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NOTES ON THE FLEA FAUNA (*INSECTA, SIPHONAPTERA*) OF THE TERRESTRIAL AZOREAN MAMMALS (1)

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INTRODUCTION

Though the fleas and their mammalian hosts of the Western European countries are now rather well known, the remote Atlantic islands did not give way to many publications on that subject despite the plague epidemics raging there at least till 1949 (POLLITZER, 1954). In fact, until quite recently, the informations about the mammal fauna of the Azorean archipelago remain incomplete and not very precise. Though, the anthropogenic origin of that fauna is established. Only two bat species occur naturally in the Azores. DROUET (1861) and GODMAN (1870) mention the presence of the rabbit (*Oryctolagus cuniculus*),

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of both the black and the brown rats (*Rattus rattus* and *R. norvegicus*), of the house mouse (*Mus domesticus*) and of two carnivores, the weasel (*Mustela nivalis*) and the ferret (*Mustela putorius furo*) whereas ULFSTRAND (1961) reports the presence of the hedgehog (*Erinaceus europaeus*) in São Miguel. However, no very precise locations are noted and the real distribution of all these species throughout the archipelago is never mentioned.

Therefore, it is not surprising that the fleas of this region were poorly studied: only six species are reported from terrestrial mammals of the archipelago. Three others must be added to have a complete view of its flea fauna. ROTHSCHILD (1911) quotes a specimen of *Ischnopsyllus intermedius* (ROTHSCHILD, 1898) preserved in the Berlin museum. JORGE (1928) reports the presence of three rodent fleas: *Xenopsylla cheopis* (ROTHSCHILD, 1903), *Leptopsylla segnis* (SCHÖNHERR, 1816) and *Nosopsyllus fasciatus* (BOSC D'ANTIC, 1800). The presence of *Stenoponia t. tripectinata* (TIRABOSCHI, 1902) is first mentioned by JORDAN (1958) and then by ABREU (1973) in São Miguel where some specimens were collected in 1903 by OGILVIE-GRANT. In his work on the British fauna, SMIT (1957) simply indicates that the Azores are included in the geographic range of *Ischnopsyllus intermedius* (ROTHSCHILD, 1898), *Dasypsyllus g. gallinulae* (DALE, 1878) and *Ceratophyllus* (*Monopsyllus*) *s. sciurorum* (SCHRANK, 1803). SMIT (1966) also quotes the presence of *Spilopsyllus cuniculi* (DALE, 1878). Unfortunately, no information is given about a precise locality, a host, a collection date or about where the specimens are preserved. These quotations, except the latter, are resumed by ABREU (1973) without any comment. TRAUB *et al.* (1983) confirm the presence of *Dasypsyllus g. gallinulae* and of *Nosopsyllus fasciatus*. They also quote the presence of *Monopsyllus s. sciurorum* as " introduced into the Azores on *Buteo* " (p. 76). Finally, *Ceratophyllus gallinae* (SCHRANK, 1803) is mentioned from Ponta Delgada (São Miguel) in May 1979 (RIBEIRO & CAPELA, 1985).

During four successive years (1993-1996), field samplings of wild mammals were organised in the late spring or early summer on different islands (fig. 1) and in various habitat types (project JNICT/ STRIDE: "The mammals of the Azores as zoonotic reservoirs"). The main objectives of these campaigns were

— the study of the geographical and ecological distributions of the terrestrial wild mammals throughout the archipelago;

— the study of the genetical, physiological and morphological characters of the Azorean mammals;

— the identification of the hosts of some micro-organisms involved in public health problems (Leptospira, Borrelia, Rickettsia and Hantaan virus);

— the comparative study of the parasites (helminths, ticks, fleas and lice) with reference to continental faunas (MATHIAS *et al.*, 1993).

A few domestic animals (cats and dogs) were also searched for fleas.

