

Fauna

GIUSEPPE CARPANETO

■ General comments on faunal communities

Beech-woods play host to a relatively poor fauna in comparison with other forest ecosystems.

This impoverishment becomes particularly obvious when compared with that of the deciduous oak-woods growing at lower altitude.

This is mostly due to a climatic gradient which, from the plain up to the mountain flanks, involves progressively lower temperatures and thus a reduction in biological diversity, especially of invertebrates. Fewer invertebrates, especially insects, translates into lower availability of food resources for vertebrates which, thanks to their endothermy, are not directly influenced by climate.

Another factor to consider is the scarcity of plant species: especially higher up in the mountains, the beech-wood is practically a single-species forest, where the tree layer is formed almost exclusively of beech, with nearly no shrub or herbaceous layers. This gives rise to the presence of only a few animal species, the food chain being based on an only slightly diversified plant biomass. In addition, beech-nuts, i.e., the fruit of the beech, whilst representing an extremely important source of food for animals, gives a very irregular yield. There may be years of considerable abundance and others of extreme of enormous scarcity.

The irregular pattern of this resource may cause a level of instability in the fauna, mammals and birds in particular. In the years of over-production (known as the "fat" years), the numbers of some animal species, especially



Hole in beech trunk, as in other trees, provide safe shelters for many animals

Common wall lizard (*Podarcis muralis*)



rodents, increase, and their abundance improves the breeding success of their predators (mainly carnivorous mammals and nocturnal raptors). Instead, in the “lean” years, rodent numbers diminish enormously, and mammals desert the beech-woods. However, many animals find refuge here from the dry heat of summer, thanks to the cool, damp microclimate, which makes beech-woods a welcoming place and partly compensates for the scarcity of food resources.

In addition to these natural factors, the faunal poverty of beech-woods also depends on the type of forestry management they receive. Many beech-woods are felled at intervals, with the subsequent re-growth of trees of the same age, i.e., young and almost identical, with straight trunks and no cavities. With such management, the trees are not given sufficient time to age and die of diseases, as happens in natural forests containing trees of all ages. Beech-woods managed for timber extraction are therefore plantations, rather than true forests.

Foresters of the old school like the idea of woodlands full of healthy trees, so they feel that the same criterion must also be applied to areas not destined for timber production. They claim that the presence of old diseased trees and fallen trunks constitutes a repository for pests, which are then enabled to spread throughout the environment.

In these now unnatural ecosystems, the number of animal species is



Fat dormouse (*Glis glis*)

extremely low - for one simple reason: the absence of old trees, with trunks full of generous cavities, renders the forest unliveable for many species of invertebrates (especially insects), which are the basis of the food chain. Moreover, many mammals and birds use the holes in old trees and rotting fallen trunks as shelters, for nesting, or in their search for food. Fat dormouse, hazel dormouse and squirrel all use such holes for shelter, whereas brown bear, badger and wild boar often dig into the dead wood to feed on the larvae of insects, termites and other invertebrates which they find there.

Species associated with the mountain environment include both heliophile and heliophobe animals and plants. For the former, a dependence on sun or shade may only be apparent: many species are attracted to open environments just because of the greater abundance of resources to be found there. The biological diversity of beech-woods is in fact based not only on the forests themselves but on the entire forest-clearing mosaic, i.e., on the dynamics of ecological succession.

The majority of animals associated with beech-woods live in the clearings that form after natural or artificial events. Lightning occasionally causes spontaneous fires that create open areas. When an old dying tree falls, it may drag many smaller neighbouring trees with it, to form a gap where light penetrates and encourages the growth of pioneer heliophile plants that cannot



Abruzzo brown bear (*Ursus arctos marsicanus*)

live in the undergrowth. In this phase of forest re-growth, the plants in the clearings are immediately invaded by numerous species of insects and other arthropods, which in turn attract insectivorous birds and lizards.

Rodents and granivorous birds also regularly visit clearings to feed on seeds and plants, while snakes set up home in these open spaces, both due to their need for thermoregulation and to prey on the rodents, lizards and small birds that abound. Tree felling by humans, if it is confined to small plots and avoids the elimination of old trees and removal of fallen rotting trunks, favours the natural dynamics of vegetation and fauna.

As will be explained in the following systematic descriptions in the chapter, very few animals are exclusive to beech-woods. The majority of species which inhabit deciduous mountain forests cover a wide ecological range and are adapted to living in diverse forest habitats over a large altitudinal belt from sea level up to approximately 1900 m. Many of these species are associated with mesophile forests, i.e., formations growing in locally cool, damp climatic situations.

Mesophile forests, apart from beech-woods, also include chestnut-woods, higher turkey oak groves, and those with a dominance of flowering ash and hop-hornbeam, or hazel and hornbeam. A further contingent of even more tolerant animal species live in all types of deciduous forests, from thermophile oak-woods on plains and low hills (dominated by downy oak) to beech-



Preservation of old or decaying trees favours natural dynamics of the fauna

woods. Many animal species are phytophages, i.e., they depend on plant resources, and may feed on leaves (phyllophages), flowers (anthophages), fruits (carpophages), sap (lymphophages) or wood (xylophages). Species associated with old trees include saproxylic species, i.e., those which live on or in decaying wood: some feed directly on rotting wood (saproxylophages) and others on the fungi that attack it (mycophages). An army of predators and parasites live at the expense of all these categories.

The complex network of interspecific relations between predators, parasites and phytophages helps to explain the surprisingly large number of insects which manage to survive in a forest in which almost all the trees are of only one species.

In the Apennines, the upper limit of beech-woods is easily identifiable because it falls precisely at the treeline, where tree vegetation ends. Above this line, only shrubs and herbaceous plants, such as juniper, can survive. Here, beech-woods are enriched by animals belonging to the mountain meadow ecosystems, many of which are of steppe origin and colonised Italy during periods of dry continental climate. The lower borders of beech-woods are much less well-defined, because they become mixed with mesophile woodland and turkey oak groves. The maximum diversity of animal species is in this transition belt, because many thermophile species of the sub-mountain horizon reach the wood. For many vertebrates, beech-woods represent a corridor through which to move, according to season, to reach mountain pastures or deciduous oak-woods.

In Latium, on the volcanic hills rising not far from the sea, and clearly separated from the Apennines, there is the peculiar phenomenon of "low-lying beech-woods" growing at altitudes below the normal lower limit. These isolated, often small woods host even fewer animal communities, and the number of exclusive or characteristic species is definitely lower than normal.



Fungi growing on trunks are an important food source, especially for invertebrates

■ Platyhelminths

The digestive system of many wild mammals is the micro-environment hosting parasitic platyhelminths, or flatworms, belonging to the trematodes and cestodes. Wolf, fox, brown bear, pine marten, beech marten and badger host various species of *Taenia*, *Echinococcus granulosus*, *Dipylidium caninum*, *Mesocestoides lineatus* and other tapeworms. *T. taeniaeformis* is particularly frequent in wild cat. These parasites normally reach maturity and reproduce sexually in the digestive systems of carnivorous mammals (definitive hosts). Their eggs are released with the animal's faeces, and are dispersed on the ground and among leaf litter, until they are swallowed by chance by intermediate hosts (usually rodents and ungulates). The larval forms then generally encyst in the muscles and viscera of their host and remain there, lying in wait until the intermediate host is devoured by a carnivore, thus perpetuating the cycle.



Aegopinella pura

Rock walls or heaps of stones, especially if carbonate, have the same function and offer both food (e.g., mosses and lichens growing on the surface) and shelter (e.g., in fissures or beneath stones). The scarcity of herbaceous plants in the undergrowth and the presence of deep litter gives rise to a particular food specialisation in various molluscs living in beech-woods, which are actually not phytophages (plant eaters) but detritivores (detritus feeders). The amount of litter consumed by molluscs, compared with what is produced in one year, ranges between 0.3% and 16% in different regions. Some species also feed on decayed wood and fungi, which are abundant in damp woodland soil. Yet others are carnivores and

■ Molluscs

Apennine beech-woods are one of the most favourable environments for the life of gastropod molluscs (slugs and snails). This is due to the cool, damp microclimate which is particularly suitable for these animals. Leaf litter, hollow trunks and decaying wood are optimal environments because, releasing calcium salts (citrates and oxalates), they buffer any acidity in the soil, a factor that is generally

unfavourable to gastropods with shells. mainly eat other molluscs, as is the case of the arionid, zonitid and milacid families. The composition of malacological fauna in a beech-wood varies greatly according to the calcareous/non-calcareous nature of the substrate, altitude and geographical setting. Beech-woods on alkaline substrates, of calcareous origin, are richer than those on acid substrates, generally of magmatic origin, although this difference is often not striking. As already mentioned, the supply of calcium salts which are released with the decomposition of leaf litter has a buffer action and facilitates standardisation. More importantly, soils on non-calcareous substrates tend to retain more moisture and thus favour the survival of many species. The number of gastropods that can be found in an Apennine beech-wood is quite constant: there are usually 22-23 species, belonging to 18-19 genera and 9-12 families. One community of species is almost always present, formed of *Acanthinula aculeata*, *Gittenbergia sororcula*, *Ena obscura*, *Punctum pygmaeum*, *Discus rotundatus*, *Vitrea subrimata*, *Aegopinella pura*, *Limax maximus*, *Deroceras reticulatum*, *Euconulus fulvus*, *Cochlodina laminata*, *Clausilia cruciata*, *Macrogaster lineolata*, *M. plicatula*, *Ciliella ciliata* and *Helicodonta obvoluta*. Nevertheless, some of these are absent in the more southerly beech-woods (e.g., *Euconulus*), which they were unable to reach during the Ice Ages. The majority of these gastropods also manage to live well in the adjoining deciduous woodlands (oak-woods and chestnut groves), growing at lower altitude.



Limax maximus



Dead beech trunk, still standing, surrounded by a tiny clearing

■ Annelids

In the deep, humus-rich soil of beechwoods, a rich and diversified life lies concealed beneath the litter of fallen leaves. Earthworms are annelids belonging to the class of the Oligochaeta and are an important component of the edaphic fauna, i.e., that associated with the soil.

These animals collect organic matter that accumulates on the surface, such as dead leaves and decaying wood



Earthworm

from fallen trunks, and carry it into their tunnels, where they feed on it. The mixing of organic matter in the soil and the formation of humus are the result of this continual work of gathering and burrowing by earthworms, as well as of the diffusion of their faeces. Some species grow very large, such as the lumbricids (up to 25 cm); others, like the enchytraeids, are tiny. Among the lumbricids, the species of the genus *Lumbricus* dig very deep permanent tunnels in the soil, from which they emerge on damp nights in search of food. The species of other genera almost never come to the surface, but burrow constantly in the soil in their search for organic debris. Earthworms are also an important source of food for many animals in the forest ecosystem. When they appear on the ground on damp or rainy nights, they are eaten by toads, salamanders, owls and shrews. They are also sought and devoured without interruption by moles and wild boar in their never-ending work of digging. Among the most common species of earthworm in the forest soils of the Apennines are *Dendrobaena byblica* and *Octolasion complanatum*.

■ Nematodes

Nematodes are also an important component of the soil fauna, in which they act as both predators of small invertebrates and consumers of roots. Most species are tiny (a few millimetres in length), but there are so many of them that they make a significant contribution to the soil biomass. Moreover, many parasitic nematodes complete their life-cycle inside the body of one or more hosts, both vertebrates and invertebrates. For example, *Trichinella* establishes itself in the muscles of many mammals (wild boar, fox, pine marten, rodents, etc.) and may also be transmitted to humans if they eat meat of these animals

that has not been sufficiently cooked. Other species live in the gastrointestinal cavities or lungs of mammals, both carnivores and herbivores (*Molineus*, *Capillaria*, *Trichurus*, *Protostrongylus*, *Trichostrongylus*, *Nematodirus*, etc.). *Skrjabinogylus nasicola* plays an interesting role: it infests the skull of the weasel (and ermine on the Alps) and causes brain damage which may lead to the death of the host. Carnivores become infested through eating the small rodents that are intermediary hosts to the parasite. Wild cat is often infested with *Toxocara mystax*, which is also found in other small carnivores. Lastly, many nematodes live in the body cavities of insects, most commonly grasshoppers and cockroaches, and reach a notable size when compared with that of their host.

■ Arachnids

The animals belonging to the class of the arachnids are characterised by four pairs of legs and two variously-shaped pairs of anterior appendages (chelicerae and pedipalps). The chelicerae are generally used for killing prey, sometimes with the aid of poison glands. The pedipalps may serve as sense organs, as auxiliary appendages used during mating, or to capture prey. Representatives of various arachnid orders may be found in beech-woods, particularly scorpions, pseudo-scorpions, mites, harvestmen and spiders.



Euscorpius sp.

Scorpions. Being thermophilous animals of sub-tropical origin, there are very few scorpions in beech-woods. These cold environments are unsuitable for organisms which require warm, relatively humid nights, in order to be able to carry out their predatory activity efficiently. Only species most resistant to low temperatures, like *Euscorpius tergestinus* and *E. italicus*, can live in mainly low-lying beech-woods growing on the Apennine foothills and pre-Apennines. They prefer stony areas under which they can find shelter during daylight hours.

Pseudo-scorpions. Pseudo-scorpions are found in the soil, beneath stones, or in the interstices that form between the bark and wood of dying trees. This micro-environment hosts a rich and diversified fauna, in which all the major groups of terrestrial arthropods are represented. Beech-woods contain pseudo-scorpions belonging to genera like *Chthonius*, *Neobisium* and *Roncus*. The name "pseudo-scorpion" derives from the pincer-like shape of the pedipalps of these tiny predators, which are just like those of scorpions.

Spiders. Many species of spider are to be found in the various micro-environments of beech-woods. These predators, with their enormous diversity of shape, size, and hunting technique, play a specialised ecological role and live practically everywhere - on trees, among bushes, on plants in the



Chthonius tetrachelatus

undergrowth, in the holes of trunks, under bark and beneath stones, amongst the grass in clearings, etc. Members of numerous families are found in beech-woods, including dysderids, agelenids, amaurobiids, clubionids, gnaphosids, philodromids, thomisids, and salticids, or jumping spiders.

To give a few examples: *Araneus diadematus* belongs to the araneids. It is mainly found on vegetation in clearings and weaves webs of a regular shape with which it captures flies and small butterflies. Many small spiders, with rounded abdomens and varied coloration (often dark), belong to the theridiids and live on vegetation, beneath stones or in tree-holes. Wolf spiders, larger in size and with a covering of short but dense hairs over the whole body, belong to the Lycosids. The members of this family hunt by sight, without using webs, and some species build tunnels in the soil in which to shelter. Various species of gnaphosids live in beech-woods beneath stones and under bark, or in the leaf litter. These spiders, generally of medium size and grey or black in colour, are active by night and catch their prey by sight. The thomisids are most often found in clearings - they camouflage themselves on flowers, awaiting butterflies and other insects. Lastly, jumping spiders may be observed moving about rapidly on plants or tree trunks, searching for minute prey on which they make surprise attacks. As well as fulfilling a role as predators, spiders are a food resource for many animals, such as birds and lizards living in beech-woods and their clearings.



Araneus diadematus

Harvestmen and mites. Harvestmen, or opiliones, may most easily be observed in clearings, where these arachnids are to be found on plants. They look very similar to spiders, with mostly compact, globular bodies, from which eight extremely long legs extend. If disturbed, they rock to and fro, probably in order to confuse a predator. Beneath stones, in amongst the litter, we may find *Trogulus* (see drawing), opiliones with an unusually flattened body and relatively short legs, or *Astrobonus kochii* which spend their lives adhering to the undersides of the stones. The mites include many families, adapted for very different lifestyles. Some species form galls, or tumours, which grow on the small branches or leaves of plants after these arachnids have pierced them. Gall-forming mites include *Aceria nervisequus* and *Acalitus stenaspis*, which belong to the family of the eriophyids and are both specific parasites on beech. Many species live in the soil: this is the case of the oribatids, tiny mites with globular or pear-shaped bodies, which are an important component of the soil fauna. Together with nematodes and collembolans (springtails), they are the most numerous organisms in forest leaf litter and humus. Instead, many other mites are parasitic and attack animals of all types. They may be found on insects and all classes of vertebrates.



Harvestman (*Astrobonus kochii*)

Species of the genus *Sarcoptes* cause a form of scabies in several species of mammals - in the Apennines, they have been found on brown bear, although the principal repository would appear to be wild boar. *Trombicula autumnalis* is also worth mentioning, and is found in all woodland environments on the plains and mountains. This mite finds its natural repository in some wild mammals, particularly badger and fox, but it also often attacks humans, producing temporary but unpleasant skin irritations. Infestation is not caused by the adults but by the hexapod larvae, which pierce the skin and release digestive enzymes in it, so that they can then suck the liquefied cells. The adults live on plants and feed on sap. Ticks are also common on mammals in beech-woods. These include the genera *Ixodes*, *Rhipicephalus* and *Hyalomma* on fox, bear, pine marten, weasel, wild boar, red deer and roe deer.

■ Crustaceans

The only crustaceans found in beech-woods are isopods, commonly known as wood lice or pill-bugs. The name of these small crustaceans adapted to the terrestrial environment derives from the fact that their legs are all of the same length and shape. Generally detritivores, these little animals are to be found beneath stones, in rock fissures, beneath the bark of trees or in decaying trunks. Various species, such as those belonging to the Armadillidiidae family, have bodies with a convex armoured back which allows them to assume a particular defence posture against predators: they curl up to protect their delicate underbellies, almost as if they were tiny armadillos. *Armadillidium vulgare* and *A. depressum* are often found in mountain woodlands. Instead, the members of the family Porcellionidae are not capable of rolling up and so take refuge beneath stones. *Porcellio arcuatus* is widespread in mountain environments. Species of the genus *Trichoniscus* mainly inhabit woodland soils.

■ Chilopods and diplopods

Chilopods, better known as centipedes, are agile nocturnal predators widespread throughout Italy. Various species are to be found in beech-woods, especially those which offer many hiding-places, i.e., stones, rocky outcrops,



Eupolybothrus grossipes

fallen trunks and hollow trees. *Lithobius castaneus* is a typical woodland species, common from the oak-woods on the plain to beech-woods as far up as the treeline.

They are rarely found in open areas - this only happens where there has been recent deforestation. Other more or less woodland species are *L. mutabilis* and *L. tylopus*. Instead, *L. forficatus* is a species frequently found in environments altered by man, like the pastures which remain after trees have been felled. Its occurrence in some beech-woods indicates that they have suffered human disturbance. *Eupolybothrus grossipes*, also belonging to the Lithobiomorphs, is a



Trachysphaera apenninorum

quite common woodland species, displaying a clear preference for beech forests. Other frequent chilopods in beech-woods are members of the geophilomorphs. Examples of these are *Geophilus insculptus*, common in the mesophile woods of peninsular Italy, and *Strigamia acuminata*. The latter species is widespread in Italy all over the Alps and along the Apennine chain, reaching as far as the Monti Peloritani in Sicily, but is absent from Sardinia. On the peninsula, it is a woodland species, typically associated with beech-woods at between 500 and 1400 m a.s.l. Lastly, *Schendyla apenninorum* is an Italian endemic species known only from a few sites in the Apennines, situated mostly in beech-woods between 900 and 1450 m a.s.l.

Diplopods (or millipedes) are mainly slow-moving detritivores: they defend themselves from predators both with their armoured exoskeletons and by secreting and then releasing repellent substances. Like the chilopods, they are to be found beneath stones, fallen tree trunks and other natural shelters. Some species are frequent in beech-woods, but they are mainly ubiquitous species. The few diplopods characteristic of the mountain forests are of the genus *Pyrgocyphosoma*, with *P. doriae*, *P. marrucinum*, *P. picenum* and *P. zangherii*, and the genus *Leptoiulus*, with *L. montivagus* and *L. trilineatus*. Whereas *L. montivagus* is widespread from the Alps to the central Apennines, *L. trilineatus* may be found as far south as Calabria. Lastly, *Trachysphaera apenninorum* is a small white soil-living diplopod, common in Apennine beech-woods.

