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THE FLEA FAUNA OF THE TICK-BORNE ENCEPHALITIS FOCAL REGION IN THE EASTERN PART OF THE RUSSIAN PLAIN

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Abstract. The paper presents a survey of flea species found in the studied territory, together with data on their distribution, host relationship, seasonal fluctuations of their numbers and possible role in tick-borne encephalitis epizootology.

Fleas are one of the most common and numerous groups of bloodsucking parasites infesting mammals and birds and many species are known as vectors of various pathoergonts. There has been little information on these arthropods from the tick-borne encephalitis (TBE) focal region in the eastern part of the Russian Plain. The paper summarizes the results of studies carried out in this part of the USSR.

MATERIAL AND METHODS

The fleas of the TBE focal region studied are characterized on the basis of a large material collected from small terrestrial mammals in the south of the Kirov Region. (Malmyzh district) by L. G. Suvorova between May and September in 1960—1962 and in 1964. Relatively small collections made by N. A. Nikitina in October 1964 and by N. F. Darskaya in August—September 1964 as well as in July and November 1965 have been added. Together these materials include about 16,000 fleas* collected from more than 16,000 small terrestrial mammals belonging to 22 species. Besides, large materials collected by L. G. Suvorova in the south of the Udmurt ASSR (Malaya Purga district) in May—September 1967 and 1968 as well as by N. N. Bakeyev and I. P. Karpukhin in the environs of Kirov in November 1966 and April 1967 were also partially used. A total of 19 flea species were encountered in all these collections. A more complete faunistic list relevant to the entire region described (including hosts and seasons which are not represented in our materials) was arranged on the basis of publications concerning the area studied and for the following adjoining territories: the Perm Region (Taskayeva 1953), the Middle Volga Region (Ioff 1954), the Volga—Kama Territory and the Tatar ASSR (Nazareva 1964, 1968a, b, Sadekova 1968, Borisova 1968), the Kirov Region (Korenberg et al. 1965, Charushina 1971) and the Komi ASSR (Novozhilova 1971). Apart from these publications, surveys of fleas of the European part of the USSR and of some other territories were also used (Ioff 1956, Ioff and Scalon 1964, Ioff et al. 1965, Sazonova 1963a, b, Scalon 1966, 1970). Consequently, another 24 species were added to our faunistic list (Table 1). Some of the taxa were included hypothetically, merely on the basis of data concerning their distribution and association with the landscape in the adjoining territories. Among them were six species infesting bats, seven species parasitizing wild and domestic predators and synanthropic rodents, three species infesting house martins and a few species parasitizing animals of which only a few specimens were examined by the authors. The list contains a total of 43 species, including five species of synanthropic fleas inhabiting human dwellings and parasitizing domestic animals or synanthropic rodents. General brief information on hosts of each flea species is given in Table 1.

* Identification of flea species, registration of age characters and other biological data were carried out by N. F. Darskaya with the assistance of A. A. Guseva, L. A. Surkova and T. A. Teplinskaya.

Table 1. List of fleas inhabiting the TBE focal region of the eastern part of the Russian Plain