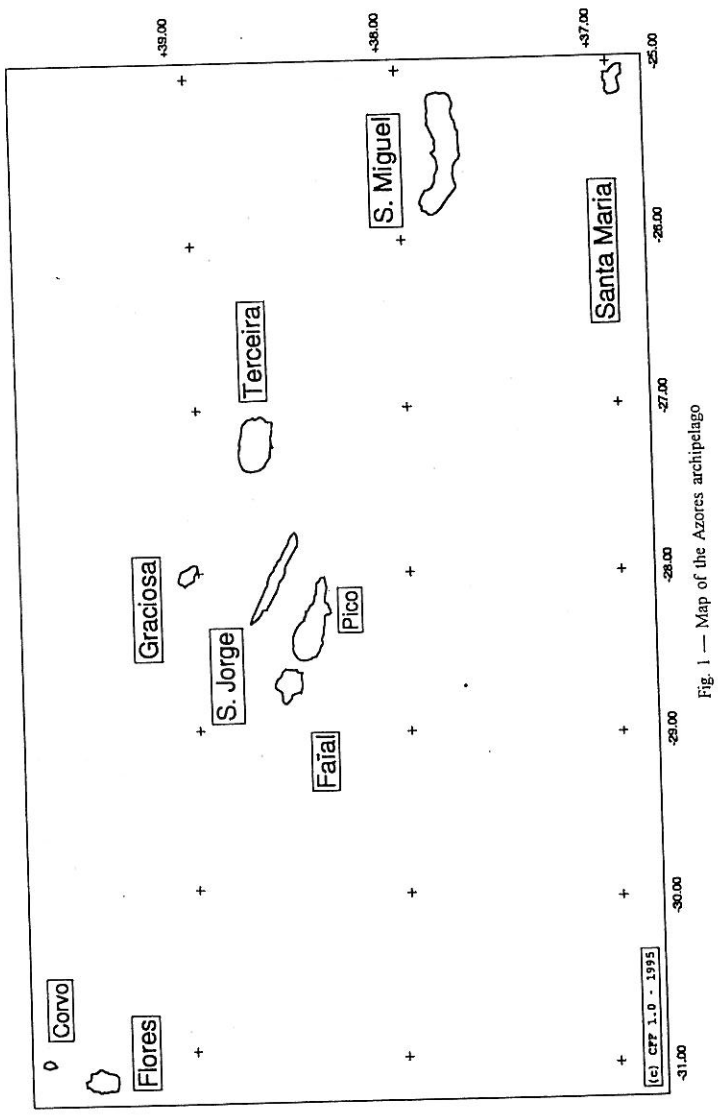

Fig. 1 — Map of the Azores archipelago

Material examined

Results obtained allowed to confirm the presence of six flea species of which three (*Ctenocephalides f. felis, C. canis* and *Nosopsyllus l. londiniensis*) were not previously referred. The specimens studied are deposited at the Museu Bocage in Lisbon or preserved in the first author's collection.

Ctenocephalides felis felis (BOUCHÉ, 1835).

This very common flea has been found on its usual host, the domestic cat (*Felis catus*). Two animals have been examined in Flores bearing respectively 10 males and 31 females (Fazenda das Lajes: 27/05/94) and one male plus five females (Monte Santa Cruz: 07/95). Another cat was found dead in Terceira bearing only one female flea (Angra do Heroísmo, June '93) and a fourth animal examined in July 1995 in Graciosa (Santa Cruz) gave 9 males and 4 females.

One dog (*Canis familiaris*) examined in Graciosa (Santa Cruz, July '95) did bear that flea too (1 male and 2 females).

Ctenocephalides canis (CURTIS, 1826).

One domestic dog bearing three females of *C. canis* has been examined in Flores (Fazenda das Lajes) the 27th May 1994.

Spilopsyllus cuniculi (DALE, 1878).

Except in Terceira, where the fleas were picked up on road killed rabbits, the collects were made on snared (Flores) or shot animals (Faial, Flores, Pico, São Jorge, São Miguel).

This oioxenous flea has been collected exclusively on its usual host, the rabbit. Its presence seems to be restricted to the central and oriental groups of islands since the rabbit fails in Corvo and doesn't bear the parasite in Flores (Tab. I). In Faial (27/06 till 01/07/93), *Spilopsyllus* has been found in different localities (Cabeço Verde, Caldeira, Capelo, Castelo Branco, Praia do Norte, Pedro Miguel and Ribeira Funda) spread all over the island. On São Jorge (12/07/95) and Pico (13/07/95), the rabbits were sampled exclusively in the central part of the islands: between Norte Grande and Cerrado dos Penedos (S. Jorge) and between S. Roque, Lagoa do Capitão and Lagoa do Caiado (Pico). In Terceira, the flea has been found in four different localities: Caparica (25/06/93 and 10/07/95), the vicinity of Furnas do Enxofre (22/06/93), the crossing of Bagacina (24/06/93 and 31/05/94) and Algar do Carvão (03/06/94). In São Miguel, the rabbits were shot near Ponta Delgada (14/06/93).

The prevalence of that parasite seems to be the highest in S. Jorge and of the same order of magnitude in Faial and Pico. In Terceira, the lower level could be due to the fact that several rabbits were not freshly killed when examined.

