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TWO INTERACTION TYPES OF ANTS LIVING IN STEPPE ECOSYSTEM IN SOUTH SIBERIA, USSR*

(Ekol. Pol. 20:103–109). The paper contains description of verious interactions of the steppe ants. Existence of two types of interaction between large ants [*Formica pratensis* (Retz.) and *F. umlensis* (Nyl.)] and small ants [*Formica picea* (Nyl.) and *F. subpilosa* (Ruzs.)] was discovered. In the first type the join inhabitation of different ant species on the same territory is achieved by the delimitation of their activities in time and space. In the second type the peculiar forms of join activities arise.

Strict distribution of feeding territorics in ants is known beginning from C. Elton's investigations (Elton 1932, Berndth 1934, Dlussky 1965, Bruyn 1968, Zakharov 1969). Also, there are known certain mechanisms of differentiated activity of ants belonged to various species (Brian 1952, Yasuno 1965, Bruyn 1968, Baroni-Urbani 1969).

Of special interest are investigations carried out to elucidate interactions of ants of different size. In the South Siberia steppes, there predominate

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small underground nests [*Formica subpilosa* (Ruzs.), *F. picea* (Nyl.), *Myrmica scabrinodis* (Nyl.), *Tetramorium caespitum* (L.), etc.], among which relatively large overground nests [*Formica pratensis* (Retz), *F. uralensis* (Ruzs.), etc.] are met.

As a result combined communities of two or three species are formed with peculiar forms of delimitations or common use of feeding territories. In the case of multispecies settlements circular location of small underground nests around large overground nests is observed.

The cartographic survey of ants' quantitative distribution has shown that neutral zones are formed among feeding territories of large species (*Formica pratensis, F. uralensis*) living in overground nests. In Figure 1 such a zone is clearly seen among continuous lines. These lines are showing the areas where at least one *F. pratensis* was noticed on each of 300 plots (25 × 25 cm) during visual morning and evening observation for 5 minutes per plot. Such plots were situated as a graticule at the distance of 2 m from each other. The neutral zone does not disappear even in the daytime when feeding territories are extended. Their borders are shown in Figure 1 with a discontinued line.

Fig. 1. The summarizing map of mutual arrangement of *Formica pratensis* nests, tracks and bounds of their feeding territories and *F. subpilosa* nests

1 — evening bounds of *F. pratensis* feeding territory, *2* — the same in the afternoon, *3* — the nests and tracks of *F. pratensis*, *4* — the nests of *F. picea*. This map is a result of the surveys of ant's dynamic density (number of ants walking through the 25 × 25 cm plot during 5 minutes). The reading points are situated even through the whole exploring territory. The special maps were done for the different days and parts of 24 hours. Only outward bounds of *F. pratensis* territories during their two extreme states of maximal expanding and maximal reduction are represented. One can see the neutral zone between the territories of two *F. pratensis* nests and also the arrangement of *F. subpilosa* nests out the *F. pratensis* territory or on their external parts mainly

Neutral zones among the territories of large species are filled with a great number of small underground nests of *F. subpilosa*. We observed the interaction of *F. pratensis* with *F. subpilosa* in the steppes of West Siberia and the interaction of *F. uralensis* with *F. picea* in the steppes of North Khakass.

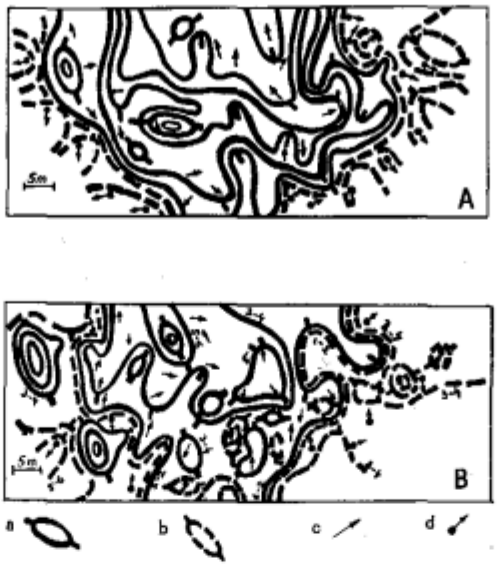

Fig. 2 *A* and *B*. Afternoon (*A*) and evening (*B*) bounds of *Formica subpilosa* and *F. pratensis* territories

a — the isolines of *F. subpilosa* dynamic density, *b* — the same of *F. pratensis*, *c* — the dominant direction of *F. subpilosa* movements, *d* — the same of *F. pratensis*. The same neutral zone as on Figure 1 with its locality is represented. The dynamic density of each ant species is represented with different isolines and the dominant directions of ant's movement are represented with different vectors. One can see that the "retreat" of one species is accompanied by "attack" of another

The character of raid activities and the distribution of the territory between *F. uralensis* and *F. pratensis* differ not so strongly. The difference between the behaviour of small ants in underground nests of the settlements under comparison is of paraamount importance.

