XXXIV International Moor Excursion 2010
Sicily and Pantelleria

12-19 September 2010

Excursion Guide

Organizers
Camilla Caló, Elisa Vescovi, Tommaso La Mantia, Salvatore Pasta, and Willy Tinner

Institute of Plant Sciences
University of Bern
Altenbergrain 21
3013 Bern
Switzerland

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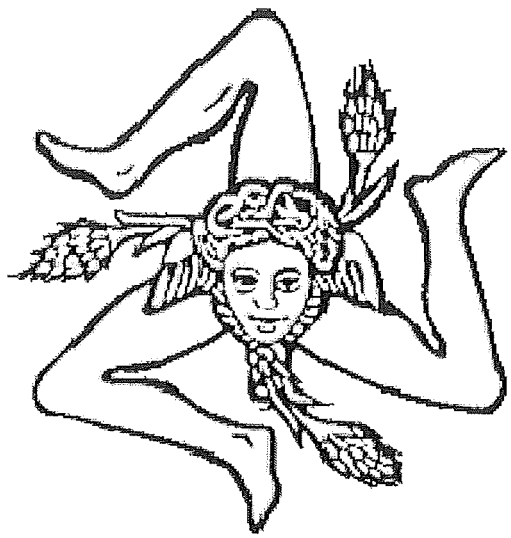

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Tel 091-6523529 fax 0916523456
Via Luigi Giannettino 4 Palermo
www.albergoathenaeum.it

13/9
Hotel Mariano Viale Risorgimento, 15 90020
Castellana Sicula (PA) 0921 642996
www.hotelmariano.net

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Park hotel la Giara Via Nazionale, 125 - 94010 Pergusa (EN)
Tel. 0935/541687Fax 0935/541521
http://www.parkhotellagiara.it/

16/9
D' Angelo Palace Hotel
Lungomare Fata Morgana (Angolo Via Michelangelo Buonaroti)
91026 Mazara del Vallo (Trapani)
http://www.dangelopalacehotel.it/

17/9
Overnight on the ferry boat from Trapani to Pantelleria

18/9
MEDITERRANEA TURISMO SRL
Lungomare Borgo Italia 71/75
Pantelleria - 91017 - TP
telefono: +39 0923911299 - fax: +39 0923912203
http://www.pantelleriahotel.it/eng/mediterraneo_hotel.htm

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PROGRAMME

Sunday, 12.9.2010
Individual arrival to Palermo (ferry, train or plain)

20.00: Albergo Athenaeum
21.00: welcome party:Circolo degli ufficiali di Palermo (Piazza S. Oliva, 25, 90141 Palermo)
Host and responsible of the day: Camilla Calo', Elisa Vescovi, Willy Tinner, Tommaso La Mantia, Salvatore Pasta

Monday, 13.9.2010

8.00: Breakfast
9.00-11.00: Trip to Bosco della Ficuzza, near Palermo: Gorgo Lungo and Gorgo Tondo di Ficuzza.
11.00-13.00: Vegetation and fire history of these upland sites (2h).
Responsible of the sites: Daniele Colombaroli, Camilla Calò
13.00-14.00 Lunch
14.00-16.00: Departure to Madonie Mountains. Gorgo Nero.
16.00-18.00: Vegetation and fire history (2h) of a mountain site.
Responsible of the site: Paul Henne
18-19.00: Travel to Castellana Sicula , Hotel Mariano.Overnight there.

Tuesday, 14.9.2010

8.00-9.00: Breakfast
9.00-10.00: Trip to the sites:
Gorgo Pollicino. Urgo di Pietra Giordano, and Marcato Cixé.
13.00-14.00 Lunch
14.00-16.00: Visiting *Abies nebrodensis* stands (2h)
Responsible of the site: Salvatore Pasta and Tommaso La Mantia.
16.00-17.00: Back to Hotel Mariano


Marcato Cixé

Wednesday 15.9.2010

8.00-9.00: Breakfast
9.00-11.00: Departure to Nebrodi Mountains:
11.00-12.00: Urio Quattrocchi.: Vegetation and fire history (1h) of a mountain site. (Responsible of the site: Daniele Colombaroli)
12.00-13.00: Lunch
13.00- 15.00: Departure to Lago Pergusa (2h)
Overnight in Enna at Parkhotel La Giara

Thursday 16.9.2010

07.00-8.00 Breakfast
8.00-10.00: Departure to Bosco Pisano
10.00-11.00: visit the *Zelkova sicula* stand (1h) Responsible of the site: Salvatore Pasta
11.00-13.00: Departure to Biviere di Gela
13.00-14.00: Lunch
14.00-15.00: Biviere di Gela. Vegetation and fire history of a coastal site with pronounced Mediterranean conditions. Responsible of the site:Willy Tinner
15.00-17.00: Departure to Agrigento
17.00-20.00: Visit to the Valley of the Temples: (UNESCO World-Heritage).
20.00-22.00: Arrival to Mazara del Vallo

Zelkova sicula

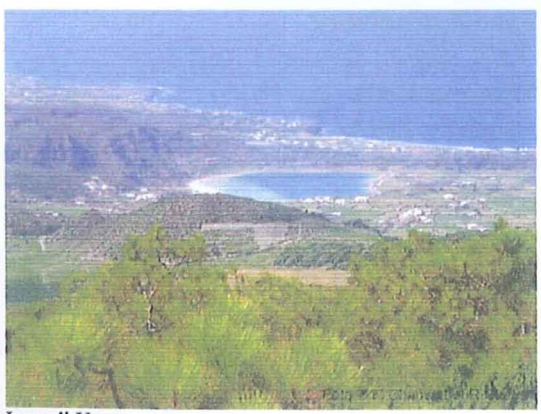
Gorgo Basso

Friday 17.9.2010

8.00: Breakfast
9.00: Gorgo Basso and Lago Preola WWF Reserve. Multiproxy studies at (partly) evergreen forested sites in coastal Sicily. Responsible of the sites: Camilla Calo' Willy Tinner, Stefania d'Angelo
15.00: Departure to Trapani,
23.00: Ferry boat to Pantelleria island

Saturday 18.9.2010
6.00 : Arrival to Pantelleria
10.00: Lago di Venere, Monte Gibele. Vegetation and fire history.
Bronze age settlement
Responsible of the day: Camilla Calo'
21.00: Farewell Party
Overnight at Pantelleria at the Mediterraneao Hotel

Sunday, 19.9.2010
Departure from Pantelleria. Return home.



Lago di Venere

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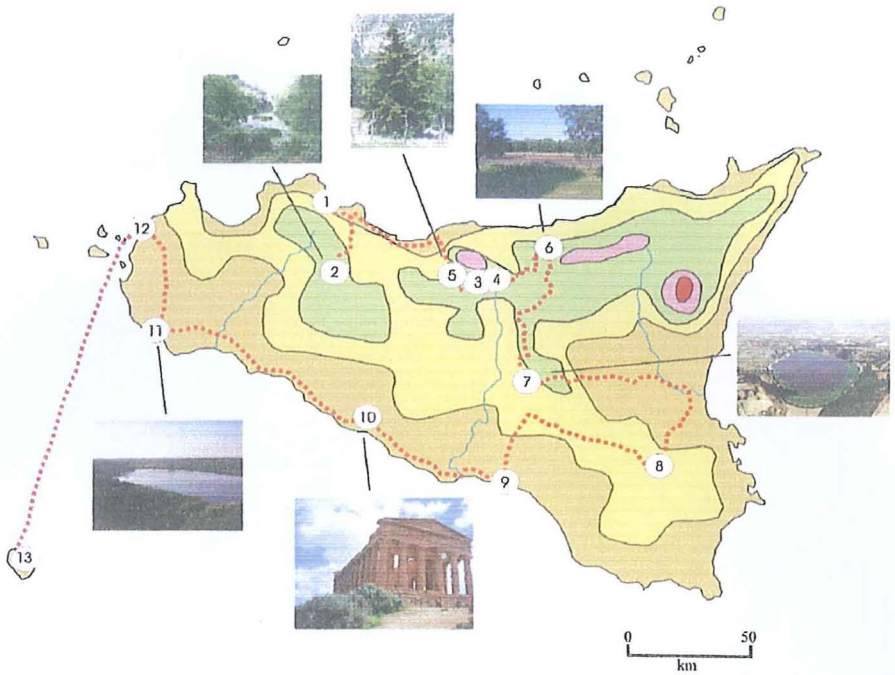
INTRODUCTION

VISITED SITES:

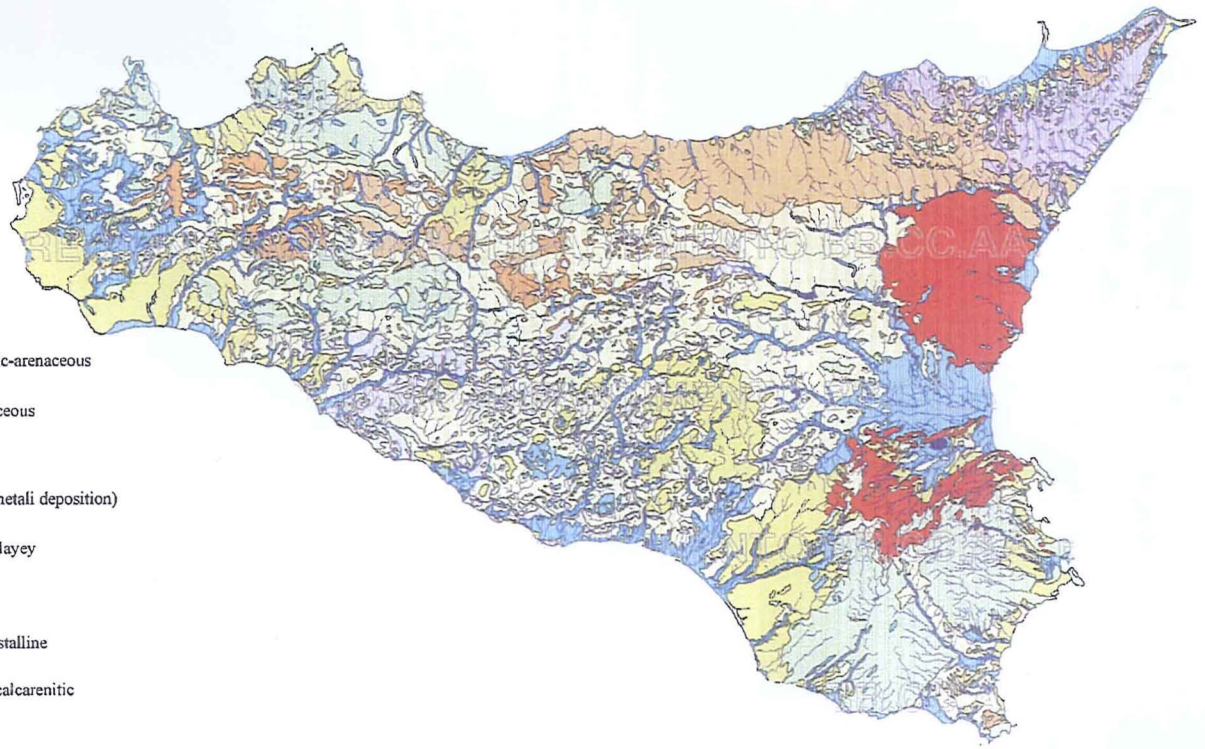


1 Palermo
2 Bosco di Ficuzza
3 Gorgo Nero
4 Gorgo Pollicino, Marcato Cixe, Urgo di Pietra Giordano
5 *Abies nebrodensis* stand
6 Urio Quattrocchi
7 Lago Pergusa
8 *Zelkova sicula* stand
9 Biviere di Gela
10 Agrigento
11 Lago Preola e Gorghi Tondi
12 Trapani
13 Lago di Venere, Pantelleria

Main (potential) vegetation formations

- Quercus ilex
- Quercus pubescens, Q.petraea, Castanea sativa
- Olea europea, Ceratonia siliqua
- Fagus silvatica, Abies alba
- Meadows, Alpine tundra

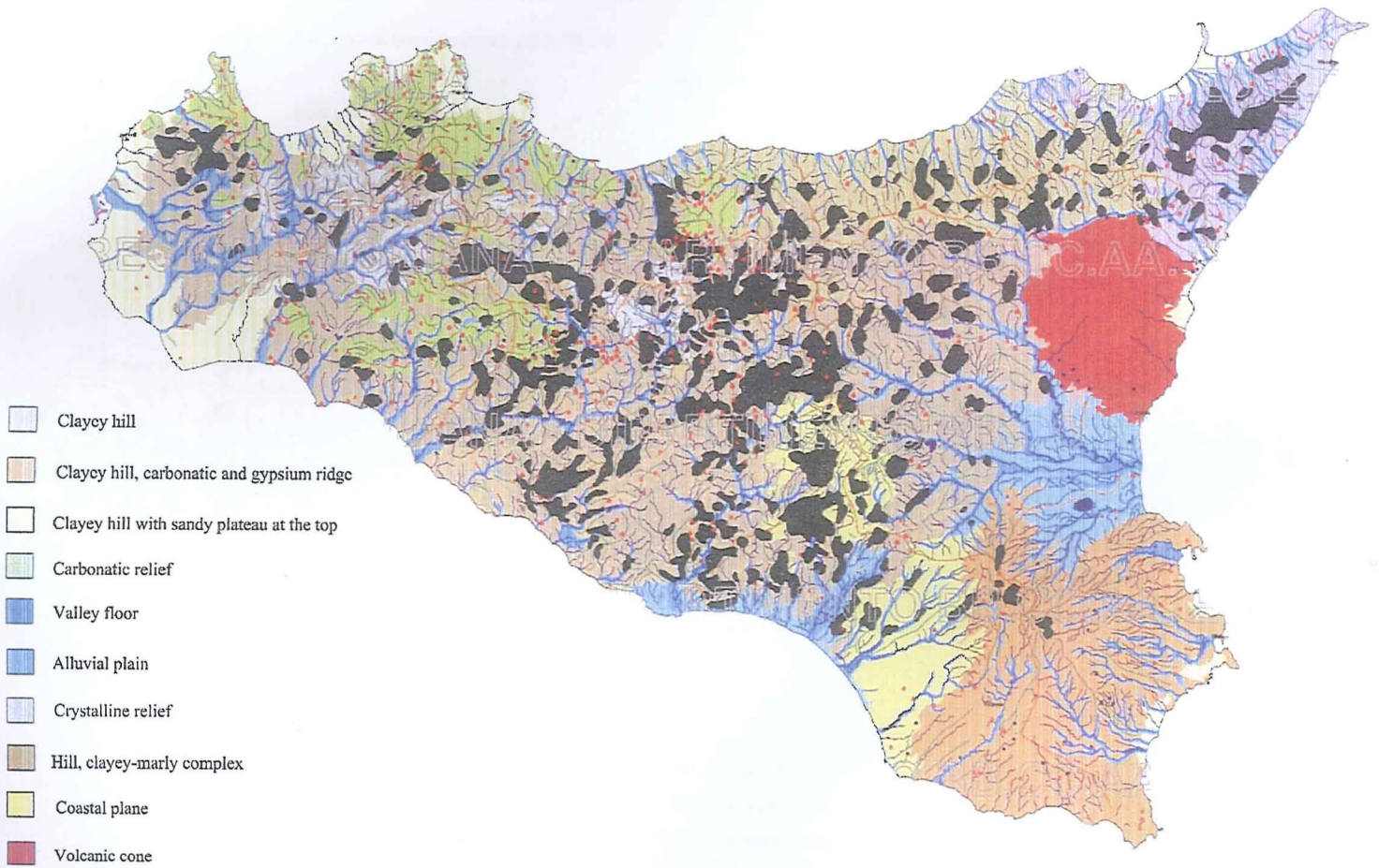
1- Lithological map



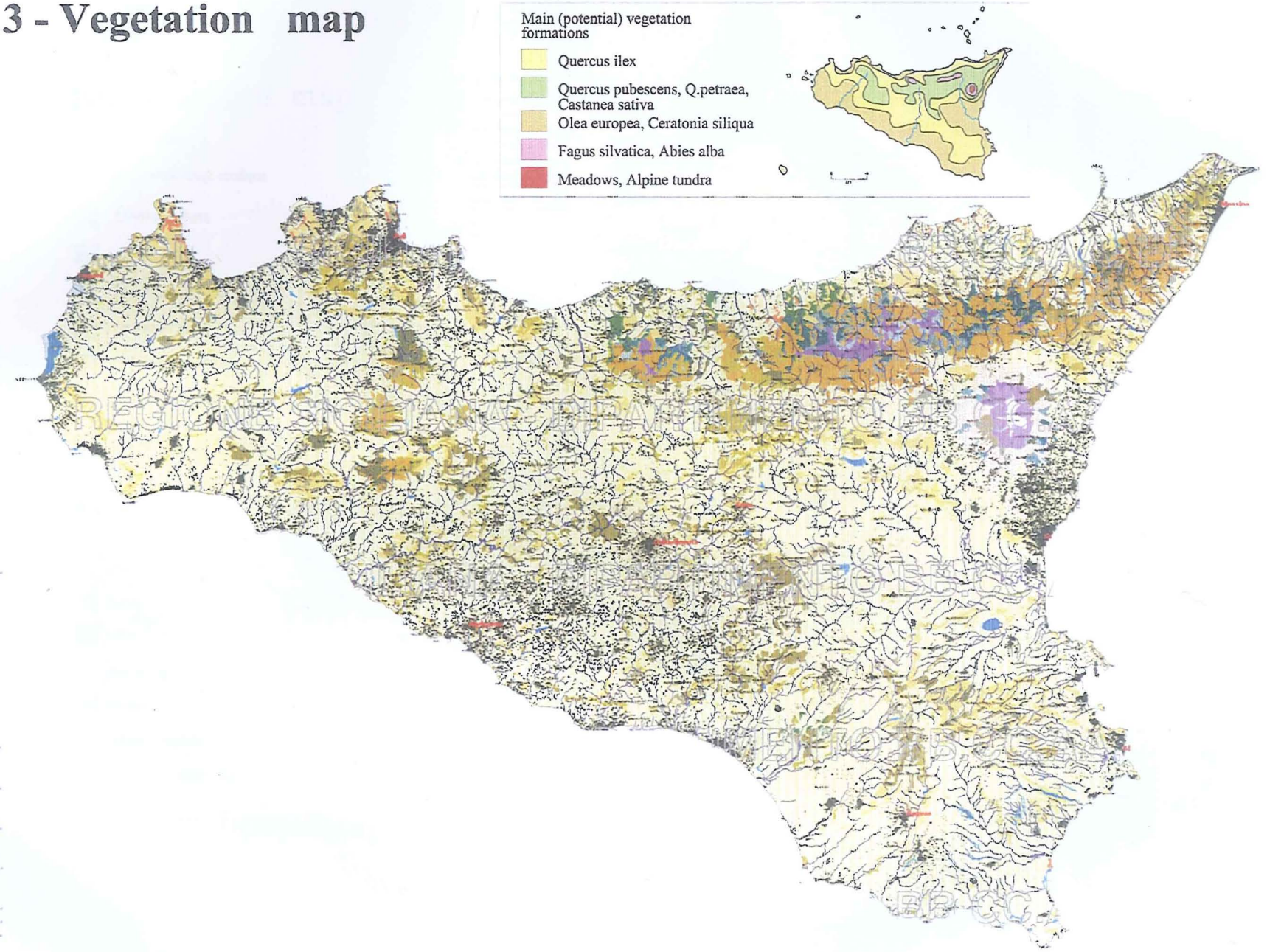
Type of rocks:

- Conglomeratic-arenaceous
- Clayey-arenaceous
- Carbonatic
- Clastic (continetali deposition)
- Arenaceous-clayey
- Evaporitic
- Schistose-crystalline
- Arenaceous-calcarenitic
- Volcanic

