MODULE 3

3.3 THE FLORA AND VEGETATION OF SIERRA NEVADA

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Phytogeography

Sierra Nevada is the culmination of the Baetic Mountains, the southernmost mountain system in the Iberian Peninsula. It is not only the highest range, at an altitude reaching 1,000m above the rest, but its slopes and secondary chains also share many of the biological riches of the whole system.

Various different factors—such as geographical location, high altitude, the heterogeneity of geological substrates, and, especially, the particular character of the Mediterranean bioclimate across the entire territory—have produced an entirely unique mountain, where flora and vegetation constitute its greatest environmental asset. This area is home to a wealth of species and so-called "plant communities" (habitats), featuring 2,232 known species and around 200 communities or associations, of which more than 100 species and about 40 communities are endemic, particularly in the high-mountain areas. All of this tells us that we are dealing with a major hub of plant biodiversity. Precipitation (rain and snow) and temperatures, together with the presence of certain substrates such as crushed, sandy dolomites, and ultrabasic rocks, among others, bring about huge contrasts in the vegetation of Sierra Nevada. Here, we find over 30 different types of Potential Natural Vegetation—that is, communities that represent what is known as the climax or stable maximum in terms of being best-suited to the environment. Each type of climax community is linked to its own particular area—which may be continuous or disjointed, but is ecologically homogeneous in terms of precipitation, temperature, and geological substrate—called a *tessella*. Each *tessella* houses a set of communities formed by the climax community and secondary communities, called *serals*. Thus, forests of Pyrenean oak, *Quercus pyrenaica*, represent the climax; and the communities associated with it—which live in the forest clearings and take their place when it is destroyed, such as the high scrubland of *Lonicera arborea*, silver broom (*Adenocarpus decorticans*), the thickets of *Cistus salvifolius*, and the *Dianthus lusitanus* community, among others—constitute what, in phytogeographical terms, is known as seral vegetation.

Simón de Rojas Clemente y Rubio and Edmond Boissier were the first authors (in 1804 and 1839–1845, respectively) to offer a phytogeographical view of the Sierra Nevada, which they divided into altitudinal sections according to the flora and vegetation covering its slopes. Clemente distinguished six geographical–botanical areas of Sierra Nevada, and Boissier identified four regions

of vegetation, an early version of would become known as *étages de végétation* or altitudinal belts. Nowadays we talk about bioclimatic belts when referring to altitudinal or latitudinal sections characterised by certain temperature values (distinguishing different thermotypes) and precipitation (distinguishing ombrotypes). In Sierra Nevada, we can identify up to five distinct thermotypes, from the Thermo-Mediterranean to the Crioro-Mediterranean, and five ombrotypes, from the upper arid to the humid, although these two particular types have a very low presence, with the dry and sub-humid types predominating. Monitoring of the relationship (via the application of bioclimatic indices) between the characteristics of the natural environment (geology, orography, climate, etc.) and the recognition of species, communities, and seral vegetation, has identified a total of 8 homogeneous areas (districts) in Sierra Nevada, included in other larger spaces (5 sectors, 2 provinces), which constitute the biogeographic typology of the territory. Hence, the following territories are differentiated: 1) the Nevada Sierran Sector, which is the central part, with siliceous metamorphic substrates, comprising the highest altitudes and an area accounting for more than 75% of the Sierra. It includes two districts: the East Nevada Sierran district and the High Nevada Sierran district. 2) the Granada and Almijara Sierran Sector, represented by the Trevenque Sierran district, covering over 10 % of the terrain and characterised by its dolomitic, rocky substrate and major sandy outcrops. This Sector is also represented by the Vega of Granada district, whose surface area barely accounts for 0.3% and which features clay soils typical of the Vega de Granada on its western slopes. 3) the Alpujarras–Gador Sierran Sector, which fundamentally constitutes calcareous and dolomitic materials in the southern foothills of Sierra Nevada, with two districts: the Gador Sierran district, accounting for approximately 7%, and the Alpujarras district, just 1%. 4) the Almería Sector, with its West Almería district, a warm territory with upper- or semi-arid ombroclimate that is distributed across the foothills and the eastern slopes. It covers an area equivalent to 5% of the total. 5) the Hoya de Guadix–Baza Sector, with the Hoya de Guadix district occupying 0.7%.

