Kinds and Distribution of Wild Rodents and Their Ectoparasites in Egypt[1,2]

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The writer made a survey in Egypt during the months of July, August, September, and part of Otcober, 1953, to determine the kinds and distribution of wild rodents and the ectoparasites that they harbor, and to provide some preliminary data on relationship to temperature, humidity, soil and vegetation types. Results of this survey are reported in this paper.

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Regional Geography

Egypt is situated between the parallels of 22° and 32° North latitude. Except for the Nile River Valley the country is barren desert. In Upper Egypt the Nile River Valley is narrow, in Lower Egypt the valley widens as a low-lying deltaic plain.

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[1] The Office of Naval Research, Biology Branch, Department of the Navy, sent the writer to Egypt during the summer of 1953 to investigate the distribution of wild rodents and their ectoparasites and to tabulate data on relationship to climate, soil and vegetation types. These studies were undertaken as part of the investigations on potential or known arthropod vectors of disease in Egypt and their rodent hosts under the direction of Harry H. Hoogstraal, Head, Dept. of Medical Zoology, U. S. Naval Medical Research Unit, No. 3, Cairo, Egypt.

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[3] The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

The Nile Valley is a rift valley formed by the settling of a narrow belt in the neighborhood of a line of fracture on the earth's surface. West of this valley the Western Desert extends to the Libyan border. The Eastern Desert, on the other hand, stretches from this valley to the Red Sea and the Palestine boundary. The portion of the Western Desert along the Mediterranean Sea is called the coastal desert. The low-lying areas, the Faiyum and the Wadi Natroun, in the Western Desert constitute low-lying saline deserts (fig. 1). For the most part the Eastern and Western Deserts consist of outcroppings of granite and gravelly limestone plateaus. To a lesser extent they contain some stretches with sand hills. South of Cairo the deserts rise to an elevation of 1,000 to 1,500 feet above sea level in a series of terraces intersected by ravines.

More detailed descriptions of these regions are given under the heading of *Distribution of the Rodents* where interrelationships are indicated.

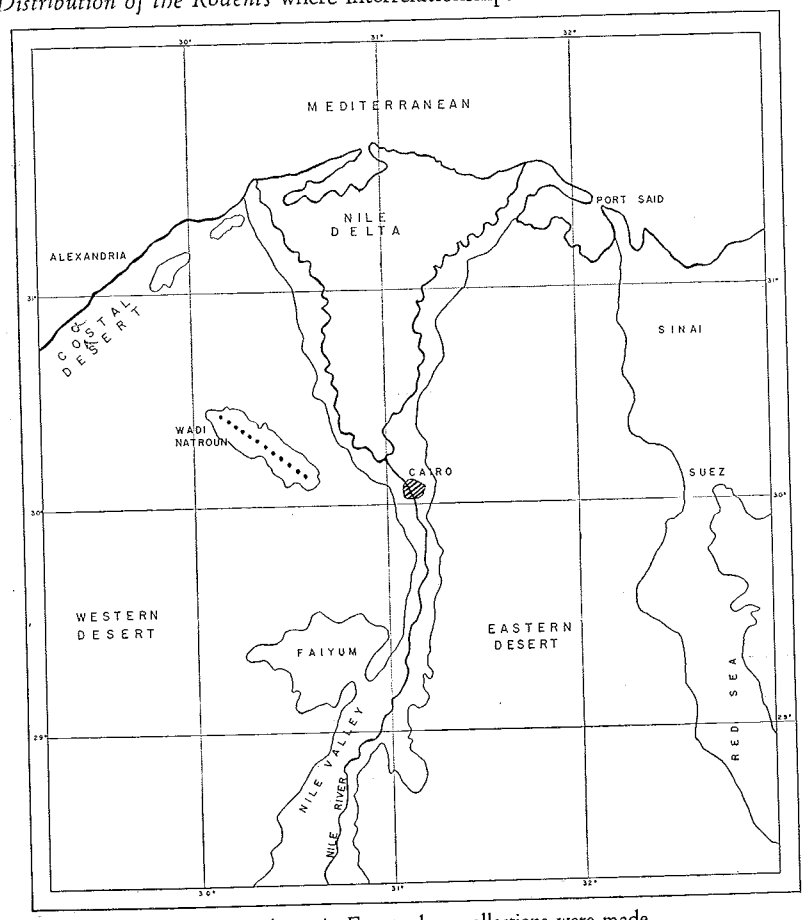

Fig. 1.—Areas in Egypt where collections were made.

CLIMATE

The summer in Egypt is dry and hot, the winter is moister and cooler, the conditions being somewhat more extreme in the desert areas than in the Nile Valley. The annual mean temperature in the Nile Valley is 70° F with monthly means ranging from 56° F in January to 82° F in July. The same annual mean obtains in the low-lying saline desert with the lowest monthly mean 53° F in January and 83° in July and August. The mean annual total precipitation is 22 mm in the former, 17 mm in the latter, with no rain in either region during the period from June to September inclusive. The mean annual relative humidity is 75 percent in the Nile Valley and 58 percent in the low-lying saline deserts.

METHODS

The specimens of rodents in 9 species collected during this survey were captured in their burrows. They were put in separate muslin bags and then placed in glass jars and killed with chloroform. Before they were removed from their burrows, however, temperature and relative humidity readings were taken outside and inside of the burrows with a portable Aminco-Dunmore electric hygrometer.

DISTRIBUTION OF THE RODENTS

Throughout this study attention has been focused primarily on wild rodents and their ectoparasites in the cutlivated Nile Valley and various parts of the barren deserts (fig. 1). The most recent names of the rodents (listed below) have been validated according to Ellerman and Morrison-Scott (1951).

CRICETIDAE

Gerbillus pyramidum Geoffroy (Greater Egyptian Gerbil). Range: Egypt and Algeria.

G. gerbillus Olivier (Lesser Egyptian Gerbil). Range: Egypt, Libya, Algeria to Palestine.

Psammomys obesus Cretzschmar (Fat Sand Rat). Range: Algeria, Tunis, Eastwards into Arabia and Palestine.

