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ON THE EPIDEMIOLOGY AND EPIZOOTIOLOGY OF CUTANEOUS LEISHMANIASIS OF THE RURAL TYPE IN THE KARSHI OASIS OF THE UZBEK SSR

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SUMMARY

The reservoir of cutaneous leishmaniasis in Karshi area, Uzbek SSR, is *Rhombomys opimus*, whose infection is seasonal with maximum in July.

The intensity of the focus depends on the survival of infected *R. opimus* through the winter.

Ten species of sandflies have been found in a focus of rural type. The more frequent in colonies of *R. opimus* are *Phlebotomus papatasi, P. mongolensis, S. graecovi* and *Sergentomyia arpaclensis;* in villages, *S. arpaclensis, S. graecovi* and *P. papatasi.* The prevalence of each species presented two peaks (in May-June and in July-August).

Judging by the prevalence and infection rate with leptomonads, *S. arpaclensis* and *P. papatasi* are the most likely vectors of cutaneous leishmaniasis in the villages and in the gerbil colonies. *P. mongolensis* must be significant for the epizootic spread. Exchange of sandflies between villages and gerbil colonies is intense, bringing infection from the natural focus into human communities.

Control experiences showed that gerbils could be erradicated in 2-3 years from oasis isolated from desert reinvasion.

Editor's summary

INTRODUCTION

Among the diseases transmitted by sandflies at the present time, cutaneous leishmaniasis of the rural type is found more frequently than others in the southern parts of the USSR. This disease occurs in the Middle-Asian republics of the USSR, particularly in the Uzbek and Turkmen republics. Its main outbreaks in recent years in the Uzbek SSR occurred in the Surkhan-Darja valley, Karshi oasis and the pre-desert area of Bukhara and Karakul oasis. In 1957-1960 the number of patients in the Uzbek SSR reached four-figure numbers.

As was first shown by LATYSHEV & KRUKOVA [11], cutaneous leishmaniasis of the rural type is a disease of desert rodents. The authors established that foci of cutaneous leishmaniasis were found in habitats of *Rhombomys opimus* Licht. and *Meriones libycus erythrourus* Gray. In addition, the epizootics involved *Spermophilopsis leptodactylus* Licht. and *Meriones meridianus* Pall.

Sandflies inhabiting burrows of rodents are the vectors of the causative agent of this disease. They maintain the epizootic among the desert rodents, and in this way

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microfoci of infection exist in nature independently of man. The disease is spread to people by sandflies flying from burrows of rodents to human settlements.

We conducted our studies in 1960, in a focus of cutaneous leishmaniasis of the rural type, in the Karshi oasis in the Uzbek SSR. The oasis is situated in the basin of the Kashka-Darja river, the waters of which are used for the irrigation of cotton fields occupying the greater part of the territory of this region. Lands not used for cotton growing serve as pastures for cattle.

This focus is one of the most epidemiologically active foci of cutaneous leishmaniasis of the rural type in the Uzbek republic. It occupies the whole territory of the Karshi area and a part of the adjacent areas. It is separated from the desert by natural barriers: large main irrigation canals filled with water, the Kashka-Darja river, and wide cultivated areas unsuitable for gerbils. Thus, the focus is isolated to a certain extent and penetration into it of gerbils from the desert is made difficult. Human cases of leishmaniasis are found in all villages of the area. Convalescents, i.e. persons with traces of scars on the skin, constitute from 28 to 89 per cent of the population. Among patients, more than 73 per cent are children under 5 years of age. In some villages the case-rate is almost equal to the birth-rate (ELISEEV [6]).

We studied the following subjects:

1 — The reservoir of the causative agent of cutaneous leishmaniasis.

2 — Sandfly fauna in colonies of *Rhombomys opimus* and in villages.

3 — Physiologic status of phlebotomus flies leaving colonies of big gerbils (*R. opimus*).

4 — The incidence of infection of burrow phlebotomus flies with leptomonads.

5 — The exchange of sandflies between colonies of big gerbils and human communities.

6 — Methods of control of big gerbils as the reservoir of the causative agent of cutaneous leishmaniasis of the rural type.

METHODS

Natural hosts of the causative agent of cutaneous leishmaniasis in Karshi area were studied by ELISEEV & SIDOROVA [8]. Their method was as follows. *Rhombomys opimus* from colonies were caught into cage-traps and examined for leishmania infection. Smears were made from the affected areas of the skin and stained after Romanovsky. In order to be able to examine the same animals at certain intervals under natural conditions, marks were made on the animals. A total of 687 rodents were marked in this way, and repeatedly were caught 190 animals once, 73 animals twice, 36 animals three times, 14 rodents four times and more (SIDOROVA [16]).

For finding out the seasonal prevalence of sandflies in colonies of big gerbils, two typical colonies were selected with holes numbering 80 and 100. Every three days one fourth of all the holes, or 20-25 holes, was covered for the night with cardboard cones lined inside with paper covered with castor oil (Fig. 1). The cones were set approximately one hour before sunset and removed the following morning at about 8 o'clock, before the hosts of the colony — the big gerbils — began to move.

