Chapter 10
Corsica

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Landscapes of Corsica (Photos by G. Paradis)

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10.1 Introduction

Corsica is the fourth largest Mediterranean Island; it is c.183 km north–south, and 83 km east–west and covers 8,682 km^2. It is situated in the western part of the Mediterranean Sea (6°12–7°13 East, 41°9–43° North), at about 90 km west of continental Italy, 14 km north of Sardinia, and 170 km south-east of continental France, its metropolitan attachment. While being part of an initial geological structure which included southern France and Sardinia for millennia, it became isolated at the end of the Miocene era. Corsica is distinct insofar as it is the most northern, the wettest and the most mountainous Mediterranean Island with many peaks over 2,000 m. Most of the island is composed of granite, with a rough cliff and peak topography on its west coast. In its north-east, schists predominate giving a smoother topography (1,767 m maximum at San Pedrone). These two major units are subdivided by a corridor creating not only distinct geological/morphological but also cultural units. Still, today, the north-east part is differentiated from the south-east into two administrative substructures (called 'départements'), namely Haute-Corse (Capital City: Bastia) and Corse-du-Sud (Capital City: Ajaccio) (Fig. 10.1). The former is more agricultural and community based, while the latter is less modified by human activity. A peculiar Quaternary deposition plain covers the east side of the island along the coast and, in the west side, the lower plains of the rivers such as Figarella, Liamone and Gravona are situated (Fig. 10.1).The varied topography gives rise to several different microclimates and vegetation communities depending on altitude, from typical Mediterranean on the coast to alpine above 1,500 m. Summers are usually hot and dry and last from May till October. Winters can be cold and there is generally snow on the highest peaks until June, but by then the ambient temperature on the coast is in the mid-20s °C and the July–September average is 27 °C. The annual average is 12 °C. Annual precipitation varies from 600 mm on the coast to 2,000 mm on the highest peaks and occurs mainly in spring and autumn, with recurrent heavy storm events; up to 400 mm can fall within 24 h, leading to destructive flash-flooding events. Heavy winds can also blow from the north and west (mistral), particularly violent and dry in summer leading to high fire risk. The northern Cape (Cap Corse) and Bonifacio strait in the south experience the fastest winds (up to 150–220 km h^{-1}). The natural vegetation of the island is Mediterranean, comprising forests, woodlands and shrubs, and covers more than half of the island. The coastal lowlands are part of the Tyrrhenian-Adriatic sclerophyllous and mixed forests ecoregion, where forests and woodlands of evergreen sclerophyll oaks predominate, chiefly Holm Oak (*Quercus ilex*) and Cork Oak (*Quercus suber*). The cooler and wetter mountains are home to the Corsican montane broadleaf and mixed forests ecoregion, which support diverse forests of oak, pine, and evergreen deciduous trees, with vegetation more typical of northern Europe on the highest peaks. Much of the coastal lowland and part of the mountain forests have been cleared for human activities.

The population is approximately 272,000 people with about half of them living in the two coastal cities of Ajaccio and Bastia. However, Corte (4,000 inhabitants), situated in the middle of the island at the crossroad of major routes (Fig. 10.1), hosts the Corsican soul, with its university and its historical past as the capital of independent

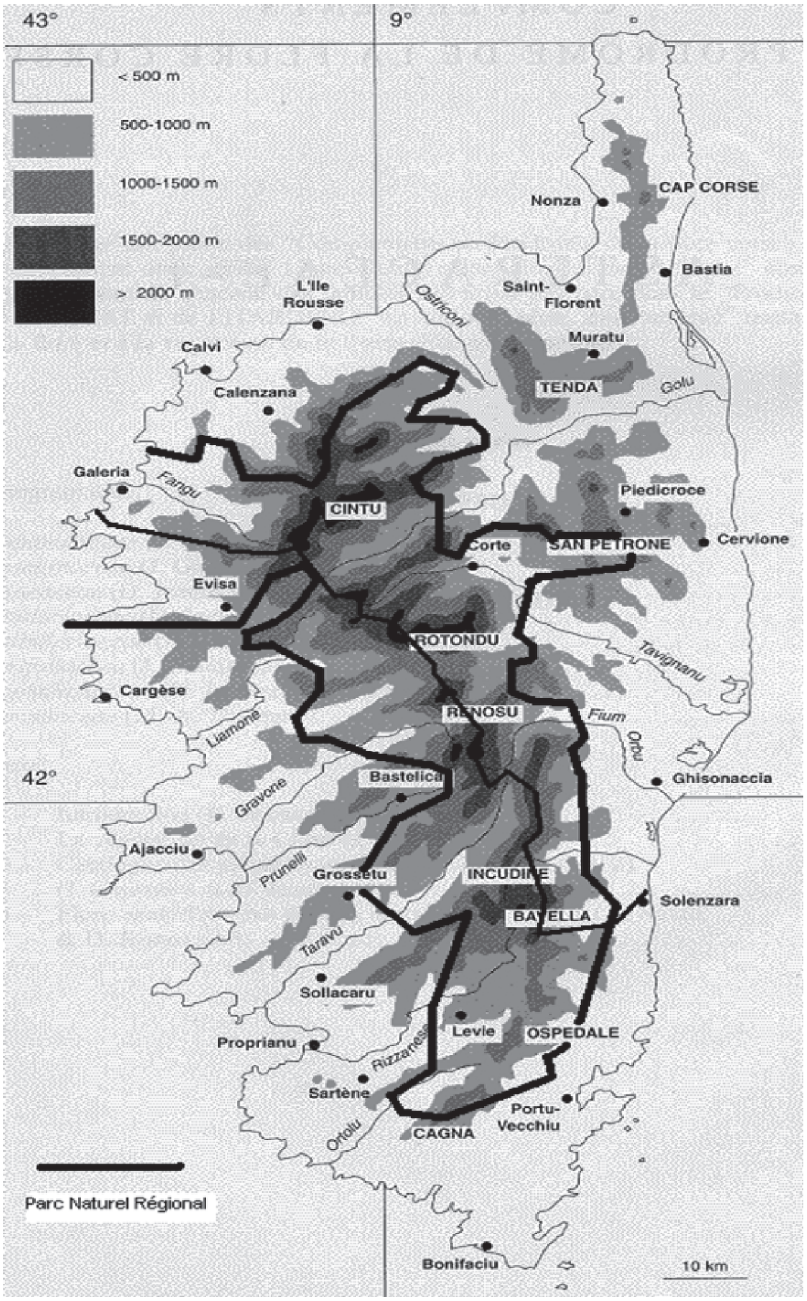

Fig. 10.1 Map of Corsica, Main cities, roads, and limits of the Natural Park (Parc Naturel Regional de Corse)

