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THE FLEA FAUNA OF THE GREAT GERBIL (RHOMBOMYS OPIMUS LICHT.) IN IRAN

A. FARHANG-AZAD and V. NERONOV*)

School of Public Health and Institute of Public Health Research, The University of Teheran and Ecology Unit, Division of Research in Epidemiology and Communications Science, World Health Organization, Geneva

Abstract. For the first time the authors have analyzed a flea fauna of the great gerbil (*Rhombomys opimus* Licht.), collected in different parts of Iran. They have made a comparison with other species of rodents of the Gerbillinae subfamily and with the flea fauna of the great gerbils from some plague endemic regions of Kazakhstan and Central Asia. An antiquity of the Central Iranian complex of populations of the great gerbil is emphasized and an assumption is made on a possible existence of natural foci of plague there.

In many places in Middle Asia and Kazakhstan, the great gerbil (*Rhombomys opimus* Licht) is known to be the principal reservoir in natural foci of plague. That is why great attention has been paid to the study of the fauna and ecology of its fleas (Zasukhin et al. 1934; Mikulin 1956; Tikhomirova, Zagniborodova 1958; Zagniborodova 1967, and many others). The great gerbil is widely distributed in Iran also (Fig. 1). As we have already mentioned (Neronov, Farhang-Azad 1971), some populations of *R. opimus* in Northern and North-Eastern Iran may have rather close links with the Turkmenian regional complex of populations of this species, where plaque epizootics were observed more than once, including some places close to the USSR-Iranian frontier (Tikhomirova 1958; Fenyuk et al. 1960). Strains of the plague bacillus have twice been isolated directly from rodents in the territory of North-eastern Iran (in 1912 by A. D. Grekov near Kjariz and in 1921 by P. F. Samsonov in the vicinity of Serakhs), and as Yu. M. Rall (1960) believed, it is likely that they were isolated from great gerbils. In connection with these facts it is of certain interest to conduct a comparative analysis of the fauna and ecology of the fleas of the great gerbil in Iran and on the enzootic for plaque areas of Middle Asia.

The first mention of fleas found on the great gerbil in Iran made was in a review by J. M. Klein et al. 1963. They indicated only three species: *Xenopsylla nuttalli*, *Coptopsylla lamellifer* and *Nosopsyllus laeviceps*. Recent extensive surveys conducted by field teams of the Institute of Public Health Research of the University of Teheran (Farhang-Azad, 1969, 1970) as well as the results of the study of the ecology of small

*) Present address: Laboratory of Medical Zoology, the Gamaleya Institute, Moscow, D-98, USSR.

Table 1. Fleas of great gerbil *(Rhombomys opimus)*—

Fleas / Mammals	Total number of species	Fleas of *R. opimus*																						
		Echidnophaga oschanini	*Synosternus cleopatrae*	*Xenopsylla hussaini*	*X. gerbilli*	*X. nuttalli*	*X. persica*	*X. conformis*	*X. buxtoni*	*Coptopsylla bairamalienis*	*C. iranica*	*C. lamellifer*	*C. meghalii*	*C. mofidii*	*C. neronovi*	*Stenoponia tripectinata*	*S. vlasovi*	*Rhadinopsylla ucrainica*	*R. syriaca*	*R. bivirgis*	*Ctenophthalmus dolichus*	*Nosopsyllus baltazardi*	*N. pringlei*
R. opimus	18	+			+	●		+		+	+	●	+	+			+					+	+
T. indica	13		+	+		+		●	○?					+		+						+	○
M. persicus	35	●		+		●	+	+	●	+	+	●		+	+	●	+	○		+	●	+	●
M. libycus	24	○						●	●		+	○		+		●		○	○		○	+	●
M. meridianus	4					+		+			+												
M. crassus	12					+		●			+			+	+	+						+	●
M. tristrami	7							○	●							○		○					
M. vinogradovi	13							+	○			○				○		○			○		
M. hurrianae	1																						
G. nanus	10		+	+		+		+			+			+		●						+	+
G. cheesmani	5		+	+		+																	+	

0 — data reviewed and published by J. M. Klein et al., 1963
① — this species was described by J. M. Klein (1963) from *M. persicus*, but according to type of habitats in these localities (Ziar Glun-abad) and further observations in this area it seems that the real host of this species is *R. opimus* and not *M. persicus*

mammal-borne infections*), the greatly increased lists of fleas found on the great gerbil and other rodents (see Table 1). Fleas were mainly collected from the animals and to a lesser extent during excavations of burrows of rodents or from their nests. In this communication we use only the data for fleas found on animals.