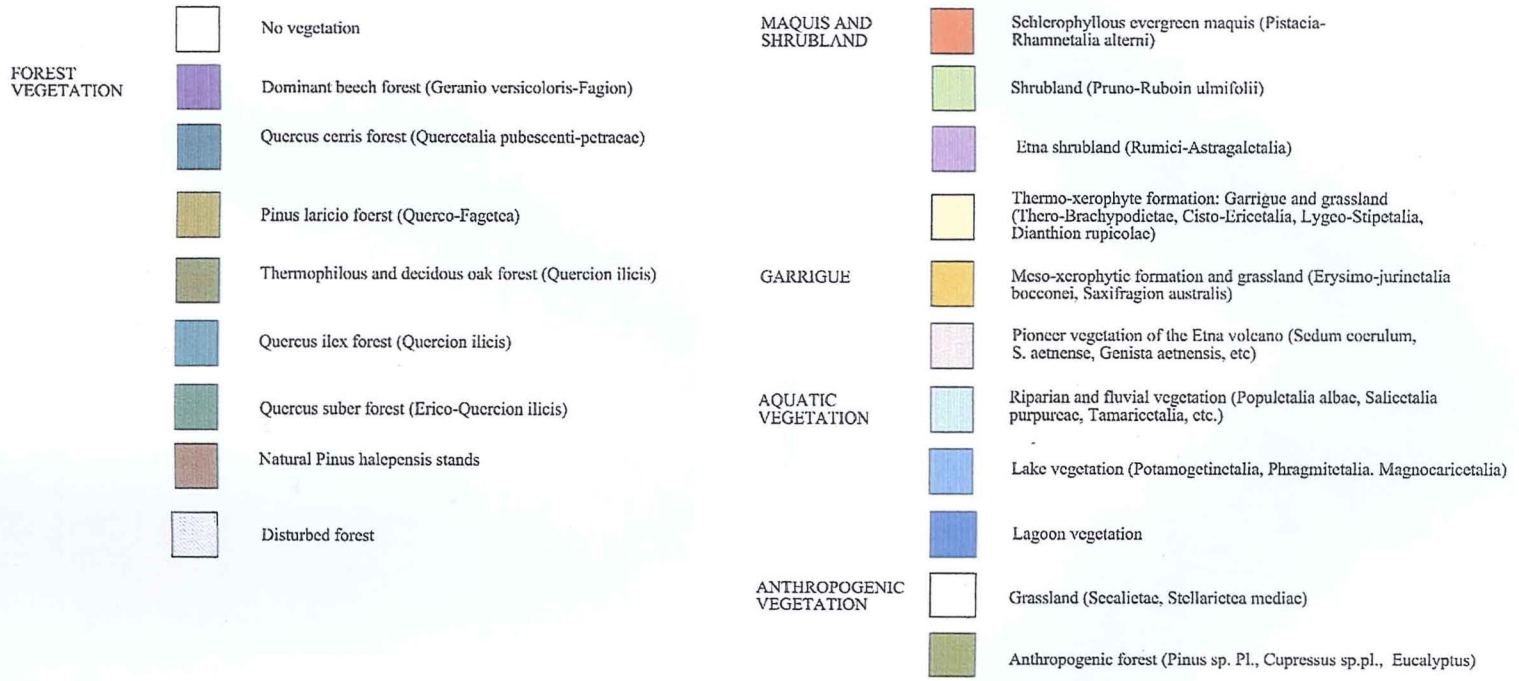
2 - Geomorphological map



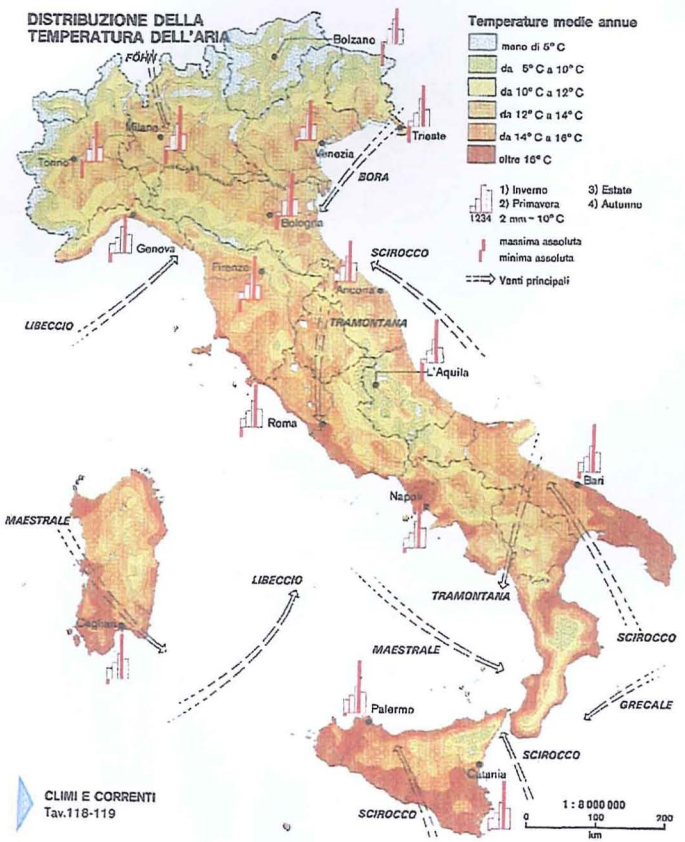
3 - Vegetation map



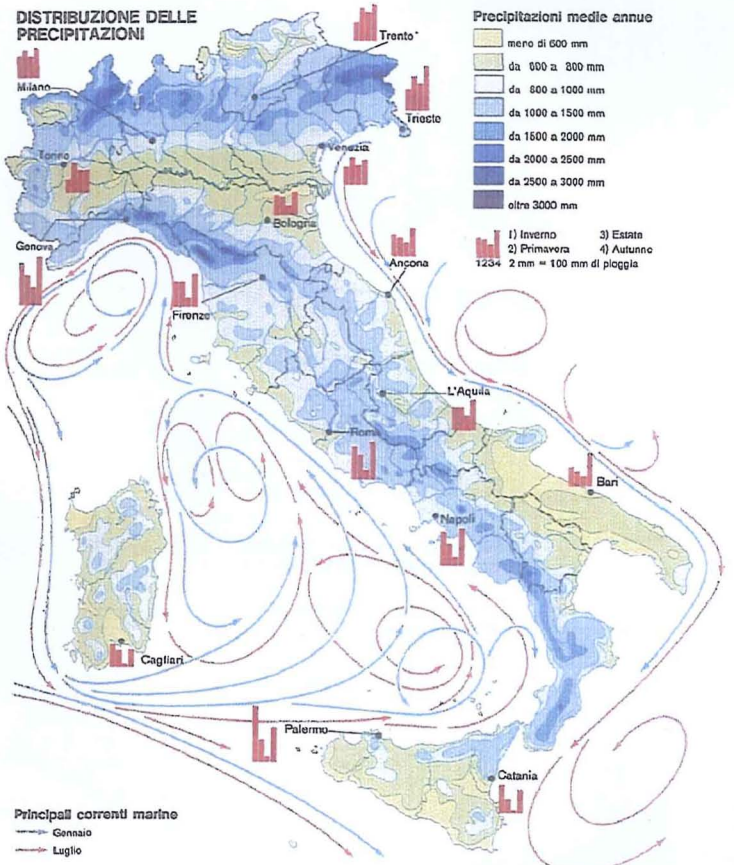
3 - LEGEND


No vegetation
FOREST VEGETATION
Dominant beech forest (Geranio versicoloris-Fagion)
Quercus cerris forest (Quercetalia pubescenti-petraeae)
Pinus laricio foerst (Querco-Fagetea)
Thermophilous and decidous oak forest (Quercion ilicis)
Quercus ilex forest (Quercion ilicis)
Quercus suber forest (Erico-Quercion ilicis)
Natural Pinus halepensis stands
Disturbed forest
MAQUIS AND SHRUBLAND
Schlerophyllous evergreen maquis (Pistacia-Rhamnetalia alterni)
Shrubland (Pruno-Ruboin ulmifolii)
Etna shrubland (Rumici-Astragaletalia)
Thermo-xerophyte formation: Garrigue and grassland (Thero-Brachypodietae, Cisto-Ericetalia, Lygeo-Stipetalia, Dianthion rupicolae)
GARRIGUE
Meso-xerophytic formation and grassland (Erysimo-jurinetalia bocconei, Saxifragion australis)
Pioneer vegetation of the Etna volcano (Sedum coerulum, S. aetnense, Genista aetnensis, etc)
AQUATIC VEGETATION
Riparian and fluvial vegetation (Populetalia albae, Salicetalia purpureae, Tamaricetalia, etc.)
Lake vegetation (Potamogetinetalia, Phragmitetalia. Magnocaricetalia)
Lagoon vegetation
ANTHROPOGENIC VEGETATION
Grassland (Secalietae, Stellarietea mediae)
Anthropogenic forest (Pinus sp. Pl., Cupressus sp.pl., Eucalyptus)

