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FLEAS and PLAGUE

in

IRAQ

and the

ARAB WORLD

by

C. Andresen Hubbard
Tigard, Oregon, U.S.A.

Part I.

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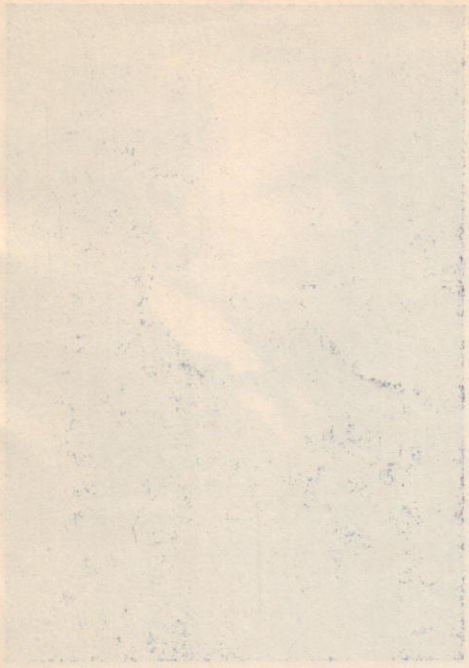
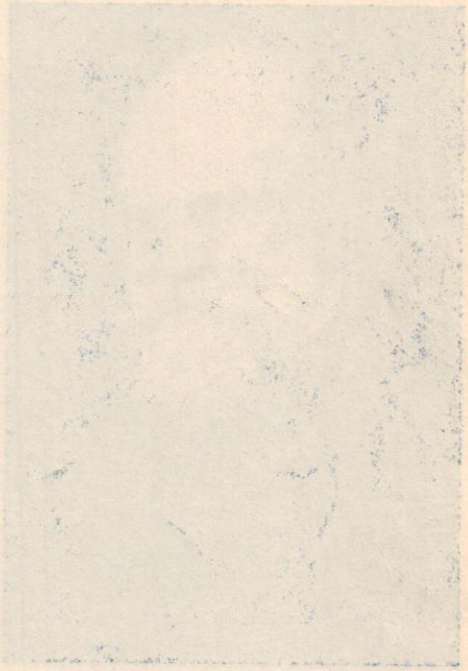
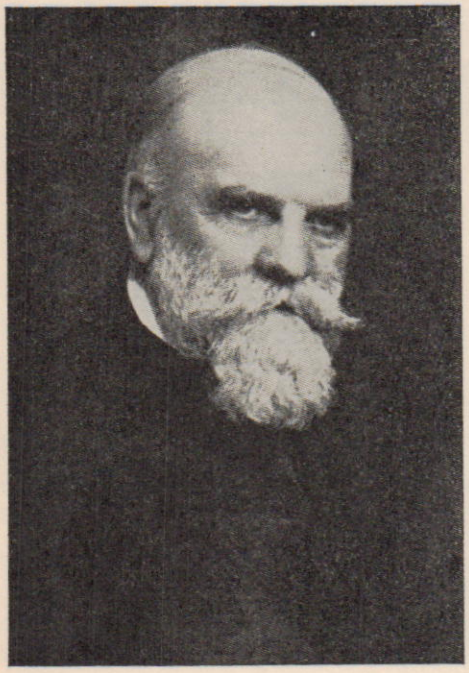




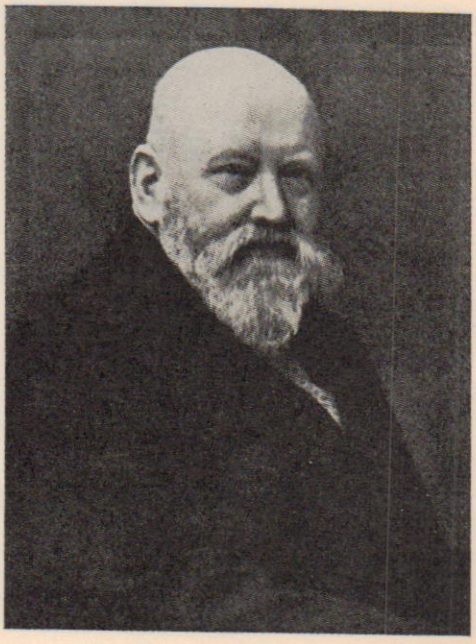
Frontispiece

The Pioneer Siphonapterists



Karl Jordan
1861 –

N. Charles Rothschild
1877–1923



L. Walter Rothschild
1868-1937

To the Memory of

Marine Corporal Flamethrower

Martin Wesley Young

my cousin

A hero of

Engebi Island

Eniwetok Atoll, the Marshals

February 20, 1944.

ACKNOWLEDGEMENTS

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BRAZIL

"Pulgas"

For assistance rendered.

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INTRODUCTION

by

Bashir E. Allouse, M.Sc., M.B.O.U.
Diector, Iraq National History Museum, Baghdad.

The author of this book, Dr. C. Andresen Hubbard of the University of Oregon, came from the United States in December 1952 under a Fulbright Grant to carry out research on the Fleas of Iraq and their relation to plague. The grant financed his stay in this country for a period of six months only, in which time he worked in cooperation with the Iraq Natural History Museum, availing himself of the facilities provided therein. In spite of the limitations of time and shortage or inadequacy of laboratory equipment, Dr. Hubbard managed to overcome all difficulties and made several trips to various parts of the country with the main object of collecting mammals and securing fleas from their bodies for comparative study and identification.

The fleas collected by the author in such a short time, although necessarily small in number, represented some 18 species and subspecies, of which six were reported as new (See: Iraq Nat. Hist. Mus. Publ. No. 11, 1956). These new findings add to the significance of the contribution which Dr. Hubbard made to our knowledge of this group of insects (Siphonaptera) in Iraq. The author expressed his desire, on several occasions, to continue this research in Iraq should a new grant be offered him either by his own government of other agencies and foundations. So far, his hopes have not been realized.

After his return to the States, Dr. Hubbard put forward his suggestion to write a comprehensive report on fleas, in book form, embodying the results of investigations made by various scientists in the rest of the Arab World, so that a general picture

of the Siphonateran fauna in this great area, ranging from the Arabian Gulf in the east to the Atlantic Ocean in the west, could be drawn. This idea seemed to us a vital step in strengthening scientific bonds between Arab scientists, now and in the future, and we immediately offered our encouragement and approval. It was understood from the beginning that the author would stress in his report the medical importance of fleas as carriers of Plague, a dangerous epidemic which broke out in the East from time to time, in earlier years.

To achieve this goal, the author maintained close contacts with the Zoological Museum at Tring, England, where fine collections of fleas are deposited and eminent Siphonapterists are ready to help. The present work, which I was given the privilege of introducing to the world of science, is the fruitful outcome of extensive studies based on field work, collected specimens and literature. Thanks to Dr. Hubbard for offering his manuscript to this Museum, freely and unconditionally, with the sole hope of seeing it published in Iraq sooner or later.

From the editorial point of view, very few alterations were made on the author's original text, but it was decided that the length of the book necessitates its publication as separate parts. Part I (now published) is more or less introductory and its main coverage are: Historical study of fleas in the Arab World; Siphonapteran fauna of the Arab States; Medical aspect of flea study; Field and laboratory techniques. Part II (to be published later) comprises the main body of the work, and is devoted to anatomical details and descriptions of Siphonapteran forms on which their diagnoses and identification are based. This part is of especial interest to the taxonomist, and is sure to give the young generation of Arab scientists the sound basis of exploring this field and adding their own contributions to the science of Biology in the Arab World.

BASHIR E. ALLOUSE.

Iraq Natural History Museum,
Baghdad: October 1958.

CHAPTER 1

HISTORY OF THE STUDY OF FLEAS IN THE ARAB WORLD

THE STUDENTS AND THEIR CONTRIBUTIONS.

Prior to the breaking of the 20th Century few records of flea collecting are to be found in the Arab World. The earliest of these seems to be the collection of a male cat flea (*C. f. felis*) by E. Saunders on February 17, 1893 at Bains Romains, Algiers, Algeria. During December of 1899, C. von Erlanger and O. Neumann collected a small series of fleas in Lahaj (Lahadj-Aden) in extreme southwest Arabia, off a gerbil (*Meriones rex*) which N.C. Rothschild described in 1903 as *Xenopsylla regis*.

During the beginning years of the 20th Century fleas began to be collected in other parts of the Arab World. The histories which follow are alphabetically arranged.

ADEN — This small area in extreme southwestern Arabia, south of Yemen, west of Hadramaut, gives one of the earliest records of Arab fleas. During December of 1899, Von Erlanger and Neumann collected the fleas off the gerbil, *Meriones rex*, which are now known as *Xenopsylla regis*. The locality is listed as "Lahaj (Lahaj or Lahej), north of Aden, South Arabia". This portion of the Arab World has not been prolific in this type of research for the only other record seems to be the collection of a series of *Xenopsylla cheopis* at Sheikh Othman, Aden, from rats during the years 1906 to 1908 by A. Mackae.

ALGERIA — This is one of the large Arab States. It measures about 1,000 miles from north to south and from east to west. To its north is the Mediterranian Sea, to the south French West Africa, to the west Morocco, and to the east Tunisia and Libya.

It is in Algeria that one finds a wealth of siphonapteran history. The earliest of Arab records is recorded at Bains Romains, Algiers, where E. Saunders in February 17, 1893, secured a male cat flea (*C. f. felis*). Fifteen years elapsed before organized collections began to be secured in the country. During 1908 at Biskra, J. Steinbach collected from February through March and L. Walter Rothschild in company with Ernst Hartert collected in March.

L. Walter Rothschild (see frontispiece) of the House of Rothschild of England, was an English financier who by avocation enjoyed being a naturalist. He established the Zoological Museum (now a part of the British Museum) at Tring, Hertsfordshire, and here is housed the Rothschild Collection of fleas, the greatest of its kind in the World and a lasting monument to his memory and that of his brother N. Charles Rothschild, and from which the great majority of the records here mentioned and mentioned in the following pages come.

Dr. Ernst Hartert, director of, and ornithologist for, the Zoological Museum of Tring, England (now a part of the British Museum) was primarily interested in birds but collected fleas as a side issue for the museum. Mr. J. Steinbach was a resident at Biskra for some period, and while living there collected fleas for the Museum at Tring.

During 1910 Walter Rothschild and Hartert again visited Algeria to collect about Hammam Rirha. In February 1911 these men were active about Biskra, Hammam Rirha and Hammam Meskoutine.

During 1912 Hartert returned to Algeria in company with Karl Jordan. In March, Hartert collected about El Golea; in April about Fort Miribel, whilt Jordan was collecting around Guelt-es-Stel in April and about Khenchela in May.

Today at 95 years of age Dr. Karl Jordan is the greatest siphonapterist in the world. He is dean of world flea students. He has nurtured and cared for the N.C. Rothschild collection of fleas of the British Museum, housed at Tring, since its birth. Jordan was born in 1861 in Westphalia, Germany. In 1893 he came to Tring and has remained with the Museum ever since. The fleas Jordan has described and the papers he has written about them are too numerous to mention here.

May of 1913 found Walter Rothschild and Hartert collecting about Ain Sefra. In May of 1914 W. Rothschild returned to Algeria with Karl Jordan, the two collecting around Hamman Meskoutine. About this time Dr. Nissen was collecting at Algiers.

World War I brought a temporary end of flea collecting in Algeria, so it was not until 1920 that research in fleas was again in progress. During this year Jordan and N. Charles Rothschild collected about Djama in February, about Touggourt in March, about Timgad in April and about El Kantara in May.

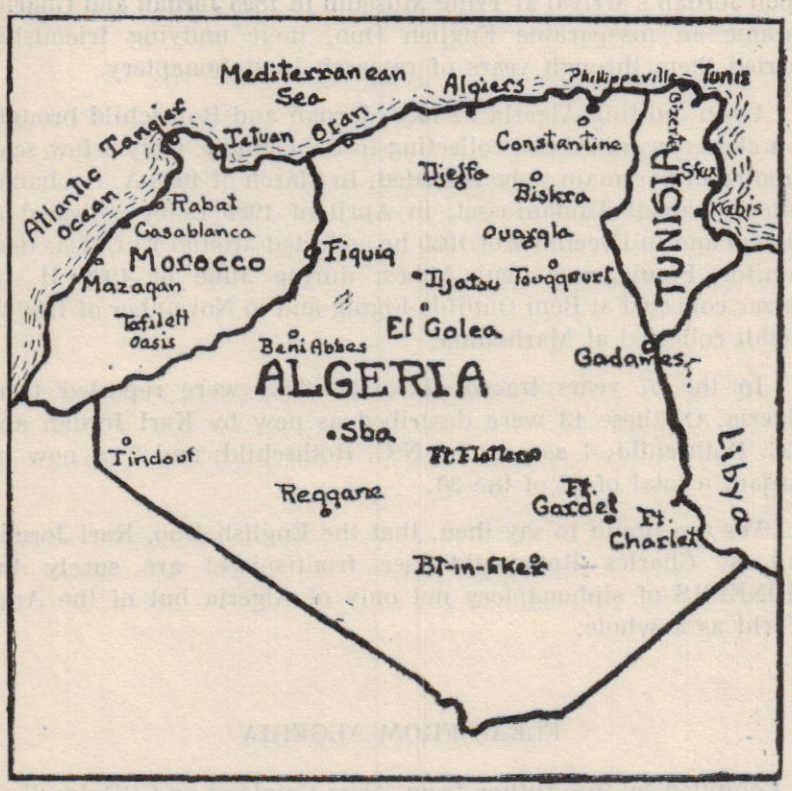

Fig. 1. Map of Algeria.

