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Mapping and demography of endangered plants in the Apuan Alps, NW Tuscany, Italy

Abstract

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The Apuan Alps, a massif located between La Spezia and Lucca on the Tyrrhenian coast of NW Tuscany, harbors a diverse flora, rich in biogeographically significant endemic and relic species. Intense exploitation of the marble outcrops and traditional agropastural practices involving fire management of pastures are the major risk factors for the survival of many species, particularly those linked to marble substrates. Distribution of the populations of 8 rare and relic species (*Anagallis tenella, Daphne alpina* subsp. *alpina*, *Horminum pyrenaicum, Biscutella cichoriifolia, Centaurea montis-borlae, Rhododendron ferrugineum, Biscutella apuana, Centaurea arachnoidea*) was mapped in the field and the density and seed production of the populations were recorded. Updated distribution maps were obtained through GIS software. Preliminary, qualitative observations on the extent to which suitable habitats are colonized by the studied species are reported.

Introduction

The Apuan Alps, with their peaks reaching almost 2000 m, mark the skyline of NW Tuscany in close proximity to the Tyrrhenian Sea. The mountain range is located between La Spezia and Lucca and extends about 55 km in length and about 25 km in width. The main watershed runs approximately parallel to the coastline with NW-SE orientation. The territory is a protected area managed by the Regional Natural Park of Apuan Alps.

The summit part of the range mainly consists of marble and other carbonate rocks. Sharp erosion profiles shape them like true alpine peaks and they have been described as "instantly petrified stormy sea" (Repetti 1833).

On the other hand, the basal part mainly consists of Palaeozoic schists of a siliceous nature. Minor rock outcrops include serpentines, marly clays, and sandstones (Carmignani & al. 2001).

The mountain range is a barrier to western winds blowing from the sea, and the winds have to rise to pass over the peaks, where the temperature is lower. Upon cooling down, the water vapor collected over the sea, condenses and then discharges as rainfall or snowfall. For this reason, the summit area receives more rainfall than the surrounding plains, following a distinctive pattern (Rapetti & Vittorini 1994) (Fig. 1).

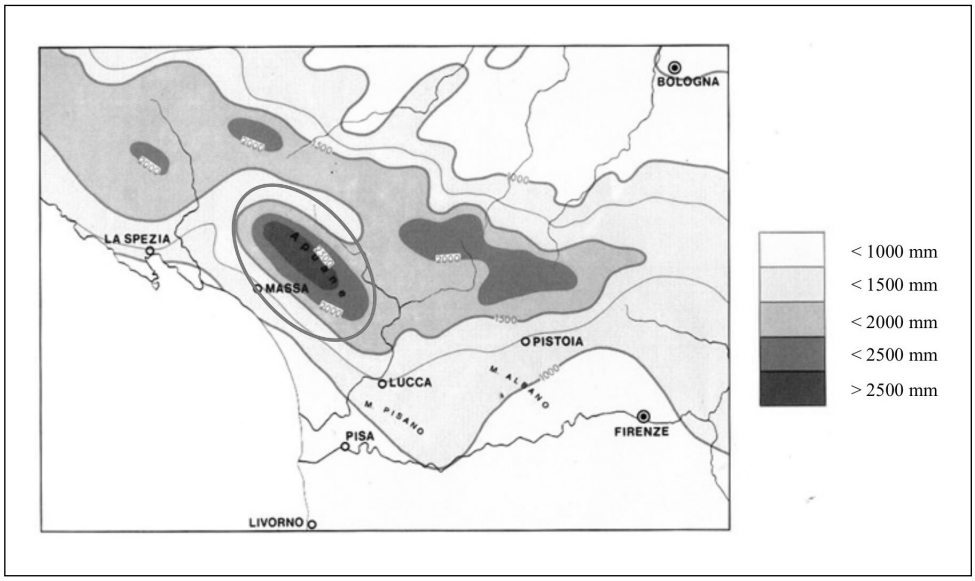

Fig. 1. Rainfall chart of N-W Tuscany. The Apuan region lies approximately within the ellipsoid.

From the climatic point of view the main watershed, parallel to the coastline, separates two main zone, the sea-side slope with higher temperatures and lower rainfall, and the inland slope where temperatures are lower and the rainfall is higher.

Another interesting feature is the presence of deep gorges carved in the sea-side slopes. At their bottom, dense shade, mild temperatures and protection from cold northerly winds determine an oceanic type climate, an outstanding feature in a Mediterranean area.

Due to the superimposition of lithologic, geomorphologic, geographic and climatic factors, combined with biogeographic history, the present Apuan flora includes a high number of taxa, which represent several floristic chorotypes that have reached the area with the migration waves preceding and following the glaciations.

The total of 1672 floristic units are reported for the area, with a high proportion of Eurasiatic elements (29%) followed by Eurimediterranean (18%), Arctic-alpine (12%), Orophytes (10%), and widely distributed units (9.5%). The endemics are about 5%, and also a small but important proportion of Atlantic species (3.5%) is present (Vaira & al. 2005).

Some Arctic-alpine and orophilous species are of special interest as microthermic relics, and demonstrate the role of this territory as a refugial area during glaciations. These taxa include *Valeriana saxatilis*, *Geranium argenteum*, *Rhododendron ferrugineum* (Ansaldi & al. 2004), *Menyanthes trifoliata*, *Eriophorum latifolium*, *Hutchinsia alpina*, *Homogyne alpina*, *Huperzia selago*, *Empetrum nigrum*, *E. hermaphroditum*, *Daphne alpina* subsp. *alpina* and *Horminum pyrenaicum*. Most of these reach the southern limit of their range in the Apuan Alps and in the Tuscan-Aemilian Apennine (Ferrarini 1970).

Deep gorges with an oceanic climate are refugial localities for Atlantic species such as *Hymenophyllum tunbrigense*, *Vandenboschia speciosa*, *Anagallis tenella* and *Euphorbia*

hyberna subsp. *insularis*, some of which grow here at the eastern border of their ranges (Ferrarini 1970a, 1977; Tomei & al. 1985; Marchetti 2004).

