STUDIES ON RODENTS AND THEIR ZOONOTIC PARASITES, PARTICULARLY LEISHMANIA, IN ISMAILIYA GOVERNORATE, A.R. EGYPT

By

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ABSTRACT

Rodents were trapped alive from different areas in Ismailiya Governorate (Suez Canal Zone), Egypt. They were identified and counted. Ectoparasites, mainly fleas of the genus Xenopsylla spp. were carefully collected, identified and counted. Blood samples were taken directly from the heart of rodents by sterile disposable syringes. Sera were separated, inactivated and examined for antibodies against Echinococcosis, Trichinosis, Toxoplasmosis and Leishmaniasis. The work was based on indirect haemagglutination tests. In addition to examination of blood films and impression smears taken from the liver and spleen as well as careful skin inspection for any induration or sore for Leishmania.

Diagnostic titers were detected. In the mean time, four rodents showed Leishmania bodies in spleenic smears, and one in skin smear.

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Rodenticide was applied on large scale. Trials were done to collect rodents for comparative studies on rodent density and flea index before and after the control measures.

The present results lay stress on the fact that rodents constitute one of the most important reservoir hosts of human parasites.

INTRODUCTION

Over the last four to five years, one has observed a marked increase in the rodent population in some Egyptian Governorates (Morsy et al., 1979, 80, 81 and El Nahal et al., 1982). This problem becomes magnified in the Suez Canal Zone as this area was nearly completely vacant during the years of Israeli-Arab War (1967-1973). The reconstruction of this area including the pre-occupied Sinai, is faced by the problem of rodents.

Generally speaking, most of the rodents' species are hosts of many serious zoonotic diseases as plague, murine typhus fever, trichinosis, toxoplasmosis, leishmaniasis, hymenolepiasis, rat bite fever, rabies... etc. Besides, rodents biting children becomes more common even during the daytime. In addition to the medical and veterinary importance, they destroy large amount of things, contaminate and feed on food stocks, damage buildings and sometimes, cause fire losses by gnawing the insulation of electrical connections.

The aim of the present work was to investigate the role played by rodents as hosts of zoonotic parasites as well as their ectoparasitic fauna and flea index in Ismailiya Governorate.

MATERIAL AND METHODS

Area of the study: Ismailiya Governorate lies on the west bank of the Suez Canal, halfway between Port Said and Suez Governorates. Through Ahmed Hamdy Tunnel, it is the stepping-stone between the Nile Delta and Sinai. The city of Ismailiya, the capital of the governorate, is some 135 Km. from Cairo.
either by the rural or the desert road by rail about 2.30 hours. The city is considered as one of the loveliest cities in Egypt. This is due to its mild sunny weather, attractive natural scenery and abundant fruit. Also, its shores on the Lake Temsah, are distinguished for their white sandy beaches and calm clear waters.

Collection of rodents: Rodents were trapped alive from eleven different areas in Ismailiya Governorate. In each time, one hundred wire box traps with spring door were used. Clean traps were set up in the evening just before sunset both indoors and outdoors and collected the next morning. Every trap was enclosed in separate white cloth bag to avoid exchange of ectoparasites. The collected rodents were transported on the same day by car to the research laboratory.

Examination of rodents: The dead rodents were considered only for rodent density. Live rodents were anaesthetized with chloroform or ether and identified. The ectoparasites were carefully collected by brushing the animal with a stiff hair brush, especially around the head, the rump and the tail head. The ectoparasites of each group of rodents were preserved in 70 per cent ethyl alcohol in separate labelled specimen tubes. The inner and outer ear surfaces, nose and the back of the head of all rodents, were carefully inspected for any induration or sore. Smears in duplicate were taken by puncture of the indurated edge of any suspected one using medi-point blood lancet (Morsy and Shoura, 1975).

Blood samples were taken directly from the heart of 150 R. norvegicus and 150 R. rattus by disposable syringes till the death of the animal. Rodents were then dissected and impression smears were prepared in duplicate from the liver and spleen. Dissection of the intestine was undertaken. The contents were collected in saline solution and sieved for the recovery of any worm present, which were collected in glycerine alcohol for identification. The results of the intestinal parasites will be published later on elsewhere by Morsy et al.