N. Charles Rothschild was the younger brother of Lionel Walter Rothschild. Walter collected in Algeria as a naturalist to fill the cases and shelves in his museum at Tring. He collected fleas for his brother Charles. Charles on the other hand, although a financier by profession, as was Walter, was by avocation a siphonapterist. Charles, until the time of his death in 1923, was the driving force which caused the terrific growth of the Rothschild collection of fleas which is conceded to be the greatest of its kind in the world. Charles was born in London May 9, 1877. Upon Jordan's arrival at Tring Museum in 1893 Jordan and Charles became an inseparable English Duo, their undying friendship carried them through years of research in siphonaptery.

Upon quitting Algeria in 1920, Jordan and Rothschild brought to a close, organized flea collecting in the country. Only a few scattered records remain to be recorded. In March of 1923 A. Buchanan collected about Tamanrasset; in April of 1929 Doley collected at Algiers and in December of 1935 he collected around El Golea, Beni Ounifde Figuig and Beni Abbes; during June of 1939 H. de Balzac collected at Beni Ounifde Figuig and in November of 1950 C. Mofidi collected at Marhouma.

In the 57 years traced above 30 fleas were reported from Algeria. Of these 13 were described as new by Karl Jordan and N.C. Rothschild; 7 as new by N.C. Rothschild; and 2 as new by Jordan, a total of 22 of the 30.

We are proud to say then, that the English Duo, Karl Jordan and N. Charles Rothschild (see frontispiece) are surely the PIONEERS of siphonaptery not only of Algeria but of the Arab World as a whole.

FLEAS FROM ALGERIA

Compiled by the Author from "The Catalog" and "Pulgas"

1. *Pulex irritans*, El Kantara, Biskra off man.
2. *A. e. maura*, Biskra, Lallal Marina off hedgehog.
3. *C. f. felis*, Algiers, Biskra off cats, rats.
4. *C. canis*, Algiers, Biskra off dog.
5. *S. pallidus*, Beni Abbes off fox.
6. *S. cleopatrae*, Djama off gerbil.
7. *P. r. riggenbachi*, Hammam Meskoutine off porcupine.
8. *X. cheopis*, Algiers off rats.

9. *X. c. mycerini*, Fort Miribel off gerbil.
10. *X. ramesis*, general in Algeria off wild mice.
11. *X. taractes*, El Golea off gerbil.
12. *R. u. arabs*, Guelt-es-Stal off bat.
13. *T. poppei*, Bou-Medine off wood mouse.
14. *T. f. favosus*, Algiers off wood mouse.
15. *S. t. tripectinata*, Hammam Meskoutine off wood mouse.
16. *L. segnis*, Algiers off rats.
17. *L. taschenbergi*, ??????.
18. *L. t. amitina*, Bou-Medine off wood mouse.
19. *L. t. calamana*, Hammam Meskoutine off wood mouse.
20. *L. a. algira*, Algiers off Barbary rat.
21. *L. a. tuggurtensis*, Touggourt, Biskra, Djama off mice.
22. *C. r. russulae*, Algiers off shrews and wild mice.
23. *R. musculana*, Khenchela, Guelt-es-Stel off gerbils.
24. *C. mira*, Biskra, El Kantara off gundi.
25. *M. laverani*, North Africa off *Eliomys*.
26. *N. fasciatus*, Algiers off rats.
27. *N. barbarus*, Algiers off Barbary rat.
28. *N. maurus*, Khenchela, Guelt-es-Stel off gerbils.
29. *N. h. mauretanicus*, Khenchela, Biskra off gerbils.
30. *N. h. oranus*, Algeria off *Meriones*.
31. *C. hirundinis*, North Africa off swallows.
32. *C. f. meridionalis*, Guelt-es-Stel off swallows.
33. *C. numidus*, Hammam Meskoutine off swallows.

[**Note:** Descriptions of species mentioned in this and the following lists, will be found in Part II. See Index at the end of the book.]

ADDENDA

Further data may be inserted below.

ASSIR — This small area north of Yemen in southwestern Arabia and bordering on the Red Sea has not been mentioned in siphonapteran literature. [See map fig. 6.]

BAHREIN — This small country about midway down the Arabian Gulf on the east coast of Arabia has had no recorded research on fleas carried out within its boundaries.

EGYPT — This is one of the medium sized Arab States. It is approximately 600 miles square. To its north is the Mediterranian Sea; to the south the Sudan; to the east the Red Sea and Jordan, and to the west Libya.

The first reported fleas to come out of Egypt were collected by the Swedish Zoological Expedition to Egypt and the White Nile which worked along the great river during 1901. These fleas taken off a bat, were sent to Wahlgren who described them as *I. consimilis* in 1904. While this Expedition was working along the White Nile, Charles Rothschild and A. Woolaston were collecting about Cairo during March. Rothschild returned to Egypt in 1903 and collected in Wady Natron in February; about Cairo, Zaghig, Bir Victoria, Mt. Muluk and Albumar during March; and in Natron Valley during February, March and April. Henley collected about Bir Hooker in March.

In 1904 Charles Rothschild again entered Egypt and collected in Natron Valley during April. Three years later during March of 1907, Rothschild again visited Egypt and collected about Cairo. This was Charles Rothschild's last visit to Egypt, and with it organized collecting ceased in this field.

Scattered records since that time are:

During November of 1909, Dr. Wakeling collected in the Libyan Desert close to Cairo. In November of 1911, Dr. Petrie collected at Kom Ombo. At Meir, Diral, in March and April of 1912, Harding King was busy collecting, while A. Bacot collected in Wady Ferran.

Forty unfertile years followed for no other records seem recorded until H. Hoostraal collected at Sinai during August of 1950 and at the Siwa Oasis during March of 1951.

Of the 14 fleas listed in the following pages as being found in Egypt, 8 were described as new by N.C. Rothschild, the others by earlier biologists.

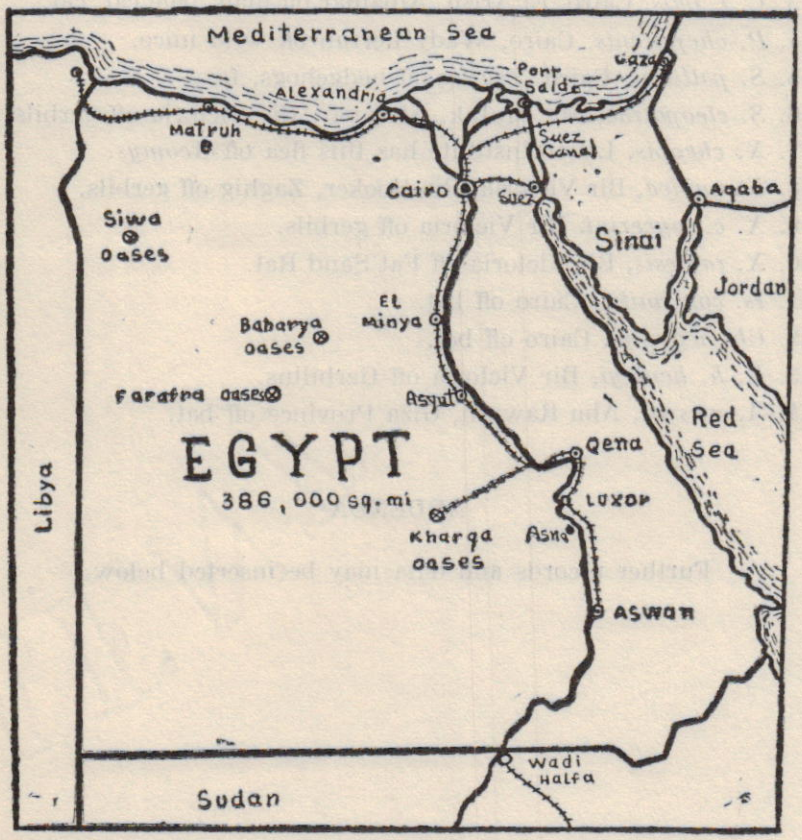

Fig. 2. Map of Egypt

THE FLEAS OF EGYPT

Compiled by the Author from the "Catalog"

or the original descriptions.

1. *E. murina*, Kom Ombo off *Rattus rattus*.
2. *P. irritans*, Cairo, Meir, Port Said off man.
3. *C. f. felis*, Cairo, El Arish, Albamar off man, pole cat, cat.
4. *P. chephrenis*, Cairo, Wady Ferran off wild mice.
5. *S. pallidus*, Cairo, Zaghig off hedgehogs, foxes.
6. *S. cleopatrae*, Mt. Muluk, Albumar, Bir Victoria off gerbils.
7. *X. cheopis*, Lister Institute has this flea off *Acomys*.
8. *X. nubica*, Bir Victoria, Bir Hooker, Zaghig off gerbils.
9. *X. c. mycerini*, Bir Victoria off gerbils.
10. *X. ramesis*, Bir Victoria off Fat Sand Rat.
11. *Is. consimilis*, Cairo off bat.
12. *Ch. aegyptia*, Cairo off bat.
13. *N. h. henleyi*, Bir Victoria off Gerbillus.
14. *A. wassifi*, Abu Rawash, Giza Province off bat.

ADDENDA

Further records and data may be inserted below.

FLEAS FROM IRAQ

Collected by the Author during 1953

1. *P. irritans*, Baghdad off man.
2. *C. f. felis*, Baghdad off cats, Hilla off wild cat.
3. *C. canis*, Hilla off rabbit.
4. *S. pallidus*, Baghdad off rabbit, hedgehog.
5. *S. cleopatrae*, Baghdad off *Meriones crassus*.
6. *X. cheopis*, Baghdad, Babylon off Norwegian rat.
7. *X. nubica*, Basra off Jerboa.
8. *X. astia*, Baghdad, Babylon, Hilla off mole rat.
9. *X. c. conformis*, Baghdad, Ramadi off gerbils.
10. *C. smiti*, Baghdad off gerbil.
11. *C. b. johnsoni*, Baghdad off bat.
12. *R. u. unipectinata*, Baghdad off bat.
13. *S. t. insperata*, Baghdad East, Baghdad West off house mouse.
14. *C. c. allousei*, Sirsang off meadow mouse.
15. *N. medus*, Baghdad off Norwegian rats.
16. *N. pringlei*, Baghdad, Ramadi off gerbils.
17. *N. durii*, Sirsang off meadow mouse.
18. *N. bunnii*, Basra off Jerboa, Baghdad off gerbil.

ADDENDA

Further data may be inserted below.

JORDAN — This is one of the smaller Arab states. Its borders are rather poorly defined. To the north lies Syria, to the east Iraq and Saudi Arabia, to the south Saudi Arabia, and to the west the Gulf of Aqaba and Egypt. Due to the changing history of Jordan and Palestine it is impossible to pinpoint actual collection records. However, the following men collected in the area as follows: T. Aharoni during March of 1912; Waterson during January of 1922; P.A. Buxton during June and July of 1923; Dr. Theodor during March of 1928, May of 1933 and during 1934. These collectors together secured only 7 kinds of fleas from the country. [Map fig. 4.]

FLEAS FROM JORDAN

1. *P. irritans*, Petra from jackal.
2. *A. e. erinacei*, Jerusalem off hedgehog.
3. *C. f. felis*, Berseba off wild cat.
4. *C. canis*, Hebron off dog.
5. *S. pallidus*, Rehoboth off hedgehog.
6. *X. cheopis*, Tabgha-Tiberias off Alexandrian rat.
7. *N. sincerus*, Rehoboth.