In order to have live sandflies from the colonies, similar cones were used, but without sticking paper. A dry truncated cone was covered with a net made of kapron (Fig. 2). Sandflies leaving a hole of the colony got into the net through the cone, and from there they were readily caught into tubes. The kapron nets were set at hours of the greatest activity of the insects, that is, aproximately one hour before sunset, and were removed at about 10-11 p.m.

In houses and outbuildings of villages sandflies were caught by the usual method, on standard sheets of paper (20×30 cm) covered with castor oil.

Live sandflies caught from gerbil colonies were dissected for the determination of the age of the population. Smears were made of the stomachs of sectioned sandflies in order to find out the infection with leptomonads. The smears were then stained after Romanovsky and examined under oil immersion.

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Fig. 1 — Carboard cone lined inside with sticking paper, which is put overnight upon the hole of a burrow for catching sandflies.

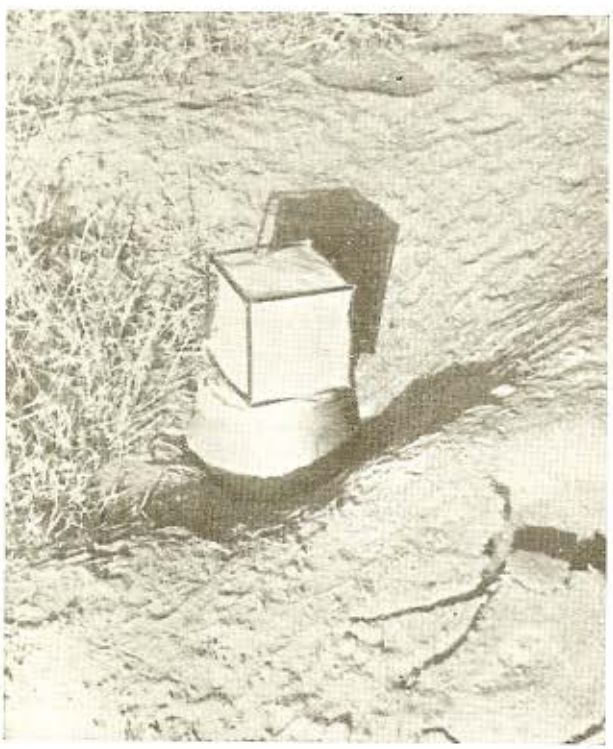

Fig. 2 — Cardboard cone with a net made of kapron for catching live sandflies.

RESULTS

1 — *Reservoir of the causative agent*

Rhombomys opimus (Fig. 3) is the natural reservoir of leishmaniae in the Karshi oasis. These rodents inhabit in the oasis dumps of numerous irrigation ditches, cemeteries, burial mounds and ruins (Fig. 4). The territory inhabited by gerbils constitutes from 2 to 10%, in average 3-4% of the total territory of the oasis. Colonies of gerbils are very frequently situated close to human communities, and some are even in the ruins of former estates, therefore there is much contact of people with sandflies from gerbil burrows.

The time of infection of big gerbils with leishmaniasis remains unknown so far. Observations by SIDOROVA [16] in the focus described here indicated the seasonal character of infection of big gerbils. In winter periods, the population of big gerbils decreases considerably. Some per cent, however, always remains, and after the winter infected gerbils may be found in colonies even at the end of June.

Thus, big gerbils preserve the causative agent of cutaneous leishmaniasis in winter time. Infected gerbils taken from the natural focus and kept in an animal house maintained leishmaniae for more than 21 months, while in gerbils marked under natural conditions almost two-years' duration (more than 23 months) of the disease was observed (ELISEEV & SIDOROVA [8]).

In spring and early in summer, big gerbils of a given age cannot be found infected; they begin to appear only from the middle of July. From this time on, the number of sick gerbils begin to grow rapidly, and in August 96 per cent of the total number of captured gerbils are infected.

First human cases in the Uzbekistan appear in the end of July and early August, that is, following the mass appearance of sandflies and infected gerbils.

2 — *Sandfly fauna*

Epidemiologic significance of sandflies in one or the other area cannot be discussed without consideration of their species composition. In a number of foci of cutaneous leishmaniasis of the rural type in the Middle Asia, such species as *P. papatasii* Scop., *P. caucasicus* Marz, and *Sergentomyia arpaclensis* Perf. are mainly found.

DERGACHEVA [5] did the main study of sandflies in this focus. The fauna was studied in colonies of big gerbils situated 2,000 m (Nos. 64 and 65) from the village, in colonies near the village (Nos. 1, 2, 3, 4) and in the village. Species composition of sandflies and their relative numbers in colonies 64 and 65 are presented in Table I.

TABLE I

Species composition of sandflies in colonies of *Rhombomys opimus* situated far from the village (Karshi oasis of the Uzbek SSR, 1960).

