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Study of the aspectional variations of siphonaptera associated with the nests of the Thomas wood rat Neotoma lepida lepida Thomas

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A STUDY OF THE ASPECTIONAL VARIATIONS OF SIPHONAPTERA ASSOCIATED WITH THE NESTS OF THE THOMAS WOOD RAT NEOTOMA LEPIDA LEPIDA THOMAS

A Thesis

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Master of Science

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by

J. Franklin Howell

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This Thesis by J. Franklin Howell is accepted in its present form by the Department of Zoology and Entomology as satisfying the Thesis requirement for the degree of Master of Science.

December, 1954

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INTRODUCTION

The purpose of this study is to determine seasonal variations, if any, in flea populations associated with the nests of the desert wood rat Neotoma lepida lepida Thomas. Although similar studies have been conducted with other rodents (Vestal, 1938; Traub and Hoff, 1951) in different geographic localities, no such study has been made with N. l. lepida in Utah.

Faunal nest surveys are becoming increasingly important in connection with the ecology of mammalian parasites. Nest consort studies, not of seasonal nature, have been conducted in California, Oregon, and Utah concerning three species belonging to the genus Neotoma. They are: (1) N. fuscipes Rhoades, (2) N. cinerea (Ord), and (3) N. l. lepida. Nevertheless, these nest studies were not done on a yearly basis so as to show differences as analyzed from a seasonal aspect.

In addition to providing further information in the field of general flea ecology, there is the importance of such a study as it is related to plague ecology (disease-host relationships). Eskey and Haas (1939) reported the Thomas wood rat (N. l. lepida) as being plague implicated and it is known that plague implicated fleas inhabit the nest of N. l. lepida (Beck, et al; 1953). Nothing is known about the population changes of these fleas as demonstrated on a seasonal basis. This thesis is presented to indicate what changes were noted from an aspectional point of view.

REVIEW OF LITERATURE

Siphonapterists have long known that flea consortes are found in the nests and on the bodies of host animals. Bishopp (1915) was one of the first to publish information relative to such flea associations. Holland (1949) explains:

> "The number of adult fleas that may be removed from an animal is not necessarily indicative of the number belonging to it, as by far the greater proportion of them is frequently to be found in the nest. Some species rarely leave the nests at all."

Rothschild and Clay (1952) in their study of bird fleas have found that certain species of fleas are associated with the nest rather than the host. Both of the above authors give some aspectional differences in flea populations.

With the advent of sylvatic plague surveys it became apparent that it was important to recognize the ecological factors related to the hosts and their flea consortes. Stewart and Evans (1941) have shown in their study of rodents and their burrows that there was a definite variation in populations of fleas as seen on an aspectional basis. Other workers, such as Holdenried, Evans, and Longanecker (1951), Longanecker and Burroughs (1952), and Burroughs (1947) have contributed information on the ecology of host-parasite relationships which includes some data relative to aspectional differences.

Eskey and Haas (1939) demonstrated that plague can be carried by wild rodent fleas and have listed many rodent fleas

which may be implicated in plague epizootics. Meyer and Holdenried (1949) substantiated that transmission of plague may occur in nature. These men through their work have emphasized the importance and necessity of further ecological data concerning rodents and their parasites with regard to seasonal differences.

In his life history study of Neotoma fuscipes, Vestal (1938) emphasizes the importance of nest and host consortes in connection with the ecology of the host. Walters and Roth (1950), years later, worked out a faunal study of the nests of Neotoma fuscipes monochroura Rhoades in Oregon. Traub and Hoff (1951) considered the wood rat nests of prime importance in their distributional studies of fleas in New Mexico. Holland (1949) believes there is an indication that the nests serve as incubators of ectoparasites especially in arid regions. Thus the ecology of the nests of rodents is becoming increasingly important to zoologists from a public health point of view.

ECOLOGICAL DESCRIPTION OF COLLECTING AREA

The region selected for the study is located three mi northeast of Jericho, Juab County, east and west of highway U. S. 6. It is an area of approximately three square miles about equally divided by the highway. The habitat location o this rodent community coupled with a high population density, facilitated the ease of collecting throughout the year.

The area has an average elevation of 5,200 feet above sea level. Physiographically the country is a rolling landscape with alternating low ridges and small valleys (Fig. 1). With respect to the soil composition, they may be of general sierozem and desert types (Odum, 1953). Scattered deposits o igneous rock and limestone are characteristic for the area.

The area is identified in this study as a Juniperus-Artemisia community. It is characterized by such plant dominants as Utah juniper (cedar)--Juniperus utahensis (Engelm.) sagebrush--Artemisia tridentata Nutt., and rabbitbrush--Chrysothamnus sp. Nutt. The junipers are characteristic of t low ridges while sagebrush and rabbitbrush are usually confin to the small valleys.

The large influent mammals consist of mule deer--Odoc eus hemionus (Rafinesque), coyote--Canis latrans Merriam, and domesticated animals (horses, sheep, and cattle) which are

Fig. 1

wintered in the area. The smaller more abundant predominant mammals consist of the jack rabbit--Lepus californicus Mearns, wood rat--Neotoma lepida, chipmunk--Eutamias minimus (Allen), kangaroo rat--Dipodomys ordii Durrant and Setzer, and white footed mouse--Peromyscus maniculatus (LeConte) and others.

