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The Tenebrionidae (Coleoptera) of a Tyrrhenian coastal area: diversity and zoogeographical composition

SIMONE FATTORINI
Dipartimento di Biologia Animale e dell'Uomo (Zoologia), Università di Roma "La Sapienza", Viale dell'Università 32, I-00185 Roma (Italy)

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SUMMARY

The family Tenebrionidae represents an important faunal component of Mediterranean coastal ecosystems. Until a recent fire (July 2000), which unfortunately destroyed large sectors of an introduced pine forest, the protected area of Castelfusano (about 1000 hectares, near Rome, Latium) was a Tyrrhenian coastal site where psammophilous vegetation, maquis, oak forests, hygrophilous forests, and an introduced pine forest occurred. The aim of this work was: (1) to provide a faunal inventory of the tenebrionids of Castelfusano before fire, and (2) to analyse this fauna from both an ecological and a zoogeographical point of view. A total of 29 tenebrionid species, belonging to three main ecological guilds, were recorded: (1) sand dwelling species inhabiting the beach-dune system; (2) geophilous species of maquis and open areas; (3) xylophilous species, especially associated with the pine forest. Based on their general distribution, the tenebrionid beetles of Castelfusano can be grouped into eight chorological categories. As to the environmental factors responsible for this chorological spectrum, a relationship can be observed between species ranges and ecological preferences. In accordance with the Tyrrhenian location of the study area, most of the species appear to be more or less widely distributed in the Mediterranean basin, with a high proportion of West Mediterranean and S-European elements. Species with such types of distribution are also typically thermophilic species. Therefore, the climate of the study area, favouring species with thermophilic preferences, can be responsible for a high incidence of species with such ranges. Species with more northern distributions are relatively scarce, including some euryoecious or xylophilous elements. The presence of species with such ranges can be related to the occurrence of patches of mesophilic vegetation in the study area. Most probably, such species largely colonised Italian coastal areas during Pleistocene glaciations. As the climate became drier and warmer, these species were forced to assume more northern distributions. However, isolated populations were able to survive also in areas like Castelfusano, where favourable habitats persisted. Therefore, these relict populations are a result of vicariance events determined by the fragmentation of Pleistocene mesophilic habitats. Most of the species recorded for the forest vegetation of Castelfusano also occurs in the adjacent Presidential Estate of Castelporziano, a large and well preserved area. Therefore, Castelporziano will operate as a source area for the tenebrionid colonisation of the Castelfusano area destroyed by fires if favourable habitats will be restored.

INTRODUCTION

The family Tenebrionidae represents a conspicuous faunal component of arid and semi-arid environments, and the importance of these beetles in Mediterranean

beach-dune ecosystems has been shown by many authors (e.g., Binaghi 1964; Marcuzzi 1965, 1982; Therond and Bigot, 1964; Canzoneri 1966; Bonometto and Canzoneri 1970; Dajoz, 1987; de los Santos, 1988; Martin Cantarino and Seva Roman, 1991; Colomini et al., 1991, 1994; Contarini, 1992; Lucarelli et al., 1993; Fallaci, 1994, 1997; Mifsud, 1999; Carpaneto and Fattorini, 2001; Fattorini and Carpaneto, 2001; Fattorini and Maltzeff, 2001). However, the family also includes a number of species inhabiting prairies and woodlands. These ecological characteristics make Tenebrionidae a very useful taxon for ecological and biogeographical researches in Mediterranean coastal areas, where a mosaic of vegetation types generally occurs.

In Italy, most of the coastal habitats have been strongly altered by human activities. In particular, the inconsiderate felling of all forms of forest vegetation has left the Italian coastal zones with very few wooded areas. At present, large forest fragments are restricted to some relict areas, being most of the coastal zones occupied by maquis, sometimes with introduced pine forests. Likewise, most of the Italian beaches and coastal dunes have been destroyed. Thus, natural sandy beaches and dunes occur in very few areas, most of which are in danger of being completely converted to urban or recreational use.

Due to this, most of the entomofauna associated with these types of habitat has almost disappeared (e.g., Carpaneto et al., 1998; Cassola, 2000; Fontana and Kleukers, 2000; Vigna Taglianti, 2000).

Until a recent fire (July 2000), which unfortunately destroyed large sectors of the introduced pine forest, the protected area of Castelfusano (about 1,000 hectares, near Rome, Latium) was a Tyrrhenian coastal site where psammophilous vegetation, maquis, oak forests, hygrophilous forests, and an introduced pine forest occurred.

This complex vegetation obviously offered a number of habitats for insects with different ecological preferences, such as those belonging to the family Tenebrionidae.

At present, the Municipality of Rome has approved and financed a project for an ecological restoration of the area. According to this project, most of the pine forest destroyed by fire will be substituted by shrubby sclerophyllous communities dominated by *Quercus ilex*.

Due to its proximity to the urban area of Rome, Castelfusano has been investigated by various entomologists from the beginning of the XX Century to the present time. Thanks to such researches (including personal collections in recent times), the knowledge of the tenebrionid fauna inhabiting this area before fire is accurate enough.

The aim of this paper is twofold. First, to provide a faunal inventory of the tenebrionids of Castelfusano before fire, which could be also used in a restoration project. Second, to analyse this fauna from both an ecological and a zoogeographical point of view.

STUDY AREA, MATERIAL AND METHODS

The study area includes the "Pineta di Castelfusano" Regional Urban Park (a part of the "Litorale Romano" State Reserve), and the adjacent seashore (Fig. 1).

The area lies on the sandy soils of the mouths of the Tevere River, and, although large sectors of the seashore are presently occupied by touristic seattlements, sites with semi-natural beaches and dunes occur in various areas. Beside the pine (*Pinus pinea*) forest, planted by Agostino Chigi in the XVIII Century, the forest vegetation of this area is prevalently represented by fragments of *Quercus ilex* woods, with some patches occupied by *Q. suber* and *Q. robur* woods.

The shrubby sclerophyllous communities are dominated by *Pistacia lentiscus* and *Phyllirea latifolia*.

Finally, the dune vegetation is mainly represented by *Ammophila arenaria*, *Cakile maritimum*, *Crithmum maritimum*, *Echinophora spinosa* and *Eryngium maritimum*.

The tenebriond material examined during this research is deposited in the following institutions and private collections: CA = coll. R. Antonelli, Roma; CF = coll. S. Fattorini, Roma; CG = coll. E. Garavaglia c/o Museo Civico di Zoologia, Roma; CL = coll. P. Luigioni c/o Museo Civico di Zoologia, Roma; CM = coll. P. Maltzeff, Roma; CP = coll. U. Pessolano, Roma; CPA = coll. G. Pace, Roma; MZUR = coll. Museo di Zoologia, Università di Roma "La Sapienza".

