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A STUDY OF THE ECOLOGY AND EPIZOOLOGY OF THE NATIVE FAUNA OF TH--ETC(U)
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A Study of the Ecology and Epizoology of the Native Fauna of the Great Salt Lake Desert

REPORT PERIOD
January 1, 1962 to March 31, 1963

ANNUAL SUMMARY PROGRESS REPORT
of the
Staff of Ecological and Epizoological Research
University of Utah
Dugway, Utah

Ecology and Epizoology Series No. 100, June 30, 1963

This work was accomplished under U.S. Army Research and Development Contract with the University of Utah.

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ORGANIZATION
Ecological and Epizoological Research
University of Utah
Dugway, Utah

Donald D. Bode', Director*

Consultant Staff

Don M. Rees - Chairman and Director**

Douglas W. Hill	Louis P. Gebhardt
Paul S. Nicholes	Angus M. Woodbury

Carl J. Christensen - Coordinator of Cooperative Research
Howard D. Johnson - Contract Coordinator

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Dale D. Parker - Resident Director

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Morse, Everett L.	Disease Survey
Olsen, Peter F.	Head, Ecology Section
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Sidwell, Robert W.	Epizoology Laboratory
Thorpe, Bert D.	Head, Epizoology Laboratory

Enlisted Personnel***

Andrews, Donald P.	Pacheco, Modesto A.
Emroll, Laurence	Petrovich, Joseph A.
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Gonzales, Rene' C.	Townes, Grady W.
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Engvall, David S.	Smith, James A.

Project Officers

Victor J. Cabelli　　Keith L. Smart, Associate　　J. S. Palmer**

*Beginning July 1, 1962　　** Resigned during year　　***Assigned for training

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INTRODUCTION

Ecology and epizoology research studies have been accomplished in accordance with the following priority schedule:

a. Maintenance of a constant surveillance of the wild animal and ectoparasite populations of Western Utah to determine the perspective of endemicity studies in the area. These include plague, tularemia, Rocky Mountain spotted fever (RMsf), Q fever, anthrax, and psittacosis.

b. Study of the relationships of the above diseases to the fauna of the area with respect to infectivity, modes of transmission and persistence in animals, and insect reservoirs of selected disease organisms.

c. Performance of experiments in the laboratory to determine susceptibility, occurrence of rickettsemia, serological response, and carrier potential of selected animals to *Rickettsia rickettsii*.

d. Initiation and pursuance of susceptibility and transmission studies of selected animals to psittacosis virus.

In addition to the above priority-listed accomplishments prescribed in the University of Utah contract, a modification providing for the accomplishment of an ecological study and a literature study, was added to the existing contract.

A portion of the scientific staff was selected to participate in the new project for periods of from seven weeks to six months. A resulting change in priority of performance and a consequent slippage of the previous priority items was mutually agreed upon.

In an attempt to clarify and make comparisons of epizoological information resulting from disease surveillance studies, a series of tabulated data covering the past 5-year period of sampling is submitted in this report.

A summary status report on Pasteurella pestis and one on P. tularensis were submitted to the project officer as per agreement. These reports were comprehensive and included data accumulated over the past 10-year period of work.

A project was also initiated to prepare and record all disease surveillance data on IBM electronic data processing cards, for efficient access to information.

All susceptibility studies, transmission studies, and selected studies to determine viremia, carrier potential and serological responses of the native animals to psittacosis virus were not initiated because adequate laboratory facilities were not available. For the same reason, experimental work with R. rickettsii was discontinued after 20 December, 1962, when the autoclaves were removed from the existing facility at GPI-1.

Considerable time and effort were expended in the preparation and testing of the new laboratory facility, for operation and safety aspects. Further operational functions were inhibited during the time that sections of the contracting organization were moving into the new laboratory.

TABLE 1. Manuscripts submitted for clearance, or to fill contractual obligations, Jan. 1, 1962 through March 31, 1963.

Author(s)	Title	Date Submitted	Date Cleared	For submission to: Journal
		1962	1962	
Sidwell and Gebhardt	Susceptibility of wild rodents to experimental infection with Q fever	Jan. 16	Feb. 16	Amer. J. Trop. Med. & Hygiene
Egoscue	A new hairless mutation in deer mice	Feb. 15	Mar. 30	Jour. Heredity
Lundgren, Marchette, and Nicholes	The use of serological and cutaneous reactions in the diagnosis of tularemia in rodents and rabbits	Originally cleared Oct. 1961	Cleared on Post April 19	Zoonoses Research
Egoscue	Color phases and their inheritance in the northern grasshopper mouse	Feb. 16	Mar. 30	J. Mammalogy
Vest & Staff	Annual Report, No. 63, 1960	1961 Originally submitted July 5	1962 Revised version, July	University Press
Vest & Staff	Presumptive Safety Report - Q fever	1962 February	April 10	University Press
Marchette, Sidwell and Nicholes	Experimental Q fever in wild animals in Utah	Mar. 21	April 30	Zoonoses Research
Marchette, Bushman Parker, and Johnson	A wild rodent (Peromyscus spp.) plague focus in Utah	May 28	July 5	Zoonoses Research
Vest (thesis)	Biotic communities in the Great Salt Lake Desert	Sept. 24	Nov. 27	University Press
Egoscue	Ecological notes and laboratory life history of the canyon mouse	Aug 24	1963 Jan. 23	J. Mammalogy

TABLE 1. (Continued)

		1962	1963	Journal
Bushman, Behle and White	Distributional data on uncommon birds in Utah and adjacent states	Dec. 6	not cleared	
Parker & Staff	Annual Report, No. 70, 1961	Aug. 2	May 6	University Press
Thorpe, Sidwell, and Marcus	Humoral factors in the resistance to *P. tularensis* infections	Dec. 10	not cleared	Oral, only
Sidwell, Thorpe and Marcus	Effect of whole-body X-irradiation upon latent infections of Q fever (Abstract)	Dec. 19	not cleared	Oral, only
Thorpe, Sidwell and Marcus	Cellular aspects of resistance to *P. tularensis* infections	Dec. 18	not cleared	Oral, only
		1963		
Thorpe and Marcus	*In vitro* studies of peritoneal mononuclear phagocytes with *P. tularensis*	Jan. 23	not cleared	
Woodbury	A review of the ecology of Eniwetok Atoll, Pacific Ocean			University Press
Reid	Mosquito-virus relations in the central Pacific Bird Flyway			University Press
Thorpe, Sidwell and Gebhardt	Literature Review, Psittacosis			
Parker & Staff	Tularemia Report - 10-year			
Parker & Staff	Plague Report - 10-year			
Lundgren and Whitehead	Literature review - Rocky Mountain spotted fever			

DISCUSSION

A brief synoptic discussion is presented here to help enlighten the reader on the general progress and accomplishments in each of our objectives. It is intended that detailed information in both text and tables can be readily located by reference to phases from this discussion.

Objective (A). (Maintenance of surveillance of wildlife for incidence of disease), ES and BA phases.

Pasteurella tularensis was determined in two species of animals which had not previously been known to harbor the organism. Gold Hill, South Skull Valley, Granite Mountain, and South Cedar Mountains were areas from which the disease organisms were taken for the first time. The serological evidence of tularemia in several new areas, and the isolation of viable organisms from one new area, indicate that this disease continues to be endemic to the entire area.

Specific *Brucella* spp. agglutinins were determined in the sera of 14 wildlife specimens in 1962. These included 11 jack rabbits, one wood rat, one Townsend ground squirrel, and one antelope ground squirrel. Five new areas have been involved in the incidence of this organism, along with the same number of areas from which previous involvement has been determined and reported. These seropositives indicate a wide range of occurrence of this disease organism. However, due to the absence of isolates, the species of *Brucella* cannot presently be determined.

There was no evidence of *Bacillus anthracis* in the wildlife or domestic animal tissues, or in their ectoparasites examined during this report period.

With the exception of the studies made in Indian Farm Canyon, no evidence of *Pasteurella pestis* has been determined in animal tissues, or in the ectoparasites processed during this report period.

The presence of the psittacosis-lymphogranuloma agent has been demonstrated in the Great Salt Lake Desert region by the isolation of a strain from the tissues of a pigeon; and by the observation of a number of seropositive wild mammals and livestock. Sera from guinea pigs which had been injected with tissues and ectoparasites from wild mammals of the area were seropositive, often to a high titer, when tested with psittacosis antigen in a complement fixation (CF) test. It was concluded that the titers observed were of a non-specific nature; or that they indicated a guinea pig infection as a result of caging in areas with infected birds or other animals, rather than being caused by tissue or ectoparasite injections.

Although difficult to interpret, it may be concluded that the incidence of Rocky Mountain spotted fever, as determined by antibody titers in native animal sera, or by antibody titers in tissue- and ectoparasite-inoculated guinea pigs, has decreased during 1962 as compared with results obtained in 1959, 1960, and 1961. No new trapping areas were implicated in 1962. One cattle serum sample from Grantsville, and two goat sera from Salt Lake County were seropositive.

Q fever antibody was demonstrated in 8.9 per cent of all wild mammal and bird sera tested, which was a decrease from the 1961 figure. The same species of animals which were implicated in previous years were again found to be seropositive. Also the areas yielding seropositive animals during this report period have been implicated in the previous years. A total of 19 isolations of Coxiella burnetii were made from wild rodent tissue in 1962, and one isolation was made from a flea pool. The main area which was implicated in the isolation data was Camelback Mountain, although surrounding areas also yielded positive specimens.

Of all the bird sera tested, none contained detectable Q fever antibody.

Twelve cattle sera from Ibapah, and one goat serum sample from Salt Lake County, were seropositive for Q fever.

Objective (B). (Relationships of diseases to the fauna of the area).

Presented in table form throughout the ES and BA phases of this report, are data relating to this objective. The tables presented include information about species involvement, area involvement, and sources of positive samples. These samples are presented for each disease organism studied.

Objective (C). (Susceptibility, serological response, and carrier potential of selected animals to Rickettsia rickettsii, and the Psittacosis virus).

Results of the susceptibility studies and the carrier potential experiments with Rickettsia rickettsii reported herein are from studies conducted prior to the inactivation of the laboratory at GPI-1, in December, 1962. It was determined from these studies that of the six species of rodents tested, only one, the montane vole, Microtus montanus, was lethally susceptible to subcutaneous infection.

Antelope ground squirrels, Citellus leucurus; western harvest mice, Reithrodontomys megalotis; canyon mice, Peromyscus crinitus; deer mice, P. maniculatus; pinyon mice, P. truei; and montane voles, Microtus montanus, were resistant to infection by organisms administered orally, by ingestion of infected carcasses.

Coyotes, Canis latrans lestes, were found to be susceptible to subcutaneous infection with 1×10^5 and 1×10^2 egg LD_{50} doses of Rickettsia rickettsii.

The potential of five species of rodents to become carriers of R. rickettsii was studied. Organisms were recovered from the tissues of some species at 14 days, but could not be detected in the tissue later, at 21 and 28 days. There was no evidence that a carrier state developed in the animals studied.

Rickettsiae were found in the circulating blood of cottontails, Sylvilagus audubonii, up to 8 days following inoculation of the organism (Table 7). Rickettsemia in rodents was found to be undetectable by methods tried beyond the 10th day following inoculation (Table 8).

Coyotes developed complement fixing antibodies two to three weeks after having eaten infected carcasses. However, rickettsiae were not recovered from their circulating blood, and no consistent increase in body temperatures could be determined during the 14-day period following infective feeding.

Although many species of ticks were tested for their ability to transmit R. rickettsii, in our laboratory, only Ornithodoros parkeri transmitted the organism to healthy guinea pigs. In addition, it was demonstrated that coxal fluid excreted by this species contained infectious organisms following infectious blood feedings. We were unable to demonstrate transovarian transmission in any of the ticks tested.

Laboratory facilities were not available to the contractor for work with the psittacosis virus.

ECA (Rickettsia rickettsii, Rocky Mountain spotted fever).

It is the purpose of these studies to determine, by experimental infections, which species of wildlife may be involved in maintaining R. rickettsii in nature. The factors thus far studied that would indicate the potential of a given species to maintain the disease are: 1) susceptibility of the species to infection; 2) development and persistence of rickettsemia; 3) persistence of rickettsiae in the tissues of the host; 4) development of antibodies against the rickettsiae; and 5) experimental transmission studies utilizing ectoparasites as vectors.

Host Susceptibility - Rodents: The susceptibility of six species of native rodents: montane vole, Microtus montanus; white-tailed antelope ground squirrel, Citellus leucurus; Ord kangaroo rat, Dipodomys ordii; desert wood rat, Neotoma lepida; canyon mouse, Peromyscus crinitus; and pinyon mouse, Peromyscus crinitus; and pinyon mouse, P. truei, to subcutaneous infection with R. rickettsii has been determined. The canyon mouse and the pinyon mouse were also tested for their susceptibility to intraperitoneal infection.

The results of these studies have been summarized in Table 2. Of the six species of rodents tested, only one, the montane vole, was lethally susceptible to infection. There was no overt evidence of infection in the remaining five species of animals. The montane vole was observed to be the most susceptible animal to subcutaneous infection, followed with increasing resistance by the desert wood rat, Ord kangaroo rat, white-tailed ground squirrel, canyon mouse and pinyon mouse. The pinyon mouse was significantly more susceptible to infection by the intraperitoneal route than by the subcutaneous route. However, there was no significant difference in the susceptibility of the canyon mouse to infection by either route. There was also no significant difference between the susceptibility by the subcutaneous route of the montane vole or the desert wood rat reported here; or the susceptibility to intraperitoneal infection as previously reported.[1]

TABLE 2. The susceptibility of rodents to subcutaneous and intraperitoneal infection with Rickettsia rickettsii.

Species	Route of Infection	ID_{50}*[2]
Microtus montanus		
Montane vole	Subcutaneous	1.6 (0.7 to 3.7)
Citellus leucurus		
Antelope ground squirrel	Subcutaneous	900 (390 to 2,100)
Dipodomys ordii		
Ord kangaroo rat	Subcutaneous	190 (46 to 790)
Neotoma lepida		
Desert wood rat	Subcutaneous	56 (15 to 216)
Peromyscus crinitus	Subcutaneous	2100 (820 to 5400)
Canyon mouse	Intraperitoneal	1800 (950 to 3500)
Peromyscus truei	Subcutaneous	31,000 (10,000 to 93,000)
Pinyon mouse	Intraperitoneal	590 (250 to 1400)

* ID_{50}s are expressed in terms of egg LD_{50}s.

Studies to determine if rodents can be infected with R. rickettsii by the oral route were undertaken. After food and water had been withheld for 24 hours, three antelope ground squirrels and ten montane voles caged individually, were fed carcasses of infected montane voles. The three squirrels and three of the ten voles fed on the carcasses. None of these animals developed any overt evidence of infection, nor did they develop any detectable CF antibody.

A similar experiment was conducted using eight animals each of the following species: pinyon mice, canyon mice, deer mice, western harvest mice, montane voles, and antelope ground squirrels. Again the animals were caged individually.

1. Ecology and Epizoology Research. 1962. Studies on the ecology and epizoology of the native fauna of the Great Salt Lake Desert. Ann. Rept., Series No. 70, for 1961. University of Utah Press. 103 pp.

2. Pizzi, M. 1950. Sampling variation of the fifty per cent end point determined by the Reed-Muench method. Human Biol., 22: 151-190.

After food and water had been withheld for 24 hours, each animal was fed a portion of infected guinea pig liver or spleen. Nearly all of the rodents readily ate the infected tissues. As in the previous experiment, none of these animals became ill and none developed detectable CF antibody.

Carnivores: Studies of the susceptibility of the coyote, *Canis latrans*, to infection with *R. rickettsii* is discussed in detail in the following sections of this report. The coyote was susceptible to subcutaneous infection with 10^5 and 10^2 egg LD_{50} doses of rickettsiae and possibly to oral infection.

Carrier Potential - Rodents: The persistence of *R. rickettsii* in the tissues of the bushy-tailed wood rat, *N. cinerea*; western harvest mouse, *Reithrodontomys megalotis*; Ord kangaroo rat, *D. ordii*; and the northern grasshopper mouse, *Onychomys leucogaster*, have been studied, in addition to the five species reported on in the previous annual report. The rodents used in this study were infected by the subcutaneous inoculation of approximately 10^4 egg LD_{50} doses.

At weekly intervals, three to five rodents of each species were anesthetized and exsanguinated by cardiac puncture. Similar tissues from each group were pooled, ground with sterile sand and suspended in sterile Sucrose-Phosphate-Glutamate (SPG) to make a 10% tissue suspension. One ml of each tissue homogenate was intraperitoneally injected into each of two guinea pigs. These guinea pigs were then observed for four weeks. Rectal temperatures of each were taken for the first 14 days. At the end of the 4-week holding period the guinea pigs were bled by cardiac puncture. Serum was then collected and tested for CF antibody. The presence of rickettsial infection in the tissues of the test animals was indicated by a sustained rectal temperature of 104 F or greater; the presence of rickettsiae in spleen smears of guinea pigs dying of the disease; or by positive CF antibody titers in surviving guinea pigs.

The results of these studies have been outlined in Tables 3 through 6. Rickettsiae were recovered from each of the 10 different tissues of the grasshopper mice examined at 7 days after the inoculation of R. rickettsii. Rickettsiae were recovered only from four to six of the different tissues of the Ord kangaroo rats, bushy-tailed wood rats, and harvest mice examined at 7 days. At 14 days, only one to three of the tissues from the grasshopper mice, Ord kangaroo rats, and harvest mice were infected, whereas none of the tissues from the bushy-tailed wood rats were infected. Rickettsiae were not isolated from any of the tissues of any of the rodents tested at 21 and 28 days.

In addition, tissues of two other species of rodents: least chipmunks, Eutamias minimus; and long-tailed pocket mice, Perognathus formosus, were tested only at one week after the inoculation of R. rickettsii. Rickettsiae were recovered from nearly all of the 10 different tissues tested from these animals.

In the animals studied there were no apparent tendencies for the infected animals to develop chronic or latent infections, or to become carriers.

RICKETTSEMIA IN RODENTS

TABLE 3. The persistence of Rickettsia rickettsii in the tissues of the northern grasshopper mouse, Onychomys leucogaster.*

Tissues	Days 7	14	21	28
Kidney	+	-	-	-
Spleen	+	-	-	-
Liver	+	+	-	-
Mesenteric lymph node	+	-	-	-
Lung	+	-	-	-
Blood	+	-	-	-
Testicle	+	-	-	-
Bone Marrow	+	-	-	-
Heart	+	+	-	-
Brain	+	+	-	-

*The tissues of five grasshopper mice were pooled at each 7-day interval.

TABLE 4. The persistence of Rickettsia rickettsii in the tissues of the Ord kangaroo rat, Dipodomys ordii.*

Tissue	Days 7	14	21	28
Spleen	-	-	-	-
Liver	+	+	-	-
Kidney	+	-	-	-
Mesenteric lymph node	-	-	-	-
Lung	+	-	-	-
Blood	-	-	-	-
Testicle	+	-	-	-
Bone marrow	-	-	-	-
Heart	-	-	-	-
Brain	-	-	-	-

*The tissues of five Ord kangaroo rats were pooled at each 7-day interval.

TABLE 5. The persistence of *Rickettsia rickettsii* in the tissues of the western harvest mouse, *Reithrodontomys megalotis*.*

Tissue	Days 7	14	21	28
Spleen	+	-	-	-
Liver	+	-	-	-
Kidney	+	-	-	-
Mesenteric lymph node	-	-	-	-
Lung	+	+	-	-
Blood	-	-	-	-
Testicle	+	-	-	-
Bone marrow	-	-	-	-
Heart	+	-	-	-
Brain	-	-	-	-

* The tissues of five harvest mice were pooled at each 7-day interval.

TABLE 6. The persistence of *Rickettsia rickettsii* in the tissues of the bushy-tailed wood rat, *Neotoma cinerea*.*

Tissue	Days 7	14	21	28
Spleen	+	-	-	-
Liver	-	-	-	-
Kidney	-	-	-	-
Mesenteric lymph node	+	-	-	-
Lung	+	-	-	-
Blood	-	-	-	-
Testicle	+	-	-	-
Bone marrow	-	-	-	-
Heart	-	-	-	-
Brain	-	-	-	-

* The tissues of three bushy-tailed wood rats were pooled at each 7-day interval.

Rickettsemia - Cottontails: In the previous annual report[1] a study of the persistence of rickettsiae in the blood of cottontails, Sylvilagus audubonii, infected by the subcutaneous inoculation of 8.5 x 10^4 egg LD_{50} doses of R. rickettsii was discussed. Blood samples were collected from animals and tested for rickettsiae on the 2nd, 4th, 6th, 8th, 10th, 12th, 14th, 21st, and 28th days following the inoculation of the rickettsiae. The rickettsiae were recovered from only one cottontail on the 4th day, and one on the 6th day.

Because these observations were not consistent with the suspected importance of the cottontail in the ecology of spotted fever,[3] nor with the observations of others,[4] this study was repeated.

In February, 1963, five cottontails trapped in the spring of 1961 were infected by the subcutaneous inoculation of 10^4 egg LD_{50} doses of rickettsiae. Blood samples were then collected and tested for rickettsiae as described above for the previous study. The results of the previous and the present study are presented in Table 7. The rickettsiae were present from the blood samples from all five cottontails tested in the present study, at 2 days, four of the five on the 4th day and the 6th day, and from one on the 8th day following inoculation of the rickettsiae.

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3. Jellison, W. L., 1945, The geographical distribution of Rocky Mountain spotted fever and Nuttall's cottontail in western United States. Pub. Health Rept., 60: 955-961.

4. Price, W. H. 1954. The epidemiology of Rocky Mountain spotted fever. II. Studies on the biological survival mechanism of Rickettsia rickettsii. Amer. J. Hyg., 60: 292-319.

RICKETTSEMIA IN COTTONTAILS

TABLE 7. The persistence of *Rickettsia rickettsii*, in the blood of the Audubon cottontail, *Sylvilagus audubonii*.

Days after inoculation of rickettsiae	Experiment No. 1. June, 1961*				
	Cottontail Number				
	2	4	6	7	16
2	-	-	-	-	-
4	-	-	-	-	+
6	-	-	+	-	-
8	-	-	-	-	-
10	-	-	-	-	-
12	-	-	-	-	-
14	-	-	-	-	-
21	-	-	-	-	-
28	-	-	-	-	-
	Experiment No. 2. February, 1962				
	19	20	25	26	30
2	+	+	+	+	+
4	+	-	+	+	+
6	+	-	+	+	+
8	-	-	+	-	-
10	-	-	-	-	-
12	-	-	-	-	-
14	-	-	-	-	-
21	-	-	-	-	-
28	-	-	-	-	-

* A summary of the data obtained from experiments conducted in June, 1961 was presented in the annual report for that year Ecology and Epizoology Research, 1962. Studies on the Ecology and Epizoology of the Native Fauna of the Great Salt Lake Desert. Ann. Rept. for 1961. Ecology and Epizoology Series No. 70. University of Utah. 103 pp.).

Rodents: The occurrence of rickettsiae in the blood of experimentally infected bushy-tailed wood rats, western harvest mice, Ord kangaroo rats, northern grasshopper mice, long-tailed pocket mice, and least chipmunks, has been studied, in addition to the five species reported on in the previous annual report.[1]

All rodents in this study were inoculated with approximately 10^4 egg LD_{50} doses of rickettsiae. Blood samples were collected from rodents by cardiac puncture. One half of each blood sample was inoculated into each of two guinea pigs. These animals were then observed for spotted fever as described previously.

The results of these studies have been summarized in Table 8. The rickettsiae were not recovered from any of the bushy-tailed wood rats tested. In the harvest mice, Ord kangaroo rats, grasshopper mice, and least chipmunks the rickettsiae were isolated from some rodents of each species on the 2nd day, and from an occasional animal on the 4th, 6th, or 8th day. Only in the long-tailed pocket mice was there a markedly persistent rickettsemia lasting for at least 10 days in the animals tested.

TABLE 8. Persistence of *Rickettsia rickettsii* in the blood of mammals.*

Species	Days 2	4	6	8	10	12	14
Neotoma cinerea							
Bushy-tailed wood rat	0/5	0/5	0/5	0/5	0/5		0/2
Reithrodontomys megalotis							
Western harvest mouse	5/5	1/5	0/5	0/5	0/5		
Dipodomys ordii							
Ord kangaroo rat	2/5	0/5	1/5	0/5	0/5		0/5
Onychomys leucogaster							
Northern grasshopper mouse	2/5	1/5	1/5	0/5	0/5	0/5	0/5
Perognathus formosus							
Long-tailed pocket mouse	5/5	5/5	4/5	5/4	4/5		
Eutamias minimus							
Least chipmunk	2/3	3/3	0/3	1/3	/3		

* Two to five animals were sacrificed at 2-day intervals and were tested individually for *R. rickettsii*.

Carnivores: The occurrence and persistence of rickettsiae in the blood of nine coyotes (*Canis latrans lestes* Merriam), exposed to infection with *R. rickettsii* by the subcutaneous and oral route have been investigated. Two coyotes (Nos. 5 and 9) were each inoculated subcutaneously with 10^5 egg LD_{50} doses of rickettsiae; and two (Nos. 1 and 2) with 10^2 egg LD_{50} doses. After food, but not water, had been withheld for 24 hours, the remaining coyotes (Nos. 3, 4, 6, 7, and 8) were fed as many *R. rickettsii* infected voles as they would readily eat. The coyotes consumed the following number and approximate weight of infected voles: No. 3, nine (270 grams); No. 4, six (180 grams); No. 6, three (90 grams); No. 7, four (120 grams); and No. 8, nine (270 grams).

The montane vole was used as a source of infected carcasses because it is a natural source of food for the coyote, and because it has been observed to be very susceptible to infection with the spotted fever rickettsiae.[1,3] Five days after being infected by the inoculation of 10^5 egg LD_{50} doses, the voles were fed to the coyotes. In our laboratory we have observed that the tissues of such infected voles contain large numbers of rickettsiae at that time. Blood samples from eight of the voles, selected at random from the 31 prior to their being fed to the coyotes, contained *R. rickettsii* as determined by guinea pig inoculation. The infected voles were killed by a blow to the head immediately prior to being fed to the coyotes.

At intervals, summarized in Table 9, two ml of blood was drawn from the jugular vein of each coyote, and one ml of each sample was immediately inoculated intraperitoneally into each of two male guinea pigs. The guinea pigs were then observed for spotted fever as previously described.

Two of the coyotes utilized did not survive until the study was completed. Coyote No. 5 began eating decreasing portions of food several days prior to the beginning of this study. After the inoculation of 10^5 egg LD_{50s} of rickettsiae, this coyote refused all food and was found dead on the morning of the 14th day. Coyote No. 2 was in apparent good health when the study began, but during the second week following the inoculation of 10^2 egg LD_{50s} of rickettsiae, it developed prolapse of the rectum and was sacrificed at the end of the 4th week.

Portions of the brain, spleen, liver, kidneys, testicles, and heart blood were removed from these two carcasses. These tissues were ground in sterile sand with a mortar and pestle, and suspended in SPG. One ml aliquot samples of each suspension were inoculated into each of two male guinea pigs. These animals were treated as were those into which the coyote blood was inoculated, as described above. None of the guinea pigs developed spotted fever symptoms, CF antibody, or resistance to challenge.

The occurrence of R. rickettsii in the blood of coyotes exposed to infection with the rickettsiae has been summarized in Table 9. Rickettsiae were not recovered from the blood of any of the coyotes after they had consumed carcasses of infected montane voles. However, four of these coyotes, Nos. 3, 6, 7, and 8, did develop CF antibody titers of 1:16 to 1:64, two to three weeks after having eaten the infected carcasses (Table 15), whereas coyote No. 4 failed to develop any detectable CF antibody.

Rickettsiae were not recovered from the blood samples collected from coyotes Nos. 1 and 2 following subcutaneous inoculation of 10^2 egg LD_{50} doses of rickettsiae, although they did develop CF antibody titers of 1:16 to 1:128 one to four weeks after inoculation of the rickettsiae.

Rickettsiae were recovered from coyote No. 5 on the 1st, 2nd, 3rd, and 7th days; and from No. 9 on the 1st through the 8th day. Blood samples were not collected on the 5th day. One week after inoculation of rickettsiae, coyote No. 5 developed CF antibody at a titer of 1:32. No additional sera samples were collected from this coyote before its death. Coyote No. 9 developed CF antibody titers of 1:16 the 1st week, 1:64 the 3rd week, and 1:128 through the 7th week. No CF antibody was demonstrated in the serum collected at the end of the 2nd week.

Seven weeks after the coyotes were first exposed to infection with spotted fever, they were tested for their immunity to subcutaneous challenge with 10^5 egg LD_{50} doses. After challenge, blood samples were again collected from the coyotes daily, and tested for the presence of rickettsiae as previously described. Rickettsiae were not present in the blood samples from coyote No. 9, but were recovered from Nos. 1, 2, 4, 6, 7, and 8 on the first day; Nos. 4 and 6 on the 2nd day, and No. 6 on the 3rd day (Table 9).

One week after challenge, coyotes Nos. 1, 3, 6, 7, and 9 had developed CF antibody titers of 1:64 to greater than 1:256 (Table 15). These titers raised slightly in Nos. 6 and 7, and decreased in Nos. 1, 3, and 9 during the following 3 weeks. Coyotes Nos. 4 and 8 did not develop detectable CF antibody titers until the 2nd week.

Rectal temperatures of the coyotes were recorded daily for 14 days following initial exposure to R. rickettsii. In all coyotes, these temperatures varied erratically from day to day, and there was no prolonged elevation of temperature in any one coyote that would have indicated the presence of infection. With the exception of Nos. 2 and 5, the coyotes ate well and remained in apparently good health throughout this study.

RICKETTSEMIA IN COYOTES

TABLE 9. Rickettsemia in coyotes exposed to infection with *Rickettsia rickettsii*.*

Days after first Exposure	Route of infection, dose, and coyote number								
	Subcutaneous - Egg $LD_{50}s$				Per os - Grams				
	10^2		10^5		270	180	90	120	270
	1	2	5	9	3	4	6	7	8
1	-	-	+	+	-	-	-	-	-
2	-	-	+	+	-	-	-	-	-
3	-	-	+	+	-	-	-	-	-
4	-	-	-	+	-	-	-	-	-
5**									
6	-	-	-	+	-	-	-	-	-
7	-	-	+	+	-	-	-	-	-
8	-	-	-	+	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-	-
	All coyotes challenged with 10^5 egg $LD_{50}s$ at 49 days								
50	+			-	+	+	+	+	+
51	-			-	-	+	+	-	-
52	-			-	-	-	+	-	-
53	-			-	-	-	-	-	-
54	-			-	-	-	-	-	-
55	-			-	-	-	-	-	-
56	-			-	-	-	-	-	-
57	-			-	-	-	-	-	-

* *R. rickettsii* infected montane vole carcasses.
** No samples were collected on this day.

Complement Fixing Antibody Persistence - Cottontails: The development and persistence of CF antibody in cottontails during the first 8 weeks following the inoculation of rickettsiae were summarized in the annual report for 1961. The persistence of the CF antibody beyond 8 weeks was continued and the results are summarized in Table 10, under Experiment No. 1. As discussed above, (rickettsemia section), additional studies of the rickettsemia in cottontails were conducted. In conjunction with these experiments, serum samples were collected from the animals under study to determine if previous observation on the development of CF antibody could be duplicated. The results of this study are summarized in Table 10, under Experiment No. 2.

TABLE 10. Rocky Mountain spotted fever CF antibody titers of cottontails, _S. audubonii_, following inoculation of _Rickettsia rickettsii_.*,**

Time*** in Weeks	Experiment No. 1. June, 1961 — Cottontail Number					
	2	4	6	7	8	16
15	64(16)	32(16)	64(32)	32(16)	32(16)	64(32)
20	64(16)	32(16)	64(16)		32(16)	
25	64(32)	32(32)	32(16)		16(16)	
30	128(32)	64(32)	64(32)		64(16)	
40	64(16)	0	32		0	
50			32(16)		0	
55			64		64	

Time in Weeks	Experiment NO. 2, February, 1962 — Cottontail Number									
	19	20	21	22	23	24	25	28	29	30
0	0	0	0	0	0	0	0	0	0	0
1		0	0	0	0	0	0	0	0	0
2	0	0		0	0		0		0	0
3		0				0	0	0	0	0
4		0		0	0		0		0	128
8				64	0	128	0		128	
13				128(8)	0	128(8)	0		64	
20				128		128			64	

* Expressed as the reciprocal of the antibody titer.
** The numbers in () represent the anticomplementary titers.
*** Data from 0 to less than 15 weeks presented in the Annual Report, 1961

The results of Experiment No. 2 demonstrated, as did those of No. 1, that CF antibody could usually not be detected in infected cottontails until at least the 4th week following inoculation of rickettsiae. Two cottontails, Nos. 23 and 25, failed to develop a detectable CF antibody through the 13 weeks, even though rickettsiae had been isolated from the blood of one of them (Table 7, No. 25). Although the anticomplementary nature of the cottontail serum interfered with several of the tests, some clear tests were observed that would indicate that CF antibody may persist for 55 weeks in the recovered animals.

Rodents: A study of persistence of RMsf CF antibody in sera of deer mice has been continued beyond the data presented in the 1961 annual report. Studies of persistence of CF antibody in three additional species: desert wood rat, Ord kangaroo rat, and meadow mice have been undertaken. Rodents used in this study were infected by subcutaneous inoculation of 1×10^4 egg LD_{50} doses of rickettsiae.

Blood samples from which sera were collected were obtained from experimentally infected animals according to schedules outlined in Tables 11 - 14. Results of these studies have been summarized in the same tables.

Because of the anticomplementary nature of deer mouse serum, it is difficult to follow the persistence of CF antibody in this animal. However, enough clear tests were obtained to demonstrate that CF antibody in deer mice may persist at titers of 1:16 to 1:64 for as long as 55 weeks. Individual desert wood rats developed CF antibody titers of 1:16 to 1:64, which remained relatively stable through the 45 weeks of testing. Meadow mice developed and maintained CF antibody titers of 1:32 to 1:256 during the first 8 to 10 weeks, after which the titers decreased. Ord kangaroo rats did not develop CF antibody until several weeks after inoculation of the rickettsiae, and titers did not exceed 1:64.

CF ANTIBODY TITERS IN RODENTS

TABLE. 11. Rocky Mountain spotted fever CF antibody titers of deer mice following inoculation of Rickettsia rickettsii.*, **, ***

Mouse	Time in Weeks						
Number	20	25	30	40	55	55	55
1	16(16)	32(16)	16(16)	32	32(16)	16	32
2	0	16(16)	32(16)	16	32	0	16
3	32(32)	128(>64)	32(16)	32	32	64	
4	16(16)	32(16)	32(8)	64	16	0	
5	32(16)	32(16)	64(64)		32	0	

* Expressed as the reciprocal of the antibody titer.

** The number in () is the anticomplementary titer.

*** One mouse was sacrificed for each serum sample.

TABLE 12. Rocky Mountain spotted fever CF antibody titers of desert wood rats, Neotoma lepida, following inoculation of Rickettsia rickettsii.*,**

Wood rat Number	Time in Weeks 0	2	4	6	15	20	30	35	45
1	0	32	16	16	16	16	16	16	32
2	0	64	64	32	0	0	0	64	16
3	0	64	16	32	0	16	16	64	16
4	0	32	16	32	32	32	16	16	
5	0	32	16	32	16	16	0	64	
6	0				0	16	0	64	
7	0				0	16	0	0	

* Expressed as the reciprocal of the antibody titer.
** Individual rats were bled repeatedly throughout this study.

TABLE 13. Rocky Mountain spotted fever CF antibody titers of meadow mice, Microtus montanus, following inoculation of Rickettsia rickettsii.*, **

Mouse Number	Time in Weeks 0	3	4	6	8	10	12	20	25
1	0	64	128	128	128	0	0	16	32
2	0	0	64	32	64	128	0	16	0
3	0	64	128	64	128	64	0	64(32)	
4	0	64	256	128	64	128	64	16	
5	0	32	128	128	256	128	64		

* Expressed as the reciprocal of the titer.
** The number in () is the anticomplementary titer.
*** The mouse was sacrificed for each serum sample.

TABLE 14. Rocky Mountain spotted fever CF antibody titers of Ord kangaroo rats, Dipodomys ordii, following inoculation of Rickettsia rickettsii.*,**

Rat Number	Time in Weeks 0	1	2	3	4	10	12
1	0	0	0	0	0	32	16
2	0	0	0	32	0	0	16
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	16
5	0	0	0	0	0	64	16

* Expressed as the reciprocal of the titer.
** A rat was sacrificed for each serum sample.

Carnivores: The development and persistence of Rocky Mountain spotted fever CF antibody in the coyote was studied in conjunction with the experimental work discussed above under Rickettsemia. Complement fixation antibody development in the coyotes used for the rickettsemia study is summarized in Table 15. Results of these observations have been discussed in detail above, with relation to the studies on the occurrence of rickettsemia in the coyotes. It was observed that coyotes readily developed CF antibody after the parenteral inoculation of 10^2 and 10^5 egg LD_{50} doses of rickettsiae. Coyotes developed comparatively lower titers after having eaten infected montane vole carcasses.

CF ANTIBODY TITERS IN COYOTES

TABLE 15. Complement fixing antibody titers of coyotes exposed to infection with *Rickettsia rickettsii*.*

Weeks after first Exposure	Route of infection, dose, and coyote number								
	Subcutaneous (Egg LD_{50}s)				Per os (grams)*				
	10^2		10^5		270[2]	180	90	120	270
	1	2	5	9	3	4	6	7	8
0	<8	<8	<8	<8	<8	<8	<8	<8	<8
1	<8	16	32	16	<8	<8	<8	8	8
2	8	8		8	<8	<8	64	8	<8
3	32	16		64	32	<8	8	64	16
4	128	<8		128	16	<8	16	16	<8
5	8			128	<8	<8	<8	<8	<8
6	32			128	<8	<8	<8	<8	<8
7	32			128	32	<8	<8	16	<8
	All coyotes challenged with 10^5 egg LD_{50}s at 7 weeks								
8	128			256	256	<8	64	128	<8
9	64			128	256	256	128	256	64
10					128		256		64
11					128		256		64

* Titers shown as the reciprocal of the highest serum dilution showing 50% lysis of sensitized sheep red blood cells.

** *R. rickettsii*-infected montane vole carcasses.

DISCUSSION

Cottontails: In utilizing field-collected cottontails rather than laboratory reared stock, it was realized that the results obtained from the type studies reported here might be influenced by any past association of the animal with *R. rickettsii* infected ticks. It was possible that various levels of immunity might have developed in many of these cottontails before they were trapped. Therefore, in discussing the results of the present studies, it must be kept in mind that variations in the responses of cottontails may result from the animal's past exposure to the rickettsiae.

The observation that rickettsemia does develop in cottontails has been demonstrated by rabbit to tick transmission of the rickettsia when the cottontial was used as the host animal for the ectoparasites.[5] The two experiments designed to determine the onset and persistence of rickettsemia in cottontails have given contrasting results. Rickettsemia in cottontails tested in February, 1962 developed earlier and persisted longer than did that of the animals tested in June, 1961 (Table 7).

The sera of three cottontails tested for rickettsemia persistence in June, 1961 had CF antibody titers of 1:32, 1:32, and 1:64 one month prior to being infected. The other two cottontails were seronegative. However, the only animals in which a rickettsemia was detected were the two having CF antibody titers of 1:32. Of the five sero-negative cottontails tested in February, all developed rickettsemia by the 2nd day after inoculation of the rickettsiae. The rickettsiae persisted in the blood for as long as 8 days.

Two conclusions can be drawn from the variation in the two different experiments on rickettsemia in cottontails. The first could be that those

5. Price, W. R. 1953. Interference phenomenon in animal infections with rickettsiae of Rocky Mountain spotted fever. Proc. Soc. Exptl. Med., 82:180-184.

animals tested in June had been held for only a few weeks in the laboratory and may have had some immunity to spotted fever, obtained by contact with infected ticks in nature. Animals tested in February had been held for 8 to 11 months in the laboratory, and this longer holding period could have permitted a decrease in any immunity the cottontails had acquired in nature.

A second reason for the variations observed in the two experiments may be related to the observations of Harshman, et al.,[6] who reported a seasonal variation in the multiplication of R. rickettsii in male Wistar strain laboratory rats, in which the rickettsiae multiplied more rapidly during the winter than during the summer months.

Additional studies will be necessary to elucidate the causes for the variations in rickettsemia of cottontails observed in this study.

No information has been available in the literature on the development and persistence of R. rickettsii CF antibody in the Audubon cottontail. However, CF positive cottontails with titers of 1:16 to 1:256 have been collected in Tooele and Juab Counties.[7] (See Table 33).

Seven of the 20 cottontails in which development and persistence of CF antibody was studied, had CF antibody titers of 1:16 to 1:64 one month prior to inoculation of the rickettsiae. Complement fixing antibody could not be detected again in these animals through the 3rd and 4th week following inoculation. A similar time was required for development of detectable CF antibody in cottontails whose sera did not contain these antibodies prior to the inoculation of rickettsiae. Maximum antibody titers were observed to last only a few weeks, then declined rapidly in several animals.

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6. Harshman, S., J. Johnson and W. H. Price. The effect of red blood cells on experimental infection of white rats with the R strain of Rickettsia rickettsii. Amer. J. Hyg., 67: 109-117. 1958

7. Unpublished data from the Epizoology Laboratory, Ecology and Epizoology Research, University of Utah.

It appears that the CF test may be inadequate as a method of detecting RMsf in the cottontail. The anticomplementary nature of the serum from cottontails interfered with the interpretation of the serological results. It was observed that antibody was slow to develop and that in two animals, Nos. 23 and 25, the CF test failed to detect the development of any RMsf antibody. It could have been possible that the dose inoculated failed to infect the animals. However, rickettsiae were recovered from the blood of No. 25 on the 2nd, 4th, 6th and 8th day after inoculation of rickettsiae, indicating that it was indeed infected.

