

**Beech forests of the Apennines**

## Italian habitats

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Cover photo: Autumn dawn in a beech-wood (photo Vitantonio Dell'Orto)

ITALIAN HABITATS

# Beech forests of the Apennines

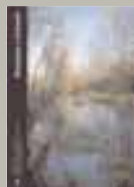
New populations and relicts of a continental forest

MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO  
MUSEO FRIULANO DI STORIA NATURALE · COMUNE DI UDINE

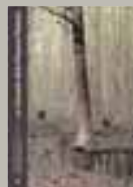
## Italian habitats



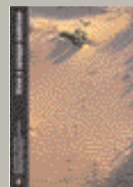
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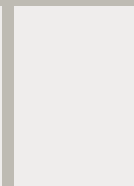
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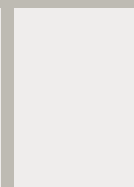
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## Introduction

GIUSEPPE CARPANETO · MAURIZIO CUTINI · GIUSEPPE MUSCIO

A proper description of beech forests in Italy means telling a story with a prominently Apennine setting, since this tree species (*Fagus sylvatica*) is pre-eminent throughout the length of the Apennine chain. The flora in these forests clearly differentiates them from beech-woods in the rest of Europe. There are also many differences between the northern, central and southern regions, the latter also including the more southerly mountains on the island of Sicily.

This wide distribution is the result of complex biogeographical events, during which the beech alternately migrated northwards and southwards along the peninsula during the Quaternary, in response to the varying

climatic conditions caused by the Ice Ages. During the post-glacial period, especially in phases with a cooler, damper climate, the beech gained advantage over other peninsular forest populations, concentrating in mountain areas, as also clearly demonstrated by data from samples of ancient pollen.

In addition, a description of the characteristics and peculiarities of the flora and fauna of the Apennine beech-woods today requires an understanding of the close relationship between human populations and mountain forests. It also means retracing the essential tracts of the complex, unique and unrepeatable history of the different uses, in both temporal and geographical senses, to which man has put forest resources.

Notwithstanding the enormous climatic and lithomorphological variety of the Apennines and the corresponding biological diversity of its forest populations, moving from the more northerly territories to those in the centre and south of



Isolated beech on the slopes of Monte Abetone (Tuscany-Emilia Apennines)



Cropping practices, livestock grazing and fallen trees form clearings in woodland

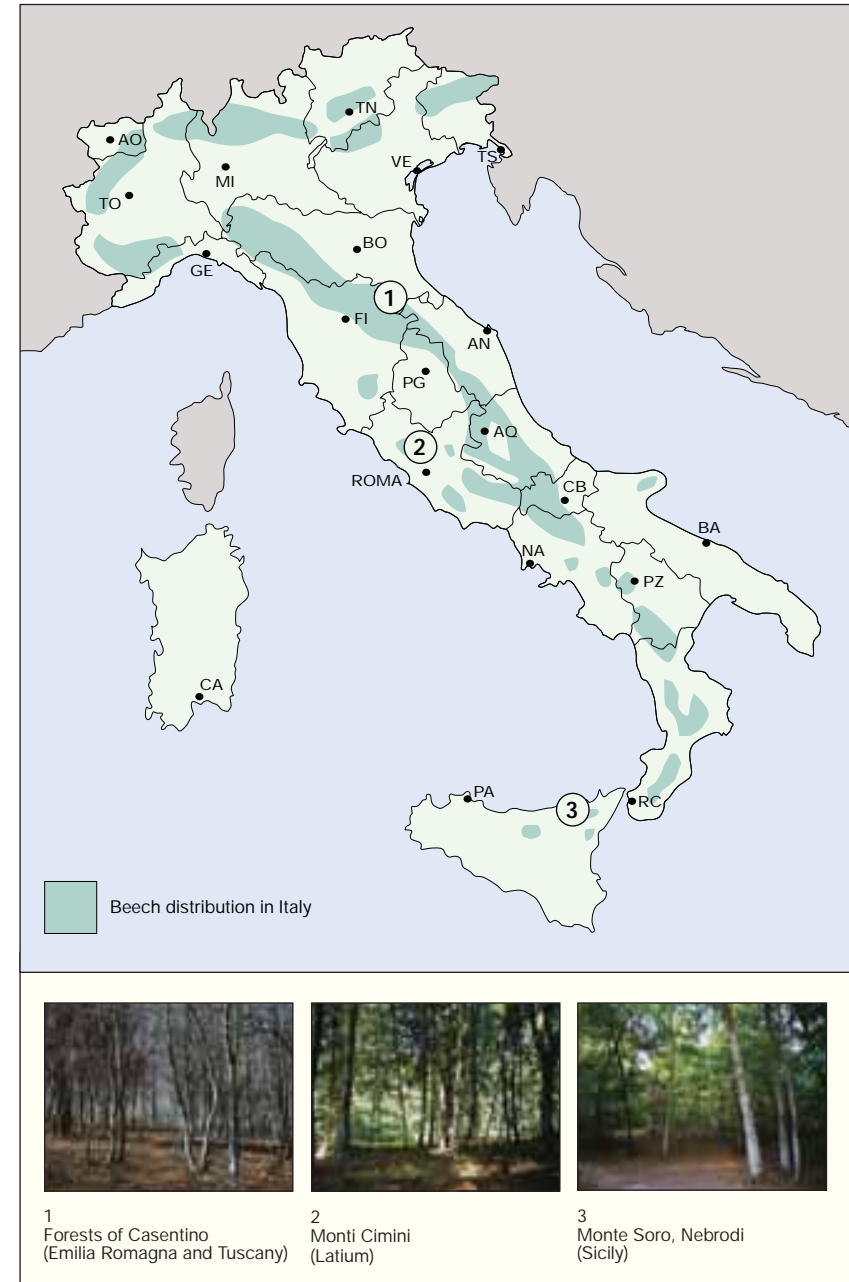
the Italian peninsula, traces of a common history may still be found. They are made up of woodland “domestication” practices or, in more drastic cases, complete eradication of the forest, to create clearings for the expansion of agriculture, even at high altitudes. Despite the many changes that man has wrought on beechwoods, their mountain setting and therefore distance from human settlements on the plains has meant that they are better preserved than other tree populations on lower-lying

hillsides, having still retained some characteristic floral traits.

Today’s Apennine mountain landscape is mainly formed of extensive pastures, which often spread from the lower hillsides right up to the mountain summits. These vast open spaces, playing host to typical vegetation and a rich fauna, might appear to be natural ecosystems produced by a long-standing equilibrium between soil, climate, and living organisms. In fact, the opposite is true: in the majority of cases, the mountain pastures extending below 1800-1900 m a.s.l. are secondary ecosystems, produced by human practices of tree felling, burning and grazing. They have replaced the original forest, dominated by beech in association with other species, which once cloaked the altitude belt in the Apennines between approximately 900 and 1900 m.

These facts must be taken into account when interpreting the landscape in natural, historical and management terms. One surprising aspect is that the open areas, despite usually being artificial, play host to many floral and faunal components not to be found in beechwoods, so that the latter would not, alone, be capable of preserving the overall biodiversity of the Apennines. This is because the fauna of the Apennine mountain communities includes many steppe species which colonised the Italian peninsula in proto-historical times, as man gradually made clearings in the forests, interrupting the continuity of the beechwoods.

Primitive hunting techniques were based on the use of fire to frighten animals prior to trapping or ambushing them. Also, as livestock has been grazed in Mediterranean regions for at least 8000 years, the antiquity and intensity of the human impact on Apennine forests can be appreciated.



The development of beech-woods (and that of other tree associations) is also considerably affected by the nature of the substrate and climatic conditions. The latter are linked not only to altitude and latitude, but also to which direction the hillsides face, local rainfall, prevailing winds, and other factors influencing the local microclimate. Soils derive from local types of rock. The lithology of the Apennine chain is extremely variable. For example, there are large deposits of sandstone, clay and marl in the Apennines of Tuscany and Emilia-Romagna, the central Apennines have a significant percentage of limestone, and then there are volcanic rocks in parts of Latium (the area around Rome). Further south, there are metamorphic rocks in Calabria, and the lava of Mount Etna in Sicily.

This variability is reflected in the chemical properties of rocks. Limestone and dolomite, for example, give rise to basic and sandstone substrates, which often have high silica content and thus form acid soils. The chemical properties of magmatic and metamorphic rocks also vary greatly - instances are the basaltic lava of basic rocks, or the acidic trachyte of the Monti della Tolfa. In addition, tectonics and lithology alter the levels of erosion which, in turn, affect the morphology of the areas involved, especially as regards the steepness of the hillsides and their permeability.

To naturalists, a tall beech-wood, which most closely resembles the original Apennine montane forest, creates an odd sensation, quite unlike those



Prostrate specimen of beech on metamorphic rock (Aspromonte, Calabria)

aroused by other Italian forests. Firstly, in summer, the surprising drop in temperature and equally unexpected rise in humidity that is noticed when entering a beech-wood is similar to what is experienced when passing from the savannah to a tropical forest. The low temperature and feeling of dampness beneath the beech canopy is not only a refreshing "oasis" for excursionists or shepherds, but also a much-needed refuge for many animals during the summer months.

The general appearance of a beech-wood is rather similar to that of a tropical forest: the oval-shaped leaves with their water-repellent surface and the smooth grey bark of the trees, the soft damp soil, the smell of decomposing organic matter, and the apparent absence of animal life, all contribute to this impression. This is partly due to the fact that beech-woods are forests adapted to a wet maritime climate, with high rainfall.

There are marked differences with respect to oak-woods, where the trees have rough bark and lobate leaves, there is less, and drier, litter, and the higher level of sunlight allows more luxuriant undergrowth and larger numbers of animals. Beech-wood undergrowth has few plants and therefore fewer food resources, so not many animals roam there. Much of the life of animals in beech-woods is conducted on the branches of the trees where, notwithstanding the relatively low numbers of plant species, a complex system of interspecific relationships between predators, prey and parasites produces unexpectedly high diversity.



A centuries-old beech

## Vegetation

MAURIZIO CUTINI · ROMEO DI PIETRO

### ■ Formation of Apennine populations during the Quaternary

Today's Apennine forests are the result of alternating events which mainly took place during the Quaternary. The climatic sequences of ice ages and inter-glacial phases caused mass migrations of the animal and plant populations, in response to the changed environment, towards locations more suitable for their survival.

During the Ice Ages in the Apennines, and more generally in the Mediterranean area, it now appears certain that forms of steppe vegetation existed (the so-called *Artemisia* steppes, which, according to pollen diagrams, were dominated by the grass, goosefoot and daisy families), whereas vegetation similar to that of the tundra can only be hypothesised in the areas surrounding the small, isolated glaciers of the major Apennine summits.

During the episodes of extreme cold, typical of the areas around the vast ice-sheets of northern Europe and which led to the diffusion in central Europe of a flora of Arctic type (*Dryas*), it is probable that the prolonged periods of dry-continental climate likewise prevented (or greatly limited) the development of any type of forest vegetation on the Italian peninsula. At each ice-age climax, forests were involved in huge shifts from north to south, concentrating in territories nowadays identified as refuge areas, i.e., extensive districts where species could survive the adverse conditions, and then gradually regained ground with the return of a more favourable climate for forest growth.

The most significant refuges were concentrated in parts of southern Europe, in particular the Iberian, Italian and Balkan peninsulas which, thanks to their



Beech leaves and nuts

A small stream cuts through the beech-wood soil



geographical position, milder temperatures, and the mitigating action of the Mediterranean Sea, played a fundamental role as a repository for European forest biodiversity throughout the Quaternary. In Italy, some sites on the edge of the Alpine chain presumably also represented refuge areas. However, it was mainly the smaller mountain districts distributed along the peninsula, especially in the south of the country, which offered the best sanctuary for the forest species known as thermophile.

Conditions in northern Italy were very similar to those in central Europe, whereas along the Apennine ridge the effects of the Ice Ages were less harsh because of the lack of extensive high-altitude mountain chains. The continental climate that accompanied the coldest periods inhibited the growth of forests, which therefore formed scanty patches, probably in the form of scrub, in areas the exact location of which still remains uncertain. Today, the general opinion favours the existence, during the dry periods, of a typically discontinuous belt of rudimentary forests located at sub-alpine altitudes.

In the first inter-glacial phases (which were of much shorter duration than the Ice Ages), when the negative effects of the preceding dry-continental phase were still felt, the protagonists of forest repopulating were probably deciduous oaks (*Quercus*), accompanied by other species such as hazel (*Corylus avellana*), lime (*Tilia*) and elm (*Ulmus*). With the establishment of a more or less



Mixed beech woodland in the Romagna Apennines

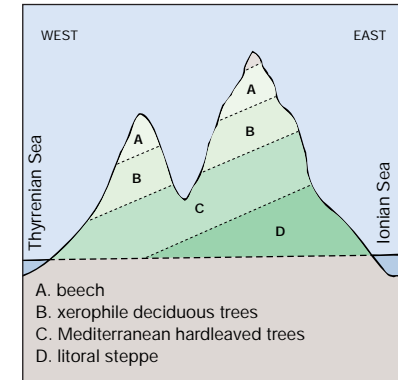
diffuse maritime climate, mixed oak-woods gradually began to include other species like beech and silver fir (*Abies alba*), which completely supplanted the pre-existing vegetation at higher altitudes. It is hypothesised that the latter were composed of mixed pine-wood of mountain pine (*Pinus mugo*) and Scots pine (*P. sylvestris*), although recent palynological studies demonstrate that the role of these populations in the post-glacial phases of forest re-colonisation in the

Mediterranean area was subordinate to similar situations in central Europe. Mixed forests of beech and fir can therefore be considered the typical montane vegetation of the interglacial periods in the Apennines.

During the initial phases of temperature rise, as the climate became increasingly maritime, the presence of beech must have been more than just sporadic, and was presumably confined to a few "cool" deep narrow valleys close to mountain summits. During later phases, instead, signalled by a further shift of the climate towards maritime, beech assumed an increasingly dominant role.