The endemic species prefer the summit area of the massif. If only the summit flora is considered, the percentage of endemism rises to 10.1% (Tomaselli & Agostini 1994). Some endemic species, like *Globularia incanescens* and *Salix crataegifolia*, are of palaeogenic origin. Other endemics have been categorized by Bechi & al. (1996) as patroendemics (*Polygala carueliana*, *Athamanta cortiana*), schizoendemics (*Astrantia pauciflora* subsp. *pauciflora*, *Buphthalmum salicifolium* subsp. *flexile*, *Carex ferruginea* subsp. *macrostachys*, *Carum appuanun* subsp. *appuanum*, *Leontodon anomalus*, *Moltkia suffruticosa*, *Santolina leucantha*, *Silene lanuginosa*, *Biscutella apuana*), apoendemics (*Galium palaeoitalicum*, *Artemisia nitida*, *Festuca apuanica*), while some are of uncertain linkage (*Centaurea montis-borlae*, *Cerastium apuanum*, *Rhamnus glaucophylla*, *Thesium sommieri*).

From the Apuan flora 105 species are listed in the RLT - Red List for Tuscany (Conti & al. 1997; Vaira & al. 2005). They have been designated as priority species for conservation projects in a Memorandum of Understanding (MoU) signed by the Department of Botanical Sciences of Pisa and the Apuan Alps Regional Natural Park. The goals set by the MoU include: (1) inventory and monitoring of populations of the priority species growing in the Park, (2) assessment of the risk category according to the IUCN criteria (IUCN 2001), (3) identification of risk factors for plant population, (4) *ex situ* conservation in the Pisa Botanic Garden seed bank, one of the nodes of RIBES Network (Rete Italiana Banche germoplasma per la conservazione Ex Situ), and (5) scientific research on reproductive biology. The present paper is a report on the first group of plants studied within the framework of the MoU (Tab. 1).

Materials and methods

The studied species were mainly selected from the RLT species growing in the Park. In agreement with the members of the Park Board, we were focused on: 2 of 3 CR species, 4 of 32 VU species, and on 2 strictly endemic species not included in the Red List (Tab. 1).

Their range was first checked from literature (Ansaldi & Bartelletti 1996; Ansaldi & al. 1994; Arrigoni 1956; Arrigoni & al. 1977; Baroni 1908; Bartelletti & al. 1996; Bazzichelli 1963; Bechi 1992; Bechi & al. 1996; Bertoloni 1819, 1833-1854; Bolzon 1894-1895; Caruel 1860; Garbari & Del Carratore 1993; Del Prete 1976; Del Prete & Miceli 1981; Del Prete & Tomaselli 1981; De Maria 1988; Ferrarini 1964, 1966, 1967, 1972, 2001; Ferrarini & Marchetti 1978, 1994; Ferrarini & al. 1997; Ferrarini & Rolla 1977; Fiori 1923-1929; Foggi & Rossi 1996; Lombardi & al. 1998; Marchetti 1973-1974, 1983; Moggi & al. 1987; Pacifico & al. 1996, 2000; Parlatore 1848-1896; Pellegrini 1942; Pichi Sermolli 1970; Pignatti 1982; Signorini 1993; Simi 1851; Soldano 1978, 1978a, 1984; Tutin & al. 1964-1980; Uncini Manganelli & Tomei 1996) and from herbarium specimens in: BOLO, GE, FI, PI, SIENA (Appendix). For each species the data were used to generate a list of known localities and a definition of potential areas, based on the ecological preferences of each species (habitat, substrate, aspect and altitude). Then a field inventory was planned to verify known localities and survey potential areas for new localities.

Table 1. Studied species.

Species	Biogeography	RLT listing (IUCN category)
Anagallis tenella	Atlantic relic	CR
Daphne alpine subsp. *alpina*	Microthermic relic	CR
Horminum pyrenaicum	Microthermic relic	VU
Biscutella cichoriifolia	Mediterranean relic	VU
Centaurea montis-borlae	Strictly endemic	VU
Rhododendron ferrugineum	Microthermic relic	VU
Biscutella apuana	Strictly endemic	---
Centaurea arachnoidea	Strictly endemic	---

We identified several sub-populations for each investigated species, following the IUCN criteria (IUCN 2001) and tagged each of them with an aluminum label bearing an identity code number. Herbarium vouchers collected from each site were deposited in PI. For each sub-population we counted single individuals or estimated their number based on the density in sample areas of 10x10 m (3-5 samples per sub-population). At each locality we recorded habitat type and substrate through direct observations, aspect by a compass, altitude by an altimeter. Notes on the whole flora were also made.

The geographic position was recorded in the field on 1:10000 maps produced by the technical services of "Regione Toscana" (CTR). For further elaborations, the geographic data were transferred to a digital map provided by the Park technical service (1:25000) by means of Arc-View GIS software (Esri). The same software was used to calculate the area of occupancy of the studied species.

Results and discussion

Anagallis tenella L. (*Primulaceae*)

Chromosome number: 2*n*=22
RLT listing: CR
Habitat: wet cliffs at road side
Altitude/substrate: 250m/siliceous
Number of Apuan populations: 1
Number of confirmed/new/not confirmed populations: 1/0/0
Area of occupancy: 20 m^2
Number of individuals: 285
Number of other localities in Tuscany: 4

This species was only reported in a single stand in the Apuan Alps near Retignano (Lucca) at an altitude of about 250 m on siliceous soil (Ferrarini & al. 1997; see also Appendix). We were able to confirm this find, limited to just 20 m^2 and to few hundred individuals. No new sites were discovered despite an intensive search in an area covering 265 ha with similar ecological conditions (Fig. 2). The site is located above a road verge, on exposed rock kept wet by a constant dripping of water, an essential element for this plant. In Tuscany such places are linked to few wetland areas close to the sea level (Di Moisè 1958; Tomei & al. 1985). During our survey the plants did not set seed.

Considering the CR status of *A. tenella* (Conti & al. 1997), we emphasize (Vaira & al. 2005) the need for the Park to provide adequate protection for this site, particularly against mowing of the road verge immediately beneath the population, done once a year, and against any capture of the water source above.