Similar observations of the incidence of anticomplementary activity of cottontail serum has been noted to occur in samples collected from animals in the field. DeBoer and Cox[8] have noted that CF tests of laboratory rabbits (presumably Oryctolagus cuniculus) sera are difficult to interpret because of the nonspecific fixation of complement by the sera.

The present studies indicate that the subspecies of Audubon's cottontail which occurs in the Great Salt Lake Basin of Utah are susceptible to RMsf and could play a role in the biological survival of virulent strains of R. rickettsii in nature.

Rodents: The six species of rodents tested were susceptible to infection with R. rickettsii to varying degrees when susceptibility was based on the CF antibody formation. Susceptibility determined by that method, however, may be misleading. We previously reported[1] that the western harvest mouse, R. megalotis, was very resistant to infection as determined by its failure to develop CF antibody after inoculation of 1.7 x 10^4 ELD_{50} doses of rickettsiae. However, in studies of the

8. DeBoer, C. I. and H. R. Cox. 1947. Specific complement fixing diagnostic antigens for neurotropic viral diseases. J. Immunol., 55: 193-204.

rickettsemia and the persistence of rickettsiae in the tissues of the harvest mouse (Tables 5 and 8), the results observed are similar to those observed in more susceptible rodents such as the Ord kangaroo rat.

Although the quantitative susceptibility of the long-tailed pocket mouse has not been determined, this species was observed to support rickettsiae in the blood longer than any other species yet tested (Table 8). In contrast, a rickettsemia could not be detected in the bushy-tailed wood rat. In the other species of rodents, rickettsemia persisted from 4 to 8 days in many of the individuals.

It is apparent from these results that ticks could take an infected blood meal from any of the species listed in Table 8, except the bushy-tailed wood rat. Thus, with this one exception, each species of rodents could contribute to the maintenance of R. rickettsii in nature. There was no evidence to indicate that a latent or carrier state of infection would develop in any of the species tested (Tables 3 to 6).

Carnivores: The results of this study indicate that 15 to 17-week old coyotes are susceptible to infection with 10^5 ELD_{50} doses of rickettsiae inoculated subcutaneously. Although these animals did not develop overt symptoms of infection, rickettsiae were recovered from the blood of two coyotes (Nos. 5 and 9) for 7 to 8 days. These coyotes also developed spotted fever CF antibody. Coyotes Nos. 1 and 2, inoculated with 10^2 ELD_{50} doses also developed CF antibody, but rickettsiae could not be demonstrated in blood samples collected from any of the animals so exposed.

Exposure to infection by either the oral or the subcutaneous route resulted in the development of a degree of resistance to challenge with 10^5 ELD_{50} doses of rickettsiae. This assumption is based on the failure of the coyotes to develop a rickettsemia after challenge similar to that occurring in response to the initial inoculation of 10^5 ELD_{50} doses in coyotes Nos. 5 and 9. The rapid increase of CF antibody in the coyotes following challenge also indicated that they, with the possible exception of Nos. 4 and 8, had experienced a previous exposure to the rickettsiae.

The persistence of R. rickettsii in the blood of subcutaneously infected coyotes is probably sufficient to infect feeding ticks. Parker[9] suggested that ticks may become infected by feeding on infected domestic dogs. This suggestion was demonstrated experimentally by Dias and Martins[10], and Price,[5] who observed that Dermacentor variabilis ticks became infected by taking a blood meal from infected dogs. Naturally infected ticks of three species have been recovered from dogs. Rickettsia rickettsii was isolated from the tick Rhipicephalus sanguineus collected from dogs in Mexico[11, 12] and from Amblyomma americana and D. variabilis collected from dogs in Arkansas.[13]

Coyotes consuming a substantially larger dose of rickettsiae than was present in the carcasses fed the coyotes in this study may develop an infection which could provide an infected blood meal for feeding ticks. Coyotes may also become carriers of infected ticks by killing and feeding on tick-infected prey, or simply by acquiring ticks from vegetation.

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9. Parker, R.R. 1935. Rocky Mountain spotted fever: Epidemiology with particular reference to distribution and prevalence in the western United States. Northwest Med., 34: 111-121.
10. Dias, E., and A. V. Martins. 1937. Aspectos de typho exanthematico em Minas Geraes. Baazil. Med., 51: 431-441.
11. Bustamente, M. E., C. Varela and C. Orbis-Merriotte. 1946. II. Estudios de fiebre manchada en Mexico. Fiebre Manchada on La Laguna. Rev. Inst. Salub. y Enferm Trop., 7:39-48.
12. Silva-Goytia, R. and A. Elizondo. 1953. Estudios fiebre manchada en Mexico. III. Estudios por medio de fijection de complemeto de sueros de ciertos animals domesticos de la Comarca Lagunera. Medicina. 33: 76-83.
13. Calhoun, E. L. and H. I. Alford, Jr. 1955. Incidence of tularemia and Rocky Mountain spotted fever among common ticks of Arkansas. Amer. J. Trop. Med. and Hyg., 4: 310-317.

Coyotes carrying infected ticks may transport them for great distances. Young and Jackson[14] reported that the average distance which tagged coyotes traveled from the point of release until they were recaptured was about 25 miles. Individual animals were recovered 1 to 400 miles from the point of release. These workers also noted that some coyotes associate with domestic dogs, allowing ample opportunity for an exchange of ectoparasites. Dogs, having acquired infected ticks, may bring them into close proximity of man.

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14. Young, D. F. and H. T. Jackson. 1951. The clever coyote. Harrisburg, Pa., The Stackpole Co., and Washington, D. C., The Wildlife Mngmt. Inst. pp. 1-411.

VECTOR TRANSMISSION

Rickettsia rickettsii: Experiments with Rickettsia rickettsii which were begun in 1961 were continued into the present report period.

Dermacentor parumapertus: In 1961 a field-trapped cottontail on which were numerous engorging ticks, was inoculated with a massive dose of R. rickettsii. Engorged ticks recovered from this rabbit were tested and found to be infected with the rickettsia. Twenty-five clutches of viable eggs were collected from these infected ticks. Samples from five of these clutches were tested and no evidence of the organism was found. However, other workers have provided evidence that indicates the organism may show up at a later stage. Therefore, larvae hatchings from these eggs were also tested, with negative results. The larvae were fed on kangaroo rats, and after ecdysis samples of the resulting nymphs were tested and found negative. The experiment was not carried further.

In attempting to repeat this experiment with laboratory reared ticks, adults were, on three different occasions, placed on field-caught jack rabbits. In each instance ticks attached, only to drop off before engorgement was nearing completion. This has been our usual experience with laboratory reared ticks of this species. A visit was made to the Rocky Mountain Laboratory to study their rearing techniques to improve our own. We found they have experienced the same difficulty with the same tick.

When larvae of the species became available, approximately 300 were placed on each of six kangaroo rats. Three days later the rats were inoculated with R. rickettsii. A total of 81 fed larvae were recovered from five of the rats. Ten of these, two from each rat, were triturated and inoculated into two guinea pigs. Neither pig developed symptoms of spotted fever. Sixty-two of the remaining ticks molted to nymphs, but were not tested further.

Ixodes kingi: An Ord kangaroo rat on which an engorging female tick of this species was found, was inoculated with R. rickettsii. At near repletion the tick was removed and held for egg laying to test whether or not transovarian transmission would occur. This tick died without laying eggs. Three other rats with engorging ticks were similarly inoculated. Only one of the female ticks laid eggs. Samples of these were inoculated into guinea pigs without producing evidence of infection. None of the eggs hatched. This tick, the second most common one in the Dugway area, has been difficult to handle in the laboratory, and so far all attempts to establish a laboratory colony have been unsuccessful.

Haemaphysalis leporis-palustris: Only after three attempts could larvae be induced to attach in sufficient numbers to justify initiating an experiment with this species. On the third attempt many larvae attached and were approaching engorgement. While the rabbit was being removed from its cage to be taken into the laboratory, it escaped. In attempting to recapture it an enlisted man struck it with an insect net. The next day it was dead. No larvae were recovered, and none were left with which to attempt another experiment.

Otobius lagophilus: Larvae of this species were placed in large numbers on each of three cottontails and one jack rabbit. Fair numbers attached on one cottontail, and many attached on the jack rabbit. Before the ticks on the jack rabbit were sufficiently engorged, the rabbit was found dead in his cage. The laboratory was dismantled while the ticks on the cottontails were engorging. At completion of engorgement the ticks were harvested for the laboratory colony. When the new laboratory is available, this experiment will be reinitiated.

Ornithodoros species near hermsi: In all our previous reports this has been reported as O. hermsi Wheeler, Herms and Meyer. Personnel at the Rocky Mountain Laboratory have determined that this is an undescribed species and have prepared descriptions for it.

Ticks of this species which were fed as larvae and nymphs on infected wood rats and guinea pigs, respectively, in 1961, are still alive in our laboratory. Although they were found infected when tested after feeding on infected hosts, they have so far failed to transmit Rocky Mountain spotted fever to a healthy host when fed. When the new laboratory is available, they will be tested for infection by inoculation into susceptible guinea pigs.

Ornithodoros parkeri: This species is the only one so far which has transmitted R. rickettsii in our laboratory. Ticks which were fed as larvae on a febrile guinea pig in 1961 molted to first instar larvae. Twelve pools of five ticks each were fed on healthy guinea pigs. Three of the pigs died of spotted fever. The remaining 9 were subsequently challenged with infective doses of R. rickettsii and developed spotted fever, indicating that they had received no infection from the ticks.

The ticks from the infected pools were, after ecdysis, offered meals on two subsequent occasions, but did not feed. Two ticks from a pool which had not transmitted on the first meal, accepted a second meal and did not transmit the disease to the host. Part of these ticks are still alive in the laboratory and will be offered an opportunity to feed when the new laboratory is available. A peculiarity of this species is that individuals may refuse to feed for as long as three years, and then feed and carry on an apparently normal existence. Their ultimate longevity is not known. We have specimens in our colony which were collected as nymphs or adults in 1958.

After imbibing a blood meal, ticks of the genus *Ornithodoros* reduce the volume of the meal by excreting a considerable percentage of the fluid portion of the blood through the coxal glands.

Twenty-four nymphs were fed on a febrile guinea pig. After the meal the ticks were placed in a clean shell vial where they excreted their coxal fluid. The ticks were then removed from the vial, and the vial was washed with sterile isotonic saline. The washings were inoculated intraperitoneally into four guinea pigs, two of which developed Rocky Mountain spotted fever and died. This would indicate that some of the rickettsiae were secreted with the coxal fluid. Other pathogens have been found to be passed off in this manner when present in the blood meal.

On subsequent occasions, 21 of these 24 nymphs fed on healthy guinea pigs. Four transmissions resulted. None of the ticks has had an opportunity to feed since the laboratory was closed. A number of them are still alive.

Pasteurella tularensis: In the 1961 annual report it was stated that laboratory experiments with this organism were completed unless, and until, a different species of tick became available for study. *Ornithodoros capensis* became that tick in 1962.

In two experiments, a total of 74 nymphs and adults of this species were fed on guinea pigs which were dying of tularemia and which had demonstrable septicemias. Eleven of these ticks were triturated and inoculated into mice.

All inoculated mice developed tularemia as indicated by gross pathology on necropsied mice, and by P. tularensis recovered from spleens smeared on GCBA plates. None of the adults laid eggs. Nine of the ticks which had been fed as nymphs ultimately fed again on a healthy *guinea pig*. No transmissions resulted. None of the ticks fed again before they died.

ES AND BA PHASES:

During the current report period wild animals were sustematically collected and examined to determine the incidence of certain diseases in these animals native to the Great Salt Lake Basin. Tissues of wildlife specimens and their ectoparasites were examined for Coxiella burnetii, Rickettsia rickettsii, Pasteurella pestis, P. tularensis, Bacillus anthracis, Brucella spp., Coccidioides immitis, the psittacosis group, and arbovirus. Serum samples were collected from the wild mammals and birds tested for the presence of RMsf, Q fever, arbovirus, and psittacosis CF antibodies, and for P. tularensis and Brucella agglutinins. A selected number of sera samples were also examined for P. pestis CF antibodies.

Techniques and methods used in the isolation of the above pathogens, with the accompanying serological procedures, are the same as were given in the Annual Reports for 1959, 1960, and 1961.[15, 16, 1] although each will be discussed briefly under each disease.

Tularemia (Pasteurella tularensis).

Wildlife serology: Pasteurella tularensis agglutinins of 1:20 or greater were noted in the sera of eleven specimens during this report period. These included an antelope ground squirrel from Gold Hill, and one from Granite Mountain; a coyote from South Skull Valley; five mule deer from Callao; a badger from Granite Mountain; a deer mouse from Johnson Pass; and a cliff chipmunk from South Cedar Mountain (Table 16). This is the first time that specific P. tularensis agglutinins have been observed in the sera of antelope ground squirrels, coyotes, and cliff chipmunks in this survey. A

15. Vest and Staff. 1959. Studies on the Ecology and Epizoology of the native fauna of the Great Salt Lake Basin. Ann. Summary Progress Report, No. 44. University Press.

16. ____________. 1960. Annual Summary Progress Report, No. 63.

review of the literature reveals that this is also the first report of the antelope ground squirrel being infected with P. tularensis in nature, although Woodbury and Parker[17] found ticks taken from this speices that contained viable organisms. Likewise, this is the first report in the literature of the cliff chipmunk being naturally infected, although others of the same genus have been found to harbor the organisms in their tissues (Parker, 1945);[18] Nakamura, 1950[19]). The other animal species mentioned have been found previously to be positive (Vest et al.,).[16]

Areas not previously yielding specimens with serological evidence of tularemia include Gold Hill, South Skull Valley, Granite Mountain, and South Cedar Mountain. Callao and Johnson Pass have yielded positive specimens of these same species in previous years (Vest et al.,).[16] The incidence of specific P. tularensis agglutinins in wildlife specimens for the past five years is presented in Table 17.

Domestic animal serology: Three domestic turkey sera obtained from Utah State University were found to contain P. tularensis agglutinins ranging from 1:20 to 1:80. This species has been previously found to naturally harbor the organism (Parker et al.,),[20] although positive serological findings have not been reported previously in the open literature. Two swine and a goat were also found to be serologically positive. The pigs were from Callao, while the goat was from Salt Lake City. Neither the goat nor the pigs have been

17. Woodbury, A. M. and D. D. Parker. 1954. Studies of tularemia, Pasteurella tularensis, Spec. Rept. No. 2. Ecological Research, Univ. of Utah.

18. Parker, R. R. 1945. Tularemia: Spontaneous occurrence in the chipmunk. Pub. Health Rept., 60: 171.

19. Nakamura, M. 1950. A survey of Pasteurella tularensis infection in the animals of the Jackson Hole area. Zoology, 35: 129-131.

20. Parker, R. R., C. B. Philip and C. E. Davis. 1932. Tularemia: occurrence in the sage hen, Centiocercus urophasianus. Pub. Health Rept., 47: 479-488.

previously reported to be naturally infected with the organisms, as far as can be determined from the literature. Two sheep sera from southern Utah were also found to be serologically positive; as were cattle specimens from Ogden, Richmond, and Logan, Utah. The sheep, cattle, and turkey sera mentioned were obtained from the Utah State University and are reported here because of their significance in showing the widespread appearance of specific tularemia agglutinins in domestic animals.

Positive reacting cattle sera (Table 18) collected for the disease survey were found in specimens taken from Ibapah, Grantsville, and Callao. Agglutinin titers ranged from 1:20 to 1:640, as shown in Table 18. Positive specimens have been previously reported from these areas (Vest et al.)[15]

Experimental work concerning the significance of these agglutinins in domestic cattle is currently being undertaken, by the injection of non-infected animals with P. tularensis strains of different virulence, and by collection of blood samples from animals raised in barns and areas expected to be free of the disease because of their isolation and distance from the endemic natural foci known to exist throughout the state.

Tissue and Ectoparasite Challenge Serology: Four groups of tissues from necropsied wildlife specimens produced agglutinins in injected guinea pigs. Titers ranged from 1:20 to 1:320. Tissues were from jack rabbits, least chipmunks, western harvest mice, Great Basin pocket mice, and a shrike (Table 19). Evidence of tularemia in the first two species has been previously reported in this survey (Vest et al.).[15, 16] The last three species have not been previously implicated with the disease in this survey, nor in the open literature. The areas involved have all had serologically positive animal specimens (not necessarily the same species) removed from them in previous years.

One group of ticks collected from jack rabbits at Government Creek also produced agglutinins in the injected guinea pigs (Table 20).

The possible significance of these agglutinin titers in the normally susceptible rodents has been discussed in detail in previous reports (Vest et al., 1961;[1] Parker and Staff).[21]

Isolations from Animal Tissues and Ectoparasites: Two strains of P. tularensis were isolated during this report period (Table 21). One isolate was from the tissues of an Ord kangaroo rat, the other from tissues of two antelope ground squirrels. This latter isolation confirms and extends the significance of the positive agglutinin titer found in this same species and reported in more detail in the section on Wildlife Serology. Natural infection in the Ord kangaroo rat has not previously been noted, although Kartman et al., (1958)[22] found some of the Dipodomys spp. to be infected. Evidence of tularemia in Callao has been shown on several previous occasions, but this is the first indication of the disease at GPI-3. Both strains of the organism are fully virulent for laboratory animals and selected wild rodents (Parker et al., 1962).[21] The organisms are both sensitive to streptomycin. No isolations were made from ectoparasite injected guinea pigs during this report period.

The findings of serologically positive specimens in several new areas, as noted earlier and the isolation of viable organisms from an old and a new area, indicate that the disease continues to be endemic to the entire region. It also probably indicates that strains of lesser virulence exist in the

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21. Parker, D. D. and Staff. 1962. Tularemia Report, 1952-1962. Ecology and Epizoology Research, No. 88. U. S. Army.

22. Kartman, L., F. F. Murray, F. M. Prince, S. F. Quan, and M. A. Holmes. 1958. Public health implications of the Microtus outbreak in Oregon and California during 1957-58. Calif. Vector Views. Calif. State Dept. of Health. 5: 19-24.

region, although none have been isolated to date. This concept is strengthened by the fact that such strains of lesser virulence were isolated from beaver dying of the disease in the Heber Valley area during the last few months. Similar strains of lesser virulence have also been isolated previously from the Utah Lake Area (see Tularemia report, 1963).

A summary of the incidence of tularemia in the animal species during the last five years (as determined by all methods in the Disease Survey Laboratory) is shown in Table 22. The incidence by area is shown in Table 23.

TULAREMIA AGGLUTININ TITERS 1959-1962

TABLE 16. Incidence of *Pasteurella tularensis* infections in wildlife specimens collected from the Great Salt Lake Desert Region, as determined by specific agglutinins in their sera.

Animal Species	Host No.	Area	Date	Agglu. Titer*
			1959	
Peromyscus maniculatus	9A 7-8	Government Creek	June	80
Odocoileus hemionus	9A 112	Johnson Pass	Jan.	80
O. hemionus	9A 113	Johnson Pass	Jan.	80
Lepus californicus	9H 208	Callao	Aug.	40
P. maniculatus	9I 74	Johnson Pass	Sept.	160
P. maniculatus	9J 44	Government Creek	Oct.	40
Reithrodontomys megalotis	9J 45	Government Creek	Oct.	80
Taxidea taxus	9K 1	Little Davis Mtn.	Nov.	160
Eutamias minimus	9K 34	Vernon	Nov.	80
P. truei	9K 76	Lookout Pass	Nov.	40
P. maniculatus	9K 84	Lookout Pass	Nov.	40
P. truei	9K 86	Lookout Pass	Nov.	40
P. truei	9K 87	Lookout Pass	Nov.	40
			1960	
P. maniculatus	OD 272	Government Creek	April	40
Dipodomys microps	OG 1664	Camelback Mtn.	July	20
			1961	
L. californicus	IH 1469	Callao	Aug.	40
L. californicus	IH 1687	West Wendover	Aug.	20
O. hemionus	IJ 1980	Fountain Green	Oct.	80
O. hemionus	IJ 1988	Callao	Oct.	40
O. hemionus	IJ 1989	Callao	Oct.	20
O. hemionus	IJ 1990	Callao	Oct.	40
O. hemionus	IJ 1991	Callao	Oct.	160
O. hemionus	IJ 1992	Callao	Oct.	40
			1962	
Citellus leucurus	2E 1070	Gold Hill	May	40
Canis latrans	2H 1742	S. Skull Valley	Aug.	320
O. hemionus	2J 2251	Callao	Oct.	40
T. taxus	2J 2306	Granite Mtn.	Oct.	160
Eutamias dorsalis	2J 2343	S. Cedar Mtn.	Oct.	20
C. leucurus	2J 2406	Granite Mtn.	Oct.	40
P. maniculatus	2J 2482	Johnson Pass	Oct.	40

* Expressed as the reciprocal of the tube agglutination titer.

CASES OF TULAREMIA INDICATED BY AGGLUTININS 1958-1962

TABLE 17. Incidence of *Pasteurella tularensis* infections in wildlife specimens collected from the Great Salt Lake Desert region, determined by specific agglutinins in sera, 1958-1962. Listed by species.

Species	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Antrozous pallidus	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Lepus californicus	10/101	10.0	1/510	0.2	0/378	-	2/522	0.4	0/486	-
Sylvilagus sp.	0/6	-	0/30	-	0/41	-	0/32	-	0/25	-
Citellus townsendii	0/0	-	0/0	-	0/4	-	0/0	-	0/3	-
C. variegatus	0/0	-	0/0	-	0/3	-	0/0	-	0/2	-
C. leucurus	0/128	-	0/236	-	0/245	-	0/202	-	2/151	1.3
Eutamias minimus	0/13	-	1/53	1.9	0/17	-	0/17	-	0/47	-
E. dorsalis	0/5	-	0/27	-	0/27	-	0/2	-	1/7	14.3
Thomomys bottae	0/1	-	0/0	-	0/1	-	0/0	-	0/0	-
Perognathus longimembris	0/16	-	0/68	-	0/58	-	0/95	-	0/32	-
P. parvus	0/39	-	0/97	-	0/113	-	0/40	-	0/62	-
P. formosus	0/39	-	0/65	-	0/110	-	0/86	-	0/96	-
Microdipodops megacephalus	0/5	-	0/10	-	0/9	-	0/3	-	0/1	-
Dipodomys ordii	0/230	-	0/416	-	0/214	-	0/193	-	0/257	-
D. microps	0/370	-	0/406	-	1/327	0.3	0/276	-	0/173	-
Reithrodontomys megalotis	0/33	-	1/102	1.0	0/44	-	0/45	-	0/84	-
Peromyscus crinitus	0/23	-	0/75	-	0/24	-	0/41	-	0/25	-
P. maniculatus	0/278	-	4/957	0.4	1/499	0.2	0/453	-	1/1117	0.1
P. truei	0/13	-	3/139	2.2	0/67	-	0/71	-	0/65	-
Onychomys leucogaster	0/4	-	0/8	-	0/6	-	0/6	-	0/5	-
Neotoma lepida	0/65	-	0/53	-	0/53	-	0/45	-	0/38	-
N. cinerea	0/1	-	0/0	-	0/0	-	0/0	-	0/0	-
Ondatra zibethicus	0/0	-	0/1	-	0/0	-	0/4	-	0/0	-
Microtus sp.	0/0	-	0/4	-	0/2	-	0/7	-	0/2	-
Mus musculus	0/4	-	0/1	-	0/1	-	0/1	-	0/0	-
Erethizon dorsatum	0/0	-	0/1	-	0/0	-	0/0	-	0/0	-
Canis latrans	0/0	-	0/1	-	0/2	-	0/0	-	1/2	50.0
Vulpes macrotis	0/0	-	0/1	-	0/2	-	0/0	-	0/2	-
Taxidea taxus	0/0	-	1/4	25.0	0/0	-	0/0	-	1/1	100.0
Spilogale gracilis	0/0	-	0/1	-	0/0	-	0/0	-	0/1	-
Lynx rufus	0/0	-	0/3	-	0/0	-	0/1	-	0/0	-
Felis catus	0/0	-	0/6	-	0/1	-	0/1	-	0/2	-
Odocoileus hemionus	0/0	-	2/15	13.3	0/17	-	6/19	31.6	1/21	5.0

TABLE 17. (Continued) - AVES.

Species	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Buteo jamaicensis										
Red-tailed hawk	0/0	-	0/2	-	0/0	-	0/0	-	0/0	-
Aquila chrysaetos										
Golden eagle	0/0	-	0/2	-	0/0	-	0/0	-	0/0	-
Recurvirostra americana										
Avocet	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Columba livia										
Domestic pigeon	0/0	-	0/3	-	0/0	-	0/0	-	0/5	-
Zenaidura macroura										
Mourning dove	0/0	-	0/0	-	0/0	-	0/0	-	0/18	-
Colaptes cafer										
Flicker	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Sayornis saya										
Say's phoebe	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Eremophila alpestris										
Horned lark	0/0	-	0/0	-	0/0	-	0/0	-	0/64	-
Aphelocoma coerulescens										
Scrub jay	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Corvus corax										
American raven	0/0	-	0/7	-	0/0	-	0/0	-	0/0	-
Parvus inornatus										
Gray titmouse	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Oreoscoptes montanus										
Sage thrasher	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Turdus migratorius										
Robin	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Lanius ludovicianus										
Great Basin shrike	0/0	-	0/0	-	0/0	-	0/0	-	0/32	-
Sturnus vulgaris										
Starling	0/0	-	0/0	-	0/0	-	0/0	-	0/9	-
Passer domesticus										
English sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Xanthocephalus xanthocephalus										
Yellow-headed blackbird	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-

TABLE 17. (Continued). AVES

Species	1958 Pos/Total	1958 %	1959 Pos/Total	1959 %	1960 Pos/Total	1960 %	1961 Pos/Total	1961 %	1962 Pos/Total	1962 %
Agelaius phoenicus										
Red wing	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Euphagus cyanocephalus										
Blackbird	0/0	-	0/1	-	0/0	-	0/0	-	0/3	-
Molothrus ater										
Cowbird	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Carpodacus mexicanus										
House finch	0/0	-	0/0	-	0/0	-	0/0	-	0/12	-
Pooecetes gramineus										
Western vesper sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/7	-
Passerculus sandwichensis										
Nevada savannah sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Chondestes grammacus										
Western lark sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Amphispiza sp.										
Sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/13	-
Spizella breweri										
Brewer sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Melospiza melodia										
Mountain song sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Zonotrichia leucophrys										
Gambel's sparrow	0/0	-	0/2	-	0/0	-	0/0	-	0/6	-
Anthus spraguei										
Pipit	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Bubo virginianus										
Horned owl	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Spinus tristis										
Pale goldfinch	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Meleagris gallopavo										
Domestic turkey	0/0	-	0/0	-	0/0	-	0/0	-	3/27	11.1
Pica pica										
Magpie	0/0	-	0/0	-	0/0	-	0/0	-	0/8	-
Total	10/1374	0.7	13/3307	0.4	2/2265	.09	7/2162	0.3	10/2851	0.4

TULAREMIA IN DOMESTIC ANIMALS

TABLE 18. Evidence of *Pasteurella tularensis* infections in domestic animals as determined by specific agglutinin titers in their sera. (Report period 1 January 1962 - 31 March 1963).

Animal species	Host No.	Area	Agglutinin Titer*
Meleagris gallopavo			
Domestic turkey	5364	Logan	40
M. gallopavo	5365	Logan	80
M. gallopavo	5368	Logan	20
Sus spp.			
Pig	1	?	40
Sus spp.	2	?	20
Capra spp.			
Goat	Cloe	Salt Lake City	40
Ovis spp.			
Sheep	6398	Southern Utah	20
Ovis spp.	6399	Southern Utah	20
Bos taurus			
Cow	577	Logan	40
B. taurus	083	Richmond	40
B. taurus	Daisy	Richmond	80
B. taurus	423	Richmond	40
B. taurus	a	Ogden	160
B. taurus	b	Ogden	80
B. taurus	c	Ogden	40

Disease Survey Cattle Samples

Area	Total Tested	Agglutination titers (number of positives)* <20	20	40	80	160	320 & 640
Ibapah	129	10	30	48	17	14	10
Callao	40	5	10	13	10	2	0
Grantsville	70	18	20	18	11	2	1

* Expressed as the reciprocal of agglutination titers.

TISSUE-INDUCED TULAREMIC AGGLUTININS IN GUINEA PIGS

TABLE 19. Incidence of *Pasteurella tularensis* infections in wildlife species of the Great Salt Lake Desert region, as determined by the induction of specific agglutinins in tissue-injected guinea pigs (1960-1962).

Animal species	Host Number	Area	Date	Agglutinin Titer
			1960	
Reithrodontomys megalotis	OE 750, 757	Fish Springs	May	20
Sylvilagus audubonii	OF 1438, 1443	Gandy	June	40
			1961	
Lepus californicus	IH 1279, 1280	Callao	Aug	80
Dipodomys ordii	IH 1246, 1261	GPI-3	Aug	40
			1962	
L. californicus	2B 100, 101	Government Creek	Feb	80
Lanius ludovicianus	B2F 209, 210 250, 251	Little Davis Mtn.	June	20
Eutamias minimus *R. megalotis*	(2J 2434, 2555) (2K 2578)	Vernon	Oct Nov	320
Perognathus parvus	2J 2490, 2520 2K 2605	Johnson Pass	Oct Nov	40

ECTOPARASITE-INDUCED TULAREMIC AGGLUTININS IN GUINEA PIGS

TABLE 20. Incidence of *Pasteurella tularensis* in ectoparasites taken from wildlife specimens of the Great Salt Lake Desert region, as determined by the production of specific agglutinins in ectoparasite-injected guinea pigs (1958-1962).

Type and species of ectoparasites	Host species	Host Number	Area	Date	Antibody Titer*
				1959	
Ticks (one pool)	*Dipodomys microps*	9I 99, 103	Old River Bed	Sept	
Dermacentor parumapertus	*D. ordii*	9J 6, 12		and	80**
Ixodes kingi	*Citellus leucurus*	9I 109		Oct	
Ticks				1961	
D. parumapertus	*Lepus californicus*	1G 1234,1235	Gandy	July	40
Ticks				1962	
D. parumapertus	*L. californicus*	2G 1521,1522, 1523	Government Creek	July	160
Lice				1961	
Neohaematopinus citellinus	*C. leucurus*	1D 371	Old River Bed	April	40

* Expressed as the reciprocal of the tube agglutination titer.

** Titer of sera from guinea pig inoculated with a pool of the two tick species.

TULAREMIA ISOLATES 1954-1962

TABLE 21. Incidence of *Pasteurella tularensis* in wildlife specimens of the Great Salt Lake Desert region, as determined by the isolation of the organism from tissue-injected guinea pigs.

Animal species	Host number	Area	Date	Isolate Designation
			1954	
Lepus californicus	4G 19	Gold Hill	July	4G 19
			1955	
L. californicus	5E 791	Fish Springs	May	5E 791
L. californicus	5F 297, 298	Callao	June	5F 297
			1956	
L. californicus	6C 187	N.Skull Valley	March	6C 187
L. californicus	6H 16, 17	N.Skull Valley	Aug	6H 16
L. californicus	6C 184, 185	N.Skull Valley	March	6C 184
			1958	
Sylvilagus audubonii	-	S.Skull Valley	June	SKV-1
L. californicus	-	S.Skull Valley	June	SKV-2
L. californicus	-	S.Skull Valley	June	SKV-3
L. californicus	8F 259, 260	N.Skull Valley	June	8F 260
			1961	
L. californicus	1H 1598	Grouse Creek	Aug	1H 1598
L. californicus	1H 1599	Grouse Creek	Aug	1H 1599
L. californicus	1H 1600	Grouse Creek	Aug	1H 1600
L. californicus	1H 1601	Grouse Creek	Aug	1H 1601
			1962	
Dipodomys ordii	2G 1460	GPI-3	July	2G 1460
Citellus leucurus	2G 1552, 1553	Callao	July	2G 1552

TULAREMIC INFECTIONS 1958-1962

TABLE 22. Incidence of Pasteurella tularensis infections in wildlife specimens of the Great Salt Lake Desert region, as determined by all methods, 1958-1962 inclusive. Listed by species.

Species	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Antrozous pallidus	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Lepus californicus	3/101	3.0	2/510	0.4	0/378	-	9/522	1.7	2/486	0.4
Sylvilagus sp.	1/6	17.0	0/30	-	1/41	2.4	0/32	-	0/25	-
Citellus townsendii	0/0	-	0/0	-	0/4	-	0/0	-	0/3	-
C. variegatus	0/0	-	0/0	-	0/3	-	0/0	-	0/32	-
C. leucurus	0/128	-	1/236	0.4	0/245	-	1/202	0.5	3/151	2.0
E. minimus	0/13	-	1/53	1.8	0/17	-	0/17	-	1/47	2.1
E. dorsalis	0/5	-	0/27	-	0/27	-	0/2	-	1/7	14.3
Thomomys bottae	0/1	-	0/0	-	0/1	-	0/0	-	0/0	-
Perognathus longimembris	0/16	-	0/68	-	0/58	-	0/95	-	0/32	-
P. parvus	0/39	-	0/97	-	0/113	-	0/40	-	1/62	1.6
P. formosus	0/39	-	0/65	-	0/110	-	0/86	-	0/96	-
Microdipodops megacephalus	0/5	-	0/10	-	0/9	-	0/3	-	0/1	-
Dipodomys ordii	0/230	-	1/416	0.2	0/214	-	1/193	0.5	1/257	0.4
D. microps	0/370	-	1/406	0.2	1/327	0.3	0/276	-	0/173	-
Reithrodontomys megalotis	0/33	-	1/102	1.0	1/44	2.3	0/45	-	1/84	1.2
Peromyscus crinitus	0/23	-	0/75	-	0/24	-	0/41	-	0/25	-
P. maniculatus	0/278	-	4/957	0.4	1/499	0.2	0/453	-	1/1017	0.1
P. truei	0/13	-	3/139	2.2	0/67	-	0/71	-	0/65	-
Onychomys leucogaster	0/4	-	0/8	-	0/6	-	0/6	-	0/5	-
Neotoma lepida	0/65	-	0/53	-	0/53	-	0/45	-	0/38	-
N. cinerea	0/1	-	0/0	-	0/0	-	0/0	-	0/0	-
Ondatra zibethicus	0/0	-	0/1	-	0/0	-	0/4	-	0/0	-
Microtus sp.	0/0	-	0/4	-	0/2	-	0/7	-	0/2	-
Mus musculus	0/4	-	0/1	-	0/0	-	0/1	-	0/0	-
Erethizon dorsatum	0/0	-	0/1	-	0/0	-	0/0	-	0/0	-
Canis latrans	0/0	-	0/1	-	0/2	-	0/0	-	1/2	50.0
Vulpes macrotis	0/0	-	0/1	-	0/2	-	0/0	-	0/2	-
Taxidea taxus	0/0	-	1/4	25.0	0/0	-	0/0	-	1/1	100.0
Spilogale gracilis	0/0	-	0/1	-	0/0	-	0/0	-	0/1	-
Lynx rufus	0/0	-	0/3	-	0/0	-	0/1	-	0/0	-
Felis catus	0/0	-	0/6	-	0/1	-	0/1	-	0/2	-
Odocoileus hemionus	0/0	-	2/15	13.3	0/17	-	6/19	31.6	1/21	4.8

TABLE 22. (Continued) AVES

Species	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Buteo jamaicensis										
Red-tailed hawk	0/0	-	0/2	-	0/0	-	0/0	-	0/0	-
Aquila chrysaetos										
Golden eagle	0/0	-	0/2	-	0/0	-	0/0	-	0/0	-
Recurvirostra americana										
Avocet	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Columba livia										
Domestic pigeon	0/0	-	0/3	-	0/0	-	0/0	-	0/5	-
Zenaidura macroura										
Mourning dove	0/0	-	0/0	-	0/0	-	0/0	-	0/18	-
Colaptes cafer										
Flicker	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Sayornis saya										
Say's phoebe	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Eremophila alpestris										
Horned lark	0/0	-	0/0	-	0/0	-	0/0	-	0/64	-
Aphelocoma coerulescens										
Scrub jay	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Corvus corax										
American raven	0/0	-	0/7	-	0/0	-	0/0	-	0/0	-
Parvus inornata										
Gray titmouse	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Oreoscoptes montanus										
Sage thrasher	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Turdus migratorius										
Robin	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Lanius ludovicianus										
Great Basin shrike	0/0	-	0/0	-	0/0	-	0/0	-	1/32	3.1
Sturnus vulgaris										
Starling	0/0	-	0/0	-	0/0	-	0/0	-	0/9	-
Passer domesticus										
English sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Xanthocephalus xanthocephalus										
Yellow-headed blackbird	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-

TABLE 22. (Continued) AVES

Species	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Agelaius phoeniceus										
Red wing	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Euphagus cyanocephalus										
Blackbird	0/0	-	0/1	-	0/0	-	0/0	-	0/3	-
Molothrus ater										
Cowbird	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Carpodacus mexicanus										
House finch	0/0	-	0/0	-	0/0	-	0/0	-	0/12	-
Pooecetes gramineus										
Western vesper sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/7	-
Passerculus sandwichensis										
Nevada savannah sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Chondestes grammacus										
Western lark sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Amphispiza sp.										
Sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/13	-
Spizella breweri										
Brewer sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Melospiza melodia										
Mountain song sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Zonotrichia leucophrys										
Gambel sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/6	-
Zonotrichia gambelii										
Gambel sparrow	0/0	-	0/2	-	0/0	-	0/0	-	0/0	-
Anthus spraguei										
Pipit	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Bubo virginianus										
Horned owl	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Spinus tristis										
Pale goldfinch	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Meleagris gallopavo										
Domestic turkey	0/0	-	0/0	-	0/0	-	0/0	-	3/27	11.1
Pica pica										
Magpie	0/0	-	0/0	-	0/0	-	0/0	-	0/8	-
Totals	4/1374	0.3	*17/3307	0.5	4/2265	0.2	17/2162	0.8	*15/2851	0.5

* These totals are more than for the same years listed by areas because some tissue pools contained two species - both of which are included in these totals.

DISTRIBUTION OF TULAREMIC INFECTIONS, 1958-1962

TABLE 23. Incidence of Pasteurella tularensis infections in wildlife specimens of the Great Salt Lake Desert region, as determined by all methods 1958-1962 inclusive. Listed by areas.

Area	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Callao	0/94	-	1/367	0.3	0/152	-	7/315	2.2	2/265	0.8
Camelback Mountain	0/68	-	0/93	-	1/147	0.7	0/64	-	0/224	-
Cedar City	0/83	-	0/20	-	0/67	-	0/0	-	0/0	-
CD22	0/0	-	0/65	-	0/0	-	0/0	-	0/0	-
Clover	0/0	-	0/144	-	0/0	-	0/33	-	0/81	-
Deep Creek	0/9	-	0/1	-	0/48	-	0/27	-	0/31	-
Duchesne	0/0	-	0/38	-	0/0	-	0/0	-	0/0	-
Dugway Mountain	0/0	-	0/18	-	0/57	-	0/1	-	0/9	-
Dugway Valley	0/72	-	1/51	2.0	0/30	-	0/27	-	0/32	-
East Wendover	0/0	-	0/0	-	0/20	-	0/15	-	0/30	-
Fillmore	0/0	-	0/70	-	0/0	-	0/0	-	0/0	-
Fish Springs	0/46	-	0/43	-	1/73	1.4	0/112	-	0/70	-
Fountain Green	0/0	-	0/0	-	0/0	-	1/3	33.3	0/0	-
Gandy	0/0	-	0/18	-	1/17	5.9	1/24	4.2	0/24	-
Gold Hill	0/132	-	0/164	-	0/102	-	0/146	-	1/135	0.7
Government Creek	0/3	-	3/454	0.7	1/54	1.9	1/124	0.8	2/273	0.7
GPI-3	0/7	-	0/0	-	0/117	-	0/50	-	1/26	3.8
Granite Mountain	0/21	-	0/35	-	0/48	-	0/27	-	2/111	1.8
Grouse Creek	0/0	-	0/0	-	0/8	-	5/13	38.5	0/13	-
Hanksville	0/0	-	0/4	-	0/0	-	0/0	-	0/0	-
Johnson Pass	0/0	-	3/37	8.1	0/2	-	0/24	-	2/104	1.9
Little Davis Mountain	0/49	-	1/122	0.8	0/60	-	0/137	-	1/262	0.4
Logan	0/0	-	0/0	-	0/80	-	0/0	-	0/27	-
Lookout Pass	0/0	-	4/45	8.9	0/77	-	0/40	-	0/75	-
Lucin	0/0	-	0/0	-	0/4	-	0/10	-	0/5	-
Manti	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Montello	0/0	-	0/0	-	0/7	-	0/3	-	0/7	-
North Cedar Mountain	0/0	-	0/0	-	0/54	-	0/25	-	0/0	-
North Skull Valley	1/88	1.1	0/240	-	0/133	-	0/42	-	0/84	-
North Wendover	0/395	-	0/196	-	0/72	-	0/49	-	0/28	-

TABLE 23.(Continued).