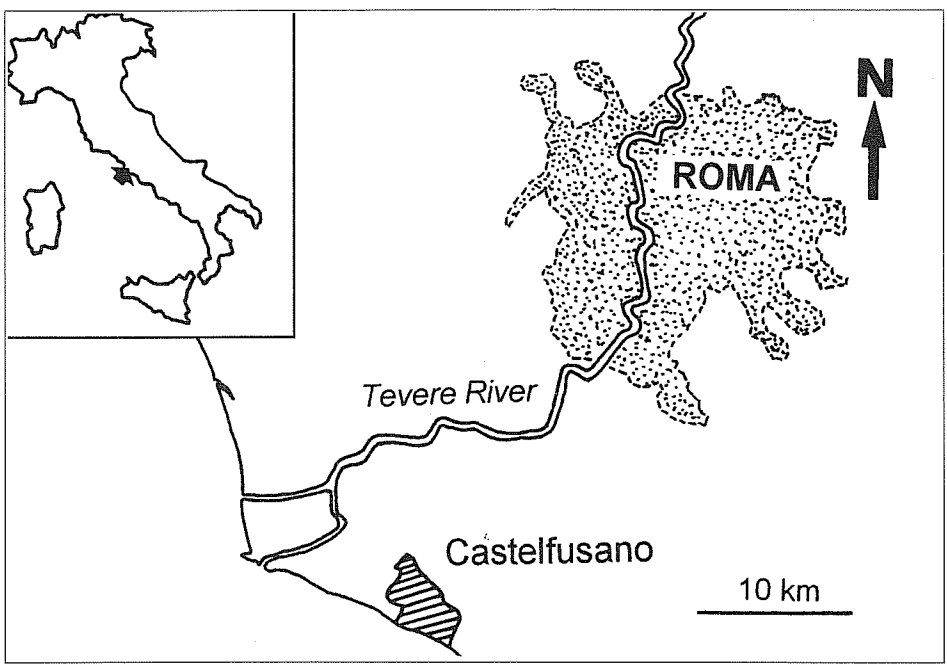

Fig. 1 - Study area

I included also some recently collected specimens for species which were reasonably present in the study area (even if not collected) also before the fire. Due to the lack of reliable data, the whole subfamily Alleculinae and the tribe Lagriini were omitted.

To compare the species richness of the main habitats of Castelfusano (i.e. beach, dune, low maquis, high maquis, oak forests, pine forests, wetlands, and steppes), a matrix of presence/absence of each species in each habitat was compiled (Table I).

Tab. I - Chorotype, ecological category and habitat distribution of the tenebrionid beetles recorded in the study area. CHOR = chorotype: COS = Cosmopolitan or Subcosmopolitan; EME = E-Mediterranean; EUR = European; MED = Mediterranean; SEU = S-European; SIE = Sibero-European; TEM = Turano-European-Mediterranean; W-MED = W-Mediterranean; EC = ecological category: E = Eurytopic; O = oligotopic; S = stenotopic; DU = dunes; LM = Low maquis; HM = High maquis; WL = Wetlands; OF = Oak forests; PI = Pine forests; ST = Steppes

	CHOR	EC	BE	DU	LM	HM	WL	OF	PI	ST
E. siculus	EME	O	-	+	+	-	-	-	-	+
T. grossa	WME	O	-	+	+	-	-	-	-	-
S. intermedia	SEU	S	-	+	-	-	-	-	-	-
S. sardoa	WME	E	-	-	-	+	+	+	+	+
A. luigionii	WME	E	-	-	+	+	-	-	-	+
S. striatus	WME	E	-	-	+	+	-	-	-	+
P. bipunctata	WME	O	-	+	+	+	-	-	-	+
B. gibba	SEU	E	-	-	-	-	+	-	-	-
P. meridianus	SEU	E	-	-	-	-	-	+	+	+
C. strigosus	SEU	O	-	-	-	-	-	+	+	-
L. pulchellum	MED	S	-	+	-	-	-	-	-	-
A. rufus	MED	S	-	+	-	-	-	-	-	-
P. provincialis	MED	S	+	+	-	-	-	-	-	-
H. pellucida	MED	S	-	+	-	-	-	-	-	-
B. reticulatus	SIE	S	-	-	-	-	+	-	-	-
S. metallicum	EUR	O	-	-	-	-	+	+	+	-
P. europaeum	EUR	S	-	-	-	-	-	-	+	-
U. culinaris	SIE	O	-	-	-	-	+	-	-	-
H. pini	SIE	S	-	-	-	-	-	-	+	-
H. fasciatus	EUR	O	-	-	-	-	-	+	+	-
M. cylindricus	SEU	O	-	-	-	-	+	+	+	-
T. obscurus	COS	E	-	-	-	-	-	+	+	-
N. noctivagus	EME	S	-	-	-	-	-	+	-	-
H. ceruleus	EUR	O	-	-	-	-	+	+	+	-
C. rotundicollis	WME	O	-	+	-	-	+	+	+	+
E. dentipes	SEU	S	-	-	-	-	-	+	+	-
N. dryadophilus	SEU	O	-	-	-	-	+	+	+	-
N. planipennis	SEU	O	-	-	-	-	+	+	-	-

This matrix is based on both personal observations in Castelfusano and the general ecological preferences shown by each species in central Italy. *Cnemeplatia atropos* was excluded because of the lack of detailed information on its ecological preferences. According to their habitat breadth in central Italy, the species were grouped into the following three categories (cf. Fattorini and Maltzeff, 2001): (1) stenotopic (species strictly associated to one or few habitats); (2) oligotopic (species mostly associated to one or few habitats, but which can also be easily encountered

in other habitats); (3) eurytopic (species occurring in a great variety of habitats) (Table I). Faunal similarity among habitats was studied using the Jacard index. In order to obtain groups of habitats with a certain degree of internal homogeneity, an average linkage cluster analysis (UPGMA) was used to cluster similarities. The same procedures were also used to classify the species according to their presence/absence in each habitat. Chorotypes follow Vigna Taglianti et al. (1999).

SPECIES LIST

The following list provides an account of the tenebrionid beetles of Castelfusano, including ecological and distributional data. The nomenclature and sequence of species follow that of Gardini (1995).

Erodius siculus neapolitanus Solier, 1834

Castelfusano, 24. VII. 1967, Carpaneto leg., 4 exs. (MZUR); idem, 2. IX. 1969, Carpaneto leg, 1 ex. (MZUR); idem, 27. VII. 1988, A. Biscaccianti leg., 1 ex. (CF); Castelfusano, ISTAT bathing establishment, beach, 9. III. 1997, S. Fattorini and G. Di Stefano leg., remains of 5 exs. (CF); idem, 23. III. 1997, S. Fattorini and G. Di Stefano leg., 1 ex. (remains) (CF); idem, 20. IV. 1997, S. Fattorini and G. Di Stefano leg., 2 exs. and remains of 4 exs. (CF); idem, 24-25. V. 1997, S. Fattorini and G. Di Stefano leg., 2 exs. (CF).

DISTRIBUTION

This species includes various subspecies, but their taxonomy is still not well studied (cf. Di Stefano and Fattorini, 2000). The nominal form *E. siculus siculus* Solier, 1834 occurs in Sicily and on Favignana. Most probably, the population inhabiting Ustica has also to be referred to the nominal form. The ssp. *dalmatinus* Kraatz, 1865 is restricted to the Adriatic coastal areas of the Italian and Balkan peninsulas, also occurring on Corfù. The ssp. *neapolitanus* occurs on the Tyrrhenian coasts of the Italian peninsula (from Tuscany to Calabria), as well as on many Sicilian islands. The populations inhabiting the Maltese Islands are currently referred to another subspecies, ssp. *melitensis* Reitter, 1914, but its actual value is questionable (cf. Mifsud and Scupola, 1998). E-Mediterranean chorotype.

