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Research Article

Calabrian Native Project: Botanical Education Applied to Conservation and Valorization of Autochthonous Woody Plants

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Abstract: Calabria is a floristic hotspot just at the center of Mediterranean Sea. Unfortunately, an increasing number of alien plant species threats this natural heritage, exactly while the crucial role of botany in secondary schools of Italy has been definitely dismantled. Calabrian Native Project is an environmental education project planned by Istituto Tecnico Agrario of Catanzaro that, reintroducing some key concepts of botany and biogeography, allowing pupils to experience a botanical excursion in the close-to-the-school Mediterranean Biodiversity Park, gives them the opportunity to become acquainted with both native and alien species. Pupils are asked to collect native plant propagules and to seed or cultivate the material in the school greenhouses, and to take care of these plants until their use. The prevalent outdoor and laboratory approach to the issue of bioinvasions, make the project very effective. This feature, with the low cost and reduced technology inputs, make the project highly replicable in other contexts, just focusing appropriate target species.

Keywords: Alien Plants, Biogeography, Bioinvasions, Biological Pollution, Botany, Calabria, Ecology, Native Plants

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1. Introduction

Calabria is the southernmost continental region of Italy. The region shows peculiar geographical features, being mostly a peninsula surrounded by the sea, and occupying a special position right at the center of the Mediterranean basin (Figure 1). This narrow and long peninsula, results biologically quite isolated by the rest of the Apennine range because the altitude of the peaks of the Pollino Massif (e.g. Serra Dolcedorme 2,267 m a.s.l., M. Pollino 2,248 m, Serra del Prete 2,180 m, Serra delle Ciavole 2,127 m, etc.) strongly limited the migration of plant species southwards (Figure 2). Moreover, as a result of a complex geological history it has an extremely varying geology and geomorphology, characterized by a manifold altitudinal range and a consequent climatic heterogeneity. The occurrence of so many changing ecological factors, supported a unique biological, evolutionary and biogeographical history, today testified by a rich vascular flora, counting 2,670 native specific and subspecific taxa [4], 2,786 if cryptogenic taxa [13] are included [3] and distinguished by a high number of regional (60) and national (270) endemics, according to Peruzzi *et al.* (2014) [31]. This level of endemism is unsurpassed among Italian continental regions, and lower only than that of Sicily and Sardinia, which, because of their insularity record a level of endemism not comparable with that of the Italian continental regions. Alien plant species (382) also occur in Calabria [20, 29, 34], and numbers are increasing due to new additions such as in Musarella (2020) [30]. The frequent tendency of alien taxa to unlimited reproduction, due to the absence of the

limiting factors normally occurring in the natural range (parasites, competitors, etc.), makes the relative abundance of these species to be one important threat for the conservation of native species and habitats [32].

Figure 1. Location of Calabria exactly at the center of Mediterranean basin.