The species is considered an Atlantic relic in Italy. The Apuan locality represents the only population significantly above the sea level and demonstrates the role played by this massif as a refugial area during cool stages of interglacial periods.

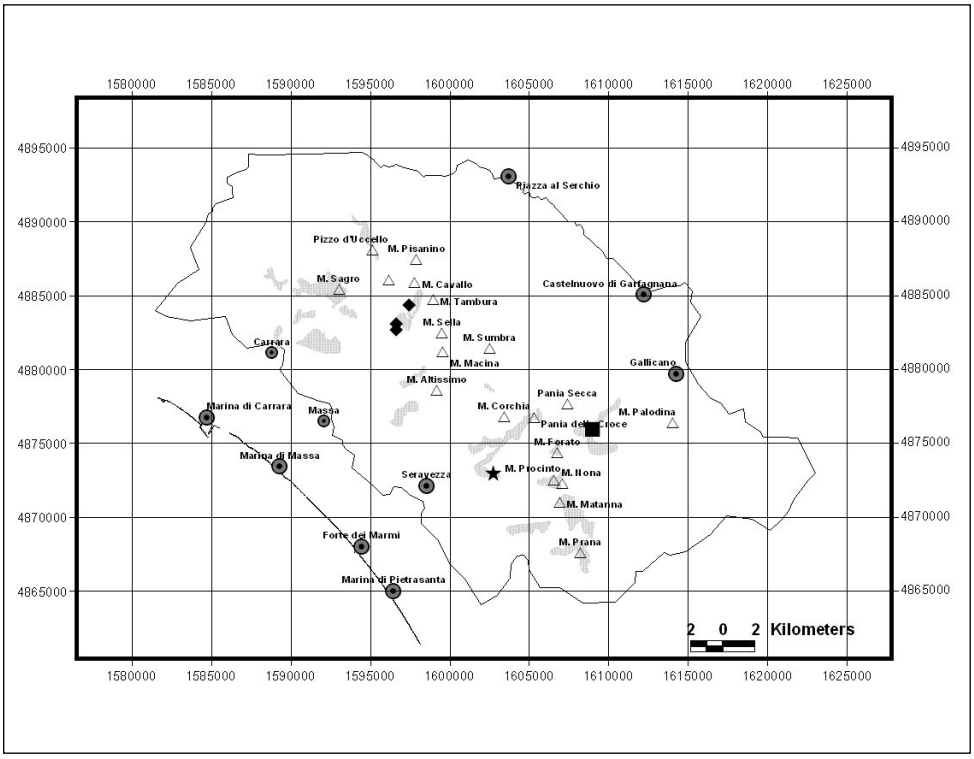

Fig. 2. Verified localities in the Apuan Alps of *Anagallis tenella* (★), *Horminum pyrenaicum* (◆), and *Rhododendron ferrugineum*(■). The shaded parts represent the studied area; the geographic grid refers to the Gauss Boaga (ROMA40) projection system.

Daphne alpina L. subsp. *alpina* (*Thymelaeaceae*)

Chromosome number: 2*n*=36
RLT listing: CR
Habitat: cliffs, screes
Altitude/substrate: 800-1300 m/calcareous
Number of Apuan populations: 33
Number of confirmed/new/not confirmed populations: 8/25/3
Area of occupancy: 437813 m^2
Number of individuals: 608
Number of other localities in Tuscany: 3

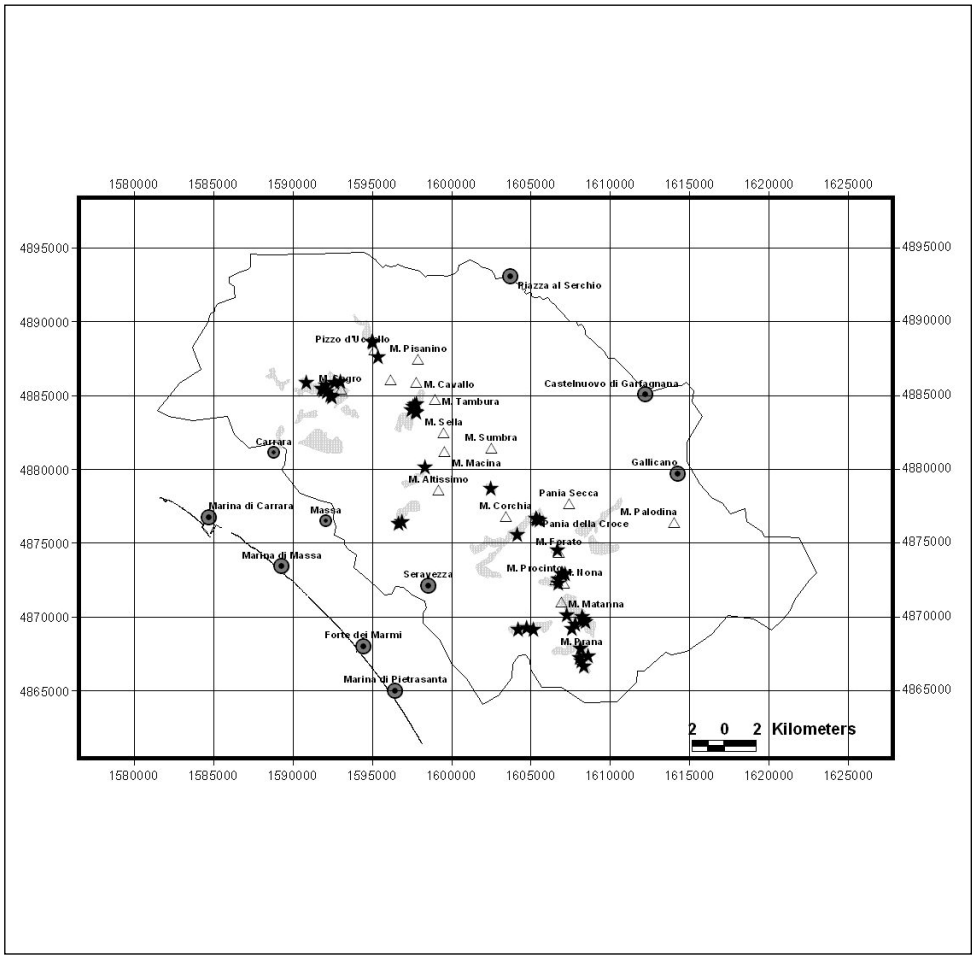

Fig. 3. Verified localities in the Apuan Alps of *Daphne alpina* subsp. *alpina* (★). The shaded parts represent the studied area; the geographic grid refers to the Gauss Boaga (ROMA40) projection system.

