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CHAPTER 2

Biodiversity in France

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2.1. Introduction

As a European country, France is at the crossroad of several biogeographic areas and pathways. Its terrestrial territory is limited by the North Sea, the Atlantic Ocean in the West and the Mediterranean Sea in the South, being therefore exposed to different marine influences. Mountains as well are part of this natural delimitation, with Vosges in the NorthEast, the Alps forming a mountainous belt in the South East and the Pyrenean chain in the Southwest separating France from the Iberian Peninsula. The resulting natural landscape is a very diverse mix of different influences, oceanic on the western side, continental in the East, alpine in South East and Mediterranean in the South (Metzger et al., 2005). This landscape is located around 46°00'N latitude and 2°00'E longitude and the altitude peaks at more than 4000 meters in Alps and Pyrénées while more than 70% of the territory is below 500 m. Actually, among the biogeographic influences found in Europe, only the Macaronesian one is to be excluded and the boreal one is present in several remote and relict places of small size. The territory has been profoundly marked by past climatic events and the presence of human populations as well.

First a short account of biodiversity will be presented, providing numbers for large groups of organisms, signaling lacks or gaps in the knowledge as well and indicate resources to have access to primary data. Second, the different ecosystems comprising these species are detailed and are provided a few examples of organisms belonging to different groups and exemplifying different biogeographic trends. Third, emphasis will be put on the dynamics of

the biota since the last quaternary climatic events, showing how they evolved and how they could be modified in the future according to climatic change.

2.2. Biodiversity numbers

The flora and fauna of France are remarkably rich for a temperate and human-modified landscape, because of the combination of different climatic and biogeographic areas. The total number of living species in France is more than 85000 of which more than 2000 are endemic and about 2500 are introduced (Gargominy et al., 2016). There about 7000 species of Plants (Tracheophyta), which represent 40% of the European species, therefore less than a few other European Mediterranean countries (Tison and Foucault, 2004). If introduced and cultivated species are considered, the number of plants in France must be set up around 10000. The largest groups in this flora belong to the palearctic realm in the families Asteraceae (1165 species), Rosaceae (580 species), Poaceae (518 species), Fabaceae (436 species), Brassicaceae (275 species), Apiaceae (262 species) and Caryophyllaceae (225 species). Other non-vascular plants (Bryophyta, Hepaticae, Algae) totalize around 3000 species. Fungi comprise more than 3000 species.

Concerning animals, there are about 1500 vertebrate species (half of them are marine), among which 284 bird species nesting for 500 species observed in France (Issa and Muller, 2015), 43 amphibians (Lescure and Massary, 2012), 135 mammals. Mammals belong to families Leporidae (4 species), Castoridae (1 species), Cricetidae (14 species), Muridae (5 species), Gliridae (3 species), Sciuridae (2 species), Erinaceidae (1 species), Soricidae (10 species), Talpidae (4 species), Bovidae (4 species), Cervidae (2 species), Suidae (1 species), orders Chiroptera (37 species), Carnivora (16 species) and Cetacea some of which are distributed and not erratically present (Savouré-Soubelet et al., 2016). It must also be mentioned that part of this biodiversity migrates in or from France (e.g., birds) and that conservation or population issues must be considered at a supra-national level.

Insects comprise more than 40000 species and the other large groups of arthropods are the Acari with several thousands of species and the Spiders with about 1500 species. Other groups like harvestmen (120 species), Pseudoscorpions (125 species) or Scorpions (5 species) are much less rich.

These counts may be very accurate for vascular plants or vertebrates but they are still very incomplete for arthropods or other small animals. A general picture can be found on GBIF web site (GBIF, 2017) or on INPN web site, including the distribution of archeological organisms' remains (INPN, 2017). Even if the list of species is quite complete now for many groups or big organisms, their accurate distribution has still to be documented. A selection of all data on France biodiversity on the GBIF portal actually shows many sampling gaps that have been discussed in a recent report available on line (Witté and Tourroult, 2017).

2.3. Regions and ecosystems

The ecosystems mainly of paleartic temperate origin are distributed in four different areas. The Atlantic area with an oceanic climate is distributed along the western coast but includes also many lowland regions inside the country such as Ile de France (around Paris), with a low elevation landscape originally harbouring either oak or hornbeam forests or open vegetation like moorland.

Uromenus rugosicollis (Audinet-Serville, 1838): an example of Atlantic distribution:

This species of katydid (Rough Saddle Bush-cricket) is distributed along the Atlantic coast; it goes north until the Cotentin and southwest until Marseille on the mediterranean coast (INPN, 2017). It is part of a group of katydids that shows a mediterranean distribution (Orthoptera Ensifera, subfamily Ephippigerinae).

The continental area is at the opposite on the eastern border from the North to the first and lower parts of the southeast mountains. As indicated by its name, the climate is continental, therefore colder and with a stronger seasonality than the previous one, more or less degraded in an oceanic one. The typical vegetation is oak and beech forest, with some elm stands in wet places.

