

**FACTORS STABILIZING THE ANT POPULATIONS
(HYMENOPTERA: FORMICIDAE) IN THE GRASS ASSOCIATIONS
OF THE TISZA BASIN**

L. GALLÉ JR.

Department of Zoology Attila József University, Szeged, Hungary

(Received 20 December 1975)

Abstract

1. It could be demonstrated in the course of the ecological investigations carried out in the grass associations along the Tisza that the most important factors regulating the ant populations were climatic factors that, as density independent factors, fundamentally determined the in populations.
2. In case of a high population density, the competition within the elementary form of life plays a stabilizing part. A suitable indicator of that is the dispersion index.

Introduction

The previous monographs dealing with the Formicoidea fauna of the Tisza basin were discussing the density conditions of the ant fauna of grass associations (GALLÉ 1967, 1969, 1972a, GALLÉ and GAUSZ 1968), as well as the most important microclimatic factors regulating those (GALLÉ 1972a, b). The aim of the present paper is to create a comprehending model about the factors regulating the ant populations of grass associations along the Tisza.

In an homogeneous or approximately homogeneous environment the ecological factors regulating the animal populations can be classified into two groups:

1. External factors, having an effect only on density (density independent factors);
2. Factors within the population, having an effect both on density and on dispersion (density dependent factors).

Density independent factors

At investigating the environmental factors regulating the ant populations, it is advisable to apply the correlation analysis between the climatic factors and the density of populations. In Table 1 we have displayed the correlation coefficients between the most important microclimatic factors and the density of ant populations obtained on the basis of the investigations at Tiszafüred (1970), Mártély (1971), and Labodár (1973). As it appears from these, the signs of coefficients are mostly

Table 1. Correlation coefficients between the most important microclimatic factors and the density of ant populations. 1) Herb-layer temperature, 2) soil temperature, 3) Humidity, 4) ground water content. In the upper line there are given the results obtained at Tiszafüred (1970), in the middle those obtained at Mártély (1971), and below those obtained at Labodár (1973)

species	1.	2.	3.	4.
<i>Myrmica specioides</i> BONDR.	0,132	-0,409	0,276	-0,605
	0,525	-0,125	0,194	0,801
	-0,692	-0,862	0,964	0,744
<i>Solenopsis fugax</i> LATR.	0,090	0,230	-0,488	-0,986
	0,373	-0,006	0,189	-0,144
	0,328	0,461	0,185	-0,257
<i>Tetramorium caespitum</i> LATR.	0,895	0,868	-0,785	0,129
	0,908	0,643	-0,708	-0,531
	0,454	0,300	-0,137	-0,463
<i>Plagiolepis vindobonensis</i> LOMN.	0,056	0,197	-0,510	-0,687
	0,463	0,447	-0,985	-0,033
	0,993	0,947	-0,941	-0,999
<i>Lasius alienus</i> FÖRST.	0,092	0,234	-0,498	-0,987
	—	—	—	—
	0,237	0,303	-0,269	-0,254
<i>Lasius niger</i> L.	-0,645	-0,280	0,908	0,681
	-0,908	-0,486	0,764	0,529
	-0,405	-0,177	-0,001	0,989

Table 2. The linear correlation coefficients reckoned between the values of the microclimatic factors and the density of ant populations (upper line), and the correlation coefficients indicating the close non-linear connection (lower line), on the basis of measurings at Labodár (1973). The single factors are marked as in Table 1.