In Italy this taxon is mainly distributed in the Alps, with a few populations possibly reaching as far south as Central Apennine (Pignatti 1982). It has been reported in the central and southern part of the Apuan Alps, slightly below the summit area, on calcareous substrate by other authors (Caruel 1860; Pellegrini 1942; Urbani 1992; Ferrarini & al. 1997).

However, its distribution and in fact its presence in the Apuan Alps has been questioned by Pignatti (1982), who pointed out a possible confusion with closely related *D. oleoides*, in partial agreement with Ferrarini & al. (1997). We were able to confirm most reported stations, find many new ones and describe diagnostic characters that help distinguish the two taxa. In *D. alpina* subsp. *alpina* the leaves are in terminal whorls, deciduous, with rounded apex hairy below, and the bark of terminal branches is grey and fissured. On the contrary, in *D. oleoides* younger leaves are in terminal whorls, the older set arranged spirally, the leaves are persistent, shortly mucronate, glabrous on both surfaces, and the bark of terminal branches is reddish, shiny, with pronounced leaf scars.

The species occupies a wide area of its potential range. It can be found nearly everywhere where calcareous cliffs or screes occur between 800 and 1300 m asl (Fig. 3). Nevertheless, we never observed dense stands but rather single individuals or very small groups of 3 or 4 plants, resulting in a very low total number of individuals for the studied area. Fruit production is abundant, but only a few fruits reach maturity, as many are shed during ripening.

Horminum pyrenaicum L. (*Labiatae*)

Chromosome number: 2*n*=12
RLT listing: VU
Habitat: Grasslands, pastures
Altitude/substrate: 1000-1600/calcareous
Number of Apuan populations: 3
Number of confirmed/new/not confirmed populations: 3/0/1
Area of occupancy: 24177 m^2
Number of individuals: 35770
Number of other localities in Tuscany: none

In Italy this species is common in the Alps. The Apuan Alps represent its only locality in Tuscany (Pignatti 1982) and the southern border of its range. It has been reported for few localities grouped in the central part of the massif, in grasslands and pastures on calcareous substrate between 1000 and 1600 m asl (Ferrarini & al. 1997). We were able to confirm 3 of 4 reported localities (Fig. 2). At two sites the population density is around 180 individuals/100 m^2, while at the remaining site only 23 isolated plants are present in an area of 4246 m^2. The plants did not flower during the survey campaign. A CR IUCN category has recently been proposed for it (Vaira & al. 2005) in replacement of VU (Conti & al. 1997).

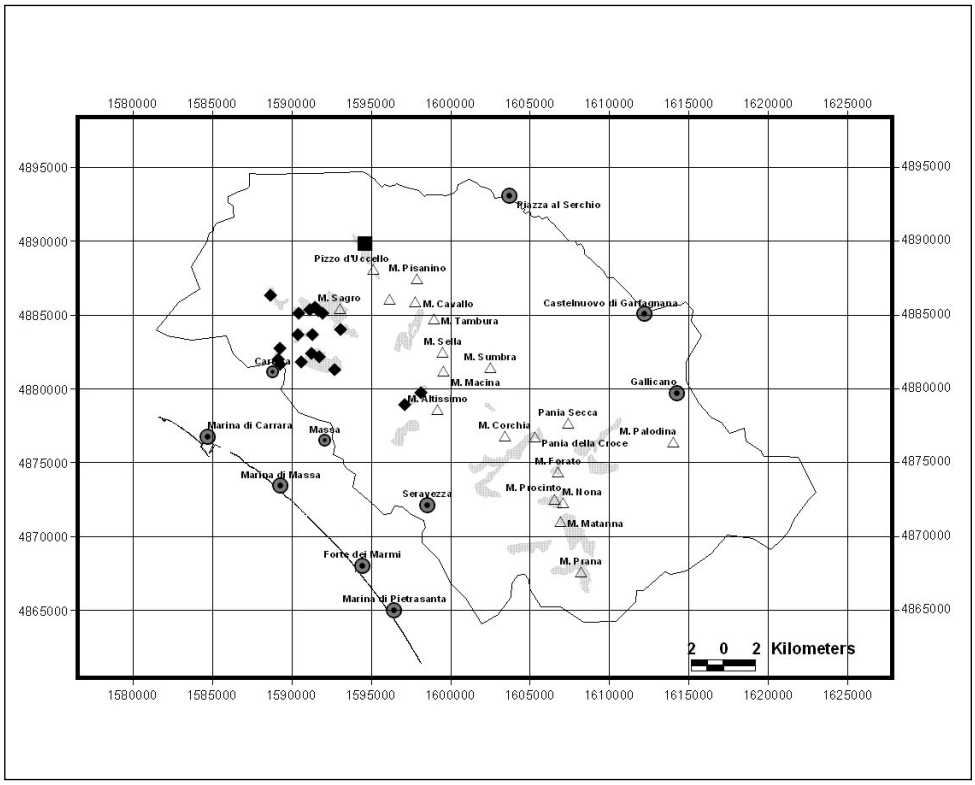

Fig. 4. Verified localities in the Apuan Alps of *Biscutella cichoriifolia* (■) and *Centaurea arachnoidea* (◆). The shaded parts represent the studied area; the geographic grid refers to the Gauss Boaga (ROMA40) projection system.

