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# ECOEPIDEMIOLOGY OF LEISHMANIASES IN SYRIA. 3. *LEISHMANIA MAJOR* INFECTION IN *PSAMMOMYS OBESUS* PROVIDES CLUES TO LIFE HISTORY OF THE RODENT AND POSSIBLE CONTROL MEASURES

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SUMMARY

Collections of *Psammomys obesus* from near Damascus, Syria in May 1990 and November 1991 contained animals of all ages. Both series had a high prevalence of *Leishmania major* infection. Lesions were small in November and large in May. Assuming the two collections were representative of typical years, it is inferred that the breeding season is between October and May: there is high winter mortality of animals born early in the breeding season, but high survival of their parents, and there is high mortality in summer of animals aged between 17 and around 20 months. Transmission in summer is, therefore, between old adults shortly before their death and young adults born in late winter or spring. Juvenile animals are not exposed to the infection. If these findings are confirmed it should be relatively easy to break this tenuous cycle.

RÉSUMÉ : **Écoépidémiologie des leishmanioses en Syrie. 3. Infestation de *Psammomys obesus* par *Leishmania major*. Relations avec le cycle biologique du Rongeur. Corollaires prophylactiques.**

Deux échantillons de *Psammomys obesus* récoltés aux environs de Damas (Syrie), en mai 1990 et en novembre 1991, constitués d'animaux de tous âges, sont reconnus infestés en forte proportion par *Leishmania major*. Les lésions, discrètes en novembre, sont nettement visibles en mai. Dans la mesure où ces échantillons sont représentatifs de la population locale, on peut inférer que la période de reproduction s'étale sur les mois froids. Les animaux nés au début de la saison de reproduction, subiraient une forte mortalité, tandis que leurs parents survivraient. Une forte proportion d' « adultes âgés » (17 à 20 mois) disparaîtrait au cours de l'été. La transmission estivale de l'infestation se ferait entre ces « adultes âgés » et les « adultes jeunes », nés en fin d'hiver ou au début du printemps. Les « jeunes » proprement dit ne seraient jamais exposés à l'infestation. La confirmation de ces hypothèses permettrait de proposer des moyens de lutte à l'encontre de ce type de réservoir.

## INTRODUCTION

The fat sand rat, *Psammomys obesus* has been found infected with *Leishmania* sp., either probably *L. major* or confirmed as such, in Israel (8), Libya (4), Algeria (6), Saudi Arabia (7), Jordan (10), Tunisia (5) and Syria (9). In all these countries this rodent is considered to be the main reservoir host of the parasite, which has caused epidemics of cutaneous leishmaniasis affecting many thousands of people. *P. obesus* is therefore one of the most significant rodents from the point of view of public health.

While there have been numerous studies on its diet and physiology, in connection with its trophic dependence on halophilic species of Chaenopodiaceae and its tendency to develop diabetes, its life history and population dynamics are poorly known. Even its taxonony (one species or two?) is controversial. There is, therefore, little basis for the development of appropriate methods for the protection of the people of North Africa and West Asia from zoonotic cutaneous leishmaniasis.

Two collections of *P. obesus* in Syria provided information which permits the proposal of testable hypotheses which may inform future studies on those aspects of the ecology of this rodent relevant to public health.

## MATERIAL AND METHODS

The collections were made at Dmeir, 40 km N. E. of Damascus, Syria, in mid-May 1990 and late November 1991. *P. obesus* is notoriously difficult to trap. Most specimens were collected by a local expert, M. Abu Jalal, who flooded the burrows with water then, with the help of assistants, captured the fleeing animals by hand. A few specimens were shot. The bounty paid was related to the size of the specimens.

In the field laboratory, the ears and nose were examined with

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the aid of a hand lens. If lesions were seen they were excised, then soaked overnight at 4° C in antibiotic saline ($10^5$ iu Penicillin G per ml) after which they were ground in fresh antibiotic saline and inoculated into NNN culture. Impression smears of suspect lesions were stained with Giemsa's stain. Parasites in culture were transferred to Montpellier for subsequent identification by isoenzyme electrophoresis.

