Capítulo 5 do Guia geobotânico da Serra da Estrela por Jan Jansen © para este Webinar Vamos Trazer as zonas húmidas da Serra da Estrela às Nossas Vidas. 02.02.2021.

Aquatic environments-Ambientes aquáticos

Figure 1 Fonte Paulo Luís Martins (spring type 5.1.2)

As a result of the high precipitation in the Serra da Estrela, various fresh water environments exist. According to their stream velocity these may be subdivided into standing waters such as lakes, ponds, swamps or bogs, and running waters such as springs, brooks, and rivers. Other factors influencing aquatic flora and fauna include nutrient availability (oligotrophic, mesotrophic, eutrophic), nature of substratum (sand, silt, clay, rock), temperature, light availability, water depth, duration of inundation, acidity, oxygen availability, and other factors some of which are also interrelated to each other.

Plants may be classified according to their water requirements. The terminology associated with the water factor is built upon three simple prefixes of Greek roots: **xero-** , dry; **hygro**-(**hydro**), wet; and **meso-**, intermediate or middle. A biotope may be prevailing wet (**hygric**); prevailingly dry (**xeric**), or of intermediate degree of wetness (**mesic**). Those plants which grow in dry biotopes are **xerophytes**; those which grow in biotopes of intermediate degree of wetness and relatively uniform water availability are **mesophytes**.

Many plant species in standing waters and streams grow entirely in water. These are called **hydrophytes**. Free of most of their weight these water plants are flexible and pliant in the stream. Some are submerged, some float on the surface, others combine both strategies. They may be free-floating, anchored or rooted, mostly taking up oxygen and nutrients via their leaves. In all aquatic or semi-aquatic ecosystems helophytes can be found. **Helophytes** are always rooted in the soil and their stalks reach over the water level. Their stalks and leaves have a special tissue called aerenchym to transport oxygen from the air. This is important if there is shortage of oxygen in the soil, especially in swamps. **Phytoplankton** consists of floating producers (mainly algae) and **zooplankton** consists of floating consumers (e.g. water fleas). Both are a vital component in food chains (larger insects, fishes, birds, mammals). However they cannot be treated in this guide. In this chapter five major aquatic or semi-aquatic ecosystems are presented, namely springs, streams, standing waters, seasonally inundated biotopes, and bogs.

5.1 Springs-Nascentes

The Serra da Estrela has a large water storage capacity hosting numerous springs with soft and crystal-clear waters. It is no surprise that in these modern times with so much pollution the precious waters from the Serra da Estrela become more and more famous. In the last fifteen years three brands of mineral waters saw the light, and all of them have already national fame.

Most of the springs can be found along the valleys. Tectonic movements probably during the Alpine reactivation (1.1) produced the so-called Manteigas-Bragança fracture. Along this ample fault several thermal springs can be found. One of them is Caldas de Manteigas in the Serra da Estrela. It is famous for its spa with sulphurous-soda waters that are recommended for the treatment of rheumatism, skin diseases and breathing ailments. It has two springs, the Fonte Quente (43ºC) and Fonte Santa (20ºC).

Near to the mountain summit three majestic peaks are grouped. They are called the Cântaros (English: jars), because they supply water the whole year round. It is in the cirque between the Cântaro Magro, (the slim jar) and the Cântaro Gordo (the fat jar) that the river Zêzere finds its offspring. In its catchment area and those of other rivers (Mondego, Alva, etc.), springs contribute to a major part of their discharge in summer.

Springs host interesting plants and are also excellent biotopes for bryophytes. More than 100 different bryophyte species occur of which about a quarter are included in the red list of the Iberian Peninsula.

In large parts of Europe springs are extremely endangered biotopes mainly as a result of draining, fertilization from adjacent areas, and their use as wells. Especially the latter applies to the Estrela. Fortunately many still host important specialized species, although most of the springs are not unspoiled anymore. Here lies an important conservation and restoration task, not only for the Park's authorities and the mineral water factories, but also for the public.

Characteristic vascular plants in springs are:

Cardamine flexuosa
Carex remota
Chrysosplenium oppositifolium
Epilobium anagallidifolium
Epilobium anagallidifolium x palustre
Epilobium obscurum
Festuca rivularis
Hypericum androsaemum
Montia fontana subsp. amporitana
Myosotis secunda
Myosotis stolonifera
Ranunculus omiophyllus
Sagina saginoides
Saxifraga clusii subsp. lepismigena
Saxifraga stellaris
Sibthorpia europaea
Stellaria alsine
Veronica serpyllifolia subsp. langei.

Based on floristic composition and ecology five different types of springs are distinguished.

5.1.1 *Chrysosplenium* springs Nascentes com *Chrysosplenium*

In the middle belt the rare Opposite-leaved golden-saxifrage (*Chrysosplenium oppositifolium*) may form creeping patches in shaded rheocrenes, mostly found on cliffs and slopes. Flushes fed by springs may support similar vegetation at some distance of the origins. **Rheocrenes** are springs from which the water rushes with high speed such as fountains and cascades. Bryophytes do not fail to grow in these environments and occasionally Wavy bitter-cress (*Cardamine flexuosa*), Cornish moneywort (*Sibthorpia europaea*) and perhaps *Saxifraga clusii* subsp. *lepismigena* grow there too. The latter is a sticky glandular-hairy Iberian endemic that is less rare in similar conditions in North-Portugal.

5.1.2 *Epilobium obscurum* springs Nascentes com Epilobium obscurum

Springs with Short-fruited willowherb (*Epilobium obscurum*) are usually less shaded than *Chrysosplenium* springs. They mainly occur in the middle, sporadically in the upper belt. Major companions are Blinks (*Montia fontana* subsp. *amporitana*) and Bog stitchwort (*Stellaria alsine*). This kind of vegetation dwells in man-made biotopes, including fountains, wet walls, and gutter streams along the road. Short-fruited willowherb produces stolons with which it can conquer the fissures in the granite walls. Some of the specimens have large petals, reason why the Portuguese taxonomist Sampaio described them as a special variety called *Epilobium obscurum* var. *herminicum*.

