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Some ecological preferences of Rhopalocera in Southern Spain (Lepidoptera)

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Summary

Studies on the ecological preferences and distribution of Rhopalocera in several types of evergreen forest in the south of the Iberian Peninsula are reported. Two variables, aridity and tree-cover, were chosen in order to characterize the preferences of the most abundant species. A classification analysis using specific abundances was performed, from which groups of characteristic species have been determined for each vegetation-type.

Introduction

In recent years, a number of studies have been published on habitat preferences of Spanish Rhopalocera and the influence of several variables, especially landscape degradation (Viejo, 1983 ; Baz, 1986). Such studies describe the typical fauna of each selected vegetation-type and demonstrate the suitability of the use of this animal group as an indicator of environmental changes. In addition, they allow the ecological requirements of species to be defined, an aspect of primary importance in protection programmes (Heath, 1981).

The aim of the present study was to characterize some ecological preferences of the most abundant species of butterflies and skippers in the most widespread vegetation-types of the southern Iberian Peninsula.

Material and methods

The study area, the Sierra Norte, covers 4000 sq.km and is located in the south of the Iberian Peninsula in the province of Seville, between the Meseta Central and the Guadalquivir River Valley (Fig. 1). It is a mountainous region with a primarily siliceous substrate (granites, slates and conglomerates). Nearly all the geological formations in this region are Palaeozoic (Molina, 1988).

The Sierra Norte climax vegetation consists of evergreen oak (*Quercus rotundifolia* Lam.) and cork oak (*Quercus suber* L.) forests (Rivas Marti-

Fig. 1. The Iberian Peninsula with a detail of the province of Sevilla, with the Sierra Norte.

NEZ, 1985). Well-preserved forests are almost non-existent today. Human disturbance has resulted in a mosaic of shrubs, grassland and climax remains.

The study is based on 240 samples obtained by visual census and captures from 1985 to 1988. The method is quite similar to that employed by POLLARD (1977). At each site a fixed route of approximately 500 meters in length was used for counts and captures (the last in order to reduce errors of identification). The recorder walked at a moderate pace and recorded all butterflies and skippers seen, taking about 1 hour for each route. Recording took place between 08.00 and 16.00 hours from February until the end of November provided that weather conditions met specified minimum criteria (POLLARD, *op. cit.*).

The total number of individuals recorded was 9151, belonging to 66 species (MOLINA, *op. cit.*), but only species seen in more than 20 individuals were taken into consideration.

All localities sampled (Table 1) were grouped according to their structural complexity into four vegetation-types : scrub, scrub/tree-covered, grass/tree-covered and hedgerows/riversides. Two variables were also considered (aridity and tree-cover) for seven localities visited every week (labelled * in Table 1). The localities were selected to represent 7 grades of aridity and 6 of tree-cover (for the latter variable, data from Ribera de Huésnar, where there is no successional stage of the evergreen forest, were omitted).

For the characterization of species preferences in relation to these two variables, two indices were applied : niche breadth (B) and baricenter (g), the expressions of which are :

$$B = \frac{1}{\sum_{i}^{m} p_i^2}$$

where pi is the proportion of specimens of i species at each locality representing a grade of aridity or tree-cover. This index gives an indication of the variety of biotopes one species can exploit (BAZ, *op. cit.* ; SOUTHWOOD, 1978).

$$g = x_1 + 2^*x_2 + 3^*x_3 + \dots\dots\dots\dots\dots\, n^*x_n \,/\, \sum_{i}^{m} x_i$$

where x_1, x_2, x_3, ... x_n are the abundances of species in each grade. The expression enables one to fix the gravity centre of the abundance distribution of each species through the grades of each variable (BAZ, *op. cit.* ; DAGET, 1977).

Table 1. Localities visited. Those used to calculate niche breadth (B) and baricenter (g) are labelled *. Vegetation-types : SC = Scrub, SC/TC = Scrub/Tree-covered, GR/TC = Grass/Tree-covered, HD/RV = Hedgerows and riversides (see text).

