimals	anterior to posterior plane of lacrimals
Ear length	half or slightly more than half hind foot length	less than half hind foot length
Diploid chromosome number (Wassif et al., 1969)	40	male 43 female 42

deeper parapterygoid fossa and other characters in Figures 33, 34, 40, Tables 8 and 12.

From *G. pyramidum*, *G. andersoni* differs in having relatively more inflated bulla, smaller dimensions, less conspicuous dorsal stripe and much smaller and less conspicuous tail brush, although De Winton (1902a, p. 45) described it as "a miniature of *G. pyramidum*." From *G. perpallidus*, *G. andersoni* differs in having darker coloration, smaller white rump patch, sole and ear pigmented, posterior margin of nasals truncate, and averaging less in all dimensions. Further comparisons can be made by examining Figures 37 and 41 and Tables 6 and 8.

For discussion of chromosomal variation, see under Comparisons in *G. pyramidum*.

Remarks.—Synonymy of *G. andersoni* with *G. eatoni* and *G. bonhotei* is based on similarity in coloration, dimensions (table 9), and other features in common. Relationships between *G. andersoni* and *G. bonhotei* were mentioned by Thomas (1919b), Flower (1932), Ellerman (1948), Ellerman and Morrison-Scott (1951), and Wassif (1953b). Note under *G. g. asyutensis* the inclusion of Sinai Peninsula specimens that were misnamed *G. gerbillus bonhotei* by Setzer (1958d). Cockrum et al. (1976a) verified the conspecificity of *andersoni* and *eatoni*.

Collection.—Dug from burrows in sand or captured with live traps.

Habitats.—Sinai Peninsula: Sandy areas in the northeast.

Nile Valley and Delta: Sandy areas in palm groves. Vegetated, cultivated, and noncultivated semidesert.

Oases (Faiyum, Wadi el Natroun, and Siwa): Vegetated sandy areas.

Western Mediterranean Coastal Desert: Coastal dunes of white, nummulitic sand. Dunes adjacent to salt marsh in *Atriplex halimus*. Salt marsh beside *Limoniastrum monopetalum* (fig. 7). Sandy and rocky slopes supporting *Lycium* sp., *Noaea mucronata*, *Thymelaea hirsuta*, and *Onopordon alexandrinum* (a thistle) where it was usually trapped beside *Lycium* bushes (fig. 48). Depressions in sandy loam supporting almost pure stands of *Artemisia inculta*. Sandy areas within stands of *Thymelaea hirsuta*, *Anabasis articulata*, and *Artemisia monosperma* and further inland in discontinuous patches of *A. monosperma* (figs. 19, 20).

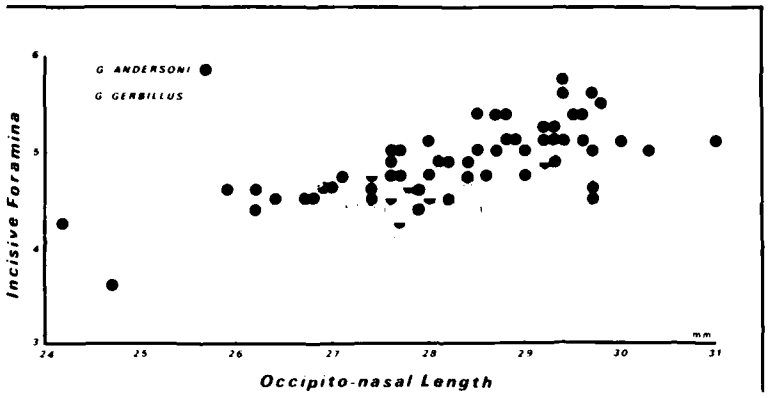


FIG. 42. Scatter diagram of incisive foramina length versus occipitonasal length in *Gerbillus andersoni* and *G. gerbillus*. Half-circles represent individuals of both species at same point. Data from all age groups.

Ranck (1968) mentioned finding the species (under *G. eatoni*) in areas devoid of sand. It is also found in similar situations in Egypt. *Gerbillus andersoni* appears to be more numerous in the Mediterranean Coastal Desert vegetation and coastal sands than *G. gerbillus* and "does not inhabit more rigorous desert areas" (Hoogstraal, 1963, p. 10) as does the latter.

Behavior.—Nocturnal. More docile in captivity than *G. gerbillus*.

Burrows.—Not distinguishable from those of *G. gerbillus*.

Reproduction.—Scattered data from September through June indicate a rather long breeding season. Mean (and range) of litter size from 10 females captured during September, October, and June is 3.9 (3 to 7).

Sex ratio.—In a sample of 251 museum specimens, males numbered 127 (50.6 per cent), and females numbered 124.

Associates.—*Gerbillus andersoni* lives in association with *G. gerbillus*, *G. perpallidus*, *Meriones shawi*, *Dipodillus amoenus*, *D. simoni*, probably *G. pyramidum* and *Jaculus orientalis*, and occasionally *D. campestris* and *Mus musculus*. It may also live in close proximity with *Psammomys obesus*, which burrows beneath *Lycium* bushes (fig. 48).

KEY TO EGYPTIAN SUBSPECIES OF *Gerbillus andersoni*

1. Mastoid chambers not prominently inflated (fig. 40). Dorsum dark. (Nile Delta and El Faiyum) ..... *andersoni*, p. 128.

2. Mastoid chambers prominently inflated (fig. 40).
   a. Dorsum dark. (Western Desert). . . . . *inflatus*, p. 128.
   b. Dorsum paler (Sinai Peninsula). . . . . *bonhotei*, p. 129.

Gerbillus andersoni andersoni De Winton, 1902

Type locality.—Egypt. ALEXANDRIA: Alexandria, El Mandara.

Distribution in Egypt.—Figure 39. Nile Delta, south to Helwan; El Faiyum.

External characters.—See species description. Generally darker than other subspecies.

Cranial characters.—Figure 40. Bulla less swollen than in other subspecies, particularly mastoid chambers (table 9).

Measurements.—Table 8. Dimensions about equal to those of *inflatus* and *bonhotei*, except for longer nasal length, shorter alveolar length, and shorter bulla length in *andersoni*.

Variations.—One albinistic specimen was collected from Imbaba, Giza Governorate.

Specimens examined.—Total 89.

DAMIETTA: Damietta W of (6), Kafr el Battikh (2).
KAFR EL SHEIKH: Baltim (19), El Burg (8), Lake Burullus eastern shore (2).
ALEXANDRIA: Dikheila airfield 0.8 km. W (1); El Mandara (Type); Abu Qir (2); El Muntaza 0.8 km. W (1), 0.8 km. E (1); Amiriya (2).
MUNUFIYA: Quweisna (6).
BEHEIRA: Rosetta (1), Lake Burullus area (6), Idku (12), Kom Hamada (2), Kafr Dawud (2), El Khatatba (3).
GIZA: Wardan (3); Abu Rawash (2); Cairo-Faiyum road km. 3 (1), km. 30 (3).
CAIRO: Helwan (2).
EL FAIYUM: Faiyum (1), Kom O Shim (1).

Published records.—Records are from De Winton, (1902a, 1903), Innes (1932), Ellerman (1949), and Setzer (1952, 1958d).

DAMIETTA: Damietta, Kafr el Battikh.
KAFR EL SHEIKH: Burullus W of Damietta, Baltim, El Burg.
MINUFIYA: Quweisna.
ALEXANDRIA: Idku, El Mandara, Dikheila airfield 0.8 km. W, Muntaza 0.8 km. E, Amiriya.
BEHEIRA: Rosetta, Kom Hamada, Kafr Dawud, El Khatatba.
GIZA: Wardan.

Gerbillus andersoni inflatus (Ranck, 1968)

Gerbillus eatoni inflatus Ranck, 1968, U.S. Nat. Mus. Bull., No. 275, p. 97.

Type locality.—Libya. CYRENAICA: Fort Cappuzo 10 km. SW.

Distribution in Egypt.—Figure 39. Western Mediterranean Coastal Desert west of Nile Delta to northeastern Libya; Wadi el Natroun and Siwa Oasis.

External characters.—Brownish orange dorsally; differs little from nominate subspecies. Pale individuals occur on light-colored coastal sands and pallid soils of Ras el Hekma and sand sheets in Wadi el Natroun.

Cranial characters.—Figure 40. Mastoid chamber of auditory bulla more inflated than in *andersoni*, but about the same as in *bonhotei* (table 9).

Measurements.—Table 8. Dimensions about equal to those of the nominate subspecies, except for greater bulla and alveolar lengths and shorter nasal length. Means (and ranges) of measurements (in millimeters) from Ranck (1968) of five adult males from the type locality are: total length 226 (218 to 236), tail length 125 (121 to 131), hind foot length 27.2 (26 to 28), ear length 15.4 (15 to 16), occipitonasal length 30.6 (29.9 to 31.7), zygomatic width 16.1 (15.6 to 16.4), interorbital width 5.9 (5.5 to 6.5), and nasal length 11.7 (11.4 to 12.3).

Specimens examined.—Total 178.

TAHREER: Cairo-Alexandria desert road km. 90 (1), km. 164 (8), km. 195 (1).
BEHEIRA: Wadi el Natroun (3).
MATRUH: Alexandria-Salum road km. 54 (8); Lake Mariut (1); Bahig 33.6 km. S (6), 38.4 km. S (1), 51.2 km. S (2); El Alamein (1); Abu Haggag 3.2 km. E (1); Ras el Hekma (38); Mersa Matruh (16), 32 km. E (2); Matruh-Qara desert road 18 km. S (3); Zawyet el Mithnivan (3); Sidi Barrani (1), 32 km. E (3), 19.2 km. E (2), 19.2 km. S (2), 4.8 km. S (1), 19.2 km. SW (5), 32 km. SW (1), 52.8 km. W (1); Buq Buq 11.2 km. SW (17); Salum (5), 24 km. E (1), 22 km. E (4), 19.2 km. E (6), 18.7 km. E (9), 16 km. E (13), 10 km. E (1), 8 km. SE (1), 6 km. S (1); Bir Bosslanga (Bir Wair) (1); Siwa Oasis (3).
Libya. CYRENAICA: Fort Capuzzo 10 km. SW (5).

Published records.—Records are from Ellerman (1949), Setzer (1958d), and Ranck (1968).

Egypt. TAHREER: Cairo-Alexandria desert road km. 195 (junction of Alexandria and Mersa Matruh roads).
MATRUH: Burg el Arab, Mersa Matruh; Sidi Barrani 19.2 km. SW, 32 km. E, 52.8 km. W.
Libya. CYRENAICA: Fort Capuzzo 10 km. SW.

Gerbillus andersoni bonhotei (Thomas, 1919)

Type locality.—Egypt. SINAI: Khubra Abu Guzoar.

Distribution in Egypt.—Figure 39. Northeastern Sinai Peninsula.

External characters.—Palest of three subspecies; being more similar in color to *G. gerbillus.*

Cranial characters.—The outstanding feature separating *bonhotei* from *andersoni* is greater inflation of bulla, in which it is comparable to *inflatus* in Figure 40 and Table 9.

Measurements.—Table 8. Dimensions somewhat smaller in general than other subspecies, but sample is smallest of three and data may not be too reliable. Bulla length, however, appears to be slightly longer in *bonhotei* than in other subspecies.

Remarks.—Setzer (1958d) and then Hoogstraal (1963) erroneously applied *G. gerbillus bonhotei* to Sinai and Suez specimens of *G. gerbillus asyutensis.*

Specimens examined.—Total six.

SINAI: Khubra Abu Guzoar, (Type, 3), Wadi Hareidin (1), Gebel Lehfan (1).

Published records.—Records are from Thomas (1919b), Flower (1932), Wassif (1953c).

SINAI: Khubra Abu Guzoar, Wadi Hareidin, Gebel Lehfan.

Gerbillus gerbillus (Olivier, 1801)

Dipus gerbillus Olivier, 1801, Bull. Sci. Philom. Paris, 2, p. 121.

Type locality.—Egypt. GIZA: Probably near the pyramids.

General distribution.—Israel, Sinai Peninsula, Egypt, Libya, Sudan, Uganda, parts of Niger, Mauritania, Chad, and Mali.

Common names.—Lesser Gerbil, *Bayoudi.*

Distribution of subspecies in Egypt.—Figure 43. *Gerbillus gerbillus asuytensis*: Sinai Peninsula, northern part of Eastern Desert; *Gerbillus gerbillus sudanensis*: Southern part of Eastern Desert; *Gerbillus gerbillus gerbillus*: Nile Delta and Western Desert.

Diagnosis.—Small yellowish orange gerbil with ear and sole not pigmented. Tail bicolored; brush moderately conspicuous, grayish to brownish. White supraorbital and postauricular markings and white rump patch prominent. Ear length less than one-half hind foot length. Skull with large bulla, incisive foramina relatively short, palatine foramina relatively long, and posterior margin of nasals round or pointed.

Adult head and body length average 88 mm.; tail 123 mm., 138

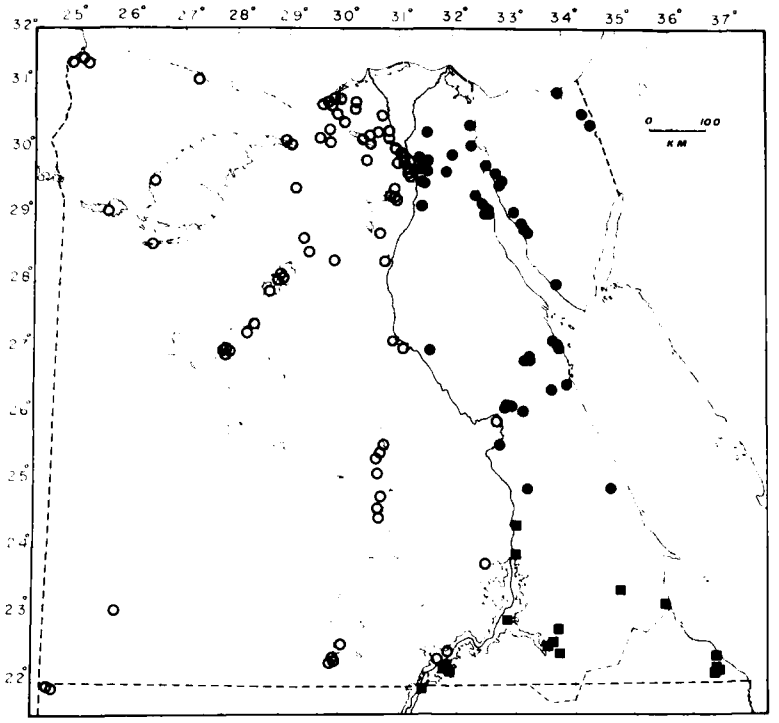


FIG. 43. Collection localities of *Gerbillus gerbillus gerbillus* (circles), *G. g. asyutensis* (dots), and *G. g. sudanensis* (squares).

per cent of head and body length; foot 30 mm.; ear 13 mm.; occipitonasal length 28.0 mm.; weight 23 gm.

External characters.—Figure 44. Upper parts pale yellowish orange to reddish orange. Dorsum slightly darker than side, contrasted further in some specimens by brownish tipped hairs, especially on rump. Color of side not extending onto foreleg or further than thigh on hind limb. Hairs of dorsum with gray bases, of side with white bases. Hair of underparts, feet, and entire ventral surface of tail white. Mystacial, suborbital, supraorbital, and postauricular areas white. White hairs nearly circumorbital in palest specimens. White rump patch large, conspicuous. Tail completely bicolored; dorsal color as back; brush fairly conspicuous,

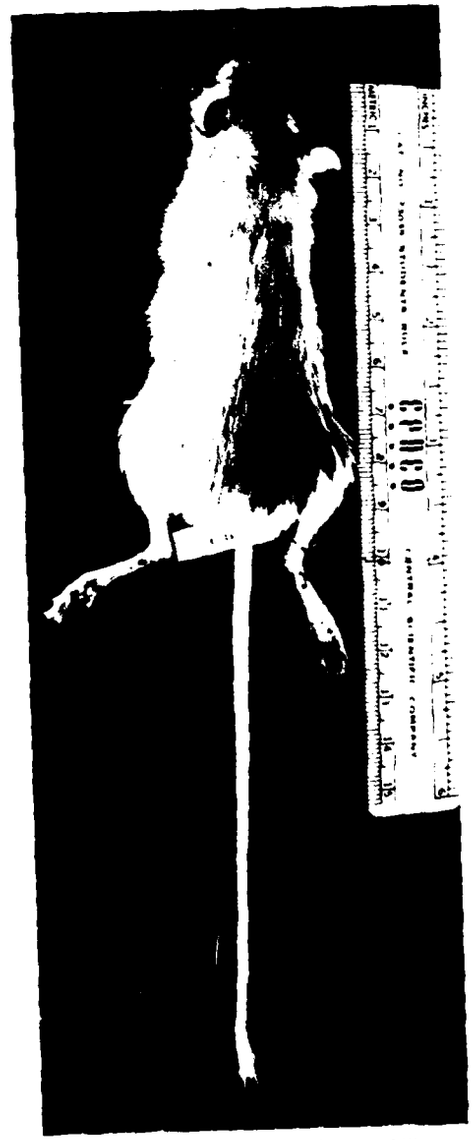


FIG. 44. Cadaver of *Gerbillus gerbillus*

grayish to brownish, and slightly more than one-third of tail length. Ear margin blackish, but ear not pigmented.

Palatal ridges.—Figure 33. Diastemal ridges broadly U-shaped; first to third intermolar ridges recurved; fourth intermolar small, crenulated; fifth directed medially, also crenulated.

Glans penis and baculum.—See under *G. pyramidum* and *G. andersoni.*

Feet.—Figure 34. Palm and sole almost completely haired. Front foot with one large, soft postidigital pad bearing proximal accessory lobe. Hind foot with large, lobed postdigital pad and indistinct posthallucal tubercle. Sole not pigmented.

Cranial characters.—Figure 40. Skull smallest of Egyptian species of *Gerbillus.* Supraorbital ridge well developed, extending anterior to level of posterior plane of lacrymal bone. Bulla more inflated than in other species of *Gerbillus.* Posterior margin of nasals round or pointed. Incisive foramina relatively short; palatine foramina relatively long (fig. 41). Anterior margin of zygomatic plate sloping anteriorly and usually reaching level of premaxillary-maxillary suture. Parapterygoid fossa deep, partly closed. Anterior margin of tympanic bulla reaching level of anterior margin of foramen ovale. Posterior margin of mastoid chambers extending beyond occipital condyle, but not to level of supraoccipital. Lateral inferior posterior mastoid chamber more inflated than lateral superior posterior chamber (fig. 40). Lip of external auditory meatus slightly thickened in adults.

Teeth.—Figure 38. See description under *G. pyramidum.*

Measurements.—Table 10. Smallest *Gerbillus* species in Egypt. Male and female dimensions subequal. Means (and ranges) of occipitonasal length (in millimeters) of 10 adult males and 10 adult females, respectively, are 27.9 (26.7 to 29.3) and 27.4 (26.7 to 28.2). Note that ear length averages less than one-half hind foot length.

Age determination.—Adults are determined by tooth wear and suture closure as in *G. pyramidum.*

Variation.—Color varies from pale yellowish orange through orangish and reddish orange in Western Desert *G. g. gerbillus.* Individuals from oases and western Nile Valley and Delta localities are slightly darker. Reddish orange specimens are from southern Wadi el Gedeed (Bir Qiseiba, Bir Kurayim, and Bir el Shab).

Samples from Sinai Peninsula and northern Eastern Desert, assigned to *G. g. asyutensis*, are slightly paler than *G. g. gerbillus* and have brownish hairs on dorsum and rump. Specimens from southern Eastern Desert, assigned to *G. g. sudanensis*, are darker than *G. g. asyutensis* and *G. g. gerbillus* from west bank of the Nile.

Size variation shows no definite directional trends among Western Desert samples. In the Eastern Desert, there is a decrease in most dimensions from north to south between *G. g. asyutensis* and *G. g. sudanensis* (table 10).

Comparisons.—Differences between *G. gerbillus* and *G. andersoni* are discussed under the latter, listed in Table 11, and shown in Figures 40-42. From *G. perpallidus* and *G. pyramidum*, *G. gerbillus* differs distinctly in dimensions (tables 7, 10) and shape of posterior margin of nasals (figs. 37, 41), and from *G. pyramidum*, in much paler color. From *Dipodillus campestris*, *G. gerbillus* can be distinguished by paler color, restriction of color in facial region, hair on soles, larger auditory bulla, shorter incisive foramina, opposite rather than alternate arrangement of first lingual and labial cusps of m^1, and narrower basioccipital.

Collection.—Easily trapped or dug from burrows in sand.

Habitats.—Sinai Peninsula: Dunes and alluvium in wadis. Limited, according to Haim and Tchernov (1974), to elevations below 1,100 m. and correlated with the distribution of *Hammada elegans*.

Nile Valley and Delta: Sand patches in palm groves and cultivated areas. Sandy areas of semidesert supporting bunch grasses (*Stipagrostis scoparia* and *Panicum turgidum*), reeds (*Phragmites australis*), and shrubs such as *Heliotropium digynum* (Briscoe, 1956; Yunker and Guirgis, 1969).

Eastern Desert: Patches of windblown sand in wadis; sand and fine gravel accumulations around trees and shrubs (fig. 15); patches of prostrate *Citrullus colocynthis* (bitter melon), as noted also by Bauer (1963), together with the jird, *Meriones crassus*; and littoral areas in sand mounds around *Nitraria retusa*. Common where sand accumulates beside houses and in sand littered with empty tins, broken pottery, and remains of reed matting.

Western Mediterranean Coastal Desert: Coastal dunes of white nummilitic sand (fig. 7). Adjacent to and sometimes in salt marshes. Sandy areas within the coastal vegetation. Incidentally, *G. ander-*

soni is more numerous than *G. gerbillus* throughout the littoral desert.

Western Desert: Wherever there are plants and sand (figs. 9, 10), although seldom in clumps of *Tamarix* sp. Occasionally found in barren areas far from vegetation where windblown detritus apparently provides food.

Oases: Vegetated, sandy areas similar to habitats described above, and debris beneath palm trees.

In all barren or vegetated desert areas, campsites attract *G. gerbillus*. As *G. pyramidum*, *G. perpallidus*, and *Meriones crassus*, it is also attracted to camel dung.

Behavior.—Nocturnal. Very nervous, bites when first handled, but becomes quite tame with repeated handling.

Burrows.—Yunker and Guirgis (1969) studied gerbil burrows in the desert and semidesert near Cairo. Burrows in desert were in flat sandy areas, rarely under plants. Burrows in semidesert were sometimes dug among roots of plants. Occupied burrows were plugged with sand during the warm period of the year (March through December) and open during the cooler wet season (January and February). A typical burrow reached a depth of 30 to 60 cm. Desert burrows were deeper (50 to 80 cm.) during the cool period. The main passage ranged from about 50 cm. to about 4.5 m. with one to four short passages, some ending blindly and containing food caches, nest materials, and/or gerbils.

Burrow microclimate.—Despite extreme temperature fluctuations in sand and outside air, Yunker and Guirgis (1969) found that temperature in burrows varied only a few degrees during a 24-hour period. Relative humidity (RH) tended to follow the 24-hour curve of readings for outside air, but at a 30 to 60 per cent higher average value. On January 24 and 25, outside air temperatures ranged from 47 to 72 degrees F, surface sand, 46 to 82 degrees F, whereas burrow temperatures were 57 degrees $\pm$ 7 in semidesert and 56 degrees $\pm$ 2 in desert. On May 23 and 24, outside air RH ranged from 15 to 88 per cent, whereas burrow RH was 81 to 100 per cent. From January to August, semidesert burrow RH averaged 10 per cent higher than desert burrow RH.

Food.—Although Bodenheimer (1935) stated that gerbils feed on seeds, roots, and insects, no locusts, crickets, butterflies, or beetles

placed in cages with Egyptian *G. gerbillus* were killed or eaten. Food in the desert is mainly seeds, leaves, buds, and fruits. Camel dung is torn apart by gerbils in search of seeds and fibers. Schmidt-Nielsen (1964) reported that this rodent can live on dry food. The physiologic features of water metabolism on this diet was studied by Burns (1956).

Food items and remnants in semidesert burrows consisted of date seeds; camel droppings; and seeds, spikes, and husks of cereal grains and other plants. Dry seeds were thought to be the staple food of desert gerbils by Yunker and Guirgis (1969).

Associates.—Although *G. gerbillus*, *G. andersoni*, *G. perpallidus*, and *G. pyramidum* are sometimes collected in the same habitat, behavioral and other relationships among them are unknown. Other species occurring with *G. gerbillus* are *Jaculus jaculus* and, in some areas, *Dipodillus amoenus*, *Pachyuromys duprasi*, *Meriones crassus*, and *M. libycus*. Burrow inhabitants listed by Yunker and Guirgis (1969) include lizards and toads (in semidesert only) and about 44 species in 14 orders of arthropods, mostly in semidesert burrows.

Reproduction.—From evidence of swollen, descended testes of males and pregnant and lactating females, the breeding period appears to be January through May. Mean (and range) of litter size of seven females captured during April and May was 4.3 (3 to 6).

Sex ratio.—In a sample of 247 museum specimens of lesser gerbils, males numbered 138 (56 per cent) and females numbered 109.

Commensalism.—Readily enters permanent or temporary dwellings in search of food or shelter (Flower, 1932, p. 416).

KEY TO EGYPTIAN SUBSPECIES OF *Gerbillus gerbillus*

1. Dorsum hairs brownish tipped; pale, yellowish orange. Dimensions about as in gerbillus. (Sinai Peninsula and northern part of Eastern Desert). . . . . *asyutensis*, p. 136.
2. Dorsum hairs not brownish tipped.
   a. Dark, clear orange. Size smaller. (Southern part of Eastern Desert). . . . . *sudanensis*, p. 138.
   b. Orange to reddish orange. Size larger. (Western Desert). . . . . *gerbillus*, p. 139.

Gerbillus gerbillus asyutensis Setzer, 1960

Gerbillus gerbillus asyutensis Setzer, 1960, J. Egypt. Publ. Health Assn., **33**, No. 1, p. 3.

Type locality.—Egypt. ASYUT: Wadi Asyuti.

Distribution in Egypt.—Figure 43. Sinai Peninsula and northern part of Eastern Desert.

External characters.—Dorsum pale yellowish orange with conspicuous brownish-tipped hairs, particularly on rump.

Cranial characters.—See species description.

Measurements.—Table 10.

Variation.—There is slight variation in size among samples of *G. g. asyutensis*. Between samples of this subspecies and *G. g. sudanensis*, however, there is a noticeable decrease in the means of most measurements.

Color varies from very pale in Wadi Asyuti (type locality) to darker along the Gulf of Suez and Red Sea coast. Samples from northwestern Eastern Desert are slightly darker than those from Sinai. Scattered individuals from wadis east of the Red Sea Hills are as pale as Wadi Asyuti sample described by Setzer (1960b).

Comparison.—Of 38 *G. g. gerbillus* specimens from the northeastern part of the Western Desert, three were as pale as Eastern Desert *G. g. asyutensis*. Of 51 specimens of *G. g. asyutensis* from the northern part of the Eastern Desert, six were as dark as Western Desert *G. g. gerbillus*.

The only difference between *G. g. asyutensis* and the nominate subspecies is slightly paler basic coloration and conspicuous dark-tipped hairs on the dorsum, particularly on the rump. Size difference between these two subspecies is negligible (table 10).

Between *G. g. asyutensis* and *G. g. sudanensis*, there are more noticeable differences in color and size. The latter is darker and averages smaller in nearly all dimensions (table 10).

Remarks.—Setzer's (1959d) application of the trinomen *bonhotei* to *G. gerbillus* from Sinai was in error. Specimens recognizable as *G. bonhotei* Thomas are synonymous with *G. andersoni* De Winton. The subspecies of *G. gerbillus* in Sinai is *G. g. asyutensis*.

Specimens examined.—Total 236.

SINAI: El Arish (7), Abu Aweigila (2), El Quseima (7), Abu Zenima (1), Ras Abu Rudeis (2), Wadi Sidr (4), Feiran Oasis (1), Ayun Musa (1).

ISMAILIA: Fayid 4.8 km. NW (13), Ismailia (1).

SUEZ: Cairo-Suez road km. 29 (1), Maadi 32 km. E (1), Wadi el Gafra (25), Wadi Iseili (8), Suez (1), Ain Sukhna (5), Wadi Nakhl (1), Wadi Abu Seyala (2), Wadi Qiseib (1), Wadi Dom (1).

RED SEA: Ras Abu el Darag 1 km. N (1); Wadi el Nil (23); Bir Zafarana (6); Ras Zafarana (9); Wadi Araba (3); Bir Abu Shaar (5); Wadi Abu Shaar (2); Wadi Bali (3); El Ahiah (2); Hurghada (1), 12 km. S (3), 14 km. S (1), 20 km. S (1); Wadi el Qreiya, Qena-Safaga road km. 77 (4); Wadi Abu Sheeh, Qena-Safaga road km. 80 (3); Wadi Umm Seleimat (2); El Kanayis (2); Wadi Umm Huweitat (1); Wadi Abu Quraiya (2); Disht el Daba road (2); Safaga 6.4 km. S (6); Abu Kharif mine area (5); Wadi Abu Zawil (4); Bir Abu Zawil (3), 6.4 km. W (6); Wadi Fatira (2); Wadi Abu Ziran (3).

SHARQIYA: Bilbeis (1).

CAIRO: Heliopolis 8 km. E (1), 12.8 km. E (9); Wadi Digla (1); Helwan (5).

ASYUT: Wadi Asyuti (20).

QENA: Wadi Qena, el Saqiya (1); Luxor (8).

Published records.—Records are from Anderson (1902), Allen (1915), Flower (1932), Wassif (1953b), Wassif and Hoogstraal (1954), Setzer (1952, 1958, 1960b), and Hoogstraal (1963).

SINAI: El Arish, Abu Aweigila, El Quseima, Ras Abu Rudeis, Abu Zenima 8 km. N, Feiran Oasis 14 km. W, Tor; Ayun Musa, Wadi Gharandal (Shurandel), Bir el Suweir (Suweira).

SUEZ: Suez, Fani

CAIRO: Heliopolis 8 km. E, Helwan 2 km. SE.

ASYUT: Wadi Asyuti.

Gerbillus gerbillus sudanensis Setzer, 1956

Gerbillus gerbillus sudanensis Setzer, 1956, J. Egypt Publ. Health Assn., 33, p. 220.

Type locality.—Sudan. KASSALA: Port Sudan.

Distribution in Egypt.—Figure 43. Southern part of Eastern Desert.

External characters.—Dorsum dark, clear orangish.

Cranial characters.—See species description.

Measurements.—Table 10. Smallest Egyptian subspecies of *G. gerbillus.*

Comparison.—See subspecies *gerbillus* and *asyutensis.* The zone of *asyutensis* and *sudanensis* intergradation is between Luxor and Aswan and extends eastward to the Red Sea. There is no intergradation with *G. g. gerbillus.*

Specimens examined.—Total 63.

RED SEA: Wadi Hodein (1), Bir Abraq (4).

SUDAN ADMINISTRATIVE: Wadi Adeib (5); Bir Kansisrob (1), 1.6 km. N (1); Abu Ramad (1).

ASWAN: Kom Ombo (6), Muneiha (8), Adindan (1), Armina Temple (1), Wadi Or (1), Qustul (1), Allaqi 11.2 km. S (8), Wadi Allaqi (1), Wadi Umm Qareiyat (3), Wadi

Nagib (5), Wadi Haimur mine area (2), Bir Murra 3.2 km. N (2), Wadi Abusku (4), Wadi Quleib (6), Gebel Magal Gabril (1).

Published records.—Records are from Hoogstraal et al. (1957b), Setzer (1958d, 1960b), and Bauer (1963).

RED SEA: Wadi Hodein, Bir Abraq.
SUDAN ADMINISTRATIVE: Wadi Adeib, Bir Kansisrob 1.6 km. N.
ASWAN: Aswan 1.6 km. SE.
Sudan. NORTHERN: Wadi Halfa, Khor Musa Pasha.

Gerbillus gerbillus gerbillus (Olivier, 1801)

Type locality.—Egypt. GIZA: Probably near the pyramids.

Distribution in Egypt.—Figure 43. Nile Delta and Western Desert.

External characters.—Dorsum orangish to reddish orange and usually lacking brownish tipped hairs.

Cranial characters.—See species description.

Measurements.—Table 10. See species description.

Variation.—See species description.

Comparison.—Differs from *G. g. asyutensis* in darker, clearer, and more orangish dorsum; and lack of brownish tipped hairs. Dimensions average slightly larger (table 10).

Differs from *G. g. sudanesis* in slightly paler dorsum and averages considerably larger in most dimensions (table 10).

Specimens examined.—Total 500.

ALEXANDRIA: El Amiriya (1).
TAHREER: Cairo-Alexandria desert road km. 110, 0.5 km. E (4), km. 143 (3).
BEHEIRA: Abu el Matamir (1); El Khatatba (2); El Birigat (1); Kafr Dawud (2); Kom Hamada (5), Bir Victoria (5); Wadi el Natroun (31), 5 km. W (9).
MATRUH: Alexandria-Salum road km. 54, 0.5 km. N (1); Bahig (1), 42 km. S (3), 51 km. S (7); Abu Mena E of (1); Burg el Arab (1); El Hawa 20 km. S of El Hamman (1); El Quweirat el Sud (1); Qasr el Qatagi (2); Nakhlat el Barraq (6); El Maghra (27), 120 km. S (10); Bir Nahid (5); Wadi Labaq (6); Minqar Abu Dweiss area (3); Camel Pass Dune area (6); Mersa Matruh 19 km. E (3); Salum 10 km. E (2), 16 km. E (1), 18 km. E (2), 19 km. E (5); Sidi Omar (1); French Camp No. 2 (1); Qara Oasis (1); Siwa Oasis (2); Aghurmi 5 km. E (3); El Maragi (5); Bahrein (6); Ain el Dakrur (10); Ain el Baqar (1).
GIZA: Cairo-Alexandria desert road km. 10 (1), km. 12 (1), km. 31 (1); Abu Ghalib (7); Abu Rawash (6); Abu Sir (4); El Mansuriya (5); Giza Pyramids (3); Mena (1); El Qatta (2); Sakkara (2); Cairo-Bahariya Oasis road km. 20 (2); Cairo-Bahariya Oasis Track km. 208, acacia grove area 6 km. SE (1); Bahariya Oasis, Bir Qasr No. 1 (40), No. 2 (7), No. 3 (13), El Hara (10), Bawiti (3), 14 km. S (6); El Aguz (6); Ain Marun (2); Ain el Beilda (8); Wadi Ghorabi (7); Uyun Tab-Limun (9); Hatiyet Tabany (1).

EL FAIYUM: Shooting club (1), Qasr Rashwan (2), Tag[illegible]a (1), Wadi Muwellih (15).

MINYA: Beni Mazar (1), Hatiyet el Sunt (2).

ASYUT: Beni Adi (8).

QENA: Dandara 6 to 8 km. S (1).

ASWAN: Kurkur Oasis (2), Seiyala (2), Abu Simbel (1).

EL WADI EL GEDEED: Farafara Oasis, 4.8 km. N (2); El Khanafis (2); Ain El Tinnin (2); Ain Besai (3); Ain el Wadi (2), Qokshira (2); Wadi Hennis (3); Batras 6.4 km. E (2); El Kharga 60 km. N (2); Kharga Oasis (4); Ganah (2); El Gezira (8); Ezbet Muhib (4); Nasser village (3); Ain Eede (11); El Mahariq (2); Ganah (2); Baris (3), 17 km. S (8); Bir Qiseiba (19); Bir Kurayim (17), 1 km. E (1), 1.5 km. E (1), 5 km. E (2); Bir el Shab (3), 6.5 km. ESE (10); Gilf el Kebir (1).

Sudan. NORTHERN: Gebel Uweinat, Karkur Murr (7).

Published records.—Records are from Anderson (1902), De Winton (1903), Bonhote (1912), Flower (1932), Hayman (1948), Setzer (1952, 1958d), Wassif (1960ab), Bauer (1963), and Osborn and Krombein (1969).

BEHEIRA: El Birigat; Zaghig; Bir Victoria; Wadi el Natroun.

GIZA: El Mansuriya; Ezbet Afifi Pasha; Abu Sir; Imbaba, Abu Ghalib; Abu Rawash; Atfih; Giza, Giza Pyramid area, Giza pyramid 8 km. NW; Sakkara; Bahariya Oasis, El Heiz, El Bawiti 40 km. S.

EL FAIYUM: Kom O Shim, Ezbet Aiyub Ali, Qasr Rashwan.

ASYUT: Beni Adi.

MATRUH: El Maghra, Siwa 6.4 km. E.

EL WADI EL GEDEED: Kharga Oasis, El Kharga, El Mahariq, Baris.

Sudan. NORTHERN: Faras West 4 km. S; Gebel Uweinat, Karkur Murr.

Genus **Dipodillus** Lataste, 1881

Orangish brown to yellowish brown rodents of varying size. Tail longer than head and body, except in *D. simoni*. Tail brush variable. Palm and sole bare. Hand with three subdigital tubercles and two palmar pads. Foot with three subdigital, one subhallucal, and two plantar tubercles (fig. 34).

Braincase usually slightly inflated and supraoccipital swollen beyond level of occipital condyle. Cranial ridges not strongly developed except supraorbitals. Some species have auditory meatus lip modified or swollen. Accessory tympanum present or absent. Chambers and cavities in mastoid bulla vary with species (fig. 47).

Upper incisor with single groove on anterior surface. Molars tuberculate, becoming laminate with wear in most species. First labial and lingual cusps of m^1 alternate, at least in immatures (fig. 38).

KEYS TO EGYPTIAN SPECIES OF *Dipodillus*

External Characters

1. Tail considerably longer than head and body.
   a. Tail usually with a conspicuous brush. White rump patch inconspicuous or absent.
      i. Color orangish brown. (Western Desert)..... *campestris*, p. 141.
      ii. Color yellowish brown.
         (a) Paler form without blackish hairs extending to base on upper side of tail surface. (Sinai Peninsula and northern Eastern Desert). *dasyurus*, p. 155.
         (b) Darker form with blackish hairs extending to base on upper side of tail. (Southern Eastern Desert)..... *mackilligini*, p. 159.
   b. Tail without a conspicuous brush. White rump patch conspicuous.
      i. Ear tip pigmented. Dorsum dark..... *amoenus*, p. 167.
      ii. Ear tip not pigmented. Dorsum pale..... *henleyi*, p. 174.
2. Tail less than to slightly longer than head and body and lacking a brush. Whitish rump patch absent. (Western Mediterranean Coastal Desert)..... *simoni*, p. 161.

Cranial Characters

1. Lip of auditory meatus not swollen.
   a. Accessory tympanum absent.
      i. Cavity of subarcuate fossa large and conspicuous (fig. 47).
         (a) Bulla not inflated beyond exoccipital. (Western Desert) *campestris*, p. 141.
         (b) Bulla inflated beyond exoccipital. (Sinai Peninsula and northern Eastern Desert)..... *dasyurus*, p. 155.
      ii. Cavity of subarcuate fossa small (fig. 47). Bulla inflated beyond level of exoccipital. (Southern Eastern Desert)..... *mackilligini*, p. 159.
   b. Accessory tympanum present. Cavity of subarcuate fossa large (fig. 47). Bulla not inflated beyond exoccipital. Shape of m^1 distinctive (figs. 38, 52)..... *simoni*, p. 161.
2. Lip of auditory meatus swollen.
   a. Swelling is an anterodorsal protuberance (fig. 35). Shape of m^1, m^2 distinctive (figs. 38, 52)..... *amoenus*, p. 167.
   b. Entire lip swollen (fig. 47). Shape of m^1 distinctive (figs. 38, 52). *henleyi*, p. 174.

Dipodillus campestris (Levaillant, 1857)

Gerbillus campestris Levaillant, 1857, Atlas Expl. Sci. Alg. Mamm., pl. V, fig. 2.

Type locality.—Algeria. CONSTANTINE: Phillipeville.

General distribution.—Egypt west of Nile River and Delta, northern Sudan, Libya, Tunisia, Algeria, Morocco, and probably northern Chad and Niger.

Common name.—Large North African Dipodil.

Distribution of subspecies in Egypt.—Figure 45. *Dipodillus campestris wassifi*: Western Mediterranean Coastal Desert; *Dipodillus campestris haymani*: Farafara Oasis, Qattara Depression, Siwa Oasis, and depressions west to Giarabub; *Dipodillus*

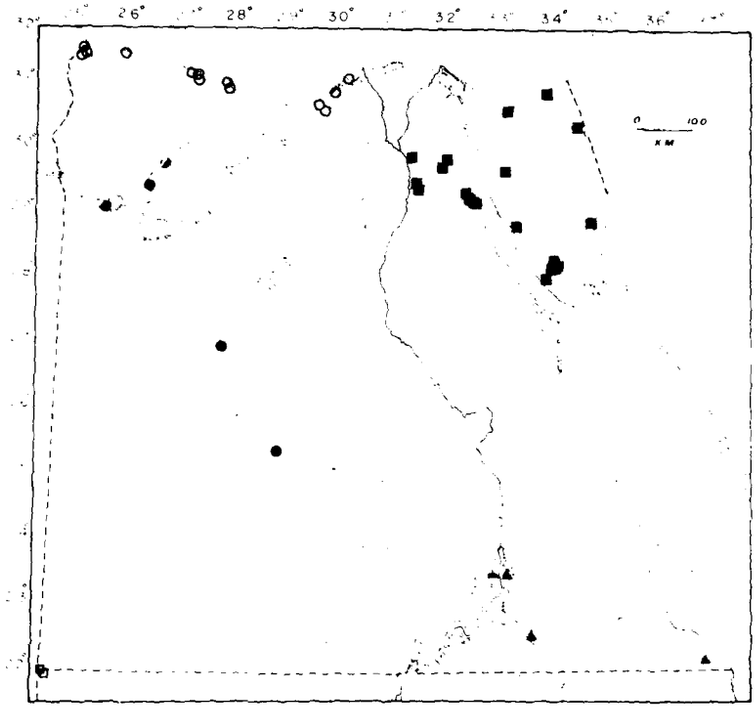


FIG. 45. Collection localities of *Dipodillus campestris wassifi* (circles), *D. c. haymani* (dots), *D. c. patrizii* (open squares), *D. c. venustus* (half circle), *D. dasyurus dasyurus* (solid squares), and *D. mackilligini* (triangles).

campestris patrizii: wadis of Gebel Uweinat and probably Gilf el Kebir; *Dipodillus campestris venustus:* west bank of Nile in Upper Egypt.

Diagnosis.—Orangish brown, slightly larger than lesser gerbil (*Gerbillus gerbillus*). Fur long, soft. Tail long, brush of varying size. Ears prominent, pigmented. Supraorbital and postauricular markings and whitish rump patch inconspicuous. Skull with bulla moderately inflated, lip of external auditory meatus unmodified, accessory tympanum absent, parapterygoid fossa shallow and open, basioccipital conspicuously broad, incisive foramina elongate, and posterior margin of nasals usually divided.

Largest of Egyptian species of *Dipodillus*. Adult head and body length average 100 mm.; tail 134 mm., 138 per cent of head and body length; foot 26 mm.; ear 17 mm.; occipitonasal length 30.0 mm.; weight 30.8 gm.

External characters.—Figure 46. Upper parts orangish to brownish. Dorsum with or without coarse agouti pattern ("streaked appearance" of Ranck, 1968, p. 141). Color gradually paling to narrow border of clear orangish on side and foreleg. All hairs of dorsum and side, except for narrow ventrolateral strip, with gray bases. Width of orangish subterminal bands and brownish tips variable. Darkest individuals without streaking on dorsum and rump. Hair of underparts and feet white. Conspicuous, broad band of dark-tipped hairs extending from mystacial area beneath eye to base of ear. Postorbital and postauricular areas of whitish hairs with dark tips and inconspicuous. Rump patch inconspicuous, white bands on hairs present or absent. Tail distinctly or indistinctly bicolored, upper surface as back, ventral surface whitish to brownish; brush conspicuous or inconspicuous, graying to fuscous or blackish, one-third to one-half of tail length. Ear pigmented.

Palatal ridges.—Figure 33. First diastemal ridge slightly curved, second diastemal ridge relatively straight. First, second, and third intermolar ridges relatively long and recurved; fourth very small; fifth large and slightly recurved.

Glans penis and baculum.—Compare notes under other species of *Dipodillus* and *Gerbillus*.

Feet.—Figure 34. Palm and sole hairless. Plantar tubercles distinct, but slightly smaller than in *D. dasyurus*. Two proximal plantar tubercles and hallucal tubercle about equidistantly spaced. Proximal nongranular part of sole pigmented.

Cranial characters.—Figure 47. Skull largest, zygomatic arch heaviest, supraorbital ridge thickest, basioccipital broadest, and auditory bulla least inflated of Egyptian species of *Dipodillus*. Posterior margin of nasals usually bifurcated, otherwise irregular or truncate. Incisive foramina relatively long, zygomatic plate large and, in adults, covering infraorbital foramen and posterior part of premaxillary-maxillary suture. Parapterygoid fossa open and shallow. Anterior margin of tympanic bulla reaching level of middle of foramen ovale. Posterior margin of mastoid bulla not extending beyond exoccipital. Anterior mastoid chamber filling less than one-

FIG. 46. Live specimen of *Dipodillus campestris wassifi*.

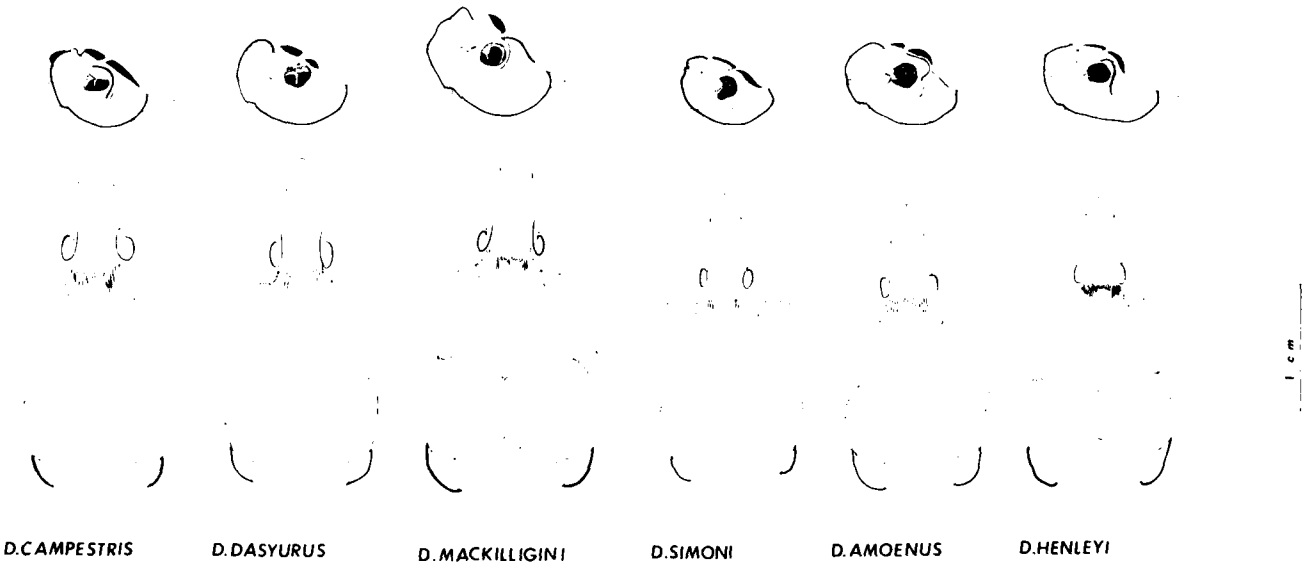


FIG. 47. Auditory bullae (above) in lateral view and outlines of skulls (below) in dorsal view of species of *Dipodillus*. Auditory bullae in heavy outline, chamber of subarcuate fossa shaded.

half of suprameatal triangle. Hamular process of temporal T-shaped, closing suprameatal triangle posteriorly. External auditory meatus lip unmodified. Subarcuate fossa very large, partially separating anterior mastoid and lateral superior mastoid chambers. Medial superior posterior cavity small, not visible in lateral view. Accessory tympanum absent, neck and body of malleus hidden by enlarged bony anterior and posterior areas of tympanum. Figure 165 shows details of auditory bulla of *D. campestris* in posterolateral view.

Teeth.—Figure 38. Upper incisor grooved; first labial and lingual cusps of m^1 alternate, at least in immatures. Cusps of m^1 separate and somewhat angular in immatures, becoming confluent and rounded in adults. First labial and second lingual folds of m^1 prominent and deep. Posterolateral folds of m^1, m^2 transient.

Confluency of three anterior cusps of m^1 begins between first labial and first lingual followed by union of anterior and first lingual. Anterior cusp of m_1 unites with first labial about the same time or slightly before union of three anterior cusps of m^1. Confluency of anterior cusps and posterior lamina of m^1 is followed by union of lamina of m^2, which precedes completion of confluency in m_1, m_2. M^1 has three transient cusps.

Measurements.—Table 12. Largest species of *Dipodillus* in Egypt. Male and female dimensions subequal. Means (and ranges) of occipitonasal length (in millimeters) of 10 adult males and 10 adult females, respectively, are 30.7 (30.0 to 31.9) and 30.2 (28.9 to 31.1).

Age determination.—Individuals are considered adult when anterior and first lingual cusps of m^1 become confluent (fig. 38) and/or basioccipital-basisphenoid suture closes.

Variation.—Color varies within subspecies in correlation with substrate. Palest specimens are *D. c. wassifi* from white limestone and pallid soils of Ras el Hekma, although *wassifi* is generally slightly darker than *haymani* from Qara and Siwa. Specimens of *D. c. patrizii* from Gebel Uweinat are slightly darker than *haymani*, and the darkest race is *venustus* of northern Sudan and southern Egypt. Degree of prominence of tail tuft varies geographically in correlation with color density.

Means of head and body length, hind foot, and occipitonasal length show slight clinal decrease west to east in samples from

TABLE 12. — Means (and ranges) of measurements, ratios, and weight of adult *Dipodillus campestris*.

	Libya	Egypt	
	D. c. brunnescens	*D. c. wassifi*	*D. c. haymani*
HBL	103.5 (99-112) 8	96.2 (86-112) 59	105.6 (86-125) 30
TL	142.2 (132-150) 7	133.8 (118-153) 51	133.6 (118-147) 31
TL/HBL%	138.0 (128.2-151.5) 7	140.0 (120.7-159.3) 51	127.2 (124.4-145.0) 29
FL	28.1 (27-30) 8	26.6 (25-29) 58	28.4 (25-30) 32
EL	17.6 (17-18) 8	16.7 (15-20) 59	17.5 (16-20) 32
Wt	— —	29.2 (21.3-38.3) 39	34.1 (26.7-44.1) 10
ONL	30.4 (29.9-31.6) 8	29.6 (27.9-31.9) 51	31.5 (28.8-33.6) 31
ZW	15.6 (15.2-16.6) 8	15.3 (14.0-17.1) 27	16.2 (15.3-17.4) 17
IOW	5.4 (5.1-5.7) 8	5.1 (4.8-5.8) 55	5.5 (5.2-6.1) 31
BCW	13.9 (13.4-14.4) 8	13.8 (12.9-15.0) 49	14.2 (13.3-15.1) 31
NL	12.0 (11.6-12.6) 8	11.6 (10.7-12.8) 49	12.4 (11.3-13.8) 28
IFL	5.4 (5.2-5.8) 8	5.4 (4.8-6.1) 54	5.6 (5.1-6.2) 31
AL	4.2 (3.8-4.5) 8	4.1 (3.6-4.6) 54	4.4 (4.1-5.4) 31
RW	— —	4.1 (3.9-4.7) 49	4.2 (3.8-4.6) 21
BL	7.6 (7.4-7.9) 8	7.6 (7.2-8.2) 45	8.1 (7.5-8.7) 31
SH	11.6 (11.5-12.0) 8	11.4 (11.0-12.3) 42	11.7 (11.3-12.3) 31

	Libya various localities	Libya-Sudan (Cufra-Uweinat)	Sudan
	D. c. dodsoni	*D. c. patrizii*	*D. c. venustus*
HBL	100.8 (92-113) 8	88.2 (80-95) 10	89.8 (80-98) 5
TL	130.8 (117-138) 8	125.6 (111-144) 9	134.0 (115-145) 5
TL/HBL%	130.2 (116.8-150.0) 8	141.6 (126.1-165.4) 9	149.2 (137.8-157.0) 5
FL	26.3 (25-28) 9	26.2 (25-28) 10	25.0 (24-26) 5*
EL	16.4 (16-18) 9	15.9 (14-17) 10	13.6 (13-15) 5
Wt	— —	24.0	26.4 (22.0-32.0) 5
ONL	30.4 (29.1-31.5) 10	29.2 (28.2-31.0) 12	29.3 (28.6-29.9) 5
ZW	15.8 (15.3-16.4) 8	15.4 (14.4-15.9) 9	14.9 (14.4-15.3) 5
IOW	5.3 (4.9-5.8) 9	5.0 (4.7-5.3) 12	5.1 (5.0-5.3) 5
BCW	13.9 (13.2-14.4) 10	13.5 (12.9-14.4) 12	13.3 (12.9-13.7) 5
NL	12.0 (11.7-12.4) 10	11.4 (11.0-12.3) 12	11.2 (10.7-11.4) 5
IFL	5.4 (5.1-5.6) 10	5.1 (4.8-5.5) 12	5.2 (4.9-5.4) 5
AL	4.1 (3.8-4.4) 10	3.9 (3.8-4.1) 12	4.3 (4.1-4.6) 5
RW	4.2 (3.9-4.5) 10	3.9 (3.6-4.2) 12	4.1 (4.0-4.3) 5
BL	8.1 (7.7-8.5) 10	7.6 (7.3-8.1) 11	7.6 (7.3-7.8) 5
SH	11.6 (11.2-11.8) 10	10.9 (10.2-11.6) 11	11.0 (10.9-11.3) 5

*Without claw.

TABLE 13. — Means (and ranges) of measurements, ratios, and weight of adult *Dipodillus dasyurus* and *D. mackilligini*.

	Sinai Peninsula	Eastern Desert	
	D. dasyurus	*D. dasyurus*	*D. mackilligini*
HBL	92.9 (80-102) 26	90.0 (82-94) 18	77.8 (72-86) 6
TL	120.9 (109-130) 23	126.8 (114-136) 16	120.2 (99-138) 6
TL/HBL%	130.0 (118.4-143.6) 23	142.2 (128.0-155.6) 15	154.0 (137.5-176.9) 5
FL	25.6 (25-27) 26	25.1 (24-27) 19	24.2 (22-26) 6
EL	14.9 (14-16) 26	14.5 (14-16) 19	12.9 (12-14) 6
Wt	— —	22.8 (16.0-34.9) 15	— —
ONL	28.6 (27.9-29.2) 17	28.3 (27.2-29.5) 18	26.9 (26.2-27.7) 3
ZW	14.9 (14.4-15.8) 6	14.8 (14.2-15.4) 14	13.3 (13.2-13.5) 3
IOW	5.0 (4.7-5.3) 22	5.0 (4.8-5.3) 19	4.8 (4.7-5.0) 6
BCW	13.4 (12.6-14.1) 13	13.2 (12.9-13.5) 8	13.2 (12.8-13.5) 5
NL	10.9 (10.2-11.8) 18	10.8 (10.3-11.5) 18	9.8 (9.7-10.6) 4
IFL	5.2 (4.8-5.5) 21	5.0 (4.4-5.8) 18	4.6 (4.3-4.8) 5
AL	4.0 (3.8-4.3) 22	4.0 (3.6-4.5) 18	3.8 (3.5-4.0) 4
RW	4.0 (3.6-4.4) 26	4.0 (3.8-4.7) 19	3.8 (3.7-3.9) 3
BL	8.0 (7.4-8.5) 18	8.0 (7.5-8.6) 19	8.2 (8.0-8.3) 3
SH	11.2 (10.8-11.7) 12	11.2 (10.9-11.8) 19	11.1 (10.9-11.3) 2

Mediterranean coast localities (table 12). For comparison, samples of *D. c. brunnescens* (Ranck, 1968) from the Cyrenaican Plateau and adjacent littoral areas of Libya and *dodsoni* from the interior are included in the table. Size increases southward slightly in Qara and Siwa, then decreases through Libyan Desert samples of *dodsoni* and *patrizii* and in *venustus* of Sudan. Other measurements, except tail length, show similar geographic variation (table 12).

Inflation of auditory bulla is greater in *D. c. haymani* than in other subspecies. Ear length is smaller in *venustus* than in other subspecies (table 12).

Comparisons.—*Dipodillus campestris* differs from *D. dasyurus* in more orangish or brownish color, slightly larger external and cranial measurements (tables 12, 13); smaller, less swollen auditory bulla (fig. 47); larger subarcuate fossa; and larger molars (fig. 38 and tables 12, 13).

Skins of *D. campestris* may be misidentified as *Gerbillus andersoni* if soles of feet are not examined. Immatures may be confused with *G. henleyi*. Otherwise, *D. campestris* is easily identifiable on the basis of cranial characters listed in Table 14 and shown in Figure 47.

Remarks.—The trinomen *D. c. venustus* (Sundevall, 1843), which was listed in Allen's (1939) "Checklist," has no referable type

TABLE 14. — Characters of species of *Dipodillus*.

Character	*D. campestris*	*D. dasyurus*	*D. mackilligini*	*D. simoni*	*D. amoenus*	*D. henleyi*	*D. nanus*
Dorsal color	orangish brown	yellowish brown	yellowish brown	yellowish brown	cinnamon to yellowish brown	buffy brown	yellowish brown
Head markings	variable			indistinct	distinct		
Ear	pigmented				tip pigmented	not pigmented	tip slightly pigmented
White rump patch	inconspicuous or absent	absent			large and conspicuous		
Bicoloring of tail	distinct or indistinct	distinct					
Sole of hind foot	pigmented	not pigmented		lightly pigmented	not pigmented		
Tail brush	variable in size	very long		almost lacking	very small		small
Palatal ridges (fig. 33)	very similar in both species		?	distinctive of species	very similar in both species		?

TABLE 14.—*continued.*

Character	*D. campestris*	*D. dasyurus*	*D. mackilligini*	*D. simoni*	*D. amoenus*	*D. henleyi*	*D. nanus*
Upper first molar (fig. 38)	first labial fold more open				first labial fold less open		
Posterior margin of mastoid bulla	not beyond level of exoccipital	beyond level of exoccipital	well beyond level of exoccipital	not or slightly beyond level of exoccipital	slightly beyond level of supraoccipital	to level of supraoccipital	beyond level of supraoccipital
Meatal lip (fig. 47)	unmodified				partially inflated	completely inflated	
Accessory tympanum	absent			present			
Subarcuate fossa (fig. 47)	large		small	large	small		
Medial superior posterior mastoid cavity	small				large		
Alveolar length of adult (mm.)	3.6-5.4	3.6-4.5	3.5-4.0	3.2-4.0	3.2-4.1	2.7-3.1	3.7-3.8
Diploid chromosome number (Wassif et al., 1969)	56	60	?	60	52	52	52

specimen. However, Happold (1967c, p. 316) applied the name to specimens from northern Sudan because they "fit Sundevall's description." Later, Petter (Part 6.3, p. 11 in Meester and Setzer, 1971) listed the subspecies, "(fide Happold 1967)." We believe that retention of the name is warranted.

Collection.—Easily trapped in all habitats and dug from burrows in sand.

Habitats.—Western Mediterranean Coastal Desert: Limestone cliffs beside the sea and inland near Salum (fig. 11), Ageeba and Ras el Hekma; quarries in limestone ridges near Burg el Arab (fig. 7); stone houses, walls, and temple ruins (Abu Mena and Abu Sir); vegetated rocky slopes, barren gullies, dunes beneath *Nitraria retusa*, and exotic *Acacia saligna* and *Atriplex* sp. on Ras el Hekma; shallow depressions with sandy-loam soil and boulder areas near Abu Haggag. Reported from sand in fig groves at Sidi Barrani (Hoogstraal, 1963).

Qattara Depression: Houses, rock outcroppings, date palm clusters, and piles of dead branches.

Farafara Oasis: Date palm clusters.

Siwa Oasis: Barley fields, palm groves, fallow sandy fields (Hoogstraal, 1963), and houses.

Gebel Uweinat, Karkur Murr: Sand among boulders and beneath sandstone blocks (Osborn and Krombein, 1969).

Considered "most widely distributed of all Libyan rodents" by Ranck (1968, p. 133) who found it living in dense growths of grass and sedge associated with agriculture; dense stands of sedges and other mesophytes including *Phragmites* in hard, salty clay margins of oases lakes; sedge pockets and areas of sand in palm groves of oases and outlying zones of *Tamarix* and *Acacia;* abundant in cliffs, rocky outcroppings and talus, and around thorny bushy perennials near the coast, but never in coastal dunes. Ranck (p. 139) stated that "Near Ghat the habitat was typical 'hamada' desert without any visible plant cover." Happold (1966a, 1967c, p. 317) trapped *D. c. venustus* in granitic Sabaloka Hills and syenitic Gebel Qeili in northern Sudan and observed that larger hills "with many crevices and cracks, are suitable habitats."

This species is less restricted to rocky situations than *D. dasyurus* of the Eastern Desert and Sinai.

Behavior.—More nervous and prone to bite than other species of *Dipodillus.*

Reproduction.—Two females from Salum, captured on March 26-28, contained six and three embryos, and a third female was lactating. Two lactating females were trapped on May 9 near Qara. One female with six embryos came from Mariut on December 3. These data indicate an extensive breeding period of about six months, but in coastal desert and inland desert populations, periods may not be synchronous. The breeding season of coastal desert populations appears to coincide with the winter rainy season (November-April), but inland populations may breed later. Happold's (1967c, p. 317) data indicate that, in Northern Sudan, the September-November breeding period "is at the end of the rains."

Sex ratio.—In a sample of 128 museum specimens of *D. campestris,* males numbered 66 (52 per cent) and females numbered 62.

Commensalism.—Found in mud and stone houses, but probably because of similarity to the natural habitat.

Economic importance.—The tag on a British Museum specimen from Siwa (misidentified originally as *G. andersoni*) reads: "The common species frequents houses. The natives consider this mouse a great delicacy."

Associates.—*Dipodillus campestris* occurs in sand with *G. gerbillus* and *G. andersoni;* cliffs and rocky areas with *Acomys cahirinus* and *Eliomys quercinus;* and salt marshes inhabited by *Psammomys obesus, D. amoenus, D. simoni,* and *D. henleyi* (Wassif, 1960c).

EGYPTIAN SUBSPECIES OF *Dipodillus campestris*

Dipodillus campestris wassifi (Setzer, 1958)

Gerbillus campestris wassifi Setzer, 1958, J. Egypt. Publ. Health Assn., **33**, No. 6, p. 209.

Type locality.—Egypt. MATRUH: Salum, Libyan Plateau 60 ± m.

Distribution in Egypt.—Figure 45. Western Mediterranean Coastal Desert from Abu Qir west to Libyan border.

External characters.—Individuals vary in dorsal color from orangish to brownish, as noted in specimens from Salum by Wassif

(1956a, p. 190). Summer pelage is paler and more orangish than winter pelage. With exception of the sample from Ras el Hekma, *wassifi* is darker than *haymani*. The tail is more distinctly bicolored and brush slightly less conspicuous than in *haymani*.

Cranial characters.—Skull not so strongly developed and supraorbital ridge thinner in *wassifi* than in *haymani*.

Measurements.—Table 12. Size averages smaller than *haymani*.

Specimens examined.—Total 90.

ALEXANDRIA: Abu Qir (1), Mariut (5).
MATRUH: Burg el Arab (8), Abu Sir (1), Abu Mena (2); Abu Haggag (2); Ras el Hekma (25); Mersa Matruh-Qara road 18 km. S (3); Ageeba (7); Sidi Barrani (3); Salum (25), 16 km. S (2); Bir Qattar (6).

Published records.—Records are from Wassif (1956a), Setzer (1958d), Hoogstraal (1963), and Ranck (1968).

Egypt. MATRUH: Salum, Mersa Matruh, Burg el Arab, Sidi Barrani.
Libya. CYRENAICA: Bardia, 5 km. W.

Dipodillus campestris haymani (Setzer, 1958)

Gerbillus campestris haymani Setzer, 1958, J. Egypt. Publ. Health Assn., 33, No. 6, p. 208.

Type locality.—Egypt. MATRUH: Siwa Oasis, Siwa.

Distribution in Egypt.—Figure 45. Farafara Oasis, Qattara Depression, Siwa Oasis, and probably depressions west to Giarabub.

External characters.—Palest subspecies. Tail less distinctly bicolored; brush slightly more conspicuous than in *wassifi*, but much less than in *patrizii* or *venustus*.

Cranial characters.—Skull generally larger, more angular and strongly developed and supraorbital ridge thicker than in other subspecies.

Measurements.—Table 12. Larger in external and most cranial measurements than other Egyptian subspecies. A sample from Qara is intermediate in some measurements between *wassifi* from Salum and *haymani* from Siwa.

Specimens examined.—Total 60.

MATRUH: Bir Abd el Nabi (1); Qara (14); Siwa Oasis (29), 5 km. N (4); Aghurmi 5 km. E (4); El Maragi (4); El Zeitun (2).
EL WADI EL GEDEED: Farafara Oasis, Batras (2).

Published records.—Records are from de Beaux (1928), Hayman (1946), Setzer (1958d), and Ranck (1968).

Egypt. MATRUH: Siwa Oasis.
Libya. CYRENAICA: Giarabub and neighboring regions, Bahr el Tubat.

Dipodillus campestris patrizii (de Beaux, 1932)

Dipodillus dodsoni patrizii de Beaux, 1932, Ann. Mus. Civ. Stor. Nat. Genova, **55**, p. 379.

Type locality.—Libya. CYRENAICA: Cufra Oasis, El Giof.

Distribution in Egypt.—Figure 45. Probably all canyons of Gebel Uweinat and possibly Gilf el Kebir.

External characters.—Color variable but generally darker with more prominent agouti pattern than *wassifi*, *haymani*, and *dodsoni*, but paler than *venustus*. Circumorbital and postauricular areas buffy. Tail indistinctly bicolored, brownish below. Tail brush distinct, fuscous.

Cranial characters.—Skull not so strongly developed as in *haymani*.

Measurements.—Table 12. Smaller generally in external and cranial measurements than *haymani*. Larger than *venustus*.

Specimens examined.—Total 12.

Libya. CYRENAICA: Cufra Oasis, el Hauuari (6).
Sudan. NORTHERN: Gebel Uweinat, Karkur Murr (6).

Published records.—Records are from de Beaux (1928), Ranck (1968), and Osborn and Krombein (1969).

Libya. CYRENAICA: Cufra Oasis, El Giof and El Hauuari.
Sudan. NORTHERN: Gebel Uweinat, Karkur Murr.

Dipodillus campestris venustus (Sundevall, 1843)

Meriones venustus Sundevall, 1843, Kongl. Svenska Vet.-Akad. Handl., Stockholm, p. 230.

Type locality.—Sudan. Near White Nile.

Distribution in Egypt.—Figure 45. Single specimen from Kalabsha.

External characters.—Smallest, darkest subspecies with most conspicuous tail brush. Dark brownish orange dorsally; circumorbital and postauricular areas buffy; tail brownish above, lighter below; brush blackish.

Cranial characters.—About as other subspecies aside from *haymani.*

Measurements.—Table 12. Most dimensions average smaller than other subspecies. Large ratio of tail length to head and body length in Happold's (1967c) Sudan sample is possibly due to method of measuring.

Remarks.—A single specimen from near Kalabsha in Upper Egypt (Yale University Peabody Museum No. 2647) was trapped "in a tiny garden near water edge" (notes of collector, Thomas Lovejoy III, 13 January 1963). Attempts to obtain more specimens from the same and adjacent areas failed (unpublished field notes). The locality is now inundated by Lake Nasser.

Specimens examined.—Total 13.

Egypt. ASWAN: Kalabsha, Beit el Wali Temple (1).
Sudan. KASSALA: Gebel Qeili (9). KHARTOUM: Sabaloka Hills (3).

Published records.—Records are from Happold (1967c).

Sudan. KHARTOUM: Sabaloka Hills and Gebel Qeili.

Dipodillus dasyurus (Wagner, 1842)

Meriones dasyurus Wagner, 1842, Arch. Nat., 8th year, 1, p. 20.

Type locality.—West coast of Arabia, exact locality not known.

General distribution.—Iraq, Arabia, Israel, Yemen, Sinai Peninsula, Eastern Desert of Egypt, and Sudan.

Common names.—Wagner's Dipodil, Rough-tailed Dipodil, Wadi Hof Gerbil.

Subspecies in Egypt.—

Dipodillus dasyurus dasyurus (Wagner, 1842)

Distribution in Egypt.—Figure 45. Sinai Peninsula and northern part of Eastern Desert.

Diagnosis.—Yellowish brown about the size of lesser gerbil (*Gerbillus gerbillus*). Fur long, soft. Tail long, brush conspicuous. Ear prominent, pigmented. Supraorbital and postauricular markings inconspicuous. Whitish rump patch absent. Skull with bulla markedly inflated, lip of external auditory meatus unmodified, accessory tympanum absent, parapterygoid fossa moderately deep and partly closed.

Adult head and body length average 93 mm.; tail 124 mm., 136 per cent of head and body length; foot 25 mm.; ear 14 mm.; occipitonasal length 28.4 mm.; weight 23.6 gm.

External characters.—Upper parts yellowish brown. Dorsum with fine agouti pattern. Color paling to narrow border of clear yellowish on side and foreleg. All hairs of dorsum and side with gray bases.

Dorsal hairs with blackish tip and yellowish subterminal band. Hairs of underparts and feet white to base. Tail bicolored, upper surface as back; ventral surface whitish. Brush about one-half length of tail, fuscous. Broad, conspicuous band of dark-tipped hairs extending from mystacial area beneath eye to base of ear. Whitish rump patch lacking. Ear pigmented.

Palatal ridges.—Similar to *D. campestris* in Figure 33, except fifth intermolar ridge is directed medially.

Glans penis and baculum.—Compare notes under other species of *Dipodillus* and *Gerbillus*.

Feet.—Figure 34. Palm and sole hairless. Tubercles distinct and slightly larger than in *D. campestris*. Two proximal plantar tubercles and hallucal tubercle spaced about equidistantly.

Cranial characters.—Figure 47. Supraorbital ridge moderately developed, particularly in comparison with *D. campestris*. Posterior margin of nasals irregular, occasionally rounded or truncate. Anterior palatine foramina relatively long. Zygomatic plate not reaching premaxillary-maxillary suture nor covering *infraorbital* foramen. Parapterygoid fossa moderately deep and partially closed. Basioccipital narrow. Anterior margin of tympanic bulla almost reaching anterior edge of foramen ovale and contacting posterior shelf of parapterygoid fossa. Posterior margin of bulla extending beyond exoccipital, but not beyond supraoccipital. Anterior mastoid chamber filling more than one-half of suprameatal triangle (fig. 47). Subarcuate fossa fairly large and partially separating anterior mastoid and lateral superior posterior mastoid chambers. Medial superior posterior cavity small and not visible in lateral view. Accessory tympanum absent (fig. 47). Lip of external auditory meatus unmodified. Hamular process of temporal usually L-shaped and closing suprameatal triangle posteriorly.

Teeth.—Figure 38. Upper incisor grooved; first labial and lingual cusps of m^1 alternate in immatures and adults. Molars with narrow,

sharp laminae in immatures similar to *simoni*, but becoming somewhat more rounded with wear. Folds deep and open. First labial fold of m_1 prominent, equal in depth to second lingual fold. Posterolateral folds of m_1, m_2 transient. Confluency of cusps of m^1, m_1, m^2, and m_2 follow sequence of *D. campestris* (p. 146 and fig. 46). M^3 has two transient cusps.

Measurements.—Table 13. Male and female dimensions subequal. Means (and ranges) of occipitonasal length (in millimeters) of 16 adult males and 18 adult females, respectively, are 28.6 (27.9 to 29.5) and 28.3 (27.2 to 30.0).

Age determination.—Adults are determined by confluency of cusps of m^1 (fig. 38) and fusion of the basioccipital-basisphenoid suture.

Variation.—There are no apparent differences in color or in brush size between *D. dasyurus* samples from Sinai Peninsula and Eastern Desert. Means of all measurements are approximately equal excepting length and proportions of tail (table 13). However, the uselessness of tail length as a taxon in this species is illustrated in the scatter diagram of tail length versus head and body length (fig. 49).

Comparisons.—Differs from *D. campestris* in paler, more yellowish color, slightly smaller average external and cranial measurements, more prominent tail brush, more inflated chambers of auditory bulla, smaller subarcuate fossa, etc. (table 14 and fig. 47). Externally, *D. dasyurus* is very similar to *D. mackilligini*, but differs from the latter in having a slightly less conspicuous tail brush, paler color, less blackish hair on upper tail surface, larger subarcuate fossa which is visible externally, and less inflated bulla (fig. 47). Comparisons with other species are summarized in Table 14 and Figure 47.

Specimens examined.—Total 83.

SINAI: El Arish (1); Bir el Maghara (1); Wadi el Sheikh (19); Wadi Raha (5); El Raba (6); St. Catherine Monastery area (3), 4.8 km. W (1); Tor (3); Gebel Dhalfa (1).

SUEZ: Ain Sukhna, 3.5 km. S (1); Wadi Nakhl (1); Wadi Abu Seyala (2); Wadi Bir el Abd (3), Wadi Dom (18); Wadi Yesein (1); Gebel Katamiya (4); Wadi Iseili (1).

CAIRO: Gebel Mokkatam (4), Wadi Hof (2), Wadi Garawi (6).

Published records.—Records are from Anderson (1902), Allen (1915), Flower (1932), Wassif and Hoogstraal (1954), Wassif (1956a), and Setzer (1958d).

SINAI: Gebel Dhalfa, Ain Sudr, Tor, Bir el Maghara, El Quseima, Gebel Umm Shomer, St. Catherine Monastery area, Suweira, Nuweibah, El Raba, Wadi Raha, and Wadi el Sheikh.

CAIRO: Wadi Hof near Helwan.

Collection.—Enters live traps readily and can be dug from sandy patches in rocky wadis.

Habitats.—Eastern Desert: Trapped where first collected by Anderson (1902, p. 261) ". . .under a shelving rock below a cliff in Wadi Hoaf, Helwan" (fig. 14); in crevices and shelves in sandstone and limestone cliffs; boulder-strewn, vegetated wadis; and beneath *Nitraria retusa* bushes on the sea shore.

Southern Sinai Peninsula: Burrows in sand patches among rocks, rocky situations to high elevations, including gardens of St. Catherine Monastery (Wassif and Hoogstraal, 1954; Wassif, 1956a), but "absent from the littoral areas (below 500 m.) of the southern zone" (Haim and Tchernov, 1974).

Buxton (1923) listed *D. dasyurus* as a salt flat dweller among Chenopodiaceae and *Tamarix* sp. in Mesopotamia, and Lewis et al. (1965) trapped it beneath thorny Rosaceae shrubs in a playa in northern Saudi Arabia.

Behavior. Details of the behavior of *D. dasyurus* in captivity were reported by Fiedler (1973).

Burrows. Tortuous burrows 15 to 20 cm. below the surface of sand between rocks, with entrances plugged with sand, were found in southern Sinai Peninsula in May (Wassif and Hoogstraal, 1954). Buxton (1923) mentioned *D. dasyurus* among desert mice which plug burrows by day to retain a favorable microclimate.

Food. In captivity, *D. dasyurus* ate foliage of *Zygophyllum coccineum*, raw carrots, dry bread, but no insects. According to Buxton (1923, p. 127), this species depends upon succulent, halophytic *Suaeda* sp. and insects in salt marshes of Mesopotamia.

Associates. Sinai Peninsula: *Sekeetamys calurus* (Wassif, 1956a), *Acomys cahirinus*, *A. russatus*, and *Eliomys quercinus*.

Eastern Desert: *Sekeetamys calurus*, *Acomys cahirinus*, and *A. russatus*.

Northern Saudi Arabia: Trapped with *D. nanus* beside burrows of *Meriones libycus* (Lewis et al., 1965).

Reproduction. Three males with testes descended from Wadi

Hof and Wadi Garawi near Helwan, February 3 and 4; and one from Wadi Dara on the Gulf of Suez, March 11.

Flower (1932) reported 12 litters born in Giza Zoological Gardens during months of October, December, January, February, March, April, May, and June, consisting of one litter of 6, one of 5, three of 4, three of 3, and four of 2 (average, 3.3).

Sex ratio.—In a sample of 76 museum specimens, males and females each numbered 38.

Dipodillus mackilligini Thomas, 1904

Dipodillus mackilligini Thomas, 1904, Ann. Mag. Nat. Hist., (ser. 7), 14, p. 158.

Type locality.—Egypt. SUDAN ADMINISTRATIVE: Wadi Allaqi (about 22° N lat., 35° E long.).

Common name.—Mackilligin's Dipodil.

Distribution in Egypt.—Figure 45. Southern part of Eastern Desert.

Diagnosis.—Yellowish brown, slightly smaller than lesser gerbil (*Gerbillus gerbillus*). Fur long, soft. Tail long; brush conspicuous, dark. Ear prominent, pigmented. Supraorbital and postauricular markings inconspicuous. White rump patch absent. Bulla markedly inflated, lip of external auditory meatus unmodified, accessory tympanum absent, subarcuate fossa small and not separating anterior and lateral superior posterior mastoid chambers.

Adult head and body length average 78 mm.; tail 120 mm., 154 per cent of head and body length; foot 24 mm.; ear 13 mm.; occipitonasal length 26.9 mm.

External characters.—Upper parts dark yellowish brown. Dorsum with fine agouti pattern. Sides paler with narrow border of clear yellowish extending onto fore and hind limbs. All hairs of dorsum and sides, except a very narrow margin, with gray bases. Dorsal hairs with blackish tips and yellowish subterminal bands. Hairs of underparts and feet white to base. Broad, conspicuous band of dark tipped hairs extending from mystacial area beneath eye to base of ear. Whitish supraorbital and postauricular areas inconspicuous. White rump patch absent. Tail indistinctly bicolored; upper surface darker than back, with blackish hairs to base. Underside of tail whitish to buff. Tail brush about one-half of tail length, fuscous. Ear pigmented.

Palatal ridges.—Not observed.

Glans penis and baculum.—Not observed.

Feet.—Palm and sole hairless. Tubercles distinct. Proximal tubercle further from others than in *D. dasyurus*. Sole not pigmented.

Cranial characters.—Figure 47. Supraorbital ridge moderately developed in comparison with *D. campestris*. Posterior margin of nasals broadly divided or truncate. Incisive foramina relatively long. Palatine foramina relatively long, open. Zygomatic plate not reaching level of premaxillary-maxillary suture, but covering infraorbital foramen. Parapterygoid fossa deep and partly closed. Basioccipital narrow. Anterior margin of tympanic bulla level with middle of foramen ovale and contacting shelf of parapterygoid fossa. Posterior margin of mastoid bulla extending beyond level of paroccipital process. Anterior mastoid chamber filling slightly more than one-half of the suprameatal triangle.

Subarcuate fossa deeper than *D. amoenus* or *D. henleyi*, but not separating anterior mastoid and lateral superior posterior mastoid chambers. Medial superior posterior cavity small, not visible in lateral view. Accessory tympanum absent (fig. 47). Lip of external auditory meatus unmodified. Hamular process of squamosal L-shaped, closing suprameatal triangle posteriorly.

Teeth.—Figure 38. Upper incisor grooved, first labial and lingual cusps of m^1 alternate, angular, and almost separate in immatures, becoming confluent and rounded in adults. Second lingual fold of m^1 deeper and more prominent than first labial fold. Posterolateral folds of m^1, m^2 transient.

Confluency of cusps of m^1, m^2, m_1, and m_2 appear to follow sequence of *D. campestris* and *D. dasyurus* (p. 146 and fig. 38). M^3 has two transient cusps separated by a labial fold.

Measurements.—Table 13.

Age determination.—Adults are determined by confluency of cusps of m^1 (fig. 38) and fusion of the basioccipital-basisphenoid suture as in other species of *Dipodillus*.

Comparisons.—*Dipodillus mackilligini* can be distinguished from other Egyptian species only by a combination of characters (table 14, fig. 38). Tooth characters of *D. mackilligini*, combined with cranial and external characters, indicate a closer relationship with

D. dasyurus, *D. campestris*, and perhaps *D. simoni*, than with *D. amoenus* and *D. henleyi*.

Ellerman (1941) referred *mackilligini* to the *dasyurus* group because of its long tail. Later, on the basis of bulla size, it was given subspecific status under *D. nanus* (Ellerman, 1949; Ellerman and Morrison-Scott, 1951; Wassif, 1956). Setzer (1959d) considered *mackilligini* a full species distinguishable from *nanus* by smaller bulla, narrower incisive foramina, curved and proportionately longer tooth row, and relatively more open parapterygoid fossa. A few more obvious differences between the two species are in Table 14. Note also that, except for size differences in the subarcuate fossa, *D. mackilligini* is very similar to *D. dasyurus* (table 14, fig. 47).

Specimens examined.—Total eight.

ASWAN: Khor Rhama el Bahari (2).
SUDAN ADMINISTRATIVE: Wadi Allaqi (3), Wadi Kansisrob (3).

Published records.—Records are from Thomas (1904), Setzer (1958d) and Hoogstraal (1963).

SUDAN ADMINISTRATIVE: Wadi Allaqi, Wadi Kansisrob.

Habitats.—East bank of Nile River in Nubia: Grassy plot beside water, bush beside water in abandoned village (from notes of collector, Christopher O. Maser).

Wadi Allaqi: Ancient ruins.

Gebel Elba: "Dug from plugged burrows in a grassy valley at about 2500 feet" altitude (Hoogstraal, 1963, p. 14).

No further information has been recorded on this species.

Dipodillus simoni (Lataste, 1881)

Gerbillus simoni Lataste, 1881, Naturaliste, Paris, 1, p. 497.

Type locality.—Algeria. CONSTANTINE: Wadi Maghra, north of Hodna.

Common name.—Simon's Dipodil.

General Distribution.—Egypt west of Nile Delta, Libya, Tunisia, and Algeria.

Subspecies in Egypt.—

Dipodillus simoni kaiseri (Setzer, 1958)

Dipodillus kaiseri Setzer, 1958, J. Egypt. Pub. Health Assn., 33, No. 6, p. 214.

Type locality.—Egypt. MATRUH: Mersa Matruh.

Distribution in Egypt.—Figure 50. Western Mediterranean Coastal Desert west of Nile Delta.

Diagnosis.—Yellowish brown mice smaller than lesser gerbils (*Gerbillus gerbillus*); tail about same length as head and body, brush lacking; ear pigmented; palm and sole naked. Whitish area around eye inconspicuous. Whitish rump patch absent.

Skull with bulla moderately inflated, lip of external auditory meatus unmodified, accessory tympanum present, and posterior margin of nasals truncate.

One of the smaller Egyptian species of *Dipodillus*. Adult head and body length average 80 mm.; tail 86 mm., 106 per cent of head and body length; foot 21 mm.; ear 12 mm.; occipitonasal length 25.2 mm.; weight 17.4 gm.

External characters.—Upper parts yellowish brown. Dorsal color paling gradually to a narrow line of clear yellowish on side. Color of side not extending onto foreleg. Dorsum with fine agouti pattern. Dorsal hair tips blackish, subterminal bands yellowish, and base gray. Hair of side yellowish with gray base, except for narrow ventrolateral strip with white base. Tail buffy with scattering of black hairs on upper surface. Brush very inconspicuous, long hairs on tip of tail only.

Underparts and upper surfaces of feet white. Band of dark-tipped hairs from mystacinal area beneath eye to base of ear, broad and conspicuous. Whitish supraorbital area inconspicuous (as opposed to conspicuous in *D. amoenus*). Whitish postauricular patch large. Whitish rump patch lacking. Ear pigmented.

Palatal ridges.—Figure 33. First diastemal ridge slightly curved; second diastemal ridge broadly U-shaped, sometimes divided; fourth intermolar ridge very small or missing; fifth intermolar not recurved.

Glans penis and baculum.—See under *Gerbillus pyramidum*, *D. campestris*, and Wassif et al. (1969).

Feet.—Figure 34. Palm and sole hairless. Two plantar tubercles and hallucal tubercle spaced about equidistantly. Sole of hind foot not pigmented.

Cranial characters.—Figures 47, 51. Supraorbital ridge moderately developed. Posterior margin of nasals truncate. Zygomatic plate

sloping posteriorly, therefore not reaching level of premaxillary-maxillary suture. Incisive foramina long. Parapterygoid fossa open and shallow. Basioccipital relatively broad. Anterior margin of tympanic bulla usually reaching level of middle of foramen ovale. Posterior margin of mastoid bulla not or barely surpassing level of exoccipital ridge. Anterior mastoid chamber filling about one-half of suprameatal triangle. Subarcuate fossa very large and partially separating anterior mastoid and lateral superior posterior mastoid chambers. Medial superior posterior cavity small and not visible in lateral view. Accessory tympanum present. Lip of external auditory meatus unmodified. Hamular process of squamosal T- or L-shaped closing suprameatal triangle posteriorly.

Teeth.—Figures 38, 52. Upper incisor grooved; first labial and lingual cusps of m^1 alternate in immatures and adults. Margins of cusps and laminae angular; folds deep and open. First labial fold in m^1 equal in depth to second lingual. A posterolateral fold is transient in m^1; lacking in m^2. Confluency of anterior cusps of m^1, m^2 occurs at same time or slightly later than in m_1, m_2. All cusps and laminae confluent in immatures. M^3 with two transient cusps. Note m^1 is distinctive of *D. simoni.*

Measurements.—Table 15. Male and female dimensions subequal. Means (and ranges) of occipitonasal length (in millimeters) of 10 adult males and seven adult females, respectively, are 25.3 (23.2 to 26.7) and 25.0 (23.4 to 25.9).

Variation.—Data from Algeria, Tunisia, Libya, and Egypt (table 15) indicate west to east clinal increase in tail length, decrease in zygomatic width, and reduced inflation of auditory bulla. Libyan specimens are darker than Egyptian, although color of dorsum, according to Ranck (1968), varies widely.

Comparisons.—*Dipodillus simoni kaiseri* from Egypt is distinguishable from the nominate form by slightly longer tail, darker color and smaller bulla. *Dipodillus simoni* can be distinguished from all other Egyptian dipodils by the relatively short, almost unicolorous, tail which lacks a brush; individual characteristics in palatal ridges (fig. 33) and molars, particularly m^1 (figs. 38, 52); and early confluency of cusps and laminae. Combinations of characters presented in Table 14 are of further use in distinguishing *D. simoni* from other species. In dimensions, *D. simoni* is more comparable with *D. amoenus* (tables 15, 16), except for shorter tail, shorter foot, longer incisive foramina, and shorter

TABLE 15. — Means (and ranges) of measurements, ratios, and weight of adult *Dipodillus simoni*.

	Egypt	Libya (Ranck, 1968)	Tunisia (Harrison, 1967)	Algeria (Petter, 1961)
HBL	80.8 (72-89) 26	83.6 (81-88) 3	72.5 (69-75) 4	(70-95)
TL	85.6 (72-96) 25	80.3 (77-83) 3	71.5 (70-74) 4	(57-84)
TL/HBL%	106.0 (94.2-118.5) 25	96.1 (92.0-102.4) 3	98.6 (94.6-101.4) 4	— —
FL	21.0 (19-22) 28	21.0 (20-21) 3	18.0 (18-19) 4*	(20-22)
EL	12.2 (11.5-14.0) 28	12.0 (12-12) 3	12.0 (12.0-12.7) 4	(11-14)
Wt	17.4 (12.6-22.3) 10	— —	— —	— —
ONL	25.2 (23.2-26.7) 17	25.5 (24.4-26.3) 3	— —	(23.5-26.0)
ZW	13.6 (12.6-14.0) 14	13.9 (13.5-14.2) 3	14.2 (14.1-14.3) 3	— —
IOW	4.6 (4.3-5.2) 25	4.8 (4.6-5.1) 3	4.6 (4.5-4.7) 4	— —
BCW	12.2 (11.5-12.6) 21	— —	11.6 (11.5-11.7) 3	— —
NL	9.2 (8.4-10.0) 21	9.6 (9.4-9.7) 3	— —	— —
IFL	4.9 (4.4-5.6) 26	— —	— —	— —
AL	3.7 (3.2-4.0) 24	— —	— —	— —
RW	3.6 (3.6-3.9) 25	— —	— —	— —
BL	7.0 (6.7-7.4) 19	— —	7.6 (7.3-8.1) 4	— —
SH	10.2 (9.5-10.7) 18	— —	— —	— —

*Without claw.

TABLE 16. — Means (and ranges) of measurements, ratios, and weight of adult *Dipodillus a. amoenus*.

	El Faiyum	Wadi el Natroun, Bir Victoria
HBL	84.0 (70-100) 13	79.9 (73-86) 18
TL	104.6 (93-115) 12	106.4 (99-116) 17
TL/HBL%	124.6 (112.0-147.4) 12	134.1 (118.8-155.4) 17
FL	22.9 (20-24) 12	22.6 (21-24) 18
EL	13.0 (12-14) 12	12.2 (11-14) 18
Wt	— —	13.2 (10.7-17.5) 10
ONL	25.8 (23.6-26.7) 10	25.2 (24.4-26.3) 15
ZW	13.9 (12.9-14.4) 5	13.4 (13.0-14.1) 10
IOW	4.6 (4.2-4.8) 11	4.4 (4.2-4.9) 18
BCW	12.4 (11.8-12.9) 10	12.2 (11.7-12.8) 18
NL	9.3 (7.9-10.0) 10	9.2 (8.6-9.8) 15
IFL	4.2 (3.8-4.6) 12	4.0 (3.7-4.2) 18
AL	3.6 (3.2-4.1) 12	3.4 (3.2-3.7) 18
RW	3.6 (3.4-3.8) 13	3.4 (3.3-3.7) 19
BL	7.8 (7.2-8.2) 12	7.7 (7.3-8.2) 19
SH	10.2 (9.6-10.5) 9	10.0 (9.6-10.3) 18

bulla. *Dipodillus simoni* is also heavier on the average than *D. amoenus*.

Remarks.—Greater average tail length of Egyptian and Libyan specimens of *D. simoni* signified for Setzer (1958d) and Ranck (1968) a distinct species, *kaiseri*. However, other measurements in Table 15 from Egypt, Libya, and Algeria, as well as tooth characters (figs. 38, 52 and Petter, 1959, fig. 1), support Wassif's (1956a, 1960c) conclusion that *simoni* and *kaiseri* are synonymous. Later Wassif et al. (1969) recorded the karyotype of Egyptian *D. simoni* as 2N=60 with 8 to 10 biarms and FN=68-69. Cockrum et al. (1976a) reported identical karyotypes from Tunisian specimens.

Specimens examined.—Total 39

ALEXANDRIA: El Amiriya (5), 1.6 km. E (1).

MATRUH: Lake Mariut (1); Bahig (7), 7 km. S (2); Abu Mena (1), 1.6 km. E (2); Burg el Arab (9); El Hammam 15 km. SSW (1); El Daba (2); Ras el Hekma (2); Mersa Matruh (3), 4.8 km. E (1); El Qasr (1); Sidi Barrani (1).

Published records.—Records are from Wassif (1956a, 1960c) and Setzer (1958d).

MATRUH: Lake Mariut, Burg el Arab, El Daba, Mersa Matruh, Sidi Barrani.

FIG. 48. Western Mediterranean Coastal Desert. Ras el Hekma. Rocky and sandy slope. Vegetation: *Lycium shawii* in foreground surrounded by thistle (*Onopordon alexandrinum*). Burrow under *Lycium* is of *Psammomys obesus*.

Collection.—Dug from burrows in salt marshes. Readily enters live traps. May be picked up by hand under a spotlight at night.

Habitat.—Littoral salt marshes (fig. 7) (Wassif, 1960c; Hoogstraal, 1963) in salty, sandy loam with halophytic vegetation; olive groves; barley fields; clay soil in *Thymelaea hirsuta* and *Anabasis articulata* associations (fig. 8); slopes above salt marshes supporting a variety of shrubs, including *Lycium shawii* and *Thymelaea hirsuta* (fig. 48).

Occurs also in high plateaus of Algerian Atlas and vegetated littoral desert in Tunisia and Libya (Harrison, 1967; Ranck, 1968).

Behavior.—Nocturnal. A very docile mouse, easily handled. When approached with a light at night, *D. simoni* either "freezes" or crawls under an available shrub.

Burrows.—In late July, Wassif (1960c) found unplugged burrows near salt marsh vegetation.

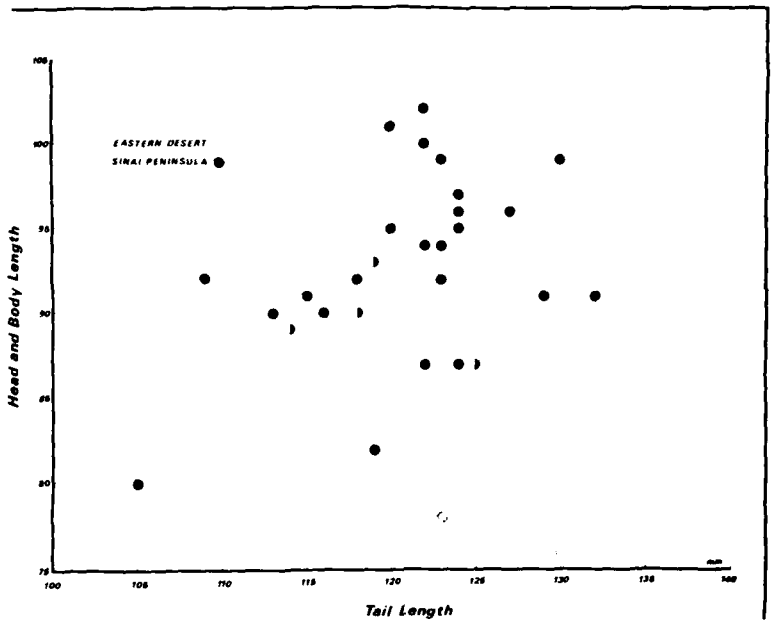


FIG. 49. Scatter diagram of tail length versus head and body length in Eastern Desert and Sinai Peninsula samples of *Dipodillus dasyurus*. Half-circles represent individuals of both samples at same point. Data from all ages.

Reproduction.—Female with four embryos, October 4 (Harrison, 1967) from Tunisia. No data from Egypt.

Associates.—Occurs in coastal salt marshes with *D. henleyi, D. amoenus, D. campestris* (Wassif, 1960c), *Psammomys obesus, Allactaga tetradactyla,* and *Jaculus orientalis;* and in the littoral desert with *Gerbillus andersoni, G. gerbillus, J. jaculus, J. orientalis, A. tetradactyla, Meriones shawi,* and possibly *P. obesus.*

Dipodillus amoenus De Winton, 1902

Dipodillus amoenus De Winton, 1902, Ann. Mag. Nat. Hist., (ser. 7), 9, p. 46.

Type locality.—Egypt. GIZA.

General distribution.—Egypt and Libya and possibly Tunisia, Algeria, Morocco, and Mauritania.

Common name.—Charming Dipodil.

Subspecies in Egypt.—

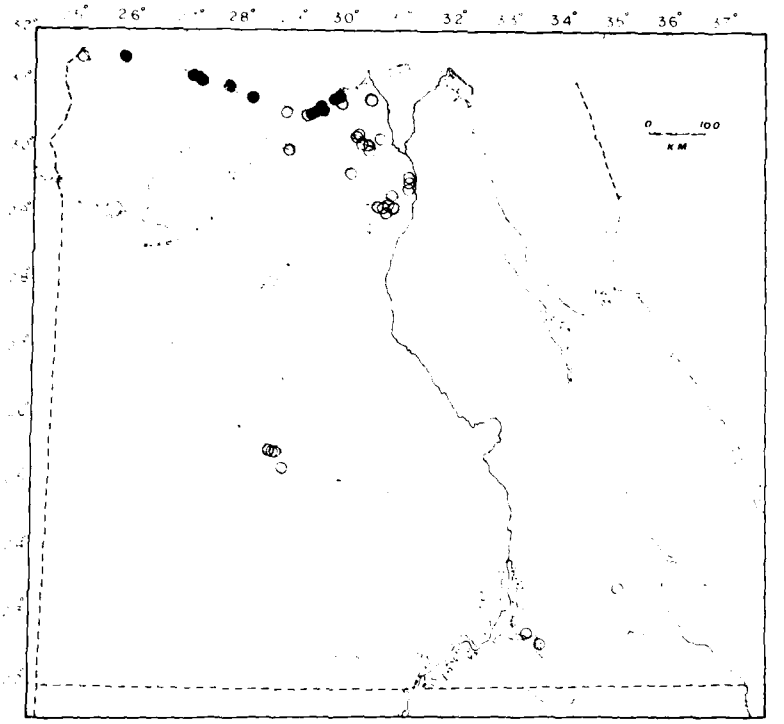


FIG. 50. Collection localities of *Dipodillus simoni kaiseri* (dots) and *D. amoenus amoenus* (circles).

Dipodillus amoenus amoenus De Winton, 1902

Distribution in Egypt.—Figure 50. Western part of Nile Delta, Western Desert to Libyan frontier, and southern part of the Eastern Desert.

Diagnosis.—Size smaller than lesser gerbil (*Gerbillus gerbillus*). Dorsum brownish with contrasting whitish areas above eye, behind ear, and above base of tail. Fur relatively short and soft. Tail longer than head and body with inconspicuous brush. Ear prominent and partly pigmented.

Incisive foramina relatively long. Bulla inflated posteriorly beyond level of supraoccipital. Lip of external auditory meatus with prominent anterodorsal swelling. Accessory tympanum present.

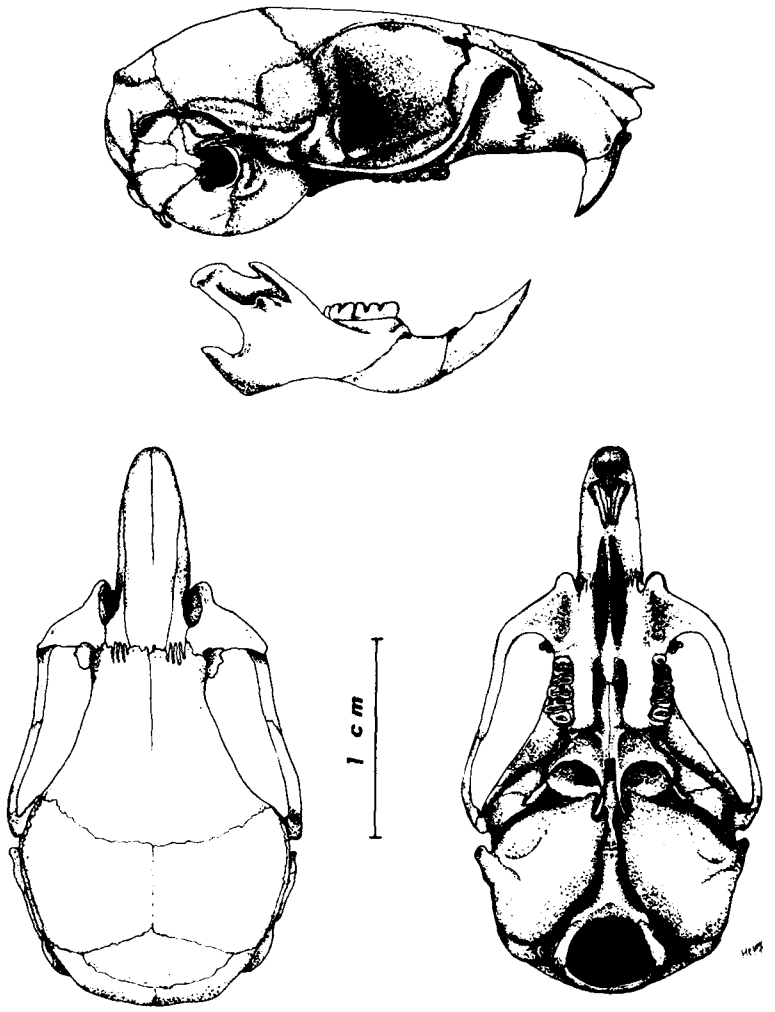


FIG. 51. Skull of *Dipodillus simoni kaiseri*.

One of the smaller Egyptian species of *Dipodillus*. Adult head and body length average 81 mm.; tail 106 mm., 130 per cent of head and body length; hind foot 23 mm.; ear 12 mm.; occipitonasal length 25.5 mm.; weight 13 gm.

External characters.—Figure 53. Dorsum dark yellowish brown. Dorsum brown in darker individuals with color gradually paling to border of clear yellowish on side. Color of side not extending onto forelimb. Dorsal hairs with blackish tips, yellowish subterminal bands, gray bases. Side with broad area of hairs with white bases. Venter, upper surface of feet, and underside of tail white. Tail bicolored; upper surface as back. Brush one-third to one-fourth length of tail, inconspicuous, fuscous. Whitish area on rump large, conspicuous. Band of dark-tipped hairs from mystacial area beneath eye to base of ear broad and conspicuous. White areas above eye and behind ear prominent. Tip of ear pigmented.

Palatal ridges.—Figure 33 Diastemal ridges slightly curved. The first to third intermolar ridges long and recurved, fourth intermolar vestigial, fifth long and curving anteriorly.

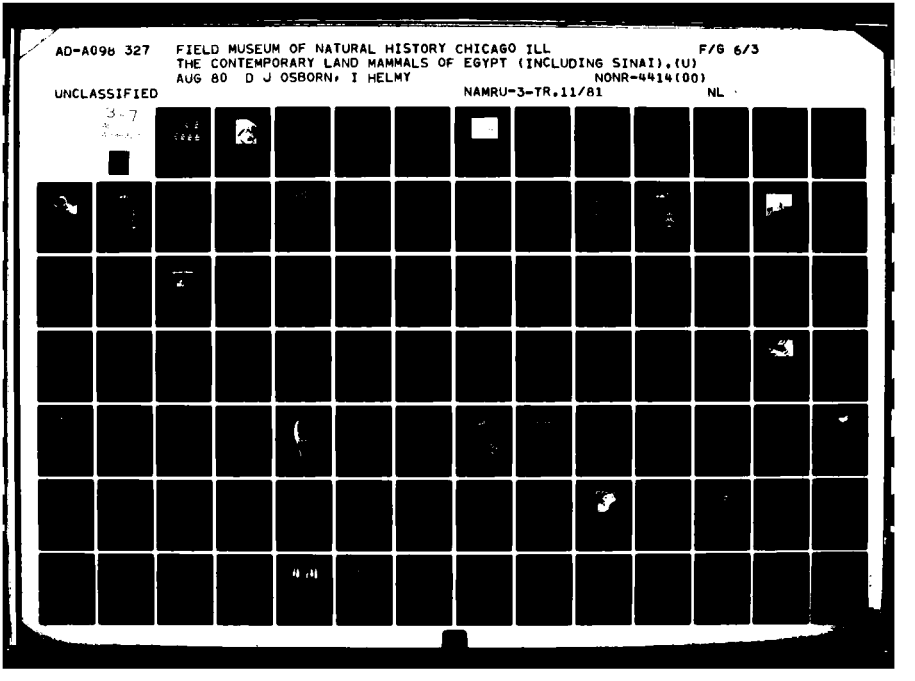
Glans penis and baculum.—In this and the following species, *D. henleyi*, the basal plate is lozenge-shaped (see also under *G. pyramidum*, *G. andersoni*, and Wassif et al., 1969).

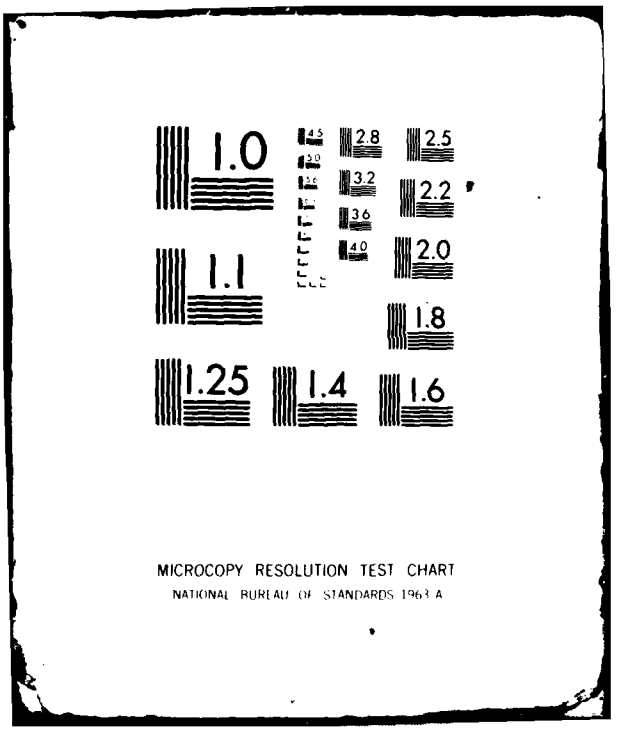
Feet.—Figure 34. Palm and sole naked. Proximal plantar tubercles small, indistinct, and close together. Sole not pigmented.

Cranial characters.—Figure 47. Supraorbital ridge moderately developed. Interparietal deep and rectangular. Posterior margin of nasals irregularly truncate to broadly rounded. Incisive foramina relatively long. Zygomatic plate projecting forward to level of premaxillary-maxillary suture. Parapterygoid fossa deep. Basioccipital relatively broad. Anterior margin of tympanic bulla extending beyond posterior margin of foramen ovale. Posterior margin of mastoid bulla extending beyond level of paroccipital and supraoccipital. Subarcuate fossa small, not dividing anterior mastoid and lateral superior posterior mastoid chambers. Medial superior posterior cavity large and visible in lateral view. Accessory tympanum present. Lip of external auditory meatus distinctive with a large anterodorsal swelling nearly touching zygomatic process of temporal. Hamular process of temporal usually L-shaped and closing the suprameatal triangle posteriorly.

Teeth.—Figures 38, 52. Upper incisor grooved; first labial and

AD-A098 327 FIELD MUSEUM OF NATURAL HISTORY CHICAGO ILL F/G 6/3
THE CONTEMPORARY LAND MAMMALS OF EGYPT (INCLUDING SINAI),(U)
AUG 80 D J OSBORN, I HELMY NONR-4414(00)
UNCLASSIFIED NAMRU-3-TR,11/81 NL




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

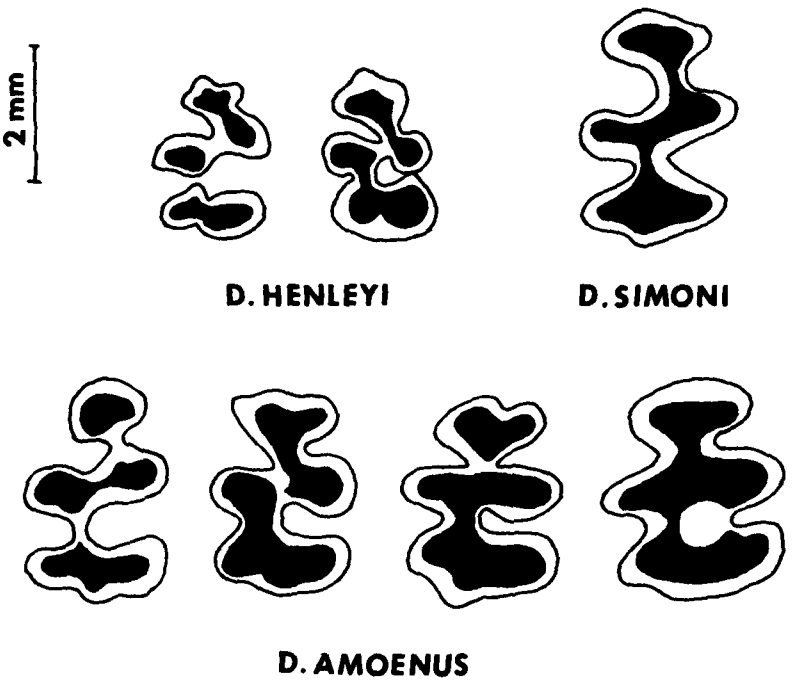


FIG. 52. Crown views of upper first molars of *Dipodillus henleyi, D. simoni,* and *D. amoenus* illustrating differences in pattern and changes with wear; and of *D. amoenus,* individual variation.

lingual cusps of m^1 alternate, at least in immatures. Margins of cusps and laminae rounded. Second lingual fold of m^1 prominent and deeper than first labial fold. Small posterolateral folds on m^1, m^2; m_1, m_2. All cusps of m^1 confluent in adults. Transverse lamination in m^2, m_1 and posterior cusps of m^1, m_1 completed in immatures. Stages of confluency of the three anterior cusps of m^1 variable and may begin between the anterior cusp and first lingual, as in *D. henleyi,* or between the first labial and first lingual (fig. 52). Stages in m_1 also appear variable, but confluency may be completed slightly before m^1.

Posterior lamina of m_1 not united with anterior cusps. Anterior and posterior laminae of m^2, m_2 not always confluent. M^3 has two or three transient cusps. Enamel pattern of m^1, m^2 is distinctive of *D. amoenus.*

FIG. 53. Cadaver of *Dipodillus amoenus amoenus*. Note distinctive white rump patch.

Measurements.—Table 16. Male and female dimensions subequal. Means (and ranges) of occipitonasal length (in millimeters) of 19 adult males and nine adult females, respectively, are 25.6 (23.6 to 26.7) and 25.2 (24.4 to 26.6).

Age determination.—Adults have part of all cusps of m^1 confluent (figs. 38, 52) and cranial sutures closed.

Variation.—Means of measurements within *D. amoenus* vary only slightly from north to south in Egypt. Samples are too small for further analyses (table 16). Ranck (1968) reported decreased "size" and reduction in inflation of auditory bulla from west to east in Libya.

Comparisons.—The nominate subspecies from Egypt is reported to be darker than *Dipodillus amoenus vivax* from Libya and with

skull less strongly developed, bulla smaller, tail shorter with brush less conspicuous (Ranck, 1968).

Relationships between *D. amoenus* and *D. nanus* or *D. dasyurus* were assumed by several authors (Ellerman and Morrison-Scott, 1951; Petter, 1961; Harrison, 1967) without evidence. The most closely related species recognized in this work are *nanus* and *henleyi*. These species and *amoenus* have similar color pattern, including whitish rump patch; anterior lip of auditory meatus completely or partially inflated (fig. 47); a small subarcuate fossa; large medial superior posterior cavity, which is visible in lateral view; and patterns of occlusal surfaces of molariform teeth similar, particularly in *amoenus* and *henleyi* (figs. 38, 52).

Dipodillus amoenus and *D. simoni* appear similar superficially, but the latter lacks a whitish rump patch, and the white marking above the eye is inconspicuous; the tail of *simoni* is shorter, with almost no brush; tooth characters of *simoni* are distinctive (fig. 52); lip of the auditory meatus is unmodified; and in *simoni*, the averages of most measurements are smaller except for incisive foramina length (tables 15, 16). Further comparisons are summarized in Table 14.

Remarks.—A specimen reported to be *D. mackilligini* from near Cairo by Bonhote (1909, p. 792) is *D. amoenus* (B. M. 9.7.1.43).

Specimens examined.—Total 102.

ALEXANDRIA: El Amiriya (8).
TAHREER: Cairo-Alexandria desert road km. 102 (1).
ASWAN: Wadi Allaqi (2), Wadi Quleib (2).
BEHEIRA: Hafs (1); Bir Victoria (3); Wadi el Natroun (18); Wadi el Natroun, Zaghig (1); El Beida (1), 5 km. S (1), 4.8 km. E (1).
MATRUH: Burg el Arab (1), Salum 17.6 km. SE (1), El Maghra (4), Camel Pass Dune area (6).
GIZA: Hawamdiya (2); El Aiyat, Mit Riheina (2); Giza Pyramids (4).
EL FAIYUM: El Auberge (1); Minshat Tantawi (3); Minshat el Amir (5); Lake Qarun (2); Abu Gandir (1); Kom O Shim (6), 1.6 km. NE (1); Tahreer Forest (2); Shooting Club (12); Seila (1).
EL WADI EL GEDEED: Dakhla Oasis, Gharb El Mawhoub (3); Bir el Nokta (1); Mut 3.2 km. S (1), 10 km. N (3).
RED SEA: Wadi Naam (1).

Published records.—Records are from De Winton (1903), Flower (1932), Setzer (1952, 1958d), and Wassif (1956a).

BEHEIRA: Hafs; Bir Victoria; Wadi el Natroun.
MATRUH: Burg el Arab, El Alamein.
EL FAIYUM: Kom O Shim, Kom O Shim 1.6 km. NE; Lake Qarun; El Auberge; Sinnuris; Seila; Minshat Tantawi; Shooting Club.

Collection.—Dug from burrows in salt marshes and hard desert soil and sand. Readily enters live traps. May be picked up by hand under a spotlight at night.

Habitats.—Southeastern Desert: Burrows found in sand under *Zilla spinosa* in Wadi Naam (Hoogstraal et al., 1957b).

Northeastern Delta (Hafs, Amiriya): Found in burrows of *Psammomys obesus* in dark, saline soil and salt marsh. Burrows found in dikes in a soil reclamation area.

Wadi el Natroun: Clover fields, salty areas, canal banks supporting *halfa* grasses (*Desmostachya bipinnata* and *Imperata cylindrica*).

El Faiyum: Under *Tamarix* sp. at edge of cultivated fields and in cultivated ground.

Camel Pass Dune area: Tents of an oil company camp on barren, hard, pebble desert like that between sand sheets in Figure 9.

Kharga Oasis: Under *Tamarix* sp. and beside stands of *Hyoscyamus muticus* in wasteland.

Mediterranean Coastal Desert: Salt marsh near the coast and sandy depressions inland (fig. 7).

El Maghra: In sand under dead fronds and other debris of wild date palms.

Dipodillus amoenus was reported from salt marsh and semidesert areas of Egypt by Wassif (1956a) and Hoogstraal (1963). According to Ranck (1968), it is the common rodent of oases in Libya, occurring under dead fronds of date palms and in cultivated land.

Burrows.—Simple and extending about 25 cm. below ground surface (Wassif, 1956a).

Commensalism.—Occasionally found in tents (see above).

Associates.—Occurs with *Psammomys obesus* and other rodents inhabiting salt marshes (see under *D. simoni*) and with *Gerbillus gerbillus* or *G. andersoni* in sandy areas.

Dipodillus henleyi De Winton, 1903

Dipodillus henleyi De Winton, 1903, Nov. Zool., 10, p. 284.

Type locality.—Egypt. BEHEIRA: Wadi el Natroun, Zaghig.

General distribution.—Jordan, Yemen, Sinai Peninsula, Egypt, Libya, Algeria, and probably Tunisia.

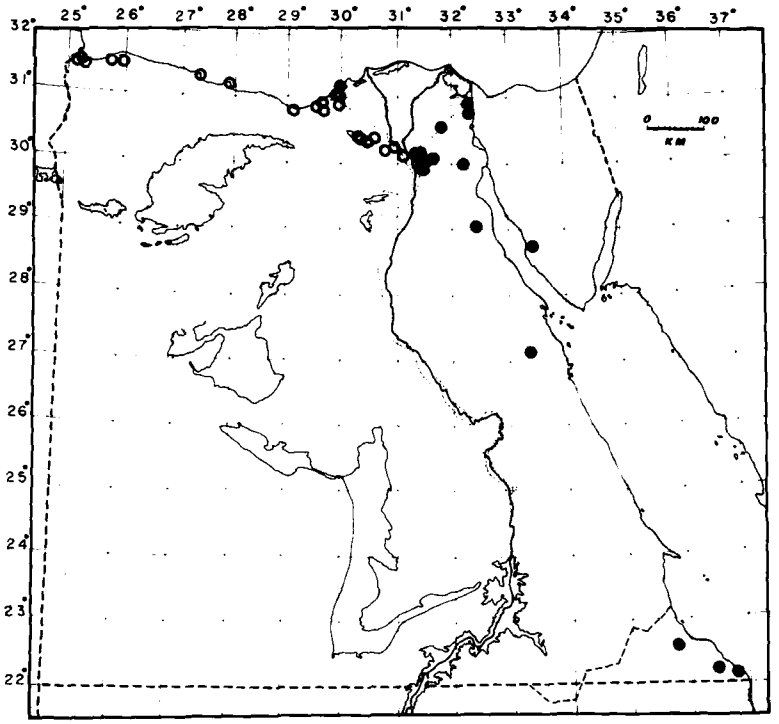


FIG. 54. Collection localities of *Dipodillus henleyi henleyi* (circles) and *D. h. mariae* (dots).

Common names.—Henley's Gerbil, Pigmy Dipodil.

Distribution of subspecies in Egypt.—Figure 54. *Dipodillus henleyi henleyi:* northern part of Western Desert; *Dipodillus henleyi mariae:* Sinai Peninsula and Eastern Desert.

Diagnosis.—Small, buffy brown with contrasting white areas above eye, behind ear, and on rump; tail longer than head and body, with inconspicuous terminal brush; ear not prominent nor pigmented. Incisive foramina relatively short. Bulla inflated posteriorly slightly beyond level of exoccipital. Entire anterior lip of external auditory meatus inflated. Accessory tympanum present.

Adult head and body length average 66 mm.; tail 88 mm., 134 per cent of head and body length; hind foot 20 mm.; ear 10 mm.; occipitonasal length 22.0 mm.; weight 10 gm.

FIG. 55. Cadaver of *Dipodillus henleyi mariae*.

External characters.—Figure 55. Dorsum buffy brown and darker than sides due to brownish tipped hairs. Dorsal and side hairs with gray base, except for narrow ventrolateral strip with white base. Side buffy, color not extending onto forelimb. Underparts, foreleg, and feet white. Band of dark-tipped hairs extending from mystacial area beneath eye to base of ear, width variable. Supraorbital and postauricular areas and rump patch white, prominent. Tail bicolored; upper surface as back, ventral white. Tail brush inconspicuous, about one-fourth or less of tail length, fuscous. Ear not pigmented.

Palatal ridges.—Similar to *D. amoenus* in Figure 33, except fourth and fifth intermolar ridges are crenulated.

Glans penis and baculum.—See under *D. amoenus*.

Feet.—Figure 34. Palm and sole hairless. Tubercles distinct. Proximal plantar tubercles close together. Sole not pigmented.

Cranial characters.—Figure 47. Skull small, fragile. Supraorbital ridges thin. Posterior margin of nasals irregularly truncate. Inter-

parietal proportionately deeper than in other species and distinctive. Anterior palatine foramen relatively short. Zygomatic plate with nearly vertical anterior margin reaching or almost reaching level of premaxillary-maxillary suture. Parapterygoid fossa moderately deep. Basioccipital slender. Anterior margin of tympanic bulla reaching level of anterior edge of foramen ovale. Posterior margin of mastoid bulla inflated almost to level of supraoccipital. Entire lip of the external auditory meatus swollen, a distinctive species character (fig. 47). Accessory tympanum present. Subarcuate fossa small and not separating anterior mastoid and lateral superior posterior mastoid chamber. Medial superior interior posterior mastoid cavity large and visible in lateral view (fig. 47). Squamosal T-shaped and closing suprameatal triangle posteriorly.

Teeth.—Figures 38, 52. Upper incisor grooved; first labial and lingual cusps of m^1 alternate; sometimes appearing opposite in worn teeth. Molars tuberculate in immatures, becoming fused with wear into laminae with rounded margins. A deep first labial fold in m^1 separates the combined anterior and lingual cusps from the first labial in immatures and adults. Union between first lingual and first labial cusps occurs in old individuals after union of first labial and posterior lamina. Second lingual fold large and deep. Posterolateral folds of m^1, m^2 transient. Anterior and first lingual cusps of m_1 usually united and confluency between first labial and lingual follows pattern of m^1. Confluency of posterior lamina of m_1 with anterior cusps and union of laminae of m_2 occurs in teeth showing considerable wear.

Note that size and pattern of molars, particularly m^1, are distinctive of *D. henleyi* (fig. 52).

Measurements.—Table 17. Smallest Egyptian species of *Dipodillus*. Male and female dimensions subequal. Means (and ranges) of occipitonasal length (in millimeters) of eight adult males and eight adult females, respectively, are 22.1 (21.4 to 22.8) and 22.0 (22.9 to 23.0).

Variation.—Color of specimens from the Eastern Desert is slightly paler than Western Desert samples, but with dark brownish hairs on the posterior dorsum more prominent. White hairs are more extensive in *D. h. mariae*. The rump patch is more conspicuous and tail about 10 per cent longer in *D. h. henleyi*.

Comparisons.—Relationship between *D. henleyi*, *D. amoenus*, and *D. nanus* are evident in the presence of a prominent white rump

TABLE 17. — Means (and ranges) of measurements, ratios, and weight of adult *Dipodillus henleyi*.

	Western Desert *D. h. henleyi*	Eastern Desert *D. h. mariae*
HBL	66.4 (62-75) 15	67.6 (62-75) 9
TL	85.4 (72-95) 15	94.4 (89-99) 8
TL/HBL%	128.8 (101.4-146.8) 15	139.8 (128.0-159.6) 8
FL	19.2 (19-20) 15	20.4 (19.5-21.0) 9
EL	9.4 (9-10) 15	9.6 (9.0-10.5) 9
Wt	9.8 (8.0-11.4) 9	7.2, 10.0
ONL	22.0 (20.9-23.0) 14	22.0 (21.0-22.6) 7
ZW	12.3 (11.9-12.8) 8	12.2 (11.8-12.5) 4
IOW	3.8 (3.6-4.4) 14	3.9 (3.7-4.2) 6
BCW	11.1 (10.8-11.7) 13	11.0 (10.4-11.4) 7
NL	7.9 (7.2-9.0) 14	7.6 (6.8-8.0) 6
IFL	3.5 (3.1-3.8) 15	3.6 (3.4-3.8) 8
AL	2.9 (2.7-3.1) 14	2.8 (2.8-3.0) 7
RW	3.0 (2.8-3.3) 12	3.0 (2.9-3.0) 3
BL	7.4 (6.8-9.0) 12	7.2 (7.0-7.3) 5
SH	9.1 (8.5-9.7) 9	9.2 (8.9-9.4) 6

patch, swelling of the anterior lip of the external auditory meatus, small subarcuate fossa, large medial superior posterior mastoid cavity, and presence of an accessory tympanum. *Dipodillus henleyi* can be distinguished from all other Egyptian species by its smaller dimensions, particularly alveolar length of upper molars; occlusal pattern of molariform teeth; swelling of the auditory meatal lip; interparietal shape; and additional characters in Figure 47 and Table 14.

Collection.—Dug from burrows in sand, trapped alive, and caught by hand at night using a spotlight.

Habitats.—Sinai Peninsula: Not well defined. Collected by Haim and Tchnernov (1974) in stoney, gravelly wadis vegetated with *Anabasis* sp. and *Lygos raetam* and *Anabasis articulata*, together with *Zilla spinosa*.

Eastern Desert: Plains, vegetated wadis (fig. 5), coastal marshes, cultivated areas (Hoogstraal, 1963), sand among rocks, in hard gravel beside the large shrub, *Salvadora persica*, and sand under stands of bunch grass, *Panicum turgidum*.

Western Desert: Newly reclaimed land; sparsely vegetated, hard sand, and densely vegetated patches of soft sand (Hoogstraal, 1963); coastal vegetation on clay and stoney land (fig. 8); *Psam-*

momys obesus burrows in salt marshes; and beside *Atriplex halimus* and *Limoniastrum monopetalum* (fig. 7). Ranck (1968) found it in Libya in salt marshes and confined to coastal plain and littoral deserts.

Burrows.—Burrows with plugged entrances were found in loose sand in stands of *Panicum turgidum* on the Red Sea coastal plain near Gebel Elba (Hoogstraal et al., 1957b). Burrows are simple and shallow.

Associates.—Found in the same habitat with *D. simoni, D. amoenus, Psammomys obesus,* and sometimes *Gerbillus gerbillus* and *G. pyramidum.*

Reproduction.—Females with four newborn young were collected in Wadi Digla, southeast of Cairo, and near Bahig in the Western Mediterranean Coastal Desert in mid-June and mid-August, respectively.

Sex ratio.—In a sample of 45 museum specimens of *D. henleyi,* there were 26 (58 per cent) males and 19 females.

KEY TO EGYPTIAN SUBSPECIES OF *Dipodillus henleyi*

1. Brownish hairs on posterior dorsum not prominent. Dark-tipped hairs of hind limb reaching heel. Tail average 10 per cent shorter. (Western Desert)..... ..... *henleyi,* p. 179.
2. Brownish hairs on posterior dorsum prominent. Dark-tipped hairs of hind limb not reaching heel. Tail average 10 per cent longer. (Sinai Peninsula, Eastern Desert)..... *mariae,* p. 180.

Dipodillus henleyi henleyi De Winton, 1903

Type locality.—Egypt. BEHEIRA: Wadi el Natroun, Zaghig.

Distribution in Egypt.—Figure 54. Western Nile Delta and Mediterranean Coastal Desert to Libyan frontier.

External characters.—Slightly darker than *D. mariae,* but brownish tipped hairs on posterior dorsum less prominent. Ventrolateral strip of hairs with white bases narrower. Whitish rump patch smaller. Dark-tipped hairs of hind leg reaching heel. In general, there is less extension of white in *D. henleyi* than in *D. mariae.*

Measurements.—Table 17. Dimensions average about the same as in *D. h. mariae,* except for slightly shorter tail.

Specimens examined.—Total 35.

BEHEIRA: Bir Victoria (2), Wadi el Natroun (2), Zaghig (Type), Gebel Muluk (1).

ALEXANDRIA: Alexandria 4.8 km. W (1), Amiriya (2).
MATRUH: Cairo-Alexandria desert road km. 55 (2); Mariut (1); Bahig (1); Burg el Arab (1); Abu Mena 1.6 km. E (1); El Imayid (1); Ras el Hekma (5); Mersa Matruh (1); Sidi Barrani 19 km. S (2), 51 km. W (2); Salum 12.8 km. SE (2), 18 km. SE (2); Bir Bosslanga (Bir Wair) (3).
GIZA: Abu Ghalib (1), Abu Rawash (1).

Published records.—Records are from De Winton (1903), Wassif (1956a), Setzer (1958d), and Hoogstraal (1963).

BEHEIRA: Bir Victoria, Wadi el Natroun, Gebel Muluk, Zaghig.
MATRUH: Cairo-Alexandria desert road km. 55; Mariut, Burg el Arab; Alexandria 48 km. W; Mersa Matruh; Sidi Barrani, 52.8 km. W, 10 km. S; Bir Bosslanga (Bir Wair).
GIZA: Abu Ghalib.

Dipodillus henleyi mariae (Bonhote, 1909)

Dipodillus mariae Bonhote, 1909, Proc. Zool. Soc., London, pt. 2, p. 792.
Dipodillus henleyi makrami Setzer, 1958, J. Egyt. Publ. Health Assn., **33**, No. 6, p. 212.

Type locality.—Egypt. CAIRO: Gebel Mokattam.

Distribution in Egypt.—Figure 54. Sinai Peninsula and Eastern Desert.

External characters.—Figure 55. Slightly paler than *D. h. henleyi*, but dark brownish hairs on posterior dorsum more prominent. Ventrolateral strip of hairs with white bases, wider. Whitish rump area larger. Band of dark-tipped hair on side of head extending from mystacinal area beneath eye to base of ear, narrower and paler. Dark-tipped hairs of hind leg not reaching heel. In general, there is more extension of white in *D. h. mariae* than in *D. h. henleyi*.

Cranial characters.—Although reported by Setzer (1958d) to have larger bullae than *D. h. henleyi*, measurements of same and skull height are not confirmative (table 17).

Measurements.—Table 17. About the same average dimensions as *D. h. henleyi*, except for slightly longer tail.

Remarks.—Specimens from the Eastern Desert previously allotted to *D. h. henleyi* (Wassif, 1956; Hoogstraal et al., 1957b) and *D. h. makrami* (Setzer, 1958d) are here identified as subspecies *D. h. mariae* because of similarity in size and color and proximity of distribution.

Specimens examined.—Total 19.

ISMAILIA: El Ballah (1), El Qantara (3).
SUEZ: Cairo-Suez road km. 22 (1), Wadi el Rokham (1).

CAIRO: Cairo (1), Gebel Mokattam (1), Gebel el Ahmar (1), Heliopolis 8 km. E (2), Cairo-suez road 2 km. E of Cairo (1), Maadi (1), Wadi Digla 3.2 km. E of Maadi (1).
RED SEA: Wadi Araba, St. Anthony Monastery area (1); Wad Bali (1).
SUDAN ADMINISTRATIVE: Wadi Ibib (1), Bir Kansisrob 3.2 km. N (1), Halaib 20.8 km. NW (1).

Published records.—Records are from Allen (1915), Wassif (1956a), Setzer (1952, 1958d), and Haim and Tchernov (1974).

SINAI: Wadi el Feiran, Gebel Maghara, Bik'at Hayareach southeast of Ras el Naqb.
ISMAILIA: El Ballah, El Qantara.
SHARQIYA: Faqus.
CAIRO: Gebel Mokattam, Heliopolis, Heliopolis 8 km. E, Ain Shams, Maadi, Wadi Digla.
SUEZ: Cairo 35 km. E, 22 km. E.
SUDAN ADMINISTRATIVE: Bir Kansisrob 3.2 km. N; Halaib 20.8 km. NW, 3.2 km. W.

Genus **Sekeetamys** Ellerman, 1947

Monotypic genus of dipodil-like rodent with naked palm and sole; long, fluffy fur; and black, bushy tail with white tip. Tubercles and pads of palm, and tubercles of sole as in genus *Dipodillus*.

Bulla greatly inflated; lateral accessory mastoid chamber present; medial superior posterior mastoid cavity relatively large, visible from behind and not concealed by exoccipital as in genus *Meriones*. Meatal lip swollen slightly ventrally. Accessory tympanum absent. Suprameatal triangle small. Superior wall of parapterygoid fossa perforated. Tubercles and configuration of upper first molar as in *Dipodillus*. Upper third molar with large, transient posterolabial fold.

Sekeetamys calurus (Thomas, 1892)

Gerbillus calurus Thomas, 1892, Ann. Mag. Nat. Hist., (ser. 6), **9**, p. 76.

Type locality.—Egypt. SINAI: "Unknown" (Thomas, 1892b, p. 77); Tor (Chaworth-Musters and Ellerman, 1947, p. 482).

General distribution.—Western portions of Arabian Peninsula, Jordan, southeastern Israel, Sinai Peninsula, Eastern Desert of Egypt.

Common names.—Bushy Tailed Dipodil, Bushy Tailed Jird, *Abu Ya.*

Distribution of subspecies in Egypt.—Figure 56. *Sekeetamys calurus calurus:* Sinai Peninsula; *Sekeetamys calurus makrami:* Eastern Desert.

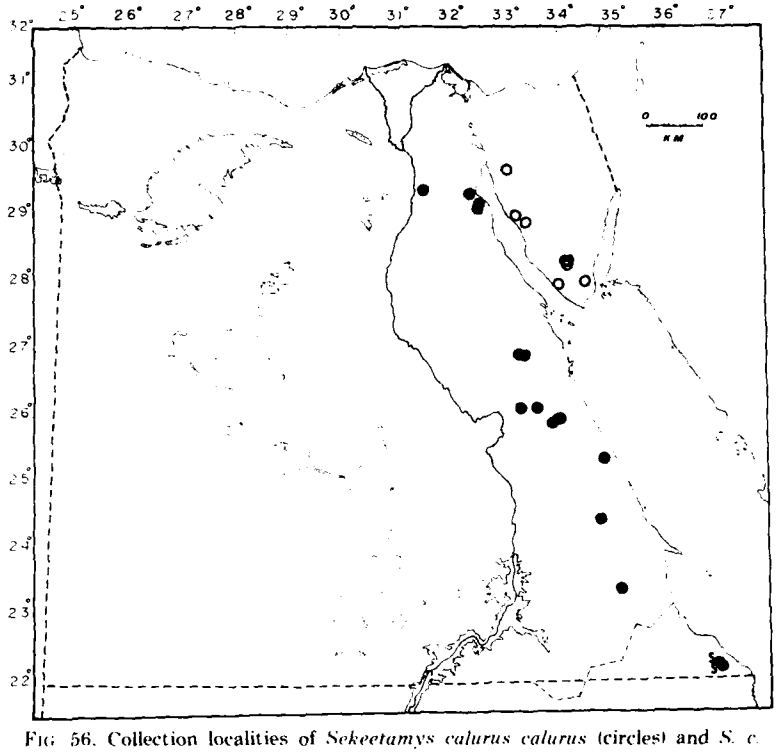


FIG. 56. Collection localities of *Sekeetamys calurus calurus* (circles) and *S. c. makrami* (dots) and sight records (S).

Diagnosis.—Large, dipodil-like rodent with naked palm and sole, fur long and fluffy, dorsal hairs brownish yellow with blackish tips, sides yellowish to orangish, underparts and feet white. Tail bushy, blackish with white tip.

Skull with greatly inflated bulla, small suprameatal triangle, mastoid with lateral accessory chamber, meatal lip not swollen, accessory tympanum absent, medial superior mastoid cavity visible posteriorly.

Adult head and body length average 114 mm.; tail 145 mm., 128 per cent of head and body length; foot 32 mm.; ear 20 mm.; occipitonasal length 35 6 mm,; weight 41 gm.

External characters.—Figure 57. Upper parts dark brownish yellow. Dorsal hair tips black, subterminal bands yellowish. Side

FIG. 57. Live specimen of *Sekeetamys calurus makrami*

with prominent line of yellowish to orangish extending to wrist and ankle. Hairs of back and side with gray bases, hairs of belly and feet white. Mystacial area orangish, suborbital and subauricular areas pale, postorbital and postauricular spots white. White rump patch absent. Ear prominent, sparsely haired, pigmented. Tail bushy and "squirrel-like" (Allen, 1915, p. 6), basal one-fifth color of back, distal four-fifths fuscous to blackish, not bicolored, usually with a conspicuous white tip.

Palatal ridges.—Figure 33. Diastemal ridges rather straight; first to fourth intermolar ridges recurved, and all about the same length; fifth directed medially, slightly shorter, and thicker.

Glans penis and baculum.—As in *Dipodillus* sp. (Wassif et al., 1969).

Feet.—Figure 34. Palm and sole hairless. Sole pigmented. Hand with three postdigital tubercles and two distinct palmar pads. Foot with three postidigital, one posthallucal, and two tarsal tubercles.

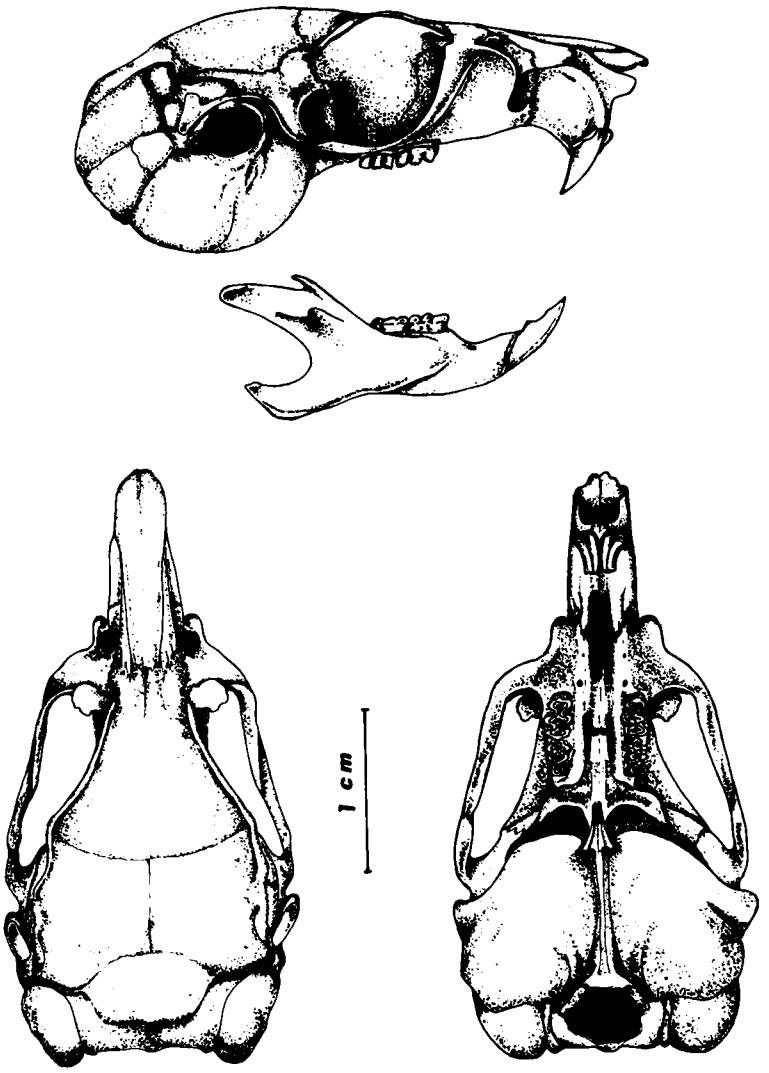


FIG. 58. Skull of *Sekeetamys calurus makrami*.