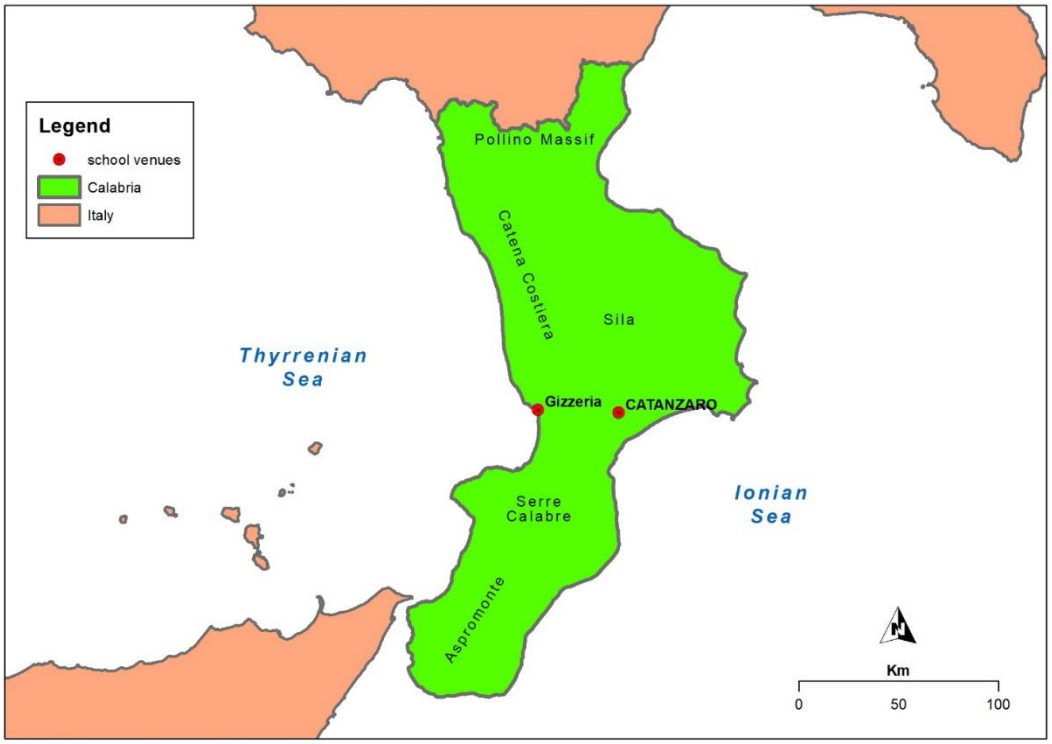

Figure 2. Calabria with its main mountain ranges. Location of the school venues.

The Istituto Tecnico Agrario "V. Emanuele II" of Catanzaro, established on 1875, in 2022 directed by headmaster Rita Elia, has a long tradition of education in the fields of agriculture and environment management for pupils 14 to 19 years old. The institute's main venue is located in the western suburbs of the city of Catanzaro, the Calabria's administrative capital, into an area formerly representing the school's farm, and now

mainly occupied by public infrastructures (roads, hospital, parking lots, etc.). A second school venue is located on the Tyrrhenian coast of Calabria, in the municipality of Gizzeria, and a third one in the Catanzaro prison house. Part of the former school's farm today is the Mediterranean Biodiversity Park, a suburban park occupying the top and the western slope of the hill north of the school's main building. The park is crossed by the Rizzitano Trail, a natural-cultural pathway planned a few years ago by a class with their teachers and named after a former school headmaster, Giuseppe Rizzitano. The vascular flora along the trail counts about three hundred taxa, ten percent of which are alien species. Among these, those woody showing the worst invasive behavior are *Robinia pseudacacia* L. (Fabaceae), *Ailanthus altissima* (Miller) Swingle (Simaroubaceae), *Pinus pinea* L. (Pinaceae), and *Eucalyptus camaldulensis* Dehnh. subsp. *camaldulensis* (Myrtaceae). The school headquarter, at the moment, is composed by the main building (E shaped), a small farm (with both open land and greenhouses), a winecellar (Figure 3).

