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MEDICAL ENTOMOLOGY PROJECT(U) SMITHSONIAN INSTITUTION
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Report Number 4

MEDICAL ENTOMOLOGY PROJECT

ANNUAL REPORT

Oliver S. Flint, Jr.

January 1, 1979

For the period January 1, 1978 to December 31, 1978

Supported by

U. S. ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND

Fort Detrick, Frederick, MD 21701

Contract No. DAMD-17-74-C-4086

Smithsonian Institution
Washington, D. C. 20560.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM	
1. REPORT NUMBER 4	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) Medical Entomology Project, (9) Rept. no. 4		5. TYPE OF REPORT & PERIOD COVERED (Annual) Report Jan 1 - 31 Dec 1978	
7. AUTHOR(s) Oliver S. Flint, Jr		8. CONTRACT OR GRANT NUMBER(s) DAMD 17-74-C-4086	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Smithsonian Institution Washington, D.C. 20560		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62770A, 3M762770A802/00/068	
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Medical Research and Development Command Fort Detrick, Frederick, MD 21701		12. REPORT DATE Jan 1 1979	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (12) 33 p.		13. NUMBER OF PAGES 33	
		15. SECURITY CLASS. (of this report) Unclassified	
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)			
18. SUPPLEMENTARY NOTES			
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)			
Mosquitoes	South America	Malaria	Anopheles
Culicidae	Central America	Arbovirus diseases	Culex
Insect vectors	Asia	Biosystematics	Aedes
	Africa		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)			
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cies and preparing monographs and technical papers which summarize data on the ecology, taxonomy and medical importance of arthropod vectors in various regions of the world. In addition, MEP performs curation and research on the national collection of mosquitoes at the National Museum of Natural History (USNM), Smithsonian Institution.

Six short papers on systematics, including three on Oriental *Aedes* (*Stegomyia*), and one on Neotropical *Culex* (*Melanoconion*) species were published during the year. An additional paper established and fully described and illustrated a neotype of the cosmopolitan *Culex quinquefasciatus* Say, and another established the usefulness of the female cibarial armature in the systematics of the genus *Culex*.

Four large monographic revisions have been completed and are awaiting either editing or final typing. These revise the mosquitoes of Japan, Korea, and the Ryukyu Islands, the *albimanus* group of the subgenus *Nyssorhynchus* of the genus *Anopheles* of the New World, the *Aedes scutellaris* group of Tonga, and the intra subgeneric classification of the subgenus *Stegomyia* of *Aedes* of the Oriental region.

Research has continued on the malaria vector groups of the genus *Anopheles* in the New World and the Orient, and on the arbovirus vectors of the subgenus *Melanoconion*, genus *Culex*, in the Neotropical region. Work commenced on the important disease vectors of the subgenus *Stegomyia*, genus *Aedes*, of the African region.

To supplement these studies important museum collections in Europe and Panama were studied by systematists of the project.

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SUMMARY

The Medical Entomology Project (MEP), a cooperative venture between the Smithsonian Institution and the U.S. Army Medical Research and Development Command, conducts biosystematic research on arthropods of medical importance to the Army. MEP fulfills this requirement by performing biosystematic studies on important groups of vectors such as anopheline vectors of malaria and culicine vectors of arbovirus diseases, providing information on potential vectors for the guidance of military field research teams and other governmental agencies and preparing monographs and technical papers which summarize data on the ecology, taxonomy and medical importance of arthropod vectors in various regions of the world. In addition, MEP performs curation and research on the national collection of mosquitoes at the National Museum of Natural History (USNM), Smithsonian Institution.

Six short papers on systematics, including three on Oriental *Aedes* (*Stegomyia*), and one on Neotropical *Culex* (*Melanoconion*) species were published during the year. An additional paper established and fully described and illustrated a neotype of the cosmopolitan *Culex quinquefasciatus* Say, and another established the usefulness of the female cibarial armature in the systematics of the genus *Culex*.

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INTRODUCTION

Biosystematic studies which lead to the precise identification of vectors are fundamental to any investigation of epidemiology and to the planning of control or eradication. They enable the vector or vectors to be recognized; their ecology and habits to be studied and information about vectorial capacity, resistance to insecticides, geographic distribution and so on to be passed on to other workers. Many instances of failure to control diseases resulting from vector borne pathogens can be traced to neglect of this aspect of preventive medicine research.

The Medical Entomology Project (MEP) was developed to perform biosystematic research on medically important arthropods to meet the U.S. Army Medical Research and Development Command's requirements for accurate identification of actual or potential vectors of human pathogens throughout the world. Thus, MEP is able to respond to these needs and the resources of the project are used to accomplish these requirements. This research was accomplished by 15 contract personnel, including 4 professional entomologists, plus the principal investigator and 2 professional entomologists from Walter Reed Institute of Research (WRAIR) on assignment to MEP. In addition, upon request, MEP provides synoptic collections of specimens for the use of various military entomologists and assists them in biosystematic studies of medically important arthropods. This level of support may range from furnishing entomologists with keys, necessary literature, and other identification guides to the loan of specialized collecting and rearing equipment which cannot be obtained from other sources. Such support has proven invaluable to all concerned, as the Smithsonian Institution has received extremely worthwhile material from these entomologists.

REVIEW OF PROGRESS FOR THE PERIOD
1 January to 31 December 1978

1. Biosystematic Studies on Culicidae

a. Genus *Anopheles*

(1) Subgenus *Cellia* (*leucosphyrus* group) of the Oriental region
(E.L. Peyton)

