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CARABID BEETLE *(COLEOPTERA, CARABIDAE)* COENOSES FOR EVALUATION OF FAUNAL RESOURCES AND IMPACT ASSESSMENT IN THE ASPROMONTE NATIONAL PARK OF CALABRIA (ITALY)*

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Abstract. Carabid beetle coenoses in the Aspromonte massif (Southern Italy) have been described and mapped in relation with the main vegetation types. On the basis of the map and of some meaningful community features an Environmental Impact Assessment (EIA) plan has been suggested. Carabid coenoses proved to have a good correlation with the vegetation types, and to be helpful for EIA.

Introduction

Carabid beetles are a group of insects, mostly predators on the soil surface and in the upper soil layers. They are known to be reliable indicators of biotic and abiotic environmental factors (Thiele 1977; Paukert *et al.* 1986; den Boer *et al.* 1987; Stork 1990). In Italy, applied studies on Carabid coenoses have been made by Brandmayr (1983a) and Pizzolotto (in print). Ground beetles play an important role in natural ecosystems; they feed on small invertebrates, and are found in the diet of amphibians, reptiles, birds and small mammals (Thiele 1977). Considering their size (from 1 mm to some centimeters) and biomass (e.g., 2kg/ha/yr in an alder forest (Thiele 1977)) it is clear that Carabids are an important link between primary and secondary consumers in the food-chains.

This paper presents the result of a field research on Carabid beetles carried out during the year 1987 on the Aspromonte massif within the Calabria National Park (Southern Italy) (Brandmayr *et al.* 1988; reprinted in Cagnin *et al.* 1991). The main objectives are i) to describe and map the Carabid beetle coenoses in the study area in relation to the main vegetation types, and ii) to produce a concise evaluation of some community features for Environmental Impact Assessment (EIA). The research is part of work supported by the Southern Italian Development Fund, with the aim to quantify the impact on the fauna of a large barrage that breaks the flow of the Menta river. The method applied refers to the works of Brandmayr and Colombetta (1981) and Brandmayr (1983), and has been used by a multidisciplinary group with expertise in micromammals, avian fauna and ground beetles; a similar one has been successfully applied to bird communities of an Alpine valley (Mingozzi and Brandmayr 1990) and to Carabid communities of the Karst near Trieste (Pizzolotto, in print).

The sample sites

All the sample sites (see Fig. 1) lie between 1300 and 1600 m a.s.l. (for topographic features, see Table 1), on siliceous bedrock (metamorphic rocks). Six vegetation types have been sampled: a dry pasture (P); a black-pine forest (*Pinus laricio*) with very old trees (Pl); an oak wood (*Quercus petraea*) with scattered trees (Q); three thermophilous beech forest stands (*Aquifolio fagetum* (Gentile 1969)) rich in holly (AF), and a moist beech stand along the Menta river banks (RM); a beech-fir forest stand (*Abieti fagetum*) (AbF); a wet-meadow alder grove (*Alnetum glutinosae*) (Ag).

Methods

The samples have been collected by means of pitfall traps: a method widely used by carabidologists (Thiele 1977) and very helpful for quantitative researches on ground beetles. The traps are plastic vessels (9 cm mouth diameter, 7.5 cm base diameter, 11 cm depth) containing 200 cc of an attracting-preserving mixture of wine vinegar with 5% formalin. This trapping method has been used by Brandmayr and coworkers since 1973.

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Table 1. The zoosociological table. Symbols for sample sites refer to the vegetation types. The annual Activity Density (aAD) values are given for each species in the sample sites. Symbol + indicates collection "by hand" (no pitfall traps). Wing size: b= brachypterous species; m= macropterous; d= dimorphic. Chorotype: I= Calabrian endemic; II= endemic to Italian Apennines (II° Southern Apennines); III= European species in the widest sense, where capital letter means cardinal point, m= restricted to the Mediterranean basin, am= Atlanto- Mediterranean; IV= Eurasiatic, Eurosiberian; V= palearctic, holarctic. *= the superspecies is *Car. hortensis*, **= *Car. intricatus*.