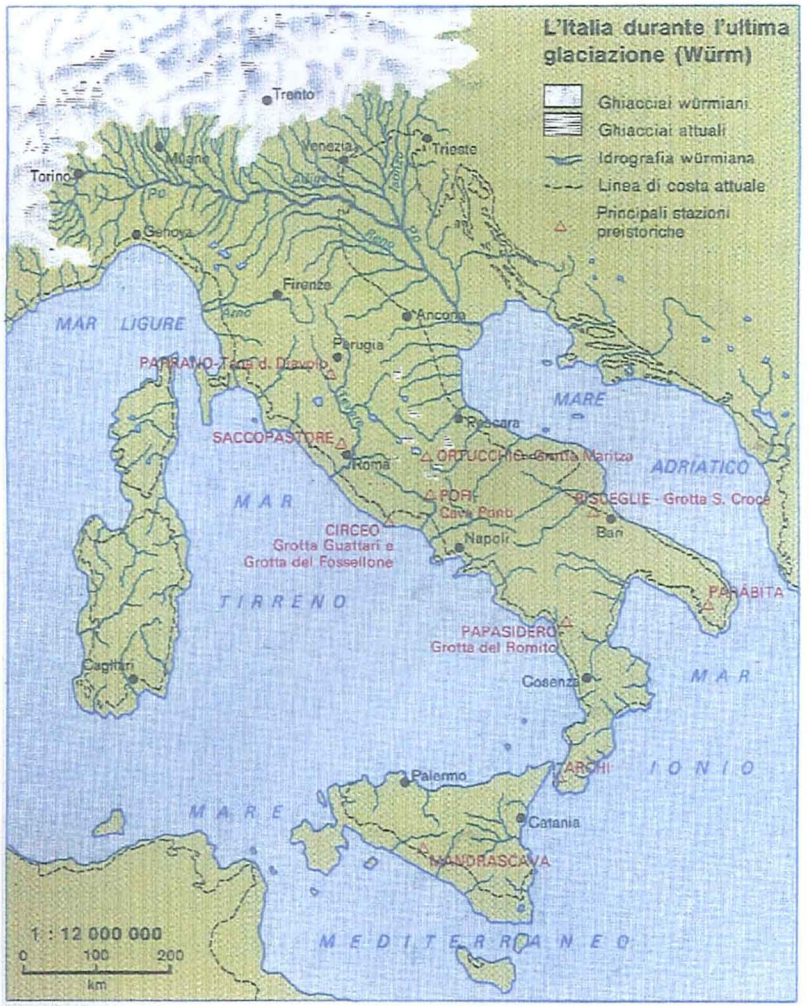
4-Mean Air Temperature



5-Mean Precipitation



6 - Italy during the Pliocene and the Last Glacial Maximum



7 – Archeological Maps

1. Early Faunal and Human Populations

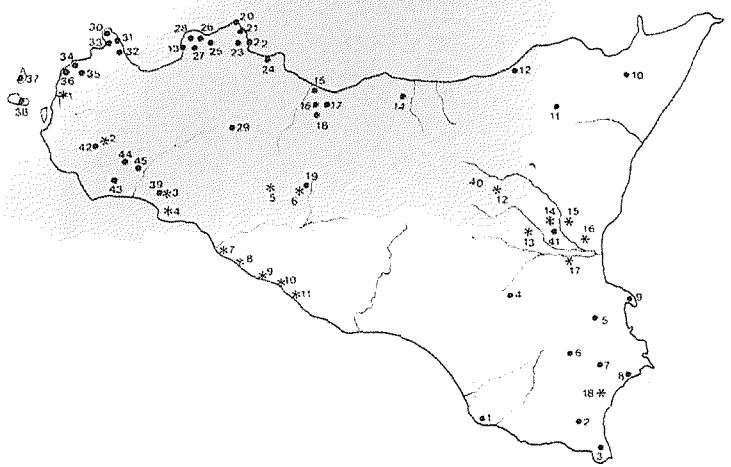


Fig. 7. *Bifacial and pebble tools* (*): 1 Guarrato, Granatello, Marausa; 2 Fiume Grande-Bovara; 3 Menfi; 4 Bertolino di Mare; 5 S. Stefano di Quisquina; 6 Rocca del Vruaro; 7 Eraclea Minoa; 8 Faro Rossello; 9 Realmonte; 10 Maddaluso; 11 Mandrascava; 12 Agira; 13 Ramacca; 14 Muglia Nord; 15 Fontanazza, Poggio Monaco; 16 Gerbini; 17 Piano Meta; 18 Noto. *Upper Palaeolithic/Mesolithic sites* (•): 1 Fontana Nuova; 2 Riparo Stafenna; 3 G. Corruggi; 4 Palike; 5 Pedagaggi; 6 Riparo San Corrado; 7 Canicattini Bagni; 8 G. Giovanna; 9 G. Acquasanta; 10 Riparo di San Basilio; 11 Riparo San Marco; 12 G. San Teodoro; 13 San Cataldo; 14 Piano di S. Foca; 15 Riparo del Castello; 16 G. Geraci, Natale, Puleri; 17 G. di Nuovo; 18 Contrada Franco; 19 G. di Acqua Fitusa; 20 G. Perciata; 21 G. Addaura; 22 Riparo Primo Pizzo; 23 G. Niscemi; 24 G. San Ciro; 25 G. di S. Rosalia; 26 G. Carburanceli; 27 G. Maccagnone; 28 G. dei Puntali, Za' Minica; 29 Contrada Drago; 30 G. di Cala Mancina; 31 G. Capreria; 32 G. dell'Uzzo; 33 G. Racchio, Isolidda; 34 G. Mangiapane; 35 G. Miceli; 36 G. Emiliana, Martogna; 37 G. dei Genovesi and other Levanzo caves; 38 Favignana caves; 39 Contrada Tardara; 40 Riparo Longo; 41 Perriere Sottano; 42 Roccazzo; 43 Parche di Bilello; 44 Cisternazza-Vallesecco; 45 Pizzo Don Pietro

2. The First Farming Societies

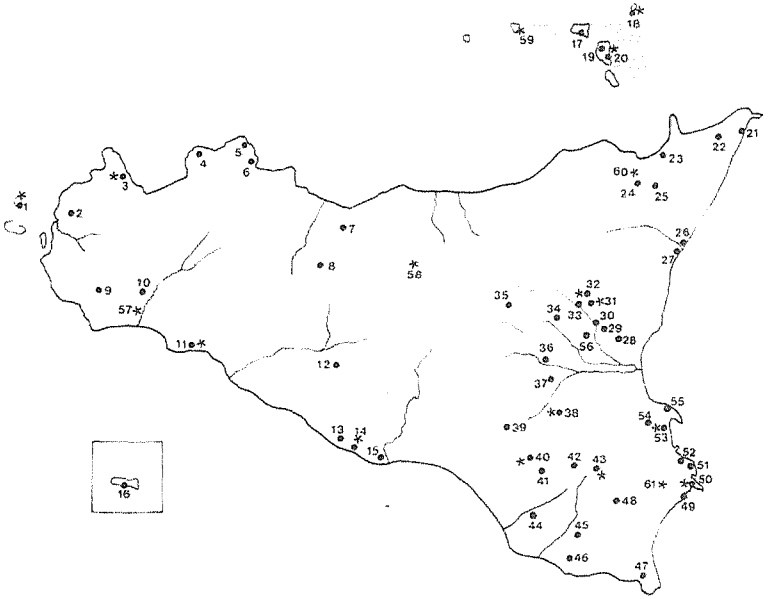


Fig. 23. *Early-Middle (•) and Late (*) Neolithic sites*: 1 G. Genovesi; 2 G. Maiorana; 3 G. Uzzo; 4 G. Puntali; 5 G. Regina; 6 M. Pellegrino; 7 G. Geraci; 8 Le Rocche; 9 Castelluccio; 10 Stretto; 11 Kronio; 12 Serra del Palco; 13 Piano Vento; 14 G. Zubbia/Infame Diavolo; 15 Casalicchio; 16 Cala Pisana; 17 Rinella; 18 Milazzese; 19 Lipari sites: Castellaro etc; 20 Lipari acropolis; 21 Boccetta; 22 Rometta; 23 Pietro Pallio; 24 M. Alfone; 25 Riparo di San Basilio; 26 Cutrufelli; 27 Naxos; 28 Valcorrente; 29 Fontana di Pepe; 30 Trefontane; 31 Biancavilla; 32 Adrano; 33 Fontanazza; 34 Muglia bassa; 35 Agira; 36 M. Alfone; 37 Torricella; 38 Palike; 39 Caltagirone; 40 Poggio Biddini; 41 Pirrone; 42 Calaforno; 43 G. Masella; 44 Paolina; 45 Bruca; 46 Scicli; 47 G. Corruggi; 48 M. Gisira; 49 Ognina; 50 Matrensa; 51 Capo Panagia; 52 Stentinello; 53 Megara; 54 Petraro; 55 Gisira; 56 Perriere Sottano; 57 Castello della Pietra; 58 G. Vecchiuzzo; 59 Filicudi; Capo Graziano; 60 Basicò; 61 G. Conzo, Chiusazza, Palombara

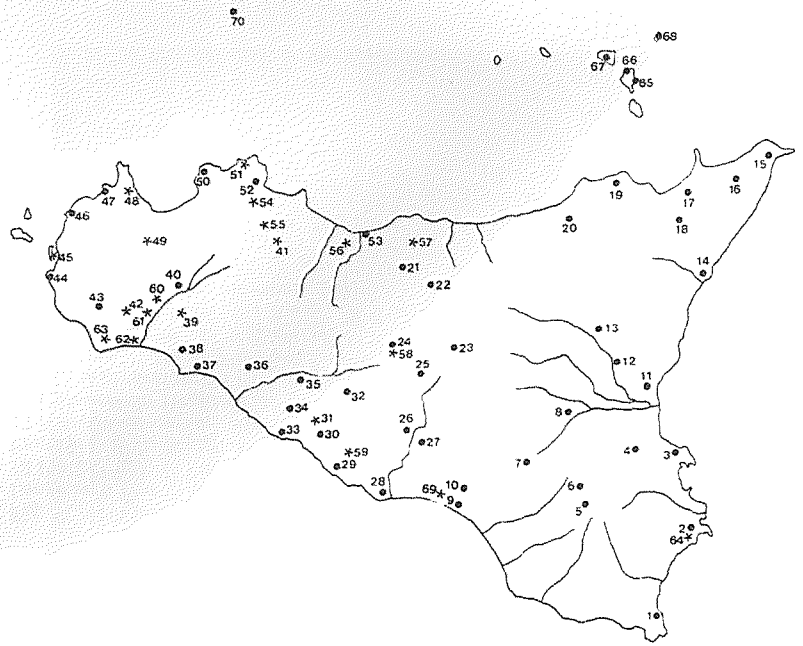


Fig. 40. *Copper Age (•) and Beaker (*) sites*: 1 G. Calafarina; 2 G. Conzo, Chiusazza; 3 Gisira; 4 Ossini; 5 Calaforno; 6 San Cono; 7 S. Ippolito; 8 Torricella; 9 Piano Notaro; 10 Settefarine; 11 Catania; 12 Trefontane; 13 Poggio dell'Aquila; 14 G. Monaci; 15 Boccetta; 16 Motta; 17 Pietro Pallio; 18 G. San Basilio; 19 Gioiosa Marea; 20 Alcara li Fusi; 21 G. Fico, Chiusilla; 22 G. Vecchiuzzo; 23 Realmese; 24 Marianopoli; 25 Caltanissetta; 26 Sommatino; 27 Riesi; 28 Casalicchio-Agnone; 29 G. Zubbia; 30 G. Ticchiara; 31 Serraferlicchio; 32 Malpasso; 33 Durrueli; 34 Busoné; 35 Capreria; 36 Ribera; 37 Kronio; 38 Tranchina; 39 S. Margherita Belice; 40 Ulina; 41 Villafrati; 42 Marcita; 43 Roccazzo; 44 Marsala; 45 Motya; 46 Erice; 47 Mocata; 48 G. Uzzo; 49 Segesta; 50 G. Puntali; 51 Carini; 52 Palermo Conca d'Oro sites; 53 Himera; 54 Torrente Cannizzaro; 55 Moarda; 56 G. Geraci, Puleri; 57 G. Chiusilla; 58 Cuti; 59 Naro; 60 S. Martino, Stretto, Cisternazza, Torre Donzelle; 61 Torrebigini; 62 Manicalunga; 63 Torre Cusa; 64 G. Palombara; 65 Lipari: acropolis; 66 Lipari: Piano Conte; 67 Salina: Malfa; 68 Panarea: Piano Quartara, Drauto; 69 Manfria; 70 Ustica: G. Azzurra