The landscape and its vegetation: Forests and vegetation series

Sierra Nevada is not characterized by extensive forests. Since ancient times, its gentle slopes have lent themselves to the use of the territory for agricultural and logging purposes. Indeed, Boissier, Willkomm, and other botanists of the 19th Century found this quite extraordinary, as they did the rich and dense thicket of thorns, hawthorns, honeysuckle, *fabaceae*, etc. Among the forest species, the oak or *carrasca*, *Quercus rotundifolia*, is the most common, forming extremely open forests, from the Thermo-Mediterranean base to the Supra-Mediterranean belt, where it can be found, under favourable conditions, at altitudes of over 2,000m. The Valencian oak, *Quercus faginea* (*alpestris*), is the tree that has suffered most due to the expansion of crops and the use of wood throughout Andalusia. In Sierra Nevada it is rare, appearing in the mid-level mountain interspersed with oaks or forming small stands. There is also only an anecdotal presence of the cork oak, *Quercus suber*, with just a handful of specimens around the Monachil basin and some Alpujarran ravines. *Quercus pyrenaica*, the Pyrenean oak, which needs high humidity, is only present in the High Nevada Sierran district, where it forms forests between the Upper-meso and Supra-Mediterranean belts. Its tessella has been used for the extended growth of the chestnut, *Castanea sativa*. Another humid forest type, that of the maple *Acer granatensis,*

is only present in some of the headwaters of the Rivers Dehesa and Camarate, with the whitebeam, *Sorbus aria*, in its upper limits. These two species are also disseminated across high Supra-Mediterranean ledges throughout the territory. The birch, *Betula fontqueri*, has barely three populations and lone specimens on the wettest slopes.

The autochthonous pine forests also suffered intense deforestation, and their tessellas were repopulated in more recent times, as early as the 20th Century, by other species and varieties of conifers that distort and mask the potential of this space. *Pinus sylvestris*, the Scots pine, which extends widely throughout the northern hemisphere, reaches the southernmost part of Sierra Nevada in the form of the endemic sub-species *Pinus nevadensis*. This is accompanied, albeit to a lesser degree, by the Iberian black pine, *Pinus nigra* subsp. *latisquama*. The wide natural area of these species, on soils that differ from those of the supra–upper and Oro-Mediterranean vegetation belts, has been reduced to the foothills of Tesoro, Trevenque, and Loma de Dílar. Among the natural specimens, throughout their natural area, repopulations of the species have been carried out, albeit also with other varieties or northern subspecies; or they have been replaced by the black pine or the dwarf mountain-pine *Pinus mugo* subsp. *Uncinata*, with repopulations reaching the 2,500m level. Occasionally, repopulations have also been carried out with hybrids between the two species. Another pine of undoubted interest, endemic to the Baetic province, is the maritime pine, *Pinus pinaster* subsp. *Acutisquama*. This is strongly characteristic of the mountains of Almijara and Bermeja, colonising substrates of dolomites and peridotites from the Thermo to the Supra-Mediterranean, where it seems to have found its optimum conditions. In Sierra Nevada, it is commonly found growing on the calcodolomites of the Trevenque district, although it has been widely used in the reforestation of the Sierra, alongside other varieties from outside the area. Finally, the Aleppo pine, *Pinus halepensis*, is also naturally found on the semi-arid Thermo and Meso-Mediterranean slopes, and is the species of pine most widely used in repopulation efforts. Among the long-lasting, low-level shrubs are junipers, *Juniperus communis*, and the savin, *Juniperus sabina*, subsp. *hemisphaerica*, both of which are commonly found particularly in the Oro-Mediterranean belt. Two other representatives of this genus, present in the lower belts, are small trees: the cade or prickly juniper, *Juniperus oxycedrus*, dotted throughout the scrubland or in open pine forests, and the conifer *Juniperus turbinata*, which grows on ledges and limestone and dolomitic rocks.

In riverbank environments, the most widespread willow tree is the grey willow, *Salix atrocinerea*, along with the pussy willow, *Salix caprea*, another species from the north that reaches its southernmost limit in Sierra Nevada, at the headwaters of the High Nevada Sierran district. The alder, *Alnus glutinosa*, grows only by the edge of some rivers. The ash, *Fraxinus angustifolia*, is only to be found in unaltered riverside soils; and, in contact with the surrounding forest, generally of Pyrenean oaks, hide the *Acer granatense* species of the maple, wild cherry trees (*Prunus avium*), checkers (*Sorbus torminalis*), some European crab apple trees (*Malus sylvestris*), and even yews, Taxus *baccata*, which can become intertwined in some of the humid, shady ravines.

The characteristic flora

Each district within Sierra Nevada presents its own characteristic vegetation series, communities, and taxa, many of which are endemic. We will highlight some of the most characteristic elements in the basal area and medium altitudes. In the high shrubland, we find several species of rose bushes, barberries, thorns, snowy mespilus, laurestine, *fabaceae*, and honeysuckle, among which the most striking examples are *fabaceae* such as silver broom (Adenocarpus decorticans), the broom *Cytisus reverchonii*, the hawthorn with reddish branches, *Crataegus granatensis*, honeysuckles such as *Lonicera arborea*, *L. splendida*, the laurestine, *Cotoneaster granatensis,* and the Penibaetic blackthorn, *Prunus ramburii*. Between the low aromatic scrub and cushion shrubs, on a siliceous substrate, we find the *Genista versicolor*, *Cytisus galianoi,* and *Astragalus nevadensis*, the Thymus *serpylloides* and *T. baeticus*, and *zahareñas* (*Sideritis glacialis* and *Sideritis hirsuta nivalis*), among other species. On limestone and dolomitic substrate, we find thorny *fabaceae* such as *Echinospartum boissieri*, *Astragalus granatense,* and *Erinacea anthyllis*, *Lavatera oblongifolia*, sage and lavender, *Salvia lavandulifolia, S. candelabrum, Lavandula lanata*, thyme such as *Thymus longiflorus, T. zygis gracilis*, and so on.

