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Introductory Chapter: Methodological Aspects for the Study of Vegetation

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1. Introduction

For the study of vegetation, there are different methodologies, among which we highlight the purely ecological and phytosociological ones; the latter have acquired relevance from the second half of the twentieth century. It is in Europe where the phytosociological method has flourished; however, the ecological one has been in the United Kingdom and America. The application of the phytosociological method has led to the creation of a nomenclature code, which requires all researchers working with this methodology [1]. Thus, various geobotanical concepts of interest have emerged, such as association, alliance, order, and vegetation classes [2]. All of these have been used by different countries for the establishment of habitats in the EU.

2. Bioclimatic and biogeographic analysis

Although the knowledge of the species has been and continues to be fundamental for the further development of phytosociology [3], no less important is the strong advance, which, from the hand of Professor Rivas Martínez, has had bioclimatology, as a basis essential in the description of phytocenoses, as well as in agricultural, forestry, and livestock planning.

Bioclimatology is an ecological science, which has gained importance in recent years and which tries to highlight the relationship between living organisms (biology) and the climate (physics) on Earth. It differs from climatology in that the information, indices, and units it uses are related and delimited by species and phytocenosis (biocenosis). The development of bioclimatology as a basic discipline at the service of geobotany has been one of the most outstanding scientific aspects in recent times; the progress of this science has made it possible to better diagnose many plant communities and above all to be able to better specify the main cliserial geoserries that are observed across an altitudinal gradient.

Of the different factors that lead to the existence of certain plant ecosystems, precipitation and temperature are among the most important ones. Thus, each region or group of biogeographic regions has a peculiar altitudinal zoning of plant ecosystems; such topographic geoserries is due to the progressive decrease of the annual average temperature with the altitude (thermoclimatic).

If the climate (temperature and precipitation) is correlated with the biocenotic discontinuities that appear in the mountains with altitude (altitudinal cliseries), we will see that certain rhythms or changes are fulfilled throughout the Earth as

a function of temperature and precipitation (thermoclimatic and ombroclimatic). Consequently, based on such changes, the physical continent, which includes the bioclimatic floors, can be recognized on the one hand and the plant biological content, which includes the vegetation series, on the other. Rivas-Martínez and Loidi [4] published the bioclimatology of the Iberian Peninsula and gave a set of biogeographic indices of high interest for the study of vegetation, studies that are later perfected in various publications by these authors (positive precipitation, positive temperature annual, continental index (I_c), ombroclimatic index (I_o), thermicity, and compensated thermicity index). Later, Cano et al. [5], studying various ecological and bioclimatic aspects of *Juniperus oxycedrus* L. forests, proposed an ombroedaphoxeric index (I_{oex}) to explain the presence of these *Juniperus* forests in bioclimatic environments not optimal for them.

The xericity of serpentines often gives rise to forests and scrublands that do not correspond to the ombrotype in the territory; plants living here develop ecophysiological and morphoanatomical adaptations to withstand the limitations. In ideal situations with good soil texture and structure and without slopes, we can assume that the water retention (WR) is maximum (100%). Otherwise, there are losses due to runoff and drainage, and the WR may therefore vary. Water is also lost through potential evapotranspiration (ETP). However, as plants have the capacity to self-regulate their losses, it can be assumed that the residual evapotranspiration $e = 0.2ETP$. So two parameters (i.e., e and WR) are implicated in the vegetation development, which is essentially conditioned by rainfall. Therefore, the Ombroclimatic Index (I_o) does not explain the presence of plant communities that are influenced by the substrate, and we propose the new ombroedaphoxeric index (I_{oex}) to explain the presence of communities with *Juniperus* spp. in territories with a thermomediterranean to supramediterranean thermotype.

$$I_{oex} = P_p \cdot e / T_p * WR, \quad (1)$$

where P_p = positive precipitation; T_p = positive temperature of the year; e = residual evapotranspiration, whose value is 0.2 ETP; WR = water retention in parts per unit, whose values may be 0.25, 0.50, 0.75, and 1 [5].