Although good progress was made on the objectives outlined in last year's report, the study during this report period has confirmed a number of new and very complex problems in the *balabacensis* complex on mainland Southeast Asia. A number of heretofore undetected forms were discovered and these will require considerable additional study to define the limits of distribution, morphological variation etc. Based on studies of the past year it now appears that the mainland fauna is composed of a number of sibling species and may prove to be as complex as some of the more popularly known anopheline complexes of the other regions of the world. These discoveries required a complete reexamination of all the considerable mainland collection at MEP and of new material acquired during the year. Part of this was brought about through the acquisition of a large batch of eggs from a colony at the London School of Tropical Medicine of the Kuala Lumpur colony or "Perlis strain" which has, until now been considered the same as the northcentral Thailand or "Chonburi form" ? (strain=colonies, form=natural populations). The eggs were hatched and reared out at MEP. Until now material of the "Perlis form" with immature stages has not been available for study. Examination of this material revealed very distinct morphological differences in the immature stages from those of northern Thailand populations. However, to date no detectable adult differences between the 2 have been noted. It has been known for some time that there were epidemiological differences in the 2 forms. The northern Thailand form (or Chonburi form) has for some time been confirmed as one of the most efficient natural vectors of human malarial parasites in Southeast Asia, while earlier studies on the "Perlis form" in northern Malaya indicate that it is a vector of simian malaria and is also involved in the transmission of human malaria but the precise identification of some of the material from Perlis is not clear. In addition, colonies of both forms have been established in numerous parts of the world from the original Bangkok, U.S. Army Laboratory, SEATO (Chonburi strain) colony and the Kuala Lumpur Institute for Medical Research (Perlis strain) colony. In each instance the Kuala Lumpur colonies have been easily established and maintained as self-mating but no successful self-mating colony of the Bangkok (Chonburi strain) has ever been established. The laboratory behavioral difference does not necessarily suggest 2 different species in itself but is of some significance when weighed with other known factors. Further study on this problem is required during the

coming year.

Studies on other Thailand material of *balabacensis* during the report period have confirmed the following: Two distinct forms occur throughout much of the country. One of these had not previously been detected and this will certainly complicate the currently accepted epidemiological concept of *balabacensis* and human malaria in some parts of Thailand. Fortunately, it appears that most of the early malaria work in Thailand by Walter Reed and SEATO Laboratory personnel can be reliably associated with the Chonburi form through the use of very adequate voucher specimens deposited at MEP. The second form somewhat resembles the Malayan "Fraser Hill form" of Colless 1957 and Reid 1968 and appears to be less common than the Chonburi form. This form is encountered over a wide range in Thailand but appears to occur in more heavily forested areas and in some cases higher elevations than the Chonburi form. Specimens have been seen from the provinces of Chanthaburi, Kanchanaburi, Nakhon Si Thammarat, Ranong and Tak. The Chonburi form in Thailand is typically a foot-hill, scrub-forest or forest-fringe inhabitant. Investigators of Walter Reed and SEATO Laboratory including this investigator, have in past field studies, observed some rather noticeable differences in the biting behavior of some populations of Thailand *balabacensis* but did not at that time note any morphological differences. Whether these behavioral differences can be associated with the 2 forms is uncertain but MAJ Bruce A. Harrison, Chief, Department of Medical Entomology, AFRIMS, has been appraised of all the preliminary findings of this study, and is actively re-investigating the *leucosphyrus* group in Thailand.

As a result of detailed studies of Thailand *balabacensis* and topotypic material of *balabacensis* during the report period I have concluded that *balabacensis* sensu stricto does not occur on mainland Southeast Asia and that several populations currently recognized as *balabacensis* or forms of *balabacensis* represent several distinct forms which will require complete new descriptions and names for several of these. These include: (1) *balabacensis introlatus*; (2) Fraser Hill form (Malaya); (3) Fraser Hill-like form (Thailand, probably not Fraser Hill form but requires comparison with typical Fraser Hill form); (4) Chonburi form (Thailand); (5) Con Son Island form (S. Vietnam); (6) Perlis form (N. Malaya); and (7) *takasagoensis* (Taiwan). MAJ Harrison and I are collaborating on a publication which we hope to publish in the March issue of *Mosquito Systematics* which will describe and rename the Thailand Chonburi form of *balabacensis* and revalidate *takasagoensis* of Taiwan. Many of the necessary setal counts, measurements, and analysis of adult characters have been completed. Illustrative plates of the pupa and adult are complete and larval drawing is in the preliminary penciled stage.

As a result of a report of my preliminary findings to MAJ Bruce Harrison.

some of my earlier findings have been confirmed in the field. In August 1978 MAJ Harrison and his team made a collection trip to southern Thailand (Isthmus of Kra) between Chumphon and Ranong. Approximately 100 blood-engorged females were isolated for egg recovery and several thousand larvae were collected from the natural habitat and reared to the adult stage. Many of the isolated females laid eggs and these have now been individually reared in Bangkok. The exact identity of some of this material has not been determined, but we are hopeful these will help to clarify some of the Thai-Malay forms. Approximately 10 Schmidt boxes of adults, including several progeny series have been pinned and the immature stages are being mounted on slides. The material will be shipped to MEP during January 1979. Another trip to this area in January-February 1979 is planned. Of greatest interest from the collection so far is the confirmation of my earlier report (MEP Annual Report of 1 September 1977) of the occurrence of *leucosphyrus* in extreme southern Thailand. MAJ Harrison and his team collected 2 females of *leucosphyrus* in a human biting collection 40 km northeast of Chumphon which is approximately 400 km north of the record I reported in 1977. Several progeny rearings were obtained from these 2 specimens.

It may appear that the Thailand work by AFRIMS personnel and the study at MEP is somewhat unrelated, but this is the first opportunity to collaborate so closely with field investigators in the early stage of a study where both parties can contribute significantly to each study. Further collaboration on other aspects of the study between AFRIMS Laboratory and MEP is planned. Recently, MAJ Harrison obtained eggs of typical *balabacensis* from Sabah, Malaysia and has successfully established a colony in Bangkok. Some of this material will soon be prepared and sent to MEP for study. A significant number of adult *balabacensis* from Sabah are in the MEP collection but very few immature stages are available. Efforts are being made to obtain eggs from the NAMRU-2 colony of *takasagoensis* for studies at AFRIMS Laboratory and MEP. In collaboration with Dr. Baimai of the Mahidol University, Bangkok, MAJ Harrison will attempt laboratory crosses and chromosomal studies of these strains in Bangkok.

On a recent trip to Kuala Lumpur MAJ Harrison borrowed several specimens of the *leucosphyrus* group, including a critical collection of the Malayan Fraser Hill form from Dr. Shivaji Ramalingam for study at MEP. This investigator has agreed to collaborate with MAJ Harrison and Dr. Ramalingam on the treatment of the Malayan and Thailand Fraser Hill forms sometime in 1979. All of these renewed activities are a direct result of the current study of the group at MEP.

During the report period, setal counts of the immature stages and preliminary drawings were accomplished on the following: *balabacensis introlatus* larva and pupa; *balabacensis* larva, pupa and wing, *pujutensis* larva and pupa, *riparis macarthurii* larva and pupa, *hackeri* larva and pupa, *leucosphyrus* larva and pupa and Thailand new species Chonburi form larva, pupa and wings. Measurements and ratio of pupal spines 9-III-VII were compiled for

approximately 110 specimens of *balabacensis*, *takasagoensis*, Fraser Hill form, Perlis form and Chonburi form. Dissections and slides of mouth parts were made for a small number of Thailand forms of *balabacensis*.