Biscutella cichoriifolia Loisel. (*Cruciferae*)

Chromosome number: 2*n*=16
RLT listing: VU
Habitat: garrigue
Altitude/substrate: 750 m
Number of Apuan populations: 1
Number of confirmed/new/not confirmed populations: 0/1/4
Area of occupancy: 3484 m^2
Number of individuals: 11
Number of other localities in Tuscany: 3

This species has a restricted distribution in Tuscany and has been reported in three localities apart from the Apuan Alps (Raffaelli 1992). Two localities have been reported in the central Apuan Alps (Ferrarini & Marchetti 1994) and two additional localities were recorded on herbarium specimens (see Appendix). We did not find the plant at any of these sites.

However, we quite unexpectedly discovered a new site with only 11 individuals in the northern part of the massif, within the extremely disturbed environment of an active marble quarry (Fig. 4).

Centaurea montis-borlae Soldano (*Compositae*)

Chromosome number: 2*n*=88
RLT listing: VU
Habitat: cliffs, platforms of Mt. Borla and adjacent places
Altitude/substrate: 1100-1400 m/marble
Number of Apuan populations: 2
Number of confirmed/new/not confirmed populations: 2/0/1
Area of occupancy: 153115 m^2
Number of individuals: 73361
Number of other localities in Tuscany: none

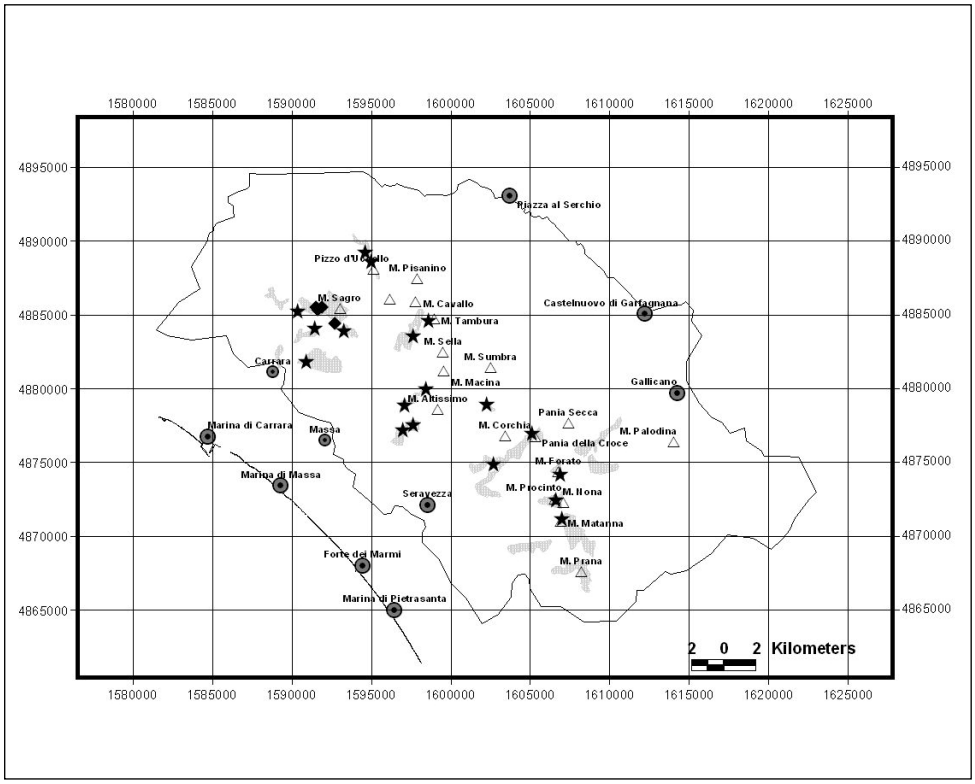

Fig. 5. Verified localities in the Apuan Alps of *Biscutella apuana* (★) and *Centaurea montis-borlae* (◆). The shaded parts represent the studied area; the geographic grid refers to the Gauss Boaga (ROMA40) projection system.

This endemic species was described by Soldano (1978), for the south-facing slopes of Mt. Borla in the northern part of the massif, where it grows on marble platforms and cliffs from 1100 to 1400 m asl. We confirmed this locality and other localities reported by Ferrarini (2001) except one ("Poggio della Signora", see Appendix). We were unable to check one located on a nearly vertical slope of friable rock ("spigolo E del Monte Sagro"). At all localities the substrate is compact marble, as defined in Carmignani & al. (2001). We did not observe the species on any other type of calcareous substrates or on marble screes, although it must be stressed that the unchecked station of Mt. Sagro is constituted by cherty limestone. We speculate that this plant might grow on the carbonate layers, very similar to marble, of this metamorphic formation. The plant grows in sparse clusters of about 50 individuals/100 m^2 and the density is rather homogeneous all over the area of occupancy except for a single individual recorded between Foce della Faggiola and Monte Maggiore. Observed seed production per individual is low and preliminary tests showed low germination rates. Cypselas badly damaged by larvae were also recorded (M. Boracchia, *pers. com.*). Further studies are in progress to clarify these aspects of reproductive biology. The habitat is heavily used for marble quarrying. As noted for other species, also *Centaurea montis-borlae* does not fully cover the potential area of marble outcrops with south-facing slopes. We checked 410 ha of such habitat on the slopes of Mt. Borla alone without finding the plant (Fig. 5). We wish to stress again that the origin of this polyploid endemic is not yet clear (Bechi & al. 1996).

Rhododendron ferrugineum L. (*Ericaceae*)

Chromosome number: 2*n*=26
RLT listing: VU
Habitat: rocks
Altitude/substrate: 500 m/siliceous
Number of Apuan populations: 1
Number of confirmed/new/not confirmed populations: 0/1/0
Area of occupancy: 250 m^2
Number of individuals: 40
Number of other localities in Tuscany: 1

In Italy, this species is common on the whole Alpine chain where it grows in heaths and highland grasslands on siliceous substrates, up to about 2300 m asl (Pignatti 1982). It is rare in the Tuscan-Aemilian Apennine, where it is mainly distributed in the Aemilian slope, except for one population at Monte Vecchio – Bocca di Scala. Its presence in Tuscany is generally interpreted as a microthermic relic (Ferrarini 1973, 1974, 1979, 1982).