5.1.3 *Ranunculus omiophyllus* springs Nascentes com *Ranunculus omiophyllus*

These springs occur occasionally in the middle belt and are predominated by Round-leaved crowfoot (*Ranunculus omiophyllus*). Small patches grow in muddy seepage areas, often in rills along unpaved roads or in small depressions in wet grasslands. Ivy-leaved crowfoot (*Ranunculus hederaceus*) occurs in more or less the same kind of biotopes. So far it has not been found in the Estrela. Round-leaved crowfoot is mainly distinguished from the latter by more deeply lobed leaves and larger flowers with petals twice the length of the sepals. Round-leaved crowfoot springs are **helocrenes**, springs from which the water slowly seeps.

5.1.4 *Myosotis* springs Nascentes com *Myostotis*

Myosotis springs are usually helocrenes too. They are predominated by Pale forget-me-not (*Myosotis stolonifera*) and a mountain form of Thyme-leaved speedwell (*Veronica serpyllifolia* ssp. *langei*). The former is mainly distributed in the higher mountains of the Iberian Peninsula, but can be found in some high mountains in Britain as well. There it also occurs in springs and flushes. *Veronica langei* is an endemic both from the Estrela and the higher mountains of Spain. It resembles *Veronica serpyllifolia* subsp. *humifusa*, a taxon that may occur in some mountains of Central Europe.

Pale forget-me-not vegetation may occur in the middle belt, but in its typical form it is best developed in the highest belt. It can be found near spring-heads and somewhat downstream in slowly flowing waters. Near bogs (5.5), humid Mat-grass swards (4.3.2), and wet heaths (2.7, 2.8) it can form mosaics with mats of *Ranunulus ololeucos*, an amphibian species that seems to prefer deeper waters (5.3.2).

5.1.5 *Saxifraga stellaris* springs Nascentes com *Saxifraga stellaris*

These springs are usually rheocrenes occurring in the upper belt and characterized by Starry saxifrage (*Saxifraga stellaris*), Alpine willowherb (*Epilobium anagallidifolium*), and *Festuca rivularis. Angelica major* is a frequent companion in this environment, but it also occurs in irrigated hay-meadows (4.4.2) and irrigated screes (6.2.2). Only at the end of summer some *Saxifraga stellaris* springs may tend to dry out. But since they mostly occur in shaded conditions beneath high granitic cliffs, they never seem to dry out totally. In the height of summer the marked colour contrast between the fresh-green of the spring and the dull-green of its surroundings results in a clear pattern. Starry saxifrage and Alpine willowherb are Arctic-Alpine relict species. In Portugal both species are restricted to the springs of the Serra da Estrela. In Europe Starry saxifrage is found in the Arctic and northern Europe and in the mountains of central and southern Europe. The presence of this species and other northern flora elements is related to the cold episodes of the Quarternary when species were driven southwards by the advancing ice-cap (1.6). In the Iberian Peninsula this flora encountered the Mediterranean mountain flora, the latter group mainly occupying

the xeric biotopes, the northern flora mainly the humid and snow-rich biotopes. Obviously springs have provided excellent refuges. The spring regime of constant temperature permits the northern plants to exist in regions where they do not otherwise occur. The lower summer temperatures in the springs have provided sufficient growth conditions.

St. Patrick's-cabbage (*Saxifraga spathularis*) may grow around springs but is widely distributed in shaded rock-fissures (6.1). It can be distinguished from Starry saxifrage by its larger leaves that are rather leathery, rounded to spoon-shaped, and coarsely toothed. The range of St. Patrick's-cabbage consists of two separate isolated areas, one in the north-western quadrant of the Iberian Peninsula, the other in Ireland.

5.2 Streams Cursos de água

From the Serra da Estrela many rivers originate. Together they form an intricate artery system throughout the mountains and the valleys. A unique situation arises in the north-eastern part of the Estrela massif, where the drainage divide of three major catchment basins of Portugal coincide: Tagus, Mondego and Douro. Going clockwise starting in the north the major rivers are Mondego, Zêzere, Beijames, Alvoco, Loriga, and Alva. The variation in discharge is mostly related to climatic factors (precipitation, snow-melt). Extremely high discharge peaks are ecological and often socio-economic disasters often caused by human influence. Though climatic change has still not been proved to be induced by man, there is no question that wildfires and extensive felling facilitate a sudden flow of run-off over stripped and bare soils directly to the stream beds. Under natural circumstances erosion would be minimal, skeletal soils would be sparse and an important part of the precipitation would infiltrate the soil or would be retained by vegetation.

Rapidly flowing streams mostly occur in the upper and middle belt. In these environments plants and other organisms must be adapted to stay attached to a firm substrate. In slowly flowing streams silt and other loose materials tend to settle (**sedimentation**), thus facilitating the establishment of rooted plants. In general there is a shift from rocky, stony river beds at higher altitudes to sandy, silty river beds at lower altitudes.

In the highest parts of the mountain small rivulets and flushes carry a vegetation that is still very much related to springs. However, at some distance slowly running streams may carry patches of *Ranunuclus ololeucos* var. *lusitanicus* often associated with the dark brown moss ***Fontinalis antipyretica***. These environments contain mostly very soft waters and frequently dry up in summer, reason why their ecology is closely related to that of the temporally inundated biotopes (5.2.2). Fast-flowing flushes at high altitudes do not contain vascular plants. Only certain bryophytes and lichens are adapted to such conditions.

Going downward, streams contain more water and chances of running dry are getting slim. From about 1,400 m until the foot of the mountain ***Ranunculus pseudofluitans*** may develop luxurious fans in relatively fast-flowing streams, often attached to firm substrates like stones. Examples can be seen throughout most of the rivers. Patches may also be found in irrigation channels and leats. Mostly at lower altitudes in still or slower-flowing waters Pond water-crawfoot (*Ranunculus peltatus*) may be found. Both Crawfoot species often grow together with Water-starworts (*Callitriche* spp.). A good example of a helophyte is the tussock forming ***Carex elata*** subsp. ***reuteriana***, an endemic from NW-Iberia, Montes de Toledo and Sierra Morena. This Sedge species occurs in the middle and lower belt and is occasionally accompanied by Hemlock water-dropwort (***Oenanthe crocata***), *Galium broterianum* and Common marsh-bedstraw (*Galium palustre*). The *Carex* tussocks collect sediments and form islands in the stream. They often consolidate and strengthen riverbanks, thus preventing erosion.