HOME AND NEST HABITS

Introduction.--The life history and habits of some species of Neotoma have been worked out previously by Goldman (1910) and Richardson (1924). Others, such as Vestal (1938), have added much to the understanding of the life history of individual species. No attempt will be made in this study to give an extended discussion of the habits of N. lepida. Nevertheless some important observations have been recorded and are described below.

The House.-- The use of the term "house" in this paper follows the designation as applied by Vestal (1938). According to Richardson (1924), immediately upon weaning the rat constructs a house. The house is built from any available materials within the immediate environs. Goldman (1910) states that those species of wood rats that live on the plains construct large conical houses chiefly of sticks; but thorny vegetation, bits of cactus, bones, stones, leaves, and almost anything else they can carry may be used. The house of the rat with which this study is concerned is made up of about 95 per cent sticks of various size, primarily from the juniper.

An occupied house may be recognized at a glance, owing to its well kept appearance and the presence of slight repairs and additions (Goldman, 1910). Vestal (1938) in his study on N. fuscipes states that the rat continually adds to its house

throughout the year. It has been said (Goldman, 1910) that the basic plan of house construction and other habits of the genus are similar, therefore it would be expected that the habits of N. l. lepida would be similar to those of N. fuscipes etc. During the October collections in the present study it was observed that several of the houses exhibited a complete new layer of material deposited on the exterior of the house. Apparently building activity increases in preparation for the winter season.

The house, depending upon age, will vary in size from two feet in diameter and six inches deep to seven feet in diameter and five feet deep. The house site is usually associated with a juniper tree. The tree serves not only for protection but as a source of food and nest location (Fig. 2).

Houses have from one to a half dozen entrances to burrows which run both above and below the surface of the ground (Fig. 3). Often during the summer months, the nest may be seen from one of these entrances. To reach a nest all outer construction as described above must first be removed.

The Nest.--Following the designation of Vestal (1938), the term "nest" refers only to the finer materials forming the actual bed for the animal. It is typically an oval pocket recessed into the wall or floor of the nest chamber (Fig. 3). Usually it is constructed of bark but whenever possible fur and other soft material is used. In the laboratory a captive rat readily substituted cotton in preference to bark. The average dimensions of the nest are:

Fig. 2

Six and one-half inches outside diameter,

Two and one-half inches inside diameter,

Three inches deep.

A teacup will easily fit into the cavity of the usual nest.

Vestal (1938) indicates the presence of one or more chambers in the house of N. fuscipes. Observations made during this study indicate the presence of only one chamber in the house of N. l. lepida--the nest chamber. This is a large chamber that contains the nest, a pile of left overs from feeding, and a pile of excreta (Fig. 3). The chamber lies on a firm foundation of heavy sticks near the center of the house.

Not only does the rat add to its house during the year but additions or changes are observed in the nest according to the season. During the late spring and summer months the nest is not oval as stated but more of a saucer shape. As the season changes the nest is reconstructed and again assumes an oval shape. The saucer shaped "summer nest" provides increased ventilation while the closed oval shaped "cold weather" nest provides warmth and protection from exposure.

Fig. 3

TECHNIQUES

Field Techniques

The field equipment necessary to collect the nests consists of: a pick-ax, heavy leather gloves, a burlap bag, and large paper bags.

The pick-ax is used to remove the house in order to obtain access to the nest. Because the house and sometimes the nest contains thorns, cactus, and other material which may produce skin abrasions, a pair of gloves are very useful.

As the nests are collected they are placed in a paper bag which is well sealed to prevent the escape of consortes. When the desired sample has been collected, best results are obtained by immediately returning to the laboratory with the collection.

Records of field observations for each collection include some of the following: Climatic conditions, host consort observations (such as the presence of live hosts in the house), size and composition of house and nest, food habits, and other miscellaneous data which would help interpret the general ecology of the nest area.

Laboratory Technique

Extraction of Consortes.--After the nests have been brought to the laboratory they are placed in a "Berlese funnel" for a twenty-four hour period. The base of the Berlese funnel

is equipped with a "catch bottle" three fourths filled with 70 per cent alcohol (Fig. 4). When collections are completed, the catch bottle is removed from the funnel and the contents are poured into a petri dish to be examined. All organisms are removed from the alcohol and debris by use of forceps, spatula, and/or medicine dropper under dissection microscope observation.

The flea consortes are immediately processed and prepared for identification. Nevertheless, all other consortes from each nest are segregated into various taxonomic groups. Insofar as possible the classification was held to Order division even though some specimens are classified to the family. Specimens of each taxonomic group, unless too large, are placed in a procaine vial for preservation. Each vial is provided with a field label which indicates the date, field number, locality, and collector. This keeping of all consortes was done to facilitate further study, if desired, as it might relate to this project. Still further, each nest collection was kept separate and stored as a unit as was likewise the case for all nest collections made for each month. This makes it possible to quickly check the collection of any taxonomic group for any given month against those of any other collection made on a monthly basis.