Fleas	Number of specimens*	Main hosts
Pulex (Pulex) irritans Linneus, 1758	—	Man, domestic animals, wild animals
Ctenocephalides canis (Curtis, 1826)	—	*Canis familiaris*
Ctenocephalides f. felis (Bouché, 1835)	—	*Felis catus*
Chaetopsylla (Ch.) trichosa (Kohaut, 1903)	—	*Meles meles*
Chaetopsylla (Ch.) globiceps (Taschenberg, 1880)	—	*Vulpes vulpes*
Paraceras m. melis (Walker, 1856)	—	*Meles meles*
Tarsopsylla o. octodecimdentata (Kolenati, 1863)	—	*Sciurus vulgaris*
Ceratophyllus gallinae (Schrank, 1803)	1	Aves
Ceratophyllus s. styx Rothschild 1900	—	*Riparia riparia*
Ceratophyllus g. garei Rothschild 1902	1	Aves
Ceratophyllus hirundinis (Curtis, 1826)	—	*Delichon urbica*
Ceratophyllus delichoni Nordberg, 1935	—	*Delichon urbica*
Monopsyllus s. sciurorum (Schrank, 1803)	203	*Sciurus vulgaris, Glis, Dryomys*
Monopsyllus i. indages (Rothschild 1908)	26	*Tamias sibiricus*
Malaraeus (Amalaraeus) penicilliger pedias (Rothschild, 1911)	1284	*Clethrionomys, Microtus, Apodemus* and othe rodents
Megabothris walkeri (Rothschild, 1902)	—	*Arvicola terrestris*
Megabothris turbidus (Rothschild, 1909)	658	*Apodemus, Clethrionomys, Microtus*
Megabothris rectangulatus (Wahlgren, 1903)	1 235	*Clethrionomys, Microtus, Lemmus* and other rodents
Megabothris calcarifer (Wagner, 1913)	—	
Nosopsyllus fasciatus (Bosc, 1800)	—	*Rattus norvegicus*
Amphipsylla rossica Wagner, 1912	4	*Microtus arvalis* and other rodents
Amphipsylla s. sibirica (Wagner, 1898)	—	*Clethrionomys* and other rodents
Leptopsylla segnis (Schönherr, 1811)	3	*Mus musculus*
Peromyscopsylla bidentata (Kolenati, 1863)	61	*Clethrionomys* and other rodents
Peromyscopsylla silvatica (Meinert, 1896)	976	*Clethrionomys* and other rodents
Ctenophthalmus (C.) agyrtes (Heller, 1896)	—	*Apodemus, Clethrionomys*, also *Talpa europaea*
Ctenophthalmus (C.) b. bisoctodentatus Kolenati, 1836	120	*Talpa europaea*
Ctenophthalmus (Euctenophthalmus) uncinatus (Wagner, 1898)	2089	*Clethrionomys, Microtus, Apodemus*
Ctenophthalmus (E.) w. wagneri Tiflov, 1927	—	*Microtus, Clethrionomys* and other rodents
Ctenophthalmus (E.) assimilis (Taschenberg, 1880)	—	*Microtus arvalis* and other rodents
Doratopsylla d. dasycnema (Rothschild, 1897)	2 646	*Sorex, Neomys*
Corrodopsylla birulai (Ioff, 1928)	351	*Neomys, Sorex*
Palaeopsylla soricis starki Wagner, 1930	3 318	*Sorex, Neomys*
Palaeopsylla kohauti Dampf, 1911	997	*Talpa europaea*
Rhadinopsylla (Actenophthalmus) i. integella Jordan et Rothschild, 1921	—	*Clethrionomys, Apodemus, Microtus* and other rodents
Catallagia dacenkoi Ioff, 1940	—	*Clethrionomys*
Hystrichopsylla (H.) orientalis Smit, 1956	1 943	*Talpa europaea, Microtus, Clethrionomys, Sorex, Neomys*
Ischnopsyllus (Hexactenopsylla) hexactenus (Kolenati, 1856)	—	
Ischnopsyllus (I.) variabilis (Wagner, 1898)	—	

Table 1. (continued)

Fleas	Number of specimens*	Main hosts
Ischnopsyllus (I.) obscurus (Wagner, 1898)	—	Chiroptera
Ischnopsyllus (I.) elongatus (Curtis, 1832)	—	
Ischnopsyllus (I.) intermedius (Rothschild, 1898)	—	
Myodopsylla trisellis Jordan, 1929	—	
Total	16 061	

Note. *Number of specimens is given for species occurring in our material from the south of the Kirov Region (refering to animals captured in cylinders or Gero traps) and for *M. sciurorum* from squirrel nests in an inclosure near the town Kirov (collected by N. N. Bakeyeva and I. P. Karpushina). The remaining species found in the area of the focal region or adjacent localities are given according to published data. With some of these species no subspecies are given.

RESULTS AND DISCUSSION

Predominant in the list are the species distributed in Europe (23 species), most of them ranging more or less into Asia, although some do not occur beyond the Urals. The number of widely distributed European-Asiatic species is smaller (11). There are also holarctic forms and inhabitants of Northern Asia with nearctic associations which penetrate into Europe (4), as well as forms with a wider distribution including cosmopolitans (5). Species widespread in forest zones predominate; some of them are associated with meadows and fields or humid habitats along the river valleys and lake shores (23). Forms typical of the steppe and forest-steppe zones are rare (2). The remaining species have no marked association with a particular landscape and include synanthropic species as well as species insufficiently studied in this respect. There are no fleas whose boundaries of distribution cross the region studied. Neither are there those which would seem more numerous here than in surrounding territories. Somewhere within the area described are presumably boundaries beyond which *A. rossica, Ct. agyrtes, Ct. assimilis* (species more common westward and southward), *Ct. wagneri* (numerous along river valleys southward and in the Ural foreland eastward), *A. sibirica, M. calcarifer* and *C. dacenkoi* (more frequent northward and eastward) are becoming less numerous.