Undisturbed development of these formations may lead to Willow scrub (*Salix atrocinerea*, ***Salix salviifolia***), under certain conditions preceded by *Genista florida* scrub (3.10), eventually leading to Alder or Portugal laurel galleries (2.2.3, 2.2.1). Downstream, the banks of the river may host species like Water-cress (***Rorippa nasturtium-aquaticum***), Blue water-speedwell (*Veronica anagallis-aquatica*), and *Veronica linkiana*. Relatively nutrient-rich streams and channels along roads may contain carpets of Fool's water-cress (*Apium nodiflorum*), sometimes accompanied by grasses like Creeping bent (*Agrostis stolonifera*) and Small sweet-grass (*Glyceria declinata*). At the lower limits of the Park some ditches near villages may yield tall nutrient-demanding species like Yellow iris (***Iris pseudacorus***), Gipsywort (***Lycopus europaeus***), Purple-loosestrife (***Lythrum salicaria***) Common reed (*Phragmites australis*), and Lesser bulrush (*Typha angustifolia*). These and other species may become more important in swamps at lower altitudes outside the Park. Here alluvial soils contain more nutrients as a result of the sedimentation of fine material. Alpine figwort (*Scrophularia canina*) can be found occasionally as a pioneer species in gravel banks along the rivers. During peak discharges large amounts of shingles and pebbles are transported by the river and deposited as gravel banks during phases of lower water levels. These dynamic biotopes are rather similar to screes (6.2).

5.3 Standing waters (shallow waters, ponds and lakes) Águas paradas (águas pouco profunndas, charcos e lagoas)

For various reasons (increase of waste water, artificial fertilizers, acidification, etc.) nutrient-poor and weakly buffered waters become increasingly rare in large parts of Europe. Fortunately most of the waters in the Serra da Estrela are still nutrient-poor (oligotrophic), only at lower altitudes waters usually become more eutrophicated and polluted, due to both natural accumulation of nutrients and stronger human influence (settlements, agriculture, industry). Vegetation types of oligotrophic waters that are rather common in the Estrela are very rare or sometimes already extinct in other parts of Europe. Vegetation of eutrophic standing waters (e.g. floating patches of Duckweed, *Lemna spp.*, helophytic stands of Common spike-rush (*Eleocharis palustris*) that is common in large parts of Europe is rather rare in Estrela, and therefore left without consideration.
Here three types of oligotrophic and mesotrophic standing waters are distinguished. Characteristic species of these biotopes are:

Antinoria agrostidea
Baldellia alpestris
Baldellia ranunculoides
Hypericum elodes
Juncus bulbosus
Juncus heterophyllus
Potamogeton polygonifolius
Ranunculus ololeucos
Sparganium angustifolium.

Note that some of the aforementioned species may also occur in slowly flowing streams. All three ecosystem types have fluctuating water levels. Occasionally they may run dry during a short period, forming transitions to communities of seasonally inundated biotopes (see 5.4).

5.3.1 Stands of *Sparganium angustifolium* Formações com *Sparganium angustifolium*

Floating bur-reed (*Sparganium angustifolium*) is an Arctic-Alpine relict and within Portugal restricted to the higher parts of the Serra da Estrela. It is a very rare species forming small-sized stands, at shallow sites joined by *Antinoria agrostidea* (Fig.101). Vegetation dominated by Floating bur-reed may be found at the margin of former glacial lakes in the upper belt. These waters are extremely

soft, nutrient-poor and slightly acid. The specimens root mainly in mineral soil, hardly enriched with fine organic material.

5.3.2 Stands of *Antinoria agrostidea* Formações com *Antinoria agrostidea*

The *Antinoria* stands occur in oligo- to perhaps mesotrophic (in exceptional cases slightly dystrophic) stagnant or slow-flowing waters. The waters are slightly to moderately acid and their conductivity, a measure for mineral content, is usually low. However there are a few exceptions, induced by excessive road gritting, recently constructed concrete gutters along the national road (Fig. 110), and local dumps from an open sewer system near the summit.

The plants root in a variety of soils from sand to gravel to peat or organic sludge. They may be joined by species such as *Ranunculus ololeucos* var. *lusitanicum*, Bog pondweed (*Potamogeton polygonifolius*) Bulbous rush (*Juncus bulbosus*) or *Juncus heterophyllus*.

In peaty situations these vegetation types transgrade into *Carex nigra* swards (5.5.2), which in turn transgrade into *Sphagnum*-rich *Juncus squarrosus* stands (see 5.5.1).

5.3.3 Stands of *Hypericum elodes* Formações com *Hypericum elodes*

These stands sparsely occur in the northern part of the Serra da Estrela. Here *Hypericum elodes* mainly grows in small pools or locally in irrigated hay-meadows, sometimes joined by the Iberian endemic *Baldellia alpestris*. In peaty situations they may grow close to *Anagallis tenella* bogs (5.5.3). Stands of *Hypericum elodes* are better developed in North-Portugal. For instance in the Serra de Montemuro both species luxuriously mingle with *Potamogeton polygonifolius*, *Juncus heterophyllus*, and *Antinoria agrostidea*, amongst others.