ADDENDA

Further records may be inserted below

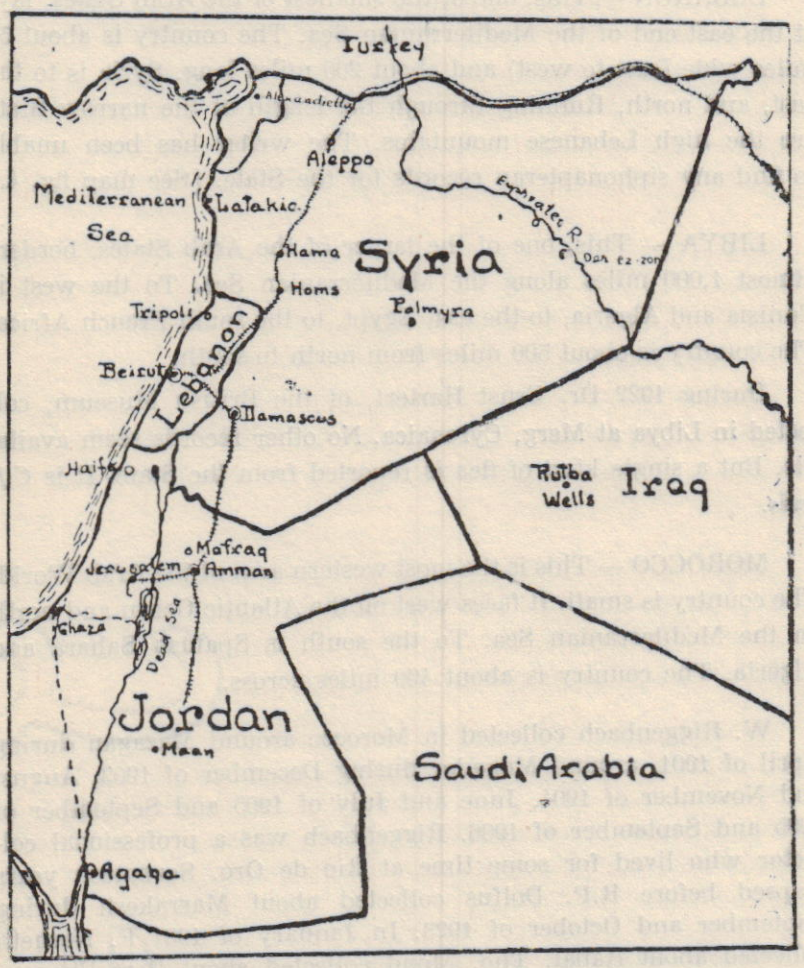

Fig. 4. Map of Syria, Lebanon and Jordan.

KUWAIT — This small area south of Iraq at the head of the Arabian Gulf does not appear in siphonapteran literature.

LAHAJ — It is difficult to separate the siphonapteran records of this southwestern area of Arabia from those of Aden. (See Aden).

LEBANON — This, one of the smallest of the Arab States, lays at the east end of the Mediterranian Sea. The country is about 50 miles wide (east to west) and about 200 miles long. Syria is to the east, and north, Running through the length of the narrow State are the high Lebanese mountains. The writer has been unable to find any siphonapteran records for the State. [See map fig. 4.]

LIBYA — This, one of the larger of the Arab States, borders almost 1,000 miles along the Mediterranian Sea. To the west is Tunisia and Algeria, to the east Egypt, to the south French Africa. The country is about 500 miles from north to south.

During 1922 Dr. Ernst Hartert, of the British Museum, collected in Libya at Merg, Cyrenaica. No other records seem available. But a single kind of flea is reported from the State. It is *C.f. felis*.

MOROCCO — This is the most western area of the Arab World. The country is small. It faces west on the Atlantic Ocean and north on the Mediterranian Sea. To the south is Spanish Sahara and Algeria. The country is about 400 miles across.

W. Riggenbach collected in Morocco around Mazagan during April of 1901, around Mogador during December of 1903, August and November of 1904, June and July of 1905 and September of 1905 and September of 1906. Riggenbach was a professional collector who lived for some time at Rio de Oro. Seventeen years elapsed before R.P. Dolfus collected about Marrakesh during September and October of 1923. In January of 1931 F. Nerneth collected about Rabat. Tho. Mond collected about Port Etienne. During 1936, R. de Brettes collected around Rabat in November and December, and J. de Lepiney collected at Goulmina in December. During February, October and November of 1938, F. Nerneth again collected around Rabat.

Only 11 kind of fleas were taken from the area during these field works.

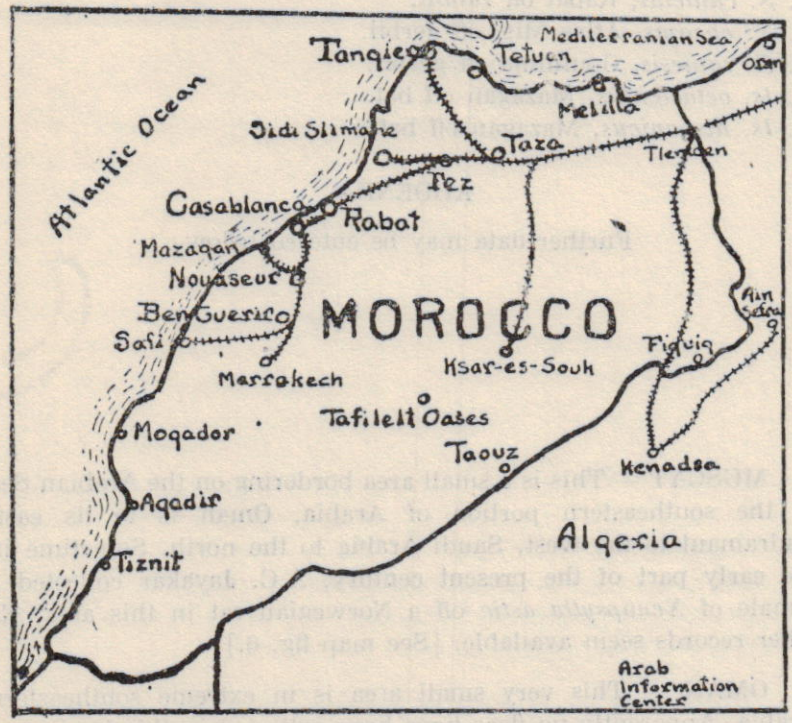

Fig. 5. Map of Morocco.

FLEAS FROM MOROCCO

1. *E. gallinacea*, Rabat off chicken.
2. *E. murina*, Marrakesh off Alexandrian rat.
3. *P. irritans*, Magador off fox.
4. *C. f. felis*, Rabat off cat, dog.
5. *C. canis*, Mogador off fox.
6. *P. r. riggenbachi*, Mogador off porcupine.
7. *S. cuniculi*, Rabat off rabbit.
8. *X. cheopis*, Atlas Mts. off gerbil.
9. *X. ramesis*, Goulmina off gerbil.
10. *Is. octactentus*, Mazagan off bat.
11. *Is. hispanicus*, Mazagan off bat.

ADDENDA

Further data may be entered below.

MUSCAT — This is a small area bordering on the Arabian Sea in the southeastern portion of Arabia. Oman is to its east, Hadramaut to the west, Saudi Arabia to the north. Sometime in the early part of the present century, A.C. Jayakar collected a female of *Xenopsylla astia* off a Norwegian rat in this area. No other records seem available. [See map fig. 6.]

OMAN — This very small area is in extreme southeastern Arabia. Apparently no fleas have been collected in this land.

QATAR — This small area lies between Oman and Bahrein. It faces the Arabian Gulf. On its west is Saudi Arabia. There seems to be no published flea records for this country.

SAUDI ARABIA — This, the largest of the Arab States, covers most of the Arabian Peninsula. It is about 1500 miles from north to south and 1000 miles from east to west. This great territory seems not to have attracted students of fleas for the only record available consists of R. Meinertzhagen having collected a flea, *C. f. felis*, off a cat at Jidda. [See map fig. 6.]

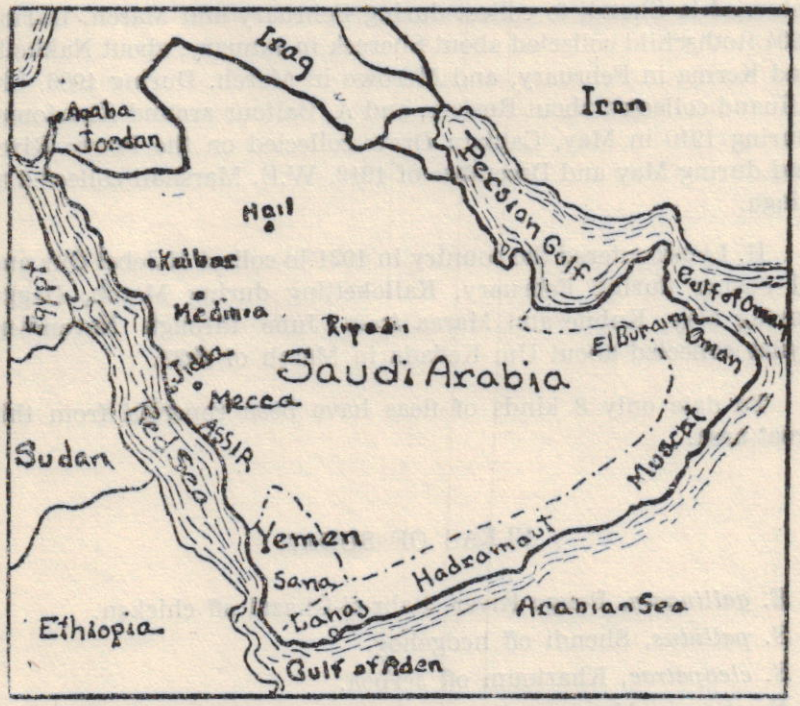

Fig. 6. Map of Arabia

(Saudi Arabia, Yemen, Hadramaut, Aden, Oman and Muscat).

[**Note:** Persian Gulf is now officially known in Iraq as the Arabian Gulf.]

SUDAN — This is one of the larger of the Arab States. It is directly south of Egypt. The country is about 1,000 miles from north to south and 800 miles from east to west.

In this country at Gebel Auli during May of 1900, H.F. Witherby, British ornithologist, collected *S. pallidus* (Tasch.) off a hedgehog to record one of the earliest Arab flea notations. During February, March and April of 1901, N.C. Rothschild (see Algeria) and A. Woolaston collected about Shendi. In 1903 these two men returned to Shendi to collect during February and March. During 1904 Rothschild collected about Shereck in January, about Nakheila and Kerma in February, and Merowe in March. During 1906, Ch. Alluand collected about Rosiers, and A. Balfour around Khartoum. During 1910 in May, Captain Drew collected on the Pongo River and during May and December of 1912, W.E. Marshall collected at Singa.

H. Lynes entered the country in 1921 to collect at Jebel Our and El Fasher during February, Kalloketting during March, Daggu during May, Kuhne and Maraa from June through November. Lynes collected about Um Kedada in March of 1922.

To date only 8 kinds of fleas have been reported from this great area.

FLEAS OF SUDAN

1. *E. gallinacea*, Pongo River, Bahr-el-Ghazal off chicken.
2. *S. pallidus*, Shendi off hedgehog.
3. *S. cleopatrae*, Khartoum off Jerboa.
4. *X. cheopis*, Merowe off porcupine.
5. *X. nubica*, El Fasher off rat.
6. *X. nilotica*, Kerma off gerbil.
7. *N. maurus*. (Locality and host ???).
8. *L. incerta*, Torit off bat.

ADDENDA

Further data may be entered below.

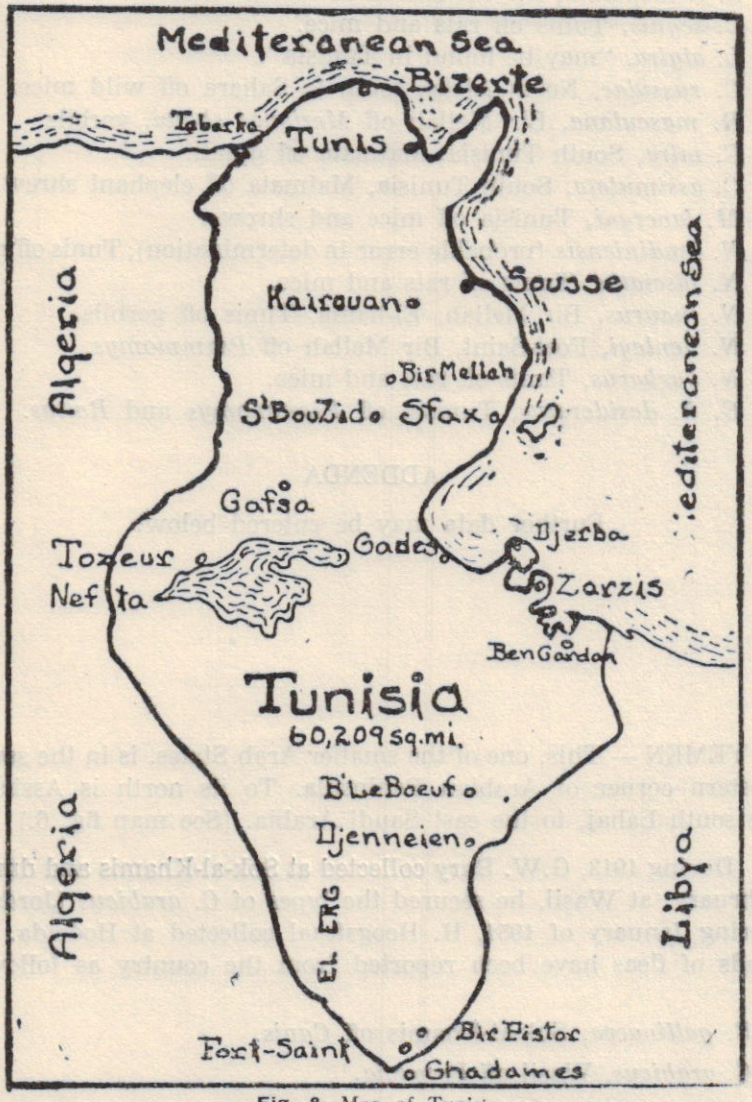

Fig. 8. Map of Tunisia.