Species of sandflies	Colony No. 64		Colony No. 65	
	No. of individuals per season, per 739 sticking papers	Dominance in per cent	No. of individuals per season, per 976 sticking papers	Dominance in per cent
Sergentomyia graecovi	1,394	43.91	630	26.14
S. arpaclensis	958	30.18	582	24.15
Phlebotomus mongolensis	448	14.11	739	30.66
P. papatasii	288	9.05	294	12.20
P. caucasicus	83	2.62	158	6.56
P. chinensis	1	0.03	3	0.13
P. alexandri	1	0.03	1	0.04
S. sogdiana	1	0.03	1	0.04
S. clydei	1	0.03	2	0.08
Total	3,175	100.00	2,410	100.00

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Fig. 1 — Carboard cone lined inside with sticking paper, which is put overnight upon the hole of a burrow for catching sandflies.

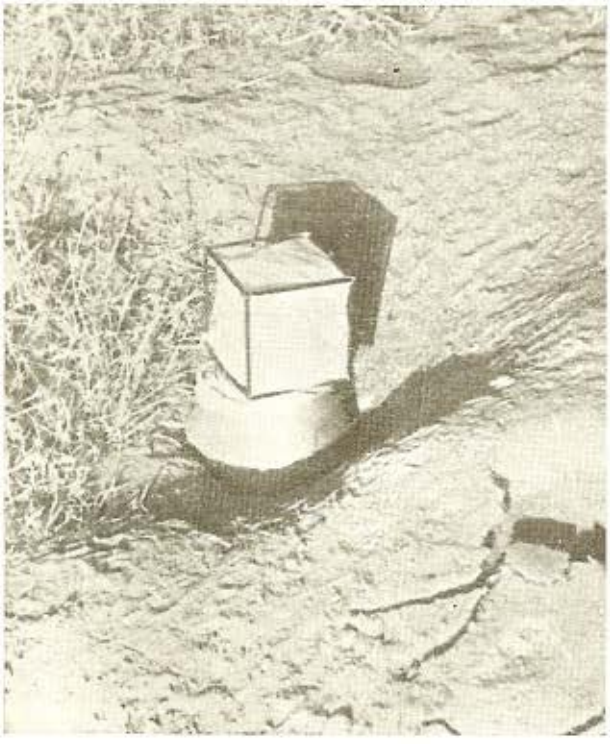

Fig. 2 — Cardboard cone with a net made of kapron for catching live sandflies.

It will be seen in Table I that in colonies of *Rhombomys opimus* such species as *S. graecovi*, *S. arpaclensis*, *P. mongolensis* and *P. papatasii* were predominant, *P. caucasicus*, was less numerous, and other species were represented occasionally.

In gerbil colonies situated in the village and near it the species composition and numbers of sandflies were similar, therefore the relevant data are summarized in Table II.

TABLE II

Species composition of sandflies in a village of Karshi area of the Uzbek SSR and in colonies of big gerbils situated near the village, 1960.

Species of sandflies	In houses of the village		Colonies Nos. 1, 2, 3, 4	
	No. of individuals per season	Dominance in per cent	No. of individuals per season	Dominance in per cent
Sergentomyia arpaclensis	13,264	53.7	226	18.2
S. graecovi	5,702	23.1	401	32.3
Phlebotomus papatasii	5,005	20.2	577	46.4
S. sogdiana	310	1.2	1	0.05
P. alexandri	216	0.9	1	0.05
P. sergenti	136	0.6	—	—
P. mongolensis	37	0.1	31	2.5
P. caucasicus	24	0.1	—	—
P. chinensis	17	0.1	7	0.5
Total	24,711	100.0	1,244	100.0

We present the data of the seasonal prevalence of sandflies in colonies of *Rhombomys opimus* for the 4 dominant species, *S. graecovi*, *S. arpaclensis*, *P. mongolensis* and *P. papatasii*. *S. graecovi* were first found in colonies on May 3-4. During the season, all the four species had two peaks of prevalence, the first in May-early June, the second in late July-August; only *S. graecovi* had the second peak in September (Fig. 5). The period of time between two peaks for *P. papatasii*, *P. mongolensis* and *S. arpaclensis* was 1-1.5 months, and for *S. graecovi* 2-2.5 months. In the middle of the summer, *S. graecovi* were very scanty; this species is apparently less heat-loving than all the others, and it spends the hot period of July-August in pre-imago stages of development, in the temperate microclimate of deep burrows. In May and September, however, *S. graecovi* is prevalent in the colonies. Two peaks of sandfly prevalence in the season correspond to two generations, which is confirmed by the seasonal dynamics of the age composition of populations of individual species.