Localities	Coordinates U.T.M.	Vegetation-type			
		SC	SC/TC	GR/TC	HD/RV
La Aulaga	29SQB2874	×			
Rio Guadiamar	29SQB3776			×	
* La Pajosa	29SQB3976	×			
La Navarra	29SQB3876		×		
* La Minilla	29SQB4973	×			
Lagos Serrano	29SQB5477	×			
El Calvario	29SQB5695		×		
Almadén Plata	29SQB5997		×		
Pto. Quejigo	29SQC6106		×		
* La Amoladera	30STH5618			×	
Repetidor TV	30STH5817			×	
* La Legua	30STH5917			×	
Valcinto	30STH6510	×			
El Pintado	30STH4707				×
* El Martinete	30STH6509		×		
* Ribera Huésnar	30STH6508				×
Cerro del Hierro	30STH7207	×			
Huerta Abajo	30STH8203			×	
* Hoya Portugués	30STH4692		×		
El Pedroso	30STH5692			×	
Constantina	30STH6896				×
El Retortillo	30STH8894			×	
Rozalejo	30STH5193	×			
Las Francas	30STH7881				×
Los Mazuecos	30STH8480			×	
Las Jarillas	30STH3776			×	
Los Melonares	30STH4678			×	
Cerro La Meona	30STH4572	×			
Arroyo Parroso	30STH5772				×
Casa Majuelo	30STH6776	×			
Barranco Hondo	30STH3568	×			
Mesa Redonda	30STH4368	×			

For the typification of each vegetation-type, a classification analysis was made. The analysis was performed by computer using the SSPC/PC+ program and the dendrogram procedure. The UPGMA method was selected as the agglomeration schedule (see SNEATH and SOKAL, 1973), and the cosine as similarity coefficient, the expression of which is :

$$I_a = \frac{\sum_{i}^{m} (x_i * y_i)}{\sum_{i}^{m} (x_i^2) \, \Sigma (y_i^2)}$$

where x_i and y_i are the abundances of species associated.

Table 2. Values of niche breadth (B) and baricenter (g) for the 44 most abundant species of the Sierra Norte. Variables are denoted ar (aridity) and tc (tree-cover).