species	1	2	3	4
<i>Myrmica specioides</i> BONDR.	-0,692	-0,862	0,964	0,744
	-0,805	-0,910	0,997	0,857
<i>Solenopsis fugax</i> LATR.	0,328	0,469	0,185	-0,257
	0,629	0,581	0,591	-0,627
<i>Tetramorium caespitum</i> LATR.	0,454	0,300	-0,137	-0,463
	0,896	0,870	-0,816	-0,509
<i>Plagiolepis vindobonensis</i> LOMN.	0,993	0,947	-0,941	-0,999
	0,997	0,963	-0,946	-0,999
<i>Lasius alienus</i> FÖRST.	0,327	0,303	-0,269	-0,257
	0,989	0,998	-0,892	-0,997
<i>Lasius niger</i> L.	-0,405	-0,177	-0,001	0,948
	-0,867	-0,908	0,997	0,998

conform in all the three areas. The use of these coefficients, however, supposes a linear connection between the climatic factors and the density of populations. If we indicate apart from the linear coefficients also the correlation coefficients that are suitable to characterize the close non-linear stochastic connections (Table 2), then it is shown by the higher numerical value of the latter ones and the significant character of those at the given degrees of liberty that the character of the connection is different from the linear one. At graphic plotting, it changes along the curve of saturation. From that, besides the density independent factors, the effect of density dependent factors may be concluded.

Density dependent factors

It would be a highly simple solution, to hold responsible the exhaustion of the available source of food, as a limiting factor, for such an „ant saturation” of the ecosystems of favourable environmental effect. Undoubtedly, it is true that ants have a large food requirement. But they are euryphages, not attached to a single source of food whose shortage would become a limiting factor of the density of population. Apart from certain special cases, therefore — e. g., from coenoses of extremely low primary production — we should not indicate the lack of nourishment as the most important limiting factor in the grass associations of the Tisza basin. In the above-mentioned ecosystems of low primary production where, usually as a result of some anthropogeneous influence, the enrichment of vegetation is restrained, e. g. on pastured dam-slopes, in weed associations *Sclerochloa-Polygonetum avicularis*, *Messor structor* LATR. and *Tetramorium caespitum* LATR. are living. These two species consume vegetable grains, as well. In their nourishment, therefore, they are at least partly independent of the far too poor primary consumption way of life of a degraded environmental systems like this. In these sites, therefore, owing to the functioning of *Messor* and partly of *Tetramorium*, the food chain reaching from plants till ants is quasi “short-circuited” by utilizing the vegetable source of energy. In most cases, however, the production of the grass coenoses along the Tisza is rich enough both at vegetable and at primary consumer level to satisfy the food requirement even of the ants being present with a high population density.

We consider the intra- and inter-specific competition, anyway, as a considerable density dependent factor. At ants, particularly in case of the so-called aggressive species, this manifests itself in the territorial behaviour (PISARSKI 1972). In a homogeneous or nearly homogeneous environment, a very suitable characteristic of the intraspecific competition is the dispersion of ants' nests. In case of a strong intraspecific competition the dispersion is of uniform type, the dispersion index ($V = \frac{s^2}{\bar{x}}$) being smaller than one. There are several literary data known concerning the dispersion of ants nests. BRIAN (1956) observed on the populations of *Myrmica rubra* and associated ants' that in case of a high density they show a random or uniform dispersion. He sees the cause of that in the intraspecific competition. BARONI—URBANI (1969) studied the dispersion of *Lasius alienus* and *Tetramorium caespitum* with the Morisita index and χ^2 testing and found it, on the basis of the χ^2 testing, being random. PETAL (1972) established, on the basis of 25 sq. m samples, some clumping dispersion on the populations of *Myrmica laevinodis* ($V=2,28$) while, in case of a smaller sample size, he noticed a random and uniform dispersion. He regards these as dispersion types inside the clumps.

If the dispersion index is plotted against the population density (\bar{x}) of the various grass associations (Figs. 1 and 2), we are learning that the dispersion index is

