Science Publications

Research Journal of Ecology and Environmental Sciences, 2022, 2, 11-22
www.scipublications.org/journal/index.php/rjees
DOI: 10.31586/rjees.2022.206

Innovation Article

Geobotanical field activities for learning landscape interpretation concepts and methods for university students

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Abstract: The objective of this work is to materialize the learning of geobotanical concepts, and a methodology for the interpretation of the landscape, which allows the student to acquire practical knowledge, to obtain sufficient autonomy that allows him to join the labor market. Regarding the methodology, 100 field samples are taken for 3 years, and the participation of 60 students. The evaluation is carried out through reports on the field study. The landscapes of various areas of southern Spain are studied. For this we rely on the methodology previously established by other researchers, through which a complete diagnosis of a territory is reached, since the series and geoseries of vegetation are revealed. Being a study of natural reality, the abstract character presented by concepts such as sigmetum, sinassociation, series, geoseries, climatophilous, edaphoxerophilous, chain; it is perfectly clarified to the student, which makes the student progress efficiently, coming to the fore the acquisition of practical knowledge compared to theoretical ones. For this reason, practical teaching acquires preponderance, since it not only provides knowledge, but also development of cognitive and psychomotor skills, which are essential in the acquisition of skills and development of the individual's personality.

Keywords: Method; Syntaxonomy; Didactics; Profile; Vegetation

How to cite this paper:
Cano Ortiz, A., Piñar Fuentes, J.C., Ighbareyeh, J., Quinto Canas, R., Musarella, C.M., & Cano, E. (2022). Geobotanical field activities for learning landscape interpretation concepts and methods for university students. *Research Journal of Ecology and Environmental Sciences*, 2(2), 11–22. Retrieved from https://www.scipublications.com/journal/index.php/rjees/article/view/206

Received: December 21, 2021
Accepted: April 4, 2022
Published: April 6, 2022

1. Introduction

1.1. Symphytosociology

Symphytosociology, also known as dynamic phytosociology, is a new relatively modern method whose objective is to understand the relationships between plant communities [1]. Symphytosociology, vegetation series or sigmetum (it is a Latinized expression, evocative of SIGMA, acronym for: Station Internacionale de Géobotanique Mediterranéene et Alpine), also called synassociation, is the basic unit of dynamic Phytosociology, and it encompasses all dynamically related plant communities, which are located in related tessellated spaces. In short, the synassociation or series of vegetation is a set of plant associations that coexist in a tessellated space (homogeneous space from the ecological and physiognomic point of view). Rívas Martínez expresses in his work a glossary of scientific terms of interest for the understanding of the concepts [1].

All the vegetation series are conditioned by various environmental factors, climate and soil and, depending on the prevailing factor, they are classified into climatophilous (lovers of the climate) and edaphoxerophilus (lovers of the soil) series: this phenomenon has universal jurisdiction. Other authors have influenced the study of vegetation series, which at this time are being a fundamental basis for territorial planning, by providing great information about the area under study, since they represent the most reliable bioindicator character that exists in the territory. In this sense, it is essential that Biology students (future Natural Sciences teachers) fully understand the concept of vegetation series, and gradually acquire a scientific language that allows them to teach their students early [2]. This leads us to propose a new practical methodology that trains future teachers [3,4]. The use of new technologies is essential in the study of the vegetation and landscape [5], since the student needs to put their field experiences on paper, by making maps and vegetation profiles. Rivas-Martínez and co-authors [6] once again emphasize the concept of the vegetation series, and taking into account the enormous number of scientific terms and phrases: they comment on the consultation of Géhu's work "Dictionnarie de sociologie et synécologie végétales".

Symphytosociology or Symphytocenology is the part of Phytocenology that studies community complexes, i.e. it tries to value the plant landscape as the set of its different evolutionary stages leading to the same climax. With this interpretation of communities, a new ecological unit arises, which because it is a different entity has its own qualities and functionality; for this reason, a particular system or typology has been created through which these new vegetation units can be recognized and subordinated [24,25].

The objectives of symphytosociological research are the same as those proposed by floristic phytocenology, although at a different level of integration; i.e., it has as its objectives the structural, syndynamic, synecological and synchorological aspects of the plant landscape, as well as the epiontological ones and catenals, the latter being of great importance for a comprehensive interpretation of the landscape.

Symphytosociology is an absolutely new science, since although the conceptual aspects have been known since the beginning of the 20th century, contemporary phytosociologists have scientifically developed the ideas of integration of communities, as something characteristic of the landscape. We highlight in this field Braun-Blanquet, Tüxen, Bolós, Gèhu, Rivas-Martínez, since they have been the first to enunciate the essential philosophical bases of this new methodology for the study of the landscape [7-9].