For the identification of the ectoparasites, it was necessary
to consult other taxonomic works as Fox (1940) and Hubbard (1947) for fleas, Hoogstraal (1956) for ticks and Ewing (1929) and Baker et al. (1956) for mites.

All blood films and impression smears were fixed in acetone free methyl alcohol and stained in Giemsa stain (1:10).

Serological examination of blood: The collected blood samples were allowed to clot naturally at room temperature for 1 to 2 hours. Sera were then separated by centrifugation and kept in labelled specimen tubes at $-30^\circ$C till examined for antibodies at the first convenience. Sera were inactivated at $56^\circ$C. for 30 minutes before serological examinations.

For antibodies against echinococcosis, toxoplasmosis and leishmaniasis, the Cellognost reagents for the haemagglutination tests for these diseases of Behring Institute (Behringwerke AG., Marburg, West Germany) were used. The technique adopted was essentially the microtitration technique described by Morsy et al. (1979, 80, 81).

For trichinosis haemagglutination test, a locally prepared reagent (Michael and Morsy, 1980) was used. The technique adopted was essentially the same as performed before by Morsy et al. (1979).

Diagnostic significance: For the evaluation of the results of Echinococcosis IHA, the interpretations of Kagan et al. (1959) and Kagan (1968) were considered. Significant titers are obtained only by the formation of complete agglutination at a serum dilution of 1:32 to 1:64 and higher. Titers between 1:512 and 1:2048 are considered as mean serum titers in patients with cystic echinococcosis.

For the evaluation of the results of Trichinosis IHA, the interpretations of Plonka et al. (1972) and Michael and Morsy (1980) were considered. Titer of 1:32 is considered negative. Titer of 1:64 is weak positive. Titers between 1:256 and 1:1024 are considered as mean serum titers in cases with encysted larvae.
For the evaluation of the results of Toxoplasmosis IHA, the interpretations of Titus (1963) and Piekarski (1966) were considered. Positive reactions beginning at a titer of 1:64 have diagnostic significance. They indicate either an old infection with *Toxoplasma* or the early stage of an infection.

For the evaluation of the results of Leishmaniasis IHA, the interpretations of Zuckerman (1975) and Bray (1980) were considered. Serum titers of 1:64 and above give a clear indication of *L. donovani* infection. Mean serum titers range from 1:256 to 1:2048. Lower titers of 1:32 to 1:64 can only be correctly interpreted in connection with the result of a second serological method (IFT or CFT). Titers lower than 1:32 generally eliminate Kala-azar.

*Time of the work*: Collections of rodents were carried out during the year 1981, exactly between February and October. Collections were done before and after application of rodenticides. The control measures were carried out on large scale all over the Governorate by the cooperation of the Authorities of Public Health of Ismailiya Governorate and of the Ministry of Agriculture. The rodenticide used was an anticoagulant which is effective against the most important rodent pests including *R. norvegicus*, *R. rattus* and *M. musculus*.

**RESULTS**

The collected rodents were: *Rattus norvegicus* (980), *Rattus rattus* (344) *Mus musculus* (50).

The ectoparasites collected were fleas, biting lice, ticks and mites (table 1). Fleas were (1) *Xenopsylla cheopis* (Rothschild, 1903), Rothschild 1909; (2) *Pulex irritans* Linnaeus, 1758; (3) *Ctenocephalides felis* (Bouche, 1835) and *Ctenopsyllus segnis* (Schonherr, 1816), Stewart, 1933. Ticks were (1) *Rhipicephalus sanguineus* group (Latreille, 1806) and (2) *Hyalomma excavatum* (= *H. anatolicum*) Mites were (1) *Ornithonyssus* sp. (immature stage) and (2) *Allodermanyssus sanguineus* (Hirst, 1914). Biting lice were Mallophaga.
The results are shown in the tables (1, 2, 3, 4, 5, 6 & 7).

### Table 1: The infestation rate of ectoparasites on 1374 rodents.

<table>
<thead>
<tr>
<th>Ectoparasites</th>
<th>Total No.</th>
<th>No. of infested rodents</th>
<th>Percentage of infested rodents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleas</td>
<td>594</td>
<td>343</td>
<td>24.9</td>
</tr>
<tr>
<td>Biting lice</td>
<td>30</td>
<td>17</td>
<td>1.2</td>
</tr>
<tr>
<td>Ticks</td>
<td>80</td>
<td>55</td>
<td>4.0</td>
</tr>
<tr>
<td>Mites</td>
<td>43</td>
<td>18</td>
<td>1.3</td>
</tr>
</tbody>
</table>

### Table 2: The average rodent density and flea index in the eleven areas of collection before application of rodenticide.