Sample sites	P	Pl	Q	AF1	AbF	AF2	RM	AF3	Ag	Wings	Distr.	Fringe
Exposure	S	E	E	SW	E	N	E	N	E			
Altitude (m asl)	1360	1390	1380	1360	1630	1280	1510	1300	1330			
Slope	20	0-15	20	15	30	25	0	30	5			
Vegetation cover	65%	65%	40%	95%	90%	100%	10-80%	95%	80%			
Lebia cianocephala	+											
1 Cicindela campestris	0.01	.	.	.	.	.	.	.	.	m	IV	–
2 Amara aenea	0.02	.	.	.	.	.	.	.	.	m	V	–
3 Harpalus impressipennis lat	0.03	.	.	.	.	.	.	.	.	m	IIINWm	–
4 Harpalus tardus	0.03	.	.	.	.	.	.	.	.	m	IV	–
5 Cymindis axillaris	0.04	.	.	.	.	.	.	.	.	d	V	–
6 Harpalus rufitarsis decipiens	0.04	.	.	.	.	.	.	.	.	m	III	–
7 Harpalus sulphuripes	0.07	.	.	.	.	.	.	.	.	d	III	–
8 Syntomus obscuroguttatus	0.09	.	.	.	.	.	.	.	.	d	III	–
9 Cymindis variolosa cyanoptera	0.10	0.01	.	.	.	.	.	.	.	d	IIIS	–
10 Calathus mollis	0.16	0.06	0.02	.	.	.	.	.	0.09	d	III	–
11 Platyderus canaliculatus	0.04	0.05	.	0.03	0.01	.	.	0.02	0.04	b	II°	–
12 Calathus fuscipes	10.16	14.2	12.01	.	.	0.15	.	0.02	0.32	d	III	–
13 Calathus montivagus	0.04	6.5	9.98	1.14	1.77	1.24	0.15	0.81	0.16	b	II°	–
14 Carabus convexus	.	.	0.95	.	.	0.15	.	0.02	.	b	IV	–
15 Trechus quadristriatus	.	.	0.02	.	.	.	.	.	.	m	V	–
16 Nebria kratteri	0.42	1.75	2.47	0.45	0.54	8.55	3.07	3.89	4.21	b	I	*
17 Carabus preslii	0.19	0.84	0.97	0.01	0.36	1.81	0.80	0.25	0.15	b	III*	*
18 Leistus spinibarbis	.	0.02	0.02	.	.	0.02	0.02	.	0.01	m	IIIam	–
											–	–
19 Cychrus italicus	0.02	.	.	0.01	0.14	.	0.36	0.47	0.30	b	II	*
20 Carabus lefebvrei	.	.	0.02	0.16	.	0.11	0.06	1.53	0.01	b	III**	–
21 Abax ater curtulus	.	.	.	0.07	.	.	.	0.42	.	b	III	*
22 Anchus ruficornis	.	.	.	.	.	.	.	0.08	0.04	m	V	–
23 Pterostichus unctulatus	.	.	.	0.53	3.01	1.32	0.27	1.57	.	b	II	*
24 Calathus fracassii	.	.	.	0.19	2.51	.	0.02	.	.	b	II°	*
25 Nebria andalusiaca	.	.	.	.	.	.	0.02	.	.	m	IIIWm	*
26 Bembidion geniculatum	.	.	.	.	.	.	0.04	.	+	m	III	*
27 Pterostichus ruffoi	.	.	.	0.2	0.04	0.02	0.74	.	0.09	b	I	*
28 Asaphidion rossii	.	.	.	.	.	.	0.02	.	0.01	m	IIIWm	–
29 Calathus piceus	0.01	.	0.02	3.17	1.40	2.05	0.23	0.13	2.96	b	IIIam	*
30 Leistus fulvibarbis	.	.	.	0.01	.	.	.	.	.	m	IIIam	–
31 Argutor angustatus	.	.	.	0.01	.	.	.	.	.	m	III	–
32 Notiophilus biguttatus	.	.	.	.	.	0.02	.	.	0.16	d	III	–
33 Trechus obtusus	.	.	.	.	.	.	.	.	1.09	b	III	–
34 Pterostichus niger	.	.	.	.	.	.	.	.	0.30	m	IV	–
35 Notiophilus rufipes	.	.	.	0.01	.	.	.	.	0.03	m	III	–
Asaphidion stierlini	.	.	.	.	.	.	.	.	+			
Bembidion (Ocydromus) gudenzii	.	.	.	.	.	.	.	.	+			
Bembidion genei	.	.	.	.	.	.	.	.	+			
Bembidion dalmatinum	.	.	.	.	.	+	.	.	+			
Bembidion lampros	.	.	.	.	+	.	.	.	.			
Bembidion gr. adreae	.	.	.	.	.	.	+	.	.			
Trichotichnus nitens	.	.	.	.	.	.	+	.	.			
total aAD	11.47	23.38	26.48	5.99	9.78	15.44	5.8	9.21	9.97			
	P	Pl	Q	AF1	AbF	AF2	RM	AF3	Ag			

The traps, 5-10 per site, were emptied monthly from May to December 1987. More than 8000 specimens belonging to 43 species have been collected.

The amount of the catches is synthesized in a zoosociological table (Table 1), where the annual Activity Density (aAD) is given for each species in the sample sites (see legend for details).

aAD = total specimens captured / US

where

$$US = \sum_{j=1}^{m} [\text{traps} \times \text{days}/10]_j$$

with m= number of sampling periods in each site during the year.

Groupings of Carabids and vegetation types

Data analysis

The cluster analysis of Table 1 (hand collections have been excluded) yielded the dendrograms in Figs 2 and 3. The classification of sample sites (Fig. 2) is

