

*apertus*, *Cernuella virgata*, *Xerotriza conspurcata*, *Trochoidea pyramidata* and *Cochlicella acuta*. The subulinid family has only one Mediterranean species, *Rumina decollata*, a heat-loving type with a subcylindrical shell which, as it grows, loses its tip. Several species of terrestrial molluscs are endemic to the islands and are only found in Sicily, Sardinia and the smaller islands. Examples are *Tacheocampylaea tacheoides* and *Oxychilus pilula*, species endemic to the island of Capraia, *Oxychilus oglasicola*, endemic to Montecristo and Pianosa, and *Ciliellopsis oglasae*, found on Montecristo. All of these minor islands belong to the Tuscan Archipelago.

Nematodes and anellids are important components of soil fauna. Nematodes act both as predators of small invertebrates and as root consumers. Annelids (earthworms) are detritivorous and constantly burrow tunnels in the soil, thus oxygenating it and mixing organic matter well. In the thin, poor soils of the maquis, these organisms are very rare, and they are found more frequently in the humus of holm oak groves. One of the most significant species from the zoogeographic viewpoint is *Hormogaster redii*, which lives on the Tyrrhenian islands and along the coastal belt of Tuscany, Latium and Campania. Even more circumscribed in distribution is *Scheroteka targionii*, found only on the island of Elba and in the Tuscan Maremma.



Scorpion (*Escorpius* sp.), after moulting

**Arachnids.** For scorpions, the Mediterranean maquis and holm oak woodland are among the most favourable environments available in Europe - thanks to the climatic conditions which suit these animals, of subtropical origin. The heat and dryness of spring and summer allow these arthropods to function efficiently as nocturnal predators, whereas the dampness and cool of autumn and winter reduces the problem of hibernation. In the holm oak groves of Monte Circeo, for example, thanks partly to its rich limestone soil,

scorpions reach high densities. *Euscorpis flavicaudis* is widespread in the evergreen maquis, as shown by its distribution in Italy (Tyrrhenian coastline, including Liguria and northern Sardinia).

Information on spiders in the Mediterranean maquis is scanty and fragmentary. A research on the gnaphosid family of spiders along the Latium coastline

has shown differences among various types of environment, such as low maquis, high maquis, holm oak woodland, and the deciduous woodland of the plain. The species living in the maquis are mainly of Mediterranean origin.

The low maquis hosts species such as *Zelotes nilicola*, *Z. tenuis*, *Trachyzelotes mutabilis*, *Nomisia aussereri* and *N. exornata*; the high maquis hosts, among others, *Zelotes fuscotestaceus*, *Z. carmeli* and *Trachyzelotes barbatus*. Lastly, mature holm oak seems to be completely deserted by gnaphosids. This decreasing trend in the richness and diversity of species, from the most juvenile stages to the most mature in the vegetational succession, is found in almost all the zoological groups studied until now. Again among the spiders, of interest is the lycosid family (wolf spiders), to which belongs *Lycosa tarentula*, a spider up to 3 cm long, which lives in tunnels in the soil. The female carries her young on her back for a few days after their birth. The bite produced by the chelicerae (poison fangs) of this spider, although causing swelling and local pain, has no serious complications. But the most dangerous species for man is *Latrodectus tredecimguttatus*, or malmignatte, the Mediterranean "black widow", belonging to the theridiid family. This small spider has a round body about 13 mm across, black with thirteen red spots. It lives under stones in the Tyrrhenian coastal belt, Sardinia, Sicily and Apulia, where it mainly preys on orthopterans, which it paralyzes with its powerful poison. The bite of this species has neurotoxic effects on man, with sometimes severe consequences. These two species, both of which are found in the maquis environment, have as their preferential habitat very warm degraded meadowland or garrigue.

Ticks (ixodoids) often have an enormous area of distribution, a common feature among parasites. However, there are some exceptions, both among the argasids and the ixodids. The former family contains *Ornithodoros erraticus*, which feeds on the blood of small mammals (rodents and insectivores) and is found mainly in coastal and subcoastal areas. The latter contains *Ixodes gibbosus* and *Hyalomma lusitanicum*, both found throughout the Mediterranean and parasitic on artiodactyls (ungulates with an even number of toes), both wild and domesticated. Again among the tick family is another



Malmignatte, or Mediterranean black widow (*Latrodectus tredecimguttatus*)

Mediterranean species, *Haemaphysalis erinacei*, which attacks small mammals (insectivores and rodents) but which is principally found on hedgehogs. Specific to wild rabbit is *Rhipicephalus pusillus*, typically distributed in the western Mediterranean (Morocco, Spanish peninsula, southern France), like the primary area of distribution of its host; in Italy, it has only been found on the island of Ustica, north of Sicily.

**Chilopods and diplopods.** Chilopods, or centipedes, are agile predators found all over Italy, and several species live in holm oak woodland and the maquis, mainly where stones and tree-trunks can be used as shelters. There are many species, belonging to the genera *Henia*, *Cryptops*, *Dignathodon*, *Eupolybothrus*, *Lithobius*, *Schendyla*, etc., although none of them may be considered exclusive to environments characterized by hard-leaved evergreen vegetation. The large scolopendra (*Scolopendra cingulata*, *S. oraniensis*), the bite of which may be extremely painful, mainly live in open habitats and are thus abundant in the most degraded portions of the maquis, like scrubland and garrigue. The same applies to diplopods (millipedes), mainly slow-moving detritivorous arthropods, which protect themselves from predators by their external thick cuticle and by the secretion of repellent substances. They too are found under stones and fallen tree-trunks, and they are quite frequent in the maquis, but are often represented by generalist species.



Scolopendra (*Scolopendra cingulata*)

**Crustaceans.** The only crustaceans which are able to live inside the Mediterranean maquis, an environment poor in surface water, are terrestrial isopods, more commonly known as woodlice. Several species, like those belonging to the armadillidiid family, have bodies which are convex and strongly cuticulated above, allowing them to assume a special kind of defence against predators: they curl themselves up into a ball, to protect their delicate underparts, just like minuscule armadilloes. Generally detritivorous, these small animals may be found under stones, in cracks in rocks, under tree bark and in rotting wood. It is in the maquis and garrigue environment that the giant of Italian terrestrial isopods lives, *Helleria brevicornis*, which may reach 26 mm in length and 13.5 mm in width. This species has an area of distribution restricted to the Tyrrhenian region, from Provence to Sardinia, on Monte Massoncello (a fossil island near Piombino) and in the Tuscan Archipelago, always along the coast. Stones also conceal species of the genus *Platyarthus*, e.g., *P. caudatus*, a Tyrrhenian species which may reach Sicily in the south, and *P. costulatus*, in the western Mediterranean. Some species of this genus are myrmecophilous, i.e., they live in symbiosis with ants, like *P. hoffmannseggi*. Among other Mediterranean species are the philosciids (*Chaetophiloscia elongata*, *C. cellaria*, *C. sicula*, *Tiroloscia macchiaie*, *T. corsica* and *Philoscia affinis*) and oniscids, like *Phalloniscus verhoeffi*. The armadillidiids include species which are almost ubiquitous and sometimes synanthropic, like *Armadillidium vulgare*, capable of living in all kinds of ecological conditions, from sea level to 3000 m, and thus also common in the Mediterranean maquis. This species is abundant in warm environments with limestone substrates, and is one of the Italian isopods which can best resist drought. It is also one of the few which is active during the hottest hours of the day. As well as the genus *Armadillidium*, there is also the genus *Armadillo* (zoologists specializing in systematics often like plays on words), with the species *A. officinalis*, of Mediterranean-Atlantic distribution. Again resorting to a play on words, the maquis also contains some species of the genera *Porcellio* (such as *P. laevis*, *P. spatulatus*, *P. orarum*) and *Porcellionides* (*P. pruinosus*, *P. sexfasciatus*), the nomenclature of which goes back to the common Italian name given to these small crustaceans: "piglets". In the deep, cool soil of holm oak groves, where even in summer sunlight is never strong, lives *Trichoniscus pusillus*, a species preferring damp habitats.

**Insects.** The most primitive insects are wingless, very small and very delicate. They are subdivided into proturans, diplurans and springtails, all more or less damp-loving and associated with soils rich in organic matter. In the low Mediterranean maquis, the soils are very shallow and dry out during summer,

but the high maquis, above all mature holm oak woodland, has conditions which are suitable for these organisms. Several species of springtails live in holm oak litter, together with their predators, such as diplurans. Among the latter are japygids, which have the terminal appendices of their abdomen transformed into a pair of pincers. They use these pincers to hold the springtail while they eat it, gracefully curving their bodies into a ring shape.

- **Heterometaboles.** The Mediterranean maquis hosts a high number of these insects, i.e., ones which do not have true larval stages, but which undergo progressive development of body and wings. Due to the scarcity of water, paleopterans (dragonflies and mayflies) are few, and polyneopterans and paraneopterans are the dominant groups. The former have mouths equipped with chewing apparatus and include mantises, stick insects, cockroaches, crickets, grasshoppers, earwigs and termites; the latter, with sucking apparatus, are mainly bugs, scale insects, aphids and cicadas. Phasmids (stick insects) are herbivorous, widespread in tropical ecosystems, and true masters of the art of camouflage, or concealing themselves from other animals. In Italy, the three species imitate leafless twigs to perfection. *Bacillus rossius* is particularly frequent in maquis formations, found in sun-loving deciduous trees but favouring evergreens in particular. In southern regions (Ionian coasts of Apulia, Basilicata and Calabria), this species cohabits with *B. atticus* and produces sterile hybrids in the natural state. The third species, smaller, is called *Clonopsis gallica*. These insects are omnivorous, and



Stick insect (*Bacillus rossius*)

move very slowly on shrubs, mainly at night, eating the leaves of lentisk, rose, pine, bramble, etc..

Mantoids, also called praying mantises, prey on small invertebrates and also have camouflaged livery to hide them from their victims, for which they lay continual ambushes. The effect of this livery, improved still further by the special shape of the body and the slow movements, also hides them from the eyes of their own predators, like birds. In Italy, most of the species are of Mediterranean type and belong to the genera *Ameles*, *Mantis*, *Empusa* and *Iris*. The mild climate and abundance of shrubs of various sizes, in which mantises lie in wait for spiders and insects, mean that the Mediterranean



Mantis eating a bug

maquis is their ideal habitat. Other polyneopterans live in the maquis and in holm oak woodland. Termites are found in old holm oak trunks, cockroaches and earwigs under stones and in the litter of the high maquis; the rare embiopterans, or web-spinners, hide under stones in their little silk tubes. But the largest order is that of orthopterans. Especially abundant during the driest and hottest months, from July until almost the end of the mild Mediterranean autumn, this very important group of primary consumers controls the excessive development of vegetation and also represents a source of plentiful food for vertebrates. Many species of orthopterans are characteristic to the Mediterranean maquis, although only a few are exclusive. Frequently found species are *Decticus albifrons*, *Platycleis intermedia*, *Gryllus bimaculatus*, *Gryllomorpha dalmatina*, *Paratettix meridionalis*, *Dociostaurus maroccanus* and *Calliptamus barbarus*. Among the species which are non-exclusive to the maquis but which are particularly abundant is *Oedipoda coerulescens*, a Central Asiatic to Mediterranean acridid (short-horned grasshopper or locust), often found along sandy paths while it carries out short flights, extending its blue rear wings.

Another easily observable acridid is the locust *Anacridium aegyptium* (8 cm long), well-known for its tendency to spend the winter in the maquis. Even in mid-winter, on fine days, this large grey orthopteran may be seen as it warms



*Anacridium aegyptium*



*Pamphagus sardus*

itself in the sun, on the top of a shrub. Very interesting from the zoogeographic viewpoint are the species of the genus *Pamphagus* (10 cm long), large orthopterans with very small wings, found in Sardinia and Sicily. These insects perhaps originated from North Africa, where there are many species, and later colonized the large Italian islands during the Messinian, when the Mediterranean partially dried up. Being heat-loving, *Pamphagus* is mainly found in garrigue environments deriving from evergreen maquis.

Bugs are subdivided into two groups: heteropterans and homopterans. In Italy, most of the former show Mediterranean distribution and the latter European. Consequently, heteropterans prevail in maquis environments, both on evergreen shrubs and on herbaceous plants in clearings. Most of the species extract lymph from plants, but the members of the reduviid family, or assassin bugs, are predators and ambush other insects, in order to suck out their internal fluids. There are also

heteropterans which do not live on plants but move along on the ground in places where vegetation is sparse: two examples are the genus *Odontoscellis* and the entire family of cydnids, easily observable on paths crossing the maquis. Among the homopterans, cicadas are frequent, mainly where the maquis is enriched with pine, both indigenous (like maritime and Aleppo pines) and introduced in historical times (like the domestic pine). The larvae of cicadas develop slowly in the soil, sucking lymph from the roots of plants. The most widespread species in coastal formations is *Cicada orni*, mainly associated with pine, and recognizable by its black spotted wings. Other homopterans are cercopids, also called spittle-insects because of the envelope of mucus secreted by the juveniles, both to pass unobserved and to avoid dehydration.

- Holometaboles. These insects have three clearly differentiated phases within their biological cycle: larva, pupa and imago (adult). The class includes ant lions, butterflies, flies, mosquitoes, beetles, wasps, bees, ants, and many others.