The interpretation of the vegetal landscape in its syndynamic sense, i.e., the reconstruction of the evolutionary series leading to the stable optimum (climax) or permanent communities, is the mission of the phytosociologist, who tries to carry out the mapping of the potential vegetation of a territory that has been altered by man: this entails having to value the vegetal landscape from a successionist point of view, as a set of more or less stable communities that are substituted or can be substituted in time and space [10-12]. With this interpretation of the landscape, future teachers can teach how the students can obtain skills, and an updated knowledge of the landscape, that allows them to solve problems about forest destruction, which in turn causes socioeconomic problems [13].

All this complex of phytocenosis on a certain soil and within the framework of a tile or of a landscape cell or pluriteselar complex, is called "synecosystem", a word that seems ambiguous due to the use of the term ecosystem. For this reason, the name of "synassociation", which comes to be synonymous with "complex of associations", "complex of substituting communities" or "mosaic of communities". The term synassociation is in the Phytosociological Science of Landscape Integration (Symphytosociology), the basic typological unit of the system, evidently as it is done in classical Phytosociology, where floristic inventories of the associations are established, also in this case "without inventories", which in this case consists of listing the associations present in a homogeneous area. In a similar way to what is done in other sciences, also in

this case a systematization is made: for this reason, the "synassociation is established as the basic unit, which is subordinate to higher hierarchical ranks: "synalliance", "synorder", "without class" [14-22, 26].

As a fundamental objective, we intend that the student obtain practical knowledge, and that he acquires skills and abilities through a set of field activities, which gives him sufficient autonomy to join the labor market.

Example: Vegetation series in which different plant associations are dynamically related (Figure 1A and Figure 1B).

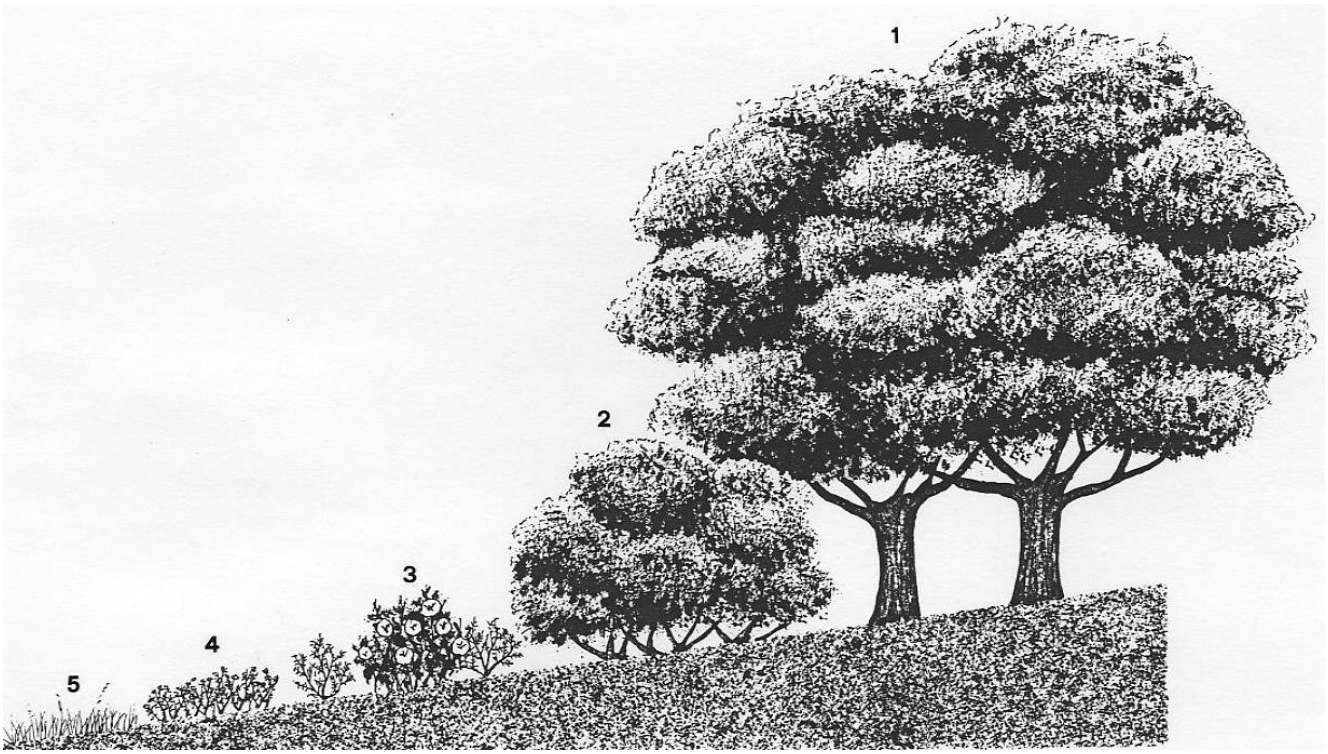

Figure 1A. Symphytosociology: 1. Paeonio-Quercetum rotundifoliae. 2. Crataego-Quercetum cocciferae. 3. Thymno orospedani-Cistetum clusii. 4. Phlomido-Brachypodietum ramosi. 5. Velezio-Asteriscetum aquuaticae, Medicago-Aegilopetum geniculatae