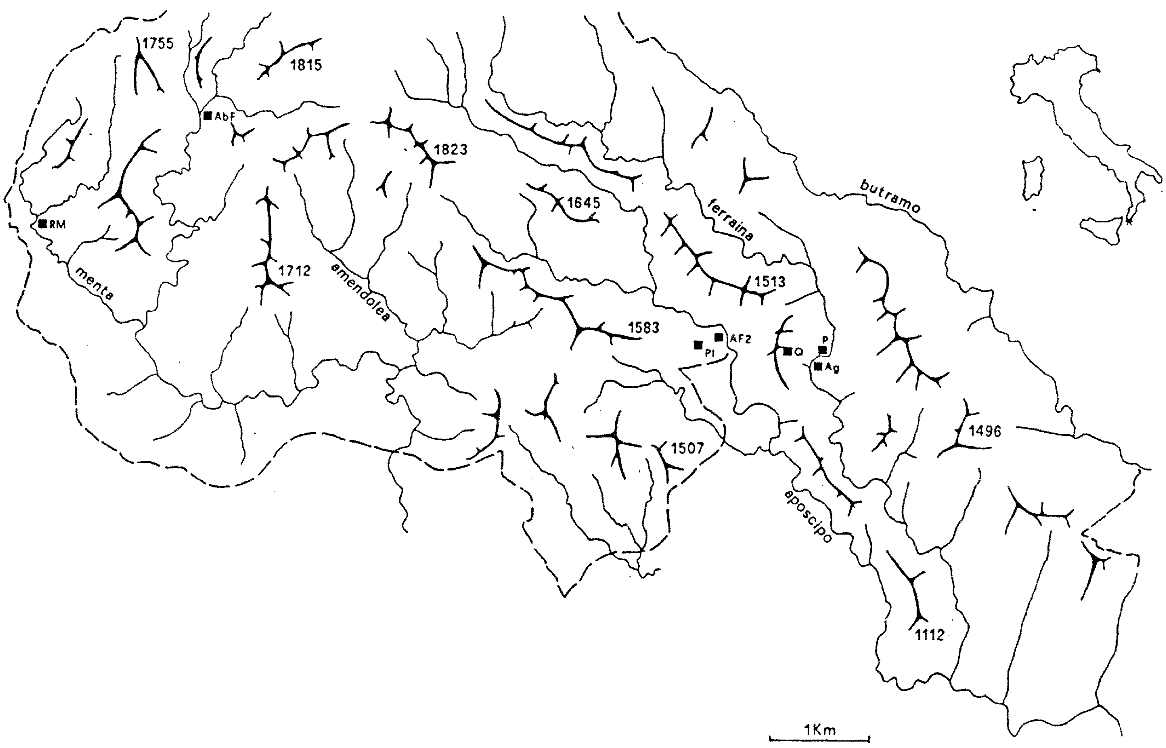

Figure 1. Topographical map, and sample sites (full squares).

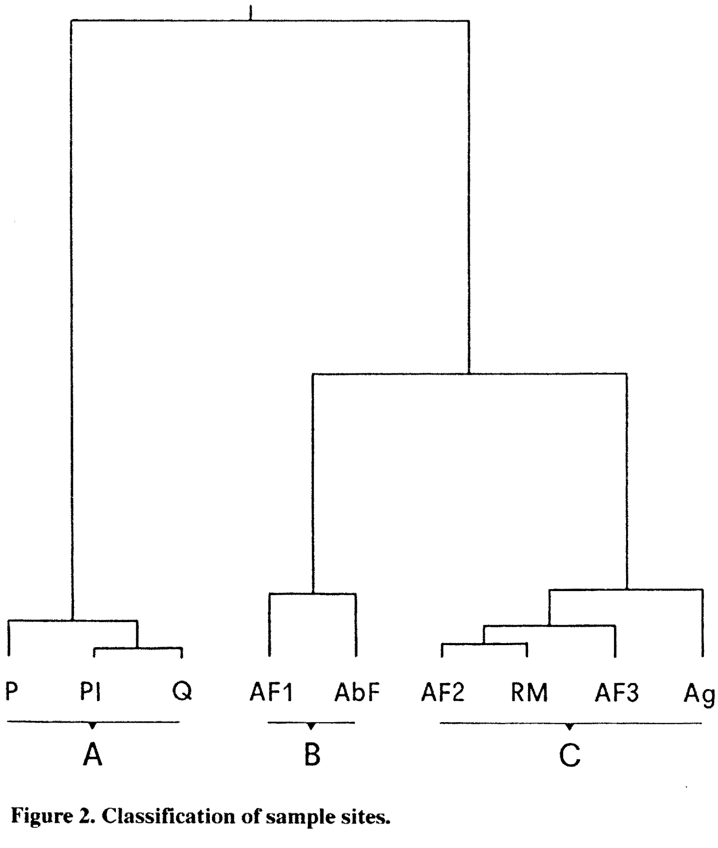

Figure 2. Classification of sample sites.

based on chord distance and sum of squares agglomeration clustering, as described in Lagonegro and Feoli (1985) (see also Feoli *et al.* 1991). In Fig. 2, three groups of sites are shown. In group A (P, Pl, Q) the pasture (P) is separated by its species composition from the Pl and Q forests. In group B we find the cool stands AbF and AF1. The group C contains the beech-forests and it is likely that the Ag site has been merged with this group on account of an "edge-effect".

The correlation between groups of species is represented in Fig. 3, where the classification is based on the correlation coefficient and average linkage clustering (Lagonegro and Feoli 1985). In order to sort out the more significant species for the communities, the following evaluation criteria were applied to compare the behaviour of the species among the sample sites:

1) Biotope Central Species (BCS): the species with the maximum row-aAD among the sample sites (bold type in Table 1).
2) Biotope Nuclear Species (BNS): the species with aAD higer than the mean row-aAD (underlined in Table 1).
3) Biotope Orbital Species (BOS): the other species.