N	Species	Bar	Gar	Btc	Gtc
1	*Syrichtus proto* (Ochsenheimer, 1808)	3.4	3.0	3.3	3.1
2	*Thymelicus flavus* (Brünnich, 1763)	4.1	4.7	3.1	4.0
3	*Spialia sertorius* (Hoffmansegg, 1804)	4.5	2.3	2.9	3.5
4	*Thymelicus actaeon* (Rottemburg, 1775)	4.8	2.9	4.3	2.9
5	*Tomares ballus* (Fabricius, 1787)	1.1	5.8	1.1	5.9
6	*Laeosopis roboris* (Esper, 1793)	1.1	6.9	1.8	5.3
7	*Celastrina argiolus* (Linnaeus, 1758)	1.3	6.5	3.0	3.7
8	*Pseudophilotes abencerragus* (Pierret, 1837)	1.8	3.1	1.7	2.4
9	*Lampides boeticus* (Linnaeus, 1767)	2.2	2.3	2.1	1.8
10	*Callophrys rubi* (Linnaeus, 1758)	2.2	3.7	2.1	4.1
11	*Glaucopsyche melanops* (Boisduval, 1828)	2.3	4.7	2.3	4.1
12	*Syntarucus pirithous* (Linnaeus, 1767)	3.1	2.7	2.8	2.2
13	*Quercusia quercus* (Linnaeus, 1758)	3.2	4.4	3.1	4.1
14	*Satyrium esculi* (Huebner, 1804)	3.5	4.4	3.2	4.1
15	*Polyommatus icarus* (Rottemburg, 1775)	3.7	4.9	3.1	4.4
16	*Aricia cramera* (Eschscholtz, 1821)	3.9	4.3	3.8	4.1
17	*Lycaena phlaeas* (Linnaeus, 1758)	5.1	4.0	4.9	4.0
18	*Pararge aegeria* (Linnaeus, 1758)	1.0	6.9	2.0	4.0
19	*Melitaea phoebe* (Denis & Schiffermueller, 1775)	1.1	3.2	1.2	3.0
20	*Polygonia c-album* (Linnaeus, 1758)	1.1	6.7	1.7	3.9
21	*Coenonympha dorus* (Esper, 1782)	1.5	2.2	1.5	1.6
22	*Pyronia bathseba* (Fabricius, 1793)	2.1	1.6	2.1	2.1
23	*Pyronia cecilia* (Vallantin, 1894)	2.1	2.0	2.1	1.7
24	*Hyponephele lupina* (Costa, 1836)	2.5	3.6	2.5	4.0
25	*Brintesia circe* (Fabricius, 1775)	2.6	4.1	2.4	3.9
26	*Hipparchia statilinus* (Hufnagel, 1766)	2.9	2.8	2.8	2.8
27	*Pyronia tithonus* (Linnaeus, 1771)	3.1	4.4	2.3	4.8
28	*Pandoriana pandora* (Denis & Schiffermueller, 1775)	3.2	5.4	2.4	3.9
29	*Vanessa cardui* (Linnaeus, 1758)	3.3	3.8	3.1	3.6
30	*Coenonympha pamphilus* (Linnaeus, 1758)	3.8	3.6	3.7	3.9
31	*Melanargia ines* (Hoffmannsegg, 1804)	4.0	2.8	4.0	2.9
32	*Maniola jurtina* (Linnaeus, 1758)	5.5	3.3	5.1	3.5
33	*Lasiommata megera* (Linnaeus, 1767)	5.5	3.5	4.6	3.2
34	*Gonepteryx rhamni* (Linnaeus, 1758)	1.3	6.7	1.2	4.2
35	*Pieris rapae* (Linnaeus, 1758)	2.4	5.8	4.7	4.1
36	*Leptidea sinapis* (Linnaeus, 1758)	2.5	4.6	2.1	5.0
37	*Anthocharis belia* (Linnaeus, 1767)	2.7	2.9	2.9	2.7
38	*Pontia daplidice* (Linnaeus, 1758)	3.0	4.1	2.9	3.6
39	*Pieris brassicae* (Linnaeus, 1758)	3.3	5.1	3.5	3.0
40	*Euchloe belemia* (Esper, 1799)	3.7	3.1	3.5	3.5
41	*Euchloe ausonia* (Huebner, 1804)	4.0	2.8	3.7	2.9
42	*Gonepteryx cleopatra* (Linnaeus, 1767)	4.3	5.3	3.4	4.6
43	*Colias croceus* (Geoffroy, 1785)	4.8	3.5	4.0	3.6
44	*Zerynthia rumina* (Linnaeus, 1758)	5.2	4.0	4.3	3.8

Results and discussion

1. Aridity

The results obtained for this variable (Table 2) allow one to deduce several groups of species (Fig. 2). Although in most cases the species are included in an intermediate zone, we have a hygrophilous group formed by: *Celastrina argiolus* (no. 7), *Laeosopis roboris* (no. 6), *Polygonia c-album* (no. 20), *Pararge aegeria* (no. 18), *Gonepteryx rhamni* (no. 34) and *Tomares ballus* (no. 5). All these are species of natural and artificial wet meadows, hedgerows and riversides, sites where they would find optimal conditions for larval development because of the occurrence of either hostplants or biotic conditions that permit an optimal growth of their preimaginal stages (this may be the case of septentrional species at the edge of their range).

At the opposite extreme, we have *Coenonympha dorus* (no. 21), *Pyronia bathseba* (no. 22), *Pyronia cecilia* (no. 23) and *Lampides boeticus* (no. 9) that characterize the driest localities and represent some of the most xerothermophilous Rhopalocera of the region.