As can be seen from Table 1, 18 species of fleas were found to occur on the great

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and other gerbils												Fleas of other animals													
N. ziarus	*N. iranus*	*N. laeviceps*	*N. turkmenicus*	*N. vlasovi*	*N. aff. tersus*	*N. sp. 2*	*Peromyscopsylla tikhomirovae*	*Paradoxopsyllus grenieri*	*P. microphthalmus*	Number of species	*Ctenocephalides canis*	*Synosternus pallidus*	*Xenopsylla astia*	*Neopsylla pleskei*	*Wagnerina schelkovnikovi*	*Ctenophthalmus iranus*	*C. congener*	*Nosopsyllus mikulini*	*N. sarinus*	*N. sp. 1*	*Amphipsylla schelkovnikovi*	*Ophthalmopsylla volgensis*	*Mesopsylla cucta*	*M. tuschkan*	*Caenopsylla lapteri*	Number of species
+		●	+	+	+					17											+					1
										9	○	+	●												+	4
+	●	+	+			+	+	○	○	25				+	●	●	+	●	+		○	●	+	○		10
+	●	○		+		+				17		+			●		○			○	○	+	○			7
				+						4																—
				+		+				10			●											+		2
	●									5						●								+		2
	●							○		8						○		○			○	○		○		5
										—			+													1
										9			+													1
										4										+						1

? — this record according to distributional patterns of the host and the flea looks rather questionable
+ — present report and data published before by A. Farhang-Azad (1969, 1970)

gerbil in Iran, up to the present time. According to the variety of species of fleas the great gerbil comes third after *Meriones persicus* (with 35 species) and *M. libycus* (with 24 species). Seventeen of these 18 species are specific to the great gerbil and the subfamily Gerbillinae on the whole; number 18, *Amphipsylla schelkovnikovi*, is a flea of small hamsters (Mikulin 1959) and may be regarded as an accidental parasite of the great gerbil. Three fleas (*X. gerbilli*, *C. meshgalii*, *N.* aff. *tersus*) were found only on *R. opimus*, the others parasitize several species of gerbils. The level of exchange by fleas among different rodents is an important index in times of plaque epizootics. Comparative calculations (Table 2) show that to a larger extent the flea fauna of the great gerbil is similar to that of *M. libycus*, *M. crassus* and *M. persicus* (35.4; 34.7; 32.5 % of species of fleas in common) and is very different from such species as *M. hurrianae*, *M. tristrami* and *Gerbillus cheesmani*. As is known, *M. libycus* and *M. persicus* are important reservoirs of plague in the Kurdistan focus (Baltazard et al. 1960) and plague epizootics among *M. libycus* were registered several times in Soviet Azerbaijan and Turkmenia (Rall 1960, 1965).

Table 2. Comparison of the flea fauna of the great gerbil (*Rhombomys opimus*) with that of other species of Gerbillinae in Iran

Compare species	Total number of species of fleas	Number of similar species	Coefficient of similarity (in %)
1 : 2	26	5	19.2
1 : 3	40	13	32.5
1 : 4	31	11	35.4
1 : 5	18	4	22.2
1 : 6	23	8	34.7
1 : 7	24	1	4.2
1 : 8	22	4	18.2
1 : 9	19	0	0.0
1 : 10	22	6	27.3
1 : 11	21	2	9.5

1 — *R. opimus;* 2 — *T. indica;* 3 — *M. persicus;* 4 — *M. libycus;* 5 — *M. meridianus;* 6 — *M. crassus;* 7 — *M. tristrami;* 8 — *M. vinogradovi;* 9 — *M. hurrianae;* 10 — *G. nanus;* 11 — *G. cheesmani.*

