Pre-Symposium Excursion: Mediterranean landscapes

12th -18th June 2011

The objective of the field trip is to introduce you to some of the most typical ecosystems of Southeastern France, from species-rich dry grasslands to forests and salt-marshes and from the sea level to the low-alpine level.

Field trip map

Avignon, the pope's palace and the bridge – Renaud Jaunatre

This itinerant field trip will begin in Avignon along the Rhone river, will tour throughout the Luberon matorrals (garrigue shrublands) and forests, the Camargue wetlands, temporary pounds and salt marshes, the Crau steppe, the Bonnieu littoral species-rich dry grasslands, the sea cliffs of the Calanques, the north forest and the exposed crests of the Sainte-Baume and mountain grasslands of the Ecrins National Park and will end in Bourg d'Oisans in the Alps.

The program:

Sunday 12th: Avignon

Monday 13th: Luberon (Daniel Pavon – Arne Saatkamp)

Tuesday 14th: Camargue (Patrick Grillas – François Mesléard – Nicole Yasercovski)
Wednesday 15th: Crau (Elise Buisson – Thierry Dutoit - Renaud Jaunatre – Axel Wolf)
Bonnieu (Daniel Pavon – Arne Saatkamp)

Thursday 16th: Calanques (Daniel Pavon – Arne Saatkamp)
Sainte Baume (Daniel Pavon – Arne Saatkamp)

Friday 17th: Ecrins National Park (Cédric Dentant)

Day 1: Luberon

Location of Excursion

1-Short description of the area

Name	Plateaux de Vaucluse, Luberon
Municipality	Lagarde d'Apt
Département (county)	Vaucluse
Ecosystem type	Traditionally managed cereal fields, dry calcareous grasslands, beech forests (*Fagus sylvatica*) and downy oak forests (*Quercus pubescens*)
Management authority	Parc Naturel du Luberon, CEEP
Protection status	None

2-Ecological characteristics

The Luberon mountain ridge is a representative of the vast surfaces of limestone mountain ridges in Southern France, North Eastern Spain and Northern Italy all with similar bedrock types, climate and agricultural landscapes.

Luberon woodland and ridges – Renaud Jaunatre

Climate of the Luberon area

This area is characterised by Mediterranean climate (Salon: mean $rainfall_{1971\text{-}2000}$: 623 mm, with maxima in April and October, data: Météofrance, 2009). There is one climatic gradient in the study area, *i.e.* a combined temperature and rainfall gradient due to the higher altitude of the Northern part of the study area. Figure 2 indicates details on rainfall and for temperatures. The rainfall pattern shows marked differences among years, notably a long dry period in summer 2007, a year when effective rainfalls did not occur until November.

The ecology of cereal weeds is closely bound to the agricultural practices of cereal cultivation (Schneider, Sukopp, & Sukopp 1994). In traditional systems in the Western Mediterranean, cereals are sown when the field has been prepared by ploughing in September and October just after the first autumn rains. Over winter, there is no treatment of the fields, in modern more intensive systems herbicides and chemical fertilizers are applied during autumn or spring. In some cases, the field is rolled over to break primary

shoots of cereals in order to produce several shoots per individual. In traditional systems, weeds, especially when they become apparent during flowering, were sometimes pulled out by hand and used as forage. Cereals are harvested between end of June and July, when they completed ripening and grains became tough. Cereals are stored dry in the storehouses. In autumn, cereal fields are used as pastures, Gerbaud *et al.* (2001) showed that cereal weeds constitute a high quality nutriment complement for sheep.

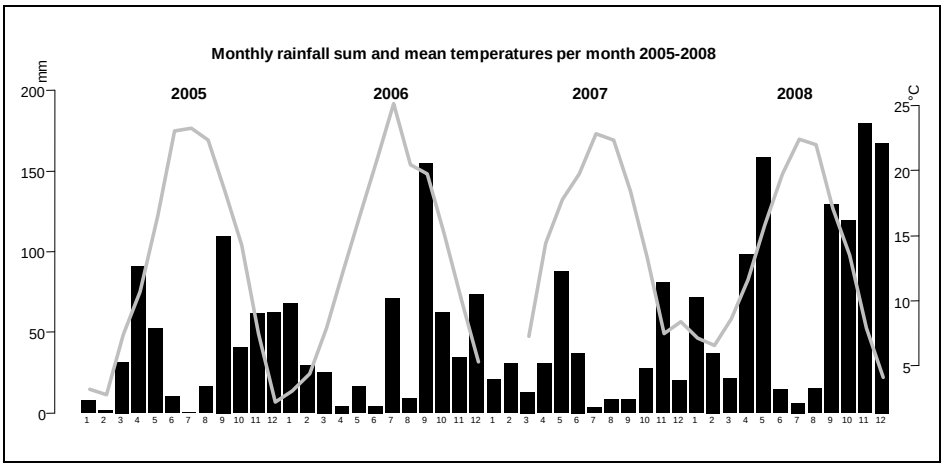

Figure 2: Monthly rainfall sum (black bars, scale at the left) and mean temperatures per month (grey line, scale at the right) for the study period, rainfall at La Roque d'Antheron, temperature at Manosque (data: www.infoclimat.fr).

Papaver rhoeas and *Centaurea cyanus* – Daniel Pavon

There are considerable differences among practices in farms in the Luberon area (see map below). Gasc (2005) identified three actual types of farms that cultivate cereals: cereal dominated farms, cereal culture with sheep flock and organic farmers with cereals. In cereal-dominated farms, herbicides are intensively used, seed material is not re-sown but bought every year and there is only a short fallow period or a rotation with another crop.

In the remaining farms, herbicide use is an exception and rotation alternate one to five years of cereals with a period of fallow-pasture or legumes. In the Luberon area the legume phase of the crop rotation is often three years of *Onobrychis sativa* (figure 3). According to the farmers experience this reduces considerably the soil seed bank of weedy species.

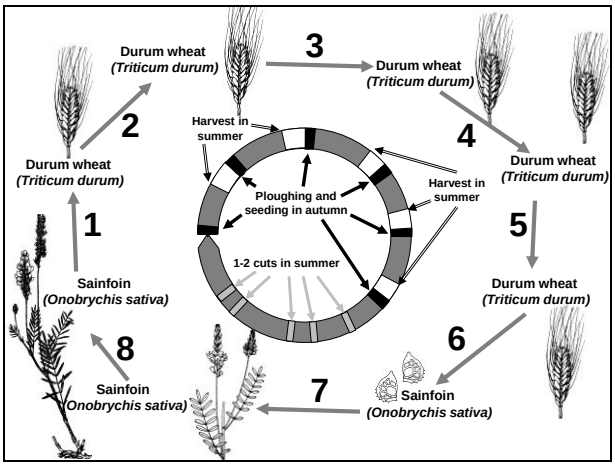

Figure 3: Eight years of traditional crop rotation in the Luberon area with intercrop; disturbances as inner circle, black: open bare soil, dark grey: standing crop, light grey: cut crop, white: stubbles.

Farm produced seed material is frequently re-sown, in some cases, especially small farms with sheep flocks. Weed seeds are even not sorted out before reseeding (Gasc 2005). Jäger (2002) counted seeds in four replicates of 1 kg seeding material and could identify 43 different cereal weed species with a mean of over 12000 weed seeds per kg seeding material. We counted weed seeds from a cereal sample from traditional cereal agriculture in Algeria, where we identified only eight species and much less seeds per kg cereals (Saatkamp, unpublished data). This illustrates that 'speirochory' *i.e.* the transport and reseeding of weed seeds into cereal field is a general and important factor for dispersal of cereal weeds, which has probably an impact on weed population dynamics. According to Jäger's (2002) and our own sample from Algeria there is no strict selection of species with particular seed sizes, however a tendency to greater plant height. Both wheat samples contain small species *(Aegilops sp., Anagallis arvensis)* as well as small seeded species *(Papaver rhoeas, Legousia speculum-veneris, Silene sp.).* In the light of the very simple techniques of some small farms, the evolution of agricultural practices in the area from first appearance of agriculture in the Neolithic to today are the mechanisation of working steps, larger cultivated surfaces, deeper ploughing and different cultivated crops together with probably a shorter field rotation. For the more intensive farms, synthetic herbicides and fertilizers, high performance crops and intensive field preparation are in sharp contrast with this traditional farming. In the study period (1983-2006), there was a shift to more winter wheat cultivation and abandonment of marginal fields and pastures (Gasc 2005).