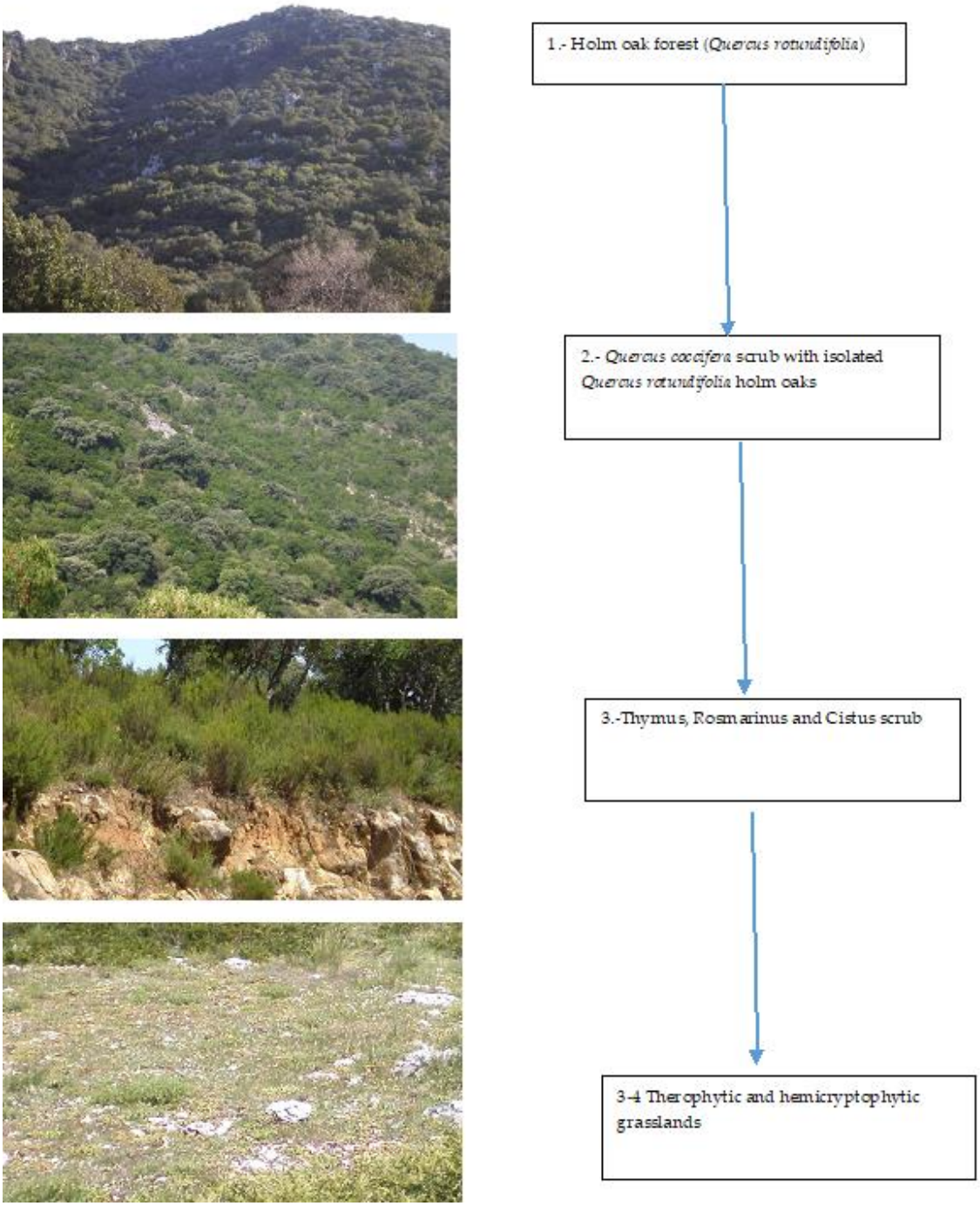

Figure 1B. Dynamics of the basophilous, mesomediterranean, dry, Betic series of the holm oak (*Quercus rotundifolia*)

1.2. Geosymphytosociology: Catenal or Landscape Dynamic Phytosociology

When, in addition to the successional stages, the catenal contacts are taken into account, we speak of Geosymphytosociology, a complex landscape unit, which is why Geosymphytosociology as a landscape science presents a higher level of Symphytosociological integration [8,26,27], being able to establish criteria similar to those of Symphytosociology in terms of typology or systematization. The basic unit being the "geosynassociation" or "geosigmetum", as well as the establishment of characteristic and differential elements, which in this case is synassociations or sigmetum. Therefore

"geosynasociation" is synonymous with the "association of synassociations" or "set of vegetation series or sigmetum", which are related by catenal contacts: this implies syndynamic relationships, therefore the many o few elements that have a synassociation (characteristics, differentials) may be in one or more other synassociations. In this case, they will not be characteristic of the synassociation but they may be characteristic of the synalliance, no order, no class, and may be characteristic of the geosynasocciation or geosigmetum. Recently, Rivas Martínez and Rivas Martínez and coauthors [1,6] published new concepts such as minor series, permaseries and geopermaseries. According to this author the minor series expresses permanent communities of vegetation and their corresponding perennial and annual substitution stages, while that the permaseries are permanent communities lacking stages of substitution. Lazare [34] introduced as new, the term "curtaseries" for those situations in which there is a temporary environmental action: a term very close to that of minoriseries, differentiated by Cano et al. [23].