Within the specialists (low B), *Melitaea phoebe* (no. 19) and *Pseudophilotes abencerragus* (no. 8) form a set of species that appear to be indifferent to humidity, and their presence in certain biotopes may be due to other factors, such as the occurrence of a particular hostplant.

With intermediate values of both B and g, *Spialia sertorius* (no. 3) exhibits a marked tendency toward dry areas, whereas *Pandoriana pandora* (no. 28), *Pieris brassicae* (no. 39), *Gonepteryx cleopatra* (no. 42), *Polyommatus icarus* (no. 15) and *Thymelicus flavus* (no. 2), typical aestival species, show some preferences for wet places. In the latter cases, however, local movements may occur in response to the need for finding new areas with a more adequate microclimate.

Finally, a set of species showing wide preferences (high B values) can be separated in the region. *Lasiommata megera* (no. 33), *Maniola jurtina* (no. 32), *Colias croceus* (no. 43), *Zerynthia rumina* (no. 44), *Lycaena phlaeas* (no. 17) or *Thymelicus actaeon* (no. 4). All these species are characteristic of "monte bajo" (mediterranean scrub) and "encinar" (evergreen oak forest) in the Iberian Peninsula (see also Viejo, *op. cit.*).

2. Tree-cover

This variable defines different groups of species (Table 2, Fig. 3). Although segregation is more confused, *Pyronia bathseba* (no. 22), *Pyronia cecilia* (no. 23), *Lampides boeticus* (no. 9), *Syntarucus pirithous* (no. 12), *Pseudophilotes abencerragus* (no. 8) and *Coenonympha dorus* (no. 21) can be

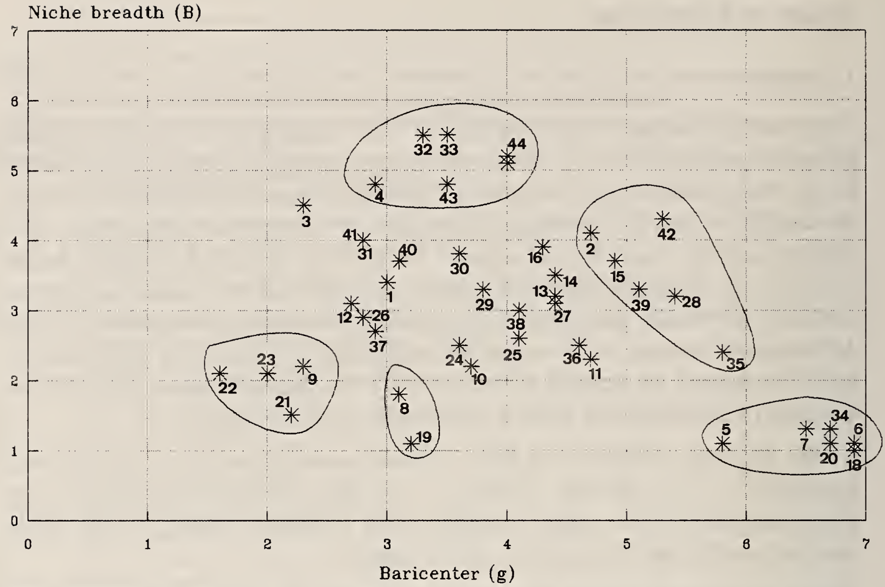

Fig. 2. Species grouped according to their values of B and g for aridity. Numbers as in table 2.