Habitat preferences

This psammophilous species is generally linked to coastal sandy dunes, also occurring in inland areas in Sicily (Di Stefano and Fattorini, 2000). In Romagna (Northern Italy, Adriatic coast), the species has been also collected in open areas within coastal woods (Zangheri, 1969).

Tentyria grossa grossa Besser, 1832

Castelfusano (Gridelli, 1950: 151); Castelfusano, 12. III. 1929, Luigioni leg., 14 exs. (CL); idem, 15. IV. 1949, C. Consiglio leg., 3 exs. (MZUR); idem, 6. V. 1962, C. Consiglio leg., 1 ex. (MZUR); idem, 24. III. 1991, P. Maltzeff leg., 2 exs. (CM); idem, 7 V. 1992, R. Antonelli leg., 1 ex. (CA); idem, 20. IV. 1997, S. Fattorini and G. Di Stefano leg., 1 ex. (CF); idem, 19. IV. 1997, S. Fattorini leg., 3 exs. (CF); idem, 20. IV. 1997, S. Fattorini and G. Di Stefano leg., 7 exs. (CF); idem, 25. V. 1997, S. Fattorini and G. Di Stefano leg., 3 exs. (CF); Castelfusano, ISTAT bathing establishment, beach, 9. III. 1997, S. Fattorini and G. Di Stefano leg., 1 ex. and remains of 1 ex. (CF); Castelfusano, , ISTAT bathing establishment, beach, 23. III. 1997, S. Fattorini and G. Di Stefano leg., 2 exs. (CF).

Distribution

A number of races are known for this specie but their taxonomy is still not well studied (cf. Mifsud and Scupola, 1998). W-Mediterranean chorotype.

Habitat preferences

Along the Tyrrhenian seashore of the Italian peninsula, this species appears to be substantially linked to dune and maquis habitats (Colombini et al., 1994; personal observations).

Stenosis intermedia (Solier, 1838)

Castelfusano, 26. XII. 1937, Cerruti leg. (sub *S. brenthoides intermedia* Gridelli det.), 1 ex. (ex coll. Cerruti, MZUR).

Distribution

Southern France, Italy, Lipari and Ustica Islands, Sicily, Tremiti Islands, Dalmatia and Dalmatian Islands, Albania, Ionian Islands (Canzoneri, 1970; Grimm, 1985). S-European chorotype.

Habitat preferences

Psammohalobiontic species, sometimes occurring beneath the bark of pine trees (Bonometto and Canzoneri, 1970).

Stenosis sardoa ardoini Canzoneri, 1970

Castelfusano, 30. VIII. 2001, M. Pitzalis and E. Trucchi leg., 1 ex.; idem, 31. V. 2001, M. Pitzalis and E. Trucchi leg., 6 exs (CF).

Distribution

The nominal form *S. sardoa sardoa* (Küster, 1848) occurs in Spain, South France, Corsica, Sardinia, Sicily (including some Sicilian islands) and in some

locations along the Tyrrhenian coasts of the Italian Peninsula from Liguria to Campania. The ssp. *ardoini* occurs on some Tuscany Islands, is some locations along the Tyrrhenian coasts of the Italian Peninsula and in Sicily (including some Sicilian Islands) (Aliquò and Leo, 1999) W-Mediterranean chorotype.

Habitat preferences
Euryoecious species, generally encountered under stones or barks, especially in winter (Aliquò and Leo, 1999).

Asida luigionii luigionii Leoni, 1909
Castelfusano, 1. X. 2001, A. Biscaccianti leg., remnants in a fox scat (CF).

Distribution
This polytypic species, endemic to Central Italy, includes the following subspecies: the typical form occurs in Liguria, Tuscany, Umbria, Latium and Abruzzi; ssp. *doriai* Leoni, 1910 on the Giglio Island (Tuscany Archipelago); and ssp. *insularis* Leoni, 1919 on various islands of the Tuscany Archipelago (cf. Fattorini, 2001a). W- Mediterranean chorotype.

Habitat preferences
Euryoecious species is generally encountered under stones in open and dry areas (Fattorini, 2001a).

Scaurus striatus (Fabricius, 1775)
Castelfusano, 12. III. 1909, Luigioni leg., 1 ex. (CL); idem, 17. V. 1992, R. Antonelli leg., 1 ex. (CA); idem, 23. III. 1997, S. Fattorini and G. Di Stefano leg., 1 ex (remains). (CF).

Distribution
Catalonia, Balearic Islands, Southern France, Corsica, Sardinia, Sicily, various Sicilian islands, Italian peninsula, Pontine Islands, Capri, the Maltese Islands (Gardini, 1976; Aliquò, 1993; Mifsud and Scupola, 1998); the occurrence in Greece is probably due to human introduction (Fattorini, 2000). W-Mediterranean chorotype.

Habitat preferences
This species, generally occurring under stones in open and dry areas (Gardini, 1976), can be also encountered in urban habitats, especially in rubble and archaeological sites (personal observations). In Apulia, Marcuzzi (1965) found this species in pine woodlands.

Pimelia bipunctata cajetana (Sénac, 1887)

Castelfusano, 15. IV. 1949, C. Consiglio leg., 6 exs. (MZUR); idem, 6.V. 1962, C. Consiglio leg., 1 ex. (MZUR); idem, 2. IX. 1969, G. Carpaneto leg., 2 exs. (MZUR); idem, 17. V. 1992, R. Antonelli leg., 1 ex. (CA); idem, 12. V. 1992, U. Pessolano leg., 5 exs. (CP); idem, 11. VI. 1992, U. Pessolano leg., 4 exs. (CP); Castelfusano, ISTAT bathing establishment, beach, 23. II. 1997, S. Fattorini and G. Di Stefano leg., 10 exs. and remains of 10 exs. (CF); idem, 23. III. 1997, S. Fattorini and G. di Stefano leg., 4 exs. (remains) (CF); idem, 9. III. 1997, S. Fattorini and G. Di Stefano leg., 5 exs. (CF); idem, 20. IV. 1997, S. Fattorini and G. Di Stefano leg., 1 ex. (CF).

Distribution

According to Canzoneri (1963), the species includes the following races (for distributional details see Gardini, 1976; Aliquò, 1990; Bonneau, 1988): ssp. *bipunctata* Fabricius, 1781 (Southern France); ssp. *papii* Canzoneri, 1963 (Liguria, Tuscany, Elba Island; northern Latium); ssp. *cajetana* (Latium, Campania). The actual value of these subspecies is however questionable. W-Mediterranean chorotype.

Habitat preferences

Psammohalobiont species (Colombini, 1994; Fallaci, 1997), rarely encountered in subcoastal areas (personal observations in Latium).

Blaps gibba Laporte de Castelanu, 1840

Castelfusano, 24. XI. 1936, 1 ex. (CG).

Distribution

Italian Peninsula, Sicily (including many Sicilian Islands), Sardinia, Corsica, Balearic Islands, Dalmatia (Fattorini and Leo, 2000). S-European chorotype.

Habitat preferences

Euryoecious and locally anthropophilic species (Fattorini and Leo, 2000). On Curzola, the species was also observed on sandy dunes together with *E. siculus* (Müller, 1921).

Leichenum pulchellum pulchellum (Lucas, 1849)

Castelfusano, ISTAT bathing establishment, beach, 20. IV. 1997, S. Fattorini and G. Di Stefano, 34 exs. (CF); idem, 25. IV. 1997, S. Fattorini and G. Di Stefano, 39 exs. (CF); idem, 25. V. 1997, S. Fattorini and G. Di Stefano, 3 exs. (CF).