As regards the explosive expansion of beech in the post-glacial era, the most widely accepted hypotheses admit the existence of different major routes of European spread: one easterly, from the western Balkans to the eastern Alps and Carpathians, to the north of Germany and Poland, up to southern Scandinavia; the other westerly, from southern France reaching as far as southern England. In Italy, it is presumed that the western Alps were reached by re-colonising routes from both the eastern Alps and the southern French mountains. Central Italy in particular was not theatre to large-scale migrations, with the northern Apennine territories being re-colonised by beech arriving from parts of the central Apennines which, in turn, must have regularly come into contact with the southern populations, which once again spread from refuge sites as much towards north as south.

Particularly interesting, when the more significant pollen diagrams of the peninsular areas registering long periods of time are studied, is the continued presence of beech in Italy starting from the mid-Pleistocene, with peaks of concentration around 200 000-170 000 years ago.



Asymmetry of vegetation belts in a section of the southern Apennines

From this point of view, the areas of central-southern Italy represented a unique area in Europe, as *Fagus* seems to have been absent for long periods in the other regions. The beech appears to have been in strong expansion between 110 000 and 75 000 years ago, while it persisted in small, isolated populations between 75 000 and 15 000 years ago, corresponding to the last glacial maximum.

To judge from pollen analysis data of the mountain basins, datable to around 37 000 years ago, the percentages found in the south (Calabria) were much more abundant. Later, during the post-glacial period, i.e., the last 10 000 years or so, there was a new huge increase in *Fagus sylvatica* in central and southern Italy, whereas the corresponding increase in the northern Apennines began approximately 5 000 years ago. This suggests a scenario of migration towards northern territories from the mountain areas of the southern Apennines, coinciding with (or perhaps later than) the migratory flux arriving from the Balkans which provided the earliest dated pollen sequences, with abundant beech pollen in sediments.

In view of these data, the Apennine beech-woods may constitute forms of vegetation of a purely and typically central-southern origin, with a special predilection for damp habitats. Combined interpretation of palynological and ecological data with examination of the current distribution of Italian beech-woods demonstrates a clear differentiation between the Alpine, pre-Alpine



Relict beech-wood (Plan Grande di Castelluccio, Monti Sibillini National Park, Umbria)

and Apennine territories, especially in central and southern areas, where characteristic traits emerge due to forms of more ancient origin, particularly rich in endemic southern Apennine species, or with an amph-Adriatic or strictly amph-Ionic distribution.

Beech may therefore have undertaken its last and definitive occupation of Mediterranean mountains during the post-glacial period (approx. 7 000 years ago), starting from southern refuges and expanding in an extremely rapid wave of re-colonisation until it reached the southernmost part of Scandinavia (approx. 2 500 years ago).

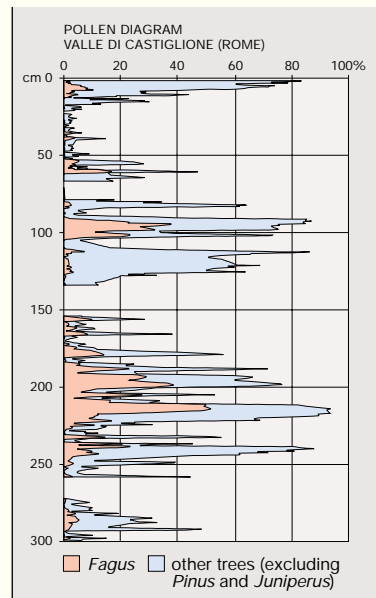
In central Italy, the expansion of beech-woods peaked between 8 000 and 4 000 years ago, so it is probable that extensive forests had progressively recovered a good part of the Tyrrhenian pre-Apennines (Tuscany and Latium regions). With the stabilisation of present-day climatic conditions, beech-woods (and, similarly, mixed mesophile forest) began to decline - especially in areas where a genuinely Mediterranean temperature and rainfall regime was becoming established - and particularly as man had already begun to have a significant affect on the peninsular forest landscape during this period. For these reasons, the presence of beech is today rather sporadic in those areas with a Mediterranean or sub-Mediterranean climate, and is reduced to mere fragments in localities where specific microclimatic conditions still exist, with high, prolonged levels of atmospheric humidity.



Summit beech population in a system of dolines (Monte Coccovello, Basilicata)

The history of vegetation, reconstructed through analyses of fossil pollens contained in lake sediments or identification of plant macrofossils (leaves, wood, seeds, fruit), clearly demonstrates that today's vegetation is the temporary result of the continuing expansions and retractions of plant populations which followed the considerable climatic oscillations during the Quaternary epoch, which were, at times cooler and wetter, and at others either hot and dry, or cold and dry. The history of the beech in the Italian peninsula forms part of this ever-changing picture. The oldest fossil pollen data show that, together with many trees which are now extinct in these regions, beech was already present in southern Italy at the start of the Quaternary, around 2 million years ago. In central Italian fossil deposits, beech is always mixed with other tree taxa in the forest expansions characteristic of the periods between glaciations. In some inter-glacial periods, the beech descended as far as sea level, as at Torre in Pietra, a few kilometres north of Rome, where fossils of leaves and fruit have been discovered, together with remains of mammals and traces of Palaeolithic man, in a forestry context. Instead, during the Ice Ages, the beech-woods were decimated and reduced to small relict populations, which survived in the damper areas, ready to spread once more, as soon as climatic conditions permitted. After the last Ice Age, the beech expanded rapidly in southern Italy. Significant percentages of pollen are shown in Campania and Latium as early as 9000 years ago, very probably resulting from

the expansion of locally persisting nuclei. The arrival of beech in the Apennines of Tuscany and Emilia-Romagna was much later, and gradually migrated along the Apennine chain. Beech is first recorded near Bologna around 5500 years ago and in Liguria 5000 years ago. In many cases, beech-woods supplanted pre-existing silver fir populations, thus completely altering the physiognomy of forest vegetation in the northern Apennines. Palaeobotanic research therefore demonstrates, on one hand, the local persistence of forest species over hundreds of thousands of years in some regions and, on the other, it traces the mobility of plant populations which, in a brief period, can expand and colonise new regions, rapidly altering the vegetation landscape.

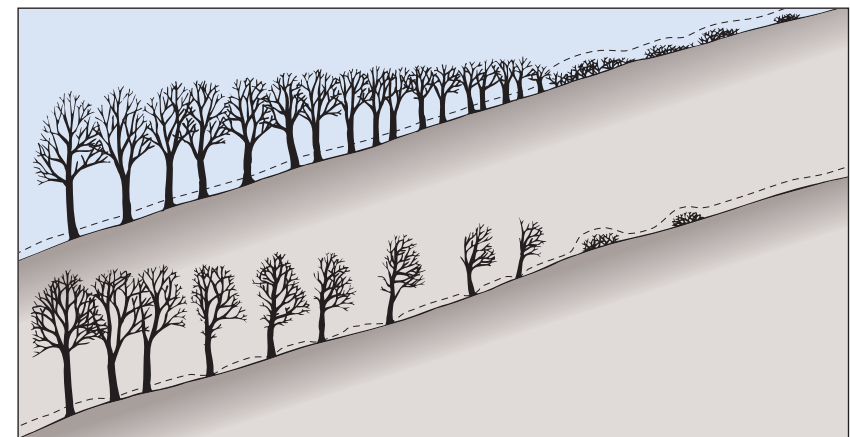


## ■ Beech: autecology and synecology

The beech is found throughout Italy, with the exception of Sardinia and the smaller islands, with a distribution following the Alpine and pre-Alpine circle, descending right down the Apennine ridge and crossing the Straits of Messina to the highest summits of the northern Sicilian mountains (the Peloritani, Nebrodi and Madonie groups). Beech mainly forms forest communities, characterising the vegetation of the sub-alpine zone which, on the Italian peninsula, is between approximately 900-1000 and 1800-1900 m a.s.l., which marks the uppermost limit for trees. Although these general characteristics remain quite constant, some differences in the positions and altitudinal limits of the beech sub-alpine zone may be identified between the Tyrrhenian and Adriatic mountain-flanks of central Italy and, to an even greater extent, on the Ionic and Tyrrhenian slopes of the Calabrian Apennines.

Owing to peculiar local climatic and microclimatic characteristics, beech also dominates in some parts of the Apennines where rainfall conditions are not optimal. In particular, the frequent fogs and wet winds descending towards the southern Tyrrhenian coastal and sub-coastal areas create perfect conditions for beech-woods, and also encourages their descent to relatively low altitudes.

Today's Apennine mountain vegetation appears to be lacking in any other woody plant that can compete with beech, which shows a surprising aptitude for expansion, in diverse habitats and in the most disparate environmental conditions (including human interference): it colonises not too high and windy summits, resists the continual browsing of livestock, and descends to very low



Natural (top) and artificial (below) limits of tree vegetation (dotted line: snow cover)

altitudes, even competing with better-adapted local species. Few tree species can modify their physiognomy to such a great extent in different environments. The expanded crown in isolated specimens of beech becomes slim and columnar in denser tall forests, as hemispheric and bush-like when growing on pastures and the more exposed mountain ridges, managing to survive in extremely limiting soil conditions and able to support the weight of snow.

On the Apennines, the lower limit of beech-woods is generally around 800-1000 m, with sporadic reductions below this, representing isolated populations of enormous biogeographical interest (see box on pp. 32-33). In the lower sub-alpine zone, up to 1400-1500 m a.s.l., mixed mesophile forests are more commonly found, dominated by beech, together with lime (*Tilia platyphyllos*), sessile oak (*Quercus petraea*), hop-hornbeam (*Ostrya carpinifolia*), mountain ash (*Sorbus aucuparia*) and various maples (*Acer pseudoplatanus*, *A. obtusatum*, *A. cappadocicum* var. *lobellii*, *A. platanoides*). Also extremely common, although never at very high altitudes, are yew (*Taxus baccata*) and, more especially, holly (*Ilex aquifolium*), which is particularly abundant in southern Italy. In the higher sub-alpine zone, beech dominates unchallenged, forming almost entirely single-species forests, with the exception of local populations mixed with silver fir. These monospecific populations lead to the idea that Apennine beech-woods are still at an immature stage, characteristically lacking other competing forest species right up to the highest altitudes, perhaps partly caused by the centuries-old exploitation of woodlands by man.



Beech-wood limit (Monte Raiamagra, 1646 m a.s.l., in the Monti Picentini Regional Park, Campania)

The nature of these woodlands thus depends strongly on the recent eradication of pre-existing vegetation - especially at higher altitudes and in the more northerly parts of the country - caused by the Ice Ages and the result of interglacial and, more especially, post-glacial repopulations, which occurred extensively in central Europe. The complexity of environmental scenarios is maximum along the Italian peninsular highlands, which are particularly accentuated, at times craggy, with average-steep slopes such as those to be found in precipitous, impervious gorges.

The conspicuous lithomorphological variability of much of the Apennines has further accentuated habitat diversification in the mountains. The uplift of this chain, which began during the Tertiary, has not yet completely exhausted its thrust, and the consequent rise, causing particularly marked "immature" formations, has meant that erosional agents have not yet had sufficient time to flatten and model the reliefs. This renders the high biogeographical value of the forest communities located in ravines and mountain gullies more understandable, as they constitute ideal habitats for the ongoing permanence of forest fragments with high tree diversity. In these environments, valuable examples of multi-layered mixed mesophile forests can be found in which beech co-exists with other species, without being able to predominate, presumably for edaphic (pertaining to soil) and microclimatic reasons. They are often small residual areas dominated by maple (*Acer pseudoplatanus*, *A. obtusatum*, *A. lobelia*, *A. platanoides*), ash (*Fraxinus excelsior*), lime (*Tilia cordata*, *T. platyphyllos*) and elm (*Ulmus glabra*). It is fascinating to view these



European beech distribution

Beech can reach a height of about 30-35 m (rarely 40 m), with a trunk diameter exceeding 1.5 m. A long-lived species, it normally reaches an age of around 150 years although, in exceptional circumstances, it may even survive for 300-400 years. The straight and generally cylindrical trunk is almost without lateral branches in some growing conditions. The upper branches are usually knotted and wide-spreading, and form a dense conical oval-shaped crown. If growing in a clearing, the branches may start with a sub-horizontal trend, and then become ascendant, thus forming a wide crown. The bark is smooth, thin, of a greyish-silver colour, often with whitish marks due to a covering of lichens. The leaves are alternate, distichous, oval or elliptical, pointed, shallowly toothed,

and with a short petiole (1-2 cm), accompanied by two shiny deciduous stipules. The leaf blade is 5-10 cm in length and approximately 3-7 cm wide, dark green and shiny above, paler and edged with hairs below. There is a well-developed root system that can reach average depths.

The tree is monoecious, with blossoms in unisexual inflorescences (the males in a hanging rounded tassel, the females erect and formed of two flowers), with typically wind pollination. It flowers in April-May, with fruit ripening in autumn (September-October).

The fruit is an achene with a coriaceous pericarp (beech-nut), approximately 1-2 cm long and pyramid-shaped, enclosed in a cupule with four valves which open on ripening.

Although fruiting every year, the beech

has an abundant production of beech-nuts only once every 4-5 years, and very abundant approximately every 5-6 years (the so-called "fat year"). It has good agamic reproductive capacity, exploited through cutting, which is followed by numerous adventitious shoots from the stump.

Its hard pink-coloured wood is easily worked and is used in furniture-making, for plywood, and railway sleepers, as well as in lathe work and wood-carving, and to produce cellulose. The wood and charcoal also make excellent fuel. The edible beech-nuts were at one time used by man as food for himself and his livestock (mainly pigs). In the past, the seed was dried and ground, to be used as a coffee substitute or to extract an oil. The beech is an eminently maritime species, i.e., a lover of moist, mild

climatic conditions, avoiding sites with a hot climate and, inversely, sites with continental characteristics.

