University of Innsbruck, Department of Botany

Excursion Report

Spain

21.05. - 28.05.2022

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Introduction

The Iberian Peninsula harbors an extraordinary level of biodiversity, entailing many plant and animal species, that occur solely or predominantly in this region. From high mountain ranges to hot thermo-mediterranean shrublands and halophytic steppes many different habitats can be found all throughout Iberia, constituting this high diversity of living organisms. This year's excursion to the north-western part of the Peninsula, covering the provinces of Aragon and Catalonia offered to the participants a glimpse into this new botanical world. Of all the various vegetation types many could be visited in the course of this excursion, from the thermophilous macchia at Cap de Creus, *Quercus suber* and *Q. ilex* forests at Massís de Cadiretes, on to the mountainous Vegetation of La Mola de Colldejou, the costal *Pinus halepensis* forests near Tamarit and the halophytic salt marshes in the Ebro Valley. An overview over all the visited vegetation types as well as their estimated relative ecological conditions (humidity and temperature) can be seen in Figure 1.

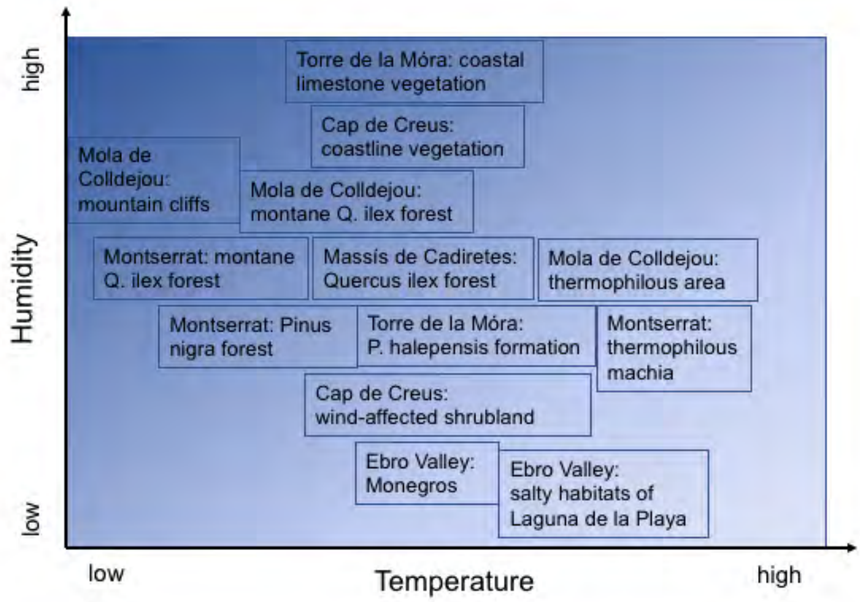


Fig. 1: Estimated relative ecological conditions (humidity and temperature) of the visited vegetation types/locations

The driest conditions could be found in the Ebro Valley at Laguna de la Playa, followed closely by the nearby *Juniperus thurifera* forests at Monegros, as well as the wind exposed areas at Cap the Creus. Among the most humid and cool locations we find the mountain cliffs and montane *Q. ilex* forests at Mola the Colldejou, as well as the coastal areas of Torre de la Móra and Cap the Creus at higher temperatures. As might be expected, this graph well reflects the trend of increasing humidity going towards higher elevations on the one hand, and higher oceanity on the other hand. Also, the effect of continentality can be observed, with more moderate temperatures in the coastal habitats, compared to the rather harsh conditions in the Ebro valley. Both trends are reflected in the species composition of the respective area.

In the following the vegetation types along with their geographic background will be explained for each location in more detail. Species lists of all the seen plant taxa are given at the end of each chapter.

<u>Day 1 (22.06.2022) Cap de Creus</u>

Lukas Gräupner, Markus Finner

Coordinates: 3° 31' 49'' E, 42° 32' 02'' N

Sea level: 0-80m above Sea level

Fig. 2: Excursion route at Cap de Creus: 0 car park; 1 coastal halophyte vegetation; 2 primary shrubland; 3 secondary shrubland with protected wet areas

In eager expectation of entering a (at least for Central Europeans) new botanical world, a change in the vegetation was already gradually apparent on the journey towards south. Entering mediterranean climate was shown already in Montelimar, France. Indicators were less trees and more shrubs, different leaf shape (more sclerophyllous) and perennial (evergreen) leafs. The submediterranean climate started already south of Valance. But obviously it's a transition and not a strict line of botanical/geographical climate zones.

Study Area

The Cap de Creus (Cape of the crosses) is a peninsula with an area of 190km² at the far northeast of Catalonia and the easternmost point of mainland Spain. Here the foothills of the Pyrenees fall into the Mediterranean, with the highest point of the peninsula, Sant Salvador Saverdera, rising 670 m above sea level. The rocks are predominantly built up from metamorphic shales and granitoids, about 2,5-3 million years ago formed by pressure and heat of plutonic magma, which cooled down slowly in the Cambrian/Darwinian.

Cap de Creus forms the northern boundary of the Gulf of Roses on the northern Costa Brava, it borders Roses and El Port de la Selva, and includes the towns of Cadaqués and Port Lligat and has been a Natural Park since 1998. The area is a windbeaten and a very rocky, dry region with nearly no trees. Due to the strong winds (northwinds, coming mainly in winter from the Pyrenees, called 'Tramuntana') vegetation is mainly cushion-shaped and much denser than elsewhere. More far away from the coast the vegetation is shaped by the human, used as vineyards whose terraces were held up by dry stone walls. Other parts functioned as pastureland and there were frequent fires that scarred the landscape. Closer to the coastline vegetation additionally gets more and more exposed to salty spray water.

Fig. 3: View towards the sea with cushion-shaped vegetation in the more exposed places, more upright forms in protected places and a less dense vegetation in the area of salty water spray (Photo: Simon Eisele)

Vegetation of Cap de Creus

The excursion started at the easternmost end of this peninsula (point 0 on the map). Along the road and car park with a more or less ruderal flora, vegetation turns quickly into a mosaic of rocks, cushion-shaped-stocky shrubs and lianas like *Juniperus oxycedrus, Pistacia lentiscus* or *Smilax aspera,* small perennials, growing in the rock crevices and more protected places like *Paronychia argentea, Polycarpon polycarpoides*, which occurs in the Iberian peninsula only on Cap de Creus and annuals like *Lagurus ovatus.*

Towards the coastline, where there is more input of salt by winds and sea spray, a higher number of salt tolerant plants can be found like *Inula crithmoides* or *Crithmum maritimum.* On the far end of the cap, in a few shady rock crevices, quite exposed to sea spray, *Asplenium marinum* was found- a place where usually a fern is not expected. In these exposed, windy, salty and dry places we also saw some South-African neophytes of the Aizoaceae: *Carpobrotus edulis and Delosperma sp.,* both very well adapted to these conditions.

In this area also a few in central Europe very common ornamental plants are growing. These will be, especially in the at the moment fast changing world of horticulture towards lowmaintenance and drought tolerant plantings, more and more important. Examples are *Asphodelus sp., Alyssum maritimum, Lavandula stoechas, Echinops ritro* or *Senecio cineraria*. It was nice to see how they grow in their natural habitat and in which plant combinations they occur.

More inside the Peninsula (points 2-3) with less strong winds (or at least not such a unprotected exposure to it), less salt influence the shrubs grew higher and also other species started occurring like *Erica arborea* and *Cistus albidus* or *Cistus monspeliensis.* In the protection of the rocks but also the shrubs, higher perennials like *Linum usitatissimum* or *Dorycnium pentaphyllum* were growing. In this area a mixture of thermo-mediterranean and atlantic flora can be found, due to the hot and dry summers (mainly caused by the winds) but weakened in its effect by the high air humidity caused by the sea in some protected places. In such protected places in combination with a damp ditch (as seen in point 3) more unexpected species like *Baldellia ranunculoides* or *Juncus pygmaeus* can be found.

Fig. 4: *Echinops ritro* (A)*; Polycarpon polycarpoides* (B)*; Helichrysum stoechas* (C)*, Asplenium marinum* (D) (Photos: Adam Seyr, Simon Eisele)

As a second spot in the cape area, we stopped at a bit more ruderal slope in the village Cadaqués to see some *Euphorbia dendroides.* These were accompanied by *Vitex agnus-castus, Parietaria officinalis* or *Oryzopsis miliaceum.*

Species list: Location 0 to 1 (Map, Figure 1):

Species	**Family**	**Comments**
Juniperus oxycedrus subsp. macrocarpa	Cupressaceae	two white wax lines on the upper side of leaves, (*J. oxycedrus* <-> *J. communis*: one line!)
Smilax aspera	Smilacaceae	Liana, heart-shaped leaves,
Pistacia lentiscus	Anacardiaceae	evergreen; pairly pinnate leaves
Lavatera olbia	Malvaceae	
Sisymbrium officinale	Brassicaceae	
Cistus salvifolius	Cistaceae	Cistrose, white flowers, broad, lanceolate leaves
Euphorbia characias	Euphorbiaceae	from Turkey to Morocco, first year vegetative then second year with flowers
Asparagus acutifolius	Asparagaceae	
Helichrysum stoechas	Asteraceae	
Brachypodium retusum	Poaceae	character species
Avena sterilis	Poaceae	short spikelets, can build small meadows, ruderal, long awns
Paronychia argentea	Caryophyllaceae	Widespread; early-branching lineages of Caryophyllaceae, with stipules, silver leaves
Polycarpon polycarpoides	Caryophyllaceae	endemic to Western mediterranean, on siliceous rocks, (Iberian Peninsula only Cap de Creus), white stiples with cap (characteristic)
Reichardia tingitana	Asteraceae	ligulate flowers, leaves almost perpendicular
Galactites tomentosus	Asteraceae	pale/pinkish flowers
Urospermum dalechampii	Asteraceae	row of bracts
Lagurus ovatus	Poaceae	hare’s tail
Plantago coronopus	Plantaginaceae	
Briza maxima	Poaceae	
Salvia officinalis	Lamiaceae	
Anagallis arvensis	Primulaceae	
Asplenium marinum	Aspleniaceae	

Species list: Location 1 to 0 (Map, Figure 1):

Inula crithmoides	Asteraceae	tolerant to salt stress and drought
Armeria ruscinonensis	Plumbaginaceae	pale flowers, endemic SW France and NE Spain, Iberian Peninsula as center of diversification, adapted to salinity
Limonium geronense	Plumbaginaceae	endemic to Cap de Creus
Frankenia laevis	Frankeniaceae	
Lolium rigidum	Poaceae	quite rigid plant
Trifolium arvense	Fabaceae	
Trifolium angustifolium	Fabaceae	
Elymus pungens	Poaceae	
Bromus madritensis	Poaceae	
Senecio cineraria	Asteraceae	Western mediterranean endemic
Daucus gingidium	Apiaceae	flowers once, then dies (hapaxanthic)
Euphorbia segetalis	Euphorbiaceae	glaucous glands
Festuca glauca	Poaceae	
Mesembryanthemum	Aizoaceae	
Astragalus tragacantha ssp.	Fabaceae	Many heads in one inflorescence
Echinops ritro	Asteraceae	
Sonchus tenerrimus	Asteraceae	
Juncus acutus	Juncaceae	
Seseli farrenyi	Apiaceae	
Phillyrea angustifolia	Oleaceae	
Matthiola incana	Brassicaceae	
Alyssum maritimum	Brassicaceae	
Pteridium aquilinum	Dennstaedtiaceae	
Linum strictum	Linaceae	
Salvia rosmarinifolium	Lamiaceae	
Crithmum maritimum	Apiaceae	

Trifolium arvense	Fabaceae	
Trifolium scabrum	Fabaceae	
Astragalus tragacantha ssp.	Fabaceae	
Juncus maritimus	Juncaceae	
Malva sylvestris	Malvaceae	
Rubia peregrina	Rubiaceae	
Vincetoxicum hirundinaria	Apocynaceae	
Parietaria judaica	Urticaceae	
Bromus hordeaceus	Poaceae	
Lavandula stoechas	Lamiaceae	
Silene gallica	Caryophyllaceae	
Cynodon dactylon	Poaceae	
Plantago crassifolia	Plantaginaceae	
Rhamnus alaternus	Rhamnaceae	
Ononis spinosa	Fabaceae	
Asphodelus cerasifera	Asphodelaceae	
Serapias lingua	Orchidaceae	
Trifolium stellatum	Fabaceae	
Sedum sediforme	Crassulaceae	
Umbilicus rupestris	Crassulaceae	
Lathyrus clymenum	Fabaceae	
Stachys brachyclada	Lamiaceae	
Carex punctata	Cyperaceae	
Carex divulsa	Cyperaceae	
Centaurium pulchellum	Gentianaceae	
Convolvulus althaeoides	Convolvulaceae	
Daphne gnidium	Thymelaeaceae	
Phagnalon saxatile	Asteraceae	

Fumaria capreolata	Papaveraceae	
Hyparrhenia hirta	Poaceae	
Parapholis incurva	Poaceae	
Oryzopsis caerulea	Poaceae	
Dianthus pyrenaicus ssp.	Caryophyllaceae	
Halimione portulacoides	Amaranthaceae	
Chenopodium rubrum	Amaranthaceae	

Species list: Location 2 to 3 (Map, Figure 1):

Linum usitatissimum	Linaceae	
Cistus albidus	Cistaceae	
Cistus monspeliensis	Cistaceae	
Petrorhagia prolifera	Caryophyllaceae	
Aegilops geniculata	Poaceae	
Linum strictum	Linaceae	yellow
Linum trigynum	Linaceae	
Erica arborea	Ericaceae	
Calicotome spinosa	Fabaceae	
Helianthemum guttatum	Cistaceae	
Dorycnium pentaphyllum	Fabaceae	

Species list: around Location 3 (Map, Figure 1)

Asplenium obovatum ssp.	Aspleniaceae	
Baldellia ranunculoides	Alismataceae	
Centaurium maritimum	Gentianaceae	
Juncus pygmaeus	Juncaceae	

Species list: Cadaqués

Euphorbia dendroides	Euphorbiaceae	
Galium maritimum	Rubiaceae	
Myrtus communis	Myrtaceae	
Oryzopsis miliacea	Poaceae	
Parietaria officinalis	Urticaceae	
Pinus halepensis	Pinaceae	
Vitex agnus-castus	Lamiaceae	

Day 2 (23.05.2022): Massís de Cadiretes

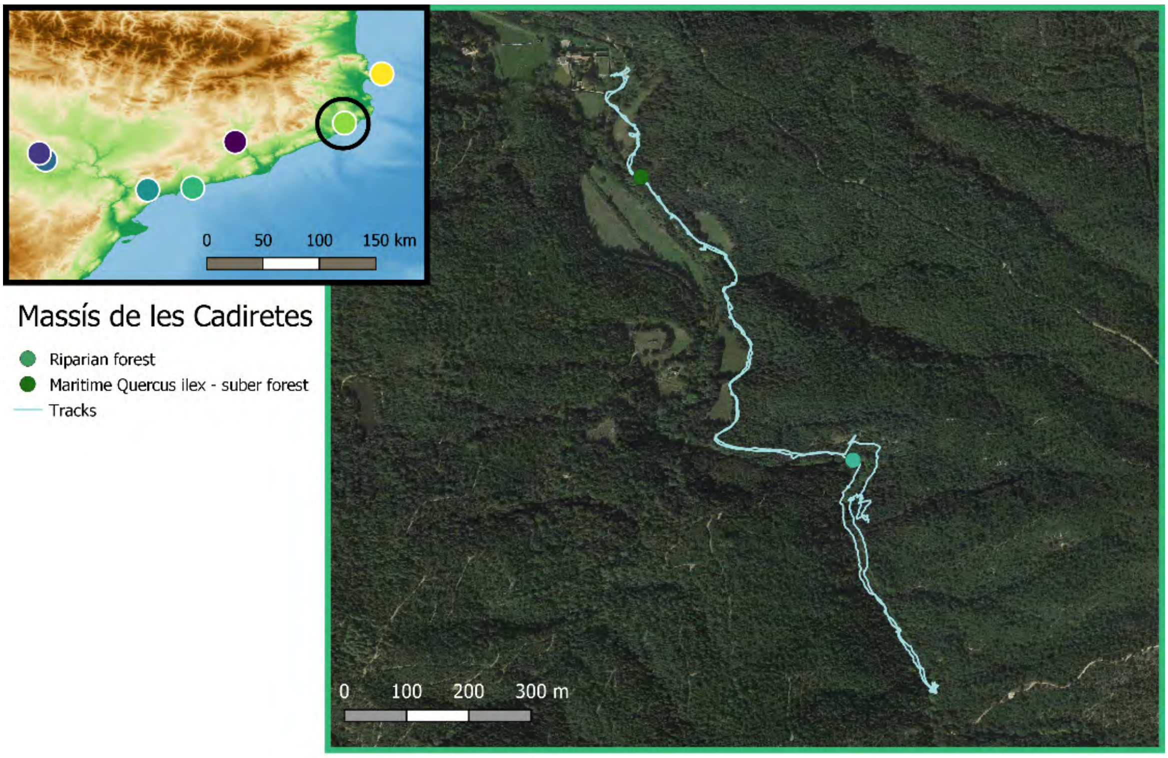
Helena Back, Sarah Brach, Sarah Kleiner

Coordinates: 2°54'2"E 41°47'11"N

Sea level: 171 m above sea level

Study area

The location of the second day of the field trip belongs to the Catalan Coastal Range. The more specified area name is Massís de Cadiretes. Furthermore, the study site is located in the south of the city Girona and is characterized by the Mediterranean climate. Figure 4 shows the route of the excursion through the forest.