■ Insects

Insects are the most important animal components in beech-woods, as in all forest environments. Thus, a great deal of space is devoted to them in this chapter, particularly to the order of Coleoptera or beetles, which display a huge diversity of ecological roles. Insects are at the base of the food chain and permit the existence of all other animals, especially vertebrates, for which they are the major food resource. Notwithstanding the poverty of plant species growing in beech-woods, insects are able to reach a high level of biodiversity. This is explained by their complex interspecific relationships which, as well as phytophages, saprophages and mycophages, contain intricate networks of predators and parasites dependent on one another.

Orthopterans and dermapterans. The Orthoptera include crickets, grasshoppers and locusts, insects adapted for jumping around in the herbaceous vegetation. This group being of steppe origin, most species live in open environments. Beech-woods, like all dimly-lit forest habitats with few herbaceous plants, are not particularly attractive to the members of this order. The species that may be found include the Gryllids *Petaloptila andreinii* and *Gryllomorpha dalmatina*, and raphidophorids of the genus *Dolichopoda*, which generally live in damp shady places, finding shelter in rocky cavities and tree-



Pseudochelydura orsinii

trunks, or under piles of timber. The Dermaptera include what are known as earwigs, insects that are adapted to living in interstices - for example, in the fissures between rocks, beneath the bark of dead trees, or under stones. In beech-woods, it is possible to find *Pseudochelydura orsinii* (northern and central Apennines), *Forficula silana* (southern Apennines and Sicily) and *Chelidurella acanthopygia* (Alps and northern Apennines). The latter, like other endemic congener species of the Alps, is an element of the sub-alpine zone, living in the boundaries between mesophile forest and pastures, and wintering in the litter of broadleaved woodlands.



Forficula silana

Hemipterans. Members of the order of the Hemiptera are characterised by a piercing-sucking mouth apparatus, an adaptation that allows them to feed on liquids, such as blood or sap. They are divided into three sub-orders: stenorrhynchs (aphids or greenfly, and scale insects), auchenorrhynchs (cicadas and leafhoppers) and heteropterans (true bugs). The first includes the beech aphid, *Phyllaphis fagi*, which pierces the terminal twigs and leaves of the plant to suck its sap. The colour of these aphids is extremely variable: yellow, green or orange, according to sex and generation. Females that breed by parthenogenesis differ in colour and shape from males and from those females destined for mating. When these aphids bite leaves, the blades roll inwards as their margins fold. Leaves and twigs dry out rapidly. When beeches grow in public parks or small woodland areas, the amount of damage caused is so great that the trees may require treatment. Scale insects are very tiny hemipterans – the females are wingless, and have bodies greatly modified for reproduction.

One common parasite on beech is *Cryptococcus fagisuga*, a carrier of a serious bark disease. Piercing the bark at its most tender points, this scale insect inoculates a fungus of the genus *Nectria*, which kills the tree's cambium cells and may even prove fatal. *Fagocyba cruenta* is a tiny delicate leafhopper belonging to the Cicadellid family, which pierces the underside of

leaves and partially discolours them. It attacks beech, hornbeam and other broadleaf trees.

Carabid beetles. Beetles are one of the most important taxonomic groups of beech-wood fauna, because many species live in forest soil, on trees or in clearings. They are easily recognised by their rigid exoskeleton, which forms a true armour plating, and by their elytra - front wings transformed into shields to protect the rear wings. One of the best represented families is that of the carabids, mainly predators that live in leaf litter, underneath stones and fallen tree trunks, feeding on invertebrates (earthworms, snails, spiders, millipedes, and other insects). The giants of the family belong to the genus *Carabus*, and have lost the ability to fly. They are very well-known for their elegant shapes, iridescent hues, and variety of sculpturing on the prothorax and elytra. The characteristic species of Apennine beech-woods is *Carabus lefebvrei*, black with an elegant blue metallic glitter, which is to be found under fallen rotting trunks, or in the basal hollows of still-standing old trees. It does not live exclusively in beech-woods, and may also be found in deciduous oak-woods or chestnut groves. Another large-sized genus is *Cychrus*, whose members are specialist feeders on snails. Head and pronotum are long and narrow, suited for penetrating shells to devour the mollusc inside. *Cychrus attenuatus* and *C. italicus* are found in Apennine beech-woods. The former is a central



Carabus lefebvrei

European species, widespread in the coniferous forests of the Alps, which reaches its southern distribution limit in the southern Apennine beech-woods, with the sub-species *C. a. latialis*. The latter is an Italian sub-endemic species, common in the forests of the Alps and Apennines. Recent research on carabid beetles in beech-woods of central Italy has identified different groups of species with three main habitats: (1) alpine zone; (2) sub-alpine mesophile forest; (3) deciduous oak-wood, sometimes reaching beech-woods. Woodland species exclusive to beech-woods belong to the first group, like *Notiophilus biguttatus*, *Calathus rotundicollis*, *Pterostichus oblongopunctatus*, *Nebria tibialis*, *Trichotichnus nitens*, *Molops ovipennis*, and species also found in open environments situated at the same altitude (mountain pastures), such as *Cychrus attenuatus*, *Calathus focarilei*, *Pterostichus morio* and *P. bicolor*. More eclectic species belong to the second group, associated with mesophile forests in general, and therefore both turkey oak groves and beech-woods. These include *Carabus lefebvrei*, *C. convexus*, *Pterostichus micans*, *Abax parallelepipedus*, *Cychrus italicus*, *Platyderus neapolitanus*, *Nebria kratteri*, *Leistus spinibarbis*, *L. fulvibarbis*, *L. sardous*, *Harpalus atratus*, *Synuchus nivalis*, *Laemostenus latialis* and *Notiophilus rufipes*. The third group includes numerous beech-wood species, like *Calosoma sycophanta*, *C. inquisitor*, *Calathus montivagus*, *Percus bilineatus*, *P. andreinii*, *Leistus rufomarginatus*, *Notiophilus substriatus* and *Dromius quadrimaculatus*.



Cychrus attenuatus



Calosoma sycophanta, with *Lymantria dispar* caterpillar

It should also be mentioned that both the species favouring mountain pastures and those preferring open sub-montane environments, such as *Carabus violaceus*, *Nebria brevicollis*, *Calathus fuscipes* and various species of *Amara*, may be found in woodland clearings.

Lastly, beech-wood soil also hosts interesting small blind endogenous carabid beetles, like *Rhegmatobius*

quadricollis and *Typhloreicheia usslaubi*, both endemic to the central Apennines. Again among the carabids, *Omoglymnus germari*, *Rhysodes sulcatus* and *Clinidium canaliculatum* represent a group of saproxylic species of ancient tropical origin, present, albeit rarely, in the Apennine woodlands.



Omoglymnus germari

Staphylinid beetles. The appearance, similar to “large ants”, which characterises the members of this family of rove beetles and which renders them unmistakable, is due to the very short elytra, which leave the abdomen completely bare. Nonetheless, these wing-case stumps hide normally developed posterior wings adapted for flight, which are kept neatly folded beneath. Although having in general a quite uniform appearance, staphylinids play very differing ecological roles: some are predators, others are mycophages or saprophages.

This numerous family includes several examples of woodland species associated with beech-woods. *Acrulia inflata* is widespread, although discontinuously, in both northern and central regions of Italy, and lives in holes in beech trunks. The genus *Atheta* includes many species, distinguishable only by experts.

Various species were reported for the first time in the Italian peninsula in 2003, following research by the National Centre for the Study and Conservation of Forest Biodiversity at Verona. *Atheta ebenina* is a sub-alpine species that lives amongst plant debris. *A. hansseni* is found in damp forests on both Alps and Apennines, where it feeds on fungi and plant debris. *A. taxiceroides* is another mountain forest species. *Atrecus affinis* and *A. longipipes* are saproxylic species to be found amongst the wood debris in cavities of large beeches or silver firs. *Ocypus tricinctus* is a woodland species and lives in beech litter: this is an Italian endemic species only found in the central-northern Apennines and Orobian Alps.



Osmoderma eremita



European stag beetle (*Lucanus cervus*)

Scarab beetles. The superfamily of scarab beetles, characterised mainly by the shape of the antennae, with lamellae at the terminal joints, includes many families spread throughout all Italian habitats. They occupy extremely diverse ecological niches in the food-chain, with primary consumers (phytophages, xylophages, rhizophages), secondary consumers (necrophages) and decomposers (saprophages and coprophages). Although most species are found over a wide altitude belt, there are also species characteristic of or exclusive to beech-woods. Among the phytophages, is *Rhizotrogus romanoi*, which has been identified in clearings in the midst of beech-woods only in the Sicilian Apennines (Madonie, Monti Nebrodi). *Amphimallon fiscus* and *A. solstitialis* live in clearings of mesophile

forests formed of beech, chestnut or turkey oak. Both *Rhizotrogus* and *Amphimallon* have rhizophagous larvae, which live in the soil feeding on the roots of plants. Species of the genus *Osmoderma* (*O. eremita*, *O. italicum*, *O. cristinae*) are saproxylic and therefore associated with old trees in mature forests, from sea level right up the mountain flanks. *O. eremita* has been included in the Habitat Directive as a species with high conservation priority, because of the rarity of the environmental conditions suitable for its biological cycle. The same lifestyle is followed in species of the genus *Gnorimus*: two (*G. nobilis*, *G. variabilis*) live in mountain mesophile forests, whereas the third (*G. decempunctatus*) is endemic to the Sicilian Apennines, in the beech-woods of the Madonie and Nebrodi mountains. Unlike the *Osmoderma*, less vagile beetles spend their entire existence in the holes of tree trunks. *Gnorimus* frequent the flowers of elder and rose-bushes, where they feed on pollen.

Other species of scarab beetles, with more or less ample altitude distribution, are found on the same flowers and thistles in clearings, such as those of the genera *Trichius*, *Cetonia*, *Cetonischema*, *Potosia*, *Eupotosia*, *Valgus*, *Hoplia*, etc.. Coprophage scarab beetle communities include a few large species and many other small ones. Practically all large-sized scarab species live in open areas like

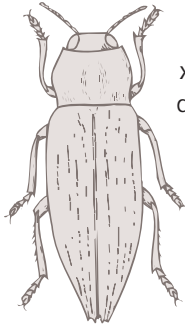
the alpine and sub-alpine pastures, except for *Anoplotrupes stercorosus*, almost exclusive to beech-woods, with which it is probably associated for microclimatic reasons. This species feeds on both excrement and fungi, and also appears to be able to survive in ungrazed woodlands. The species that depends least on the excrement resource is *Trypocopris pyrenaicus*, associated with mesophile forests in general, from damp oak-woods on the plain to beech-woods, and which appears to eat only fungi or decomposing organic matter. As well as these "giants", sometimes 20 mm long, many coprophagous species exist with an average size of around 5 mm: they are the *Aphodius (sensu lato)*, a genus that has recently been subdivided, but which we will continue to maintain in its traditional unit for practical reasons.

Among these species, *Aphodius zenkeri* is certainly the one most closely linked to beech-woods; others (*A. uliginosus*, *A. borealis*, *A. siculus*) are associated with mesophile forests in general or else to the mosaics of woodland clearings on mountainsides. The lucanids are also a family of scarab beetles, including what are known as stag beetles, because of the shape of their antennae. These large coleopterans (*Lucanus cervus* – a species listed in the Habitat Directive, and *L. tetraodon*) are widespread in all deciduous forests from sea level up as far as the treeline. Other lucanids (*Synodendron cylindricum*, *Platycerus caraboides*, *P. caprea*) show a preference for mountain forests, where they are without doubt more frequent.



Gigantic male specimen of *Lucanus tetraodon*

Buprestid beetles. The family of buprestids, or jewel beetles, include many species of varying sizes. They are usually narrow and oval-shaped, almost always with a pointed tip and often bright metallic colours. They are all phytophages: the adults are frequent visitors to flowers, feeding on pollen, whereas the larvae of many species are xylophages and bore tunnels in wood, generally feeding on dead or dying plants. Various species of buprestids have polyphagous larvae, which survive at the cost of numerous broadleaf trees, without any clear preference, as is the case for *Chrysobothris affinis*, *Agrilus cyanescens* and *A. viridis*. Others, such as *Acmaeodera pilosellae*, *A. flavofasciata*, *Agrilus biguttatus* and *A. graminis*, show a certain predilection for oak, beech and related trees. Lastly, there are species associated with beech and a few other mesophile or riparian plants. These include *Dicerca berolinensis* (see drawing), found on beech, birch and hornbeam, *D. alni*, mainly on beech and common alder, and *Agrilus olivicolor*, on hornbeam, hazel and beech.



Anobiid and bostrychid beetles. These are small beetles with generally xylophagous larvae, which excavate tunnels in dead wood. The anobiids, which belong to the family of common furniture “woodworm”, have a life-cycle that may extend to more than one year. They have the strange habit of banging their heads hard against the walls of their tunnels, emitting little thumps which are interpreted as sexual calls. *Gynobius planus* inhabits broadleaf forests, especially on oak and beech, whereas *Hemicoelus costatus* is a typical species of beech-woods, living in dead branches and trunks. Other species, polyphagous on broadleaved trees which also often attack beech, are *Gastrallus laevigatus*, *Hemicoelus fulvicornis*, *Oligomerus brunneus*, *Priobium carpini* and *Ptinomorphus imperialis*.

The bostrychids are represented by only a few species in Italy. Two of these are polyphagous and live on various broadleaved trees including beech: they are *Bostrychus capucinus* and *Licheniphanes varius*. The former can be distinguished easily from the others by its black head and prothorax, and the elytra are usually red. The latter is considered a typical species of the primary forests of central Europe. It is extremely rare in Italy and has never been collected on beech. According to some scientists, *L. varius* only grows in the wood of broadleaved trees already attacked by the ascomycete fungus *Nummularia bulliardii*. Recent studies show that this requirement is not a peculiarity of this bostrychid, but is shared with other species of saproxylophagous insects.

Nitidulid beetles and their allies. The nitidulids are small or minute beetles found on flowers, fungi, beneath bark, or in carrion. Almost exclusive to beech-woods are *Epuraea fageticola* and *E. silacea* - both indicators, amongst other things, of a high level of ecosystem integrity. Other species of the same genus (*E. variegata*, *E. terminalis*, *E. neglecta*, *E. binotata*) preferably inhabit beech-woods, but may also be found in other forest environments.

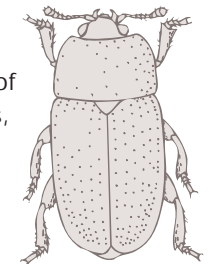
These are mycetophagous species, which therefore feed on fungi and mostly frequent the polyporaceans, fungi with a woody thallus growing on tree trunks. These small coleopterans may also be found under the bark of dead trees, where they eat the moulds that develop in this microhabitat.

A similar ecological role is filled by the rare *Ipidia binotata* (see drawing) and by *Glischrochilus hortensis* (in mesophile woodlands). In spring, various species of *Meligethes* visit flowers in the undergrowth and clearings, devouring pollen or anthers: *Meligethes subaeneus* (on *Cardamine* flowers), *M. czwalinai* (monophage on the perennial honesty *Lunaria rediviva*) and *M. atramentarius* and *M. kunzei* (on the flowers of *Lamium* and *Lamiastrum galeobdolon*). All these species are widely found in mesophile woodlands, but most especially in beech-woods.

Other close families offer similar examples. For example, the alexids include the genus *Sphaerosoma* with some mycetophagous species endemic to the Apennines, which may be observed beneath the bark in beech-woods: *S. solari* of the southern Apennines, *S. apuanum* of the Tuscan Apennines, and others. Among the endomychids, *Endomychus coccineus* and *Mycetina cruciata* are worthy of mention - they are both mycetophages living on polyporaceans. *Rhizophagus nitidulus* and *R. dispar* figure among the monotomids. These are both widespread in Europe, are never more than 4 mm in length, live beneath bark, and prey on tiny beetles.



Meligethes czwalinai



Tenebrionid and oedemerid beetles. Typically saprophagous and particularly numerous in hot dry environments, the tenebrionids are not very well represented in beech-woods. The only exceptions are the woodland phytosaprophagous or mycophagous species living on plant or fungus detritus in dead tree trunks. They are mostly species associated with deciduous forests at all altitudes, such as the genera *Enoplopus*, *Helops* and *Nalassus*. In mature forests with many dead trees, they may become abundant and represent an index of the woody necromass. A typical mycophagous species is *Diaperis boleti*, which lives on fungi, especially polyporaceans growing on old trunks. As regards the other families of heteromorous beetles, there are no species among the meloids or oedemerids exclusive to beech-woods. The latter include species associated with mesophile woodlands in general, and are often to be found in clearings in the midst of beech-woods, such as *Oedemera (Oncomera) femoralis*, *Ischnomera cyanea*, *I. coerulea* and *I. cinerascens*.

Cerambycid beetles. Amongst the phytophagous insects, cerambycids, or long-horn beetles, play an important role in forest communities. The adults feed on buds and sap, whereas the larvae are xylophagous, i.e., they eat wood. As an adaptation to this lifestyle, cerambycid larvae have lost their legs and move about using muscle movements inside the tunnels they excavate while eating. Some species may cause damage to forestry economics when they become



Enoplopus in decayed wood of an old tree

over-abundant, by ruining the timber. The adults are immediately distinguishable from other beetles by their very long antennae and robust mandibles, which they use to cut plant tissues. The antennae are usually longer in the male, and are used as scent organs, both in search of females and to identify any rivals who might invade his territory. The adults of many species can be found on flowers in the undergrowth or clearings, where they stop to feed on pollen, showing a strong predilection for the flowers of elders and umbellifers.

A species of enormous ecological and biogeographical interest is *Acanthocinus xanthoneurus*, exclusive to beech-woods and endemic to the Italian Apennines (from the Tuscany-Emilia Romagna Apennines to Sicily). The larva is monophagous and only feeds on beech wood. The adults are nocturnal and frequent dead beeches, on which they lay their eggs. A characteristic species, although not exclusive to beech-woods, is *Rosalia alpina*, widespread from Europe to the Caucasus, and well-known for its flamboyant blue colouring with large black markings. Although the majority of larvae develop on beech trunks, this species may also breed on other broadleaved trees. The adults are diurnal. *Leptura aurulenta*, a species with Europe-wide distribution but quite rare and localised on the Apennines, is also almost exclusive to beech-woods. The adults are florivorous and diurnal. Another species found prevalently in beech-woods is *Saphanus piceus*: the adult is nocturnal and the larva feeds on



Acanthocinus xanthoneurus, an Italian endemic species exclusive to beech



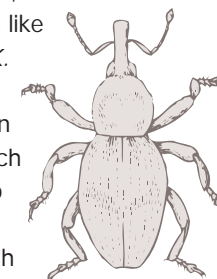
Rosalia alpina

broadleaved trees of the mesophile forest (beech sycamore, hornbeam, etc.). *Stenocorus meridianus* and *Musaria affinis* are two Euro-siberian species which breed in various types of forest but are to be found almost exclusively in beech-woods on the Apennines. The former lives in the woody roots of trees, the latter on herbaceous plants.