There are three territories in Sierra Nevada, apart from their summits, which deserve special mention. The Dehesa del Camarate is an area featuring deciduous forests, evocative of northerly landscapes. It has become a focal point for hikers and day-trippers who call the place “the enchanted forest”, for its extraordinarily beautiful chromatic contrasts in autumn—the browny-red tops of the Pyrenean oaks, maples, whitebeams, willows, birches, and alders. The other, very special, spot is the collection of fractured dolomites that have created large expanses of sandy terrain around Trevenque. The vegetation is very open, and here it is the Thymus that predominates, with a high percentage of endemic forms: *Erodium boissieri, E. astragaloides, Helianthemum pannosun, H. estevei, Santolina elegans, Rothmaleria granatensis, Convolvulus boissieri,* and *Thymus granatensis*, for example. The third territory worthy of highlighting, at the base of the far south-eastern tip of Sierra Nevada, is that belonging to the West Almería district. The decrease in precipitation, west–east, is particularly striking, and in this district the rains barely reach the semi-arid ombroclimate, in sharp contrast to the rest of the vegetation. The landscape here, which is very bare, becomes semi-desertic and the plants are quite distinct from those in the rest of the Sierra. This is a xeric shrubland, known for its abundant endemisms, featuring plants such as *Salsola papillosa, S. genistoides, Hammada articulata, Euzomodendron bourgeanum, Limonium insigne,* and *Withania frutescens*, among others.

The high peaks: The supraforest level

The high-mountain vegetation belt begins above the upper limit of the current forests—or those of past forests, until deforestation started at least 4,000 years ago and then intensified during the last millennium. At present, this limit is above 2,450m (± 100m), which represents the natural timber line of the forest. This has now disappeared, but has been partially rebuilt with repopulations of the native pine *Pinus sylvestris nevadensis* and also with *Pinus uncinata* and hybrids, including varieties of Pyrenean wild pines. From the bioclimatic point of view, this belt corresponds with the upper

edge of the Oro-Mediterranean belt, with potential juniper vegetation of savin junipers (*Genista versicolor*) and *fabaceae* (*Cytisus galianoi*). It also corresponds with the Crioro-Mediterranean belt, with dry, not very dense grassland of perennial, dwarf plants, which starts at 2,800m (± 50m) on the northern slope of the High Nevada Sierran district and 3,000m on the southern side, and reaches the highest peaks of the Sierra. It is the best example of upper-Oro Crioro-Mediterranean in the entire Mediterranean Region. The special climatic conditions distinguish this territory from the rest, with its long duration of snow, average sub-zero temperatures that last for six months or more, and a summer without rainfall. Hence, the ombroclimate present in the Oro-Mediterranean belt—generally humid/sub-humid—becomes, at altitude, dry and even semi-arid, as the number of months with sub-zero temperatures increases. The marked summer aridity and the stony, dry appearance of the peaks of Sierra Nevada contrast with that of the evergreen herbaceous plant communities (*borreguiles*) of the depressions and adjacent thalwegs, with deep hydromorphic or hygro-peaty soils caused by the formation of springs and streams derived from the thaw.

The flora of this belt also features a wealth of endemisms, many species being well known—for example, in the thyme scrub, such striking plants as *Artemisia granatensis, Nevadensia purpurea, Eryngium glaciale, Linaria glacialis,* or *Viola crassiuscula*. Among the *borreguiles*, we find *Gentiana verna sierrae, Plantago nivalis, Ranunculus alismoides, Veronica nevadensis,* and *Pinguicula nevadensis*. In the Crioro-Mediterranean belt alone there are 185 species, 69 endemics (37.3%), and 25 plant associations, all of which (100%) are endemic.

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Links to resources on the flora of Sierra Nevada:

Vascular flora of Eastern Andalusia: *http://www.jolube.es/entrada_jolube_FVA.htm*

High-altitude flora: *http://www.herbmedit.org/flora/21-247.pdf*

Flora under threat: *https://ac.els-cdn.com/S0006320797001699/1-s2.0-S0006320797001699-main.pdf?_tid=8412c81f-16b0-4a82-b40d-cb006ff504fa&acdnat=1530095479_529d4af32e158fd8dc36249baf9cf460*

The flora of the peaks of Sierra Nevada: *https://www.youtube.com/watch?v=-rgylyhZKrA*

Sierra Nevada, island of biodiversity: *https://www.youtube.com/watch?v=UWUMGJw82cM*

The protective forest: *https://www.youtube.com/watch?v=eONojuhrLNg*