Tracks: GPS by Simon Eisele; Basemap overview: © OpenStreetMap contributors 2022; Basemap detail: © GoogleMaps 2022; Map created by Michael Mitschke

Fig. 5: Overview of the study location (upper left), Excursion route (left)

Geology

The Catalan Coastal Range was formed during the Eocene and Oligocene when the Iberian plate collided with the European plate and the Pyrenees formed. The ground of the study site is based on Plutonic Granit rocks from the Cambrium Ordovicium Era. Given this, the Granit in the ground indicates nutrient poor soils which tends to acidification.

Climate

The area is rather inland but still influenced by Mediterranean climate. This mean subhumid climate conditions. This gets confirmed by the annual precipitation rate of 733 mm in the area (Weather & Climate 2022). Due to the location, there is less wind than in e.g., Cap de Creus and the vegetation is not limited by the wind impact.

The Quercus suber-ilex forest

The Q. suber – Q. ilex forest of the study site is dominated by the two mentioned species. Quercus ilex is separated in two subspecies Q. ilex ssp. Ilex and Quercus ilex ssp. Rotundifolia. At the location the subspecies Q. ilex ilex occurs due to the more humid conditions. If the climate was more effected by drought the subspecies Q.ilex rotundifolia would outcompete Q. ilex ilex. Both species belong to evergreen trees. The distribution of Quercus suber is correlated to the relatively acid ground. Additionally, Q. suber needs humid conditions, mild temperature all year around and can grow on thin soils. The canopy was rather open which allows e.g., Erica arborea to develop in the sub-growth. Species that are typical for the forest are for example Asparagus acutifolius, Cistus salviifolius and Clematis flavia.

Furthermore, the distribution of Quercus suber is influenced by humans since the harvest of the bark was used for cork production. The certain structure of the bark imparts a fire resistance of the tree against fire events.

Additionally, this day of excursion we found an individuum of the genus Osmunda the species Osmunda regalis. This individuum was located near by the river El Ridaura. The occurrence of this species indicates an oceanic and humid climate conditions which corresponds with the found location.

Fig. 6: *Osmunda regalis* (own images).

Fig. 7: Location where *O. regalis* grows (own image).

Species list: Quercus ilex forest.

Species	Family	Comments
Trees		
Alnus glutinosa	Betulaceae	
Castanea sativa	Fagaceae	
Prunus avium	Rosaceae	Red extra flora nectar glands
Prunus spinosa	Rosaceae	The leaf margin has a double, fine perforation
Quercus suber	Fagaceae	Cambium forms cork layer
Quercus ilex ssp. ilex	Fagaceae	Leaf underside white hairy
Quercus pubescens	Fagaceae	
Sorbus torminalis	Rosaceae	Flowers have five petals and form a multi-flowered umbrella panicle
Shrubs		
Arbutus unedo	Ericaceae	Is known as the symbol tree of Madrid

Asparagus acutifolius	Asparagaceae	Tiny leaves, characteristic species of the forest
Calicotome spinosa	Fabaceae	
Cistus salviifolius	Cistaceae	Found on silicate
Cornus sanguinea	Cornaceae	
Corylus avellana	Betulaceae	
Crataegus monogyna	Rosaceae	Prefers calcareous soils
Daphne gnidium	Thymelaeaceae	A wax coating makes the leaves appear blue-green
Dorycnium hirstum	Fabaceae	Very hairy
Euonymus europea	Celastraceae	Square stems
Erica arborea	Ericaceae	Strictly grows on silicate, young branches are hairy
Genista triflora	Fabaceae	Yellow flowert
Ilex aquifolium	Aquifoliaceae	
Pistacia lentiscus	Anacardiaceae	Paired pinnate leaves
Phillyrea angustifolia	Oleaceae	The upper side of the leaf is olive green, the underside bare and yellowish green
Rhamnus alaternus	Rhamnaceae	Stipules
Ruscus aculeatus	Asparagaceae	Apparent leaves are phylloclades
Salvia rosmarinus	Lamiaceae	Essential oils, underside of the leaf has two white stripes
Spartium junceum	Fabaceae	As soon as an insect lands on its wings, the pollen is hurled onto the ventral side of the insect
Viburnum tinus	Adoxaceae	
Herbs		
Anemone nemorosa	Ranunculaceae	
Aquilegia vulgaris	Ranunculaceae	On top the leaves are bluish-green colored, underneath hairy and grayish-green
Antirrhinum majus	Plantaginaceae	
Bituminaria bituminosa	Fabaceae	Plant smells like tar
Centaurea pinnata	Asteraceae	Pinnate appendix
Dorycnium hirsutum	Fabaceae	Heavily hairy

Eupatorium cannabinum	Asteraceae	
Euphorbia amygdaloides	Euphorbiaceae	
Filago vulgaris	Asteraceae	Plant is woolly hairy
Geranium robertianum	Geraniaceae	
Lapsana communis	Asteraceae	Plant has milky fluid
Lathyrus latifolius	Fabaceae	
Lilium martagon	Liliaceae	Leaves are arranged in whorls
Mercurialis annua	Euphorbiaceae	
Mercurialis perennis	Euphorbiaceae	Deciduous leaves are petiolated
Ornithopus compressus	Fabaceae	Both sides of the leaf are hairy
Orobanche hederae	Orobanchaceae	
Sedum sediforme	Crassulaceae	Evergreen and succulent
Sherardia arvensis	Rubiaceae	Square hairy stems
Symphytum tuberosum	Boraginaceae	The above-ground parts of the plant are hairy
Torilis arvensis	Apiaceae	
Umbilicus rupestris	Crassulaceae	The leaf blade of the basal leaves is sunken like an umbilicus
Vicia cracca	Fabaceae	
Grasses		
Brachypodium sylvaticum	Poaceae	Nodes are hairy. Grows in dense clusters
Bromus hordeaceus	Poaceae	Annual grass, Ligula is hairy
Carex depressa	Cyperaceae	
Carex pendula	Cyperaceae	The leaf sheaths have distinct lattice veins
Carex sylvatica	Cyperaceae	Heterostachyae and a shadow plant
Cynosurus echinatus	Poaceae	
Luzula forsteri	Juncaceae	
Melica uniflora	Poaceae	Opposite the ligule a tapering appendage
Poa trivialis	Poaceae	
Ferns		

Asplenium onopteris	Aspleniaceae	Elongated sori
Osmunda regalis	Osmundacea	Separated fertiles
Polypodium cambricum	Polypodiaceae	Leaf margin is slightly translucent and cartilaginous
Polypodium setiferum	Dryopteridaceae	Bristly awn on the pinnae
Pteridium aquilinum	Dennstaedtiaceae	
Lianas		
Clematis flammula	Ranunculaceae	Fruits have a feathery tail
Clematis vitalba	Ranunculaceae	
Dioscorea communis	Dioscoreaceae	Foliage leaves are arrow or heart shaped
Hedera helix	Araliaceae	
Lonicera implexa	Caprifoliaceae	Leaves are fused at the base and waxy on the lower side of the leaf
Lonicera periclymenum	Caprifoliaceae	
Rubia peregrina	Rubiaceae	Sticky
Smilax aspera	Smilaceae	Tridentate, monoecious and strong-smelling inflorescences

Day 3 (24.5.2022): Torre de la Móra (Tamarit)

Marion Fink, Moritz Stegener

Coordinates: 1° 34’ 33’’ E, 41° 12’ 51’’ N

Habitats:

- Location 1: Transition zone from road to forest
- Location 2: Successional stages of former olive groves
- Location 3: Coastal vegetation over limestone

Study Area

Starting from Camping Torre de la Móra, our excursion took us along Carrer Baix Llobregat into the Bosc de la Marquesa and further to the coast.

The Bosc de la Marquesa Nature Reserve is located 8 km east of the city of Tarragona and stretches from Platja Llarga to Punta de la Móra. The name of the destination refers to the Marquise Caridad Barraqué de Borràs (+1984), who successfully averted building speculation in the 1970s and set the starting point for the near-natural preservation of the area. The non-profit organization DEPANA (Lliga per a la Defensa del Patrimoni Natural), founded in Barcelona in 1976, is responsible for preserving this natural heritage.

In terms of climate, the area around Tarragona is characterized by warm, comparatively humid and predominantly clear summers and cold, windy winter months. The temperature rarely drops below freezing during these winter months (Fig. 1, 2).

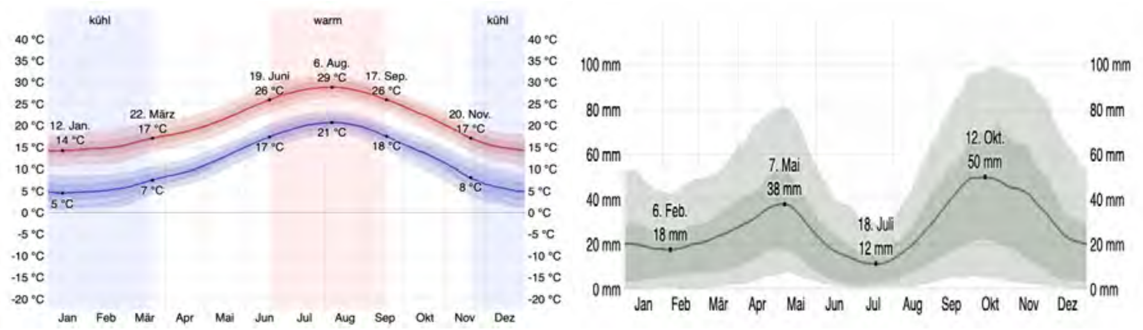


Fig. 8: Left: Average of the monthly high (red line) and low (blue line) temperatures for Tarragona; Right: Average monthly precipitation (gray line) for Tarragona ©WheatherSpark.com

A rough overview of the landscape shows that forest communities have established themselves here at sites that tend to be humid over developed soils. There are also clear species-specific tendencies regarding the distribution of characteristic tree species in the area. While *Pinus halepensis* formations are mainly found along the coast, *Quercus ilex* inhabits thermophilic locations in the backland adjacent to the coast. The soils in the excursion area are the result of chemical and physical weathering from calcareous sedimentary rock. In comparison to the days before, we are on much younger rocks but the continuous drying out of the soil during the vegetation period largely prevents the establishment of annual species.

Transition zone from road to forest (Location 1)

On the edge of the road a sizable population of *Arundo donax* stands out. This species was already valued in ancient times as a fast-growing and therefore cheap building material. The species, of which diploid and tetraploid populations are known, is considered an alien species in large parts of the Mediterranean region.

Among the climbing plant species are *Smilax aspera*, *Hedera helix* and *Aristolochia pistolochia*, which is pollinated by Diptera, and respectively *Clematis flammula*, a character species of thermophilic *Quercus ilex* forests.

Among the Poaceae found on this excursion day is *Brachypodium retusum*, a character species of the Macchia Vegetation adapted to dry soil conditions.

The Lamiaceae family is represented by the species *Stachys brachyclada*, which is impressively polymorphic in terms of site-specific size adaptation and trait expression.

We had already discovered this species at Cap de Creus, where it only grew a few centimeters high. Contrastingly, in this nitrogen-rich location over developed soil, it grows into stately specimens.

The occurrence of *Parietaria officinalis* suggests a nitrogenous soil condition. Human influence on this habitat is once again highlighted by the presence of ruderal floral elements such as *Piptatherum miliaceum*.

Successional stages of former olive groves (Location 2)

The anthropogenically created terracing of the landscape suggests the presence of a former olive plantation. Accordingly, isolated specimens of *Olea europaea* (Fig.3) and with them also *Osyris alba* (Fig. 4), which forms a semiparasitic symbiosis with *Olea europaea*, could be found.

The course of succession has shaped this habitat into the vegetation formation so-called ‘Brolla’, which consists of open layers of *Pinus pinea* and *Pinus halepensis* (Fig. 5) in the upper stories and includes shade-loving shrubs in the understory layers.

Chamaerops humilis (Fig. 6), besides the observed *Rhamnus lycioides*, one of the character species of thermophilous Màquia, was observed in sunlit sites in the undergrowth. The distribution area of this dwarf palm, which colonises sandy soils in Màquia, Garrigues, rocky outcrops and sites where summers are dry and hot and winters are without prolonged frosts, includes the western and central Mediterranean region and extends eastwards to Italy and Libya. In central Spain, it forms the “palmetto formation” with short-stemmed individuals.

The cespitose hemicryptophyte *Carex halleriana* represents the Cyperaceae family in the visited thermophilic habitat. The species with a broad topographical distribution amplitude grows on sunny, dry slopes in the Mediterranean scrub and in the warmer areas of deciduous forests on shallow, calcareous or siliceous, base-rich soils.

Carex halleriana, a species with flat hairy tubes and 3 stigmas, is habitually characterized by up to 2, mostly long-stalked female spikes and differs from the habitually similar *Carex transsilvanica* by the length of the tubes (these 4-5 mm long) and the shape of the fruits (these triangular). Both of these Cyperaceae species occur, albeit rarely, in Austria.

Fig. 9: A: *Olea europaea* as a sign of the anthropogenic influence (Olive terrace plantation), B: *Osyris alba*, a parasitic plant feeding on Olea europaea

Fig. 10: A: *Pinus halepensis*, easily distinctive by the gray bark and the dried-out cones, which stay on the branches for years. B: *Chamaerops humilis*, a thermophilus palm, which occurs on the east coast of the Iberian Peninsula from Barcelona eastwards. It only tolerates short frost.

Coastal vegetation over limestone (Location 3)

Myrtus communis and *Juniperus phoenicea* subsp. *urbinate,* both floral elements of thermophilic Màquia near the coast, were some of – in terms of area – the most common species we found close to the cliffs. They only grew to the height of a few meters and formed a dense undergrowth, which did not allow a lot of light to reach the ground floor. Therefore only a few undergrowth species were able to grow in this community.

In sunny locations near the coast, *Centaurea linifolia*, an endemic of the western Iberian Peninsula, is found over weakly developed soils.

Due to the harsh weather conditions, which consisted of strong winds and sea spray, the vegetation got smaller the closer we got to the cliffs (Fig. 7).

The area of the cliffs, above the splash water horizon, is dominated by mostly perennial, salt-tolerant taxa such as *Crithmum maritimum, Helichrysum stoechas, Limonium gibertii, Plantago crassifolia and Limbarda crithmoides.*

Fig. 11: Gradual shift in plant height and density with decreased distance to the cliffs.

Species list: Location 1

Species	**Family**	**Comments**
Aristolochia pistolochia	Aristolochiaceae	
Arundo donax	Poaceae	
Asparagus acutifolius	Asparagaceae	

**Brachypodium retusum*	Poaceae	
***Clematis flammula*	Ranunculaceae	
Cynoglossum creticum	Boraginaceae	
Hedera helix	Araliaceae	
Morus sp.	Moraceae	
Olea europaea	Oleaceae	
Parietaria officinalis	Urticaceae	
Piptatherum miliaceum	Poaceae	
Pistacia lentiscus	Anacardiaceae	
Rubia peregrina	Rubiaceae	
Smilax aspera	Smilacaceae	
Sonchus tenerrimus	Asteraceae	
Stachys brachyclada	Lamiaceae.	

