

AUCHENORRHYNCHA / HOST PLANTS ASSOCIATIONS IN EAST MEDITERRANEAN  
COMMUNITIES: A MULTIVARIATE APPROACH ON STRUCTURE AND SPECIFICITY<sup>3</sup>

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ABSTRACT

We investigated the relations between fourteen Auchenorrhyncha species and the plants in an east mediterranean shrubland. We tried to reveal covariation patterns between biotope descriptive variables and insect species, abundances and preferences. We devised a new quantitative approach to estimate preference. Insects niche parameters and overlaps were estimated and the niche structure in various seasons was compared to predictions of traditional niche theory. By using character set types in a monocharacter growth form system, instead of plant species, we discovered negative correlations between community diversities and temporal stability.

KEYWORDS

Insect plant relationship, Niche structure, East Mediterranean, Multivariate techniques, Diversity.

INTRODUCTION

Plants give biotopes their characteristic configuration. In consequence, various aspects of them were quantified in an attempt the guiding forces of animal assemblages to be analyzed (MacArthur, 1964; Andrzejewska, 1965; James, 1971; Shugart & Patten, 1972; Roth, 1976; Blondel & Cuvellier, 1977; Rotenberry & Wiens, 1980; Mac Nally & Doolan, 1986). The selection of the critical variables to be measured, was based largely on the suspicion and the field experience of the investigator, on a particular group of animals. For this reason, the collected data sets contained an amount of extraneous information, as a result of the redundancy and the correlation of the selected variables (Mac Nally & Doolan, 1986).

To isolate this effect of variables, a reductionistic method was usually undertaken, and the original data set was reduced to a small set of orthogonal factors (Rotenberry & Wiens, 1980; Mac Nally & Doolan, 1986, among others). This reduction, made possible the quantification of the multidimensional Hutchinsonian niche, initially for molluscs (Green, 1971) and then for birds (James, 1971; Rotenberry & Wiens, 1980), for plants (Johnson, 1977a,b), for small mammals (Dueser & Shugart, 1978) and recently for cicadas (Mac Nally & Doolan, 1986).

Through this approach and after the identification of the above MENTIONED axis, as resource axes, the niche parameters of each animal species were estimated, and the niche structure of the animal communities was sought, very often with obscured results, because of the inadequacies of the collected data (Pianka, 1975; Rotenberry & Wiens, 1980). The problems associated with this unclear patterns, stemmed from three error sources. 1) The scaling problem in the sampling design was not always taken in mind, and biotope descriptive variables were measured in incompatible scales than animal abundances (Petraakis & Catsadorakis, 1987 in press). 2) Data sets were collected from broad biogeographic regions and thus were largely inadequate to generalize interpopulation dynamics such as niche compressions or expansions (Cody, 1975; Rotenberry and Wiens, 1980.3) To our knowledge, there is not any published work on the study of the niche space mobility within one year; the existing works (Waloff & Solomon, 1973; Morris, 1973; Gibson, 1976, among others), do not quantify niche space in the context of multivariate techniques.

In this paper, we analyze the relationships of Auchenorrhyncha niches with the habitat in an east-Mediterranean region, on Kynosura peninsula, near Marathon village in Greece. Firstly we describe vegetation gradients with two alternative sets of variables. Then we estimate the niche parameters of insect species and their changes in three main seasons of the year. We then examine the relations of niches of the insect species and test the compatibility of this community patterns with predictions of niche theory.

PROCEDURES

**Study area:** The study was undertaken at a northeastern exposed hillside on the base of Kynosura peninsula. Dominant vegetation is a Juniperus phoenicea and Olea europea codominated shrubland with openings dominated by annual and perennial herbs and low chamaephytes and hemicryptophytes. The depth of the soil is low (<= 5cm in many cases) and the parental material is usually exposed (Petraakis, 1984).

**Sampling:** The sampled sites are quadrats (10 x 10 m<sup>2</sup>), located at regular intervals along a transect strip descending the hillside from the top. Ten quadrats were sampled for insects at fortnight intervals with a sweep net by one person to reduce collector bias. Within a quadrat, the sweep net passed through every vegetation phase, readily distinguished by eye and the content of the net, was transferred in a plastic bag where insects were killed by ethyl acetate. This was considered as one sample. Two kinds of

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3. Financial support for this paper came from nowhere.

samples were taken from shrubs and low trees - trees with distinct trunk were rare in the broader region and absent from our transect. The first kind corresponded to the first one meter in the base of the plant where lower branches were intermingled with herbs grown under the shrub. The second kind corresponded to the rest of the shrub.

