THE DISTRIBUTION AND MOVEMENT OF RATS AND THEIR ECTOPARASITES ON MONA ISLAND, WEST INDIES

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PREFACE

The distribution of rats and their ectoparasites is not well known on small islands that dot the Caribbean area. To evaluate the potential health hazard of these animals to personnel in this region, it was decided that a survey of Mona Island, West Indies would be highly desirable. At the beginning of this study, nothing was known concerning the species of rats or their ectoparasites that might occur on the island. Data were taken during the period December 1954 through November 1955.

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CHAPTER I

INTRODUCTION

The increasing knowledge of ectoparasites of animals as factors in the transmission of disease emphasizes the need for additional information on their distribution and ecology. The transmission of plague by fleas, of Rocky Mountain spotted fever by ticks, and typhus fever by lice and fleas are well known examples of human diseases involving ectoparasites.

The Norway rat Rattus norvegicus (Erxleben) and the roof rat Rattus rattus (Linnaeus) are the two principal known reservoirs of typhus in the Caribbean. Information is limited on the occurrence of these animals and their ectoparasites on small islands that dot the area. In view of this, a study of rats and their ectoparasites was conducted on Mona Island, West Indies from December 1, 1954 to November 30, 1955.

In this study, emphasis was placed on individual rats and their ectoparasites. The principal objectives were, (a) determination of rat species present and their distribution on the island, (b) determination of the species of ectoparasites found on the rats, and (c) observations on the amount of rat movement between population units.

The roof rat Rattus rattus (Linnaeus) was the only species of rat taken during the survey. Several subspecies of the roof rat are known. However, interbreeding does occur between subspecies and their habits are similar. It is almost impossible to assign a wild caught rat to a given subspecies owing to their varied appearance. For this reason, the group

is referred to at the specific level, Rattus rattus or roof rat. All subsequent references to "rats", except in the literature review, unless otherwise stated, apply to this species.

Transportation difficulties between Puerto Rico and Mona Island, prevented a systematic trapping schedule. It was possible, however, to collect data for each month of the year and this manuscript is based on these collections.

Location.--Mona Island is located in Latitude 18°05' North and Longitude 67°55' West, in the middle of Mona Passage, a body of water ranging from 1,000 feet to 3,800 feet in depth. It is about 45 miles west of Mayaguez, Puerto Rico, and 40 miles east of Punta Espada, Dominican Republic. The island is politically part of Puerto Rico. Shaped like a lima bean, with the concave shoreline on the North, the island is about 6 miles long from West to East and 4 1/2 miles wide from North to South. The total area is 13,640 acres.

Topography.--The island has two distinct levels: The coastal plain and the limestone plateau. The plateau is from 175 to 250 feet above the sea and comprises the greater portion of the island. The limestone is very porous, which permits rapid drainage. For this reason, there are no rivers or springs on the plateau. The subterranean drainage has produced remarkable caves and caverns that honeycomb the island. Water is permanently found in a few cement catchments and cisterns, built by people who have sporadically lived on the island.

Climate.--The climate of the island is dry and warm. The annual mean temperature is 82°F., with an average annual mean variation of 6°F. A 34-year record of rainfall from the lighthouse, 1919 to 1952, averaged

37.85 inches per year.

Forest Type.--The island forests are of four distinct types, represented as follows (Wadsworth, 1945).

Type	Acres
Cactus Brush	2,700
Upland Forest	9,680
Central Lowland Forests	345
Coastal Forests	900

The cactus brush is generally less than 6 feet tall, and is made up of shrubs, small trees, and eight species of cacti. It is found on the east, north, and southeast edges of the plateau; mostly on the east, where it extends inland about a mile. The upland forest, the most extensive on the plateau, is made up of small trees generally growing to about 20 feet in height. The central lowland forest grows in the depressions on the plateau where the soil is deepest. It is similar to the upland forest, but is more dense and taller, growing to 40 feet in height. The coastal forest grows on the coastal plain chiefly to the southwest. It is by far the best developed, with trees to 20 inches in diameter and 60 feet in height.

The low coastal plain which varies from three-fourths of a mile to 25 feet in width, extends from Sardinera Beach to Uvero Beach, a distance of some 5 miles. A large section, covering several hundred acres in the vicinity of Sardinera Beach, has been planted with Casuarina and Mahogany trees. Coconut palms are abundant in the coastal area.

Activities of Man on the Island.--The activities of man on Mona Island probably began over a thousand years ago when Arawak Indians reached the island from the east. They apparently lived in the numerous caves, as relics are still to be found.

The first white man to land on the island was Christopher Columbus in 1494; on his second voyage to the new world. In 1508 Don Juan Ponce De Leon stopped at Mona Island for several days on his way from Santo Domingo to colonize San Juan Batista (Puerto Rico).

Since the days of Columbus and Ponce De Leon, Mona Island has had an interesting and colorful history: Farmers, miners, and pirates have at one time or another used it for their various activities.

In 1903, a lighthouse was constructed on the island near East Cape. United States Coast Guard personnel, three in number, man this isolated station. During the survey, they were the only people permanently on the island.

The island became an insular forest in 1919. A Civilian Conservation Corps camp of 200 boys, which operated at Sardinera Beach from 1937 to 1941, constructed several trails and built a crude truck road across the island to the lighthouse. The old buildings of the camp still remain, and were used as a base of operations during the survey.

It would be interesting to know how and when rats first gained access to Mona Island. Perhaps the ancestors of the present population came ashore with Columbus. Then again, they may be a recent introduction.

CHAPTER II

REVIEW OF THE LITERATURE

Apparently no mention is made in the literature of either rats or their ectoparasites occurring on Mona Island. Anthony (1926) reports only two species of mammals known from Mona Island, Noctillio vespertinus mastivus Dahl and Mormops blainvillii Leach.

Ramos (1946) lists mammals, birds, amphibians, and many hundreds of insect species found on Mona Island, but again no mention is made of rats. Wolcott (1941) reports two species of fleas taken on Mona Island, Tunga penetrans Linnaeus on man, and Ctenocephalides canis Curtis on dogs. A species of tick Amblyomma cruciferum Neumann, was collected from an iguana lizard Cyclura stegnegeri Barbour and Noble, that had been captured on Mona Island and returned to Puerto Rico (Tate 1946).

On the island of Puerto Rico a very thorough rat flea survey was made by Carrion (1927-1932). Fox (1946) was the first to report any species of mites occurring on rats in Puerto Rico. Tate (1941) mentions examining five "Brown rats" for ticks with negative results.

The first comprehensive survey of rat ectoparasites, in an urban area in Puerto Rico, was by Fox (1951), who showed that the most common ectoparasites on rats in San Juan were Xenopsylla cheopis (Rothschild), Echidnophaga gallinacea (Westwood), Polyplax spinulosa (Burmeister), Bdellonyssus bacoti (Hirst), Laelaps nuttalli Hirst, and Ornithodoros puertoricensis Fox. Pippin (1956) in a similar

survey on the western end of the island of Puerto Rico found essentially the same thing as Fox.

Extensive information is available on the Norway rat; particularly in the reports published by workers of the Rodent Ecology Project at the Johns Hopkins School of Hygiene and Public Health (Davis and Emlen 1948, Emlen and Davis 1948, Emlen et al. 1948, Davis et al. 1948). Considerably less information exists on the roof rat, particularly in rural areas.

Ecke (1955) states that feral roof rats are seldom found in south Georgia. Roof rats are frequently encountered in fields, fence rows, and at the edge of swamps, sometimes several miles from a house or barn; indicating a less tenacious association with mankind than the Norway rat (Worth 1950). There is evidence that roof rats trapped and liberated in the same areas tend to remain, and do not wander far (Baker 1946, Worth 1950, Spencer and Davis 1950).

The medical and economic importance of various groups of ectoparasites have been treated in a number of texts, such as Hull (1955), Herms (1953), Matheson (1950), and Baker et al. (1956).

Pratt (1954) surveyed the literature and distribution of some common domestic rat ectoparasites in the United States. An excellent description of Polyplax spinulosa (Burmeister) and Hoplopleura oenomydis Ferris, two common rat lice, is furnished by Pratt and Karp (1953).

CHAPTER III

MATERIAL AND METHODS

Trapping Operations.--The species of rats occurring on the island, if any, were unknown; therefore, traps were set in as many different type habitats as possible. The only type trap used was a wooden box trap similar in construction to that described by Richter and Emlen (1945). The traps were baited with fresh apple, which proved satisfactory. Since rats are largely nocturnal in habit, the traps were distributed in the afternoon and checked the following morning. If specimens were taken, a record was made of the location and type habitat. The captured rats were then taken to the field laboratory where they were examined for ectoparasites.

Handling Rats for Examination.--The following procedure was used in handling the rats for examination. Rats were removed from the traps by allowing them to run into a two gallon glass jar. The rats readily entered the jar and little difficulty was encountered. After the rats entered the jar a lid was quickly placed on top. A wad of absorbent cotton, with approximately 4cc's of ether added, was introduced into the jar and the lid closed tightly. The rats became anaesthetized rather quickly, depending on the sex. Adult males required almost twice as long as adult females. The rat was left in the jar until its deep gasping breath indicated it was near death. The rat was then removed from the jar and could be handled for several minutes without regaining consciousness. Only 4, of 237 rats handled, died from the

anaesthetic.

Combing for Ectoparasites.--The rats were held over a large white enamel pan and combed vigorously. A fine comb, similar to that used in combing babies hair was used for this purpose. In addition, each rat was examined carefully, using forceps and teasing needles, to locate any ectoparasites missed in the combing process. At least 15 minutes was spent in the examination of each rat.