Meriones shawi Duverney (Shaw's Jird). Range: Morocco, Algeria, Tunis, Libya, Egypt, Palestine.

M. crassus Sundevall (Sundevall's Jird). Range: Sinai, Arabia, Egypt, Sudan, Algeria.

MURIDAE

Arvicanthis niloticus Desmarest (Kusu Rat). Range: Egypt.

Nesokia indica Gray and Hardwicke (Bandicoot Rat). Range: Egypt, South Waziristan, Punjab, Sind, Delhi and Fategarh in the United Provinces, Rajputana, Kumaon, Iraq, Kabul in Afghanistan.

DIPODIDAE

Jaculus orientalis Erxleben (Greater Egyptian Jerboa). Range: Egypt, Libya, Tunis, Algeria.

J. jaculus Linnaeus (Lesser Egyptian Jerboa). Range: Egypt. The typical race has also been reported from Palestine.

CULTIVATED NILE VALLEY

The kusu rat, *Arvicanthis* niloticus, is restricted to the cultivated Nile Valley (fig. 1). Its burrows were found in various habitats throughout this densely inhabited area. Some were constructed on the side of steep banks of hard sun-dried alluvial mud near irrigation canals. Many of these banks were thickly populated with *Eragrostis cynosuriodes* (Retz.) Roem. et Schult. The grassy covering of other banks usually consisted of *Phragmites communis* Trin. This grass also formed a low bushy covering in fallow areas and fair stands in brackish water. The most profuse growth observed, however, was on canal banks. Some banks were sparsely fringed with *Ricinus communis L.*

In native villages the burrows of *Arvicanthis niloticus* were constructed for the most part at the base of date palms. On one occasion 7 of these kusu rats were captured in a burrow beneath a pile of limestone rocks on a flat barren area adjacent to an irrigated cotton field.

Burrows of *Arvicanthis niloticus* ranged in length from 3 to 10 feet and from 1 to 2½ feet in depth. Those near irrigation canals had a relative humidity ranging from 54 to 78 percent and temperatures from 68° to 94° F (August 1953). Humidity ranges outside of these burrows (44 to 66 percent) were lower than those measured within; the outside temperatures were higher (90° to 106° F).

The humidities in the burrows at the base of date palms were high during the early morning hours but decreased towards noon. The inside temperatures showed a gradual increase from 8:30 A. M. to 11:30 A. M. but dropped 2 degrees at 1 P. M. Temperatures outside the burrows were consistently higher than those within the burrows while the outside humidities were correspondingly lower.

The temperature of the burrow constructed beneath the limestone rocks was 84° F, the relative humidity 66 percent. Temperature of the air outside was 90° F, the relative humidity 56.5 percent (5 August 1953 at 9:20 A. M.).

In areas of the cultivated Nile Valley where flat alluvial strips are covered with wind-blown sand, vegetational types gradually change into desert conditions. Plants indicating transitions in conditions from the cultivated Nile Valley to desert are: *Calligonum comosum* L'Herit, *Stipa tortilis* Asch., and *Tamarix arborea* Bunge.

Habitats of the other rodents were found in various parts of the Eastern and Western Deserts (fig. 1). The Eastern Desert is strikingly different from the Western Desert in its relief, vegetation, and geology (Davis, 1953). In certain places the Eastern Desert is dissected by wadis. After intervals of several years these wadis are subject to sporadic torrents that may destroy the vegetation and wash away the soil (Kassas, 1952). This may explain the rather complex pattern of the plant cover in these habitats. Important species were *Zilla spinosa* (Forsk.) Prantl, *Panicum turgidum* Forsk., *Farsetia aegyptiaca* Turra Farset, and *Heliotropium luteum* Poir. Water tends to fill the wadis for short periods only after very heavy rainfall in the mountains. Ten millimeters of rain is enough to cause flooding (Davis, 1953).

The Western Desert (fig. 1) consists chiefly of barren gravelly plains upon which may be seen occasional barren sand hills. The area is devoid of

vegetation where wide expanses of gravel occur. The highest air temperature recorded in the barren regions of the Western Desert for July was 120° F at 10:30 A. M., 22 July 1953. The lowest temperature was 68° F at 7:30 A. M., 30 July 1953. The highest relative humidity measured in the atmosphere was 54 percent at 8:30 A. M., 29 July 1953 and the lowest, 16.8 percent at 12:30 P. M., 31 July 1953. The highest burrow temperature recorded was 108° F at noon 17 July 1953 in a burrow occupied by *Gerbillus gerbillus* and 108° F at 12:30 P. M., 31 July 1953 in a burrow inhabited by *G. pyramidum*. The highest relative humidity (75.5 percent) was measured at 9:00 A. M., 29 July 1953 in a burrow inhabited by *G. pyramidum*. The lowest relative humidity (25.5 percent) was recorded at noon 17 July 1953 in a burrow inhabited by *G. gerbillus*. It can be seen that a desert rodent would pass through quite a range of climatological conditions if it entered or left its burrow during the day. For example, on 27 July 1953 at 10:45 A. M., the air temperature on the barren areas of the deserts was 102° F; ground temperature, 115° F; and the burrow temperature, 90° F. During this period the relative humidity of the atmosphere was 34 percent; at ground level, 33.5 percent; and the burrow, 55 percent. At 11:20 A. M. on the same day the air temperature was 100° F; the ground temperature, 120° F; and the burrow temperature, 98° F. During this same period the relative humidity of the atmosphere was 35 percent; at ground level, 31.5 percent; and the burrow, 46.5 percent.

At any given time variations in temperature and relative humidity could be recorded in closely adjacent places. The effect of these variations on the activity of the tenebrionid beetle, *Prionotheca coronata* Ol., attracted our attention. These insects, commonly seen on the surface in the barren regions of the deserts, would cease their activities during the hottest part of the day and either dig into the sand or enter small burrows previously constructed. The reactions of these insects indicated that temperature and relative humidity also played an important part in controlling their diurnal activities.