Distribution

The nominal form is widely distributed in coastal sandy areas of the western Mediterranean Basin, also occurring with scattered populations in sandy habitats of river banks (Gridelli, 1939, Canzoneri, 1977); another subspecies, ssp. *pumilum* Baudi, 1876, occurs in Egypt, Eritrea, Lebanon, Anatolia, Syria, Iraq, Arabia and on Cyprus (Kaszab, 1982). Mediterranean chorotype.

Habitat preferences

According to Soldati (1995), the species appears to be linked to the small valleys between dune crests. By contrast, at Castelfusano the species was found in a narrow strip of the seashore between the eulittoral zone and the first dune.

Cnemeplatia atropos atropos A. Costa, 1847

Castelfusano, 27. IX. 2001, M. Pitzalis and E. Trucchi leg., 1 ex. (CF).

Distribution

The nominal form is widely distributed in Southern Europe and Western Central Asia (Kaszab, 1982); another subspecies, ssp. *africana* Kaszab, 1938, occurs in Spain and North Western Africa (Español, 1959). Turano-Europeo-Mediterranean chorotype.

Habitat preferences

In Veneto, the species has been collected by Scupola (1982) within the sawdust into a cavity of an old poplar. On the Maltese Islands, the species has been collected under bark of *Eucalyptus* trees and in soil under *Ceratonia siliqua*. (Mifsud and Scupola, 1998)

Pedinus meridianus Mulsant and Rey, 1853

Castelfusano, 27. 09. 2001, M. Pitzalis and E. Trucchi leg., 2 exs (CF).

Distribution

Southern France, Corsica, Italian Peninsula, Sardinia, Tuscany Archipelago, Tremiti Islands, Dalmatian Islands (Gardini, 1976). S-European chorotype.

Habitat preferences

Euryoecious species, generally encountered under stones in various types of semi-arid environments like maquis and dry prairies, from the sea level to 1800 m (Gardini, 1976).

Colpotus strigosus strigosus (A. Costa, 1847)

Castelfusano (Gardini, 1976); Castelfusano, 20. II. 1954, 1 ex. (P. Leo, pers.

com.); Castelfusano, 26. XII. 1937, Cerruti leg., 1 ex.; idem, 11. X. 1942, Cerruti leg., 1 ex. (ex coll. Cerruti, MZUR).

Distribution

Italian Apennines. The typical form, *C. strigosus strigosus*, is distributed along the Apennines from Emilia Romagna to Calabria; the subspecies *ganglbaueri* d'Amore Fracassi, 1907 is localised in some high altitude sites in the Central Apennines; the subspecies *oglasensis* Gardini, 1976 is endemic to the Tuscany Archipelago (the ssp. was described from Montecristo Island; however, the population of La Scola island could also be referred to this subspecies, cf. Lo Cascio et al., 2000); the subspecies *ragusae* d'Amore Fracassi, 1907 occurs in Sicily, Basilicata and Calabria (Fattorini, 2001). S-European chorotype.

Habitat preferences

Euryoecious species, generally encountered under stones or barks, in various types of woods (oak, pine and beech forests), maquis, and dry prairies (Gardini, 1976).

Ammobius rufus Lucas, 1849

Castelfusano, ISTAT bathing establishment, 20. IV. 1997, S. Fattorini and G. Di Stefano, 26 exs. (CF); idem, 27. IV. 1997, S. Fattorini and G. Di Stefano, 33 exs. (CF); idem, 25. V. 1997, S. Fattorini and G. Di Stefano, 7 exs. (CF).

Distribution

Mediterranean to Black Sea (Mifsud and Scupola, 1998). Mediterranean chorotype.

Habitat preferences

Psammohalobiont species (Bonometto and Canzoneri, 1970). At Castelfusano it was found together with *E. siculus* and *P. bipunctata*.

Phaleria provincialis ghidinii Canzoneri, 1961

Castelfusano, 10. VI. 1932, Garavaglia leg., 1 ex. (sub *acuminata* ab. *maculata*) (CG).

Distribution

This species shows a clearly disjunct distribution, occurring on North West Mediterranean sandy shores on one side, and on Cyprus on the other side (Grimm, 1991). The West Mediterranean populations are currently referred to the ssp. *provincialis* Fauvel, 1901, ssp. *intermedia* Schuster, 1930 and ssp. *ghidinii*,

but their actual value is questionable. The population of Cyprus is regarded as another subspecies, ssp. *cypria* Grimm, 1991. Mediterranean chorotypes.

Habitat preferences
Psammohalobiont species, mostly linked to the seashore and the outermost part of the dune systems (Colombini et al., 1994).

Halammobia pellucida (Herbst, 1799)
Castelfusano, ISTAT bathing establishment, 20. IV. 1997, S. Fattorini and G. Di Stefano, 65 exs. (CF); idem, 25. IV. 1997, S. Fattorini and G. Di Stefano, 73 exs. (CF); idem, 25. V. 1997, S. Fattorini and G. Di Stefano, 3 exs. (CF).

Distribution
This species appears to be widely distributed in the western part of the Mediterranean Basin (Grimm, 1985), also occurring on Zakynthos and in Peloponnese (Moragues, 1988; Whitehead, 1997; Fattorini 2000). Mediterranean chorotype.

Habitat preferences
Psammohalobiont species, strictly linked to sandy beach and dune ecosystems. At Castelfusano, this nocturnal tenebrionid (cf. Tongiorgi, 1969) was collected at the base of plants living in the supralittoral zone by using pitfall traps during the night.

Bolitophagus reticulatus (Linné, 1767)
Castelfusano, 10. VII. 1999, 1 ex. (CF).

Distribution
Europe, Palearctic Asia (Canzoneri, 1977). Sibero-European chorotype.

Habitat preferences
Mycophagous species, associated with polypores living on trees, especially beech (Gridelli, 1956). In Italy, this species appears to be rather rare, also showing a very scattered distribution.

Scaphidema metallicum (Fabricius, 1792)
Castelfusano, 6. IV. 2001, A. Biscaccianti leg., 1 ex. (CF).

Distribution
Lapland, England, Central Europe, Spain, Italy, Corsica (Scupola, 1982).

European chorotype. This species, quoted from Valle d'Aosta, Piemonte, Lombardia, Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia, Emilia Romagna, Tuscany, Calabria, Basilicata and Apulia (cf. Angelini, 1986, 1987, 1991; Canzoneri and Vienna, 1987; Cecchi and Bartolozzi, 1997, Marcuzzi, 1998), is new to Latium.

Habitat preferences
Xylophilous species, living beneath the bark and in rotten wood of deciduous species, and, sometimes, of conifers (Scupola, 1982).

Platydema europaeum Laporte de Castelnau and Brullé, 1831
Castelfusano, 12. III. 1929, Luigioni leg., 1 ex. (CL); idem, 24. XI. 1931, 1 ex. (CG).

Distribution
Spain, Southern France, Corsica, Dalmatia, Caucasus, Cyprus, Italy (Gebien 1938-43; Bonneau, 1988). S-European chorotype.

Habitat preferences
This species, apparently linked to polypores living on pine logs and trunks (Soldati, 1995), seems to be very rare in Italy.