Group 1 (see Fig. 3 and Table 1) is distinctly separated from the others being composed by eleven species eight of which have been captured only in site P, while one (*Calathus mollis*) is clearly BCS in P. Group 6 is characterized by two species exclusive in RM; and by one (*Pterostichus ruffoi*) BCS in RM, that behaves as BNS in AF1. *Asaphidion rossii* is a humid soil preferring species and has been captured only in RM and Ag sites. All the species avoid sites P, Pl and Q. This group is tied to clusters 7 and 8, in which species centered on wet or cool biotopes appear. Among the three species forming group 7, *Calathus piceus* is BCS in AF1, and the remaining have been captured only in AF1. Group 8 is composed by species preferring almost exclusively Ag site (see Table 1). All the species forming group 4 are BCS in AF3; while the two species forming group 5 are BCS in AbF, and they avoid sites P, Pl and Q. Group 2 is characterized by species centered in thermophilous biotopes, but they are present also in other biotopes; among them *Calathus montivagus* has been captured in all the sample sites and it is BCS in Q and behaves as BNS only in Pl. Group 3 is formed by three species that behave as BNS in more than one site (*Nebria kratteri* and *Carabus preslii*), or that does not show clear site preference (*Leistus spinibarbis*).

Carabid beetle communities

On the basis of species and site classifications, and of recent studies (Brandmayr and Zetto Brandmayr 1984; Brandmayr and Pizzolotto 1988, 1990; Pizzolotto

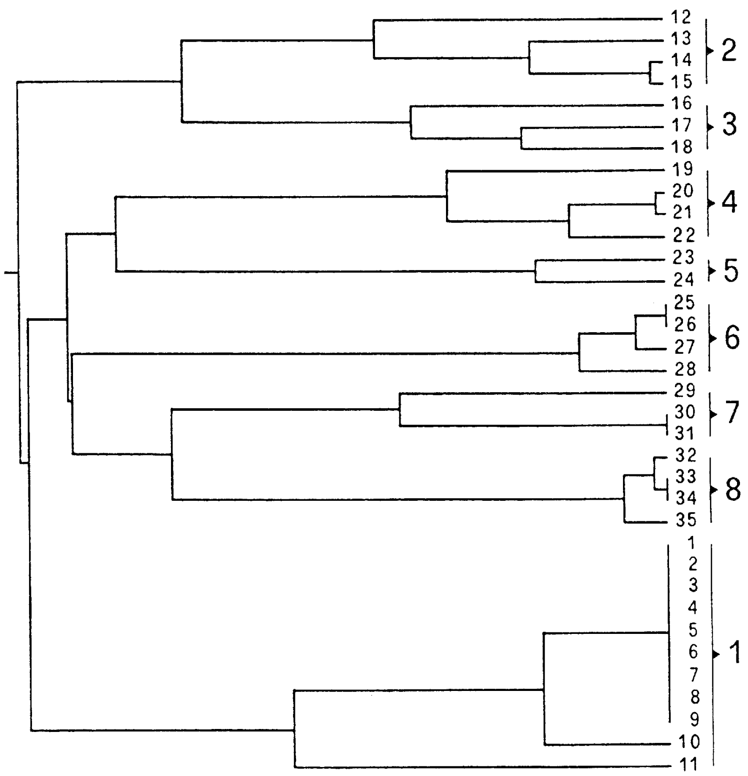

Figure 3. Classification of species.

et al. 1991; Pizzolotto, unpublished data) four Carabid communities have been recognized (only leading species are mentioned).

1. The community of dry pastures and larger clearings with *Cymindis variolosa, Harpalus sulphuripes* and *H. impressipennis*. The community of these biotopes under strong human impact is characterized by species exclusive in the pasture. They are highly thermophilous, feeding on seed (*Harpalus* and *Amara*), favourished by light herb-layer (*Cymindis*), as a consequence of overgrazing. *Calathus mollis* shows a peak (BCS) in open land, but sparser populations are found in thermophilous forests. *Calathus fuscipes* shows here a secondary peak of abundance.

2. The community of thermophilous pine and oak forests with *Calathus fuscipes, C. montivagus* and *Carabus convexus*. The thermophilous forests harbour a difficult-to-define and species poor community, needing further investigations. Only *C. convexus* is an apparent associated species of the deciduous oak forests. It shows maximum aAD in site Q, and decreasing abundances in the sites AF2 and AF3 (that show increasing cooler microclimates). A similar trend has been found in the Thyrrenian mountain-range of Calabria (Pizzolotto, unpubl.), and also in the Nebrodi mountains of Sicily (Brandmayr and Pizzolotto 1990). *C. fuscipes* and *C. montivagus* show a clear preference for this bioclimatic belt. The first is a thermophilous species wich prefers pastures and open vegetation, but in mediterranean regions may shift its habitat choice to woods; the second is an eurytopous forest dweller. In this community it is also frequent to find large numbers of *Carabus preslii* and *Nebria kratteri*.

3. The community of beech and fir-beech mixed forests with *Pterostichus ruffoi* and *Carabus lefebvrei*. This is likely the climax community of the Aspromonte subatlantic vegetation belt (sensu Pignatti 1979). *P. ruffoi (cristatus* group) is endemic to the Aspromonte massif (Sciaky 1984), *C. lefebvrei*, an endemism of the southern Apennines, is a vicariant of the European *C. intricatus* and is represented here by ssp. *lefebvrei* endemic to Sicily and the Aspromonte massif. *Pterostichus unctulatus, Abax ater, Calathus fracassii* and *piceus* are also typical species of this community. With regard to *A. ater*, it is to be pointed out that Aspromonte lies at the southern edge of its range, and that the bedrock hardly favours the diffusion of this calcium-requiring species. Its presence in such a biogeographical context should be further investigated. Fir-beech mixed forests harbour almost the same community of the beech forests (same leading species), but in cooler biotopes a variant with *Pt. unctulatus, Calathus fracassi* and *C. piceus* gains importance. Brandmayr and Zetto Brandmayr (1984) show similar results for cool beech woods (*Asyneumati-Fagetum*) in the Pollino massif 200 km north of Aspromonte. For these reasons, this community has been separated from the beech one in the computation of faunistic values (see below).

