

Granites, 'espigueiros' and oak woodlands: A short stay in the Peneda-Gerês National Park (Portugal)

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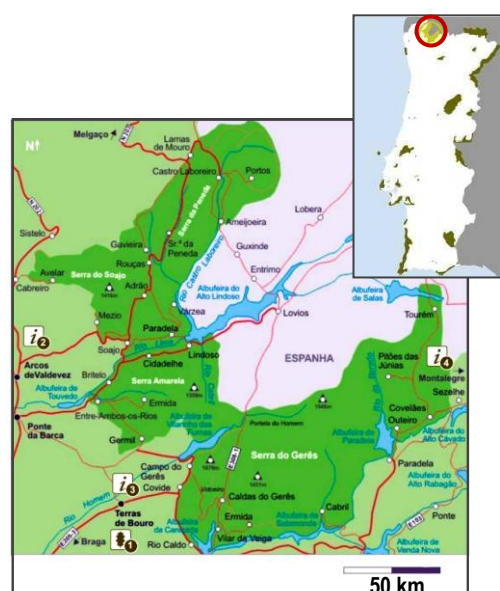
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Espigueiros in the town of Lindoso, in the Peneda-Gerês National Park. The building material is a two mica granite of Carboniferous age.

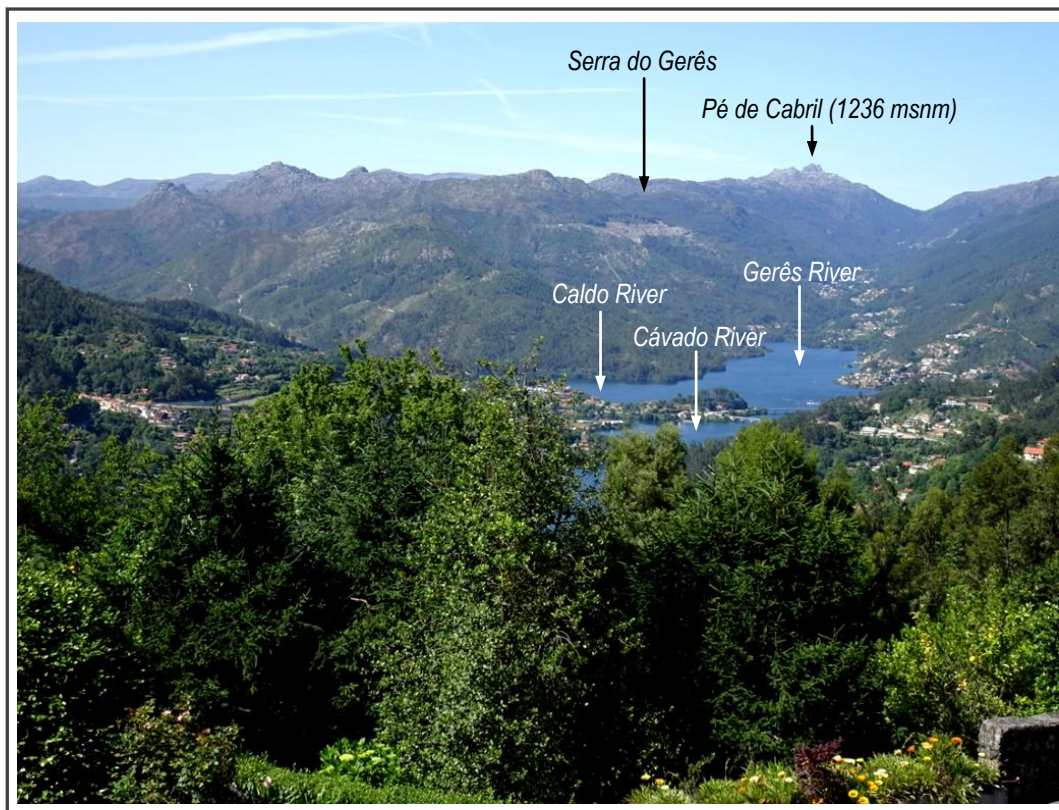
The Peneda-Gêres National Park is the only park in Portugal with the status of 'national', and was created on May 8, 1971 because of its scientific interest and to protect the natural and cultural environment; the park has a horseshoe shape that opens to the northeast and extends for about 703 km², of which only about 53 km² are of public property, the rest being privately owned or communal property (Wikipedia 2022).

If we wanted to sum up the Peneda-Gêres National Park in three words, we would have to mention: mountains, granites and oak woodlands. We don't want to be unfair to the rest of the tree species and plants in general, but the oak trees truly stand out among them. The same happens with the granites, since there are also outcrops of metamorphic rocks. However the relief is marked by granitic peaks subject to strong differential erosion due to the systematic crossing of faults that generate a



The horseshoe shape of the Peneda-Gerês National Park (Unmundoinfinito.com 2022) and its location within Portugal (top right), red circle (slidetodoc 2022). Other protected areas are also indicated.