Plants were sampled for coverage, density and height. These parameters were selected because they provide the necessary plant parameters for the estimation of foliage volume through the parabolic estimator formula:  $\sqrt{2}(\text{height})\sqrt{\text{coverage}}$ , modified from Whittaker (1961) without species corrections. Height was measured in the field and it is the mean value of all individuals of a plant species or a plant character set type (CST see below). Coverage was estimated by a photo-computational method (Petrakis, in prep). Five photographs of each quadrat were taken with a 17mmF optical lens and the transparency was then projected onto a board of a digitizing areometer connected serially to a computer. With an appropriate program (written by Petrakis) we then calculated the percentage of each species, or CST, with corrections for the parallax of the picture introduced by the lens. Although photo-computational methods require an appreciable amount of experience with the plant populations, they have been proved very accurate in estimating plant performance and abundance (Stocck, 1979). This procedure was repeated twice, in February and in May and the data were pooled.

At the same time intervals we measured plant phenological parameters in a quantitative manner but these data are not incorporated into the subsequent statistical analyses, though they are taken into account in the discussion of results and will be reported in another paper.

**Variables and statistical procedures:** So far, in the literature, biotope descriptive variables fall into two broad categories. The first comprises "coverage" variables and the second "structural" variables (e.g. Rotenberry & Wiens, 1980). Here we chose an alternative approach. Our first variable set included all plant species. Thirty plant species that had coverage in one site at least .5 m<sup>2</sup> were included and 27 species were disregarded as rare. Twenty two of the disregarded species had also very low weights in another study of Coleoptera plants associations in a neighboring site (Iselepatioti-Petraki unpubl.). Also we used an alternative set of variables, where plants are considered as CST in a non taxonomic monocharacter growth form system (MGFS) (Petrakis in prep.). In this classificatory scheme plants were assigned in 25 anatomical phenological and ecophysiological characters. This classification is proved here as a more powerful tool for variable set construction, since most characters in the scheme are insect oriented. In degraded Mediterranean plant formations, plants have evolved defending strategies to cope with grazing and drought. The morphological and phenological features of these adaptations are not discrete and unique, but they are performed in a variety of intensities not necessarily related to the intensity of the exerted pressure. For these reasons these two classifications produced two slightly different spaces as it can be seen in Fig. 1 and 2, the CSTs space being more easily explicable in the context of insect plant relationships.

For the estimation of insect niche parameters we took the multivariate approach, which reduces the dimensionality of the resource space with minimal information loss, and provides the possibility of tests for these parameters. The method was the principal components analysis (PCA), a robust technique in data bodies free of disjunctions and non-linearities (Gauch et al, 1977; Johnson, 1977b; Orloci, 1979; Gauch, 1982; Greig-Smith, 1983). Disjunction do not seem to exist, as it can be seen in the dendrogram of Fig. 2. To cope with the problem of non-linearities we transformed the original matrices to the octave scale (Gauch, 1982). A divisive classification (Ilefkovitch, 1976) was applied on each PCA output to detect site groups along resource gradients. With PCA the diagnosis of resource gradients and the estimation of insect niche parameters became possible.

For the estimation of niche breadth (B) and overlap (O) a methodology compatible to that of Johnson (1977b) was adopted. Each principal resource axis was divided into five equally spaced intervals, and the abundance of each insect in the set of sites that fell in each interval was calculated. B was estimated by the formula  $B_i = 1/\sum p_{ijk}$  (Hill, 1973)  $i=1, \dots, N$ ;  $k=1, \dots, t$ ;  $j=1, \dots, 5$ ; where  $B_i$  = breadth of the i-th species in the k-th resource axis,  $p_{ijk}$  = proportion of the i-th species in the j-th interval of k-th axis; N=total number of species; t=number of principal axes. O on a principal axis was measured by the formula:  $O_{ijk} = \sum p_{ihk} p_{jhk} / \sqrt{\sum p_{ihk}^2 \sum p_{jhk}^2}$ ,  $i, h=1, \dots, N$ ;  $j=1, \dots, 5$ ;  $k=1, \dots, t$  where  $O_{ijk}$  = overlap between i-th and h-th species on k-th principal resource axis (Levins, 1966; Pianka, 1975). All these parameters were calculated in each of the three seasons in which the year was subdivided.

The maximum number of axes which accounted for the total trended variation in the data set was estimated by Anderson's (1963) criterion. All tests were performed at .05 probability level.

PCA was also used here as direct seeking method for site preference and as an indirect method for the detection of insect plant associations in a way similar to the indirect gradient analysis (Nichols, 1977). We have extended this seeking approach to all the seasons and we have measured the "mobility" of the sites, by calculating the length of the trajectory of the site, regarded as a point in an insect variable multidimensional space (Table 4 and Fig. 6). We feel that these mobilities are useful measures of the temporal association patterns of insects and plants, together with the possibility to probe the mechanisms through which biotope structural and temporal diversities affect these patterns.

