

# FIELD NOTES FROM ANDALUCÍA, SPAIN

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## Introduction

In late April 2013 Jürg Steiger, Heiko Rischer, and I performed a field trip to Andalusia (Andalucía), southern Spain in order to see and study some carnivorous plant species *in situ*. The following text is a report of our findings and conclusions.

Situated at the westernmost end of the Mediterranean Sea between 36°N and 39°N and spanning the altitudinal range from sea level to almost 3500 m (highest point in continental Spain), Andalusia is inhabited by a diverse flora composed of Mediterranean (adapted to summer drought, usually in lowlands), high mountain (adapted to snow cover and freezing in the winter, limited to high mountain elevations), oceanic (depending on permanently humid, usually frost-free conditions, predominantly in the westernmost parts of Andalusia that are strongly influenced by westerly winds from the Atlantic ocean), and a few xero-tropical (adapted to prolonged drought) elements.

The southernmost corner around Gibraltar and the southernmost cape of the Iberian Peninsula around Tarifa marks the western end of the Betic System (part of the Alpine belt) that extends from there to the easternmost border of Andalusia, and contains most of the region's highland areas, including the Sierra Nevada near Granada as its highest peak. This series of mountain ranges separates the basin of the Guadalquivir River to the north from the Mediterranean basin to the south. It is essentially this montane area that serves as a migration route for plants that are less well adapted to drought than those of the Mediterranean element, and it consequently hosts the majority of carnivorous plants in Andalusia (Table 2), most of which are derived from temperate Subatlantic/Submediterranean (*Pinguicula nevadensis*, *P. grandiflora*, *P. dertosensis*, *P. mundi*, *P. vallisneriifolia*) and/or Atlantic (*Drosophyllum lusitanicum*, *P. lusitanica*) elements.

## Climate

The general climate of Andalusia is determined by its position in the Mediterranean climatic zone that is marked by mild, humid winters and warm, dry summers (Table 1).

Table 1. Climate of Andalusia.		
Place, alt., Koeppen-Geiger Class	Temperature (°C max. / min. / avg.)	Precipitation (mm max. / min. / ann.)
Tabernas (300 m) BSk (Steppe, mid-lat.)	30 (Jul./Aug.) / 9 (Jan.) / 18	38 (Oct.) / 4 (Jul./Aug.) / 240
Gibraltar (coast) Csa (Medit.)	25 (Aug.) / 13 (Jan.) / 18.5	146 (Dec.) / 1 (Jul.) / 775
Granada (738 m) Csa (Medit.)	25 (Jul.) / 7 (Jan.) / 15	31 (Dec.) / 2 (Jul.) / 360
Cazorla (753 m) Csa (Medit.)	25 (Jul.) / 6 (Jan.) / 14	57 (Mar.) / 6 (Jul.) / 360

(data from Wikipedia, <http://en.wikipedia.org/>, retrieved on June 30, 2014)

## Places Visited

### Los Alcornocales

Located at the westernmost end of the Betic System north of Gibraltar and extending from Tarifa at Spain's southern end to Algodonales some 80 km to the north the natural park Los Alcornocales covers 1678 km<sup>2</sup> and is one of the major natural parks in Spain. The hilly country (the highest peak being Pico del Aljibe, 1092 m alt.) is mainly composed of Aquitanian (Miocene) sandstones and conglomerates (sedimentary flysch units forming the Campo de Gibraltar Complex). The climate is Mediterranean with a strong oceanic influence (Tarifa is already at the Atlantic coast) characteristic for the Tingitano-Onubo-Algarvian province. The vegetation is marked by primary cork forest where it is not disturbed by agriculture. Common woody species being cork oaks (*Quercus suber*), Portuguese oaks (*Quercus faginea*), Pyrenean oaks (*Quercus pyrenaica*), olive trees (*Olea europaea*), alders (*Alnus glutinosa*), holly trees (*Ilex aquifolium*), bay laurels (*Laurus nobilis*), rhododendrons (*Rhododendron ponticum*), and tree heaths (*Erica arborea*).

### Sierras de Tejeda, Almijara y Alhama

Situated between Malaga at the southern Mediterranean coast of Spain ("Costa del Sol") and Spain's highest continental peak in the Sierra Nevada, the three ranges in the natural park of Sierras de Tejeda, Almijara y Alhama (together 407 km<sup>2</sup>) are an assemblage of mountains of moderate elevation (the highest peaks reaching 2067, 1732 and 1715 m alt., respectively). The landscape is dominated by karstic Jurassic limestone covered by Mediterranean sclerophyllous vegetation and its transition to montane vegetation at higher altitudes.

