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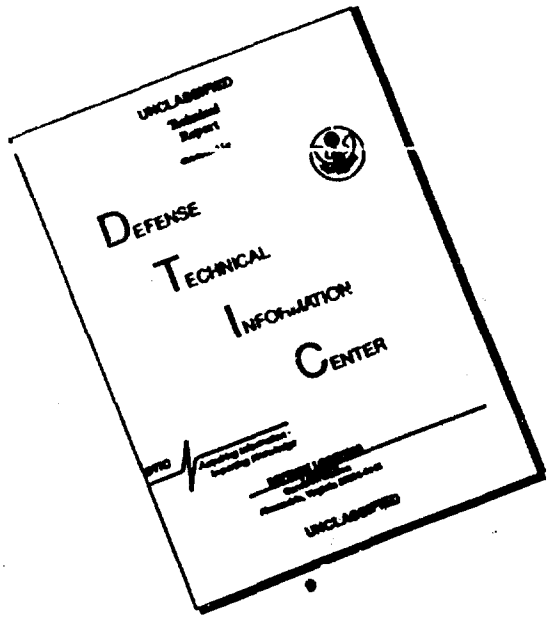

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ZOOLOGICOPARASITOLOGICAL CHARACTERIZATION OF A NATURAL FOCUS OF TULAREMIA IN THE FLOOD PLAIN OF THE MIDDLE COURSE OF THE IRTYSH RIVER

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The topographical classification of natural foci of tularemia has been elaborated with sufficient completeness for various regions in the Soviet Union. The zoologicoparasitological features of these foci have also been systematized (Olsuf'yev, 1947; Kondrashkin, 1955; Bozhenko, 1958; Maksimov, 1960; and so on), but the tularemia focus in the flood plain of the middle course of the Irtysh River had until recently not been studied. Its existence as a natural and constantly active area in this region of the river on the territory of the Pavlodarskaya Oblast of the Tselinnyy Kray in the Kazakh SSR is confirmed by the periodic illnesses of people and isolation of cultures of the causative agent itself from ixodic ticks (Dermacentor marginatus Sulz.) and aquatic Microtinae (Arvicola terrestris L.) (see map).

In connection with extensive construction of industrial enterprises of all-union significance wide utilization of the flood plain of the Irtysh River is also planned for farm and crop needs. The execution of these measures demands salubrification of this territory, and this can be effectuated only upon detailed study of the epizootiology of the tularemia focus existing here and of its theriological and parasitological peculiarities.

The flood plain territory of the River Irtysh where the tularemia focus is located is characterized by distinctive ecological conditions which cannot completely fit any one topographical zone. Here there is a great variety of microlandscapes with relief and vegetation characteristic of them. This is caused by the intrazonal state of the flood plain of this river. The flood plain woods of poplar, birch, and aspen alternate with thickets of salicaceous bushes, and the latter with meadows.

lay lands occupy 53% of the flood plain. Boggy places are very frequently encountered and occupy up to 13% of the area. Ten percent of the area of the flood plain is occupied by various waters (lakes, creeks, oxbows), and the places unsuitable for cultivation take up 24%. In the flood plain moreover regions which have gone to steppe are to be found, and on the flood-plain benches sands and shore-line dunes (Sinel'shchikov, 1961).

Material and Method

The research was conducted from 1955 to 1960 in the flood plain of the Irtysh River from the city of Pavlodar to the border of the Omskaya Oblast where in this period cases of tularemia were noted.

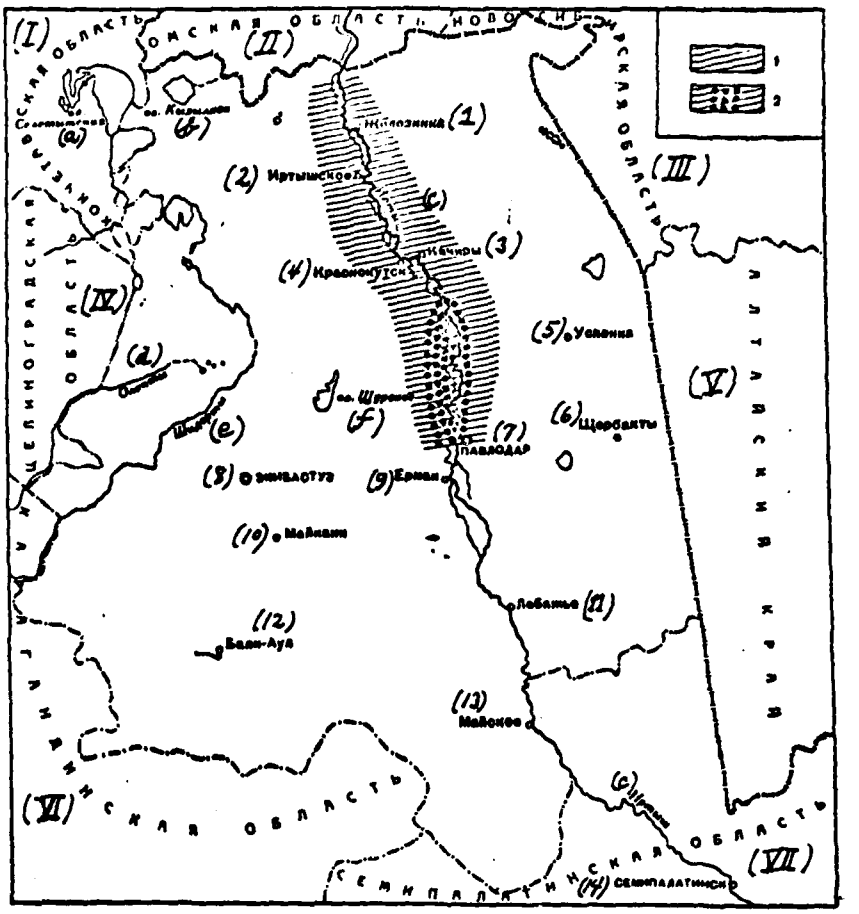
Small mammals were caught in Gero snares and bow traps Nos 0 and 1 and delivered to the field laboratory in cloth bags; 4503 small animals were caught in all, chiefly rodents and insectivores; 1982 animals were combed to collect ectoparasites and they yielded 11,002 specimens of Gamasoidea and ixodic ticks, lice, and fleas. In addition to reveal the transmission vectors of this disease we collected ixodic ticks from domestic animals (cattle and sheep) and also caught bloodsucking dipterans (mosquitos, horseflies, midges, sandflies, and flies) in different parts of the focus.