In the village, the first sandflies were found on sticking papers on April 27. A total of nine species were found during the season (Table II). The prevalence of sandflies was high: on one sticking paper an average of 60 specimens were caught during the season. It will be seen in Table II that in the village *S. arpaclensis* and *S. graecovi*

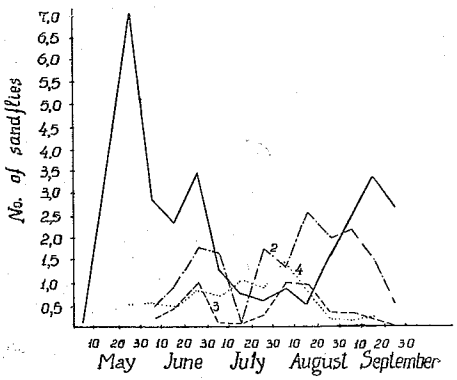

Fig. 5 — Seasonal prevalence of most numerous species of sandflies in a colony of *Rhombomys opimus*, in the Karshi oasis of the Uzbek SSR, 1960: 1 — *S. graecovi*. 2 — *S. arpaclensis*. 3 — *P. papatasii*. 4 — *P. mongolensis*.

were most prevalent; *P. papatasii* occupied the third place, other species were not numerous. The seasonal prevalence of sandflies in the village is presented in Fig. 6.

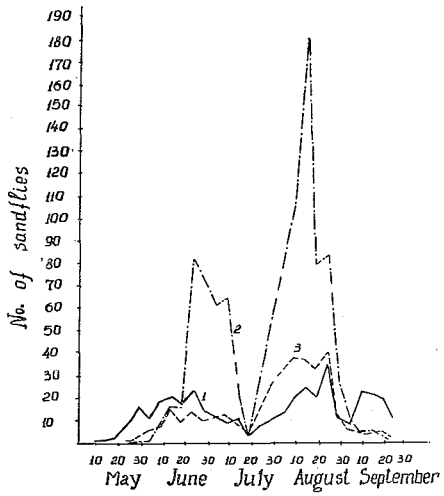

Fig. 6 — Seasonal prevalence of most numerous species of sandflies in a village of Karshi area of the Uzbek SSR, 1960.

Comparison of Tables I and II indicates that in all the three types of biotopes, that is, in colonies of gerbils more or less removed from villages, in colonies situated in villages or close to them, and in villages such species as *S. arpaclensis, S. graecovi, P. papatasii* and *P. mongolensis* prevail. However, in colonies situated far from the village *P. papatasii* was fourth in frequency, but in colonies in or close to the village it occupied the first place.

3 — *Physiologic status of sandflies leaving colonies of big gerbils*

A — *Composition of sandflies in relation to stages of digestion.* In the evening, sandflies leave all their shelters regardless of whether the latter serve as places for the day's rest, breeding places or feeding places. Inhabited colonies of *Rhombomys opimus* meet all the above requirements, but still in the evening sandflies leave them. Most sandflies leaving burrows were found to be hungry. This is particularly true for *S. graecovi* and *S. arpaclensis,* as from 71.2 to 87.2% of the members of these species were hungry females. Females with mature ova were not numerous, and at the intermediate stages of digestion were quite few. Among *P. papatasii* and *P. mongolensis* leaving the same colonies, hungry females were less numerous in comparison with the former, but there were much more females with mature ova, also at the intermediate stages of digestion (Fig. 7). It is difficult to explain such differences. It is possible that species of *Sergentomyia* are more adapted to life in rodents' burrows, and therefore their females in most cases remain till the end of the digestion in burrows where oviposition occurs. Hungry females leave colonies due to more marked positive phototaxis to twilight.

B — *Age composition of sandflies.* Epidemiologically dangerous in leishmaniasis are only female sandflies which suck blood twice. Second blood-sucking is in most cases, associated with repeated gonotrophic cycle. But occasionally female sandflies are found with two-coloured blood in their stomach, which means that they sucked blood repeatedly during one gonotrophic cycle (DOLMATOVA [4], LISSOVA [12, 13, 14]). Such females are found more frequently in human settlements. Among sandflies living in burrows such phenomenon is rarely observed.

Epidemiologic significance of repeated bloodsucking during the first gonotrophic cycle and of sucking during the second cycle is not equal. According to KHODUKIN [9] and ADLER & THEODOR [1], leptomonads appear in the intestinal tract of sandflies on the day after infection, and beginning with the 5th to the 8th day the intensity of infection of female sandflies increases. This period of 5-8 days is approximately equal to the duration of one gonotrophic cycle, and bloodsucking at the beginning of the second cycle occurs in the presence of greater number of leptomonads in the intestinal tract and mainly in the pharynx of infected sandflies. We believe, therefore, that bites of sandflies during repeated gonotrophic cycles play the main role in the transmission of the causative agent of leishmaniasis. Hence, of great importance is the determination of age composition of separate species of sandflies leaving colonies of *Rhombomys opimus* in the focus of cutaneous leishmaniasis.