### Sierra de Abrucena

This mountain range in the eastern third of the Sierra Nevada (862 km<sup>2</sup> in the core area of which is protected as a national park) is separated from the main massif by the pass Puerto de la Ragua (2038 m alt.), and it reaches its highest elevation (Chullo, 2612 m alt.) close to this incision. Like the main massif it is predominantly composed of mica schist (metamorphic), and the vegetation is similar at least at lower altitudes. The climate is slightly drier than in the western Sierra Nevada, and immediately to the east of the Sierra de Abrucena is the Desierto de Tabernas, one of the driest places in Spain (240 mm precipitation per year) and Europe's only natural desert. At the northern slope the mountains are forested almost to their summits (which is in sharp contrast to the western Sierra Nevada where the summit area is dominated by scant alpine meadows interspersed with almost barren areas).

### Sierra de Segura and Sierra de Cazorla

Surrounded and threatened by the sprawling and highly intensified olive agro-industry of the province of Jaen in north-easternmost Andalusia, the natural park Sierras de Cazorla, Segura y las Villas still harbors the richest forests in southern Spain that already provided the wood for the Spanish Armada. Covering 2143 km<sup>2</sup> it is also the largest natural park in Andalusia. The mountainous area belongs to the Prebetic System (external Betics) to the north of the Penibetic system (that comprises the Sierra Nevada and the Sierras de Tejeda, Almijara y Alhama) and is mainly composed of Jurassic limestone and locally of dolomite. The highest peak (Las Banderillas) reaches 1993 m alt. The Guadalquivir and Segura rivers (the major catchment basins in Andalusia) both originate in the Sierra de Segura.

### Los Alcornocales

From a carnivorous plant perspective, *Drosophyllum* occupies a unique position, comparable only to the probably more famous Venus' Flytrap or the still quite enigmatic *Cephalotus*. *Drosophyl-*

Table 2. Carnivorous plants of Andalusia.	
Places visited in 2013 (not visited in 2013)	Species encountered (+ literature and/or previous excursions)
Los Alcornocales	<i>Drosophyllum lusitanicum</i> <i>Pinguicula lusitanica</i>
Sierras de Tejeda, Almijara y Alhama	<i>P. vallisneriifolia</i> <i>P. dertosensis</i>
(Sierra Nevada) Abrucena	( <i>P. nevadensis</i> ) ( <i>P. grandiflora</i> )
Sierra de Segura	<i>P. mundi</i> <i>P. vallisneriifolia</i>
Sierra de Cazorla	<i>P. vallisneriifolia</i> <i>P. dertosensis</i>

*lum lusitanicum* is the sole representative of Drosophyllaceae, and it is restricted to the westernmost part of the Iberian Peninsula and a limited area in adjacent Morocco. The affinity of *Drosophyllum* to the Droseraceae is more remote than generally appreciated, and it is obviously most closely related to the tropical West African liana family Dioncophyllaceae (to which the part-time carnivorous *Triphyphyllum peltatum* belongs). Unlike *Drosera* and most other carnivorous plants with adhesive traps, *Drosophyllum* has the glandular tentacles on the lower, abaxial leaf surface, and they are not capable of rapid movement, a feature it shares with *Triphyophyllum*. Unlike *Triphyophyllum*, all leaves of *Drosophyllum* are, however, carnivorous, and the characteristic hooked leaves of the climbing Dioncophyllaceae have never been observed in the European low shrub (or dwarf tree, as it has sometimes been called) that generally occurs outside the forests. The habitat of *Drosophyllum* is a sandy heathland with sparse competing vegetation marked by comparatively high air and soil humidity. The soil surface is, however, usually bone dry and unexpectedly solid, at least during most time of the year. *Drosophyllum* is found at several places throughout the Los Alcornocales Natural Park (Fig. 1).

*Pinguicula lusitanica* (Fig. 2) is far less exacting than *Drosophyllum* in its habitat requirements, and it is consequently quite widespread in the oceanic part of Europe and northern Africa, from Algeria to Scotland. Systematically, *P. lusitanica* occupies a basal position in the genus, and it is with some probability the oldest European butterwort. It depends on a continuous supply of surface water, so it prefers wetter places than *Drosophyllum* during active growth and is a characteristic species occurring along ephemeral trickles that may dry up completely during summer.

#### Sierras de Tejeda, Almijara y Alhama

In Spain, the largest group of *Pinguicula* species (*P. longifolia*, *P. dertosensis*, *P. mundi*, *P. vallisneriifolia*) is specialized on permanently wet limestone rocks (e.g., near waterfalls, along creeks and in narrow gorges) devoid of competing vegetation, usually at low altitude in high mountains, frequently associated with the maidenhair fern, *Adiantum capillus-veneris*. All three mountain ranges in the Sierras de Tejeda, Almijara y Alhama Natural Park are inhabited by at least one of these *Pinguicula* species. We chose two localities of comparatively low altitude at which the butterworts have been observed flowering as early as February in order to encounter well-developed plants in flower. The most noteworthy species is *P. vallisneriifolia* that occurs close to a waterfall in the Sierra de Alhama (Fig. 3). This population was the first to extend the known distribution of the species



Figure 1: *Drosophyllum lusitanicum* near Los Barrios, Los Alcornocales Natural Park.