In Table 3 we show summarized data of the fauna of fleas of the great gerbil from different parts of its range in Kazakhstan and Middle Asia. The greatest number of species of fleas (27) was discovered in deserts to the south of Lake Balkhash (Mikulin 1956), but in the other three cases (Southern Turkmenistan, Kara-Kum desert, the North-western edge of the range) the fauna of fleas is also more diverse than in Iran. These differences are connected first of all with the volume of materials investigated, as in

Table 3. Fleas of the great gerbil *(Rhombomys opimus)* in different parts

	Place of study and authors	Total number of species of fleas	Fleas of *R. opimus*													
			Echidnophaga oschanini	*Xenopsylla conformis*	*X. gerbilli*	*X. hirtipes*	*X. nuttalli*	*X. skrjabini*	*Coptopsylla hajramalievensis*	*C. lamellifer*	*C. olagn*	*Nosopsyllus wrealis*	*N. laeviceps*	*N. turkmenicus*	*N. mokrzeckyi*	*N. tersus*
1	Ust-Urt, Mangischlak, Pre-Embian flat plain (Mironov et al. 1965)	23	+	+	+	–	+	o	+	+	–	–	+	+	–	–
2	Southern Pre-Balkhash region (Mikulin) 1956	27	+	+	o	o	–	o	+	o	–	+	+	+	–	+
3	Kara-Kum Desert including SW, Central and SE parts (Tikhomirova, Zagniborodova, 1958)	22	+	+	o[1]	o	o[2]	–	+	+	o[2]	–	+	+	–	+
4	Southern Turkmenistan, including SW and Central Kopet-Dag and foothills of the Praropamiz mountains (Tikhomirova, Zagniborodova 1958, with additional data from Zagniborodova et al. 1967)	26	+	+	o	+	o[3]	–	+	+	+	–	+[4]	+	+[5]	+[5]

[1]) numerous in south-eastern part of Kara-Kum desert
[2]) numerous in south-western part of Kara-Kum desert
[3]) numerous in pre-mountains of south-western Kopet-Dag
[4]) this species was found only in SW Kopet-Dag
[5]) these species were found only in the region of the foothills of the Paropamiz mountains

Middle Asia and Kazakhstan parasitological survey were made on a massive scale; tens of thousands of animals were checked in different seasons of the year and in different habitats, while in Iran the number of animals examined was more limited (see Table 4). In any case, if we take as a comparison only the species of fleas that are specific to *R. opimus* and the subfamily Gerbillinae, we see that Iranian populations of the great gerbil differ very little from populations to the North; 18 species of fleas in the Southern Prebalkhash region and in Southern Turkmenistan, 17 species in Iran, 16 in the Kara-Kum desert and 14 in the North-west of the range. Several species of fleas of this group play a paramount role in plague epizootics in desert foci of Middle Asia and Kazakhstan.

Features of the adaptation of fleas not only to the principal host but also to the environment are of great importance in the analysis of their fauna (Ioff 1941; Mikulin 1956). Therefore, Zagniborodova (1960) in West Turkmenia differentiatied three groups of fleas: species which are often found in sandy areas, species which prefer areas with firm soil, and species which occur evenly all over this territory. Accordingly, depending on ecological conditions in different parts of the range of the great gerbil, the composition of flea fauna is rather sharply distinguished. In the North-western part (precmbian flat plain) *X. skrjabini* and *Ctenophthalmus dolichus* dominate; in the Southern region of Turkmenistan, the dominant species are already different—*X. gerbilli* and *X. nuttalli*. There are also considerable difference in the ratio of species of fleas in the different landscape sections, in the Prebalkhash region and in Kara-Kum desert (Mikulin 1956; Tikhomirova, Zagniborodova 1958).