In all 1405 head of cattle and 203 sheep were examined, from which 2189 specimens of sexually mature ixodic ticks were collected. Besides this, when analyzing 28 birdnests -- of tree sparrows (Passer montanus L.), sand martins (Riparia riparia L.), and skylarks (Alauda arvensis L.) -- 26 larvae and nymphs of ixodids, 94 parasitic ticks, and 69 fleas were collected.

Of the 45,471 bloodsucking dipterans caught 34,176 mosquitos, 6043 midges, 2753 horseflies, and 2499 sandflies were looked over. Few flies were caught.

Theriological Features of Focus

On the flood plain of the middle course of the River Irtysh in the territory of the permanently active tularemia focus 26 species of rodents, insectivores, and predators have been recorded. Here the most numerous of them in our observation are: the water vole (Arvicola terrestris L.), the steward vole (Microtus oeconomus Pall.), the gregarious or narrow-skulled vole (Microtus gregalis Pall.), the red Siberian vole (Clethrionomys rutilus Pall.), the house mouse (Mus musculus L.), the woodmouse (Apodemus sylvaticus L.), and the common shrew (Sorex araneus L.). Less frequently encountered are the meadow mouse (Apodemus agrarius Pall.), the harvest mouse (Micromys minutus Pall.), the Norway rat (Rattus norvegicus Berk.), the field mouse (Microtus arvalis Pall.), the hamster (Cricetus cricetus L.), the small shrew (Sorex minutus L.), and the long-eared urchin (Erinaceus auritus Gm.). At times the red-cheeked suslik (Citellus erythrogenus Br.), the large jerboa (Allactaga jaculus Pall.),



Location of Natural Focus of Tularemia in Flood Plain of Middle Course of Irtysh River

1 -- Distribution of cases of human tularemia in occurrence of epizootics among water voles, 2 -- territory where bacteriological analyses finds causative agent of tularemia among water voles. Key: political divisions: I -- Kokchetavskaya Oblast, II -- Omskaya Oblast, III -- Novosibirskaya Oblast, IV -- Tselinogradskaya Oblast, V -- Altayskiy Kray, VI -- Karagandinskaya Oblast, VII -- Semipalatinskaya Oblast; natural features: a -- Selerytenіz Lake, b -- Kyzylkak Lake, c -- the Irtysh, d -- the Olenty, e -- the Shiderty, f -- Lake Shchurskoye; settlements: 1 -- Zhelezinka, 2 -- Irtyshskoye, 3 -- Kachiry, 4 -- Krasnokutsk, 5 -- Uspenka, 6 -- Shcherbakty, 7 -- Pavlodar, 8 -- Ekibastuz, 9 -- Yermak, 10 -- Maykain, 11 -- Lebyazh'ye, 12 -- Bayan-Aul, 13 -- Mayskoye, 14 -- Semipalatinsk.

and the steppe lemming (Lagurus lagurus Pall.) visit the flood plain from the adjacent steppes. On the shore slope of the flood plain bench the Chinese hamster (Cricetulus barabensis Pall.), the Dzungarian hamster (Rhodopus sungorus Pall.), and the subterranean vole (Ellobius talpinus Pall.) are common; the gray hamster (Cricetulus migratorius Pall.) and the European mole (Talpa europea L.) are found. All these animals come into the flood plain by chance when settling or hunting for females during the mating season, etc.

Of the predators are encountered the weasel (Mustela nivalis L.), the ermine (Mustela erminaea L.), and the Corsac fox (Vulpes corsac L.).