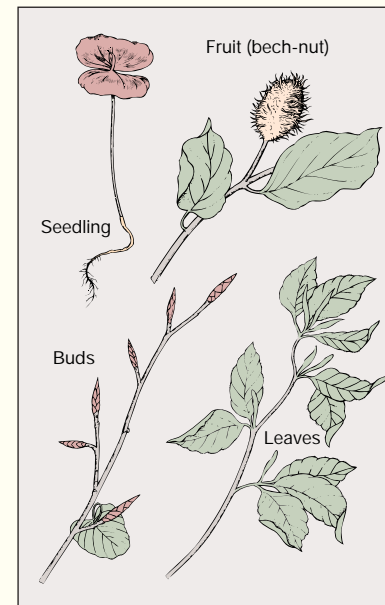
It grows in sites with an annual average temperature of 6 to 12 °C, with an optimum towards the higher values, as long as they are compensated by rainfall, with a growing season ranging from 110 to 160/180 days, which is generally considered a brief period. Spring frosts are a very frequent adversity, and the beech is especially susceptible at its lower altitude limit, where the growing season commences earlier. Groundwater cannot substitute for rainfall, as the roots have high transpiration requirements and thus the root apparatus develops in the upper soil layers. For this reason, the tree exploits water vapour as well as water percolating along the trunk.



Trunk with seedlings



Lichens on beech bark



Beech-nut production in a good year

A species deeply anchored in the superstitions of the peoples of the Old World, the yew is an ancient conifer, the result of an evolutionary process which, with the red fleshy case surrounding its seed (the aril), seems to have clearly differentiated it from the other conifers which it apparently resembles. Its legendary notoriety is certainly to be attributed to the (not always!) verified poisonous characteristics of its foliage, but also, at least in temperate climates, to the hardness of its wood, which was widely used in manufacturing from the end of the last Ice Age up to the 17th century. A quite small tree, the yew does not usually exceed 10 metres, although specimens have been recorded with a height of 25 metres. It has unlimited longevity, as it is capable of regenerating from root buds and of persisting indefinitely with clonal populations. Its distribution area is as vast as its populations are scanty, rare and fragmentary. In Europe, it is the woody species with the widest latitudinal distribution, across the barrier of the Mediterranean Sea, perhaps equalled only by the birch. But its frequency is extremely low everywhere. True "yew woodlands" are rare; the yew almost always forms populations of a few individuals incorporated here and there in a system of temperate deciduous broadleaved forests, most often beech-woods. It frequently coexists with holly in the lower-lying Apennine beech-woods, where it contributes towards the formation of spectacular "multilayered" beech forests. In these community conditions, the yew (and to a lesser extent, holly) tends to colonise forests where there are many rocky outcrops of the

limestone substrate, revealing its close link to a propagation strategy associated with populations of frugiferous birds and the fact that survival is easier in the initial stages in the more open areas of a forest community. This is also confirmed by its behaviour at the northern limits of its European distribution area, on the Baltic coasts and islands, where it avoids direct competition with trees in mixed coniferous and deciduous forests, colonising coastal areas which are still in the emerging phase following the sea-level rise in the region. A witness to the floral richness of the luxuriant forests of Europe at the end of the Tertiary epoch, thanks to its regenerative vitality and propagation capacity, the yew was able to avoid the decimation which the flora suffered during the dramatic climatic transformations culminating in the Quaternary Ice Ages. Its poisonous foliage undoubtedly also defended it against the herbivores populating the vast European grasslands during the last Ice Age, favouring its persistence in forest refuges. Its fleshy aril also probably allowed it to spread rapidly after the glaciations, which would explain its swift re-expansion northwards and its presence in today's vegetation.



communities as testimonies of a late-boreal or early-maritime epoch, antecedent to the mass arrival of beech. From the lithological point of view, beech appears to be quite indifferent to substrate, growing well on soils of both volcanic origin and on calcareous, arenaceous and granitic soils. It generally prefers the fresh moist climatic conditions common in the sub-alpine belt in the Apennines.



Tall beeches in the Apennines near Modena

The most typical forest associations develop in temperate-cold conditions with plentiful water supply. The dominance of broad-leaved species gives rise to the composition of forest habitats that are particularly shady in summer and very well illuminated in winter.

The preferred climate of beech-woods is maritime, i.e., relatively wet throughout the year. However, in Mediterranean regions, there may be a definite decrease in rainfall during summer, which almost never translates into marked and prolonged water stress, except obviously on extremely rare occasions. During the winter months, average monthly temperatures drop below 0°C, although lengthy periods of winter frost are rather rare, owing partly to abundant snowfalls on the Apennine mountains. This seasonality is directly responsible for the pedological conditions that become established in a beech-wood. During winter, biological processes are greatly slowed, and acidic humus and soluble substances leached from the surface layers of soil accumulate. In summer, instead, there is abundant production of organic matter composed of readily mineralised beech leaves. During this phase, decay is very rapid, and organic matter mixes with the mineral component, trapping soluble ions and leading to the deposition of a "sweet" type of humus (*mull*), which preserves and increases soil fertility.

High ecological flexibility and optimal use of resources has allowed *Fagus sylvatica* to grow in very diverse habitats and to compete with local species during the last few millennia, forming Apennine populations with relatively uniform physiognomy and structural appearance. This varied and complex floral scenario, especially at lower altitudes, is also a consequence of human exploitation. The extremely intricate bioclimatic, lithomorphological and floral situation in Italy has enabled beech-woods to establish equally variegated associations, which are today identified and classified in terms of differing forest plant associations.

The assignment of Apennine beech-woods is extremely complex, as around 40 different types have been identified. This abundant nomenclature is mainly ascribable to the floral and community diversity of Apennine beech-woods, due to the influence of physical-biotic factors on the evolution of the peninsular flora and vegetation. A key role is played here by the geographical location of the Apennines, which lie deeply wedged in the Mediterranean basin and display a clear bioclimatic and biogeographical gradient in terms of latitude - not to mention the palaeogeographical and palaeoclimatic vicissitudes undergone by the various peninsular sectors at the end of the Tertiary and during the Quaternary.

The following table (complete with geographical distribution and ecological description) summarises beech-wood associations (i.e., limited to communities where *Fagus sylvatica* dominates) described for the Apennines, and is derived from the most recent phyto-sociological hypotheses in studies examining these formations.

For ease of interpretation, the associations are divided by geographical sector (northern, central and southern Apennines). The associations of oldest and most consolidated use, i.e., most widespread, are highlighted in grey; italics refer to still widely-used nomenclature synonyms.



Autumn colours in a mixed beech-wood (Vallonina, Monte Terminillo, Latium)

#### NORTHERN APENNINES

GYMNOCARPIO DRYOPTERIDIS - FAGETUM Tuscany-Emilia Romagna and Apuan Alps	mixed beech and fir woodlands on fresh soils of mull type
ROSO PENDULINAE-FAGETUM Tuscany-Emilia Romagna (Abetone)	acidophile microthermal beech-woods, mainly south-facing
MONOTROPO-FAGETUM Monte Amiata	microthermal beech-woods on volcanic substrates
TROCHISCANTHO NODIFLORI-FAGETUM Liguria, Emilia-Romagna, Tuscany	neutrophilous beech-wood with wide altitudinal distribution
FESTUCO HETEROPHYLLAE-FAGETUM Rio Solano Valley in Casentino	dense beech-wood with scarce undergrowth
SESLERIO CYLINDRICAЕ-FAGETUM Liguria, Emilia-Romagna and Pavia Apennines	transition beech-wood on neutral-basaltic substrates
SESLERIO ITALICAЕ-FAGETUM Mugello-Romagna Apennines	thermophilous sub-rupestral beech-woods of the lower montane horizon on prevalently limestone substrates
LEUCOJO-FAGETUM Parma Apennines	transition beech-woods on neutral substrates
DAPHNO LAUREOLAE-FAGETUM Tuscany and Emilia-Romagna Apennines in provinces of Piacenza and Bologna	lower montane belt beech-wood rich in oak-wood species
STAPHYLEO PINNATAЕ-FAGETUM Tuscany, Emilia-Romagna and northern Marches Apennines	thermophilous beech-woods on marly limestone substrates of the submontane horizon
CARDAMINO CHELIDONIAЕ-FAGETUM Vallombrosa Wood	beech-woods with fir
ACERI PLATANOIDIS-FAGETUM Tuscany and Emilia-Romagna Apennines, Campigna and Sasso-Fratino Forests	Mixed beech-woods with <i>Abies alba</i> and thermophilous broadleaved trees of lower montane horizon
GALEOPI-FAGETUM Romagna Apennines	transition beech-woods of maritime type
POLYGONATO VERTICILLATI-FAGETUM Romagna Apennines	transition beech-woods of maritime type on slightly acid soils
CORYDALIDI-FAGETUM Tuscany, Marches and northern Latium	thermophilous beech-woods
ADENOSTYLO GLABRAE-FAGETUM Tuscany and Marches Apennines in the provinces of Pesaro and Urbino	transition beech-woods with high soil moisture content
GALIO ODORATI-FAGETUM Tuscany and Emilia Apennines	mature beech-woods on eutrophic substrates rich in humus (mull type)
CARDAMINO HEPTAPHYLLAE-FAGETUM Tuscany and Emilia-Romagna, Monte Amiata	trophic beech-woods, slightly acidophile, rich in species of genus <i>Cardamine</i>

AGROSTIDO TENUIS-FAGETUM Monte Amiata	low-altitude beech-woods on volcanic substrates		
LUZULO PEDEMONTANAE-FAGETUM Tuscany Apennines in Lunigiana and Garfagnana	impoverished acidophile beech-woods growing on moder soils		
VERONICO URTICIFOLIAE-FAGETUM Liguria-Piedmont Apennines	impoverished acidophile beech-woods		
LUZULO NIVAE-FAGETUM Northern Apennines	impoverished acidophile beech-woods		
CENTRAL APENNINES			
CARDAMINO KITABELII-FAGETUM Central Apennines as far as Monti Simbruini-Ernci	microthermal beech-woods on limestone substrates of central and central-northern Apennines		
POLYSTICHO ACULEATI-FAGETUM All major mountains of central Apennines from Monte Catria to Matese	microthermal beech-woods of sub-alpine belt on prevalently limestone substrates		
SOLIDAGINI-FAGETUM Central Apennines	beech-woods on acid and sub-acid substrates of lower to mid-montane horizons		
ARISTOLOCHIO-FAGETUM Tyrrhenian sector of central-northern Latium	low-lying beech-woods on pyroclastic volcanic substrates		
FRAXINO ORNI-FAGETUM Tyrrhenian sector of central-northern Latium	low-lying beech-woods on pyroclastic volcanic substrates		
ALLIO PENDULINI-FAGETUM Northern Latium and southern Tuscany	beech-woods of submontane belt of Latium volcanoes and Monte Amiata		
DACTYLORHIZO FUCHSII-FAGETUM Umbria-Marches Apennines (especially in provinces of Pesaro and Urbino)	beech-woods of lower montane belt and submontane horizon rich in <i>Quercetalia pubescentis</i> species		
CARICI SYLVATICAE-FAGETUM Umbria-Marches Apennines	thermophilous beech-woods on slightly acid substrates		
LATHYRO VENETI-FAGETUM Central Apennines	calcicole thermophilous beech-woods of the submontane and lower montane horizon in contact with woods of <i>Ostrya carpinifolia</i>		
DIGITALIO MICRANTHAE-FAGETUM Central Apennines	impoverished thermophilous beech-woods on limestone substrates, with obvious ingressions of <i>Quercetalia pubescenti-petraeae</i> species		
POLYSTICHO SETIFERI-FAGETUM Umbria-Marches Apennines, Monte Amiata	thermophilous beech-woods rich in <i>Quercetalia pubescenti-petraeae</i> species		
ARISTOLOCHIO-FAGETUM Tyrrhenian sector of central-northern Latium	low-lying beech-woods on volcanic substrates		
ALLIO PENDULINI-FAGETUM Northern Latium and southern Tuscany	beech-woods of submontane belt of Latium volcanoes and Monte Amiata		
SOUTHERN APENNINES			
ANEMONO APENNINAE-FAGETUM Southern Italy from Abruzzo to Sicily (recorded also in Latium, Umbria and the Marches)	southern Italian thermophilous beech-woods in contact with sub-montane oak-woods and mixed woodland		
AQUIFOLIO-FAGETUM	equivalent to ANEMONO APENNINAE-FAGETUM		
ANTHRISCO SICULAE-FAGETUM Sicily (Nebrodi, Etna and Madonie)	beech-woods of montane belt, indifferent to substrate		
AREMONIO-FAGETUM Gargano promontory	low-lying thermophilous beech-woods of Gargano and southern Apennines		
MOEHRINGIO MUSCOSAE-FAGETUM Campania Apennines (Monti Picentini)	beech-woods of lower montane horizon, with well-developed undergrowth		
MOEHRINGIO TRINERVAE-FAGETUM Cilento National Park, Pollino Massif	microthermal beech-woods on limestone substrates		
MELITTO ALBIDAE-FAGETUM Sicily, mountains between eastern sector of Nebrodi mountains and western Peloritani chain	thermophilous beech-woods of lower montane horizon on siliceous substrates, limited to north-facing slopes		
ACERI LOBELII-FAGETUM Lucano Apennines	beech-woods of mid-montane horizon on carbonate or flyschoid substrates		
LUZULO SICULAE-FAGETUM Sicily (Madonie)	microthermal beech-woods of upper montane horizon on limestone and dolomitic substrates		
EPIACTIDO MERIDIONALIS-FAGETUM Sicily (Etna)	pioneer silicolous beech-woods on volcanic substrates of montane belt		
GALIO HIRSUTI-FAGETUM Calabria (Aspromonte)	acidophile beech-woods on ultra-mafic substrates (often mixed with <i>Abies alba</i> ), of mid-montane belt		
RUBO AETNICI-FAGETUM Sicily (Etna); eastern slopes	thermophilous silicolous beech-woods of the lower montane horizon on volcanic substrates		
RANUNCULO BRUTII-FAGETUM Basilicata and Calabria (especially on Pollino massif)	microthermal beech-woods of southern Italy		
ASYNEUMATI-FAGETUM Calabria, Basilicata and central-southern Campania	microthermal beech-woods of upper montane horizon of southern Apennines		
CAMPANULO TRICHOCALYCINAE-FAGETUM	equivalent to ASYNEUMATI-FAGETUM		
GERANIO VERSICOLORIS-FAGETUM Calabria and Basilicata	microthermal beech-woods		
ADOXO MOSCHATELLINAE-FAGETUM Lucano Apennines	microthermal beech-woods in contact with sub-alpine belt		
DORONICO COLUMNAE-FAGETUM Calabrian-Lucano Apennines	pioneer beech-woods on rocky substrates of upper montane horizon		

## ■ Beech-woods of the northern Apennines

In the geographical context of the northern Apennines, beech-woods are almost exclusively found between 1000 and 1700-1800 metres a.s.l.. Almost everywhere, beech-woods form the upper limit of the tree vegetation, except in the upper Sestaione valley, where there is a relict strip of sub-Alpine red fir-wood (at Campolino). Most of the lands that fall within the northern Apennines belong to what is known as the Macigno formation - nutrient-poor sandstone which disaggregates to form typically sandy soils with limited silt and clay contents. In bioclimatic terms, the beech-woods of the northern Apennines are strictly maritime, with annual rainfall that is always above 1500 mm (with peaks exceeding 2500 mm), which permits permanent beech woodland even in situations of edaphic water deficit such as that often found in rocky environments.