Analysis of wing spot variation of over 100 specimens of Thai *balabacensis* forms and typical *balabacensis* was also made.

In addition this investigator has reviewed 6 manuscripts written by other investigators, and identified approximately 250 Philippine mosquitoes (mostly anophelines) for MAJ Stephen M. Valder of the U.S. Air Force.

(2) Subgenus *Anopheles* (*arribalzagia* group) of the Neotropical region (G.K. Bryce)

During the period from December 1977 to December 1978 I continued work on a revision of the *arribalzagia* group of the subgenus *Anopheles*. This revision will tentatively include the following species: *apicimacula*, *gabaldoni intermedius*, *mattogrossensis*, *mediopunctatus*, *minor*, *neomaculipalpus*, *peryassui punctimacula*, *shannoni* and *vestitipennis*. At this point I feel there is sufficient material available to justify including these species in this revision. This series also includes those species which are believed to be medically important.

To date, I have examined most of the material available in the UCLA collection. This includes approximately 2300 pinned adults and 800 mounted whole larvae, larval exuviae, pupal exuviae and male genitalia. Of these specimens there are only 170 individual rearings. Most of the pertinent literature has also been reviewed.

Because of the somewhat limited amount of material available and the small number of individual rearings, certain problems have arisen which are as yet unresolved. The most notable of these involved the nominal species *apicimacula* Dyar and Knab, 1906, described from Guatemala, and *intermedius* Chagas, 1908, described from Brazil. Specimens from the type localities can be separated reliably and match their descriptions fairly well. However, material which has been called *intermedius* from Central America cannot be reliably distinguished from the *apicimacula* material. From the small sample examined it appears that some of the characters which have been used to differentiate the species grade clinally into one another. The status of these nominal species is not yet clear.

A portion of the mosquito collection from the project "Mosquitoes of Middle America" at UCLA was transferred to the USNM this year. The latter part of October was spent in preparing this material for transit and then transporting this material by truck to the Medical Entomology

Project, USNM. An additional three weeks were spent at the facilities of the Medical Entomology Project examining material. This stay was most important for this revision. Close to 1500 specimens were sorted through to determine the desirability of further examination. Of these, approximately 1000 were borrowed and sent to UCLA for detailed study. From this material about 200 male genitalia slides need to be prepared. This material may be very important in helping to resolve some of the problems mentioned earlier, since much of it comes from localities previously unrepresented. Holotypes of the following nominal species were also borrowed: *apicimacula*, *celidopus*, *fluminensis*, *malefactor*, *punctimacula*, *shannoni*, *strigimacula* and *vestitipennis*. Additionally, material from other groups in the subgenus *Anopheles* was examined.

(3) Subgenus *Anopheles* and *Nyssorhynchus* of the Neotropical region
(M.E. Faran)

Research has begun on the *pseudopunctipennis* complex of *Anopheles*. Preliminary examination of the larvae and pupae of the nominal species *franciscanus* and *pseudopunctipennis* was undertaken with specimens from California, Mexico, Panama, Venezuela, Grenada, Ecuador and Argentina. In the process of reviewing the literature and compiling the species' synonymies, 426 papers have been cited for these two species.

The handbook on the species of *Nyssorhynchus* occurring in the Amazon Basin is now in the final stages of preparation. This handbook contains keys to the females, male genitalia and larvae. Also included is a brief discussion of the bionomics, medical importance and distribution of each species. Illustrations are provided of the wing of the female, male genitalia, pupa and larva. The primary purpose of these keys will be to support ongoing research conducted by the U.S. Army Medical Research Unit (USAMRU) in Brasilia.

Plans are being made for a field trip to Brazil, scheduled for the summer of 1979, in support of malaria investigations by USAMRU-Brasilia. Necessary equipment and specimen labels have been ordered through WRAIR and MEP respectively.

Assistance was given to the Department of Entomology, WRAIR in the Delmarva Peninsula arbovirus studies. Several weeks were spent at Pocomoke Cypress Swamp, Maryland, and Assateague National Wildlife Area conducting field studies. As a result of these studies 995 individual rearings (749 larval, 196 pupal, 50 incomplete) were made for 2,739 specimens of the following species: *Aedes* (*Aedes*) *cinereus*, *Ae.* (*Aedimorphus*) *vexans*, *Ae.* (*Och.*) *atlanticus*, *Ae.* (*Och.*) *canadensis*, *Ae.* (*Och.*) *cantator*, *Ae.* (*Och.*) *infirmatus*, *Ae.* (*Och.*) *triseriatus-hendersoni*, *Anopheles* (*Anopheles*) *crucians* complex, *Culex* (*Cul.*) *restuans*, *Cu.* (*Cul.*) *salinarius*, *Cu.* (*Neo-*

Culex) *territans*, *Culiseta* (*Climacura*) *melanura*, *Cx.* (*Culiseta*) *inornata*, *Orthopodomyia* *signifera*, *Psorophora* (*Janthinosoma*) *ferox* and *Ps.* (*Psorophora*) *howardii*. In addition, 6,000 larvae of *Ae.* (*Och.*) *atlanticus* were collected in attempts at colonization of this species at WRAIR. Also, 3,000 larvae of *Ae. infirmatus* were collected and pooled for virus studies. Continued support has been given WRAIR in assisting and directing mosquito identifications.

Investigation was made into the feasibility of developing a computerized system for handling specimens and associated data in the development of a data base that will be easily available for various users. In conjunction with this preliminary study, an eight week FORTRAN Computer Course was taken at WRAIR.

A new species in the *oswaldoi* complex of the *albimanus* section was described. Although nothing is known concerning the medical importance of this species, it is possible that it may be a vector of malaria in Ecuador. A description of this species will be published in "Mosquito Systematics" during March 1979.

The symposium, "A Multidisciplinary or Holistic Approach to Mosquito Systematics," has been organized and will take place at the annual meeting of the American Mosquito Control Association in April 1979. The purpose of this symposium is to bring together scientists from several fields such as cytogenetics, electrophoresis, genetics, etc., whose research has an important impact upon mosquito systematics. This symposium will encourage the interaction among individuals from these different disciplines in approaching systematic problems.