Burrows constructed by *Gerbillus gerbillus* and *G. pyramidium* were somewhat similar in structure although the two species were never found together. These burrows ranged from 3 to 12 feet in length and from 1 to 3½ feet in depth; some were fairly straight and others were slightly curved or U-shaped. All of them had their entrances plugged with sand.

The majority of the burrows of *Gerbillus gerbillus* were found at the base of hillocks formed by wind-blown sand. These hillocks were held in place by two species of grasses, *Aristida scoparia* and *Panicum turgidum*, that appeared to be good sand-binders. These grasses are characteristic of the sandy plains. A few of the burrows were located on the side of shallow sand-filled wadis; some were also constructed on flat sandy plains on which occurred sparse tufts of *Panicum turgidum* and *Heliotropium luteum*. Only a small number of burrows made by *Gerbillus pyramidum* were located. They were found in areas similar to those of *G. gerbillus*. Sandy places inhabited by these two gerbils furnished a loose substratum in which burrows could be easily dug.

Plugged burrows of *Jaculus jaculus* were constructed in the hard clayey-sand

slopes in barren areas of the deserts. These slopes descended gradually as much as 250 feet and were devoid of vegetation. Ground temperatures on these barren declivities ranged from 78° to 104° F during the first two weeks in September, 1953, when they were examined for rodent burrows. Atmospheric humidity ranged from 33.5 to 48 percent. Within the burrows the temperatures varied from 80° to 100° F and the relative humidity ranged from 35.5 to 49.5 percent. The depth of some of these burrows was much greater than those of any other species of rodents investigated in this survey. They extended from 1 to 5½ feet below the surface and were 2 to 13 feet long. Considerable time was utilized digging at great depths in this hard soil.

Entrances to burrows made by *Meriones crassus* remained opened. Usually there were several emergency exits which the rodent invariably used in its attempt to escape as the diggers removed soil from the corridors. These well-ventilated burrows varied in length from 3 to 15 feet and in depth from 1 to 3½ feet. During the last week in September, 1953, burrow temperatures ranged from 77° to 97° F and their relative humidity from 24 to 78 percent. Air temperatures during this period varied from 78° to 103° F; the relative humidity from 21.5 to 77 percent.

Many burrows of *Meriones crassus* were found on the sides of shallow sand-filled wadis in the vicinity of the Cairo-Suez road. The edges of these wadis were fringed with bushes of *Lasiurus hirsutus*. Hard clayey-sand banks along the Cairo-Suez road were perforated with the open burrows of this rodent and bordered with bushes of *Haloxylon salicornicum*. In areas formerly occupied by army barracks this rodent had constructed its burrows in the hard clayey-sand beneath empty tins of various sizes and beneath broken bottles and old automobile tires. A sparse growth of *Panicum turgidum* had established itself in the midst of this detritus.

The present land surfaces of the coastal portion of the Western Desert consist chiefly of oolitic limestone (Ball 1939). The coastal region under observation during this survey comprises the area around Burg-el-Arab in the Mariut district about 25 miles west of Alexandria (fig. 1). A ridge of oolitic limestone parallels this part of the coastline for long distances. Another ridge, at a distance inland, runs parallel with that on the coast. A belt of white sand, together with sand hills of various sizes, also extends along the shore. Small white hillocks of wind-blown sand that fringed the shore-line supported communities of *Calamagrostis arenaria* (L.) and *Pancratium maritimum* L.

The area between the coastal and inland ridges of limestone is interrupted by sandy depressions that form salt marshes with characteristic halophytic communities. Typical marginal plants of these saline lagoons are *Suaeda fruticosa* Forsk., and *Salicornia fruticosa* (L.). The absence of halophytes in the central part of these salt beds is due to excessive accumulation of salt (Tadros, 1953).

A semi-desert lying near the marshes was dotted with hillocks and carpeted with perennial shrubs, *Limoniastrum monopetalum* Boiss. and *Arthrocnemum glaucum* (Del.) Unger-Sternb. Open burrows of *Psammomys obesus* were found at the base of these hillocks in the flat loamy soil. These burrows ranged from 8 to 12 feet in length and from 1 to 2 feet in depth. Some of

them presented 3 to 5 entrances and were provided with an assemblage of lateral corridors. During the middle of August, 1953, when these rodents were captured, the temperature in their burrows varied from 80° to 92° F while the relative humidity varied from 36.5 to 53.5 percent.

Plugged burrows of *Jaculus orientalis* and open burrows of *Meriones shawi* were located on barren isolated sand slopes approximately 5 miles from the Mediterranean Sea. Intervening sand flats were heavily furrowed and covered with fragments of limestone. The burrows of *Jaculus orientalis* were 5 to 10 feet long and 2½ to 3 feet deep. Their temperatures ranged from 82° to 94° F; their relative humidity varied from 43 to 72 percent. Air temperatures during this period fluctuated between 86° and 96° F; the relative humidity from 36 to 59 percent.

Only two burrows of *Meriones shawi* were found. They were 10 feet long and 2½ feet deep. On 14 August 1953 when one of these rodents was captured the burrow temperature was 88° F and the relative humidity, 42 percent. The following day the temperature in a burrow inhabited by another specimen of *Meriones shawi* was 90° F and the relative humidity, 58.5 percent at 3:00 P. M. The air temperature was 94° F, the relative humidity, 39.5 percent.

Because of its proximity to the Mediterranean Sea the coastal area of the Western Desert receives more rain than any other part of Egypt. Most of the rain occurs during the winter months. The humidities in this area cause a great amount of dew precipitation which probably has an important influence on increasing the moisture content of the soil. This dew is of great importance in the water economy of perennials and summer annuals. It is perhaps the most obvious source of water for many small mammals though a more constant source is the vegetation (Buxton, 1923). From the point of view of climate the coastal region is more Mediterranean than anything else.