Table I. Number of rabbits examined in different islands of Azores and prevalence of their usual flea *Spilopsyllus cuniculi*

	Rabbits		Prevalence	Fleas			
	examined	with fleas	%	Males	Females	Mean nb/rabbit	Sex ratio
Flores	25	0	0.0			0.0	
Faial	62	27	43.5	70	120	7.0	0.37
Pico	15	7	46.7	77	140	31.0	0.35
São Jorge	16	14	87.5	138	163	21.5	0.46
Terceira	28	7	25.0	17	14	4.4	0.55
São Miguel	3	3	100.0	10	39	16.3	0.20
	149	**58**	**38.9**	**312**	**476**	**13.6**	**0.40**

Table II. Number of wild mammal examined in different islands of Azores and fleas collected

	Nb. of hosts examined with fleas	Prevalence %	*S.t. tripectinata* Males	*S.t. tripectinata* Females	*N. fasciatus* Males	*N. fasciatus* Females	*N. l. londiniensis* Males
Mus domesticus							
Flores	66 1	1.52					1
Graciosa	43 2	4.65				2	
Pico	8 0	0					
São Jorge	1 0	0					
Terceira	57 9	15.79	14	18			
São Miguel	23 6	26.09	1	2	1	2	1
Rattus rattus							
Flores	17 5	29.41			3	4	
Graciosa	4 0	0					
Pico	5 0	0					
São Jorge	10 0	0					
Terceira	66 5	7.58			2	7	
São Miguel	24 1	4.17		1			
Rattus norvegicus							
Flores	9 0						
São Jorge	1 0						
Terceira	3 1				2		

Nosopsyllus fasciatus (Bosc d'Antic, 1800).

Twenty-three specimens were collected on three mammal species (Tab. II) and on four islands.

Flores: Monte (Santa Cruz): one male on a black rat (09/07/95); Caldeira (Mosteiro): one male and one female on a black rat (06/07/95) and one female (29/06/96) on another black rat; Lajes (Boca da Baleia) one male and one female on two different black rats (27/06/96) and Fajã Grande (Fonte Frade): one female on a black rat (26/06/96).

Graciosa: Santa Cruz and Canada do Pinheiro: two females on two different mice (06 and 08/07/95, respectively).

Terceira: São Bartolomeu (20/06/93): two males on a brown rat; Caparica (22/06/93): one female on a black rat; Crossing of Bagacina (10/07/95): one female on a black rat; Lagoa do Negro (centre of the island) on three different black rats: one male plus a female (23/06/93); one female and one male plus three females (10/07/95).

São Miguel: Água do Alto: one male and one female, on two different house mice (25 and 26/05/94); Santana (06/07/95): one female on a mouse.

The observed sex ratio (0.58) is quite the same as what is mentioned by Beaucournu (1976) (0.56).

Nosopsyllus londiniensis londiniensis (Rothschild, 1903)

Two male specimens of that species have been found on house mice, the first in São Miguel island (Santana, 06/07/95) and the second in Flores (Monte, Santa Cruz: 25/06/96).

Stenoponia tripectinata tripectinata (Tiraboschi, 1902).

The collected material consists of only one female specimen found on a black rat (São Miguel: Altiprado, 27/05/94) and 35 individuals collected on house mice (Tab. II), either in São Miguel or in Terceira. In São Miguel, one male and one female have been found at Água do Alto (26 and 27/05/94) on two different mice and one more female was found in Santana (06/07/95). In Terceira, most of the fleas have been collected at Caparica:

1 male (22/06/93); 2 females on two different mice (02/06/94); 12 males and 10 females (10/07/95) on 3 mice bearing respectively 3 m + 3 f; 1 f and 9 m + 6 f. Another female has been found on an individual trapped near the garbage dump of Angra do Heroísmo (01/06/94) and two animals caught in the neighbourhood of the Gruta do Natal (04/06/94) and along the road bordering the northern edge of the Caldeira de Guilherme Moniz (02/06/94) did bear respectively 3 females and 1 male plus 2 females. All the mice examined in the other islands were negative.

Caparica is a small meadow bordered by dry stone walls with brambles and surrounded by other meadows or by *Pittosporum undulatum* plantations. The soil is quite moist with a dense cover of *Mentha sp.*. Near Gruta do Natal, the mice were caught at the edge of a wet meadow, with trees, brambles and shrubs thickets. These locations in moist habitats do contrast strongly with the usual habitat of this flea species in the Mediterranean biome (dry open stations, low shrublands) (BEAUCOURNU, 1976).