Corsica. Today the island is an administrative 'region' of France, with a peculiar political status compared to the other metropolitan regions, and an assembly. With 365 villages, many inhabited by less than 100 people, Corsica is the least densely populated 'region' of France, with 30 inhabitants/km^2 vs. 108 in France as a whole while about half the island has a population density of 10 inhabitants/km^2. The earliest signs of habitation, dated to c.6570 BC were of humans living in caves with subsequent development of agro-pastoral practices. Situated at the crossroads of the major maritime trade routes of the Mediterranean 'Old World', invasions from successive civilizations until the 6th/5th century BC, were accompanied by alliances which were just as quickly compromised by the constant arrival of newcomers. After a long and devastating conquest (259–162 BC) the Romans finally seized the island which marked from the 1st century BC a turbulent period in history. This peaceful period (*Pax Romana*) induced relative prosperity in the eastern coastal area. After the collapse of the Roman Empire (5th century) and barbarian invasions, Corsica was finally granted (late 8th century) to the papacy. During that period, indigenous populations had moved to the protected inner mountains in order to avoid the successive coastal invasions. The island was then threatened between 800 and 1100 by the Arabs (the Saracens or Moors – from whom the symbol of Corsica: the Head of a Moor, originated). In 1077, Pope Gregory VII ceded Corsica to Pisa, and in the mid-15th century Genoa administered Corsica harshly and unpopularly, but giving Corsica its Italian flavour. At that time, the now famous Pasquale Paoli headed a rebellion in 1755. He gave Corsica its independence, a capital in the city of Corte, a university and he established the structures of a state in which the 'Corsican nation' is sovereign. However, this period resulted in the cession (1768) of Corsica to France to pay off a debt. One consequence of the transfer was the French citizenship of Napoleon I, who was born in 1769 in Ajaccio, and who is today a figure of the Corsican soul. A short period of English administration, 1794 to 1796 ensued and then administration passed to the French at the Congress of Vienna (1815). French rule brought education and relative order, but economic life remained agrarian. The intervention of French troops and the victorious campaigns of Napoleon strengthened the bonds with France, which, with its colonial Empire, quickly became a land of emigration offsetting a major population increase during the 19th century. Due to its troubled history, a unique climate and topography, and its isolation from continental France, Corsica had to find a compromise between facing the drastic economic changes of the 20th century and, conserving its natural resources which constitute the main wealth of the island.

10.2 Physical Environment

10.2.1 Geology and Soils

Corsica is usually described as a 'mountain in the sea' due to its unique mountainous topography emerging from the Mediterranean Sea. The Corsican Mountains belong to the Alpine orogenic system, distinguished by a complex lithological

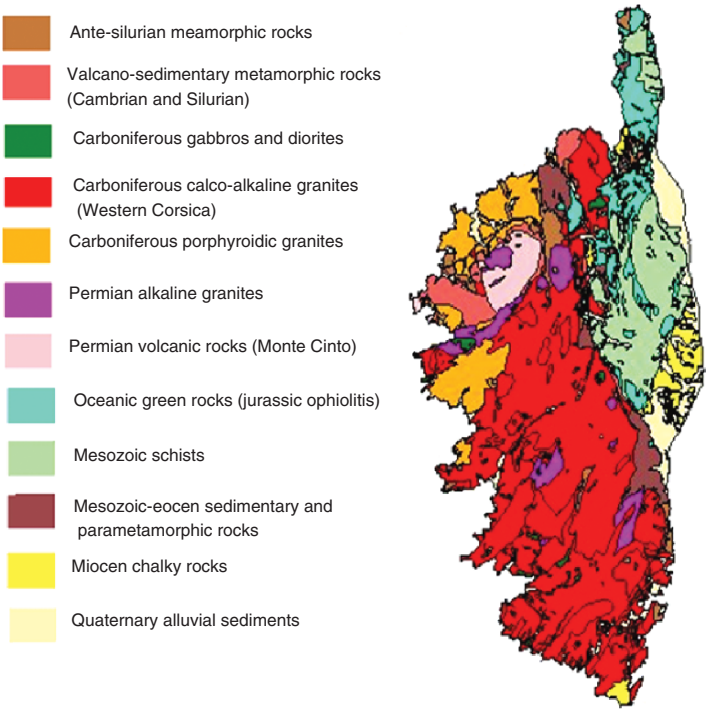

Fig. 10.2 Geological Map of Corsica (From Office de l'Environnement de la Corse)

composition and relief. Crystalline rocks such as granite, rhyolite, gneiss, quartzite, and schist predominate. Glacial reliefs are numerous in the high summits. Mesozoic rocks, mainly limestone, appear occasionally in small and scattered areas. Corsica came into existence about 250 million years ago, when geological uplifts produced the mass of granite which forms the backbone of the island. Some 200 million years later, the uplifts, forced a mass of sedimentary rock against the eastern side of the island. The pressures involved caused a metamorphosis into a folded bed of hard, resistant schists. The later changes to the Corsican landscape were caused by the effects of erosion. Glaciation during the Quaternary had some effect on the highest peaks (Kuhlemann et al. 2005), but most of erosion is the result of the island's abundant precipitation which has given rise to parallel steep sided V-shaped valleys.

The island can be divided into four main geological structures (Fig. 10.2): (1) the initial rocks (west and south) composed of granites with inserts of basic rocks with volcanic zones where the highest peaks stand. The main granite spine of the island takes a meandering north-west/south-east line down the centre of Corsica

and covers more than 50% of the island. Monte Cinto is the highest peak at 2,710 m, (2) the schist area (north-east), (3), the corridor in between these two zones, a sedimentary zone from initial rocks and submitted to tectonic and (4) the alluvial eastern plain.

Above this rocky structure, Corsica's soils are typical of the Mediterranean basin, i.e. they are relatively young, poor and superficial with low concentrations of P, N, Ca and K. Due to the steep slopes and runoff which curtails pedogenesis, superficial lithosols have developed on the slopes in contrast with valley bottoms where nutrient-enriched colluvial silts are predominant. Brown soils have developed on acidic rocks under forests, but are rapidly eroded when vegetation is removed (after clearing or fire). Then soils can become red when water alters rocks to liberate ferric oxides, or even bare rocks are exposed on the steepest slopes. Dark brown soils with humus and calcium or clay enrichment are rare, mainly developing in dry areas, under maquis shrublands. On the most arid sites, old Mediterranean red soils occur. These result from the transport of clay and silts; they are poor in organic elements. Alluvial soils characterize valley bottoms and the eastern plain, and are often deep and poor in colloids but rich in minerals.

10.2.2 Climate

Due to its topography, Corsica experiences a wide range of climates (Ascensio 1983). The north-western coastal range (Balagna and Agriate desert) and extreme south can receive less than 600 mm $year^{-1}$ precipitation. At the other extreme, the inner mountains can receive more than 1,500 mm, leaving the protected valley bottoms at intermediate levels of 800/1,000 mm $year^{-1}$ (Fig. 10.3). July is the driest month. As in a typical Mediterranean climate, heavy rainfall events occur regularly. Stormy days average up to 37 days $year^{-1}$ in Ajaccio. Snow is rare on the coast, sparse falls occur mainly in February, but above 700 m, snow is common between October and April and can reach 1 m depth, but does not persist. Above 1,400/1,700 m, snow persists throughout the winter until May providing limited skiing facilities, e.g. at the Vergio pass.