(4) Subgenus *Nyssorhynchus* (*argyritarsis* section)
(K. L. Linthicum)

The thesis was completed, submitted and accepted. Work continued on the thesis, adding and checking all the collection data in the process of preparing a suitable manuscript. This work having been completed, Mr. Linthicum was separated from the project early in the year (3-25-78). He has, however, continued to work on the manuscript and it is now nearly ready for final review.

b. Genus *Culex*, subgenus *Melanoconion* of the Neotropical region
(S. Sirivanakarn)

In preparation for a revision of the *ocossa* and *taenioopus* groups, considerable progress has been made in basic comparative studies of the adults and immature stages. This included especially the comparative study with an analysis of the taxonomic significance of the female cibarial armatures, larval and pupal stages. As a result of this study, several important taxonomic characters have

been found that provide a basis for determining the relationship between or among species and various species groups. In the course of this study, a manuscript on the female cibarial armatures of *Melanoconion* and related subgenera of New World *Culex* was prepared and several illustrations were made for publication in the December issue of "Mosquito Systematics." From this study, it has become possible for the first time to incorporate the female characters with the male genitalia and the immature stages in developing a sounder classification of the *ocossa*, *taeniopus* and several other groups of *Melanoconion*. In revising species in these 2 groups, the illustrations of the adults of *ocossa* and *opisthopus* and illustration of the male genitalia of *pereyrai* were made.

About 300 slides of the male genitalia and female cibarial armatures were prepared during the year. Preliminary and/or final identification was made of several specimens among the undetermined material in the collections of the Mosquitoes of Middle America Project. All the associated pupal and larval specimens in the field collections made by E.L. Peyton in Panama and Colombia, Y.-M. Huang in Ecuador and the author in Guatemala were examined, sorted and curated. In addition, identification of about 300 genitalia slides of over 20 species was made for the Center of Disease Control, Colorado, of which about 200 specimens were sorted out, properly mounted, labelled, and incorporated with the rest of the *Melanoconion* collection.

Through a loan from the British Museum, types of the 11 following nominal species were examined: *ocellatus*, *thomasi*, *clarki*, *humilis*, *indecorableis*, *gordoni*, *spissipes*, *theobaldi*, *nigrescens*, *nigricorpus* and *chrysothorax*. Notes on the taxonomic and nomenclatural status of these species were gathered, some of which will be published for clarification of their identity and validity in the coming year. Included also was the examination of the types (genitalia mount) of *pereyrai* and *faurani* (members of the *taeniopus* group) loaned from the personal collection of Dr. J. Pedro Duret in Argentina.

Work has been initiated on the realignment of species on the basis of comparative morphology of all stages. Because of the lack of a comprehensive scheme of classification in previous studies, it was deemed most essential to develop a scheme which would not only provide a more precise definition of various species groups but also reflect phylogenetic relationships among them. This basic study would considerably facilitate the choice of most reliable characters for separating and grouping species as well as provide a sound basis for the taxonomic treatment of individual species groups. In connection with the revision of the *ocossa* and *taeniopus* groups, progress has been made in assembling species and further attempt will be made in the coming year to develop a preliminary scheme of classification.

From 6 to 19 September, a field trip was made to Gorgas Memorial Laboratory in Panama. The purposes of the trip were three-fold. 1) to assess the material of *Culex*, subgenus *Melanoconion*, in the collection of the G.M.L., 2) to obtain the loan of additional specimens of species in the *ocossa* and *taeniopus* groups, and 3) to consult with Drs. Galindo and Adames about problems in these groups. A series of a form close to *taeniopus*, a series of color forms of *spissipes*, and material collected by Aitken in Trinidad were borrowed. Numerous discussions were held with Dr. Galindo and other personnel of the Laboratory which resulted in a clarification of usage of names, the status of various species in Panama, collaborative agreements, and the gift of valuable material from laboratory colonies.

c. Genus *Aedes*, subgenus *Stegomyia* of the African region
(Y.-M. Huang)

During the early part of the year, 2 monographs: (1) The systematics of the subgenus *Stegomyia*, genus *Aedes*, in the Oriental region with keys to the species and (2) A revision of the *Aedes scutellaris* group of Tonga were prepared for publication. It is anticipated that both monographs will be published in 1979. In addition, 3 taxonomic papers dealing with the Oriental species were published.

The biosystematic studies of the subgenus *Stegomyia* of Africa were commenced during the year. A preliminary examination and sorting of all available material in the MEP collection has been accomplished. It consists of 12 species, and a total of 524 adults.

A trip to the European museums was taken between July 31 and October 13, 1978. The main purpose of the trip was to study type-specimens of African *Stegomyia*, to obtain important existing material and to arrange for the loan of the material in the European museums.

Six European museums: (1) British Museum (Natural History), London; (2) London School of Hygiene and Tropical Medicine, London; (3) Museum National d'Histoire Naturelle, Paris; (4) Institut Pasteur, Paris; (5) Services Scientifiques Centraux de l'Office de la Recherche Scientifique et Technique Outre-Mer, Bondy, France; (6) Musee Royale de l'Afrique Centrale, Tervuren, Belgium, were visited and all collections were examined. A total of 50 primary types (including names in synonymy) of African *Stegomyia* in the European museums (45 in BM(NH), 2 in ORSTOM and 3 in Congo Museum) were studied. Notes on the taxonomic characters and type-data were taken for all type-specimens. All the specimens were identified and data recorded, and important material was selected for loan. A total of 900 specimens, including 9 type-specimens, were hand-carried back on loan from this trip.

In addition, as a result of these European studies, the taxonomic study of African *Stegomyia* has gained full support from Dr. J. Mouchet and Dr. M. Cornet, both of ORSTOM (see appendix 1).

Examination of the type-specimens and other material in the European museums has indicated that: (1) there is much confusion and misidentification among African *Stegomyia*; (2) there is a great lack of reared material of this subgenus; (3) there is very little biological and ecological information available; and (4) approximately, 80% of the material in the European museums were from West Africa.

Study of the type-specimens of *Aedes simpsoni* (Theobald), *Aedes lilii* (Theobald) and *Aedes bromeliae* (Theobald) at the British Museum (Natural History) and examination of available material thus far has revealed that *Aedes simpsoni* is a species complex and that both *lilii* and *bromeliae* which had been synonymized with *simpsoni* might be recognized as distinct species. A detailed study of the *Aedes simpsoni* complex is underway. However, much more material from both South and East Africa will be needed before a final conclusion can be reached.