The rodent predominating in the flood plain -- the water vole, the steward vole, the red Siberian and the gregarious voles, wood and house mice -- are unevenly distributed. The red Siberian vole, for example, is more frequently encountered in the northern part, closer to the Omskaya Oblast boundary, where it lives in the flood plain bushes, thickets of osier willow and laurel willow, in forests on the shores of the water-courses and on islands, and sometimes in reed thickets and even in flood plain meadows. In the central part, however, the wood mouse, on the contrary, is very numerous in the same habitats. It is found along the banks of water-courses, lakes, and on the steppe terraces in bushy thickets. The house mouse is found over the whole flood plain -- most often in the northern and central parts where it lives in bushes, sedges, and meadows. The steward vole keeps to moist grassy biotopes -- marshes, shores, water-courses and lakes, and sedge thickets. The gregarious (narrow-skulled) vole, on the contrary, settles the drier part of the flood plain focus -- the banks of flood plain benches and water-courses, but with stands of different sorts of grass which retain moisture for a long time and with vegetation of weeds and bushes.

According to observations by V.I. Pakizh (oral communication) water voles are settled in the flood plain in a mosaic pattern. The areas which they inhabit are often changed because of migrations which depend chiefly on the change in the hydrological conditions of the Irtysh River. The numbers of this animal on the territory of the focus are subject to considerable fluctuations, chiefly affected by the conditions of the river itself and the tularemia epizootic occurring in connection with them. Although in some years the voles are very numerous the industrial bag of them still remains insignificant -- not more than 5000 skins a year.

Seasonal, as well as annual fluctuations are detected in the dynamics of the numbers of the water voles. These fluctuations are characterized by two rises -- the first during the flood when a great number of rodents accumulates in the undergrowth, branches of trees, and on the elevations in the ground where the water does not reach when the river overflows its banks. During the flood there is considerable animal mortality from predators, hunger, various physical reasons, epizootics, etc. The height of the flood and its duration, i.e., the period of the crest of the flood waters, exert a rather substantial effect on

the multiplication of these voles. In a long, high flood the percentage of pregnant females decreases. This could, for example, be observed in 1957 when the number of pregnant females fell from 90 to 33-35%. Moreover the average number of embryos per female also decreases. In the same year of 1957 the number of embryos per pregnant female fell from 8.5 to 7.5. Although the process of vole reproduction is somewhat retarded by the flood situation there is still no complete cessation of it. After the flood the yearly minimum number of these animals is generally observed. The second quantitative rise in numbers of voles is seen at the end of summer and in autumn. At this time after the drop in the flood waters there is a resettlement back into the habitats characteristic of these animals and further multiplication under favorable living conditions.

Thus the source of the causative agent of tularemia in the flood plain focus in the middle course of the Irtysh River in the Pavlodarskaya Oblast is made up of the following animals according to the susceptibility classification of N.G. Olsuf'yev and T.N. Dunayeva (1960): the water vole, the steward vole, and the gregarious vole. As the epizootic spreads the hous mouse, woodmouse, red Siberian vole, and shrew are drawn into its circle.

Parasitological Features of the Focus

On the territory of the tularemia focus in the flood plain of the middle course of the River Irtysh ixodic ticks (Ixodidae) are represented by Dermacentor marginatus Sulz and Ixodes (lividus) Leach (Sinel'shchikov, 1959). It is possible to find Dermacentor pictus Herm. and Ixodes apronophorus P. Sch. which are discovered in the river flood plain to the north and south of the focus.

The most numerous is D. marginatus, sexually mature individuals of which we collected not only from cattle and sheep, but also from people who had been in the biotopes of D. marginatus habitation during the period of activity of the adult ticks. In the period of activity of these sanguivores two waves are seen. The first wave begins in the first half of April after melting of the snow and driving the cattle out to pasture and ends in June. To be sure, during the summer season, i.e., in July and August, hungry sexually mature ticks attack people and animals when they are in the moist spots inhabited by the ticks. The second, autumnal wave of animal infestation with ticks begins at the end of August and continues throughout September. We did not encounter ticks in October (Sinel'shchikov, 1961).

A second type of ixodid in the focus is I. plumbeus, found not only in nests of sand martins (46.6% of the nests examined) as an habitual parasite, but also in the nests of tree sparrows, in the ground nest of the skylark, and on the woodmouse when combed. Recently this sanguivore has been attracting more and more attention as a vector of the causative agents in the natural foci of diseases (Fedorov and Tyushnyakova, 1958).

Among the sanguivorous dipterans in the flood plain the first place in numbers belongs to the mosquitoes (Culicidae), after them come the gnats (Simuliidae), then the horseflies (Tabanidae), and after them the midges (Heleidae).

The mosquito fauna at the present time counts twelve species. The predominant ones are Aedes caspius dorsalis Meig., Ae. intrudens Dyar., Ae. cataphylla Dyar., Ae. flavescens Muell., Ae. rossicus D.G.M., Ae. excrucians Walk., Ae. cinereus Meig., Culex pipiens L., C. modestus Fic., Anopheles m. maculipennis Meig., and Teobaldia sp.