Once the methodology for the study of vegetation is known, it is possible to establish measures that mitigate natural disasters, such as landslides, snow avalanches, due to the increase in climatic irregularities, increasing and decreasing rainfall in different territories of the planet. For this reason, it is essential that an evaluation of ecosystem services be originated, given a growing concern of the population for sociocultural aspects, which value the aesthetics of the landscape and the high botanical-ecological values of the territory [28-30].

The current work aims to enhance practical teaching over theory, promoting student training for their incorporation into the labor market. The autonomy of the student is encouraged to carry out studies that are currently demanded by the EU and a teaching method that presents an important innovative component.

2. Materials and Methods

Due to the fact that for years theoretical teaching has dominated practice, in relation to the learning of Geobotany, with negative evaluations for students, we modified the teaching method and increased the practical field contents over the theoretical ones. We formulate the hypothesis about the increase in the success rate of the students, by increasing the practical teaching over the theoretical one.

The application of the classical phytosociological method [31] that we have conceptually already reported in Cano-Ortiz et al. [24], as well as the application of modern syntaxonomy and geosyntaxonomy will allow us to make a detailed study on land use planning, as well as a comprehensive interpretation of the plant landscape. To ensure that the theoretical concepts are understood by the student, we program some field practices, in which the vegetation in four natural parks is studied. Study that consists of the application of sampling techniques (phytosociological inventories and no inventories), and the collection of seeds in a simple way from the most representative plant communities [32], as well as botanical herbalizations and *in situ* interpretation of the vegetation catenas, with the elaboration of the different profiles, in which the existing vegetation units are reflected. Due to the abstract nature of scientific terminology, we use the inductive method, through which the student can check *in situ* the meaning of said terminology. However, it is also necessary to use the deductive method to approach the interpretation of the large vegetation units.

Both symphytosociology and geosymphytosociology are abstract concepts from a theoretical point of view. For this reason, we go to field practices, through which students learn to differentiate plant communities and their interpretation, obtaining a real vision of the landscape, and understanding why a series or sigmetun is climatophilous versus adafoxerophilous and edaphohygrophilous [33]. For this, several field trips are made, to places where the natural vegetation is well preserved and there is no human manipulation, visiting the Andújar Natural Parks (Sierra Morena), Sierra de Cazorla-Segura-Las Villas, Sierra Magina, Sierra de Grazalema. In the transects (profiles) we obtain

a set of plant communities that mark the plant diversity of the territory. In addition to the vegetation profiles or catenas for each of the study places, an idealized profile is presented in which we express the environment of two large vegetation units: the climatophilous versus the edaphoxerophilous (Figure 2); the rest of the profiles or catenas (geosigmetum) are always made indicating the same orientation (north) [34].

For field work, the number of samples taken is 100 (25 for each of the 4 Natural Parks), among the 20 students that make up the group and for 3 years, between 3-4 field days in spring, which it implied the involvement of 60 different students. Previously, students have been given a class manual, in which the methodology to be followed on field sampling and the interpretation of the landscape and vegetation is explained. At the same time, the student studies the existing vegetation in the 4 Natural Parks: he has had to search for the publications available for these territories on climatology, bioclimatology, biogeography and vegetation.

To evaluate the student's learning, an exhaustive report of the field activities of each of the Natural Parks is made, obtaining a positive evaluation if the qualification of approved is passed, for those who do not obtain it they must issue a new report, for this they have to restructure the one carried out in the first evaluation. To know if the proposed objectives have been achieved, an evaluation is carried out, in which each student has had to make a report on the field work carried out. In said report the inventories and field profiles have been incorporated, as well as an interpretation of the type of existing plant communities, types of forests and their dynamics; as well as the types and how many links (sigmetum) exist in the catena of each Natural Park. The more or less positive evaluation depends on the interpretation of the natural reality that the student makes of the territory.

3. Results and Discussion

The field study carried out by the student, in which inventories and profiles are carried out, and a vegetal dynamic is established, allows the student to learn geobotanical concepts in a practical way, and interpret the reality of the 4 studied territories. Thus, it has been achieved that the abstract concepts of symphytosociology and geosymphitociology are assumed by the student. The planning of the different programmed activities has allowed a fairly exhaustive study of the work areas.

In the case of Sierra Morena, the geosigmetum is made up of 4 climatophilous s and 2 edaphoxerophilous series (Figure 3); in the Cazorla-Segura-Las Villas Natural Park (Figure 4) the catena presents 3 climatophilous and 3 edaphoxerophilous series. For the case of the Sierra Magina Natural Park (Figure 5), the profile shows 1 climatophilous series versus 2 edaphoxerophilous. In the case of the Sierra de Grazalema Natural Park (Figure 6), the north orientation only presents a climatological series, but of a high botanical-ecological value because it presents the endemism *Abies pinsapo* Boiss as the head of the series, with the south orientation being more diverse. with 2 climatophilous series and one edaphoxerophilous.