'sawtooth' morphology, which accounts for most of the relief of the summits of the park.

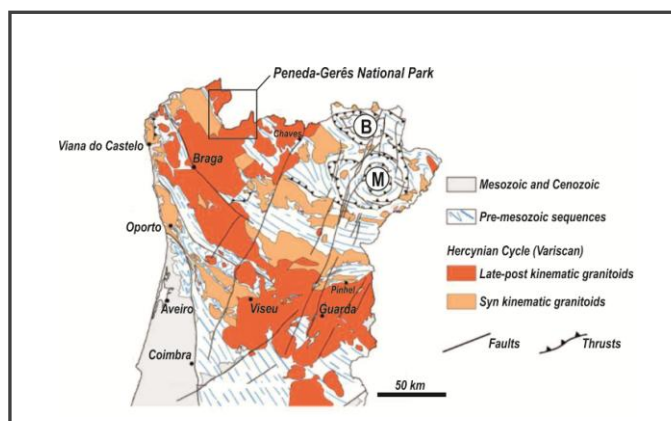


View to the north from the Pousada de Caniçada-Gerês, from where the park's mountain ranges and the place where the reservoirs of the three rivers cross. Names of rivers according to the Registo Nacional de Dados Geográficos (2022).

Let us say that the park is an excellent and vibrant combination of natural (*physiography, geology, vegetation, fauna*) and cultural (*villages, monasteries, castles*) features, which offer an extraordinary view of northwestern Portugal, making it a must-see place. The authors of this article spent three days in this place which is OK for a first contact, but it is a little too short given how much there is to be seen.

A fundamentally Hercynian geology

The Hercynian Tectonic Cycle, also known today as Variscan, is of Paleozoic age, and begins in the Ordovician with the marine transgression that led to the formation of the Armorican Quartzite. Towards the Middle Devonian, this 'quiet' sedimentary (*and partly volcanic*) phase ends and the compressional phases (F1-F3) begin, culminating in the Carboniferous. It is during the Devonian that the tectonic emplacement in Portugal of the mafic-



Simplified geology of northern Portugal showing the massive emplacement of granitic rocks and the position of the Peneda-Gerês National Park. Adapted from Azevedo et al. (2005). The position of the Bragança (B) and Morais (M) Complexes is also shown.

ultramafic complexes of Bragança and Morais took place.

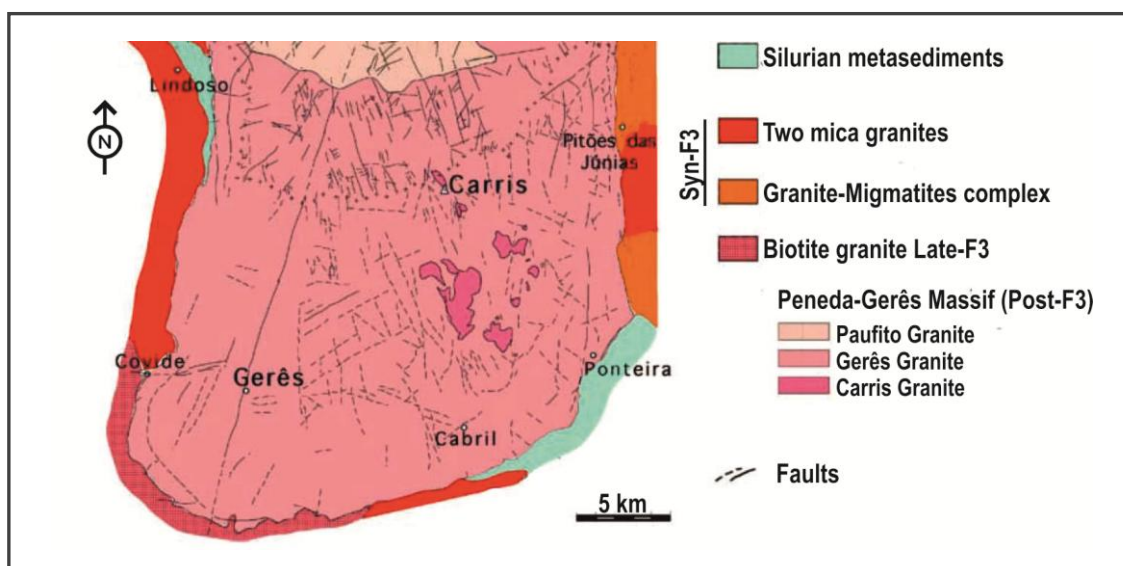
Regarding the region where the Peneda-Gerês National Park is located, syn- and post-F3 granites (*Upper Carboniferous and Lower Permian respectively*) are recognized (Mendes and Dias 2004). The former comprise two-mica granites, a migmatite-granite complex, and late biotite granites. On the other hand there are the post-F3 granites, which we visited in the Cabril - Ponteira area, where the so-called Gerês Granite (Mendes and Dias 2004), a coarse-grained biotite granite, can be observed.