Flea Mounting Techniques.--They are taken directly from the alcohol preservative and placed in two per cent aqueous sodium hydroxide solution, remaining until properly cleared. This requires varying lengths of time. If they proved difficult to clear, the abdomen was punctured with a needle, allowing

A. Lid

B. Light bulb (Source of heat)

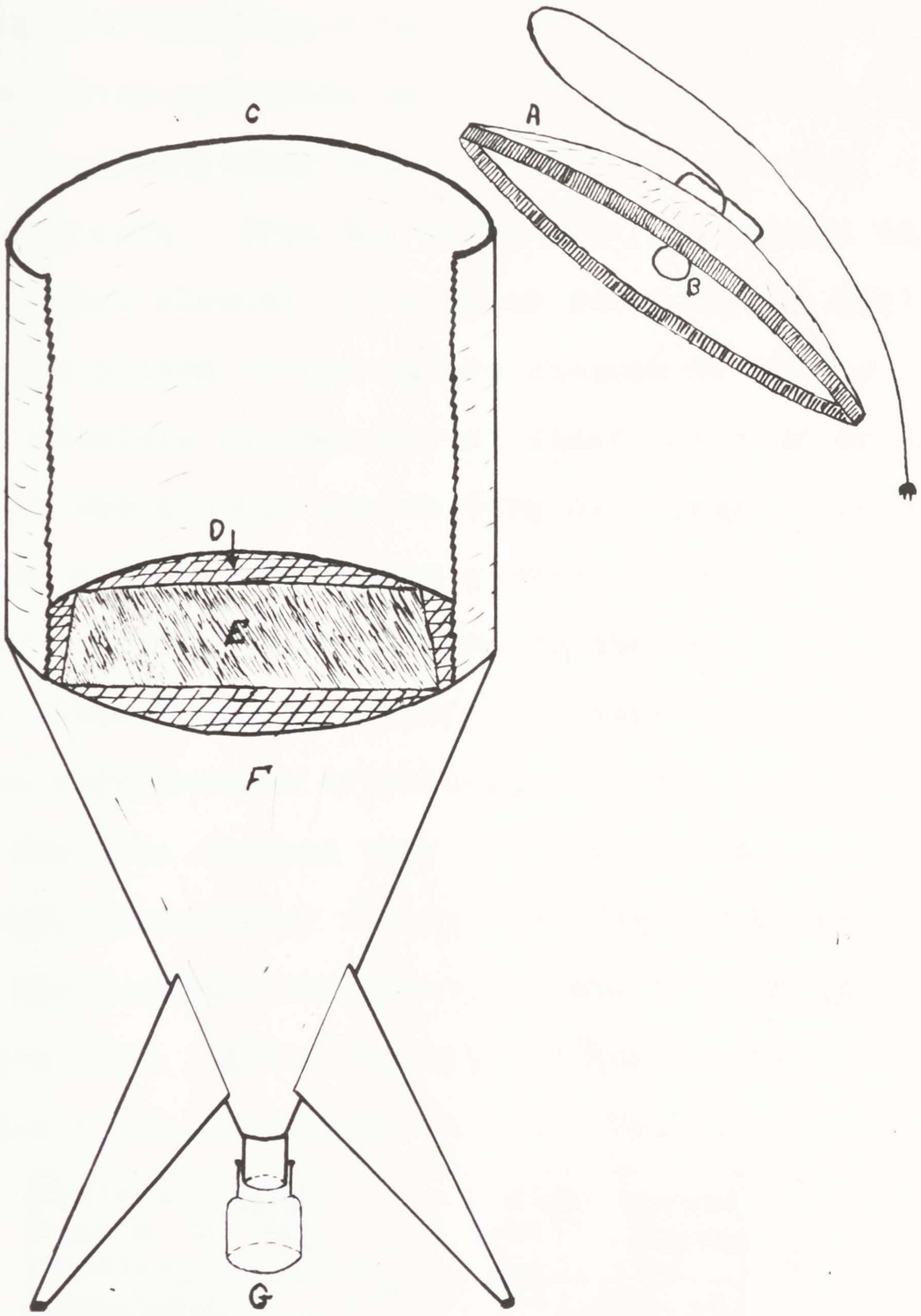
C. Body

D. Screen

E. Cheese cloth on screen

F. Funnel

G. Catch bottle

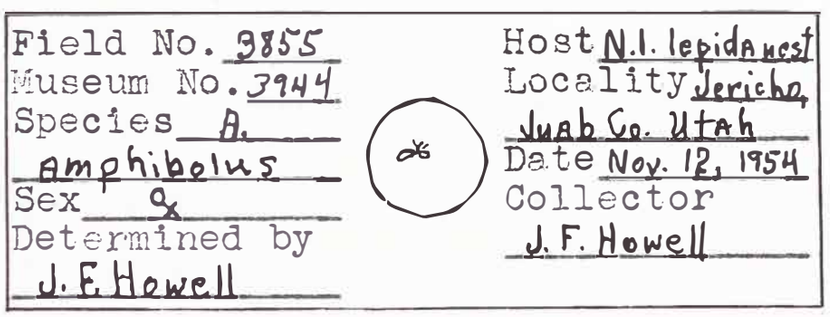


BERLESE FUNNEL

Fig. 4

NaOH digestion to take place more quickly.

From the sodium hydroxide the fleas are placed in tap water for twelve to twenty-four hours where some clearing continued at a slow rate. From the water they are placed in 50 per cent acid ethyl alcohol (acid-water ratio..1/100 HCl), from which they are placed in successive changes of 70 per cent, 95 per cent, and absolute alcohol for at least one hour each. They may remain in the alcohol for as long as twenty-four hours depending upon the convenience of the worker. Specimens may be left indefinitely in any solution following and including 70 per cent alcohol without damage, except absolute alcohol in which they become very brittle if allowed to remain for a prolonged period. From the alcohol they are transfered to oil of wintergreen (Methyl Salicylate) for at least twelve hours. From the oil of wintergreen, the specimens are mounted in clarite on glass slides. After the clarite has become sufficiently dry each slide is labeled as shown below:



Following the preparation of the specimens, they are classified to species and the data is compiled on cards prepared for that purpose.