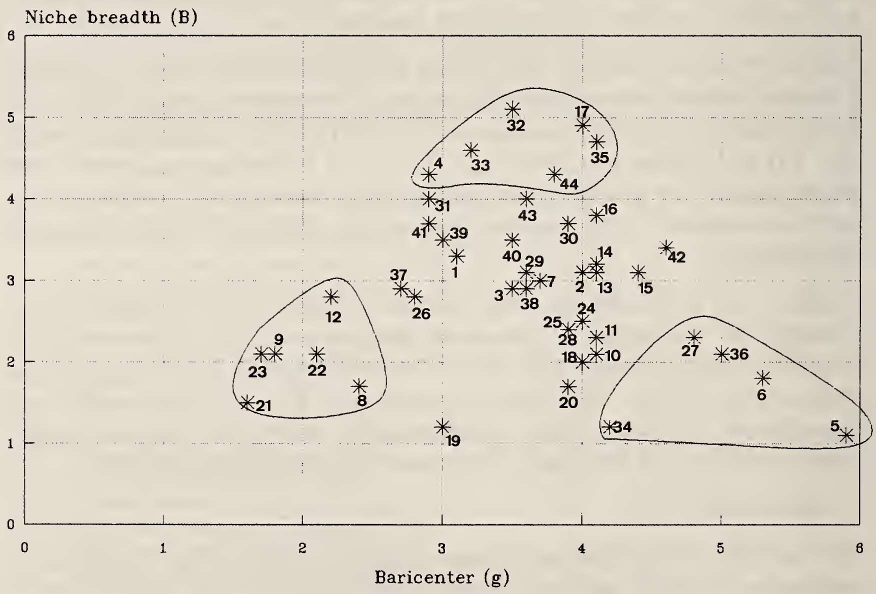

Fig. 3. Species grouped according to their values of B and g for tree-cover. Numbers as in table 2.

separated as species from scrub or areas with scarce tree-cover. These species feed on herbaceous plants or shrubs of the evergreen forest undergrowth and are thermophilous.

As with the previous variable, a wide group of indifferent species are also found (intermediate B and g values) with *Thymelicus actaeon* (no. 4), *Lycaena phlaeas* (no. 17), *Maniola jurtina* (no. 32), *Lasiommata megera* (no. 33), *Pieris rapae* (no. 35), *Colias croceus* (no. 43) and *Zerynthia rumina* (no. 44) as the taxa with minimal preferences on this variable.

Finally, *Pyronia tithonus* (no. 27), *Leptidea sinapis* (no. 36), *Laeosopis roboris* (no. 6), *Tomares ballus* (no. 5) and *Gonepteryx rhamni* (no. 34) prefer areas with developed tree-cover.

3. Cluster analysis

Cluster analysis (Table 3, Fig. 4) of these results allows one to define each vegetation-type in the study area as follows :

— The areas with thermophilous scrub are typified by the presence and abundance of *Pyronia bathseba* (no. 22), *Pyronia cecilia* (no. 23), *Coenonympha dorus* (no. 21), *Lampides boeticus* (no. 9) and *Syntarucus pirithous* (no. 12). In the dendrogram these species appear closely linked with *Pseudophilotes abencerragus* (no. 8), *Anthocharis belia* (no. 37), *Hipparchia statilinus* (no. 26) and *Euchloe ausonia* (no. 41), which are also observed in woodland areas with a damper climate.

— *Melanargia ines* (no. 31), *Euchloe belemia* (no. 40) and *Zerynthia rumina* (no. 44) are characteristic of open places, with few bushes, irrespective of the degree of tree-cover. These taxa are widely distributed in the region. *Melitaea phoebe* (no. 19) and *Pontia daplidice* (no. 38) appear as typical intermediate species between grass/tree-covered and woodland areas.

— *Tomares ballus* (no. 5) and *Leptidea sinapis* (no. 36) are the most specialized species, since they are found in areas with some structural complexity (scrub/tree-covered, high scrub) and a temperate climate. They characterize the most preserved areas in the region.

— *Lasiommata megera* (no. 33), *Maniola jurtina* (no. 32), *Spialia sertorius* (no. 3), *Colias croceus* (no. 43), *Thymelicus actaeon* (no. 4), *Coenonympha pamphilus* (no. 30) and *Callophrys rubi* (no. 10) show preferences between scrub and scrub/tree-cover, being always more abundant in dry areas.