Washing for Ectoparasites.--Ectoparasites may also be removed from rats by washing. A few rats that were not marked and released, were utilized to check this method. The following procedure was followed: The rats were killed and placed in a refrigerator for 12-24 hours. After removing from the refrigerator, the rats were warmed slowly to room temperature and placed in quart jars, one half full of water, in which a teaspoonful of detergent had been dissolved (Calgonite). Three drops of isopropyl alcohol were added to reduce foaming. The jars were sealed and shaken vigorously at 10 minute intervals over a period of two hours. The animals were then removed from the jars, care being taken to wash all ectoparasites out of the fur back into the jar. After allowing the jars to set for several hours, overnight if possible, the detergent solution was siphoned off, leaving the residue containing the ectoparasites in the bottom of the jar. This residue was then transferred to a filter funnel and allowed to stand for several minutes. The ectoparasites were then removed from the filter paper and either mounted directly, or stored in vials containing 70% alcohol, to which had been added a small amount of glycerine.

Mounting Methods.--Ectoparasites to be examined were placed on

microscope slides in streaks of glycerine for preliminary determination and counting under a dissecting microscope. Mites to be mounted were taken from the glycerine and mounted directly in Hoyer's solution. The lice to be mounted were punctured on the ventral surface of the abdomen with a fine needle, placed in a 10% solution of KOH, and heated slowly until the body contents could be gently pressed out with a curved needle. The specimens were then placed in a cell slide containing 10% alcohol; average specimen for 15 minutes, larger specimens required a longer time, and some a change of 95% alcohol. While in the alcohol any particles of dirt and body content were removed. The lice were then transferred to clove oil for clearing; a minimum length of time, from one to five minutes, never longer, was allowed for the clearing process. The specimens were then removed from the clove oil and mounted in gum damar.

The ectoparasites were checked by a specialist from time to time, to verify species determinations.

Marking the Rats.--Rats that were to be released for movement studies were marked by the ear notching and toe clipping method. Marked rats were released the same day in the area where they were originally captured, or taken to other areas at varying distances from their original point of capture.

CHAPTER IV

RESULTS

Rattus rattus (Linnaeus)

Habitat Preference.—Rattus rattus was the only species of rat found on Mona Island and was most common on the low coastal plain. Abandoned man-made structures were the preferred habitat. Every building on the coastal area supported at least one family of rats and the larger structures, such as the old Civilian Conservation Corps mess hall, several. Rats were also found under brush piles in the coconut groves, near water catchments, on the brush covered airstrip, and occasionally near the mouth of caves at Sardinera Beach. A small colony was also found on the beach near the lighthouse, where the Coast Guard personnel maintained a flock of chickens.

With the exception of 6 rats taken at the lighthouse, no individuals were trapped on the plateau. The extreme difficulty in penetrating the brush and cactus on the plateau necessitated the placing of traps near the road and along established trails. Figure 2 denotes where traps were placed and rats caught. It is quite possible that rats occur in areas of the island that were not accessible for trapping.

Live Trapping.—Table I presents the results of trapping during the 12 month period. The higher number of individuals captured in May, June and July reflects a greater trapping effort and not necessarily a fluctuation in the rat population. The total of 237 rats includes those captured more than once. Of the total rats captured, 62 percent were

males and 38 percent females.

Rat fatalities connected with trapping were extremely low. Only three of the total number caught were found dead in the traps and these are not included in the total number examined.

Activity.--The rats were rarely observed during daylight hours. Occasionally one would be seen in a coconut palm or scampering into a building. No rats were captured during daylight hours in traps that were available for observation.

Rat nests were not part of this study. However, several nests were observed in coconut palms and in the old buildings. No evidence was found that the rats burrowed in the soil.

The rats apparently feed on a variety of vegetable matter. The stomach contents of 10 rats showed about 90 percent vegetable matter and 10 percent insect parts. Most of the coconuts on the island, as they became ripe, were eaten by rats. However, two orange trees near Sardinera Beach produced fruit, which was not eaten to any extent by the rats.

Ectoparasites

Species.--Five species of ectoparasites were found on the rats. They are Echinolaelaps echidninus (Berlese), the spiny rat mite, occurring on rats throughout the world; Laelaps nuttalli Hirst, the domestic rat mite, common on the genus Rattus in tropical and temperate regions of the world; Ornithonyssus bacoti (Hirst), the tropical rat mite, cosmopolitan in distribution; Polyplax spinulosa (Burmeister), the spiny rat louse, found on rats throughout the world, and Hoplopleura

oenomydis Ferris, the tropical rat louse, common on rats in tropical and subtropical regions of the world.

The findings are rather surprising as to the number of species. From past experience, there are usually a number of different species of ectoparasites to be found on rats over a period of time. The lack of fleas and ticks on the rats is rather unusual. However, examinations of other species of animals on the island: bats, birds, feral goats, feral pigs, and feral cats, failed to find any specimens of fleas or ticks. One species of tick, Amblyomma cruciferum Neumann, was taken from the iguana lizard Cyclura stegnegeri Barbour and Noble.

Percent Infestation and Number of Ectoparasites.--A total of 4,092 ectoparasites was removed from the 237 rats. Echinolaelaps echidninus (Berlese) was the most common ectoparasite found on the rats, accounting for 30.2 percent of the total. The remainder included Polyplax spinulosa (Burmeister), 27.1 percent; Laelaps nuttalli Hirst, 19.9 percent; Hoplopleura oenomydis Ferris, 12 percent and Ornithonyssus bacoti (Hirst) 10.8 percent.

The average number of specimens per rat and the percentage of rats parasitized by a species were calculated by months for the total population and for each species. The results are presented in Figure 4-10. In general there appears to be a slight increase in the mean number of parasites and the percent infestation during the summer months. The only species that showed good correlation between percent infestation and mean, was Ornithonyssus bacoti (Hirst) (Figure 10).

Percent Infestation, Temperature and Rainfall.--The temperature variations are so small in this area that they probably do not play an

important role in fluctuation of ectoparasite populations. The rainfall is rather evenly distributed over the year, and appears to have little effect on percent infestations (Figure 11-12). A study, made over a period of several years, would be needed for any significant results.

Methods of Examining for Ectoparasites.--The two methods of removing parasites, by washing and by combing, showed little difference as far as the number and species of ectoparasites removed were concerned. The combing method was used, after trying both, as it was less bother and time consuming.

Reinfestation and Movement of the Host

Ectoparasites.--During the period May 10, 1955 through August 12, 1955, 71 rats were captured, examined for ectoparasites, marked, and released. From May 11, 1955 through September 22, 1955, 41 (57.7 percent) were recaptured at least once and reexamined to determine the rate and amount of reinfestation.

Table II, presents data on the results of this study. In general, indications are, that the level of parasitism of individual rats, as far as numbers are concerned, tends to remain about the same. Rats with light infestations originally, remained so and rats with heavier infestations originally, regained the larger numbers.

The reinfestation rate in the case of the spiny rat louse Polyplax spinulosa (Burmeister) was rather startling in a number of instances. Table II, for example, shows that 10 lice were removed from rat number 3 on May 11, 28 on May 27, and 32 on May 28. In order to simplify identification, only the third stage nymphs and adults of the lice were

recorded in this particular phase of the study.

The spiny rat louse, as do other species of rodent lice, reportedly spends its entire life cycle on the body of the host. The life cycle, from egg to adult, is completed in 18 to 25 days, depending on temperature. If a small error in recording the numbers of lice on rat number 3 is accepted, it is still evident the rat acquired a number of lice between May 27 and 28. A number of instances similar to this would seem to rule out the element of error and chance.

The mite populations on the individual rats, showed a rather rapid recovery. However, it should be pointed out that all stages, with the exception of eggs, were recorded and the possibility of error when dealing with relatively small numbers is rather high. Echinolaelaps echidninus (Berlese), the most common species of mite on the rats, showed the greatest recovery rates. Since the mites found on the rats do not spend their entire life cycle on the host, a fluctuation in numbers might be expected over a period of time.

Rattus rattus.--The ability of roof rats to find their way back to their home habitat, after being removed some distance away and liberated, has not been studied to any extent. Most studies have been made by releasing the rats in their original habitat and trying to determine their dispersal from this point.

From May 10, 1955 through August 12, 1955, 40 marked rats were released in areas at varying distances from their original point of capture. Sixteen (26 percent) were later recovered. Table III, presents the results of this experiment. Of the 16 rats recaptured, 11 made their way back to the point of initial capture, indicating this was

probably their home habitat. Rats number 28, 37, 38, and 71 (Table III) present a different picture. There is some indication these rats moved about between the buildings in the old Civilian Conservation Corps Camp area and the airstrip. Rat number 31 apparently was trying to return to its home habitat, the fishing shack, as it was captured at the stable, which was on the road from the release point to the fishing shack (Figure 3).

The most remarkable recovery was rat number 41 (Table III). This individual was captured at the laboratory on July 5 and released the same day at the fishing shack. On July 7, this same rat was recaptured at the laboratory. The distance travelled was approximately 8,700 yards. This was the longest distance any rat travelled, and is believed to be a record for this species.

The low recovery rate (26 percent), of rats liberated at points other than their home habitat, suggests something may have happened to the remaining individuals. A number of marked rats, for example, were taken to the fishing shack and released over a period of time. Only two were ever recovered and these had returned to their original habitat. During the same period, several rats were captured in this area, released and later recaptured.

Movement Between Population Units.--Of the 41 marked rats recovered, 5 (12.2 percent) were taken in an area other than their original point of capture. These 5 exceptions had all been released in areas other than their original point of capture. The rats that were marked and released in the area where they were captured, were never recovered more than 50 yards from that area.

CHAPTER V

DISCUSSION

The result of trapping 237 rats on Mona Island, West Indies, during the period December 1, 1954 through November 30, 1955, indicates the only species of rat found on the island is the roof rat Rattus rattus (Linnaeus). The preferred habitat of these rats is the abandoned buildings found on the low coastal area. No rats were found on the plateau, with the exception of a small colony near the lighthouse. Lack of water and the relatively small known food supply, probably limits the rat activity to the low coastal areas. It was not possible to trap in all sections of the island, and there may be rat colonies in these areas. However, it was quite evident the rats preferred the man-made structures for harborage. It might be deduced from this, that this species of rat is found on most of the small islands in the Caribbean that are, or have been populated by man.