5.4 Seasonally inundated biotopes Biótopos sazonalmente inundados

These biotopes consist of flooded areas that dry out seasonally; consequently the vegetation is rich in annuals. The stands are related to therophytic grasslands (3.1) and sometimes it is difficult to tell one from the other. These short-lived communities host species that are able to complete their life cycle within a very short time, surviving (as seed) unfavourable events such as low temperatures, inundation, ploughing, etc. Many of the species produce seeds that are able to stay dormant during decades, suddenly germinating when conditions become favourable again. Amphibious communities mostly dominated by Bur-marigolds (*Bidens spp.*) and Water-peppers (*Polygonum spp.*) occur in relatively nutrient-rich environments. These are rare in Estrela but elsewhere generally common and therefore left without consideration. Amphibious communities from oligotrophic biotopes are of particular interest within the 15 member states of the European Union. This type of vegetation usually occupies small areas (often less than a square meter), occurring on bare soils or in gaps of vegetation that mostly originate from disturbance. In the Estrela the following characteristic species occur:

Centaurium maritimum
Cicendia filiformis
Holcus gayanus
Hypericum humifusum
Illecebrum verticillatum
Gnaphalium luteo-album
Gnaphalium uliginosum
Juncus bufonius
Juncus capitatus
Juncus tenageia subsp. tenageia
Juncus tenageia subsp. perpusillus
Lythrum portula
Mentha pulegium
Molineriella laevis
Radiola linoides
Scirpus setaceus
Sedum maireanum.

Here four typical plant assemblages are distinguished:

5.4.1 Dwarfrush community with *Cicendia filiformis* Comunidade de pequenos juncos com *Cicendia filiformis*

This rare miniature community is characterized by the presence of Yellow centaury (*Cicendia filiformis*), a tiny yellow-flowering member of the Gentiane family. Dwarf rush (*Juncus capitatus*) is one of its companions. The temporally inundated micro-stands with *Cicendia* occur in both the lower and middle belt and are examples of "warp-and-woof" communities. They mainly consist of dwarf plants occupying microsites (the warp) within taller formations (the woof). The micro-stands develop in early spring in open grasslands (pastures, meadows). In the course of the season the grasslands become more dense and (depending on the altitude and the fluctuation of the climate) by the end of spring or the beginning of summer the micro-stands die off and are hardly recognizable anymore.

5.4.2 *Illecebrum* community Communidade de *Illecebrum*

Characteristic species are Coral necklace (*Illecebrum verticillatum*), Trailing St. John's-wort (*Hypericum humifusum*), and Water-purselane (*Lythrum portula*). These are frequently accompanied by Dwarfrush species (*Juncus capitatus*, *Juncus bufonius*, *Juncus tenageia* subsp. *tenageia*) and Spurrey species (*Spergularia capillacea*, *Spergularia rubra*). Stands occur from the lower to the middle belt around the edges of pools, rivers, shallow ditches, gravel pits, rye-fields, footpaths, car tracks, drove-roads, etc. Periodical inundation or percolation at low water levels during a considerable part of the rainy season is assumed. The water mostly originates from direct precipitation water or indirectly from run-off, more rarely from seepage. Mostly standing waters are concerned, but sometimes slowly running (on gently sloped sites).

5.4.3 *Holcus gayanus-Bryum alpinum* carpets Tapetes de *Holcus gayanus* e *Bryum alpinum*

These carpets are inhabited by various species and may appear as miniature gardens. The vegetation consists of a perennial moss layer of *Bryum alpinum* in which tiny annuals and bulbous plants occur such as the characteristic *Holcus gayanus*, a northwest Iberian endemic annual grass species. *Bryum alpinum* is rather common in the Serra da Estrela, especially in the cirques and the higher parts of the glacial valleys. There it thrives extremely well in intermittent, slowly percolating flows on warm gently sloped granitic rocks, polished by the ancient glaciers. The preponderant rocky environment functions as a storage heater. It affects the microclimate of the moss carpets by direct thermal conduction and by the radiation of collected solar heat. Temperature extremes are pronounced on rocky surfaces, but as long as the moss carpets are soaked, temperature fluctuations stay relatively attenuated. However in July dry moss carpets may be easily heated more than twice the surrounding atmosphere. The vascular plants in the perennial *Bryum* carpets have a typical southern growth rhythm. Some annuals can be observed already in early winter. In early spring the aspect is formed by the flowered specimens of *Narcissus* and *Crocus*. However most species have a late vernal or early aestival maximum, depending on the weather conditions. Then the green to reddish-brown moss layer of *Bryum alpinum* is often covered by a blond-coloured blanket of *Holcus gayanus* (Fig.105). *Merendera montana* is the last species to flower (mid to late summer). From October to July there is a chance of freezing. In winter *Bryum* carpets lit by the sun may thaw during the day, while shaded carpets may stay frozen. Melt water influence declines in the course of spring, admitting an increasing influence of rain water. It is then that temperatures

of the *Bryum* carpets rise and the vascular plants start to come out, most of them reaching their maximal development from late spring to early summer.
For some species the temporally irrigated carpets function as sanctuaries against wildfires. The stands occupy more or less natural habitats and often host a large number of Iberian endemics, such as *Sedum maireanum* and *Scilla ramburei* subsp. *beirana*. The miniature carpets are very well-developed in the Serra da Estrela, but they can also be seen in the Serra da Gardunha, Serra do Gerês and Montesinho.

5.4.4 *Juncus perpusillus* populations Populações de *Juncus perpusillus*

Juncus tenageia subsp. *perpusillus* is a tiny Iberian endemic dwarfrush, related to Sand rush (*Juncus tenageia* subsp. *tenageia*). Populations usually form small patches in seasonally inundated hollows (Portuguese: charcos, poças) in Mat-grass swards (4.3.2), which are subjected to summer grazing (Fig. 106). The patches are well-developed in summer, when the hollows run dry. Within Portugal this biotope is restricted to the upper belt of the Serra da Estrela. *Spergularia rubra* subsp. *capillacea*, a species indicative for trampled areas (7.2), is often present.