Cranial characters.—Figure 58. Skull elongate with prominent supraorbital ridges and conspicuous cranial ridges, nasals pointed posteriorly, interparietal outline ovoid, bulla markedly inflated. Anterior surface of tympanic bulla extending almost to level of anterior margin of foramen ovale. Posterior margin of mastoid chambers extending beyond level of paroccipital and supraoccipital. Medial superior posterior mastoid cavity visible from behind. Accessory mastoid chamber posterior to auditory meatus. Suprameatal triangle small, or "vestigial" (Ellerman, 1941, p. 527), closed posteriorly by vertical extension of L-shaped suprameatal process of temporal bone. Accessory tympanum absent. Auditory meatus inflated slightly ventrally. Width across meatuses slightly greater than zygomatic width. Parapterygoid fossa with large perforation in superior wall. Zygomatic arch slender. Zygomatic plate broad and high, anterior margin gradually rounded, not reaching level of premaxillary-maxillary suture.

Teeth.—Figure 59. Upper incisor grooved on anterior surface. Upper first molar with alternate first lingual and labial cusps. Cusps of m_1 become confluent shortly before m^1 as in other Gerbillinae. M^3 with transient posterolabial fold.

Measurements.—Table 18. Male and female dimensions subequal.

Age determination.—Adults have m^1 with anterior cusps confluent and cranial sutures closed, as in gerbils and dipodils.

Variation.—The tail lacks a white tip in a few specimens from Sinai and the Eastern Desert, including the type of *S. c. makrami.* Specimens of *S. c. makrami* from the Eastern Desert are generally darker than *S. c. calurus* from Sinai Peninsula and, except for five pale individuals from sandstone and limestone habitats in the northern part of the Eastern Desert, have a narrower line of clear color on the side.

The posterolabial fold on m^3 is visible in 10 (50 per cent) of 20 specimens from the Eastern Desert and 21 (70 per cent) of 30 specimens from Sinai Peninsula. Observations indicate that the posterolabial fold is transient and disappears at an earlier age in Eastern Desert animals than in those from the Sinai Peninsula. The type specimen of *S. c. makrami* has m^3 peglike and lacking a posterolabial fold. *Sekeetamys c. makrami* average dimensions are mostly slightly smaller than *S. c. calurus* (table 18). Intergrades between the two subspecies occur in the northern part of the Eastern Desert.

Comparisons.—*Sekeetamys calurus* differs strikingly from all other Egyptian Gerbillinae by its bushy tail with white tip. One other rodent, *Eliomys quercinus*, has a black bushy tail, but is distinguished by a black facial mask. Cranially, *Sekeetamys* differs from the genus *Meriones* in that the medial superior posterior mastoid cavity is not covered by the exoccipital. The molar pattern also differs in the two genera (fig. 59). Feet (fig. 34), teeth (figs. 38, 59), and bulla are most similar to genus *Dipodillus*. Palatal ridges of *Sekeetamys* are distinctive (fig. 33). The diploid chromosome number is 38, as in Egyptian *Gerbillus pyramidum* (Wassif et al., 1969).

Remarks.—This rodent, like *Pachyuromys duprasi*, is an aberrant form requiring special taxonomic consideration. Previously, *S. calurus* has been considered to be a separate genus as well as a subgenus, or a species of *Gerbillus*, *Dipodillus*, or *Meriones* (Anderson, 1902; Allen, 1915, 1939; Innes, 1932; Flower, 1932; Ellerman, 1941, 1948, 1949; Chaworth-Musters and Ellerman, 1947; Ellerman and Morrison-Scott, 1951; Wassif, 1954; Wassif and Hoogstraal, 1953; Petter, 1956; Wassif et al., 1969).

Collection.—Trapped alive in rocky habitats, shelving limestone (fig. 14), pockets in sandstone cliffs, crevices in granite, or among boulders; sometimes far from vegetation.

Habitats.—Strictly a rock-adapted rodent, *S. calurus* is rarely trapped away from rocks or cliffs (fig. 14) and is occasionally captured in abandoned stone huts. Reported from mountain tops in Sinai Peninsula (Haim and Tchernov, 1974).

Behavior.—Easily excited when first captured, extremely agile, and difficult to handle; becomes docile after several weeks of repeated handling. Specimens taken from live traps invariably have the snout injured from striking the wire mesh in attempting to escape.

Climbing ability, according to Zahavi and Wahrman (1957), surpasses that of *Dipodillus dasyurus*, which live in the same habitat. The bushy tail, they think, may be of some advantage.

Nocturnal, becoming active at dusk, *Sekeetamys* is beautifully graceful in motion. The tail held squirrel-like in an upright, curved position, is never allowed to touch the ground.

Food.—Near Fawakhir mine, *S. makrami* was trapped in crevices containing parts of seed capsules of *Zilla spinosa*, seed coats of

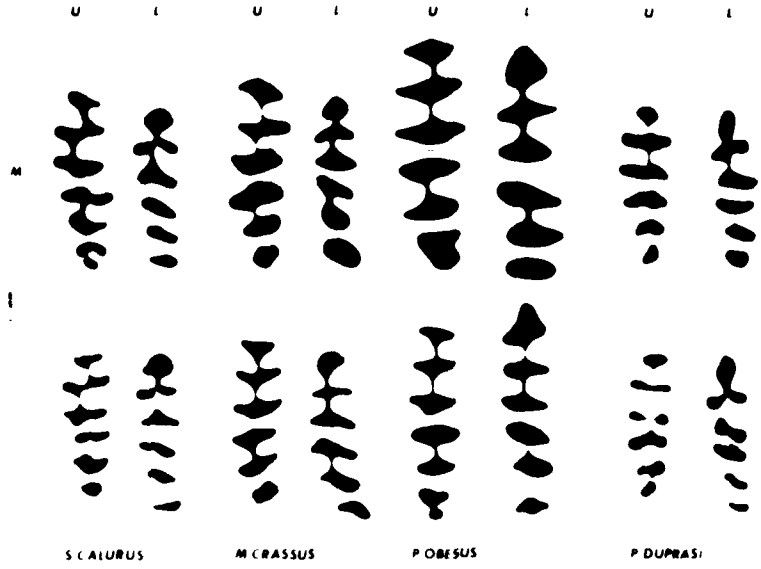


FIG. 59. Crown views of right upper (U) and left lower (L) molars of mature (M) and immature (I) *Sekeetamys calurus*, *Meriones crassus*, *Psammomys obesus*, and *Pachyuromys duprasi*.

TABLE 18. Means (and ranges) of measurements, ratios, and weight of adult *Sekeetamys calurus*.

	S. c. calurus	*S. c. makrumi*
HBL	118.9 (98-128) 25	110.1 (98-119) 20
TL	144.4 (131-164) 20	146.2 (131-164) 19
TL/HBL%	123.6 (110-148) 20	133.3 (116-149) 19
FL	33.1 (31-35) 25	31.3 (29-33) 21
EL	21.4 (20-23) 25	19.2 (17.0-20.5) 21
Wt	--	41.4 (26.6-49.8) 17
ONL	35.8 (34.5-37.4) 20	35.4 (33.0-37.5) 18
ZW	18.2 (17.2-19.1) 10	18.0 (16.9-19.0) 18
IOW	5.5 (5.2-5.9) 26	5.4 (5.0-5.7) 20
NL	14.4 (13.5-15.5) 20	13.6 (12.4-15.5) 17
IFL	6.4 (6.1-6.8) 18	5.8 (5.2-6.4) 20
AL	5.2 (4.8-5.8) 17	4.8 (4.5-5.1) 20
RW	4.6 (4.3-5.1) 26	4.6 (4.2-5.1) 19
BL	11.7 (11.0-12.7) 25	11.6 (11.0-12.3) 20
SH	13.8 (13.0-14.7) 22	13.6 (13.2-14.3) 20

Citrullus colocynthis, and parts of succulent *Zygophyllum coccineum*. In Wadi Fatira, *Aerva javanica* was eaten and carried to dens. Branches of *Z. coccineum* and *Cleome droserifolia* given to captive *Sekeetamys* were eaten with apparent relish. Captive animals also ate cockroaches and crickets.

Associates.—*Eliomys quercinus*, *Acomys cahirinus*, *A. russatus*, and *Dipodillus dasyurus* are rock-adapted and live in the same habitat as *Sekeetamys*.

Reproduction.—No information from nature is available. Flower (1932) reported litters from captive animals every month of the year except September. Number of young averaged 2.8 in 47 litters; two litters of six were recorded.

Sex ratio.—A sample of 24 from the Eastern Desert consisted of 13 (54 per cent) males and 11 females.

KEY TO EGYPTIAN SUBSPECIES OF
Sekeetamys calurus

1. Color pale, side stripe wider; dimensions slightly larger, particularly incisive foramina length. (Sinai Peninsula). . . . . *calurus*, p. 188.
2. Color dark, side stripe narrower; dimensions slightly smaller, particularly incisive foramina length. (Eastern Desert). . . . . *makrami*, p. 189.

Sekeetamys calurus calurus (Thomas, 1892).

Type locality.—Egypt. SINAI: Tor.

Distribution in Egypt.—Figure 56. Northern, central, and southern parts of Sinai Peninsula.

External characters.—See species description. *Sekeetamys c. calurus* has a narrower dorsal stripe, broader strip of clear color on side, and is paler than *S. c. makrami*.

Cranial characters.—See species description.

Teeth.—Figure 59, and see discussion under species. Posterolabial folds on m^1 were found in 70 per cent of *S. c. calurus* and 50 per cent of *S. c. makrami* specimens.

Measurements.—Table 18. *Sekeetamys c. calurus* average dimensions are slightly larger than *S. c. makrami*, especially incisive foramina length.

Specimens examined.—Total 30.

SINAI: Sinai (locality not stated) (2); Wadi el Sheikh (6), 4.8 km. W (5); St. Catherine Monastery area (9); Wadi Raha (2); Tor (5); Umm Bugma (1).

Published records.—Records are from Anderson (1902), Allen (1915), Flower (1932), Wassif and Hoogstraal (1953), Setzer (1961a), and Haim and Tchernov (1974).

SINAI: Abu Zenima, Umm Bugma (Ambogma), Wadi Saal, Tor, St. Catherine Monastery area, Gebel Yiallaq (Yelleq).

Sekeetamys calurus makrami (Setzer, 1961)

Sekeetamys makrami Setzer, 1961, J. Egypt. Pub. Health Assn., **36**, No. 3, p. 90.

Type locality.—Egypt. RED SEA: Wadi Gumbiet.

Distribution in Egypt.—Figure 56. Eastern Desert.

External characters.—See species description. *Sekeetamys c. makrami* has a broader dorsal stripe, narrower strip of clear color on side, and is slightly darker than the nominate subspecies in the southern part, but not in the northern part, of the Eastern Desert.

Cranial characters.—See species description.

Teeth.—Figure 59, and see discussion under species and *S. c. calurus*.

Measurements.—Table 18. *Sekeetamys c. makrami* average dimensions are mostly smaller than *S. c. calurus*, especially incisive foramina length.

Remarks.—Some differentiation, probably due to isolation, has occurred between populations of *S. calurus* in Sinai and the Eastern Desert. The degree of difference is not considered sufficient to warrant full species rank for the Eastern Desert population, as proposed by Setzer (1961a). Setzer's decision was based on a single atypical specimen.

Specimens examined.—Total 25.

SUEZ: Ain Sukhna cliffs (2), Wadi Qiseib (1), Wadi Dom (1).

CAIRO: Wadi Hof (2).

RED SEA: Wadi Fatira, Abu Kharif mine area (2); Wadi Abu Sheeh (1); mouth of Wadi Atalla (3); Bir Seyala (1); Wadi el Hammamat, Fawakhir mine area (8); Wadi Abu Qraiya (1); Wadi Sikait (1); Bir Gumbiet (Type).

SUDAN ADMINISTRATIVE: Gebel Nesla (1).

Published records.—Records are from Anderson (1902), Hoogstraal et al. (1957b), and Setzer (1961a).

RED SEA: Wadi Sikait, Bir Gumbeit.

Sight record of D. J. Osborn.—

SUDAN ADMINISTRATIVE: Gebel Elba, Wadi Akwamtra tributary.

Genus **Meriones** Illiger, 1811

Slender to stocky rodents with dorsum yellowish brown to brownish, venter white. Ear large, sparsely haired. Tail fully haired, tip bicolored with a black dorsal brush. Length of tail greater than 85 per cent of head and body length. Palm bare, sole partly haired. Hand with three postdigital tubercles and two large palmar pads. Foot with one large postdigital pad, a hallucal tubercle, and no plantar tubercles (fig. 34).

Skull angular in some species, usually with supraorbital ridge well developed. Tympanic bulla prominently inflated, mastoid and meatal swelling variable. Accessory tympanum absent in most species. Interparietal and exoccipital slightly modified by expansion of bullae. Medial superior posterior mastoid cavity relatively small and concealed by exoccipital.

Upper incisor with single groove on anterior surface. Molars hypsodont when immature, always with prismatic crowns; never tuberculate. First upper molar three-rooted in adults. Third upper and lower molars usually simple, peglike, occasionally with single transient fold.

KEY TO EGYPTIAN SPECIES OF
Meriones

1. Posterior surface of mastoid bulla inflated beyond level of paroccipital process. External auditory meatus swollen to or almost to level of zygomatic process of temporal. Tail with long, conspicuous black brush.
   a. Suprameatal triangle open posteriorly. Accessory tympanum absent. Tail base buffy. Claws pale.
      i. Bulla excessively inflated. Exoccipital and basioccipital constricted (fig. 60). Ear not pigmented. Feet white. (Sinai Peninsula, Eastern and Western Deserts)..... *crassus*, p. 191.
      ii. Bulla not excessively inflated. Exoccipital and basioccipital not constricted (fig. 61). Ear pigmented. Feet partly colored. (Northeastern Sinai Peninsula)..... *sacramenti*, p. 204.
   b. Suprameatal triangle closed posteriorly. Accessory tympanum present. Tail base orangish. Ears not pigmented. Claws black. (Western Desert)..... *libycus*, p. 207.
2. Posterior surface of mastoid bulla not inflated beyond level of paroccipital process. Auditory meatus not greatly swollen. Tail without long, conspicuous black brush.
   a. Suprameatal triangle partially closed posteriorly. Belly hairs with gray base. Ear pigmented. Tail brush large. (Western Desert)..... *shawi*, p. 214.

b. Suprameatal triangle completely closed posteriorly. Belly hairs usually lacking gray base. Ear pigmented. Tail brush very small. (Northeastern Sinai Peninsula)..... *tristrami*, p. 218.

Meriones crassus Sundevall, 1842

Meriones crassus Sundevall, 1842, Kongel. Svenska Vet.-Akad. Handl. Stockholm, pl. II, fig. 4a,b,c,d, p. 233.

Type locality.—Egypt. SINAI: Ayun Musa.

General distribution.—West Pakistan, Afghanistan, southern Russian Turkestan, Iran, Iraq, Syria, Lebanon, Jordan, Israel, Saudi Arabia, Sinai Peninsula, Egypt, northern Sudan, Libya, Algeria, northern Nigeria.

Common names.—Silky Jird, Sundevall's Jird.

Distribution of subspecies in Egypt.—Figure 62. *Meriones crassus crassus:* Sinai Peninsula and greater part of Eastern Desert; *Meriones crassus pallidus:* Southern part of Eastern Dessert; *Meriones crassus perpallidus:* Western Desert.

Diagnosis.—Large gerbil with long, soft dorsal pelage. Dorsum pale yellowish brown, side with narrow, buff-colored areas, hairs of venter and feet white. Mystacial and circumorbital areas pale; postauricular patch conspicuous, white. Tail either faintly or not bicolored, white or buffy below, upper surface as dorsum, with conspicuous black apical brush. Ear, sole, and claws not pigmented. Sole partly haired.

Skull angular, strongly ridged in adults. Bulla inflated posteriorly beyond level of paroccipital process; anterior lip of external auditory meatus conspicuously swollen to level of zygomatic process of temporal. Accessory tympanum absent.

Adult head and body length average 136 mm.; tail 133 mm., 98 per cent of head and body length; hind foot 34 mm.; ear 18 mm.; occipitonasal length 38.6 mm.; weight 80 gm.

External characters.—Figure 63. Dorsal pelage long, soft. Dorsum pale brownish yellow, finely marked with black. Dorsal color separated from white of venter by narrow, clear buff area on side and thigh. All dorsal hairs, except white postauricular patch, with gray bases. Belly hairs with or without gray bases. Mystacial and circumorbital areas pale. Dark color of upper portion of head not extending below level of nose, eye, and ear. Postauricular patch conspicuous, white. Ear with long, pale buff to whitish hairs on anterior

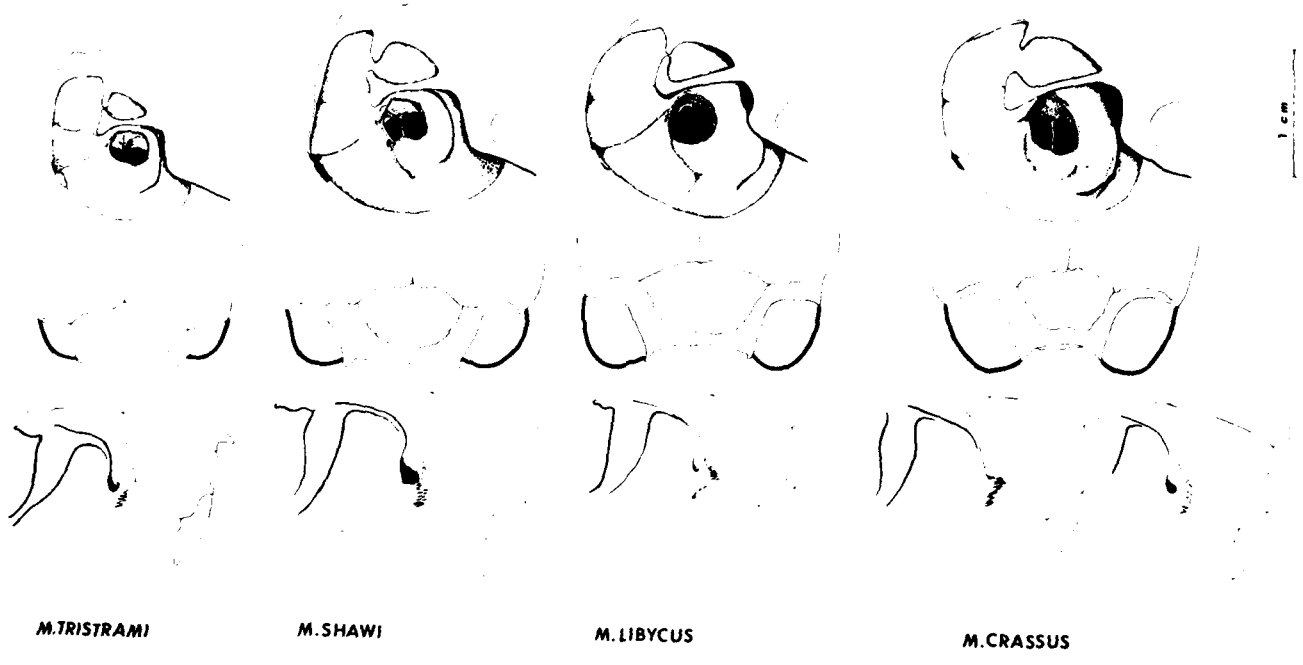


FIG. 60. Auditory bullae in lateral and dorsal views (heavy lines), interparietal shapes, and exposure of infraorbital foramina in lateral view, in species of *Meriones*. Compare with skull of *M. sacramenti* in Figure 61.

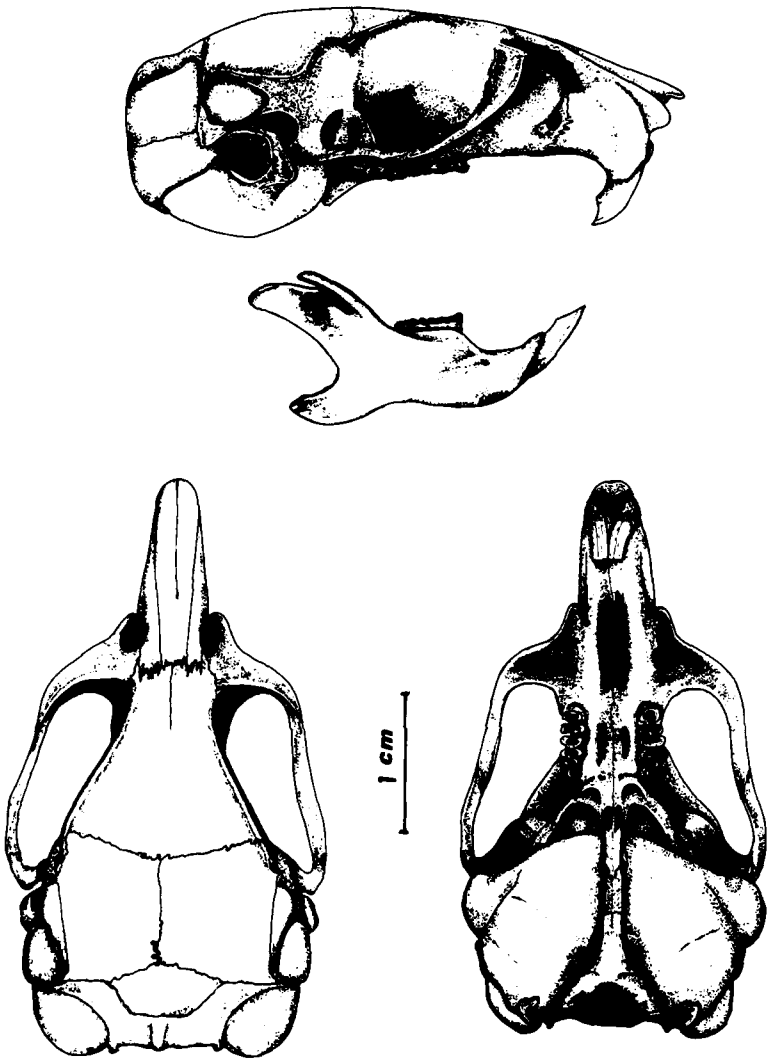


FIG. 61. Skull of *Meriones sacramenti*.

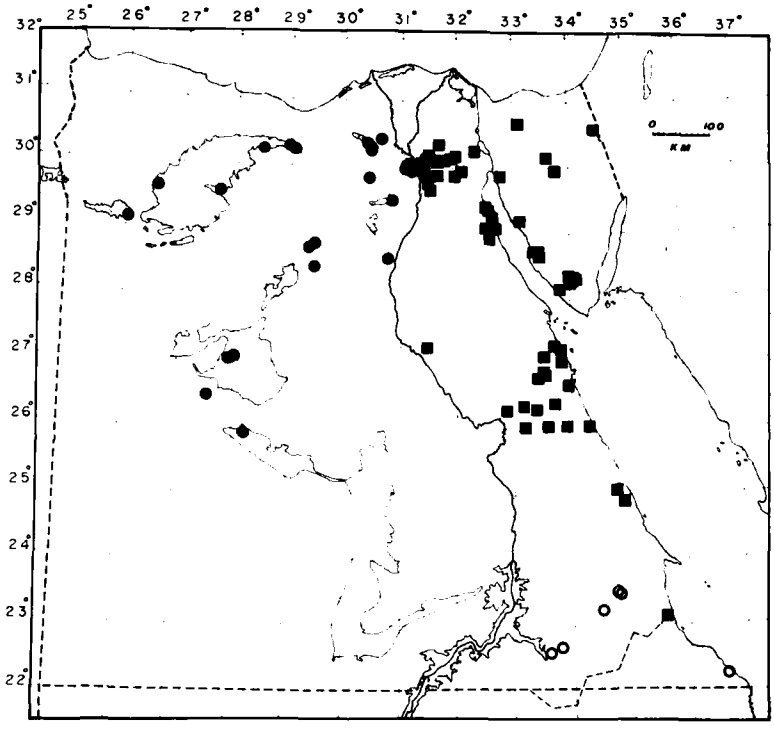


FIG. 62. Collection localities of *Meriones crassus crassus* (squares), *M. c. perpallidus* (dots), and *M. c. pallidus* (circles).

margin; whitish hairs sparsely covering inner and outer surfaces of pinna. Foot and hand white. Tail with upper surface color of dorsum; underside usually white, distinctly or indistinctly bicolored. Apical brush prominent, black, about one-third length of tail. Underside of tip clear white or with scattered black hairs.

Palatal ridges.—Figure 33. Diastemal ridges thick, straight. First, second, and third intermolar ridges recurved, almost reaching midline. Fourth and fifth intermolar ridges directed medially.

Glans penis and baculum.—The minute spines of the penis are in pentagonal sockets. The three cartilaginous processes of the baculum are not separate, but joined together at their bases and separated from the shaft by connective tissue. (See under *Gerbillus pyramidum* and Wassif et al., 1969.)

FIG. 63. Live specimen of *Meriones crassus*.

Feet.—Figure 34. Palm bare, sole partly haired. Fore foot with three distinct postdigital pads and two distinct proximal plantar pads. Hind foot with large, lobed postdigital pad and a single hallucal pad.

Cranial characters.—Figure 60. Skull angular, strongly ridged in adults. Supraorbital ridge prominent. Posterior margin of nasals variable in position, but usually anterior to posterior level of fronto-premaxillary suture (table 20). Interparietal narrow with posterior margin angular. Zygomatic plate rarely reaching level of premaxillary-maxillary suture, completely or partially covering infraorbital foramen in lateral view. Small notch in base of zygomatic plate allows exposure of the foramen. Posterior mastoid chambers of bulla swollen markedly beyond level of paroccipital process and supraoccipital. Suprameatal triangle open posteriorly;

not enclosed by occipital or temporal processes. Tympanic bulla conspicuously swollen with anterior margin encroaching onto the parapterygoid fossa and reaching level of anterior margin of foramen ovale. Auditory meatal area swollen dorsally, ventrally, and anteriorly, usually contacting zygomatic process of temporal (fig. 60). Width across external auditory meatal swellings greater than zygomatic width. Accessory tympanum absent.

Teeth.—Anterior surface of upper incisor grooved. Molariform teeth hypsodont in immatures, cusps prismatic, never tubercular (fig. 59). Upper and lower third molars peglike.

Measurements.—Table 19. Males consistently larger than females. Measurements are of adult males. Means (and ranges) of occipitonasal length (in millimeters) of 10 adult males and 11 adult females are 39.7 (37.7 to 42.2) and 38.1 (36.2 to 39.3), respectively.

Age determination.—Adult specimens have lateral folds of m^1 not extending below level of alveolus, and tooth roots exposed (fig. 73 of *Psammomys obesus*).

Variation.—Dark and pale individuals exist in all samples designated as *M. c. pallidus* from the southern Eastern Desert (fig. 62). Samples from Sinai Peninsula, northern Eastern Desert, and Western Desert are consistently darker than *M. c. pallidus*. Samples from the Western Desert show a clinal increase from north to south in darkness of dorsal color and in percentage of uniformly colored vs. bicolored tails.

Samples from the northern Western Desert were named *M. c. perpallidus* by Setzer (1961a) and said to be paler than *M. c. crassus*. These subspecies cannot be distinguished by this character alone. Gray basal bands on belly hairs predominate in *perpallidus* and increase in width and darkness from north to south. Exposure of the infraorbital foramen occurs in a greater percentage of *perpallidus* than of Eastern Desert subspecies (table 20). The frequency of this character also increases slightly from north to south in the Western Desert.

The average dimensions of samples from the Western Desert are smaller than those from the Eastern Desert, except in the southern part of the range of *M. c. crassus*. The mean of most dimensions increases from north to south in the Western Desert and decreases from north to south in the Eastern Desert (table 21).

Comparisons.—*Meriones crassus* differs from other Egyptian

TABLE 19. — Means (and ranges) of measurements, ratios, and weight of adult *Meriones crassus*.

	M. c. crassus	*M. c. pallidus*	*M. c. perpallidus*
HBL	136.5 (114-153) 47	134.8 (131-138) 4	134.1 (116-152) 28
TL	136.9 (105-158) 40	135.2 (133-140) 4	126.1 (115-135) 22
TL/HBL%	101.3 (86.0-116.2) 40	100.4 (96.4-104.4) 4	93.7 (85.7-103.1) 22
FL	34.5 (31-37) 48	35.5 (35-36) 4	32.2 (30-35) 29
EL	18.6 (14-22) 46	17.8 (16-19) 4	18.4 (16-21) 29
Wt	83.3 (54.0-112.8) 26	85.2 (70.7-93.4) 4	76.0 (51.0-99.0) 22
ONL	39.1 (36.6-42.2) 47	38.4 (37.3-38.9) 4	37.9 (34.5-40.4) 25
ZW	21.2 (18.0-22.9) 38	20.7, 21.0	20.6 (19.1-22.2) 23
IOW	6.1 (5.3-7.0) 45	5.9 (5.8-6.0) 4	6.0 (5.5-6.6) 27
NL	15.1 (12.7-16.6) 45	14.6 (13.8-15.2) 4	14.6 (12.8-15.5) 23
IFL	6.8 (5.2-8.2) 46	6.7 (6.3-7.2) 4	6.6 (6.0-7.3) 27
AL	5.6 (4.8-6.4) 45	5.6 (5.3-5.8) 4	5.8 (5.1-6.3) 27
RW	5.4 (4.8-6.1) 45	5.2 (5.1-5.3) 4	5.2 (4.4-5.8) 27
BL	15.3 (12.9-16.6) 39	15.4 (14.9-15.7) 4	14.8 (13.8-15.8) 26
SH	15.9 (14.1-17.0) 44	15.9 (15.8-16.0) 3	15.5 (14.6-16.4) 28
PAW	10.8 (9.5-12.5) 32	10.5 (9.9-11.2) 4	11.6 (10.7-12.2) 7

TABLE 20. — Color and cranial variations in *Meriones crassus*.

	Western Desert *M. c. perpallidus*			Sinai Peninsula and Eastern Desert *M. c. crassus* and *M. c. pallidus*		
1. Basal bands of belly hairs:						
	Gray	White		Gray	White	
Number	45	13		8	120	
Per cent	81	19		6	94	
2. Coloration of base of tail:						
	Bicolored	Not bicolored		Bicolored	Not bicolored	
Number	34	23		94	27	
Per cent	60	40		78	22	
3. Position of posterior margin of nasals with respect to posterior level of fronto-premaxillary suture:						
	Anterior	Intermediate	Equal	Anterior	Intermediate	Equal
Number	39	10	8	110	6	5
Per cent	68	18	14	91	5	4
4. Exposure of infraorbital foramen in lateral view:						
	Exposed	Not exposed		Exposed	Not exposed	
Number	38	22		19	64	
Per cent	63	37		23	77	

TABLE 21. — Means (and ranges) of head and body and occipitonasal lengths of adult *Meriones crassus* from Sinai Peninsula and northern to southern localities in Eastern and Western Deserts.

	HBL	ONL
Sinai Peninsula	139.0 (130-153) 8	39.3 (36.6-41.3) 8
Eastern Desert		
Wadis Gafra and Iseili	141.3 (132-151) 12	39.7 (37.7-42.2) 10
Red Sea localities	140.0 (122-148) 8	39.7 (38.4-42.1) 9
Wadi Asyuti	130.6 (120-143) 7	37.8 (36.7-40.8) 7
Wadi Qena system	131.0 (114-140) 12	38.8 (36.8-40.9) 13
Wadi Allaqi system	134.8 (131-138) 4	38.4 (37.3-38.9) 4
Western Desert		
Northern localities	128.2 (116-136) 6	36.8 (34.5-39.2) 7
Hatiyet el Sunt	131.0 (119-144) 12	37.8 (36.3-39.0) 9
Farafara Oasis	141.3 (123-152) 10	38.9 (35.0-40.4) 9

species in having paler color, band of clear color on side narrower, feet with white hairs only, mastoid chamber and meatus much more inflated, exoccipital and basioccipital constricted, and mean of paroccipital width (PAW) actually and relatively smaller (tables 19, 22). The infraorbital foramen is much less exposed in *M. crassus* than in *M. shawi* and *M. tristrami*, but about the same as in *M. sacramenti* (figs. 60, 61). Additional comparative characters are in Table 23.

The diploid chromosome number and FN of *M. crassus* are 60 and 72; of *M. libycus*, 44 and 74; *M. shawi*, 44 and 78; and *M. tristrami*, 72 and 74 (Nadler and Lay, 1967).

Collection.—*Meriones crassus* readily enters live traps placed near burrows or in vegetation. Digging is sometimes difficult due to hardness of terrain. Occasionally, specimens have been captured by hand at night on barren desert.

Habitats.—This species is found in wadis and coastal areas of Sinai Peninsula and the Eastern Desert (figs. 5, 15) where there is vegetation or human habitation or past activity. Burrows may be in barren, stoney, gravelly, or mud terraces around or beneath buildings or tents; under trash heaps (Briscoe, 1956) and straw piles, but not always in the immediate vicinity of a food source. Hoogstraal (1963) observed burrows 0.2 km. from vegetation in Wadi Digla east of Maadi. Similar situations exist in the Western Desert (fig. 64).

Shrubs with which *M. crassus* is usually associated in wadis of the

FIG. 64. Western Desert. Pebble desert interspersed with soft sand and gypsum (*nafash*). About 7 km. SE of km. 208 on Cairo-Bahariya road. Tree in background (*Acacia raddiana*) is over 100 m. from the burrow. Habitat of *Meriones crassus perpallidus*. At 3 km. beyond, there is an acacia grove in a depression at about 28°55′ N lat., 29°31′ E long.

Eastern Desert are *Cassia senna* (Hoogstraal et al., 1957b), *C. italica*, *Lygos raetum*, *Acacia* sp.; *Leptadenia pyrotechnica*; *Calligonum comosum*; *Zilla spinosa*; *Citrullus colocynthis*, also mentioned by Lewis et al. (1965) in northern Saudi Arabia; and *Panicum turgidum*, also noted by Briscoe (1956). Patches of date palms (*Phoenix dactylifera*) and rushes (*Juncus* sp.) may also harbor colonies of this jird. Near Gulf of Suez shores, *M. Crassus* has been trapped beside *Nitraria retusa*.

In the Western Desert, this species is found under acacias and in

surrounding desert (fig. 64), beside *Calligonum comosum* (fig. 9), near human camps and trash heaps in otherwise barren desert; in shallow depressions beneath stands of *Hyoscyamus muticus;* in outlying areas around oases beneath *Nitraria retusa* (fig. 17), and in sand beneath date palms. The western-most locality was barren desert between Siwa and Qara. Ranck (1968) referred to Libyan habitats of *M. crassus* as marginal, since he did not collect it in date palm groves or oasis vegetation.

Activity.—Lewis et al. (1965) found that, in northern Saudi Arabia, *M. crassus* became active at twilight, and the period of greatest activity was for about an hour after dark. In Wadi Umm Karayiet, a tributary of Wadi Allaqi, *M. c. pallidus* was taken in our live traps between 1200 and 1400 hours (universal time) in March.

Captive behavior.—Meriones crassus, except for *Pachyuromys duprasi,* is the most docile wild rodent in Egypt. Specimens grasped and removed from live traps do not bite and make little effort to escape.

Burrows.—Burrows of *M. crassus* are shallow with numerous openings (Briscoe, 1956), often in very hard ground. This species is not known to plug openings with sand or earth.

Burrow microclimate.—According to Briscoe (1956), burrow temperatures during late September 1953 ranged from 77° to 97°F., and relative humidity, from 24 to 78 per cent. Air temperatures at this time were 78° to 103°F., and relative humidity, 21.5 to 77 per cent.

Food.—Fruits and/or seeds of one or two plant species listed above (figs. 9, 15) are often the only food source for this rodent. Green vegetation is eaten when available. Bitter, green fruits as well as dry pulp and seeds of *Citrullus colocynthis,* for examples, are staple food in much of the Eastern Desert. Vegetable material from camel dung around campsites provides food in otherwise sterile environments. Lewis et al. (1965, p. 73), stated from observations in northern Saudi Arabia: "Perhaps one of the major reasons for its success as a species lies in its ability to exist on any food available."

Tortonese (1948) fed captive *Meriones* (probably *M. crassus*) from the vicinity of Tel el Kebir in Wadi Tumilat, leaves, fruit peels, bread, cheese, and small pieces of meat. We have fed it raw potatoes, raw carrots, dried bread, and various seeds.

Seeds of *Zilla spinosa* and seeds and stalks of *Anabasis articulata*

were regularly found near burrow openings in Sinai (Haim and Tchernov, 1974).

Reproduction.—The average number of young in a sample of 10 reproducing females, including embryos, fetal scars, and nestlings was 3.3 (range, 1 to 5). An eight-month breeding period is indicated by data from November to June.

Sex ratio.—In a museum sample of 73 specimens, there were 36 (49 per cent) males and 37 females.

Associates.—Rodents living in the same habitat as *M. crassus* are *Jaculus jaculus*, *Gerbillus gerbillus*, *G. perpallidus*, and occasionally, *M. shawi* and *M. lybicus*.

KEY TO EGYPTIAN SUBSPECIES OF *Meriones crassus*

1. Belly hairs usually with gray bases, infraorbital foramen exposed (table 20). (Western Desert)..... *perpallidus*, p. 202.
2. Belly hairs usually white to base, infraorbital foramen not exposed (table 20).
   a. Dorsum slightly darker than in *pallidus*. (Northern Eastern Desert and Sinai Peninsula)..... *crassus*, p. 201.
   b. Dorsum slightly paler than in *crassus*. (Southern Eastern Desert)..... *pallidus*, p. 203.

Meriones crassus crassus Sundevall, 1842

Meriones crassus asyutensis Setzer, 1961, J. Egypt. Publ. Health Assn., **36**, No. 3, p. 82.

Type locality.—Egypt. SINAI: Ayun Musa.

Distribution in Egypt.—Figure 62. Sinai Peninsula and greater part of Eastern Desert.

External characters.—See under species description. *Meriones c. crassus* specimens usually lack gray bases on belly hairs (table 20).

Cranial characters.—Infraorbital foramen not exposed in lateral view in a larger proportion of individuals (table 20) than in other subspecies.

Measurements.—Table 19. Average dimensions of *M. c. crassus* are larger than *pallidus* and *perpallidus*.

Remarks.—Data from *M. c. crassus* and *pallidus* are combined in Table 20. *Meriones c. asyutensis* described by Setzer (1961a, p. 82) from three specimens is considered synonymous with *M. c. crassus*. Seven additional specimens from the type locality do not exhibit the paleness described by Setzer. See also remarks under *M. shawi*.

Specimens examined.—Total 193.

SINAI: Bir Thal (1); El Quseima (2); Gebel el Bruk (2); Feiran Oasis (2), 1.6 km. E (4); Wadi el Sheikh (5); St. Catherine Monastery area (8); Ismailia 80 km. E (1).

ISMAILIA: Fayid 4.8 km. NW (2).

SUEZ: Heliopolis 12.8 km. E (1); Cairo-Suez road km. 18 (3), km. 29 (1), km. 34 (1), km. 35 (1), km. 40 (4); El Dar el Bayda (2); Wadi el Gafra (14); Wadi Iseili (23); Bir Gindali (1); Gebel el Katamiya observatory area (2); Wadi Dom (3); Wadi Abu Sanduq (6).

RED SEA: Wadi el Nil (4); St. Paul Monastery area (1); Bir Zafarana (2); Ras Zafarana (6); Wadi Bali (2); Wadi Umm Delfa (2); Bir Abu Zawal (4); Wadi Fatira (4); Abu Kharif mine area (3); Wadi Atalla mouth (7); Wadi Abu Sheeh 96 km. E of Qena (1); Wadi Graygar (4); Wadi Semna (2); Wadi Abu Shaar (2); El Ahiah 10 km. N (3); Safaga (1); Quseir (3); Qusur el Banat (3); Fawakhir mine 4.8 km. E (2); Wadi Umm el Seniyet (2); Wadi Abu Ziran (4); Wadi Abu Qraiya (1); Wadi Sukari (2); Bir Shalatein (3).

QENA: Wadi el Sheikh Isa mouth (4).

SHARQIYA: Bilbeis (2).

CAIRO: Gebel el Ahmar (1); Heliopolis 4.8 km. E (1), 8 km. E (8); Cairo-Suez road km. 11 (1); Wadi Digla 3.2 km. E of Maadi (4); Wadi Hof (2); Wadi Garawi 10 km. SE of Helwan (3).

ASYUT: Wadi Asyuti (10).

Published records.—Records are from Bonhote (1912), Allen (1915), Flower (1932), Chaworth-Musters and Ellerman (1947), Setzer (1952, 1961a), and Haim and Tchernov (1974).

SINAI: Ayun Musa; Gebel el Bruk, Nakhl, Kossaima (El Quseima), Tor, Wadi Feiran, Feiran Oasis, Feiran Oasis 1.6 km. E, St. Catherine Monastery area, Bir Thal, Mt. Sinai, Umm Shomer, Gebel El Igema (Gebel Egma).

ISMAILIA: Fayid 4.8 km. NW.

SUEZ: Cairo-Suez road km. 12.8, km. 18, km. 35; Bir Gindali.

CAIRO: Gebel el Ahmar; Cairo-Suez road km. 8, km. 11; Maadi 3.2 km. E.

RED SEA: Ras Zafarana, Quseir.

Meriones crassus perpallidus Setzer, 1961

Meriones crassus perpallidus Setzer, 1961, J. Egypt. Publ. Health Assn. **36**, No. 3, p. 86.

Type locality.—Egypt. GIZA: Cairo-Alexandria desert road km. 4.

Distribution in Egypt.—Figure 62. Western Desert south of Western Mediterranean Coastal Desert vegetation.

External characters.—Under species description. Belly hairs of *M. c. perpallidus* usually have a gray base (table 20).

Cranial characters.—See species description. A larger proportion

of *perpallidus* have the infraorbital foramen exposed in lateral view (table 20) than in other subspecies.

Measurements.—Table 19.

Variation.—Samples from the northern part of the Western Desert are paler, include a smaller percentage of individuals having belly hairs with gray bases, and have smaller average dimensions than samples from further south.

Comparisons.—*Meriones c. perpallidus* differs from *M. c. pallidus* in the same way that it differs from the nominate subspecies: darker color, belly hairs with gray bases, and slightly smaller dimensions.

Remarks.—Specimens of *M. c. perpallidus* examined by Setzer (1961a) differed little from the nominate subspecies, except in size, but clinal variation from north to south in size, color, exposure of infraorbital foramen, and other characters (table 20) are distinctive enough to warrant retention of the trinomen.

Meriones crassus selysi (Pomel, 1856) is an Algerian form. The name was applied to specimens from Wadi el Natroun by Schwann (1905) and Bonhote (1912b). Other subspecies have since been described from intermediate areas.

Specimens examined.—Total 75.

GIZA: Giza (1); Cairo-Alexandria desert road km. 10 (1), km. 4 (Type); Gebel el Ghigiga (3); Abu Rawash (1); Kirdasa (3); Cairo-Bahariya road km. 208, Acacia grove, 7 km. E (6).

FAIYUM: Lake Qarun, 3 km. NW (1).

EL MINYA: el Bahnasa (3), Hatyet el Sunt (16).

BEHEIRA: Bir Victoria (7), Wadi el Natroun (2).

MATRUH: Camel Pass Dune area (4); El Maghra 27 km. W (1); Raqabet el Rala (1); Bir Nahid (1); Siwa-Qara road 46 km. NE of Siwa (1); Qara (1), French Camp No. 2 (1).

EL WADI EL GEDEED: Farafara Oasis, El Khanafis (1); Bir Qokshira (2), 4.8 km. NE (1); Abu Minqar (14), 80 km. S (2); Kharga Oasis, Ain Amur (1).

Published records.—Records are from Schwann (1905), Innes (1932), and Setzer (1961a).

BEHEIRA: Bir Victoria, Wadi el Natroun, Abu Makkar Monastery.

GIZA: Cairo-Alexandria desert road km. 4.6, km. 10; Kirdasa.

FAIYUM: Lake Qarun 3 km. NW.

EL MINYA: El Bahnasa.

Meriones crassus pallidus Bonhote, 1912

Meriones crassus pallidus Bonhote, 1912, Abstr. Proc. Zool. Soc., London, No. 103, p. 3.

Type locality.—Sudan. NORTHERN: Atbara.

Distribution.—Figure 62. Southern part of Eastern Desert and northeastern Sudan.

External characters.—*Meriones c. pallidus* is slightly paler than other subspecies in Egypt.

Cranial characters.—See species description. In cranial characters, *M. c. pallidus* does not differ from the nominate form.

Measurements.—Table 19.

Remarks.—*Meriones c. pallidus* differs very little from the nominate subspecies except in paler color, as noted by Bonhote (1912), and slightly smaller dimensions.

Specimens examined.—Total 24.

RED SEA: Wadi Gumbiet (1), Bir Abraq (8).

SUDAN ADMINISTRATIVE: Abu Ramad (1).

ASWAN: Wadi Umm Karayiet (11), Bir Haimur (3).

Published records.—Records are from Hoogstraal et al. (1957b) and Setzer (1961a).

RED SEA: Bir Abraq, Wadi Naam.

Meriones sacramenti Thomas, 1922

Meriones sacramenti Thomas, 1922, Ann. Mag. Nat. Hist., (ser. 9), **10**, p. 552.

Type locality.—Israel: Beersheba 16 km. S.

General distribution.—Southern Israel and northeastern Sinai Peninsula.

Common name.—Negev Jird.

Distribution in Egypt.—Figure 65. Northeastern Sinai Peninsula.

Diagnosis.—Large jird with relatively coarse pelage. Dorsum dark cinnamon brown, side with line of clear cinnamon, venter white. Ear prominent, tip pigmented. Tail with line of black or scattered black hairs along upper surface, not bicolored. Tail brush black, conspicuous. Sole with small bare area. Claws pale.

Skull angular with strongly developed supraorbital ridge. Posterior margin of nasal anterior to posterior level of fronto-premaxillary suture. Infraorbital foramen exposed. Mastoid bulla inflated beyond level of paroccipital. Suprameatal triangle open posteriorly. Auditory meatus swollen to level of zygomatic process of temporal. Accessory tympanum absent.

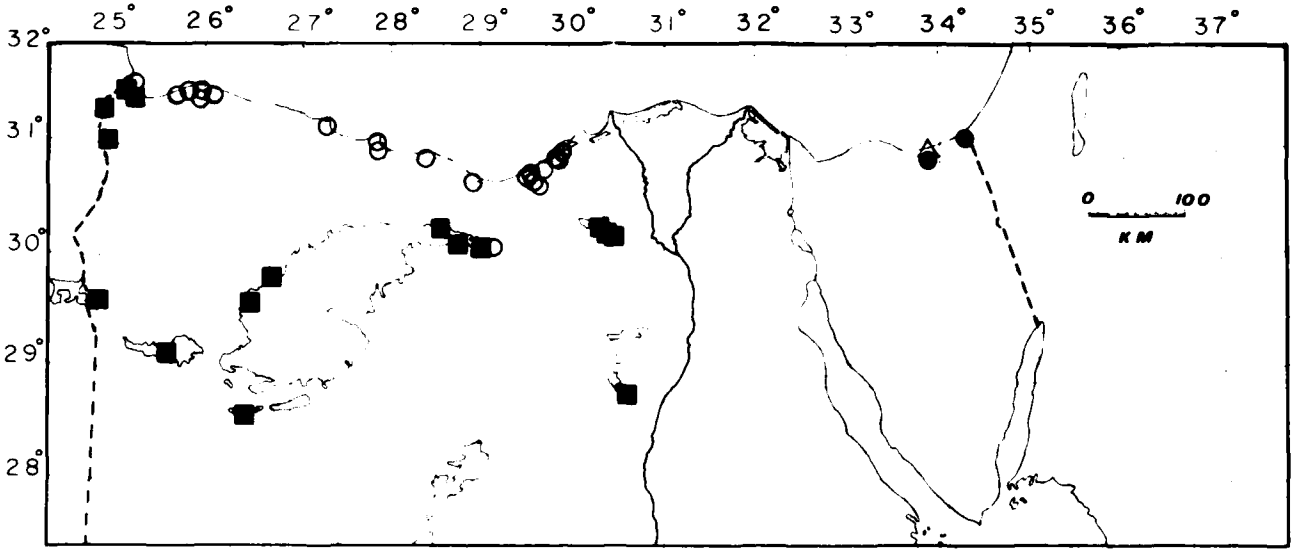


FIG. 65. Collection localities of *Meriones sacramenti* (dots), *M. libycus libycus* (squares), *M. shawi isis* (circles), and *M. tristrami* (triangle).

Head and body length average 155 mm.; tail 151 mm., 97 per cent of head and body length; hind foot 36 mm.; ear 18 mm.; occipitonasal length 41.6 mm.

External characters.—Dorsum dark cinnamon brown, side with conspicuous line of clear cinnamon extending from wrist to heel and sometimes onto side of foot. Venter white. Hairs of dorsum and side with gray bases, belly hairs with gray bases in about 50 per cent of individuals examined. Feet white, except as noted above, claws pale. Band extending from mystacial area beneath eye to base of ear slightly paler than upper surface of head. Supraorbital patch small, indistinct. Postauricular patch small, whitish. Ear with distal one-third pigmented. Anterior margin of pinna with long buffy to cinnamon hairs, inner hairs white, outer cinnamon. Upper surface of tail paler than back, with conspicuous black brush about one-third of tail length and a line of black or scattered black hairs nearly reaching the base. Tail otherwise buffy and not clearly bicolored except for tip.

Palatal ridges.—Not observed.

Glans penis and baculum.—Not observed.

Feet.—Palm bare; sole with small naked area. Claws pale.

Cranial characters.—Figure 61. Cranium somewhat angular, supraorbital ridge strongly developed. Posterior margin of nasals rounded, not reaching posterior level of frontopremaxillary suture. Anterior margin of zygomatic plate reaching or almost reaching level of premaxillary-maxillary suture and not completely covering infraorbital foramen. Interparietal with round posterior margin. Tympanic bulla markedly swollen, anterior margin level with or beyond middle of foramen ovale. Mastoid chambers conspicuously swollen, posterior surface extending slightly posterior to paroccipital process. Suprameatal triangle open posteriorly. External auditory meatus swollen anteriorly to level of zygomatic process of temporal. Distance across meatuses usually slightly greater than zygomatic width. Accessory tympanum absent.

Teeth.—Upper incisor grooved. Molar pattern prismatic as in other species of *Meriones*.

Measurements.—Table 22. Male and female dimensions subequal.

Age determination.—Adults have the same features as *M. crassus*.

Variation.—Some individual variation was observed in meatal swelling. Specimens from Israel have a continuous black line on the upper tail surface from tip to base. In Sinai specimens, the line is indefinite.

Comparisons.—*Meriones sacramenti* is distinguishable from *M. crassus* by darker color, pigmented ears, color on feet, less inflated mastoid chambers and meatus of bulla, and less modification of interparietal and occipital. It differs from *M. lybicus* in having ear pigmented, paler color, claws pale, posterior margin of nasals not reaching posterior level of frontopremaxillary suture, infraorbital foramen exposed, and suprameatal triangle open posteriorly. From *M. shawi*, *M. sacramenti* differs in having tail brush larger, infraorbital foramen less exposed, and mastoid chamber and meatus of bulla much more inflated. Comparison with *M. tristrami* is under that species. Further comparisons are in Tables 22 and 23 and Figure 60. Most dimensions of *M. sacramenti* average slightly larger, except for bulla length in *M. crassus*, than those of other Egyptian species of *Meriones*.

Remarks.—*Meriones sacramenti* appears to be more closely related to *M. shawi* than to other species in Egypt. No local information on natural history is available. In Israel, it inhabits sandy localities and is unevenly distributed (Zahavi and Wahrman, 1957).

A single specimen of *M. sacramenti* from Bir Lehfan, northeastern Sinai Peninsula, called *M. shawi shawi* by Wassif (1953b), was assumed to be *M. tristrami* by Petter (1957) because of geographic location, and accepted as such by Zahavi and Wahrman (1957), Setzer (1961a), and Hoogstraal (1963).

Specimens of *M. sacramenti* from Rafa in Giza Zoological Museum were marked "*Psammomys.*"

Specimens examined.—Total 21.

Egypt: SINAI: Bir Lehfan (1), Rafa (9).

Israel: Beersheba (2), 16 km. S (2); Zahr el Rubin (2); Rishon el Zion (1); Ramleh (2); "Palestine" (2).

Published records.—SINAI: Bir Lehfan (Wassif, 1953b).

Meriones libycus (Lichtenstein, 1823)

Gerbillus libycus Lichtenstein, 1823, Verzeich. Doubl. Zool. Mus. Berlin, No. 9, p. 5.

Type locality.—Egypt: Libyan Desert of describer taken to mean

"near Alexandria" by Chaworth-Musters and Ellerman (1947, p. 485).

General distribution.—Iran, Azerbaijan S.S.R., Iraq, Syria, Jordan, Israel, Western Desert of Egypt, Libya.

Common name.—Libyan Jird.

Subspecies in Egypt.—

Meriones libycus libycus Lichtenstein, 1823

Type locality.—Egypt. Western Desert, probably south of Alexandria.

Distribution in Egypt.—Figure 65. Northern part of Western Desert.

Diagnosis.—Large jird with soft pelage, dorsum dark yellowish brown, side with line of clear orangish, venter white. Ear not pigmented. Tail color of back, not distinctly bicolored, and with an orangish base. Tail brush black, conspicuous. Sole partly haired, not pigmented. Claws black.

Skull not prominently angular, but with well-developed supraorbital ridge. Posterior margin of nasals level with or behind posterior margin of frontopremaxillary suture. Infraorbital foramen not visible in lateral view. Mastoid bulla inflated beyond level of paroccipital process. Suprameatal triangle usually closed posteriorly. Auditory meatus swollen to level of zygomatic process of temporal bone. Accessory tympanum present.

Adult head and body length average 142 mm.; tail 145 mm., 102 per cent of head and body length; hind foot 35 mm.; ear 20 mm.; occipitonasal length 38.6 mm.; weight 84 gm.

External characters.—Dorsum dark yellowish brown; side with narrow but conspicuous line of clear orangish extending from wrist to heel and sometimes onto side of foot; venter white, occasionally with cream-colored areas on chest and belly.

Hairs of dorsum, side, and greater part of belly with gray bases. Feet white, except for color on side as noted and with blackish claws. Mystacial, preorbital, suborbital, and subauricular areas grayish.

Postauricular patch small, whitish. Ear not pigmented, long buffy hairs on anterior margin, pinna sparsely covered with buffy white hairs, producing a whitish border. Upper surface of tail color of back with scattered black hairs. Tail brush on upper surface of tip black,

TABLE 22. — Means (and ranges) of measurements, ratios, and weight of adults of species of *Meriones*.

	M. sacramenti	*M. libycus*	*M. shawi*	*M. tristrami*
HBL	153.5 (131-170) 14	141.5 (123-155) 53	143.0 (128-160) 31	129.0 (121-134) 6
TL	151.4 (130-162) 7	145.4 (115-157) 44	139.6 (122-155) 25	133.0 (125-140) 6
TL/HBL%	95.5 (90.7-114.1) 7	102.8 (87.8-120.9) 43	97.3 (88.4-113.4) 23	103.1 (98.5-104.7) 6
FL	35.9 (30-41) 14	35.1 (32-38) 55	34.6 (32-37) 31	33.7 (32-35) 6
EL	18.9 (17-22) 14	19.6 (18-22) 55	19.2 (17-22) 31	19.8 (19-22) 6
Wt	— —	84.0 (65.0-108.8) 32	90.6 (70.0-120.2) 11	— —
GNL	41.7 (39.0-44.0) 14	38.6 (36.4-42.0) 52	38.8 (37.1-41.5) 20	36.0 (35.1-37.1) 4
ZW	23.6 (22.5-25.8) 8	20.4 (18.9-22.3) 42	22.0 (20.6-23.5) 18	19.3 (18.8-19.6) 4
IOW	6.4 (5.7-7.3) 15	6.8 (6.0-7.6) 51	6.4 (5.8-7.2) 21	5.8 (5.7-5.9) 4
NL	16.3 (15.3-17.0) 15	15.2 (14.1-16.6) 51	15.1 (13.9-16.7) 20	14.3 (13.5-15.3) 6
IFL	7.8 (7.2-8.4) 15	7.2 (6.4-7.8) 52	7.4 (6.4-8.1) 22	6.7 (5.9-6.8) 6
AL	6.5 (5.9-7.0) 15	5.6 (5.1-6.8) 52	6.0 (5.6-6.3) 22	5.7 (5.4-5.9) 6
RW	5.9 (5.3-6.4) 15	5.2 (4.6-6.8) 51	5.5 (5.1-5.9) 22	5.2 (4.9-5.4) 6
BL	14.7 (13.4-15.4) 15	14.6 (13.2-15.7) 51	13.3 (12.4-14.2) 15	11.2 (10.8-11.5) 4
SH	16.8 (15.0-18.1) 14	15.8 (14.7-17.1) 51	16.0 (15.2-16.7) 22	14.5 (14.4-14.7) 4
PAW	12.7 (11.5-13.5) 5	12.4 (10.9-13.2) 27	12.1 (10.9-13.2) 6	10.9 (10.2-11.5) 4

TABLE 23. — Characters of species of *Meriones*.

Character	*M. libycus*	*M. crassus*	*M. sacramenti*	*M. shawi*	*M. tristrami*
Ear color	pale		distal ½, blackish		
Postauricular patch	small	large	small		
Claw color	black	pale			
Line of clear color on side	orangish, fairly prominent extending onto fore foot and heel	buffy, not prominent, not extending onto fore limb or heel	cinnamon, extending onto fore foot and heel	yellowish to orangish, prominent, extending onto fore foot and heel	yellow to orangish, extending to fore limb and heel
Color of tail base	orangish, not bicolored	buffy to cinnamon, bicolored and not bicolored	buffy, bicolored	cinnamon, not distinctly bicolored	orangish, bicolored
Tail brush	⅓ tail length, conspicuous	⅓–½ tail length, fairly conspicuous	⅓ of tail length, conspicuous	⅓ of tail length, not conspicuous	¼ of tail length, not conspicuous
Basal band of belly hairs	dark gray	lacking or pale to dark gray	present and gray in about 50%	dark gray	lacking or very pale gray
Exposure of infraorbital foramen in lateral view	never exposed	partly or not exposed	partly exposed	exposed, large and conspicuous	partly exposed

TABLE 23. — *continued.*

Character	*M. libycus*	*M. crassus*	*M. sacramenti*	*M. shawi*	*M. tristrami*
Posterior margin of nasals relative to posterior margin of frontopremaxillary suture	level with	anterior to or level with	anterior to		
Closure posteriorly of suprameatal triangle	closed or almost closed by hamular process of temporal	open		partly closed by process of supraoccipital	closed
Inflation of meatal lip and relation to zygomatic process of squamosal	conspicuous, touching or *almost touching* zygomatic	very conspicuous, touching zygomatic	conspicuous, almost touching zygomatic	moderate, never touching zygomatic	not inflated
Posterior surface of mastoid bulla relative to paroccipital process	slightly beyond paroccipital	well beyond paroccipital	slightly beyond paroccipital	never beyond paroccipital	
Accessory tympanum	present	absent			
2n chromosome number (Zahavi & Wahrman, 1957)	44	60	46	44	72

very conspicuous, about one-third tail length. Tail not distinctly bicolored; proximal portion of underside dark orangish.

Palatal ridges.—Identical with that of *M. crassus* (fig. 33).

Glans penis and baculum.—See under *M. crassus.*

Feet.—Palm bare, sole partly naked proximally. Claws black.

Cranial characters.—Figure 60. Skull somewhat angular with prominent supraorbital ridge. Posterior margin of nasals rounded or pointed extending to or slightly beyond level of frontopremaxillary suture. Anterior margin of zygomatic plate reaching or almost reaching level of premaxillary-maxillary suture and covering infraorbital foramen. Interparietal with round posterior margin. Tympanic bulla conspicuously swollen, with anterior margin level with or beyond middle of foramen ovale. Posterior surface of mastoid bulla slightly posterior to paroccipital process. Suprameatal triangle closed or almost closed posteriorly by ascending portion of suprameatal process of temporal. External meatal swelling reaching level of zygomatic process of temporal. Distance across meatuses greater than zygomatic width. Accessory tympanum present.

Teeth.—Figure 59. Upper incisor grooved. Molar pattern prismatic as in other species of *Meriones.* M^3 with transient posterior fold.

Measurements.—Table 22. Male and female dimensions subequal. Means (and ranges) of occipitonasal length (in millimeters) of 25 adult males and 28 adult females, respectively are: 38.8 (36.4 to 41.4) and 38.3 (35.8 to 40.9).

Age determination.—Adults have the same features as *M. crassus.*

Variation.—No distinct variation was observed in Egyptian material.

Comparisons.—Table 23. *Meriones libycus* is distinguishable from other species of Egyptian jirds by its darker color, orangish base of tail, dark claws, more anterior position of margin of zygomatic plate, and presence of an accessory tympanum. Differences are discussed under other species and listed in Table 23. Chromosomal comparisons are under *M. crassus.*

Remarks.—Specimens referred to here as *M. libycus* are identical with material called *M. caudatus* by Ranck (1968). The only specimens of *M. libycus* identified by Setzer (1961a, p. 87) and

discussed by Hoogstraal (1963, p. 18) are from Salum on the Libyan frontier. All others from coastal localities between Alexandria and Salum were *M. shawi*. Hayman (1948, p. 40) misidentified *M. libycus* from Bahrein as *Psammomys obesus*.

Confusion of taxonomists was also discussed by Lay and Nadler (1969), who succeeded in hybridizing *M. libycus* and *M. shawi* in captivity. Further discussion is given under *M. shawi*.

Specimens examined.—Total 110.

BEHEIRA: Wadi el Natroun, Gebel Muluk (5), Zaghig (3).

MATRUH: Qur el Hilab (2); El Maghra (28), Hatiyet Labaq (5); Abu Dweiss (4); Bir Abd el Nabi (2); Qara (18); Bahrein (16); El Malfa (2); Ain Qureishit (4); Abu Shuruf (1); Ain el Baqar (7); Salum 16 km. E (4), 17 km. E (1), 19 km. E (3); Bir Sidi Omar (1); Bir Shafarzin (1).

EL FAIYUM: Wadi Muwellih, Bir Dakaar (3).

Published records.—Records are from Chaworth-Musters and Ellerman (1947), Hayman (1948, as *Psammomys obesus*), and Setzer (1961a).

BEHEIRA: Wadi el Natroun.

MATRUH: Salum, Bahrein.

Collection.—*Meriones libycus*, like other species of the genus, readily enters live traps placed beside burrows or in vegetation. Digging for it is sometimes difficult, because burrows penetrate between roots of plants.

Habitats.—This species is found commonly in sand mounds formed around *Nitraria retusa* (fig. 17) in Wadi Muwellih, El Maghra, Qara, and Bahrein. One habitat in Wadi Muwellih included the grass *Desmostachya bipinnata*. Dead fronds under clusters of date palms harbor the species, and similar cover was provided by a pile of dead olive branches at Qara which hid burrows of this rodent. Specimens obtained from a rush-reed (*Juncus* sp.-*Phragmites australis*) association at El Maghra were probably only foraging there. One specimen was dug from a hole in hard barren ground under an acacia tree in the Maghra area.

A colony at Bahrein burrowed in damp, salty sand beneath *Tamarix* sp. and *Nitraria retusa*.

East of Salum, *M. libycus* was trapped beneath *Lycium* sp. and *Nitraria retusa* on sandy ridges above a salt marsh.

Two individuals were trapped beside holes in hard ground near scattered vegetation (*Hammada scoparia*, *Pityranthus tortuosus*,

Zilla spinosa, Artemisia inculta, Peganum harmala, Carthamus sp.) at Bir Sidi Omar and Bir Shafarzin near the Libyan border.

The occupation by *M. libycus* of both mesic and dry habitats in the Western Desert of Egypt is in contrast to the restricted ecological distribution reported by investigators in other countries.

Lewis et al. (1965, p. 73) found *M. libycus syrius* in northern Saudi Arabia only in "association with more or less permanent vegetation or with water." Ranck (1968, p. 165) observed that, in Libya, *M. caudatus* (*M. libycus*) "is never found associated with mesic habitats."

Activity.—This species has been observed among shrubs after sunrise at El Maghra. Lewis et al. (1965) remarked that *M. l. syrius* was active during the day in northern Saudi Arabia. Ranck (1968, p. 169) recorded an individual foraging in full daylight in Libya. In the vicinity of Benne-Abbes, Algeria, *M. libycus* was active during the day for periods long enough to allow visual studies (Daly and Daly, 1975a).

Captive behavior.—*Meriones libycus*, unlike *shawi* and *crassus*, is very aggressive, difficult to handle, and bites readily.

Burrows.—Burrows with numerous openings are dug in mounds around vegetation or hidden beneath the detritus under wild date palms. One burrow under an isolated acacia tree contained a store of pods and seeds.

Reproduction.—Data from four females taken in April and May averaged three young, with a range of two to four.

Sex ratio.—In a sample of 82 museum specimens, males and females were equal in number.

Meriones shawi Rozet, 1833

Meriones shawi Rozet, 1833, Voyage dans la Régence d'Alger, 1, p. 243.

Type locality.—Algeria. ORAN: Oran.

General distribution.—Egypt, Libya, Tunisia, Algeria, and Morocco.

Common name.—Shaw's Jird.

Subspecies in Egypt.—

Meriones shawi isis (Thomas, 1919)

Meriones isis Thomas, 1919, Ann. Mag. Nat. Hist., (ser. 9), 3, p. 271.

Type locality.—Egypt. ALEXANDRIA: Alexandria, Ramleh.

Distribution in Egypt.—Figure 65. Coastal desert, from type locality west to Salum on Libyan frontier, and El Maghra.

Diagnosis.—Large jird with soft pelage. Dorsum brownish yellow, side with conspicuous line of clear yellowish or orangish extending to wrist and heel. Venter white with pale yellowish areas. Ear prominent and pigmented. Tail with upper surface paler than dorsum, not distinctly bicolored, underside cinnamon colored. Tail brush blackish, about one-fourth of tail length. Sole partly haired, not pigmented. Claws pale.

Skull somewhat angular but not strongly ridged. Mastoid bulla moderately inflated but not extending beyond level of paroccipital process. Infraorbital foramen large and conspicuous in lateral view. Posterior margin of nasals anterior to posterior level of frontopremaxillary suture. Accessory tympanum absent.

Adult head and body length average 143 mm.; tail 140 mm., 97 per cent of head and body length; hind foot 34 mm.; ear 19 mm.; occipitonasal length 38.8 mm.; weight 90 gm.

External characters.—Dorsum dark brownish yellow; side with narrow but conspicuous line of clear yellowish or orangish extending to wrist and heel and sometimes onto side of foot; venter white with pale yellowish area on upper chest and sometimes middle of belly. Hairs of dorsum, side, and greater part of belly with gray bases. Feet white except for coloration on side as noted. Band from mystacial area beneath eye to base of ear very slightly paler than upper surface of head. Preorbital and postorbital spots conspicuous, grayish. Postauricular patch small and whitish. Ear sparsely covered with short, buffy hairs; long hairs fringing anterior margin. Distal one-third of pinna pigmented. Upper surface of tail with blackish hairs but paler than dorsum; blackish brush on upper surface of tip about one-fourth of tail length. Tail not distinctly bicolored, underside of base near cinnamon color.

Feet.—Palm bare; sole partly naked proximally. Claws pale.

Palatal ridges.—Similar to that of *M. crassus* (fig. 33).

Glans penis and baculum.—Not observed.

Cranial characters.—Figure 60. Cranium not prominently angular or ridged. Posterior margin of nasals not extending to posterior level of frontopremaxillary suture. Anterior margin of zygomatic plate not reaching level of premaxillary-maxillary suture and not concealing large infraorbital foramen. Interparietal with round posterior margin. Tympanic bulla conspicuously swollen; posterior surface of mastoid bulla extending beyond level of exoccipital, but not beyond level of paroccipital process. Suprameatal triangle almost closed posteriorly by descending process of supraoccipital. External auditory meatal swelling not reaching level of zygoma and distance across meatuses slightly less than zygomatic width. Accessory tympanum absent.

Teeth.—Figure 59. Upper incisors grooved. Molar pattern prismatic as in other species of genus, except lingual and labial folds of m^2 are often equal in depth. M^3 with transient posterior fold.

Measurements.—Table 22. Male and female dimensions subequal. Means (and ranges) of occipitonasal length (in millimeters) of eight adult males and seven adult females are 38.8 (37.1 to 41.5) and 38.6 (35.3 to 40.0), respectively.

Age determination.—Adults have same features as *M. crassus.*

Variation.—Specimens from near Alexandria have the meatal area slightly more swollen than those from other parts of Egypt. Occasional specimens have posterior margin of nasals about level with the posterior border of the frontopremaxillary suture.

Comparisons.—*Meriones shawi* differs from *M. crassus* in darker color, more prominent strip of clear color on side, ear pigmented, and mastoid chamber and meatus considerably less inflated. It differs from *M. libycus* in having base of tail paler, tail brush much smaller, ear pigmented, claws pale, posterior margin of nasals anterior to level of frontopremaxillary suture, infraorbital foramen exposed, and mastoid bulla and meatus less swollen. From *M. sacramenti, M. shawi* differs in having belly hairs with gray bases, more conspicuous tail brush, more inflated mastoid bulla, slightly more exposed infraorbital foramen, and slightly smaller dimensions (table 22). Characters can be compared in Figure 60 and Table 23. Refer also to *M. crassus* and *M. libycus.*

Remarks.—Controversies and errors (Flower, 1932; Setzer, 1961a; Ranck, 1968) on the status of *M. shawi* in Egypt were resolved by Lay and Nadler (1969). Morphological characters presented in Table

23, in addition to those from Petter (1953, 1961) and Lay and Nadler (1969), confirm *M. shawi* as a species distinct from *M. libycus*.

The name "melanurus" was applied by Rüppell (1842, p. 95) to representatives of *M. crassus* from sandy areas "near Alexandria," Egypt and "Peträischen Arabien" (Stony Arabia or Arabia Petra is actually the core of the Sinai Plateau according to Abu Al-Izz, 1971), near Tor, Sinai. Fitzinger and Heuglin's (1866, p. 574) *Rhombomys melanurus* from Tor could only be *M. crassus* on geographic grounds and, likewise, Nehring's (1901, p. 170) *M. (Rhombomys) melanurus* from Koseir (Quseir) on the Gulf of Suez. Nehring's descriptions of meatal and bullar inflations also indicate *M. crassus*. Anderson (1902, p. 267) and Bonhote (1912, p. 227) applied "*melanurus*" as a trinomen to *M. shawi*, whereas Thomas (1919a, p. 264) thought the name was best applied to the form with a prominent black tail tuft, *M. libycus*, in agreement with Rüppell's figure and description. Unfortunately, Rüppell's "types" did not represent either species. Such confusion places "*melanurus*" in obsolescence.

Meriones shawi isis Thomas (1919a), however, is a valid trinomen, and "*isis*" has apparently been applied to specimens of *M. shawi* only.

Specimens examined.—Total 59.

ALEXANDRIA: Ramleh (1), near Alexandria (2), El Amiriya 5 km. S (2).

MATRUH: Lake Mariut (7); Bahig 8 km. S (1), 12-13 km. NE (11); Burg el Arab (6); Abu Mena (2), 4.8 km. E (1); El Daba (1); El Alamein (6); El Maghra (2); Abu Haggag 1.6 km. E (1); Ras el Hekma (1); Mersa Matruh (8); Sidi Barrani 22.8 km. E (1), 3.2 km. S (1), 19.2 km. S (1), 48 km. W (2), 52.8 km. W (1); Salum (1).

Published records.—Records are from Anderson (1902), Thomas (1919a), Chaworth-Musters and Ellerman (1947), and Setzer (1961a under *M. l. libycus*).

ALEXANDRIA: Ramleh, Alexandria, Mex.

MATRUH: Mersa Matruh; Burg el Arab; El Daba; El Alamein; Sidi Barrani 22.8 km. E, 3.2 km. S, 8 km. S, 19.2 km. S, 48 km. W, 52.8 km. W; Salum.

Collection.—*Meriones shawi*, like other jirds, readily enters live traps. Digging it from burrows in hard clay or within the roots of shrubs is often difficult.

Habitats.—*Meriones shawi* burrows in hard clay of Western Mediterranean Coastal Desert, particularly beneath the shrubs *Anabasis articulata* and *Lycium* sp. (fig. 8), where its burrows may be mistaken for those of *Psammomys obesus* and vice versa. It has also been collected from Bedouin barley fields, fields overgrown

with thistles, beneath *Lycium sp.* (fig. 48) on rocky slopes and coastal dunes, and in mounds of sand around *Nitraria retusa* in the eastern part of El Maghra (fig. 17). Specimens referred to *M. l. libycus* from fig groves (fig. 7) on the Mediterranean coast west of Alexandria (Hoogstraal, 1963) were *M. s. isis.*

Activity.—According to Petter (1961), *M. shawi* is active outside of burrows during part of the day in Algeria.

Captive behavior.—Although not initially as docile as *M. crassus*, *M. shawi* responds favorably to frequent handling.

Burrows.—Burrows are usually dug beneath shrubs and have numerous openings which are not closed.

Food.—Information on food plants of this species is lacking. It does, however, frequent Bedouin barley fields in the coastal desert and no doubt takes a toll from the annual crop.

Reproduction.—No information was obtained on the Egyptian form.

Sex ratio.—In a sample of 46 museum specimens, there were 22 (48 per cent) males and 24 females.

Meriones tristrami Thomas, 1892

Meriones tristrami Thomas, 1892, Ann. Mag. Nat. Hist. (ser. 6), 9, p. 148.

Type locality.—Israel: Dead Sea Region.

General distribution.—Iran, Iraq, Azerbaijan S.S.R., Turkey, Syria, Lebanon, Palestine, and northeastern Sinai Peninsula.

Common name.—Tristram's Jird.

Subspecies in Egypt.—Probably the nominate subspecies.

Meriones tristrami tristrami Thomas, 1892

Distribution in Egypt.—Figure 65. Known in Egypt from specimens reported from El Arish, northeastern Sinai Peninsula (Zahavi and Wahrman, 1957).

Diagnosis.—Rather small jird with soft pelage, dorsum yellowish brown, side with line of clear yellowish extending onto wrist and heel. Venter white. Ear prominent, tip pigmented. Tail upper surface as back, bicolored; underside orangish to cinnamon. Tail brush blackish and poorly developed. Sole partly haired, not pigmented. Claws pale.

Skull rounded, weakly ridged. Mastoid bulla moderately inflated but not extending beyond level of exoccipital or paroccipital process. Infraorbital foramen partly exposed in lateral view. Posterior margin of nasals anterior to posterior level of frontopremaxillary suture. Lip of auditory meatus very slightly swollen. Accessory tympanum absent.

Adult head and body length average 129 mm.; tail 133 mm., 103 per cent of head and body length; hind foot 34 mm.; ear 20 mm.; occipitonasal length 36.0 mm.

External characters.—Dorsum varying from pale to dark yellowish brown; side with narrow but conspicuous line of clear yellowish to orangish extending to wrist and heel and sometimes onto foot; venter white, and feet white, except as noted. Hairs of dorsum and side with gray bases. Belly hairs usually all white, except for occasional individuals with very faint gray bases. Mystacial, preorbital, suborbital, and subauricular areas slightly paler than upper surface of head. Postorbital spot conspicuous, grayish. Postauricular spot conspicuous and white. Ear with long whitish hairs on anterior margin, pinna sparsely covered with whitish hairs; distal one-third pigmented. Tail with color of upper surface as dorsum; bicolored, underside at base orangish. Blackish brush on upper surface of tip of short hairs inconspicuous, about one-fourth length of tail.

Palatal ridges.—Not observed.

Feet.—Palm bare, sole partly naked proximally. Claws pale.

Cranial characters.—Figure 60. Cranium not prominently angular or ridged. Posterior margin of nasals not extending to posterior level of frontopremaxillary suture. Anterior margin of zygomatic plate not reaching level of premaxillary-maxillary suture and only partially concealing infraorbital foramen. Interparietal broad, somewhat ovoid. Tympanic bulla conspicuously swollen; anterior surface level with middle of foramen ovale. Posterior surface of mastoid bulla not extending beyond level of exoccipital and paroccipital process. Suprameatal triangle closed posteriorly by union of descending process of supraoccipital and ascending portion of suprameatal process of temporal. Lip of external auditory meatus slightly swollen. Accessory tympanum absent.

Teeth.—Upper incisors grooved, molars as in other species.

Measurements.—Table 22.

Age determination.—Adults have same features as *M. crassus.*

Variation.—Considerable variation in shade of color exists in this species. Zahavi and Wahrman (1957) noted that coloration often resembled shade of the soil in which it lived.

Comparisons.—Table 23. *Meriones tristrami* is distinguishable from all other Egyptian species of *Meriones* by the very poorly developed tail brush; small mastoid bulla, combined with closure posteriorly of the suprameatal triangle; and the broad, ovoid interparietal (fig. 60).

Specimens examined.—Six from various localities in Lebanon and Syria.

Published records.—Record from Zahavi and Wahrman (1957).

SINAI: El Arish.

Habitats.—According to Zahavi and Wahrman (1957), this is a widely ranging species in Israel; living in sand along the Mediterranean coast, alluvial soils, clay soils, and suitable situations in mountains.

Economic importance.—This species, according to Zahavi and Wahrman (1957), shows fluctuations in numbers and in some years is a pest to agriculture.

Genus **Pachyuromys** Lataste, 1880

Monotypic genus of jird-like rodent with long, fluffy fur. Tail relatively short, club-shaped, lacking apical brush. Palm and sole partly haired; pads and hallucal tubercle like *Gerbillus* and *Meriones.*

Bulla extremely inflated. Meatal lip swollen to level of zygomatic process of temporal. Accessory tympanum present. Suprameatal triangle very large, but closed posteriorly. Parapterygoid fossa with superior wall perforated. Enamel pattern of molars laminated.

Pachyuromys duprasi Lataste, 1880

Pachyuromys duprasi Lataste, 1880, Naturaliste, Paris, 1, p. 314.

Type locality.—Algeria. GHARDAIA: Loghouat.

General distribution.—Northwestern Egypt, Libya, Tunisia, Algeria.

Common names.—Fat Tailed Jird, *Abu Lya.*

Subspecies in Egypt.—

Pachyuromys duprasi natronensis De Winton, 1903

Pachyuromys duprasi natronensis De Winton, 1903, Nov. Zool., 10, p. 285.

Type locality.—Egypt. BEHEIRA: Bir Victoria.

Distribution in Egypt.—Figure 66. Northern part of desert west of the Nile Delta.

Diagnosis.—Jird-like rodent with fur long and fluffy, palm and sole partly haired, dorsal hairs pale cinnamon with blackish tips, sides pale cinnamon, underparts and feet white. Tail shorter than head and body, club-shaped, lacking a brush.

Skull with extremely inflated auditory bulla, large suprameatal triangle, meatal lip swollen, accessory tympanum present, paroccipital process elongate and adnate to bulla.

Adult head and body length average 108 mm.; tail 58 mm., 54 per cent of head and body length; foot 23 mm.; ear 14 mm.; occipitonasal length 34 mm.; weight 36.5 gm.

External characters.—Figure 67. Upper parts pale cinnamon, dorsal hairs tipped with black, side with narrow strip of pale cinnamon extending almost to heel, but not onto forelimb. Hairs of back and side with dark gray bases; hairs of belly, underparts, and feet white. Mystacial area partly pigmented, circumorbital area color of sides, white supraorbital spot faint or lacking, white postauricular patch small. White rump patch absent. Ear pigmented, sparsely haired, anteroventral margin with tuft of long cinnamon hairs. Tail thick and club-shaped, bicolored, dorsal surface color of side, ventral surface white, apical brush lacking.

Palatal ridges.—Not observed.

Glans penis and baculum.—Not observed.

Feet.—Palm and sole partly haired, pads and tubercle similar to *Gerbillus* and *Meriones* in Figure 34.

Cranial characters.—Figure 68. Skull elongate despite triangular outline due to enormously swollen auditory bullae. Supraorbital ridge poorly developed, not reaching level of posterior margin of lacrimal. Parietal ridge inconspicuous. Interparietal narrow, angular in outline posteriorly. Anterior surface of tympanic bulla anterior to level of foramen ovale. Posterior margin of mastoid chambers extending well beyond posterior margin of supraoccipital and paroccipital. Medial superior mastoid cavity absent. Subarcuate fossa small. Suprameatal triangle very large, closed posterior-

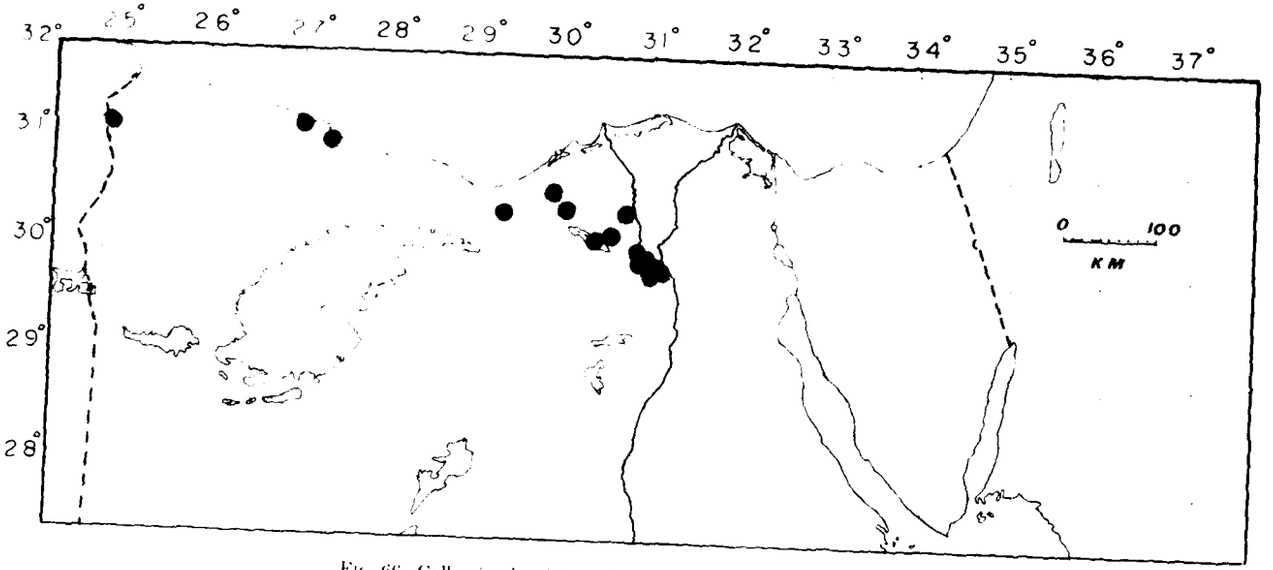


FIG. 66. Collection localities of *Pachyuromys duprasi natronensis*

FIG. 67. Live specimen of *Pachyuromys duprasi natronensis*.

ly by union of descending process of supraoccipital and ascending part of suprameatal process of temporal bone. External auditory meatus swollen, contacting zygomatic process of temporal. Accessory tympanum present. Supraoccipital and basioccipital narrow, constricted by swelling of bullae. Paroccipital process elongate, thin, adnate to wall of bulla. Parapterygoid fossa deep, crowded by bulla, and with large perforation in superior wall. Zygomatic plate with rounded anterior margin not reaching level of premaxillary-maxillary suture.

Teeth.—Figure 59. Upper incisors grooved on anterior surface. Molars rooted. M^1 and m_1 appear to be tuberculate in very young animals, becoming laminate in immatures. M^2 and m_2 show no indication of tubercles. Enamel pattern more similar to that of *Meriones crassus* rather than adult *Gerbillus*, as indicated by Petter (1956). Third molars simple, lacking folds.

Measurements.—Table 24. Male and female dimensions subequal.

Age determination.—Adults have laminae of molars worn and skull sutures closed.

Variation.—Individual variation in presence or absence of black-tipped hairs on the side and in shade of color is noticeable and was mentioned by Setzer (1963).

TABLE 24. — Means (and ranges) of measurements, ratios, and weight of adult *Pachyuromys duprasi natronensis*.

HBL	108.3 (93-121) 4	ZW	19.3 (17.5-20.2) 4
TL	58.2 (55-62) 4	IOW	6.2 (5.8-6.4) 4
TL/HBL%	54.5 (47.9-66.6) 4	NL	13.0 (11.7-13.8) 4
FL	23.3 (22-24) 4	IFL	6.4 (6.2-6.8) 4
EL	14.0 (12-16) 4	AL	5.2 (4.8-5.7) 4
Wt	36.5 (22.0-44.6) 3	RW	4.9 (4.4-5.0) 4
ONL	24.9 (32.4-36.5) 4	SH	14.7 (14.2-15.0) 4

Comparisons.—Egyptian specimens of *P. d. natronensis* differ from Libyan samples, the nominate form, and *P. duprasi faroulti* of Algeria in paler color. *Pachyuromys duprasi* differs externally from all other rodents by its short, thick tail; cranially by its enormously inflated auditory bulla and shape of interparietal and paroccipital process (fig. 68). Color in Egyptian specimens is similar to *Meriones crassus* rather than *M. libycus*, as was suggested by Setzer (1963).

Specimens examined.—Total 14.

BEHEIRA: El Khatatba (3), Bir Victoria (Type and 2), 1.6 km. E (1), Wadi el Natroun (3).

TAHREER: Cairo-Alexandria desert road km. 163 (1).

MATRUH: Cairo-Alexandria desert road km. 26 (1), Abd el Mawla (1), Bir Shafarzin 25.6 km. E (1).

Published records.—Records are from Setzer (1952, 1963) and Hoogstraal (1963).

BEHEIRA: Kom Hamada, between Kom Hamada and Bir Victoria, El Khatatba, Bir Victoria.

TAHREER: Cairo-Alexandria desert road km. 179.

MATRUH: Cairo-Alexandria desert road km. 17, Abar el Dafa (36 km. W of Mersa Matruh).

GIZA: El Qatta, Abu Ghalib W of, Abu Rawash W of, near Cairo, Cairo-Alexandria desert road km. 10.5.

Collection.—Trapped alive and dug from burrows.

Habitats.—Vegetated sand sheets (fig. 10) south of the Western Mediterranean Coastal Desert and southern limits of the coastal desert vegetation (fig. 20); sometimes in rocky desert. One was trapped in a stand of *Anabasis articulata* in an isolated sandy depression east of Bir Shafarzin, and another was dug from barren gravel 26 km. NW of Cairo. The type locality, Bir Victoria, is a small, shallow sandy depression sparsely vegetated with *Artemisia*

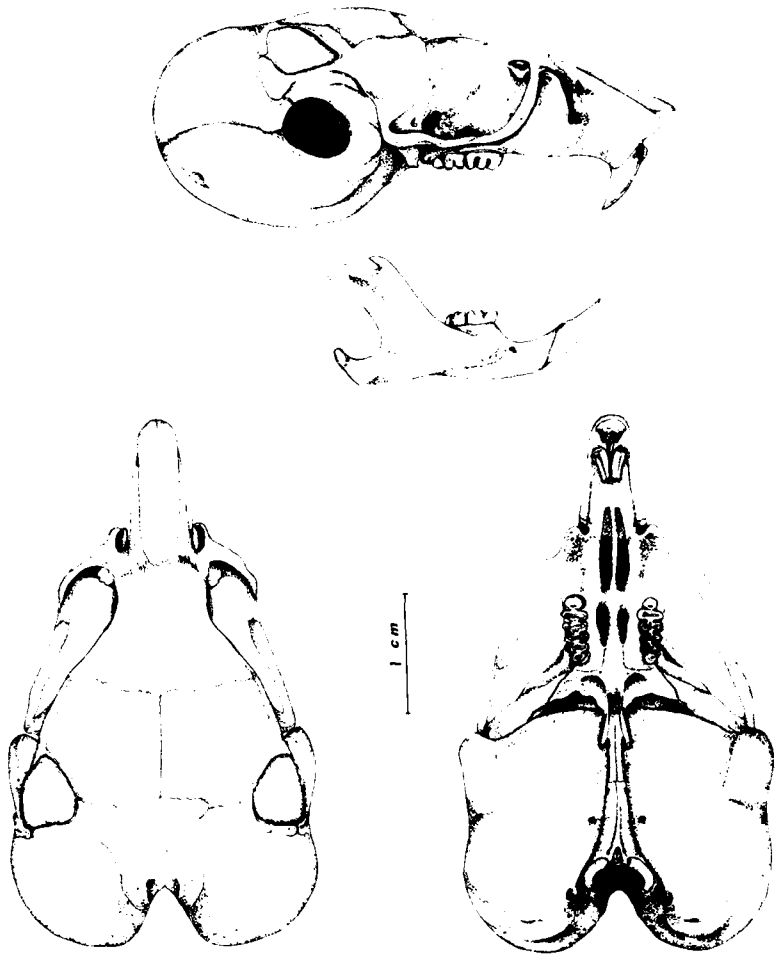


FIG. 68. Skull of *Pachyuromys duprasi natronensis*

monosperma and patches of *Hyoscyamus muticus*. These habitats are comparable with what Ranck (1968, p. 157) called "transitional deserts which run roughly parallel to the more lush coastal plain" and where *P. duprasi* was "most abundant."

Burrows.—We have dug fat tailed rats from simple burrows about 1 m. in depth in hard sand. Petter (1961) illustrated a very complex burrow of the Algerian subspecies. We have observed that this rodent moves about considerably and may occupy burrows of other species.

Activity.—We have observed that, in the wild, fat tailed rats become active at dusk.

Captive behavior.—The most docile of Egyptian rodents. Never bites and makes little effort to escape when handled. In captivity, strangely enough, this lethargic animal is cannabalistic (Flower, 1932), and females have eaten their young.

Food.—*Pachyuromys duprasi* no doubt utilizes a variety of plants, but we have only observed it feeding on *Anabasis articulata* and *Artemisia monosperma*.

In the laboratory, Petter (1961) fed Algerian fat tailed rats grain, chopped meat, cheese, milk, lettuce, and lucerne (*Medicago sativa*). He also mentioned its affinity for live crickets. Suggestion has been made that, in Libya, terrestrial snails were eaten by *P. duprasi* (Setzer, 1957, p. 60). Thus far, we have been unable to check this possibility, but have observed what appeared to be "gnawed" snail shells in *Pachyuromys* habitat in the Western Desert.

Associates.—*Meriones crassus*, *Gerbillus gerbillus*, *G. andersoni*, *G. perpallidus*, *G. pyramidum* (possibly), and *Jaculus jaculus* live in the same habitats as *P. duprasi*.

Reproduction.—Flower (1932) reported litters of three to five, seven, and nine born in captivity and during the months of April, May, July, October, and November.

Young at birth were said to be naked, blind, and helpless, like those of *Rattus* sp.

Genus **Psammomys** Cretzschmar, 1828

Stocky rodents, dorsum blackish to reddish orange, side and venter yellowish. Ear small, rounded. Tail less than 85 per cent of head and body length, fully haired; tip black with dorsal brush. Palm bare; sole partly haired.

Skull angular and strongly ridged. Bulla including meatus greatly inflated. Interparietal outline squarish. Exoccipital broad and flaring. Paroccipital process very large, extending laterally. Upper incisor smooth on anterior surface. Molars hypsodont when immature, crowns prismatic.

Psammomys obesus Cretzschmar, 1828

Psammomys obesus Cretzschmar, 1828, *in* Ruppell, Atlas zu der Reise im nordliche Afrika, Saugeth., pl. 22, 23, p. 58.

Type locality.—Egypt. ALEXANDRIA: Alexandria.

General distribution.—Israel, Arabia, Sinai Peninsula, Egypt, Sudan, Libya, Tunisia, Algeria, Morocco.

Common names.—Fat Sand Rat, *Jarada.*

Distribution of subspecies in Egypt.—Figure 69. *Psammomys obesus terraesanctae:* northern and southern parts of Sinai Peninsula and northern part of Eastern Desert. *Psammomys obesus nicolli:* northeastern part of Nile Delta; *Psammomys obesus obesus:* northwestern part of Nile Delta and northern part of Western Desert.

Diagnosis.—Large blackish to reddish orange rodent with yellowish side and belly. Tail thick, shorter than head and body; tip black, prominent. Ears short, rounded, densely haired. Sole partly haired. Skull angular and strongly ridged. Bulla greatly inflated, anterior lip of external auditory meatus swollen to level of zygomatic process of temporal bone. Exoccipital and paroccipital broad, prominent. Upper incisor smooth on anterior surface. Crowns of molariform teeth prismatic, never tuberculate.

Adult head and body length average 170 mm.; tail 130 mm., 76 per cent of head and body length; hind foot 38 mm.; ear 15 mm.; occipitonasal length 42.6 mm.; weight 146.8 gm.

External characters.—Figure 70. Dorsum blackish yellow to brownish or reddish orange. Width of color bands on dorsal hairs vary with subspecies and habitat (fig. 71). Side brownish to yellowish. Venter pale to dark yellow. All hairs with gray base except white hairs in axilla, groin, and behind ear. Foot with upper surface yellowish. Hair tuft on sole yellowish to whitish. Ear, foot, and claws pigmented. Ear densely haired, whitish or yellowish. Whitish postorbital spot absent. Postauricular spot white, small. Entire tail tip black, not bicolored; black brush prominent.

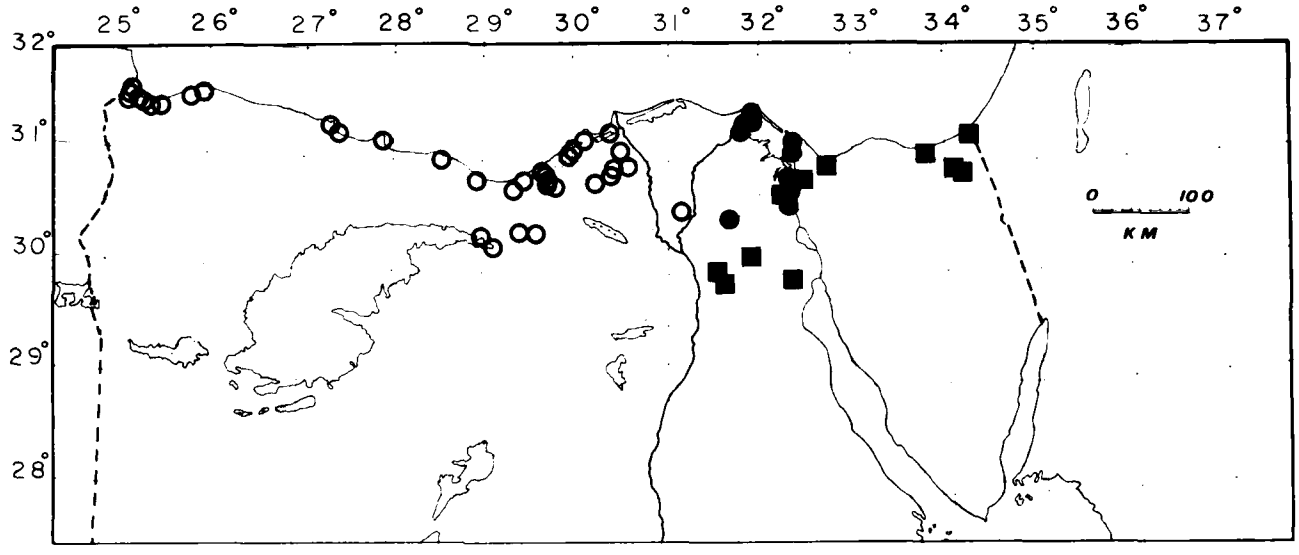


FIG. 69. Collection localities of *Psammomys obesus obesus* (circles), *P. o. nicolli* (dots), and *P. o. terraesanctae* (squares).

FIG. 70. Cadaver of *Psammomys obesus obesus*

Palatal ridges.—Figure 33. Diastemal ridges thick and slightly curved. First to third intermolar ridges recurved; fourth intermolar ridge short; fifth, long, curving anteriorly.

Glans penis and baculum.—Not observed.

Feet.—Figure 34. Palm bare, sole with tuft of plantar hairs. Tubercles and pads of palm as in other Gerbillinae. Sole with three subdigital tubercles, a hallucal tubercle, and single plantar tubercle.

Cranial characters.—Figure 72. Skull massive, strongly ridged, angular. Zygomatic arch heavy and wide. Supraorbital and parietal ridges prominent. Anterior margin of zygomatic plate usually reaching level of premaxillary-maxillary suture. Notch at level of antorbital foramen prominent. Interparietal outline squarish. Exoccipital and paroccipital broad and flaring. Anterior margin of tympanic bulla slightly beyond posterior margin of foramen ovale. Posterior margin of mastoid bulla usually beyond level of occipital condyle, but not beyond level of paroccipital process. Anterior lip of auditory meatus swollen to level of zygomatic process of temporal bone.

Teeth.—Figure 59. Upper incisor without anterior groove except distal 2.5 mm. in nestlings. Molariform teeth hypsodont in immatures, rooted in adults (fig. 73), cusps prismatic, never tuberculate even before eruption. First upper molar with two large and one small root in adults. M^1 with transient fold, m_1 simple.

Measurements.—Table 25.

Age determination.—Adult specimens have lateral folds of upper first molar not extending below alveolar level and roots of teeth usually exposed (fig. 73). Strongly developed parietal ridges and closure of the suprameatal triangle posteriorly by fusion of the hamular process of the squamosal and the supraoccipital process are additional criteria used in adult selection.

Variation.—Samples from salt marsh habitats in the Nile Delta designated as subspecies *nicolli* show much more extension of melanin than *obesus* and *terraesanctae* from coastal salt marsh and desert habitats (Thomas, 1908). Color variations within subspecies are listed in Table 26, and variation in width of color bands of hairs is shown in Figure 71. Tips of hairs are blackish in darker individuals, brownish in paler ones. Subterminal bands are yellowish orange and basal bands dark gray. Figure 71 illustrates hairs with color bands of average widths. Means (and ranges) of tip,

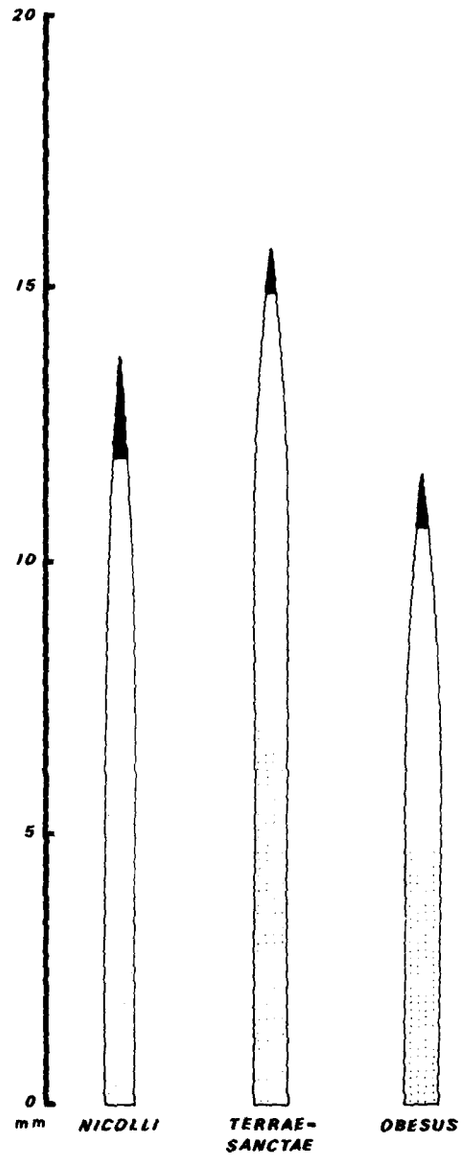


FIG. 71. Diagrams of middorsal hairs from subspecies of *Psammomys obesus*. Each figure represents average of five hairs. Black tip represents blackish or brownish color; clear subterminal part, yellowish orange; and punctate basal part, dark gray.

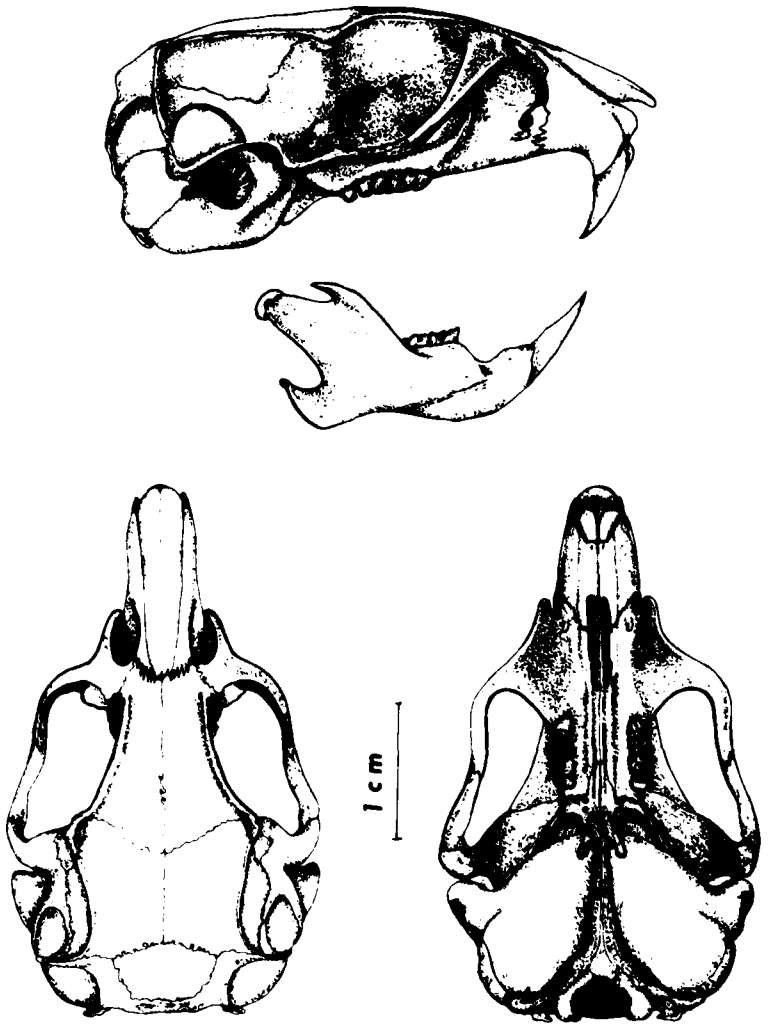


FIG. 72. Skull of *Psammomys obesus*

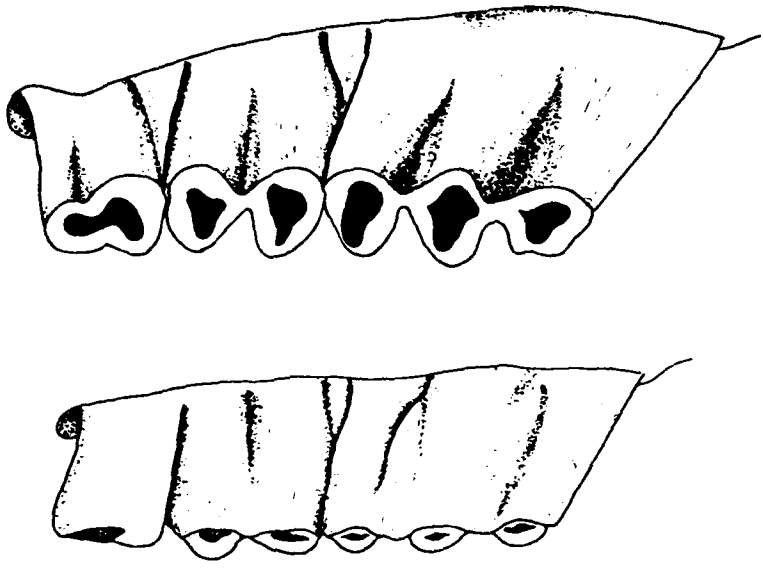


FIG. 73. Lateral view of right upper molars of adult (above) and immature (below) *Psammomys obesus*. Note that lateral folds do not extend below alveolar level in adult or mature molars, but do so in immatures. The same age criterion is used for *Meriones* sp.

subterminal, and basal bands of five middorsal hairs (in millimeters) from a specimen of *nicolli* are: 1.8 (1.5 to 2.0), 2.9 (2.6 to 4.0), and 8.9 (8.2 to 10.0), respectively; *terraesanctae:* 0.6 (0.4 to 1.1), 8.0 (7.0 to 8.9), and 6.8 (6.3 to 7.3); *obesus:* 0.8 (0.6 to 1.2), 5.6 (5.3 to 5.8), and 4.8 (3.6 to 5.6).

Specimens of *obesus* and *terraesanctae* from desert habitats are essentially alike in color and width of hair bands. Specimens of *obesus* from coastal salt marshes differ, as shown in Figure 71.

In comparison with these subspecies, samples of *nicolli* are darker and average larger in all measurements. Subspecies *nicolli* and *terraesanctae* are similar in having the posterior nasal margin reaching the level of the posterior edges of the frontopremaxillary suture, but in *obesus*, nasal margin is anterior to this point (fig. 74). There are few exceptions within samples examined, although some have posterior nasal margin in an intermediate position (table 27). Nasal length (table 25) does not reflect this morphological difference.

Comparisons.—The only Egyptian rodents with which *Psammomys obesus* might be confused are *Meriones libycus, M. crassus,*

TABLE 25. — Means (and ranges) of measurements, ratios, and weight of adult *Psammomys obesus*.

	P. o. obesus	*P. o. nicolli*	*P. o. terraesanctae*
HBL	168.4 (151-187) 73	178.6 (160-199) 41	157.5 (144-168) 20
TL	125.4 (100-144) 69	143.5 (122-157) 38	122.8 (115-131) 19
TL/HBL%	73.5 (60.9-82.5) 71	80.2 (69.1-90.1) 38	78.0 (73.6-89.6) 19
FL	36.9 (32-40) 78	40.2 (38-43) 46	36.8 (35-40) 21
EL	14.8 (14-16) 77	16.0 (14-18) 41	14.6 (13-17) 21
Wt	141.8 (116.3-205.1) 37	130.0 (106.6-223.0) 27	114.5 (92.1-135.3) 12
ONL	41.7 (38.8-45.4) 68	45.4 (42.8-48.2) 40	41.0 (37.7-44.9) 22
ZW	24.9 (23.7-27.4) 59	26.7 (25.4-28.8) 31	24.4 (22.2-26.6) 18
IOW	6.7 (6.0-7.3) 68	7.1 (6.3-8.2) 38	6.6 (5.8-7.3) 20
NL	16.2 (14.0-17.6) 67	18.6 (17.0-20.9) 38	16.6 (15.0-18.5) 21
IFL	6.4 (4.6-7.2) 71	7.2 (6.3-8.0) 39	6.4 (5.7-7.1) 21
AL	7.2 (6.8-7.9) 77	7.7 (7.2-8.4) 43	7.1 (6.8-8.0) 23
RW	6.2 (5.8-6.8) 74	6.6 (6.3-7.4) 32	6.2 (5.7-6.8) 22
BL	13.3 (12.3-14.4) 73	14.2 (13.1-15.3) 40	13.6 (12.2-14.6) 23
SH	16.2 (14.7-17.7) 72	17.5 (15.2-19.2) 37	15.9 (14.7-17.5) 23
POW	14.7 (12.8-16.5) 36	16.4 (15.2-17.9) 26	14.4 (12.9-15.9) 15

and *M. shawi;* however, slightly longer tails and ears, bicolored tail tips, whitish bellies, and grooved upper incisors in *Meriones* distinguish them from *Psammomys*. Cranial characters are discussed under species of *Meriones*.

Remarks.—No specimens of *Psammomys* are known from the Delta between east and west branches of the Nile, except near Ras el Bar in the northeast and Quweisna in the south (fig. 69). No evidence of fat sand rats has been found in the extensive salt marshes and stands of halophytic plants south of Lake Burullus or between Kafr el Sheikh and Baltim. Differences in position of posterior margin of the nasals (fig. 74, table 27) in eastern and western populations illustrate the effectiveness of this hiatus as a barrier to gene flow.

Color and size differences (tables 26, 25), useful as they are in separating subspecies, are environmentally influenced. Desert *P. o. obesus* are almost identical in size and coloration with desert *P. o. terraesanctae*.

Specimens identified as *P. obesus* from Bahrein (Hayman, 1949) are *Meriones libycus*, and those from Wadi el Natroun, El Beida (Setzer, 1963) and "hard surface sand desert near Bir Hooker" (Hoogstraal, 1963, p. 20) are *M. crassus*.

Convexity of parietals suggested by Setzer (1963) as a diagnostic

TABLE 26. — Color patterns of *Psammomys obesus*.

Region	*P. o. obesus*	*P. o. nicolli*	*P. o. terraesanctae*
Crown	without or with a scattering of black-tipped hairs	with all hairs black tipped	without black-tipped hairs
Dorsum	orange yellow, brownish yellow, brownish orange	blackish to brownish yellow	orange yellow to brownish orange
Side	narrow strip of pale yellowish to yellowish brown	narrow strip of yellowish to brown	broad strip of clear, pale yellow
Belly	pale to dark yellow	dark yellow	pale yellow with some white
Tail	black dorsal hairs 75% from tip	black hairs on entire dorsal surface	with black dorsal hairs 40-50% from tip

character of *P. o. nicolli* is a normal condition of all three subspecies.

Collection.—Digging is the only effective method of obtaining quantities of fat sand rats alive. Daly and Daly (1974) captured them in wire cage traps baited with *Suaeda vermiculata* (=*S. mollis*).

Habitats.—Habitats of *Psammomys* are saline soils and salt marshes with stands of succulent halophytic vegetation chiefly of family Chenopodiaceae. Coastal salt marshes (fig. 7) are subject to flooding in winter rainy season, and sand rats must sometimes abandon burrows and move to higher land (Wassif, 1953b). Inland, fat sand rats depend chiefly upon two plant species, *Anabasis articulata* and *Hammada elegans*, and occur to the southern limits of these species, except along the Red Sea coast and on the limestone plateau of the Western Desert.

On the coastal plain, plants suitable for fat sand rats occur on

TABLE 27. Variation in position of posterior margins of nasals in *Psammomys obesus*.

Subspecies	No. examined	No. with nasal margin		
		Anterior	Posterior	Intermediate
P. o. obesus	104	89	4	11
P. o. nicolli	40	2	36	2
P. o. terraesanctae	26	3	21	2

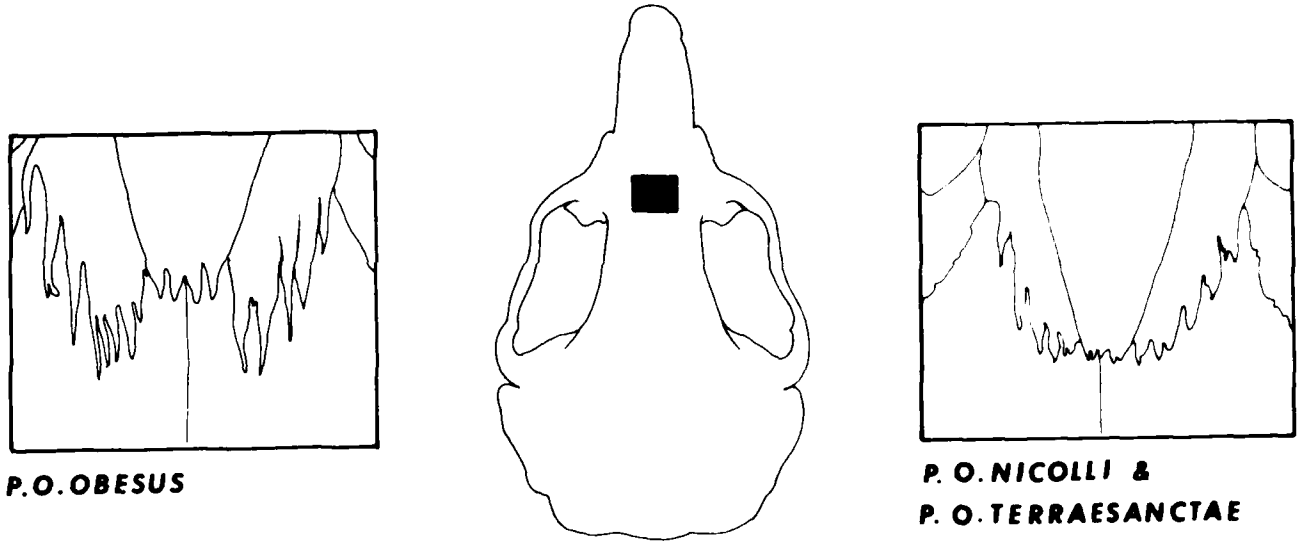


FIG. 74. Anterior and posterior position of posterior margin of nasals in subspecies of *Psammomys obesus*

loamy and sandy soils, usually where rainwater accumulates. Short wadis of northern Eastern and Western Deserts are suitable sites, but are subject to severe flooding.

Psammomys burrows beside and beneath the Cairo-Alexandria desert road in the Nubareia area, behind stone cribbing under highways in the Suez Canal area, in piles of stone around poles of power lines in the rocky desert west of Mersa Matruh, and in embankments along the Alexandria-Salum railway.

The most southern colony in the Western Desert was discovered in the salt marsh of El Maghra in the northeastern part of Qattara Depression. East of there, a small colony subsisted in an isolated stand of *Hammada elegans* on hard gravelly desert near Qaret el Mashruka. There is another colony to the west in Wadi Labaq.

A typical *Psammomys* colony will have a burrow beneath nearly every shrub and a maze of trails running between burrows and food supply.

Behavior.—Sand rats are mainly diurnal and can be seen climbing into low shrubs, cutting branches, and dragging them into burrows. Food is not actively stored in burrows, but large accumulations of waste give this impression. The desire for fresh food and trampling of uneaten portions can be observed in captive animals.

Natural curiosity of the fat sand rat gives the impression of docility. Quite the contrary, it is a vicious fighter when confined in groups and will bite readily if restrained.

Antisocial behavior has been studied in attempts to find compatable pairs for laboratory colonies (Prange et al., 1968). Daly and Daly (1957b) found *P. obesus* to be the most aggressive and solitary of gerbils studied thus far.

Persons who have seen wild fat sand rats standing upright and alert beside their burrows, likened them to prairie dogs of western U.S.A. (Flower, 1932).

Burrows.—Fat sand rats dig tunnel networks in earth or sand mounds around shrub bases. Rock piles and stone cribbing are also attractive burrow sites. An occupied burrow has signs of recent digging, fresh tracks, waste food in or beside openings, and usually toilets near openings. The toilets, slight excavations from covering feces and urine (fig. 75), are characteristic of *Psammomys* and *Meriones*.

Tunnels of a burrow system are seldom deeper than 0.5 m., but

FIG. 75. Burrow and toilet of *Psammomys obesus*. If the hillock is damp or contains fresh feces, a sand rat is "at home."

may be several meters in length. Burrow systems in salt marshes are more complex than in desert, probably because of soil conditions. Burrow systems in mounds beneath desert plants often have a central chamber, and in wadis subject to flood, tunnels do not extend below the base of the mound.

The number of openings in 19 burrow systems near Damanhour, Hafs, ranged from 4 to 11, with an average of seven. Shallow burrows with one, two, or three openings were considered temporary feeding or hiding places. In another area near Ras el Ish, the number of openings in 14 burrow systems ranged from 6 to 21, with an average of 11.

Plants in salt marshes beneath which burrows are dug, in addition to the species listed above, are: *Salicornia fruticosa*, *Halocnemon strobilaceum*, *Arthrocnemon glaucum*, *Salsola kali*, exotic *Atriplex nummularia*, and other food plants of family Chenopodiaceae. Desert populations burrow beneath *Anabasis articulata*, *Hammada elegans*, and *Lycium* sp. (figs. 8, 48) in the Mediterranean Coastal Desert. Petter (1961) listed additional plants in Algeria.

Associates.—Rodents living in the same habitats as *Psammomys* are: *Pachyuromys duprasi*, *Jaculus orientalis*, *J. jaculus*, *Allactaga tetradactyla*, *Mus musculus*, *Dipodillus amoenus*, *D. simoni*, *D. henleyi*, *D. campestris*, and *Meriones shawi*. The following have been removed from *Psammomys* burrow systems: *J. orientalis*, *D. amoenus*, *D. henleyi*, *M. musculus*, *Hemiechinus auritus*, cobras (*Naja* sp.), and scorpions.

Food and other uses of plants.—Fat sand rats require large quantities of food because of the high water content of vegetation on which they feed (Schmidt-Nielsen, 1964); therefore, succulent species of family Chenopodiaceae are their major natural food. Of these, the following are, from personal observation, known to be eaten in large quantities: *Salicornia fruticosa*, *Halocnemon strobilaceum*, *Salsola tetrandra*, *Atriplex inamoena*, *A. halimus*, *Anabasis articulata*, and *Hammada elegans*. Eaten in small quantity are: *Zygophyllum coccineum*, *Z. album*, *Frankenia hirsuta*, and when green, *Zilla spinosa*. Desert populations feed chiefly on *Anabasis articulata* and *Hammada elegans*.

The following list includes species found inside burrows: leaves and stems of *Mesembryanthemum crystallinum* and *Limoniastrum monopetalum* and calyces of *Hyoscyamus muticus*. Thirteen species listed by Wassif (1953b) added *Bassia muricata*, *Salsola inermis*, *Arthrocnemon glaucum*, *Nitraria retusa*, *Spergularia diandra*, *Cakile maritima*, *Parapholis marginata*, and *Sphenopus divaricatus*.

Three main food species recorded by Daly and Daly (1973) in Wadi Saoura, Algeria, were *Suaeda vermiculata* (=*S. mollis*), *Traganum nudatum*, and *Salsola foetida*. *Zygophyllum album*, if eaten to excess, caused mild poisoning. They also noted that in some areas fat sand rats must compete with camels for food.

Anderson (1902), upon removing 500 heads of barley from a burrow, concluded that *P. obesus* was very destructive to grain. Observations indicate this species is not a seed eater, although according to Petter (1961), it can be brought to accept sunflower seeds, along with carrots, lettuce, figs, cherries, etc. He, too, has found stalks of wheat within burrows of *Psammomys*. Grain might well have been brought into burrows by commensals such as *Jaculus orientalis*.

Nests found in burrows in coastal deserts were made from shredded woody stems of *Zilla spinosa* and *Anabasis articulata*, *Stipa capensis* and various other Graminae, *Ifloga spicata* and *Filago*

TABLE 28. — Numbers of burrow systems and occupation; numbers and distribution of sexes within age classes of *Psammomys obesus*.

Location	Date	Burrows Dug	Burrows In use	Total Animals	Total Males	Total Females	Adult and Subadult Males	Adult and Subadult Females	Juvenile Males	Juvenile Females	Nestling Males	Nestling Females
Damanhour	Oct. 24	—	—	19	9	6	—	—	—	—	4	
Port Said	Nov. 6	18	18	15	7	8	6	7	—	—	1	1
Amiriya	Dec. 23	—	—	77	37	40	29	35	7	3	1	2
Damietta	May 3, 4	42	42	103	41	46	17	30	24	16	16 (3 dead)	
Amiriya	May 18, 19	—	—	52	24	28	23	27	—	—	1	1
Damanhour	May 22	—	—	14	7	7	6	5	1	2	—	—
Wadi Gindali	June 2	16	7	11	1	10	—	5	1	5	—	—

desertorum, *Medicago* sp., and a combination of paper and grass. In salt marshes near Damietta, nests were of fragmented *Frankenia revoluta*, *Salicornia fruticosa*, and rice straw; near the sea at Ras el Hekma, of long grass-like leaves of marine *Posidonia oceanica* and *Cymodocea major*.

Included in nests were flower stalks of *Plantago ovata*, pods of *Astragulus* sp., stems of *Phragmites australis*, barley straw, feathers, dry camel dung, and an assortment of fragmented cigarette boxes, bits of plastic, gum wrappers, and cigarette filters gleaned from roadside areas.

Reproduction.—Data on reproduction are limited, but indicate that the breeding period is from September to May, about eight months. Ten litters, fetuses, and nestlings, averaged 3.2, range 1 to 8. Gestation in the Algerian subspecies is 23 to 25 days (Daly and Daly, 1975b).

Populations.—Difference in numbers of animals inhabiting densely vegetated salt marshes (fig. 7) compared with desert situations (fig. 5) are considerable. Data collected over a period of years from several salt marshes and one desert locality, Wadi Gindali, are in Table 28. Accurate estimates of areas are, however, lacking.

On November 6, 1964, the population of a 200- by 8-m. strip of vegetation (*Salicornia fruticosa* and *Halocnemon strobilaceum*) on the eastern shore of Lake Manzala near Ras el Ish occupied 14 burrow systems and consisted of six adult males, seven adult females, and one juvenile of each sex. There was approximately one mature animal per burrow system. Females with nestlings, juveniles, and sometimes subadults of mixed sexes are found occupying the same burrow system, but adult males and females, never. Daly and Daly (1974) studied spatial distribution in an area near Benne-Abbes, Algeria.

Sex ratios.—Number of males and females in samples where removal was complete indicate about equal numbers or slightly more males in younger age groups and fewer males in older groups. Data in Table 29 indicate a predominance of females in all age groups. A greater turnover among males was noted by Daly and Daly (1974).

Predators.—Diurnal hawks doubtlessly prey upon fat sand rats. The skin of a juvenile impaled on a shrub in Wadi Labaq, west of Maghra Oasis, indicated predation by a shrike. Cobras (*Naja* sp.)

TABLE 29. — Number and per cent of males and females in three age classes of museum samples of *Psammomys obesus*.

	Adult		Subadult		Juvenile	
	Males	Females	Males	Females	Males	Females
Number	76	101	30	54	10	17
Per cent	43	57	36	64	37	63

have, on several occasions, been removed from burrows in salt marshes.

Economic importance.—The discovery by Schmidt-Nielsen et al. (1964) that *Psammomys obesus* develops diabetes mellitus syndromes from dietetic changes, has resulted in demands for large numbers of this species from diabetes research laboratories (Brunk and Strasser, 1967; DeFronzo et al., 1967), consequently researchers were challenged to develop techniques of maintaining laboratory colonies (Prange et al., 1968; Strasser, 1968). Further studies are by Hackel, Labovitz et al. (1967); Hackel, Mikat el al. (1967); Brodoff and Zeballos (1970); and Brodoff et al. (1971).

Bedouins near Amiriya dig fat sand rats for food.

Notation.—A maxillary with two molars of *Psammomys obesus* from the Upper Paleolithic site at Khor el Sil, Kom Ombo, was identified by P. Turnbull (personal communication, 1975). This was from Late Pleistocene collections discussed by Reed et al. (1967) and Reed and Turnbull (1969).

KEY TO EGYPTIAN SUBSPECIES OF *Psammomys obesus*

1. Posterior margin of nasals not reaching posterior limits of frontopremaxillary sutures (fig. 74). Dorsum brownish (table 26). (Northwestern Nile Delta and Western Desert). . . . . *obesus*, p. 242.
2. Posterior margin of nasals reaching posterior limits of frontopremaxillary sutures (fig. 74).
   a. Size large, dorsum blackish (table 26). (Northeastern Nile Delta). *nicolli*, p. 243.
   b. Size smaller, dorsum reddish orange (table 26). (Eastern Desert and Sinai Peninsula). . . . . *terraesanctae*, p. 244.

Psammomys obesus obesus Cretzschmar, 1828

Type locality.—Egypt. ALEXANDRIA: Alexandria.

Distribution in Egypt.—Figure 69. Northwestern part of Nile Delta and northern part of Western Desert.

External characters.—Dorsum reddish to brownish orange, sides clear yellow, belly pale yellow with white hairs in axilla and groin in

paler individuals. Tail with black hairs along about 75 per cent of dorsal side (table 26).

Cranial characters.—Figure 72. Skull large and strongly ridged in majority of adults. Posterior margin of nasals not reaching level of posterior edges of frontopremaxillary suture (fig. 74).

Measurements.—Table 25. Intermediate in dimensions between other two subspecies.

Variation.—This subspecies varies considerably in color depending upon habitat. Those from the southern limits of distribution are as pale as specimens of *terraesanctae*, but differ in having shorter basal bands on the hairs. Specimens from salt marshes within the Delta are sometimes almost as dark as *nicolli*, but lack the extensive amount of blackish hairs, particularly on the dorsal surface of the tail (table 26).

Comparisons.—*Psammomys o. obesus* can be distinguished from *nicolli* and *terraesanctae* by the anterior position of the posterior margin of nasals (fig. 74) and, in most cases, by color (tables 26, 27).

Specimens examined.—Total 221.

MINUFIYA: Quweisna (1).

BEHEIRA: Idku 2 km. W (1), Hafs (38), Abu el Matamir (2).

TAHREER: Cairo-Alexandria desert road km. 153 (1), Nubareia (2).

ALEXANDRIA: Mandara (1), Mex (1), El Amiriya (56).

MATRUH: Lake Mariut (21); Bahig (2), 19 km. S (1), 25 km. S (2), 48 km. SE (1); Burg el Arab (9); Abu Mena (2); El Hammam (4), 6 km. S (5); El Afritat (5); Qaret el Mashruka 1 km. N (1); Qur el Hilab (1); El Maghra (1); Wadi Labaq, 30 km. W of El Maghra (2); El Alamein (9); El Daba (7); Ras el Hekma (9); Mersa Matruh (6), 22 km. E (1); Sidi Barrani (3), 42 km. W (2); Salum 3.2 km. S (7), 4.8 km. S (2), 10 km. SE (7), 18 km. E (1), 22 km. E (6), 24 km. E (3), 48 km. E (1).

Published records.—Records are from Anderson (1902), Bonhote (1909), Wassif (1953b), and Hoogstraal (1963).

BEHEIRA: Rosetta, Idku 2 km. W, Hafs, Abu el Matamir, Busili, Abu Hommos.

MUNIFIYA: Quweisna.

ALEXANDRIA: Mandara, El Amiriya.

MATRUH: Lake Mariut, Burg el Arab, Sidi Abd el Rahman, El Alamein, El Daba, Mersa Matruh.

Psammomys obesus nicolli Thomas, 1908

Psammomys obesus nicolli Thomas, 1908, Ann. Mag. Nat. Hist., (ser. 8), 2, p. 92.

Type locality.—Egypt. DAMIETTA: Damietta.

Distribution in Egypt.—Figure 69. Northeastern part of Nile Delta. Salt marshes, shores of Lake Manzalla.

External characters.—Dorsum blackish to brownish yellow (fig. 71), sides brownish, belly dark yellow. Tail with black hairs along entire dorsal surface.

Cranial characters.—Skull large, strongly ridged. Posterior margin of nasals reaching level of posterior edges of frontopremaxillary suture (figs. 72, 74; table 27).

Measurements.—Table 25. Largest of subspecies.

Comparison.—External features of subspecies listed in Table 26 and hair color bands in Figure 71 indicate *P. o. nicolli* is much darker and with greater extension of melanin than either *obesus* or *terraesanctae*.

Cranially, *nicolli* can be distinguished from *obesus* by slightly larger dimensions and position of posterior margin of nasals (fig. 74). From *terraesanctae*, distinguishing characters are color and size (fig. 71; tables 25, 26).

Remarks.—Intergrades between *nicolli* and *terraesanctae* from El Ballah are listed under both names. A series somewhat paler than typical *nicolli* and having dimensions comparable with *terraesanctae* was placed in the latter category.

Specimens examined.—Total 90.

PORT SAID: Port Said (12), Ras el Ish (26), Bayadeia (2).

ISMAILIA: El Ballah (4), Ismailia (1).

SHARQIYA: Tel Abu Ekaim (1).

DAMIETTA: Ras el Bar (1), Shatt Gheit el Nasara (23), Damietta (19), Fariskur (1).

Published records.—Records are from Thomas (1908), Hoogstraal (1963), and Setzer (1963).

PORT SAID: Port Said, Ras el Ish.

ISMAILIA: El Ballah, El Qantara.

SHARQIYA: Between Gezira Seud and San el Haggar, Tel Abu Ekaim.

DAMIETTA: Damietta, Shata, Shatt Gheit el Nasara, Fariskur.

Psammomys obesus terraesanctae Thomas, 1902

Psammomys obesus terraesanctae Thomas, 1902, Ann. Mag. Nat. Hist., (ser. 6), 9, p. 363.

Type locality.—Palestine, Dead Sea.

Distribution in Egypt.—Figure 69. Northern and southern parts of Sinai Peninsula and northern part of Eastern Desert.

External characters.—Palest subspecies of fat sand rat in Egypt. Dorsum reddish orange, sides clear yellow, and belly pale yellow with white hairs in axilla and groin (table 26). Dorsal hairs (fig. 71) with very narrow blackish or brownish terminal bands.

Cranial characters.—Skull fairly strongly ridged. Posterior margin of nasals reaches level of posterior edges of frontopremaxillary suture (fig. 74).

Measurements.—Table 25. Smallest of subspecies in Egypt.

Comparison.—*Psammomys o. terraesanctae* can be distinguished from *nicolli* and *obesus* by paler coloration (table 26) and smaller dimensions (table 25), and from the latter by difference in position of posterior margin of nasals (fig. 74). Though similarity in coloration exists between desert specimens of *obesus* and *terraesanctae*, the latter differs in having shorter tips, wider subterminal and basal color bands on dorsal hairs (fig. 71).

Remarks.—Specimens of *terraesanctae* from dark, saline soils approach *nicolli* in coloration, but those from adjacent pale soils are light colored as are those from typical desert situations. The posterior margin of the nasals, unlike the majority from Egypt, is in the anterior position in the type of *terraesanctae* and a few additional specimens from Palestine and Saudi Arabia. This may well be an example of character displacement.

Specimens examined.—Total 37.

SINAI: El Arish 137 km. W (2), Wadi Abu Aweigila (1), Wadi Gedeiret (1).

ISMAILIA: El Ballah (12).

SUEZ: Wadi el Rokham (1), Wadi el Gafra (2), Wadi Gindali (16), Wadi el Nasouri (2).

Published records.—Records are from Flower (1932), Wassif (1953b), and Hoogstraal (1963).

SINAI: Rafa, Wadi Gedeirat, Khabra Abu Guzoar, El Hamda, Awlad Ali, El Qantara, Rumani, Quseima, El Arish.

SUEZ: Wadi el Rokham, Wadi el Nasouri.

Family 2. Spalacidae

Genus **Spalax** Güldenstaedt, 1770

Blind fossorial rodents lacking external ear. Tail not visible. Pelage soft, nondirectional. Supraoccipital broad, flat, and sloping

forward. Interparietal absent. Median sagittal and lambdoidal ridges present, skull otherwise smooth. Upper incisor orthodont, smooth on anterior surface. Molar outline round, enamel pattern S-shaped. Dental formula: $\frac{1}{1}, \frac{0}{0}, \frac{0}{0}, \frac{3}{3} \times 2 = 16$.

Spalax ehrenbergi Nehring, 1898

Spalax ehrenbergi Nehring, 1898, S. B. Ges. Nat. Fr. Berlin (for 1897), pl. 2, p. 178.

Type locality.—Israel: Jaffa.

General distribution.—Syria, Lebanon, Israel, Egypt, Libya.

Common names.—Mole Rat, *Abu Amma*.

Subspecies in Egypt.—

Spalax ehrenbergi aegyptiacus (Nehring, 1898)

Spalax aegyptiacus Nehring, 1898, S. B. Ges. Nat. Fr. Berlin (for 1897), p. 180.

Type locality.—Egypt. ALEXANDRIA: Ramleh.

Distribution in Egypt.—Figure 76. Northern part of Western Mediterranean Coastal Desert.

Diagnosis.—Blind, mole-like, fossorial rodent. Pelage brownish, soft, nondirectional. Eye vestigial, covered with hairy skin. Pinna absent, meatal opening prominent. Tail not visible. Snout broad, flat, with band of soft, stiff bristles extending from nostril to level of eye.

Supraoccipital large, flat, sloping forward. Median sagittal and lambdoidal ridges prominent, supraorbital and tempoparietal ridges absent. Interparietal absent. Infraorbital foramen large, incisive foramen small, palatal foramen minute. Upper incisor orthodont, anterior surface smooth. Molars round in outline, enamel pattern S-shaped.

Adult total length average 184 mm., foot 25 mm., condylonasal length 43 mm.

External characters.—Figure 77. Upper parts reddish to pale brown, venter grayish. All hairs with blackish bases; basal bands narrower on belly than on dorsal and side hairs. Fur velvety, soft, and nondirectional. Feet pale silver gray above. Pinna absent, meatal opening with a prominent cartilaginous tube. Snout broad, flat, with band of short, stiff, pale bristles extending from nostril to level of eye. Normal vibrissae absent. Tail not visible externally.

Cranial characters.—Figure 78. Braincase triangular in shape.

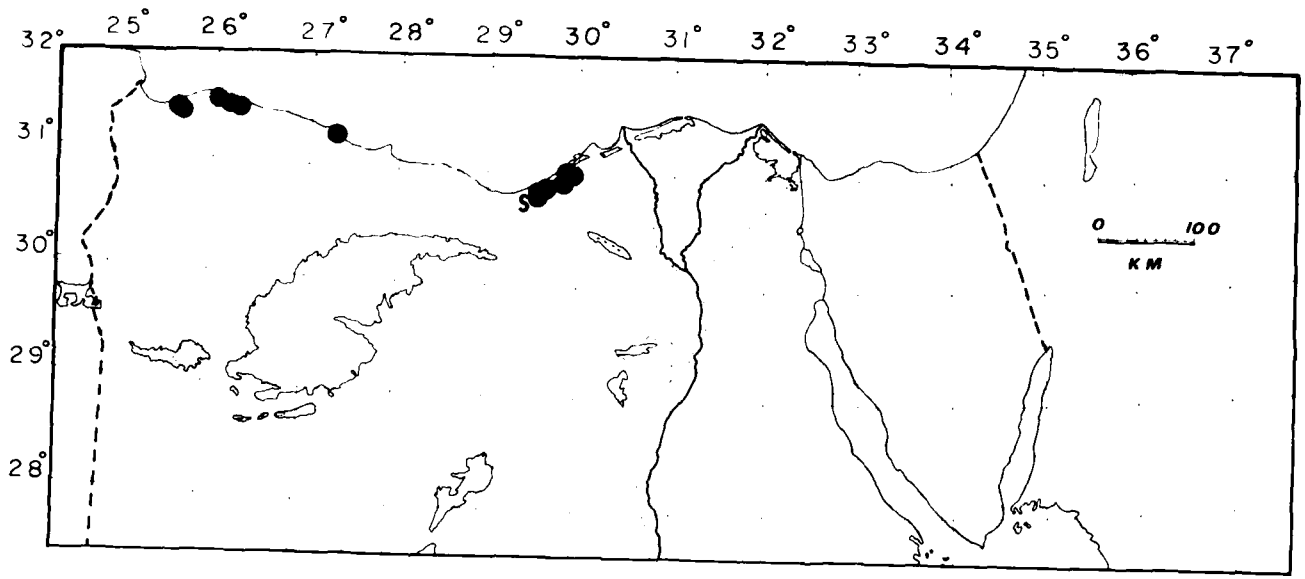


FIG. 76. Collection localities of *Spalax ehrenbergi aegyptiacus* and sight record (S).