To detect niche overlap relationships of insects in the three seasons, we submitted the matrix of insects by their niche overlap coefficients to a centroid clustering procedures (Orloci & Kenkel, 1985). The strategy was the minimization of group centroid distances measured by the Lance and Williams (1966) formula, since we intended to fuse into groups all species, according to their higher overlap. We have also analyzed our original data matrix of sites by plant species, to seek for floristic similarities among sites. The strategy was the minimization of between group sum of squares, and the algorithm was Orloci's (1967) "sum of squares agglomeration" (SSA). Diversities were calculated by Simpson's and Shannon's formulas (Pielou, 1977).

## RESULTS AND DISCUSSION

**Axes description and resource axes derivation:** Fourteen Auchenorrhyncha species were found in the set of ten sites. From the centered PCA by which the raw data matrix was analyzed in a space of plant species, it can be seen that site groups coincide with those formed by SSA clustering (Fig. 1 & 2). This implies that a contribution of plant species to the vegetative dissimilarity of sites is equal to their contribution to the separation of sites along the resource axes. Anderson's criterion predicted that maximum parsimony is attained at the first two principal axes ( $\chi^2 = 18.17$ ,  $df=27$ ). The amount of trended variation accounted for by the first two principal axes is moderate (Fig. 1). This may be a result of remaining non-linearities after octave scale transformation. Most surprising was that no plant species were significantly correlated to the third and subsequent axes. Nevertheless, these two axes are ecologically interpretable, though not fully. Shrubs and low trees in Mediterranean formations are well correlated to the first axis, not all of them however (Table 2). First principal axis (PA) therefore can be considered as a gradient from rocky soilless

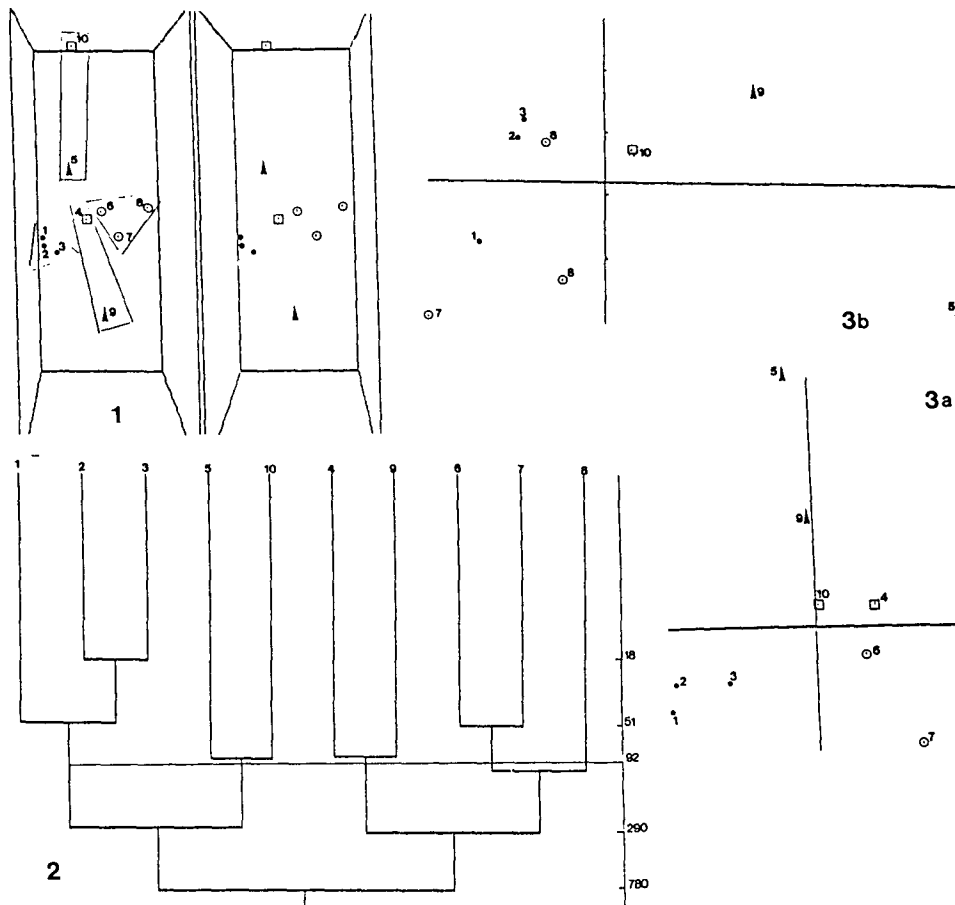


Table 3] Correlations of CSTs with the vegetation principal components. Only significant correlations are shown.