DISCUSSION

The fact that there are seasonal variations in flea populations throughout North America has been common knowledge among Entomologists for several years. Traub and Hoff (1951) reported that very few fleas are to be found during the summer months in New Mexico. Variations among flea populations, similar to the above example, have been reported by Hubbard (1947); Holland (1949); Holdenried, Evans, and Longanecker (1951); Stewart and Evans (1941); and Longanecker and Burroughs (1952).

In 1939, Eskey and Haas indicated the importance of burrow openings and excavated nests in connection with flea populations. Since 1939 two detailed studies have been made concerning those species of fleas found in rodent burrows and also of the species found upon the host. The first, by Stewart and Evans (1941), establishes definite seasonal variations among those fleas in the burrow and on the host. The second, by Holdenried, Evans, and Longanecker (1951), was a continuation of the first and covered a five year period (1940 to 1945). Both of the above studies were in agreement regarding the flea populations.

A number of species of nest and burrow inhabiting fleas have been implicated with plague transmission (Eskey and Haas, 1939). Therefore, from the standpoint of plague-vector

relationship, it is important to recognize kinds of consortes located in nests and burrows of host organisms.

Hampton (1940) published an account showing the presence of plague organisms in N. l. lepida. With N. l. lepida implicated as a host animal for both the disease organism and the vector it was deemed important to observe population variations of implicated vectors as found in the nests of the host.

Beginning February 6, 1954, nest collections of the desert wood rat (N. l. lepida) were begun and extended over a period of ten months to November 12, 1954. All collections were made three miles north of Jericho, Utah, near highway U.S. 6.

The seventy-eight nests collected contained an average of fourteen plus fleas per nest giving a total of 1097 specimens. Although there were only two predominant species (Megarthroglossus smiti* and Anomiopsylla amphibolus Wagner), eleven other species were identified from the collections. They are:

Monosyllus w. wagneri (Baker)

Monosyllus sp.

*Eustorgio Mendez at Berkeley, California has recently completed an unpublished monograph of the genus Megarthroglossus. Specimens of this genus were sent to him for examination. He identified them as a new species which he has named M. smiti.

Anomiopsylla amphibolus

Epitedia stanfordi Traub

Orchopeas sexdentatus Baker

Orchopeas sp.**

Atyphloceras echis J. and R.

Thrassis sp.

Meringis sp.

Megarthroglossus smiti

Malaraeus euphorbi (Rothschild)

Various species of fleas demonstrate greater or lesser host specificity. It is also known that some interchange in fleas constantly occurs between various hosts in nature. Such fleas not commonly found upon any given host may be identified as accidental or occasional parasites. In a study involving several months of observations it would be expected that a certain number of occasional or accidental flea parasites would be found associated with a given species of host. Likewise there would be found other species which would be quite host specific. Longanecker and Burroughs (1952) mention the occurrence of several species not considered as being host specific upon squirrels. They also state that only one or two of these occasional parasites are found at the same time on a single host.

**All specimens not identified to species were females. Specimens of this sex are sometimes difficult to accurately place to species in the absence of males.