The main season of mosquito attack is June and July, with a peak in numbers in the second half of June. The first mosquitoes in the flood plain appear in the second half of April. At this time females of Anopheles and Culex which have overwintered are caught. A mass emergence of overwintering females occurs in the first half of May when they invade in numbers which are still small (27-35 specimens per 100 swings of the net). There are very few mosquitoes in the flood plain at the time the flood waters rise, but with the formation of bodies of water, ordinarily in June, the number of mosquitoes, especially of the genus Aedes, rapidly rises and by the middle of June has already reached 1219-1965 specimens per 100 swings of the net. In July their number gradually decreases, helped on by the large number of dragon flies which appears at this time. In August and September very few mosquitoes are met with. At this time their entry into hibernation takes place and is generally finished in the first ten days of October (Sinel'shchikov, 1961).

The species composition of the gnat fauna has not yet been clarified. The appearance of these dipterans in the flood plain is connected with the onset of hot weather, i.e., it is seen from the second half of May and beginning of June. The main season of their infestation is the second half of June to the middle of July when an average of 550-600 specimens are caught per 100 swings of the net, and sometimes up to 1000 specimens. The massing of the gnats coincides with the cessation of the inflow of water during flood time. At the end of July the number of gnats drops greatly -- an average of up to 125 specimens per 100 swings of the net, but in some years with favorable temperature conditions they are still caught in considerable quantity in the second ten days of August (Sinel'shchikov, 1961).

Twenty species of horsefly fauna have been discovered in the flood plain: Tabanus solstitialis Schin., T. nigrivitta N. Ols., T. sareptanus Szil., T. m. muhlfeldi Br., T. confinis Ztt., T. distinguendus Verr., T. montanus Mg., T. bovinus L., T. a. autumnalis L., T. b. bromius L., T. sabuletorum N. Ols., T. rusticus L., Chrysops relictus Mg., Ch. sepulcralis F., Ch. concavus Lw., Ch. caecutiens L., Ch. rufipes Mg., Chrysozona pluvialis L., Ch. hispanica Szil., Ch. turkestanica Kroeb.

Because of the penetration of a number of southern forms northwards and of northern forms southwards the flood plain of the Irtysh

is characterized by mixture of the faunal sets in the different topographical zones (Sinel'shchikov, 1961).

The flight of horseflies in the flood plain begins at the end of May and beginning of June and ends in August. The earliest capture of horseflies which we have noted was on 18 May and the latest on 19 August. The mass flight of these sanguivores takes place from the second half of June to the second half of July. Comparison of the periods of horsefly flight in the flood plain of the middle course of the River Irtysh with those in the Omskaya Oblast, according to the data of V.I. Alifanov (1955), and in the Barabinskaya Steppe in the environs of the village of Spasskoye in the Novosibirskaya Oblast, according to N.G. Olsuf'yev's findings (1949), showed that in the flood plain of the Irtysh in the Pavlodarskaya Oblast the beginning of flight of such widespread species as T. a. autumnalis, T. nigrivitta, T. rusticus, T. solstitialis, T. bovinus, and Chrysops relictus takes place 20 or 30 days earlier than in the Omskaya and Novosibirskaya Oblasts. The emergence of Chrysozona pluvialis is noted somewhat later. The data on the end of flight of these horseflies, however, is not entirely clear, but it may nevertheless be said that it finishes at almost the same times in all three oblasts. The total duration of horsefly flight in days in the flood plain, however, is greater than in the two other areas (Sinel'shchikov, 1962). Therefore the protracted period of horsefly flight in the flood plain of the River Irtysh in the Pavlodarskaya Oblast is comparison to the northern latitudes of the adjacent oblasts is a certain epidemiological indication in the origin of tularemia outbreaks.

According to research by M.S. Shakirzyanova (1961, 1963) the midge fauna in the environs of the city of Pavlodar, both in the flood plain and in the areas closely contiguous to it, counts thirteen species in all. This figure is unquestionably not final and in the future a certain increase in their species composition may be expected. Among the midges collected were detected the following species: Culicoides pulicaris punctatus Mg., C. pulicaris ssp. n. Schak., C. riethi Kieff., C. nubeculosus Mg., C. fascipennis Staeg., C. subfascipennis Kieff., C. salinarius Kieff., C. simulator Edw., C. tentorius Aust., C. cunctans Winn., C. sp. (turkmenicus aff.), Leptoconops caucasicus Jutz., Laseochelea sp.

Midges fly from May to October. Most of them are found in collections from June to September. The maximum number of them was caught in the second ten days in June in 1959 (an average of 164 specimens per 100 swings of the net), and in the first ten days in July 1960. Isolated specimens were found on agricultural animals in October.

Among the blood-sucking flies (Muscidae) in the flood plain are found the following: Stomoxys calcitrans L., Haematobia atripalpis Bezzi, and H. stimulans Mg. These flies are seen everywhere. The first species is common in the near vicinity of human settlements and the other two in the pasturelands.

Species Composition of Blood-sucking Arthropods on Rodents and Insectivores Predominating in Flood Plain Areas of Focus

Study of the total ectoparasitic infestation of the most widespread voles in the flood plain focus of tularemia showed that the degree of the degree of invasion is 61.4% of the coefficient of occurrence. Here those most affected by parasites are the gregarious voles (80.5%); following them are the red Siberian voles (64.7%), steward voles (60.0%), and water voles (44.4%). Affliction of the remaining small mammals of the flood plain, however -- wood, field, and hous mice and shrews -- did not exceed 40.2% on the whole.