The order of the neuropterans includes ant lions, all predators, the larvae of which dig funnel-shaped traps in sandy soil. In the Mediterranean maquis and its clearings, we find the enormous *Palpares libelluloides*, with a wing span of up to 11 cm, the elegant *Libelloides* (= *Ascalaphus*) with long clavate (club-shaped) antennae, and the delicate *Raphidia*, the flattened larvae of which live under the bark of old tree-trunks.

There are relatively few species exclusive to the Mediterranean maquis. In most cases, each species of butterfly or moth exploits a large set of host plants growing in environments ranging from sea level to medium and high mountain. This is true both as regards plants which produce flowers, from which adult butterflies suck nectar, and the plants on which the larvae, or caterpillars, live, devouring enormous quantities of leaves.

The papilionids, or swallow-tails, are a widespread family which includes many species in the tropical belt, but the northern hemisphere has very few genera and a relatively low number of species. There are eight species living in Italy, all large, and characterized by beautifully elegant wing patterns. The swallow-tails (*Papilio machaon*) and *Iphiclides podalirius* are widespread from sea level to 1500 m, but are much more abundant in coastal and plain environments, where they may be seen from as early as the end of March. The evergreen maquis of Sardinia hosts Sardinian swallow-tail (*Papilio hospiton*), a species endemic to Sardinia and Corsica. The plants on which these insects feed are the umbellifers growing in clearings of the evergreen maquis. Instead, scarce



Cicada (*Cicada orni*)



*Libelloides coccajus*, an ascalaphid neuropteran



The most important and significant species of butterfly for the Mediterranean maquis is *Charaxes jasius*, also known as strawberry tree butterfly, since its life-cycle is essentially associated with strawberry tree.



swallow-tail lays its eggs on shrubby and arboreal species of the rose family. In maquis environments, its larvae are mainly found on blackthorn or sloe (*Prunus spinosa*) and on trees in any nearby orchards.

The pierid family contains cabbage butterflies, particularly associated with crucifers and cresses. The most heat-loving species is *Pieris mannii*, often observed in the evergreen maquis. Cleopatra (*Gonepteryx cleopatra*) is quite common and widespread in coastal and plain areas, where it lays its eggs on buckthorn (*Rhamnus alaternus*). Although it is sometimes found above 1500 m, it is generally rare in mountains. Although cabbage butterflies are almost all white, apart from small black spots at the tips of the front wings, cleopatra is brightly coloured, the livery of the male being yellow and orange and that of the female green and pale yellow.

The nymphalids are part of a family of large or medium-sized, often brightly coloured butterflies. The most important and significant species in the Mediterranean maquis is *Charaxes jasius*, also called strawberry tree butterfly. It is very widespread in Africa and the Mediterranean, frequent along the Tyrrhenian coast, and rarer along the Adriatic, where it is not found north of Porto Civitanova Marche. The zoogeographic interest of this butterfly lies in the fact that it belongs to a genus with prevalent African and tropical diffusion, containing about one hundred species, almost all widespread south of the Sahara. Closely associated with the distribution of strawberry tree (*Arbutus unedo*), this butterfly species may penetrate inland, forming small populations in the "hot spots" of the Sabini mountains and even near Orvieto, where strawberry tree survives in pockets of evergreen vegetation, together with holm oak, tree heath and other species. The strawberry tree butterfly is large, and flies rapidly and powerfully. Like all the members of its genus, it has a beautiful coloured pattern on the underside of its wings, which is revealed when it rests with closed wings and which allows it to be identified immediately. All the *Charaxes* are territorial and aggressive: each individual defends a very large territory, so that these butterflies are never very abundant. Their territorial behaviour has been studied in the Mediterranean maquis of the Tuscan littoral near Capalbio, where the males are accustomed to rest on the tops of wooden constructions about 2 m high, which the local (human) hunters set up in order to trap wild boar. The males survey their territory from these artificial resting-places, and alternate periods of rest with patrolling flights during which they ferociously attack intruders. In many cases, they also exploit the remains of any dead tree-trunks, still standing and clearly visible among the evergreen shrubs.

The aggressivity of *Charaxes jasius* in the mating season is such that it will

attack butterflies belonging to other species and sometimes even birds! One male was observed for a few seconds while it chased a hoopoe which had crossed its territory. Cases of "aggression" towards man have also been recorded: males sometimes devote a few seconds of their fighting activity to surprising, but harmless, sorties or charges against the heads of passers-by. These attacks on birds and people only last a short time, compared with the long chases after other males of the same species, showing that the butterflies soon realize their mistake and flutter away.

One very elegant livery, black with white spots, is that of species of the genus *Limenitis*. The larvae of these butterflies feed on honeysuckle leaves and thus, in the evergreen maquis, are mainly associated with the occurrence of *Lonicera implexa*. The coloured patterns of the limenites may be an adaptation to forest and maquis environments, since they imitate the play of light and shadow through foliage. The most widespread species in evergreen maquis is *L. reducta*; *L. camilla* is much rarer.

The satyrine subfamily includes many species generally associated with graminaceous plants (grasses), with small, camouflaged patterns, prevalently in various shades of brown. The many grasses which grow in sparse maquis and garrigue host several species of widespread satyrines, and also other, more warmth-loving ones such as *Pyronia cecilia*, found in grasses of the genus *Deschampsia*. The showiest is *Melanargia arge*, an interesting species endemic to mainland Italy, with a livery which is unlike that normally found in the subfamily, being white with black spots. The species is only found locally and is never abundant, since it does not fly higher than 1000 m and prefers hilly coastal areas.

The lycaenids are small butterflies which, in most cases, have a characteristic pattern of small ocelli and spots, differing from one species to another, on the underside of the wings. In addition, many species show clearcut sexual dimorphism: the wings of the males are mainly blue, those of the females generally darker, tending towards brown. Most of the species are associated with shrubby and herbaceous leguminous plants in the sparse maquis and are often seen flying only a few inches above the soil; some live their larval stage in association with ants. They are generally widespread both geographically and ecologically, being found from sea level to mountain plateaus. For instance, *Leptote pirithous* lies on various leguminous plants growing both in the evergreen maquis and in deciduous woodland. *Satyrium ilicis* is a species found in oak woodland, including holm oak (otherwise known as ilex), from which the name of the species is taken, and it is thus found from the evergreen maquis to high hilly oak woodland.



*Limenitis reducta*

Hesperiids, or skippers, are small, modestly coloured butterflies, the caterpillars of which feed mainly on roses, asters, malva (hollyhock) and grasses. Many species live in the Mediterranean maquis and garrigue without being exclusive to this environment. The most heat-loving species is perhaps *Gegenes pumilio*, found in grasses in the garrigue and arid meadows. It is occasionally found further inland but does not fly higher than 500 m.

Zygaenids, or burnet moths, are a family of small butterflies, brightly coloured, slow-flying, with daytime habits. This set of characteristics affords them good protection against predators, thanks to their peculiar toxicity. The tissues of these moths are impregnated with poisonous substances which cause vomiting in many predators, such as birds and reptiles, which rapidly learn to recognize their wing decorations and thus to avoid them. Therefore, these moths do not need speed to help them escape from predators - on the contrary, they flaunt their livery in order to identify themselves.

Most moths, or nocturnal lepidopterans, are not brightly coloured. But the arctiids are an exception to this rule, most of the species having back wings coloured red, yellow and black, and front wings dark, with white spots or stripes. These species pass daytime hours resting in the undergrowth, where they pass unobserved thanks to the fact that their front wings, when closed, imitate the play of light and shadow in foliage. If they are obliged to fly, the



Oleander hawk-moth (*Daphnis nerii*)

sudden opening of the brightly coloured back wings frightens predators, which lose precious moments in which to attack. The most heat-loving species is *Euplagia quadripunctaria*, frequent mainly in rocky limestone environments covered with evergreen vegetation. Adults have striped front wings, and the larvae are omnivorous. Hawk-moths are a family of large, hairy moths, almost all nocturnal. Some species are found most frequently in the Mediterranean maquis and in coastal areas generally. Examples are death's-head hawk-moth (*Acherontia atropos*), convolvulus hawk-moth (*Agrius convolvuli*), privet hawk-moth (*Sphinx ligustri*) and spurge hawk-moth (*Hyles euphorbiae*).

Other large moths belong to the family of the saturniids, mainly widespread in tropical regions. The few species present in Europe are more or less warmth-loving, like the great peacock (*Saturnia pyri*), also called Giant Emperor or Viennese Emperor, found from sea level to about 1000 m. It is often found on trees in abandoned orchards where the Mediterranean maquis has grown around pear, apple, sloe and almond trees. Its very large larvae may reach 12 cm in length, are pale green in colour, and have many blue tubercles.

The most numerous families of the order of the butterflies are noctuids, or owlet moths, and geometrids. Noctuids are moths with camouflaged colouring and mainly omnivorous larvae. Several species, e.g., *Hyperba lividalis*, *Daubepplusia daubei*, *Anepia silenae*, *Leucania putrescens*, *Sablia prominens*, *S. sicula* and *Cerastis faceta*, are Mediterranean species typically associated with beaches and may also penetrate inland. Characteristically



*Euplagia quadripunctaria*



Caterpillar of spurge hawk-moth (*Hyles euphorbiae*)



Caterpillar of oleander hawk-moth (*Daphnis nerii*)



*Drepana uncinula*

found in holm oak woodland is *Catocala nymphagoga*. There are also *Ochropleura leucogaster*, found on leguminous plants of the genus *Lotus*; *Orthosia rorida*, found on the shrub *Paliurus spina-christi*, typical of some aspects of the Mediterranean maquis and pseudo-maquis; and *Ammopolia witzenmanni*, a western Mediterranean species, with a few populations in mainland Italy and Sardinia. Of interest is the subtropical *Ophiusa tirhaca*, which lives on terebinth, lentisk and sumac.

The caterpillars of geometrids are easily identified by the fact that they have only two pairs of abdominal prolegs (instead of five), and thus typically proceed in a series of arch-like movements. Some caterpillars of this family are masters in the art of camouflage: in case of danger, they freeze in an erect position, in perfect imitation of a twig. Most of the species eat the leaves of both broad-leaved and conifer trees and shrubs. This family contains several species living in the Mediterranean maquis and "hot spots" further inland. Example are *Eucrostes indigenata* and *Xenochlorodes beryllaria* (both seldom observed and only found from sea level to about 700 m), but mainly the species of the genus *Idea*, more common and widespread, like *I. efflorata*, *I.*



*Ophiusa tirhaca*

*obsoletaria*, *I. virgularia*, *I. subsericeata*, *I. infirmaria*, *I. distinctaria* (= *ruficostata*), *I. ostrinaria* and *Rhodomietria sacraria*. Typical of holm oak is *Apochima flabellaria*, a holo-Mediterranean species, but even more heat-loving are *Thera cupressata*, *Eupithecia unedonata*, *Calospilos pantarius*, *Semiothisa aestimaria*, *Chemerina caliginearia* and *Campaea honoraria*.

Dipterans have very many families and species in Italy, although little is known of their geographic and ecological distributions. They are also animals with great capacity for dispersion, and so are not very useful as indicators of environmental diversity. Many syrphids hover over flowers in clearings in the Mediterranean maquis. Most of the species form part of some complex of Batesian mimicry, i.e., they perfectly imitate the bright colours of wasps, yellow with black stripes, or the brown and black stripes of bees. The absence of surface water favours species which reproduce in holm oak woodland in cavities in old tree-trunks, where rainwater collects to form tiny pools containing high concentrations of tannin. In these very small temporary bodies of water, the aquatic larvae of some syrphids (e.g., *Myiathropa florea*) and some specialized culicids (mosquitoes) develop in peace and quiet, thanks to the



*Eupithecia simplicata*

absence of predators. In evergreen and mixed holm oak woodland of the Latium littoral, at least two species of mosquito have been found, well adapted to this life-style: *Anopheles plumbeus* and *Aedes geniculatus*, usually widespread in deciduous woodland. Also of interest is the presence of sciomyzid (shade-loving) dipterans, parasitic on terrestrial gastropod molluscs: among western Mediterranean species are *Pherbina mediterranea*, *Euthycera alaris*, *Ilione trifaria* and *I. unipunctata*, which have been reported from the Sardinian maquis.

Beetles are the most numerous order of insects, containing families which are highly diversified from both morphological and ecological viewpoints. They eat anything, from leaves, flowers, fruit, wood, roots, debris, fungi, mosses, lichen and excrement to carrion; many are predators, others are parasites.

Carabid beetles are representatives of a very numerous family (more than 1300 species in Italy), and good examples of "adaptive radiation" based on predation, in which each species eats invertebrates in proportion to its own size. Carabids are excellent ecological and biogeographic markers because of their high degree of environmental "faithfulness" and their tendency to become endemic. However, the percentage of species exclusively or prevalently associated with the Mediterranean maquis is relatively low. Recent research carried out along the littoral of Latium (in the Italian president's farm in the country at Castelporziano and in the National Park of the Circeo



*Eupeodes*, a syrphid hover-fly

promontory) have shown that the coastal evergreen maquis hosts several heat-loving but not exclusive species, with high capacity for dispersion, and thus recruited partly from other boundary formations like coastal sand dunes, garrigue and plain deciduous woodland. Only the platynines of the genus *Olisthopus*, some dromiines (*Metadromius* and *Microlestes*) and lebiines (*Paradromius*, *Philorhizus* and *Syntomus*) may be considered as characteristic of this type of environment.