2. Field and Museum Studies

a. Panama

Dr. Sunthorn Sirivanakarn visited the Gorgas Memorial Laboratory between 6 and 19 September, 1978. While there he surveyed their collection for useful *Melanoconion* material, and arranged for the loan of 55 specimens. He also consulted with Drs. Galindo and Adams on problems of mutual concern.

b. European Museums

Dr. Yiau-Min Huang visited 6 European museums between 31 July and 13 October 1978. In their collections she located and studied 50 primary types of African *Stegomyia*. In addition to study of other useful material she was able to borrow 900 most valuable specimens mostly from West Africa, for study at MEP.

3. Curatorial Activities

a. Status of the World collection of Culicidae

During the year a major effort to improve the curatorial status of the collections has continued. The entire slide collection, approximately 80,000 slides, has been resorted and the various separate collections consolidated. New labels were typed and affixed to all the slide boxes.

The World collection of *Anopheles* has been totally reworked. The old Museum collection, the "excess" collection, the CDC collection, and the Belkin collection (except for the New World material) have all been transferred to standard National Museum trays and fully integrated. The *Anopheles (Nyssorhynchus) albimanus* group specimens studied by M.E. Faran are being individually labelled with identifications and incorporated. The collection is arranged by subgenera and alphabetically by species, and then by geographic area. Each tray has been labelled with the genus, subgenus, species and geographic area of the contents. The *Anopheles* collection is housed in about 100 Museum drawers.

The genera *Armigeres*, *Bironella*, and *Coquillettidia* were also similarly curated. Work is now progressing on the genus *Culex*, which is nearly half finished. Additional material of *Aedes* from Alaska was similarly curated and returned to this section of the collection which had been curated earlier.

b. Contract collectors

Mr. B.N. Mohan of Coonoor, Southwest India sent a collection of 599 reared associated adult mosquitoes collected by him in the Nilgiri Hills area during 1978. Of greatest significance were 240 topotypic specimens of *Anopheles (Cellia) elegans*. Mr. Mohan has been collecting off and on for MEP for the past 5 years through small grants from the MEP contract. The project has derived a considerable amount of very valuable material from Southern India through Mr. Mohan at a minimal cost. This most recent collection from Mr. Mohan concluded the current agreement between Mr. Mohan and the Smithsonian Institution for collecting in India.

Mr. J. Muspratt of Johannesburg, South Africa fulfilled his obligation with two final lots, containing 233 adults, 3 slides and 145 vials of immatures. During the period from 1975 to 1978 we have received many lots from him which have contained in total 56 culicine species (including *Toxorhynchites*), and 8 anopheline species. Species have been received in the following genera: *Toxorhynchites*, *Mimomyia*, *Uranotaenia*, *Eretmapodites*, *Aedes*, *Culiseta*, *Culex* and *Anopheles*. Of special value have been reared topotypic material of 14 culicine and 2 anopheline species, and material of 8 *Stegomyia* species, 4 of which were topotypic. These collections from South Africa are the single most important collections we have from the area.

c. Accessions and other activities of the MEP collections management section

The 66 accessions received by MEP are summarized in appendix 2. During 1978 these totaled 32,587 specimens. The outstanding accession was the gift

of another portion of the Mosquitoes of Middle America Collection from Dr. John N. Belkin. The remaining portion of the New World *Anopheles*, except for that part being studied by G.K. Bryce, and many excess supplies and reprints were driven here by Mr. Bryce at the expense of the Department of Entomology, Smithsonian Institution. Also received was a very valuable synoptic collection of Japanese mosquitoes which is the basis for Tanaka's monograph on the "Mosquitoes of Japan" being prepared for publication by MEP. Dr. Kenneth L. Knight's extensive collection of mosquitoes from Egypt and Yemen was accessioned early in the year. This collection will be extremely useful in the current work on African and Middle East mosquitoes.

Outgoing material involving specimens (loans, return of borrowed material, etc.,) accounted for 7,926 specimens in 58 transactions. The largest returned loan was to the British Museum (Natural History) in which 816 adults and 94 slides were returned. Dr. Mattingly made several large requests for material of *Tripteroides*, borrowing 1,469 adults and 2,109 slides.

4. Other Activities

a. Identification services

In keeping with one of the stated duties of MEP, the staff made, or arranged to have made, numerous identifications of material submitted from outside sources. About a dozen of these transactions involved small lots of mosquitoes and other insects. However, several major lots were handled during the year.

The Center for Disease Control, Fort Collins, Colorado has a major program searching out the vectors of various arboviruses in the New World. Consequently many specimens of concern are submitted for identification to Dr. Sirivanakarn each year (see letter from Dr. Francy, appendix 1). During the past year many hundreds of identifications were made, mostly of the subgenus *Melanoconion*. Valuable material of *epanastasis*, *vomerifer*, *pereyrai*, and *faurani* from southern Brazil were thus obtained for the revision of the *taeniopus* group. In addition, examples of a new species were obtained, which will be described in collaboration with Mr. W.L. Jakob in the near future.

In collaboration with field studies of the epidemiology of VEE conducted by Drs. William F. Scherer and Ed Cupp, Cornell University, identification of 12 *Melanoconion* species collected from La Avellana, Guatemala in the summer of 1977 was provided. Recent contact with Dr. Ed Cupp has indicated that further identification of this nature is required for the material collected at the study site during the summer of 1978.

Major Stephen M. Valder of the U.S. Air Force submitted a collection resulting from a survey of Dumaguete, Negros Island, Phillipines, which was especially rich in anophelines, and was identified by Mr. E.L. Peyton.

Mr. Peyton examined approximately 150 reared associated specimens of the *leucosphyrus* group from 2 NIH colonies for Dr. Ronald Rosenberg and discovered that one colony which Dr. Rosenberg had established from eggs obtained at the Institute for Medical Research (IMR), Kuala Lumpur, Malaysia, and assumed to be true *balabacensis* from Sabah, East Malaysia was in fact the Perlis (N. Malaya) strain and not *balabacensis*. This probably indicates that the original colonies in Kuala Lumpur have become contaminated. Colonies of four strains are maintained in the same insectary room at the IMR. This has now been confirmed by MAJ Bruce A. Harrison (pers. communication 21 December 1978) who obtained eggs from the IMR in November 1978 which were labeled as the inland Sabah, Malaysia, *balabacensis* colony. A very successful self-mating colony of these was established in the AFRIMS Laboratory in Bangkok and these also have proven to be the Perlis strain.

b. Publications

Six papers by staff members of the project were published during the year. (appendix 3). These report incidental findings discovered in the process of the large research programs just recently initiated. The last three parts of the "A Mosquito Taxonomic Glossary" by Harbach and Knight were published during 1978. Although these last three parts were not directly supported by MEP, the project has provided illustrative services, loan of material, review of manuscripts, etc. throughout the years of publication of the glossary, and will again provide extensive illustrative support for the final book form of the glossary.