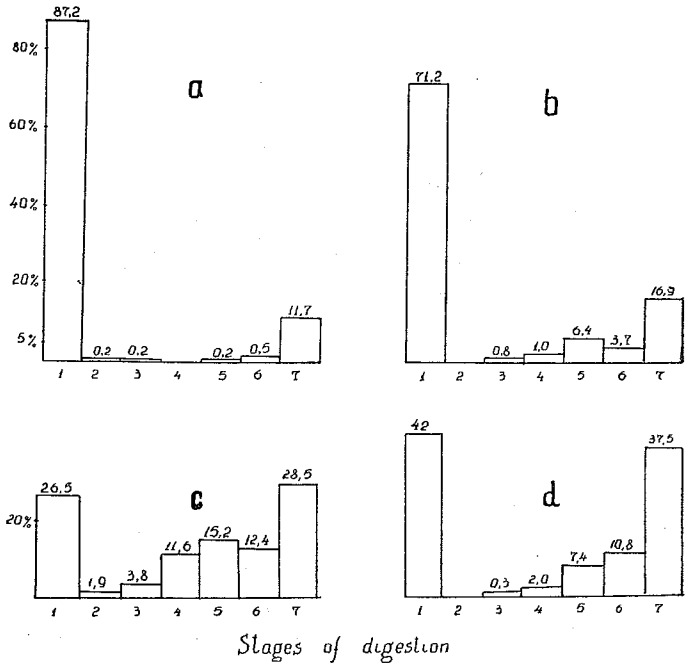

Fig. 7 — Composition of sandflies leaving gerbil colonies in relation to stages of digestion: (a) *S. graecovi*, (b) *S. arpaclensis*, (c) *P. papatasii*, (d) *P. caucasicus*.

We differentiated nulliparous and parous sandfly females on the basis of differences in the structure of their reproductive organs by the method described elsewhere (DOLMATOVA [4]). During the season of 1960 we examined 1,562 female sandflies from colonies of *Rhombomys opimus* in order to determine their age. The percentage of parous females changes during the season. Its usual peaks occur 7-10 days after the seasonal peaks of the first and second generations. In the Karshi oasis the first rise in incidence of parous females for *S. arpaclensis* and *S. graecovi*, according to sections, is observed at the end of June and early July (up to 40%), and the second rise at the end of August-early September (up to 60%). The average per cent of parous females during the season in these species is 18.1 and 20.7, respectively. Besides, the epidemiological significance of this or that species depends to a great extent upon its incidence; for example, in early August the per cent of parous females is lower (25%) than at the end of August (60%), but the incidence of the species is high and parous females are numerous.

Among other species of sandflies the age of only 202 females of *P. papatasii* and 216 females of *P. mongolensis* was determined; 151 (74,7%) and 117 (54,1%) of them, respectively, were found to be parous. Evidently, in these species the per cent of parous females is considerably higher than in *S. graecovi* and *S. arpaclensis*, and this suggests their certain epidemiologic significance.

4 — *Infection of burrow sandflies with leptomonads*

For the determination of infection with leptomonads of individual species of sandflies leaving colonies of big gerbils smears were made from stomachs of all dissected female sandflies, except for newborns. During the season smears were prepared from a total of 1,020 sandflies distributed by species in the following way: *S. graecovi* — 186; *S. arpaclensis* — 114; *P. papatasii* — 407; *P. mongolensis* — 313. Other species of sandflies were not numerous and all of them were not infected. Of 1,020 sandflies 112 were infected with different flagellates, 59 of them with leptomonads.

Both broad and narrow leptomonads were found in the stomachs of sandflies (SHUIKINA [15]). Narrow leptomonads represent in-

vasive forms and are found at later stages of digestion in sandflies (Table III).

TABLE III

Infection of sandflies with leptomonads at different stages of digestion, after Sella-Dolmatova.

Stages of digestion	Leptomonads		
	Type I	Type II	Types I and II
III	1	—	—
IV	4	1	1
V	14	1	3
VI	3	18	8
VII	1	1	—

First leptomonads were found at the end of May in one of 63 sectioned females of *P. mongolensis*. Subsequently, the number of findings increased. From a colony near the village where there were infected gerbils, 326 smears were made from sandflies, and 18 (5.3%) of them were found to contain leptomonads. In colonies situated 500-2,000 m from the village 527 smears of sandflies were made, and leptomonads were found in 31 (5.9%). In these colonies there were also infected rodents. Among sandflies captured in uninhabited colonies leptomonads were found only in one of 69 smears (1.4%). In colonies far from the village the four most numerous species were found to be infected, but the rate of infection was not similar in all. The rate of infection with leptomonads in *S. arpaclensis* and *S. mongolensis* was higher than in *P. papatasii* and *S. graecovi* (Table IV). During the season only 3 females of *P. papatasii* out of 110 dissected were found infected with leptomonads, and for *S. graecovi* the respective figures were 1 of 73.

TABLE IV

Infection of sandflies with leptomonads in colonies of big gerbils in the Karshi oasis, 1960.