13. *C. wassiliewi*, Bir Mellah and Djennejen off gerbils, mice.
14. *T. f. favosus*. "may be found in Tunisia".
15. *S. t. tripectinata*, Tunis off rats and mice.
16. *S. t. insperata*, Bir Mellah off *Meriones shawi*.
17. *L. segnis*, Tunis off rats and mice.
18. *L. algira*, "may be found in Tunisia".
19. *C. russulae*, North Africa south to Sahara off wild mice.
20. *R. masculana*, Bir Mellah off *Meriones shawi*, gerbils.
21. *C. mira*, South Tunisia, Matmata off gundi.
22. *C. assimulata*, South Tunisia, Matmata off elephant shrew.
23. *M. laverani*, Tunisia off mice and shrews.
24. *N. londiniensis* (probable error in determination), Tunis off rats.
25. *N. fasciatus*, Tunis off rats and mice.
26. *N. maurus*, Bir Mellah, El-hania, Tunis off gerbils.
27. *N. henleyi*, Fort-Saint, Bir Mellah off *Psammomys*.
28. *N. barbarus*, Tunis off rats and mice.
29. *C. h. desideratus*, Tunisia off *Psammomys* and *Rattus*.

ADDENDA

Further data may be entered below.

YEMEN — This, one of the smaller Arab States, is in the south-western corner of Arabian Peninsula. To its north is Assir, to the south Lahaj, to the east Saudi Arabia. (See map fig. 6.)

During 1913, G.W. Bury collected at Sok-al-Khamis and during February, at Wasil, he secured the types of *C. arabicus* (Jordan). During January of 1951, H. Hoogstraal collected at Hodeida. Six kinds of fleas have been reported from the country as follows:

1. *E. gallinacea*, Sok-al-Khamis off *Canis*.
2. *C. arabicus*, Wasil off *Procavia*.
3. *C. f. felis*, Sok-al-Khamis off civet cat.
4. *C. canis*, Sok-al-Khamis off *Canis*.
5. *S. pallidus*, Hodeida off rabbit.
6. *X. cheopis*, Sok-al-Khamis off jerboa.

CHAPTER 2

THE MEDICAL IMPORTANCE OF FLEAS

BUBONIC PLAGUE IN THE ARAB WORLD

A Summary of Plague in Iraq.

by

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Consideration of the Arab (*et seq.*) annals would suggest that bubonic plague played an important part in the depopulation and weakness of Iraq, which became increasingly noticeable after the end of the 10th century A.D. From this point onwards, recurrent and devastating epidemics of plague can be traced; each visitation attended by a deathroll running to tens, or even hundreds, of thousands. Major epidemics in Iraq are recorded during the following years A.D.: 1033 ... 1037-43 ... 1056-57 ... 1076 ... 1349 ... 1360 ... 1364 ... 1390-91 ... 14 outbreaks in the Arab world between 1419 and 1915 ... (?1551-52) ... 1635 ... 1654 ... 1683 ... 1689 ... 1719 ... 1738-39 ... 1760 (N. Iraq only) ... 1772-74 ... 1831-33 ... 1849-50 ... 1876-77.

Since that year plague has not reappeared on a comparable scale in Iraq, but a low level of endemicity would seem to have persisted in the larger towns until the fourth decade of the present century. Thus, minor outbreaks occurred in Iraq in the "eighties" of the last century and later, between 1918 and 1923, no less than 1,850 cases of bubonic plague were reported from the country. The incidence of plague declined irregularly thereafter until 1936, when the last case was diagnosed in a European living in Baghdad.

The great historical epidemics of the Middle East are either known or assumed to have been mainly bubonic in type. Such are

characteristically heralded by an epizootic of plague among the domestic rat colonies; the ensuing human plague morbidity following closely the curve of mortality among the rats. Infection of man is through the bite of an infected rat flea, which has abandoned the cooling corpse of its normal host. Direct transmission from man-to-man is exceptional and is generally believed to play a minor roll in the generation of epidemic plague in this region. So long as the infection lingers in the rats of that district (which it may do for many decades), so long will human infections continue to occur. Thus the post-epidemic period is prolonged and marked by an irregular decline in the disease in man, until cases become rare and sporadic. In the meantime, the remnants of the rat population are becoming more and more able to resist or overcome the plague infection; a process which culminates in the eventual disappearance of plague among that particular rat community. At this point, the last risk of human infection is removed and, in addition, the area will retain for some time a natural resistance to the importation of the disease. The protective immuniological barrier declines with the steady and inevitable replenishment of the rat population; when the stage is again set for the generation of a new epidemic. It has always been assumed that the fresh onset of plague in Iraq could only take place through the importation of human cases, or infected rats, from neighbouring and known active foci of the infection. Events during the last decade show that this assumption is not necessarily correct.

In the early weeks of 1945, the Tigris river overflowed its banks and caused the evacuation of certain riverian villages near Ali Gharbi, in the north of Amara liwa. In the temporary ("sarifa") dwellings, set up close to the flood waters, a sudden epidemic of bubonic plague appeared. This was checked after the villagers had been evacuated from the huts, which were immediately burned down. Rodents, assumed to be rats, were killed in the village at the same time. The interesting feature of this epidemic is that no connection could be traced with any other contemporary focus of human plague. In the spring of 1947, a localized outbreak of plague occurred in certain villages close to the Syria-Turkey frontier; this epidemic was short-lived with a mortality of 13 among the 14 cases reported. In October of the same year, an outbreak of pneumonic plague was reported from isolated Kurdish villages in the uplands of western Iran. This focus was investigated by a well organized team from Teheran who, after four years of intensive study in the field, reached grave and far-reaching conclusions touching the epidemiology of plague in this region.

Briefly, it was demonstrated that the source and reservoir of human plague in the Iranian highlands is in the wild population of small, burrowing rodents of the genus *Meriones*. Annually, during the warm season, over 10% of these animals harbour the infection, which is transmitted from one to another by fleas of the genera *Xenopsylla* and *Nosopsyllus*. These animals are far more resistant to plague than the domestic rat and. though a proportion of those infected may succumb, a sufficient number survive, with a latent or chronic infection, to maintain the disease from year-to-year without noticeable depletion of their numbers. Infected fleas were caught around the entrances of *Meriones* burrows, as well as on the normal animal host. The human case, which triggered-off the epidemic, was presumed to have been infected through the bite of a *Meriones* flea whilst visiting a deserted mill, in which *Meriones* were later trapped. The area of *Meriones* plague was found to occupy an extensive tract of country westwards to the Iraq frontier. The spontaneous appearance of plague at Ali Gharbi and on the Syria — Turkey frontier could then be explained: it became feasible to believe that this focus of *Meriones* plague extended deeply into Iraq.

The fauna of Iraq includes possibly 31 species of rodents, and 5 geographical sub-species. The genus *Meriones* is represented by 4 species and one sub-species, all but one form apparently confined to the northern, or upland, districts of the country. Wild, burrowing rodents of other types are however ubiquitous throughout the plains of Iraq; many of these belong to the genera known to be highly susceptible to plague. Some of these are now known to harbour fleas which might act as efficient vectors of plague from animal to man.

It would thus appear that one, or more, natural reservoirs of plague may have existed unsuspected within the borders of Iraq. It can also be true that such reservoirs have contributed to the initiation of many of the disastrous plagues of history.

Further study of this serious question must proceed and research on the flea populations of the wild rodents in Iraq must continue until it is known with what efficiency each of these fleas can transmit plague not only from rodent to rodent but also from rodent to man. So one can see the direct bearing fleas have upon the epidemiology of plague in Iraq and the Arab world.

PLAGUE IN THE MIDDLE EAST WITH SPECIAL REFERENCE TO PALESTINE

by

B. FELDMAN-MUHSAM

Until recently, it was generally accepted that the first record of an epidemic of bubonic plague is the description in the Bible (1 Samuel, V and VI) of a disease which broke out among the Philistines (1320 BC). The disease was characterized by high mortality and by "emerods". To stop the epidemic, the Philistines offered the God of Israel golden images of their emerods and of the mice that marred the land.

Recently, the nature of this outbreak has been questioned by Shrewsbury (1949) and Girard (1950) who think that the "emerods" were haemorrhoides, and the disease bacillary dysentary. McArthur (1952), on the other hand, reaffirmed that the disease was none other than plague. The presence of rats in ancient Palestine is proved because a skeleton undistinguishable from that of *Rattus rattus* was found by Haas at Mount Carmel in a Neolithic site.

Blondheim (1953) goes even further in his interpretation of the Biblical text. He assumes that the epidemics which broke out among the Israelites at Bethshemesh, after they had received back the ark from the Philistines was pneumonic plague.

The first certain record of a plague epidemic in the Middle East in historical times is contained in the writings of Rufus, a physician who lived at Ephesus during the time of Trajan, about AD 100. He noted the occurrence of fatal cases of bubonic plague during his own time in Syria, Egypt and Libya as well as previous cases during the time of Dionysius, about 300 BC. With respect to the disease described by Rufus, there can be no doubt about its identity: the patients are said to suffer **from fever, pain, delirium** and large buboes not only in the usual positions but also behind the knee and at the elbow.

The Great Plague of Justinian in AD 542, which was probably the first plague pandemic, is known in the history of pestilence from the writings of Procopius, a Byzantine historian, who was born in Palestine and lived in Constantinople. Procopius writes that the epidemic began in Pelusium (Egypt), from where it spread to the rest of Egypt, then proceeded to Palestine, and from there to the whole world. It is worth mentioning Procopius' observation "that the disease seemed always to be spread inland from the coastal region, thence penetrating into the interior". It is difficult to believe that Palestine was spared from Plague as long as from the time of Justinian until the 18th century, but if there have been any outbreaks during this time, they cannot have been very impressive, as apparently no reports have been preserved, or at least they are so inconspicuous that they have not come to the attention of present historians. There are, in fact, descriptions of many different diseases in the history of the Crusades and the Kingdom of Jerusalem, but none seem to refer to plague. Even during the horror of the Black Death which ravaged Europe during the 14th century and is supposed to have been brought there from East Asia through South Russia, one gets the impression that Palestine had been spared. Plague is known to have appeared in Egypt and Arabia in 1346, and in Constantinople in 1347, but Syria and Palestine are apparently nowhere mentioned in the reports on the Black Death.

During the 18th and the beginning of the 19th century, the Middle East (Iraq, Syria, Palestine, Turkey and Egypt) was known to be the seat of frequent and reoccurring plague outbreaks. The plague of Marseilles in 1720 and that of Messina in 1743 were known to have been brought there on ships from the Middle East. During 1773-1843 plague epidemics were recorded 13 times at the coast of Syria and Palestine. The plague epidemic which attacked the French troops of Napoleon in Alexandria in 1798 and later in Palestine, has been recorded in the documentary painting by Baron Gross (1804) which can still be seen in the Louvre Museum at Paris. In this picture, Napoleon is shown to touch plague patients during his visit to the Lazaretto of Jaffa, in order to encourage his soldiers and to prove to them that plague is not contagious. The Egyptian plague of 1834-35 is of particular importance from the point of view of the development of our understanding of the nature of the disease, as at that time a large group of European physicians resided in Egypt and had an opportunity of studying the different aspects of this disease by direct observation.

The most widespread pandemic of plague had broken out in Canton in 1894, made almost the tour of the world and reached the Middle East in 1899. It was recorded in various sea ports, such as Alexandria, Beirut and Smyrna, but it seems to have spread to a considerable extent only in Egypt.

Exact data on plague in Palestine are available since the end of the first world war and the establishment of the British mandatory government. Plague was then obviously included among notifiable diseases and detailed statistics were regularly published. Since 1921 up to 1947, 290 cases were recorded, almost all in the two port towns of Jaffa and Haifa. Cases were reported in each of the years 1921, 1922, 1923, and 1924; there was an interval of 15 years after which cases occurred every year from 1941-1947.

Most cases were bubonic and only a few septicaemic. During 1921-1924, the peak was in 1922 with 63 cases in Jaffa alone. Extensive anti-rat measures were undertaken and the number of cases declined to 15 in 1923 and 2 in 1924.

The plague was again imported to Haifa in 1941, probably from Port Said (Egypt), where sporadic cases had been recorded in 1940. From 1941 to 1947 cases occurred every year at Haifa or at Jaffa-Tel Aviv, or in both cities, the number varying from 10 to 93 cases per year. In 1947, an extensive DDT campaign was carried out in Haifa. Dusting of people with DDT, and spraying of basements, ground floors, streets and houses were systematically performed. The outbreak which had begun with 14 cases in the first 8 days of July, was soon stopped by these efficient measures.