Legousia speculum-veneris
Daniel Pavon

3-Excursion Area history /context

Several processes have been identified that trigger(ed) the regression of cereal weeds in present day landscapes and at the same time favoured other often more ruderal species. (i) The use of herbicides impacts both plant establishment and soil seed banks, favouring resistant lines (Ball 1992; Schneider *et al*. 1994; Fried *et al*. 2009). (ii) Change in characters, identity and density of crop plants yields a higher competition on weed species (Schneider *et al*. 1994), however Roche *et al.* (2002) clearly showed that higher cereal density favours cereal weeds with respect to other ruderal plants. (iii) The use of chemical fertilizers instead of organic manure triggered regression mediated by

a changed nutrient status of soils (Schneider *et al*. 1994). (iv) Cleaning of seeding material before sowing leads to a lower seed input and enhanced isolation of populations among different fields (Schneider *et al*. 1994; Ellenberg 1996; Olivereau 1996; Jäger 2002). In general, arable weeds are known to form often long time persistent seed banks, but some cereal weeds like for example *Agrostemma githago* lack any dormancy or darkness inhibition of germination and do not form a persistent soil seed bank (Schneider *et al*. 1994; this work). In areas with traditional cereal agriculture, where these species still persist, it could be shown that cereal weed communities quickly lose the most interesting species after abandonment, and their regeneration from the soil seed bank is impossible (Jäger 2002; Dutoit *et al.* 2003). This can at least partly be explained by the striking differences in the longevity of soil seed banks, but also by the changes in dispersal processes at the landscape scale (Schneider *et al.* 1994; Saatkamp *et al.* 2009; llenberg 199E6; Bonn & Poschlod 1998; Jäger 2002; Dutoit *et al.* 2003). Because of its high diversity in rare cereal weeds and the traditional agriculture the Luberon area is of high conservation interest on a European scale for these plants (Aboucaya *et al*. 2000).

Agrostemma githago
Daniel Pavon

3-Points of interest

We will have a look on some very species rich cereal fields, to then have time to do a small hike in an area composed of cereal fields, dry calcareous grasslands, downy oak and beech forests. This will give the opportunity to have a deep insight into the vegetation complexes of a traditionally managed limestone upland area of South Eastern France.

5-References

(the papers of Gerbaud et al, Dutoit et al and Saatkamp et al are related/realised in the area visited, they can be requested for at the following e-mail adresses : arnesaatkamp@gmx.de, thierry.dutoit@univ-avignon.fr)

Aboucaya, A., Jauzein, P., Vinciguerra, L., & Virevaire, M. (2000) Plan National d'Action pour la conservation des plantes messicoles. PhD thesis, Direction de la Nature et des Paysages, Ministère de l'Aménagement du territoire et de l'environnement.

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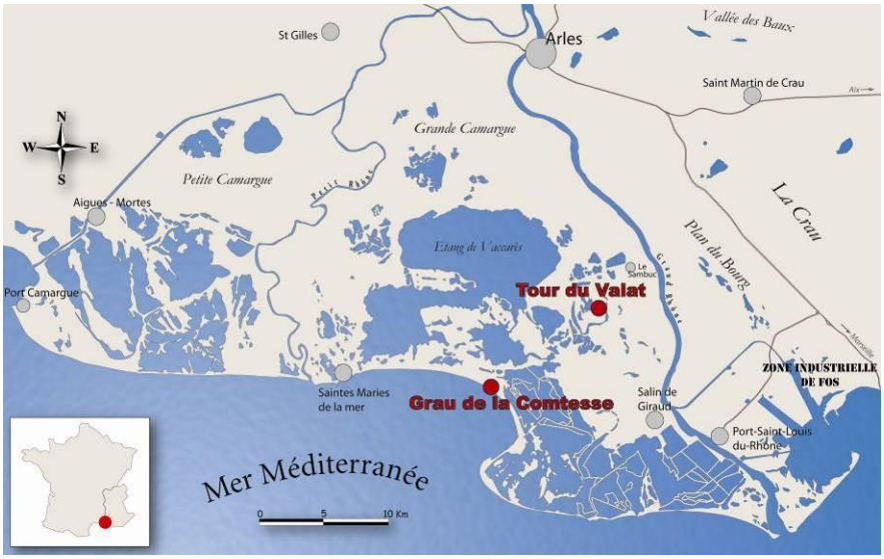
Schneider,C., Sukopp,U., & Sukopp,H. (1994) *Biologisch-ökologische Grundlagen des Schutzes gefährdeter Segetalpflanzen*. Bundesamt für Naturschutz, Bonn-Bad Godesberg.

Centaurea cyanus - Daniel Pavon

Day 2: Wetlands in Camargue

Location of Tour du Valat area and excursion point



Detail of Excursion route

1-Short description of the area

Name	*Tour du Valat : Camargue delta*
Municipality	*Arles*
Département (county)	*Bouches-du-Rhône (13)*
Ecosystem type	*Wetland*
Management authority	*Fondation Tour du Valat*
Protection status	*Nature Reserve, Natura 2000, Ramsar, MAB, Regional Natural Park*

2-Ecological characteristics

Damasonium polyspermum (temporary pool) – Patrick Grillas Tour du valat

The Camargue is large deltaic plain (145 000ha), built in the last thousands years by the Rhône river which presents at present only 2 branches almost completely embanked. The sediment is mainly from lagoon and marine origin, thus including salts. The mean slope is very small (0.17%) with local variation of elevation related to former lagoon or the bed river arms, alluvial levees, coastal dunes (including old dune systems). The riverine sediment which locally overtops the saline sediment creates contrasted salinities at short distance.

The climate is “Mediterranean sub-humid with cold winters” where the summer drought is exacerbated by the frequent strong day winds (Mistral). The large evapotranspiration enhances in summer period the salinity of the soils.

The ecology of the vegetation in the Camargue is mainly controlled by 2 factors: flood/drought and salinity. Both factors are to a large extent related to land elevation but the granulometry of the sediment plays also a role in the soil salinity.

Tour du Valat estate contains a former meander of the Rhône River which leads to contrasted soil and land elevation characteristics. Thus, on short distance a wide array of Camargue inland vegetation types can be seen ranging from:

Cressa cretica (temporary pool) – Patrick Grillas Tour du Valat

* **wetland** dominated by helophytes (*Scirpus tabernaemontani, Sc. litoralis, Bolboschoenus maritmus*) or submerged macrophytes (*Potamogeton pectinatus, P. pusillus, Zannichellia pedunculata, Z. obtusifolia, Callitriche truncata, Ruppia maritima*, etc including many species of charophytes (*Chara aspera, C. galioides, C. globularis, C. vulgaris, C. contraria, C. canescens*, …).
* **Mediterranean salt meadows** dominated by *Juncus maritimus* and *J. acutus*
* **Salt steppes** dominated by *Arthrocnemum macrostachyum* or *Sarcocornia fruticosa*
* **Hydromorphic halophyte grasslands** dominated by *Halimione portulacoides* with annual grasses (*Parapholis spp, Hordeum marinum, Polypogon maritimus*)
* **Meso-Mediterranean xerophilous annual grasslands** dominated by *Brachypodium distachyon*, many species of annual *Trifolium* and *Medicago*, *Linum strictum*, *Crepis spp*, *Evax pygmaea*, *Filago vulgaris*, *Asteriscus aquaticus*, *Scorpiurus muricatus*, *Vulpia ciliata*, *Limonium narbonense*, *L. virgatum*, …
* **Perennial grasslands** dominated by *Brachypodium phoenicoides*, often colonized by *Phillyrea angustifolia*
* **Riverine forest (remnants)** *(Populus alba, Ulmus minor, Fraxinus angustfolia, Salix alba, Laurus nobilis, Crataegus monogyna, Cornus sanguinea, Brachypodium sylvaticum) along the former river beds and at present developing along freshwater canals.*

Zannichellia obtusifolia (St Seren) – Patrick Grillas Tour du Valat

These vegetation types are grazed by the local breed of cattle and horses. Grazing is an important management tool for the management of wetlands, allowing the development of submerged vegetation in the wetlands contributing thus to their important role for the hundreds of thousands of ducks wintering and migrating throughout the Camargue.

Until recently rabbits were numerous on grasslands; it was a keystone species for controlling the encroachment of shrubs (*P. angustifolia*). Rabbit is at present at the verge of extinction in Tour du Valat estate and more globally in the Camargue as a result of the recent introduction (1986) of the Viral Hemorrhagic Disease.