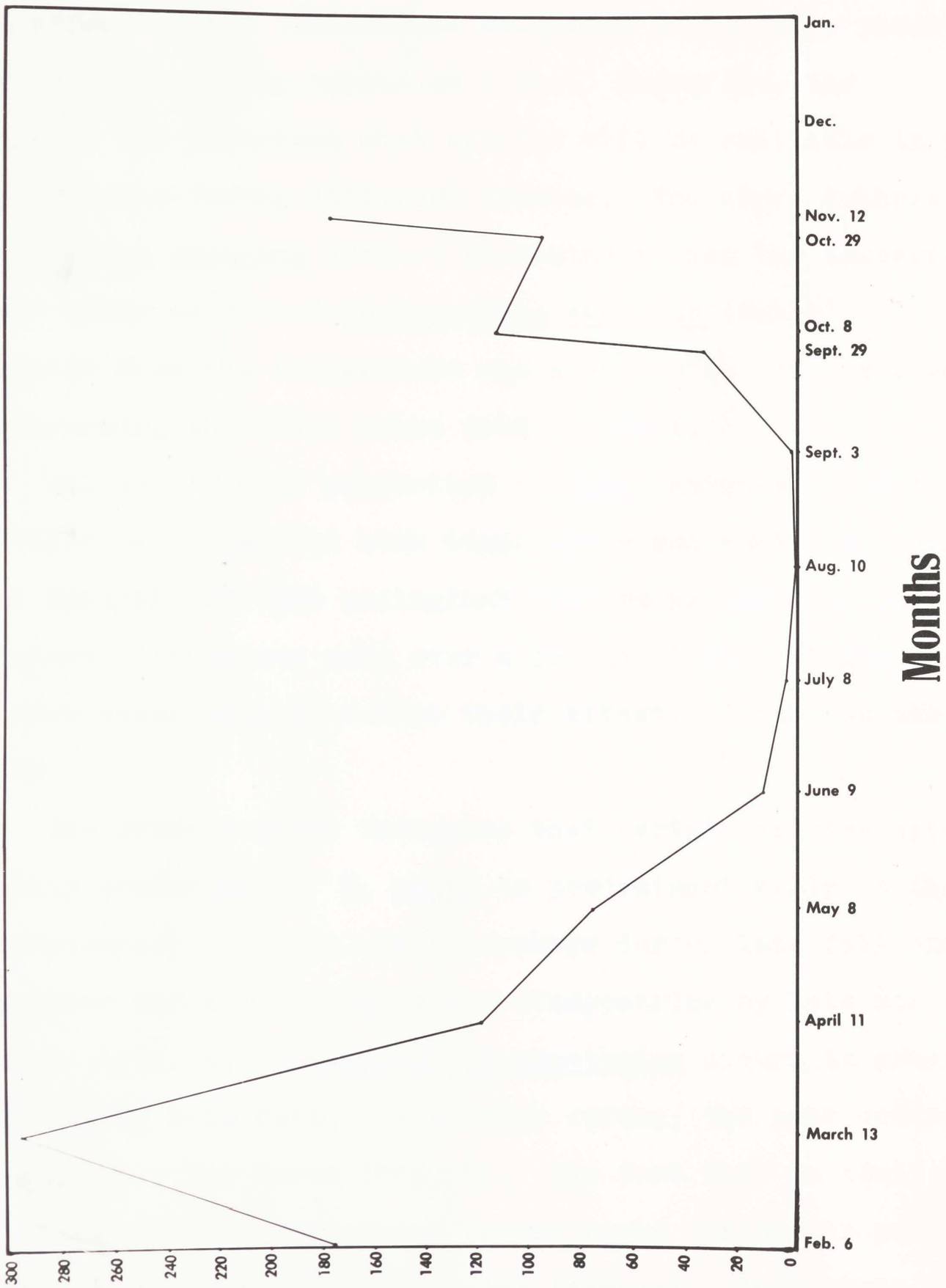
With reference to the species encountered in this study, it seems to be entirely evident that Anomiopsylla amphibolus is restrictive in host association to N. l. lepida and related species. Other authors have also found this to be the case (Hubbard, 1947; Holland, 1949). Not much is known about the new species Megarthroglossus smiti but it too seems to be restricted to N. l. lepida from data gathered so far. M. w. wagneri on the other hand is listed by most authors as being a "mouse" flea most commonly found associated with species of the genus Peromyscus in the Great Basin area of the Western United States. It was also collected in the nests of pack rats in this study.

Population trends for all species studied are described in Fig. 5. Analysis of this graph indicates very definite seasonal differences. The late spring and early fall months show sparse population, the summer months showing no appreciable numbers of individuals as contrasted to the very high population density during the late fall and winter months.

Longanecker and Burroughs (1952) established temperature as the ecological factor that influenced population changes of fleas among California ground squirrels Citellus beecheyi (Merriam). Kessel (1939) in his "Embryology of Fleas" emphasizes the importance of temperature and humidity as primary factors in controlling the embryonic growth of fleas.

Longanecker and Burroughs (1952) and Stewart and Evans (1941) working at Calaveras Dam, Alameda County, California on the California ground squirrel have shown that one species of