The cause of the different diversity is due to differences between environmental factors, such as the substrate, the orography, the bioclimate. The field work in which plant communities are sampled, botanical species are herbalized and various profiles are drawn by hand, attending to the orientations of the territory, motivate the student who learns to correlate diversity with the present environmental parameters, as well as to assimilate the theoretical concepts on the study of the landscape. This field knowledge that the student acquires, is strengthened with the laboratory study, in the school gardens and in botanical gardens [2,35] in which the student learns to perform the determination of species using dichotomous keys, as well as the management of software to obtain profiles or vegetation catenas.

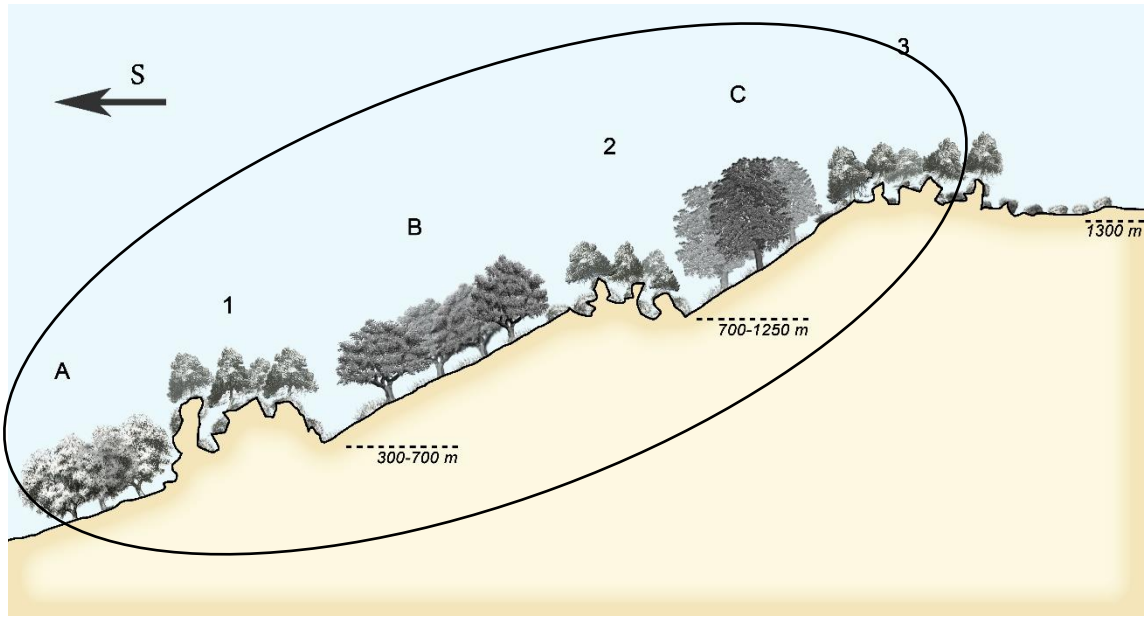

Figure 2. A, B, C Climathophilous forests (Climathophilous vegetation series). 1, 2, 3 Edaphoxerophilous forests (Edaphoxerophilous Vegetation Series).