FIG. 77. Live specimen of *Spalax ehrenbergi aegyptiacus*.

Zygomatic arch wide, especially at the temporal process. Supraorbital and tempoparietal ridges lacking. Median sagittal and lambdoidal ridges prominent. Interparietal absent. Posterior nasal margin narrow, irregular. Zygomatic plate small. Infraorbital foramen very large, incisive foramen small, palatal foramen minute. Parapterygoid fossa small, roof nearly obliterated by large foramen. Posterior palatal margin about level with m^3, bearing a median spine. Palate constricted, deeply grooved and ridged. Tympanic bulla moderately inflated. Occipital condyle almost completely behind level of supraoccipital. Supraoccipital large and sloping forward to level of zygomatic process of temporal. Lambdoidal crest high and prominent. Mandible with well-developed coronoid process. Alveolar process prominent and protruding to height of the condylar process. Angular process turned outward.

Teeth.—Figure 79. Incisors long. Upper incisor broad, orthodont,

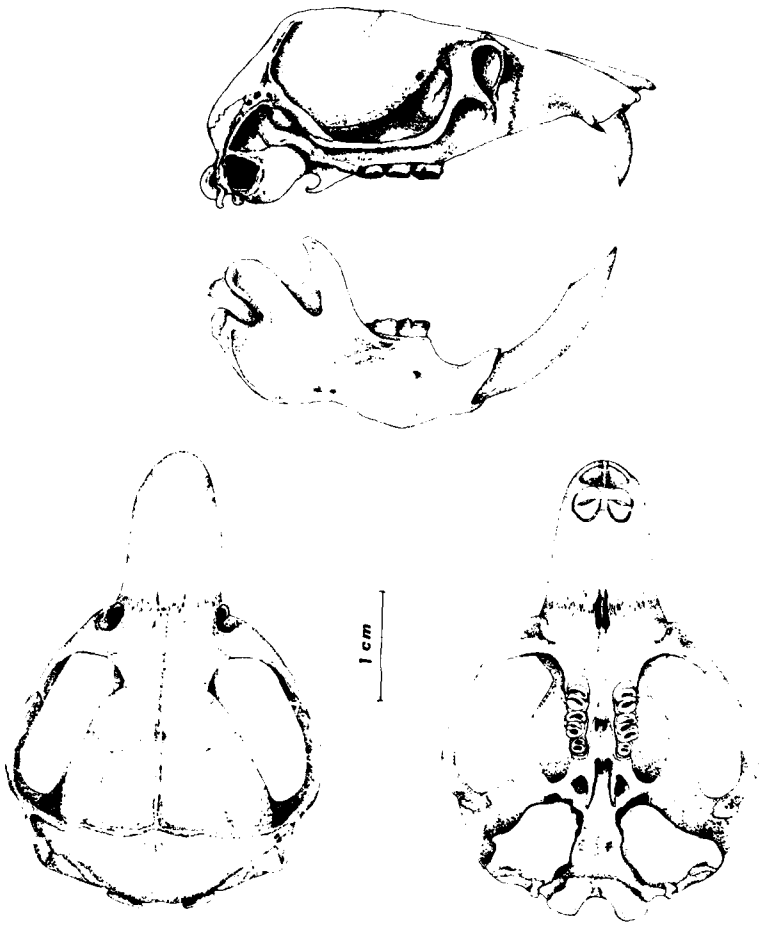


FIG. 78. Skull of *Spalax ehrenbergi aegyptiacus*.

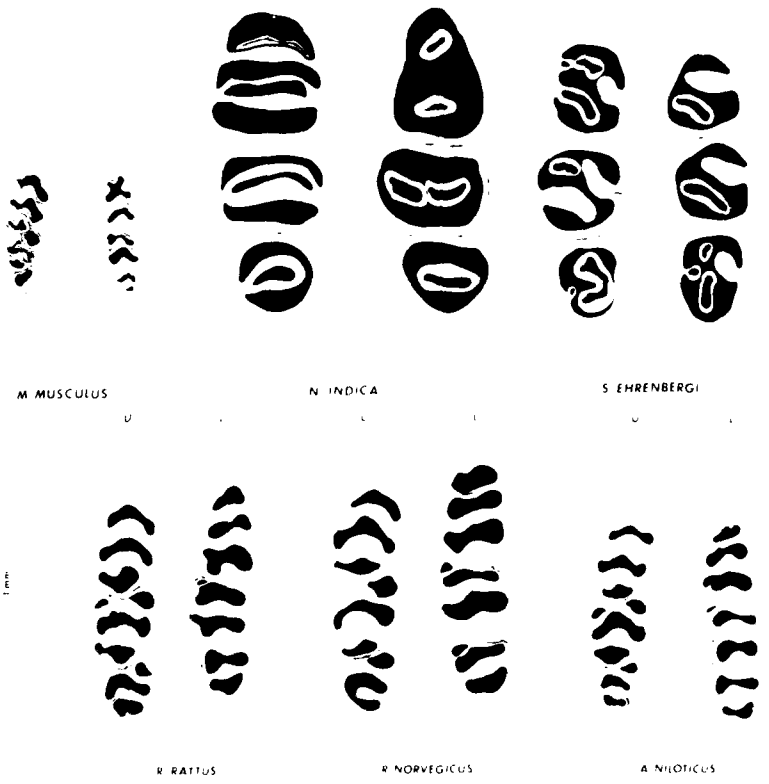


FIG. 79. Crown views of right upper (U) and left lower (L) molars of Egyptian Muridae and *Spalax ehrenbergi*

anterior surface smooth. Molars round in outline, inner and outer reentrant folds forming an S-shaped pattern. M^1, m_1 subequal, slightly larger than m^1. Folds in adult m^1 become isolated into two inlets.

Measurements.—Table 30. Males average slightly larger than females.

Age determination.—Adults have folds of m^1 isolated into islets, cranial sutures closed, and median sagittal ridge prominent.

Variation.—Measurements of specimens from Libya average slightly smaller than those from Egypt (Ranck, 1968).

TABLE 30. — Means (and ranges) of measurements, and weight of adult *Spalax ehrenbergi aegyptiacus*.

	Male	Female
Total length	189.0 (163-203) 7	178.0 (155-204) 15
FL	25.0 (23-26) 7	24.9 (23-26) 15
CNL	44.2 (42.5-46.5) 7	41.8 (37.9-44.5) 11
ZW	31.7 (29.5-33.8) 6	28.8 (26.3-31.9) 13
IOW	7.1 (6.8- 7.5) 7	7.1 (6.6- 7.5) 14
IFL	4.0 (3.8- 4.1) 4	3.8 (3.4- 4.0) 4
AL	7.6 (7.4- 7.7) 4	7.5 (7.4- 7.5) 4
RW	8.7 (8.4- 9.2) 7	8.1 (7.5- 8.8) 14
SH	17.6 (16.4-18.9) 7	17.3 (16.5-18.4) 12
Wt	— —	107.2, 120.4

Comparisons.—*Spalax ehrenbergi* differs from *S. leucodon* in smaller size and having two instead of one islet in adult m^4. *Spalax e. aegyptiacus* differs from the nominate subspecies in smaller average measurements.

Specimens examined.—Total 35.

MATRUH: Mariut (9); Bahig (9); Burg el Arab (10), 12.8 km. W (2); Zawiyet el Mithniyan (1); Sidi Barrani 28.8 km. E (1), 32 km. E. (1); Buq Buq 8 km. SW (1), 9.6 km. SW (1).

Sight record of D. J. Osborn.—

MATRUH: El Hammam 1 km. S (mounds).

Published records.—Records are from Anderson (1902), Flower (1932), and Hoogstraal et al. (1955).

ALEXANDRIA: Ramleh, El Amiriya.

MATRUH: Mariut, Burg el Arab, Mersa Matruh, Sidi Barrani 28.8 km. E.

Collection.—*Spalax* is caught easily in Macabee pocket gopher traps. Hoogstraal (1963, p. 21) took specimens "with onion bait and a noose hung in an opened burrow." We have also captured it alive by closing off the burrow behind an animal when it came to plug the opening. A pit is dug 25 to 30 cm. behind the opening to within a few centimeters of the tunnel so that a shovel or hoe can be quickly driven across the tunnel to prevent retreat.

Habitats.—Western Mediterranean Coastal Desert plain in deep sandy and loamy soils where *Asphodelus microcarpus* predominates and Bedouins have established barley fields. The most western site of collection in Egypt is 9.6 km. SW of Buq Buq in sandy soil under

a plant community dominated by *Thymelaea hirsuta*. Not found in low areas subject to flooding nor in the higher rocky areas.

Ranck (1967, p. 197) reported the species from the coastal plain and uplands of the Cyrenaican Plateau in Libya, and "larger valleys and more fertile soils of the higher tablelands."

Burrows.—Subterranean tunnels 30 to 40 m. in length and 46 cm. below the surface were exposed near Mariut (Anderson, 1892). Tunnels are usually branched and have food storage, sanitary, and nesting chambers. Excavated soil from several passages is pushed to the surface forming small mounds 10 to 20 cm. high. Breeding mounds, according to Nevo (1961) who studied *S. e. ehrenbergi* in Israel, average about 40 cm. in height, 160 cm. long, and 135 cm. wide. These mounds, constructed at the beginning of the rainy season (October-November) contain nesting and food storage chambers and numerous passages.

Behavior.—Extremely alert and aggressive in captivity, biting readily.

Hoarding instinct has been observed in captive *S. ehrenbergi* (Anderson, 1892), but not in *S. leucodon* (Watson, 1961). Storage chambers containing tubers or bulbs are usually found in burrows of *S. ehrenbergi* (Anderson, 1902 and personal observations of authors).

Spalax initiates burrowing by scratching with the foreclaws and thrusting with the head. The incisors do the major work of excavation in hard ground. The head is also used to push and pack soft or loose soil (Montagu, 1924; Reed, 1958; Watson; 1961). During winter and spring rainy seasons, *Spalax* is active and mounds of excavated earth are common, but in the dry season few are visible.

Various aspects of the behavior of *S. ehrenbergi* have been studied by Nevo (1961, 1969, p. 485). In the latter publication, mating behavior was said to consist of "three distinct stages—agnostic, courtship, and copulation" and to vary between chromosome forms. Copulation in nature, according to Nevo, takes place in the females' breeding mounds.

Although adapted to live subterraneanly, *S. ehrenbergi* is known to be active on the ground surface during night or day for the occasional purposes of collecting green food, finding a mate, and in the case of dispersing young, searching for future territory. *Spalax* skulls found in barn owl pellets (Bate, 1945; Dor, 1947) were the original indirect evidence of nocturnal surface activity.

Food.—Bulbs, tubers, and roots are gathered by *Spalax* and stored in the burrow system. Sixty-eight bulbs were once removed from two storage chambers (Anderson, 1902). An important food of *S. e. aegyptiacus* is the tubers of a lily, *Asphodeles microcarpus*. Most of the plants listed by Nevo (1961) which are eaten by *S. e. ehrenbergi* in Israel, occur in the habitat of *S. e. aegyptiacus*. Among these are bulbs and corms of *Narcissus tazetta, Belevalia flexuosa, Gladiolus italicus, Oxalis pes-caprae, Arisarum vulgare;* roots of *Alhagi mannifera;* and foliage of *Asphodelus microcarpus, Urginea maritima, Medicago* sp., *Hordeum* sp., and *Eryngium* sp.

Captive animals have been fed potatoes, onions, carrots, beets, and shelled broad beans (Watson, 1961). We found that *S. e. aegyptiacus* could be maintained satisfactorily for several days on an onion diet.

Associates.—Burrows of *Spalax* occur in habitats occupied by *Gerbillus andersoni, Meriones shawi, Jaculus jaculus, J. orientalis, Allactaga tetradactyla, Psammomys obesus*, and other species inhabiting sandy and clay soils of the Western Mediterranean Coastal Desert.

Reproduction.—No data from Egypt. Nevo (1961) recorded one litter per year, pregnant females from January-March, most frequent number of young three to four, and range of litter size one to nine in Israel.

Sex ratio.—A sample of 27 museum specimens of *S. e. aegyptiacus* included seven (26 per cent) males and 20 females. Fewer males than females were also found in *S. e. ehrenbergi*. In 18 litters comprising a total of 67 specimens, 27, or 40.3 per cent, were males, and in 106 adults, 37, or 34.9 per cent, were males (Nevo, 1961).

Remarks.—Lay and Nadler (1972) postulated that the ancestral stock of North African *Spalax* originated from northern Sinai and southern Israel populations, which, even though separated by a hiatus of 400 km., and some 10,000 to 25,000 years, have the same 2n=60 karyotypes.

Wahrman et al. (1969) discovered that in Israel, distinct, but homogeneous, populations occurred with decreasing diploid numbers northward in correlation with decreasing aridity.

Family 3. Muridae

Fur soft to relatively harsh and spinous. Tail without apical

brush, annulations not concealed by hair or bristles. Supraorbital spots not prominent except in genus *Acomys*. Supraorbital and tempoparietal ridges prominent except in genus *Mus*. Infraorbital foramen relatively large, incisive foramen long, except in genus *Nesokia;* palatine foramen minute. Tympanic and mastoid bullae slightly inflated. Upper incisor variable in curvature, anterior surface smooth. Cheek teeth tuberculate (tubercles in three longitudinal rows) or laminate, never prismatic. Dental formula: $\frac{1}{1}, \frac{0}{0}, \frac{0}{0}, \frac{3}{3} \times 2 = 16$.

KEY TO EGYPTIAN GENERA OF MURIDAE

1. Dorsal pelage spinous. Tempoparietal suture following cranial ridge. Interparietal very large, semicircular in outline, occupying one-half or more of area between cranial ridges. ..... *Acomys*, p. 285.
2. Dorsal pelage not spinous. Tempoparietal suture turning downward and caudad above base of zygomatic process of temporal bone. Interparietal with variable outline, occupying less than one-half of area between cranial ridges.
   a. Size large, head and body length greater than 150 mm.
      i. Dorsum brownish. Palatal margin level with or behind posterior edge of m^3.
         (a) Incisive foramen relatively long. Zygomatic arch not bowed laterally. Upper incisor compressed, opisthodont. Mandible with small alveolar process. ..... *Rattus*, p. 263.
         (b) Incisive foramen actually and relatively very short. Zygomatic arch bowed laterally. Upper incisor not compressed, proodont. Mandible with large alveolar process. ..... *Nesokia*, p. 309.
      ii. Dorsum speckled black and yellowish. Palatal margin anterior to posterior edge of m^1 ..... *Arvicanthus*, p. 254.
   b. Size small, head and body length less than 100 mm. ..... *Mus*, p. 273.

Genus **Arvicanthis** Lesson, 1842

Large murid, pelage relatively harsh, speckled black and yellowish dorsally with black middorsal stripe. Tail shorter than head and body, distinctly bicolored, annulations almost concealed by hair.

Skull massive, strongly ridged. Zygomatic arch thickened in middle. Interparietal ovoid to rectangular in outline. Postpalatal margin anterior to posterior edge of m^1. M^1 seven-rooted, slightly longer but narrower than m^2.

Arvicanthis niloticus (Desmarest, 1822)

Arvicola niloticus Desmarest, 1822, Encylcopedie Methodique Mammalogie, pt. 2, p. 281.

Type locality.—Egypt.

General distribution.—Southwestern Arabia, Egypt, Sudan, Ethiopia, Uganda, Kenya, Tanzania, Chad, and from Nigeria west to Senegal.

Common names.—Nile Kusu, Grass Rat, Field Rat, *Far el Gheiti.*

Subspecies in Egypt.—

Arvicanthis niloticus niloticus (Desmarest, 1822)

Type locality.—Egypt.

Distribution in Egypt.—Figure 80. Nile Valley and Delta, El Faiyum, Dakhla and Kharga Oases, El Maghra, and canals extending into Western Mediterranean Coastal Desert.

Diagnosis.—Large, slender rat with dorsum speckled black and yellow; belly white. Ear longer than one-half hind foot length, covered with orangish hairs. Tail thin, shorter than head and body length, bicolored, blackish above, yellowish below.

Supraorbital ridges prominent and forming a postorbital process in adults; tempoparietal ridges curving and high on the braincase. Incisive foramen relatively long and extending to level of anterior root of m^1. M^1 lacking cingulum on anterior border of crown.

Adult head and body length average 180 mm.; tail 142 mm., 78 per cent of head and body length; foot 36 mm.; ear 21 mm.; condylonasal length 38.5 mm.; weight 140 gm.

External characters.—Figure 81, Table 32. Dorsal pelage coarse, speckled black and yellow. Hairs of dorsum with narrow black tip, broad yellow subterminal band, and black base. Middorsal stripe black, indistinct or distinct, extending from crown to base of tail. Belly hairs whitish with black base. Mystacial and circumorbital area, ear, and small postauricular patch orangish. Long yellowish to orangish hairs on rump. Foot orangish to blackish above. Palm and sole bare, pigmented. Tail bicolored, blackish above, whitish to yellowish below; hairs almost concealing annulations.

Cranial characters.—Figure 82 and Table 32. Dorsal skull outline convex in lateral view. Braincase relatively broad. Zygomatic arch thickened in middle, not bowed laterally. Rostrum broad, short in appearance. Nasals tapering gradually posteriorly, posterior margin abrupt and divided. Supraorbital ridge prominent and forming a postorbital process in adults. Frontoparietal suture U-shaped. Tempoparietal suture turning abruptly downward and caudad above

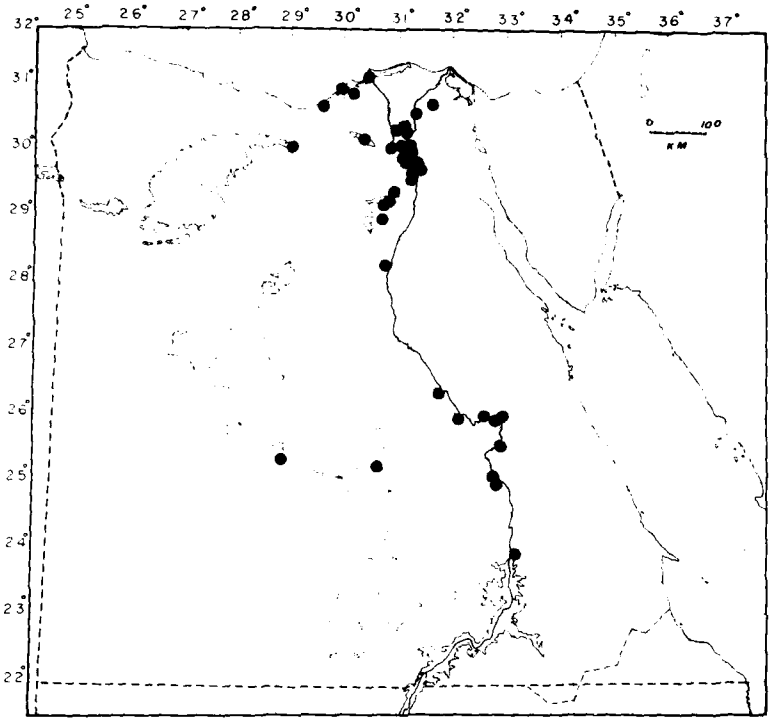


FIG. 80. Collection localities of *Arvicanthis niloticus niloticus*.

base of zygomatic process of temporal. Tempoparietal ridge high on cranium, curving slightly laterad. Parietal part of ridge less developed than temporal. Interparietal irregularly ovoid to almost rectangular in outline. Lambdoidal and median supraoccipital ridges prominent. Occipital condyle protruding slightly beyond posterior level of supraoccipital.

Zygomatic plate sharply rounded above, anterior margin nearly vertical, not reaching level of premaxillary-maxillary suture. Infraorbital foramen relatively large. Incisive foramen long and narrow, posterior margin almost level with anteromedial root of m^1. Postpalatal foramen minute and situated on or just anterior to the maxillopalatine suture. Posterior palatine margin anterior to posterior level of m^3. As in Anderson's (1902, p. 280) description, there is "no post dental shelf." Palate constricted slightly. Parapteryg id fossa narrow and deep. Tympanic bulla moderately

FIG. 81. Dorsal views of Muridae. Left to right: *Arvicanthis niloticus niloticus* (two specimens), *Rattus rattus* (two specimens), *R. norvegicus*, and *Nesokia indica*.

inflated, compressed laterally. Mandible relatively deep, coronoid process prominent, alveolus of incisor small.

Teeth.—Figure 79 and Table 32. Incisor compressed, opisthodont, anterior surface smooth. Molars relatively heavy, cuspidate, becoming laminate. Laminae crescent shaped, particularly on m^1. M^1 with five long and two short roots, cingulum lacking, and anterolateral cusp present. M^2 broader than m^1, anterolateral cusp variable; present on m_2. M^3 with two laminae and a distinct anteromedial cusp.

Measurements.—Table 31. Male and female measurements subequal.

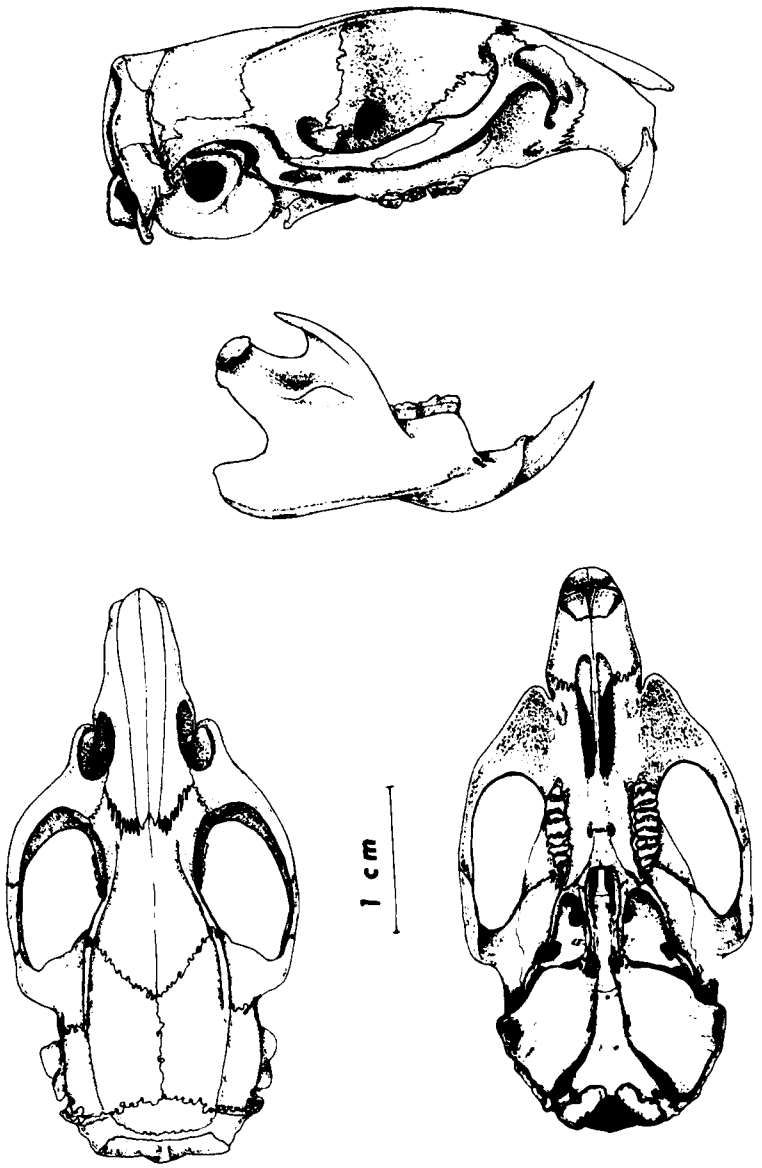


FIG. 82. Skull of *Arvicanthis niloticus niloticus*

TABLE 31. — Means (and ranges) of measurements, ratios, and weight of adult *Rattus rattus*, *R. norvegicus*, and *Arvicanthis niloticus*.

	R. rattus	*R. norvegicus*	*A. niloticus*
HBL	180.1 (156-208) 19	219.9 (196-254) 13	180.6 (159-202) 20
TL	219.3 (188-244) 17	196.0 (145-234) 13	142.3 (125-173) 15
TL/HBL%	121.4 (113.3-134.1) 17	88.4 (64.2-99.0) 12	78.7 (70.9-90.2) 15
FL	36.2 (32-39) 21	43.4 (40-51) 13	36.7 (33-42) 20
EL	23.7 (21-26) 21	20.8 (20-23) 13	21.0 (19-23) 20
Wt	137.3 (87.0-174.0) 17	259.3 (208.3-360.0) 4	139.8 (102.0-201.2) 8
CNL	41.4 (38.5-44.6) 18	46.8 (43.2-52.2) 12	38.5 (35.1-41.8) 19
ZW	19.8 (17.7-22.4) 18	23.2 (20.9-26.9) 7	19.6 (18.2-20.8) 18
IOW	5.8 (5.3- 6.7) 18	6.5 (5.9- 7.3) 12	5.6 (5.0- 5.9) 19
RW	7.5 (6.7- 8.6) 17	8.9 (8.2-10.5) 11	7.2 (6.5- 7.9) 13
NL	15.1 (13.2-16.9) 17	17.5 (16.1-19.3) 12	15.0 (13.0-16.5) 19
IFL	7.4 (6.8- 8.4) 18	7.9 (7.0- 8.8) 12	8.6 (8.2- 9.5) 19
AL	6.9 (6.3- 7.6) 18	7.4 (6.8- 7.8) 12	7.6 (6.8- 8.2) 19
SH	14.6 (13.3-16.3) 18	16.3 (15.1-18.2) 10	14.8 (14.0-16.0) 19

Age determination.—Adults have well-developed postorbital process and cranial sutures closed.

Variation.—Dorsal stripe distinction and amount of yellow or orange hair on rump vary individually.

Comparisons.—*Arvicanthis niloticus* differs from other large Egyptian murids in speckled color and orangish marking, postpalatal margin anterior to posterior edge of m^3, and other characters in Table 32. *Arvicanthis n. niloticus* differs from Sudanese subspecies *testicularis* in darker color and proportionately shorter tail.

Specimens examined.—Total 130.

DAQAHLIYA: Minshat el Ikhwa (1), Mit Ghamr (3).

BEHEIRA: Wadi el Natroun (1), Rosetta (6), Kafr el Dawar (2).

MINUFIYA: Quweisna (1), El Ghunamiya (1), Nadir (1), Birket el Sabh (1).

GIZA: Giza (3), Wardan (1), El Baragil (1), Abu Rawash (3), Kirdasa (3), Zawyet Abu Mussalam (1), Sakkara (4), Bulaq el Dakrur (1), El Marazig (2).

CAIRO: Cairo (12), Maadi (1).

EL FAIYUM: Shooting Club (1), Shakshuk (2), Lake Qarun (2), Gharah (1).

SOHAG: Awlad Hamza (3), Sohag (2).

QENA: Qena (4), Dandara (4), Isna (5), Isna E. (1), Wadi Nassim (1), Dishna (4), Abu Shusha (6), Luxor (1).

ASWAN: East Aswan (1).

MATRUH: Bahig (26), El Maghra (3).

EL WADI EL GEDEED: Dakhla Oasis, Mut (13); Kharga Oasis, El Kharga (1).

TABLE 32. — Characters of *Rattus rattus*, *R. norvegicus*, and *Arvicanthis niloticus*.

Character	*R. rattus*	*R. norvegicus*	*A. niloticus*
Color	back brownish, belly gray buff, or cream	back brownish, belly gray	back speckled yellow and black, belly white and black
Tail coloring	not bicolored	bicolored	
Ear length	more than ½ hind foot length	less than ½ hind foot length	more than ½ hind foot length
Tail length	more than head and body length	less than head and body length	
Postaxial pectoral mammae	one pair	two pairs	one pair
Posterior margin of incisive foramina	level with anterior root of m^1	not level with anterior root of m^1	level with anterior root of m^1

TABLE 32. — *continued.*

Character	*R. rattus*	*R. norvegicus*	*A. niloticus*
Postpalatal margin	posterior to m^3		not posterior to m^3
Tempoparietal ridges	curving, low on brain case	parallel, high on brain case	curving, high on brain case
Occipital condyles	not protruding beyond supraoccipital	protruding beyond supraoccipital	protruding slightly beyond supraoccipital
Cingulum on m	absent	present	absent
Anterolateral cusp of m^1	present	absent	variable
Anterolateral cusp of m_1	variable	present	

Published records.—Records are from Anderson (1902) and Setzer (1952, 1963).

DAQAHLIYA: Minshat el Ikhwa.

ALEXANDRIA: Alexandria.

BEHEIRA: Wadi el Natroun.

MINUFIYA: Quweisna, El Ghunamiya.

QALYUBIYA: Qalyub, Qalama.

GIZA: Wardan, El Baragil, El Magedla, Zawyet Abu Massalam, Nahya, Abu Rawash, Sakkara, Bulaq el Dakrur.

EL FAIYUM: Shooting Club, Lake Qarun.

MINYA: Minya

QENA: Wadi Nassim.

ASWAN: Aswan.

Habitats.—Flower (1932) said *A. niloticus* was never known to enter houses. Hoogstraal, (1963, p. 22) remarked that, although these animals live in close proximity to human structures, they are "seldom if ever encountered inside buildings."

Setzer (1952) likened *A. niloticus* in appearance with the North and South American cricetine genus *Sigmodon*, which also occupies a similar ecological niche.

In nature, habitats are canal banks with grass cover of *Desmostachya bipinnata* and *Imperata cylindrica*, gardens, fields, railway embankments, and almost any damp area under vegetative cover or piles of crop wastes. Recent collections (1967) are from olive groves and gardens in Bahig following completion of a freshwater canal into that area of the Western Mediterranean Coastal Desert.

One specimen of *A. niloticus* was found dead under a date palm in the palm-reed-rush community of El Maghra in 1965 and two were trapped there in 1974. How the animals arrived in such an area surrounded by many kilometers of waterless desert is a mystery, unless they were carried in accidently in some kind of camel load, as has also been assumed in the case of *Mus musculus*.

Burrows—Burrows are shallow, long, and winding with numerous openings and never closed. Short burrows are used as temporary hiding or feeding places.

Activity and behavior.—Diurnal and nocturnal. Usually seen and trapped during hottest period of the day. Can be seen crossing highways that run between canal banks or other areas of suitable habitat.

Hassan and Hegazy (1968) reported one mature male and one mature female per burrow, except during the winter when these rats congregate for warmth.

Arvicanthis niloticus, like *Rattus* sp., is aggressive and difficult to handle.

Reproduction.—According to Hassan and Hegazy (1968), the main breeding period is June-November. They found 60 per cent of females pregnant in October and five to six per cent in January. Gestation period was 20 days, litter size five to six, number of litters per female three to four per year, and females matured in three months. The life span in nature was estimated at two and one-half to three years.

Happold (1966b) reported young were seen at all times in North Sudan, and pregnant females with two to ten young were collected in February, July, and September. The rainy season had no effect on reproduction.

Sex ratio.—A museum sample of 40 consisted of 17 (42.5 per cent) males and 23 females.

Economic importance.—Hassan and Hegazy (1968) place considerable emphasis on the importance of *A. niloticus* as a pest to agriculture. They considered it to be the most numerous of murids, because its natural enemies, snakes and mongoose, have been killed off by man, and because the climate is favorable.

It reportedly eats grains, vegetables, and fruits; gnaws the base of sugar cane, damaging approximately 30 per cent in upper Egypt; damages trees by gnawing the bark; and takes cotton bolls to make nests.

Remarks.—Possibly *A. niloticus* is Klunzinger's (1878, p. 148) "large thick-headed field mice which frequent the fields and earthen dikes, and in many quarters are esteemed as dainties by the peasants." It was also eaten by the Romans.

Genus **Rattus** Fischer, 1803

Large murids with relatively harsh pelage, brownish dorsally. Tail length variable, color variable, annulations conspicuous.

Skull massive, strongly ridged. Zygomatic arch slender. Interparietal semicircular to shield-shaped in outline. Postpalatal margin posterior to m^1. M^1 five-rooted, crown longer than m^2.

KEY TO EGYPTIAN SPECIES OF *Rattus*

1. Back brownish; belly gray, buff or cream. Tail length more than 100 per cent of head and body, slender, not bicolored. Ear length more than one-half hind foot. Tempoparietal ridges curving laterally, low on braincase. M^1 without a cingulum, m_2 with anterolateral cusp (fig. 79). ..... *rattus*, p. 264.
2. Back brownish; belly gray. Tail length less than 100 per cent of head and body, thick, bicolored. Ear length less than one-half hind foot. Tempoparietal ridges parallel, high on braincase. M^1 with a cingulum, m_2 without anterolateral cusp (fig. 79). ..... *norvegicus*, p. 269.

Rattus rattus (Linnaeus, 1758)

Mus rattus, Linnaeus, 1758, Syst. Nat., 10th ed., p. 61.

Type locality.—Sweden: Upsala.

General distribution.—Almost cosmopolitan due to accidental transportation by man. May occur in the wild state in parts of southeastern Asia.

Common names.—House Rat, Black Rat.

Distribution in Egypt.—Figure 83. Nile Valley and Delta, coastal towns, and certain oases in Western Desert.

Diagnosis.—Large, slender murid. Dorsum brownish; venter gray, buff, or white. Muzzle sharp. Ear longer than one-half hind foot length, sparsely haired. Tail thin, longer than head and body length, not bicolored.

Skull elongate. Tempoparietal ridges low on cranium, curving laterally; area between ridges convex. Zygomatic arches slender, not flaring laterally. Occipital condyle not protruding beyond level of supraoccipital. Incisive foramen reaching level of anterior root of m^1. M^1 lacking a cingulum on anterior border of crown.

Adult head and body length average 180 mm.; tail 219 mm., 120 per cent of head and body length; foot 36 mm.; ear 24 mm.; condylonasal length 41.4 mm.; weight 137 gm.

External characters.—Figure 81. Three color phases occurring in Egypt, with previously recognized subspecific names in parentheses, are:

1. Dorsum blackish brown; venter, hand, and foot gray (*rattus*).
2. Dorsum grizzled brown; venter hairs gray with buff tip; hand and foot brownish, toes whitish (*alexandrinus*).
3. Dorsum pale grizzled brown; venter hairs white with pale

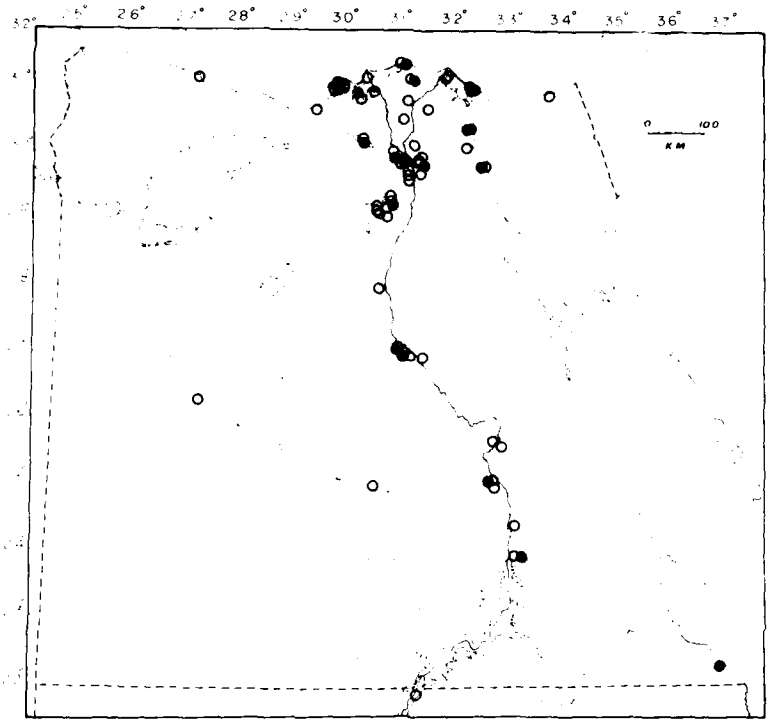


FIG. 83. Collection localities of *Rattus rattus* (circles) and *R. norvegicus* (dots).

yellowish or cream tip; hand and foot pale grayish to whitish (*frugivorous*).

Ear relatively long and sparsely haired. Tail thin, relatively long, brownish, not bicolored. Palm and sole naked.

Cranial characters.—Figure 84. Posterior margin of nasals round or truncate, not reaching level of posterior margin of frontopremaxillary suture. Supraorbital and parietal ridges strongly developed, the latter curving laterally, low on side of braincase; area between ridges convex. Median supraoccipital ridge prominent. Occipital condyle not protruding beyond level of supraoccipital. Zygomatic plate projecting forward slightly, gradually rounded above, narrow in proportion to height. Incisive foramen usually reaching level of anterior root of m^1.

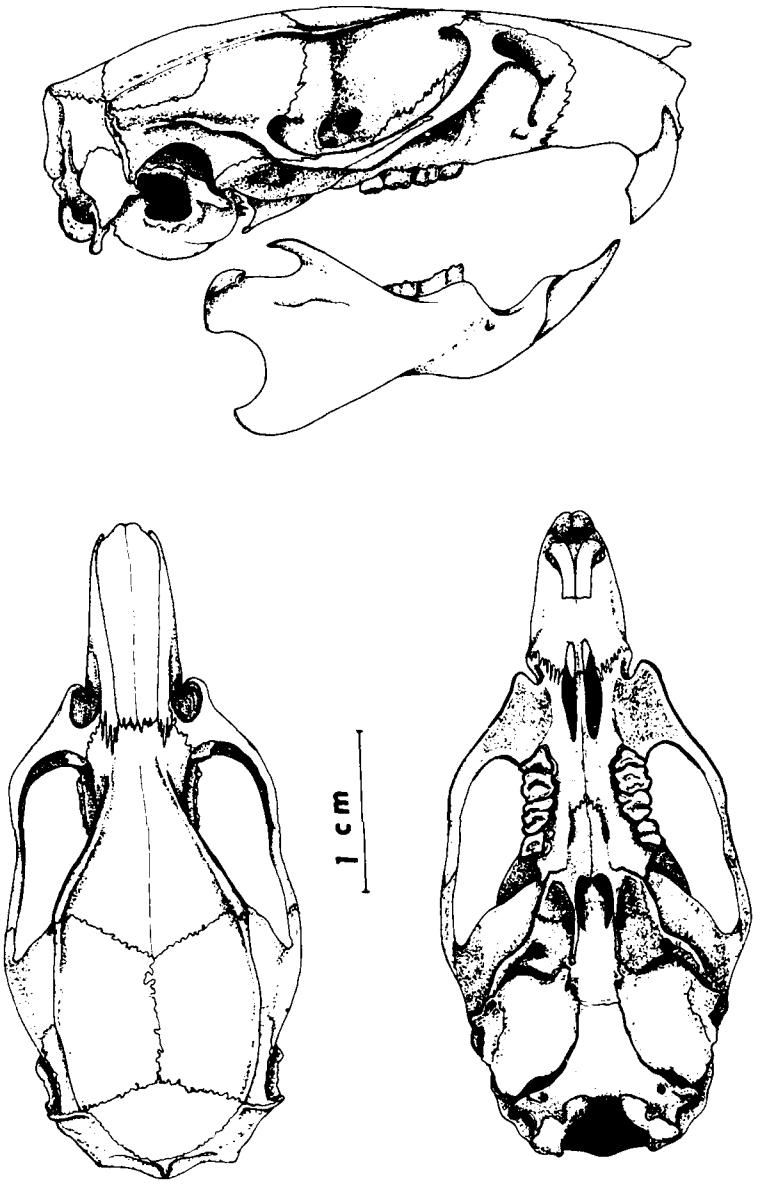
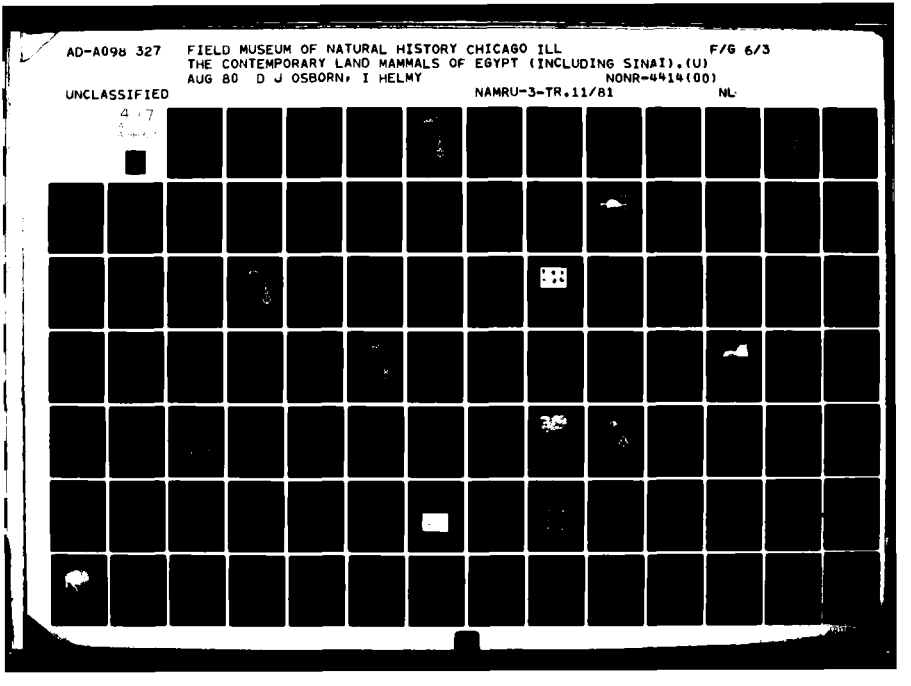
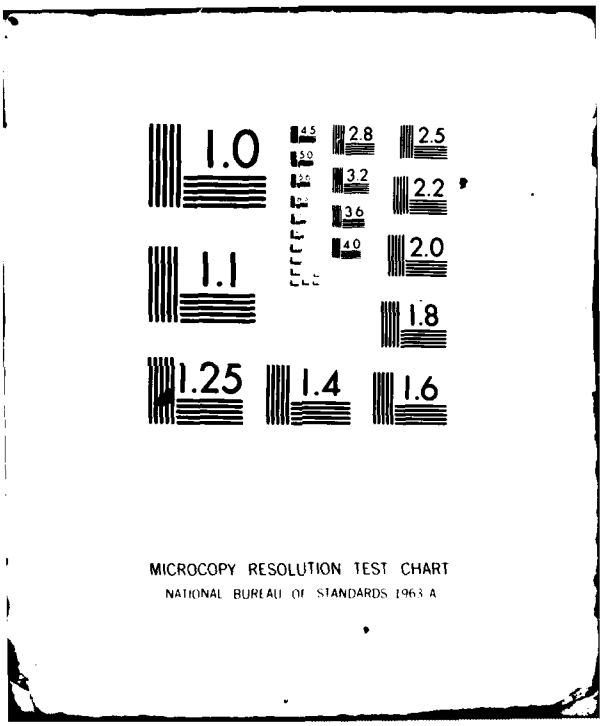


Fig. 84. Skull of *Rattus rattus*

AD-A098 327 FIELD MUSEUM OF NATURAL HISTORY CHICAGO ILL F/G 6/3
THE CONTEMPORARY LAND MAMMALS OF EGYPT (INCLUDING SINAI).(U)
AUG 80 D J OSBORN, I HELMY NONR-4414(00)
UNCLASSIFIED NAMRU-3-TR.11/81 NL




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
7.1
8.0
9.0
10.0
11.2
12.5
14.0
16.0
18.0
20.0
22.4
25.0
28.0
32.0
36.0
40.0
45.0
50.0
56.0
63.0
71.0
80.0
90.0
100.0
112.0
125.0
140.0
160.0
180.0
200.0
224.0
250.0
280.0
320.0
360.0
400.0
450.0
500.0
560.0
630.0
710.0
800.0
900.0
1000.0
1120.0
1250.0
1400.0
1600.0
1800.0
2000.0
2240.0
2500.0
2800.0
3200.0
3600.0
4000.0
4500.0
5000.0
5600.0
6300.0
7100.0
8000.0
9000.0
10000.0
11200.0
12500.0
14000.0
16000.0
18000.0
20000.0
22400.0
25000.0
28000.0
32000.0
36000.0
40000.0
45000.0
50000.0
56000.0
63000.0
71000.0
80000.0
90000.0
100000.0
112000.0
125000.0
140000.0
160000.0
180000.0
200000.0
224000.0
250000.0
280000.0
320000.0
360000.0
400000.0
450000.0
500000.0
560000.0
630000.0
710000.0
800000.0
900000.0
1000000.0
1120000.0
1250000.0
1400000.0
1600000.0
1800000.0
2000000.0
2240000.0
2500000.0
2800000.0
3200000.0
3600000.0
4000000.0
4500000.0
5000000.0
5600000.0
6300000.0
7100000.0
8000000.0
9000000.0
10000000.0
11200000.0
12500000.0
14000000.0
16000000.0
18000000.0
20000000.0
22400000.0
25000000.0
28000000.0
32000000.0
36000000.0
40000000.0
45000000.0
50000000.0
56000000.0
63000000.0
71000000.0
80000000.0
90000000.0
100000000.0
112000000.0
125000000.0
140000000.0
160000000.0
180000000.0
200000000.0
224000000.0
250000000.0
280000000.0
320000000.0
360000000.0
400000000.0
450000000.0
500000000.0
560000000.0
630000000.0
710000000.0
800000000.0
900000000.0
1000000000.0
1120000000.0
1250000000.0
1400000000.0
1600000000.0
1800000000.0
2000000000.0
2240000000.0
2500000000.0
2800000000.0
3200000000.0
3600000000.0
4000000000.0
4500000000.0
5000000000.0
5600000000.0
6300000000.0
7100000000.0
8000000000.0
9000000000.0
10000000000.0
11200000000.0
12500000000.0
14000000000.0
16000000000.0
18000000000.0
20000000000.0
22400000000.0
25000000000.0
28000000000.0
32000000000.0
36000000000.0
40000000000.0
45000000000.0
50000000000.0
56000000000.0
63000000000.0
71000000000.0
80000000000.0
90000000000.0
100000000000.0
112000000000.0
125000000000.0
140000000000.0
160000000000.0
180000000000.0
200000000000.0
224000000000.0
250000000000.0
280000000000.0
320000000000.0
360000000000.0
400000000000.0
450000000000.0
500000000000.0
560000000000.0
630000000000.0
710000000000.0
800000000000.0
900000000000.0
1000000000000.0
1120000000000.0
1250000000000.0
1400000000000.0
1600000000000.0
1800000000000.0
2000000000000.0
2240000000000.0
2500000000000.0
2800000000000.0
3200000000000.0
3600000000000.0
4000000000000.0
4500000000000.0
5000000000000.0
5600000000000.0
6300000000000.0
7100000000000.0
8000000000000.0
9000000000000.0
10000000000000.0
11200000000000.0
12500000000000.0
14000000000000.0
16000000000000.0
18000000000000.0
20000000000000.0
22400000000000.0
25000000000000.0
28000000000000.0
32000000000000.0
36000000000000.0
40000000000000.0
45000000000000.0
50000000000000.0
56000000000000.0
63000000000000.0
71000000000000.0
80000000000000.0
90000000000000.0
100000000000000.0
112000000000000.0
125000000000000.0
140000000000000.0
160000000000000.0
180000000000000.0
200000000000000.0
224000000000000.0
250000000000000.0
280000000000000.0
320000000000000.0
360000000000000.0
400000000000000.0
450000000000000.0
500000000000000.0
560000000000000.0
630000000000000.0
710000000000000.0
800000000000000.0
900000000000000.0
1000000000000000.0
1120000000000000.0
1250000000000000.0
1400000000000000.0
1600000000000000.0
1800000000000000.0
2000000000000000.0
2240000000000000.0
2500000000000000.0
2800000000000000.0
3200000000000000.0
3600000000000000.0
4000000000000000.0
4500000000000000.0
5000000000000000.0
5600000000000000.0
6300000000000000.0
7100000000000000.0
8000000000000000.0
9000000000000000.0
10000000000000000.0
11200000000000000.0
12500000000000000.0
14000000000000000.0
16000000000000000.0
18000000000000000.0
20000000000000000.0
22400000000000000.0
25000000000000000.0
28000000000000000.0
32000000000000000.0
36000000000000000.0
40000000000000000.0
45000000000000000.0
50000000000000000.0
56000000000000000.0
63000000000000000.0
71000000000000000.0
80000000000000000.0
90000000000000000.0
100000000000000000.0
112000000000000000.0
125000000000000000.0
140000000000000000.0
160000000000000000.0
180000000000000000.0
200000000000000000.0
224000000000000000.0
250000000000000000.0
280000000000000000.0
320000000000000000.0
360000000000000000.0
400000000000000000.0
450000000000000000.0
500000000000000000.0
560000000000000000.0
630000000000000000.0
710000000000000000.0
800000000000000000.0
900000000000000000.0
1000000000000000000.0
1120000000000000000.0
1250000000000000000.0
1400000000000000000.0
1600000000000000000.0
1800000000000000000.0
2000000000000000000.0
2240000000000000000.0
2500000000000000000.0
2800000000000000000.0
3200000000000000000.0
3600000000000000000.0
4000000000000000000.0
4500000000000000000.0
5000000000000000000.0
5600000000000000000.0
6300000000000000000.0
7100000000000000000.0
8000000000000000000.0
9000000000000000000.0
10000000000000000000.0
11200000000000000000.0
12500000000000000000.0
14000000000000000000.0
16000000000000000000.0
18000000000000000000.0
20000000000000000000.0
22400000000000000000.0
25000000000000000000.0
28000000000000000000.0
32000000000000000000.0
36000000000000000000.0
40000000000000000000.0
45000000000000000000.0
50000000000000000000.0
56000000000000000000.0
63000000000000000000.0
71000000000000000000.0
80000000000000000000.0
90000000000000000000.0
100000000000000000000.0
112000000000000000000.0
125000000000000000000.0
140000000000000000000.0
160000000000000000000.0
180000000000000000000.0
200000000000000000000.0
224000000000000000000.0
250000000000000000000.0
280000000000000000000.0
320000000000000000000.0
360000000000000000000.0
400000000000000000000.0
450000000000000000000.0
500000000000000000000.0
560000000000000000000.0
630000000000000000000.0
710000000000000000000.0
800000000000000000000.0
900000000000000000000.0
1000000000000000000000.0
1120000000000000000000.0
1250000000000000000000.0
1400000000000000000000.0
1600000000000000000000.0
1800000000000000000000.0
2000000000000000000000.0
2240000000000000000000.0
2500000000000000000000.0
2800000000000000000000.0
3200000000000000000000.0
3600000000000000000000.0
4000000000000000000000.0
4500000000000000000000.0
5000000000000000000000.0
5600000000000000000000.0
6300000000000000000000.0
7100000000000000000000.0
8000000000000000000000.0
9000000000000000000000.0
10000000000000000000000.0
11200000000000000000000.0
12500000000000000000000.0
14000000000000000000000.0
16000000000000000000000.0
18000000000000000000000.0
20000000000000000000000.0
22400000000000000000000.0
25000000000000000000000.0
28000000000000000000000.0
32000000000000000000000.0
36000000000000000000000.0
40000000000000000000000.0
45000000000000000000000.0
50000000000000000000000.0
56000000000000000000000.0
63000000000000000000000.0
71000000000000000000000.0
80000000000000000000000.0
90000000000000000000000.0
100000000000000000000000.0
112000000000000000000000.0
125000000000000000000000.0
140000000000000000000000.0
160000000000000000000000.0
180000000000000000000000.0
200000000000000000000000.0
224000000000000000000000.0
250000000000000000000000.0
280000000000000000000000.0
320000000000000000000000.0
360000000000000000000000.0
400000000000000000000000.0
450000000000000000000000.0
500000000000000000000000.0
560000000000000000000000.0
630000000000000000000000.0
710000000000000000000000.0
800000000000000000000000.0
900000000000000000000000.0
1000000000000000000000000.0
1120000000000000000000000.0
1250000000000000000000000.0
1400000000000000000000000.0
1600000000000000000000000.0
1800000000000000000000000.0
2000000000000000000000000.0
2240000000000000000000000.0
2500000000000000000000000.0
2800000000000000000000000.0
3200000000000000000000000.0
3600000000000000000000000.0
4000000000000000000000000.0
4500000000000000000000000.0
5000000000000000000000000.0
5600000000000000000000000.0
6300000000000000000000000.0
7100000000000000000000000.0
8000000000000000000000000.0
9000000000000000000000000.0
10000000000000000000000000.0
11200000000000000000000000.0
12500000000000000000000000.0
14000000000000000000000000.0
16000000000000000000000000.0
18000000000000000000000000.0
20000000000000000000000000.0
22400000000000000000000000.0
25000000000000000000000000.0
28000000000000000000000000.0
32000000000000000000000000.0
36000000000000000000000000.0
40000000000000000000000000.0
45000000000000000000000000.0
50000000000000000000000000.0
56000000000000000000000000.0
63000000000000000000000000.0
71000000000000000000000000.0
80000000000000000000000000.0
90000000000000000000000000.0
100000000000000000000000000.0
112000000000000000000000000.0
125000000000000000000000000.0
140000000000000000000000000.0
160000000000000000000000000.0
180000000000000000000000000.0
200000000000000000000000000.0
224000000000000000000000000.0
250000000000000000000000000.0
280000000000000000000000000.0
320000000000000000000000000.0
360000000000000000000000000.0
400000000000000000000000000.0
450000000000000000000000000.0
500000000000000000000000000.0
560000000000000000000000000.0
630000000000000000000000000.0
710000000000000000000000000.0
800000000000000000000000000.0
900000000000000000000000000.0
1000000000000000000000000000.0
1120000000000000000000000000.0
1250000000000000000000000000.0
1400000000000000000000000000.0
1600000000000000000000000000.0
1800000000000000000000000000.0
2000000000000000000000000000.0
2240000000000000000000000000.0
2500000000000000000000000000.0
2800000000000000000000000000.0
3200000000000000000000000000.0
3600000000000000000000000000.0
4000000000000000000000000000.0
4500000000000000000000000000.0
5000000000000000000000000000.0
5600000000000000000000000000.0
6300000000000000000000000000.0
7100000000000000000000000000.0
8000000000000000000000000000.0
9000000000000000000000000000.0
10000000000000000000000000000.0
11200000000000000000000000000.0
12500000000000000000000000000.0
14000000000000000000000000000.0
16000000000000000000000000000.0
18000000000000000000000000000.0
20000000000000000000000000000.0
22400000000000000000000000000.0
25000000000000000000000000000.0
28000000000000000000000000000.0
32000000000000000000000000000.0
36000000000000000000000000000.0
40000000000000000000000000000.0
45000000000000000000000000000.0
50000000000000000000000000000.0
56000000000000000000000000000.0
63000000000000000000000000000.0
71000000000000000000000000000.0
80000000000000000000000000000.0
90000000000000000000000000000.0
100000000000000000000000000000.0
112000000000000000000000000000.0
125000000000000000000000000000.0
140000000000000000000000000000.0
160000000000000000000000000000.0
180000000000000000000000000000.0
200000000000000000000000000000.0
224000000000000000000000000000.0
250000000000000000000000000000.0
280000000000000000000000000000.0
320000000000000000000000000000.0
360000000000000000000000000000.0
400000000000000000000000000000.0
450000000000000000000000000000.0
500000000000000000000000000000.0
560000000000000000000000000000.0
630000000000000000000000000000.0
710000000000000000000000000000.0
800000000000000000000000000000.0
900000000000000000000000000000.0
1000000000000000000000000000000.0
1120000000000000000000000000000.0
1250000000000000000000000000000.0
1400000000000000000000000000000.0
1600000000000000000000000000000.0
1800000000000000000000000000000.0
2000000000000000000000000000000.0
2240000000000000000000000000000.0
2500000000000000000000000000000.0
2800000000000000000000000000000.0
3200000000000000000000000000000.0
3600000000000000000000000000000.0
4000000000000000000000000000000.0
4500000000000000000000000000000.0
5000000000000000000000000000000.0
5600000000000000000000000000000.0
6300000000000000000000000000000.0
7100000000000000000000000000000.0
8000000000000000000000000000000.0
9000000000000000000000000000000.0
10000000000000000000000000000000.0
11200000000000000000000000000000.0
12500000000000000000000000000000.0
14000000000000000000000000000000.0
16000000000000000000000000000000.0
18000000000000000000000000000000.0
20000000000000000000000000000000.0
22400000000000000000000000000000.0
25000000000000000000000000000000.0
28000000000000000000000000000000.0
32000000000000000000000000000000.0
36000000000000000000000000000000.0
40000000000000000000000000000000.0
45000000000000000000000000000000.0
50000000000000000000000000000000.0
56000000000000000000000000000000.0
63000000000000000000000000000000.0
71000000000000000000000000000000.0
80000000000000000000000000000000.0
90000000000000000000000000000000.0
100000000000000000000000000000000.0
112000000000000000000000000000000.0
125000000000000000000000000000000.0
140000000000000000000000000000000.0
160000000000000000000000000000000.0
180000000000000000000000000000000.0
200000000000000000000000000000000.0
224000000000000000000000000000000.0
250000000000000000000000000000000.0
280000000000000000000000000000000.0
320000000000000000000000000000000.0
360000000000000000000000000000000.0
400000000000000000000000000000000.0
450000000000000000000000000000000.0
500000000000000000000000000000000.0
560000000000000000000000000000000.0
630000000000000000000000000000000.0
710000000000000000000000000000000.0
800000000000000000000000000000000.0
900000000000000000000000000000000.0
1000000000000000000000000000000000.0
1120000000000000000000000000000000.0
1250000000000000000000000000000000.0
1400000000000000000000000000000000.0
1600000000000000000000000000000000.0
1800000000000000000000000000000000.0
2000000000000000000000000000000000.0
2240000000000000000000000000000000.0
2500000000000000000000000000000000.0
2800000000000000000000000000000000.0
3200000000000000000000000000000000.0
3600000000000000000000000000000000.0
4000000000000000000000000000000000.0
4500000000000000000000000000000000.0
5000000000000000000000000000000000.0
5600000000000000000000000000000000.0
6300000000000000000000000000000000.0
7100000000000000000000000000000000.0
8000000000000000000000000000000000.0
9000000000000000000000000000000000.0
10000000000000000000000000000000000.0
11200000000000000000000000000000000.0
12500000000000000000000000000000000.0
14000000000000000000000000000000000.0
16000000000000000000000000000000000.0
18000000000000000000000000000000000.0
20000000000000000000000000000000000.0
22400000000000000000000000000000000.0
25000000000000000000000000000000000.0
28000000000000000000000000000000000.0
32000000000000000000000000000000000.0
36000000000000000000000000000000000.0
40000000000000000000000000000000000.0
45000000000000000000000000000000000.0
50000000000000000000000000000000000.0
56000000000000000000000000000000000.0
63000000000000000000000000000000000.0
71000000000000000000000000000000000.0
80000000000000000000000000000000000.0
90000000000000000000000000000000000.0
100000000000000000000000000000000000.0
112000000000000000000000000000000000.0
125000000000000000000000000000000000.0
140000000000000000000000000000000000.0
160000000000000000000000000000000000.0
180000000000000000000000000000000000.0
200000000000000000000000000000000000.0
224000000000000000000000000000000000.0
250000000000000000000000000000000000.0
280000000000000000000000000000000000.0
320000000000000000000000000000000000.0
360000000000000000000000000000000000.0
400000000000000000000000000000000000.0
450000000000000000000000000000000000.0
500000000000000000000000000000000000.0
560000000000000000000000000000000000.0
630000000000000000000000000000000000.0
710000000000000000000000000000000000.0
800000000000000000000000000000000000.0
900000000000000000000000000000000000.0
1000000000000000000000000000000000000.0
1120000000000000000000000000000000000.0
1250000000000000000000000000000000000.0
1400000000000000000000000000000000000.0
1600000000000000000000000000000000000.0
1800000000000000000000000000000000000.0
2000000000000000000000000000000000000.0
2240000000000000000000000000000000000.0
2500000000000000000000000000000000000.0
2800000000000000000000000000000000000.0
3200000000000000000000000000000000000.0
3600000000000000000000000000000000000.0
4000000000000000000000000000000000000.0
4500000000000000000000000000000000000.0
5000000000000000000000000000000000000.0
5600000000000000000000000000000000000.0
6300000000000000000000000000000000000.0
7100000000000000000000000000000000000.0
8000000000000000000000000000000000000.0
9000000000000000000000000000000000000.0
10000000000000000000000000000000000000.0
11200000000000000000000000000000000000.0
12500000000000000000000000000000000000.0
14000000000000000000000000000000000000.0
16000000000000000000000000000000000000.0
18000000000000000000000000000000000000.0
20000000000000000000000000000000000000.0
22400000000000000000000000000000000000.0
25000000000000000000000000000000000000.0
28000000000000000000000000000000000000.0
32000000000000000000000000000000000000.0
36000000000000000000000000000000000000.0
40000000000000000000000000000000000000.0
45000000000000000000000000000000000000.0
50000000000000000000000000000000000000.0
56000000000000000000000000000000000000.0
63000000000000000000000000000000000000.0
71000000000000000000000000000000000000.0
80000000000000000000000000000000000000.0
90000000000000000000000000000000000000.0
100000000000000000000000000000000000000.0
112000000000000000000000000000000000000.0
125000000000000000000000000000000000000.0
140000000000000000000000000000000000000.0
160000000000000000000000000000000000000.0
180000000000000000000000000000000000000.0
200000000000000000000000000000000000000.0
224000000000000000000000000000000000000.0
250000000000000000000000000000000000000.0
280000000000000000000000000000000000000.0
320000000000000000000000000000000000000.0
360000000000000000000000000000000000000.0
400000000000000000000000000000000000000.0
450000000000000000000000000000000000000.0
500000000000000000000000000000000000000.0
560000000000000000000000000000000000000.0
630000000000000000000000000000000000000.0
710000000000000000000000000000000000000.0
800000000000000000000000000000000000000.0
900000000000000000000000000000000000000.0
1000000000000000000000000000000000000000.0
1120000000000000000000000000000000000000.0
1250000000000000000000000000000000000000.0
1400000000000000000000000000000000000000.0
1600000000000000000000000000000000000000.0
1800000000000000000000000000000000000000.0
2000000000000000000000000000000000000000.0
2240000000000000000000000000000000000000.0
2500000000000000000000000000000000000000.0
2800000000000000000000000000000000000000.0
3200000000000000000000000000000000000000.0
3600000000000000000000000000000000000000.0
4000000000000000000000000000000000000000.0
4500000000000000000000000000000000000000.0
5000000000000000000000000000000000000000.0
5600000000000000000000000000000000000000.0
6300000000000000000000000000000000000000.0
7100000000000000000000000000000000000000.0
8000000000000000000000000000000000000000.0
9000000000000000000000000000000000000000.0
10000000000000000000000000000000000000000.0
11200000000000000000000000000000000000000.0
12500000000000000000000000000000000000000.0
14000000000000000000000000000000000000000.0
16000000000000000000000000000000000000000.0
18000000000000000000000000000000000000000.0
20000000000000000000000000000000000000000.0
22400000000000000000000000000000000000000.0
25000000000000000000000000000000000000000.0
28000000000000000000000000000000000000000.0
32000000000000000000000000000000000000000.0
36000000000000000000000000000000000000000.0
40000000000000000000000000000000000000000.0
45000000000000000000000000000000000000000.0
50000000000000000000000000000000000000000.0
56000000000000000000000000000000000000000.0
63000000000000000000000000000000000000000.0
71000000000000000000000000000000000000000.0
80000000000000000000000000000000000000000.0
90000000000000000000000000000000000000000.0
100000000000000000000000000000000000000000.0
112000000000000000000000000000000000000000.0
125000000000000000000000000000000000000000.0
140000000000000000000000000000000000000000.0
160000000000000000000000000000000000000000.0
180000000000000000000000000000000000000000.0
200000000000000000000000000000000000000000.0
224000000000000000000000000000000000000000.0
250000000000000000000000000000000000000000.0
280000000000000000000000000000000000000000.0
320000000000000000000000000000000000000000.0
360000000000000000000000000000000000000000.0
400000000000000000000000000000000000000000.0
450000000000000000000000000000000000000000.0
500000000000000000000000000000000000000000.0
560000000000000000000000000000000000000000.0
630000000000000000000000000000000000000000.0
710000000000000000000000000000000000000000.0
800000000000000000000000000000000000000000.0
900000000000000000000000000000000000000000.0
1000000000000000000000000000000000000000000.0
1120000000000000000000000000000000000000000.0
1250000000000000000000000000000000000000000.0
1400000000000000000000000000000000000000000.0
1600000000000000000000000000000000000000000.0
1800000000000000000000000000000000000000000.0
2000000000000000000000000000000000000000000.0
2240000000000000000000000000000000000000000.0
2500000000000000000000000000000000000000000.0
2800000000000000000000000000000000000000000.0
3200000000000000000000000000000000000000000.0
3600000000000000000000000000000000000000000.0
4000000000000000000000000000000000000000000.0
4500000000000000000000000000000000000000000.0
5000000000000000000000000000000000000000000.0
5600000000000000000000000000000000000000000.0
6300000000000000000000000000000000000000000.0
7100000000000000000000000000000000000000000.0
8000000000000000000000000000000000000000000.0
9000000000000000000000000000000000000000000.0
10000000000000000000000000000000000000000000.0
11200000000000000000000000000000000000000000.0
12500000000000000000000000000000000000000000.0
14000000000000000000000000000000000000000000.0
16000000000000000000000000000000000000000000.0
18000000000000000000000000000000000000000000.0
20000000000000000000000000000000000000000000.0
22400000000000000000000000000000000000000000.0
25000000000000000000000000000000000000000000.0
28000000000000000000000000000000000000000000.0
32000000000000000000000000000000000000000000.0
36000000000000000000000000000000000000000000.0
40000000000000000000000000000000000000000000.0
45000000000000000000000000000000000000000000.0
50000000000000000000000000000000000000000000.0
56000000000000000000000000000000000000000000.0
63000000000000000000000000000000000000000000.0
71000000000000000000000000000000000000000000.0
80000000000000000000000000000000000000000000.0
90000000000000000000000000000000000000000000.0
100000000000000000000000000000000000000000000.0
112000000000000000000000000000000000000000000.0
125000000000000000000000000000000000000000000.0
140000000000000000000000000000000000000000000.0
160000000000000000000000000000000000000000000.0
180000000000000000000000000000000000000000000.0
200000000000000000000000000000000000000000000.0
224000000000000000000000000000000000000000000.0
250000000000000000000000000000000000000000000.0
280000000000000000000000000000000000000000000.0
320000000000000000000000000000000000000000000.0
360000000000000000000000000000000000000000000.0
400000000000000000000000000000000000000000000.0
450000000000000000000000000000000000000000000.0
500000000000000000000000000000000000000000000.0
560000000000000000000000000000000000000000000.0
630000000000000000000000000000000000000000000.0
710000000000000000000000000000000000000000000.0
800000000000000000000000000000000000000000000.0
900000000000000000000000000000000000000000000.0
1000000000000000000000000000000000000000000000.0
1120000000000000000000000000000000000000000000.0
1250000000000000000000000000000000000000000000.0
1400000000000000000000000000000000000000000000.0
1600000000000000000000000000000000000000000000.0
1800000000000000000000000000000000000000000000.0
2000000000000000000000000000000000000000000000.0
2240000000000000000000000000000000000000000000.0
2500000000000000000000000000000000000000000000.0
2800000000000000000000000000000000000000000000.0
3200000000000000000000000000000000000000000000.0
3600000000000000000000000000000000000000000000.0
4000000000000000000000000000000000000000000000.0
4500000000000000000000000000000000000000000000.0
5000000000000000000000000000000000000000000000.0
5600000000000000000000000000000000000000000000.0
6300000000000000000000000000000000000000000000.0
7100000000000000000000000000000000000000000000.0
8000000000000000000000000000000000000000000000.0
9000000000000000000000000000000000000000000000.0
10000000000000000000000000000000000000000000000.0
11200000000000000000000000000000000000000000000.0
12500000000000000000000000000000000000000000000.0
14000000000000000000000000000000000000000000000.0
16000000000000000000000000000000000000000000000.0
18000000000000000000000000000000000000000000000.0
20000000000000000000000000000000000000000000000.0
22400000000000000000000000000000000000000000000.0
25000000000000000000000000000000000000000000000.0
28000000000000000000000000000000000000000000000.0
32000000000000000000000000000000000000000000000.0
36000000000000000000000000000000000000000000000.0
40000000000000000000000000000000000000000000000.0
45000000000000000000000000000000000000000000000.0
50000000000000000000000000000000000000000000000.0
56000000000000000000000000000000000000000000000.0
63000000000000000000000000000000000000000000000.0
71000000000000000000000000000000000000000000000.0
80000000000000000000000000000000000000000000000.0
90000000000000000000000000000000000000000000000.0
100000000000000000000000000000000000000000000000.0
112000000000000000000000000000000000000000000000.0
125000000000000000000000000000000000000000000000.0
140000000000000000000000000000000000000000000000.0
160000000000000000000000000000000000000000000000.0
180000000000000000000000000000000000000000000000.0
200000000000000000000000000000000000000000000000.0
224000000000000000000000000000000000000000000000.0
250000000000000000000000000000000000000000000000.0
280000000000000000000000000000000000000000000000.0
320000000000000000000000000000000000000000000000.0
360000000000000000000000000000000000000000000000.0
400000000000000000000000000000000000000000000000.0
450000000000000000000000000000000000000000000000.0
500000000000000000000000000000000000000000000000.0
560000000000000000000000000000000000000000000000.0
630000000000000000000000000000000000000000000000.0
710000000000000000000000000000000000000000000000.0
800000000000000000000000000000000000000000000000.0
900000000000000000000000000000000000000000000000.0
1000000000000000000000000000000000000000000000000.0
1120000000000000000000000000000000000000000000000.0
1250000000000000000000000000000000000000000000000.0
1400000000000000000000000000000000000000000000000.0
1600000000000000000000000000000000000000000000000.0
1800000000000000000000000000000000000000000000000.0
2000000000000000000000000000000000000000000000000.0
2240000000000000000000000000000000000000000000000.0
2500000000000000000000000000000000000000000000000.0
2800000000000000000000000000000000000000000000000.0
3200000000000000000000000000000000000000000000000.0
3600000000000000000000000000000000000000000000000.0
4000000000000000000000000000000000000000000000000.0
4500000000000000000000000000000000000000000000000.0
5000000000000000000000000000000000000000000000000.0
5600000000000000000000000000000000000000000000000.0
6300000000000000000000000000000000000000000000000.0
7100000000000000000000000000000000000000000000000.0
8000000000000000000000000000000000000000000000000.0
9000000000000000000000000000000000000000000000000.0
10000000000000000000000000000000000000000000000000.0
11200000000000000000000000000000000000000000000000.0
12500000000000000000000000000000000000000000000000.0
14000000000000000000000000000000000000000000000000.0
16000000000000000000000000000000000000000000000000.0
18000000000000000000000000000000000000000000000000.0
20000000000000000000000000000000000000000000000000.0
22400000000000000000000000000000000000000000000000.0
25000000000000000000000000000000000000000000000000.0
28000000000000000000000000000000000000000000000000.0
32000000000000000000000000000000000000000000000000.0
36000000000000000000000000000000000000000000000000.0
40000000000000000000000000000000000000000000000000.0
45000000000000000000000000000000000000000000000000.0
50000000000000000000000000000000000000000000000000.0
56000000000000000000000000000000000000000000000000.0
63000000000000000000000000000000000000000000000000.0
71000000000000000000000000000000000000000000000000.0
80000000000000000000000000000000000000000000000000.0
90000000000000000000000000000000000000000000000000.0
100000000000000000000000000000000000000000000000000.0
112000000000000000000000000000000000000000000000000.0
125000000000000000000000000000000000000000000000000.0
140000000000000000000000000000000000000000000000000.0
160000000000000000000000000000000000000000000000000.0
180000000000000000000000000000000000000000000000000.0
200000000000000000000000000000000000000000000000000.0
224000000000000000000000000000000000000000000000000.0
250000000000000000000000000000000000000000000000000.0
280000000000000000000000000000000000000000000000000.0
320000000000000000000000000000000000000000000000000.0
360000000000000000000000000000000000000000000000000.0
400000000000000000000000000000000000000000000000000.0
450000000000000000000000000000000000000000000000000.0
500000000000000000000000000000000000000000000000000.0
560000000000000000000000000000000000000000000000000.0
630000000000000000000000000000000000000000000000000.0
710000000000000000000000000000000000000000000000000.0
800000000000000000000000000000000000000000000000000.0
900000000000000000000000000000000000000000000000000.0
1000000000000000000000000000000000000000000000000000.0
1120000000000000000000000000000000000000000000000000.0
1250000000000000000000000000000000000000000000000000.0
1400000000000000000000000000000000000000000000000000.0
1600000000000000000000000000000000000000000000000000.0
1800000000000000000000000000000000000000000000000000.0
2000000000000000000000000000000000000000000000000000.0
2240000000000000000000000000000000000000000000000000.0
2500000000000000000000000000000000000000000000000000.0
2800000000000000000000000000000000000000000000000000.0
3200000000000000000000000000000000000000000000000000.0
3600000000000000000000000000000000000000000000000000.0
4000000000000000000000000000000000000000000000000000.0
4500000000000000000000000000000000000000000000000000.0
5000000000000000000000000000000000000000000000000000.0
5600000000000000000000000000000000000000000000000000.0
6300000000000000000000000000000000000000000000000000.0
7100000000000000000000000000000000000000000000000000.0
8000000000000000000000000000000000000000000000000000.0
9000000000000000000000000000000000000000000000000000.0
10000000000000000000000000000000000000000000000000000.0
11200000000000000000000000000000000000000000000000000.0
12500000000000000000000000000000000000000000000000000.0
14000000000000000000000000000000000000000000000000000.0
16000000000000000000000000000000000000000000000000000.0
18000000000000000000000000000000000000000000000000000.0
20000000000000000000000000000000000000000000000000000.0
22400000000000000000000000000000000000000000000000000.0
25000000000000000000000000000000000000000000000000000.0
28000000000000000000000000000000000000000000000000000.0
32000000000000000000000000000000000000000000000000000.0
36000000000000000000000000000000000000000000000000000.0
40000000000000000000000000000000000000000000000000000.0
45000000000000000000000000000000000000000000000000000.0
50000000000000000000000000000000000000000000000000000.0
56000000000000000000000000000000000000000000000000000.0
63000000000000000000000000000000000000000000000000000.0
71000000000000000000000000000000000000000000000000000.0
80000000000000000000000000000000000000000000000000000.0
90000000000000000000000000000000000000000000000000000.0
100000000000000000000000000000000000000000000000000000.0
112000000000000000000000000000000000000000000000000000.0
125000000000000000000000000000000000000000000000000000.0
140000000000000000000000000000000000000000000000000000.0
160000000000000000000000000000000000000000000000000000.0
180000000000000000000000000000000000000000000000000000.0
200000000000000000000000000000000000000000000000000000.0
224000000000000000000000000000000000000000000000000000.0
250000000000000000000000000000000000000000000000000000.0
280000000000000000000000000000000000000000000000000000.0
320000000000000000000000000000000000000000000000000000.0
360000000000000000000000000000000000000000000000000000.0
400000000000000000000000000000000000000000000000000000.0
450000000000000000000000000000000000000000000000000000.0
500000000000000000000000000000000000000000000000000000.0
560000000000000000000000000000000000000000000000000000.0
630000000000000000000000000000000000000000000000000000.0
710000000000000000000000000000000000000000000000000000.0
800000000000000000000000000000000000000000000000000000.0
900000000000000000000000000000000000000000000000000000.0
1000000000000000000000000000000000000000000000000000000.0
1120000000000000000000000000000000000000000000000000000.0
1250000000000000000000000000000000000000000000000000000.0
1400000000000000000000000000000000000000000000000000000.0
1600000000000000000000000000000000000000000000000000000.0
1800000000000000000000000000000000000000000000000000000.0
2000000000000000000000000000000000000000000000000000000.0
2240000000000000000000000000000000000000000000000000000.0
2500000000000000000000000000000000000000000000000000000.0
2800000000000000000000000000000000000000000000000000000.0
3200000000000000000000000000000000000000000000000000000.0
3600000000000000000000000000000000000000000000000000000.0
4000000000000000000000000000000000000000000000000000000.0
4500000000000000000000000000000000000000000000000000000.0
5000000000000000000000000000000000000000000000000000000.0
5600000000000000000000000000000000000000000000000000000.0
6300000000000000000000000000000000000000000000000000000.0
7100000000000000000000000000000000000000000000000000000.0
8000000000000000000000000000000000000000000000000000000.0
9000000000000000000000000000000000000000000000000000000.0
10000000000000000000000000000000000000000000000000000000.0
11200000000000000000000000000000000000000000000000000000.0
12500000000000000000000000000000000000000000000000000000.0
14000000000000000000000000000000000000000000000000000000.0
16000000000000000000000000000000000000000000000000000000.0
18000000000000000000000000000000000000000000000000000000.0
20000000000000000000000000000000000000000000000000000000.0
22400000000000000000000000000000000000000000000000000000.0
25000000000000000000000000000000000000000000000000000000.0
28000000000000000000000000000000000000000000000000000000.0
32000000000000000000000000000000000000000000000000000000.0
36000000000000000000000000000000000000000000000000000000.0
40000000000000000000000000000000000000000000000000000000.0
45000000000000000000000000000000000000000000000000000000.0
50000000000000000000000000000000000000000000000000000000.0
56000000000000000000000000000000000000000000000000000000.0
63000000000000000000000000000000000000000000000000000000.0
71000000000000000000000000000000000000000000000000000000.0
80000000000000000000000000000000000000000000000000000000.0
90000000000000000000000000000000000000000000000000000000.0
100000000000000000000000000000000000000000000000000000000.0
112000000000000000000000000000000000000000000000000000000.0
125000000000000000000000000000000000000000000000000000000.0
140000000000000000000000000000000000000000000000000000000.0
160000000000000000000000000000000000000000000000000000000.0
180000000000000000000000000000000000000000000000000000000.0
200000000000000000000000000000000000000000000000000000000.0
224000000000000000000000000000000000000000000000000000000.0
250000000000000000000000000000000000000000000000000000000.0
280000000000000000000000000000000000000000000000000000000.0
320000000000000000000000000000000000000000000000000000000.0
360000000000000000000000000000000000000000000000000000000.0
400000000000000000000000000000000000000000000000000000000.0
450000000000000000000000000000000000000000000000000000000.0
500000000000000000000000000000000000000000000000000000000.0
560000000000000000000000000000000000000000000000000000000.0
630000000000000000000000000000000000000000000000000000000.0
710000000000000000000000000000000000000000000000000000000.0
800000000000000000000000000000000000000000000000000000000.0
900000000000000000000000000000000000000000000000000000000.0
1000000000000000000000000000000000000000000000000000000000.0
1120000000000000000000000000000000000000000000000000000000.0
1250000000000000000000000000000000000000000000000000000000.0
1400000000000000000000000000000000000000000000000000000000.0
1600000000000000000000000000000000000000000000000000000000.0
1800000000000000000000000000000000000000000000000000000000.0
2000000000000000000000000000000000000000000000000000000000.0
2240000000000000000000000000000000000000000000000000000000.0
2500000000000000000000000000000000000000000000000000000000.0
2800000000000000000000000000000000000000000000000000000000.0
3200000000000000000000000000000000000000000000000000000000.0
3600000000000000000000000000000000000000000000000000000000.0
4000000000000000000000000000000000000000000000000000000000.0
4500000000000000000000000000000000000000000000000000000000.0
5000000000000000000000000000000000000000000000000000000000.0
5600000000000000000000000000000000000000000000000000000000.0
6300000000000000000000000000000000000000000000000000000000.0
7100000000000000000000000000000000000000000000000000000000.0
8000000000000000000000000000000000000000000000000000000000.0
9000000000000000000000000000000000000000000000000000000000.0
10000000000000000000000000000000000000000000000000000000000.0
11200000000000000000000000000000000000000000000000000000000.0
12500000000000000000000000000000000000000000000000000000000.0
14000000000000000000000000000000000000000000000000000000000.0
16000000000000000000000000000000000000000000000000000000000.0
18000000000000000000000000000000000000000000000000000000000.0
20000000000000000000000000000000000000000000000000000000000.0
22400000000000000000000000000000000000000000000000000000000.0
25000000000000000000000000000000000000000000000000000000000.0
28000000000000000000000000000000000000000000000000000000000.0
32000000000000000000000000000000000000000000000000000000000.0
36000000000000000000000000000000000000000000000000000000000.0
40000000000000000000000000000000000000000000000000000000000.0
45000000000000000000000000000000000000000000000000000000000.0
50000000000000000000000000000000000000000000000000000000000.0
56000000000000000000000000000000000000000000000000000000000.0
63000000000000000000000000000000000000000000000000000000000.0
71000000000000000000000000000000000000000000000000000000000.0
80000000000000000000000000000000000000000000000000000000000.0
90000000000000000000000000000000000000000000000000000000000.0
100000000000000000000000000000000000000000000000000000000000.0
112000000000000000000000000000000000000000000000000000000000.0
125000000000000000000000000000000000000000000000000000000000.0
140000000000000000000000000000000000000000000000000000000000.0
160000000000000000000000000000000000000000000000000000000000.0
180000000000000000000000000000000000000000000000000000000000.0
200000000000000000000000000000000000000000000000000000000000.0
224000000000000000000000000000000000000000000000000000000000.0
250000000000000000000000000000000000000000000000000000000000.

Teeth.—Figure 79. Upper incisor smooth on anterior surface. M^1 without cingulum on anterior border of crown and lacking accessory outer tubercle. First laminae of m^1 crescentric, cusps normal. M^2 with posterior outer tubercle, m_2 with or without accessory anterolateral tubercle.

Measurements.—Table 31. Male and female dimensions subequal. Means (and ranges) of condylonasal length (in millimeters) of nine adult males and nine adult females are 40.7 (38.5 to 46.8) and 42.1 (39.4 to 44.6), respectively.

Note that tail length in *R. rattus* is more than 100 per cent of head and body length, ear length more than one-half hind foot length, and hindfoot length less than 40 mm.

Age determination.—Adults have cusps of molars worn to laminate pattern, cranial sutures closed.

Variation.—Color phases listed above were previously given subspecific names, but all three and intermediates may occur in any one locality in Egypt (Setzer, 1952). Caslick (1956) found different color phases in the same litter in *R. rattus* in U.S.A.

Comparisons.—*Rattus rattus* differs externally from *R. norvegicus* in having head and body length averaging shorter, tail longer rather than shorter than head and body, ear more than one-half hind foot length, and hind foot actually shorter; cranially, in having the tempoparietal ridges curving outward instead of being parallel, occipital condyle not protruding rather than protruding beyond the level of the supraoccipital, and m^1 lacking a cingulum (table 32).

Both *R. rattus* and *R. norvegicus* can be distinguished from *Arvicanthis niloticus* on the basis of color, since the latter has the dorsum speckled black and yellow, whereas in *Rattus*, the dorsum is brownish. Cranially *Rattus* sp. have the postpalatal margin behind m^3, whereas in *Arvicanthis*, it is anterior to m^3. Other differences are in Table 32. Differences between *R. rattus* and *Nesokia indica* are listed under the latter.

Specimens examined.—Total 96.

SINAI: El Arish (1).

PORT SAID: Ras el Ish (5).

ISMAILIA: Ismailia (4).

SUEZ: Port Tawfik (1).

GHARBIYA: Mehalla el Kubra (1).

DAMIETTA: Shatt Gheit el Nasara (3), Kafr el Battikh (1).

KAFR EL SHEIKH: Kafr el Sheikh (1), Baltim (5), El Burg (1).

BEHEIRA: Rosetta (1), Wadi el Natroun (1), Beni Salami (1).

ALEXANDRIA: Alexandria (5).

MINUFIYA: Birket el Sabh (2).

QALYUBIYA: El Khanka (1).

GIZA: Giza (4); Giza Zoological Gardens (1); El Badrshein, El Maraziq (4); Abu Rawash (6); Abu Ghalib (1); Tanash (5); Sakkara (1).

CAIRO: Cairo (3), Abassia Fever Hospital (1), Gebel Mokattam (1), Bulaq (1), Heliopolis (1), Maadi (1).

EL FAIYUM: Seila (2), Abu Gandir (1), Qalamsha (4), Gharah (4), Kom O Shim (1).

ASYUT: Asyut (1).

QENA: Luxor, Valley of the Kings (1); Isna, Wadi Nassim (1), Dandara Temple (1), El Taramsa (1).

ASWAN: Kom Ombo (5).

MATRUH: Bahig (1).

EL WADI EL GEDEED: Kharga Oasis, Bulaq (2), Farafara Oasis, Abu Minqar (7).

Published records.—Records are from Anderson (1902), Bonhote (1910), Flower (1932), Setzer (1952, 1963), and Hoogstraal (1963).

SINAI: El Arish.

ISMAILIA: Fayid.

DAQAHLIYA: Simbillawein 8 km. W.

DAMIETTA: Shatt Gheit el Nasara, Kafr el Battikh.

KAFR EL SHEIKH: El Burg.

ALEXANDRIA: Alexandria (Alexandria harbor area, Karmouz, El Manshiya, El Atarein, El Labban, Mina el Basal); Ramleh.

BEHEIRA: Rosetta, Damanhour, Fuwa, Wadi el Natroun.

GIZA: Giza; Abu Rawash; Abu Rawash 3.2 km. W, 4.8 km. W; Tanash; Mena suburb; Sakkara; Kafr Teharmes; Talbia; Atf.

CAIRO: Cairo, Heliopolis, Bulaq, Abbasia, Maadi.

EL FAIYUM: Faiyum, Kom O Shim, Qasrel Gebali.

MINYA: El Minya.

ASYUT: Asyut, Beni Adi, El Wilidiya, El Badari.

QENA: Isna, Wadi Nassim.

ASWAN: Aswan.

MATRUH: Mersa Matruh.

Sudan. NORTHERN: Wadi Halfa.

Collection.—Dug from burrows and live-trapped. Conibear traps are effective in capturing rats that avoid live traps.

Habitats.—Commensal with man, *R. rattus* is common in houses

and buildings throughout the Nile Delta and Valley and in coastal towns. Hoogstraal (1963) mentioned finding it in desert towns along the Alexandria-Mersa Matruh railway. In the Abu Minqar area south of Farafara Oasis, *R. rattus* was trapped in houses and grain storage areas. In the Nile Valley and Delta, *R. rattus* inhabits canal banks and cultivated fields. According to Hassan and Hegazy (1968), this species prefers a drier habitat than *R. norvegicus* such as higher parts of buildings and seed and grain stores. The *frugivorous* phase or "palm rat" they wrote, is harmful to date palm trees.

Burrows.—Burrows are like those of *R. norvegicus*, shallow and with many openings, but not as close to water.

Activity.—Diurnal and nocturnal.

Captive behavior.—Like *R. norvegicus*, *R. rattus* is aggressive, difficult to handle, and bites readily.

Food.—*Rattus rattus* is known to feed on tomatoes, egg plant, and other vegetables in rural Egypt. Bonhote (1910) noted that this rat ate the fruit and seeds of the plane tree (*Ficus sycomorus*). Hassan and Hegazy (1968) reported it feeding in grain and seed stores.

Populations.—*Rattus rattus* appears to be more numerous than *R. norvegicus* (Hoogstraal, 1963).

Associates.—Although Hassan and Hegazy (1968) stated that *R. rattus* avoids the habitats of *R. norvegicus*, the two species are often collected in the same local area. Further comments are under *R. norvegicus* and *Arvicanthis niloticus*.

Sex ratio.—A museum sample of 24 contained 11 (46 per cent) males and 13 females.

Rattus norvegicus (Berkenhout, 1769)

Mus norvegicus Berkenhout 1769, Outlines Nat. Hist., Gt. Britain and Ireland, Vol 1, p. 5.

Type locality.—Great Britain.

General distribution.—Nearly cosmopolitan due to accidental transportation by man. May occur in original wild state in north-eastern Asia.

Common names.—Norway Rat, Brown Rat, Sewer Rat.

Distribution in Egypt.—Figure 83. Coastal towns, Nile Delta and Valley.

Diagnosis.—Large, stocky rat. Dorsum dark brown, venter gray. Muzzle blunt. Ear shorter than one-half hind foot length, densely haired. Tail thick, shorter than head and body length, bicolored.

Skull elongate. Tempoparietal ridges parallel, high on side of cranium, area between ridges almost flat. Zygomatic arches slender, not flaring laterally. Occipital condyle protruding beyond level of supraoccipital. Incisive foramen not reaching level of anterior root of m^1. M^1 with a cingulum on anterior border of crown.

Adult head and body length average 220 mm.; tail 196 mm., 88 per cent of head and body length; foot 43 mm.; ear 20 mm.; condylonasal length 46.8 mm.; weight 259 gm.

External characters.—Figure 81. Dorsum dark brown, side brown mixed with gray; belly hairs grayish, with white or cream tips. All hairs with gray base. Ear relatively short, densely covered with short hairs. Tail thick, relatively short, sparsely haired; bicolored, brownish above, paler or whitish below. Feet sparsely covered with whitish hairs above, palm and sole naked.

Cranial characters.—Figure 85. Nasals with posterior margin rounded or pointed, usually level with posterior margin of frontopremaxillary suture. Supraorbital ridges strongly developed, tempoparietal ridges parallel, high on side of braincase, area between ridges relatively flat. Median supraoccipital ridge prominent.

Occipital condyle protruding beyond level of supraoccipital. Zygomatic plate projecting forward slightly, sharply rounded above, wide in proportion to height. Incisive foramen seldom reaching level of anterior root of m^1.

Teeth.—Figure 79. Upper incisor smooth on anterior surface. M^1 with cingulum on anterior border of crown, sometimes with small accessory outer tubercle on first lamina; first lamina distorted by supression of outer cusp. M^2 without posterior outer tubercle, m_2 with accessory transient anterolateral tubercle.

Measurements.—Table 31. Male and female dimensions subequal. Means (and ranges) of condylonasal length (in millimeters) of four adult males and eight adult females are 47.9 (45.0 to 52.2) and 46.2 (43.2 to 50.7), respectively.

Note that tail length in *R. norvegicus* is less than 100 per cent of

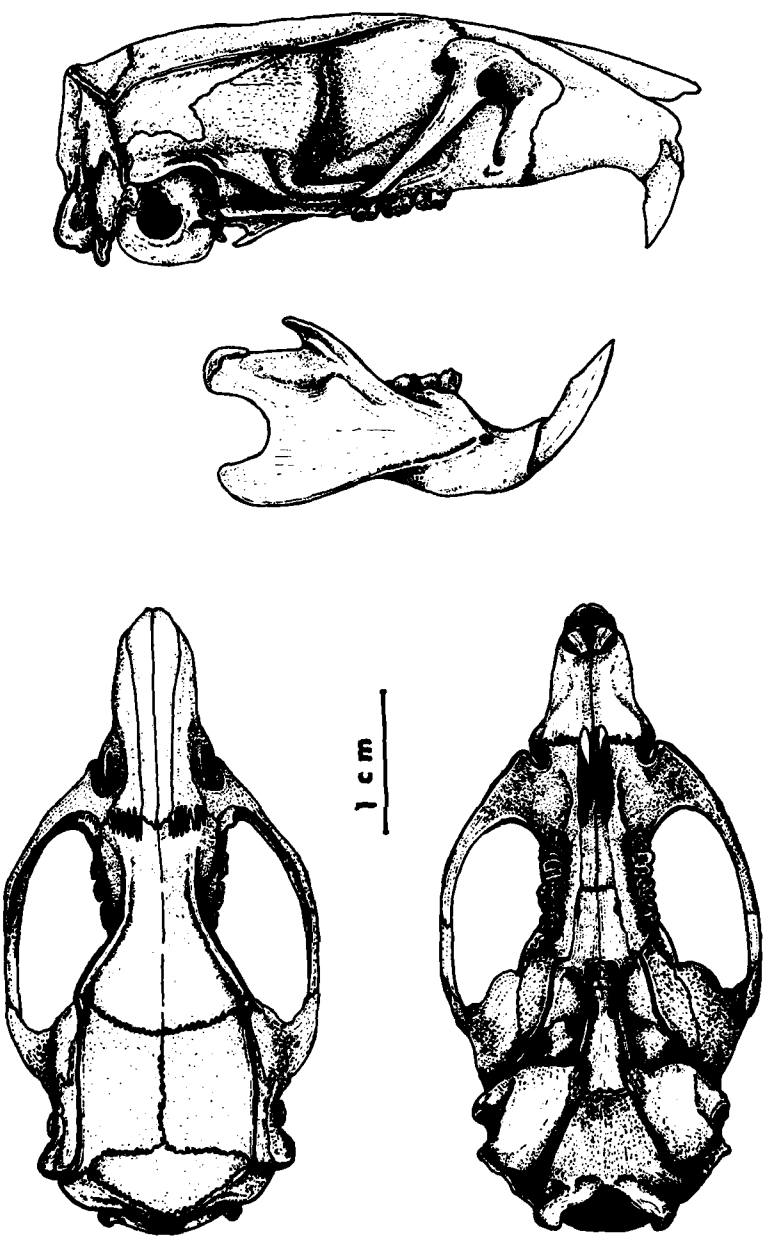


FIG. 85. Skull of *Rattus norvegicus*.

head and body length, ear length less than one-half hind foot length, and hind foot length is 40 mm. or more.

Age determination.—Adults have cusps of molars worn to laminate pattern, cranial sutures closed.

Comparisons.—*Rattus norvegicus* and *R. rattus* are compared under the latter and with *Arvicanthis* in Table 32.

Specimens examined.—Total 41.

PORT SAID: Port Said (2), El Ghamil Beach (3), Ras el Ish (1).

KAFR EL SHEIKH: Baltim (1), El Hamul (1).

ALEXANDRIA: Alexandria (6).

GIZA: Giza (1), Giza Zoological Gardens (4), Abu Rawash (12), Abu Ghalib (1), Imbaba 1.6 km. W (2).

BEHEIRA: Wadi el Natroun (1).

ASYUT: Asyut Fever Hospital (1), Beni Adi (1).

QENA: Isna (2).

SUDAN ADMINISTRATIVE: Abu Ramad (2).

Published records.—Records are from Anderson (1902), Bonhote (1910), Flower (1932), Setzer (1952, 1963), and Hoogstraal (1963).

PORT SAID: Port Said.

ISMAILIA: Ismailia.

SUEZ: Suez.

ALEXANDRIA: Alexandria (Alexandria harbor area, Mina el Basal, El Labban, Karmouz, Sharia France, Customs area, El Atarien).

BEHEIRA: Abu Hommos, Damanhour, Fuwa, Wadi el Natroun.

GIZA: Abu Rawash, Abu Ghalib, Kafr Hakim, Imbaba 1 km. W, Atf.

CAIRO: Cairo.

EL FAIYUM: Faiyum.

ASYUT: Beni Adi.

QENA: Isna.

ASWAN: Aswan.

Collection.—Dug from burrows and live-trapped. Conibear traps are effective in capturing this species.

Egyptian rat-catchers, if not cautioned, will break off the incisors to lessen the chances of being bitten or having the rats chew through a sack and escaping.

Habitats.—Commensal with man, *R. norvegicus* has been trapped in village houses and buildings in the Nile Valley and Delta and in buildings in coastal towns. In the wild state, habitat requirements

are definitely mesic. Burrows in canal banks are near water and the species has also been dug from burrows beside the sea. Hassan and Hegazy (1968) remarked that *R. norvegicus* burrowed beneath buildings because of dampness. They also found it in stables and chicken houses.

Burrows.—Burrows usually have several openings that are never closed. Burrows are commonly dug around and under buildings and near water.

Behavior.—Mainly nocturnal. *Rattus norvegicus* readily enters water and often escapes native rat-catchers by diving into canals and swimming under the surface. Captive rats are aggressive and difficult to handle without being bitten.

Food.—Diet of *R. norvegicus* appears to be more omnivorous than that of *R. rattus*. Burrows at Gamil Beach, Port Said, contained fish and a crab. Hassan and Hegazy (1968) reported that it attacked chicks, ate eggs, and killed and ate the black rat.

Populations.—Recent observers (Hoogstraal, 1963) suggest that *R. norvegicus* is not as abundant as *R. rattus*. Earlier observations (Bonhote, 1910) indicated that the former was gradually replacing the latter. Bonhote also maintained that *R. norvegicus* had driven *Arvicanthis niloticus* out of Giza Zoological Gardens.

Associates.—*Rattus norvegicus, R. rattus, Mus musculus,* and *Acomys cahirinus* are all commensal with man, but their relationships to one another in buildings are not clearly known. In nature, there is a certain amount of habitat sharing between all these species along with *A. niloticus*.

Reproduction.—The only record we have from Egypt is six fetuses from a female caught in February.

Sex ratio.—A museum sample of 20 contained seven (35 per cent) males and 13 females.

Genus **Mus** Linnaeus, 1758

Small murids with soft pelage, grayish to brownish dorsally. Tail usually slightly longer than head and body, indistinctly bicolored, annulations almost concealed by hair.

Skull fragile, rounded; rostrum short, ridges weakly developed. Interparietal ligulate in outline. Zygomatic plate with prominent masseteric tuberosity. Postpalatal margin posterior to level of m^3.

Upper incisor with prominent subapical notch. M^1 three-rooted, crown longer than m^2 and m^3 combined.

Mus musculus Linnaeus, 1758

Mus musculus Linnaeus, 1758, Syst. Nat., 10th ed., p. 62.

Type locality.—Sweden: Upsala.

General distribution.—Cosmopolitan.

Subspecies in Egypt.—

Mus musculus praetextus (Brants, 1827)

Mus praetextus Brants, 1827, Het geslacht der Muizen, p. 125.

Type locality.—Syria.

Common names.—House Mouse, *Far, Sisi.*

Distribution in Egypt.—Figure 86. Northeastern and Western Sinai Peninsula, Suez Canal area, Gulf of Suez and Red Sea Coast south to Mersa el Alem, Nile Delta and Valley, Western Mediterranean Coastal Desert, oases of the Western Desert.

Diagnosis.—Small murid with dorsum gray or brownish, venter white to buffy. Tail usually slightly longer than head and body, indistinctly bicolored.

Skull fragile, rostrum relatively short, cranium rounded, ridges weakly developed. Interparietal broad, ligulate in outline. Upper incisor with prominent subapical notch. M^1 as long as m^2 and m^3 combined.

Adult head and body length average 84 mm.; tail 84 mm., 100 per cent of head and body length; foot 19 mm.; ear 14 mm.; occipitonasal length 22.1 mm.; weight 15.0 gm.

External characters.—Pelage soft. Dorsal color varying from gray and tawny to light and dark brown. Side with or without narrow, clear tawny border. Belly white to buffy. Dorsum darker than side due to greater number of black hairs and black-tipped hairs. Dorsal and side hairs with dark gray base. Belly hairs with or without gray base. General color determined by subterminal bands of pale gray, tawny, or cinnamon on back and side. Hair of ear, suborbital spot, and postauricular patch slightly paler than color hairs. Mystacial, suborbital, and subauricular areas color of side. Tail indistinctly bicolored, brownish above, whitish below.

Setzer (1952, p. 362) recognized three main color phases in Egyp-

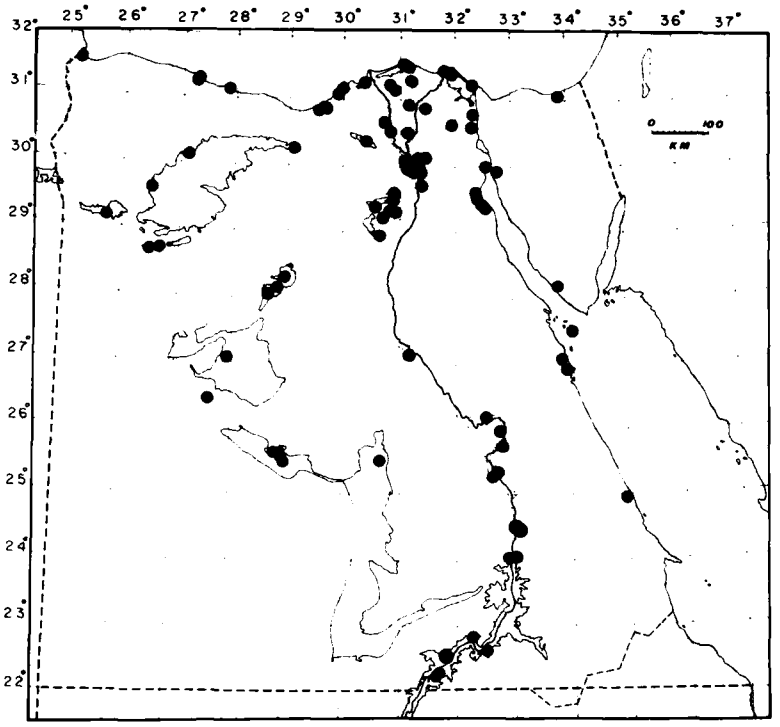


FIG. 86. Collection localities of *Mus musculus praetextus*.

tian *Mus musculus*. A fourth from Alexandria he referred to as a light phase that did not correspond to "any of the named kinds supposed to be in the area." The four color phases are listed in Table 33 with Setzer's color description (1952, p. 362) in parentheses.

Cranial characters.—Figure 87. Skull fragile. Rostrum relatively short. Braincase rounded. Supraorbital and tempoparietal suture turning abruptly downward and caudad above base of zygomatic process of squamosal; interparietal broad, ligulate in outline. Lambdoidal and median supraoccipital ridges not prominent. Posterior nasal margin truncate or bluntly rounded. Zygomatic plate small, sharply rounded above; bearing a conspicuous masseteric tuberosity on lower border. Incisive foramen long and extending to level of medial root of m^1. Palatine foramen minute. Parapterygoid fossa long, broad, and shallow. Postpalatal margin posterior to level of

TABLE 33. Color phases of *Mus musculus praetextus*.

Dorsal color/distribution	Intermixture of black	Side and flank	Belly hairs
Gray (pallid neutral gray) W. Coastal Desert	strong	pale gray	white to base; white, gray base
Tawny (light phase) Individual variant	very light	pale tawny	white to base
Light brown (cinnamon brown) Common	light	buffy to brown	white to base; white or buffy, gray base
Dark brown (mummy brown) Common	strong	buffy to brown	buffy, gray base

m^3. Tympanic bulla moderately inflated, mastoid bulla slightly inflated. Occipital condyle not protruding beyond level of supraoccipital. Mandible with well-developed coronoid and alveolar processes.

Teeth.—Figure 79. Upper incisor compressed, opisthodont, anterior surface smooth, cutting edge with prominent subapical notch cut into it by action of the lower incisor. M^1 with three roots. Crown of m^1 longer than m^2, m^3 together. First lamina of m^1 distorted by backward displacement of outer cusp. M^2 lacking additional anteriolateral cusp. M^3 with two laminae.

Measurements.—Tables 34, 35. Male and female measurements subequal. Means (and ranges) of occipitonasal length (in millimeters) of 10 adult males and 10 adult females are 21.9 (20.6 to 23.5) and 22.0 (21.1 to 22.9), respectively.

Age determination.—Adults have cusps of molars worn to laminate pattern, cranial sutures closed.

Variation.—Color phases, variation in size and in proportion of tail to head and body length are summarized in Tables 33 and 35.

Typical *Mus m. praetextus* has a light or dark brown back; white or buffy belly; belly hairs usually with gray bases; and commonly a narrow tawny border on the side. It is found in northeastern Sinai Peninsula; Suez Canal zone; Gulf of Suez and Red Sea coasts south to Mersa el Alem; Nile Delta and Valley; oases of Siwa, Qara, Bahariya, Farafara, Dakhla, and Kharga; and the area around Salum. Both dark and light phases occur in these areas. Darkest individuals are usually found in the more mesic habitats. Tawny

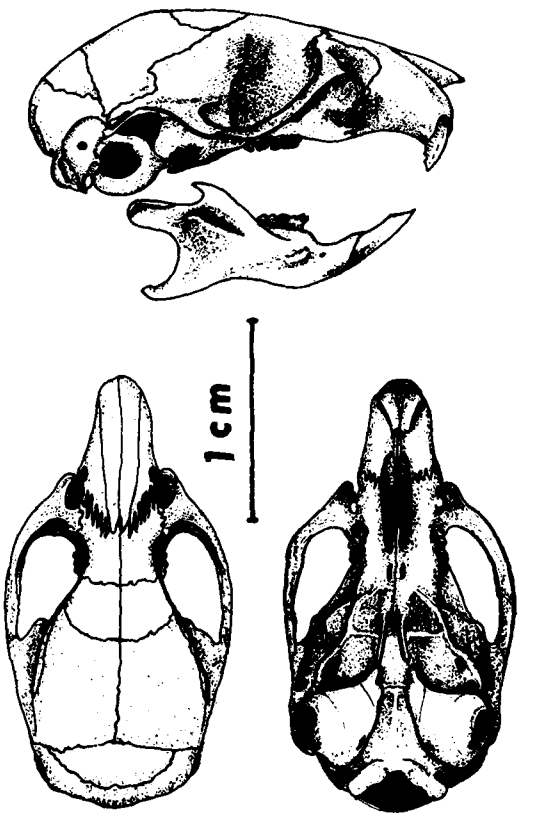


FIG. 87. Skull of *Mus musculus praetextus*.

TABLE 34. — Means (and ranges) of measurements, ratios, and weight of adult *Mus musculus praetextus*.

	Nile Delta (Feral and Commensal)	Qara (Commensal)	Bahariya Oasis (Feral and Commensal)	Bahrein (Feral)
HBL	83.7 (78-91) 10	83.1 (76-91) 8	81.8 (71-90) 9	87.5 (82-93) 7
TL	77.2 (66-85) 10	87.1 (80-95) 8	79.0 (73-89) 8	91.8 (88-95) 7
TL/HBL%	91.4 (75.8-103.7) 10	105.0 (98.9-121.7) 8	97.4 (91.4-105.6) 8	105.0 (97.7-113.4) 7
FL	18.0 (16-20) 10	19.1 (18-20) 8	18.8 (18.0-20.5) 8	19.5 (19-20) 7
EL	13.7 (13-15) 9	13.8 (13-14) 8	14.6 (14-16) 8	14.0 (13-15) 7
Wt	13.4 (9.4-20.1) 9	17.4 (11.3-20.9) 8	14.3 (10.0-19.9) 8	— —
ONL	21.6 (21.0-22.3) 11	22.1 (21.2-22.7) 9	22.0 (20.6-23.5) 8	22.8 (22.4-23.1) 4
ZW	11.2 (9.9-12.1) 9	11.6 (10.9-12.0) 8	10.6 (10.4-12.5) 8	12.4 (12.1-12.9) 6
IOW	3.4 (3.2- 3.7) 10	3.6 (3.5- 3.9) 8	3.5 (3.3- 3.8) 10	3.8 (3.6- 3.9) 7
BCW	9.8 (9.5-10.2) 10	10.0 (9.8-10.4) 8	9.9 (9.4-10.6) 10	10.2 (10.0-10.4) 6
HL	8.0 (7.9- 8.3) 8	8.2 (7.6- 8.6) 8	8.2 (7.4- 9.0) 8	8.4 (8.2- 8.5) 4
IFL	5.0 (4.8- 5.2) 10	5.2 (4.9- 5.5) 8	5.3 (4.9- 5.5) 10	4.4 (3.8- 5.6) 7
AL	3.6 (3.3- 3.8) 9	3.8 (3.7- 4.0) 8	3.7 (3.4- 4.0) 10	3.9 (3.8- 4.0) 7
RW	3.6 (3.4- 4.0) 10	3.8 (3.6- 4.0) 8	3.8 (3.3- 4.0) 9	4.0 (3.9- 4.2) 7
SH	8.0 (7.7- 8.5) 10	8.2 (8.1- 8.4) 8	8.2 (7.9- 8.8) 10	8.4 (8.2- 8.8) 7

TABLE 35. — Means (and ranges) and ratios of head and body length and tail length of *Mus musculus praetextus*.

Localities/habit/color	HBL	TL	TL/HBL%
El Arish Commensal Light brown; white bellies	79.5 (71-89) 13	79.6 (63-90) 13	100.2 (87.5-115.2) 13
Nile Delta (Baltim, Kafr el Sheikh) Feral Light and dark brown; white bellies	77.3 (55-95) 20	74.2 (59-85) 20	96.6 (82.3-107.5) 20
Abu Rawash Feral Dark brown; white and buff bellies	76.2 (69-85) 19	66.8 (53-80) 19	87.6 (72.6-95.7) 19
Upper Nile (Kom Ombo south) Feral and commensal Light and dark brown; white and buff bellies	80.2 (64-90) 22	77.4 (64-88) 22	96.6 (84.4-104.7) 22
Bahariya Oasis Feral and commensal Light brown; white bellies	73.8 (68-82) 12	76.0 (70-81) 12	103.3 (92.6-110.2) 12

TABLE 35. — *continued.*

Localities/habit/color	HBL	TL	TL/HBL%
Farafara, Dakhla Oases			
Feral			
Light brown; white bellies	81.1 (69-95) 24	76.9 (68-88) 14	95.1 (86.3-104.3) 14
Bahrein and Nuweimisa			
Feral			
Light brown; white and buff bellies	84.2 (74-93) 16	88.2 (73-97) 16	104.8 (97.7-113.4) 16
El Maghra			
Feral			
Light brown; dark buffy brown bellies	76.8 (70-84) 10	88.4 (82-95) 10	115.4 (104.7-125.7) 10
Qara			
Commensal			
Light brown; white bellies	83.1 (76-91) 8	87.1 (80-95) 8	105.0 (98.9-121.7) 8
Ras el Hekma			
Feral and commensal			
Gray and light brown; white bellies	78.4 (66-87) 21	82.0 (68-95) 19	104.4 (94.9-114.0) 19
Salum			
Feral and commensal			
Light and dark brown bellies	84.8 (69-103) 20	83.3 (69-94) 20	98.4 (87.9-113.2) 20

individuals occur occasionally in the Nile Delta. One was found on the Gulf of Suez coast.

Two populations distinct from all other *praetextus* are: (1) from the Western Mediterranean Coastal Desert (Bahig, Abu Mena, Ras el Hekma, and Mersa Matruh) and have dorsum pale gray or brown and belly white (table 33) and (2) from El Maghra with dorsum light brown and belly dark buffy brown (table 33). Two specimens from Wadi Muwellih have equally dark bellies.

In Libya, coastal populations are dark, and inland populations pale (Ranck, 1968). The reverse occurs in the Western Desert of Egypt, excepting specimens from Salum, which may represent the eastern limit of the dark coastal types mentioned by Ranck.

Adult measurements (table 34) indicate that the Nile Valley and Delta populations average slightly smaller than those from other parts of Egypt. Data on all ages (table 35) show considerable variation in tail length, but no sharp differences between samples of feral and commensal mice. In fact, samples from Egypt have no set of characters that can be considered typically commensal or feral.

Setzer (1957c) and Ranck (1968) maintained that, in Libya, *M. musculus* segregated into commensal and feral types, although not with all the distinctive features set forth by Schwarz and Schwarz (1943).

Comparison.—*Mus musculus* can be distinguished from most other Egyptian mice by small size; lack of contrasting head, side, and rump markings; tail lacking a brush (in comparison with mice other than murids); interparietal ligulate in outline; subapical notch on upper incisor; and prominent masseteric tuberosity on lower border of zygomatic plate.

Remarks.—There has no doubt been continuous transportation of house mice up and down the Nile Valley and Delta and between the Nile and the Suez Canal zone and the more accessible oases for a long period of time; the result is a rather uniform population in these areas. *Mus* was probably originally transported by camel caravans to the oases. Oases with continued contact with the Nile by modern transportation have house mouse populations most like the Nile Valley populations. In less accessible areas such as El Maghra, populations of house mice have followed the trend of natural subspeciation and, under mesic conditions, become dark. House mice of the relatively xeric coastal desert of pale soils differentiated into a lighter form.

Samples from Gulf of Suez and Red Sea coasts are too small for satisfactory analysis.

Specimens examined.—Total 392.

SINAI: El Arish (18), Ayun Musa (1), El Tor (2).

PORT SAID: El Gamil beach (5).

ISMAILIA: Ismailia (5), El Ballah (3).

SUEZ: Suez (1), Ain Sukhna (5), Wadi Abu Seyala (2), Wadi Dom (1), Wadi Abu Sanduq 4 km. S (1), Wadi Yesein (1).

RED SEA: Safaga 6.4 km. S (3), Hurghada (3), Mersa el Alem (3).

SHARQIYA: Tel Abu Ekaim near El Salhiya (1).

DAQAHLIYA: Simbillawein (1).

GHARBIYA: El Mehalla el Kubra (1).

DAMIETTA: Shatt Gheit el Nasara (2), Shatt el Mel (3), Kafr el Battikh (1).

KAFR EL SHEIKH: Baltim (22), El Burg (6), El Hamul (11), Burullus (6), Kafr el Sheikh (2), El Hamra (5), Tel Khamis (9).

BEHEIRA: Kom Hamada (1), Wadi el Natroun (9).

ALEXANDRIA: Alexandria harbor area (1).

MINUFIYA: Birket el Sabh (1).

GIZA: Abu Rawash (26); Giza (4); Giza Zoological Gardens (2); Awlad Hawra (1); Bahariya Oasis, Bawiti (4), Bir Qasr (9).

CAIRO: Abassia Fever Hospital (3), Maadi (1), Helwan (6).

EL FAIYUM: Abu Gandir (1), Ezbet Ayub Ali (1), Seila (1), Minshat Tantawi (1), Shooting Club (1), Lake Qarun SW end (1), Wadi Muwellih (2).

ASYUT: Asyut (2).

QENA: Dishna (1), Isna (1), El Deir (1).

ASWAN: Kom Ombo, El Biyara (8); Aswan (1); West Aswan (3); Aswan Dam Hospital (2); Amada Temple (1); Armina West (4); Armina Temple 10 km. NW (1); El Siboua Temple (1); Gebel Adda (2); Qustul West (1).

MATRUH: Bahig (8), 10 km. S (1); Abu Mena 3.2 km. E (4), 6.4 km. E (1); El Hammam (3); Ras el Hekma (24); Mersa Matruh (4), 10 km. E (1); El Maghra (13); Abu Dweiss (2); Siwa (4); Siwa Oasis, Abu Shuruf (1); Bahrein (16); Nuweimisa (3); Qara (10); Salum (21), 1.6 km. E (1); Bir el Qattara (3), El Zeitun (1).

EL WADI EL GEDEED: Farafara Oasis (1); Dakhla Oasis, Mut (17), 4.8 km. N (3), 5 km. N (1), 10 km. N (6); Bir el Nokta (4); Gharb el Mawhoub (3); Abu Minqar (1); Bir No. 2 (1); Kharga Oasis, El Gezira (5).

Published records.—Records are from Anderson (1902), Schwann (1905), Bonhote (1909, 1912), De Winton (1903), Flower (1932), Ellerman (1948), Hayman (1948), Setzer (1952), and Wassif (1953b, 1960b).

SINAI: El Arish, Ayun Musa.

PORT SAID: Port Said.

SUEZ: Suez.

RED SEA: Shadwan Island.
DAQAHLIYA: Simbillawein 8 km. W.
KAFR EL SHEIKH: Baltim.
ALEXANDRIA: Alexandria, Dikheila airfield 0.8 km. W.
BEHEIRA: Idku; Wadi el Natroun; Wadi el Natroun, Zaghig.
MINUFIYA: Nadir.
GIZA: Kafr Teharmes, El Kunaiyisa, Talbia, Giza Zoological Gardens.
CAIRO: Cairo, Heliopolis, Maadi.
EL FAIYUM: Faiyum.
ASWAN: Aswan
MATRUH: Siwa Oasis.
EL WADI EL GEDEED: Kharga Oasis, Kharga.
Sudan. NORTHERN: Wadi Halfa.

Collection.—Trapped alive and dug from burrows. Disturbance at one or more openings of a communal burrow can cause house mice to leave by another entrance one by one where they can be picked up by hand.

Habitats.—Throughout Egypt, *M. musculus* has been collected from houses and tents. It also inhabits grain stores and is common in gardens and fields. In nature, the habitats of *Mus* are as follows:

Gulf of Suez: Beach sand at Ain Sukhna under dense growth of *Salicornia fruticosa* and in rocky wadi mouths near the sea.

Port Said, Gamil Beach: Coarse sand with scattered *Suaeda salsa.*

Nile Delta and Nile Valley: Sand flats at El Borg near Baltim covered with *Alhagi mannifera* and *Carthamus glaucus.*

In salty waste land at El Hamra and Tel Khamis, house mouse trails ran between scattered *Suaeda pruinosa* and burrows were located under this shrub. Other halophytic Chenopodiaceae in the latter area were *Halocnemon strobilaceum* and *Arthrocnemon glaucum*, together with *Mesembryanthemum nodiflorum.* These areas of black salty silt were identical with *Psammomys obesus* habitat in the western part of the Delta near Hafs, but no mammals other than *Mus* were collected.

Near Abu Rawash, house mice were dug from burrows in grassy hummocks in a meadow.

Bauer (1963) collected *Mus* from canal banks and beside the Nile in Upper Egypt.

Western Mediterranean Coastal Desert: Palm and olive groves, edges of barley fields in *Anabasis articulata* (fig. 8) in vicinities of

Bahig and Abu Mena, respectively. On Ras el Hekma, *Mus* was collected at cliff bases and in sand dunes near the sea, and in rocky terrain and salt marshes.

Near Salum at Bir Qattara, house mice were taken under dense vegetation and among rocks at a cliff base spring near the sea.

Western Desert Oases: *Mus musculus* and no other rodent, with the exception of *Arvicanthus niloticus* from Maghra, inhabits the palm-reed-rush (*Phoenix-Phragmites-Juncus*) community of salt-encrusted lake shores and salty sand (fig. 22). In Farafara Oasis, *Mus* was also trapped beneath wild date palms in dry, windblown sand. One specimen was dug from a shallow burrow under a carton in dry sand south of the coastal vegetation. The area had been a Pan American Oil Company campsite two weeks previously.

In Libya, Ranck (1968) reported *Mus* from elevated patches of *Phragmites* in areas of open water; sedges and other mesophytic plants encircling saline lakes; and mesic pockets in the coastal escarpment.

Happold (1967bd) found *Mus* in houses and stores in Khartoum in winter months. It was not found in villages away from the Nile Valley

Behavior.—Communal. Nocturnal in nature, but commensal individuals appear to be less so. Although easily handled, *Mus* bites readily.

Burrows.—Shallow, usually under shrubs or in grass or rush-covered hummocks. Several short tunnels lead to a large nest chamber.

Associates.—*Mus* shares habitats with nearly every other Egyptian rodent except those confined to dry, barren desert. Relationships between species are not known, although evidence from collections from houses and buildings in the Nile Valley and Delta indicates that *Acomys cahirinus* becomes the dominant species, forcing *Mus* to be feral (see commensalism notes under *A. cahirinus*).

Food.—Various crop plants and stored agricultural products are eaten by *Mus*. Presence of house mice in *sebakhas* in the Western Desert was discovered from cuttings of *Juncus* sp. Habitat data indicate that *Mus*, like *Psammomys obesus*, can survive on halophytic Chenopodiaceae.

Reproduction.—No evidence of a breeding season. Gravid females and young in nests were found the year around. Average and range of embryos and fetuses from six females were six (three to seven). Communal nests contained 10, 18, and 19 young.

Sex ratio.—In a sample of 59 museum specimens of *Mus musculus*, males numbered 26 (44 per cent) and females 33.

Economic importance.—Hassan and Hegazy (1968) mentioned that *Mus* ate and lived in grain stores.

Genus Acomys I. Geoffroy St. Hilaire, 1838

Small- to medium-size murids with prominent pigmented ears. Dorsal pelage spinous. Spines V-shaped in cross section. Tail with broad conspicuous annulations alternating with bristles. Skull strongly built; braincase broad, conspicuously convex dorsally. Supraorbital and tempoparietal ridges well developed, the latter low on the braincase and curving outward. Median supraoccipital ridge prominent. Interparietal very large, semicircular. Tempoparietal suture following cranial ridge. Posterior nasal margin divided. Zygomatic plate relatively large, gradually rounded above, masseteric tuberosity on lower border inconspicuous. Incisive foramen long and extending to level of medial root of m^1. Palatine foramen minute. Parapterygoid fossa very long, broad, and shallow. Palatines forming a shelf closing the mesopterygoid fossa to the level of or anterior to the level of the basisphenoid-presphenoid suture. Tympanic bulla moderately inflated, mastoid ossified. Occipital condyle not protruding beyond level of supraoccipital. Mandible with very small coronoid and alveolar processes.

Upper incisor compressed, opisthodont, anterior surface smooth, cutting edge normal. M^1 three-rooted; crown not longer than m^2, m^3 together. First lamina of m^1 somewhat distorted backward as in *Mus*. M^2 with an additional but transient anterolateral cusp as in *Rattus rattus*. M^3 with two laminae as in *Mus*.

KEY TO EGYPTIAN SPECIES OF *Acomys*

1. Dorsal color reddish; palm, sole, and tail black. Tail shorter than head and body. Palate without a median keel. Apex of mesopterygoid shelf anterior to basisphenoid-presphenoid suture ..... *russatus*, p. 286.
2. Dorsal color brownish, blackish, or slate, not reddish. Palm, sole, and tail not black. Tail usually longer than head and body. Palate with a median keel. Apex of mesopterygoid shelf at level of basisphenoid-presphenoid suture. ..... *cahirinus*, p. 293.

Acomys russatus (Wagner, 1840)

Mus russatus Wagner, 1840, Abh. Bayer Akad. Wiss. Math.-Naturwiss. Kl., 3, pl. 3, fig. 2, p. 195.

Type locality.—Egypt. SINAI: probably Nohel.

General distribution.—Saudi Arabia, Israel, Sinai Peninsula, Egypt.

Common name.—Golden Spiny Mouse.

Distribution of subspecies in Egypt.—Figure 88. *Acomys russatus russatus:* southern part of Sinai Peninsula; *Acomys russatus aegyptiacus:* northern part of Eastern Desert of Egypt.

Diagnosis.—Dorsum reddish orange; venter pale yellowish white; palm, sole, ear, and tail black. Spinous pelage on head, back, side, and rump. Tail shorter than head and body, not bicolored; annulations fairly conspicuous, alternating with white bristles.

Skull with apex of mesopterygoid shelf anterior to level of basisphenoid-presphenoid suture. Palate without median keel. Zygomatic arch noticeably thickened anteriorly.

Adult head and body length average 111 mm.; tail 70 mm., 62 per cent of head and body length; hind foot 20 mm.; ear 19 mm.; occipitonasal length 28.9 mm.; weight 36.0 gm.

External characters.—Figure 89. Pelage spiny on head, back, side, and rump. Dorsal color reddish to reddish orange. Side and rump yellowish to yellowish brown. Belly and underparts whitish to yellowish, darkened by the grayish bases of the hairs. All dorsal hairs and spines with a minute black tip, broad orangish to yellowish subterminal band, and pale gray base. Legs grayish. Palms, soles, ear, and tail black. Tail not bicolored.

Ear covered with white and buffy hairs. Mystacial area dark due to white hairs not quite concealing the black skin. Pre- and suborbital region color of side. Suborbital spot small, white, and conspicuous. Ear with white basal and posterior patches.

Baculum.—Baculum terminates in a completely ossified trifid, lateral ossicles equal in size with medial (Atallah, 1967).

Cranial characters.—See Figure 91 of *Acomys cahirinus* skull and

Opposite:

FIG. 88. Collection localities of *Acomys russatus russatus* (circles) and *A. r. aegyptiacus* (dots).

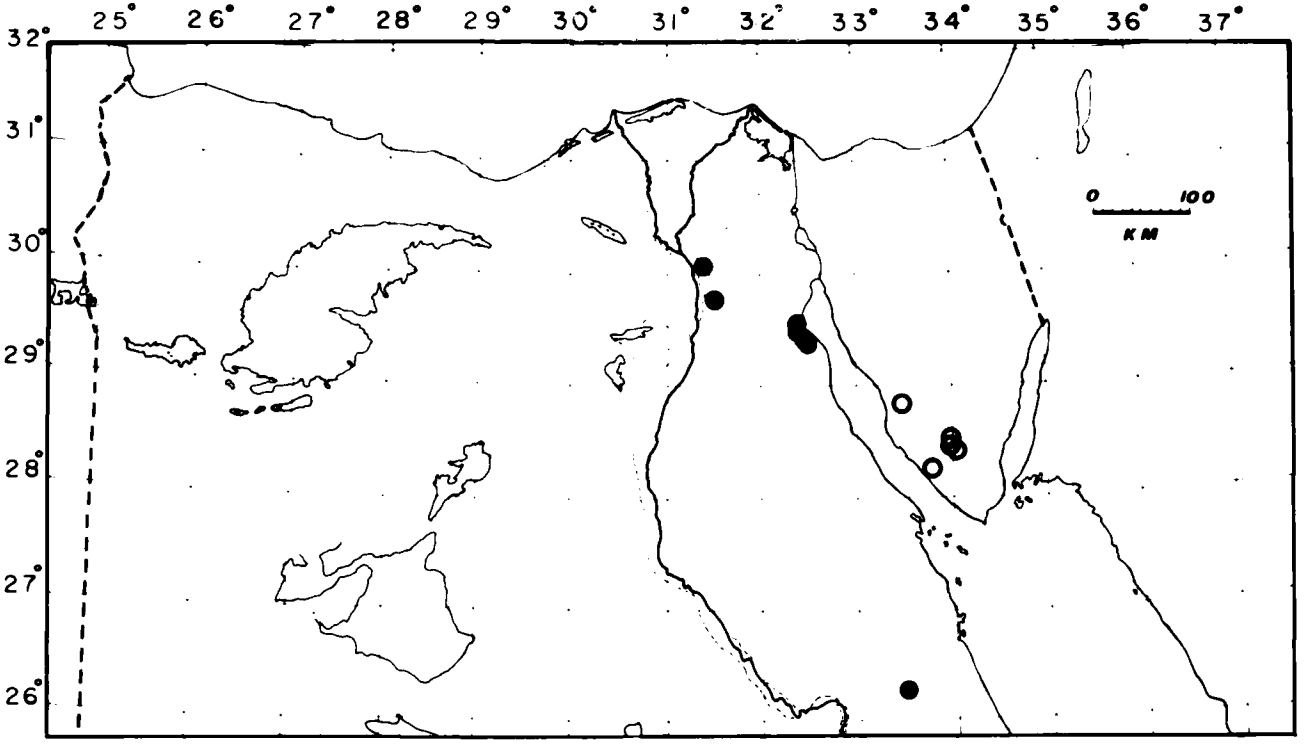

25°
26°
27°
28°
29°
30°
31°
32°
33°
34°
35°
36°
37°
32°
31°
30°
29°
28°
27°
26°
0
100
KM

FIG. 89. *Live specimen of Acomys russatus.*

description under genus. Braincase broad; interparietal very large, semicircular; supraorbital and parietal ridges well developed, the latter curving outward. Apex of mesopterygoid shelf anterior to level of basisphenoid-presphenoid suture. Palate lacking a median keel. Zygomatic arch noticeably thickened anteriorly, compared with *A. cahirinus*.

Teeth.—Molars are identical to *A. cahirinus*. Upper incisor opisthodont, with anterior surface smooth.

Measurements.—Table 36. Tail shorter than head and body length. Male and female dimensions equal.

Age determination.—Adult specimens have well-developed cranial ridges, basioccipital-basisphenoid suture closed, and molar cusps showing some amount of wear.

Comparisons.—*Acomys russatus* and *A. cahirinus* differ from all other Egyptian rodents in having spiny dorsal pelage. *Acomys russatus* differs from *A. cahirinus* in having dorsal color reddish, rather than blackish, slate, or brownish; tail much shorter than head

TABLE 36. — Means (and ranges) of measurements, ratios, and weight of adult *Acomys russatus*.

	Sinai Peninsula *A. r. russatus*	Eastern Desert *A. r. aegyptiacus*
HBL	113.0 (106-122) 15	109.2 (90-117) 6
TL	74.8 (68-81) 8	64.4 (56-75) 5
TL/HBL%	67.0 (60.5-76.4) 8	58.9 (50.0-70.5) 5
FL	20.4 (20-22) 16	19.2 (19-20) 6
EL	20.3 (19-22) 16	19.3 (16-20) 6
Wt	— —	37.0 (24.0-53.2) 3
ONL	28.7 (27.6-31.1) 11	29.2 (27.8-31.1) 5
ZW	14.3 (13.9-14.8) 14	14.4 (13.9-14.8) 4
IOW	4.5 (4.3- 4.9) 18	4.6 (4.4- 4.9) 5
BCW	13.1 (12.4-13.7) 17	13.1 (12.4-13.6) 4
NL	11.2 (10.0-12.0) 11	11.5 (11.0-12.0) 5
IFL	6.2 (6.4- 7.4) 18	6.9 (6.6- 7.4) 4
AL	5.0 (4.8- 5.2) 18	5.2 (5.0- 5.2) 5
SH	10.4 (9.9-10.9) 16	10.4 (9.9-10.9) 4

and body length (tables 36, 37); palate without a median keel; apex of mesopterygoid shelf anterior to basisphenoid-presphenoid suture; and zygomatic arch thickened anteriorly.

Collection.—Golden spiny mice will enter live traps. None have been dug from burrows.

Habitats.—*Acomys russatus* is known only from rocky hillsides, cliffs, and boulder-strewn canyons.

Behavior.—This species has been seen active during morning and afternoon in southern Sinai (Wassif and Hoogstraal, 1953). In some areas where it shares the habitat with *A. cahirinus*, it is diurnal.

Acomys russatus, like other spiny mice, is agile and difficult to handle, but not as aggressive as *A. cahirinus*.

Commensalism.—We do not know if *A. russatus* enters buildings.

Associates.—In rocky habitat in the Sinai Peninsula, *A. russatus* is found in the same habitat as *A. cahirinus*, *Dipodillus dasyurus*, *Sekeetamys calurus*, and *Eliomys quercinus*. In the Eastern Desert, it occurs with the same species except for *E. quercinus*.

Populations.—*Acomys russatus* is rare in nature and in museum collections compared with *A. cahirinus*. It also appears to be discontinuously distributed, whereas *A. cahirinus* shows continuous distribution, at least in mountainous areas, in the Eastern Desert.

Reproduction.—The only records from Egypt are two young born in May and three fetuses collected in June.

TABLE 37. — Means (and ranges) of measurements, ratios, and weight of adult *Acomys cahirinus*.

	Sinai Peninsula *A. c. dimidiatus*	North Galala Plateau *A. c. megalodus*	South Galala Plateau, Northern Red Sea Mts. *A. c. hunteri*	Southern Eastern Desert *A. c. hunteri*
HBL	113.0 (93-125) 31	119.4 (95-138) 50	113.5 (105-122) 12	107.7 (93-122) 90
TL	108.0 (85-123) 20	114.3 (101-134) 38	124.2 (119-135) 8	116.0 (97-138) 78
TL/HBL%	97.9 (86.0-113.6) 20	98.7 (95.2-118.1) 38	110.3 (98.4-120.5) 8	108.5 (86.6-139.4) 76
FL	21.0 (20.5-22.0) 31	21.2 (19-23) 50	20.5 (20-22) 13	19.8 (18.0-21.5) 91
EL	24.2 (21-28) 30	22.5 (19-31) 50	22.5 (21-24) 13	20.6 (18-23) 91
Wt	— —	47.3 (34.3-64.0) 23	35.6 (30.0-40.8) 7	36.4 (20.9-50.4) 53
ONL	31.2 (27.5-33.0) 41	32.9 (28.4-36.9) 44	31.2 (29.9-33.3) 9	29.4 (26.6-33.9) 76
ZW	15.1 (13.4-16.0) 27	15.7 (14.2-17.4) 35	14.4 (13.5-15.2) 8	14.0 (12.8-15.7) 52
IOW	4.8 (4.5- 5.0) 32	4.9 (4.5- 5.2) 41	4.6 (4.3- 4.9) 11	4.0 (4.1- 5.2) 80
BCW	13.0 (12.6-13.8) 32	13.2 (12.3-14.2) 42	12.8 (12.4-13.4) 11	12.5 (11.6-13.5) 78
NL	12.3 (10.4-13.9) 29	13.2 (11.1-14.8) 39	12.2 (11.4-13.9) 8	11.4 (10.1-13.6) 73
IFL	7.0 (6.1- 7.6) 32	7.9 (6.8- 8.6) 40	7.4 (7.0- 8.0) 10	7.0 (6.2- 8.1) 82
AL	4.5 (4.2- 4.8) 32	5.1 (4.4- 5.6) 40	4.7 (4.4- 5.2) 10	4.5 (4.1- 5.4) 81
SH	10.6 (9.6-11.8) 32	10.7 (9.8-11.5) 41	10.4 (9.8-11.2) 11	10.0 (9.1-10.9) 76
RW	4.4 (4.3- 4.6) 9	4.7 (4.2- 5.2) 27	4.3 (3.9- 4.8) 11	4.1 (3.7- 4.5) 34

TABLE 37. — *continued.*

	Nile Valley and Delta	Bahariya Oasis	Farafara and Dakhla Oases	Gebel Uweinat
	A. c. cahirinus	*A. c. cahirinus*	*A. c. helmyi ssp. nov.*	*A. c. viator*
HBL	111.3 (100-120) 34	98.5 (75-126) 10	118.0 (102-131) 18	89.5 (87-93) 8
TL	102.0 (92-137) 30	106.3 (87-132) 8	113.4 (102-129) 18	103.6 (88-118) 7
TL/HBL%	102.0 (75.4-124.5) 27	106.9 (87.5-133.3) 8	96.1 (85.5-120.6) 18	115.4 (98.9-132.6) 7
FL	19.9 (18-21) 35	20.9 (20-23) 10	20.8 (20-22) 19	18.9 (18-20) 8
EL	20.8 (18-24) 35	18.6 (15-22) 10	21.2 (19-24) 19	19.7 (19-21) 8
Wt	40.8 (29.9-51.5) 20	——	48.0 (28-63) 19	——
ONL	29.6 (27.6-31.4) 34	28.6 (26.7-30.2) 11	31.0 (29.8-32.6) 14	——
ZW	14.2 (13.2-15.2) 28	13.8 (13.0-14.6) 10	15.7 (14.3-17.2) 13	——
IOW	4.5 (4.4- 4.8) 35	4.7 (4.2- 5.0) 12	4.9 (4.7- 5.2) 15	——
BCW	12.5 (11.5-13.4) 36	12.4 (11.5-13.2) 12	12.8 (12.1-13.6) 16	——
NL	11.3 (10.1-13.0) 33	10.5 (9.5-11.6) 11	11.9 (11.2-12.4) 14	——
IFL	6.9 (6.0- 7.8) 35	6.4 (5.9- 7.2) 12	7.1 (6.6- 7.6) 15	——
AL	4.4 (3.8- 4.9) 34	4.5 (4.2- 4.8) 12	4.8 (4.6- 5.2) 15	——
SH	10.0 (9.4-10.9) 35	9.9 (9.0-11.2) 12	10.2 (9.8-11.1) 15	——
RW	4.2 (3.8- 4.6) 22	——	4.4 (3.9- 4.8) 15	——

Sex ratio.—In a museum sample of 31, there were 12 (38 per cent) males and 19 females.

Remarks.—Shkolnik and Borut (1969) showed that *A. russatus* was better adapted for a diurnal existence than *A. cahirinus* because of its ability to withstand much higher ambient temperatures, to utilize salty water, and to extract water from halophytic plants. *Acomys cahirinus*, however, can withstand much colder situations which accounts for its existing at much higher elevations than *A. russatus*.

Spiny mice were found to possess a "kidney with an outstandingly efficient mechanism for urine concentration" (Shkolnik and Borut, 1969, p. 254). Both species were thought to obtain additional water by eating desert snails, and *A. russatus* was often observed eating *Atriplex halimus*, *Hammada scoparia*, and *Anabasis articulata*.