Orobanche alsatica Kirschl., 1836: an example of continental distribution:

This is a parasitic species of the family Orobanchaceae usually developing on the plant *Peucedanum cervaria* (L.) Lapeyr. (family Apiaceae). It occurs at the border of woodlands within high non-ligneous vegetation (INPN, 2017; Muller, 2006). Its distribution is mainly around central Europe and its occurrence in France is limited to the central eastern part of the country.

The mountainous area is obviously related to mountains, either in the Pyrénées or in the Alps, and at a lesser degree in Massif Central. Colder and with a shorter summer season, this area is divided in several successive altitudinal zones. From the lower to the higher, can be found the following levels: “collinéen”(<1300 m) mostly forested with oaks (*Quercus*), “montagnard” (between 1300m and 1800m) mostly forested with abies firs (*Abies*), beeches (*Fagus*) and some maples (*Acer*), with “subalpin”(1800-2400m) today occupied mainly by anthropogenic grasslands but originally with spruce (*Picea* sp.) and larch (*Larix*) and “alpin” levels (2400-3000) with alpine grasslands and small bushes (*Juniperus*). Elevation numbers are given for gross information but vary according to the mountain' side and to the latitude.

Soldanella alpina L. : an example of mountainous distribution

According to genetic analysis, this group of plants (family Primulaceae) originates in Central Asia and exemplifies the diversity of plants occurring in mountains of France. *S. alpina* L. is a short plant growing close to the soil, found at high elevation (>2000m) in Combes where snow is occurring until late in the season.

The Mediterranean area is limited to the Southern part of the country along the Mediterranean coast from Spain to Italy with the typical original corresponding climate, combining soft winter, rainy spring and hot summers. This area harboured olive tree (*Olea*) and oak (*Q. suber* or *Q. ilex*) forests, shrubby evergreen vegetation on acid or calcareous soils (maquis, garrigue).

Quercus suber L. : an example of Mediterranean distribution

The cork oak (Family Fagaceae) is distributed in the western part of the Mediterranean area in Spain, North Africa, southern France and Italy. This tree is typical of the Mediterranean area.

2.4. Evolution of the biota since Quaternary era and in the future

The landscape of France has been deeply modified during the last glaciation events. The ice belt has been moving far to the South and ecosystems have strongly shifted as well. Moving back to the North from more southern areas after glaciation events has been classically documented for many organisms with some presumptive roads of recolonization and diversification (Hewitt, 1999. Taberlet et al., 1998; Schmitt, 2007). Even 6000 years ago, the

distribution of the main ecosystems was still quite different (Prentice et al., 1996). These changes have left some traces in term of genetic structure, endemism and more basically in term of ecosystem richness. A simple comparison with other areas in Europe or in other temperate areas in the world less directly affected by glaciations showed lower species numbers in ecosystems of France for many groups or organisms than in temperate areas less affected by glaciations. This situation has been especially mentioned for trees but is true for many groups.

Since ever after these dramatic events, Man has had a very strong influence on ecosystems and profoundly modified them. The first consequence in historical term, beginning thousands of years ago (Late Iron Age) and continuing until the 18th century, was the decrease in forested areas that have been replaced by cultivated areas and pastures, both in the lowlands and in the mountains. In addition to this big change in the ecosystems, many species have spread in a way that often has to be understood with archeological studies. For example, an animal as common as the rabbit (*Oryctolagus cuniculus*(Linnaeus, 1758)) was distributed mainly in the South East and has spread to the North with the practice of breeding and hunting in the Middle Ages (Callou, 2003). Today, this species is distributed all over the landscape and is usually and misleadingly perceived as a common species that has always taken part of the natural communities. The same way, sheep and cowherds (*Ovis aries* and *Bos taurus*) have deeply modified the biota of the Alps mountainous area by grazing since the Late Iron Age and the Roman period (Giguët-Covex et al., 2014).

Today, industrial agricultural and forestry practices significantly decrease the diversity of natural biota, by impacting natural communities and decreasing the species numbers. Primary functions of ecosystems are at risk of failure in several regions (especially pollination and water quality). Paradoxical situations begin to be observed with part of biodiversity higher in semi-urban areas than in intensive agricultural landscape (Deguines et al., 2012).

The effect of climate change is well documented, especially for some well-studied groups like birds or butterflies (DeVictor et al., 2012) and there is a shift for southern populations to go to the North.

2.5. Biodiversity in overseas territory

France includes as well many tropical overseas territories including French Guiana (Amazonia), les Antilles Françaises in the Caribbean region, New Caledonia in the Pacific, La

Réunion and Mayotte in the Indian Ocean, and several other smaller or biologically less rich locations (Gargominy, 2003). Taking into account such places with very rich, endemic and diverse biota pushes up the estimates of species richness to twice the number cited higher (around 160000 species). The inventory of biodiversity in all these regions is still in progress (e.g., Guilbert et al., 2014) which means that the total number of species is actually much higher, including for endemic ones.

2.6. Natural Parks and Reserves

It exists 10 national parks and 51 regional parks in France, which represent around 17% of area of the national territory. Several ones are located in overseas regions. These parks are tolerant to some agricultural, breeding and touristic activities in specific conditions. They welcome more than 5 millions of visitors per year.

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