The community is poorer in the most mature aspects of coastal evergreen vegetation, like high maquis and holm oak woodland. It includes both woodland species in deciduous woodland (e.g., *Carabus lefebvrei*, *Notiophilus rufipes*, *Calathus montivagus*) and species in open formations like garrigue and nearby agricultural and grazing land (e.g., *Carabus rossii* and *Trechus quadristriatus*). One of the few species which may be considered typical of holm oak woodland is *Laemostenus algerinus*, distributed in the western Mediterranean. Lastly, the high maquis and holm oak woodland may contain exclusive soil-living carabids such as *Typhloreicheia* and *Anillus*, of particular significance as pre-Quaternary relicts with Gondwanian affinities. Open clearings created by man, resulting from the destruction of the evergreen maquis, like garrigue, cultivated land now abandoned, and arid grazing areas used for cattle in winter, contain much richer communities of carabids. These communities formed from elements of steppe origin, widespread, which colonized these environments

after their transformation by man. However, typically warmth-loving species are not lacking, being very widespread in the Mediterranean (*Campalita maderae*, *Carterus dama*, *Ophonus incisus*) or western Mediterranean (*Parophonus hispanus*).

The communities of phytophagous beetles which live in the evergreen maquis are mainly oedemerids, cerambycids (long-horned beetles), buprestids, chrysomelids (leaf beetles), curculionids (snout beetles, weevils), nitidulids and scarabaeoids. Together, these communities are best represented in the low maquis, and gradually become rarer in more mature stages of the succession, i.e., high maquis and holm oak woodland. This is because most flower-living insects are heliophiles (sun-loving) and thus prefer sunlit environments, avoiding mature holm oak where the tree cover is so dense that sunlight cannot reach the undergrowth. These insects, together with reptiles and birds, are mainly seen in clearings, at the edges of the maquis, or along the paths and roads which cross it, where ecotonal (transitional) vegetation grows, with many different flowering, mainly herbaceous plants. This means that the structure of these communities of insects, in the forest/maquis/garrigue mosaic of evergreen vegetation, is founded on a dynamic equilibrium which continually develops towards the formation and maintenance of clearings, by natural mechanisms such as fire and grazing. Phytophagous insects, above all the flower-living ones which are associated with the flowers of herbaceous and shrubby plants, are favoured by the early stages of the ecological succession, and continually move in search of them as they are reconstituted, after the fall of an old tree or as the result of fire.

Many plant-eating beetles of the Mediterranean maquis, especially those which frequent flowering plants, are aposematic, i.e., they have patterns of brightly coloured spots and stripes, with prevailing red, orange, yellow and black. They are generally poisonous or taste disgusting to other animals which try to eat them, and thus signal to predators that they are not edible (or sometimes they are edible species which imitate inedible ones in order to deceive predators - the so-called Batesian mimicry). In the first case, inedible insects of various families or orders use the same pattern (e.g., red with black stripes) to teach predators quickly that their hoped-for meal is not available (Müllerian mimicry). These mimic chains, sets of edible and inedible species with the same colours and patterns, are flower-living beetles of various families (cerambycids, buprestids, meloids, clerids, chrysomelids, etc.), dipterans (syrphids, stratiomyids or soldier-flies), hymenopterans (vespids), butterflies (zygaenids, ctenuchids), homopterans (cercopids or spittle-insects), etc..

Oedemerids are particularly abundant throughout spring on wild rose and

members of the aster family, along the paths crossing maquis or holm oak woodland. The same flowers also grow in the spaces between hard-leaved shrubs of the low maquis used as pasture by livestock, in garrigue and in clearings which open in the vegetation as a result of either spontaneous or artificially caused fires. In this environmental mosaic, examples of eedemerid species are *Oedemera barbara*, *O. caudata*, *O. flavipes*, *O. nobilis*, *O. podagrariae*, *O. atrata* and *O. lurida*. Some of them prevail in the low, open maquis (*O. barbara*, *O. caudata*, *O. simplex*), others in the high maquis (*O. atrata*), and yet others more or less throughout the succession (*O. flavipes*, *O. nobilis*, *O. podagrariae*). The same may be said of chrysomelid beetles, a family which includes a very high number of flower-living and leaf-eating species.

Many chrysomelids are of Mediterranean distribution, and are mainly widespread in maquis clearings. According to research carried out in the 1970s in the National Park of Circeo, there are differences in the ecological distribution of the various species. Some are only found in the low maquis (*Longitarsus lateripunctatus*) or only in the high maquis (*L. ballotae*, *Aphthona nigriceps*, *Cryptocephalus ilicis*, *C. bimaculatus*, *C. marginellus*). Others are widespread in both types (*Aphthona pygmaea*, *Longitarsus jacobaeae*, *L. tabidus*, *L. succineus*, *L. pratensis*, *Psylliodes cupreus*, *Cryptocephalus fulvus*, *C. hypochoeridis*, *C. blanduloides*, *C. trimaculatus*, *Pachybrachis exclusus*, *P. salfi*) or even more extensively, as far as the deciduous woodland of plains (*Psylliodes chrysocephalus*, *P. gibbosus*, *Longitarsus luridus*, *Cryptocephalus labiatus*). Cerambycids and buprestids are phytophagous insects (often eating flowers) in their adult stage but xylophagous (wood-eating) as larvae. The larvae spend sometimes quite long periods eating the wood of living trees, burrowing winding tunnels in the trunks. Some are monophagous, i.e., associated with only one species of host trees, or polyphagous, attacking many species of trees belonging to numerous families. Intermediate species are oligophagous, attacking several genera of trees of the same family, or a few genera of two or



The hymenopteran *Megascolia sexmaculata*

102 three related families, and so on. The adults of many species live among tree foliage and are therefore difficult to find. But other adults are found on flowers and are easy to observe in maquis clearings, on umbrelliferous plants, members of the rose and aster families, particularly thistles, and sometimes elder. In order to study these animals, cerambycid and buprestid experts collect branches suspected of being under attack by these parasites and keep them in the laboratory, patiently awaiting the moment when the insects conclude their larval state and leave the wood.

Cerambycids, easily recognizable by their quite long, oval or cylindrical bodies and their very long antennae or "horns", may be large, medium-sized or small. Among the largest species are members of the genus *Cerambyx*, with four species common to both holm oak and deciduous woodland. The most heat-loving is the oak cerambyx (*Cerambyx cerdo*) - very well-known since it is often found in public parks and gardens in the middle of towns. This species lives in all types of oakland, as far as the mountains, but it is more common in plain and low hilly environments, above all in holm oak. The larvae of some cerambycids of Mediterranean distribution, typical of the evergreen maquis,

develop in the wood of conifers of the genera *Pinus* and *Juniperus*. Examples are *Icosium tomentosum* (a species associated with juniper), *Pogonocherus neuhausi* and *Arhopalus syriacus* (both found in pines).

Other species are typical of the maquis, being heat-loving and more or less widespread in coastal and subcoastal belts, but not exclusive to them. This category contains species abundant in Mediterranean countries, such as *Priobius myardi*, *Hesperophanes sericeus*, *Poecilium labratum*, *O. lividum*, *Pseudosphegistes cinereus*, *Parmena algerica*, *P. solieri*, *Niphona picticornis* and *Deroplia troberti*.

Buprestids include flower-visiting species and are easily observed in clearings; those preferring flowering trees are much rarer. The former category contains the genera *Anthaxia* and *Acmaeodera*, small buprestids common on flowers of the aster family growing among the shrubs of the evergreen maquis.

Typical of Mediterranean formations are species of the genus *Chalcophora*, large buprestids with very shiny, hard body covers, the larvae of which develop in pine wood. Trunks of pines may often be seen to have the typical oval-shaped exit holes made by adults when they finally reach the light after



Oak cerambyx (*Cerambyx cerdo*)



*Chalcophora* sp.



*Melanophila cuspidata*

having spent their long larval phase inside the wood. Although the cuticle of these beetles is brilliant and highly coloured, it does hide them on the shiny flakes of the bark of pine trees when sunlight strikes it.

Of great interest are species of the genus *Melanophila*. This name (which means "loving black") is due to the fact that these buprestids are attracted by burnt wood and thus frequent areas subjected to fire. *M. acuminata* always lives in conifer wood; *M. cuspidata*, instead, is polyphagous, and its larvae attack any kind of conifer or broad-leaved tree which has been superficially burnt, thus showing true adaptation to life in environments like the Mediter-

anean maquis, periodically subjected to spontaneous fires. Melanophiles are among the very few buprestids which fly by night, and specimens may easily be caught by attracting them with lights.

Species of the genus *Acmaeodera* are generally polyphagous, but some show special preferences, like *A. degener*, which appears to favour the wood of evergreen oaks and is often collected on holm and cork oak. *A. quadrifasciata* is generally found on juniper, and *Acmaeoderella virgulata* on the roots of scabious in coastal areas. Lentisk bushes host *Capnodis cariosa*, one of the largest Italian buprestids, with elegant black, grey and white livery; its larvae live in the roots of Anacardiaceae.

The genus *Anthaxia* contains at least 40 species reported in Italy. These small buprestids, often brightly coloured or with coppery tones, are generally oligophagous or polyphagous. Some species are mainly or exclusively found in the coastal belt. For instance, in Latium, *A. nigritula* shows a particular predilection for the pine woods of the littoral belt (*P. pinea*, *P. pinaster*) and adults are found on the flowers of roses or asters, as early as the end of March. *A. praeclara* favours *Pinus halepensis* and *A. dimidiata* olive trees - to the extent that it is recognized as a parasite; *A. funerula* often lives on shrubby leguminous plants (*Sarothamnus*, *Cytisus*, *Ulex*, *Spartium*, *Genista*, *Calycotome*).

Among species of the genus *Agrius* (about 50 in Italy) three are associated with the evergreen maquis: *A. marozzini* (which attacks lentisk and tere-

binth), *A. elegans* (living on various rose and heath species) and *A. pisanus* (specialized to life in the roots of the leguminous *Dorycnium hirsutum*).

Nitidulids are a family of small or very small beetles, generally phytophagous, although some genera are necrophagous and are therefore found on carrion. Among phytophagous nitidulids found in the Mediterranean maquis, many belong to the genus *Meligethes*, living on flowers and eating pollen and anthers. Many species are strictly monophagous, being associated with a single plant species. In this way, although they avoid competition for food, their survival depends dramatically on the presence of the only plant they eat. For example, *Meligethes grenieri* and *M. lindbergi* are two western Mediterranean species, both found in the low maquis on cliffs. The former lives on *Rosmarinus officinalis* and the latter on *Teucrium flavum*. Other species of the genus *Teucrium* host *Meligethes distinctus*, with European distribution, widespread in both low and high maquis and in clearings in holm oak woodland. On the bright flowers of *Cistus*, which is one of the most attractive trophic resources for flower-eating insects of the low maquis and garrigue, lives *Meligethes fuscus*, another western Mediterranean species, quite frequent along the western coasts of the Italian peninsula, Sicily and Sardinia.

The same distribution model is also found in *M. nigritus* which, however, lives on *Lavandula stoechas*, mainly in cliff environments on siliceous soils. On the flowers of shrubby leguminous plants we find *M. immundus* and *M. punctatus*, both very widespread in Mediterranean countries. The former species is not very abundant and lives on several genera such as *Genista*, *Calycotome*, *Lembotropis*, etc.; the latter is very common on *Spartium junceum*. The association between *Meligethinus pallidulus* and the rare dwarf palm, *Chamaerops humilis*, is interesting: both the host plant and the insect are now rare in nature, but both may be found in parks and gardens, where the palm tree is planted by man for ornamental purposes.

Tenebrionids (darkling or ground beetles) are a mainly detritivorous family, mainly represented in the subtropical, arid belt of the planet. Precisely for this reason, in Europe they are mainly found in coastal and subcoastal environments, where they are a constant element of the entomofauna, from sand dunes to evergreen maquis. As many genera of tenebrionids are wingless, this family tends to become endemic, mainly in southern regions and on the islands. Species of the genera *Pimelia*, *Erodium* and *Tentyria* are associated with sandy soils and beaches, and as far inland as internal consolidated dunes covered with Mediterranean maquis. But the most characteristic species of the maquis and garrigue are perhaps those of the genera *Scaurus* and *Akis*, mainly observed on rocky terrains.

Holm oak woodland also contains tree-living species found on old tree-trunks, like the rare *Ipthimus italicus*. Species of the genus *Stenosis* live under tree bark and stones.

Scarabaeoids are a very heterogeneous superfamily, both morphologically and ecologically. Species of the genus *Scarabaeus* may be seen as they roll their little balls of dung along, in clearings and on paths. These coprophagous (= dung-eating) species construct underground nests complete with food supplies for their larvae. Of the six Italian species, *S. laticollis*, *S. variolosus* and *S. typhon* are more or less abundant in the low maquis and garrigue. Another widespread species in these environments is *Sisyphus schaefferi*, the rear legs of which are greatly prolonged and curved in order to roll dung balls along more rapidly. *Heptaulacus rasettii* and *Ceratophyus rossii* are two very rare endemites, until now only definitely found in the Mediterranean maquis of San Rossore, on the Tuscan littoral.