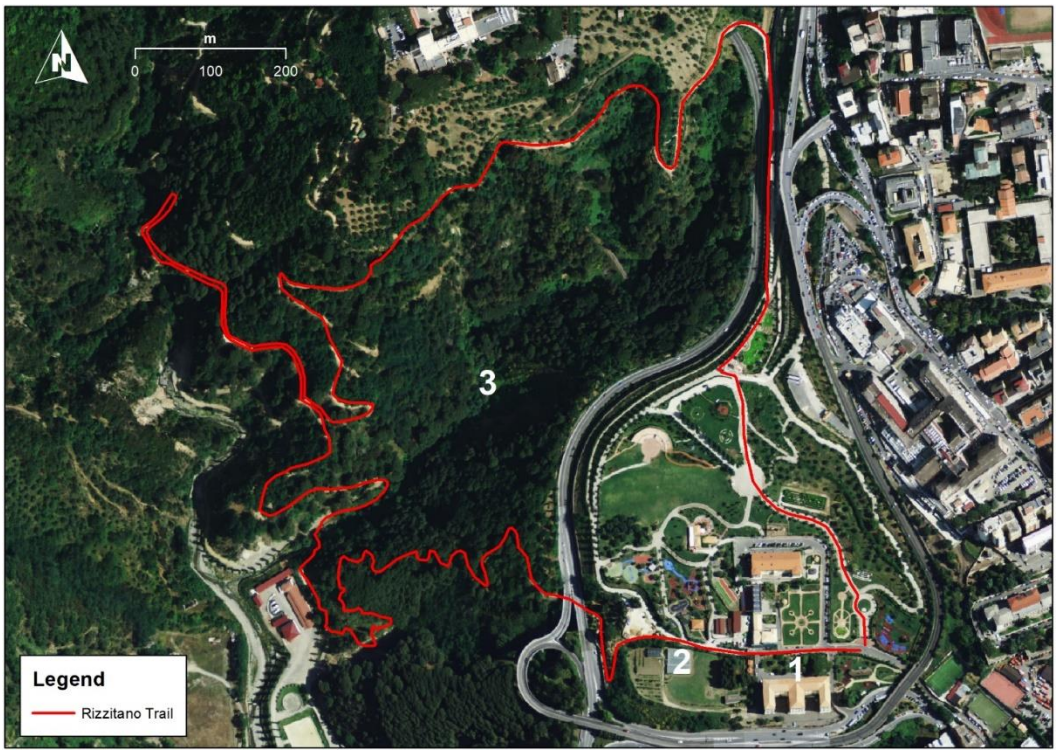

Figure 3. Map from orthophotography of the Mediterranean Biodiversity Park (3), with the Rizzitano Trail (red line), the headquarter of the Istituto Tecnico Agrario of Catanzaro (1) and the school's farm (2).

While just about 20% of the pupils attending the school lives downtown, most of the students come from villages belonging to the Catanzaro province and surrounding the town. Many students daily travel the road home-school-home, but around 50 of them, coming from localities too far from the school, do live inside the school Monday to Friday in a boarding school, including resting spaces, study area, kitchen, refectory, night rooms. Several students join this community with a limited cognitive basis and a rather weak educational background. Therefore, they often aspire to avoid a highly theoretical didactic path. In fact, such a training implies a high level of abstraction, an activity to which they are mostly not accustomed. On the contrary, these students tend to be particularly at ease in didactic-educational activities involving an eminent practical-laboratory commitment, allowing them a direct experience of contents and principles. As part of this kind of educative proposal the teacher plays the role of guide in the interpretation and generalization of the experience, in relation to the student's own social and inner world,

until the moment in which new learning occurs to close the experiential learning cycle [28]. The model of learning styles [26], intimately connected to the theory of multiple intelligences [21], highlights how each individual shows the tendency to prefer a different learning style: activist, thoughtful, theorist or pragmatist.

Botany is traditionally taught as an autonomous subject in agricultural vocational schools. Knowledge about the anatomy, morphology, physiology and ecology of plants has long been considered a fundamental element of the specific course of study. Furthermore, thanks to the subject's environmental aspects (floristics, plant ecology, phytosociology, phytogeography), botany can contribute to the development of ecological sensitivity. Based on this awareness, since the end of the 1990s, a significant teaching experience in environmental botany has been developed at the Istituto Tecnico Agrario of Catanzaro [14, 15, 16, 17]. This heterogeneous path of botany teaching experiences, however, suffered a sudden setback as a consequence of the reorganization of secondary school norms [24] resulting from the so-called Gelmini Reform [22, 23] which just canceled botany from the curricula of agriculture schools.

The weakening of the botanical training at national level, forced a serious local rethinking of study plans, evidencing the need to reintroduce didactic elements related to botany. This, at least in our school, has been obtained mainly applying the principles of short teaching [18], along with those of outdoor environmental education [25] and with the additional inspiration coming from recent experiences from other Mediterranean countries [6, 7, 8, 9, 10, 11, 12, 27, 31, 33, 34]. Elements of histology and morphology of vascular plants have been re-introduced in different subjects, while elements of environmental botany have been included, at the second year, in the Biology study plan, under the name Calabrian Native Project.