Species-list for location 2 and 3

Species	**Family**	**Comments**
Anagallis arvensis	Primulaceae	
Aphyllanthes monspeliensis	Asparagaceae	
Asparagus horridus	Asparagaceae	
Asperula cynanchica	Rubiaceae	
Asphodelus fistulosus	Asphodelaceae	
Blackstonia perfoliata	Gentianaceae	
**Brachypodium retusum*	Poaceae	
Bupleurum fruticosum	Apiaceae	
Carex halleriana	Cyperaceae	
Centaurea linifolia	Asteraceae	
* *Chamaerops humilis*	Arecaceae	

Chiliadenus glutinosus	Asteraceae	
Cistus monspeliensis	Cistaceae	
Cistus albidus	Cistaceae	
Cistus salviifolius	Cistaceae	
Cistus clusii	Cistaceae	
Crithmum maritimum	Apiaceae	
Cytinus hypocistis	Cytinaceae	
Dipcadi serotinum	Asparagaceae	
Dorycnium hirsutum	Fabaceae	
Dorycnium pentaphyllum	Fabaceae	
Erica multiflora	Ericaceae	
Euphorbia characias	Euphorbiaceae	
Euphorbia exigua	Euphorbiaceae	
Euphorbia segetalis	Euphorbiaceae	
Euphorbia flavicoma	Euphorbiaceae	
Fumana ericifolia	Cistaceae	
Gladiolus illyricus	Iridaceae	
Gleditsia triacanthos	Fabaceae	
Helianthemum marifolium	Cistaceae	
Helichrysum stoechas	Asteraceae	
Hyparrhenia hirta	Poaceae	
Juniperus oxycedrus	Cupressaceae	
Juniperus phoenicea ssp. *Turbinata*	Cupressaceae	
Lagurus ovatus	Poaceae	
Limbarda crithmoides	Asteraceae	
Limonium gibertii	Plumbaginaceae	

Linum strictum	Linaceae	
Lonicera implexa	Caprifoliaceae	
+*Myrtus communis*	Myrtaceae	
Ophrys apifera	Orchidaceae	
Osyris alba	Santalaceae	
Pallenis spinosa	Asteraceae	
Parapholis incurva	Poaceae	
Pinus pinea	Pinaceae	
Pinus halepensis	Pinaceae	
Pistacia lentiscus	Anacardiaceae	
Plantago afra	Plantaginaceae	
Plantago crassifolia	Plantaginaceae	
Polygala rupestris	Polygalaceae	
Quercus ilex	Fagaceae	
+*Quercus coccifera*	Fagaceae	
* *Rhamnus lycioides*	Rhamnaceae	
Rhamnus alaternus	Rhamnaceae	
Ruscus aculeatus	Asparagaceae	
Ruta chalepensis	Rutaceae	
Sanguisorba minor	Rosaceae	
Schoenus nigricans	Cyperaceae	
Sedum sediforme	Crassulaceae	
Sherardia arvensis	Rubiaceae	
Sisymbrium officinale	Brassicaceae	
Stipa offneri	Poaceae	
Thymelaea hirsuta	Thymelaeaceae	
Thymus vulgaris	Lamiaceae	

Torilis nodosa	Apiaceae	
Ulex parviflorus	Fabaceae	

(*) Character species of thermophilous Màquia

(**) Character species of thermophilous *Quercus ilex* forests

(+) Companion species of thermophilous Màquia

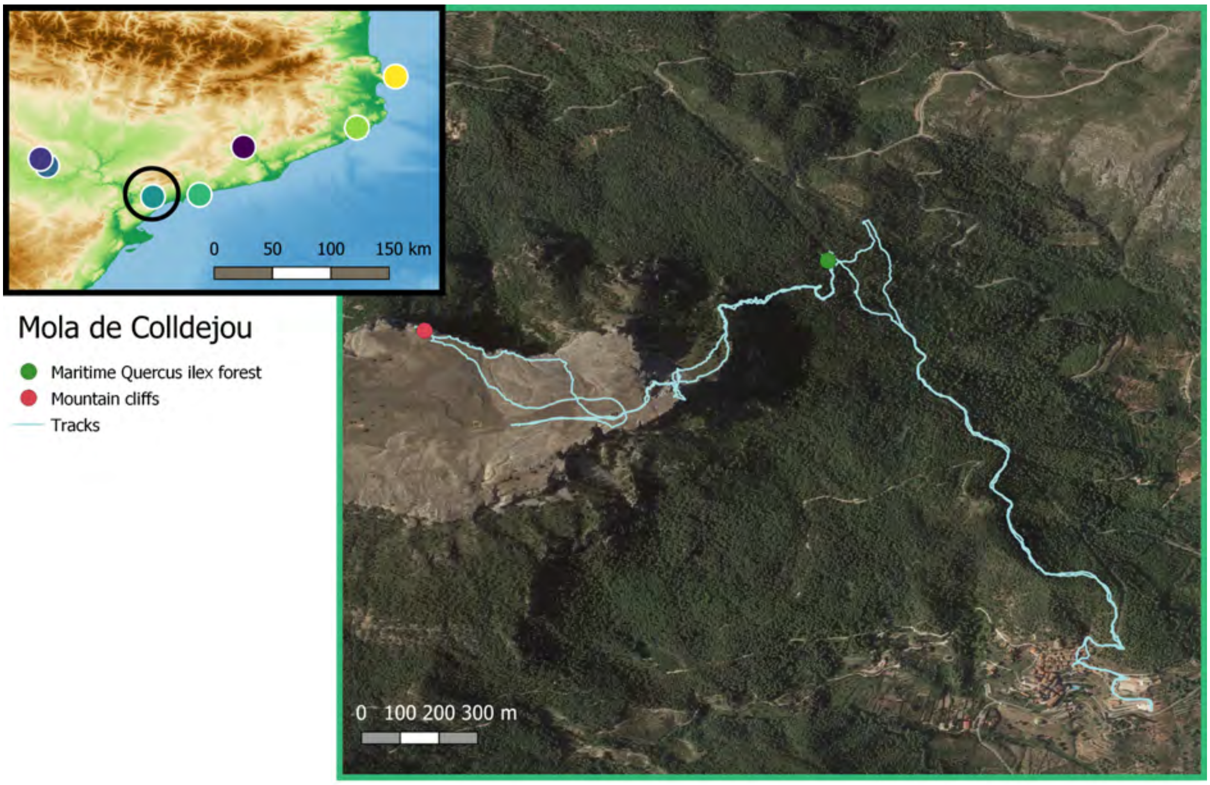
<u>Day 4 (25.05.2022): Mola de Colldejou</u>

Žan Cimerman, Felix Faltner, Felix Wetzel

Coordinates: 0° 87‘ 01“ E, 41° 10‘ 72“ N

Vegetation types at Mola de Colldejou:

- Quercus ilex forest
- Mountain cliffs



Tracks: GPS by Simon Eisele; Basemap overview: © OpenStreetMap contributors 2022; Basemap detail: © GoogleMaps 2022; Map created by Michael Mitschke

Fig. 12: On the fourth day we visited Mola de Colldejou. Examined vegetation types are marked in the upper panels together with a line showing the respective paths of the excursions.

Study Area

On the fourth day of our excursion, we drove from our camping site in Torre de la Móra to the village Colldejou (400 m above sea level), which is located ca. 30 km west of Tarragona, to explore the Mola de Colldejou ridge. Mola de Colldejou is part of the Catalan Pre-Coastal Range which consists of calcareous rocks. This mountain range was formed in the Mesozoic when rivers flowing from East to West brought sediments and entered into the sea at the site of the present-day Ebro Basin in forms of deltas, which turned into the mountains. The highest elevation of Mola de Colldejou is 921 m in the shape of a plateau surrounded by cliffs, used as pastures which leads to occurrence of ruderal species. Already climbing we gained an impression of the wetter sides of the Mediterranean climate. These strong rains in spring and also in autumn are typical for the region and the precipitation rises with increasing height where the oromediterranean thermotype takes effect. When there is no wind (most often from NW), fog often occurs because of the near coast which is ca. 10 km apart.

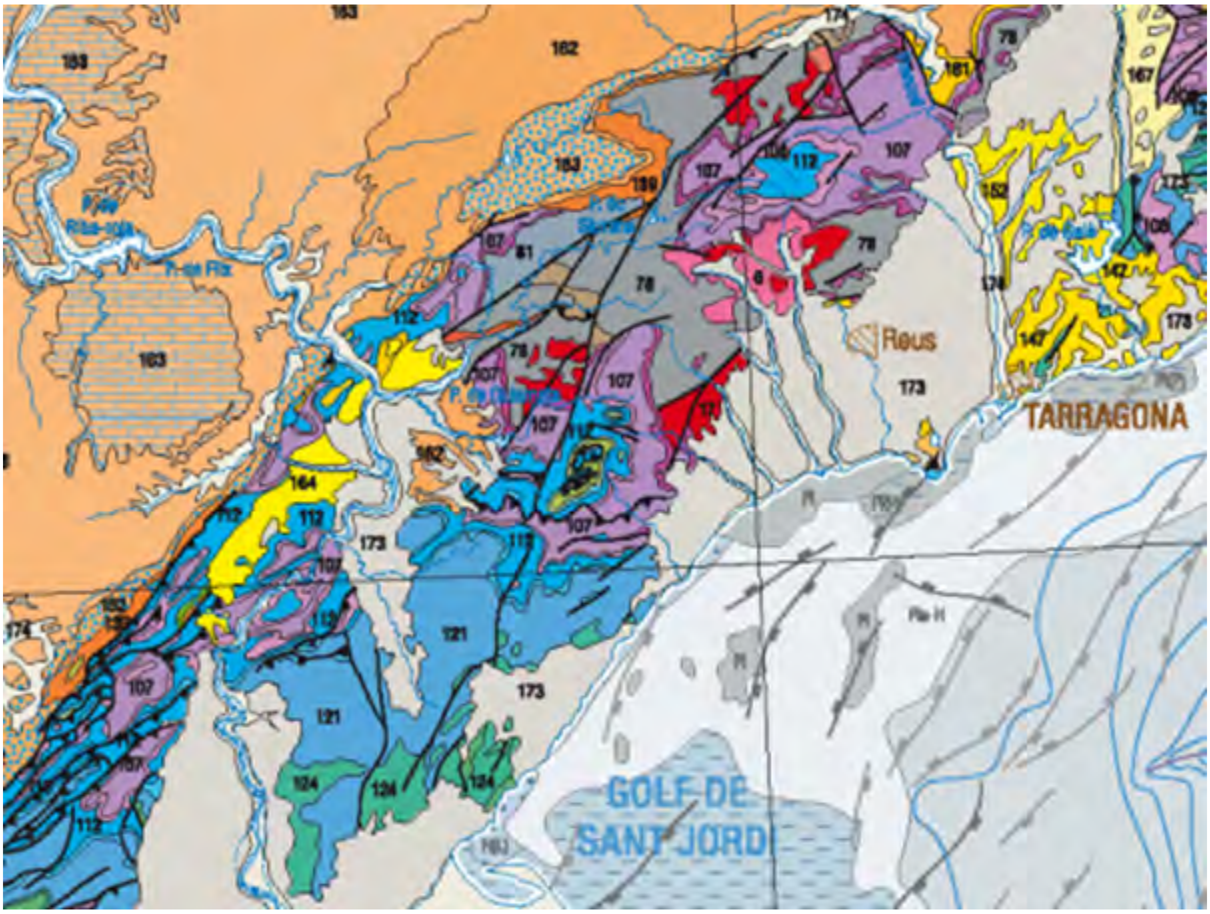


Fig. 13: Geology of the region, Image source: IGME, 2015: Mapa Geológico de España y Portugal.

Legend:
173 - conglomerates, gravels, sands, shales, calcarenite marls, travertine limestones and tuffs
169 - shales, sandstones, conglomerate and limestone, to travertine veins
164 - conglomerates, sandstones, shales, limestones, marls and gypsum
163 - conglomerates, sandstones, shales, limestones and gypsum
152 - white marls, limestones, blocalcarenites and breccias
124 - limestone and marls
121 - massive dolomites, limestones, dolomites and marls
112 - carniolas, dolomitic breccias, dolomites and limestone
107 - dolomites, limestones and marls
78 - slates, grauvacas and limestones
17 - biotitic granites
8 - inhomogeneous granites and magmatitic complexes

The types of bedrock that characterize Mola de Colldejou are as follows: in the NW part we found lower Cretaceous limestones, marls, sandstones and shales. Moving W and to the center of the mountain range, there lie dolomites and limestone of the upper Triassic-lower Jurassic transition. On the W and E sides, lower Triassic conglomerates, sandstones, and clays take place. In the central part, following to the N Devonian and Carboniferous limestones, slates and sandstones are found, also greywacke slates and conglomerates. Scattered igneous rock in the central part is granite. Holocene detrital sediments were deposited on the E side of the mountain all the way to the coast (IGN 2022).

Fig. 14: The sea is just ca. 10 km away from Mola de Colldejou.

Vegetation of Mola de Colldejou

The vegetation changes with the decreasing temperature and the increasing humidity due to the elevation and is additionally modified by human influence. In the lower parts of Mola de Colldejou secondary shrublands can be found that replace the natural forest vegetation. At a higher elevation grow *Quercus ilex* forests with less species and a simpler structure. When the vegetation gets more open because of the height, *Pinus nigra* occurs and indicates the Mediterranean mountain vegetation (oromediterranean).

Fig. 15: Stand of *Pinus nigra* at the upper elevations.

We started to talk about the vegetation in a protective cave in the summit area of the mountain: In the high levels of the mountains grazing between winter and spring is common, traditionally with sheep and horses that were brought from the Pyrenees (transhumance). This management leads to treeless grasslands of *Aphyllanthes monspeliensis* (Aphyllanthion) in which naturally tree species like *Pinus nigra* would occur. *Aphyllanthes monspeliensis*, a blue flowering species in the family Asparagaceae with no visible leaves, is not strictly limited to the mountains - we saw it also in the coastal areas on day 3 - but builds the vegetation of this grassland type. It is accompanied by species like *Thalictrum tuberosum*, typical on limestone, and the Asteraceae species like *Phagnalon saxatile*, *Senecio doronicum*, *Serratula nudicaulis*.

Fig. 16: Left to right: *Aphyllanthes monspeliensis*, *Erodium foetidum* ssp. *celtibericum*, *Paeonia officinalis* (photos: Simon Eisele)

The mountain top plateau impresses due to its diversity and not inconsiderable number of endemic species. The most iconic species of this vegetation are elements of the spiny cushions that are typical for the oromediterranean vegetation which corresponds to the alpine vegetation but has marked summer droughts. These plants grow in dense cushions as protection against the harsh environment and come with stings or thorns as defence against herbivory. Typical for it are e. g. *Erinacea anthyllis*, a Fabaceae with purple-violet flowers, which is distributed from Northern Africa to the Pyrenees or the Brassicaceae *Alyssum spinosum*. Two endemics are for example *Armeria fontqueri* that grows elsewhere on cliffs with Atlantic vegetation and *Erodium foetidum* ssp. *celtibericum* which is endemic between Valencia and Tarragona.

On our climb-down we stopped in a shady, species poor montane forest which was characterized by oceanic species like the dominant *Quercus ilex*, *Ilex aquifolium*, *Hedera helix*, *Helleborus foetidus*, but also more continental species such as *Quercus coccifera* and *Amelanchier ovalis*. The further occurring *Quercus* x *cerrioides* exemplifies this transition because it is a hybrid of the continental *Quercus faginea* and coastal/submediterranean *Quercus pubescens*. Submediterranean echos due to the mountain climate are also represented by *Prunus mahaleb*, *Ruscus aculeatus* and the already mentioned *Ilex aquifolium*.

At the lower elevations low scrubs can be found where no forest exists. Many of the species in these scrubs like *Helichrysum stoechas*, *Santolina chamaecyparissus*, *Lavandula latifolia*, *Thymus vulgaris*, *Satureja montana* are abundant in volatile oils which are important for resistance against herbivory or for enticement of (pollinating) insects. Occurring grass-likes are the widespread *Brachypodium retusum*, *Bromus erectus* agg., *Avenula iberica* and *Carex flacca*. In thermophilous areas of Mola de Colldejou such as South-exposed hillsides with a warm climate we could see various species we also learned about in the Bosc de la Marquesa on day 3 near the coast such as *Dorycnium pentaphyllum*, *Blackstonia perfoliata*, *Osyris alba*, *Ulex parviflorus* and *Cytinus hypocistis*.

Fig. 17: *Cytinus hypocistis*

More open and rocky sites were characterized by single shrubs like *Juniperus oxycedrus* ssp. *oxycedrus*, *Pistacia lentiscus*, *Bupleurum fruticescens* and also trees like *Pinus halepensis* next to herbaceous and grasy species.

Fig. 18: *Coris monspeliensis*

The transition from widely natural or close-to-nature mediterranean to secondary shrubland, caused by wood clearing, was indicated by the Fabaceae *Genista patens*, *Ononis spinosa*, *Argyrolobium zanonii*, the Asteraceae *Centaurea linifolia*, *Staehelina dubia*, *Carduncellus monspeliensis* and other species such as *Thymelaea tinctoria*, *Helianthemum syriacum* and *Stipa offneri*. An impressive panicle grass, that was found at the wayside, was *Ampelodesmos mauritanicus* which is mainly distributed to Africa and favored by fire and grazing. It is not certainly resolved, if it is native to the visited region.