Leptura aurulenta

Curculionid beetles and their allies. A large and diversified family of lithophage insects, like that of the curculionids, or weevils, do not lack representatives characteristic of beech-woods. The genera *Acalles*, *Kyklioacalles* and *Echinodera*, very similar to one another, include numerous species which are widespread in forests throughout Europe. They are xylophagous insects, found under bark, in tree stumps and in woody debris inside holes in trunks. *Acalles aubei* (see drawing), *A. camelus*, *A. lemur*, *A. parvulus* and others can be found in beech-woods, like *Kyklioacalles fausti* and the Italian endemics *K. saccoi* and *K. solarii*. *Echinodera hypocrita* is also characteristic of beech-woods. *Cotaster uncipes* is a xylophagous species, common in the montane deciduous forest of southern Europe, which mainly colonises tree stumps and fallen trunks. This is also where some *Otiorhynchus* may be found: although polyphagous, they are to a certain extent associated with mesophile broadleaved forests, e.g., *O. cyclophthalmus*, endemic to the northern Apennines. Many species of *Phyllobius* and *Polydrusus*, living on foliage, are also typical of beech-woods: for instance, *Phyllobius romanus*, *P. maculicornis* and *P. argentatus* belong to the former, and an Italian endemic species, *Polydrusus amplicollis*, belongs to the latter. *Orchestes fagi* is a monophagous species, specialised for life on beech, the tiny larvae of which are miners that excavate micro-tunnels in the leaves. They frequently multiply at a prodigious rate until they make holes in the leaves of an entire forest. Other families closely related to the curculionids may be found in beech-woods: these include the anthribids, attelabids and apionids. Various species of bruchids, or seed beetles, have been found in central Apennine beech-woods, but none is exclusive to these environments: they are *Paleoacanthoscelides gilvus*, *Spermophagus sericeus*, and various species of *Bruchus* and *Bruchidius*.



Siphonapterans. Fleas are generally more dependent on their host species than on habitat. Nonetheless, the presence of forest humus with leaf litter and the damp microclimate are favourable ecological factors for the development of flea larvae, which feed on organic matter. In these soils rich in detritus, terrestrial mammals excavate temporary lairs or dens, where fleas can complete their larval cycle. Instead, breeding success for bird fleas depends on the structure and position of the nest. In beech-wood mammals, the presence of fleas may have a double significance. In some cases, it documents relationships of kinship between mammals of the same order or family; in others, it testifies to a relationship of predation between them. For example, some species of fleas are linked to the order of carnivores, like badger, pine marten, weasel and fox. This is the case of *Paraceras melis* and *Chaetopsylla (Chaetopsylla) trichosa*. Other species of flea found on the same carnivores arrive from their prey: *Ceratophyllus (Monopsyllus) sciurorum* from rodents, *Archaeopsylla erinacei* and *Hystrichopsylla talpae* from insectivores and *Dasysyllus gallinulae* from birds. *Chaetopsylla (Arctopsylla) tuberculiceps* is found on brown bear, and is a species-specific parasite, which is not however recorded for the bear population of the Apennines.



Syrphus torvus

Dipterans. The large order of the dipterans, characterised by a single pair of wings and a mouth apparatus suited to lapping and sucking liquid foods, is widely represented in beech-wood communities. Many mycetophilids (*Mycetophila*, *Mycomya*, etc.) live in fungi and are therefore associated with the damp undergrowth of mesophile forests. *Xylophagus ater* is a Euro-siberian species, whose predator larvae live beneath the bark and in rotting wood, feeding on larvae of xylophagous insects. Its lifestyle means that it is a species of cold forests, a requirement that involves a certain preference for beech-woods in peninsular Italy. The families of hybotids and empidids include numerous hygrophilous and sciaphilous species, which therefore love humidity and shade. These dipterans find optimal living conditions in the beech-wood undergrowth, in proximity to the clearings by streams or in grassy glades. Here, they make forays to flowers and plants in search of prey, tiny insects which they capture

and eat on the wing. *Tachypeza* and *Tachydromia* are two genera of hybotids associated with trees, as they prey upon saproxylic insects.

The syrphid or hoverfly family also has woodland species associated with mesophile beech-woods and oak-woods. Their larvae develop in the holes in tree trunks where a puddle of water has formed. They find specific ecological conditions in this substrate of muddy debris: poor in oxygen and highly acidic. Some genera have evolved a long slim breathing tube, which allows them to breathe on the surface whilst eating on the bottom. Species include *Chalcosyrphus* and others which have become particularly rare, due to their requirement for mature forests (*Brachyopa pilosa*, *Brachypalpus laphriformis*, *Callicera aurata*). Other syrphids usually found in beech-woods and their clearings are *Chrysotoxum cautum* and *Syrphus torvus*.

The tachinids are a family of parasitic flies, i.e., their larvae develop inside the bodies of the larvae of other insects. The females lay their eggs directly on the body of the chosen victim. There are numerous woodland species present in beech-woods, which mainly parasitise the caterpillars of lepidopterans and larvae of tenthrinid wasps, such as *Compsilura concinnata*, *Ceromya bicolor*, *Carcelia lucorum*, *C. falenaria*, *C. bombylans*, *Cylindromia pusilla* and others.

Some other dipteran families are also parasitoids. One example is *Leopoldius coronatus*: the adults of this conopid frequent flowers, whereas the larvae live at the expense of various insects.

Lastly, the gall-forming dipterans of the cecidomyiid family should not be forgotten. They are represented in beech-woods by two very well-known specialised parasites, *Mikiola fagi* and *Hartigiola annulipes*. The female, before laying her eggs, pierces the adaxial surface of a beech leaf and inoculates substances into it that trigger a tumoral reaction in the plant tissues. This forms a gall, a protuberance of the plant tissue, in which the larva grows



Chrysotoxum cautum



Leopoldius coronatus

protected and finds food for its entire cycle. With its oval shape and red colouring, the gall of *M. fagi* is the most conspicuous and best-known.

Other dipterans, such as the agromyzids, have leaf miner larvae which excavate minuscule tunnels inside plant tissues. For example, *Phytomyza illicicola* digs tunnels in leaves of holly, a common plant in the lower-lying Apennine beech-woods. Last but not least, various dipterans are parasites of wild mammals. The oestrids are parasitic on herbivorous mammals: their larvae dig tunnels in the flesh of their victims causing myiases, i.e., tumoral formations. Species of the genera *Hypoderma* may attack roe deer and red deer; *Lipoptena cervi* has a wider spectrum of hosts, also parasitising fox and, most probably, other carnivores.

Lepidopterans. Lepidopterans are always numerous in a forest community, even when there are relatively few plant species, as in beech-woods. This is due to the fact that many species of butterflies and moths can feed on the same plant and, in addition, there are many clearings in beech-woods, where plant diversity is much higher.

The larvae of lepidopterans, caterpillars, are generally phytophagous and, with their chewing mouth parts, feed on the leaves on which they move about on their short legs, also making use of the abdominal appendages known as pseudopods. Instead, adults use a proboscis (which is curled up in a spiral



Hipparchia fagi

when not in use) to suck nectar from flowers. Among diurnal butterflies which live in forests, some species are camouflaged, having dark wings with many pale markings, which imitate the play of light and shade formed by the sun's rays penetrating through the foliage. Examples are *Pararge aegeria* and *Hamearis lucina*, two species of diurnal butterflies with habits more closely linked to woodland. The colour contrast is even more evident, and has a different adaptive significance, in the genus *Limenitis*, which is also typically woodland, belonging to the family of the nymphalids. *Limenitis reducta* can easily be seen fluttering above the shrubs of the undergrowth.

Many nymphalids are ecotonal rather than woodland, because they preferably live in the borders between woodlands and fields, or in clearings in the middle of forests. A typical inhabitant of beech-wood clearings is the papilionid *Parnassius mnemosyne*, the caterpillars of which live on the plants of the genus *Corydalis*. Other butterflies preferring clearings are to be found in that wide altitude interval between the deciduous oak-woods on the plains and the beech-woods. Most European nymphalids are inconspicuous, their muted colours alternating with numerous black markings, so that they can rest on the forest floor without being too obvious. This cryptic, but extremely elegant, type of colouring is found in various genera, including *Argynnis*, *Mesoacidalia*, *Fabriciana*, *Issoria*, *Pandoriana*, *Brenthis* and *Melitaea*. Other satyrine nymphalids, such as *Hipparchia fagi*, *H. hermione* and *Kanetisa circe*, possess



Kanetisa circe



Limantria dispar



Caterpillar of *Limantria dispar*

a very efficacious type of cryptic pattern and coloration, which renders them almost invisible to predators when they are resting on tree-trunks. The most highly specialised species include *Lasiommata petropolitana*, a very rare and localised Eurosiberian species, which flies in beech woodland clearings in the central Apennines for a period of around two weeks, from the end of May to mid-June. Instead the related *Pararge maera* is found throughout the Apennine chain. *Erebia ligea* is also present in clearings, where the caterpillars live on grasses, together with the lycaenid *Lycaena virgaureae*, with its striking sexual dimorphism.

One of the better represented families of nocturnal lepidopterans, or moths, is that of the geometrids, which are particularly abundant in woodland environments. Their caterpillars have only two pairs of abdominal suckers and are masters of cryptic mimicry - they become immobile and thus invisible on the twigs or bark of trees. The species which appear to be most closely associated with the environments of mesophilous beech-woods and oak-woods in the Apennines include *Ennomos quercinaria*, *Scotopteryx chenopodiata*, *S. moeniata*, *Chloroclysta miata*, *Epirrita christyi*, *Mesotype didymata* and *Eupithecia subfuscata*. In the beech-woods of Abruzzo, *Macaria wauaria* is also present. One geometrid which can cause sometimes great damage to the beech is *Operophtera fagata*, which possesses marked sexual dimorphism. As in many other geometrids, the females - unlike the males - are brachypterous, i.e., their

wings are very short and so they are incapable of flight. They climb slowly up beech trunks and, after being fertilised, lay their eggs on the leaves. The larvae later consume the leaf blade almost entirely, leaving only the midrib.

The better known moths include the false processionary moths, *Limantria dispar* and *L. monacha*, which often cause preoccupation with their dramatic demographic explosions, and the skin irritation caused by their caterpillars. These species are widespread in all deciduous forests up to 1500 m, especially in oak-woods and beech-woods.

The most brightly coloured family are the arctiids. The anterior wings of these pretty moths are often dark, with pale marks or stripes, as in *Arctia caja* and *Callimorpha dominula*, respectively. This allows them to rest on leaf litter or at the base of trunks during the day without being seen. In the unlikelihood of their being discovered, they play their final card: they suddenly fly away exhibiting their red or yellow posterior wings, which are invisible at rest but extremely conspicuous in flight.

Hymenopterans. Ants, honeybees, bumblebees, wasps, and numerous related forms all belong to the order of the hymenopterans.

Various omnivorous species are part of the vespid family, feeding on plant products (fruit, flowers) and flesh. They conduct a social life and often form nests in a forest environment. For example, *Vespula rufa* builds nests in woodland soils, and *Dolichovespula*



Larva of *Cimbex*

saxonica constructs paper-like nests, either in the holes of trees or hanging from the trunks. Some families belong to the superfamily of the tenthredinoids, whose larvae show an extraordinary similarity to caterpillars of the lepidopterans. This is an interesting phenomenon of convergence between Hymenopterans and butterflies, which only involves the larval stage: in both groups, the larvae live attached to and feed on leaves. The main difference lies in the number of abdominal pseudopods - tenthredinids always have more than five. The cimbicid family contains few genera, including four species of *Cimbex* (*C. fagi*, *C. connatus*, *C. luteus*, *C. femoratus*). These are the largest tenthredinoids in Europe, and may have a wingspan of more than 5 cm. Their larvae are also very large and brilliant green in colour. They feed on the leaves of beech, birch and other broadleaved trees.



Apennine wolf (*Canis lupus*)

■ Vertebrates

Beech-woods frequently disillusion ramblers who walk through them in the hope of seeing animals. For the majority of people, including many naturalists, "animals" just mean vertebrates, so that the disappointment is even greater. Outings inevitably end without a single sighting, apart from signs of the presence of a bird or two, such as a wood-pigeon's feather, the song of a bullfinch hidden among the foliage in the treetops, or the flight of a mistle thrush as it crosses a clearing. As in all Italian environments, this is often caused by the relationship between man and other animals, which is problematic in this country and still depends on management methods. Nevertheless, in the specific case of beech-woods, we have to admit that the fauna is impoverished. As mentioned at the beginning of this chapter, the climate and poverty of resources render beech-woods a place of passage for most vertebrates - a fact which will become even clearer in the following pages. Many species of mammals and birds, albeit in small numbers, frequent these woodlands, but in a transitory manner. For example, in the hot summer months, beech-woods may be places where animals rest, waiting to recommence their nocturnal activities in cultivated fields or pastures. However, this seasonal role should not be underestimated, because it is a very important phase in the daily and seasonal rhythms of animals' lives.

Amphibians. On the beech leaf litter, on rainy days in late summer or autumn, ramblers may suddenly come across a spotted salamander (*Salamandra salamandra*) with its elegant black and yellow livery. This species has an irregular distribution along the Apennines, being common in some areas and very rare in others. A subspecies, *S. s. gigliolii*, is to be found in the southern Apennines, identifiable by its colours, with much more yellow than black. The spotted salamander reproduces in slow moving stretches of streams and in spring waters, where the female gives birth to well-developed larvae. Speckled salamanders (*Salamandrina perspicillata*, *S. terdigitata*) are more thermophilous species, widespread at lower altitudes, up to approximately 1500 m. This genus, which is virtually endemic to the Italian peninsula, is emblematic of our fauna, having been chosen as the symbol of the Italian Zoological Union. Spotted salamanders live mainly in beech-woods in the Apennines, whereas speckled salamanders are to be found in all damp forests of the peninsula, as long as they are traversed by clear streams where the females can lay their eggs.

The Italian frog (*Rana italica*), a typical mountain species which never strays far from water, lives in the same environment as the speckled salamander. It passes

a great deal of time immobile on the rocks beside streams, awaiting the arrival of small prey. The agile frog (*Rana dalmatina*) lives in the leaf litter and undergrowth of damp forests, from the hygrophilous oak-woods on the plains to the upper beech-wood limit. It reproduces in pools, very often temporary ones, which form in beech-woods in early spring, with the melting of the snow. Another very characteristic species of damp woodland environments is the Apennine yellow-bellied toad (*Bombina pachypus*), which generally frequents temporary muddy puddles, even very small ones lacking vegetation, like those formed by vehicles making ruts in forest tracks. Seen from behind, the dull colour of this small toad allows it to merge easily with the mud. However, the underparts of the body are bright yellow and black - this is a warning to predators that the toad is equipped with glands which secrete toxic substances. The common toad (*Bufo bufo*) may also be found in beech-wood undergrowth. This ubiquitous species finds refuge in tree stumps, beneath fallen trunks, or in holes at the base of trees.

Reptiles. Low temperatures and scarce sunlight make beech-woods unsuitable for reptiles, which are ectothermal animals which always need time to warm themselves prior to embarking on their daily activities. Indeed, the presence of these animals in a shady environment like a beech-wood is linked to the dynamics of the clearings in which they live, like castaways on small islands. Every now and again, these fragmented habitats come into contact with one another, due to



Speckled salamander (*Salamandrina terdigitata*)

natural events or human tree-felling, permitting reptiles (and many other sun-loving animals) to move along temporary corridors formed by the ecological succession. The species living in these clearings demonstrate high altitudinal distribution, ecological range, and capability for dispersal. Snakes include the western whip snake (*Hierophis viridiflavus*), Aesculapian snake (*Zamenis longissimus*), red-eye whip snake (*Z. lineatus*), smooth snake (*Coronella austriaca*) and viper (*Vipera aspis*). The subspecies *V. a. hugyi*, with its characteristic dorsal pattern, lives in clearings in the beech-woods of Basilicata and Calabria.

The characteristic species of lizards are the slow-worm (*Anguis fragilis*), which is completely without legs, and common wall lizard (*Podarcis muralis*). The slow-worm is mainly nocturnal and is regularly found inside cavities in trees, where it spends the daylight hours. The common wall lizard frequents the rocky cliffs or emerging rocks which interrupt the monotony of the woody landscape. It often appears to be very abundant on escarpments along the sides of roads passing through beech-woods, and is thus one of the few animal species favoured by a certain level of habitat alteration at the hands of man. The Apennine populations are brown in colour, with diffuse black markings, and often with two blackish stripes extending along the flanks. The ventral parts of males may have yellow or orange markings of varying intensity. In the clearings of the southern beech-woods the Italian wall lizard (*Podarcis sicula*) may also be found. This thermophilous species is mainly associated with meadows.



Slow-worm (*Anguis fragilis*)

Birds. Being forest ecosystems, beech-woods host a large number of bird species. Nonetheless, many fewer are found than in deciduous oak woodland, the type with maximum biodiversity. This is due, as explained in the first section on communities, to the climatic gradient and consequent reduction of food resources from the plains to the mountains.

The number of birds is even lower in even-aged beech-woods managed for timber production, where the absence of old trees means that this particular habitat does not attract many nesting birds. For this reason, tits, nuthatches, treecreepers, collared flycatchers, spotted flycatchers and hoopoes are rarely found in these “unnatural” woodlands. The same is true of woodpeckers which, although able to use their beaks to dig out nesting sites in tree trunks, prefer already decaying wood, which yields more easily. Woodpeckers and other birds are also less numerous in woodlands composed of healthy trees simply because they are unable to find sufficient quantities of xylophagous and saprophagous insects to eat.

- **Diurnal raptors.** The most characteristic hawks of beech-woods are the goshawk (*Accipiter gentilis*) and sparrowhawk (*A. nisus*). The goshawk is more closely associated with forest environments, whereas the sparrowhawk is more often seen in ecotones, such as pastures with trees and shrubs, where forest re-growth is under way. Both the goshawk and sparrowhawk display



Juvenile goshawk (*Accipiter gentilis*)

morphological adaptations to forest life: their relatively short, stubby wings and long tail permit them to move agilely amongst the vegetation and veer suddenly to avoid tree trunks when chasing their prey. Both display sexual dimorphism in terms of plumage and size, a fact that leads to interesting considerations on their ecology and evolution. Males are markedly smaller than females.

Since the goshawk is larger than the sparrowhawk, goshawk males are only slightly bigger than female sparrowhawks. Why this difference in size between the two sexes? The explanation may lie in feeding strategies in a wooded environment, which offers little prey and makes hunting problematic. A pair in which the two sexes are of a different size succeeds in procuring a wider spectrum of prey for the young, compensating for their scarcity and the difficulty inherent in capture.

The buzzard (*Buteo buteo*) and honey buzzard (*Pernis apivorus*) are also often to be found in the forest, as both nest on tall trees. However, whereas the buzzard hunts in open spaces, the honey buzzard also searches for prey in the forest, where it may spend a long time plundering nests of wasps or feeding on caterpillars. None of the other diurnal raptors is suited to life in the forest because their hunting techniques are based on sight and necessitate open areas, such as pastures. Ubiquitous falcons like the kestrel, hobby and merlin can only be glimpsed occasionally in large clearings.



Sparrowhawk (*Accipiter nisus*)

● Nocturnal raptors. Nocturnal raptors such as the eagle owl (*Bubo bubo*), long-eared owl (*Asio otus*) and tawny owl (*Strix aluco*) belong to the order of the strigiforms. None of these species is exclusive to beech-woods, but all are associated with deciduous forests, at least for nesting purposes. This means that they are more common on mountains than in hilly and plain areas where deforestation has been greater. The eagle owl is immediately identifiable by its large size and prominent oblique ear tufts. Its prey includes dormice, hares, pine martens, woodcock, and even foxes. It nests in rocky environments, especially in isolated vegetation-covered ravines. It is somewhat rare in Italy, but is easily recognised by its deep, harsh call, which may be heard as far as 5 km away. The long-eared owl is identified by its long erect ear tufts, while the tawny owl does not have them at all. The tawny owl is also the only one of these species to have dark eyes instead of reddish-orange ones. Both the long-eared owl and tawny owl display a greater adaptability to living in environments frequented by man, at least where there is little hunting. It would appear that, in some regions, where an agro-forestry mosaic has developed extensively, human activities favour these birds, by causing an increase in the numbers of the small rodents on which they feed. The barn owl (*Tyto alba*), identified by the pale plumage on its breast, lives where the beech-wood has reclaimed ground from age-old mountain cultivations and has re-grown around old abandoned country dwellings. It nests in ruins, caves or rocky cavities.