The main aims of the project are those educational. Raising students' awareness of environmental issues is a training priority for the school. It is crucial to prevent the introduction of new exotic plant species.

It is equally important to try to re-introduce notions of botany into the curricula, as well as to exploit the educational potential of outdoor environmental education.

Additional aims of the project are the development of effective agronomic protocols for the native plant species treated, and the production of native plant material to be used in the school spaces.

The objective of this paper is to share with the scientific community the concern about the cancellation of a fundamental discipline such as botany from the curriculum of agricultural technicians, so that, from this awareness, the willingness to promote its reintroduction will hopefully emerge. An additional very important objective of the paper is to share the good practices of outdoor environmental education we experienced with Calabrian Native Project with other Italian and European schools, in order to spread, through the learning-by-doing approach, more environmental awareness among the new generations about how important is to work with native plants and, on the other side, to avoid using the alien ones.

2. Materials & methods

The principles of multiple intelligences [21] and those of outdoor environmental education [25] has been the theoretical background of the project. The rural background, statistically prevalent among our students, is mostly referable to situations in which the ability to solve problems of a practical-applicative nature is primarily required, or even simply good manual skills are requested, much more than the ability to formulate abstract reflections and thoughts. Boys with such a family background, not infrequently have also behind them school experiences which, concentrated on the generic national curriculum, have ended up in resulting excessively theoretical and therefore unsatisfactory, at least for the peculiar characteristics of these students. It is not therefore rare that our students, with valuable cognitive skills, arrive in secondary school without the self-confidence and

the basic prerequisites that this school cycle requires. The application of the theory of multiple intelligences in this project consists precisely in maximizing the practical-laboratory skills of the students, gradually stimulating their self-confidence and their ability to engage in more theoretical and abstract tasks. The project is in fact mainly focused on didactic activities to be experienced outside the classroom, in semi-natural environment and in some school laboratories. The organization of the work, for each single class involved in the project, has been divided in six phases, as summarized in Table 1.

Table 1. Most important phases of the Calabrian Native Project.

nr.	phases	theme	topic	content	material
1	Indoor preliminary education (6-10 h; 3-4 weeks)	Safety (at work, during excursions)	Individual safety tools	Boot, gloves, glasses, etc.	PwPt slides
			Safety Behaviors		PwPt slides
		Environmental Botany lecturing	Levels of plants organization	Plant individual, population, species, plant association	PwPt slides
			Biodiversity	Biodiversity and naturality	PwPt slides
			Principles of Biogeography	Biogeographic regions	PwPt slides
				Key concepts: alien, native, endemic (definitions)	PwPt slides
			Bioinvasions	Mechanisms, damages, costs (economic and ecologic) of biological pollution, prevention and post-invasion action	PwPt slides
		Pre-outdoor requirements	Tools	Student are asked to buy individual safety and gardening tools	Trekking (or safety) boots, gardening gloves, safety glasses, gardening scissor and shovel
			Authorization	One/both parents are asked to sign a specific authorization	PDF file available on Google Classroom, to be downloaded, printed, filled and signed by parents
2	Outdoor environmental education (2-4 h; morning)	Naturalistic excursion	Observations on alien and native woody plant species	Scientific names of plants observed, family, ecology of each single species, biogeographic origin, traditional and modern practical uses	Students are stimulated to take notes and pictures during the activity
			Observation on different ecological features of the BMP (bedrock, water, etc.)	Names of different bedrocks are provided, microecology of places is explained	Students are stimulated to take notes and pictures during the activity
			Collection of plant reproductive materials	Seeds	Plastic bags to collect seeds, acorns, etc.
				Branches	Garden scissors are used to collect young branched, later cuttings
3	Greenhouse work		Preparation of soil	Soil is prepared mixing peat and sand (1:2)	Garden shovels are used to perform the mixing