F. picea individuals are much more industrious than *F. subpilosa* ones. They have longer period of activity. As a result two types of interaction of ants living in underground and overground nests are taking place.

1. In the case of the interaction of two nests of *F. pratensis* with many nests of *F. subpilosa* only one species is on the territory at a certain moment in spite of extension and contraction of the territories inhabited by these species during 24 hours.

Figure 2 shows how close are the borders of spreading of these two species in the neutral zone but they never overlap.

The comparison of Figures 2 *A* and 2 *B* shows that the contraction of the territory occupied by *F. pratensis* in the evening is accompanied by the propor-

tionate compensative extension of the territory of *F. subpilosa*. The shift of the maximum activities of *F. subpilosa* for the evening time is taking place under the influence of *F. pratensis*.

As can be seen from Figure 3 *F. subpilosa* nests not influenced by *F. pratensis* individuals have the maximum activities in the afternoon.

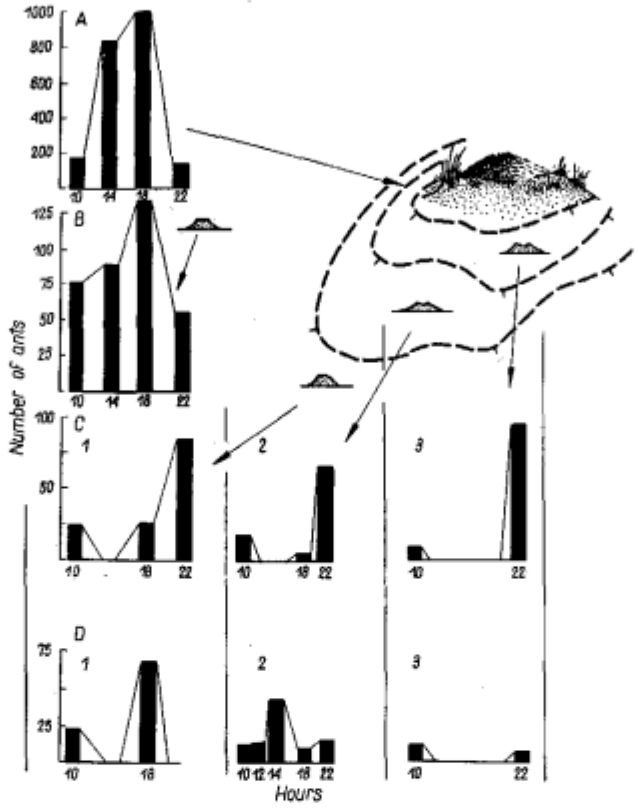

Fig. 3. Daily cycle of *Formica subpilosa* nests situated in different parts of *F. pratensis* territory in comparison with *F. pratensis* daily cycle

The height of each column shows the number of ants leaving the nest during 5 minutes. *A* – the daily cycle of one of *F. pratensis* nest, *B* – the same of *F. subpilosa* nest situated in the neutral zone between the *F. pratensis* territories, *C* – the same of *F. subpilosa* nests situated in external (*1*) and middle (*2*) parts of *F. pratensis* territory and near *F. pratensis* nest (*3*), *D* – the same of *F. subpilosa* nests dug far from *F. pratensis* nest and transplanted into external (*1*) and middle (*2*) parts of *F. pratensis* territory and near *F. pratensis* nest (*3*). Comparing this diagram, one can see that *F. subpilosa* individuals have daily cycle similar with *F. pratensis* when they live out of *F. pratensis* influence. The shift of the peak activity to the evening time increases with the decrease of the distance between the nest of *F. pratensis*. The daily activity of transplanted *F. subpilosa* nests changes accordingly to this. The nest transplanted too near to *F. pratensis* nest soon almost ceased working

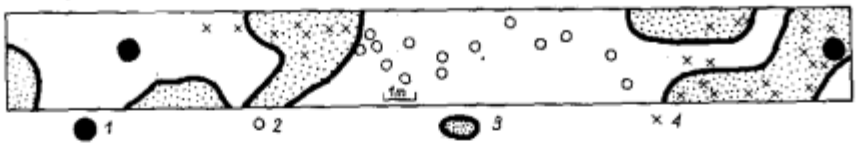

Fig. 4. The zone of join activity of *Formica uralensis* and *F. picea*

1 – the nests of *F. uralensis*, *2* – the nests of *F. picea*, *3* – the zone of join activity of *F. uralensis* and *F. picea*, *4* – the points of territory where *F. uralensis* find the hidden baits. The zones of join activity of *F. uralensis* and *F. picea* are showed on the plane of transsect laying between two *F. uralensis* nests (with their neutral zone and *F. picea* nest inhabiting this zone). The meat baits hidden in different ways were placed in each m^2 of the transsect. One can see that ants pull the hidden baits apart mainly in the zone of join activity of the two species