Table 1 shows the number of different flea species in our materials from the south of the Kirov Region. The fleas were collected from small terrestrial mammals captured in cylindrical pitfall traps and Gero break-back traps. The collecting results were therefore not equivalent. On the animals captured in pitfall traps the fleas of almost all species were more numerous than on animals of the same species captured in Gero traps. This may be explained by the fact that fleas leave the animals killed in break-back traps more quickly than in the case of live hosts captured in cylinders. However, there are differences in rates of infestation with various species of fleas. This depends on their mobility and the degree of their association with the host's body. Thus, with voles of the genus *Clethrionomys* captured in cylinders, in comparison with those killed in snap traps, the mean infestation per host was 3—4

times higher for *Ct. uncinatus*, *M. turbidus* and *M. rectangulatus* and twice as high for *M. penicilliger*. Only in the case of *P. silvatica* fleas which are characterized by a great association with the host's body, the infestation rates on animals captured by both methods were almost identical. These fleas seem to remain on the carcasses longer than other fleas do. There was a relatively little difference in the numbers of *D. dasycnema* on shrews caught both in cylinders and traps (less than 1.5 times), but the numbers of *P. soricis* on animals in cylinders were thrice as high as on shrews caught in traps. A small number of shrew fleas occurred on *Clethrionomys* and *Microtus* voles captured in traps, but on animals captured in cylinders their number was 30—50 times higher. This big difference evidently resulted from the transfer of fleas to voles from shrews which died more quickly in cylinders; on the other hand, *P. soricis* probably left the bodies of voles captured in snap traps, too. The great (6—10 fold) increase of the number of *H. orientalis* on *Clethrionomys* voles caught in cylinders as opposed to similar animals captured in Gero traps may be also due to a transfer from shrews. The number of these fleas on shrews caught in cylinders was also higher than on specimens caught in snap traps, but to a lesser degree. These facts show that most flea species quickly leave the animals killed in traps and cannot be collected, while in cylinders they are apt to transfer from dead animals to live ones and can be collected without much loss. The data on fleas obtained from cylinder-trapping undoubtedly reflect fairly correctly the ratio of occurrence of flea species on all animals captured, but they greatly distort our concept of their actual distribution among different mammals as well as the degree of this interspecific host contact by fleas.

The described lack of reliable information on fleas collected by each method of host capture and the impossibility of making corrections by comparison compelled us to use the materials only separately, selecting data relevant to the problem under study. The distribution of fleas of each species among different hosts could be judged primarily from the specimens collected from animals caught in snap-traps. The most common species of vole fleas were encountered on small terrestrial mammals of all common species (6—9). The shrew fleas were found on a smaller range of hosts, basically on specific hosts (5 species). *H. orientalis* was characteristic of rodents as well as insectivores (7 species). The fleas which were collected from animals caught in cylinders showed a much greater potential to infest various animals — the fleas of every common species were found on animals of this category belonging to 13—18 species.

The quantitative ratios of flea species parasitic on shrews, voles and mice can be judged from the composition of all fleas collected from animals caught in cylinders, considering the total as a "sample" taken from nature. According to the number of specimens collected, *P. soricis* and *D. dasycnema*, parasites of common shrews and also *H. orientalis* typical of shrews, voles as well as rodents top the list. Among rodent parasites collected the most numerous was *Ct. uncinatus* which is more common on bank voles and common voles than on mice. The next most numerous was *M. rectangulatus*, more characteristic of *Microtus* than *Clethrionomys*. The sixth in rank was *M. penicilliger*, common on voles of both genera, but relatively rare on *M. arvalis*. The next was *M. turbidus*, more frequent on mice than on voles. *P. silvatica* fleas ranked as the eighth, but during the short season of their parasitic stage they actually occupied the third place; they were more characteristic of voles of the genus *Clethrionomys*, primarily *Cl. rutilus*.