Fig. 5

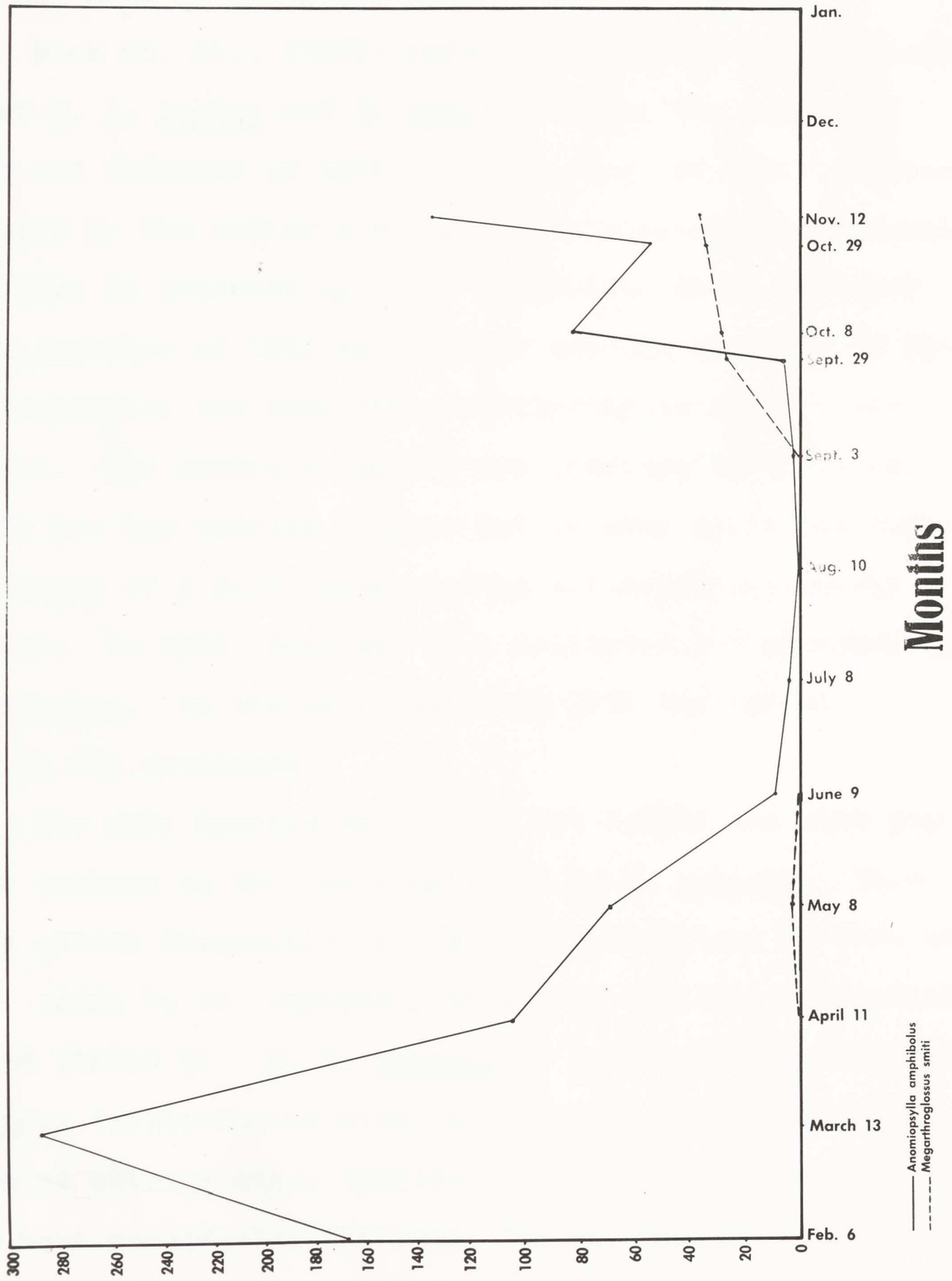

Jan.
Dec.
Nov. 12
Oct. 29
Oct. 8
Sept. 29
Sept. 3
Aug. 10
July 8
June 9
May 8
April 11
March 13
Feb. 6
Months
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Total Number of Specimens per Month

flea replaces the other according to temperature change (the season affecting the temperature change). Temperature seems to affect the breeding habits of fleas. Therefore, the environment may determine what species will be available in the flea population during different seasons. The above authors found Diamanus montanus (Baker) predominant when the temperature was below 60°F. and Hoplopsyllus anomalus (Baker) predominant when the temperature was above 60°F. The same was true concerning the fleas taken from the host.

All significant population changes, as noted in this study might be correlated with temperature and humidity changes. Careful analysis of such ecological factors as humidity and temperature differences made over a period of several seasons would more accurately determine their effect, if any, on the parasite.

The present study indicates that certain species appear seasonally predominant. M. smiti is predominant early in the fall (September) leveling off in numbers during late fall and early winter and almost completely disappearing by late winter (February) (Fig. 6). Anomiopsylla amphibolus occurs in greatest numbers during late fall, winter, and spring, the peak coming between January and March (Fig. 5). The fact that no adult fleas of any species were found in the nests during the period from June to September is of special interest. This study and the study of Traub and Hoff (1951) are in agreement regarding summer populations. The ecological factors influencing the decrease in summer populations are unknown. Epitedia stanfordi

Fig. 6


Jan.
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June 9
May 8
April 11
March 13
Feb. 6
Months
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Anomiopsylla amphibolus
Megarthroglossus smiti
Total Number of Specimens per Month

seems to be evenly distributed throughout the period of high populations of the most common fleas. All other species of this study have an irregular appearance.

Beck et. al., (1953) made a comparative nest consort study of N. l. lepida and N. cinerea during the months of October and November of 1952. A comparison of their studies and those made by the author with regard to comparative seasonal populations is interesting. The collecting dates (October through November of 1952 and October through November of 1954) were practically the same and a similarity in species was collected. The genera collected are identically the same. Not only are the species similar but in many cases the number of specimens of a particular species collected are nearly identical. In 1952, Beck et. al., collected 206 specimens of A. amphibolus. In the same months in 1954 the writer collected 270 specimens.

The only species which does not follow the same population pattern in the two studies is M. w. wagneri. This species occurs frequently in the 1952 collections by Beck et. al. It seems to be completely absent in the fall collections for 1954 (Table I). M. w. wagneri is most commonly found on Peromyscus (white-footed mice) although it is of accidental occurrence on many other species of animals. It seems to have little host specificity (Hubbard, 1948). Due to lack of host specificity if one or two nests were collected in an area heavily populated with Peromyscus it is likely that more M. w. wagneri would be expected. Comparative figures on population density

regarding the species of fleas from the October and November collections is shown in Table I.

TABLE I

A COMPARISON OF THE FLEA POPULATION OF 1954 AND 1952

IN THE NESTS OF THE DESERT PACK RAT

SPECIES	Oct. 13, to Nov. 17, 1952 No. of Specimens	Oct. 8, to Nov. 12, 1954 No. of Specimens
Anomiopsylla amphibolus	206	270
Orchopeas sexdentatus	6	1
Malaraeus euphorbi	45	2
Monopsyllus w. wagneri	18	0
Atyphloceras echis	5	2
*Megarthroglossus smiti	34	97
Epitedia wenmanni	1	0
Epitedia stanfordi	34	8
Meringis parkeri	1	0

*Megarthroglossus d. divisus collected in the 1952 study is synonomous with M. smiti.