Flooded 'Cerisieres' temporary pool - Aline Waterkeyn – Tour du Valat

3-Excursion itinerary

Lythrum tribracteatum (temporary pool) – Jean Roché

The excursion will start from the edges of the former river bed where irrigation canals maintain corridors of riverine forest. The itinerary will then cross various herbaceous vegetation along a topographic (not obvious!) and salinity (soil) gradient leading to large stand of Salt steppe vegetation where *Athrocnemum* and *Sarcocornia* dominated along alternate strips corresponding to differential deposits of sediment in the oxbow. This vegetation often flooded in winter exhibits sharp gradients in the distribution of plant species at very local scale related to contrasted conditions in summer (drought and salinity) and in winter (flood frequency and duration).

The next stop will be temporary pools remaining from the filling in of an old arm of the oxbow (4000yrs BP). The water of the pool (in winter!) is almost fresh and the species richness of the pool is high including several protected species in France (*Damasonium polyspermum*, *Pulicaria sicula*, *Cressa cretica*, *Lythrum tribracteatum*). Remnants of the riverine forest (in poor condition) and of the natural fluvial levee can still be seen.

The itinerary will then go through several types of halophyte grasslands with a large diversity of species. Different stages of colonization by *Phillyrea angustifolia* will be seen along our way

(according to topographic gradients). A large levee will show both the diversity of the vegetation along topographic gradient and the effects of domestic and rabbit grazing on a suite of exclosures built 35 years ago.
A visit in the nearby marsh (St Seren) will allow us to see the halo-nitrophilous vegetation that develp after the drawdown of the water, notably with *Crypsis aculeata*, *Chenopodium chenopodioides*, and *Suaeda splendens*. For the most water-motivated (and/or best equipped) a visit can be made to the water body to look for *Potamogeton*, *Zannichellia* and *Chara* species.

4-Scientific themes which could be addressed:
The importance of grazing on the structure and the dynamics of the vegetation is studied for more than 30 years on the estate on both aquatic and terrestrial habitats. The current lines of research are on the control of ungrazed species in the context of extensive grazing and more specifically on the dynamics of *P. angustifolia*. The on-going monitoring of the terrestrial vegetation allows the assessment of the impact of inter-annual fluctuation in rainfall. These themes could be discussed and illustrated during the walk.

5-Flora which could be used:
Fournier, P., 1936 - 1961 – 1990 Les quatre flores de France , Lechevalier, Paris, 1090 p
Mouronval J.B., Baudouin S. 2010. Plantes aquatiques de Camargue et de Crau. Office National de la Chasse et de la Faune Sauvage - Paris - 120 p

6-Selected References

Mesléard, F., P. Grillas & J. Lepart, 1991. Plant community succession in a coastal wetland after abandonment of cultivation: the example of the Rhône delta. Vegetatio, 94 : 35-45.

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Muller S.D., H. Bruneton , P. Grillas, T. Rey, I. Soulié-Märsche, P. Schevin, A. Thiéry, A. Waterkeyn & N. Yavercovski, 2008. Long-term dynamics of a Mediterranean alkaline vernal pool (Rhône delta, southern France). Wetlands 28(4):951-966.

Otero C. & A. D. Bailey, 2003. Europe's natural and cultural heritage. The european estate: La tour du Valat, France. Friends of the countryside, Brussels.

Gagea mauritanica – Patrick Grillas Tour du Valat

Day 2: Vegetation in the Camargue delta

2. Dune vegetation of Grau de la comtesse area

Detail of Excursion route

1-Short description of the area

Name	*Rhone Delta, Camargue*
Municipality	*Saintes Maries de la Mer*
Département (county)	*Bouches-du-Rhône (13)*
Ecosystem type	*Coastal dunes*
Management authority	*Conservatoire du Littoral and Société nationale de protection de la nature*
Protection status	*Natura 2000,, Regional Natural Park , National reserve of Camargue, Ramsar, MAB*

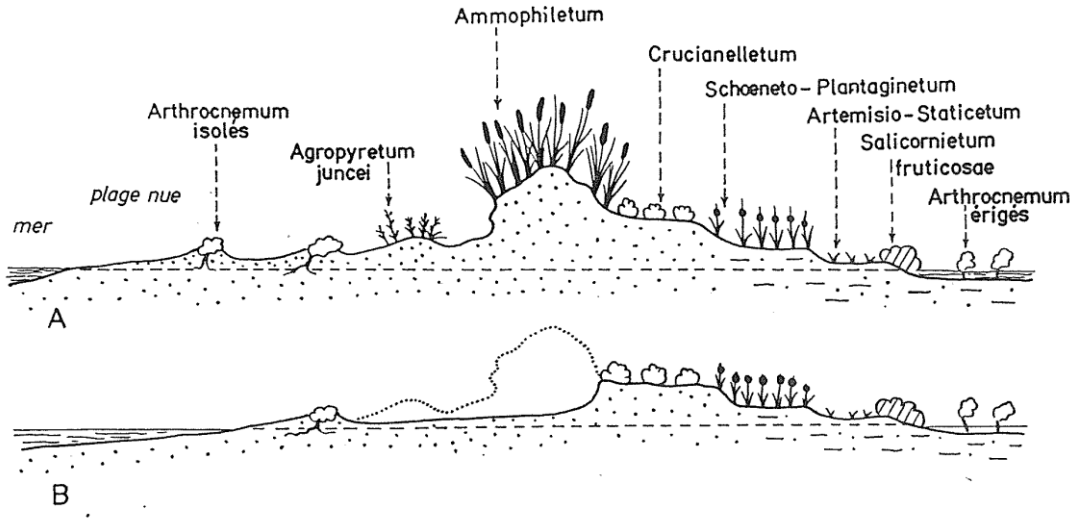

Fig. 9. — Les ceintures de végétation sur la Montille du Gênois, à l'Etang des Batayolles.

from : **Molinier, R. & Tallon G.,** 1965. Etudes botaniques en Camargue. I La Camargue pays de dunes. II Vers la forêt en Camargue. *Revue d'Histoire Naturelle*, n°^{s} 1-2 : 1-192

2-Ecological characteristics

The littoral dunes of the Camargue lie from the Grau-du-Roi to Port-Saint Louis du Rhône. They form the last dune complex representative of the French Mediterranean sand coast. They reach respectively 7 and 9 m high at the heads of the Espiguette and Beauduc sites. Despite their small size they strongly contribute to the Camargue flora, by their specificity and species richness; the vegetation is constituted by psammophilous and littoral species, none or little halophilous, and for some adapted to burying. At the foot of the dunes and between them, the vegetation is mainly salt and/or flood tolerant.

On a large part of the delta, coastal dunes are threatened by marine erosion. The profile of the littoral zone is unbalanced by the strong reduction of coarse sediments inflows from the Rhône river

(dams) ; it tends to reach a new equilibrium of the coastline thus exhibiting areas with fast regression and others, less abundant, unchanged or showing some accretion. In the recession zones, winter storms hardly damage the dunes. Other important threats for the dunes are the uncontrolled touristic use (beach of Arles at Piémanson, beach of Saintes-Marie de la Mer) and the local development of invasive species (*Carpobrotus spp*, *Senecio inaequidens*).
Since 1975 the littoral dunes situated on the ''réserve de Carmague'' are subjected to a statutory protection and to a sedimentary statement rather favorable.

Fixed dune with *Helychrysum stoechas*, Jean Roché

The Camargue dune systems are exposed to violent winds during most of the year (mistral and winds from the sea) and to an intense summer drought which both limit vegetation cover. In autumn and winter, storms lead to a strong increase of the sea level (it can reach 2 m!), and the outer dunes are then strongly beaten by waves. The plants of *Oyatare* are then often uprooted, prefiguring the regression of the dune. "Ganivelles" (local name for windscreen) favor the sand recharge of the outer dune and of the white dune ; however the sand of the beach , hardened by salt, is not easily mobilized by wind.

The coastal dune system of the'' Réserve'' reaches 4 m high and is only 20 m wide but it lays on 12 km long. It is composed of nine discontinuous massifs on the West of the'' Poste des douanes'', and of a lower one almost continuous between the '' Poste des douanes'' and the '' Grau de la Comtesse''. The inner dunes are bordered by "sansouires" (local name for scrub vegetation dominated by *Arthrocnemum spp and Sarcocornia spp*) which fringe the lagoons close to the sea. The dune system is organized from the sea to inland:

- In the upper beach are found the pioneer stages of the edification of the dunes: (**embryonic shifting dunes**) with *Arthrocnemum macrostachyum* and *Elymus farctus*. They are replaced locally by *Sporobolus arenarius* on salty encrusted sands, and on the upper beach vegetation dominated by *Echinophora spinosa* and *Elymus farctus* with *Mathiola sinuata*, *Euphorbia peplis* (very rare).

