A LIMITED RAT-FLEA SURVEY OF RAS-BEIRUT, LEBANON

By

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RAT-FLEA SURVEY

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ABSTRACT

A limited rat-flea survey was conducted in the area of Ras-Beirut, Lebanon, during the period from March to December, 1960, to determine the frequency of occurrence of the Oriental Rat Flea, Xenopsylla cheopis, upon its natural hosts.

Both live-trapped and snap-trapped rats were included in the survey. A total of 284 were examined and 644 fleas secured, 618 of which were Xenopsylla cheopis. This species of fleas is of high potential importance as a vector of disease and is by far the most common flea (2.17 per rat) upon Rattus norvegicus, the Norway Rat.

Two other species, Leptopsylla segnis and Ctenocephalides felis felis, were found in small numbers but do not seem to be very common in this area upon the Norway Rat.

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I. INTRODUCTION

A limited rat-flea survey was conducted in the area of Ras-Beirut, Lebanon, during the year 1960 beginning in March and ending in December, excluding the month of July.

This survey dealt with an investigation of the frequency of occurrence of the Indian or Oriental Rat Flea, Xenopsylla cheopis, upon its natural hosts. This species of fleas is of high potential capacity as a vector of disease in this part of the world, and is considered to be of great medical and veterinary importance.

Unfortunately, there is no official record of any rat-flea surveys in the Lebanon, either by the Government's Ministry of Health or any other Public Health department. Because of this, coupled with the need for information concerning the distribution of rat-fleas, it is hoped that this survey will help future investigators to obtain more accurate information concerning the status of rat fleas in this area.

II. REVIEW OF LITERATURE

The medical importance of fleas was first demonstrated by the British Plague Commission in 1906-1907 when fleas were shown to be the vectors of Bacillus pestis, the causative agent of the dreadful bubonic plague. Until that time plague had been one of the most feared and fatal diseases of man, and whenever it occurred epidemically it exterminated large numbers of the population.

Matheson (1950) reported that Scott, 1939, traced plague to at least 300 B.C. as a fatal disease in Libya, Egypt and Syria, though its origin is not definitely known. Petrie, et al (1924) reported that there are references to at least 121 years of plague in Egypt scattered throughout the chronicles to the year 1844. They also mention that the Arab traveller, Ibn Batuta, from Tangier, experienced an outbreak of plague in India on his return from China. He fell ill with the disease in 1332. A few years later he encountered an offshoot of plague in the summer of 1348 inCairo.

The first acute epidemic of plague was one that raged throughout Europe during the fourteenth century, killing off fully one-fourth of the entire population. From then until near the end of the seventeenth century it was

almost constantly present in Europe. In 1665 the great plague of London occurred and nearly 70,000 persons had died by the middle of the nineteenth century. Toward the end of the nineteenth century sporadic outbreaks occurred in various European seaports and in many other parts of the world. In 1894 it appeared in Hong Kong, in Bombay, India in 1896, in 1898 in Egypt, in 1899 in Manilla, the same year in Buenos Aires and Rio de Janeiro, 1900 in San Francisco, and in 1914 in New Orleans. It also became established in Mexico, Australia, and other countries as has been related by Matheson (1950). He also reported that, since plague appeared in India in 1898, Heiser states that over 10,000,000 people have died, the annual death rate between 1898 and 1918 being 500,000. At the present time the death rate is probably less than 50,000 as of 1935.

Also according to Matheson (1950), it was not until 1894 that Yersin and Kitasato independently isolated the causative organism, Bacillus pestis. Simond in 1898, suggested that fleas were the vectors, and Liston, 1905, demonstrated the development of the bacilli in the gut of the Oriental Rat Flea, Xenopsylla cheopis (Roths, 1903).

As has been reported by the Advisory Committee in 1906, the German Plague Commission also found bacilli in fleas taken from plague-infested rats but did not regard the bites of fleas as a probable means of transmission as Simond had

suggested.

The mechanism by which fleas infected with the bacilli transmit the disease from rodent to rodent and also to man was observed and first established by Bacot and Martin in 1914. Immediately after this finding, fleas became of great importance to medical entomologists who started many investigations on fleas in order to determine their relationship with plague and certain other diseases.