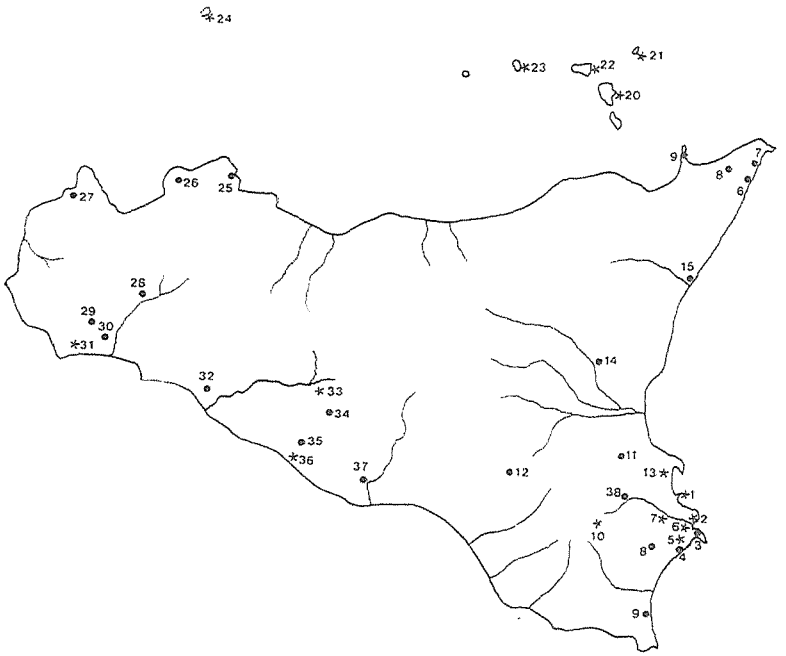


Fig. 73. *Middle Bronze Age sites (•); with imported Mycenaean (LH IIIA-IIIB) or Cypriot pottery (*)*: 1 Thapsos; 2 Syracuse; 3 Plemmyrion; 4 Ognina; 5 Matrensa; 6 Cozzo del Pantano; 7 Floridia; 8 G. Chiusazza; 9 G. Calafarina; 10 Buscemi; 11 Lentini; 12 Caltagirone; 13 Molinello; 14 Paternò; 15 Naxos; 16 Messina; 17 Paradiso; 18 Rometta; 19 Milazzo; 20 Lipari: Castello, Urnazzo; 21 Panarea: Milazzese; 22 Salina: Portella, Serro dei Cianfi; 23 Filicudi: Capo Graziano; 24 Ustica: I Faraglioni; 25 G. Ferraro; 26 G. dei Puntali; 27 G. Mangiapane; 28 Monte Castellazzo; 29 Marcita; 30 Case Pietra; 31 Erbe Bianche; 32 Scirinda; 33 Milena; 34 Caldare; 35 G. Ticchiara; 36 Cannatello; 37 Madre Chiesa; 38 Pantalica

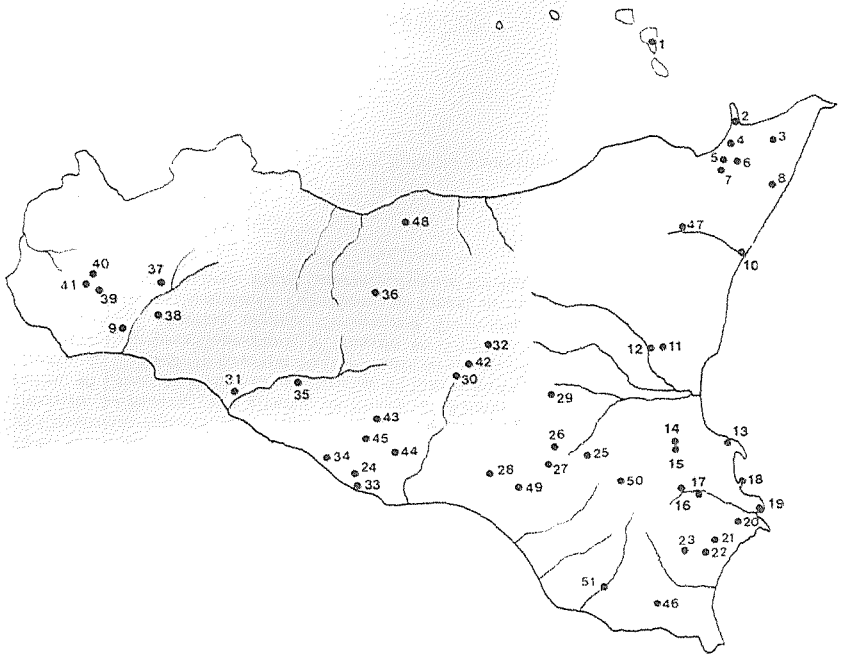


Fig. 97. LBA and EIA sites and hoards: 1 Lipari; 2 Milazzo; 3 Rometta; 4 Pozzo di Gotto; 5 Longane; 6 Piano Cannafè; 7 Pietro Pallio; 8 Fiumedinisi; 9 Stretto; 10 Naxos; 11 Paternò; 12 Pietralunga; 13 Punta Castelluzzo; 14 Lentini (Metapiccola, San Mauro); 15 Carrube; 16 Pantalica; 17 Rivetazzo; 18 Thapsos; 19 Syracuse; 20 Cozzo Pantano; 21 Cassibile; 22 Avola; 23 Noto; 24 Boccazza; 25 Mulino della Badia-Madonna del Piano; 26 Caltagirone; 27 Monte San Mauro; 28 Dessueri; 29 Cittadella-Morgantina; 30 Sabucina; 31 Scirinda; 32 Calascibetta (Carcarella); 33 Castellazzo di Palma; 34 Cannatello; 35 Sant'Angelo Muxaro; 36 Valledolmo; 37 Monte Finestrelle; 38 Santa Margherita Belice; 39 Timpone Pontillo; 40 San Ciro; 41 Mokarta; 42 Capodarso; 43 Canicatti; 44 Campobello di Licata; 45 Naro; 46 Spaccaforno; 47 Malvagna hoard; 48 Gratteri hoard; 49 Niscemi hoard; 50 Vizzini (Tre Canali) hoard; 51 Castelluccio hoard

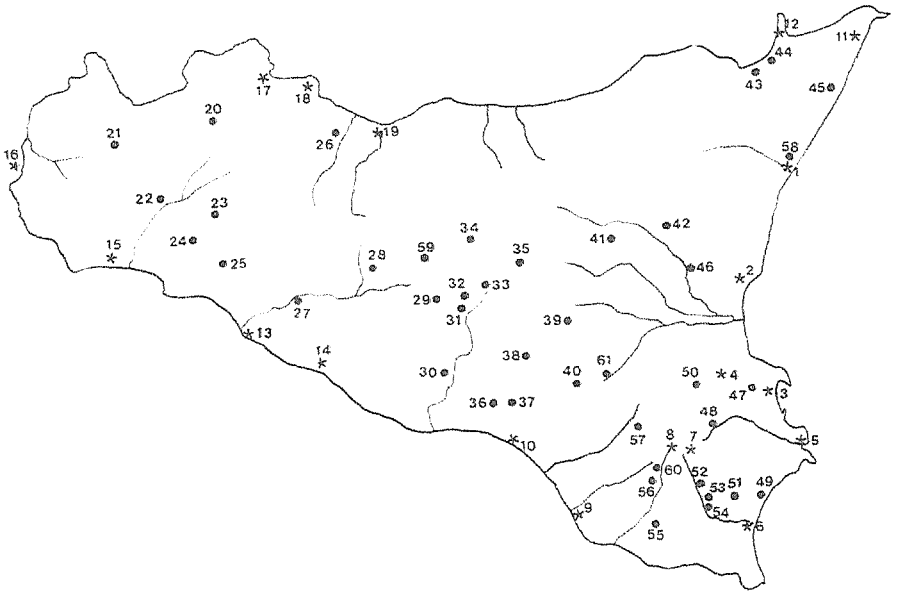


Fig. 116. *Greek and Phoenician settlements (*) and indigenous sites (•), 8th-6th centuries* BC: 1 Naxos; 2 Catania; 3 Megara Hyblaea; 4 Lentini; 5 Syracuse; 6 Helorus; 7 Akrai (Palazzolo); 8 Casmene (Monte Casale); 9 Camarina; 10 Gela; 11 Zancle (Messina); 12 Mylai; 13 Heraclea Minoa; 14 Akragas (Agrigento); 15 Selinus; 16 Motya; 17 Panormus (Palermo); 18 Solunto; 19 Himera; 20 Monte Iato; 21 Segesta; 22 M. Castellazzo; 23 Entella; 24 M. Adranone; 25 Caltabellotta; 26 Mura Pregne; 27 S. Angelo Muxaro; 28 Polizzello; 29 Vassallaggi; 30 M. Saraceno; 31 Gibil Gabib; 32 Sabucina; 33 Capodarso; 34 Terravecchia di Cuti; 35 Calascibetta cemeteries; 36 Butera; 37 Dessueri; 38 M. Bubbonia; 39 Morgantina; 40 M. San Mauro; 41 Centuripe; 42 Mendolito; 43 Longane; 44 Pozzo di Gotto; 45 Fiumedinisi; 46 Paternò; 47 Villasmundo; 48 Pantalica; 49 Avola; 50 Ossini; 51 Noto; 52 Tremenzano; 53 Finocchito; 54 Giummarito, Murmure; 55 Modica; 56 Castiglione; 57 M. Casasia; 58 Cocolonazzo; 59 Marianopoli; 60 Giarratana hoard; 61 San Cataldo hoard