Tawny owl (*Strix aluco*)

● Woodpeckers. Woodpeckers have an important role to play in forest ecology. They mainly feed on insects inhabiting tree trunks, especially the fat xylophagous larvae of cerambycid and buprestid beetles. The birds thus limit beetle numbers, contributing towards preservation of the trees. Woodpeckers also feed on termites, which live in rotting trunks eating dead wood, and ants, which build their communal nests in the holes. The noise these birds produce with their beaks is an indication of their constant work tapping holes in tree trunks. It is also an acoustic technique for signalling the bird's presence, marking territory and defining boundaries. True tree surgeons, woodpeckers also use their beaks to excavate their nests in the wood of rotting trunks, forming cavities that may later be used by other birds, mammals, or various organisms. This is the reason why woodpeckers are key animals in the forest ecosystem: as well as indicating the status of the environment, they also function as regulators of a highly complex ecological equilibrium.



Green woodpecker (*Picus viridis*)

The commonest woodpeckers in Apennine beech-woods are the green woodpecker (*Picus viridis*) and great spotted or pied woodpecker (*Picoides major*). The lesser spotted woodpecker (*P. minor*), whose presence is indicative of a higher level of complexity and diversity of the forest ecosystem, is less frequent. Even rarer is the middle spotted woodpecker (*P. medius*), which may be observed in central-southern Apennine beech-woods, usually between 1000 and 1500 m. But the rarest and most localised species is the white-backed woodpecker (*P. leucotos*), found in mature beech-woods of the central Apennines, particularly fully protected forests which therefore contain many tall trees, such as the Abruzzo National Park and the Foresta Umbra in Gargano (Apulia).

The black woodpecker (*Dryocopus martius*), a species usually preferring coniferous forests - its natural habitat on the Alps and over the rest of its vast Eurasian distribution area - may be found in mature beech-woods of the southern Apennines, in Campania, Basilicata and Calabria. The wryneck (*Jynx torquilla*) may also be spotted in clearings at the edge of woodlands, intent on devouring ants. Unlike true woodpeckers, it does not have a conspicuous plumage, but is perfectly camouflaged against tree trunks.

● Other orders. The woodcock (*Scolopax rusticola*) is the only member of the charadriiforms which normally lives in beech-woods, as in all types of deciduous forest in Italy. It is identified by its camouflaged plumage, short neck and very long beak, with which it extracts earthworms and other invertebrates from the litter and upper layers of soil. In general, woodcocks breed in central and northern Europe and spend the winter in Mediterranean countries.

Among the more frequent columbids in beech-woods, especially during summer, are the woodpigeon (*Columba palumbus*) and stock dove (*C. oenas*). By day, these two species fly out to open areas to feed, but use deciduous forests to roost and nest. Whereas the former gathers in large groups, the latter is usually solitary and prefers holes in trees or rocks. For both, their diet is omnivorous, although prevalently granivorous; during the winter months, they tend to move down to lower altitudes, seeking snow-free areas where food may be more easily found.

The cuckoo (*Cuculus canorus*) is a common inhabitant of all Italian forests and is never missing from beech-woods. It is known for its habit of laying its eggs in the nests of birds belonging to other species, consigning its offspring to the parental care of the parasitised species. The female cuckoo unfailingly lays her eggs in a nest of the bird species by which she was raised. She uses both visual and acoustic recognition for this, identifying the song most similar to that of her adoptive male parent, which she has retained in her memory. Cuckoos mainly eat insects, particularly caterpillars of large lepidopters, such as lymmantriid and processionary moths, thus contributing towards regulating their numbers.



Robin (*Erithacus rubecula*)

● Songbirds. The passeriforms or songbirds include numerous families and very many species of omnivorous, insectivorous, granivorous or frugivorous birds. Perhaps the most easily identified is the robin (*Erithacus rubecola*), which lays its eggs in a nest on the ground, often at the foot of large trees or among bushes in the undergrowth of beech-woods and other mesophilous woodlands. Like other bird species, the Italian populations of robin are formed of two separate contingents: numerous

individuals only come to Italy to over-winter and leave in early spring to nest in northern Europe; others remain and nest in the Apennine forests, beech-woods being preferred because of the cool damp conditions that are maintained during summer. Turdids which always nest in this habitat are the mistle thrush (*Turdus viscivorus*), song thrush (*T. philomelos*), blackbird (*T. merula*) and nightingale (*Luscinia megarhynchos*). Rocky outcrops or ruined buildings in the midst of a beech-wood, or at its edges, permits



Golden oriole (*Oriolus oriolus*)

the settling of other very territorial turdids, like the blue rock thrush (*Monticola solitarius*), rock thrush (*M. saxatilis*) and black redstart (*Phoenicurus ochruros*). The males are easily distinguished by their striking plumage, whereas the females are duller. The blue rock thrush male is an almost uniform dark blue, apart from its black tail and wings. The male rock thrush has a rufous breast and tail, with a white back. The smaller and slimmer black redstart male is an almost uniform dark colour, with a red tail.

The golden oriole (*Oriolus oriolus*) is a typical woodland bird the size of a thrush. The male has a startling yellow and black livery, with an orange beak; the female is more greenish-coloured, with speckled underparts. They can usually be glimpsed in clearings and on the edges of deciduous woodlands.

The family of leaf warblers comprises many small insectivorous birds that nest in trees, bushes and hedgerows. The chiffchaff (*Phylloscopus collybita*) and wood warbler (*P. sibilatrix*) are leaf warblers that more often nest in beech-wood undergrowth. They are small, highly active birds, which move continually on the branches of trees in search of minute prey. The wood warbler is instantly recognisable by its more noticeable plumage, with yellow throat, white underparts and greenish back. The chiffchaff possesses a resident contingent, i.e., birds which remain in Italy all year round, whereas the wood warbler is a migrant which nests in Europe and winters in Africa. It is a bird of passage in this country, but it does stop occasionally and nest in mountain areas.

The blackcap (*Sylvia atricapilla*) often nests on shrubs in the undergrowth, in all types of forest, from holly groves to beech-woods. The male and female are recognisable by the colour of their crowns, which are black and reddish,

respectively. Another typical forest warbler is the melodious warbler (*Hippolais polyglotta*), identifiable by the bright yellow colour of its underparts.

The smallest bird of the Italian fauna is the wren (*Troglodytes troglodytes*), with its brown speckled plumage. This tiny insectivorous bird nests in bushes, hollow trunks or among rocks. It is mainly active within the intricacies of the shrub vegetation, which it systematically explores, searching for caterpillars, butterflies, beetles and spiders. It has a very wide altitudinal range and is thus found in all Apennine forest habitats.

An insectivore, belonging to the muscicapid family, which, although not very common, regularly nests in Apennine beech-woods, is the collared flycatcher (*Ficedula albicollis*). It is one of the species which lay their eggs in holes in trees, and thus requires a mature forest of uneven age. It is related to the ubiquitous spotted flycatcher (*Muscicapa striata*), which may also be observed in large clearings or at the boundaries between beech-woods and alpine pastures. Collared flycatchers, or at least the males, are immediately distinguishable from spotted flycatchers by their conspicuous black and white plumage.

Tits, belonging to the parid family, are highly prolific, active small birds with short beaks. The most typical species and almost exclusive to beech-woods is the marsh tit (*Parus palustris*), which nests in these forests in summer and, in winter, moves slightly lower down to turkey oak groves. The coal tit (*P. ater*)



Wren (*Troglodytes troglodytes*)

also displays a tendency to nest in mountain environments. It prefers coniferous forests on the Alpine chain, but also frequents deciduous forests in the Apennines. Beech-woods also play host to the most common and widespread species of parids, which are found in all wooded environments in Italy, including town parks and gardens: the great tit (*P. major*) and blue tit (*P. caeruleus*). Both these birds show a preference for conifers, but are also regularly found in deciduous woodlands.

The nuthatch (*Sitta europaea*) is essentially a tree-living bird and also nests in tree holes. It passes its time climbing and flitting up and down the trunks and carefully inspecting the bark in its search for insects. The short-toed treecreeper (*Certhia brachydactyla*) and treecreeper (*C. familiaris*) fill a similar ecological role to the nuthatch, although they have a differently shaped beak, slightly curving downwards. The former lives in woodlands from sea level up to approximately 1000 m; the latter is widespread in Alpine coniferous forests, and may also be seen in some areas of the Apennines, although it is not common.

The fringillid family includes various species with pronounced sexual dimorphism: flamboyant males, and brown or greyish, dull-coloured females, often streaked. Males use their elegant plumage to advertise and defend their territory, accompanying this visual message with that of their melodious song.



Bullfinch (*Pyrrhula pyrrhula*)

The most characteristic bird species in beech-woods, although difficult to see because it is very elusive, is the bullfinch (*Pyrrhula pyrrhula*). This bird, with its elegant pinkish-red and grey plumage, inhabits dense tree vegetation from whence it emits its piping, penetrating call.

The behaviour of the chaffinch (*Fringilla coelebs*) is entirely different – these birds can regularly be seen on the ground, especially in early morning or towards dusk. They nest in woodlands on the hills and mountains, but move further down into the valleys for the winter months. Another species which regularly nests in beech-woods is the hawfinch (*Coccothraustes coccothraustes*), which uses its large robust beak to crack open beechnuts and other seeds. Unlike the bullfinch, it loves to sit on the highest branches of the trees, making itself highly visible.

The coniferous forests of the Alps are characterised by the presence of the nutcracker and oak-woods by the jay, but beech-woods can claim no typical crow. The jay (*Garrulus glandarius*) often reaches around 1700 m, but its mountain populations are sparser than those on the plains and hills, demonstrating that the species does not find optimal ecological conditions here. The jackdaw (*Corvus monedula*), a gregarious and highly eclectic crow, settles wherever there are ruined buildings, at any altitude. Ancient abandoned hermitages, around which the beech-wood has re-grown, sometimes become a stronghold for its noisy flocks, with their very intense social life.



Jay (*Garrulus glandarius*)

Mammals

● Insectivores and bats. Insectivorous mammals frequenting beech-wood undergrowth and clearings are species with wide altitudinal distribution, found in plain and mountain woodlands alike. An ubiquitous example is the hedgehog (*Erinaceus europaeus*), an omnivore which finds numerous food resources in leaf litter and amongst the vegetation in clearings. Various small insectivores of the shrew family also wander around in the night hours seeking earthworms, snails, spiders and insects. They are Antinori's shrew (*Sorex antinorii*), Apennine shrew (*S. samniticus*), pygmy shrew (*S. minutus*) and bicoloured white-toothed shrew (*Crocidura leucodon*). Their field of action is the surface of the ground and all its many micro-cavities, which they painstakingly explore with their long sensitive snouts. The ecological role played by shrews above ground is the same as that of moles in the soil. Beneath the litter, buried in the deep humus of woodlands and clearings, live the blind mole (*Talpa caeca*), Roman mole (*T. romana*) and northern mole (*T. europaea*), which prey on the invertebrates they find in their subterranean tunnels.

Several species of chiropterans, or bats, frequent beech-woods and other Apennine deciduous forests. In particular, numerous species of myotis bat hunt in the clearings or open areas situated at the woodland edges, and then shelter in holes in trees during the day. Bats, like many other animals, prefer



Blind mole (*Talpa caeca*)



Wild cat (*Felis s. silvestris*)

uneven-aged forest, with abundant hollow trees which can guarantee them not only daytime shelter, but also their source of prey. Many of the insects preyed upon by bats, being xylophagous, saprophagous or mycophagous, pass at least part of their life-cycles in holes in tree-trunks. Yet other insects are their parasites or predators, so that they too, albeit indirectly, depend on old trees. The species of this complex nocturnal community include the noctules (*Nyctalus noctula*, *N. leisleri*, *N. lasiopterus*), common long-eared bat (*Plecotus auritus*), barbastelle (*Barbastella barbastellus*), pipistrelles (*Pipistrellus nathusii*, *P. pipistrellus*, *Hypsugo savii*), serotine (*Eptesicus serotinus*) and some myotis bats (*Myotis bechsteinii*, *M. mystacinus*).



Noctule (*Nyctalus noctula*)

The environmental mosaic created by mountain beech-woods and their clearings are one of the most important habitat types for bats. Most probably, many individuals of woodland species with wide ecological range colonise beech-woods to avoid the competition and over-population of deciduous oak-woods. On the one hand, the low temperatures in beech-woods may be a limiting factor for bats but, on the other, the high humidity during the summer months may counterbalance the seasonal aridity and lack of insects surviving in other environments. It is also probable that bats, like other mammals and many birds, change altitude according to season.

● Carnivores. Carnivorous mammals are of huge ecological significance. The wolf (*Canis lupus*), fox (*Vulpes vulpes*), pine marten (*Martes martes*), beech marten (*M. foina*), western polecat (*Mustela putorius*), weasel (*M. nivalis*), badger (*Meles meles*) and wild cat (*Felis s. silvestris*) are to be found in all types of forest habitat on the Apennines. The wide spectrum of potential prey and relative indifference of these species to abiotic factors (temperature, humidity, etc.) allow them to live in extremely diverse environmental contexts. The limitations to their effective distribution are mainly the consequences of human activities, such as deforestation, pollution, or direct elimination through hunting and various forms of persecution (poisoned bait, traps, etc.). Another factor causing the absence or rarity of these animals in some

districts is impoverishment of the food chain and therefore a scarcity of prey. This reduces breeding success and so the predators disperse in search of new territories, during which time there is a high rate of mortality.

The Abruzzo brown bear (*Ursus arctos marsicanus*) and lynx (*Lynx lynx*) both live in protected areas of the central Apennines, but are localised and rare. Some decades ago, the wolf was in a similar situation and many prophesied its impending extinction in Italy. Instead, favourable conditions have allowed its populations to increase somewhat and to expand throughout the Apennine chain, to the point of colonising even the western Alps. Nowadays, the Apennine populations of all carnivores find their principal refuge in mountain forests, and so particularly in beech-woods, although they make frequent incursions into open areas such as pastures or cultivated fields to feed.

- **Ungulates.** The prey of large carnivores are extremely rare in Apennine ecosystems. Despite the commendable efforts in recent decades by the fauna management authorities, to glimpse a red or roe deer in most parts of the peninsula is an exceptional event. The population density of ungulates is still very low with respect to the carrying capacity of Apennine forests. Paradoxically, in some small protected areas, the densities of red and roe deer and wild boar are high enough to cause damage to the vegetation and thus require programmed culling. Instead, outside these reserves, illegal



Lynx (*Lynx lynx*)

hunting and also the presence of far too many feral dogs prevent these animals from reaching sufficient densities to form an eco-tourist attraction and food resource for large wild carnivores.

The roe deer (*Capreolus capreolus*) is a small cervine deer, with a black muzzle and three-pointed antlers; males are virtually tail-less, but females have a false tail composed of a tuft of white hairs. Instead, the red deer (*Cervus elaphus*) is a large mammal with many-pointed antlers. Both red and roe deer females give birth at the beginning of June, and the young fawns have a characteristic dappled coat, i.e., with white markings. This is a true model of camouflage, typical of forest environments, which has already been mentioned in the section on lepidopterans. Indeed, young fawns spend many hours alone, crouching immobile in the undergrowth, while their mothers wander off to graze. Their colouring renders them less conspicuous to the eyes of predators.

The ecology and behaviour of these two species display marked differences: roe deer are solitary and territorial, whereas red deer tend to gather together in herds. Roe deer are found in beech-woods all year round, but red deer, if they can make a choice of where to go, tend to frequent forests mainly in winter; during the rest of the year, they prefer to roam the green high-mountain pastures. In reality, however, they are constrained to use the woodlands as daytime refuges and usually only emerge at dusk, when there



Red deer (*Cervus elaphus*)

is less fear of disturbance from humans. Their large size and social habits render red deer highly visible and they very often attract too much attention. In any case, red deer have shown that they prefer deciduous oak-woods to beech-woods.

Studies on territorial exploitation by wild boar (*Sus scrofa*) indicate that, wherever possible, these animals also choose to avoid beech-woods. They generally prefer to remain below 1000 m, preferring oak-woods, chestnut groves, scrub, and open areas offering them a wider range of food resources.

- **Rodents.** Few rodents live in beech-woods: all the species frequenting this type of habitat show a marked preference for deciduous oak-woods. The most visible species, also thanks to its diurnal habits, is the red squirrel (*Sciurus vulgaris*). Despite its name, in Italy this species includes populations with coats coloured variously from dark brown to almost black, with white underparts. Red squirrel distribution is often discontinuous in both space and time. In many oak and beech woodlands, they may disappear for many years and then unexpectedly reappear. The reasons for these population dynamics are unclear, but they may have something to do with the fragmentation of forest habitats, leading to genetic isolation. As squirrels, being territorial and aggressive towards others of their own species, are always at low population densities, an excessively high level of inter-breeding may cause local extinction in areas



Red squirrel (*Sciurus vulgaris*)

which are too small. These areas may then be re-colonised at a later date, when suitable forest corridors have formed. It should also be noted that red squirrels appear to prefer coniferous forests rather than deciduous ones. Conversely, deciduous forests are the preferred habitats of members of the glirid family, such as the fat dormouse (*Glis glis*) and hazel dormouse (*Muscardinus avellanarius*), which are both to be found in beech-woods.

Squirrels and dormice have different strategies for surviving the winter. The red squirrel stores surplus food, accumulating beech-nuts, acorns and other foodstuffs in its chosen hiding-places. The fat dormouse and hazel dormouse hibernate during the winter months, after having spent a period of fattening-up in autumn to accumulate food reserves in their bodies. Beech-nuts are an important source of food during this fattening phase prior to hibernation.

The bank vole (*Clethrionomys glareolus*), with its russet-coloured back, is a species associated with deciduous forest ecosystems with abundant leaf litter and rich undergrowth. They live as far as the upper beech limit, and dig complex systems of tunnels with entrances at the base of old trees, tree stumps or rocks. The yellow-necked mouse (*Apodemus flavicollis*) is a species related to the wood mouse (*A. sylvaticus*). The latter is more common in plains and hilly areas, whereas the yellow-necked mouse shows a marked tendency to live in mesophile and montane forests, such as turkey oak groves and beech-woods.



Bank vole (*Clethrionomys glareolus*)

Conservation and management

GIUSEPPE CARPANETO · MAURIZIO CUTINI · ROMEO DI PIETRO

■ Human-forest relationships in the Apennine mountains

Although today's Apennine beechwoods appear to display their natural purity and floral originality, it must not be forgotten that these forests have, over the centuries, repeatedly suffered at the hands of man. In the not too distant past, woodlands were of much greater socio-economic importance, especially during some periods of history, than nowadays: they provided the primary source of raw materials on



Beech shoots grow at the base of an old trunk

which an often poor local economy, more or less at subsistence level, was based or re-launched. Prior to the eighteenth century, the value of woodland in daily life - not just for farmers - was markedly higher than in later times. Forests represented a permanent stock of timber and firewood and, particularly if composed of broadleaved trees, grazing grounds for livestock, mainly sheep, pigs and cattle. Tree use through various forms of coppice management supplied food for livestock in mountain areas, which were directly grazed by animals or which provided forage for use during the winter months.