See further notes on food under *A. cahirinus*.

KEY TO EGYPTIAN SUBSPECIES OF *Acomys russatus*

1. Dorsum dark reddish orange. Tail average 20 per cent longer. Hind foot slightly longer. (Southern part of Sinai Peninsula)..... *russatus*, p. 292.
2. Dorsum pale reddish orange. Tail average 20 per cent shorter. Hind foot slightly shorter. (Northern part of Eastern Desert)..... *aegyptiacus*, p. 293.

Acomys russatus russatus (Wagner, 1840)

Type locality.—Egypt. SINAI.

Distribution in Egypt.—Figure 88. Southern part of Sinai Peninsula.

External characters.—See species description. *Acomys r. russatus* is slightly darker or more reddish than *A. r. aegyptiacus*.

Cranial characters.—See species description. There are no cranial differences between the Egyptian subspecies of *A. russatus*.

Measurements.—Table 36. Tail length is about 20 per cent, and hind foot length slightly longer in *A. r. russatus* than in *A. r. aegyptiacus*.

Specimens examined.—Total 21.

SINAI: Wadi el Sheikh (9), St. Catherine Monastery area (6), Wadi el Arbaein (1), Feiran Oasis (2), Tor (3).

Published records.—Records are from Flower (1932), Wassif and Hoogstraal (1953), and Setzer (1959c).

SINAI: Feiran Oasis, St. Catherine Monastery area, and inland from Tor.

Acomys russatus aegyptiacus Bonhote, 1912

Acomys russatus aegyptiacus Bonhote, 1912, Abstr. Proc. Zool. Soc., London, No. 103, p. 3; Proc. Zool. Soc., London, p. 230.

Type locality.—Egypt. CAIRO: Helwan, Wadi Hof.

Distribution in Egypt.—Figure 88. Northern part of Eastern Desert.

External characters.—See species description. *Acomys r. aegyptiacus* is slightly paler or more orangish than *A. r. russatus.*

Cranial characters.—See species description.

Measurements.—Table 36. Differences in dimensions of the two subspecies, *aegyptiacus* and *russatus*, are discussed under the latter.

Remarks.—Differences between the subspecies are very slight, and further sampling may indicate that no real differences exist.

Specimens examined.—Total 15.

SUEZ: Wadi Abu Seyala (2), Bir Abu Seyala (1), Wadi Qiseib (6), Bir Qiseib (3).
CAIRO: Gebel Mokattam (1), Wadi Hof (Type).
RED SEA: Wadi Atalla mouth (1).

Published records.—Records are from Bonhote (1909, 1912) and Setzer (1959e).

CAIRO: Gebel Mokattam, Wadi Hof.
SUEZ: Wadi Sayal (Wadi Abu Seyala).

Acomys cahirinus (Desmarest, 1819)

Mus cahirinus Desmarest, 1819, Nouveau Dictionnaire Hist. Nat., V[illegible]. p. 70.

Type locality.—Egypt. CAIRO: Probably [illegible].

Common names.—Egyptian Spiny Mouse, *Abu Shoaka.*

General distribution.—Western Sind, southern Iran, southern Asia Minor, Arabian Peninsula, Jordan, Israel, islands of Cyprus and Crete, Sinai Peninsula, Egypt, Libya, Mauritania, Morocco; Sudan south through Ethiopia, Somalia, Kenya, and Tanzania to Rhodesia; and west to Nigeria and southern Algeria.

Distribution of subspecies in Egypt.—Figure 90. *Acomys cahirinus cahirinus:* Nile Delta and Nile Valley south to Aswan, Suez Canal area, Bahariya Oasis; *Acomys cahirinus dimidiatus:*

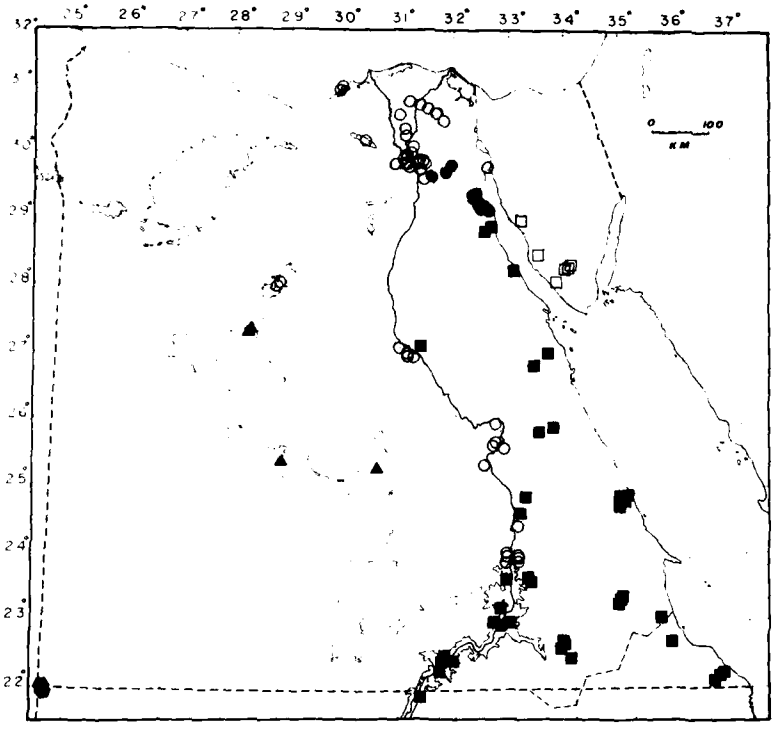


FIG. 90. Collection localities of *Acomys cahirinus cahirinus* (circles), *A. c. megalodus* (dots), *A. c. dimidiatus* (open squares), *A. c. hunteri* (solid squares), *A. c. helmyi* (triangles), and *A. c. viator* (hexagons).

southern part of Sinai Peninsula; *Acomys cahirinus megalodus:* northern part of Eastern Desert south to Wadi Araba; *Acomys cahirinus hunteri:* Eastern Desert south of Wadi Araba, Nile Valley south of Aswan; *Acomys cahirinus helmyi:* Farafara, Dakhla, and Kharga Oases; *Acomys cahirinus viator:* Gebel Uweinat and possibly Gilf el Kebir.

Diagnosis.— Color ranging from brownish cinnamon dorsally, with white belly and feet, to overall slate with white toes. Spinous pelage extends from behind shoulders onto rump. Tail usually longer than head and body length, bicolored or not, annulations broad, alternating with whitish or brownish bristles.

Skull with apex of mesopterygoid shelf at level of basisphenoid-presphenoid suture. Palate with median keel. Zygomatic arch unmodified.

Adult head and body length average 108 mm.; tail 109 mm., 104 per cent of head and body length; foot 20 mm.; ear 21 mm.; occipitonasal length 30.1 mm.; weight 41.6 gm.

External characters.—Pelage spiny from behind shoulder onto rump, but not on side. Color of Nile Valley and Delta populations: overall slate with white feet; no suborbital, sub- or postauricular markings; tail not bicolored. Color of desert populations: dorsum pale to dark brownish; side, rump, and limbs pale to dark cinnamon; belly, underparts, and feet white. Dorsal hairs and spines with black tip, cinnamon subterminal band, and pale gray base in shoulder region; white base in lumbar and sacral region. Width of tip, subterminal, and basal color bands variable. Ear pigmented, covered with whitish hairs. Tail bicolored, brownish above, whitish below. Mystacial area partly pigmented. Pre- and suborbital region color of side. Suborbital spot small, white, and conspicuous. Ear with white basal and posterior patches.

Baculum.—Baculum terminates in a trifid, with middle ossicle ossified, lateral ossicles small and cartilaginous (Atallah, 1967).

Cranial characters.—Figure 91. See description under genus. Braincase broad; interparietal very large, semicircular; supraorbital and parietal ridges well developed, the latter curving outward. Apex of the mesopterygoid shelf at level of the basisphenoid-presphenoid suture. Palate with a median keel. Zygomatic arch not thickened anteriorly, compared with *A. russatus*.

Teeth.—Upper incisor opisthodont, with anterior surface smooth. M^1 not longer than m^2, m^3 together; m^2 with transient anterolateral cusp; m^3 with two laminae.

Measurements.—Table 37. Tail usually as long as head and body length. Male and female dimensions subequal, as noted by Setzer (1959e).

Age determination.—Adult specimens have well-developed cranial ridges, basioccipital-basisphenoid suture closed, teeth with cusps showing some amount of wear.

Variation.—The main color differences between melanistic commensal subspecies *cahirinus* and other Egyptian subspecies have been dealt with. *Acomys c. dimidiatus* from Sinai Peninsula is the palest of desert subspecies; *megalodus* of the North Galala Plateau is slightly darker, and pigmentation increases through the southern

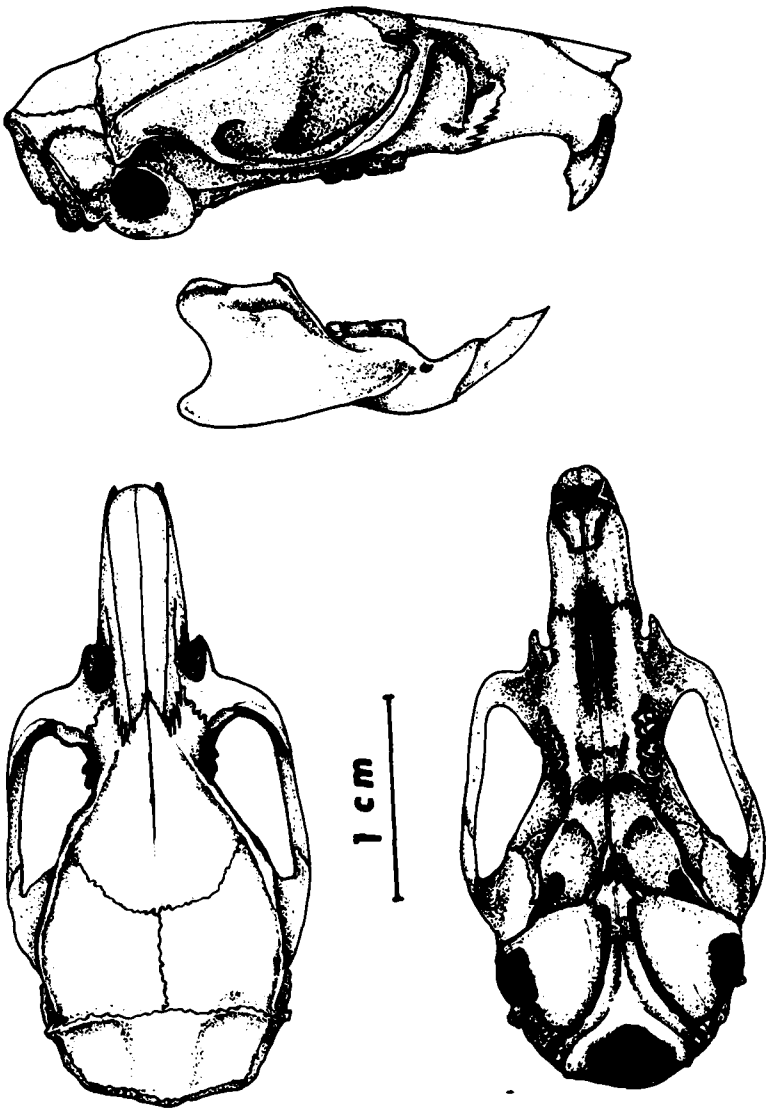


FIG. 91. Skull of *Acomys cahirinus*.

part of the range of this subspecies into *hunteri*. Samples from Gebel Mokattam near Cairo and cliffs near Helwan show intergradation in color with *cahirinus* and are comparable in dimensions. Southward along the Nile Valley, intergradation between *cahirinus* and *hunteri* has been observed.

In a sample of *hunteri* from Fawakhir mine area, those from buildings approach *cahirinus* in having side and belly grayish. Specimens from surrounding hills became more similar to typical *hunteri* the further they were trapped from dwellings.

Color of *cahirinus* specimens from houses in Bahariya Oasis ranges from overall slate with white feet of typical commensal, to blackish brown dorsally, side brownish or grayish, belly grayish to white; similar to a sample of *cahirinus* from Gebel el Ghigiga in the Cairo area. Specimens from houses in Kharga and Dakhla Oases are slate color dorsally, pale on the underside, and are probably commensals of *A. c. helmyi*. Samples of *helmyi* from isolated areas in Farafara Oasis are about as pale dorsally as *megalodus*.

Acomys c. viator from Gebel Uweinat is about the same color as *hunteri*.

Dimensions vary considerably in *A. cahirinus* (table 37). Specimens with the largest dimensions are of subspecies *megalodus* from Gebel Katamiya in the northern Eastern Desert. In general, size diminishes east from there into *dimidiatus*, west into *cahirinus*, and south into *hunteri*. Another subspecies of large dimensions is *helmyi* from Farafara Oasis. *Acomys c. viator* specimens from Gebel Uweinat are representative of a race with smaller dimensions than Egyptian subspecies.

Comparisons.—*Acomys cahirinus* and *A. russatus* differ from all other Egyptian rodents in having spiny dorsal pelage. Comparison between these two species is under the latter.

Remarks.—Setzer (1959) retained *A. cahirinus* as a monotypic species and referred the other named Egyptian forms to *A. dimidiatus*. He argued that *cahirinus* differed from *dimidiatus* in that the majority were either partly or totally melanistic, had smaller dimensions, especially the nasal length, braincase more flattened, foramen magnum more rounded and extending further dorsally, upper incisor more nearly vertical, and pterygoid fossa longer and broader.

Melanism is prominent in *cahirinus*, but intergradation occurs

between Nile Valley and desert forms, as has also been noted by Bauer (1963). With regard to measurements, data in Table 37 indicate considerable geographical variation in dimensions in *A. cahirinus* in Egypt. *Acomys c. cahirinus* appears to be significantly smaller than *megalodus*, but there are gradations in dimensions between all populations of this species.

Atallah (1967), following Setzer (1959), recognized *A. cahirinus* and *A. dimidiatus* as distinct species and listed nasal length and cranial conformation as the discriminating characters. Incidentally, nasal length according to Setzer, is the median length. In Table 37, it is the greatest length of the nasals (NL).

Skull height (SH) in Table 37 gives no indication of any disproportionately flattened or rounded braincase. Shape of the foramen magnum does not show any consistant variations in shape. When compared by camera lucida drawings, upper incisors show no differences in curvature. Neither could any differences be discerned in the parapterygoid fossae. Thus, we are convinced that a single species, *A. cahirinus*, occurs in Egypt.

Happold (1969) concluded that *A. cahirinus cineraceus* was the only subspecies in gebels north of Khartoum and probably *A. cahirinus* was the only species occurring in that region. Intergradation between subspecies *hunteri* and *cineraceus* has not been demonstrated.

Collection.—Spiny mice readily enter live traps and occasionally are dug from burrows.

Habitats.—In the Nile Delta and Valley, the melanistic *A. c. cahirinus* is considered to be almost completely commensal (Setzer, 1959e), because it is the commonest mouse in buildings and houses. Some have been taken in gardens, date groves, and rocky hills and cliffs bordering the Nile Delta and Valley. The subspecies is numerous in tombs and temples where, incidentally, melanism tends to become diluted.

Desert subspecies usually inhabit rocky hillsides, cliffs, and boulder-strewn canyons (fig. 16), but they may also be found living commensally in settlements and native huts (Hoogstraal et al., 1957). Concentrations of spiny mice occur in the vicinity of date palms in the Eastern and Western Deserts.

Altitude appears to have no effect on distribution as long as food is available (Hoogstraal et al., 1957b).

Burrows.—Spiny mice were reported from burrows in sand in the southeastern part of Egypt (Hoogstraal et al., 1957b). One was dug from a simple burrow about 0.5 m. in length in a hard gravel terrace in Wadi Araba.

Behavior.—This species has been seen active at all hours of the day, but mostly in early morning and late afternoor (Hoogstraal et al., 1957b).

Spiny mice are extremely agile, difficult to handle, and bite readily.

Economic importance.—The fact that *A. cahirinus* lives in close association with man leads one to assume that it feeds on crops and food stores. The possibility of *Acomys* as a reservoir for communicable arthropod-borne diseases has been considered, and samples from Wadis in the Gulf of Suez area were tested for typhus group antibodies. Results did not show clearly the presence of either epidemic or murine typhus (Hoogstraal et al., 1967b).

Diabetes mellitus has been described from *A. c. dimidiatus*, and *A. c. cahirinus* is under investigation (Strasser, 1968; Strasser and Brunk, 1968; Brunk and Strasser, 1969). A review of the literature is given by Strasser (1968).

Food.—*Acomys cahirinus* utilizes a variety of plants and seeds for food. Dates are a staple diet in some areas. Those living in barren cliffs lacking plants probably forage for windblown plant remains trapped in crevices. We are quite certain that undigested organic matter in human feces supplements the diet of *A. cahirinus* in the vicinity of Egyptian Frontier Corps camps and houses along the Gulf of Suez coast of Egypt.

The dried flesh and bone marrow of mummified humans is a source of food for *A. cahirinus* in the tombs of Gebel Drunka southwest of Asyut. In tombs of west Aswan, Maser (1966) observed *A. cahirinus* scavenging the feces of fruit bats (*Roussettus a. aegyptiacus*). Apparently, the spiny mice living in these tombs do not forage outside for food, since we and Maser noted the lack of *Acomys* traffic in and out of the tombs. We noted also that the mice were active during the day in the tombs. Maser found only spiders in the stomachs of *A. cahirinus* collected from barren sandstone hills beside the Nile River in Egyptian Nubia (unpublished field notes of Christopher O. Maser).

Another interesting find was mice with stomachs filled with green

algae, the only plant food available in the spring of 1965, which appeared along the shores of Lake Nasser following a rising and lowering of the water level (Dr. C. A. Reed, personal communication).

We have tested the proclivity of *A. cahirinus* for insects such as crickets, locusts, butterflies, and moths. Locust legs and wings are often found in rock crevices inhabited by *A. cahirinus* in the Eastern Desert. Captive *A. cahirinus* in Oman (Harrison, 1972) ate berries, biscuits, lizards, any large insects, camel spiders, and scorpions.

The eating of desert snails by *A. cahirinus* was reported by Flower (1932), Bodenheimer (1935), Cloudsley-Thompson and Chadwick (1964), and Shkolnik and Borut (1969). Middens of shells of *Eremica desertorum* are a common feature in canyons of the limestone plateaus east of Cairo. Unlike jerboas and jirds, spiny mice are unable to subsist on a diet of dry food alone. High evaporative water loss is probably compensated for by the water obtained from eating land snails (Shkolnik and Borut, 1969).

In the Eastern Desert of Egypt, snails are found only in the northern limestone plateau (excepting the Gebel Elba area). In areas lacking snails, insects, other invertebrates, and possibly small vertebrates probably provide the necessary water, or as was mentioned under *A. russatus*, salty, succulent plants may suffice.

Acomys cahirinus from sandstone and granite habitats pay no attention to proffered snails. Spiny mice from limestone areas, however, quickly dispose of snails in the following manner: A snail that is sealed onto a branch or another snail is "deftly" pried off with the incisors, unattached snails are readily accepted. The seal is pierced, and the tongue and lower incisors are worked into the opening. The liquid behind the seal is lapped, and then the mouse bites off bits of the shell until it reaches the snail, which is quickly pulled out and devoured. Slime presents no problem to a spiny mouse, for second and third snails are accepted as readily as the first. Shells gnawed by captive spiny mice are in Figure 92.

Commensalism.—In Egypt, *A. cahirinus* lives in houses in desert outposts and crowded urban areas. Bodenheimer (1935) observed that this spiny mouse invaded houses in Jerusalem at the beginning of cold weather. It has been referred to as the "house-mouse" of Cairo (Heuglin, 1877) and said to outnumber *Mus musculus* in human dwellings (Bonhote, 1910; Flower, 1932). In marked contrast are the statements of Ranck (1968) and Happold (1969) that commensalism was unknown in *A. cahirinus* in Libya and Sudan. Such a

FIG. 92. Shells of snails (*Eremica desertorum*) gnawed by a captive *Acomys cahirinus*.

reversal of habitat, Happold (1969, p. 141) suggested, "may be a result of competition between commensal species, or because of the denser human habitation in Egypt, which results in 'jebel-like' habitats." This does not explain commensalism in the desert, however.

Egyptian houses are constructed either of brick, stone, and mortar or of mud and brick and therefore are similar to the natural cliff and rock habitat of *A. cahirinus*. Availability of food and absence of predators in desert houses furnishes spiny mice with an ideal situation.

In the Nile Valley and Delta, *Acomys* may simply be better adapted to living in houses than is *Mus*, which is usually found in the more mesic, vegetated habitats. The short, mild Egyptian winter probably does not force *Mus* indoors as is the case in more rigorous climates.

Populations.—The first NAMRU-3 expedition to Gebel Elba (Hoogstraal et al., 1957a) in the spring of 1954 reported the follow-

ing catches of *A. c. hunteri* (as *A. dimidiatus hunteri*): In Wadi Kansisrob, 3 March, 42 spiny mice were taken in 72 live traps, and 30, 42, 38, 35, 19, and 15 per night were trapped in the general area over a period of six days.

The NAMRU-3 expedition to Gebel Elba in the spring of 1967 recorded the following catches: In Wadi Kansisrob, 18 February, three spiny mice were taken in 50 live traps, and three, five, three, one, and seven per night were trapped in other areas around Gebel Elba with an average daily setting of 24 traps for five days. The total catch of this expedition, including that from Wadi Kansisrob, was 22 spiny mice per 170 trap nights.

We have no idea of what factors might have caused such fluctuation in the spiny mouse populations of Gebel Elba. In 1967, as in 1954, there was no indication of drought, and mountain slopes and valleys abounded in green vegetation. In fact, this area supports the richest flora in Egypt and has a more stable climate than other parts of the Eastern Desert.

One other locality from which we have data on numbers of spiny mice is a cliff area around Bir Qiseib, 5.8 km. inside Wadi Qiseib from the Gulf of Suez, where we obtained 5 to 12 *A. cahirinus* in single night catches with 50 live traps.

Catches of commensal *A. cahirinus* always contain fewer adult animals than collections from nature, and as a result, *A. c. cahirinus* samples in Table 37 are small.

Associates.—In rocky habitat in the Sinai Peninsula, *A. cahirinus* can be found with *Eliomys melanurus*, *A. russatus*, *Dipodillus dasyurus*, and *Sekeetamys calurus*. In the Eastern Desert, it occurs with the same species, except for *Eliomys quercinus*. In southeastern Egypt, during a period of extremely high population, *A. cahirinus* was collected from sandy habitat with *Gerbillus gerbillus* (Hoogstraal et al., 1957a). In the Western Desert, *A. cahirinus* occurs with *Dipodillus campestris patrizii* in rocky areas and with *G. gerbillus* in sandy areas. As a commensal, *A. cahirinus* appears to share the same areas with *Rattus*, and to some extent with *Mus musculus*.

Reproduction.—Number of young based on fetal scars, embryos, and fetal counts from 13 noncommensal females ranged from one to six (average, three). The females were collected in the months of February, March, April, June, September, and October.

Sex ratio.—A sample of 122 museum specimens of *A. cahirinus*, contained 57 (46 per cent) males and 65 females.

Notation.—Many wild spiny mice lack either part of or the entire tail. Not only do the vertebrae separate as readily as those in a lizard's tail, but the skin slips off like a loose sheath. Preparing study skins of these mice is one of the most frustrating tasks of the collector. The tail invariably drops off, and the skin tears at the slightest tug. Extreme care must be taken when handling live spiny mice to prevent injuries.

There is a possibility that tail autotomy is an escape mechanism (Michener, 1976), but how does one differentiate between tails damaged by predators or in fighting? The focus of repeated attacks by aggressive captive adult *A. cahirinus* is the tail (personal observations of D. Osborn).

KEY TO EGYPTIAN SUBSPECIES OF *Acomys cahirinus*

1. Dorsum blackish, belly slate. (Nile Valley and Delta)..... ***cahirinus*, p. 303.**
2. Dorsum brownish, belly white.
   a. Dorsum dark brown.
      i. Head and body length average less than 100 mm. (Southwestern part of Western Desert)..... ***viator*, p. 305.**
      ii. Head and body length average more than 100 mm. (Southern part of Eastern Desert)..... ***hunteri*, p. 305.**
   b. Dorsum pale brown.
      i. Tail distinctly bicolored.
         (a) Color paler, dimensions average slightly smaller. (Sinai Peninsula)..... ***dimidiatus*, p. 306.**
         (b) Color darker, dimensions average slightly larger. (Northern part of Eastern Desert)..... ***megalodus*, p. 307.**
      ii. Tail indistinctly bicolored. (Western Desert oases except Bahariya)..... ***helmyi*, p. 308.**

Acomys cahirinus cahirinus (Desmarest, 1819)

Type locality.—Egypt. CAIRO: Cairo.

Distribution in Egypt.—Figure 90. Nile Delta, Nile Valley south to Aswan, Suez Canal area, Bahariya Oasis.

External characters.—See species description. *Acomys c. cahirinus* specimens from houses and agricultural areas are usually melanistic, but those from tombs and cliffs may have the dorsum blackish brown, side grayish or brownish, belly pale, and tail indistinctly or distinctly bicolored.

Cranial characters.—Figure 91. See species description.

Measurements.—Table 37. Dimensions of *A. c. cahirinus* are comparable with *A. c. hunteri* from the southern part of the Eastern Desert, but significantly smaller on the average than in subspecies *dimidiatus*, *megalodus*, and *helmyi*.

Variation.—Variation in color and intergradation with other subspecies have been discussed. An albinistic specimen was collected from Abu Rawash, Giza Governorate.

Comparisons.—*Acomys c. cahirinus* can usually be distinguished from other subspecies on bases of its melanistic or slate color and tail not bicolored or indistinctly bicolored.

Specimens examined.—Total 275.

SUEZ: Suez (9).

SHARQIYA: Faqus (1).

DAQAHLIYA: Aga Minshat el Ikhwa (2).

GHARBIYA: Tanta (3), Sherbin (3).

ALEXANDRIA: Port of Alexandria (2), Alexandria (1).

MINUFIYA: Birket el Sabh (1).

GIZA: Abu Rawash (35); Tanash (2); Mena Village (3); Giza (18); Gebel al Ghigiga (4); Saqiyet Meki (1); Abassia (15); Kafr Taharmes (1); Bahariya Oasis, Mandisha (5); Bawiti (4); Ain Marun (1); El Aguz (1).

CAIRO: Abassia (15), Abassia Fever Hospital area (11), Citadel (3), Gebel Mokattam (5), Sharabiya (2), Maadi (9), Helwan (13), Bab el Sharia (1).

ASYUT: Asyut (2), Tombs in Gebel Drunka (10), Asyut Fever Hospital (1), Ben Adi (4).

QENA: Qena (1), Dandara Temple (21), Kaiman el Matana (1), Luxor (5), Valley of the Kings (14), Habou city temple (1).

ASWAN: Muneiha (9); Kom Ombo (1); Aswan Dam Hospital, west bank (5); West Aswan tombs (5); West Aswan, Nile bank (16); Aswan, 19.2 km. N (2), 16. km. N (4); El Koror area (2).

Published records.—Records are from Flower (1932), Setzer (1952, 1959e), and Wassif (1960a).

SUEZ: Suez.

SHARQIYA: Faqus, Mina el Qamh.

DAQAHLIYA: Aga Minshat el Ikhwa, Simbillawein 8 km. W.

GHARBIYA: Tanta, Sherbin, Mehalla el Kubra.

ALEXANDRIA: Alexandria.

BEHEIRA: Wadi el Natroun.

MINUFIYA: Quesna (Quweisna).

QALYUBIYA: Basus, Nawa.

GIZA: Giza: Abu Rawash; Kafr Taharmes; Saqyet Meki; Tanash; Bahariya Oasis, Bawiti and Mandisha.

CAIRO: Abassia, Abassia Fever Hospital, Cairo Citadel, Sharabiya, Maadi, Bab el Sharia.

ASYUT: Asyut.

QENA: Kaiman el Matana.

Acomys cahirinus viator (Thomas, 1902)

Acomys viator Thomas, 1902, Proc. Zool. Soc., London, 2, p. 10.

Type locality.—Libya. TRIPOLITANIA: Socna, Wadi Sultan.

Distribution in Egypt.—Figure 90. Gebel Uweinat and possibly Gilf el Kebir.

External characters.—Dorsum dark brownish; side, rump, and outer leg surface dark cinnamon. Belly, underparts, and feet white. Tail distinctly bicolored, brownish above, white below. *Acomys c. viator* is similar in color to *hunteri*.

Cranial characters.—See species description.

Measurements.—Table 37. *Acomys c. viator* is significantly smaller in average dimensions than other Egyptian subspecies, except for foot length.

Specimens examined.—Total 18.

Sudan. NORTHERN: Gebel Uweinat, Karkur Murr (8).

Libya. CYRENAICA: Cufra Oasis, El Giof (10).

Acomys cahirinus hunteri (De Winton, 1901)

Acomys hunteri De Winton, 1901, Nov. Zool., 8, p. 401.

Type locality.—Sudan. KASSALA: Tokar.

Distribution in Egypt.—Figure 90. Eastern Desert from Wadi Araba southward. West side of Nile River south of Aswan.

External characters.—See species description. Dorsum dark brown; side, rump, and outer leg dark cinnamon. Belly, underparts, and feet white. Tail bicolored, brownish above whitish below. There is a tendency toward melanism in commensals.

Cranial characters.—See species description.

Measurements.—Table 37. *Acomys c. hunteri* has smaller dimensions than the northern *megalodus* subspecies.

Variation.—Color variation in *hunteri* was discussed above. There

are pale individuals in the northern part of the range and there is considerable difference in size between northern and southern populations of *hunteri* (table 37). Intergradation has been demonstrated between subspecies *hunteri* and *megalodus*, and *hunteri* and *cahirinus*.

Comparisons.—*Acomys c. hunteri* is generally darker and smaller than *megalodus*, about equal in dimensions to *cahirinus*, but does not show the extreme melanism nor dark blackish back and brownish or grayish sides of nonmelanistic *cahirinus*.

Specimens examined.—Total 171.

RED SEA: Wadi Araba (4), Ras Zafarana (1), Wadi el Deir (9), Ras Gharib (1), Wadi Bali (5), Wadi Fatira near Abu Kharif mine (1), Wadi Sikait (1), Wadi Ghadir (6), Mersa Alem 20 km. SW (1), Fawakhir Mine area (28), Wadi Sukari (4), Bir Abraq (7), Wadi Hodein (2), Bir Gumbiet (1), Wadi Gumbiet (1), Qusur el Banat (1).

SUDAN ADMINISTRATIVE: Gebel Hamra Dom (2), Wadi Kansisrob (7), Bir Kansisrob (11), Wadi Akwamtra (16).

ASYUT: Wadi Asyuti (2).

ASWAN: Kom Ombo (1); Kom Ombo, El Kagug cave (8); Gebel Magal Gabril area (4); Bir Umm Hibal in Wadi Dihmit (1); Wadi Allaqi (2); Allaqi Village 11.2 km. S (1); Bir Murra (2); Wadi Nagib (4); Wadi Haimur mine area (2); Bir Haimur (1); Wadi Abusku (1); Wadi Quleib (4); Armena East pumping station (4); Gebel Adda (1); Ballana East (9); Nag Misaw (4); Kalabasha 4 km. S (1); Seyala West (3); Madiq (3); Dakka 2 km. N (1).

Sudan. NORTHERN: Wadi Halfa (3).

Published records.—Records are from Flower (1932), Hoogstraal et al., (1957b), Setzer (1959), Hoogstraal (1963), and Bauer (1963).

RED SEA: Wadi Sikait, Wadi Hodein, Wadi Gumbiet, Bir Abraq.

SUDAN ADMINISTRATIVE: Bir Kansisrob, Wadi Kansisrob.

ASWAN: Abu Simbel, Wadi Allaqi.
Sudan. NORTHERN: Wadi Halfa, Khor Musa Pasha.

Acomys cahirinus dimidiatus (Cretzschmar, 1826)

Mus dimidiatus, Cretzschmar, 1826, *in* Ruppel, Atlas zu der Reise im nordliche Afrika, Saugeth. pl. 13, fig. a, p. 37.

Type locality.—Egypt. SINAI.

Distribution in Egypt.—Figure 90. Southern part of Sinai Peninsula.

External characters.—See species description. Dorsum pale brownish. Side, rump, and outer leg surface pale cinnamon. Belly, underparts, and feet white. Tail bicolored, pale brownish above,

white below. *Acomys c. dimidiatus* is the palest Egyptian subspecies.

Cranial characters.—See species description.

Measurements.—Table 37. *Acomys c. dimidiatus* averages slightly smaller in most dimensions, except ear length, than the largest Egyptian subspecies, *megalodus*.

Comparison.—*Acomys c. dimidiatus* is paler and slightly smaller than *A. c. megalodus* from which it is barely distinguishable. From other species, except the Western Desert *helmyi*, *dimidiatus* can be distinguished by much larger average dimensions, especially ear length (table 37), and conspicuously paler coloration. See under *A. c. helmyi* for comparison with that subspecies.

Intergradation between *dimidiatus* and *megalodus* has not been demonstrated.

Specimens examined.—Total 33.

SINAI: Wadi el Sheikh (20), Feiran Oasis (3), Wadi el Arbaein (3), St. Catherine Monastery area (6), Tor (1).

Published records.—Records are from Wassif and Hoogstraal (1954) and Setzer (1959).

SINAI: St. Catherine Monastery area, Feiran Oasis, Bir Thal.

Acomys cahirinus megalodus (Setzer, 1959)

Acomys dimidiatus megalodus Setzer, 1959, J. Egypt. Publ. Health Assn., **34**, No. 3, p. 98.

Type locality.—Egypt. SUEZ: Wadi Sayal (Wadi Abu Seyala).

Distribution in Egypt.—Figure 90. Northern part of Eastern Desert north of Wadi Araba.

External characters.—See species description. Dorsum pale to dark brownish. Side, rump, and outer leg surfaces pale to dark cinnamon. Belly, underparts, and feet white. Tail bicolored, pale brownish above, white below. *Acomys c. megalodus* is slightly darker than *dimidiatus* and considerably paler than darker *hunteri*.

Cranial characters.—See species description.

Measurements.—Table 37. *Acomys c. megalodus* averages considerably larger in most measurements than other Egyptian subspecies.

Comparisons.—*Acomys c. megalodus* differs only slightly in size

and color from *dimidiatus*, but on the basis of geographical separation, these two subspecies are being retained. From typical *hunteri* and *cahirinus*, *A. c. megalodus* can be distinguished on the bases of larger size (table 37) and paler color. Intergradation between these subspecies has been demonstrated. Comparison with *helmyi* is given under that subspecies.

Specimens examined.—Total 118.

SUEZ: Gebel Katamiya (15); Wadi Iseili (3); Ain Sukhna (11), 3.5 km. S (1); Gebel Sukhna (2); Wadi Abu Seyala (17, Type); Wadi Nasr (1); Wadi Nakl (5); Wadi Yesein (5); Wadi Qiseib (27); Wadi Dom (22); Wadi Abu Sanduq (2).

CAIRO: Wadi Hof (6).

Published records.—Records are from Setzer (1959) and Hoogstraal (1963).

SUEZ: Ain Sukhna, Wadi Sayal (Wadi Abu Seyala).

Acomys cahirinus helmyi ssp. nov. Osborn

Type.—Field Museum Natural History No. 108279, original No. 13901 in H. Hoogstraal catalog. Adult female skin and skull. Collected April 21, 1969, by Ibrahim Helmy.

Type locality.—Egypt. EL WADI EL GEDEED: Farafara Oasis, Ain el Wadi (56 km. NNE of Qasr Farafara).

Distribution in Egypt.—Figure 90. Farafara, Dakhla, and Kharga Oases.

External characters.—Dorsum pale brownish, side, rump, and outer leg surface pale cinnamon. Belly, underparts, and feet white. Tail not distinctly bicolored, pale brownish above, whitish below. *Acomys c. helmyi* is almost identical in color with *megalodus* except for the obscure bicoloring of the tail.

Cranial characters.—See species description.

Measurements.—Table 37. *Acomys c. helmyi* averages slightly less in some measurements than the large pale subspecies *megalodus* of the Eastern Desert. Measurements of the type specimen are: Head and body length 127 mm.; tail 113 mm., 88 per cent of head and body length; hind foot 20 mm.; ear 22 mm.; occipitonasal length 31.4 mm.; weight 31.4 gm.

Habitats.—*Acomys c. helmyi* was trapped at Ain el Wadi in damp sand under wild date palms (*Phoenix dactylifera*). The only other vegetation in the area was *Tamarix* sp. Five kilometers N in Wadi

Hennis, *A. c. helmyi* was trapped in dry sand under wild date palms. Two and three specimens of *Gerbillus g. gerbillus* were trapped in the same habitats, respectively. Commensal *Acomys* from Dakhla and Kharga oases are tentatively considered as belonging to this subspecies.

Specimens examined.—Total 31.

EL WADI EL GEDEED: Farafara Oasis, Ain el Wadi (Type, 14), Wadi Hennis (2); Dakhla Oasis, Mut (6), 10 km. S (5); El Kharga, Hibis Temple (3).

Published records.—Wassif (1960b) referred spiny mice from Dakhla Oasis, Mut to *A. c. cahirinus.*

Genus **Nesokia** Gray, 1842

Monotypic genus of large, rat-like rodent with tail considerably shorter than head and body length.

Skull slightly modified for fossorial life. Incisive foramen short, palatal foramen minute, palate constricted and deeply grooved, occipital region broad and sloping forward slightly. Upper incisor proodont. Cheek teeth with thin, transverse ridges.

Nesokia indica (Gray and Hardwicke, 1832)

Arvicola indica Gray and Hardwicke, 1832, Ill. Ind. Zool., Vol. 1, pl. XI.

Type locality.—India.

General distribution.—Southwestern Asia from Chinese Turkestan into Turkey, Syria, Israel, and northern Saudi Arabia; northern Egypt.

Common names.—Bandicoot Rat, *Girdi, Abu Emaya, Abu Afan.*

Subspecies in Egypt.—

Nesokia indica suilla (Thomas, 1907)

Nesokia suilla Thomas, 1907, Ann. Mag. Nat. Hist., (ser. 7), 20, p. 203.

Type locality.—Egypt. SUEZ: El Shallufa (Shaluf).

Distribution in Egypt.—Figure 93. El Shallufa near Suez, northwestern margins of the Nile Delta, Wadi el Natroun, Bahariya Oasis.

Diagnosis.—Large, stocky rat with dorsum pale brown, venter buffy, feet white, muzzle blunt. Ear large, sparsely haired. Tail considerably shorter than head and body length, thinly haired.

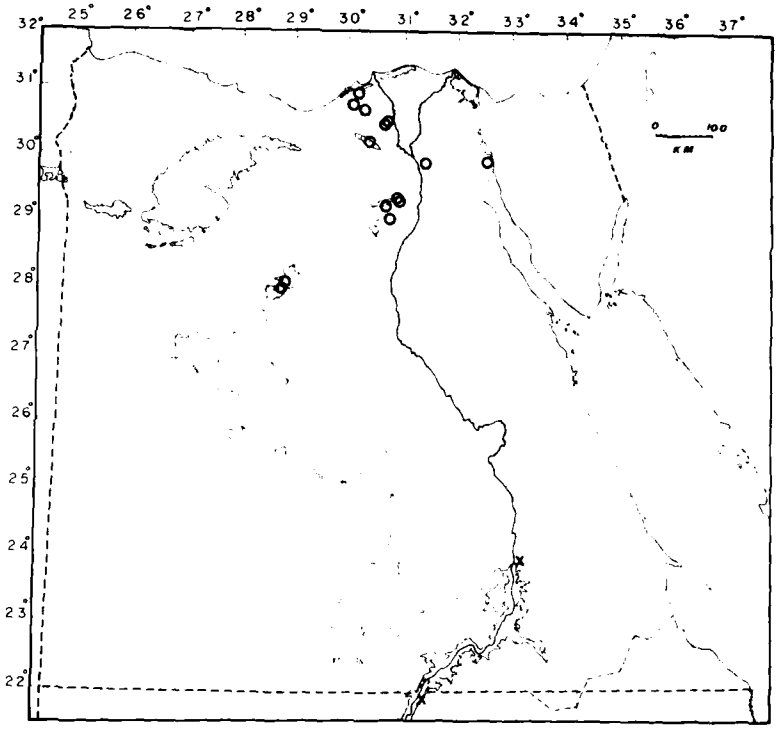


FIG. 93. Collection localities of *Nesokia indica suilla* and sites of Paleolithic remains (X).

Skull angular, strongly ridged. Tempoparietal ridges curving laterally; area between ridges flat. Zygomatic arch thickened anteriorly, bowing laterally. Occipital condyle protruding beyond level of supraoccipital. Supraoccipital large, sloping forward. Incisive and palatal foramina short. Molars laminate, cusps lacking.

Adult head and body length average 184 mm.; tail 121 mm., 66 per cent of head and body length; foot 39 mm.; ear 20 mm.; condyloincisive length 44.2 mm.; weight 244 gm.

External characters.—Figure 81. Pelage comparatively soft. Dorsal hairs with pale brown tips, side and venter hairs buffy. All hairs with gray base. White patch on throat variable. Feet white. Palm and sole naked. Ear relatively long, sparsely haired. Tail thick, brownish, sparsely haired, shorter than head and body length. External fossorial modifications lacking, except for long claws.

Cranial characters.—Figure 94. Skull large, strong, and angular. Braincase large, convex, strongly ridged. Rostrum relatively short, broad. Nasals spatulate in outline, posterior margin narrow, irregularly rounded. Zygomatic arch thickened anteriorly, curving laterally. Supraorbital and cranial ridges strongly developed, the latter high on the braincase and curving laterally. Interparietal relatively small, shape varying from broadly triangular to ovoid with suture extremely irregular. Lambdoidal crest high and prominent. Supraoccipital large and sloping forward slightly. Median supraoccipital ridge not prominent. Occipital condyle protruding well beyond level of supraoccipital. Zygomatic plate large, extending forward to level of premaxillary-maxillary suture. Infraorbital canal large, conspicuous. Tempoparietal suture turning abruptly downward and caudad above base of zygomatic process of temporal. Auditory bulla relatively small. Incisive foramen actually and relatively short, palatine foramen minute. Root of upper incisor forming a hillock behind the palatine foramen. Mandible with well-developed coronoid and alveolar processes. Palate constricted and deeply grooved. Postpalatal margin about level with m^3. Parapterygoid fossa narrow and deep. Pterygoid process long and extending below level of tympanic bulla.

Teeth.—Figure 79. Incisors long. Upper incisor proodont, broad, not compressed; anterior surface smooth and flat. Molars lacking evidence of cusps. Occlusal surfaces with thin transverse laminae. M^1 with five roots, crown longer than that of m^2.

Measurements.—Table 38. Male and female dimensions subequal.

Age determination.—Adults have cranial sutures closed and laminae of upper molars broadly crescent-shaped or transverse.

Variation.—Individual variation in presences or absence of white throat patch.

Comparisons.—*Nesokia i. suilla* appears to differ from *N. i. bacheri* in having slightly smaller dimensions. *Nesokia indica* dif-

TABLE 38. — Means (and ranges) of measurements, ratios, and weight of adult *Nesokia indica suilla*.

HBL	183.6 (165-197) 5	CIL	44.2 (42.0-46.1) 8
TL	121.0 (110-134) 5	ZW	27.7 (26.1-29.3) 7
TL/HBL%	66.2 (62.0-69.0) 5	IOW	6.6 (6.3- 7.2) 8
FL	39.0 (36-42) 5	NL	15.6 (14.8-16.3) 5
EL	20.4 (20-21) 5	IFL	6.2 (5.7- 6.8) 8
Wt	244.0 (205.5-280.0) 3	AL	9.7 (9.0-10.4) 8

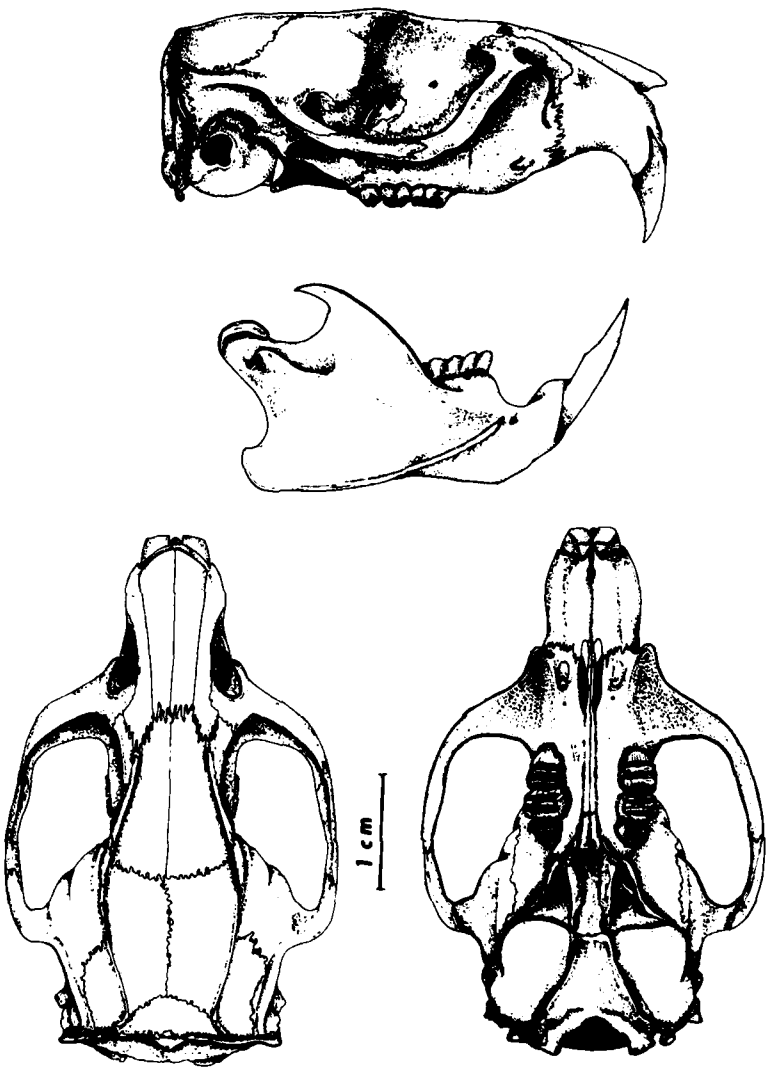


FIG. 94. Skull of *Nesokia indica suilla*.

fers from other larger murids in having less contrast between color of dorsum and venter, entire upper surface of feet white, tail relatively shorter than head and body length, zygomatic arches flaring, incisive foramina relatively short, supraoccipital proportionately larger and sloping forward, lambdoidal ridge prominent, incisors proodont, and molars lacking cusps.

Specimens examined.—Total 53.

SUEZ: El Shallufa (2).

BEHEIRA: Kom Hamada, Dissht el Ashraf (6); Kafr el Dawar (1); Kom el Hanash (3); Wadi el Natroun (10).

CAIRO: Cairo (3).

EL FAIYUM: Faiyum (6); Lake Qarum (6), 1.6 km. N (1); Tamiya (1), E. Ayub Ali (1).

GIZA: Bahariya Oasis, Bir Wigaba (1); Bir Qasr (1); Mandisha (8); El Ghaba (3).

Published records.—Records are from Anderson (1902), Flower (1932), Hoogstraal et al. (1955), and Wassif (1960b).

SUEZ: Shaluf (El Shallufa).

BEHEIRA: Kom el Hanash, Wadi el Natroun.

FAIYUM: Lake Qarun; Lake Qarun SE end, 1.6 km. N; Tamiya; Ezbet Ayub Ali.

GIZA: Bahariya Oasis, Mandisha, El Aguz.

Paleolithic sites.—References are under Remarks.

ASWAN: Khor el Sil.

Sudan, NORTHERN: Wadi Halfa.

Collection.—Dug from burrows.

Habitats.—Damp soil in cultivated and wasteland (fig. 21), borders of saline lakes, and canal banks.

Burrows.—Burrows are usually less than 0.5 m. below the surface and, according to Briscoe (1956), consists of a network of corridors varying from about 2.5 to 9 m. in length. Hoogstraal (1963) found nest chambers to be at a lower level than subsurface tunnels.

In El Faiyum in late August, 1953, when air temperatures ranged from 86° to 106° F. and relative humidity, from 29.7 to 47 per cent, temperature and humidity in bandicoot rat burrows varied from 84° to 104° F. and 54.5 to 75.0 per cent, respectively (Briscoe, 1956).

Captive behavior.—Extremely aggressive and bites without hesitation. One animal which we reared by hand and kept for seven

months never tamed. Lay (1967, p. 190) remarked that, in Iran, "all bandicoots . . . captured alive fought fiercely."

We have not observed this rat outside a burrow, but it may go out to obtain food. Farmers have reported damage to young watermelons where it was present.

Food.—Fleshy roots of *Alhagi mannifera* and *Typha elephantina* are eaten by *Nesokia* and stored in underground chambers. Hoogstraal (1963) remarked that farmers complained of damage to corn, barley, and vegetables by this species. In the laboratory, we reared *Nesokia* on a diet of raw carrots.

Associates.—*Nesokia* has been collected in the same areas as other Murine rats and burrows in dense vegetation occupied by *Gerbillus pyramidum* (fig. 21). Whether any other rodents utilize burrows of *Nesokia* is not known.

Reproduction.—Flower (1932) reported six litters containing one to four young born February to June in Giza Zoological Gardens. We collected three naked young from a nest in Bahariya Oasis in mid-October. A female from Wadi el Natroun was lactating in October. Data from other sources indicate that there is no established breeding season in the species (Lay, 1967).

Remarks.—Populations of *N. indica* in Egypt are scattered (fig. 93) and isolated. Evidence that the former range was greater than it is today is indicated by British Museum specimens (4.8.4.1, 4.8.4.2, 4.8.4.3) collected in 1904 from the vicinity of Cairo, where the species no longer exists, and fossil jaws recovered from Upper Paleolithic sites of Late Pleistocene in the Nile Valley at Khor el Sil near Kom Ombo (P. F. Turnbull, personal communication; Reed et al., 1967; Reed and Turnbull, 1969) and Wadi Halfa in northern Sudan (Robinson, 1966).

The problem of determining the origin of relict populations of bandicoot rats in the oases of Bahariya and Wadi el Natroun is provocative, since these depressions are surrounded by barren desert and developed partly as a result of deflation by wind (p. 21). Obviously, *N. indica* was there before the period of aridity and wind action began.

The migration of *Nesokia* into Egypt was probably via riverine or deltaic habitats across northern Sinai, which are now defunct or inundated. A number of geological facts presented by Abu al-Izz (1971) can be used to explain the once widespread distribution (fig.

93). During the Miocene, the western end of the old Nile Delta was at what is now known as Wadi el Natroun. The eastern end was in the area of the Suez Canal. At the end of the Pliocene, the Nile Valley to Kom Ombo was an elongated estuary. In the Pleistocene, Wadi Tumilat functioned both as a drain and a tributary of the Nile. There were, of course, suitable habitats and ample opportunities for population expansion during the wetter periods of Egypt's geological history. During Oligocene and Miocene, lakes occurred between Bahariya depression and Maghagha in the Nile Valley. After the Oligocene, the land rose and the lakes shrank. Dessication and excavation of the Bahariya depression resumed. In the Pleistocene, the Nile River cut through the eastern edge of El Faiyum depression filling it with water. Subsequent dry periods resulted in isolation.

Disappearance of *Nesokia* from the Nile Valley in Upper Nubia could possibly have been due to down-cutting of the river and dessication and disappearance of habitats. In lower Nubia, the rest of the Nile Valley and most of the Delta, intensification of agriculture and the flood method of irrigation could have accounted for its disappearance.

The Suez population of *Nesokia* was believed by Aharoni (1932) to have come there by ship; a rather fanciful and presumptuous conclusion.

Family 4. Muscardinidae

Characters are given under the genus.

Genus **Eliomys** Wagner, 1840

Monotypic, polymorphic genus of a squirrel-like rodent. Fur soft, dense. Black facial mask prominent and distinctive. Tail bushy, almost round, black with tip white and base of short gray hairs. Palm and sole bare.

Skull smooth, round, lacking ridges. Zygomatic plate small, infraorbital canal very large. Incisive foramen relatively long, broadening posteriorly. Palatine foramen small, ovoid. Tympanic and mastoid bullae conspicuously inflated. Tympanic bulla with three prominent partitions. Superior wall of parapterygoid fossa perforated. Angle of lower jaw with single large foramen. Upper incisor orthodont, anterior surface smooth. Crowns of cheek teeth squarish, concave, and transversely ridged. Dental formula: $\frac{1}{1}, \frac{0}{0}, \frac{1}{1}, \frac{3}{3} \times 2 = 20$.

Eliomys quercinus (Linnaeus, 1766)

Mus quercinus Linnaeus, 1766, Syst. Nat., 12th ed., p. 84.

Type locality.—Germany.

General distribution.—Europe, Western U.S.S.R., Turkey, Syria, Israel, northern Saudi Arabia, Sinai Peninsula, northwestern Egypt, Libya, Tunisia, Algeria, Morocco, Spanish Sahara, and islands in the western Mediterranean Sea.

Common names.—Garden Dormouse, *Abu Khol.*

Distribution of subspecies in Egypt.—Figure 95. *Eliomys quercinus melanurus:* Sinai Peninsula; *Eliomys quercinus cyrenaicus:* western part of Mediterranean Coastal Desert.

Diagnosis.—Squirrel-like rodent. Tail black, partly bushy with gray base and white tip. Face with black mask from whiskers to base of ears. Dorsum brownish, side gray, underparts and feet white.

Skull smooth, auditory bulla greatly inflated, with three conspicuous partitions. Suprameatal triangle large, meatal lip expanded anteriorly, accessory tympanum absent. Upper incisor smooth. Cheek teeth four, crowns squarish, surface concave, transversely ridged.

Adult head and body length average 124 mm.; tail 114 mm., 92 per cent of head and body length; foot 26 mm.; ear 28 mm.; occipitonasal length 35 mm.; weight 52 gm.

External characters.—Figure 96. Dorsum brownish, side gray and belly whitish to cream. All hairs with dark gray bases except whitish area of throat and cheek. Rostrum and crown orangish. Black facial marking begins posterior to mystacial area, encircles eye, and continues to base of ear. White area of cheek extends to shoulder region. Ear with long, white hairs around opening; inner surface thinly covered with short, white hairs; outer surface almost naked. Black patch medial to pinna. Postauricular patch white. Base of tail, about one-fourth of tail length, covered with short whitish to grayish hairs; rest of tail black and bushy, except for small white tip. Feet thinly covered with white hairs above, palm and sole naked.

Cranial characters.—Figure 97. Rostrum elongate; cranium smooth, rounded; nasals truncate or emarginate posteriorly; fronto-

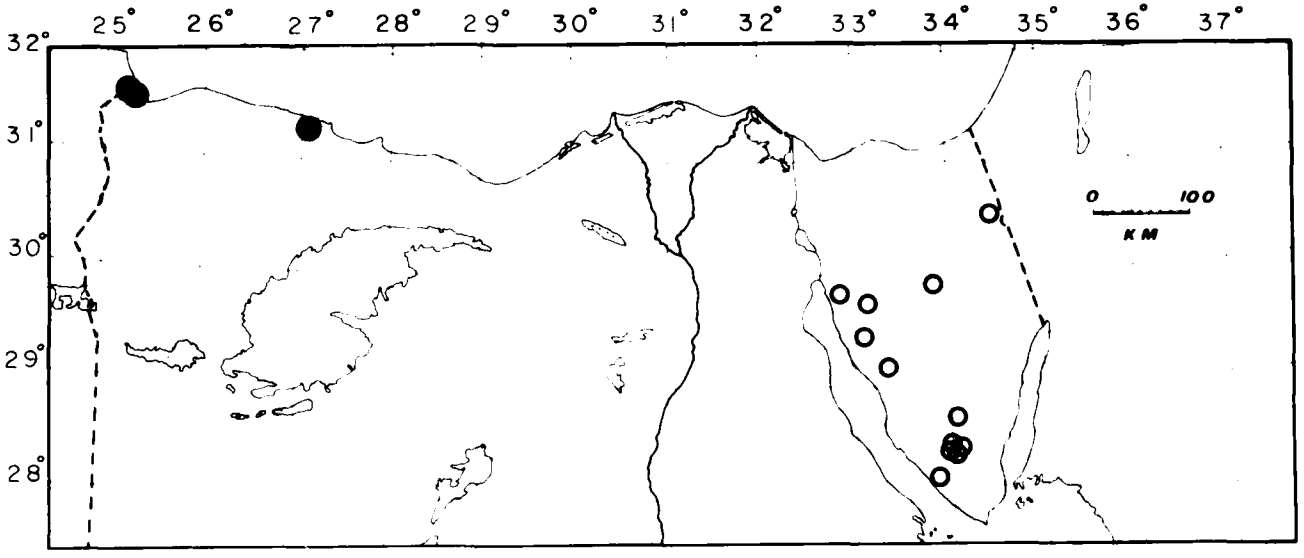


FIG. 95. Collection localities of *Eliomys q. tercinus melanurus* (circles) and *E. q. cyrenaicus* (dots).

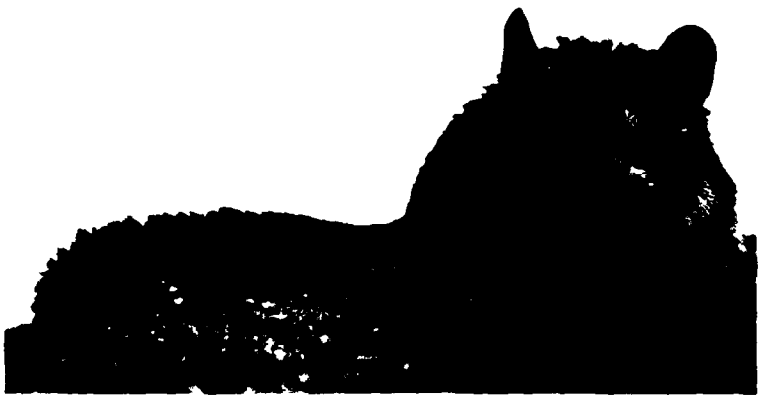


FIG. 96. Live specimen of *Eliomys quercinus cyrenaicus*.

parietal suture U-shaped due to encroachment of frontals posteriorly between parietals; interparietal broad, ligulate in outline. Zygomatic plate small, but with prominent masseteric tuberosity; infraorbital canal very large. Incisive foramen relatively long, narrow anteriorly, and broad posteriorly. Posterior palatine foramen very small, ovoid in outline, and diverging posteriorly. Parapterygoid fossa broad, shallow; superior wall perforated. Postpalatal margin level with posterior edge of molars.

Tympanic bulla greatly inflated and with three distinct partitions visible through the external auditory meatus. Suprameatal triangle large and open posteriorly. Mastoid bulla with large anterior chamber, subarcuate fossa not conspicuous, medial inferior posterior mastoid chamber very large, accessory mastoid chamber present. Accessory tympanum absent. Anterior lip of external auditory meatus broadened. Angle of lower jaw large, inflected, with single large foramen.

Baculum.—Baculum flattened and curved dorsoventrally, tapering from base to tip with small lateral projections at middle (Didier, 1953).

Teeth.—Upper incisor orthodont, smooth on anterior surface. Cheek teeth brachydont; crowns squarish, concave, and transversely ridged.

Measurements.—Table 39. Male and female dimensions subequal.

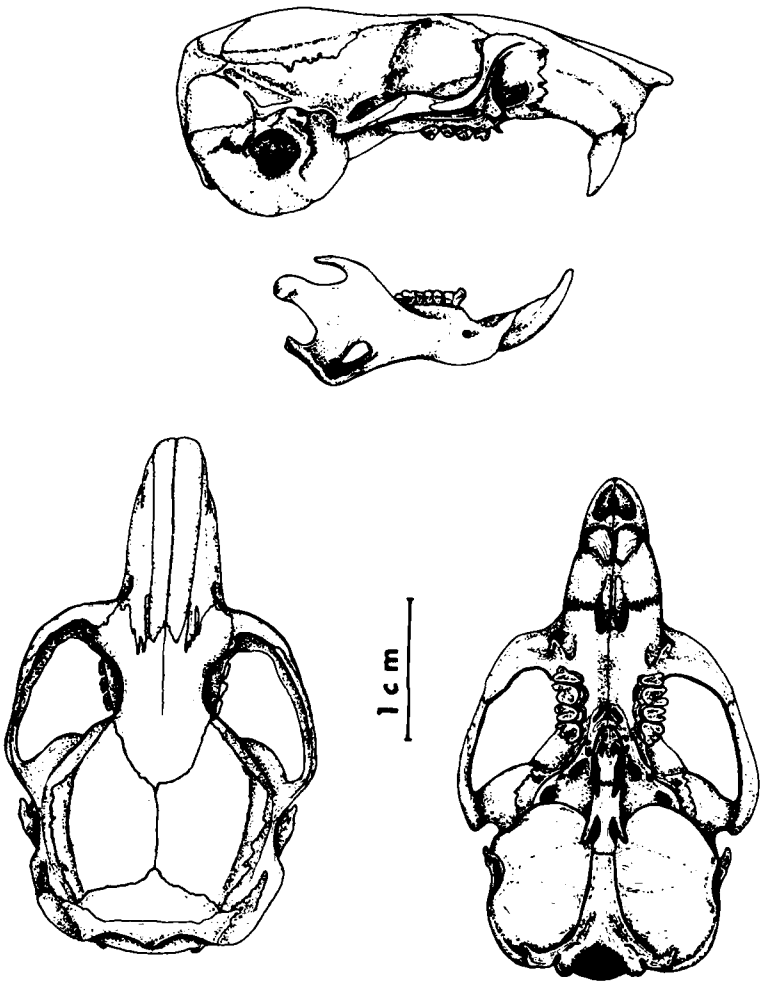


FIG. 97. Skull of *Eliomys quercinus*.

Age determination.—Adult animals have cusps of molars worn and cranial sutures closed.

Variation.—Tails of some specimens lack white tips. *Eliomys q. cyrenaicus* from the Western Desert is somewhat darker than *E. q. malanurus* from Sinai and has a slightly shorter ear and longer alveolus (table 39). Smaller auditory bulla and shorter tail in *cyrenaicus* were reported by Hoogstraal et al. (1955), Hoogstraal (1963), and Ranck (1968), but data in Table 39 do not support these conclusions. Bulla length, incidentally, is a highly variable measurement. Skull height, an indicator of the degree of tympanic bulla inflation, is a reliable check against erroneous assumptions about bulla size in small samples. Size of the foramen in the angle of the lower jaw is individually variable and therefore not consistently smaller in *cyrenaicus* as the aforementioned authors assumed. The most obvious difference between *E. q. cyrenaicus* and *E. q. melanurus*, which occupy the ends of a series of circum-Mediterranean subspecies, is the proportion of the length of the grayish, short-haired portion of the tail to the length of the rest of the tail: about one-sixth in *cyrenaicus* and one-third in *melanurus*. *Eliomys melanurus* was formerly considered to be a distinct species, but Niethammer (1959) recognized it as a subspecies of *E. quercinus*. He found differences between the subspecies mainly in the color pattern of the tail base. Corbet (1966, p. 208) supported the latter's decision of combining the various forms into a single species because of the lack of demonstration of "an abrupt and absolute discontinuity in variation." Ranck (1968) also accepted Niethammer's conclusions.

Comparisons.—*Eliomys quercinus* differs from all other Egyptian rodents in having black facial markings: black, bushy tail with short-haired base; premolars in upper and lower jaws; and cheek teeth with concave surfaces. *Sekeetamys calurus* is the only other Egyptian rodent with a black, bushy tail.

Collection.—*Eliomys* readily enters live traps.

Habitats.—Trapped alive in limestone cliffs of Western Mediterranean Coastal Desert. In Sinai, it has been taken in gardens, in the mountains, and in a Bedouin tent (Wassif and Hoogstraal, 1953). Flower (1932) reported one caught in a new stone building at El Kossaima. Ranck (1968) reported *E. q. denticularis* from loose sand

TABLE 39. — Means (and ranges) of measurements, ratios, and weight of adult *Eliomys quercinus*.

	E. q. melanurus	*E. q. cyrenaicus*
HBL	121.6 (104-135) 5	124.2 (110-140) 25
TL	112.2 (109-117) 4	114.9 (104-127) 22
TL/HBL%	89.4 (82.6-96.5) 4	92.9 (77.2-100.9) 22
FL	27.5 (26-29) 5	26.3 (24.0-29.0) 26
EL	31.2 (29-33) 5	27.1 (25-31) 26
Wt	— —	51.8 (38.4-63.0) 16
ONL	34.6 (33.6-36.0) 5	35.3 (34.3-36.6) 17
ZW	19.6 (19.1-20.0) 3	20.0 (19.0-21.5) 17
IOW	4.6 (4.6- 4.7) 5	4.5 (4.3- 4.8) 17
NL	12.6 (12.3-12.8) 5	13.5 (12.3-14.5) 17
IFL	4.3 (3.8- 4.8) 4	4.8 (4.4- 5.2) 14
AL	4.3 (3.8- 5.1) 3	5.5 (5.2- 5.6) 16
BL	11.6 (10.9-12.1) 5	10.7 (10.1-11.4) 17
SH	14.4 (14.0-14.8) 4	14.5 (13.6-15.4) 17

around the base of unpruned date palms and tamarix clumps in the Fezzan district of Libya.

Captive behavior.—Extremely wild and agressive. We have not kept this species in captivity long enough to study its responses further.

Associates.—In Sinai Peninsula, *E. quercinus* lives in rocky habitats with *Sekeetamys calurus*, *Dipodillus dasyurus*, *Acomys cahirinus*, and *A. russatus*. In the Western Desert, it is found in coastal cliffs with *D. campestris*.

Reproduction.—No information is available on reproduction in Egyptian subspecies.

Sex ratio.—A sample of 30 specimens from the Western Mediterranean Coastal Desert contained 12 (40 per cent) males and 18 females.

KEY TO EGYPTIAN SUBSPECIES OF *Eliomys quercinus*

1. Basal one-third of tail grayish. Color pale. (Sinai Peninsula). . . *melanurus*, p. 321.
2. Basal one-sixth of tail grayish. Color darker. (Northwestern part of Western Desert). . . . . *cyrenaicus*, p. 322.

Eliomys quercinus melanurus (Wagner, 1840)

Eliomys (*Myoxus*) *melanurus* Wagner, 1840, Abh. Bayer Akad. Wiss. Math.-Naturwiss. Kl., pl. 3, fig. 1, p. 176.

Type locality.—Egypt. SINAI.

Distribution in Egypt.—Figure 95. Sinai Peninsula.

External characters.—Slightly paler and with short-haired, gray basal part of tail about twice as long as in *E. q. cyrenaicus.*

Measurements.—Table 39. Ear length averages slightly longer and alveolar length shorter in *melanurus* than in *cyrenaicus.* See under variation.

Specimens examined.—Total six.

SINAI: Wadi Arbaein (3), Wadi el Raba (1), Gebel Musa (1), Tor (1).

Published records.—Records are from Anderson (1902), Flower (1932), Wassif and Hoogstraal (1953), Hoogstraal (1963), and Haim and Tchernov (1974).

SINAI: Nakhl; St. Catherine Monastery area; Gebel Musa; Wadi el Arbaein; El Raba; Wadi Rahaba, Quo Monastery area; El Kossaima (El Quseima); Ain Sudr; Nohel; Wadi Dalma.

Eliomys quercinus cyrenaicus (Festa, 1921)

Eliomys cyrenaicus Festa, 1921, Boll. Mus. Zool. Anat. Comp. Univ. Torino, **36**, No. 740, p. 4.

Type locality.—Libya. CYRENAICA: Gheminez.

Distribution in Egypt.—Figure 95. Northwestern part of Western Desert.

External characters.—Slightly darker and with short-haired, gray basal part of tail about one-half as long as in *melanurus.*

Measurements.—Table 39. Ear length averages slightly shorter and alveolar length longer in *cyrenaicus* than in *melanurus.* See under variation.

Specimens examined.—Total 30.

MATRUH: Ageeba 24 km. W of Mersa Matruh (18), Salum area (11), Salum 16 km. E (1).

Published records.—Records are from Hoogstraal et al. (1955) and Hoogstraal (1963).

MATRUH: Salum.

Family 5. Dipodidae

Relatively small to large rodents, head and body length average 105 to 148 mm. Modified for bipedal locomotion. Tibia and fibula fused, hind foot elongate, functional toes three, forelimb reduced, neck short. Tail about 150 per cent of head and body length, with

broad, feathered black subterminal band and white tip. All species have conspicuous whitish to grayish hip bands. Infraorbital foramen greatly enlarged. Upper root of zygomatic process posterior to lower root. Maxillary plate minute. Postpalatal margin posterior to level of m^3. Bulla inflation variable. Angular process of lower jaw perforated. Upper incisors smooth on anterior surface in genus *Allactaga*, grooved in *Jaculus*. Dental formula: $\frac{1}{1}, \frac{0}{0}, \frac{0\text{-}1}{0}, \frac{3}{3} \times 2 = 16\text{-}18$.

KEY TO EGYPTIAN GENERA OF DIPODIDAE

1. Ear longer than one-half hind foot length. Hind foot with three functional and one vestigial toe. Whitish hip bands not converging above base of tail. Mastoid bulla not inflated, tympanic bulla slightly inflated and not fused anteroventrally. Rudimentary premolar in upper jaw. Enamel pattern of m^1 and m^2 E-shaped (fig. 98, table 40). ..... *Allactaga*, p. 323.
2. Ear shorter than one-half hind foot length, hind foot with three functional toes. Whitish hip bands converging above base of tail. Mastoid and tympanic bullae greatly inflated, the latter fused anteroventrally. Premolar lacking in upper jaw. Enamel pattern of m^1 and m^2 Z-shaped (fig. 98, table 40). ..... *Jaculus*, p. 333.

Genus **Allactaga** Cuvier, 1836

Small jerboa. Dorsum speckled black and orange. White hip bands not converging above base of tail. Hind foot with three toes functional and one vestigial. Large digital and plantar pads not concealed by hair.

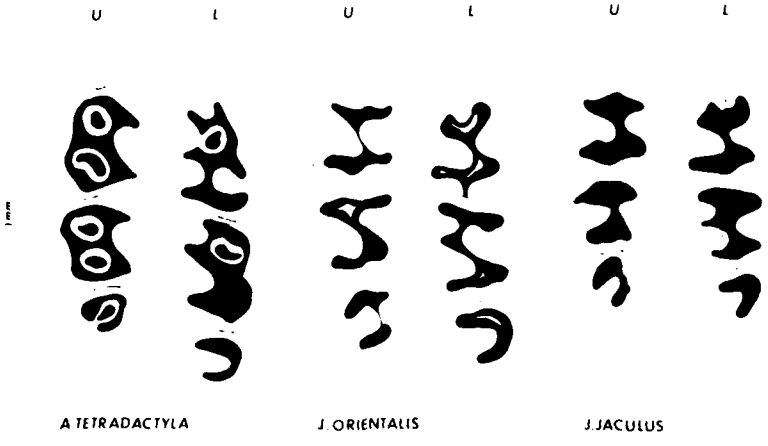


FIG. 98. Crown views of right upper (U) and left lower (L) molars of mature *Allactaga tetradactyla*, *Jaculus orientalis*, and *J. jaculus*.

TABLE 40. — Characters of Egyptian jerboas.

Character	*Jaculus orientalis*	*J. jaculus*	*Allactaga tetradactyla*
Dorsal color	brownish orange	orangish to brownish cinnamon	speckled black and orange
Ear	pigmented	tip pigmented	pigmented
Toes	3 normal		3 normal, 1 vestigial
Soles	haired		naked
Digital pads	small, covered with hair		large, naked
Glans penis	large, oval, covered with small recurved spines; two long terminal spikes.	cylindrical, minute pits and scales; no spines or spikes.	cordate, covered with short spines; no spikes.
Baculum	present		absent

TABLE 40. — *continued.*

Character	*Jaculus orientalis*	*J. jaculus*	*Allactaga tetradactyla*
Head and body length	137-160	95-120	102-119
Hind foot length	71-78	56-68	51-59
Ear length	28-35	19-28	37-43
Interparietal	broad, shield-shaped		broad, triangular
Posterior nasal margin (fig. 102)	bifurcated in broad V-shape	bifurcated in broad U-shape	truncate with small median V
Foramina maxillaris	closed dorsally		open dorsally
Lateral extension of zygomatic process	slightly beyond level of meatal lip	not beyond level of meatal lip	well beyond level of meatal lip
Lip of external auditory meatus	flaring laterally	not flaring laterally	flaring laterally

TABLE 40. — *continued.*

Character	*Jaculus orientalis*	*J. jaculus*	*Allactaga tetradactyla*
Postpalatal process	with 2 spines		with single spine
Teeth in upper jaw	3 molars		1 small premolar, 3 molars
Crowns of m_1, m^1	Z-shaped		E-shaped
Form of incisors	orthodont	opisthodont	proodont
Surface of upper incisor	grooved		smooth
Lower jaw	with shallow fossa between m_1 and coronoid process		with deep fossa
	inflected		not inflected
Angle of lower jaw	with single, large, round foramen	with 1 or 2 round foramina or varying size	usually with single large oval foramen

Zygomatic process of temporal without prominent lateral process, but extending beyond level of lip of external auditory meatus. Bony plate of lower root of zygomatic process not fused with maxilla (foramina maxillaris open dorsally). Jugual with vertical and horizontal parts narrow. Interparietal broad, triangular. Postpalatal process with single spine. Mastoid bulla not inflated. Tympanic bulla slightly inflated, apices not fused. Upper incisor proodont, anterior surface smooth. Upper jaw with one vestigial premolar, three molars. M^1 and m^2 with E-shaped enamel pattern. Lower jaw with angle uninflected, perforated by single, large foramen. Fossa between m^3 and outer side of jaw, deep. Baculum absent.

Allactaga tetradactyla (Lichtenstein, 1823)

Dipus tetradactyla Lichtenstein, 1823, Verzeichniss der Doubletten des Zoologischen Museums der Berlin., p. 2.

Type locality.—Egypt: "Libyan Desert between Siwa and Alexandria" (describer) taken to mean "Egypt, near Alexandria" by Ellerman (1940, p. 584).

General distribution.—Mediterranean Coastal Desert of Egypt and eastern Libya.

Common names.—Four-toed Jerboa, *Gerbouh.*

Distribution in Egypt.—Figure 99. Northern part of Western Mediterranean Coastal Desert.

Diagnosis.—Small jerboa with dorsum speckled black and orange, side grayish, and venter white. Ear pigmented, longer than one-half of hind foot length. Toe and tarsal pads large, not concealed by hair. Three functional toes, one vestigial.

Skull inflated, mastoid bulla not expanded, tympanic bulla slightly expanded. Posterior margin of nasals truncate with a small median "V."

Adult head and body length average 110 mm.; tail 169 mm., 155 per cent of head and body length; hind foot 56 mm.; ear 40 mm.; occipitonasal length 29 mm.; weight 52 gm.

External characters.—Figure 100. Dorsum dark, speckled black and orange; rump orangish, sides grayish. Dorsum hairs with black tips, orangish subterminal bands, and gray bases. Side hairs black tipped, white to base. Belly, underparts, and forelimb white. Hind foot with blackish hairs on underside of metatarsal and base of toes.

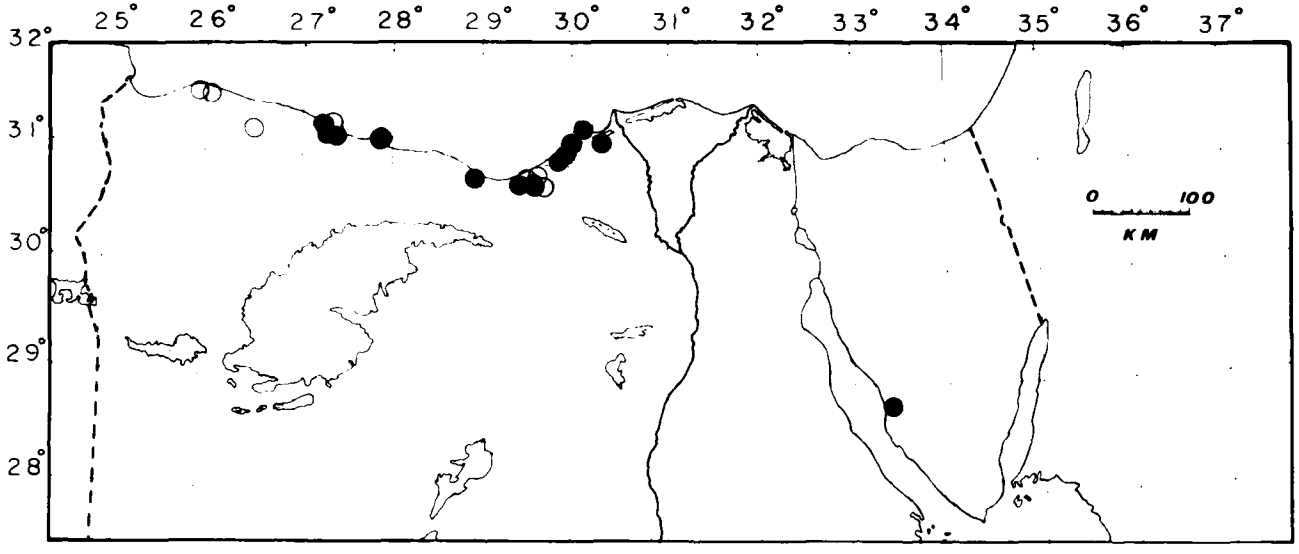


FIG. 99. Collection localities of *Allactaga tetradactyla* (circles) and *Jaculus orientalis orientalis* (dots).

FIG. 100. Live specimen of *Allactaga tetradactyla*.

Distal part of toes white. Mystacial area buffy. Suborbital area white. Postorbital and postauricular patches buffy. Ear pigmented, covered with whitish hairs. Whitish posterolateral hip bands not converging above base of tail. Tail paler than dorsum on upper surface, gradually becoming whitish on underside, with blackish, feathered subterminal band and white tip.

Feet.—Hind foot with three functional toes, one vestigial. Sole naked. Plantar and digital pads large, naked.

Cranial characters.—Figure 101. Most characters were described under genus and listed in Table 40. Cranium broadly triangular, parietal region inflated. Interparietal broad, triangular. Nasals truncate posteriorly with small median "V" (fig. 102). Zygomatic process of temporal extending beyond level of lip of external auditory meatus. Meatal lip flaring laterally. Mastoid bulla not inflated, tympanic bulla slightly inflated. Lower jaw with angle uninflected, perforated by a single, large oval foramen. Fossa between posterior molar and outer side of jaw deep.

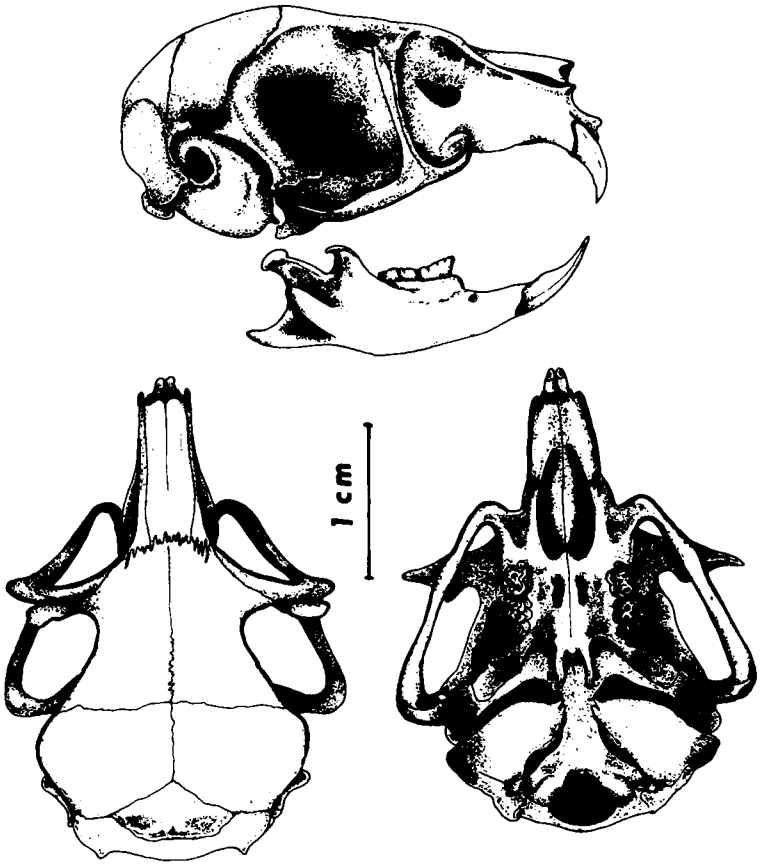


FIG. 101. Skull of *Allactaga tetradactyla*.

Teeth.—Upper incisor slender, proodont, smooth on outer surface (fig. 101). Upper jaw with one vestigial premolar and three molars. M^1, m^2 with E-shaped enamel pattern (fig. 98).

Measurements.—Table 41. Male dimensions average very slightly larger than female. Means (and ranges) of occipitonasal length (in millimeters) of 11 adult males and nine adult females are 29.0 (28.1 to 30.1) and 28.9 (27.3 to 30.4), respectively.

Age determination.—Adults have enamel cusps of upper molars

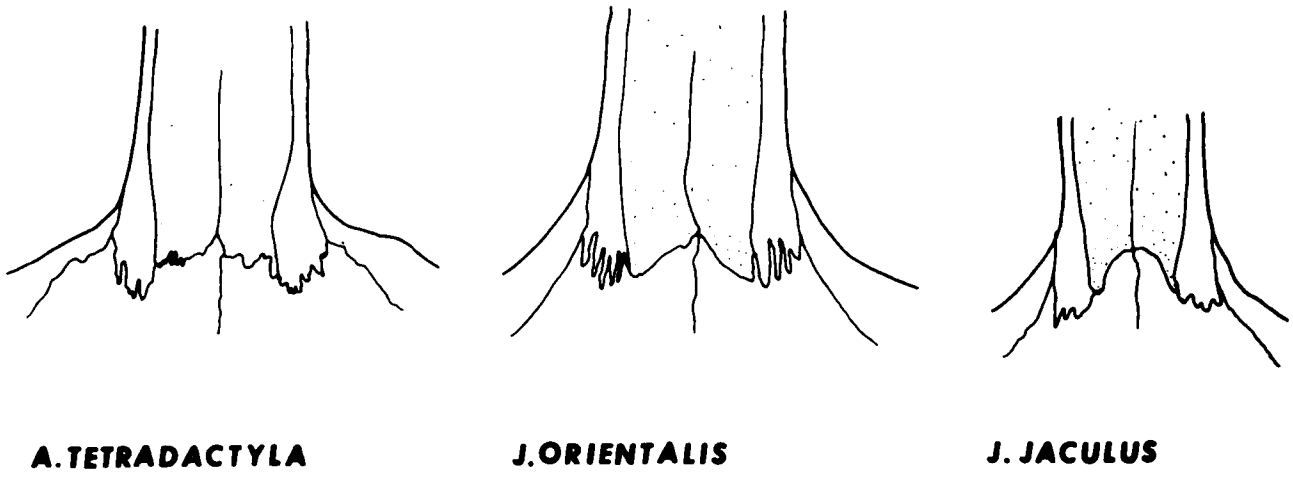


FIG. 102. Posterior margins of nasals of *Allactaga tetradactyla*, *Jaculus orientalis*, and *J. jaculus*.

TABLE 41. Means (and ranges) of measurements, ratios, and weight of adult *Allactaga tetradactyla* and *Jaculus orientalis*

	A. tetradactyla	*J. orientalis*
HBL	109.7 (102-119) 19	148.4 (137-160) 31
TL	169.0 (154-180) 17	224.2 (195-243) 31
TL/HBL%	154.7 (138.7-169.5) 17	146.1 (127.5-177.3) 31
FL	56.1 (51-59) 19	74.7 (71-78) 31
EL	40.6 (37-43) 19	32.9 (28-35) 30
Wt	48.0, 52.8, 56.0	134.5 (108.6-147.0) 17
ONL	28.9 (27.3-30.4) 20	36.9 (36.2-38.0) 26
ZW	20.9 (19.1-22.6) 16	28.3 (27.1-30.0) 24
IOW	9.8 (9.1-10.5) 20	14.5 (13.9-15.3) 25
NL	10.7 (10.0-11.6) 19	15.1 (13.9-17.0) 25
IFL	5.6 (5.1- 6.0) 20	5.6 (5.1- 6.2) 26
AL	5.9 (5.2- 6.2) 20	6.7 (6.2- 7.4) 25
SH	13.4 (12.8-13.8) 19	17.7 (17.0-18.6) 26

united into lamellae, cranial sutures closed. In addition, degree of development of the dorsolateral inflections of the anterior part of the zygomatic arches correlates with tooth wear and suture closure (Lewis et al., 1965).

Comparisons.—*Allactaga tetradactyla* can be distinguished from other Egyptian jerboas, *Jaculus jaculus* and *J. orientalis*, by its longer ears, darker color, vestigial fourth toe, rudimentary upper premolar, proodont incisor with smooth anterior surface, lack of inflation of auditory bulla, and other characters in Table 40 and Figure 102. Wassif (1960d) should be consulted for additional osteological and other differences between Egyptian jerboas.

Specimens examined.—Total 25.

MATRUH: Burg el Arab (8); Bahig S of (5); Bahig 18 km. S (2); Abu Mena (3), 11.2 km. E (1); Mersa Matruh (5); Sidi Barrani (1).

Published records.—Records are from Setzer (1958a) and Hoogstraal (1963).

MATRUH: Burg el Arab, Mersa Matruh, Sidi Barani 8 km. E, Abar el Dafa.

Collection.—Dug from burrows and collected with butterfly nets at night using spotlight.

Habitats.—*Allactaga tetradactyla* inhabits salt marshes and adjacent areas in coastal valleys of the Western Desert. It is also found inland on flat, clay desert in the vicinity of Bedouin barley fields and/or in areas where the predominant vegetation is *Anabasis articulata* (fig. 8).

Burrows.—Simple, 60 to 150 cm. deep. "Burrows appear often to be occupied only briefly and empty burrows of *Jaculus orientalis* are sometimes utilized." Winter rains often flood their burrows (Hoogstraal, 1963, p. 29).

Associates.—*Allactaga tetradactyla* lives in salt marshes with *Psammomys obesus*, *Jaculus orientalis*, and *Dipodillus* sp. (fig. 7). Inland, in hard clay desert, it is again found with these species and with *Meriones shawi* (fig. 8).

Populations.—Hoogstraal (1963) remarked on the small numbers of this species and its ecological limitation, that it had disappeared from certain coastal valleys near Alexandria, and that desert reclamation threatened it with extinction.

Genus **Jaculus** Erxleben, 1777

Large and small jerboas. Dorsal color varying from dark brownish orange to orangish or cinnamon. White hip bands converging above base of tail. Hind foot with three functional toes. Digital and plantar pads small, concealed by long stiff hairs.

Zygomatic process of temporal with lateral process extending slightly or not beyond level of lip of external auditory meatus. Bony plate of lower root of zygomatic process fused with outer surface of maxilla closing foramina maxillaris dorsally. Jugal with broad vertical part and narrow horizontal part. Interparietal narrow, shield-shaped. Postpalatal process with two spines. Posterior margin of mastoid bulla inflated beyond level of supraoccipital. Tympanic bulla greatly inflated, apices fused medially below basioccipital and basisphenoid. Upper incisor orthodont or opithsodont, grooved on anterior surface. Upper jaw with three molars, first and second with Z-shaped enamel pattern. Lower jaw with angular process inflected and a shallow fossa between posterior molar and outer side of jaw. Baculum present.

Skin folds can be brought over nostrils for protection when the animals are burrowing and pushing soil with the short, broad snout.

KEY TO EGYPTIAN SPECIES OF *Jaculus*

1 Size large, head and body length 135-160 mm., ear length 28-35 mm., hind foot length more than 70 mm. Anterior mastoid chamber not completely filling suprameatal triangle. Posterior margin of nasals with V-shaped division (fig. 102) . . . . . *orientalis*, p. 334.

2 Size small, head and body length 99-120 mm., ear length 18-28 mm., hind foot length less than 70 mm. Anterior mastoid chamber completely filling

suprameatal triangle. Posterior margin of nasals with U-shaped division (fig. 102) ..... *jaculus*, p. 339.

Jaculus orientalis Erxleben, 1777

Jaculus orientalis Erxleben, 1777, Systema Regni Animalis, p. 404.

Type locality.—Egypt. SINAI: "In the mountains separating Egypt from Arabia" (according to the describer on p. 404).

General distribution.—Sinai Peninsula, Egypt, Libya, Tunisia, Algeria, and Morocco.

Common names.—Greater Egyptian Jerboa, *Gerbouh.*

Subspecies in Egypt.—

Jaculus orientalis orientalis Erxleben, 1777

Type locality.—Given under species.

Distribution in Egypt.—Figure 99. Northern Sinai, Southwestern Sinai Peninsula, Western Mediterranean Coastal Desert.

Diagnosis.—Large jerboa with dorsum brownish orange, side and hip band grayish. Ear pigmented. Hind foot with sole haired. Heel, metatarsus, and base of toes black. Tail long, with black subterminal band and white tip.

Skull inflated. Anterior mastoid chamber partly filling suprameatal triangle. Posterior margin of nasals with V-shaped division. Angle of lower jaw inflated, perforated with single large, round foramen.

Largest species of genus in Egypt. Adult head and body length average 148 mm.; tail 224 mm., 146 per cent of head and body length; hind foot 74 mm.; ear 32 mm.; weight 134 gm.

External characters.—Dorsum brownish orange, sides grayish due to black-tipped white hairs, becoming buffy to orangish on flank and thigh. Hip band of white hairs with grayish tips. Dorsum hairs with gray bases, orangish subterminal bands, and brownish tips. Underparts and forelimb white. Side of snout and head buffy. Supraorbital and postauricular spots small, whitish. Ear pigmented, whitish hairs on inner surface, buffy hairs on outer surface and lower anterior margin. Hind limb brownish orange on outer side. Foot white above, hair of sole and base of toes blackish, toe tips white. Tail with upper surface paler than dorsum, bicolored, underside white. Distal part of tail with white, feathered tip and

black, subterminal band. Dorsal tail surface whitish proximal to black band.

Feet.—Palm naked. Sole haired. Plantar and digital pads small and concealed by brush of long, stiff hairs.

Cranial characters.—Figure 103. Posterior nasal margin bifurcated into a broad "V" (fig. 102). Anterior mastoid chamber not filling suprameatal triangle. Lateral extension of zygomatic processs of temporal bone extending slightly beyond level of lip of external auditory meatus. Lip of meatus flaring laterally. Lower jaw with angular process inflected and perforated by one large round

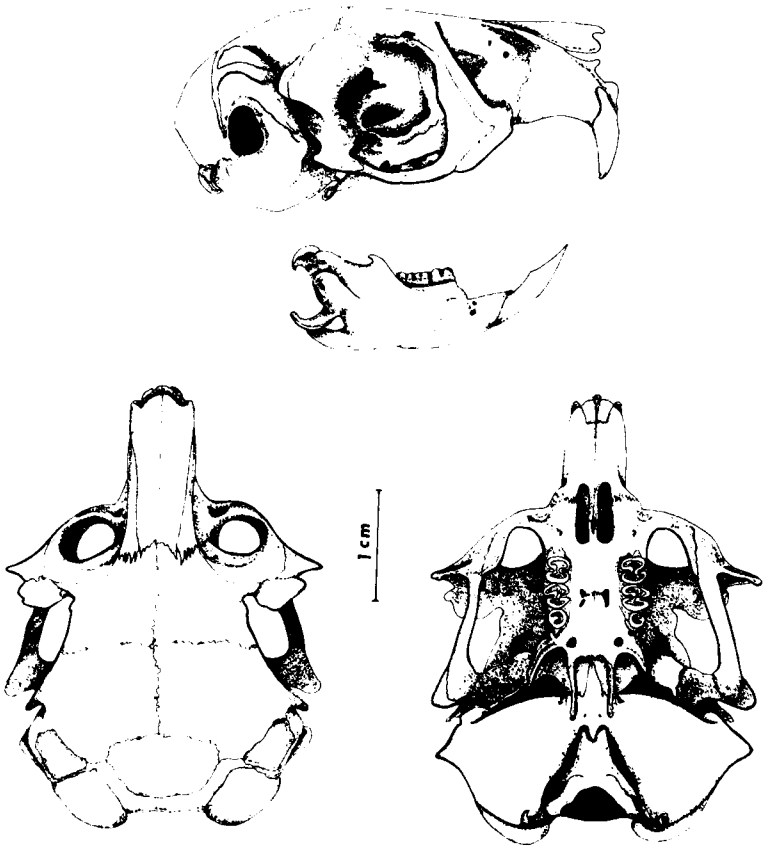


FIG. 103. Skull of *Jaculus orientalis orientalis*.

foramen. Characters in common with *J. jaculus* were discussed under the genus.

Teeth.—Figure 98. Incisors orthodont, upper with groove on anterior surface. Molars three in upper and lower jaws, enamel pattern of m^1, m^2 Z-shaped.

Measurements.—Table 41. Males average slightly larger in most dimensions than females, except occipitonasal length, the averages (and ranges) of which, in 14 adult males and 12 adult females, are (in millimeters): 36.7 (36.2 to 37.8) and 37.1 (36.3 to 38.0), respectively.

Age determination.—Adults have enamel cusps of upper molars united into lamellae and skull sutures closed. Degree of development of the dorsolateral inflection of the anterior end of zygomatic arch correlates with tooth wear and suture closure as in *Allactaga.*

Variation.—Individual variation in color was noted by Setzer (1958a).

Comparisons.—*Jaculus orientalis* differs from *A. tetradactyla* in larger dimensions, except for ear length, slightly paler color, hair on sole, hair concealing tarsal and toe pads, greater inflation of auditory bulla, and other characters listed under the descriptions of genera and in Table 40. From *J. jaculus*, *J. orientalis* differs in larger dimensions, especially ear and hind foot length, darker color, completely pigmented ear, less swollen anterior mastoid chamber, V-shaped, rather than U-shaped, posterior nasal margin (fig. 102), and other characters listed in Table 40.

Remarks.—Immature specimens from Ras Abu Rudeis on the Gulf of Suez coast of Sinai Peninsula are treated as *J. o. orientalis* since no adult specimens are available, as also noted by Setzer (1958a) and Hoogstraal (1963).

Specimens examined.—Total 83.

SINAI: Ras Abu Rudeis (2).

BEHEIRA: Beheira Nakhla (1).

ALEXANDRIA: Abu Qir (3), Ramleh (1), Amiriya (12).

MATRUH: Lake Mariut (8); Bahig (6), 18 km. S (2), 25.6 km. S (10); Abu Mena (4), 6.4 km. E (1); Burg el Arab (4); Raqabet el Halif (1); El Alamein (3); Ras el Hekma (5); Maatin el Garawla (1); Mersa Matruh (3), 1.6 km. NE (3), 2.4 km. NE (11), 8 km. NE (2).

Published records.—Records are from Anderson (1902), Setzer (1958a), Hoogstraal (1963), and Haim and Tchernov (1974).

SINAI: Ras Abu Rudeis, Nakhl, Kuntila, Gebel Maghara.

BEHEIRA: South side of Lake Idku (Abu Hommos area).

ALEXANDRIA: Ramleh, Alexandria.

MATRUH: Burg el Arab; El Hammam; El Daba; El Alamein; Mersa Matruh, 1.6 km. NE, 2.4 km. NE, 8 km. NE; Sidi Barrani.

Collection.—Dug from burrows and captured at night under a spotlight with butterfly nets. Occasionally taken in live traps.

Habitats.—Sinai Peninsula: Seashore area near Ras Abu Rudeis on the Gulf of Suez coast and northern and eastern desert areas.

Western Mediterranean Coastal Desert: Salt marshes with dominant plant usually *Salicornia fruticosa* (fig. 7); limestone slopes above salt marshes supporting *Suaeda fruticosa* (fig. 7); gardens; olive groves; Bedouin barley fields; clay desert in the *Thymelaea-Anabasis* association (fig. 8); and sandy or rocky slopes supporting *Thymelaea hirsuta, Noaea mucronata, Lycium* sp., and *Echinops spinosissimus.* One specimen was collected near *Artemisia monosperma* in a sandy area 6.4 km. E of Abu Mena.

Behavior.—Kirmiz's (1965) remark that some burrows led into large underground recreation parlors or "jerboa clubs," where these rodents gather to frolic, is no doubt a Bedouin fabrication.

Jaculus orientalis is strictly nocturnal, becoming active at dusk. It is a sociable species, and solitary individuals are rarely found as is common with *J. jaculus.*

Greater jerboas are relatively docile and not prone to bite. They do not struggle to escape if held by the tail.

Burrows.—Burrows are usually in hard ground, slanting to a depth of about 2 m. Openings are closed when occupied, at least in summer, with one or two sand plugs. One or two escape tunnels may be present and difficult to locate on the surface. There is usually a sleeping or nest chamber containing camel hair or shredded plant material and a food storage chamber (Hoogstraal, 1963). Burrow locations vary seasonally from hillsides in the winter rainy season to near margins of fields or close to vegetation in summer (Kirmiz, 1965). In the latter habitat, *J. orientalis* may be found in burrows of *Meriones shawi.* In salt marshes, *J. orientalis* shares burrows with *Psammomys obesus. Allactaga tetradactyla* is occasionally removed from burrows of *J. orientalis.*

Food.—Sprouting vegetation, plant roots, or barley grains planted by Bedouins are listed as food of wild *J. orientalis* by Kir-

miz (1962, p. 32) and are the preferred foods of captive jerboas, but "they will eat bread, rice, and vegetables, such as fresh corn, green peas, green beans, carrots, potatoes, lentils, etc. They also eat peanuts and melon seeds. They do not eat dates, dry fruits, bananas or tomatoes." In Kirmiz's laboratory, *J. orientalis* survived on wheat and barley grains alone for one to three years. Hoogstraal (1963) found quantities of dates (contrary to Kirmiz, 1962), barley, and other seeds stored in burrows. With the variety of perennial and ephemeral plants in the Western Mediterranean Coastal Desert flora, there is no lack of food for this and other rodent species. A collection of seed capsules and dry fruits from the burrow of a greater jerboa near Bahig in April, 1964, included mostly *Malva aegyptia*, and *Calendula micrantha*, *Trigonella stellata*, *Astragulus hamosus*, *Medicago* sp., *Lophochloa pumila*, and *Parapholis marginata*. Various succulent shrubs, such as *Salicornia fruticosa* and *Suaeda fruticosa*, are probably browsed by *J. orientalis* inhabiting salt marshes or the periphery.

Although *J. orientalis* appears to be physiologically capable of surviving in true desert along with *J. jaculus*, it does not. Perhaps availability of food limits this larger species to the littoral semidesert.

Water.—Kirmiz (1962, 1965), in studies of the physical, behavioral, and physiological adaptations of *J. orientalis* to the desert environment of the Western Mediterranean Coastal Desert, emphasized its ability to live in the laboratory on dry food without water. Our experience with this species and *J. jaculus* indicates that succulent vegetation and new growth (e.g., barley sprouts) provide available water in nature.

Populations.—Hoogstraal (1963, p. 32) recorded 1 to 50 or more greater jerboas per 0.8 km., "depending both on availability of food and nature of soil."

Associates.—As mentioned, *J. orientalis* is found with *A. tetradactyla* and *P. obesus*. The species has also been collected in the same habitat with *Meriones shawi*, *Gerbillus andersoni*, *J. jaculus*, and various *Dipodillus* sp., all inhabitants of the Western Mediterranean Coastal Desert and, some of them, the coastal salt marshes.

Reproduction.—*Jaculus orientalis* does not breed in captivity, according to Kirmiz (1962). Reproductive data from wild specimens

are scanty. One postpartum female had two fetal scars in March, another was found lactating in June, and a third carried two fetuses in August. Flower (1932) said three appeared to be the average litter size, noted one case of four or five, and gave months of birth as February, April, and early July. These data indicate that the breeding season begins after the winter rains (November-February) and lasts about five or six months.

Sex ratio.—In a sample of 64 museum specimens of greater jerboas, males numbered 30 and females 34.

Economic importance.—Thighs and lumbar regions are roasted and eaten by Bedouins.

These rodents probably cause some loss to Bedouins by feeding on sprouting barley and ripe grain.

Jaculus jaculus (Linnaeus, 1758)

Mus jaculus Linnaeus, 1758, Syst. Nat., 10th ed., p. 62.

Type locality.—Northern Egypt.

General distribution.—Iraq, Syria, Lebanon, Israel, Jordan, Saudi Arabia, Sinai Peninsula, Egypt, Libya, Algeria, Mauritania, Spanish Sahara, Chad, Niger, and Somalia.

Distribution of subspecies in Egypt.—Figure 104. *Jaculus jaculus schlueteri:* Sinai Peninsula, northern part of Eastern Desert; *Jaculus jaculus butleri:* southern part of Eastern Desert; *Jaculus jaculus flavillus:* Western Mediterranean Coastal Desert; *Jaculus jaculus jaculus:* Western Desert from the Mediterranean Coastal Desert southward.

Common names.—Lesser Jerboa, *Gerbouh.*

Diagnosis.—Small jerboa with dorsum orangish to brownish cinnamon. Side orangish to grayish, hip band whitish to grayish. Ear tip pigmented. Hind foot with or without dark hair on heel or metatarsus. Toes three. Tail long, with black subterminal band and white tip.

Parietal portions of skull inflated. Anterior chamber of mastoid bulla completely filling suprameatal triangle. Posterior margin of nasals with a U-shaped division. Lower jaw with angle inflected and perforated with one or two foramina of varying size.

Smallest species of the genus in Egypt. Adult head and body length average 107 mm.; tail 181 mm., 166 per cent of head and

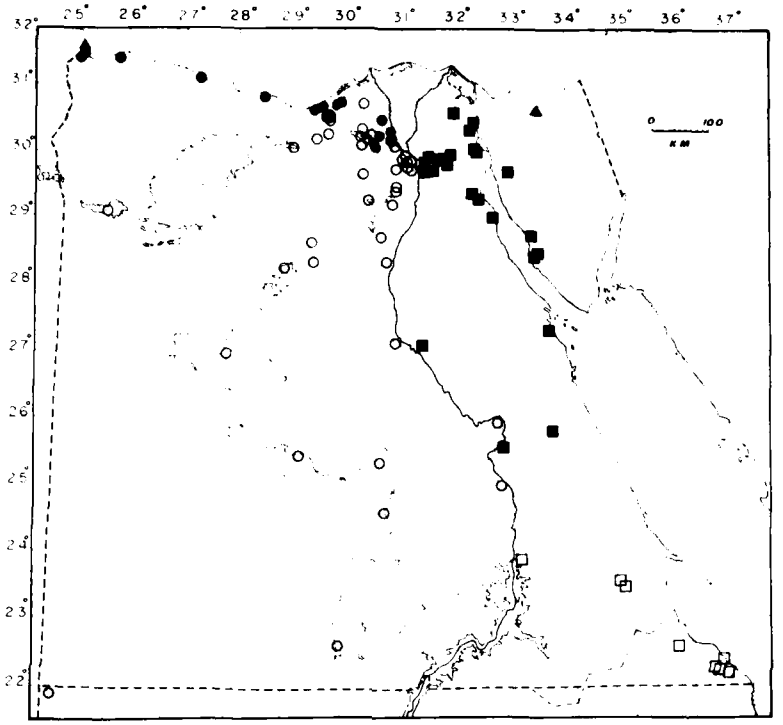


FIG. 104. Collection localities of *Jaculus jaculus jaculus* (circles), *J. j. flavillus* (dots), *J. j. schlueteri* (closed squares), *J. j. butleri* (open squares), and *Hystrix cristata* (triangles).

body length; hind foot 62 mm.; ear 22 mm.; occipitonasal length 32 mm.; weight 55.0 gm.

External characters.—Figure 105. Dorsum orangish to brownish cinnamon. Sides orangish to grayish, hip band whitish to grayish due to varying widths of blackish hair tips. Thighs orangish to cinnamon. Dorsal hairs with gray bases. Side, belly, and hip band hairs with white bases. Underparts and forelimb white. Hind foot sometimes with blackish or buffy hairs on heel, metatarsus, and base of toes. Distal part of toes and upper side of foot white. Ear tip pigmented. Whitish hairs on inner surface of ear denser than on outer surface. Anterior margin of ear with whitish fringe. Mystacial and preorbital areas white, suborbital areas white or partly

pigmented. Supraorbital spot large, white. Postauricular spot white, inconspicuous. Upper surface of tail about color of dorsum, gradually becoming whitish on underside. Tail cylindrical except for broad blackish or brownish feathered subterminal band and white tip. Subterminal band often preceeded by white ring which may or may not connect on underside with the white of tip. The black band is thereby "complete" or "incomplete" (table 42).

Feet.—Palm naked, sole haired. Plantar and digital pads small and concealed by brush of long, stiff hairs.

Cranial characters.—See Figure 103 of *Jaculus orientalis.* Most characters were described under genus and are listed in Table 42. Skull triangular in dorsal outline, parietal region inflated. Interparietal broad, shield-shaped. Anterior mastoid chamber completely filling suprameatal triangle. Posterior margin of nasals with a U-shaped division (fig. 102). Angle of lower jaw inflected, perforated by one or two round foramina of varying size (fig. 106).

Teeth.—Figure 98. Upper incisor opisthodont, anterior surface grooved. Three molars in upper and lower jaws. Enamel pattern of m^1, m^2 Z-shaped.

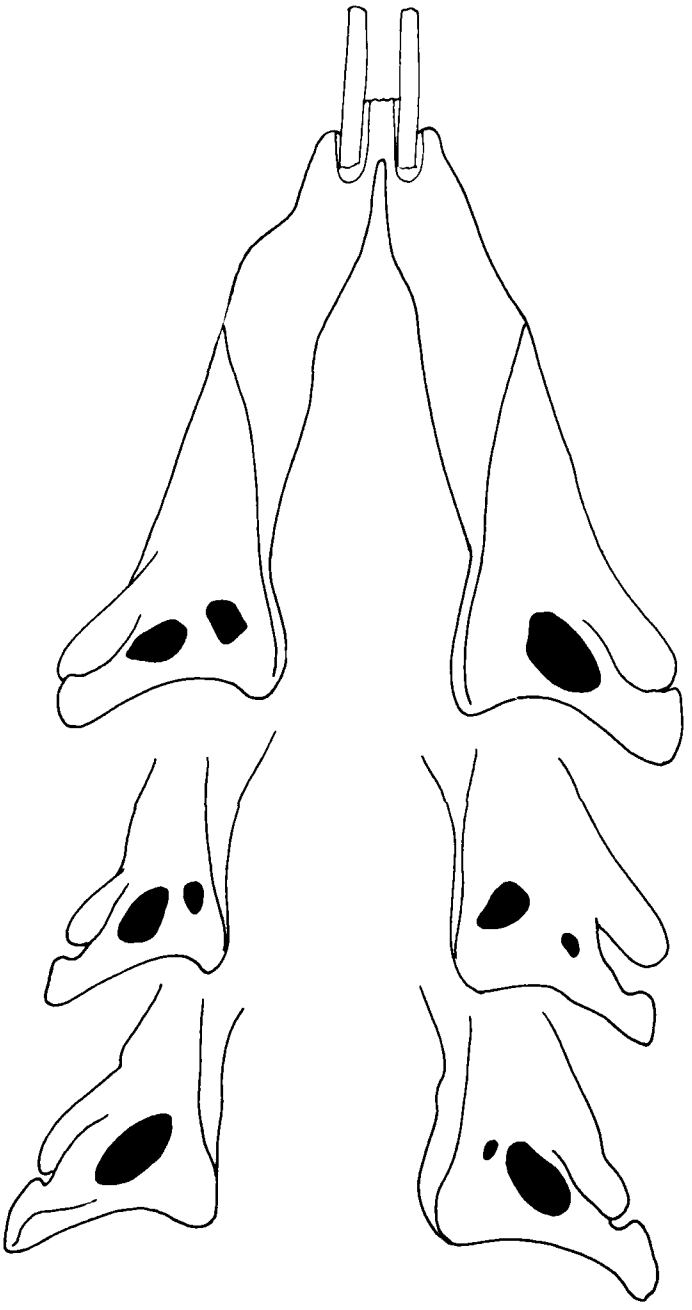
FIG. 105. Live specimen of *Jaculus jaculus jaculus.* Note that longest vibrissae are contacting ground.

TABLE 42.—Color and cranial variations in *Jaculus jaculus*.

	Sinai Peninsula and Eastern Desert				Western Desert			
	J. j. schlueteri		*J. j. butleri*		*J. j. flavilus*		*J. j. jaculus*	
1. Dorsal color:	brown	orange	brown	orange	brown	orange	brown	orange
Number	47	3	31	3	27	0	3	135
Per cent	94	6	90	10	100	0	2	98
2. Underside of black tail band:	complete	incomplete	complete	incomplete	complete	incomplete	complete	incomplete
Number	16	2	20	2	16	4	34	61
Per cent	89	11	90	10	80	20	36	64
3. Foramina in angle of lower jaw:	two	one	two	one	two	one	two	one
Number	28	17	10	15	16	12	44	83
Per cent	62	38	40	60	58	42	34	66

Opposite:

FIG. 106. Lower jaw (upper) and posteriors of lower jaws (lower two figures) in ventral view of *Jaculus jaculus* showing variations in foramina in angles of jaw. Single foramina in each jaw is not shown.



Measurements.—Table 43. Dimensions of males and females subequal. Means (and ranges) of occipitonasal length (in millimeters) of 10 adult males and eight adult females, are: 31.4 (30.7 to 32.2) and 31.4 (31.0 to 31.8), respectively.

Age determination.—Adults have enamel cusps of upper molars united into lamellae and cranial sutures closed. In addition, degree of development of the dorsolateral inflections of zygomatic arches correlates with tooth wear and suture closure as in *Allactaga* and *J. orientalis.*

Variation.—Dorsal color in *J. jaculus* varies from brownish orange to brownish cinnamon in Sinai Peninsula, Eastern Desert, and Western Mediterranean Coastal Desert subspecies *schlueteri, butleri,* and *flavillus,* respectively, to orangish in Western Desert *jaculus.* Individuals of either color phase can be found randomly distributed within the geographical range of the other. Immatures and molting individuals cannot always be segregated into one or the other color phase. The black tail band is usually complete, hip bands more grayish, and hairs of sole more commonly pigmented in the brownish races; whereas in orangish *J. jaculus,* the black tail band is usually incomplete, hip bands less grayish, and hairs of sole less commonly pigmented (table 42). The data in Table 42 were initially segregated on the basis of dorsal color.

Thomas (1922) noted that color was more uniformly darker and tail band usually complete in *J. j. butleri* in Sudan compared with *J. j. jaculus* of Egypt.

Number and size of foramina in the angle of the lower jaw vary through one large, one large and one small, two large, and two small (fig. 106). Asymmetry in number and size is common, although in Table 42, the largest number in either side of the jaw only was recorded.

In a sample of 12 orangish *J. j. jaculus* from the semidesert near Giza, four were asymmetrical, five had one foramen in each side, and three had two foramina in each side. In another sample of 12 of mixed colors from Bir Victoria, one was asymmetrical, six had one foramen in each side, and five had two foramina in each side. Three of the latter were dark in color. Data in Table 42 show that in the northern subspecies, *schlueteri* and *flavillus,* 60 per cent have two foramina in one side of the lower jaw, and 40 per cent have a single foramen in the lower jaw. In subspecies *butleri* and *jaculus,* approx-

TABLE 43. — Means (and ranges) of measurements, ratios, and weight of adult *Jaculus jaculus*.

	J. j. jaculus	*J. j. flavillus*	*J. j. schlueteri*	*J. j. butleri*
HBL	109.7 (98-118) 78	111.4 (101-119) 25	111.8 (99-120) 39	105.3 (95-112) 16
TL	180.9 (160-203) 76	180.4 (162-197) 22	186.9 (165-205) 36	177.4 (150-190) 16
TL HBL^{-1}	168.8 (148.1-189.0) 76	162.4 (149.1-178.8) 22	162.8 (149.1-191.5) 37	168.5 (145.4-194.0) 16
FL	62.1 (56-66) 80	61.4 (57-65) 26	63.9 (60-68) 40	59.5 (59-62) 6
EL	20.5 (19-23) 80	24.1 (20-27) 26	23.4 (19-28) 39	20.1 (16-22) 16
Wt	55.0 (45-73) 60	— —	50.8, 62.0, 66.4	50.4 (43.0-58.0) 12
ONL	31.3 (30.2-32.7) 77	31.0 (29.7-32.6) 24	31.6 (29.5-32.7) 30	30.9 (30.0-33.5) 15
ZW	22.6 (19.9-24.4) 71	22.6 (21.3-24.0) 22	22.4 (20.7-23.3) 24	22.9 (21.7-24.4) 13
IOW	12.0 (11.2-12.8) 77	11.7 (10.9-12.9) 25	11.6 (11.0-12.5) 31	12.2 (11.3-12.5) 15
NL	12.0 (11.0-13.3) 75	12.0 (11.1-13.1) 25	12.4 (10.9-13.9) 29	12.3 (11.6-14.0) 15
IFL	4.4 (3.7- 5.1) 77	4.4 (3.9- 4.6) 25	4.4 (3.8- 5.2) 31	4.4 (4.0- 4.7) 15
AL	5.3 (4.8- 5.6) 77	5.3 (4.8- 5.6) 25	5.4 (4.8- 6.2) 32	5.1 (4.5- 5.4) 15
SH	15.1 (14.4-16.1) 77	15.1 (14.6-15.6) 25	15.2 (14.4-15.9) 33	14.6 (14.3-15.1) 15

imately the reverse occurs, 40 per cent have two foramina and 60 per cent have one foramen (table 42). Thomas (1922) recorded a single foramen only in the lower jaw of *J. j. butleri* in Sudan. Number of foramina in the lower jaw is of limited use in distinguishing subspecies and of some value in separating species of jerboas.

Jaculus j. butleri is smaller in most dimensions than other Egyptian subspecies (table 43). In *J. j. schlueteri*, the hind foot averages slightly longer than in other subspecies (fig. 107). In the northern subspecies, *schlueteri* and *flavillus*, ears average longer than in subspecies *butleri* and *jaculus* to the south. Other measurements show no significant clinal variation. Skull height, which is an indicator of variation in parietal swelling and/or bulla inflation, gives no indication of proportional differences among subspecies.

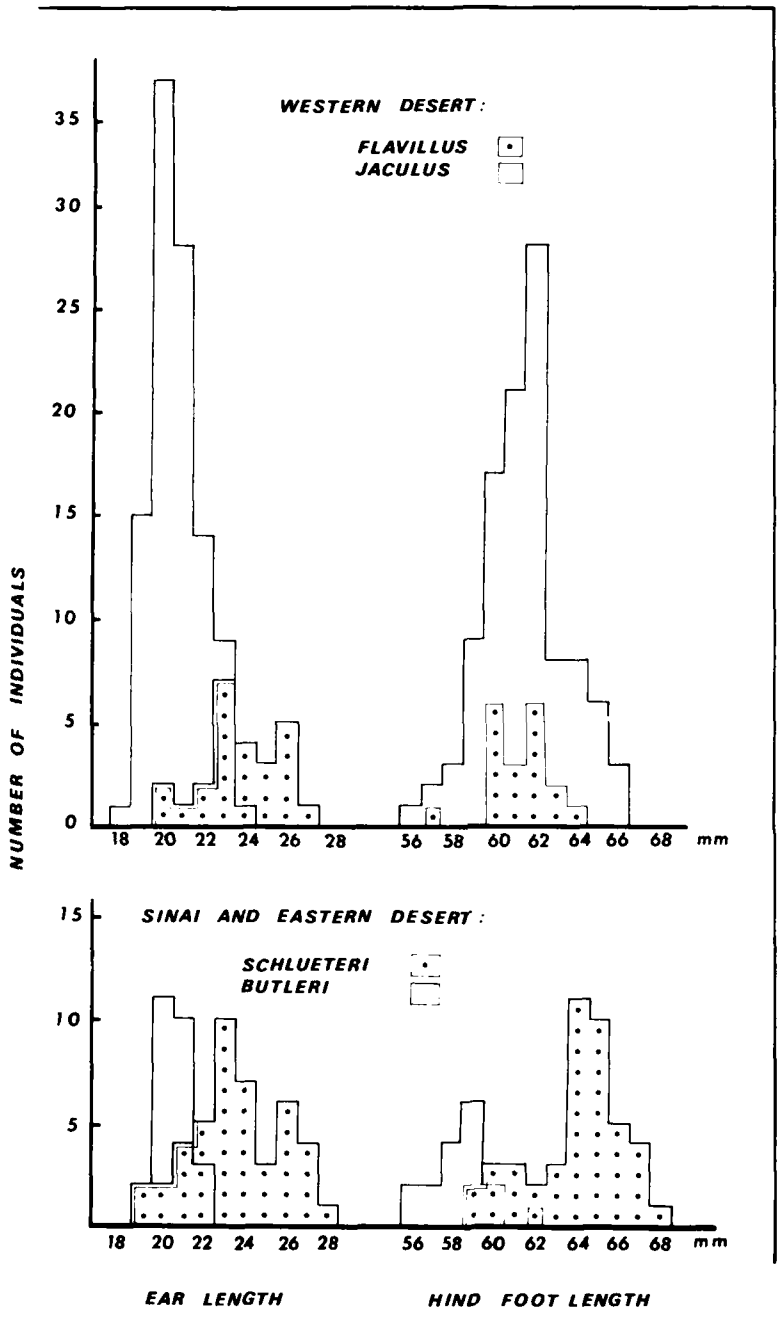
Comparison.—*Jaculus jaculus* can be distinguished from *J. orientalis* by smaller external and cranial dimensions, especially the shorter hind foot and ear; paler color; less pigmentation on ear; more swollen anterior mastoid chamber, completely filling the suprameatal triangle; and U-shaped, rather than V-shaped, posterior bifurcation of the nasals (fig. 102). These and additional characters are listed in Table 42. *Jaculus jaculus* differs from *Allactaga tetradactyla* in paler color; much shorter and less pigmented ears; hair on sole; pads of foot concealed by hair; lack of the nonfunctional fourth toe; much greater inflation of the auditory bulla; upper incisor opisthodont and grooved, rather than proodont and smooth; and lack of a premolar. Additional characters are listed in Table 42.

Remarks.—The two color phases, orangish and brownish cinnamon, according to Ranck (1968), represent two sympatric species, *J. jaculus* and *J. deserti*. The latter, he maintains, can be distinguished from *J. jaculus* by the following characters: (1) darker hair on dorsum, side, and sole of feet; (2) smaller, more compact skulls; (3) more inflated auditory bulla; and (4) two distinct foramina of equal or unequal size in the angular process of the mandible as opposed to a single foramen.

Four "distinct" Libyan populations of *J. deserti* recognized by Ranck (1968) consisted of two specimens allotted to *J. deserti*

Opposite:

FIG. 107. Frequency diagrams of ear length and hind foot length of subspecies of *Jaculus jaculus*. Overlapping is indicated by double lines.


WESTERN DESERT:
FLAVILLUS
JACULUS
NUMBER OF INDIVIDUALS
35
30
25
20
15
10
5
0
18 20 22 24 26 28
56 58 60 62 64 66 68
mm
SINAI AND EASTERN DESERT:
SCHLUETERI
BUTLERI
15
10
5
18 20 22 24 26 28
56 58 60 62 64 66 68
mm
EAR LENGTH
HIND FOOT LENGTH

flavillus, and five, one, and one for each of three "new" subspecies. He also considered *schlueteri* a subspecies of *J. deserti*. The data presented herein on variation (table 42, fig. 107) are not in accord with Ranck's conclusions and do not support the application of *J. deserti* to Egyptian and Libyan subspecies.

Collection.—Dug from burrows and caught at night under a spotlight with an insect net. *Jaculus jaculus* enters live traps, particularly when placed beside feeding stations (fig. 108) or in tracks made in sand by a vehicle. Incidently, trap lines placed in car tracks are also effective in capturing other species that frequent sandy habitats.

Habitats.—Sinai Peninsula: "Loose sand hills and hillocks" in the north (Wassif, 1953b, p. 115); "plains and wide, sandy wadis, often near tamarisk trees, from the Red Sea coasts to high altitudes" (Hoogstraal, 1963, p. 30). "It exists up to an altitude of 1,500 meters on the plateau of St. Catherine Monastery" (Haim and Tchernov, 1974, p. 216).

Eastern Desert: Sand and gravel accumulations around trees and shrubs; hard, sandy, and gravelly terraces and deltas of mountain wadis; coastal plains; and intersecting wadis. Reported from acacia parkland at the foot of Gebel Elba (Hoogstraal, 1963) where burrows were found in sandy areas near vegetation.

Western Desert: Mediterranean Coastal Desert on clay soils in and around Bedouin barley fields and in *Thymelaea-Anabasis* communities (fig. 19); and sandy areas supporting *Artemisia monosperma* (fig. 20), margins of oases, and depressions supporting one or several species of grasses and/or flowering plants (fig. 10). South of the littoral vegetation, burrows are usually in hard, barren sand slopes as far as several hundred meters from the nearest vegetation.

Behavior.—*Jaculus jaculus*, as other Egyptian jerboas, is strictly nocturnal. Unlike the more sociable *J. orientalis*, solitary individuals are commonly found wandering at night in barren desert. This proneness to wander was mentioned by Harding-King (1925) who once followed a jerboa's track in the Western Desert for about 14 km.

Jaculus jaculus is nervous, struggles to escape, does not bite when handled, and emits plaintive cries. If held by the tail, jerboas cease struggling.

FIG. 108. Western Desert 3 km. SSE of Camel Pass Dune. Solitary specimen of *Cornulaca monocantha*, an important browse plant of *Gazella* sp. and a food source for *Jaculus jaculus*. Note foot and tail markings of the latter indicating activity while feeding. Live trap at left caught one specimen of *J. jaculus jaculus*.

Driving a car around or over a burrow, even in daytime, stimulates a jerboa to leave the burrow. After an erratic chase, if the jerboa is not captured, it will return and disappear into the burrow via the single, small opening. If attempt is made to dig out the jerboa, it may suddenly emerge from the ground via an escape passage. If chased, the jerboa may again lead an erratic flight and return to the burrow site. If, in its movements, another hole was discovered, the jerboa would enter it. A jerboa, well in advance of its pursuers, may stop suddenly and remain motionless, sometimes avoiding fur-

ther discovery. For additional information on *J. jaculus* behavior, Happold (1967a, 1968a) should be consulted.

Burrows.—Burrows dug in hard, barren sand or beneath *serir* are usually difficult to find, because all excavated material is carried away by wind. Occupied burrows are plugged with sand in summer, open in winter. Burrows are simple, slanting, a meter or more in depth, and according to Hoogstraal (1963), usually deeper in winter than in summer. One or two escape exits are usually dug vertically just beneath the ground surface. The nest chamber near the end of the burrow is furnished with shredded plant material.

West of Cairo, in hard, barren clayey-sand slopes that descended gradually for as much as 64 m., Briscoe (1956) found shallow to exceptionally deep burrows. The burrows extended from 30 to 168 cm. below the surface and were 60 to 196 cm. long. In early September, 1953, ground temperatures varied from 78° to 104° F. and relative humidity, 33.5 to 48 per cent. Within burrows, temperature varied from 80° to 100° F. and relative humidity 35.5 to 49.5 per cent.

Food.—Happold (1968a, p. 433) found that "seeds, dried desert grasses, and roots" were the normal food of the lesser jerboa in Sudan. He (Happold, 1967a) fed captive animals grass, cubes of cucumber, and sunflower seeds as a basic diet and said it cannot eat large, hard seeds and will reject them. We have maintained *J. jaculus* in captivity on a diet of dry bread, sorghum grain, and raw carrots. Tortonese (1948) fed captive *J. jaculus* leaves, fruit peels, crumbs of bread, and cheese.

In the Eastern Desert, lesser jerboas were trapped beside the pungent-smelling *Cleome droserifolia* and, in captivity, ate the harsh, glandular foliage. *Aerva javanica* was also eaten. Jerboas taken in *Salsola baryosma* on the Red Sea coastal plain were assumed to feed on the succulent leaves. At El Maghra in the Western Desert, a stand of *Zygophyllum album* was found to be a feeding area of *J. jaculus*. Captive animals readily accepted and ate the fleshy leaves. A specimen or two of lesser jerboa can usually be caught beside spiny *Cornulaca monocantha*, where foot and tail markings indicate jerboas have been feeding (fig. 108). Seeds and new growth of various grasses, such as the hummock-forming *Stipagrostis scoparia* and *S. vulnerans*, are eaten as is the large, common bunch grass, *Panicum turgidum* (fig. 20). Seeds of *Calligonum comosum* (fig. 9) are also eaten. *Stipagrostis plumosa*, a

small grass of runnels and sandy depressions, is often kept closely clipped by grazing lesser jerboas.

The inability of *J. jaculus* to cope with large, hard seeds probably accounts for the absence of the species from certain acacia groves where no other plants exist. *Meriones crassus, M. libycus, Gerbillus gerbillus,* and *G. perpallidus* can utilize acacia seeds and are found near trees on otherwise barren gravel or sand. Jerboas that we found at night in barren desert were assumed to be "foraging" for small, windblown seeds trapped in crevices or hollows.

In the Western Mediterranean Coastal Desert, food of the lesser jerboa no doubt includes barley and sprouting grain and other plants also eaten by the greater jerboa. *Jaculus jaculus* collected in *Thymelaea-Anabasis* associations (fig. 19) and in the vicinity of *Artemisia monosperma* (fig. 20) probably eat some parts of these plants, particularly the buds of the latter. Beyond this, we have no exact information of foods of the lesser jerboa in this area.

Observations of Happold (1967a) in Sudan and of Hoogstraal et al. (1957b) in Egypt indicate that *J. jaculus* does not store food in its burrows. Our investigations in Egypt have resulted in the same conclusion.

Water.—Water is metabolized from the natural food of *J. jaculus,* although experimenters have shown that this species will lose weight rapidly on a diet of dry grain alone (Schmidt-Nielsen, 1964, p. 182). Tortonese (1948) and Happold (1968a) observed that *J. jaculus* drinks water in captivity. In nature, jerboas may utilize dew (Bagnold, 1954).

Details of the physiologic features of water economy in *J. jaculus* have been discussed by Shalaby (1962) and Gabr and Shalaby (1962, 1964).

Populations.—Lesser jerboas are never abundant, and usually no more than three or four are seen in any one locality. The distribution in Sudan is "patchy" (Happold, 1967a), and like *J. orientalis,* numbers vary with availability of food and type of terrain.

Associates.—*Jaculus jaculus* shares the same environments with *Allactaga tetradactyla, J. orientalis, Meriones libycus, M. shawi, M. crassus, Gerbillus gerbillus, G. andersoni, G. pyramidum, G. perpallidus, Pachyuromys duprasi,* and some *Dipodillus* sp. Burrow sites, except for areas within the Western Mediterranean Coastal

Desert vegetation, are isolated from most other species, except perhaps *M. crassus*.

Reproduction.—Flower (1932) reported four young born in May and examined nestlings in August. Additional records of pregnant and lactating females occur from February to September. Number of young range from 4 to 10.

Happold (1967a) gave the reproductive period at Khartoum from October to November in 1964 and October to February in 1965. Average number of young in 18 litters which he examined was three, range two to five.

Later, he (Happold, 1970) succeeded in breeding *J. j. butleri* in captivity by providing adequate space and suitable nesting conditions. He described in detail courtship and mating behavior and development of the young.

Sex ratio.—In a sample of 144 museum specimens of lesser jerboas, males numbered 75 (52 per cent) and females 69.

Economic importance.—These rodents probably cause some loss to Bedouins by feeding on sprouting barley and grain. Hoogstraal (1963) observed that this jerboa never invaded established cultivated areas. We have a single specimen from a peanut field in the desert edge near Abu Rawash.

KEY TO EGYPTIAN SUBSPECIES OF *Jaculus jaculus*

1. Dorsum brownish, black tail band usually complete on the underside.
   a. Ear length averaging more than 23 mm.
      i. Hind foot length averaging more than 63 mm. (Sinai Peninsula and northern part of Eastern Desert) ..... *schlueteri*, p. 352.
      ii. Hind foot length averaging less than 63 mm. (Western Mediterranean Coastal Desert) ..... *flavillus*, p. 353.
   b. Ear length averaging less than 23 mm. (Southern part of Eastern Desert) ..... *butleri*, p. 355.
2. Dorsum orangish, black tail band usually incomplete on the underside. (Western Desert) ..... *jaculus*, p. 356.

Jaculus jaculus schlueteri (Nehring, 1901)

Dipus schlueteri Nehring, 1901, S.B. Ges. Nat. Fr. Berlin, p. 163.

Type locality.—Israel: Jaffa.

Distribution in Egypt.—Figure 104. Sinai Peninsula and northern part of Eastern Desert.

External characters.—Dorsum brownish cinnamon, side and hip band white with cinnamon and grayish or blackish tipped hairs.

Mystacial and preorbital area white; supraorbital spot buffy, inconspicuous; postauricular spot small, whitish. Black tail band complete on underside in 89 per cent of specimens (table 42).

Cranial characters.—See species description. Angle of lower jaw with two foramina in 62 per cent and one foramen in 38 per cent of specimens (table 42).

Measurements.—Table 43, Figure 107.

Variation.—Orangish individuals appear sporadically in the population. Those in the Eastern Desert near Cairo were considered by Setzer (1959a) to be intergrades with *J. j. jaculus* of the Western Desert.

Intergradation cannot be demonstrated between *schlueteri* and *butleri* because of lack of material.

Comparisons.—*Jaculus j. schlueteri* differs from other Egyptian subspecies chiefly in greater average hind foot length (table 43, fig. 107). Other differences are mentioned under the following subspecies.

Specimens examined.—Total 64.

SINAI: Ras Abu Rudeis (10), Wadi Raha (2), Feiran Oasis (2).

ISMAILIA: Fayid (10), 4.8 km. NE (5).

SUEZ: Wadi Ghuweibba (2); Ain Sukhna area (3); Wadi el Katamiya mouth (2); Wadi el Gafra (1); Wadi Gindali (1); Cairo-Suez road km. 28 (2), km. 24 (2), km. 20 (1), km. 18 (1).

CAIRO: Wadi Digla (1), Gebel el Ahmar (4), Heliopolis 8 km. E (4).

RED SEA: Wadi el Nil (1), Wadi Abu Shaar (1), Abu Kharif mine area in Wadi Fatira (1), Fawakhir mine (1), 16 km. E in Wadi Abu Ziran (1); Wadi Umm Selemat (1).

ASYUT: Wadi el Asyuti 20 km. SE of Asyut (3).

QENA: Luxor (2).

Published records.—Records are from Allen (1915), Wassif (1953b), and Setzer (1958a). Some were listed by these authors as *J. j. jaculus.*

SINAI: Ras Abu Rudeis, Wadi Feiran, Feiran Oasis, Wadi Raha.

SHARQIYA: El Salhiya.

ISMAILIA: Nefisha, El Ferden.

SUEZ: Wadi Ghuweibba, Ain Sukhna.

Jaculus jaculus flavillus Setzer, 1955

Jaculus jaculus flavillus Setzer, 1955, Proc. Biol. Soc. Wash, **68**, p. 184.

Type locality.—Egypt. MATRUH: Salum, Bir Bosslanga (Bir Wair).

Distribution in Egypt.—Figure 104. Western Mediterranean Coastal Desert.

External characters.—Dorsum brownish cinnamon, side and hip bar white with cinnamon and blackish tipped hairs. Mystacial and preorbital areas white; supraorbital spot whitish, not prominent; postauricular spot small, white. Black tail band complete on underside in 80 per cent of specimens (table 42).

Cranial characters.—See species description. Angle of lower jaw with two foramina in 58 per cent and one foramen in 42 per cent of specimens (table 42).

Measurements.—Table 43, Figure 107.

Variation.—Orangish individuals appear sporadically in the population. Intergradation between *J. j. flavillus* and *J. j. jaculus* occurs in the areas of Wadi el Natroun, Bir Victoria (Setzer, 1958a) and El Birigat (fig. 104) and could no doubt be demonstrated all along the southern limits of the Mediterranean Coastal Desert vegetation.

Comparisons.—Longer average ear length (fig. 107) and brownish rather than orangish color in *flavillus* are the main characters that can be used to distinguish the subspecies from *jaculus*. From *schlueteri*, *flavillus* differs in slightly smaller average hind foot length. In coloration, these two subspecies are nearly identical.

Specimens examined.—Total 49.

BEHEIRA: Bir Victoria (12); Wadi el Natroun, Abu Makkar Monastery (Deir Makaryus) (1); Wadi el Natroun (7), 15 km. W (4); El Hamra (1); El Khatatba (4); Kom Hamada (1); El Birigat (2).

MATRUH: El Amiriya (2); Bahig (1), 18 km. SE (2); Burg el Arab (1); Raqabet el Halif (1); Abu Mena (2); El Hawa 20 km. S of El Hammam (1); El Daba (1); Mersa Matruh (1); Sidi Barrani 32 km. W (4); Salum, Bir Bosslanga (Bir Wair) (Type).

Published records.—Records are from Setzer (1955, 1958a), and some were listed by him as *J. j. jaculus*.

BEHEIRA: El Khatatba, Kom Hamada.

MATRUH: Burg el Arab, El Daba, Mersa Matruh, Sidi Barrani 32 km. W, Bir Bosslanga (Bir Wair).

Jaculus jaculus butleri Thomas, 1922

Jaculus jaculus butleri Thomas, 1922, Ann. Mag. Nat. Hist., (ser. 9), 9, p. 296.
Jaculus jaculus elbaensis Setzer, 1955, Proc. Biol. Soc., Wash., 68, p. 183.

Type locality.—Sudan. KHARTOUM: Khartoum.

Distribution in Egypt.—Figure 104. Southern part of Eastern Desert.

External characters.—Dorsum brownish orange; side and hip band white with pale orangish and grayish tipped hairs. Mystacial and preorbital areas white; supraorbital spot whitish, not prominent; postauricular spot small, white. Black tail band complete on underside in 90 per cent of specimens (table 42).

Cranial characters.—See species description. Angle of lower jaw with two foramina in 40 per cent or one foramen in 60 per cent of specimens (table 42).

Measurements.—Table 43, Figure 107. *Jaculus j. butleri* averages slightly smaller in most dimensions than other Egyptian subspecies.

Variation.—A few specimens approach subspecies *jaculus* in having more orangish coloration. Intergradation cannot be demonstrated between *butleri* and *schlueteri* because of lack of material.

Comparisons.—*Jaculus j. butleri* differs from *J. j. schlueteri* mainly in shorter hind foot and ear (fig. 107) and slightly more orangish color. From subspecies *jaculus*, *butleri* differs in less orangish and more brownish color, and much larger frequency of specimens with black tail band complete on underside (90 per cent vs. 36 per cent) (table 42).

Remarks.—We have synonymized *J. j. elbaensis* Setzer under *J. j. butleri* Thomas, owing to similarity in color; equal numbers with black tail band complete on underside; comparable cranial characters, including frequency of two foramina in the lower jaw; and equal dimensions, particularly hind foot and ear length, of respective samples.

Specimens examined.—Total 31.

RED SEA: Wadi Naam (1), Bir Abraq (4).
ASWAN: Aswan 1.6 km. SE (1), Wadi el Allaqi (1).
SUDAN ADMINISTRATIVE: Wadi Ibib (2); Wadi Adeib, 4.8 km. N Bir Kan-

sisrob (4), 4 km. N of Bir Kansisrob (3); Bir Sarrara (1); Abu Ramad 4 km. N (1), Wadi Darawena (1).

Sudan. KASSALA: Wadi Onib (1).

KHARTOUM: Khartoum 16 km. N (11).