Mean annual temperature is around 15 °C on the coast with a decrease according to altitude of −0.65 °C per 100 m. Above 1,400 m, mean annual temperature is 7°, −1.5 °C at the Mt Cinto. Mean temperatures on the coast in January are 8.5 °C and 23 °C in July and August. The maximum recorded temperature is 41.8 °C (July 25, 1965) and the minimum −15.8 °C (March 1963). Maximum number of days with temperatures under −5 °C are 1–5, and maximum days above 30 °C are 15–40 depending on the location. The west coast is generally sunnier than the east coast. This climatic variation has contributed to a regionalization of cultures and land use.

Fig. 10.3 Yearly precipitation in Corsica (1950–1983). (From Ascencio 1983)

10.3 The Biotic Elements

10.3.1 Vegetation

The altitudinal range of this island gives rise to several forest zones (Gamisans 1978; Figs. 10.4 and 10.5). The driest sites on the coast characterize the thermo-Mediterranean stage. Then, the lowest elevations characterize the meso-mediterranean and supra-mediterranean stages, with the predominance of sclerophyllous evergreen oak forests (*Quercus ilex, Q. suber*). In the medium elevations (400–1,000 m) mesophyllous pine forests (*Pinus pinaster*) are widespread, and mixed deciduous forests (*Quercus pubescens, Q. petraea, Ostrya carpinifolia, Alnus cordata,*

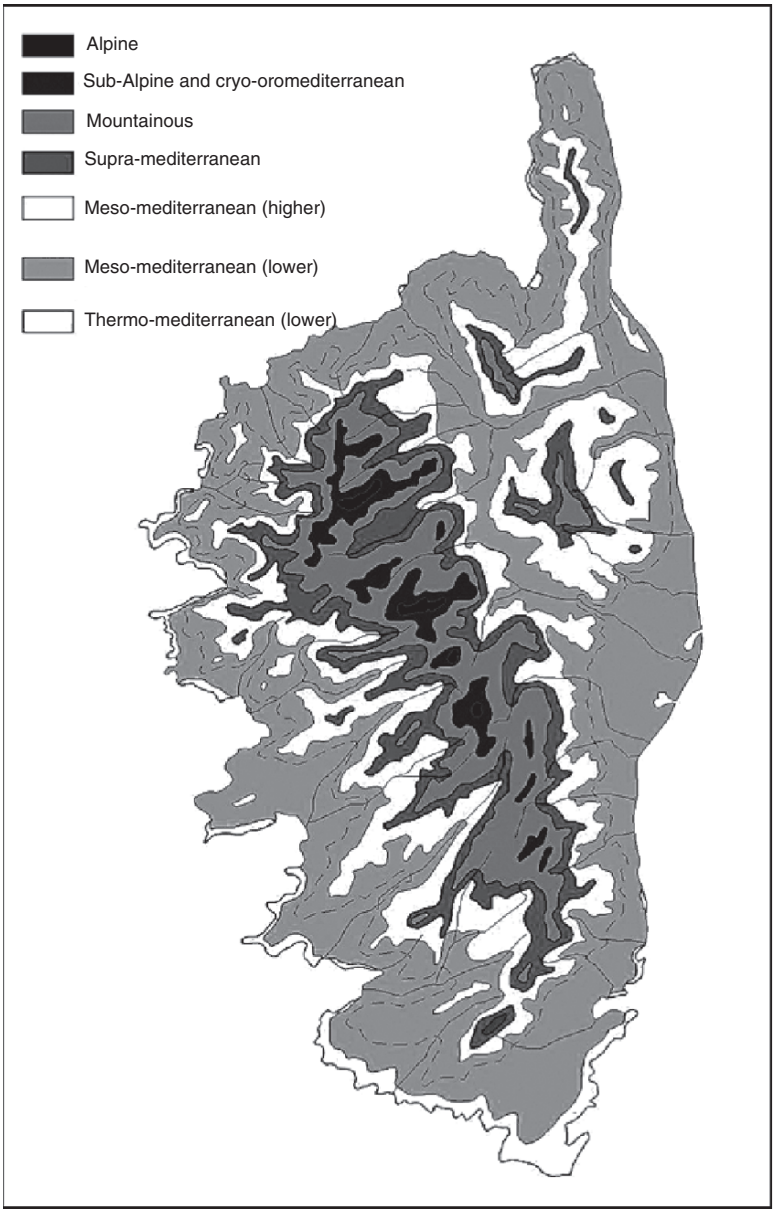

Fig. 10.4 Vegetation zones in Corsica (Paradis 2004)

Castanea sativa) are locally abundant, as in the north-eastern Castagniccia Mountains. A sharp north–south gradient in terms of plant communities typifies the highest elevations of the mountainous stage. *Pinus laricio* dominates on south-facing slopes with a more Mediterranean cold and humid bioclimate, while silver

Fig. 10.5 Landscapes of Corsica. (Photos courtesy of G. Paradis) (A) Mountainous and Alpine landscapes at Monte Renoso, (B) higher meso-mediterranean landscape at Riventosa, its village, abandoned terraces and typical *Quercus ilex*, *Cistus spp., Erica arborea* and *Arbutus unedo* 'maquis' shrubland, (C) littoral landscape with sand dunes at the Ostriconi river and (D) rocky cliffs at Girolata (Scandola Reserve) (*See Colour Plates*)

fir (*Abies alba*) and beech (*Fagus sylvatica*) predominate in the 'mountainous' bioclimate of the north-facing slopes. The high summits are characterized by the subalpine and alpine stages, with the dominance of a dwarf shrub alder (*Alnus suaveolens*), juniper (*Juniperus communis* subsp. *alpina*), and maple (*Acer pseudoplatanus*). Significant relict tree species appear locally all along the altitudinal gradient of the ecoregion, for example the deciduous common oak (*Quercus robur*) occurs in coastal flood-plains, *Juniperus thurifera* woodlands occur in rocky canyons of the continental mountain massifs, and birch (*Betula pendula*) stands occur in the highest elevations. Besides these communities, Corsica hosts various endemic plant and animal species.

10.3.2 Flora

Corsica's flora is a combination of species from North Africa, South West France and the Alps, and includes many endemics such as the alder *Alnus alnobetula*

subsp. *suaveolens* and the Corsican pine (*Pinus nigra* subsp. *laricio*). However, this endemic flora is not homogeneous. First, the richness of endemic species depends on the vegetation belt: the higher the altitude, the higher is the relative number of endemic species. Second, as observed in other parts of the Mediterranean Basin, the spatial distribution of endemics is disjoint: though species endemic to the island itself are the most abundant, Corsica shares several endemics with other islands or fragments of adjacent continents. Finally, endemic species can be relicts or newly formed, thus are classified to different categories (Table 10.1). The origins of this flora can be explained by geological events, a unique climate, and intense human activities. This endemic flora is the reason why Corsica is considered a biodiversity hot spot in the Western Mediterranean region (Médail and Quézel 1997).