In this respect, a quick inspection of the Gerês Granite along the CM1361, N308 and CM1021 roads (from Cabril to Ponteira), allows the rapid identification of medium-coarse grained facies (5-10 mm), with abundant biotite, amphibole, quartz, feldspar and plagioclase. The feldspars are strongly altered to clay (*kaolin*), that together with the oxidation of the rock result in a general pale gray-yellow color of the rock. To the east of Ponteira, Silurian metasediments are also recognized (see map below).

Granitoid is a broad term that encompasses a diverse category of plutonic igneous rocks, consisting mainly of quartz, plagioclase and feldspar.

Syn-, late-, post-kinematic. In this particular case it refers to granitoid emplacements that occurred during, at the end of, and immediately after the Hercynian (Variscan) F3 tectonic phase.

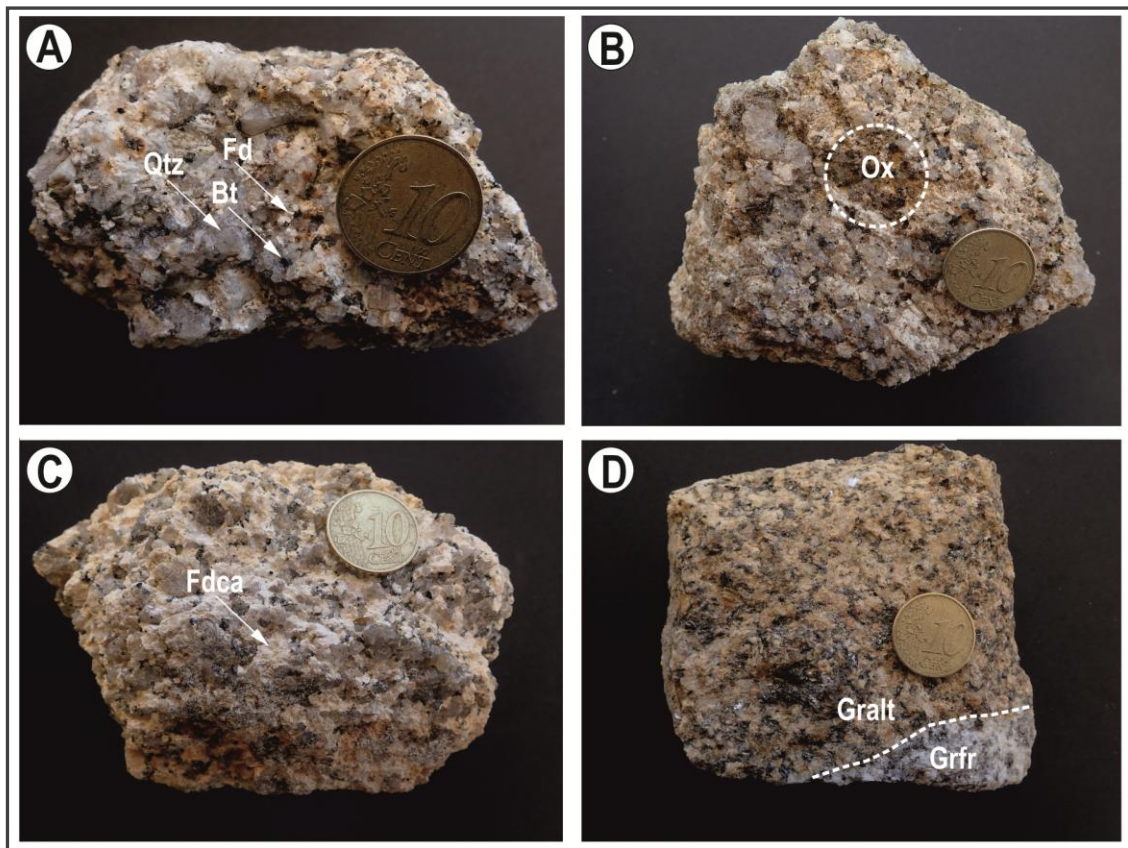
Calc-alkaline. A somewhat misleading term that has been used to designate: (1) island arc rocks, (2) andesites, (3) rocks with high LILE/HFSE ratios, (4) rocks with negative Nb anomalies, etc (Sheth et al. 2002).



Geologic map of the area. Adapted from Mendes and Dias (2004).



Beginning of the visit to the Cabril-Ponteira sector (Gerês Granite domain). Left, map of the Peneda-Gerês National Park next to the Salamonde dam (barragem). Right, the dammed water in the middle of the local forests.



The Gêres Granite, medium to coarse grained, with abundant quartz (Qtz), feldspar (Fd) and biotite (Bt). A: Near the Salamonde dam (barragem); B and C: Near the village of Fafião; D: In the surroundings of Bosto Chão. These rocks show oxidation (Ox) mainly at the expense of biotite, which gives them a pink-orange tone. The feldspars are also affected by chemical weathering degrading to kaolin (Fdca). The contrast between the "fresh" rock and the altered one is evident (Grfr-Gralt). Given the protected nature of the site, none of the samples were obtained from outcrops, corresponding to fallen pieces (but identifiable as to their origin). The coin corresponds to 10€ Euro.