4. The community of water-meadow alder woods with *Pterostichus niger* and *Asaphidion rossii*. Alder riparian groves are narrow stripes of homogeneous vegetation confined to the large rivers below 1400 m. These biotopes represent an interesting aspect of the Aspromonte landscape, because they pass through different vegetation belts. A typical community is easy to recognize, and in particular when hand collections are taken into account, but often the edge-effect makes their fauna more similar to that of the adjacent habitats. *P. niger* and some species of the *Bembidion* genus are exclusive of this community, but the abundance of the latter is not easy to measure with pitfall traps. The edge-effect is responsible for the presence of *C. fuscipes* and *mollis*, and the wet-cool microclimate for many forest species, such as *Notiophilus biguttatus*, while the water content of the soil for some moist-preferring carabids, such as *Trechus obtusus*.

The low number of species is a general feature of these communities. One reason is the "tectonic juvenility" of the Aspromonte massif, whose height increased by 1000 meters only in the last million years (Ghisetti 1980), so that true mountain biotopes arose only in recent times (in geological sense), and almost no endemics evolved in these mountains. Other reasons for the low diversity values are two ecological factors at least. The first is geomorphology: metamorphic bedrock with low permeability to rain water, and acclivity favour the acidity of the soil and slow pedogenesis, so that species requiring more mature soils or calcareous bedrock (*Abax ater, Licinus*) are penalized. The second reason is climate: mild winters, oceanic conditions and the dense fog affecting the ridges hinder the development of cooler beech forests with more rich carabid communities.

Map of the carabid communities

To outline the extent of the communities is a real difficulty when mapping a territory. In fact, a large number of samples would provide a solution for the problem, but it is not feasible to follow this option in EIA. So, we hope that, once found a correlation between vegetation and carabidocoenoses, a reasonable approach to the problem is simply to consider the extent of a carabid community as that corresponding to the vegetation type with which it is associated.

Fig. 4 is the simplified vegetation map of the studied area (from Pedrotti *et al.* 1988; reprinted in Cagnin *et al.* 1991) on the basis of which the map of the carabid communities (Fig. 5) has been drawn. Borders among carabid communities are coenoclinal zones, so they have been left white. The *Pt. ruffoi* and *C. lefebvrei* community is the most widespread in the studied area; while it is likely that the community of

Figure 4. Vegetation map. Where: Fa= beech; AbF= fir and beech; Pi= pine; Q= oak; p= pasture; + + += pine reafforestation; .... = alder; = ferns.