The excessive exploitation of beech-woods, in both pastoral terms and to make way for arable crops, as well as the alteration and degradation of the forest undergrowth, has led to the rarefaction of species less resistant to these types of use or, in the worst cases, to their local extinction. To quote just two examples, the disappearance of holly and yew, both species of high phytogeographical value, has been recorded in several areas of the Apennines. However, the over-exploitation and consequent impoverishment of forestry resources, through excessive, poorly-planned or disorganised local activities, should not be the excuse to unjustly ignore an emerging trend in the alternating cycles of customs of exploitation followed by awareness of the need to protect woodlands.

A monumental specimen of pollarded beech (Monte Lucretilli, central Apennines)



As early as the Middle Ages, there are records of areas of forest being banned for any kind of activity, to prevent and/or limit excessive exploitation of particularly rich areas by the local inhabitants. It was clearly understood that maintenance of forest vegetation would ensure the protection of hill-sides at greater risk from landslides, and thus also protect people's homes and livelihoods (especially farmers) further down the mountains or on the plain below.

The 18th century set the stage for varied alarm bells to ring regarding the future of timber supplies in many parts of Europe (France, Germany, Austria, Switzerland, and later also Italy). The latter half of the century produced a wealth of testimonies on the degradation of vegetation, including direct reports of increasingly frequent floods, landslides, avalanches and other natural calamities, which were scrupulously documented in local chronicles.

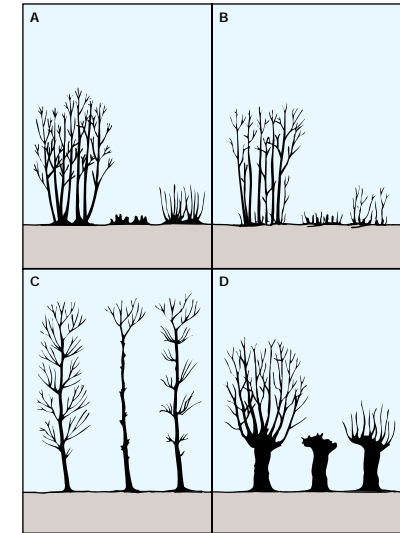
From the very earliest times, the integration of crops, pastures and trees has been a fundamental characteristic in the Mediterranean mountain systems with an agro-sylvo-pastoral economy. In addition, this relationship between forest populations and agricultural-pastoral exploitation is much more complicated than is commonly believed. Surviving examples from the Ligurian Apennines are particularly evocative of this. A very marked propensity towards maintenance of woodland resources appeared to triumph, applying methods of land use which were in no way random, but which reflected profound knowledge of the places, instruments and forest species involved.



Pasture next to a beech-wood (Monte Terminillo, Latium)

Human activities and nature were in harmony - a circumstance that was not mere chance but the result of a complicated process, through which consumers applied a background of practical knowledge as sophisticated as it was efficient:

"... with respect to the known destruction of woodlands, if this has happened over a long period, I can say that I myself am 58 years old or thereabouts, and it seems that I have always seen them in just about the same state as they are now... the beech woodlands higher up the mountains are quite commonly used for firewood by the local inhabitants, and the property and land is sometimes also used for sowing crops after the soil has been duly prepared".



Methods for wood production. A and B: cutting from stump and root offshoots; C: suckering; D: pollarding

This statement by the Prefect of the mountain comune of S. Stefano in Valle d'Aveto (dated 1806), does not suggest any correlation between the disappearance of the woodland cover and the temporary use of forested land for agriculture - known locally as *"ronchi"* (singular - *ronco*). This is only one of the methods of temporary cropping of the much wider universal farming practice of stubble-burning. This Ligurian dialectal term, which roughly translates as to *prune*, *hoe*, and *weed*, may therefore be taken to mean a forest plot managed by coppicing in the form of what is known as *"suckering"*, i.e., cutting off lateral branches very close to the trunk, in order to obtain new shoots and thereafter forage for livestock.

Multi-purpose methods were applied to exploiting the same plots of land - agricultural, pastoral, or silvicultural - without destroying the tree cover. Notwithstanding this type of *"integrated"* use, other conflicts of interest emerged in the exploitation of the Apennine beech-woods. Many scholars have discussed the contradictory co-existence, not without strong social contrasts, between producing wood and charcoal in the transformation from the *"wood and charcoal civilisation"* prior to the 18th century to the *"coal civilisation"* of the 19th century, which have affected the Apennine mountains in the last three centuries.

The beech-woods of today bear innumerable signs of man's exploitation over the centuries. The Apennine forests have long been contended by various "economic propensities", which have fundamentally altered them and modified their original spatial, ecological and floral-structural properties.

The most ancient use of the forest was as a place for grazing livestock: during the Middle Ages, in agreements regarding the buying and selling of areas of forest, the value of the woodland was mainly attributed on the basis of the number of animals it could support. In the same way, the Gregorian Cadastre (19th century) accurately registered "yielding" woodlands, i.e., those capable of producing food for domestic animals. This utilisation, together with exploitation of the "secondary" productivity of the forest (acorns, beech-nuts, leaves and



Forest track in beech-wood (Monti Picentini Regional Park, Campania)

herbaceous plants of the undergrowth), did not include the removal of timber, except in very small amounts for the needs of the local communities, who benefited from this resource on the basis of centuries of common rights deriving directly from medieval customs. The forest which supported this "green economy" may have been a tall forest, with small clearings where animals grazed on the fresh undergrowth, or perhaps it had the appearance of "savannah" (*sensu* Rackham), i.e., with not very dense tree cover, so that a luxuriant carpet of herbaceous plants could grow. This grass cover was exploited for grazing during spring-early summer and early autumn, while during the hottest and driest period in summer, the poor pasture was integrated with gathered beech leaves strewn on the ground. In many areas of the Apennines, a particular form of utilisation of forested land was long practised - the "*ronco*", which included the cultivation of cereals in forest soils the year after coppicing the woodland. This was followed by the possibility of grazing sheep and goats, the production of foliage and then, after only 9-10 years, renewed cutting. This type of beech-wood use also included beech-nuts, i.e., the fruit of the beech tree. Obviously, they were mainly used for feeding pigs, sheep and goats (and also humans in times of famine). A much more curious form of use (quite widespread in central Italy) was the crushing of beech-nuts, which yielded a combustible oil of enormous economic value. Practically odourless and giving off little smoke, it was very suitable for the lighting requirements of genteel homes. The often dramatic effects of these types of use was undoubtedly progressive soil

erosion, with the consequent profound alteration of the floral composition of the forests. In this context, limited to tree species, in 1871 the Italian botanist Agostino Reali wrote an interesting page about the holly in the Camerino territory: "...in all our forests ... abundant hollies, sometimes very large ones, prospered, and were felled with the rest of the trees to provide firewood and charcoal...". As regards the lime tree, he states: "At one time it was very abundant in the Camerino area ... but at present it is almost completely deprived". Yet again, writing of the yew, Reali recalled "...of the big yew wood which cloaked the mountain of Montecavallo, a portion still exists, which we hope will not share the fate of all the rest - sold off to the woodcutters and charcoal burners".

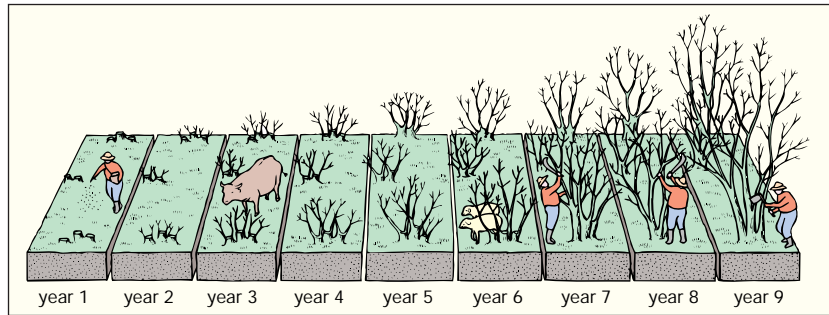
The transformation of the territory that occurred during the 18th and 19th

centuries had even more devastating outcomes, and many beech-woods disappeared under the axes of the mountain farmers, who pushed cereal cropping to altitudes - in the midst of the beech distribution belt - today unthinkable. Recent research on patterns of land use in an area of the Apennines in the Marche has shown that almost none of the current beech-woods is more than 150 years old!

Certainly, this piece of information cannot be generalised to all the Apennine beech-woods, but it does give the sense of mountains entirely dominated by man, by his crops and his economy, and, for this reason, it demonstrates that we cannot understand the present-day mountain forest ecosystems without taking into account their history and the fact that they have been one of the mainstays of Apennine society for centuries.



The edge of a beech-wood subjected to disturbance by over-grazing (Monte Vigilio, Monti Simbruini Regional Park, Latium)



Hypothesised 14th-century exploitation of a woodland plot in the Umbria-Marches Apennines. Cereals are sown after coppicing, the woodland is then grazed, and leafy branches cut for use as forage.

Those beech-woods which served to produce large quantities of charcoal for furnaces and foundries, silk mills and glassworks, became severely degraded over time, becoming very dense coppices and, with 15- to 20-year rotations, areas with either no trees with wide crowns, or areas with no undergrowth. This exploitation necessarily contrasted with the traditional silvicultural practices of the local communities, as very often nothing much remained except sterile soil, because of the excessive numbers of charcoal burners who had exploited the woodland in the past. Many chronicles dating from the latter half of the 18th century point to the great demand for charcoal as one of the main causes of the devastation of forests. In particular, for the whole of the south of Italy, the result of exploiting beech-woods for charcoal was widespread, as demonstrated in large districts of the Apennines in Abruzzo. In many of these mountain areas, the diversified use of forest resources led to differentiation between coppiced woodlands and woods of tall and medium-sized trees, the former used for firewood, the latter mainly destined to become raw materials for civil, military and naval constructions, as well as for craftsmen's work.

However, it should be made clear that the widespread practice of cutting known as "pollarding", which is extremely common in beech-woods all over the Apennines, represents a perfect integration of the woodland-pasture system, thanks to the traditional knowledge of mountain populations on the renewable uses of trees. In this sense - thinking back once again to past centuries - beech-woods may be viewed as "treed pastures". This is the model of Mediterranean "savannahs" described by Rackham, in a radical change of perspective which interprets the forest land not merely as damaged by pasturing, but as an anthropomorphic-geographical context in which livestock rearing, production processes and forage resources are integrated - a model common to all Mediterranean mountain regions.

■ Conservation and management of the vegetated landscape

Some of the Apennine beech-woods are identified as priority habitats in the 92/43/EEC Directive, better known as the "Habitat Directive". The adjective "priority" is used in it to define those habitats which are at risk of disappearing from the territory of member states of the European Union and for which the EU has a special responsibility for conservation.

In the annex to the Directive, which reports the "Types of natural habitat of European interest, the preservation of which requires the designation of special conservation areas", at point 92 (Deciduous Mediterranean Forests) "Apennine Beech-woods with *Taxus* and *Ilex*" (code 92.10) and "Apennine Beech-woods with *Abies alba* and Beech-woods with *Abies nebrodensis*" (code 92.20) are listed as priorities. These habitats are thus included in the list of Sites of European Union Interest and specific management plans are provided for them. In general, the problems and principles of forest management are similar for both beech-woods and other deciduous forests. However, it is necessary to distinguish between silviculture and conservation of the forest ecosystem - two types of management with different objectives. The main purpose of the former is timber production, even when practised according to the principles of sustainable growth and including other collateral uses. It is still only an economic activity, like agriculture and pasturing, to be conducted in areas destined for this use. Instead, conservation of the forest ecosystem should be carried out in properly protected territories (parks and reserves) and should be founded on the maintenance of biodiversity and ecosystem integrity. It involves the monitoring of natural forest dynamics (privileging the protection of so-called "ancient" woodlands) and only minor interventions are needed to correct alterations produced directly or indirectly by human activities.

The current extent of Apennine beech-woods is quite definitely greater than the historical minima which these formations reached in past epochs, when the degree of deforestation on the mountains was much greater than at present. Old photographs speak clearly: it often comes as a surprise to see photographs taken in the early 20th century showing bare, semi-deserted landscapes in areas which are today covered by beech-wood. This is a natural consequence of the fact that livestock pasturing has more or less been completely abandoned, and replaced by jobs which were better paid, or at least more desirable in certain historical periods characterised by mass urbanisation, especially in the lowlands.

The uncontrolled removal of firewood and the spread of pastures have much less impact nowadays than in the past, due to the depopulation of mountain

The list of protected species includes an entire family, the *Orchidaceae*, entitlement to protection of which is in many cases recognised at group level, although some of the species in the family are not in fact rare. Many species are easy to find during an excursion in a beech-wood. Indeed, it is not by chance that some of them have been used as species characterising the ecology of a

grouping in phyto-sociological nomenclature (*Cephalanthero-Fagion*, *Epipactido-Fagetum*, *Dactylorizo-Fagetum*, etc.). Clearly, not all species of orchids find their true optimum in beech-woods: some are “elective” of this ecosystem, others are “preferential”, and yet others grow there only as “ingressive” species. Some genera, such as *Cephalanthera* or

Epipactis, are almost exclusively woodland; others avoid wooded environments (*Ophrys*, *Serapias*, *Nigritella*). Listed below are orchids growing in Apennine beech-woods with their chorotype, preferred habitat and Italian distribution.

In addition to those listed, similar species also grow in beech-woods, having arrived from the forest edges or

from shrub areas (*Epipactis atrorubens*, *Goodyera repens*, *Leucorchis albida*, *Listera cordata*, *Orchis provincialis*, *O. purpurea*, *O. spitzelii*, *Platanthera bifolia*, *P. chlorantha*) and other extremely sporadic species arriving from non-woodland habitats (*Coeloglossum viride*, *Gymnadenia conopsea*, *Himantoglossum adriaticum*, *Neotinea intacta*).

<i>Elective species of beech-woods</i> · Chorotype	Habitat	Italian distribution
<i>Epipactis meridionalis</i> · Endemic	Beech-woods	Sicily, Calabria and Basilicata (reports for Abruzzo, Latium and Campania to be confirmed)
<i>Epipactis persica</i> · SE European (sub-endemic)	Apennine beech-woods	Missing from the Alps, Umbria, Molise, Apulia and Sicily
<i>Epipactis viridiflora</i> · Sub-Atlantic	Beech-woods	To be defined. Reports for Lombardy, Emilia-Romagna, Marches, Abruzzo and Latium
<i>Limodorum brulloi</i> · Endemic	Beech- and fir-woods, and woods of <i>Pinus nigra</i> ssp. <i>calabrica</i>	Calabria, in Sila and Aspromonte only
<i>Preferential species of beech-woods</i> · Chorotype		
<i>Cephalanthera damasonium</i> · Euro-Mediterranean	Beech-woods, mesophilous broadleaved woods, beech-wood edges	Throughout
<i>Cephalanthera rubra</i> · Eurasian	Beech-woods and mesophilous broadleaved woods	Throughout
<i>Corallorhiza trifida</i> · Circumboreal	Beech-, fir- and pine-woods	Alps and Apennines excluding Apulia, Sicily and Sardinia
<i>Epipactis flaminia</i> · Endemic	Beech- and fir-woods	Apennines in Tuscany and Emilia-Romagna
<i>Epipactis leptochila</i> · Central-European	Thermophilous beech-woods	Alps, excl. Friuli, Valle d'Aosta and Liguria, eastern Apennine slopes as far south as Abruzzo
<i>Epipogium aphyllum</i> · Eurosiberian	Beech- and pine-woods	From the Alps to Calabria, absent from Valle d'Aosta, Liguria, Umbria, Sicily and Sardinia
<i>Neottia nidus-avis</i> · Eurasian	Mesophilous broadleaved woods on deep soils	Throughout
<i>Woodland species often common in beech-woods</i> · Chorotype		
<i>Cephalanthera longifolia</i> · Eurasian	Broadleaved woods and mesophilous oak-woods	Throughout
<i>Cypripedium calceolus</i> · Eurosiberian	Beech-woods and Apennine mountain pine-woods	Alpine regions excluding Liguria; only in Abruzzo Apennines
<i>Epipactis helleborine</i> · Paleo-temperate	Broadleaved woods on deep soils	Throughout
<i>Epipactis microphylla</i> · Euro-Caucasian	Cool oak-woods, broadleaved woods, preferably on limestone	Throughout, excluding Valle d'Aosta
<i>Epipactis muelleri</i> · Central-European	Broadleaved woods	Eastern Alps from Liguria to Friuli, northern and Central Apennines to Molise (reports for Umbria to be confirmed) and Apulia
<i>Listera ovata</i> · Eurasiatic	Broadleaved woods on deep sub-acid soils	Throughout
<i>Dactylorhiza maculata</i> s.l. Eurosiberian	Broadleaved woods, mountain and sub-montane scrub on deep sub-acid, occasionally flooded, soils	Throughout, excluding Sardinia, with 3 sub-species: ssp. <i>maculata</i> , ssp. <i>fuchsii</i> , ssp. <i>sacclifera</i>
<i>Orchis pallens</i> · Euro-Caucasian	Broadleaved woods, mountain scrub	Throughout, excluding Umbria, Apulia and islands

communities. The habit of allowing livestock to graze at will has gradually been replaced by intensive rearing indoors, apart from a very few areas in the central and more often, southern Apennines, where traditional pasturing is still practised locally. This custom, based on transhumance, is today facilitated by motorised transport, involves vertical migration of livestock, during which even beech-woods are invaded - often illegally - in some periods of the year. The consequence is accentuated hydrogeological instability, soil erosion, and hindrance to the natural re-growth of woodland, depriving the plant communities of structure and thus modifying their floral composition.

Since ancient times, man has taken advantage of the possibility of grazing in forests, practised with all habitually reared animals (sheep, goats, cattle, horses, donkeys, pigs). However, this activity has markedly reduced in recent decades, thanks partly to the introduction of restrictive measures to protect forests. The various changes in local customs and economy have had unequal effects on beech-woods. On one hand, there has been the re-formation of the forest cover in areas where the continual passage of livestock and voluntary action by herdsmen had impeded its regrowth. This has had a positive impact on the biological diversity of forest communities, and has allowed re-unification of forest fragments which had remained isolated, re-establishing the gene flow between populations of animals and plants.



Beech-wood canopy in autumn

On the other hand, the disappearance of pastures is a problem for those plant and animal communities preferring the open environments which had formed during the millennial interaction between man and forests. The hunting territory for many species of raptors (eagles, buzzards, falcons, etc.) has become smaller, and areas of pasture for wild herbivores, such as red and roe deer, have diminished. In addition to this, many species of animals (and also plants) can only live successfully where the grass is short, having been recently grazed by herbivores.



Beech colours in autumn

The excessive reduction of forests or pastures, caused respectively by tree-felling or the abandonment of grazing, produces an imbalance in plant and animal communities. For example, the disappearance of forests creates survival problems for brown bears, especially in autumn, when acorns and beech-nuts are an important food resource for these animals before their winter hibernation. Smaller pastures also create problems for bears, especially in spring, when they move into open areas to browse on fresh greenery. In both cases, the shortage of food means that the bears tend to invade farming areas in search of something to eat. A similar case is the damage to woodland renewal caused by wild herbivores (deer) which, forced to seek refuge in patches of woodland which are too small, and often surrounded by areas used by humans, destroy young seedlings and strip the bark off the trees, especially during the winter months: if these animals were given the opportunity to graze in wide pastures adjoining the forests, this problem would be greatly reduced.

So, management aimed at the conservation of biodiversity in the mountains should always aim at maintaining a mosaic of ecosystems, in order to help guarantee the survival of all components - both heliophilous (sun-loving) and sciaphilous (shade-loving) species - and permitting the more vagile animals to exploit both types of habitat according to the season and their own specific requirements.