The Faiyum, a low-lying saline area in the Western Desert is about 50 miles southwest of Cairo (fig. 1). It lies from 100 to 250 feet below sea level. The lowest part of this region is occupied by a brackish lake—Birket Quarum—whose axis extends 25 miles and whose breadth is 5 miles at the widest point. Lacustrine deposits and rich alluvial soil in the Faiyum depression were laid down in Pleistocene and Recent geological periods (Ball, 1939). The soil layers are rich in chlorides and sulphates which are brought to or near the surface by the action of infiltrating water coming from high-level irrigation canals. Only a small amount of sand is mixed with this soil.

Plugged, damp burrows of the bandicoot rat, *Nesokia indica,* were constructed along the banks of the irrigation canals that intersected the surrounding terrain. *Alhagi maurorum* Medic., a thorny, deep rooted, much branched spinose shrub grows here in pure dense stands; it is an indicator of saline soils.

The burrows of the bandicoot rat were long, varying from 8 to 30 feet. Their depth ranged from 1½ to 2 feet. The corridors were a complicated labyrinthine network honey-combed with pockets. During the last week in August, 1953, the humidity in most of these damp burrows was high, ranging from 54.5 to 75 percent. A few, however, varied from 43 to 53 percent. Burrow temperatures fluctuated between 84° to 104° F. Air temperatures

ranged from 86° to 106° F while the humidity varied from 29.5 to 47 percent.

The valley of the Wadi Natroun, another low-lying saline region in the Western Desert, represents a new distributional record for *Nesokia indica*. This valley, 50 miles northwest of Cairo, is approximately 20 miles long and nowhere more than 5 miles wide (fig. 1). There is a chain of 12 small lakes in the valley which contain natural deposits of carbonate of soda and varying quantities of sodium chloride. The surface sand for some distance around the lakes is highly saline. The layer of clay beneath this sandy surface is also strongly impregnated with sodium chloride.

Stands of *Alhagi maurorum* were growing here as were similar species in the Faiyum. Burrows of the bandicoot rat were similar in structure to those examined in the Faiyum but were not as damp. Climatological readings taken in them during the first week in October, 1953, showed that their temperatures varied from 96° to 98° F and their relative humidity from 49 to 50 percent. Air temperatures during this period ranged from 98° to 101° F and and the relative humidity from 44 to 48 percent.

ECTOPARASITES

A total of 178 rodents (including 9 species) was collected during this study. Of this number 90 (50.5 percent) harbored ectoparasites; 88 or 49.4 percent were not parasitized. The total number of parasites collected from the rodent hosts was 1149. This number included 146 ticks; 365 fleas; 252 mites; and 386 lice. The average number of parasites per rat, however, is indicated by the parasite index in the following data.

	Number with ectoparasites	Number of ectoparasites	Parasite index
Arvicanthis niloticus	20	516	25.5
Gerbillus gerbillus	25	197	7.8
G. pyramidum	7	65	9.2
Jaculus jaculus	11	74	6.7
Meriones crassus	16	240	15.0
Jaculus orientalis	3	19	6.3
Meriones shawi	2	12	6.0
Psammomys obesus	1	2	2.0
Nesokia indica	5	15	3.0

TICKS

A total of 116 specimens of *Hyalomma* sp. (46 larvae; 46 nymphs; 10♂♂; 14♀♀ (table 1) was recovered from 20 rodents. There were 111 or 95.6 percent which were obtained from the barren regions of the deserts. Of this number (111) 47 or 40 percent were recovered from 9 specimens of *Gerbillus gerbillus;* 33 or 28.4 percent from 3 specimens of *G. pyramidum;* 14 or 12 percent from 5 specimens of *Jaculus jaculus;* and 17 or 14.6 percent from 1 specimen of *Meriones crassus*. From the coastal area of the Western Desert 3 or 2.5 percent of these ticks were obtained from 1 specimen of *Meriones shawi* and 2 or 1.7 percent from 1 specimen of the fat sand rat, *Psammomys obesus*. The majority of these ticks (80) were found on 9 specimens of *Gerbillus gerbillus* and 3 specimens of *G. pyramidum*. The largest

number found on a single host, 17, was recovered from host No. 184, *Meriones crassus* (13 larvae; 4 nymphs). A total of 18 specimens of *Hyalomma dromedarii* Koch (13 larvae; 4 nymphs; 1 ♂) was removed from 6 rodents. Most of these ticks, 15 or 83 percent, were found in the Wadi Natroun on the bandicoot rat, *Nesokia indica;* 3 or 17 percent were recovered from a single jird, *Meriones crassus,* in barren desert regions. In portions of the barren deserts 2 larvae of *Rhipicephalus* sp. were found on *Gerbillus pyramidum.* In the cultivated Nile Valley 3 nymphs of *Hyalomma leachii* (Aud.) were obtained from the kusu rat, *Arvicanthis niloticus.* A total of 7 specimens of *Ornithodorus erraticus* Lucas was found on 2 other kusu rats (1 host had 4 larvae and the other host had 3 nymphs).

FLEAS

A total of 139 specimens of *Xenopsylla cheopis* (Roths.) (73 ♂ ♂ and 63 ♀♀) was recovered from 21 rodents (table 1). Most of the fleas (93 or

TABLE 1.—Kinds and number of ticks and fleas collected on 9 species of rodents.