Chick and Martin in 1911 reported that the particular fleas found in greatest numbers upon rats seem to be determined by geographical characteristics including climate and the habitat of the rats examined. Also according to Chick and Martin (1911), Xenopsylla cheopis was described as Pulex cheopis by Rothschild in 1903 after examination of specimens taken from several small rodents in Egypt and Sudan. This is the commonest rat flea in the tropical and sub-tropical parts of the world. In India it forms almost 100 per cent of all the rat fleas found. In the warmer parts of the temperate regions such as the Mediterranean, Southern Japan, San Francisco and Australia as far as Sydney, it also occurs in varying proportions according to the time of year. It was also reported by Jordan and Rothschild to be common in South Africa and Central and South America.

In general, fleas are cosmopolitan, facultative parasites found in all climates from the arctic regions to

the tropical zone (Metcalf, Flint and Metcalf, 1951). According to the Advisory Committee in 1908, fleas are usually dispersed by means of the host in its natural wanderings and with or without their host when carried in merchandise. This latter fact is of special importance in countries having seaports. When carried to a new area fleas will select their true host or the next best available animal. This fact was reported by the Advisory Committee in 1911. Trapping of rats in order to determine the frequency of occurrence of Xenopsylla cheopis upon its natural hosts has become a common practice in the control of both plague and endemic typhus since the work of the British-Indian Plague Commission started in 1906 and has confirmed the great medical importance of fleas.

In 1923, Dunn found that Xenopsylla cheopis was commonly found infesting rats and mice which lived in more or less close association with man or in close contact with buildings. This was also demonstrated by Eskey (1938).

Vogel (1935), in his survey of the port of Philadelphia, concluded that Xenopsylla cheopis was essentially a rat nest parasite and this habit probably accounted for the fact that rats caught in a sheltered place had many fleas of this species. On the other hand, rats caught a few hundred feet away had no such fleas.

In 1957, Gratz published his rat-flea survey of

Haifa Port and attempted to evaluate the possible transmission of plague by fleas. He too observed that Xenopsylla cheopis was by far the most common flea on the Norway and Roof Rat. Populations reached their peak in late August and early September in Haifa. He further concluded that the lowest percentage of infestation by Xenopsylla cheopis of both species of rats was during the winter months, falling as low as 8 per cent in January. However, the rate of infestation for all rats, from July to November, was between 93 per cent and 100 per cent.

Davis (1951) reported that Xenopsylla cheopis populations reached a peak from May to June and were lowest in July and August. He also concluded that the Norway Rat had more fleas than did the Roof Rat. In both cases male rats had more fleas than the females. On cold days there were more female fleas than males and on warm days male fleas outnumbered the females. This was similarly concluded for Leptopsylla segnis, the House Mouse Flea. Davis speculated that this was in part due to the higher frequency of feeding by the male fleas in the warm months. Maximum abundance occurred in the spring season, but because of overlapping of maxima for various species, fleas may be abundant for almost six months.

Cole (1945) and Bacot, Petrie, and Todd (1914) obtained results similar to those of Davis and reported that it was

probably due to the fact that males feed more frequently in hot weather and less frequently in cold weather.

Matheson (1950) reports that in rather cool, humid climates the length of life of a flea is much longer than in dry, hot climates. Under the most favorable conditions, 21-22 days are necessary for the completion of the life cycle of a flea. This had originally been reported by the Advisory Committee for Plague in India (1906-1907).

Riley and Johannsen (1932) reported that hungry fleas readily attacked animals other than their normal hosts and that herein lay their potentiality as carriers of disease to man. Further, fleas, though the most important, were not the only factor in the spread of the plague bacilli. Any blood-sucking insect which feeds upon a plague-infected host and then passes to a healthy individual might transfer the bacilli. Verjbitski in 1908 reported that even bedbugs might convey the disease and Hertzog (Riley and Johannsen, 1932) found the bacilli in a head louse, Pediculus humanus. That these organisms were potential vectors of the disease, however, was not demonstrated.

III. MATERIALS AND METHODS

Rat-trapping was conducted throughout the area of Ras-Beirut. Rats were captured in live cage-type traps. In addition, snap traps were occasionally used. Both live-trapped and snap-trapped rats were included in the survey and examined for fleas.

The bait used in the live-traps included peanuts, fresh carrots, tomatoes, cucumbers, white and yellow cheese, peanut butter on bread and bread soaked in fresh olive oil. The most satisfactory baits were found to be yellow cheese and bread dipped in olive oil. The latter bait was especially satisfactory since it is very odoriferous and is a good attractant for rats. Cockroaches avoided it and did not attempt to feed upon it. Most of the local people use it on a very limited scale for trapping rats around their homes. Raisins and many others of the previously mentioned baits were used on snap traps and proved to be effective.