To maintain this habitat diversity in beech-woods, the abundant presence of wild herbivorous mammals, such as red and roe deer, is important. A limited

number of cattle, sheep and horses may also be allowed into protected areas (obviously not those set aside for full conservation), as long as they do not exceed the carrying capacity of the beech-wood, i.e., the maximum number of individuals that can live there without causing irreversible alterations to the composition and physiognomy of the vegetation.

The enormous importance of clearings in beech-woods is stressed in all faunal studies on insects, reptiles, birds and mammals. Clearings are also important in the ecology of large mammals, as proven by telemetric studies on their home ranges, which have demonstrated that all the animals pass a large percentage of their time in clearings, especially for feeding. These open areas are the result of natural events, such as fire caused by lightning, the fall of a large tree which drags neighbouring young trees down with it, or a landslide, with the consequent fall of trees and loss of soil. In this way, "oases" of light are formed in the heart of the beech-wood, where numerous species of heliophile and pioneer plants grow, creating trophic resources for many animals. A multitude of phytophagous insects also fly here, and birds arrive, attracted by the abundance of insects, seeds and berries, reptiles establish their territories for thermoregulation, roe deer visit regularly to eat the grass, and so on.

Managers of beech-woods should therefore bear in mind the importance of clearings and, where there are none, take steps to create them. It is also worth considering the importance of mixed-age stands, i.e., the contemporary and



Chestnut orchard planted to substitute beech-wood (Monti Cimini, Latium)

contiguous presence of both young and old trees. This factor is a guarantee of maximum diversity for animal communities, in that the co-existence of trees of all ages - young, developing, mature and decaying - gives rise to a multi-layered forest in which the highest number of animal species can find their own ecological niche. Beech-woods composed of nothing but trees of the same age are generally the consequence of silvicultural practices which have involved mass planting.



Roe deer (*Capreolus capreolus*)

Natural beech-woods obviously contain trees at all stages of growth, because they have grown independently of one another. It is important, however, not to forget that the multiple exploitation of beech-woods, protracted over the centuries, has partly altered their floral composition through modifications to ecological characteristics. Several kinds of cutting methods, varying locally depending on the economy of the area - gathering of fungi and wild fruits, and exploitation by grazing in the woodland - has led to the predominance of various practices of maintaining a forest of tall trees and/or use by coppicing. In the latter case, varying beech-wood management methods have resulted: coppicing, when only stumps remain; pollarding, when the cutting is done at 1-3 m from the ground; and pruning, when only the branches of the tree are cut off. Pruning and pollarding have practically died out in most woodlands, whereas coppicing is still maintained at a very local level, as a support to agricultural and livestock activities. At one time, pollarding supplied twigs for forage or osier for bindings and basketwork, as well as fuel, while "pruned" trees were only found in very restricted areas, near houses, at the edge of fields, and along roadsides.

Where true forest ecosystem conservation is practised, trees must be allowed to grow, mature, die and fall, just like any other living organisms. This is a natural condition which occurs in forests and which is opposed by the old school of foresters, who base their view on the fact that fallen trunks represent a reservoir for parasites dangerous for other plants. Instead, ecosystem conservation is the only way truly to preserve communities, hosting not only rare saproxylic insects, today threatened by extinction, but also the resources to sustain a large number of organisms, including birds and mammals, which find food and shelter in old hollow trunks.

Suggestions for teaching

MARGHERITA SOLARI

■ Beech-woods and man

- Aims: to increase awareness of landscape changes in relation to climate and man's impact during various periods of history; to acquire tools and skills in interdisciplinary and multidisciplinary studies, to understand the importance of direct interviews in research; to become acquainted with agencies working locally.

- Level: high-school pupils between 16 and 18 years of age.

- Equipment: literature; computers; materials to set up a small exhibition; proper clothing for field trips.

- Possible collaborators: science and arts teachers; nature and history guides, forest rangers.

- Timing: this may be a long-term project, extending over more than one school year.



Improper use of trees: carved writing

PRELIMINARY STAGE

1. Prepare a work plan which includes research times and methods. This may involve a general introductory part to be presented to the whole class, with lessons on the beech and its autecology, the beech-wood as an ecosystem, distribution of beech-woods from the post-glacial period until today, exploitation of beech-woods by man through the ages. Other aspects could be studied further in groups, perhaps based on pupils' requests and/or talents. In view of the complexity of the work, ample space should be allocated for on-going comparisons with other teachers and final checks with other groups. This may involve the design and setting-up of a display area by pupils.

2. Introduce the work in class, agree on aims and purposes with the pupils,

An isolated beech specimen in the Apuan Alps (Tuscany)



working methods and possible external collaboration.

3. Agree with an expert nature guide on the timing and itineraries for two excursions to a local beech-wood: the best times are one in late spring-early summer (May-June) and one in autumn (September-October), to compare the two situations.

FIELD EXCURSION

4. Guided observation, with the help of a guide or forest ranger, of the salient characteristics of the beech tree: inflorescence, colour of bark and leaves, presence of leaf stipules, shape of the crown and estimation of the height of isolated specimens (e.g., measuring the length of their shadow compared with that of a pole of known height, and calculating the height in proportion); observation of the beech-wood environment; soil, light, presence or absence of undergrowth, presence of mushrooms or toadstools, shrubs or herbaceous plants, tree stumps, presence of any other tree species (Norway spruce, silver fir, lime, sessile oak, hop-hornbeam, mountain ash, sycamore) and animals.

ONGOING CLASS WORK

5. Summarise, if necessary with discussion, the peculiarities which have made and/or make the beech-wood a particularly important environment for the life of man: economic value of the timber to be used to make furniture,



The beech-wood treeline in the Apennines near Modena (Emilia Romagna)

items of wood-carving, production of cellulose or charcoal; beech-nuts as food for animals (and sometimes humans), production of oil and flour; leaves as fodder for animals; importance of beech-woods in curbing hydrogeological instability (bans on felling in some areas close to towns and villages); beech-woods for recreational purposes.

6. Introduce further study of human impact through the ages, which has given rise to periods of severe regression of beech-woods, to make room for pastures or cereal crops, or else as a consequence of fires purposely started by hunters to destroy cover for animals. Digress to the history of the spread of beech-

woods in Italy from the Quaternary to today, also in relation to climatic variations and the predilection of the beech for maritime climates. Analyse the limiting ecological factors (rainfall, temperature, etc.).

7. Divide the class into groups to conduct research on various subjects: fauna of beech-woods (vertebrates and invertebrates), plants and mushrooms of the undergrowth, beech-woods on old maps and in historical legal documents regarding the exploitation of woodlands, forestry techniques and felling of woodlands in relation to hydrogeological instability, the timber production-chain in the past and nowadays, woodlands in poetry and legend. During the various phases of group work, guide pupils in their research, both for gathering and using bibliographical material and as regards involvement forest rangers, local town council, etc. who must be contacted in good time. Plan this type of activity well ahead!

8. Collect the work of all the groups and draft an integrated text which could perhaps be revised and printed (if adequate funds can be found). References in the literature could provide a starting-point for pupils who wish to go into further depth on aspects of the project prepared by their classmates. It is also useful to refer to literary works.

9. Summarise group work on panels (or on-screen), and set up a temporary exhibition on the school premises.



Isolated beech specimens (Monte Rotondo, Monti Sibillini Park, Umbria)



Beech-wood undergrowth often lacks shrubs and herbaceous plants

■ The undergrowth in beech-woods

- Aims: to develop the capacity for observation, analysis and comparison; to develop skills in identifying species of flowers; to increase awareness of the relationships between life-cycle and habitat in some plants.
- Level: pupils of 12 and 13 years old.
- Equipment: literature; suitable equipment and proper clothing for field trip.
- Possible collaborators: nature guides or expert botanists.

PRELIMINARY STAGE

1. Introduce the work in class. Study the beech-wood environment: the ecology of the beech, its exploitation by man, aspects of the fauna and ecosystem. Encourage individual summaries by the pupils themselves of the fundamental aspects presented in the lessons.
2. Ask a botanist or nature guide to come to class and illustrate the main aspects of beech-wood undergrowth, limiting factors for herbaceous species and shrubs (light, moisture, soil acidity, etc.), and analysis of the characteristics of some herbaceous species which flower early, before leaves appear on the trees. For the northern Apennines, the choice might be easily identified species like oakfores wood-rush, dog violet and red helleborine, or some orchids which are more specific to beech-woods, such as *Epipactis persica*, *E. flaminea*, *E. leptochila* and *Cephalanthera damasonium*.
3. Pupils should prepare cards to be filled in with information during the field survey of the environment (soil, light, moisture, approximate sizes of trees, presence of undergrowth, presence of species known to pupils, etc.).

FIELD EXCURSION

4. Organise an excursion with a nature guide to a local beech-wood in the springtime; also involved are field observations, filling in of information cards by pupils, and a search for the undergrowth species characterising beech-woods.

ONGOING CLASS WORK

5. Summarise the collected data. Prepare illustrated cards on the species studied and found in the undergrowth, with drawings, photographs, and descriptions useful for their identification.
6. Discuss the difficulties faced in the work, personal gratification, the importance of developing a careful eye for observation.
7. Make some final remarks on the importance of the environmental conservation of beech-woods.

■ Beech galls

- Aims: to increase observation and analytical skills; to improve understanding of the role of organisms in an ecosystem.
- Level: pupils of 12 and 13 years old. With appropriate simplification, this project could also be presented to children of 9 to 10 years old.
- Equipment: literature; computers; equipment and proper clothing for field trip; stationery for the preparation of cards or posters.
- Possible collaborator: nature guide.

PRELIMINARY STAGE

1. Introduce the work: give a brief description in class of subjects relating to tree parasites and, especially, how many invertebrates fill this role in certain stages of their development.

FIELD EXCURSION

2. Organise an excursion to a local beech-wood, in late spring or autumn, and observe the characteristics of the beech that allow its identification (colour of bark and leaves, shape of leaves, presence of leaf stipules, flowers and beech-nuts, etc.). Collect leaves bearing galls (at ground level or on low branches). If it is difficult to organise an excursion, obtain sprays of beech leaves with galls and some fragments of bark and trunk beforehand, to take into class for observation.

ONGOING CLASS WORK

3. Study the life-cycle of holometabolous insects, discuss the characteristics of the various stages (egg, larva, pupa, adult insect) by means of suitable examples.
4. Describe the characteristics of the order of Dipterans; summarise the concepts acquired on cards compiled individually by pupils.
5. Introduce further study, using the literature, of the life-cycle of *Mikiola fagi* and *Hartigola annulipes* and on the mechanism of gall formation (response of the plant to chemical stress caused by the insect, which gives rise to overlaying of plant tissue, which is then used by the larva as a source of food, etc.). Find pictures of the adult insect.
6. Observe the galls with magnifying lenses or an optical microscope (magnification of 40x is sufficient); perhaps prepare sections and make observations. Summarise the data and observations on a poster prepared by the pupils.
7. Conclude with comments in class on symbiosis and parasitism.



In spring, the females of the dipteran *Mikiola fagi* lay their eggs in beech buds (1). The newly-hatched larvae creep through the bud leaflets until they reach the veins of the upper leaf-blade, which they penetrate. This gives rise to a gall, first a green excrescence, then reddish (2). The larvae (2-3 mm long and pale in colour) develop inside the gall, which is hollow and has coriaceous walls (3), and feed on the

internal tissue. In autumn, the galls fall to the ground with the leaves and the larvae over-winter until, in spring, they become pupae. Then adults emerge as gnats 4-5 mm long, dark in colour, and with a pink or yellowish underbelly. *Hartigola annulipes* shows similar behaviour: the dipteran lays its egg next to a leaf vein. The resulting gall is cylindrical in shape and covered in hairs.



Mikiola fagi galls



Autumn dawn in the beech-wood

■ Ideas for inspiration in beech-woods

- Aims: to increase awareness of the importance of natural environments for pleasure; to stimulate creativity.
- Level: pupils 9 -14 years old.
- Equipment: proper clothing for field trip; literature.
- Possible collaborators: science and arts teachers, nature guides.



Long-eared owl (*Asio otus*)

PRELIMINARY STAGE

1. Search for material on woodlands and forests in the literature: e.g., the story of Hansel and Gretel, the legend of the magician Merlin and the Lady of the Lake, sagas about medieval knights (Gawain and the Green Knight), the tales of Robin Hood of Sherwood Forest, Rudyard Kipling's *The Jungle Book*, etc.
2. Study the elements characterising story-books for children, and help pupils to draft a fairy-tale.
3. Introduce the work to be done in class, agreeing on aims and objectives with pupils. Read aloud some passages from the more significant or well-known texts.
4. Ask pupils why they think woodlands have always attracted people: for explorations, games, relaxation, etc.

FIELD EXCURSION

5. Observe the beech-wood environment: ground, light, undergrowth, tree stumps, sizes of trees, presence of tree species other than beech (Norway spruce, silver fir, lime, sessile oak, hop-hornbeam, mountain ash, sycamore), birds and other animals (identified by their song or other signs of their presence).
6. Share personal reflections on the beech-wood environment, e.g., by light glancing through the leaves, peace, and quietness.
7. Divide the class in groups and, within the groups, discuss the most suitable techniques for representing the woodland: drawings, paintings, texts, poems, etc.
8. Prepare a draft of a fairy-tale set in a wood.

ONGOING CLASS WORK

9. Organise individual final preparation of the fairy-tale, correction of the text, reading in class of pupils' efforts.
10. Discuss the recreational function of a particular natural environment such as a beech-wood.

ARRIGONI P.V., 1998 - La vegetazione forestale, Boschi e Macchie di Toscana (*"Forest vegetation, Tuscan woodlands and maquis"*). Regione Toscana.

Detailed text on Tuscan forest vegetation, with identification and description of all woodland plant associations in the region.

BERNETTI G., 2000 - Selvicoltura speciale (*"Special silviculture"*). UTET, Torino.

Although mainly regarding types of woodland management, the text also covers taxonomy, biogeography, paleobotany, autecology and synecology.

BIONDI E. (ed.), 1989 - Il bosco nell'Appennino. Storia, vegetazione, ecologia, economia e conservazione del bosco appenninico (*"Apennine woodlands. History, vegetation, ecology, economics and conservation"*). Centro Studi Valleremita.

Wide-ranging panorama of Apennine forest vegetation, covering not only floral and community aspects, but also problems associated with woodland exploitation and management by man.

BONANI S., BRUNI A., CAPPELLI F., DONDINI G., OLIVARI S., PERILLI E., VERGARI S., 2002 - Habitat e vertebrati: faggete dell'Appennino settentrionale (*"Habitat and vertebrates: northern Apennine beech-woods"*). Quaderni Conservazione Habitat, 2. Corpo Forestale dello Stato, Centro Nazionale per lo Studio e la Conservazione della Biodiversità Forestale di Verona, Gianluigi Arcari Editore, Mantova.

This work describes the invertebrate fauna of nature reserves in the Tuscany-Emilia-Romagna Apennines. It gives useful information on the geography, geology, climatology and pedology of beech-woods.

CERRETTI P., TAGLIAPIETRA A., TISATO M., VANIN S., MASON F., ZAPPAROLI M. (a cura di), 2003 - Artropodi dell'orizzonte del faggio nell'Appennino settentrionale (*"Arthropods of the beech-wood belt in the northern Apennines"*). Conservazione Habitat Invertebrati, 2. Gianluigi Arcari Editore, Mantova.

A description of the arthropod fauna in beech-woods of the Tuscan and Emilia-Romagna Apennines.

GENTILE S., 1970 - Sui faggeti dell'Italia meridionale (*"Beech-woods of southern Italy"*). Atti Ist. Bot. Univ. Pavia ser. 6, 5 (1969): 207-306.

Phytosociological and phytogeographical panorama of the beech-woods of southern Italy and on possible affinities with other beech-wood types in southern Europe.

GIACOMINI V., FENAROLI L., 1958 - La Flora (*"Italian flora"*). Collana "Conosci l'Italia", vol. II. Touring Club Italiano, Milano.

A physiognomic and phytogeographical summary of the characteristics of Italian flora - one of the first, and still not superseded, perspectives of the vegetation in Italy.

MINELLI A., CHEMINI C., ARGANO A., LA POSTA S., RUFFO A. (editors), 2002 - La fauna in Italia (*"Italian fauna"*). Touring Club Italiano e Ministero dell'Ambiente e della Tutela del Territorio, Roma.

Complete, up-to-date treatise on Italian fauna, with many references to legislative and conservation aspects.

MINELLI A., RUFFO S., LA POSTA S., 1993-1995 - Checklist delle specie della fauna italiana (*"Checklist of Italian Fauna"*). Calderini, Bologna.

Lists all known species of Italian fauna, with authoritative, standard nomenclature. The series is in 110 parts. On-line: <http://checklist.faunaitalia.it>

PIGNATTI S., 1998 - I boschi d'Italia (*"Italian woodlands"*). UTET, Torino.

A description of the communities and systematic ecological interpretation of Italian forest vegetation, from Alpine coniferous forests to the sclerophyllous flora of the Mediterranean maquis.

SANSA R., 2003 - L'oro verde. I boschi nello Stato pontificio tra XVIII e XIX secolo (*"Green gold. Woodlands in the Papal State between the 18th and 19th centuries"*). Cleub, Bologna.

A recent volume dealing with the management of the woodland resources of the Papal State according to methods of environmental history, with special focus on the social and economic questions arising in the 18th and 19th centuries on the exploitation and maintenance of forest resources.

Glossary

- > Association: plant community that is united both physiognomically and floristically, in which the dominant species are commonly those of the upper vegetation layer.
- > Autecology: study of the ecological relationships between living species and their environment.
- > Boreal: refers to the cold zones of northern Eurasia and North America, where the climate is characterised by long cold winters and short mild summers. The typical vegetation of these environments is the taiga (= boreal coniferous woodland).
- > Calcicole: plant species or communities preferring soils rich in calcium, with pH generally higher than 7.5.
- > Coppice: woodland which is periodically cut, so as to produce new shoots from old stumps.
- > Deciduous: applied to trees that shed their leaves seasonally.
- > Ecological range: the capacity of a species to populate habitats with features differing according to ecological factors. Species with wide ecological valency can tolerate oscillations in one or more such factors (euryecious); ones with low ecological valency are associated with habitats characterised by very limited oscillations in ecological parameters (stenoecious)
- > Ecosystem: a discrete unit that consists of living and non-living parts, interacting to form a stable system.
- > Eutrophic: applied to an environment with high availability of nutrients.
- > Evergreen: applied to a tree or shrub that has persistent leaves, and whose crown is never wholly bare.
- > Humus: surface organic soil layer that may be divided into types, e.g., mor (acid, layered), typical of coniferous forests, mull (alkaline, decomposed), typical of temperate deciduous woodlands and mesophilous grasslands, and moder, which has intermediate characteristics.
- > Hygrophyte: a plant living in wet environments with soil often saturated with water.
- > Maritime: used of a climate that is greatly modified by ocean influences. Typical characteristics include relatively small diurnal and seasonal temperature variations and atmospheric humidity.
- > Mesophile: an organism or plant community requiring an environment with intermediate or high amounts of water.
- > Microtherm: plant species or community adapted to living in cool temperate environments.
- > Oligotrophic: environment with a low availability of nutrients.
- > Pioneer: a plant species or community among the first to colonise open sites.
- > Relict community: a plant community that

- formerly had a much wider distribution but now occurs only very locally.
- > Sciaphilous: shade-loving, e.g., applied to plants growing in dense woodland undergrowth.
- > Synecology: study of ecosystems considered as single structures, their dynamics, and the interactions among their components.
- > Syntaxonomy: ranking of phytosociological units in a hierarchical system.
- > Thermophile: an organism which grows best at relatively high temperatures.
- > Xerophyte: a plant which can grow in arid environments and withstand periods of drought.