Uloma culinaris (Linné, 1758)
Pineta di Castelfusano, 22. V. 1993, U. Pessolano leg., 1 ex. (CF); idem, 10. VII. 1999, 1 ex. (CF).

Distribution
Europe, Caucasus, Siberia, Iran (Gebien, 1938-43; Gridelli, 1956). Sibero-European chorotype.

Habitat preferences
Xylophilous species, living beneath the bark and in rotten wood of both deciduous and coniferous species (especially pines) (Scupola, 1982; Grimm, 1985; Bonneau, 1988).

Hypophloeus fasciatus Fabricius, 1790
Castelfusano, 3. VI. 2001, S. Fattorini leg., under pine barks, 4 exs. (CF).

Distribution
Europe (Kaszab, 1969). The species has been also quoted from North Africa by some authors (cfr. Aliquò and Leo, 1996). European chorotype?

The species was previously quoted from Latium by Porta (1934) without any specified localities.

Habitat preferences
This species lives beneath the bark of oaks (Kaszab, 1969; Soldati, 1995).

Hypophloeus pini (Panzer, 1799)
Castelfusano, 12. III. 1929, Luigioni leg., 1 ex. (CL); Castelfusano, 7. II. 1993, G. Pace leg., 4 exs. (P. Leo pers. com.); Castelfusano, 3. VI. 2001, S. Fattorini leg., under pine barks, 2 exs. (CF).

Distribution
Southern Europe, southern regions of Central Europe, Siberia to Transbajkalia (Kaszab, 1969), some Canary Islands and scattered localities in North Western Africa (Leo, 1991). Sibero-European chorotype.

Habitat preferences
This species lives into scolitid galleries beneath the bark of conifers (Kaszab, 1969; Soldati, 1995).

Menephilus cylindricus Herbst, 1784
Castelfusano, 1. V. 1973, A. Pacifici leg., 2 exs.; idem, 23. X. 1975, A. Pacifici leg., 1 ex. ; idem, 27. II. 1977, A. Pacifici leg., 5 exs. (P. Leo pers. com.); Castelfusano, 12. III. 1929, Luigioni leg., 2 exs. (ex coll. Cerruti, MZUR); idem, 24. XI. 1931, 4 exs. (CG); idem, 19. III. 1948, De Maggi leg., 1 ex. (ex coll. Cerruti, MZUR); idem, 17. IV. 1993, R. Antonelli leg., 2 exs. (CA); idem, 23. II. 1997, S. Fattorini leg., 1 ex. (CF); idem, under barks of *Pinus* sp., 25. IV. 1998, G. Pace leg., 1 ex. (CPA).

Distribution
The nominal form is distributed in Central and Southern Europe, on Cyprus and in Anatolia; the ssp. *maroccanus* Théry, 1932 occurs in Morocco (Canzoneri, 1966). S-European chorotype.

Habitat preferences
Xylophilous species, living beneath the bark of both coniferous (especially *Pinus* spp.) and deciduous species (Kaszab, 1967; Soldati, 1995).

Tenebrio obscurus Fabricius, 1792
Castelfusano, 21. VII. 1969, Marozzini leg., 1 ex. (MZUR).

Distribution
Subcosmopolitan.

Habitat preferences
Anthropophilous species. In natural habitats, this species can be found beneath the bark of old trees (Scupola, 1982).

Neatus noctivagus (Mulsant, 1854)
Castelfusano, 8. VIII. 2001, A. Biscaccianti leg., 1 ex. (CF).

Distribution
Southern Italy, Sicily, Dalmatia, Albania (cf. Fattorini and Matlzeff, 2001). E-Mediterranean chorotype.

Habitat preferences
Xylophilus species (Fattorini and Maltzeff, 2001).

Helops coeruleus (Linné, 1758)
Castelfusano, 26. XII. 1937, Cerruti leg., 2 exs. (ex coll. Cerruti, MZUR); idem, 28. VI. 1987, Pischedda leg., 2 exs. (MZUR); idem, 24. III. 1991, P. Maltzeff leg., 2 exs. (CM).

Distribution
Southern England, Holland, France, Southern Germany (scattered localities), Italian peninsula, Corsica, Sardinia, Sicily, Yugoslavia, Albania, Bulgaria, Greece, Southern Russia, Caucasus, Anatolia, Western Iran (Fattorini, 2001). European chorotype.

Habitat preferences
Xylophagous species, living beneath the bark or into holes of both deciduous and coniferous species (Gardini, 1976; Scupola, 1982; Grimm, 1985).

Catomus rotundicollis (Guérin-Méneville, 1825)
Castelfusano, 24. XI. 1931, 1 ex. (CG); idem, 26. XII. 1937, Cerruti leg., 1 ex. (ex coll. Cerruti, MZUR); idem, 11. X. 1992, R. Antonelli leg., 2 exs. (CA).

Distribution
Spain, Balearic Islands, Southern France, Corsica, Italian peninsula, Sardinia, Sicily, the Maltese Islands, Tunisia (Gardini, 1976; Leo, 1983; Grimm, 1986; Aliquò, 1993). W- Mediterranean chorotype.

Habitat preferences
This species, generally linked to the Mediterranean maquis (where it can be encountered under barks), can be also found under stones in open habitats and in the sand at the base of plants living on coastal dunes (Gardini, 1976).

Enoplopus dentipes (Rossi, 1790)
Castelfusano, 28. VI. 1987, Pischedda leg., 1 ex. (MZUR); idem, 24. III. 1991, under barks, P. Maltzeff leg., 3 exs. (CM); Castelfusano beach, under stone, 23. II. 1997, S. Fattorini leg., 1 ex. (CF).

Distribution
Southern France, scattered localities in Bavaria, Italian peninsula, Sicily, Yugoslavia, Albania, Greece, Bulgaria, Romania, western and southern Hungary (Ardoin, 1958; Kaszab, 1967). S-European chorotype.

Habitat preferences
This species, generally common under the bark of deciduous species, can be also encountered under pine barks, on the ground, and under stones (Marcuzzi, 1965; Scupola, 1982; Grimm, 1985).

Nalassus dryadophilus (Mulsant, 1854)
Castelfusano, 1. 29. VI. 2001, A. Biscaccianti leg., 1 ex. (CF).

Distribution
Southern France, Italy (including Sicily and Sardinia), ex Yugoslavia, Albania, Greece, Bulgaria, Romania, Hungary (Gridelli, 1956: 5; Kaszab, 1967; Gardini, 1976; Canzoneri, 1977). S-European chorotype.

Habitat preferences
This species is generally common under the bark of both deciduous species and pine trees (Grimm, 1985; Soldati, 1995).

Nalassus planipennis (Küster, 1850)
Castelfusano, 16. III. 1981, A. Pacifici leg., 4 exs. (P. Leo personal communication).

Distribution
Species endemic to central and southern Italy (Gardini, 1976). S- European chorotype.

Habitat preferences

Xylophilous species, encountered beneath the bark of *Castanea sativa* and *Eucalyptus* sp. (Gardini, 1976).