<table>
<thead>
<tr>
<th>Area of collection</th>
<th>Date of collection</th>
<th>Rodent density</th>
<th>Flea index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. El Sheikh Zayed</td>
<td>1 to 7 March, 1981</td>
<td>8%</td>
<td>0.3</td>
</tr>
<tr>
<td>2. Nefeshah</td>
<td>8 to 14 March, 1981</td>
<td>19%</td>
<td>0.5</td>
</tr>
<tr>
<td>3. Abou Atwah</td>
<td>15 to 20 March, 1981</td>
<td>17%</td>
<td>0.5</td>
</tr>
<tr>
<td>4. Areisht Ismaliya</td>
<td>1 to 10 April, 1981</td>
<td>14%</td>
<td>0.5</td>
</tr>
<tr>
<td>5. El Kantara Gharb</td>
<td>3 to 7 May, 1981</td>
<td>17%</td>
<td>0.5</td>
</tr>
<tr>
<td>6. Fayed</td>
<td>17 to 21 May, 1981</td>
<td>14%</td>
<td>0.5</td>
</tr>
<tr>
<td>7. Hai El Afrang</td>
<td>4 to 9 July, 1981</td>
<td>11%</td>
<td>0.4</td>
</tr>
<tr>
<td>8. Hai El Arab</td>
<td>11 to 16 July, 1981</td>
<td>14%</td>
<td>0.5</td>
</tr>
<tr>
<td>9. El Hekr</td>
<td>19 to 29 July, 1981</td>
<td>18%</td>
<td>0.4</td>
</tr>
<tr>
<td>10. Mansheyt El Shohada</td>
<td>8 to 13 August, 1981</td>
<td>23%</td>
<td>0.3</td>
</tr>
<tr>
<td>11. El Tal El Kabeer</td>
<td>2 Feb. to 7 June, 1981</td>
<td>28%</td>
<td>0.6</td>
</tr>
</tbody>
</table>
Table 3: The average rodent density and flea index in the eleven areas of collection after application of rodenticide.

<table>
<thead>
<tr>
<th>Area of collection</th>
<th>Date of collection</th>
<th>Rodent density</th>
<th>Flea index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. El Sheikh Zayed</td>
<td>13 to 15 October, 1981</td>
<td>3%</td>
<td>—</td>
</tr>
<tr>
<td>2. Nefeshah</td>
<td>19 to 22 September, 1981</td>
<td>8%</td>
<td>0.4</td>
</tr>
<tr>
<td>3. Abou Atwah</td>
<td>22 to 24 September, 1981</td>
<td>3%</td>
<td>0.2</td>
</tr>
<tr>
<td>4. Areisht Ismailiya</td>
<td>8 to 11 September, 1981</td>
<td>3%</td>
<td>0.4</td>
</tr>
<tr>
<td>5. El Kantara Gharb</td>
<td>22 to 28 August, 1981</td>
<td>5%</td>
<td>0.4</td>
</tr>
<tr>
<td>6. Fayed</td>
<td>5 to 10 September, 1981</td>
<td>1%</td>
<td>—</td>
</tr>
<tr>
<td>7. Hai El Afrang</td>
<td>3 to 5 October, 1981</td>
<td>2%</td>
<td>—</td>
</tr>
<tr>
<td>8. Hai El Arab</td>
<td>19 to 22 September, 1981</td>
<td>1%</td>
<td>—</td>
</tr>
<tr>
<td>9. El Hekr</td>
<td>26 to 1 October, 1981</td>
<td>2%</td>
<td>0.3</td>
</tr>
<tr>
<td>10. Mansheyt El Shohada</td>
<td>26/9 to 1 October, 1981</td>
<td>2%</td>
<td>0.2</td>
</tr>
<tr>
<td>11. El Tal El Kabeer</td>
<td>23 Aug. to 23 Sept., 1981</td>
<td>16%</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Table 4: The results of indirect haemagglutination tests among 150 serum samples of R. norvegicus.