In terms of vegetation, the northern Apennine beech-woods do not greatly differ from their central-European counterparts. Two main types are identified. Neutrophile or neutro-basophile beech-woods grow on deep, nutrient-rich soils characterised by the frequent presence of dentaria (crucifers belonging to the genus *Cardamine*), including coralroot bittercress (*C. bulbifera*), seven-leaflet bittercress (*C. heptaphylla*), Kitaibel's bittercress (*C. kitaibellii*) and also *C. pentaphyllos*. Instead, acidophile beech-woods tend to grow on acid,



Arenaceous oligocene rocks in a Tuscany-Emilia Apennine beech-wood

oligotrophic soils which are subject to intense leaching and are associated with species of the genus *Luzula* (wood-rushes). The most significant species include oakforest wood-rush (*L. luzuloides*), snowy wood-rush (*L. nivea*), greater wood-rush (*L. sylvatica* subsp. *sylvatica*) and *L. pedemontana*. At their most typical, acidophile beech-woods have an undergrowth where bilberry (*Vaccinium myrtillus*) dominates, accompanied by heath spotted orchid (*Dactylorhiza maculate*), a bedstraw (*Galium rotundifolium*), rough small-reed (*Calamagrostis arundinacea*), lesser wintergreen (*Pyrola minor*) and nettle-leaved speedwell (*Veronica urticifolia*). However, in situations with high soil moisture, ferns such as deer fern (*Blechnum spicant*) and mountain fern (*Dryopteris oreopteris*) flourish. In thermo-xerophile associations, beech is more often accompanied by oaks and other typical species of oak-woods, such as wood sage (*Teucrium scorodonia*) and bitter vetchling (*Lathyrus montanus*).

Another type of ecological classification of beech-woods follows the criterion of altitude. Two main types are also identified in this case: thermophile and microthermal.

Thermophile beech-woods are substantially of rupestral type, i.e., they grow on shallow soils (rendzina type) which sometimes leads to a slight water deficit in summer. These woods often have open canopies which allow species to enter the undergrowth from the surrounding scrub and meadows. Floral



Seven-leaflet bittercress (*Cardamine heptaphylla*)

There are numerous heterotopic sites of beech along the Apennine chain, i.e., sites where the habitual lower altitudinal limit of the species (or of the community arising from it) descends significantly. On the Italian peninsula, the bioclimatic belt pertaining to beech usually lies between 900 and 1800 m a.s.l. However, this view is simplistic, and does not take into account the ranges of site parameters and/or microclimatic factors which may act locally. There are heterotopic beech sites in Tuscany, with many records in the Apennines near Pistoia (in the municipalities of Cutigliano and Gavinana, some isolated nuclei of beech-wood are reported at 500 and 650 m, respectively), in the Casentino Apennines (near Subbiano, beech stumps litter the woodlands of sweet chestnut (*Castanea sativa*) and turkey oak (*Quercus cerris*) at altitudes between 600 and 700 m), and in the valley of the Scabbia torrent, on Monte Amiata, where beech stumps are found below 500 m.

In the Siena area, between Uopimi and Montebecci, at the head of the Staggia valley, isolated sites of beech are recorded at altitudes close to 300 m. Various heterotopic beech sites are also recorded in the Marches between 300 and 500 m a.s.l.: the valley of the Cinante, S. Angelo in Pontano, the S. Ginesio hills around Sarnano, Scappuccia valley at Genga, Monte Brardo along the Montebello trench, Monti dei Cingoli on the northern slopes of Monte Nero, and Monte Albullo around Monteciccardo. In Abruzzo, the beech populations in the Parco dell'Annunziata in the province of Chieti are worthy of mention. Latium is the region where the most frequent and

most significant heterotopic beech sites are to be found. In the province of Viterbo, the many ravines (a consequence of erosion accelerated by runoff waters on the tufa banks) and the constant presence of brown soils and andosols appear to have played a key role in the maintenance and renewal of beech, despite relatively low rainfall. For a better understanding of the spatial extent of the phenomenon, the most recent censuses have recorded 28 localities in the Viterbo area where belts of true beech-wood, or sparse and isolated individual beech trees, are found at altitudes of less than 650 m (on average approximately 400 m a.s.l.). The most interesting sites include those on the Monti della Tolfa, where a belt of beech-wood exists in the Cinque Bottini district, mixed with chestnut, sessile oak, holm oak (*Quercus ilex*) and hornbeam, with an undergrowth of sage leaf rockrose (*Cistus salvifolius*), growing at an altitude of between 350 and 320 m a.s.l. Low-altitude beeches are also to be found in other regional mountain groups, including the Monti Lucretili, Monti Lepini, Monti Ernici, Colli Albani and Monti Aurunci, where the heterotrophic sites of this species are between 400 and 700 m. The absolute minima (100-150 m a.s.l.) are reached in environments of almost flat alluvial terracing, in two locations very distant from one another: there are sporadic beech trees in the mixed oak copses which line the lower reaches of the river Fiora in north-western Latium, and the mixed woodland of beech with turkey oak, Italian oak (*Quercus frainetto*) and pedunculata oak (*Quercus robur*) of Bosco Faito, located in Valle del Sacco near Frosinone.

The situation is completely different in Campania, where there is a drastic reduction in the heterotopic sites of beech, which are limited to the Avellino Apennines (Valle del Sabato), where beech is found between 500 and 600 m, and the eastern flanks of the Monti Alburni (800-900 m). There is a peculiar strip of beech-wood growing inside the spent crater of Monte Vulture, in Basilicata, on the shores of the Monticchio lakes, where beech grows at an altitude of 650 m in company with silver fir (the latter probably introduced by man). In Apulia, the Gargano promontory hosts a "pure" nucleus of beech-wood, extending for 40 hectares of the Vallone Grande near Ischitella, which represents the lowest offshoot (mainly around 300 m, but with isolated beech specimens as far down as 270 m) of the famous Foresta Umbra. The low-lying beech-woods in Calabria grow at altitudes varying between 700 and 800 m, and essentially characterise the deepest valleys of Sila, Aspromonte

and the Serre Calabre. However, absolute minima are identified in various sites around 500 m, along the mountain flanks of Aspromonte (Scarpa della Pietra, Fosso Corvicello) and at 410 m on the slopes above the Fusolano torrent near Cinquefrondi. In Sicily, beech grows on Etna, the Madonie-Nebrodi mountains and the western edges of the Peloritani chain. When they are compared with the heterotopic sites of beech on the mainland, the low-lying beech-woods of Etna are not particularly low, as they are situated both near Zafferana Etnea, at 800-900 m (Valle S. Giacomo) and 1040 m (Vallone Cazzaventilaru). Conversely, considered within the Sicilian forestry context, these sites fully demonstrate their degree of isolation, in that the Etna beech-woods generally occupy an altitudinal band that rarely encroaches below 1400 m. Also on the Madonie and Nebrodi, the lower limit of beech is around 1050-1100 m, with rigorously northern exposure.



Springtime example of heterotrophic beech-wood (in leaf) within a mixed oak-wood (still bare) on Monti della Tolfa at approx. 350 m a.s.l. (northern Latium)

species indicators of thermophilous beech-woods include some orchids - in particular three species of the *Cephalanthera* genus: red helleborine (*C. rubra*), white helleborine (*C. damasonium*) and narrow-leaved helleborine (*C. longifolia*) - and, subordinately, other species widespread in lower-lying oak-woods, such as whitebeam (*Sorbus aria*), Italian maple (*Acer opalus*), dog's tooth violet (*Erythronium dens-canis*), perennial cornflower (*Centaurea montana*), fingered sedge (*Carex digitata*), mountain sedge (*C. montana*), wood sedge (*C. sylvatica*), false baby's breath (*Galium aristatum*) and wood bedstraw (*G. laevigatum*).

Microthermal beech-woods grow at higher altitudes. They are characterised by significant floral impoverishment, as they lose many of the species common to oak-woods and mixed mesophile woodlands. The trunks and branches of the beeches are progressively modified and take on an increasingly contorted and prostrate bearing as the treeline is approached. Among the more widespread species in high-altitude beech-woods are sycamore and mountain ash, purple lettuce (*Prenanthes purpurea*), adenostyles (*Adenostyles glabra*), wood-sorrel (*Oxalis acetosella*), trochiscanthes (*Trochiscanthes nodiflorus*), golden-rod (*Solidago virgaurea*), and some other species coming from the high-mountain moorlands above, like bilberry, wavy hair-grass (*Avenella flexuosa*) and alpine rose (*Rosa pendulina*).



Romagna Apennine beech-woods

**Liguria.** At 1803 metres, Monte Maggiorasca is the culmination of the Ligurian Apennines, so it is not surprising that beech-woods represent the plant formations closing the altitudinal zoning of vegetation almost everywhere. From the floral viewpoint, the Ligurian beech-woods are distinguished by an abundance of trochiscanthes, an umbellifer with a distribution area extending from the Apennines around Pistoia to the Piedmont Alps.

This species easily adapts to changing environmental conditions - a fact which enables it to be widespread all along the bioclimatic zone pertaining to beech-woods, to which are added frequent transgressions, both sub-montane oak-woods, and in the fir-woods of the Maritime Alps and other lower-lying Ligurian-Piedmont Apennines.

Other abundant species are knotted cranesbill (*Geranium nodosum*), coralroot bittercress, toothwort, herb paris (*Paris quadrifolia*), early dog violet (*Viola reichenbachiana*), wood bedstraw, woodruff (*Galium odoratum*), snowy wood-rush, a wood ragwort (*Senecio fuchsii*), three-leaved valerian (*Valeriana tripteris*) and dark rampion (*Phyteuma ovatum*).

In Liguria, it is not always possible to distinguish between neutro-basophile and acidophile beech-woods, in that the more mature examples of both tend to converge towards the same type of humus, despite starting from sometimes very different substrates.



Knotted cranesbill (*Geranium nodosum*)



Herb paris (*Paris quadrifolia*)



Liverwort (*Hepatica nobilis*)



Large white buttercup (*Ranunculus platanifolius*)

The neutro-basophile beech-woods of the higher mountains contain an abundance of species that can tolerate very cold temperatures. These include large white buttercup (*Ranunculus platanifolius*), wood stitchwort (*Stellaria nemorum*), mountain ash, common figwort (*Scrophularia nodosa*), yellow archangel (*Lamiastrum galeobdolon*) and goatsbeard spiraea (*Aruncus dioicus*). Instead, lower down, the woods are distinguished by relatively thermophile species, including liverwort, hepatica (*Hepatica nobilis*), an anemone (*Anemone trifolia*), primrose (*Primula vulgaris*), sanicle (*Sanicula europaea*), autumn moor grass (*Sesleria autumnalis*) and nettle-leaved bellflower (*Campanula trachelium*). Acidophile beech-woods mainly grow on primitive soils which, in relation to the almost direct contact between the humified layer and the rock, have a pH that remains acid throughout the soil profile. As well as the various wood-rushes, heather (*Calluna vulgaris*) and bilberry characterise this type of woodland. On low-altitude sites, acidophile beech-woods share boundaries with acidophile oak-woods of sessile oak and bladderseed (*Physospermum cornubiense*) - for example, on Monte Bregaceto and Monte Antola - or with groves of turkey oaks and bitter vetchling in Val d'Aveto.

**Emilia Romagna.** Beech-woods dominate the sub-alpine belt of Emilia-Romagna between 800 and 1750 m a.s.l. In the past, these woods were managed by coppicing, and so the widespread change to tall trunks is only recent. In physiognomic terms, beech is the dominant species and is only rarely accompanied by other trees, the most significant being silver fir, mountain ash, sycamore, hornbeam (*Carpinus betulus*), lime and ash. Thermophile beech-woods grow in contact with mixed oak-woods, with the addition of Norway maple. These are beech-woods with high floral richness, in terms of both woody species and undergrowth. In particular, many species may be observed in the tree layer which are characteristic of Alpine valleys and ravines, such as Norway maple, sycamore, ash, lime and elder (*Sambucus nigra*). Similarly, ravine species are also found in the undergrowth, examples being perennial honesty (*Lunaria rediviva*), an adenostyles (*Adenostyles australis*), Jupiter's distaff (*Salvia glutinosa*), southern woodruff (*Asperula*

*taurina*) and some ferns such as hart's tongue fern (*Phyllitis scolopendrium*), soft shield fern (*Polystichum setiferum*) and lady fern (*Athyrium filix-foemina*). Where the substrate is eutrophic, with mull humus, this same type of beech-wood has greater species richness and an abundance of species typical of oak-hornbeam woodlands on the plain. These include mouse plant (*Arisarum proboscideum*), asarabacca (*Asarum europaeum*), wood anemone (*Anemone nemorosa*), martagon lily (*Lilium martagon*), wood millet (*Milium effusum*) and species of the nitrophilous edges of these woods, such as enchanter's nightshade (*Circaea lutetiana*), touch-me-not balsam (*Impatiens noli-tangere*) and ground elder (*Aegopodium podagraria*). In conditions of lower pH, and as a consequence of blandly oligotrophic substrates, species typical of sessile oak-woods or primitive turkey oak groves may become abundant, such as wavy hair-grass, snowy wood-rush, hawkweeds (*Hieracium sylvaticum*, *H. racemosum*), common twayblade (*Listera ovata*), common spotted orchid (*Dactylorhiza fuchsii*) and variousleaf fescue (*Festuca heterophylla*).