The observed sex ratio (0.71) doesn't differ significantly from the value (0.78) mentioned by BEAUCOURNU (1976) on Corsican samples.

OTHER SPECIES

Other wild mammal species live in the Azorean archipelago. We had the opportunity to catch some of them: one weasel in São Mateus (Terceira), one ferret near the crossing of Bagacina (centre of Terceira), others in Flores (Cova da Pedra and Fonte Frade) and sixteen hedgehogs either in São Miguel (12) or in Terceira (4). No flea was collected on these animals. As far as the bats are concerned, we didn't make any attempt to trap them.

DISCUSSION AND CONCLUSIONS

From a biogeographical point of view, all the mammal-fleas or lice reported so far from the Azores, due to their wide distributional range, don't give many informations about the possible origin of their host species. *C. canis, C. f. felis, N. fasciatus, N. londiniensis* are cosmopolitan whereas *S. cuniculi* and *Polyplax spinulosa* (BURMEISTER, 1839) are strictly bound to their respective hosts (rabbit and black rat) and have been introduced with them into many countries or remote islands. From that point of view, the probable absence of *S. cuniculi* from Flores is worth mention. *S. t. tripectinata* alone indicates that the house mouse was introduced into the archipelago, at least in Terceira and São Miguel, from the Mediterranean basin. Its range is indeed restricted to the countries bordering the Mediterranean sea and to Madeira where it has also been introduced by man with the mouse (BEAUCOURNU & LAUNAY, 1990).

The presence of *Ceratophyllus sciurorum* in the archipelago has to be confirmed because the mention made by TRAUB *et al.*, (1983) is not clear enough. Indeed, the common buzzards are native to the archipelago and were therefore not introduced. Nevertheless it is possible that the first buzzards reaching the Azores did bear the flea and that the parasite did adapt to that particular host

in insular conditions and is now able to survive on it in the absence of its primary (red squirrel) or secondary (dormice and martens) hosts (*sensu* BEAUCOURNU & LAUNAY, 1990).

It is surprising that we didn't find *Archaeopsylla erinacei* since that flea is sometimes plentiful on some continental hedgehogs.

From an epidemiological point of view, we must remember that *Nosopsyllus fasciatus* and the louse, *Polyplax spinulosa*, may harbour *Rickettsia moori*, the agent of the murine typhus and *Yersinia pestis*, the agent of the plague (BEAUCOURNU, 1968, 1976).

In conclusion, the Azorean flea fauna seems very poor compared to the continental one, even considering only the host species shared by both geographical entities. The species inhabiting the Azores are very common ones, widespread all over the Palearctic region (*C. gallinae* and *D. g. gallinulae*) or even cosmopolitan (*C. canis, C. f. felis, N. fasciatus* and *N. londiniensis*). Our observations are therefore not surprising even if further research will probably bring some extra species. Reduction of the species number and selection of the most common and ecologically tolerant species are two characteristics of many insular communities. The fact that *Stenoponia* was found in moist habitats seems to indicate a niche enlargement which is consistent with the insular syndrome hypothesis.

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SUMMARY

During three successive years, field samplings of wild mammals were organised on different Azorean islands and the ectoparasites were collected. Among 340 murid rodents, 31 did bear at least one flea. *Nosopsyllus l. londiniensis* has been

found on the mouse in São Miguel. *Stenoponia t. tripectinata* has been discovered in Terceira and in São Miguel, mainly on house mice and on one black rat out of 121. *Nosopsyllus fasciatus* was present on the mouse an on both the black and the Norway rats. Its presence has been evidenced in four islands: São Miguel, Terceira, Graciosa and Flores. Numerous rabbits were also examined in the visited islands (São Miguel, Terceira, Pico, São Jorge, Faial and Flores) and were found heavily parasited by their commonest flea, *Spilopsyllus cuniculi*. In Flores, however, that flea seems to be lacking. Though no systematic search has been done on domestic animals, the presence of *Ctenocephalides f. felis* is also reported from Flores, Terceira and Graciosa whereas *C. canis* has been found on a dog in Flores. The flea fauna of the Azorean archipelago is therefore characterized by a few species amongst the most cosmopolitan ones.