Taking into account these local differences we decided to examine features of faunistic complexes of fleas within the limits of the Iranian part of the range of the great gerbil directly in certain areas. In all, we had more or less comparable data for five settlements of *R. opimus* (Table 4, Fig. 1). Three of them (on the Turkmenian Plain, in the vicinity

of its range in Kazakhstan and Middle Asia.

and other gerbils									Fleas of other animals																
N. vlasovi	*Paradoxopsyllus repandus*	*P. tertifrons*	*Ctenophthalmus dolichus*	*Rhadinopsylla celebis*	*R. soria*	*Stenoponia conspecta*	*S. vlasovi*	Number of species	*Puler irritans*	*Ctenocephalides canis*	*Symsternus longispinus*	*S. pallidus*	*Rostropsylla daca*	*Nosopsyllus fidus*	*Citellophilus trispinus*	*Frontopsylla semura*	*F. frontalis*	*Ophthalmopsylla volgensis*	*Mesopsylla eucta*	*M. lenis*	*M. rothschildi*	*M. tuschkan*	*Amphipsylla schelkovnikovi*	*Neopsylla tvratura*	*N. setosa*	Number of species
–	+		o	+	–	+	+	14	+	+	–	–	–	–	+	+	–	+	–	+	–	+	+	–	+	8
–	+	o	+	+	+	+	+	18	+	–	+	–	–	+	+	–	+	–	+	+	–	–	–	+	+	9
–	–	+	+	+	+	–	+	16	–	–	+	+	+	–	+	–	–	–	+	–	+	–	–	–	–	6
+[*]	+[*]	+[*]	+	+	–	–	+	18	+	–	+	+	+	–	–	–	+	–	+	–	+	–	+	–	–	8

*) these species were found only in central Kopet-Dag
– fleas of this species were not found on the great gerbils
+ fleas of this sppecies were found on the great gerbils
o fleas of this species were most numerous on the great gerbils

Table 4. Fleas of the great gerbil *(Rhombomys opimus)* in different parts of its range in Iran

No. on the map	Place and time of collection	No. of checked great gerbils	No. of collected fleas	Total No. of species of fleas	Species of fleas															
					E. oschanini	*X. gerbilli*	*X. nuttalli*	*X. conformis*	*C. hairamaliensis*	*C. lamellifer*	*C. mesghalii*	*C. mofidii*	*N. baltazardi*	*N. pringlei*	*N. ziarus*	*N. laeviceps*	*N. turkmenicus*	*N. vlasovi*	*N. aff. tersus*	*A. schelkovnikovi*
1	Turkmen Sahra [XI — 1957*); VII — 1967]	? 20	48	4	—	—	21	—	—	13	—	—	—	—	—	13	—	—	1	—
2	Dasht [VII — 1969]	10	32	5	3	—	26	1	—	—	—	—	—	—	—	1	—	—	—	1
3	Loftabad [XI—XII — 1964, 1965; VIII — 1968]	18	181	6	—	123	—	5	9	16	—	—	—	—	—	—	16	12	—	—
4	Tabas [XII — 1965; V — 1966]	30	61	4	—	—	5	38	—	—	—	1	17	—	—	—	—	—	—	—
5	Isfahan-Gawkhoni area (6 points), [X—XII 1964, 1965; V — 1969]	130	1001	7	41	—	579	61	—	2	39	—	—	55	224	—	—	—	—	—

*) This collection was made by an expedition of the Pasteur Institute (Klein et al., 1963)

of Dasht and near Loftabad) could be related to the Turkmenian regional complex of populations of the great gerbil, and two others (in the vicinity of Tabas and Isfahan) belong to the Central-Iranian complex (Neronov, Farhang-Azad 1971). The total number of species of fleas, discovered on animals at different points, was not very large—from 4 to 7 species, although a survey was made in the spring and autumn-winter periods, when the composition of the flea fauna on animals is always more varied.

An analysis of Table 4 shows that, according to the composition of species of fleas, a population of great gerbils in the vicinity of Loftabad is distinguished from those of all other parts. It has only one species of flea in common with the population on the Turkmenian Plain (*C. lamellifer*, totalling 9 species) and one species in common with