Beech-woods of the upper belt of the Emilia-Romagna Apennines are of purely maritime type, as they benefit from more than 2000 mm of annual rainfall. With respect to the type of beech-wood described previously, these microthermal beech-woods have much less floral diversity (e.g., Norway maple and wych elm become little more than sporadic), whereas species like trifoliolate bittercress (*Cardamine trifolia*), whorled Solomon's seal (*Polygonatum*



Martagon lily (*Lilium martagon*)



Hard shield fern (*Polystichum aculeatum*, left) and northern holly fern (*Polystichum lonchitis*, right)

*verticillatum*) and common hemp-nettle (*Galeopsis tetrahit*) take on a differentiating role in the undergrowth. Some of the most important beech-woods of the Apennines are to be found in Emilia-Romagna, such as those in the Campigna district, and the justly famous Sasso Fratino Nature Reserve which, with its 45 hectares, is one of the rare remaining examples of what must have been the primordial Apennine mountain forest. It is a mixed woodland of fir and beech associated with other mesophile broadleaf trees

(and occasionally, yew), which would appear never to have suffered from clearing or selective felling.

Two types of beech-wood are also identified in the mountain/sub-alpine sectors of the eastern Emilia-Romagna Apennines (Reggio Emilia-Bologna area). At higher altitudes, always exceeding 1400-1500 m, the potential natural woodland is composed of microthermal beech-woods with silver fir and undergrowth prevalently characterised by pteridophytes (ferns) with a boreal distribution, such as oak fern (*Gymnocarpium dryopteris*), broad buckler fern (*Dryopteris dilatata*), northern holly fern (*Polystichum lonchitis*), hard shield fern (*Polystichum aculeatum*), a beech fern (*Phegopteris polypodioides*) and male fern (*Dryopteris filix-mas*). This conifer-mixed beech-wood, of a significantly boreal imprint, fits the climate of this sector of the Apennines, which displays widespread thermal continentality (average annual excursion over 20°C), very cold temperatures (average annual temperature 6°C) and abundant precipitation (more than 2000 mm/year). It is not by mere chance that some specimens of Norway spruce (*Picea abies*) grow in a spontaneous state in this type of beech-wood, in their turn related to the relict strip of sub-Alpine red fir wood growing on the Alpe delle Tre Potenze in Tuscany. Lower down, the beech-wood flora may again include silver fir, but it almost entirely loses its contingents of microthermal and high-mountain moorland species. Instead, some species belonging to low-altitude beech-woods, such as seven-leaflet bittercress, coral-root bittercress, sanicle, wood anemone and wood melick (*Melica uniflora*) become abundant.

In broad terms, the beech-woods of the western Emilia-Romagna Apennines (around Piacenza and Parma) reintroduce the forest composition of the

Ligurian beech-woods with which they are in close contact. As well as mountain ash and sycamore, Alpine rose may be locally abundant at high altitudes. A few associations of pioneer beech-wood mixed with a type of pine (*Pinus uncinata*) and silver fir are also of interest.

**Tuscany.** The Tuscan beech-woods are mainly located at altitudes between 900 and 1800 m a.s.l.. Stands of beech outside the northern Apennines are found in the Apuan Alps, on Monte Amiata, the Colline Metallifere and Monte Cetona. Tuscany also has beech-woods differentiated, according to type of substrate, into acidophile or neutro-basophile, eutrophic/oligotrophic or, again on the basis of bioclimate, into thermophile, mesothermal and microthermal. In the Tuscan sector of the northern Apennines, neutro-basophile beech-woods play host to many of the most frequent species in such woods throughout most of Europe, i.e., hornbeam, woodruff, wood anemone, early dog violet, wood millet (*Milium effusum*), dog's mercury (*Mercurialis perennis*), coral-root bittercress, seven-leaflet bittercress, knotted cranesbill, purple lettuce, male fern, a wood rugwort and wood hawkweed.

One type of eutrophic neutro-basophile beech-wood is thermophile woodland growing at between 700 and 900 m, characterised by numerous species arriving from even lower down, such as hawthorn (*Crataegus monogyna*), variousleaf fescue, spring vetchling (*Lathyrus venetus*), bugle (*Ajuga reptans*),



Fato Nero beech-wood in the Apuan Alps (Tuscany)

wood speedwell (*Veronica montana*) and black bryony (*Tamus communis*). On the Tuscan mountain-sides (La Verna) with a particularly steep northern or north-eastern exposure, typical ravine beech-woods develop, rich in pteridophytes, including hart's tongue fern and meso-hygrophile species (mouse plant), of which the notable tree exponents are Norway maple, wych elm and ash.

The microthermal beech-woods of the Tuscan Apennines are often mixed with silver fir and contain some species coming from the sub-Alpine bilberry moorlands of the belt above. These include alpine coltsfoot (*Homogyne alpina*), lesser wintergreen (*Pyrola minor*), lesser twayblade (*Listera cordata*), coralroot orchid (*Corallorhiza trifida*), rock bramble (*Rubus saxatilis*) and wood cow-wheat (*Melampyrum sylvaticum*).

Also in Tuscany, as in Emilia-Romagna, species like polypody, a beech fern (*Phegopteris polypodioides*) and northern holly fern may give rise to the kind of high-altitude beech-wood typical of extremely fresh and deep, usually leached, soils. Thick undergrowth of bilberry and Alpine rose (around Abetone) indicates soils with higher acidity.

On Monte Amiata, which forms a sort of "maritime island" within a typically sub-Mediterranean context of relatively scarce rainfall, beech-woods are particularly luxuriant over an altitude span of almost 1000 metres. Here, as in the rest of the Apennine chain, low-altitude beech-woods contain species still clearly



Beech-wood surrounding the Sanctuary of La Verna (Tuscany)

associated with the oak-woods below, such as common Solomon's seal (*Polygonatum multiflorum*), few-leaved hawkweed (*Hieracium murorum*) and crosswort (*Cruciata glabra*). A peculiar feature is the massive presence (partly also due to human disturbance) of species particularly common on volcanic rocks, such as broom (*Cytisus scopiarus*), wild strawberry (*Fragaria vesca*) and colonial bentgrass (*Agrostis tenuis*).

Beech-woods of the upper sub-alpine zone (1400-1700 m) in this area are differentiated by the presence of male fern, wood-sorrel (*Oxalis acetosella*) and an adenostyles (*Adenostyles alpina*). Also worthy of note is silver fir

in the Monte Amiata area which, however, is only partly linked to the floral context of beech-woods, as it is more frequently associated with mesophile groves of turkey oaks.

The beech-woods of the Apuan Alps form a large arc from Monte Tambura to Pania Secca. For ecological and anthropogenic reasons, Apuan beech-woods are severely fragmented. For example, one of the ecological causes is that high-mountain grassland vegetation dominated by mat grass, fescue, or moor grass), as well as juniper and bilberry, penetrate into the woodland, leading to significant lowering of the upper limit which, in the Apuan Alps, runs approximately along the 1600 m contour line.

Another ecological cause is the division of Apuan beech-woods into "vertical" belts, linked to the definite rise in altitude of both mixed oak-wood and pioneer ash-hornbeam woodlands. The latter sever the beech-woods longitudinally up the mountain-sides, until they directly rejoin the shrub vegetation of the belt above.

However, even more than factors of bioclimate or geomorphology, Apuan beech-woods have suffered drastically from the sylvicultural hand of man, who has reduced many tall beech forests to a sparse scattering of shrubs. Only the extremely maritime climate (annual precipitation of over 3000 mm) and lack of truly competitive species have preserved these woods until now, although in a somewhat impoverished state.



Lesser wintergreen (*Pyrola minor*)

Red helleborine (*Cephalanthera rubra*)Sword-leaved helleborine (*Cephalanthera longifolia*)

In terms of communities, beech-woods in the Apuan Alps demonstrate less obvious altitude zoning than that of the northern Apennines, because there is often some degree of penetration between thermophile and microthermal flora. The thermophile flora includes orchids belonging to the genera *Cephalanthera* and *Epipactis*, and the various species typical of mixed oak-woods. The microthermal flora is still tied to the same species favouring high altitudes which characterise the beech-woods of the northern Apennines, for example, polypody and aposeris (*Aposeris foetida*). Only pioneer beech-woods are affected by soil type. Open-canopied beech-woods with an undergrowth of a moor grass (*Sesleria argenta*) grow on carboniferous substrates, whereas on silicates the classic beech-wood with many species of *Luzula* prevails.

### ■ Beech-woods of the central Apennines

In the central Apennines, beech-woods are a dominant note in the mountain landscape. They are very well represented, as many of the mountains are above 1800-2000 metres a.s.l.. Unlike the northern Apennines, which are prevalently composed of siliceous rocks, the central Apennines are mainly carboniferous. There are only a few arenaceous mountain chains of any importance, although some are quite significant in terms of extent and height (for example, Monti della Laga). Volcanic outcrops are mainly found in Latium

There is good ground cover in a beech-wood during the growing season, the delicate green foliage providing extensive areas of shade. The forest has an entirely different appearance depending on the type of use to which the beech timber is put: as firewood or for producing charcoal - this is especially true of rugged terrain with rocky outcrops, which is managed by periodic coppicing, or when the trees are well rooted in deeper soils and felled for their valuable timber. In the latter case, the beech trees are tall, with columnar, smooth grey trunks. They are spaced widely apart, with spreading crowns, and there is therefore ample cover of the ground beneath. The altitude at which beeches grow and the shade they provide have a double function: they protect the ground beneath from evaporation and the trees themselves from abrupt changes in temperature. In autumn, the falling leaves form a soft litter. This is gradually decomposed, not only by various

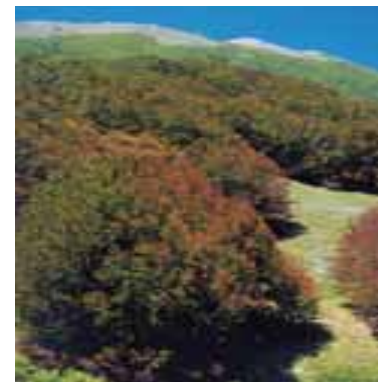
animal and plant organisms, which are practically invisible to the naked eye, but also by macromycete fungi, i.e., those of a certain size. The fungi most commonly found in beech-woods include those belonging to the genera *Boletus* (*Boletus regius*, *B. appendiculatus*), *Russula* (*R. fellea*, *R. cyanoxantha*, *R. lepida*, *R. delica*, *R. laurocerasi*), *Lactarius* (*L. piperatus*, *L. pergamenus*, *L. pallidus*, *L. blennius*, *L. vellereus*), *Ramaria* (*R. flava*, *R. formosa*, *R. botrytis*), *Cortinarius* (*C. coeruleus*, *C. traganus*), *Cantharellus* (*C. cibarius*) and other smaller ones. Other species may be found in beech-woods managed by coppicing, due both to mixing with other plant species and to the greater amount of light.

Other types of fungi are those defined as lignicolous, i.e., growing either on rotting stumps, like *Coriolus versicolor*, or on still living but evidently afflicted plants and/or on horizontal fallen trees, like *Fomes fomentarius* or *Ganoderma applanatum*.

*Ganoderma applanatum*Fungus on a beech trunk (*Fomes* sp.)



Beech-wood on the slopes of Monte Bove (Monti Sibillini Park, Umbria)



A beech-wood near Rifugio del Diavolo (Abruzzo)

(near Viterbo and the Albani Hills south of Rome). Despite the relatively low altitudes of the Latium volcanoes (the tallest being Monte Cimino, at 1008 m), beech-woods are quite frequent, especially in what are known as heterotrophic stands.

Despite their size, the beech-woods of the central Apennines display significant floral impoverishment compared with the rest of the Apennines. This is due not only to their role of biogeographical hinge within the peninsula, but also to the relative

distance from the distributional centre of many of the species normally associated with a beech-wood ecosystem. All species belonging to Alpine beech-woods are lost, as the southern limit of their distribution area corresponds to the northern Apennines. Examples are *Luzula pedemontana* and the related snowy woodrush, *aposeris*, northern bilberry (*Vaccinium uliginosum*), trochiscanthes, lesser twayblade, polypody, Alpine coltsfoot, Christmas rose (*Helleborus niger*) and scorzonera-leaved rampion (*Phyteuma scorzonerifolium*). At the same time, all the endemic species or those with amphi-Adriatic distribution which characterise the beech-woods of the southern Apennines are absent or sporadic in the central Apennines - such as Caucasian leopardbane (*Doronicum orientale*), here replaced by heart-leaved leopardbane (*Doronicum columnae*), Lobel's maple (*Acer cappadocicum* ssp. *lobelii*), a buttercup (*Ranunculus brutius*), a bellflower (*Asyneuma trichocalycina*) and Sicilian woodrush (*Luzula sicula*).

Like other central-Apennine vegetation types, beech-woods display a preferential floral-biogeographical link with similar formations on the Balkan peninsula and, more in particular, in the Dinarides. At community level, two main types of beech-wood are also identified in the central Apennines, which, as usual, are distinguished from each another on the basis of altitude.