ECONOMIC AND MEDICAL IMPORTANCE

Fleas are a definite menace to the health of man and animals, either as an entomophobia or as direct vectors of diseases. They are of wide distribution, numerous, and very definitely of parasitic habit in the adult condition. In the Rocky Mountain region, fleas are common vectors of plague, tularemia, and tyhpus fever (Stark, 1948). These diseases often affect other animals as well as man. Stewart and Evans (1941) have said:

> "Because of the difference in seasonal distribution of fleas, collections should be correlated with those times of year when species capable of transmitting the infection are abundant. It is quite possible that many of those areas heretofore recorded as being free from plague infection have been placed in this category because they were surveyed at a time when efficient vectors had been largely replaced by species which are either very poor vectors or incapable of transmitting plague."

Fleas implicated with plague in the Western United States have been listed by Eskey and Haas (1939). A list of plague implicated fleas for Utah is found in the reports of studies conducted by Allred (1951) and Beck (1954).* Of the fleas listed for Utah in the above reports, the following species have been found as consortes in the nests of N. l. lepida in this study:

Monosyllus w. wagneri

*Unpublished manuscript

Orchopeas sexdentatus

Thrassis sp.

M. w. wagneri and O. sexdentatus are listed a potential vectors of plague, e.g. in the laboratory they experimentally transmit plague. Thrassis sp. is listed as a capable vector of plague, e.g. they are known to transmit plague in nature (Allred, 1951). The genus Thrassis is listed because several of the species of this genus in Utah have been proven plague positive (Allred, 1951).

That seasonal variations in populations occur has been well demonstrated in this study. Such aspectional studies emphasize the importance of obtaining information on population variations. Data gathered enables one to make chronological predictions for epizootics based upon the species composition of flea populations (Stewart and Evans, 1941). This report, therefore, has attempted to facilitate a better understanding of the problem of seasonal variations of flea populations. It has established data which can be used to accurately identify the seasonal variations in flea population for such consortes in the nests of N. l. lepida in central Utah. Whether this data will be valid within other areas of the state is not known. Such information when applied to vectors of disease adds much to the understanding of ecological factors related to these vectors as has been mentioned above for plague. The same can be said for general disease ecology.

CONCLUSIONS

From the 1097 specimens of fleas collected over a ten month period near Jericho, Juab County, Utah, two definite seasonal variations in populations have been found. The entire flea population analyzed statistically on a year's basis, showed that a relatively low population existed from May through September, while October through April displayed a comparatively high population of fleas.

The most abundantly collected species of flea which was taken was A. amphibolus. This is a flea which is not usually found in any great numbers on the body of the host animal but occurs in abundance in the host nests at certain seasons of the year. Of the total number (924) taken the peak population was reached in March. They gradually begin to thin out and completely disappear in July. They begin to reappear in late September.

With respect to the factors involved in bringing about these seasonal variations, there is some evidence to indicate that there is a correlation between humidity and temperature in regard to these population changes.

A comparison of data between this study and one made by Beck et. al. for the months of October and November shows many points in common. The species listing and population figures are much in agreement.

With reference to the economic importance of this study it has been pointed out that of the eleven species collected, three are plague implicated. Of the three implicated species two, O. sexdentatus and M. w. wagneri, are defined by Eskey and Haas (1939) as being potential vectors while Thrassis sp. is classified as being a capable vector.

This study indicates that it is especially important to make year round collections in order to establish accurate distributional records for any locality. It is quite apparent that a single or several collections made in the summer months with respect to species found in this study would not have accurate representation from a distributional point of view. It likewise emphasizes the need for all seasonal observation to gain a proper perspective in population index.

This study has revealed that the greater population of fleas found in the nests are not particularly implicated with plague. However, it is known that some of these species of fleas are involved with other diseases as vectors, such as typhus and tularemia.

Much work needs to be done to determine the exact factors involved in regulating the number of fleas in respect to season. It would have been well to have made accurate determinations of the flea larvae taken in this study. The rearing of the larvae from such a study would constitute a contribution of paramount importance in and of itself.

In conclusion it should be mentioned that the general examination of all other consortes of the nests seem to show