Parallel to the bioclimatic studies, biogeographic studies are carried out [6], which are also fundamental to the interpretation of the vegetation. In this sense, chorology or phytogeography is a branch of geography with a biological base that deals with the distribution of living organisms on Earth, a science that relates the physical to the biological. Both plant chorology or phytogeography and phytosociology are highly topical, due to the importance of plant communities in the definition and delimitation of territories; chorology and biogeography become synonymous, since they are derived from chorus (Greek) = “limited place” and logos = “science.”

Biogeography is also a science derived from geobotany, which with the collaboration of other sciences, such as geography, edaphology, geology, zoology, and botany, is capable of establishing a typology or systematic of the planet's surface, through knowledge of the distribution of syntaxa, which is already the object of geobotany, botanical sociology, or phytosociology, currently known as vegetation science, whose objective is the knowledge of vascular plant communities or phytocenosis.

One of the criteria traditionally used in the recognition and delimitation of biogeographic areas with their own identity is the presence or absence of families, genera, species, and subspecies. These taxa are called endemisms, especially those whose distribution area is smaller than the biogeographic region. Endemic species and plant communities are used in the definition and delimitation of chorological units as are the provinces and sectors.

Professor Rivas-Martínez, in successive works, explains the fundamental biogeographic concepts for studying vegetation. According to Rivas-Martínez et al. [7], the main typological units in decreasing rank are kingdom, region, province, sector, district, country, landscape cell, and tesella.

The elemental unit of biogeography or “tesella” is a space or geographic surface of variable extension, homogeneous from the ecological point of view, which means that it only presents a certain type of potential natural vegetation (climatophilous, edaphoxerophilous, or edaphohygrophilous) as a mature stage of the ecosystem or biogeocenosis and, consequently, a single sequence of natural communities of substitution. The neighboring tesellas, related by an edaphic or climatic gradient, represent vegetation geoseries, which is the general expression of the zonation phenomenon. The tesella is the only biogeographic unit that can be repeated disjoint. A mosaic of tesellas or permatesellas, related in the same territory by their corresponding topographic geoserie, constitutes the landscape cell (such as river valleys, marshes, peneplains, and high mountain summit, among others). The biogeographic country is a well-delimited geographic territory, with a set of species, plant communities, and topographic geoseries.

The district must be a region characterized by the presence of peculiar associations and species that are lacking in nearby areas or districts; it is also characterized by a traditional use of the territory by man, although it does not have to be a close correlation between the natural regions, man-made, and biogeographic districts. However, experience shows that it can be useful to make both concepts coincide; in this way, the typological union between anthropogeography or human geography and biogeography (phytogeography and zoogeography) would be favored.

The sector is a large territory with a geographical entity that has its own taxa and associations, as well as its own vegetation geoseries and its own permanent and subserial communities.

The province is a large territory that, in addition to having a large number of endemisms, has climatic domains, series, geoseries, and permanent communities; a peculiar altitudinal zoning of vegetation is also characteristic of each province.

The region is a very extensive territory, which has a flora in which there are endemic species, genera, and even families. It presents particular climatic domains and territories and consequently series, geoseries (catenal set of series), and its own bioclimatic stages.

The kingdom is the supreme unit of biogeography and in it, in addition to taxonomic and ecosystem considerations, the origin of flora and fauna comes into play as well as the formation of large continents, the climate, and the paleoclimate.

Once the bioclimatology and biogeography of a territory are known, it is necessary to value a precise methodology for the study of phytocenoses. We lean toward the phytosociological method widely applied in Europe, America, and North Africa by different authors [8–10], with certain geobotanical concepts [2].

3. Conclusions

Although there are different methodologies for the study of vegetation, the phytosociological method is one of the most used worldwide, a method that relies on prior knowledge of the distribution of flora, ecological and geological aspects [11], and bioclimatic and biogeographic, and the catenal contacts between plant communities (associations), which must always be included in a hierarchical system of syntaxonomic ranges.

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