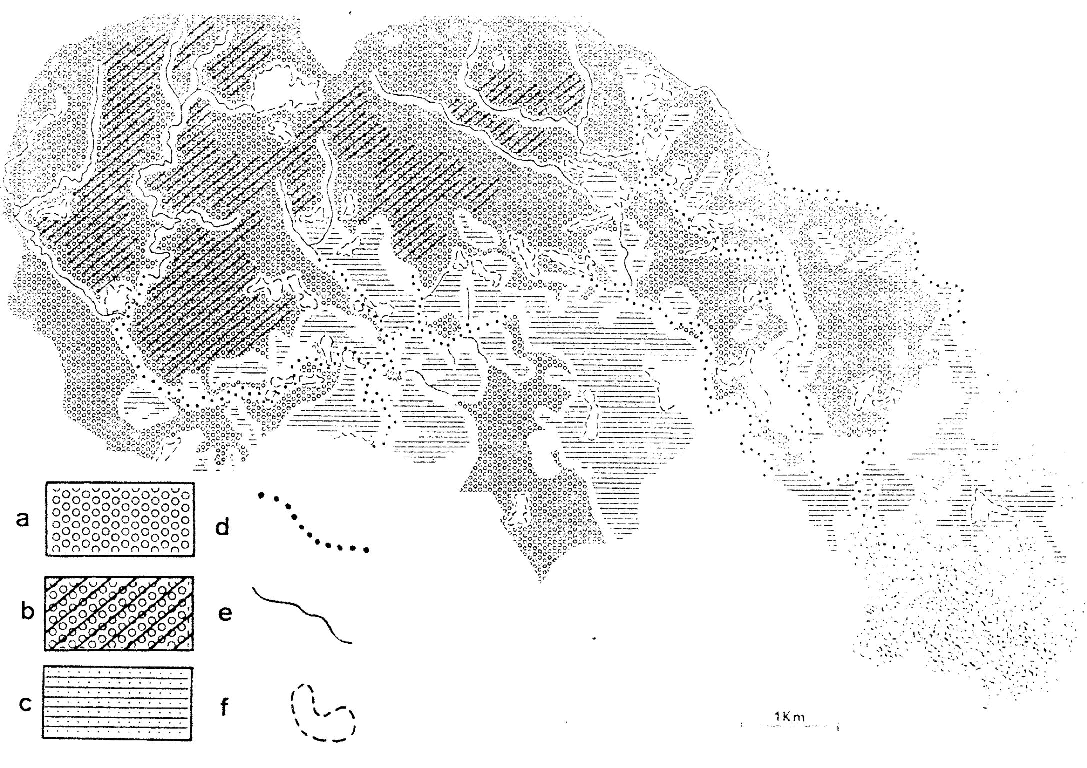

Figure 5. Carabid coenoses map. a: *P. ruffoi, C. lefebrei;* b: affected by *Formica rufa*; c: *C. fuscipes, C. monivagus, C. convexus*; d: *P. niger, A. rossii;* e: *Bembidion decorum (*only hypothesized); f: *H. impressipennis, H. sulphuripes, C. variolosa.*

Table 2. Natural values for the sample sites.

	P	Pl	Q	AF2	AF3	AF1	RM	AbF	Ag
spp brac	2	3	3	4	5	4	4	5	3
aAD brac	1	2	3	5	5	5	5	5	5
spp end	1	2	1	2	2	2	2	3	2
end/5	3	3	2	3	3	5	4	5	4
aAD end	1	2	3	4	3	2	4	3	3
spp lim	2	2	2	3	3	3	4	4	2
lim/10	2	1	2	3	3	4	5	4	3
aAD lim	1	1	1	5	4	4	5	5	4
l/lmax	2	3	3	3	4	3	4	4	3

pine and oak forests becomes more important at lower altitudes. Pastures are very fragmented, and give a moasaic-like pattern to the landscape.

Indexes of the "faunistic value" of the Carabid beetle resources

The "faunistic value" of the Carabid beetle resources is expressed by numerical indexes (based on a Principal Component Analysis (PCA) computation; see below) that give an estimate of the carabid coenoses importance for the "ecological situation" in the study area.

Some meaningful community features, i.e., ecological and chorological features of the sampled species, have been taken into account to compute the indexes: wing size, endemic species, species at the fringe of distribution, species diversity. These features are well-correlated with the degree of evolution and "naturalness" of the Carabid communities, and they are easy to quantify for the evaluation of the faunal resources. The weight of each feature has been calculated as number of species and specimens contributing to the importance of the feature in each sample site (as described below).

We think that it is useful to take into account both the number of species and specimens, because they give information about environmental degradation factors from both the historical and the present time point of view. It is likely that degradation factors acting since historical times may affect the existence itself of some species in the territory; modifying their geographical distribution (boundaries), or hampering the settling down of endemic species. The present time intensity of degradation may be reflected by the weight of the community features evaluated as number of individuals showing those features.

Description of the computation.

The following is an example for the endemic species in site P (see Table 1); they have been weighted by three ways: three are the endemic species in site P, and they correspond to 18% of the species in this site, and to 60% of the endemics (5 species) of the sampled fauna (i.e, the list of species in Table 1). The aAD (specimens) of the endemic species have been summed and the percentage ratio on the taAD has been calculated (4%) (i.e., the dominance of the endemic species). The three percentage values (18%, 60%, 4%) have been assigned to classes on a five-grade scale (0-20%=1, 21-40%=2, ...). Similar weights have been calculated for all the community features. A new matrix (Table 2; that we can call the "natural value matrix") describing the sample sites on the basis of these classes has been written. This matrix has been used for the PCA computation, focusing the attention on the "space of the natural value" rather than on the wider space of the communities.

To get information about the correlation existing between the natural value matrix and the community matrix, about the reliability of Carabid coenoses to predict conditions of environmental degradation, the sample sites have been clustered on the basis of the natural value matrix, then the classification has been compared with the dendrogram of Fig. 2. The χ^2 of the resulting cross-table (Fig. 6) is significant with a probability of p=0.9 (χ^2 =13.5, for 4 d.f.).

The PCA of the natural value matrix (Fig. 7) arranges the sample sites along the first axis according to a gradient of decreasing degradation from left (P site) to right (AbF site); but only 87% of the total dispersion is deducted by the two first axes. PCA is interpreted taking into account the angular distance among the sample sites rather than to refer the degradation gradient to a linear pattern. Worth of noting is that I and II of the PCA axes partition the sample sites in a similar way as in Fig. 6 (Table 2). The indexes of faunistic value have been assigned to the quadrants of the PCA space counterclockwise starting from value 1 assigned to quadrant II. Site P received value 1; sites Pl and Q value 2; sites AF2, AF3, RM and Ag value 3; sites AbF and AF1 value 4.