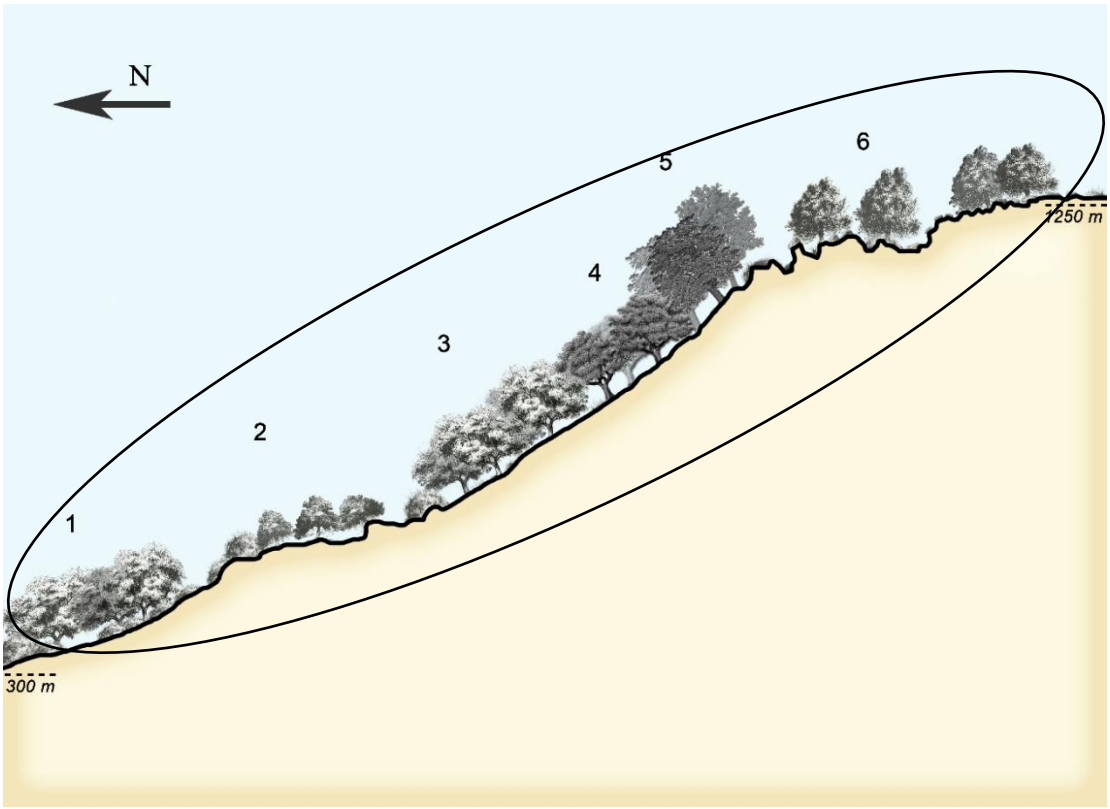

Figure 3. Profile or catena of Sierra Morena. Geosigmetum = Geosynasociation (Set of sigmetum or series of vegetation). A) Climathophilous series 1. *Myrto-Querco rotundifoliae* s. (series of Luso-Extremaduran dry silicicolous thermomediterranean holm oak forests); 3. *Pyro-Querco rotundifoliae* s. (series of the Luso-Extremadura dry silicicolous mesomediterranean holm oak forests); 4. *Poterio-Querco suberis* s. (Luso-Extremaduran sub-humid siliciculic alcornornocales series); 5. *Arbuto-Querco pyrenaicae* s. (series of Luso-Extremadura wet silicicolous mesomediterranean oak forests); B) Edaphoxerophilous series 2. *Genisto polyanthi-Juniperetum badiae*. 6. Edaphoxerophilous community of *Juniperus oxycedrus* subsp. *badia* and *Echinospartum ibericum* [21].