Published records.—Records are from Setzer (1955, 1958a) and Hoogstraal et al. (1957b) and were listed as *J. j. elbaensis.*

RED SEA: Bir Abraq, Wadi Naam.

SUDAN ADMINISTRATIVE: Wadi Darawena; Bir Sarrara; Bir Kansisrob 4 km. N, 4.8 km. N.

Jaculus jaculus jaculus (Linnaeus, 1758)

Type locality.—Northern Egypt, probably near Giza Pyramids.

Distribution in Egypt.—Figure 104. Western Desert south of Mediterranean Coastal Desert.

External characters.—Dorsum orangish; side and hip band white with pale orangish and grayish tipped hairs. Mystacial and preorbital area white; supraorbital spot white, conspicuous; postauricular spot small, white. Black tail band complete on underside in 36 per cent of specimens (table 42).

Cranial characters.—See species description. Angle of lower jaw with two foramina in 34 per cent and one foramen in 66 per cent of specimens (table 42).

Measurements.—Table 43, Figure 107.

Variation.—Brownish individuals appear sporadically in the population. An albino specimen and three with white areas on the back were collected from the desert near Giza Pyramids. Intergradation mentioned under *J. j. flavillus* occurs between *J. j. jaculus* and *J. j. flavillus* in the areas of Wadi el Natroun, Bir Victoria (Setzer, 1958a), and El Birigat. Setzer also considered the few orangish specimens of *schlueteri* east of Cairo as intergrades.

Comparisons.—*Jaculus j. jaculus* differs from other Egyptian subspecies by greater percentage of individuals with dorsum orangish (table 42). From Mediterranean Coastal Desert subspecies *flavillus,* it can be distinguished by shorter ear length, and from *schlueteri,* by shorter ear and hind foot (table 43, fig. 107). Dimensions of *J. j. jaculus* average slightly larger than in *J. j. butleri* (table 43, fig. 107).

Specimens examined.—Total 155.

EL TAHREER: El Tahreer 3.2 km. W (1), Cairo-Alexandria desert road km. 165 (1).

BEHEIRA: Bir Victoria (3), Wadi el Natroun (3), El Birigat 2 km. W (2), Abu el Matamir (1), Wadi el Farigh (1).

GIZA: El Mansuriya (2); Abu Rawash (10); Abu Ghalib (6); Giza Pyramids 8 km. W (1), 8 km. NW (31; Sakkara (1); Faiyum road km. 5 (1); El Qatta (2); Bahariya Oasis, Bir Qasr (4), Bawiti (3), Ain Guffara (1), El Hara (1).

EL FAIYUM: Faiyum (2); Kom O Shim (5), 3.2 km. N (2); west end of Lake Qarum, 3 km. N (3); Wadi Muwellih (12).

MINYA: Hatiyet el Sunt (4), El Bahnasa (1).

ASYUT: Beni Adi (5).

QENA: Wadi Nassim (2), Dandara 6 to 8 km. S (1).

MATRUH: Cairo-Alexandria desert road km. 17 (1), km. 30 (1), km. 35 (1), km. 102 (1); Bahig 35 km. S (1), 42 km. S (1); Ilwat Hawa (5); Bir Nahid (1); Qaret el Ided (1); Qaret el Mashruka (2); Qasr el Qatagi (1); El Maghra (23); Siwa Oasis (1), Ain el Dakrur (1); Camel Pass Dune area (5).

EL WADI EL GEDEED:†Farafara Oasis 4.8 km. NE (3); Dakhla Oasis, Balat (1); Kharga Oasis, Baris (10), El Gezira (2), El Kharga 8 km. S (1); Nasser Village (2); Bir Quiseiba (3).

Sudan. NORTHERN: Gebel Uweinat, Karkur Murr (3).

Published records.—Records are from Wassif (1953b) and Setzer (1958a).

BEHEIRA: El Birigat 2 km. W, Abu el Matamir, El Khatatba 1.6 km. W, Kom Hamada, Bir Victoria, Wadi el Natroun, Zaghig.

GIZA: Imbaba, Abu Ghalib, Abu Rawash, Sakkara.

FAIYUM: Kom O Shim, Kom O Shim 1.6 km. N, near Lake Qarun.

QENA: Wadi Nassim.

MATRUH: Cairo-Alexandria desert road km. 30, Siwa Oasis.

EL WADI EL GEDEED: Kharga Oasis.

Sudan. NORTHERN: Gebel Uweinat, (one specimen of two was erroneously labelled *J. deserti rarus* Ranck, 1968 by Osborn and Krombein, 1969).

Family 6. Hystricidae

Characters under species.

Genus **Hystrix** Linnaeus, 1758

Hystrix cristata Linnaeus, 1758

Hystrix cristata Linnaeus, 1758, Syst. Nat., 10th ed., p. 56.

Type locality.—Italy: Rome.

General distribution.—Italy, Sicily, Mauritania, Morocco, Algeria, Tunisia, Libya, Egypt, Northern Sudan, Asben, Senegal.

Common name.—Crested Porcupine.

Distribution in Egypt.—Figure 104. Probably limited to cliffs north of Salum, if not extinct.

Diagnosis.—Dorsum and tail pelage of long, round, hollow, black and white quills. Head and body length average about 600 mm. Toes four, five. Nasofrontal region of skull inflated, nasals extremely long and broad. Angular process of mandible arising from outer side of alveoli. Crowns of cheek teeth flat, complexly folded. Dental formula: $\frac{1}{1}, \frac{0}{0}, \frac{1}{1}, \frac{3}{3} \times 2 = 20$.

Historical notes.—A Bedouin in Salum recalled having killed a porcupine in the cliffs north of there in the 1950's. He referred to it as "Porc épic."

Carvings of porcupine occur in the Fifth and Sixth Dynasty mastaba of Pehenouka at Sakkara.

Bisharin tribesmen claimed that porcupine occur in the Red Sea or Kassala District of Sudan and called it "hanhan" (Keimer, 1949).

Quills reported by Wassif (1953b) and Hoogstraal (1963) from Ain Gudairat (Ain el Gedeirat), 90 km. SE of El Arish in northeastern Sinai may have been of *H. indica* which ranges from Saudi Arabia, Israel, Syria, and Turkey eastward into India and Ceylon.

ORDER CARNIVORA

KEY TO EGYPTIAN FAMILIES OF CARNIVORA

Cranial and Dental Characters

1. Upper tooth row longer than one-half skull length.
   a. Alisphenoid canal present. Rostrum narrow. Paroccipital process not extending below bulla. . . . . Family 1. Canidae, p. 359.
   b. Alisphenoid canal lacking. Rostrum broad. Paroccipital process extending below bulla. . . . . Family 4. Hyaenidae, p. 422.
2. Upper tooth row shorter than one-half skull length.
   a. Lower cheek teeth three. Rostrum short, broad. Cranium short, rounded. Postpalatal foramen on maxillopalatine suture. . . . . Family 5. Felidae, p. 434.
   b. Lower cheek teeth four or more. Cranium elongate. Postpalatal foramen on maxilla.
      i. Rostrum relatively short. Bulla not constricted nor divided by septum. . . . . Family 2. Mustelidae, p. 395.
      ii. Rostrum relatively long. Bulla constricted and divided by septum. . . . . Family 3. Viverridae, p. 410.

External Characters

1. Limbs long. Features dog- or cat-like. Hind foot with four toes.
   a. Dog-like. Muzzle long. Tail bushy. Claws blunt, nonretractile.
      i. *Pelage never striped or spotted.* Muzzle slender. Fore and hind limb length equal. . . . . Family 1. Canidae, p. 359.
      ii. Pelage striped. Muzzle broad. Hind limb shorter than fore. . . . . Family 4. Hyaenidae, p. 422.
   b. Cat-like. Muzzle short, broad. Tail cylindrical, never bushy. Pelage usually with stripes and/or spots. Claws sharp, curved, and retractile (except in *Acinonyx*). . . . . Family 5. Felidae, p. 434.
2. Limbs short. Features weasel-like. Hind foot with five toes.
   a. Pelage plain or striped. Tail slender or bushy, two-thirds or less than length of head and body. . . . . Family 2. Mustelidae, p. 395.
   b. Pelage coarsely grizzled or spotted and striped. Tail cylindrical to somewhat bushy, longer than two-thirds of head and body. . Family 3. Viverridae, p. 410.

Family 1. Canidae

Carnivores with dog-like features. Muzzle elongate; ears large, erect, pointed; legs long in proportion to body length. Feet

semidigitigrade, toes 5-4, inner toe of forefoot vestigial; claws blunt, nonretractile. Tail long, two-thirds of or more than length of head and body, bushy, and with scent gland near dorsal base.

Rostrum and nasals elongate, upper tooth row length equal to or greater than one-half skull length. Paroccipital process prominent, protruding. Tympanic bulla conspicuously inflated, septum lacking. Alisphenoid canal present. Baculum well developed, grooved on underside.

Incisors unspecialized; canines long, powerful; premolars sharp; carnassials well developed, modified for cutting and crushing; remaining molars are the crushing type. Dental formula: $\frac{3}{3}, \frac{1}{1}, \frac{4}{4}, \frac{2}{3} \times 2 = 42$.

KEY TO EGYPTIAN GENERA OF CANIDAE

1. Dorsum blackish, side yellowish. Tail brush-like, tip black. Frontal region of skull strongly elevated. Postorbital process convex above. Postorbital swelling present. Cranium broadest at bases of zygomatic processes of temporals. ..... *Canis*, p. 360.

2. Dorsum reddish, side grayish to buffy. Tail brush-like or bushy and club-shaped, tip black or white. Frontal region of skull not elevated or slightly elevated. Postorbital process concave above. Postorbital swelling absent. Cranium broadest on sides, narrower at bases of zygomatic processes of temporals.

   a. Tail relatively long (62 per cent of head and body length), cylindrical, tip white. Dorsal stripe broad, prominent. Side grizzled gray and yellowish. Skull ridged in adults. Frontal region not elevated. ..... *Vulpes*, p. 371.

   b. Tail relatively short (55 per cent of head and body length), brush-like, tip black. Dorsal stripe narrow, inconspicuous. Side pale yellowish buff. Skull smooth or with inconspicuous lyre-shaped ridges. Frontal region elevated slightly. ..... *Fennecus*, p. 387.

Genus **Canis** Linnaeus, 1758

Dog-like carnivores with broad dorsal mane. Tail relatively short, brush-like, tip black. Pupil of eye round. Frontal region of skull inflated. Postorbital process convex dorsally, lacking posterior ridge. Postorbital region swollen. Posterior end of nasals at level of or posterior to frontomaxillary suture. Cranial ridges high and prominent. External occipital protuberance extends caudad of occipital condyle. Tip of zygomatic process thin. Cranium broadest at base of zygomatic process. Canines relatively short, thick; point of upper canine does not reach level of mental foramen when jaws are closed. Cheek teeth heavy, with or without cingula.

Canis aureus Linnaeus, 1758

Canis aureus Linnaeus, 1758, Syst. Nat., 10th ed., p. 40.

Type locality.—Iran, LARISTAN (now FARS).

General distribution.—Thailand and Burma west throughout India and Ceylon, Pakistan, Afghanistan, southern Turkestan, Iran, Iraq, Transcaucasia, Turkey, southern Russia and southeastern Europe, Syria, Lebanon, Jordan, parts of Saudi Arabia, Israel, Sinai Peninsula, Egypt, Sudan, Ethiopia, Somalia, and Kenya. Libya west to Morocco and Rio de Oro and south to Senegal.

Common names.—Jackal, *Deeb, Abu Soliman.*

Subspecies in Egypt.—

Canis aureus lupaster (Hemprich and Ehrenberg, 1833)

Canis lupaster Hemprich and Ehrenberg, 1833, Symbolae Physical Mamm., Dec. 2, folio ff.

Type locality.—Egypt. EL FAIYUM.

Distribution in Egypt.—Figure 109. Sinai Peninsula, Nile Delta and Valley and bordering deserts, Western Mediterranean Coastal Desert, and oases of the Western Desert.

Diagnosis.—Size and appearance like a large blackish yellow dog with a dorsal mane. Tail relatively short, brush-like, black dorsally and on tip. Black marking on anterior of forelimb.

Skull dog-like, frontals inflated. Cranial ridges prominent. External occipital protuberance extends caudad of occipital condyle. Postorbital process large, convex dorsally. Nasal bones taper gradually posteriorly, terminating at level of or posterior to fronto-maxillary suture. Bulla rounded, smooth. Jaw teeth in line, not crowded. Last lower premolar with two posterior cusps and a cingulum.

Adult head and body length average 872 mm.; tail 312 mm., 36 per cent of head and body length; foot 200 mm.; ear 112 mm.; condyloincisive length 185 mm.; weight 13 kg.

External characters.—Dorsal mane of long, coarse, black-tipped hairs with yellowish subterminal bands and buff to whitish bases, extends from crown to base of tail and onto shoulder and hip. Agouti nature of hairs on hip gives an impression of broken stripes. Side yellowish, with scattering of black- and white-tipped hairs. Chin grayish; throat, belly, and inside of legs whitish to yellowish. Chest with medial strip of black-tipped hairs. Axillary, inguinal, and

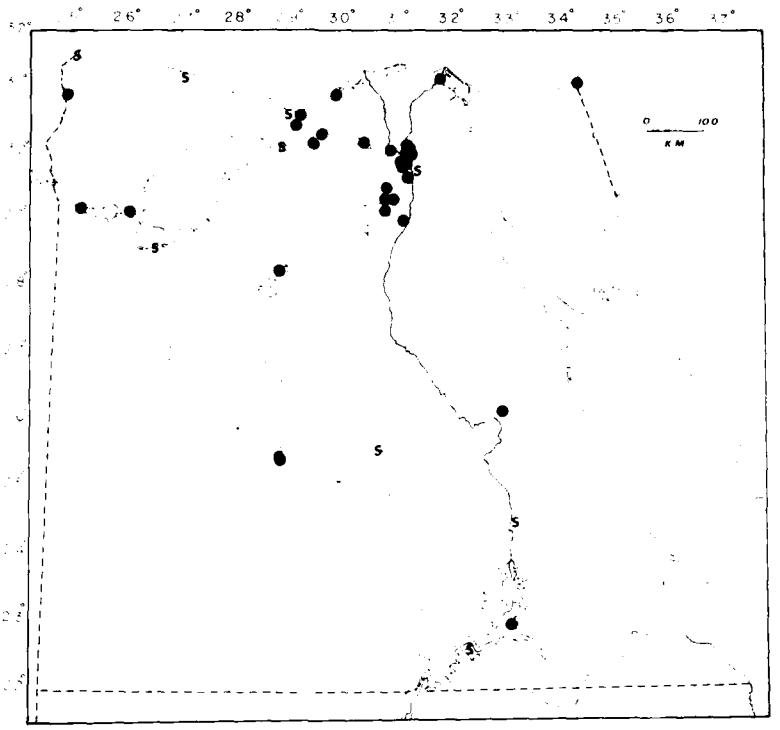


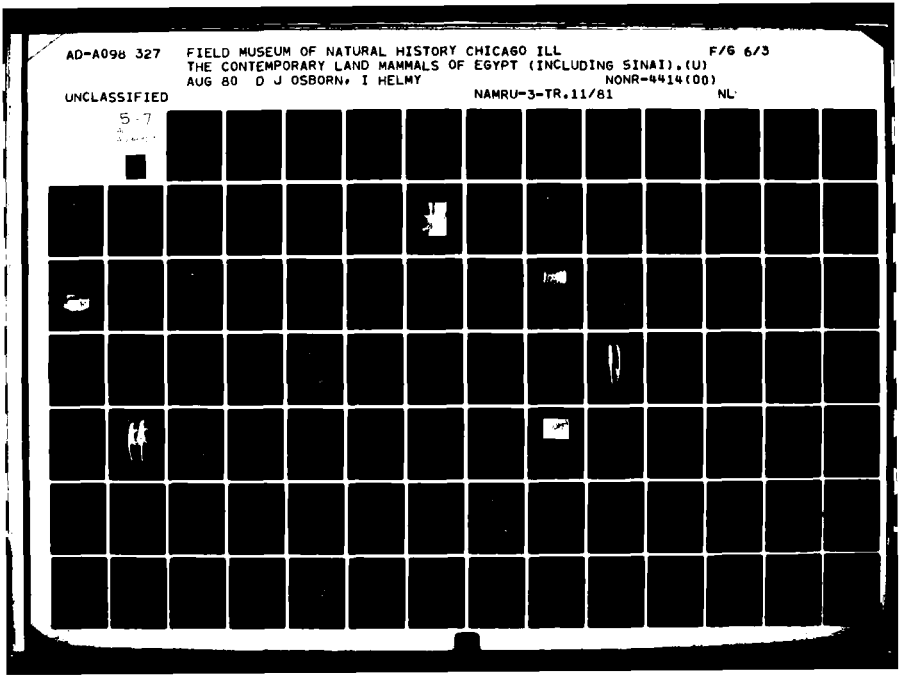
FIG. 109. Collection localities of *Canis aureus lupaster* and sight records (S).

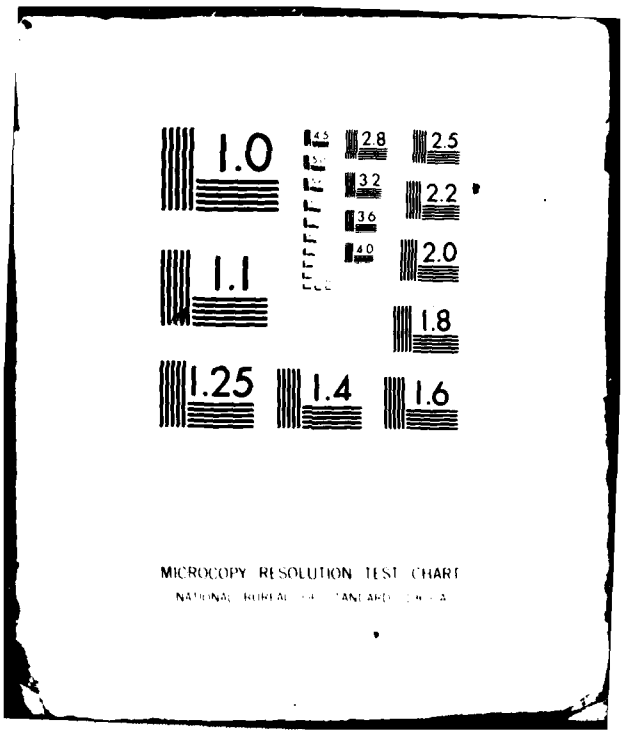
perineal areas whitish. Hairs on side of neck whitish, black-tipped. Muzzle rufous grizzled with white. Frontal area and cheek grizzled white, yellowish, and black. Crown rufous or grizzled rufous, yellowish, and black. Ear rufous behind, buffy inside with black-tipped hairs on anterior margin. Legs deep buff to rufous on outer side. Feet orangish buff; hair of palm and sole rufous, not covering pads. Prominent black stripe along anterior of foreleg.

Pelage of young pale brownish above from snout to rump with narrow black dorsal stripe. Throat and belly buff. Short, faint black stripe on anterior of lower foreleg.

Cranial characters.—Figure 110. Skull large, elongate; frontal, sagittal, and lambdoidal ridges strongly developed. External occipital protuberance prominent, extending considerably posterior to level of occipital condyle. Frontal region inflated. Postorbital pro-

AD-A098 327 FIELD MUSEUM OF NATURAL HISTORY CHICAGO ILL F/G 6/3
THE CONTEMPORARY LAND MAMMALS OF EGYPT (INCLUDING SINAI).(U)
AUG 80 D J OSBORN, I HELMY NONR-4414(00)
UNCLASSIFIED NAMRU-3-TR.11/81 NL




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART

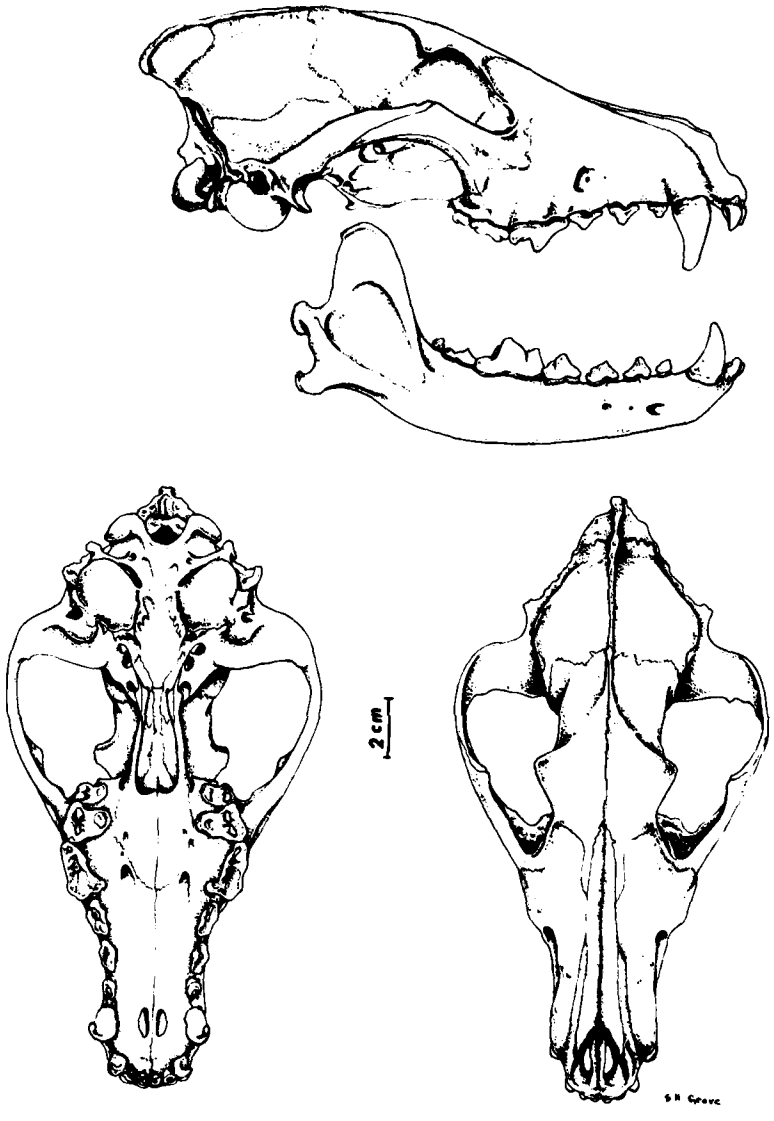


FIG. 110. Skull of *Canis aureus lupaster*.

cess convex above, posterior ridge lacking. Nasals long, tapering gradually posteriorly, terminating at level of or posterior to level of frontomaxillary suture. Postorbital region swollen. Paroccipital process large, projecting. Bulla large, rounded, and smooth.

Baculum.—Baculum similar to that of *Vulpes* sp., but smoother, longer, and relatively slenderer. Deep, thin-edged ventral channel extends about four-fifths of length from base. Cross-section triangular for that distance, then changes to elongate, rounded tip (Didier, 1946). Total lengths of two adult bacula, 70 and 73 mm.

Teeth.—Teeth similar to *Vulpes* sp., but much larger and heavier, crowns relatively higher, canines heavier and shorter. Upper canine tip does not reach level of mental foramen when jaw is closed; p_4 has two posterior tubercles and a cingulum. Cingula on outer borders of $m^{1,2}$ wide and conspicuous, but cusps narrow. Lower carnassial has large metaconid, heel area nearly one-half that of rest of tooth, and cusps strongly developed (fig. 110).

Measurements.—Table 44. Male and female dimensions appear to be subequal, but Anderson (1902) said females were much smaller than males.

Age determination.—Adults have frontoparietal ridges fused posterior to frontoparietal suture, forming a high sagittal ridge, cranial sutures closed, teeth worn. Teeth show varying degrees of wear, greatest in desert specimens.

Variation.—Width of dorsum varies individually and independently of width of mane. Tone of rufous color on snout, back of ears, and feet also varies individually. Specimens from desert localities slightly paler than those from the Nile Delta and Valley. Flower (1932) said jackals from northwestern Egypt were smaller

TABLE 44. — Means (and ranges) of measurements, ratios, and weight of adult *Canis aureus lupaster.*

HBL	871.6 (822-923) 9	RW	33.8 (31.2-37.8) 14
TL	312.8 (290-347) 9	POW	34.8 (31.8-38.9) 13
TL/HBL%	35.8 (33.7-39.5) 9	BCW*	54.4 (51.8-59.1) 13
FL	199.8 (190-212) 9	NL	72.0 (65.9-84.8) 14
EL	112.4 (104-121) 9	M^1-M^1	58.2 (54.2-63.0) 14
Wt (kg.)	13.0 (10.0-15.0) 4	C-M^2	80.3 (75.6-86.8) 14
CIL	185.2 (173.5-196.0) 13	SH	66.8 (62.0-74.0) 9
ZW	101.4 (93.5-111.4) 14		

*At level of tempoparietal suture.

than those from the Nile Delta and considered them as subspecies *tripolitanus*. Setzer (1957c) did not concur, nor do the data herein. Determination of intergradation in this area awaits further collecting.

Comparisons.—*Canis aureus* is distinguishable from other Egyptian Canidae in having the dorsum blackish and maned, frontal region of skull elevated, a prominent postorbital swelling, cranium broadest at bases of zygomatic processes, and larger dimensions (tables 44, 45, 46). *Canis a. lupaster* is considered to be the largest and darkest of North African and Southwest Asian subspecies (Pocock, 1941).

Large canid skulls found in the desert are usually dog. Some have been deposited in museums and labelled "jackal." Following are characters that distinguish dog from jackal skulls. No single character, however, is always reliable.

(1) Greater inflation of frontal region between postorbital processes.
(2) Forehead steeper due to lesser angle between rostrum and cranium.
(3) Dorsal surface of braincase lower relative to postorbital processes.
(4) Postorbital region more inflated and elongated.
(5) Auditory bulla flattened, less inflated, and surface rough rather than smooth.
(6) Zygomatic arch with greater upward curvature.
(7) Snout and palate usually shorter and broader.
(8) Jugular or paroccipital process heavier and more protruding.
(9) Hypoglossal foramen on transverse ridge of above usually more anterior and ventral in position.
(10) Tuberosities on basioccipital larger.
(11) Lower jaw shorter, thicker and more curved.
(12) Posterior margin of ramus concave rather than straight.
(13) Level of last lower molar above others.
(14) Canines and other teeth generally larger.
(15) Cingula lacking on first and second upper premolars.
(16) Teeth usually crowded and set at angles rather than in line.
(17) Fourth lower premolar with one rather than two posterior tubercles and lacking cingulum (fig. 111).
(18) Posterior heel of lower carnassial relatively narrower and cusps less strongly developed.

TABLE 45. — Means (and ranges) of measurements, ratios, and weight of adult male (M) and female (F) *Vulpes vulpes aegyptiaca*.

		Giza	Bahig
HBL	M	602.1 (541-652) 9	554.4 (533-592) 8
	F	589.6 (552-634) 24	513.4 (465-570) 7
TL	M	374.6 (343-401) 9	349.5 (326-398) 8
	F	361.6 (307-391) 23	320.8 (302-368) 7
TL/HBL%	M	62.9 (58.7-67.2) 8	62.8 (57.3-67.2) 8
	F	61.4 (58.2-74.4) 23	62.8 (52.9-72.8) 7
FL	M	149.8 (136-165) 9	137.5 (127-149) 8
	F	148.7 (134-160) 24	123.3 (105-134) 6
EL	M	99.0 (93-109) 9	93.1 (91-106) 8
	F	97.7 (91-106) 24	88.6 (70-104) 7
Wt (kg.)	M	6.0	
	F	4.6, 4.8, 4.8, 5.5	
CIL	M	133.7 (125.5-142.3) 13	124.2 (119.8-132.9) 7
	F	130.7 (123.0-139.6) 22	115.6 (109.5-120.4) 13
ZW	M	71.2 (65.1-76.5) 12	66.8 (62.5-69.1) 11
	F	70.2 (66.2-75.8) 24	63.7 (59.8-69.1) 13
RW	M	21.8 (20.5-22.6) 13	20.2 (19.1-22.3) 12
	F	21.6 (19.3-22.5) 23	18.7 (17.1-20.1) 13
POW	M	21.0 (19.5-22.8) 12	21.2 (19.7-23.4) 12
	F	21.2 (18.9-25.6) 23	21.8 (19.8-23.2) 13
BCW	M	45.6 (43.0-50.9) 12	44.1 (42.7-45.4) 12
	F	44.6 (42.8-46.5) 23	43.0 (41.6-55.3) 13
NL	M	48.9 (38.4-56.7) 13	44.5 (41.5-49.6) 11
	F	48.6 (45.3-52.6) 23	41.8 (38.2-48.2) 13
C-M^2	M	61.0 (55.3-64.5) 13	57.1 (55.0-62.1) 9
	F	59.7 (56.8-63.6) 22	54.4 (51.4-57.0) 12
M^1-M^1	M	37.8 (35.0-39.9) 13	35.4 (33.1-36.9) 10
	F	37.2 (35.5-40.6) 22	34.2 (32.9-36.8) 10
SH	M	47.8 (44.0-49.1) 12	45.8 (44.6-46.7) 8
	F	46.8 (45.4-48.6) 10	44.0 (43.2-45.4) 8

Discussion of characters of domestic versus wild canids are in Gidley (1914), Lawrence (1967), and Lawrence and Bossert (1967).

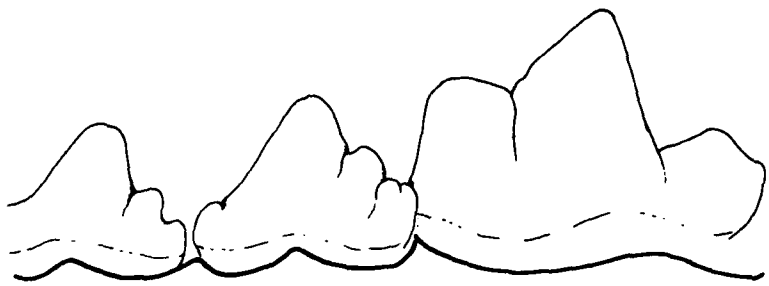
Remarks.—References to wolves in literature on Egypt can be inferred as meaning jackals. The Arabic name, *Deeb*, is applied to both *C. lupus* and *C. aureus*. Embalmed remains of jackals and dogs have been reported from tombs near Asyut, ancient Egyptian city of Anubis, the "jackal" god, which was also known as Lycopolis, city of wolves, during the Ptolemaic period (Ebers, 1878; Murray,

TABLE 46. — Means (and ranges) of measurements, ratios, and weight of adult male (M) and female (F) *Vulpes r. rueppelli*.

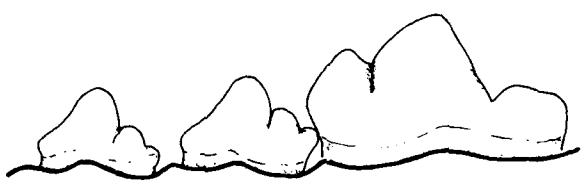
		Sinai Peninsula	Eastern Desert	Western Desert
HBL	M	——	468.5 (428-519) 15	463.2 (419-476) 13
	F	505.0 (469-559) 3	442.5 (411-468) 8	449.0 (418-460) 5
TL	M	——	343.6 (290-387) 15	337.8 (305-380) 13
	F	308.6 (281-363) 3	326.4 (273-354) 8	318.8 (292-345) 5
TL/HBL%	M	——	73.3 (67.4-78.8) 15	73.4 (67.6-83.8) 13
	F	61.6 (50.4-74.5) 3	73.8 (61.0-77.9) 8	71.0 (68.4-75.0) 5
FL	M	——	127.0 (115-138) 16	126.6 (119-134) 13
	F	121.6 (110-129) 3	121.5 (112-131) 8	121.4 (119-125) 5
EL	M	——	101.6 (95-110) 14	95.0 (89-107) 13
	F	102.3 (96-108) 3	97.5 (93-110) 8	91.2 (88-94) 5
Wt (kg.)	M	——	1.9 (1.4- 2.3) 6	1.7 (1.4- 1.9) 7
	F	——	1.5, 1.7	1.7 (1.4- 1.8) 4
CIL	M	109.0	106.4 (98.2-113.9) 15	106.1 (97.5-110.5) 13
	F	105.9 (110.2-108.8) 4	102.3 (99.0-105.8) 8	101.2 (91.0-103.8) 5
ZW	M	59.6	60.0 (55.5-65.6) 15	58.1 (55.6-62.4) 13
	F	58.8 (56.7-60.3) 4	57.3 (56.4-58.4) 8	57.8 (55.7-59.8) 5
RW	M	17.7	16.8 (15.3-18.4) 15	16.5 (15.7-17.3) 13
	F	17.2 (16.8-17.4) 4	16.8 (15.9-17.5) 8	16.2 (15.2-18.1) 5
POW	M	22.0	20.0 (17.9-23.4) 15	20.4 (18.6-22.9) 13
	F	20.2 (18.3-22.9) 4	20.6 (18.8-21.9) 8	20.2 (19.2-22.4) 5
BOW	M	42.0	40.3 (38.8-42.0) 15	40.2 (38.0-42.0) 13
	F	39.3 (38.9-39.7) 4	39.9 (38.0-41.6) 8	39.3 (38.4-40.8) 5
NL	M	38.5	36.5 (31.8-41.1) 15	38.2 (34.4-41.2) 13
	F	36.6 (34.6-38.3) 4	35.4 (33.0-38.4) 8	36.9 (36.1-38.1) 5
C-M^2	M	——	49.4 (46.4-52.4) 13	50.0 (43.7-52.9) 13
	F	48.2 (44.7-49.8) 4	47.4 (44.6-49.6) 7	48.6 (46.8-51.2) 5
M^1-M^1	M	——	31.0 (29.5-33.5) 13	31.2 (29.9-33.4) 12
	F	31.7 (29.6-33.1) 4	30.3 (29.3-31.1) 6	31.4 (29.5-34.0) 5
SH	M	42.9	41.0 (39.6-42.4) 15	41.4 (40.3-42.5) 13
	F	41.0 (40.6-41.3) 4	41.4 (40.7-42.4) 8	41.2 (40.4-42.5) 5

1891; Gaillard, 1927). In 1965, we searched many of the Gebel Durunka tombs, but found only fox (*Vulpes vulpes*) remains, along with mummified humans. We are inclined to believe that Anubis was a fox rather than a jackal, because all of the statuary and heiroglyphs of Anubis are of an animal with the tail of a fox.

References to wolves in Sinai could possibly mean *C. lupus*. Palmer (1872) accounted the fighting of dogs with a large "wolf" in Wadi Aleyat, a tributary of Wadi Feiran near the Oasis. He also



JACKAL



DOG

FIG. 111. Left mandibular teeth ($pm_{3,4}$; m_1) of jackal and dog. Drawings are not to same scale. See explanation in text.

found remains of a camel in Wadi Gharandel which, according to Bedouins, had been killed by a pack of wolves. Hart (1891) made no mention of wolves in Sinai, but several "wolves" were said to have been shot during an expedition to Sinai in 1927 (Bodenheimer and Theodor, 1929), and Howells (1956) reported wolves in Wadi Gazzah, northeastern Sinai. Wolves are still widespread in the Arabian Peninsula (Harrison, 1968), but are now considered to be intruders in Israel from the east and north (Bodenheimer, 1958). Wolves in Sinai could doubtlessly be considered as strays.

Specimens examined.—Total 62.

DAQAHLIYA: Faraskur (2).

ALEXANDRIA: Ramleh (1).

MINUFIYA: Mohammed Ali Barrage Park (1).

QALYUBIYA: Qalyub (1); Sindbis (1); Sanafir, Ezbet Ibsan (1).

GIZA: Giza (2); Imbaba (1); Abu Rawash (3); Abu Ghalib (1); Giza Pyramid area (1), 16 km. W (1); Badrshein (1); Kirdasa (1); El Baragil (1).

EL FAIYUM: Faiyum (1); Kom O Shim (2), 1.6 km. W (1), 10 km. N (1); Kom O Shim Forest (10); Tamiya (3).

BENI SUEF: Beni Suef (1).

QENA: Qena-Safaga road km. 5 (1), Luxor (1).

ASWAN: Wadi Allaqi (1), Wadi Allaqi 11.2 km. S of Allaqi Village (2), Wadi el Targama (1), Khor Abusku S of Wadi Nogdeb (8).

MATRUH: El Afritat 17 km. SW of El Hammam (1); Alam Shaltut 72 km. S of Bahig (1); between Nakhlet el Barraq and Qaret el Mashruka (1); Bir Shaqqa (1); Siwa Oasis 20 km. E of (1), Aghurmi (2).

EL WADI EL GEDEED: Dakhla Oasis, Dakhla (2); El Gezira SE of Kharaga (1).

Sight records of I. Helmy and D. Osborn.—

CAIRO: Helwan.

EL FAIYUM: El Mishigeiga.

MATRUH: Nuweimesa, Wadi Labaq (tracks).

ASWAN: Road between Idfu and Kom Ombo.

Published records.—Records are from Anderson (1902), Harding-King (1925), Flower (1932), Omer-Cooper (1947), Tregenza (1955), Howells (1956), and Setzer (1961b).

SINAI: Wadi Gazzaht (probably *C. a. syriacus*).

RED SEA: Wadi Midhais.

DAQAHLIYA: Faraskur.

QUALYUBIYA: Sindbis.

GIZA: Giza, Abu Rawash, Abu Ghalib, El Baragil, Bahariya Oasis.

EL FAIYUM: Faiyum, Kom O Shim 1 km. W, Lake Qarun.

BENI SUEF: Beni Suef.

QENA: Luxor, Thebes.

ASWAN: El Dirr (sight record).

BEHEIRA: Wadi el Natroun.

MATRUH: Mersa Matruh, Redunkalil Tutuatee, Sitra, Salum (sight record), El Alamein (sight record).

EL WADI EL GEDEED: Dakhla Oasis, Rashida, Mut, Kharga Oasis (sight record).

Collection.—Shot at night using spotlight. Trapped with sardine bait.

Habitats.—Nile Delta and Valley and adjacent desert; Western Mediterranean Coastal Desert; rocky areas in southern edge of Coastal Desert; oases. Frequently seen in isolated cliffs and rocky hillocks in semi-barren desert.

Dens.—Tombs, natural caves, and crevices.

Habits.—Nocturnal, but often seen in late afternoon.

Food.—Jackals are known to eat dates, mulberries, apricots, and other fruits in season. North of El Faiyum, they supposedly lived on fish that were easily caught in shallow water (Anderson, 1902). They are attracted to carcasses (Dorst, 1970), and Manson-Bahr (1936) shot jackals beside a dead donkey near Cairo.

Jackals living near the Nile Valley and Delta are reputed to feed on various cultivated crops and fruit and to prey upon domestic animals (Flower, 1932; Setzer, 1961b; Hoogstraal, 1964). Howells (1956) wrote that, in Wadi Gazzah, northeastern Sinai, jackals entered camps and villages to kill chickens, young goats, and sheep. Corn, watermelons, pumpkins, and grapes were also eaten, and jackals reportedly destroyed corn and melon patches.

Kasim (1912) found evidence that a great number of desert snails (*Eremica desertorum*) were eaten by jackals near Bir el Malla on the Sidi Barrani-Siwa road. Sandford (1936) discovered a mud pan in northeastern Sudan where jackals had dug hundreds of *Pila* (*Ampullaria* of authors) *wernerei*, an operculate fresh water snail, out of the cracks.

Stomach contents of a jackal trapped near Bir Shaqqa contained shell fragments of the desert snail, gazelle remains, wings of a hawk moth (*Acherontia atropos*), a muscid fly, and a fly larva. In Wadi Allaqi, Osborn (1968a) shot a jackal and found its stomach to be full of fish scavenged from the waste of fishermen.

In Iran, stomachs of jackals examined by Lay (1967, p. 20[3]) contained "grasshoppers, grapes, blackberries, grain seed, dates, freshwater crabs, carrion, and one *Mus musculus*."

Although some authors are inclined to consider the jackal a scavenger (Setzer, 1952, 1961b; Hoogstraal, 1964; Dorst, 1970), evidence indicates that it is an opportunistic omnivore.

Reproduction.—Flower (1932) recognized a definite breeding season. Nine wild litters were born in March, April, and May. Thirty litters were born in Giza Zoological Gardens between the second

week in March and first week in May. The average litter size was 4.5, maximum eight.

Folklore.—According to Arab belief, the jackal is feared more than the fox by poultry, and if a jackal happens to pass under roosting chickens, they will all fall down from fear. A jackal's tongue left in a house will supposedly cause the inmates to argue and become hostile to one another. The flesh is considered to be useful in cases of madness and epilepsy. The right eye is said to protect the wearer from the evil eye and the heart to protect him from attack by beasts of prey (Jayakar, 1906).

Genus **Vulpes** Oken, 1816

Reddish foxes. Tail relatively long, bushy, and club-shaped; tip white. Pupil of eye elongate vertically. Frontal region of skull not inflated. Posterior end of nasals anterior to posterior level of frontomaxillary suture. Cranium broadest on sides, narrower at base of zygomatic processes of temporals.

Postorbital process concave dorsally, posterior margin ridged. Postorbital swelling nil. Vertical curvature of zygomatic arch high. Tip of zygomatic process of temporal relatively thick. Canines slender, elongate; point of upper canine reaching level of mental foramen when jaws are closed. Cheek teeth narrower and more trenchant than in genus *Canis*.

KEY TO EGYPTIAN SPECIES OF *Vulpes*

1. Size large, foot 100-150 mm., skull length 110-145 mm. Back of ear black. Belly blackish. Black mark on foreleg. Nasomaxillary contact narrow or lacking (fig. 112). . . . . *vulpes*, p. 371.
2. Size smaller, foot 90-115 mm., skull length 90-109 mm. Back of ear pale brown. Belly white. No black mark on foreleg. Nasomaxillary contact broad (fig. 112) . . . . . *rueppelli*, p. 379.

Vulpes vulpes (Linnaeus, 1758)

Canis vulpes Linnaeus, 1758, Syst. Nat., 10th ed., p. 40.

Type locality.—Sweden: Upsala.

General distribution.—Eastern North America, British Isles, Europe, Asia (northern and southwestern), Saudi Arabia, Sinai Peninsula, Egypt and Sudan west to Morocco.

Common names.—Red Fox, Nile Fox, *Taaleb, Abu Hussein.*

Subspecies in Egypt.—

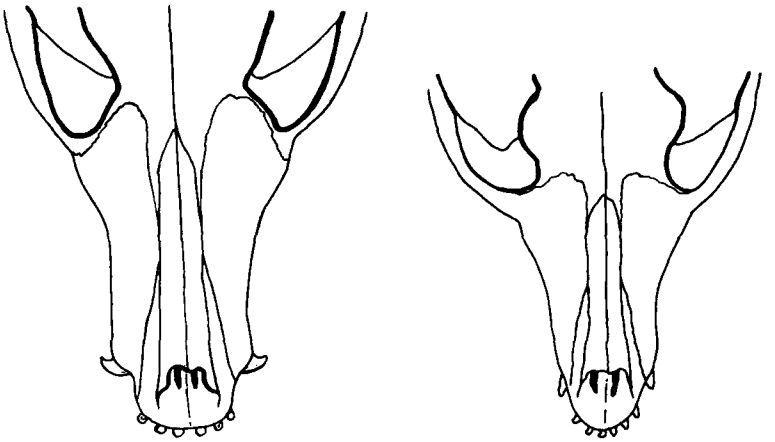


FIG. 112. Comparison of nasomaxillary contact and shape of posterior margins of nasals in *Vulpes vulpes* and *V. rueppelli.*

Vulpes vulpes aegyptiaca (Sonnini, 1816)

Canis aegyptiacus Sonnini, 1816, Nouv. Dict. Sci. Nat., Vol. VI, p. 524.

Type locality.—Egypt. GIZA: Giza Pyramids.

Distribution in Egypt.—Figure 113. Sinai Peninsula, northern part of Eastern Desert, Nile Delta and Valley, Western Mediterranean Coastal Desert.

Diagnosis.—Large fox. Ear relatively large, black posteriorly. Tail long, bushy, and club-shaped; tip white. Dorsum reddish to reddish brown; side yellowish gray; venter brownish or blackish. Foreleg with prominent, elongate, black marking.

Cranial ridges prominent. Superior edge of lambdoidal ridge extending beyond level of occipital condyle. Postorbital process concave dorsally. Nasal bones taper gradually posteriorly. Nasomaxillary contact nil or very narrow.

Adult head and body length average of male and female, respectively, 578, 551 mm.; tail 362, 341 mm., 62 per cent of head and body length; hind foot 143, 136 mm.; ear 96, 83 mm.; condyloincisive length 128, 123 mm.

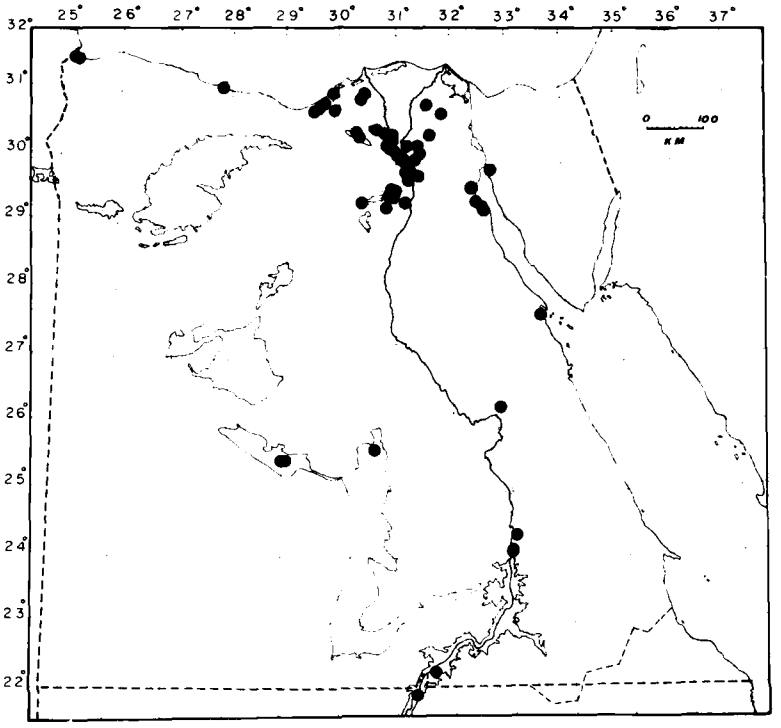


FIG. 113. Collection localities of *Vulpes vulpes aegyptiaca*.

External characters.—Dorsal stripe reddish to reddish brown, 50 to 80 mm. wide, extending from eye to basal one-third of tail, broadest on shoulders (forming a "cross") and on pelvis, darkened between ear and shoulder by black and black-tipped guard hairs. Grizzling, due to long guard hairs with blackish tips and white subterminal bands, occurs over entire dorsum, is most pronounced on shoulder and hip, and occurs on cheek, throat, and chest. Side grizzled gray and yellowish. Throat and belly brownish or blackish. Muzzle buff dorsally to about level of eye, reddish laterally. Chin whitish. Cheek deep buff to reddish. Dark stripe from mystacial area to eye indistinct; prominent on juvenile pelage only. Hairs on side of neck buffy with black tips. A whitish or buffy stripe sometimes separates this marking from brown of throat. Axillary and groin patches whitish, buffy, or orangish. Ear whitish to cream on inner side with brush of long hairs on lower medial margin. Back

of ear black, base brownish or color of back. Tail long, bushy, and club-shaped; reddish or brownish dorsally; paler ventrally, hairs buffy with dark tips; gland on upper base marked with blackish hairs; tip white. Foreleg with brownish and whitish markings and prominent black anterior stripe. Back of foreleg and foot brown to reddish brown. Hind limb similarly marked, black usually limited to upper foot. Hair of palm and sole not covering pads.

Juvenile pelage brownish dorsally; side, throat, and belly grayish. Black stripe on foreleg prominent.

Cranial characters.—Figure 114. Skull elongate. Frontoparietal, sagittal, and lambdoidal ridges prominent. Superior edge of the lambdoidal extends caudad beyond level of occipital condyle. Frontal region not inflated. Postorbital process concave dorsally, posterior ridge conspicuous and continuous with cranial ridge. Nasals taper gradually posteriorly, terminating anterior to posterior level of frontomaxillary suture. Nasomaxillary contact very narrow or absent due to contact of premaxillary and frontal processes (fig. 112). Paroccipital process large, prominent, and attached to bulla. Bulla large, rounded, and smooth.

Baculum.—Baculum triangular in cross-section, ventral channel extends entire length, surface somewhat rough, base not enlarged. There are two obscure distal tuberosities (Didier, 1946). Total lengths of two adult bacula, 46 and 47 mm.

Teeth.—Teeth of Egyptian canids are all very similar. Foxes have slenderer teeth with lower crowns, smaller carnassials, and greater relative length of canines than jackals.

Measurements.—Table 45. Male dimensions average considerably larger than female.

Age determination.—Old adults have frontoparietal ridges fused posterior to frontoparietal suture and forming a sharp-edged sagittal ridge, cranial sutures closed, teeth well worn.

Adults have frontoparietal ridges forming a narrow "V" or, if fused, sagittal ridge rounded and without sharp edges; cranial sutures closed; teeth slightly worn.

Subadults have frontoparietal ridges lyre-shaped to broadly V-shaped, basioccipital-basisphenoid suture usually open, teeth sometimes slightly worn.

Juveniles have cranium smooth or with inconspicuous lyre-

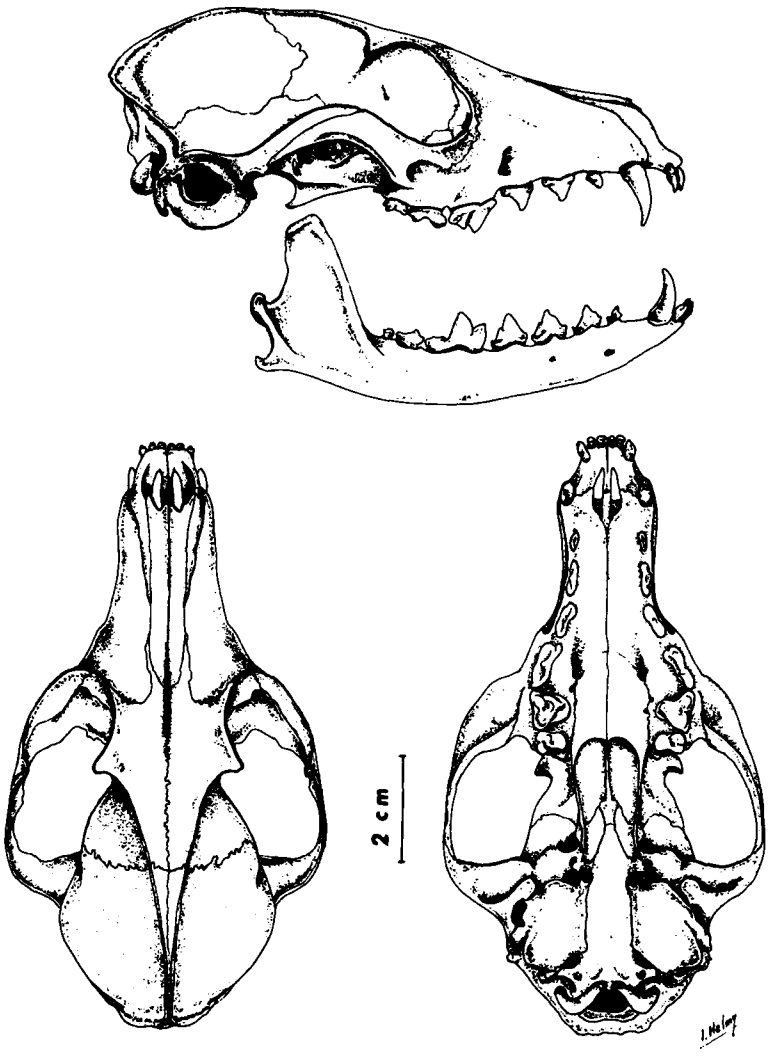


FIG. 114. Skull of *Vulpes vulpes aegyptiaca*.

shaped ridges, basioccipital-basisphenoid suture open, teeth unworn.

Variation.—Adult pelages are paler in summer than in winter; bellies are brownish in summer, blackish in winter. Two color phases, brownish red with little yellow and reddish yellow, occur in Nile Valley and Delta populations in frequencies of about 60 and 40 per cent, respectively. Desert specimens are paler in either of above color phases. Desert specimens with cranial ridge development comparable to Nile Valley and Delta specimens are considerably smaller in all dimensions (table 45), and teeth of subadults sometimes show as much wear as old adults of the latter. No old adults have been collected from desert localities. Setzer's (1961b) and Hoogstraal's (1963) statements that foxes from the Delta are smaller than those from elsewhere in Egypt are erroneous.

Comparisons.—*Vulpes vulpes* differs from *V. rueppelli* in darker color, back of ear being black instead of pale brown, venter blackish instead of white, presence of black mark on foreleg, larger average dimensions (tables 45, 46), more prominent cranial ridges, less inflated bulla (figs. 114, 117), more gradual posterior taper of nasals (fig. 112), lambdoidal ridge extending posteriorly beyond level of occipital condyle, and narrower nasomaxillary contact (fig. 112).

Means (and ranges) of ratios of length of nasomaxillary contact to nasal length × 100 in 19 juvenile and subadult *V. vulpes* and 52 adult *V. rueppelli*, respectively, are 12 (4 to 17) and 25 (15 to 38).

Vulpes vulpes aegyptiaca is a larger and darker race than *V. v. arabica* and *V. v. palaestina*.

Specimens examined.—Total 216.

SUEZ: Suez (1); Gebel Sukhna, N of (2); Wadi Qiseib (1); Abu el Darag (1), 1 km. N (1).

SHARQIYA: Bilbeis (6).

BEHEIRA: El Khatatba (2), Hafs (3), Damanhour (1).

MINUFIYA: Ashmun (1), Saqyet Abu Shara (5).

QALYUBIYA: Sindbis (15), Abu Zabal (1).

GIZA: El Qatta (1); Ausim (3), Bashtil (2), Tanash (3), Saft el Laban (1), Warraq el Arab (1), Wardan (1), Minshat el Bakkari (5), Kafr Hakim (9), El Mansuriya (5), Abu Rawash (7), El Kom el Akhdar (1), Beni Magdul (1), Abu Ghalib (2), Nahya (2), El Mitimdiya (2), Kafret Nassar (1), El Talbiya (1), Imbaba (3), Ezbet Moneib (1), Gizzaya (2), Geziret Muhamed (9), Giza Pyramids (3), Giza (6), Sakkara (5), Dahshur Pyramid (1), Kafr Ammar (3), El Tabin (1).

CAIRO: Heliopolis (1), Cairo (2).

EL FAIYUM: Faiyum (5), Kom O Shim (4), Tamiya (3), Fanus (4), Qasr Rashwan (4), Lake Qarun NW end (2).

BENI SUEF: Maidum (1).

QENA: Wadi Qena (1).

ASWAN: Kom Ombo (2); Aswan (3), Koror area (1); Gebel Adda (3); Wadi el Targama (1); Wadi Allaqi (1).

ALEXANDRIA: Mariut (1).

EL TAHREER: Cairo-Alexandria desert road km. 164 (1).

BEHEIRA: Bir Victoria (1); Wadi el Natroun (5), El Beida (1).

MATRUH: Burg el Arab (3); Bahig (17), 4.8 km. S (1), 8 km. S (1), 15 km. S (1), 18 km. S (1), 6 km. SW (1), 9 km. SW (4); El Qarasat (1), 9 km. SW (2); El Afritat, 17 km. SW El Hammam (2); Abu Hagag (1); Salum 4.8 km. SE (1), Bir Wair (1).

EL WADI EL GEDEED: Kharga Oasis (2); Dakhla Oasis, Mut (1), Asment (2), El Sheikh el Waly (2); Balat (1).

Sudan. NORTHERN: Wadi Halfa (2).

Published records.—Records are from Anderson (1902), Bonhote (1902), Flower (1932), Tregenza (1958), and Setzer (1952, 1961b).

SINAI: Ayun Musa, various northern coastal localities.

SUEZ: Gebel Sukhna, N of.

RED SEA: Gemsa (report from guide).

SHARQIYA: Bilbeis, Faqus.

DAQAHLIYA: Simbillawein 8 km. W.

BEHEIRA: Hafs.

MINUFIYA: Ashmun.

QALYUBIYA: Sindbis, Kanka, Abu Zabal.

GIZA: Abu Ghalib, Imbaba, El Mitimdiya, Gizzaya, El Mansuriya, El Kom el Akhdar, Kafret Nassar, Nahya, Kafr Hakim, El Talbiya, Giza Pyramids area, Tanash, Bamha, Kafr Ammar, El Tabin, Abu Rawash, Ezbet Moneib, Bashtil, Minshat el Bakkari, Geziret Muhamed, Warraq el Arab, El Baragil, Beni Magdul, Aiyut Barnasht, Dahshur Pyramid, Badrshein.

CAIRO: Heliopolis.

EL FAIYUM: Qasr Rashwan, Fanus, Lake Qarun W end 3 km. N, Tamiya.

BENI SUEF: Maidum.

BEHEIRA: Bir Victoria, between Bir Victoria and El Khatatba, Wadi el Natroun.

MATRUH: Bahig 4.8 km. S, Burg el Arab.

Sudan. NORTHERN: Wadi Halfa.

Collection.—Shot at night under a spotlight; trapped near burrows or in foraging areas, usually with sardine bait.

Habitats.—Sinai Peninsula: Northern coastal desert according to Flower (1932) and reported from vicinity of Ayun Musa (Anderson,

1902). Later collectors failed to find this species in Sinai (Wassif, 1954c; Wassif and Hoogstraal, 1954; Hoogstraal, 1964).

Eastern Desert: Northern part. Vegetated wadis from Abu el Darag northward. Also reported from Gemsa (Tregenza, 1958) and seen occasionally along Cairo-Suez road.

Nile Valley and Delta: Inhabits date and fruit groves, cultivated areas, and suburban gardens. Dens in desert hills allow easy access to cultivated areas.

Western Mediterranean Coastal Desert: Common throughout this area (figs. 8, 19), occasionally southward in semibarren and barren desert.

Oases: Known to occur in Wadi el Natroun, El Faiyum, and Kharga and Dakhla Oases where habitats are similar to those of the Nile Valley.

Habits.—*Vulpes vulpes* is not strictly nocturnal and is commonly seen during daylight hours. Foxes will often run out of dens when approached by a vehicle or a man on foot.

Dens.—Dens usually have several openings and preferred sites are in hillsides under rocks. One den was under an old concrete floor in barren gravel north of El Beida, Wadi el Natroun. Clay hills or *karms*, excavations from Roman cisterns, south of Burg el Arab are well-known burrowing sites (Sandford and Arkell, 1939). Foxes also burrow in palm groves, fields, gardens, and beneath walls, stables, and houses. Other common den sites are ruins, tombs, and quarries.

Food.—Stomachs of *V. vulpes* have contained green figs, various plant remains, insect remains, bread stolen from a Bedouin camp, remains of birds, *Gerbillus* sp. *Dipodillus simoni*, *Mus musculus*, and sardine bait. A skull of *Poecilictis libyca* was found beside fox dens in hills west of Wadi el Natroun. Flower (1932) reported one with its stomach full of mole crickets. He fed captive foxes plums, fresh dates, and raw eggs. According to Tregenza's (1958) guides, foxes near Gemsa on the Gulf of Suez fed on crabs and dead fish thrown out by fisherman. Whether vegetable material forms a greater part of the diet than meat is not known.

Water.—Availability of water may be a factor limiting the distribution of *V. vulpes* to the Nile Valley and Delta, the Western Mediterranean Coastal Desert, oases, and northern parts of the Eastern Desert and Sinai Peninsula. The southernmost locality of

collection on the Gulf of Suez was near Abu el Darag. That far south, fresh water is available at all times a few kilometers from the seacoast. Tregenza's (1958) guides told him the Nile fox was found near Gemsa, but had to go into the mountains to drink.

Reproduction.—No data are available on reproduction of *V. vulpes* in Egypt, except the recording of four pups in March (Hoogstraal et al., 1957b).

Sex ratio.—A sample of 174 museum specimens contained equal numbers of males and females.

Remarks.—The ranges of *V. vulpes* and *V. rueppelli* overlap only slightly. The latter is the more desert-adapted, probably due to its smaller size plus its ability to survive in waterless areas.

Folklore.—The fox is considered by Arabs to be a cowardly beast of prey; weak, wily, deceitful, and cunning. It is said to feign death by filling its abdomen with air so as to appear bloated and then to lie on its side and raise two legs high in the air. Thus it awaits the approach of unsuspecting prey so it can capture them. Hunting dogs, supposedly, are not fooled by this ruse.

Klunzinger (1878, p. 401) told the following as an example of numerous tales concerning the fox's reputed cunningness:

"A fox wanted the chickens which he saw a man carrying to market in a basket. The fox ran ahead of the man and played dead in the middle of the road. The man passed with little more than a glance. The trick was repeated two more times. On seeing a third dead fox the man decided that three fox skins would be worth carrying to market to sell. He put down the basket of chickens and went back along the road to retrieve the first two foxes, but returned empty handed only to find that the third fox had vanished and his chickens as well."

Vulpes rueppelli (Schinz, 1825)

Canis rueppelli Schinz, 1825, Das Thierreich, Vol. 4, p. 508

Type locality.—Sudan. NORTHERN: Dongola.

General distribution.—Afghanistan, Iran, Jordan, Saudi Arabia, Sinai Peninsula, Egypt, Sudan, Somalia, Asben, Libya, Algeria.

Common names.—Rueppell's Sand Fox, *Taaleb, Abu Hussein.*

Subspecies in Egypt.—

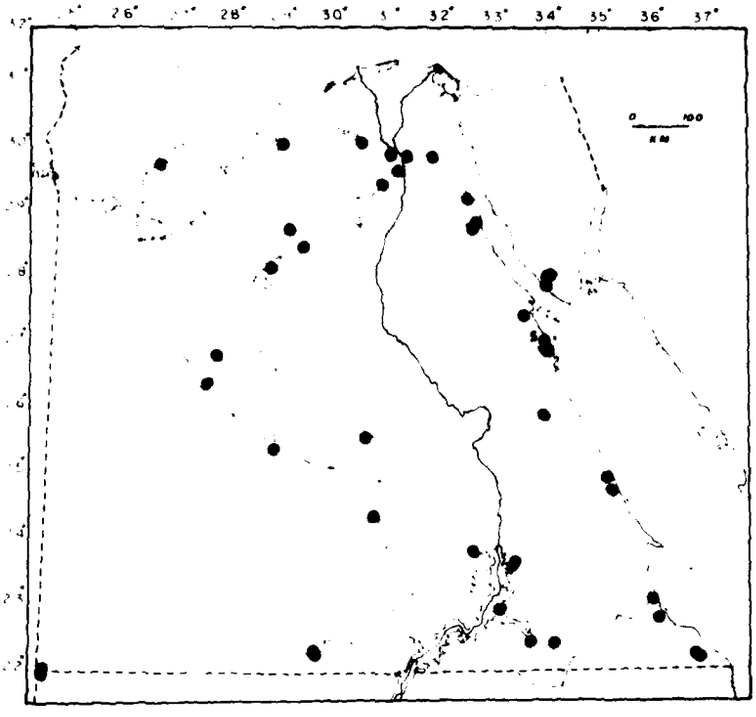


FIG. 115. Collection localities of *Vulpes rueppelli rueppelli* and sight record (S).

Vulpes rueppelli rueppelli (Schinz, 1825)

Distribution in Egypt.—Figure 115. Sinai Peninsula, Eastern Desert, Western Desert.

Diagnosis.—Small fox. Ear large, pale brown or rufous posteriorly. Tail long, bushy, club-shaped; tip white. Dorsum grizzled reddish, side buffy gray, and venter whitish.

Frontoparietal ridge lyre- to V-shaped. Postorbital process concave dorsally. Superior edge of lambdoidal ridge not extending beyond posterior level of upper lip of foramen magnum. Nasal bones tapering abruptly posteriorly. Nasomaxillary contact broad, always separating premaxilla and frontal. Bulla proportionately large.

Adult head and body length average 456 mm.; tail 281 mm., 72.8

per cent of head and body length; hind foot 124 mm.; ear 96 mm.; condyloincisive length 104 mm.; weight 1.7 kg.

External characters.—Figure 116. Fur long, soft, dense, particularly in winter. Dorsum grizzled reddish from nape to base of tail. Guard hairs with short reddish tips, broad white distal subterminal bands, fuscous to reddish proximal subterminal bands, and

FIG. 116. Live specimen of *Vulpes rueppelli rueppelli*.

whitish bases. Under hairs fuscous; sometimes with pale or whitish bases. Side grayish buff to whitish with grizzling on upper part and scattered black-tipped hairs on lower. Grizzling extends over shoulders, entire dorsum, upper side, pelvis, and upper parts of fore and hind limbs. Winter pelages often have a bluish tint over the grizzled areas. Under hairs of side have pale buffy tips, whitish to grayish bases. Side of neck is yellowish buff. Axillary area is orangish buff. Chin, cheeks, throat, belly, and inside of legs are whitish. Lower throat and chest are variable, with areas of brownish or grayish tipped hairs. Mammary area of adult females is reddish. Belly hairs, except as noted, are usually white to bases; occasionally with dark bases. Facial area is buff to orangish buff. Mystacial area brownish, continuous with brownish to orangish lacrimal stripe. Ear white to cream anteriorly and on margin, fuscous to pale reddish brown posteriorly. Crown and nape are concolorous with back of ear. Tail bushy, club-shaped, buff to pale orangish buff with dorsal stripe of brownish to blackish tipped hairs, and tip white. Dark hair and depression in fur over gland on upper tail base prominent. Anterior foreleg and outer side of hindleg pale reddish buff. Back of foreleg from elbow to palm and back of thigh and sole reddish brown. Hair of palm and sole partly covering pads.

Cranial characters.—Figure 117. Skull elongate. Cranial ridges lyre- to V-shaped, much less prominent than in *V. vulpes*. Superior margin of lambdoidal ridge not extending beyond posterior level of upper lip of foramen magnum. Postorbital process concave dorsally, posterior ridge inconspicuous, continuous with cranial ridge. Nasals tapering abruptly posteriorly, terminating anterior to posterior level of frontomaxillary suture. Nasomaxillary contact broad (fig. 112).

Baculum.—The baculum is essentially a miniature of that of *V. vulpes*, except more sharply ridged dorsally. Mean (and ranges) of total length of five adult bacula are 38 (34 to 41) mm.

Teeth.—Teeth smaller and slenderer than in *V. vulpes*.

Measurements.—Table 46. Male dimensions average slightly larger than female.

Age determination.—Adults have a short sagittal ridge; parietal ridges V-shaped, well developed; cranium rough; teeth worn.

Subadults have parietal ridges lyre-shaped, poorly developed; cranium smooth to slightly rough; teeth slightly worn.

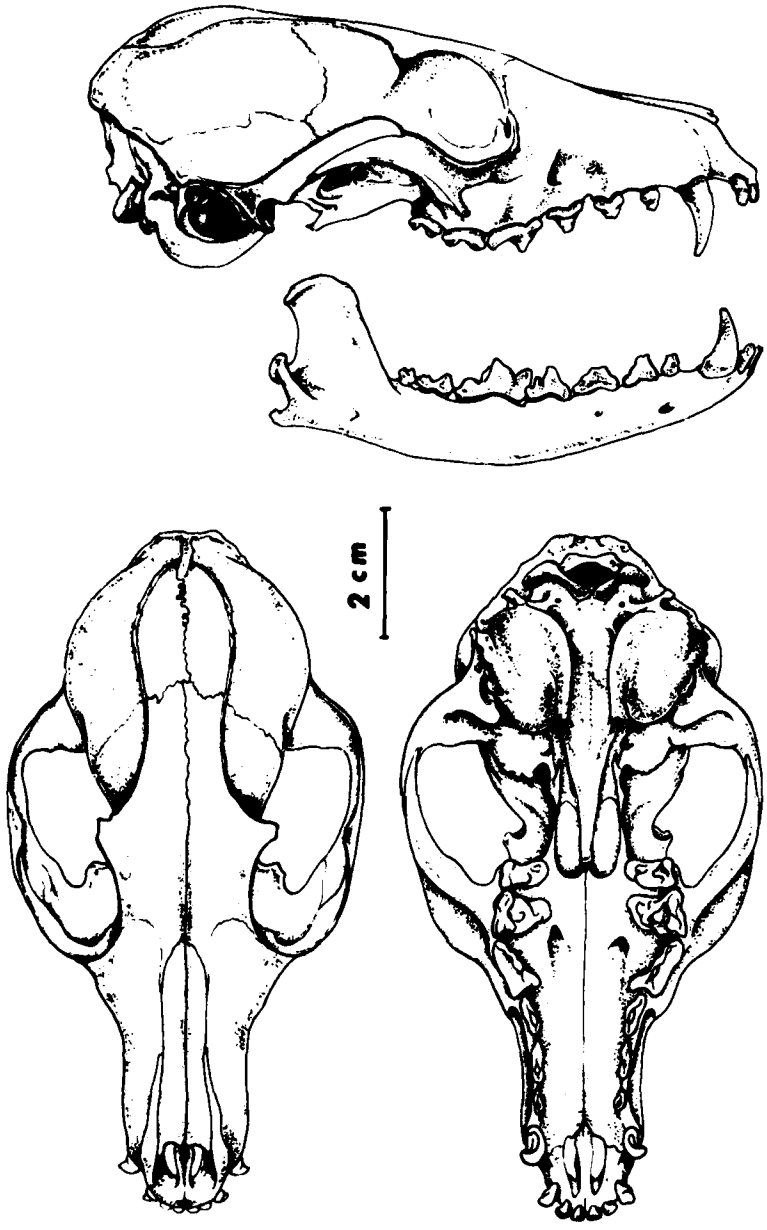


FIG. 117. Skull of *Vulpes rueppelli rueppelli*.

Juveniles have a smooth cranium.

Variation.—Summer pelages are more grayish than winter ones due to thinness of guard hairs. Some individuals have a strip of black-tipped hairs on side of foot. Specimens from southern parts of Western and Eastern Deserts have lacrimal stripes slightly darker and area of dark-tipped hair on throat larger than do individuals from northern localities. A few southern specimens have belly hairs with gray bases. Some Sinai specimens are brownish instead of reddish.

An accessory cusp was present on pm_3 in four (50 per cent) of eight specimens from Sinai Peninsula, seven (28 per cent) of 25 from the Eastern Desert, and four (38 per cent) of 29 from the Western Desert. In two specimens only, an accessory cusp was also present on pm_2.

No subspecific differences could be found among Sinai, Eastern Desert, and Western Desert population samples.

Comparisons.—The adult skull of *V. rueppelli* is a replica of that of a subadult *V. vulpes*, except for relatively larger bulla, broadness of nasomaxillary contact, and shape of posterior nasal margin (figs. 112, 114, 117). Differences between the two species are under the latter. Dimensions can be compared in Tables 45 and 46. In comparison with *Fennecus zerda*, *V. rueppelli* is larger, much darker, has a longer tail, smaller bulla, frontals not elevated, and white tail tip instead of black. Specimens in molt are sometimes mistaken for *F. zerda*.

From *V. pallida* of Sudan, *V. rueppelli* is distinguishable by reddish color, longer ears, lack of black mark on foreleg, and tail tip being white instead of black.

From *V. r. sabaea* of Saudi Arabia, *V. r. rueppelli* differs in having darker color and slightly larger dimensions.

Specimens examined.—Total 115.

SINAI: Wadi Abu Zeitouna (3), Wadi el Sheikh 16 km. W of St. Catherine Monastery (4), Wadi el Raba (1), Tor (3).

SUEZ: Wadi Iseili (3), Wadi Qiseib (1).

CAIRO: near Cairo (1).

RED SEA: Wadi Araba, Bir Zafarana (2), St. Anthony Monastery area (1), Bir Abu Shaar (2); Hurghada 14 km. S (2), 16 km. S (1); Wadi Umm Huweitat (1); Fawakhir Mine area (2); Mersa el Alam (1); Wadi Gemal (2).

SUDAN ADMINISTRATIVE: Bir Shalatein (1), Wadi Ibib (2), Wadi Darawena (4), Bir Akwamtra area (1).

GIZA: El Mansuriya (1); Sakkara (1); Bahariya Oasis (1); Bawiti (3); Ain el Guffara E of Bawiti (7); Ain el Beilda W of Bawiti (2); El Qasa, No. 2 NE of Bawiti (2), No. 3 NW of Bawiti (1); Ain Marun (2); El Hara (3); El Ghaba el Qiblya (1); El Agouz (1); Wadi Ghorabi (1); Cairo-Bahariya Oasis track km. 208, acacia grove area 6 km. SE (1).

EL FAIYUM: Qasr el Sagha (1), 20 km. N of cultivation (1).

MINYA: Hatiyet el Sunt (1).

ASWAN: Kurkur Oasis (9); Wadi Dihmit, Bir Umm Hibal area (1); Bir Umm Qareiyat area (4); Wadi Murra, Bir Murra area (2); Wadi Allaqi, 11.2 km. SE of Allaqi Village (1).

BEHEIRA: Wadi el Natroun, Deir Makaryus area (1).

MATRUH: El Maghra (4); Bir Abd el Nabi (2); Siwa Oasis, El Maragi, W of (1); El Malfa 110 km. W of Siwa (1).

EL WADI EL GEDEED: Farafara Oasis, Abu Minqar (1); Ain Gellaw (1); Dakhla Oasis, Mut (1); Kharga Oasis, Dush (1); Ain Amur (2), El Gizera (1); Bir Kiseiba (4); Bir Kurayim (3); Bir el Shab (3).

Sudan. NORTHERN: Gebel Uweinat, Karkur Murr (4).

Sight record of D. Osborn and I. Helmy.—

RED SEA: Wadi Mellaha.

Published records.—Records are from Anderson (1902), De Winton (1903), Flower (1932), Bagnold (1933), Hoogstraal et al. (1957b), Setzer (1961b), and Hoogstraal (1964).

SINAI: Wadi el Sheikh; Wadi Abu Zeitouna; Wadi el Raba.

RED SEA: St. Anthony Monastery area.

QUALYUBIYA: Sindbis.

GIZA: Imbaba.

EL FAIYUM: 20 km. N of cultivation.

BEHEIRA: Wadi el Natroun, Deir Makaryus.

EL WADI EL GEDEED: Karkur Tahl (sight record).

SUDAN ADMINISTRATIVE: Wadi Darawena.

Collection.—Readily enters live traps baited with meat, sardines, or even bread. On the Red Sea shore, some were shot at night from distances of a few meters when they came to lick empty sardine and corned beef tins.

Habitats.—*Vulpes rueppelli* is the most ubiquitous of Egyptian foxes, not restricted to sandy areas, and far more widely distributed than *V. vulpes*, particularly in waterless regions.

Sinai Peninsula: Reported from northern and southern Sinai (Flower, 1932) in littoral semideserts and rocky wadis (Hoogstraal, 1964).

Eastern Desert: Figure 16. Ranges throughout the Eastern Desert in wadis and coastal areas.

Western Desert: Figures 9, 18. Ranges throughout the Western Desert south of the Coastal Desert, particularly in vegetated areas, isolated acacia groves, tamarisc clumps, palm groves, and oases, where Rueppell's foxes hunt in patches of grass and mound-forming vegetation (fig. 17). They can always be found in the vicinity of springs and shallow wells.

A few specimens have been collected on the borders of the Nile Valley and Delta, but none from the Delta or the Western Mediterranean Coastal Desert, probably because of the predominance of *V. vulpes* in those areas.

Habits.—*Vulpes rueppelli* is sometimes seen during the day. One was flushed in mid-afternoon in the rocky canyon of Wadi Mellaha. Foxes were seen in late afternoon prior to being trapped in Karkur Murr, Gebel Uweinat, and near an acacia grove south of the Cairo-Bahariya Oasis track.

Three males and one female were trapped beside palms at Bir Kiseiba within two hours after sundown. Hoogstraal (1964) observed Rueppell's foxes at dusk in the Gebel Elba area.

On several occasions, when we were camped on the shores of the Red Sea, Rueppell's foxes came within a few meters to lick empty meat and sardine tins. Bagnold (1933) noted the indifference of this fox toward his camp in Karkur Tahl, Gebel Uweinat.

Hungry sand foxes often become a nuisance by setting off rodent live traps in trying to reach the peanut butter bait. Rodents in traps were sometimes mangled by them.

Burrows and dens.—De Winton (1903) dug a sand fox from a shallow burrow where the animal's nose was seen protruding. At Bir el Shab and Bir Kiseiba, we found dens in dead fronds under dense clumps of dom palms (*Hyphaena thebaica*), but nowhere else were we able to locate them. In rocky areas, *V. rueppelli* doubtlessly dens in crevices.

Food.—Hoogstraal (1964) reported that, in Sinai, a camel carcass attracted Rueppell's sand foxes. He also said that Bisharin tribesmen in the Gebel Elba area maintained that this fox stole lambs.

Stomachs have contained rodents, feathers of small birds, lizards (*Euromastix aegyptius* and *Eremias* sp.), remains of insects

(grasshoppers, mole crickets, and scarabid beetles), and dates. In the Bir el Shab area, we observed where sand foxes had gnawed the fibrous fruits of dom palm. Tregenza (1958) remarked on their ability to climb date palms.

Water.—Captive *V. rueppelli* will drink water. The species is always found in the vicinity of wells and springs, and tracks have indicated that it drank water. Tracks have also been reported long distances from water (Hurst, 1910), and we have collected it in waterless areas. There is a possibility that this fox can utilize brackish water.

An old Arab fable mentioned by Hurst (1910) is that this fox drinks from the wind by sleeping with its head into the breeze.

Reproduction.—One female collected from Wadi Iseili in June had three small fetal scars.

Sex ratio.—A sample of 67 museum specimens contained 39 (58 per cent) males and 28 females.

Economic importance.—As mentioned, this fox is suspected of preying on lambs. According to Hurst (1910), Arabs eat sand foxes.

Genus **Fennecus** Desmarest, 1804

Small, pale, buffy fox with narrow reddish dorsal stripe. Ear relatively large. Tail relatively short, brushy; tip black. Pupil of eye round. Frontal region of skull slightly inflated. Nasals ending anterior to posterior level of frontomaxillary suture. Cranium broadest on sides, narrower at base of zygomatic processes. Postorbital process concave dorsally, posterior margin not ridged. Postorbital swelling lacking. Vertical curvature of zygomatic arch low. Tip of zygomatic process of temporal thin. Canines slender, elongate; point of upper canine reaching level of mental foramen when jaws are closed. Tympanic bulla markedly inflated. Lower jaw very shallow and slender. Cheek teeth narrower than in *Vulpes*.

Fennecus zerda (Zimmermann, 1780)

Canis zerda Zimmermann, 1780, Geographische Geschichte des Menschen, Vol. 2, p. 247.

Type locality.—"Sahara and other regions back of the Atlas Mountains and in Tripoli" (describer) and "sandy deserts of North Africa" (Flower, 1932, p. 401).

General distribution.—Kuwait, northern Sinai Peninsula, Egypt,

and northern Sudan west of the Nile River; thence westward across the Sahara into Mauritania.

Common names.—Fennec Fox, *Fennec.*

Distribution in Egypt.—Figure 118. Northern Sinai Peninsula and Western Desert south of Mediterranean Coastal Desert.

Diagnosis.—Small, buff colored; dorsal stripe narrow, reddish. Ear very large, triangular. Tail relatively short and brushy with a black tip.

Skull rounded, ridges inconspicuous, frontal region slightly inflated. Rostrum short, narrow. Tympanic bulla greatly inflated.

Adult head and body length average 367 mm.; tail 205 mm., 55 per cent of head and body length; foot 103 mm.; ear 95 mm.; condyloincisive length 83.8 mm.; weight 1 kg.

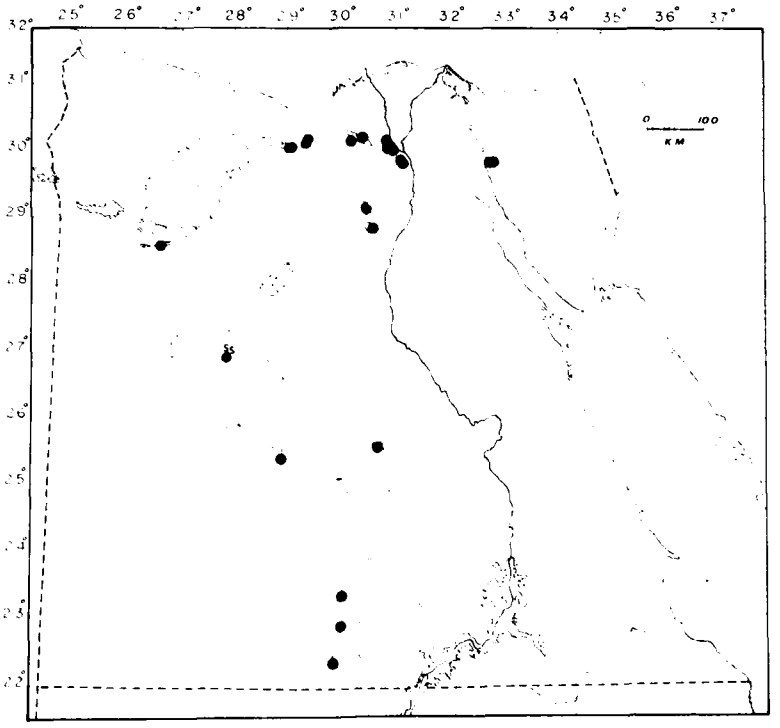


FIG. 118. Collection localities of *Fennecus zerda* and sight record (S).

External characters.—Figure 119. Fur long, soft, silky. Dorsal stripe pale grizzled reddish and buff, 2.5 to 5.0 cm. wide from shoulder to base of tail; sometimes widening over hips. Grizzling due to guard hairs with narrow black tips and narrow rufous and white subterminal bands. Side and outer surface of legs pale yellowish buff. Chin, cheek, side of throat, belly, and inner side of legs white. The mammary area of adult females is rufous. Facial area buffy. Mystacial area and lacrimal stripe pale brownish. Ear white anteriorly and on margin, pale brownish posteriorly. Crown and nape pale brownish to rufous. Narrow line of black on neck and shoulders due to black-tipped hairs lacking white subterminal bands. Scattered guard hairs, in addition to color hairs mentioned above, are all black or with gray bases. Under hairs of dorsum have minute blackish tips, conspicuous rufous subterminal bands, and grayish or buffy bases. Juvenile pelages paler than adult, with little or no rufous, and facial marking inconspicuous. Tail brushy, not club-shaped as in *Vulpes;* dorsal hairs with blackish or reddish tips; color grading to pale reddish or whitish below. Tail tip and hair over gland on upper base of tail black. Hair of palm and sole buffy, long, completely concealing pads.

FIG. 119. Young *Fennecus zerda.*

Cranial characters.—Figure 120. Cranium rounded, frontal region slightly inflated, rostrum short, narrow. Cranial ridges, if present, lyre-shaped, inconspicuous. Lambdoidal ridge low, superior edge not exceeding posterior level of upper lip of foramen magnum. Postorbital process concave dorsally, posterior ridge lacking. Nasals tapering abruptly posteriorly, terminating anterior to posterior level of frontomaxillary suture. Nasomaxillary contact broad as in *V. rueppelli.* Tympanic bulla greatly inflated. Basioccipital and basisphenoid markedly constricted. External auditory meatus opening very large. Lower jaw very shallow and slender.

Baculum.—Baculum relatively large and heavy compared with *Vulpes* sp. Ventral surface channeled almost entire length, edges irregular. Cross section triangular. Base rounded, bulging slightly; tip small, slender (Didier, 1946). Total lengths of two bacula were 31 and 36 mm.

Teeth.—Teeth smaller and slenderer than in *V. rueppelli.* Cingulum on anterior of upper cranassial (pm^4) more strongly developed than in other foxes. An accessory cusp is occasionally present on pm^3.

Measurements.—Table 47. Male and female measurements are subequal.

Age determination.—Adults have cranium roughened on sides;

TABLE 47. — Means (and ranges) of measurements, ratios, and weight of adult *Fennecus zerda.*

	Desert Oases	Desert-Delta
HB[1]	367.6 (357-387) 11	368.0 (337-387) 35
TL	203.7 (187-226) 11	207.4 (186-230) 35
TL/HBL%	55.4 (51.4-60.8) 11	56.2 (51.8-63.7) 35
FL	103.8 (94-111) 11	103.2 (93-110) 35
EL	94.2 (88-104) 11	96.3 (92-104) 35
Wt (kg.)	1.05 (0.8- 1.15) 9	
CIL	83.9 (80.4-88.0) 12	83.6 (80.6-87.6) 38
ZW	46.6 (45.4-47.9) 12	46.2 (37.4-48.3) 29
RW	13.1 (12.5-13.6) 12	12.7 (11.9-13.6) 37
POW	18.6 (16.1-20.7) 12	18.4 (16.5-20.7) 36
BCW	36.4 (35.6-37.8) 12	36.7 (34.9-38.1) 35
NL	28.3 (25.3-30.3) 12	27.3 (24.7-29.3) 36
C-M^1	36.2 (34.5-37.8) 11	35.9 (34.2-37.7) 35
M^1-M^1	25.2 (24.5-26.9) 10	24.9 (23.1-26.2) 32
BL	21.3 (20.0-22.4) 12	21.4 (20.7-23.0) 37
SH	37.2 (35.8-38.2) 11	36.8 (35.5-38.2) 34

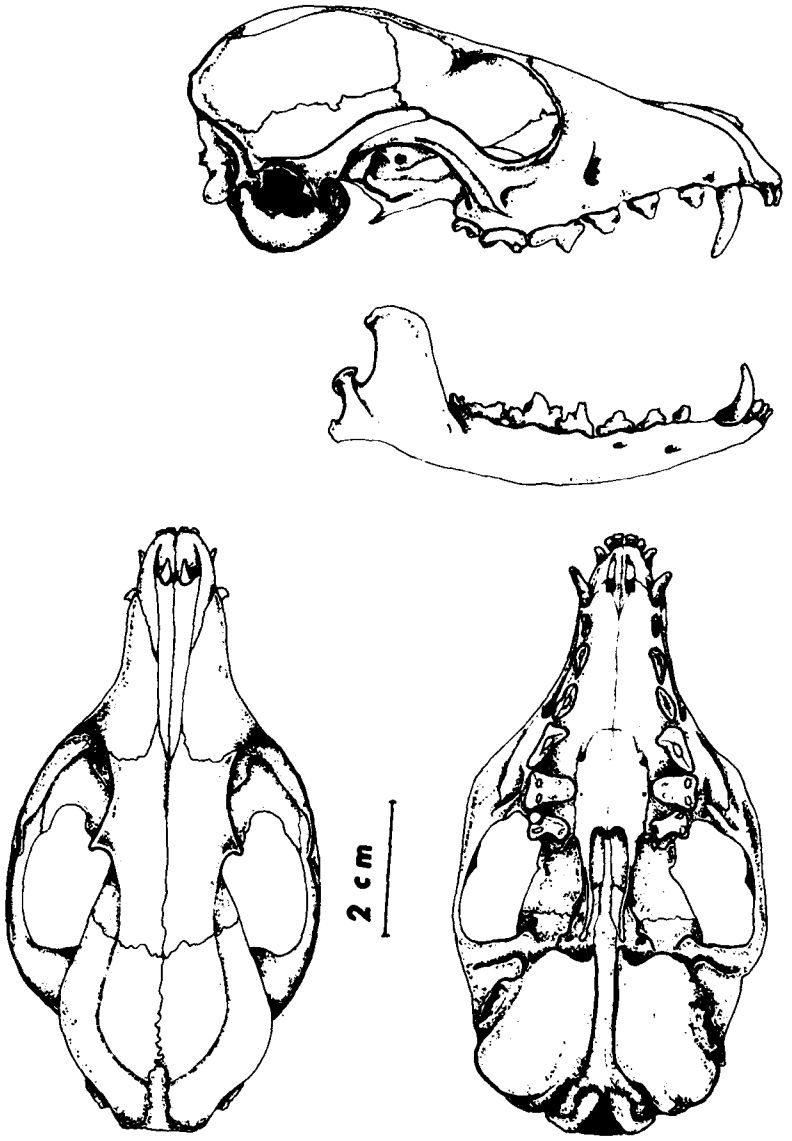


FIG. 120. Skull of *Fennecus zerda*.

parietal ridges low, lyre-shaped; postorbital process pointed, slightly hooked; and basioccipital-basisphenoid suture fused.

Subadults have cranium smooth, parietal ridges slightly developed, postorbital process blunt, and basioccipital-basisphenoid suture not completely fused.

Juveniles have cranium smooth, postorbital process blunt, and sutures open.

Variation.—Adult and subadult pelages have varying amounts of grizzling on dorsum. Summer pelages are thinner, but about same general color as winter pelages. Molting pelages appear grayish, yellowish, or rufescent dorsally.

Dorsum under hairs in winter pelages have a broad, dark gray basal band fading to whitish proximally. Under hairs in summer pelages are buff to base.

Winter pelages are divisible into pale and dark and narrow and broad dorsal stripes, which are about 2.5 and 5.0 cm. wide, respectively. In a sample of 16 males and 20 females, dorsal stripes were dark in 90 per cent of males and 75 per cent of females. Narrow and broad dorsal stripes occurred in equal numbers in both sexes. There was no indication of geographical variation in either character. Setzer (1961b, p. 118) recognized a "wide range of color. . . .from a pale sandy hue to rich brownish tone" and "no age or seasonal difference in this range of color."

Comparisons.—Small size, pale color, narrow reddish dorsal stripe, shorter tail, black tail tip, and proportionately larger ears distinguish *F. zerda* externally from other Egyptian foxes. Cranially, *F. zerda* differs in having a shorter, narrower rostrum; slightly elevated frontals; smoother, more rounded braincase; large tympanic bulla; and smaller, slenderer lower jaw (tables 45-47; figs. 114, 117, 120).

Specimens examined.—Total 114.

BEHEIRA: El Khatatba (3), Wadi el Natroun (8), Wadi el Farigh (3).

GIZA: El Qatta (15), Abu Ghalib (24), between Abu Ghalib and Cairo on Cairo-Alexandria desert road (37), Kirdasa (1), Giza Pyramids area (2).

EL FAIYUM: Lake Quarun 10 km. SW (1); Wadi Muwellih (3).

MATRUH: Qaret el Mashruka 8 km. S (1), Nakhlat el Barraq (1), El Maghra (10), Bir Mikheimin (1 drowned in well), Nuweimisa (1).

EL WADI EL GEDEED: Kharga Oasis (1), 10 km. S (1), Dakhla Oasis, Mut (1).

Sight record of I. Helmy.—

EL WADI EL GEDEED: Farafara Oasis, El Qasr.

Published records.—Records are from Anderson (1902), De Winton (1903), Bonhote (1912), Bagnold (1931), Flower (1932), Setzer (1961b), and Hoogstraal (1964).

SINAI: 33 km. NE of Suez and 25 km. E of Suez Canal.

BEHEIRA: El Khatatba, Wadi el Natroun.

GIZA: Wardan, Abu Rawash, Abu Ghalib, between Abu Ghalib and Cairo on Cairo-Alexandria desert road, El Qatta, Kirdasa, Giza Pyramids area, Bahariya Oasis.

EL FAIYUM: Lake Qarun 10 km. SW.

EL WADI EL GEDEED: Dakhla Oasis, Mut; Kharga Oasis; Bir Abu Hussein; Bir Murr; Bir el Shab (sight record).

Collection.—Dug from burrows, shot at night using a spotlight, and trapped alive with sardine bait.

Habitats.—Burrows in sandy areas of desert (Anderson, 1902; Thomas, 1913), usually near vegetation. We have dug fennecs from burrows in hillocks under *Nitraria retusa*, *Zygophyllum album*, and *Calligonum comosum* and shot them at night in the same vegetation. Stands of *Artemisia monosperma* and bunch grass (*Panicum turgidum*) are also frequented by fennecs (fig. 20).

Flower (1932, p. 402) reported a specimen from "undulating country with sand dunes" in Northwestern Sinai Peninsula. Most of 48 specimens brought into Giza Zoological Gardens, he wrote, came from an area west of Giza north to Wadi el Natroun. Vegetated sandy areas between Giza Pyramids and El Khatatba have also provided a large sample of fennecs (Hoogstraal, 1964). None have been collected or reported from the Western Mediterranean Coastal Desert.

Activity.—Feeding is almost strictly a nocturnal activity, although we have noted fennecs feeding on insect larvae during the day. Fennecs are often seen in afternoon, singly or in small groups, sitting on mounds or small hills (Hoogstraal, 1964).

Voice.—Flower (1932) described the voice correctly as like the bark of a small dog.

Burrows.—Burrows we have dug were simple tunnels 1 to 2.5 m. long and reaching a depth of about 1 m. Gauthier-Pilters (1967) reported a burrow in Algeria 10 m. long and 1 m. deep. Burrows may

be in flat barren sand, low hills, vegetated hillocks, or according to Bruce (1790), among the dead fronds of date palms. We have collected *V. rueppelli*, but not *F. zerda*, in the last.

Food.—"The stomach of a fennec shot in the vegetated area of Nuweimisa Oasis in March, 1964 contained only lepidopterous larvae [*Heliothis* (*Chlorides*); Noctuidae"] (Hoogstraal, 1964, p. 214), which we found everywhere on the ground between *Zygophyllum album* at the time. Stomachs from other specimens contained feathers of small birds and remains of *Jaculus jaculus*.

Insects, beetles in particular; small rodents (Gerbillinae), lizards, birds, and plant material have been listed as food of wild fennecs (Thomas, 1913; Buxton, 1923; Gauthier-Pilters, 1967). Dekeyser (1955) included roots of orobanche (*Cistanche phelipaea*).

Bruce (1790) fed a captive fennec dates, sweet fruits, bread with honey or sugar, and eggs of pigeons or small birds. He observed the animal did not know how to handle a hen's egg, but a broken egg was quickly eaten. Schmidt-Nielsen's (1964) fennecs ate a similar variety, including table scraps. Pet fennecs of Gauthier-Pilters (1967) were said to hide food like a red fox.

One captive fennec had an affinity for sweets such as cake, chocolate, sweetened stewed fruits, whipped cream, and honey, but not for sour foods. It also ate various nuts and fruits (Vogel, 1962).

Water.—The fennec appears to be the only desert carnivore that is entirely independent of drinking water, according to Schmidt-Nielson (1964) and Gauthier-Pilters (1967). Fennecs we have kept in captivity for a week or so did not drink water even though panting from heat. Fennecs kept as pets (Vogel, 1962) and in zoos drink water regularly.

Reproduction.—Flower (1932) reported litters of three born in Giza Zoological Garden in July and April. Captive fennecs from Algeria bred in February, March, and April and gave birth in May and June after 50 to 52 days of gestation. Litter sizes were one to three (Saint-Girons, 1962). In Gauthier-Pilters' (1967) notes on mating in captivity, the rutting period was January and February, gestation 49 to 52 days, and birth period February and March. We dug two young, which were probably weaned, from a burrow in Wadi Muwellih in May (fig. 119).

Sex ratio.—A sample of 71 from Giza Governorate contained 34 (48 per cent) males and 37 females.

Predators.—According to Gauthier-Pilters (1967, p. 117), "enemies of the fennec are jackals, hyenas, vultures as well as dogs and men."

Economic importance.—Young fennecs are fattened and eaten in the Western Sahara (Monod, 1958).

Family 2. Mustelidae

Small to medium size, slender carnivores. Pelage marked or unmarked. Muzzle short; ears small, rounded; legs short in proportion to body length. Feet plantigrade to digitigrade, functional toes 5-5, claws nonretracile. Tail cylindrical or bushy, two-thirds of or less than length of head and body. Anal scent glands well developed. Males larger than females in some genera.

Rostrum and nasals short. Upper tooth row length less than one-half skull length. Paroccipital process not prominent, fused completely to tympanic bulla. Bulla moderately inflated, septum absent. Postglenoid process curved over glenoid fossa locking mandible in place. Alisphenoid canal absent. Baculum well developed.

Incisors unspecialized; canines elongate, sharp; premolars small, reduced in number, constriction commonly present between lateral and medial parts of m^1. Dental formula: $\frac{3}{3}, \frac{1}{1}, \frac{3-4}{3}, \frac{1}{2} \times 2 = 34$ or 36.

KEY TO EGYPTIAN GENERA OF MUSTELIDAE

1. Dorsum striped black and white. Parapterygoid fused with tympanic bulla.
   a. *Black middorsal stripes four or five. Palm and sole haired. Postorbital swelling* inconspicuous. Meatal lip inflated. ..... *Poecilictis*, p. 395.
   b. Black middorsal stripes three. Palm and sole naked. Postorbital swelling very conspicuous. Meatal lip not inflated. ..... *Ictonyx*, p. 403.
2. Dorsum brown. Parapterygoid not fused with tympanic bulla. ... *Mustela*, p. 405.

Genus **Poecilictis** Thomas and Hinton, 1920

Shaggy, black- and white-striped, bushy-tailed weasels. Middorsal longitudinal black stripes four or five. Palm and sole haired; toe pads concealed. Skull short, cranium outline triangular in dorsal view. Postorbital swelling moderate. Postorbital constriction slightly wider than rostrum. Tympanic and mastoid bullae inflated.

Poecilictis libyca (Hemprich and Ehrenberg, 1833)

Mustela libyca Hemprich and Ehrenberg, 1833, Symbolae Physicae Mamm., 2, folio k, p. 6.

Type locality.—Libya (Setzer, 1959c); Egypt, MATRUH: Libyan Desert between Siwa and Alexandria (Flower, 1932).

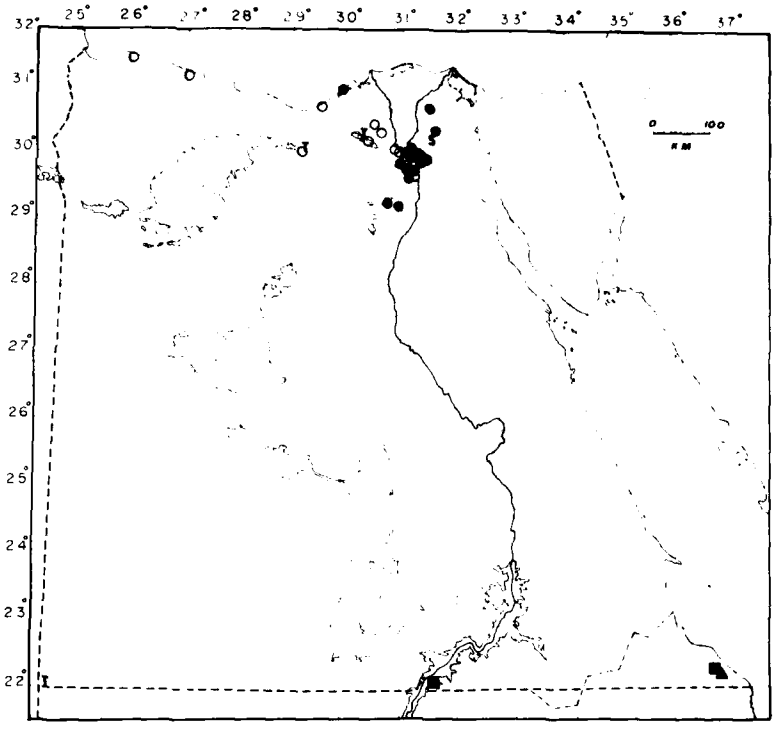


FIG. 121. Collection localities of *Poecilictis libyca libyca* (circles) and records of tracks (T), *Ictonyx striatus erythreae* (triangle), *Mustela nivalis subpalmata* (dots) and sight records (S), and *Genetta genetta senegalensis* (squares).

General distribution.—Mediterranean Coastal Desert from western margin of Nile Delta west to Morocco; northern Sudan, Chad, Niger, Mali, and Mauritania.

Common names.—Striped Weasel, *Abu Menten.*

Subspecies in Egypt.—

Poecilictis libyca libyca (Hemprich and Ehrenberg, 1833)

Poecilictis libyca alexandrae Setzer, 1959, J. Egypt. Publ. Health Assn., 33, No. 6, p. 201.

Type locality.—Libya.

Distribution in Egypt.—Figure 121. Western margin of Nile

FIG. 122. Mustelidae. Left to right: dorsal and ventral views of *Mustela nivalis subpalmata*; two dorsal views and a ventral view of *Poecilictis libyca libyca*; dorsal and ventral views of *Ictonyx striatus erythreae*.

Delta, Western Mediterranean Coastal Desert, Wadi el Natroun, El Maghra, and Gebel Uweinat.

Diagnosis.—Dorsum with four or five black stripes alternating with white. White band encircling head. Outline of cranium broadly triangular in dorsal view. Postorbital swellings moderate. Mastoid and paroccipital processes obsolete. Tympanic and mastoid bullae and lower lip of auditory meatus inflated. Adult head and body length average 256 mm.; tail 174.0 mm., 67.7 per cent of head and body length; foot 41.0 mm.; ear 22.2 mm.; condyloincisive length 52.9 mm.; averaged weight of various individuals 200 gm.

External characters.—Figure 122. Pelage shaggy, markings black and white. Dorsum with three black stripes beginning behind ears. Middle stripe subdivided middorsally into two or three additional stripes that fuse on rump and base of tail. Black stripes are produced by black under hairs and white stripes by guard hairs that are white to their bases. Pelage may appear spotted. Venter, legs, and

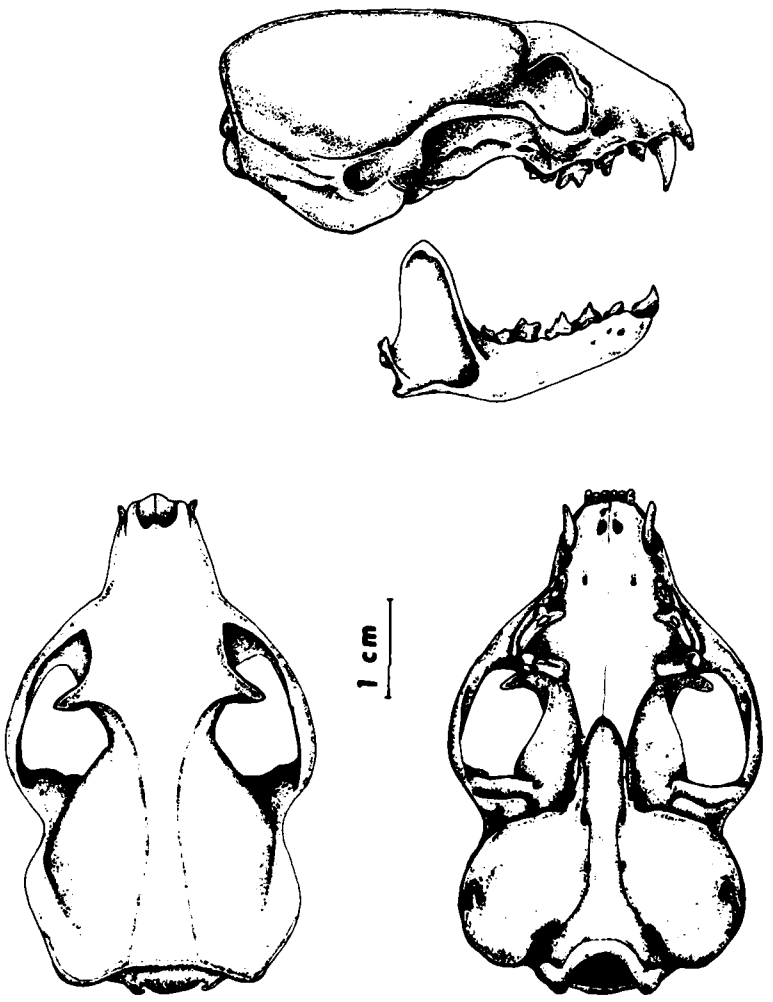


FIG. 123. Skull of *Poecilictis libyca libyca*.

feet black. Palm, sole, and toes haired; toe pads concealed by hair. Snout black, mystacial area white. Head encircled by white band passing between eyes and ears and on underside of jaws. Ear tip sometimes white. Upper tail hairs with long, white tips, black subterminal bands, and white bases. Lower hairs with black tips increasing in length from middle to end of tail. Underside of tail tip black.

Cranial characters.—Figure 123. Skull short, broad; cranium relatively shallow, outline triangular in dorsal view. Sutures not visible, except in juveniles. Sagittal ridge broad and low in subadults, becoming slightly higher and narrower in adults. Lambdoidal ridge fairly prominent, lateral portion extending posterior to supraoccipital, but not beyond level of posterior margin of mastoid bulla nor even approaching level of upper lip of foramen magnum. Postorbital process prominent. Postorbital inflation moderate. Postorbital constriction slightly wider than rostrum. Tympanic and mastoid bullae and lower lip of auditory meatus strongly inflated. Mastoid and paroccipital processes obsolete. Parapterygoid fused with tympanic bulla. Zygomatic arch not strongly curved upward. Coronoid process of lower jaw rounded.

Teeth.—Outer upper incisor considerably larger than others. Upper and lower premolars not crowded; anterior cusps triangular and larger than posterior cusps. Carnassials markedly sectorial. Upper carnassial with outer anterior cingulum cusp-like, inner cusps prominent, and constriction between anterior and posterior crowns deep. Width across crown of m^1 greater than width of carnassial (pm^4). Lower carnassial with anterior crown and inner cusp subequal; heel much larger than m_2. M_2 relatively large, with three fairly prominent cusps.

Baculum.—Baculum length about 32 mm. in adult; base swollen slightly, rugose; shaft smooth, curved slightly dorsad; tip teardrop shaped and oblique to shaft (Setzer, 1960a).

Measurements.—Table 48. Male and female measurements subequal. Means (and ranges) of condyloincisive length (in millimeters) of 11 subadult males and eight subadult females are 49.9 (48.2 to 54.9) and 49.8 (46.8 to 52.8), respectively.

One adult female, one subadult female, and one juvenile of unknown sex weighed 181.0, 171.2, and 192.0 gm., respectively. Three males examined after death by Flower (1932) weighed 200, 200, and 250 gm.

TABLE 48. — Means (and ranges) of measurements and ratios of adult *Poecilictis l. libyca* and adult male (M) and female (F) *Ictonyx striatus erythreae*.

	P. l. lybica		*I. s. erythreae*	
	Western Mediterranean Coastal Desert	Western border of Nile Delta	Gebel Elba	
			M	F
HBL	263.4 (254-279) 5	231, 243	369	325
TL	178.2 (160-193) 4	179, 162	273	288
TL/HBL%	67.0 (61.1-72.2) 5	71.5, 66.6	73.9	88.6
FL	41.2 (38-46) 5	40, 41	58	53
BL	22.8 (21-25) 5	22, 20	26	24
CIL	54.5 (52.7-56.5) 5	51.4 (48.8-54.3) 7	61.0	56.7
ZW	34.5 (32.8-35.4) 5	32.3 (30.0-34.0) 7	37.9	33.8
POW	11.8 (11.4-12.6) 5	11.2 (11.0-11.7) 6	13.3	13.2
MW	31.9 (29.9-32.7) 5	29.9 (28.5-31.6) 6	31.9	29.8
RW	11.1 (10.6-11.8) 5	10.3 (9.9-10.8) 7	14.1	12.2
SH	23.1 (21.8-23.7) 5	22.8 (22.0-23.4) 6	23.3	22.4
M^1	6.5 (5.6- 7.2) 5	6.2 (5.8- 6.5) 7	—	—
P^4-P^4	19.3 (18.5-19.8) 5	18.4 (18.0-18.9) 7	21.9	21.2
I-M^1	20.7 (20.1-21.4) 5	19.8 (19.1-20.7) 7	22.7	21.3
Post M^1	33.8 (32.1-35.2) 5	31.6 (29.5-33.6) 7	—	—
I-M^1/CIL%	38.0 (37.6-39.0) 5	38.4 (37.4-39.8) 7	—	—
Post M^1/CIL%	62.0 (60.9-62.6) 5	61.4 (60.2-62.5) 7	—	—

Age determination.—Juveniles have a smooth cranium, some sutures not fused, frontal swellings prominent, and all permanent teeth not in position. Subadults have parallel parietal ridges forming a broad plateau about as wide as or wider than the occipital condyles, lambdoidal ridge not prominent, frontal swellings prominent, all sutures fused, and all permanent teeth in position. Adults have parietal ridges close together and forming a sagittal ridge which is narrower than the occipital condyles, lambdoidal ridge prominent, frontal swellings obsolete, and teeth worn.

Variation.—Specimens from areas adjacent to the Nile Delta and west to Bir Victoria average slightly smaller in most dimensions than those from the Western Mediterranean Coastal Desert (table 48).

Three variations in median lumbar stripe—complete, incomplete, and absent—appear to be clinal in distribution from west to east, but data are insufficient for definite conclusions. Amount of white on ear tip varies individually. Photographs of specimens from Libya (Zammarano, 1930) also indicate some variation in color pattern.

Comparisons.—*Poecilictis libyca* differs from all other small Egyptian carnivores, except *Ictonyx striatus*, by its black and

white dorsal striping. From the latter it differs in having the median dorsal stripe subdivided in the lumbar region. The black stripes are due to black under hairs, whereas in *I. striatus* black stripes are of black guard hairs. Cranially, *P. libyca* differs from the latter in having smaller postorbital swellings, bulla more inflated, meatal lip inflated, mastoid process obsolete, and smaller dimensions (table 48).

Poecilictis l. libyca is intermediate in size between the subspecies *vaillanti* of Tunisia and Algeria and *multivittata* of Sudan (Thomas and Hinton, 1920).

Remarks.—Following is an annotated list of characters which were considered to be diagnostic for *P. l. alexandrae* ssp. nov. Setzer (1959c) from the western border of the Nile Delta in comparison with *P. l. libyca* from the Western Mediterranean Coastal Desert.

1. "Small body size." Setzer compared his type, a subadult, with two adult specimens of *P. l. libyca.* External measurements in Table 48 are of four to five adult *libyca* and two adult "*alexandrae.*" Mean (and range) of head and body length (in millimeters) for two adult plus 12 subadult "*alexandrae*" are 230.4 (205 to 243); foot length 37.2 (32 to 43). These data in conjunction with those in Table 48 indicate that there is clinal reduction in size from west to east in *P. l. libyca* in Egypt.

2. "Tail relatively long." Tail length is not relatively longer in the "*alexandrae*" sample and also averages slightly shorter than in *libyca.* Mean (and range) of tail length (in millimeters) of two adult plus 11 subadult "*alexandrae*" are 151.6 (124 to 179), whereas the mean (and range) of ratio of tail length to head and body length in per cent are 64.9 (58.2 to 71.5).

3. "Skull small." Adult skulls in the "*alexandrae*" sample are slightly smaller and have less prominent ridges than older adult skulls of *P. l. libyca* (table 48). Mean condyloincisive length, plus or minus two standard errors, of *P. l. libyca* is 54.5 ± 3.16, and for the "*alexandrae*" sample, 51.4 ± 1.396. Furthermore, statistical analysis indicates no significant difference between samples, where $t = 1.79$ with 10 degrees of freedom.

4. "M^1 and p^4 small." M^1 averages slightly smaller in the "*alexandrae*" sample, but shows more variation in *libyca* (table 48). Visual examination indicated no marked size difference in p^4 between samples.

5. "Upper premolars and molars small." Length of upper tooth

row (I-M^1) in the "*alexandrae*" sample averages 0.7 mm. less than *libyca* (table 48). The ratio of tooth row to condyloincisive length (I-M^1/CIL) is essentially the same in both samples. The teeth of "*alexandrae*" are not small and weak in proportion to skull size as suggested elsewhere (Hoogstraal, 1964).

6. "Audital portion of auditory bulla strongly inflated; mastoidal portion of auditory bulla but slightly inflated." Setzer's (1959c) type of "*alexandrae*" is the only specimen that shows this condition. Prominent inflation of the mastoid bulla is a characteristic of *P. libyca.*

7. "Postpalatal length of skull relatively long." Ratios of postpalatal length to condyloincisive length (Post M^1/CIL) are about the same in both samples (table 48). Postpalatal length averaged 2.2 mm. less in the eastern sample (table 48).

8. "The posterior white rosette is not divided by the central dorsal black stripe." This character (median stripe absent) was present in 25 per cent of the "*alexandrae*" sample and in one specimen of *libyca* from Bahig (table 49). The high frequencies of two additional variations, median stripe complete and median stripe incomplete, in Table 49 reduce further the value of "rosette all white" as a diagnostic character of Setzer's (1959c) proposed subspecies.

The above notes indicate that the "*alexandrae*" sample is not taxonomically distinct from *P. l. libyca.* Data in Tables 48 and 49 indicate further that dimensions and color characters are clinal in nature. The two populations under consideration are doubtlessly continuous.

Specimens examined.—Total 45.

MATRUH: SIDI Barrani 31 km. E (1); Mersa Matruh (3); Bahig (4); Giza 16 km. NW (1), 32 km. NW (1); Bir Nahid (1).

BEHEIRA: Wadi el Natroun (2), hills, W of (1 skull beside fox den); El Beida (2); Bir Victoria (1).

EL TAHREER: El Tahreer (1).

GIZA: El Qatta (5), Abu Ghalib (10), between Abu Ghalib and Cairo-Alexandria desert road (1), Abu Rawash (2), Giza Pyramids area (3), Giza (2).

CAIRO: Near Cairo (4).

Sight record of D. Osborn.—Tracks photographed at El Maghra, April, 1977.

Published records.—Records are from Anderson (1902), De Win-

TABLE 49. — Variation in median lumbar stripe in samples of *Poecilictis libyca*. Terminology in parentheses is from Setzer (1959c).

Median lumbar stripe	Western Mediterranean Coastal Desert		Western Border of Nile Delta	
	No.	%	No.	%
Complete (white rosette divided)	4	44.4	8	28.5
Incomplete (white rosette partially divided or with central black spot)	4	44.4	13	46.4
Absent (rosette all white)	1	11.1	7	25.0
Totals	9		28	

ton (1902), Flower (1932), Setzer (1959c), Hoogstraal (1964), and Missone (1970).

MATRUH: Sidi Barrani 31 km. E, Mersa Matruh, Bahig.

BEHEIRA: Wadi el Natroun.

GIZA: El Qatta, Abu Rawash, Giza, Sakkara.

Libya. CYRENAICA: Gebel Uweinat (tracks photographed).

Collection.—Dug from shallow burrows in flat sand, hard ground, or in mounds (Hoogstraal, 1964).

Habitat.—Vegetated sandy desert bordering the Nile Delta. Discontinuous patches of vegetation west of the Delta, sandy areas of Wadi el Natroun, and Western Mediterranean Coastal Desert south of the coastal salt marshes (De Winton, 1903; Hoogstraal, 1964).

Behavior.—Reported by Hoogstraal (1964, p. 217) to "growl, bark, and hiss viciously at sudden sounds" and to raise the nape and spinal hair when annoyed. Flower (1932, p. 404) said that, in captivity, "these animals become tame, do not smell and make interesting pets."

Food.—Thought to live almost entirely on lizards (De Winton, 1903). Animals in captivity have been fed young live mice.

Reproduction.—Flower (1932, p. 404) recorded five litters of one to three born in Giza Zoological Gardens in January, February, and March. He described the newborn as "pink, hairless and helpless." Hoogstraal (1964) examined a female from Bahig in September, which contained advanced embryos.

Genus **Ictonyx** Kaup, 1835

Long-haired, black- and white-striped, bushy-tailed weasels. Mid-

dorsal longitudinal black stripes three. Palm and sole naked. Skull elongate. Postorbital swelling prominent. Postorbital constriction about same width as rostrum. Tympanic bulla inflated.

Ictonyx striatus (Perry, 1810)

Bradypus striatus Perry, 1810, Arcana or the Mus. Nat. Hist., pt. II, pl. (41), text.

Type locality.—South Africa: Cape of Good Hope.

General distribution.—Sudan west through Chad, Niger, Mali, Mauritania, and Senegal; and south through Ethiopia, southwestern Somalia, Kenya, Tanzania, and the remainder of Africa south of Zaire.

Common names.—Zoril, *Abu Afene.*

Subspecies in Egypt.—

Ictonyx striatus erythreae De Winton, 1898

Ictonyx striatus erythreae De Winton, 1898 Ann. Mag. Nat. Hist., (ser. 7), 1, p. 248.

Type locality.—Sudan, KASSALA: Suakin.

Distribution in Egypt.—Figure 121. Southeasternmost part of Eastern Desert.

Diagnosis.—Dorsum with three prominent black stripes alternating with white. White band across forehead. Palm and sole bare. Skull elongate. Postorbital swelling prominent. Mastoid and paroccipital processes protruding.

Head and body length average 347 mm.; tail 280 mm., 81 per cent of head and body length; foot 56 mm.; ear 25 mm.; and occipitonasal length 58.8 mm.

External characters.—Figure 122. Pelage shaggy, markings black and white. Dorsum with three clearly defined black stripes beginning behind head, broadening and separating widely on middorsum, fused on rump. Black stripes of all black hairs, white markings of all white hairs. Belly, legs, and feet black; latter sometimes with scattering of white hairs. Palm and sole bare. Lips sometimes white. Ear tip white. A broken white band crosses the head between eyes and ears. Upper and lower basal one-third of tail black; remainder of tail hairs with white tips and black bases.

Cranial characters.—Skull elongate; cranium high, rounded. No sutures visible in adults. Nasofrontal region markedly swollen.

Sagittal ridge narrow and clearly defined. Lambdoidal ridge is prominent, superior margin extends beyond the posterior level of the occipital condyle. Postorbital process moderately developed, postorbital inflation prominent. Postorbital constriction about same width as rostrum. Tympanic bulla inflated, fused with parapterygoid. Mastoid bulla and lower lip of auditory meatus not inflated. Mastoidal and paroccipital processes prominent, protruding. Zygomatic arch strongly curved upward. Tip of coronoid process of lower jaw rounded.

Baculum.—Baculum length about 52 mm. Base enlarged; shaft tapering gradually to flared tip, curved dorsad (Didier, 1947).

Teeth.—Outer upper incisor (I^3) much larger than others. Upper premolars crowded. First premolars simple, second upper and lower with large triangular anterior cusps and small posterior cusps. Carnassials are markedly sectorial. Upper carnassial with outer anterior cingulum cusp-like; inner cusps prominent, two-thirds height of anterior crown; and deep constriction between anterior and posterior crowns. Inner cusps and anterior crown of lower carnassial subequal. Heel about the size of m_2. Width across crown of m^1 greater than width of carnassial. M_2 relatively large with three prominent cusps.

Measurements.—Table 48.

Comparisons.—*Ictonyx striatus* differs from all other small Egyptian carnivores, except *Poecilictis libyca*, in having black and white markings. Comparison with *P. libyca* is under the latter. *Ictonyx striatus erythreae* can be distinguished from subspecies *sudanicus* by reddish tone to black parts of pelage, black pigmented areas more extensive, and smaller dimensions (Setzer, 1956).

Specimens examined.—Total two.

SUDAN ADMINISTRATIVE: Wadi Darawena (2).

Collection.—Trapped in parkland in traps set for fox in Wadi Darawena (Hoogstraal et al., 1957ab).

Food.—Reptiles, rodents, and bird eggs (Dorst, 1970).

Reproduction.—Number of young two to three. Fur is short and marked like adults (Dorst, 1970).

Genus **Mustela** Linnaeus, 1758

Slender, short-haired, brown weasels. Legs short; tail short, cylin-

drical. Rostrum short, broad. Cranium elongate, dorsoventrally flattened. Postorbital swelling absent. Postorbital constriction narrower than rostrum. Bulla moderately inflated and not fused with parapterygoid.

Mustela nivalis Linnaeus, 1766

Mustela nivalis Linnaeus, 1766, Syst. Nat., 12th ed., p. 69.

Type locality.—Sweden: VESTERBOTEN.

General distribution.—Circumpolar in temperate, north temperate, and arctic regions. Also in Lebanon, Egypt, Morocco, and Algeria.

Common names.—Weasel, *Ersa.*

Subspecies in Egypt.—

Mustela nivalis subpalmata (Hemprich and Ehrenberg, 1833).

Mustela subpalmata Hemprich and Ehrenberg, 1833, Symbolae Physical Mamm., Vol. 3, folio k, p. 2.

Type locality.—Egypt. Houses of Cairo and Alexandria.

Distribution in Egypt.—Figure 121. Lower Nile Valley and Nile Delta.

Diagnosis.—Brown above, whitish below. Body slender, tail and legs short. Skull flattish, rostrum very short and broad. Hamular process of parapterygoid not fused with bulla.

Head and body length of adult male and female, respectively, average 278, 242 mm.; tail 116, 99 mm., 41.6 per cent of head and body length; foot 50, 38 mm.; ear 21, 18 mm.; condyloincisive length 50.0, 43.2 mm.

External characters.—Figure 122. Dorsum and side dark brown. Venter whitish to cream. Demarcation between side and belly straight or irregular. Chin white, throat sometimes spotted. Tail unicolor, tip slightly darker than rest of tail and body. Toes whitish. Hair of palm sometimes whitish, sole brown.

Cranial characters.—Figure 124. Cranium elongate, shallow, sagittal and lambdoidal ridges prominent; the latter not exceeding posterior level of upper lip of foramen magnum. Rostrum markedly short and broad. Postorbital process relatively small. Postorbital swelling nil. Postorbital constriction narrower than rostrum (table 50). Tympanic and mastoid bullae moderately inflated. Tympanic bulla not fused with parapterygoid. Mastoid process prominent.

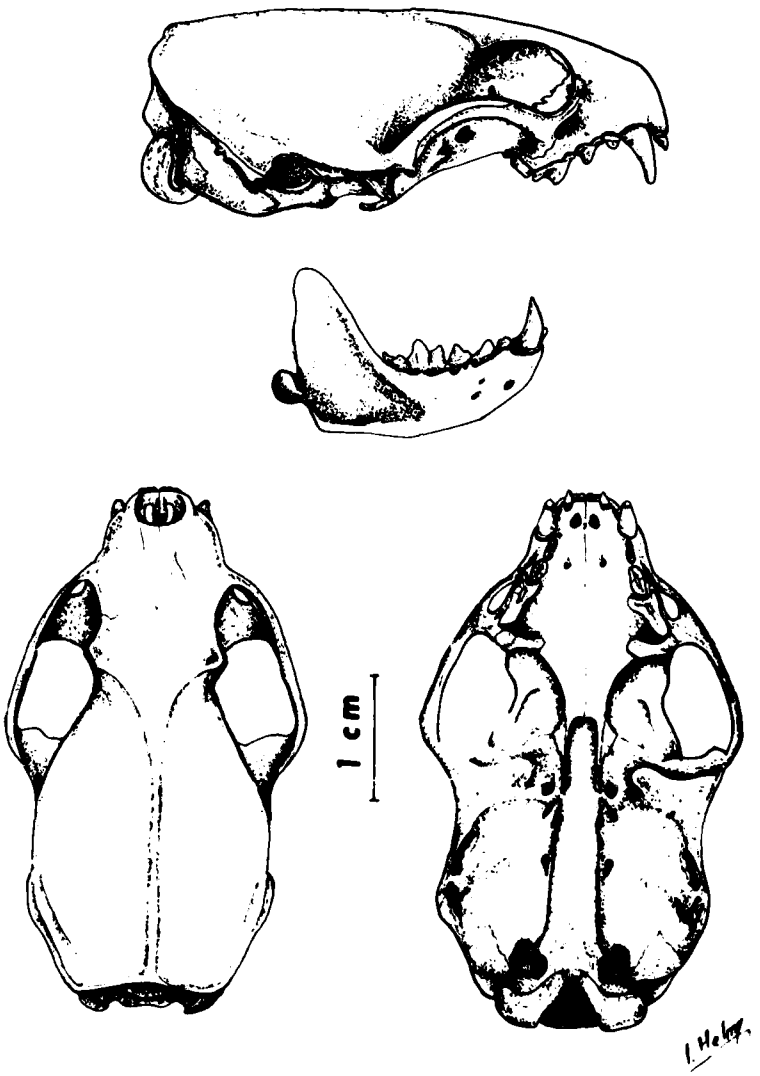


FIG. 124. Skull of *Mustela nivalis subpalmata*.

Paroccipital fused to bulla. Zygomatic arch not strongly curved upward. Tip of coronoid process of lower jaw angular.

Teeth.—Outer upper incisor slightly larger than others. Upper and lower premolars single cusped, triangular in lateral view, crowded, and crowns oblique to axis of tooth row (Miller, 1912, p. 414). Carnassial trenchant. Outer anterior cingulum of upper carnassial obsolete, inner anterior cusp reduced. Constriction between anterior and posterior crowns shallow. Inner cusp of lower carnassial obsolete and heel slightly larger than m_2. Width across crown of m^1 less than width of carnassial (pm^1). M_2 reduced and simple.

Baculum.—Baculum is slender, grooved below, and hooked distally.

Measurements.—Table 50. Male dimensions average considerably larger than female. Flower (1932) listed the weights of three females as 200 gm. each.

Age determination.—Adults have well-developed cranial ridges.

Variation.—Belly color varies from nearly pure white to creamy yellow. The area varies individually from a narrow, irregular, and occasionally broken midventral line with wider patches on chest and throat to a completely pale underside, sometimes extending onto side of throat and head. Bonhote (1909) mentioned variation in amount of white on the underparts.

TABLE 50. — Means (and ranges) of measurements and ratios of adult male (M) and female (F) *Mustela nivalis subpalmata.*

HBL	M	288.8 (252-301) 9	RW	M	11.4 (10.7-14.2) 7
	F	241.8 (232-259) 5		F	9.2 (8.7-10.2) 6
TL	M	116.8 (109-129) 9	POW	M	8.5 (7.9- 8.8) 7
	F	99.4 (94-110) 5		F	7.9 (7.4- 8.7) 6
TL/HBL%	M	42.2 (39.2-45.9) 9	MW	M	25.6 (25.0-26.8) 7
	F	41.1 (37.8-46.4) 5		F	21.1 (20.0-22.3) 6
FL	M	50.2 (45-55) 9	P^4-P^4	M	15.8 (15.4-16.5) 7
	F	38.6 (34-42) 5		F	13.6 (13.3-13.9) 4
EL	M	21.3 (20-23) 9	C-M^1	M	14.0 (13.5-14.2) 7
	F	18.0 (15-20) 5		F	11.9 (11.5-12.5) 5
CIL	M	50.0 (48.2-51.2) 7	SH	M	16.7 (16.2-17.4) 7
	F	43.2 (41.8-43.9) 5		F	14.8 (14.4-15.2) 5
ZW	M	28.4 (26.8-29.3) 6			
	F	23.5 (22.2-24.9) 6			

Comparisons.—*Mustela nivalis* differs from other Egyptian Mustelidae in having brownish color; slender, short tail; absence of postorbital swelling; and bulla not fused with parapterygoid. *Mustela nivalis subpalmata* is larger than northern subspecies.

Specimens examined—Total 38.

QALYUBIYA: Shubra Shihab (1), Kafr el Shurafa (1).

GIZA: Tanash (2), Mena (1), Giza Zoological Gardens (4), El Mansuriya (2), Sakkara (1).

CAIRO: Cairo (15), Bulaq el Dakrur (2), Abassia (4), Sharabiya (1).

EL FAIYUM: Shakshuk (2), Seila (2).

Published records.—Records are from Taylor (1897), [illegible]on (1897, 1902), Flower (1932), Setzer (1952, 1959c), and Ho[illegible]traal (1964).

ALEXANDRIA: Alexandria.

SHARQIYA: El Qanayat (sight record).

QALYUBIYA: Sindbis.

DAQAHLIYA: Simbillawein 8 km. W.

GIZA: Tanash, El Mansuriya, Kafr Teharmes, Kuneissa, Saqyet Meki, Abu Rawash, Sakkara.

CAIRO: Cairo, Abassia, Old Cairo walls (sight record).

EL FAIYUM: Shakshuk, Seila.

Habitat.—Most specimens are from houses and public buildings; a few from cultivated fields and canal banks. According to Hoogstraal (1964), the species is no longer numerous in public places, such as clubs, restaurants, and theaters, as Flower (1932) observed earlier.

Habits.—In Egypt, *M. nivalis* is almost completely commensal. It is mainly nocturnal, but individuals have been seen during the day (Taylor, 1897; Flower, 1932).

Food.—Anderson (1897) reported natives saying weasels killed rats and mice in houses. Stomach contents have contained cockroaches, tenebrionid beetles, red ants, a small bird, fish, and fish bait.

Reproduction.—Flower (1932) noted a litter of five born in December.

Remarks.—Rüppell (1826) considered the Egyptian and European weasels to be conspecific, but thought that the species had been introduced into Egypt.

Family 3. Viverridae

Small to medium size carnivores. Pelage coarsely grizzled or spotted and striped. Muzzle long; ears relatively short, rounded; legs short in proportion to body length. Feet semi-plantigrade to digitigrade. Toes 5-5, pollex and hallux vestigial, claws semiretractile in some genera. Tail somewhat bushy, longer than two-thirds length of head and body. Anal scent glands usually well developed.

Rostrum relatively long, upper tooth row length less than one-half skull length. Paroccipital process fused completely to tympanic bulla. Bulla constricted externally, divided by septum. Alisphenoid canal absent. Baculum well developed.

Middle lower incisor raised above level of other two; canines small, elongate; premolars small, pm_1 reduced or absent; upper carnassial usually without anterior lobe, lower with well-developed talon; molars relatively large, first much larger than second. Dental formula: $\frac{3}{3}, \frac{1}{1}, \frac{4}{4}, \frac{2}{2} \times 2 = 40$.

KEY TO EGYPTIAN GENERA OF VIVERRIDAE

1. Body spotted and striped, tail banded. Tail cylindrical. Ear longer than broad. Frontal swelling slight, postorbital bar lacking. Postpalatal margin slightly behind last molar. Posterior chamber of tympanic bulla not inflated below level of anterior chamber..... *Genetta*, p. 410.
2. Body and tail grizzled. Tail tapering. Ear broader than long. Frontal and postorbital swelling prominent. Postorbital bar complete in adults. Postpalatal margin at level of glenoid fossa. Posterior chamber of tympanic bulla inflated below level of anterior chamber..... *Herpestes*, p. 415.

Genus **Genetta** Oken, 1816

Cat-like, long-bodied, long-tailed, short-legged carnivores. Pelage striped and spotted. Tail with contrasting dark and light rings. Claws short, semi-retractile.

Skull elongate, postorbital processes moderately developed. Palatal margin not extended posteriorly. Chambers of tympanic bulla about subequal.

Genetta genetta (Linnaeus, 1758)

Viverra genetta Linnaeus, 1758, Syst. Nat., 10th ed., p. 45.

Type locality.—Spain.

General distribution.—Southwestern Europe, northwestern Africa, southeastern Egypt and Sudan, west to Senegal and south

into Somalia, thence west and south into South Africa. In the Arabian Peninsula: Israel, Aden, and Yemen.

Common name.—Common Genet.

Subspecies in Egypt.—

Genetta genetta senegalensis (Fischer, 1829)

Viverra senegalensis Fischer, 1829, Synopsis Mammalia, p. 170.

Type locality.—Senegal.

Distribution in Egypt.—Figure 121. Southeastern and southwestern parts of Eastern Desert.

Diagnosis.—Body elongate, weasel-like. Pelage short, soft, grayish with black spots and stripes. Tail long, cylindrical, ringed with black and yellowish bands. Palm and sole haired. Ear long and narrow.

Skull elongate. Cranium markedly constricted posteriorly. Nasofrontal region slightly inflated. Postpalatal margin slightly posterior to last molar. Postorbital process moderately developed. Cranium broadest at sides.

Head and body length average 454 mm.; tail 382 mm., 85 per cent of head and body length; foot 78 mm.; condyloincisive length 79.8 mm.

External characters.—Figure 125. Dorsum with median black crest extending from shoulder to base of tail. Six thin stripes on neck and shoulders and rows of elongate spots on dorsum and sides. Stripes and spots blackish or brownish on yellowish gray background. Chest and belly grayish to buffy. Axilla and groin whitish. Lacrimal stripe black. Muzzle tip and suborbital area whitish. Frontal area pale gray with a dark median stripe. Crown and ear grayish. All hairs with gray bases. Tail with series of alternate blackish and pale rings. Blackish rings number 9-10 and are complete; pale rings are yellowish above, whitish below. Tail tip is usually whitish, sometimes black. Outer side of legs and upper part of feet are grayish. Palm and sole haired, black; toe pads not concealed.

Cranial characters.—Figure 126. Cranium elongate, narrowly constricted posteriorly; broadest on sides, narrower at bases of zygomatic processes of temporals. Nasofrontal region slightly swollen, postorbital swelling nil. Parietal ridges obscure, sagittal

FIG. 125. Museum specimen of *Genetta genetta senegalensis*.

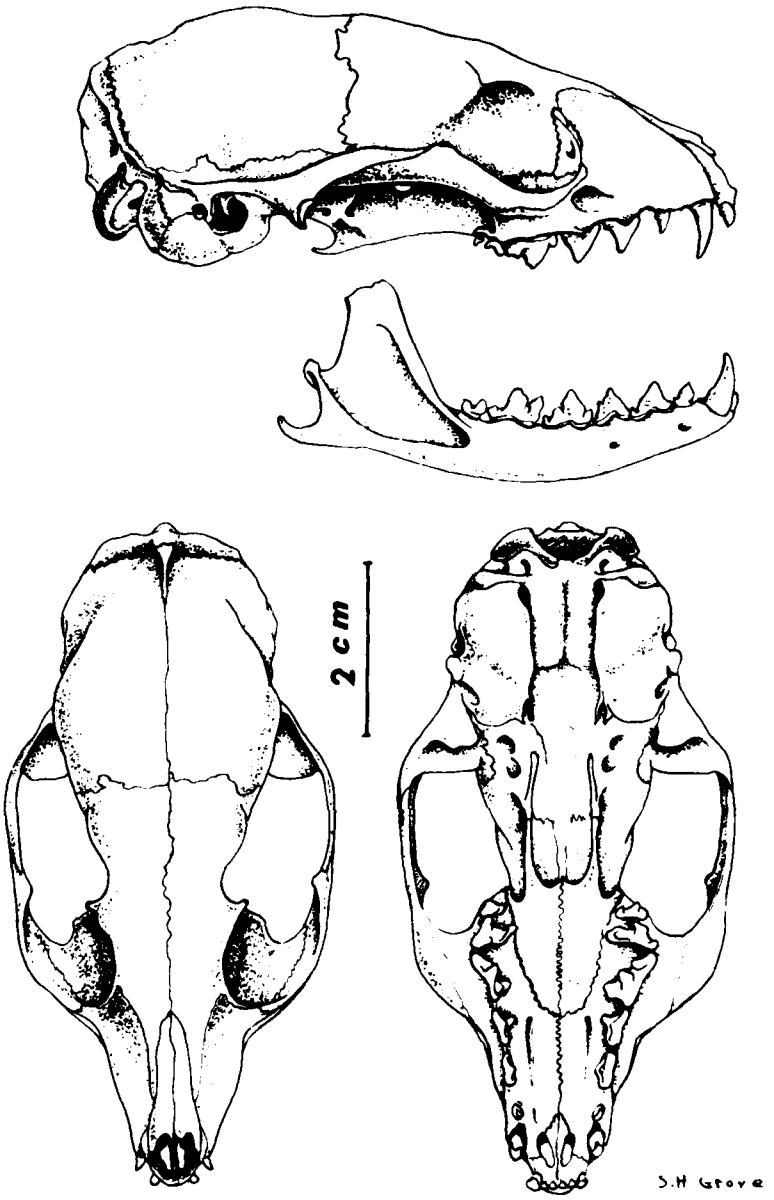


FIG. 126. Skull of *Genetta genetta senegalensis*

ridge prominent posteriorly; lambdoidal ridge prominent, with superior edge slightly caudad of occipital condyle. Frontal process extends about one-half length of nasal, but does not contact premaxilla. Posterior margin of nasals anterior to frontomaxillary suture. Malar in contact with lacrimal. Postorbital process moderately developed. Malar not thickened vertically, postorbital process nil. Infraorbital foramen large, roundish. Incisive foramen elongate. Postpalatal foramen posterior in position, opposite anterior edge of pm^1. Postpalatal margin has a median spine and is slightly posterior to last molar. Hamular process of parapterygoid slender and pointed. Post-tympanic chamber larger than anterior, but not so large as in *Herpestes*. Meatal opening large, roundish. Coronoid process of mandible high and slender; angle slender and unmodified.