- the **Shifting dune** (white **Dune)** characterized by a vegetation adapted to burying and dominated by *Ammophila arenaria* subsp. *australis* and *Echinophora spinosa*, ,with *Medicago marina, Anthemis maritima, Eryngium maritimum, Euphorbia paralias, Medicago littoralis, Pancratium maritimum*, etc

Eryngium maritimum
Marc Thibault - Tour du valat

- **the fixed coastal dunes with herbaceous vegetation (Grey Dune)**, grows since the top of the slopes, the vegetation of the **Grey dune**, with several vegetations groups :

. *Crucianalla maritima* and *Malcomia littorea* group (rare in the Western Camargue)

. *Helychrysum stoechas* and *Malcomia littorea group*

. *Artemisia glutinosa* and *Teucrium polium* group (only present at the West of the Grand Rhône river)

. the *Scirpoides romanus* group

The main other species found are *Scabiosa matitima, Scirpoides romanus, Centaurea aspera, Vulpia membranacea, , Bromus diandrus subsp. diandrus*. On few littoral dunes situated at the West of the ''poste des douanes'' and in Beauduc, can be observed thermo-Mediterranean bushes with *Juniperus turbinata*, *Pistacia lentiscus, Asparagus acutifolius, Phillyrea angustifolia, Clematis flammula, Cutandia maritima*. In the ''petite Camargue'' (Western part of the Camargue), these bushes are often surmounted by a tree stratum of *Pinus pinea* and shelter species as *Smilax aspera* or *Rubia peregrina* .

-In dune slacks, the low marshes vegetation is supplied by the fresh water table of the dune. Different types of vegetation are found corresponding to small differences in elevation and soil characteristics:

- **the Humid dune slack**: is characterized by the presence of the hygrophilous and likely halophilous species *Schoenus nigricans* , associated in the dunes of ''Beauduc'' to *Erianthus ravennae, Imperata cylindrical* and *Phragmites australis*.

- **the halo-psammophile meadows** are located below *Schoenus nigricans* communities and often mixed with them, at the interface between the lagoon brackish water table and the fresh water table of the dune; it is characterized by *Juncus acutus* and *J. maritimus*, *Plantago crassifolia*, *Carex extensa*, *Spartina versicolor*.

The **glasswort communities** (Mediterranean salt steppes) are located between the dunes and the lagoons, on low sandy shelves stemmed from the dune erosion and enriched with silts. They are submitted to frequent winter floods, and to a severe summer drought enhancing salinity. On the

shelves dominate *Limonium virgatum* and *Artemisisa caerulea* often associated with *Limonium echioides, Parapholis spp, Blackstonia imperfoliata*. On the edges in contact with *Arthrocnemum spp* scrub vegetation (''sansouire'') or with the lagoon is found a community dominated by *Limonium virgatum* and *Limonium girardianum* (a nationally protected species, endemic of Catalonia and Provençe).

Limonium girardianum
Marc Thibault -Tour du valat)

Lower in the topographic gradient, halophytic is found with different dominant species according to salinity and flood conditions (from high to low locations):

- *Sarcocornia fruticosa and Limonium bellidifolium* comunities, with patches dominated by *Sarcocornia perenne (Mediterranean halophilous scrubs)*
- *Arthrocnemum macrostachyum* community, often with *Althenia filiformis* when flooded in spring
- Annual Salicornia communities (*Salicornia patula* and *Salicornia emerici*),

3-Excursion itinerary

The walking tour will start at the parking ''de la Comtesse''. In the direction of the sea along the '' la Comtesse'' dike, we shall observe the diverse types of sansouire edging the lagoons, the different *Limonium* species of the Camargue, as also fragment of fixed dunes crossed by the track (with *Crucianella maritima, Echinophora spinosa, Bromus diandrus, Vulpia spp, Alysssum maritimum*). At the '' Grau de la Comtesse'', we shall observe the vegetations of the upper beach, embryonic and white dunes.

Pancratium maritimum - Jean Roché

4-Scientific themes which could be addressed:

The conservation and management of the dune systems depends on a sound management of the coastline and the protection against disturbance. It requires thus a consistent policy at a large scale and enforcement of the existing regulation. Beside policy, the main scientific issues are the development and test of management techniques which will limit the disturbance by (summer) users. Considering the high human pressure, the combination of strictly protected areas and raised awareness of policy makers and visitors are of paramount importance. On the technical side, the restoration of degraded vegetation is a challenge under the dry Mediterranean climate.

5-Flora which could be used:

MOLINA J. 1996. Flore de Camargue. Parc Naturel Régional de Camargue

FOURNIER, P., 1936 - 1961 – 1990 Les quatre flores de France , Lechevalier, Paris, 1090 p

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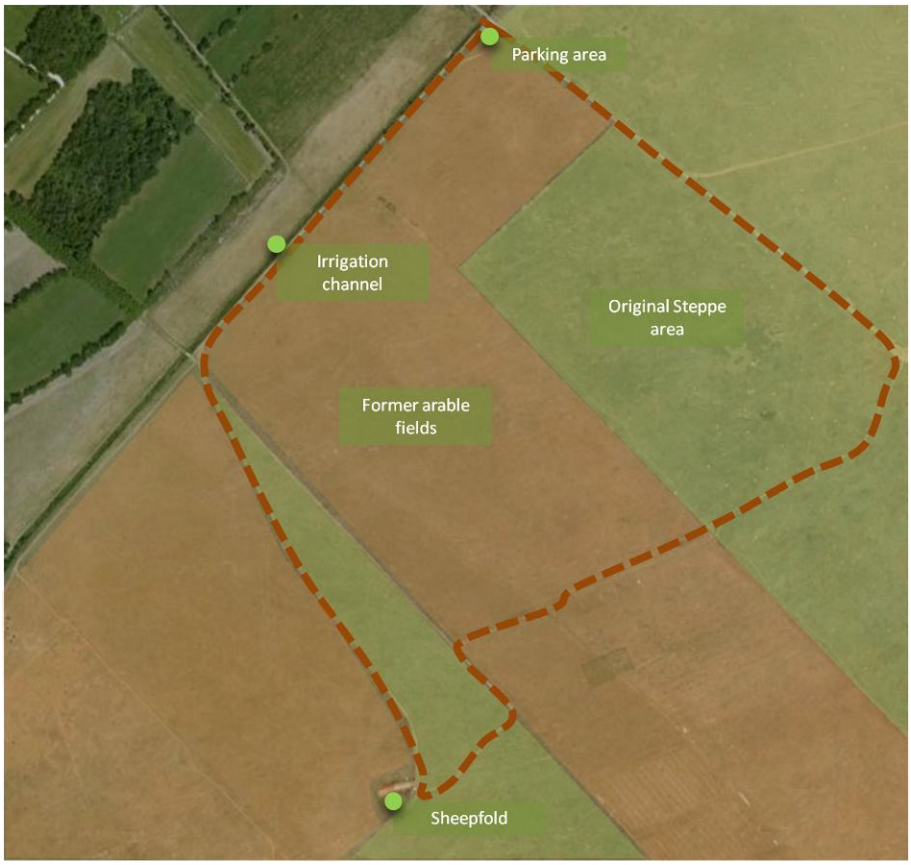
Crucianella maritima - Jean Roché

Day 3: Mediterranean steppe vegetation in La Crau area

Location of La Crau area and excursion point

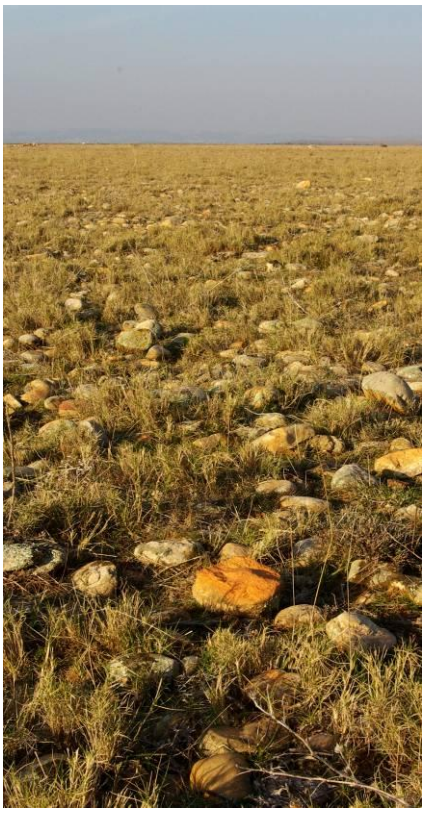
Detail of Excursion route



1-Short description of the area

Name	Plaine de Crau: Crau steppe area
Municipality	St Martin de Crau, Arles, Miramas.
Département (county)	Bouches-du-Rhônes (13)
Ecosystem type	Mediterranean steppe
Management authority	CEEP (Conservatoire Etudes Ecosystèmes de Provence : Association for Nature Conservation in Provence)
Protection status	Special Protection Area, Special Conservation Area, Natura 2000, Nature Reserve

2-Ecological characteristics



Merinos d'Arles sheep – the steppe - Renaud Jaunatre

The plain of La Crau is in southern Provence and extends over some 60,000 ha in what was once the delta of the Durance river. This steppe-like region is bordered to the west by the Rhône delta, to the east by the Berre lagoon, to the north by the Alpilles (a small mountain range), and to the south by the Mediterranean Sea. It was called the *campus lapideus* (the stone field) by the Romans while several authors of the 19th century referred to it as monotonous and uninteresting. Not surprisingly, it therefore attracted little scientific interest and was poorly understood by ecologists and naturalists. Before the 20th century, the steppe supported mainly shepherds and their flocks and was visited only by the occasional geographer and/or naturalist. It was not until the 1950s that biologists began to investigate the La Crau exceptional habitats .