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Neg.</th>
<th>I.H.A. Titers</th>
<th>Positive reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1:32</td>
<td>1:64</td>
<td>1:128</td>
</tr>
<tr>
<td>Echinococos's</td>
<td>148</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td>Trichinosis</td>
<td>142</td>
<td>—</td>
<td>4</td>
</tr>
<tr>
<td>Toxoplasmosis</td>
<td>129</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Leishmaniasi</td>
<td>118</td>
<td>—</td>
<td>10</td>
</tr>
</tbody>
</table>
Table 5: The results of indirect haemagglutination tests among 150 serum samples of *R. rattus*.

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Neg.</th>
<th>I.H.A. Titers</th>
<th>Positive reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echinococcosis</td>
<td>144</td>
<td>1:32 1:64 1:128 1:256 1:512 1:1024</td>
<td>— 6 — — — — 4.0%</td>
</tr>
<tr>
<td>Trichinosis</td>
<td>147</td>
<td>1:32 1:64 1:128 1:256 1:512 1:1024</td>
<td>— 3 — — — — 2.0%</td>
</tr>
<tr>
<td>Toxoplasmosis</td>
<td>135</td>
<td>1:32 1:64 1:128 1:256 1:512 1:1024</td>
<td>— 6 6 3 — — 10.0%</td>
</tr>
<tr>
<td>Leishmaniasis</td>
<td>132</td>
<td>1:32 1:64 1:128 1:256 1:512 1:1024</td>
<td>— 3 6 6 3 — 12.0%</td>
</tr>
</tbody>
</table>

N.B.: The serum samples of the six *R. rattus* which gave Echinococcosis IHA titers of 1:128 gave also Toxoplasmosis IHA titers at 1:128.

Table 6: The results of indirect haemagglutination tests among 300 serum samples (150 of *R. norvegicus* and 150 of *R. rattus*) examined.

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Neg.</th>
<th>I.H.A. Titers</th>
<th>Positive reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echinococcosis</td>
<td>292</td>
<td>1:32 1:64 1:128 1:256 1:512 1:1024</td>
<td>— 8 — — — — 2.7%</td>
</tr>
<tr>
<td>Trichinosis</td>
<td>289</td>
<td>1:32 1:64 1:128 1:256 1:512 1:1024</td>
<td>— 7 3 1 — — 3.7%</td>
</tr>
<tr>
<td>Toxoplasmosis</td>
<td>264</td>
<td>1:32 1:64 1:128 1:256 1:512 1:1024</td>
<td>2 6 12 11 5 — 11.3%</td>
</tr>
<tr>
<td>Leishmaniasis</td>
<td>250</td>
<td>1:32 1:64 1:128 1:256 1:512 1:1024</td>
<td>— 13 16 10 7 4 16.7%</td>
</tr>
</tbody>
</table>

Table 7: The results of skin inspection, blood films and impression smears of liver and spleen of *R. norvegicus* and *R. rattus* for *Leishmania* infection.

<table>
<thead>
<tr>
<th>Organ examined</th>
<th><em>R. norvegicus</em></th>
<th><em>R. rattus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. examined</td>
<td>No. positive</td>
</tr>
<tr>
<td>Suspected skin induration</td>
<td>12 1</td>
<td>1 5</td>
</tr>
<tr>
<td>Blood films</td>
<td>150</td>
<td>—</td>
</tr>
<tr>
<td>Liver smears</td>
<td>150</td>
<td>—</td>
</tr>
<tr>
<td>Spleen smears</td>
<td>150</td>
<td>4</td>
</tr>
</tbody>
</table>
N.B.: a total of 980 R. norvegicus and 344 R. rattus were skin inspected for induration or sore. Only 12 of the former species and five of the latter species showed suspected skin indurations. The results of their examination are shown in the above mentioned table (7).

DISCUSSION

The present study dealt with the common types of rodents. (1) Rattus norvegicus (the brown or Norway rat) is a burrowing rat and confines its activities usually to the lower parts of buildings, but may occur in the vicinity of dumps or sources of food supply away from buildings. It nests usually in burrows, beneath floors or concrete slabs, in rubbish piles or areas adjacent to refuse dumps. It is of world wide distribution. (2) Rattus rattus (the black rat) is a climbing rat and usually occupies the upper parts of buildings. It is seldom found in burrows and prefers to nest in attics, trees and shrubbery. Three subspecies belong to this species: Rattus r. rattus (the ship rat), Rattus r. alexandrinus (the Alexandrina or roof rat) and Rattus r. frugivorus (the frugivorus rat). They are closely related forms with generally similar habits and widely distributed throughout the warm parts of the world. (3) Mus musculus (the house mouse) is widely distributed in and around human habitations. It is a pest by damaging and contaminating foodstuffs and by nesting in clothing and goods.