The strong kaolinization of the feldspar in the granites has favored erosion and the generation of a relief with elongated and isolated blocks on the summits, to which the structural control of the park's mountain ranges has also contributed. The area is intensely faulted, with the large Gerês - Lovios fault, of late Hercynian or early Alpine age standing out.



Left, an elongated granitic summit and fallen blocks in the Bosto Chão sector. Right, some of the main structures (lineaments) in the Peneda-Gerês National Park. Image: Google Earth.

The Gerês-Lovios fault presents associated activity of thermal waters of low temperature (41-46°C), with a pH of 8.18-8.47 and a composition dominated by Na⁺ and HCO⁻³ (Carreira *et al.* 2021). With historical references dating back to Roman times, it was only in the early 18th century that the first thermal establishment was built in Gerês; today, Termas do Gerês is one of the main and most important Portuguese spas (Gerês 2021).

On another route, moving NNE along the N308-1 road (*Portugal*) and then along the OR312 and OU-540 towards the west-southwest (*Spain*), and finally the N304-1 we reached the locality of Lindoso, and a little further the village of Soajo, where medium-grained two mica granites crop out. Lindoso and Soajo are famous for having large concentrations of espigueiros, which is the Portuguese term for hórreo (a term applied in Galicia, Spain).



Above, the two mica granite from Lindoso, the lichen measures about 3 cm. Below, the two mica granite from Soajo. Yellow circles: muscovite; white circles: biotite.

Another distinctive feature of these granite dominated mountains is the presence of several 'granitic chaos'. A granitic chaos consists of a large number of rounded boulders of metric to decametric scale that have been formed by the weathering of a granitic massif, which is favored by the existence of vertical, horizontal and oblique jointing.

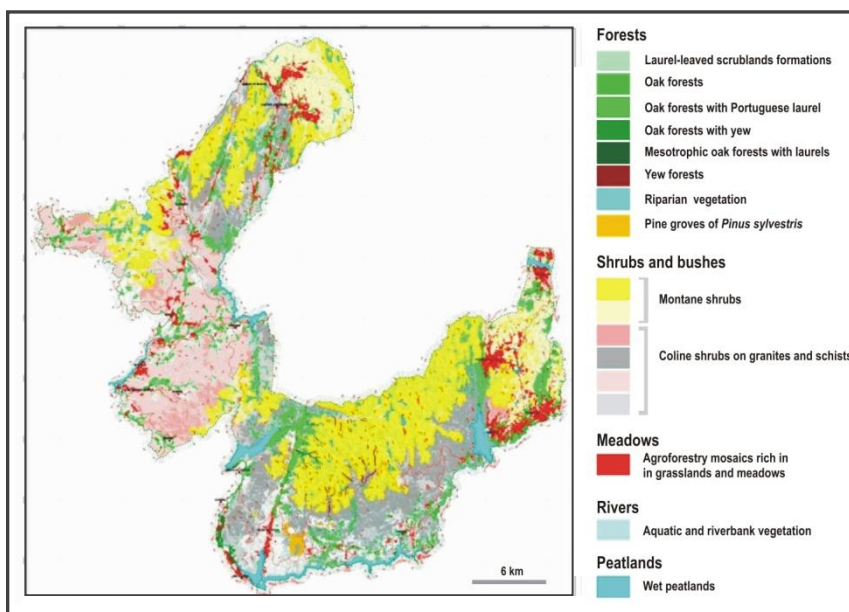


Above, beginning of the formation of a granitic chaos around a summit subject to significant erosion (Ponteira). Below, the village of Ponteira, in the middle of a granitic chaos.

It should also be noted that the entire Gerês mountain massif was intensely affected by the last glacial cycle (115,000-11,700 years ago) (Palacios *et al.* 2022); glaciers reached 7.6 km in the Serra do Gerês, with ice thicknesses of 225 m (Pérez-Alberti 2022).

Vegetation (and something more)

Thanks to the climatic diversity of the area, enhanced by the rugged relief of the terrain, the Peneda-Gerês National Park has a very rich vascular and bryological flora (*Instituto da Conservação da Natureza e da Biodiversidade* 2010). The oak groves stand out, mainly *Quercus robur* (sessile oak) and *Quercus pyrenaica* (Pyrenean oak), accompanied by *Betula celtiberica* (birch), *Prunus lusitanica* (Portuguese laurel), *Taxus baccata* (yew), *Sorbus aucuparia* (rowan) or *Ilex aquifolium* (holly). In the shrub stratum *Crataegus monogyna*, *Pyrus cordata*, *Frangula alnus*, various species of *Cytisus*, *Erica arborea*, *Ruscus aculeatus* and *Vaccinium myrtillus* stand out.