Hosts	No. of ticks collected	Hyalomma sp.	Ornithodorus erraticus	Rhipicephalus sp.	Haemaphysalis leachii	Hyalomma dromedarii
Arvicanthis niloticus	10	0	7	0	3	0
Gerbillus gerbillus	47	47	0	0	0	0
G. pyramidum	35	33	0	2	0	0
Jaculus jaculus	14	14	0	0	0	0
Meriones crassus	20	17	0	0	0	3
Jaculus orientalis	0	0	0	0	0	0
Meriones shawi	3	3	0	0	0	0
Psammomys obesus	2	2	0	0	0	0
Nesokia indica	15	0	0	0	0	15
Total	146	116	7	2	3	18

	No. of fleas collected	Ctenocephalides felis strongylus	Echidnophaga gallinacea	Mesopsylla tuschkan n. sp.	Synosternus cleopatrae	Synosternus pallidus	Xenopsylla cheopis	Xenopsylla conformis mycerini
Arvicanthis niloticus	99	0	6	0	0	0	93	0
Gerbillus gerbillus	39	2	0	0	36	0	1	0
G. pyramidum	11	0	0	0	11	0	0	0
Jaculus jaculus	37	0	0	0	1	0	36	0
Meriones crassus	169	0	0	0	20	15	9	125
Jaculus orientalis	7	0	0	7	0	0	0	0
Meriones shawi	3	0	0	0	3	0	0	0
Psammomys obesus	0	0	0	0	0	0	0	0
Nesokia indica	0	0	0	0	0	0	0	0
Total	365	2	6	7	71	15	139	125

66.1 percent) were taken from rodents in barren places of the deserts. The majority of them (93 or 66.1 percent) were recovered from 9 specimens of *Arvicanthis niloticus* in the cultivated Nile Valley. In barren sandy areas 36 or 25.8 percent were taken from 7 specimens of *Jaculus jaculus;* 9 or 6.5 percent from 4 specimens of *Meriones crassus;* and 1 was from *Gerbillus gerbillus.* A total of 125 specimens of *Xenopsylla conformis mycerini* (Roths.) (49 ♂♂ and 76 ♀♀) was obtained from 9 specimens of *Meriones crassus* in barren regions of the deserts. These fleas were not found on any of the other rodent hosts nor were they taken in any of the other areas investigated. The largest number of these ectoparasites on a single host was 33 (9 ♂♂ and 24 ♀♀); 2 males, on the other hand, represented the smallest number from one host. There were 71 specimens of *Synosternus cleopatrae* (Roths.) (43 ♂♂ and 28 ♀♀) which were recovered from 18 rodents. A total of 68 or 95.6 percent was found on rodents in barren desert areas. From these areas 36 of these fleas (50 percent) were recovered from 8 specimens of *Gerbillus gerbillus;* 11 or 15.5 percent from 2 specimens of *Gerbillus pyramidum;* 20 or 28.1 percent from 6 specimens of *Meriones crassus;* and 1 or 1.4 percent from 1 specimen of *Jaculus jaculus.* Only 3 or 4.2 percent were found on 1 specimen of *Meriones shawi* in the coastal region of the Western Desert. The predominant hosts harboring *Synosternus cleopatrae* were *Gerbillus gerbillus* (8 specimens) and *Meriones crassus* (6 specimens). Only 15 specimens of *Synosternus pallidus* (Tasch.) were found (2 ♂♂ and 13 ♀♀). They were taken from 4 jirds, *Meriones crassus,* in the barren parts of the desert. A total of 6 specimens of *Echidnophaga gallinacea* (West.) (3 ♂♂ and 3 ♀♀) was recovered from 2 kusu rats, *Arvicanthis niloticus,* in the cultivated Nile Valley. One of these rodents harbored 3 ♂♂; the other one had 3 ♀♀. The coastal region of the Western Desert yielded 7 specimens (4 ♂♂ and 3 ♀♀) of *Mesopysylla tuschkan* n. sp. They were recovered from a single jerboa, *Jaculus orientalis.* These fleas were not found in any of the other areas under investigation. Only 2 specimens of *Ctenocephalides felis strongylus* (Jordan) were found. Both of them were females and were recovered from one host, *Gerbillus gerbillus,* in barren desert areas.

MITES

A total of 252 mites was recovered from 7 species of rodents (table 2). Of this number 94 specimens of *Bdellonyssus bacoti* (Hirst) (22 ♂♂ and 72 nymphs) were collected from 15 rodent hosts. A total of 50 or 53.1 percent of these mites was found on 6 rodents in the cultivated Nile Valley; 18 or 19.1 percent were taken from 4 rodents in the coastal region of the Western Desert; and 26 or 27.6 percent were taken from 5 rodents in barren areas of the deserts. From barren desert areas 4 or 4.2 percent of *Bdellonyssus bacoti* were recovered from 1 specimen of *Gerbillus pyramidum;* 17 or 18 percent from 2 specimens of *G. gerbillus;* and 5 or 5.3 percent from *Jaculus jaculus.* In the cultivated Nile Valley a total of 50 or 53.1 percent of these mites was obtained from 6 specimens of *Arvicanthis niloticus.* From the coastal region of the Western Desert 6 or 6.3 percent of *Bdellonyssus bacoti* were found on the jird, *Meriones shawi* and 12 or 12.7 percent were obtained from the jerboa, *Jaculus orientalis.* Host No. 60, *Arvicanthis niloticus,* was