Figure 2: *Pinguicula lusitanica* growing next to a stand of *Drosophyllum lusitanicum* near Gaucín, Los Alcornocales Natural Park.





Figure 3: *Pinguicula vallisneriifolia* in the Sierra de Alhama (left); *P. vallisneriifolia*, Sierra de Segura (right).



Figure 4: *Pinguicula dertosensis* in the Sierra de Almijara (left); *P. dertosensis*, Sierra de Cazorla (right).

that had been considered an endemic of the Sierra de Segura and Sierra de Cazorla before. More recently (Barona *et al.* 2008; Navarro *et al.* 2010), additional populations have been discovered in the province of Valencia, i.e. even beyond Andalusia. This is a remarkable career of a species that has been considered extinct shortly after its discovery, considered extremely rare after its rediscovery, considered extremely local after the discovery of additional populations nearby, and is now known to be fairly widespread and not critically threatened as a more serious floristic investigation has commenced throughout southern Spain.

An interesting parallel is also displayed by the other species in the area, viz. *P. dertosensis*, which is represented in the Sierras de Tejeda and Almijara (Fig. 4) by one population each. This is so far the southernmost known extension of the ranges of both species. But while *P. vallisneriifolia* is apparently restricted to the Betic system, *P. dertosensis* reaches considerably further north to central Spain and Catalunya. The most obvious difference between the two species being leaf length.

#### Sierra de Abrucena

The Sierra de Abrucena attracted our attention because an outlying population of *P. grandiflora* has been reported from there. This widespread and common species has a western European distribution that is even less oceanic in character (reaching northwestern Italy) than the range of *P. lusitanica* but in southern Europe and northern Africa it is restricted to high altitudes, occurring in



Figure 5: *Pinguicula mundi*, Sierra de Segura (left); *P. mundi*, Rio Mundo (right).

wet places in (sub-)alpine meadows. 2013 saw an unusual outbreak of winter in what should have been spring in the region. The unexpected snowfall even at low altitudes in late April caused several accidents and prevented us from seeing this butterwort at 1700 m alt.

*P. nevadensis* that grows in the vicinity occurs at even higher altitudes (2000-3000 m) in wet situations with sparse vegetation, and it does usually not appear before June. As far as we know, this is the only endemic carnivorous plant species in Andalusia.

#### Sierra de Segura and Sierra de Cazorla

All three butterwort species occurring in this natural park are growing in wet limestone habitats comparable to those in the Sierras de Tejeda, Almijara y Alhama Natural Park. Politically, the type locality of the apparently rare *P. mundi* in the vicinity of a locally famous waterfall lies just outside Andalusia in the province of Albacete (Castilla-La Mancha) in the natural park Calares del Mundo y de la Sima (Fig. 5). Due to its unclear taxonomic status and delimitation, the total distribution of this species is not very well known. During our trip we discovered a new site of this species in the core of the Sierra de Segura (Fig. 5), so it is now known to be likewise indigenous in Andalusia.

A rather common sight (if you know where to look) is *P. vallisneriifolia* (Fig. 3) that could be called the heraldic butterwort of the Sierra de Cazorla.

So far the known number of populations of *P. dertosensis* in the Sierra de Cazorla (Fig. 4) is limited but this may well change in the near future.

Morphologically *P. mundi* occupies an intermediate position between *P. vallisneriifolia* (that has still longer, usually hanging leaves) and *P. dertosensis* (that has involute rather than wavy leaf margins) but genetically (based on ITS sequence similarity, Kondo & Shimai 2006) the affinities of *P. vallisneriifolia* lie with *P. balcanica* from the Balkan peninsula, those of *P. dertosensis* with *P. macroceras* (derived in *P. sect. Pinguicula*), and those of *P. mundi* with *P. corsica* (the only diploid in the section, nested within a core group that is widespread in Europe and also includes *P. nevadensis* and *P. grandiflora*).

While *P. vallisneriifolia* is tetraploid, *P. dertosensis* and *P. mundi* are both octoploid (Casper & Stimpert 2009), and not hexaploid (as reported by Blanca *et al.* 1999). It nevertheless appears somewhat premature to rule out a hybridogenic origin of the latter two taxa.

#### Further Carnivorous Plant Species from Nearby Areas

In addition to the taxa mentioned above, Andalusia hosts two globally widespread azonal (aquatic) *Utricularia* species, *U. australis* (common in western Andalusia) and *U. gibba* (local in and

around the Donana Natural Park near Huelva), and the circumboreal *Drosera rotundifolia* (local at high altitudes in the Sierra Nevada).

*Drosera intermedia* that is fairly common in Portugal (frequently growing together with *P. lusitanica*), *P. vulgaris* that is known from the Montes Universales (E Teruel and NW Cuenca Provinces in central Spain) and from the Rif mountains in northern Morocco, and *Utricularia minor* that occurs in highlands of adjacent Castilla-La Mancha, have not been recorded from Andalusia so far.

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