Traps were set in the late afternoon between 5:00 p.m. and 7:00 p.m. and the live-traps were checked once, very early the following morning. The snap-traps were

checked once, four to five hours after they had been set and another time early in the morning, at the same time the live-traps were checked.

Live-trapped rats were brought to the laboratory where they were transferred alive into large glass jars and chloroformed. The advantage of the use of the glass jars was twofold: first, it was quite impossible for any of the fleas to escape and second, any fleas that left the host before being affected by the chloroform were easily found in the jars.

The snap-trapped, dead rats were immediately transferred into plastic bags and chloroformed.

The chloroformed rats in both cases were further examined for any fleas that might still adhere to the fur. This was done by carefully searching through the pelage with the aid of forceps and a probe. This method replaced combing and avoided damage that might have resulted to the fleas. The rats were later discarded and the fleas were preserved in 70 per cent alcohol until the time of identification.

Some of the fleas were prepared for study by standard whole mount methods and mounted in Canada Balsam on glass slides. This was done by placing the fleas in 10 per cent aqueous KOH solution and allowing them to remain there for about two days. They were then transferred to water to

which a few drops of HCl had been added and left for one half hour. Finally, they were dehydrated by use of several degrees of alcohol, first into 70 per cent and then 95 per cent absolute alcohol. After being cleared in xylol for one hour, they were mounted permanently on glass slides in Canada Balsam and labelled.

During this survey, a chronological record was kept of the host, its sex, the locality from which it was trapped, the date of collection, and its ectoparasites. Special attention was paid to the number, sex, and species of fleas which was the main interest in this investigation.

IV. RESULTS AND DISCUSSION

The results of the survey are given in Tables 1 and 2 in the following pages.

During the period of the survey, there were 284 rats trapped. 223 of these were caught in live cage-type traps and the remaining 61 were snap-trapped. Of the total number of rats, 282 (almost 100 per cent) were Rattus norvegicus and only 2 were female Rattus rattus. Fifty per cent of the Norway Rats were females. Seventy-eight of the total rats were not infested with fleas. However, the rate of infestation for all the rats trapped was about 72.5 per cent. Seventeen of the total number of rats were immature, of which nine were females and eight were males.

From the 284 rats collected, a total of 644 fleas was obtained. Of these, 618 were Xenopsylla cheopis, 20 were Leptopsylla segnis, and only 6 were Ctenocephalides felis felis.

On the basis of these figures, a total average of 2.26 fleas per rat and an average of 2.17 per rat for Xenopsylla cheopis was calculated.

Table 1

The numbers, species and sex of fleas collected on rats trapped in Ras-Beirut, Lebanon, during a period of nine months in 1960

Month	Number of rats		Species and sex of fleas						Total number of fleas per month	Number of fleas per rat per month
	Live-trapped	Snap-trapped	*Xenopsylla cheopis* ♂	*Xenopsylla cheopis* ♀	*Leptopsylla segnis* ♂	*Leptopsylla segnis* ♀	*Ctenocephalides felis felis* ♂	*Ctenocephalides felis felis* ♀		
March	9	-	4	2	-	1	-	-	7	0.77
April	12	7	76	70	1	6	2	2	157	8.26
May	18	5	15	11	-	-	-	-	26	1.13
June	32	11	41	37	-	-	-	-	78	1.81
August	19	2	26	34	-	-	-	-	60	2.85
September	36	13	77	99	-	-	-	-	176	3.59
October	34	6	28	31	3	8	-	2	72	1.80
November	32	11	18	21	1	-	-	-	40	0.93
December	31	6	9	19	-	-	-	-	28	0.75
Total	223	61	294	324	5	15	2	4	644	

It is also of interest to compare the number of fleas found on male rats with those found on female rats. It was found that 269 of the total number of fleas were present on male rats and 375 fleas on female rats. This does not agree with Davis (1951) who observed that male rats of both species had more fleas than females.

The sex ratio of the fleas is of possible importance in the knowledge of the natural history of the fleas. It may be noted from Table 1 that of the 618 Xenopsylla cheopis, 294 are males and 324 are females. Further, 5 Leptopsylla segnis are males and 15 females, while there are only 2 males and 4 females Ctenocephalides felis felis.