The plain of La Crau is of great biological importance. Its vegetation has been shaped over centuries by :

-(1) a dry and windy Mediterranean climate (mean annual temperature 14°C; mean annual precipitation ~500 mm; >3,000 hours of sunshine per year and strong winds that blow on average 334 days annually);

-(2) most unusual soil conditions: soil is only about 40 cm deep and overlies a 5 to 25m thick impermeable bedrock that makes the watertable inaccessible to plant roots. The topography is extremely flat and about 50% of the ground is covered by large stones; and,

-(3) at least two thousand years of itinerant or mobile sheep grazing.

The vegetation of the steppe is dominated by *Brachypodium retusum* and includes species, such as *Asphodelus ayardii*, *Thymus vulgaris* and the Poacea,

Stipa capillata. It is relatively homogeneous with patches of low-growing vegetation consisting of the stonecrop, *Crassula tillaea*, lichens, liverworts, mosses and cyanobacteria. There are no woody plants taller than 50 cm and almost 50% are annual plant species that germinate mainly in autumn, spend winter as seedlings, grow in the spring and flower from March to May or in September. Most of the plant biomass is produced in spring and autumn. The primary productivity of this steppe vegetation is estimated to be 2.1 tons of dry matter/ha/year, which is similar to other steppe formations, such as in the Sahel, Africa.

Asphodelus ayardii
Renaud Jaunatre

The uniqueness of the steppe is attributable to its overall floristic composition and structure compared with other *Brachypodium retusum* plant communities (e.g. garrigues which include *Rosmarinus officinalis* or *Smilax aspera*). Itinerant sheep grazing has been the traditional land-use for several centuries and it is the only vegetation management advocated to ensure the durability of the steppe.

The steppe is a haven to several interesting birds including: the only French population of breeding *Pterocles alchata* (pin-tailed sandgrouse), the largest French population of *Tetrax tetrax* (little bustard) and one of the two French populations of the globally threatened *Falco naumanni* (lesser kestrel). The steppe also provides a habitat for *Lacerta lepida* (jeweled lizard), several arthropod species among which an endemic apterous grasshopper, *Prionotropis rhodanica* (hedgehog grasshopper), and an endemic Coleoptera, *Acmaeoderella perroti* (Crau jewel beetle).

Spring annuals (*Evax pygmaea, Brachypodium distachyon, Salvia verbenaca, etc.*) Renaud Jaunatre

Prionotropis hystrix rhodanica
Renaud Jaunatre

3-Excursion itinerary

The excursion will go through the natural steppe areas and former arable fields. Natural steppe communities will be dominated by characteristic perennials: *Brachypodium retusum*, *Thymus vulgaris*, *Stipa capillata* and *Asphodelus ayardii*. Species like *Vulpia ciliata*, *Botryochloa ischaemum*, *Convolvulus cantabrica*, *Reichardia picroides* or *Eryngium campestre* will also be well represented. Even in June, it will be possible to see some earlier

annuals like *Evax pygmaea*, *Sideritis romana*, *Plantago lagopus, Brachypodium distachyon* or *Cynosurus echinatus*. Some areas of the natural steppe have been cultivated for melon production in the 70's. Even after 40 years, plant communities are still slightly different, dominated by other species: *Bromus madritensis*, *Aegilops ovata*, *Lobularia maritima*, *Calamintha nepeta* or *Euphorbia cyparicias*. The route will join a sheepfold, which will be surrounded by a characteristic belt of more nitrophilous vegetation : *Silybum marianum* or *Ecballium elaterium* and then by *Hordeum murinum* and *Onopordum Illyricum* (host of the endemic Coleoptera : Crau jewel beetle). To complete the loop, we will walk next to the irrigation channel which sometimes floods the steppe in winter and leads to a community dominated by *Brachypodium phoenicoides* and *Verbascum sinuatum*. In the old well some ferns communities can be present with species such as *Scolopendrium sagittatum* which is a protected species in France. A look at the foundations of a former Roman sheepfold can give an idea about the history of the traditional sheep grazing system which has been used in this area for 2000 years.

Evax pygmaea
Renaud Jaunatre

4-Scientific themes which could be adressed:

From 2000 so far, important research programs were led to (i) identify the original ecosystems which were present in the La Crau plain before the Neolithic, (ii) identify long-term changes in the vegetation of ecosystems which are characterized by recurrent disturbance (here sheep grazing for around 5000 to 6000 years, (iii) identify the impacts of land-use changes (intensification of agricultural practices) on biodiversity, (iv) identify the original and reference ecosystems, (v) set up operations of ecological restoration. These themes could be discussed and illustrated during the walk.

6-Flora which could be used :
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6-Selected References

Text and photos : Buisson Elise, Jaunatre Renaud, Daniel Pavon & Dutoit Thierry.
UMR CNRS IRD université d'Avignon IMEP (Mediterranean Institute of Ecology and Paleoecology).
IUT, Site agroparc, BP 1207, 84911 Avignon Cedex 9 – France
You can ask for following papers at this address : elise.buisson@univ-avignon.fr

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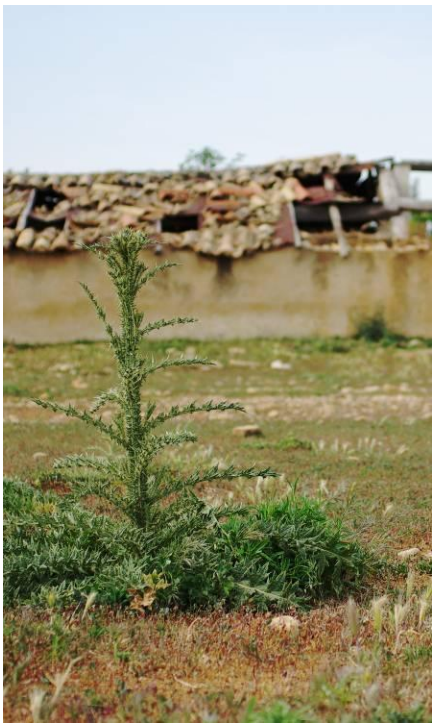

Onopordum illyricum next to an old sheepfold
Renaud Jaunatre

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The steppe landscape -Renaud Jaunatre

Day 3: Bonnieu

Location of Bonnieu area

Name	Plaine de Bonnieu – Bonnieu area
Municipality	Martigues
Département (county)	Bouches-du-Rhônes (13)
Ecosystem type	Mediterranean annuals grassland
Protection status	Special Protection Area, Special Conservation Area, Natura 2000, Nature Reserve

Bellis annua grassland – Renaud Jaunatre

The Bonnieu area is a sandy miocenic molasse coastal plain exposed to a cool marine breeze which thus benefits from cool temperatures in winter and exhibit a very original vegetation with many annuals and bulbous plants like *Allium chamaemoly*, *Gagea mauritanica*, *Merendera filifolia* or *Hyoseris scabra.*