**The Marches and Umbria.** In the province of Pesaro-Urbino, with its arenaceous, marly-arenaceous and calcareous-marl substrates, many of the floral and community characteristics already seen in the adjacent beech-woods of the western slopes of the Tuscan and Emilia-Romagna Apennines are found again. Instead, carbonate massifs prevail in the provinces of Ascoli

Piceno and Macerata, so their beech-woods take on a more definitely central-Appennine appearance.

The Montefeltro beech-woods occupy the mountains on the orographical right of the Marecchia Valley. Although this area contains the highest summits, well below the potential limit of woodland, beech-woods never tend to exceed 1300 m. From the community point of view, the beech-woods growing at lower altitudes, sharing boundaries with oak-woods and mixed woodland, have a floral composition with hop-hornbeam, Italian maple, field maple (*Acer campestre*), lime and flowering ash (*Fraxinus ornus*) in the tree layer, with Alpine spindle-tree (*Euonymus latifolius*), European bladdernut (*Staphylea pinnata*), hazel and common dogwood (*Cornus sanguinea*) in the shrub layer, and various orchids (narrow-leaved helleborine, red helleborine, broad-leaved helleborine (*Epipactus helleborine*), tiny-leaved helleborine (*E. microphylla*), etc.) in the herbaceous layer.

At higher altitudes, the accompanying tree species become Norway spruce and sycamore, whereas in the herbaceous layer adenostyles also appears. Where the water-table is very shallow and almost flat morphology prevails, the tree layer of beech-woods is enriched by ash, whereas at ground level asarabacca (*Asarum europaeum* subsp. *caucasicum*) and perennial cornflower may become dominant. Again on arenaceous substrates, but further south, on the border with Umbria, with a rigorously northern exposure,



Alpine squill (*Scilla bifolia*)

thermophile beech-woods stretch down the impluvia to 450-500 m a.s.l.. It is only when approaching the true limestone ridge, on the border between the Marche and Umbria, that beech-woods begin to display that central-Appennine identity that reaches its maximum expression in the Abruzzo Apennines. These are calcicole beech-woods distributed throughout the sub-alpine bioclimatic belt, within which two major types, one following the other, can be identified along the altitudinal gradient.

Microthermal beech-woods are already discernable from 1250-1300 m and occasionally reach (where possible) as far as the upper limit of forest vegetation, except in some sporadic cases of mountaintop vegetation of herbaceous type due to the "summit effect" (Monte Catria). Dentarias are particularly numerous in this type of beech-wood, especially nine-leaflet bittercress (*Cardamine enneaphyllos*), Kitaibel's bittercress and coral-root bittercress. Other preferential species

for this environment are mountain ash, an adenostyles, hard fern, purple lettuce, Alpine honeysuckle (*Lonicera alpigena*), herb paris, wood stitchwort and nodding wintergreen (*Orthilia secunda*). The neutro-basophile beech-woods at lower altitudes (800-1000 m) have a richer flora due to the presence of numerous mixed-woodland species. In the tree layer, species like Bosnian maple (*Acer obtusatum*), whitebeam (*Sorbus aria*) and hop-hornbeam take on an important role, while the undergrowth is dominated by cyclamen or sowbread (*Cyclamen hederifolium*), spring vetchling, Alpine squill (*Scilla bifolia*) and Boccone's hellebore (*Helleborus bocconeii*). In Umbria, this type of beech-wood is found mainly on the Apennine foothills or at the base of the true Apennine ridge; further west, it becomes extremely rare and confined to a few relict locations on the Monti Martani.



Mountain ash (*Sorbus aucuparia*)



Alpine spindle-tree (*Euonymus latifolius*)

**Latium.** The distribution of beech-woods in Latium (Lazio: the region surrounding Rome) more or less follows the lines of the principal summits, laid out in such a way as to form three distinct rows of mountains orientated from the north-west to south-east of the region: the true Apennine ridge, the Latium Apennine foothills, and the western mountains (Monti della Tolfa, Monti Lepini, Monti Ausoni and Monti Aurunci), which form an extremely discontinuous strip of territory running a few kilometres inland. Between the Monti della Tolfa (north-west) and the northern sector of the Volsci (south-west), the two main regional volcanic complexes interpose: that of Vulsino-Cimino-Vicano-Sabatino to the north and the Albani Hills, immediately south of Rome. The slopes of the ancient Latium volcanic calderas, although having no true vegetation belt of beech, do contain low-lying beech-wood (or single specimens of beech at low altitude) which are a distinctive note within the entire forest context of central Italy.

Depending on the prevailing type of substrate, the Latium Apennine beech-woods are more or less calcicole and usually grow on deep soils. As occurs throughout most of the Apennines, altitude zoning separates the high microthermal beech-woods from the lower thermophile communities. Nevertheless, the floral differences between the two are never too evident, or are in any case rarely qualitative. The microthermal beech-woods simply display less floral richness, lacking most of the species coming from the oak-



Isolated specimens of beech (Monte Vigilio, Monti Simbruini Regional Park, Latium)

woods below. Some species are again identified as indicators of microthermal beech-wood conditions; these include mountain lettuce, nodding wintergreen, mezereon (*Daphne mezereum*), dark red helleborine (*Epipactis atrorubens*), hard shield fern and northern holly fern. Some of the loveliest beech-woods in the Latium Apennines grow around Monte Terminillo (especially Val Leonina), Monti Simbruini, Monti Ernici and Monte Meta. Despite having no specific floral peculiarities, these woodlands include all the species that normally characterise the floral retinue of beech, described in detail in the previous sections. Although beech is always by far the dominant species,



Purple lettuce (*Prenanthes purpurea*)

other species like elm and sycamore trees are often the largest specimens in a beech-wood. On the Latium side of the Monti della Laga, the beech-woods have floral and community characteristics differing from the other central-Apennine beech-woods, due to the siliceous substrate. Here the woods are displaced upwards by groves of turkey oak beneath and their optimal growth is inhibited by the often excessively steep hill-sides and scarps. However, there are some large beech-woods like the monumental Bosco Sant'Egidio, below Pizzo di Sevo in the commune of Amatrice, or the belts of woodland surrounding the morainic lakes of Pannicaro in the Accumoli district.

Moving towards western Latium, beech-woods progressively lose their classic Apennine appearance, characterised by the two altitude variants. The Latium pre-Apennines never reach high enough to allow the growth of microthermal beech-woods. On the contrary, thermophile beech-woods are very well represented and are particularly rich in undergrowth species. In some parts of the Monti Lucretili, holly is particularly abundant, and more or less characterises the boundary with mixed mesophile oak-woods.

In the lower mountain areas that do not exceed 1200-1300 m (Monti Prenestini, Monti Sabini), the treeline is not formed by beech-woods, but by woodlands with more of a pioneer nature (often ash-hornbeam woods), which are less affected by the critical environmental conditions of summit sites (strong winds, high evapotranspiration, shallow soils). This characteristic is even more evident

in the limestone coastal chain of the Monti Aurunci, in the extreme south of Latium, where at 1400-1500 metres (on Monte Ruazzo and Monte Petrella), the beech-woods growing up the northern valleys are bordered at the summit by a narrow band of hornbeam woodland. The beech-woods of the Volsci (Monti Lepini, Monti Ausoni, Monti Aurunci) are direct testimony of the floral impoverishment in a north-west to south-east direction. On the Monti Lepini (1536 m), the northern sub-unit of the Volsci, the beech-woods still contain numerous species common to the analogous central European formations and the rest of the Apennines, such as yew, holly, sycamore, hard shield fern, yellow anemone (*Anemone ranunculoides*), hepatica, yellow archangel (*Lamiastrum galeobdolon*) and Alpine honeysuckle. On the Monti Ausoni (1116 m), the central sub-unit of the Monti Volsci, beech-woods are nowadays absent (although the place-name Monte delle Fate = Monte delle Faete, from the Italian *faggete* = beech-woods, may suggest a recent disappearance).

On the Monti Aurunci (1535 m), the southern sub-unit of the Volsci, beech and holly grow to high altitudes, but not the other common species in the Apennines behind and already mentioned for the Monti Lepini. Conversely, there is an array of species from the hornbeam woodlands: flowering ash, Bosnian maple, orange lily (*Lilium bulbiferum* ssp. *croceum*), blue wood anemone (*Anemone apennina*) and autumn moor grass (*Sesleria autumnalis*), which all reach the highest altitudes.



Orange lily (*Lilium bulbiferum* ssp. *croceum*)

A brief mention should also be made of the beech-woods growing on the volcanic substrates of northern Latium, where the reliefs are no higher than 1000 m and beech trees necessarily become fragmentary. In many cases, they are restricted to heterotopic relict stands confined to sheltered valleys or ravines.

Nevertheless, beech-woods of a climax character do persist, such as those on the summit of Monte Cimino or Monte Fogliano, which benefit from wetter and cooler mesoclimatic and microclimatic conditions. In these environments, beech-woods present a quite rich floral retinue, characterised by species normally associated with these woods. They include sycamore, holly, woodruff, coral-root bittercress, Kitaibel's bittercress, another bittercress (*Cardamine chelidonia*), spurge laurel (*Daphne laureola*), wood spurge (*Euphorbia amygdaloides*) and birdsnest orchid (*Neottia nidus-avis*). Species more typical of mixed mesophile woodlands may again be found, such as wood melick (*Melica uniflora*), soft shield fern (*Polystichum setiferum*), spring vetchling, blue wood anemone, sowbread, butcher's broom (*Ruscus aculeatus*) and an onion (*Allium pendulinum*).

The sometimes copious presence of species, considered rare in central-Apennine beech-woods, like seven-leaflet bittercress, yellow anemone and a bedstraw (*Galium rotundifolium*) is also interesting.



Wood spurge (*Euphorbia amygdaloides*)



Yellow anemone (*Anemone ranunculoides*)



Birdsnest orchid (*Neottia nidus-avis*)

Within the Aquifoliaceae family, the genus *Ilex* is largely dominant, being composed of around 400 species with mostly tropical or subtropical distribution. *Ilex aquifolium* is the only representative of this genus present in Europe. Its distribution extends in latitude from the mountains of north Africa to Scotland and southern parts of the Scandinavian peninsula. In terms of longitude, this species occupies mainly western and central Europe, where the effects of the moist and relatively warm currents arriving from the Atlantic Ocean are still felt (the eastern frontier of its distribution area coincides with the 0 °C isotherm in January). The furthest eastern limit of distribution coincides with the Caucasus mountains and Iran, although some authors attribute the populations in these regions to an autonomous species (*Ilex colchica*). Holly is present throughout Italy (including the islands), where it forms part of various forest and shrub associations. As regards morphological characteristics, holly is often in shrub form or, more rarely, as a small evergreen tree up to 8-10 m tall (rarely 15 m). The oval-shaped leaves are alternate, with a short petiole, dark shiny green and leathery above, paler below, with lobed margins. In younger specimens, the leaf margins have 6-8 spines per side. Holly flowers in April-May, and the fruit forms a cluster, which is bright glossy red when it ripens in autumn. In ecological terms, holly may be defined as a mesophilous and sciophilous species, associated with mild wet winters and not overly dry summers. For this reason, it grows in the montane belt (although intense harvesting and uprooting, especially in

past years, has made it somewhat rare). Holly is mainly found in woodlands of broadleaved trees and, in particular, thermophilous beech-woods, where it is often accompanied by yew (*Taxus baccata*), hornbeam (*Carpinus betulus*), sycamores (*Acer pseudoplatanus*, *A. cappadocicum* ssp. *lobelia*, *A. platanoides*), silver fir (*Abies alba*) and Italian alder (*Alnus cordata*). It is also not uncommon to find it in montane forests of holm oak (*Quercus ilex*) and deciduous broadleaves (sycamore, hornbeam, oak). Particularly interesting in this sense are the mixed montane oak-woods with holly of the Madonie and the siliceous mountains on Sardinia (true forests of holly grow on the eastern slopes of Monte Ferru), the belts of Tertiary forest with *Taxus* and *Ilex* of Gennargentu, holm oak-woods with holly, and woodlands with holm oak, oriental hornbeam (*Carpinus orientalis*), phillyrea (*Phillyrea latifolia*), holly, laurustine (*Viburnum tinus*) and strawberry tree (*Arbutus unedo*) on the Monti Ausoni-Aurunci (southern Latium), and mixed woodlands of beech and sessile oak (*Quercus petraea*), holly and bay (*Laurus nobilis*) of the Monti della Tolfa (north-western Latium).



**Abruzzo and Molise.** In a mainly mountainous territory like Abruzzo, a woodland of beeches is obviously the most widespread forest type. In the areas where the principal mountains are concentrated, beech woodland gives the appearance of a warm green mantle spread over the slopes, from which emerge, imperious, the summits of the major chains (Gran Sasso, Majella, Velino-Sirente, Laga). These mountains are all well over 2400 m, and thus leave plenty of space for true alpine vegetation belts, with dwarf shrubs and then primary meadows and alpine tundra. Because of the centuries-old practice of grazing sheep and goats at high altitudes and transhumance, it is nowadays extremely rare to find a truly natural boundary between beech-woods and moorland with dwarf shrubs which is not interposed by secondary pasture. One of the best is without doubt the beech-wood/mountain pine landscape still recognisable today on the Montagna della Majella and, to a lesser extent, in the National Park of Abruzzo, Lazio and Molise.



Beech-wood on carbonate substrate in Abruzzo

As in much of the central Apennines, the floral composition of beech-woods in Abruzzo does not greatly differ between north-facing and south-facing slopes, whereas more clearcut differences appear when studying the altitudinal gradients. The upper limit of the Abruzzo beech-woods, where there is no definite human interference, is quite variable and mainly depends on prevailing winds. Instead, the lower limit is more or less related to exposure. The beech-woods of the Adriatic slopes are generally already luxuriant from 900-1000 m a.s.l. (Laga, Gran Sasso, Majella), whereas in the internal, more continental, sectors this limit may be as high as 1400-1500 m.

