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Aspects of the distribution of ants in an insular mediterranean ecosystem (Cyclades is., Greece)

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Synopsis: *Synopsis:* The composition, spatial distribution, nest density and dimensions and feeding habits of an ant community in an insular maquis ecosystem of Greece were studied. A comparison was made between the ant fauna of that and similar ecosystems in Italy.

Keywords: *Keywords:* Ants, maquis, spatial distribution, Greece.

INTRODUCTION

Since 1981, a research program has been undertaken in order to study the structure and function of a representative insular ecosystem in the island of Naxos, the largest of the Cyclades islands in the Aegean Sea. The principal vegetational components of this ecosystem are evergreen sclerophylls.

The role of ants in such mediterranean ecosystems has not been studied properly. The only recent work in the Mediterranean area is that of BARONI-URBANI (1968). Since ants are known to be important factors in the functioning of ecosystems, it was decided to study the composition, population density, spatial and temporal distribution, daily rythms of activity, feeding habits, total biomass, energy content and other ecological parameters of the ant community of this mediterranean ecosystem. This paper deals with the first results obtained in this study, namely the composition and the spatial distribution together with some notes on other aspects. This study concerns results obtained from November 1981 up to April 1984.

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I. — SITE AND METHODS

A) Site description

The study area is situated in the eastern part of Naxos island on the Cyclades group in the central Aegean. It lies on a hill of calcareous substrate covered by rocks mostly of medium to large size. The vegetation consists mainly of *Juniperus phoenicea* (37 % cover). A large proportion (47 %) is open ground containing various herbaceous species. Human interference expresses itself mainly by grazing from goats. The climate of Naxos can be considered as temperate to maritime with an annual range of temperatures of about 13°C (MATSAKIS *et al.*, in press).

B) Materials and methods

In order to find out the total number of species in the biotope, four sources were used. First, a search of the area was carried out with the specific aim to find ants' nests under stones, in litter or in the uncovered ground. Selected areas of approximately 100 m^2 were picked out from the whole study area in which all stones were upturned and litter was searched thoroughly. The other three sources were material collected from 1 m^2 quadrats with hand sorting. 25×25 cm quadrats of litter extracted from Berlese funnels and pitfall traps placed under trees and in the uncovered ground. All species were identified to specific level.

Quantitative sampling took place during spring when the ants were most active in three consecutive years, 1982, 1983 and 1984. The density of the ants' nests was calculated using 10 quadrats, 16 m^2 (4×4) each, picked out randomly. The size of the sampling unit was chosen arbitrarily so that it contained a sufficient number of nests, it was fairly representative as far as vegetation was concerned and did not require much time to search through. The number of samples was calculated from the number of samples equation (SOUTHWOOD, 1978) with a standard error predetermined at 5%.

In order to assess the density of the individuals for the three most dominant species, ten whole nests of each species were unearthed, transported to the laboratory and their population was counted. Biomasses were estimated using microanalytical balances.

II. — RESULTS

A) Faunal composition, density and biomass

The ant fauna of the study area consists of ten species. A list is given in Table I. Two of the species were not observed in the quadrats. The density of the nests of all the species was 0.63 nests/m^2. There are two predominant species, *Plagiolepsis pygmaea* (workers 1.1-2 mm, fem. 2.6-4.5 mm, males 1.5-2.1 mm) and *Crematogaster sordidula* (work. 2-2.9 mm, fem. 6-6.5 mm, males 1.9-2.9 mm).The number of their nests corresponds to 78% of the total. All species except the unknown

Leptothorax sp. (work. 2.3-3.1 mm, fem. 3.5-4.7 mm, males 2.5-3.2 mm) are common, widely distributed in the eastern Mediterranean area. Most of them are anthropophilous. Seven of them are new for the fauna of Naxos island.