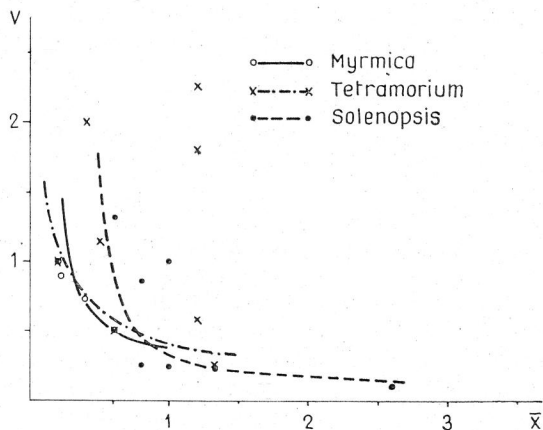


Fig. 1. Depending of the dispersion index (V) on the average density (\bar{x}). The peculiar situation of the points concerning *Tetramorium* (1.2; 1.8) and (1.2; 2.25) is probably explained by that, in the ecosystem given, several nests lying close to one another belong to the same colony and were counted separately

inversely proportional to population density. In case of a few species, present with the highest nest density, the equality between them has the following form:

Myrmica specioides BONDR.:

$$V = 0.3 + \frac{1}{12.574\bar{x} - 2.275}$$

Tetramorium caespitum LATR.:

$$V = 0.1 + \frac{1}{0.3883 + 2.822\bar{x}}$$

Solenopsis fugax LATR.:

$$V = 0.1 + \frac{1}{8,478\bar{x} - 3.854}$$

Lasius niger L.:

$$V = 0.4 + \frac{1}{10.31\bar{x} - 0.366}$$

Plagiolepis spp.:

$$V = 0.2 + \frac{1}{0.137 + 3.031\bar{x}}$$

Together with the increase in density the dispersion becomes, therefore, more uniform, in sites of a higher population density, owing to the competitive relation

between the nests, the “reciprocal repelling effect” of nests grows stronger. The mosaic-like arrangement of the territories and nests is a result just of that fact.

In a part of ants, on the other hand, the intraspecific competition is exceeded

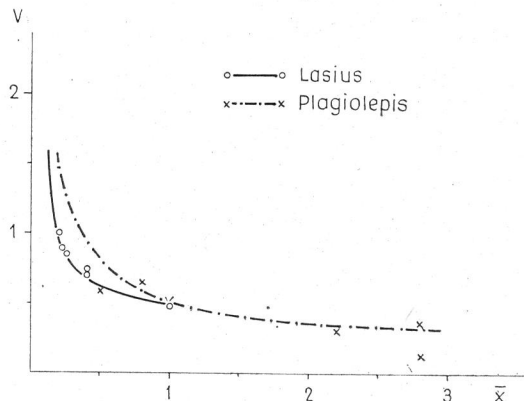


Fig. 2. Depending of the dispersion index (V) on the average density (\bar{x}) in case of *Lasius niger* and *Plagiolepis* spp.

by the interspecific one, as seen in the laboratory model experiments, as well (MOLNÁR 1975), e. g. concerning the species *Lasius affinis* SCHENCK. The workers — coming from different colonies of *Lasius affinis* that are very frequent in the grass associations along the Tisza — did not show any aggressive behaviour at all facing one another; at the same time, they attacked the individuals of other species in a very aggressive way.

According to the above, when we speak of competition as a population-stabilizing factor, in case of ants that may refer not only to the intraspecific form or to the interspecific one but to both of them. It is decided by the ethological character of the population given, which of these will play a more considerable part. As to the competition, in the literature there were several papers published so far (BRIAN 1956, 1965, PONTIN 1961, 1963, REZNIKOVA 1974, STEBAEV and REZNIKOVA 1972, BARONI URBANI 1969, 1974).

Interaction of density and of regulating factors

For summarizing the above, we may illustrate in a simple model the interaction of density and the factors regulating the ant populations (Fig. 3). Advancing from a habitat that is unfavourable to an at population towards another that is favourable, the density independent factors (DNDF) become more and more of preconditioning character. At the same time, as already mentioned, the density of population (D) is changing along the saturation curve, as density is stabilized at a permanent level by density dependent factors (DDF), manifesting themselves with the increased population density. The effect of the density dependent factors is, therefore, strengthened by the increase in density. Then, just as a result of that these factors stabilize the population in a favourable environment, too, at a permanent level, the tempo of its increasing becomes slower and later on stops increasing, together with that of density. The effect of these DDF factors is therefore

changing, as advancing towards a habitat of a more and more favourable environmental effect, along the longistic curve. The connection between the three variables (DNDF, D, DDF) is shown by the spatial curve seen in Fig. 3. Finally, the dependence of the density dependent factors upon density is given by the projection of the spatial curve at the plane determined by axes D and DDF that is an exponential curve.