Baculum.—Baculum small, 6 to 7 mm. long; swollen at both ends, especially at base; and shaped somewhat like a phalanx (Didier, 1948).

Teeth.—Similar to, but smaller than, *Herpestes*, except for anterior premolars. Anterior face of upper incisor row slightly convex. Outer incisors larger than others. First premolars, upper and lower, larger than corresponding outer incisor. Pm^1 simple; pm_1 with small posterior cusp; $pm^{2-4}_{2,3,4}$ with prominent posterior cusps. Upper carnassial has a prominent inner anterior lobe bearing low cusp and an obscure antero-lateral cusp-like cingulum. First upper molar width narrower than pm^4. Lower carnassial with three prominent anterior cusps; posteriormost largest, inner smallest; heel area less than one-half that of crown and smaller than m_2.

Measurements.—Table 51. Male and female dimensions are subequal.

Comparisons.—*Genetta genetta* differs from all other small Egyptian carnivores in having prominent stripes and rows of spots on body and rings or bands on tail. Cranially and dentally, it differs from the Mustelidae in the elongate cranium and rostrum and greater number of teeth. From *Herpestes* it differs cranially in lack of prominent frontal and postorbital swellings, poorly developed postorbital processes, and less prominent inflation of posterior tympanic chamber.

Remarks. The trinomen *G. g. senegalensis* is tentatively retained for Egyptian specimens.

TABLE 51. — Means (and ranges) of measurements and ratios of *Genetta genetta* and *Herpestes ichneumon*.

	Genetta g. senegalensis	*Herpestes i. ichneumon*
HBL	453.8 (408-528) 4	560.3 (546-608) 6
TL	381.8 (352-516) 4	433.6 (363-460) 6
TL/HBL%	85.2 (66.6-98.8) 4	77.4 (65.8-82.8) 6
FL	77.8 (74-86) 4	104.8 (101-113) 6
EL	41.0 (37-46) 4	35.8 (35-37) 6
CIL	79.8 (78.7-80.8) 4	102.9 (99.8-109.4) 9
ZW	41.1 (38.9-43.7) 5	51.2 (49.4-54.1) 9
RW	12.3 (11.4-13.0) 5	19.2 (18.4-20.6) 9
POW	12.6 (12.0-13.1) 5	18.4 (17.0-20.3) 9
BOW	28.6 (27.7-30.5) 5	34.9 (33.6-35.5) 9
NL	18.0 (17.2-19.0) 5	— —
I-M^2	34.7 (34.1-35.6) 4	42.6 (41.1-44.8) 8
M^1-M^1	24.1 (22.2-25.6) 5	30.8 (29.7-31.9) 9
SH	30.1 (29.5-30.6) 4	38.1 (36.7-39.3) 9

Specimens examined.—Total six.

SUDAN ADMINISTRATIVE: Bir Kansisrob (2).

ASWAN: Gebel Adda (1).

Sudan. UPPER NILE: Paloich 1.2 km. NE (1); Malakal 25 km. N (1), 13.3 km. N (1).

Collection.—Trapped alive and shot at night under a spotlight (Hoogstraal et al., 1957ab; Hoogstraal, 1964).

Habitat.—Dry savanna, acacia parkland, and rocky slopes of desert mountains.

Habits.—Nocturnal. Dorst (1970) refers to genets as blood-thirsty, wasteful killers.

Food.—Various rodents, birds, reptiles, insects, and some vegetable material (Dorst, 1970). Hoogstraal (1964) suggested spiny mice (*Acomys cahirinus*) were a main food source in the Gebel Elba area.

Genus **Herpestes** Illiger, 1811

Weasel-like, long-bodied, long-tailed, short-legged carnivores. Pelage coarse, grizzled. Tail broad and flattened at base, distal one-half tapered. Claws nonretractile.

Skull elongate, narrow, and deep. Postorbital processes well developed, fused in adults to form a postorbital bar. Postpalatal

margin extended posteriorly. Posterior chamber of tympanic bulla much larger than anterior chamber.

Herpestes ichneumon (Linnaeus, 1758)

Viverra ichneumon Linnaeus, 1758, Syst. Nat., 10th ed., p. 43.

Type locality.—Egypt: ad ripas Nili.

General distribution.—Spain, Portugal, Dalmatia, Turkey, Lebanon, Israel, Jordan, Egypt, Libya, Morocco, Algeria, Sudan, Ethiopia, Kenya, Central Africa west through Nigeria, southern Mali etc., eastern equatorial Africa and southern Africa except for parts of southwestern and South Africa.

Common names.—Egyptian Mongoose, *Nims.*

Subspecies in Egypt.—

Herpestes ichneumon ichneumon (Linnaeus, 1758)

Distribution in Egypt.—Figure 127. Nile Delta, Nile Valley south to Asyut, El Faiyum, and Burg el Arab.

Diagnosis.—Body elongate, weasel-like. Pelage long, coarse, grizzled blackish brown and cream. Tail long and tapering with black tip. Palm and sole naked. Ear short, broad and rounded.

Skull elongate, nasofrontal and postorbital regions prominently inflated. Postpalatal margin at level of glenoid fossa. Postorbital bar complete or nearly so. Cranium broadest at base of zygomatic processes of temporals.

Adult head and body length average 560 mm.; tail 434 mm., 77 per cent of head and body length; foot 104 mm.; ear 41 mm.; condyloincisive length 102.9 mm.

External characters.—Figure 128. Dorsum and side hairs grizzled. Guard hairs long, coarse, with eight alternating blackish brown and cream bands. Under hairs yellowish brown to orangish with brownish bases. Venter partly grizzled, clear yellowish brown or orangish medially. Muzzle blackish; frontal, cheek, and throat hairs short and grizzled. Mystacial area to orbit and circumorbital area sparsely haired or almost bare. Ear short, broad, and pale brownish. Tail color of dorsum, hair longest at base, and gradually shortening toward tip. Tip a tuft of long, black hairs. Feet black or brown. Palm and sole naked, pigmented. Juvenile pelage like adult but paler.

Cranial characters.—Figure 129. Cranium elongate, deep and

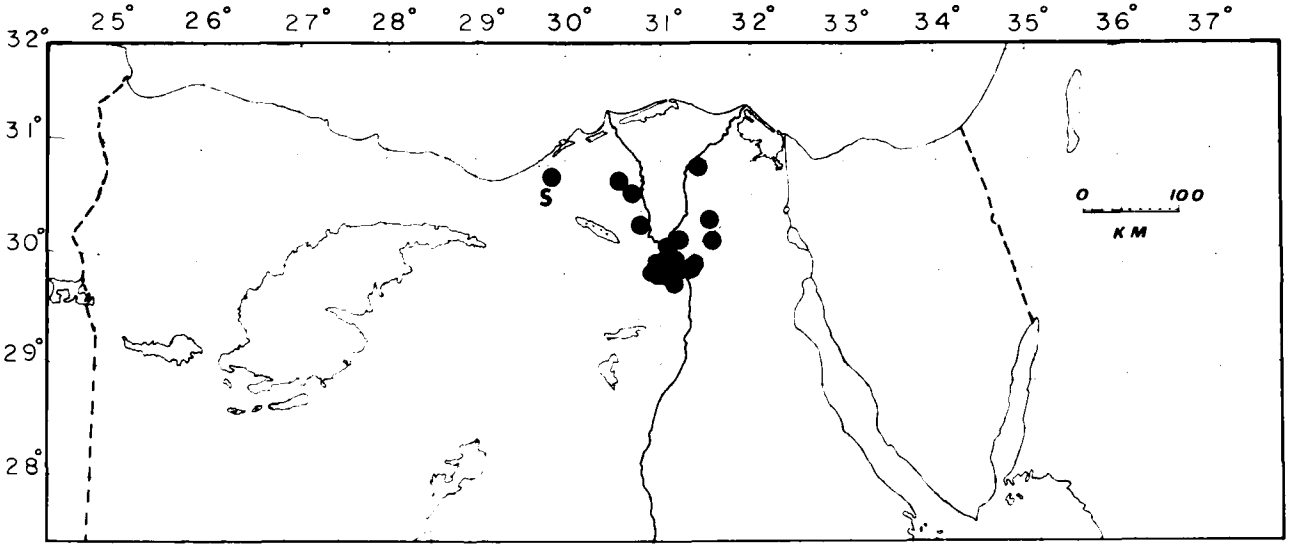


FIG. 127. Collection localities of *Herpestes ichneumon ichneumon* and sight record (S).

FIG. 128. Cadavers of *Herpestes ichneumon ichneumon*

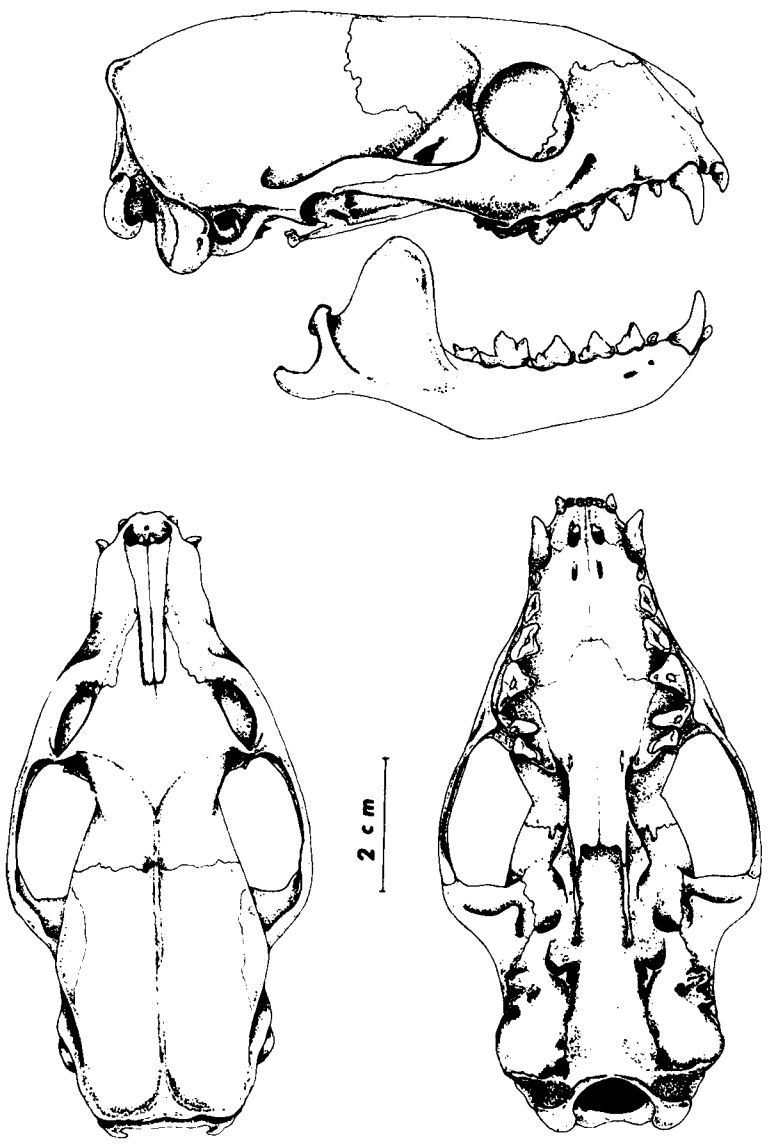


FIG. 129. Skull of *Herpestes ichneumon ichneumon*.

narrow, constricted slightly posteriorly; broadest at base of zygomatic processes of temporals. Nasofrontal and postorbital regions prominently swollen. Postorbital constriction relatively broad. Ridges strongly developed. Superior edge of lambdoidal ridge extending beyond posterior level of upper lip of foramen magnum. Frontal process extending about one-third length of nasal and contacting premaxilla. Posterior margin of nasals level with frontomaxillary suture. Postorbital bar complete in adults. Malar thickened vertically behind postorbital process and not contacting lacrimal. Infraorbital foramen small, elongated dorsoventrally. Incisive foramen ovoid. Postpalatal foramen small, forward in position, opposite anterior edge of pm^2. Postpalatal margin truncate or serrate, never with median projection, and extending posteriorly almost to level of glenoid fossa. Hamular process of parapterygoid thickened terminally. Post-tympanic chamber swollen ventrally below level of anterior chamber and laterally beyond level of mastoid. Meatal opening small, elongate. Coronoid process of mandible short, broad; angle expanded laterally.

Baculum.—Baculum relatively large, about 18 mm. long; anterior portion slender; posterior enlarged, hollow, and ladle-like ventrally, with saddle-like dorsal projection (Didier, 1948).

Teeth.—Anterior face of upper incisor row straight. Outer incisors much larger than others. First premolars, upper and lower, simple, smaller than corresponding outer incisors. Upper and lower second molars triangular in lateral view, $pm^{2,3}$ without secondary cusps; $pm_{2,3}$ with posterior basal cingular cusps; pm_4 with well-developed posterior secondary cusp. Upper carnassial with large anteromedial lobe bearing prominent cusp; anterolateral cingulum prominent and bearing a distinct cusp. First upper molar width greater than pm^4. Lower carnassial with three prominent anterior cusps; anterior crown and inner cusp subequal and about two-thirds height of posterior crown. Heel low, one-half area of m_2.

Measurements.—Table 51. Male and female dimensions are subequal.

Age determination.—Adults have nasofrontal suture fused, median sagittal ridge well developed.

Comparisons.—*Herpestes ichneuman* is distinguishable from all other Egyptian carnivores by its speckled coloring; long, tapering tail; short, broad ears; high, narrow skull; swollen frontal region;

and elongate palate. Further differences between this species and *Genetta genetta* are under the latter.

Ten subspecies in addition to *H. i. ichneuman* are listed from Africa (Allen, 1939). Differences among them appear to be trivial.

Specimens examined.—Total 51.

BEHEIRA: Dilingat (2), El Tarrana (1).

TAHREER: Nubareia (1).

SHARQIYA: Bilbeis (3), Zagzig (1).

QALYUBIYA: Sindbis (1).

MINUFIYA: Mohammed Ali Barrage park (1).

GIZA: El Mitimdiya (1), Kirdasa (1), Abu Rawash (17), El Baragil (3), Zawyet Abu Musallam (1), Nahya (1), Minshat el Bakkari (3), Kafret Nassar (3), Cairo-Alexandria desert road km. 5 (1), El Harraniya (1), Beni Magdul (5), El Kom el Ahmar (1).

CAIRO: Cairo (3).

Sight record of I. Helmy.—

MATRUH: Burg el Arab, 1976.

Published records.—Records are from Anderson (1902), Flower (1932), Setzer (1952), and Hoogstraal (1964).

BEHEIRA: Kom Hamada.

DAMIETTA: Fariskur.

QALYUBIYA: Sindbis.

SHARQIYA: Bilbeis.

DAQAHLIYA: Simbillawein 8 km. E.

GIZA: Mena, Giza, Imbaba.

CAIRO: Abassia Fever Hospital grounds.

Distribution notes.—Flower (1932) reported having seen this species throughout El Faiyum and said it occurred "for certain" in the Upper Egyptian Governorates of Beni Suef, Minya, and Asyut. He said it was reported from as far south as Wadi Halfa, but had no evidence of its occurrence in Lower Nubia. "Reports of mongooses south of Asyut are unconfirmed" (Hoogstraal, 1964, p. 219).

The specimen from Nubareia and the sighting at Burg el Arab represent recent expansion of range following completion of an irrigation canal into the desert.

Collection.—Trapped or dug from burrows.

Habitats.—Cultivated areas of Nile Valley and Delta, near water.

Habits.—Terrestrial, but readily enters water and swims well. Diurnal and crepuscular. Although appearing to be slow moving

when seen crossing roads, mongooses are extremely alert and agile. When excited, the long hair is raised and back arched, nearly doubling the animal's bulk, a common trait among mongooses (Pocock, 1941; Hinton and Dunn, 1967).

Burrows.—Burrows are in cultivated areas and in canal banks.

Food.—Rodents, birds, bird eggs, probably poultry, reptiles, frogs, fish, and various aquatic and terrestrial invertebrates. Reported to eat eggs of Nile crocodile (Anderson, 1902).

Reproduction.—Wild-born litters have been found in February, May, July, September, and October, which suggests there is no fixed breeding season (Flower, 1932). Litter sizes are two to four (Dorst, 1970).

Remarks.—The mongoose, or Pharaoh's cat, was revered in ancient Egypt because of its taste for crocodile eggs and ability to kill poisonous snakes (Anderson, 1902). This author and others have also mentioned its popularity as a household pet (Russell, 1831; Flower, 1932; Hoogstraal, 1964).

Family 4. Hyaenidae

Large carnivores with body or legs striped or body spotted, and a dorsal mane. Muzzle relatively long; ears large, erect. Hind limbs shorter than fore. Feet digitigrade, toes 4,5-4; 4-4 functional. Claws short, blunt, nonretractile. Tail bushy, less than two-thirds length of head and body.

Rostrum relatively long and broad. *Alisphenoid canal absent.* Upper tooth row slightly longer than one-half length of skull. Paroccipital in contact with bulla and projecting below it. Bulla moderately inflated.

KEY TO EGYPTIAN GENERA OF HYAENIDAE

1. Size large. Skull and jaws massive. Bulla undivided. Incisors unspecialized, outer much larger than inner; canines powerful; carnassials well developed; premolars large, crowns conical (function in crushing bone); molars large. . . . *Hyaena*, p. 422.
2. Size smaller. Skull and jaws weak. Bulla divided. Canines long and slender. Outer incisors slightly larger than inner. Premolars small, widely spaced; carnassials undeveloped; molars small. . . . . *Proteles*, p. 432.

Genus **Hyaena** Brisson, 1762

Large-headed, dog-like carnivores. Shoulders markedly higher than rump. Body striped or stripes on legs only. Toes four on fore

and hind feet. Skull very large, teeth massive. Dental formula: $\frac{3}{3}\cdot\frac{1}{1}\cdot\frac{4}{3}\cdot\frac{1}{1}\times 2=34$.

Hyaena hyaena (Linnaeus, 1758)

Canis hyaena Linnaeus, 1758, Syst. Nat., 10th ed., p. 40.

Type locality.—Iran, LARISTAN: Benna Mts. (Thomas, 1911).

General distribution.—India, Nepal, Afghanistan, Pakistan, Iran, Southern Russian Turkestan, Transcaucasia, Asian Turkey, Syria, Lebanon, Iraq, Saudi Arabia, Yemen, Jordan, Israel, Sinai Peninsula, Egypt, Libya, Algeria, Morocco, Sudan, Asben, Ethiopia, Somalia, Kenya.

Common names.—Striped Hyena, *Dubbah, Dab.*

Subspecies in Egypt.—

Hyaena hyaena dubbah (Meyer, 1793)

Hyaena dubbah Meyer, 1793, Uebersicht der Entdeckungen in Neu-Holland und Africa, p. 94. Based on Bruce's travels to discover source of Nile.

Type locality.—Sudan. NORTHERN: Atbara.

Distribution in Egypt.—Figure 130. Sinai Peninsula, Eastern and Western Deserts in part.

Diagnosis.—Body and legs transversely striped black and grayish. Dorsal crest of long, black-tipped hairs. Tail relatively short, brush-like. Head disproportionately large. Ear large, blackish.

Skull massive, frontal region inflated, cranium slightly wider than rostrum, sagittal ridge extremely high and prominent. Angular process of lower jaw prominent, spoon-shaped, and above level of tooth row. Teeth very large, especially carnassials. Protocone of p^4 not sloping forward, but extending at right angle to main axis of tooth.

Head and body length average 1,038 mm.; tail 308 mm., 30 per cent of head and body length; foot 210 mm.; ear 152 mm.; condyloincisive length 214 mm.; weight 18 to 20 kg.

External characters.—Figure 131. Stripes brownish or blackish on whitish or pale buff ground color. Stripes on neck and side transverse, broken. Three broad diagonal stripes cross shoulder onto chest; two or three narrower stripes cross hips diagonally onto

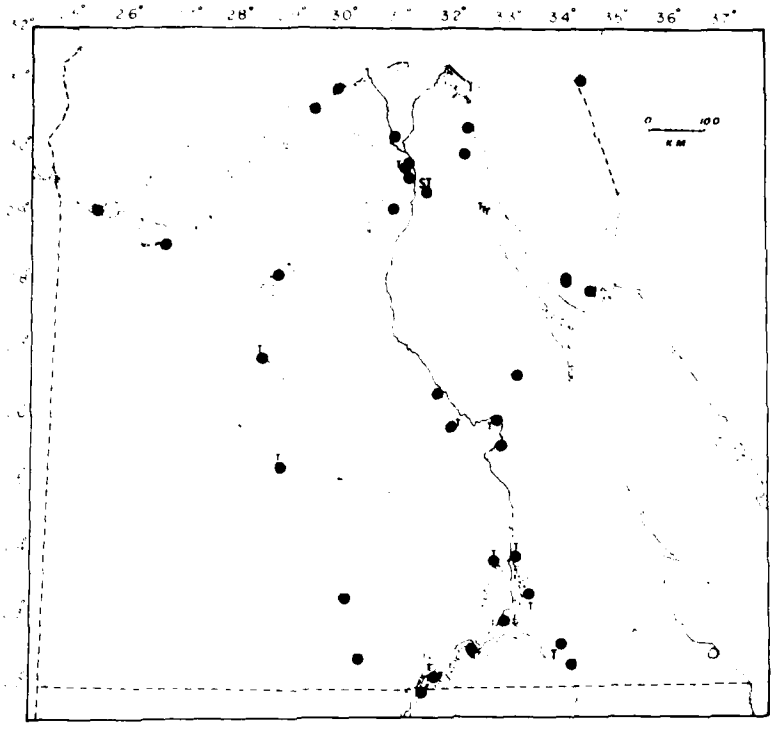


FIG. 130. Collection localities of *Hyaena hyaena dubbah*, sight records (S), and tracks (T). *Proteles cristata* (circle)

hind limb. Markings on neck and belly faint. Throat blackish or brownish. Stripes on legs sharply defined, incomplete on inner side. Toes brownish above, buff between. Muzzle thinly haired, grizzled or grayish. Vibrissae sparse, very stiff; whitish, grayish, or black. Lips thick, blackish. Ground color of cheek, head, and neck darker than rest of body. Ear large, pointed; hair sparse, except on edges, and buffy. Skin of ear blackish on outer surface, paler with dark spots in inner. Dorsal crest or mane broad and extending from nape to base of tail. Hairs long (about 250 mm.), coarse with blackish terminal band (55 mm.), white subterminal band (45 mm.), four or five alternating bands of black or brown and white (80 mm.), and broad white basal band (65 mm.). Tail relatively short, brush-like, white with narrow dorsal stripe of black-tipped hairs and a black tip.

FIG. 131. Cadaver of *Hyaena hyaena dubbah*.

Young have same markings as adult. Sexes easily recognized by external genitalia. Gland dorsal to anus prominent.

Locomotion.—Hyenas running on level ground appear clumsy. The gait is a slow, laboring canter accentuated by the long forelimbs and up and down movement of head. In rough country, movement appears more rapid and graceful.

Cranial characters.—Figure 132. Skull massive, cranium high and narrow. Sagittal ridge very high and prominent; supraoccipital projection extending well beyond posterior level of occipital condyle. Zygomatic arch very thick, flaring widely posteriorly. Rostrum relatively short, broad; breadth nearly that of sides of cranium. Nasals deeply separated anteriorly, attenuated posteriorly. Nasomaxillary contact nil. Frontal slope steep and frontal region inflated. Postorbital process very large, slightly concave dorsally, ridged posteriorly. Postorbital process of malar equally large. Postorbital swelling of cranium prominent. Greatest width of cranium is at base of zygomatic processes of temporal bones.

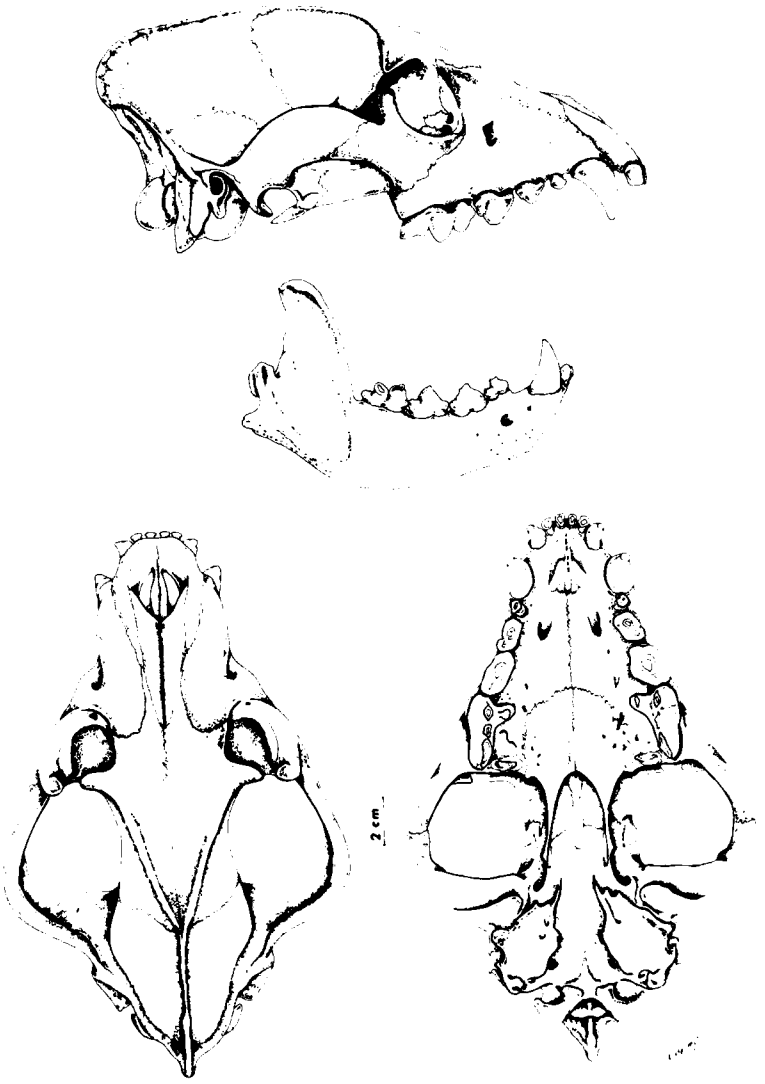


FIG. 132. Skull of *Hyaena hyaena dubbah*.

Posterior end of malar is at mid-section of zygomatic arch. Incisive foramen elongate. Palatine foramen at level of second premolars. Posterior margin of palate at level of posterior edge of m^1. Occipital area narrow and triangular. Paroccipital process prominent, projecting ventrally slightly below bulla. Tympanic bulla prominently swollen, surface smooth, undivided. External auditory meatus with tubular bony orifice. Lower jaw curved upward posteriorly. Angular process prominent, spoon-shaped, above level of tooth row.

Teeth.—Outer upper incisors about twice size of inner. Canines very heavy and powerful. First upper premolar small, conical, sometimes absent in adults; pm^2 and pm^3 broad, not compressed, long axes oblique to jaw margin. Carnassial (pm^4) large, powerful, with protocone extending at right angle to main axis of tooth, not sloping forward. M^1 large and three-rooted. Lower teeth comparable in development; m_1 with functional talonid. Carnassials function in slicing, crushing, and chopping (Ewer, 1954).

Baculum.—Absent.

Measurements.—Table 52. Male and female measurements are subequal. Dorst (1970) gives the weight as 50 kg.

Variation.—Color of stripes and throat vary from blackish to brownish; ground color whitish to pale and grayish buff.

Comparisons.—*Hyaena h. dubbah* of eastern Africa differs from *H. h. barbara* of northwestern Africa chiefly in the smaller size of skull and pm^4 (Pocock, 1934). From *H. h. syriaca*, *H. h. dubbah* differs in smaller cranial dimensions when compared with Harrison's (1968) data. Presence or absence of underwool in winter coat as a character appears to be of no taxonomic importance.

Specimens examined.—Total 25.

MINUFIYA: Minuf (1).

TABLE 52. — Means (and ranges) of measurements, ratios, and weight of adult *Hyaena h. dubbah*.

HBL	1038.0 (1020-1075) 4	RW	51.9 (50.0-54.2) 5
TL	308.0 (290-350) 4	POW	37.2 (30.3-42.3) 5
TL/HBL%	29.6 (27.8-32.6) 4	MW	80.2 (76.1-84.1) 5
FL	210.0 (205-215) 4	NL	61.4 (59.2-64.2) 3
EL	152.2 (145-155) 4	PM^4-PM^4	83.2 (75.7-86.7) 5
Wt (kg.)	19.2 (19-20) 4	PM^4	31.1 (29.8-32.3) 5
CIL	213.8 (209-220) 5	I-PM^4	107.1 (105.8-109.4) 5
ZW	150.5 (146.2-157.1) 5		

GIZA: Giza Pyramids area, gallery 1 km NW of Cheops Pyramid (one skull and two lower jaws).

MATRUH: *Bahig* (one lower jaw from cave).

ASWAN: Bir Murra (3), Bir Haimur (1), Allaqi Village 9–1 km S (4), El Dirr, E of (1), Wadi el Targama (1), Khor Abusku (9).

Sudan, NORTHERN: Wadi Halfa (1).

Sight records.—Records of D. Osborn, I. Helmy, H. Hoogstraal, and Frontier Corps Soldiers (last reported by I. Helmy).

SUEZ: Wadi Dom, Wadi Abu Sanduq (tracks, 1956), Ras Abu el Darag.

GIZA: Giza Pyramids area.

ASWAN: Wadi Abu Subeira, Barqet Tokham (tracks, 1966), Wadi Kurkur, Qusr ul West, Gebel Adda (tracks, 1963), Umm Shilman Plains (tracks and dens, 1966).

EL WADI EL GEDEED: Bir Karawein, Mut.

QENA: Dandara, S of (tracks, 1966), Abydos, W of (tracks, 1968).

MATRUH: Qara (1976), El Ghazalat near Bir Abd el Nabi (tracks, 1976).

Published reports.—Hyenas in Sinai may represent either subspecies *syriaca* or *sultana*. Specimens from this area were not available. Reports are from Oliver (1804, cited by Anderson, 1902), Belzoni (1819, cited by Fagan, 1975), Palmer (1872), Murray (1891), Buxton et al., (1895), Anderson (1902), Barron (1907ab), Weigall (1909), Hurst (1910), Harding-King (1925), Murray (1935, 1967), Omer-Cooper (1947), Wassif (1953b), Wassif and Hoogstraal (1953), Howells (1956), and Hoogstraal (1964).

SINAI: Wadi Kid (den), Wadi Gazzah, Maqdaba (tracks), Gebel Musa, Gebel Umm Rijlein, St. Catherine Monastery area.

ISMAILIA: "Hyena Quarries" E of Lake Timsah.

SUEZ: Gebel Iweibid (caves and old bone middens).

ALEXANDRIA: Alexandria.

GIZA: Bahariya Oasis.

CAIRO: Wadi Hof 1933, 1956.

EL FAIYUM: Qasr el Sagha and Qasr Qarun.

RED SEA: Wadi Fatira.

SOHAG: Gebel el Haridi (tracks).

QENA: Karnak Temple, Luxor.

ASWAN: Wadi Abu Subeira.

MATRUH: Sitra, Siwa, and Maragi Oases.

EL WADI EL GEDEED: Farafara Oasis, Bir Murr and Bir Karawein; Dakhla Oasis; Bir Nakheila, one day's journey N of (tracks).

Sudan, KASSALA: Bir Meisa.

Remarks on distribution.—Judging from statements of early writers, hyenas were more numerous and widespread in Egypt

previously than today. They commonly entered towns in search of food (Russell, 1831).

Fitzinger (1860) included in the distribution the Western Mediterranean Coastal Desert and Nile Valley and Delta. Anderson (1902) listed desert margins of the Nile Valley from Cairo to Esna, desert surrounding El Faiyum, and Bahariya and Farafara Oases. Flower (1932) said that hyenas were not known to occur in the Nile Delta, but were on both sides of the Nile all the way to Nubia. He also mentioned valleys inland from Salum and along the Mediterranean coast east to Alexandria and in Sinai. Omer-Cooper (1947, p. 26) reported that hyenas in the vicinity of Siwa and Maragi Oases had been "practically exterminated by poison." Native helpers told him that hyenas occurred at Sitra. Hyenas which occasionally range through the Eastern Desert are thought by natives to come from Sudan following rains (Tregenza, 1955).

The Nile Valley south of Cairo to Nubia appears to be the area of highest concentration of *H. hyaena* in Egypt today.

Collection.—Hyenas were shot at night from a car using a spotlight (Osborn, 1968a). In Palestine, Bird (1946) shot hyenas at night from a blind when they came to a goat carcass he had staked out.

Habitats.—Like other large Egyptian carnivores, hyenas inhabit desert areas bordering the Nile Valley and oases and invade cultivated areas at night to feed and drink. Those in remote desert areas 15 to 25 km. from cultivation probably followed camel caravans in anticipation of a dead camel (Anderson, 1902). Osborn (1968a) collected hyenas along the ancient caravan road from Sudan to Daraw over which thousands of market camels pass each year. The Darb el Arbaein (Forty Days Road) and other routes in the Western Desert are now rarely used, and hyenas no longer live along them.

In Sinai, hyenas frequent areas of human habitation and coastal regions.

Dens.—Dens are in natural caves and cracks or among boulders or blocks of stone and are recognizable by accumulations of bones (Anderson, 1902; Barron, 1907b). Tombs and temple ruins are also known to have been occupied by hyenas (Murray, 1891).

Habits.—Striped hyenas are strictly nocturnal. They are shy, yet approach closely camps or dwellings in search of food. No

documented evidence is available that this species has attacked men, although folklore is full of such "reports."

Osborn (1968a) was told by a Bishari that striped hyenas resorted to cannibalism at times of food shortage. Osborn killed one hyena that was carrying off the day-old carcass of another hyena used as a lure. Brown and spotted hyenas are reputed to be cannibalistic, but this was disputed by Hughes (1954). However, cannibalism in the spotted hyena was witnessed by Kruuk (1968).

Striped hyenas drag or carry carcasses to their dens, where conspicuous bone middens accumulate (Anderson, 1902; Barron, 1907b; Reed, 1966; Reed, personal communication; and observations of D. Osborn). According to Hughes (1954), other species of hyenas do not.

Drake-Brockman (1910) mentioned that old striped hyenas in Somalia became destructive and hunted sheep and goats by day and slaughtered them wantonly. Murray (1935) reported the mutilation of a herd of sheep by striped hyenas near Gebel Umm Rijlein in Sinai.

The cowardliness of striped hyenas has been remarked upon by numerous authors. Anderson (1902, p. 200) was able to approach within a few yards of hyenas during the day. "When disturbed they show no fight, but only anxiety to make off with all possible haste." Tate-Regan (1946) said the striped hyena refrained from biting when attacked and had a suppressed instinct of self preservation. This aspect of hyena behavior figures strongly in folklore, and claims have been made that a man can creep into a den and capture a hyena alive without any resistance by throwing a cloak over it and tying a rope around its legs (Kitto, 1841; Jayakar, 1908). Authenticated observations of this feat occur in the literature (Wood, 1807; Murray, 1935; Kullman, 1965; Street, 1967; Hassinger, 1973).

Food.—Striped hyenas are notoriously eaters of carrion, and their powerful jaws and teeth enable them to crack large bones. Hyenas collected by Osborn (1968a) in Nubia subsisted chiefly on the remains of dead camels along the road from Sudan to Daraw. Stomach contents also included seeds of *heglig* (*Balanites aegyptiaca*). Specimens collected from the Nile area near Allaqi Village contained fish thrown out by fishermen and bones of gazelle and stork. There is ample evidence that hyenas will eat human carcasses if available (Doughty, 1888; Zeuner, 1963; Harrison, 1968; Osborn, 1968a). Adams (1870) and Kitto (1841) reported that hungry hyenas

are sometimes destructive to crops, especially Indian corn, and they are known to feed on dates in the Nile Valley (Murray, 1967). Captive hyenas will eat ripe dates, bananas, tomatoes, plums, watermelons, etc., "in addition or almost in preference to meat" (Flower, 1932, p. 394). If carrion is unavailable, hyenas will move to the sea and break open shells (Klunzinger, 1878). In Iraq, hyenas were reported to have killed a horse and a donkey, and one person told of feeding desert tortoises to a pet hyena (Hatt, 1959). Earlier writers mention the hyena as a killer of asses and mules and, occasionally, cattle (Wilkinson, 1878; Bruce, 1790). The latter stated that hyenas had a fondness for dogs and would hunt them in his camp. Bird (1946) described hyena depredation in flocks of sheep and goats in Palestine. Further notes on the catholic food habits of the striped hyena are in Kruuk's (1976) studies in the Serengeti.

An old hyena cave in the limestone cliff 1 km. NW of Cheops pyramid contained skulls and bones of domestic animals, including dogs, foxes, pig, and bones of a giant freshwater turtle. Hyena skulls and lower jaws were also retrieved from this cave.

Water.—Hyenas drink periodically and are no doubt unable to survive without a source of water.

Economic importance.—Ancient Egyptian peasants hunted hyenas for duty and amusement along with other animals that destroyed fields or flocks (Kitto, 1841; Wilkinson, 1878). Old Kingdom Egyptians force-fed hyenas to fatten for the table, as depicted in the tomb of Mereruka (Sixth Dynasty, 2300 B.C.) at Sakkara. Brentjes (1966) has presented evidence that these animals were aardwolf rather than hyena. Hyenas were supposedly tamed and used in hunting. There is no evidence, however, that Ancient Egyptians considered them sacred.

Numerous sources mentioned the eating of hyenas by modern Egyptian peasants. Others known to eat them are certain Arabian Bedouins (Doughty, 1888), Palestinian laborers (Zeuner, 1963), Sinai Bedouins (Murray, 1935), and Tuaregs (Ihote, 1946).

Hyenas were once a valuable commodity. The flesh was sold in the markets, and Ulemə, or religious leaders, were the chief buyers. Various parts were sold for charms and medicines (Klunzinger, 1878).

Reproduction.—The only records from Egypt are a nearly full-term female with one 504-gm. fetus and one resorption, and an old

female with a resorption. Both were taken in March from tributaries of Wadi Allaqi.

Folklore.—Although considered to be a cowardly animal, the striped hyena is feared by Egyptians; particularly farmers and Bedouins. Legends depict it as savage, dangerous, treacherous, cunning, and greedy. Nevertheless, it is commonly believed that to eat the heart will give one courage. Whiskers and eyeballs are believed to give protection from the evil eye. Many parts of the hyena are used to increase virility or to impart strength or bravery in men. Various ailments and afflictions are treated with specific organs. Further information on hyena folklore is available in Fitzinger (1860), Klunzinger (1878), Jayakar (1908), Weigall (1909), and Osborn (1968a).

Genus **Proteles** I. Geoffroy St.-Hilaire, 1824

Hyena-like insectivore. Striped on body and legs. Toes 5-4; inner toe on forefoot vestigial. Teeth peg-like. Dental formula: $\frac{3}{3}, \frac{1}{1}, \frac{3}{1-2}, \frac{1}{1-2} \times 2 = 28\text{-}32$, usually 30.

Proteles cristatus (Sparrmann, 1783)

Viverra cristata Sparrmann, 1783, Resa Goda-Hopps-Udden, Vol. 1, p. 581.

Type locality.—South Africa. Cape of Good Hope, Somerset East, near Little Fish River.

General distribution.—Southeastern Egypt, Sudan, Ethiopia, Somalia, Kenya, Tanzania, Mozambique, Rhodesia, South Africa, South West Africa.

Common names.—Aard Wolf, *Deeb.*

Probable subspecies in Egypt.—

Proteles cristatus pallidior Cabrera, 1910

Proteles cristatus pallidior Cabrera, 1910, Ann. Mag. Nat. Hist., (ser. 8), 6, p. 464.

Distribution in Egypt.—Known only from two specimens reportedly shot by Negumi (1949) in 1940 near Halaib in SUDAN ADMINISTRATIVE GOV. Hoogstraal et al. (1957b) gave the collection locality as Gebel Hamra Dom some 80 km. N of Halaib (fig. 130).

Diagnosis.—Hyena-like, but smaller and slenderer. Skull not massive. Teeth peg-like.

External characters.—Hyena-like in body form, forelimbs longer

than hind, forefeet with five rather than four toes. Striping on body and legs as in *Hyaena hyaena*. Muzzle, chin, and part of area around eyes, nude and black. Dorsal crest prominent. Ear long, tip narrowly rounded.

Cranial characters.—Skull proportionately smaller and more lightly built than in *Hyaena*. Cranium low, broadest on sides, narrower at bases of zygomatic processes of temporals. Sagittal ridge low. Supraoccipital process extending slightly beyond posterior level of occipital condyle. Rostrum blunt, relatively long, sides parallel, and width almost equal to that of cranium. Nasals not as deeply separated anteriorly as in *Hyaena*, attentuated posteriorly. Nasomaxillary contact very broad. Frontal slope gradual, and frontal region only slightly swollen. Postorbital swelling nil. Postorbital process of frontal large, slightly concave dorsally. Postorbital process of malar equally large. Zygomatic arch flaring. Posterior end of malar extending to level of glenoid fossa. Incisive foramen ovoid. Posterior margin of palate extending to level of optic foramen. Paroccipital process adnate to bulla, not projecting. Alisphenoid canal lacking. Tympanic bulla prominent, posterior chamber much larger than anterior and extending beyond level of paroccipital process and below level of tooth row. Lower jaw constricted behind canines, curved upward posteriorly so that angular process is above level of tooth row. Angular process projects posterior to articular, but is not spoon-shaped as in *Hyaena*.

Teeth.—Incisors and canines normal. Outer incisors slightly larger than inner. Canines long, slender, cheek teeth small, conical, widely spaced, and in parallel rows.

Comparisons.—*Proteles cristatus* differs from *H. hyaena* in smaller size, five toes rather than four on forefoot, skull much smaller and lighter, and cheek teeth peg-like rather than sectorial.

Specimens examined.—Total two.

SUDAN ADMINISTRATIVE: Gebel Hamra Dom (1).
Southern Rhodesia: Bulawayo 30 km. W (1).

Habitat.—Plains and savanna.

Habits.—Nocturnal and apparently shy and secretive.

Food.—Insects, primarily termites and larvae when available; probably carrion, eggs, and small vertebrates.

Family 5. Felidae

Medium to large carnivores. Pelage usually marked with stripes and/or spots. Muzzle conspicuously short; ears more or less triangular, sometimes tufted. Legs moderately long relative to body length. Feet digitigrade; toes 5-4; inner toe on forefoot vestigial. Claws sharp, strongly curved, retractile (semiretractile in *Acinonyx*). Tail cylindrical, length variable among species. Tongue covered with horny, curved papillae.

Rostrum and nasals short; cranium short, rounded. Upper tooth row length less than one-half skull length. Paroccipital process flattened against bulla. Tympanic bulla conspicuously inflated, divided by septum. Postpalatal foramen on maxillopalatine suture, not on maxilla. Alisphenoid canal absent. Baculum absent or vestigial.

Postorbital process of zygomatic arch prominent. Incisors small, chisel-like, and in tranverse line; canines elongate, sharply pointed; post canine diastema present, except in *Acinonyx*; premolars sharp; pm^1 reduced, often absent; carnassials large, well developed, lower smaller than upper; upper molar small, crown tranverse. Dental formula: $\frac{3}{3}\cdot\frac{1}{1}\cdot\frac{3}{2}\cdot\frac{1}{1}\times 2=30$.

Key to Egyptian Genera of Felidae

1. Small to medium size cats. Markings faint stripes and spots. Ear tuft, if present, very short. Nasal branch of premaxilla broad. Posterolateral margins of palate deeply notched..... *Felis*, p. 434.
2. Medium size cats. Markings very faint to nil. Ear tuft very long. Facial stripe from nose through lacrimal onto forehead. Nasal branch of premaxilla long, thin, usually contacting frontal process. Posterolateral margins of palate shallowly notched..... *Caracal*, p. 447.
3. Large cats. Markings prominent spots. Nasal branch of premaxilla narrow, not contacting frontal process. Posterolateral margins of palate without notches.
   a. Spots in rosettes. Black facial stripe absent. Skull elongate, profile flattish. Malar-maxillary suture below infraorbital foramen at lowest level. Infraorbital foramen large, ovoid..... *Panthera*, p. 451.
   b. Spots solid. Black facial stripe from mouth to eye. Claws nonretractile. Skull short, profile highly domed. Malar-maxillary suture completely above infraorbital foramen. Latter small, narrowed vertically..... *Acinonyx*, p. 455.

Genus **Felis** Linnaeus, 1758

Small to medium-size cats. Color pattern of indistinct stripes and spots in adults. Back of ear black and/or reddish. Claws completely retractile. Skull broad, rather evenly rounded or domed in lateral outline. Nasal branch of premaxilla broad opposite tip of nasal, then becoming abruptly pointed. Posterolateral margins of palate deeply

notched. Postcanine diastema wide. First upper premolar usually present. Inner cusp of upper carnassial usually well developed, except in *F. margarita*. Anterior accessory cusp of second upper premolar small and not in line with main cusp.

KEY TO EGYPTIAN SPECIES OF GENUS *Felis*

1. Color dark. Ear small. Black elbow mark absent. Tympanic bulla moderately inflated. Nasals ending about at level of frontomaxillary suture.
   a. Size large, tail relatively short (one-third head and body length), hind foot length over 140 mm. Ear tuft present, short. Cheek stripe absent. Skull large, condyloincisive length over 95 mm. Postorbital swelling present. . . . . *chaus*, p. 435.
   b. Size small, tail relatively long (two-thirds head and body length), hind foot length under 140 mm. Ear tuft absent. Cheek stripe present. Skull small, condyloincisive length under 95 mm. Postorbital swelling absent. . . . . *sylvestris*, p. 440.
2. Color pale. Ear large, broad. Black elbow mark present. Tympanic bulla greatly inflated. Nasals long, ending posterior to level of frontomaxillary suture. . . . . *margarita*, p. 444.

Felis chaus Güldenstaedt, 1776

Felis chaus Güldenstaedt, 1776, Nov. Com. Acad. Petrop., 20, p. 483.

Type locality.—U.S.S.R.: Terek River N of Caucasus.

General distribution.—Vietnam, Thailand, Burma, Yunnan Province of Western China, Nepal, India, Ceylon, Chinese and Russian Turkestan, Afghanistan, Pakistan, Iran, Iraq, west shore of Caspian to Volga Delta, eastern Transcaucasia, southern Turkey, Israel, Jordan, Egypt.

Common names.—Jungle Cat, Swamp Cat, *Qut Barri* (male), *Qutta Barria* (female).

Subspecies in Egypt.—

Felis chaus nilotica De Winton, 1898

Felis chaus nilotica De Winton, 1898, Ann. Mag. Nat. Hist., (ser. 7), 2, p. 292.

Type locality.—Egypt. CAIRO: near Cairo.

Distribution in Egypt.—Figure 133. Nile Delta, Nile Valley south to Aswan, El Faiyum, Farafara and Dakhla Oases, Western Mediterranean Coastal Desert.

Diagnosis.—Color dark, grizzled buff. Body markings indistinct. Lacrimal stripe dark brown, prominent. Cheek plain. Ear reddish brown with black tip and small tuft. Tail relatively short with several black distal rings and black tip.

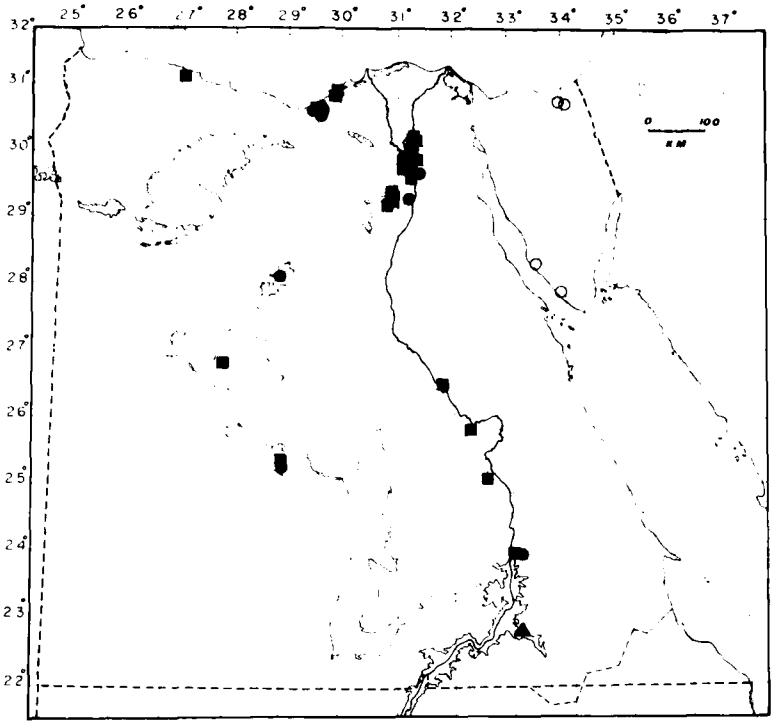


FIG. 133. Collection localities of *Felis chaus nilotica* (squares), *F. sylvestris libyca* (dots), *F. s. tristrami* (circles), and *F. margarita* (triangle).

Rostrum and cranium elongate. Postorbital width slightly more than rostral width. Anterior end of zygomatic process attenuate.

Head and body length average 674 mm.; tail 254 mm., 38 per cent of head and body length; foot 168 mm.; ear 71 mm.; condyloincisive length 112.8 mm.; weight 9.0 kg.

External characters.—Similar to *F. sylvestris*, but head and body markings less conspicuous, except for black ear tufts and prominent dark brown lacrimal stripe. Dorsal line blackish, reddish tinted posteriorly. Dorsum yellowish brown grizzled with black and yellow. Side and outer side of legs paler. Under hair fuscous. Chin pale buff; throat darker, grizzled; chest, belly, and inside of legs yellowish. Axilla and groin whitish. Faint, pale brownish spots on side and belly and faint stripes on upper legs. Nasal region pale buff, lacrimal stripe dark brown, supraorbital patch whitish, cheek plain.

Forehead, crown, and nape faintly striped. Ear reddish brown behind, base blackish, tip black with short tuft and inner side whitish. Tail relatively short, concolorate with back proximally and grayish distally with two narrow black bands and short black tip. Feet orangish to brownish yellow above, palm and sole blackish or brownish. Young have a more distinct pattern than adults.

Cranial characters.—Figure 134. Rostrum and cranium somewhat elongate. Frontal and postorbital swelling prominent. Postorbital width slightly more than rostral width. Nasals tapering gradually posteriorly; posterior margin level with or slightly posterior to frontomaxillary suture. Cranial crests and ridges strongly developed. Anterior end of zygomatic process attenuate. Malar-maxillary suture below infraorbital foramen at its lowest level. Mastoid process large, protruding.

Teeth.—Dentition similar to but much larger than *F. sylvestris*, especially anterior cusp of upper carnassial.

Measurements.—Table 53.

Comparisons.—*Felis chaus* differs from *F. sylvestris* in having body markings less conspicuous, cheek stripe lacking, lacrimal stripe more prominent, black ear tufts, tail shorter, skull more elongate, postorbital swellings, anterior end of zygomatic process

TABLE 53. — Means (and ranges) of measurements, ratios, and weight of *Felis sylvestris* and *F. chaus*.

	F. s. tristrami	*F. s. libyca*	*F. c. nilotica*
HBL	498.5 (471-545) 4	449.5 (373-483) 6	674.5 (595-760) 12
TL	319.2 (282-390) 4	291.2 (237-337) 6	254.8 (210-280) 12
TL/HBL%	64.0 (57.8-78.3) 4	64.8 (62.5-70.8) 6	37.8 (33.8-44.5) 12
FL	121.0 (115-131) 4*	124.8 (110-136) 6	168.4 (145-178) 12
EL	56.5 (55-58) 4	61.5 (56-70) 6	71.4 (63-78) 12
Wt (kg.)	——	2.5, 3.8	9.0 (7.0-11.2) 5
CIL	——	83.1 (70.8-90.6) 11	112.8 (98.2-123.9) 18
ZW	——	64.6 (53.9-72.5) 11	79.8 (70.0-92.1) 16
RW	——	22.6 (19.6-25.3) 11	30.8 (26.6-34.0) 18
POW	——	32.6 (26.5-35.0) 11	36.2 (31.5-38.6) 17
MB	——	40.6 (37.2-42.9) 7	48.0 (42.6-53.8) 15
NL	——	24.4 (22.5-26.3) 10	36.6 (31.8-41.8) 17
PM^4	——	10.9 (9.9-11.9) 9	14.9 (13.5-16.5) 18
PM^4-PM^4	——	36.7 (34.5-39.4) 8	48.6 (44.8-53.4) 15
C-M^1	——	26.3 (26.1-31.7) 12	39.6 (34.9-41.9) 14
SH	——	45.4 (41.2-49.3) 9	57.1 (48.8-61.6) 14

*Not including claw.

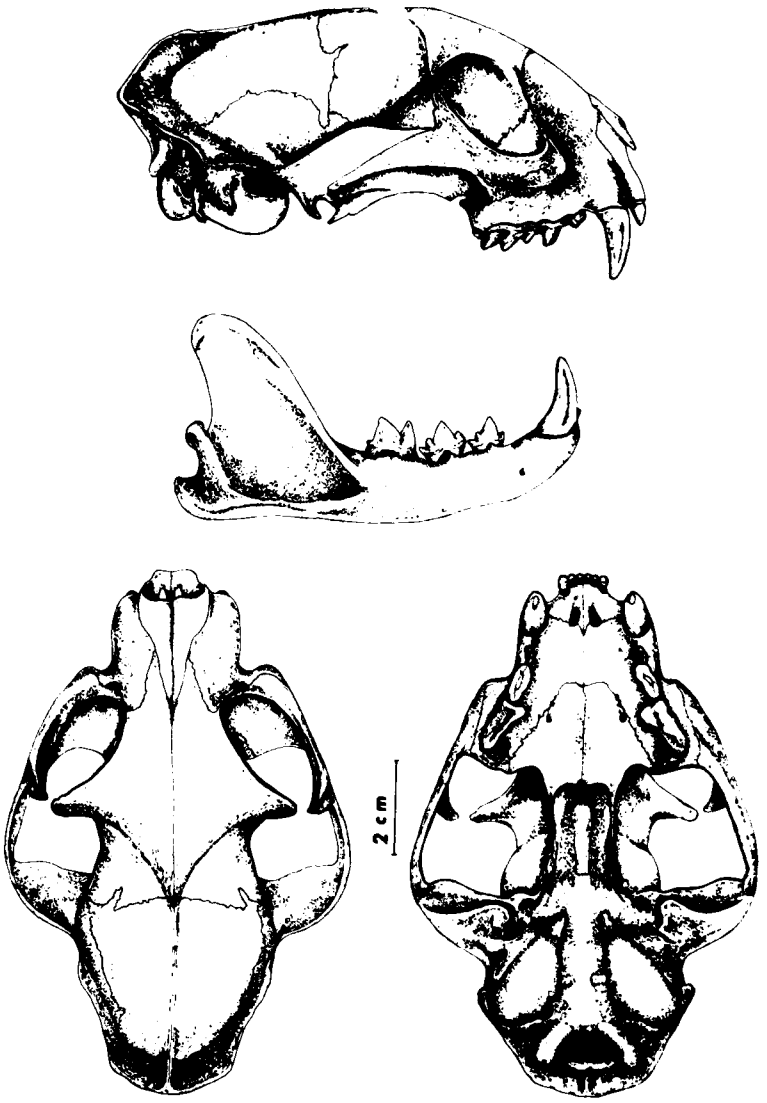


FIG. 134. Skull of *Felis chaus nilotica*

attenuated instead of rounded, and larger dimensions. According to Pocock (1951), the only way some individuals of the two species can be distinguished externally is by relative tail lengths.

Felis chaus differs from *F. margarita* in having darker color, less conspicuous markings, narrower ears, pads of feet not covered with hair, relatively shorter tail, relatively shorter nasals, and much smaller bullae.

From *F. chaus furax* of the Eastern Mediterranean, *F. c. nilotica* differs in having darker color and smaller teeth.

Specimens examined.—Total 38.

ALEXANDRIA: Alexandria (1), Amiriya-Alexandria road, about 15 km. W of Alexandria (1), about 20 km. W of (1).

QALYUBIYA: Tukh, El Ahmar (4); Sanafir, Esbet Ibsan (2); Qalyub (1).

GIZA: Giza (1), El Baragil (1), Abu Rawash (2), Beni Yusef (1), Giza Pyramids (1), Sakkara (1), Kafr Hakim (1).

CAIRO: Cairo (Type, 3).

EL FAIYUM: Tamiya (2), Sinnuris (1), Kom O Shim (1), Fanus (1), no exact locality (1).

SOHAG: Akhmim (2).

QENA: Farshout (1), Wadi Nassim (1).

ASWAN: Aswan (1).

MATRUH: Bahig (1), 14 km. S (1).

EL WADI EL GEDEED: Farafara Oasis, Hatiyet el Sheikh Marzuk (one old poorly mounted skin); Dakhla Oasis; Mut (1), 4.8 km. N (1).

Published records.—Records are from De Winton (1898), Anderson (1902), Bonhote (1909), Flower (1932), Wassif (1960b), and Hoogstraal (1964).

QALYUBIYA: Benha; Tukh.

GIZA: Giza Zoological Gardens.

EL FAIYUM: Various localities.

QENA: Wadi Nassim; Nag Ayed, Tuftish Farshout (Farshout).

ASWAN: Aswan.

MATRUH: Bahig; Bahig 14 km. SW; Mersa Matruh, E and W of; Wadi el Raml (16.6 km. S of Mersa Matruh).

EL WADI EL GEDEED: Dakhla Oasis.

Collection.—Easily trapped or shot.

Habitat.—Low cultivated or marshy ground, reed beds, fields of sugar cane, bean fields, or any similar thick cover (Anderson, 1902; Flower, 1932). Reference by Anderson to cornfields between Alexandria and Siwa must mean Bedouin barley fields west of Alexan-

dria. We have taken specimens near Alexandria in reed (*Phragmites australis*) swamp and in low vegetation of the Western Mediterranean Coastal Desert (fig. 19). Flower (1932) reported this cat from cliffs east and west of Mersa Matruh.

Behavior.—*Felis chaus* shows "remarkably little fear of man" (Hoogstraal, 1964, p. 222). One killed with a .22-caliber pistol at night near Alexandria was hit on the third shot. It showed no indication of fright (I. Helmy, personal communication).

Food.—According to Flower (1932), *F. chaus* eats snakes of genera *Coluber* and *Psammophis* and dead fish. One collected from near Alexandria had its stomach full of fish which it had either stolen from fishermen or scavenged. Bonhote (1909) remarked that this cat did considerable damage each year to animals and birds in the Giza Zoological Gardens. Reference was also made to predation on sheep.

Reproduction.—Litter sizes are two to three, rarely four to six, and young are born from January to April (Flower, 1932).

Remarks.—Ancient Egyptians mummified *F. chaus*, but whether it was domesticated at the time is debatable (Morrison-Scott, 1952; Monaiery, 1965).

Felis sylvestris Schreber, 1777

Felis (Catus) sylvestris Schreber, 1777, Die Säugeth., 3, p. 397.

Type locality.—Germany.

General distribution.—British Isles, Western Europe, Balkans, Turkey, Ukraine, Transcaucasia, Russian and Chinese Turkestan, Kazakstan, India, Afghanistan, Iran, Iraq, Arabian Peninsula, Syria, Lebanon, Israel, Jordan, Sinai Peninsula, Egypt, Sudan across North Africa to Morocco, south of the Sahara into North Nigeria, Asben, Ethiopia and Somalia, and southward into South Africa.

Common names.—Wild Cat, *Qut Gebeli.*

Distribution of subspecies in Egypt.—Figure 133. *Felis sylvestris libyca:* margins of Nile Valley and Delta, oases, and Western Mediterranean Coastal Desert; *Felis sylvestris tristrami:* Sinai Peninsula.

Diagnosis.—Slender, similar to house cat. Color grizzled buff with indistinct stripes and spots. Lacrimal stripe pale brown. Cheek

striped. Ear reddish brown, tuft nil. Tail relatively long with several distal rings and black tip.

Rostrum and cranium short and broad. Postorbital width about one and one-half times rostral width. Anterior end of zygomatic process broad and rounded.

Head and body length average 450 mm.; tail 291 mm., 64 per cent of head and body length; foot 124 mm.; ear 62 mm.; condyloincisive length 83.1 mm.; weight 3 kg.

External characters.—Similar to domestic cat, but legs and tail longer. Dorsal line blackish. Dorsum buff grizzled with black and white or yellow, side and outer side of legs paler. Under hair grayish. Chin and throat whitish; chest, belly, and inside of legs whitish to buff. Axilla grayish or white, groin white. Pale brownish spots on belly and side change to faint vertical lines on shoulder and flank. Upper legs with broad brownish bands. Broken stripes on feet. Nasal region orangish, lacrimal stripe pale brown, and supraorbital patch whitish. Faint stripes on cheek, crown, nape, and dorsum. Ear reddish brown behind, margin blackish, tip without tuft, inner hairs whitish or cream. Tail relatively long, blackish above at base, with three black distal rings, and black tip. Feet yellowish above, palm and sole black.

Cranial characters.—Figure 135. Rostrum and cranium short and broad. Frontal and postorbital swelling nil. Postorbital width about one and one-half times rostral width. Nasals tapering abruptly posteriorly, with posterior margin anterior to or level with frontomaxillary suture. Cranial ridges not strongly developed. Anterior end of zygomatic process rounded. Malar-maxillary suture with ventral margin level with lower edge of infraorbital foramen. Mastoid process small and appressed.

Baculum.—Baculum about 5 mm. in length; cross-shaped due to lateral projections near base (Didier, 1949).

Measurements.—Table 53.

Comparisons.—Comparison of *F. sylvestris* and *F. chaus* are under the latter. *Felis sylvestris* differs from *F. margarita* in having less conspicuous markings, smaller ears, relatively shorter nasals, and smaller bullae.

Remarks.—Some authors (Smithers in Meester and Setzer, 1971) consider *F. libyca* as a separate species. Mummified cats described

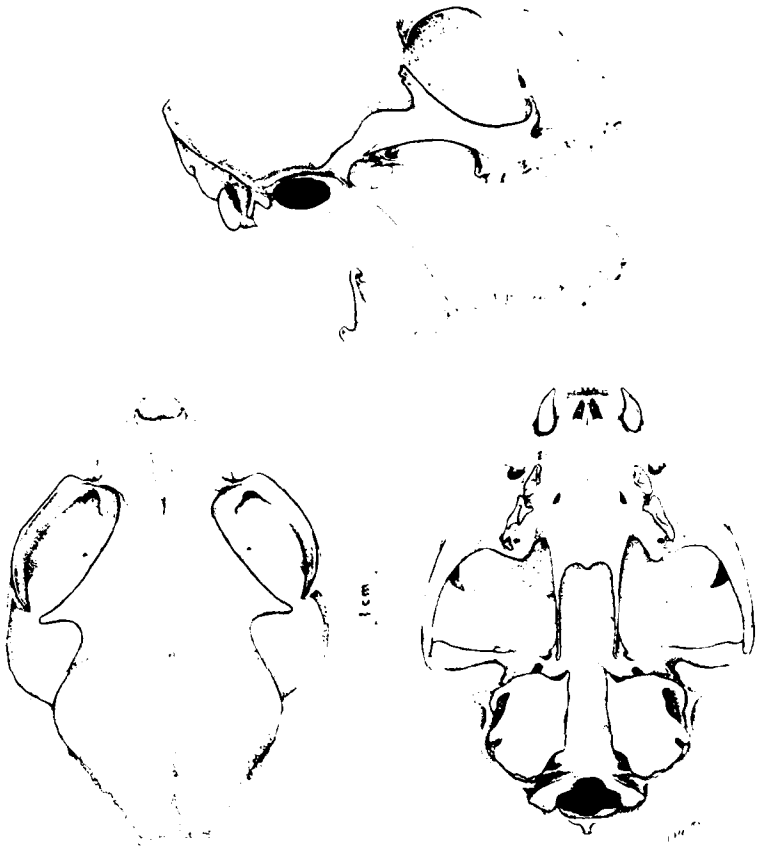


FIG. 135. Skull of *Felis sylvestris libyca*

as *F. libyca bubastis* Hemprich and Ehrenberg (1833) are considered to be a variety of domestic cat (*F. catus*) by Morrison-Scott (1952) and Haltenorth (1953a). Monaiery (1965) proposed that domestic cats originated in Egypt from wild stock.

Habitats.—Dry situations in rocky or wooded districts (Anderson, 1902). Hoogstraal (1964) reported *F. sylvestris* from the Western Mediterranean Coastal Desert in a barley field in flat, vegetated desert, and a desert valley. One was collected near Abu Mena in habitat shown in Figure 8.

Habits.—Nocturnal.

Food.—Hares, rodents, reptiles, birds; probably young of gazelles. Said to eat insects and fruits (Dorst, 1970).

Reproduction.—No data from Egypt. Dorst (1970) lists two to five as number in litters. He also remarked that *F. sylvestris* interbred with domestic cats. This we heard also from Bedouins in Egypt.

Subspecies in Egypt.—

Felis sylvestris libyca (Forster, 1780)

Felis libyca Forster, 1780, *in* Buffon, Nat. Vierf. Thiere, Vol. 6, p. 613.

Type locality.—Tunisia: Gafsa.

Distribution in Egypt.—Figure 133. Margins of Nile Valley and Delta, Western Mediterranean Coastal Desert.

External characters.—In comparison with *F. s. tristrami*, *F. s. libyca* is paler and more buffy, markings are less prominent, back of ears is paler, and there is slightly more black on the feet.

Cranial characters.—See species description.

Measurements.—Table 53.

Specimens examined.—Total 13.

GIZA: Bahariya Oasis, Mandisha (1), El Aguz (1).

MATRUH: Burg el Arab (1); Bahig (5), 5 km. S (1), 16 km. S (1), 48 km. S (1); Abu Mena 5 km. SE (1); El Qarasat (1), El Maghra (1).

EL WADI EL GEDEED: Dakhla Oasis, Mut (1).

BENI SUEF: Maidum (1).

ASWAN: Aswan (1), Wadi el Targama (1).

Published records.—Records are from Anderson (1902), Flower (1932), and Hoogstraal (1964).

MATRUH: Bahig SSW 16 to 50 km.

CAIRO: Wadi Hof (skull found in cave).

BENI SUEF: Maidum.

Remarks.—A specimen from Bir Victoria was described as having yellowish body color and reddish tail (De Winton, 1903).

Felis sylvestris tristrami (Pocock, 1944)

Felis libyca tristrami Pocock, 1944, Ann. Mag. Nat. Hist., (ser. 11), **11**, p. 125.

Type locality.—Jordan, MOAB: Ghor Seisaban.

Distribution in Egypt.—Figure 133. Sinai Peninsula.

External characters.—In comparison with *F. s. libyca*, *F. s. tristrami* is darker and more grayish, markings are slightly more prominent, backs of ears are darker, and there is less black on the feet.

Cranial characters.—See under species description.

Measurements.—Table 53. No external measurements available from Sinai specimens. Cranial measurements of one Sinai specimen are: CIL 89.9, ZW 72.2, POW 35.2, RW 26.0, NL 27.3, PM^1-PM^1 38.9, SH 47.8. (See Appendix 1 for explanations of abbreviations.)

Specimens examined.—Total one.

SINAI: No exact locality (1).

Published records.—Records are from Flower (1932) and Harrison (1968).

SINAI: Awlad Ali in Wadi el Arish (sight record), Abu Durda Mines between Tor and Ras Jehan (specimen).

Felis margarita Loche, 1858

Felis margarita Loche, 1858, Rev. Mag. Zool., 10, No. 2., p. 49, pl. 1.

Type locality.—Algeria. SAHARAN OASES: Ngoussi (Negousa, Negonca).

General distribution.—Southern Russian Turkestan, Iran, Arabian Peninsula, Algeria, Egypt, Libya, Morocco, and Asben.

Common name.—Sand cat.

Probable subspecies in Egypt.—

Felis margarita margarita Loche, 1858

Type locality.—See above under species.

Distribution in Egypt.—Not known, but reportedly "found in very sandy tracts of desert only" by Flower (1932, p. 390), who observed two in the Zoological Garden at Zagazig, 1912-1914. Listing of Sinai by Ellerman and Morrison-Scott (1951) was without documentation. One specimen was collected by I. Helmy in 1975 in the southwestern part of the Eastern Desert (fig. 133).

Diagnosis.—Color pale grizzled buff. Body markings indistinct. Foreleg markings prominent. Ear very broad; distal one-fourth black behind, base rufous. Tail slightly more than one-half head and

body length. Hair of palm and sole covering pads. Ears set low giving broad, flat appearance to head.

Rostrum and cranium short, broad. Postorbital width one and one-fourth times rostral width. Anterior end of zygomatic process gradually tapering. Bulla greatly inflated. Basioccipital constricted.

Head and body length average 461 mm.; tail 225 mm., 55 per cent of head and body length; foot 110 mm.; ear 66 mm.; condyloincisive length 85.4 mm.

External characters.—Fur longer and silkier than in other species of *Felis*. Dorsal line blackish. Dorsum pale buff grizzled with black and white. Side and outer side of legs paler. Under hair grayish. Venter white except for orangish throat. Indistinct longitudinal streaks on head, nape, and shoulders. Vertical grayish stripes on side and flank. Two black stripes encircle foreleg and fuse with patch inside elbow. Thigh with five fairly distinct stripes. Face whitish. Upper muzzle, lacrimal, and postorbital stripes orangish buff. Ear broad, inner side white, margin pale buff, distal one-fourth of back black, base rufous. Latter color extends onto nape and side of neck. Tail grayish above, whitish to buff below, with four indistinct stripes dorsally near tip and conspicuous black tip. Feet whitish to buff above; palm and sole brownish; hair long, curly, and completely covering pads.

Cranial characters.—Figure 136. Rostrum and cranium short and broad. Zygomatic arches relatively wide. Skull arched in lateral outline. Frontal and postorbital swellings prominent. Nasals constricted slightly medially, converging abruptly posteriorly, and ending well behind level of frontomaxillary suture. Lambdoidal ridge well developed, sagittal crest prominent posteriorly, frontal ridges continuous with postorbital processes. Maxillary protuberance dorsolateral to infraorbital foramen obsolete. Anterior end of zygomatic process attenuate. Mastoid process prominent. Paroccipital process adnate to bulla. Tympanic bulla greatly inflated. Basioccipital noticeably constricted and narrower than mesopterygoid fossa. Malar-maxillary suture sloping and below level of infraorbital foramen posteriorly.

Teeth.—Inner lobe of upper carnassial reduced, though protoconid is distinct.

Measurements.—External and cranial measurements of one immature Egyptian specimen are: HBL 438, TL 248, HF 117, Ear 71,

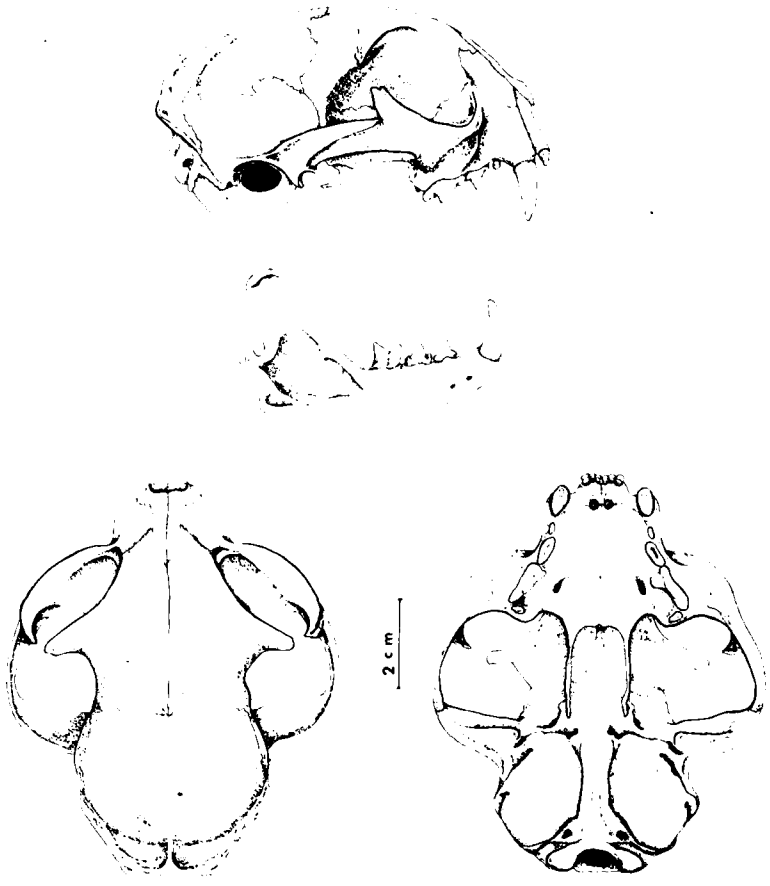


FIG. 136. Skull of *Felis margarita*.

CIL 77.9, ZW (approx.) 61.8, POW 35.4, RW 18.3, NL 24.4, PM^4-PM^1 32.0, SH 44.6. (See Appendix 1.)

Comparisons.—*Felis margarita* is easily identified from other species of *Felis* by its paler color; prominent facial and foreleg markings; large, broad ears lacking tufts; rounded, shortened cranium and rostrum; relatively large tympanic bulla; and constricted basioccipital. Hemmer et al. (1976) recognized *F. m. margarita* as the smallest of four races.

Specimens examined.—Total three.

Saudi Arabia: El Rub el Khali (1).

Aden: Beihan (1).

Egypt. ASWAN: Wadi el Targama (1).

Sight record of I. Helmy.—

ASWAN: Wadi el Targama (3) 1974.

Habitat.—Reported to occur in sandy areas of desert, to which the species appears to be adapted due to the long fur covering the feet, large ears, and greatly inflated tympanic bullae.

Behavior.—Nocturnal. Short legs and low-set, broad ears allow the sand cat to present a low profile; an advantage to a predator in sparsely vegetated areas. Further notes are in Hemmer (1974) and Hemmer et al. (1976).

Food.—Reptiles, birds, and rodents.

Reproduction.—Known to give birth to four and five young.

Genus **Caracal** Gray, 1843

Medium size, long-limbed, short-tailed cat with long ear tufts. Pelage without pattern except striping on side and spotting on venter. Nasal branch of premaxilla long, attenuate; sometimes contacting frontal process, which is also elongate. Notch in posterolateral edge of palate shallow. Postcanine diastema short. First upper premolar usually absent. Inner cusp of upper carnassial reduced. Inferior edge of lower jaw straight.

Caracal caracal (Schreber, 1776)

Felis caracal Schreber, 1776, Die Saugeth., pl. 110, text 3, pp. 413, 587.

Type locality.—South Africa: Cape of Good Hope, Table Mountain.

General distribution.—Central India, Afghanistan, Russian Turkestan, Iran, Asian Turkey, Syria, Jordan, Israel, Saudi Arabia, Sinai Peninsula, Egypt, Libya, Algeria, Morocco, Sudan west to Mauritania. Ethiopia, Somalia, Kenya south and southwest into Mozambique, and South Africa.

Common names.—Caracal, *Umm Rishat.*

Probable subspecies in Egypt.—

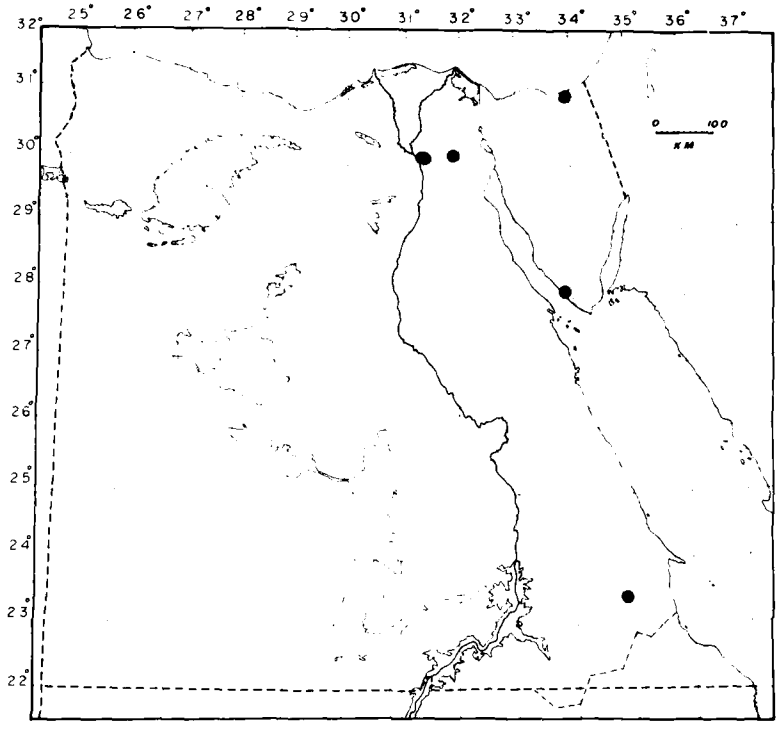


FIG. 137. Collection localities of *Caracal caracal schmitzi*.

Caracal caracal schmitzi (Matschie, 1912)

Felis (Caracal) caracal schmitzi Matschie, 1912, S.B.Ges. Nat. Fr. Berlin, p. 64.

Type locality.—Jordan: Ain ed Dachubeijir.

Distribution in Egypt.—Figure 137. Sinai Peninsula, northern part of Eastern Desert.

Diagnosis.—Light reddish brown on dorsum and side, venter white. Tail short, color of dorsum, tip black. Ear with long black tuft.

Cranium relatively long, rostrum short. Postorbital and rostral widths subequal. Anterior end of zygomatic process gradually tapered, tip rounded.

External characters.—Dorsum light reddish brown grizzled with white. Side paler and with scattering of buffy spots or faint striping.

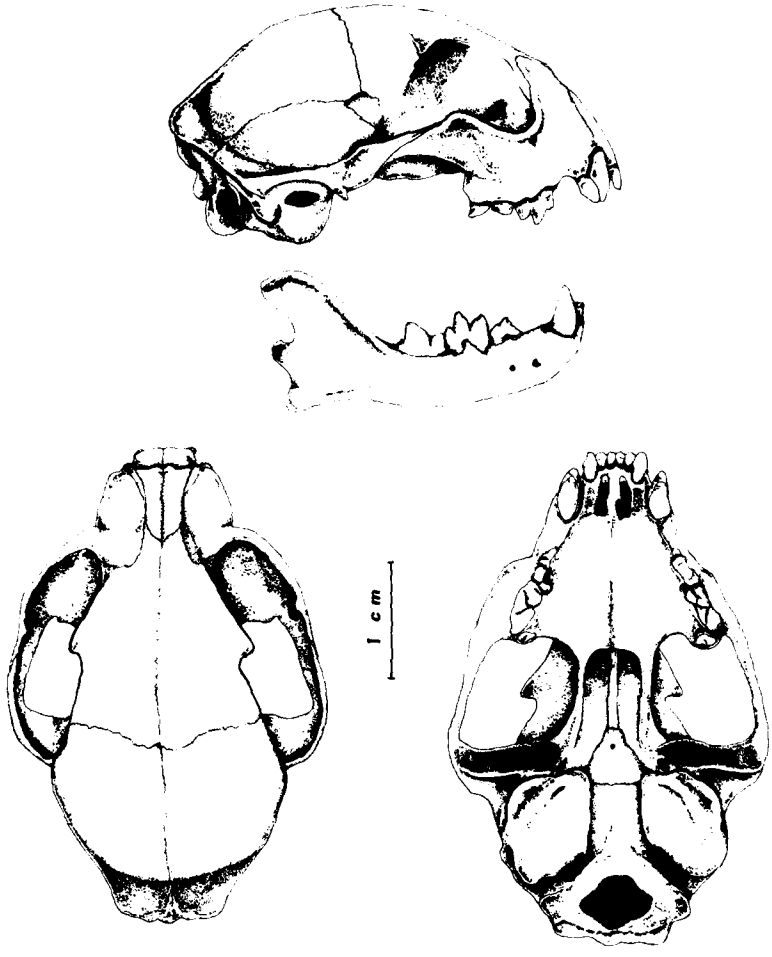


FIG. 138. Skull of *Caracal caracal schmitzi*.

Chin and gular regions whitish; throat and chest rufous; belly and inside of legs whitish with scattering of spots. Faint striping on outer side of legs. Face reddish brown, paler above eye. Blackish stripe continuous from nose through lacrimal onto forehead. Mystacial area blackish. Ear elongate, blackish behind, tip with long black tuft (40 to 60 mm.); inner side and margins whitish. Tail relatively short, indistinctly bicolored. Feet faintly marked with brown, palm and sole light brown, pads partly concealed.

Cranial characters.—Figure 138. Rostrum short, cranium relatively long. Skull outline rounded in lateral view. Cranial ridges moderately developed. Nasal branch of premaxilla long, attenuate; sometimes contacting elongate frontal process. Nasals narrowed gradually posteriorly, posterior margin rounded or truncate and level with or slightly anterior to frontomaxillary suture. Postorbital swelling nil. Postorbital processes relatively short. Postorbital and rostral widths subequal. Malar-maxillary suture sloping and below level of infraorbital foramen posteriorly. Anterior end of zygomatic process gradually tapered, tip rounded. Mastoid process protruding. Paroccipital adnate to bulla. Bulla inflation as in *Felis chaus*. Posterolateral margin of palate with slight notch, medial margin further posterior than in *Felis*. Lower jaw with inferior edge straight and angular process not curving upward.

Baculum.—Baculum length about 6 mm.; base broadened, triangular in outline (Didier, 1949).

Teeth.—Dentition similar to *Felis*, except the inner cusp of the upper carnassial is more reduced.

Comparisons.—*Caracal caracal* differs externally from other Egyptian Felidae by having less conspicuous markings, reddish color, long ear tufts, and shorter tail. Cranially, *C. caracal* differs from *Felis* species in having a long, attenuate nasal process of the premaxilla, less developed postorbital processes, and a straight inferior margin on the lower jaw. From *Panthera* and *Acinonyx*, *Caracal* differs in lacking spots, having ear tufts, small posteropalatal notches, and contact between premaxilla and frontal processes.

Specimens examined.—Total four.

SINAI: El Arish (1); Tor, N of (1).

CAIRO: Foum el Khalig (Old Cairo) (1), Gebel Mokattam (1).

Published records and reports.—The following are listed by date, where possible, from Anderson (1902), Flower (1932), Russell (1949ab), Hoogstraal et al. (1957b) and Hoogstraal (1964).

SINAI: El Arish (1920), Tor N of (1902).

SUEZ: Between Helwan and Gulf of Suez (1902).

CAIRO: Foum el Khalig (Old Cairo) (1904), Gebel Mokattam (1939).

RED SEA: Bir Abraq (1940), Wadis of Eastern Desert (1940's).

Habitats.—Savanna, rocky and hilly desert.

Food.—Gazelles, hares, rodents, birds, reptiles.

Remarks.—This cat was known to the ancient Egyptians as indicated by drawings on tomb walls at Beni Hassan (Anderson, 1902).

Genus **Panthera** Oken, 1816

Large, long-tailed cats. Color plain or with stripes or broken spots.

Skull elongate, nasals broad. Profile of cranium flattish or broadly convex. Nasal branch of premaxilla narrow. Posterolateral margins of palate without notches. Tympanic bulla relatively small. Anterior cusp of second upper premolar internal and relatively small.

Panthera pardus (Linnaeus, 1758)

Felis pardus Linnaeus, 1758, Syst. Nat., 10th ed., p. 41.

Type locality.—Valley of the Nile (describer and Hollister, 1918), Egypt (Thomas, 1911), Egypt or Sudan (Flower, 1932).

General distribution.—Eastern Siberia, Manchuria, China, Malaysia, Vietnam, Java and Kangean Islands, Burma, Nepal, Kashmir, Tibet, India, Sri Lanka, Pakistan, Baluchistan, southwestern Turkestan, Iran, Transcaucasia, Asian Turkey, Saudi Arabia, Yemen, Syria, Lebanon, Israel, Jordan, Sinai, Egypt, Algeria, Morocco, Sudan, Ethiopia, Somalia, thence westward to Senegal and the remainder of Africa southward.

Common names.—Leopard. *Memoura, Nimr.*

Probable subspecies and distribution in Egypt.—Figure 139. *Panthera pardus jarvisi:* Sinai Peninsula; *Panthera pardus pardus:* Eastern and Western Deserts.

Diagnosis.—Large, long-tailed cat. Color yellowish dorsally with pattern of brown to black spots forming rosettes. Venter white. Ear black behind with white spot.

Cranium relatively flat in lateral profile. Postpalatal margin posterior to anterior end of presphenoid. Protocone on inner lobe of upper carnassial.

Head and body length average 95-100 cm.; tail 60-95 cm.

External characters.—Large cat marked with black spots forming open rosettes. Dorsal color buff to pale yellow fading to white on venter. Spots less dense on underparts and inner sides of legs.

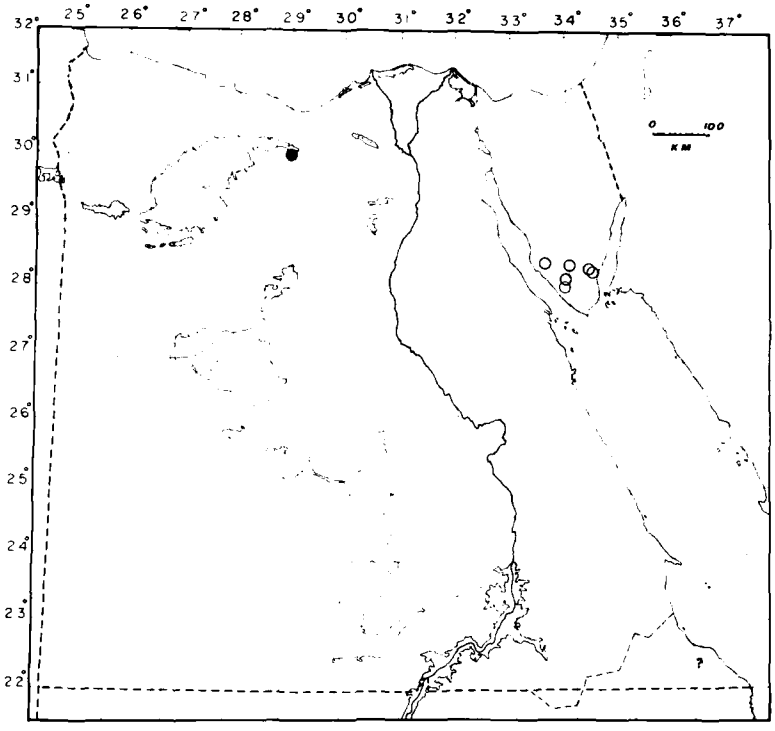


FIG. 139. Collection localities of *Panthera pardus pardus* (dot) and *P. p. jarvisi* (circles).

broken on chest. Facial markings nil. Ear black behind with white spot, whitish or cream on inner side. Tail spotted as body; spots becoming solid and appearing as bands distally.

Cranial characters.—Figure 140. Skull massive, strongly ridged, elongate. Nasal process of premaxilla narrow, attenuate. Nasals broad, convex, and tapering gradually posteriorly to rounded margin about level with frontomaxillary suture. Premaxillary processes of nasal short. Postorbital swelling prominent. Postorbital width considerably less than rostral width. Malar very deep. Malar-maxillary suture straight, sloping, and ending below level of infraorbital foramen. Latter very large and ovoid with maxillary protuberance present and situated above posterior level of upper second premolar. Anterior end of zygomatic process acute. Incisive foramen ovoid. Palatal foramen opposite inner lobe of carnassial.

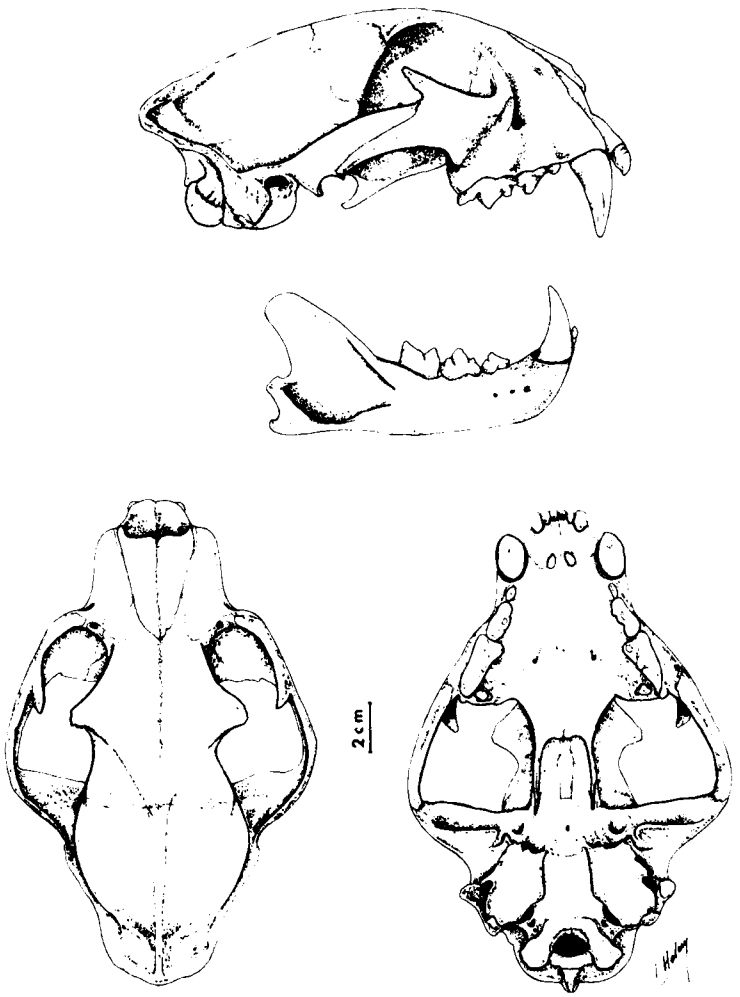


FIG. 140. Skull of *Panthera pardus*.

Lateral postpalatal margins without notches; posterior margin well behind anterior end of presphenoid. Mesopterygoid space narrower than basioccipital and with edges curved inward. Mastoid and paroccipital processes prominent. Mandible very strong, inferior edge curved.

Teeth.—Canines relatively long and powerful. Postcanine diastemas wide. Cheek teeth similar to *Felis*, except second upper premolar less compressed and with small anterior secondary internal cusp. There is a protocone on the inner lobe of the upper carnassial.

Comparisons.—*Panthera pardus* differs from most other Egyptian felids by larger size, pattern of broken spots, flatness of skull, largeness of infraorbital foramen, posterior postion of latter, posterior position of postpalatal margin, and narrowness of mesopterygoid space.

Habitats.—Rocky mountains, cliffs, and wadis. Known to have inhabited Western Mediterranean Coastal Desert and Qattara Depression around oases-like areas.

Food.—According to Murray (1930), the Sinai leopard feeds mainly on hyraxes and ibex. Instances of predation on camels and donkeys in Sinai have been reported (Hume, 1906; Murray, 1935).

Remarks.—Leopards are portrayed on tomb walls at Beni Hassan (Anderson, 1902).

Probable subspecies of Panthera in Egypt.—

Panthera pardus jarvisi Pocock, 1932

Panthera pardus jarvisi Pocock, 1932, Abstr. Proc. Zool. Soc., London, 1932, No. 347, p. 33.

Type locality.—SINAI: southwestern Sinai, no exact locality.

Distribution in Egypt.—Figure 139. Sinai Peninsula.

External characters.—Dorsum creamy buff, flank grayish, venter white. Rosettes with centers slightly darkened.

Specimen examined.—SINAI: no exact locality (Type).

Published records and reports.—The following are listed by date, where possible, from Palmer (1872), Hart (1891), Buxton et al. (1895), Hume (1906), Barron (1907a), Pocock (1932), Negumi (1949), Hardy (1949), Wassif and Hoogstraal (1954), and Murray (1935, 1967).

SINAI: Wadi Sigilliyeh (tracks, 1872); Ain el Taba (tracks, 1891); Gebel Shomer and Gebel Serbal (Bedouin report, 1891); Wadi Nasli and Wadi er Rimm (tracks, 1894); Wadi Isla, Wadi Aad, and Gebel Ferani (tracks, 1906); Wadi Threya and Wadi Nasb (camels killed by leopards, 1906); Haid Merzega Pass (Bedouin leopard trap, 1906); Wadi Geba (tracks, 1907); Wadi Sheqer (camels killed by leopards, 1907); Moiyet Luliya (Pearl's Spring) below Gebel Yithmid (one seen, 1929); Wadi Hebron (11 donkeys killed by leopards, 1929); mountains of Sinai (male and female shot, 1939-1940); Gebel Serbal (skin, 1942); no exact locality (type and skin, 1900; one shot, 1945; mounted skin, early 1950's).

Panthera pardus pardus (Linnaeus, 1758)

Type locality.—See under species.

Distribution in Egypt.—Figure 139. Northern part of Western Desert (previously) and possibly Gebel Elba area.

External characters.—Large leopard, variable in size and color. More ochraceous buff colored and with spots smaller and darker than in *P. p. jarvisi.*

Specimens examined.—Total one.

Sudan: No exact locality (1).

Published records and reports.—Sources are Barron and Hume (1902), Flower (1932), Fahmy (1936), Tregenza (1955), Hoogstraal et al. (1957b).

RED SEA: Said to be absent in Eastern Desert. Guides have mentioned that leopards were present in the Eastern Desert in times of more vegetation.

SUDAN ADMINISTRATIVE: Occasionally found in the Elba Mountains and legendary among the Bisharin of that area.

MATRUH: Skin seen in 1913 from El Maghra 10 km. SW, and said to occur between Mariut and Siwa.

Genus **Acinonyx** Brookes, 1828

Monotypic genus of long-limbed, panther-like cats. Pelage spotted. Ears small. Claws not retractile.

Skull short, broad, conspicuously domed. Frontal region exceptionally broad, swollen. Nasal branch of premaxilla attenuate. Posterior margin of palate without lateral notches. Postcanine diastemas nil. Anterior accessory cusp of second upper premolar in line with others. Inner cusp of upper carnassial obsolete; lower carnassial with posterior talonid-like cusp.

Acinonyx jubatus (Schreber, 1776)

Felis jubata Schreber, 1776, Die Saugeth., 3, pl. 105.

Type locality.—South Africa: Cape of Good Hope.

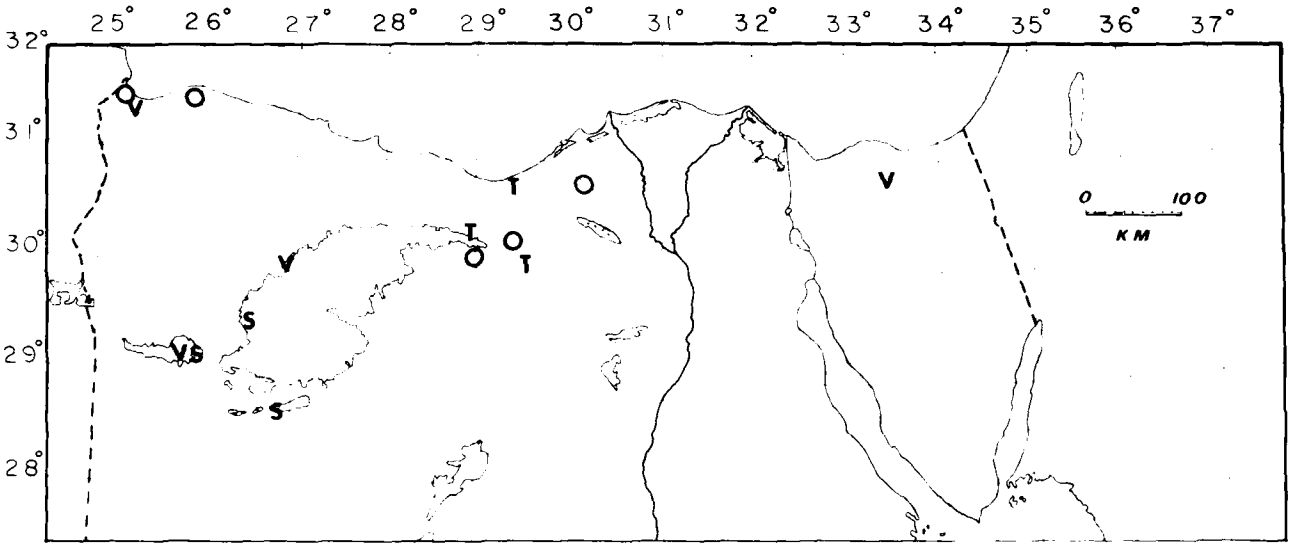


FIG. 141. Collection localities, sight records (S), tracks (T), and verbal reports (V) of *Acinonyx jubatus*. See text for dates.

General distribution.—Parts of India (previously), Baluchistan, Afghanistan, southern Russian Turkmenia, Iran, Iraq, Syria, Jordan, Saudi Arabia, Sinai Peninsula, Egypt, Libya (?), Morocco, Rio di Oro, Sudan, Ethiopia, Somalia, Chad, northern Nigeria south into southern and southwestern Africa.

Common names.—Cheetah, Hunting Leopard, *Fahd.*

Distribution in Egypt.—Figure 141. Northern Sinai Peninsula and northern half of Western Desert.

Diagnosis.—Large, long-tailed cat. Grayish to yellowish dorsally, with pattern of solid black spots; venter white. Ear small, tip yellowish, base black.

Cranium conspicuously domed. Infraorbital foramen small, narrowed vertically. Postpalatal margin almost level with anterior end of presphenoid. Upper carnassial with inner lobe reduced and lacking protocone.

External characters.—Body size and tail length about as in *Panthera.* Legs long, slender. Ear small, short. Paws small, compact. Mane on nape and shoulders. Latter covers entire dorsum in cubs. Dorsum, side, and outer legs yellowish to pale buff or grayish white covered with close-set, solid blackish spots. Venter white. Tail marked like body proximally, distal one-third ringed, tip white. Prominent, black, curved stripe between mouth and eye. Ear tip yellowish, base of ear black.

Cranial characters.—Figure 142. Cranium thin boned, lightweight, relatively short, broad and markedly domed with peak anterior to postorbital process. Premaxillary process thin, elongate. Nasals very broad, flat, tapering gradually to an abruptly rounded posterior margin, and ending at level of frontomaxillary suture. Dorsofrontal region very broad and conspicuously swollen. Postorbital processes short. Postorbital swelling prominent. Postorbital width slightly more than rostral width. Anterior of zygomatic process broadly rounded. Sagittal crest developed posteriorly only. Lambdoidal ridge prominent. Infraorbital foramen opposite middle cusp of upper carnassial; small, narrowed vertically, and lacking maxillary protuberance. Malar relatively shallow. Malar-maxillary suture angular in outline, not extending below level of infraorbital foramen. Incisive foramen rounded. Palatal foramen opposite posterior cusp of carnassial. Postpalatal margin well behind m^1. Anterior lip of glenoid slightly developed. Mesopterygoid wider than basioccipital, edges curved inward. Mastoid and paroccipital

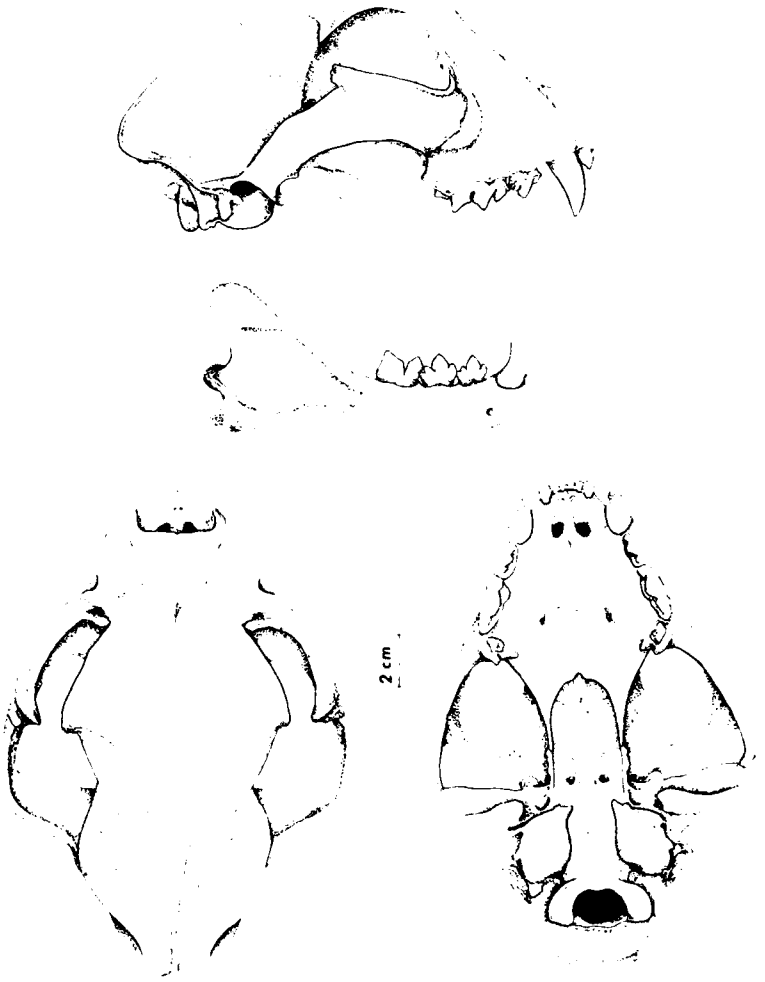
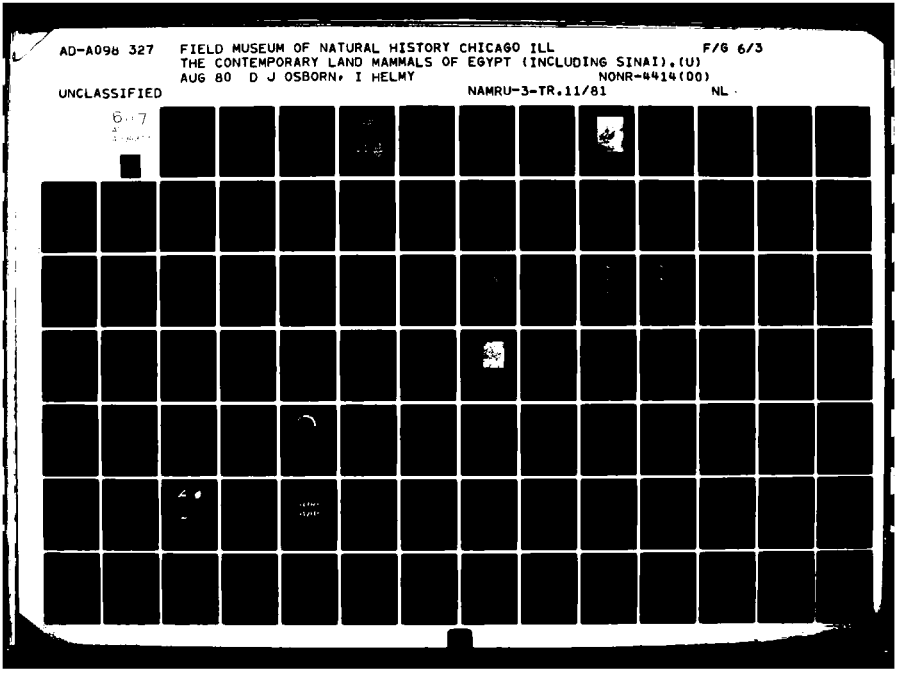
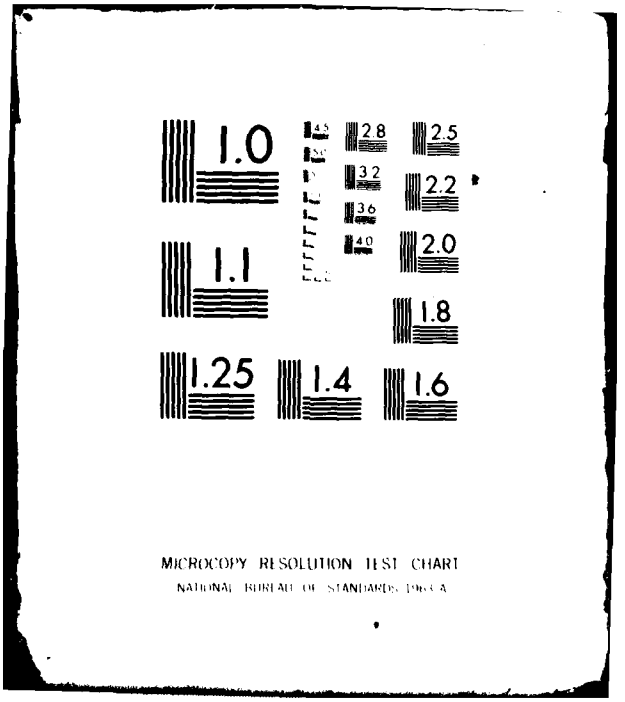


FIG. 142. Skull of *Acinonyx jubatus*

AD-A098 327 FIELD MUSEUM OF NATURAL HISTORY CHICAGO ILL F/G 6/3
THE CONTEMPORARY LAND MAMMALS OF EGYPT (INCLUDING SINAI).(U)
AUG 80 D J OSBORN, I HELMY NONR-4414(00)
UNCLASSIFIED NAMRU-3-TR.11/81 NL




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

processes protruding and prominent. Exoccipital relatively low and broad. Mandible relatively weak, inferior edge almost straight.

Teeth.—Canines relatively short. Postcanine diastema nil. Anterior cusp of second upper premolar well developed and in line with main cusp. Upper carnassial length subequal with length of canine. The inner lobe is vestigial, and an anterior cingular cusp is present. The lower carnassial has a talonid-like cusp.

Specimens examined.—Total four.

MATRUH: Cairo-Alexandria desert road km. 125, 15 km. N (1); Qur el Hilab 45 km. ENE of El Maghra, killed in 1974 by Bedouins (2).

Kenya: Athi River (1).

Sight records of I. Helmy.—

MATRUH: Sitra Oasis (six, 1975), El Zeitun (seven, 1975).

Published records and reports.—The following are listed by date, where possible, from Flower (1932), Hardy (1949), Russell (1951), Murray (1935, 1967), Hoogstraal (1964), and Hoogstraal et al. (1968).

SINAI: Sinai Desert (two seen, early 1946).

MATRUH: Alexandria 66 km. W (tracks of two, 1909); El Maghra 8 km. N (one shot, 1910); common around El Maghra (early 1930's); Giza Pyramids 166 km. W (tracks, late 1920's); present prior to World War II in low-lying parts of Western Desert, such as El Maghra; Salum area (three cubs, 1927; one shot, 1934; skin seen, 1937; two verbal reports, 1934); Sitra (one seen, 1964); Sidi Barrani (one shot, 1964); Qattara Depression cliffs (few pairs reported, late 1920's); Tal el Fawakhir (one seen, 1965); Hatiyet Labaq (tracks, 1967); Cairo-Alexandria desert road km. 125, 15 km. N (one shot, 1967).

In addition to the above, Omer-Cooper (1947, p. 21) reported that hunting leopards occurred "in the coastal belt (a few miles in width) of the Western Desert." Bedouins reported cheetahs in Qattara Depression from El Maghra to Tal el Fawakhir (Hoogstraal et al., 1968).

Habitat.—Savanna and semi-desert. Known from Western Mediterranean Coastal Desert and sparsely vegetated areas of Qattara Depression, acacia groves, and oasis-like depressions.

Habits.—Usually approaches prey then runs it down, rather than stalking like the leopard. Western Desert Bedouins claim "that it perches in acacia branches to attack gazelles." (Hoogstraal et al., 1968, p. 65).

Food.—Hares, gazelles (Russell, 1951; Murray, 1967), domestic sheep (Hoogstraal et al., 1968), and probably rodents and birds.

ORDER HYRACOIDEA

Family Procaviidae

Genus **Procavia** Storr, 1780

Rock hyraxes. Grayish to yellowish or orangish brown dorsally, venter buffy. Frontals of skull flat, triangular. Postorbital process of frontal and malar not fused. Tempoparietal ridges fused posteriorly in adults. Parietals extend slightly posterior to interparietal. Cheek teeth brachydont, four-rooted. Upper premolars of adults shorter than molars. Dental formula: $\frac{1}{2}, \frac{0}{0}, \frac{4}{4}, \frac{3}{3} \times 2 = 34$.

Procavia capensis (Pallas, 1766)

Cavia capensis Pallas, 1766, Miscellanea Zool., p. 30 pls. 3, 4.

Type locality.—Africa: Cape of Good Hope.

General distribution.—Syria, Lebanon, Israel, southern Arabian Peninsula, Egypt, Algeria, Libya, Tibesti, Azbine, Sudan, Ethiopia, and Somalia southwards to South Africa and westwards to Senegal.

Common names.—Hyrax, Coney, Dassie, *Wabar, Buar, Kalidob.*

Distribution of subspecies in Egypt.—Figure 143. *Procavia capensis syriaca:* Sinai Peninsula; *Procavia capensis ruficeps:* Eastern Desert.

Diagnosis.—Rodent or hare-like. Grayish to yellowish brown; tailless; ear short, rounded. Palm and sole with large, firm pads. Toes with nails.

Skull strongly built, angular; nasals broadest posteriorly; frontal flat, triangular in outline with prominent postorbital process. Zygomatic process of temporal begins at level of nuchal ridge. Lower jaw deep, ramus and angle greatly expanded. Upper incisors tusk-like, lower incisors pectinate. Lophs of upper cheek teeth U-shaped; lower, W-shaped.

Height at shoulders about 25 cm., head and body length 40 cm., foot 6.6 cm., ear 3.3 cm., weight 2 to 4 kg.

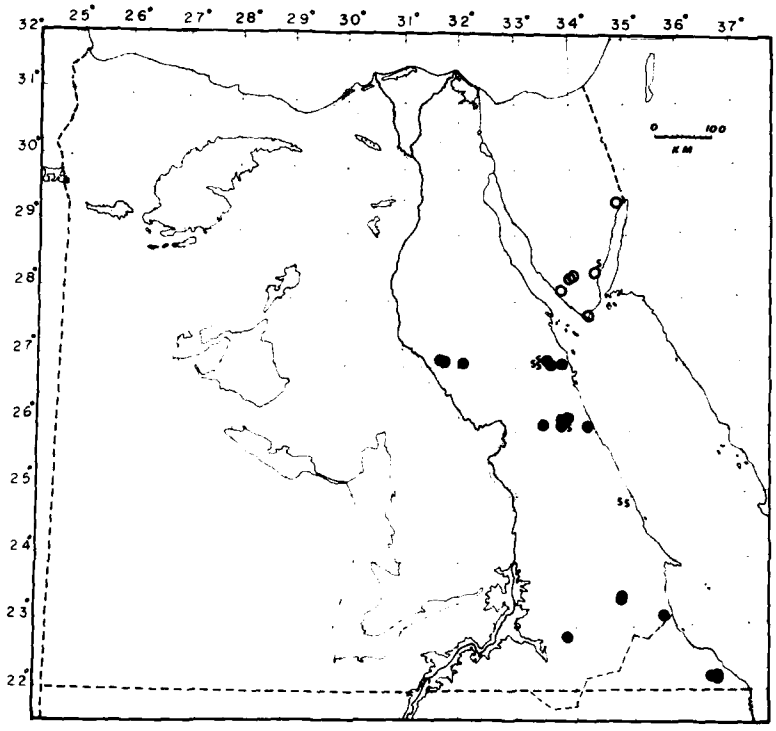


FIG. 143. Collection localities of *Procavia capensis syriaca* (circles), *P. c. ruficeps* (dots), and sight records (S).

External characters.—Fur relatively short, soft. Dorsum and side grayish to yellowish brown; throat, belly, and inside of legs pale brownish or buff. Middorsal scent gland marked, in some individuals, with yellowish or orangish hairs. Dorsum and side hairs with brownish tips, yellowish to orangish subterminal bands, and brown bases. All other hairs also have brown bases. Long, blackish tactile hairs scattered over dorsum and side. Mystacial, supraorbital, and postauricular areas paler than body. Gular area with large vibrissae. Snout short, pointed. Ears short, rounded. Tail lacking. Feet plantigrade. Palm and sole with firm, naked pads. Forefoot with four short toes bearing blunt nails. Hind foot with two long, webbed toes bearing nails and an inner grasping toe with sharp, curved claw.

Cranial characters.—Figures 144, 145. Skull strongly built and

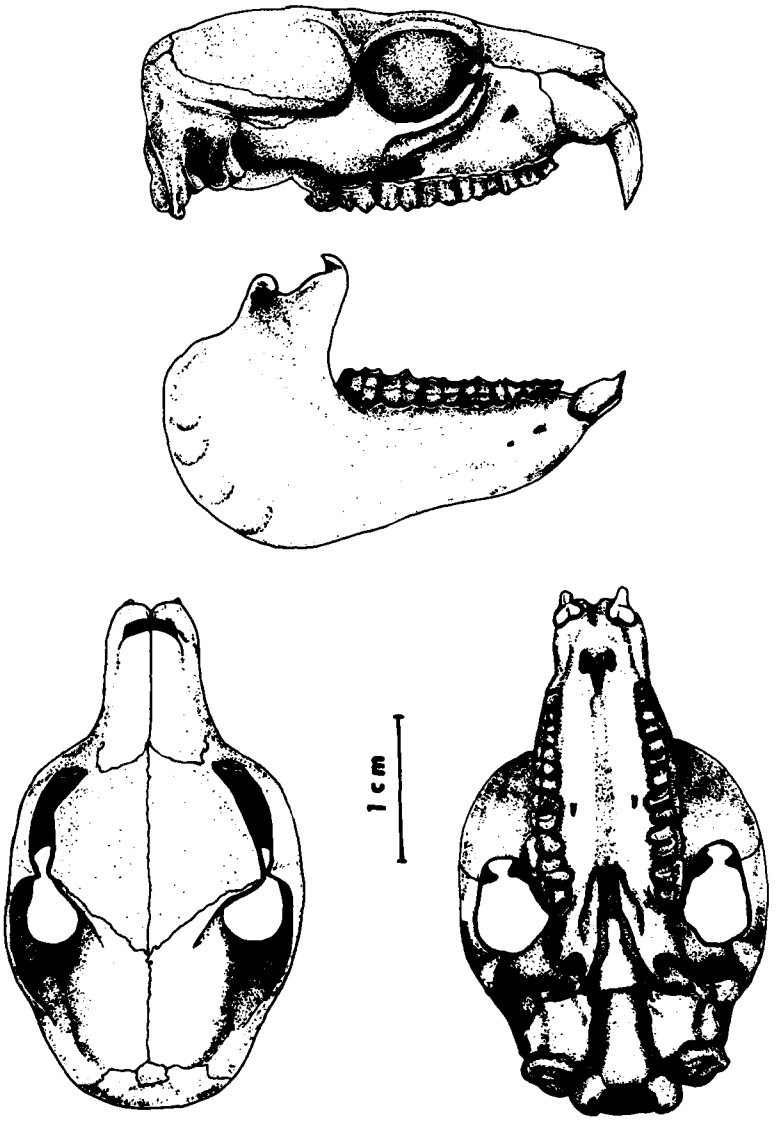


FIG. 144. Skull of *Procavia capensis*.

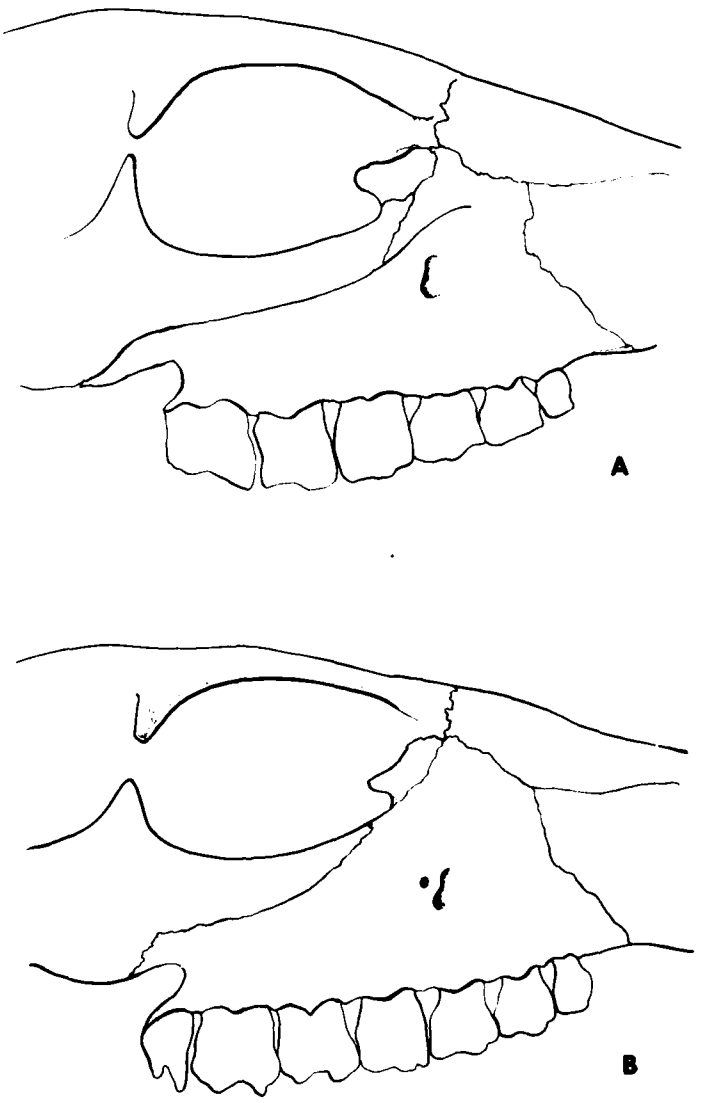


FIG. 145. Comparison of position of anterior end of malar relative to lacrimal in *Procavia capensis ruficeps* (A) and *P. c. syriacus* (B).

angular. Rostrum relatively short, compressed laterally, and nasals very broad posteriorly. Interorbital region broad, flattened dorsally; frontals triangular with prominent postorbital processes. Lacrimal with prominent peg-like projection. Tempoparietal ridges fused posteriorly in adults forming a high, median sagittal crest. Interparietal small, triangular to pentagonal in outline. Parietal extends posteriorly slightly beyond level of interparietal. Nuchal ridge well developed in adults. Zygomatic process of temporal begins almost at the nuchal ridge. Zygomatic arch does not flare laterally. Malar very long, extending from level of lacrimal posteriorly to form outer part of glenoid cavity; middle broadened vertically and has a long postorbital process. Supraoccipital vertical. Paroccipital process elongate, extending below levels of occipital condyle and auditory bulla. Incisive foramen small, round; posterior palatine foramen minute. Posterior margin of palate anterior to last molar. Parapterygoid fossa prominent. Mandible deep; angular region rounded and greatly enlarged.

Teeth.—Upper incisors two only and continuously growing, widely spaced, tusk-like, triangular in cross section, pointed tips. Lower incisors broad, pectinate. Cheek teeth brachydont with deep lophs; upper with U-shaped lophs, lower, W-shaped.

Measurements.—Table 54.

Age determination.—Adult specimens have median sagittal crest on posterior cranium and majority of sutures closed.

Comparisons.—*Procavia c. syriaca* is darker and more orangish than *P. c. ruficeps*, has hairs of dorsal spot concolor rather than banded, and anterior end of malar not contacting lacrimal.

Variation.—Pelage of young is markedly grayer than adult. Individual variation in adult color was noted by Gray (1868), Anderson (1902), and Flower (1932).

TABLE 54. — Means (and ranges) of measurements of *Procavia capensis*.

	*P. c. syriaca**	*P. c. ruficeps*
HBL	473.8 (345-574) 17	464.8 (458-478) 4
FL	72.2 (56-81) 17	68.8 (67-72) 4
EL	34.8 (26-40) 17	33.8 (30-36) 4
CIL	88.0 (72.7-99.8) 21	88.9 (86.2-92.1) 3
ZW	50.6 (41.2-61.9) 21	52.0 (51.0-54.0) 3
TRL	36.6 (26.2-41.7) 21	35.8 (35.2-36.2) 4

*Data summarized from Harrison (1968).

Collection.—Hyraxes have been caught by hand and by dogs when well away from the vicinity of rocks (Hoogstraal et al., 1957ab; Bedan, 1928). Steel traps set in trails between cliffs and food trees will sometimes catch them (Osborn, 1968a). Shooting is satisfactory, providing animals are on exposed rocks away from dens, otherwise, if an animal does not die immediately, it can escape. Gunfire and other noises usually cause hyraxes to disappear for half an hour or more (Hoogstraal et al., 1957ab).

Habitat.—Figure 146. Rock falls and crevices in cliffs in the vicinity of acacia trees. Dens are always in deep crevices too narrow for human passage. Remaining walls of Roman buildings provided a suitable den site in Wadi Semna.

Behavior.—Hyraxes live in colonies, are nocturnal and diurnal in activity and may be seen sunning on exposed rocks. Feeding is mainly at night. They are very agile and can move rapidly and gracefully in trees and rocks. Climbing ability is due to glandular, cohesive foot pads and almost opposable inner hind toe. A high-pitched alarm call is given by sentinels. Other sounds have been noted. Feces and urine are deposited habitually in specific places. White, bleached urine streaks on rocks are a sign of hyrax dens (fig. 146), although they remain visible for years after dens have been deserted.

Populations.—Information on populations is sketchy. According to Anderson (1902), hyraxes were so abundant in upper reaches of Wadi Sheitun that Schweinfurth called it "Valle di Hyrax." Barron and Hume (1902) wrote that hyraxes were once numerous in the Eastern Desert as far north as Bir Inglizi (Beida) on the Qena-Quseir road, but that, due to promiscuous cutting of acacia trees, only a small population remained near the Sudan frontier. Flower (1932) reported the disappearance of many colonies between 1914 and 1920, a period of critical food and fuel shortage in Egypt.

Small colonies still exist in southern Sinai Peninsula and the Eastern Desert (fig. 143) far north of the limits decided by Barron and Hume (1902). Floyer (1887) and Tregenza (1955) reported hyraxes from Wadi Qattar, and we observed them there and in Wadi Umm Yassar in 1966. Cutting of acacia trees for making charcoal, a practice that continues over much of the Eastern Desert, has probably reduced or eliminated hyraxes in many areas, e.g., parts of Wadi Sukari and Wadi Ghadir and probably wadis in the Maaza

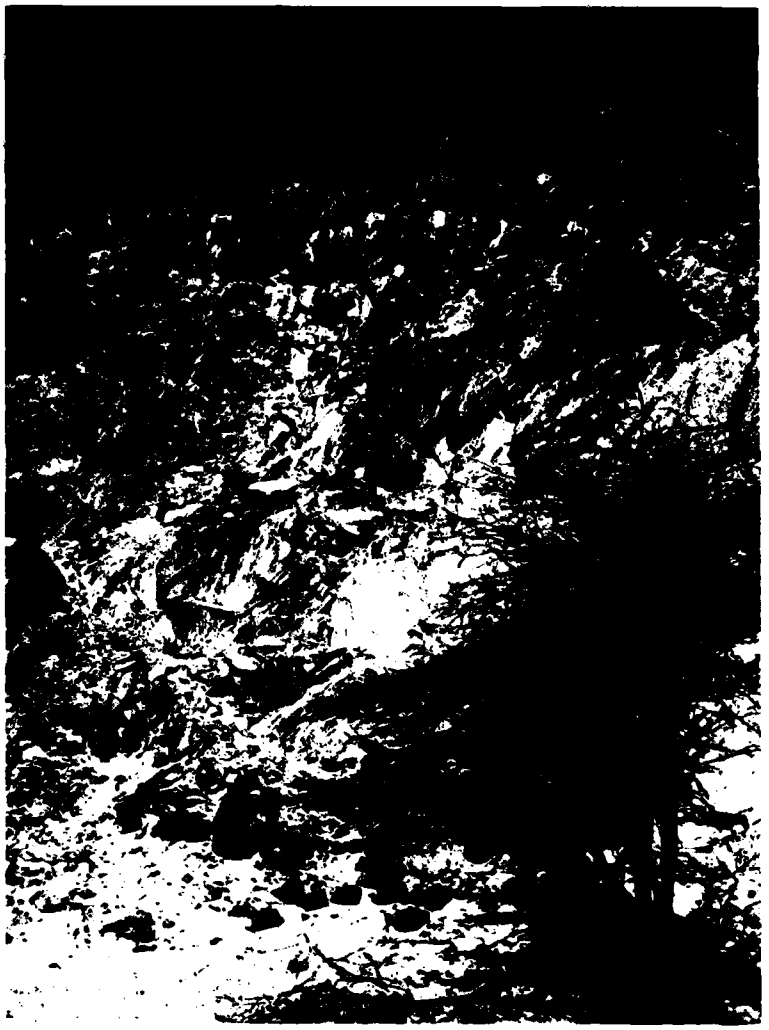


FIG. 146. Habitat of *Procavia capensis* in Wadi Nagib. Note white urine streaks on rocks. Tree is *Acacia ehrenbergiana*.

Plateau. Bedouins with guns are also a factor to be considered (Hoogstraal, 1964).

Hoogstraal et al. (1957ab) observed many old dens marked with white urine streaks and suggested that this indicated either periodic movements or that populations were smaller than before. Their estimates of numbers of hyraxes in the Bir Kansisrob and Bir Abraq areas were 100 and 12 to 20, respectively. Osborn (1968a) reported seeing 11, including two young specimens in Wadi Nagib.

Reproduction.—A colony from Sinai Peninsula stock in Giza Zoological Gardens produced 14 litters, averaging 2.5 young per litter, five being the largest (Flower, 1932). Roche (1960) reported litter size is usually two to three, maximum three in captive *P. c. syriaca* in France. Captive *P. c. syriaca* in Israel usually begin mating in August and bear young from mid-March into May. The usual number of young is three to four. Young are fully active soon after birth (Mendelssohn, 1965).

Economic importance.—Russell (1949b) mentioned that hyrax guano is sometimes used for fertilizer. Bedouins kill them for food.

Food.—Over much of the Eastern Desert, acacia leaves and pods are staple food of hyraxes. In Wadi Aqwamtra, Gebel Elba, they fed selectively on *Rumex vesicarius.* Reports indicate they can eat almost any plant, even those toxic to other animals such as *Solanum* sp., *Euphorbia* sp., and *Ficus* sp. Halophytic plants are probably eaten, and listings also include grasses, herbs, berries, small fruits, bark, lichens, leaves of climbable shrubs and trees (Mendelssohn, 1965; Sale, 1965; Dorst, 1970). Captive hyraxes eat almost anything except meat. They have been fed barley, bread, bread and milk, sorghum grain, cooked rice, clover, alfalfa, alfalfa hay, carrots, beets, eggplant, other vegetables, dates, grapes, other fruits, mealworms, insects, and small vertebrates (Bruce, 1790; Mendelssohn, 1965; Flower, 1932; Hauser, 1951).

Water.—Rock hyraxes drink very little water, but according to Dorst (1970), may travel distances of 640 m. to obtain it. Most colonies in the Eastern Desert live in waterless areas.

Folklore.—According to Sinai Bedouins of earlier times, the Coney is ". . .man's brother. The peculiar conformation of its feet are proof that it is the descendent of a human being transformed; they will not eat its flesh and declare that if a man were to do so, he would never look upon his father and mother again" (Palmer, 1872, p. 89).

Apparently, modern Bedouins have forgotten this taboo, for they wantonly slaughter the animal.

KEY TO EGYPTIAN SUBSPECIES OF *Procavia capensis*

1. Dorsum yellowish to orangish brown. Hairs of dorsal spot concolor. Anterior end of malar not contacting lacrimal (fig. 145). (Sinai Peninsula)..... *syriaca*, p. 468.
2. Dorsum grayish to yellowish brown. Hairs of dorsal spot with dark base and generally dark tip. Anterior end of malar usually contacting lacrimal (fig. 145). (Eastern Desert)..... *ruficeps*, p. 468.

Procavia capensis syriaca (Schreber, 1784)

Hyrax syriacus Schreber, 1784, Die Säugeth., Vol. 4, pl. 240B (1792), p. 923.

Type locality.—Lebanon: Mt. Lebanon.

Distribution in Egypt.—Figure 143. Sinai Peninsula.

External characters.—Dorsum orangish brown, venter buff to pale brownish. Hairs of dorsal spot around gland concolor, at least inner margin, yellowish to orangish.

Cranial characters.—See species description and Figures 144, 145. Malar not contacting lacrimal.

Measurements.—Table 54.

Comparisons.—*Procavia c. syriaca* differs from *P. c. ruficeps* in darker, more orangish color; dorsal spot more clearly marked, and malar not contacting lacrimal.

Specimens examined.—Total 17.

SINAI: Wadi Abu Zeitouna (3), Gebel Musa (1), Wadi Taba (1), Wadi Ergein (4), Gebel Hammami (1), St. Catherine Monastery area (1), "Sinai" (6).

Published records.—Records are from Hart (1891), Anderson (1902), Brauer (1917), Flower (1932), Hahn (1934), and Wassif and Hoogstraal (1953).

SINAI: Wadi Ergein, Gebel Musa, St. Catherine Monastery area, Gebel Hammami, El Tor, Wadi Adani, Ras Muhammed, and Dahab (reported by Bedouins).

Procavia capensis ruficeps (Hemprich and Ehrenberg, 1832)

Hyrax ruficeps Hemprich and Ehrenberg, 1832, Symbolae Physicae Mamm., Dec.1, folio h, pl. 2, upper fig.

Hyrax burtonii Gray, 1868, Ann. Mag. Nat. Hist. (ser. 4), 1, p. 43.

Type locality.—Sudan. NORTHERN: Dongola

Distribution in Egypt.—Figure 143. Eastern Desert.

External characters.—Dorsum grayish to yellowish brown, venter

buffy. Hairs of dorsal spot around gland usually with dark tips, pale yellowish subterminal bands, and brownish bases.

Cranial characters.—See species description and Figures 144 and 145. Malar usually contacting lacrimal.

Comparisons.—*Procavia c. ruficeps* differs from *P. c. syriaca* in paler more yellowish and sometimes grayish pelage; dorsal spot hairs not clearly separable from dorsum; and malar usually contacting lacrimal.

Remarks.—*Procavia c. ruficeps*, on basis of priority, is considered synonymous with *P. c. burtoni* described from an individual variant.

Specimens examined.—Total 21.

Egypt: No exact localities (3).

RED SEA: Wadi Abu Kaleja (4), Wadi Habib (1), Bir Abraq (4), Gebel Abraq (1), Wadi Hodein (2), Wadi Atallah, 6.6 km. inside (old skull).

ASWAN: Wadi Nagib (2).

SUDAN ADMINISTRATIVE: Bir Kansisrob (3).

Sight records (individuals, fresh tracks, fresh feces) of D. Osborn and I. Helmy.—

RED SEA: Wadi Umm Yassar, Wadi Qattar, Gebel Umm Disi, Wadi Semna, Wadi Ghadir, Wadi Sukari.

ASWAN: Wadi Magal Gabril.

SUDAN ADMINISTRATIVE: Wadi Aqwamtra, Wadi Kansisrob.

Published records.—Records are from Floyer (1887), Anderson (1902), Barron and Hume (1902), Bonhote (1909, 1912), Bedan (1928), Negumi (1952), Tregenza (1955), Hoogstraal et al. (1957ab), and Osborn (1968a).

RED SEA: Wadi Qattar, Wadi Umm Delfa, Wadi Habib, Wadi Abu Kaleja (Abu Khalifa), Wadi Fertili, Wadi Sheitun, Bir Inglizi (Beida), Ras Gurdi, Bir Abraq, Gebel Abraq, Wadi Hodein.

ASWAN: Wadi Nagib.

SUDAN ADMINISTRATIVE: Wadi Kansisrob.

ORDER PERISSODACTYLA

Family Equidae

Genus **Equus** Linnaeus, 1758

Genus of large-headed, slenderly built horse-like mammals, with or without stripes. Tail long, tufted. Short mane on neck. Bare callosity on inner side of foreleg. Skull with cranium short, but large; rostrum elongate; nasals long, narrow, projecting freely; orbits small, enclosed. Ethmoidal fissure absent. Canines in diastema, usually only in males. Cheek teeth extremely hypsodont, crowns squarish with complex foldings of enamel, dentine, and cement. Anterior pillar of upper cheek teeth united by narrow enamel bordered neck to dentine of main body of tooth. Dental formula: $\frac{3}{3}, \frac{0\text{-}1}{0\text{-}1}, \frac{3\text{-}4}{3}, \frac{3}{3} \times 2 = 36\text{-}42$.

Equus asinus Linnaeus, 1758

Equus asinus Linnaeus, 1758, Syst. Nat., ed. 10, p. 73.

Type locality.—". . .in Oriente."

General distribution.—Southeastern Egypt, eastern Sudan, Eritrea, Somalia, northern Chad.

Common names.—Wild Ass, *Hamar el Wadi, Homard Beri.*

Subspecies in Egypt.—

Equus asinus africanus (Fitzinger, 1857)

Asinus africanus Fitzinger, 1857, Naturgesch. Säugeth., Vol. 3, p. 667.

Asinus taeniopus Heuglin, 1861, Nova Acta Acad. Caes. Leop.-Carol., Jena, Vol. 28, No. 10, pl. 1, p. 1.

Type locality.—Nubia.

Distribution in Egypt.—Figure 147. Southeastern Egypt.

Diagnosis.—Dorsum and side pale gray with reddish sheen; legs paler than body; head, neck, and legs without stripes; shoulder cross present, variable. Eye ring, inside of ear, muzzle, underside of lower

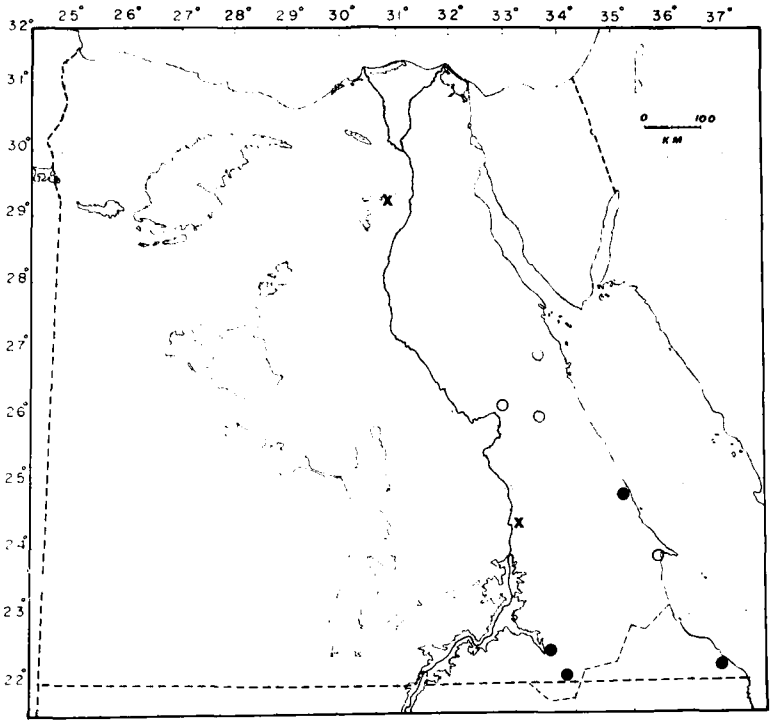


FIG. 147. Localities of observations of *Equus asinus africanus* in 1800's (circles) and from 1950 to date (dots); paleolithic and prehistoric remains (X).

jaw, and venter white. Short mane on neck, forelock absent. Ear very large. Tail long, tufted.

Shoulder height 115 to 125 cm.