parasitized by 20 of these mites (3♀♀ and 17 nymphs); host No. 148, also a kusu rat, harbored 21 (3♀♀ and 18 nymphs). Approximately three times as many nymphs as female mites were present on the 15 rodent hosts (22♀♀; 72 nymphs). No males were found. A total of 102 mites representing new genera and species was found on 4 species of rodents. Of this number 82 *Ng. A, N. sp. D* were recovered from 15 rodents in barren portions of the deserts. There were 19 or 23.1 percent of these mites which were removed from 5 specimens of *Gerbillus gerbillus;* 3 or 3.6 percent from 2 specimens of *Gerbillus pyramidum;* 1 or 1.2 percent from 1 specimen of *Jaculus jaculus;* and 59 or 71.9 percent from 7 specimens of *Meriones crassus.* Host No. 92, *Meriones crassus,* harbored 19 of these ectoparasites (7♀♀ and 12 nymphs); host No. 182, also a specimen of *Meriones crassus,* had 18 (6♀♀ and 12 nymphs). Only 1 male was found. The number of nymphs obtained, 47, was much greater than that of the adults (1♂ and 34♀♀). There were 14 other mites (2♂♂; 8♀♀; 4 nymphs) collected in the barren regions of the deserts that also represented new genera and species (*Ng. A, N. sp. C*). A total of 12 or 85.7 percent of these parasites was obtained from 3 specimens of *Gerbillus gerbillus;* 2 of them, or 14.2 percent, were found on 1 specimen of *G. pyramidum.* One female specimen, *Ng. A, N. sp. B,* was found on host No. 47, *G. pyramidum,* in a barren desert area. Another new genus and species, *Ng. A, N. sp. E,* found on 2 rodents in the same area, consisted of a nymph recovered from host No. 86, *Meriones crassus,* and 1 female and 3 nymphs removed from host No. 166, *Jaculus jaculus.* A total of 17 specimens of *Androlaelaps marshalli* Berlese (4♂♂; 11♀♀; 2 nymphs) was recovered from 4 gerbils, *Gerbillus gerbillus,* in barren regions of the deserts. There were 38 specimens of *Hirstionyssus* n. sp. (9♂♂ and 29♀♀) which were also removed from 4 of these gerbils in similar barren areas. Host No. 20 harbored 12 or 31.5 percent of these mites; Host No. 21 had 16 or 42.1 percent; host No. 28 had 9 or 23.6 percent; and host No. 39 had 1 or 2.6 percent. A single female specimen of *Haemolaelaps murinus* Berlese was found on *Arvicanthis niloticus,* host No. 73, in the cultivated Nile Valley.

LICE

There was a total of 386 lice collected from 4 species of rodents (table 2). Of this number 379 (53♂♂; 47♀♀; 279 nymphs) were *Polyplax abyssinica* Ferris and 7 (3♂♂ and 4 nymphs) were *P. gerbilli* Ferris. In the cultivated Nile Valley 12 kusu rats, *Arvicanthis niloticus,* harbored 356 specimens (93.9 percent) of *Polyplax abyssinica* (50♂♂; 42♀♀; 264 nymphs). This was an average of 29.7 lice per rat. In the barren regions of the deserts 8 or 2.1 percent of these lice were found on *Gerbillus gerbillus;* 2 or 0.5 percent on *G. pyramidum;* and 13 or 3.4 percent on *Jaculus jaculus.* In the same regions a total of 3 specimens of *Polyplax gerbilli* (1♂ and 2 nymphs) was found on a gerbil, *Gerbillus pyramidum* and 4 (2♂♂ and 2 nymphs) were found on another specimen of *G. pyramidum.*

NESTS

A total of 87 rodent nests was examined for ectoparasites. There were 7 with 120 ticks (5 larvae; 90 nymphs; 15♂♂; 10♀♀). This number included

TABLE 2.—Kinds and number of mites and lice collected on 9 species of rodents.

Hosts	No. of Mites collected	Androlaelaps marshalli	Bdellonyssus bacoti	Haemolaelaps murinus	Hirstionyssus n. sp.	New genera and species	No. of Lice collected	Polyplax abyssinica	Polyplax gerbilli
Arvicanthis niloticus	51	0	50	1	0	0	356	356	0
Gerbillus gerbillus	103	17	17	0	38	31	8	8	0
G. pyramidum	10	0	4	0	0	6	9	2	7
Jaculus jaculus	10	0	5	0	0	5	13	13	0
Meriones crassus	60	0	0	0	0	60	0	0	0
Jaculus orientalis	12	0	12	0	0	0	0	0	0
Meriones shawi	6	0	6	0	0	0	0	0	0
Psammomys obesus	0	0	0	0	0	0	0	0	0
Nesokia indica	0	0	0	0	0	0	0	0	0
Total	252	17	94	1	38	102	386	379	7

95 specimens of the argasid tick, *Ornithodorus erraticus,* (5 larvae; 65 nymphs; 15 ♂♂; 10 ♀♀) which were collected from 4 nests in empty burrows in the cultivated Nile Valley. The same area yielded 25 nymphs of the ixodid tick, *Haemaphysalis leachii;* these were found in a single nest also removed from an empty burrow.

A total of 40 fleas, *Xenopsylla cheopis,* (Roths.) was found in 7 nests (19 ♂♂ and 21 ♀♀). Of this number 38 (18 ♂♂ and 20 ♀♀) were collected from 6 nests of the kusu rat, *Arvicanthis niloticus,* in the cultivated Nile Valley; 2 were found in a nest in an empty burrow in a barren area of the desert. (There were 163 undetermined flea larvae recovered from 5 nests of the kusu rat and 33 from 2 nests in empty burrows).

A total of 284 parasitic mites (11 ♂♂; 100 ♀♀; 173 nymphs) was collected from 22 nests. One male specimen, *Androlaelaps marshalli,* was found in an unoccupied nest in a barren portion of the desert. Of the 169 specimens of *Bdellonyssus bacoti* recovered from 12 nests (23 ♂♂ and 146 nymphs), 14 (7 ♂♂ and 7 nymphs) were found in 4 nests occupied by *Arvicanthis niloticus* in the cultivated Nile Valley. The remainder, 155, consisting of 16 ♀♀ and 179 nymphs were found in 8 nests. A total of 11 ♀♀ and 93 nymphs of *B. bacoti* was found in 5 nests in empty burrows in the cultivated Nile Valley; 5 ♀♀ and 46 nymphs were found in 3 nests in empty burrows in barren regions of the deserts. One female specimen of *Haemolaelaps* n. sp. was found in a nest of *Arvicanthis niloticus* while 8 of them (2 ♂♂ and 6 nymphs) were taken from empty burrows. A total of 25 specimens of *Haemolaelaps inops* var. *zulu* Berlese (2 ♂♂; 18 ♀♀; 5 nymphs) was collected from 3 nests of *Arvicanthis niloticus* in the cultivated Nile Valley; the remaining 50 (3 ♂♂; 32 ♀♀; 15 nymphs) were found in 2 nests in empty burrows. Of the 13 new genera and species (1 ♂; 11 ♀♀; 1 nymph), 3 specimens were found in a single nest of *Arvicanthis niloticus* in the cultivated Nile Valley; 9 were in a single nest of *Gerbillus gerbillus* in a barren area of the desert; and 1 specimen was recovered from a single nest in an empty

burrow in a similar region. The 17 specimens of *Steatonyssus viator* (Hirst) (2♂♂ and 15♀♀) were also found in a single nest in an unoccupied burrow in a barren portion of the desert. Free-living oribatid and phytoseid mites (559 specimens) were predominant in nests found in empty burrows.