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Table 6.1 Terms used to describe Mediterranean sclerophyllous shrubland (Tomaselli, 1981a; Margaris, 1981)

	High matorral (not usually subdivided on the basis of substrata)	Middle matorral	Low matorral
France	*Maquis* (xerophilous, sclerophyllous and evergreen low trees, generally very dense and impenetrable)	*Garrigue* (sometimes only with reference to calcareous substrata)	Less well defined, but sometimes *garrigue* (or *landes* on siliceous substrata)
Spain	*Matorral denso, espinal*	*Matorral claro, jaral* (on siliceous substrata)	Less well defined, but *tomillar* is used
Italy	*Macchia alta*	*Macchia bassa*	*Garriga (gariga)*
Greece			*Phrygana*
Eastern Mediterranean			*Batha*
Other MTEs			
California	*Chaparral*	*Scrub*	*Coastal sage*
South Africa	*Fynbos*		
Australia	*Mallee*		

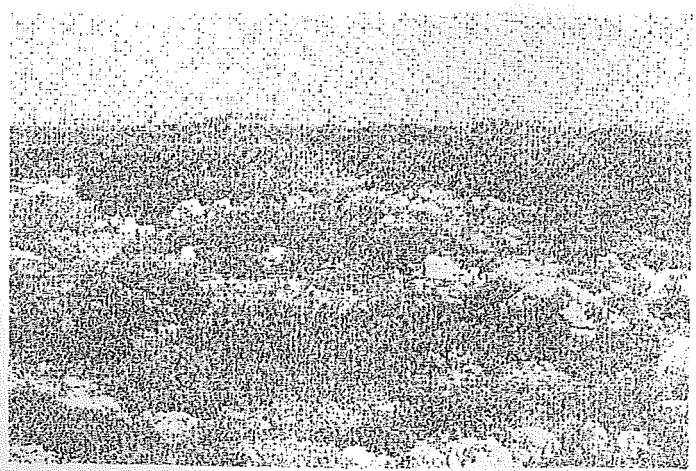

Plate 6.1 Garrigue/steppe vegetation. Note the areas of bare ground between the cushion-shaped, low growing vegetation

6.2 Plant and animal communities

Plant and animal communities do not, of course, live in isolation from each other. Birds, insects, small mammals etc. all have their preferred habitat and within these make specific use of plant matter, whether as food or shelter.

Table 6.2 Regional variation in numbers of species (in brackets) in some characteristic genera of Mediterranean sclerophyllous shrubland

Western Mediterranean (e.g. Morocco)	Circum-Mediterranean	Eastern Mediterranean (e.g. Turkey)
Genista (22)	*Anagyris*	*Sideritis* (about 20)
Helianthemum (22)	*Artemisia*	*Hypericum* (about 15)
Teucrium (14)	*Calicotome*	*Salvia* (about 15)
Cistus (12)	*Ceratonia*	*Satureja* (about 12)
Cytisus (12)	*Fumana*	*Phlomis* (about 10)
Thymus (10)	*Jasminum*	*Rhamnus* (about 7)
Thymelaea (9)	*Juniperus*	*Ebenus* (about 5)
Halimium (8)	*Laurus*	*Daphne* (about 3)
Erica (7)	*Lonicera*	*Globularia* (3)
Adenocarpus (6)	*Myrtus*	*Astragalus* (impossible to determine)
Asparagus (6)	*Olea*	
Coronilla (5)	*Osyris*	
Lavandula (at least 5)	*Phagnalon*	
Ulex (4)	*Phillyrea*	
	Pinus	
	Pistacia	
	Quercus	
	Rhamnus	
	Rosmarinus	
	Ruscus	
	Spartium	
	Staehelina	
	Viburnum	
	Ziziphus	

Source: adapted from Quézel (1981).

Animals and plants interact as part of ecosystems, as discussed in Chapter 7. Unfortunately, research on Mediterranean animal populations has taken place in a degree of isolation from that of plant ecology and there are few syntheses of the animal ecology of the region. However, some of the more common associations of plant and animal communities are examined in the following sections on the characteristic vegetation communities. In general birds are excluded from this immediate discussion but are considered separately in Section 6.3.

6.2.1 Sclerophyllous shrubland or maquis

Sclerophyllous shrubland is the most widespread vegetation type found around the Mediterranean Basin, usually where precipitation levels range from 350 mm to 1500 mm per annum (Faulkner and Hill, 1997). It is absent from the coastal regions of Libya and Egypt. Typical plants include olive (*Olea*), carob

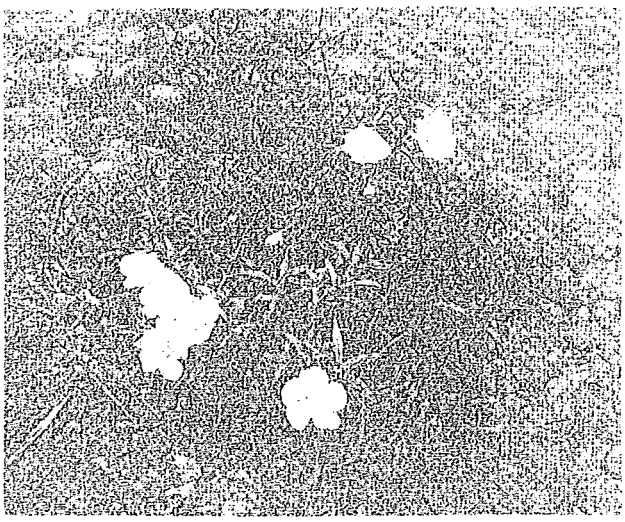

Plate 6.2 *Cistus ladanifer* (gum cistus). This species occurs in two forms, with or without five purple spots at the base of the petals.

(*Ceratonia*), *Pistacia*, *Cistus* and many labiate herbaceous species. Some genera are found throughout the region but the widespread distribution of maquis belies significant variations in floristic composition between the western and eastern regions of the Basin (Quézel, 1981); there are more species of *Erica* and *Cistus* in France and Morocco, for example, but more species of *Salvia* and *Phlomis* in Greece and Turkey (see Table 6.2). As well as regional variations in type of shrubland, it is possible to distinguish between maquis and garrigue on calcareous and non-calcareous substrates, for example the various species of *Erica* or *Cistus* found on non-calcareous soils in the western Mediterranean.

Four species of oak and two of pine are particularly common in sclerophyllous shrublands – holm oak (*Quercus ilex*), kermes oak (*Q. coccifera*), cork oak (*Q. suber*), *Q. calliprinos*, Aleppo pine (*Pinus halepensis*) and Calabrian pine (*P. brutia*). Their distributions may be regional rather than circum-Mediterranean; for example, holm oak does not grow in Turkey and Calabrian pine is not found in the western Mediterranean. Other conifers also grow in sclerophyllous shrublands, such as junipers (*Juniperus oxycedrus*, *J. phoenicea*) and alerce (*Tetraclinis articulata*), which is restricted to the southern part of the Iberian Peninsula and northern Africa.

Additional important trees are olives (*Olea europaea*) and *Pistacia* (the lentisc or mastic tree, *P. lentiscus*, in the eastern Mediterranean, and the terebinth or turpentine tree, *P. terebinthus*). These may all be found in communities with or without the carob (*Ceratonia*). Across the Mediterranean there are also the strawberry trees (*Arbutus unedo* and *A. andrachne*, the latter found only in the eastern Mediterranean) and species of *Cistus* (Plate 6.2), *Phillyrea* and *Laurus*. There is some indication of an increase in the arborescent elements of sclerophyllous shrubland in the eastern Mediterranean (Quézel, 1981).

A variety of medium to large mammals is found in maquis communities. These include rabbits (*Oryctolagus cuniculus*) and red deer (*Cervus elaphus*). In the Iberian Peninsula maquis is important habitat for remaining populations of the Iberian lynx (*Lynx pardinus*), whose conservation is discussed in Section 9.3.5a. Small-mammal diversity is relatively low (Tucker and Evans, 1997). By contrast there is a rich and abundant reptile fauna. Typical species include the globally threatened Hermann's tortoise (*Testudo hermanni*), spur-thighed tortoise (*T. graeca*) and marginated tortoise (*T. marginata*). Lizards include the agama (*Agama stellio*) and Lilford's wall lizard (*Podarcis lilfordi*), while snakes include the large whip snake (*Coluber jugularis*) and the western whip snake (*C. viridiflavus*).

A fairly characteristic assemblage of birds is found in maquis, including warblers (*Sylvia* spp.), buntings (*Emberiza* spp.) and partridges (*Alectoris* spp.). Some birds are locally common such as the black francolin (*Francolinus francolinus*) in Turkey and Cyprus; others are more widespread such as shrikes (*Lanius* spp.) and finches (*Carduelis* spp.) (Tucker and Evans, 1997). More open ground, such as garrigue, is important for diurnal and nocturnal raptors attracted by high densities of prey. Such birds of prey include the short-toed eagle (*Circaetus gallicus*), the long-legged buzzard (*Buteo rufinus*), golden eagle (*Aquila chrysaetos*), kestrel (*Falco tinnunculus*), eagle owl (*Bubo bubo*), Scops owl (*Otus scops*), little owl (*Athene noctua*) and Bonelli's eagle (*Hieraaëtus fasciatus*). There is also a range of insectivorous birds such as the nightjars (*Caprimulgus europaeus* and *C. ruficollis*), the bee-eater (*Merops apiaster*) and the roller (*Coracias garrulus*). In rocky and dry grass habitats characteristic species include the short-toed lark (*Calandrella brachydactyla*), crested lark (*Galerida cristata*), thekla lark (*G. theklae*), tawny pipit (*Anthus campestris*), black-eared wheatear (*Oenanthe hispanica*) and several species of partridge (*Alectoris* spp.) (Tucker and Evans, 1997).