No cases have been recorded since 1947 in Palestine. This year was also the last plague year in Labanon and Egypt. The other countries of the Middle East became plague-free even before.

As both the two main Palestinian epidemics, that of 1921-24 and 1941-47, are suspected to have been imported from Egypt, the epidemiology of plague in Palestine is apparently associated with that of Egypt. An interesting correspondence is exhibited by the seasonality of plague in the two countries, Wakil (1932) found a correlation between the seasonal incidence of plague in Egypt and geographic latitude. In Upper Egypt, the seasonal peak occurs during March — May, in Middle Egypt during April — June, and in the Mediterranian ports during May — October.

In view of the small number of cases which occurred in

Palestine, it is difficult to draw definite conclusions about the seasonal incidence of plague in this country. But if the two main epidemics are broken up into separate upflares, preceded by several months without any new cases, it can be noticed that seven of them started in June — July, one in May, and one in November. Most of these upflares subsided in November — December of the same year. Sporadic cases were noticed during all months of the year. Thus the seasonal picture of Palestine seems to fit into the pattern observed in Egypt: the further one proceeds to the North, the later the seasonal peak of plague.

On the other hand, Pollock who studied the epidemic of 1947 in Haifa, considered plague to be endemic in the Haifa area, because infected rats had been found constantly during 1941-42 and 1944-47, numbering from 6 to 236 in various years. But other considerations seem to contradict Pollock's assumption. In fact, during all the years from 1925 to 1940, not a single case of plague had occurred and no infected rats had been found by the health authorities. Since 1949, again, no infected rats were recorded. It is therefore much more probable that both the epidemics of 1921-24 and 1941-47, which always appeared in the two port cities of the country, were imported, developed to a certain peak and then terminated, owing to efficient public health measures.

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PLAGUE

Bernon B. Link, U.S. Pub. Health Serv. writes: Plague always has been one of mankind's worst enemies. As a pestilential disease, it can be traced back uninterruptedly to the third century before the Christian era when Dionysius spoke of it as a fatal disease in Libya, Egypt and Syria. Prior to that time, Homer described plague among the Greeks at the siege of Troy in 1184 B.C., ascribing it to the wrath of Apollo who was angered at an insult to his high priest Chryses, and also to the god's malevolence and disgust at the filth lying about the camp. Probably the earliest known reference to plague occurs in the First Book of Samuel, Chapters 5 and 6, where-mention is made of the disease having broken out in Canaan during military operations against the Israelites, centuries before the Christian era. It is stated that the inhabitants of several cities were attacked with emerods, and that the pestilence caused a deadly destruction. In Bethschemesch, over 50,000 persons died. It also is recorded that in order that the plague might be stayed, the Philistines made propitiatory offerings of golden images of their tumors and of the mice that marred the land to the God of Israel. This appears to be the earliest reference to an epizootic among mice in connection with the disease.

Rufus of Ephesus, about 100 A.D., probably gave the first description of plague which has been preserved. The first recorded plague epidemic in the world's history occurred in the reign of Marcus Aurelius 164-180 A.D., the second, in Egypt in 542. The Great Plague of Justinian in the sixth century is said to have carried off half the population of the Roman Empire.

In the fourteenth century, a new European epidemic began which became known as the Black Death. It is estimated that it killed one-quarter of the population of Europe, or about 25 million persons. In some countries, however, the total deaths approximated 70 per cent of the inhabitants. Plague continued to hold sway in Europe during the fifteenth, sixteenth, seventeenth, and eighteenth centuries, but seems to have disappeared by the middle of the nineteenth century.

The present pandemic, which began in the Orient in 1894, has had the most widespread distribution of any of the known epidemics. It has invaded every continent of the world, and has been reported from nearly every country. India suffered most with about 12 million deaths reported in the last 54 years. Although the mortality rate does not approach that of the Black Death of the fourteenth century, the present pandemic ranks alongside of the

most important previous ones as far as the total number of cases is concerned; and far exceeds all others in regards to its widespread distribution. The world distribution of the present pandemic as regards to the Arab World has these beginning dates for the original outbreaks.

Basra, Iraq	1896
Jidda, Saudi Arabia	1897
Alexandria, Egypt	1899
Beirut, Labanon	1899
Algeria	1903
Tunisia	1907
Casablanca, Morocco	1910

HOW PLAGUE WORKS

Plague is a bacterial disease caused by the organism *Pasteurella pestis*. This bacillus was first isolated during 1894. Yersin and Kitasato working independently discovered it about the same time. The bacillus is a short, plump oval rod measuring from 0.3 to 1.25 μ in length. It can be found singly or in pairs, but long chains are rare. There is no characteristic arrangement. The bacillus is encapsulated, non-motile. Involution forms are common and may appear as coccus forms, large rods or swollen bodies. The plague bacillus does not produce soluble toxic substances. In general, the life of this bacteria outside the animal body is precarious. It seems to disappear speedily from soil, water, and buried bodies.

The opinion has been expressed that plague caused by this organism is primarily a disease of wild rodents, and that man is only an incidental victim. But in spite of this opinion it is said that about one-quarter of the population of Europe was carried off by this disease during the "great mortality" of Black Death of the fourteenth century. A civilization, or lack of it, in which peoples are allowed to live in filth and poverty making them the bedfellows with rats and mice, fosters outbreaks of human plague. In the Arab world, besides large concentrations of Norwegian rats and house mice, a whole series of wild rodents may harbor plague. Living close to the soil as the Arab farmer, and the poorer classes do, gives the flea an easy chance to carry the disease from rodent to man.

Plague in man is generally found to be of two types.

PESTIS, BUBONIC PLAGUE, or BLACK DEATH

This type of plague develops in man only after he has been bitten by a flea which has become infective through sucking blood from a plague infected animal. In this type of plague diagnosis on clinical grounds is said to be relatively simple. An inflammatory swelling of the lymphatic glands occurs. These are called buboes. From these, bacilli may pass over into the blood. It is from these buboes that the disease received its name bubonic plague and from the point of attack the name of glandular plague. When the bacilli pass into the blood, they multiply extensively. Septicemia may occur and at times subcutaneous hemorrhages. These hemorrhages were far more common during the Middle Ages than now. The black patches due to the hemorrhages gave the medieval name of "Black Death". The case mortality of bubonic plague is from 60 to 90 per cent where treatment is not secured.

In bubonic plague the role played by the flea is of vital importance. It is the go-between or vector. Under certain conditions the flea may transmit plague between rodent and man. These conditions are as follows: First, the rodent must be infected and have the plague bacilli invading the blood stream. Second, the flea must feed upon the infected rodent and suck into its mouth-parts, and swallow into its proventriculus and stomach, the blood containing the plague bacilli. Third, in the proventriculus of the flea the bacteria of plague multiply rapidly to form an obstruction. This obstruction or dam is called a "block" and fleas so affected are said to be "blocked". Sometimes this block may occur in the esophagus. It is not possible for the flea to swallow beyond the block. Fourth, the flea is now infectious. It becomes hungry, wishes to feed. If it bites a man or an uninfected rodent it sucks the blood into its mouth-parts but is unable to swallow it because of the block. As the new blood washes across the block, the plague bacilli become mixed with it. Because the flea cannot swallow, it vomites or regurgitates the now infected blood back into the bite and so the bacilli make their way into the new animal and infection begins. Blocked fleas are unusually dangerous because, being unable to satisfy their hunger, they repeatedly bite and try to feed, thus spreading the infection as they go.

Since plague bacilli can be found in the feces of fleas it has been thought that the scratching of this fecal matter into the skin could cause plague infection, but recent researches tend to discredit this theory.

PNEUMONIC PLAGUE

This type of plague is also known as plague pneumonia. It occurs secondary to bubonic plague. It seems that the bubonic plague infection settles in the lungs of man to give a pneumonia-like condition there. In this type of the disease in man, no flea is necessary for the spread of the infection. In patients suffering from this type, huge numbers of the plague bacilli are found in the sputum and the infection is spread from person to person through the cough or sneeze droplets. Because of this direct spread, pneumonic plague is very much more dangerous than the bubonic type. It is also much more fatal, the case fatality being almost 100 per cent. In Manchuria during the years 1910-1912, 60,000 fatal cases were attributed to this lung infection.

SYLVATIC, MURINE or CAMPESTRAL PLAGUE

In order to distinguish the plagues caused by *Pasteurella pestis* in man and in rats, mice and other wild rodents the terms sylvatic plague or plague of the wilds, or campestral plague or the plague of the meadows has been suggested and widely used in case of the disease in the rodents. That these plagues play a great part in keeping the rodents in check there is little doubt. It is recognized that great numbers of rodents die in this manner and that human beings should avoid to close association with these forms and should definitely not handle any of the types which are sick, seemingly inactive, or easy to secure for handling.

PLAGUE IMMUNITY and TREATMENT

According to Dr. Vernon B. Link of the U.S. Public Health Sercive, the treatment of human plague has been improved greatly in recent years. He writes "formerly, bubonic plague killed about two-thirds while pneumonic plague was almost invariably fatal. While many types of therapy have been tried, there were but two that were at all effective: serum with which to treat cases, and vaccines to prevent the disease. Serum was fairly effective if given early and in large doses. Vaccines have been used on a large scale in various parts of the world, but are not 100 per cent effective, and the period of protection is limited to several months. In the late 1930s, sulfa drugs were found to be of value in the

treatment as well as in the prophylaxis of plague, and sulfadiazine is probably the most efficacious. Streptomycin is an even better drug. A combination of streptomycin and sulfadiazine, if given early enough and in adequate doses, is capable of curing even pneumonic plague.

The development of almost specific methods of treating plague has taken away some of the fears which were so justly warranted when this disease struck a community. However, there are still ample reasons why vigilance cannot be relaxed against plague at this time, merely because good methods of treatment now are possessed. Plague still demands respect because it is reservoired and pooled in the rats and mice and wild rodents of practically all countries".

MURINE TYPHUS

In countries, such as the United States, where Murine Typhus is found, fleas are known to be the vector. For example, during May of 1939 on a certain farm in Georgia, U.S.A., where a farmer lay ill with a case of endemic typhus fever, several rats were trapped. From these were removed 135 *Echidnophaga gallinacea*, the Tropical Hen flea, 5 *Xenopsylla cheopis*, the Oriental Rat flea, and 7 *Leptopsylla segnis*, the European Mouse flea, all of which proved typhus positive as did the brains of the rats.

The causative agent of the disease is *Rickettsia powazekii mooser*. Fleas are the vector. The incubation period in man is from 5 to 18 days. Violent headaches, with fever and chills are characteristic. A macular eruption occurs after the 4th day. The crisis occurs in 12 days with recovery in about 2 weeks. In the U.S., case fatality is about 2 per cent. The disease is pooled in rats, mice and many wild rodents thus the name murine typhus. Recovery results in a solid and lasting immunity.

TULAREMIA (RABBIT FEVER or DEER FLY FEVER)

This North American disease is contracted by man through skinning diseased animals, or through the bite of a vector which may be a tick, a fly or a flea. The causative agent is a tiny rod *Pasteurella tularensis*. In man four types of clinical tularemia are recognized. The more common type is the glandular or ulceroglandular variety. The disease is characterized by headache, pains

and fever. A papule appears where the bacteria enter the body. This later breaks down and forms an ulcer. Certain glands become painful and swollen and may break down and discharge purulent material. The disease runs a course of from 2 to 4 weeks. The case fatality is low, being about 5 per cent. An attack of the disease confers a solid immunity.

SALMONELLOSIS

Salmonella enteritidis and *S. typhi-murium* are two bacteria which occur in mice all over the world. While culturing flea feces to determine the presence of plague infection, Eskey discovered that a number of rat fleas were excreting *S. enteritidis* which they had apparently acquired from blood streams of mice infected with the organisms. Eskey and his co-workers were able to transmit *Salmonella* organisms by the bite of infected Oriental Rat fleas and Northern Rat fleas. Eskey concluded that these two fleas may play an important part in the transmission and dissemination of *S. enteritidis* among rodents and that human infection might be contracted from the bite of the fleas or from infected flea feces contaminating food.

FLEA ALLERGY

It has long been known that certain individuals suffer more severely from bites of fleas than do others, and today they are considered to suffer from flea allergy. In people sensitive to flea bites the wound may be followed by swelling which can develop into a large welt. The situation is aggravated by the accompanying itch and scratching. In so far as most of these attacks are from the cat flea, the dog flea and the human flea which are found in large numbers all over the Arab World, the attack is more in the nature of a nuisance raid than one of danger, for these three fleas are not known to be vectors of plague.

In many places people suffering from flea allergy can clear up the situation by doing without pet cats and dogs. However, when one thinks of the large number of cats, dogs, jackals which are maintained in the Arab countries the problem is not so easily solved. Practically all itch allaying preparations obtainable at drug stores have been tried to sooth the bites of fleas. One investigator told the writer that a piece of adhesive tape placed over the bite would stop the itching.