Of ixodic ticks on these rodents very few pre-imago stages were found. The appearance of larvae of D. marginatus on rodents in the flood plain ordinarily begins in June and lasts to the first ten days in August. The nymphs, however, are found chiefly in July-August; in September they as a rule are not found (Sinel'shchikov, 1964). But we have more than once noted the appearance of larvae and nymphs of these ticks on animals from the second ten days in April. This early appearance may be explained by the autumn delay in egg-laying by well-fed females until spring of the following year (Alfeyev, 1954).

The small number of pre-imago stages of D. marginatus on rodents of the flood plain is explained by the flood water inundation of a substantial territory for a rather long time (to 2-2.5 months). This has its effect on the percentage survival of sexually mature forms of the ticks, which do not withstand the protracted inundation and perish (Petrov et al., 1958).

Notwithstanding that I. plumbeus ticks are avian parasites we found four nymphs when combing a woodmouse. This case indicates that nymphs are less specialized in regard to hosts than are the larva and imago. Therefore they may suck the blood not only of various birds, but also of rodents which accidentally invade the holes of sand martins (bank swallows) (Glashchinskaya-Babenko, 1956).

Parasitic ticks. Our observation is that 21 species of Parasitidae are noted on rodents and insectivores which are the most numerous in the flood plain tularemia focus. Among them are Laelaps muris Ljungh., L. hilaris Koch., L. clethrionomydis Lange, L. agilis Koch., L. species, Eulaelaps stabularis Koch., Eu. kolpakovae Breg., Hyperlaelaps amphibius Zachv., Hr. arvalis Zachv., Haemolaelaps glasgowi Ew., Hl. semidesertus Breg., Hypoaspis murinus Stru. et Menz., Haemogamasus nidi Mich., Hg. ambulans Thorell., Hirstionyssus isabellinus Oudms., Hi. musculi Johnst., Euriparasitus emarginatus Koch., Parasitus sp., Poecilochirus necrophori Vitzt., Macrocheles decoloratus Koch., M. matrius Hull.

The total infestation by these parasites of the rodents caught did not exceed 45.1%; the average number of ticks per affected animal, however, reached 9.1 specimens. The shrews examined showed a 40.6% infestation with an average number of 1.6 ticks. The greatest parasitid infestation of these mammals was noted in April before the breaking up of the Irtysh when the index of abundance on the animals reached its highest values (Table I). Subsequently the number of ticks on the animals fell considerably, as is quite evident from the drop in the index from May to June. It is apparent that the situation of rodents in unfavorable circumstances during the flood is also reflected in the number of their parasites.

TABLE I. Change in Index of Abundance of Abundance of Parasitids by Months on Rodents and Insectivores in Flood Plain Tularemia Focus in 1955-1960 in Pavlodarskaya Oblast of Kazakh SSR

Species	Months III Mch	IV Apr	V May	VI Jun	VII Jul	VIII Aug
Water vole	7.3	13.3	9.0	12.4	6.7	6.5
Steward vole	—	8.4	3.6	4.0	—	—
Gregarious vole	5.0	11.5	3.2	—	—	—
Red Siberian vole	—	4.5	2.0	—	—	—
House mouse	—	1.3	—	—	—	—
Woodmouse	—	9.3	1.0	—	—	—
Common shrew	—	1.2	0.2	0.2	—	—

TABLE II. Degree of Infestation of Flood Plain Tularemia Focus in Pavlodarskaya Oblast of Kazakh SSR by Various Parasitids in 1955-1960 (in %)

Species of parasitid ticks	Water vole	Steward vole	Gregarious vole	Siberian vole	House mouse	Wood mouse	Common shrew
Laelaps muris	44,4	17,4	3,2	3,0	57,0	5,0	1,8
L. inlaris	0,7	18,4	5,3	0,01	—	—	57,7
L. clethrionomydis	2,8	6,2	73,7	54,0	9,7	30,7	7,9
L. agilis	—	1,6	—	0,5	0,7	8,0	—
L. species	0,1	—	—	—	—	—	—
Eulaelaps stabularis	0,8	4,1	2,8	2,2	1,3	1,3	—
E. kolpakovae	0,6	—	—	0,01	0,6	30,0	—
Hyperlaelaps amphibius	29,1	—	—	—	—	—	7,3
H. arvalis	—	21,4	2,1	7,6	—	5,0	—
Haemolaelaps glasgowi	10,0	12,4	5,3	26,0	—	10,0	9,1
H. semidesertus	0,2	1,8	—	—	8,7	—	—
Hypoaspis murinus	—	—	—	0,01	—	—	—
Haemogamasus nidi	1,0	—	—	0,01	—	5,0	—
H. ambulans	1,3	7,1	3,2	0,01	22,0	—	8,2
Hirstionyssus isabellinus	6,1	4,8	3,2	6,1	—	—	—
H. musculi	1,7	1,4	—	—	—	5,0	—
Euriparasitus emarginatus	0,1	—	—	0,01	—	—	—
Poecilochirus necrophori	—	1,8	0,1	0,5	—	—	—
Parasitus species	—	1,6	—	—	—	—	—
Macrocheles decoloratus	1,1	—	—	0,01	—	—	—
M. matrius	1,0	—	0,1	—	—	—	—
Total of tick species	16	13	10	15	7	9	6

In studying the degree of affection of rodents by the various species of parasitids it may be seen that each animal is parasitized by a certain number of species which are in the majority on it (Table II).