ECOLOGICAL AND ZOOGEOGRAPHICAL ANALYSIS

A total of 29 species was recorded from Castelfusano. Even if some faunistic data are based on ancient collections never confirmed, this lack of recent records is probably due to a scarce research more than a local extinction. Actually, recent records of some localised and stenoecious species, such as *L. pulchellum*, *U. culinaris*, *M. cylindricus*, *S. metallicum*, *N. picipes* and *B. reticulatus* indicate that, in spite of a high human pressure (especially on the beach in summer), Castelfusano was a well preserved area, harbouring a rich tenebrionid fauna. Also, preliminary researches, which we are conducting in the study area, suggest the recent fires which destroyed a large part of the pine forest, probably did not cause local extinction or population decrease of species. In contrast, *P. provincialis* is probably extinct in this area because of the high human pressure on the beach.

This high number of species (about 11% of the whole Italian fauna, cf. Fattorini and Maltzeff, 2001) can be interpreted as a result of the occurrence of many different, and rather well preserved habitats. Within the study area, the following major habitat types can be recognised: beach, dunes, low maquis, high maquis, wetlands, oak forests, pine forests, and steppes. High values of tenebrionid species richness were observed for the dune system and for forest habitats (Fig. 2). High richness associated to sandy dunes can be related to the fact that many tenebrionid groups are well adapted to desert habitats. The high number of species recorded in forest habitats can be related to their heterogeneity (see below). Both dunes and forests harbour stenotopic species (Fig. 3). Stenotopic species occurring on dunes are represented by tenebrionids strictly associated to sandy habitats, while those of forests are typically xylophilous beetles, associated with particular vegetation types. Using a cluster analysis to study faunal relationships between habitats, the following three main clusters can be observed (Fig. 4): (1) beach; (2) dune, maquis habitats and steppes; (3) wetlands, oak forests and pine forests. Also, the second cluster includes two minor clusters: one represented by the dune habitat, the other grouping the maquis habitats and the steppes. The third cluster includes the wetlands and a cluster grouping the forest habitats. Note that the beach habitat is well apart because only one stenotopic species (*P. provincialis*) was recorded for this habitat. As a whole, these results suggest the presence of some well-defined tenebrionid communities: (1) psammophilous species associated to the dune habitat; (2) species associated with open areas and shrub vegetation; (3) xylophylous species associated with various types of forests (including those of wetlands). A cluster analysis of species based on their presence in each habitat support such results (Fig. 5), showing the presence of at least three main guilds of species:

(1) psammophilous species inhabiting the beach-dune system (*E. siculus*, *P. bipunctata*, *S. intermedia*, *L. pulchellum*, *A. rufus*, *P. provincialis*, *H. pellucida*);

(2) geophilous species of maquis and open areas (*T. grossa*, *S. sardoa*, *S. striatus*, *A. luigionii*, *B. gibba*, *P. meridianus*, *C. strigosus*, *C. rotudicollis*);

(3) xylophilous species, especially linked to pine forests (*C. atropos*, *S. metallicum*, *P. europaeum*, *B. reticulatus*, *U. culinaris*, *H. fasciatus*, *H. pini*, *M. cylindricus*, *N. noctivagus*, *T. obscurus*, *H. coeruleus*, *E. dentipes*, *N. dryadophilus*, *N. planipennis*).

Based on their general distribution, the tenebrionid beetles of Castelfusano can be grouped into eight chorological categories (Fig. 6). The S-European, Mediterranean and W-Mediterranean chorotypes are the most represented. If the chorotypes are grouped into more general distribution types, we can find that the species distributed in Europe (European and S-European chorotypes) and those distributed in the Mediterranean (Mediterranean, W-Mediterranean, and E-Mediterranean chorotypes) are represented with the same proportions; by contrast the species widely distributed in Europe and Asia (Sibero-European, Turano-Europeo-Mediterranean and Subcosmopolitan chorotypes) are poorly represented (Fig. 7).

Both present (environmental) and historical (palaeocological and palaeogeographical) factors can be evoked to explain such highly diversified zoogeographical composition. As to the environmental factors responsible for the chorological spectrum of the tenebrionid fauna of Castelfusano, a relationship can be observed between species ranges and ecological preferences. In accordance with the Tyrrhenian location of the study area, a great number of species appears to be more or less widely distributed in the Mediterranean basin, with a high proportion of W-Mediterranean elements; obviously, species with such type of distribution are also typically thermophilic species. Therefore,

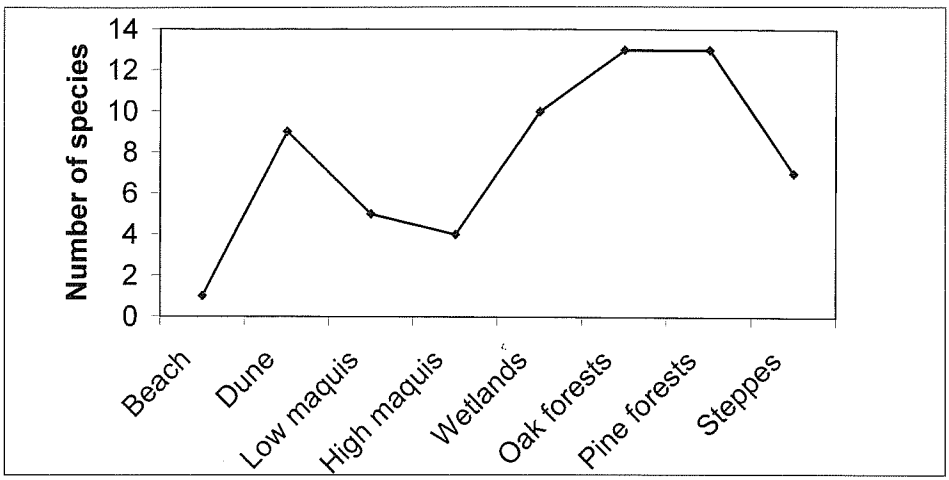

Fig. 2 - Number of tenebrionid species in each habitat

the climate of the study area, favouring species with thermophilic preferences, can be responsible for a high incidence of species with such ranges. As an evidence of this fact, most of the psammophilous and geophilous species belong to the Mediterranean, W-Mediterranean, and E-Mediterranean chorotypes (Fig. 8). Also, a comparison of the chorological composition observed in each habitat reveals a high percentage of species with "Mediterranean" distributions (i.e., Mediterranean, W-Mediterranean and E-Mediterranean chorotypes) in the beach, dune, maquis and steppe habitats (Fig. 9).

Species with more northern distributions (e.g., S-European, European and Sibero-European species) are mostly (or only) represented within the xylophilous elements (Fig. 8). In particular, "European" species (i.e., species belonging to the European and S-European chorotypes) showed high percentages in wetlands, oak forests, and