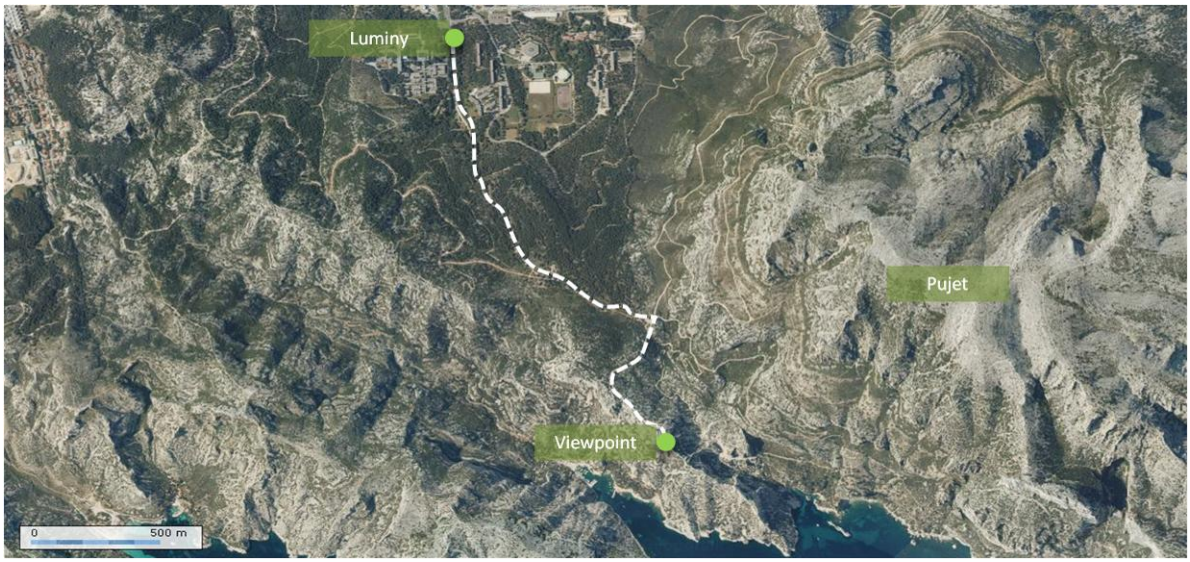
The walk will go through typical Mediterranean shrublands and pinewoods, species-rich annuals and bulbous grasslands and embryonic sand dunes. The difficulty of conservation of such ecosystems which are in the center of many anthropogenic pressures (tourist overcrowding, industrial buildings and pollution, etc.) will be discussed and very well illustrated during the walk, especially with the presence of the nationally protected *Convolvulus lineatus* of which the distribution is almost limited to parking areas.

Convolvulus lineatus – Renaud Jaunatre

Day 4: Calanques

Location of Calanques

Detail of excursion route



Sormiou Calanques – Daniel Pavon

1-Short description of the area

Name	*Calanques de Marseille*
Municipality	*Marseille - Luminy*
Département (county)	*Bouches-du-Rhône (13)*
Ecosystem type	*Calcareous mattoral and sea cliff*
Management authority	*National Forest Office (ONF) – Littoral conservatory*
Protection status	*National Park Project*

2-Ecological characteristics

Located almost entirely in Marseille area, Calanques cliffs stand on the Mediterranean sea. This wildlife sanctuary close to the center of Marseille hosts a unique flora and fauna which are often unknown from the numerous visitors. The Calanques is a huge limestone massif facing the sea. This sedimentary rock was formed on the ancient sea bed by an accumulation of fragments of various origins. Thus, you will find a flora adapted to a calcareous soil with basic pH. In addition, rain water quickly drains down to the subsoil through a deep fault system, further accentuating soil aridity.

Average annual rainfall for the city of Marseille is usually around 600 to 700 mm. However, much of the coast of Marseille and more specifically Cape Croisette, is located under a Mediterranean semi-arid climate with 400-500 mm of annual rainfall. The Mistral, which blows from the north-west is the prevailing wind in western Provence and increases the dryness of the Calanques.

3- Vegetation

Six large phytoecologic areas can be distinguished in the Calanques :

Seaside vegetation: halophile communities

These communities are composed of plants capable of undergoing high concentrations of salt and are mainly found on rocks and cliffs overlooking the sea. Some of these communities can be found further inland where the coast is gently sloping. The amount of salt in soils depends heavily on the wind during storms and the spray which carries salt inland. The salinity is not favorable to settlement of a diverse flora but leads to the presence of an original and adapted one.

Halophytic and halo-resistant communities are found close to the sea and host remarkable species now critically endangered, such as *Astragalus tragacantha*, *Plantago subulata*, *Silene sedoides*, *Thymelaea tartonraira*, etc..

Plantago subulata – Daniel Pavon

Astragalus tragacantha – Daniel Pavon

Ophrys aranifera subsp. massiliensis Daniel Pavon

Sub-littoral communities

When soil salt is no longer a dominant factor, we observe the settlement of a flora more representative of the entire area. These *Pistacia lentiscus* communities constitute an homogeneous coastal belt which is embedded in the schrubland. In the valleys with a temperate coastal ambience they are associated with some rare *Myrtus communis* and *Ophrys aranifera subsp. massiliensis*. *Euphorbia dendroides* is also characteristic of these sub-littoral communities.

From dry grassland to schrubland to pinewood

The schrubland is a legacy of several millenaries of fire use. All species that we observe are therefore fire resistant. Fires are not an ecological disaster for these environments and plant species, if the fire regime remains moderate (one ever 100 years or so). The Mediterranean schrubland is a more or less dense and small form of vegetation which is constituted by a flora with various colors and scents. It can be very spaced and leads to natural dry grasslands or very dense with a tree layer of *Pinus halepensis*. Usually, there is a massive expanse of *Brachypodium retusum*, mixed with *Quercus coccifera*, *Rosmarinus officinalis*, *Cistus spp.* and *Erica multiflora*. The older pines are seen today in the immediate vicinity of the city, from the Roy d'Espagne to Luminy. Deep valley bottoms and northern flanks host here and there hardwoods such as *Quercus pubescens* or *Acer monspessulanus*.

Screes

Calcareous screes are omnipresent in the Calanques and host a particuliar vegetation including the Marseille areas endemic Caryophyllaceae : *Gouffeia arenarioides* = *Arenaria provincialis*.

Gouffeia arenarioides = *Arenaria provincialis* – Daniel Pavon

Erica multiflora – Daniel Pavon

Crests and summits

Most of Provence small mountain ridges reveal their wealth to the braves who reach their peak. Puget Mount, close to Luminy, provides a unique scenic viewpoint on the coastline from Marseille to Cassis. Harsh local climatic conditions (regular strong winds and large temperature amplitude) favor typical hedgehog-like schrubland with some Provence endemic species like *Genista lobelii* or *Santolina decumbens*.

Fauna:

The very open landscape provides a habitat for numerous animal species, from invertebrate to mammals. During the excursion we certainly will hear famous cicadas. Among them, *Cicada orni* which has 11 black points on the wings and which lives in pinewood and *Tibicina garricola* which has 6 yellow circle spots on the thorax and lives in schrublands. Some remarkable butterflies should be observable, *Zerynthia rumina*, which is protected and which lives on *Aristolochia pistolochia* or *Charaxes jasius* whose larvae feeds on *Arbutus unedo*. The Calanques host also a rare mollusk: *Tudorella sulcata*. Some reptiles like the gecko *Hemidactylus turcicus*, the lizard *Timon Lepidus* or the snake *Malpolon monspessulanus*. Many birds are found in the Calanques optimal habitats to nest or to hunt: some cliff birds like the Peregrine falcon *Falco peregrinus*, the blue rock thrush *Monticola solitarius* or the endangered Bonnelli's eagle *Hieraaetus fasciatus*; some schrubland birds like the Sardinian warbler *Sylvia melanocephala*, Dartforb warbler *Sylvia undata*, the Black eared wheatear *Oenanthe hispanica* or the European stonechat *Saxicola torquata*. Some bat species lives on the cliffs, including the largest bat of France: *Tadarida teniotis* and the smallest European mammal: *Suncus etruscus*.