After considerable research upon flea allergy, Ely Lilly and Co., well known American drug house, took over the manufacture of a preparation which they named "Flea Antigen". This is prepared by a method developed at the Hooper Foundation of Medical Research of the University of California. It is an extract of the fleas of cats, dogs and humans in sterile phenolated isotonic saline solution. The usual subcutaneous dose for adults is 0.2 cc. This dose is usually increased to 0.4 cc. for 5 subsequent injections with intervals of 2 days between. The preparation number is PA-90. It may be purchased in 5 cc. vials. This preparation is effective only against the human flea, the cat flea and the dog flea. It must be administered by a physician.

FLEAS AS HOUSEHOLD PESTS

The human flea, the cat flea and the dog flea can become a serious household pest during the season of their maximum abundance, which is generally during summer and fall. The fleas are either carried into the house by cats or dogs or they are emerging from their cocoons which may be under rugs, in cracks or just on the floor.

The first point of control of fleas in the home is to determine where the fleas are originating. If they are coming off the cats and dogs, these animals should be thoroughly powdered with flea powder and the application of the powder should be at regular intervals. Floor should be cleaned of dust and castings, flea eggs and larvae. DDT is used everywhere today to combat fleas. It has put to an end the use of such controls as salt water and naphthalene flakes.

this top hole. With fine iron wire securely wire the door to the snap. Place in position so door is closed, then nail the mouse trap with lath nails securely to the base. To set the trap run the trigger through the small hole in the door as it is forced down to setting position and connect trigger connections as usual.

Three accessories are next cut from the metal sheet. Cut a piece three-eighths of an inch by 3 inches, round off the corners, slip this under the hook which was made for the bait and clamp it in place with a pair of pliers. This is the treadle upon which the animals steps to set off the trap. Cut two pieces three-eighths of an inch by $1\frac{1}{4}$ inches, round off the corners and bend up at right angle about a quarter of an inch from the end. Nail these in place, one on either side of the mouse trap so that they fill up the hole below the door. Nail a piece of board, $\frac{1}{4}$ by 1 inch across the back of the trap over the screen and raised about $\frac{1}{2}$ inch above the floor — this will prevent the bait from falling out during transit.

After a model is once set up, others can be quickly built. The time required is about one hour. Due to the large loss of these small traps through children and jackals, the investigator will be building them constantly. The traps should not be built much larger since the larger the door the more easily it can be pushed open because of the increased leverage. The trap should be just big enough to allow the collector's open hand easy entrance, and just as easy an exit when the fist is pulled out with the trapped animal in it.

These traps should be made in units of 12, piled in 3 tiers of 4 each and a carrying box made for the 12. Empty dynamite boxes or other dovetailed jointed boxes, make excellent carrying cases. Each trap of the series of 12 should have a number on it in several places. If numbered, the traps can be set out in rotation and picked up in rotation. Lost traps can be more easily located in this way.

These small traps will hold all types of gerbils, jerboas, date rats and house mice of the plains regions, and the wood mice and meadow mice of the mountains. They will not hold mole rats, house rats or squirrels.

It is next to useless for the collector to burden himself with snap mouse traps. On rare occassions, however, they do prove useful. If large numbers of the snap traps are set out on a bright moon light night, a night during which it is known that the moon will set about an hour before dawn, the mice to be caught will run at large during this hour of darkness, get into the traps and will

be warm and with fleas when the collector can pick up the catch in the morning.

Three other types of traps are needed for thorough field work. The Mole rat *Nesokia* requires a special trap. It is made in the United States and can be ordered from any American hardware store for about 50 cents. It is called the "Macabee gopher trap". The Mole rat's burrow is opened and the set trap introduced into the burrow. When the animal comes to shut the burrow it is caught by the trap. The trap kills by driving steel spikes into the animal's belly. These traps will also catch gerbils which close their burrows upon retiring. These traps will not catch *Spalax*, the black mole rat.

Spalax can best be caught by one of America's best mole traps. It is called the "Out of Sight Mole trap". This trap can be secured anywhere in the United States for 3 dollars. It is the only trap which will consistently capture *Spalax*. The trap squeezes the animal to death, so the traps should be visited often.

The common steel trap is very successful against house rats. Set the trap where the rats are known to be, place a piece of white cloth over the trap. The rats will find the white cloth, step on it from curiosity and be caught.

The novelty of long lines of small box traps is the variety of mice and other small rodents in each night's catch. Box traps are generally set for anything that will enter them. The plan is not exactly to set the traps at random, but each location should be carefully considered as to how much shelter the small animal will have to get to the trap. The small rodents depend primarily on natural shelter for their safety. Naturally then, the most profitable places to set traps will be under banks, in cavities, under bushes at base of palm trees, along walls, under logs and under rocks. In sandy wastes, the trails of the small animals can be seen in the sand. Make sets along these trails. A stick or the heel of the shoe dragged along in the sand to form a small furrow will attract many mice. Make sets along the furrow.

The matter of bait is one of question. Almost everything in the line of food has been tried to coax small animals into traps, but a bait which practically climaxes all others as far as tastes of the majority of small rodents is concerned is quick cooking rolled oats. A small handful of this thrown into a trap attract a mouse a long ways. Common rolled oats give only about 50 per cent of the results secured by quick cooking. Apple or other moist fruit have always

Typical Basic Trap Equipment Used by Present-Day Siphonapterists in Their Research

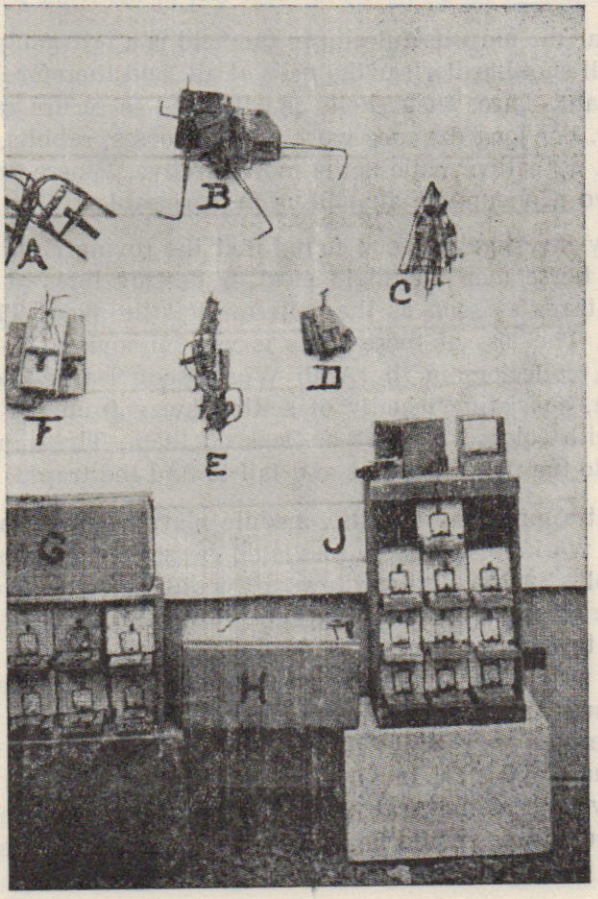

Fig. 10. Traps used by the author:

A. Out-of-sight mole trap.
B. Chinch gopher trap.
C. Macabee gopher trap.
D. Snap mouse trap.
E. Steel trap.
F. Snap rat trap.
G. Hammerhead box trap.
H. Sliding door box trap.
J. Author's all-purpose live trap.

been excellent bait but the moisture content runs rapidly through the intestine to badly soil the inside of the trap and muss up the feet and the fur of the animal. Small carnivores such as weasels and shrews do not come into these small traps more quickly if they are baited with meat, but if they happen along they enter probably only to investigate the odors left in the traps by mice.

By far the most useful gun in the field is a .410-gauge shotgun. The small shot hardly tear the pelts at all, and therefore the bleeding is scant. Three inch shells can be used to secure rabbits and squirrels. For long distance work on mongooses, rabbits, squirrels, jackals a .22 caliber riflle is the most effective. Where firearms are prohibited a pneumatic air rifle is indispensable.

Early investigators soon found that the roving children, sheep herders, horse men all might steal or destroy lines of box traps or snap traps as soon as the collector left the field. This is still the case. The loss of these traps is very annoying. To overcome this loss, collectors in the Arab World soon learned to create a diversion, consisting usually of setting away from the trap lines stakes with colored banners or flags on them. The inquisitive go directly to the flying banners and fail to find the traps.

The trapping day and its schedule plays an important part in the field work. Box trap lines should be set out as close to dusk as possible. Such a timing allows all possible nocturnal rodents to enter the traps before morning and allows the diurnal rodents to enter in the early morning. Collections from box traps should be made as near after sunrise as possible. The sun and heat irritate the animals and soon they worry themselves to death. Also ants which become very active at daybreak may enter the traps, kill the animals and start moving the flesh of the animals away. In a country such as the Arab World, where jackals abound without check, most traps should be tied down, otherwise they are carried away by the jackals for the mice which are in the traps.

It is the custom of this writer to kill all small mice at the trap, thus doing away with the necessity of again looking through them. Insert the hand into the trap, close it slowly and gently over the mouse, withdraw the hand, then force the thumb behind the ear until the neck is broken. No bleeding results if the operation is properly performed. Drop the dead mice in the clear glass jars of a biological collecting vest worn by the collector. Handle all mice carefully and quietly, any rough treatment will cause the fleas to hop off. In so far as there seem to be little if any correlation between the mouse and the number of fleas it will

carry, it is generally not necessary to keep mice of the same kind separated. However, under no conditions should different kinds of mice be mixed in a single jar.

A CERTAIN AMOUNT OF CAUTION SHOULD BE USED IN HANDLING WILD MICE

Some collectors wear rubber or leather gloves to prevent the hands from being bitten. However, the writer has never worn gloves and when one becomes accustomed to handling large numbers of live mice one is seldom bitten. Even the large Date rats seemed not to bite. To try to handle squirrels, Mole rats or House rats without hand protection would be a folly and a danger. Discretion is soon learned in handling wild animals.

While it is important to know where to trap, it is also just as important to know where not to trap. Generally it is useless to trap where there are house cats at large. The cats soon eat all the available mice. It is generally not good practice to trap several nights in the same spot. The available mice are generally taken the first night. While many mice can be taken about grain stacks these are usually without many fleas because they have made new nests at the new source of food and left most of their fleas in the old nest which they have deserted. Where nests can be found, these are the collectors prizes if they are old and well established. Often several hundred fleas can be taken from a nest, while off the mouse which has just come from it, there may be only a few. It is quite a problem to get fleas out of a nest, so they should be collected and placed in paper sacks and at a time of leisure looked over for the flea population.

After all animals of a night's catch have been carried back to the field laboratory, preparations must be made for the securing of the fleas and a decision must be reached as to how many, if any, are to be used for plague studies and how many, if any, are to be used for taxonomy. The only equipment necessary is 2 per cent saline solution for fleas for plague studies, and 70 per cent alcohol, chloroform, vials, labels, dissecting needles and a good sized white enameled dishpan for identification purposes. Some collectors use a comb to comb fleas off the host. The main point in removing the fleas from the hosts is that the collector get comfortable and out of the wind. Fleas will leave the host more readily if the hosts are cold. The collector should sit with the dishpan between his knees. With some slight

force drop the hosts out of their container into the dishpan. The force with which they hit the bottom will jar most of the fleas off. These can be picked out of the pan with the dissecting needle dampened in the vial of 70 per cent alcohol waiting for the reception of the fleas if they are to be used in identification, or the needle can be moistened in the saline solution if the fleas are to be used for plague technique. After pummeling the hosts for a short time to force the rest of the fleas off, take the host by the tail and back legs with one hand, then with the other hand rapidly run the fingers downwards against the fur. This operation will force more fleas off the hosts. The final step is directed against stubborn fleas. Pour a small amount of chloroform (ether will not work) into a clean glass pint jar. Dangle the host in the jar by a hind foot while forcing the hand over the opening for pressure inside the jar. Most remaining fleas will hop off the host and die in the jar.

In plague studies the wild rodents trapped or shot should be cleaned of fleas and other ectoparasites, then autopsied. If the animal's organs appeared infected, samples should be sent to the laboratory (probably the closest medical school bacteriological laboratory) in iced thermos jugs. It is needless to say that any studies carried on in the field of plague should also carry due respect for the disease, and rubber gloves and other precautions should be rigidly followed. Fleas to be used in plague studies are placed in 2 per cent saline solution in glass vials and shipped to the laboratory by mail.

Fleas which are collected solely for identification should be stored in vials of 70 per cent alcohol until they can be processed.

All hosts which cannot be positively identified by the collector should be made into cabinet skins with skull attached and turned over to a mammologist for identification.

Nests are difficult to process but if care is taken even larva can be salvaged. Place the nest in a small box with screen bottom. Suspend box over white dishpan. Many of the fleas will drop into the dishpan. By keeping the nest slightly damp all the larvae will eventually pupate and emerge to fall into the pan. Large numbers of fleas can be secured in this way for taxonomic purposes. Where possible the host should be taken with the nest.