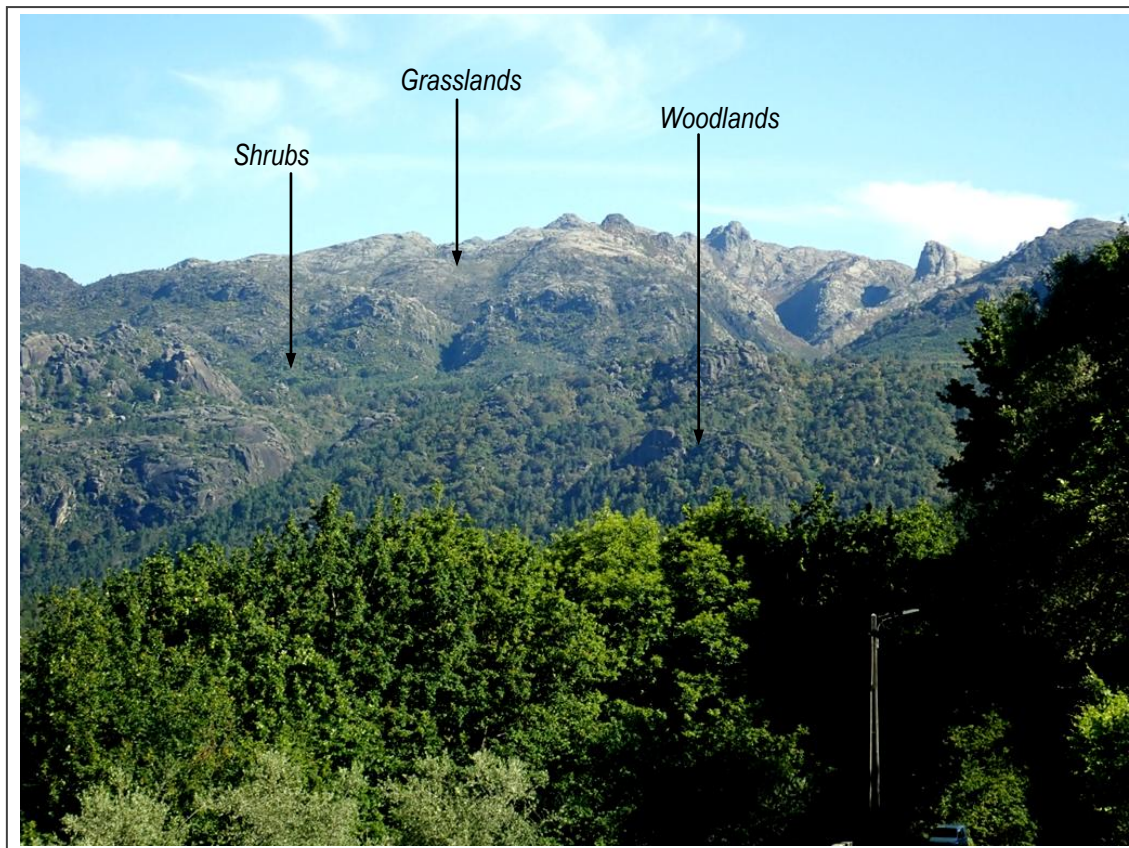
Main plant formations of the Peneda-Gerês National Park. Adapted and simplified from Instituto da Conservação da Natureza e da Biodiversidade (2010).

In the Park there are important oak groves - Castro Laboreiro, Mata do Cabril, Beredo and the river Mau - but the most important for its extension and degree of conservation is the Mata de Albergaria. It occupies an area of 1371.3 ha in the Gerês Mountains, along the valley of the Homem River and its tributaries. It is a mature forest dominated by sessile oak, and also Pyrenean oaks, as well as other species characteristic of the Galician-Portuguese oak forests that constituted the primitive vegetation of a large part of northwestern Portugal.



Sessile oak (*Quercus robur*). On the left, specimen next to the CM1021 road, near the village of Bosto Chão. On the right, lobed leaves with very short petioles and acorns (arrow) on very long peduncles (same oak).

The natural richness of this sector (*Mata de Albergaria*) is great and has a high level of protection. For example, it is forbidden to stop with the vehicle in a stretch of several kilometers along the N308 road that goes from Portela do Homem to the border (*Portugal-Spain*). However, there are various trails that allow exploration of the zone.