The ectoparasites found on the rats, were all common rat parasites: Echinolaelaps echidninus (Berlese), Laelaps nuttalli Hirst, Ornithonyssus bacoti (Hirst), Polyplax spinulosa (Burmeister) and Hoplopleura oenomydis Ferris. The small number of ectoparasite species is not the usual condition encountered with this species of rat. Rattus rattus generally has a large number of species of ectoparasites associated with it over a period of time. It is quite probable, other species of ectoparasites would be found on Mona Island, with the examination of larger numbers of rats over a longer period of time.

The species of ectoparasites found and the prevalence is not in accord with the results obtained by Fox (1951) in an urban area in Puerto Rico. Echinolaelaps echidninus (Berlese) was the most common ectoparasite on the rats from Mona Island, while in Puerto Rico Laelaps nuttalli Hirst, was the most common species found. The spiny rat louse was rather uncommon in Puerto Rico, but accounted for 27.1 percent of the total numbers of ectoparasites from rats on Mona Island. Fleas and ticks were common on the rats in Puerto Rico, but none were found on Mona Island rats. The absence, or rather the inability to find fleas and ticks on the rats is rather puzzling. The failure to find these Arthropods on other animals, would suggest they either do not occur on the island, or are rare.

The mean number of ectoparasites per rat and the percent infestation (Figure 4-10) show a slight increase during the summer months. It should be pointed out, however, that the number of rats examined per month was not great and the experiment was not conducted over a long period of time. Before any interpretation of seasonal variance can be made, comparisons would have to be made over a period of several years. The tropical rat mite Ornithonyssus bacoti (Hirst) (Figure 8), was the only species that showed a consistent correlation between percent infestation and mean for each month of the year. The rather evenly distributed rainfall and slight variation in temperature (Figure 11-12) had no apparent effect on the infestation rate of the ectoparasites. Again this is difficult to judge without comparison.

In the removal of ectoparasites from rats, the combing and picking method was found to be the most feasible under field conditions. The

amount of time and the materials required for washing would not be practical under most conditions. It is believed that better results can be obtained by a thorough job of combing and picking than by washing under any condition.

Approximately 75 percent of the mites and lice were removed by the initial brushing and the remainder by picking over the rat with a teasing needle and forceps. The number of ectoparasites not discovered by this method is believed to be insignificant.

In the study of reinfestation rates of ectoparasites (Table II), it was noted the rats with the least number of ectoparasites on the first examination were found to regain approximately the same small number on subsequent examinations. In contrast, the individuals with heavier infestations to begin with, were inclined to regain the higher number of ectoparasites. This would suggest that rats, like humans, may vary in their susceptibility to parasite infestations.

The spiny rat louse, in a number of instances (Table II), showed a tendency to repopulate a host rather quickly. In this particular situation, indications are, the louse may not be confined to the body of the host for its entire life cycle. Since the spiny rat louse has been incriminated experimentally in the transmission of typhus fever, the possibility exists that this louse may be more important in the transmission of typhus from rat to rat in nature than is now supposed.

Seventy-one marked rats were released during the period May 10, 1955 through August 12, 1955. Forty-one (57.7 percent) were recovered at least once. Forty of the marked rats were released in areas other than where captured. The recovery in this group was 16 (26 percent). The rate

of recovery of the rats liberated where they were originally captured was almost 85 percent.

The low recovery rate of the 40 rats liberated in areas other than their home habitat, suggests that a high percentage did not survive. What did happen is not clear, but the possibility exists that the rats may have been destroyed by other rats who occupied the area where the marked rats were released. There is probably a rather delicate balance between the rats in any given area and the available food supply, and any factor that would upset this balance would likely be resisted vigorously.

Of the 16 rats recaptured after being released away from their home habitat, 11 or 69 percent had returned to their original point of capture. This suggests a strong tendency to find their way back to their home range. Rats that were marked and released in the area where they were captured were never recovered more than 50 yards from that area. This would support the findings of Worth (1950) in Florida, Spencer and Davis (1950) in Hawaii, and Baker (1946) in Guam, who showed roof rats do not stray far from their home range.

CHAPTER VI

SUMMARY

A survey of rats and their ectoparasites was made on Mona Island, West Indies from December 1, 1954 through November 30, 1955.

One species of rat, Rattus rattus (Linnaeus), was found on the island. Their preferred habitat was the abandoned man-made structures on the low coastal area. The only area on the plateau where rats were taken was at the lighthouse.

Five species of ectoparasites were found on the rats: Echinolaelaps echidninus (Berlese), Laelaps nuttalli Hirst, Ornithonyssus bacoti (Hirst), Polyplax spinulosa (Burmeister), and Hoplopleura oenomydis Ferris. Echinolaelaps echidninus was the most common ectoparasite found on the rats. There appeared to be a slight increase during the summer months in the percent of rats infested and mean number of parasites per rat. Little correlation could be seen between percent infestation, temperature, and rainfall.

The spiny rat louse Polyplax spinulosa (Burmeister) appeared to reinfest a deloused host rather rapidly, indicating a movement from nest to host or host to host. In general, rats with light ectoparasite infestations originally became re-infested with similarly low populations. Those rats that had heavier infestations originally, regained the higher number of ectoparasites.

Rats removed from their home habitat and liberated demonstrated a strong tendency to return to their home habitat. One individual rat

was recaptured after it had travelled approximately five miles.

There appeared to be little movement of the rats between population units. Individuals were rarely recaptured far from their original point of capture.

LITERATURE CITED

Anthony, H. E. 1925. Mammals of Porto Rico, living and extinct. Sci. Surv. Porto Rico and Virgin Islands, Pts. 1-2. N.Y. Acad. Sci. 9: 1-238.

Baker, R. H. 1946. A study of rodent populations on Guam, Marianna Islands. Ecol. Mon. 16: 393-408.

Baker, E. W., T. M. Evans, D. J. Gould, W. B. Hull, and H. L. Keegan. 1956. A manual of parasitic mites of medical or economic importance. National Pest Control Association, Inc., New York. 170 p.

Carrion, A. L. 1927. Preliminary report on a rat and flea survey of the city of San Juan, Porto Rico. Porto Rico Jour. Pub. Health Trop. Med. 3: 131-145.

____ 1928. Preliminary report on a rat-flea survey of the city of San Juan, Porto Rico. Porto Rico Jour. Pub. Health Trop. Med. 4: 84-92.

____ 1929. Third report on a rat-flea survey of the city of San Juan, Porto Rico. Porto Rico Jour. Pub. Health Trop. Med. 5: 158-166.

____ 1932. Final report on a rat-flea survey of San Juan, Porto Rico. Pub. Health Rep. 47: 193-201.

Davis, David E., and John T. Emlen, Jr. 1948. The placental scar as a measure of fertility in rats. Jour. Wildlife Management. 12: 162-166.

____, John T. Emlen, and Allen W. Stokes. 1948. Studies on home range in the brown rat. Jour. Mamm. 29: 207-225.

Ecke, Dean H. 1955. Roof rat populations in Southwest Georgia. Pub. Health Mon. 27: 1-18.

Emlen, John T., Jr., and David E. Davis. 1948. Determination of reproductive rates in rat populations by examination of carcasses. Physiol. Zool. 21: 59-65.

____, Allen W. Stokes, and Charles P. Winsor. 1948. The rate of recovery of decimated populations of brown rats in nature. Ecology. 29: 133-145.

Fox, Irving. 1946. A new genus, Borinquolaelaps, and new species of mites from rats in Puerto Rico. Jour. Parasitol. 32: 445-452.

____ 1947. Ornithodoros puertoricensis, a new tick from rats in Puerto Rico. Jour. Parasitol. 33(3): 253-259.

____ 1951. Relative and seasonal abundance of the common rat ectoparasites of San Juan, Puerto Rico. Jour. Parasitol. 37(1): 85-95.

Herms, William B. 1953. Medical entomology. MacMillan Co., New York. 582p.

Hull, Thomas G. 1955. Diseases transmitted from animals to man. Charles C. Thomas, Springfield, Ill. 717p.

Matheson, Robert. 1950. Medical entomology. Comstock Pub. Co., Ithaca, N.Y. 629p.

Pippin, Warren F. 1956. Unpublished data.

Pratt, Harry D. and Herbert Karp. 1953. Notes on the rat lice Polyplax spinulosa (Burmeister) and Hoplopleura oenomydis Ferris. Jour. Parasitol. 39(5): 495-504.

____,and Newell E. Good. 1954. Distribution of some common domestic rat ectoparasites in the United States. Jour. Parasitol. 40(2): 113-129.

Ramos, J. A. 1946. The insects of Mona Island (West Indies). Jour. Agri. Univ. Puerto Rico. 30(1): 1-74.

Richter, C. P. and J. T. Emlen, Jr. 1945. A modified rabbit box trap for use in catching live wild rats for laboratory and field studies. Pub. Health Rep. 60: 1303-1308.

Spencer, H. J. and D. E. Davis. 1950. Movement and survival of rats in Hawaii. Jour. Mamm. 31: 154-157.

Tate, H. D. 1941. The biology of the tropical cattle tick and other species of tick in Puerto Rico, with notes on the effect on ticks of arsenical dips. Puerto Rico Jour. Agri. 25: 1-24.

Wadsworth, Frank H. 1945. The potentialities of forestry on Mona Island. Carib. Forester. 6(4): 219-244.

Wolcott, George N. 1941. Supplement to "Insectae Borinquensis". Jour. Agri. Univ. Puerto Rico. 25: 33-158.

Worth, C. B. 1950. Field and laboratory observations on roof rats, Rattus rattus (Linnaeus) in Florida. Jour. Mamm. 31: 293-304.