TAB. I. – **Number and density of nests, density of individuals and biomasses**

Species	Total No. of nests in area	No. of nests/m^2	No. of ind/m^2	Biomass mg/m^2
Plagiolepis pygmaea	190	0.4	81.2	4.9
Crematogaster sordidula *.	48	0.1	165.6	61.3
Camponotus gestroi *	22	0.04	36.0	543.6
Leptothorax sp. *	18	0.04		
Pheidole pallidula *	7	0.01		
Camponotus kiesenwetteri * . . .	9	0.02		
Camponotus aethiops	6	0.01		
Messor meridionalis				
Tetramorium caespitum *	1	0,01		
Solenopsis fugax *				

* New for the fauna of Naxos.

The density of individuals and the total biomass of the three most important species appear also in Table I. *C. gestroi* (work. 4.3-7.9 mm, fem. 10-10.5 mm, males 7-8 mm), although having much less abundant nests, has a high biomass because the individuals of this species are considerably larger. The next two species, *Leptothorax* sp. and *P. pallidula* (work. 1.6-2.6 mm, fem. 6-8.5 mm, males 3.7-5 mm) are much smaller and will contribute very little to the total biomass.

B) Spatial distribution

The nests seem to be dispersed randomly throughout the study area. Using the Morisita index of dispersion, this assumption was proved correct for all species. A test for clumping was performed for each species separately. The T-square sampling test (Diggle 1983) showed that nests of *P. pygmaea* show a clumped pattern while nests of all the other species are randomly distributed. However, some species may prefer to make their nests under or near certain major plants. To test this, from the maps of the quadrats, the total area covered by the major plants was calculated and the relationship between the number of nests of each species and the area of each plant was tabulated. Using the formula for the comparison of two percentages, the densities of each species under or near *J. phoenicea* and *O. europaea* were compared. The results appear in Table II. From this it is evident that *P. pygmaea*, *C. gestroi* and *C. kiesenwetteri* prefer *O. europaea* from *J. phoenicea* while *C. sordidula*, *Leptothorax* sp. and *P. pallidula* have no statistically significant preference among the two plants.

The degree of association between nests and the edge of the tree cover was also investigated. Table III lists the results. It is observed that *P. pygmaea*, *Leptothorax* sp., *C. kiesenwetteri* and *C. aethiops* make their nests on the average under the tree cover while *C. sordidula*, *C. gestroi* and *P. pallidula* make them on the average

TAB. II. – **Relationship between number of nests and tree cover.** (Asterisks denote statistically significant difference.)

Species	In *J. phoen.*	In *O. europ.*	In *P. lent.*	*d* between *J. p* and *O.* 2
P. pygmaea	0.85	1.44	1.06	11.8 *
C. sordidula	0.30	0.44	0.33	0.25
C. gestroi	0.12	0.50		3.14*
Leptothorax sp.	0.07	0.22		1.63
P. pallidula	0.10	0.11		N.S
C. kiesenwetteri	0.02	0.22		2.6 *

a short distance outside the cover. Also noteworthy are the facts that *Leptothorax* sp. prefers deep cover, very near the tree trunk, *C. sordidula* makes nests quite far away from *P. lentiscus* and *C. aethiops* makes its nests only under *J. phoenicea* and not under the other plants.

TAB. III. – **Mean distance in cm between nests and tree cover** (σ_n in parenthesis)

Species	*J. phoenicea*	*O. europaea*	*P. lentiscus*
P. pygmaea	−27 (58)	−12 (57)	4 (34)
C. sordidula	4 (52)	4 (37)	80 (0)
C. gestroi	26 (25)	0 (48)	–
Leptothorax sp.	−98 (29)	−40 (38)	–
P. pallidula	23 (34)	40 (10)	–
C. kiesenwetteri	−40 (30)	−33 (57)	–
C. aethiops	−55 (64)	35 (15)	

The degree of association between nests of different species was also investigated. The mean distance of each species from the edge of the tree cover was compared with the mean distance of every other species. From Table IV, it can be seen that *Leptothorax* sp. and *P. pygmaea* make their nest further apart from most other species under *J. phoenicea* but under *O. europaea* which covers a much smaller area, there is no difference in where the nests are located.

