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DISPERSION OF THE NESTS OF AN ANT SPECIES (HYMENOPTERA: FORMICIDAE)

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Abstract

On the basis of dispersion-index, Morisita's index and the "mean crowding", the dispersion of nests of the very high density population of *Lasius alienus* FÖRST. (1.27 nests/sq. m) in the *Festucetum vaginatae* plant association turned out to be of uniform type. However by the fitting-test to positive bionomial distribution and to that of Poisson, random dispersion was rendered more probable. In this way the results of dispersion index and the fitting-test to some extent contradict each other. It is also true for the *L. alienus* population that an increase in density involves a change in the uniform direction of dispersion.

Introduction, Methods

Some publications are known concerning the dispersion of ants. BRIAN (1956) studied the distribution of *Myrmica rubra, M. scabrinodis,* and *Leptothorax acervorum,* by investigating the fitting to Poisson's distribution. BARONI—URBANI (1969) identified the dispersion of *Lasius alienus* and *Tetramorium ceaspitum* with the $\varkappa^2$-test and Morisita's index; PETAL (1972) applied the dispersion index $s^2/\bar{x}$ to study the dispersion of the nests of *Myrmica laevinodis*; GALLÉ (1975) investigated the connection between the density and the dispersion-index in five ant species. As the type of dispersion in a homogeneous or neraly homogeneous environment may be an index of the intraspecific competition (BRIAN, 1965; GALLÉ, 1975), a knowledge of the dispersion is essential in the ecological study of ants.

In the present work, the dispersion of nests of the ant species *Lasius alienus* FÖRST. in the phyto-association *Festucetum vaginatae* is demonstrated. As pointed out by NIELSEN in his papers on the density, biomass and productivity of *Lasius alienus* populations in the grassland ecosystems in Denmark (NIELSEN, 1972a, b, 1974a, b), in habitats of sandy soil the nests of this ant cannot be delimited sharply from one another. As there are some groups with larger or smaller individual members in the soil, it is difficult to define the limits of nests. In the course of the investigation, therefore, only those groups of individuals were qualified as nests where broods could be found.

Since the nest-density of the *Lasius alienus* population is very high in the course of recordings the sampling size selected as "minimiareal" was 4 sq. m (a square of 2×2 m). Thirty six samples like this were made.

Several methods are known for identifying the three kinds of dispersion archetypes: the random, clumping and uniform ones. From among these in evaluation of the data the following were applied: dispersion index and $\varkappa^2$-test (SOUTHWOOD, 1968), Morisita's index (ibid.), "mean crowding" (LLOYD, 1967) and fitting-tests to Poisson's and positive binomial distributions (DOBÓ-ZAJTA, 1958; ANDREWARTHA, 1961; MACARTHUR and CONNELL, 1967; GALLÉ, 1973).

Results and Discussion

In the course of recording, the following characteristric features were found:

total nest number (Σx)	183 nests
sample average ($\bar{x}$)	5,083 nests/4 sq. m
sq. m average ($\bar{x}$/sq.m)	1,270 nests/sq. m
standard deviation (s)	1,158
variance (s^2)	2,493

On the basis of the above traits, according to the formula

$$N = \left(\frac{t.s}{D.\bar{x}}\right)^2$$

(SOUTHWOOD, 1968), where D=0,1, 39 samples are necessary at a 5 per cent significance-level (t=2,03), and 27 samples at a 10 per cent significance level (t=1,69). Thus, the 36 samples recorded at a 5 per cent significance level may be considered satisfactory.

The data of the dispersion index

$$V = \frac{s^2}{\bar{x}}$$

are contained in Table I. It is also to be seen from the Table that the value of V is much below 1, while the value of $\varkappa^2$ falls outside the 0.05 and 0.95 limits of the table. Therefore, by reason of the test, the probality of Poisson's distribution can be rejected with 95 per cent certainty and the low value of V indicates a uniform dispersion.

The form of Morisita's index is as follows:

$$I_\delta = N\frac{\Sigma x^2 - \Sigma x}{(\Sigma x)^2 - \Sigma x} \qquad (1)$$

The test of the significant different from the random one is:

$$F_0 = \frac{I(\Sigma x - 1) + N - \Sigma x}{N - 1} \qquad (2)$$

The value of I_δ, on the basis of (1), is 0.987. The result of the F test, according to (2), is 0.922, i.e. non-significant. However as pointed out by BARONI—URBANI, equation (2) is not suitable for testing the significante of uniform dispersion.

Lloyd's charactersistic, "mean crowding", (1967) is very suitable for discribing dispersion and particulary the ratio $\overset{*}{m}/m$, named by "patchiness". In this case, the

Table 1. Results of the dispersion index (V) and $\varkappa^2$-test $\varkappa^2_p$=values of the $\varkappa^2$-table; $\varkappa^2_{exp}$=calculated from the dispersion index; df_1=degrees of freedom from the table; df_2=real degrees of freedom

data	value	df_1	df_2
$\chi^2_p(0.95)$	18.5	30	35
$\chi^2_p(0.05)$	43.8	30	35
χ^2_{exp}	17.2	30	35
V	0,49	—	—

real "mean crowding" is not taken into consideration, but an estimated value of this:

$$\overset{*}{x} = \frac{\Sigma x_i^2}{\Sigma x_i} - 1$$

For the dispersion of *Lasius alienus* nests this is 4,489 and $\overset{*}{x}/\bar{x}$ is 0,8832 i.e. smaller han unity. This similarly points to a uniform dispersion.