5.5 Bogs Turfeiras

Bogs are **ombrotrophic** formations (= largely depending on atmospheric water). They are mainly composed of peat mosses (*Sphagnum* spp.) and often joined by sedges (*Carex* spp.), and sometimes by rushes (*Juncus* spp.), a few forbs, and dwarfshrubs.
A peat moss keeps on growing in its top, while at the bottom it dies from lack of light and starts to decay. Its top is just a few centimetres above the water table, while the rest retains large amounts of water. Under favourable conditions peat mosses may increase a few centimetres up to almost half a meter per year. A large amount of peat mosses may actively raise the water table, thus creating a bog formation. The cell walls of peat mosses function as ion exchangers. They absorb cations from rain, run-off or blown-in particles and in exchange release hydrogen ions turning the water very acid. However they bind much more nutrients than the plants need for their survival. In this way peat mosses create and maintain a nutrient-poor, acidic environment that stimulates their own growth but is intolerable to all but a small number of highly specialized plant species.
The property of bogs to conserve organic rests (pollen, leaves, roots, etc.) adds to their scientific interest. It is possible to trace the vegetation history and related climate by studying the deposits. These are well-conserved in the acidic bog layers, which actually function as natural archives.
The Estrela has a dry period in summer and consequently bogs are mostly small-sized, occurring in depressions, water margins, and seepage areas. However, most known peat moss species from Portugal do occur and some of them are restricted to the Estrela.
In the Estrela only very small parts of bogs may be influenced by precipitation only. Most of them are also fed by run-off water, which contains more minerals thus facilitating the growth of less specialized species. The purpose and size of this guide does not permit a detailed description of the bog complexes, reason why only three groups are distinguished.
More or less characteristic species are:

Agrostis canina
Anagallis tenella
Arnica montana subsp. atlantica
Carex demissa
Carex echinata
Carex nigra subsp. iberica
Drosera rotundifolia
Epilobium palustre
Eriophorum angustifolium
Juncus alpinoarticulatus subsp. alpestris
Juncus articulatus
Lycopodiella inundata
Menyanthes trifoliata
Ranunculus flammula

Scutellaria minor
Trichophorum cespitosum subsp. germanicum
Veronica scutellata
Viola palustris
Wahlenbergia hederacea.

Bogs are vulnerable and in the Estrela they are endangered. Of course the dry summers are limiting but the main cause of deterioration is pollution. There is uncontrolled rubbish dump. Some visitors leave rubbish after a pick-nick in the summer season (e.g. frequently at Covão do Boi). In winter "ski-tourists" use plastics for sliding and leave them being prey for the winds. After months, even years they can be found scattered for miles around, blocking rivulets and choking bogs. However, not only visitors can be blamed. At the top of the mountain an open sewer system of the shopping centre discharges into an oligotrophic rivulet and reaches some extremely sensitive bogs. Some of the concrete gutters along the roads discharge in bogs and nutrient-poor waters.

5.5.1 *Juncus squarrosus-Sphagnum* bogs Turfeiras com *Juncus squarrosus* e *Sphagnum*

These are the most common type of bogs and occur in the upper belt. They consist of *Sphagnum* hummocks in which Heath rush (*Juncus squarrosus*) most frequently grows, often joined by species such as Star sedge (*Carex echinata*), Round-leaved sundew (*Drosera rotundifolia*), and Bog violet (*Viola palustris*). *Drosera* is one of the most specialized plants. This perennial herb is notable for its insectivorous habit. Its leaves are covered with long gland-tipped hairs that are irritable and mobile, entrapping and digesting insects. The use of this alternative nutrient source is an excellent adaptation to the nutrient-poor bog environment. The less the bogs are influenced by run-off the more competitive *Drosera* becomes. At the margins of the bogs *Drosera* is replaced by other species that profit from the mineral-rich soil. For instance in less peaty but still hygromorphic organic soils the appearance of Marsh gentian (*Gentiana pneumonanthe*) and Common lousewort (*Pedicularis sylvatica* subsp. *sylvatica*) show the transition to humid Mat-grass swards (4.3.2). *Juncus squarrosus-Sphagnum* bogs are mostly found along small ponds and glacial lakes, but they may also form complex mosaics with wet heaths (3.7, 3.8). In these situations the rare Bilberry (*Vaccinium myrtillus*) may show up.

5.5.2 *Carex iberica* bog Turfeiras com *Carex iberica*

Swards of an Iberian subspecies of the Common sedge (*Carex nigra* subsp. *iberica*) prefer rather muddy soils and occur mostly in channels adjacent to the slightly raised *Sphagnum* carpets of 5.5.1. They are mostly species-poor and occur in the upper belt. Some good examples can be observed near Fonte Perus, Covão do Boi, and Covão do Cimeiro.

5.5.3 *Anagallis tenella* bog Turfeiras com *Anagallis tenella*

In the middle belt small *Sphagnum*-rich vegetation patches may occasionally occur in irrigated meadows or near seepage areas. These patches develop under stagnating water conditions causing accumulation of peat. The vegetation includes some species that never seem to reach the upper belt such as Bog pimpernell (*Anagallis tenella*), *Arnica montana* subsp. *atlantica*, Common yellow sedge (*Carex demissa*), Lesser spearwort (*Ranunculus flammula*), and Marsh speedwell (*Veronica scutellata*). These species often intermingle with elements from humid Mat-grass swards (4.3.3) and nutrient-poor wet meadows (4.4.2).