The manuscript by Tanaka monographing the mosquitoes of Japan, Korea and the Ryukyu Islands has been edited, an extremely time consuming job for Dr. Ronald A. Ward. Final typing on mats for publication is proceeding steadily, and is more than two-thirds completed. The manuscript should be with the printers in early 1979.

c. Illustrations

The scientific illustration staff was highly productive during the year. With the new programs that have recently been initiated, over 150 pencil drawings and 85 setal counts were made. Most of these pencil drawings have not been verified by the specialists yet, and will need minor modifications before they can be finally inked. Corrections and minor modifications were made to 62 plates plus similar changes and numbering

to 81 plates of the Tanaka manuscript. Final inked illustrations, to the number of about 160, including several ink wash habitus drawings, were completed during the year.

Mr. Vichai Malikul participated in the teaching program of the summer workshop in Natural Science Illustration at the U.S. Department of Agriculture Graduate School. He presented the demonstration on brush technique as used in the production of mosquito habitus illustrations.

d. Scientific literature

Over 500 reprint folders were typed and filed during the year. Continuing our long established tradition, a carton of duplicate reprints was sent to the Military Entomology Information Service, Armed Forces Pest Control Board for inclusion in their files.

Several hundred references for the years 1974-1977 were furnished to Dr. Knight for inclusion in his "Supplement to a Catalog of the Mosquitoes of the World." Additional lists of references on *Toxorhynchites* were furnished to Dr. W.A. Steffan, and on the *kochi* group of *Finlaya* to Mrs. Rampa Rattanarithikul of the AFRIMS Laboratory, Bangkok.

e. Participation in scientific activities

Dr. O.S. Flint, Jr., served as Smithsonian Institution liaison representative to the Armed Forces Pest Control Board and presented two reports concerning MEP activities at the quarterly meetings of the Board.

Dr. M.E. Faran attended the Annual Meeting of the American Society of Tropical Medicine and Hygiene at Chicago from November 5-10. At the same meetings a paper "Identification of a new enzootic vector of Venezuelan encephalitis virus" was presented by Drs. E.W. Cupp and W.F. Scherer of Cornell University and S. Sirivanakarn of MEP.

Mr. E.L. Peyton has served as a member of the registration committee for the 1979 meeting of the American Mosquito Control Association to be held April 8-12, 1979 in Washington, D.C. Three brief meetings of the committee were held during the year. Drs. Knight and Faran have organized the symposium "A multidisciplinary or holistic approach to mosquito systematics" to be held at the same AMCA meetings.

f. Visitors

During the year 29 visitors signed the guest book in the project. Overseas visitors included Dr. Richard F. Darsie, Jr. (San Salvador, El Salvador), Dr. David Flores (Bogota, Colombia), Dr. Jack Peterson (Panama,

Panama) and Dr. Donald J. Pletsch (Mexico, Mexico).

Dr. William E. Bickley (University of Maryland, College Park) has been working regularly in the project for several days each week. He is identifying and curating the North American mosquitoes, especially the genus *Culiseta*.

Dr. Darsie visited the project twice for several weeks each to study and select material of North American mosquitoes for use in the project on keys to the mosquitoes of North America, north of Mexico. This is a joint project of Drs. Darsie and Ward, and is funded by the American Mosquito Control Association.

Dr. W.A. Steffan (Bishop Museum, Honolulu) spent a week in December studying and photographing types and other important material of *Toxorhynchites* for his revision of the genus.

g. Consultants

The consultants of MEP are identified in appendix 4. Dr. Peter F. Mattingly has completed the descriptions of 16 species of the genus *Tripteroides* of Southeast Asia, leaving only 6 more to be described plus some small isolates of atypical material to be discussed. All the basic illustrations have been completed, and only small corrections are likely to be required from now on. Everything has confirmed his first impression that the currently accepted subgenera are unnatural, and even that the separation of the genus from related genera is at present impossible. These major problems will receive much attention in the next year.

Bruce A. Harrison has completed and had reviewed at MEP the draft manuscript on the *Anopheles (Cellia) minimus* group of Thailand. Although this study has been supported in part by the AFRIMS, U.S. Army Medical Component, Bangkok, Walter Reed Institute of Research and the Medical Entomology Project, the basic study of this group was supported from the beginning by SEATO Medical Research Laboratory and MEP as a portion of Southeast Asia mosquito studies. The MEP has provided considerable technical support toward the completion of the study, including the support for all of the illustrations and the typing of the original draft.

Dr. Kenneth L. Knight completed early in the year the descriptions of both sexes, the pupa and the larva of *Aedes (Finlaya) harinasutai* n.sp. A member of the *niveus* group, this species has been found by Drs. Gould and Harinasuta to be a vector of bancroftian filariasis in Kanchanaburi Prov., Thailand.

In collaboration with Dr. Ralph E. Harbach (supported by a grant from the National Institutes of Health) work continued on the production of the last remaining sections of "A Mosquito Taxonomic Glossary" with the 16th and last section being published in the December issue of Mosquito Systematics. This project was initiated in 1969 at our request, and has received frequent illustrator support and personnel assistance over the years.

Dr. John N. Belkin consulted with the MEP staff and Dr. Knight during the period August 14-18, 1978. In addition to consultation with the staff about problems of mutual interest, everyone had a round-table discussion with Drs. Knight and Harbach about the Mosquito Glossary during the same period.

Dr. James B. Hitchcock completed preparation of a draft on the bionomics and medical importance of the *Aedes scutellaris* group of Tonga. Virtually all his observations have not been previously published and they should greatly add to our knowledge of this vector group. The final monograph will be coauthored by Huang and Hitchcock.

5. Recommendations

With the completion of most phases of research on the mosquitoes of Southeast Asia, the research emphasis has turned to Latin America and Africa. Fortunately, there are old collections of Latin American mosquitoes here, and new valuable material in the Mosquitoes of Middle America Collection which Dr. Belkin is transferring to the National Museum of Natural History. In spite of this, there is the lack of good individually reared material from most of South America. If there is the lack of material from parts of Latin America, then there is almost nothing available, specially individually reared adults, from Africa. The situation with Africa now is very similar to that with Southeast Asia when SEAMP-MEP was begun 15 years ago.