Species list: Upper elevations of Mola incl. Aphyllanthion

Species	Family	Comments
Alyssum spinosum (syn.	Brassicaceae	
Anthemis arvensis	Asteraceae	
Anthyllis cytisoides	Fabaceae	Thermomediterranean shrub
Anthyllis montana	Fabaceae	Pink flowers, top leaflet bigger
Anthyllis vulneraria subsp. rubri	Fabaceae	All leaflets same size
Aphyllanthes monspeliensis	Asparagaceae	
Armeria fontqueri	Plumbaginaceae	endemic
Asperula cynanchica	Rubiaceae	
Asphodelus cerasiferus	Xanthorrhoeaceae	
Asterolinon linum-stellatum	Primulaceae	

Athericum liliago	Asparagaceae	
Campanula speciosa subsp. affinis	Campanulaceae	Endemic to Catalan mountains and Pre-Pyrenees
Carex flacca	Cyperaceae	
Catapodium rigidum	Poaceae	Annual, spiclets on one side of the inflorescence
Clypeola jonthlaspi	Brassicaceae	Perfectly circular fruits
Coriaria myrtifolia	Coriariaceae	
Coris monspeliensis	Primulaceae	
Crepis albida	Asteraceae	Scales of the involucrum with white margin
Dianthus panicum	Caryophyllaceae	Short, rosé entire petals
Dorycnium pentaphyllum	Fabaceae	
Erinacea anthyllis	Fabaceae	Purple-violet flowers
Erodium foetidum subsp. celtibericum	Geraniaceae	Woody, 2 petals with marked spot, endemic
Erysimum grandiflorum	Brassicaceae	Yellow flowers, linealic leaves
Euphorbia nevadensis	Euphorbiaceae	Endemic to Spain, rare
Festuca paniculata	Poaceae	On S-exposed slopes with deep soil
Globularia repens	Campanulaceae	
Globularia vulgaris	Campanulaceae	
Helianthemum appeninum	Cistaceae	
Inula montana	Asteraceae	Endemic to W-mediterranean mountains
Knautia rupicola	Caprifoliaceae	
Koeleria vallesiana	Poaceae	
Linum narbonense	Linaceae	With silvery margin, perennial
Lithospermum fruticosum	Boraginaceae	Small shrub

Lonicera pyrenaica	Caprifoliaceae	Endemic to Pyrenees and coastal mountain range
Marrubium supinum	Lamiaceae	Dense inflorescence like spheres, densely hairy, pale pinkish flowers
Orobanche hederae	Orobanchaceae	
Paeonia officinalis subsp. microcarpa	Paeoniaceae	Pink flowers, submediterranean montane species
Phagnalon saxatile	Asteraceae	
Phlomis lignitis	Lamiaceae	Yellow flowers, big upper lip thermomediterranean
Phyteuma orbiculare	Campanulaceae	
Pinus nigra	Pinaceae	
Plantago sempervirens	Plantaginaceae	Low shrub
Polygala calcarea	Polygalaceae	On calcareous substrate
Potentilla caulescens	Rosaceae	Limited to high mountains
Santolina chamaecyparissus	Asteraceae	chamaephyt
Saxifraga fragilis	Saxifragaceae	
Senecio doronicum	Asteraceae	
Serratula nudicaulis	Asteraceae	
Sideritis hirsuta	Lamiaceae	Similar to Stachys, but stamens in tube of the corolla
Sideritis spinosa	Lamiaceae	
Silene vulgaris	Caryophyllaceae	
Teucrium aureum	Lamiaceae	Yellow inflorescence
Teucrium polium subsp. aureum	Lamiaceae	Part of variable group with many subspecies
Thalictrum tuberosum	Ranunculaceae	

Species list: Species-poor montane forest

Species	Family	Comments
Acer opalus subsp. granatensis	Sapindaceae	Red leafstalk, similar to A. pseudoplatanus, but leaf sections shorter, more obtuse
Amelanchier ovalis	Rosaceae	In spring with hairy leaves
Antirrhinum litigiosum	Plantaginaceae	Endemite of the Iberian system
Arbutus unedo	Ericaceae	Fruits first green, then red, verrucous
Asplenium onopteris	Aspleniaceae	
Cistus albidus	Cistaceae	
Conopodium majus	Apiaceae	With tuber
Euphorbia characias	Euphorbiaceae	-1000 m SL
Euphorbia serrulata	Euphorbiaceae	(*E. stricta*) Coarsely serrated leaves
Hedera helix	Araliaceae	
Helleborus foetidus	Ranunculaceae	Common in the subalpine altitude in the Pyrenees
Ilex aquifolium	Aquifoliaceae	
Leuzea conifera	Asteraceae	Involucrum looks like a cone, no appendices like *Centaurea*
Lonicera implexa	Caprifoliaceae	Leaves connate
Lonicera pyrenaica	Caprifoliaceae	
Osyris alba	Santalaceae	parasitic
Phillyrea angustifolia	Oleaceae	
Prunus mahaleb	Rosaceae	has extrafloral nectaries
Quercus coccifera	Fagaceae	
Quercus ilex	Fagaceae	

Quercus x cerrioides	Fagaceae	Hybrid of continental *Q. faginea* and coastal/submediterranean *Q. pubescens*
Rubia peregrina	Rubiaceae	
Rubus fruticosus	Rosaceae	
Ruscus aculeatus	Asparagaceae	Long rootstock
Salvia lavandulifolia subsp. vellerea	Lamiaceae	Endemite of the Iberian system
Scabiosa columbaria	Caprifoliaceae	
Smilax aspera	Smilacaceae	

Species list: Thermophilous area

Species	**Family**	**Comments**
(Coriaria myrtifolia)	Coriariaceae	
(Dorycnium pentaphyllum)	Fabaceae	
(Osyris alba)	Santalaceae	
Aegilops geniculata	Poaceae	
Blackstonia perfoliata	Gentianaceae	
Cytinus hypocistis	Cytinaceae	Parasite on *Cistus*
Daphne gnidium	Thymelaeaceae	
Dorycnium hirta	Fabaceae	
Eryngium campestre	Apiaceae	
Helichrysum stoechas	Asteraceae	
Inula viscosa (Syn. Dittrichia	Asteraceae	Yellow, late flowers
Laserpitium gallicum	Apiaceae	Slender leaf sections
Prunus spinosa	Rosaceae	
Rosa micrantha	Rosaceae	
Salvia rosmarinus	Lamiaceae	
Sanguisorba minor	Rosaceae	

Sorbus domestica	Rosaceae	
Ulex parviflorus	Fabaceae	

Species list: Vegetation of low scrubs

Species	**Family**	**Comments**
(Carex flacca)	Poaceae	
(Helichrysum stoechas)	Asteraceae	
(Santolina chamaecyparissus)	Asteraceae	
Avenula iberica	Poaceae	
Brachypodium retusum	Poaceae	
Bromus erectus agg.	Poaceae	
Erica multiflora	Ericaceae	
Euphorbia flavicoma	Euphorbiaceae	Glaucus plant
Lavandula latifolia	Lamiaceae	Broader and longer leaves than *L. stoechas*
Ononis minutissima	Lamiaceae	Small yellow flowers
Pallenis spinosa	Asteraceae	
Satureja montana	Lamiaceae	
Thymus vulgaris	Lamiaceae	

Species list: More open, rocky vegetation

Species	**Family**	**Comment**
(Coris monspeliensis)	Primulaceae	
(Rubia peregrina)	Rubiaceae	
Bupleurum fruticosum	Apiaceae	
Cephalanthera longifolia	Orchidaceae	

Convolvulus lanuginosus	Convolvulaceae	hairy
Fumana thymifolia	Cistaceae	Long stipules
Gladiolus illyricus	Iridaceae	
Helianthemum oelandicum subsp.	Cistaceae	Leaves are hairy on both sides
Juniperus oxycedrus subsp.	Cupressaceae	
Onobrychis arenaria	Fabaceae	
Pinus halepensis	Pinaceae	
Pistacia lentiscus	Anacardiaceae	

Species list: Transition to Mediterranean secondary shrubland

Species	**Family**	**Comment**
(Lithospermum fruticosum)	Boraginaceae	
Ampelodesmos mauritanicus	Poaceae	Very tall, native?
Argyrolobium zanonii	Fabaceae	Low scrub
Carduncellus monspeliensis	Asteraceae	Bluish, very spiny
Centaurea linifolia	Asteraceae	
Fumana ericifolia	Cistaceae	No stipules
Genista patens	Fabaceae	Tall shrub
Helianthemum syriacum	Cistaceae	
Ononis spinosa	Fabaceae	
Quercus faginea	Fagaceae	In wintercold areas instead of *Q. ilex*
Staehelina dubia	Asteraceae	Similar ecology like *Leuzea conifera*
Stipa offneri	Poaceae	
Thesium humifusum subsp.	Santalaceae	Lignified basis
Thymelaea tinctoria	Thymelaeaceae	Little shrub, hairy leaves

Day 5 (26.05.2022): Ebro Valley

Jonas Noah Geurden, Valentin Heimer and Michael Mitschke

Coordinates: -0° 25‘ 85“ E, 41° 48‘ 65“ N

Vegetation types:

Location 1: Laguna de La Playa

- Salt Marsh
- Gradient to salt marsh
- Mediterranean *Lygeum spartum* steppe

Location 2: Monegros

- *Juniperus thurifera* forest
- Gypsum vegetation

Fig. 18: On the fifth day we visited the Laguna de La Playa and the Monegros (encircled in the lower right panel). The vegetation types we examined are marked in the upper panels together with a line showing the respective paths of the excursions.

Study Area

The Ebro Valley is located in the north-east of the Iberian Peninsula and surrounded by the mountain ranges of the Pyrenees in the north, the Catalan coastal ranges in the east and the Iberian system in the south and southwest.

In mid-Tertiary the basin contained a sea-tongue from the Atlantic Ocean, which later was disconnected due to tectonic activity building an endorheic basin. Sedimentation, evaporation and influx of eroded sediments from the surrounding mountain ranges contributed to the recent geology of the area consisting of limestone and evaporites like gypsum and salt. By the end of Tertiary, the basin emptied, and the Ebro fluvial network was formed.

The central part of the Ebro Valley has a Mediterranean-Continental climate with summer drought and high differences in temperature between hot summer and cold winter. Due to the rain-shadow of the surrounding mountain ranges, the climate is very dry (< 400 mm precipitation per year). The Cierzo, fierce and cool winds, lead to additional drying of the area. In winter there is often inversion. Overall, the climate is very different from the other locations we visited during the excursion.

Although the human population density is low, there has been a huge anthropogenic impact on the landscape since antiquity. Agriculture shapes the landscape and is possible due to irrigation from the Ebro river system. Extensive deforestation has caused the current desert-like appearance of the region.

Laguna de La Playa (Location 1)

In the Ebro Valley we visited the Saladas de Sástago-Bujaraloz at the Laguna de La Playa. The salt lake is only filled with water in winter and evaporates in spring, resulting in an empty pan covered by white salt crystals. The vegetation is arranged in a gradient of salt and humidity, both increasing towards the salt lake. Here occur halophytic plants together with not specialized annuals. Many species show succulent growth as an adaptation to the high salinity of their habitat.

Directly at the brink, where salinity and humidity are highest, we saw the species-poor Suadeto braun-blanquetii formation at the **Salt Marsh** (Fig.1, Fig.2 A). It grows at the border areas of the lake and remains of former salines, where it is not submerged. Those structures are fixed by the roots of the plants and would erode without them.

At medium salinity and humidity in areas of a little higher elevation perennial species and some annuals build the **Gradient to the Salt Marsh** (Fig.1, Fig. 2 B), a transitional zone.

In flat areas with deep soils adjacent to the transitional zone, salinity and humidity are low. Here grows the **Mediterranean *Lygeum spartum* steppe** (Fig.1, Fig. 2 C). It is typical for areas where aridity and continental influence prevent the growth of tree species and huge shrubs. Like in Eurasian steppes, perennial species are dominant, but contrary to Eurasian steppes there are many open patches where annual species grow. Hence, it is more similar to semi-arid northern African vegetation. We also found some ruderal species indicating a certain amount of grazing and thus showing the anthropogenic impact on the area.

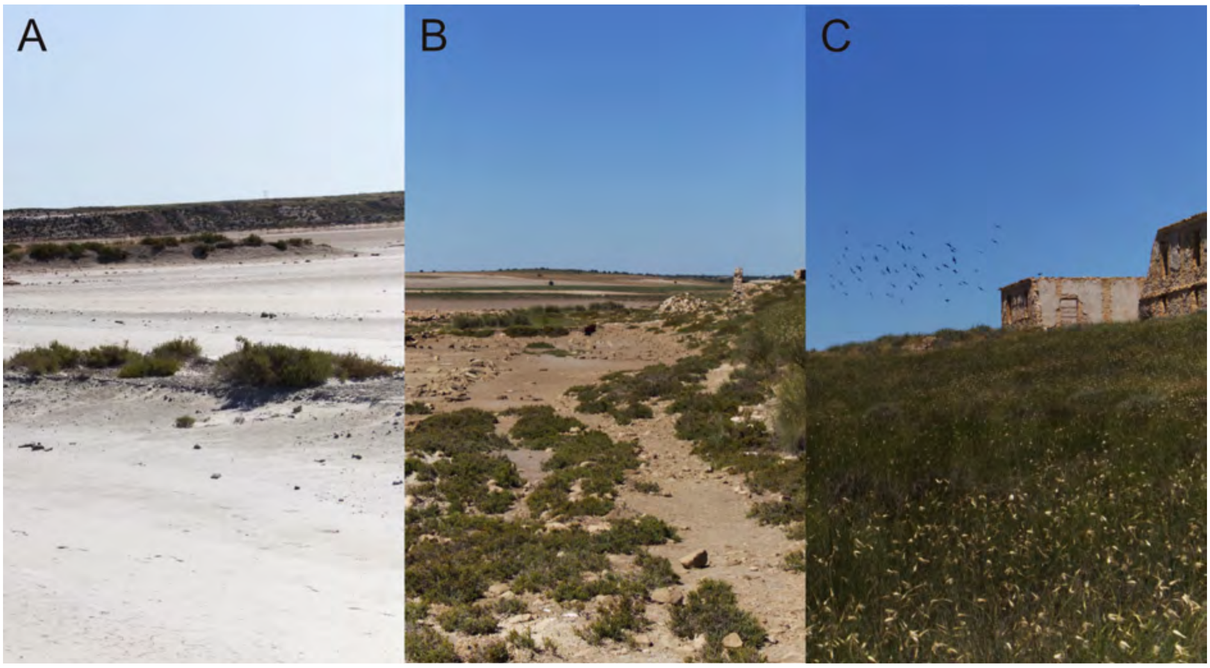


Fig. 19: Vegetation types at the Laguna de La Playa. A: Suadeto braun-blanquetii formation at the Salt Marsh growing on a former saline inside of the evaporated salt lake. B: Gradient to Salt Marsh, growing at slightly higher elevation. C: Mediterranean *Lygeum spartum* steppe, growing on adjacent flat and elevated areas.

Fig. 20: Typical plant species of the vegetation at the Laguna de La Playa: 1. *Aizoon hispanicum* 2. *Lygeum spartum* 3. *Campanula fastigiata* 4. *Frankenia pulverulenta* 5. *Platycapnos spicata* 6. *Euphorbia sulcata*

Monegros (Location 2)

We also visited gypsum hills in the Monegros, a small mountain range in the Ebro Valley. The name means “black mountains”, which describes the dark color of the *Juniperus thurifera* trees that covered the area. Here are some of the few remaining forests and woodlands of the Ebro Valley located.

The ***Juniperus thurifera* forest** (Fig.1, Fig. 4 A) is the climax vegetation of large parts of the area but is strongly affected by anthropogenic deforestation. *Juniperus thurifera* does not build close forests but open woodlands with open areas between the trees, leaving room for shrublands. This results in a comparably high species diversity. *Juniperus thurifera* is a typical continental species and needs cold temperatures in winter to be competitive and persist. Inversion allows its survival in low areas of the Ebro Valley, despite it being otherwise restricted to higher altitudes.

On the top of the Monegros **gypsum hills** (Fig.1, Fig. 4 B) *Juniperus thurifera* is replaced by *Quercus coccifera* and *Pinus halepensis*, since these areas are protected from inversion. The vegetation is similar to the continental thermophilous Macchia. Additionally, we also found gypsophilous species.