CSTs	Component	I	II	III	IV	V
	Eigenvalue	24.6	16.8	12.39	10.78	9.20
	Cumulative% var	28.52	47.76	62.13	74.62	85.29
JuniphoesIII		-.47				
JuniphoesLow		.46				
Oleaeurodicacrophylous		.65	-.47			.52
Pistlent		.71			.56	
Pistlere			.47			
Phiofrut			-.40			
Quercocc		.46	-.40	.62		
Prunwebb		.72				
Euphacan		-.51				
Urgimari		.75				
Cyclgrae		-.83				
AvenbarbGroup			.90			
KnauinteGroup		.65	.41			.56
Thapparg			.65			
Anengavo			-.62	-.64		
Seladent		.42			.64	

Fig.1 Stereogram of the ordination of sites in a space of plant species foliage volume. Horizontal axis is 1-st PA, vertical axis is 2-d PA and depth axis is 3-d PA. Groups are marked by lines.

Fig.2 Dendrogram of sites (SSA algorithm). Transverse line has been arbitrary drawn.

Fig.3 Ordination plot of sites in a CSTs space. a) Horizontal is 1-st PA, vertical is the 2-d PA. b) Horizontal is 2-d PA and vertical is 3-d PA.

openings (Cyclgrae is an indicator species of these biotopes) to mediterranean thermophilous shrublands. The high loading of *A.barbata* has an obscured basis while the correlation of *K.integrifolia* can be explained by its preference to grow under *J.phoenicea* shrubs. Second PA clearly reflects covariations in opening occupators -*P.fruticosa* is a phrygic element and *O.europea* is correlated to this PA because of its second low growth form which is a less efficient competitor to grasses and forbs. This aspect of *O. europea* will be clarified in the sequel.

The ordination of sites within a CST space is necessary if we are aiming to avoid such spurious correlations that were induced by the Latin bionym. 22 CSTs were recognized by allocating the plants into the MGS characters. In the scattergram (Fig.3) the groups are broadly the same as in Fig.1 with one exception (sites 4 and 5). However the positions of sites and group centroids are quite different. Total

trended variation is 62.13% and is accounted for by the first 3 PAs (Anderson's  $\chi^2 = 4.01$  at  $df=27$ ). By comparing the two ordinations it is easily seen that there exist more trended variation, though it is distributed in three orthogonal PAs. Also all three PAs are readily interpreted in terms of CSTs internally and diversity measures externally (Table 3). The first PA clearly represents covariations in the high shrub layer and a contrast between this phase and the opening occupiators (*E.acanthothaemos* and *C.graecum*). The CST Knautgroup comprises of plants favored by the microclimate beneath shrubs - they possess thin and large leaves with thin palisade layer. This may explain their high loadings on the first PA. The negative correlation of *J.phoenicea* with this PA is a result of the reciprocity of the distributions of the two CSTs in which the plant was splitted. The second PA reflects variations in the herb layer. *Q.europea* and *Q.coccifera* are shrubs obviously associated with some herbs while *P.terebinthus* being a deciduous shrub, prevents the growth of the herb layers underneath as a result of the timing of the leaves shedding (Petraakis, 1984). The same holds for *Q.coccifera*. *A.pavonina* occupies usually small openings. The third PA is a contrast between *Q.coccifera* and *A.pavonina*, a situation taking place from January to March. Fourth PA can be summarized under the label 'axis of *S.denticulata*'. This pteridophyte prevents soil from drought until May (Petraakis's, phenological observation). *P.lentiscus* is positively correlated to this PA as a result of its spatial concurrence with *S.denticulata*. Fifth PA can be labeled 'Q.europea low trees and underneath herbs'. It is the macrophyllous form of this plant that allows sunlight to pass through its foliage in the winter and favors thus the growth of Knautgroup CST. This effect was lost in the previous ordination.

**Niche breadth:** The meanings assigned to each vegetation PA, allowed for a consideration of these components as resource components (RC) and the estimation of Auchenorrhyncha species niche parameters. Possible values for B are 1.00 (for species occurring in only one plot, but not exclusively) to 5.00 (for species occurring in all plots, but not exclusively). In Fig.4 can be visualized the temporal pattern of Bs. Because Resource axes (RA) are orthogonal the volumes of these 'boxes' are serving as estimates of Bs (Pianka, 1975).