Progress during the past years in gathering material from the New World has begun to yield results, but we have only started with Africa. Dr. Huang's trip to Europe opened many doors and will, we hope, prove profitable in the future. But, there is no substitute for the quality and quantity of material that our own professional staff can generate on a well supported field trip. Because it takes time to develop the contacts necessary for a good trip, these can often be foreseen and budgets prepared well in advance. However, some trips develop very suddenly when we are invited to join with others and, if we can take advantage of such offers, a substantial cost saving can result.

In the light of our need for quality material from Latin America and Africa, we must not only carefully plan for field work, but be prepared to move quickly to take advantage of special offers. It is therefore recommended that field collecting by the professional staff be considered as an essential part of the overall program, consistent with the funds available for each contract year.



DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL

BUREAU OF LABORATORIES
VECTOR-BORNE DISEASES DIVISION
POST OFFICE BOX 2087
FORT COLLINS, COLORADO 80522

Appendix 1

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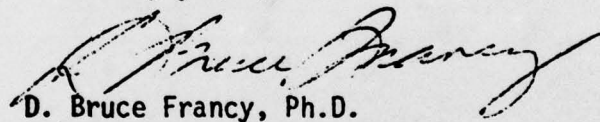
August 21, 1978

Dr. Sunthorn Sirivanakarn
Med. Entomology Project NHB-165
Smithsonian Institute
Washington, D.C. 20560

Dear Dr. Sirivanakarn:

Thanks very much for the determinations which you made on the Dominican Republic mosquitoes which we sent. Dr. Mitchell of the VBDD has a manuscript draft of the work done in the Dominican Republic following an apparent EE epizootic in equines. We are grateful for your assistance which will be acknowledged in the publication.

Sincerely yours,


D. Bruce Francy, Ph.D.
Chief, Vector Ecology Branch

cc:
W.L. Jakob
T.P. Monath
C.J. Mitchell

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OFFICE DE LA RECHERCHE SCIENTIFIQUE
ET TECHNIQUE OUTRE-MER

SERVICES SCIENTIFIQUES
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70-74, route d'Aulnay, 93140 BONDY

Tél. : 847.31.95 (lignes groupées)

SYM. : JM/mt/ 280/78

Appendix 1

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BONDY, le 7 novembre 1978

Monsieur J. MOUCHET
Entomologiste médical

au

Docteur Ronald A. WARD
Smithsonian Institution
WASHINGTON, D.C. 20560

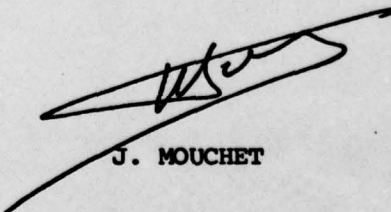
U.S.A.

Cher Docteur Ward,

Je vous remercie de votre lettre du 17 octobre 1978. Nous avons été très heureux de la visite du Docteur HUANG qui a apporté une contribution extrêmement fructueuse à nos chercheurs travaillant sur les vecteurs de Fièvre jaune en Afrique. Nous allons d'ailleurs recueillir du matériel dans des conditions écologiques bien précises pour essayer de débrouiller les complexes *Ae. simpsoni* et *Ae. africanus* en fonction de l'adaptation écologique et éventuellement trophique des diverses formes.

Comme a dû vous le dire le Docteur HUANG nous avons une très importante collection de moustiques d'Afrique et tout chercheur qui s'intéresse à la taxonomie de ce groupe est le bienvenu. Mais en général le temps prévu dans notre Institut est trop court pour que le travail se fasse dans de bonnes conditions.

Je vous prie de recevoir, cher Docteur Ward, mon plus amical souvenir.


J. MOUCHET

R.W.
13 Nov 78

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Dr. M. CORNET
10, Avenue Mireio
06100 NICE - France

V/RM. _____

Appendix 1

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Nice BONDY, le 2 octobre 1978

Miss Y.M. HUANG
Medical Entomology Project
Department of Entomology
U.S. National Museum
Smithsonian Institution
WASHINGTON, D.C. 20560
U.S.A.

Chère Mademoiselle Huang,

Je vous serais très reconnaissant de bien vouloir me faire parvenir un tiré à part de votre publication où vous attribuez Aedes vittatus au sous genre Aedimorphus; au cas où cela ne vous serait pas possible, pourriez-vous m' en indiquer la référence exacte.

J' ai regardé de nouveau avec soin les exemplaires d' Aedes du groupe africanus que j' ai ici et je suppose que vous serez intéressée de savoir qu' Aedes opok existe bien en Afrique de l' ouest (Sénégal, Empire Centrafricain).

J' ai écrit à mon camarade Max Germain à Dakar afin qu' il essaie de vous envoyer des oeufs d' Aedes aegypti et de ce que nous appelions A.simpsoni (non anthropophile).

Pour ce dernier, je me permet de vous signaler que les oeufs n' éclosent qu' après plusieurs immersions suivies de dessiccation (4 à 6 en moyenne).

Il m' a été très agréable de vous rencontrer et j' ai hâte de voir paraître le résultat de vos travaux qui nous intéressent énormément.

Avec mes remerciements et mon meilleur souvenir,



M. CORNET

Appendix 2

ACCESSIONS OF THE MEDICAL ENTOMOLOGY PROJECT, 1978

Source	Number of Accessions	Adults	Slides	Other
University of California Los Angeles, California	4	11,213	1,701	1,490 Unmounted Immatures
U.S.N. Medical Lab. Pacific APO San Francisco 96343	1	3,420	2,845	0
Dr. K. L. Knight Raleigh, North Carolina	1	2,054	1,443	0
SEATO Medical Research Lab. Bangkok, Thailand	3	1,008	1,210	74 Unmounted Immatures
B. N. Mohan Coonor, India	1	599	0	595 Unmounted Immatures
Johns Hopkins University School of Hygiene & Public Health Baltimore, Maryland	1	492	421	0
Museum of Comp. Zoology Cambridge, Massachusetts	2	455	0	0
ORSTOM Bondy, France	2	351	10	0
Cornell University Ithaca, New York	1	302	147	0