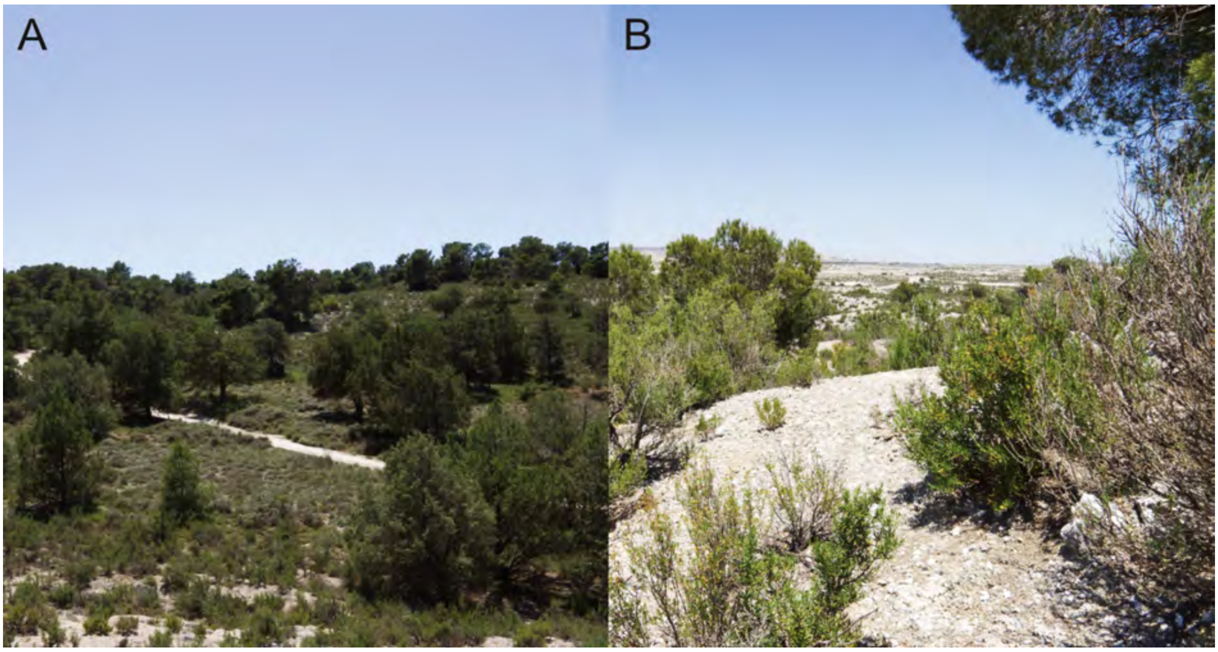


Fig. 21: Vegetation types at the Monegros. A: *Juniperus thurifera* forest grows in areas with temperature inversion in winter. B: The top of the gypsum hills is not affected by inversion, resulting in a vegetation similar to thermophilous Macchia. Additionally, gypsophilous vegetation can be found.

Fig. 22: Typical plant species of the vegetation in the Monegros: 1. *Anagallis foemina* 2. *Juniperus thurifera* 3. *Consolida pubescens* 4. *Valerianella multidentata* 5. *Ephedra nebrodensis* 6. *Phalaris canariensis*

Species List: Location 1 - Laguna de la Playa

Species	**Family**	**Comment**
Agropyron cristatum	Poaceae	*Juniperus thurifera*-forest + gypsum soil
Aizoon hispanicum	Aizoaceae	salt-vegetation; fig. A-1
Asphodelus cf ramosus	Liliaceae	ruderal
Asterolinon stellatum	Primulaceae	ruderal, annual, mediterranean
Arthrocnemum macrostachyum	Amaranthaceae	salt-vegetation
Atriplex halimus	Amaranthaceae	salt-vegetation
Boleum asperum	Brassicaceae	Gypsophiletalia, very rare, was not seen → *Eruca vesicaria*
Brachypodium retusum	Poaceae	*Juniperus thurifera*-forest + gypsum soil
Bupleurum fruticescens	Apiaceae	*Juniperus thurifera*-forest + gypsum soil
Campanula fastigiata	Campanulaceae	open soil, gypsum specialist; fig. A-3
Centaurea solstitialis	Asteraceae	*Juniperus thurifera*-forest + gypsum soil
Clypeola jonthlaspi	Brassicaceae	*Juniperus thurifera*-forest + gypsum soil
Consolida pubescens	Ranunculaceae	ruderal/segetal; fig. B-3

Coronilla juncea	Fabaceae	*Juniperus thurifera*-forest + gypsum soil
Eruca vesicaria	Brassicaceae	Garrigue-vegetation in Ebro Basin
Euphorbia falcata	Euphorbiaceae	ruderal/segetal, Laguna de la playa
Euphorbia serrata	Euphorbiaceae	ruderal, open landscape
Euphorbia sulcata	Euphorbiaceae	mediterranean, Laguna de la playa; fig. A-6
Filago vulgaris	Asteraceae	ruderal, Laguna de la playa
Frankenia pulverulenta	Frankeniaceae	salt-vegetation, Laguna de la playa; fig. A-4
Frankenia thymifolia	Frankeniaceae	Laguna de la playa: transition
Galium parisiense	Rubiaceae	*Juniperus thurifera*-forest + gypsum soil
Hedysarum boveanum	Fabaceae	*Juniperus thurifera*-forest + gypsum soil
Helianthemum appeninum	Cistaceae	*Juniperus thurifera*-forest + gypsum soil
Helianthemum marifolium	Cistaceae	*Juniperus thurifera*-forest + gypsum soil
Helianthemum squamatum	Cistaceae	Gypsophiletalia
Helianthemum syriacum	Cistaceae	*Juniperus thurifera*-forest + gypsum soil
Herniaria fruticosa	Caryophyllaceae	Gypsophiletalia
Herniaria hirsuta	Caryophyllaceae	*Juniperus thurifera*-forest + gypsum soil
Hippocrepis multisiliquosa	Fabaceae	Laguna de la playa: Monegros-steppes
Hordeum murinum	Poaceae	ruderal
Limonium costae	Plumbaginaceae	*Juniperus thurifera*-forest + gypsum soil
Limonium echioides	Plumbaginaceae	salt-vegetation
Limonium stenophyllum	Plumbaginaceae	salt-vegetation, endemic in Ebro Valley
Linum strictum	Linaceae	mediterranean open habitats
Lomelosia simplex	Caprifoliaceae	Laguna de la playa: Monegros-steppes
Lygeum spartum	Poaceae	Laguna de la playa: Monegros-steppes; fig. A-2
Malva aegyptia	Malvaceae	*Juniperus thurifera*-forest + gypsum soil
Melica ciliata	Poaceae	*Juniperus thurifera*-forest + gypsum soil
Neatostema apulum	Boragiaceae	Laguna de la playa: Monegros-steppes
Nonea micrantha	Boraginaceae	ruderal/segetal

Papaver hybrida	Papaveraceae	ruderal/segetal
Parapholis incurva	Poaceae	ruderal
Peganum harmala	Nitrariaceae	*Juniperus thurifera*-forest + gypsum soil
Phalaris canariensis	Poaceae	*Juniperus thurifera*-forest + gypsum soil; fig. B-5
Pinus halepensis	Pinaceae	*Juniperus thurifera*-forest + gypsum soil
Platycapnos spicata	Papaveraceae	ruderal, open soil, Laguna de la playa: transition; fig. A-5
Quercus coccifera	Fagaceae	*Juniperus thurifera*-forest + gypsum soil
Salsola vermiculata	Amaranthaceae	Garrigue-vegetation in Ebro Basin
Salvia rosmarinus	Lamiaceae	*Juniperus thurifera*-forest + gypsum soil
Spergularia cf diandra	Caryophyllaceae	salt-vegetation
Sphenopus divaricatus	Poaceae	Laguna de la playa: Monegros-steppes
Stipa lagascae	Poaceae	*Juniperus thurifera*-forest + gypsum soil
Stipa parviflora	Poaceae	Laguna de la playa: Monegros-steppes
Suaeda vera	Amaranthaceae	salt-vegetation
Taeniatherum caput-medusae	Poaceae	ruderal
Thapsia villosa	Apiaceae	*Juniperus thurifera*-forest + gypsum soil
Thymus zygis	Lamiaceae	Laguna de la playa: Monegros-steppes
Ziziphora hispanica	Lamiaceae	*Juniperus thurifera*-forest + gypsum soil

Species List: Location 2 - Monegros

Species	**Family**	**Comment**
Agropyron cristatum	Poaceae	*Juniperus thurifera*-forest + gypsum soil
Anagallis arvensis	Primulaceae	ruderal
Anagallis foemina	Primulaceae	ruderal, segatal, calcerous; fig. B-1
Asparagus acutifolius	Asparagaceae	mediterranean forest margins
Brachypodium retusum	Poaceae	*Juniperus thurifera*-forest + gypsum soil
Bupleurum fruticescens	Apiaceae	*Juniperus thurifera*-forest + gypsum soil
Bupleurum semicompositum	Apiaceae	*ruderal*

Campanula erinus	Campanulaceae	open soil in calcerous habitats
Centaurea solstitialis	Asteraceae	J*Juniperus thurifera*-forest + gypsum soil
Centaurium erythraea	Gentianaceae	ruderal, calcerous
Centranthus calcitrapae	Caprifoliaceae	calcerous/gypsum soil
Chaenorrhinum exilis	Plantaginaceae	open soil in gypsum-hills
Cistus clusii	Cistaceae	Macchia, Garrigue
Clypeola jonthlaspi	Brassicaceae	*Juniperus thurifera*-forest + gypsum soil
Coronilla juncea	Fabaceae	*Juniperus thurifera*-forest + gypsum soil
Descurainia sophia	Brassicaceae	ruderal/segetal
Dipcadi serotinum	Asparagaceae	western Mediterranean, rocky + sandy soil
Echinaria capitata	Poaceae	ruderal
Elymus pungens	Poaceae	ruderal
Ephedra nebrodensis	Ephedraceae	dry calcerous habitats, on rocks and gypsum; fig. B-5
Euphorbia falcata	Euphorbiaceae	ruderal/segetal, Laguna de la playa
Euphorbia serrata	Euphorbiaceae	ruderal, open landscape
Galium parisiense	Rubiaceae	*Juniperus thurifera*-forest + gypsum soil
Hedysarum boveanum	Fabaceae	*Juniperus thurifera*-forest + gypsum soil
Helianthemum appeninum	Cistaceae	*Juniperus thurifera*-forest + gypsum soil
Helianthemum marifolium	Cistaceae	*Juniperus thurifera*-forest + gypsum soil
Helianthemum syriacum	Cistaceae	*Juniperus thurifera*-forest + gypsum soil
Herniaria hirsuta	Caryophyllaceae	*Juniperus thurifera*-forest + gypsum soil
Hordeum murinum	Poaceae	ruderal
Juniperus thurifera	Cupressaceae	West-Mediterranean endemic; continental, mountains; fig. B-2
Lappula squarrosa	Boraginaceae	ruderal/segetal
Limonium costae	Plumbaginaceae	*Juniperus thurifera*-forest + gypsum soil
Linum strictum	Linaceae	mediterranean open habitats
Malva aegyptia	Malvaceae	*Juniperus thurifera*-forest + gypsum soil
Melica ciliata	Poaceae	*Juniperus thurifera*-forest + gypsum soil
Parapholis incurva	Poaceae	ruderal

Peganum harmala	Nitrariaceae	*Juniperus thurifera*-forest + gypsum soil
Phalaris canariensis	Poaceae	*Juniperus thurifera*-forest + gypsum soil; fig. B-5
Pinus halepensis	Pinaceae	*Juniperus thurifera*-forest + gypsum soil
Quercus coccifera	Fagaceae	*Juniperus thurifera*-forest + gypsum soil
Reseda alba	Resedaceae	ruderal
Reseda phyteuma	Resedaceae	ruderal
Rhamnus lycioides	Rhamnaceae	*Juniperus thurifera*-forest + gypsum soil
Salvia rosmarinus	Lamiaceae	*Juniperus thurifera*-forest + gypsum soil
Stipa lagascae	Poaceae	*Juniperus thurifera*-forest + gypsum soil
Thapsia villosa	Apiaceae	*Juniperus thurifera*-forest + gypsum soil
Trigonella monspeliaca	Fabaceae	open soil in gypsum-hills
Valerianella multidentata	Caprifoliaceae	ruderal/segetal; fig. 5
Ziziphora hispanica	Lamiaceae	*Juniperus thurifera*-forest + gypsum soil

Day 6 (27.05.2022): Montserrat

Jet Vessies, Simon Eisele

Coordinates: 1° 78’ 54’’ E, 41° 61’ 00’’ N

Goals of the day:

- Repetition of species seen during the excursion so far
- Montaneous Q. ilex forests

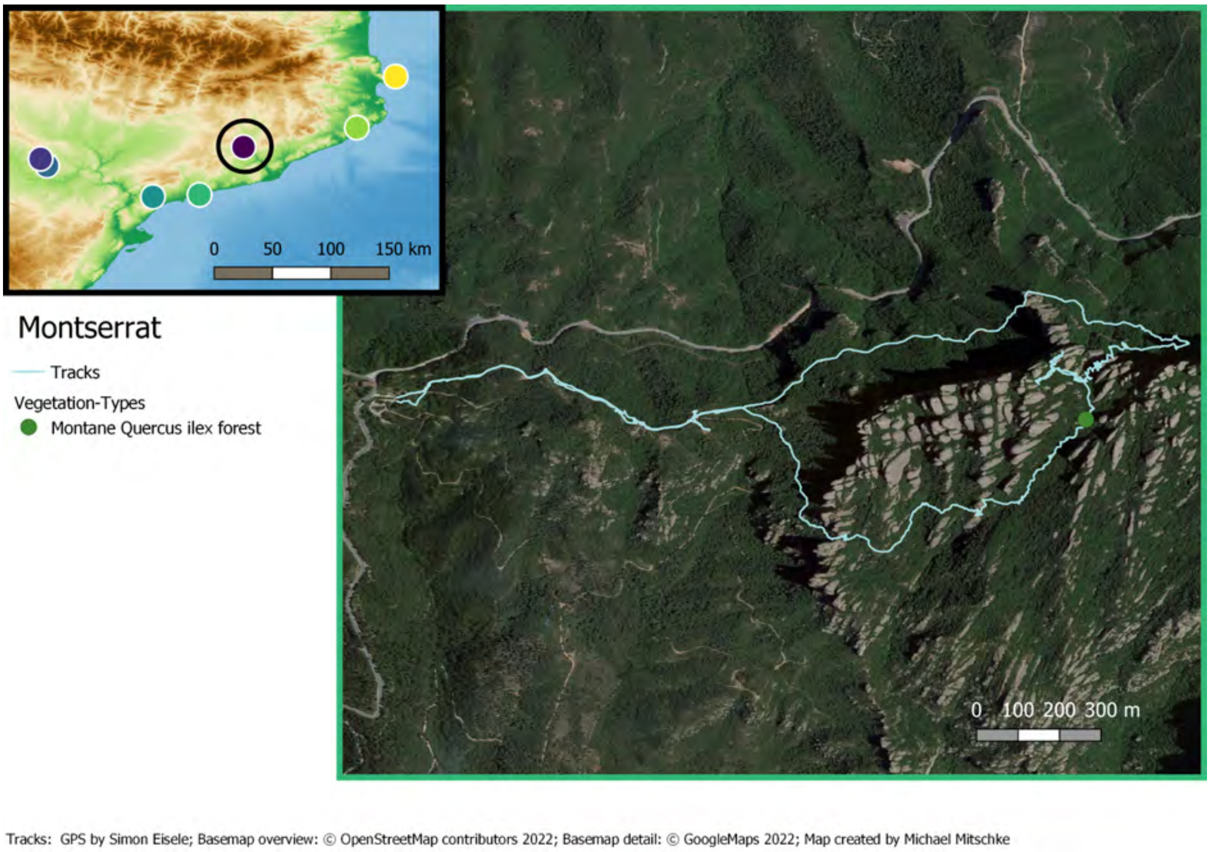


Fig. 23: Geographic overview (left), Excursion Hiking Route at Montserrat (right).

Study Area

Montserrat is a mountain range 50km northwest of Barcelona in Spain. It belongs to the Catalan mountain range. Montserrat means ‘serrated mountain’, because it is known for its impressive rock formations. The place is also well known as a place of pilgrimage, especially the Monastery of Montserrat. Our excursion started at the ‘Can Maçana’ parking in the western part of Montserrat at 710 masl. This area is also called the ‘needles’ region, known for the impressive needle-like rock structures. Another name is the ‘enchanted priests’, because all needles look like priests from the monastery that never left Montserrat anymore. Our highest point of the day was ‘Portell Estret’ at 1007 masl. Finally, we went back to the parking over a steep north exposed channel and along the north side of the rocks.