— Hedgerows and riversides show a very similar fauna. *Pandoriana pandora* (no. 28), *Pieris brassicae* (no. 39), *Pieris rapae* (no. 35), *Pyronia tithonus* (no. 27), *Pararge aegeria* (no. 18), *Polygonia c-album* (no. 20)), *Laeosopis roboris* (no. 6) and *Celastrina argiolus* (no. 7) are common species in these habitats showing some preferences for tree-cover.

Table 3. Average abundances of species at each vegetation-type (all localities included) used for cluster analysis. Abbreviations as in table 1. Species are named with the first letter of their genus and three first letters of specific name. Numbers correspond with those of table 2 and figs 2 and 3.

N	Species	Vegetation-types			
		SC/TC	SC	GR/TC	HD/RV
1	SPRO	27.70	17.00	27.30	4.30
2	TFLA	1.70	4.50	5.25	7.30
3	SSER	2.70	2.20	1.25	1.70
4	TACT	18.30	5.17	8.75	3.30
5	TBAL	5.00	0.00	0.50	0.00
6	LROB	0.66	0.00	0.25	21.70
7	CARG	0.67	1.00	1.00	37.00
8	PABE	11.70	40.30	0.25	0.00
9	LBOE	3.70	55.00	3.00	2.70
10	CRUB	6.50	5.00	0.00	0.33
11	PICA	5.33	1.30	6.50	2.67
12	SPIR	5.83	43.30	2.75	4.00
13	QQUE	33.80	0.00	71.00	2.30
14	SESC	25.00	1.00	38.00	6.30
15	GMEL	4.30	2.33	8.50	0.00
16	ACRA	37.70	12.00	80.30	4.70
17	LPHL	41.90	30.60	43.70	7.33
18	PAEG	0.33	0.33	0.00	94.00
19	MPHO	0.00	0.00	15.25	0.33
20	PCAL	0.33	0.00	0.50	2.16
21	CDOR	1.33	20.00	0.00	0.00
22	PBAT	2.00	79.00	7.00	0.00
23	PCEC	15.00	230.70	5.25	1.25
27	PTIT	14.50	0.00	7.00	11.00
25	BCIR	5.17	0.00	9.25	1.30
24	HLUP	16.50	8.30	20.25	0.00
26	HSTA	5.50	14.30	3.00	0.00
28	PPAN	1.33	0.34	6.34	9.31
29	VCAR	1.50	1.01	5.79	0.63
30	CPAM	132.17	88.30	52.50	11.70
31	MINE	4.20	19.30	14.25	0.00
32	MJUR	81.80	127.30	62.00	22.00
33	LMEG	1.70	3.70	1.00	1.00
34	GRHA	0.17	0.00	1.00	15.70
35	PRAP	12.84	9.00	11.00	99.30
36	LSIN	12.50	1.30	0.00	2.67
37	ABEL	1.17	3.70	0.25	0.50
38	PDAP	3.30	3.70	16.00	1.00
39	PBRA	0.17	1.70	4.00	10.00
40	EBEL	0.67	3.30	2.25	0.00
41	EAUS	4.30	17.00	5.25	0.00
42	GCLE	4.50	0.33	3.00	7.67
43	CCRO	10.83	14.70	7.00	7.33
44	ZRUM	1.33	8.30	4.75	2.67