In the present study, four groups of arthropod-ectoparasites were detected on the collected rodents, namely: fleas, biting lice, ticks and mites.

All species of fleas (Xenopsylla, Pulex, Ctenocephalides and Ctenopsyllus) are ectoparasites of warm blooded animals, visiting their hosts for blood meals. Each flea has its preferred host or related group of hosts. However, the host-parasite relationship by its true meaning is not absolute and flea passes from one host to another. Most rat fleas for examples, feed on several kinds of animals and even man (Rumreich and Wynn, 1945). No doubt, plague and murine typhus fever are the most important rat-borne diseases transmitted by fleas. Besides, fleas act
as intermediate hosts for hymenolepiasis (the common cestode of rodents) and also cause flea dermatitis.

The rat louse (Mallophaga or biting lice), although common on domestic rats and transmit rickettsiae of murine typhus from rat to rat (Mooser et al., 1931), but it is not known to feed on man (Soulsby, 1978).

On the other hand, mice and rats are important hosts on which ticks may develop on large numbers. Endemic relapsing fever is one of the most important rat-borne diseases transmitted to man by ticks (Dutton and Todd, 1905). The disease occurs in the Middle East, Mediterranean basin and the New World (Peters and Gilles, 1977).

Parasitic mites of mice and rats may remain on their hosts after feeding while others leave them and infest their nests, crevices and other surrounding places. Most of rat mites move freely from one host to another and some species readily attack man as sarcoptid itch mite. Besides, the larval stages of trombiculid infested rodents transmit scrub typhus fever (Philip, 1949) and also cause severe dermatitis (Jones, 1950). The tropical rat mite, Lipoyssus bacoti transmits endemic typhus fever (Dove and Shelmire, 1931) and Allodermanyssus sanguineus is the vector of human rickettsialpox (Huebner et al., 1946).

Regarding rodent density and flea index (table 2) before control measures against rodents, the highest density was in El Tal El Kabeer (28%), followed by Mansheyt El Shohada (23%) and the lowest was in El Sheikh Zayed (8%). On the other hand, the highest flea index was in El Tal El Kabeer (0.6) and the lowest was in Mansheyt El Shohada and El Sheikh Zayed (0.3 in both). After application of rodenticide (table 3), the highest rodent density was in El Tal El Kabeer (16%) and the lowest was in Fayed and Hai El Arab (1% in both). The highest flea index was in El Tal El Kabeer, Nefeshah, Arcisht Ismailiya and El Kantara Gharb (0.4) and the lowest was zero in each of El Sheikh Zayed, Fayed, Hai El Afrang and Hai El Arab. It was suspected that the flea index would remain as it
was, if not increased as no control measure was carried out against fleas. Generally speaking, the overall rodent density was 16.6% and dropped to 4.1% after application of the rodenticide. However, if one excludes El Tal El Kabeer, which is a typical rural area, the rodent density will be lower than that mentioned above.

Echinococcosis is a cosmopolitan disease. Each continent has its own major and minor foci of human and animal infection. In Egypt, human cases have been reported (Botros et al., 1975). On the other hand, the incidence of infection among camels, cattle, sheep and pigs ranged between 31%, 10% and 1.3% (Halawani, 1956) and 7.95%, 0.27%, 0.27% and 4.46% (Hamdy et al., 1980) respectively. In the present study, 2 out of 150 R. norvegicus and six out of 150 R. rattus showed sero-positive reactions at dilution of 1:128. The overall sero-positive reaction was eight out of 300 (2.7%). The six serum samples of R. rattus which gave sero-positive reaction with Echinococcosis IHA, also gave sero-positive reaction with Toxoplasmosis IHA at the same dilution (1:128). It could be a cross reaction between both antibodies. Williams and Prezioso (1971) found persons with Chaga's disease and Taenia saginata to be serologically positive for echinococcosis at dilution up to 1:64. Also, Botros et al. (1973) observed that schistosomal antibodies reacted with echinococcal antigen in IHA. However, in the present study, another two echinococcal sero-positive samples did not react with Toxoplasmosis IHA. Also, 12 toxoplasmosis sera at dilutions 1:32 (2), 1:64 (6) and 1:128 (4) did not react with Echinococcosis IHA. So, it is accepted to be double infection rather than cross reaction.