6.2.1a Maquis – climax community or not?

The presence of trees in some areas of maquis and garrigue has introduced the debate about the position of maquis in a successional sequence. In some instances maquis has been interpreted as a climax vegetation community; elsewhere it is regarded as a stage in succession, either progressive or retrogressive. Many of these ideas are exemplified in the work of Tomaselli (1981b) and Barbero *et al.* (1990). However, the application of succession theory to mediterranean ecosystems is increasingly viewed as inappropriate. This is based on the argument that mediterranean vegetation development is not progressive and unidirectional and therefore successional; instead, frequent disturbances result in perturbation-dependent communities (see Section 7.4). The argument is compelling but not fully accepted and much of the literature still reflects the influence of Clementsian successional ideas.

Where maquis and garrigue are considered as climax communities the two characteristic species are olive (*Olea oleaster*) and carob (*Ceratonia siliqua*), often found in association with *Pistacia lentiscus*, Mediterranean buckthorn (*Rhamnus alaternus*) and *Phillyrea angustifolia*, although this association depends

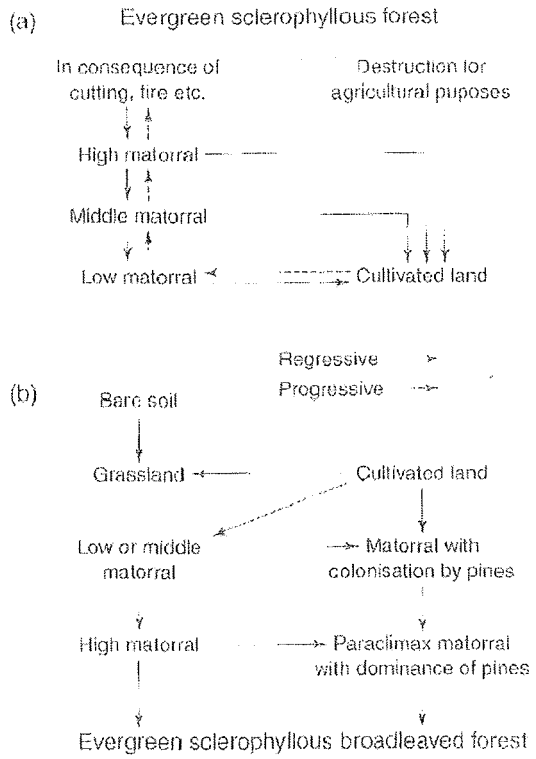

Figure 6.3 (a) Theoretical regressive and progressive succession from or to forest. After Tomaselli (1981b). (b) Theoretical progressive succession with pines which tend to replace (paraclimax) forests of hard broadleaved evergreen species. After Tomaselli (1981b).

on geographical distribution. In the southern Iberian Peninsula, the dwarf palm (*Chamaerops humilis*) often grows in association with *Olea* and *Ceratonia*; on the northern coast of Crete, the Theophrastus palm (*Phoenix theophrasti*) is typical. From Greece eastwards, the strawberry tree (*Arbutus andrachne*) is an important associate. In southern Spain and Portugal, climax maquis may also be dominated by the tree heath (*Erica arborea*). Climax maquis or matorral extends along the coasts of northwest Spain, southern France, central-southern Italy, southern Greece, western and southern Turkey, Israel, the Mediterranean islands and parts of North Africa (Tomaselli, 1981b).

In the view of succession-based analysts most maquis is not climactic, but represents a stage in a progressive succession to forest or a retrogression from forest. Through fire, excessive grazing and felling of climax trees, high or dense matorral degrades. Matorral may also become established where cultivation is abandoned. Figure 6.3(a) illustrates the generalised theoretical successional sequence (Tomaselli, 1981b), which can be compared with Figure 6.3(b) where matorral is colonised by pines and eventually progresses to evergreen sclerophyllous broadleaved forest, often dominated by holm oak (*Quercus ilex*). The presence of pine trees is especially important in progressive successions, and pine communities are considered in more detail below (Section 6.2.3).

At the wetter and cooler winter margins of its distribution, sclerophyllous shrubland merges into forest cover. This may be the cool-temperate deciduous forests further north in Europe or coniferous forests at higher altitudes, both more typical of non-mediterranean-type climates, but the transition may be to broadleaved evergreen forests where holm oak (*Quercus ilex*) is almost the only canopy tree. This forest type is considered next.

6.2.2 Evergreen oak forest

Holm oak (*Quercus ilex*) may be present in shrubland or maquis communities and it has leaves similar to those of the evergreen shrub oaks *Q. coccifera* and *Q. calliprinos*. However, at the wetter and cooler peripheries of maquis (in Emberger's cold semiarid and temperate humid Mediterranean bioclimates) holm oak may form continuous cover (Terradas, 1999). This oak is a circum-Mediterranean species, especially abundant in the western Mediterranean, but absent from those regions where summer drought is too sustained. Thus in the drier parts of the basin, such as North Africa, southern Spain and southern Greece, it is mainly found at higher elevations. Holm oak forests are particularly extensive in Spain, Morocco, France, Italy, Corsica and Sicily. Much of the research on the ecology of holm oak forest has been carried out in France and Spain (Rodà *et al.*, 1999).

Holm oak may form mixed forests with Aleppo pine (*Pinus halepensis*) or stone or umbrella pine (*P. pinea*) but it tends to be the dominant tree species in closed forests. In mixed forests the pines are frequently taller than the oaks (Terradas, 1999). Other trees and shrubs may also be present such as *Arbutus unedo*, *Phillyrea latifolia*, *Rhamnus alaternus* and *Pistacia lentiscus*. Climbing plants may be important, such as ivy (*Hedera* spp.), honeysuckle (*Lonicera* spp.) and clematis (*Clematis* spp.). The grass cover is rarely very extensive.

Until at least the 1970s, closed-canopy holm oak forests were thought of as climax communities and capable of self-regeneration. It is now clear that the tree has been closely favoured by people. Pollen analysis suggests that in southern France it became dominant only after 2000 BP and spread with the increase in human activity and the rise of agriculture in Gallo-Roman times (Terradas, 1999). Today few forests are undisturbed; most bear evidence of cultivation and coppicing (Rodà *et al.*, 1999).

Ecologists are interested as to whether holm oak forests are capable of self-regeneration. Observations show that when forests are well established, there are few oak saplings growing in the understorey, which suggests a problem in the recruitment of younger trees. At the same time there appear to be large numbers of seedlings. The question is, therefore, what happens to the seedlings to prevent them from growing into saplings?

Holm oaks grow slowly, forming dense canopies. Under reduced light levels and associated higher soil moisture, germination of acorns is stimulated and survival of seedlings is good – experiments indicate that high light levels do not increase growth rates in seedlings, presumably because the reduced leaf area ratio offsets any increase in photosynthesis (Retana *et al.*, 1999). This

makes the seedlings shade-tolerant and they can survive for years without significant growth beneath the canopy. Some 55% of a seedling's weight is in root biomass in shady environments – a considerable investment in non-photosynthetic structures, leading to high maintenance costs and so small net carbon gain and slow growth rates. However, once a disturbance occurs seedling survival is seriously affected and few are able to grow on to the sapling stage.

The main disturbance factor is fire, which eliminates most seedlings, except those which are very large (Retana *et al.*, 1999). Acorns are also unlikely to survive fire because of desiccation. As a result regeneration of holm oak after fire is dependent on resprouting of older trees rather than germination of seeds. Acorn production and establishment of new seedlings are subsequently delayed until the resprouts reach reproductive age. Regeneration by resprouting of stumps is further aided by their already-existing root systems; resprout growth rates are high in the first year after a disturbance (Terradas, 1999). If seedlings are prevented from growing into saplings and the number of resprouting individuals is high enough to complete regeneration, then does it matter that this is the principal method? At present the answer is debatable. Resprouting does not introduce new genotypes into a forest (Retana *et al.*, 1999). In addition, resprouting stumps gradually become senescent (aged), which might lead to low production and eventual degradation of holm oak forests. However, many holm oak forests in France possibly date from the Middle Ages and as yet show no sign of decline.

Although the ability of holm oaks to regenerate from seedlings is rare under closed canopies because of the absence of old seedlings, seedling survival rates increase in mixed Aleppo pine and oak stands as light levels increase slightly. As a result holm oak saplings become more abundant. In turn this leads to a gradual replacement of pine by oak and the long-term dominance of oak. Young pines are less able to establish themselves in a shaded understorey provided by an oak canopy (Retana *et al.*, 1999). The progressive recruitment of young oaks beneath Aleppo pine lends some support to traditional ideas of vegetation succession from pine to oak as outlined in Figure 6.3(b).

Holm oak forests have been managed since early historical times. On poor soils, as in central and western Spain and in Portugal, holm oak woodlands have been managed as *dehesas* (or *montados* in Portugal). These are savanna-type ecosystems with trees growing in a generally non-treed landscape. Their management over the centuries was traditionally for their firewood, for their acorns for livestock, as shelter for livestock and as pasture for sheep and cattle. Today they have a conservation value because of their high biodiversity. *Dehesa* systems are described further in Sections 8.5 and 9.3.4. Closed holm oak forests have also been managed since at least Neolithic times, generally as coppice plots (Terradas, 1999). Charcoal and tannin production used to be important but have now declined. Today their main use is for firewood.