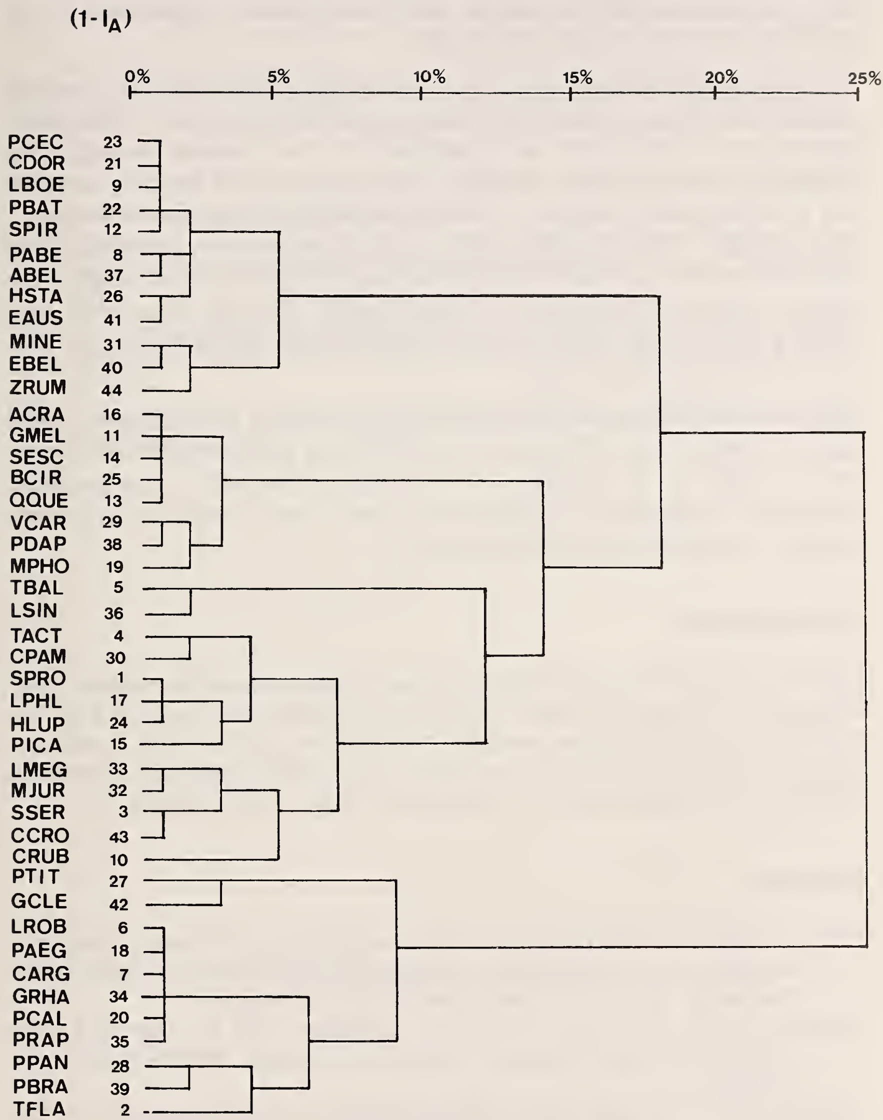

Fig. 4. Dendrogram obtained by cluster analysis of the specific abundances in the four vegetation-types. Species abbreviations and numbers as in table 3.

These results are similar to those obtained by GARCIA-BARROS (1982), VIEJO (*op. cit.*) and BAZ (*op. cit.*) concerning the two variables considered here. Minor differences may be due to other subspecies or adaptations of the species at the limit of their distribution.

The analysis of variables taken into consideration independently, does not seem to adequately explain the habitat selection by species. The spatial distribution of adults can be determined by the presence of the larval foodplant or nectar-sources. However, the results must be carefully analyzed and possible annual changes in this spatial distribution cannot be excluded. Such changes would be due to the typical mediterranean irregularity of resources and the associated interspecific competition that would result in the spatial or temporal segregation of related species. This may be so in the case of the genus *Pyronia* (VIEJO, 1982) or the Pierinae species (VIEJO, *op. cit.* ; COURTNEY and CHEW, 1987).

Thus, if the floral composition and distribution of an area is known, some general aspects of its Rhopalocera fauna can be predetermined. However, more studies on this subject are necessary (principally in geographical variations of preferences) to determine general trends useful for evaluation projects or management of natural areas.

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