As well as dung beetles, there are also species which eat keratin and are found on the dead bodies of mammals and birds. A typical example is *Trox litoralis*, mainly found in coastal areas. Other genera of scarabaeoids habitually observed in the evergreen maquis are phytophagous, and include *Pachypus*, *Anoxia*, *Haplidia*, *Amphimallon*, *Polyphylla*, *Anomala*, *Pentodon* and *Phyllognathus*. One of the most localized species is *Paratriodonta romana*, endemic to the Roman littoral, where it is frequent on aster and flowers of the rose families in spring. Cetonian beetles, or chafers, are mainly frugivorous (fruit- or flower-eating). Species of the genera *Cetonia*, *Potosia* and *Valgus* are mainly found on the flowers of thistles and elder, in clearings in the maquis. Their larvae live in decomposing vegetal matter, e.g., woody debris inside old tree-trunks. The rare *Osmoderma eremita* also develops in old tree-trunks and may be seen in hollows in centuries-old holm oaks, in well-preserved evergreen forestland.

Among the curculionids, a very numerous family, are several examples of species typical of the evergreen Mediterranean maquis, often associated with single genera or single species of their host plants. Holm oak hosts three common, widespread species at low altitudes, particularly if the woodland is mainly composed of *Quercus ilex*: these are *Caulostrophus subsulcatus*, *Echinodera brisouti* and *Coeliodes ilicis*. In the garrigue, instead, we find more or less widespread species associated with wild rose, like *Auleto-bius pubescens*, *Phrissotrichum tubiferum* and *Cistapion cyanescens*. Heaths host *Polydrusus parallelus* and *Ctenomeropsis nigra* (closely associated with *Erica arborea*). Junipers are frequented by *Nanodiscus transversus*, while phillyrea and wild olive are attacked by *Rhodocytus cribripennis*, although both species are quite rare in Italy. Pines have *Hylesinus oleiperda*,

a western Mediterranean species, locally common.

Hymenopterans are insects with a very high capacity for dispersion, as they fly over enormous territories while searching for food. Thus, the species living in the Mediterranean maquis have a wide geographic distribution and adapt to different habitats. There are no truly exclusive species, since all of them are more or less common in deciduous woodland. This is the case of almost all the families of wasps, bees, bumble bees and ants. Many species are found on the flowers of herbaceous plants in clearings and along paths crossing the maquis, but may also be observed on evergreen shrubs. We find species with



*Oxythrea funesta* on *Silybum marianum*

Mediterranean distribution in several families, like the halictids (*Lasioglossum* spp.) andrenids (*Andrena* spp.), megachilids (*Megachile atratula*, *M. variscopa*, *Osmia latreillei*, *O. signata*) and bees (*Eucera numida*, *E. oraniensis*, *E. parvula*, *Anthophora canescens*). The maquis also contains large bees like those of the genera *Bombus*, *Psithyrus* and *Xylocopa*. Clearings in the maquis are also decorated with the brightly coloured, elegant livery of chrysidids and mutillids.

In mature holm oak woodland, where microclimatic conditions are less affected by seasonal variations, deep humus enriched with leaves accumulating on the ground and the presence of large stones may attract soil-living arthropods, living deep in the ground. Several beetles (carabids, cholevids, staphylinids, etc.) are members of this category, and also ants. Some of them belong to Mediterranean species and live in both deciduous oak woodland and in mature holm oak and the high maquis. Typical soil-living ants belong to the genera *Hypoconera*, *Aphaenogaster*, *Smithistruma* and *Leptanilla*. Small soil-living ants are almost unknown, due to the lack of specific research. Completely different are ants of the genus *Messor*. Large and sun-loving, they are constantly on the move over the ground, in search of the seeds which are their main food resource. Some species are widespread throughout the Mediterranean (*M. meridionalis*, *M. minor*); others are typical of its western part (*M. barbarus*, *M. capitatus*, *M. sanctus*) and form differentiated populations (sub-species) in some of the small islands off Sicily.

**Fishes, amphibians and reptiles.** The limited and temporary occurrence of freshwater environments is a factor which greatly restricts the distribution of fishes and amphibians in the Mediterranean maquis. There are no fishes typical of this particular environment, in which pools of fresh water dry up completely in summer. The ichthyofauna of the few watercourses which cross the maquis varies according to the type of watercourse and is thus independent of the surrounding terrestrial environment. Streams contain white bleak (*Alburnus albidus*) and spined loach (*Cobitis taenia*) and rivers freshwater species like pike (*Esox lucius*), carp (*Cyprinus carpio*), tench (*Tinca tinca*), barbel (*Barbus plebejus*) and Adriatic loach (*Rutilus rubilio*) and seawater species like grey mullet (*Mugil, Liza*) which sometimes swim up the lower stretches of watercourses.

The few species of amphibians found in the maquis are those which only frequent water for mating purposes, at the end of winter or beginning of spring. Toads are mainly terrestrial and nocturnal animals: during the day, they burrow into damp soil in the shade of shrubs, and at night, thanks to the greater atmospheric humidity, they hop about searching for prey. One typical amphi-



A pair of green toads (*Bufo viridis*) mating

bian of the Mediterranean maquis is green toad (*Bufo viridis*) which, only in this environment, regularly manages to compete with common toad (*Bufo bufo*), widespread everywhere. Green toad also manages to reproduce in brackish waters, which common toad avoids. Other typical inhabitants of the maquis are tree frogs, small amphibians adapted to living on plants, thanks to the sticky pads on their toes. Tree frogs also need water only in the mating season, are active at night, and spend the hottest hours of the day hidden among the vegetation. The Italian tree frog (*Hyla intermedia*) is the commonest and is widespread in all regions; the Tyrrhenian version (*H. sarda*) is found in Sardinia, Corsica and the Tuscan Archipelago; the Mediterranean tree frog (*H. meridionalis*) is only found in Liguria.

The toads and tree frogs of the Mediterranean maquis generally mate in temporary pools which form in winter as a result of rain and dry up completely in summer. In July and August, the existence of these pools is easily recognizable by the vegetation surrounding them. Isolated stretches of water-loving vegetation, with prevailing rushes and flocks of dragonflies in the middle of the Mediterranean maquis, allow attentive observers to identify some small depression in the ground where the soil manages to remain damp even in the



Tyrrhenian tree frog (*Hyla sarda*)

Land tortoise (*Testudo hermanni*)Moorish gecko (*Tarentola mauritanica*)Dalmatian algyroid (*Algyroides nigropunctatus*)

hottest months. In these points, in winter and early spring, small ponds teeming with life are to be found, where aquatic insects and amphibians regularly gather to mate. In Sicily and Sardinia there are also two discoglossids, painted (*Discoglossus pictus*) and Sardinian (*D. sardus*), found not only in coastal environments but also in mountains. The environmental mosaic composed of garrigue/maquis/evergreen forest hosts most of the reptiles of the Italian fauna.

The only native species of land tortoise (*Testudo hermanni*) lives along the Tyrrhenian littoral, in southern Italy and the islands. The other two species present in Italy, spur-thighed tortoise (*T. graeca*) and marginated tortoise (*T. marginata*), both introduced by man, may be found in limited areas of the maquis, mainly in Sardinia and along the Tuscany-Latium coastal belt.

Almost all the species of lizards found in Italy are exclusively or prevalently widespread in the maquis or garrigue. This is true of the four species of geckoes living in Italy: Moorish gecko (*Tarentola mauritanica*), European leaf-toed gecko (*Euleptes europaea*), Turkish gecko (*Hemidactylus turcicus*), and Kotschy's gecko (*Cyrtopodion kotschy*). The first two are widespread in all coastal regions, the others are local and not easy to find. European leaf-toed gecko is a Tyrrhenian species, mainly observed in Sardinia and the Tuscan Archipelago, whereas Kotschy's gecko is only found along

the coast of Apulia, which it seems to have colonized in recent times from the Balkan peninsula. In addition, the maquis also hosts most of the Italian lizards, although not exclusively.

The species most frequently found in Italy are green lizard (*Lacerta bilineata*), Italian wall-lizard (*Podarcis sicula*) and wall-lizard (*Podarcis muralis*). Although green lizard and Italian wall-lizard may be found at high altitudes, it is along the sea-level belt that these reptiles reach their highest rate of reproduction and maximum populations, thanks to the favourable climatic conditions and the abundance of insects as food. More local in geographic distribution are Wagler's lizard (*P. wagleriana*), Tyrrhenian lizard (*Podarcis tiliguerta*) and pygmy algyroid (*Algyroides fitzingeri*), all Tyrrhenian. The first species is endemic to Sicily and the nearby small islands, the other two live in Sardinia and Corsica. Tyrrhenian lizard is also common on the minor islands, while pygmy algyroid is rare, in both Sardinia and Corsica. Instead, in the areas towards the north-western and north-eastern boundaries of Italy, we find ocellated lizard (*Timon lepidus*) in the evergreen maquis of Liguria, Dalmatian algyroid (*Algyroides nigropunctatus*) and Dalmatian wall-lizard (*Podarcis melisellensis*), in similar environments in the province of Trieste.

Italian wall-lizard (*Podarcis sicula*)

Eyed skink (*Chalcides ocellatus*)Leopard snake (*Elaphe situla*)

The skink family contains three-toed skink (*Chalcides chalcides*) and eyed skink (*Chalcides ocellatus*). The former is recognizable by its long, snake-like body, with very small limbs. It is abundant in clearings in the maquis and garrigue but is not found at high altitudes. Instead, eyed skink has a short body with well-developed legs, and does not like mountains. Slow-worm (*Anguis fragilis*) is the only Italian representative of the slow-worm family. This species, completely devoid of limbs, seems to be more abundant at intermediate altitudes; only observed rarely in the Mediterranean maquis, it is occasionally found under stones or in rotting holm oak trunks.

The most common snakes in the Mediterranean maquis are western whip snake (*Coluber viriflavus*), Aesculapian snake (*Elaphe longissima*, *E. lineata*) and four-lined snake (*E. quatuorlineata*). The first is ubiquitous, from sea level to mountain pastures; the last is more heat-loving and prefers the low maquis or garrigue. Aesculapian snake prefers to climb up trees and therefore also lives in the high maquis.

All eat lizards, small rodents and birds. Adults may reach about 2 metres in length (2.60 m in four-lined snake) and some times prey on young rabbits.

The mosaic of evergreen maquis and cultivated land on the plateau of Murge in Apulia and in eastern Sicily is the home of leopard snake (*Elaphe situla*), which has large red spots bordered with black along its back. This very beautiful snake takes refuge in the dry stone walls which are still used to define plots of agricultural land, or under stones at the borders of the maquis or in clearings. Horseshoe snake (*Coluber hippocrepis*) is a western Mediterranean species, reported in Sardinia and on the island of Pantelleria, in maquis and garrigue environments. In the boundary areas are also two species of opisthoglyphs, i.e., snakes which have their poison fangs set well

back in the jaw - a characteristic which generally makes them less dangerous than vipers. Examples are Montpellier snake (*Malpolon monspessulanum*) and cat snake (*Telescopus fallax*), found respectively in western Liguria and the province of Trieste.

Lastly, common viper (*Vipera aspis*) is found regularly in the Mediterranean maquis, where it may reach high population densities with respect to other types of environment, thanks to the favourable climate and the protection afforded by shrubs, which hide it from predators.

**Birds.** Many species of birds, of which only a few are exclusive to the Mediterranean habitat, live in the varied mosaic of environments containing holm oak and other primary hard-leaved tree formations. Most of the species are amply distributed from the ecological viewpoint, or are in common in submountain and low mountain habitats.

Many bird species migrate seasonally and choose the Mediterranean maquis in which to pass cold winter months.

For example, hedge sparrow (*Prunella modularis*) and whinchat (*Saxicola rubetra*) nest in the mountains and spend the winter mainly in shrubby land on plains and hills.

The reason for these migratory movements is not so much to escape from cold as to find greater quantities of food. Many birds, above all insect-eaters, find more prey in the maquis rather than elsewhere, because many insects are active there even in winter, thanks to the mild, rainy climate. In addition, evergreen bushes guarantee protection from the eyes of predators. In spring and autumn, the Mediterranean maquis is home to many migratory birds flying along the coasts and over the islands.

The phenomenon of migration confers strategic importance upon the Mediterranean maquis, due to the conservation of its biodiversity - although, unfortunately, often illegal hunting and shooting continue in this splendid environmental context. For example, it is within the framework of evergreen maquis that, every year, birds of prey, honey buzzard in particular, are massacred as they fly over the Strait of Messina, shot down or trapped by centuries-old tradition. During the last few years, this slaughter has been greatly reduced, thanks to increased surveillance by the State Forestry Corps, assisted by

Whinchat (*Saxicola rubetra*)

Sardinian warbler (*Sylvia melanocephala*)Subalpine warbler (*Sylvia cantillans*)

members of many wildlife protection associations.