The animals were measured (head and body, hind foot and tail), and those of 1991 were dissected to determine their sexual state.

## RESULTS

Sixty four animals were examined in May 1990 and 53 in November 1991. Sixty five of the 117 animals showed lesions, parasitological confirmation by culture was attempted on 46, and the infection was confirmed in 33. All 33 strains formally identified were *L. major,* of zymodene MON 26 (9).

As the collections were biased towards larger animals the age structure of the population cannot be determined in detail. However, specimens ranged in head and body length from 120 mm (very young) to 190 mm in May, and from 110 mm to 200 mm in November, indicating that animals of all ages were present in both collections.

In the November collection, males with descended testes were all 170 mm (H + B) or larger: all males of this size were therefore termed adult. Many females in the November collection were in breeding condition. Among the 20 measuring 165 mm or more, five showed no sexual activity, nine had perforate genital openings only, five contained foetuses and one was lactating.

All animals with visible lesions were adults. In May 1990, 42 of 54 adults (78 %) showed lesions. These were all large and conspicuous, whether on the ears or nose. In November 1991, 23 of 36 adults (64 %) had visible lesions. These were all small and inconspicuous swellings of the rim of the ear: none was seen on the nose.

## INTERPRETATION AND DISCUSSION

The high success rate in parasitological confirmation of clinical lesions indicates that clinical diagnosis is sufficiently reliable to determine the presence of infection. Some infected animals with early lesions may have been missed. The high rate of infection of *P. obesus* at Dmeir substantiates the role of this rodent in the maintenance of the parasite.

The presence of young and sub-adult animals in both collections, and of pregant females in November implies, assuming it takes two months to reach adult size, births from late October to mid-December and from mid-March to early May. These findings are consistent with those of Amirat *et al.* (2), who further indicated little if any reproduction in the summer, though these authors were dealing with a different subspecies, in Algeria.

Further interpretation depends on the assumption that both the May and November collections represented typical years, and that transmission of *L. major* occurs in the summer, perhaps between July and September. The conclusions can only, therefore, be taken as working hypotheses requiring testing by further study.

The two relevant findings are: 1. That the proportion of adults infected in May, at the end of breeding season, and seven or eight months after the previous transmission season was high, and even higher than that in November, shortly after the transmission season; 2. The lesions in May were all large, consistent with their being old, while those of November were all small.

The high infection rate in May implies that there was no dilution by adults born since the previous transmission season. Animals born between October and February should be adult by May and cannot be infected. Unless they all died, they should have diluted their infected parents, lowering the infection rate in May. There must, therefore, have been very high mortality of young born early in the breeding season, as well as almost complete survival of adults entering the breeding season.

The small size of lesions in November implies that all the adults infected some 14 or more months earlier, which provided the high May infection rate, were dead by late November. A high death rate in adults in summer is consistent with previous findings of (1, 2) in Algeria, that there are considerable weight loss and signs of stress in summer.

The results combine to indicate the following distinctive life cycle pattern: 1. Animals born in February to May survive their first summer, during which they become infected, and breed for the first time, at nine or more months of age, from October onwards; 2. These adults mostly survive the winter, but die in their second summer, during which they pass the infection to younger adults; 3. Animals born early in the breeding season mostly die during the winter. They may well breed during their short lives; 4. There are, then, two distinct groups: those born early in the breeding season, which do not survive more than five months, and those born later in the season, which do not breed till they are nine months old, and survive at least 17 months.

The importance of this pattern, if it is correct, is that juvenile animals are rarely if ever infected with *L. major,* which is transmitted between old animal shortly before their death, and younger adults.