Area	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Old River Bed	0/24	-	1/288	0.3	0/60	-	1/30	3.3	0/66	-
Payson	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Roosevelt	0/0	-	0/0	-	0/0	-	0/3	-	0/1	-
Settlement Canyon	0/0	-	0/0	-	0/0	-	0/7	-	0/0	-
Sheeprock Mountain	0/0	-	0/1	-	0/0	-	0/0	-	0/0	-
Simpson Mountain	0/0	-	0/18	-	0/8	-	0/45	-	0/38	-
South Cedar Mountain	0/148	-	0/279	-	0/182	-	0/202	-	1/249	0.4
South Skull Valley	*3/3	100.0	0/47	-	0/66	-	0/85	-	1/111	0.9
South Wendover	0/0	-	0/104	-	0/13	-	0/45	-	0/25	-
South Willow	0/0	-	0/30	-	0/0	-	0/0	-	0/0	-
Test Grid	0/98	-	0/36	-	0/61	-	0/39	-	0/67	-
Trout Creek	0/12	-	0/24	-	0/200	-	0/198	-	0/93	-
Vernon	0/0	-	1/106	0.9	0/37	-	0/34	-	1/46	2.2
West Wendover	0/0	-	0/0	-	0/113	-	1/105	0.9	0/52	-
Wig Mountain	0/11	-	0/127	-	0/58	-	0/58	-	0/146	-
Wildcat Mountain	0/0	-	0/24	-	0/38	-	0/0	-	0/36	-
Total	4/1367* (1364)	0.29	15/3309	0.45	4/2265	0.18	17/2162	0.78	14/2851	0.49

* Not included in totals of other tables (by area)

Brucellosis (Brucella spp.)- Wildlife Serology: Specific Brucella agglutinins were demonstrated in the sera of 14 wildlife specimens in 1962. These consisted of eleven jack rabbits, one wood rat, one Townsend ground squirrel, one antelope ground squirrel (Table 24). Jack rabbits and wood rats have previously been found to have these agglutinins in their sera (Vest et al., 1962)[1], but this is the first incidence of such agglutinins in the two species of Citellus in this survey. As noted in Table 24, the areas involved, which have previously yielded positive specimens, are Government Creek, Trout Creek, and Callao. New areas include South Skull Valley, Wildcat Mountain, West Wendover, Johnson Pass, and Gandy. These findings indicate the organisms may be much more widespread than has been previously determined. The species involved are unknown, as no isolations were made during the year, and previous isolates yielded one strain of Br. suis from a jack rabbit (Stoenner et al., 1959),[23] and several strains of Br. neotomae from wood rats (Vest et al.,)[1].

Domestic Animal Serology: One turkey serum was found to contain agglutinins of a titer of 1:80 (Table 25). This same bird and two others from the same flock were also found to be positive for P. tularensis agglutinins (see tularemia section). Several cattle and sheep found to be positive for P. tularensis agglutinins were also found to have Brucella agglutinins ranging from 1:20 to 1:320 (Table 25). Cattle from Ibapah yielded 63 positive sera in a dilution of 1:40; those from Callao yielded 26 of 40, and those from Grantsville gave 32 of 70 positive sera.

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23. Stoenner, H. G., R. Holdenried, D. Lackman, and J. S. Orsborn, Jr., 1959. The occurrence of Coxiella burnetii, Brucella and other pathogens among fauna of the Great Salt Lake Desert in Utah. Amer. J. Trop. Med. * Hyg. 8: 590-596.

TABLE 24. Evidence of brucellosis in wildlife specimens collected from the Great Salt Lake Desert area, 1954-1962 inclusive, as determined by serological methods.

Species	Host Number	Area	Year	Agglutinin Titers
Neotoma lepida		Little Granite Mtn	1955*	*
N. lepida		Gold Hill	1955*	*
N. lepida		Gold Hill	1955*	*
N. lepida		Gold Hill	1955*	*
N. lepida		Gold Hill	1955*	*
N. lepida		Gold Hill	1955*	*
Peromyscus maniculatus	9E 51	Callao	1959	40
N. lepida	OF 1268	Trout Creek	1960	160
N. lepida	OF 1270	Trout Creek	1960	320
N. lepida	OF 1435	Trout Creek	1960	640
L. californicus	OA 14	North Wig Mountain	1960	40
L. californicus	OA 21	North Wig Mountain	1960	40
L. californicus	OS 23	North Wig Mountain	1960	80
N. lepida	OE 836	Gold Hill	1960	40
L. californicus	1H 1306	Callao	1961	80
L. californicus	1H 1307	Callao	1961	40
L. californicus	1H 1308	Callao	1961	160
L. californicus	1E 514	Callao	1961	160
N. lepida	1G 1213	South Cedar Mountain	1961	1280
Columba livia	1K 2156	Government Creek	1961	80
Citellus townsendii	2C 328	Government Creek	1962	40
N. lepida	2F 1218	Trout Creek	1962	640
L. californicus	2G 1524	Government Creek	1962	80
L. californicus	2H 1740	South Skull Valley	1962	20
L. californicus	2H 1741	South Skull Valley	1962	80
L. californicus	2H 1821	Callao	1962	20
L. californicus	2H 1826	Callao	1962	40
L. californicus	2H 1827	Callao	1962	20
L. californicus	2H 1828	Callao	1962	40
Citellus leucurus	2I 1865	Wildcat Mountain	1962	20
L. californicus	2I 2057	West Wendover	1962	20
L. californicus	2J 2140	Johnson Pass	1962	80
L. californicus	2J 2141	Johnson Pass	1962	80
L. californicus	2L 2836	Gandy	1962	20

* Stoenner et al., 1959

There was no evidence of *Brucella* organisms as determined by agglutinins produced by tissue or ectoparasite-injected guinea pigs during this period. No isolations were made from any of the original animal tissues.

TABLE 25. Incidence of brucellosis in domestic animals, as determined by serological methods. Calendar year 1962.

Species	Host Number	Area	Agglutinin Titers
Meleagris gallopavo	5365	Logan	80
M. gallopavo	6348	Southern Utah	20
Bos taurus	083	Richmond	40
Bos taurus	Daisy	Richmond	80
Bos taurus	Steer "A"	Ogden	40
Ovis spp.	1763	Arco, Idaho	20
Ovis spp.	Lizzy	Arco, Idaho	20

Anthrax (*Bacillus anthracis*): There was no evidence of this organism in the wildlife or domestic animal tissue samples processed during this period.

Coccidiomycosis (*Coccidiodes immitis*): There was no evidence of this organism in the wildlife or the ectoparasite specimens processed by the laboratory during this period. Approximately 30% of the total specimens received were randomly examined for the organism - 100% of the samples from GPI-3 and CD 22 were examined. Surveillance procedures for the species were discontinued at the end of the calendar year, in accordance with a directive previously received from the Project Office.

Plague (*Pasteurella pestis*): There was no evidence of this organism in the tissues or the ectoparasites of animal specimens processed during this report period, as determined by procedures described elsewhere (Thorpe et al., 1963).[24] Additional studies, both serological (CF and hemagglutination tests) and cultural, also failed to yield evidence of this organism in these specimens. Serological tests on the sera of the animals collected in the Indian Farm Canyon focus produced excellent correlations with the isolations.

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24. Thorpe, B. D., N. J. Marchette and J. B. Bushman. 1963. Virulence studies of *Pasteurella pestis* isolates from the Great Salt Lake Desert. Amer. J. Trop. Med. & Hyg., 12: 219-222.

These additional studies were performed at no cost to the contract (in time or materials), and will be reported in detail at a later time.

Q fever (Coxiella burnetii): In previous reports, it has been pointed out that an apparent epizootic of Q fever occurred in 1960 in the Great Salt Lake Desert area, as indicated by a marked increase in number of sera containing Q fever antibody, and by many isolations of the causal agent. Since this reported epizootic, the incidence of the disease occurrence in native animals of the area has steadily decreased. As will be observed in the following report, this trend has continued during 1962 also, with only individual areas still yielding infected animals.

Methods: The techniques for performing the serological tests for Q fever remained the same as was reported in previous reports. This was a complement fixation test employing Phase II (egg-adapted) antigen obtained commercially from Lederle Laboratories. An overnight serum-antigen-complement incubation was used, followed by a 30-minute incubation when sensitized red blood cells were added. Complete details of the test can be found in the Epizoology Laboratory protocol.[25]

Isolations were accomplished as have been previously described. In brief, this consisted of intraperitoneal injection of tissue or ectoparasite suspensions into hamsters and guinea pigs, and the subsequent sacrifice of the animals at one, two and four weeks after injection. When sacrificed, lung, liver, kidney, and spleen were removed and stored in a dry ice chest. Blood was also removed and the serum separated and tested for presence of Q fever antibody. A rise in titer by the four-week sacrifice period was indicative of

25. Standard Methods for Examination of samples of wildlife tissues and wild, domestic, and human serum. University of Utah Epizoology Diagnostic Laboratory.

a confirmed isolation of the organism. Tissue were selected for this isolation process by the standard screening procedure of injecting aliquots of the tissue into indicator guinea pigs, bleeding these animals four weeks later, and testing their sera for Q fever antibody of 1:8 or greater (the Epizoology Laboratory protocol states 1:16 or greater, but numerous studies in the laboratory have shown that 1:8 Q fever titers in guinea pigs are indicative of infection).

Results: Results of serological tests for Q fever antibody in wild mammals and birds are shown according to species in Table 26. All species which were seropositive, as judged by a titer of 1:16 or greater, were the same as observed in previous years; that is, no new species were found to be reactive. The total and per cent seropositives decreased in 1962, as compared to 1959, 1960, and 1961, a total of 227 of 2,851 sera being positive, for 8.7 per cent. The animals in which this decrease was shown were jack rabbits, little pocket mice, Great Basin pocket mice, Ord kangaroo rats, chisel-toothed kangaroo rats, western harvest mice, canyon mice, deer mice, and pinyon mice. Two species, long-tailed pocket mice and the desert wood rats, had no positive sera in 1962, compared to 4 of 86 (4.6%), and 10 of 45 (22.2%), respectively, in 1961. Cottontails, antelope ground squirrels, grasshopper mice, and mule deer sera were more seropositive in 1962, percentage-wise, although fewer were trapped in some instances.

The serological results did not compare closely with the incidence of Q fever rickettsiae in tissues from the animals tested. The latter results are shown in Table 27. All indications of C. burnetii in the tissue were confirmed by hamster and guinea pig injections and are considered isolations since the positive tissue is in storage at dry ice temperature. As indicated in Table 27, 19 isolations were made, but since more mammals were trapped, the per cent of positives was less. No isolations were reported in Ord kangaroo rats, which yielded detectable organisms in 1961. Conversely, three species (cottontails, little pocket mice, and western harvest mice) contained infected tissue in 1962, but did not in 1961. This is the first time an isolation has ever been reported in the western harvest mouse. The majority of isolations were made from the tissues of chisel-toothed kangaroo mice and deer mice, coinciding with results of previous years.

Table 28 lists the distribution of Q fever seropositive wild animals per year tested. Callao yielded the most animals with positive sera, followed by Little Davis Mountain, South Cedar Mountain, Government Creek, Camelback Mountain, and Johnson Pass, each with 10 or more seropositive animals. Nearly every other area trapped also contained positive animals in high percentages. Most of the areas in which large numbers of seropositive animals were trapped also contained seropositive animals in 1960 and 1961.

Nine of the 33 areas trapped yielded animals from which C. burnetii was isolated. A breakdown of the distribution of isolations according to area and year tested, is shown in Table 28, while Table 29 summarizes the C. burnetii isolation data for 1962. One area in particular (Camelback Mountain), has yielded infected animals for the past three years. The infected animals from this area during 1962 were chisel-toothed kangaroo rats (6), deer mice (3), and one jack rabbit. Only one other area, Old River Bed, yielded more than one isolate, these being from a deer mouse and a little pocket mouse. In nearly every trapping month, an isolation was made from some area. Due to the trapping technique, however, few areas were trapped in every month.

Coxiella burnetii was isolated from one ectoparasite pool consisting of 15 fleas taken from deer mice and pinyon mice trapped at South Cedar Mountain in March. It should be pointed out that C. burnetii was also isolated from deer mice from the same area a month previous to this. A comparison of the past five years' survey for C. burnetii in ectoparasites is given in Table 30.

The trapping areas from which animals containing detectable C. burnetii were found (Government Creek, South Cedar Mountain, Old River Bed, Camelback Mountain, and Dugway Valley), are adjacent to each other, indicating a possible local epizootic or focus.

A summary of the presence of Q fever antibody in livestock is shown in Table 31. Although sera from cattle, goats, pigs, and sheep were tested in 1962, only 12 of 247 cattle and one of four goats, contained antibody titers of 1:16 or greater. Most of the reacting cattle sera were from Ibapah, although of eight tested from Logan, one reacted. The titers ranged from 1:16 to 1:256 in the positive sera, the majority being 1:16 to 1:32. The goat sera were obtained from the Virology Laboratory, University of Utah, and were taken from animals kept in Salt Lake County.

All birds tested (a total of 243) were uniformly negative (less than 1:16) when tested for Q fever antibody. No isolations of C. burnetii were made from bird tissues.

Discussion: Comparing serological and isolation data for the five-year period, it is apparent that the 1960 epizootic of Q fever in the Great Salt Lake Desert region is still subsiding. The primary areas in which the disease agent can still be isolated are in the vicinity of Camelback Mountain, although C. burnetii can be demonstrated in other widely scattered areas, indicating its probable presence as a latent infection among certain rodent species. Outstanding among the rodents that contain Q fever rickettsiae in their tissues, is the chisel-toothed kangaroo rat. In the Camelback Mountain area, this was the only rodent which yielded isolations of the organism during 1960 and 1961. In 1962 this species again yielded several isolations, but it is significant that _C. burnetii_ was also isolated from two other wild animal types, deer mice and a jack rabbit, indicating a probable spread of the disease agent from the original reservoir, and the possible beginning of a new epizootic of the disease. One agent which may be responsible for this spread of _C. burnetii_ is the flea, since an isolation of the organism was made from a pool of these ectoparasites taken from deer mice and pinyon mice trapped in the South Cedar Mountain area. This is the first isolation of _C. burnetii_ from an ectoparasite since 1960, the year of the proposed Q fever epizootic, and it, too, may be indicative of a reactivation of the disease in the wildlife. A separate investigation (Sidwell, 1963)[26] has shown that an infection of _C. burnetii_ can become latent in animals to the point of being not readily detectable in tissues. These latent infections were shown to be reactivated by irradiation, injections of cortisone, and pregnancy. The infection reactivation resulted in a spread of _C. burnetii_ to non-infected animals. Fecal material, urine, and blood were shown to be infective in the infection-reactivated animals.

The lack of correlation between serology and isolations can be explained in two ways. First, most antibody titers demonstrated in wild animal sera are from 1:16 to 1:64. It has been shown that in some animal sera (pinyon mice, deer mice, and desert wood rats) nonspecific titers of 1:16 and occasionally 1:32, are observed.[27] In other animals (meadow mice, Ord kangaroo rats), a Q fever antibody titer of 1:8 or greater is apparently specific and

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26. Sidwell, R. W. 1963. Experimental studies of latent Q fever infections. PH.D. thesis, Dept. of Microbiology, Univ. of Utah, Salt Lake City, Utah.

27. Sidwell, R. W. and L. P. Gebhardt. 1962. Q fever antibody response in native rodents of Utah. J. Immunology, 89: 318-322.

significant. Many animals trapped have not been investigated in this manner. Thus, although for yearly comparative purposes, titers of 1:16 or greater are significant, it is difficult to obtain correlation between serology and isolation.

A second reason for the lack of correlation observed is the fact that an initial Q fever infection will stimulate an antibody response which may appear weeks later, and persist for long periods of time; while the disease agent may be apparently cleared from all tissue within several weeks (Sidwell and Gebhardt, 1963).[28] Therefore, isolations (except at a low titer) will seldom be made in nature when antibody is present.

Although the birds tested in 1962 were all serologically negative and contained no detectable C. burnetii in their tissues; investigations in other parts of the world have reported seropositive birds and the Q fever organism has been isolated from at least three species (Vest et al., 1961).[29] It is probable that if the disease reaches epizootic proportions, Q fever-positive birds will be found in the Great Salt Lake Desert region.

Q fever antibody detected in cattle sera may be indicative of infection with this agent since livestock are known to be reservoirs of the disease, and latent infections are well known among sheep and cattle (Sidwell,1963).[26] A survey of human sera in Utah (Blank et al., 1958)[30] showed a significant number of reactors in areas associated with livestock. Counties in the vicinity of Dugway Proving Ground were included among the positive areas.

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28. Sidwell, R. W. and L. P. Gebhardt. 1963. The susceptibility of wild rodents to experimental infections with Coxiella burnetii. Amer. J. Trop. Med. and Hyg., 12(3).

29. Vest, E. D., J. B. Bushman, N. J. Marchette, D. D. Parker, D. E. Johnson, D. L. Lundgren, E. L. Morse, R. W. Sidwell, and B. D. Thorpe. 1961. Studies on ecology of Q fever in native fauna in the Great Salt Lake Desert. University of Utah, Ecology and Epizoology Series No. 66.

30. Blank, C. H., R. S. Fraser, and W. W. Smith. 1958. Incidence of Q fever antibodies in Utah. Rocky Mountain Med. Journal. September.

Q FEVER CASES REVEALED BY CF ANTIBODY

TABLE 26. Incidence of Q fever complement fixing antibody* in wild mammal and bird sera per year tested.

Species	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Antrozous pallidus	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Lepus californicus	10/101	10.0	57/510	11.1	154/378	40.7	119/522	22.8	104/486	21.4
Sylvilagus sp.	0/6	-	6/30	20.0	8/41	19.5	6/32	18.8	11/25	44.0
Citellus townsendii	0/0	-	0/0	-	0/4	-	0/0	-	0/3	-
C. variegatus	0/0	-	0/0	-	0/3	-	0/0	-	0/2	-
C. leucurus	4/128	3.1	7/236	3.0	17/245	6.9	5/202	2.5	2/151	3.9
Eutamias minimus	0/13	-	0/53	-	0/17	-	0/17	-	0/47	-
E. dorsalis	0/5	-	1/27	3.7	1/27	3.7	0/2	-	0/7	-
Thomomys bottae	1/1	100.0	0/0	-	1/1	100.0	0/0	-	0/0	-
Perognathus longimembris	1/16	6.3	1/68	1.4	8/58	13.8	8/95	8.4	2/32	6.3
P. parvus	0/39	-	15/97	15.4	10/113	8.8	7/40	17.5	4/62	6.5
P. formosus	1/39	2.6	1/65	1.5	1/110	0.9	4/86	4.6	0/96	-
Microdipodops megacephalus	0/5	-	0/10	-	0/9	-	0/3	-	0/1	-
Dipodomys ordii	14/230	6.2	30/416	7.2	37/214	17.3	19/193	9.8	5/257	1.9
D. microps	22/370	6.0	22/406	5.4	122/327	37.3	54/276	19.6	5/173	2.9
Reithrodontomys megalotis	1/33	3.1	9/102	8.8	7/44	15.9	10/45	22.2	2/84	2.4
Peromyscus crinitus	0/23	-	3/75	4.0	7/24	29.2	6/41	14.6	1/25	4.0
P. maniculatus	6/278	2.2	63/957	6.5	126/499	25.3	54/453	11.9	81/1017	8.0
P. truei	0/13	-	4/139	2.8	11/67	16.4	5/71	7.0	3/65	4.6
Onychomys leucogaster	2/4	50.0	1/8	12.5	1/6	16.7	2/6	33.3	2/5	40.0
Neotoma lepida	2/65	3.1	5/53	9.4	15/53	28.2	10/45	22.2	0/38	-
N. cinerea	0/1	-	0/0	-	0/0	-	0/0	-	0/0	-
Ondatra zibethicus	0/0	-	0/1	-	0/0	-	0/4	-	0/0	-
Microtus sp.	0/0	-	0/4	-	0/2	-	0/7	-	0/2	-
Mus musculus	0/4	-	0/1	-	1/1	100.0	0/1	-	0/0	-
Erethizon dorsatum	0/0	-	0/1	-	0/0	-	0/0	-	0/0	-
Canis latrans	0/0	-	0/1	-	0/2	-	0/0	-	0/2	-
Vulpes macrotis	0/0	-	0/1	-	2/2	100.0	0/0	-	0/2	-
Taxidea taxus	0/0	-	0/4	-	0/0	-	0/0	-	0/1	-
Spilogale gracilis	0/0	-	0/1	-	0/0	-	0/0	-	0/1	-
Lynx rufus	0/0	-	0/3	-	0/0	-	0/1	-	0/0	-
Felis catus	0/0	-	0/6	-	0/1	-	0/1	-	0/2	-
Odocoileus hemionus	0/0	-	7/15	46.6	3/17	17.6	3/19	15.8	5/21	23.8

TABLE 26 (continued) AVES

Species	1958 Pos/Total	%	1959 Pos/Total	%	1960 Pos/Total	%	1961 Pos/Total	%	1962 Pos/Total	%
Buteo jamaicensis Red-tailed hawk	0/0	-	0/2	-	0/0	-	0/0	-	0/0	-
Aquila chrysaetos Golden eagle	0/0	-	0/2	-	0/0	-	0/0	-	0/0	-
Recurvirostra americana Avocet	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Columba livia Domestic pigeon	0/0	-	0/3	-	0/0	-	0/0	-	0/5	-
Zenaidura macroura Mourning dove	0/0	-	0/0	-	0/0	-	0/0	-	0/18	-
Colaptes cafer Flicker	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Sayornis saya Say's phoebe	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Eremophila alpestris Horned lark	0/0	-	0/0	-	0/0	-	0/0	-	0/64	-
Aphelocoma coerulescens Scrub jay	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Corvus corax American raven	0/0	-	0/7	-	0/0	-	0/0	-	0/0	-
Parus inornata Gray titmouse	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Oreoscoptes montanus Sage thrasher	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Turdus migratorius Robin	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Lanius ludovicianus Great Basin shrike	0/0	-	0/0	-	0/0	-	0/0	-	0/32	-
Sturnus vulgaris Starling	0/0	-	0/0	-	0/0	-	0/0	-	0/9	-
Passer domesticus English sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Xanthocephalus xanthocephalus Yellow-headed blackbird	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-

TABLE 26. (Continued). AVES

Species	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Agelaius phoeniceus										
Red wing	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Euphagus cyanocephalus										
Blackbird	0/0	-	0/1	-	0/0	-	0/0	-	0/3	-
Molothrus ater										
Cowbird	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Carpodacus mexicanus										
House finch	0/0	-	0/0	-	0/0	-	0/0	-	0/12	-
Pooecetes gramineus										
Western vesper sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/7	-
Passerculus sandwichensis										
Nevada savannah sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Chondestes grammacus										
Western lark sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Amphispiza sp.										
Sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/13	-
Spizella breweri										
Brewer sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Melospiza melodia										
Mountain song sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Zonotrichia leucophrys										
Gambel sparrow	0/0	-	0/2	-	0/0	-	0/0	-	0/6	-
Anthus spraguei										
Pipit	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Bubo virginianus										
Horned owl	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Spinus tristis										
Pale goldfinch	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Meleagris gallopavo										
Domestic turkey	0/0	-	0/0	-	0/0	-	0/0	-	0/27	-
Pica pica										
Magpie	0/0	-	0/0	-	0/0	-	0/0	-	0/8	-
Total	64/1374	4.7	232/3307	7.0	532/2265	23.5	312/2162	14.4	227/2851	8.9

* Titers of 1:16 or greater

TISSUE-INDUCED Q FEVER CF ANTIBODY TITERS 1958-1962

TABLE 27. Incidence of Coxiella burnetii in wildlife tissues, as determined by positive Q fever complement fixation antibody titers in indicator guinea pigs and hamsters.* Indicated per year tested.

	1958		1959		1960		1961		1962	
Species	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Antrozous pallidus	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Lepus californicus	2/228	0.9	2/442	0.5	8/372	2.2	2/401	0.5	3/439	6.8
Sylvilagus sp.	0/8	-	0/0	-	2/36	5.6	0/23	-	1/27	3.7
Citellus townsendii	0/0	-	0/0	-	1/5	20.0	0/0	-	0/3	-
C. variegatus	0/0	-	0/0	-	0/2	-	0/0	-	0/3	-
C. leucurus	1/212	0.5	2/221	0.9	0/261	-	0/217	-	0/153	-
Eutamias minimus	0/44	-	0/47	-	1/23	4.3	0/42	-	0/55	-
E. dorsalis	0/14	-	0/20	-	0/34	-	0/1	-	0/7	-
Thomomys bottae	0/1	-	0/0	-	1/1	100.0	0/0	-	0/0	-
Perognathus longimembris	0/88	-	2/85	2.3	0/68	-	0/113	-	1/58	1.7
P. parvus	0/117	-	0/89	-	0/124	-	0/59	-	0/68	-
P. formosus	0/71	-	0/62	-	1/121	0.8	0/98	-	0/108	-
Microdipodops megacephalus	0/15	-	0/5	-	0/10	-	0/6	-	0/0	-
Dipodomys ordii	3/607	0.5	1/250	0.4	1/236	0.4	1/229	0.4	0/300	-
D. microps	3/683	0.4	2/249	1.6	16/339	4.7	11/307	3.6	7/181	3.9
Reithrodontomys megalotis	0/60	-	0/106	-	0/52	-	0/51	-	1/94	1.1
Peromyscue crinitus	0/42	-	0/80	-	0/27	-	0/45	-	0/28	-
P. maniculatus	0/752	-	0/611	-	1/541	0.2	2/483	0.4	6/1100	0.5
P. truei	0/27	-	1/134	0.7	0/73	-	0/75	-	0/70	-
Onychomys leucogaster	0/10	-	0/8	-	0/6	-	0/6	-	0/5	-
Neotoma lepida	3/98	3.1	0/46	-	0/53	-	0/45	-	0/37	-
N. cinerea	0/1	-	o/1	-	0/0	-	0/0	-	0/0	-
Ondatra zibethicus	0/0	-	0/0	-	0/0	-	0/8	-	0/0	-
Microtus sp.	0/0	-	0/4	-	0/2	-	0/8	-	0/5	-
Mus musculus	0/0	-	0/0	-	0/1	-	0/1	-	0/0	-
Erethizon dorsatum	0/3	-	0/3	-	0/0	-	0/1	-	0/0	-
Canis latrans	0/0	-	1/2	50.0	0/0	-	0/0	-	0/0	-
Vulpes macrotis	0/2	-	0/0	-	0/1	-	0/1	-	0/0	-
Taxidea taxus	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Spilogale gracilis	0/2	-	0/0	-	0/0	-	0/0	-	0/1	-
Lynx rufus	0/0	-	0/0	-	0/0	-	0/0	-	0/0	-
Felis catus	0/0	-	0/6	-	0/1	-	0/1	-	0/2	-
Odocoileus hemionus	0/0	-	0/0	-	0/0	-	0/0	-	0/5	-

TABLE 27. (Continued) - <u>AVES</u>

Species	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
<u>Recurvirostra americana</u>										
Avocet	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
<u>Columba livia</u>										
Domestic pigeon	0/0	-	0/0	-	0/0	-	0/2	-	0/5	-
<u>Zenaidura macroura</u>										
Mourning dove	0/0	-	0/0	-	0/0	-	0/0	-	0/20	-
<u>Colaptes cafer</u>										
Flicker	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
<u>Sayornis saya</u>										
Say s phoebe	0/0	-	0/0	-	0/0	-	0/0	-	0/6	-
<u>Eremophila alpestris</u>										
Horned lark	0/0	-	0/0	-	0/0	-	0/0	-	0/89	-
<u>Aphelocoma coerulescens</u>										
Scrub jay	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
<u>Corvus corax</u>										
American raven	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
<u>Parus inornatus</u>										
Gray titmouse	0/0	-	0/0-	-	0/0	-	0/0	-	0/6	-
<u>Oreoscoptes montanus</u>										
Sage thrasher	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
<u>Turdus migratorius</u>										
Robin	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
<u>Lanius ludovicianus</u>										
Great Basin shrike	0/0	-	0/0	-	0/0	-	0/0	-	0/34	-
<u>Sturnus vulgaris</u>										
Starling	0/0	-	0/0	-	0/0	-	0/0	-	0/11	-
<u>Passer domesticus</u>										
English sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/5	-
<u>Sturna neglecta</u>										
Meadow lark	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
<u>Xanthocephalus xanthocephalus</u>										
Yellow headed blackbird	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
<u>Agelaius phoeniceus</u>										
Redwing	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-

TABLE 27. (Continued) - AVES

Species	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Euphagus cyanocephalus										
Blackbird	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Molothrus ater										
Cowbird	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Hesperiphona vespertina										
Grosbeak	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Carpodacus mexicanus										
House finch	0/0	-	0/0	-	0/0	-	0/0	-	0/14	-
Pooecetes gramineus										
Western vesper sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/7	-
Passerculus sandwichensis										
Nevada savannah sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Chondestes grammacus										
Western lark sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Amphispiza sp.										
Sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/12	-
Junco oreganus										
Junco	0/0	-	0/0	-	0/0	-	0/0	-	0/5	-
Spizella breweri										
Brewer sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/6	-
Melospiza melodia										
Mountain song sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Zonotrichia leucophrys										
Gambel's sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/7	-
Anthus spraguei										
Pipit	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Spinus tristis										
Pale goldfinch	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Chlorura chlorura										
Green-tailed towhee	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Amphispiza belli										
Sage sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Total	12/3085	0.4	12/2471	0.5	32/2389	1.3	16/2224	0.7	19/3020	0.6

*Guinea pigs bled 42 days after tissue inoculation through 1959; 28 days after inoculation, beginning 1960.

DISTRIBUTION OF Q FEVER CASES, 1958-1962

TABLE 28. Distribution of Q fever according to area in Utah, as determined by positive complement fixation antibody titers in wild mammals and birds. Indicated per year tested.*

Area	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Callao	4/94	4.3	33/367	9.8	34/152	22.4	75/315	23.8	60/265	22.6
Camelback Mountain	2/68	2.9	2/93	2.1	46/147	31.3	6/64	9.4	10/224	4.5
Cedar City	0/0	-	3/65	4.6	0/0	-	0/0	-	0/0	-
CD 22	4/83	4.8	1/20	5.0	15/67	22.4	0/0	-	0/0	-
Clover	0/0	-	11/144	7.6	0/0	-	7/33	21.2	5/81	6.2
Deep Creek	0/0	-	1/1	100.0	17/48	35.4	9/27	33.3	2/31	6.5
Duchesne	0/0	-	3/65	4.6	0/0	-	0/0	-	0/0	-
Dugway Mountain	0/0	-	0/18	-	13/57	22.8	0/1	-	1/9	11.1
Dugway Valley	8/72	11.1	2/51	3.9	6/30	20.0	0/27	-	1/32	3.1
East Wendover	0/0	-	0/0	-	5/20	25.0	1/15	6.6	1/30	3.3
Fillmore	0/0	-	5/70	7.1	0/0	-	0/0	-	0/0	-
Fish Springs	2/46	4.8	11/43	25.5	20/73	27.4	16/112	14.3	3/70	4.3
Fountain Green	0/0	-	0/0	-	0/0	-	1/3	33.3	0/0	-
Gandy	0/0	-	0/18	-	6/17	35.3	9/24	37.5	4/24	16.7
Gold Hill	4/132	3.0	22/164	13.4	21/102	20.6	39/146	26.7	14/135	10.4
Government Creek	0/3	-	18/454	4.0	7/54	12.9	18/124	14.5	12/273	4.4
GPI-3	0/7	-	0/0	-	27/117	23.1	5/50	10.0	1/26	3.8
Granite Mountain	0/21	-	0/35	-	10/48	20.8	0/27	-	5/111	4.5
Grouse Creek	0/0	-	0/0	-	7/8	87.5	2/13	15.4	0/13	-
Hanksville	0/0	-	0/4	-	0/0	-	0/0	-	0/0	-
Johnson Pass	0/0	-	4/37	10.8	0/2	-	0/24	-	10/104	9.6
Little Davis Mountain	3/49	6.1	9/122	7.3	20/60	33.3	15/137	10.9	25/262	9.5
Logan	0/0	-	0/0	-	15/80	18.8	0/0	-	0/27	-
Lookout Pass	0/0	-	4/45	8.8	8/77	10.4	1/40	2.5	7/75	9.3
Lucin	0/0	-	0/0	-	4/4	100.0	0/10	-	1/5	20.0
Manti	0/0	-	0/0	-	0/0	-	0/0	-	2/4	50.0
Montello	0/0	-	0/0	-	3/7	42.8	0/3	-	0/7	-
North Cedar Mountain	0/0	-	0/0	-	6/54	11.1	0/25	-	0/0	-
North Skull Valley	8/88	9.1	12/240	5.0	28/133	36.1	9/42	21.4	8/84	9.5

TABLE 28 (Continued).

Area	1958 Pos/Total	1958 %	1959 Pos/Total	1959 %	1960 Pos/Total	1960 %	1961 Pos/Total	1961 %	1962 Pos/Total	1962 %
North Wendover	17/395	4.3	35/196	17.8	5/72	6.9	0/49	-	1/28	3.6
Old River Bed	2/24	8.3	7/288	2.4	27/60	45.0	5/30	16.7	0/66	-
Payson	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Roosevelt	0/0	-	0/0	-	0/0	-	0/3	-	0/1	-
Settlement Canyon	0/0	-	0/0	-	0/0	-	0/7	-	0/0	-
Sheeprock Mountain	0/0	-	0/1	-	0/0	-	0/0	-	0/0	-
Simpson Mountain	0/0	-	1/18	5.5	3/8	37.5	2/45	4.4	4/38	10.5
South Cedar Mountain	4/148	2.7	8/279	2.8	15/182	8.2	9/202	4.5	16/249	6.4
South Skull Valley	0/0	-	3/47	6.3	19/66	28.8	12/85	14.1	4/111	3.6
South Wendover	0/0	-	17/104	16.3	2/13	15.4	3/45	6.8	1/25	4.0
South Willow	0/0	-	3/30	10.0	0/0	-	0/0	-	0/0	-
Test Grid	2/98	2.0	1/36	2.7	13/61	21.3	2/39	5.1	4/67	5.9
Trout Creek	1/12	8.3	1/24	4.1	65/200	32.5	41/198	20.7	6/93	6.5
Vernon	0/0	-	1/106	0.9	0/37	-	2/34	5.9	8/46	17.4
West Wendover	0/0	-	0/0	-	28/113	24.8	9/105	8.6	2/52	3.8
Wig Mountain	1/11	9.1	14/127	13.2	14/58	24.1	13/58	22.4	9/146	6.2
Wildcat Mountain	0/0	-	1/24	4.1	3/38	7.9	0/0	-	0/36	-
Totals	64/1364	4.7	232/3307	7.0	532/2265	23.5	312/2162	14.4	227/2851	8.0

* Titers of 1:16 or greater.

DISTRIBUTION OF Q FEVER CASES INDICATED BY TISSUE-INOCULATIONS

TABLE 29. Distribution according to area of Coxiella burnetii as determined by positive complement fixation antibody titers in wild mammal and bird tissue-inoculated guinea pigs.* Listed by year tested.

Area	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Callao	1/187	0.5	3/371	0.8	3/145	2.1	2/300	0.7	1/238	0.4
Camelback Mountain	0/88	-	0/84	-	8/154	5.2	3/66	4.5	10/246	4.0
CD 22	1/110	0.9	0/20	-	0/68	-	0/0	-	0/0	-
Cedar City	0/0	-	0/64	-	0/0	-	0/0	-	0/0	-
Clover	0/85	-	0/72	-	0/0	-	0/34	-	0/88	-
Deep Creek	0/0	-	0/0	-	2/49	4.1	0/24	-	0/30	-
Duchesne	0/0	-	0/30	-	0/2	-	0/0	-	0/0	-
Dugway Mountain	0/0	-	0/23	-	0/60	-	0/1	-	0/9	-
Dugway Valley	1/82	1.2	2/72	2.7	0/31	-	1/51	2.0	1/34	2.9
East Wendover	0/0	-	0/0	-	0/23	-	0/16	-	0/36	-
Easy Area	0/11	-	0/0	-	0/0	-	0/0	-	0/0	-
Fillmore	0/0	-	0/72	-	0/0	-	0/0	-	0/0	-
Fish Springs	1/52	1.9	1/50	2.0	4/86	4.7	2/126	1.6	0/74	-
Gandy	0/0	-	0/14	-	0/21	-	0/10	-	1/24	4.2
Gold Hill	0/216	-	4/179	2.2	2/104	1.9	1/170	0.6	0/140	-
Government Creek	1/90	0.1	0/292	-	3/175	1.7	0/90	-	1/324	0.3
GPI-3	0/0	-	0/0	-	0/0	-	1/57	1.8	0/27	-
Granite Mountain	0/57	-	0/38	-	0/49	-	1/32	3.1	0/118	-
Grouse Creek	0/0	-	0/0	-	0/8	-	0/13	-	0/13	-
Hanksville	0/0	-	0/4	-	0/0	-	0/0	-	0/0	-
Johnson Pass	0/0	-	0/35	-	0/2	-	0/24	-	1/106	0.9
Little Davis Mountain	0/107	-	0/122	-	0/56	-	0/138	-	0/314	-
Logan	0/0	-	0/0	-	0/80	-	0/0	-	0/0	-
Lookout Pass	0/0	-	0/47	-	0/92	-	0/42	-	0/79	-
Lucin	0/0	-	0/0	-	0/4	-	0/10	-	0/4	-
Manti	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Montello	0/0	-	0/0	-	0/7	-	0/4	-	0/8	-
North Cedar Mountain	0/0	-	0/0	-	0/59	-	0/26	-	0/0	-
North Skull Valley	0/244	-	0/132	-	0/136	-	0/44	-	0/87	-

TABLE 29. (Continued).

Area	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
North Wendover	4/582	0.7	1/212	0.4	0/77	-	0/53	-	0/30	-
Old River Bed	0/293	-	0/104	-	0/56	-	1/34	2.9	2/77	2.6
Settlement Canyon	0/0	-	0/0	-	0/0	-	0/7	-	0/0	-
Simpson Mountain	0/12	-	0/3	-	0/8	-	0/48	-	0/42	-
South Cedar Mountain	2/500	0.4	0/49	-	3/194	1.5	0/208	-	1/262	0.4
South Skull Valley	0/15	-	0/29	-	3/72	4.2	1/77	1.3	0/106	-
South Wendover	0/0	-	0/117	-	0/15	-	0/61	-	0/34	-
South Willow	0/0	-	0/29	-	0/0	-	0/0	-	0/0	-
Test Grid	1/125	0.8	0/20	-	3/67	4.5	1/39	2.6	0/68	-
Trout Creek	0/0	-	1/20	5.0	1/218	0.5	1/201	0.5	0/103	-
Utah Lake	0/0	-	0/13	-	0/0	-	0/0	-	0/0	-
Vernon	0/60	-	0/51	-	0/42	-	0/50	-	0/47	-
West Wendover	0/0	-	0/0	-	0/135	-	1/119	0.8	1/58	1.7
Wig Mountain	0/54	-	0/113	-	0/56	-	0/49	-	0/148	-
Wildcat Mountain	0/30	-	0/0	-	0/38	-	0/0	-	0/42	-
Totals	12/3085	0.4	12/2471	0.5	32/2389	1.3	12/2224	0.7	19/3020	0.6

* Guinea pigs bled 42 days after tissue inoculation through 1959; 28 days after inoculation beginning with 1960.

Q FEVER ISOLATIONS

TABLE 30. Summary of data concerning 1962 isolations of Coxiella burnetii.

Strain No.	Species	Host Nos.	Area	Maximum CF Titers Rodent	G.Pig	Hamster
2-7	Reithrodontomys megalotis	2A 51, 52, 58	Government Creek	0	8	32
2-151	Peromyscus maniculatus	2B 204, 205	So. Cedar Mountain	0	256	256
2-439	P. maniculatus	2D 681,682	Old River Bed	0	16	32
2-441	Perognathus longimembris	2D 673, 686	Old River Bed	0	16	64
2-891	Dipodomys microps	2F 1385, 1386	Camelback Mountain	0	64	128
2-897	D. microps	2F 1392, 1425	Camelback Mountain	0	64	64
2-901	P. maniculatus	2F 1397, 1427, 1428	Camelback Mountain	0	32	16
2-913	D. microps	2F 1411, 1420	Camelback Mountain	0	64	16
2-919	D. microps	2F 1421, 1424, 1439	Camelback Mountain	16	64	32
2-1117	Lepus californicus	2H 1667	Camelback Mountain	0	8	16
2-1179	P. maniculatus	2H 1764, 1765	Camelback Mountain	0	16	16
2-1203	P. maniculatus	2H 1779, 1780	Camelback Mountain	0	64	32
2-1205	D. microps	2H 1783, 1784, 1785	Camelback Mountain	16	64	32
2-1207	D. microps	2H 1778, 1802, 1803	Camelback Mountain	0	32	16
2-1309	D. microps	2I 1899, 1935	West Wendover	0	64	64
2-1449	S. audubonii	2J 2135	Johnson Pass	16	32	16
2-1483	P. maniculatus	2J 2167, 2189	Dugway Valley	16	256	128
2-1859	L. californicus	2K 2805, 2806	Callao	0	16	32
2-1867	L. californicus	2K 2838, 2839	Gandy	0	8	8
E-31	FLEAS, from P. maniculatus or P. truei	2C 229, 286, 300, 302, 253, 285	So. Cedar Mountain	0	64	16

Q FEVER INCIDENCE IN ECTOPARASITES

TABLE 31. Incidence of <u>Coxiella burnetii</u> in ectoparasites, per year tested, as indicated by positive CF titers in sub-inoculated guinea pigs,* and hamsters.**

	1958		1959		1960		1961		1962	
Ectoparasites	Pos/Tested	%	Pos/Tested	%	Pos/Tested	%	Pos/Tested	%	Pos/Tested	%
Ticks	0/71	-	0/134	-	9/192	4.7	0/243	-	0/198	-
Fleas	0/73	-	2/112	1.8	6/119	5.0	0/150	-	1/155	0.6
Lice	0/41	-	0/38	-	1/40	2.5	0/37	-	0/75****	-
Mites	0/26	-	1/53	1.9	3/32	9.4	0/36	-	0/19	-

* Guinea pigs bled 42 days after inoculation through 1959; after 28 days, beginning 1960.
** Hamsters employed to isolate organism.
*** Data include 5 tick pools from Pacific birds.
**** Data include 24 lice pools from Pacific birds.

Q FEVER INCIDENCE IN LIVESTOCK

TABLE 32. Incidence of Q fever complement fixing antibody* in livestock sera, per year tested.

	1958		1959		1960		1961		1962	
Animal	Pos/Tested	%	Pos/Tested	%	Pos/Tested	%	Pos/Tested	%	Pos/Tested	%
Pigs	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Cattle	0/176	-	91/1964	4.6	13/74	17.6	0/9	-	12/247	4.9
Sheep	0/0	-	0/196	-	0/1	-	0/0	-	0/5	-
Goats	0/0	-	0/0	-	0/0	-	0/0	-	1/4	25.0

* Titers of 1:16 or greater.