Trichinosis is also another cosmopolitan disease. Infection in man commonly results from eating raw or inadequately cooked pork or pork products (Peters and Gilles, 1977). Pigs usually acquire the infection by eating infected rodents. In Egypt, human cases have been reported (Ostertag, 1922 and Morcos et al., 1978). Also, Tadros and Iskander (1975), Sedik et al. (1975) and El Nawawi (1977) using the trichinoscope technique proved the presence of T. spiralis in fresh pork samples, and Siam et al.
(1979) isolated the parasite. Rashwan (1979) in Alexandria, using muscle examination detected infection in stray dogs and rodents, but not in stray cats. Morsy et al. (1981) by autopsies, found *T. spiralis* adults in two out of 57 stray cats collected in Cairo. Also, Morsy et al. (1980) in Port Said, using Trichinosis IHA, found 13.3% of *R. norvegicus* and 1.4% of *R. rattus* to have positive reactions at dilutions up to 1:256 and 1:64 respectively. In the present study, eight out of 150 *R. norvegicus* and three out of 150 *R. rattus* reacted positively at dilutions up to 1:512 and 1:128 respectively. The overall sero-positive reaction was 11 out of 300 (3.7%).

Toxoplasmosis has a world wide geographical and zoological distribution (WHO, 1969). It is more or less endemic in the Middle East (Morsy and Michael, 1980). In Egypt, human cases have been reported from allover the country (Rifaat et al., 1978). Infection have been also reported in dogs and cats (Rifaat et al., 1970), camels (Michael et al., 1977) and farm animals (Rifaat et al., 1979). Morsy et al. (1981) in Port Said, using Toxoplasmosis IHA found an incidence of 30.76% among *R. norvegicus* at dilution up to 1:1024. El Nahal et al. (1982) in Giza, using IHA, found 26.6% of *R. norvegicus* and 16.6% of *R. rattus* reacted positively at dilutions up to 1:512 and 1:128 respectively. In the present study, 19 out of 150 (12.6%) *R. norvegicus* and 15 out of 150 (10%) *R. rattus* reacted positively at dilutions up to 1:512 in both species.

Epidemiological evidence suggests that predation by cats (definitive host) on infected rodents and the feeding of raw meat containing the cysts to cats are the major source of their infection (Dubey, 1973 and Overdulve, 1978). Man and other animals apart from congenital infection, are infected by eating the cysts in not well cooked meat or in rare instance by ingestion of oocysts from cats faeces (Garnham, 1982). So, the presence of *Toxoplasma* infection in rodents, in one way or another leads to more prevalence rate of human and animal infection.

Leishmaniasis is essentially a zoonosis associated with rodents (Peters and Gilles, 1977). They are transmitted by *Phlebotomus* sp. which spend the days in cool deep crevices in
the ground, between rocks, in caves, house walls... etc. The disease became adapted to canines and man in whom they cause three main clinical types. In general, there is a primary lesion of the skin (cutaneous leishmaniasis) or which, in some areas of the world, may metastasize to the lymph glands, other areas of the skin and the mucocutaneous junction (mucocutaneous leishmaniasis). In other areas, the infection metastasize throughout the reticulo-endothelial system of the body (visceral leishmaniasis).