Hemidactylus turcicus – Daniel Pavon

Cicada orni – Daniel Pavon

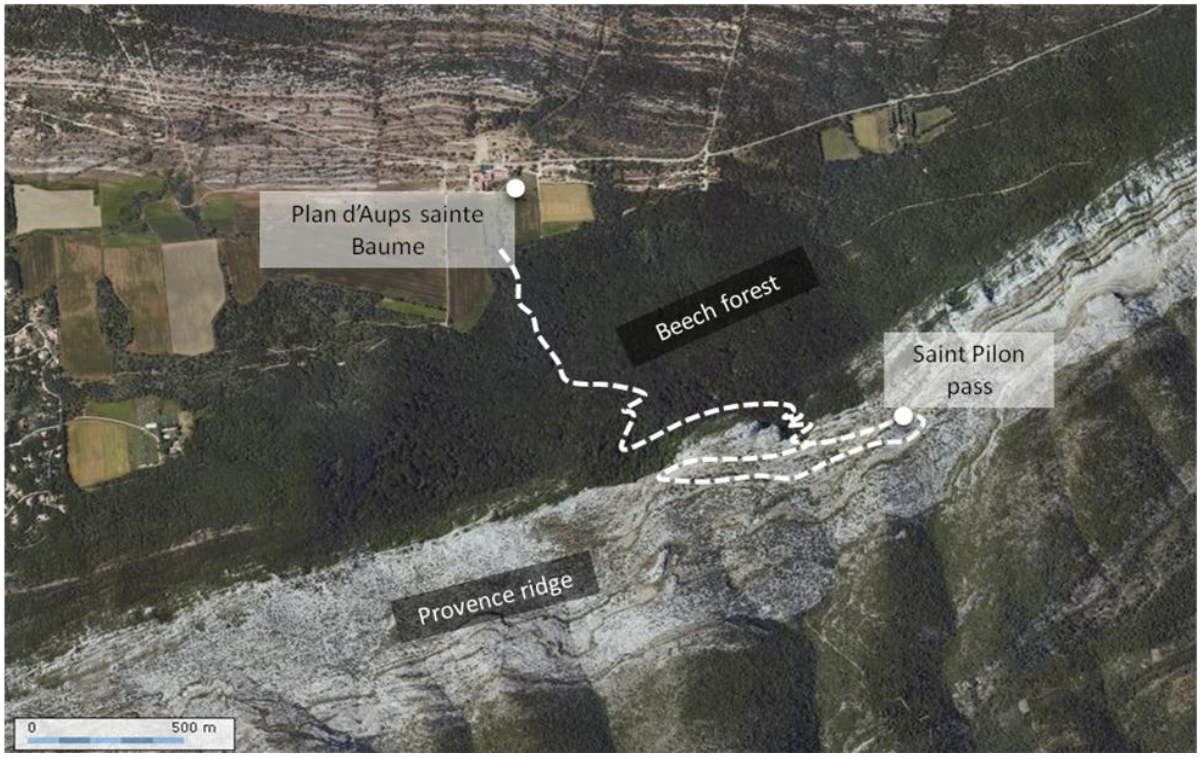
More than 60 bird species which live in the Calanques are protected, five mammals and all reptiles and amphibians are also protected on the site. It contains about 50 plant species of interest and about 30 are protected by law. Other prospecting work should be conducted to assess more precisely the Calanques richness. Although the naturalistic importance of the site is obvious and while human activities are still increasing (overcrowding of coastal areas, etc.), there is no protection status regulating the Calanques with the exception of the lands of the Littoral Conservatory and National Forest Office. A Public Interest Group (GIP Calanques Marseille Cassis) was established in order to change this situation and to create the first peri-urban National Park.

Morgiou Calanques

Renaud Jaunatre

Day 4: Sainte Baume

Location of Excursion

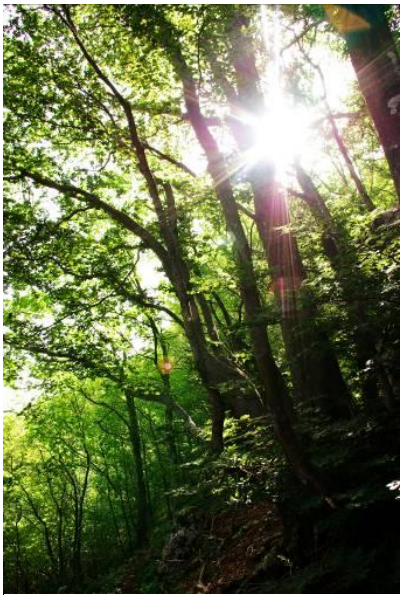


1-Short description of the area

Name	Sainte Baume
Département (county)	Bouches-du-Rhône (13) – Var (83)
Ecosystem type	Beech forest and Provence ridges

Genista lobelii – Daniel Pavon

2-Ecological characteristics



Beech forest

The Sainte-Baume massif, which straddles the departments of Bouches-du-Rhône and Var is an important forested mountainous entity. It is located just 30 km east of Marseille and 22 km from the sea and culminates at 1,178m. It includes a large unfragmented forest patch with a high diversity of flora and fauna.

On the shady side of the mountain at the bottom of the cliffs, there is a deciduous forest (*Quercus pubescens*, *Acer spp*., etc.) dominated in some places by beech (*Fagus sylvatica*). Trees are also represented by holly (*Ilex aquifolium*) and the yew (*Taxus baccata*). Some herbaceous species such as the *Lilium martagon* are very original for the region. This plant community is not uncommon in mid-European region, but exceptional in south Provence coasts. Its stability seems guaranted by its location (north-facing side of the mountain), and by the local microclimate maintained in part by the presence of the forest. While this area of south Provence receives an average of almost 700 mm of rainfall per year, the forest of Sainte Baume receives about 1,000 mm.

Saxifraga callosa subsp. catalaunica
Daniel Pavon

Another point of interest is in the summit ridge. These sectors, which have played a role as a refuge during periods of climate change, host original plant species. There is a habitat of "hedgehog-like heath" dominated mainly by two species endemic from Provence, *Genista lobelii* and *Santolina decumbens*, and by the *Juniperus phoenicea*, a rupicolous shrub of wider distribution in the Mediterranean area. On these ridges, ledges and cliffs facing north also house original features such as *Saxifraga callosa subsp. catalaunica*, an endemic of the Alps and SW of Catalonia, or even *Silene saxifraga*, orophytes from southeastern Europe.

Southern slopes are constituted by more typical pinewoods and shrublands, surrounded by some very species-rich dry grasslands or pastures (*Jurinea humilis*, *Fritillaria involucrata*, *Gagea spp*., *Tulipa australis*, etc.).

Sainte-Baume ridge – Daniel Pavon

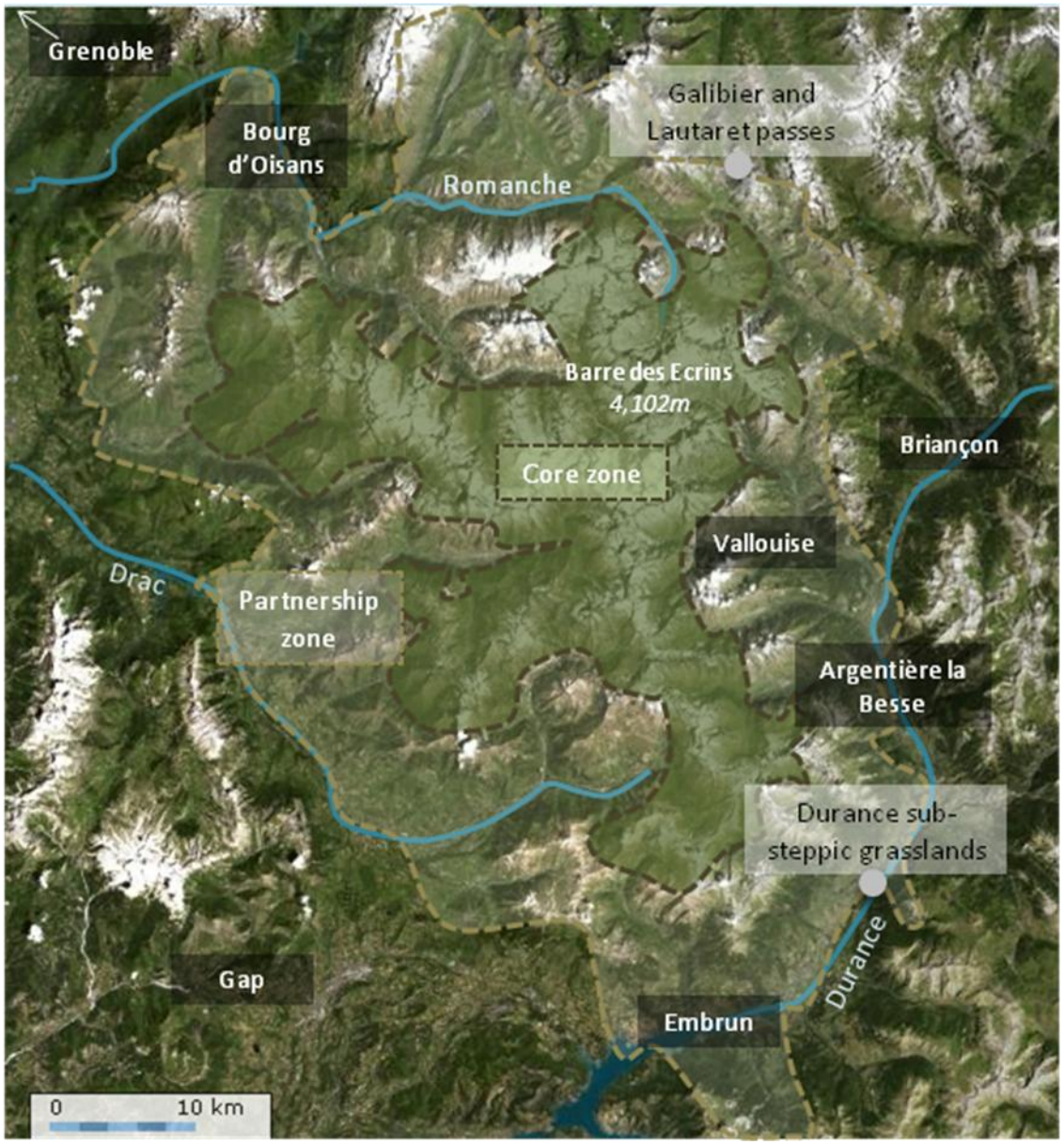
The route will go through the fresh and shaddy beech forest of the north face in order to join the ridge by the Saint Pilon pass (962m). Here, we will see many plant species, but don't forget to have a look to the very scenic view, from the Mediterranean sea to the Ecrins.