Rocky Mountain spotted fever (*Rickettsia rickettsii*): The incidence of Rocky Mountain spotted fever (RMsf) in wildlife has been difficult to ascertain in past reports. Serologically, the greatest occurrence of RMsf antibody was observed in 1959, but the number of seropositives has been continually decreasing since that time. This year was no exception, with fewer seropositives being demonstrated than in previous years, although more animals were trapped. A greater incidence of RMsf antibody was noted in sera from tissue and ectoparasite - challenged guinea pigs in 1960; these numbers have also been continually decreasing since then, including this past year (1962).

Methods: The serological test for RMsf is a CF test employing soluble type antigen obtained from Lederle Laboratories. The technique for the test was the same as described in this report for Q fever.

Attempts to isolate *R. rickettsii* consisted of intraperitoneal injection of tissue or ectoparasite pools into *Microtus montanus* and guinea pigs, both quite susceptible to the rickettsiae, and sacrifice of these animals at varying times after injection. Lung, liver, kidney, spleen, and testes were removed from each animal and stored at dry ice temperatures. The tissues to be injected into *Microtus* and guinea pigs were selected on the basis of a 1:64 or greater RMsf CF titer induced in routinely tissue- or ectoparasite-injected indicator guinea pigs. Work with injection of embryonated hen's eggs with tissue or ectoparasites, in past years, has yielded inconclusive results, and for this reason the above procedure was initiated.

Results: A total of 2,851 wild mammal and bird sera were tested for the presence of RMsf CF antibody. Results of these tests are shown in Tables 33 and 34, according to animal species and area, respectively. Of the total tested, 288 (10.1%) were positive at a titer of 1:16 or greater, a decrease of 7.5% from 1961.

Several wild animal species (jack rabbits, deer mice, chisel-toothed kangaroo rats, Great Basin pocket mice, cottontails, and grasshopper mice) were seropositive more frequently than others. Among the birds tested, one horned lark and one black-throated sparrow were seropositive. Twenty-eight areas yielded reactive animals. These were widely scattered, with no outstanding foci of infection being apparent. No areas which had not contained seropositive animals in previous years were implicated in 1962.

Tissue of 101 of the 3,020 wild mammals and birds tested, were considered infected with R. rickettsii, as indicated by CF titers of 1:16 or greater in inoculated guinea pigs. The data concerning the infected tissues are indicated in Tables 35 and 36, according to species and area, respectively.

Thirty-seven of 198 tick pools, 11 of 155 flea pools, five of 75 louse pools, and one of 19 mite pools incited RMsf titers in injected guinea pigs (Table 37). Compared with 1961, this was a decrease of positives in all but mites. No mites were found positive in 1961. A breakdown of the ectoparasite data according to area is shown in Table 38.

Livestock tested for RMsf antibody included two pigs, 247 cattle, five sheep and four goats. Of these, one cattle serum sample from Grantsville had a RMsf titer of 1:16, and two goat sera from Salt Lake County were also 1:16. A five-year summary of the incidence of RMsf antibody in livestock sera is compiled in Table 39.

Discussion: Experiments have been conducted to determine the significance of RMsf CF antibody titers in various species of wildlife (ECA, p.25). Sera from E. minimus, C. leucurus, R. megalotis, P. formosus, M. montanus, D. ordii, and C. latrans have shown no nonspecific fixation of complement in the presence of RMsf antigen. The sera of O. leucogaster, P. maniculatus, and S. audubonii, were frequently found to be anticomplementary. Studies have not been made of the possibility of nonspecific fixation of complement by the sera of other species of wildlife.

All titers observed may be important statistically, however, when comparing results in the same species or area each year. A marked increase or decrease in the frequency of seropositive animals would then be indicative of a fluctuation of the incidence of the disease in such a population. It is for this purpose that the data are presented for a five-year period.

Results of tissue and ectoparasite challenge of guinea pigs are also difficult to interpret because of nonspecific complement fixation by the sera of normal guinea pigs in the presence of RMsf antigen. A complete discussion of this problem was presented in the 1960 Annual Report.[16] It may be concluded, however, that there have been no virulent strains of R. rickettsii present in the tissue samples examined.

SPOTTED FEVER CF ANTIBODY IN WILD ANIMALS

TABLE 33. Incidence of Rocky Mountain spotted fever complement fixing antibody* in wildlife sera per year tested.

Species	1958 Pos/Total	1958 %	1959 Pos/Total	1959 %	1960 Pos/Total	1960 %	1961 Pos/Total	1961 %	1962 Pos/Total	1962 %
Antrozous pallidus	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Lepus californicus	9/101	9.0	269/510	52.7	153/378	40.5	224-522	42.9	170/486	35.0
Sylvilagus nuttallii	0/0	-	2/4	50.0	0/1	-	1/2	50.0	0/0	-
S. audubonii	0/6	-	4/26	15.0	6/40	15.0	7/30	23.3	8/25	32.0
Citellus townsendii	0/0	-	0/0	-	0/4	-	0/2	-	0/3	-
C. variegatus	0/0	-	0/0	-	1/3	33.3	0/0	-	0/2	-
C. leucurus	14/128	10.9	79/236	33.0	43/245	17.6	43/202	21.3	9/151	6.0
Eutamias minimus	0/13	-	3/53	5.6	1/17	5.9	2/17	11.8	1/47	2.1
E. dorsalis	1/5	20.0	7/27	25.9	0/27	-	0/2	-	0/7	-
Thomomys bottae	0/1	-	0/0	-	0/0	-	0/0	-	0/0	-
Perognathus longimembris	2/16	12.5	5/68	7.3	4/58	6.9	4/95	4.2	0/32	-
P. parvus	0/39	-	14/97	14.4	3/113	2.6	7/40	17.5	8/62	12.9
P. formosus	0/39	-	9/65	13.8	0/110	-	4/86	4.6	0.96	-
Microdipodops megacephalus	0/5	-	1/10	10.0	0/9	-	0/4	-	0/1	-
Dipodomys ordii	17/230	7.4	83/416	19.9	35/214	16.4	23/193	11.9	3/257	1.2
D. microps	40/370	10.8	88/406	21.6	52/327	15.9	22/276	8.0	11/173	6.4
Reithrodontomys megalotis	4/33	12.2	9/102	8.8	1/44	2.3	1/45	2.2	1/84	1.2
Peromyscus crinitus	0/23	-	15/75	20.0	4/24	16.7	0/41	-	0/25	-
P. maniculatus	20/278	7.2	176/957	18.3	49/499	9.8	30/453	6.6	70/1017	6.9
P. truei	1/13	7.7	28/139	14.7	2.67	3.0	3/71	4.2	1/65	1.5
Onychomys leucogaster	2/4	50.0	0/8	-	0/6	-	2/6	33.3	2/5	40.0
Neotoma lepida	2/65	3.1	16/53	20.1	7/53	13.2	6/45	13.3	0/38	-
N. cinerea	0/1	-	0/0	-	0/1	-	0/0	-	0/0	-
Ondatra zibethicus	0/0	-	0/1	-	0/0	-	0/4	-	0/0	-
Microtus sp.	0/0	-	0/4	-	0/2	-	0/7	-	0/2	-
Mus musculus	0/4	-	0/1	-	1/1	100.0	0/1	-	0/0	-
Lynx rufus	0/0	-	0/3	-	0/0	-	0/1	-	0/0	-
Felis catus	0/0	-	0/6	-	0/1	-	0/1	-	0/2	-
Canis latrans	0/0	-	1/3	33.3	0/1	-	0/0	-	0/2	-
Odocoileus hemionus	0/0	-	0/15	-	1/17	5.9	0/19	-	2/21	9.5
Erethizon dorsatum	0/0	-	0/1	-	0/0	-	0/0	-	0/0	-
[illegible]	0/0	-	0/1	-	0/2	-	0/0	-	0/2	-

TABLE 33. (Continued) - AVES

Species	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Buteo jamaicensis										
Red-tailed hawk	0/0	-	0/2	-	0/0	-	0/0	-	0/0	-
Aquila chrysaetos										
Golden eagle	0/0	-	0/2	-	0/1	-	0/0	-	0/0	-
Recurvirostra americana										
Avocet	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Columba livia										
Domestic pigeon	0/0	-	0/3	-	0/0	-	0/3	-	0/5	-
Zenaidura macroura										
Mourning dove	0/0	-	0/0	-	0/0	-	0/0	-	0/18	-
Colaptes cafer										
Flicker	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Sayornis saya										
Say's phoebe	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Eremophila alpestris										
Horned lark	0/0	-	0/0	-	0/0	-	0/0	-	1/64	1.6
Aphelocoma coerulescens										
Scrub jay	0/0	-	0/0	-	0/0	-	0/1	-	0/2	-
Corvus corax										
American raven	0/0	-	0/7	-	0/0	-	0/0	-	0/0	-
Parus inornatus										
Gray titmouse	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Oreoscoptes montanus										
Sage thrasher	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Turdus migratorius										
Robin	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Lanius ludovicianus										
Great Basin shrike	0/0	-	0/0	-	0/0	-	0/0	-	0/32	-
Sturnus vulgaris										
Starling	0/0	-	0/0	-	0/0	-	0/1	-	0/9	-
Passer domesticus										
English sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Xanthocephalus xanthocephalus										
Yellow-headed blackbird	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Agelaius phoeniceus										
Red wing	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-

TABLE 33. (Continued) - AVES

Species	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Euphagus cyanocephalus										
Blackbird	0/0	-	0/1	-	0/0	-	0/0	-	0/3	-
Molothrus ater										
Cowbird	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Carpodacus mexicanus										
House finch	0/0	-	0/0	-	0/0	-	0/0	-	0/12	-
Pooecetes gramineus										
Western vesper sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/7	-
Passerculus sandwichensis										
Nevada savannah sparoow	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Chondestes grammacus										
Western lark sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Amphispiza sp.										
Sparrow	0/0	-	0/0	-	0/0	-	0/0	-	1/13	7.7
Spizella breweri										
Brewer sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Melospiza melodia										
Mountain song sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Zonotrichia leucophrys										
White-crowned sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/6	-
Zonotrichia gambelii										
Gambel sparrow	0/0	-	0/2	-	0/0	-	0/0	-	0/0	-
Anthus spraguei										
Pipit	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Bubo virginianus										
Horned owl	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Spinus tristis										
Pale goldfinch	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Meleagris gallopavo										
Domestic turkey	0/0	-	0/0	-	0/0	-	0/0	-	0/27	-
Pica pica										
Magpie	0/0	-	0/0	-	0/0	-	0/0	-	0/8	-
Totals	113/1364	8.28	809/3390	24.4	363/2265	16.0	379/2167	17.4	288/2851	10.1

*** Titers of 1:16 or greater**

DISTRIBUTION OF SPOTTED FEVER IN WILD ANIMALS

TABLE 34. Distribution of Rocky Mountain spotted fever according to areas in Utah, as determined by positive complement fixation antibody in native mammals and birds. Indicated per year tested.

Area	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Callao	9/94	9.6	86/367	23.4	26/152	17.1	97/315	30.8	70/265	26.4
Camelback Mountain	2/68	2.9	1/93	1.0	16/147	10.9	4/64	6.3	15/224	6.7
CD 22	6/83	7.2	3/30	15.0	0/67	-	0/0	-	0/0	-
Cedar City	0/0	-	18/65	27.6	0/0	-	0/0	-	0/0	-
Clover	0/0	-	24/144	16.6	0/0	-	0/33	-	7/81	8.6
Deep Creek	1/9	11.0	1/1	100.0	8/48	16.7	8/27	29.6	1/31	3.2
Duchesne	0/0	-	1/38	2.6	0/0	-	0/0	-	0/0	-
Dugway Mountain	0/0	-	5/18	27.7	17/57	29.8	0/1	-	1/9	11.1
Dugway Valley	19/72	26.4	9/51	17.6	1/30	3.3	0/7	-	2/32	6.3
East Wendover	0/0	-	0/0	-	2/20	10.0	0/15	-	0/30	-
Fillmore	0/0	-	11/70	15.7	0/0	-	0/0	-	0/0	-
Fish Springs	1/46	2.2	18/43	41.8	11/73	15.1	12/112	10.7	14/70	20.0
Fountain Green	0/0	-	0/0	-	0/0	-	0/3	-	0/0	-
Gandy	0/0	-	4/18	22.2	0/17	-	14/24	58.3	2/24	8.3
Gold Hill	11/132	8.3	95/164	57.9	13/102	12.7	25/146	17.1	16/135	14.9
Government Creek	0/3	-	96/454	21.1	4/54	7.4	45/124	36.3	18/273	6.6
GPI-3	0/7	-	0/0	-	10/117	8.5	2/50	4.0	1/26	3.8
Granite Mountain	0/21	-	8/35	22.8	10/48	20.8	0/27	-	3/111	2.7
Grouse Creek	0/0	-	0/0	-	6/8	75.0	4/13	30.8	5/13	38.5
Hanksville	0/0	-	0/4	-	0/0	-	0/0	-	0/0	-
Johnson Pass	0/0	-	5/37	13.5	1/2	50.0	0/24	-	2/104	1.9
Little Davis Mountain	4/49	8.1	31/122	25.4	19/60	31.7	28/137	20.4	30/262	11.4
Logan	0/0	-	0/0	-	3/80	3.8	0/0	-	0/27	-
Lookout Pass	0/0	-	13/45	28.8	3/77	3.9	0/40	-	1/75	1.3
Lucin	0/0	-	0/0	-	4/4	100.0	5/10	50.0	3/5	60.0
Manti	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Montello	0/0	-	0/0	-	2/7	28.6	1/3	33.3	0/7	-

TABLE 34. (Continued).

Area	1958 Pos/Total	1958 %	1959 Pos/Total	1959 %	1960 Pos/Total	1960 %	1961 Pos/Total	1961 %	1962 Pos/Total	1962 %
North Cedar Mountain	0/0	-	0/0	-	1/54	1.9	2/25	8.0	0/0	-
North Skull Valley	6/88	6.8	78/240	32.5	25/133	18.8	3/42	7.1	9/84	10.7
North Wendover	28/395	7.1	80/196	40.8	13/72	18.1	4/49	8.2	1/28	3.6
Old River Bed	4/24	16.7	58/288	20.1	32/60	53.3	9/30	30.0	5/66	7.6
Payson	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Roosevelt	0/0	-	0/0	-	0/0	-	0/3	-	0/1	-
Settlement Canyon	0/0	-	0/0	-	0/0	-	0/7	-	0/0	-
Sheeprock Mountain	0/0	-	0/1	-	0/0	-	0/0	-	0/0	-
Simpson Mountain	0/0	-	3/18	16.6	2/8	25.0	5/45	11.1	2/38	5.3
South Cedar Mountain	17/148	11.5	44/279	15.7	15/182	8.2	1/202	5.2	26/249	10.5
South Skull Valley	0/0	-	12/47	25.5	18/66	27.2	22/85	25.9	6/111	5.4
South Wendover	0/0	-	24/104	23.0	3/13	23.1	2/45	4.4	0/25	-
South Willow	0/0	-	13/30	43.3	0/0	-	0/0	-	0/0	-
Test Grid	2/98	2.0	2/36	5.5	3/61	4.9	0/39	-	6/67	8.9
Trout Creek	1/12	8.3	7/24	29.1	46/200	23.0	48/198	24.2	7/93	7.5
Vernon	0/0	-	7/106	6.6	4/37	10.8	1/34	2.9	6/46	13.0
West Wendover	0/0	-	0/0	-	19/113	16.8	13/105	12.4	8/52	15.4
Wig Mountain	1/11	9.1	52/127	40.9	23/58	39.7	11/58	19.0	21/146	14.4
Wildcat Mountain	0/0	-	0/24	-	3/38	7.9	0/0	-	0/36	-
Totals	113/1364	8.3	809/3309	24.4	363/2265	16.0	379/2162	17.4	288/2851	10.1

TISSUE-INDUCED SPOTTED FEVER CF ANTIBODY IN GUINEA PIGS

TABLE 35. Incidence of Rickettsia rickettsii in wildlife tissues, as determined by positive complement fixation antibody* in indicator guinea pigs.** Indicated per year tested.

Species	1958		1959		1960		1961		1962	
	Pos/Tested	%	Pos/Tested	%	Pos/Tested	%	Pos/Tested	%	Pos/Tested	%
Antrozous pallidus	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Lepus californicus	1/228	0.4	65/442	14.7	71/372	19.1	44/401	11.0	22/439	5.0
Sylvilagus sp.	0/8	-	0/0	-	10/36	27.7	6/23	26.1	3/27	11.1
Citellus townsendii	0/0	-	0/0	-	0/5	-	0/0	-	0/3	-
C. variegatus	0/0	-	0/0	-	1/2	50.0	0/0	-	0/3	-
C. leucurus	2/212	0.9	15/221	6.7	36/261	13.8	19/217	8.8	5/153	3.2
Eutamias minimus	0/44	-	3/47	6.3	5/23	21.7	1/42	2.4	1/55	1.8
E. dorsalis	0/14	-	2/20	10.0	3/34	8.8	0/1	-	0/7	-
Thomomys bottae	0/1	-	0/0	-	0/1	-	0/0	-	0/0	-
Perognathus longimembris	0/88	-	6/85	7.1	10/68	14.7	8/113	7.1	1/58	1.7
P. parvus	0/117	-	0/89	-	10/124	8.1	0/59	-	2/68	2.9
P. formosus	0/71	-	0/62	-	14/121	11.6	3/98	3.1	4/108	3.7
Microdipodops megacephalus	0/15	-	2/5	40.0	2/10	20.0	0/6	-	0/0	-
Dipodomys ordii	8/607	1.3	24/250	10.0	27/236	11.4	12/229	5.2	11/300	3.6
D. microps	7/683	1.0	18/249	7.2	39/339	11.5	10/307	3.3	8/181	4.0
Reithrodontomys megalotis	0/60	-	2/106	1.8	9/52	17.3	2/51	3.9	2/94	2.1
Peromyscus crinitus	0/42	-	4/80	5.0	5/27	18.5	2/45	4.4	3/28	10.7
P. maniculatus	8/752	1.1	35/611	5.7	63/541	11.6	15/483	3.1	31/1100	2.8
P. truei	0/27	-	5/134	3.7	7/73	9.6	2/75	2.7	3/70	4.3
Onychomys leucogaster	0/10	-	0/8	-	2/6	33.3	0/6	-	3/5	60.0
Neotoma lepida	3/98	3.1	3/46	6.5	12/53	22.6	1/45	2.2	1/37	2.7
N. cinerea	0/1	-	0/1	-	0/0	-	0/0	-	0/0	-
Ondatra zibethicus	0/0	-	0/0	-	0/0	-	0/8	-	0/0	-
Microtus sp.	0/0	-	0/4	-	1/2	50.0	0/8	-	0/5	-
Mus musculus	0/0	-	0/0	-	1/1	100.0	0/1	-	0/0	-
Erethizon dorsatum	0/3	-	2/3	66.6	0/0	-	0/1	-	0/0	-
Canis latrans	0/0	-	2/2	100.0	0/0	-	0/0	-	0/0	-
Vulpes macrotis	0/2	-	0/0	-	1/1	100.0	0/1	-	0/0	-
Taxidea taxus	0/0	-	0/0	-	0/0	-	0/0	-	1/1	100.0
Spilogale gracilis	1/2	50.0	0/0	-	0/0	-	0/0	-	0/1	-
Lynx rufus	0/0	-	0/0	-	0/0	-	0/0	-	0/10	-
Felis catus	0/0	-	1/6	16.6	0/1	-	0/1	-	0/2	-
Odocoileus hemionus	0/0	-	2/10	20.0	0/0	-	0/0	-	1/5	20.0

TABLE 35. (Continued) - AVES

Species	1958		1959		1960		1961		1962	
	Pos/Tested	%	Pos/Tested	%	Pos/Tested	%	Pos/Tested	%	Pos/Tested	%
Recurvirostra americana										
Avocet	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Columba livia										
Domestic pigeon	0/0	-	0/0	-	0/0	-	0/2	-	0/5	-
Zenaidura macroura										
Mourning dove	0/0	-	0/0	-	0/0	-	0/0	-	0/20	-
Colaptes cafer										
Flicker	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Sayornis saya										
Say's phoebe	0/0	-	0/0	-	0/0	-	0/0	-	0/6	-
Eremophila alpestris										
Horned lark	0/0	-	0/0	-	0/0	-	0/0	-	3/89	3.4
Aphelocoma coerulescens										
Scrub jay	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Corvus corax										
American raven	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Parus inornatus										
Gray titmouse	0/0	-	0/0	-	0/0	-	0/0	-	0/6	-
Oreoscoptes montanus										
Sage thrasher	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Turdus migratorius										
Robin	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Lanius ludovicianus										
Great Basin shrike	0/0	-	0/0	-	0/0	-	0/0	-	1/34	2.9
Sturnus vulgaris										
Starling	0/0	-	0/0	-	0/0	-	0/0	-	0/11	-
Passer domesticus										
English sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/5	-
Sturna neglecta										
Meadow lark	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Xanthocephalus xanthocephalus										
Yellow headed blackbird	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-

TABLE 35. (Continued). - AVES

Species	1958 Pos/Total	1958 %	1959 Pos/Total	1959 %	1960 Pos/Total	1960 %	1961 Pos/Total	1961 %	1962 Pos/Total	1962 %
Agelaius phoeniceus										
Redwing	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Euphagus cyanocephalus										
Blackbird	0/0	-	0/0	-	0/0	-	0/0	-	1/3	33.3
Molothrus ater										
Cowbird	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Hesperiphona vespertina										
Grosbeak	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Carpodacus mexicanus										
House finch	0/0	-	0/0	-	0/0	-	0/0	-	0/14	-
Pooecetes gramineus										
Western vesper sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/7	-
Passerculus sandwichensis										
Nevada savannah sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Chondestes grammacus										
Western lark sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Amphispiza sp.										
Sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/12	-
Junco oreganus										
Junco	0/0	-	0/0	-	0/0	-	0/0	-	0/5	-
Spizella breweri										
Brewer sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/6	-
Melospiza melodia										
Mountain song sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/3	-
Zonotrichia leucophrys										
White crowned sparrow	0/0	-	0/0	-	0/0	-	0/0	-	0/7	-
Anthus spraguei										
Pipit	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Spinus tristis										
Pale goldfinch	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Chlorura chlorura										
Green-tailed towhee	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Amphispiza belli										
Sage sparrow	9/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Totals	30/3085	1.0	193/2471	7.7	329/2389	13.8	125/2224	5.6	107/3020	3.5

* Titers of 1:16 or greater.

** Guinea pigs bled 42 days after tissue inoculation through 1958; 28 days after, beginning with 1960.

DISTRIBUTION OF SPOTTED FEVER AS INDICATED BY TISSUE INDUCED CF ANTIBODY

TABLE 36. Distribution according to area of Rickettsia rickettsii as determined by positive complement fixation antibody* in wild mammal and bird tissue-inoculated guinea pigs.** Listed per year tested.

Area	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Callao	3/187	1.6	49/371	13.2	13/145	9.0	35/300	11.7	14/238	5.9
Camelback Mountain	0/88	-	4/84	4.7	20/154	13.0	3/66	4.5	2/246	0.8
CD22	0/110	-	0/20	-	11/68	16.2	0/0	-	0/0	-
Cedar City	0/0	-	5/64	7.8	0/0	-	0/0	-	0/0	-
Clover	0/85	-	0/72	-	0/0	-	3/34	8.8	5/88	5.7
Deep Creek	0/0	-	0/0	-	6/49	12.2	0/24	-	1/30	3.3
Duchesne	0/0	-	1/30	3.3	1/2	50.0	0/0	-	0/0	-
Dugway Mountain	0/0	-	0/23	-	12/60	20.0	0/1	-	0/9	-
Dugway Valley	1/82	1.2	13/72	18.0	4/31	12.9	0/51	-	2/34	5.9
East Wendover	0/0	-	0/0	-	3/23	13.0	0/16	-	1/36	2.8
Easy Area	1/11	9.1	0/0	-	0/0	-	0/0	-	0/0	-
Fillmore	0/0	-	1/72	1.3	0/0	-	0/0	-	0/0	-
Fish Springs	1/52	1.9	2/50	4.0	17/86	19.8	4/126	3.2	2/74	2.7
Gandy	0/0	-	1/14	7.1	5/21	23.8	5/10	50.0	0/24	-
Gold Hill	1/216	0.5	27/179	15.0	13/104	12.5	4/170	2.4	3/140	2.1
Government Creek	1/90	1.1	17/292	5.8	24/175	13.7	4/90	4.4	22/324	6.8
GPI-3	0/0	-	0/0	-	0/0	-	9/57	15.8	5/27	18.5
Granite Mountain	0/47	-	1/38	2.6	14/49	28.6	6/32	18.8	6/118	5.1
Grouse Creek	0/0	-	0/0	-	3/8	37.5	0/13	-	1/13	7.7
Hanksville	0/0	-	0/4	-	0/0	-	0/0	-	0/0	-
Johnson Pass	0/0	-	2/35	5.7	1/2	50.0	2/24	8.3	3/106	2.8
Little Davis Mountain	0/107	-	4/122	3.2	9/56	16.1	3/138	2.2	10/314	3.2
Logan	0/0	-	0/0	-	8/80	10.0	0/0	-	0/0	-
Lookout Pass	0/0	-	0/47	-	3/92	3.2	1/42	2.4	2/79	2.5
Lucin	0/0	-	0/0	-	2/4	50.0	0/10	-	0/4	-
Manti	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Montello	0/0	-	0/0	-	1/7	14.2	0/4	-	0/8	-
North Cedar Mountain	0/0	-	0/0	-	8/59	13.6	0/26	-	0/0	-

TABLE 36. (Continued)

Area	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
North Skull Valley	6/244	2.5	1/132	0.7	27/136	19.9	7/44	15.9	5/87	5.7
North Wendover	0/582	-	15/212	7.1	15/77	19.5	2/53	3.8	0/30	-
Old River Bed	5/293	1.7	13/104	12.5	2/56	3.6	4/34	11.8	0/77	-
Settlement Canyon	0/0	-	0/0	-	0/0	-	0/7	-	0/0	-
Simpson Mountain	0/12	-	1/3	33.3	2/8	25.0	0/48	-	2/42	4.8
South Cedar Mountain	9/500	1.8	1/49	2.0	19/194	9.8	12/208	5.8	8/262	3.1
South Skull Valley	2/15	13.6	5/29	17.2	7/72	9.7	7/77	9/1	0/106	-
South Wendover	0/0	-	6/117	5.1	1/15	6.6	2/61	3.3	0/34	-
South Willow	0/0	-	1/29	3.4	0/0	-	0/0	-	0/0	-
Test Grid	0/125	-	3/20	15.0	10/67	14.9	1/39	2.6	6/68	8.8
Trout Creek	0/0	-	2/20	10.0	26/218	11.9	3/201	1.5	1/103	1.0
Utah Lake	0/0	-	0/13	-	0/0	-	0/0	-	0/0	-
Vernon	0/60	-	5/51	9.8	1/42	2.4	1/50	2.0	1/47	2.1
West Wendover	0/0	-	0/0	-	26/135	19.3	2/119	1.7	0/58	-
Wig Mountain	0/54	-	13/113	11.5	9/56	16.1	4/49	8.2	5/148	3.4
Wildcat Mountain	0/30	-	0/0	-	6/38	15.8	0/0	-	0/42	-
Totals	30/2990	1.0	193/2481	7.7	329/2389	13.8	125/2224	5.6	107/3020	3.5

* Titers of 1:16 or greater.

** Guinea pigs bled 42 days after tissue inoculation through 1958; 28 days after, beginning with 1960.

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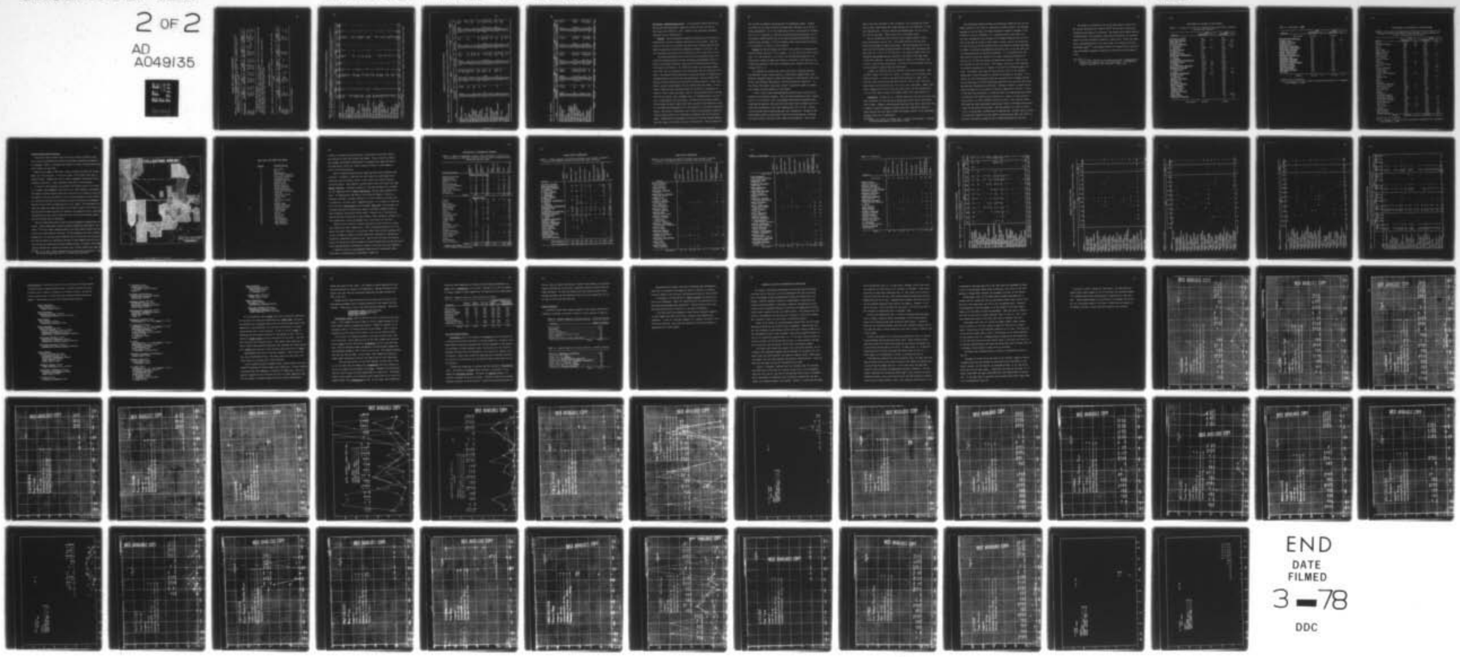

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SPOTTED FEVER INCIDENCE IN ECTOPARASITES

TABLE 37. Incidence of *Rickettsia rickettsii* in ectoparasites, as determined by positive complement fixation antibody titers* in guinea pigs.**. Data expressed as pools of ectoparasites. Indicated per year tested.

	1958		1959		1960		1961		1962	
Ectoparasites	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Ticks	14/71	19.7	24/134	17.9	105/192	54.7	67/243	27.6	37/198***	18.7
Fleas	6/73	8.2	23/112	20.5	32/119	26.9	22/150	14.6	11/155	7.1
Lice	9/41	21.9	9/38	23.7	27/40	67.5	5/37	13.5****	5/75*****	6.7
Mites	2/26	7.6	12/53	22.6	18/32	56.2	0/36	-	1/19	0.5

* Titers of 1:16 or greater
** Guinea pigs bled 42 days after inoculation through 1959; 28 days after, beginning with 1960.
*** Data include 5 tick pools from the Pacific area.
**** One louse pool from the Pacific area induced a 1:16 RMsf titer in guinea pigs.
***** Data include 24 louse pools from Pacific birds.

SPOTTED FEVER IN LIVESTOCK

TABLE 38. Incidence of Rocky Mountain spotted fever antibody* in livestock sera, per year tested.

	1958		1959		1960		1961		1962	
Animal	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Pigs	0/0	-	0/0	-	0/0	-	0/0	-	0/2	-
Cattle	3/176	1.7	83/1964	4.2	1/74	13.5	0/9	-	1/247	0.4
Sheep	0/0	-	5/196	2.6	0/1	-	0/0	-	0/5	-
Goats	0/0	-	0/0	-	0/0	-	0/0	-	2/4	50.0

* Titers of 1:16 or greater.

DISTRIBUTION OF SPOTTED FEVER IN ECTOPARASITES

TABLE 39. Incidence of Rickettsia rickettsii in ectoparasite pools from native animals collected in Utah and Nevada, determined by complement fixation antibody* in indicator guinea pigs.**

Area	Fleas			Ticks			Mites			Lice		
	No. Ectos	No. Pools	Pos/ RMsf	No. Ectos	No. Pools	Pos/ RMsf	No. Ectos	No. Pools	Pos/ RMsf	No. Ectos	No. Pools	Pos/ RMsf
Callao	189	10	-	712	32	16	25	2	-	25	1	1
Camelback Mountain	157	9	3	269	14	6	81	2	-	62	4	
Clover	99	5	-	160	3	1	23	1	-	23	1	1
Deep Creek	-	-	-	66	3	-	-	-	-	67	1	-
Dugway Mountain	-	-	-	51	2	1	-	-	-	-	-	-
Dugway Valley	36	2	-	5	1	-	-	-	-	-	-	-
East Wendover	14	1	-	-	-	-	-	-	-	17	1	-
Fish Springs	21	2	-	126	5	-	36	2	-	58	2	-
Gandy	122	3	-	77	3	-	-	-	-	-	-	-
Gold Hill	164	7	-	498	16	-	-	-	-	10	1	-
Government Creek	217	17	3	503	20	3	18	1	-	105	4	2
GPI-3	74	4	-	-	-	-	-	-	-	183	2	-
Granite Mountain	108	5	1	83	5	-	125	3	-	69	3	-
Grouse Creek	-	-	-	3	1	-	-	-	-	-	-	-
Johnson Pass	111	6	-	40	3	-	151	4	-	14	1	-
Little Davis Mountain	343	16	-	351	9	1	13	1	-	395	7	-
Lookout Pass	188	6	1	5	1	-	353	6	1	29	1	-
Lucin	-	-	-	12	1	-	-	-	-	-	-	-
North Skull Valley	206	7	1	144	7	1	-	-	-	-	-	-
North Wendover	151	4	-	-	-	-	-	-	-	8	1	-
Old River Bed	59	12	-	265	10	1	-	-	-	49	1	-
Simpson Mountain	106	5	-	61	2	-	17	1	-	-	-	-
South Cedar Mountain	213	12	-	128	6	1	122	2	-	37	2	-
South Skull Valley	166	7	-	221	8	1	-	-	-	51	1	-
South Wendover	30	2	-	-	-	-	16	1	-	32	1	-
Test Grid	50	4	2	32	2	-	8	1	-	-	-	-
Trout Creek	30	2	-	412	17	2	4	1	-	118	2	-
Vernon	27	2	-	-	-	-	18	1	-	30	1	-
West Wendover	23	2	-	16	1	-	-	-	-	23	1	-
Wig Mountain	209	7	-	240	11	2	8	1	-	32	1	-
Wildcat Mountain	44	9	-	-	-	-	-	-	-	34	1	-
Pacific Islands	-	-	-	70	4	-	5	1	-	1335	25	1
Totals	3167	168	11	4550	187	37	1023	31	1	2796	66	5

* Titer of 1:16 or greater.

** Guinea pigs bled 42 days after tissue inoculation through 1958; 28 days after, beginning with 1960.

DISTRIBUTION OF SPOTTED FEVER SEROPOSITIVES

Table 40. Distribution of Rocky Mountain spotted fever seropositives in wildlife of western Utah.

	1958		1959		1960		1961		1962	
Area	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
Callao	9/94	9.6	86/367	23.4	26/152	17.1	97/315	30.8	70/265	26.4
Camelback Mountain	2/68	2.9	1/93	1.0	16/147	10.9	4/64	6.3	15/224	6.7
CD22	6/83	7.2	3/20	15.0	0/67	-	0/0	-	0/0	-
Cedar City	0/0	-	18/65	27.6	0/0	-	0/0	-	0/0	-
Clover	0/0	-	24/144	16.6	0/0	-	0/33	-	7/81	8.6
Deep Creek	1/9	11.0	1/1	100.0	8/48	16.7	8/27	29.6	1/31	3.2
Duchesne	0/0	-	1/38	2.6	0/0	-	0/0	-	0/0	-
Dugway Mountain	0/0	-	5/18	27.7	17/57	29.8	0/1	-	1/9	11.1
Dugway Valley	19/72	26.4	9/51	17.6	1/30	3.3	0/7	-	2/32	6.3
East Wendover	0/0	-	0/0	-	2/20	10.0	0/15	-	0/30	-
Fillmore	0/0	-	11/70	15.7	0/0	-	0/0	-	0/0	-
Fish Springs	1/46	2.2	18/43	41.8	11/73	15.1	12/112	10.7	14/70	20.0
Fountain Green	0/0	-	0/0	-	0/0	-	0/3	-	0/0	-
Gandy	0/0	-	4/18	22.2	0/17	-	14/24	58.3	2/24	8.3
Gold Hill	11/132	8.3	95/164	57.9	13/102	12.7	25/146	17.1	16/135	14.9
Government Creek	0/3	-	96/454	21.1	4/54	7.4	45/124	36.3	18/273	6.6
GPI-3	0/7	-	0/0	-	10/117	8.5	2/50	4.0	1/26	3.8
Granite Mountain	0/21	-	8/35	22.8	10/48	20.8	0/27	-	3/111	2.7
Grouse Creek	0/0	-	0/0	-	6/8	75.0	4/13	30.8	5/13	38.5
Hanksville	0/0	-	0/4	-	0/0	-	0/0	-	0/0	-
Johnson Pass	0/0	-	5/37	13.5	1/2	50.0	0/24	-	2/104	1.9
Little Davis Mountain	4/49	8.1	31/122	25.4	19/60	31.7	28/137	20.4	30/262	11.4
Logan	0/0	-	0/0	-	3/80	3.8	0/0	-	0/27	-
Lookout Pass	0/0	-	13/45	28.8	3/77	3.9	0/40	-	1/75	1.3
Lucin	0/0	-	0/0	-	4/4	100.0	5/10	50.0	3/5	60.0
Manti	0/0	-	0/0	-	0/0	-	0/0	-	0/4	-
Montello	0/0	-	0/0	-	2/7	28.6	1/3	33.3	0/7	-
North Cedar Mountain	0/0	-	0/0	-	1/54	1.9	2/25	8.0	0/0	-

Table 40 (Continued).

Area	1958		1959		1960		1961		1962	
	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%	Pos/Total	%
North Skull Valley	6/88	6.8	78/240	32.5	25/133	18.8	3/42	7.1	9/84	10.7
North Wendover	28/395	7.1	80/196	40.8	13/72	18.1	4/49	8.2	1/28	3.6
Old River Bed	4/24	16.7	58/288	20.1	32/60	53.3	9/30	30.0	5/66	7.6
Payson	0/0	-	0/0	-	0/0	-	0/0	-	0/1	-
Roosevelt	0/0	-	0/0	-	0/0	-	0/3	-	0/1	-
Settlement Canyon	0/0	-	0/0	-	0/0	-	0/7	-	0/0	-
Sheeprock Mountain	0/0	-	0/1	-	0/0	-	0/0	-	0/0	-
Simpson Mountain	0/0	-	3/18	16.6	2/8	25.0	5/45	11.1	2/38	5.3
South Cedar Mountain	17/148	11.5	44/279	15.7	15/182	8.2	1/202	5.2	26/249	10.5
South Skull Valley	0/0	-	12/47	25.5	18/66	27.2	22/85	25.9	6/111	5.4
South Wendover	0/0	-	24/104	23.0	3/13	23.1	2/45	4.4	0/25	-
South Willow	0/0	-	13/30	43.3	0/0	-	0/0	-	0/0	-
Test Grid	2/98	2.0	2/36	5.5	3/61	4.9	0/39	-	6/67	8.9
Trout Creek	1/12	8.3	7/24	29.1	46/200	23.0	48/198	24.2	7/93	7.5
Vernon	0/0	-	7/106	6.6	4/37	10.8	1/34	2.9	6/46	13.0
West Wendover	0/0	-	0/0	-	19/113	16.8	13/105	12.4	8/52	15.4
Wig Mountain	1/11	9.1	52/127	40.9	23/58	39.7	11/58	19.0	21/146	14.4
Wildcat Mountain	0/0	-	0/24	-	3/38	7.9	0/0	-	0/36	-
Totals	113/1364	8.3	809/3309	24.4	363/2265	16.0	379/2162	17.4	288/2851	10.0

Psittacosis - Lymphogranuloma group: All psittacosis survey work by the Ecology and Epizoology group stopped at the end of 1958, and did not start again until October 1, 1962. Results to be presented, therefore, represent only a 3-month period.

Methods: Since psittacosis antibody had previously been surveyed in wildlife sera, the test technique used earlier was continued. This consisted of the use of an insoluble type psittacosis antigen obtained from Lederle Laboratories (psittacosis diagnostic antigen No. 2615-31). The test technique was the same as that described in this report for Q fever.

The method employed for the isolation of the psittacosis agent from tissue and ectoparasites was devised following correspondence with Dr. B. Eddie of the Hooper Foundation, University of California Medical Center, San Francisco, California. Dr. Eddie has studied the psittacosis agents since 1930, and is very familiar with the methods used for isolation of the agent. The method devised consisted of injecting tissues or ectoparasites intraperitoneally into white mice and guinea pigs, and sacrificing these animals at times varying up to six weeks following injection. Lung, liver, kidney, spleen, and peritoneal fluid is removed from each animal. Care is taken to observed each sacrificed animal for evidence of enlargement of spleen or liver, excess peritoneal fluid (a sticky gray-white film covering the liver and spleen) and a congested lung; all manifestations of the disease. Serum removed from each animal is tested for psittacosis antibody. Tissue smears are made, lightly heat fixed, stained by the Machiavello method, and examined microscopically for the presence of red-stained elementary bodies. The tissue is submitted to up to three blind passages through laboratory animals before it is considered as infected with the psittacosis agent. Concomitant blind passages of tissue are also made through embryonated hen's eggs via the yolk sac route of inoculation. Yolk sac smears are also stained and examined microscopically for elementary bodies. Tissues are chosen for the above isolation processes when they meet any of the following requirements: (a) if the tissue pool incites a psittacosis CF antibody titer of 1:16 or greater in routinely injected indicator guinea pigs; (b) if the original animal exhibits any of the above mentioned pathological characteristics upon necropsy; (c) if the original animal serum contains psittacosis CF antibody at a titer of 1:16 or greater.