Thus, of sixteen species of parasitid ticks caught on the water vole four predominating species must be noted (L. muris, Hr. amphibius, Hl. glasgowi, Hi. isabellinus). The index of abundance of the first reaches 18.0 specimens per animal combed, with a maximum population number of 63 specimens. The second species is far less widespread and has an index of only 0.6 specimens. The last two species were encountered significantly less often. The remaining

species of ticks were found on voles in single specimens.

On the steward vole the thirteen species represented for this rodent are predominantly L. muris, L. hilaris, L. clethrionomydis, Hr. arvalis, Hl. glasgowi, Hg. ambulans. Most of all the rodents were infested with Hr. arvalis (21.4%) and L. hilaris (18.4%), while the average density (index of abundance) of ticks of the first species per affected animal was 1.9 specimens. Four other species of parasitids (L. muris, L. clethrionomydis, Hl. glasgowi, and Hg. ambulans) were found in lesser number on the steward vole; the other seven species were found in unique examples.

The fur of the gregarious (narrow-skulled) vole disclosed ten species of parasitid ticks. The most often encountered on these rodents was L. clethrionomydis -- 73.7% of all the animals examined. L. hilaris and Hl. glasgowi were found considerably less often, while the others were discovered in single specimens.

Fifteen parasitid species were found on the red Siberian vole. Of them four species are predominant in the numbers in which they occur. L. clethrionomydis was discovered on 54.0% of the animals examined and Hl. glasgowi on 26.0%, with an average density of 2.7 ticks per animal. The vole infestation with Hr. arvalis at 6.6% and Hi. isabellinus at 6.1% was somewhat less. The rodents were very insignificantly affected by the other ticks.

The house mouse is infested with seven species of parasitid ticks. Of this number four species stood out in the mass nature of their infestation of the animals: L. muris, Hg. ambulans, L. clethrionomydis, and Hl. semidesertus. The other species of ticks rarely infest these rodents. It must be noted that despite the high degree of dissemination of certain parasitid species among mice the density of ticks per animal is very small. For the greater part they are encountered in single specimens.

The woodmouse is parasitized by nine species of parasitids. Four of them may be assigned to those which frequently affect the animals (L. clethrionomydis, Eu. kolpakovae, Hl. glasgowi, and L. agilis). All the ticks discovered on field mice, despite the large percentage of their infestation of the animals, were found on them in single specimens.

Six tick species, of which L. hilaris alone was found in a percentage of 57.7 on the captured animals, were discovered on the common shrew. The other species are distributed among the shrews in small quantity, most often as unique specimens.

Fleas on rodents and insectivores in the flood plain focus of tularemia are represented by 16 species, to which belong Ceratophyllus walkeri Roths., C. penicilliger penicilliger Gr., C. tesquorum transvolgensis L., C. fidus J. et R., C. gallinae tribulis Jord., Ctenophthalmus arvalis W. et I., C. assimilis Tasch., Leptopsylla segnis Schoen.,

L. sviridovi Ioff., Mesopsylla hebes J. et R., Amphipsylla rossica Wagn., Neopsylla pleskei disjuncta Mik., N.pleskei (rossica?) J. et Ar., Pectinoctenes pavlovskii I., Doratopsylla birulai I., Frontopsylla elata popovi Zep.

The total infestation of captured animals by these species of fleas did not average more than 33.2% with an index of abundance of 1.9 specimens per animal. Most parasites were found on the rodents in April and May and far fewer in the other months of the spring-summer season (Table III).

The degree of affection by the individual flea species of the rodents and shrews in the tularemia focus is rather varied (Table IV). In analyzing Table IV it may be noted that in addition to the fleas specific for different hosts in predominant amount a rather large percentage ratio of fleas are found which are characteristic not only of the given moist flood plain biotope, but also of the neighboring steppe and house biotopes. The finding of such fleas nonspecific for a given host is explained by the contact between animals on uninundated areas of the flood plain during the flood, and also by contacts between flood plain rodents and the rodents of other biotopes during their migrations.

The affection of the water vole by fleas reaches 58.3% with an average number of 1.6 specimens of the parasites on a single vole. The most collected of them were Ceratophyllus walkeri and C. p. penicilliger; considerably less collected was Ctenophthalmus assimilis, and there was an isolated Pectinotenus pavlovskii (Sinel'shchikov, 1956). The intensity of animal infestation in the spring-summer season, as observations showed, increases by May, when it reaches 1.4 specimens per animal. By autumn this intensity averages a drop to 1.0 specimen.