A good collector places his labels with the collection data thereon inside of the vial, but most of us lick the label and stick it to the outside so that it can fall off and cause confusion.

Field notes are something each collector has his own ideas

about. Perhaps the writing of these gives the collector a few moments of relaxation before setting out to collect the traps set for diurnal animals or to hunt and shoot a few larger animals.

THE LABORATORY MANUAL

It is not very often that one finds time in the field to mount fleas for determination or carry out plague studies. These operations are reserved for a well equipped laboratory. Plague studies should be carried out only in a bacteriological laboratory but processing fleas for mounting and identification can be carried out in any well lighted, well ventilated room.

PLAGUE STUDIES

Upon receipt of the iced jugs of suspected tissue from the field, the tissue is macerated and injected into, or inoculated onto the skin of a guinea pig. If plague is present in the tissue, the guinea pig generally dies in about 5 days and a presumptive diagnosis can be made at autopsy. This diagnosis then is confirmed by bacteriological procedures and seriological tests. The fleas and other ectoparasites which have been removed from the hosts and are in 2 per cent saline solution should be counted, identified as to species, macerated in mortars, emulsified in normal saline solution, and injected into or inoculated onto the skin of guinea pigs. As in the case of autopsied materials, if plague is present the guinea pig will die in about 5 days. The susceptibility of native wild rodents to plague infection can be tested in the same way.

PLAGUE TRANSMISSION METHODS

Vernon B. Link and Frank M. Prince, two of the leading plague specialists in the United States, have developed the following techniques in plague transmission in their government laboratory at San Francisco, California. They state in CDC Bulletin, August 1950 "In addition to its field work on plague, the Western Communicable Disease Center Laboratory carries on plague research activities. One of the more interesting types of research is concerned with transmission studies in which the vector efficiency of fleas is studied under varying conditions.

Ogata in 1897 brought forth the theory that fleas were involved in the spread of plague among rats. Simond in 1898 supported this theory experimentally, but assumed that flea feces were res-

ponsible for the transfer of the organism from diseased to healthy rats. The Commission for the Investigation of Plague in India, working from 1905 to 1916, proved beyond a doubt that the rat and its fleas were the common reservoir and vector in plague epidemics. However, they did attach undue importance to the role played by deposition of flea feces during the process of biting and subsequent rubbing into the skin by the victim's scratching efforts. Bacot and Martin in 1914 demonstrated the ability of infected fleas to transmit *Pasteurella pestis* by feeding them on the shaved abdomens of rats. They first observed the "blockage" of fleas by masses of plague organisms.

In flea transmission research at this laboratory, unique methods have been developed for the study of the flea in determining its efficiency as a vector of plague. Laboratory albino mice, used as the host animal, are bred in the animal house in quantities sufficient to provide several thousand each winter. After the young mice have reached an age of approximately 4 weeks, they are separated according to sex and placed in stock cages. When mice are used in experiments, they are transfered to an individual quart jar which is provided with sawdust, drinking water, food pellets, and an identification record.

Fleas to be used in experiments either are raised in the laboratory or are obtained in the field from wild rodent sources, brought into the laboratory, and placed in numbered test tubes, one flea to each tube. Fleas subsist on animal blood and exhibit a peculiar preference for blood from a particular host. This result of host adaptation is so specific that the entomologist usually can tell from what host the flea was taken when the flea is identified. Certain fleas will feed on almost any available warm-blooded host, whereas others have been known to starve to death before they would feed on man or laboratory animals.

In the flea transmission studies, fleas first are given an opportunity to feed on a normal albino mouse. The abdomen of the mouse is shaved with electric clippers. The mouse is then placed in a white enamel pan and induced to enter a plastic tube which has a hole cut in the center. When the mouse is in the tube with shaved abdomen over the hole, a rubber stopper is placed in each end of the tube to keep the mouse immobilized. The tube is then placed upsidedown on a grooved wooded block with the mouse's abdomen exposed through the hole in the tube. The flea is then taken from its test tube by removing the cotton plug and upending the tube onto the mouse. The flea ordinarily will settle

down and feed on the mouse. By the use of a hand lens and a pocket flash light, the attendant can see whether the feeding flea is taking blood into its stomach. The records of the details of the feeding are kept on a card prepared for each individual flea. After fleas have fed, selected specimens are removed from the mouse, placed in a drop of water on a microscope slide, and covered with a cover slip. The flea then can be examined under the microscope to check on the quantity of blood taken and for the purpose of making serial photographs.

Albino mice to be used as reservoir hosts for the infection of fleas, are inoculated by the subcutaneous injection of 0.1 cubic centimeter of a 24 hour tryptose broth culture of *P. pestis*. In 24 to 48 hours after injection, most of the mice will be moribund and have a terminal septicemia. This is checked by snipping off the tip of the tail and making a blood smear which is stained and examined for organisms. Frequently there are as many organisms as red blood cells. If the smear shows 10 or more bacilli per oil-immersion field, the mouse is satisfactory for use as a host. Fleas are placed *en masse* on that mouse in a jar. After they have fed, the fleas are removed from the jar containing the mouse by means of a suction tube and placed in their individual test tubes.

On succeeding days, each flea's feces are cultured in order to determine whether or not the flea actually ingested plague bacilli. If the culture is positive, the flea is known to be infected. Some fleas will not remain infected but will rid themselves of plague by means of the normal emptying processes of the digestive tract. However, most species of fleas which have become infected will retain the infection and develop masses of organisms which can be seen readily by microscopical examination of the stomach. Each flea is given a daily opportunity to feed on a normal mouse and, although infected with large masses of organisms in its stomach, it will not trasmit plague to the mouse. A flea does not become infective until a mass develops which prevents ingested blood from entering the flea's stomach (blockage). When this happens, the flea remains hungry after its attempted unsuccessful feeding, and it will make repeated efforts to feed. During this active search for blood, the blocked flea will regurgitate some of the blood which entered its esophagus but could not enter the stomach. By this process, some of the plague bacilli which formed the obstructing mass may be washed out mechanically with the regurgitated blood through the flea's proboscis and enter the body of the animal on which the flea is trying to feed. Plague is thus transmitted. Although fleas may become unblocked, they usually do not do so,

and the resultant lack of nutrition causes them to shrink in size and starve to death within 3 or 4 days. It is during this period of starvation and repeated attempts at trying to feed that the flea is usually dangerous as a vector of plague.

The Oriental rat flea, *Xenopsylla cheopis*, is a very efficient vector of plague because the plague masses tend to form in the proventriculus, an organ located between the esophagus and the stomach. The localization of masses in this area causes blockage much earlier than when the masses tend to form in the stomach proper and secondarily invade the proventriculus as is the case in most wild rodent fleas. *X. cheopis* usually blocks in about 2 weeks' time, while wild rodent fleas usually require a much longer period to become blocked".

SLIDE PREPARATION

When one is ready to proceed with slide making, the specimens taken in the field and stored in 70 per cent alcohol should be returned to water. Beyond this not a great deal of equipment is necessary for the work. Bleach is necessary. This should be a 10 per cent solution of sodium or potassium hydroxide. Also at hand should be a 1 per cent solution of acetic acid, 25, 75, and 95 per cent alcohol, carbol-xylol, cedar oil, xylene and mounting media. Carbol-xylol can be made by placing a pound bottle of carbolic acid crystals in warm water until it dissolves, then pouring half of it out of the bottle and replacing the half with warm xylene. The solution should be strong enough so that when cold there are carbolic acid crystals precipitated on the bottom. The best of microscope slides and cover glasses should always be used. For the sake of beauty the author always prefers to use round cover glasses.

Two things are of utmost importance in mounting fleas; first, the bleaching; second, the consistency of the mounting media.

Preparations are best carried through in watch glasses, those with ground glass edge. These stack nicely and are evaporation proof, and data can be written on the ground glass edge.

The student should always remember that before bleaching there are many things of interest to be found on the inside of the flea which bleach will completely ruin for study. Some of these things of interest are:

The internal anatomy of the flea, about which little has been recorded.

Eggs in the abdomen of the female, these frequently differing with the species in size, shape, and number,

The Cysticercoid stage of the tapeworm, which at times can be seen in large numbers in the abdomens of the fleas,

Nematodes, which sometimes completely pack the abdominal cavity,

Threadworm larvae which wind in seemingly endless length in the flea's body.

All these should be studied before the fleas are bleached. To bring these things to light, remove the fleas from the 70 per cent alcohol in which they have been stored and place them in 96 per cent alcohol. After a few hours pipet off the alcohol and flood the specimens with carbol-xylol. They will begin to clear immediately. Check with microscope for interesting points and any found worth preserving can be prepared for mounting by being placed in xylene for a short time, then mounted in balsam or other favored mounting media. Very satisfactory identifications can often be made from such mounts but they are never mounts that one can look upon with pride because of the cloudiness of the specimens. Carbol-xylol treatment at this time in no way affects the specimens for bleach treatment. To return the specimens to bleach, thoroughly wash balsam off with xylene and then place them in carbol-xylol. After an hour or so run fleas through 96, 50, 25 per cent alcohol and then to water. From water place specimens in bleach.

Fleas that are to be mounted without preceding examination should be moved from the 70 per cent alcohol into water. Place data upon the ground glass edge of the watchglass. Allow to stand in the water about 24 hours. Drain off water and flood specimens with bleach. It is difficult to say how long a flea should remain in bleach. Experience in this line is the best teacher. Pale fleas require very little bleaching, dark, large fleas may take a long time. If specimens are watched carefully, bleaching can be hastened by heating the bleach. The process should never be one of boiling and never should one heat the bleach to such an extent that the delicate edges of the sclerites become disfigured. Bleaching should continue until the entire visceral mass has disappeared. The author has always preferred a slow room temperature bleaching. This gives good definition to the sclerite edges and there is generally no distortion. DO NOT OVER-BLEACH. Under-bleached specimens can always be returned to the bleach, but over-bleached specimens are often a total loss.

After the bleaching has been completed the specimens should

be thoroughly rinsed in water, then for 24 hours suspended in a 1 per cent solution of acetic acid. This is, of course, to neutralize any bleach remaining in the specimens. After washing off the acetic acid with water the fleas should be run through the alcohol solution, 25, 50, 75, and 96 per cent, several hours each. From the alcohols run the specimens into carbol-xylol. After a few hours check for clearness with microscope. If there is any trace of cloudiness run the fleas back through the process and bleach again. When bleached properly the fleas should be as clear as glass, when taken from the carbol-xylol.

Before mounting fleas one should prepare a mounting mat. On a white index card place a microscope slide and mark around it with a pencil. Remove slide and divide outline of slide into 3 one inch squares. Divide the middle square with 2 lines running from opposite corners. The lines will cross at the center of the square. Center at the cross point a $\frac{1}{4}$ inch round cover glass, and outline with pencil. Repeat process with various sizes of square and round cover glasses. With such a mat the specimens can be centered on the slide, as can the cover glasses and labels which go on the ends.

After specimens have been bleached and cleared to the satisfaction of the worker they should be changed from the clearing solution to xylene in which they should remain for a day. When one is ready to mount, transfer the specimens to new xylene. Slides and cover glasses should be at hand soaking in 96 per cent alcohol. Dry the cleansing alcohol off a slide and a cover glass. Place the slide on the mounting mat. Drop a drop or two of Canada balsam or other preferred mounting medium on the center of the slide and evenly spread it over the area to be covered by the cover glass. Dip the tip of a dissecting needle into the balsam, apply the sticky tip to the flea to be mounted, lift it from the xylene into the balsam, center, and with a pair of forceps drop the cover glass into place. The specimen or specimens should not drift. In multiple mounts care should be taken that all specimens are completely submerged in the balsam or air will seep into the fleas and cause them to turn black. In case specimens drift, lift cover glass, reset flea or fleas and replace cover. Specimens which turn black must be unmounted, run back to the alcohol solutions and left there until the air escapes, then run back through the processes again. In case balsam does not completely spread under cover glass, add a bit more with a quill or dissecting needle. Mounts look very much better if not too much mounting media is used and the cover glass rests snugly against the flea.

Various mounting media should be given trial by the student before he accepts one for use. The author has always worked with balsam. The skill with which one mounts will depend entirely on how well he understands the working of the media. The author has always preferred to use a thin balsam in a warm room. Balsam does not set rapidly but drying can be hastened in an oven. Balsam should be thinned to the consistency desired by adding xylene.

Few persons agree as to the arrangement of fleas upon slides. However, fleas should never be thrown into the media to drift where they will as the cover glass settles down. There should always be some definite arrangement. For exchange purposes the writer prefers to place on a slide a male and a female of the same species, the male above the female below, both with legs up, bodies parallel with top and bottom of the slide, heads to the left, and equidistant between center of the slide and the edge of a $\frac{3}{4}$ inch round cover glass. Rare specimens should be mounted singly in the center of a $\frac{1}{2}$ inch cover glass. To show variation, as many as 50 medium-sized fleas can be nicely arranged in rows under a $\frac{3}{4}$ inch cover glass.