Geology

The geological origin of Montserrat is based on sedimentary rock. The sediment accumulated in the area that is now the Ebro basin when rivers from the Catalan Mountain range were flowing to the west into the Atlantic Ocean 55 - 35 million years ago.

This agglomerate of pebble- and cobble sized clasts is held together by a calcareous natural cement (sand and clay), called limestone conglomerate. Tectonic movements broke the accumulated sediments into a system of parallel cracks, whereafter wind & water erosion formed the round shape of towers as we see it nowadays.

In reference to the remarkable shape, people named the rocks after animals and figures such as "the bishop" or "the scorpion", around which many legends entwine.

Vegetation of Montserrat

Because we are in a mountain area, we passed by different vegetation types by elevation. Generally, underneath 800 masl we saw the secondary thermophilous mediterranean machia with *Pinus halepensis* occasionally occurring.

Above 800 masl, we found *Pinus nigra*. You can recognize the difference by the shape of the crown of the trees. *P. nigra* has a very flat crown, while *P. halepensis* has a more pointy crown. Above 800 masl, we were in *Quercus ilex* forests (Quercetum ilicis vegetation type), with old *P. nigra* trees in between. In these forests the tree layer is quite dense, while the understory is very open. It is slightly more humid in this area of the mediterranean and especially in the gullies and couloirs. This is where we found those *Quercus ilex* forests.

Compared to the lowland *Q. ilex* forests, some of the species are missing. We see less *Viburnum tinus,* less *Rhamnus alaternus* and less lianas. We have seen some *Rhamnus lycioides*, which has narrower leaves than the *R. alaternus.* Typical species we still found in the Montserrat *Q. ilex* forests were *Ruscus aculeatus, Carex depressa, Carex halleriana, Asparagus acutifolius, Erica multiflora and Erica arborea.*

In the most humid areas with well-developed soils, we also found more mesophilous species like *Corylus avellana, Acer opalus and Daphne laureola.* Here, we also found old big *P. halepensis* trees, which are the remnants of a time where the landscape was more open (machia) because more *Q. ilex* was harvested for firewood. Coppice was a common treatment in this time, this means that trees were cut several times for firewood. We saw that out of 1 *Q. ilex* stem, several stems developed after the coppice. Also, on the north-facing slopes on the way down after ‘Portell estret’, we saw more of those mesophilous species in humid areas.

Finally, the vegetation of Montserrat is rather species rich, because different vegetation types and niches occur along an elevational gradient. The area provides refugia for species endemic to Montserrat like *Saxifraga callosa ssp. catalaunica.* Therefore, it is part of Natura 2000 Management and Project Life to achieve biodiversity conservation and forest fire prevention through an innovative instrument: integrated silvopastoral management (i.e. combining forestry with livestock grazing).

Fig. 24: Rock formation of Montserrat with *Quercus ilex* forest in between.

Fig. 25: Quercus ilex forest with open understory.

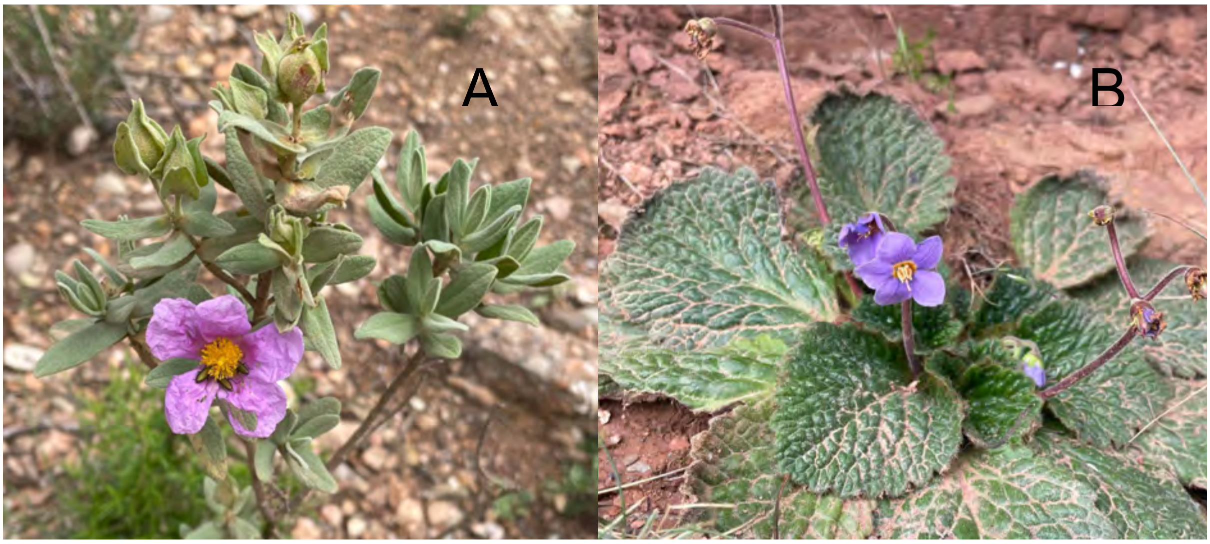


Fig. 26: A: *Cistus albidus* as character species of the thermophilous macchia, B: *Ramonda myconi* growing in shady rock niches.

Species list: Vegetation below 800 masl (thermophilous macchia)

Species	**Family**	**Comments**
Acer monspessulanum	Sapindaceae	Submediterranean species
Amelanchier ovalis	Rosaceae	
Aphyllanthes monspeliensis	Asparagaceae	
Biscutella laevigata	Brassicaceae	Many morphological diverse subsp.
Bupleurum fruticosum	Apiaceae	Shrubby thermophilous
Buxus sempervirens	Buxaceae	In all Mediterranean areas, except Italy. Unknown why we don't find it in Italy. Often used for ornamental hedges. Gets eaten by the 'box tree mot' or *Cydalima perspectalis.* Can grow here also as a tree
Colutea arborescens	Fabaceae	Fruits blow up and explode to spread
Cytisophyllum sessilifolium	Fabaceae	
Dorycnium pentaphyllum	Fabaceae	
Euphorbia segetalis	Euphorbiaceae	
Genista hispanica	Fabaceae	Hairy scrub
Gladiolus illyricus	Iridaceae	
Globularia alypum	Plantaginaceae	
Globularia repens	Plantaginaceae	

Juniperus oxycedrus	Cupressaceae	
Lonicera implexa	Caprifoliaceae	
Ophrys fusca	Orchidaceae	
Phillyrea latifolia	Oleaceae	
Pinus halepensis	Pinaceae	
Quercus coccifera	Fagaceae	
Quercus Ilex	Fagaceae	
Ramonda myconi	Gesneriaceae	dries out and recovers after rain
Rubia peregrina	Rubiaceae	
Salvia rosmarinus	Lamiaceae	
Santolina chamaecyparis	Orchidaceae	
Saxifraga callosa ssp. catalaunica	Saxifragaceae	called "Queens krown"; Endemic to Montserrat and la Mola
Sorbus aria	Rosaceae	
Veronica austriaca	Plantaginaceae	
Viburnum tinus	Adoxaceae	

Species list: vegetation above 800 masl (mesophilous vegetation)

Species	**Family**	**Comments**
Acer opalus	Sapindaceae	
Argyrolobium zanonii	Fabaceae	Trifoliate, Common in shrublands
Asparagus acutifolius	Asparagaceae	
Asplenium ceterach	Aspleniaceae	Fern on rock
Asplenium fontanum	Aspleniaceae	Fern on rock (dry rock walls)
Atropa belladonna	Solanaceae	Often in disturbed locations with avalanches and rockfall
Brachypodium retusum	Poaceae	
Buxus sempervirens	Buxaceae	can grow here also as a tree
Carex depressa	Cyperaceae	
Carex halleriana	Cyperaceae	
Cistus albidus	Cistaceae	Character species of macchia

Clematis vitalba	Ranunculaceae	
Colutea arborescens	Fabaceae	Fruits blow up and explode to spread
Corylus avellana	Betulaceae	
Daphne laureola	Thymelaeaceae	Spatulate leaves, needs some humidity, forms understory in *Q. ilex* forests.
Erica arborea	Ericaceae	Usually on silicate soil, but it occurs here because the soil is deep and the pH not too high, even though we have limestone cementation in his conglomerate
Erica multiflora	Ericaceae	
Erysimum grandiflorum	Brassicaceae	Perennial, undivided leaves
Genista scorpius	Fabaceae	Grazing pressure, robust spines, simple leaves. Loses leaves when it is too dry.
Globularia alypum	Plantaginaceae	Head purple, but blue when younger. Big scrub
Helianthemum appeninum	Cistaceae	White flowers & narrow leaves, found in rocky places
Helianthemum oelandicum	Cistaceae	Yellow flowers & hairy leaves
Helleborus foetidus	Ranunculaceae	
Ilex aquifolium	Aquifoliaceae	Sign of oceanity
Juniperus phoenicea	Cupressaceae	Thin limestone soils
Knautia arvensis ssp. subscaposa	Caprifoliaceae	
Linum narbonense	Linaceae	Shrubby linum
Linum tenuifolium	Linaceae	
Orobanche latisquama	Orobanchaceae	Parasites on *Salvia rosmarinus*
Pinus nigra	Pinaceae	
Pistacia lentiscus	Anacardiaceae	
Prunus avium	Rosaceae	
Rhamnus lycioides	Rhamnaceae	Narrow leaves
Ruscus aculeatus	Asparagaceae	
Ruta chalepensis	Rutaceae	
Sorbus aria	Rosaceae	

Taxus baccata	Taxaceae	Sign of oceanity - Montserrat is a refugium for t. baccata
Teucrium aureum	Lamiaceae	
Teucrium chamaedrys	Lamiaceae	
Tilia platyphyllos	Malvaceae	Only in very protected channels that are shady and humid

Appendix: Seminar Presentations

Geography of Spain

Jet Vessies

The kingdom of Spain is located on the Iberian Peninsula, measuring 505.992 km^2, being the 4th biggest country in Europe. In the west its borders are defined by the Atlantic Ocean and Portugal, in the north the Pyrenees form the border to France and to the south and west the country is surrounded by the Mediterranean sea, with the country of Gibraltar (British overseas territory) in the most southern part. Beside mainland Spain, there are several island groups belonging to the country, namely the Balearic Islands in the Mediterranean Sea and the Canary islands in the Atlantic ocean. Also, there are uninhabited islands in front of the coast to the south. To the Kingdom also belong several minor territories overseas, most of these are along the Moroccan coast.
There are 17 autonomous communities in Spain, of which we visited Aragón and Cataluña in the northeast of the country. The autonomous communities are divided into 50 provinces. Aragón is divided into Huesca, Zaragoza and Teruel, Cataluña into Barcelona, Girona, Lleida and Tarragon. The capital of Spain is Madrid, the second biggest city is Barcelona (in Cataluña). The biggest city of Aragón is Zaragoza.
Spain inhabits 47.35 million people, of which 7.56 million people in Cataluña and 1.32 million in Aragón. The biggest language spoken in Spain is Spanish. In the north, the languages Galician, Astur-Leonese, Basque, Aragonese, Occitan and Catalan (in Cataluña) are the biggest spoken languages (from west to east). Catalan is not just the biggest spoken language in Cataluña, but also further down the eastern coast and on the Balearic Islands.
The distribution of inhabitants in Spain is very unequal. Most people live along the coast and in the big cities inland, while the rural areas are very sparsely populated. A general trend is that young people move away from the rural areas to live in the urban spaces, where more possibilities for employment are found. The Spanish economy consists mainly of the automotive industry, agriculture, tourism, energy, transport, and science and technology.

Fig. 27: Topography of Spain (Gallardo, 2015).

Spain has a very diverse geomorphology and geology, making it a country with many different vegetation types and landscapes. There are several mountain areas and ranges, the main ones are the Cordillera Cantábrica, Sistema Ibérico, Sistema Central, Montes de Toledo, Sierra Morena and the Sistema Bético. In Cataluña we have the Pyrenees to the north and the catalan coastal mountain range to the east, which we also visited during the excursion. In Aragón we find the Pyrenees in the north.
There are several big rivers running through Spain, of which the Ebro (also running through Aragon and Cataluña) is the longest one that runs just through Spain. Other big rivers are the Duero, Tajo, Guadiana, Guadalquivir, Serua, Júcar and Miño. The Ebro makes for the big river basin that we visited in Aragón.
Because of the diversity of geology, geomorphology, and climate there are many different soils found in Spain (fig. 1). The ones found in the areas of our excursion are: dystric, gleyic, and calcic cambisols, and gypsisols.

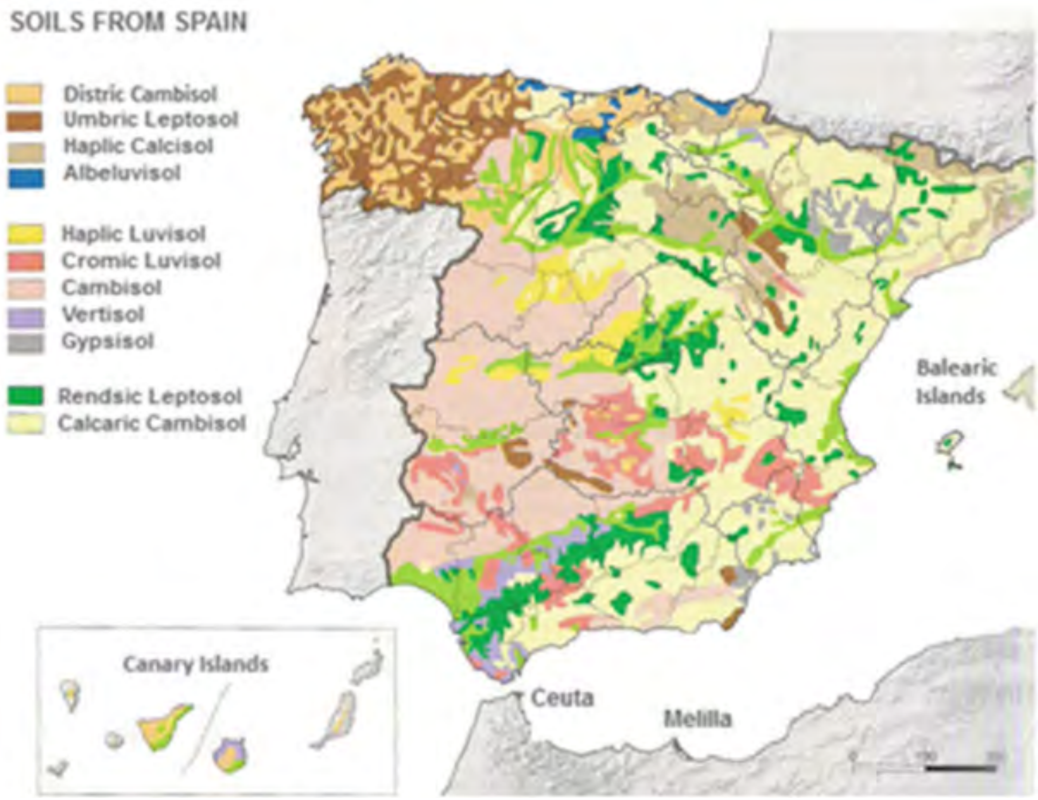


Fig. 28: Main soil types in Spain (Gallardo, 2015).

Geology of Catalunya and Aragón

Helena Back

The Iberian Peninsula has its own geological history. 100 Ma years ago, during the Cretaceous, the Iberian plate was separated from the European and African plate. Parts of the plate e.g., the Northeastern part were under the sea, which is why clastic sediments were deposited. The plate moved towards the European plate and 65 million years ago, during the late Cretaceous, both plates started to collide. The Pyrenees started to develop, and the Iberian and Coastal range lifted. The collision finished around 25 million years ago and the Pyrenees were formed. The rocks are reaching until Cap the Creus where it sinks into the Mediterranean Sea.

As a consequence of the collision, the Ebro basin formed which was disconnected from the Tethys Ocean due to the Catalan Coastal range but open to the Atlantic. From the Pyrenees the Ebro basin was filled with sediments and slowly lost the connection to the Atlantic sea. It became an endorheic system with a high evaporation which resulted in salt deposits. Further many rivers entrained into the basin, building large alluviums and bringing gravels, sands and clays. Closer to the center of the Ebro basin carbonates, gypsums, and occasionally peats were deposited due to the evaporation. Until the soils of the area are

Figure 1 shows an overview of the main geological units of the Iberian Peninsula. In the Following the more detailed geological situations is listed for the stations of the excursion:

<u>Cap de Creus</u>: Metamorphic rocks that were originally sedimentary rocks from the Cambrium Ordovicium era. Mainly Silicates.