Results: Of 930 wild mammal and 120 bird sera tested, 26 contained psittacosis antibody titers of 1:16 or greater. All but two of the positive sera were 1:16. One serum had a 1:32 titer, and the remaining sample was 1:64. Seropositive animals included jack rabbits, cottontails, rock squirrels, antelope gound squirrels, deer mice, grasshopper mice, domestic cats, deer, and a pigeon (Table 41).

The seropositive animals were taken from Callao, Camelback Mountain, East Wendover, Gandy, Granite Mountain, Johnson Pass, Lookout Pass, North Wendover, Sheeprock Mountain, South Cedar Mountain, South Wendover, Test Grid, Vernon, West Wendover, Wig Mountain, and Wildcat Mountain (Table 42). It was obvious that nearly every area in which a significant number of animals were trapped contained evidence of the disease.

A total of 403 tissue-challenged guinea pig pools were tested for the presence of psittacosis antibody. Forty-two were seropositive,titers ranging from 1:16 to as high as 1:256. One hundred seventy-five ectoparasite-challenged guinea pig pools were also tested for psittacosis antibody, and 16 of these were seropositive, with titers ranging from 1:16 to 1:256. Several saline-injected control guinea pigs were also seropositive. Because of the questionable nature of these results eight of the reacting sera, including one saline control, were sent to Dr. Eddie for confirmation. Four of the eight titers were confirmed by that laboratory; two, including the saline control serum, being higher than those obtained by this laboratory. Of the four remaining sera, two were reported anticomplementary, and two titers could not be confirmed. These results will be discussed later.

The one seropositive bird serum was from a pigeon trapped at GPI-1, with a psittacosis titer of 1:64. The tissue from this bird was given three blind passages through fertile eggs. The third passage yolk sac material was then injected intraperitoneally into white mice, producing antibody titers of 1:32 to 1:64 in their sera. The original pigeon tissue and subsequent egg passage material resulted in the death of the eggs within 5 days after injection. The original material induced a CF antibody titer of 1:32 in the indicator guinea pigs. This was the only confirmed isolation of the psittacosis group during the 1962 period.

A number of livestock sera were tested for psittacosis antibody. They included 5 sheep, 247 cattle and 4 goats. Of these, one of the sheep sera, obtained from Dr. J. Storz at the Utah State University at Logan, had a titer of 1:256; and 29 cattle sera had titers of 1:16 to 1:256. Eleven of these cattle, all with titers of 1:16 or 1:32, were from Ibapah. Eight, with titers ranging from 1:16 to 1:256, were from Callao; and ten, ranging from 1:16 to 1:256, (most of them in the higher range), were from Grantsville.

Discussion: Stoenner et al., (1959)[23] found sera from the Great Salt Lake Basin cottontail and the Great Basin pocket mouse which reacted with psittacosis antigen. Pigeons, antelope ground squirrels, deer mice, house cats, and a number of other wild mammals and birds have been reported as capable of being infected this this agent (Sidwell and Thorpe, 1962)[31] so the psittacosis antibody titers may be significant.

31. Sidwell, R. W. and B. D. Thorpe. 1962. A review of psittacosis. Ecology and Epizoology Research, University of Utah.

The differences observed between the Epizoology Laboratory test and the Hooper Foundation test could be attributed to several factors: the antigens employed are not the same, the Hooper Foundation antigen is prepared at the Foundation; the test technique, i.e., incubation times, units used, etc., may vary, although the exact protocol of the Hooper Foundation was not available at the time of writing of this report; finally, some of the serum sent had been stored for several months and had been frozen and thawed repeatedly. Dr. Eddie, in personal correspondence pointed out that it was the first positive guinea pig sera she had ever encountered. It is speculated that the many observed titers are indicative of a past or present psittacosis infection, but not from the tissue or ectoparasites injected. There are several reasons for this conclusion. The original tissue pools were subjected to extensive procedures in an attempt to isolate the psittacosis agent from them. No evidence, other than the controversial titers in the indicator guinea pigs, could be obtained to indicate the presence of the agent. In addition, all the reacting guinea pigs were purchased from non-Dugway sources, and had been kept in an area containing young psittacine and other birds which may have been infected with psittacosis. Further, evidence in support of the above conclusion is in the form of a personal communication from Dr. J. Storz of the Utah State University, in which he states that some guinea pig colonies in California were infected with psittacosis as a result of being reared in areas adjacent to either infected livestock or birds. Sera from 203 tissue-challenged and other experimental guinea pigs raised at the Dugway Colony were tested for psittacosis CF antibody. With the exception of three low titers (1:16), no psittacosis antibody could be demonstrated. Attempts have been made to isolate the organism from the original reacting guinea pigs, but results to date are inconclusive, primarily due to cumbersome methods of isolation.

The numbers of seropositive cattle and sheep compare closely with the results obtained by Dr. Storz at USU,[32] who has been studying the incidence of psittacosis in livestock. The disease often causes abortion in these animals, and therefore a check should be made of the livestock owners as to the incidence of abortion in their herds. Cattle and sheep feces, and absorbed material have been shown to be infective with the psittacosis agent,[31] and represent sources of contamination of surroundings and possible subsequent infection of susceptible wildlife populations.

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32. Storz, J. 1962. Studies on the latent psittacosis lymphogranuloma infection of sheep in Utah. Oral presentation - Intermountain Branch of American Soc. for Microbiol., Logan, Utah.

PSITTACOSIS CF ANTIBODY IN WILD ANIMALS

TABLE 41. Incidence of psittacosis complement fixing antibody*in wildlife sera per year tested**

Species	1958 Pos/Total	1958 %	1962 Pos/Total	1962 %
Antrozous pallidus	0/0	-	0/0	-
Lepus californicus	4/101	4.0	5/149	3.4
Sylvilagus sp.	0/6	-	1/5	20.0
Citellus townsendii	0/0	-	0/0	-
C. variegatus	0/0	-	1/1	100.0
C. leucurus	1/128	0/8	1/96	1.0
Eutamias minimus	0/13	-	0/27	-
E. dorsalis	0/5	-	0/3	-
Thomomys bottae	0/1	-	0/0	-
Perognathus longimembris	0/16	-	0/18	-
P. parvus	0/39	-	0/23	-
P. formosus	0/39	-	0/41	-
Microdipodops megacephalus	0/5	-	0/1	-
Dipodomys ordii	7/230	3.0	0/66	-
D. microps	3/370	0.8	0/45	-
Reithrodontomys megalotis	1/33	3.2	0/43	-
Peromyscus crinitus	0/23	-	0/12	-
P. maniculatus	2/278	0.7	14/311	4.5
P. truei	0/13	-	0/0	-
Onychomys leucogaster	1/4	25.0	1/3	33.3
Neotoma lepida	5/65	7.7	0/12	-
N. cinerea	0/1	-	0/0	-
Ondatra zibethicus	0/0	-	0/0	-
Microtus sp.	0/0	-	0/3	-
Mus musculus	0/4	-	0/0	-
Erethizon dorsatum	0/0	-	0/0	-
Canis latrans	0/0	-	0/0	-
Vulpes macrotis	0/0	-	0/1	-
Taxidea taxus	0/0	-	0/1	-
Spilogale gracilis	0/0	-	0/1	-
Lynx rufus	0/0	-	0/0	-
Felis catus	0/0	-	1/1	100.0
Odocoileus hemionus	0/0	-	1/17	5.9
Sub-totals	24/1374		25/930	

TABLE 41. (Continued) - AVES

Species	1958 Pos/Total	1958 %	1962 Pos/Total	1962 %
Sub-totals	24/1374		25/930	
Recurvirostra americana	0/0	-	0/1	-
Columba livia	0/0	-	1/3	33.3
Zenaidura macroura	0/0	-	0/6	-
Sayornis saya	0/0	-	0/3	-
Ereomophila alpestris	0/0	-	0/24	-
Aphelocoma coerulescens	0/0	-	0/2	-
Oreoscoptes montanus	0/0	-	0/1	-
Lanius ludovicianus	0/0	-	0/23	-
*Passer domesticus**	0/0	-	0/3	-
Euphagus cyanocephalus	0/0	-	0/3	-
Molothrus ater	0/0	-	0/1	-
Carpodacus mexicanus	0/0	-	0/8	-
Pooecetes gramineus	0/0	-	0/3	-
Passerculus sandwichensis	0/0	-	o/1	-
Spizella breweri	0/0	-	0/1	-
Melospiza melodia	0/0	-	0/3	-
Bubo virginianus	0/0	-	0/1	-
Meleagris gallopavo	0/0	-	0/27	-
Pica pica	0/0	-	0/8	-
Totals	24/1374	1.7	26/1052	2.5

* Titer of 1:16 or greater

** After ceasing at the end of 1958, psittacosis serology did not recommence until October 1, 1962.

DISTRIBUTION OF PSITTACOSIS IN NATIVE ANIMALS

TABLE 42. Distribution of psittacosis according to areas in Utah, as determined by positive complement fixing antibody* in native animals and birds. Indicated per year tested.**

	1958		1962	
Area	Pos/Total	%	Pos/Total	%
Callao	3/94	3.2	4/91	4.4
Camelback Mountain	2/68	2.9	1/60	1.7
CD 22	2/83	2.4	0/0	-
Clover	0/0	-	0/0	-
Deep Creek	0/0	-	0/27	-
Dugway Mountain	0/9	-	0/0	-
Dugway Valley	3/72	4.2	0/29	-
East Wendover	0/0	-	1/30	3.3
Fish Springs	0/46	-	0/7	-
Fountain Green	0/0	-	0/0	-
Gandy	0/0	-	1/13	7.7
Gold Hill	1/132	0.8	0/0	-
Government Creek	0/3	-	0/117	-
GPI-3	0/7	-	1/16	6.3
Granite Mountain	0/21	-	1/51	2.0
Grouse Creek	0/0	-	0/14	-
Johnson Pass	0/0	-	1/73	1.4
Little Davis Mountain	3/49	6.1	0/10	-
Logan	0/0	-	0/27	-
Lookout Pass	0/0	-	2/78	2.6
Lucin	0/0	-	0/5	-
Manti	0/0	-	0/0	-
Montello	0/0	-	0/7	-
North Cedar Mountain	0/0	-	0/0	-
North Skull Valley	2/88	2.3	0/0	-
North Wendover	0/395	-	1/35	2.9
Old River Bed	0/24	-	0/10	-
Payson	0/0	-	0/1	-
Roosevelt	0/0	-	0/0	-
Settlement Canyon	0/0	-	0/0	-
Sheeprock Mountain	0/0	-	2/38	5.3
South Cedar Mountain	5/148	3.4	3/66	4.5
South Skull Valley	0/0	-	0/19	-
South Wendover	0/0	-	1/25	4.0
Test Grid	1/98	1.0	1/22	4.5
Trout Creek	1/12	8.3	0/0	-
Vernon	0/0	-	3/46	6.5
West Wendover	0/0	-	1/52	1.9
Wig Mountain	0/11	-	1/50	2.0
Wildcat Mountain	0/0	-	1/35	2.9
Totals	24/1374	1.7	26/1052	2.5

*Titers of 1:16 or greater

**After ceasing at the end of 1958, psittacosis serology did not recommence until October 1, 1958.

<u>Wildlife Disease Survey Sampling</u>:

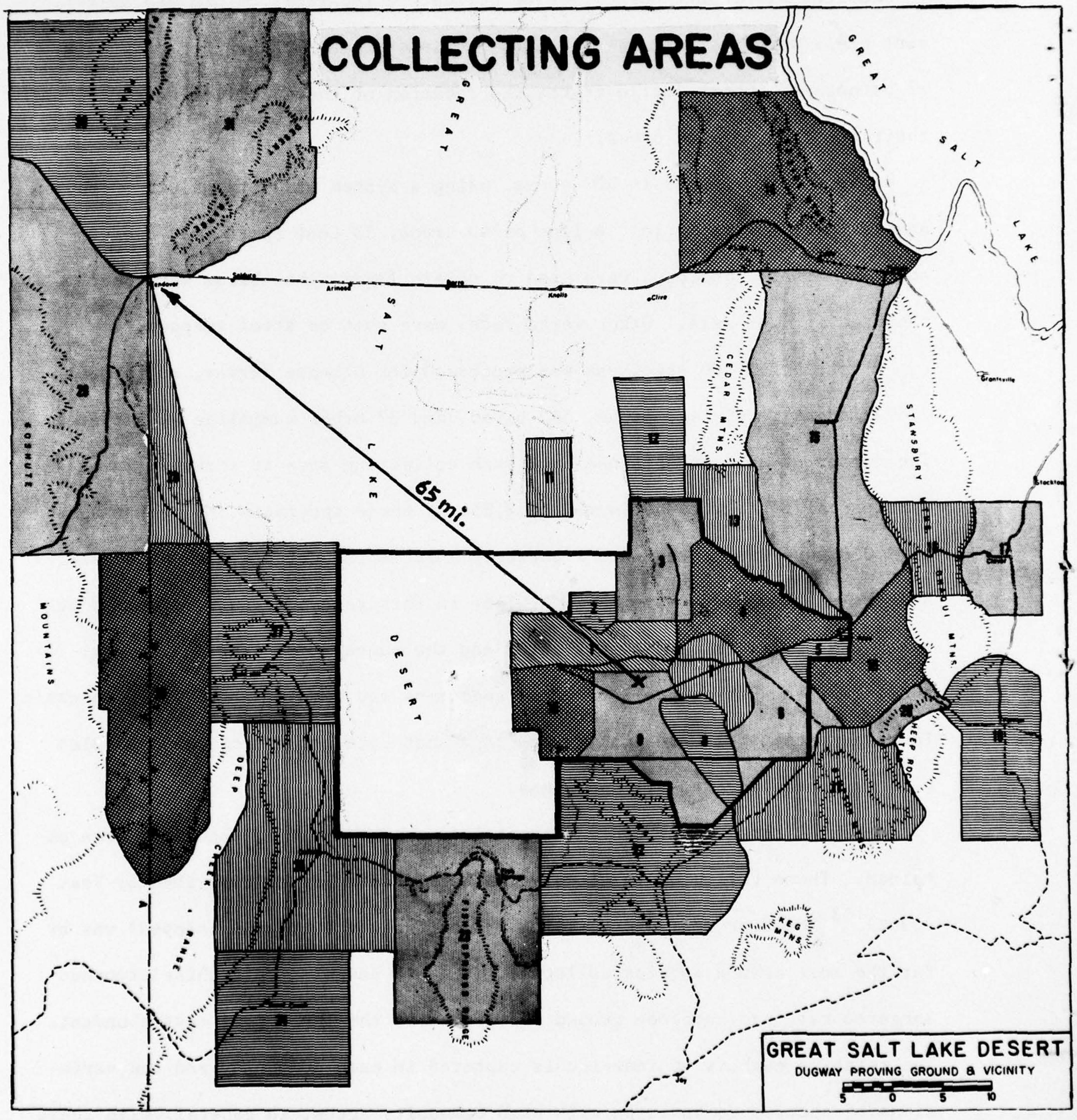
During this report period, major collecting locations on DPG and adjacent areas were systematically visited and specimens obtained for diagnosis of pathogens. Chart I illustrates the location of these collecting areas and their relation to each other.

Rodents were trapped in DPG areas, using a system of 49 traps set 33 feet apart, in a 7x7-trap grid. A line of 40 traps, 33 feet apart, was used on adjacent areas. Shotguns were used to obtain lagomorphs; birds were shot or captured in mist-nets. Other vertebrates were shot or steel-trapped.

A total of 3,790 specimens was processed for Disease Survey, as follows: 2,574 rodents, 596 lagomorphs, 583 birds, and 37 other mammalian vertebrates. The number of animals obtained from each collecting area is shown in Table 43. Serological tests were performed on 2,851 of these specimens and the tissues of 3,020 were inoculated into laboratory animals for detection of pathogens. Results of these tests are shown earlier in this report. The discrepancy between the number of animals collected and the number tested is due in part to the lag period between collection of specimens and completion of all diagnostic laboratory tests; and in part to the fact that both blood and tissue samples were not obtained from all specimens.

Table 44 shows major habitat types from which mammalian specimens were obtained. These follow quite closely the biotic communities described by Vest (1962).[33] The deer mouse (comprising 48% of the total rodents trapped) was by far the most common species collected. The Ord kangaroo rat, chisel-toothed kangaroo rat, and antelope ground squirrel were the three next most abundant. The relative numbers of individuals captured in each community and the variations of species composition with each community agree, in general, with these results obtained over a period of several years in which studies were made spe-

33. Vest, E. D. 1962. Biotic communities in the Great Salt Lake Desert. Ecology and Epizoology Series No. 73. University of Utah Press.



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GREAT SALT LAKE DESERT MAP LEGEND

Number	Collecting Area
1	Test Grids
2	GPI-3
3	Wig Mountain
4	South Cedar Mountains
5	Little Davis Mountain
6	Government Creek
7	Camelback Mountain
8	Old River Bed
9	Dugway Valley
10	Granite Mountain
11	Wildcat Mountain
12	North Wig Mountain
13	North Cedar Mountains
14	Lakeside
15	North Skull Valley
16	Johnson Pass
17	Clover
18	South Skull Valley
19	Vernon
20	Lookout Pass
21	Simpson Mountains
22	Dugway Mountains
23	Fish Springs
24	Trout Creek
25	Callao
26	Deep Creek
27	Gold Hill
28	East Wendover
29	South Wendover
30	West Wendover
31	North Wendover

cifically to determine these affinities, during which over 18,000 rodents were captured in more than 200,000 trap nights. Data in Table 48, however, are strongly influenced by differences in trapping effort among the different communities, and by the relative amount of habitat in each community within the collecting areas.

Table 45 summarizes major habitat types from which avian specimens were collected. In general, birds show far less fidelity to established biotic communities than do rodents, and as a result these data reflect primarily collecting effort. Most commonly collected species were the horned lark, *Eremophila alpestris*, a permanent resident and the most abundant bird at Dugway; and the loggerhead shrike, *Lanius ludovicianus*, another common permanent resident. Of approximately 225 kinds of birds found at Dugway (including 16 permanent residents, 28 summer residents, 13 winter residents, and more than 115 migrants), the horned lark, loggerhead shrike, 7 or 8 species of hawks and owls, the raven (*Corvus corax*), and the magpie (*Pica pica*), would probably be of prime importance in fostering the spread of epizootic disease because of their abundance, distribution and/or habits. However, any of the migratory species arriving or departing in large numbers, could introduce a pathogen into local populations or carry a pathogen from a local focus to a new area.

Tables 46 and 47 provide a monthly tabulation of the collection of specimens, mammals and birds, respectively. Since the sampling program is not conducted with equal intensity in all periods, these tables reflect sampling effort as well as seasonal changes in animal populations influenced by reproduction, estivation, hibernation, migration, etc. Earlier work has shown that approximately 130 species of birds are present in western Tooele County during spring and fall migrating periods, with greatest numbers in late April and late September.

A general outline of the geographic distribution of psittacosis, RMsf, and Q fever in ectoparasites is presented in Table 48.

DISTRIBUTION OF VERTEBRATES COLLECTED

TABLE 43. Number of lagomorphs, rodents, other vertebrates, and birds collected from each of the major wildlife collecting areas on Dugway Proving Ground and adjacent areas.

Collection Areas	Number of Visits	Lagomorphs	Number of Visits	Rodents	Other Vertebrates	Number of Visits	Birds	Total Vertebrates
Dugway Proving Ground								
Camelback Mountain	4	24	5	207	1	13	84	316
Dugway Valley	1	3	2	40				43
Government Creek	5	32	6	186		19	215	433
GPI-3			2	27				27
Granite Mountain	1	9	2	88	1	7	41	139
Little Davis Mountain	5	30	3	321		12	65	416
Old River Bed	3	16	3	81		4	18	115
South Cedar Mountain	3	13	4	245	1	18	94	353
Test Grid	1	11	2	61		1	3	75
Wig Mountain	4	36	3	158		2	11	205
Totals		174		1414	3		531	2122
Adjacent Areas								
Callao	16	182	5	101	30	5	23	336
Clover	2	12	2	72				84
Deep Creek	1	8	1	24				32
Dugway Mountain	1	6			1	1	5	12
East Wendover			1	36				36
Fish Springs	1	6	2	67		1	7	80
Gandy	2	18	1	8				26
Gold Hill	1	22	1	134	1			157
Government Creek	1	10	1	12	12			22
Grouse Creek	1	13						13
Johnson Pass	1	9	2	101	1	1	1	112
Lookout Pass	1	1	1	78				79
Lucin	1	5						5
Montello	1	8						8
North Skull Valley	1	10	1	76		1	2	88
North Wendover	1	1	1	30				31
Payson*			1	1				1
Simpson Mountain			1	42				42
South Skull Valley	2	26	2	157	1	4	14	198
South Wendover	1	3	1	34				37
Trout Creek	3	40	1	63				103
Vernon	1	8	1	39				47
West Wendover	2	34	1	43				77
Wildcat Mountain			1	42				42
Totals		422		1160	34		52	1668
Totals, All Areas		596		2574	37		583	3790

* Not a regular collecting area.

MAMMAL-HABITAT CORRELATION

TABLE 44. Mammal specimens collected for disease survey studies, tabulated according to the general habitat from which they were collected.

Species / Habitat	Marsh	Vegetated dunes	Mixed brush	Juniper mountain	Juniper brush	Greasewood	Shadscale-budsage	Shadscale-gray molly	Shadscale-gray molly greasewood	TOTAL
Antrozous pallidus				3						3
Lepus californicus		66	59	5	37	115		3	279	564
Sylvilagus audubonii		1	1	2	4	4			18	30
S. nuttallii				2						2
Citellus leucurus		83	38	6	8	8	6		28	177
C. townsendii									3	3
C. variegatus				3						3
Eutamias minimus		1	26	2	1	2			23	55
E. dorsalis				7						7
Perognathus longimembris		26	19			4			1	50
P. parvus			9	58	1					68
P. formosus			70	16	2	2	8		9	107
Microdipodops megacephalus		1								1
Dipodomys ordii		251	26	9	52	26	8		11	383
D. microps		34	83	6	1	4	14	5	61	208
Reithrodontomys megalotis	12	38	28	18	6	10	4	2	9	127
Peromyscus crinitus			20	7					1	28
P. maniculatus	4	165	290	241	101	161	72	11	189	1234
P. truei		1	2	57	14					74
Onychomys leucogaster		2	1				2			5
Neotoma lepida		2	12	16	5	3			1	39
Microtus longicaudus				4						4
Erethizon dorsatum				1						1
Canis latrans			2							2
Vulpes macrotis		1	1							2
Lynx rufus			1							1
Taxidea taxus									1	1
Spilogale gracilis				1						1
Felis catus									2	2
Odocoileus hemionus				25						25
Total species	2	14	18	21	12	11	7	4	15	30
Total specimens	16	672	688	489	232	339	114	21	636	3207

BIRD-HABITAT CORRELATION

TABLE 45. Avian species collected for disease survey studies, tabulated according to the general habitat from which they were collected.

Species	Marsh	Vegetated dunes	Mixed brush	Juniper Mountain	Juniper brush	Greasewood	Shadscale-budsage	Shadscale-gray molly	Shadscale-gray molly-greasewood	TOTAL
Falco sparverius										
Sparrow hawk									1	1
Fulica americana										
American coot	1									1
Charadrius vociferus										
Killdeer	3								1	4
Recurvirostra americana										
American avocet									3	3
Columba livia										
Domestic pigeon									5	5
Zenaidura macroura										
Mourning dove			4	9	8	1		1	16	39
Bubo virginianus										
Great horned owl	1							1		2
Chordeiles minor										
Common nighthawk	5			1						6
Colaptes cafer										
Red-shafted flicker									1	1
Tyrannus tyrannus										
Eastern kingbird								1		1
T. verticalis										
Western kingbird				4						4
Myiarchus cinerescens										
Ash-throated flycatcher					1					1
Sayornis saya										
Say's phoebe			2	1	5				8	16
Empidonax wrightii										
Gray flycatcher									1	1
Eremophila alpestris										
Horned lark	6	2	29	1	8			15	127	188
Aphelocoma coerulescens										
Scrub jay				1	2					3
Corvus corax										
Common raven									3	3
Parus inornatus										
Plain titmouse			1	6	10					17
Sub-totals	16	2	36	23	34	1		18	166	296

TABLE 45. (Continued)

Habitat	Marsh	Vegetated dunes	Mixed brush	Juniper mountain	Juniper brush	Greasewood	Pickleweed	Shadscale-gray molly	Shadscale-gray molly-greasewood	TOTAL
Sub-totals	16	2	36	23	34	1		18	166	296
Sitta canadensis										
Red-breasted nuthatch			1							1
Troglodytes aedon										
House wren									1	1
Salpinctes obsoletus										
Rock wren			1	2		1				4
Mimus polyglottos										
Mockingbird			1							1
Oreoscoptes montanus										
Sage thrasher		1			1				2	4
Turdus migratorius										
Robin		1	1							2
Polioptila caerulea										
Blue-gray gnatcatcher				1						1
Anthus spinoletta										
Water pipit				2					13	16
Lanius ludovicianus										
Loggerhead shrike		4	6	5	14			3	24	56
Sturnus vulgaris										
Starling									22	22
Passer domesticus										
House sparrow									15	15
Sturnella neglecta										
Western meadowlark								1	1	2
X. xanthocephalus										
Yellow-headed blackbird									1	1
Agelaius phoeniceus										
Red-winged blackbird									4	4
Icterus parisorum										
Scott's oriole				1						1
Euphagus cyanocephalus										
Brewer's blackbird									9	9
Molothrus ater										
Brown-headed cowbird				1					1	2
Hesperiphona vespertina										
Evening grosbeak									2	2
Carpodacus mexicanus										
House finch	1			3	4		7		13	28
Sub-totals	17	8	46	37	53	2	7	22	274	468

TABLE 45. (Continued)

Species / Habitat	Marsh	Vegetated dunes	Mixed brush	Juniper mountain	Juniper brush	Greasewood	Pickleweed	Shadscale-gray molly	Shadscale-gray molly-greasewood	TOTAL
Sub-totals	17	8	46	39	53	2	7	22	274	468
<u>Spinus tristis</u>										
American goldfinch									2	2
<u>Chlorura chlorura</u>										
Green-tailed towhee				1					2	3
<u>Passerculus sandwichensis</u>										
Savannah sparrow				7						7
<u>Pooecetes gramineus</u>										
Vesper sparrow				1				2	9	12
<u>Chondestes grammacus</u>										
Lark sparrow	1			2	2				3	8
<u>Amphispiza bilineata</u>										
Black-throated sparrow			6	2	6	1		3	13	31
<u>A. belli</u>										
Sage sparrow		2							3	5
<u>Junco oreganus</u>										
Oregon junco			2	3	3				6	14
<u>Spizella passerina</u>										
Chipping sparrow				1						1
<u>Spizella breweri</u>										
Brewer's sparrow			1						10	11
<u>Zonotrichia querula</u>										
Harris' sparrow									1	1
<u>Z. leucophrys</u>										
White-crowned sparrow	1								16	17
<u>Melospiza melodia</u>										
Song sparrow	1								2	3
Totals	20	10	55	56	64	3	7	27	341	583

SEASONAL COLLECTION OF MAMMALS

TABLE 46. Mammalian species collected for disease survey studies. Tabulated according to month and year collected.

Species	1962 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	1963 Jan	Feb	Total
Antrozous pallidus								3							3
Lepus californicus	18	39	36	31	50	66	53	74	66	43	29	7	14	38	564
Sylvilagus audubonii		1	2	4	1	3	6	4		5	1		2	1	30
S. nuttallii						2									2
Citellus leucurus	1		6	2	9	7	16	14	39	38	12	13		20	177
C. townsendii			3												3
C. variegatus						2		1							3
Eutamias minimus				12			7			32	4				55
E. dorsalis				3		1				2	1				7
Perognathus longimembris				4	17		1		26		2				50
P. parvus				11	30	1			6	9	11				68
P. formosus			9	11	11	5	2	25	22	15	7				107
Microdipodops megacephalus										1					1
Dipodomys ordii	15		70	16	37	29	17	29	25	17	29	11		88	383
D. microps	1	1	8	5	40	41	10	23	21	18	13	1		26	208
Reithrodontomys megalotis	9		26	5	6	2			13	19	18	1		28	127
Peromyscus crinitus			2		4	3		4	1	8	6				28
P. maniculatus	38	93	181	160	134	87	28	52	62	181	83	8		127	1234
P. truei		1	9	3		1		3		33	21			3	74
Onychomys leucogaster							1	1	1	1	1				5
Neotoma lepida	1		10	2	1	7	1	3	6	5	1			2	39
Microtus longicaudus										2	2				4
Erethizon dorsatum										1					1
Canis latrans							1	1							2
Vulpes macrotis					1							1			2
Lynx rufus													1		1
Taxidea taxus										1					1
Spilogale gracilis								1							1
Felis catus							1		1						2
Odocoileus hemionus										17			8		25
Total species	7	5	12	14	13	15	13	15	13	20	17	7	4	9	30
Total specimens	83	135	362	269	341	257	144	238	289	448	241	42	25	333	3207

SEASONAL COLLECTIONS OF BIRDS

TABLE 47. Avian species collected for disease survey studies. Tabulated according to month and year.

Species	1962												1963		Total
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	
<u>Falco</u> <u>sparverius</u>															
Sparrow hawk							1								1
<u>Fulica</u> <u>americana</u>															
American coot			1												1
<u>Charadrius</u> <u>vociferus</u>															
Killdeer							3		1						4
<u>Recurvirostra</u> <u>americana</u>															
American avocet						2	1								3
<u>Columba</u> <u>livia</u>															
Domestic pigeon			1		1		1	1		1					5
<u>Zenaidura</u> <u>macroura</u>															
Mourning dove					8	9	17			1					39
<u>Bubo</u> <u>virginianus</u>															
Great horned owl							1				1				2
<u>Chordeiles</u> <u>minor</u>															
Common nighthawk							6								6
<u>Colaptes</u> <u>cafer</u>															
Red-shafted flicker			1												1
<u>Tyrannus</u> <u>tyrannus</u>															
Eastern kingbird						1									1
<u>T.</u> <u>verticalis</u>															
Western kingbird						3	1								4
<u>Myiarchus</u> <u>cinerescens</u>															
Ash-throated flycatcher					1										1
<u>Sayornis</u> <u>saya</u>															
Say's phoebe					1	5	8		2						16
<u>Empidonax</u> <u>wrightii</u>															
Gray flycatcher					1										1
<u>Eremophila</u> <u>alpestris</u>															
Horned lark		45	15	4	29	30	7	27	9	2	3	1	4	12	188
<u>Aphelocoma</u> <u>coerulescens</u>															
Scrub jay													1		3
<u>Corvus</u> <u>corax</u>															
[illegible]		2											1		3

TABLE 47. (Continued)

Species	1962												1963		
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Total
Sub-totals		47	18	4	41	50	48	32	12	4	4	1	6	12	279
<u>Parus inornatus</u>															
Plain titmouse					3	2	2	5	2	1		1	1		17
<u>Sitta canadensis</u>															
Red-breasted nuthatch								1							1
<u>Troglodytes aedon</u>															
House wren						1									1
<u>Salpinctes obsoletus</u>															
Rock wren					1		3								4
<u>Mimus polyglottos</u>															
Mockingbird					1										1
<u>Oreoscoptes montanus</u>															
Sage thrasher					2	1		1							4
<u>Turdus migratorius</u>															
Robin								1		1					2
<u>Polioptila caerulea</u>															
Blue-gray gnatcatcher						1									1
<u>Anthus spinoletta</u>															
Water pipit					12	2				2					16
<u>Lanius ludovicianus</u>															
Loggerhead shrike		2				13	16	19	2	2			1	1	56
<u>Sturnus vulgaris</u>															
Starling			21								1				22
<u>Passer domesticus</u>															
House sparrow			2	1	1					3	3	1	4		15
<u>Sturnella neglecta</u>															
Western meadowlark			1											1	2
<u>X. xanthocephalus</u>															
Yellow-headed blackbird					1										1
<u>Agelaius phoeniceus</u>															
Red-winged blackbird			4												4
<u>Icterus parisorum</u>															
Scott's oriole							1								1
<u>Euphagus cyanocephalus</u>															
Brewer's blackbird										8		1			9
Sub-totals		49	46	5	62	70	70	59	16	21	8	4	12	14	436

TABLE 47. (Continued)

Species	1962 Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	1963 Jan	Feb	Total
Sub-totals		49	46	5	62	70	70	59	16	21	8	4	12	14	436
Molothrus ater															
Brown-headed cowbird							2								2
Hesperiphona vespertina															
Evening grosbeak			2												2
Carpodacus mexicanus															
House finch						4	2		1		5	7	2	7	28
Spinus tristis															
American goldfinch			2												2
Chlorura chlorura															
Green-tailed towhee				1	2										3
Passerculus sandwichensis															
Savannah sparrow							7								7
Pooecetes gramineus															
Vesper sparrow				8				1	3						12
Chondestes grammacus															
Lark sparrow				3		3	2								8
Amphispiza bilineata															
Black-throated sparrow					5	10	12	2				2			31
A. belli															
Sage sparrow						1	2						2		5
Junco oreganus															
Oregon junco			5							5		1	3		14
Spizella passerina															
Chipping sparrow								1							1
S. breweri															
Brewer's sparrow			3	2	6										11
Zonotrichia querula															
Harris' sparrow									1						1
Z. leucophrys															
White-crowned sparrow			6	7					1	3					17
Melospiza melodia															
Song sparrow									1	2					3
Totals		49	55	23	79	90	103	63	23	31	13	14	19	21	583

DISTRIBUTION OF ECTOPARASITES COLLECTED

TABLE 48. Areas from which groups of ectoparasites were collected and pooled for disease survey studies. Positive pools are tabulated according to areas and disease.

Area	Fleas					Ticks					Mites					Lice				
	Number		Pos/pools			Number		Pos/pools			Number		Pos/pools			Number		Pos/pools		
	Ectos	Pools	RMsf	Q fev.	Psitt.	Ectos	Pools	RMsf	Psitt.	Tular	Ectos	Pools	RMsf	Q fev	Psitt	Ectos	Pools	RMsf	Q fev	Psitt
Callao	189	10				726	32	16			25	2				25	1	1		
Camelback Mountain	217	12	3			296	16	8		1	56	2				92	5			1
Clover	99	5			2	160	3	1			23	1				23	1	1		
Deep Creek						66	3									67	1			
Dugway Mountain						51	2													
Dugway Valley	47	3			1	29	2				10	1								
East Wendover	14	1				22	1									17	1			
Fish Springs	21					126	5				36	2				58	2			
Gandy	122	3				77	3													
Gold Hill	164	7				498	16									10	1			
Government Creek	248	17	2			556	23	5	2		18	1				105	4	2		
GPI-3	74	4														183	2			
Granite Mountain	108	5	1			83	5				125	3				69	3			
Grouse Creek						3	1													
Johnson Pass	111	6			1	40	3				151	4			2	14	1			1
Little Davis Mtn.	456	23				464	17	1			26	2				395	7			
Lookout Pass	188	6			2						253	6	1		1	29	1			
Lucin						12	1													
Montello						31	2													
No. Skull Valley	211	7	1			144	7	1												
North Wendover	151	4														8	1			
Old River Bed	85	5				315	12	1								49	1			
Simpson Mountain	106	5				61	2				17	1								
So. Cedar Mountain	248	14		1		297	13				122	2				63	3			
So. Skull Valley	406	16				270	11	1								51	1			
South Wendover	30	2				11	1				16	1				32	1			
Test Grid	50	4				32	2				8	1				115	1			
Trout Creek	30	2				551	19	2			4	1				3	1			
Vernon	27	2									18	1				20	1			
West Wendover	23	2				99	5									23	1			
Wig Mountain	260	10				616	24	2			8	1				32	1			
Wildcat Mountain	44	4														43	1			
Pacific Birds						70	4									1372	24	1		
Totals	3729	179	10	1	6	5706	235	39	2	1	916	32	1		3	2889	67	5		2

Tick Collection: During the course of the total effort of Ecology and Epizoology Research at Dugway Proving Ground, 21 species of ticks have been collected from 31 species of mammals and 2 species of birds. During the current report period, 16 species have been recovered from 23 species of mammals. These mammals and the ticks recovered from them are:

Order Insectivora
- *Sorex vagrans* Baird
  - *Ixodes soricis* Gregson

Order Chiroptera
- *Antrozous pallidus* (LeConte)
  - *Ornithodoros kelleyi* Cooley and Kohls

Order Primata
- *Homo sapiens* Linnaeus
  - *Dermacentor andersoni* Stiles

Order Lagomorpha
- *Lepus californicus* Gray
  - *Otobius lagophilus* Cooley and Kohls
  - *Dermacentor parumapertus* Neumann
  - *Haemaphysalis leporis-palustris* (Packard)
- *Sylvilagus audubonii* (Baird)
  - *Dermacentor parumapertus* Neumann
  - *Haemaphysalis leporis-palustris* (Packard)
- *Sylvilagus nuttallii* (Bachman)
  - *Haemaphysalis leporis-palustris* (Packard)

Order Rodentia
- *Citellus leucurus* (Merriam)
  - *Ornithodoros parkeri* Cooley
  - *Dermacentor parumapertus* Neumann
  - *Ixodes angustus* Neumann
  - *Ixodes kingi* Bishopp
- *Eutamias dorsalis* (Baird)
  - *Ixodes pacificus* Cooley and Kohls
- *Perognathus longimembris* (Coues)
  - *Dermacentor parumapertus* Neumann
  - *Ixodes kingi* Bishopp
- *P. parvus* (Peale)
  - *Dermacentor andersoni* Stiles

P. formosus Merriam
Ixodes kingi Bishopp
I. jellisoni Cooley and Kohls
Ixodes sp.

Dipodomys ordii Woodhouse
Dermacentor parumapertus Neumann
Ixodes kingi Bishopp

Dipodomys microps (Merriam)
Ornithodoros parkeri Cooley
Dermacentor parumapertus Neumann
Ixodes kingi Bishopp

Reithrodontomys megalotis (Baird)
Dermacentor parumapertus Neumann
Ixodes kingi Bishopp
Ixodes sp.

Peromyscus crinitus Goldman
Ornithodoros sp. nov. near hermsi W. H. & M.

P. maniculatus (Wagner)
Ornithodoros sp. nov. near hermsi W. H. & M.
Dermacentor andersoni Stiles
D. parumapertus Neumann
Ixodes pacificus Cooley and Kohls
I. kingi Bishopp
I. ochatonae Gregson
Ixodes sp.

P. truei
Ornithodoros sp. nov. near hermsi W. H. & M.
Dermacentor andersoni Stiles
D. parumapertus Neumann
Ixodes kingi Bishopp
I. pacificus Cooley and Kohls

Onychomys leucogaster (Wied-Neuwied)
Ixodes kingi Bishopp

Neotoma cinerea (Ord)
Ixodes kingi Bishopp
I. ochotonae Gregson

N. lepida Thomas
Ornithodoros sp. nov. near hermsi W. H. & M.
Dermacentor andersoni Stiles
D. parumapertus Neumann
Ixodes kingi Bishopp
I. ochotanae Gregson
I. pacificus Cooley and Kohls
I. woodi Bishopp

Order Carnivora
Vulpes macrotis Merriam
Ixodes kingi Bishopp
I. texianus Banks

Taxidea taxus (Schreber)
Ixodes kingi Bishopp

Order Artiodactyla
Bos taurus Linnaeus
Dermacentor albipictus Packard

Odocoileus hemionus Rafinesque
Dermacentor albipictus Packard
Ixodes pacificus Cooley and Kohls

In a few instances larval Ixodes could not be positively identified. In the case of the tentative identification of Ixodes woodi, the specimen concerned was an engorged female which was held for egg laying. After completion of the oviposition, the tick was so distorted as to render identification more or less uncertain. If this is truly I. woodi, it represents the first known collection of the species in Utah. The collection of Ixodes soricis is also a new record for the state. Both have been collected from adjoining atates. Both species were submitted to Glen M. Kohls, Rocky Mountain Laboratory, who confirmed the identification of I. soricis and concurred in the tentative identification of I. woodi.

Approximately 860 lots of ticks were examined. Most of them, 830 lots, were from Disease Survey. The annual report for 1961 gives a detailed report on a typical year's tick collection.

In his ecological survey of Dugway Valley, Tooele County, Utah, Vest (1962)[33] recognized and defined eight plant communities. He gave evidence to indicate that each community, in addition to supporting a flora of a specific composition, was attractive as well to a rodent population more or less constant in species composition of the rodent ectoparasites.

During the course of this study, 1,791 rodents of eleven species were trapped and processed for recovery of ectoparasites. During the present report period, the ticks from this study were identified and some analyses were made of the data.

Inasmuch as the study was confined to the rodents of the valley floor amd bordering piedmont areas, no great diversity of tick species could be expected. There were, in fact, only three species recognized. These were:

Ornithodoros parkeri Cooley and Kohls
Dermacentor parumapertus Neumann
Ixodes kingi Bishopp

Ornithodoros parkeri lives on the host for only a few days in the larval stage. In the nymphal and adult stages it lives in animal burrows off the host, feeding rapidly as opportunity affords. Though not uncommon in its ecological niche, it is seldom collected by our methods. Since it was encountered only five times in this study, it will not be treated further.

Of the total 1,791 animals processed, ticks were recovered from 1,000, or 55.8 per cent. Forty-eight per cent of the total animals were infected with I. kingi; 28.6 per cent with D. parumapertus, and 23.3 per cent with both. Rate of infection showed considerable variation between communities. The pickleweed community, with 19.8 per cent was low. The shadscale-budsage, with 68.2 per cent was high. By and large, those communities having the higher rodent populations also have the higher rates of tick infestation.