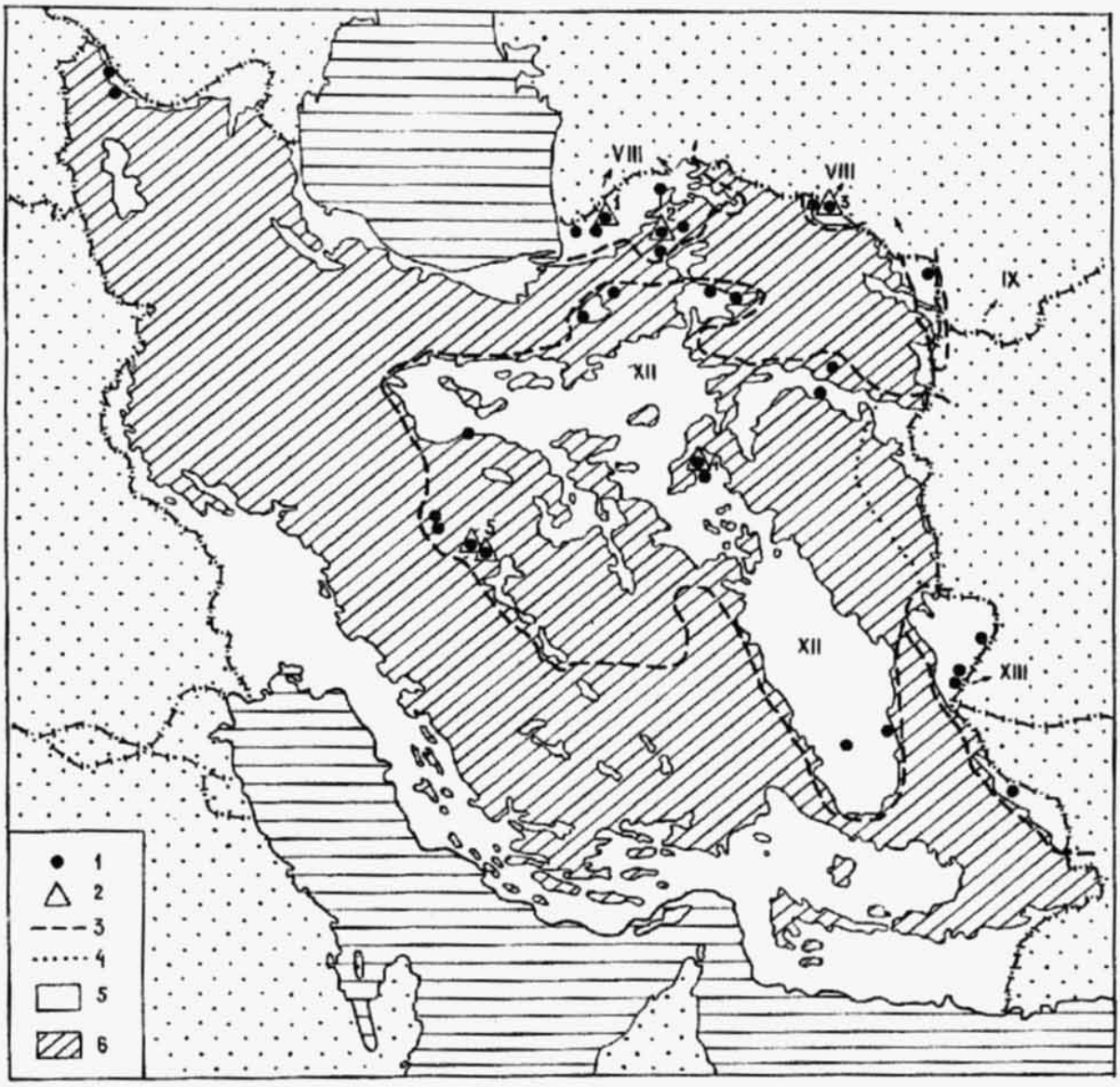

Fig. 1. The range of the great gerbil in Iran and distribution of flea collecting sites. 1.— Points of discovery of great gerbil in Iran. Description of them is given by us (Neronov, Farhang-Azad, 1971) elsewhere. 2. — Sites of collection of fleas from great gerbils. Names (1 — 5) and time of collection are given in table 4. 3. — Boundaries of different regional complexes of populations of the great gerbil. VIII — Turkmenian regional complex; IX — South-Eastern Kara-Kumian (after Dubrovsky, Kuceruk, 1971); XII — Central Iranian; XIII — Seistanian (after Neronov, Farhang-Azad, 1971). 4. — Supposed boundary of the Central Iranian regional complex. For specification, data on the structure of range of great gerbil in Afghanistan are needed. 5. — Area is below 900 m. above sea level. 6. — Area is over 900 m. above sea level. In both cases schematically after the map of Iran, 1 : 1.500.000 scale, 1968.