On Monte Velino, in particular, the beech-wood is sparse (when compared with the considerable bulk of the massif), only becoming a true forest in confined areas (Vallone di Teve, Valle Cerchiata, Costa della Tavola). In the north-eastern sector of Monte Velino, the altitudinal interval of beech-woods falls between the 1500 m of Piani di Pezza up as far as the treeline, around 1800-1850 m. The entire south-facing mountain-side of the massif is practically devoid of beech-wood. On Gran Sasso, as on all the main limestone mountain massifs, especially in the southern sector (Majella, Morrone, Abruzzo National Park, Simbruini), beech-woods show classical

altitudinal zoning, characterised by thermophile communities with holly starting from the boundary with turkey oak up to 1300-1400 m, and microthermal beech-woods from 1400-1500 m up to the treeline.

As well as displaying obviously different floral retinues (the thermophile communities are rich in species common to the oak-woods and mixed woodlands lower down), the two altimetric aspects of the Abruzzo beech-wood denote an equally clear biogeographical separation - the thermophile ones being very similar to the analogous formations in the southern Apennines, of which they are a natural continuation: abundant holly, and undergrowth characterised by species like pencilled cranesbill (*Geranium versicolor*), blue wood anemone, a bittercress, Lobel's maple, a fescue (*Festuca exaltata*) and a dead-nettle (*Lamium flexuosum*). The microthermal woodlands are clearly separated from those in the south, which take on a character certainly more of the central-European/Dinaric type.

Within the general context of Abruzzo beech-wood communities, those on the Monti della Laga are quite clearly distinguished, since this is the only siliceous massif of any size in the central Apennines. Here the acidic soils support species that are usually rare or even absent from central-Apennine forests (bilberry, loose silky-bent (*Apera spica-venti*), bitter vetchling, nettle-leaved speedwell, wood cow-wheat, greater wood-rush, lesser wintergreen, deer fern and heath spotted orchid), recalling similar formations in the northern



Beech-wood in Abruzzo National Park

Apennines and western Alps. The link with the northern Apennines is also geographically revealed by the substitution of pencilled cranesbill (abundant in the other regional mountain massifs) with knotted cranesbill, the distribution area of which reaches its southern limit in the Gran Sasso-Monti della Laga National Park. A special mention should also be made of the Bosco della Martese, on the northern slopes of the chain, which is host to perhaps the only true mixed beech-silver fir community of the central Apennines. On the Monti della Laga, fir-beech woodlands extend from 1300 to 1750 m a.s.l., where, in the stands that have suffered less from human impact, fir may even become dominant.

In Molise, beech-woods grow exclusively in the northern and western parts of the region, where the major mountain groups are to be found (Monti le Mainarde, Monti del Matese). The Molise beech-woods do not differ greatly from those in Abruzzo. However, in Molise, even more so than in Abruzzo, there is a clearcut transition towards the analogous communities of the southern Apennines. An increasingly important role is taken on by Lobel's maple, which may even become dominant in some deep enclosed valleys. Southern species like Sicilian woodrush and pencilled cranesbill may be copious in the undergrowth.

The aspect which best distinguishes the Molise beech-woods from those in Abruzzo is a much higher frequency of mixed communities of beech and fir. In Molise, these grow in geographically separated groups and are well differentiated in terms of flora.

At Collemeluccio, near Pescocostanzo, a small belt of woodland exists between 900 and 1150 m, in which fir forms typically thermophile communities associated with beech and turkey oak. The larger fir-beech woodlands are further north and, although nowadays extremely fragmentary, may be considered as relicts of a single large population, which declined over the years because of human activities. In the deeper, more enclosed, valleys an extremely interesting type of mixed mountain woodland is to be found, with the contemporary presence of beech, silver fir, Lobel's maple, sycamore, lime and ash.



Beech-wood with bilberry (Monti della Laga, Abruzzo)

## ■ Beech-woods of the southern Apennines

Whereas the beech-woods of the northern Apennines have floral characteristics in common with the analogous central-European ones, and those of the central Apennines show more or less obvious similarities with the western slopes of the Dinaric mountains, the beech-woods of the southern Apennines have much more marked floral and community autonomy.

The arrival of a mostly new floral component is testimony to the past (and in some senses current) geographical isolation of the area, due to the marginal position of southern-Apennine beech-woods with respect to the distribution area of beech, and to the probable crossing of a significant biogeographical line. The floral contingent of southern Italian beech-woods is composed partly of endemic or Italian sub-endemic species (with a distribution area exclusively or prevalently in southern Italy), such as Sicilian woodrush, a buttercup (*Ranunculus brutius*), a bellflower (*Asneuma trichocalycinum*), a fescue (*Festuca exaltata*), southern helleborine (*Epipactis meridionalis*) and of other species with a distributional centre in the southern Apennines and central-southern Balkans, like pencilled cranesbill, Caucasian leopardsbane, huetia (*Huetia cynapioides*), a dead-nettle (*Lamium flexuosum*) and two-flowered everlasting-pea (*Lathyrus grandiflorus*). In phyto-sociological terms, this flora, together with other species with a wider peninsular distribution but still with clear Apennine-Balkan



Blue wood anemone (*Anemone apennina*)

overtones, such as spring vetchling, an onion (*Allium pendulinum*), blue wood anemone, sowbread, a bittercress (*Cardamine chelidonia*) and bastard agrimony (*Aremonia agrimonioides*), has led not only to proposals for new local associations, but also to the definition of an endemic association for the beech-woods of southern Italy (*Geranio versicoloris-Fagion*). This has recently also been identified in the beech-woods of western Greece, testifying to the close biogeographical kinship linking the southern Apennines with the southern Balkans.

In Annex 1 of EC Directive 92/43 (February 1994), the priority habitat "Apennine beech-woods with *Taxus* and *Ilex*" is defined as that composed of thermophile beech forests in the Italian mountains south of the 42nd parallel, severely fragmented and rich in endemic species. It is thus clear that the distributional centre of this habitat coincides exactly with the southern Apennines.

**Campania and Basilicata.** It is probably within these two regions that beech-woods with yew and holly are displayed at their best and with their widest diffusion in Italy. The fact that no mountain-top in Campania is higher than 2000 m means that, almost without a break, beech-woods cloak the flanks of all the major summits with the exception of Monte Cervati in Cilento, where a tiny summit area, occupied by secondary pastures, remains uncovered.

Among the more luxuriant Campania beech-woods are those on the Monti Picentini, favoured by both high soil fertility and a rainfall regime that exceeds an annual 2000 mm everywhere. These are beech-woods growing on Mesozoic calcareous soils on top of which a thick volcanic mantle has been deposited, on more than one occasion, by the eruptions of Vesuvius. The tall beech forests are generally pure stands or have only a few other tree species including sycamore, Lobel's maple, elm, mountain ash and, in extremely rare cases (Valle d'Acero in the Bagnoli Irpino district), silver birch (*Betula pendula*).



Caucasian leopardsbane (*Doronicum orientale*)



Spring vetchling (*Lathyrus venetus*)

Beech-wood altitudinal zoning is not very evident on the Monti Picentini, but the fact that the low-altitude beech-woods display higher floral richness than those higher up must in any case be taken as a constant. Among the species which suddenly decrease in numbers at greater heights as they pass from one altitude to another are holly, an onion (*Allium pendulinum*), spring vetchling, wood melick and wood spurge. The herbaceous undergrowth is rich in ferns, includes male fern and soft shield fern. Instead, hard shield fern differentiates the high-altitude beech-woods, which also host other species, such as wood-sorrel (*Oxalis acetosella*), an adenostyles (*Adenostyles australis*), a grass (*Hordelymus europaeus*) and wood stitchwort.

Given their geographical vicinity, it is obvious that the Cilento beech-woods do not differ greatly from those of Monti Picentini. Nevertheless, *Alnus cordata* is more widespread in the boundary area with groves of turkey oak, and the presence of silver fir in some Cilento sites may be seen as one of the main distinguishing characteristics at the level of physiognomy.

As well as being the most important nucleus of *Abies alba* at regional level, the fir-wood of Monte Motola is very special woodland that is reminiscent, in certain ways, of some types of beech-wood with fir in Dalmatia. It is characterised by a dominant tree layer composed, not only of beech, but also of hop-hornbeam, flowering ash and Bosnian maple, and undergrowth in which autumn moor grass is often abundant, accompanied by other typical



Wood-sorrel (*Oxalis acetosella*)

species of hornbeam woodland, such as orange lily, round-leaved saxifrage (*Saxifraga rotundifolia*) and Colonna's skullcap (*Scutellaria columnae*).

At floral level, the main differences between the Cilento beech-woods (especially those of the Montie Cervati) and those of the Picentini appear in the herbaceous undergrowth, because the alluvial plain of the river Sele, which separates the two communities, also represents the northern boundary of the buttercup *Ranunculus brutius*, south-eastern European orophyte, highly indicative of the microthermic beech-forests of sothern Italy.

The beech-woods of the Taburno-Camposauro group differ little from those of Cilento and the Picentini. However, as the main summits are relatively low, no high-altitude beech-wood belt can develop. Some floral characteristics begin to appear in these beech-woods, revealing a biogeographical link with those in the central Apennines.

In Basilicata, because of the particular conformation of the relief, with relatively large, impressive massifs, beech-woods are one of the most common types of vegetation. They occupy an altitude belt between 1200 and 1800 m a.s.l., with peaks of above 1900 m (Monte Sirino) and may even touch 2000 m (Pollino). In relation to factors such as geographical location, type of substrate and bioclimate, the Lucania beech-woods may be placed in four different groups. The beech-woods of the carbonate ridge of the Lucania Apennines *sensu stricto* include Monte Volturino, Monte della Madonna di Viggiano, Serra di



Beech-wood of Monte Cervati rich in Italian alder (*Alnus cordata*) in Cilento National Park (Campania)

Buttercup (*Ranunculus brutius*)*Asyneuma trichocalycinum*

Calvello, Monte Calvelluzzo, Monte Arioso and Monte Pierfaone; those of the high carbonate massifs of southern Lucania - Monte Sirino, Monte Alpi and Pollino chain; those at lower altitude on the arenaceous or flysch substrates of central and central-southern Lucania (Li Foj, Gallipoli-Cognato, Monte Caldarosa, Monte Caramola), and the low-lying beech-woods on the volcanic substrates of Monte Vulture.

Two main types of beech-wood are distinguished in Basilicata, differing in floral composition and structural characteristics. On one hand, there are low-altitude thermophile beech-woods, which reach 1350-1400 m, maintaining moderate floral homogeneity. On the other, there are microthermal beech-woods, which are at their optimum starting from 1500 m and reaching the treeline where, except in particular cases, they taper into the secondary grasslands of the sub-alpine belt.

Between the thermophile and microthermal beech-woods there is an intermediate strip (approx. 1250-1400 m), characterised by significant floral impoverishment, due to a lack of species both from the mesophile oak-woods below and from the summit above. Especially in southern Lucania, beech is the absolutely dominant species and tends to form monophytic communities. Accompanying tree species are rare, being limited to a few isolated specimens of mountain ash, whitebeam, Lobel's maple, sycamore and goat willow (*Salix caprea*). Only on the northern slopes of Monte Pollino is silver fir the species

mainly associated with beech. On Pollino, the beech-fir association gives rise to perhaps the purest example of the mature appearance of Apennine mountain forests until about five thousand years ago. Nowadays, in even the best-preserved mixed communities, although it is beech that maintains a certain physiognomic supremacy, many old firs still soar proudly above the woodland canopy.

At a structural level, the Lucania high-altitude beech-woods display notable floral poverty, in both tree and shrub layers. The latter is composed almost exclusively of young specimens of beech, a bramble (*Rubus hirtus*), spurge laurel (*Daphne laureola*) and, even more sporadically, downy rose (*Rosa tormentosa*), another rose (*Rosa glutinosa*) and honeysuckle. The herbaceous undergrowth of these communities is also relatively poor, although it is in this layer that high-altitude beech-woods demonstrate the floral characteristics which clearly distinguish them from those lower down. This separation emerges with the presence of various microthermal species like the bellflower *Asyneuma trichocalycinum* and the buttercup *Ranunculus brutius*, but also yellow archangel, a bladder campion (*Silene vulgaris* ssp. *commutata*), the bedstraw *Galium rotundifolium*, yellow birdsnest (*Monotropa hypopitys*), large-flowered calamint (*Calamintha grandiflora*), wood stitchwort, lesser honeywort (*Cerintho auriculata*), moschatel (*Adoxa moschatellina*), wood-sorrel, lesser wintergreen,



Beech-wood treeline (1900 m a.s.l.) on Monte Sirino-Papa (southern Basilicata) adjoining secondary grasslands with *Bromus erectus* and *Sesleria nitida*



Contact between high-altitude beech-wood and sub-alpine pine-wood with Heldreich pine on NW slopes of Monte Pollino (Basilicata)

nodding wintergreen, the grass *Hordelymus europaeus* and perennial sweet-pea (*Lathyrus vernus*). The topmost segment of the beech-wood (especially in its more dispersed forms) is often characterised by the copious presence of *Doronicum columnae*, which arrives from the consolidated damp screes above. One of the peculiarities of the microthermal beech-woods on Monte Pollino (and to a very limited extent also on Monte

Alpi) is the chain contact (i.e., occurring spatially between two different types of potential vegetation) between the mountain beech-woods and the pine forest, with Heldreich pine (*Pinus leucodermis*) in the sub-alpine zone. This is the only Apennine example of any size where a formation of conifers is located above the beech-wood. The strips of alpine pine-woods in the northern Apennines are today confined to a few specimens, the mountain pines of the Majella are more pertinent to high-mountain moorland, and the Sicilian fir (*Abies nebrodensis*) of the Madonie (Sicily) is almost non-existent at a community level.