List of species

- Abax parallelepipedus* - 89
- Abies alba* - 15, 27, 29, 52, 58, 65, 133
- Abies nebrodensis* - 62, 66, 68, 133
- Abruzzo brown bear - 73, 76, 83, 122
- Acalitus stenaspis* - 83
- Acalles* - 99
- Acalles aubei* - 99
- Acalles camelus* - 99
- Acalles lemur* - 99
- Acalles parvulus* - 99
- Acanthinula aculeata* - 77
- Acanthocinus xanthoneurus* - 97
- Accipiter gentilis* - 110
- Accipiter nisus* - 110, 111
- Acer campestre* - 47
- Acer cappadocicum* ssp. *lobelii* - 20, 21, 45, 52
- Acer obtusatum* - 20, 21, 47
- Acer opalus* - 34
- Acer platanoides* - 20, 21, 36, 52
- Acer pseudoplatanus* - 20, 21, 34, 52
- Aceria nervisequus* - 83
- Acmaeodera flavofasciata* - 94
- Acmaeodera pilosellae* - 94
- Acrulia inflata* - 91
- Adenostyles* - 34, 36, 41, 46, 47
- Adenostyles alpina* - 41
- Adenostyles australis* - 36
- Adenostyles glabra* - 34
- Adoxa moschatellina* - 61
- Aegopinella pura* - 76, 77
- Aegopodium podagaria* - 37
- Aesculapian snake - 109
- Agile frog - 108
- Agrilus biguttatus* - 94
- Agrilus cyanescens* - 94
- Agrilus graminis* - 94
- Agrilus olivicolor* - 94
- Agrilus viridis* - 94
- Agrostis tenuis* - 41
- Ajuga reptans* - 39
- Allium pendulinum* - 51, 57, 58, 63
- Allium ursinum* - 63, 64
- Alnus cordata* - 52, 58
- Alnus glutinosa* - 62
- Alpine coltsfoot - 40, 45
- Alpine honeysuckle - 47, 50, 61
- Alpine rose - 34, 39, 40
- Alpine spindle-tree - 46, 47, 62
- Alpine squill - 46, 47
- Amara* - 91
- Amphimallon* - 92
- Amphimallon fuscum* - 92
- Amphimallon solstitialis* - 92
- Anemone* - 36
- Anemone apennina* - 50, 56
- Anemone nemorosa* - 37
- Anemone ranunculoides* - 50, 51
- Anemone trifolia* - 36
- Anguis fragilis* - 109
- Anoplotrupes stercorosus* - 93
- Ant - 113
- Anthriscus nemorosa* - 63
- Antinori's shrew - 119
- Apennine shrew - 119
- Apennine wolf - 106
- Apennine yellow-bellied toad - 108
- Aphid - 87
- Aphodius* - 93
- Aphodius borealis* - 93
- Aphodius siculus* - 93
- Aphodius uliginosus* - 93
- Aphodius zenkeri* - 93
- Apodemus flavicollis* - 125
- Apodemus sylvaticus* - 125
- Aposeris - 42, 45
- Aposeris foetida* - 42
- Araneus diadematus* - 82
- Arbutus unedo* - 52
- Archaeopsylla erinacei* - 100
- Arctia caja* - 105
- Aremonia agrimonioides* - 57, 65
- Argynnis* - 103
- Arisarum proboscideum* - 37
- Armadillidium depressum* - 84
- Armadillidium vulgare* - 84
- Aruncus dioicus* - 36
- Asarabacca - 37, 46
- Asarum europaeum* - 37
- Asarum europaeum* ssp. *caucasicum* - 46
- Ash - 21, 36, 40, 46, 55
- Asio otus* - 112, 149
- Asperula taurina* - 36, 37
- Astrobunus kochii* - 83
- Asyneuma trichocalycina* - 45, 60
- Atheta* - 91
- Atheta ebenina* - 91
- Atheta hansseni* - 91
- Atheta taxiceroides* - 91
- Athyrium filix-foemina* - 37
- Atrecus affinis* - 91
- Atrecus longipes* - 91
- Austrian pine - 66
- Autumn moor grass - 36, 50, 58
- Avenella flexuosa* - 34
- Badger - 73, 76, 83, 100, 121
- Bank vole - 125
- Barbastella barbastellus* - 121
- Barbastelle - 121
- Barn owl - 112
- Bastard agrimony - 57, 65
- Bat - 119
- Bay - 52
- Bear - 83, 137
- Bedstraw - 31, 51, 61
- Beech - 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 28, 31, 32, 33, 34, 36, 38, 39, 41, 43, 46, 48, 49, 50, 51, 53, 55, 56, 57, 58, 59, 60, 61, 63, 64, 65, 66, 67, 68, 69, 71, 78, 83, 85, 87, 88, 91, 92, 94, 97, 99, 101, 104, 105, 107, 126, 127, 130, 131, 137, 139, 140, 141, 142, 143, 145, 146, 149
- Beech aphid - 87
- Beech fern - 38, 40
- Beech marten - 76, 121
- Bellflower - 45, 56, 60, 61
- Berberis aetnensis* - 69
- Betula aetnensis* - 69
- Betula pendula* - 57
- Bicoloured white-toothed shrew - 119
- Bilberry - 31, 34, 36, 40, 54, 55
- Birdsnest orchid - 51, 69
- Bitter vetchling - 31, 36, 54
- Bittercress - 51, 54, 57, 63, 65, 67
- Black bryony - 40
- Black redstart - 115
- Black woodpecker - 113
- Blackbird - 115
- Blackcap - 115
- Bladder campion - 61
- Bladderseed - 36
- Blechnum spicant* - 31
- Blind mole - 119
- Blue rock thrush - 115
- Blue tit - 117
- Blue wood anemone - 50, 51, 54, 56, 57, 63, 65, 69
- Boccione's hellebore - 47
- Boletus appendiculatus* - 43
- Boletus regius* - 43
- Bombina pachypus* - 108
- Bosnian maple - 47, 50, 58, 62, 64
- Bostrichus capucinus* - 94
- Brachyopa pilosa* - 101
- Brachypalpus laphriformis* - 101
- Bramble - 61, 62
- Brenthis - 103
- Broad buckler fern - 38
- Broad-leaved hellebore - 46
- Bromus erectus* - 61
- Broom - 41
- Brown bear - 73, 100, 137
- Bruchidius* - 99
- Bruchus* - 99

Brullo's limodorum - 67
Bubo bubo - 112
Bufo bufo - 108
 Bugle - 39
 Bullfinch - 107, 117, 118
 Butcher's broom - 51, 64
Buteo buteo - 111
 Buttercup - 45, 56, 59, 60, 61
 Butterfly - 102
 Buzzard - 111, 137
 Calabrian pine - 66, 69
Calamagrostis arundinacea - 191
Calamintha grandiflora - 61
Calathus focarilei - 89
Calathus fuscipes - 91
Calathus montivagus - 89
Calathus rotundicollis - 89
Callicera aurata - 101
Callimorpha dominula - 105
Calluna vulgaris - 36
Calosoma inquisitor - 89
Calosoma sycophanta - 89, 90
Campanula trachelium - 36
Canis lupus - 106, 121
Cantharellus cibarius - 43
 Capillaria - 80
Capreolus capreolus - 123, 139
 Carabus - 88
Carabus convexus - 89
Carabus lefebvrei - 88, 89
Carabus violaceus - 91
Carcellia bombylians - 101
Carcellia falenaria - 101
Carcellia lucorum - 101
Cardamine - 27, 30, 95
Cardamine bulbifera - 30
Cardamine chelidonia - 51, 57, 63, 65
Cardamine enneaphyllos - 47
Cardamine glauca - 67
Cardamine graeca - 63
Cardamine heptaphylla - 30, 31
Cardamine kitaibelii - 30
Cardamine pentaphyllos - 30
Cardamine trifolia - 37
Carex digitata - 34
Carex montana - 34
Carex sylvatica - 34
Carpinus betulus - 36, 52
Carpinus orientalis - 52
Castanea sativa - 32
 Cat's ear - 67
 Catterpillar - 102
 Caucasian leopardsbane - 45, 56, 57, 62
Centaurea montana - 34
 Centipede - 84
Cephalanthera - 34, 42, 135
Cephalanthera damasonium - 34, 134, 145
Cephalanthera longifolia - 34, 42, 134
Cephalanthera rubra - 34, 42, 124, 134
Ceratophyllum (Monopsyllus) sciurorum - 100

Cerintho auriculata - 61
Ceromya bicolor - 101
Certhia brachydactyla - 117
Certhia familiaris - 117
Cervus elaphus - 123
Cetonia - 92
Cetonischema - 92
Chaetopsylla (Arctopsylla) tuberculiceps - 100
Chaetopsylla (Chaetopsylla) trichosa - 100
 Chaffinch - 118
Chalcosyrphus - 101
Chelidurella acanthopygia - 87
 Chiffchaff - 115
Chloroclysta miata - 104
 Christmas rose - 45
Chrysobothris affinis - 94
Chrysotoxum cautum - 101
 Chthonius - 81
Chthonius tetrachelatus - 81
 Cicada - 87
Ciliella ciliata - 77
 Cimbex - 105
Cimbex connatus - 105
Cimbex fagi - 105
Cimbex femoratus - 105
Cimbex luteus - 105
Circaea lutetiana - 37
Cistus salvifolius - 32
Clausilia cruciata - 77
Clethrionomys glareolus - 125
Clinidium canaliculatum - 91
 Coal tit - 116
Coccothraustes coccothraustes - 118
Cochlodina laminata - 77
Coeloglossum viride - 135
 Collared flycatcher - 110, 116
 Colonial bentgrass - 41, 54
 Colonna's skullcap - 59
Columba oenas - 114
Columba palumbus - 114
 Common alder - 62, 94
 Common dogwood - 46
 Common figwort - 36
 Common hemp-nettle - 38
 Common juniper - 69
 Common long-eared bat - 121
 Common Solomon's seal - 41
 Common spotted orchid - 37
 Common toad - 108
 Common twayblade - 37
 Common wall lizard - 70, 109
Compsilura concinnata - 101
 Coral spurge - 62
Corallorhiza trifida - 40, 134
 Coralroot bittercress - 30, 35, 38, 39, 47, 51
 Coralroot orchid - 40
Corioliolus versicolor - 43
Cornus sanguinea - 46
Coronella austriaca - 109
Cortinarius coeruleus - 43
Cortinarius traganus - 43
Corvus monedula - 118

Corydalis - 103
Corylus avellana - 14
Colaster uncipectus - 99
 Cow parsley - 63
Crataegus laevigata - 62
Crataegus monogyna - 39
 Cricket - 86
Crocodylus leucodon - 119
 Crosswort - 41
Cruciata glabra - 41
Cryptococcus fagisuga - 87
 Cuckoo - 114
Cuculus canorus - 114
Cychnus - 88
Cychnus attenuatus - 88, 89
Cychnus attenuatus ssp. *latialis* - 89
Cychnus italicus - 88, 89
Cyclamen hederifolium - 47
 Cyclamen see sowbread - 47
Cylindromyia pusilla - 101
Cypripedium calceolus - 134
Cytisus scoparius - 41
Dactylorhiza fuchsii - 37
Dactylorhiza maculata - 31, 134
Dactylorhiza maculata ssp. *fuchsii* - 135
Dactylorhiza maculata ssp. *maculata* - 135
Dactylorhiza maculata ssp. *saccifera* - 135
Daphne laureola - 51, 61
Daphne mezereum - 49
 Dark rampion - 35
 Dark red helleborine - 49
Dasyphyllus gallinulae - 100
 Dead-nettle - 54, 56, 63
 Deer fern - 31, 54
Dendrobaena byblica - 79
 Dentaria - 30, 47
Deroceras reticulatum - 77
Dicipera boleti - 96
Dicercia alni - 94
Dicercia berolinensis - 94
Digitalis micrantha - 65
Diplydium caninum - 76
Discus rotundatus - 77
 Dog - 123
 Dog's mercury - 39, 64, 69
 Dog's tooth violet - 34, 145
Dolichopoda - 86
Dolichovespula saxonica - 105
 Donkey - 136
Doronicum columnae - 45, 62
Doronicum orientale - 45, 57
 Downy oak - 74
 Downy rose - 61
Dromius quadrimaculatus - 89
Dryocopus martius - 113
Dryopteris dilatata - 38
Dryopteris filix-mas - 38
 Eagle - 137
 Eagle owl - 112
 Early dog violet - 35, 39, 64
 Earthworm - 79
 Earwig - 87

Echinococcus granulosus - 76
 Echinodera - 99
Echinodera hypocrita - 99
 Elder - 36, 97
 Elm - 14, 21, 36, 37, 40, 49, 57
Elymus panormitanum - 67
Ena obscura - 77
 Enchanter's nightshade - 37
Enomychus coccineus - 95
Ennomos quercinaria - 104
Enoplopus - 96
Epipactis - 42, 63, 135
Epipactis atrorubens - 49, 135
Epipactis flaminia - 134, 145
Epipactis helleborine - 46, 63, 134
Epipactis leptochila - 134, 145
Epipactis meridionalis - 56, 67, 134
Epipactis microphylla - 46, 63, 134
Epipactis muelleri - 134
Epipactis persica - 134, 145
Epipactis purpurata - 63
Epipactis viridiflora - 134
Epipogium aphyllum - 134
Epirrita christyi - 104
Eptesicus serotinus - 121
Epurea binotata - 95
Epurea fagetica - 95
Epurea neglecta - 95
Epurea silacea - 95
Epurea terminalis - 95
Epurea variegata - 95
Erebia ligea - 104
Erica arborea - 66
Erinaceus europaeus - 119
Eriotheca rubecula - 114
 Ermine - 80
Erythronium dens-canis - 34
 Etna barberry - 69
 Etna birch - 69
 Etna broom - 69
Euconulus - 77
Euconulus fulvus - 77
Euonymus europaeus - 64
Euonymus latifolius - 46, 47
Euonymus verrucosus - 62
Euphorbia amygdaloides - 51
Euphorbia corolliflora - 62
Euphorbia dulcis - 62
Eupithecia subfuscata - 104
Eupolybothrus grossipes - 84, 85
Eupotosia - 92
 European bladder-nut - 46
 European stag beetle - 92
Euscorpius - 80
Euscorpius italicus - 81
Euscorpius tergestinus - 81
Fabriciana - 103
Fagocyba cruenta - 87
Fagus - 16
Fagus sylvatica - 7, 16, 25, 26, 69
 Falcon - 137
 False baby's breath - 34
 False processionary moth - 105
 Fat dormouse - 72, 73, 112, 125

Felis silvestris silvestris - 120, 121
 Fescue - 54, 56, 62
 Elder - 36, 97
Festuca heterophylla - 37
Festuca trichophylla - 66
 Few-leaved hawkweed - 41
Ficedula albicollis - 116
 Field maple - 46, 62, 64
 Fingered sedge - 34
 Fir - 15, 27, 38, 55, 58, 61, 65, 66
 Flea - 100
 Flowering ash - 46, 50, 58, 74
 Fomes - 43
Fomes fomentarius - 43
Forficula silana - 87
 Fox - 76, 79, 83, 100, 102, 112, 121
 Foxglove - 65
Fragaria vesca - 41
Fraxinus excelsior - 21
 Fringilla coelebs - 118
Galeopsis tetrahit - 38
Galium aristatum - 34
Galium laevigatum - 34
Galium odoratum - 35, 64
Galium rotundifolium - 31
Ganoderma applanatum - 43
Garrulus glandarius - 118
Gastrallus laevigatus - 94
Genista aetnensis - 69
Genista anglica - 66
 Gentiana - 103
Geophilus insculptus - 85
Geranium nodosum - 35
Geranium robertianum - 64
Geranium versicolor - 54, 65
Gittenbergia sororcula - 77
Glis glis - 72, 125
Glischrochilus hortensis - 95
Gnorimus - 92
Gnorimus decempunctatus - 92
Gnorimus nobilis - 92
Gnorimus variabilis - 92
 Goat - 136
 Goat willow - 60
 Goatsbeard spiraea - 36
 Golden oriole - 115
 Golden-rod - 34
Goodyera repens - 135
 Goshawk - 110, 111
 Grasshopper - 86
 Great tit - 117
 Greater wood-rush - 31, 54
 Green woodpecker - 113
 Greenfly see aphid - 87
 Grey moor grass - 66
 Ground elder - 37
Gryllomorpha dalmatina - 86
Grynobius planus - 94
Gymnadenia conopsea - 135
Gymnocarpium dryopteris - 38
Hamearis lucina - 103
 Hard shield fern - 38, 47, 49, 50, 58
 Hare - 112

Harpalus atratus - 89
 Hart's tongue fern - 37, 40
Hartigiola annulipes - 101, 146, 147
 Hawfinch - 118
 Hawkweed - 37, 39
 Hawthorn - 39, 62
 Hazel - 14, 46, 74, 94
 Hazel dormouse - 73, 125
 Heath spotted orchid - 31, 54
 Heather - 36
 Hedgehog - 119
 Heldreich pine - 62, 64, 66
Helicodonta obvoluta - 77
Helleborus bocconei - 47
Helleborus niger - 45
 Helops - 96
Hemicoelus costatus - 94
Hemicoelus fulvicornis - 94
 Hepatica - 35, 36, 50
Hepatica nobilis - 35, 36
 Herb paris - 35, 47
 Herb robert - 64
Hesperis matronalis - 95
Hieracium murorum - 41
Hieracium racemosum - 47
Hieracium sylvaticum - 37
Hierophis viridiflavus - 109
Himantoglossum adriaticum - 135
Hipparchia fagi - 102, 103
Hipparchia hermione - 103
Hippolaia polyglotta - 116
 Hobby - 111
 Holly - 20, 24, 49, 50, 51, 52, 54, 57, 58, 62, 63, 64, 68, 69, 102, 127, 131
 Holm oak - 32, 52
Homogyne alpina - 40
 Honey buzzard - 111
 Hoopoe - 110
 Hop-hornbeam - 20, 46, 47, 58, 62, 74, 142, 149
 Hoplia - 92
Hordelymus europaeus - 58, 62
 Hornbeam - 32, 36, 39, 52, 64, 74, 88, 94, 99
 Horse - 136
 Huetia - 56
Huetia cynapioides - 56
 Hyalomma - 83
Hypochoeris laevigata - 67
Hypoderma - 102
Hypsugo savii - 121
Hystriochopsylla talpae - 100
Ilex - 52, 57, 133
Ilex aquifolium - 20, 52
Ilex colchica - 52
Impatiens noli-tangere - 37
Ipida binotata - 95
Ischnomera cinerascens - 96
Ischnomera coerulea - 96
Ischnomera cyanea - 96
 Issoria - 103
 Italian alder - 52, 59
 Italian frog - 107
 Italian maple - 34, 46