Cutaneous or dermal leishmaniasis occurs in scattered foci throughout the tropical and subtropical belts. Arid or even semi-desert terrain provides ideal habitats for the reservoir hosts (rodents) and the insect vector (sand flies). Generally speaking, the disease in endemic in nearly all the Middle East countries (Adler, 1964 and Morsy, 1975). In Egypt, human cases of cutaneous leishmaniasis have been reported by several authors mainly Panayotatou (1923, 28), Khalil Bey (1934, 35) and Halawani (1940) and recently by Soliman and Abo-Shady (1981) and Morsy et al. (1982). Abo-Shady (1982) isolated a Leishmania strain from one of her patients. On the other hand, Phillips (1904) examined patients with splenomegaly with or without ascites in El Kasr El Ainy Hospital of Cairo, found 32 per cent of them having Leishmania bodies by splenic puncture. Recently, Tawfik and Awadallah (1982) in Alexandria, detected a case of infantile visceral leishmaniasis as indicated by sternal puncture. The senior author also examined the slide of this case which was kindly handled to him by Prof. Hassan Abdel Aal, Dean, Al Azhar Faculty of Medicine. Regarding non human leishmaniasis, Rifaat et al. (1968) did not find natural visceral leishmaniasis in 443 stray dogs and 324 rodents. Their work was based on formol gel test, smear examination and culture of spleens and livers. Recently, Morsy et al. (1981) in Port Said, using Leishmaniasis IHA, found 9.5% of R. norvegicus and 8.1% of R. rattus to have positive reactions at dilutions up to 1:512 and 1:64 respectively. Michael et al. (1982) in Ismailiya, using the same serological technique, found three out of 80 stray cats reacted positively at dilution of 1:1024. El Nahal et al. (1982) in Giza, using Leishmaniasis IHA, found 15% of R. norvegicus serologically positive at dilution up to 1:512. Khalid et al.
(1982) in Cairo, using L. IHA, found four out of 43 stray dogs with positive reactions at dilution up to 1:512.

In the present study, 32 out of 150 (21.3%) *R. norvegicus* and 18 out of 150 (12%) *R. rattus* reacted positively at dilutions up to 1:1024 and 1:512 respectively. The overall sero-positive reaction was 50 out of 300 (16.7%). Skin inspection of 980 *R. norvegicus* and 344 *R. rattus* showed 12 and five indurations respectively. Smear examination of these skin indurations showed *Leishmania* bodies in few numbers in only one case of *P. norvegicus* (table 7). In addition four out of 150, *R. norvegicus* showed *Leishmania* bodies in smears of impressed spleen materials. However, blood films and smears of impressed liver materials did not show *Leishmania* bodies.

The low prevalence of human and canine cases of leishmaniasis and the presence of a high density of rodents, suggested that both visceral and cutaneous leishmaniasis are principally diseases of wild mammals. This fact was observed in some other parts of the world by Garnham (1971), Lainson and Shaw (1971) in the New World, Ashford et al. (1977) in Libya, Morsy and Shoura (1976) in Saudi Arabia, Bettini et al. (1980) in Italy and Morsy et al. (1981) in Jordan.

Generally speaking, with the presence of reservoirs (rodents mainly), insect vector and sporadic human cases, an outbreak or even a sudden marked increase of human cases of leishmaniasis is very suspected sooner or later. That was the case in Russia (Hoare, 1955), in Israel (Katzenellenbogen and Confino, 1964) and in Saudi Arabia, in both of Riyadh (Morsy and Shoura, 1976) and Bisha (Sebai and Morsy, 1976).

**CONCLUSION**

Rodents as rats and mice in their long association with man and animals have left their mark on the pages of history. They have followed man to almost all inhabited parts of the world, carrying with them serious human and animal diseases and in general interfering with human welfare. As the authors mentioned before, programmes undertaken to control any pest, must
take into consideration the associated fauna, so as not to upset the balance of nature. Toxicants employed to kill rodents may provide an opportunity for competitors to replace them and vice versa. There must be complete epidemiologic, ecologic, agricultural and meteorologic data to carry out successful control measures. People must understand and appreciate the attempt to help the Authorities and take an active share in the controlling programmes. One must always remember "WHEREVER THEIR IS DIRT, THERE ARE RODENTS".

It is concluded that rodents and *Rattus norvegicus* in particular, are among the most important reservoirs for many zoonotic diseases, especially leishmaniasis. Numerically speaking, rodents are probably responsible for more diseases of man than any other type of animals.

Generally speaking, it is illogical to limit epidemiological studies by national boundaries. No doubt, high speed air travel has resulted in the spread of many diseases beyond their natural geographical boundaries. For example, patients may arrive in Egypt with visceral leishmaniasis from the Sudan and so on. Even infected wild mammals or insect vectors may arrive from any neighbouring countries. We hope that the extensive work we are doing may throw more light on the epidemiology of rat-borne diseases.

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