Comparisons.—*Equus a. africanus* differs from *E. a. somaliensis* in darker color, lack of leg stripes, presence of white eye ring in all individuals, more strongly developed dorsal stripe and shoulder cross, and a dark spot on outer side of the fetlock. From the domestic ass, *E. a. africanus* differs in paler color, lack of leg stripes, legs paler than body, lack of dark patch at ear base and tip, and presence of dark spot on outer side of fetlock.

Habitat.—According to Ziccardi (1970), wild asses prefer arid, remote wadis, and plains with xerophytic vegetation.

Remarks.—Equus a. taeniopus is considered obsolete on bases of the description having been of a living animal with no definite locality (Sclater, 1884; Harper, 1940), and the drawing to be of either a domestic donkey (Neumann, 1935) or an inaccurate representation of a wild one (Antonius, 1937). Lydekker (1916, p. 38) favored retention of the subspecies and listed "typical locality Hawash district of Abyssinia." Hoogstraal et al. (1957b) listed it tentatively from southeastern Egypt. Ziccardi (1970) called it the Eritrean wild ass.

Historical notes.—Late Paleolithic shoreline deposits in El Faiyum contain *Equus* fragments, and wild ass occurred in the prehistoric Kom Ombo Plain fauna (Butzer and Hansen, 1968). Prehistoric rock drawings of wild ass are in the Wadi Muktil (Muqtil)-Wadi Natash area (Floyer, 1893) and further north in Wadi el Hammamat.

Domestication in the Nile Valley was estimated to have been between 3,500 and 3,300 B.C. A predynastic period slate depicts asses being traded with Libya. Ramses III hunted donkeys, and they were well known as wild animals in Egypt until about 1,100 B.C. (Talbot, 1960; Zeuner, 1963).

Originally, *Equus asinus* probably ranged from Somalia through the Libyan Desert to Morocco (Zeuner, 1963). The Nubian wild ass (*E. a. africanus*) is thought to have inhabited most of the Eastern Desert and parts of the Western Desert along the Sudan border (Talbot, 1960). Harding-King (1925) referred to Uweinat as a place where wild asses fed when there was pasture.

References to wild asses in literature on Egypt are scarce. Anderson (1898, 1902) wrote that wild asses had been seen near Wadi Kittar (Qattar) and Ayd near Old Keneh (Qena) in the 1820's by James Burton (MSS in British Museum). Flower (1932) maintained that Anderson's quotations from Burton's MSS were in error, because they referred to Nubia. Burton's localities are validated, however, by the fact that he traveled with Wilkinson (1832) in 1823 in the Eastern Desert northeast of Qena.

Burton wrote that the Bedouins let their female donkeys loose to be bred by wild males and that white offspring, called "*Homar Wahsh*," always resulted from these matings. The animal seen near Old Qena was described as white with a dark dorsal line.

Anderson (1898, p. XXV) also wrote of Linant de Bellefonds' explorations in the mid 1800's in southeastern Egypt: "Having

cleared the defiles of Wadi Daffeti; Linant de Bellefonds visited the mountain and valley of Beint el Fegue. Hereabouts many wild asses occurred, extremely shy, and scenting man from a great distance. They were trapped by the Bisharin Arabs who used their flesh as food."

A pair of semi-wild donkeys with one young were seen in the Qattar area by Floyer (1887) who met with the owner 32 km. further north. These donkeys, wrote Floyer (1887, p. 671), "leapt from rock to rock with the agility of goats." Later he (Floyer, 1893) remarked that wild ass were still found in the area south of a line from Berenice to the Nile.

According to Flower (1932, p. 432), "there appear to be no certain records of genuine wild ass having occurred in Egypt during the nineteenth century." Conflicting reports continued to be published in the 20th century. Barron and Hume (1902) said wild asses were fairly common south of the Qena-Quseir road in the Eastern Desert, but according to Ball (1912), wild asses had disappeared from southeastern Egypt. Bedouins often pointed out "wild donkeys" to Murray (1935), which he assumed were feral. One sight record which he considered authentic was near Gebel Shindeib (Shendib).

The last wild ass of Nubian origin was supposedly shot in 1925 near Gebel Rababa on the Sudan-Eritrea border (Antonius, 1937) and "considered to be extinct in its former range" (Setzer, 1956, p. 569). However, Zeuner (1963) published a photo of a Nubian wild ass captured near Abu Hamad (19° 32′ N lat., 33° 19′ E long.) in northern Sudan. Hoogstraal (1964) received authentic reports of wild asses in the Red Sea area of Kassala Province of Sudan. Negumi (1952) concluded that *E. asinus* was spottily distributed in the Eastern Desert.

After years of uncertainty as to the status of this animal in Egypt, several herds of 2 to 10 wild asses were seen in the spring of 1954 (Hoogstraal et al., 1957ab; Hoogstraal, 1964) on the coastal plains north of Gebel Elba. Talbot (1960) also reported scattered herds in southeastern Egypt and northeastern Sudan. In October 1964, we saw two donkeys in Wadi Sukari which, our guide told us later, were wild asses. In spring of 1967, we inquired about wild asses in the Gebel Elba area and were told by our Bishari guide that they were south of us in Sudan. Apparently, the herds move about over an area of considerable size. In Talbot's (1960, p. 272) opinion,

the present herds may be partly feral "as they are considered property of the local Bedouin."

In 1974, one wild ass was observed by I. Helmy in Wadi Allaqi.

Remains of *E. a. africanus* have recently been reported from Late Paleolithic sites near Kom Ombo (Reed and Turnbull, 1969; Churcher, 1972).

ORDER ARTIODACTYLA

Family 1. Suidae

Genus **Sus** Linnaeus, 1758

Description under species.

Sus scrofa Linnaeus, 1758

Sus scrofa Linnaeus, 1758, Syst. Nat., ed. 10, p. 49.

Type locality.—Germany.

General distribution.—Continental Europe, southwestern U.S.S.R., Turkey; Transcaucasia eastward and northward into Siberia, China, Japan, Vietnam and Malay; parts of Syria, northern Arabian Peninsula, Israel, Jordan, Libya, Tunisia, Algeria, Morocco, Spanish Sahara, and Sudan. Extinct in Egypt.

Common names.—Wild Boar, *Hanzir*.

Previous distribution in Egypt.—Figure 148. Nile Delta, Wadi el Natroun, *El Faiyum, El Maghra (possibly), and probably most of* the Nile Valley in prehistoric and historic times.

Diagnosis.—Large, sturdily built with hump over shoulders. Pelage bristly and shaggy. Color dull brownish black to yellowish gray. Young striped brown and yellow. Ear moderately large, erect, pointed, and densely pilose. Dorsal crest present. Tail relatively short. Lateral digits small, but functional. Muzzle elongate, ending in a flat, disk-shaped, naked pad. Skull narrow, elongate; braincase small; supraoccipital high; paroccipital extremely long. Incisors proodont. Canines tusk-like and continuously growing. Upper canine turning outward, forward, and upward; wearing against lower and producing sharp, flat edges. Molariform teeth brachydont and bunodont, increasing in size and complexity posteriorly. Pm_1 small, transient, and in diastema between canine and pm_2. Dental formula: $\frac{3}{3}\,\frac{1}{1}\,\frac{4}{4}\,\frac{3}{3} \times 2 = 44$.

Historical notes.—The last Egyptian wild boar is supposedly

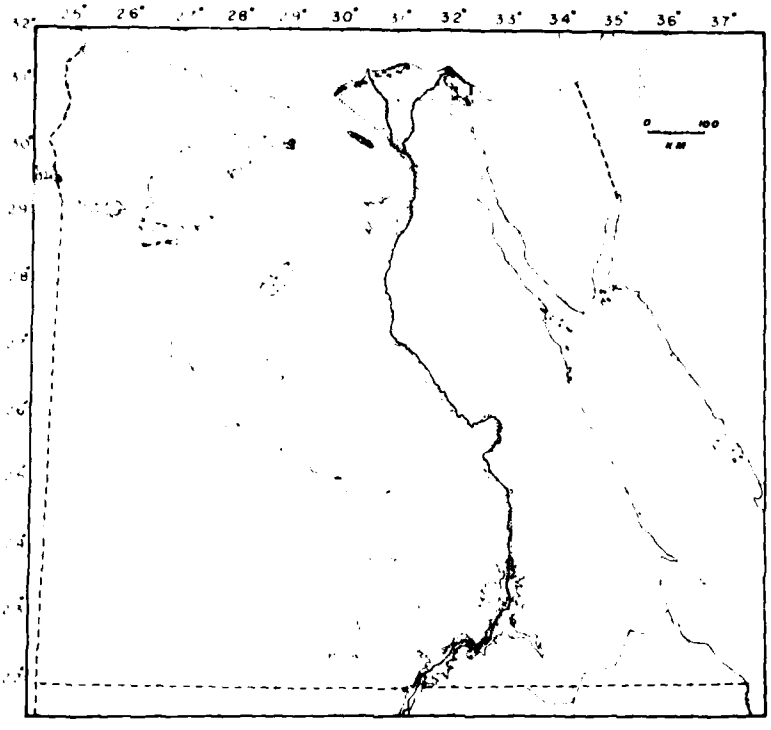


FIG. 148. Previous distribution of *Sus scrofa*.

represented by British Museum specimen No. 2450 which died December 20, 1912, in Giza Zoological Gardens, where it had lived for more than 14, possibly 18, years (Flower, 1931, p. 224). Wild boar became extinct in Egypt about 1900. Strekalovsky (1949) said the last wild boar was shot in Wadi el Natroun in 1894. Russell (1951, p. 19) commented, "when I came to Egypt in 1902 the last wild boar had just been killed in the reed beds and swamps of Wadi Natrun and Moghra oasis." It was common previously in swamps of the Nile Delta, Giza, El Faiyum, and Wadi el Natroun (Anderson, 1902; De Winton, 1903; Flower, 1932). According to the last, Prince Kemal el Din restocked Wadi el Natroun in 1907 with wild boar from Hungary, but they were soon shot by poachers. Negumi (1952) wrote that, 50 to 70 years before, wild boar attacked Bedouin sheep near the Giza swamps. Persistent hunting and burning of habitat exterminated the species.

Butzer and Hansen (1968) listed *Sus* remains from Late Paleolithic deposits in El Faiyum.

Ancient Egyptians reportedly domesticated pigs from Neolithic at least into Dynastic times and later in the 18th Dynasty (Zeuner, 1963). During Roman times, boar hunts in El Faiyum were fairly common (Lindsay, 1965).

Family 2. Hippopotamidae

Genus **Hippopotamus** Linnaeus, 1758

Description under species.

Hippopotamus amphibius Linnaeus, 1758

Hippopotamus amphibius Linnaeus, 1758, Syst. Nat., ed. 10, p. 74.

Type locality.—Egypt: Nile River.

General distribution.—River systems of Africa.

Common names.—Hippopotamus, *Barnik*.

Previous distribution in Egypt.—Figure 149. Nile River, excepting Rosetta branch.

Diagnosis.—Very large, heavily built, and amphibious. Skin almost hairless, except for bristles on muzzle and tail. Mouth enormous; snout broad; nostrils dorsal, widely separated, and protruding. Ears relatively small and erect. Tail short. Legs short and heavy. Feet short, broad, four-toed, with rounded hoofs. Skull massive and extremely broad across the canines.

Incisors and canines tusk-like and continuously growing. Cheek teeth bunodont with trefoil-shaped dentine islands. Dental formula: $\frac{2\text{-}3}{1\text{-}2}, \frac{1}{1}, \frac{4}{4}, \frac{3}{3} \times 2 = 38$ or 42.

Historical notes.—Sporadic occurrences of hippopotamus along the Nile were documented by Flower (1932). He found no indication of it having lived in the Rosetta branch, but gathered evidence from early writers and dredged bones that this beast had lived along the Damietta branch, the papyrus swamps east of there, and the ancient Pelusian branch of the Nile. Kock (1970a) has shown that *H. amphibius* occurred originally in two disjunct areas (fig. 149).

The last two hippos were reportedly killed near Damietta in 1600 (quoted from Buffon's Natural History, 1764, by Anderson, 1902). Sonnini (1807) wrote that the last one killed in Egypt was in 1685. However, Burckhardt (1819, p. 67) reported one killed in 1816 near

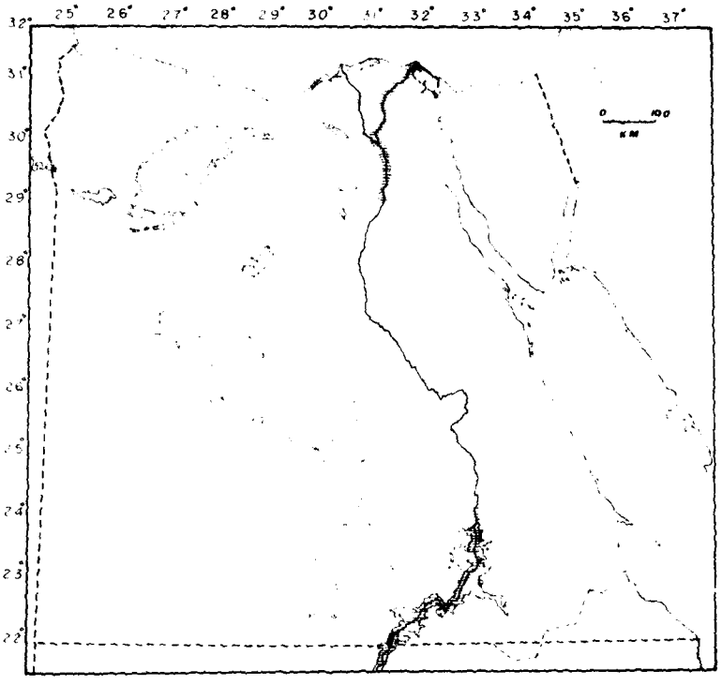


FIG. 149. Previous distribution of *Hippopotamus amphibius*.

Wadi Halfa and a second traveling to Derau (Daraw) 36 km. N of Aswan. Flower (1932) recorded the latter as 1816 or 1818. Butzer (1959) gives 1658 as the date of the last hippopotamus killed in the Delta and 1850 for Upper Egypt. Additional records listed by Kock (1970a) for Egypt are: Damietta (1600, 1815), near Cairo (1580), Abu Girgeh (1658), and Wadi Halfa (1812).

The ancient Egyptians called the hippopotamus "Nile Horse." It damaged their fishing nets and ate their crops and was therefore considered an incarnation of an evil force and was hunted and harpooned. Harpooning of hippos was also a sport of the Ptolemaics (Lindsay, 1965).

Hippo remains from Late Pleistocene middens were found at Kom Ombo (Reed and Turnbull, 1969).

Folklore.—Around the hippo, as with many other large mammals, there has developed a repertory of legends and medicinal properties.

Burned hippopotamus skin mixed with flower of pulse and applied to cancer is supposed to cure it in three days. The gall bladder soaked for 30 days in water then pounded and mixed with honey that has not been over fire is said to cure a black eye in two or three days. Rubbing with a hippopotamus tooth is a "cure" for stomach ache. Burning pieces of skin in the middle of a town is a "protection" from calamities. Application of burned skin is supposed to remove swelling and inflammation. A hippopotamus in a dream "indicates" a lie and an affair that will not be completed (Jayakar, 1908).

Family 3. Bovidae

Small to large ungulates with horns present on both sexes. Legs long relative to body. Feet unguligrade, toes four with hoofs, and lateral digits usually vestigial. Anterior portion of skull elongate, braincase relatively large, postorbital bar present, paroccipital process prominent, but not extending much below level of tympanic bulla

Upper incisors and canines absent. Cheek teeth usually hypsodont. Posterior premolars like molars. Dental formula: $\frac{0}{3}, \frac{0}{1}, \frac{3}{3}, \times 2 = 32$.

Key to Egyptian Genera of Bovidae

1. Horns arising from a frontal pedicel or buttress. Facial and other markings absent. Muffle naked. Skull with large lacrymal or infraorbital fossa. ..... *Alcelaphus*, p. 484.

2. Horns not arising from a pedicel. Muffle haired.
   a. Facial markings present.
      i. Size small, height at shoulder less than 1 m. Tail short, reaching less than one-half way to heel. Horns short, arising above orbits. Skull with large infraorbital or lacrymal fossa. ..... *Gazella*, p. 486.
      ii. Size large, height at shoulder more than 1 m. Tail long, reaching heel. Horns long, arising behind orbits. Infraorbital fossa lacking.
         (a) Horns straight or curved. ..... *Oryx*, p. 480.
         (b) Horns spiralled. ..... *Addax*, p. 482.
   b. Facial markings absent.
      i. Horns scimitar-shaped, curving dorsally and posteriorly, anterior surface broadest with numerous large transverse knobs. Beard present. Black and white leg markings. ..... *Capra*, p. 514.
      ii. Horns not as above, curving dorsally, laterally, and inwardly; transversely

ridged from base to tip. Beard absent. Long hair from sides of jaws to upper forelegs. No leg markings..... *Ammotragus*, p. 521.

Genus **Oryx** Blainville, 1816

Description under species.

Oryx dammah (Cretzschmar, 1826)

Antilope dammah Cretzschmar, 1826, *in* Ruppell, Atlas zu der Reise im nordlichen Afrika von Ruppell, pt.1, Saugeth., p. 22.

Type locality.—Sudan. KORDOFAN: Gebel Haraza.

General distribution.—Desert regions of North Africa from north of Khartoum west to southern Tunisia and as far south as Senegambia.

Common names.—Scimitar Horned Oryx, White Oryx, *Meha*, *Abu Herab*.

Previous distribution in Egypt.—Figure 150. Western Desert until about middle of 19th century (Flower, 1932; Kock, 1970b).

Diagnosis.—Large, pale, long-horned antelope. Pelage yellowish or reddish white; neck, shoulders, dorsal stripe, upper base of tail, and tail tuft brownish; head and muzzle whitish with large grayish or brownish patches on nose and forehead which may or may not connect with stripe through eye from base of ear and horn; ear whitish; legs whitish, forepart brownish; flank stripe faint. Tail tuft long and nearly reaching dew claws. White rump patch absent. Knee tufts absent.

Skull lacking infraorbital fossa. Ethmoidal fissure small. Premaxilla not contacting nasal.

Horns very long, cylindrical, straight or scimitar-like; basal half ridged; postorbital in origin with base on plane of frontals.

Molars large; internal cusps between inner lobes of upper molars and external cusps between outer lobes of lower molars.

Historical notes.—Until the first half of the 19th century, oryx occurred over much of the Western Desert, according to records accumulated by Kock (1970b). Localities where oryx were observed are as follows: Western Desert (1859); Siwa Oasis, Kharga Oasis, and south of El Faiyum (1869); El Faiyum area (1800, 1835); western Giza Governorate and Wadi el Natroun (until 1800). Probably, Schweinfurth's (1874) "l'antilope Dama" of Kharga and Dakhla Oases was, correctly, *Antilope dammah* Cretzschmar, 1826.

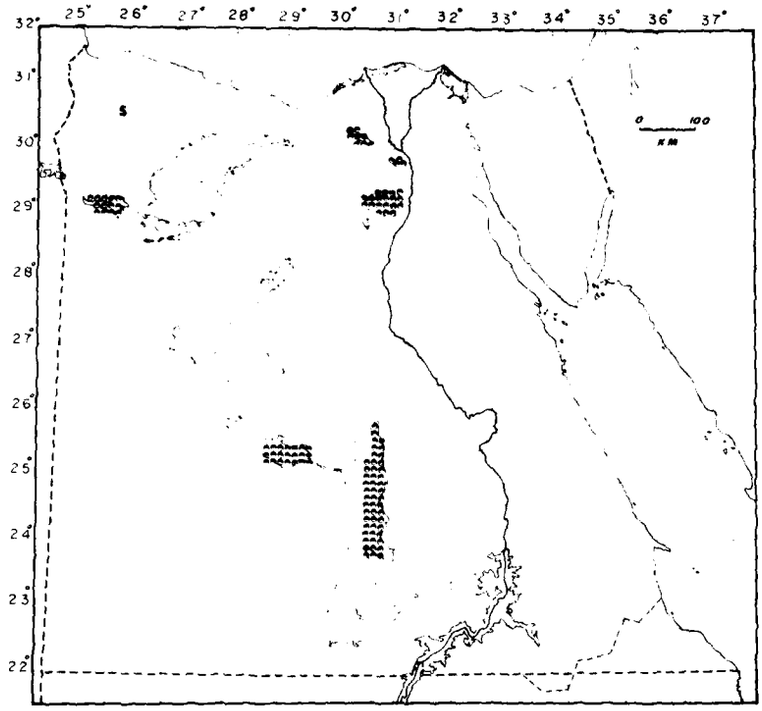


FIG. 150. Previous distribution of *Oryx damah* and recent sight record (S).

The only recent record from Egypt is a single individual seen near the Siwa road, 130 km. S of Mersa Matruh by I. Helmy in 1975.

Prehistoric rock paintings of oryx exist at Gebel Uweinat (Almasy, 1936), indicating the former range included northwestern Sudan, southwestern Egypt, and adjacent parts of Libya (Osborn and Krombein, 1969).

Oryx leucoryx was reported to have existed in northern Sinai and lower Israel until about 1800 (Talbot, 1960).

Ancient Egyptians captured oryxes, kept them in semi-domestication, and sacrificed them for their gods. In Butzer (1959), the oryx is one of the commonest of animals depicted in temples and tombs of dynastic Egypt.

During the reign of Ptolemy II (283 to 246 B.C.), oryx and

hartebeests were among the animals displayed in Alexandria (Jennison, 1937).

Genus **Addax** Rafinesque, 1815

Description under species.

Addax nasomaculatus (Blainville, 1816)

Cerophorus (*Gazella*) or *Antilope nasomaculata* Blainville, 1816, Bull. Sci. Soc. Philo., Paris, p. 75.

Type locality.—Probably Senegambia, West Africa (Ellerman and Morrison-Scott, 1951).

General distribution.—Desert areas from Dongola west of Nile River to Senegal.

Common names.—Addax, *Meha, Akash, Begra el Ouash.*

Previous distribution in Egypt.—Figure 151. Probably ranged over most of the Western Desert.

Diagnosis.—Large pale antelope. Horns long (65 cm. or more), slender, and twisted. Hoofs exceedingly broad and shallow. Shoulder height 97 to 108 cm. Color brownish gray in winter, pale reddish in summer. Head darker than body with white X-like facial patch. Muffle haired. Patches of long hair below eyes and on side of neck. Forehead tuft, dorsal crest, and tail tuft short, blackish. Post-auricular area, hindquarters, tail (except tuft), venter, and legs white. Tail tip reaching below heel. Facial and inguinal glands lacking. Interdigital glands present. Skull without supraorbital pit or infraorbital fossa. Ethmoidal fissure small. Horns postorbital, long, twisted, and with prominent annulations.

Upper molars squarish and with accessory columns on either side.

Historical notes.—Information on previous distribution of the addax in Egypt is very limited. It probably inhabited most of the Western Desert periodically, depending upon availability of grazing.

According to Heuglin (quoted by Sclater and Thomas, 1894-1900), in the mid-1800's, the addax ranged northwards into the Libyan Desert of Egypt to the oases and El Faiyum. "Earlier than the two wars, but within the memory of living man, occasional herds of Addax followed the grazing into Egypt from further west" (Russell, 1951, p. 19). It is now one of the rarest mammals in Libya (Setzer, 1957c), although it had been recorded from hinterlands of Bengazi

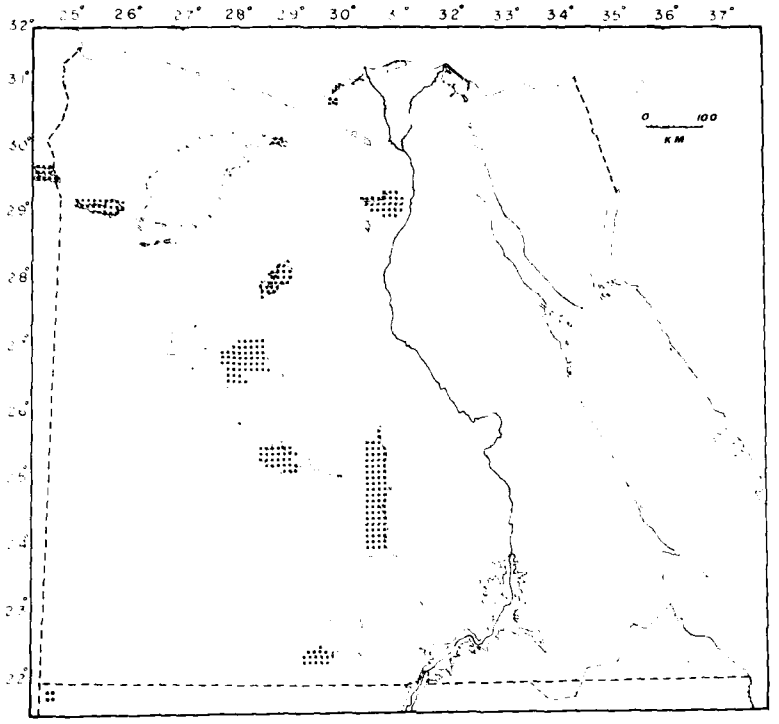


FIG. 151. Previous distribution of *Addax nasomaculatus*.

(de Beaux, 1932), Giarabub, and Cufra (Toschi, 1954) in Cyrenaica. Other localities of observation listed by Kock (1970b) are: Libyan Desert, no exact locality (1855, 1877); Western Mediterranean Coastal Desert, no exact locality (1877); north of El Faiyum (1869); oases of Middle and Upper Egypt (1869); Surarieh south of Beni Suef (1863); and Herwer (Antinoë) (1863). A skeleton, date of death unknown, was found in 1938 in Wadi Aqaba in the southern Gilf el Kebir (Kock, 1970b). An old weathered horn was found at Bir Terfawi in 1972 by Ali Abu Resha, official desert guide, Kharga Oasis (personal communication).

In 1927, Murray (1967, p. 167) was told by a Bedouin that, 30 years before, "four wild cows" (addax antelope) had been seen near Minqar Abu Dweiss in Qattara Depression. Flower (1932) quoted a personal communication from T. W. Russell of the Egyptian police

that the last known specimen of addax was shot by a Bedouin in 1900 in the Mariut District about 65 km. W of Alexandria. In a footnote, Murray (1967, p. 167) wrote: "Abu Fidel killed the last addax in Egypt by running it down with his car near Sheb while on Clayton's 1931 expedition." Negumi (1952) listed two localities: near Bir Dibbis and south of Uweinat. Of the two areas, Uweinat is presently the most likely to be visited by addax grazing northward (Osborn and Krombein, 1969).

This species, like other Egyptian antelopes, was hunted and kept captive by ancient Egyptians. It is depicted in many tombs and temples (Butzer, 1959).

Genus **Alcelaphus** Blaineville, 1816

Description under species.

Alcelaphus buselaphus (Pallas, 1766)

Antilope buselaphus Pallas, 1766, Misc. Zool., p. 7.

Type locality.—Probably Morocco (Lydekker, 1916).

General distribution.—Somalia, Ethiopia, Uganda, Sudan, Chad, Central African Republic, and Cameroons. Previous distribution included Egypt, Libya, Tunisia, Algeria, and Morocco.

Common names.—Bubal Hartebeest, *Begra el Ouash*.

Previous distribution in Egypt.—Figure 152. Oases and oasis-like depressions of Western Desert; Western Mediterranean Coastal Desert.

Diagnosis.—Large reddish, ungainly antelope with abnormally long face. Horns doubly curved. Shoulder height about 110 cm., markedly higher than rump. Color uniformly pale reddish or yellowish with no contrasting markings on head and limbs and rump patch paler than body. Faint blackish areas on forehead, muzzle, shoulder, and thigh. Whitish patch on hip. Muffle bare. Tail reaching heel; tuft thin and brownish. Lacrymal glands prominent. Skull with large infraorbital fossa; ethmoidal fissure and supra orbital pit lacking. Rostrum narrow and elongate. Frontal region abnormally elongate. Premaxillary not contacting nasal. Fronto-parietal suture on lower side of skull.

Horns U-shaped in frontal view, diverging posteriorly in line with face, then rising almost vertically, and bending again sharply posteriorly in the middle. Ridges prominent to second curvature,

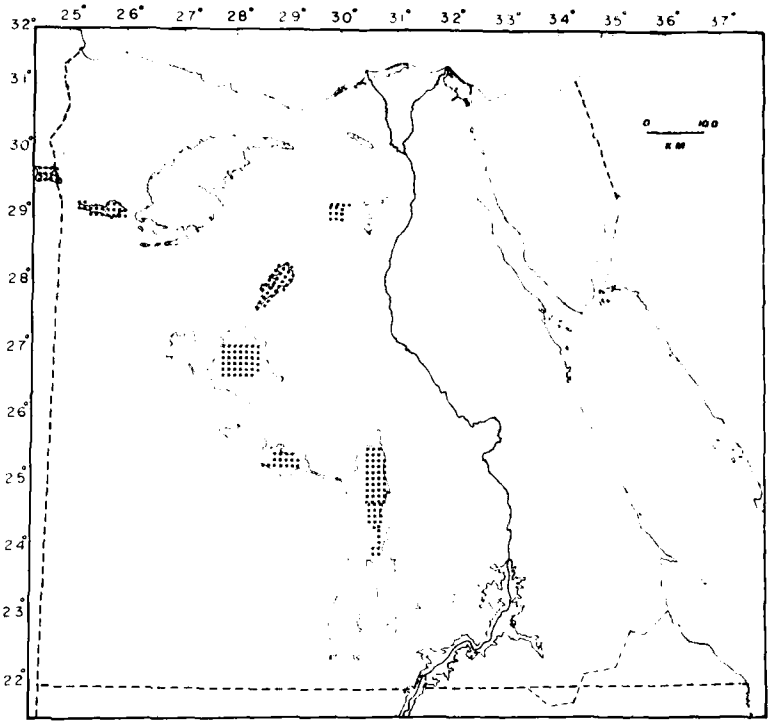


FIG. 152. Previous distribution of *Alcelaphus buselaphus*.

tips smooth. Cores angulated; united at base on a single elevated frontal pedicel which projects posteriorly in line with face and beyond level of the occiput.

Molars hypsodont, upper molars narrow, and inner accessory columns absent.

Historical notes.—The hartebeest is probably the animal of the Western Mediterranean Coastal Desert referred to by Sonnini (1807) who saw herds of 8 to 10, said the Arabs hunted them, and had seen them domesticated by Bedouins of Abu Qir and Alexandria, who had captured them when young. Cailliaud (1826, p. 134) described a ruminant, "baquar ou boeuf sauvage," which was as large as a calf and seen in El Bahrein. Anderson (1902) wrote that Dr. R. C. Mitchell had been told by Bedouins of El Faiyum that hartebeest were to be found two days journey by camel due west of Lake Kurun

(Qarun), a distance of roughly 80 to 100 km. On the basis of descriptions by Siwa residents of an animal "the size of a donkey, of a yellowish brown colour, with two horns like a cow's," Belgrave (1923, p. 202) searched the uninhabited oasis of Gagub (Qeiqab) near Giarabub without finding any trace of the hartebeest. In 1965, a Bedouin in Salum mentioned having seen a "wild cow" about 30 years before in Siwa Oasis. Jennison (1937) assumed that hartebeest must have once been common all along the North African coast because of the traffic in these animals in Roman times. They were among the animals displayed in Alexandria during the reign of Ptolemy II (283 to 246 B.C.).

Indefinite as these reports appear, plus the fact that the name Begra el Ouash (also spelled Begra el Ouach, Bakkar Wahash, and Bekker el Wash or Wahash), meaning wild cow or ox, has been used indiscriminately by Arabs for both *Addax* and *Alcelaphus*, some were certainly of the latter. Within historical time, the hartebeest no doubt existed in vegetated areas of the Western Desert.

There are no specimens from Egypt except mummified remains from El Abadiyah, El Faiyum, and Sakkara (Anderson, 1902; Loret and Gaillard, 1908; Blaine, 1914), and Pleistocene fossil fragments from Kom Ombo and Wadi Halfa, Sudan (Reed and Turnbull, 1969). Tombs and temples of ancient Egypt were adorned with figures of hartebeests (Butzer, 1959).

Genus **Gazella** Blainville, 1816

Small, slender antelopes with horn bases curving dorsally and posteriorly and tips recurving. Color buff to brown with contrasting facial, side, hip, and gluteal markings and a white rump patch. Tail short, blackish, and tufted. Muffle completely haired. Carpal tufts present. Inguinal, interdigital, and lacrimal (facial) glands present.

Braincase expanded, bulla enlarged; infraorbital (lacrimal) fossa and ethmoidal fissure large and prominent. Premaxilla contacting nasal. Horn core supraorbital and extending dorsally from base.

KEY TO EGYPTIAN SPECIES OF *Gazella*

1. Color buffy, facial markings indistinct, lacking blackish hairs. Male horns slightly recurved, spreading apically (fig. 157). Skull with fenestra in infraorbital fossa, posterior nasal margin and interparietal suture round (fig. 156). (Western Desert) ..... *leptoceros*, p. 487.

2. Color brownish, facial markings distinct, with blackish hairs. Male horns slightly to strongly recurved, curving forward and inward apically (fig. 157). Skull lacking fenestra in infraorbital fossa, interparietal suture angular (fig. 156).

a. Horns of adult male long and straight to semi-lyrate. Horns of adult female long and slender. Posterior nasal margin triangular. Parietal ridges present. (Sinai Peninsula, Eastern and Western Deserts)..... *dorcas*, p. 501.

b. Horns of adult male short and semi-lyrate. Horns of adult female short and slender. Posterior nasal margin round. Parietal ridges absent. (Sinai Peninsula) ..... *gazella*, p. 513.

Gazella leptoceros (F. Cuvier, 1842)

Antilope leptoceros F. Cuvier, 1842, *in* E. Geoffroy St. Hilaire and F. Cuvier, Hist. Nat. Mamm., Vol. 4, pt. 72, pls. 424, 425.

Type locality.—Egypt. MATRUH: "Probably desert between Giza and Wadi Natroun, Lower Egypt, as the type specimen was brought to Paris by James Burton *circa* 1833 though in 1842 Cuvier wrote 'Senaar'" (Flower, 1932, p. 438).

General distribution.—Western Desert of Egypt, Libya, Tunisia, Algeria, and probably northwestern Sudan.

Common names.—Slender-Horned Gazelle, White Gazelle, *Reem, Ghazal Abyad.*

Subspecies in Egypt.—

Gazella leptoceros leptoceros (F. Cuvier, 1842)

Type locality.—Given above under species.

Distribution in Egypt.—Figure 153. Northern part of Western Desert south of Mediterranean Coastal Desert vegetation. Possibly in the vicinity of Gebel Uweinat.

Diagnosis.—Pale yellowish to buff with indistinct facial and body markings. Horns in male not lyrate in frontal view; slightly recurved and spreading at tips. Skull with elongate fenestra in infraorbital fossa and posterior margin of nasals round. Interparietal suture outline semicircular.

Height at shoulders in adult male about 63 cm., head and body length average 94 cm., tail length 15 cm., hind foot 30 cm., ear 14 cm., condylobasal length 17.4 cm., weight approximately 15 kg.

External characters.—Pale, yellowish to buffy brown dorsally with pale and dark side stripes, triangular hip patch, and pygal border indistinct. Color of side not extending down outside of legs. Circumoral region, throat, chest, belly, rump, and legs white. Facial markings indistinct, paler than body markings and lacking brownish or reddish hairs. Ear pale buff on outer surface, cream or

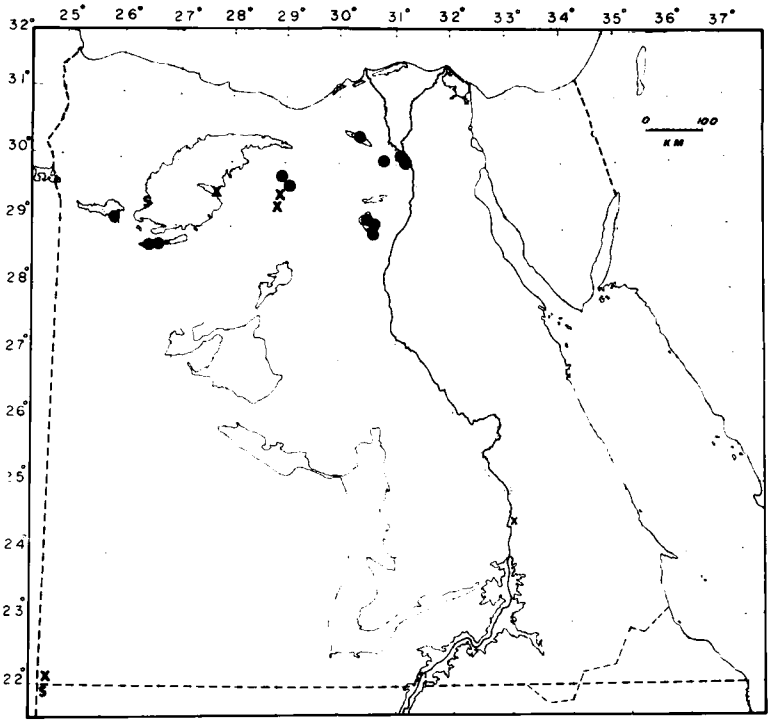


FIG. 153. Collection localities of *Gazella leptoceros leptoceros;* sight records (S); skulls and horns, date of death unknown (X).

whitish on inner surface. Tail, knee tufts and hair between dew claws and hoofs, brownish to blackish.

Hoofs.—Hoofs of specimens from sandy areas are reported to be much longer and more diverging than of those from hard and stony desert (Thomas, 1894b; Sclater and Thomas, 1897-1900) and considered to be an adaptation for easier movement on sand (Loder, 1894; Schomber and Kock, 1960). Thomas (1894a), Bramley (1895), and Hoogstraal (1963) listed longer hoofs as a taxonomic character separating *G. leptoceros* from *G. dorcas.*

In both species of Egyptian gazelles, those living on sand tend to have longer hoofs, probably because of lack of wear as in the case of hoofed mammals in zoos on soft substrates. Hoof measurements of specimens from hard, stony desert together with a few from sandy

TABLE 55. — Hind hoof length (and ranges) in subadult and adult gazelles from hard and sandy desert.

	G. dorcas	*G. leptoceros*
Hard desert:		
Males	40.6 (36-46) 10	50.5 (45-55) 4
Females	43.0 (34-48) 9	42, 44
Sandy desert:		
Males	52, 67	60

desert in Table 55 indicate that hoofs are longer in *leptoceros* than in *dorcas*, but that abnormalities occur in both species when living on sand. Measurements of hind hoofs are given because they are less variable individually than measurements of fore hoofs. Thomas (1894b) gave the hind hoof length of 56 mm. for *G. l. loderi* from sand dunes in Algeria.

Cranial characters.—Figures 154, 155. Skull rather elongate, narrowing posteriorly, without parietal ridges, supraoccipital crest pronounced and extending posteriorly beyond level of occipital condyle. Posterior margin of nasals tapering abruptly (rounded) from a point posterior to the ethmoidal fissure and the beginning of the nasofrontal suture. Interparietal suture semicircular (fig. 156). Infraorbital fossa with elongate fenestra perforating the nasolacrimal canal. One-half of the infraorbital fossa is formed by encroachment of the jugal onto the lacrimal bone. Jugomaxillary suture is angular in outline (fig. 155). Length of premaxillary contact with the nasal, a character stressed by Gentry (1964) in comparing African gazelles, is quite variable, but usually greater than length of the maxillary contact (fig. 155). Auditory bulla with broken ridge on ventral surface. Basioccipital broad, sides parallel, and tuberosities slightly developed. Additional characters are listed in Table 56.

Horns and horn cores.—Male horns are long, slightly recurved, and diverging gradually from the base (fig. 157). The tips curve slightly anteriorly and outwardly. Annulations are conspicuous, close together, and complete, except for distal three or four below the smooth, curving tips. Smooth tips are 25 to 50 per cent of total horn length, depending on age (fig. 157). Female horns are straighter and slenderer, annulations shallower and less conspicuous than in males.

Horn cores are conspicuously pitted and grooved on all surfaces, with intermittent grooves running from base to tip (fig. 154). Like

TABLE 56. — Cranial and horn characters of *Gazella leptoceros*, *G. dorcas*, and *G. gazella*.

Character	*G. leptoceros*	*G. dorcas*	*G. gazella*
Infraorbital fossa	deep, fenestra present	shallow, fenestra absent	
Interparietal suture	round	angular	
Parietal ridges	absent	present	absent
Posterior nasal margin	round	triangular	round
Supraorbital pit	deep, 2 foramina	shallow, 1 foramen	
Ventral surface of bulla	ridged	smooth	

TABLE 56. — *continued.*

Character	*G. leptoceros*	*G. dorcas*	*G. gazella*
Lingual surface of m_2, m_1	prominently ridged	not prominently ridged	
Posterolabial fold of m_2, m_1	present	absent	
Male horns	long, slightly curved, tips spreading	long, slightly to strongly curved, tips not spreading	short, strongly curved, tips not spreading
Female horns	long, slender	long, slender	short, slender
Basioccipital	not constricted	constricted	not constricted
Supraoccipital crest	posterior to level of occipital condyles	anterior to level of occipital condyles	level with occipital condyles

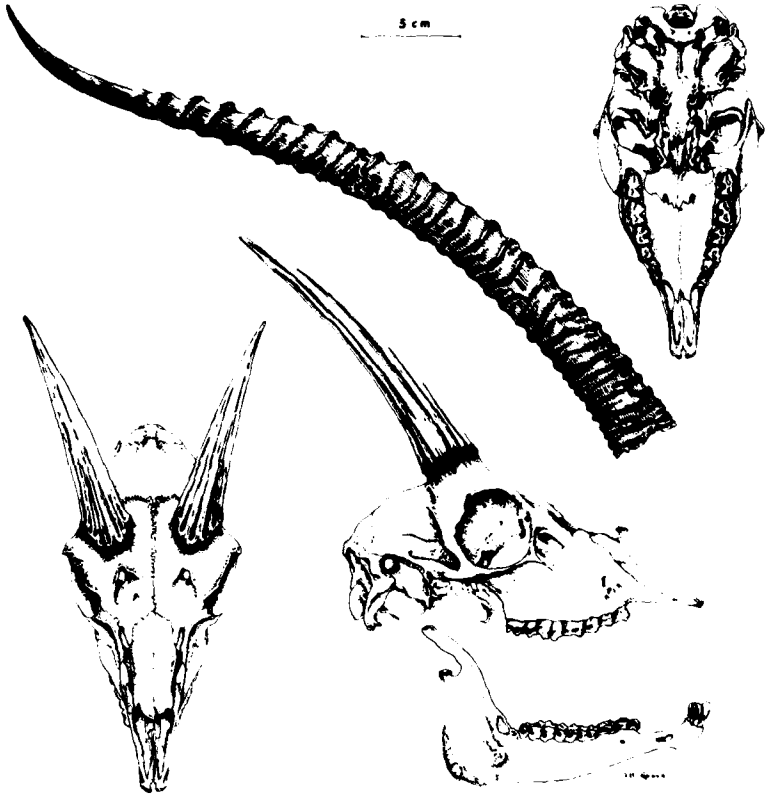


FIG. 154. Skull of *Gazella leptoceros leptoceros*.

the horns, the cores are relatively straight and not diverging. The base of the male horn core is ovoid in cross section and broader anteriorly than posteriorly. The female core is much smaller in diameter and round in cross section (fig. 158).

Teeth.—Figure 156. Lingual ridges are prominent in lower molars (m_2, m_3), particularly in subadults. Large posterior labial folds are also present on these teeth.

Measurements.—Table 57. Lack of female specimens limits knowledge of sexual difference in dimensions in this species.

Age determination.—Specimens are considered adult when all permanent teeth have emerged. Subadults have m^3 emerging.

TABLE 57. — Means (and ranges) of measurements and weight of adult male (M) and female (F) *Gazella dorcas* and *G. leptoceros*.

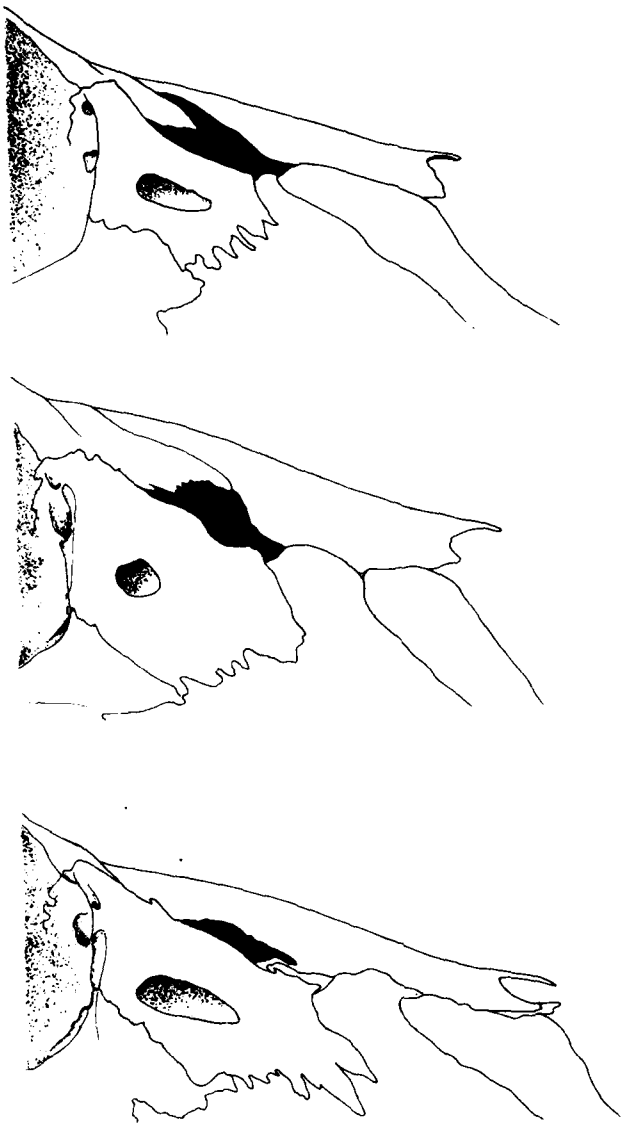
		G. d. dorcas	*G. d. littoralis*	*G. l. leptoceros*
HBL	M	902.0 (871-958) 8	893.2 (860-930) 6	937.0 (885-999) 4
	F	869.3 (830-924) 6	938.1 (909-991) 7	955
TL	M	151.8 (120-180) 8	142.6 (135-157) 6	162.0 (155-166) 4
	F	137.8 (120-179) 6	129.0 (102-145) 7	125
FL	M	309.0 (289-320) 8	320.0 (309-330) 6	320.0 (307-335) 4
	F	291.2 (261-308) 6	308.6 (247-332) 7	300
EL	M	124.8 (120-130) 8	135.3 (129-149) 6	140.0 (132-145) 4
	F	125.0 (120-129) 6	138.1 (130-148) 7	130
Wt (kg.)		15.4 (14.0-18.0) 5		15.0
CBL	M	165.3 (160.5-170.7) 11	171.0 (167.4-176.0) 5	175.1 (171.8-180.4) 3
	F	156.3 (151.0-161.5) 5	165.0 (156.6-171.1) 8	169.3
TRL	M	51.4 (46.5-53.7) 9	54.2 (51.2-58.3) 5	61.8 (57.5-69.7) 4
	F	52.1 (50.1-54.2) 4	52.4 (50.9-54.3) 8	54.8
OW	M	78.2 (75.0-81.9) 11	78.4 (77.0-81.0) 5	82.8 (80.4-86.6) 5
	F	73.7 (70.8-78.2) 6	74.4 (71.9-77.8) 8	80.0
POW	M	51.7 (48.4-54.4) 11	51.2 (49.6-52.9) 5	52.7 (51.5-54.5) 5
	F	50.3 (49.0-52.8) 5	50.6 (48.9-52.6) 8	52.4
BCW	M	54.6 (51.7-57.0) 11	56.3 (55.5-57.1) 4	55.3 (53.2-58.1) 5
	F	54.0 (51.0-55.5) 5	54.9 (53.6-55.3) 8	52.6
NL	M	45.4 (39.0-48.5) 11	42.4 (35.7-45.1) 5	49.2 (46.0-53.5) 5
	F	40.8 (36.5-46.1) 6	44.3 (37.1-47.0) 8	50.7
MW	M	44.6 (42.5-47.3) 9	47.1 (44.1-51.2) 4	49.2 (42.9-51.6) 6
	F	44.9 (44.3-45.3) 3	44.0 (43.0-45.5) 7	48.6
BOW	M	12.9 (11.0-14.5) 9	14.1 (13.7-14.8) 4	17.6 (16.3-19.2) 3
	F	— —	13.4 (12.5-14.5) 7	— —
SH	M	69.6 (66.1-74.7) 11	69.5 (67.2-73.5) 5	71.8 (69.6-75.2) 4
	F	65.2 (62.5-67.5) 6	66.4 (62.3-70.4) 8	69.7
BL	M	26.9 (23.8-29.9) 9	26.0 (23.8-28.8) 4	26.4 (25.4-27.9) 3
	F	— —	24.4 (23.3-25.8) 6	23.9
HCW	M	55.6 (52.3-57.9) 8	68.2 (62.6-73.5) 7	58.8 (57.7-62.2) 4
	F	51.8 (49.2-52.6) 7	50.9 (48.7-53.4) 5	45.9
HL	M	233.1 (215-275) 7		326.6 (294-366) 3

Sexual dimorphism.—Differences between sexes in horns and horn cores were discussed above and shown in Figures 157, 158.

Comparisons.—*Gazella l. leptoceros* is somewhat smaller and darker than *G. l. loderi*. Compared with *G. dorcas*, *G. leptoceros* is considerably paler, but young female specimens cannot always be

G. DORCAS

FIG. 155. Lateral views of anterior part of skulls of *Gazella leptoceros* (opposite) and *G. dorcas* (above) showing variations in lengths of premaxillary and maxillary contacts with nasal bone, differences in position of the jugo-maxillary suture, and the fenestra in the suborbital fossa of *G. leptoceros*.



G. LEPTOCEROS

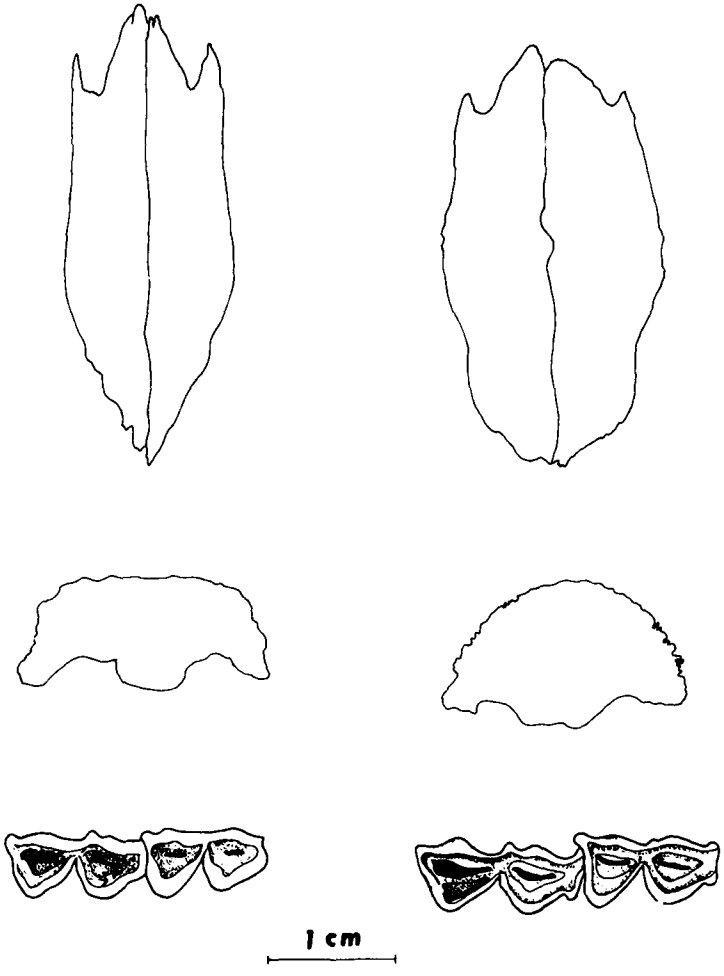


FIG. 156. Nasal bones, interparietals, and lower second and third molars of *Gazella leptoceros* and *G. dorcas*. Anterior ends of nasals and interparietals toward top of figure. Lingual side of teeth upward, anterior to right. Scale refers to molars only.

identified by color alone. Facial markings, however, are consistently paler in *leptoceros*. The two species differ in numerous other ways listed in Table 56 and shown in Figures 154-158, 161. The auditory bulla is less inflated in *leptoceros*. The basioccipital has straight sides compared with the narrower constricted basioccipita[1] of *G. dorcas*. The latter, however, has larger, more prominent tuberosities on the basioccipital for muscle attachment.

A line drawn from the ventral surface of the occipital condyle to the posterior margin of m^3 will not pass through the bulla, except in young individuals of *leptoceros*. Such a line will pass through the bulla in *dorcas*, indicating that basioccipital and basisphenoid meet at a sharper angle in *G. leptoceros* than in *G. dorcas*. Differences in horns and horn cores are illustrated in Figures 157 and 158 and listed in Table 56. Horn cores of male *leptoceros* are conspicuously pitted on all surfaces, with intermittent grooves running from base to tip (fig. 154), whereas in *dorcas*, grooves extend to the tip only on the posterolateral surface. Differences in dentition are most obvious in m_2, m_3. Enamel is thinner, dentine thicker, islets larger, labial surfaces more folded, and posterolateral folds much more pronounced in *G. leptoceros* (fig. 156).

Gazella leptoceros differs externally from *G. gazella* about as from *G. dorcas* in longer, straighter, and outward turning horns; paler coloration; and fainter markings. The posterior nasal margins of *leptoceros* and *gazella* are similar, but interparietal shapes are different, and the latter rarely has a fenestra in the infraorbital fossa (table 56).

Remarks.—The fenestra in the infraorbital fossa is also present in species beyond the boundaries of Egypt — *G. subgutturosa* of southwestern Asia, *G. marica* of Arabia, and occasionally *G. g. arabica*.

Specimens examined.—Skins and/or skulls, 17. (Year of collection follows number of specimens.)

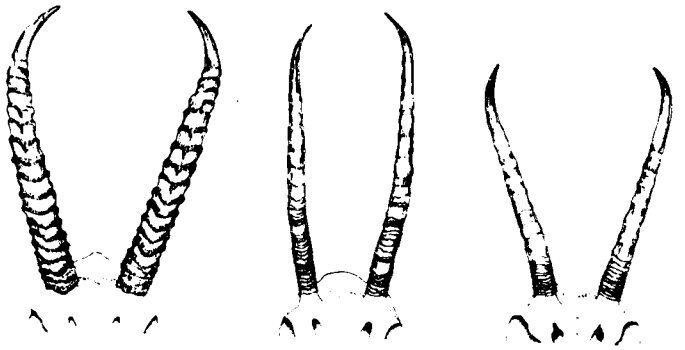
BEHEIRA: Wadi el Natroun (1) 1896.

GIZA: Abu Rawash (1) 1921; Giza, W of (1) 1930.

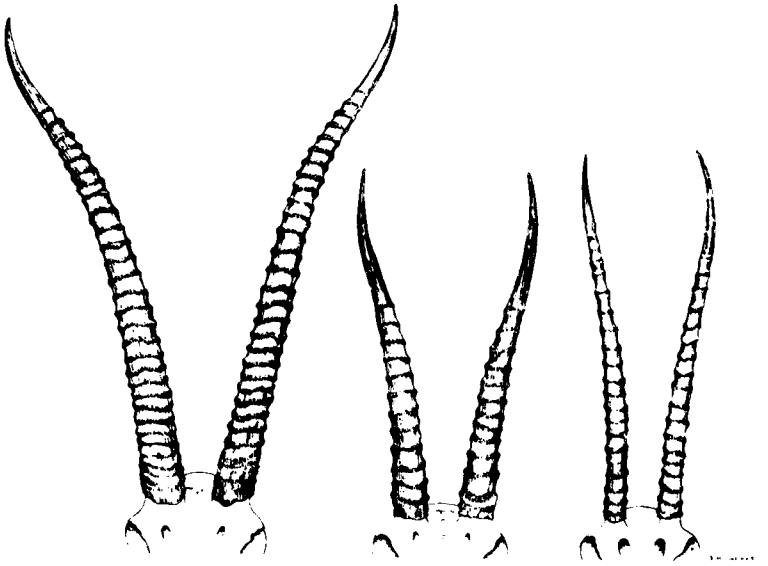
FAIYUM: Wadi Rayan (2) 1951, Wadi Mishigeiga (1) 1966, Wadi Muwellih (3) 1966.

MATRUH: Cairo, 48 to 64 km. W of (1) 1895; El Maghra, 95 km. SSE, between Misaada and El Rammak Dunes (3) 1964; Nuweimisa (2) 1964; Bahrein (1) 1935; desert near Siwa (1) 1935.

Horns or skulls, date of death unknown:



G. DORCAS



G. LEPTOCEROS

FIG. 157. Frontal views of horns of *Gazella dorcas* (left to right: adult male, adult female, and subadult female) and *G. leptoceros* (left to right: adult male, subadult male, and adult female).

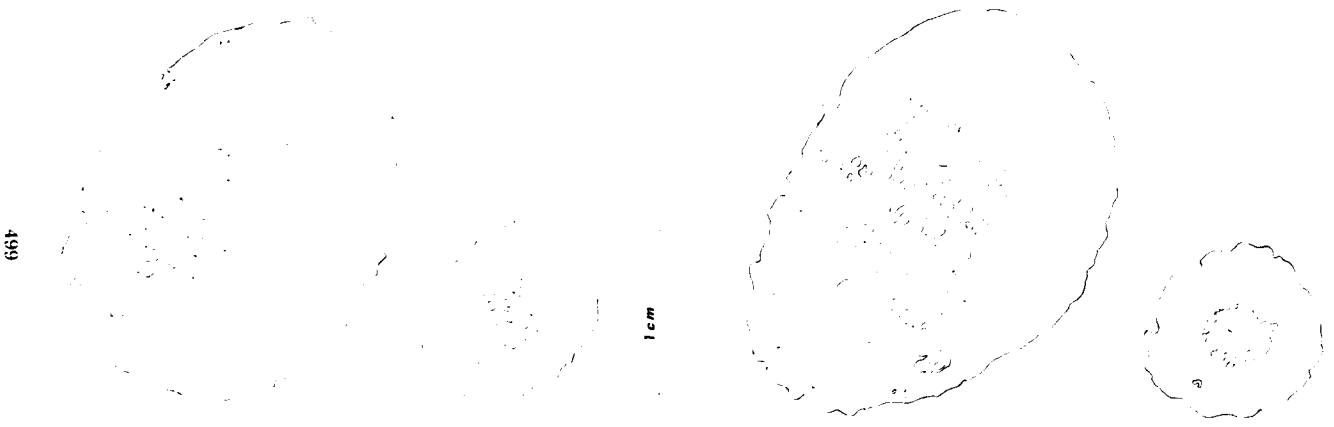


FIG. 158. Cross-sections of bases of left horn cores of adult males (left) and females (right) of *Gazella dorcas* and *G. leptoceros*.

MATRUH: Acacia grove 120 km. S of El Maghra (3), Acacia grove 48 km. SW of south end of Abu Sennan Dune (1); Acacia groves, Qattara Depression (1).

Two "recent" skulls were recorded from north and south of Gebel Uweinat by Missone (1969).

Sight record of I. Helmy.—One large male on limestone plateau between El Naqb el Abyad and El Naqb el Ahmar on Siwa-Qara track about 10 km. E of Qara (May 1965).

Published records.—Records are from Bramley (1895), Anderson (1902), Shaw (1933), and Churcher (1972).

BEHEIRA: Wadi el Natroun.

MATRUH: Cairo 48 to 64 km. W, Western Desert, wadis of Gebel Uweinat in 1932.

ASWAN: Kom Ombo (horn core from Late Paleolithic deposits).

Habitats.—Areas between dunes with scattered *Cornulaca monocantha* shrubs south of El Maghra, depressions with stands of *Acacia raddiana* (fig. 18), and sandy areas bordering oases supporting *Nitraria retusa* (fig. 17) are frequented by this gazelle. One individual has been observed on hard, barren desert between Qara and Siwa. The general opinion on habitat of *G. leptoceros*, from observations in Algeria (Loder, 1894; Thomas, 1894ab; Pease, 1896), Tunisia (Schomber and Kock, 1960), and Egypt (Hoogstraal, 1964) is that it lives almost exclusively in dunes or sandy areas. Bramley (1895) described a hunt for white gazelle 48 to 64 km. W of Cairo on hard desert interspersed with patches of sand supporting permanent and ephemeral vegetation.

Although not strictly a sand gazelle in Egypt, *G. leptoceros* is referred to as "Gazelle des Sables" (Pease, 1896) in Algeria. The fact that it has never been reported from the Mediterranean Coastal Desert, where *G. dorcas* still exists, suggests that it is more of a desert inhabiting species than *G. dorcas*. Both species, however, frequent sandy areas because of the browse plant, *Nitraria retusa* (fig. 17).

Flower's (1932, p. 438) statement that *G. leptoceros* "existed but was not numerous in the desert west of Giza which stretches from the Wadi Natroun southward to the Faiyum," was verified by contemporary collections from the area (fig. 153). There is no evidence however, that *G. leptoceros* now occupies this area.

Behavior.—*Gazella leptoceros* is active during cooler periods of the day and possibly at night. During the hot part of the day,

gazelles lie in the shade of acacia trees or scrape a pit in the sand mound under a shrub to get into the small amount of shade that is cast.

Bramley (1895) observed in Egypt that this gazelle would stand motionless when danger approached. Both species, we have observed, run out of the protection of *Nitraria* bushes in soft sand onto hard desert or out of an acacia grove into barren desert when frightened by an approaching vehicle.

Water.—Nothing is known of the water economy of the white gazelle. We have observed it coming to drink from a spring in Wadi Muwellih.

Food.—*Nitraria retusa* (fig. 17), a shrub of saline sandy areas bordering oases, is a staple food of gazelles in the northern part of the Western Desert and often heavily browsed. Specimens of *G. leptoceros* with stomachs full of spiny *Cornulaca monocantha* (fig. 108) were collected between Misaada and El Rammak Dunes, 95 km. SSE of El Maghra. A flower head of *Launaea capitata* was found in one gazelle from Wadi Muwellih. Tracks and clippings around *Calligonum comosum* in that area (fig. 9) indicated that this plant was also browsed.

Gazella leptoceros probably feeds on acacia and other plants which have been recorded from *G. dorcas* where the ranges of the species overlap.

Desert guides have remarked that the celery-flavored *Pituranthos tortuosus* (fig. 10) is a favorite food of white gazelle. Bramley (1895) was informed that a plant resembling cranesbill (*Geranium* sp. or *Erodium* sp.) was also relished.

Associates.—*Gazella leptoceros* has been found together with *G. dorcas* in Wadi Muwellih and Nuweimisa and flushed from the same acacia groves as the latter, but at different times.

Reproduction.—In Giza Zoological Gardens, the gestation period was five and one-half months, or less than 167 days (Flower, 1932). In Algeria, female *G. leptoceros* often have two young and *G. dorcas* only one (Pease, 1896).

Gazella dorcas (Linnaeus, 1758)

Capra dorcas Linnaeus, 1758, Syst. Nat., ed. 10, p. 69.

Type locality.—"Lower Egypt" (Blaine, 1913, p. 292).

General distribution.—Syria, Palestine, Arabia, Sinai Peninsula,

Egypt, Libya, Tunisia, Algeria, Morocco, Sudan, northern Ethiopia, and Chad.

Common names.—Dorcas Gazelle, *Afri, Ghazal.*

Distribution of subspecies in Egypt.—Figure 160. *Gazella dorcas saudiya:* Sinai Peninsula; *Gazella dorcas littoralis:* Eastern Desert; *Gazella dorcas dorcas:* Western Desert.

Diagnosis.—Brownish red with distinct facial and body markings. Horns in male straight to semilyrate in frontal view. Male horns are either almost straight and slightly spreading with tips not hooked, or strongly curved and semilyrate with tips hooked forward and inward. Fenestra lacking in infraorbital fossa, posterior margin of nasals triangular, interparietal suture outline angular.

Height at shoulder of adult about 55 cm., head and body length average 90 cm., tail length 15 cm., hind foot 30 cm., ear 13 cm., condylobasal length 16.4 cm., weight 15 kg.

External characters.—Reddish brown dorsally with pale side stripe and triangular hip patch distinct, dark side stripe and pygal border about the same shade or darker than dorsum. Color of side extending down outside of legs. Circumoral region grayish. Throat, chest, belly, rump, and inside of legs white to varying shades of buff. Facial markings distinct. Central facial band from base of horns reddish, either becoming paler toward nostrils or with blackish nose spot. Light lateral facial stripe from base of horns to muzzle, whitish. Dark lateral facial stripe from lacrimal gland to mouth, brownish to blackish. Ear grayish on outer surface, buffy on inner surface with pale border. Tail, carpal tufts, and hair between dewclaws and hoofs black.

Hoofs.—Hoofs of specimens from sandy areas tend to be longer than those from hard and stony desert (table 55 and discussion under *G. leptoceros*).

Cranial characters.—Figures 156, 161. Skull broad posteriorly with parietal ridges present in all ages and supraoccipital crest not pronounced nor extending beyond level of occipital condyle. Posterior margin of nasals tapering gradually (angular) beginning at level of ethmoidal fissure and anterior to nasofrontal suture. Interparietal suture outline angular (fig. 156). Infraorbital fossa lacking fenestra. One-third of the infraorbital fossa is formed by encroachment of the jugal onto the lacrimal bone.

Jugomaxillary suture straight or slightly curved (fig. 155).

Length of premaxilla contact with nasal variable, but usually less than length of maxilla contact (fig. 155). Auditory bulla with smooth ventral surface. Basioccipital constricted due to medial swelling of bullae. Tuberosities on basioccipital strongly developed. These and additional characters are listed in Table 56.

Horns and horn cores.—Figures 157, 158. Male horns are of two types. In subspecies *dorcas* and *littoralis*, horns are semilyrate in frontal view with tips curving strongly anteriorly and inwardly, strongly curved backward and forward in lateral view. In *saudiya*, horns are not lyrate, but almost straight and spreading very slightly, with tips slightly curved inwardly in frontal view, and nearly straight in lateral view. Annulations are conspicuous, not as close as in *G. leptoceros*, and complete except for distal 10 to 12 below the short tip. Smooth tips are about 25 per cent of total horn length (fig. 157). Female horns are slenderer and straighter than male, with thin, poorly developed annulations (fig. 157).

Horn cores of males diverge widely from the base in *dorcas* and *littoralis*, and like the horns, are strongly curved (fig. 161). Proximal grooves extend to tips only on the posterolateral surface. Horn cores of females are less diverging and smoother. Base of male horn core in cross section is ovoid and narrower anteriorly than posteriorly. The female horn core is slightly ovoid and much smaller in diameter (fig. 158).

Teeth.—Figure 156. Lingual ridges not prominent on lower molars (m_2, m_3). Posterior labial folds absent. Enamel is thick, dentine thin, and islets small.

Measurements.—Table 57. Males are larger than females, with exception of a few dimensions in *littoralis*. Tail length, although quite variable, averages shorter in females.

Age determination.—Specimens are considered adult when all permanent teeth have emerged.

Sexual dimorphism.—Differences between sexes in horns, horn cores, and measurements are discussed above and illustrated in Figures 157, 158.

Variation.—Coloration varies from pale to dark reddish brown, with dark side stripe the same shade as the back in Western Desert *dorcas*, slightly darker than the back in the Eastern Desert *littoralis*, and paler again in *saudiya* of Sinai and the Arabian Peninsula. The last two usually have a dark or blackish spot on the nose,

and *dorcas* does not. In *saudiya*, the belly is marked with reddish buff, but other subspecies have pure white bellies.

Horns are often blacker in the Eastern Desert form, as discerned by Blaine (1913). Most *littoralis* have a V-shaped postpalatal margin, but in *dorcas*, it is U-shaped.

Ear, foot, and a few other measurements average slightly larger in *littoralis* than in *dorcas* (table 57).

Comparisons.—Comparison with *G. leptoceros* is under that species and in Table 56. *Gazella dorcas* can be distinguished from the more similar *G. gazella* by longer and straighter male horns and longer female horns, posterior margin of the nasals triangular rather than rounded. Where the ranges overlap, *G. dorcas* has reddish buff markings on the belly, and the belly is white in *G. gazella*. Species characters are compared in Table 56.

Habitats.—Eastern Desert: Accessible wadis and canyons of North and South Galala Plateaus, wadis of Red Sea Hills, vegetated beaches on Gulf of Suez and Red Sea coasts, and coastal plains of the southeast. "The proximity of gazelles to the sea coast in the Elba area is in strong contrast to their complete absence from the relatively rich Mediterranean littoral of northern Egypt, where larger human populations and easy accessibility by jeep have driven them miles inland to more barren desert" (Hoogstraal et al., 1957b, p. 61).

Western Desert: Littoral desert inland from the coast, sandy and hard desert, margins of oases, wadis and canyons in cliff and mountain areas.

Behavior.—Activity generally appears to be similar in *G. dorcas* and *G. leptoceros*. The seeking of shade is characteristic of both, and in the Eastern Desert, *G. dorcas* takes advantage of overhanging cliffs.

The alarm note of *dorcas*, according to Flower (1932, p. 440), "...is a single, short bark uttered by one animal. It is an instant signal to the whole herd."

Gazelles are very nervous and wild, but if raised from a young age, they become tame and docile. Gazelles become comparatively tame in oases in summer when they come to drink at the springs (Anderson, 1902). Buxton et al. (1895) and Osborn and Krombein (1969) experienced the habit of *G. dorcas* of keeping in advance of

pursuers in a wadi until it was nearly at an end or became steep and rocky, then turning and attempting to run through its followers.

Water.—Observations made on *G. dorcas* in the vicinity of Khartoum, Sudan, indicate that gazelles must drink, even in winter, and appear to inhabit areas "where some water, fresh or saline, or dew and succulent food are available, even if considerable distances have to be travelled in order to obtain them" (Cloudsley-Thompson and Ghobrial, 1965, p. 1313). Captive gazelles deprived of water were able to survive up to 12 days in winter and five days in summer in Khartoum (Ghobrial and Cloudsley-Thompson, 1966), and withstood a weight loss of 17 to 20 per cent (Ghobrial, 1976). During the dry season in Sudan, dorcas gazelles ate leaves only of *Acacia tortilis*, which contained about 60 per cent moisture, and not ends of twigs or bark. Grasses (*Panicum turgidum*, *Aristida* sp.) and green shrubs (*Capparis decidua*, *Leptadenia pyrotechnica*, *Boscia senegalensis*, and *Cassia senna*) were ignored (Carlisle and Ghobrial, 1968).

The demand for water provoked gazelles to race through Wilkinson's (1832) camp in a narrow wadi in order to drink from a spring further inside the valley. Tracks of gazelles along the banks of the Nile River in Nubia are common, and occasionally, the animals themselves are seen drinking.

In the interior of the Egyptian deserts, gazelle tracks are always present around shallow, saline wells (personal observations of the authors). Meinertzhagen (1954) observed gazelles drinking sea water on an island off the Somalia coast and on the Red Sea Littoral. However, Ghobrial's (1976, p. 490) experimental results showed "that gazelles do not voluntarily ingest sea water to any great extent, even when deprived of fresh water."

Food.—In the Eastern Desert, *Acacia ehrenbergiana* and *A. raddiana* are staple food of *G. dorcas*. Leaves, thorns, and flowers are stripped from accessible branches (fig. 159), and pods are eaten green or dry. The one-and-a-half-inch long thorns have been found in stomach contents. *Nitraria retusa* (fig. 17) is also browsed along the Gulf of Suez and northern part of the Red Sea coast.

Additional plant species which have been found in the stomachs of gazelles are: pieces of the midrib of a date palm leaf (*Phoenix dactylifera*) and flower head of *Cuscuta* sp. near Bir Abbad; leaflets of *Psoralea plicata*, Wadi Allaqi 11 km. inland from Allaqi Village;

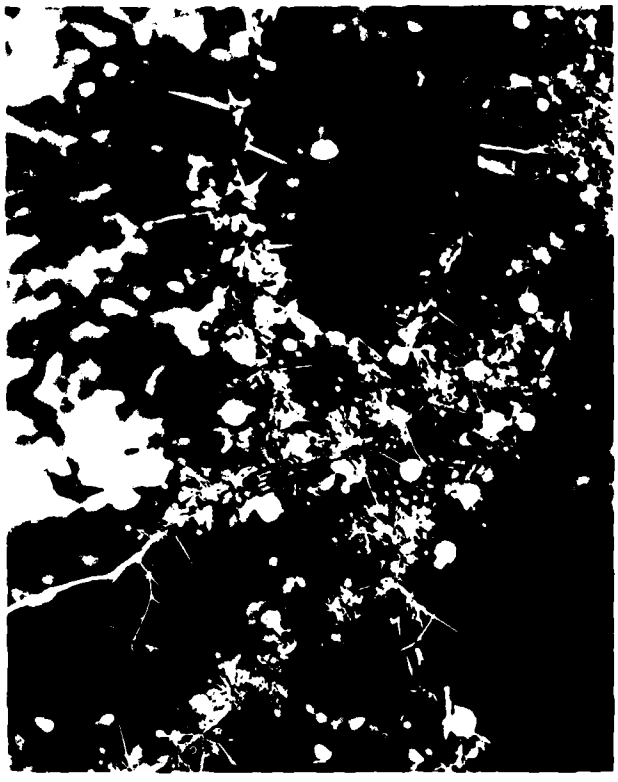


FIG. 159. *Acacia ehrenbergiana* browsed by *Gazella dorcas*. Twigs are stripped of leaves, flowers, bark, and thorns.

pods of *Astragulus vogelii*, Wadi Umm Karayiet and Wadi Allaqi junction; leaf fragments of *P. plicata* and possibly *Cleome* sp., Wadi Ibib; leaves of *P. plicata* and fruits of *Crotalaria* sp., Wadi Eteigan; leaves, flowers, and fruits of *Hippocrepis constricta*, pods of *Crotalaria aegyptiaca* (?), fruits of *Euphorbia granulata*, pods of *Lotus glinoides*, and leaf fragments of *Aizoon canariense* in Wadi Yoider, near Gebel Nesla.

In the northern sector of the Western Desert, *Nitraria retusa*, mentioned under *G. leptoceros* (fig. 17), is also a staple food of *G. dorcas*. Pods of *Acacia raddiana* were found in a specimen from Tahl el Fawakhir near Qara, and doubtlessly *Acacia* sp. are eaten whenever available. Fragments of *Moltkiopsis ciliata*, *Anabasis*

articulata, and *Suaeda* sp. were found in a gazelle from the vicinity of Qaret el Mashruka. Various plants mentioned under *G. leptoceros* are probably eaten by *G. dorcas* and vice versa.

In wadis of Gebel Uweinat, browse plants are: *Crotalaria thebaica*, *Argyrolobium saharae*, *Trichodesma africanum*, *Farsettia ramosissima*, and bitter green fruits of *Citrullus colocynthis* (=*Colocynthis vulgaris*) (Osborn and Krombein, 1969). Continuous browsing of gazelles and periodic cropping by camels prevent some species such as *Convolvulus lanatus* and *Astragulus spinosus* from becoming more than a small, dense cushion (fig. 12). We observed that gazelle browse camel thorn, *Alhagi mannifera* (=*A. maurorum*) in vicinities of Bahariya, Dakhla, and Kharga Oases. Careful examination of a gazelle feeding area, an association of *A. mannifera* and *Imperata cylindrica*, revealed no evidence that the grass was eaten by gazelles. Anderson (1902) wrote that gazelles occasionally fed at night on crops in the oases.

Reproduction.—The gestation period of five and a half months is the same for *G. dorcas* as *G. leptoceros*. Single embryos, fetuses, and newly born young taken from seven females in December, March, and April indicate that one young is usual in *G. dorcas*.

Associates.—*Gazella dorcas* is found together with *G. leptoceros*, as mentioned under the latter, and occasionally with camel herds in the Mediterranean Coastal Desert. In Tunisia, it apparently joins herds of camels to play with them (Schomber and Kock, 1960).

Predators.—Jackal, wild cats, and cheetah are presumably natural predators of gazelle. The most efficient predator is man, with snares and wheel traps (Anderson, 1902), guns, and automobiles. Flower (1932) mentioned the decrease of gazelles due to man in the previous 40 years.

Wanton slaughter of gazelles under the guise of "sport" so that a car may be draped with dead bodies for a photograph, together with the traditional belief that "there are always plenty of gazelles," is rapidly reducing these animals to extinction.

Remarks.—Remains of *G. dorcas* found in Late Paleolithic sites near Kom Ombo have been reported by Reed and Turnbull (1969) and Churcher (1972).

KEY TO EGYPTIAN SUBSPECIES OF *Gazella dorcas*

1. Horns of male spreading from base, curved, tips hooked. Venter white.
   a. Dark side stripe usually darker than back. Black nose spot present. (Eastern Desert)..... *littoralis*, p. 508.

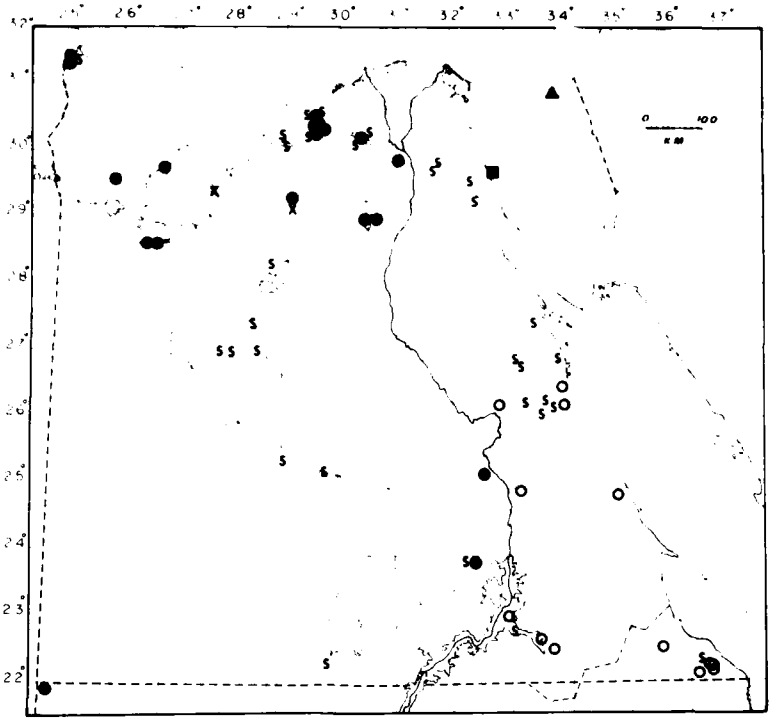


FIG. 160. Collection localities of *Gazella dorcas dorcas* (dots), *G. d. littoralis* (circles), *G. d. saudiya* (square), and *G. gazella arabica* (triangle); sight records (S); and skulls and horns, date of death unknown (X).

b. Dark side stripe usually paler than back. Black nose spot absent. (Western Desert)..... *dorcas*, p. 509.

2. Horns of male not spreading from base, almost straight, tips not hooked. Dark side stripe usually paler than back. Black nose spot variable. Venter marked with reddish buff. (Sinai Peninsula)..... *saudiya*, p. 512.

Gazella dorcas littoralis (Blaine, 1913)

Gazella littoralis Blaine, 1913, Ann. Mag. Nat. Hist., (ser. 18), 11, p. 295.

Type locality.—Sudan: Khor Asot, Nubian Desert.

Distribution in Egypt.—Figure 160. Eastern Desert.

External characters.—Reddish brown, with dark side stripe darker than back. Blackish nose spot usually present. Belly and underparts white.

Cranial characters.—Figure 161. See species description. Postpalatal margin usually V-shaped.

Horns.—Figure 157. See species description. Horns generally blacker than in other subspecies. Length and shape about as in *G. d. dorcas*, but shorter and more curved than in *G. d. saudiya*. Comparison is given under the latter subspecies.

Measurements.—Table 57. *Gazella d. littoralis* averages slightly larger in most dimensions, particularly ear length and horn core width, than *G. d. dorcas*. From data given by Groves and Harrison (1967) and Harrison (1968), *littoralis* is generally larger than *saudiya*. Some discussion of measurements is given under the latter subspecies.

Specimens examined.—Skins and/or skulls, 22. (Year of collection follows the number of specimens.)

RED SEA: Wadi Umm Huweitat (1) 1965, Wadi Saqi (1) 1966, Wadi Sukari (1) 1965, Bir Abbad (1) 1964, Wadi Umm Had (1) 1975.

QENA: Wadi Qena mouth (2) 1966.

SUDAN ADMINISTRATIVE: Wadi Ibib (1) 1967, Wadi Yoider near Gebel Nesla (2) 1967, Wadi Eteigan (1) 1967; Wadi Abeib 3.6 km. N of Bir Kansisrob (3) 1954, 6.4 km. N of Bir Kansisrob (3) 1954.

ASWAN: Wadi Allaqi 11.2 km. SE of Allaqi Village (2) 1966, Wadi Umm Karayiet-Wadi Allaqi junction (1) 1966, Bir Murra (2) 1966.

Sight records.—Personal observations of I. Helmy and D. Osborn.

SUEZ: Wadi el Gindali (small herd) and Wadi Iseili (2-3) 1964, Wadi el Ghuweibba (1) 1966, Wadi Abu Seyala (5) 1961.

RED SEA: Wadi Mellaha (1) 1965, Wadi Atrash (1) 1965, Wadi Fatira el Zarka (1) 1965, Wadi Abu Sheeh (4) 1969, Wadi Semna (10) 1966, Wadi Atallah (1) 1969, Dissht el Daba (1) 1965, Wadi Abu Ziran (1) 1966, Wadi Umm Had (1) 1975.

ASWAN: Allaqi Village 20 km. S (1) 1966.

SUDAN ADMINISTRATIVE: Wadi Eteigan (2) and Wadi Diib (small herds) 1967.

Published records.—Records are from Hoogstraal et al. (1957b).

SUDAN ADMINISTRATIVE: Wadi Adeib, 3.6 km. N of Bir Kansisrob, 6.4 km. N of Bir Kansisrob, and coastal plain near Gebel Elba (herds of 2 to 20) 1954.

Gazella dorcas dorcas (Linnaeus, 1758)

Type locality.—Lower Egypt.

Distribution in Egypt.—Figure 160. Western Desert.

External characters.—Pale reddish brown, dark side stripe usual-

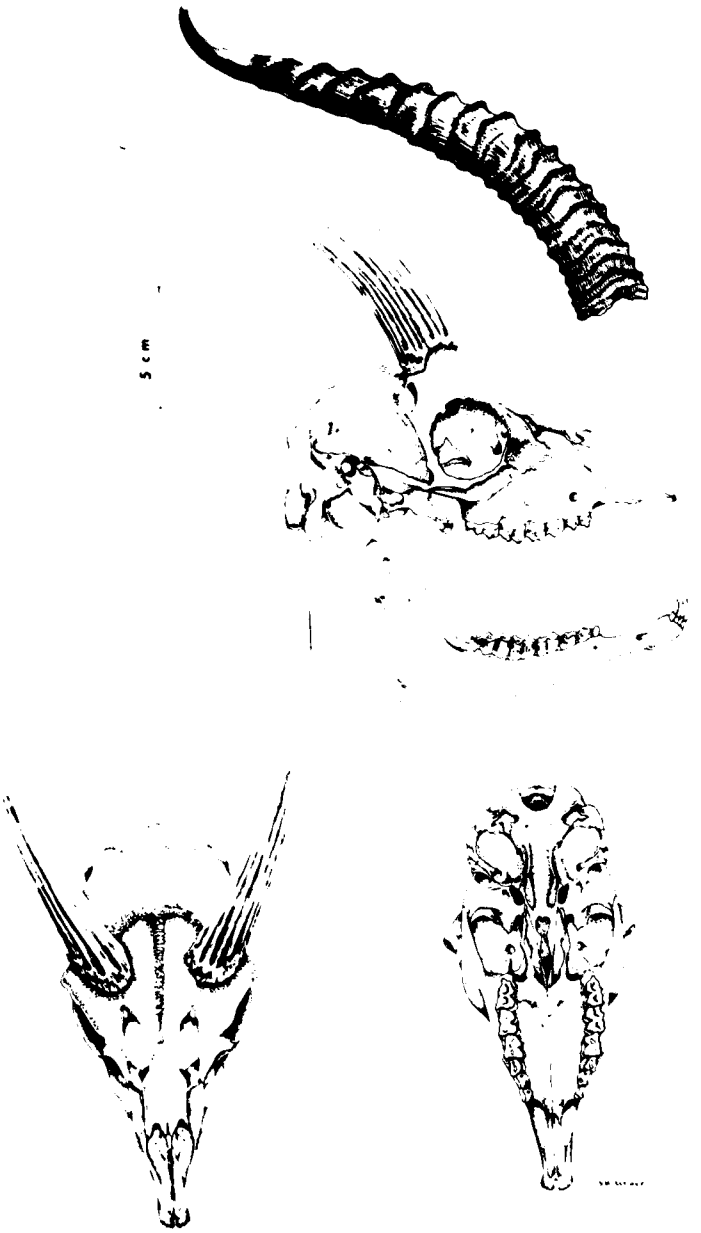


FIG. 161. Skull of *Gazella dorcas*.

ly slightly paler than back. Blackish nose spot absent. Belly and underparts white.

Cranial characters.—Figure 161. See species description. Post-palatal margin usually U-shaped.

Horns.—Figure 157. Similar in outline to *G. d. littoralis.*

Measurements.—Table 57. *Gazella d. dorcas* averages slightly smaller in most dimensions, particularly ear length and horn core width, than *G. d. littoralis.* Further comparisons are under the species and *G. d. saudiya.*

Specimens examined.—Skins, skulls, and horns, 40. (Year of collection follows number of specimens.)

FAIYUM: Wadi Rayan (2) 1950, (1) 1951; Wadi Mishigeiga (1) 1966.

QENA: Isna, Wadi Nassim (3) 1953.

ASWAN: Kurkur Oasis (3) 1963.

BEHEIRA: Wadi el Natroun (2) 1923.

MATRUH: Qasr el Qatagi (2) 1962, (1) 1965; Nakhlet el Barraq (1) 1962, (1) 1963; Qaret el Mashruka (2) 1962; El Fureinat (2) 1974; El Maghra E of (1), 20 km. E of (1) 1974; Acacia grove 120 km. S of El Maghra (1) 1965 and horns (date of death unknown); Raqabet el Rala (1) 1964; Wadi Umm Shedak (1) 1962; Qara, Tahl el Fawakhir (1) 1965; Bahrein (1) 1964; Nuweimisa (2) 1964; Siwa Oasis 10 km. N (1) 1974, 48 km. N (1) 1951; Salum 24 km. SW (2) 1953; Bir Sidi Omar (1) 1964; Acacia groves, Qattara Depression (two cadavers, date of death unknown).

Sudan. NORTHERN: Gebel Uweinat, Karkur Murr 12 km. W (2) 1967.

Sight records.—Personal observations of I. Helmy and D. Osborn.

GIZA: Bahariya Oasis N of (2) 1966.

BEHEIRA: Bir Victoria (2) 1969.

MATRUH: Wadi el Farigh (2) 1969; Abu Mena 10 km. E (2-3) 1963; El Afritat (2) 1964, 1970; Wadi Labaq (1) 1966; Halfaya (small herd) 1965; Qur el Hilab (10) 1965; El Maghra (small herd) 1958, 1960, 1963, 1965, 1967, none seen in 1977; Bir Mikheimin (1), Hatiyet Labbaq (one seen and tracks of several), Samaket Gaballa (2), acacia groves in Qattara Depression (tracks of a few individuals) 1977.

EL WADI EL GEDEED: Farafara Oasis, Hatiyet el Sheikh Marzuk (1), Karawein (4-5), El Gau (1), Wadi Hennis (2) 1969; Dakhla Oasis, Mut (1) 1969; Dakhla Oasis 60 km. E (small herd) 1966; Bir el Shab (1) 1967.

ASWAN: Kurkur Oasis (2) 1962.

Published records.—Records are from Hoogstraal (1964).

MATRUH: Siwa 48 km. N.

GIZA: Giza pyramids a few miles W of.

FAIYUM: Wadi Rayan.

QENA: Wadi Nassim.

Gazella dorcas saudiya (Carruthers and Schwarz, 1935)

Gazella gazella saudiya Carruthers and Schwarz, 1935, Proc. Zool. Soc., London, 1935, p. 155.

Type locality.—Saudi Arabia: Dhalm 240 km. NE of Mecca.

Distribution in Egypt.—Figure 160. Sinai Peninsula.

External characters.—Pale reddish brown, dark side stripe usually paler than back as in *G. d. dorcas*. Blackish nose spot variable. Differs from other subspecies in not having the belly pure white, but variably marked with reddish buff, especially below the side stripe (after Harrison, 1968).

Cranial characters.—Differs from other *G. dorcas* subspecies in having a generally longer nasopremaxilla contact (Harrison, 1968, p. 357).

Horns.—Horns, in contrast with other subspecies of *G. dorcas*, are longer, straighter, and not spreading. Harrison's (1968) measurements of horn length, in straight line from anterior base to tip, of adult males from Arabia range from 244.5 to 304 mm. Measurements taken on the front curve of *G. dorcas* from Egypt (table 56) range from 215 to 275 mm., which would be considerably less if taken in a straight line.

Measurements.—Ear length, according to Groves and Harrison (1967), is very long in *G. d. saudiya*, but they were comparing the shorter-eared *G. gazella arabica*. No external measurements are available from *saudiya*.

Cranial measurements from Arabian specimens given by Groves and Harrison (1967) and Harrison (1968), when compared with those in Table 57, indicate that *littoralis* is slightly larger than *saudiya*. Horn core width is considerably less in *G. d. saudiya* from Arabia than in Egyptian subspecies (table 57). The above authors list a mean horn core width of 37.6 ± 1.8 mm. and maximum of less than 60 mm., respectively, for *saudiya*.

Remarks.—No specimens are available from Sinai Peninsula, and there are no examples of intergradation between the subspecies *littoralis* and *saudiya*.

Sclater and Thomas (1894-1900) assumed *G. arabica* reported by Hemprich and Ehrenberg (1833) on the Sinai coast between Suez and Tor to be *G. dorcas*.

Specimens examined.—Total three.

Saudi Arabia: Dhalm (3).

Published records.—Record is from Anderson (1902).

SINAI: Ayun Musa.

Gazella gazella (Pallas, 1766)

Antilope gazella Pallas, 1766, Misc. Zool., p. 7.

Type locality.—Syria.

General distribution.—Syria, Palestine, Arabian Peninsula, Sinai Peninsula.

Common names.—Mountain Gazelle, Arabian Gazella, *Idmi.*

Subspecies in Egypt.—

Gazella gazella arabica (Lichtenstein, 1827)

Antilope arabica Lichtenstein, 1827, Darstellung Saugeth., pl. 6.

Type locality.—Saudi Arabia: Farsan Island, eastern Red Sea coast.

Distribution in Egypt.—Figure 160. Northeastern part of Sinai Peninsula.

Diagnosis.—Pale reddish brown with distinct facial markings and a dusky nose spot. Body markings variable. Horns short and strongly curved. Fenestra usually lacking in infraorbital fossa. Posterior margin of nasals round, interparietal suture angular.

Height at shoulder in adult male about 58 cm., condylobasal length about 18 cm.

External characters.—Pale reddish brown dorsally with distinct gazelline markings. Dark side stripe grayish black. Belly and underparts white. Very similar to *G. d. dorcas.*

Cranial characters.—Braincase expanded posteriorly. Parietal ridges absent. Supraoccipital crest about level with posterior margin of occipital condyle. Posterior margin of nasals round, interparietal suture angular. Infraorbital fossa lacking fenestra, with few exceptions. Premaxilla usually not in contact with nasal. Auditory bulla more swollen than in *G. dorcas* (Gentry, 1964).

Horns.—Male horns are shorter than in other gazelles, spreading from the base, strongly recurved, with tips turning forward and inward. Female horns are straighter, slenderer, and markedly

shorter than in the male of the species or females of other species (Harrison, 1968). Straight line measurements of male horns from Harrison range from 150 to 254 mm. and from Morrison-Scott (1939), 205 to 256 mm.

Teeth.—Similar to *G. dorcas* in Figure 156.

Measurements.—Means (and ranges) of measurements (in millimeters) of males listed by Harrison (1968) that are comparable with those in Table 57 are: Condylobasal length 183.1 (174.4 to 191.0) 8, braincase width 54.6 (52.3 to 56.8) 11, postorbital width 52.3 (49.1 to 55.8) 11, and upper tooth row length 57.0 (54.0 to 60.0) 11. These data indicate that *G. gazella* is larger than *G. dorcas*. Ear lengths of 109, 119, and 120 mm. given by Harrison are shorter than measurements of *G. dorcas* in Table 57. Horn core width of adult males from Groves and Harrison (1967) is 64.5 ± 2.3 mm. and from Morrison-Scott (1939), 65.9 mm. (60.2 to 69.0) 15, somewhat less than *G. d. littoralis* of the Eastern Desert.

Comparisons.—According to Harrison (1968), *G. gazella* is larger and longer limbed than *G. dorcas* and has much shorter ears. The two species are similar in color and have comparable variations. *Gazella gazella* can be distinguished from *G. dorcas* and *G. leptoceros* by its shorter horns in both sexes, shorter ears, and cranial combination of round posterior nasal margin, angular interparietal, and shortness of or absence of premaxillary-nasal contact. Various characters of gazelles are compared in Table 56.

Specimens examined.—Four from Saudi Arabia.

Published records.—Said to have been seen in Sinai, including Wadi el Arish (Flower, 1932, p. 438).

Habitats.—Coastal plains, foothills, and mountains of the Arabian Peninsula; absent from interior steppe and desert (Harrison, 1968).

Genus **Capra** Linnaeus, 1758

Large, goat-like bovid with scimitar-shaped horns curving dorsally and posteriorly. Male horn with large, anterior knobs. Color brownish, leg markings black and white. Muffle completely haired. Beard present in male. Tail shorter than ear. Interdigital glands present on forefoot, subcaudal glands present in male. Lacrimal and inguinal glands absent.

Braincase not expanded. Orbital region noticeably broad. Fron-

tonasal region concave. Infraorbital fossa lacking, ethmoidal fissure small. Premaxilla contacting nasal. Horn core supraorbital and extending dorsally from base.

Capra ibex Linnaeus, 1758

Capra ibex Linnaeus, 1758, Syst. Nat., ed. 10, p. 68.

Type locality.—Valais, Switzerland.

General distribution.—Mountains of southern and eastern Europe, Transcaucasia, Russian and Chinese Turkestan, Mongolia, Afghanistan, India, Saudi Arabia, Syria, Israel, Egypt, Sudan, Ethiopia.

Common names.—Ibex, *Taytal, Beden.*

Subspecies in Egypt.—

Capra ibex nubiana (F. Cuvier, 1825)

Capra nubiana F. Cuvier, 1825, *in* I. Geoffroy St. Hilaire and F. Cuvier, Hist. Nat. Mamm., Vol. 3, pt. 50, pl. 397, p. 2.

Type locality.—Egypt. Nubia or Upper Egypt.

Distribution in Egypt.—Figure 162. Sinai Peninsula and Eastern Desert.

Diagnosis.—Upper parts brownish with contrasting black spinal crest and black and white leg markings. Beard present in male. Tail shorter than ear. Male horn long, scimitar-shaped, anterior surface knobbed. Skull broad at orbits, nasofrontal region concave. Shoulder height 84 to 87 cm.

External characters.—General color brownish grizzled with whitish. Muzzle, chin, beard, chest, spinal crest, flank, side of tail, and front part of legs (except knees and pasterns) black. Belly, inner side of thigh, inner and back side of legs, knees, and a band above each hoof, whitish. Faint mark between eye and mouth. Outer side of ear brownish, inner blackish with white border. Muffle completely haired.

Cranial characters.—Figure 163. Orbital region broad, prominent. Frontonasal contour concave. Braincase constricted laterally. Occipital condyle protrudes well beyond level of supraoccipital in adults. Frontoparietal suture almost straight. Interparietal suture curved. Premaxillary long, contacting nasal. Nasofrontal suture posterior to anterior margin of orbit. Infraorbital fossa lacking,

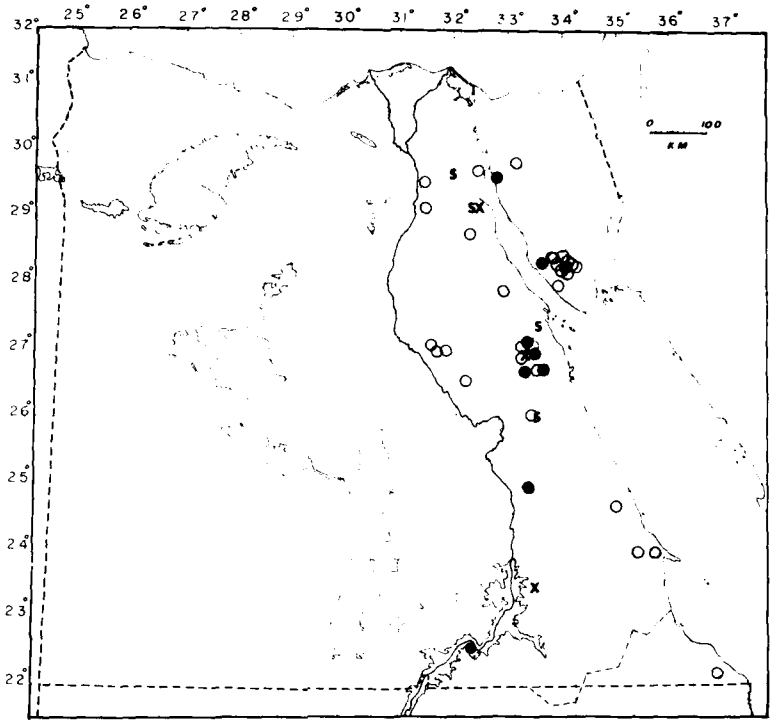


FIG. 162. Collection localities of *Capra ibex nubiana*, undated and prior to 1932 (circles) and 1948 to date (dots); horns or skulls, date of death unknown (X); and sight records (S).

ethmoidal fissure small. Postpalatal margin has a narrow V-shaped cleft and apex of cleft reaches level of m^2.

Horns and horn cores.—Figure 163. Horns present in both sexes; smaller and relatively smooth in female. Male horn scimitar-shaped; curving dorsally and posteriorly, medially at tip; reaching outside curve length of 1 m. or more; flattened laterally, anterior surface broadest and with large, regularly arranged transverse knobs almost to tip. Pronounced keel between knobs from base to tip. Base of horn supraorbital in position. Core grooved and pitted on all surfaces from base to tip. Cross-section ovoid, broadest anteriorly. Basal part hollow, without trabeculae.

Teeth.—Figure 163. Upper cheek teeth, except pm^1 with well

FIG. 163. Skull of *Capra ibex nubiana*.

developed labial ridges. M^3 without posterior accessory lingual ridge.

Measurements.—Table 58.

Sexual dimorphism.—Males are larger than females. Male horns in comparison with female are much longer, heavier, and have knobs on the anterior surface. Males and very old females have beards.

Variation.—Knobs on horns are reported to be narrower and less regular in Sinai than in Eastern Desert specimens (Lydekker, 1916).

Comparisons.—*Capra i. nubiana*, in comparison with the Abyssinian ibex, (*C. i. walie*), is smaller, paler, has a slightly longer beard, and longer and less massive horns (Dorst, 1970).

Specimens examined.—Skins and skulls, four. (Year of collection follows number of specimens.)

TABLE 58. — Measurements of two specimens of *Capra ibex nubiana*.

	Immature Male	Adult Female
HBL	999	— —
TL	82	— —
FL	250	— —
EL	114	— —
CBL	197	208
OW	109.8	108.6
BCW	68.9	68.1
NL	70.3	73.6
TRL	62.7	65.0
HL	630	320

SINAI: Gebel el Rabbah (2) 1905.

RED SEA: Wadi Gozah (immature skin) 1964, Wadi Rawd Ayiad (1) 1965.

Horns or skulls, date of death unknown:

SUEZ: Wadi Qiseib (3).

RED SEA: Gebel Abu Harba (1).

ASWAN: Bir Umm Hibal (1).

Sight records of D. Osborn and I. Helmy.—Bir Qiseib (small herd and individuals seen on several occasions) 1964 - 1967, Wadi Abu Sanduq (tracks, 1964), Bir Mellaha (1) 1965, Gebel Katamiya (droppings and reports of animals seen by observatory personnel) 1964.

Published records and reports.—The following are listings by date, where possible from Palmer (1872), Wilkinson (1832), Hart (1891), Floyer (1893), Buxton et al. (1895), Buxton (1898), Anderson (1902), Hume (1906), Barron (1907a), Weldon (1909), Stuart (1910), Murray (1912, 1930, 1967), Flower (1932), Russell (1949a), Tregenza (1955, 1958), Couturier (1962), Wassif and Hoogstraal (1954), Hoogstraal et al. (1957ab), Hoogstraal (1964), and Kock (1971).

SINAI: Wadi Isla (Isleh) (1923, 1893); near Tor (1823); Wadi Hebran (1823, 1851, 1932); Gebel Horeb (1831); Wadi Feiran (1826); Gebel Serbal (1831, 1918, 1949, 1964); Mt. Sinai (1832); Wadi Salafe (1851); Wadi el Kharig (Rhatakit) (1851); Wadi Gharandal and Wadi Sigilliyeh (tracks, 1872); Wadi Hanjurat el Qattar (herd, 1872); Gebel Umm Shomer and Wadi Saal (herd, 1872; reported 1968); Wadi Araba and Gebel Hor (1891); Gebel Umm Alawi and Wadi Nasb (1893); Wadi Nesle (23 seen in mts. prior to 1895); Gebel Baba, Wadi Shellal, Wadi Aleyat, Gebel Hamra, Nakb Baraq (1898); Gebel Genawi, Wadi Kid (Kyd), Wadi Ethmiemat, Tellat Gimal, and Fersh Sheikh el Arab (1906); Gebel el Raba (Rhaba, Rabbah) (12 seen, 1909; reported 1968); Gebel Sinn (good place for ibex, 1909); Gebel Catherine (no date); Wadi Satakh and Wadi Geba (1907); Gebel Tarbush (1932, 1949); St. Catherine Monastery area (1954); Ayun Musa (1956); Gebel Umm Afruth and Feiran Oasis (1968).

ISMAILIYA: Gebel Shubrawit (one seen several times in 1967; personal communication of an Egyptian military officer).

SUEZ: Gebel Ataqa (no date), mountains near Suez (1866), Gebel Naqud (1881).

CAIRO: Toura cliffs (prior to 1893), El Saff Plateau (prior to 1932).

RED SEA: Gebel Tenassib and Wadi Qattar (two shot, 1823), near Quseir (1878), Bir Hindusi and Gebel Abu Tiyur (1865, 1878), St. Paul Monastery area (1876, 1878), Wadi el Abyad and Wadi Naqud (1881), Gebel Gharib (1886), Gebel Qattar (Kitar) (1892, 1893), Gebel Abu Dokhan (1892, 1893, numerous in 1910, 1951), Gebel Zabarra and Wadi Lahama (Lehema) (two shot, 1893), Bir Sheitun (100 killed about 1918; one shot in 1927), Wadi Asyuti and Wadi Habeeb (one killed, one seen in 1927), Wadi Umm Balad (1947), Gebel Umm Gidri and Gebel Shayeb (always present, 1949), Wadi Rishrash (30 to 40 photographed in 1932; a few left in 1960), Wadi Markh, 40 to 45 km. NW of Qena (old horn, 1951), Wadi Mitgal, Gebel Abu Harba, and Wadi el Atrash (1951).

ASWAN: Near Aswan, El Diwan near El Derr (1813).

SUDAN ADMINISTRATIVE: Gebel Shellal (many seen, 1926), Gebel Elba area (horns seen in local huts, natives reported killings in dry seasons, 1954).

Sudan. KASSALA: Gebel Asoteriba (about 50 seen on summit, 1926).

Habitats.—Rocky wadis, cliffs, and mountains. One specimen was shot on the barren rocky, gravelly plain of Wadi Rawd Ayiad near Qusur el Banat.

Behavior.—Ibex are alert and shy. Their agility enables them to ascend steep cliffs rapidly. A climbing ibex may suddenly become motionless and impossible to see. The alarm note is a sharp whistle.

Water.—Ibex cannot survive without water and apparently travel long distances in order to drink. Their vulnerability at watering places is mentioned below.

Food.—*Acacia raddiana* was browsed by ibex in Wadi Abu Sanduq. Woody shrubs browsed in Wadi Qiseib were: *Lindenbergia sinaica; Lycium shawii; Capparis spinosa*, particularly the flower buds (Osborn, 1968b); and *Ficus pseudosycomorus. Phragmites australis, Imperata cylindrica, Juncus rigidus*, and *Alhagi mannifera* were also eaten. Funnel-shaped pits in wadi gravel seen by Tregenza (1958) were supposedly made by ibex that twisted out the roots of *Lotus arabicus.*

Aside from food plants, an Abadi told us that the male ibex rub their horns in the stiff, pungent foliage of *Cleome droserifolia.*

Associates.—In times past, ibex and Barbary sheep probably inhabited much the same areas.

Predators.—Buxton et al. (1895) reported killing of ibex by leopards in Sinai.

Historical notes.—Ibex are depicted on rocks throughout the Eastern Desert. Particularly good Stone Age carvings are in the Nubian sandstones of Wadi Hammamat (personal observations of authors).

Prehistoric man hunted ibex by bringing them to bay with dogs, then killing them with stones or arrows; or by lying in ambush in little stone blinds built near watering places where they could be stoned or shot. Hunting methods today are essentially the same, and the stone blinds remain as they were built centuries ago.

During Dynastic times, temples and tombs the length of Egypt were adorned with figures of ibex. The early Egyptians hunted ibex for sport, kept them as pets, and offered them in sacrifice to their gods (Buxton et al., 1895).

Capturing or killing animals for pleasure as well as profit is an ancient profession which has changed little with time. Northern Sinai tribes once had an ibex business with Suez (Weldon, 1909). Bedouins of the Hamada section of southwestern Sinai sometimes had tame ibexes with their sheep and goats (Murray, 1912).

In the early 1900's according to Russell (1949ab, 1951), hunters were few and their weapons primitive. During World War I, Egyptians in the Nile Valley towns of Ekhmim, Ebnub, Badari, and Minya exchanged their flintlocks for modern military rifles. Armed with efficient weapons and rope snares, they mercilessly hunted the ibex for profit in the sale of meat. Bir Sheitun, sometimes being the only available water for hundreds of miles, was a favorite shooting and snaring spot. A steep-sided rain pool on Gebel Umm Boanik was said to be a natural trap for thirsty ibex (Murray, 1912). Russell (1951) estimated a kill of about 100 at Bir Sheitun during one summer.

Travelers of the past century in Egypt reported ibex from the bluffs overlooking the Nile eastward to all the plateaus and peaks of the Eastern Desert and Sinai Peninsula (fig. 162). Flower (1932) noted that, before completion of the railway between Luxor and Aswan, ibex came to the Nile for water.

About the year 1900, Prince Kemal el Din established an ibex sanctuary with food and water in Wadi Rishrash (Halton, 1935). It was maintained for about 40 years. Russell (1949a) photographed 30 or 40 ibex there in 1932. Latest reports are that a few ibex may still be seen in the area (Talbot, 1960). This reserve probably saved the ibex from annihilation in this part of the Eastern Desert.

We know that ibex still exist in the more remote mountain peaks, but the necessity for water makes them vulnerable to human predation throughout much of the year. Were it not for the security of the Wadis Qiseib and Abu Sanduq enforced by the Frontier Patrol stations there, the small herds inhabiting these areas would probably have been eliminated long ago.

Today, crudely made swords fitted with an ibex horn sheath are popular tourist items in the bazaars of Aswan. The horns are said to be brought from Gebel Elba by Bisharin tribesmen.

Genus **Ammotragus** Blyth, 1840

Monotypic genus of large sheep-like bovid with horns curving outward, backward, downward, and inward. Color nearly uniform reddish or chestnut. Beard absent. Hair from jaw to upper foreleg long, mane-like. Tail long, nearly reaching hock. Lacrimal, tarsal, and subcaudal glands absent.

Braincase not expanded. Frontonasal region flat. Infraorbital fossa lacking, ethmoidal fissure very small. Premaxilla contacting nasal. Horn core postorbital and extending laterally and posteriorly from base on same plane as frontals.

Ammotragus lervia (Pallas, 1777)

Antilope lervia Pallas, 1777, Spicilegia, Zool., Vol. 12, p. 12.

Type locality.—"Western Algeria, Department of Oran" (Harper, 1940, p. 327).

General distribution.—Egypt, southeastern Libya, Sudan, Tunisia, Morocco, Algeria, Mauretania.

Common names.—Barbary Sheep, Maned Sheep, *Aoudad, Kebsh el Gebel, Wadden, Arui.*

Subspecies in Egypt.—

Ammotragus lervia ornatus (I. Geoffroy St. Hilaire, 1827)

Ovis ornata I. Geoffroy St. Hilaire, 1827, Dict. Class. Hist. Nat., Vol. 11, p. 264.

Type locality.—Egypt. CAIRO: Near Cairo.

Distribution in Egypt.—Figure 164. Central part of Eastern Desert, central and southwestern parts of Western Desert.

Diagnosis.—Reddish color with long mane from jaw to upper foreleg. Beard absent. Tail considerably longer than ear. Frontonasal region flat. Infraorbital fossa lacking. Premaxilla contacting

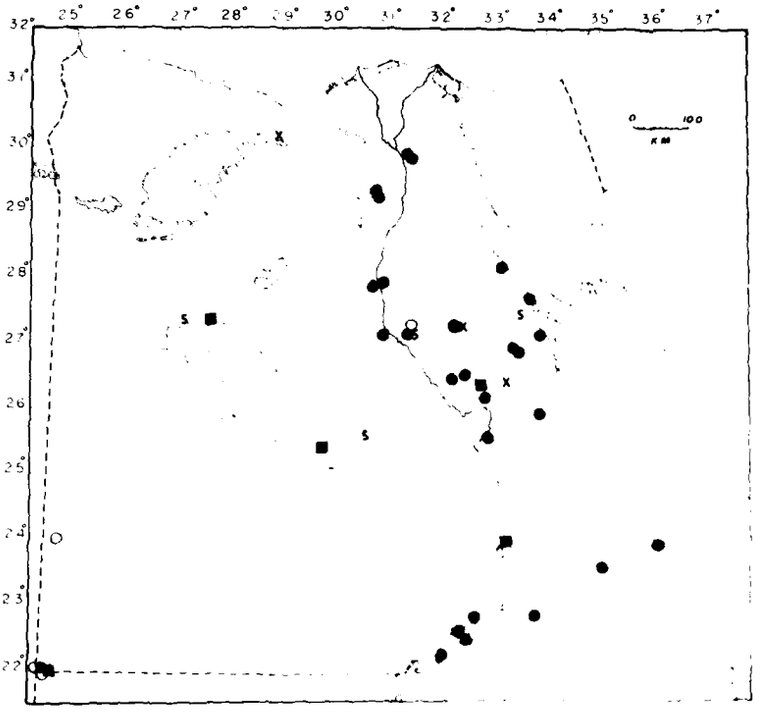


FIG. 164. Collection localities of *Ammotragus* [illegible] 1932 (circles), 1932-1948 (dots), and 1949 to date (squares) [illegible] *date of death unknown* (X) *and sight records* [illegible]

nasal. Horns heavy, postorbital and curving outward, backward downward, and inward. Shoulder height about [illegible]

External characters. General color reddish or chestnut; fore and outer part of legs brownish. Inside of ear, chin, ventral upper [illegible] side of legs, and upper part of foot whitish. Long mane on side of jaw, neck, chest, and upper foreleg darker than body and becoming skirt-like on forelegs. Beard absent. Muffle completely haired. Tail considerably longer than ear, reaching nearly to hock, with long hair on distal half.

Cranial characters. Skull triangular in lateral outline. Fronto-nasal contour flat. Braincase constricted laterally. Occipital condyles not protruding beyond level of supraoccipital. Frontoparietal

suture broadly V-shaped. Interparietal suture broadly shield-shaped. Infraorbital fossa lacking, and ethmoidal fissure very small. Premaxilla contacting nasal. Nasofrontal suture forward of anterior margin of orbit. Postpalatal margin with narrow U-shaped cleft and apex of cleft reaching level of m^3.

Horns and horn cores.—Horns heavy, with ventral keel; conspicuous annulations from base to tip and curving outward, backward, downward, and inward; larger and more strongly annulated in male. Cores close together at base, almost pedicellate, postorbital, and on same plane as flat frontonasal region of skull. Base deeply perforated, shallow grooves and pits from base to tip. Cross-section eliptical. Interior hollow to tip and irregularly subdivided by thick trabeculae.

Teeth.—Labial ridges of upper cheek teeth, except pm^1, well developed. M^3 with accessory posterior vertical lingual ridge.

Comparisons.—*Ammotragus l. ornatus* differs from other subspecies in having slightly darker color and absence of white subauricular patch and dark median facial marking.

Specimens examined.—Total two.

EL WADI EL GEDEED: Bir el Obeiyid NW of Farafara Oasis (severed head examined and photographed by I. Helmy, February 1972), Ain Amur NW of Kharga Oasis (old weathered skull, date of death unknown).

Published records.—The following is a listing of kills and observations by date, wherever possible, from Wilkinson (1832), Sclater (1895), Anderson (1898, 1902), Buxton (1898), Barron and Hume (1902), Bedan (1928), Flower (1932), Shaw (1933), Mason (1936), Negumi (1952), Tregenza (1955, 1958), Murray (1967), Missone (1969, 1970), and Kock (1971).

CAIRO: Cairo, hills east of (late 1700's); near Cairo (type).

FAIYUM: Birket el Qarun, W of (1875); near El Faiyum (1902).

MINYA: Near El Minya (1861, 1868), rocky hills near El Minya (1902).

QENA: Near Qena (1893), Thebes (1861, 1868).

ASYUT: Manfalut (1827).

RED SEA: Gebel Abraq (no date); Gebel Qattar (1823, 1892, 1893); Wadi Medisa (horns, 1893); Gemsa area (1893, 1910); Wadi Sceitun (1893); Ain Yassar (old horn, 1893); Wadi el Gosa (Gossal) (1893, 1902); Wadi Seqel and Wadi Esserba (prior to 1898); Ras Banas, Ras Gharib, and Qena-Quseir road (1902); Bir Abu Shaar (1910); Bir Abu Laseifa (1912); Wadi Tarfa (prior to 1920); Gebel Aradia (droppings, 1920); Bir Sheitun (1927); Wadi Asyuti (1927, 1934); Wadi Badia and Wadi Umm Sidri (old horns, 1949); plateau E of Asyut (reported by guides, 1949); Wadi Qena plateau (1951).

ASWAN: El Derr (Diwan) and Aswan (1813), Wadi Sibaa (1860), Wadi Hor (no date), Korosko (1861).

MATRUH: Qattara Depression near Minqar Abu Dweiss (old horns, 1927).

EL WADI EL GEDEED: Gilf el Kebir, Wadi Hamra (1935); Wadi el Malik (1933, 1934), Gebel Uweinat (1923, 1925, 1932, 1933, 1934, 1935, 1969), Karkur Tahl (1934).

Libya. SYRENAICA: Gebel Uweinat, Ain Dua (1933, 1943), Ain Zueia (two specs, 1962).

Sudan. NORTHERN: Semneh (herd of about 13 in 1890), Abu Hamed (1861, 1913).

Unpublished sight records.—

RED SEA: Wadi Mellaha, 1963 or 1964 (personal observation of Dr. Hassan Sabr, former director of Giza Zoological Gardens); Wadi Asyuti tributary, March 1969 (personal observation of Dr. Hani Zeny, Director of Nag Hamadi sugar company).

EL WADI EL GEDEED: Near Ain Dalla on Guss Abu Said Plateau NW of Farafara Oasis, 1969 (personal observation of I. Helmy), and Ain Umm Dabadib (personal observation of Abd el Magid el Doghal, Governor of El Wadi el Gedeed).

Habitats.—Rocky desert mountain and cliff areas. Descend into wadis and plains to feed.

Behavior.—Like ibex, Barbary sheep are alert, shy, and extremely agile in rocky terrain.

Food and water.—*Ammotragus* feeds on a variety of desert plants. Bedan (1928) observed one browsing on *Tamarix* sp. in Wadi Habeeb. Mason (1936) said it thrived on the bitter *Colocynthis vulgaris* (=*Citrullus colocynthis*) gourds in Wadi Hamra. Dorst (1970) mentioned *Acacia* sp. and *Calotropis* sp., and said they can obtain moisture from plants such as *Rumex* sp., but drink if water is available. Russell (1949b, p. 7) commented that "unlike ibex, sheep are not snared at waterholes because they do not drink."

Historical notes.—Within historical time, Barbary sheep probably inhabited most of the Eastern Desert and areas of rugged terrain in the Western Desert (fig. 164). In the Eastern Desert, incidentally, a well, a wadi, and a mountain are called Umm Kibash (mother of wild sheep). The type of *A. l. ornatus* was shot "outside the gates of Cairo" (Rothschild, 1913, p. 459), and Barbary sheep were reported to have existed in the hills east of Cairo in the late 1700's (Anderson, 1898). Russell (1831) commented that sheep lived in the rocky deserts bordering the Nile, but did not occur habitually in the vicinity of Cairo. Numerous explorers since have observed Barbary sheep and their remains and published these, together with reports from guides. Many of these references pertain to Wadi Qena, Wadi Asyuti, and adjacent drainages in the Maaza Plateau. Flower (1932,

p. 435) stated that, although the Barbary sheep was said to occur on both sides of the Nile in Upper Egypt during 1900-1909, by 1910, it had become "really scarce." Bedan (1928) killed a Barbary sheep in Wadi Asyuti in February 1927. He commented on the hunting pressure during World War I in the Wadi Asyuti area and said that a 1920 expedition had found no game. Some sheep, he thought, took refuge in an inaccessible cliff east of Wadi Asyuti on the west side of Wadi Qena. Russell (1949ab, 1951) recounted the decimation of Barbary sheep and ibex in the Wadi Qena-Wadi Asyuti country by commercial hunters, particularly during the war years when meat was scarce and expensive. He concluded that wild sheep no longer existed north of Gebel Elba.

Of interest is the comment by Hoogstraal (1964, p. 237) that "Legends of wild sheep on Gebel Elba are rife among Bishareen, but we obtained no specimens." We do not know if sheep ever existed in the Elba mountains, although they were known to occur on Gebel Hisse (Isse or Is) 100 km. SW of Elba (Sclater, 1895).

Recent observations of Barbary sheep in Wadi Asyuti and Wadi Mellaha in the Eastern Desert and Ain Dalla and Gebel Uweinat in the Western Desert (see above) indicate that small populations survive in isolated areas. The most recent record is a specimen killed by a hunter in 1972 near Bir el Obeiyid NW of Farafara Oasis. Further indication of the former extent of distribution is the horns found in 1927 in Qattara Depression near Minqar Abu Dweiss (Murray, 1967).

According to Zeuner (1963), Barbary sheep, unlike other native bovids, were never "domesticated." They were hunted and presented as offerings by the ancient Egyptians and are fairly common in tomb and temple reliefs (Butzer, 1959).

APPENDIX

Explanation of abbreviations. Abbreviations used in the text and tables are: N, north; S, south; E, east; W, west; mm., millimeter(s); cm., centimeter(s); m., meter(s); km., kilometer(s); oz., ounce(s); gm., gram(s); kg., kilogram(s); C, centigrade; F, Fahrenheit; RH, relative humidity.

In tables, all measurements are given in millimeters and weights in gm., unless stated otherwise. Numbers after ranges are number of specimens.

Abbreviations for measurements are:

AL	Alveolar length of upper cheek teeth.
BCW	Braincase width.
BL	*Bullar length.* The greatest horizontal distance from the anterior-most surface to the point of contact with the paroccipital process on the posterior-most surface of the *right auditory bulla.*
BOW	Basioccipital width. Least width of basioccipital bone between the auditory bullae.
CBL	Condylobasal length. Greatest distance between the anterior-most surface of premaxilla to posterior-most surface of occipital condyles.
CIL	Condyloincisive length. Greatest length between posterior margin of occipital condyles to anterior-most surface of incisors.
CNL	Condylonasal length.
$C\text{-}M^1$, $C\text{-}M^2$	Distance from anterior-most surface of canine to posterior of first or *second molar.*
EL	Ear length from notch to tip.
FL	Foot length. Length of the hind foot including claw, unless stated otherwise.
HBL	Head and body length. Total length minus tail length. Not to be confused with term "body size" of Ranck (1968) and others who mean total length.
HCW	Horn core width. Greatest distance across the outside margins of the horn cores.
HL	Horn length. Taken along anterior surface of horn, unless stated otherwise.
IFL	Greatest length of *the right incisive foramen.*
IOW	Least interorbital width.

$I\text{-}PM^4$, $I\text{-}M^2$	Distance from anterior-most surface of incisors to posterior of fourth upper premolar or second upper molar.
$M^1 - M^1$	Width across first upper molars.
MW	Mastoid width.
NL	Nasal length. Greatest length of nasal bones, unless stated otherwise.
ONL	Occipitonasal length (see SL).
OW	Orbital width. Greatest width across orbital bones.
$P^4 - P^4$	Width across fourth upper premolars.
PAW	Paroccipital width.
PL	Palatal length. Greatest distance from the anterior-most surface of the premaxilla to the posterior palatal margin.
POW	Postorbital width.
PM^4	Length of fourth upper premolar.
PPF	Greatest length of right posterior palatine foramen.
PW	Least pterygoid width.
RW	Rostral width. In carnivores, it is greatest width across alveoli of upper canines; in rodents, it is greatest width anterior to the zygomatic plate.
SH	Skull height. Taken from highest point of skull to underside of a plate of known thickness upon which the skull rests with incisors or canines and bulla. Thickness of plate is then subtracted to give the measurement.
SL	Skull length. Greatest horizontal length of skull, including mastoid bullae in some cases.
TL	Tail length. Dorsal length of tail vertebrae from articulation with sacrum to tip of last tail vertebra.
TL/HBL*100	Tail length divided by head and body length. Tail, head, and body length ratio in per cent.
TRL	Upper tooth row length (crown length).
Wt	Weight in grams, unless stated otherwise.
ZW	Greatest zygomatic width.

APPENDIX 2

The auditory bulla.—Terminology of chambers and related structures of the middle ear (Dr. D. M. Lay, personal communication) used in taxonomic sections of the text are illustrated in Figure 165.

Opposite:

FIG. 165. — Auditory bulla of *Dipodillus campestris*. A, Posterolateral view of exterior showing chambers and associated structures. B, Same view enlarged, with walls partially removed to show partitions and relationships of chambers and semicircular canals. Arrows indicate communication between chambers. Numbered parts are:

1. Posterior arm of tympanic bone.
2. Tympanic chamber.
3. Manubrium of malleus.
4. External auditory meatus.
5. Lip of external auditory meatus.
6. Anterior arm of tympanic bone.
7. Incisura tympanicum.
8. Hamular process of temporal bone.
9. Suprameatal triangle.
10. Supraoccipital.
11. Anterior mastoid chamber.
12. Subarcuate fossa.
13. Lateral superior posterior mastoid chamber.
14. Medial inferior posterior mastoid chamber.
15. Occipital condyle.
16. Lateral inferior posterior mastoid chamber.
17. Paroccipital process.
18. Anterior semicircular canal.
19. Posterior semicircular canal.
20. Lateral semicircular canal.

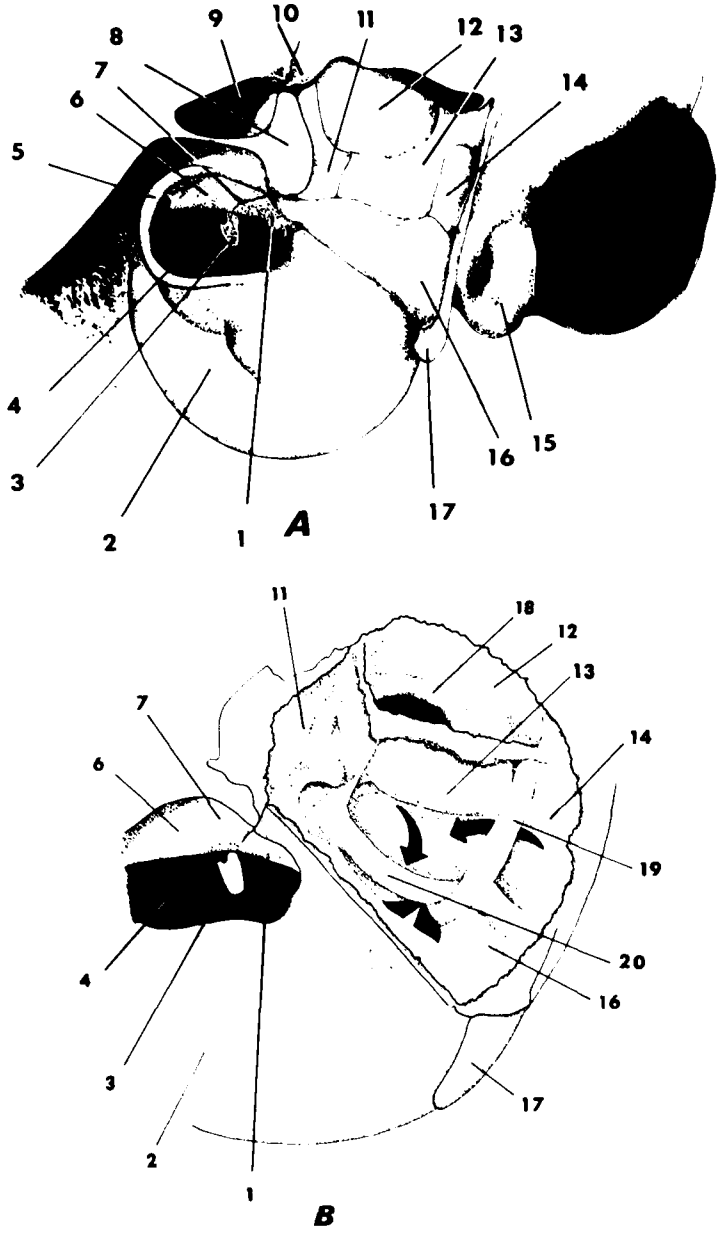


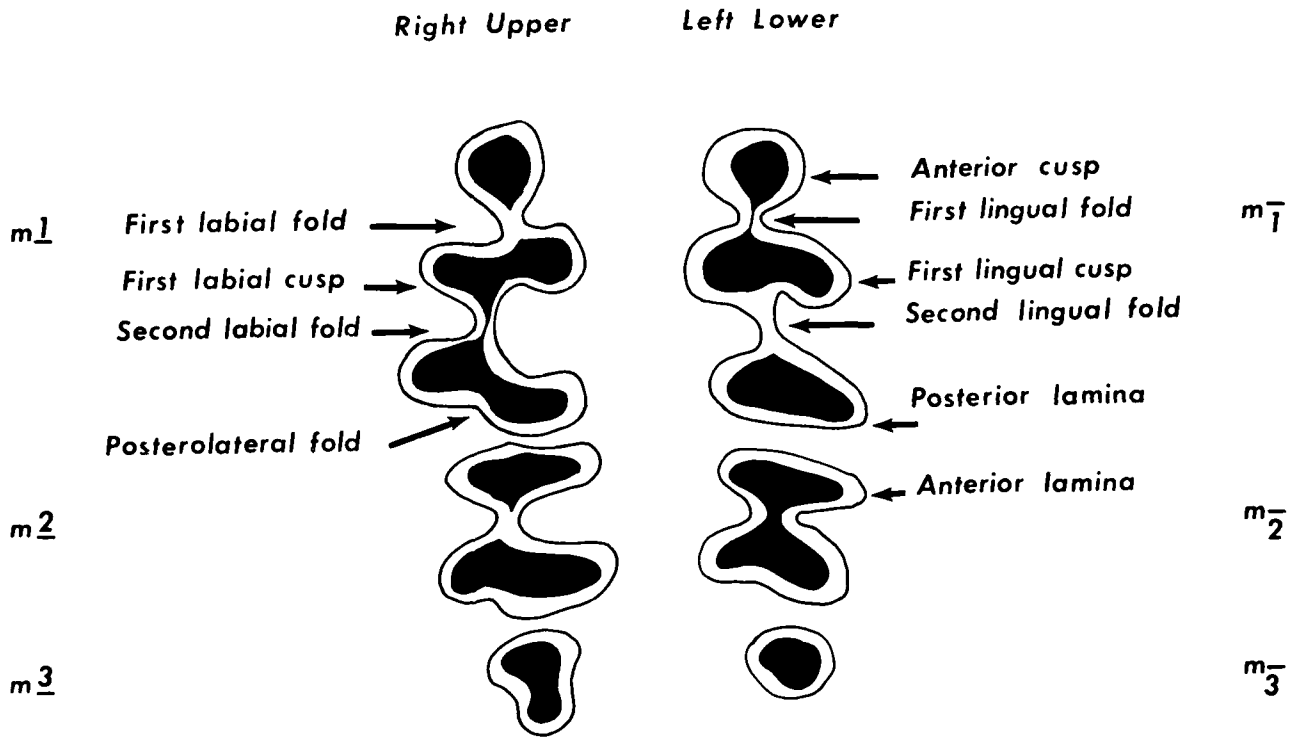
FIG. 165. Auditory bullae of *Dipodillus campestris*

APPENDIX 3

Tooth terminology.—Figure 166 shows the terminology used in the text for rodent molars.

Opposite:

FIG. 166. Terminology used in describing molars of Gerbillinae.


Right Upper
Left Lower
m1
First labial fold
First labial cusp
Second labial fold
Posterolateral fold
m2
m3
Anterior cusp
First lingual fold
First lingual cusp
Second lingual fold
Posterior lamina
Anterior lamina
m1
m2
m3

APPENDIX 4

The Governorates of Egypt.

Figure 167 shows the governorates of Egypt at the time the manuscript went to press.

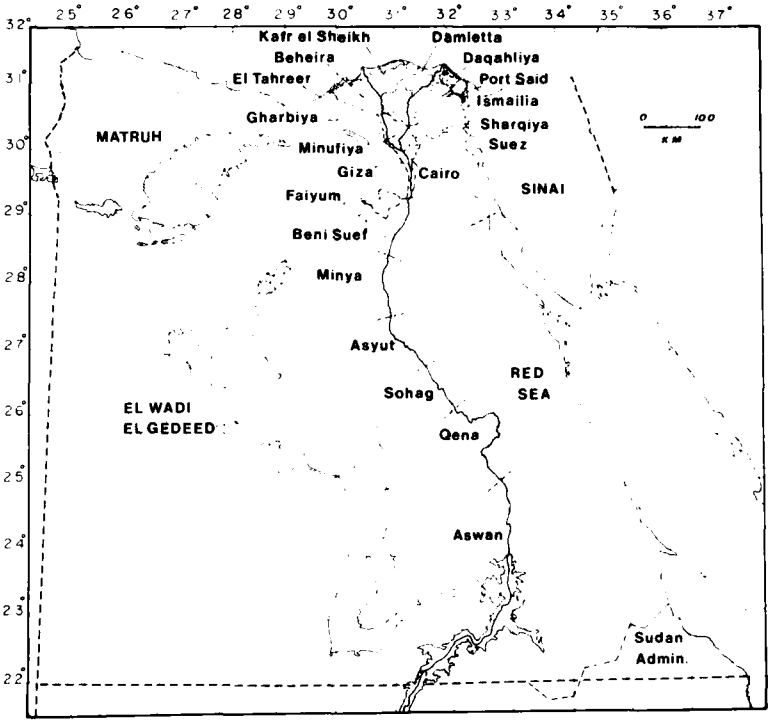


FIG. 167. Governorates of Egypt.

APPENDIX 5

GAZETTEER OF LOCALITIES MENTIONED IN THE TEXT

Where possible, coordinates are from the United States Board on Geographic Names, 1959, *Egypt and the Gaza Strip*, Gazetteer No. 45.