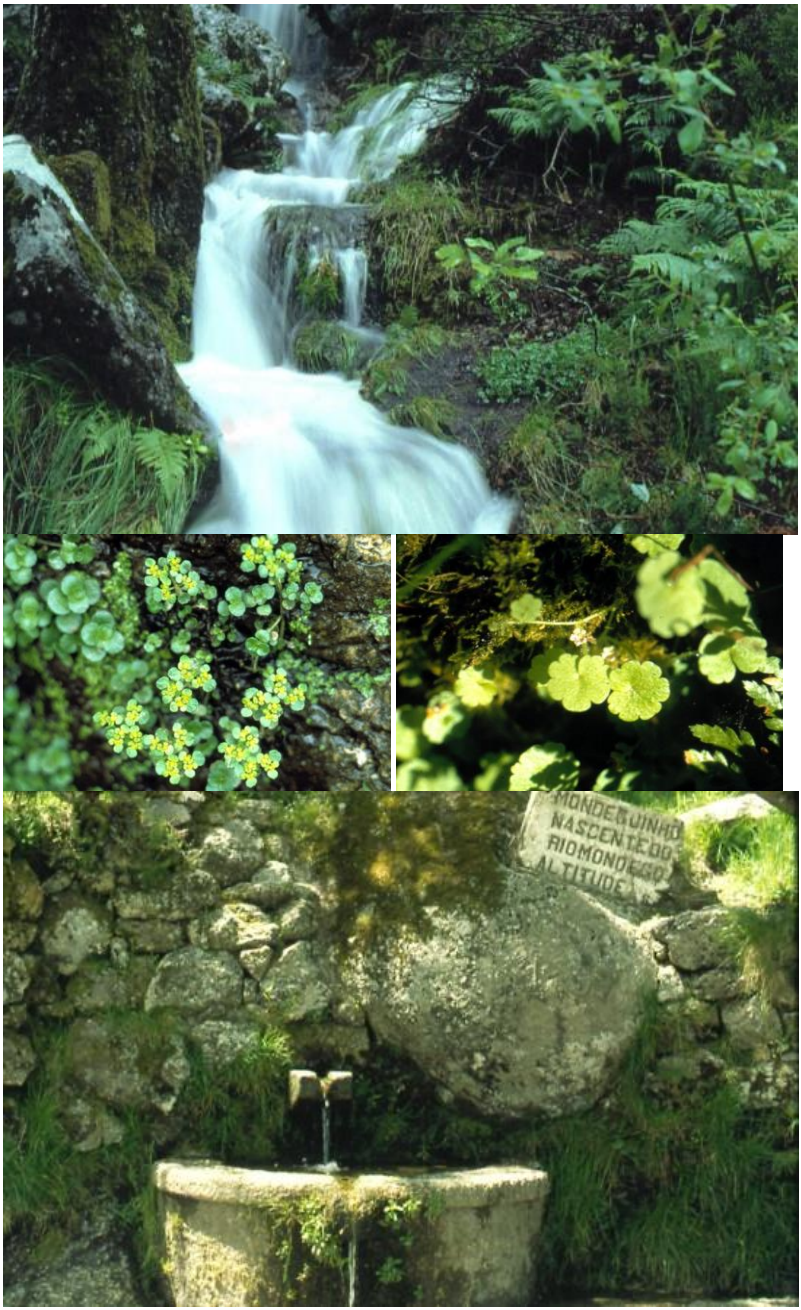


Figure 2 Top: shaded flush. Mid: *Chrysosplenium oppositifolium*, *Sibthorpia europaea*. Bottom: converted spring called Mondeguinho generally considered the origin of the Mondego river.

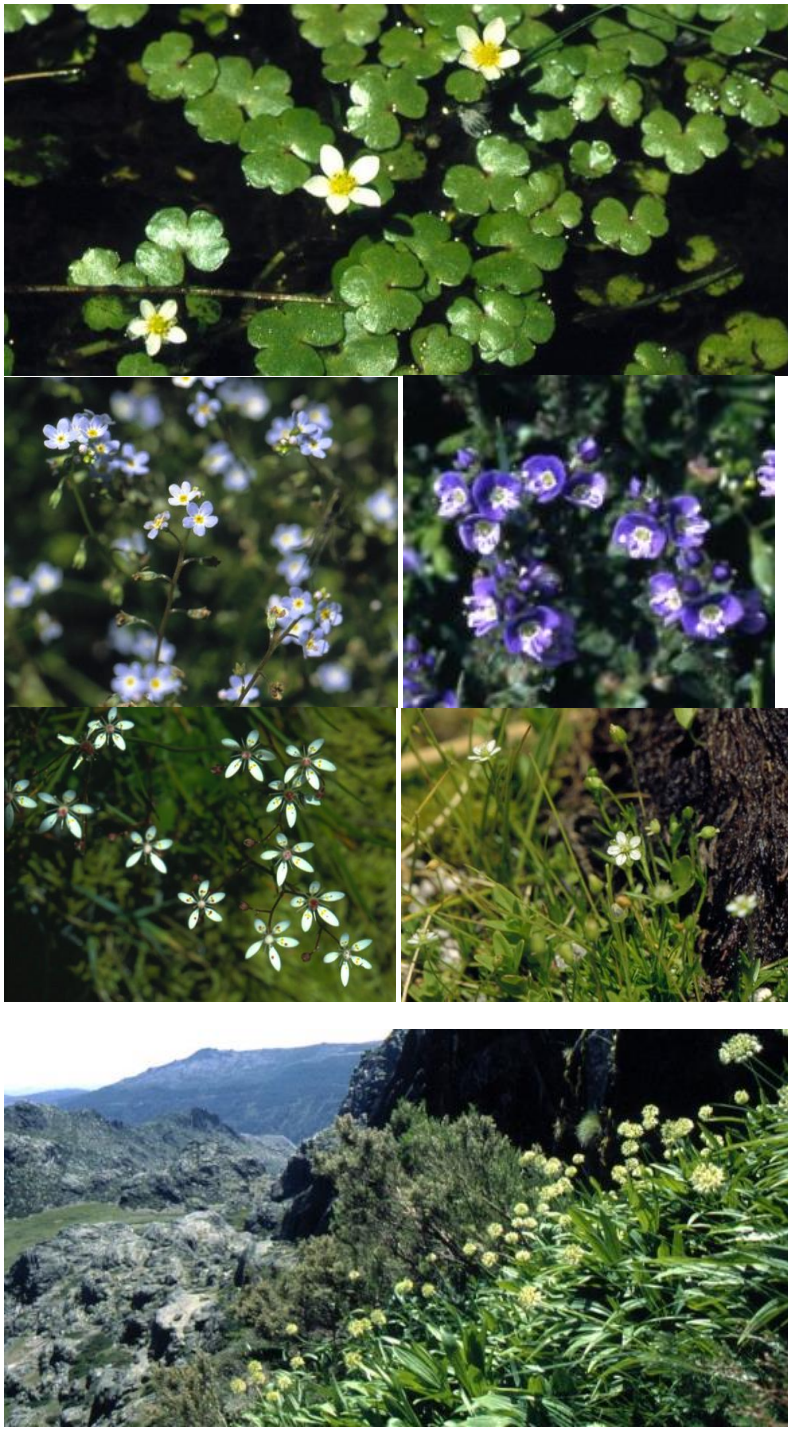


Figure 3 Top: *Ranunculus omiophyllus*. Mid: *Myosotis stolonifera*, *Veronica langei*, *Saxifraga stellaris*, *Sagina saginoides*. Bottom: aspect of *Allium victorialis*.