Some large herbivores are found in broadleaved evergreen oak forests, such as red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and wild boar (*Sus scrofa*). Large carnivores such as the brown bear (*Ursus arctos*), the wolf (*Canis lupus*) and the two species of lynx (*Lynx lynx* and *L. pardinus*) are generally

rare and found only in a few locations (Tucker and Evans, 1997). The bird fauna of broadleaved evergreen oak forests is richer than that of Mediterranean coniferous forests. There are important breeding populations of raptors such as the honey buzzard (*Pernis apivorus*), short-toed eagle (*Circaetus gallicus*), lesser spotted eagle (*Aquila pomarina*) and the globally threatened Spanish imperial eagle (*A. adalberti*). Kites (*Milvus milvus, M. migrans*), flycatchers (*Muscicapa striata* and *Ficedula semitorquata*) and warblers (the olivaceous warbler *Hippolais pallida*, the olive-tree warbler *H. olivetorum*, Bonelli's warbler *Phylloscopus bonelli*) are all found in evergreen and deciduous oak forests (Tucker and Evans, 1997).

6.2.3 Coniferous forests

Coniferous forest vegetation is found widely around the Mediterranean Basin, especially in mountainous areas, and pines form a major component. Cedar forests are found in the Atlas Mountains (*Cedrus atlantica*), in Cyprus (*C. brevifolia*) and in Turkey and Lebanon (*C. libani*). Companion species include maples (*Acer monspessulanum* and *A. obtusatum*), holly (*Ilex aquifolium*) and yew (*Taxus baccata*). Firs occupy varying areas in high mountain regions; *Abies pinsapo* in Spain, *A. nebrodensis* in Sicily and Calabria, *A. cilicica* in Turkey and *A. cephalonica* in Greece (Le Houérou, 1981). In addition there are junipers (*Juniperus oxycedrus, J. phoenicea*) and alerce (*Tetraclinis articulata*), which is restricted to the southern part of the Iberian Peninsula and northern Africa.

The large mammal diversity of coniferous forests includes the wolf (*Canis lupus*), wild cat (*Felis sylvestris*) and pine marten (*Martes martes*). In some high-altitude forests chamoix (*Rupicapra rupicapra*) and wild sheep (*Ovis ammon*) may be found (Tucker and Evans, 1997). Birds of Mediterranean coniferous forests are similar to those of non-Mediterranean coniferous regions, being dominated by a number of ubiquitous species such as woodpigeons (*Columba palumbus*), turtle doves (*Streptopelia turtur*), firecrests (*Regulus ignicapillus*) and green woodpeckers (*Picus viridis*). There are a few species restricted to Mediterranean coniferous forests (in comparison with broadleaved forest) – the Corsican nuthatch (*Sitta whiteheadi*), Krüper's nuthatch (*S. krüperi*) and the crossbill (*Loxia curvirostra*) (Tucker and Evans, 1997).

List of pollen types

Abies
Acacia
Acanthus
Acer
Acer: clumps
Aesculus
Agrimonia-type
Agrostemma githago
Ailanthus
Alisma-type
Allium-type
Alnus glutinosa-type
Alnus viridis
Amaranthus
Ambrosia
Ammi-type
Anemone hortensis-type
Anemone palmata-type
Anogramma leptophylla
Anthemis-type
Anthericum
Anthoceros laevis
Anthoceros punctatus
Anthriscus sylvestris-type
Anthyllis
Apiaceae
Apium-type
Arbutus
Arnoseris minima
Artemisia
Asparagus
Asphodeline
Asphodelus albus-type
Asphodelus fistulosus
Asplenium-type
Aster-type
Asteraceae Subfam. Asteroideae
Asteraceae Subfam. Cichorioideae
Astragalus-type
Athyrium filix-femina
Bellis
Betula
Bidens-type
Boraginaceae
Borago officinalis
Botrychium
Brassicaceae
Bupleurum
Buxus sempervirens
Calendula
Calligonum
Callitriche
Caltha-type
Calystegia
Cannabis sativa
Carduus
Carlina
Carpinus betulus
Carthamus
Caryophyllaceae Subfam. Silenoideae-type
Castanea sativa
Cedrus
Celtis australis
Centaurea nigra-type
Centaurea scabiosa-type
Centaurium
Centranthus
Cerastium-type
Ceratonia siliqua
Ceratophyllum: spine
Cercophora-type
Cerealia-type
Cerinthe
Chaerophyllum hirsutum-type
Chaerophyllum-type
Chamaerops humilis
Cheilanthes-type
Chenopodiaceae-type
Cirsium
Cistaceae
Cistus
Citrus
Cladium mariscus
Clematis
Colchicum-type
Consolida-type
Convolvulus
Coriaria
Corrigiola littoralis
Corylus avellana
Cuscuta
Cyclamen hederifolium
Cyclamen purpurascens
Cynoglossum officinale-type
Cyperaceae
Cyperus-type
Daphne
Daucus
Dianthus superbus-type
Dinoflagellate
Diporotheca
Dipsacus
Dorycnium
Dryopteris dilatata-type
Dryopteris filix-mas-type
Echinops
Echium
Ephedra distachya-type
Ephedra fragilis-type
Epilobium
Equisetum
Erica arborea-type
Erodium
Eryngium
Eucalyptus
Eupatorium
Euphorbia
Euphrasia-type
Fabaceae
Fagus sylvatica
Falcaria-type
Fedia cornucopiae
Ficus carica
Filipendula
Foeniculum-type
Fraxinus oxycarpa
Fraxinus ornus
Fumana
Galanthus-type
Gelasinospora
Genista-type
Gentiana-type
Geranium
Geum-type
Gladiolus-type
Glomus
Gnaphalium-type
Gypsophila arrostii
Hedera helix
Hedwigia
Helianthemum
Heliotropium
Helleborus viridis
Heracleum
Herniaria-type
Hippocrepis-type
Hippophae rhamnoides
Humulus lupulus
Hydrocotyle
Hypericum perforatum-type
Ilex aquifolium
Iris pseudacorus-type
Isoetes
Jasione
Juglans regia
Juncaceae
Juniperus-type
Knautia
Lamiaceae
Lemnaceae
Ligusticum mutellina
Ligustrum
Liliaceae-type
Limonium
Linaria-type
Linum
Linum austriacum-type
Linum catharticum-type
Linum usitatissimum
Lithospermum officinale
Loranthus europaeus
Lotus-type
Luzula
Lychnis viscaria-type
Lychnis-type
Lycium
Lycopodium clavatum-type
Lygeum spartum
Lysimachia vulgaris-type
Lythrum
Lythrum portula
Malvaceae
Matthiola-type
Medicago falcata-type
Melampyrum
Mentha-type
Menyanthes trifoliata
Mercurialis annua

Mercurialis perennis
Microthyrium
Minuartia rubra-type
Moehringia-type
Monolete fern spore
Montia
Morus
Mougeotia
Myriophyllum alterniflorum
Myriophyllum spicatum
Myrtus communis
Nerium oleander
Nigella
Nymphaea
Odontites-type
Oenanthe
Olea
Onobrychis
Ononis-type
Onopordum
Onosma
Ophioglossum lusitanicum
Ophioglossum vulgatum
Orlaya grandiflora
Ornithogalum-type
Ornithopus
Osmunda regalis
Osmunda regalis: clumps
Ostrya-type
Papaver rhoeas-type
Parnassia palustris
Paronychia-type
Pediastrum
Pediastrum angulosum
Pediastrum boryanum var. boryanum s.l.
Pediastrum boryanum var. longicorne
Petasites
Peucedanum-type
Phillyrea
Phlomis
Phragmites australis
Picea
Pimpinella major-type
Pinus Subgen. Pinus
Pinus Subgen. Strobus
Pinus: stomata
Pistacia
Pisum sativum
Plantago coronopus-type
Plantago lanceolata-type
Plantago maior
Plantago maritima-type
Platanus
Poaceae
Podospora-type
Polygala vulgaris-type
Polygonatum
Polygonum aviculare-type
Polygonum persicaria-type
Polypodium
Populus
Potamogeton-type
Potentilla-type
Prunella-type
Prunus-type
Psoralia bituminosa
Pteridium aquilinum
Pteridium aquilinum: clumps
Pteris cretica
Quercus cerris-type
Quercus ilex-type
Quercus pubescens-type
Quercus suber-type
Quercus Undiff. 1
Quercus Undiff. 2
Ranunculus acris-type
Ranunculus lingua-type
Ranunculus Subgen. Batrachium
Ranunculus-type
Reseda-type
Rhamnus
Rhinanthus
Rhus
Rhynchospora
Rhynchospora alba-type
Ribes
Riccia
Robinia pseudo-acacia
Romulea
Rosa
Rosaceae
Rubiaceae
Rubus
Rumex
Rumex acetosa-type
Rumex acetosella
Rumex acetosella-type
Rumex obtusifolius-type
Rumex scutatus-type
Ruppia
Sagina
Sagittaria
Salix
Sambucus ebulus
Sambucus nigra
Sanguisorba minor-type
Sanguisorba officinalis
Sanicula europaea
Saxifraga granulata-type
Saxifraga tridactylitis-type
Scabiosa
Scandix-type
Scilla-type
Scirpus
Scleranthus
Scorzonera humilis-type
Scrophularia-type
Scrophulariaceae
Scutellaria-type
Secale
Sedum-type
Selaginella denticulata
Senecio-type
Serratula-type
Sideritis
Silene dioica-type
Silene vulgaris-type
Simethis planifolia
Sison amomum
Smyrnium-type
Solanum dulcamara
Solanum nigrum-type
Sorbus-type
Sparganium-type
Spergula-type
Sphagnum
Spirogyra-type
Sporormiella
Stachys-type
Succisa
Tamarix
Taxus baccata
Teucrium
Thalictrum
Thelygonum cynocrambe
Thelypteris palustris
Tilia
Tilletia sphagni
Tofieldia
Torilis arvensis
Trachycarpus fortunei
Trifolium pratense-type
Trifolium repens-type
Trifolium-type
Trilete fern spore
Trollius europaeus
Tuberaria
Turgenia latifolia
Typha latifolia-type
Ulmus
Urtica dioica-type
Urtica membranacea-type
Urtica pilulifera
Ustulina deusta
Utricularia
Utricularia: spine
Valeriana tuberosa
Valerianaceae
Valerianella
Verbascum
Verbena officinalis
Veronica
Viburnum tinus
Vicia-type
Viola
Vitis
Xanthium
Zea mays
Zelkova