APPENDIX

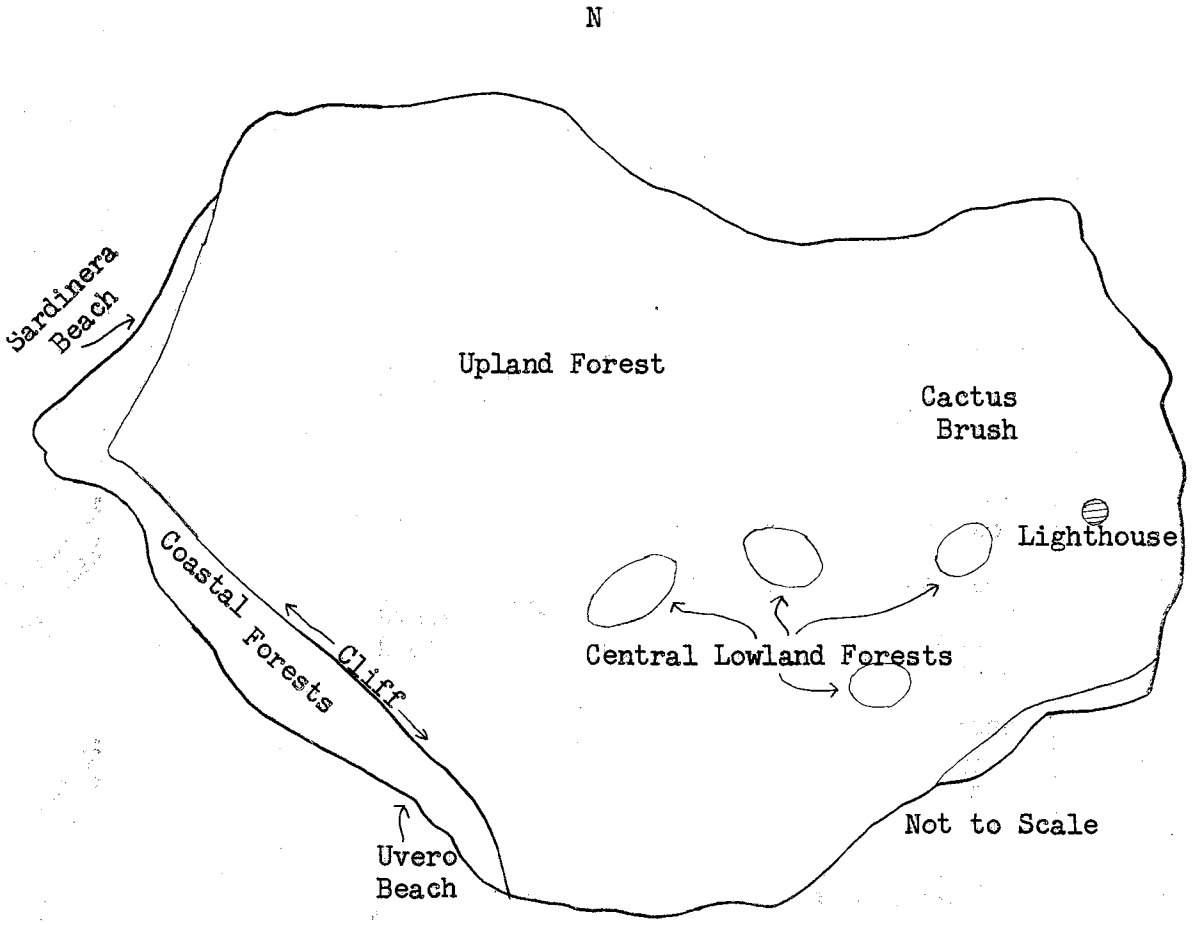

Figure 1. Mona Island Showing Forest Types, Lighthouse, Cliff and Coastal Areas.

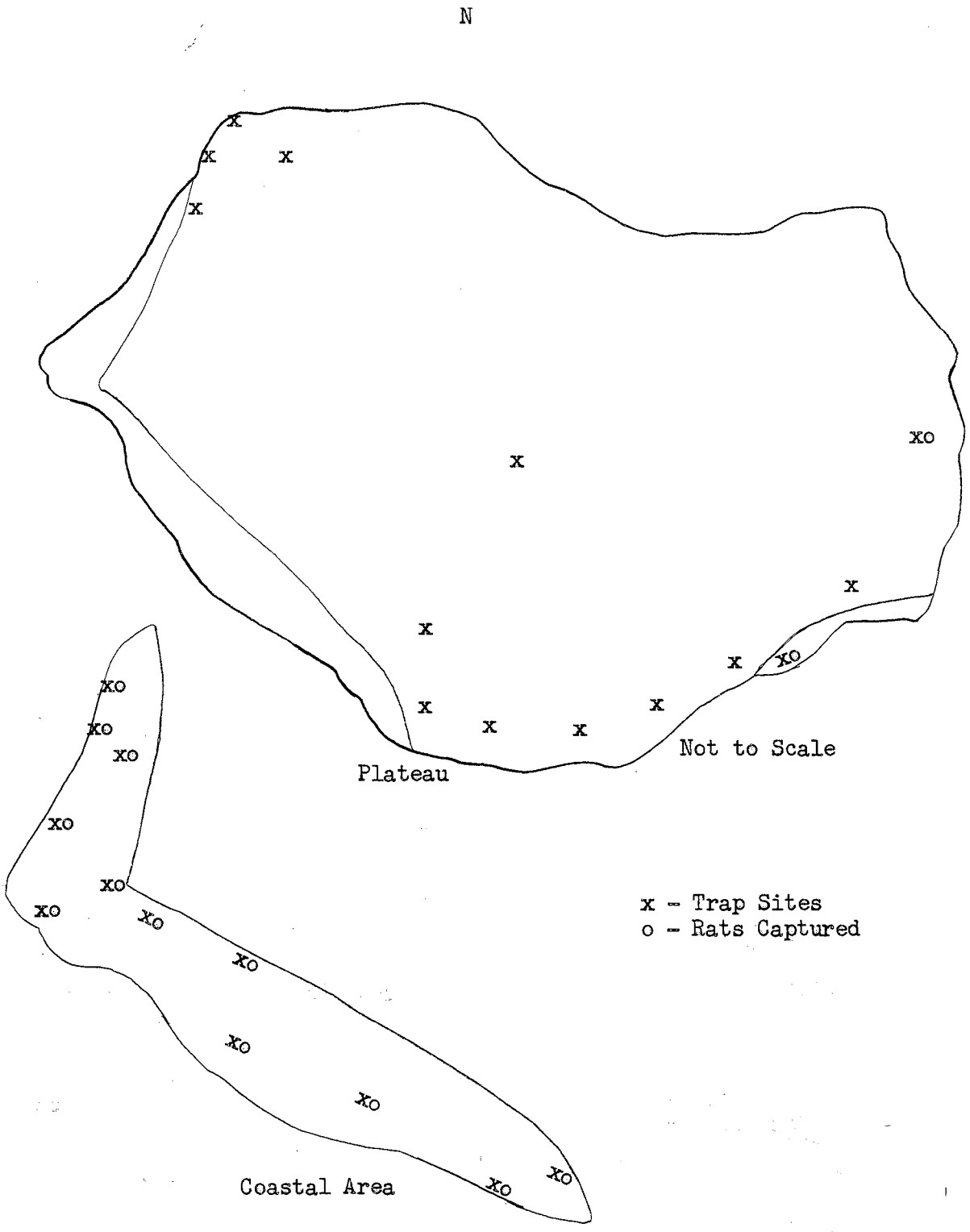

Figure 2. Mona Island Showing Where Traps were Set and Rats Captured on the Plateau and Coastal Areas.

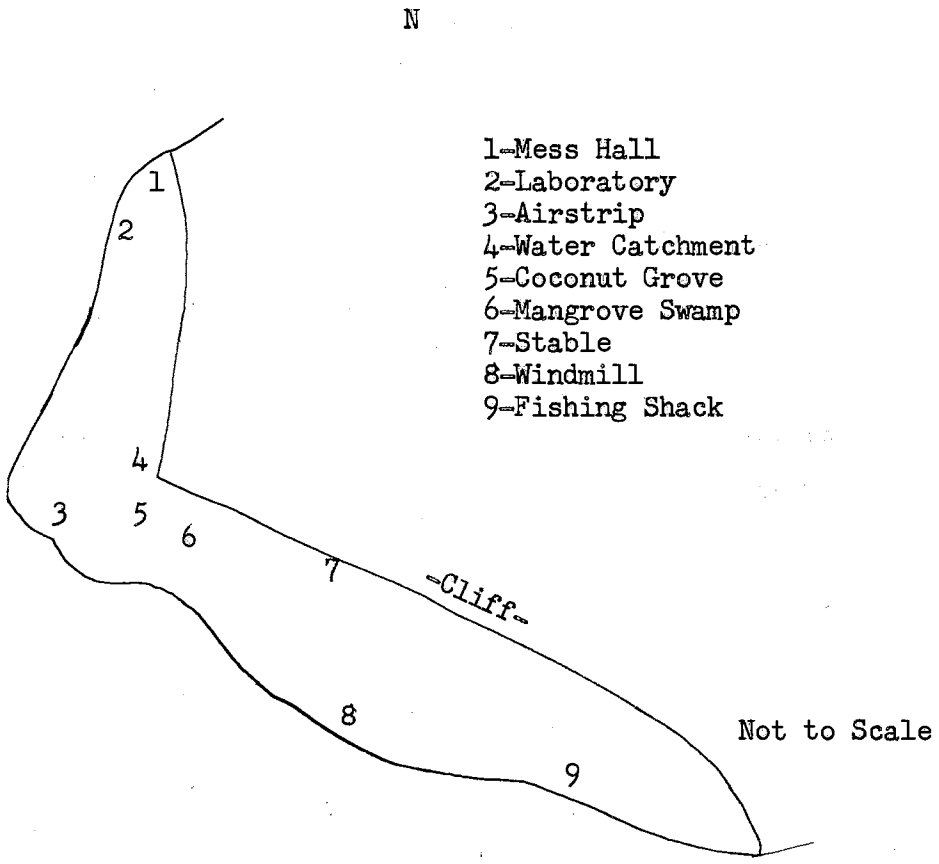

Figure 3. Mona Island Coastal Area Showing Capture and Release Points for Movement Studies of Rattus rattus (Linnaeus).

TABLE I.

Number of Rats Captured by Month.