The species was not known for the Apuan Alps until recently (Ansaldi & al. 2004). A very small population was found in a deep gorge, at an altitude of 500 m., under conditions similar to those of prealpine zones with an oceanic climate (Fig. 2). The population lives on a steep slope of siliceous substrate, surrounded by a mesophilous wood and partially shaded by tree canopies. This habitat sharply contrasts with that of the Apennine populations, which thrive at much higher altitudes near summits in open heaths and in full sunlight. Plant habit is also different, particularly as regards the longer internodes. Another difference concerns the low density of the stand. The population is composed of about 40

individuals, with an average density of 16 individuals/100 m^2 and does not form a continuous cover like the Apennine. Further studies are in progress to ascertain the presence of *Rhododendron ferrugineum* in other places of the massif and to clarify morphological and anatomical features.

Biscutella apuana Raffaelli (*Cruciferae*)

Chromosome number: 2*n*=18
RLT listing: –
Habitat: grasslands, screes
Altitude/substrate: 300-1300 m/calcareous
Number of Apuan populations: 12
Number of confirmed/new/not confirmed populations: 7/5/6
Area of occupancy: 300360 m^2
Number of individuals: 40013
Number of other localities in Tuscany: none

The species was described by Raffaelli & Fiesoli (1993) who isolated it from the Apuan *Biscutella* populations previously identified as *B. laevigata* s. l. For this reason, we also checked literature records and herbarium specimens of *B. laevigata*.

B. apuana can be easily distinguished from *B. laevigata* of the presence of 2-4 stem leaves (lacking in *B. laevigata*) and hairy/papillose siliculas (glabrous in *B. laevigata*).

This plant has been reported for the whole territory, at altitudes ranging from 300 to 1300 m asl in grasslands and screes on calcareous substrates (Ferrarini & Marchetti 1994). In our field survey, 6 localities were not confirmed, but 5 new stations were found on the same substrate and in the same habitat type. All new localities are near active marble quarries. Four of the new localities lie in the northern part of the territory and one in the central area (Fig. 4).

Most observed populations vary in density from 1 to 47 individuals/100 m^2, but single, isolated individuals have also been observed. There are wide gaps between sub-populations where the substrate and the habitat type are suitable for the plant.

Due to its recent taxonomic recognizing from the *Biscutella laevigata* complex, *B. apuana* was not included in the Regional Red List for Tuscany (Conti & al. 1997). Its conservation status was assessed as VU in a later study (Vaira & al. 2005).

Centaurea arachnoidea Viv. (*Compositae*)

Chromosome number: 2*n*=18
RLT listing: –
Habitat: discontinuous grassland on compact rock and fine-grained debris
Altitude/substrate: 300-1300 m/calcareous
Number of Apuan populations: 16
Number of confirmed/new/not confirmed populations: 6/10/2
Area of occupancy: 192546 m^2
Number of individuals: 40423
Number of other localities in Tuscany: none

This plant is an Apuan endemic. Reports of other stations in Tuscany and in Latium (Ferrarini 2001) are not supported by herbarium specimens.

Most of the reported localities (Ferrarini 2001) were confirmed during our field survey and a good number of potential areas in the northwestern part of the territory turned out to be new localities (Fig. 5). *C. arachnoidea* grows in discontinuous grasslands on compact rock and fine-grained debris on calcareous substrate mainly of metamorphic origin. Many populations live at the edge of active quarries. Average density is 21 individuals/100 m^2, but many isolated individuals exist.

We observed many vital cypselas per individual, and preliminary tests showed a high germination rate (G. Bedini, *unpubl.*).

Judged from its extremely restricted area and small population size, the threat category of *Centaurea arachnoidea* has been assessed as VU (Vaira & al. 2005).

Conclusions

GIS treatment of the survey data provided a reliable estimate of population size, both as to the area and the number of individuals, and allowed an accurate assessment of risk categories.

The eight species studied showed different behavior regarding population size, and colonization of suitable habitats.

A first group of four species (*Anagallis tenella*, *Biscutella cichoriifolia*, *Daphne alpina* subsp. *alpina*, *Rhododendron ferrugineum*) live in the Apuan Alps with very small populations (11-608 individuals). These populations are generally considered relics of past distribution patterns. Except for *Daphne alpina* subsp. *alpina*, we observed that they occupy a tiny portion of the suitable habitat. However, we cannot currently give precise measurements, due to the lack of digital cartographic data allowing an accurate estimate of the distribution of ecological data (substrate, altitude, aspect, habitat type). For example, *Anagallis tenella* is missing from an area of 265 ha where we have directly observed, *in situ*, that conditions are similar to those of the single extant Apuan stand.

Three species have a higher number of individuals (40000-70000) and are distributed in larger areas of the territory, albeit none appears to fully cover its potential range. Again, this conclusion is supported by personal observations rather than an instrumental measurement. For example, *Centaurea montis-borlae* is missing from an area of 410 ha of Mt. Borla, where ecological conditions seem suitable for its growth. Obviously, other factors play an important role in shaping the range of a species. Low seed production and poor seed germination success might account for the inability of *Centaurea montis-borlae* to colonize adjacent areas. Thus, we have started reproductive biology studies on *C. montis-borlae* to clarify distribution patterns.

It is striking that the smallest number of individuals is associated to relic species, reinforcing the bio-geographic interpretation that small populations are the remains of a much larger past range. These small populations cannot expand their range again because they lack specific morpho-physiological adaptations to survive outside of their micro-environment. Endemic species that have evolved within the area as a result of speciation processes are fitter to the general climatic and ecological conditions of the area and appear to be able to colonize greater portions of the territory.

The case of *Horminum pyrenaicum* is slightly different because the number of individuals is relatively high. However, its area of occupancy is one order of magnitude smaller than that of endemic species, in accordance with its relic status. It seems, therefore, that the relic situation is characterized either by a low number of individuals or a restricted area of occupancy.