Local and months	*P. papatasii*		*P. mongolensis*		*S. arpaclensis*		*S. graecovi*	
	Total No. of smears	Infected	Total No. of smears	Infected	Total No. of smears	Infected	Total No. of smears	Infected
Colonies situated 500-2,000 m from the village:								
June	43	2	67	2	27	1	42	—
July	12	—	86	9	10	1	20	1
August	52	—	40	7	22	5	7	—
September	3	1	2	—	2	2	4	—
Total for the season	110	3	195	18	61	9	73	1
Colonies situated near the village:								
June	99	1	2	—	16	—	29	1
July	46	—	5	—	18	—	11	—
August	78	15	1	—	8	1	5	—
September	—	—	—	—	—	—	—	—
Total for the season	223	16	8	—	42	1	45	1

In colonies situated near the village there were few infected female sandflies in June and July, but in August the number infected increased considerably. Of 78 smears made of the stomachs of *P. papatasii* 15 were found to contain leptomonads (19.2%); for *S. arpaclensis* leptomonads were found in one smear out of eight.

Thus, of the four most prevalent species of sandflies *S. arpaclensis* appears to be the most likely vector of the causative agent of cutaneous leishmaniasis, as this species is the dominant in the village, is found in great number in colonies of big gerbils, attacks man, has sufficiently long life and is infected with leptomonads to a considerable extent. *P. mongolensis* also has high rates of infection, but is very scanty in the village, and therefore may probably be important in transmitting the infection from gerbil to gerbil only.

P. papatasii are relatively numerous both in gerbil colonies and in the village, are most long-lived and aggressive towards human beings of all the species discussed, but their rate of infection with leptomonads is lower than that of *S. arpaclensis* and *P. mongolensis*. It is still possible that *P. papatasii* may play a certain role in transmitting the agent of cutaneous leishmaniasis. In our focus *S. graecovi* can hardly be the vector because, first, at the peak of epidemic season — July and August — this species is not very numerous, in September their prevalence is higher because of young females, and, second, *S. graecovi* were found to be infected mainly with trypanosomes and crithidiae which cannot be considered to be the causative agents of cutaneous leishmaniasis.

5 — *Exchange of sandflies between gerbil colonies and the village*

LATYSHEV & KRUKOVA [10], by releasing stained sandflies determined the range of their flights under conditions of sand desert. According to these authors, sandflies are capable to cover the distance up to 1.5 km from gerbil colonies to the village. Sandflies flying from such gerbil colonies to human communities transmit the causative agent of cutaneous leishmaniasis to people.

We studied the flights of sandflies from gerbil colonies to the village and from the village to gerbil colonies. A place was selected so that the distance between the village and gerbil colonies was 81 m. At different distances from the village and the colonies sticking papers were set to catch sandflies. Between the colonies and the village there were no shelters for sandflies, so that sandflies caught on sticking papers were either from the village or from gerbil colonies. The sticking papers were covered with castor oil, and sandflies flying between the village and colonies were caught on them. Sticking papers were put both close to and far from the village or the colonies and many sandflies were caught (from 123 to 486 sandflies per 75 pieces of sticking paper).

The exchange of sandflies between the village and colonies is very intensive.

Our studies showed that most sandflies fly low above the ground. Pieces of sticking papers were put at different heights above the ground, and the maximum number of sandflies was caught on the lowest row, less on the middle and still less on the upper row (Table V).

TABLE V

Results of catching sandflies at different heights above the ground.

Rows of sticking papers	Height above the ground (cm)	No. of sticking papers	Date of catch and number of sandflies		
			June, 19-20	June, 30-July, 1	July, 27-28
Upper	90-120	25	67	265	17
Middle	50- 80	25	129	412	37
Lower	30- 40	25	221	1,358	204

Sticking papers placed directly upon the ground gave even greater number of sandflies than those in the lower at the height of 30-40 cm. While in the upper row the average catch of sandflies per piece of sticking paper was 0.8, in the middle row 1.7 and in the lower row 14.7, sticking papers of the same size placed directly upon the ground yielded from 150 to 307 sandflies. The flight of sandflies low above the ground makes it possible to use, successfully, the barrier treatment of the ground around the community being protected. Such experiment was conducted in the Turkmen SSR with good results (ALEKSEEV, KERBABAEV & FEDDER [2]).

The causative agent of cutaneous leishmaniasis is transmitted from a natural focus to a human community by sandflies going from colonies of big gerbils to human settlements. The flight of sandflies from human communities to gerbil colonies does not seem to be less intensive so that possible migration of the causative agent in the reverse direction, that is from the village to the nearby colonies, cannot be ruled out.

As mentioned above, human cases in the focus begin to appear at the end of July-early August, that is, they follow mass appearance of infected gerbils and high prevalence of sandflies.

When the infection from a natural focus has been introduced into a human settlement, however, the possibility can not be ruled out that it may be transmitted from a sick person to a healthy one by sandflies living in the settlement.

ELISEEV confirmed this suggestion by the following data (1961):

1 — Mass human cases of cutaneous leishmaniasis occur in areas where occasional colonies of big gerbils were found but where there were no other natural sources of the causative agent (ELISEEV, KOZLOV & SIDOROVA [7]; ELISEEV [6]).

2 — Occurrence of human cases in villages situated at 4-5 kilometers from gerbil colonies, a distance much greater than that of sandflies' flights.