A taxon is 'endemic if confined to a particular area through historical, ecological or physiological reasons' (Major 1988). Gamisans and Jeanmonod (1993) recorded 2,978 taxa (species range or below) on Corsica. The authors recorded 454 introduced taxa and 2,524 natural taxa, with 2,092 species, 264 subspecies, 89 varieties and 82 hybrids. This endemism represents 12.2% of the flora, i.e. 296 taxa. The endemic species distribution on the island is not homogeneous. While 39.5% belong to the Mediterranean floristic element, the holarctic non-Mediterranean floristic element (Eurasiatic, Eurosiberian, Atlantic, Circumboreal, Arcticoalpine) reaches 37.8% of the flora and dominates the mountain flora, rich in endemic taxa (35.69%). Thus many endemic taxa are found in the island's mountains (154 taxa) where the overall flora is poor. This relatively high richness compared with the total number of present taxa in the alpine range (43.97%) can be explained by reduced competition, allowing endemic species like *Stachys corsica*, *Robertia taraxacoides, Cerastium soleirolii*, and *Galium corsicum* to survive in a wider ecological amplitude than elsewhere (Gamisans 1991). Most of the endemic mountain taxa have affinities to alpine-arctic species, which probably date to periods of climate change in the late Tertiary (Contandriopoulos 1962). These affinities can probably explain the reason why the majority of endemic taxa limited to Corsica are of non-Mediterranean origins.

The percentage of all endemic taxa which occur in Corsica is a function of their endemic distribution (Gamisans and Marzocchi 1996). The authors note that most of the endemic taxa are strictly confined on Corsica (131 endemics, 5% of the flora), but 75 taxa are endemic to both Corsica and Sardinia, a number which might have been higher if Sardinia had higher mountains; 14 taxa are endemic to Corsica, Sardinia and the Tuscan archipelago, 11 are balearic-cyrno-sardinian endemics, and 65 other taxa shared with adjacent territories, other islands or fragments of continent which have historical land connections with Corsica (Table 10.1).

This disjoint endemism involves almost 30% of endemic taxa distributed on the different parts of the cyrno-sardinian tectonic microplate (which fragmented and derivated in the Miocene), but some overseas areas as well. Thus, as suggested by Thompson (2005), 'there is a clear concordance between endemic distribution patterns and the geological history of the region. Corsica integrates the Tyrrhenian flora domain and particularly the Cyrno-Sardinian subdomain, with a consistent Corsican sector, constituting ubiquitous endemic taxa, at all altitudes (Gamisans 1991).

Table 10.1 Example of species endemic to Corsica and other Mediterranean regions. Examples of palaeo-, patro-, apo- and schizo-endemics are also given

	Alps	Pyrenees	Sierra nevada (Spain)	Sardinia (Italy)	Elba (Italy)	Hyeres islands (France)	Calabria (Italy)	Sicily (Italy)	Mallorca (Spain)
Bupleurum stellatum	■								
Viola argenteria	■								
Galium cometherizon		■							
Bunium alpinum subsp. corydalinum			■						
Herniaria latifolia subsp. Litardierei				■					
Limonium strictissimum				■					
Linaria flava subsp. Sardoa				■					
Silene velutina				■					
Nananthea perpusilla				■					
Anchusa crispa				■					
Ptilostemon casabonae				■	■	■			
Alnus cordata							■		
Berberis aetnensis							■	■	
Pinus nigra subsp. laricio							■	■	
Plantago coronopus subsp. humilis								■	
Helicodiceros muscivorus				■					■

Table 10.1 (continued)

		Alps	Pyrenees	Sierra nevada (Spain)	Sardinia (Italy)	Elba (Italy)	Hyeres islands (France)	Calabria (Italy)	Sicily (Italy)	Mallorca (Spain)
Palaeo	*Morisia monanthos*				■					
	Soleirola soleirolii				■					■
	Nananthea perpusilla				■					
	Castroviejoa frigida				■					
Patro	*Pinguicula corsica*									
	Arrhenatherum elatius subsp. sardoum				■					
	Phalaris arundinacea subsp. rotgesii									
	Leucanthemopsis alpina subsp. tomentosa									
Schizo Apo	*Cerastium soleirolii*									
	Cymbalaria hepaticifolia									
	Viola Corsica									
	Genista Corsica									
	Phyteuma serratum									
	Draba loiseleurii									
	Alnus alnobetula subsp. suaveolens									

Endemic plants can be relicts, the so-called palaeo-endemic taxa or newly formed, the neo-endemic taxa (Favarger and Contandriopoulos 1961, Stebbins and Major 1965). Karyotype variations based on chromosomal counts specify the affinities between endemic taxa and close corresponding taxa to produce a fourfold classification of endemics: the palaeo-, the patro-, the apo- and the schizo-endemics (Favarger and Contandriopoulos 1961; Table 10.1). The palaeo-endemics are systematically isolated taxa. They are clearly ancient with little variability. The patro-endemics are diploid endemic taxa, representing ancestors of now more widespread and more recent polyploid corresponding taxa. The apo-endemics are polyploid on Corsica (so recent) and possess large area diploid correspondent taxa, out of Corsica. Apo-endemics are thus the reverse of patro-endemics. Finally, both of the schizo-endemics possess one or more corresponding taxa (vicariants) in other areas. They have the same chromosomal number. This category of endemics has undergone a slow-acting differentiation due to the fragmentation of the range of a widespread ancestral taxon. This progressive differentiation has produced endemic taxa in different parts of the original distribution. Contandriopoulos (1962) and Gamisans (1991) proposed that, as patro- and palaeo-endemics underline the conservative character of a flora, schizo-endemics permit to precise to past relationships between Corsica and other territories. They consitute the most important group of endemics, found in the Centre and South European orophilous Mediterranean element. The apo-endemics show that taxa have evolved on Corsica, though they show little variation in other areas.

This endemic richness, coupled with a large number of threatened areas on the island, make Corsica a hot spot of biodiversity (Fig. 10.6). On a total of 173 protected species at different levels (regional to international), 52 species are endemic (almost 30%).

10.3.3 Fauna

Despite a high level of plant biodiversity in Corsica, the number of animal species on the island is significantly lower than continental France, particularly for the well-studied group of mammals. Today, there are 17 mammal species on the island (excluding chiroptera); most derive from continental Europe, and many reflect deliberate and accidental introductions, e.g. the rat (*Rattus rattus frugivorus*). Hunting practices have also reduced the population of some species and eradicated others.