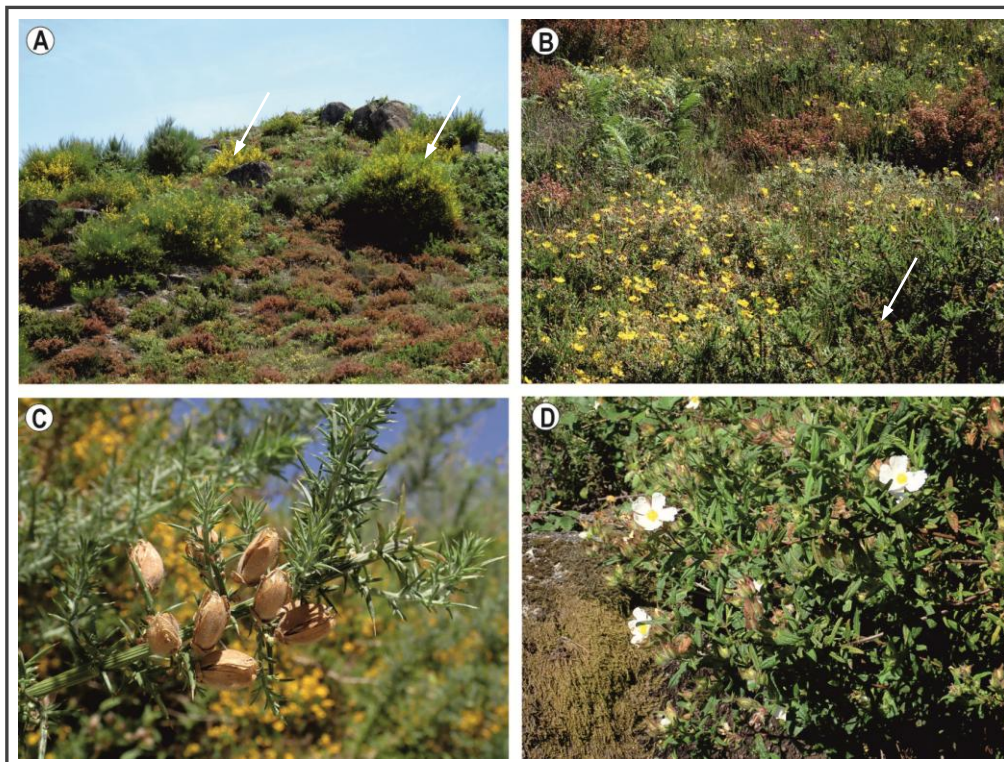


Vertical zonation of the vegetation in Serra do Gerês.

Another plant formation of special interest are the laurel-leaved scrublands formation, which is dominated by *Prunus lusitanica*, a plant of the rose family that is considered a relict of the laurel forests that covered the area of the Mediterranean basin during the Tertiary. This forest type receded and became almost extinct, having survived only in some humid temperate or mountainous enclaves such as northern Portugal and Spain, the Moroccan mountains and the French and Spanish Pyrenees, and in the Macaronesia region (*Madeira and the Canary Islands*). It was in these temperate refuges that this species survived to the present day, especially in Macaronesia.

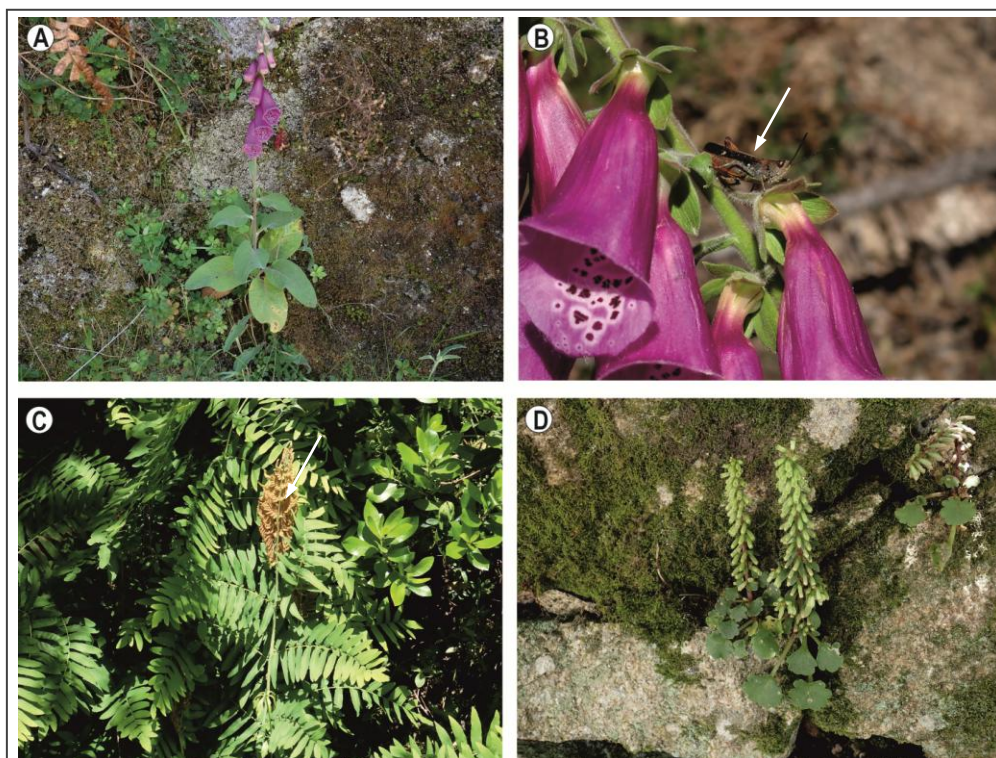
However, most of the territory (74%), especially at high altitudes, is covered by shrubs and bushes. The most common species are gorses (*characterized by the presence of Ulex minor and Ulex europaeus*) and heaths (*dominated by Erica umbellata and Calluna vulgaris*). At higher altitudes there are juniper groves with *Juniperus communis* subsp. *alpina* and *Erica australis* subsp. *aragonensis*, and hygrophilous thickets composed of *Erica tetralix*, *Ulex minor*, *Erica ciliaris*, *Drosera rotundifolia*, *Pinguicula lusitanica*, *Viola palustris* subsp. *juressi* and *Molinia caerulea*, among others.