3 — Family cases or group cases in areas far from gerbil colonies.

4 — Frequently, after eradication of all infected gerbils around a village, cases still occur, if by the time of eradication of rodents at least a few people have happened to get infected.

6 — *Control of big gerbils as reservoirs of the causative agent of cutaneous leishmaniasis of the rural type*

Control of sandfly vectors by treatment of premises and houses in village with insecticides in 1958-1959 did not result in eradication of the disease. Methods for control of sandflies in burrows of rodents have not yet been worked out. Considering the fact that the focus in the oasis was isolated to a certain extent and access of gerbils from the desert was impeded, but still big gerbils were the only reservoir of the causative agent of cutaneous leishmaniasis, control was effected through eradication of gerbils. The main work was carried out by ELISEEV [6] under the guidance of prof. L. M. Isaev.

A map showing the distribution of gerbil colonies was preliminarily drawn. This made it possible to define the borders of the territory to be treated. In this particular case under treatment were colonies of epidemiologically dangerous populations of rodents within the natural limits of villages, that is, territories inhabited by autonomous populations, separated from each other and from adjacent desert population by main irrigation canals and other barriers impeding free movement of rodents from the territory of one population to that of another. Within villages, all colonies regardless of the distance between them and the habitations were to be destroyed (ELISEEV [6]).

A method of poisoning gerbils with grain baits containing zink phosphide (Zn_3P_2) was found to be effective in the control of big gerbils. A hundred parts by weight of wheat, 2 parts of vegetable oil and 12 parts of zink phosphide are used. This bait is put 10-15 cm deep into the burrow. Such work should be started early, before gerbils begin to breed and before sandflies fly out

of their colonies. This reduces the cost of treatment, and besides, destruction of gerbils later, that is during epizootic, induces infected sandflies to fly to villages for a second bloodsucking. Due to this, possibilities for human exposure to infected sandflies become greater and may lead to an artificial outbreak of leishmaniasis in the community.

In the Uzbek SSR it is most advisable to start this work in March. One and the same territory should be repeatedly treated during one season. Intervals between treatments should not excede one month, because, in this way rapid breeding of gerbils may be prevented. During the second year after treatment, control with poisoning of previously ommitted colonies should be conducted. In 1960 gerbil control in the Uzbek SSR was delayed; four cycles of poisoning were carried out in May, June, July and September. After three cycles, here and there occasional live colonies remained which had been ommitted by chance during treatment.

Reduction of the number of gerbils to the minimum does not result in complete sanitation of the locality. Cessation of cases was achieved only in such places where, after treatment, not a single live colony with infected gerbils was left.

Control of gerbils in the Karshi area was carried out in 1960-1961. In 1961, in this area, a total of 90 cases were reported as compared with 159 cases in 1960, and 1,916 cases in 1958.

CONCLUSIONS

1 — The reservoir of the causative agent of cutaneous leishmaniasis in a natural focus in the Karshi area of the Uzbek SSR was found to be *Rhombomys opimus*. Infection of the rodents is of seasonal character, and mass infection occurs in July.

2 — The causative agent of cutaneous leishmaniasis persists in gerbils during the winter. The intensity of the focus depends on the survival of infected *Rhombomys opimus* through the winter.

3 — Ten species of sandflies have been found in a focus of cutaneous leishmaniasis of the rural type: *P. papatasii*, *P. mongolensis*, *S. graecovi*, *S. arpaclensis*, *P. caucasicus*, *P. alexandri*, *P. sergenti*, *P. chinensis*, *S. sogdiana* and *S. clydei*. The first four species are most prevalent in colonies of *Rhombomys opimus*. In villages *S. arpaclensis*, *S. graecovi* and *P. papatasii* are more prevalent, but *P. mongolensis* were not numerous.

4 — All the four species dominating in colonies had two peaks of prevalence during the season: the first at the end of May and early June, and the second at the end of July and first half of August; only *S. graecovi* showed the second peak in September.

5 — In the evening, *P. papatasii* and *P. mongolensis* leave the colonies of *Rhombomys opimus* at all stages of digestion, whereas females of *S. graecovi* and *S. arpaclensis* are in most cases hungry (71.2-87.2%), when they leave colonies.

6 — Female sandflies leave colonies both during the first and the following gonotrophic cycles. During the season *S. graecovi* had 18.1% parous females, *S. arpaclensis* had 20%, *P. papatasii* 74.7%, *P. mongolensis* 54.1%.

7 — The rate of infection with leptomonads was almost similar in sandflies captured from colonies situated both close to and far from the village (500-2,000 m): 5.3 and 5.9%, respectively.

8 — In colonies remote from the village, the highest rate of infections of sandflies females with leptomonads was found in *S. arpaclensis* and *P. mongolensis* (up to 22.7% in August). *P. papatasii* and *S. graecovi* in these colonies were infected to much lesser extent. In colonies near the village a high infection-rate was found in *P. papatasii* (19.2%), in August.