Completely different physiognomy and structural characteristics are displayed by the beech-woods of the lower mountain belt. In particular, the vertical stratification of the woodland involves not only the dominant tree layer of beech, but also a second layer composed of various tree species arriving from the altitudinal belt below. These include Lobel's maple, Bosnian maple, field maple, turkey oak, common alder (*Alnus glutinosa*), yew and, more rarely, hop-hornbeam. The shrub layer is also particularly rich, thanks to the presence, occasionally overwhelming, of holly. It is accompanied by a host of other shrubs, such as various species of wild rose (*Rosa arvensis*, *R. nitidula*, *R. obtusifolia*, *R. canina* s.s.), two bramble species (*Rubus canescens* and *R. hirtus*), hawthorn (*Crataegus monogyna*), midland hawthorn (*C. laevigata*), Alpine spindle-tree, rough-stemmed spindle-tree (*Euonymus verrucosus*), wild crab (*Malus sylvestris*), wild pear (*Pyrus pyraster*) and spurge laurel.

Amongst the more significant herbaceous species are those mainly pertaining to the southern Apennines, including Sicilian woodrush, Caucasian leopardbane, a fescue (*Festuca exaltata*), wood spurge, coral spurge (*Euphorbia corallioides*), sweet spurge (*Euphorbia dulcis*), pencilled cranesbill

and a dead nettle (*Lamium flexuosum*). Others also reach the central and northern Apennines, like sowbread, an onion (*Allium pendulinum*), two species of bittercress (*Cardamine graeca* and *C. chelidonia*), blue wood anemone, spring vetchling and a cow parsley (*Anthriscus nemorosa*).

Among the types of beech-wood immediately identifiable in terms of physiognomy, special mention is due to those with ramsons (*Allium ursinum*). This type of beech-wood is not strictly confined to southern Italy, but often appears in other peninsular and central-European contexts. These woodlands are characterised by a carpet colonisation of the undergrowth by ramsons, without any apparent breaks in continuity. The practice of allowing livestock to wander and graze in the woodland probably greatly facilitates the spread of this species, which tends to concentrate with greater ease on rich deep soils, or in small impluvia and hollows, provided that the soil is never completely anaerobic. Holly is also often dominant in thermophile beech-woods growing at intermediate heights (1200-1450 m), at times accompanied by Lobel's maple and yew. In the well-known Bosco di Laurenzana (a regional nature reserve on the slopes of Monte Calderosa) and Bosco di Vaccarizzo (on the spurs of Monte Alpi), this type of intermediate beech-wood is also enriched by silver fir, while in the herbaceous undergrowth (especially at Laurenzana) helleborine members of the orchid family (genus *Epipactis*) are plentiful, including *E. helleborine*, *E. purpurata* and *E. microphylla*.



Mixed woodland of beech and silver fir on Piana di San Francesco (Pollino National Park, Basilicata)

**Apulia and Calabria.** In Apulia, beech is confined to the Gargano promontory, where this species covers practically the entire bioclimatic horizon of sciaphilic broadleaves. More specifically, beech-wood occupies exclusively the northern, north-eastern and north-western hillsides, which are the only ones to benefit from cool wet currents in spring and summer. Compared with the other Apennine beech-woods, those in Gargano have considerable structural complexity, accompanied by a surprising floral richness. Already at quite low altitudes (400-600 m), they are associated with other trees like hornbeam, lime, Bosnian maple, turkey oak and pedunculate oak, whilst in the secondary tree layer (5-8 m in height) yew and field maple also take on a significant role. The relatively high temperatures, high air moisture and limited temperature excursion all lead to typically sub-Mediterranean-maritime shrubby undergrowth, where holly (high shrub layer) and butcher's broom (low shrub layer) dominate uncontested, with yew, spindle-tree (*Euonymus europaeus*) and spurge laurel as borders and weighty curtains of ivy clinging to the beech trunks almost as far up as the canopy.

The particularly rich herbaceous layer has many typical beech-wood species, including central-European ones like wood melick (*Melica uniflora*), early dog violet (*Viola reichenbachiana*), sanicle (*Sanicula europaea*), dog's mercury (*Mercurialis perennis*), ramsons (*Allium ursinum*), woodruff (*Galium odoratum*), herb robert (*Geranium robertianum*), wood millet (*Milium effusum*), and montane



Mixed woodland of beech and Heldreich pine on the northern slopes of Montea (Monti di Verbarico, Calabria)

Mediterranean species, such as sowbread, blue wood anemone, woolly buttercup (*Ranunculus lanuginosus*) and bastard agrimony (*Aremonia agrimonioides*) and endemic or sub-endemic species, including a bittercress (*Cardamine chelidonia*) and a foxglove (*Digitalis micrantha*).



Pencilled cranesbill (*Geranium versicolor*)

In contrast to Apulia, the high mountains of Calabria allow beeches to form extensive, almost continuous woodlands, from the southern slopes of Monte Pollino down to the extreme southern tip of Aspromonte. Whereas the high peaks of the Pollino massif (2264 m) allow conifers to grow above the beech-woods, in the other Calabrian mountains beech woodland pushes up to the tops of the highest summits, with a very few exceptions like Monte Botte Donato (1929 m) in Sila Grande, or Montalto (1955 m) in Aspromonte, where a paltry summit area of arid meadow remains. From a lithological point of view, the Calabrian beech-woods are divided into calcicolous (i.e., growing on carbonate substrates) such as those of Monte Pollino, and silicolous (growing on crystalline substrates like granite, gneiss, phyllite, micaschist or flysch), such as those of the true Calabrian Apennines, which snake southwards from Passo dello Scalone along the coastal chain, Silano massif and Serre Calabre, finally to reach Aspromonte.

The types of beech-wood already identified for Basilicata are unaltered on the major mountain systems of the Calabrian Apennines. However, there is no upper belt with microthermal beech-woods on the Serre Calabre, as suitable conditions do not exist: the highest peak is little more than 1400 m. As in Basilicata, beech-woods in northern Calabria share boundaries with woods of Heldreich pine. However, whereas in Basilicata the latter tends to establish a strictly chain contact with the beech-woods confined to the sub-alpine zone, on the Calabrian slopes of Monte Pollino and even more so on the mountains of Verbicaro and Orsomarso, Heldreich pine descends well into the belt of beech, even far enough to come into contact with holm oak woodland.

Also in Calabria, large stands of beech-woods are found mixed with *Abies alba* (principally on Sila Piccola, Serre Calabre and Aspromonte). In most cases, fir tends to grow in the upper belt of the beech-wood. Only in the Serre Calabre is it confined to the lower belt of oak-woods where, in some cases, it forms

almost pure fir-woods (in the Bosco di Santa Maria at the Certosa, fir is still to be found at an altitude of 850 m). A well-known difference in Calabrian beech-woods (Sila, Serre Calabre, Aspromonte) is the presence of Calabrian pine (*Pinus nigra* subsp. *calabrica*). This conifer is not in fact closely linked with beech, as its optimal habitat is in an overlapping area between sub-alpine oak-wood and low-mountain beech-wood, i.e., between 1000 and 1500 m a.s.l., exclusively on acid or sub-acid substrates.

The floral composition of the undergrowth in the Calabrian Apennine beech-woods does not differ greatly from that on Monte Pollino. The differences mainly regard the contingent of species coming from adjacent plant communities. Thus, for example, in the rupestral beech-woods of Monte Pollino calcicolous species are found belonging to the arid meadows or steppe woodlands of the amphi-Adriatic type (with a distribution area including the Apennines and north-west Balkans), such as grey moor grass (*Sesleria nitida*) or another moor grass species (*Sesleria* gr. *juncifolia*), Austrian pine (*Pinus nigra* subsp. *nigra*) or Heldreich pine (*Pinus leucodermis*); the Calabrian ones contain sub-Atlantic acidophile species (with the distribution centre positioned in western Europe), like tree heath (*Erica arborea*), petty whin (*Genista anglica*) and slender creeping red fescue (*Festuca trichophylla*), or species with strictly Calabrian-Sicilian Italian distribution, such as, again, Calabrian pine or an oak species (*Quercus congesta*), a bittercress (*Cardamine*



Sparse beech-wood with scattered specimens of *Abies nebrodensis* (Mattie, Madonie Park, Sicily)

*glauca*) or a cat's ear (*Hypochoeris laevigata*). Only in the beech-woods of Aspromonte are nemoral species to be found with a narrow distribution between Calabria, the Peloritani mountains and Mount Etna, such as a wheatgrass (*Elymus panormitanum*), southern helleborine (*Epipactis meridionalis*) and Brullo's limodorum (*Limodorum brulloi*), which are absent in the remaining Lucanian-Calabrian beech-woods. On Aspromonte, especially in ravines or the deeply-cut valleys of the north-eastern slopes, where frequent lasting fogs cause an extremely high level of humidity, the beech-woods are very rich in yew and sycamore.

**Sicily.** Comparing the climatic parameters of the Sicilian sites where beech grows with those of the rest of the Apennines, or on average in Europe, it is immediately apparent that Sicilian beech-woods are very often found in climatic environments which are not originally their own. Many of the beech-woods (e.g., those under the 1500-m contour line), grow in an environment characterised by bioclimatic parameters (such as level of summer aridity), which would not be compatible with beech vegetation in other places. Thus, the presence of beech in Sicily, in an environment external to its true belt of macroclimatic vegetation, must be linked exclusively, or almost exclusively, to secondary meso-bioclimatic and micro-bioclimatic factors, or to edaphic factors which contribute towards mitigating the Mediterranean climate and recreating sub-maritime conditions. In Sicily, factors such as the direction and strength of the prevailing winds, degree of cloud cover and occult precipitations and the amount of snowfall compared with the total, have much greater importance than in other Apennine areas. For example, the northerly wind which in Sicily, in defiance of common belief, is cool and wet, mainly blows between the months of March and June, when the tender leaves of beech are more subject to the pernicious effects of transpiration. Then there is spring fog - another crucial factor - a phenomenon which commonly occurs on the north-facing slopes of the high Sicilian mountains - locations that, not by chance, are occupied by beech-woods. It is important to stress that, as well as causing copious occult precipitation, spring fogs help to avoid episodes of excessive leaf transpiration and late frosts, the latter being capable of damaging young beech plants, sometimes mortally.

In Sicily, beech-woods are only to be found in the northern part of the island, which coincides with the east-west alignment of the principal mountain chains (Monti Madonie, Monti Nebrodi, Mount Etna). Altogether, the area of beech distribution extends for 100 km and has an average width of 7-8 km, which may reach 10-12 km in some of the wide valleys of the Nebrodi range, which

run north-south. An interesting strip of beech-wood (Malabotta) grows on some clay-arenaceous mountains at the edge of the Peloritani chain.

Within its Sicilian distribution area, beech never forms a continuous belt of forest vegetation, but is very fragmentary, due to the wide, deep gullies that intersperse the major mountain summits and the poor capacity of beech to grow on south-facing slopes.

Also within its hypothetical distribution area at high altitude, Sicilian beech-woods often form a mosaic with other types of potential woodland, or with grassland and secondary montane garrigue which occur in the wide man-made clearings. It has been estimated that, in the last two centuries Sicilian beech-woods have lost more than 25% of their surface area because of the activities of humans, and an even higher percentage of their stock, through widespread, uncontrolled tree-felling and coppicing. Compared with Calabria, and more generally the rest of the southern Apennines, the beech-woods of Sicily are relatively impoverished. For example, there is no trace of silver fir, which instead prospers luxuriously on nearby Aspromonte. Nevertheless, a sort of geographical and community vicariance does exist, due to the presence, in the beech-woods of the Monti Madonie, of the very rare Sicilian fir (*Abies nebrodensis*), today reduced to relicts and confined to approximately thirty specimens scattered in the Madonna degli Angeli valley in the Polizzi-Generosa district.



Giant hollies on Plana dei Mandarinini (Madonie Park, Sicily)

Yew is quite rare in Sicily, whereas holly is relatively abundant, especially in thermophile beech-woods.

Both species sometimes form peculiar associations in terms of their structural physiognomic, and community characteristics. This has happened, for example, in the Bosco Tassita in the western Monti Nebrodi, growing on sandstone scree roughly cemented with calcareous grains. It is a mixed pioneer beech-wood, rather stunted (because of the rocky substrate), in which it is not possible to attribute physiognomic dominance to beech, as



Mixed beech-wood on lava substrate on Mount Etna, dominated by *Fagus sylvatica*, *Pinus nigra* ssp. *calabrica* and *Betula aetnensis*

yew, sycamore and holly cover equivalent areas. The other undoubted peculiarity is the stand of giant hollies in the Madonie Park (Piano dei Mandarinini, 1100 m), with specimens over 20 metres tall, and trunks with a diameter of just under one metre. This pure holly association is anomalous in vegetation terms, and appears to have derived from human interference: the tangle of crowns are effective in trapping snow and thus provide a winter shelter for flocks of livestock.

The beech-woods on Mount Etna contain notable floral differences with respect to those in the Apennines. Some species relatively common to southern Italy are absent, such as holly, yew, birdsnest orchid, blue wood violet, three-veined sandwort (*Moheringia trinervia*), ramsons, dog's mercury and wood meadow-grass (*Poa nemoralis*). The most interesting forms are probably those of pioneer type on primitive soils, which contain species rarely forming part of the beech-wood floral retinue. Here, beech is mainly accompanied by Calabrian pine and, more rarely, Etna birch (*Betula aetnensis*) and the southern form of sessile oak (*Quercus petraea* ssp. *austrotyrrhena*). The shrub undergrowth is prevalently common juniper (*Juniperus hemisphaerica*) and Etna barberry (*Berberis aetnensis*), whereas the shrub belt surrounding the woodland is formed of Etna broom (*Genista aetnensis*). The Mount Etna beech-woods, notwithstanding their extreme floral poverty, do have some very interesting ecological peculiarities. For example, they are among the very few which grow on a substrate of lava and lapilli, and the only ones in Europe growing on a still active volcano which, with its unpredictable activity, has a considerable effect on distribution.