This study indicates that there may be differences between the potential and actual distribution of the studied species and that predictive distribution models based on habitat type, altitude, aspect and substrate should be checked in the field. A correlation can be inferred between bio-geographic type and the ratio area of occupancy/potential distribution, but with species-specific adjustments. Nevertheless, the ability to map ecological factors, leading to a definition of potential distributions for plant taxa, provides a baseline against which field data can be referred. Furthermore, a more detailed, quantitative analysis of the distribution of ecological factors in the territory would allow a stricter correlation between potential and actual distribution of plants. The discrepancy between potential and actual distribution may be due to the impact of human activity in the area, which has been going on for several centuries (marble quarries, wood cutting, sheep raising and periodical wood and pasture fires set as a misunderstood land management method by shepherds). In order to clarify this matter, we are planning further studies in the area as new digital thematic maps are available, allowing quantitative measurements of the distribution of ecological factors.

Appendix

Specimens seen: label information is given in a short form, the full information is available from the authors upon request.

Anagallis tenella: Tra Retignano e la Risvolta, 23.VII.1982, *Marchetti* (SIENA).

Biscutella apuana (many specimens are reported as *B. laevigata*): Forno,1903, *Bicknell* (GE); Alpi Apuane, Orto botanico di Pian della Fioba, 1984, *Bassani* (SIENA); A q.300 m, tra Miseglia e Ponti di Vara, 1978, *Marchetti* (SIENA); A q. 300 m, Forno, 1977, *Marchetti* (SIENA); Alpi Apuane a Fatonero, 1869, *Cocchi* (FI); Tra Levigliani e vetta del M. Pania della Croce, 800-1858 m, 1950, *Pichi Sermolli*, *Bavazzano*, *Contardo* (FI); Pania della Croce, *Raffaelli* (PI); Nei pressi della galleria Valsola, 900 m, 1988, *Raffaelli*, *Fiorini*, *Fiesoli* (FI); Tra Isola Santa e Arni, 1987, *Raffaelli* (FI); Alpi Apuane, Nei pressi della galleria del Passo del Vestito, 1987, *Raffaelli et al*. (FI); Tra Isola Santa e Arni, 1987, *Raffaelli et al*. (FI); Dintorni di Campocecina, 1969, *Moggi et al*. (FI); Da Campocecina alla vetta del M. Sagro, 1969, Moggi et al. (FI); Tra Isola Santa e Arni, 1987, *Raffaelli et al*. (FI); Canal Cerignano, Borra, nei pressi della funicolare, 1957, *Beruti* (FI); Castelnuovo Garfagnana, Tra Isola Santa e Camporgiano, 1988, *Raffaelli*. (FI); Nei pressi della galleria Valsola lungo la strada di Pian della Fioba, 1988, *Raffaelli* (FI); Tra Pian della Fioba e il Passo del Vestito, 1987, *Raffaelli* (FI); Boschi radi e rocce della valle di Arni, Substrato calcareo, 1989, *Raffaelli* (FI); Sopra la galleria del Passo del Vestito (FI); Pania, Alpi Apuane, In pascuis saxosis (prati della Pania), 1893, *Sommier* (FI); Rupi delle parti elevate della Pania della Croce Alpi Apuane,1891, *Martelli* (FI); Alpi Apuane alla Pania della Croce presso la vetta, 1891, *Martelli* (FI); Pania della Croce sopra Mosceta, 1891, *Martelli*

(FI); Toscana: Monte Matanna e M. Procinto, 1934, *Chiarugi* (FI); Lungo il Carrione sopra Carrara, 1891, *Fantozzi* (FI); Pania alla Croce, 1958, *Lanza* (FI); Prope pagum Forno, loco C. Biforco dicto, alt. 200-300 m. - 1924, *Fiori* (FI); Monte Garnerone, 1964, *Ferrarini* (FI); Legi in Apuanis, 1830, *Fiori* (FI); Legi in Apuanis, 1922, Fiori (FI); Alpi Apuane, Tambura, 1897, *Targ.-Tozz*. (FI); Alpi Apuane, Altissimo, 1897, *Targ.-Tozz*. (FI); Alpi Apuane, Tambura, 1897, *Targ.-Tozz*. (FI); Passo del Vestito, Galleria del Cipollaio, 1953, *Corradi* (FI); Altissimo, versante settentrionale, 1951, *Pichi* (FI); Carrara, *Bolzon* (FI); 1922, *Fiori* (FI); vertice della Pania, Torrente del Ponchio nell'Alpe di Terrinca, M. Altissimo, Corchia, 1869, *Simi* (FI); Colonnata (FI); Resceto, 1862, *Beccari* (FI); Cave di Ravaccione, 1913, *Savelli* (FI); Sorgenti del Frigido, 1863, *Beccari* (FI); Minucciano, Vinca (Pisanino), 1891, *Sommier* (FI); Resceto, 1862, *Beccari* (FI); Forno (MS), 1924, *Fiori* (FI); Tambura, 1857, *Grilli* (FI); Tambura, 1881, *Martelli* (FI); Valle della Turrite Secca, Grotta Giancona, 1955, *Padula* (FI); Forno, 1924, *Fiori* (FI); Sul Pisanino Alpi Apuane, 1870, *Giannini* (FI); In monte Tambura, supra Resceto (Alp. Apuan.), 1825, *Levier* (FI); M.te Tambura, Alpi Apuane, 1878, *Herbarium Della Nave* (FI); Alpi Apuane a M.te Forato, 1892, *Herbarium P. Fantozzi* (FI); Rupi di Falcovaja (?) Monte Altissimo, 1857, *Erbario M. Grilli*, (FI); Alpi Apuane, a Bertoloni, Da Parlatore in Sett. 1842, *Fiori* (FI); Tambura Alpium Apuanarum, *Savi*,1841, (FI); Tambura, 1830, *Bertoloni* (BOLO); Alpi Apuane,1844, *Puccinelli* (BOLO); In Lunentium lapidicinis ubi frequens, 1806, (BOLO); Legi in Sagro, Alpi Apuanarum, 1.VII.1808, (BOLO); Legi in Tambura, Alpi Apuanarum, 1822 (BOLO); In calcareis Tambura, Inizio luglio 1843, *Savi* (BOLO); Legi in Alpi Apuanarum sopra Fornole ad levam Frigidae. 1809 (BOLO).