Once dominant, this group of endemics has largely disappeared. These include squirrels, ermines, shrew (*Episoriculus corsicanus*), Sardinian Pika (*Prolagus sardus*), mole (*Talpa tyrrhenica*) and otter (*Algarolutra majori*). Only a rare and endemic herbivore, the emblematic Corsican moufflon (*Ovis gmelini musimon var. corsicana*), is still naturally present in the region's forests. The population of the endemic deer species (*Cervus elaphus corsicanus*, Fig. 10.7), an endangered species included in the IUCN Red List of threatened fauna, is the result of a successful reintroduction from Sardinia. This is the only area where this species still survives in the wild nowadays. Flying mammals such as chiroptera, are well represented

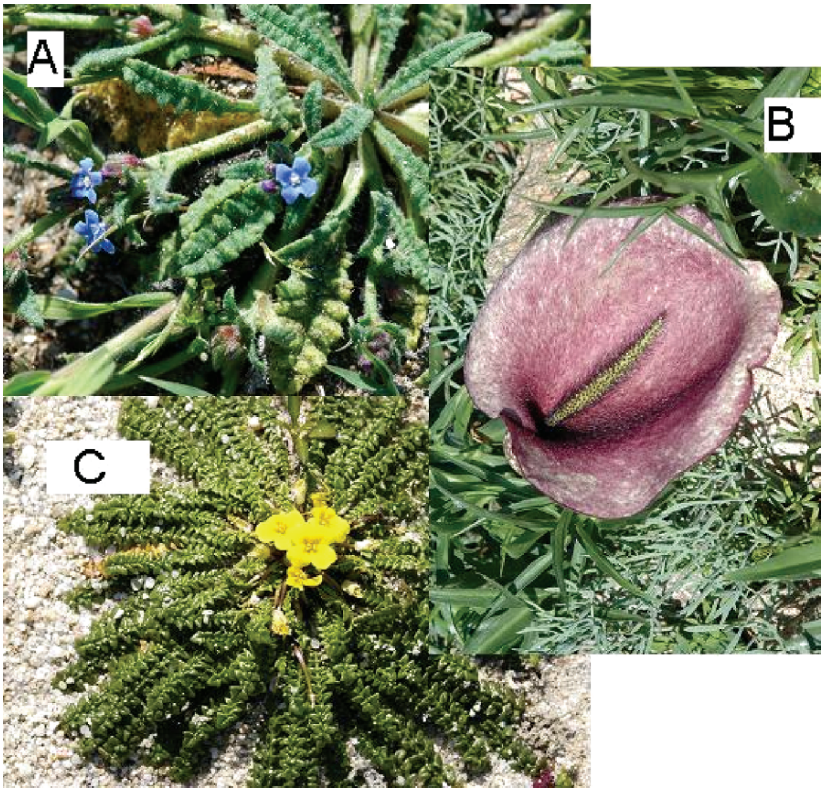

Fig. 10.6 Endemic plants in Corsica (Photo courtesy of G. Paradis) (A) *Anchusa crispa*, (B) *Helicodiceros muscivorus*, (C) *Morisia monanthos* (*See Colour Plates*)

with 26 species, but there are no endemic species. There are also very few bird species on the island; notably 109 nesting species, 152 visiting species and 3 introduced species. The forests of the Corsican Mountains also host a number of birds. These include the endemic Corsican nuthatch (*Sitta whiteheadi*), which is ecologically adapted and restricted to mature pine trees of the *Pinus laricio* old-growth forests, two species of endangered raptors and rare Palearctic birds such as the bearded vulture (*Gypaetus barbatus*, Fig. 10.7). Some endemics have disappeared as for example, the eagle owl *Bubo insularis.*

Corsica hosts also only 7 amphibian species and 12 reptiles (2 turtles, 4 lizards, 3 snakes, and 3 tarantulas), but with many endemic species as *Euproctus montanus, Discoglossus montalentii*, and a salamander (*Salamandra corsica*, Fig. 10.7*)*, or Bedriaga lizard (*Lacerta bedriagae*). Some species are not represented as web-toed salamander (*Hydromantes spp.*) present on the neighbouring island of Sardinia, tritons, and vipers. Among the reptiles, the most representative species of this ecoregion are also typical of similar forest ecosystems such as

Fig. 10.7 Emblematic endemic animals of Corsica (Photo courtesy of DIREN Corse) (A) *Gypaetus barbutus*, (B) *Cervus elaphus corsicanus*, (C) *Salamandra corsica* (*See Colour Plates*)

mountain conifer and broadleaf mixed forests from the southern European Mediterranean countries. Examples are *Algyroïdes fitzingeri, Podarcis tiliguerta* and *Podarcis sicula*. Although the terrestrial molluscs community is relatively poor, recent studies illustrate a diverse community, with a high level of endemism. Among the 160 taxa, 25% are strictly endemic to Corsica but sporadically represented, e.g. Corsican Snail *Tyrrhenaria (Helix) ceratina*; 500 species of spiders are present on the island with 80 endemics. Among them, the Corsican Mygale (*Cteniza sauvagesi*) is distributed only in Corsica, Sardinia and the Pontines islands.

Finally, insects are sparsely represented even given the fact that not all species have been documented. For lepidoptera, it is generally assumed that continental France hosts 5,111 species (Lerault 1997). In Corsica, there are only 1,384 species (Rungs 1988). Recently some new butterfly species have been discovered but Corsica remains an island with few species. Indeed, famous species as *Parnassius* and *Erebia* have never been observed in Corsica. On the contrary, according to Lerault (1997), 137 species (and 84 subspecies) have only been observed in Corsica (for France), either because they are endemics (*Papilio hospiton, Fabriciana elisa*) or because they are on the border of geographic repartition. Less than 50 species of Dragonflies are observed in Corsica (100 in France), only 4 cicada species (16 in France) among which 3 are endemics as *Cicadetta fangoana*, which was recently registered.

10.4 Cultural Landscapes

Due to its history, Corsica is usually considered more as a mountainous area than an island, and until the 20th century, most of the people lived in the inner valleys for protection from invaders coming from the sea. Indeed, the sea is not the main component of the Corsican soul and culture, neither in relation to food, nor economy; the sea has been considered as a barrier rather than an open door to neighbouring countries. The first regular sea link with continental cities started only in 1960 (Simi 1981).