Several types of B can be recognized in Fig.4 and one case is worth mentioned. While insects occurring in only one site have always B 1.00 the opposite is not always true. Absent species have 0 B. Ecological specialists and generalists can be diagnosed from this diagrams of Bs and these terms can be extended to include a temporal component. Generalists are expected to have a cubic niche space - e.g. *B.basiniger* in summer- while ecological specialists have niche dimensions elongated on one at least RA - e.g. *P.spumarius* in all seasons. The most striking case is *D.aaculipes*. In spring it fed on *Q.coccifera* and *Q.europea* and other shrubs as well but few individuals were also accidentally found on nearby herbs. However in summer it abandoned *Q.coccifera* and migrated to other shrubs and herbs as well. *D.aaculipes* had expanded its overall B in summer by restricting specialization that means, by restricting its B on *Q.coccifera* axis and dilated its B on the other 2 RAs. We accept this criticism that the same movements of niche dimensions on RAs may be artifacts of our procedure. In our procedure we have not weighted intervals by a resource utilization coefficient (Colwell & Futuyma, 1971), though we have included insect oriented biotope descriptive parameters (CSTs). For this reason an accidental finding of an insect normally foraging on shrub foliage, in herb layer, is equally weighted for the estimation of its B to an occurrence of this on a shrub for feeding or oviposition. Also a source of error is the host switches in the life stages of an insect. Insects *D.aaculipes* and *B.basiniger* are examples of such switches. Another type of error is the occurrence of an insect in a biotope because it prefers microclimatic conditions together with its feeding plant. *M.matsumuri* and *P.spumarius* exhibit such a behavior. While they are normal grass-forb feeders, they prefer to feed on plants growing underneath or nearby tall shrubs. Some individuals of these insects have been collected from the upper parts of shrubs while their nymphs have consistently been found on grasses and forbs. Their Bs therefore are not restricted to the second axis, but are extended to the other two. Their higher extensions

Table 1). List of insect and plant species and codes discussed in this paper. +

Insects		
1	<i>Asicla Asiraca clavicornis</i> (Fabr.)	5 Dicsp. <i>Dictyophara</i> sp.
2	<i>Balcliu Balclutha saltuella</i> (Kirsch.)	6 Empdec <i>Empoasca decipiens</i> (Paol.)
3	<i>Bubsut Bubastia suturalis</i> (Dlab.)	7 Eupael <i>Eupteryx aelissae</i> (Curt.)
4	<i>Dalmac Dalmatium aaculipes</i> (Dlab.)	8 Harins <i>Hardyopsis insularis</i> (Rib.)
	13 <i>Phispu Philaenus spumarius</i> (L.)	11 Opssp. <i>Opsius</i> sp.
		12 Penlep <i>Pentastiridius leporinus</i> (L.)
		14 Quabas <i>Quadrastylum basiniger</i> (Dlab.)
Plants		
	<i>Juniperus phoenicea</i> + <i>Olea europea</i> + <i>Pistacia lentiscus</i> + <i>Pistacia terebinthus</i> + <i>Phlomis fruticosa</i>	
	<i>Quercus coccifera</i> + <i>Prunus webbii</i> + <i>Euphorbia acanthothaemos</i> + <i>Urginea maritima</i> + <i>Cyclamen graecum</i>	
	<i>Avena barbata</i> + <i>Knautia integrifolia</i> + <i>Crepis dioscoridis</i> + <i>Thapsia garganica</i> + <i>Aneomina pavonina</i>	
	<i>Selaginella denticulata</i> + <i>Crocus laevigatus</i> + <i>Ceterach officinarum</i> + <i>Asparagus ephyllus</i> + <i>Pimpinella cretica</i>	
	<i>Dactylis glomerata</i> + <i>Dynosorus echinatus</i> + <i>Trifolium stellatum</i> + <i>Sedum aspera</i> + <i>Clematis cirrhosa</i>	
	<i>Nigella damascena</i> + <i>Fragaria vesicaria</i> + <i>Lagurus orolus</i> + <i>Prasium majus</i> + <i>Scandix pecten veneris</i>	

+ plant species codes are the first 4 letters of the genus and the species name.

to the other RAs can be explained by the diversity of CSTs highly loaded on these RAs. In general the trend of all insects to show reduced Bs on the second RA, can be explained clearly by the lower diversity of CSTs within the grass-forb layers. We have not yet found a sampling design to cope with these difficulties and may be it is impossible in monitoring studies, where the impact on the biotope must be minimal. We conclude from the B pattern that temporal niche allocation may be an important mechanism in reducing interspecific competition in these ecosystems and this is reflected even in seasons with severe environmental stress - winter and summer.

**Niche overlaps:** We used niche overlap (O) as a measure of the degree of cooccurrence of insect species in the 5 intervals on the RAs. In Fig.5 the dendrograms of the Os relationships on the first RA are graphically summarized. At .50 the recognized groups are 3 in winter, 3 in spring and 5 in summer.