A total of 12 lice (4♂♂; 10♀; 7 nymphs) was also recovered from 3 nests in barren areas of the deserts. One nest of *Gerbillus gerbillus* had 3 specimens of *Polyplax abyssinica* (1♂ and 2 nymphs); another nest of the same species of rodent had 5 specimens of *P. abyssinica* (2♂♂; 1♀; 2 nymphs). A single nest of *Gerbillus pyramidum* had 4 specimens of *Polyplax gerbilli* (2♂♂ and 2 nymphs).

Of the 87 nests examined for ticks, fleas, lice, and mites, 40 or 46.4 percent (exclusive of the undetermined flea larvae) yielded 1015 specimens (456 ectoparasites and 559 free-living mites).

Specimens of the following arthropods were also found in nests removed from occupied and unoccupied rodent burrows. Their occurrence was probably incidental.

COLEOPTERA. Dermestidae: *Attagenus* sp. Ptinidae: *Gibbium psylloides* (Czemp.) in nest of *Arvicanthis niloticus*. Cucujidae: *Laemophloeus* sp. Staphylinidae: *Tachyporus* sp. in nest of *Arvicanthis niloticus; Trogophlaeus* sp. in nest of *Arvicanthis niloticus*. Coccinellidae: *Rhizobius chrysomeloides* (Hbst.) in nest of *Arvicanthis niloticus*. Curculionidae: *Sitona* sp. nr. *crinitus* Hbst. in nest of *Meriones crassus*. Tenebrionidae: *Blaps* sp.; *Eurycaulus hirsutus* Mill.; *Platynosum paulinae* Muls. Histeridae: *Saprinus* sp. Nitidulidae: *Carpophilus* sp. Lathridiidae: *Holoparamecus kunzei* Aube; *Migneauxia crassiuscula* (Aube).

HYMENOPTERA. Formicidae in nest of *Arvicanthis niloticus*: *Tetramorium simillium* (F. Sm.); *Pheidole* sp.; *Cardicondyla* sp.; *Solenopsis* sp.; *Monomorium* sp.

CORRODENTIA. Atropidae: *Lepinotus* n. sp.

DIPTERA. Muscidae: *Fannia* sp. (Larvae) in nest of *Psammomys obesus*. Drosophilidae: *Drosophila melanogaster* Mg. Sphaeroceridae: *Leptocerca* sp. in nest of *Meriones shawi*.

LEPIDOPTERA. Pyralididae: *Aglossa* sp. in nest of *Psammomys obesus*. Cosmopterygidae: *Pyroderces* sp. Tineidae: *Tinea* sp.

EMBIOPTERA. In nest of *Arvicanthis niloticus*. *Oligtoma nigra* Hag.; *Embyia savigny* Westwood; *Haploembyia solieri* Westwood.

THYSANURA. In nest of *Meriones crassus*. *Ctenolepisma targionii* Grassi & Rovelli; *C. michaelseni* Escherich.

DISCUSSION

Climatic factors that exist within a burrow are much different from those that prevail outside. Burrow humidity was always higher than that of the atmosphere outside while atmospheric temperature was always higher outside than that within the burrow.

The species composition of ticks on the several rodents did not vary greatly. In the barren and coastal regions of the deserts *Hyalomma* sp. was predominant on rodent hosts; in the Wadi Natroun, *Hyalomma dromedarii;* and in the cultivated Nile Valley, *Ornithodorus erraticus* and *Haemaphysalis leachii*. These ticks did not exhibit host-specificity, *Hyalomma* sp. having been obtained from 6 species of rodents, and, a total of 18 *H. dromedarii* from 2 species of rodents. The remainder were too few in number to be considered from the point of view of host-specificity. Of the 146 ticks recovered from their hosts,

larvae and nymphs (65 and 56 respectively) were taken more frequently than mature specimens (11 ♂♂ and 14♀♀).

Ioff (1941) states that the number of female fleas is almost always higher than males in collections recovered from animals. Of the 365 fleas collected during this study, however, the sex ratios were approximately equal, 174 ♂♂ and 191 ♀♀. With the exception of 10 specimens these fleas were restricted to the cultivated Nile Valley and barren desert areas, thereby occupying comparatively large areas of territory populated by their hosts. The cosmopolitan rat flea, *Xenopsylla cheopis,* was predominant but not highly host-specific. It was found on 4 species of rodents in the cultivated Nile Valley and barren desert regions. Most of them (93) were recovered from 9 specimens of *Arvicanthis niloticus* and had a *cheopis* index of 10.3 per rat. *Xenopsylla conformis mycerini* was the only flea found in large numbers (125) that showed specificity of host selection. It was found only on Sundevall's jird, *Meriones crassus,* and had a parasite index of 13.8 per rat. Opportunity for its transfer to other species of rodents, on the other hand, may have been lacking or there may have been physiological restrictions. The third largest group of fleas collected, *Synosternus cleopatrae,* did not exhibit any evidence of host specificity having been recovered from 5 host species. The flea fauna did not show a considerable range in specificity of host selection. Multiple infestations, however, were observed on 10 hosts. A total of 9 of these hosts were infested by 2 species of fleas; host No. 189, *Meriones crassus,* was infested by 3 species. The microclimate of the habitats had temperatures that ranged from 77° to 108° F and relatively high humidities, factors more or less favorable for the multiplication of fleas. Ioff (*loc. cit.*) has indicated that for adult fleas 70 to 100 percent humidity may be considered favorable.