It is generally not a good practice to mix species of fleas under a cover glass.

Many specialists prefer to mount fleas with heads to the right.

Although students of fleas have labeled slides with india ink on the glass slide ends, with special write-on-glass inks, and write on ground ends, all meticulously prepared slides have a neat paper label pasted on each end. Labels should be affixed at the time the mount is made. In this way the label will dry out thoroughly and make a better inking surface as the balsam dries in the oven. Some key number must be placed upon the label in pencil so that, when labels are hard enough to ink in, the specimens can be referred back to the field log for collection data. Labels should be done in india ink with a crow quill or fine steel pen. Type specimens should be further marked with some colored ink. What data goes on each label is a matter of choice. This collector places common name of host, location of collection, date, personal log number and his name on right hand label; technical name of flea and technical name of host on left hand label. All data on labels should be carefully and neatly printed.

Before affixing labels or labeling upon them, make sure legs of the specimens are up.

When the slide is finished and ready to be stored away it should represent the collector and his skill, and should be something of which he can be justly proud.

CHAPTER 4

THE ANATOMY OF THE FLEA IN RELATION TO ITS TAXONOMY

As in the case of all insects, the body of the flea is divided into head, thorax and abdomen. Each of these regions with its appendages is of taxonomic importance.

Head:

In fleas the head is divided sometimes by a dorsal sulcus, which when present separates the head into anterior and posterior parts with free movement between. This hinging point extends from the antennal grooves over the top of the head. The antennae, one on each side of the head, lie in the antennal groove. The nature of the antenna as well as the groove occasionally has importance in classification. The antennal grooves divide the head into a post-antennal region and a pre-antennal region. The bristles and spines found upon each are of taxonomic importance. The pre-antennal region is divided into a forward frons, and a lower gena. Many fleas bear on their frons a small notch or tubercle which is known as the frontal notch or frontal tubercle. In many cases the lower portion of the gena is modified into a series of black flat teeth which make up the genal comb or ctenidium. In some cases the lower margin of the gena is studded with genal spinelets. In fleas eyes may be absent, or there may be vestiges of varying density, or simple eyes variously shaped and generally jet black. The bristles vary in nature. Generally these taper evenly from the base to the tip, occassionally they are flattened and broadened at the mid-point. In some cases bristles are heavily pigmented and stout, in which case they are called spiniforms. In case there are 2 rows of bristles on the gena the lower row is called the ocular or genal row and the bristle closest to the eye or eye position is called the ocular bristle.

Of the mouth parts, generally only the labial palps are of systematic value, the length and number of segments occasionally appearing in descriptions. In bat fleas, however, the shape of the maxillae is important. These may be truncate or acuminate.

Thorax:

Considerable space has been devoted to the structure of the siphonapteran thorax, but taxonomically the only portion which has any great significance is the pronotum and the absence or presence on it of the pronotal comb. When present this comb varies in the number of the stout black teeth. Sometimes "indistinct pseudospines" are present and in other cases the teeth are short and no more pigmented than the pronotum itself.

Legs:

The arrangement and number of the bristles on the tarsus of the flea leg is of considerable importance in generic delineation. Occasionally the armature on the inner surface of the hind-coxa is important. Now and then other parts of the flea leg are used in taxonomy.

Abdomen:

Three features of the flea abdomen make it of importance taxonomically; the number of rows of bristles on each segment, the presence or absence of, and the number of antepygidial bristles, and the genitalia. Each segment consists of a dorsal tergite and a ventral sternite. The tergite may have its apical border denticulate, or this border may be armed with apical spinelets which may be pseudoctenidia as in some bat fleas, or heavy and tooth-like, or just small pale teeth as in many fleas. The VII tergite usually bears up to 4 stout antepygidial bristles of varying lengths and on each side, but these may be absent. The antepygidial bristles are of taxonomic importance.

Modified Segments:

Frequently as one becomes better acquainted with fleas, he has only to glance at the genitalia to make determinations. The genitalia are then, of great taxonomic importance. In the male the genitalia have evolved, in part, from the ninth abdominal segment, the tergite forming the clasper which consists of a broad plate, ventrally prolonged to form the manubrium and dorsally bears the protuberance called the process of the clasper. Hinged to the clasper is its movable process the finger (exopodite) whose shape, size, and armature are very significant. Shape, structure and armature of the IX sternite are also of taxonomic importance. The penis with its springs and paramere do occasionally have systematic importance. In the female the apical outline of the VII sternite is of tremendous importance. Once in a while the armature of

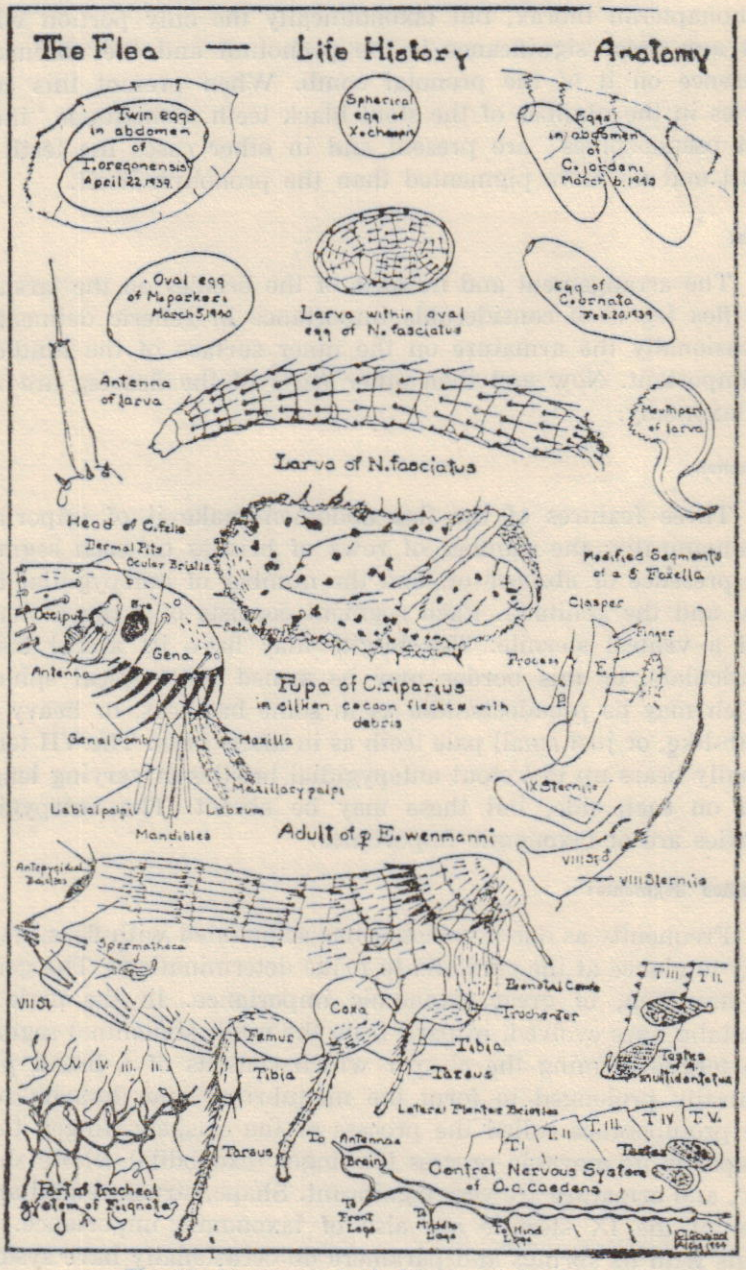

Fig. 11. Anatomy and life History of the flea.

this sternite is important taxonomically. Some investigators have had a tendency to minimize the importance of the shape and structure of the spermatheca (receptaculum seminis), a heavily sclerotized sperm holding body within the abdomen of the female. The organ consists of a body or head and a tail or appendix, the appendix often with a terminal appendage. In most fleas this organ is single, but in a few it is double.

الشاسعة من العالم الممتدة من الخليج العربي شرقا الى المحيط الاطلسي غربا. وقد قابلنا هذه الفكرة بالاستحسان والتشجيع اعتقادا منا بان مثل هذا الكتاب سيضع بين ايدي علماء العرب الناشئين اساسا طيبا تقوم عليه جهود علمية مثمرة في المستقبل . هذا فضلا عما للبراغيث من علاقة وثيقة بنقل مرض الطاعون ، ذلك الوباء الخطير الذي فتك بارواح الكثيرين من سكان الشرق العربي في سنوات خلت .

وتحقيقا لهذا الهدف اجرى المؤلف اتصالات وثيقة بالمتحف الحيواني في ترنك (Tring) بانكلترة حيث توجد اغنى مجموعة من البراغيث في العالم وحيث يعمل اشهر الاختصاصيين بهذه المجموعة من الحشرات . والكتاب الحالي الذي اتشرف بتقديمه الى القراء المختصين هو ثمرة ابحاث مستفيضة مبنية على العمل الحقلي والنماذج المحفوظة والمصادر الاصلية . ونحن بهذه المناسبة نشكر الدكتور هابرد على اهدائه مسودات الكتاب الى متحف التاريخ الطبيعي ، دون قيد او شرط ، لغرض طبعه ونشره .

لقد قسم المؤلف الكتاب الى جزأين الجزء الاول (وهو الذي ننشره الان) هو بمثابة تمهيد للكتاب ، ويتضمن الموضوعات الاتية : (١) لمحة تاريخية عن دراسة البراغيث في العالم العربي مع كشف عام بالانواع التي وجدها الباحثون في مختلف البلاد العربية . (٢) الناحية الطبية لدراسة البراغيث . (٣) الطرق الحقلية والمختبرية لدراسة البراغيث . (٤) التركيب التشريحي للبراغيث وعلاقته بتصنيفها العلمي .

اما الجزء الثاني (وسينشر فيما بعد) فيشكل الجانب العلمي من الموضوع وقد خصصه المؤلف لتصنيف البراغيث الموجودة في العالم العربي ومميزاتها التشريحية الدقيقة مما له اهمية خاصة بالنسبة لعلماء التصنيف الحيواني لا سيما المهتمين منهم بهذه المجموعة من الحشرات . واننا لنعتقد بان هذا القسم من الكتاب سيضع بين ايدي علماء العرب اساسا علميا يمكنهم من التوغل في هذا الحقل وتقديم اضافات جديدة الى معرفتنا عن الحيوانات الموجودة في وطننا العربي العام .

بشير اللوس

متحف التاريخ الطبيعي
بغداد : تشرين الاول ١٩٥٨.

مقدمة الكتاب

بقلم

بشير اللوس

الاستاذ في كلية العلوم ومدير متحف التاريخ الطبيعي

ان مؤلف هذا الكتاب الدكتور سي• اندرسن هابرد ، الاستاذ بجامعة اوريكون الاميركية هو احد مشاهير الاختصاصيين بدراسة البراغيث ، وكان قد جاء الى العراق في كانون الاول ١٩٥٢ على نفقة الفلبرايت بمهمة علمية لمدة ستة اشهر لغرض جمع ودراسة انواع البراغيث في العراق وعلاقتها بمرض الطاعون ، على ان يكون مقره في متحف التاريخ الطبيعي في بغداد ويقوم بابحاثه بالتعاون مع المتحف والاستفادة من التسهيلات الموجودة فيه • وبالرغم من قصر المدة المتيسرة للبحث وهي ٦ اشهر فقط وقلة الوسائل المختبرية ، تمكن الدكتور هابرد بجهوده المتواصلة ان يجمع النماذج من انحاء مختلفة من العراق في سفرات علمية متعددة حصل بنتيجتها على عدد لا بأس به من اللبائن العراقية جمع منها ما تيسر من البراغيث المتطفلة على اجسامها واحتفظ بها لغرض الدراسة والتشخيص •

وقد اظهرت الدراسات العلمية المقارنة ان المجموعة الصغيرة من البراغيث التي حصل عليها المؤلف في العراق تمثل (١٨) نوعا وضربا ، ستة منها كانت جديدة بالنسبة للعلم وقد وصفت وصفا علميا دقيقا وافرد لها المتحف نشرة خاصة صدرت تحت العدد (١١) في سنة ١٩٥٦ • وهذا الكشف الجديد يضفي على الخدمة التي قدمها الدكتور هابرد للمعرفة العلمية اهمية خاصة • ولو ان الظروف سمحت له لاستئناف هذه الدراسة على نفقة حكومته او اية مؤسسة اخرى لفعل ذلك •

ولدى رجوع الدكتور هابرد الى بلاده ، ابدى رغبته في كتابة تقرير مطول (بشكل كتاب) يتضمن نتائج دراساته في العراق ، مع ما توصل العلماء الأخرون الى معرفته عن البراغيث في البلاد العربية الاخرى ، ليخرج من ذلك بصورة شاملة لانواع البراغيث الموجودة في هذه المنطقة

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تأليف

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