		Greenhouse work (2 h; afternoon)	Preparation of phytocells	Phytocells are filled for 1/5 (3-5 cm) of gravel, then soil up to around 7 cm of the rim	Garden shovels, phytocells, gravel, soil
			Seeding seeds	Phytocell are seeded with 3 acorns	Seeds, acorns
			Planting cuttings	Phytocell are seeded with many cuttings	Cuttings
			Irrigation	Seeded and planted phytocell	Water
4	Post-planting work	Homework (1-2 weeks)	Write a detailed report of the phases 2-3	Report on former steps of the project	Pc, report
			Write files on targets species	Files on targets species	Pc, species files
		Caring activity (2-7 months)	Periodical irrigation of phytocells	Removed the Covid-19 restrictions, the students can reach the school farm at coffee break (10.50-11.10)	Water
			Checking the germination process	Removed the Covid-19 restrictions, the students can reach the school farm at coffee break (10.50-11.10)	Checking the phytocells
5	Testing	Testing the entire project (1-2 h)	Written/oral interview on the project phases, key-concepts, experiences done and the activity finalities	Students are tested on main concept faced by the project	Questionnaire or interview
6	Use of plant material		Replacement of exotic plants with native ones in the school garden	When alien trees or shrubs plants die they are replaced by students with native ones produced during the project	Native plants produced during the project
			Sold for gardening	Part or the produce native plants are sold	Native plants produced during the project
			Gifted for renaturation projects	Part or the produce native plants are gifted for private planting and restoration project	Native plants produced during the project

The first phase (6-10 hours) of the project consists of the indoor preliminary education, which aims to provide students with basic knowledge on the main themes of the project: safety, botany, ecology, biogeography, bioinvasions.

The second phase, the outdoor environmental excursion (2-4 hours), consists of a didactic excursion in the Mediterranean Biodiversity Park adjacent to the school. During this activity students come into direct contact with the native and alien species present, take notes on the information provided, collect seeds and cuttings of some of the project's target species.

The third phase (greenhouse work, 2 hours), takes place in the institute greenhouses and consists of the sowing (Figure 5) or planting (Figure 4) of the materials collected

during the excursion. Excursions and greenhouse work usually take place on the same school day, the first in the morning, the second after lunch.

Figure 4. A few students attending the class 2B of Istituto Tecnico Agrario of Catanzaro inside one of the greenhouses of the school farm, while working on cuttings of *Pistacia lentiscus* planted in a box containing garden soil. When rooted, the new plants are transplanted in single pots. The correct use of gloves and safety glasses is part of the safety training promoted by the Calabrian Native Project.

Figure 5. The inner side of a phytocell partially filled with garden soil. Three acorns of *Quercus virgiliana* are usually placed (the number helps to reduce the empty phytocells) more or less at the vertices of an equilater triangle. When covered by a 1-2 cm layer of additional garden soil and

regularly watered, seeds will be ready to sprout in 4-6 weeks, depending on the average temperatures. This system, according to what experienced during the years dedicated to Calabrian Native Project, is the easiest and more productive way to get seedling, later plants, from the acorn of this species collected in the Mediterranean Biodiversity Park in Catanzaro.

The fourth phase (post-planting work) consists in following the evolution of the material planted during the previous phase. The students can reach the school farm by their own, in spontaneous groups during the morning break to water the seedbeds under the supervision of the farm staff. The whole class can spend a few hours along the rest of the school year in the farm accompanied by the teacher to water seedlings and check their development.

During the fifth phase (testing) it is expected the students to prepare a detailed report on the entire activity, including the excursion and greenhouse work (phases 3 and 4), and to write some files on single plant species as homework. Moreover, in this phase the knowledge acquired by the students is verified and evaluated. Over the years, both structured written tests and, more frequently, oral interviews have been used for this purpose. The focus aspects on which students are interviewed are the aims of the project, the project phases, the key-concepts, and, in general, the quality of experiences done.