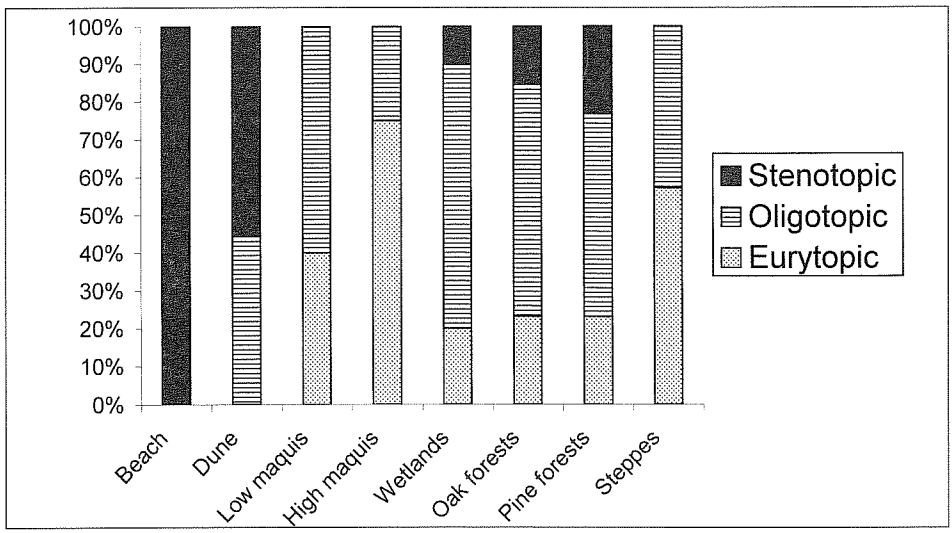

Fig. 3 - Proportion of eurytopic, oligotopic and stenotopic species in each habitat

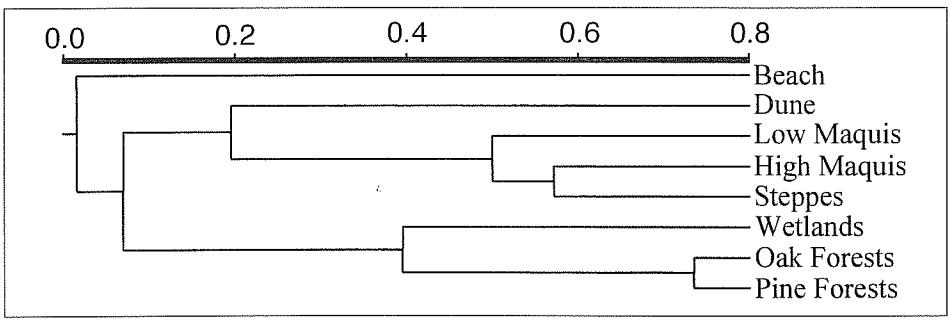

Fig. 4 - Similarity among habitats obtained by cluster analysis (Jaccard index + UPGMA)

pine forests (Fig. 9). As a rule, the presence of species with such ranges can be related to the occurrence of patches of mesophilic vegetation in the study area.

Most probably, such species largely colonised Italian coastal areas during Pleistocene glaciations, as a consequence of a more temperate climate that favoured the dispersal of mesophilic species from northern and inland regions

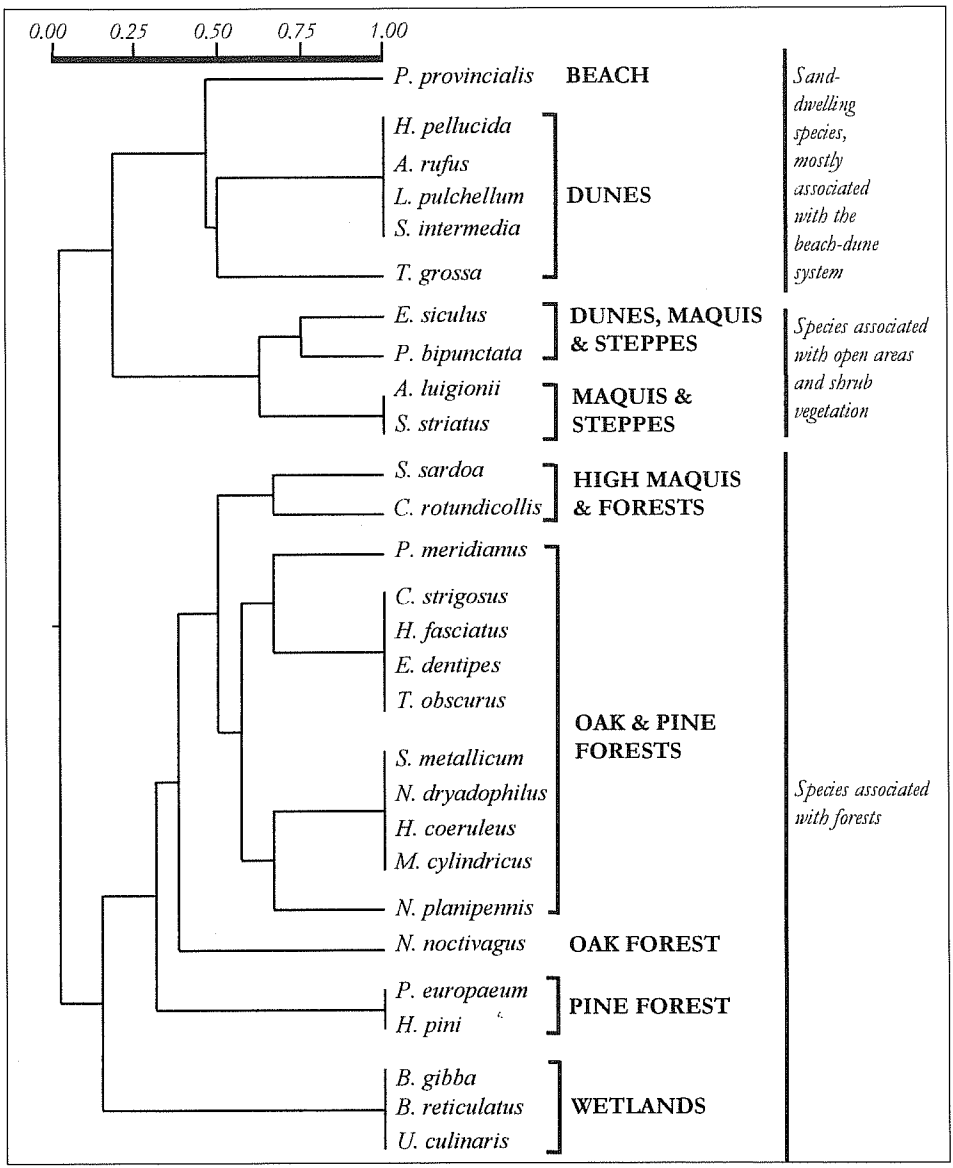

Fig. 5 - Species guilds obtained by cluster analysis (Jaccard index + UPGMA)