All eight flea species mentioned above are widespread in the forest zones and inhabit the taiga as well as deciduous forests. Four of them should be considered as rather typical of the taiga *(M. rectangulatus, M. penicilliger, P. silvatica* and *Ct. uncinatus)*. They also occur in the forest-tundra, the first two in the tundra as well. The remaining four species *(P. soricis, D. dasycnema, H. orientalis, M. turbidus)* are more characteristic of broad-leaved forests. In the taiga zone they become less numerous in the north, while in the forest-tundra they are rare or absent. In the southern direction, however, their range is greater than that of the previous group — they inhabit the forest-steppe and penetrate into the steppe along river valleys. Among squirrel fleas two species are characteristic of the taiga (*T. octodecimdentata* and *M. indages*) and one species (*M. sciurorum*, common both to the squirrel and the dormouse) is typical of broad-leaved forests, but reaches as far as the northern taiga. *T. europaea* and its fleas inhabit forest-steppes, broad-leaved and coniferous broad-leaved forests and are also numerous in the southern taiga. One of the mole fleas *(Ct. bisoctodentatus)* accompanies its host farther southwards than the other *(P. kohauti)*, whose southern boundary is running in the zone of the coniferous-broad-leaved forests.

Thus, the most numerous fleas on small terrestrial mammals of the TBE focal region in the eastern part of the Russian Plain were species widely distributed in the forest zones, represented equally by forms characteristic of the taiga and of broad-leaved forests.

Our only available information on the seasonal fluctuation of the number of different flea species refers to the mean infestation per host in the southern part of the Kirov Region, mainly between May and September, and partly in the October—November period. The abundance of fleas on hosts depends on the numbers of adults in the population, their feeding activity and character of parasitism, as well as on the level and direction of fluctuation of the host numbers. Our material was inadequate for estimating the flea populations due to the absence of data on the host shelters, the permanent habitation of immature stages and on the temporary occurrence of a certain number of adults. The flea abundance on hosts may only be an indicator of the relative numbers of adults, but this does not apply to all flea species and to all seasons. However, a comparison of our data on seasonal fluctuation of flea numbers on their hosts with published data on the adult composition according to their physiological age and condition (Darskaya 1953, 1970, Darskaya et al. 1960, Sazonova 1963a, b) as well as with some unpublished observations of the authors of this paper, does present a general view of the way of life and annual cycle of fleas in the south of the Kirov Region.

On the basis of our collections from animals captured in cylinders we calculated the mean flea infestations per main hosts (according to one or more species), and counted all flea specimens of each species collected. For example, we divided the number of *P. soricis* collected from hosts of all species by the number of four species of *Sorex* and *N. fodiens*, the main hosts of fleas of this species. The composition of adults according to their physiological age was studied by examining the degree of integument wear, primarily in flea specimens preserved in alcohol (Darskaya et al. 1966). Simultaneously their generative condition was recorded according to the presence of eggs ready for oviposition as visible through the integument. Live fleas were rarely studied, but if so, the size of the fatbody was additionally assessed through the integument and the physiological age of dissected females was estimated according to features relevant to ovaries (Kunitskaya 1960).

In the south of the Kirov Region most common species of fleas found on rodents and insectivores were represented by numerous adults in spring. In that period fleas which had overwintered became active. Apparently most of them overwintered as adults in cocoons, but a lesser number, after leaving the cocoons and already having had a meal, were in the condition of generative rest (the nature of which has not been determined yet). Both types possessed a large fatbody in winter. In different species of this group the number of adults overwintering outside cocoons varied more or less (sometimes there were no adults of this category). The adults of some species also emerged from their cocoons in autumn accidentally, namely when an animal visited the nest where cocoons with developed adults were present. The fleas of this group of species reproduced from spring onwards throughout the warm season. The development of immature stages took place quickly due to the warmth in nests inhabited by animals and also due to the warmed air and upper soil layer. In summer great numbers of new young adults emerged in July and were continuously encountered throughout summer and autumn.

It was difficult to estimate the exact number of generations produced by adults which had overwintered. An "overlapping" of generations took place because the period of oviposition by overwintered females was long (not shorter than until July) and their progeny promptly multiplied. Hovewer, there is no doubt that many adults of most species of this flea group managed to produce several filial generations in accordance with a prolonged reproduction period of each host species (several litters of