Month	Number	Species
Dec.	10	Rattus rattus
Jan.	7	"
Feb.	12	"
Mar.	8	"
Apr.	13	"
May	57	"
June	49	"
July	46	"
Aug.	9	"
Sept.	7	"
Oct.	8	"
Nov.	11	"
Total	237	

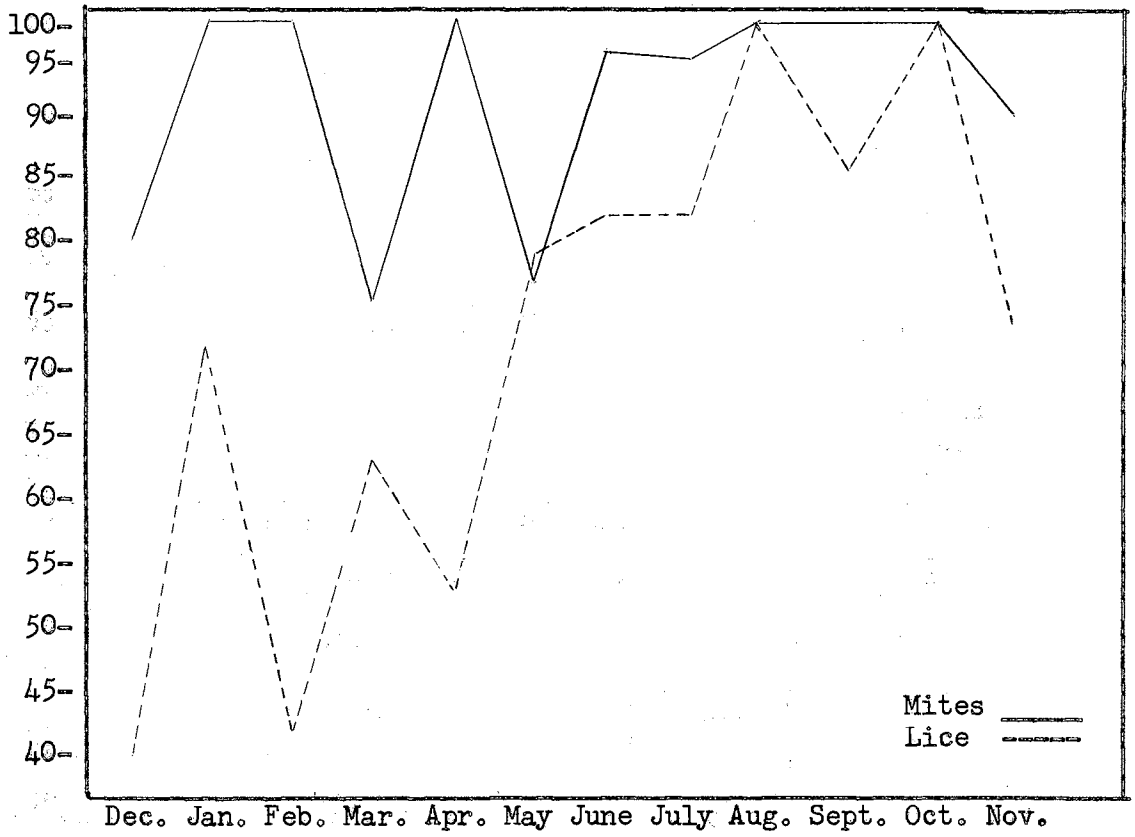

Figure 4. Percent of Rats Infested by Mites and Lice.

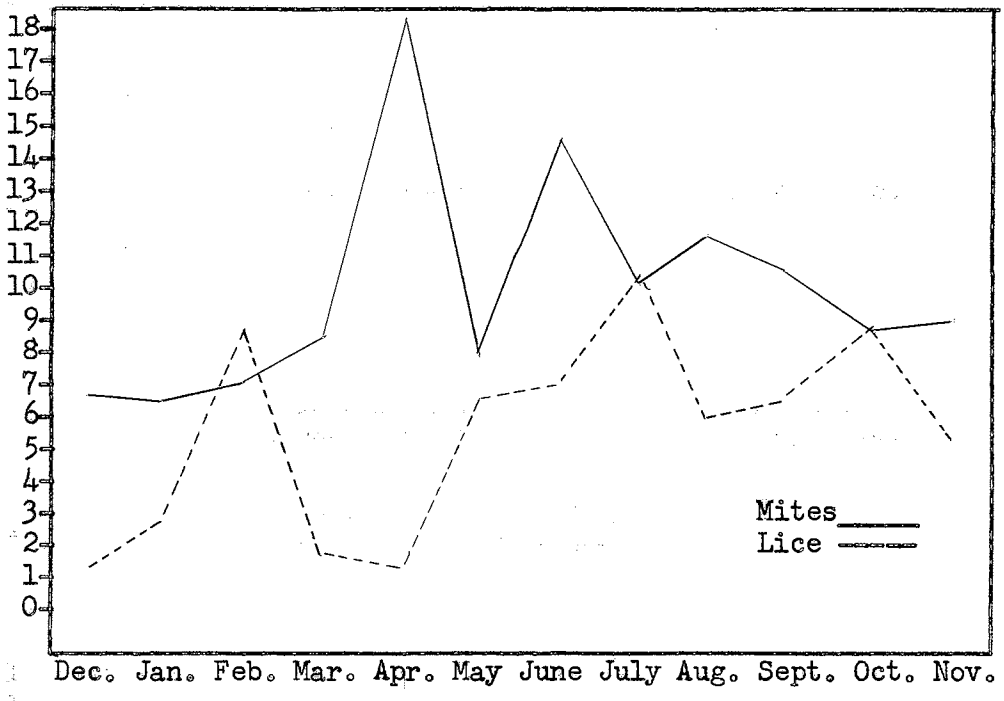

Figure 5. Mean Number of Mites and Lice Per Rat.

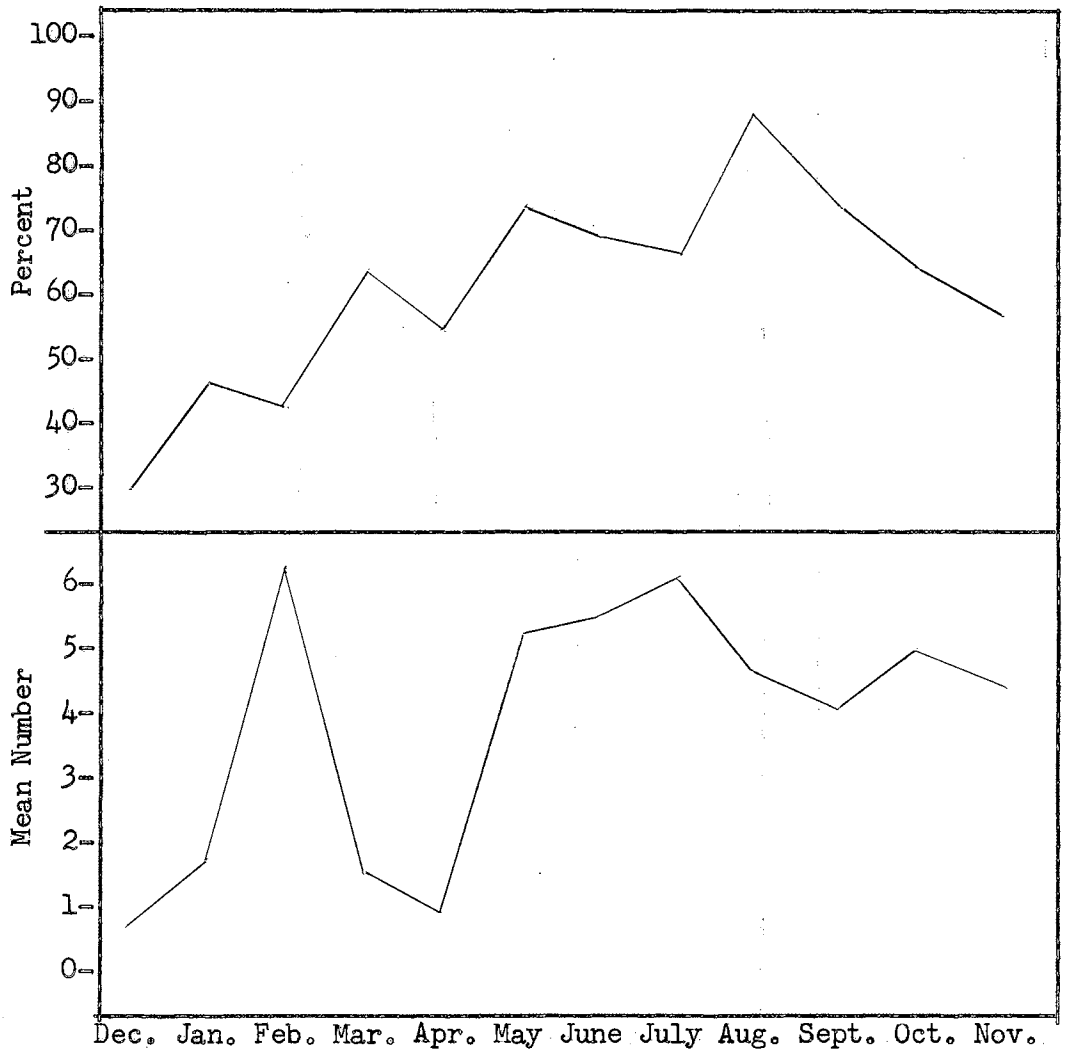

Figure 6. Percent of Rats Infested by Polyplax spinulosa, and Mean Number of Lice Per Rat.