The faunistic value of the zoocoenotic landscape has been considered for a grid of 500m sq. quadrats (Fig. 8) on the basis of the Carabid beetles resources (zoocoenotic map) as follows:

community of dry pastures and larger clearings with *Cymindis variolosa*, *Harpalus sulphuripes* and *H. impressipennis*: value 1;

community of thermophilous pine and oak forests with *Calathus fuscipes*, *C. montivagus* and *Carabus convexus*: value 2;

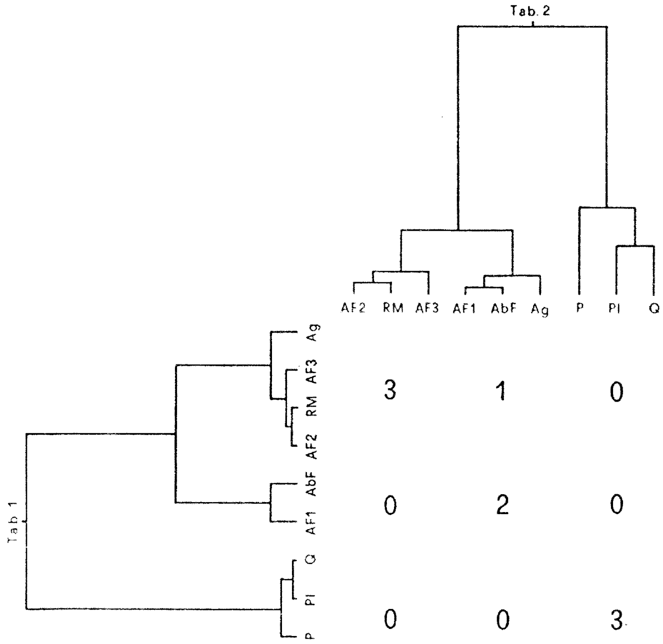

Figure 6. Matrix resulting by comparing the sample sites classifications based on data of Table 1 and Table.

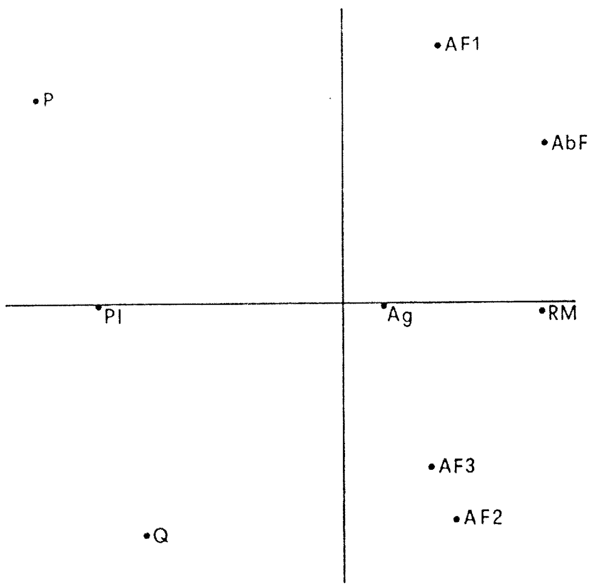

Figure 7. PCA ordination of the sample sites.

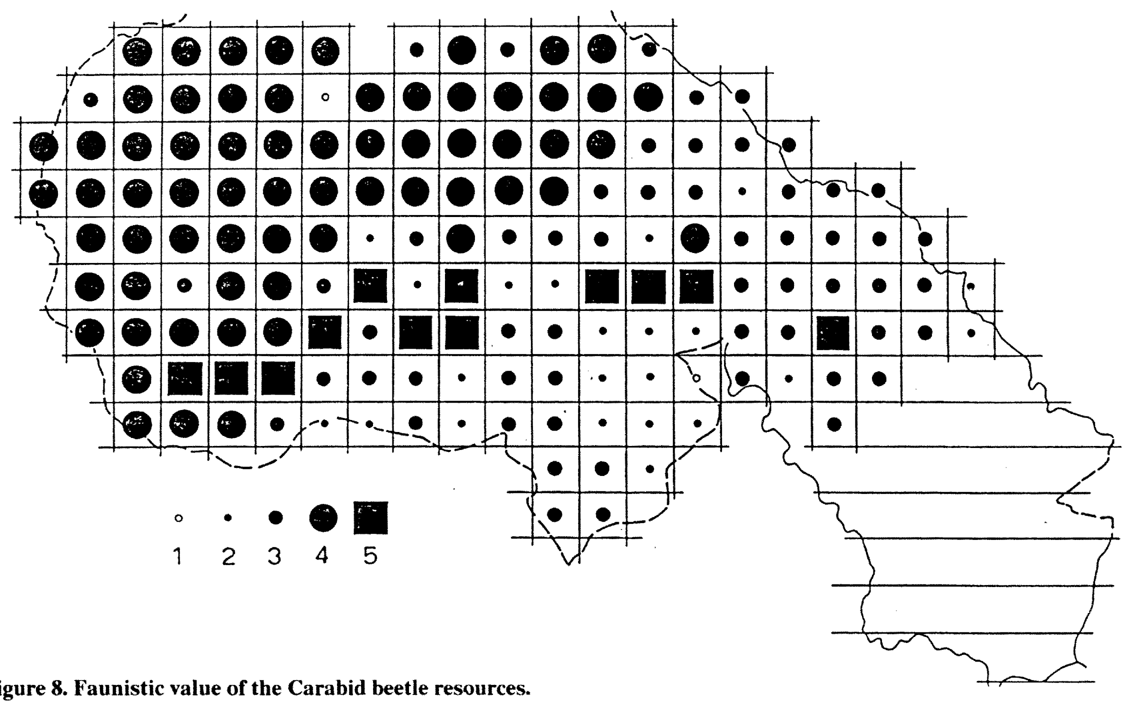

Figure 8. Faunistic value of the Carabid beetle resources.

community of beech and fir-beech mixed forests with *Pterostichus ruffoi* and *Carabus lefebvrei*: value 3 if the community is harboured by a beech forest, value 4 if by a fir-beech forest;

community of water-meadow alder woods with *Pterostichus niger* and *Asaphidion rossii:* value 3.