TAB. IV. – **Degree of association between species. * means significant difference in distance, N.S. means not significant difference. The top right half concerns nests under or near *J. phoenicea* while the bottom left half concerns nests under or near *O. europaea*.**

Species	*C. sor.*	*C. ges.*	*Lept.*	*P. pal.*	*C. kies.*	*C. ae.*
P. pygmaea	*	*	*	*	N.S.	N.S.
C. sordidula	–	N.S.	*	N.S.	N.S.	N.S.
C. gestroi	N.S.	–	*	N.S.	N.S.	N.S.
Leptothorax sp.	N.S.	N.S.	–	*	N.S.	N.S.
P. pallidula	N.S.	N.S.	N.S.	–	N.S.	N.S.
C. kiesenwetteri	N.S.	N.S.	N.S.	N.S.	–	N.S.
C. aethiops	N.S.	N.S.	N.S.	N.S.	N.S.	–

Finally, an attempt was made to discover if the ants prefered to orient their nests in some specific direction from the trees. After calculation of the angles of the nests to the tree trunk, it was found that the ants did not prefer one or more particular sides of the tree.

C) Nest structure

All species except *Leptothorax* sp. make their nests exclusively under stones. *C. gestroi* usually has more than one entrance but the entrances are always less than 20 cm apart. *M. meridionalis's* nests cover large areas of approximately 22,500 cm^2 and their entrances are always under stones. *Leptothorax* sp. makes its nests in various places, under stones, in thick litter, in dry wood, in abandoned spider nests, etc.

The dimensions of the nests of the two principal species, *P. pygmaea* and *C. sordidula* were calculated. The volume of the nests of *C. sordidula* ranges from 1,200 up to 5,500 cm^3 while that of the nests of *P. pygmaea* from 100 to 200 cm^3. The ground area covered by the nests ranges from 50 to 250 cm^2 for *C. sordidula* and from 20 to 40 cm^2 for *P. pygmaea.*

The size of the stones under which the two principal species make their nests was calculated. For *C. sordidula* the area ranged from 80 up to 1,300 cm^2. For *P. pygmaea* it ranged from 20 up to 300 cm^2.

D) Food sources

C. sordidula is predominantly carnivorous. It feeds from freshly killed or disabled animals such as spiders, snails, coleoptera, etc; Workers have been observed to transport in the nests, grains and other plant material which might be used for food. They have also been observed to tend Hemiptera (Fam. Coccidae and Tettigometridae) and receive droplets of some liquid.

P. pygmaea seems to be omnivorous. Workers have been seen transporting both plant and animal material in equal quantities. The same is true of *P. pallidula.*

M. meridionalis is granivorous. A variety of seeds at large quantities enter the nest. Occasionaly, a dead insect is also transported in the nest.

The three *Camponotus* species are predominantly carnivorous; They have been seen carrying a variety of whole insects towards their nest.

E) Foraging

Six of the ten species in the study area are using trails on the ground or on the plants from their food source to the nest. They are *P. pygmaea, C. sordidula, P. pallidula, M. meridionalis, T. caespitum* and *S. fugax.* The other four, *C. gestroi, C. kiesenwetteri, C. aethiops* and *Leptothorax* sp. do not use trails but forage individually.

F) Foraging territory

The foraging territory of two principal species was calculated by using honey baits. The observed maximum territory of *C. sordidula* was 55 cm^2 while that of *P. pygmaea* was 4 cm^2. During the summer period, the maximum foraging territory of *M. meridionalis* was calculated by observing the food sources of that ant. It was calculated to be 700 m^2.

G) Comparison with similar ecosystems

Three parameters were used for the comparison of the study area in Naxos with two similar areas in Italy (Baroni-Urbani, 1968), one a degrated macchia with *Fraxinus ornus* and *Pistacia lentiscus* and the other a full macchia with *Quercus ilex*, *Q. pubescens* and *Arbutus unedo*.