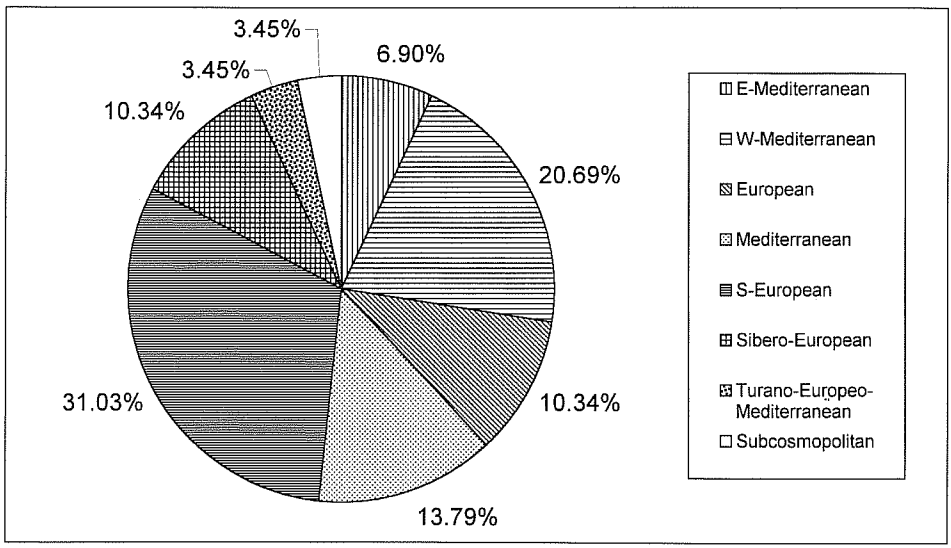

Fig. 6 - Percentage of chorotypes found in the tenebrionids of Castelfusano

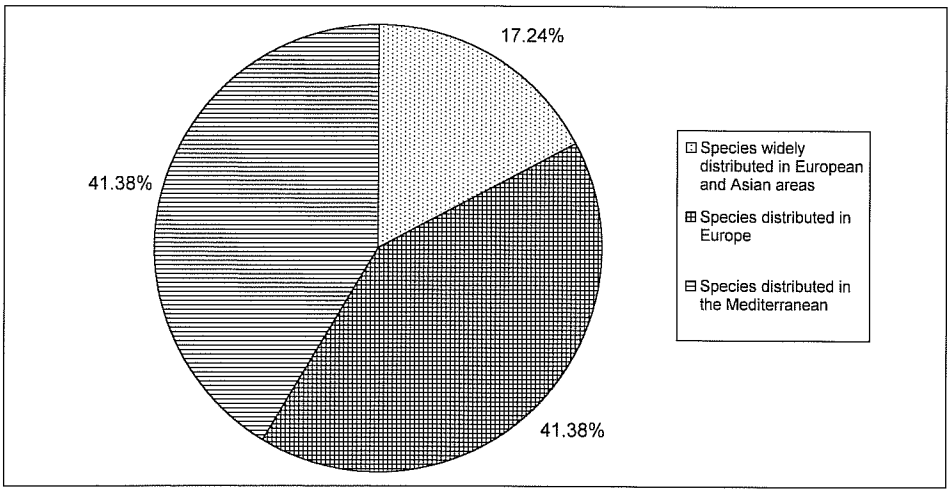

Fig. 7 - Chorological spectrum by major chorological categories

to southern and coastal areas. As the climate became drier and warmer, these species were forced to assume more northern distributions. However, isolated populations were able to survive also in areas, where favourable habitats persisted. In fact, the area of Castelfusano was occupied by lagoons during the Pleistocene, but we can assume that true mesophilic woods (and their associated beetle communities) occurred in neighbouring areas and extended their range to the area of present day Castelfusano. Therefore, these relict populations are a result

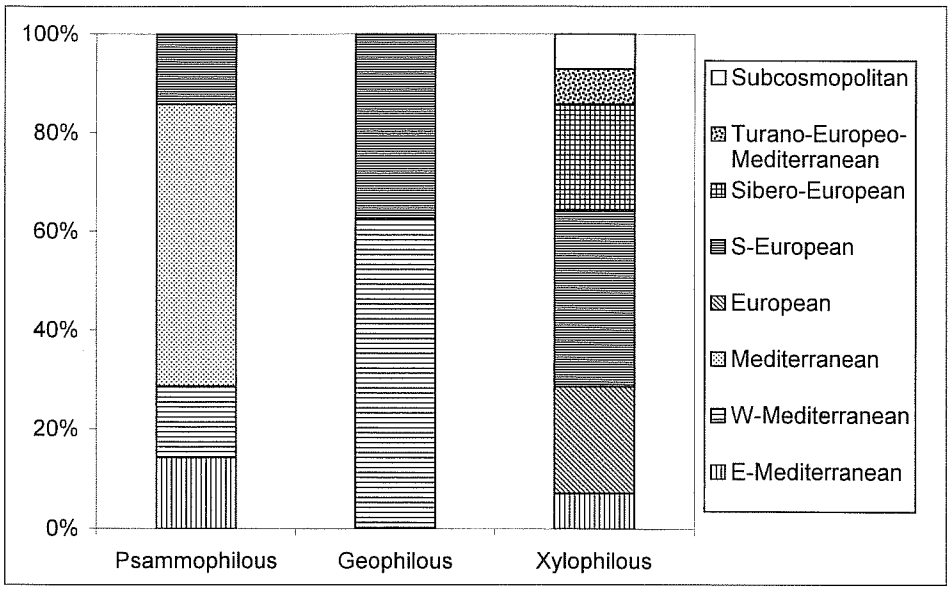

Fig. 8 - Proportions of chorotypes in the three major ecological groups

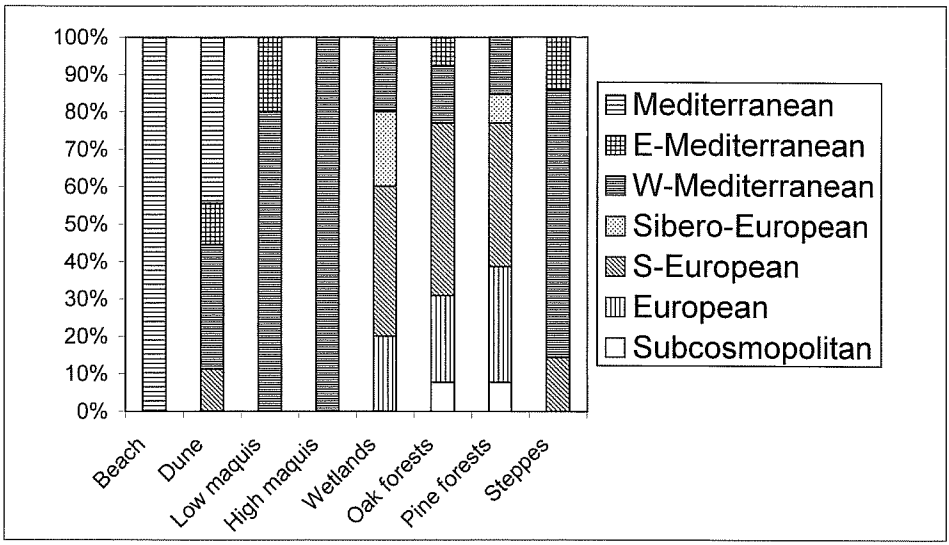

Fig. 9 - Proportions of chorotypes in each habitat

of vicariance events determined by the fragmentation of mesophilic habitats that were widespread also over coastal areas during Pleistocene glaciations.

Interestingly, the pine forest appeared to be one of the most favourable habitat, most of the species being virtually able to live there (Fig. 2), including a rather high

proportion of stenotopic species (Fig. 3). This could be due to the peculiar nature of this habitat. As a forest, the pinewoods can harbour xylophilous species, probably originally associated to mesophilic woods but which are forced to live in pine woodlands because of the destruction of these habitats. On the other hand, the pine forest also has a thermophilic character, which allows the presence of thermophilic species, especially in the adjacent clearings. Therefore, both thermophilic and mesophilic vegetation types have to be restored to allow the restoration of the tenebrionid communities that inhabited the study areas before fire. Most of the species recorded for the forest vegetation of Castelfusano also occurs in the adjacent Presidential Estate of Castelporziano (Fattorini and Maltzeff, 2001), a large and well preserved area. Therefore, Castelporziano will operate as a source area for the tenebrionid colonisation of the Castelfusano area destroyed by fires if favourable habitats will be restored.

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