The values have been assigned to the quadrats taking into account the community with the maximum value enclosed in each one of them. Considering the importance of the alder wood and the riparian communities (very close to the quadrant I of the PCA), we think that the quadrats including alder wood communities and two forest communities, one of them with the value 3 or 4, can be considered very important areas for the biological conservation. We have chosen this criterion to adjust the value of these quadrats to 5.

Community features

a) *Wing size.* On the basis of this morphological characteristic we can distinguish the macropterous form with well developed wings, and high "dispersal power" (den Boer *et al.* 1980). The greater the dispersal power, the more "degraded" (Brandmayr 1983b; and Brandmayr 1991 for a detailed discussion) and "younger" (den Boer *et al.* 1980) is a carabid community (see also Aukema 1986). It is likely that a community with large number of flying species is very resilient to changes. For the evaluation, the ratio of brachypterous species and their dominance has been computed in the sites. The classes are proportional to the brachypterous form.

b) *Endemic species.* Importance has been given to the endemics of the southern Apennine (chorotype II° in the zoosociological table), because *Pt. ruffoi* is the only stenoendemic (chorotype I) of the Aspromonte. A direct correlation has been found between the number of endemics and the degree of carabid community evolution from the open land to the forest (Brandmayr 1983). For the evaluation: the same as under a), and also the ratio of endemic species on the sum of the endemics catched during the research.

c) *Species at the southern fringe of distribution.* Many species widespread in Italy and in Europe reach the southern limit of their range in the Aspromonte massif. Here some of them may show a different habitat choice. The evaluation is the same as under b).

d) *Species diversity.* Evaluated by means of the Shannon index (natural logarithm) as I/I_{max}.

Conclusions

The environment of the studied area shows a high degree of naturalness. The pastures are the only zones markedly affected by grazing. Termination of this activity is badly needed.

The carabid community of the wet meadow alder groves has special importance in that it has the highest number of species, and includes nearly all the endemics. This community in account of its environmen-

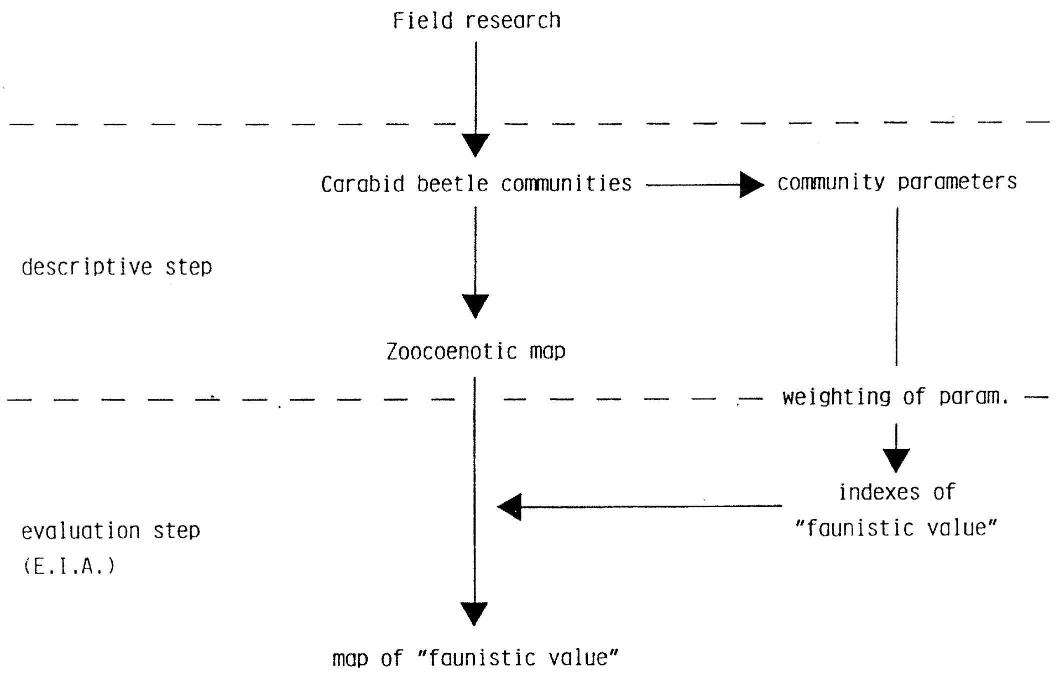

Figure 9. Main steps of the Environmental Impact Assessment for the Menta river barrage in the Aspromonte Massif.

tal features, and of the edge-effect, plays an important role in the conservation of carabid diversity within the oak and beech vegetation belts (the samnitic and subatlantic vegetation belts of Pignatti 1979). It provides a refuge for the species.

Estimates of the "faunistic value" of the carabid resources provided the results shown in Fig. 8. The highest values are found in the larger valleys, where the soils are better conserved and/or some habitat types, like the alder groves, are important. The water factor proved to be of great importance, often in restricting the habitat affinity of some species (e.g., *Trichotichnus nitens*) that in the other Apennines chains behave more eurytopic.

The indexing method proved to be simple and easy to use. We think that it may be helpful to avoid wasting of time and money in environmental impact assessment studies. The main steps of the study are summarized in Fig. 9 (see also Mingozzi and Brandmayr 1990). New community features will probably improve the evaluation method.

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