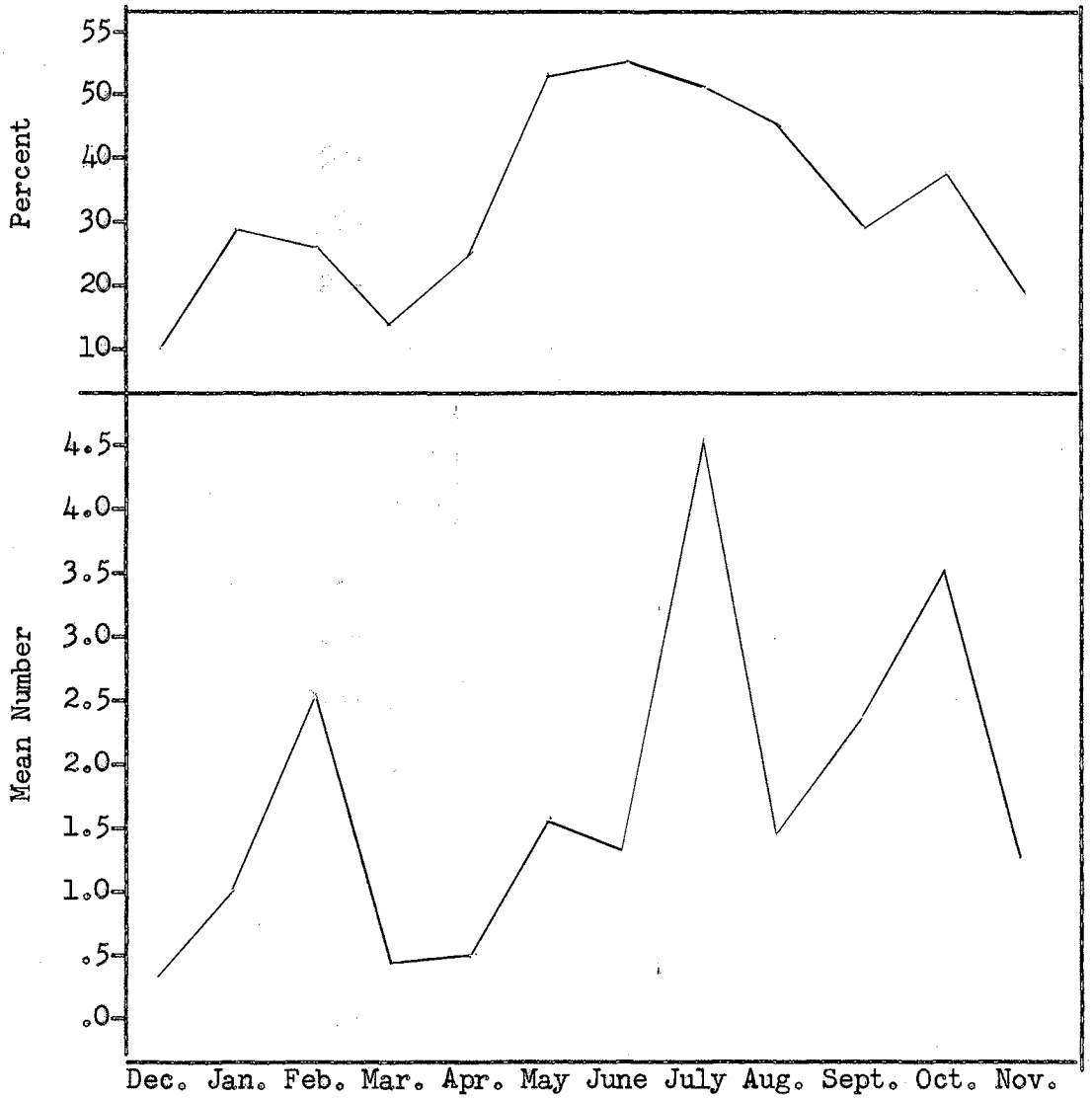

Figure 7. Percent of Rats Infested by Hoplopleura oenomydes, and Mean Number of Lice Per Rat.

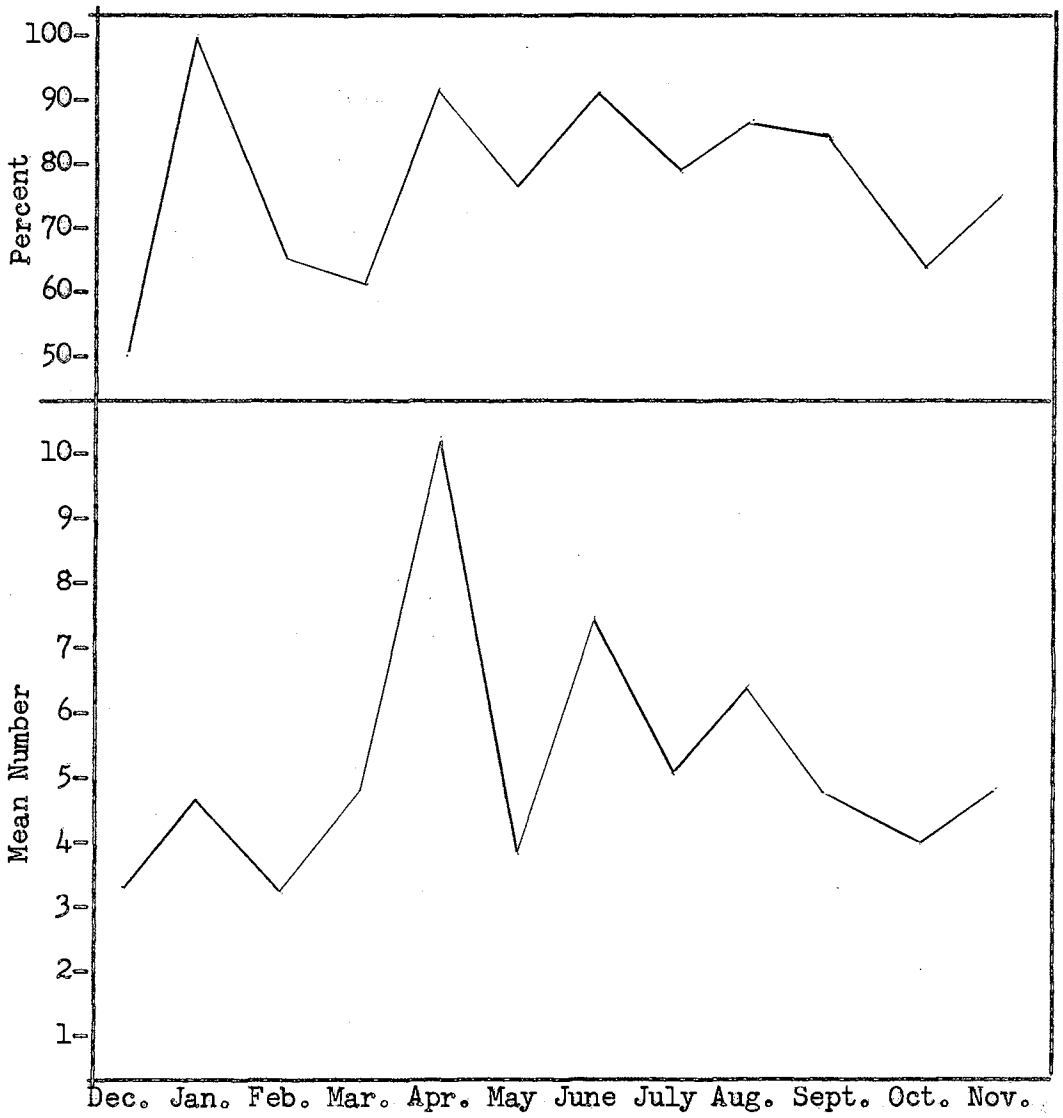

Figure 8. Percent of Rats Infested by Echinolaelaps echidninus, and Mean Number of Mites Per Rat.

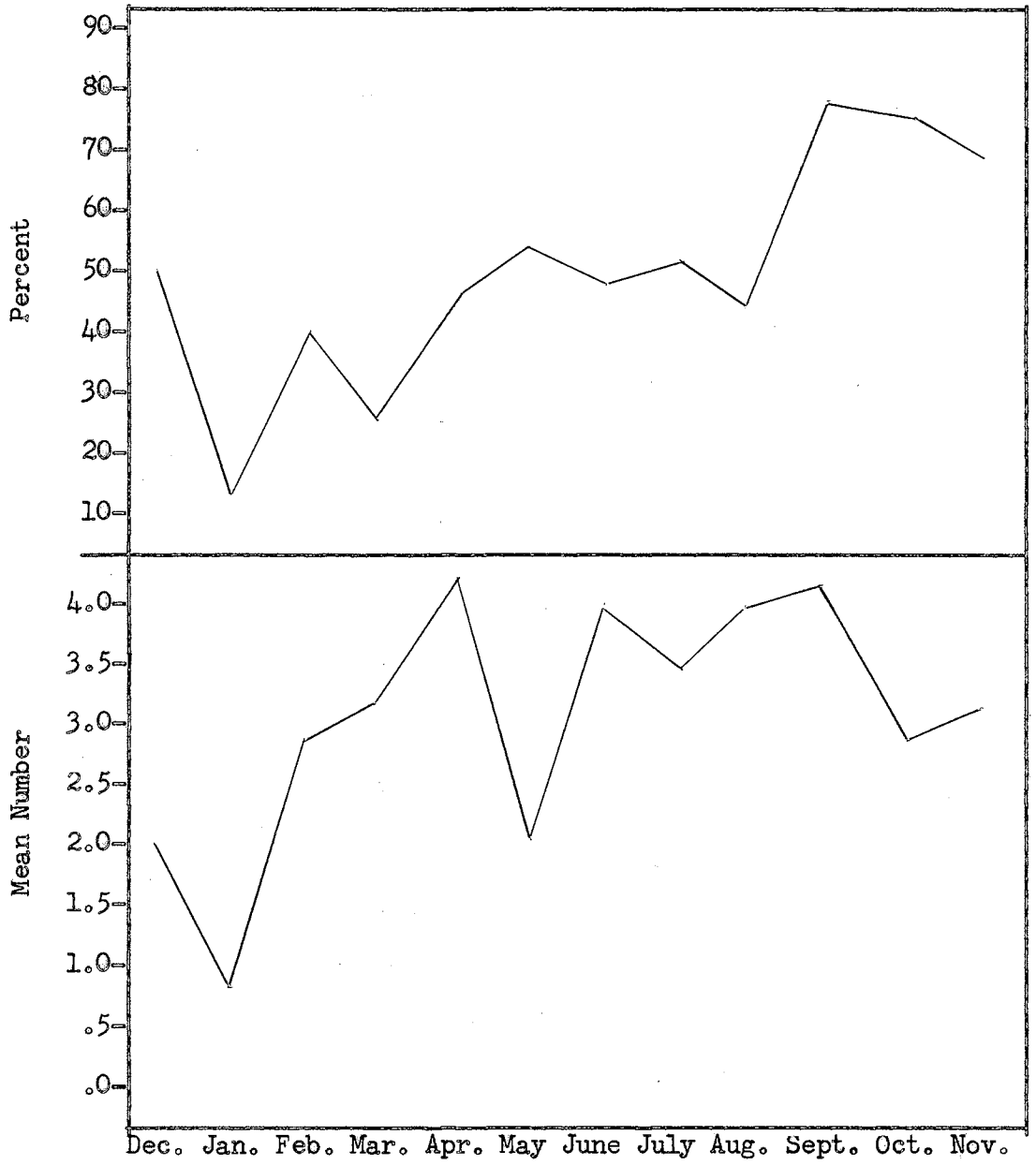

Figure 9. Percent of Rats Infested by Laelaps nuttalli, and Mean Number of Mites Per Rat.