The Cape Corse region is more open to sea resources, as it is only 40 km wide, and almost every village has an access to the sea. Apart from this peculiar region, Corsican landscapes are fairly homogeneous, with a distinction for the Castagniccia region (876 km^2, north-west Corsica, on the schistic zone). This is strongly influenced by chestnut trees ('Castagna' in Corsican language), and totally modified by humans (Pitte, 1986). There, chestnut trees (called 'Bread fruit tree' in the 19th century) replaced the original oak forest in a context where importations were limited and populations had to survive in the inner mountains (Caratini, 1995). Chestnuts were used for the fruit itself, converted to flour, and used as animal forage with a high nutritive value compared to wheat. Centuries of chestnut cultivation left this region 50–90% covered by chestnut trees. At that time, the forest was managed and understorey vegetation was cleared. Castagniccia was one of the richest and most populated regions until the 19th century, with peculiar habitations built for the storage and transformation of chestnuts. Since the beginning of the 20th century, when trading with continental cities was easier and the wheat market accessible for importation, exploitation of chestnuts collapsed. These forests still remain, but have now been abandoned for decades. The understorey vegetation developed as a dense shrubland of typical Mediterranean vegetation and the oak forest progressively reinvaded its original territory. At the same time, tannin industries promoted deforestation because of their wood requirements (19th century), and fire-prone shrublands progressively developed. The collapsing and aging forest also became progressively infested with fungi like *Phytophthora* on roots and barks, and more recently by *Endothia parasitica* on barks and branches, as well as insect attacks on trees but more particularly on fruits. Nevertheless, Castagniccia still remains a distinctive densely forested landscape of north-eastern Corsica.

Besides these two regions, Corsican landscapes are more the consequence of traditional practices oscillating between a typical Mediterranean climate and an alpine climate influence. As a consequence, most villages are located around 800/1,000 m altitude, at the boundary between the cultivation zone below this altitude and the sylvopastoral area above (Fig. 10.5). The cultivation zone is devoted to cereals (wheat, maize), olive trees on the driest parts, and rye or chestnut trees on the wetter higher altitude and north-facing slopes. Extending these cultivations from the valleys to more mountainous areas during the 19th century population growth required the building of stone terraces that covered most of the island according to the land-use/landcover map

(called Plan Terrier, Albitreccia (1942) ordered by King Louis 15th when Corsica first belonged to France in 1772. After land abandonment, these constructions were progressively affected by erosion and today their remnants are covered by the invading shrublands. Orchards, private gardens for vegetables and vineyards are only located around villages and still remain nowadays for private use. Chestnut orchards are, however, mostly abandoned. Past cultivation areas are now colonised by shrublands and pine oak forest, mainly used for pastures and recurrently cleared by burning. For centuries, shepherds have been acknowledged to use both private and common territories for their sheep and cattle grazing (Etienne 1977; Joffre 1982). They now remain the only inhabitants of a sparsely populated region where territories are abandoned. The only way to guarantee enough forage is to clear the landscape as soon as unpalatable shrublands have developed. That process takes only around 5–7 years in this wet area of the Mediterranean. The use of fires to clear the landscape is neither a new tool in the Corsican land-management practices, nor a rare disturbance in this type of ecosystem (Cerutti 1990). Actually, Mediterranean vegetation is fairly adapted to recurrent fires with protection organs as thick cork layers (*Quercus suber*), seed resistance (*Cistus spp, Pinus halepensis*), or resprouting abilities (*Quercus ilex, Erica arborea*). However, human practices have shifted from low intensity fires to remove the debris after clearance, to total burning of biomass leading to uncontrolled intense fires (Joffre 1982). Above 1,000 m, landscapes are mostly forested and rocky, and devoted to summer grazing on alpine pastures, around glacier lakes. Old sheep-folds bear witness to past grazing activity in the upper mountains when the lower valleys were too dry in summer. At the highest altitudes there are also emblematic *Pinus laricio* forests which were used in the 18th century by the naval industry for shipbuilding. The forest remains managed but not really for commercial use.

10.5 Recent Environmental Changes

After centuries of a closeted way of life in inner Corsica based on self-sufficiency and protection, coupled with a constant population growth, the 20th century was marked by the collapse of traditional practices and the emergence of modern Corsica. Recent environmental changes have then been driven by changes in population density and distribution, and the consequent changes on human practices and land uses (Box 10.1). The maximum population reached 290,000 inhabitants at the beginning of the 20th century and rapidly collapsed, particularly in the inner mountains, to 190,000 in 1950 (Simi 1981).

10.5.1 Rural Exodus, Land Abandonment

The population collapse particularly occurred in the villages of inner Corsica. The lack of land following population growth, and the ongoing isolation within a world shifting to international trading and communication, lead to heavy emigration at the

Box 10.1 Corsican Landscapes in the 21st Century: The Threat of Global Changes

Corsica, like most of the Mediterranean landscapes, has been submitted to intense land abandonment and substantial changes in climate for the last decades. Recent observations indicate the development of shrublands and forests on previously cultivated areas, in a context where summer-drought and temperatures are increasing. In the future, the impacts of these changes on ecosystems may result from complex interactions between direct effects on vegetation functioning, water stress and subsequent modifications in flammability and fire regime leading to changes in standing biomass and plant species composition. Dynamic and functional vegetation models dealing with fire risk assessment, and coupled with climate scenarios issued from atmospheric models are useful tools to apprehend the complex interactions between processes. Meteorological models predict that climatic changes in Corsica, under double atmospheric CO_2 concentration expected at the end of the 21st century, would cause an increase in temperatures, particularly in summer (+4°C), and a change in the rainfall pattern leading to a decrease in low rainfall events and an increase in intense rainfall events (heavy storm events). Based on this result, and applied to a study case on the typical Maquis shrubland/forest ecosystem of Corsica, Mouillot *et al.* (2002) concluded that there would be no drastic changes in the post-fire succession process, but modifications in the water budget and an increase in the length of the drought period varying between 0 and +8 weeks. Regarding fire frequency, climate changes tend to decrease the time return interval between two successive fires from 20 to 16 years for the shrublands and from 72 to 62 years in the forested stages. This increase in fire frequency leads to shrub dominated landscapes where forests tend to disappear (from 30% to 13% for dense forest in Fig 10.8), which accentuates the yield/loss of water by additional deep drainage and runoff. This is without accounting for changes in human pressure, management policies and the relation of people to fire, that could mitigate this result.

beginning of the 20th century. Targeted destinations were mainly emerging big cities on continental France, but also North America and agricultural French colonies, especially those in North Africa. This process was accentuated by the reduction in the male population during World Wars I and II. Indeed, in the 1950s, the aging population could not maintain agricultural activities, and traditional practices were no longer attractive in a context of new policies adapted to the European or global markets, especially the demand for increased efficiency. Consequently, only arable lands accessible to mechanization were maintained and the degradation of terraces began on the steeper slopes. During that period, cultivated areas declined from 30.3% during the 19th century to 7.4% in 1929 (Simi 1981), and cultivated forests as chestnut forests and olive orchards were abandoned to degradation, and invasion by competitive species. Only a few orchards continue to be maintained around villages. In addition pastures disappeared along with numerous orchid species (for example,

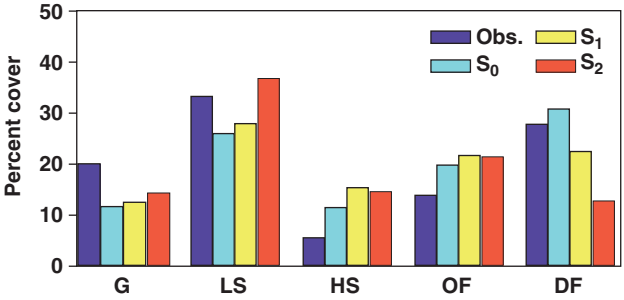

Fig. 10.8 Landscape composition (Grassland (G), Low Shrublands (LS), High Shrublands (HS), Open forests (OF), Dense forest (DF)) for the observed scenario, current climate S0, changes in rainfall (S1) and changes in rainfall + temperature (S2)

Ophrys tenthredinifera) due to the invasion of chamaephytes (*Teucrium capitatum, Teucrium marum* and *Cistus spp.*), which were subsequently succeeded by a dense shrubland with *Quercus ilex, Phillyrea angustifolia* and *Juniperus oxycedrus*.