Finally, the sixth phase (use of plant material) that unfolds over several years. Students are periodically required to carry out replanting operations or even collaborate in the planting of native plants in different sectors of the school farm.

The teaching materials (PowerPoint presentations converted into pdf files) used for lessons are provided to students through a virtual classroom created by the teacher in a Google school environment. Families are required to first sign a release authorizing their children to participate in the project, relieving the school (and school staff) of the responsibility deriving from unforeseeable accidents, as well as to undertake to provide students, at their own expense, with individual safety devices (boots, gloves, safety glasses) to operate in compliance with the in force safety rules. This document is also provided to students via virtual classroom, as well as Rizzitano Trail Guide, describing the Biodiversity Mediterranean Park, available in both Italian and English languages, written during the 2013-2014 school year by a class who participated to a regional competition on the planning of natural-cultural trails.

The target species of the project have been the following: *Ampelodesmos mauritanicus* (Poir.) T. Durand & Schinz (Poaceae), *Arbutus unedo* L. (Ericaceae), *Cytisus infestus* (C. Presl) Guss. subsp. *infestus* (Fabaceae), *Cistus creticus* L. subsp. *eriocephalus* (Viv.) Greuter & Burdet (Cistaceae), *Cistus monspeliensis* L. (Cistaceae), *Cistus salviifolius* L. (Cistaceae), *Emerus major* Mill. subsp. *emeroides* (Boiss. & Spruner) Soldano & F.Conti (Fabaceae), *Fraxinus ornus* L. subsp. *ornus* (Oleaceae), *Genista monspessulana* (L.) L.A.S. Johnson (Fabaceae), *Helichrysum italicum* (Roth) G. Don subsp. *italicum* (Asteraceae), *Myrtus communis* L. (Myrtaceae), *Phlomis fruticosa* L. (Lamiaceae), *Pistacia lentiscus* L. (Anacardiaceae), *Rhamnus alaternus* L. (Rhamnaceae), *Quercus ilex* L. (Fagaceae), *Quercus suber* L. (Fagaceae), *Quercus virgiliana* Ten. (*Q. pubescens* s.l.; Fagaceae), *Salix alba* L. (Salicaceae), *Teucrium siculum* (Raf.) Guss. subsp. *siculum* (Lamiaceae), *Ulmus minor* Mill. subsp. *minor* (Ulmaceae), *Viburnum tinus* L. subsp. *tinus* (Viburnaceae). Names have been attributed according to Bartolucci *et al.* (2018) [4].

In order to provide an evaluation of the overall results of the project, the total number students attending the project, the number (and percentage) of those who had positive results in the subject, has been recorded and calculated. Data are summarized in the Table 2.

3. Results

The project produced different interesting results. First of all, the educative quantitative result, as summarized in the Table 2. Almost six hundred (597) young

students, during the last eight years, have been involved in the project's activities. They are now more scientifically educated about the issue represented by alien plant, so we can hope in the future they will be more aware citizens and, even better, more attentive professional technicians in the agricultural and environmental sector. A good number (547, 92.2%) of total pupils involved in the project, had a good final result in the specific subject. A second important goal is represented by the increased integration in the class of pupils with special needs. Outdoor activities, along with practical-laboratory training and the help of support teachers, are very effective for this purpose.

Table 2. Total, positive, average amount of students and classes involved in the Calabrian Native Project in the period 2014-2022.