It can be shown that *P.spumarius* is not related with any other species while *M.matsumuri* is grouped with different species in each season. In the winter it is more related to *H.insularis* and *Opsius* sp. while in the summer it is grouped with *B.basiniger*. In spring it is related to *P.leporinus*. The degree in which these relationships include spatial cooccurrence was tested by correlating the overlap matrix to the initial matrix of occurrences. This yielded non significant correlations ( $r=.18$ ).

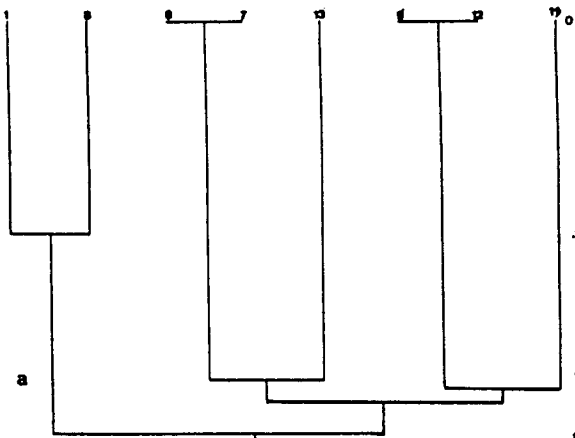


Table 4] Mobility of sites in an insect variables space. Evenness and diversities are in an CSTs space. 1= mobility, 2= Shannon's index, 3= Simpson's index, 4= Richness, 5= Evenness.

Site	1	2	3	4	5
1	98	1.45	1.31	1.79	.95
2	117	1.89	.88	1.39	.78
3	108	1.69	1.61	1.79	.99
4	69	.64	.41	1.89	.59
5	143	1.83	.97	1.10	.94
6	44	.64	.41	1.10	.58
7	138	1.47	1.34	1.61	.91
8	48	.64	.41	1.89	.58
9	104	.58	.38	.69	.72
10	128	1.36	1.14	1.61	.84

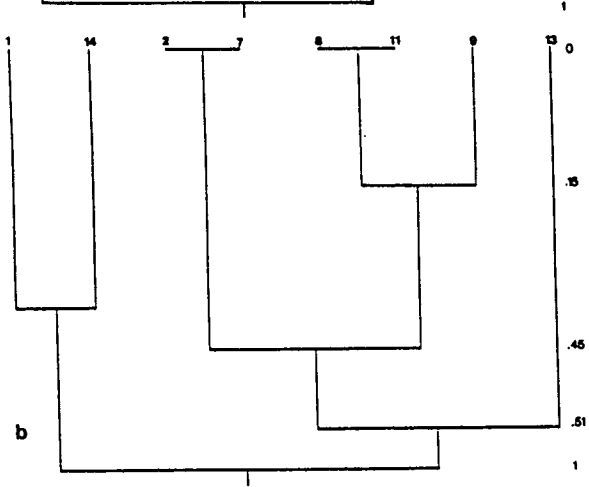
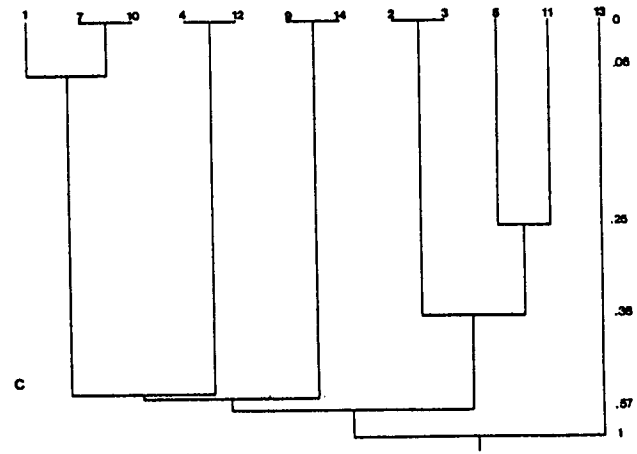


Fig.5 Dendrographic relationships of niche overlap among insect species on the first resource component. a) Winter. b) Spring. c) Summer.



The O relationships we have found, support the first part of Pianka's (1974,1975) prediction that Os should vary inversely with respect to diversity while they are contrary to the second part of the prediction, that Bs remain more or less unchanged (Fig.4). In the summer when species diversity is high the O is reduced, as can be seen in Fig.5, while in the winter, when species diversity is low O is high.