Among birds which are truly exclusive to, or prevalent in, the Mediterranean environment are some species of insectivorous passerines belonging to the silviid family, like Sardinian warbler (*Sylvia melanocephala*), spectacled warbler (*S. conspicillata*), subalpine warbler (*S. cantillans*), Dartford warbler (*S. undata*) and La Marmora's warbler (*S. sarda*). They are all more or less heat-loving species which mainly live in shrubby layers of vegetation. Sardinian warbler is widespread in Mediterranean countries, where it is non-migratory and common in the evergreen maquis, but it may also be found in shrubland at other altitudes. Spectacled warbler and subalpine warbler spend spring and summer in the maquis, where they nest, but they winter respectively in North Africa and south of the Sahara. Both frequent hard-leaved shrubs, but spectacled warbler likes halophilous (salt-loving) vegetation, whereas subalpine warbler

also lives in pubescent oak. Instead, Dartford warbler and La Marmora's warbler are two western Mediterranean species, mainly non-migratory: the former is from the western Mediterranean and Atlantic and favours heath formations; the latter is only found along the Mediterranean coast of Spain, the Balearic islands and the Tyrrhenian islands (Corsica, Sardinia, Tuscan Arcipelago, Aeolian islands), where they live on hard-leaved shrubs. Another silviid often found in the Mediterranean maquis is firecrest (*Regulus ignicapillus*), with mainly resident populations. The yellow, black and white stripes on its head easily identify it. It is one of the smallest Italian birds, together with wren (*Troglodytes troglodytes*), is tiny, with camouflaged plumage, and explores the inside of shrubs as if they were caverns composed of vegetation. Other insectivorous birds widespread both in the Mediterranean maquis and in other Italian habi-

tats are stonechat (*Saxicola torquata*), whinchat (*Saxicola rubetra*) and hedge sparrow (*Prunella modularis*). The first two like to sit on the tops of shrubs or isolated branches of trees, where they proclaim territorial ownership. Hedge sparrow remains at the base of shrubs, almost as if it were ashamed of its modest plumage. And yet this bird too has an intense and interesting social life. Ethologists have discovered a high degree of "sexual freedom" in this species, and it may indeed be monogamous, polygynous (one male with several females) or polyandrous (one female with several males). Polyandry, a quite rare reproductive model in nature, is advantageous when food is scarce, and the female accepts food and sexual attentions from one or more males, different from the dominant one. This takes place surreptitiously, thanks to the density of shrubby vegetation which hides acts of female "unfaithfulness". Other birds seeking food on the ground and taking shelter among shrubs are blackbird (*Turdus merula*) and robin redbreast (*Erithacus rubecula*). Blackbird is an omnivorous, resident species, widespread almost everywhere; robin only stays in the maquis in winter months.

The pattern of maquis, garrigue and dry meadows, with rocks often emerging from the poor soil, so typical of the southern regions, is home to wheatear (*Oenanthe hispanica*), a vivacious insect-eater which explores the terrain, like all members of the motacillid family. Instead, where outcropping rocks are higher and larger, we find blue rock-thrush (*Monticola solitarius*), as large as a blackbird and easily recognizable by the dark blue plumage of the male. Wheatear is a migrating bird which nests in the Mediterranean area and winters south of the Sahara, whereas blue rock-thrush is normally resident. This beautiful bird may often be seen on abandoned buildings and ruins, particular-

Firecrest (*Regulus ignicapillus*)Stonechat (*Saxicola torquata*)

Woodchat (*Lanius senator*) on its nestCiril bunting (*Emberiza cirilus*)Hoopoe (*Upupa epops*)

ly those built on the top of hills, like the ancient watchtowers erected in Medieval times to signal the arrival of Saracen pirates and still standing all along the Tyrrhenian coastline, from the Tuscan Maremma to Sicily.

Shrikes, or butcher-birds, are larger insectivores which eat large insects and sometimes even small vertebrates (lizards, baby mice, small nestlings). In the Mediterranean maquis, the most frequently encountered species are woodchat (*Lanius senator*) and red-backed shrike (*L. collurio*), although the most heat-loving is lesser grey shrike (*L. minor*), much rarer.

There are no granivorous passerines exclusive to the Mediterranean maquis, although ciril bunting (*Emberiza cirilus*) and serin (*Serinus serinus*) are two warmth-loving species, mainly resident, which often nest in the high maquis and frequent transitional environments such as the edges of woodland and clearings.

Magpie (*Pica pica*) and jay (*Garrulus glandarius*) are two solitary members of the crow family which live in all European habitats and are often found in the maquis. Magpie prefers open shrubland interrupted by meadows with sparse trees. Jay is regularly found in the high maquis where the trees are prevalently holm oak and cork oak.

Associated with magpie is great spotted cuckoo (*Clamator glandarius*), seen in holm oak woodland and littoral pine woods, although it is quite rare

and localized. Unlike the common cuckoo (*Cuculus canorus*), which lays its single egg in the nests of various small passerines, great spotted cuckoo is specifically parasitic on magpie (sometimes also hooded crow), and seeks out its nest in order to leave its egg there.

Two very brightly coloured birds belong to the order of the Coraciiformes: bee-eater (*Merops apiaster*) and roller (*Coracias garrulus*). These two extra-palaearctic representatives of Mediterranean fauna are very widespread in Africa and southern Asia. Both nest in Mediterranean countries and winter in shrubby savannah land south of the Sahara. Bee-eater is adept at capturing large insects in flight, mainly cicadas, dragonflies, large butterflies (bees, wasps, bumble bees) and large beetles (scarabaeids, cerambycids). It nests in colonies, burrowing tunnels in the kind of clay walls which are left standing after road works have been terminated, or after landslides. In these flamboyant societies of birds, some individuals do not reproduce, but play a role in feeding the nestlings born to other pairs to which they are related (altruistic behaviour). Instead, roller, larger and generally solitary, rests on branches before swooping down on large insects as they proceed, unaware of the danger, on the ground. The same order also contains hoopoe (*Upupa epops*), not exclusive to the Mediterranean maquis but always found in it. This bird, with its

Bee-eater (*Merops apiaster*)

showy plumage, crest of feathers on the head, and long curved beak, is immediately recognizable as it scratches among leaves and in the soil, searching for insects. It often nests in abandoned buildings or even within the walls of inhabited ones.

Among the Falconidae are several species, none of them exclusive to the maquis. In spring and summer, we find harrier eagle, or serpent eagle (*Circus gallicus*) and honey-buzzard (*Pernis apivorus*). Serpent eagle flies over the low maquis and garrigue, seeking the snakes which are its favourite prey. Honey-buzzard flies between the tops of trees and shrubs, every so often descending to the ground to eat insects. Instead, in winter months, hen harrier patrols the garrigue in search of small rodents, large insects, and lizards which have interrupted their period of lethargy to warm themselves in the sun on mild days. Bonelli's eagle (*Hieraetus fasciatus*) mainly eats wild rabbits, as well as birds ambushed in maquis clearings. Peregrine falcon (*Falco peregrinus*) is a



Honey-buzzard (*Pernis apivorus*)

non-migratory species and nests on the rocky limestone cliffs or large boulders emerging from the bright green of the maquis. Pigeons and thrushes are among its favourite prey.

Eleonora's falcon (*Falco eleonora*) is a migratory species which nests in colonies on isolated rocky outcrops in the Mediterranean islands, and then winters along the eastern coast of Africa, often in Madagascar. Hobby (*Falco subbuteo*) prefers the low maquis, and hunts young sparrows as they learn how to fly. Red-footed falcon (*Falco tinnunculus*), common mainly in the south, flies over the garrigue during the afternoon, until sunset, to capture flying insects.

Among the largest birds are Sardinian or Barbary partridge (*Alectoris barbara*), a sedentary, omnivorous species, widespread throughout North Africa and Sardinia, in both open land and the maquis. Other gallinacean species seen in these environments are quail (*Coturnix coturnix*), common grey partridge (*Perdix perdix*) and pheasant (*Phasianus colchicus*), introduced from Asia in historical times for both ornamental and hunting purposes.

Nocturnal raptors are not very abundant in the maquis, due to their difficulty in locating prey in the middle of the vegetation. Little owl (*Athene noctua*) and scops owl (*Otus scops*) are two of the most frequent species. The latter is especially abundant in southern regions, mainly during migratory passages, when travelling birds join resident ones. Both little owl and scops owl are very small and mainly eat insects. But the larger tawny owl (*Strix aluco*) and barn owl (*Tyto alba*) prevalently hunt rodents. Tawny owl is found mainly in holm oak woodland, and barn owl where ruins and old buildings can be used as refuges and nesting sites. During sunset hours and for most of the night, nightjar (*Caprimulgus europaeus*) is active, flying between trees and shrubs in the maquis, garrigue and along their paths, in search of insects. With its agile flight and sudden swoops, nightjar can capture moths and large beetles active at night, entering into competition with bats.

Holm oak and scrubby woodland host several species of woodpecker, mainly eating xylophagous (wood-eating) insects. They include green woodpecker (*Picus viridis*) and lesser spotted woodpecker (*Picoides minor*). Belonging to the same order is wryneck (*Jynx torquilla*), which mainly eats ants and termites.



Nightjar (*Caprimulgus europaeus*)



Fallow deer (*Dama dama*)

**Mammals.** Although it is difficult to identify animals in other zoological groups which are truly exclusive to the Mediterranean maquis, when speaking of mammals the search becomes even more arduous. On one hand, the small number of species reduces the probability of finding representatives of all ecological categories; on the other, the endothermy of these animals - that is, the fact that they have physiological mechanisms which render them independent of the external temperature - means that most mammals have been able to colonize all the environments of the Italian peninsula, and often those of northern Italy as well. In addition, it must be considered that mammals, above all those of medium and large size, need extensive territories in order to search for food and are thus at a disadvantage when set in such a restricted coastal habitat as the evergreen maquis which, during glacial periods, occupied an even smaller surface area than it does today. The populations of mammals associated exclusively with the evergreen maquis would have been too small to be vital from the genetic viewpoint. In historical times, in some areas of mainland Italy where environmental continuity existed from the mountains to the sea, some large mammals moved to the plains during winter months and often reached the maquis. In this way, grazing pressure on the natural vegetation remained slight, because the animals migrated from one type of habitat to another according to season. Wild boar, roebuck and deer moved as far as the evergreen maquis in winter to exploit the green clearings where grass had regrown after the summer fires, and then moved inland, to deciduous woodland, in spring and summer. Even wolves could move around in the same way, following their prey. This flow of energy between bordering ecosystems was interrupted by the development of intensive agriculture and the growth of towns in the plain, as barriers were inevitably erected against the free passage of wild animals. At the present time, this leads to greater grazing pressure in protected areas of Mediterranean maquis, which must support wild boar and sometimes roebuck too, in excessive numbers, throughout the year. This situation does not apply to small and medium-sized mammals, the populations of which follow dynamic models similar to those of reptiles and insects, and are associated with circumscribed territories, without seasonal movements. Insectivorous mammals include hedgehog (*Erinaceus europaeus*) and several species of shrew, mouse, etc. Hedgehogs are omnivorous, and their diet includes protein of both animal and vegetal origin. This means that hedgehogs are in effect scavengers which move undisturbed among the vegetation and eat almost everything they find, from strawberry tree berries to vipers, from chicory leaves to locusts. They also have another name in Italian - "hedge pig" - which often leads to confusion with porcupine. The maquis in



Lesser white-toothed shrew (*Crocidura suaveolens*)

north-eastern Italy also hosts a larger relative, eastern hedgehog (*E. concolor*). On the opposite scale, even tiny, hyperactive shrews are already predators: they eat enormous quantities of invertebrates, from earthworms to beetles, which they seek out avidly with their long, sensitive snouts. The most heat-loving and characteristic of the maquis are white-toothed shrew (*Suncus etruscus*) and lesser white-toothed shrew (*Crocidura suaveolens*). Roman mole (*Talpa romana*) also lives in sandy soils, but avoids the intricate weave of roots which represent the subterranean world of the maquis, and is thus mainly found in dry meadows resulting from the extreme degradation of evergreen vegetation. In temperate zones, mole mainly eats worms, but in the Mediterranean zone its diet also includes a large number of insects, isopods and spiders.

Bats fly at night on the low maquis to capture moths and large beetles in flight. During the day, they rest in the hollow trunks of old holm oaks or in cracks between rocks. Although no research has defined the ecological distribution of bats, European free-tailed bat (*Tadarida teniotis*), Savi's pipistrelle (*Pipistrellus savii*) and Kuhl's pipistrelle (*P. kuhlii*) seem to frequent the low maquis most.

Italian hare (*Lepus corsicanus*), recently discovered and thus only slightly known from the ecological viewpoint, may be the only lagomorph indigenous to the Italian Mediterranean maquis, exploiting its transitional aspects, such as clearings and the ecotonal zones between open and cultivated meadows. The other species, wild rabbit (*Oryctolagus cuniculus*), although more widespread and abundant than hare, is not native to Italy, but was introduced in historical times from the western Mediterranean (Spain and North Africa).

At the present time, rabbit forms stable populations mainly in the coastal and

subcoastal maquis of the Tyrrhenian littoral, Sardinia, Sicily, and many of the small islands. These populations fluctuate in numbers both as a result of the periodic collapse of their food resources, and because of myxomatosis, an epidemic disease often used by man to control the numbers of proliferating wild rabbits. Both rabbits and hares only eat vegetable matter, which they seek by night and during the day, but mainly at dawn and sunset. These animals are greatly sought after by many carnivorous mammals and birds of prey, and are thus always on the alert, ears pricked, ready to dart off into the protection of bushes at the least provocation. Hare sleeps and raises its young in grassy beds among bushes, whereas rabbit digs deep tunnels in sandy terrain.