The tick indices have not yet been computed; but when this is done it will be found that the number of D. parumapertus ticks per infested animal will be higher than the number of I. kingi. Frequently the infestation with the latter species has been represented by a single tick. The highest number of this species to be recovered from a single host was 73; while the highest number of D. parumapertus was 395. By and large, those communities having the lower populations of rodents had the higher percentages of I. kingi over D. parumapertus, in our study. However, due to the low numbers of animals trapped in these communities, the figures may lack significance.

TABLE 49. Community survey of ticks occurring on rodents.

Community	Animals brushed	Number infested	Per cent infested	Species Composition: Ixodes kingi	Species Composition: Both	Species Composition: Dermacentor parumapertus
Mixed brush	465	275	.592	.515	.264	.219
Juniper brush	478	307	.644	.339	.260	.395
Shadscale-budsage	208	142	.682	.614	.172	.213
Vegetated dunes	323	164	.507	.564	.268	.166
Greasewood	133	68	.511	.148	.111	.740
Pickleweed	111	22	.198	.625	.062	.312
Shadscale-gray molly-greasewood	52	14	.269	.923	.000	.077
Shadscale-gray molly	21	9	.428	.857	.000	.142
Totals	1.791	1,001	.558	.480	.233	.286

Tick Life History Studies:

Ornithodoros ticks of the species near hermsi have been the object of a detailed life history study which is nearing completion. Personnel from Rocky Mountain Laboratory requested and received specimens of this species for assistance in their taxonomic study. Our material will be listed as paratypes and about half the specimens will be returned for deposit in our collections. After their studies are published and a name made available for the tick, we can publish our life history study and much other data on this species.

Attempts are being made to colonize two other species of Ornithodoros ticks. One species, O. kelleyi Cooley and Kohls, is parasitic on the migrant bat Antrozous pallidus. The other, O. capensis Neumann, is a parasite of pelagic birds of the tropics. Nothing is known of the epidemiological potential of either species. Because of the migratory habits of the bat, which is widely distributed in western North America, and the holotropical distribution of the birds, laboratory colonies of these ticks are highly desirable. To date both species have been reared from fed larvae through adulthood, and have produced larvae of the next generation; but so far none of the larvae have been fed.

Faunal Laboratory:

Laboratory-reared small mammals supplied to the various sections are summarized according to sections in Table 50, and by species in Table 51.

TABLE 50. Mammals supplied to various sections. Listed by sections

Section	Number of animals
Bacteriology	2,141
Epizoology	1,542
Disease Survey	233
Vector transmission	41
Faunal Laboratory (carnivore food)	136
Project Officer	200
University of Utah (various departments)	180
Total	4,473

TABLE 51. Mammals supplied to various sections. Listed by species

Deer mice (*Peromyscus maniculatus*)	2,874
Pinyon mice (*P. truei*)	366
Canyon mice (*P. crinitus*)	174
Harvest mice (*Reithrodontomys megalotis*)	83
Northern grasshopper mice (*Onychomys leucogaster*)	327
Desert wood rat (*Neotoma lepida*)	297
Bushy-tailed wood rat (*N. cinerea*)	17
Montane vole (*Microtus montanus*)	352
Total	4,473

Approximately 500 animals were used as breeding stock replacements; there were an estimated 1,000 animals on hand, in addition to breeding colonies, making a total of about 6,000 produced during the report period.

A new species, the Polynesian rat (Rattus exulans) was successfully bred in the laboratory. About 100 young were born, and reproduction has been maintained through three generations. Thirteen kinds of small mammals have now been bred in captivity at the Faunal Laboratory.

A one-year field study designed to show relative seasonal abundance of small mammals and their fleas from a vegetated dune community was completed. A total of 1,564 small mammals of 11 species, and about 1,700 fleas were collected. Data from this project are now being analyzed in preparation for a final report.

GRAPHICAL ANALYSIS OF EPIZOOLOGICAL SURVEILLANCE

The subject of Predictive Epizoology was assiduously pursued during the latter half of the year, and it was determined that with the present state of knowledge no precise mathematical formula for prediction can be devised. However, graphical analysis of epizoological surveillance may possibly show some promise in providing a method of determining the point at which control procedures should be instituted, by comparison with known control areas, general activity, and other factors. Such analysis may also lead to a determination of the direction of spread of a particular disease due to specific causes, and thus assist in predictive efforts.

Graphs of the results of the Epizoological Surveillance and the Faunal Examination Phases for the calendar year are appended. These portray the per cent incidence of each disease studied within the confines of DPG and in the Intermediate Array or Zone of Danger to man and his domestic animals, as well as in the Distance Control Zone (i.e., 70-120 miles from the center of activity at DPG), and the Terrain Control Zone, an area protected from Dugway's activities both by distance (50-70 miles) and mountain ranges.

The results are divided into animal, bird, and cattle sections, and according to the laboratory methods used to determine the incidence rate. Numerals under the slash represent the number of samples tested. Where given, the numbers over the slash represent the positive identifications. Dates are those for the month in which the specimen was collected.

Figure 1, Tularemia, indicates that the incidence rate for tularemia rose from zero in the winter to a high of 11 per cent in the Intermediate Array for July, and to 7 per cent in the Distance Control Array in December. While these might be considered to be of epizootic proportions, the small sample size mitigates against this finding. Further, no isolations were made from ectoparasites (Fig. 2), in these zones, although a fairly high rate was noted for the Inner Zone in June, October, and November. Some tissue isolations of about equal amplitude (Fig. 3), were noted in all zones except the Inner Zone for July, which neared epizootic proportions and then immediately fell off to zero. Beginning with November, bird sera and tissue are reported separately from those of the mammals. However, to the end of the year, a zero incidence rate was noted. No cattle sera (Fig. 6) were received for processing prior to December, 1962.

Q fever sera examination (Fig. 7) shows an extremely high percentage rate in January, February, March, and December in the Distance Control Array, with relatively high rates during the other months. In general, there is fair correlation between the Inner and Intermediate Array, and in all cases the rates in these arrays were less than or equal to those of the control zones.

Q fever was negative in all zones for ectoparasites (Fig. 9), and for tissue examined from the Distance Control Zone. Small positive percentages were noted in the Inner Zone during the late winter and spring, and in the Terrain Control Zone in the Fall, as shown by Fig. 8. No positive identifications of Q fever were made from birds (Figs. 10 and 11). Q fever appears to be widespread in cattle, as indicated by Fig. 12.

Rocky Mountain spotted fever sera examination (Fig. 13) shows some very high incidence rates for the control zones for the winter and spring, falling off during the summer and fall. In the Inner Array the high point started in April and then correspondingly declined to December. In like manner, high point for the Terrain Array came in June, and that of the Intermediate Array in July, with resultant fall-off from February in the Distance Array by tissue analysis, with a later periodic rise and fall. It is interesting to note that the rate in the Inner Array for September was equal to that of the Distance Control Array of February. The levels in the Intermediate or "Danger Zone" remained low throughout the year, by this method.

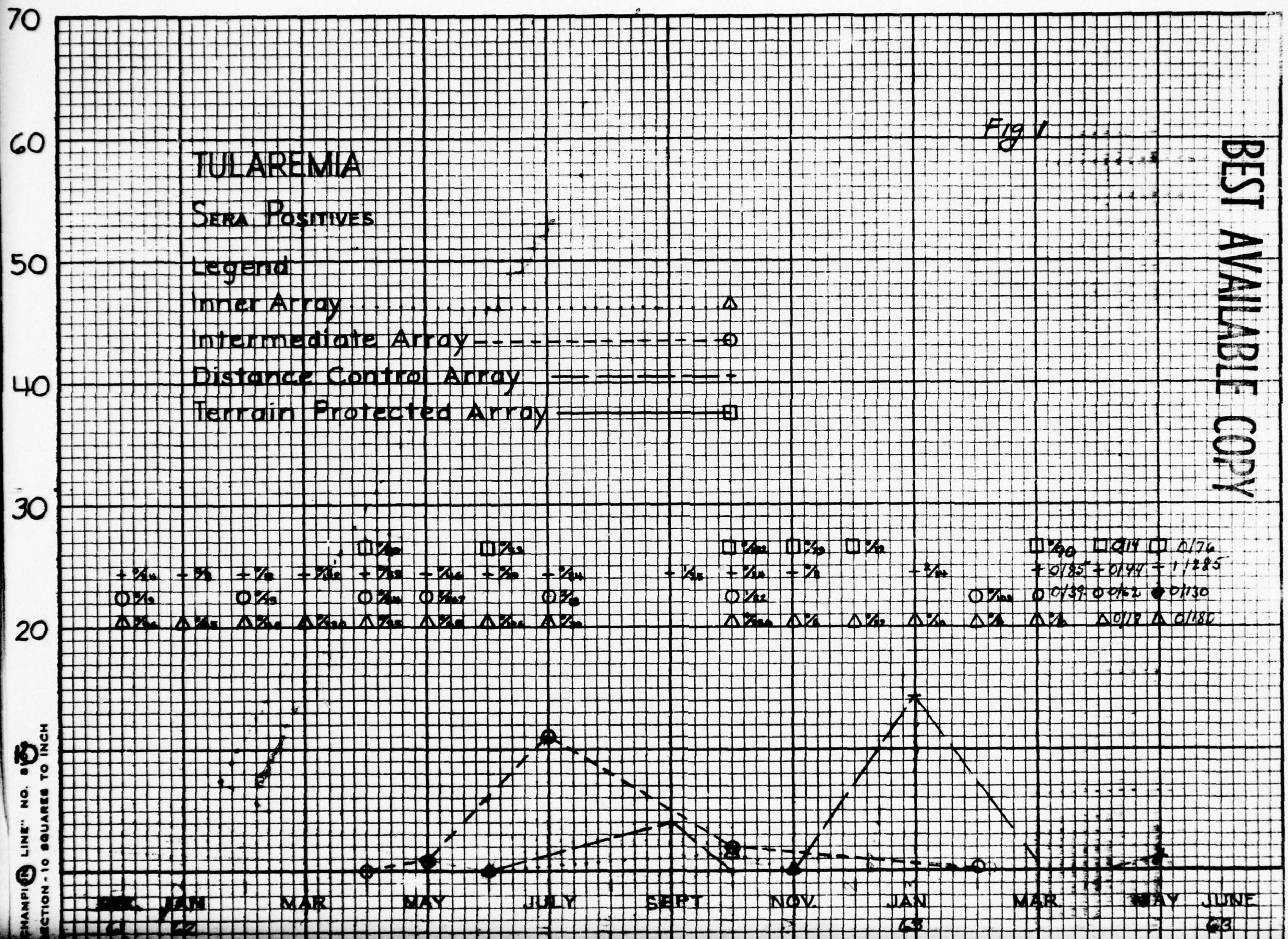
Ectoparasites (Fig. 15) for RMsf showed extremely high peaks of incidence rate for January and June in the Distance Control Zone, and for June and July in the Inner Zone, and July in the Intermediate Zone. Generally the ectoparasite infection appears to be the highest in the early summer months, with low points in March and September. RMsf was noted in birds by sera only in May, with no tissue positives (Figs. 16 and 17). Only a very minor amount was noted in the cattle sera taken in December (Fig. 18).

Psittacosis sera (Fig. 19) tested from August onward, shows a normal cyclic variation in all zones, going as high as 10 per cent in a single month. Correlation of data indicates endemicity in all zones. The same conclusion may be reached from a study of the graphing of the tissue positives of this disease (Fig. 20), although infected ectoparasites were found only in the Inner Array and the Terrain Control Zones in the early fall (Fig. 21). No positive identifications were made from either bird sera or tissue (Fig. 24) in December, the only month in which sera was available.

No Anthrax was discovered either in tissue or ectoparasites (Figs. 25 and 26).

Although not called for by the terms of the contract, samples collected throughout the year were checked for Brucellosis by the University in the public interest, and the results, as indicated by Figs. 27, 28, and 29 are given here for the same reason. A high level was noted by sera (Fig. 27) in March, within DPG, and again within DPG and in the Control Zone in the summer. On the other hand, no positives were obtained from either tissue (Fig. 28) or ectoparasites (Fig. 29).

Tularemia, Q fever, Brucellosis, Psittacosis, and Rocky Mountain spotted fever remain endemic in all of the areas, with periodic endemic foci outbreaks which often reach epizootic proportions for short periods. These diseases appear to be prevalent in the mammals and cattle, but not to any great extent in the birds. Anthrax does not appear to be endemic, but may be latent and should continue to be watched.



BEST AVAILABLE COPY
Fig 1
TULAREMIA
SERA POSITIVES
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
70
60
50
40
30
20
10
DEC. 61
JAN 62
MAR
MAY
JULY
SEPT
NOV.
JAN 63
MAR.
MAY
JUNE 63
"CHAMPION LINE" NO. 8
SECTION - 10 SQUARES TO INCH

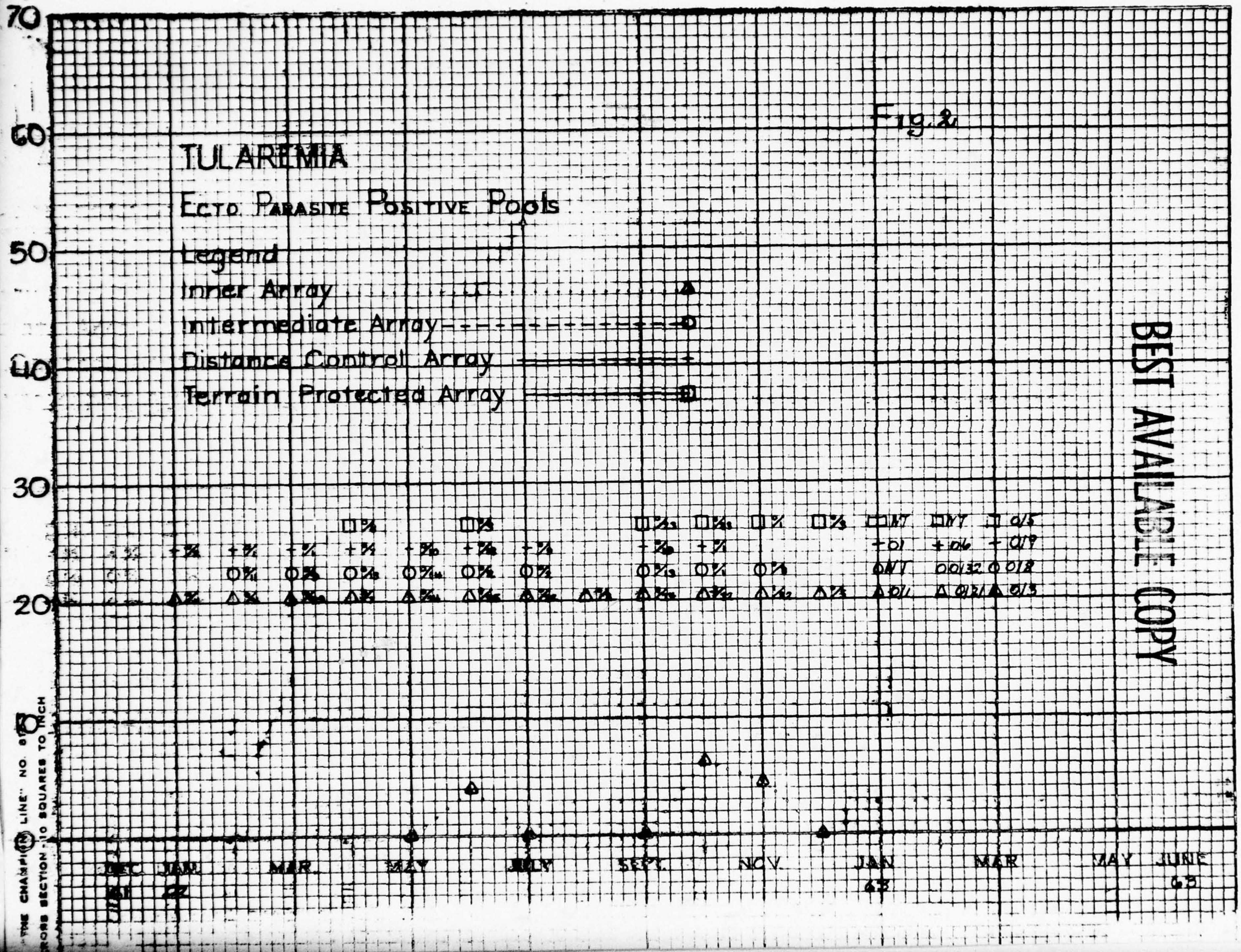
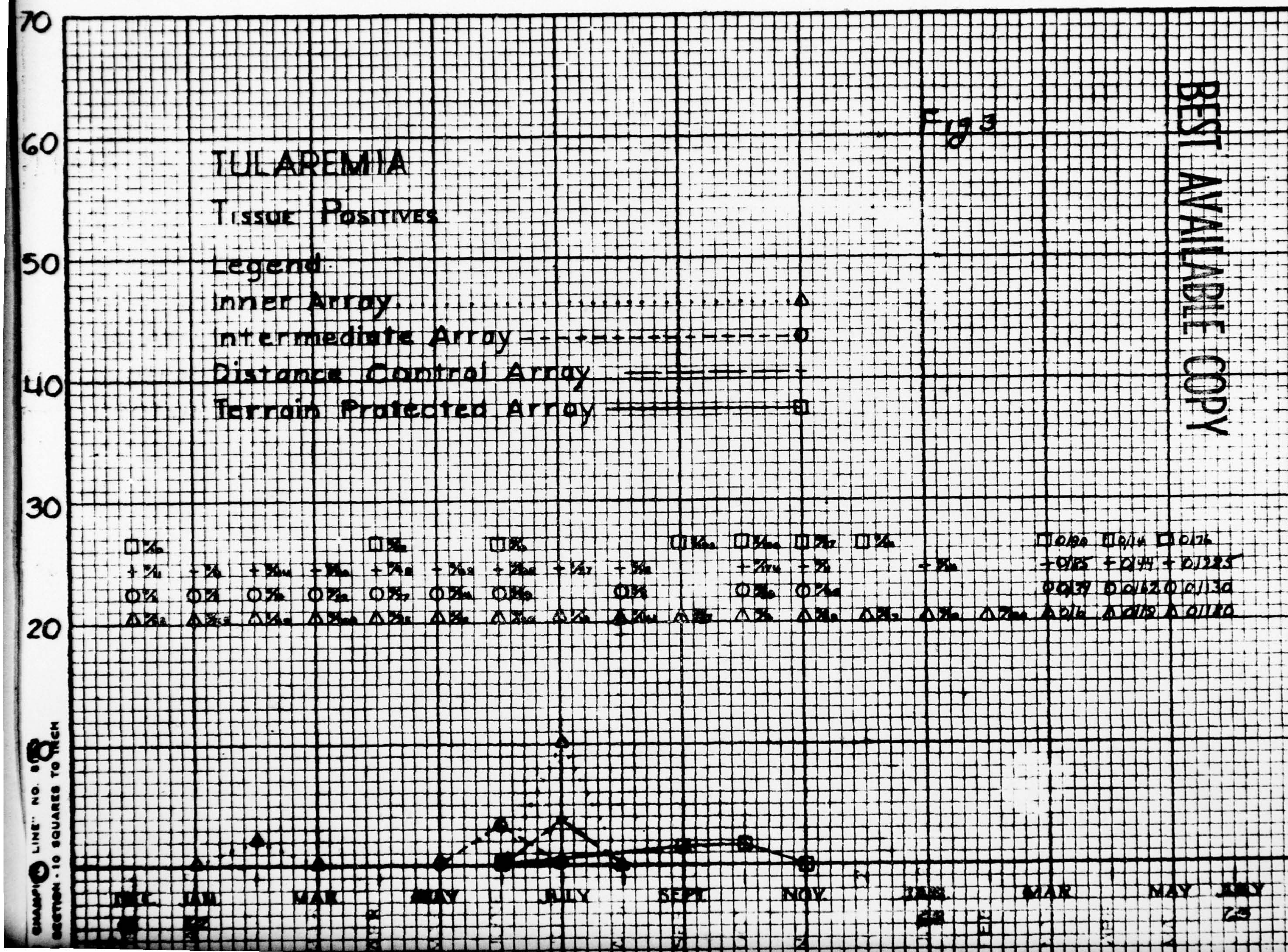


Fig. 2
TULAREMIA
Ecto Parasite Positive Pools
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
70
60
50
40
30
20
10
DEC 61
JAN 62
MAR.
MAY
JULY
SEPT.
NOV.
JAN 63
MAR
MAY
JUNE 63



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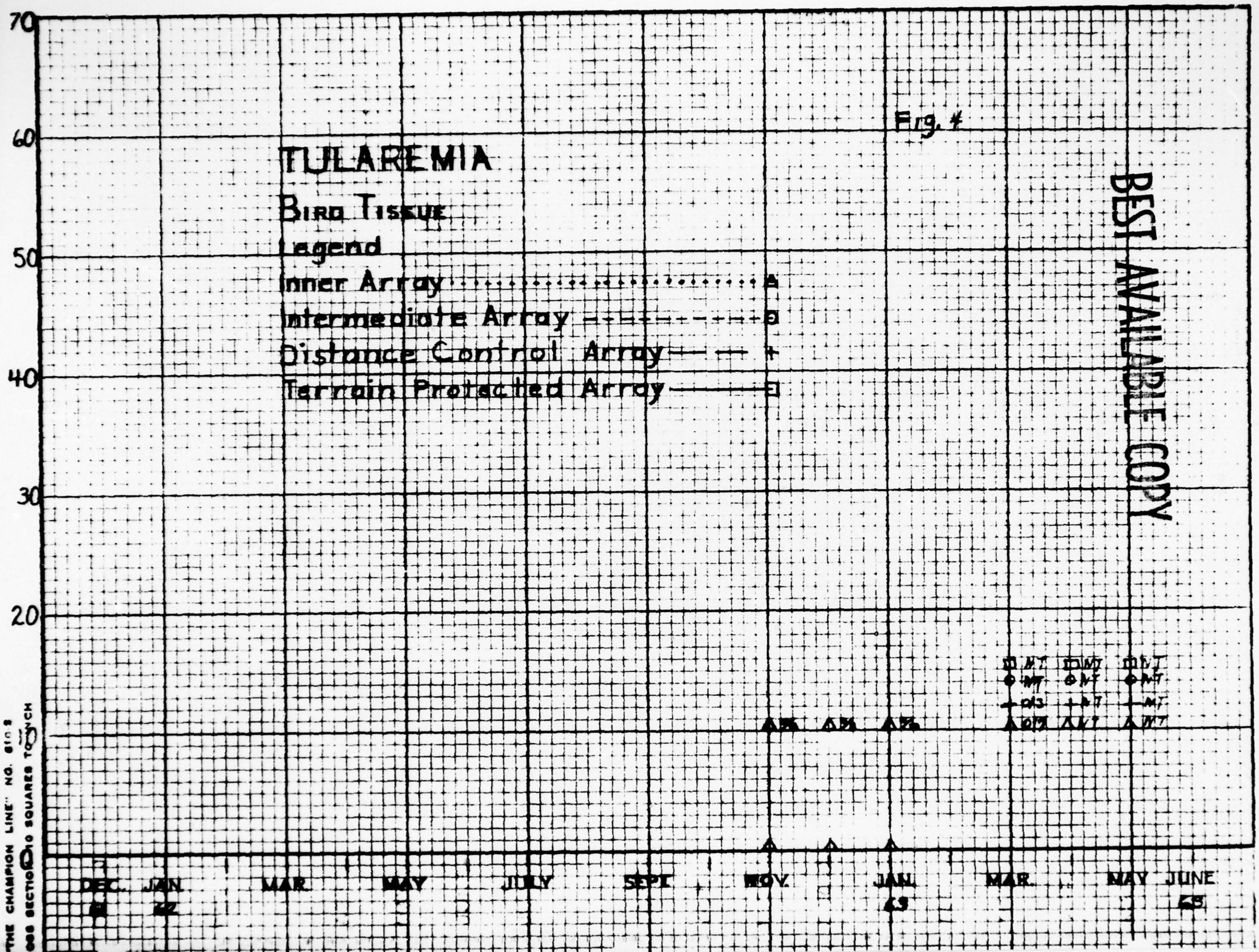
Fig. 4
TULAREMIA
Bird Tissue
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
70
60
50
40
30
20
10
0
DEC.
JAN.
MAR.
MAY
JULY
SEPT.
NOV.
JAN.
MAR.
MAY
JUNE
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"THE CHAMPION LINE" NO. 810 S
CROSS SECTION 10 SQUARES TO INCH

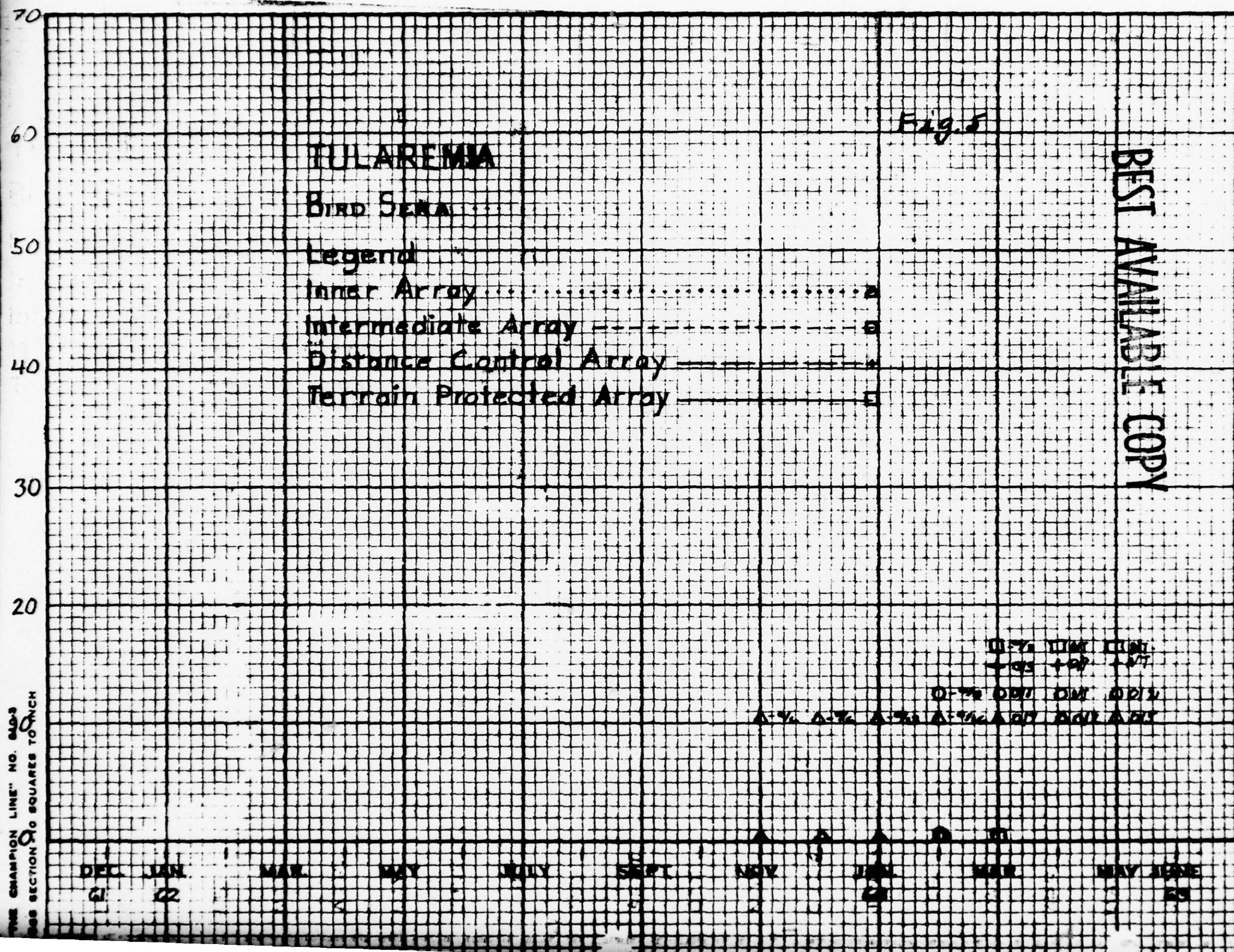

TULAREMIA
BIRD SERA
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
70
60
50
40
30
20
10
0
DEC. 61
JAN. 62
MAR.
MAY
JULY
SEPT.
NOV.
JAN. 63
MAR.
MAY
JUNE 63
BEST AVAILABLE COPY
"THE CHAMPION LINE" NO.
SECTION 10 SQUARES TO INCH

Fig. 5

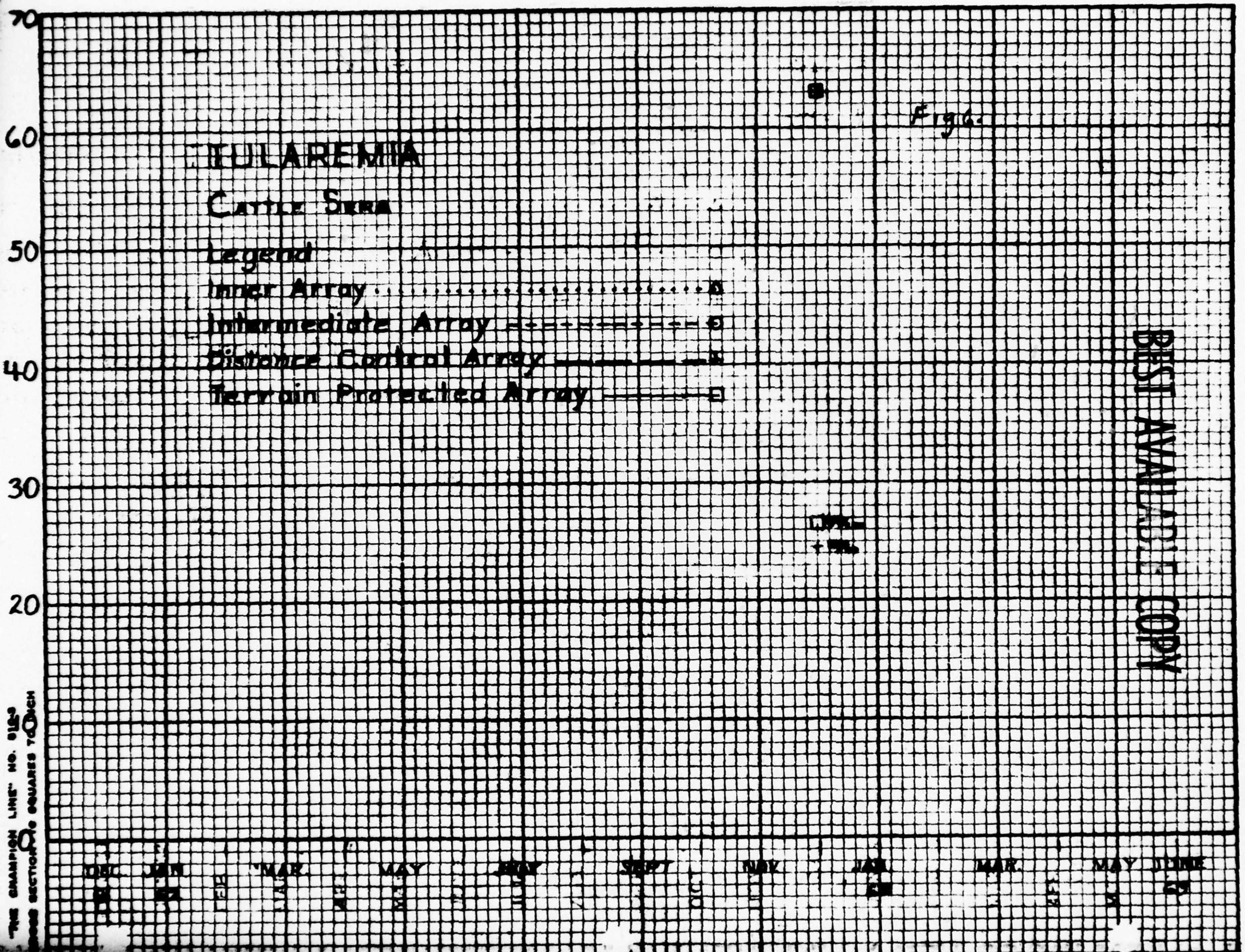
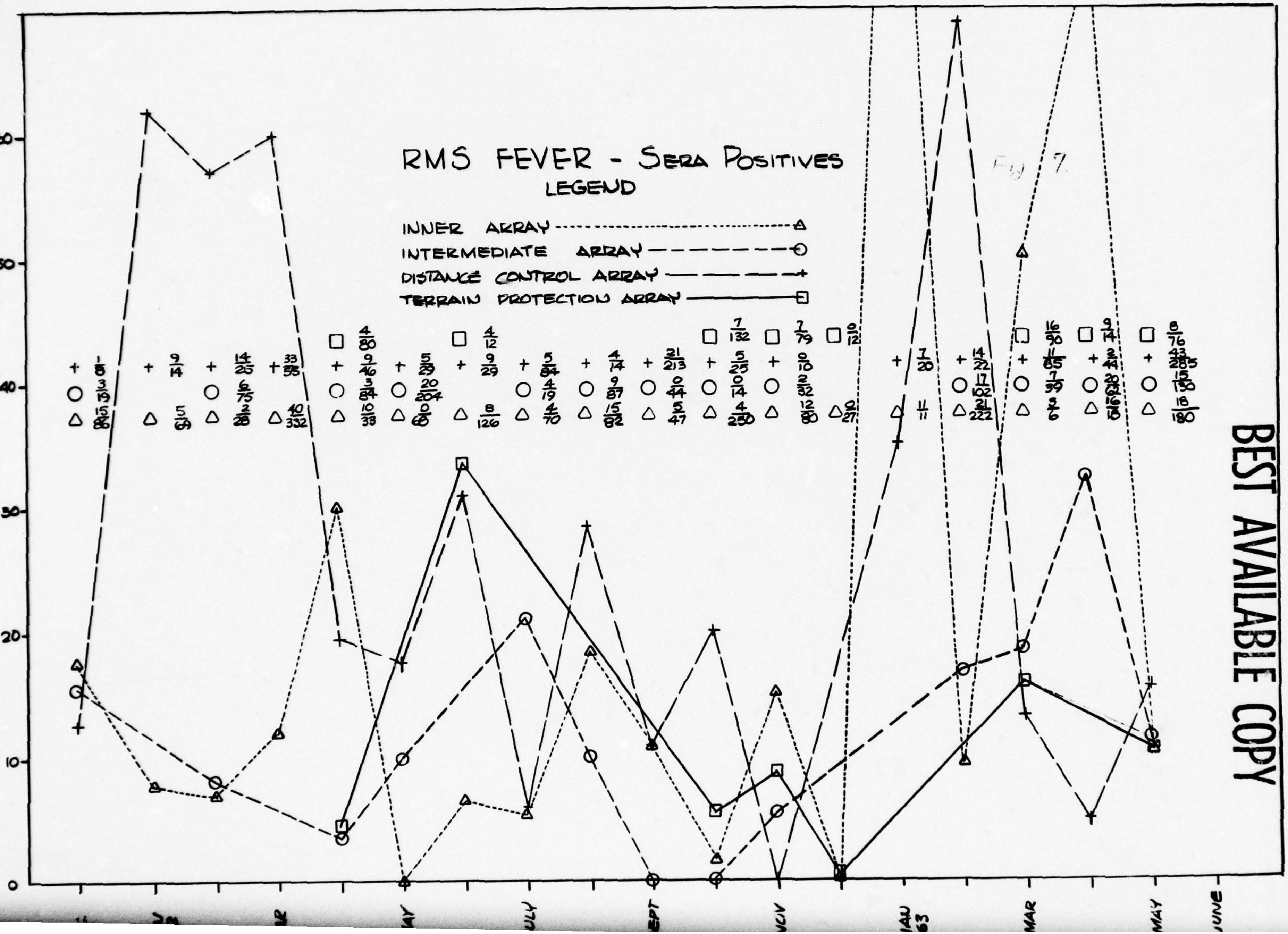
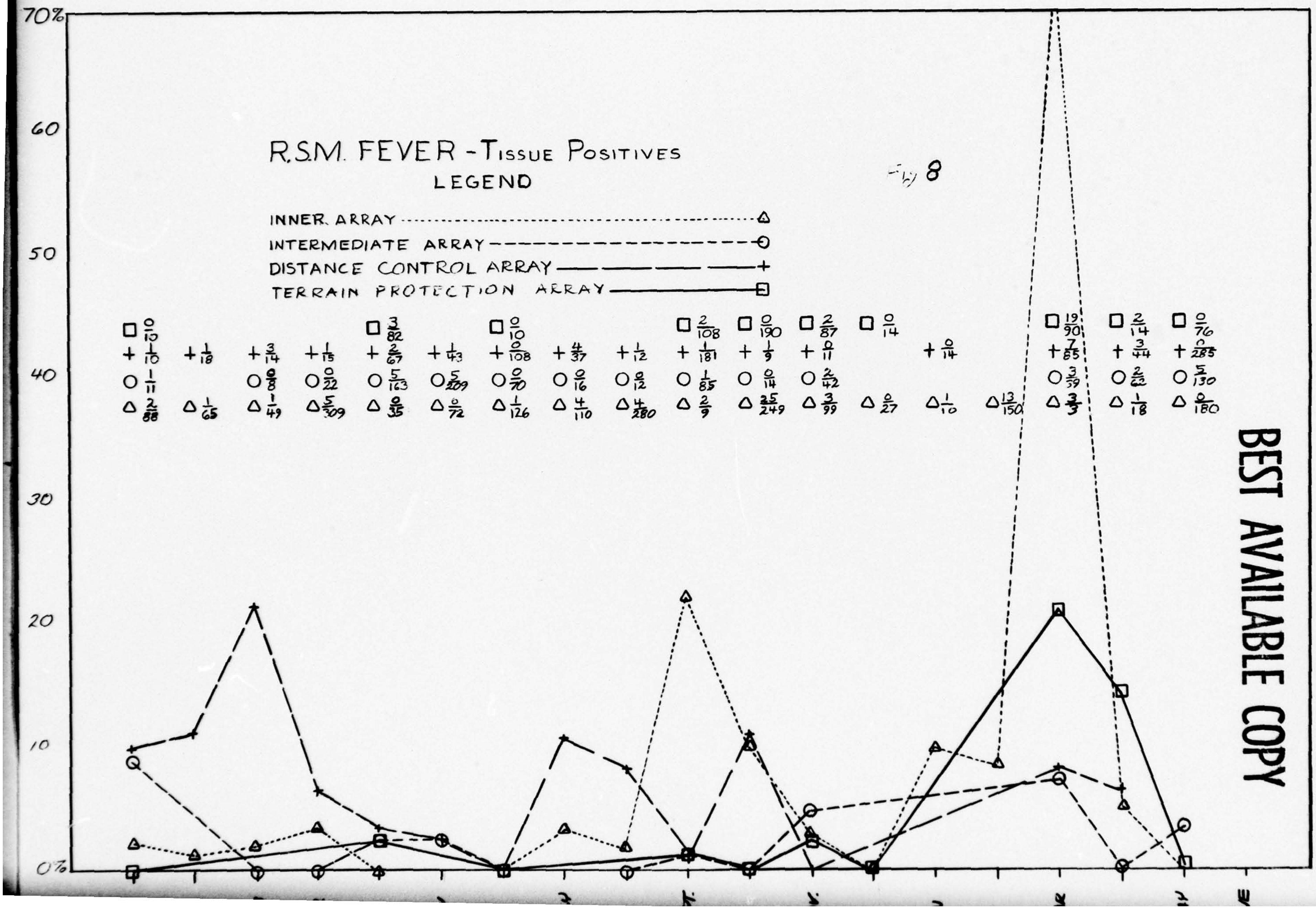


Fig. 6
TULAREMIA
Cattle Sera
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
70
60
50
40
30
20
0
DEC.
JAN
MAR
MAY
SEPT
NOV
JAN
MAR.
MAY
JUNE


RMS FEVER - SERA POSITIVES
LEGEND
INNER ARRAY
INTERMEDIATE ARRAY
DISTANCE CONTROL ARRAY
TERRAIN PROTECTION ARRAY
60
50
40
30
20
10
0
JULY
SEPT
MAR
MAY
JUNE


R.S.M. FEVER - Tissue Positives
LEGEND
INNER ARRAY
INTERMEDIATE ARRAY
DISTANCE CONTROL ARRAY
TERRAIN PROTECTION ARRAY
Fig 8
70%
60
50
40
30
20
10
0%