Biscutella cichoriifolia: Monte Matanna e Monte Procinto. *Chiarugi* (FI); Tra Levigliani e il Passo dell'Alpino, 1862 *Savi*. (PI *as B. hispida*).

Centaurea arachnoidea: Cave di Colonnata alla "Grotta Lunga". 1841. *Meneghini* (PI, *as C. rupestris*); Lunensis lapidiciniis. *Auct. ignoto* (PI, *as C. rupestris*); Pendici del M. Uccelliera, sopra Carrara, a q. 1225 m circa. Su cipollino. 7.VII.1982. *Marchetti*. (GE); In pascosis montanis etruriae. VII.1885 *Costa Reghini* (GE *as C. rupestris*); Alpi Apuane, Miseglia sopra Carrara, alt. 300 m, erboso su calcare cavernoso. 17.VII.1984. *Bassani*, *Ferrarini* (SIENA *as C. rupestris* subsp. *arachnoidea*); In rupi di calcare cavernoso, a q. 300 m, fra Miseglia e Ponti di Vara, sopra Carrara, Alpi Apuane. 28.VI.1978 *Marchetti*. (SIENA *as C. rupestris* subsp. *arachnoidea*); Lungo la strada per Campocecina a q. 1200 m, alla curva a sud nelle pedici del M. Uccelliera, sopra Carrara, Alpi Apuane. 26.VIII.1978 *Marchetti* (SIENA *as C. rupestris* subsp. *arachnoidea*); Su rupi di calcare cavernoso, a q. 300, tra Miseglia e Ponti di Vara, sopra Carrara (MS), Alpi Apuane. 21.VI.1975. *Marchetti* (SIENA *as C. rupestris* subsp. *arachnoidea*); Lungo la strada per Campocecina a q. 1200 m, alla curva a sud nelle pendici del M. Uccelliera, sopra Carrara, Alpi Apuane. 26.VIII.1978 *Marchetti* (SIENA *as C. rupestris* subsp. *arachnoidea*); Legit in lapidicinis lunensium. VIII.1841 *Cherici* (FI *as C. rupestris*); Alpi Apuane, lungo il Carrione, fra Carrara e Colonnata. 28.VII.1891. *Fantozzi* (FI *as C. rupestris)*; Luoghi rupestri attorno Carrara. 1893. *Bolzon*. Rev. Fiori 13.XII.1904 (FI *as C. rupestris*); Alpi Apuane: nelle fessure delle rupi calcaree presso le cave di Ravaccione (Carrara). 21.V.1913. *Savelli* (FI *as C. rupestris* var. *arachnoidea*) *(=* var. *subinermis*); Sulle rupi a Torano presso Carrara. VII.1901. *Vaccari* (FI *as C. rupestris*); Torrano, Lapidicinis Lunensibus, Grotta Lunga prope Colonnata (BOLO *as C. rupestris*).

Centaurea montis-borlae: Nelle fessure delle rupi di marmo, a q. 1300 m, esp. Sud, alla Foce di Pianza nelle pendici del M. Borla, Alpi Apuane. 27.VIII.1960 *Ferrarini* (SIENA); Versante meridionale del Poggio della Signora, nelle pendici del M. Spallone, a q. 1500 m circa. Gruppo del M. Sagro, sopra Carrara. Alpi Apuane. Su calcare a liste di selce. 5.IX.1983 *Marchetti* (SIENA); Foce di Pianza (gruppo del Sagro: Alpi Apuane. Alt. 1200 m; 3.VIII.1977 (Typus) *Soldano* (FI); Toscana. Massa. Fivizzano: piedi del Monte Borla alle cave Walton. m 1250. 24.VII.1977 *Soldano* (FI).

Daphne alpina subsp. *alpina*: Monte Prana sopra Camaiore, VIII.1891 *Pellegrini* (PI); Lago di Camaiore, s.d. *Puccinelli* (FI); Monte Matanna (Grotta all'Onda), 20.V.1878 *Bottini* (PI); Monte Procinto (Cintura e cima) e M. Nona (Alpe della Grotta). 1893,1895, 1896 *Sommier* (FI); 1930, 1934 *Chiarugi* (FI); Alpi Apuane, Monte Procinto, 9.VII.1934 *Chiarugi* (FI); Cintura del Procinto, Alpi Apuane, 9.VII. et 5.VIII.1893 *Sommier* (FI, *as D. mezereum*); Versilia, Alpe della Grotta e Cintura del Procinto, sotto il M. Nona (900 - 1000 m) Alpi Apuane, 21.VI.1930 *Chiarugi* (FI, *as D. olaeifolia*.); Cintura del Procinto, Alpi Apuane, 9.VII.1899 *Sommier* (FI, *as D. mezereum*); Alpi Apuane, Monte Procinto, 9.VII.1934 *Chiarugi* (FI); Cima del Procinto, Alpi Apuane, in rupibus, pauca specimina vidi, 10.VII.1893 *Sommier* (FI); Cintura del Procinto, Alpi Apuane, 5.VIII.1893 *Sommier* (FI); Cima del Procinto, Alpi Apuane, in rupibus rara, 6.VIII.1893 *Sommier* (FI); Cintura del Procinto, Alpi Apuane, 9.VII.1893 *Sommier* (FI); Cintura del Procinto, 17.IX.1896 Legit adde aliis (FI, *as Daphne*).

Horminum pyrenaicum: Sotto il Passo della Focolaccia, nel versante massese, lungo il sentiero 166, a q. 1300 circa. Pendici del M. Tambura, Alpi Apuane. Su marmo. 2.IX.1980. *Marchetti* (SIENA); Alpi Apuane. Alla Vettolina sopra Resceto m 850 valletta esp. SO su calcare a liste di selce. 2.VIII.1959. *Ferrarini* (FI); Tambura, Alpi Apuane. 1874. *Guidoni* (BOLO); Alpi Apuane. Vetullini. 16.VII.1830. *filius Joseph* (BOLO).

Rhododendron ferrugineum: Canale delle Rondini, Gallicano (Lucca), alt. 500 m. 27.VIII.2003. *Ansaldi*, *Cassettari*, *Adami* (PI).

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