RESUMO

Durante três anos consecutivos foram colhidos os ectoparasitas de mamíferos capturados em várias ilhas do Arquipélago dos Açores. Dos 230 roedores murídeos analisados, 26 continham pelo menos uma pulga. Nos 121 indivíduos examinados na Terceira e em S. Miguel foi encontrada *Stenoponia t. tripectinata* em ratinhos-caseiros *(Mus musculus)* e numa ratazana-preta *(Ratus rattus)*. *Nosopsyllus l.londiniensis* foi encontrada em ratinhos-caseiros em S. Miguel. A presença de *Nosophyllus fasciatus* foi detectada em quatro ilhas: S. Miguel, Terceira, Graciosa e Flores, no ratinho-caseiro, na ratazana-preta e na ratazana-castanha *(R. norvegicus)*. Por outro lado, os numerosos coelhos *(Oryctolagus cuniculus)* examinados nas várias ilhas visitadas (S. Miguel, Terceira, Graciosa, S. Jorge) estavam fortemente parasitados pela sua pulga mais comum *Spilopsyllus cuniculi,* com excepção das Flores, onde esta espécie parece estar ausente. Embora não tenha sido efectuada uma pesquisa sistemática nos animais domésticos, a presença de *Ctenocephalides f. felis* foi também detectada nas Flores, Terceira e Graciosa enquanto que *C. canis* foi encontrada num cão, nas Flores. A fauna de sifonápteros do Arquipélago dos Açores parece assim ser caracterizada por uma reduzida diversidade de espécies, de entre as mais cosmopolitas.

REFERENCES

ABREU, M. H., 1973. Introdução ao estudo dos Siphonaptera de Portugal. *Arq. Mus. Bocage*, **2**: 197-211.

BEAUCOURNU, J. C., 1968. Les anoploures de lagomorphes, rongeurs et insectivores dans la région paléarctique occidentale et en particulier en France. *Ann. Parasit. hum. comp.*, **43**: 201-271.

BEAUCOURNU, J. C., 1976. *Contribution à l'étude des siphonaptères de mammifères du nord-ouest de la région méditerranéenne (France, Italie, Péninsule ibérique)*. Thèse Doc. Sc. nat. Univ. Rennes, 283 pp. + ann.

BEAUCOURNU, J. C. & LAUNAY, H., 1990. *Les puces de France et du Bassin méditerranéen occidental*. Faune de France n° 76. Féd. franç. Soc. Sc. nat., Paris, 548 pp.

DROUET, H., 1861. *Eléments de la faune açoréenne*. Baillière & fils et Rothschild, Paris, pp. 105-110.

GODMAN, F.d. C., 1870. *Natural History of the Azores or Western islands*. Van Voorst, Paternoster Row ed. London, 345 pp.

JORDAN, K.. 1958. Contribution to the taxonomy of *Stenoponia* J. et R (1911), a genus of Palaearctic and Nearctic fleas. *Bull. Brit. Mus. (Nat. Hist.) Entomology*, **6**: 169-202.

JORGE R., 1928. Portugal (session d'octobre 1924), in *Les Faunes régionales des rongeurs et des puces dans leurs rapports avec la peste. Résultats de l'enquête du Comité permanent de l'Office international de l'Hygiène publique 1924-1927*. Masson & Cie, Paris, pp. 89-90.

MATHIAS, M.L., SANTOS-REIS, M., COLLARES-PEREIRA, M., OOM M.M., RAMALHINHO, M.G., PETRUCCI-FONSECA, F., BACELLAR, F., NÚNCIO, S., MARTINS, L., FONS, R. & LIBOIS, R., 1993. The mammals of the Azores as zoonotic reservoirs: an insular syndrome ? Abstracts 1st. Symp. « Fauna and Flora of the Atlantic islands», Funchal, 04-09/10/93, p. 40.

POLLITZER, R., 1954. *La Peste*. Monographie O.M.S., Genève, 737 pp.

RIBEIRO, H. e CAPELA, R. A., 1985. Contribução para o estudo dos sifonápteros de Portugal continental e Região Autónoma dos Açores (*Insecta, Siphonaptera*). *Bol. Soc. port. Entomol.*, 1 supl. **1**: 233-237.

ROTHSCHILD, C., 1911. On the bat-fleas described by Kolenati. *Nov. Zool.*, **18**: 48-56.

TRAUB, R., ROTHSCHILD, M. & HADDOW, J.F., 1983. *The Rothschild collection of fleas. The Ceratophyllidae: key to the genera and host relationships*. Univ. Press, Cambridge, 288 pp.

SMIT, F.G.A.M., 1957. *Handbooks for the identification of British insects. Siphonaptera* 1 (16). Royal Entomological Society, London, 94 pp., 200 figs.

SMIT, F.G.A.M., 1966. *Insecta helvetica: catalogus I:Siphonaptera*. Lausanne, 106 pp.

ULFSTRAND, S., 1961. On the vertebrate fauna of the Azores. *Bol. Museu municip. Funchal*, **14**: 75-86.