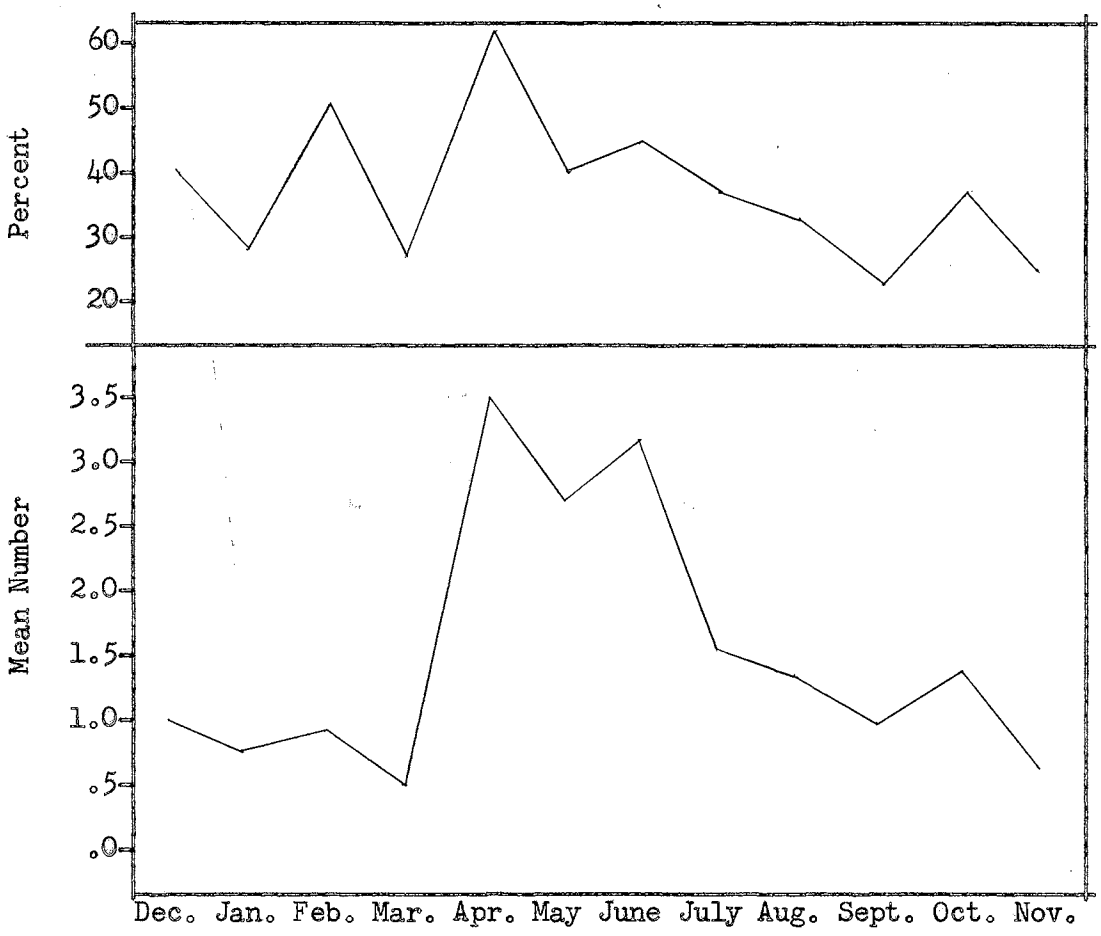

Figure 10. Percent of Rats Infested by Ornithonyssus bacoti, and Mean Number of Mites Per Rat.

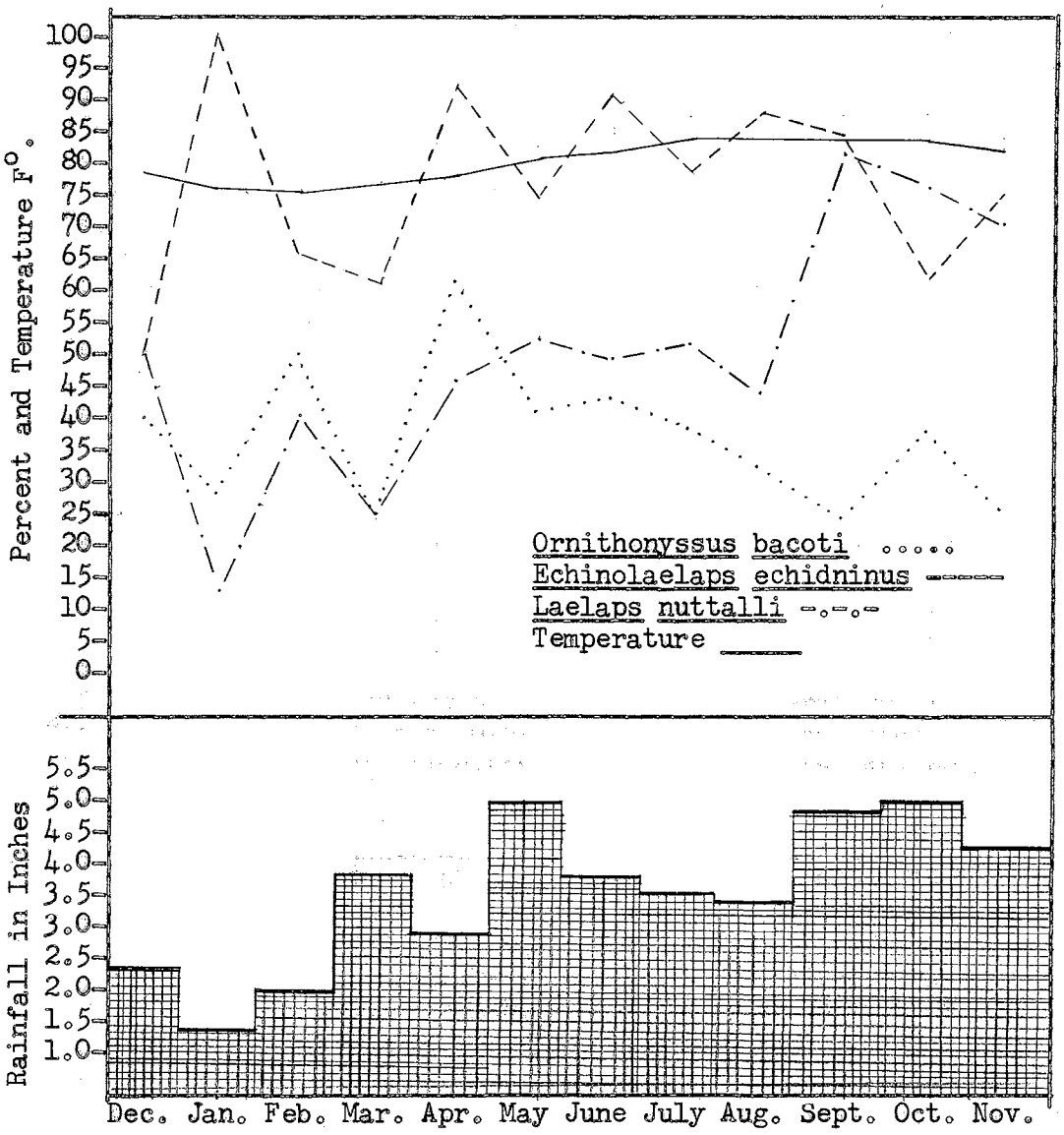

Figure 11. Comparison of Rainfall and Temperature with Percent of Rats Infested by Ornithonyssus bacoti, Echinolaelaps echidninus, and Laelaps nuttalli.