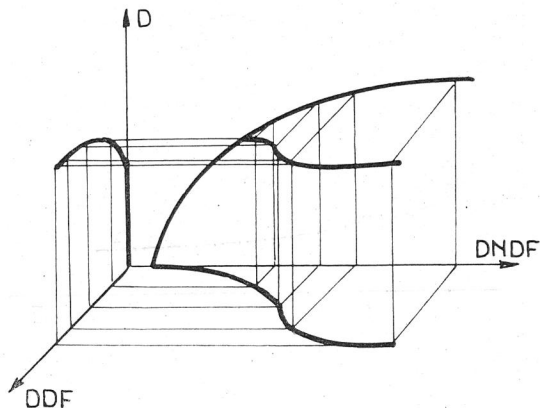


Fig. 3. Interaction of the density independent factors (DNDF), population density (D), and the density dependent factors (DHF).

References

- BARONI URBANI, C. (1969): Ant communities of the high-altitude Appennine grasslands. — *Ecology* 50, 488—492.
- BARONI URBANI, C., KANNOVSKI, P. B. (1974): Patterns in the red imported fire ant settlement of a Louisiana pasture: some demographic parameters, interspecific competition and food sharing. — *Environmental Entomol.* 3, 756—760.
- BRIAN, M. V. (1956): The natural density of *Myrmica rubra* and associated ants in West Scotland. — *Ins. Soc.* 3, 473—487.
- BRIAN, M. V. (1965): Social insect populations. — London—New York.
- GALLÉ, L., Jr. (1967): Ecological and zoocoenological conditions of the Formicoidea fauna at Tiszakürt. — *Tiscia (Szeged)* 3, 67—73.
- GALLÉ, L., Jr. (1969): Myrmecological investigations in the environs of Kisköre. — *Tiscia (Szeged)* 5, 87—95.
- GALLÉ, L., Jr. (1972a): Formicidae populations of the ecosystems in the environs of Tiszafüred. — *Tiscia (Szeged)* 7, 51—68.
- GALLÉ, L., Jr. (1972b): Study of ant populations in various grassland ecosystems. — *Acta Biol. Szeged* 18, 159—164.
- GALLÉ, L., Jr. and GAUSZ, J. (1968): Data for knowledge of the entomology of the Upper-Tisza district. — *Tiscia (Szeged)* 4, 83—101.
- MOLNÁR, KATALIN (1975): Intra- és interspecifikus kompetíció vizsgálata hangyákon (Investigation of intraspecific and interspecific competition in ants). — Manuscript.
- PETAL, JOANNA (1972): Methods of investigating of the productivity of ants. — *Ekol. Polska* 20, 9—22.
- PISARSKI, B. (1972): Personal communications.
- PONTIN, A. J. (1961): Population stabilization and competition between the ants *Lasius flavus* (F.) and *Lasius niger* (L.). — *J. Anim. Ecol.* 30, 47—54.
- PONTIN, A. J. (1963): Further considerations of competition and the ecology of the ants *Lasius flavus* (F.) and *Lasius niger* (L.). — *J. Anim. Ecol.* 32, 565—574.
- REZNIKOVA, JOANNA I. (1974): Mechanism of territorial interaction in *Formica pratensis* (Hymenoptera: Formicidae). — *Zool. Zhurn.* 53, 212—223.
- STEBAEV, I. V. and REZNIKOVA JOANNA I. (1972): Two interaction types of ants living in steppe ecosystem in South Siberia, USSR. — *Ekol. Polska* 20, 103—109.