Figure 4 Top: *Saxifraga stellaris* spring. Mid: *Epilobium anagallidifolium, Angelica major*. Bottom: *Philonotis* sp. (moss) with capsules and juvenile *Epilobium*; *Saxifraga stellaris* spring and *Bruchia vogesiaca* habitat.

Figure 5 Top: snow providing meltwater, *Ranunculus ololeucos* rivulet. Mid: natural discharge pattern in *Nardus* swards. Bottom: *Rana iberica*.

Figure 6 Top: Vale do Conde rivulet running through *Potentilla-Calluna* mato. Mid: upper Zêzere river. Bottom: Zêzere river with flowering *Ranunculus pseudofluitans*, patches of *Fontinalis antipyretica* (dark brown)) and *Carex reuteriana* tussocks.

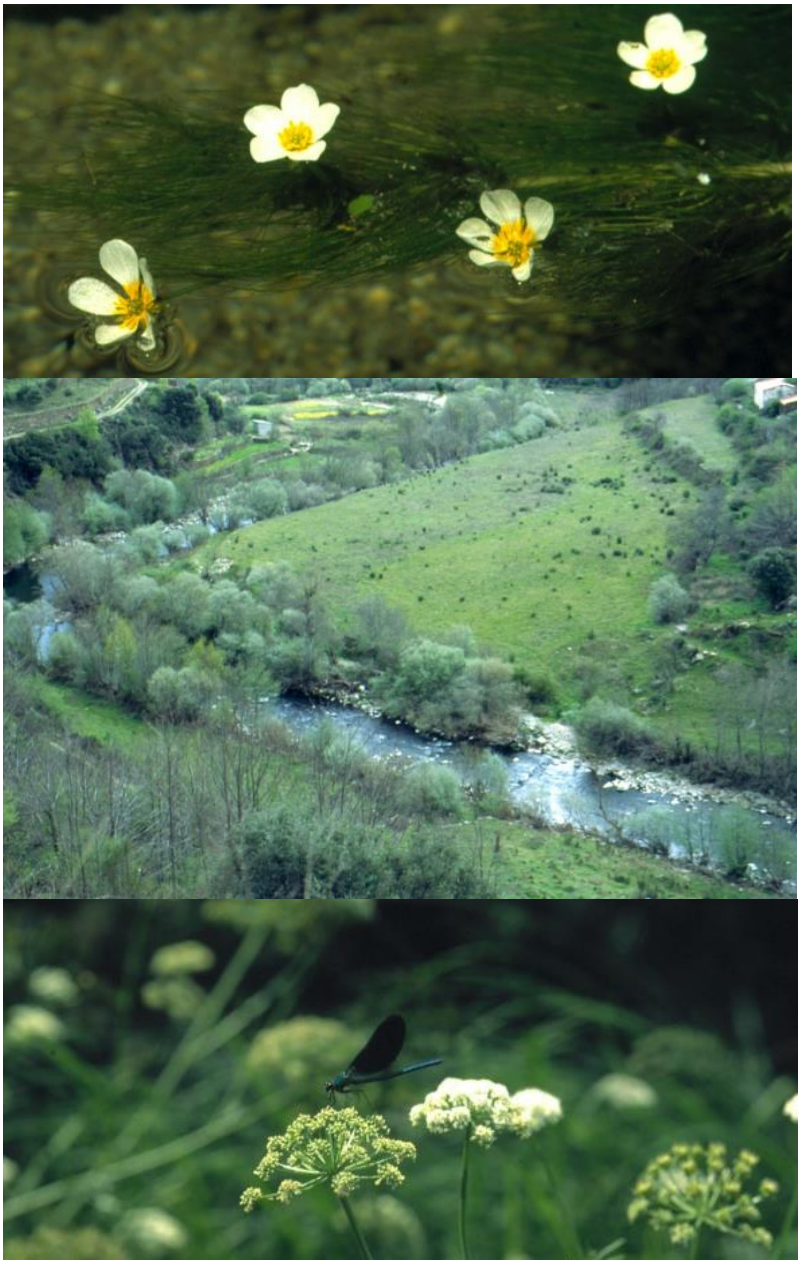


Figure 7 Top-bottom: *Ranunculus pseudofluitans*; banks of Zêzere with tree growth of a.o. *Salix saliviifolia* (grey). Bottom: Iberian Demoiselle (*Calopteryx xanthostoma*) on *Oenanthe crocata*.

Figure 8 Top-bottom: *Rorippa nasturtium-aquaticum*; *Lycopus europaeus*, *Lythrum salicaria*; *Iris pseudacorus*.

Figure 9 Top-bottom: frozen lake in March, aspect of *Sparganium angustifolium* (left) and *Antinoria agrostidea* (right) in July; *Sparaganium angustifolium*.

Figure 10 Top-bottom: Lagoa Redonda with aspect of *Potamogeton polygonifolius*; *Antinoria agrostidea*; *Ranunculus ololeucos*.

Figure 11 Top-bottom: *Baldellia alpestris*; *Juncus heterophyllus*; *Hypericum elodes*.

Figure 12 Top: *Rana perezi*; edge of shallow pond with *Illecebrum* community surrounded by scrub with *Halimium alyssoides* and *Cytisus striatus*; *Juncus capitatus*, *Cicendia filiformis*.

Figure 13 Top-bottom: *Holcus gayanus-Bryum alpinum* carpet in early spring; in late spring; *Sedum maireanum*.