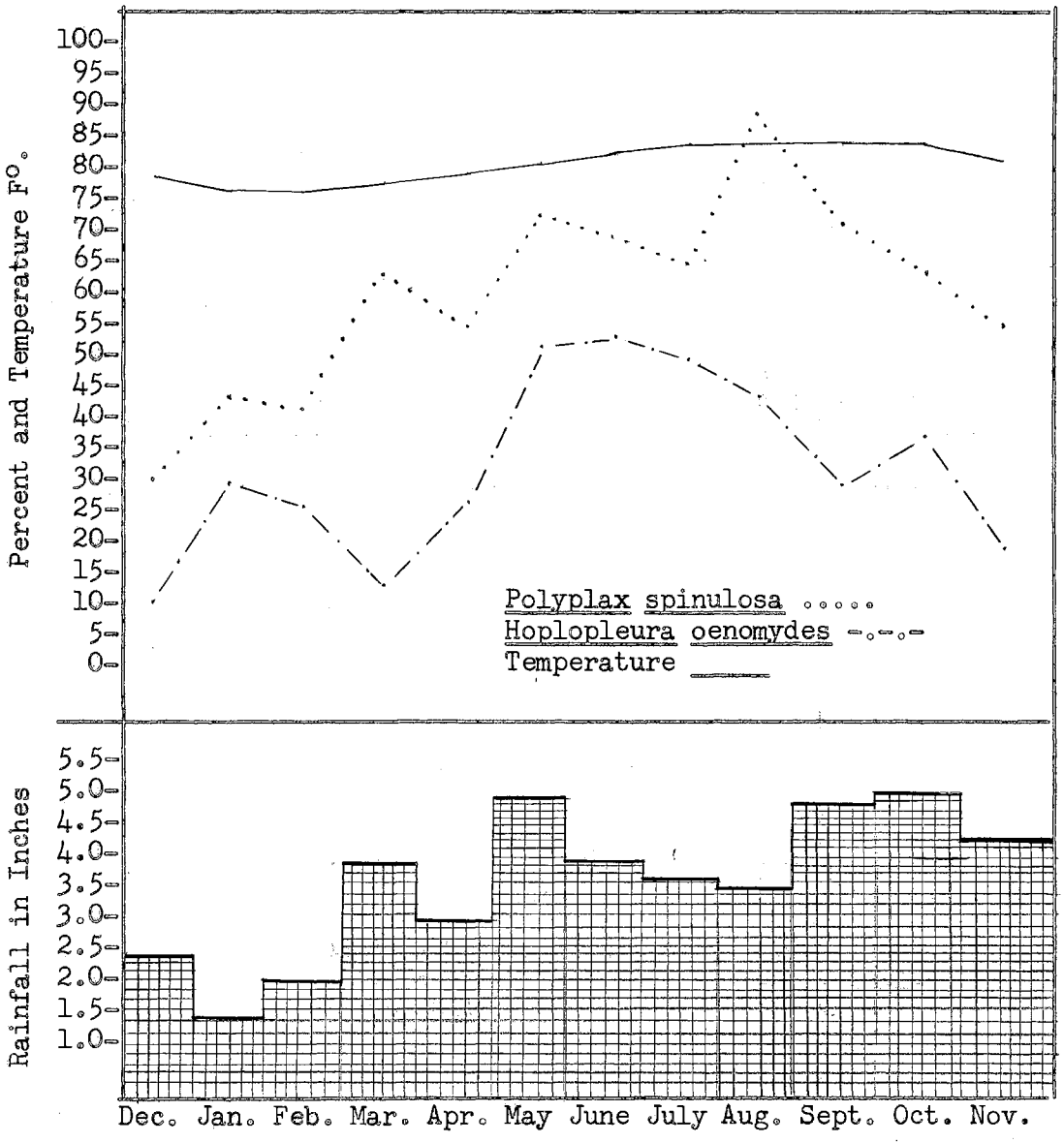

Figure 12. Comparison of Rainfall and Temperature with Percent of Rats Infested by Polyplax spinulosa and Hoplopleura oenomydes.

TABLE II

Ectoparasites on Rats when Originally Captured and when Recaptured.

Rat Number	Date Captured and Released	Date Recaptured	Ectoparasites and Numbers Recovered
1	10 May		Ee (1) Ps (3)
		11 May	Ee (3)
		24 May	Ee (2) Ps (1)
		28 May	Ps (4)
		16 July	Ee (3) Ln (1) Ps (6) Ho(4)
2	10 May		Ee (2)
		12 May	Ee (3) Ob (2)
		4 June	Ee (4)
3	11 May		Ps (10) Ee (3)
		27 May	Ps (28) Ee (14) Ln (8)
		28 May	Ps (32) Ee (2)
4	11 May		Ho (9) Ee (3) Ln (2)
		12 May	Ho (1) Ee (1) Ob (3)
		28 May	Ps (4) Ho (6) Ee (2) Ob(1)
5	11 May		Ps (11) Ee (4)
		20 May	Ps (12) Ln (5)
6	12 May		Ob (1) Ln (5)
		17 May	Ob (3) Ee (2) Ln (2)
9	12 May		Ho (3)
		25 May	Ho (1) Ln (5)
10	12 May		Ps (8) Ee (7) Ln (5)
		17 May	Ps (18) Ee (3)
11	12 May		Ps (2) Ob (1)
		18 May	Ps (1) Ob (3) Ln (4)

Ps - Polyplax spinulosa
Ho - Hoplopleura oenomydes
Ee - Echinolaelaps echidninus
Ln - Laelaps nuttalli
Ob - Ornithonyssus bacoti

TABLE II (Continued)

Rat Number	Date Captured and Released	Date Recaptured	Ectoparasites and Numbers Recovered
13	18 May		Ho (2) Ee (2)
		19 May	Ee (4)
14	20 May		Ee (2) Ob (6)
		5 June	Ps (3) Ee (5) Ln (4)
15	20 May		Ps (6) Ho (4) Ee (7)
		5 June	Ps (5) Ee (5) Ln (5)
16	24 May		Ps (3) Ee (18) Ln (9)
		26 May	Ee (65) Ln (24) Ob (12)
18	25 May		Ho (3)
		22 Sept.	Ho (5) Ee (6)
20	25 May		0
		26 May	0
23	25 May		Ps (3)
		26 May	Ps (5) Ee (1)
24	26 May		Ee (6) Ln (2)
		7 June	Ee (4)
25	27 May		Ps (28) Ee (11)
		28 May	Ps (9) Ee (6)
26	4 June		Ps (3) Ee (8) Ln (5)
		5 June	Ps (1) Ee (3)
		11 July	Ee (6) Ob (4) Ln (4)
27	4 June		Ee (2) Ln (4)
		5 June	Ln (4)
28	7 June		Ps (9) Ee (7) Ob (6)
		9 June	Ps (3) Ee (2)

Ps - *Polyplax spinulosa*
Ho - *Hoplopleura oenomydes*
Ee - *Echinolaelaps echidninus*
Ln - *Laelaps nuttalli*
Ob - *Ornithonyssus bacoti*

TABLE II (Continued)

Rat Number	Date Captured and Released	Date Recaptured	Ectoparasites and Numbers Recovered
29	7 June		0
		15 July	Ee (4)
30	7 June		Ee (3)
		7 July	Ho (1) Ee (4)
31	7 June		Ho (1) Ln (4)
		15 July	Ho (2) Ln (5) Ob (1)
32	8 June		Ps (3) Ob (2)
		6 July	Ps (2) Ee (9) Ln (4)
		11 July	Ps (6) Ee (4) Ln (6)
33	8 June		Ps (8) Ho (3) Ob (6)
		9 June	Ps (5) Ee (14) Ln (17)
34	8 June		Ps (2) Ho (6) Ee (5)
		9 June	Ps (2) Ee (3) Ln (5)
37	5 July		Ps (17) Ho (6) Ee (22)
		7 July	Ps (8) Ee (14)
38	5 July		Ee (7) Ln (3)
		6 July	Ps (3) Ee (8)
		11 July	Ps (12) Ee (4) Ob (14)
39	5 July		Ee (3) Ln (5)
		6 July	Ee (9) Ln (3) Ob (3)
40	5 July		Ps (22) Ho (8) Ee (16) Ln(4)
		7 July	Ps (5) Ee (14)
		11 July	Ps (12) Ee (5)
41	5 July		Ob (7) Ps (2)
		7 July	Ps (8) Ob (3)

Ps - Polyplax spinulosa
Ho - Hoplopleura oenomydes
Ee - Echinolaelaps echidninus
Ln - Laelaps nuttalli
Ob - Ornithonyssus bacoti

TABLE II (Continued)

Rat Number	Date Captured and Released	Date Recaptured	Ectoparasites and Numbers Recovered
42	5 July		Ps (6) Ee (5) Ln (2)
		6 July	Ps (7) Ee (12)
		11 July	Ps (3) Ee (6)
51	7 July		Ps (9) Ho (3) Ln (6)
		12 July	Ps (19) Ln (2)
53	7 July		Ee (8) Ln (13) Ob (3)
		11 July	Ee (2) Ln (5)
58	13 July		Ps (94) Ho (21) Ln (9)
		21 Sept.	Ps (28) Ee (19) Ln (14)
63	14 July		Ps (3) Ee (20) Ln (7)
		15 July	Ee (10)
68	11 Aug.		Ps (32) Ho (6) Ob (14)
		12 Aug.	Ps (28) Ob (7)
69	11 Aug.		Ps (8) Ee (3)
		12 Aug.	Ps (2) Ee (1)
70	11 Aug.		Ps (14) Ho (3) Ln (5)
		22 Aug.	Ps (20) Ln (8) Ee (4)
71	12 Aug.		Ps (11) Ee (5)
		25 Aug.	Ps (10) Ee (2) Ln (3)

Ps - Polyplax spinulosa
Ho - Hoplopleura oenomydes
Ee - Echinolaelaps echidninus
Ln - Laelaps nuttalli
Ob - Ornithonyssus bacoti

TABLE III

Movement of Rats Shown by Trapping Records.

Rat Number	Date and Original Point of Capture	Liberation Point	Date and Recapture Point	Approximate Distance Travelled in Yards
1	10 May Mangrove Swamp	Laboratory	11 May Mangrove Swamp	1100
4	11 May Water Catchment	Windmill	12 May Water Catchment	1700
14	20 May Mess Hall	Laboratory	5 June Mess Hall	350
28	7 June Airstrip	Airstrip	9 June Laboratory	600
30	7 June Laboratory	Mess Hall	7 July Laboratory	350
31	7 June Fishing Shack	Mess Hall	15 July Stable	1500
32	8 June Airstrip	Mess Hall	6 July Airstrip	950
		Stable	11 July Airstrip	850

TABLE III (Continued)

Rat Number	Date and Original Point of Capture	Liberation Point	Date and Recapture Point	Approximate Distance Travelled in Yards
37	5 July Airstrip	Airstrip	7 July Mess Hall	950
38	5 July Mess Hall	Mess Hall	6 July Airstrip	900
		Stable	11 July Airstrip	850
40	5 July Laboratory	Mess Hall	7 July Laboratory	350
		Stable	11 July Laboratory	1400
41	5 July Laboratory	Fishing Shack	7 July Laboratory	8700
42	5 July Mess Hall	Stable	11 July Mess Hall	1500
51	7 July Mess Hall	Stable	12 July Mess Hall	1500
53	7 July Laboratory	Stable	11 July Laboratory	1200
58	13 July Coconut Grove	Fishing Shack	21 Sept. Coconut Grove	4400
71	12 Aug. Mess Hall	Mess Hall	25 Aug. Laboratory	350

VITA

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Master of Science

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