young) and with a yet longer reproduction period of all host species as a whole. The ability of fleas to complete their life cycle within 14—28 days at a temperature of nests inhabited by warm-blooded hosts was established in experiments with fleas of several species. The minimum periods of flea development were shorter than the period during which the young of small mammals or birds occupied the nest, while the maximum periods were only slightly longer. This flea group included *M. turbidus*, *M. rectangulatus*, *Ct. uncinatus* and probably *D. dasycnema* and *P. soricis*. For the last two species the duration of oviposition has yet not been established. The bird fleas *Ceratophyllus* had a similar annual cycle. They produced either one (in the case of so-called "sedentary fleas", specific parasites of the house martin) or 2—3 generations (in the case of *C. garei* and *C. gallinae*, so-called "migratory fleas", parasitizing many birds). The number of generations was determined by the number of broods and by the longer or shorter nesting period of hosts belonging to one or more species. Most flea adults overwintered in cocoons, but in some species (e.g. *C. delichoni*) adults were observed to emerge from cocoons prior to the departure of young birds from their nests, and primarily well-fed specimens with a large fatbody overwintered (Darskaya 1954, 1964). In this flea group may also be listed *M. sciurorum* and *M. indages*, parasites of arboreal rodents. The former overwinter as adults outside cocoons. In November 1966 numerous, very fat, feeding but not reproducing adults of *M. sciurorum* were found in inhabited squirrel nests in an open enclosure on the outskirts of Kirov city.

The second group of flea species is characterized by a short-term, seasonal period of adult occurrence in nature. Adults appear at the end of summer or in autumn, soon become very abundant on their hosts but then gradually their numbers decrease and they disappear altogether. During this period eggs are laid continuously. The life cycle is long. The major part of the development takes place at the low temperature prevalent in uninhabited nests; at some stage the development is either delayed or possibly slowed down. The majority of these fleas produce one generation per year and only some may produce another, not very numerous generation, which develops rapidly in inhabited nests during the autumn and winter season. The species concerned are *P. silvatica*, *P. bidentata* and *R. integella*.

The third group consisted of species whose adults occur and reproduce the whole year round. Here belongs primarily *M. penicilliger* which is very abundant on hosts in spring. This abundance is partly due to the onset of activity of specimens which have completed metamorphosis the previous autumn, and overwintered with a fully developed fatbody, in the uninhabited nests. In addition, in spring there are also old adults which have overwintered and reproduced in inhabited winter nests, as well as their progeny which completed their life cycle by that time. In late autumn adults of these species become more numerous on their hosts. During the year a number of specimens undoubtedly produces several filial generations due to the fact that oviposition and emergence from cocoons take place all the year round. The life cycle of these fleas is rapidly completed both in the spring-summer and the autumn-winter shelters warmed up by the hosts. A similar annual cycle is completed by *A. rossica* and *A. sibirica*. Other species, e.g. *H. orientalis*, are characterized by a peak of abundance at the end of summer and in autumn, but with presence of adults and oviposition throughout the year. However, they probably produce only one generation, whose emergence from cocoons is prolonged and whose mass appearance is associated with autumn. Their life cycle is slow, lasting about one year. The adults live for a long time, especially in a cold period. Individual specimens live from autumn to spring. The relative number of old adults is always much higher (8—36 %) than in other species (1—5 %).

The mole flea *P. kohauti* whose biology has been unknown until recently, should be considered separately. Their number on hosts was found to be higher in September—October than in the preceding warm period. At the beginning of November 1965 the mean infestation per host exceeded 15.0 and the females continued to lay eggs.

Now let us discuss and assess fleas as blood-sucking insects maintaining contact between hosts, many of which are known as vectors of TBE virus. The number of flea species and genera, in which TBE virus was found to occur naturally or for which the ability of maintenance and transmission of this virus was established experimentally, is increasing regularly year after year. In some foci the virus was detected in fleas of all common species belonging to 11 genera and subgenera (Chipanina et al. 1971). It is believed that fleas take part in the circulation of the virus in the Siberian foci of tick-borne encephalitis. In view of the special importance attached to birds in that region and the fact that the virus was isolated from house martin fleas, bird fleas in general are attracting more attention (Kraminsky and Feoktistov 1971). However, the problem of the role of fleas in the epizootology of tick-borne encephalitis, including the problem of the fate of the virus in fleas of different systematic affinities as well as ecological-biological features, remain to be solved in future studies. An attempt was made to compare the fleas of the Sverdlovsk Region according to their importance in interspecific contact between their hosts; this was assessed according to the number of host species on which each flea species was collected (Glazova 1971). With reference to the southern part of the region described we shall discuss here the role played by fleas in the intra- and interspecific contact of hosts on the basis of the above information about the way of life and primarily on the annual cycle of these insects.