The meadows and grasslands represent only 4% of the park's total area but are home to a great biodiversity with several endemic and rare species. Also noteworthy is the presence of peat bogs, of great national interest due to their rarity, size and quality.



In spring the hairy-fruited broom (*Cytisus striatus*) and other genisteas, with their large yellow flowers, together with various rockroses and heathers color the landscape. A: Heather (below) and *Cytisus striatus* (arrows); B: In the foreground on the right, gorse (*Ulex*) (arrow) without flowers, on the left, rockroses. C: *Ulex europaeus* in fruit; D: *Cistus psilosepalus*, a rockrose with white flowers.

Along the watercourses the riparian vegetation is formed by ash trees (*Fraxinus angustifolia* and *F. excelsior*), birches (*Betula celtiberica*), bay trees (*Laurus nobilis*), willows (*Salix atrocinerea*), alders (*Alnus glutinosa*), alder buckthorns (*Frangula alnus*) and large ferns such as the chain fern (*Woodwardia radicans*) and the royal fern (*Osmunda regalis*).

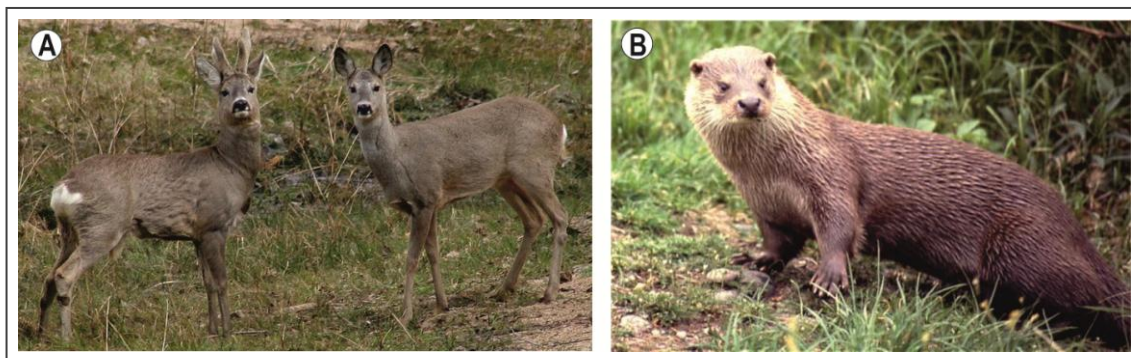


A and B: Common foxglove (*Digitalis purpurea*), very abundant in the area, in B there is a grasshopper (arrow). C: Royal fern (*Osmunda regalis*), a plant with large fronds and numerous sporangia (arrow) that grows on stream edges and cool, moist places. D: Navelwort (*Umbilicus rupestris*), which grows in rock crevices, walls and roofs.

In addition to the natural vegetation, in some areas there are old conifer plantations, especially pine groves of *Pinus sylvestris*, which now form well-developed forests.



On the other hand, the fauna of Peneda-Gerês includes mammals such as the Iberian wolf, roe deer, wild boar, otter, wild cat, the beech and pine martens, squirrels and the Gredos ibex.