Dormouse (*Muscardinus avellanarius*)

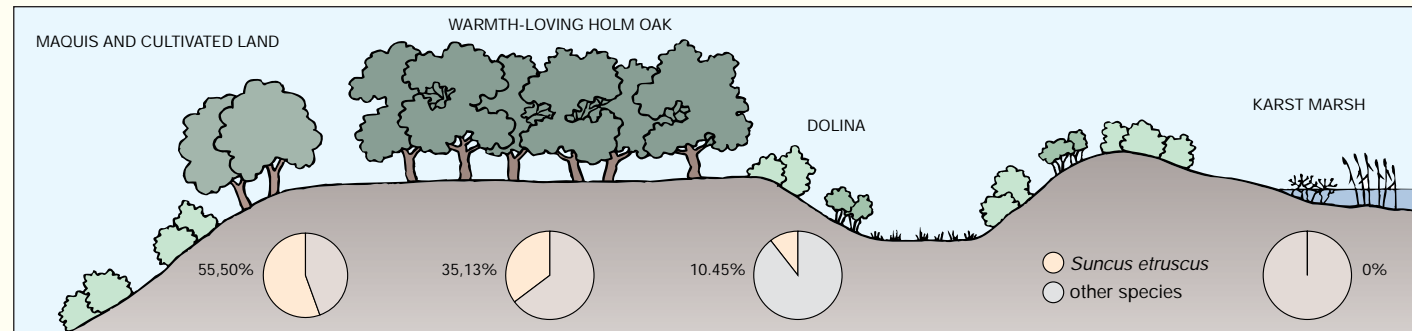
With its warm, dry climate, evening breezes, salty atmosphere, spectacular flowerings, and particular sounds and scents, the maquis typically grows along coastlines throughout the Mediterranean basin. Blinding sunlight, the hypnotic sawing sound of cicadas, the cries of seagulls, and the fragrance of thyme, sage and origan accompany our perception of this environment, which is in fact also populated by invisible communities of small mammals. These harsh habitats - intricate, hot, arid, but seasonally rich in food resources - host tiny warmth-loving mammals. They include some minuscule shrews, generally found in African parts of the Mediterranean or in south-east Asia. One example is white-toothed shrew (*Suncus etruscus*), certainly the most common, always accompanied by lesser white-toothed shrew (*Crocidura suaveolens*), but in Sicily and several other Mediterranean islands the latter is replaced by its Sicilian relative (*Crocidura sicula*).

Other common cortège species are bicoloured white-toothed shrew (*Crocidura leucodon*), replaced in Sardinia by greater white-toothed shrew (*Crocidura russula*), imported by man,

wood mouse or long-tailed field mouse (*Apodemus sylvaticus*), and a small contingent of anthropophilous species. These may include house mouse (*Mus domesticus*) and black rat (*Rattus rattus*), which both often prefer living on and in cliffs and stony habitats. The microhabitat represented by cracks between rocks is particularly stable from the thermic viewpoint, and enables these animals to withstand summer aridity more easily. This type of habitat is also chosen by a glirid, garden (or oak) dormouse (*Eliomys quercinus*), which in these intricate belts of coastal and insular vegetation is differentiated into various karyological races differing in size and colour. The cool undergrowth of the maquis is also frequented by another glirid, hazel dormouse (*Muscardinus avellanarius*) which, in Sicily, has a particular aspect: a clearly marked dorso-ventral line and white stripes on the face. Garden dormouse, hazel dormouse and black rat all build spherical nests suspended in the tangled undergrowth of the maquis. According to season, these nests may serve various functions, but are generally used for raising young. European hedgehog (*Erinaceus europaeus*) is always common in the

maquis undergrowth. Although never reaching high populations, it exploits the deepest tangles of thorny bushes to build a nest, composed of a heap of small twigs and dry leaves between 20 and 30 cm high. Inside this simple structure, the female wriggles her body around in order to create a protected space in which to feed her babies when they are very small. In the reduced maquis in the high Adriatic, near the frontier between Italy and Slovenia, the western hedgehog encounters the larger eastern species (*Erinaceus concolor*), forming unusual mixed populations which may be found around Duino-Aurisina (Trieste). But they are not the only peculiarity to be found in the high Adriatic Mediterranean maquis. In the same area, the most typical warmth-loving Mediterranean micro-mammals cross with the range of distribution of snow vole (*Chionomys nivalis*) which, here, may even be found near sea level. Although in itself this fact may be surprising, it should be recalled that snow vole prefers rocky haunts, and the numerous cracks in the limestone rocks provide plenty of microclimates suiting its biological needs. In this particular habitat, the importance of altitude for other vertebrates preferring

stony habitats (*Eliomys quercinus*, *Vipera ammodytes*, etc.) widens considerably, sometimes ranging from sea level to the highest mountain massifs. The current extent and flora and fauna of the Italian belt of the Mediterranean maquis were influenced, on one hand, by the Messinian salinity crisis (Miocene) and, on the other, by the consequences of the most recent Neozoic glaciations, which covered large areas with ice and repeatedly reduced the vegetational cover (see also page 75). Both because of their limited surface area and the cyclical effects of glaciations on their width, the various belts of the Mediterranean maquis did not allow the differentiation of a large number of endemites. But some small mammals which live in this habitat evolved in conditions of isolation, sometimes differentiating to a considerable degree. An example is white-toothed shrew (*Crocidura sicula*), today found exclusively in the Sicilian and Maltese island system (Sicily, Egadi, Ustica, and Gozo). These little animals are valuable elements within the Italian Mediterranean fauna, and are perhaps the only current endemic mammals with populations which were not introduced into the islands by man.



Relative abundance of white-toothed shrew (*Suncus etruscus*) in an environment with maquis and cultivated land on the high Adriatic coastline and in habitats further inland, intensely karstified. This tiny shrew shows relative densities directly connected with environmental temperature, greater in the coastal maquis than on the karst plateau, but inversely correlated with soil humidity. Instead, the density and abundance of other species of micro-mammals appears to vary locally, according to opposing thermal and hygrometric gradients

Other species of rodents live in the maquis and are the basic food resource for many animals such as carnivorous mammals, birds of prey (falcons and owls) and snakes. The glirid family contain dormouse (*Muscardinus avellanarius*) and garden dormouse (*Eliomys quercinus*). Dormouse populations in the Mediterranean maquis have a particular biological cycle, different from that described for those living in deciduous woodland. For example, their period of hibernation is much shorter or almost absent, thanks to the availability of food and the mild climate. Both species are widespread, from evergreen maquis to beech woods. Garden dormouse seems to prefer habitats where the maquis is sparse and interrupted by limestone rocks, full of holes in which this species can easily find refuge.

All the murids in Italy are amply distributed, from sea level to mountain woodland. Black rat (*Rattus rattus*) is the most heat-loving of all small Italian rodents, revealing its remote South-East Asian origins. In the high maquis, black rat builds nests in trees and often raids birds' nests, eating both eggs and nestlings. If present in great numbers, it probably has a negative influence on the conservation of several species of birds and also dormice.

Porcupine (*Hystrix cristata*) is the largest rodent found in the maquis. It searches



Porcupine (*Hystrix cristata*)

for food, which consists of roots, leaves and fruit lying on the ground, mainly at night. According to some experts, porcupine became extinct in Europe during the last glaciation, for natural reasons, and was reintroduced into Italy by the Romans, who were accustomed to eating it as a delicacy. According to others, small numbers of the species survived in Italy, explaining why no recent fossils remain. In any case, the genus *Hystrix* seems to be of paleotropical origin, with an ample distribution which includes most of Africa and the temperate-hot zones of Asia. In Italy, the species is common mainly on the Tyrrhenian flank, in environments with evergreen maquis and deciduous woodland, but it may reach the Apennines, and has also colonized the Adriatic flank.

In areas in which the Mediterranean maquis and holm oak woodland have been enriched with domestic pine, giving rise to the typical pinewoods flanking beaches, are populations of European red squirrel (*Sciurus vulgaris*). This species, mainly found in mountain woods, may appear as a relict population in plain and hilly land, e.g., in the Mediterranean maquis mixed with domestic pine along the Tuscany-Latium littoral. Its populations are subjected to great oscillations in numbers, and may become so scarce as to appear locally extinct from a certain locality for decades. On the Roman littoral, squirrel has been observed very recently, after many years of apparent absence.

Fox (*Vulpes vulpes*), badger (*Meles meles*) and pine marten (*Martes martes*), stone marten or beech marten (*Martes foina*) and weasel (*Mustela nivalis*) are carnivorous mammals living in the evergreen maquis, but all of them may also be found in the Apennines.

Pine marten is the only tree-living species, preying on the contents of birds' nests, dormice and black rats. It has also been observed to take tits and dormice, slipping a stealthy paw into their nests, in natural holes in tree-trunks or even in the artificial nesting-boxes set in place by bird-watchers or environmentally sensitive groups of people, to monitor tree-living animals. Fox, stone marten and weasel all turn their attention mainly to small soil-living rodents and wild rabbits, although their diet does contain vegetable matter.

Above all, fox, stone marten and pine marten consume great quantities of fruit and berries, like those of strawberry tree, juniper, sloe, bramble and other plant species of the rose family. For stone marten, fruit may represent up to 60% of its total diet. The animal portion of badger's diet in the Mediterranean maquis includes many insects, mainly larvae, for which the animal digs in the soil, whereas in deciduous forest environments the main prey are worms. These differences in preferred food in species living either in the evergreen maquis or in deciduous forest may be observed in all the carnivores.

Ungulates indigenous to the Italian Mediterranean maquis are wild boar (*Sus*

*scrofa*) and roebuck (*Capreolus capreolus*), both adapted to living in dense shrubby undergrowth. Fallow deer (*Dama dama*), extinct in prehistorical times in Italian ecosystems, is considered a species introduced from the Middle East, and thus not indigenous. Today, it is found in many protected areas, reintroduced for recreative and ornamental purposes; however, the authorities managing reserves or parks must very often intervene to allow it to survive, by supplying food both during winter months and during summer drought. Also not considered native to Italy are the mouflon (*Ovis orientalis*) and the wild goat of Montecristo (*Capra aegagrus*), both originating from the Middle East, representing the ancestors of, respectively, domestic sheep and goats. Today, mouflon is widespread over enormous areas of the Mediterranean maquis, above all in Sardinia and some small islands like Capraia, Elba, Giglio, Asinara, Zannone and Marettimo.

Red deer (*Cervus elaphus*) is a species mainly found in deciduous woodland and mountain pastures, although it can survive in pure or mixed evergreen formations, like the populations introduced into Sardinia in ancient times. Until a few decades ago, these Sardinian herds living in the maquis were believed to be autochthonous and part of a subspecies endemic to the island. It now appears that they are the result of ancient introduction from Italy and they thus



Mouflon (*Ovis orientalis*)

constitute the last residual core of animals native to the mainland. And indeed, all the populations of red deer living in Italy (with the possible exception of the Bosco della Mesola, on the Adriatic flank of Italy south of Venice) derive from recent reintroductions of individuals from central and eastern Europe. Also in the case of wild boar, most of the herds now living in the Mediterranean maquis are the offspring of animals from other European countries, artificially introduced for hunting purposes.

Wild boar, due to its large size and long skull, is easily distinguished from the original Maremma boar (*Sus scrofa majori*), now living in a few protected areas and well adapted to life in equilibrium with the natural resources of the Mediterranean undergrowth. Unlike other Italian ungulates, wild boar does not only eat vegetable matter, but is omnivorous, behaving like a predator every time it meets small, weak or easily captured animals. The young of mammals, the nestlings of soil-nesting birds, reptiles and invertebrates are a regular part of the diet of boar which, when in excessive numbers, may damage other animal species, to the extent of risking their survival in small areas. The current absence of wolf in the Mediterranean environment has led to over-reproduction of wild boar, which has no other predators capable of controlling its populations and thus seriously damages the soil of the maquis and its resources.



Wild boar (*Sus scrofa*)

### ■ Conservation and management of the landscape

For thousands of years, man's activities in the Mediterranean regions have brought about a steady and considerable transformation of the natural environment, by means of traditional practices involving agriculture, forestry and pasturage. This transformation, contrary to popular belief, has caused an increase in the diversity of species and habitats, changing what was once a monotonous landscape of primary forest dominated by holm oak and a few other species, to a varied mosaic of maquis, garrigue, dry pasture and secondary forest. Its animal communities have thereby been enriched with opportunistic species of high ecological plasticity which have spread along the coasts, starting from more inland habitats. However, although man and his interventions often enhanced biodiversity in the past, as the dynamics of the landscape reveal, at the present time the opposite is true, since the powerful instruments of modern technology are too invasive and destructive of the fragile biological equilibrium.

In the specific case of the maquis, in those places where it still grows along a narrow coastal belt, man - with his buildings, tourist resorts, roads, railways, and all their infinite infrastructures - has endangered that vital minimum surface area which is indispensable for balanced, well-organized development of so many vegetal formations. If we compare the present state of the vegetation with its situation only a few decades ago, it is clear that urbanization and the abandon of agriculture after the Second World War have meant that the "natural" vegetal cover has increased so much that some aspects of the landscape, once provided by replacement plant communities, has almost completely disappeared. The result is floristic impoverishment.

At the present time, the factor which most influences the transformation of vegetation, causing the regression of more evolved, better structured types to degraded ones, is fire - or, rather, a repeated series of fires. On one hand, fire eliminates those species which are less capable of recovery; on the other, the soil progressively becomes poorer and shallower.

As a consequence of the passage of fire in the short term (from one to a few



A walk on the hills of the Ligurian riviera, further south along the Amalfi coast, or in other places of interest to tourists may reveal surprises. Among the buckthorn and lentisk, which we expect to see, we also find a series of plants which are absolutely out of the ordinary, yet clearly well integrated in the luxuriant natural vegetation. These are exotic species, i.e., ones which grow outside their original area of distribution.