Another prediction of current niche theory (Cody, 1975) that our findings do not support is the 'compensation hypothesis'. According to this hypothesis, high O between two species in one RA is compensated by reduced O on the second RA. We observed all the alternatives. For example, *Opsius* sp. and *E.melissae* overlap was .82 on the first RA in winter and .94 on the second while on the third axis was 0.00 - dendrograms on the overlaps on subsequent RAs beyond the first are not shown. This departure from traditional niche theory prediction seems to be a result of our different scale of approach to community

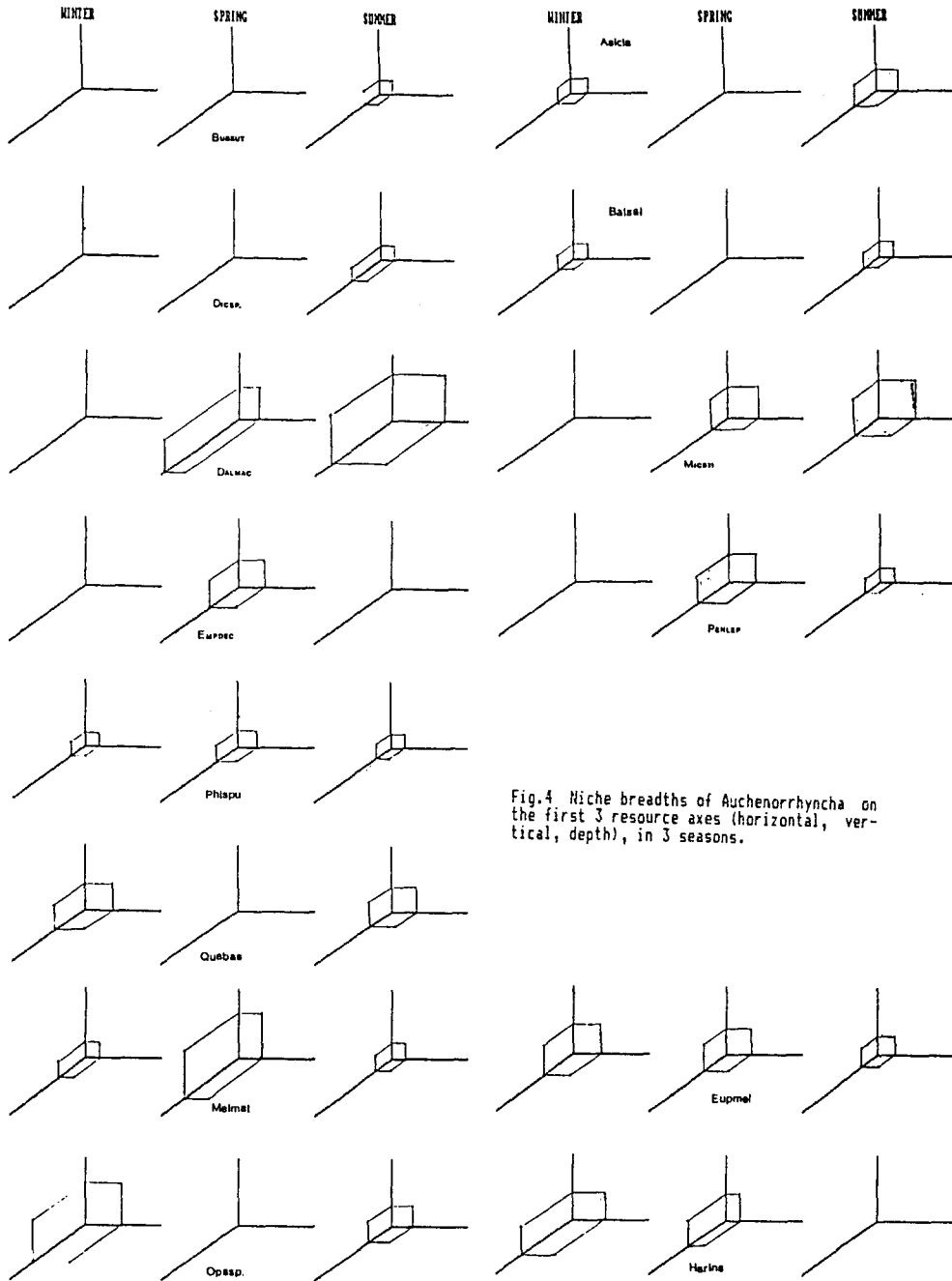


Fig.4 Niche breadths of Auchenorrhyncha on the first 3 resource axes (horizontal, vertical, depth), in 3 seasons.

analysis. As Rotenberry and Wiens (1960) have pointed out 'most of the evidence offered to support those arguments came from comparative biogeographic studies' thus being inappropriate to analyze interactions between populations and individuals.

**Mobility of sites:** In Fig.6 it can be visualized the positions of ten sites in an insect abundance space. All ordinations have efficiently concentrated the trended variation in two axes and this variation was surprisingly high (71.41%, 76.33% and 65.40%). In Table 4 are depicted the mobilities of the sites, their ranks and three aspects of the diversity (Pielou, 1977), dominance or concentration was measured by Simpson's index, uncertainty was measured by Shannon-Weaver index and richness was measured as the logarithm of existing CSTs.