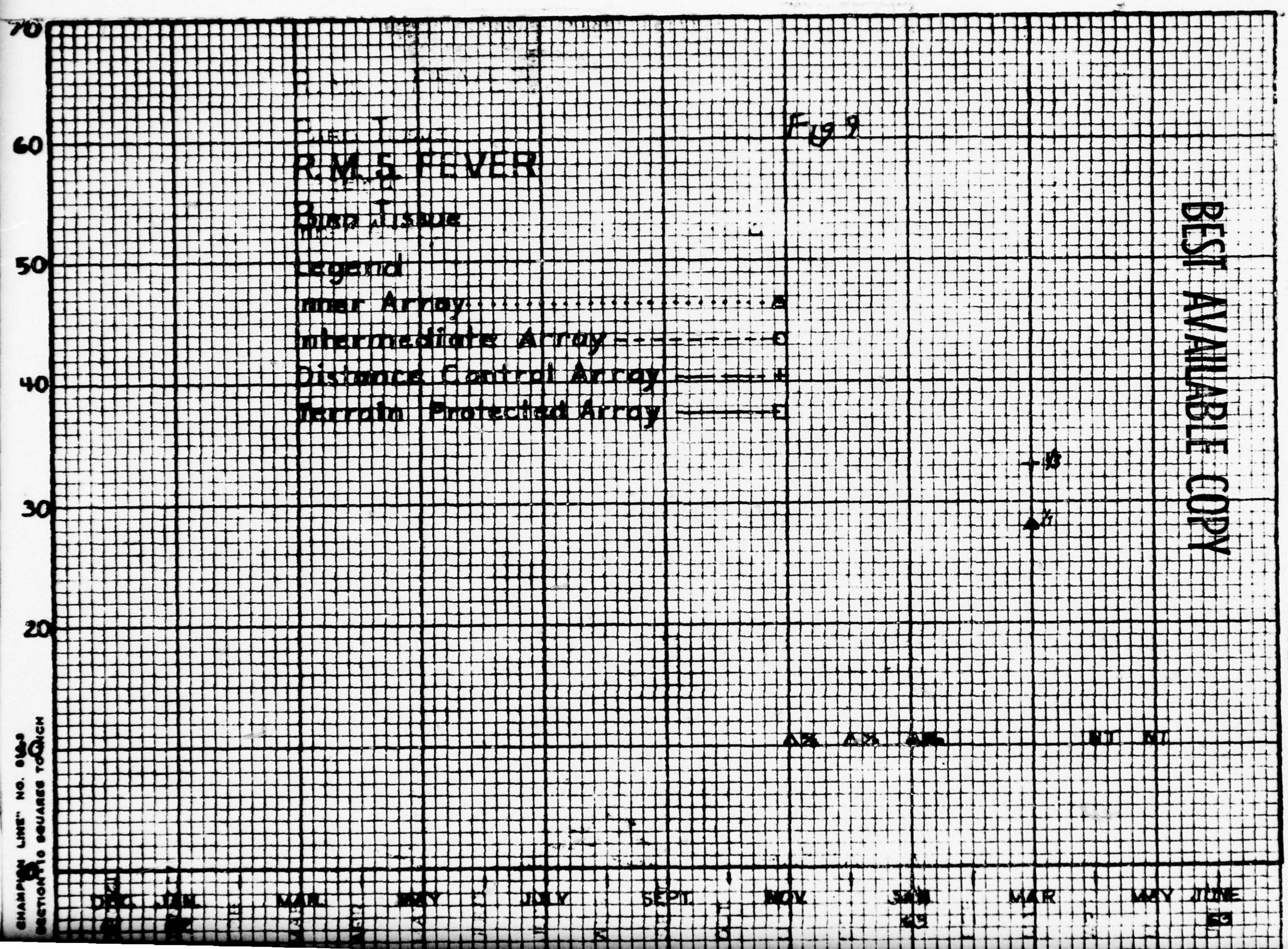


Fig 9
R.M.S. FEVER
Bird Tissue
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
70
60
50
40
30
20
10
DEC.
JAN.
MAR.
MAY
JULY
SEPT.
NOV.
JAN.
MAR.
MAY
JUNE
BEST AVAILABLE COPY
"CHAMPION LINE" NO. 8163
SECTION 10 SQUARES TO INCH

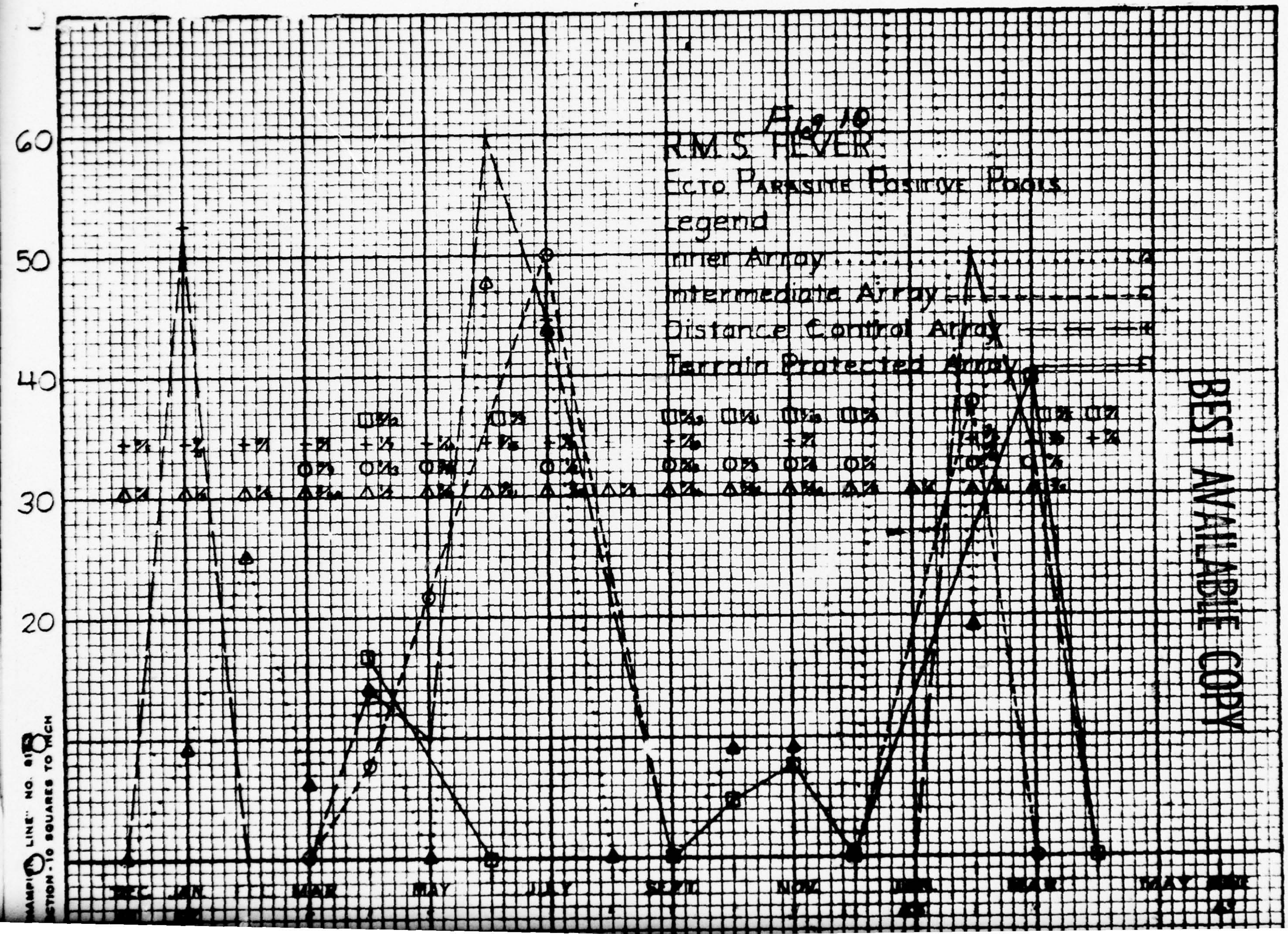
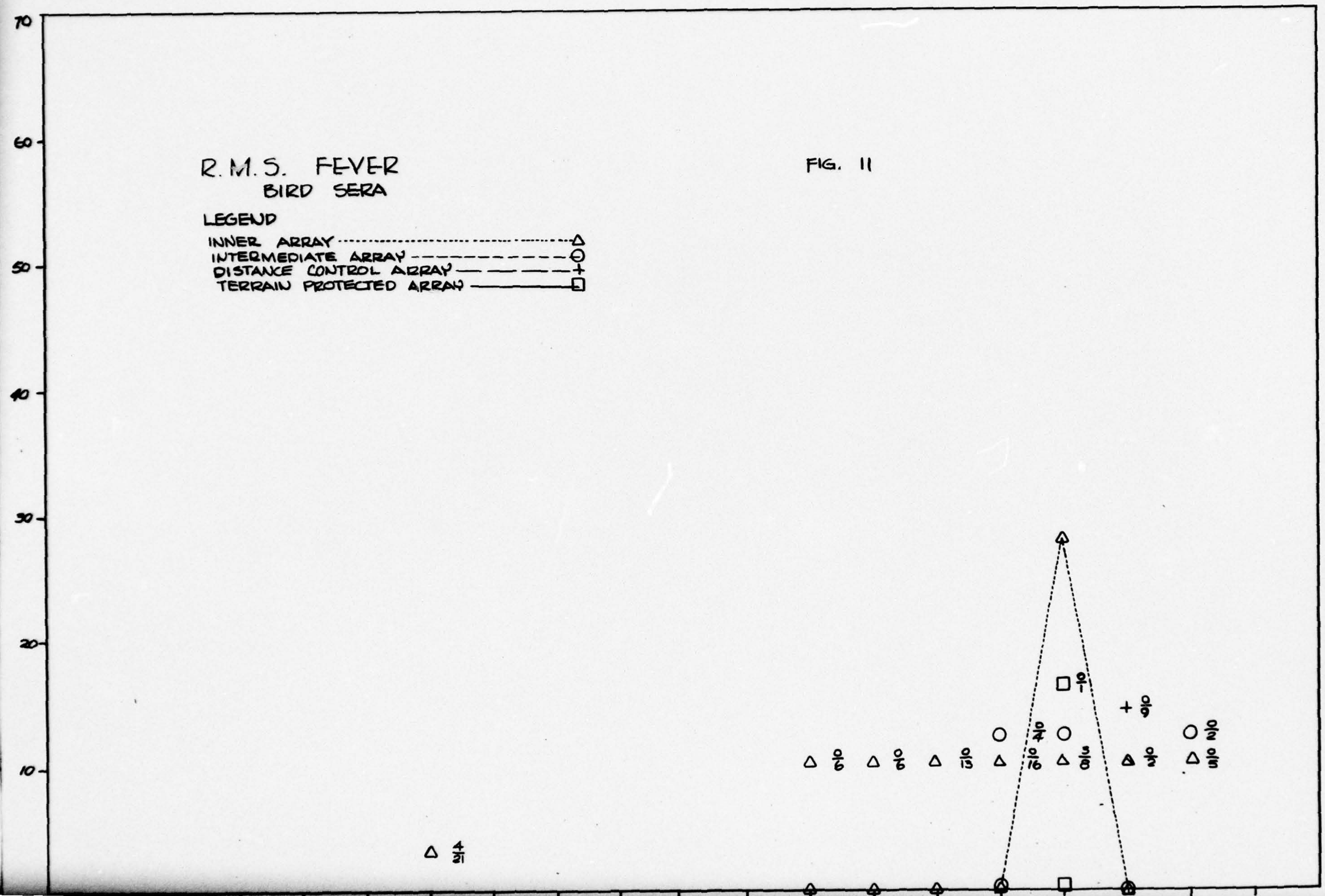


Fig 10
R.M.S. FEVER
Ecto Parasite Positive Pools
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
60
50
40
30
20
10
0
DEC
JAN
MAR
MAY
JULY
SEPT
NOV
MAR
MAY
BEST AVAILABLE COPY



R.M.S. FEVER
BIRD SERA
LEGEND
INNER ARRAY
INTERMEDIATE ARRAY
DISTANCE CONTROL ARRAY
TERRAIN PROTECTED ARRAY
70
60
50
40
30
20
10
4/21
0/6
0/6
0/13
0/16
0/4
3/8
0/1
0/9
0/2
0/2
0/5

FIG. 11

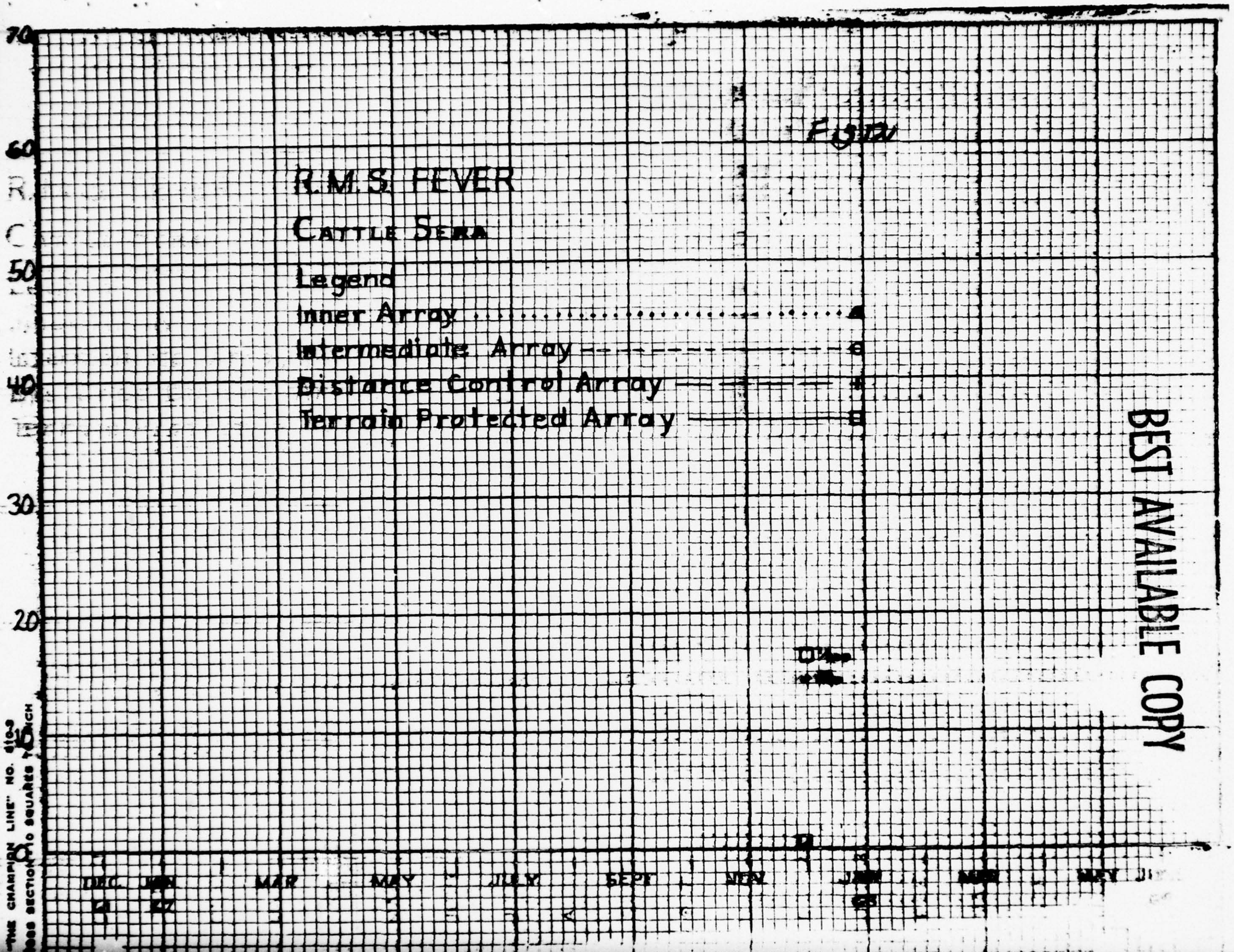


Fig
R.M.S. FEVER
CATTLE SERA
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
70
60
50
40
30
20
10
0
DEC.
JAN
MAR
MAY
JULY
SEPT
NOV
JAN
MAY
"THE CHAMPION LINE" NO. 610-9
SECTION 10 SQUARES TO INCH

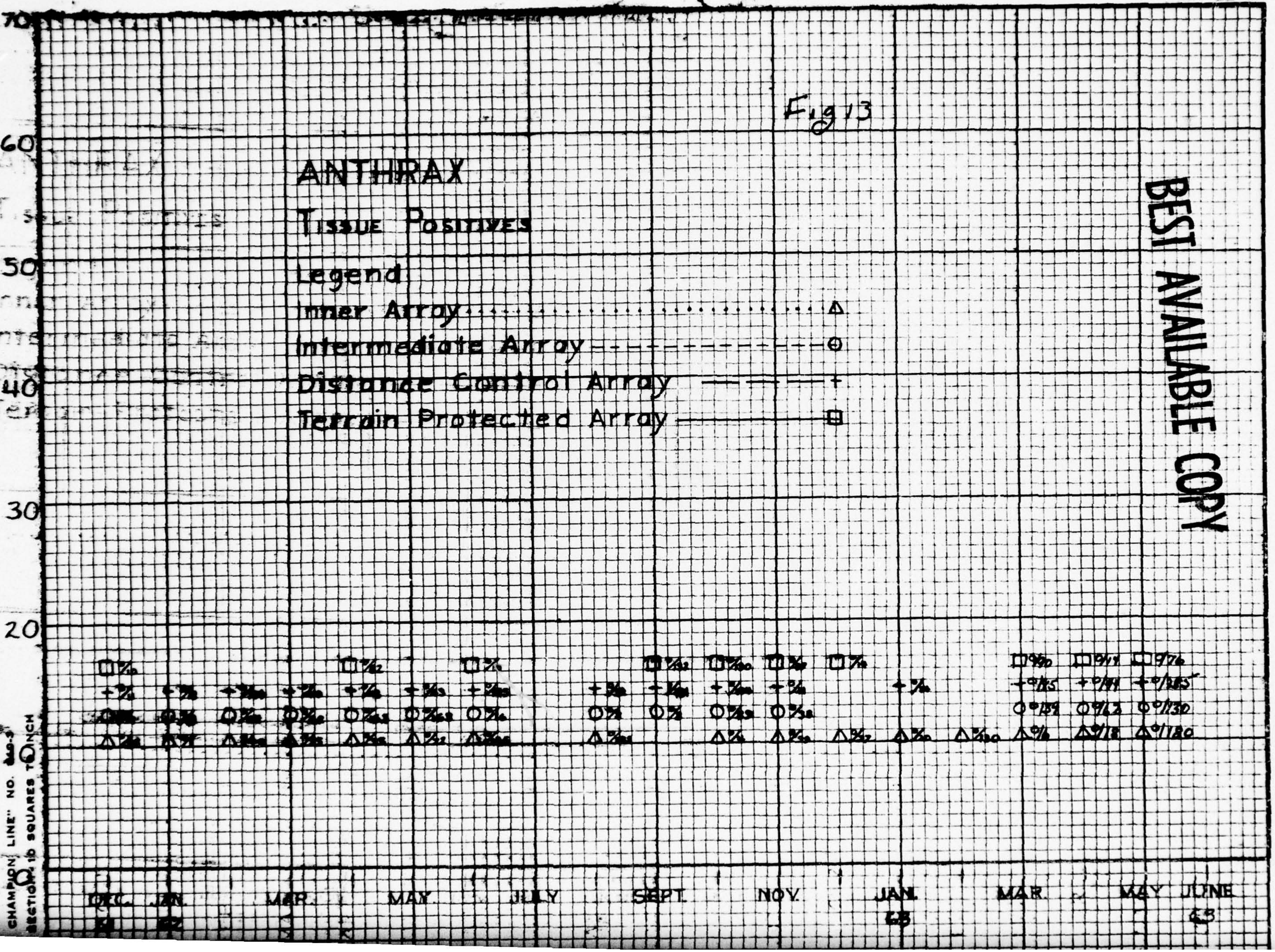

ANTHRAX
TISSUE POSITIVES
Legend
Inner Array △
Intermediate Array ⊖
Distance Control Array +
Terrain Protected Array ⊞
70
60
50
40
30
20
10
0
DEC. 61
JAN. 62
MAR.
MAY
JULY
SEPT.
NOV.
JAN. 63
MAR.
MAY
JUNE 63
"CHAMPION LINE" NO.
SECTION 10 SQUARES TO INCH

Fig 13

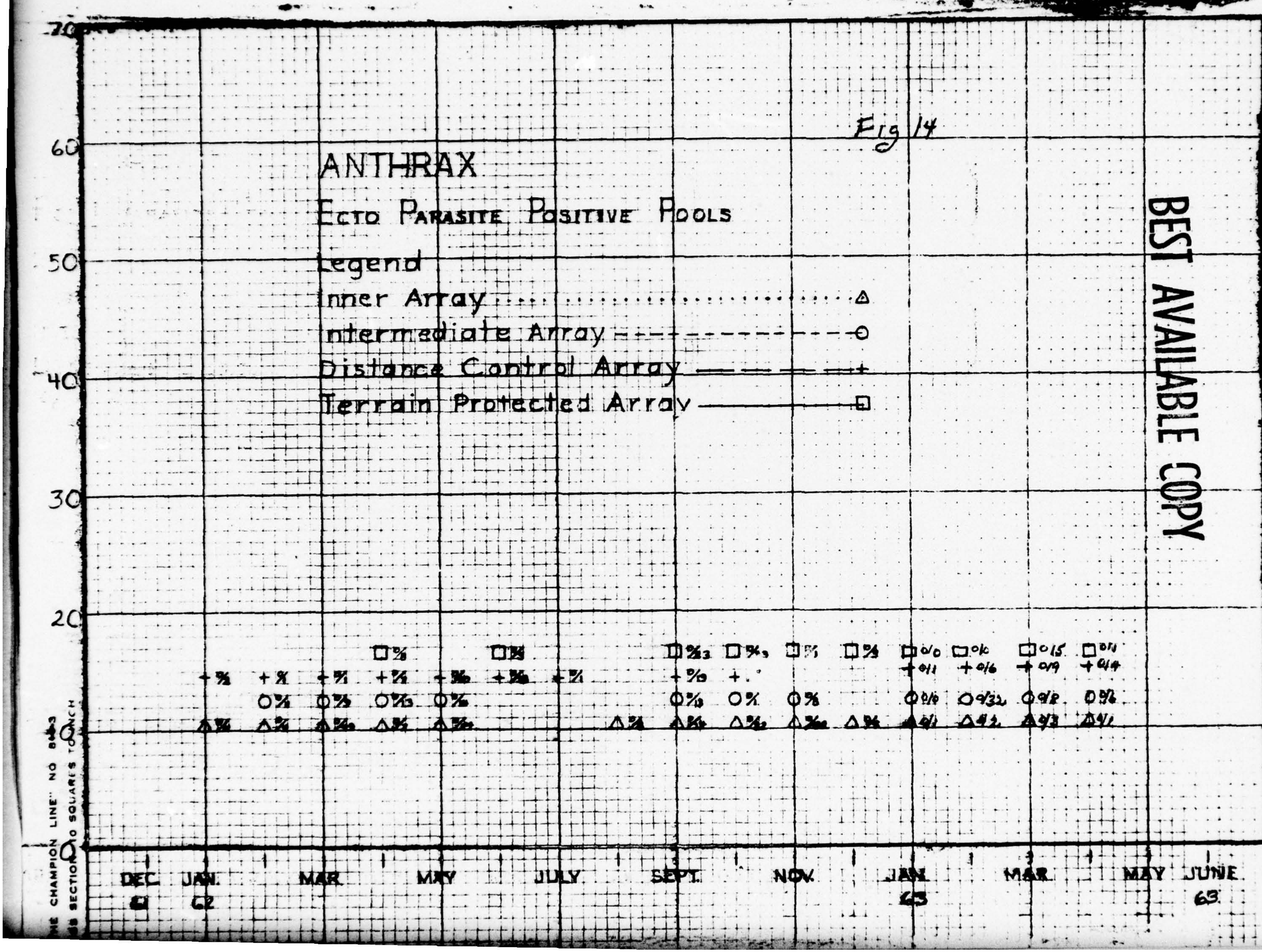


Fig 14
ANTHRAX
ECTO PARASITE POSITIVE POOLS
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
70
60
50
40
30
20
10
0
DEC 61
JAN. 62
MAR
MAY
JULY
SEPT.
NOV.
JAN 63
MAR
MAY
JUNE 63
BEST AVAILABLE COPY

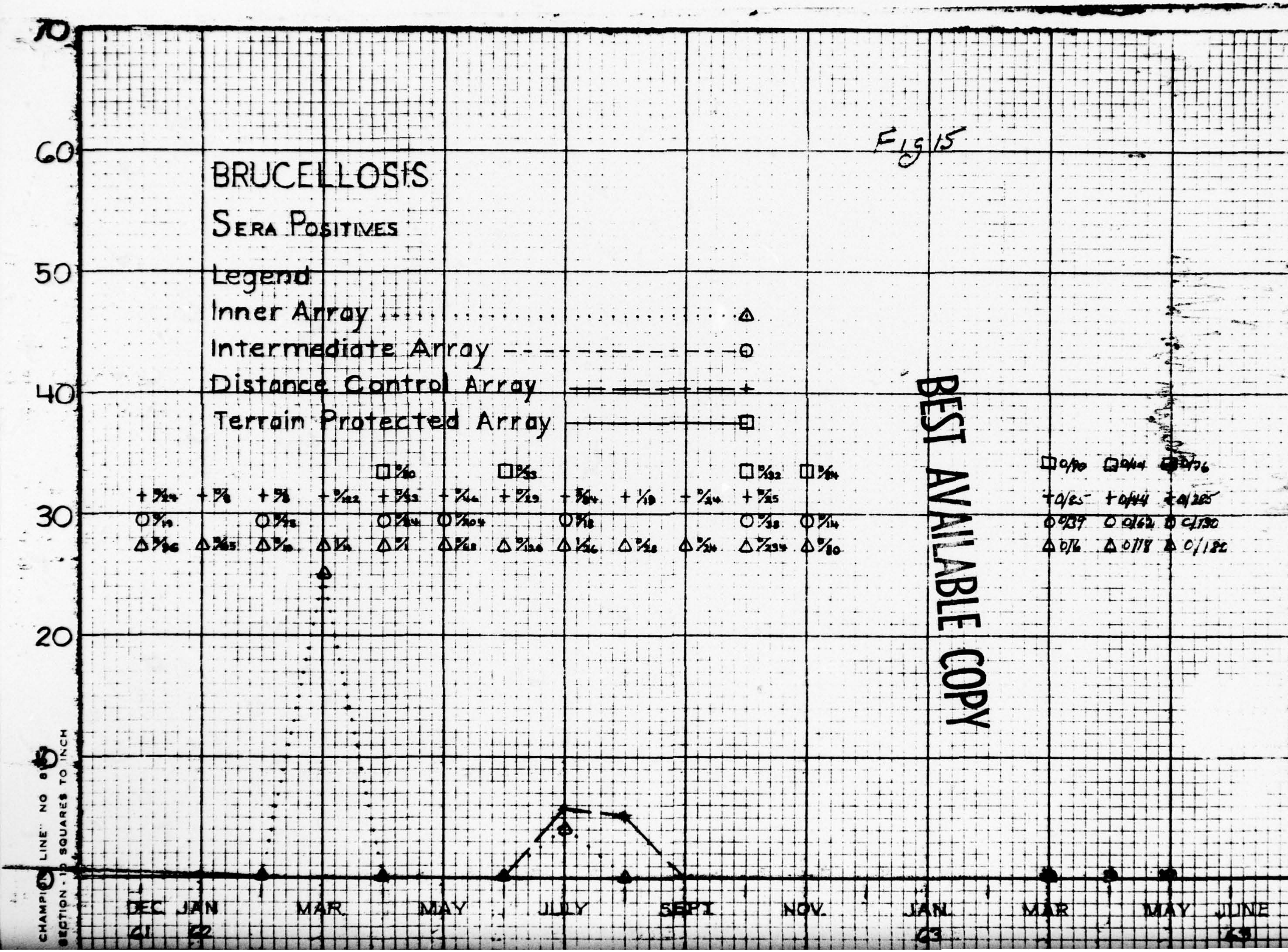


Fig 15
BRUCELLOSIS
SERA POSITIVES
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
70
60
50
40
30
20
10
0
DEC 41
JAN 42
MAR.
MAY
JULY
SEPT
NOV.
JAN. 43
MAR
MAY
JUNE 43
BEST AVAILABLE COPY
CHAMPION LINE" NO 8
SECTION - 10 SQUARES TO INCH

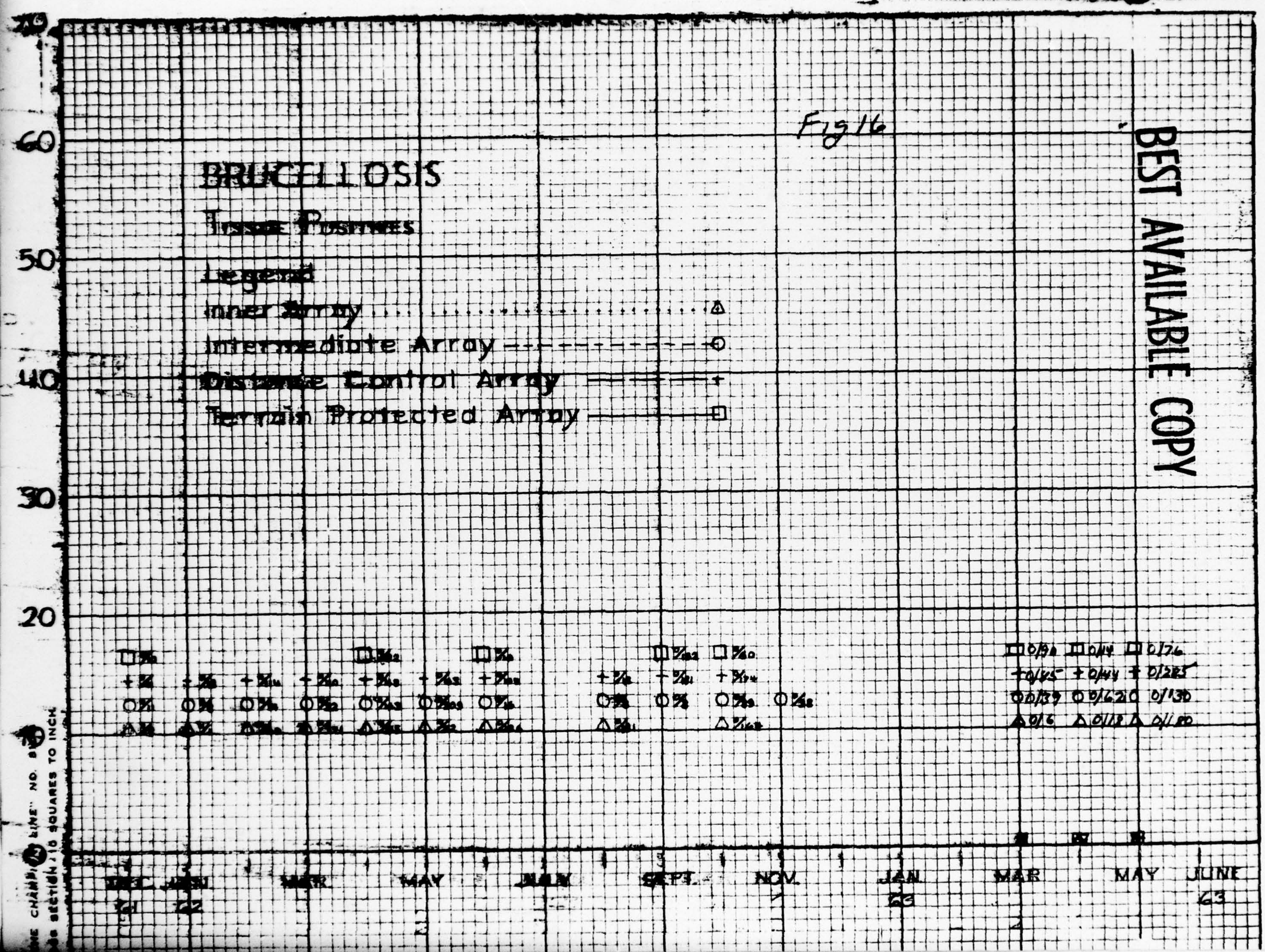


Fig 16
BRUCELLOSIS
Tissue Positives
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
60
50
40
30
20
10
DEC. 61
JAN. 62
MAR
MAY
JULY
SEPT.
NOV.
JAN. 63
MAR
MAY
JUNE 63
BEST AVAILABLE COPY

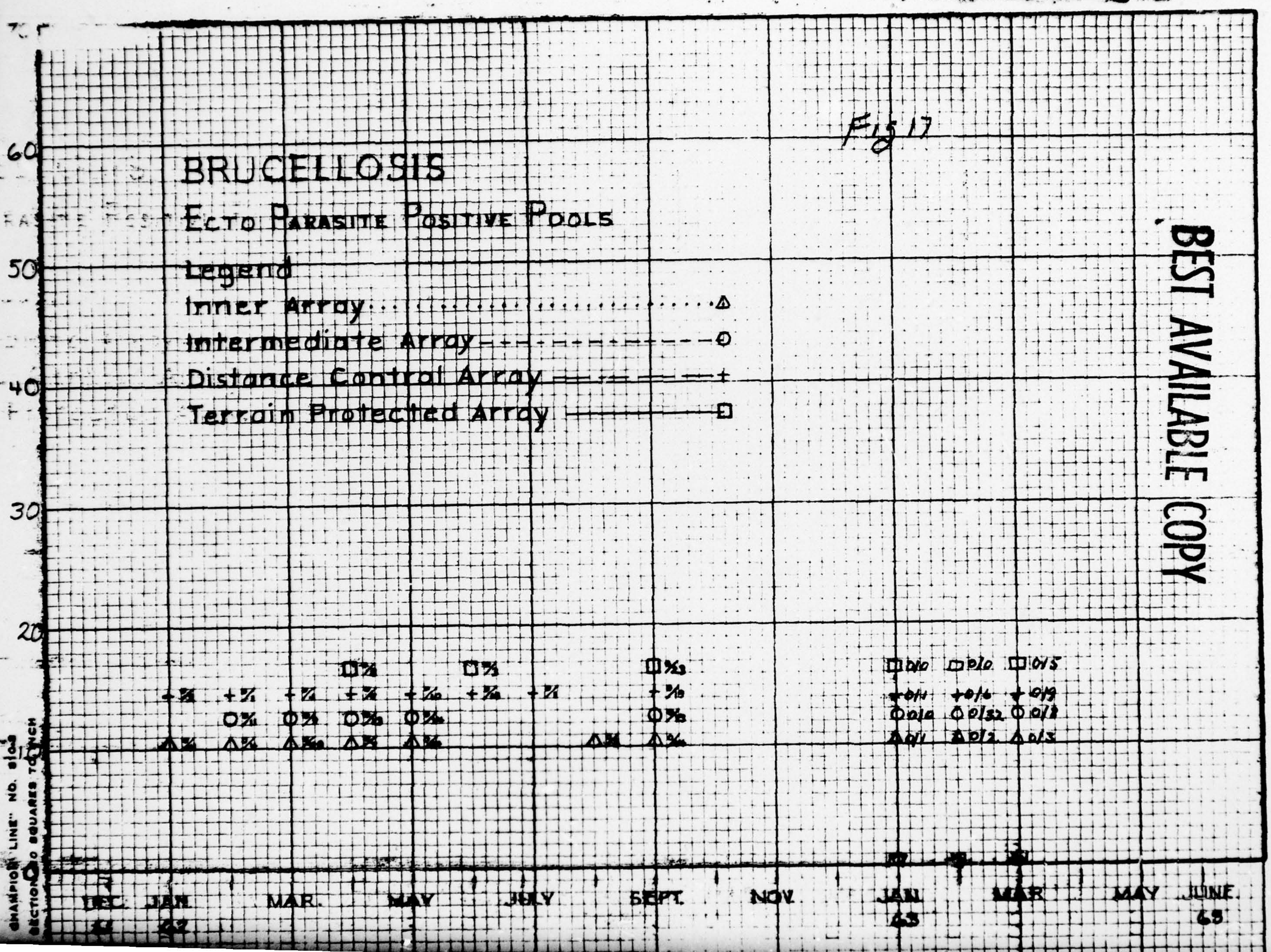
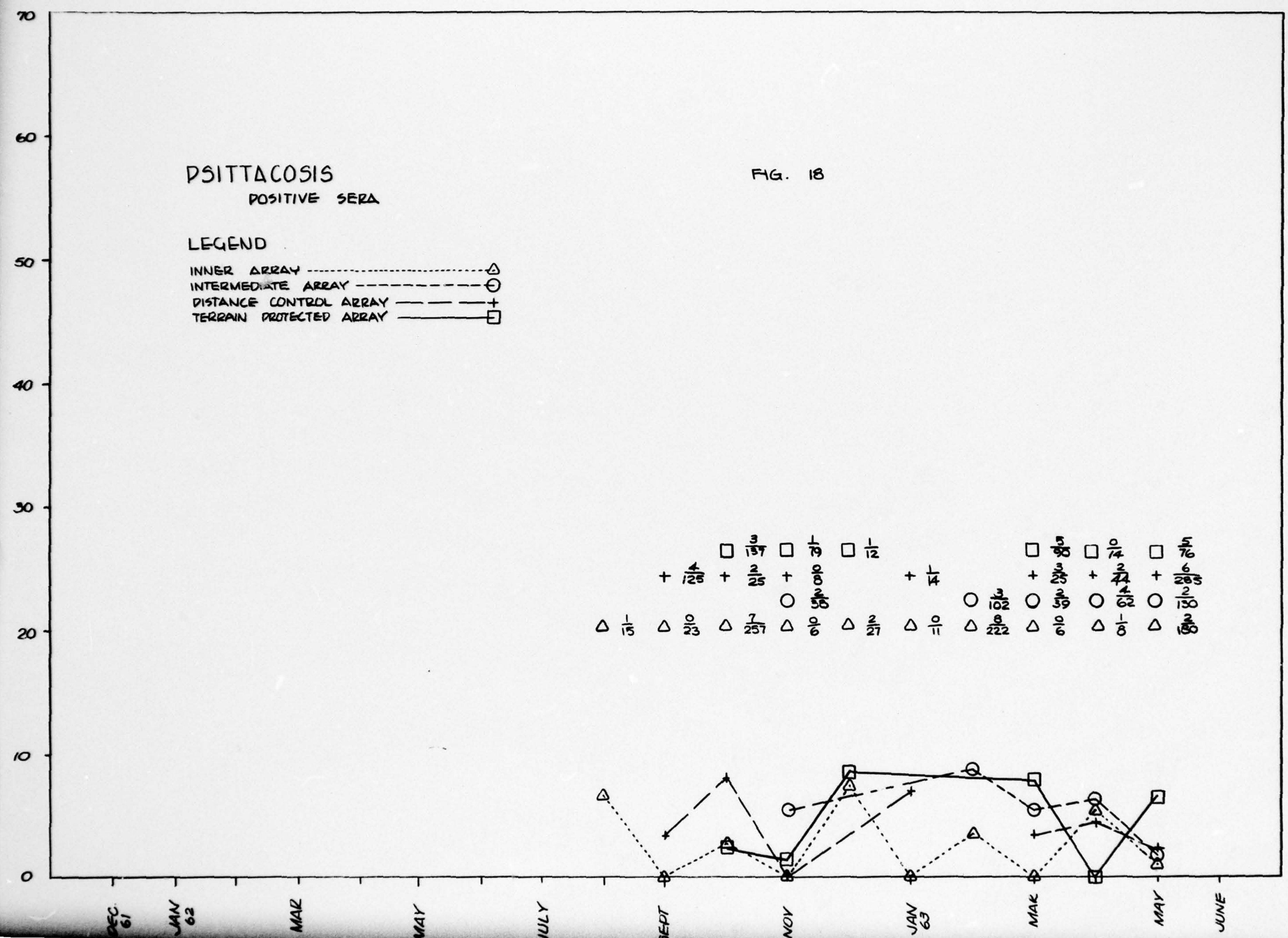
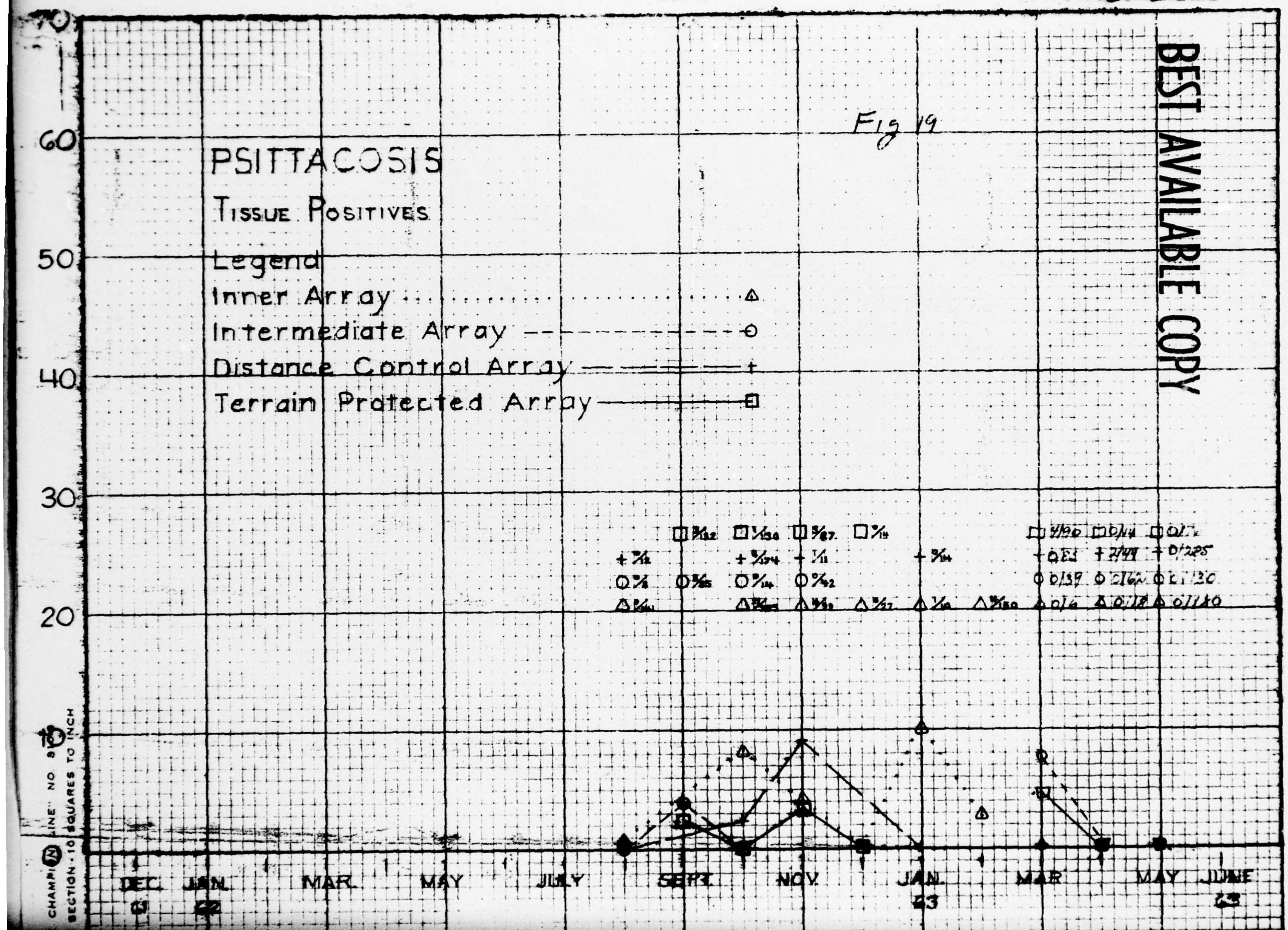