Table 2. Fitting of the observed data to the probability distributions. x/sample=nest number/sample; 0_i=frequency observed; $E_{i\ Poisson}$=frequency calculated on the basis of Poisson's distribution; $E_{i\ pos.b.1.}$=frequency calculated on the basis of positive binomial distribution; $E_{i\ pos.b.2.}$=frequency calculated on the basis of positive bionomial distribution in the domain between 0 and 7 nests/sample

x/sample	0_i	$E_{i\ Poisson}$	$E_{i\ pos.b.1.}$	$E_{i\ pos.b.2.}$
0	0	0.219	0.057	0.006
1	1	1.119	0.452	0.118
2	3	2.854	1.661	0.825
3	4	4.852	3.689	3.200
4	7	6.188	5.532	7.480
5	11	6.307	5.902	10.480
6	5	5.364	4.591	8.150
7	2	3.909	2.623	1.060
8	0	2.491	1.092	—
9	2	1.415	0.325	—
10	0	0.720	0.065	—
11	0	0.348	0.078	—
12	1	0.140	0.000	—

Both on the basis of above facts, and as a result of the negative *k*-value of the negative binomial distribution used for identifying the clumping dispersion, the probality of a clumping dispersion can significantly be rejected. Thus, from among the theoretical probality distributions, Poisson's and positive binomial fitting are to be performed. The data of the fitting test are contained in Table 2. According to the fitting investigation performed with the x^2 test, for Poisson's distribution $\varkappa^2=11.03$; $0.05<p<0.10$. Accordingly, although positive binomial distribution cannot be rejected significantly, Poisson's distribution and hence random dispersion seem to be more probable. The results of this test are therefore at variance with the $\varkappa^2$ test of the dispersion index, where a significant deviation from random dispersion was observed. On graphical fitting, however, if the 8 and 12 nests/sample extreme values obtained in the course of recording are not taken into consideration, positive binomial distribution seems to give a comparatively good approximation. However the probality obtained by the $\varkappa^2$ fitting test is a low one, even in this way (Fig. 1:4). The graphical fitting to Poisson's distribution — with the exception of the observed points (5.11) — is similarly closed (Fig. 1:2). According to the available literature data, clumping dispersion of ant nests was investigated only by PETAL (1972), in the case of *Myrmica laevinodis*. The density of the population studied by her, however, was very low. On the other hand, BRIAN (1956), in the case of *Myrmica* species, too, observed uniform and random dis-

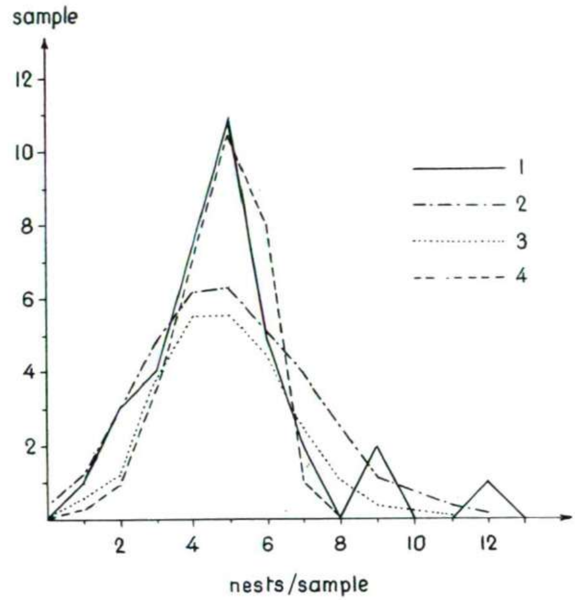

Fig. 1. Graphical fitting. 1 = data observed, 2 = poisson's distribution, 3 = positive binomial distribution, 4 = positive binomial distribution in the domain between 0 and 7 nests/sample ($E_{i\ pos.b.2.}$ values).

persion. BARONI—URBANI (1969) investigated *Lasius alienus* populations with a density of about 0.3 nest/sq.m. in *Brachipodietum* and *Festucetum* phyto-associations. On the basis of the $\varkappa^2$-test of the V index, the dispersion proved to be a random type.

According to the results obtained with the same method, the dispersion of the *L. alienus* population investigated in the present paper is uniform, and its density is much higher (1.27 nests/sq. m). Comparing the data of PETAL and BRIAN concerning the *Myrmica* species, as well as the values of present paper, with Baroni—Urbani's *L. alienus* data, it is seen that in the case of a higher density the dispersion is shifted to be uniform — to wich attention was called with the inverse proportionalty of the density and dispersion index (V) in a previous paper (GALLÉ, 1975). This connection between the density and dispersion index can be explained via the density-dependent character of the intraspecific competition inducing a uniform dispersion.

Conclusions

In respect of the dispersion of *Lasius alienus* population of very high density, the following conclusions may be drawn:

1. On the basis of Morisita's index, mean crowding analysis and the dispersion index, the dispersion proved to be uniform.

2. The fitting study into the theoretical distributions, on the other hand, makes Poisson's distribution more probable than the positive binomial one. Negative binomial dispersion can be rejected because of the results of every test and the negative value of "k".

3. On the basis of the dispersion index, comparing the present investigations with Baroni—Urbani's results (1969), an inverse proportionality may be observed between the density and dispersion index.

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