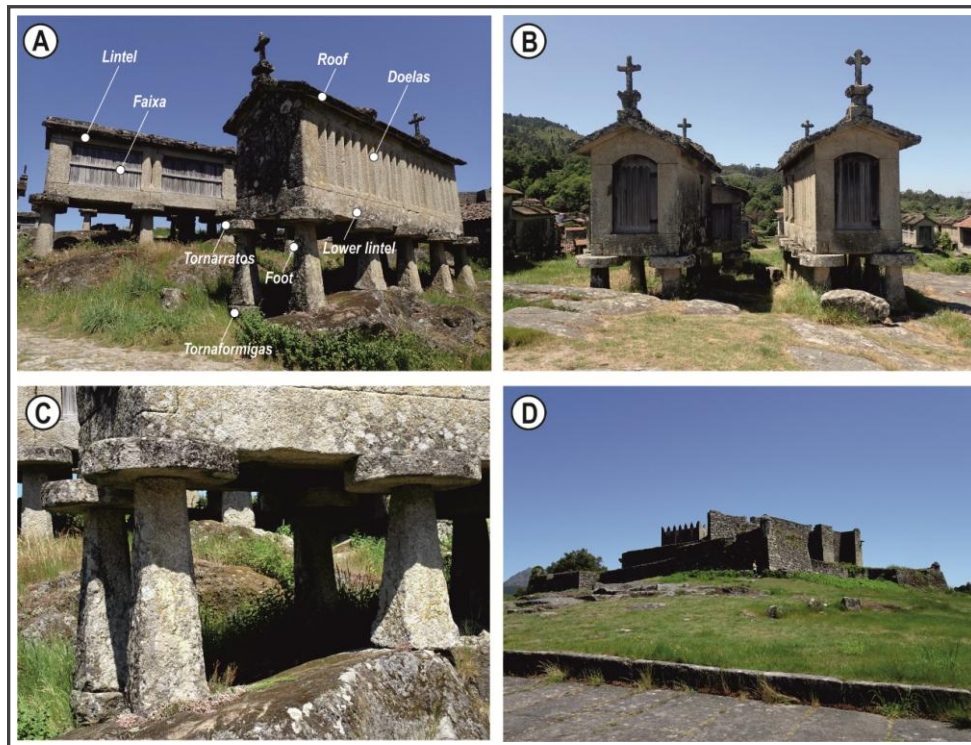
A: Roe deer (*Capreolus capreolus*); this is the flagship species of the PNPG and is well represented here; their number has increased significantly in recent years, following the population trend in the north of the country; image: Wikipedia (2022b). B: Otter (*Lutra lutra*); a carnivore well adapted to freshwater systems and whose population is in decline in Europe, it finds in the National Park area conditions favorable to its existence, namely watercourses where food availability is sufficient and the presence of vegetation on the banks provides shelter; image: Serra do Gerês (2022).

Birds include the red kite, the common buzzard, the eagle owl, the hawk and the northern stonechat; common reptiles are the snub-nosed viper and the Cantabrian viper, the water snake and the black-green lizard. Amphibians include the Iberian salamander and the Iberian horned toad (Wikipedia 2022a).

The espigueiros: echoes from the past and a very real present

According to an article in the VortexMag network (VxMag 2021), the espigueiros (or *hórreos* as they are called in Galicia and Asturias - Spain) are true works of ancestral art, with a high symbolic and historical value. They are granaries where farmers store corn cobs. These can be private or communal, and the size of a granary reflects the production and harvest. The espigueiros are closely related to the introduction of corn to the Iberian Peninsula, from where it spread to other parts of the world. Maize was introduced mainly in the Minho and Galicia regions, where it found favorable conditions for its cultivation.

Taking as a reference the existing models in the Minho region (*Galicia-Portugal*), the espigueiros are generally made of wood or stone, the latter almost always of granite of the region, and in our case, a Hercynian two micas granite (*espigueiros of Lindoso and Soajo*). The espigueiro is built on pillars that raise it from the ground, leaving spaces to allow aeration of the interior through the fissures that are purposely left open. The granite outcrops where they are located serve as foundations and provide security and stability to the group.



Espigueiros from the locality of Lindoso (A-C). A: Constructive elements of an espigueiro (names according to Cppablog 2022); B: Alignments of espigueiros according to a main northeast direction; C: The base of an espigueiro showing in detail the tornaformigas, the foot and the tornarratos (see A); D: Lindoso Castle, a monument that fulfilled defensive functions during military conflicts with the kingdom of Castile; it was erected in the early 13th century during the reign of Don Afonso III. During the Restoration Wars (17th century) it assumed great importance due to its border location with Spain (TurismoenPortugal.org 2022).



The espigueiros and the castle of Lindoso. Google Earth image.



The espigueiros from Soajo. A to C show espigueiros built on top of a subhorizontal undulating surface of the Soajo granite. The smooth surface probably corresponds to the development of decompression joints. D: a Soajo cat napping during a warm afternoon in late May 2022.

The espigueiros are also characterized by ornamental elements on the top, usually a cross, which blesses the corn and guarantees divine protection throughout the following year. In several places in Portugal, rural communities still use espigueiros, as in Lindoso and Soajo in the Peneda-Gerês National Park. In Lindoso there are about 60 espigueiros dating from the 18th and 19th centuries thus forming the largest group of this type of construction in the Iberian Peninsula. In Soajo there are a total of 24 espigueiros that make up the so-called Eira Comunitária do Soajo.

Final words

For those who have never visited the Peneda-Gerês National Park (PNPG), getting there is a positive surprise. The PNPG is surprising for its mountains, surprising for its vegetation, and surprising for its water reservoirs. The authors of this article have visited many parks in Spain and Europe, and let us say that this one stands among the best. It is worth coming back and if the reader of this brief article has never been there, then a visit to PNPG is a must.

Images (unless indicated): P. Cubas & R. Oyarzun.

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