Source	Number of Accessions	Adults	Slides	Other
British Museum (Natural History) London, England	9	266	29	28 Unmtd. Immatures
SAIMR Johannesburg, South Africa	4	233	3	145 Unmtd. Immatures 6 Lots Eggs
C. M. & O. S. Flint Alexandria, Virginia	1	155	0	221 Unmounted Immatures
London School Hygiene & Tropical Medicine, London, England	1	142	0	0
Gorgas Memorial Laboratory Balboa Heights, C. Z.	1	136	0	0
Musee Royale de l'Afrique Centrale Tervuren, Brussels, Belgium	1	102	0	0
Communicable Disease Center Ft. Collins, Colorado	3	100	300	142 Unmounted Adults
University of California Davis, California	1	63	0	0
Ross Institute London, England	1	49	0	49 Unmounted Immatures
Wm. Bickley College Park, Maryland	1	40	15	0
V. M. Ford Chandler, Arizona	1	39	0	58 Unmounted Immatures

Source	Number of Accessions	Adults	Slides	Other
Systematic Entomology Lab USDA, Washington, D. C.	6	34	0	16 Unmounted Adults
University of Madras Madras, India	1	33	30	0
Pasteur Institute Paris, France	1	32	0	0
G. Hevel NMNH, Washington, D. C.	2	27	0	0
CSIRO Canberra, ACT, Australia	1	25	0	0
D. J. Pletsch Mexico, D. F., Mexico	2	12	0	0
Bishop Museum Honolulu, Hawaii	1	11	0	0
W. F. Pippin Los Alamos, New Mexico	1	9	0	0
University of Malaysia Kuala Lumpur, Malaysia	1	6	0	0
University of Manitoba Winnipeg, Man., Canada	1	6	3	0
U.S.A.F. 6201 Epidemiology Flt. APO San Francisco, 96346	1	5	17	0

Source	Number of Accessions	Adults	Slides	Other
Nagasaki University School of Medicine, Japan	1	4	2	0
U.S. Army Medical Research Unit (Trans-Amazon) Belem, Brazil	1	4	0	0
Musee Nationale d'Histoire Naturelle Paris, France	1	4	0	0
U.S. Army Health & Environmental Activity, Ft. Meade, Maryland	1	2	0	1 Unmounted Adult
Justus Liebig University Giessen, Germany	1	0	0	107 Unmounted Immatures
R. M. Rosenberg Bethesda, Maryland	1	0	0	2 Egg Lots 50 Unmtd. Immatures
Institute Nacional de Microbiologia Buenos Aires, Argentina	1	0	2	0
Peace Corps W. Samoa	1	0	0	0

SUMMARY OF ACCESSIONS FROM 1 JAN 1978 TO 31 DEC 1978

66 Accessions (Numbers 668-735)

2,817 Unmounted Immatures
 159 Unmounted Adults
 8,178 Slides
 21,433 Adults

32,587 Total Specimens

Other Material Received

475 Pill Box Unmounted Adults
 8 Lots of Eggs to be Reared

Outgoing Material

73 Shipments
 58 Involving Specimens

945 Unmounted Immatures
 308 Unmounted Adults
 3,211 Slides
 3,462 Adults

7,926 Total Specimens

Largest Returned Loans

British Museum: 816 Adults; 94 Slides
 L. T. Nielsen, University of Utah: 413 Adults

Largest Loans

British Museum (P.F.M.)
Tripteroides - 1,469 Adults; 2,109 Slides

Bishop Museum
Toxorhynchites - 160 Adults; 161 Slides

Appendix 3

PUBLICATIONS OF THE MEDICAL ENTOMOLOGY PROJECT

- Huang, Y.-M. 1978. The identity of two species of *Stegomyia* belonging to the *Aedes albolineatus* group (Diptera: Culicidae). *Mosq. Syst.* 10(2):197-210. (June)
- Sirivanakarn, S. 1978. Revalidation of *Culex (Melanoconion) invocator* Pazos with a redescription of adults and illustration of male genitalia (Diptera: Culicidae). *Mosq. Syst.* 10(2):239-245. (June)
- Sirivanakarn, S. and G. B. White. 1978. Neotype designation of *Culex quinquefasciatus* Say (Diptera: Culicidae). *Proc. Ent. Soc. Wash.* 80(3):360-372. (July)
- Huang, Y.-M. 1978. Redescription and subgeneric position of *Aedes meronephada* (Dyar and Shannon) with notes on the subgenus *Diceromyia* (Diptera: Culicidae). *Mosq. Syst.* 10(3):334-350. (September)
- _____ 1978. Taxonomic status of *Aedes (Stegomyia) laffooni* Knight and Rozeboom with a description of *Aedes (Stegomyia) pseudalbolineatus* Brug (Diptera: Culicidae). *Mosq. Syst.* 10(3):351-364. (September)
- Sirivanakarn, S. 1978. The female cibarial armature of New World *Culex*, subgenus *Melanoconion* and related subgenera with notes on this character in subgenera *Culex*, *Lutzia* and *Neoculex* and genera *Galindomyia* and *Deinocerites* (Diptera: Culicidae). *Mosq. Syst.* 10(4):474-492. (December)

Appendix 4

MEDICAL ENTOMOLOGY PROJECT CONSULTANTS

- Dr. John N. Belkin, University of California, Los Angeles, California -
New World Culicidae.
- Dr. Pedro Galindo, Gorgas Memorial Laboratory, P. O. Box 2016, Balboa
Heights, Canal Zone - New World Culicidae.
- MAJ Bruce A. Harrison, Department of Medical Entomology, U. S. Army
Component, Armed Forces Research Institute of Medical Sciences,
APO San Francisco - Oriental *Anopheles*.
- Dr. James B. Hitchcock, Jr., P. O. Box 1288, Nevada City, California
95959 - Pacific Culicidae.
- Dr. Botha de Meillon, Philadelphia, Pennsylvania - Culicidae of Africa
and Southeast Asia.
- Dr. J. M. Klein, Institut Pasteur de l'Iran, Iran - Oriental Culicidae.
- Professor Kenneth L. Knight, North Carolina State University, Raleigh,
North Carolina - *Aedes (Finlaya)* and mosquito glossary.
- Dr. Peter F. Mattingly, British Museum (Natural History), London,
England - African Culicidae and *Tripteroides*.
- Dr. J. Rageau, ORSTOM, Bondy, France - Culicidae.
- Dr. Shivaji Ramalingam, University of Malaya, Kuala Lumpur, Malaysia -
Topomyia, Malaya, Armigeres and Malaysian Culicidae.
- Dr. Graham G. White, British Museum (Natural History), London, England -
African Culicidae.

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