Italian oak - 32, 64
 Italian wall lizard - 109
Ixodes - 83
 Jackdaw - 118
 Jay - **118**
 Juniper - 75
Juniperus - **18**
Juniperus hemisphaerica - 69
 Jupiter's distaff - 36
Jynx torquilla - 113
Kanetisa circe - **103**
 Kestrel - 111
 Kitaibel's bittercress - 30, 47, 51
 Knotted cranesbill - **35**, 39, 55
Kykliocalles - 99
Kykliocalles fausti - 99
Kykliocalles saccoi - 99
Kykliocalles solarii - 99
Lactarius blennius - 43
Lactarius pallidus - 43
Lactarius pergamenus - 43
Lactarius piperatus - 43
Lactarius vellereus - 43
 Lady fern - 37
Laemostes laticollis - 89
Lamiastrum galeobdolon - 36, 50, 95
Lamium - 95
Lamium flexuosum - 54, 56, 63
 Large white buttercup - **36**
 Large-flowered calamint - 61
Lasiommatata petropolitana - 104
Lathyrus grandiflorus - 56
Lathyrus montanus - 31
Lathyrus venetus - 39, **57**
Lathyrus vernus - 62
Laurus nobilis - 52
 Laurustine - 52
 Leafhopper - 87
Leistus fulvibarbis - 89
Leistus rufomarginatus - 89
Leistus sardous - 89
Leistus spinibarbis - 89
Leopoldius coronatus - **101**
Leptoiulus - 85
Leptoiulus montivagus - 85
Leptoiulus trilineatus - 85
Leptura aurulenta - 97, **99**
 Lesser honeywort - 61
 Lesser spotted woodpecker - 113
 Lesser twayblade - 40, 45
 Lesser wintergreen - 31, 40, **41**, 54, 61
Leucorchis albida - 135
 Lichen - **22**
Lichenophanes varius - 94
Lilium bulbiferum ssp. *croceum* - **50**
Lilium martagon - **37**
Limantria dispar - **104**, 105
Limantria monacha - 105
Limax maximus - **77**
 Lime - 14, 20, 21, 36, 46, 55, 64, 131, 142, 149
Limenitis - 103
Limenitis reducta - 103

Limodorum brulloi - 67, 134
Lipoptena cervi - 102
Listera cordata - 40, 135
Listera ovata - 37, 134
Lithobius castaneus - 85
Lithobius forficatus - 85
Lithobius mutabilis - 85
Lithobius tylopus - 85
 Lobel's maple - 45, 54, 55, 57, 60, 62, 63
 Locust - 86
 Long-eared owl - 112, **149**
Lonicera alpigena - 47
Lucanus cervus - **92**, 93
Lucanus tetraodon - **93**
Lunaria rediviva - 36, 95
Luscinia megarhynchos - 115
 Luzula - 31, 42
 Luzula luzuloides - 31
 Luzula nivea - 31
 Luzula pedemontana - 31, 45
 Luzula sicula - 45
 Luzula sylvatica ssp. *sylvatica* - 31
Lycaena virgaureae - 104
Lymantria dispar - **90**
 Lymmantriid moth - 114
 Lynx - **122**
Lynx lynx - **122**
Macaria wauaria - 104
Macrogaster lineolata - 77
Macrogaster plicatula - 77
Maculinea rebell - 103
 Male fern - 38, 39, 41, 58
Malus sylvestris - 62
 Maple - 20, 21, 52, 142, 149
 Marsh tit - 116
 Martagon lily - **37**
Martes foina - 121
Martes martes - 121
Melampyrum sylvaticum - 40
Meles meles - 121
Melica uniflora - 38, 51, 64
Meligethes - 95
Meligethes atramentarius - 95
Meligethes czwalinai - **95**
Meligethes kunzei - 95
Meligethes matronalis - 95
Meligethes subaeneus - 95
Melittaea - 103
 Melodious warbler - 116
Mercurialis perennis - 39, 64
 Merlin - 111
Mesoacidalia - 103
Mesocostoides lineatus - 76
Mesotype didymata - 104
 Mezereon - 49
 Middle spotted woodpecker - 113
 Midland hawthorn - 62
Mikiola fagi - 101, 102, 146, 147
Mikiola fagi (galls) - **147**
Milium effusum - 37, 39, 64
 Milliped - 85
 Mistle thrush - 107, 115
 Mite - 80, 83
Moehringia trinervia - 69

Mole - 79, 119
Molineus - 80
Molops ovipennis - 89
Monotropa hypopitys - 61
Monticola saxatilis - 115
Monticola solitarius - 115
 Moschatel - 61
 Moth - 102
 Mountain ash - 20, 34, 36, 39, **47**, 57, 60, 142, 149
 Mountain fern - 31
 Mountain pine - 15
 Mountain sedge - 34
 Mouse plant - 37, 40
Musaria affinis - 99
Muscardinus avellanarius - 125
Muscicapa striata - 116
Mustela nivalis - 121
Mustela putorius - 121
Mycetina cruciata - 95
 Mycetophila - 100
 Mycomya - 100
 Myotis bat - 121
Myotis bechsteinii - 121
Myotis mystacinus - 121
Nalassus - 96
 Narrow-leaved helleborine - 34, **42**, 46
Nebria brevicollis - 91
Nebria krateri - 89
Nebria tibialis - 89
Nectria - 87
Nematodirus - 80
Neobisium - 81
Neotinea intacta - 135
Neottia nidus-avis - **51**, 134
 Nettle-leaved bellflower - 36
 Nettle-leaved speedwell - 31, 54
 Nightingale - 115
Nigritella - 135
 Nine-leaflet bittercress - 47
 Noctule - **121**
 Nodding wintergreen - 47, 49, 62
 Northern bilberry - 45
 Northern holly fern - **38**, 40, 49
 Northern mole - 119
 Norway maple - 36, 37, 40, 46
 Norway spruce - 38, 142, 149
Notiophilus biguttatus - 89
Notiophilus rufipes - 89
Notiophilus substriatus - 89
Nummularia bulliardi - 94
 Nutcracker - 118
 Nuthatch - 110, 117
Nyctalus lasiopterus - 121
Nyctalus leisleri - 121
Nyctalus noctula - **121**
 Oak - 32, 52, 66, 94
 Oak fern - 38, 42, 45
 Oakforest wood-rush - 31, 145
Octolopium complanatum - 79
Ocypus tricinctus - 91
Oedemera (Oncomera) femoralis - 96
Oligomerus brunneus - 94
Omoglymmius germari - **91**

Onion - 51, 57, 58, 63
Operophtera fagata - 104
Ophrys - 135
 Orange lily - **50**, 59
Orchestes fagi - 99
Orchis pallens - 134
Orchis provincialis - 135
Orchis purpurea - 135
Orchis spitzelii - 135
 Oriental hornbeam - 52
Oriolus oriolus - **115**
Orthilla secunda - 47
Osmoderma - 92
Osmoderma cristinae - 92
Osmoderma eremita - **92**
Osmoderma italicum - 92
Ostrya carpinifolia - 20, 28
Otiorhynchus - 99
Otiorhynchus cyclophthalmus - 99
 Owl - 79
Oxalis acetosella - 34, 41, **58**
Paleoacanthoscelides gilvus - 99
Pandoriana - 103
Paraceras melis - 100
Pararge aegeria - 103
Pararge maera - 104
Paris quadrifolia - **35**
Parnassius mnemosyne - 103
Parus ater - 116
Parus caeruleus - 117
Parus major - 117
Parus palustris - 116
 Pedunculate oak - 32
 Pencilled cranesbill - 54, 55, 56, **62**, **65**
Percus andreinii - 89
Percus bilineatus - 89
 Perennial cornflower - 34, 46
 Perennial honesty - 36
 Priobium carpini - 94
 Processionary moth - 114
Protostrongylus - 80
Pseudochelydura orsinii - **86**, 87
 Pseudo-scorpion - 80, 81
Pterostichus bicolor - 89
Pterostichus micans - 89
Pterostichus morio - 89
Pterostichus oblongopunctatus - 89
Ptinomorphus imperialis - 94
Punctum pygmaeum - 77
 Purple lettuce - 34, 39, 47, **49**
 Pygmy shrew - 119
Pyrgocyphosoma - 85
Pyrgocyphosoma doriae - 85
Pyrgocyphosoma marrucinum - 85
Pyrgocyphosoma picenum - 85
Pyrgocyphosoma zangherii - 85
 Pyrola minor - 31, 40, **41**
Pyrrhula pyrrhula - **117**, 118
 Pyrus pyraeaster - 62
Quercus - 14
Quercus cerris - 32
Quercus congesta - 67
Quercus frainetto - 32

Picus viridis - **113**
 Pied woodpecker - 113
 Pig - 136
 Pill bug see wood lice - 84
 Pine marten - 76, 79, 83, 100, 112, 121
Pinus - **18**
Pinus leucodermis - 62, 66
Pinus mugo - 15
Pinus nigra subsp. *calabrica* - 66, **69**, 134
Pinus nigra subsp. *nigra* - 66
Pinus sylvestris - 15
Pinus uncinata - 39
 Pipistrelle - 121
Pipistrellus nathusii - 121
Pipistrellus pipistrellus - 121
Platanthera bifolia - 135
Platanthera chlorantha - 135
Platycerus caprea - 93
Platycerus caraboides - 93
Platycerus neapolitanus - 89
Plecotus auritus - 121
Poa nemoralis - 69
Podarcis muralis - **70**, 109
Podarcis sicula - 109
Polydrusus - 99
Polydrusus amplicollis - 99
Polygonatum multiflorum - 41
Polygonatum verticillatum - 37, 38
Polystichum aculeatum - **38**
Polystichum lonchitis - **38**
Polystichum setiferum - 37, 51
Porcellio arcuatus - 84
Potosia - 92
Prenanthes purpurea - 34, **49**
 Primrose - 36
Primula vulgaris - 36
Priobium carpini - 94
 Processionary moth - 114
Protostrongylus - 80
Pseudochelydura orsinii - **86**, 87
 Pseudo-scorpion - 80, 81
Pterostichus bicolor - 89
Pterostichus micans - 89
Pterostichus morio - 89
Pterostichus oblongopunctatus - 89
Ptinomorphus imperialis - 94
Punctum pygmaeum - 77
 Purple lettuce - 34, 39, 47, **49**
 Pygmy shrew - 119
Pyrgocyphosoma - 85
Pyrgocyphosoma doriae - 85
Pyrgocyphosoma marrucinum - 85
Pyrgocyphosoma picenum - 85
Pyrgocyphosoma zangherii - 85
 Pyrola minor - 31, 40, **41**
Pyrrhula pyrrhula - **117**, 118
 Pyrus pyraeaster - 62
Quercus - 14
Quercus cerris - 32
Quercus congesta - 67
Quercus frainetto - 32

Quercus ilex - 32, 52
Quercus petraea - 20, 52
Quercus petraea ssp. *austrorythrena* - 69
Quercus robur - 32
Ramaria botrytis - 43
Ramaria flava - 43
Ramaria formosa - 43
 Ramsons - 63, 64, 69
Rana dalmatina - 108
Rana italica - 107
Ranunculus brutius - 45, **60**
Ranunculus lanuginosus - 65
Ranunculus platanifolius - **36**
 Red deer - 83, 102, 122, **123**, 124, 137
 Red helleborine - 34, **42**, 46, 145
 Red squirrel - **124**, 125
 Red-eye whip snake - 109
Rhegmatobius quadricollis - 91
Rhipicephalus - 83
Rhizophagus neapolitanus - 95
Rhizophagus nitidulus - 95
Rhizotrogus - 92
Rhizotrogus romanus - 92
Rhysodes sulcatus - 91
 Robin - **114**
 Rock bramble - 40
 Rock thrush - 115
 Roe deer - 83, 102, 122, 123, 137, 138, **139**
 Roman mole - 119
Roncus - 81
Rosa arvensis - 62
Rosa canina - 62
Rosa glutinosa - 61
Rosa nitidula - 62
Rosa obtusifolia - 62
Rosa pendulina - 34
Rosa tomentosa - 61
Rosalia alpina - 97, **98**
 Rough small-reed - 31
 Rough-stemmed spindle-tree - 62
 Round-leaved saxifrage - 59
Rubus canescens - 62
Rubus hirtus - 61
Rubus saxatilis - 40
Ruscus aculeatus - 51
Russula cyanoxantha - 43
Russula delicata - 43
Russula fellea - 43
Russula laurocerasi - 43
Russula lepida - 43
 Sage leaf rockrose - 32
 Salamander - 79
Salamandra salamandra - 107
Salamandra salamandra ssp. *giglioli* - 107
Salamandrina perspicillata - 107
Salamandrina terdigitata - 107, **108**
Salix caprea - 60
Salvia glutinosa - 36
Sambucus nigra - 36
 Sanicle - 36, 38, 64

Sanicula europaea - 36, 64
Saphanus piceus - 97
Sarcoptes - 83
Saxifraga rotundifolia - 59
Scale insect - 87
Schendyla apenninorum - 85
Scilla bifolia - 46, 47
Sciurus vulgaris - 124
Scolopax rusticola - 114
Scorpion - 80, 81
Scorzonera-leaved rampion - 45
Scotopteryx chenopodiata - 104
Scotopteryx moeniata - 104
Scots pine - 15
Scrophularia nodosa - 36
Scutellaria columnae - 59
Senecio fuchsii - 35
Serapias - 135
Serotine - 121
Sesleria argentea - 42
Sesleria autumnalis - 36, 50
Sesleria gr. *juncifolia* - 66
Sesleria nitida - 61, 66
Sessile oak - 20, 32, 36, 37, 52, 69, 74, 142, 149
Seven-leaflet bittercress - 30, 31, 35, 38, 39, 51
Sheep - 136
Short-toed treecreeper - 110, 117
Shrew - 79
Sicilian fir - 62, 68
Sicilian woodrush - 45, 55, 56, 62
Silene vulgaris ssp. *commutata* - 61
Silver birch - 57, 94, 105
Silver fir - 15, 18, 20, 33, 36, 38, 39, 40, 41, 52, 55, 58, 60, 63, 68, 91, 142, 149
Sitta europaea - 117
Skrjabinogylus nasicola - 80
Slender creeping red fescue - 66
Slow-worm - 109
Slug - 76
Smooth snake - 109
Snail - 76
Snowy wood-rush - 31, 35, 37, 45
Soft shield fern - 37, 51, 58
Solidago virgaurea - 34
Song thrush - 115
Sorbus aria - 34, 47
Sorbus aucuparia - 20, 47
Sorex antinorii - 119
Sorex minutus - 119
Sorex samniticus - 119
Southern helleborine - 56, 67
Southern woodruff - 36
Sowbread - 47, 51, 57, 63, 65
Sparrowhawk - 110, 111
Speckled salamander - 107, 108
Spermophagus sericeus - 99
Sphaerosoma - 95
Sphaerosoma apuanum - 95
Sphaerosoma solaris - 95
Spider - 80, 81
Spindle-tree - 64

Spotted flycatcher - 110, 116
Spotted salamander - 107
Spring vetchling - 39, 47, 51, 57, 58, 63
Spurge laurel - 51, 61, 62, 64
Squirrel - 73, 124, 125
Stag beetle - 93
Staphylea pinnata - 46
Stellaria nemorum - 36
Stenocorus meridianus - 99
Stock dove - 114
Strawberry tree - 52
Strigamia acuminata - 85
Strix aluco - 112
Sus scrofa - 124
Sweet chestnut - 32, 92
Sweet spurge - 62
Sword-leaved helleborine - 42
Sycamore - 34, 36, 39, 46, 49, 50, 51, 55, 57, 60, 67, 69, 99
Sylvia atricapilla - 115
Synodendron cylindricum - 93
Synuchus nivalis - 89
Syrphus torvus - 100, 101
Tachydromia - 101
Tachypeza - 101
Taenia - 76
Taenia taeniaeformis - 76
Talpa caeca - 119
Talpa europaea - 119
Talpa romana - 119
Tamus communis - 40
Tawny owl - 112
Taxus - 52, 57, 133
Taxus baccata - 20, 24, 52
Termite - 113
Teucrium scorodonia - 31
Thelypteris limbosperma - 31
Three-leaved valerian - 35
Three-veined sandwort - 69
Tick - 83
Tilia - 14
Tilia platyphyllos - 20, 21
Tiny-leafed helleborine - 46
Tit - 110, 116
Toad - 79
Touch-me-not balsam - 37
Toxocara mystax - 80
Trachysphaera appenninorum - 85
Tree heath - 66
Treecreeper - 117
Trichinella - 79
Trichius - 92
Trichoniscus - 84
Trichostrongylus - 80
Trichotichnus nitens - 89
Trichurus - 80
Trifoliolate bittercress - 37
Trochiscanthes - 34, 35, 45
Trochiscanthes nodiflorus - 34
Troglodytes troglodytes - 116
Trogulus - 83
Trombicula autumnalis - 83
True bug - 87
Trypocoprpris pyrenaicus - 93

Turdus merula - 115
Turdus philomelos - 115
Turdus viscivorus - 115
Turkey oak - 32, 55, 62, 64, 92
Two-flowered everlasting-pea - 56
Typhloreicheia ussilaubi - 91
Tyto alba - 112
Ulmus - 14
Ulmus glabra - 21
Ursus arctos marsicanus - 73, 122
Vaccinium myrtillus - 31
Vaccinium uliginosum - 45
Valeriana tripteris - 35
Valgus - 92
Variousleaf fescue - 37, 39
Veronica montana - 40
Veronica urticifolia - 31
Vespula rufa - 105
Viburnum tinus - 52
Viola reichenbachiana - 35, 64
Viper - 109
Vipera aspis - 109
Vipera aspis hugyi - 109
Vitrea subrimata - 77
Vulpes vulpes - 121
Wavy hair-grass - 34, 37
Weasel - 80, 83, 100, 121
Western polecat - 121
Western whip snake - 109
Wheatgrass - 67
White helleborine - 34, 42
White-backed woodpecker - 113
Whitebeam - 34, 47, 60
Whorled Solomon's seal - 37
Wild boar - 73, 79, 83, 122, 124
Wild cat - 76, 80, 121
Wild crab - 62
Wild pear - 62
Wild rose - 62
Wild strawberry - 41
Wolf - 76, 121, 122
Wolf spider - 82
Wood anemone - 37, 38, 39
Wood bedstraw - 34, 35
Wood cow-wheat - 40, 54
Wood lice - 84
Wood meadow-grass - 69
Wood melick - 38, 51, 58, 64
Wood millet - 37, 39, 64
Wood mouse - 125
Wood ragwort - 35, 39
Wood sage - 31
Wood sedge - 34
Wood speedwell - 40
Wood spurge - 51, 58, 62
Wood stitchwort - 36, 47, 58, 61
Wood warbler - 115
Woodcock - 112, 114
Woodpecker - 110, 113
Woodpigeon - 107, 114
Woodruff - 35, 39, 51, 64
Wood-rushes - 31, 36
Wood-sorrel - 34, 41, 58, 61

Woodworm - 94
Woolly buttercup - 65
Wren - 116
Wryneck - 113
Xylophagus ater - 100
Yellow anemone - 50, 51
Yellow archangel - 36, 50, 61
Yellow birdsnest - 61
Yellow-necked mouse - 125
Yew - 20, 24, 38, 50, 52, 57, 62, 63, 64, 67, 69, 127, 131
Zamenis lineatus - 109
Zamenis longissimus - 109

For data and information kindly provided, the authors wish to thank:

Paolo Audisio (nitidulid beetles and allies)
Marco Bologna (oedemerid and meloid beetles)
Alessandro Biscaccianti (long-horn beetles)
Aldo Brilli-Cattarini and Leonardo Gubellini
(heterotrophic sites of beech)
Enzo Colonnelli (curculionid beetles)
Fabio Conti (heterotrophic sites of beech)
Francesca Di Franco (spiders)
Gianna Dondini and Simone Vergari (bats)
Claudio Flamigni (lepidopterans)
Folco Giusti (molluscs)
Gianluca Nardi (anobiid and bostrychid beetles)
Giovanni Salerno (traditional uses of beech)
Renato Sansa (historical-economic aspects of
beech-wood exploitation)
Valerio Sbordoni (lepidopterans)
Augusto Vigna Taglianti (dermapterans and
carabid beetles)
Marcello Zampetti (gall-forming insects and
bruchid beetles)
Marzio Zapparoli (chilopods)

Thanks are also due to
Maria Manuela Giovannelli, Erika Gozzi,
Paola Sergo and Maura Tavano

The authors assume full responsibility for any
errors or omissions in the text.

This volume was produced with funds from the
Italian Ministry of the Environment and Territory
Protection