Fleas of the forest zone, as opposed to fleas of steppes and deserts, are characterized by a lesser specific association with their hosts. Many species parasitize voles and mice and undoubtedly breed in their shelters. The same applies to parasites of shrews. The populations of each species seem to be common on all their hosts. The populations common to hosts of several species also exist in bird parasites of the "migratory fleas" group. When nests are left by their inhabitants, the adult fleas then present in them migrate in search for new hosts, contributing in this way to the contact between inhabitants of different shelters and nests. Thus, fleas of small rodents were encountered on shrews and birds, and vice versa.

Voles are more heavily infested with fleas than mice. Voles, mice and squirrels are infested with fleas throughout the year. The presence and activity of adults of some species is associated with the autumn-winter period. Specific fleas of shrews are primarily found in the spring-summer period, but fleas collected from shrews trapped in the mole burrows, were also encountered in October and November; their numbers were higher than those on animals trapped in cylinders in September. It is possible that mole burrows constitute a habitat in the moderate climate where the active life of some flea species is prolonged or may last all the year round. *P. soricis* and *D. dasycnema* collected there in November were still feeding but did not reproduce any more and became fat, while *P. kohauti*, specific to the mole, continued to reproduce and the fatbody in them was as small as it was in the summer.

A spring surge of adult activity is typical of most common species of fleas parasitic on small terrestrial mammals and birds in the southern area of the Kirov Region and so is their abundance on hosts (list of fleas is given in the description of the first and third ecological groups). The onset of this surge is not evident in our complete material, but the observation of N. F. Darskaya, carried out in another area of a similar latitude, reveals that this may happen in early spring when the snow cover has not yet melted away. From May to June an intensive interchange of fleas takes place between hosts of the same or different species. In this period the fleas are numerous, aggressive and apparently least fastidious. They do not stay long on the same host individual and settle down in breeding nests of more suitable hosts. Particularly interesting are species whose adults are not only passively transferred by animals and birds, but which are capable of independent active migration (the bird fleas

Ceratophyllus, the squirrel and chipmunk fleas *Monopsyllus*, and many fleas of closely related genera). At the turn of spring and summer more favourable conditions for the flea migration on the ground surface exist in the forest zone than in the open areas situated southward. Fleas present in the breeding nests of their hosts are in close contact with nest inhabitants, as they feed frequently. According to observations made in an experiment with some *Nosopsyllus*, *Ctenophthalmus* s.l. and *Leptopsylla*, fleas feed on an average 5 to 12 times per 24 hours (Kosminsky 1965, Yurgenson 1965 etc.). The flea species whose adults are active in autumn-winter, primarily make contact with inhabitants of one nest or within one part of a winter colony of one host species. They are of particular interest because in some TBE foci their epizootological role is supposed to be most likely played in the autumn-winter season (Kraminsky and Feoktistov 1971). In view of the information on the TBE virus accumulation in arthropods at certain temperatures, attention should be paid to the presence of fleas in inhabited breeding or winter nests which are constantly kept warm by the hosts. In this respect one should also consider fleas which are closely associated with the body of the host e.g. *Peromyscopsylla*, *D. dasycnema*. It would be expedient to check a possible long-term maintenance of the virus in flea species whose adults had fed, became fat and inactive and were numerous until the period of spring activity (e.g. *Ct. uncinatus*, *M. sciurorum*, *C. delichoni* and probably some other species of the first ecological group). In species of fleas breeding in the cold season the number of fed adults surviving until spring is smaller *(M. penicilliger*, *A. rossica*, *A. sibirica*, *H. orientalis*, *R. integella)*.

Consequently, in the south of the Kirov Region interchange of fleas of several species and genera between their hosts takes place throughout the year. The intensity and extent of this contact and the species composition of fleas participating in it vary according to seasons. A particular intensity and scope of this contact is attained at the beginning of the warm season, when the number of flea specimens and species participating in it is highest.

ФАУНА БЛОХ ОЧАГОВОГО РЕГИОНА КЛЕЩЕВОГО ЭНЦЕФАЛИТА ВОСТОКА РУССКОЙ РАВНИНЫ

Н. Ф. Дарская и Л. Г. Суворова

Резюме. В работе приведен обзор видов блох обнаруженных на изучаемой территории, вместе с данными об их распространении, отношении к хозяевам, сезонных колебаниях их численности и их возможной роли в эпизоотологии клещевого энцефалита.

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