Locality	Governorate	N Lat. (°)	(′)	E Long. (°)	(′)
Abar el Dafa	MATRUH	31	19	26	53
Abassia	CAIRO	30	04	31	17
Abd el Mawla (Gebel)	MATRUH	30	33	29	13
Abnub (Ebnub)	ASYUT	27	16	31	09
Abu Aweigila (Augeila)	SINAI	30	50	34	07
Abu Darag	SUEZ	29	29	32	27
Abu Durba (Darba) Mine	SINAI	28	29	33	20
Abu el Matamir	*BEHEIRA*	*30*	*55*	*30*	*11*
Abu Gandir (Jandir)	EL FAIYUM	29	14	30	41
Abu Ghalib	GIZA	30	16	30	54
Abu Girgeh	SINAI	not found			
Abu Haggag	MATRUH	31	08	27	50
Abu Hammad	*SHARQIYA*	30	32	31	40
Abu Hommos (Hummus)	BEHEIRA	31	06	30	19
Abu Kharif Mine	RED SEA	26	48	33	25
Abu Kir (Abu Qir)	ALEXANDRIA	31	19	30	04
Abu Makkar Monastery	*see* Deir Makaryus	—	—	—	—
Abu Mena (Mina)	MATRUH	30	51	29	40
Abu Minqar	EL WADI EL GEDEED	26	30	27	38
Abu Ramad	SUDAN ADMIN.	22	21	36	27
Abu Rawash (Ruawash, Roash)	GIZA	30	02	31	06
Abu Sennan Dune	MATRUH	29	33	28	53
Abu Shuruf	*see* Ain Abu Shuruf	—	—	—	—
Abu Shusha	QENA	26	10	32	01
Abu Simbil (Simbel)	ASWAN	22	22	31	38
Abu Simbil West	*see* Abu Simbil	—	—	—	—
Abu Sir	GIZA	29	53	31	13
Abu Sir	MATRUH	30	57	29	31
Abu Sultan	ISMAILIA	30	25	32	19
Abu Zabal (Zaabal)	QALYUBIYA	30	15	31	21
Abu Zenima (Zeneima)	SINAI	29	03	33	06
Abydos	QENA	26	11	31	55

Locality	Governorate	N Lat. (°)	(′)	E Long. (°)	(′)
Acacia grove	GIZA	28	55	29	31
Acacia grove	MATRUH	29	13	29	05
Acacia groves, Qattara Depression	MATRUH	29	37	27	32
Adindan	ASWAN	22	12	31	30
Aga Minshat el Ikhwa	*see* Minshat el Ikhwa	—	—	—	—
Ageeba	MATRUH	28 km. W of Mersa Matruh			
Aghurmi	MATRUH	29	15	25	20
Aguz	*see* El Aguz	—	—	—	—
Ain Abu Nateigina (Nateiqina)	SINAI	29	15	33	30
Ain Abu Shuruf	MATRUH	29	11	25	45
Ain Amur	EL WADI EL GEDEED	25	39	30	00
Ain Beshai (Ibshai)	EL WADI EL GEDEED	27	02	27	57
Ain Dalla	EL WADI EL GEDEED	27	19	27	20
Ain Eede	EL WADI EL GEDEED	not found			
Ain el Baqar	MATRUH	29	13	25	37
Ain el Beilda	GIZA	5 km. W of Bawiti			
Ain el Dakrur	MATRUH	not found			
Ain el Furtaga	SINAI	29	03	34	33
Ain el Gedeirat (Ain Gudairat)	SINAI	30	39	34	26
Ain el Qht	GIZA	10-15 km. E of Bawiti			
Ain el Senned	SINAI	not found			
Ain el Tinnin	EL WADI EL GEDEED	26	52	27	58
Ain el Wadi	EL WADI EL GEDEED	28	20	29	04
Ain Gellaw	EL WADI EL GEDEED	15-20 km. SE of El Qasr			
Ain Ghabah	GIZA	2-3 km. N of El Aguz			
Ain Guffara	GIZA	28	18	28	56
Ain Marun	GIZA	28	25	28	54
Ain Musib Nabbut	EL WADI EL GEDEED	24	31	30	39
Ain Qureishit	*see* El Zeitun	—	—	—	—
Ain Ruweishid	RED SEA	26	58	33	23
Ain Shams	CAIRO	30	08	31	19
Ain Sudr	SINAI	29	49	33	06
Ain Sukhna (Sokhna)	SUEZ	29	35	32	20
Ain Taba	SINAI	29	30	34	53
Ain Umm Dabadib	EL WADI EL GEDEED	25	46	30	25
Ain Zeitun	MATRUH	29	10	25	47
Ain Zueia	Libya. CYRENAICA	21	53	24	50
Aiyut Barnasht	GIZA	29	41	31	15
Akhmim (Ekhmim)	SOHAG	26	34	31	44
Alam Shaltut	MATRUH	30	46	29	50
Alexandria (Iskanderiya, Eskenderiya)	ALEXANDRIA	31	12	29	54
Allaqi Village	ASWAN	23	07	32	45
Amada Temple	ASWAN	22	43	32	15
Ambogma	*see* Umm Bugma	—	—	—	—
Ambukol (Ambikol, Ambikul)	Sudan. NORTHERN	21	19	30	53

Locality	Governorate	N Lat. (°)	(′)	E Long. (°)	(′)
Antinoe (Antinopolis)	*see* El Sheikh Ibada	—	—	—	—
Armena (Armina)	ASWAN	22	27	31	51
Armina Temple	ASWAN	22	25	31	47
Asaa	*see* El Qasr	—	—	—	—
Ashmun el Ghunamiya	MINUFIYA	31	18	31	44
Asment	EL WADI EL GEDEED	25	55	29	25
Aswan (Assouan)	ASWAN	24	05	32	53
Aswan Dam Hospital	*see* Aswan	—	—	—	—
Aswan West	*see* Aswan	—	—	—	—
Asyut (Assiut, Siout)	ASYUT	27	11	31	11
Atf	*see* El Atf	—	—	—	—
Atfih	GIZA	29	24	31	15
Ausim (Awsim)	GIZA	30	07	31	08
Awlad Ali	SINAI	30	52	34	04
Awlad Hamza	SOHAG	26	24	31	49
Awlad Hawra	GIZA	not found			
Ayun Musa	SINAI	29	52	32	39
Bab el Sharia (Bab el Shaariya)	*see* Cairo	—	—	—	—
Badari	*see* El Badari	—	—	—	—
Bahariya Oasis	*see* Bawiti	—	—	—	—
Bahig	MATRUH	30	56	29	35
Bahrein	MATRUH	28	40	26	32
Bahr el Tubat	Libya, CYRENAICA	29	36	24	53
Balat	EL WADI EL GEDEED	25	33	29	18
Ballana	ASWAN	22	16	31	34
Baltim	KAFR EL SHEIKH	31	33	31	05
Bardia	Libya, CYRENAICA	31	46	25	06
Baris (Berys)	EL WADI EL GEDEED	24	40	30	36
Barqet Tokham	ASWAN	23	35	33	25
Bashtil	GIZA	30	05	31	11
Basus	QALYUBIYA	30	08	31	13
Batras	EL WADI EL GEDEED	5 km. W of Qasr el Farafara			
Bawiti	GIZA	28	21	28	52
Bayadeia	*see* PORT SAID	—	—	—	—
Beheira Nakhla	BEHEIRA	not found			
Beit el Wali Temple	*see* Kalabsha	—	—	—	—
Benha	QALYUBIYA	30	28	31	11
Beni Adi	ASYUT	27	15	30	35
Beni Magdul	GIZA	30	02	31	07
Beni Mazar	MINYA	28	30	30	48
Beni Salami (Ezbet Bint Salami)	BEHEIRA	30	20	30	25
Beni Salami (Salama)	GIZA	30	19	30	51
Beni Suef	BENI SUEF	29	05	31	05
Beni Yusef	GIZA	not found			
Bik 'at Hayareach	*see* Ras el Naqb				
Bilbeis	SHARQIYA	30	25	31	34
Bir Abbad	RED SEA	25	02	33	04

Locality	Governorate	N Lat. (°)	(′)	E Long. (°)	(′)
Bir Abd el Nabi	MATRUH	29	59	26	58
Bir Abraq (Bir Abrag)	RED SEA	23	25	34	48
Bir Abu Hussein	EL WADI EL GEDEED	22	53	29	55
Bir Abu Kharif	*see* Bir Fatira	—	—	—	—
Bir Abu Laseifa	RED SEA	26	54	32	27
Bir Abu Sanduq	SUEZ	29	25	32	31
Bir Abu Seyala (Bir Sayal, Ma Sweillim)	SUEZ	29	32	32	22
Bir Abu Shaar	RED SEA	27	22	33	37
Bir Abu Zawal	RED SEA	26	40	33	14
Bir Akwamtra	SUDAN ADMIN.	22	13	36	18
Bir Beida (Inglizi)	RED SEA	26	05	34	07
Bir Bosslanga	*see* Bir Wair	—	—	—	—
Bir Dakaar	*see* Bir Samweil	—	—	—	—
Bir Dibbis (Dibis)	EL WADI EL GEDEED	22	09	29	27
Bir el Aradj	*see* El Areg	—	—	—	—
Bir el Hammamat	RED SEA	25	58	33	33
Bir el Iseila	GIZA	10-15 km. SW of Ain Guffara			
Bir el Maghara	SINAI	30	42	33	23
Bir el Malla	MATRUH	31	10	26	01
Bir el Nokta	EL WADI EL GEDEED	5 km. W of Gharb el Mawhoub			
Bir el Obeiyid	EL WADI EL GEDEED	27	19	27	40
Bir el Qattara	MATRUH	31	35	25	10
Bir el Qryeia	RED SEA	26	22	33	01
Bir el Shab (El Sheb)	EL WADI EL GEDEED	22	19	29	46
Bir el Suweir (Suweira)	SINAI	29	15	34	43
Bir Fatira (Abu Kharif)	RED SEA	26	50	33	30
Bir Ghadir	RED SEA	24	48	34	47
Bir Gindali	SUEZ	29	55	31	40
Bir Gumbiet	RED SEA	23	21	34	47
Bir Haimur (Haimur wells)	ASWAN	22	43	33	47
Bir Hassana	SINAI	30	28	33	47
Bir Hindusi	RED SEA	25	49	34	11
Bir Hooker	BEHEIRA	30	23	30	20
Bir Inglizi	*see* Bir Beida	—	—	—	—
Bir Kansisrob	SUDAN ADMIN.	22	15	36	22
Bir Karawein	EL WADI EL GEDEED	27	06	28	32
Birket el Sabh	MINUFIYA	30	38	31	05
Birket el Qarun	*see* Lake Qarun	—	—	—	—
Bir Kibash	*see* Bir Umm Kibash	—	—	—	—
Bir Kiseiba	EL WADI EL GEDEED	22	41	29	55
Bir Kurayim (Kreyim)	EL WADI EL GEDEED	22	24	29	43
Bir Kussaima	*see* El Qoseima	—	—	—	—
Bir Lehfan	SINAI	31	01	33	52
Bir Meisa	Sudan. KASSALA	21	21	35	35
Bir Mellaha	RED SEA	27	34	33	27

Locality	Governorate	N Lat.		E Long.	
		( )	( )	( )	( )
Bir Mikheimin (Nahda and Nahid on topog. maps)	MATRUH	30	13	28	52
Bir Murr	EL WADI EL GEDEED	23	21	30	05
Bir Murr (Farafara)	EL WADI EL GEDEED	27	06	28	32
Bir Murra	ASWAN	22	32	33	54
Bir Nagib (Nakeyb)	ASWAN	22	50	33	44
Bir Nahed (Nahid)	MATRUH	4.5 km. E of El Maghra			
Bir Nakheila	EL WADI EL GEDEED	24	01	30	52
Bir Number two	EL WADI EL GEDEED	4 km. N of Mut			
Birqash	GIZA	30	10	31	02
Bir Qasr, Nos. 1, 2, 3	GIZA *see* El Qasr	–	–	–	–
Bir Qattar	MATRUH	31	35	25	10
Bir Qattar (Kittar, Guttar)	RED SEA	27	05	33	17
Bir Qiseib	SUEZ	29	24	32	29
Bir Qokshira	EL WADI EL GEDEED	not found			
Bir Safsaf	EL WADI EL GEDEED	22	44	29	18
Bir Samweil	EL FAIYUM	28	53	30	30
Bir Sarrara	SUDAN ADMIN.	22	16	36	30
Bir Semna	RED SEA	26	27	33	35
Bir Seyala	RED SEA	26	07	33	56
Bir Shafarzin	MATRUH	31	19	24	53
Bir Shalatein	SUDAN ADMIN.	23	08	35	36
Bir Shaqqa	MATRUH	30	52	24	59
Bir Sheitun	RED SEA	26	48	32	07
Bir Sidi Omar	MATRUH	31	24	24	52
Bir Terfawi (Tarfawi)	EL WADI EL GEDEED	22	55	28	53
Bir Thal	SINAI	29	10	33	04
Bir Umm Delfa	RED SEA	27	00	33	34
Bir Umm Dud	RED SEA	26	58	31	44
Bir Umm Hibal	ASWAN	23	42	33	14
Bir Umm Kibash	RED SEA	26	55	33	38
Bir Umm Qareiyat	ASWAN	22	33	33	22
Bir Victoria (El Qaraya)	BEHEIRA	30	24	30	37
Bir Wair (Bosslanga)	MATRUH	31	33	25	05
Bir Wigaba	MATRUH	not found			
Bir Zafarana	RED SEA	29	07	32	33
Biyala	KAFR EL SHEIKH	31	10	31	13
Bubastis	SHARQIYA	30	34	31	31
Bulaq	*see* Cairo	–	–	–	–
Bulaq	EL WADI EL GEDEED	25	12	30	32
Bulaq el Dakrur	CAIRO	30	02	31	11
Buq Buq	MATRUH	31	31	25	34
Burg el Arab	MATRUH	30	55	29	32
Burullus District	KAFR EL SHEIKH	31	35	31	05
Busili (Buseili)	BEHEIRA	31	20	30	24
Cairo	CAIRO	30	03	31	15
Cairo Citadel	*see* Cairo	–	–	–	–

Locality	Governorate	N Lat. (°)	(')	E Long. (°)	(')
Camel Pass Dune (Ghard el Qattaniya)	MATRUH	29	50	30	17
Dahab (Dhahab)	SINAI	28	29	34	32
Dahshur Pyramids	GIZA	29	48	31	12
Dakhla Oasis	*see* Mut	–	–	–	–
Dakka	ASWAN	23	12	32	45
Damanhour	BEHEIRA	31	02	30	28
Damietta (Dumiat)	DAMIETTA	31	25	31	48
Dandara (Dendera)	QENA	26	10	32	39
Daraw (Derau)	ASWAN	24	25	32	56
Deir Makaryus	BEHEIRA	30	18	30	29
Dikheila Airfield	*see* Alexandria	–	–	–	–
Dilingat	BEHEIRA	30	50	30	30
Dinshawi	MINUFIYA	30	36	30	51
Dishna	QENA	26	07	32	28
Disshet el Dabba (Dissht el Daba)	RED SEA	27	04	33	53
Dist el Ashraf	BEHEIRA	30	43	30	39
Durunka	*see* Gebel Drunka	–	–	–	–
Dush	EL WADI EL GEDEED	24	34	30	42
El Abadiyah	GIZA	31	22	31	07
El Abbasa	SHARQIYA	30	32	31	42
El Afritat	MATRUH	17 km. SW of El Hammam			
El Aguz	GIZA	5 km. SSE of Bawiti			
El Ahiah	*see* Hurghada	–	–	–	–
El Ahmar	QALYUBIYA	not found			
El Aiyat	GIZA	29	37	31	15
El Alamein	MATRUH	30	49	28	57
El Amiriya	ALEXANDRIA	31	35	31	01
El Arbaein Monastery	*see* Wadi el Arbaein	–	–	–	–
El Areg (Arig, Arej, Aradj, Arag)	MATRUH	28	56	26	24
El Arish	SINAI	31	08	33	48
El Atarien	*see* Alexandria	–	–	–	–
El Atf	GIZA	29	39	31	16
El Auberge	*see* Shaksuk	–	–	–	–
El Badari	ASYUT	26	59	31	25
El Badrshein (Badrashein)	GIZA	29	51	31	16
El Bahnasa (Behnessa)	MINYA	28	32	30	39
El Bahrein	*see* Bahrein	–	–	–	–
El Bakhanis	KAFR EL SHEIKH	31	11	30	53
El Ballah	ISMAILIA	30	46	32	19
El Baradiah	QALYUBIYA	30	14	31	09
El Baragil	GIZA	30	04	31	09
El Barqil	EL FAIYUM	not found			
El Beida (Bir Beida)	BEHEIRA	30	27	30	15
El Birigat	BEHEIRA	30	30	30	50
El Biyara	ASWAN	not found			
El Burg	KAFR EL SHEIKH	31	35	30	59

Locality	Governorate	N Lat. (°)	(′)	E Long. (°)	(′)
El Daba (Dabah)	MATRUH	31	02	28	26
El Dar el Bayda (Qasr Abbas I)	SUEZ	30	08	31	51
El Deir	QENA	26	03	32	45
El Deir el Beida	*see* El Dar el Bayda	—	—	—	—
El Dirr Temple	ASWAN	22	44	32	15
El Faiyum	*see* Faiyum	—	—	—	—
El Ferden (Firdan)	ISMAILIA	30	41	32	20
El Ferinat (Fureinat)	MATRUH	30	14	29	15
El Gamil	PORT SAID	10 km. W of Port Said			
El Gau	EL WADI EL GEDEED	15 km. SW of Qasr el Farafara			
El Gezira	EL WADI EL GEDEED	not found			
El Ghaba el Qiblya	*see* El Aguz	—	—	—	—
El Ghazalat	MATRUH	20 km. SW of Bir Abd el Nabi			
El Ghunamiya	MINUFIYA	30	13	31	01
El Hamda (Hamtha)	SINAI	30	55	33	52
El Hammam	MATRUH	30	50	29	23
El Hamra	BEHEIRA	not found			
El Hamra	KAFR EL SHEIKH	31	10	30	52
El Hamul	KAFR EL SHEIKH	31	19	31	10
El Hara	*see* Bawiti	—	—	—	—
El Harraniya	GIZA	29	58	31	10
El Hawa	*see* Ilwat Hawa	—	—	—	—
El Heiz	GIZA	28	02	28	39
El Imayid	MATRUH	30	47	29	12
El Kagug Cave	ASWAN	24	40	32	57
El Kanayat	*see* El Qanayat	—		—	—
El Kanayis	RED SEA	25	00	33	19
El Khanafis	EL WADI EL GEDEED	15-18 km. E of Qasr el Farafara			
El Khanka	QALYUBIYA	30	13	31	21
El Kharga	EL WADI EL GEDEED	25	26	30	33
El Khatatba	BEHEIRA	30	23	30	50
El Kom el Ahmar	GIZA	30	17	31	16
El Koror	*see* Aswan				
El Kossaima	*see* El Quseima				
El Kubri	SUEZ	30	02	32	33
El Kunaiyisa (Kuneisa)	GIZA	29	59	31	11
El Kuntila	SINAI	30	00	34	41
El Kuraimat	GIZA	29	18	31	13
El Labban	*see* Alexandria				
El Lisht Pyramid	GIZA	29	34	31	14
El Magedla	*see* Beni Magdul				
El Maghra (Moghra)	MATRUH	30	15	28	55
El Mahariq	EL WADI EL GEDEED	25	37	30	39
El Malfa (Ain Melfa)	MATRUH	29	45	24	50

Locality	Governorate	N Lat.		E Long.	
		( )	( )	( )	( )
El Mandara	ALEXANDRIA	31	13	30	41
El Manshiya	ALEXANDRIA	31	15	30	01
El Mansuriya	GIZA	30	08	31	05
El Maragi (Maraqi)	MATRUH	29	14	25	19
El Maraziq	GIZA	29	49	31	16
El Marg	QALYUBIYA	30	09	31	20
El Mawhoub	*see* Gharb el Mawhoub	—	—	—	—
El Mehalla el Kubra	*see* Mehalla el Kubra	—	—	—	—
El Mellaha	RED SEA	28	12	33	10
El Miharraqa	ASWAN	23	03	32	44
El Minya (Minia)	MINYA	28	06	30	45
El Mishigeiga	EL FAIYUM	29	07	30	27
El Mitimdiya	GIZA	30	03	31	10
El Muhsib	*see* Ain Musib Nabbut	—	—	—	—
El Muntazah	ALEXANDRIA	31	17	30	01
El Naqb el Abyad	MATRUH	29	27	26	20
El Naqb el Ahmar	MATRUH	29	29	26	25
El Nassariya	EL FAIYUM	29	21	30	41
El Qanayat	SHARQIYA	30	37	31	28
El Qantara	SINAI	30	51	32	19
El Qantara	ISMAILIA	30	52	32	18
El Qarasat	MATRUH	5 km. SE of Abu Mena			
El Qaraya	*see* Bir Victoria	—	—	—	—
El Qasr	GIZA	28	21	28	51
El Qatta	GIZA	30	13	30	58
El Quseima (Kossaima)	SINAI	30	40	34	22
El Quweirat el Sud	MATRUH	20 km. SE of Qaret el Mashruka			
El Raba (El Rabba)	*see* Gebel El Rabbah	—	—	—	—
El Rammak Dune	MATRUH	29	34	29	17
El Ras el Ahmar	SINAI	30	59	33	48
El Saboua Temple (El Sibu)	ASWAN	22	45	32	34
El Saff	GIZA	29	34	31	18
El Salhiya	SHARQIYA	29	26	31	14
El Saqiya (Saghee station)	RED SEA	26	44	32	53
El Shallufa	SUEZ	30	07	32	34
El Sheb	*see* Bir el Shab	—	—	—	—
El Sheikh Ibada	MINYA	27	48	30	52
El Sheikh el Waly	EL WADI EL GEDEED	5 km. E of Mut			
El Sibu	*see* El Saboua Temple	—	—	—	—
El Tabin	GIZA	29	47	31	18
El Tahreer (Tahrir)	TAHREER	30	40	30	15
El Talbia (Talbiya)	GIZA	30	46	30	52
El Taramsa	QENA	26	08	32	42
El Tarrana	BEHEIRA	30	26	30	50
El Wilidiya	ASYUT	27	12	31	10
El Zeitun	MATRUH	29	10	25	47

Locality	Governorate	N Lat. ( )	( )	E Long. ( )	( )
Ezbet Abu Zeid	EL FAIYUM	not found			
Ezbet Afifi Pasha	GIZA	30	08	31	02
Ezbet Ayub Ali	EL FAIYUM	not found			
Ezbet Beni Salami	*see* Beni Salami	—	—	—	—
Ezbet el Asfar	EL FAIYUM	not found			
Ezbet Ibhsan	QALYUBIYA	not found			
Ezbet Moneib	*see* Giza	—	—	—	—
Ezbet Muhsib	*see* Ain Muhsib Nabbut	—	—	—	—
Ezzeit (Marsa ez Zeitiya)	RED SEA	27	50	33	35
Faiyum (Feyum)	EL FAIYUM	29	19	30	48
Fani	SUEZ	not found			
Fanus	EL FAIYUM	29	32	30	58
Faqus	SHARQIYA	30	44	31	48
Farafara Oasis	*see* Qasr el Farafara	—	—	—	—
Faras	Sudan. NORTHERN	22	10	31	27
Faraskur (Fariskur)	DAMIETTA	31	20	31	43
Farshout (Farshut)	QENA	26	03	32	09
Fassulet Misaada	MATRUH	29	27	29	12
Fawakhir Mine	RED SEA	26	01	33	36
Fayid	ISMAILIA	30	20	32	18
Feiran Oasis	SINAI	28	42	33	38
Fersh Sheikh el Arab	SINAI	not found			
Fort Capuzzo	Lybia. CYRENAICA	31	33	25	04
Foum el Khalig (Old Cairo)	*see* Cairo	—	—	—	—
French Camp No. 2	MATRUH	29	47	27	23
Fuwa	BEHEIRA	31	12	30	33
Gabub (Qeigab)	MATRUH	29	35	24	56
Ganah	EL WADI EL GEDEED	25	20	30	31
Gara	*see* Qara	—	—	—	—
Gardaga	*see* Hurgadah	—	—	—	—
Gattah	EL FAIYUM	not found			
Gebel Abraq	RED SEA	23	23	34	45
Gebel Abu Dokhan (Dukhan)	RED SEA	27	13	33	16
Gebel Abu Harba	RED SEA	27	17	33	13
Gebel Abu Tiyur	RED SEA	25	43	34	16
Gebel Adda	ASWAN	22	16	31	36
Gebel Ain	ASWAN	not found			
Gebel Akheider	RED SEA	29	44	32	11
Gebel Ambish	BENI SUEF	not found			
Gebel Aradia	RED SEA	26	20	33	29
Gebel Asoteriba (Asotriba)	Sudan. KASSALA	21	51	36	30
Gebel Ataqa	SUEZ	29	55	32	20
Gebel Baba (el Babar)	SINAI	29	16	33	43
Gebel Catherine (Katrina)	SINAI	28	31	33	57
Gebel Deshesha (Dishasha)	BENI SUEF	28	59	30	51
Gebel Dhalfa (Dalfah)	SINAI	30	45	34	12
Gebel Dhulal (Dhalal, Dalal)	SINAI	28	54	33	54
Gebel Drunka (Durunka)	ASYUT	27	07	31	10

Locality	Governorate	N Lat.		E Long.	
		( )	( )	( )	( )
Gebel Egma	SINAI	29	12	34	02
Gebel el Ahmar	CAIRO	30	03	31	18
Gebel Elba	SUDAN ADMIN.	22	11	36	21
Gebel el Bruk (Buruk)	SINAI	30	11	33	42
Gebel el Ghigiga	GIZA	30	01	31	02
Gebel el Haridi	SOHAG	26	47	31	55
Gebel el Katamiya (Kutamiya)	SUEZ	29	56	31	49
Gebel el Rabbah	SINAI	30	01	33	11
Gebel el Silsila	ASWAN	24	38	32	56
Gebel el Themed (Yithmid)	SINAI	29	42	34	23
Gebel Faraid	RED SEA	23	31	35	20
Gebel Ferani	SINAI	not found			
Gebel Genawi	SINAI	not found			
Gebel Gharib	RED SEA	28	07	32	54
Gebel Gurdi	*see* Ras Abu Gurdi	–		—	—
Gebel Hamata	RED SEA	24	12	35	00
Gebel Hammami	SINAI	29	12	32	58
Gebel Hamra	SINAI	28	35	34	30
Gebel Hamra Dom	SUDAN ADMIN.	22	39	35	39
Gebel Hebron	SINAI	28	33	33	37
Gebel Hindusi	RED SEA	25	51	34	14
Gebel Hisse (Isse, Is)	Sudan. KASSALA	21	55	35	29
Gebel Hor (Har)	SINAI	29	53	32	56
Gebel Horeb	SINAI	W of Gebel Musa			
Gebel Hormadjan	SINAI	not found			
Gebel Iweibid (Oweibid, Awabed)	SUEZ	30	06	32	09
Gebel Katamiya (Kutamiya)	SUEZ	29	56	31	49
Gebel Lehfan (Lahfan)	SINAI	31	01	33	52
Gebel Magal Gabril	ASWAN	22	53	33	36
Gebel Maghara	SINAI	30	42	33	23
Gebel Mokattam	CAIRO	30	02	31	17
Gebel Muluk	BEHEIRA	31	21	30	18
Gebel Muqsim	SUDAN ADMIN.	22	10	34	01
Gebel Musa (Moosa) (Mount Sinai)	SINAI	28	32	33	59
Gebel Naqud	SUEZ	not found			
Gebel Nesla	SUDAN ADMIN.	22	15	36	16
Gebel Nugrus	RED SEA	24	49	34	36
Gebel Qattar	RED SEA	27	05	33	22
Gebel Serbal	SINAI	28	39	33	39
Gebel Shallal (Shellal)	SUDAN ADMIN.	22	01	36	31
Gebel Shayeb (Shayeb el Banat)	RED SEA	26	59	33	29
Gebel Shindeib (Shendib)	SUDAN ADMIN.	22	01	36	17
Gebel Shubrawit	ISMAILIA	30	17	32	17
Gebel Sukhna	*see* Khashm el Galala	–		–	
Gebel Tarbush	SINAI	28	36	33	50
Gebel Umm Afruth	SINAI	29	10	34	15
Gebel Umm Alawi	SINAI	28	34	34	02

Locality	Governorate	N Lat. (°)	(′)	E Long. (°)	(′)
Gebel Umm Boanik	SINAI(?)	not found			
Gebel Umm Disi	RED SEA	27	02	33	15
Gebel Umm Gidri	RED SEA	26	58	33	36
Gebel Umm Harba	RED SEA	23	37	34	31
Gebel Umm Kibash	*see* Bir Umm Kibash	—	—	—	—
Gebel Umm Rijlein	SINAI	not found			
Gebel Umm Shomer	SINAI	28	22	33	55
Gebel Umm Tenassib	RED SEA	28	30	32	34
Gebel Uweinat	EL WADI EL GEDEED	21	54	24	58
Gebel Yelleq (Yiallaq)	SINAI	30	22	33	31
Gebel Yithmid	*see* Gebel el Themed	—	—	—	—
Gebel Zabara	SINAI	24	45	34	42
Gemsa	RED SEA	27	38	33	35
Gezira Seud	SHARQIYA	30	50	32	16
Geziret Muhamed	GIZA	30	07	31	12
Gharah	EL FAIYUM	29	08	30	42
Gharb el Mawhoub	EL WADI EL GEDEED	25	40	28	45
Gharb el Qattaniya	*see* Camel Pass Dune	—	—	—	—
Ghardaqa	*see* Hurghada	—	—	—	—
Giarabub (Garabub)	Libya. CYRENAICA	29	45	24	33
Gilf el Kebir	EL WADI EL GEDEED	23	27	26	00
Giza	GIZA	30	01	31	13
Giza Pyramids	GIZA	29	59	31	08
Giza Zoological Gardens	*see* Giza	—	—	—	—
Gizzaya	*see* Giza	—	—	—	—
Gobala	GIZA	13 km. E of Bawiti			
Guttar	*see* Bir or Gebel Qattar	—	—	—	—
Habou City Temple	*see* Luxor	—	—	—	—
Hafs	BEHEIRA	31	00	30	20
Haid Merzega Pass	SINAI	not found			
Haimur wells	*see* Bir Haimur	—	—	—	—
Halaib	SUDAN ADMIN.	22	13	36	38
Halfaya	MATRUH	31	30	25	11
Hammam Musa	SINAI	28	17	33	55
Hatiyet el Sheikh Marzuk	EL WADI EL GEDEED	26	49	27	51
Hatiyet el Sunt (Acacia grove)	MINYA	28	26	29	42
Hatiyet Labbaq	MATRUH	30	20	28	36
Hatiyet Tabany	GIZA	not found			
Hawamdiya (Hawamidiya)	GIZA	29	54	31	15
Heliopolis	CAIRO	30	06	31	20
Helwan	CAIRO	29	51	31	20
Herwer	*see* El Sheikh Ibada	—	—	—	—
Hibis Temple	*see* El Kharga	—	—	—	—
Hod Subeira (Abu Sobeira)	ASWAN	24	13	32	53
Hurghada (Ghardaqa)	RED SEA	27	14	33	50
Idfina	BEHEIRA	31	18	30	31
Idku	BEHEIRA	31	18	30	18
Idwa (Idwah)	EL FAIYUM	29	19	30	52

Locality	Governorate	N Lat.		E Long.	
		( )	( )	( )	( )
Ilwat Hawa	MATRUH	30	41	29	17
Imbaba	GIZA	30	04	31	13
Ismailia	ISMAILIA	30	35	32	16
Isna (Esna)	QENA	25	18	32	33
Kafr Abu Sir	QALYUBIYA	not found			
Kafr Ammar	GIZA	29	30	31	14
Kafr Daoud (Dawud)	BEHEIRA	30	28	30	49
Kafr el Battikh	DAMIETTA	31	24	31	44
Kafr el Dawar	BEHEIRA	31	10	30	09
Kafr el Sheikh	KAFR EL SHEIKH	31	07	30	56
Kafr el Shobak	QALYUBIYA	30	17	31	19
Kafr el Shurafa	QALYUBIYA	30	22	31	20
Kafret el Gebel	GIZA	29	58	31	09
Kafret Nassar	GIZA	30	00	31	08
Kafr Hakim	GIZA	30	05	31	07
Kafr Teharmes	GIZA	30	01	31	11
Kaiman el Matana	QENA	25	49	32	43
Kalabsha	ASWAN	23	33	32	52
Kalamsha	EL FAIYUM	not found			
Karawein	EL WADI EL GEDEED	27	06	28	32
Karkur Murr	Sudan. NORTHERN	21	53	25	06
Karkur Tahl	EL WADI EL GEDEED	22	02	25	08
Karmouz	*see* Alexandria	—	—	—	—
Karnak Temple	*see* Luxor	—	—	—	—
Kasr Rashwan	*see* Qasr Rashwan	—	—	—	—
Kasr Saghig	*see* Zaghig	—	—	—	—
Katamiya Canyon	*see* Wadi el Katamiya	—	—	—	—
Keneh	*see* Qena	—	—	—	—
Khabra Abu Guzour (Gazour)	SINAI	31	00	34	20
Khanka	*see* El Khanka	—	—	—	—
Kharga Oasis	*see* El Kharga	—	—	—	—
Khartoum	Sudan. KHARTOUM	15	40	32	35
Khashm el Galala	SUEZ	29	34	32	20
Khor Abusku	ASWAN	23	13	32	52
Khor Asot	Sudan. KASSALA	18	18	36	10
Khor el Madiq	*see* Madiq	—	—	—	—
Khor el Sil	ASWAN	not found			
Khor Musa Pasha	Sudan. NORTHERN	21	51	31	16
Khor Rhama el Bahari	ASWAN	23	33	32	53
Kirdasa	GIZA	30	02	31	07
Kittar	*see* Bir or Gebel Qattar	—	—	—	—
Kom Ashmun	EL FAIYUM	29	18	30	58
Kom Aushim	*see* Kom O Shim	—	—	—	—
Kom el Hanash	BEHEIRA	30	59	30	03
Kom Hamada	BEHEIRA	30	46	30	42
Kom Ombo	ASWAN	24	28	32	57
Kom Ombo Temple	*see* Kom Ombo	—	—	—	—
Kom O Shim (Kom Aushim)	EL FAIYUM	29	34	30	55

Locality	Governorate	N Lat. (°)	N Lat. (')	E Long. (°)	E Long. (')
Kom O Shim Forest	*see* Kom Oshim	—	—	—	—
Korosko	ASWAN	22	36	32	20
Kosseima	*see* El Kosseima	—	—	—	—
Kosseir	*see* Quseir	—	—	—	—
Kubra Abu Guzoar	*see* Khabra Abu Guzour	—	—	—	—
Kuneissa	*see* El Kunaiyisa	—	—	—	—
Kuntila	SINAI	30	00	34	41
Kurkur Oasis	ASWAN	23	54	32	19
Lake Burullus	KAFR EL SHEIKH	31	30	30	50
Lake Idku	*see* Idku	—	—	—	—
Lake Qarun (Kurun) (Birket Qarun)	EL FAIYUM	29	28	30	40
Lake Timsah	ISMAILIA-SINAI	30	34	32	17
Luxor	QENA	25	41	32	39
Maadi	CAIRO	29	58	31	15
Maatin el Garawla	MATRUH	31	14	27	24
Madiq	ASWAN	22	44	32	09
Maghagha	MINYA	28	39	30	50
Maidum	BENI SUEF	29	22	31	10
Mallawi (Mellawi)	MINYA	27	44	30	50
Mandisha	MATRUH	28	21	28	55
Manfalut (Monfalut)	ASYUT	27	19	30	58
Manshiyet Radwan	GIZA	30	09	31	02
Maqdabah (Magdaba)	SINAI	30	53	34	02
Maragi (Maraqi)	MATRUH	29	14	25	19
Marsaba	MATRUH	not found			
Maryiut (Mariut)	ALEXANDRIA	31	01	29	48
Mazraet el Gebel el Asfar	QALYUBIYA	not found			
Mehalla el Kubra	*GHARBIYA*	*30*	*58*	*31*	*10*
Mena (Mina)	GIZA	29	58	31	08
Mersa el Alem (Alam)	RED SEA	25	04	34	54
Mersa Matruh	MATRUH	31	21	27	14
Mex	ALEXANDRIA	31	09	29	51
Mina el Basal	*see* Alexandria	—	—	—	—
Mina el Qamh	SHARQIYA	30	30	31	15
Minqar Abu Dweiss	MATRUH	30	24	28	32
Minqat Tukh	*see* Tukh	—	—	—	—
Minshat Beni Osman	EL FAIYUM	not found			
Minshat el Amir (Mohamed Ali Pasha)	EL FAIYUM	not found			
Minshat el Bakkari	GIZA	30	01	31	08
Minshat el Ikhwa	DAQAHLIYA	30	56	31	21
Minshat Tantawi	EL FAIYUM	not found			
Minuet el Sultan (Minyet el Sultan)	GIZA	not found			
Minuf	MINUFIYA	30	28	30	56
Misaada Dune	MATRUH	29	25	29	05
Mit Faris	MINUFIYA	30	37	31	03

Locality	*Governorate*	N Lat. (°)	(′)	E *Long.* (°)	(′)
Mit Ghamr	DAQAHLIYA	30	43	31	16
Mit Riheina	GIZA	29	51	31	15
Mohammed Ali Barrage Park	MINUFIYA	30	12	31	07
Moiyet Luliya (Pearl's Spring)	SINAI	not found			
Mokattam Hills	*see* Gebel Mokattam	—	—	—	—
Monfalut (Monafalut)	*see* Manfalut	—	—	—	—
Mt. Sinai	*see* Gebel Musa	—	—	—	—
Mudrit el Tahreer	*see* El Tahreer	—	—	—	—
Muneiha	ASWAN	24	29	32	53
Mut	EL WADI EL GEDEED	25	29	28	59
Nadir	MINUFIYA	30	33	30	51
Nag Ayed	*see* Farshout	—	—	—	—
Nag Farqanda West	ASWAN	22	23	31	45
Nag Misaw	ASWAN	22	22	31	42
Nahya	GIZA	30	03	31	07
Naikhala	ASWAN	not found			
Nakhl (Nekhl)	SINAI	29	55	33	45
Nakhlat el Barraq	MATRUH	30	27	29	32
Naqb Abu Dweis	MATRUH	30	27	28	34
Naqb Baraq (Barach)	SINAI	not found			
Nasser Village (Nasier)	EL WADI EL GEDEED	20 km. S of Kharga			
Nawa	QALYUBIYA	30	14	31	16
Nefisha (Nafisha)	ISMAILIA	30	34	32	15
Nohel	SINAI	not found			
Nubareia	TAHREER	30	43	30	46
Nuweibah (Nuheibeh)	SINAI	28	58	34	39
Nuweimisa	MATRUH	28	42	26	44
Old Qena	RED SEA	ruins 20 km. S of El Saqiya			
Paris	*see* Baris	—	—	—	—
Port Said	PORT SAID	31	16	32	18
Port Tawfik (Taufiq, Tewfiq)	SUEZ	29	57	32	34
Qalama	QALYUBIYA	30	13	31	12
Qalamsha(h)	FAIYUM	29	10	30	50
Qalt Umm Disi	RED SEA	27	00	33	15
Qalyub	QALYUBIYA	31	11	31	13
Qanatir	*see* Shibin el Qanatir	—	—	—	—
Qara (Gara)	MATRUH	29	37	26	31
Qaret el Ided (Idad)	MATRUH	29	55	28	54
Qaret el Mashruka	MATRUH	30	16	29	32
Qaret Sumara	MATRUH	30	21	29	05
Qasr el Farafara	EL WADI EL GEDEED	27	03	27	58
Qasr el Gebali	EL FAIYUM	29	20	30	38
Qasr el Qatagi	MATRUH	30	32	29	39
Qasr el Sagha	EL FAIYUM	29	36	30	40
Qasr Qarun	EL FAIYUM	29	25	30	25
Qasr Rashwan	EL FAIYUM	29	30	30	55
Qasr Saghig	*see* Zaghig	—	—	—	—

Locality	Governorate	N Lat. (°)	N Lat. (′)	E Long. (°)	E Long. (′)
Qeigab	*see* Gabug	—	—	—	—
Qena (Kenah, Kina, Qina)	QENA	26	10	32	43
Qokshira	*see* Qasr el Farafara	—	—	—	—
Quo Monastery	SINAI	28	25	34	00
Qur el Hilab	MATRUH	30	21	29	17
Quseir (Kosseir)	RED SEA	26	06	34	17
Qustul and Qustul west	ASWAN	22	14	31	39
Qusur el Banat	RED SEA	25	55	33	16
Quweisna (Quesna)	MINUFIYA	30	34	31	09
Rafa	SINAI	31	17	34	14
Ramleh	ALEXANDRIA	31	14	29	58
Raqabet el Halif	MATRUH	30	44	29	40
Raqabet el Rala	MATRUH	30	21	28	52
Ras Abu el Darag	SUEZ	29	23	32	33
Ras Abu Gurdi (Gebel Gurdi)	RED SEA	24	00	35	05
Ras Abu Rudeis (Rudeis-Sidri Oilfield)	SINAI	28	59	33	10
Ras Banas	RED SEA	23	54	35	48
Ras el Bar	DAMIETTA	31	32	31	50
Ras el Hekma (Hikma)	MATRUH	31	20	27	50
Ras el Ish (Esh)	PORT SAID	31	08	32	18
Ras el Kanayis	*see* Ras el Hekma	—	—	—	—
Ras el Naqb	SINAI	29	36	34	51
Ras el Sudar	SINAI	29	36	32	40
Ras Gharib	RED SEA	28	21	33	06
Ras Gurdi	RED SEA	not found			
Rashid	*see* Rosetta	—	—	—	—
Ras Jehan (Gihan)	*see* Abu Durba Mine	—	—	—	—
Ras Muhammed (Mohammad)	SINAI	27	44	34	15
Ras Zafarana (Zaafarana)	RED SEA	29	07	32	39
Redunkalil Tutuatee	MATRUH	29	11	25	34
Risan Aneiza (Risan Eineiza)	SINAI	30	54	33	44
Rishon el Zion	ISRAEL	31	57	34	48
Romani (Rumana)	SINAI	31	00	32	40
Rosetta (Rashid)	BEHEIRA	31	24	30	25
Royal Shooting Club	*see* Kom O Shim	—	—	—	—
Safaga	RED SEA	26	44	33	56
Saft el Laban	GIZA	30	02	31	10
Saghee Station	*see* El Sagiya	—	—	—	—
Sakkara (Saqqara)	GIZA	29	51	31	13
Salum (Sollum)	MATRUH	31	34	25	09
Samaket Gaballa	MATRUH	30	28	29	05
Samalut	MINYA	28	18	30	42
San el Haggar	SHARQIYA	30	58	31	52
Saqyet Abu Shara	MINUFIYA	30	19	31	05
Seket Meki (Saqyat Makki)	GIZA	30	00	31	13
Seila	EL FAIYUM	29	21	30	58
Seiyala (Seyala and Seiyala West)	ASWAN	22	59	32	40

Locality	Governorate	N Lat.		E Long.	
		( )	( )	( )	( )
Shadwan Island	RED SEA	27	30	33	59
Shakshuk	EL FAIYUM	29	28	30	42
Sharabiya	*see* Cairo	—	—	—	—
Shata	DAMIETTA	31	25	31	52
Shatt el Mel	DAMIETTA	not found			
Shatt Gheit el Nasara	DAMIETTA	31	24	31	49
Sherbin (Shirbin)	GHARBIYA	31	11	31	32
Shibin el Qanatir	QALYUBIYA	30	19	31	19
Shubra Shihab	QALYUBIYA	30	17	31	07
Sidi Abd el Rahman	MATRUH	30	58	28	44
Sidi Barrani	MATRUH	31	36	25	55
Simbillawein	DAQAHLIYA	30	53	31	32
Sinnuris	EL FAIYUM	29	25	30	52
Sitra	MATRUH	28	42	26	54
Siwa and Siwa Oasis	MATRUH	29	12	25	31
Sohag	SOHAG	26	33	31	42
St. Anthony Monastery	RED SEA	28	56	32	21
St. Catherine Monastery	SINAI	28	31	33	57
St. Paul Monastery	RED SEA	28	51	32	33
Suez	SUEZ	29	58	32	33
Surarieh	BENI SUEF	not found			
Suweira	SINAI	29	15	34	43
Tahreer Forest	EL FAIYUM	not found			
Talbia	GIZA	30	00	31	11
Talha Station	*see* Kom Hamada	—	—	—	—
Talh el Fawakhir (Acacia Grove)	MATRUH	29	45	26	38
Tamiya	EL FAIYUM	29	29	30	58
Tanash	GIZA	30	08	31	11
Tanta	GHARBIYA	30	47	31	00
Tel Abu Ekaim (Akim)	SHARQIYA	30	51	32	06
Tel Basta	SHARQIYA	30	34	31	31
Tel el Amarna	MINYA	27	39	30	58
Tel el Kebir	SHARQIYA	30	33	31	47
Tellat Gimal	SINAI	not found			
Tel Khamis or Saad Khamis	KAFR EL SHEIKH	not found			
Thebes	*see* Luxor	—	—	—	—
Tor (El Tur)	SINAI	28	14	33	37
Toura (Tura) Cliffs	CAIRO	29	56	31	19
Tukh (Mingat Tukh)	QALYUBIYA	30	50	31	06
Umm Bugma (Umm Bogma, Ambogma)	SINAI	28	59	33	21
Umm Shilman Plains	ASWAN	22	40	33	45
Uyun Tablimun	GIZA	28	02	28	44
Valley of the Kings	QENA	25	44	32	36
Wadi Aad	SINAI	not found			
Wadi Abbad	*see* Bir Abbad	—	—	—	—
Wadi Abu Aweigila	SINAI	29	20	31	29
Wadi Abu Hor	ASWAN	23	29	32	57

Locality	Governorate	N Lat. (°)	(′)	E Long. (°)	(′)
Wadi Abu Kaleja (Khalifa, Haleifa)	RED SEA	26	55	31	45
Wadi Abu Quraiya	RED SEA	25	16	33	59
Wadi Abu Sanduq	*see* Bir Abu Sanduq	—	—	—	—
Wadi Abu Seyala	*see* Bir Abu Seyala	—	—	—	—
Wadi Abu Shaar	*see* Bir Abu Shaar	—	—	—	—
Wadi Abu Sheeh	RED SEA	26	42	33	36
Wadi Abusku	*see* Khor Abusku	—	—	—	—
Wadi Abu Subeira	*see* Hod Subeira	—	—	—	—
Wadi Abu Zawal	*see* Bir Abu Zawal	—	—	—	—
Wadi Abu Zeitouna (Zaitouna)	SINAI	28	23	33	58
Wadi Abu Ziran (Zeiran)	RED SEA	26	09	33	58
Wadi Adani	SINAI	not found			
Wadi Adeib	SUDAN ADMIN.	22	15	36	26
Wadi Ain el Gefeef	SINAI	not found			
Wadi Akwamtra	*see* Bir Akwamtra	—	—	—	—
Wadi Aleyat	SINAI	28	41	33	41
Wadi Allaqi	*see* Allaqi Village	—	—	—	—
Wadi Ambagi	RED SEA	not found			
Wadi Aqaba	EL WADI EL GEDEED	23	28	25	48
Wadi Araba	*see* Bir Zafarana	—	—	—	—
Wadi Araba	SINAI	28	19	33	31
Wadi Aruba	SINAI	28	58	34	14
Wadi Atallah	RED SEA	26	03	33	36
Wadi Bada	SUEZ	29	43	32	16
Wadi Bali	RED SEA	27	27	33	39
Wadi Bir el Abd	SUEZ	29	32	32	22
Wadi Daffeti (Defeit)	SUDAN ADMIN.	22	13	34	11
Wadi Dalma	SINAI	not found			
Wadi Darawena	SUDAN ADMIN.	22	11	36	22
Wadi Digla	CAIRO	29	58	31	18
Wadi Dihmit	*see* Bir Umm Hibal	—	—	—	—
Wadi Diib (Dib, Kiraf)	SUDAN ADMIN.	22	28	36	06
Wadi Dom (Doam, Doum)	SUEZ	29	26	32	20
Wadi el Abyad	RED SEA	not found			
Wadi el Arbaein (Arbain)	SINAI	28	32	33	57
Wadi el Arish	*see* El Arish	—	—	—	—
Wadi el Asyuti (Assiuti)	ASYUT	27	10	31	16
Wadi el Atrash	RED SEA	26	39	32	46
Wadi el Baharri (Bahharah)	SUEZ	30	01	32	26
Wadi el Deir	RED SEA	28	54	32	40
Wadi el Farigh (Faregh)	BEHEIRA	30	13	30	20
Wadi el Gafra	SUEZ	30	24	31	36
Wadi el Ghazal	MATRUH	south of Sidi Barrani			
Wadi el Gindali	*see* Bir Gindali	—	—	—	—
Wadi el Gosa (Gossal)	RED SEA	27	10	33	05
Wadi el Hammamat	*see* Bir el Hammamat			—	—

Locality	Governorate	N Lat. (°)	(')	E Long. (°)	(')
Wadi el Katamiya	SUEZ	29	58	31	49
Wadi el Kharig (Rhatakit)	SINAI	29	03	33	22
Wadi el Laqeita	QENA	25	52	33	07
Wadi el Melik (Abd el Malik)	EL WADI EL GEDEED	23	50	25	18
Wadi el Nasouri	SUEZ	30	10	31	29
Wadi el Natroun (Natron, Natrun)	BEHEIRA	30	25	30	13
Wadi el Nil	RED SEA	29	20	32	35
Wadi el Qreiya (Qurrayyah)	RED SEA	26	20	32	46
Wadi el Raba (Raha)	SINAI	29	55	32	50
Wadi el Rayan (Raiyan)	EL FAIYUM	29	05	30	20
Wadi el Rokham	SUEZ	25	22	32	21
Wadi el Sheikh	SINAI	28	44	33	50
Wadi el Sheikh Isa	QENA	26	12	32	39
Wadi el Targama (Targamy)	ASWAN	22	55	33	10
Wadi Ergein (Ergayn)	SINAI	not found			
Wadi er Rimm	SINAI	not found			
Wadi Esserba (Heisurba)	RED SEA	not found			
Wadi Eteigan	SUDAN ADMIN.	22	07	36	03
Wadi Ethmiemat	SINAI	not found			
Wadi Fatira (Fatiri)	*see* Bir Fatira	—	—	—	—
Wadi Fatira el Zarka	RED SEA	26	50	33	20
Wadi Feiran	SINAI	28	45	33	25
Wadi Fertili	RED SEA	27	08	31	40
Wadi Figo (Fegar, Beint el Fegue)	SUDAN ADMIN.	22	15	35	10
Wadi Gabgaba	ASWAN	22	37	33	17
Wadi Garawi (Gerrawi)	CAIRO	29	47	31	19
Wadi Gazzah (Ghazzah)	SINAI	31	25	34	25
Wadi Geba	SINAI	not found			
Wadi Gedeiret	*see* Ain Gedeirat	—	—	—	—
Wadi Gemal	RED SEA	24	40	35	06
Wadi Ghadir	*see* Bir Ghadir	—	—	—	—
Wadi Gharandal (Shurandel)	SINAI	29	20	33	00
Wadi Ghorabi	GIZA	28	29	29	02
Wadi Ghozah	RED SEA	26	59	33	12
Wadi Ghuweibba (Ghweibba)	SUEZ	29	36	32	20
Wadi Gindali	*see* Bir Gindali	—	—	—	—
Wadi Gossal	*see* Wadi el Gosa	—	—	—	—
Wadi Graygar	RED SEA	not found			
Wadi Gumbiet	*see* Bir Gumbiet	—	—	—	—
Wadi Gurdi	RED SEA	26	40	32	4.
Wadi Habib (Habeeb)	RED SEA	27	11	31	46
Wadi Hagul	SUEZ	29	42	32	22
Wadi Haimur Mine	ASWAN	22	36	33	17
Wadi Halfa	Sudan, NORTHERN	21	56	31	20
Wadi Hammad	RED SEA	26	48	32	46
Wadi Hamra	EL WADI EL GEDEED	23	50	25	26
Wadi Hanjurat el Gattar	Israel	30	47	34	58

Locality	Governorate	N Lat. (°)	(′)	E Long. (°)	(′)
Wadi Hareidin (Hereidin)	SINAI	30	59	33	53
Wadi Hebron (Hibron)	SINAI	28	31	33	42
Wadi Hennis	EL WADI EL GEDEED	27	24	28	16
Wadi Hodein	RED SEA	23	04	35	30
Wadi Hof (Hoaf)	CAIRO	29	53	31	18
Wadi Hor (Or)	ASWAN	22	15	31	50
Wadi Ibib	SUDAN ADMIN.	22	50	35	46
Wadi Iseili	SUEZ	30	04	31	55
Wadi Isla (Isleh, Ishli)	SINAI	28	08	33	43
Wadi Kansisrob	*see* Bir Kansisrob	—	—	—	—
Wadi Kharit	RED SEA	24	26	33	03
Wadi Kid (Kyd)	SINAI	28	07	34	30
Wadi Kiraf	*see* Wadi Diib	—	—	—	—
Wadi Kurkur	ASWAN	23	56	32	35
Wadi Labaq	MATRUH	30	20	28	32
Wadi Lahami (Lehema)	RED SEA	24	13	35	25
Wadi Magal Gabril	ASWAN	22	53	33	36
Wadi Markh (Merkh)	RED SEA	26	21	33	03
Wadi Medisa	RED SEA	26	55	33	10
Wadi Mellaha	*see* Bir Mellaha	—	—	—	—
Wadi Midhais	RED SEA	not found			
Wadi Mishigeiga	EL FAIYUM	29	07	30	27
Wadi Mitgal	RED SEA	not found			
Wadi Muktil (Muqtil)	RED SEA	24	25	34	00
Wadi Muwellih	*see* Bir Samweil	—	—	—	—
Wadi Naam	RED SEA	23	18	34	59
Wadi Nagib	*see* Bir Nagib	—	—	—	—
Wadi Nakl (Nakhl)	SUEZ	29	32	32	22
Wadi Naqud	RED SEA	not found			
Wadi Nasb	SINAI	28	28	34	08
Wadi Nasli (Nesle)	SINAI	not found			
Wadi Nasouri	*see* Wadi el Nasouri	—	—	—	—
Wadi Nasr	SUEZ	29	31	32	23
Wadi Nassim	QENA	25	15	32	27
Wadi Nekla	MATRUH	not found			
Wadi Nogdeb (Nujdayb)	ASWAN	23	15	33	07
Wadi Onib (Onibe)	Sudan. KASSALA	21	31	35	56
Wadi Qasab (Gusab)	RED SEA	26	19	32	02
Wadi Qattar	*see* Bir Qattar	—	—	—	—
Wadi Qena	*see* Qena	—	—	—	—
Wadi Qiseib	*see* Bir Qiseib	—	—	—	—
Wadi Quleib	ASWAN	22	47	33	12
Wadi Rad Ayia	*see* Qusur el Banat	—	—	—	—
Wadi Raha	SINAI	28	34	33	57
Wadi Rahaba	SINAI	28	25	34	00
Wadi Rished (Reshid)	SINAI	not found			
Wadi Rishrash (Rashrash)	RED SEA	29	29	31	16
Wadi Saal	SINAI	28	45	34	27

Locality	Governorate	N Lat. (°) (′)	E Long. (°) (′)
Wadi Salafe (Solaf)	SINAI	28 38	33 47
Wadi Saqi	RED SEA	26 21	33 52
Wadi Sceitun	*see* Bir Sheitun	— —	— —
Wadi Satakh	SINAI	not found	
Wadi Semna	*see* Bir Semna	— —	— —
Wadi Seqel	RED SEA	not found	
Wadi Serimtai	SUDAN ADMIN.	22 12	36 28
Wadi Shait	RED SEA	24 33	33 01
Wadi Shawak	RED SEA	not found	
Wadi Sheitun (Scietun)	*see* Bir Sheitun	— —	— —
Wadi Sheger	SINAI	not found	
Wadi Shellal	SINAI	28 56	33 18
Wadi Sibaa	ASWAN	22 45	32 34
Wadi Sidr	SINAI	29 39	32 41
Wadi Sigilliyeh	SINAI	not found	
Wadi Sikait	RED SEA	24 40	34 48
Wadi Sukari	RED SEA	25 03	34 49
Wadi Taba	SINAI	29 32	34 52
Wadi Tarfa	ASYUT	28 25	30 50
Wadi Threya	SINAI	not found	
Wadi Timar (Thiman)	SINAI	28 15	33 45
Wadi Tumilat	SHARQIYA	30 31	31 43
Wadi Umm Balad	RED SEA	not found	
Wadi Umm Delfa (Delfi)	*see* Bir Umm Delfa	— —	— —
Wadi Umm Dud	*see* Bir Umm Dud	— —	— —
Wadi Umm el Seniyat	RED SEA	not found	
Wadi Umm Had	RED SEA	26 20	33 23
Wadi Umm Huweitat	RED SEA	26 35	33 57
Wadi Umm Qareiyat	*see* Bir Umm Qareiyat	— —	— —
Wadi Umm Seleimat (Sulaymat)	RED SEA	26 16	32 45
Wadi Umm Shedak	MATRUH	not found	
Wadi Umm Sidri	RED SEA	27 54	32 33
Wadi Umm Yassar	RED SEA	not found	
Wadi Wardan	SINAI	29 30	32 43
Wadi Yesein	SUEZ	29 27	32 28
Wadi Yoider	SUDAN ADMIN.	22 17	36 18
Wadi Zeidun (Zaidun)	RED SEA	25 33	33 04
Wadi Zeidun	SINAI	not found	
Wardan	GIZA	30 19	30 54
Warraq el Arab	GIZA	30 06	31 12
Zagazig	SHARQIYA	30 35	31 31
Zaghig (Qasr Saghig)	*see* Gebel Muluk	— —	— —
Zahr el Rubin	SINAI	not found	
Zaiyan Temple	EL WADI EL GEDEED	25 12	30 32
Zawyet Abu Musallam	GIZA	29 56	31 10
Zawyet el Mithniyan	MATRUH	31 30	26 15
Zeitun	*see* El Zeitun	— —	— —

APPENDIX 6

Definitions of terms used in the text.—

Ain.—Spring (plural *Ayun*). Sometimes applied to wells and cisterns.

Bir.—Well. Sometimes applied to springs.

Darb.—Camel road.

Galt or *Qalt.*—Natural rock basin (plural *Qulut*) or hollow in rocks carved by water, together with gravel and stone.

Gebel or *Jebel.*—A hill or mountain or the desert.

Hatiyet.—Patches of vegetation in otherwise barren desert, with or without a well.

Minqar.—A promontory or outstanding part of a cliff.

Naqb.—A deep pass between cliffs from a plateau to low lands and vice versa.

Oasis.—Vegetated area with natural occurring water, with or without cultivation.

Qaret.—A small hill, pile of boulders, or isolated rock formation.

Qasr.—Literally, a palace. Used in reference to ruins.

Qur.—A conical hill or rock pile.

Tahl.—Similar in meaning to *Hatiyet*, but the area would have larger trees.

Wadi, Karkur, or *Khor.*—A gully, canyon, or valley; typically, a dry stream bed.

REFERENCES

ABD EL RAHMAN A. A. and K. H. BATANOUY
1959. The phenology of the desert in relation to environment. Bull. Inst. Desert Egypte, **9**, pp. 11-19.
1966. Microclimatic conditions in Wadi Hoff. Bull. Soc. Geogr. Egypte, **39**, pp. 137-153.

ABD EL RAHMAN A. A. and M. N. EL HADIDY
1959. Some observations on the effect of wind on the desert vegetation along Suez road. Bull. Soc. Geogr. Egypte, **32**, pp. 207-216.

ABU AL IZZ M. A.
1971. Landforms of Egypt. American University, Cairo. xv + 281 pp.

ADAMS A. L.
1870. Notes of a naturalist in the Nile Valley and Malta. Edmonston and Douglas, Edinburg xvi + 295 pp.

ADOLPH E. F. and associates
1947. Physiology of man in the desert. Interscience Publ. Inc., New York. xiii + 357 pp.

ARAL ON: B
1932. Die Muriden von Palestina und Syrien. Z. Saugetierk., **7**, pp. 166-240.

ATT F. M.
1952. Outstanding variations in rainfall on the north coast of Egypt. Bull. Inst. Fouad I Desert Egypte, **2**, pp. 5-6.

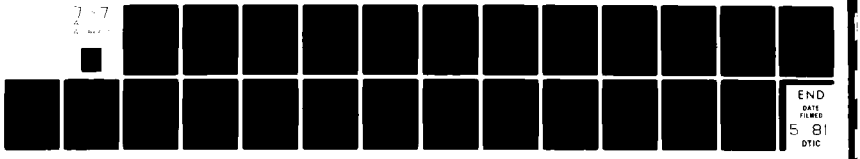
ALLEN G. M.
1915. Mammals obtained by the Phillips Palestine Expedition. Bull. Mus. Comp. Zool., Harvard, **59**, pp. 1-14.
1939. A checklist of African mammals. Bull. Mus. Comp. Zool., Harvard, **83**, pp. 1-763.

ALMASY L. E. DE
1936. Recentes exploration dans le Desert Libique (1932-1936). Publications Speciales de la Societe Royal de Geographie d'Egypte. 97 pp.

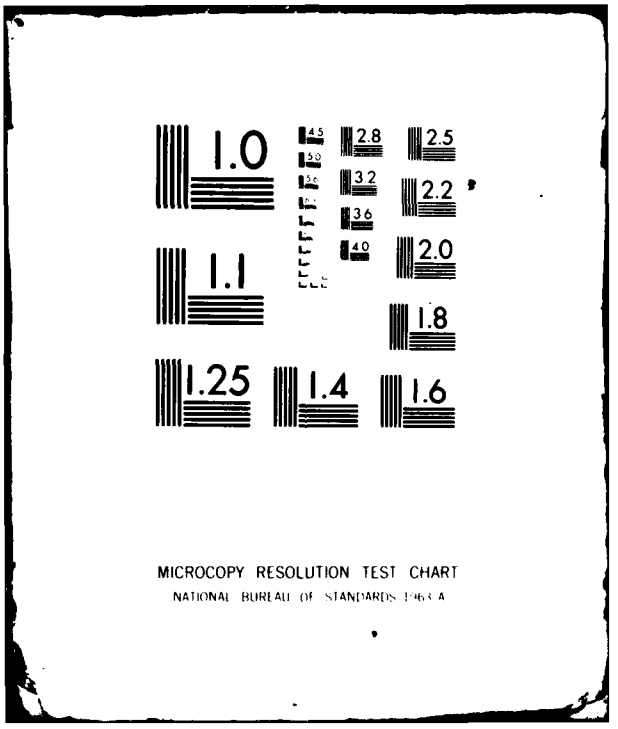
ALPINI P.
1735. Historiae Aegypti naturalis, Vol. 1. Lungundi Batavorum, Apud Gerardium Potvlie, xvi + 260 pp.

ANDERSON J.
1892. Remarks on the occurrence of *Spalax typhlus* in Africa. Proc. Zool. Soc., London, **1892**, pp. 472-476.
1897. Exhibition of a coloured drawing of, and remarks upon, the Egyptian weasel (*Mustela subpalmata*). Proc. Zool. Soc., London, **1897**, pp. 600-601.
1898. Zoology of Egypt. Vol. 1. Reptilia and Batrachia. Bernard Quaritch, London. lxv + 371 pp.

AD-A098 327 FIELD MUSEUM OF NATURAL HISTORY CHICAGO ILL F/G 6/3
THE CONTEMPORARY LAND MAMMALS OF EGYPT (INCLUDING SINAI).(U)
AUG 80 D J OSBORN, I HELMY NONR-4414(00)
UNCLASSIFIED NAMRU-3-TR.11/81 NL



END
DATE FILMED
5 81
DTIC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

1902. Zoology of Egypt: Mammalia. (Revised and completed by W. E. De Winton). Hugh Rees Ltd., London. xvii+374 pp.

ANTONIUS, O.

1937. On the geographical distribution, in former times and today, of the Recent Equidae. Proc. Zool. Soc., London, (ser. B) 107, pp. 557-564.

ASCHERSON, P. F. A.

1874. Exploration of the Libyan Desert. Gard. Chron., (n.s.) 2, pp. 646, 647, 743.

ATALLAH, S. I.

1967. A new species of spiny mouse (*Acomys*) from Jordan. J. Mammal., 48, pp. 258-261.

AUDOUIN, V.

1829. Description et sommaire des Mammifères carnassiers. *In* Vol. II Description de L'Égypte. De L'Imprimerie Imperiale, Paris, pp. 744-750.

BAGNOLD, R. A.

1931. Journeys in the Libyan Desert, 1929 and 1930. Geogr. J., 78, pp. 13-39, 524-535.

1933. A further journey through the Libyan Desert. Geogr. J., 82, pp. 103-129, 211-235.

1935. Libyan sands: Travel in a dead world. Hodder and Stoughton, London. 288 pp.

1936. The Libyan Desert. J. R. Afr. Soc., 35, pp. 294-305.

1942. The principles of blown sand and desert dunes. Morrow, New York. xx+265 pp.

1954. The physical aspects of dry deserts. *In* Cloudsley-Thompson, J. L., ed., Biology of Deserts. Institute of Biology, London, pp. 7-12.

BAHMANYAR, M. and D. M. LAY

1975. First record of *Gerbillus henleyi* De Winton, 1903, and records of other rodents from northern Yemen. Mammalia, 39, pp. 322-325.

BALL, J.

1912. The geography and geology of southeastern Egypt, Ministry of Finance, Survey Dept., Gov. Press, Cairo. xii+394 pp.

1927. Problems of the Libyan Desert. Geogr. J., 70, pp. 21-38, 105-128, 209-224, 512.

1933. The Qattara Depression of the Libyan Desert and the possibility of its utilization for power production. Geogr. J., 82, pp. 289-314.

1939. Contributions to the geography of Egypt. Ministry of Finance, Survey Dept., Cairo. 300 pp.

BARRON, T.

1907a. The topography and geology of the Peninsula of Sinai (western portion). Nat. Print. Dept., Cairo. 241 pp.

1907b. The topography and geology of the district between Cairo and Suez. Nat. Print. Dept., Cairo. 133 pp.

BARRON, T. and W. F. HUME

1902. Topography and geology of the Eastern Desert of Egypt (central portion). Nat. Print. Dept., Cairo. 331 pp.

BATE, D. M. A.

1945. Notes on small mammals from the Lebanon mountains, Syria. Ann. Mag. Nat. Hist., (ser. 11), 12, pp. 141-158.

BAUER, K.
1963. Ergebnisse der Zoologischen Nubien-Expedition 1962. Teil XIX, Säugetiere. Ann. Naturhistor. Mus. Wein, **66**, pp. 495-506.
BEADNELL, H. J. L.
1910. The sand-dunes of the Libyan Desert. Geogr. J., **35**, pp. 379-395.
1931. Zerzura. Geogr. J., **77**, pp. 245-250.
BEDAN, -.
1928. A desert expedition. Blackwood's Mag., **223** (1350), pp. 519-548.
BEECHER, W. J.
1969. Possible motion detection in the middle ear. Bull. Chicago Acad. Sci., **11**, pp. 155-210.
BELGRAVE, C. D.
1923. Siwa, the oasis of Jupiter Ammon. John Lane the Bodley Head Ltd., London. xxix+275 pp.
BIRD, F. W.
1946. The hyaena in Palestine. Bull. Jerusalem Nat. Club, **21**, p. 1.
BLAINE, G.
1913. On the relationship of *Gazella isabella* to *Gazella dorcas*, with a description of a new species and subspecies. Ann. Mag. Nat. Hist., (ser. 8), **11**, pp. 291-296.
1914. An extinct hartebeeste from Egypt. Ann. Mag. Nat. Hist., (ser. 8), **13**, pp. 335-337.
BODENHEIMER, F. S.
1935. Animal life in Palestine. L. Mayer, Jerusalem. xiii+506 pp.
1958. The present taxonomic status of the terrestrial mammals of Palestine. Bull. Res. Council Israel, **7B** (3-4), pp. 165-190.
BODENHEIMER, F. S. and O. THEODOR
1929. Ergebnisse der Sinai-expedition 1927. J. C. Hinrichsche, Leipzig. viii+143 pp.
BONHOTE, J. L.
1909. On a small collection of mammals from Egypt. Proc. Zool. Soc., London, **1909**, pp. 788-798.
1910. On the varieties of *Mus rattus* in Egypt. Proc. Zool. Soc., London, **1910**, pp. 651-665.
1912. On a further collection of mammals from Egypt and Sinai. Proc. Zool. Soc., London, **1912**, pp. 224-231.
BOULOS, L.
1966a. A natural history study of Kurkur Oasis, Libyan Desert, Egypt. IV. The vegetation. Postilla, No. 100, pp. 1-22.
1966b. Flora of the Nile region in Egyptian Nubia. Feddes Repert., **73**, pp. 184-215.
1967. On the weed flora of Aswan, Egypt. Bot. Not., **120**, pp. 368-372.
1968. The discovery of Medemia Palm in the Nubian Desert of Egypt. Bot. Not., **121**, pp. 117-120.
BRAMLEY, W. E. J.
1895. On Loder's gazelle in Egypt and the mode of capture. Proc. Zool. Soc., London, **1895**, pp. 863-865.
BRAUER, A.
1917. Neue Procaviiden. Sber. Ges. Naturf. Freunde Berlin, **1917**, pp. 294-303.
BRENTJES, B. VON
1966. Einige Bemerkungen zur Darstellung der Hyänen, Erdwölfe und Hyänenhunde in den Kulturen des Alten orients. Z. Säugetierk., **31**, pp. 308-314.

BRISCOE, M. S.
1956. Kinds and distribution of wild rodents and their ectoparasites in Egypt. Amer. Midl. Nat., 55 (2), pp. 393-408.

BRODOFF, B. N. and G. ZEBALLOS
1970. Further studies on the effect of hypothalamic lesions in the sand rat (*Psammomys obesus*). Diabetologia, 6, pp. 366-370.

BRODOFF, B. N., A. KAGAN, B. SLOTNIK, and J. HAGEDOORN
1971. The effect of hypothalamic lesions in the sand rat maintained on a high fat diet. Unpublished manuscript.

BROWN, G. W. ED.
1968. Desert biology. Academic Press, New York. xvii+635 pp.

BRUCE, J.
1790. Select specimens of natural history collected in travels to discover the source of the Nile in Egypt, Arabia, Abyssinia, and Nubia. Vol. 6. Jackson, Dublin. xxiv+286 pp.

BRUNK, R. and H. STRASSER
1967. Hamatologische Standardwerte bei der Sandratte (*Psammomys obesus*). Kleintierpraxis, 12, pp. 236-240.
1969. Unterschiede im weissen Blutbild und in der Blutglukosekonzentration gefutterter und gefasteter Stachelmäuse (*Acomys cahirinus*, Desmarest, 1819). Berl. Munch. Tierärztl. Wochenschr., 82, pp. 93-96.

BRUNNER, E.
1969. Animals of ancient Egypt. Animals, 11, pp. 559-562.

BUDGE, E. A. W.
1926. The dwellers on the Nile. The Religious Tract Society, London. xxxii+326 pp.

BURCKHARDT, J. L.
1819. Travels in Nubia. John Murray, London. cii+543 pp.

BURNS, T. W.
1956. Endocrine factors in the water metabolism of the desert mammal *G. gerbillus*. Endocrinology, 58 (2), pp. 243-254.

BUTZER, K. W.
1959. Studien zum vor- und fruhgeschichtlichen Landschaftswandel der Sahara. III. Die Naturlandschaft Agyptens wahrend der Vorgeschichte und der Dynatischen Zeit. Akad. Wiss. Literatur. Math. Naturw., No. 2, pp. 1-122.
1965. Desert landforms at the Kurkur Oasis, Egypt. Ann. Assn. Amer. Geogr., 55, pp. 578-591.

BUTZER, K. W. and C. L. HANSEN
1968. Desert and river in Nubia. Univ. Wisc. Press, Madison. xxi+562 pp.

BUTZER, K. W. and C. R. TWIDALE
1966. Deserts in the past. *In* Hills, E. S. ed., Arid Lands, Methuen & Co., Ltd., London, pp. 127-144.

BUXTON, E. N.
1898. Short stalks. Edward Stanford, London. Second series, xi+226 pp.

BUXTON, H. M. B., C. E. B. BUXTON, and T. B. BUXTON
1895. On either side of the Red Sea. Edward Stanford, London. viii+163 pp.

BUXTON, P. A.
1923. Animal life in deserts. Edward Arnold Ltd., London. xv+176 pp.

CAILLIAUD, M. F.
1826. Voyage à Méroé et au Fleuve Blanc, Vol. 1. A L'Imprimerie Royal, Paris. xv+429 pp.

CARLISLE, D. B. and L. I. GHOBRIAL
1968. Food and water requirements of dorcas gazelle in the Sudan. Mammalia, **32**, pp. 570-576.

CASLICK, J. W.
1956. Color phases of the roof rat, *Rattus rattus*. J. Mammal., **32**, pp. 255-257.

CATON-THOMPSON, G. and E. W. GARDNER
1932. The prehistoric geography of Kharga Oasis. Geogr. J., **80**, pp. 369-409.

CHAWORTH-MUSTERS, J. L. and J. R. ELLERMAN
1947. A revision of the genus *Meriones*. Proc. Zool. Soc., London, **117**, pp. 478-504.

CHURCHER, C. S.
1972. Late Pleistocene vertebrates from archaeological sites in the plain of Kom Ombo, Upper Egypt. Life Sci. Contr., R. Ontario Mus., No. 82, 172 pp.

CLOUDSLEY-THOMPSON, J. L., ED.
1954. Biology of deserts. Institute of Biology, London. 224 p.

CLOUDSLEY-THOMPSON, J. L. and M. J. CHADWICK
1964. Life in deserts. G. T. Foulis & Co. Ltd., London. xvi+218 pp.

CLOUDSLEY-THOMPSON, J. L. and L. GHOBRIAL
1965. Water economy of the dorcas gazelle. Nature, **207**, p. 1313.

COCKRUM, E. L., T. C. VAUGHAN, and P. J. VAUGHAN
1976a. A review of North African short-tailed gerbils (*Dipodillus*) with description of a new taxon from Tunisia. Mammalia, **40**, pp. 313-326.
1976b. *Gerbillus andersoni* De Winton, a species new to Tunisia. Mammalia, **40**, pp. 467-473.

CORBET, G. B.
1966. The terrestrial mammals of Western Europe, Dufour, Philadelphia. xi+264 pp.

COUTURIER, M. A. M.
1962. Le Bouqetin des Alpes. Couturier, Grenoble. xi+1,564 pp.

DALY, M. and S. DALY
1973. On the feeding ecology of *Psammomys obesus* (Rodentia: Gerbillidae) in Wadi Saoura, Algeria. Mammalia, **37**, pp. 545-591.
1974. Spatial distribution of a leaf-eating Saharan gerbil (*Psammomys obesus*) in relation to its food. Mammalia, **38**, pp. 591-603.
1975a. Socio-ecology of Saharan gerbils, especially *Meriones libycus*. Mammalia, **39**, pp. 289-311.
1975b. Behavior of *Psammomys obesus* (Rodentia: Gerbillinae) in the Algerian Sahara. Z. Tierpsychol., **37**, pp. 298-321.

DAVIS, P. H.
1953. The vegetation of the deserts near Cairo. J. Ecol., **41** (1), pp. 157-173.

DAWSON, W. R.
1924. The mouse in Egyptian and later medicine. J. Egypt. Archaeol., **10**, pp. 83-86.

DE BEAUX, O.
1928. Risultati zoologici della missione inviata dalla R. Societa Geographica *Italiana per l'esplorazione dell' oasis di* Giarabub. (1926-1927). Mammiferi. Ann. Mus. Civ. Stor. Nat. Genova, **53**, pp. 39-76.

1932. Spedizione scientifica all' oasis di Cufra. Ann. Mus. Civ. Stor. Nat. Genova, 55, pp. 374-395.

DE BLASE, A.

1972. *Rhinolophus euryale* and *R. mehelyi* (Chiroptera, Rhinolophidae) in Egypt and southwest Asia. Israel J. Zool., 21, pp. 1-12.

DE BLASE, A. and R. E. MARTIN

1974. A manual of mammalogy. Wm. C. Brown, Dubuque. xv+329 pp.

DE FRONZO, R., E. MIKI, and J. STEINKE

1967. Diabetic syndrome in sand rats. III. Observations on adipose tissue and liver in the non-diabetic stage. Diabetologia, 3, pp. 140-142.

DEKEYSER, P. L.

1955. Les Mammifères de L'Afrique Noire Française. Institut Français D'Afrique Noire, Dakar. 426 pp.

DE WINTON, W. E.

1898. *Felis chaus* and its allies, with descriptions of new subspecies. Ann. Mag. Nat. Hist., (ser. 7), 2, pp. 291-294.

1902a. Descriptions of two new gerbils from Egypt. Ann. Mag. Nat. Hist., (ser. 7), 9, pp. 45-47.

1902b. Descriptions of two new hares from Egypt. Nov. Zool., 9, pp. 444-445.

1903. List of mammals obtained by the Hon. N. Charles Rothschild and the Hon. Francis R. Henley in the Natroun Valley, Egypt. Nov. Zool., 10, pp. 279-285.

DIDIER, R.

1946. Etude systematique de lós penien des mammifères. Mammalia, 10, pp. 78-91.

1947. Etude systematique de lós penien des mammifères. Mammalia, 11, pp. 139-152.

1948. Etude systematique de lós penien des mammifères. Mammalia, 12, pp. 67-93.

1949. Etude systematique de lós penien des mammifères. Mammalia, 13, pp. 17-37.

1953. Etude systematique de lós penien des mammifères. Mammalia, 17, pp. 260-269.

1954. Etude systematique de lós penien des mammifères. Rongeurs. Famille des Muridés. Mammalia, 18, pp. 237-256.

1956. Etude systematique de lós penien des mammifères. Mammalia, 20, pp. 238-247.

DOR, M.

1947. Observations sur les micromammifères trouvés dans les pelotes de la Chouette effraye (*Tyto alba*) en Palestine. Mammalia, 11, pp. 50-54.

DORST, J.

1970. A field guide to the larger mammals of Africa. Hougton Mifflin, Boston. 287 pp.

DOUGHTY, C. M.

1888. Travels in Arabia Deserta. Jonathon Cape, London. XIX+690 pp.

DRAKE-BROCKMAN, R. E.

1910. The mammals of Somaliland. Hurst and Blackett, Ltd., London. xvii+201 pp.

DRAR, M.

1955. Egypt, Eritrea, Libya and the Sudan. Arid Zone Research VI. Plant Ecology. UNESCO, Paris. pp. 151-194.

DUMREICHER, A. VON

1931. Trackers and smugglers in the deserts of Egypt. Methuen and Co. Ltd., London. xii+248 pp.

DUNBAR, J. H.
1941. The rock pictures of Lower Nubia. Service des Antiquités de L'Egypte, Cairo. x+100 pp.
EBERS, G.
1878. Egypt: Descriptive, historical, and picturesque, Vol. 2. Cassell, Peter, Galpin and Co., London, Paris, New York. xxii+388 pp.
EDNEY, E. B.
1966. Animals of the desert. *In* Hills, E. S., ed., Arid Lands. Methuen and Co. Ltd., London. pp. 181-215.
EISENTRAUT, M.
1969. Das Gaumenfaltenmuster bei westafrikanischen Muriden. Zool. Jahrb. Syst. Bd., 96 (478), pp. 478-490.
EL DANASORI, G.
1957. The weather of Egypt. *In* Studies in Geography of Egypt (In Arabic), section 5. Misr Book Shop, Cairo. pp. 142-187.
EL HADIDI, M. N. and S. GHABBOUR
1968. A floristic study of the Nile Valley at Aswan. Rev. Zool. Bot. Afr., 78, pp. 394-407.
ELLERMAN, J. R.
1940. The families and genera of living rodents, Vol. I. British Mus. (Nat. Hist.), London. xxvi+689 pp.
1941. The families and genera of living rodents, Vol. II. Brit. Mus. (Nat. Hist.), London. xii+690 pp.
1948. Rodents of south-west Asia. Proc. Zool. Soc., London, 118, pp. 765-816.
1949. The families and genera of living rodents, Vol. III, pt. 1. Brit. Mus. (Nat. Hist.), London. 210 pp.
ELLERMAN, J. R. and T. C. S. MORRISON-SCOTT
1951. Checklist of Palaearctic and Indian mammals 1758 to 1946. Brit. Mus. (Nat. Hist.), London. 810 pp.
ELLERMAN, J. R., T. C. S. MORRISON-SCOTT, and R. W. HAYMAN
1953. Southern African mammals. Brit. Mus. (Nat. Hist.), London. 363 pp.
EWER, R. F.
1954. Some adaptive features in the dentition of hyenas. Ann. Mag. Nat. Hist., (ser. 12), 7, pp. 188-194.
FAGAN, B. M.
1975. The rape of the Nile. Charles Scribner's Sons, New York, xiv + 399 pp.
FAHMY, I. R.
1936. Report on Gebel Elba. Egypt. Univ. Press, Cairo. 58 pp.
FIEDLER, U.
1973. Beobachtungen zur Biologie einiger Gerbillinen, insbesondere *Gerbillus* (*Dipodillus*) *dasyurus* (Myomorpha, Rodentia) in Gefangenschaft. Z. Säugetierk., 38, pp. 321-340.
FITZINGER, L. J.
1860. Naturgeschichte der Säugethiere, Vol. I. Aus der kaiserlichköniglichen Hof- und Staatsdruckeri, Vienna. 487 pp.
FITZINGER, L. J. and TH. HEUGLIN VON
1866. Systematische übersicht der Säugethiere Nordost-Afrika's mit Einschluss der arabische Küste, des rothen Meeres, der Somal- und der Nilquellen-Länder, südwärts bis zum vierten Grade nördlicher Breite. Sber. Akad. Wiss. Wien, 54, pp. 537-611.

FLOWER, S. S.
1931. Contributions to our knowledge of the duration of life in vertebrate animals. Proc. Zool. Soc., London, 1931, pp. 145-234.
1932. Notes on the recent mammals of Egypt, with a list of the species recorded from that kingdom. Proc. Zool. Soc., London, 1932, pp. 368-450.
FLOYER, E. A.
1887. Notes on a sketch map of two routes in the Eastern Desert of Egypt. Proc. R. Geogr. Soc., London, 9, pp. 659-681.
1893. Further routes in the Eastern Desert of Egypt. Geogr. J., 1 (5), pp. 408-431.
FORSKAL, P.
1775. Descriptions animalium. Mölleri, Hauniae. xxxiv+164 pp.
GABR, M. F. A. and A. A. SHALABY
1962. Glucose content of the blood of the desert mammal *Jaculus jaculus* in relation to its body water balance. Bull. Zool. Soc. Egypt, 17, pp. 15-20.
1964. Studies on the concentration of the total electrolytes and some organic ions in the urine of the desert mammal *Jaculus jaculus*, in relation to its water economy. Bull. Zool. Soc. Egypt, 19, pp. 45-59.
GAILLARD, C. and G. DARESSY
1905. La faune momifiée de l'antique Égypte. De L'Institut Francais D'Archéologié Orientale, Le Caire. 159 pp.
GAILLARD, M. C.
1927. Les animaux consacrés a'la divinité l'ancienne Lycopolis. Egypt. Serv. Antiques, 27, pp. 33-42.
GAISLER, J., G. MADKOUR, and J. PELIKAN
1972. On the bats (Chiroptera) of Egypt. Acta Sc. Nat. Brno, 6, pp. 1-40.
1973. On the bats of Egypt. Prirodoved. Pr. Ustavu Cesk. Akad. Ved. Brno, 6, pp. 1-40.
GAUTHIER-PILTERS, H.
1967. The fennec. Afr. Wildl. 21, pp. 117-125.
GAUTIER, E. F.
1935. Sahara the great desert. Columbia Univ., New York. xviii+264 pp.
GENTRY, A. W.
1964. Skull characters of African gazelles. Ann. Mag. Nat. Hist., (ser. 13), 7, pp. 353-382.
GEOFFROY SAINT-HILAIRE, E.
1818. Description de l'Egypte. Histoire naturelle, description des mammiferes qui se trouvent en Egypte, Vol. II. Paris. pp. 94-144.
GEOFFROY SAINT-HILAIRE, E. and V. AUDOUIN
1829. Mammifères. *In* Vol. II of 'Description de l'Egypte. De L'Imprimerie Impériale, Paris. pp. 733-743.
GEOFFROY SAINT-HILAIRE, I.
1827. Mémoire sur quelques espèces nouvelles ou peu connues du genre Musaraigne. Mem. Mus. Hist. Nat. Paris, 15, pp. 117-144.
1847. Vie, travaux et doctrine scientifique d' Étienne Geoffroy Saint-Hilaire, Librarie Société Geologique de France. 479 pp.
GHOBRIAL, L. I.
1976. Observations on the intake of sea water by the dorcas gazelle. Mammalia, 40, pp. 489-494.
GHOBRIAL, L. I. and J. L. CLOUDSLEY-THOMPSON
1966. Effect of deprivation of water on the dorcas gazelle. Nature, 212, p. 306.

GIDLEY, J. W.
1914. Preliminary report on a recently discovered Pleistocene cave deposit near Cumberland, Maryland. Proc. U.S. Nat. Mus., **46**, pp. 93-102.
GIEGENGACK, R. F., JR.
1968. Late-Pleistocene history of the Nile Valley in Nubia (unpublished Doctoral Dissertation, Yale Univ.).
GRAY, J. E.
1868. Revision of the species of *Hyrax*, founded on specimens in the British Museum. Ann. Mag. Nat. Hist., (ser. 4), **1**, pp. 35-41.
GROVES, C. P. and D. L. HARRISON
1967. The taxonomy of the gazelles (genus *Gazella*) of Arabia. J. Zool., London, **152**, pp. 381-387.
HACKEL, D. B., H. E. LEBOVITZ, L. A. FROHMAN, E. MIKAT, and K. SCHMIDT-NIELSEN
1967. Effect of caloric restriction on the glucose tolerance and plasma insulin of the sand rat. Metabolism, **16**, pp. 1133-1139.
HACKEL, D. B., E. MIKAT, H. E. LEBOVITZ, K. SCHMIDT-NIELSEN, E. S. HORTON, and T. D. KINNEY
1967. The sand rat (*Psammomys obesus*) as an experimental animal in studies of diabetes mellitus. Diabetologia, **3**, pp. 130-134.
HAHN, H.
1934. Die Familie der Procaviidae. Zeitschr. Saugetierk., **9**, pp. 207-358.
HAIM, A. and E. TCHERNOV
1974. The distribution of myomorph rodents in the Sinai Peninsula. Mammalia, **38**, pp. 201-223.
HALTENORTH, T.
1953a. Die Wildkatzen der alten Welt: eine ubersicht die Untergattung *Felis*. Geest and Portig, Leipzig. 166 pp.
1953b. Lebende arabische Sandkatze, *Felis margarita* (Loche, 1858). Säugetierk. Mitt., **1**, pp. 71-73.
HALTON, L.
1935. An Egyptian game reserve. Sheltering migratory ibex. Field, **166**, p. 1520.
HAPPOLD, D. C. D.
1966a. The mammals of Jebel Marra, Sudan. J. Zool., London, **149**, pp. 126-136.
1966b. Breeding periods of rodents in the Northern Sudan. Rev. Zool. Bot. Africa, **74** (3-4), pp. 357-363.
1967a. Biology of the jerboa, *Jaculus jaculus butleri* (Rodentia, Dipodidae), in the Sudan. J. Zool., London, **151**, pp. 257-275.
1967b. Additional information on the mammalian fauna of the Sudan. Mammalia, **31**, pp. 605-609.
1967c. *Gerbillus* (*Dipodillus*) *campestris* (Gerbillinae, Rodentia) from the Sudan. J. Nat. Hist., **1**, pp. 315-317.
1967d. Guide to the natural history of Khartoum Province. Part III. Mammals. Sudan Notes Rec., **48**, pp. 1-22.
1968a. The Sudanese jerboa. Animals, **10** (9), pp. 432-433.
1968b. Observations of *Gerbillus pyramidum* (Gerbillinae, Rodentia) at Khartoum, Sudan. Mammalia, **32**, pp. 44-53.
1969. The mammalian fauna of some jebels in the northern Sudan. J. Zool., London, **157**, pp. 133-145.
1970. Reproduction and development of the Sudanese jerboa, *Jaculus jaculus butleri* (Rodentia, Dipodidae). J. Zool., London, **162**, pp. 505-515.

HARDING-KING, W. J. H.
1925. Mysteries of the Libyan Desert. Seeley, Service and Co. Ltd., London. 384 pp.

HARDY, E.
1949. The Palestine leopard. J. Soc. Preserv. Fauna Emp., **55**, pp. 16-20.

HARPER, F.
1940. The nomenclature and type localities of certain Old World animals. J. Mammal., **21**, pp. 191-203, 322-332.

HARRISON, D. L.
1964. The mammals of Arabia, Vol. I. Ernest Benn Ltd., London. xx+192 pp.
1967. Observations on some rodents from Tunisia, with the description of a new gerbil (Gerbillinae: Rodentia). Mammalia, **31**, pp. 381-389.
1968. The Mammals of Arabia, Vol. II. Ernest Benn Ltd., London. xiv+pp. 193-381.
1972. The mammals of Arabia, Vol. III. Ernest Benn Ltd., London. xvii+pp. 382-670.

HART, H. C.
1891. Some account of the fauna and flora of Sinai, Petra, and Wady Arabah. Watt, London. x+255 pp.

HARTERT, E.
1913. Expedition to the central western Sahara. III: Notes on ruminants and other large mammals. Nov. Zool., **20**, pp. 33-37.

HASSAN, M. I.
1953. Physical elements of agricultural land use in the Nile Delta. Bull. Soc. Géogr. D'Égypte, **26**, pp. 227-241.

HASSAN, M. S. and A. HEGAZY
1968. Rats injurious to agriculture and their control (In Arabic). Tech. Bull. U. A. R. Min. Agric., Cairo, No. 28, pp. 1-31.

HASSIB, M.
1951. Distribution of plant communities in Egypt. Fac. Sci. Fouad I Univ., Cairo, Bull. No. 29, pp. 59-261.

HASSINGER, J. D.
1973. A survey of the mammals of Afghanistan. Fieldiana, Zoo., **60**, xi+195 pp.

HATT, R. T.
1959. The mammals of Iraq. Misc. Publ. Univ. Mich., No. 106, 113 pp.

HAUSER, W.
1951. Beobachtungen an einigen Tierformen Angolas in der Natur und nach dem Fang, 3: Klippschliefer, *Procavia capensis* Pall. Zool. Garten Leipzig, **18**, pp. 208-210.

HAYMAN, R. W.
1948. The Armstrong College zoological expedition to Siwa Oasis (Libyan Desert) 1935. Mammalia. Proc. Egypt. Acad. Sci., **4**, pp. 38-43.

HEFNY, M. B.
1953. Two climatic maps of the Nile Basin and vicinity. Bull. Soc. R. Geogr. Égypte, **26**, pp. 182-192.

HEIM DE BALSAC, H. and J. J. BARLOY
1966. Revision des Crocidures du groupe *flavescens-occidentalis-manni*. Mammalia, **30**, pp. 601-633.

HEIM DE BALSAC, H. and M. LAMOTTE
1957. Evolution et phylogénie des Soricidés Africains (suite et fin). Mammalia, **21**, pp. 15-49.
HEIM DE BALSAC, H. and P. MEIN
1971. Les musaraignes momifiées des hypogees de Thebes. Existence d'un metalophe chez Crocidurinae (sensu repenning). Mammalia, **35**, pp. 220-244.
HEMMER, H.
1974. Studien zur systematik und biologie der Sandkatze. Z. Kölner Zoo, **17**, pp. 11-20.
HEMMER, H., P. GRUBB, and C. P. GROVES
1976. Notes on the sand cat, *Felis margarita* Loche, 1858. Z. Säuegetierk., **41**, pp. 286-303.
HEMPRICH, F. W. and C. G. EHRENBERG
1828-1833. Symbolae physicae seu icones et descriptiones mammalium. Decas 1, 1828 (plates published in 1828; part of text not until 1833). Decas 2, 1830 (published in 1833; *fide* C. D. Sherborn).
HENDERSON, K. D. D.
1965. Sudan Republic, 256 pp. Praeger, New York.
HEUGLIN, TH. VON
1877. Reise im Nordost Afrika, Vol. 2, iv+304 pp. Westermann, Brannschweig.
HILLS, E. S. (ed.)
1966. Arid lands. Methuen and Co., Ltd., London, xviii + 461 pp.
HINTON, H. E. and A. M. S. DUNN
1967. Mongooses. Oliver and Boyd, London. vii+144 pp.
HOLLAND, F. W.
1868. On the Peninsula of Sinai. J. Roy. Geogr. Soc., London, **38**, pp. 237-257.
HOLLISTER, N.
1918. East African mammals in the United States National Museum. Part I. Insectivora, Chiroptera, and Carnivora. U.S. Nat. Mus. Bull., **99**, 194 pp.
HOOGSTRAAL, H.
1960. Faunal exploration as a basic approach for studying infections common to man and animals. East Afr. Med. J., **33** (1), pp. 275-282.
1962. A brief review of the contemporary land mammals of Egypt (including Sinai), 1: Insectivora and Chiroptera. J. Egypt. Publ. Hlth. Assn., **37** (4), pp. 143-162.
1963. A brief review of the contemporary land mammals of Egypt (including Sinai), 2: Lagomorpha and Rodentia. J. Egypt. Publ. Hlth. Assn., **38** (1), pp. 1-35.
1964. A brief review of the contemporary land mammals of Egypt (including Sinai), 3: Carnivora, Hyracoidea, Perissodactyla and Artiodactyla. J. Egypt. Publ. Hlth. Assn., **39** (4), pp. 205-239.
HOOGSTRAAL, H., M. N. KAISER, R. A. ORMSBEE, D. J. OSBORN, I. HELMY, and S. GABER
1967. *Hyalomma* (*Hyalommina*) *rhipicephaloides* Neumann (Ixodoidae: Ixodidae): Its identity, hosts, and ecology, and *Rickettsia conori*, *R. prowazekia*, and *Coxiella burneti* infections in rodent hosts in Egypt. J. Med. Entomol., **4**, pp. 391-400.
HOOGSTRAAL, H., K. WASSIF, I. HELMY, and M. KAISER
1968. The Cheetah, *Acinonyx jubatus* Schreber, in Egypt. Bull. Zool. Soc. Egypt, **21**, pp. 63-68.

HOOGSTRAAL, H., K. WASSIF, and M. N. KAISER
1955. New mammal records from the Western Desert of Egypt. Bull. Zool. Soc. Egypt, 12, pp. 7-12.
1957a. Results of the NAMRU-3 Southeastern Egypt expedition, 1954, 1: Introduction, itinerary, and environmental conditions. Bull. Zool. Soc. Egypt, 12, pp. 7-12.
1957b. Results of the NAMRU-3 Southeastern Egypt expedition, 1954, 6: Observations on non-domesticated mammals and their ectoparasites. Bull. Zool. Soc. Egypt, 13, pp. 52-75.
HOWELLS, V.
1956. A naturalist in Palestine. Andrew Melrose, London. 192 pp.
HUGHES, A. R.
1954. Hyaenas versus australopithecines as agents of bone accumulation. Amer. J. Phys. Anthropol., 12, pp. 467-486.
HUME, W. F.
1906. The topography and geology of the Peninsula of Sinai (south-eastern portion). National Printing Department, Cairo. 280 pp.
1921. The Egyptian wilderness. Geogr. J., 58, pp. 249-276.
1925. Geology of Egypt, Vol. 1 and 2, pt. 1 and 2. Gov. Press, Ministry of Finance, Cairo, xiv + 408, lxv + 300 pp., xxxv + pp. 301-688.
HURST, H. E.
1910. A journey from Wadi Halfa to Aswan. Cairo Sci. J., 4, pp. 8-10.
INNES, W.
1932. Nos mammiferes rongeurs (Rodentia). Bull. Inst. Désert Égypte, 14, pp. 1-61.
JARVIS, C. S.
1937. Three deserts. Dutton, New York. ix+313 pp.
JAYAKAR, A. S. G. (transl.)
1906. Ad-Damiri's hayat al-hayawan (A zoological lexicon). Vol. I. Luzac & Co., London, xxx + 875 pp.
1908. Ad-Damiri's hayat al-hayawan (A zoological lexicon), Vol. II, pt. 1. Luzac & Co., London. 604 pp.
JENNISON, G.
1937. Animals for show and pleasure in ancient Rome. The Univ. Press, Manchester. xiv+209 pp.
KASIM, M.
1912. A meteorological expedition to Siwa. Cairo Sci. J., 6, pp. 76-84.
KASSAS, M.
1952. Habitat and plant communities in the Egyptian desert, I: Introduction. J. Ecol., 40, pp. 342-351.
1953. Habitat and plant communities in the Egyptian desert, II: The features of a desert community. J. Ecol., 41, pp. 248-256.
1955. Rainfall and vegetation belts in arid northeast Africa. Plant Ecology, Proc. Mont. Symp. (UNESCO). pp. 49-50.
1956. The mist oasis of Erkwit, Sudan. J. Ecol., 44, pp. 180-194.
1966. Plant life in deserts. *In* Hills, E. S., ed., Arid Lands. Methuen and Co., Ltd., London. pp. 145-180.
KASSAS, M. and W. A. GIRGIS
1964. Habitat and plant communities in the Egyptian desert, V: The limestone plateau. J. Ecol., 52, pp. 107-119.

1965. Habitat and plant communities in the Egyptian desert, VI: The units of a desert ecosystem. J. Ecol., **53**, pp. 715-728.

1970. Habitat and plant communities in the Egyptian desert, VII: Geographical facies of plant communities. J. Ecol., **58**, pp. 335-350.

1972. Studies on the ecology of the Eastern Desert of Egypt, I: The region between latitude 27° 30′ and latitude 25° 30′ N. Bull. Soc. Géogr. Égypte, **41-42**, pp. 43-72.

KASSAS, M. and M. IMAM

1954. Habitat and plant communities in the Egyptian desert, III: The wadi bed ecosystem. J. Ecol., **42**, pp. 425-441.

1959. Habitat and plant communities in the Egyptian desert, IV: The gravel desert. J. Ecol., **47**, pp. 289-310.

KASSAS, M. and M. A. ZAHRAN

1962. Studies on the ecology of the Red Sea coastal land, I: The district of Gebel Ataqa and El-Galala El-Bahariya. Bull. Soc. Géogr. Égypte, **35**, pp. 129-175.

1965. Studies on the ecology of the Red Sea coastal land, II: The district from El-Galala El-Qibliya to Hurghada. Bull. Soc. Géogr. Égypte, **38**, pp. 155-193.

1967. On the ecology of the Red Sea littoral salt marsh, Egypt. Ecol. Monogr., **37**, pp. 297-316.

1971. Plant life on the coastal mountains of the Red Sea, Egypt. J. Indian Bot. Soc., 50A., pp. 571-589.

KEIMER, L.

1942. Quelques représentations rarissimes de Mustélidés conservées sur de bas-reliefs de l'ancien empire. De L'Institut Francais D'Arch. Oriental. pp. 1-29.

1944. L'Oryctérope dans L'Egypte ancienne. Etudes Egyptologie, VI, pp. 1-20.

1949. Le porc-'epic dans L'Egypte ancienne. Ann. Service Antiqitee Egypte, **49**, pp. 393-415.

1955. Interprétation de plusieurs passages contenus dans les "Histories" d'Héredote. Bull. Inst. Égypte, **36**, pp. 455-476.

KEMAL EL DIN, H.

1928. L'exploration du Désert de Libye. Géographie, **1928**, pp. 171-183, 320-336.

KHAIRAT, O.

1954. Hunting in Ancient Egypt. Egyptian Shooting and Fishing Club, Cairo. 13 pp.

KIRMIZ, J. P.

1962. Adaptation to desert environment. Butterworths, London. xi+168 pp.

1965. The jerboa and the desert. Sci. J., Nos. 64-65, pp. 47-51.

KITTO, J.

1841. Palestine: The physical geography and natural history of the holy land. Charles Knight & Co., London. 438 pp.

KLUNZINGER, C. B.

1878. Upper Egypt: Its people and its products. Scribner, Armstrong and Co., New York. xv+408 pp.

KOCK, D.

1970a. Die Verbreitungsgeschichte des Flusspferdes, *Hippopotamus amphibius* Linné, 1758, im unteren Nilgebiet. Ein Beitrag zur Zoogeographie Nordafrikas. Säugetierk. Mitt., **18**, pp. 12-25.

1970b. Zur Verbreitung der Mendesantilope, *Addax nasomaculatus* (De Blainville, 1816), und des Spiessbockes, *Oryx gazella* (Linné 1758) im Nilgebiet. Ein Beitrag zur Zoogeographie Nordafrikas. Säugetierk. Mitt., **18**, pp. 25-37.

1971. Zur Verbreitung von Mahnenschaf und Steinbock im Nilgebiet. Ein Beitrag zur Zoogeographie Nordost-Afrikas. Säugetierk. Mitt., **19**, pp. 28-39.

KRUUK, H.
1968. Hyenas, the hunters nobody knows. Nat. Geogr., **134**, pp. 44-57.
1976. Feeding and social behavior of the striped hyaena (*Hyaena* vulgaris Desmarest), E. Afr. Wildl. J., **44**, pp. 91-111.

KULLMAN, E.
1965. Die Säugetier Afghanistans. 1. Carnivora, Artiodactyla, Primates. Sci. Quart. J. Fac. Sci. Kabul, pp. 1-17.

LAWRENCE, B.
1967. Early domestic dogs. Z. Säugetierk., **32**, pp. 44-59.

LAWRENCE, B. and W. H. BOSSERT
1967. Multiple character analysis of *Canis lupus, latrans* and *familiaris*, with a discussion of the relationships of *Canis niger*. Amer. Zool., **7**, pp. 223-232.

LAY, D. M.
1967. A study of the mammals of Iran. Fieldiana: Zool., **54**, pp. 1-282.
1972. The anatomy, physiology, functional significance and evolution of specialized hearing organs of the Gerbillinae rodents. J. Morphol., **138**, pp. 41-120.

LAY, D. M., K. AGERSON, and C. F. NADLER
1975. Chromosomes of some species of *Gerbillus* (Mammalia: Rodentia). Z. Säugetierk., **40**, pp. 141-150.

LAY, D. M., and C. F. NADLER
1969. Hybridization in the rodent genus *Meriones*. I: Breeding and cytological analyses of *Meriones shawi* (m.) × *Meriones libycus* (f.) hybrids. Cytogenetics, **8**, pp. 35-50.
1972. Cytogenetics and origin of North African spalax (Rodentia: Spalacidae). Cytogenetics, **11**, pp. 279-285.

LEGOUIX, J. P., F. PETTER, and A. WISNER
1954. Etude de l'audition chez des Mammifères a bulles tympaniques hypertrophiées. Mammalia, **18**, pp. 262-271.

LEWIS, R. E., J. H. LEWIS, and D. L. HARRISON
1965. On a collection of mammals from northern Saudi Arabia. Proc. Zool. Soc., London, **144** (1), pp. 61-74.

LHOTE, H.
1946. Observations sur la répartition actuelle et les moeurs de quelques grands mammiféres du pays Tuareg. Mammalia, **10**, pp. 26-56.

LIKE, A. A. and E. MIKI
1967. Diabetic syndrome in sand rats. IV: Morphologic changes in islet tissue. Diabetologia, **3**, pp. 143-166.

LINDSAY, J.
1965. Leisure and pleasure in Roman Egypt. Muller, London. xiv + 482 pp.

LODER, E. G.
1894. On the "Reem" antelope of Algeria. Proc. Zool. Soc., London, **1894**, pp. 473-476.

LONG, G. A.
1955. The study of natural vegetation as a basis for pasture improvement in the Western Desert of Egypt. Bull. Inst. Désert Égypte, **5**, pp. 18-48.

LORET, V. and C. GAILLARD
1908. La faune momifiée de l'ancienne Egypte. Arch. Mus. Hist. Nat., Lyon, 8, pp. i-vii, 1-200.
LYDEKKER, R.
1916. Catalogue of the Ungulate mammals in the British Museum (Natural History), Vol. 5. British Museum, London. xlv+207 pp.
MACDOUGAL, D. T.
1913. The deserts of western Egypt. Plant World., 16, pp. 291-303.
MADKOUR, G. A.
1961. The structure of the facial area in the mouse-tailed bat, *Rhinopoma hardwickei cystops* Thomas. Bull. Zool. Soc. Egypt, 16, pp. 50-54.
MANSON-BAHR, P.
1936. Wolves in Palestine and Egypt. Field, 167 (4355), p. 1448.
MASER, C. O.
1966. Commensal relationship betwen *Acomys* and *Rousettus*. J. Mammal., 47, p. 153.
MASON, M.
1936. The paradise of fools. Hodder and Stoughton, London. 282 pp.
MCGINNIES, W. G., B. J. GOLDMAN, and P. PAYLORE
1968. Deserts of the world. Univ. Arizona Press, Tuscon. xxviii+788 pp.
MEESTER, J. and H. W. SETZER (ed.)
1971. The mammals of Africa—An identification manual. Smithsonian Inst. Press, Washington, D.C. vii+pagination by parts.
MEIGS, P.
1966. Desert littoral of Egypt. UNESCO, Paris. 144 pp.
MEINERTZHAGEN, R.
1954. Birds of Arabia. Oliver and Boyd, London. 624 pp.
MENDELSSOHN, H.
1965. Breeding the Syrian hyrax *Procavia capensis syriaca* Schreber, 1784. Int. Zoo Yearbook, 5, pp. 116-125.
MICHENER, G. R.
1976. Tail autotomy as an escape mechanism in *Rattus rattus*. J. Mammal., 57, pp. 600-603.
MIGAHID, A. M. and A. A. ABD EL RAHMAN
1953a. Studies in the water economy of Egyptian desert plants, I: Desert climate and its relation to vegetation. Bull. Inst. Désert Égypte, 3, pp. 5-24.
1953b. Studies in the water economy of Egyptian desert plants, II: Soil and water conditions and their relation to vegetation. Bull. Inst. Désert Égypte, 3, pp. 25-57.
1953c. Studies in the water economy of Egyptian desert plants, III: Observations on the drought resistance of desert plants. Bull. Inst. Désert Égypte, 3, pp. 59-83.
MIGAHID, A. M., A. A. ABD EL RAHMAN, M. EL SHAFEI ALI, and M. A. HAMMOUDA
1955. Types of habitat and vegetation at Ras el Hikma. Bull. Inst. Désert Égypte, 5, pp. 107-190.
MIGAHID, A. M. and M. A. AYYAD
1959a. An ecological study of Ras el Hikma district, I: The climatic environment of the vegetation. Bull. Inst. Désert Égypte, 9, pp. 1-45.
1959b. An ecological study of Ras el Hikma district, III: Plant habitats and communities. Bull. Inst. Désert Égypte, 9, pp. 74-98.

1959c. An ecological study of Ras el Hikma district, IV: Structure of vegetation in the main habitats. Bull. Inst. Désert Égypte, 9, pp. 99-120.

MIKI, E., A. A. LIKE, J. S. SOELDNER, J. STEINKE, and G. F. CAHILL, JR.
1966. Acute ketotic-type diabetic syndrome in sand rats (*Psammomys obesus*) with special reference to the pancreas. Metabolism, 15, pp. 749-760.

MIKI, E., A. A. LIKE, J. STEINKE, and J. S. SOELDNER
1967. Diabetic syndrome in sand rats, II: Variability and association with diet. *Diabetologia*, 3, pp. 135-139.

MILLER, G. S.
1912. Catalogue of the mammals of western Europe. British Museum (Natural History), London. xv+1019 pp.

MISSONE, X.
1969. Expédition scientifique Belge dans le Désert de Libye Jebel Uweinat 1968-1969, V: La Faune. Africa-Tervuren, 15, pp. 117-119.
1970. Animals of the Libyan Desert. Int. Union Conserv. Nat. Bull., 2, pp. 131-132.

MITWALLY, M.
1953. Physiographic features of the oases of the Libyan Desert. Bull. Inst. Désert Égypte, 3, pp. 143-163.
1954. The call of the desert. Bull. Inst. Désert Égypte, 4, pp. 125-129.

MONAIERY, A. M. EL
1955. Situation of wild mammals in Egypt. Bull. Zool. Soc. Egypt, 12, p. 1 (1954).
1965. Some notes on the Egyptian cat and its origin. Bull. Zool. Soc. Egypte, 20, pp. 71-72.

MONOD, TH.
1958. Majabat Al-Koubra. Contribution a l'etude L' "Empty Quarter" Ouest Saharien. Mem. L'Inst. Francais D'Afr. Noire. No. 52, 406 pp.

MONTAGU, I.
1924. On the burrowing of the rodent, *Spalax* (*Mesospalax*). Proc. Zool. Soc., London, 1924, pt. IV, pp. 1,153-1,160.

MONTASIR, A. H.
1954. Habitat factors and plant distribution in Egypt. Bull. Inst. Désert Égypte, 4, pp. 36-64.

MORRISON-SCOTT, T. C. S.
1939. Some Arabian mammals collected by Mr. H. St. J. B. Philby, C. I. E. Nov. Zool., 41, pp. 181-211.

MORRISON-SCOTT, T. C. S.
1952. The mummified cats of ancient Egypt. Proc. Zool. Soc., London, 121, pp. 861-867.

MOUNTFORT, G.
1965. Portrait of a desert. Collins, London. 192 pp.

MURRAY, G. W.
1912. The hamada country. Cairo Sci. J., 6, pp. 264-273.
1930. Egyptian mountains. Alpine J., 42, pp. 226-235.
1935. Sons of Ishmael. Routledge & Sons Ltd., London. xv+344 pp.
1950. The Egyptian desert and its antiquity. Paper No. 40, Survey Dept. of Egypt, Cairo. 22 pp.
1951. The Egyptian climate: an historical outline. Geogr. J., 117, pp. 422-434.
1967. Dare me to the desert. Allen and Unwin Ltd., London. 214 pp.

MURRAY, J.
1891. Handbook for travelers in lower and upper Egypt 8th ed. rev. John Murray, London. 568 pp.
MUSCHLER, R.
1912. A manual flora of Egypt, Vol. 2. Friedlander, Berlin. pp. 673-1312.
NADLER, C. F. and D. M. LAY
1967. Chromosomes of some species of *Meriones* (Mammalia: Rodentia). Z. Säugetierk., **32**, pp. 285-291.
NEGUMI, A.
1949. List of desert animals seen or collected during the periods shown. Bull. Zool. Soc. Egypt, **8**, pp. 20-21.
1952. Egyptian mammals (In Arabic). Khalil Ibrahim, Alexandria. n+134 pp.
NEHRING, A.
1901. Über *Dipus schlüteri* n. sp. und einige andere Nager aus Palestina. S. B. Ges. Nat. Fr., **1901** (8), pp. 163-176.
NEUMANN, O.
1935. Über afrikanische wildesel. Z. Säugetierk., **10**, pp. 152-153.
NEVO, E.
1961. Observations on Israeli populations of the mole rat *Spalax e. ehrenbergi* Nehring. Mammalia, **25**, pp. 127-144.
1969. Mole rat *Spalax ehrenbergi*: Mating behavior and evolutionary significance. Science, **163**, pp. 484-486.
NEWBOLD, D.
1928. Rock-pictures and archaeology in the Libyan Desert. Antiquity, **2**, pp. 261-288.
NIETHAMMER, J.
1959. Die nordafrikanischen Unterarten des Gartenschläfers (*Eliomys quercinus*). Z. Säugetierk., **24**, pp. 35-45.
OMER-COOPER, J.
1947. The Armstrong College zoological expedition to Siwa Oasis (Libyan Desert)
1935. General Report. Proc. Egypt. Acad. Sci., **3**, pp. 1-52.
OSBORN, D. J.
1968a. Hyena hunt. Bull. Field Mus. Nat. Hist., **39**, pp. 2-6, 14.
1968b. Notes on medicinal and other uses of plants in Egypt. Econ. Botany, **22**, pp. 165-177.
OSBORN, D. J. and K. V. KROMBEIN
1969. Habitats, flora, mammals, and wasps of gebel 'Uweinat, Libyan Desert. Smithson. Contr. Zool., No. 11, pp. 1-18.
PALMER, E. H.
1872. The desert of the exodus. Harper, New York. xvi+470 pp.
PATON, D.
1925. Animals of ancient Egypt. Oxford Univ. Press, London. 37 pp.
PEARSE, C. K.
1955. Improving Egypt's range forage. Bull. Inst. Désert Égypte, **5**, pp. 77-86.
PEASE, A. E.
1896. On the antelopes of the Aures and Eastern Algerian Sahara. Proc. Zool. Soc., London, **1896**, pp. 809-814.
PEEL, R. F.
1939. The Gilf Kebir. *In* Bagnold, R. A., An expedition to the Gilf Kebir and 'Uweinat, 1936, pt. 4. Geogr. J., **93**, pp. 295-307.

PELIKAN J., G. MADKOUR and J. GAISLER
1971. On some mammals from Egypt (Insectivora, Lagomorpha, Rodentia). Zool. Listy, **20**, pp. 307-318.
PERRET R.
1935. Le climat du Sahara. Ann. Géogr., **44**, pp. 162-186.
PETERMANN A.
1861. Mittheilungen aus Justus Perthes' Geographischer Anstalt etc. Perthes, Gotha. viii+482 pp.
PETTER F.
1953a. Note préliminaire sur l'Ethologie et l'Ethologie de *Meriones libycus* (Rongeurs, Gerbillidés). Mammalia, **17**, pp. 281-294.
1953b. Remarques sur la signification des bulles tympaniques chez les Mammiferes. C. R. Acad. Sci., Paris, **237**, pp. 848-849.
1956. Evolution du dessin de la surface d'usure des molaires de *Gerbillus*, *Meriones*, *Pachyuromus* et *Sekeetamys*. Mammalia, **20**, pp. 419-426.
1957. Liste commentee des espèces de gerbillidés de Palestine. Mammalia, **21**, pp. 241-257.
1959. Evolution du dessin de la surface d'usure des molaires des Gerbillidés Mammalia, **23**, pp. 304-315.
1961. Repartition geographique et écologie des rongeurs désertiques (du Sahara occidental à l'Iran oriental). Mammalia, **25**, (special no.), pp. 1-222.
POCOCK R. I.
1932. The leopards of Africa. Proc. Zool. Soc., London, **1932**, pp. 543-591.
1934. The races of the striped and brown hyenas. Proc. Zool. Soc., London, **1934**, pp. 799-835.
1941. The fauna of British India including Ceylon and Burma. Mammalia, Vol. II. Taylor and Francis Ltd., London. xii+503 pp.
1951. Catalogue of the Genus *Felis*. British Museum (Nat. Hist.), London. vii+190 pp.
POMEL M. A.
1856. Notes sur la mammalogie de l'Algérie. Compt. Rend. Acad. Sci. Paris, **42**, pp. 652-655.
PRAAKASH I. and P. K. GHOSH (ed.)
1975. Rodents in desert environments. The Hague, Junk. xvi+624 pp.
PRANGE H. D., K. SCHMIDT NIELSEN and D. B. HACKEL
1968. Care and breeding of the fat sand rat (*Psammomys obesus* Cretzschmar). Lab. Anim. Care, **18**, pp. 170-181.
RANCK G. L.
1968. The rodents of Libya: taxonomy, ecology, and zoogeographical relationships. U. S. Nat. Mus. Bull., **275**, pp. vii+264.
REED C. A.
1958. Observations on the burrowing rodent *Spalax* in Iraq. J. Mammal., **39**, pp. 366-389.
1964. A natural history study of Kurkur Oasis, Libyan Desert, Western Governate, Egypt. Postilla, No. 84, pp. 1-20.
1966. Organic remains from Yale University Nubian expedition archaeological sites D1-21B and W0-2A, with a discussion of the radiocarbon determinations. Postilla, No. 102, pp. 35-46.
REED C. A., M. A. BAUMHOFF, K. W. BUTZER, H. WALTER and D. S. BOLOYAN
1967. Preliminary report on the archaeological aspects of the Yale University

prehistoric expedition to Nubia, 1962-1963. Extract from Fouilles en Nubie (1961-1963). Antiquities Department of Egypt, Cairo. 12 pp.

REED, C. A. and P. F. TURNBULL

1969. Late Pleistocene mammals from Nubia. *In* van Zinderen Bakker, E. M., ed., Palaeoecology of Africa and of the Surrounding Islands and Antarctica, Vol. IV. Balkerna, Capetown. pp. 55-56.

ROBERTS, A.

1951. The mammals of South Africa. Trustees of "The Mammals of South Africa" Book Fund. xlviii+700 pp.

ROBINSON, P.

1966. Fossil occurrence of murine rodent (*Nesokia indica*) in the Sudan. Science, 154, p. 264.

ROCHE, J.

1960. Nouvelles donnees sur la reproduction des Hyracoides. Mammalia, 26, pp. 517-529.

ROTHSCHILD, W.

1913. On *Ovis lervia* Pallas and its subspecies. Nov. Zool., 20, pp. 459-460.

RUPPELL, E.

1826. Atlas zu der Reise im nordlichen Afrika. Erste Abteilung Zoologie der Senkenbergischen naturforschenden Gesellschaft. Säugethiere., Frankfurt am Mein. pp. 1-78.

1829. Reisen in Nubien, Kordofan und dem Peträischen Arabien. Frankfurt am Mein. 40 pp.

1842. Saugetheire aus der Ordnung der Nager, beobachtet im nordöstlichen Afrika. Mus. Senckenb., Abh., 3, pp. 91-116.

RUSSELL, M.

1831. View of ancient and modern Egypt with an outline of its natural history. Oliver and Boyd, Edinburgh. 480 pp.

RUSSELL, TH

1949a. Egyptian service. John Murray, London. xi+294 pp.

1949b. Desert fauna. Bull. Zool. Soc. Egypt, No. 8, pp. 5-8.

1951. The fauna of the Egyptian deserts. Bull. Zool. Soc. Egypt, No. 9, pp. 19-21.

SAID, R.

1962. The geology of Egypt. Elsevier, Amsterdam-New York. iv+357 pp.

SAINT-GIRONS, M.

1962. Notes sur les dates de reproduction en captivité du Fennec, *Fennecus zerda* (Zimmermann, 1780). Z. Saugetierk., 27, pp. 181-184.

SALE, J. B.

1965. The feeding behaviour of rock hyraxes (genera *Procavia* and *Heterohyrax*) in Kenya. E. Afr. Wildl. J., 3, pp. 1-18.

SANBORN, C. C. and H. HOOGSTRAAL

1953. Some mammals of Yemen and their ectoparasites. Fieldiana: Zool., 34, pp. 229-252.

1955. The identification of Egyptian bats. J. Egypt. Publ. Hlth. Assn., 30 (4), pp. 103-119.

SANDFORD, K. S.

1936. Observations on the distribution of land and fresh-water mollusca in the southern Libyan Desert. Quart. J. Geol. Soc. London, 92, pp. 201-220.

SANDFORD, K. A. and W. J. ARKELL
1933. Paleolithic man in the Nile Valley in Nubia and upper Egypt. Univ. Chicago Oriental Inst. Publ., Vol. 17. xvii+92 pp.
1939. Paleolithic man and the Nile Valley in Lower Egypt. Univ. Chicago Oriental Inst. Pub., **46**, xix+105 pp.

SCHMIDT-NIELSEN, B. and K. SCHMIDT-NIELSEN
1949. The water economy of desert mammals. Sci. Mon., **69**, pp. 180-185.
1950. Evaporative water loss in desert rodents in their natural habitat. Ecology, **31**, pp. 75-85.
1952. Water metabolism in desert animals. Physiol. Rev., **32**, pp. 135-166.

SCHMIDT-NIELSEN, K.
1964. Desert animals. Oxford University Press, London. 277 pp.

SCHMIDT-NIELSEN, K., H. B. HAINES, and D. B. HACKEL
1964. Diabetes mellitus in the sand rat induced by standard laboratory diets. Science, **143**, pp. 689-690.

SCHOMBER, H. W. and D. KOCK
1960. The wild life of Tunisia, pt. 2. Afr. Wildl., **14** (4), pp. 277-282.

SCHWANN, H.
1905. A list of mammals collected by the Hon. N. C. Rothschild, the Hon. F. R. Henley, and Mr. A. F. R. Wollaston in Egypt and the Soudan in January, February, and March 1904. Nov. Zool., **12**, pp. 1-5.

SCHWARZ, E. and H. K. SCHWARZ
1943. The wild and commensal stocks of the house mouse, *Mus musculus* Linnaeus. J. Mammal., **24**, pp. 59-72.

SCHWEINFURTH, G.
1874. Notice sur la grande oases du Désert Libyque. Bull. Soc. Geogr., (ser. vii), **6**, pp. 627-634.

SCLATER, P. L.
1884. On some mammals from Somali-land. Proc. Zool. Soc., London, **1884**, pp. 538-542.
1895. On the occurrence of the barbary sheep in Egypt. Proc. Zool. Soc., London, **1895**, pp. 85-86.

SCLATER, P. L. and O. THOMAS
1894-1900. The book of antelopes, vols. I-IV. Porter, London. xxxv+220 and 242 pp.

SETZER, H. W.
1952. Notes on mammals from the Nile Delta region of Egypt. Proc. U.S. Nat. Mus., **102** (3305), pp. 343-369.
1955. Two new jerboas from Egypt. Proc. Biol. Soc. Wash. **68**, pp. 183-184.
1956. Mammals of the Anglo-Egyptian Sudan. Proc. U.S. Nat. Mus., **106** (3377), pp. 447-587.
1957a. An extra tooth in *Crocidura*. J. Mammal., **38**, pp. 258-259.
1957b. The hedgehogs and shrews (Insectivora) of Egypt. J. Egypt. Publ. Hlth. Assn., **32** (1), pp. 1-17.
1957c. A review of Libyan mammals. J. Egypt. Publ. Health Assn., **32** (2), pp. 41-82.
1958a. The jerboas of Egypt. J. Egypt. Publ. Health Assn., **33** (3), pp. 87-94.
1958b. The hares of Egypt. J. Egypt. Publ. Health Assn., **33** (5), pp. 145-151.

1958c. The mustelids of Egypt. J. Egypt. Publ. Health Assn., **33** (6), pp. 199-204.
1958d. The gerbils of Egypt. J. Egypt. Publ. Health Assn., **33** (6), pp. 205-227.
1959. The spiny mice (*Acomys*) of Egypt. J. Egypt. Publ. Health Assn., **34** (3), pp. 93-101.
1960a. The baculum of *Poecilicitis libyca*. J. Mammal., **41**, pp. 138-139.
1960b. Two new mammals from Egypt. J. Egypt. Publ. Health Assn., **35** (1), pp. 1-5.
1961a. The jirds (Mammalia: Rodentia) of Egypt. J. Egypt. Publ. Health Assn., **36** (3), pp. 81-92.
1961b. The canids (Mammalia) of Egypt. J. Egypt. Publ. Health Assn., **36** (3), pp. 113-118.
1963. Notes on some Egyptian rodents. J. Egypt. Publ. Health Assn., **38** (2), pp. 51-60.

SHALABY, A. A.
1962. The effect of injected water on the water economy of the desert mammal *Jaculus jaculus*. 1: The total body water content and water of different tissues. Bull. Zool. Soc. Egypt, **17**, pp. 1-14.

SHATA, A.
1955. An introductory note on the geology of the northern portion of the Western Desert of Egypt. Bull. Inst. Désert Égypte, **5**, pp. 96-102.

SHAW, W. B. K.
1931. Botanical notes: Appendix IV. *In* Bagnold, R. A., Journeys in the Libyan Desert 1929 and 1930. Geogr. J., **78**, pp. 534-535.
1933. Libyan Desert: Note on wild life. J. Soc. Pres. Fauna Empire, **20**, p. 15.
1934. The flora of the Libyan Desert: Botanical notes. J. Soc. Pres. Fauna Empire, **7** (1934), pp. 281-289.

SHAW, W. B. K. and J. HUTCHINSON
1931. The flora of the Libyan Desert. Bull. Misc. Inform. Roy. Bot. Gard., Kew, **4** (1931), pp. 161-166.

SHEHATA, I. and A. KAWASHTI
1966. Comparative drought resistance in summer of camels, donkeys, sheep and goats. Bull. Inst. Désert Égypte, **16**, pp. 181-203.

SHERBORN, C. D.
1897. On the dates of the natural history portion of Savigny's "Description de l'Égypte." Proc. Zool. Soc., London, **1897**, pp. 285-288.

SHKOLNIK, A. and A. BORUT
1969. Temperature and water relations in two species of spiny mice (*Acomys*). J. Mammal., **50**, pp. 245-255.

SONNINI, C. S.
1807. Travels in Upper and Lower Egypt, Vol. 1-3. John Stockdale, London. xix+376, vii+368, and vii+314 pp.

SPITZENBERGER, F.
1970. Erstnachweise der Wimperspitzmaus (*Suncus etruscus*) für Kreta und Kleinasien und der Verbreitung der Art im Südwestasiatischen Raum. Z. Säugetierk., **35**, pp. 107-113.

STRASSER, H.
1968. A breeding program for spontaneously diabetic experimental animals: *Psammomys obesus* (sand rat) and *Acomys cahirinus* (spiny mouse). Lab. Anim. Care, **18** (3), pp. 328-338.

STRASSER, H. and R. BRUNK
1968. Hämatologische Standardwerte bei der Stachelmaus (*Acomys cahirinus*, Desmarest 1819). Kleintierpraxis, **13**, pp. 65-74.
STREET, W. S.
1967. Collecting in Afghanistan. Explorers J., **45**, pp. 103-111.
STREKALOVSKY, N. W.
1949. Shooting and fishing in Egypt, 12 pp. R. Schindler Egyptian State Tourist Dept., Cairo.
STUART, M. V.
1910. Gebel Dokhan. Cairo Sci. J., **4**, pp. 64-66.
TACKHOLM, V.
1956. Report on the botanical excursion of the Desert Institute to the Red Sea coast and the two Galalas in spring 1956. Bull. Inst. Désert Égypte, **6** (2), pp. 1-27.
1974. Students' flora of Egypt, 888 pp. Cairo Univ., Cairo.
TADROS, T. M.
1953. A phytosociological study of halophilous communities from Mareotis (Egypt). Vegetatio Acta Geobot., **4**, pp. 102-124.
1956. An ecological survey of the semi-arid coastal strip of the Western Desert of Egypt. Bull. Inst. Désert Égypte, **6** (2), pp. 28-56.
TADROS, T. M. and A. M. A. BERLANTA
1958a. Further contribution to the study of the sociology and ecology of the halophilous plant communities of Mareotis (Egypt). Vegetatio Acta Geobot., **8**, pp. 137-160.
1958b. The plant communities of barley fields and uncultivated areas of Mareotis (Egypt). Vegetatio Acta Geobot., **8**, pp. 161-175.
TADROS, T. M. and H. M. EL SHARKAWI
1960a. Phytosociological and ecological studies of the vegetation of Fuk-Ras el Hekma area, I: Sociology of the communities. Bull. Inst. Désert Égypte, **10**, pp. 37-59.
1960b. Phytosociological and ecological studies of the vegetation of Fuk-Ras el Hekma area, II: Consistency and homogeneity of the open desert communities. Bull. Inst. Désert Égypte, **10**, pp. 61-83.

TALBOT, L. M.
1960. A look at threatened species. Oryx, **5**, pp. 153-293.
TATE REGAN, C. (ed.)
1946. Natural history. Ward, Lock & Co., Ltd., London. 896 pp.
TAYLOR, E. C.
1897. Exhibition of a skin of, and remarks upon, the Egyptian weasel (*Mustela subpalmata*). Proc. Zool. Soc., London, **1897**, pp. 601-602.
TCHERNOV, E.
1968. Succession of rodent faunas during the Upper Pleistocene of Israel. Paul Parey, Hamburg. 152 pp.
THOMAS, H.
1921. Some observations on plants in the Libyan Desert. J. Ecol., **9**, pp. 75-89.
THOMAS, O.
1892a. On the species of the Hyracoidea. Proc. Zool. Soc. London, **1892**, pp. 50-76.
1892b. Descriptions of three new gerbils in the British Museum collection. Ann. Mag. Nat. Hist., (ser 6), **9**, pp. 76-79.

1894a. On some gazelles brought by Sir Edmund Loder from Algeria. Proc. Zool. Soc. London, **1894**, pp. 467-472.

1894b. Preliminary diagnosis of a new gazelle from Algeria. Ann. Mag. Nat. Nist., (ser. 6), **13**, p. 452.

1904. On small mammals collected by Mr. A. M. Mackilligin in the Eastern Desert of Egypt. Ann. Mag. Nat. Hist., (ser. 7), **14**, pp. 155-159.

1908. The *Psammomys* of the alluvial soil of the Nile Delta. Ann. Mag. Nat. Hist., (ser. 8), **2**, pp. 91-92.

1911. The mammals of the tenth edition of Linnaeus; an attempt to fix the types of the genera and the exact bases and localities of the species. Proc. Zool. Soc., London, **1911**, pp. 120-158.

1913. Expedition to the central western Sahara, Part II, Mammals. Nov. Zool., **20**, pp. 28-33.

1919a. Notes on gerbils referred to the genus *Meriones*, with descriptions of new species and subspecies. Ann. Mag. Nat. Hist., (ser. 9), **3**, pp. 263-273.

1919b. Two new gerbils from Sinai. Ann. Mag. Nat. Hist., (ser. 9), **3**, pp. 559-560.

1922. The forms of *Jaculus jaculus* in Egypt and Syria. Ann. Mag. Nat. Hist., (ser. 9), **9**, pp. 295-297.

THOMAS, O. and M. A. C. HINTON

1920. On the group of African zorils represented by *Ictonyx lybica*. Ann. Mag. Nat. Hist., (ser. 9), **5**, pp. 367-369.

TORTONESE, E.

1948. Ecological notes on a desert area of Lower Egypt (Tel el Kebir) (In Italian). Boll. Museo Zool. Univ. Torino, **1** (13), pp. 155-183.

TOSCHI, A.

1954. Elenco preliminare dei Mammiferi della Libia. Lab. Zool. Appl. *alla* Caccia, Univ. Bologna, **2**, pp. 241-273.

TREGENZA, L. A.

1955. The Red Sea Mountains of Egypt. Oxford University Press, London. xiii+247 pp.

1958. Egyptian years. Oxford University Press, London. xx+198 pp.

VAUGHAN, T. A.

1972. Mammalogy. Saunders, Philadelphia. viii+463 pp.

VOGEL, C.

1962. Einige Gefangenschaftsbeobachtungen am weiblichen Fenek, *Fennecus zerda* (Zimm., 1780). Z. Säugetierk., **27**, pp. 193-204.

WAHRMAN, J., R. GOITEIN, and E. NEVO

1969. Mole rat spalax: evolutionary significance of chromosome variation. Science, **164**, pp. 82-84.

WAHRMAN J. and Z. ZAHAVI

1955. Cytological contributions to the phylogeny and classification of the rodent genus *Gerbillus*. Nature, **175**, pp. 600-602.

WAISEL, Y.

1958. Dew absorption by plants of arid zones. Bull. Res. Counc. Israel, **6D**, pp. 180-186.

WASSIF, K.

1944. On the occurrence of *Paraechinus dorsalis* (Anderson and de Winton) in South Sinai, with a note on the osteology of the animal. Bull. Fac. Sci. Cairo, No. 25, pp. 203-212.

1946a. Anterior process of the malleus in rodents. Nature, **157**, p. 630.
1946b. The processus muscularis and the tensor tympani muscle of bats. Nature, **157**, pp. 877-878.
1948. Studies on the structure of the auditory ossicles and tympanic bone in Egyptian Insectivora, Chiroptera and Rodentia. Bull. Fac. Sci. Cairo, No. 27, pp. 177-213.
1949. Trident bat (*Asellia tridens*) in the Egyptian oasis of Kharga. Bull. Zool. Soc. Egypt, No. 8, pp. 9-12.
1950. The tensor tympani muscle of bats. Ann. Mag. Nat. Hist., (ser. 12), **3**, pp. 811-812.
1951. The anterior process and the ossification of the malleus in mammals. Science, **113** (2937), pp. 486-487.
1953a. On the occurrence of hedgehogs of the genus Paraechinus in the El Tahreer Province of Egypt. Bull. Zool. Soc., Egypt, **11**, pp. 40-47.
1953b. On a collection of mammals from northern Sinai. Bull. Inst. Désert Égypte, **3** (1), pp. 107-118.
1954. The bushy-tailed Gerbil, *Gerbillus calurus* Thomas of south Sinai. J. Mammal., **35**, pp. 243-248.
1956a. Studies on gerbils of the subgenus *Dipodillus* recorded from Egypt. Ain Shams Sci. Bull., No. 1, pp. 173-194.
1956b. *Pseudorca crassidens* Owen from Mediterranean shores of Egypt. J. Mammal., **37**, p. 456.
1957. The development of auditory ossicles and tympanic bone in mammals with special reference to the part played by the anterior process in the ossification of the Malleus. Ain Shams Sci Bull., No. 2, pp. 259-289.
1960a. On a collection of mammals from the Egyptian oases of Bahariya and Farafara. Ain Shams Sci. Bull., No. 4, pp. 137-145.
1960b. Mammals from the Egyptian oases of Kharga, Dakhla, Bahariya and Farafara (Al-Wadi Al Gadid). Bull. Zool. Soc. Egypt, **14**, pp. 15-17.
1960c. Further observations on *Gerbillus simoni* Lataste from the Egyptian Province (U.A.R.). Bull. Zool. Soc. Egypt, **15** (29), pp. 29-31.
1960d. Studies on the osteology of Egyptian Jerboas. Bull. Zool. Soc. Egypt, **15** (29), pp. 71-92.
1962. The serotine bat, *Eptesicus isabellinus innesi* Lataste from Egypt. Bull. Zool. Soc. Egypt, **17**, pp. 108-110.
1971. The structure of the sternum and ribs in Egyptian bats (Microchiroptera). Bull. Zool. Soc. Egypt, **23**, pp. 39-51.

WASSIF, K. and H. HOOGSTRAAL
1953. The mammals of south Sinai, Egypt, Proc. Egypt. Acad. Sci., **9**, pp. 63-79.

WASSIF, K., R. G. LUTFY, and S. WASSIF
1969. Morphological, cytological and taxonomical studies of the rodent genera *Gerbillus* and *Dipodillus* from Egypt. Proc. Egypt. Acad. Sci., **22**, pp. 79-93.

WASSIF, K. and G. MADKOUR
1963. Studies on the osteology of the rat-tailed bats of the genus *Rhinopoma* found in Egypt. Bull. Zool. Soc. Egypt, **18**, pp. 56-80.
1969a. The structure of the hyoid bone, larynx and upper part of trachea in some Egyptian bats. Bull. Zool. Soc. Egypt, **22**, pp. 15-26.
1969b. The structure of the wing phalanges in some insectivorous bats (Microchiroptera). Reprinted from the Ain Shams Sci. Bull., No. 13, pp. 133-144.

1972a. The structure of the palatal rugae in some Egyptian bats. Zool. Anz., 188, pp. 29-36.

1972b. The tongue papillae of Egyptian bats (Microchiroptera). Bull. Zool. Soc. Egypt, 24, pp. 1-4.

1972c. The structure of the os penis in Egyptian bats (Microchiroptera). Bull. Zool. Soc. Egypt, 24, pp. 45-51.

WATSON, G. E. 3RD

1961. Behavior and ecological notes on *Spalax leucodon*. J. Mammal., 42, pp. 359-365.

WEIGALL, A. E. P.

1909. Travels in the Upper Egyptian deserts. Blackwood and Sons, Edinburgh. xiv+193 pp.

WELDON, L. B.

1909. Six months in northern Sinai. Cairo Sci. J., 3, pp. 155-161.

WELLARD, J.

1965. The great Sahara. D. P. Dutton & Co. Inc., New York. 350 pp.

WHITEHOUSE, M. A.

1887. The Raian Moeris; or storage reservoir of Middle Egypt. Proc. R. Geogr. Soc., 9, pp. 608-613.

WILKINSON, J.

1832. Notes on a part of the Eastern Desert of Upper Egypt. J. R. Geogr. Soc., London, 2, pp. 28-60.

WILKINSON, J. G.

1878. The manners and customs of the ancient Egyptians, Vol. III (rev.). Dodd, Mead and Co., New York. xi+528 pp.

WILLIAMS, C. B.

1954. Some bioclimatic observations in the Egyptian Desert, pp. 18-27. *In* Cloudsley-Thompson, J. L., ed., Biology of Deserts. Institute of Biology, Tavistock House, London.

WILLIAMS, M. A. J. and D. N. HALL

1965. Recent expeditions to Libya from the Royal Military Academy, Sandhurst. Geogr. J., 131, pp. 462-501.

WINKLER, H. A.

1938. Rock drawings of southern upper Egypt, I: Sir Robert Monod desert expedition seasons 1936-1937. Arch. Survey of Egypt Mem. 26 of the Egypt. Explor. Soc. London, pp. viii, 44, XLI.

WISNER, A., J. P. LEGOUIX, and F. PETTER

1954. Etude histologique de l'orielle d'un Rongeur a bulles tympaniques hypertrophiées: *Meriones crassus*. Mammalia, 18, pp. 371-379.

WOOD, W.

1807. Zoography, Vol. 1. Cadell and Davis, London. xix + 572 pp.

YOUSSEF, E.

1962. The structure of the skull in the long-eared hedgehog, *Hemiechinus auritus aegyptius* (Fischer). Bull. Zool. Soc. Egypt, 17, pp. 36-55.

YUNKER, C. E. and S. S. GUIRGIS

1969. Studies of rodent burrows and their ectoparasites in the Egyptian Desert, 1: Environment and microenvironment; some factors influencing acarine distribution. J. Egypt. Publ. Health Assn., 44 (5), pp. 498-542.

ZAHAVI, A. and J. WAHRMAN
1957. The cytotaxonomy, ecology, and evolution of the gerbils and jirds of Israel (Rodentia-Gerbillinae). Mammalia, **21**, pp. 341-380.
ZAHRAN, M. A.
1965. Distribution of the mangrove vegetation in U.A.R. (Egypt). Bull. Inst. Désert Égypte, **15**, pp. 8-12.
1966. Ecological study of Wadi Dunkul. Bull. Inst. Désert Égypte, **16**, pp. 127-143.
1969. On the ecology of the east coast of the Gulf of Suez, 1: Littoral salt marsh. Bull. Inst. Désert Égypte, **17**, pp. 225-250.
ZAMMARANO, V. T.
1930. Le colonie Italiane di directo dominio Faune e Caccia, 222 pp. Ministero delle Colonie, Roma.
ZEIN EL DIN, H. F. and H. A. HAFEZ
1959. Bats of Egypt (In Arabic). Dar el Feker el Araby, Cairo. 128 pp.
ZEUNER, F. E.
1963. A history of domesticated animals. Hutchinson, London. 560 pp.
ZICCARDI, F.
1970. The African wild ass. Afr. Wildl., **24**, pp. 202-208, 287-292.
ZOHARY, M.
1935. Die phytogeographische Gliederung der flora der Halbinsel Sinai. Beih. Bot. Centralbl., **52**, pp. 549-621.
1944. Vegetational transects through the desert of Sinai. Palest. J. Bot., Jerusalem Ser., **3**, pp. 57-78.
1954. Hydro-economical types in the vegetation of Near East deserts. *In* Cloudsley-Thompson, J. L., ed., Biology of Deserts, pp. 56-57.
1962. On hydro-ecological relations of the Near East desert vegetation. Unesco, Arid Zone Research, **16**, pp. 199-212.

DA
FILM