9 — Judging by the high prevalence of sandflies both in villages and in colonies, and by a relatively high infection-rate with leptomonads, *S. arpaclensis* and *P. papatasii* are most likely vectors of the causative agent of cutaneous leishmaniasis.

10 — *P. mongolensis* are numerous in colonies and are possibly significant in the

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spread of epizootics among gerbils but in villages they are found only occasionally and cannot transmit the causative agent to man.

11 — *S. graecovi* is the dominating species in May and September, but not very numerous in the middle of summer (July, August). Its prevalence in September is due to flying out of young females which have no epidemiologic significance.

12 — Exchange of sandflies between the village and gerbil colonies is very intense. Sandflies from gerbil colonies bring the causative agent of cutaneous leishmaniasis from the natural focus into a human community. A possibility of transmission of the causative agent in the reverse direction, that is, from the village to gerbil colonies, cannot be ruled out.

13 — The experience of control in the Karshi area showed that in an oasis isolated from penetration of gerbils from the desert it is practically possible to eradicate gerbils in 2-3 years by poisoning and to protect the population from infection with leishmaniasis.

RESUMO E CONCLUSÕES

Epidemiologia e epizootiologia da leishmaniose cutânea de tipo rural no oasis de Karshi, da R.S.S. de Uzbek.

1 — Num foco de leishmaniose cutânea da área de Karshi, na R.S.S. de Uzbek, verificou-se que o reservatório do agente etiológico é o roedor gerbilíneo *Rhombomys opimus*. O parasitismo nos roedores tem caráter estacional, sua infecção em massa ocorrendo em julho.

2 — O parasitismo nos gerbilíneos persiste durante o inverno e a intensidade do foco depende da sobrevivência dos *R. opimus* infectados até a próxima estação de transmissão.

3 — Dez espécies de flebótomos foram achadas num foco de leishmaniose do tipo rural: *P. papatasii, P. mongolensis, S. graecovi, S. arpaclensis, P. caucasicus, P. alexandri, P. sergenti, P. chinensis, P. sogdiana* e *S. clydei*. As quatro primeiras predominam nas colônias de *R. opimus*, enquanto nas cidades são mais freqüentes *S. arpaclensis, S. graecovi* e *P. papatasii*, sendo pouco numerosos os *P. mongolensis*.

4 — Tôdas as quatro espécies predominantes nas colônias apresentaram dois picos de freqüência durante a estação: o primeiro no fim de maio e princípio de junho e o segundo no fim de julho e primeira quinzena de agôsto; apenas para o *S. graecovi* o segundo pico ocorreu em setembro.

5 — À noite o *P. papatasii* e o *P. mongolensis* deixam as colônias de *R. opimus* em tôdas as fases da digestão, ao passo que em sua maioria (71,2 a 87,2%) as fêmeas de *S. graecovi* e *S. arpaclensis* estão famintas ao saírem das colônias.

6 — As fêmeas de flebótomos deixam as colônias de gerbilíneos durante o primeiro e o segundo ciclos gonotróficos. Durante a estação de transmissão, a percentagem de fêmeas que já haviam desovado foi de 18,1 entre os *S. graecovi*, 20,7 entre os *S. arpaclensis*, 74,7 entre os *P. papatasii* e 54,1 entre os *P. mongolensis*.

7 — A proporção de flebótomos com leptômonas foi quase semelhante entre os exemplares capturados em colônias próximas ou afastadas da cidade (500 a 2.000 metros): 5,3% e 5,9%, respectivamente.

8 — Nas colônias afastadas da cidade a maior taxa de infecção foi encontrada entre as fêmeas de *S. arpaclensis* e *P. mongolensis*: até 22,7% em agôsto. *P. papatasii* e *S. graecovi* mostram-se infectados em proporções muito menores. Nas colônias próximas da cidade um índice de infecção elevado foi observado para o *P. papatasii*: 19,2% em agôsto.

9 — Por sua alta incidência tanto nas cidades como nas colônias, bem como por seus elevados índices de infecção, o *S. arpaclensis* e o *P. papatasii* são considerados os prováveis vetores da leishmaniose cutânea na área.

10 — O *P. mongolensis* é abundante nas colônias de gerbilíneos e provàvelmente importante na disseminação da epizootia entre êles, mas nas cidades é achado só ocasionalmente e não transmite o parasito ao homem.

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11 — O *S. graecovi* é a espécie predominante em maio e setembro, mas não muito freqüente no meio do verão (julho, agôsto). Sua prevalência em setembro é devida às fêmeas recém-nascidas, que não têm importância epidemiológica.

12 — O movimento de flebótomos entre a cidade e as colônias de gerbilíneos e viceversa é muito intenso. Os flebótomos das colônias de gerbilíneos trazem o parasito dos focos naturais para as comunidades humanas e é possível que o inverso também ocorra.

13 — Experiência de contrôle na área de Karshi mostrou que, num oasis ao qual não podem vir ter gerbilíneos provenientes do deserto, é possível erradicar êsses roedores por envenenamento em 2 a 3 anos e proteger da leishmaniose a população humana.

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