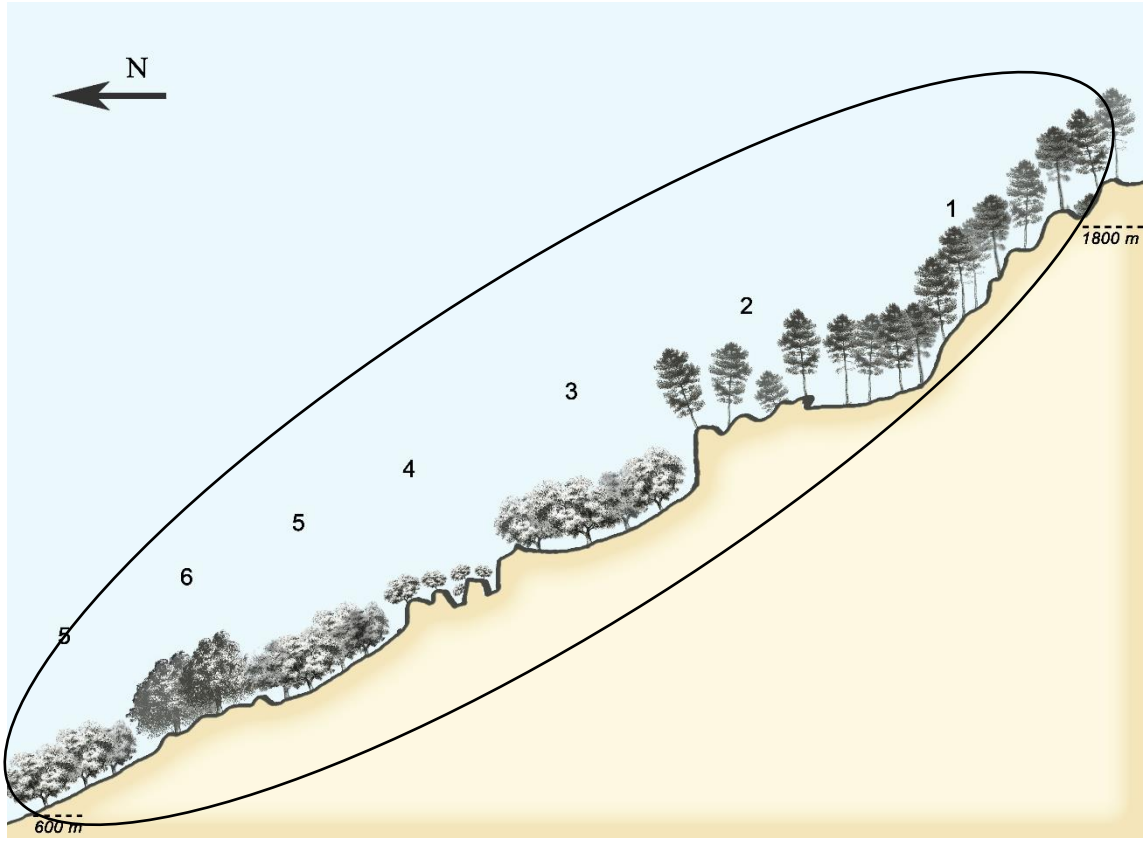

Figure 4. Profile or catena Sierra de Cazorla. Geosigmetum = Geosynasociation (Set of sigmetum or series of vegetation). A) Climathophilous series 1. *Junipero phoeniceae-Pino clusianae* s. (Supra-Mediterranean pine forests of Betic black pine); 3. *Berberido hispanicae-Querco alpestris* s. (Baetic sub-humid supra-Mediterranean forests); 5. *Paeonio coriaceae-Querco rotundifoliae* s. (series of the Mesomediterranean basophilous dry Betic Holm oak forests). B) Edaphoxerophilous series 2. *Rhamno lycioidis-Pino halepensis* s. (edaphoxerophilous series of Betic Mesomediterranean pine forests); 4. *Junipero phoeniceae-Querco rotundifoliae* s. (subhumid-humid edaphoxerophilous series of Betic holm oak forests); 6. *Junipero phoeniceae-badiae* s. (Dry edaphoxerophilous series of Betic junipers) [21].

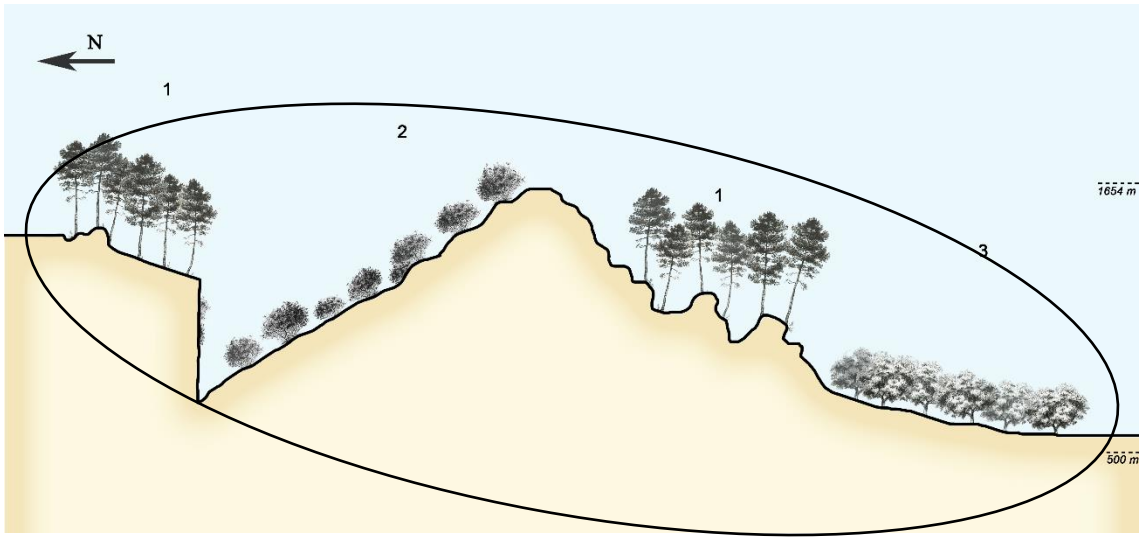

Figure 5. Profile or catena Sierra Magina. Geosigmetum = Geosynasociation (Set of sigmetum or series of vegetation). A) Climathophilous series 3. *Peonio coriaceae-Querco rotundifoliae* (series of the mesomediterranean basophilous dry Betic holm oak forests). B) Edaphoxerophilous series 1. *Rhamno lycioidis-Pino halepensis* s (edaphoxerophilous series from Betic mesomediterranean pine forests); 2. *Teline patentis-Pistacio terebinthi* s. (Betic sub-humid cornicabrales).