populations from the vicinities of Tabas, Dasht and Isfahan (*X. conformis**) (totalling 9, 10, 11 species of fleas respectively). This indicates the considerable difference in ecological conditions in these areas and to some degree their isolation (see Fig. 1). It is of interest to mention that only in the vicinity of Loftabad such species of fleas as *X. gerbilli*, *C. bairamaliensis*, *N. turkmenicus*, which are widely distributed in Middle Asia, were discovered on the great gerbil in Iran (Tables 3,4).

The dominant species found on great gerbils in the Central Iranian regional complex is *X. nuttalli*, which is also rather common in the vicinity of Dasht, on the Turkmenian Plain and further to the North in West Turkmenia. On the other hand, the presence of several species of fleas, which are absent both in Northern Iran and in the territory of Middle Asia (*C. mishgalli*, *C. mofidii*, *N. baltazardi*, *N. pringlei*, *N. ziarus*), is very characteristic for this complex. It is necessary to underline that for *C. meshgalii* and *N. ziarus* the great gerbil is undoubtedly the principal host. The originality of the flea fauna in the Central Iranian complex and the presence of endemic species here among parasites of the great gerbil once more bear witness to its antiquity and isolation. It would be interesting to continue this comparative analysis using the data on flea fauna of the great gerbil from separate settlements in Iranian Azarbaijan and also from the Seistanian regional complex (Fig. 1), but unfortunately we do not have such data yet.

Cultures of the plague bacillus were isolated many times from a great number of species of fleas (Rall 1960, Fenyuk et al. 1060) and at least ten of them were found on the great gerbil in the Iranian part of its range. However, not all species of fleas have the same importance as vectors of plague. Observations on foci and experimental data showed that, on the basis of several criteria (Ioff 1941; Novokreshchenova, Kuznetsova 1964), only fleas of genus *Xenopsylla* are principal vectors of plague in Northern deserts. In the territory of Western Turkmenia, for example, during the plague epizootic in 1953—55, the main epizootiological role belonged to *X. hirtipes*, *X. conformis* and *X. nuttalli* (Mikulin et al. 1960). The latter two species, as was described above, are rather numerous in populations of the great gerbil in Northern and Nort-eastern Iran, and also in the Central-Iranian complex. Therefore, there are grounds to believe that the circulation of the plague bacillus is also possible in the territory of the Iranian part of the range of *R. opimus*. The most favourable conditions for natural foci of plague should be in areas where there are dense settlements of *R. opimus* and *M. libycus*, between which there is a rather wide exchange of fleas.

A special epizootiological survey of the Iranian part of *R. opimus* is needed for corroboration of this assumption and also detailed studies on the ecology of different species of fleas are required in order to estimate their role as potential vectors of plaque in Iran.

ФАУНА БЛОХ БОЛЬШОЙ ПЕСЧАНКИ (*RHOMBOMYS OPIMUS* LICHT.) В ИРАНЕ

А. Фаранг-Азад и В. Перонов

Резюме. Впервые авторы анализируют фауну блох больших песчанок (*Rhombomys opimus* Licht.), добытых в разных частях Ирана. Приводится сравнение с другими видами грызунов подсемейства Gerbillinae и с фауной блох большой песчанки и некоторых эндемичных по чуме районов Казахстана и Средней Азии. Подчеркивается древность Центрально-Иранского комплекса популяций большой песчанки и делается предположение о возможности существования природных очагов чумы на его территории.

*) This species which is widely distributed in Iran, as is mentioned by Mikulin (1956) and Zagniborodova (1960), is more characteristic for small gerbils (*M. libycus*, *M. meridianus*), although it is very often found also on great gerbils.

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A. F.—A. ,School of Public Health, The University of Teheran, Teheran, Iran