Since the 1950s, the main activity has been sheep, goat and cattle rearing. This activity was maintained by the blue cheese factory of 'Roquefort Société' (headquarters in southern France), which utilized sheep milk. This kept rural villages alive. However, free grazing in Corsica has been allowed for centuries, but is rarely balanced with forage production. Indeed, in some fragile areas, overgrazing by cattle progressively increased the alteration of montane pastures (the protected high altitude pastures called 'pozzines' around glacial lakes) and coastal dunes. In addition, widespread pig grazing became uncontrolled, and after the 1970s the traditional use of nose rings, preventing pigs from digging and spoiling grasslands, was abandoned. On other (and major) areas, the whole landscape has rapidly been invaded by 'maquis' shrublands and grasslands, closing up the territory with a dense, unpalatable and fire-prone vegetation of *Cistus spp, Arbutus unedo* and *Erica arborea* (Barry and Maniere 1975; Joffre et al. 1982; Mouillot et al. 2005). The low severity traditional burnings used to clean-up debris from deforestation were extended as a landscape clearing tool and applied to a dense and flammable vegetation over large homogeneous areas. Then, fires were set more frequently and could spread more easily. In some places, these frequent fires progressively altered soils and substrates where plants can hardly establish, whereas soil deposits can modify substrates in valley bottoms. Fires in Corsica mainly affect shrublands, so the forest still develops at a rate of 1% year^{-1} (Mouillot et al. 2005), despite this high fire frequency, but could be much higher. The major process involved was the recurrence of fires in previously burnt areas with a fire return interval of 7–12 years while other areas keep being unaffected for decades (Mouillot et al. 2003). As a consequence, forests progressively develop next to shrubland/grassland zones affected by recurrent fires. These shrublands are now generally maintained into their shrubby stage.

10.5.2 Modern Agriculture on the Eastern Plain

The second half of the century was marked by the emergence of coastal cities for tourism and the eastern plain for agriculture. On the eastern plain, composed of coastal lagoons and sandy beaches, no major city developed until recently. The plain remained unused until the 20th century except for the Roman city of Aleria, and has long been infested with mosquitoes carrying malaria. Droughts, hunger and epidemics have deterred colonisation. At the end of the 19th century, treatment for malaria as well as pumping and drainage were developed with success, allowing the population to develop settlements which led to the total exploitation of the plain in the 1950s (Simi 1981). Agricultural development on the eastern plain induced significant environmental changes as, for example, the creation of dams on lower valleys (Peri, Teppe Rosse, Alzitone on the eastern plain), soil drainage, lagoons transformations, the use of pesticides and nutrients inputs. Among other consequences, the filling up of marshes and lagoons (e.g. St. Florent, Porto Novo, Pinarello) by individuals or town councils, caused the disappearance of species in these habitats. Eutrophication due to phosphorus and nitrogen release from fertilizers used in agriculture is also threatening coastal lagoons due to the development of competitive species such as *Ceratophyllum demersum* and *Paspalum distichum*.

This agricultural development unfortunately coincided with the lowest population density of the island after decades of emigration since the beginning of the century. The French decolonization of northern Africa (1962) resulted in the return of hundreds of settlers hitherto employed and experienced in agriculture in a Mediterranean climate, alongside with their northern-African employees. The development of the eastern plain was a success within a few years, leading to the economic development of Corsica's poorest region with a reverse trend in inner Corsica. The separation of the local and migrant communities, due to geographical, historical and cultural differences, and particularly the invasion of settlers in this uninhabited region, inevitably created tensions and misunderstandings, and enhanced the revival of the independence ideology. However, at the end of the 20th century the plain is an arable and productive zone for vineyards and fruit trees with a modern landscape structure and cypress hedges to provide protection from cold winds. Trees orchards cover 3,500 ha in 1977 for citrus fruits and Corsica became the first French producer and exporter. Corsica specialized into seedless tangerines. Other fruits, vegetables (670 ha), olives (229 ha) and chestnuts (157 ha) represent a minor fraction of cultivations. The main land uses are vineyards covering 32,000 ha in 1976. The case of vineyards in Corsica (Simi 1981; Levratto 2004), as a traditional production since antiquity, followed the shift from the small private vineyards covering 9,000 ha in the mountains in 1960, to an industrial production on the eastern plain. However, the low quality of these wines induced the collapse of the production and abandonment of vineyards, covering only 7,000 ha in 2004. Only the traditional sites returned the activity, under quality labels (Appellation d'Origine Controlée, AOC): Cape Corse Muscat, Ajaccio, Patrimonio and Vin de Corse (covering the whole vineyard).

10.5.3 Tourism and Coastal Development

In Corsica, the main threat to landscapes and species conservation is tourism and it is localized in the more sensitive zones: the coast and higher mountains. Tourism is a long standing activity in Corsica with the British and Russian vacation spots in Ajaccio since the 1850s, an activity which exploded in the 1970s with 700,000 tourists a year near Porto-Vecchio, Calvi and Ajaccio and the eastern plain (Bona 2004). Benefiting from its mild climate, various landscapes, nice beaches, and peculiar traditions and culture, Corsica invested most of its activity on tourism. Even if it is far from being comparable with the Balearic Islands (Spain), tourism seriously affects coastal sand dunes. Mountain areas are more protected with fewer tourists and many are actively concerned with species conservation (Richez 1993, 1994). Coastal conservation problems are exacerbated by sand use for construction or for tourism activities and habitations. These as well as road and resort development near the coast, and trails on the dunes threaten these habitats, exacerbate wind erosion, and have modified marine streams and convections and, in turn, affected sand deposition or erosion. In the coastal sand dunes only the endemics *Anchusa crispa* and *Linaria flava* subsp. *sardoa* are legally protected.