The historical tradition of acclimatization nurseries and nursery-gardens specializing in both growing plants and selling them, has led to a constant process of floristic enrichment in exotic ornamental species. If the species in question come from bioclimatic situations similar to those of



Ailanthus, or tree of Paradise (*Ailanthus altissima*)



*Pittosporum tobira*

the Mediterranean environment, they become integrated with it and may even replace local indigenous species. Examples are ornamental shrubs like pittosporum (*Pittosporum tobira*, widespread everywhere, and *P. undulatum*), a close relative from Australia, with beautiful blue flowers; *Sollya heterophylla*, naturalized around La Mortola (western Liguria, near the border with France); yellow African mimosas (*Acacia dealbata* and *A. cyanophylla*), which form true groves (in the south of France, they even gave rise to the name of the town called Bornes-les-Mimosas); oleaster (*Elaeagnus pungens*), Chinese or glossy privet (*Ligustrum lucidum*), and roses growing in clusters (e.g., *Rosa banksiae*), which come from China and Japan.

We also find lianas, like the southern African senecio (*Senecio deltoideus*, *S. angulatus*), and *Danaë racemosa*, from Asia Minor, an introduced species grown in Liguria as a green frond and widespread in the area, its seeds being spread by birds.

Other species, like wattle (*Acacia saligna*) or acacia (*Robinia pseudacacia*), were originally planted

extensively in heavily anthropized areas for purposes of reafforestation or along road embankments.

Special mention must be made of the ailanthus, or tree of Paradise (*Ailanthus altissima*), from the Far East. It was introduced into Italy in 1760 as a useful plant and, thanks to its great capacity for producing shoots and abundant seeds, it invaded the Mediterranean

environment in the same way that acacia invaded the Po Plain area. In particular, it expanded steadily in the natural reserve on the island of Montecristo, off the Tuscan coast. Not checked by herbivores, which do not like its unpleasant taste, it invaded open spaces created by over-grazing by goats on the small island, leading to a situation of biological disequilibrium.



Mimosa (*Acacia dealbata*)



Open spaces in the maquis allow olive trees to be cultivated, surrounded by a low protecting wall



Maquis near Arbatax (Sardinia)

years), the structural and floristic characteristics of the vegetation regress. Where slopes are steep, soil leaching may be very severe, above all if fire is followed by intense rainfall: clearly, when these two phenomena - fire and water - follow closely upon each other, the finest soil particles are carried away and the superficial layers become even thinner. The result is a pebbly soil, poor in nutritive substances, on which only discontinuous formations made up of undemanding species can survive. Floristic impoverishment is thus due more to soil impoverishment than to any direct damage to plants by fire. There is a close relationship between type of vegetation and frequency of fires, and this means that areas at greater risk of fire must be identified. A properly constructed map of the real vegetation growing in such areas would highlight the types of vegetation which are statistically most vulnerable to fire, so that rational plans for prevention and environmental management could be laid down. In the long term, such interventions must aim at re-creating the tree cover (particularly holm oak woodland) by choosing specific plants suitable for each location. This kind of reconstitution must take into account the natural dynamic steps of nature and thus must develop woodland not simply by planting the end-species, but by using intermediate species capable of "paving the way" - preparing and setting up the ecological conditions suitable for the planned final result. One intermediate stage towards proper tree cover, set within programs respecting the natural dynamism of shrubby formations, is to favour species which propagate easily and rapidly - i.e., the principal shrubs of the maquis, selected according to local ecological and vegetational conditions. In any case, local interventions must first be examined in great detail, to ensure that they really are suitable for the conditions of the area in question. Clearly, the territory, profoundly transformed as it is by man, can never really return to its original state. We have seen that, in the case of the Mediterranean vegetation, naturalness and biodiversity are often inversely proportional. So action must be taken on the basis of rational, precise management strategies, with the main aims of maintaining high levels of biodiversity and conserving a certain level of naturalness resulting from that ancient dynamic equilibrium which once existed between proto-historical man and the environment.

In all the Mediterranean-type ecosystems in the world (they also exist in California, Chile, Southern Africa and Australia), the question of fire is one of the most hotly debated topics in the field of conservation and management of fauna. Apart from the direct consequences (positive or negative, as the case may be) on plant life, we must also ask ourselves what impact fire has on animals. The answer, here, becomes complex because, as well as considering the effects of fire on faunal conservation in ecological terms, many people are concerned about the effects which it may have on individual animals, in ethical terms. Most public opinion is oriented in more animalistic than environmentalistic terms, and the general public does not really know much about the evolutionary mechanisms and functioning of ecosystems, so that it acts for emotional rather than rational reasons, and very often interventions which are harmful for conservation itself are urged or carried out.

A typical example of this way of thinking is the case of capturing tortoises and putting them inside protected fenced-off pens to prevent them from being killed by fire. What actually happens is that a natural population originally in equilibrium with its environment is destroyed. At the same time, the delicate network of territorial and social relationships between individuals and the living space which they had created for themselves according to the availability of resources, is equally destroyed. The fact that a certain number of tortoises die during fires is part of a natural, ongoing process: their bodies are consumed by other animals, thus contributing to the general flow of matter and energy.

Clearly, when fires are deliberately set and thus repeated too often in time, the number of tortoises and other animals which perish may be too high and may threaten their survival in terms of species present in a certain area. So fires must be fought when they are too frequent and destroy too much of a protected area. There is also the fact that we do not know much about the effects which foam-producing and other chemicals used in fire-fighting may have on the animals on which they fall, but they can hardly be beneficial!

Although many birds and their nests, reptiles and mammals, and an enormous number of invertebrates die during fires, their death is in fact part of a cycle which feeds and supports the organisms living in the evergreen maquis. There are plants, called pyrophytes, which (like some animals) actually benefit by fires, since fires help them, afterwards, to avoid competition with other species. One particular case is that of the buprestid beetles of the genus *Melanophila* (see section on insects), which lay their eggs in burnt tree-trunks. In addition, wild boar quickly arrive to feed in clearings which have been created by fire,



Blue tit on her nest

where they search for the bodies of dead animals, dig easily in the soil now freed of vegetation, and find roots, tubers, insect larvae and other delicacies. The fire which occurred on July 4 2000 and devastated the pinewood and maquis of Castelfusano (near Rome) represented an opportunity to study the recolonization of burnt-out portions of maquis by animals. Already in spring 2001, many species of phytophagous beetles were to be found on the flowers blooming on newly grown plants. Throughout spring and summer, flowers of the rose families and asters were covered with oedemerids and scarabaeoids, all actively living out their lives. One species of the genus *Amphimallon* turned out to be much more abundant in the burnt areas of pinewood than in those untouched by fire. It is an incontrovertible fact that environmental heterogeneity does cause an enormous increase in faunistic diversity. If the authorities managing a protected area of Mediterranean maquis were able to work until the so-called climatic phase is reached, with mature holm oak woodland over the entire surface, the diversity of animal species in the area would collapse and the plant community would be poor and monotonous, formed only of shade-loving and hygrophilous species. The undergrowth would be poor in species attractive to herbivores, it would contain neither flowers for flower-living insects nor food for insectivorous birds, and it would not allow that thermo-regulation necessary to so many "cold-blooded" animals such as reptiles, and butterflies.

Spontaneous fires and the fall of trees generally give rise to a precious mosaic of

clearings, alternations between closed and open areas, maintained in time by the activities of herbivorous mammals, working as "nature's gardeners". In this complex puzzle of tiny plots of land at various phases in the natural succession, shade-loving and sun-loving species, both animal and plant, alternate. It is not by chance that the paths which cross the maquis represent so many ecotonal (transitional) strips where species diversity is very high. During the night, they act as flight-paths along which moths fly, followed by their predators, bats.

Proper management of the Mediterranean maquis must bear all these factors in mind, and not simply fix on the idea of a uniform landscape which, while it may correspond to the ideal model of climax, also signifies the impoverishment of so many communities. The best strategy would be that of guaranteeing a high degree of variety and structure in the vegetation, trying to reconstruct equilibria among plants, herbivores and predators, and controlling fires without regarding them as agents of evil. Nor is an inflexible position from the ethical viewpoint to be recommended: instead, management should consider the possibility of interventions aimed at controlling the numbers of animal populations when they threaten the conservation of other species. For instance, throughout Italy the numbers of crows, starlings and wild boar are on the increase - to the extent that they have become a nuisance because their activities are enhanced by those of man. Crows and starlings cause great falls in the numbers and sometimes even the disappearance of many species of small birds and insects. Wild boar threaten many species of plants (orchid, lily,



Dormouse (*Muscardinus avellanarius*) on a nesting-box

amaryllis and iris) and animals. The presence of herbivorous mammals is important in all ecosystems and thus also in the evergreen maquis which, however, due to its physiognomy, can really only host roebuck. Fallow deer and muflon, introduced by man in more or less ancient times, are the subject of hot debate. In spite of their Middle Eastern origin, they now live in many protected areas and are often the main attraction for visitors. Removing fallow deer from the Maremma natural park or muflon from Sardinia would, today, be an academic exercise and highly unpopular with the general public. But their numbers should be reduced where they damage the vegetation. And it would even be better to keep some of them in very large fenced-off portions of land, near pic-nic areas, which could act as "buffer zones", attracting the public while concentrating and maintaining the anthropic load in a few isolated points. In this way, the negative impact of mass tourism on areas with higher degrees of naturalness could be avoided. The management of hunting and shooting in the Mediterranean maquis should also be planned better, bearing in mind special criteria for protecting local biodiversity. Some particular areas of the maquis habitat are traditionally hunting reserves, precisely because they host game which is specifically suited to the environment.

One outstanding example is that of Italian hare (*Lepus corsicanus*), for centuries known to the hunters of central Italy by the name of "maquis hare". Although popular wisdom had already identified its peculiarities, the specific status of this splendid Italian endemite was only recognized about ten years



Italian hare (*Lepus corsicanus*) is easily distinguished from common hare by its two-coloured flanks



Hermann's tortoises (*Testudo hermanni*) hatching

ago, thanks to studies on morphology and genetics. Its conservation requires special measures regarding the management of some human activities, including careful planning of hunting quotas in the areas of greatest importance for this species, also drastic culling (central-southern Italy) or cessation of the practice of deliberately introducing hare (Sicily) to support the populations of European hare (*Lepus europaeus*) for hunting purposes. European hare competes with Italian hare for resources, obliging the latter to take shelter in less productive habitats and thus reducing its numbers.

Also Italian roebuck (*Capreolus capreolus italicus*) is well adapted to the sometimes harsh environmental conditions of the Mediterranean maquis. Its peculiarity is shown both by its small size and the characteristic yellowish colour of its rump patch, and by the presence of some nuclear markers typical of its genome. Decimated for centuries by hunting, it appears to survive only in some isolated populations in central and southern Italy (Lazio: Castelporziano; Apulia: Foresta Umbra, Gargano promontory; Calabria: Orsomarso mountains). The main danger for roebuck is genetic contamination due to the practice of introducing other animals to support populations for hunting purposes. The introduction of the larger Central European roebuck already seems to have led to hybridization in several areas of southern Tuscany (Maremma, Siena hills). The conservation of the genetic pool of Italian roebuck is thus linked to measures which favour the autonomous expansion of the remaining populations, at the same time eliminating the practice of introducing allochthonous (non-indigenous) roebuck for hunting.

Another example is the conservation of Hermann's tortoise, of which Italy has several precious populations. The attention of authorities should be devoted not only towards preventing these animals from being collected from the wild and used for commercial and amateur purposes, but also towards containing the populations of some introduced species (spur-thighed tortoise, marginated tortoise) which locally compete for food with the indigenous species and lower its birth rate by producing sterile hybrids. The Mediterranean maquis is thus an environment of considerable importance for the conservation of many species listed in the Habitat Directive (92/43/CE): as well as *Testudo hermanni*, the maquis also contains *T. marginata* and *T. graeca*. Again, among reptiles, the Habitat Directive includes four-lined snake (*Elaphe quatuorlineata*), leopard snake (*E. situla*) and Sardinian discoglossus (*Discoglossus sardus*), the survival of which is at least partly associated with that of the Mediterranean maquis.

Proper management of fauna also means that the activities of some species, introduced or favoured by man, must be prevented from causing the extinction of many others and impoverishing biological communities.

## Suggestions for teaching

MARGHERITA SOLARI

### ■ Introduction

Although the environment of the Mediterranean maquis is a precious heritage constantly in front of our eyes, only a few people are able to appreciate it in its totality.

The following sections propose some teaching suggestions offering stimulation to teachers and all those who wish to reveal the richness and intricacy of this particular environment to young people of all ages.

### ■ Fire: study models

- Aims: to enhance awareness of the damage which repeated fires can produce in the Mediterranean maquis; to develop aware behaviour and a capacity for assessment and analysis; to teach the importance of the use of models in risk prevention; to understand the usefulness of prevention.
- Level: children and youngsters from 8-13 years of age.
- Equipment: illustrations of woodland, maquis and garrigue environments; charts and diagrams on the growth and development of plants which produce shoots rapidly. Material for producing models (available from stationery shops) and, if possible, equipment for sampling invertebrate fauna from the soil and identifying it.
- Possible collaborators: forestry corps guards, naturalists.

### PRELIMINARY PHASE

1. Make a list of the possible causes of fire, subdividing them into various types: natural versus anthropic, deliberately set (arson), negligence, etc..
2. Discuss the causes of fire, and examine the problem from the viewpoint of newspaper articles and TV presentation, or statistics.
3. According to the above, prepare a list of measures which, in your students' view, would be most effective in reducing the risk of fire. Compare these measures with the provisions set out by the main laws in force.
4. Describe in a simple manner the various types of vegetation found in the Mediterranean maquis and garrigue. Illustrate the mechanism of shoot production in some maquis species, e.g., heath, strawberry tree.