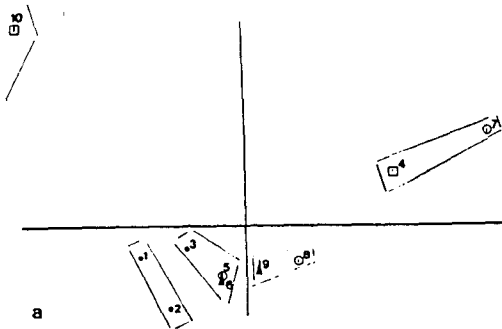


Fig.6 PCA ordination plots of sites in an insect space (two first PA are shown). a) Winter (cumulative % variance = 71.41). b) Spring (cumulative % variance = 76.33). c) Summer (cumulative % variance = 65.40). Site marks are those of Fig.3a.

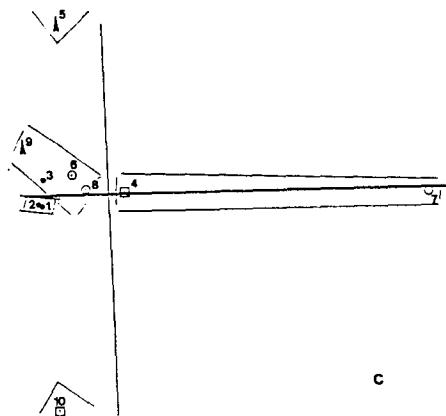
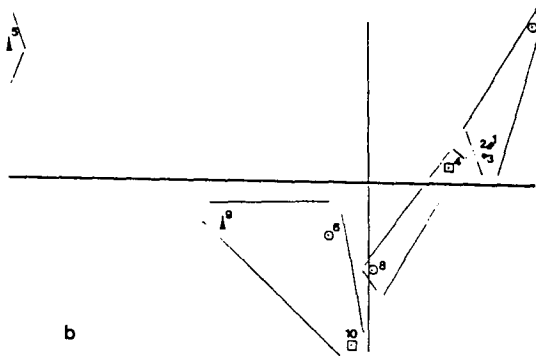


Table 2) Correlations of plant species with the vegetation principal components. Only significant correlations are shown.

plants	Component Eigenvalue	I 211.71	II 155.83
	Cumulative% var.	27.13	47.09
Gleaeuro		.74	.47
Pistlent		.69	
Frunwebb		.76	
Cycligrae		-.88	
Urgimari			.48
Avencarb		.48	.83
Knauinte		.62	
Crepidios			.98
Phiofrut			.48

Although site groups, forced by ordinating sites in a CST space, are different than those presented in Fig.6, the ordinations between seasons show a noticeable similarity in clustering sites. Summer and spring aspects of this insect community, are more similar than the winter aspect. Three sites (5, 7 and 10) are located consistently at the margins of the bidimensional space and these sites are the first three most mobile. It seems probable that the locations of these sites have caused the compression of the others around the origin at least in one axis. We accept this, since we intend to obtain an overall picture of the Auchenorrhyncha community. For all sites we calculated the Spearman's rank correlation coefficient to test the null hypothesis that site mobility is independent of site diversity and evenness. The test indicated that at all probability levels, there is an almost complete concordance between mobilities from one side and diversities and evennesses from the other, that is, the most diverse sites were preferred in various seasons by different Auchenorrhyncha species and abundances, in a strict accordance to their diversities in growth forms ( $r_{12} = .905$ ;  $r_{13} = .911$ ;  $r_{14} = .918$  and  $r_{15} = .968$  all significant at  $P = .01$ ). We tried also the same analysis with the site diversity measured in a plant species space. Although richness and evenness were significantly correlated to mobility -  $r_{14} = .598$ ,  $P = .18$ ;  $r_{15} = .723$ ,  $P = .05$  - their values are quite low to support any other discussion. In addition Shannon's and Simpson's diversities, were not significantly correlated to mobilities.

These results provide a clear answer to the question left open by Murdoch et al. (1972). Indeed the important relation is between plant structural diversities and insects and not between plant species diversities and insects. Since mobility is an appropriate estimate of site instability (though short term), we can infer that not only the most diverse sites are not the most stable but the opposite is clearly true. Certainly this does not contradict the generalization drawn from a plenty of communities studied when they were in equilibrium. Nevertheless, we believe that between consecutive years variation must be studied in the context of this methodology in order this prediction to be testified.

#### ACKNOWLEDGEMENTS

We thank Marios Kephelopoulis for the efficient algorithms and the program he wrote for the calculation of niche overlaps.

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