<u>Massís de Cadiretes</u>: Granites from the Cambrium Ordovicium Era.

<u>La Mola del Colldejou</u>: Muschelkalk deposition from the Jurassic, Cretaceous and Triassic era.

<u>Monegros in the Ebro basin:</u> Alluvial fans and fluvial depositions. In the center carbonated and evaporitic lakes.

Fig. 29: Main geological units of the Iberian Peninsula (<u>http://atlasnacional.ign.es/wane/Geolog%C3%ADa</u>).

Biogeography and Iberia as Pleistocene Refugium

Michael Mitschke

Biogeography is a highly interdisciplinary research area studying the distribution of for example species, habitats or ecosystems, but also classifies territories hierarchically. Plants are often used for the hierarchial classification of terrestrial systems. The different typological units of the hierarchy, like region, province or sector, are reasoned for example by the occurrence of endemics, an own macro-series or particular succession (Salvador et al. 2017). The biogeographic sub-regions of the Iberian Peninsula are Atlantic-Central at the north-eastern Atlantic coast, Alpine-Caucasian in the Pyrenees and West Mediterranean from the southern Atlantic coast over the central parts and the Mediterranean coast. Our excursion took place in the West Mediterranean sub-region (Salvador et al. 2017). The Mediterranean Region is characterized by hot summers with low precipitation - a summer drought - and mild winters with high precipitation. Ever-green and broad-leafed plant species are characteristic.

In the coastal, maritime “Valencia-Provençe and Balearic Province” we visited Cap de Creus, Montserrat, Massís de les Cadiretes, Bosc de la Marquesa and Mola de Colldejou. In the more continental and arid “Central Iberian Mediterranean Province” we visited Laguna Playa and the Monegros (Salvador et al. 2017).

The recent biogeography is largely shaped by the historic distribution of species. During the ice ages of the Pleistocene, species needed Refugia - places to persist in unsuitable conditions (Medail and Diadema 2009). The location of Refugia is determined by abiotic conditions as well as biogeographic history. For Europe the three major Mediterranean Peninsulas Balkans, Italy and Iberia are considered important Refugia (Nieto Feliner 2014, Gomez and Lunt 2007). Overall favorable for species persistence are mountain ranges by allowing for altitudinal shifts and protected microclimates in gorges and valleys as well as coastal areas by providing local moist and warm conditions (Medail and Diadema 2009). Both Mountain ranges and coastal areas are found in abundance in Iberia. Since different species need different niches, there was not one refugium in the Iberian Peninsula but multiple Refugia within Refugia (Gomez and Lunt 2007). Most of the Refugia were located in southern Iberia. Since not all species expanded and the others experienced genetic loss with re-colonization, southern richness and northern purity can be observed (Gomez and Lunt 2007). Former Refugia are valuable for nature conservation. Endemism and genetic diversity are still high and since they supported species persistence during shifting climate in Pleistocene, they are possibly also suited for species persistence in upcoming climate change (Gomez and Lunt 2007, Medail and Diadema 2009).

We did not directly look into Refugia during the excursion, but we found species which, like species surviving in Pleistocene Refugia, survive unsuitable macroclimatic conditions by persisting in favorable micro-/mesoclimates. Species like *Viburnum tinus* and *Osmunda regalis* are subtropical remnants not adapted to Mediterranean summer-droughts but can persist for example in humid coastal *Quercus ilex* forests as we saw in the Massís de les Cadiretes. *Ilex aquifolium* and *Taxus baccata* also prefer more humid conditions but are less thermophilous and occur for example in the upper region of the Massís de les Cadiretes and valleys of Montserrat. *Juniperus thurifera* needs cold winters to compete and is hence mostly found in higher altitudes, but also in the Monegros, where inversion allows its persistence.

Fig. 30: Salvador et al. 2017: Biogeographic provinces of the Iberian Peninsula are shown. The Western Mediterranean subregion (II) is divided into continental and coastal Provinces. The different biogeographic areas are caused for example by differences in climate, geology and historic distribution of species.

Elevation belts in the Mediterranean

Sarah Brach

Elevation belts are the stratification of ecosystems due to different environmental conditions at different altitudes. Factors which are forming these different ecosystems are for example temperature, soil characteristics, solar radiation or humidity. The first time a person described elevational zonation was Alexander von Humbold in Ecuador on Mount Chimborazo.

Formerly, the classification of the elevation belts in the Mediterranean was according to European vegetation and was not adapted to the Mediterranean area. A new classification was made by Emberger in 1933 and was based on annual precipitation and estimate of evaporation based on the maximum temperature of the warmest month and minimum temperature of the coldest month. The most commonly used classification today is the classification of vegetation soils based on thermal criteria introduced in 1981 by Rivas-Martinez.

The Mediterranean encompasses a large part of the Iberian Peninsula. The elevational zonations which can be found there are divided into six zones. The first zone is called Inframediterráneo and is a desert area with vegetation which is usually characterized by thorny bushes. Bioindicators for this zone are, for example, *Teucrium lanigerum* and *Launaea arorescens*. The second zone is called Termomediterráneo and consists of thermophilous, sclerophyllous forests at an altitude between 0 m to 600 m. Normally, the thermo-Mediterranean is quite coastal, but it also occurs in inland areas where there is noch adiabatic gradient phenomenon. Bioindicators are, for example, *Aristolochia baetica* or *Chamaerops humilis*. The third elevation zone is Mesomediterráneo and consists of holm oak forests, cork oak forests and deciduous forests at an altitude of 600 m to 1200 m. This zone is the predominant type in the Iberian Peninsula and is characterized by winter frosts and high temperatures in summer, which causes water stress for the plants. Bioindicators are *Quercus ilex* and *Quercus suber*. The fourth altitude zone which is situated at an altitude between 1000 m and 1600 m consists of aciculifolious forests. The zone is often limited by slopes and is characterized by a mountain climate with frequent frosts in winter and high temperatures in summer. *Juniperus thurifera* and *Acer granatense* are examples of bioindicators of this zone. The fifth elevation zone which is situated at an altitude between 1600 m to 2000 m is called "Oromediterráneo" and consists of open coniferous forests. It is characterised by a mountain climate with frequent frost in winter and high temperatures in summer. Bioindicators are, for example, Pinus *nigra* and *Genista versicolor*. The elevation zone which is the most elevated at an altitude between 2700 m and 3000 m is called "Crioromediterráneo" and consists of open grasslands. It is characterised by a high Mediterranean mountain climate with frequent frosts and long winter. The summer is drought which leads to a very short favorable period for plant development. Plants and bioindicators which grow there are, for example *Agrostis nevadensis* and *Erigeron frigidus*.

During the excursion we saw the elevation zone „Oromediterráneo" for example on day four, which was found on the mountain top plateau. On day five of the excursion we saw a desert area in the Ebro Valley, which can be found at the elevational zone „Inframediterráneo". The aridity is high due to strong winds, temperature extremes in summer and winter and as well as rain shadow caused by the bordering mountain chains.

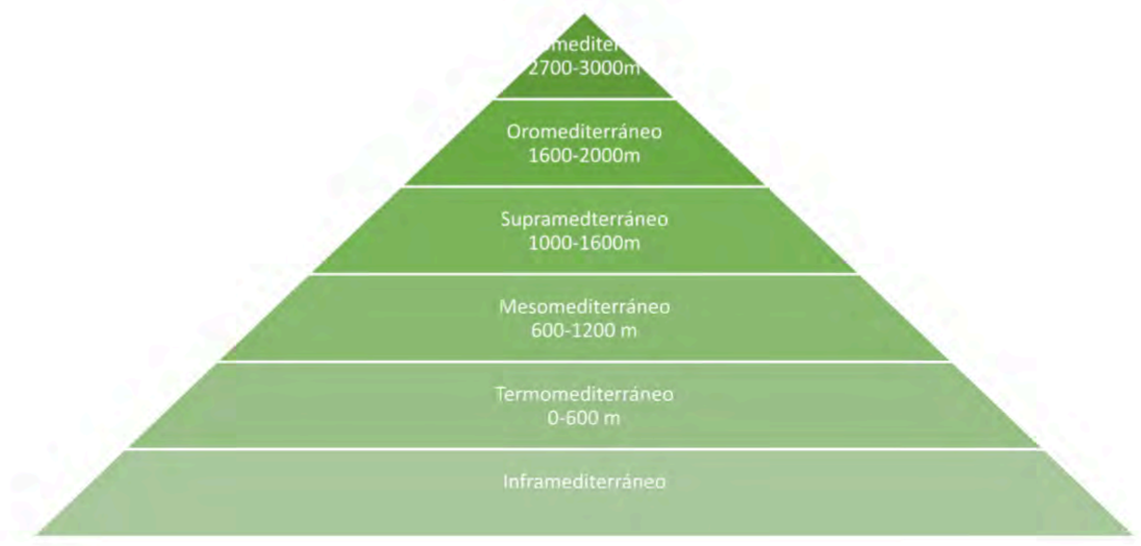


Fig. 31: Elevational zonations of the Iberian Peninsula introduced by Rivas-Martinez.

Mediterranean shrub vegetation: Garrigue, Macchie

Simon Eisele

Two common vegetation types that occur in the Mediterranean region are Shrublands and Scrublands. Shrublands, commonly called “maquia” “maquis” or “macchie”, are 2-4 meters tall hardwood stiff-leaved evergreen formations, sometimes interspersed with trees, allowing only a small amount of ground flora to grow. They occur on calcareous soils in the coastal area and are mostly result from the impact of human activities. They act as successional stages of evergreen forests, as potential vegetation or permanent communities when soil conditions do not allow forests to develop. Some character species of this vegetation type are *Arbutus unedo, Cistus monspeliensis, Lavandula stoechas, Erica arborea, Myrtus communis* and *Salvia rosmarinus.*

Scrublands, also called “garrigues”, are widespread dwarf shrub community which grows knee high and represents an open plant community among which occur in large numbers therophytes and geophytes. They occur on both siliceous and calcareous substrates and are also result of years of human intervention. Some character species of this vegetation type are *Cistus albidus, Aphyllanthes monspeliensis, Globularia alypum, Ulex parviflorus* and *Smilax aspera.*

In the Mediterranean region there are many witnesses of prehistoric and early historic settlement. In the times of Romans and Greeks, wood was exploited and used for construction and shipbuilding, for furnaces to extract metal, to fire pottery or to melt glass. The bark of the trees was used for tanning leather and sheep and goats grazed heavily. Furthermore, forest fires contributed to reduction of forest stands. That development was the basic reason for widespread occurrence of macchie and garrigue in the Mediterranean region. Today they mostly occur in areas where agriculture is not profitable because of poor soils or not possible because of the steepness of the soils or rockiness.

Besides the forest fires caused by humans, natural wildfires are an important factor for the spread and preservation of shrub and dwarf shrub formations. The Mediterranean vegetation is particularly vulnerable to fire because of seasonal coincidence of heat and drought, the density of shrubs and trees, and the essential oils and resins that make the scleromorphic leaves and wood very flammable. Therefore, native plants developed specific adaptations like high regenerative capacities or germination abilities of seeds who improve after fire passage. However, fires cause downgrading of biomass, reduced land productivity, increased runoff and deep percolation on the burned slopes which leads to high erosion and leaching of nutrients.

During the excursion we saw the biggest and most species rich macchie and garrigue at Cap de Creus. Some smaller and sometimes patchy forms of this vegetation type in combination with other vegetation types, for instance Quercus ilex forest, we saw at Bosc de Marquesa, where it occurs as a transitional stage from the forest to the rock cliffs of the sea. Furthermore, we saw some elements at Laguna de la Playa and at Montserrat between the rock faces.

To sum it up: macchie and garrigue often occur together or besides each other and can be seen as anthropogenic degradation stages of the hardwood forest, which are causes by different intensities of cane felling, artificial fires and grazing. In case of cutting at intervals of 20 years, a macchie is formed, and in case of a rhythm of 6-8 years, a garrigue. But there are also natural forms of this vegetation type caused by wildfires. In case of excessive exploitation, grass communities prevail as the third stage of degradation. If this continues, Mediterranean rocky heaths or vegetation-free areas are formed.

Mediterranean forests in the Iberian Peninsula: Quercus ilex, Quercus suber, Quercus pyrenaica, Pinus halepensis

Felix Wetzel, Daniel Baumgartner

The Mediterranean forest vegetation is characterized by the abundance of sclerophyllous, evergreen trees and shrubs.

Quercus ilex can be designated as main indicator species of the Mediterranean, occurring with two subspecies in this region. *Quercus ilex* subsp. *ilex* has entire or dentated lanceolate to oblongo-lanceolate leaves with 7-14 veins and grows in the coastal humid parts of the Iberian Peninsula. Under warm and coastal conditions, the forests of *Quercus ilex* subsp. *ilex*, the so called "encinares", evolve a dense shrublayer. In the Massís de les Cadiretes we saw it accompanying *Quercus suber* in forests with e. g. *Clematis flammula*, *Rubia peregrina*, *Ruscus aculeatus* and *Asparagus acutifolius*. By contrast it occurs also in higher elevations which we experienced in a species poor and shady montane forest of Mola de Colldejou: due to the height, ozeanic and submediterranean species such as *Ilex aquifolium*, *Rubus fruticosus*, *Asplenium onopteris*, *Helleborus foetidus*, *Prunus mahaleb* and *Scabiosa columbaria* could thrive. Another example for a montane *Quercus ilex* forest was on the higher elevations (ca. 800 m) of Montserrat where we could see mainly *Ruscus aculeatus*, maybe benefitted by grazing, *Asparagus acutifolius* and *Erica arborea* and rarely *Viburnum tinus*, *Rhamnus alaternus* and less lianas in the understory.

Quercus ilex subsp. *rotundifolia* has suborbicular to broadly elliptical leaves with 5-8 veins and is characteristic for the more continental and thermomediterranean parts of Spain with marked summer droughts. Due to that fact we saw it less than *Quercus ilex* subsp. *ilex* during the excursion. In thermo- and mesomediterranean thermotypes the Rubio longifoliae-Quercetum rotundifoliae is the typical plant community whilst in higher elevations it is the Hedero helicis-Quercetum rotundifoliae.

Quercus suber is also an evergreen oak with heterophyllous oval leaves and a characteristic thick bark which protects the phloem of fire damages and is used by humans for a long time. Typically, *Quercus suber* grows in northeastern Spain on poor, sandy and silicate soils in the coastal, thermomediterranean region under subhumid conditions corresponding to ca. 800 mm precipitation per year. It is furthermore often planted for cork stripping in the Western Mediterranean. Natural *Quercus suber* forests ("alcornocales") have a rich understorey of two shrub layers in young states with many subtropical evergreen species such as Viburnum tinus besides *Rhamnus alaternus*, *Phyllirea latifolia* and angustifolia and lianas like *Clematis vitalba*, *Hedera helix*, *Lonicera implexa*. Heliophilous shrubs like *Erica arborea*, *E. scoparia*, *Cistus salvifolius* and *Prunus spinosa* are also typical. In the herbaceous layer occur e. g. *Luzula forsteri* and the ferns *Asplenium onopteris* and *Polypodium cambricum*.

Quercus pyrenaica is, in contrast to the above-named evergreen oak species, a marcescent tree with deeply lobed leaves which are pubescent on the lower side. This oak grows under subhumid-hyperhumid climate and is limited by summer drought which leads to a more submediterranean distribution in transition between the Mediterranean and temperate forests in the Western Mediterranean region. It occurs mostly on siliceous and deep soils in medium elevations, but notwithstanding its name barely in the Pyrenees. The forests called "melojares" were often used for coppice and grazing and are therefore rarely dense. There are three important associations in the Iberian Peninsula: the Pulmonario longifoliae-, Luzulo forsteri-, and Cephalanthero rubrae-Quercetum pyrenaicae. We did not see *Quercus pyrenaica* forests on our excursion.

Pinus halepensis has light-green needled in pairs and cones that hang characteristically in a 90° angle from the branches. The tree crown is light and irregular, often shaped by the influence of strong wind, and the bark is typically grey. Forests of *Pinus halepensis* occur in coastal areas and low elevations of the Iberian Peninsula primarily on base-rich soils. In the

Bosc de la Marquesa we could see a coastal *Pinus halepensis* formation on former olive tree terraces which corresponds rather a shrubland with open tree layer of monodominant *Pinus halepensis*. The understorey of this Macchia consists of thermophilous species like *Rhamnus lycioides*, *Chamaerops humilis*, *Quercus coccifera* besides *Rhamnus alaternus*, *Ulex parviflorus*, *Juniperus oxycedrus* subsp. *oxycedrus*, *Erica multiflora* and *Osyris alba* together with *Olea europaea*. In transition to the sea the shrublayer gets more dense and lower comprising *Myrtus communis*, *Juniperus phoenicea* subsp. *turbinata* and halophytic her. In this zone *Pinus halepensis* grows more like a shrub which leads to the complete loss of a forest appearance. Besides from that *Pinus halepensis* subordinated also in other forest types like *Quercus suber* forests.