Of the 252 mites found *Bdellonyssus bacoti* was the most abundant and also the most widely distributed having been found in the cultivated Nile Valley, the barren areas of the deserts, and the Mediterranean coast. It occurred on 6 different species of rodents and had a *bacoti* index of 6.6 per rat. Although in most parasitic mites the form most abundantly found on the host is the female, we found more nymphal forms than females of *B. bacoti* on the rodents. There were no males. The apparently rare species was *Haemolaelaps murinus,* only a single specimen having been found. Of the 4 new genera and species of mites, the most abundant was *Ng A, n. sp. D* which occurred on 4 species of rodents in barren desert regions and which had a parasite index of 5.5 per rat. *Hirstionyssus* sp. was found in similar areas on 4 gerbils and had a parasite index of 9.5 mites per rat. There was no marked host-specificity in the mite fauna. As a group the gerbils were more heavily infested with them than were the other groups of rodents.

The lice exhibited a rather high degree of host-specificity as compared with the other ectoparasites. Of the 386 lice collected, 356 were found on *Arvicanthis niloticus* in the cultivated Nile Valley. Only 30 lice were found on 3 species of rodents in barren desert regions. Hopkins (1949) considers the appearance of *Polyplax* on rodents, and also on shrews, well authenticated instances of a definite and permanent establishment of a parasite genus on two widely separated groups of hosts. Since *Polyplax abyssinica* was obtained with

much frequency from a given rodent species (*Arvicanthis niloticus*) the probability that it was a normal parasite of this host became more obvious, especially since it occurred in such large numbers. Too few *Polyplax gerbilli* were found (7) to arrive at any conclusions concerning host-specificity.

The heaviest infestations of ectoparasites were found on the following rodents: *Gerbillus gerbillus* and *G. pyramidum,* ticks; *Meriones crassus* and *Arvicanthis niloticus,* fleas; *Gerbillus gerbillus, Meriones crassus,* and *Arvicanthis niloticus,* mites; *A. niloticus,* lice.

Since each collection may be considered to represent the parasite index of the burrows, it may be assumed that the collections obtained from the rodents and nests portray the population density and species composition in given areas. The figures, however, do not necessarily indicate population trends, as the number of host records differ for each month, but they do suggest that there may be certain seasonal differences in the relationships of the various ectoparasites to their hosts. These differences may be attributed to several factors. The parasites vary in the length of time spent on the host; some spend all or most of their adult life there, while others may be primarily inhabitants of the burrow or the nest. Since different species of rodents were not found using the same system of burrows we have no specific data to show what opportunity there may be providing for the exchange of ectoparasites to other species. On the other hand, parasite transfer could be effected directly from host to host of the same species utilizing the same burrows or indirectly from nest material and burrow surfaces. The rodents, judging from the evidence ascertained from nests, seemed to be particularly effective in seeding their habitats with parasites, especially mites, with which other rodents might come in contact.

Usually each kind of rodent was restricted to a narrow range of habitat conditions. The kusu rat, *Arvicanthis niloticus,* occurred in proximity to cultivated fields in the Nile Valley. One reason for this appeared to be the availability of seeds of crop plants and weedy grasses as food. The gerbils, Sundevall's jirds, and the lesser Egyptian jerboas were restricted to barren areas in the deserts. *Gerbillus gerbillus* and *G. pyramidum* were usually found at the base of hillocks of wind-blown sand where the burrows could be easily dug. *Jaculus jaculus* occurred in hard clayey-sand slopes devoid of vegetation and *Meriones crassus* was most abundant on the sides of shallow-filled wadis and roadside banks on which various shrubs were growing. In the coastal region of the Western Desert *Jaculus orientalis* and *Meriones shawi* occupied barren isolated sand slopes while the fat sand rat, *Psammomys obesus,* occurred in a semi-desert densely populated with perennial shrubs and dotted with hillocks. The bandicoot rat, *Nesokia indica,* was restricted to the low-lying saline regions of the Western Desert. In the Faiyum the high water table kept the burrows of this rodent damp and the humidity high (maximum humidity 75 percent). Ectoparasites were not found on bandicoots removed from these damp burrows. In the Wadi Natroun, however, where the water table was low, burrows of these rodents were dry and the humidity relatively low (maximum humidity 50 percent). Bandicoot rats removed from these dry burrows were parasitized with ticks.

The rodent populations appeared to be distributed chiefly in relation to type of soil, micro-topographic features, availability of suitable food plants, and micro-climatic conditions, especially humidity within the burrows.

SUMMARY

A survey was made to determine the kinds and distribution of wild rodents and their ectoparasites and to provide preliminary data on relationship to temperature, humidity, soil and vegetation conditions in Egypt.

The areas investigated were the cultivated Nile Valley, and the Eastern and Western Deserts.

The kusu rat, *Arvicanthis niloticus,* was found chiefly in proximity to cultivated fields in the Nile Valley. *Gerbillus gerbillus, G. pyramidum, Jaculus jaculus,* and *Meriones crassus* were restricted to barren desert regions. *Jaculus orientalis, Meriones shawi,* and *Psammomys obesus* were located in the coastal area of the Western Desert. The bandicoot rat, *Nesokia indica,* was restricted to the low-lying saline areas in the Western Desert.

A total of 178 rodents, including 9 species, was collected.

The chief factors governing the distribution of these rodents were the type of soil, micro-topographic features, availability of suitable food plants, and micro-climatic conditions, especially humidity within the burrows.

Humidity was always lower and temperature always higher outside of the burrows than those within the burrows.

A total of 1149 ectoparasites representing 23 species was collected during July, August, September, and part of October, 1953. Of this number 365 fleas were recovered from 56 rodents; 146 ricks from 30 rodents; 252 mites from 7 rodents; and 386 lice from 4 rodents.

Nests examined for ectoparasites yielded 120 ticks; 40 fleas; 284 mites; and 12 lice. The nest afuna also included 559 free-living mites (oribatids and phytoseids) and miscellaneous arthropods representing 7 orders.

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