Fig 17
BRUCELLOSIS
Ecto Parasite Positive Pools
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
60
50
40
30
20
10
0
DEC. 61
JAN 62
MAR.
MAY
JULY
SEPT.
NOV.
JAN 63
MAR
MAY
JUNE 63

FIG. 18


PSITTACOSIS
POSITIVE SERA
LEGEND
INNER ARRAY
INTERMEDIATE ARRAY
DISTANCE CONTROL ARRAY
TERRAIN PROTECTED ARRAY
70
60
50
40
30
20
10
0
DEC 61
JAN 62
MAR
MAY
JULY
SEPT
NOV
JAN 63
MAR
MAY
JUNE


BEST AVAILABLE COPY
Fig 19
PSITTACOSIS
Tissue Positives
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
70
60
50
40
30
20
10
DEC. 61
JAN. 62
MAR.
MAY
JULY
SEPT.
NOV.
JAN. 63
MAR.
MAY
JUNE 63
CHAMPION LINE NO
SECTION - 10 SQUARES TO INCH

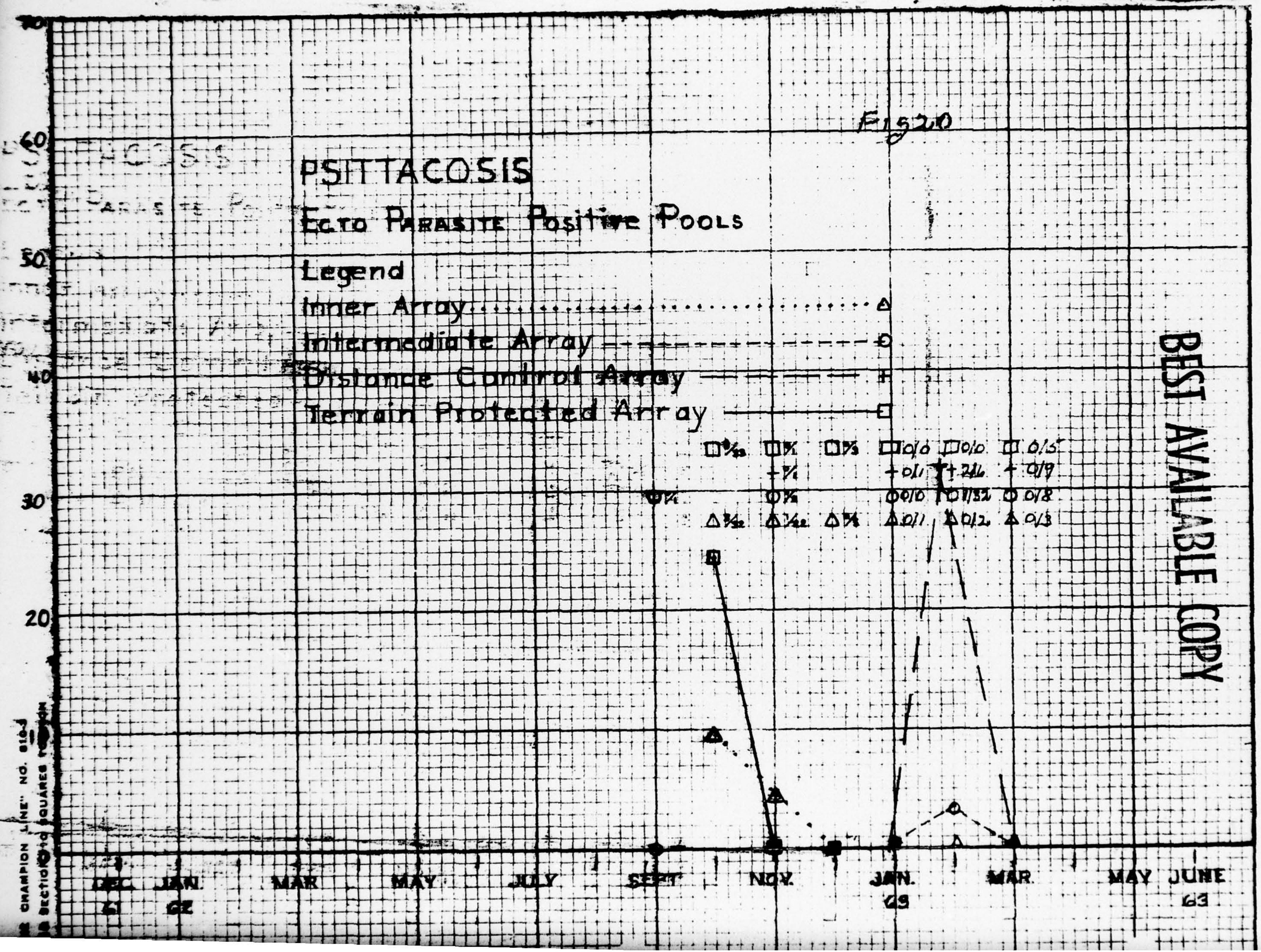
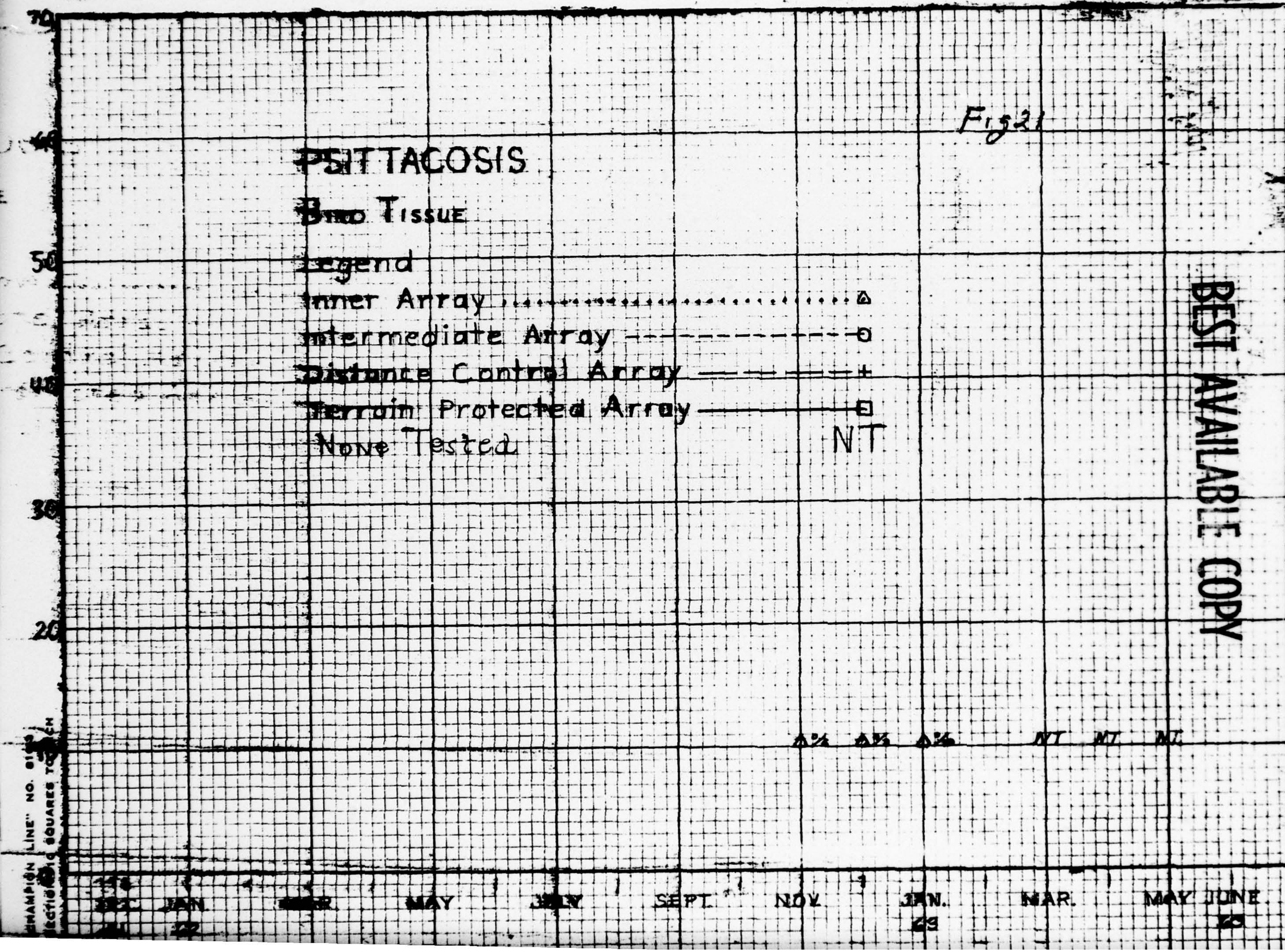


Fig 20
PSITTACOSIS
Ecto Parasite Positive Pools
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
BEST AVAILABLE COPY
60
50
40
30
20
DEC. 61
JAN. 62
MAR
MAY
JULY
SEPT
NOV.
JAN. 63
MAR
MAY
JUNE 63
CHAMPION LINE" NO. 810-J
SECTION 10 SQUARES TO INCH

Fig 21



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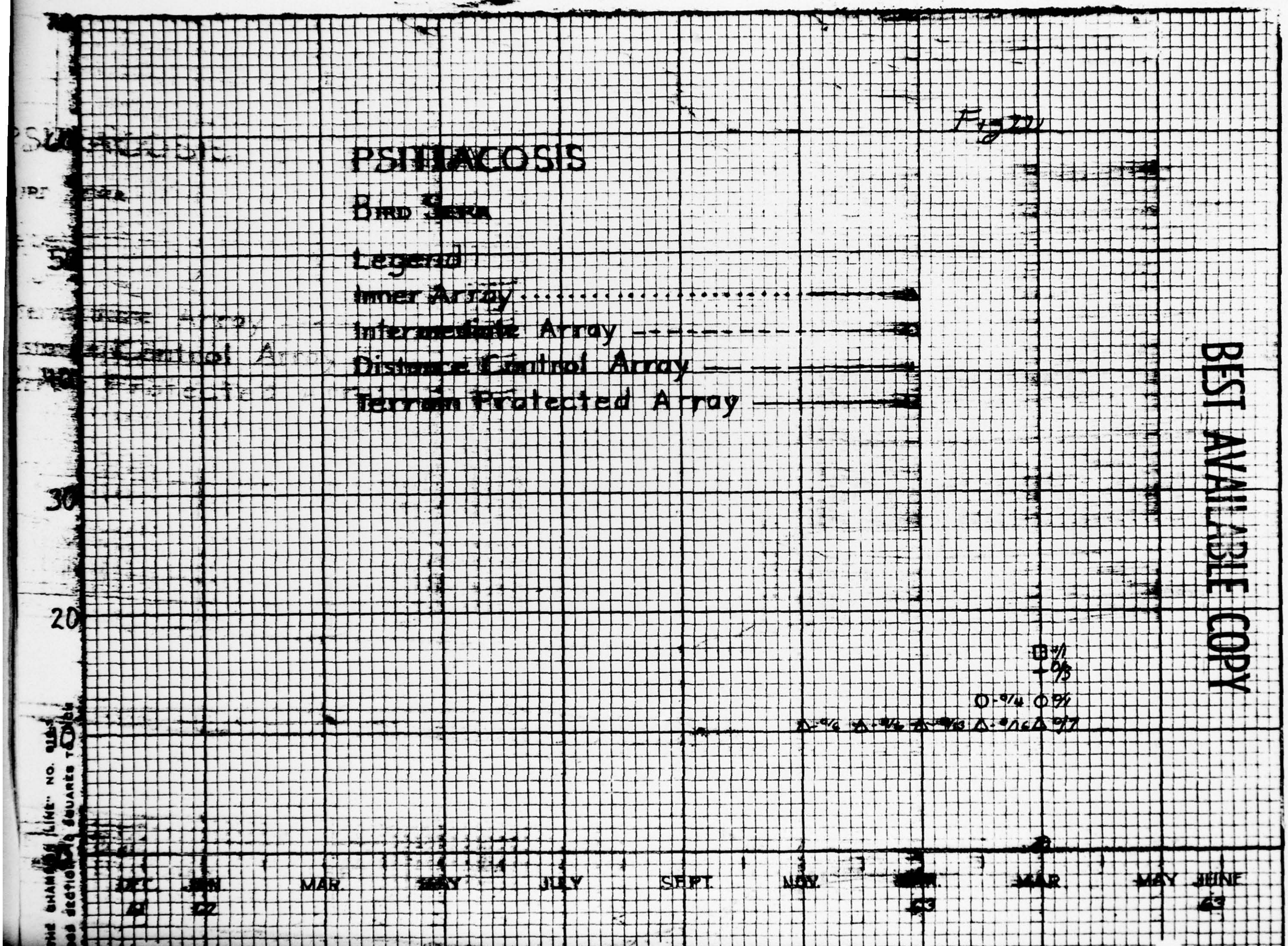
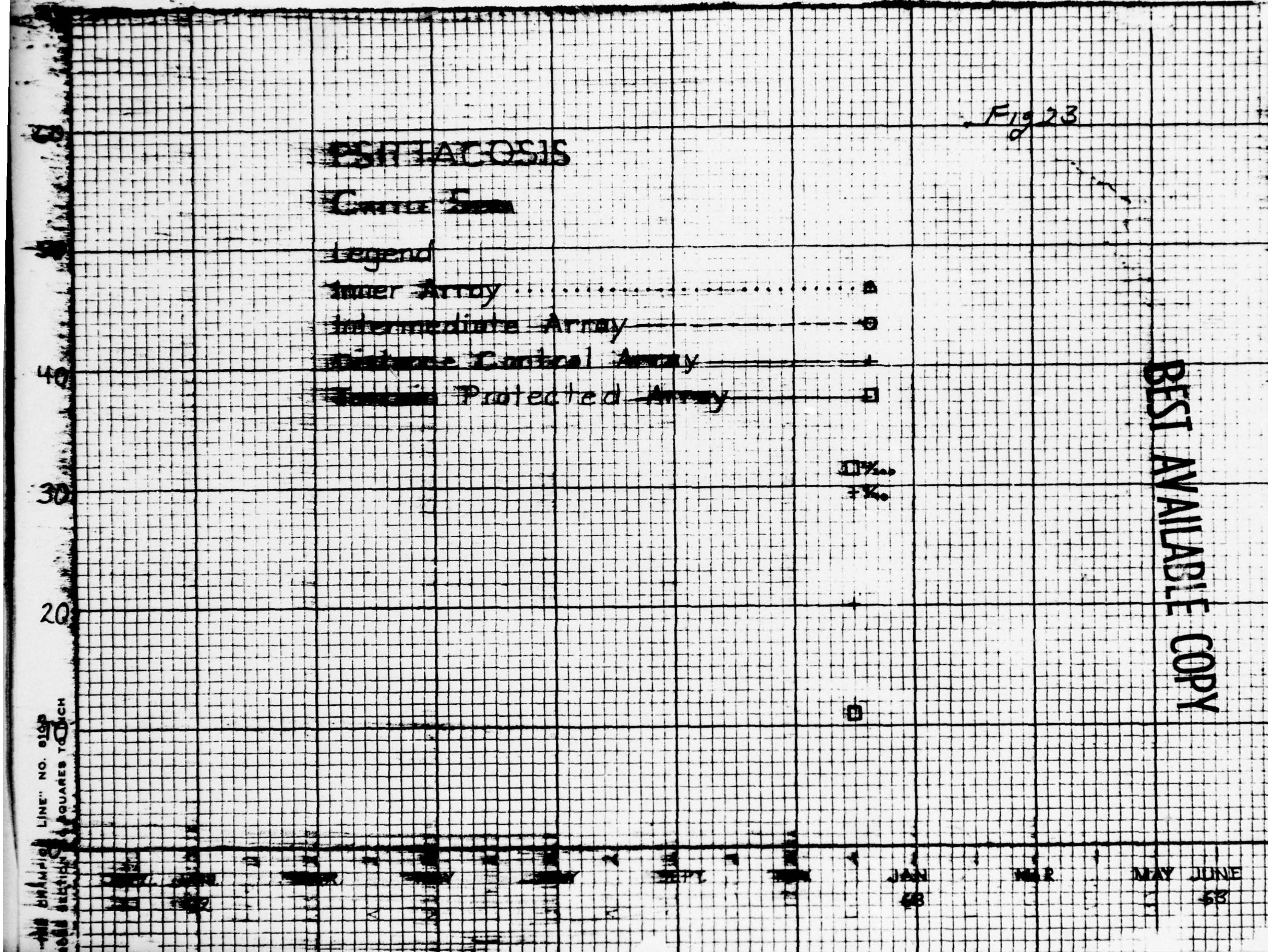

PSITTACOSIS
Legend
Array
Distance Control Array
Terrain Protected Array
30
20
MAR.
JULY
SEPT.
NOV.
MAR.
MAY
JUNE

Fig 23



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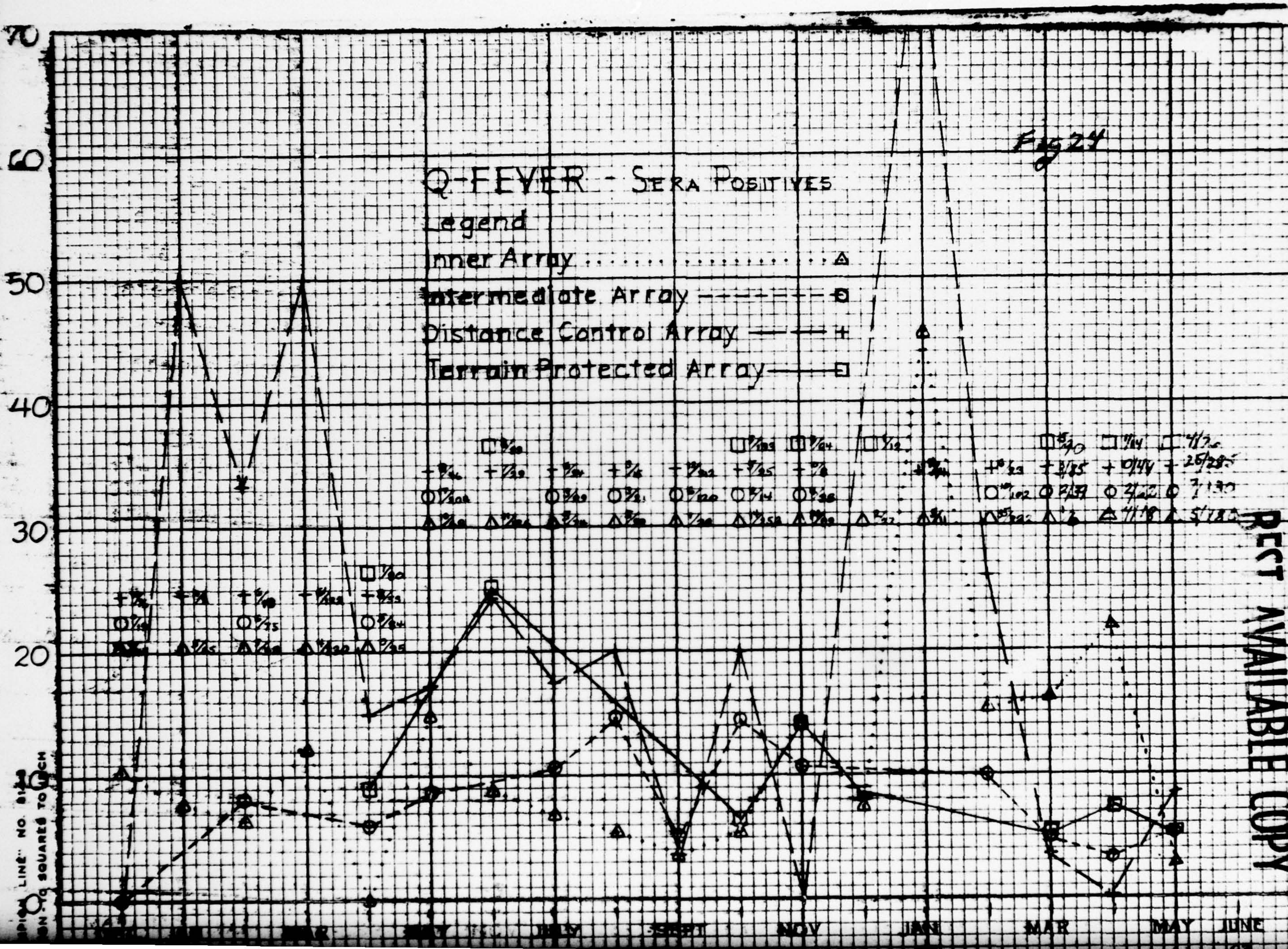


Fig 24
Q-FEVER - SERA POSITIVES
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
70
60
50
40
30
20
10
0
MAR
MAY
JULY
SEPT
NOV
JAN
MAR
MAY
JUNE
BEST AVAILABLE COPY

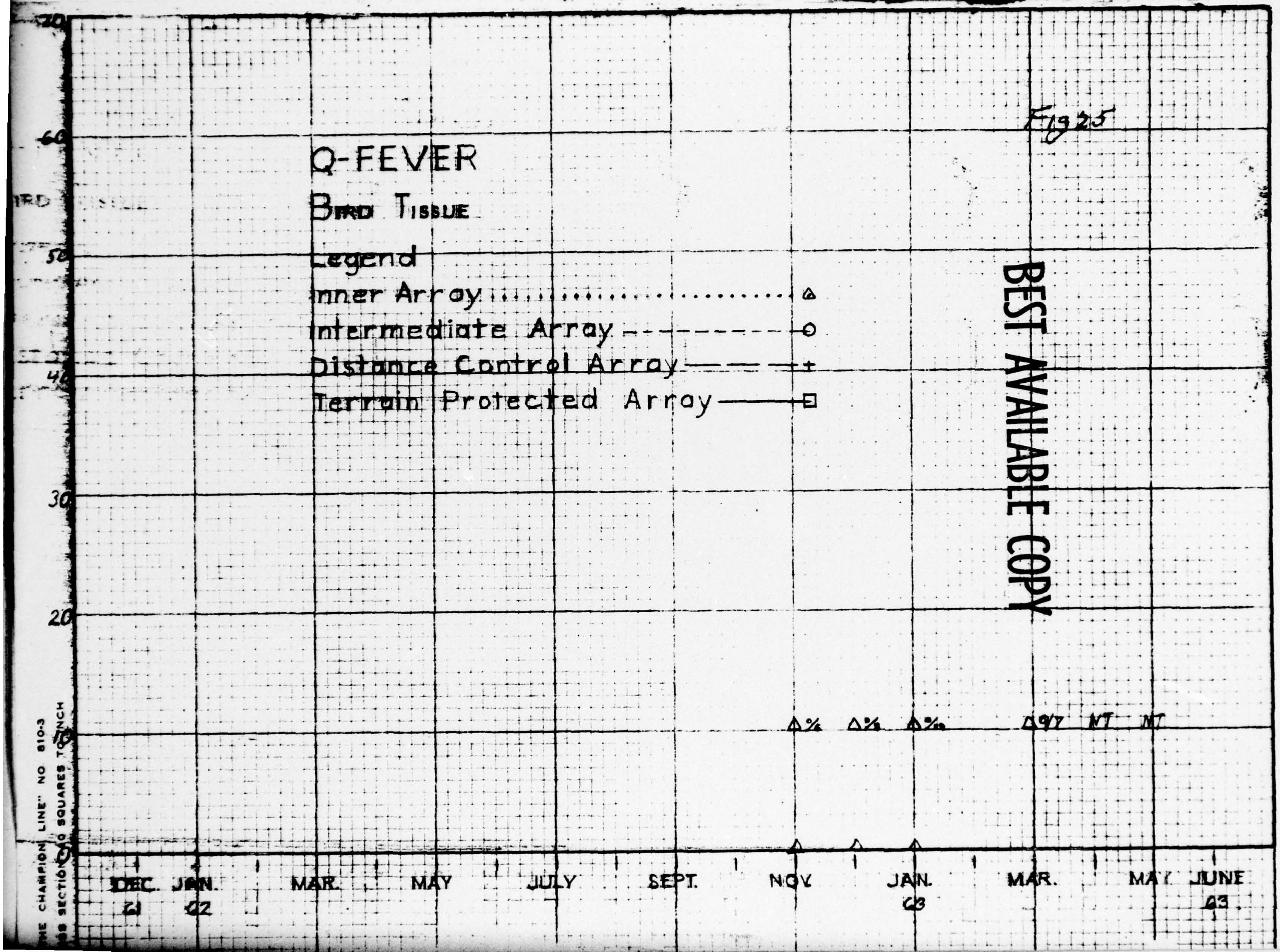


Fig 25
Q-FEVER
BIRD TISSUE
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
BEST AVAILABLE COPY
70
60
50
40
30
20
10
0
DEC. 61
JAN. 62
MAR.
MAY
JULY
SEPT.
NOV.
JAN. 63
MAR.
MAY
JUNE 63
NT
NT
THE CHAMPION LINE" NO 810-3
CROSS SECTION 10 SQUARES TO INCH

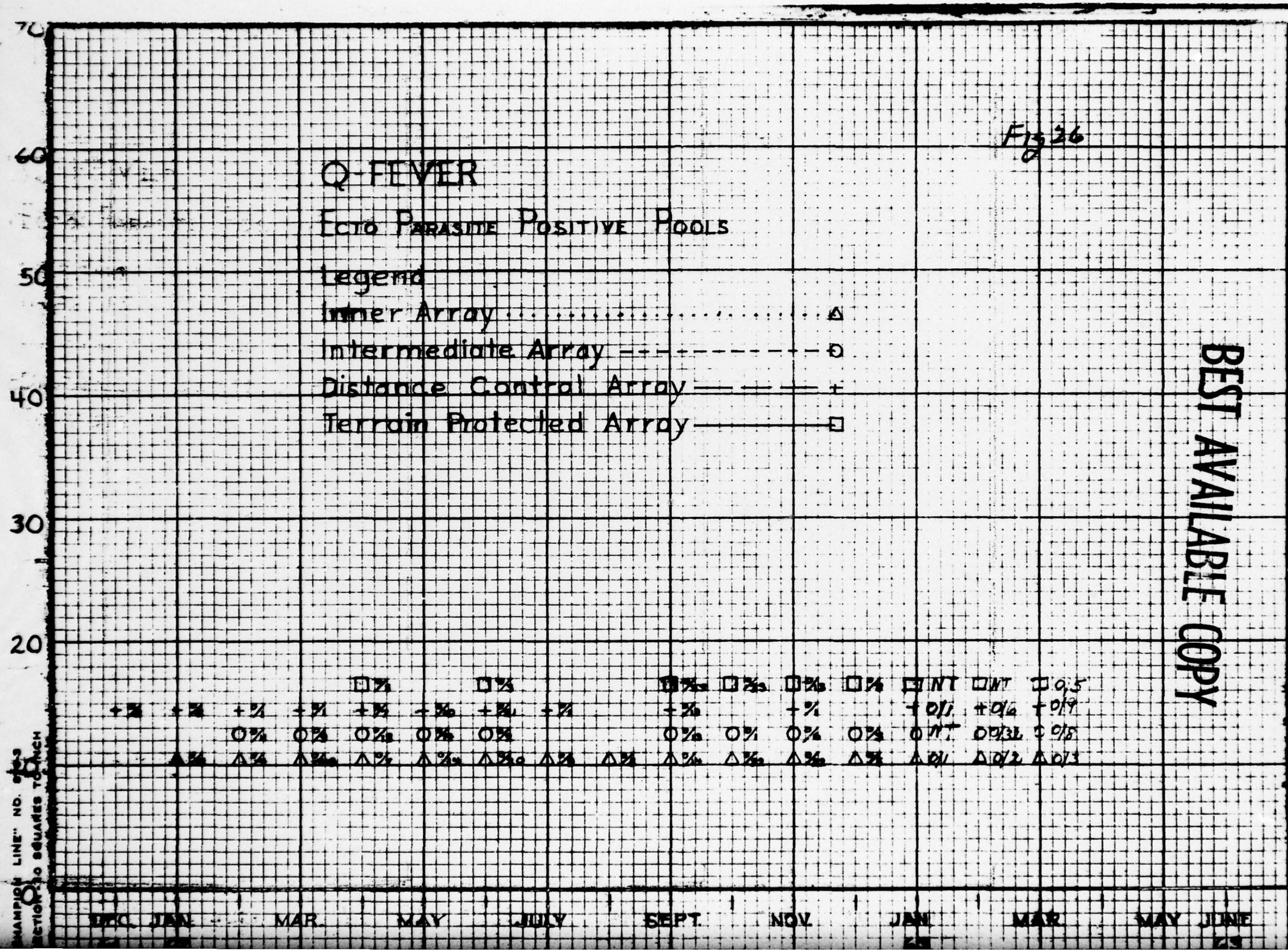


Fig 26
Q-FEVER
Ecto Parasite Positive Pools
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
BEST AVAILABLE COPY
70
60
50
40
30
20
10
0
DEC.
JAN.
MAR.
MAY
JULY
SEPT.
NOV.
JAN.
MAR.
MAY
JUNE
"CHAMPION LINE" NO.
SECTION-10 SQUARES TO INCH

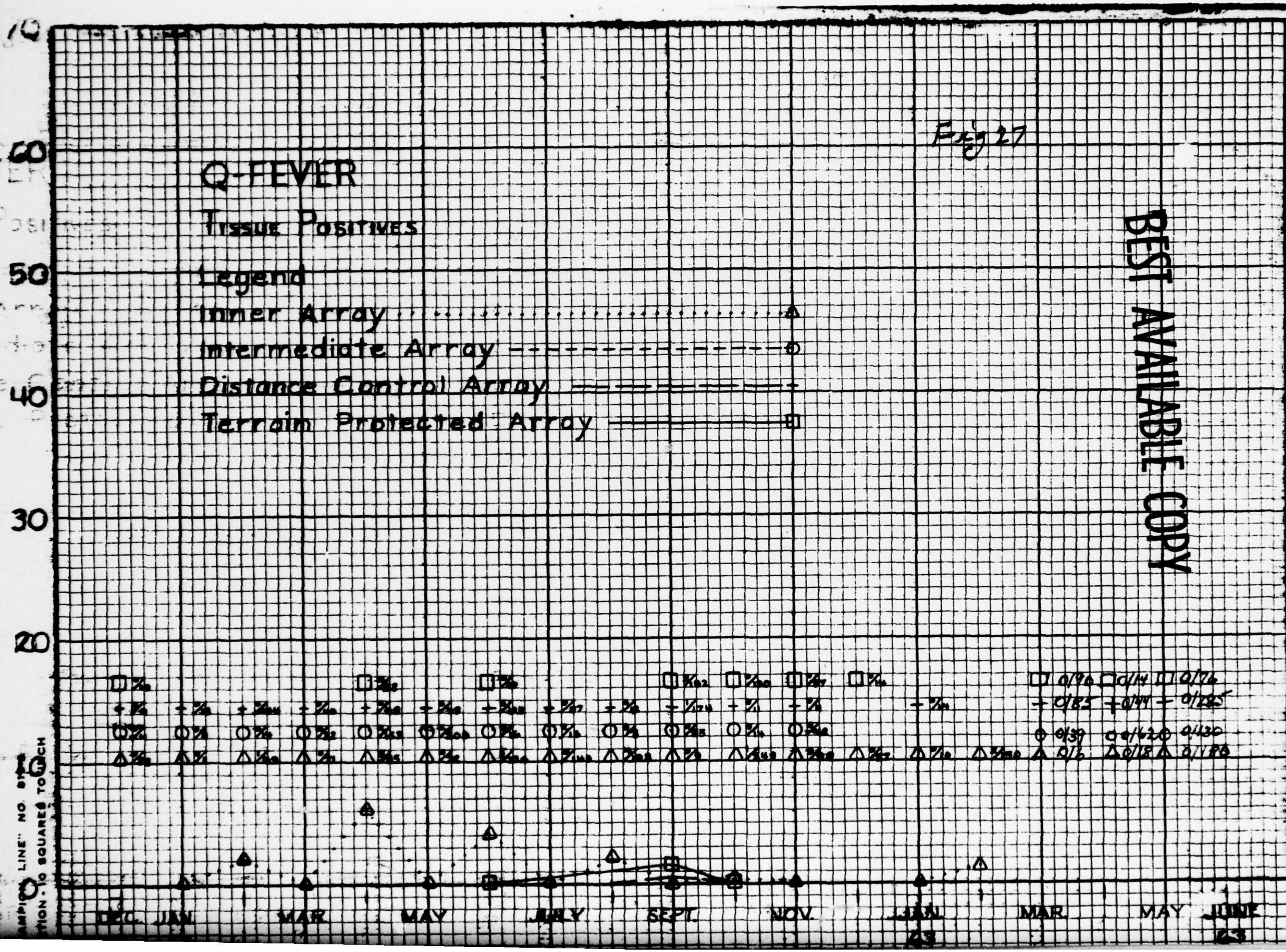
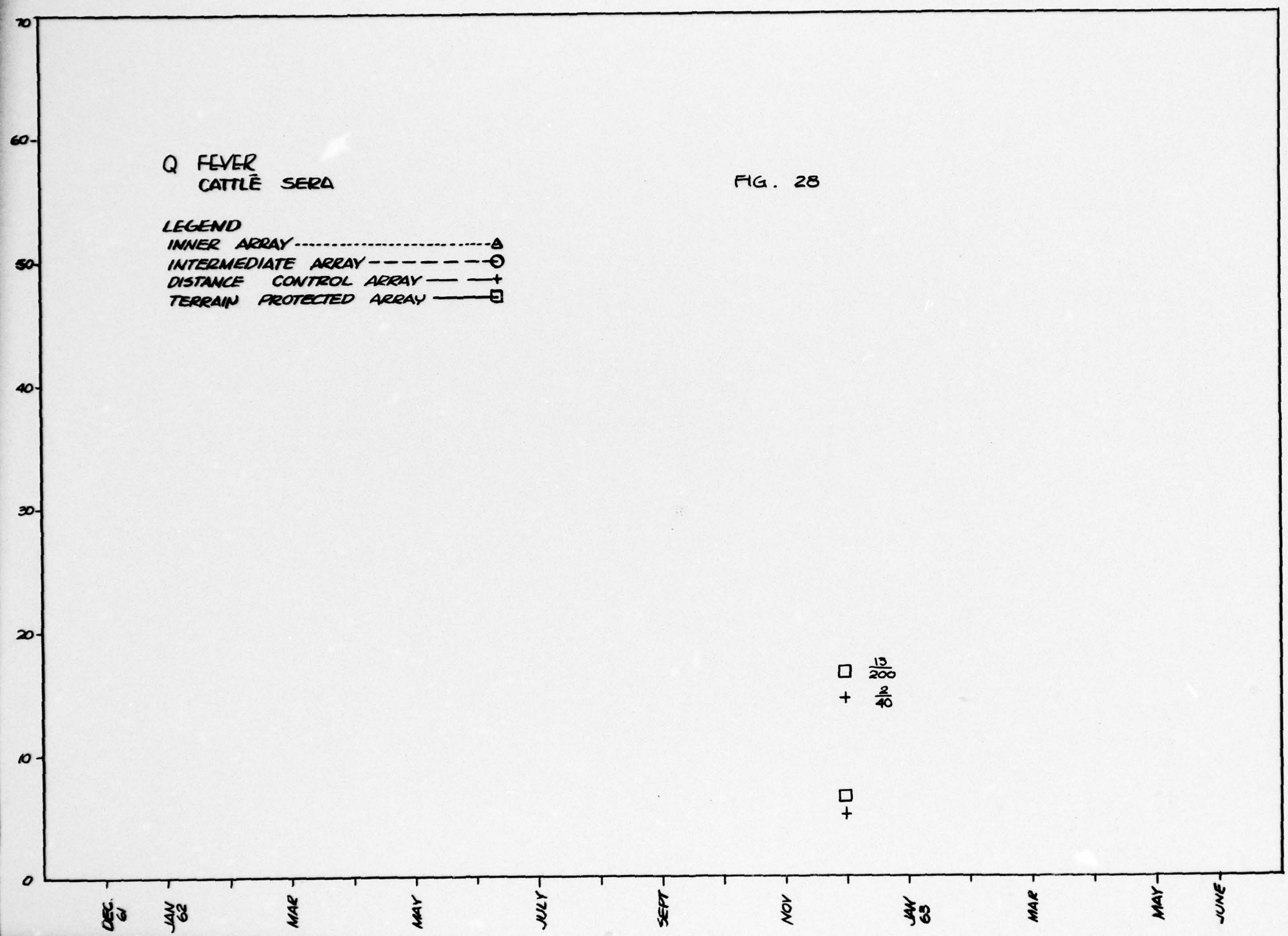
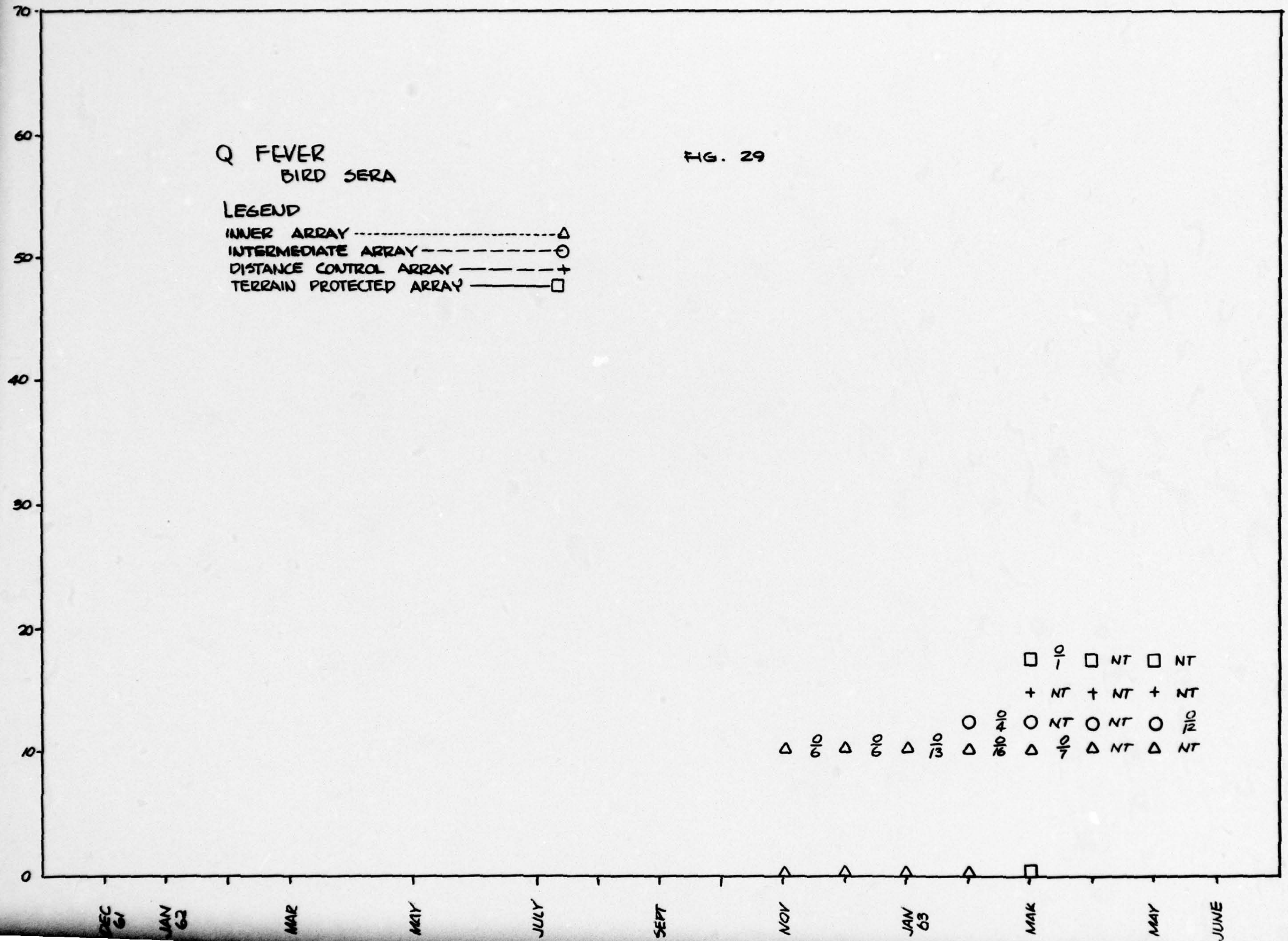


Fig 27
Q-FEVER
Tissue Positives
Legend
Inner Array
Intermediate Array
Distance Control Array
Terrain Protected Array
BEST AVAILABLE COPY
70
60
50
40
30
20
10
0
DEC. JAN. MAR. MAY JULY SEPT. NOV. JAN. MAR. MAY JUNE



Q FEVER
CATTLE SERA
LEGEND
INNER ARRAY
INTERMEDIATE ARRAY
DISTANCE CONTROL ARRAY
TERRAIN PROTECTED ARRAY
13/200
2/40
70
60
50
40
30
20
10
0
DEC. 61
JAN 62
MAR
MAY
JULY
SEPT
NOV
JAN 63
MAR
MAY
JUNE

FIG. 28



Q FEVER
BIRD SERA
LEGEND
INNER ARRAY
INTERMEDIATE ARRAY
DISTANCE CONTROL ARRAY
TERRAIN PROTECTED ARRAY
FIG. 29
70
60
50
40
30
20
10
0
DEC 61
JAN 62
MAR
MAY
JULY
SEPT
NOV
JAN 63
MAR
MAY
JUNE
NT