Figure 14 Top-bottom: *Juncus perpusillus* and *Spergularia capillacea*; *Mentha pulegium*, *Carex echinata*; bog with dystrophic brown tinted water.

Figure 15 Top-bottom: bog; *Potentilla erecta* in *Sphagnum-Polytrichum* moss carpet; *Carex iberica*, *Carex demissa*.

Figure 16 Top-bottom: *Arnica atlantica*; *Trichophorum germanicum*; *Lycopodiella inundata* and *Drosera rotundifolia*.

Figure 17 Top-bottom: *Anagallis tenella*; *Wahlenbergia hederacea*; small lake with aspect of *Menyanthes trifoliata* (front) and *Ranunculus ololeucos* (background).

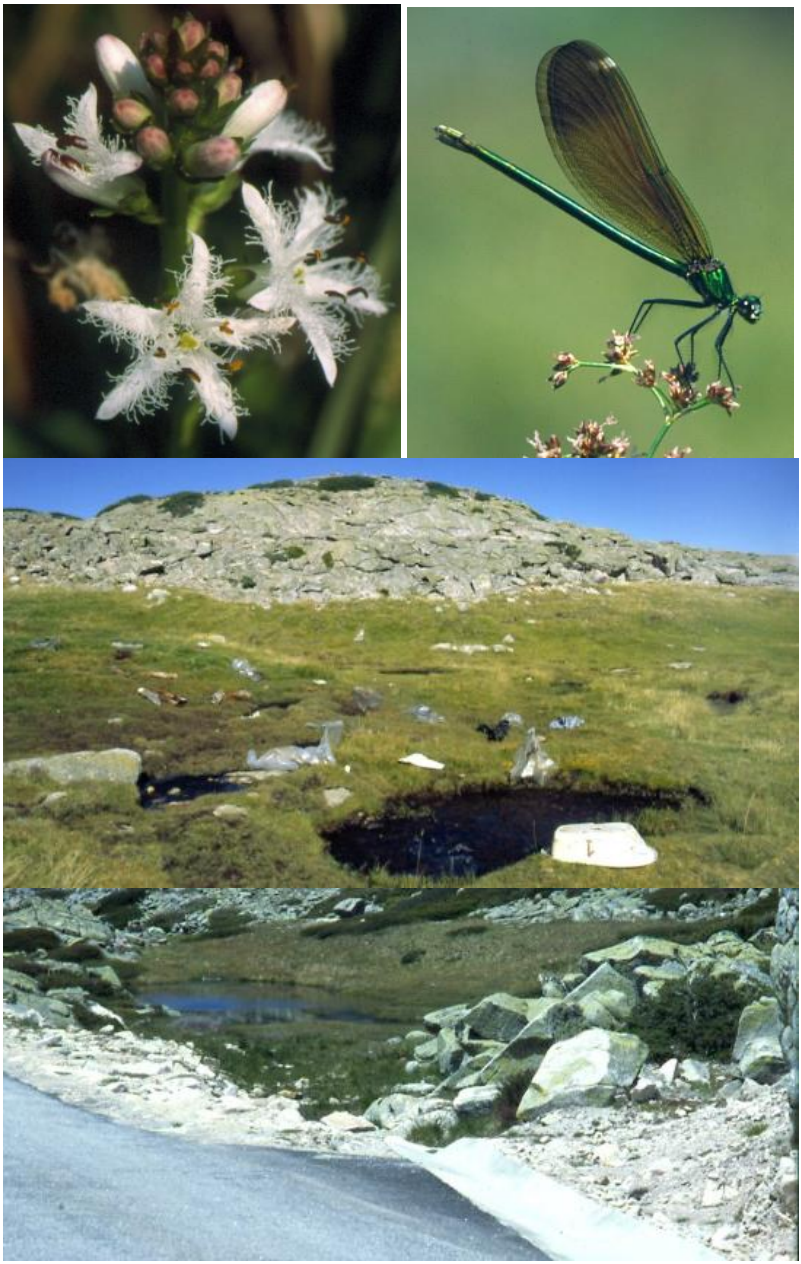
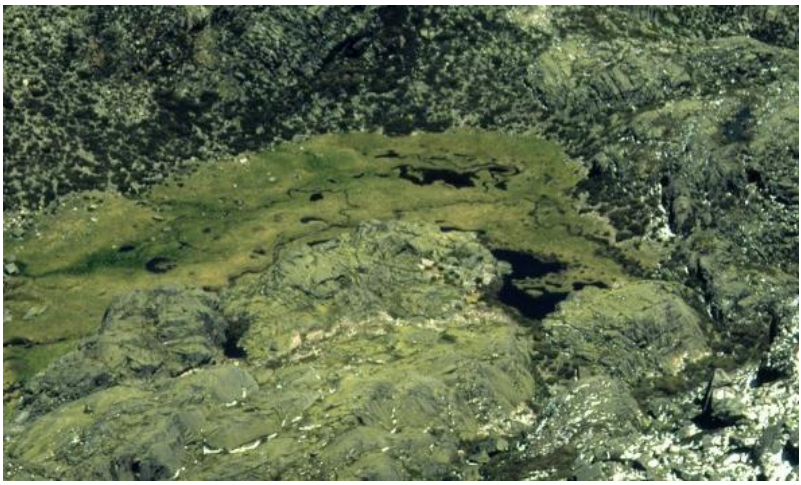


Figure 18 Top: *Menyanthes trifoliata*, Southern demoiselle (*Calopteryx xanthostoma*). Mid: bog polluted by plastics used by "ski-tourists". Bottom: gutter along the road made of allochtonous calcium containing material (concrete) discharges in bog system. In winter large amounts of salts used for road gritting flow in the system, raising the conductivity of the extremely soft waters.



Figuur 19 Top: *Vaccinium myrtillus* may be found in bogs. Mid: bog with some flowering *Viola palustris*. Bottom: Covão do Cimeiro with mosaic of rivulets, ponds, bogs and *Nardus*-swards.