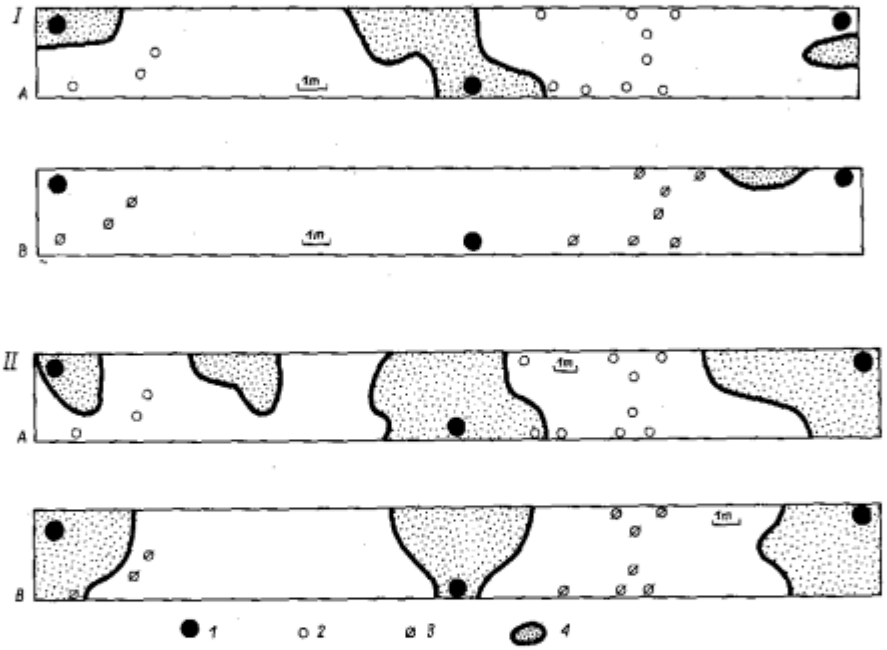

Fig. 5. The plots where *Formica uralensis* individuals found the baits hidden in complicated paper containers before (*A*) and after (*B*) removing of *F. picea* nests

I – the baits hidden in complicated paper containers, *II* – the baits exposed on the ground. *1* – the nests of *F. uralensis*, *2* – the nests of *F. picea*, *3* – removed nests of *F. picea*, *4* – the plots where *F. uralensis* found the baits. *I A* – it is the transsect connecting 3 nests of *F. uralensis*. The plots where *F. uralensis* individuals have found the baits before removing of *F. picea* nests are distinguished. *I B* – it is the same after removing *F. picea* nests. One can see that *F. uralensis* almost stopped find the baits. *II A* and *B* – It can be seen that *F. uralensis* can find the non-concealed baits both in the case of presence and absence of *F. picea*

After placing the nests of *F. subpilosa* in the area near those of *F. pratensis* the peak of activities shifts for the evening hours which are typical for *F. subpilosa* constantly living here.

2. In the case of the interaction of *F. uralensis* overground nests with *F. picea* underground nests the difference of their activities in time is not observed and the part of the territory under the *F. uralensis* ontrol is turned into a peculiar zone of joint actions of these species.

The placing of meat bait in the slots on the ground and in compound paper containers has shown that in difficult situations *F. uralensis* can find bait quicker in the zones where both species act at the same time. Coincidence of these zones can be seen in Figure 4. As the map in Figure 5 (*I*) shows after artificial taking *F. picea* from the territory *F. uralensis* could not find baits in the containers of intricate design and in the slots on the ground. However, it found non-concealed baits exposed on the ground [Fig. 5 (*II*)]. Evidently, *F. picea* individuals competing with *F. uralensis* ones while picking up bait are stimulated the raid activities of the latter. The opposite effect was not revealed.

Thus, the joint usage of the territory by two active species living in overground and underground nests is characterized not by the distribution of the spheres of their activities but, on the contrary, by the improving of the search efficiency in the zones of their joint actions.

The character and the efficiency of ant activities in multispecies settlements deponds not only on the natural conditions and the peculiarities of species but also on the interrelations formed in multispecies complex where they act. There interrelations of the natural complex guarantee the optimal exploitation of the ecosystem resources by ants.

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DWA TYPY ODDZIAŁYWAŃ MRÓWEK ŻYJĄCYCH W EKOSYSTEMIE STEPOWYM POŁUDNIOWEJ SYBERII

Streszczenie

W pracy zawarto opis różnych oddziaływań wzajemnych zachodzących między gatunkami mrówek żyjących w stepach Południowej Syberii. Odkryto dwa typy oddziaływań wzajemnych między dużymi mrówkami [*Formica pratensis* (Retz.) i *F. uralensis* (Nyl.)] oraz mrówkami małymi [*Formica picea* (Nyl.) i *F. subpilosa* (Ruzs.)]. Pierwszy typ polega na tym, że wspólne zasiedlenie tego samego terenu przez różne gatunki mrówek dokonuje się na skutek rozgraniczenia ich czynności w czasie i w przestrzeni, drugi natomiast na wykształceniu się specjalnych oddziaływań wzajemnych, zachodzących między tymi formami mrówek.

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