Maquis on island of Zannone (Latium): trees in foreground have been defoliated by salt-laden wind





Maquis recovering after the passage of fire: holm oak, heath and diss grass are once again growing strongly

#### ANALYSIS OF THE PROBLEM OF FIRE

5. Hypothesize the effects of fire in various types of vegetal cover, e.g., pinewood without shrubby undergrowth, pinewood with shrubby undergrowth containing shoot-producing shrubs, maquis with strawberry tree, heath and spiny broom.

6. Construct models in polystyrol foam, plywood or cardboard, with cut-outs of the various plant types, such as trees, shrubs and grasses. For each model, hypothesize the consequences of one isolated fire and of repeated outbreaks. Complete the models with initial (pre-fire), intermediate and final phases. The results might be as follows:

- Pinewood without shrubby undergrowth: after a fire, damage is limited to young pines, and flames do not reach the tops of the highest pines; the ecosystem reconstitutes itself when the terrain becomes mature again. After several fires, damage may be considerable.
- Pinewood with shrubby undergrowth containing shoot-producing shrubs: after a rapid fire, since shrubs carry flames right to the tops of plants, both pines and shrubs die; shoot-producing shrubs quickly reconstitute the undergrowth, preventing the settling of species extraneous to the initial plant community. After several fires, damage is irreparable and leads to regression of plant communities.
- Maquis with strawberry tree, heath and spiny broom: after a fire which expands rapidly, the situation may return to its original state within 8-10 years, since these species are capable of producing shoots easily. After several fires, damage is irreparable and leads to regression of plant communities.
- In all types of vegetation, therefore, a single fire may not represent a serious threat and may indeed be beneficial - particularly if the burnt territory now has new features favourable to both animal and vegetal species, unlike those existing before: this increases biodiversity.
- In all other cases, repeated fires create imbalance and lower the degree of evolution of the environment, leading to impoverishment: garrigue and poor, discontinuous meadowland are the end-results.

#### EXCURSION

7. Study on-site the effects of a fire on the ecosystem, by analysing the invertebrate fauna in the soil as a good biomarker for comparative research: this type of study may proceed with a series of samplings in an area which was subjected to fire a short time previously (e.g., less than one year). Compare the results obtained with the structure of the populations in an unburnt area similar to the burnt one.

Repeating this examination one or two years later considerably enhances the significance of the study. For soil fauna, carry out direct research (noting the greater number of species found) or set traps to monitor fauna active in the shallowest layers of soil. Collect complementary data for other faunistic groups by taking soil samples, which can then be examined in the laboratory by gently heating them and collecting the animals as they try to escape from the artificial source of heat (Berlese funnels).

8. Analysis of faunistic data: comparisons of the structures of invertebrate communities may reveal the absence or reduction, for instance, of typical litter fauna (diplopods, springtails) in burnt areas; the presence of earth worms and phytophagous gastropod molluscs may also be influenced by fire. In some groups of soil beetles, the number of typically woodland-loving species, with little capacity for flight, will fall, as opposed to an increase in the number of winged species, which are obviously more able to move about easily and have a greater potential for dispersion.

During the recolonization phase, the numbers of both species and individuals definitely increase, thus substantially augmenting biodiversity. Species typical of open and transitional areas clearly tend to penetrate and occupy the newly available environments; woodland species tend to re-occupy burnt areas as the woodland reconstitutes itself.

9. Debate and conclusions: thinking about the consequences of fire in the environment of the Mediterranean maquis should stimulate the desire to demonstrate and promote awareness and responsible behaviour among everyone, young and old alike, although it should not be forgotten that even events like fires have their own importance and significance in the natural evolution of vegetation and fauna. Fires, if sporadic, can lead to enrichment, and the extreme action of man is sometimes not indispensable and may even be harmful: for example, using foaming chemicals to put out fires kills or maims many living species.

#### ■ Leaf morphology of some species found in the Mediterranean maquis

- Aims: to develop capacities for analysis, observation, comparison, and hypothesis; to understand the delicate equilibrium between form and function in vegetal organisms; to understand the relations between biology, phenology (the study of periodical biological phenomena), climate and environment.
- Level: high school students (14 years of age upwards); the same subjects, simplified, may be presented to younger students.
- Equipment: distribution maps of species such as holm oak, oleander and



Low maquis with thyme and ever-lasting flowers

lentisk; the leaves of these species; microscopy and thin sections of the same leaves; identification manual of trees and shrubs; manual of plant histology. Clothing suitable for excursions.

#### PRELIMINARY PHASE

1. Research and analysis of temperature and rainfall trends in some climates of Mediterranean type, which show differences in periods of drought: thermo-Mediterranean (7-8 months without rain), meso-Mediterranean (5-6 months of drought) and sub-Mediterranean (3-4 months). Analysis of relative temperature and rainfall diagrams, and of aridity and solar radiation in summer in environments with these climates.
2. Discussion on probable factors influencing vegetation: clearly, summer drought is of primary importance, followed by low temperatures poorly tolerated by hot-climate species.
3. In-depth study of the form and functions of the various organs of plants: stem, root apparatus and leaves, with reference to the metabolic processes of synthesis which occur in leaves (photosynthesis, respiration, transpiration).
4. Bibliographic research on the various adaptations which plants make to resist summer drought. For instance, attention could focus on some aspects of their biological cycle, like maximum vegetative activity in spring, vegetative rest and estivation (with loss of leaves) in summer, or two or three months of

active vegetation in spring for annual plants. Other morphological adaptations are: modification of leaves, which in maquis plants become spiny, to limit transpiration; development of hard leaves with dense down, which reduces the impact of solar radiation and transpiration; thick protective cuticle; development of woody rather than soft stems.

#### EXCURSION

5. Choose an accessible area of Mediterranean maquis with representative vegetation, and organize an excursion, preferably in spring.

6. Focus students' attention on the individual and most significant features of the vegetation.

7. Complete observations and, if possible, take suitable photographs. Limit the collection of leaves, for classroom study later, to the minimum, in order not to transmit or encourage poor awareness of the need to respect the environment, since this would obviously be counter-productive. Collect dry leaves from the ground.



Ramblers' path in the Cilento Park (Campania)

#### CONTINUATION OF STUDY IN THE CLASSROOM

8. Observe and compare leaves from different types of trees, e.g., holm oak, laurel, oleander, wild olive (which has hard, thick leaves, sometimes downy on the underside). Compare them with leaves from species living in a continental climate, such as hornbeam or beech. Demonstrate distribution maps of species, for comparison with other plants living in the Mediterranean climatic belt.

9. Observe under the microscope and compare cross-sections of leaves - preferably wild olive, holm oak or laurel (the latter are more difficult to dissect, so it is better to buy commercially prepared slides), or even oleander (which is highly specialized). Focus students' attention on how cross-sections are cut, particularly if you let the students do this themselves, and ensure that they are properly protected (e.g., gloves or rubber tubing). Note the superficial cuticle and the fact that stomata are sunk in cavities with protective hairs, to limit transpiration as much as possible.

The following may usually easily be identified on the upper sides of leaves:

- epidermis covered with a thick cuticle
- hypodermis a few cell layers deep
- palisade parenchyma
- spongy parenchyma

Instead, on the underside, note:

- the possible presence of crypts covered with hairs, which have the function of insulating the leaf and minimizing transpiration
- stomatal apertures (inside the crypts).

10. Collect all data and summarize students' impressions in a final report.

#### ■ Essential oils contained in Mediterranean plants

- Aims: to develop capacities for observation and how to make connections; to stimulate an attitude of personal investigation which enhances experiences and the use of one's senses in gaining knowledge; to highlight awareness of the links between territory and cultural traditions (e.g., cookery and plants which can be eaten, or used for medicinal purposes).

- Level: primary school children (6-10 years of age).

- Equipment: suitable clothing; identification manual of plants; recipes, cookery books, or information on the applications of medicinal plants.

#### PRELIMINARY EXCURSION

1. Identify one or more areas in the Mediterranean maquis containing the plant essences most frequently used in daily life: rosemary, thyme, savory, juniper,



Asparagus (*Asparagus acutifolius*)

laurel (dried bay leaves), sage, myrtle, asparagus, honeysuckle, and also strawberry tree and buckthorn.

2. Plan the excursion in spring, when flowering plants are in full bloom.

3. Ask each student separately to observe forms and colours, to feel the shape and consistency of leaves and stems with their fingers, and to use their sense of smell to appreciate scented plants, if necessary by squeezing leaves or berries. Give them sufficient information enabling them to avoid poisonous plants (e.g., lentisk and oleander), and tell them not to bring their faces too close to the ground in places where poisonous snakes could be hiding.

4. Draw students' attention to some of the most representative plants used in daily life, perhaps the most abundant in the area, or the least well-known, for the sake of comparison.

5. Ask students to make drawings of four or five plants on which to continue in-depth study. Observe any bees and their hives in the vicinity.

#### CONTINUATION OF STUDY IN THE CLASSROOM

6. Get students to organize and exchange their information, by asking them which of the plants they observed are used in everyday life, not only in the kitchen. If possible, compare names in your language, the Latin names, and any slang or dialect names.

7. Provide further teaching information on why Mediterranean plants are rich in essential oils as an eco-physiological adaptation to the environment (resistant to heat, attractive to insects, unattractive to wood-eating insects, etc.). Further information on the chemical nature of substances like hydrocarbons, alcohols, aldehydes, etc. can only be supplied to older students.

8. Carry out research on the possible medicinal and therapeutic uses of some of the plant species studied.

9. Create a file with the description, properties, uses, recipes and "portraits" of each species (information may vary from bibliographic sources to oral tradition).

#### CONCLUSION OF STUDY

10. If possible, grow some species of the Mediterranean maquis in the laboratory.



Lentisk (*Pistacia lentiscus*)

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## Glossary

> Allochthonous: referring to organisms which are extraneous to the territory in which they live.  
> Anthropophilous: referring to organisms which preferably live in contact with man and in any case near human artefacts.  
> Aposematic: referring to colouring, smell, structure or attitude signalling in some way to potential predators that an organism exploits toxic or poisonous systems of self-defence. Aposematic attitudes, colourings or structure sometimes also occur in organisms which are devoid of these defence systems (cfr. Batesian mimicry).  
> Biome: a set of habitats with particularly homogeneous vegetational and climatic physiognomy, but at the same time widespread in several areas of the Earth. The names of biomes change according to continent, but they all refer to the same basic models (e.g., chaparral = Mediterranean maquis = maquis; tropical rain forest = rain forest, etc.).  
> Biotope: the physical location where life occurs. By definition, it is identified solely by the abiotic variables of the site in question.  
> Calcicole: referring to organisms associated with substrates particularly rich in calcium.  
> Detritivore: an organism feeding on organic matter and debris.  
> Ecosystem: identifying the network of relations (trophic, demographic, etc.) among organisms living in a certain habitat or set of habitats. For this reason, the term is almost always followed or preceded by some kind of territorial specification (ecosystem of tropical rain forest, agro-ecosystem, etc.).  
> Ecotone: the transitional environment between clearly defined habitats (e.g., between beech woodland and high-altitude meadows above the snow-line).  
> Edaphic: referring to the edaphon, or to organisms living in it. The edaphon is a superficial layer of soil in which environmental and trophic conditions are compatible with life.  
> Endemite: an organism original to and exclusive to a limited area, almost always accompanied by some kind of geographic specification. The phenomenon is called endemism.  
> Euryoecious: species which can tolerate wide variations in physico-chemical parameters.  
> Frugivore: an organism mainly feeding on fruit.  
> Heliophile: an organism which seeks direct exposure to sunlight.  
> Humicole: an animal species living in humus.  
> Hygrophilous: an organism which seeks conditions of high environmental humidity.  
> Lithoclasiphile: an organism which preferably lives in cavities and hollows in rocks.  
> Macrotherm: a plant species or formation typical of warm climates.  
> Mesophilous: an organism which attempts to avoid extreme living conditions.

> Meso-Mediterranean: plant formations which avoid the most extreme climatic and environmental conditions of the Mediterranean regions.  
> Nemoral: plants associated with woodland undergrowth, generally early-flowering.  
> Oligophage: a highly specialized organism from the trophic viewpoint. Oligophagous organisms are particularly limited in their range of food, sometimes being associated with a single trophic resource.  
> Polyphage: a poorly specialized organism from the trophic viewpoint. Polyphagous organisms are able to exploit a large variety of food resources.  
> Sciaphile: an organism associated with cool, shady habitats, e.g., those typical of the thickest undergrowth.  
> Sillicicole: an organism living in substrates particularly rich in silicon dioxide.  
> Scrub: particular type of vegetation, composed of low, impenetrable undergrowth developing on hard, stony soils.  
> Synanthropic: an organism which, in most cases, cannot live without man.  
> Thermo-Mediterranean: a species preferring the hottest areas of the Mediterranean basin.  
> Thermophile: an organism preferring high temperatures.  
> Thermoxerophile: an organism which seeks both high environmental temperatures and conditions of high aridity.  
> Xerophilous: an organism which seeks conditions of high aridity.  
> Xerophytic: a plant layer with prevailing conditions of high aridity.  
> Xerothermic: referring to a hot, arid habitat.  
> Xylophage: an organism capable of eating and digesting wood.  
> Zoocenosis: community of animals linked by ecological relationships.

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