TABLE III. Change in Index of Abundance of Fleas by Months of Spring-Summer Season on Animals in Flood Plain Focus of Tularemia in Pavlodarskaya Oblast of Kazakh SSR in 1955-1960

Species	Months			
	Apr	May	Jun	Jul
Water vole	1.3	1.4	1.2	1.0
Steward vole	1.3	3.8	2.0	—
Gregarious vole	2.0	1.5	—	—
Red Siberian vole	4.1	1.7	1.0	—
House mouse	1.0	—	—	—
Common shrew	1.6	—	—	—

The degree of infestation of steward voles in all the years of study in the focus did not exceed an average of 2.5 specimens per animal with an occurrence factor of 57.8%. As for species, Ceratophyllus walkeri, the specific flea of water voles, was seen to predominate on these voles. Significantly less often were encountered C. p. penicilliger and Ctenophthalmus assimilis, while unique specimens of Ct. arvalis L., L. segnis, and A. rossica occurred. The appearance on the steward vole of such purely steppe fleas is the result of contact with susliks living on the banks of the flood plain and with house mice which have moved into it.

TABLE IV. Degree of Affection of Animals by Different Species of Flea in Flood Plain Focus of Tularemia in Pavlodarskaya Oblast of Kazakh SSR (in percentages)

Species	Water vole	Steward vole	Gregarious vole	Siberian vole	House mouse	Wood mouse	common shrew
Ceratophyllus walkeri	34,7	74,6	22,2	—	—	—	—
C. p. penicilliger	71,4	8,9	55,5	60,0	—	—	11,1
C. tesquorum transvolgensis	—	—	—	—	5,3	14,3	—
C. fidus	—	—	—	—	31,6	—	—
C. gallinae tribulis*	—	—	—	—	—	—	—
Ctenophthalmus arvalis	—	3,0	11,1	66,6	10,5	—	—
» assimilis	8,0	8,9	—	—	—	14,3	11,1
Leptopsylla segnis	—	3,0	—	—	57,9	—	—
» sylvatica	—	—	11,1	—	—	—	—
Mesopsylla hebes	—	—	0,1	—	—	—	—
Amphipsylla rossica	—	1,4	—	—	—	—	—
Frontopsylla elata popovi	—	—	0,1	0,4	—	—	—
Neopsylla pleskei disjuncta	—	—	—	—	5,3	—	—
» » (rossica?)	—	—	—	0,1	—	—	—
Pectinoctenus pavlovskii	0,1	—	—	—	10,5	—	—
Doratopsylla birulai	—	—	—	—	—	—	22,2
Total	4	6	6	4	6	2	4

*This species is discovered only in the nests of sand martins (bank swallows) (Riparia riparia) and tree sparrows (Passer montanus).

Gregarious voles are 44.4% infested with fleas. The principal ones proved to be Cer. p. penicilliger and C. walkeri, with Ct. arvalis and L. sylvatica in lesser number. There are unique finds of M. hebes and Fr. elata popovi. In most cases the latter are received by the gregarious voles from steppe or forest rodents. Most fleas are noted on the animals in April.

Infestation of red Siberian voles with fleas did not exceed 13.2% with an abundance index of 2.3 specimens per animal. Numerically the main fleas were Ceratophyllus p. penicilliger and Ctenophthalmus arvalis. The other two species -- F. elata popovi and N. pleskei (rossica?) -- are represented by unique specimens. All of the last three species of flea are received by the voles from steppe rodents. Just as in the preceding voles the greatest index of abundance in this species of rodent was in April (4.1 specimens).

In house mice the total flea infestation reached 12.6% and the index of abundance 0.5 specimen. The fleas specific to mice preponderated: Ceratophyllus fidus and L. segnis. The others -- Ceratophyllus tesquorum transvolgensis, Ctenophthalmus arvalis, N. pleskei disjuncta, and P. pavlovskii -- were encountered singly on the animals and were transferred to them from other rodents.

The affection of woodmice by fleas was very small -- only 9.3%, and then only as single specimens. The Cer. tesquorum transvolgensis and Ct. assimilis not specific to woodmice were discovered on them.

The common shrew was found to be insignificantly infested with fleas -- only 27.0% with an index of abundance of 0.5 specimen per animal. Both the Doratopsylla pirulai specific to this insectivore and the Cer. p. penicilliger and Ct. assimilis acquired by them from rodents were discovered.

In the combings of woodmice and shrews their greatest infestation by fleas was noted in April; for house mice this question still remains unclear.

Lice. Lice infestation of the main species of vole in the flood plain tularemia focus fluctuates considerably. While in 1957 lice infested 35.1% of all the voles caught in the flood plain, in 1958 on the other hand their number rose to 72.4%. In the following years the percentage of infested animals fell to 40.3% in 1959 and 46.1% in 1960. There was also a considerable change in the degree of infestation by these bloodsuckers by seasons of the year. In spring when the animals were combed few lice were found -- only 3.8 specimens each in April and 6.3 specimens in May. In summer, however, the number of them rose drastically. In June the average number of parasites per vole rose to 20.9 specimens. In July and August they became somewhat less abundant -- 17.4 and 15.1 specimens respectively. In autumn and winter the fleas were ordinarily no more abundant than 3.5 specimens per animal.