10.6 Landscape Conservation

In Corsica, most rare species are on the less suitable sites for vegetation development, e.g. sand dunes and coastal cliffs, marshes and ponds subject to alternate floods and drought, cliffs in the mountains and overgrazed areas. These areas unfortunately appear to be the most exposed to recent changes in human pressure, and many efforts now focus on keeping the long-standing features of Corsican landscapes and diversity. Consequently, efforts have been made to classify protected species according to their distribution area, and to determine conservation priorities. The most protected species are endemics unique to Corsica (e.g. *Thymelaea tartonraira* subsp. *thomasii*), then endemics to both Corsica and Sardinia, and endemics common to Corsica, Sardinia and the Balearics. Legally, a list of protected species was published on May 13, 1982, 6 years after the law on the protection of species (July 10, 1976), and was modified on August 31, 1995; 450 taxa of species or subspecies for France, and 127 in Corsica. At the regional level, an additional list was published (July 24, 1986) with 62 additional taxa, most of which were included on the national list in 1995. In 2005, only 56 taxa belong to the regional list. However, these lists are just indicative and do not invoke any legal procedure or fine in case of species destruction or collection. In France, Plant National Museums (conservatoires botaniques nationaux) aim to conserve existing plants. The ‘Conservatoire Botanique National Mediterranéen’ in Porquerolles (CBNMP) is in charge of southern France, including Corsica. The institution conserves species ex situ so that

reintroductions can be made in cases of destruction. Seeds are collected and stored, as well as vegetative parts such as bulbs, rhizomes or lignotuber. For example, in Corsica, CBNMP has reintroduced the populations for two endemics: *Anchusa crispa* on the site of Portigliolo (in 1992), *Brassica insularis* on the calcareous cliffs at Punta Calcina (north Porto Vecchio) in 1996, and the non-endemic *Armeria pungens* on sand dunes at Sperone (Bonifacio) in 1992. Besides this list of species, numerous local and national agencies were created for the protection and conservation of habitats in Corsica, juxtaposed with maintenance of human populations within these habitats. The French Ministry of Ecology is the main financial support for protection of species and habitats, and, at the regional level, DIREN (Direction Regional de l'Environnement) and OEC (Office de l'Environnement de la Corse). DIREN is the regional representation of the minister in each region of France, while OEC was created in 1993 and is specific to Corsica. Another important environmental organization in Corsica, depending on OEC and DIREN, is the Regional Park PNRC (Parc Naturel Régional de Corse), created in 1972 and covering 350 000 ha. Its main objective is to limit land abandonment and maintain traditional landscapes and human practices. Among others, its main success was to maintain breeding in the inner mountains, encourage the restoration of sheepfolds, and the creation of mountain trails and guest houses, and focus on keeping the three emblematic threatened species Corsican moufflon (*Ovis gmelini musimon*var *corsicana*), bearded vulture (*Gypaetus barbatus*) and osprey (*Pandion haliaetus*). The conservation effort on subalpine pastures 'pozzines' around montane and subalpine lakes as Lac de Creno, Lac de Nino and Renoso with protection and management, allowed, for example, the threatened population of *Drosera rotundifolia* to grow. The Corsican deer (*Cervus elaphus corsicanus*) was also reintroduced from Sardinia, and the natural reserve of Scandola (north-east of the island on the coast) was created. The National Forest Service (ONF) is more focused on protection of species in the forests only and forest management. At a local/regional level, towns or counties created natural reserves (Table 10.2).

Within these reserves, hunting, fishing or diving is forbidden, and management plans are settled to maintain habitat quality and rare species. For instance, in Lavezzi islands, grazing was suppressed to allow for natural vegetation to regrow. At local level, the Conservatoire de l'Espace Littoral et des Rivages Lacustres (CEL, French Minister for Ecology) bought some sites on coastal Corsica (c.15,000 ha, Table 10.2). In this way, numerous small sites have been designated mainly on small rocky capes. Managements of these sites belong to the city councils.

As on continental France, the 'Arrêtés de Biotope' for some specific sites have been created for the protection of rare species which can be animals as Audouin's gull (*Larus audouinii*) or plants (e.g. *Silene velutina* or *Nananthea perpusilla*). Within these sites, it is forbidden to build, and to access during bird nesting periods. Natural Zones of Ecological, Faunistic and Floristic Interest (Z.N.I.E.F.F.) have been created to protect threatened habitats and rare species at the national level. In 2005, the French Minister of Ecology decided for each region to select a scientific council for nature conservation: the CSRPN (Conseil Scientifique Régional du

Table 10.2 Protected areas in Corsica

Reserve name	Reserve type*	Surface area (ha)	Date	Protected species
Finochiarola islands	Nat. Res.	3	1987	*Hibiscus kosteletskya pentacarpos*
Scandola	Nat. Res.	1511	1975	*Armeria soleirolii* *Seseli praecox* *Vitex agnus-castus*
Cerbicales islands	Nat. Res.	36	1981	*Helicodiceros muscivorus*
Bonifacio strait	Nat. Res.	79460	1999	*Nananthea perpusilla* *Ipomoea sagittata* *Armeria pungens* *Silene velutina* *Helicodiceros muscivorus* *Spergularia macrorhiza* *Evax rotundata* *Asplenium marinum* *Mesembryanthemum crystallinum*
Tre Padule de Suartone (Paradis and Pozzo di Borgo, 2005)	Nat. Res.	217	2000	*Isoetes velata* *Isoetes hystrix* *Pilularia minuta* *Drimia (Urginea) maritima* *Drimia (Urginea) undata* *Littorella uniflora* *Ranunculus ophioglossifolius* *Ranunculus revelierei* *Ambrosina bassii* *Gennaria diphylla* *Orchis longicornu* *Serapias nurrica*
Agriates	CEL	6000		
Valinco bay	CEL	2094		
Bonifacio	CEL	2132		
Piana islet (Ajaccio)	AB			
Porto-Vechio islets:				
Ziglione, Stagnolu, Cornuta, Roscana				
Capense islet (Cap Corse)				
Erbaju sand dunes (Ortolu river)				
Northern Cape Corse,	ZNIEFF			
Albo				
Nonza,				

(continued)

Table 10.2 (continued)

Reserve name	Reserve type*	Surface area (ha)	Date	Protected species
Ostriconi delta				
gulf of Porto				
Sanguinaires islands				
gulf of Valincu				
Roccapina hills				
Restonica valley				
pass of Bavella				

*Nat. Res: Natural reserves, CEL: Conservatoire de l'Espace Littoral, AB: Arrêté de Biotope, ZNIEFF: Natural Zones of Ecological, Faunistic and Floristic interest.

Patrimoine Naturel), composed of plant and animal specialists. They compiled a list of remarkable taxa to justify for ZNIEFF and to determine their contour line and area. Some sites, classified for their remarkable landscapes (from the 1930 law) can facilitate the conservation of some species.

More recently, the Natura 2000 network aims to protect biodiversity in the European Union. Its goal is to maintain or restore natural habitats of great floristic and faunistic importance. Creating these zones must contribute to fulfilling the objectives from the Rio conference on biodiversity in 1992. The network will host sites named by each European country for birds or habitats. Some sites were proposed in Corsica, but it is not yet decided which one will be designated. In France, the application of this network faces misunderstanding and conflicts with unions of hunters, even though hunting will be allowed within these sites, together with agricultural and breeding activities.

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