Fig. **32**: Coastal *Pinus halepensis* formation (left), montane *Quercus ilex* forest (right).

Gypsophilous vegetation

Jonas Geurden

Gypsum is saturated calcium sulfate in its crystalline form: $CA[SO_4]*2H_2O$. Its reaction formula is: $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$ | Calciumcarbonate + Sulfuric Acid → Calciumsulfite + Water + Carbondioxide.
Gypsum forms mainly via two ways: Either through crystallization of mineral-rich (sea-) water or through direct contact of sulfuric acid and calcareous rock.

Gypsum soil has a high amount of calcium and sulfur which leads to an increased accumulation of those chemicals in plants. Habitats are often exposed, dry and open and therefore also susceptible to erosion.
Climate in regions with gypsum soil has a relatively high temperature gradient, mainly on a day-night cycle.
Gypsum crust (physical soil crust) on surface is a barrier that needs to be dealt with.
Biological soil crust within gypsum habitats is very important for carbon and nitrogen cycling, water infiltration and runoff as well as soil stability.

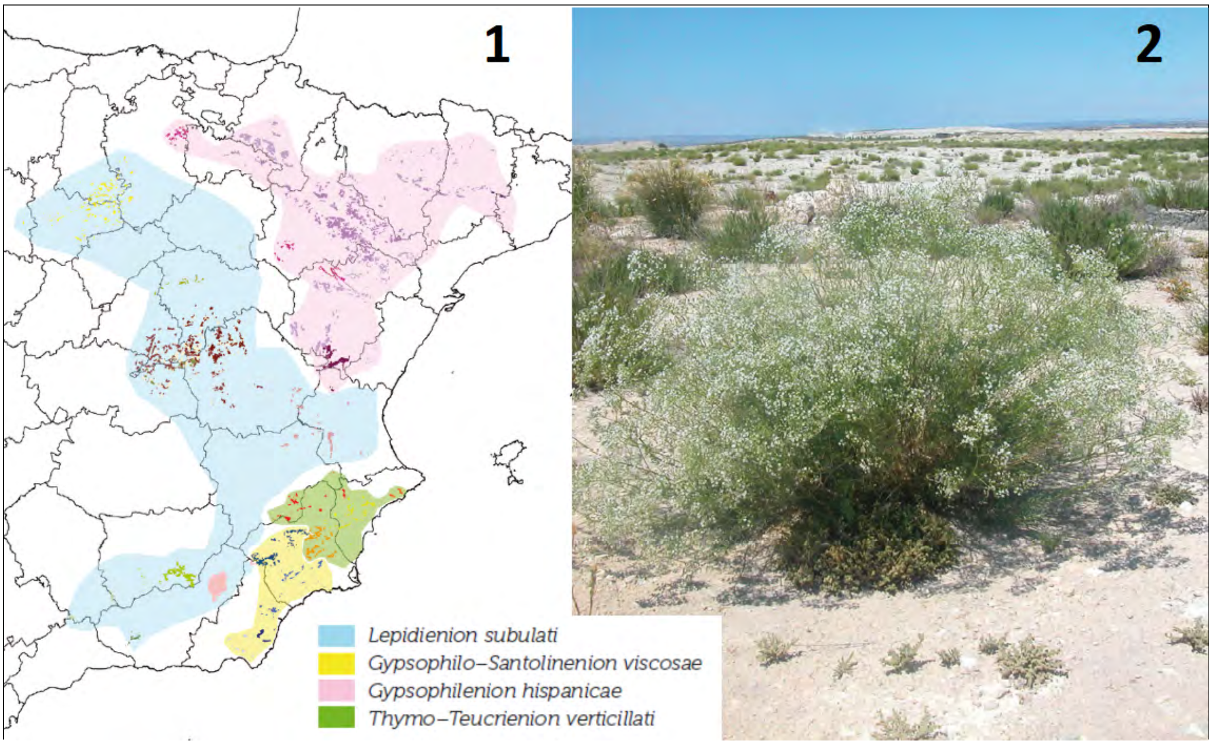


Fig. 33: (1) distribution of the Gypsophiletalia (2) typical Gypsophiletalia vegetation [Garrido-Becerra et al. 2011 - La vegetacion del orden Gypsophiletalia: matorrales sobre yeso].

There exist different habitat types. (1) Lakes of gypsum karst (e.g. Lake of Banyoles) are water bodies above gypsum soil. There are no specific plant species which adapted this habitat.
(2) Forests on gypsum soil can also form. In general a less extreme climate is necessary for their existence. (3) Gypsum grasslands often have a very high diversity and a high amount of endemism. On the Iberian Peninsula this vegetation is called Iberian gypsum vegetation and defined by the order of the Gypsophiletalia.

The Gypsophiletalia is an order of the class Ononido-Rosmarinetea and combines four alliances which are geographically and climatically distinct. The alliance of the Ebro basin is called Gypsophilion hispanicae. Characterspecies of the order and this alliance are *Boleum asperum*, *Euphorbia minuta ssp. moleroi*, *Frankenia thymifolia*, *Gypsophila struthium* ssp. *hispanica*, *Helianthemum squamatum*, *Herniaria fruticosa*, *Launaea fragilis*, *Lepidium subulatum*, *Ononis tridentata*, *Sideritis spinulosa* and *Thymus loscosii*.

Gypsum plants can be put in three categories: (1) Wide gypsophiles can penetrate the physical soil crust and have physical adjustments to the chemical limitations. (2) Narrow gypsophiles can deal with physical soil crust but have no specific adaptations. (3) Gypsophags are non-specialists which need the physical soil crust to be absent or reduced.
Specialised gypsum plants in general have efficient germination at low temperatures, seed and fruit heteromorphism within and among populations and short distance seed dispersal. The latter is responsible for the high endemism and the taxa being relatively old.
The biological soil crust is most important for ecosystem processes. It mainly determines the structure within plant communities.
Gypsum plants are generally endangered by climate change and landscape fragmentation.

Mediterranean vegetation and climate warming

Žan L. Cimerman

We are living in a world with a changing climate. Extreme weather events, floods, and drought are just some of the changes we are already seeing, but what are the effects of climate change on Mediterranean plants? A study by Giménez-Benavides et al. (2017) outlines some effects of climate change on Mediterranean vegetation. Because of higher temperatures, many plants are changing their distribution areas. We witness the so-called 'Escalator effect' in mountains, which is seen as an upward migration of species. Retrospective studies have provided clear evidence of rapid vegetation changes in the Mediterranean high mountains, both by re-visiting surveys and analysis of historical aerial images and palynological records. Increased summer drought events are influencing the flowering period, either shifting the flowering period or changing the duration of it. Other effects include decreased reproductive performance, vulnerability to pollinator limitation etc. During the excursion we saw some dying old trees, which could be the state for many more plants in the future.

Mediterranean forest growth is constrained by drought and high temperatures during summer. This is also the reason why many trees do not grow as tall as they would in a more temperate climate. A study (Sabaté et al. 2022) focused *on Quercus ilex, Pinus halepensis, P. pinaster, P. sylvestris, and Fagus sylvatica* forests in the Mediterranean highlights some effects of water availability and higher temperatures on the growth of these trees. The predicted increase in temperature would significantly influence mean leaf life span in such a way that the life span of leaves of evergreen species would be reduced, accelerating leaf turnover. *Q. ilex* and *Pinus* species would expend more carbon in maintaining and producing leaves to replace those lost in an increased turnover rate. In general, temperature and rainfall may constrain growth during certain periods, but if rainfall increases in the future, a positive effect on growth is likely.

Although the changes may seem negative, many ecosystems are durable and have mechanisms to survive harsh periods. An interesting example of the resilience of the mediterranean ecosystem was shown in a study (Mouillot et al. 2016), where they used two indicators, namely the normalized difference vegetation index (NDVI) and the enhanced vegetation index (EVI) to test the recovery of the ecosystem from successive disturbances between 2000 and 2013. This included the peculiar 2003 heat wave, a pest attack in 2005 (gypsy moth defoliation), and a severe drought in 2006. Both the indicators were affected in 2005 and 2006, but a quick recovery was observed after 2007, followed by a stable trajectory even during the dry years of 2009 and 2010. This leads to a highly stable ecosystem. The authors concluded that this forest is resilient to climate change.

Exploitation of cork

Adam Seyr

Cork is a biological material that has attracted the attention of humans since antiquity. Due to its unique properties such as elasticity, near impermeability, hydrophobicity, low density and low thermal and acoustic conductivity it is a well-suited material for various applications. We all know cork as the closure of wine bottles, but it is also used for gaskets, fishing floats, badminton shuttlecocks, music instruments, insulation material and much more.

From the botanical point of view cork is the phellem of the bark system in dicotyledonous plants with secondary growth. It consists of dead cells with thick cell walls making up a three-dimensional network of a solid matrix that encircles hollow air-filled spaces. The main structural components are suberin, lignin and the polysaccharides cellulose and hemicelluloses.

The industrially used cork is extracted from the bark of the cork oak *Quercus suber*. The extraction of cork is done manually with a very sharp axe by cutting large rectangular planks and pulling them out from the tree. The cork oak is unique in its high capability to regenerate a new outer bark after harvest. The first cork harvest is conducted when the tree is approximately 30 years old. Thereafter, harvests are practiced at 9- to 12- year intervals, the time necessary for the trees to grow a new layer of bark of ca 30 mm thickness.

Quercus suber is an evergreen tree native to the western Mediterranean areas of southern Europe and North Africa. This low spreading tree with a short stem and long branches attains average heights of 15 m and can live up to 200 years. Each year, cork oak trees produce a new cork ring that is not shed naturally. Over the years, the cork coat can reach a thickness of up to 20 centimeters. This feature, extremely rare in the plant kingdom, has evolved as protection against the periodic fires common throughout the Mediterranean.

Besides being the source of cork, the cork oak savannas are valued for their ecological role to contain desertification and soil erosion, for their high biodiversity and for their role in the global carbon budget. However, the present cork oak savannas are not natural systems, but the result of centuries' continuing human activity. Such human shaped ecosystems can only be maintained through sustainable use. Nowadays many cork oak savannas are endangered by abandonment in southwestern Europe and by overuse in north western Africa. To counteract this, Payments for Ecosystem Services (PES) schemes could provide opportunities to promote sustainable use, conservation and restoration of cork oak savannas.

Fig. 34: Harvesting of cork from *Quercus suber*.

Animals in the Mediterranean parts / steppes of the Iberian Peninsula

Valentin Heimer

The Iberian Peninsula is characterized by an extraordinarily high diversity of not only vascular plants but also animals. A total of 115 mammal, 28 amphibian, 47 reptile and 661 bird species have been recorded for the Iberian Peninsula, not to mention the approximately 45,000 arthropod species. The extensive dry and continental regions within the peninsula are habitats of European relevance for numerous steppe birds, such as Giant bustard (*Otis tarda*) and Little bustard (*Tetrax tetrax*), two species of sandgrouses (*Pterocles orientalis* and *Pterocles alchata*), and several larks, such as the Calandra lark (*Melanocorypha calandra*) and Dupont's lark (*Chersophilus duponti*). While exhibiting climatically different conditions, also the Mediterranean regions that can mostly be found at the eastern and southern coast of the peninsula, are incredibly species rich and provide habitat for numerous animals such as Hermann's tortoise (*Testudo hermanni*) or the Montpellier snake (*Malpolon monspessulanus*), the largest reptile on the Iberian Peninsula.

Spain and Portugal are not only rich in species but also represent hotspots of endemism due to several refugia that allowed the survival of many biota during Pleistocene glaciations. Thus, many endemic species can be found on the Iberian Peninsula, such as the Spanish imperial eagle (*Aquila adalberti*), the Iberian lynx (*Lynx pardinus*), the Iberian midwife toad (*Alytes cisternasii*), the Andalucian anomalous blue (*Polyommatus violetae*) and the grasshopper *Dociostaurus hispanicus.*

During the excursion, we saw several species characteristic for the steppe regions of Spain. Prime examples of these are the Common Roller (*Coracias garrulus*), a strikingly blue insect-feeding bird of the family of Coraciidae that inhabitats rather open landscapes with some trees or shrubs and the Eurasian hoopoe (*Upupa epops*) of the same family, that can be found in similar habitats. Another species which is widespread in Spain and that we saw often during the excursion is the Red kite (*Milvus milvus*), a bird of open agricultural land and steppes that is rather uncommon in Tyrol. A rarer sight also in Spain is the Lesser kestrel (*Falco naumanni*), which we were lucky enough to see at Laguna de la Playa in the Ebro basin. This species has undergone severe population declines, resulting in its extinction in Catalonia in the 1980s and substantial efforts have since then been undertaken to support its reestablishment in the region. Another ornithological highlight of the excursion were several Common griffins (*Gyps vulvus*) which we could observe directly above our heads during the drive from Laguna de la Playa to Monegros. Typical insects of thermophilous habitats that we saw were the mantis *Empusa pennata* in the salt marsh vegetation of Laguna de la Playa and a species of the rarely seen family of spoonwings (Nemopteridae), which we found in the open *Juniperus thurifera* forests

Fig. 35: Common griffin (*Gyps vulvus*) and spoonwing (Nemopteridae).

Recent history of Catalonia: the long way of becoming independent

Markus Finner

The term "Catalonia" is first documented in an early 12th-century Latin chronicle. In a long history of being invaded and becoming independent again, being part of the Kingdoms of Aragon and Castile, always caught between the rulers of Spain, France and the Habsburg dynasty. This region was always stuck between self-government and foreign rule.

Most important Ups and Downs in terms of self-government in the recent Catalonian history:

- Since the 1830s catalonia became a centre of Spain's industrialization. At the same time also a Catalan cultural renaissance a cultural movement to recover Catalan language and culture after a long period of decay. The 'Catalan Commonwealth' was created
- In 1919 the Commonwealth promoted the first project of a Statute of Autonomy, but the disagreements with the government of Madrid, the opposition of sectors of Spanish society and the coincidence with the rise of the workers movement and anarchistic tendencies provoked the fall of the project and ended up in the 1923–1930 dictatorship of Miguel Primo de Rivera with repression of Catalan nationalism, language and labour movement.
- After the fall of Primo de Rivera, the Catalan left made great efforts to create Catalan self-determination, the party achieved a spectacular victory in the municipal elections 1931 and proclaimed the Catalan Republic with a newStatute of Autonomy for Catalonia. The Statute gave a strong grant of self-government, and declared Catalan as official language
- In July 1936, the Spanish Army carried out a partially failed coup d'état which led to the Spanish Civil War. As in the rest of Spain, the Franco era (1939–1975) in Catalonia abolished completely the Catalan self-government, the statute of Autonomy and brought in a dictatorial regime, which took strong measures against Catalan nationalism, culture and language.
- The economic recovery after the civil war was very slow.The period was marked by agricultural modernization, a massive expansion of industry and the start of mass tourism, which was

concentrated on the coast. As industry in Catalonia expanded, workers migrated from rural areas across Spain to work in Barcelona and its surrounding area.

- Franco's death initiated a period during which democratic liberties were restored. In 1979, the new Statute of Autonomy was finally approved. In it, Catalonia is defined as a "nationality", Catalan is recognized as Catalonia's own language, and became co-official with Spanish. First election to the Parliament of Catalonia under this Statute gave the Catalan presidency to Jordi Pujol, a position he would hold until 2003.
- A 2003 elected left-wing nationalist government proved unstable. The new Statute of Autonomy of August 2006 consolidated the self-government, and included the definition of Catalonia as a nation, but Constitutional Court of Spain decided to declare nonvalid some of the articles (e.g. autonomous Catalan system of Justice, aspects of the financing, the status of the Catalan language or the references of Catalonia as a nation) As a response many demonstrations were held, and the civil society started a process of organization the right of self-determination. This ended up in a controversial independence referendum in Catalonia on 1 October 2017. It was declared illegal in September 2017 and suspended by the Constitutional Court of Spain and also the European Commission agreed that the referendum was illegal. Just hours after this declaration the Spanish Constitution declared the dissolution of the Catalan Parliament and dismissed Catalonia's Government, including its president, Carles Puigdemont. Spanish Deputy Prime Minister Santamaria was chosen to assume the functions of the President of Catalonia.
- On 1 May 2018 Quim Torra was elected President of Catalonia after the Spanish courts blocked the election of Carles Puigdemont.

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