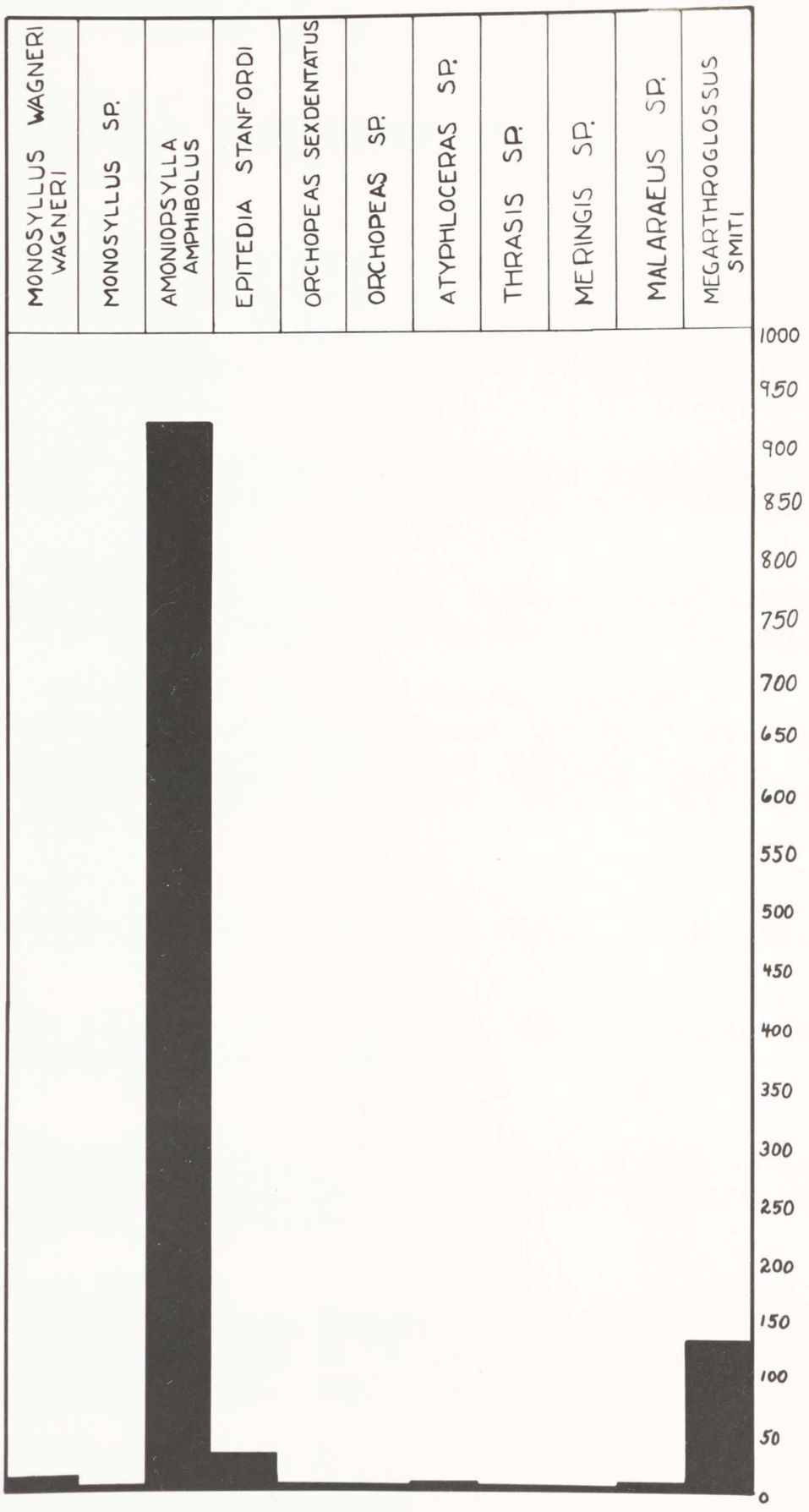
responses to seasonal variations as determined by the population index. Some of these consortes were: mites, soft bodies ticks, hard bodied ticks, spiders, pseudoscorpions, and other arthropods.

SIPHONAPTERA FROM NESTS OF NEOTOMA LEPIDA LEPIDA

DATE OF COLLECTION	TOTAL NO. OF SPECIMENS	NO. OF NESTS COLLECTED	MONOSYLLUS WAGNERI WAGNERI	MONOSYLLUS SP.	ANOMIOPSYLLA AMPHIBOLUS	EPITEDIA STANFORDI	ORCHOPEAS SEXDENTATUS	ORCHOPEAS SP.	ATYPHLOCERAS SP.	THRASSIS SP.	MERINGIS SP.	MEGARTHROGLOSSUS SMITI	MALARAEUS SP.	FIELD NUMBERS
Feb. 6 1954	177	6	1		168	8								3817
March 13 1954	295	7			293	1				1				3820
April 11 1954	119	5	6		105	5	1				1			3828
May 8 1954	75	7	1		69	3						2		3834
June 9 1954	10	7	1		9									3838
July 8 1954	4	6			4									3855
Aug. 11 1954	0	11												3885
Sept. 3 1954	2	6			2									3916
Sept. 29 1954	32	6			4							27		3917
Oct. 8 1954	116	6			82	3			2			29		3918
Oct. 29 1954	93	5		2	54	3		1				33		3920
Nov. 12 1954	174	6			134	2						35	2	3922
Dec. 1954														
Jan. 1955														

CHART ONE

Fig. 7


MONOSYLLUS WAGNERI WAGNERI
MONOSYLLUS SP.
AMONIOPSYLLA AMPHIBOLUS
EPITEDIA STANFORDI
ORCHOPEAS SEXDENTATUS
ORCHOPEAS SP.
ATYPHLOCERAS SP.
THRASIS SP.
MERINGIS SP.
MALARAEUS SP.
MEGARTHROGLOSSUS SMITI
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
NUMBER OF SPECIMENS
SPECIES

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ABSTRACT

Much work has been done concerning those parasites found upon the host. Very little has been done concerning those parasites that are parasitic but are very rarely found upon the host. Therefore, the purpose of this study is to determine seasonal distribution of those fleas found in the nests of the desert wood rat (*N. l. lepida*).

This paper shows that there is a seasonal variation of flea populations within a certain geographic area. It also shows that certain species of fleas are distributed seasonally; not all species being present in the same season.

Three of the eleven species collected from the nests are plague implicated, being either potential or capable vectors.

A number of other nest consortes were found to demonstrate seasonal variations to some extent.

Collecting and laboratory methods for the collection and preparation of fleas are discussed.