(*a*) *Relative abundance*, C/F, where C = number of nests in the study area and F = number of quadrats where each species was observed.

The values of C/F for two of the species present in the Naxos study area are compared in Table V. There is a strong similarity between Naxos and the full macchia for *P. pygmaea* and a strong similarity between Naxos and the degraded macchia for *P. pallidula*.

TAB. V. – **Relative abundance (C/F) of nests for Naxos, italian full macchia and italian degraded macchia**

Species	Naxos	Full macchia	Degrad. macchia
P. pygmaea	6.3	5.6	1.7
P. pallidula	1.7	3.0	1.7

(*b*) *Motomura index of complexity*, $a = b\text{-}\log y/x$ where x = order of abundance of each species, y = total number of nests for each species and b = coefficient dependent on density. The index is inversely proportional to the complexity of the ant fauna of the region. The degraded macchia has $a = 0.159$, the full macchia has $a = 0.231$ and the Naxos area has $a = 0.252$. It is observed that the Naxos area is more close to the full macchia than to the degraded macchia as far as the complexity of the ant fauna is concerned.

(*c*) *Shannon index of stability*, $H = c(\log N - 1/N * \Sigma n_r * \log n_r)$ where n_r = number of nests for each species, S = total number of species and $c = 3.321928$. The values of H are proportional to the stability of the ant community. The degraded macchia has $H = 2.865$, the full macchia has $H = 2.487$ and the Naxos area has $H = 2.225$. Again here it is observed that the Naxos area is more close to the full macchia than to the degraded macchia.

III. – CONCLUSION

It is difficult to draw conclusions especially in comparison with similar ecosystems as that under study. The complexity of mediterranean ecosystems and their mosaic nature compared with those of arid, semi-arid or forest regions has

discouraged research on their ecological structure and function. Also, the complexity of ant populations due to their social nature does not leave us with a broad field of existing results. This is where the interest of the present study lies. The ant community of the study area contains many interesting aspects that can be elucidated. The number of species is not so large to hinder quantitative observations. The ecological parameters such as nest position or feeding habits vary from species to species and the study of the other plant and animal components of the ecosystem which is under way will eventually permit to define the ant community. Currently, more emphasis is placed on the daily and seasonal fluctuations of the ant population and their activity.

Summary

The composition, spatial distribution, nest density and dimensions and feeding habits of an ant community in a maquis ecosystem on the island of Naxos, Greece, were studied. Ten species were identified, *Plagiolepsis pygmaea* and *Crematogaster sordidula* being dominant. Nest density for all species was calculated at 0.63 nests/m^2. The nests are dispersed randomly. However, some species prefer to make their nests near certain trees. Almost all species make their nests under stones. Nest volume and area was calculated for the two dominant species. Observations on the feeding habits of all species are included. A comparison was made between Naxos and similar ecosystems in Italy.

Résumé

Quelques aspects de la distribution des fourmis dans un écosystème méditerranéen (Cyclades is., Grèce)

Quelques aspects de l'écologie d'une communauté de fourmis ont été étudiés dans un maquis sur l'île de Naxos, Grèce. Dix espèces ont été identifiées, parmi lesquelles prédominent *Plagiolepis pygmaea* et *Crematogaster sordidula*. La densité des nids pour l'ensemble des espèces a été évaluée à 0.63 nids/m^2. Les nids présentent une distribution au hasard. Quelques espèces font leurs nids près de certains arbres. Presque toutes les espèces construisent leurs nids sous les pierres. Le volume du nid et la superficie couverte par celui-ci ont été évalués pour les deux espèces prédominantes. Des observations sur le comportement alimentaire de toutes les espèces ont été effectuées. Les résultats de l'île de Naxos sont comparés à ceux concernant des écosystèmes similaires d'Italie.

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