Table 2

Summary of collected data

Total number of rats	Total number of fleas	Fleas per rat	Xeno-psylla cheopis	Xeno-psylla cheopis per rat	Lepto-psylla segnis	Cteno-cephalides felis felis
284	644	2.26	618	2.17	20	6

Infestation of fleas does not seem to depend on the sex and age of the host. The number of male fleas, 301, among the three species found, differs only slightly from the number of female fleas, 343. Unlike what Davis (1951) had found in San Antonio, Texas, the male fleas occurred less frequently than the females.

Rats trapped in buildings or very close to buildings had a higher infestation of fleas than those trapped along the seashore or in open areas. This fact was also observed by Dunn (1923), Eskey (1938), and Vogel (1935).

Another observation seems to be the higher infestation of fleas on rats during the warmmonths. It is possible, as pointed out by some investigators, that there might be a proportional relationship between the infestation of fleas and the average temperature.

The rats examined were infested mainly with the Oriental Rat Flea, Xenopsylla cheopis. Most of the other species of fleas were not common and occurred infrequently. As some investigators have pointed out in other countries the observation made in Ras-Beirut might be due to the excessive humidity, especially during the hot months, which may have an inhibitory effect on the occurrence of other species of fleas. Although this is a possible explanation, a better one lies in the fact that Rattus norvegicus is not the normal host of either Leptopsylla segnis or Ctenocephalides felis felis.

Other ectoparasites collected on rats included a large number of the Spiny Rat Louse, Polyplax spinulosa, and some mites which are not yet identified.

V. CONCLUSIONS

Rattus norvegicus, the Norway Rat, is the most dominant host species of Xenopsylla cheopis, the Oriental Rat Flea. It is difficult to draw any conclusions about Rattus rattus, the Roof Rat, since only two of these were trapped.

Xenopsylla cheopis, the Oriental Rat Flea, is by far the most common flea found on the Norway Rat. This is in agreement with the results of other investigators. This species reaches its peak in the early and late months of the summer. The exceptionally high number indicated for the month of April is due to the 106 fleas collected from only one immature female Norway Rat trapped indoors, otherwise the number would have been low during that month.

Therefore, based upon data yielded by this investigation it is obvious that this is the only species which may be considered to be a vector of high potential importance in the event of an epidemic of bubonic plague in this area. Further studies of the frequency of occurrence of Xenopsylla cheopis upon the Norway Rat in Beirut should yield valuable information concerning the potential importance of this

species in the Levant.

Leptopsylla segnis, the House Mouse Flea, was found during the cooler months of March, April, October and November. It was entirely absent during the hot summer months. Though the number was small, their seasonal distribution seems to agree with the results of Gratz (1957) in Haifa Port.

Ctenocephalides felis felis, the Cat Flea, rarely occurred on the rats. Only six were found during the course of the investigation. The infrequency of this species is readily explainable by the observation of various workers that while Ctenocephalides felis felis is perhaps less host specific than most other fleas, the Norway Rat is certainly not to be considered as one of its normal hosts.

VI. SUMMARY

1. A limited rat-flea survey was conducted in the area of Ras-Beirut, from March to December, 1960, excluding the month of July. It dealt with an investigation of the frequency of occurrence of the Oriental Rat Flea, Xenopsylla cheopis, upon its natural hosts.

2. Rat-trapping was done throughout the area of Ras-Beirut. Both live-trapped and snap-trapped rats were included in the survey and examined for fleas. The fleas collected were preserved in 70 per cent alcohol. Some were permanently mounted on slides.

3. A total of 284 rats was examined; of these 282 were Norway Rats, Rattus norvegicus, and only 2 were female Roof Rats, Rattus rattus. Fifty per cent of the Norway rats were females.

644 fleas were collected. Of these 618 were Xenopsylla cheopis, 20 were Leptopsylla segnis, and only 6 were Ctenocephalides felis felis.

These figures yield a total average of 2.26 fleas per rat and an average of 2.17 fleas per rat for Xenopsylla cheopis alone.

4. Rattus norvegicus, the Norway Rat, is the predominant host species of Xenopsylla cheopis.

Xenopsylla cheopis, the Oriental Rat Flea, is by far the most common flea found upon Rattus norvegicus.

5. Two other species of fleas, Leptopsylla segnis, the House Mouse Flea, and Ctenocephalides felis felis, the Cat Flea, were sporadically collected in small numbers.

6. Other ectoparasites found on rats included the Spiny Rat Louse, Polyplax spinulosa, and some mites which have not yet been identified.

VII. REFERENCES

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