The water vole was 35.0% infested with lice, but in the affected rodents the number of parasites varies greatly by seasons of the year. In spring no more than 6.4 specimens on the average are found per animal. In contrast in June during the flood there is now a count of 25.3 lice. The preservation of the lice Hoplopleura acanthopus on the rodents at this time is assisted by the adaptational features in the structure of their external covering which help them to grasp bubbles of wate when the voles dive and to keep them on the surface of their bodies under water. Up to 150 parasites have been removed from much weakened individuals in May and June. In July and August the number of lice decreased somewhat, but still remained rather high -- 19.0 specimens in July and 16.3 specimens in August. However strangely, in fall and winter the index of abundance on the animals did not exceed 3.5 specimens per vole. Moreover it must be mentioned that in May and June hypopi of tyroglyphoid mites -- Myacarus arvicolae -- were often found on the animals and sometimes in rather considerable quantity (up to 500-600 or more specimens).

Steward voles infested with lice were most often encountered in June. The index of abundance of lice on them rose from 3.7 specimens in April to 5.4 specimens per animal in June, but the occurrence factor did not rise above 40.3% in all the years of our research. All the parasites taken from the steward voles belonged to a single species -- Hoplopleura acanthopus.

If the percentage of louse infested gregarious voles in some years rose to 85.7 the index of insect abundance on the animals was the highest

in April -- 6.3 specimens per animal with subsequent reduction to 4.5 by June.

The occurrence factor of lice on red Siberian voles reached 24.3% and the number of parasites was 10.3 per animal. Most lice were taken from these voles in May. Subsequently the number of them did not exceed 2.3 specimens per animal.

Infestation of house mice and woodmice, as well as of common shrews, was very rare in the whole period of our observations, and then the sole specimens were of Hoplopleura acanthopus. We did not detect other species of the parasites.

In comparing the species composition of the ectoparasites on the principal voles in the tularemia focus it may be stated that they have several parasitic species in common among parasitids, fleas, and lice. Thus, there are eight species in common among the parasitid ticks: L. muris, L. hilaris, L. clethrionomydis, Eu. stabularis, Hl. glasgowi, Hg. ambulans, Hi. isabellinus, and Poec. necrophori. One species of flea -- Cer. penicilliger penicilliger -- is parasitic on all four voles, while Cer. walkeri is encountered only on three, the red Siberian vole being excluded. Ct. arvalis is also found on three voles (the water vole excluded). Lice of the species Hoplopleura acanthopus are parasitic on all four voles and sometimes on mice. This community of parasites among these rodents in the tularemia focus of the flood plain is on the one hand explained by the great contact connections between the water voles and steward voles because of the common nature of their biotopes, and on the other hand by contacts between these voles and the gregarious and red Siberian voles on uninundated areas and trees standing in the water during the flood on the river. Some species of steppe parasites come into the flood plain through contact between flood plain rodents and steppe rodents during migrations during the flood, but animals moving from house biotopes into the flood plain also bring along their specific parasites.

It must moreover be mentioned that examination in the flood plain of twelve nests of sand martins (bank swallows) (Riparia riparia L.), thirteen nests of tree sparrows (Passer montanus L.) from abandoned holes of sand martins along the steep banks of the flood plain bench, and of three nests of skylarks (Alauda arvensis L.) on the ground not far from the flood plain bank showed 60.7% infestation of them by ectoparasites. The index of abundance of parasites per nest examined reached 6.0 specimens. Here seven tree sparrow nests were infested (54.0%), five sand martin nests (41.7%), and one skylark nest (33.3%). Fleas infested nine tree sparrow nests (69.2%) and one sand martin nest (8.3%). No fleas were discovered in the skylark nests. Among the parasites were found parasitid ticks: Haemolaelaps glasgowi (67 specimens), Hl. casalis (26 specimens), and Phytoseidae (1 specimen); but there were 69 specimens of flea (only Ceratophyllus gallinae tribulis).

Thus, in addition to the parasitids and fleas specific for the birds -- Hl. casalis, Cer. gallinae tribulis -- the Hl. glasgowi tick characteristic of rodent of the flood plain type is also encountered. Hl. glasgowi is known as a vector of the tularemia microbe (Nel'zina and Romanova, 1951). All this gives reason to assume that birds participate in transfer and dissemination of ticks of this type over the focus.

Conclusions

The characteristic features of the microlandscapes in the flood plain of the middle course of the River Irtysh in the Pavlodarskaya Oblast of the Kazakh SSR have fostered the creation there of favorable biocoenoses for preservation of the causative agent of tularemia. The components in the rise of these biocoenoses, in addition to the four species of vole (water, steward, gregarious, and Siberian vole with the ixodic ticks Dermacentor marginatus and the parasitids L. muris, L. hilaris, Hl. glasgowi, Hi. isabellinus) there could also be the dipteran flying bloodsuckers -- the mosquitoes Ae. excrucians, Ae. flavescens; the horseflies Tabanus solstitialis, Chrysozona pluvialis, and Chrysops relictus; and the midges Culicoides pulicaris. All these components are familiar as custodians and vectors of the causative agent of tularemia.*

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*We do not include the fleas Cer. walkeri, Cer. penic. penicilliger, and L. segnis among the components of "tularemic" biocoenoses, although affect the rodents of this focus to a considerable extent, because in the opinion of N.G. Olsuf'yev and T.N. Dunayeva (1960) "...the role of these bloodsuckers in the transfer of the tularemia exciter is more properly considered random and particularly in the period of diffuse winter epizootics among rodents."

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