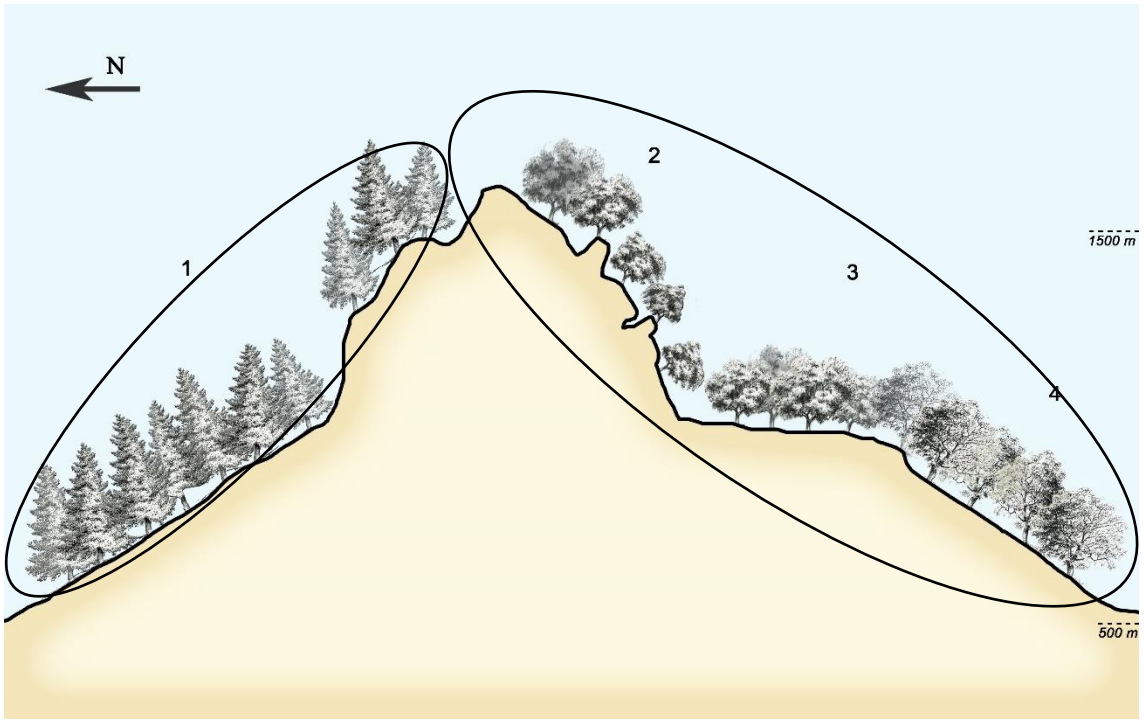

Figure 6. Profile or catena Sierra de Grazalema. Geosigmetum = Geosynasociation (Set of sigmetum or series of vegetation). A) Climathophilous series 1. *Paeonio broteroi-Abieto pinsapo* s. (Mesomediterranean basophilous humid-hyperhumid series of the Ronda forests of *Abies pinsapo*); 3. *Paeonio coriaceae-Querco rotundifoliae* s. (series of dry Betic basophilous mesomediterranian holm oak forests); 4. *Oleo sylvestris-Querco alpestris* s. (Thermo-mesomediterranean neutral-basophilous dry-humid western Betic series B) Edaphoxerophilous series 2. *Bupleuro gibraltarici-Querco rotundifoliae* s. (Subhumid basophilous thermomediterranean edaphoxerophilous series from Betic holm oak forests).

The field activities carried out by the students in the aforementioned Natural Parks have been reported by themself. In the reports, the students have included the bioclimate

and the biogeographical unit of the study area, the phytosociological sampling of the dominant forests and thickets, have named and selected the species that characterize the communities. From this, they proposed the series of existing vegetation and generated the profile of each of the studied areas up to finally include the main habitats present in each series of vegetation. The evaluation of these field activities through the reports issued, leads us to a success rate in the three years that ranges between 90-100%: this means that in the first evaluation, almost all of them exceed the established minimum, and in the second call, 100% pass rates are obtained.

4. Conclusions

The study of vegetation series and geoseries provides high information on the diversity of plant communities in the work area. Live observation together with the vegetation sampling, provide sufficient data and information to the student / researcher to understand the theoretical aspects of the integral landscape. In addition, it is verified that the diversity of phytocenosis is different among the study areas. The most different profiles correspond to the Cazorla-Segura-Las Villas Natural Park and Sierra Morena, due to the particular orography, the substrate and the existing bioclimate, both very harsh from the orographic point of view. The thermotype for Sierra Morena oscillates between the thermo and the supra-Mediterranean and the ombrotype between the dry and the humid, and the siliceous substrate. On the contrary, the Cazorlan territories with calcareous and limestone-dolomitic substrates have a thermotype that ranges from the meso to the oromediterranean and an ombrotype that oscillates between dry and humid. However, the less diverse areas in terms of the number of plant communities are less important, since the areas of Grazalema and Magina can be considered botanical islands, with a rate of species of high botanical interest.

This practical field work supports the acquisition of theoretical knowledge, so in the teaching of the natural environment, it is advisable to apply equal importance to practical content compared to the theoretical one. In this study we have observed that students obtain more solid knowledge and better academic results. By increasing the importance of practical teaching, it is verified that the student acquires theoretical knowledge more solidly, and the success rate of the students increases, reaching 90-100% of those who pass the pass.

Author Contributions: Conceptualization, A.C.O. and C.M.M.; methodology, A.C.O., C.M.M. and E.C.; formal analysis, J.C.P.F., R.Q.C. and E.C.; investigation, A.C.O., C.M.M., J.M.H.I. and E.C.; resources, A.C.O. and E.C.; data curation, J.C.P.F. and R.Q.C; writing — original draft preparation, A.C.O. and E. C.; writing — review and editing, A.C.O., C.M.M. and E.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

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