Jurinea humilis
Daniel Pavon

Santolina decumbens
Daniel Pavon

Day 5 : Ecrins National Park

Location of Ecrins National Park and points of interest



1-Short description of the area

Name	*Ecrins National park*
Département (county)	*Isère (38) and Hautes-Alpes (05)*
Management authority	*French National Park*
Protection status	*National Park*

2-The Park

Situated between Gap, Grenoble and Briançon, the Ecrins National Park is bounded by the watersheds of the Romanche to the north, the Guisane and Durance to the east and south, and the Drac to the west. The high mountain area is structured around the chain of major peaks, and the complex massif culminates in the Barre des Ecrins at 4,102 m. More than 150 peaks are over 3,000 m high, and the valley floors are at around 1,000 m above sea level.

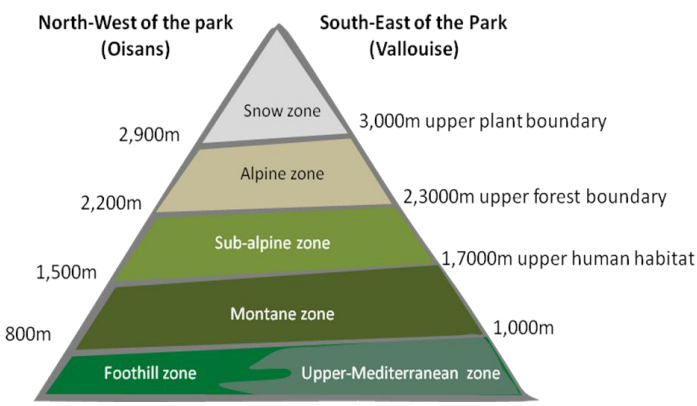
Lautaret pass – Ecrins National Park

Pulsatilla montana – Ecins National Park

Ecrins National Park has been created in 1973 and, like other French National Parks, is made up of a core and partnership zone. The core zone is a protected and unspoiled area which is subject to special rules, whereas the partnership zone is governed by a convention adopted by the relevant communes. The park status is reviewed every 15 years, and each park represents an ecological partnership between the core zone and surrounding areas whereby the economic value of the natural resources is promoted along with sustainable development in the communes. Each national park is managed by a public body affiliated to the Ministry for Ecology and Sustainable Development.

2-Ecological characteristics

As in all mountain landscapes, vegetation is distributed along an altitudinal gradient. This distribution comes from temperature variations with altitude. The thermal gradient, about 0.5°C by 100m of elevation, causes an indirect zonation of water, soil and rural utilization. Altitude alone is not a good predictor of biological conditions. Boundaries between zones are higher in north faces (ubacs) than in south faces (adrets) and higher in intern Alps (Durance valley) than in the middle Alps (Drac or Romanche valleys).

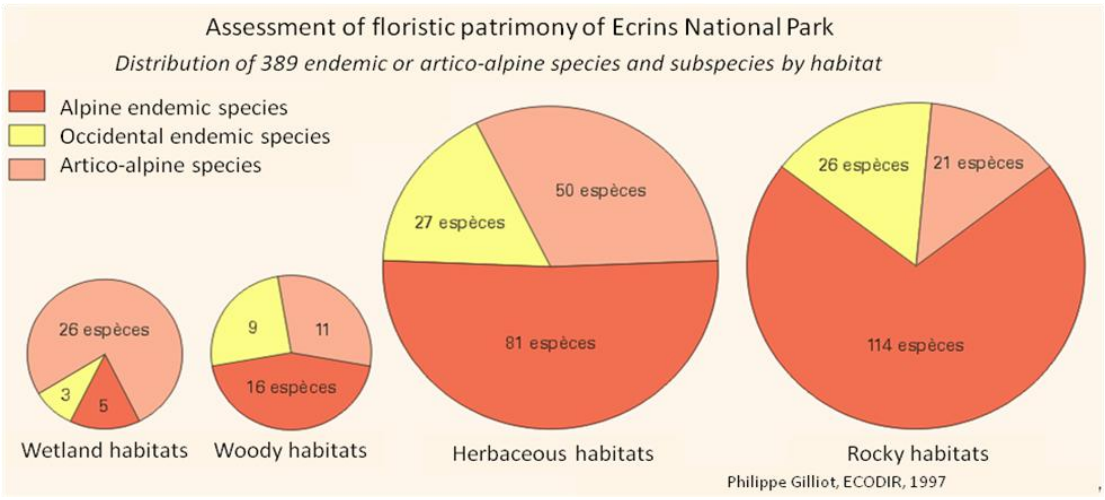


Lilium martagon
Renaud Jaunatre

Dryas octopetala
Renaud Jaunatre

Potentilla delphinensis
Ecrins National Park

Each altitudinal zone corresponds to a 4°C difference in average annual temperature. The vertical succession of zones, from the supra-Mediterranean conditions to alpine and nival conditions, reproduces the climatic variations which are approximately the same between temperate Europe areas and Arctic areas. Growth of most plants requires a night temperature above 0°C. The physiological activity is effective for an average daily temperature above 5°C. The growing season decreases from 6 to 7 days by 100m of elevation. From 8 months at 1,000m, it is only 2 ½ months at 2,400m.



The number of species remains high up to 2,000m and then decreases. Species richness becomes very low above 3,000 m. Cosmopolitan and Eurasian species are present on Ecrins areas, but they are particularly dominant in the forests (*Lilium martagon*, *Cypripedium calceolus*) and in wetlands. Mediterranean species, like *Cotinus coggygria* or *Aristolochia pistolochia*, spread through the low elevation valleys. For example, the Durance is an axis of penetration of Mediterranean species into the area. A steppe-like vegetation is most common from Embrun to L'Argentière-la-Bessée (*Astragalus alopecurus*, *Pulsatilla montana*). The Mediterraneo-montane species (*Astragalus sempervirens*) are more abundant on the southern slopes. Endemics of the Western Alps are represented by few species (*Berardia subacaulis* or *Potentilla delphinensis*). Orophytes, which are species restricted to mountain areas, represents the most characteristic group of the

Eryngium alpinum – Ecrins National Park

National Park (*Leontopodium alpinum*, *Campanula thyrsoides*). Arctico-alpine species were widespread distributed in plains during the last ice age and then took refuge in the Arctic and the Alps during the postglacial warming of the last ten millennia: *Silene acaulis, Dryas octopetala* or *Salix herbacea*. Over 1,800 different plants have been identified in the National Park. Around 168 plant species are of particular value, from protected species (*Eryngium alpinum*) to species classified in the French red list of rare and endangered species (*Cotoneaster atlanticus*, *Prunus brigantica*).

Lichens are found everywhere, and are often the last outposts of the plant world, tinting the screes and giving every site its own personalized color scheme. The plant life is evolving as the climate changes. We are seeing a dramatic decline in species dating back to the Ice Ages (*Betula pubescens*, *Carex bicolor*) whilst the aspen, which traditionally grows on the plains, is taking over the heaths and rocky ground. The Ecrins National Park therefore needs proactive conservation policies, and relies on flower registers and a map of the natural environments.

Carex bicolor – *E*crins National Park

3-Excursion itinerary

First, we will stop on the Durance-made sub-steppic grasslands. This environment is influenced by a continental-type climate in the inner Alps and by a particular geology of the Durance river former alluvial terraces. Then, we will focus on the grazed alpine grasslands of the Lautaret and Galibier passes where some artico-alpine species still occur. Discussions will tackle land-uses and crowding issues, speciation of plant species and particularities of alpine plant species.

Durance steppe-like grasslands – Ecrins National Park

Durance Valley – Ecrins National Park

5-Flora which could be used:

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6-Bibliography

http://www.ecrins-parcnational.fr/

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Cédric Dentant (Ecrins National Park, Gap)
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