The transmission cycle of *L. major* is therefore very tenuous depending on just how long the old adults survive into the summer, and on just when transmission starts. This might explain the absence of *L. major* in some colonies of *P. obesus* in Libya (3), Tunisia (J.-A. Rioux, unpublished observations) or Algeria (J.-P. Dedet, pers. comm.) and also provide clues for the rational protection of people from infection.

Among the many environmental changes which have occurred in the areas in which *L. major* is maintained by *P. obesus,* the decline in the use of camels may have removed the only major competitor for food, and the wholesale destruction of carnivorous birds and mammals may have removed predator pressure. It is likely that minor changes, based perhaps on food availability and predation, might be effective in preventing human infection, with minimal damage to the fragile semi-desert environments where *P. obesus* lives.

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REFERENCES

1. Amirat Z., Khammar F., Brudieux R. : Variations saisonnaires de l'activité sexuelle chez deux espèces de rongeurs du Sahara algérien. *Mammalia,* 1977, *41,* 341-356.
2. Amirat Z., Khammar F., Brudieux R. : Comparative seasonal variations of adrenal weight in two species of desert rodents *Psammomys obesus* and *Gerbillus gerbillus. Mammalia,* 1980, *44,* 399-408.
3. Ashford R. W., Chance M. L., Ebert E. F., Schnur L. F., Bushwereb A. K., Drebi S. M. : Cutaneous leishmaniasis in the Libyan Arab Republic: distribution of the disease and identity of the parasite. *Ann. Trop. Med. Parasitol.,* 1976, *70,* 401-410.
4. Ashford R. W., Schnur L. F., Chance M. L., Samaan S. A., Ahmed H. N. : Cutaneous leishmaniasis in the Libyan Arab Republic: preliminary ecological findings. *Ann. Trop. Med. Parasitol.,* 1977, *71,* 265-272.
5. Ben Ismail R., Ben Rachid M. S., Gradoni L., Gramiccia M., Helal H., Bachamba D. : Zoonotic cutaneous leishmaniasis in Tunisia: study of reservoir hosts in the Douara disease focus. *Ann. Soc. Belge Med. Trop.,* 1987, *67,* 335-343.
6. Belazzoug S. : Isolation of *Leishmania major* from *Psammomys obesus* in Algeria. *Trans. R. Soc. Trop. Med. Hyg.,* 1983, *77,* 876.
7. El Bihari S., Kawasmeh Z. A., Al Naiem A. H. : Possible reservoir hosts of zoonotic cutaneous leishmaniasis in Al Hassa oasis, Saudi Arabia. *Ann. Trop. Med. Parasitol.,* 1984, *78,* 543-545.
8. Gunders A. E., Lindror R., Montilio B., Amiti P. : Isolation of *Leishmania* sp. from *Psammomys obesus* in Judea. *Trans. R. Soc. Trop. Med. Hyg.,* 1968, *62,* 465.
9. Rioux J.-A., Dereure J., Khiami A., Pratlong F., Sirdar K., Lambert M. : Ecoépidémiologie des leishmanioses en Syrie. 1 — Infestation de *Psammomys obesus Cretzschmar (Rodentia-Gerbillidae)* par *Leishmania major* Yakimoff et Schokhor (Kinetoplastida-Trypanosomatidae). *Ann. Parasitol. Hum. Comp.,* 1990, *65,* 203-207.
10. Saliba E. K., Oumeish O. Y., Haddadin J., Amr Z., Ashford R. W. : Cutaneous leishmaniasis in Mowaqqar area. Amman Governorate, Jordan. *Ann. Trop. Med. Parasitol.,* 1985, *79,* 139-146.

## ADDENDUM

In a further collection of 25 adult animals on September 8, 1992, only five had visible lesions but all were examined and 23 were found positive by smear and for culture. All visible lesions were very small. This findind supports the view that transmission is intense and is from old, dying adults to younger adults. The lack of dilution by animals born during winter is, however, called into question.

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