year		1			2			3			4			5			6			7			8			
school year		2014-2015			2015-2016			2016-2017			2017-2018			2018-2019			2019-2020			2020-2021			2021-2022			
students		total	positive	%	total	positive	%	total	positive	%	total	positive	%	total	positive	%	total	positive	%	total	positive	%	total	positive	%	
class	2A	20	20	100	20	17	85	23	13	57	20	20	100	20	17	85	18	18	100	15	13	87	19	19	100	
	2B	13	12	92	22	21	95	26	23	88	21	21	100	21	21	100	18	18	100	14	14	100	15	15	100	
	2C	22	20	91	24	24	100	23	20	87	20	20	100	20	20	100	21	21	100	17	13	76	15	15	100	
	2G				14	10	71	21	16	76	13	13	100	15	14	93	18	18	100	13	10	77	19	18	95	
	2L							17	13	76																
total		55			80			110			74			76			75			59			68			597
positive		52			72			85			74			72			75			50			67			547
average%		94			88			77			100			95			100			85			99			92,2

The third goal reached by the project is the amount of agronomic protocols developed during the project for the optimization of germination and cultivation of native plants. While a lot of agronomic information is available for the most common forest plants (even alien), much less is available for native species [1, 2, 5, 32].

Around 1,500 native plants have been produced by the project, distributed among the target species as shown in Table 3. This native plant material has been partially used at school to replace old alien trees died; the rest has been sold or gifted for nature restoration projects.

One additional output of the project has been an increased citizen awareness in the town of Catanzaro, which pushed the town municipality to approve a green regulation under which the use of exotic plants is forbidden [19].

Table 3. Native plants produced in the school farm under the Calabrian Native Project during the period 2014-2022.

species	%	nr
Quercus virgiliana	55	825
Quercus suber	10	150
Quercus ilex	8	120
Myrtus communis	7	105
Pistacia lentiscus	5	75
Phlomis fruticosa	2	30
Cistus monspeliensis	2	30
Rhamnus alaternus	2	30

Salix alba	2	30
Viburnum tinus subsp. *tinus*	2	30
Cistus creticus subsp. *eriocephalus*	1	15
Cistus salviifolius	1	15
Ampelodesmos mauritanicus	0.6	9
Cytisus infestus subsp. *infestus*	0.4	6
Emerus major subsp. *emeroides*	0.4	6
Fraxinus ornus subsp. *ornus*	0.4	6
Genista monspessulana	0.4	6
Arbutus unedo	0.2	3
Helichrysum italicum subsp. *italicum*	0.2	3
Teucrium siculum subsp. *siculum*	0.2	3
Ulmus minor subsp. *minor*	0.2	3
	100	1,500

4. Discussion

The need to conserve natural environments and indigenous biodiversity for the benefit of future generations, as well as to limit the negative effects of climate change, calls education agencies, school in the lead, to the duty of promoting knowledge and awareness. Although there are many ways to raise mindfulness among new generations on environmental issues, nothing more than direct experimentation with the environment is effective in building this sensitivity. Outdoor environmental education is based on experiential learning, a kind of first-hand experiences capable to put the student in contact with real contexts and problems [25]. If the experiential learning cycle [28] does not explains the complexity of the human mind and its ability to process complex information, it still provides a theoretical structure useful for connecting the different moments of the learning process. In fact, it suggests that it is not enough for the student to take part in outdoor activities for the experience to be translated into an educational result. For these reasons the Calabrian Native Project aims to provide students with a heterogeneous series of didactic experiences, in order to allow them to achieve a lasting educational result. The project, compared to the available literature [6, 7, 8, 9, 10, 11, 12, 25, 27, 28, 33, 35, 36], shows many interesting and original aspects. A first original aspect of this educational project is exactly the topic related to addressees. In fact, no didactical experience involving pupils belonging to this age range, implying struggling with alien plants, is reported in literature. A second very important aspect, regards the inclusion of pupils with special needs in the project activities and finalities. These students, inside the national Italian school system, do attend normal classes, associated to a support teacher. The project has many activities that help the inclusion process, and closer and supportive relationships inside the class. A third interesting aspect is the main project target. In this case, in fact, the target is not just the knowledge regarding the studied objects (plants, both native and alien). Despite this information has been part of the process, the true objective is a sort of new mentality, new eyes thanks to which to look at plants as elements coming from a specific biogeographical context and suitable only for that. A fourth aspect is the clear connection between each single species and its environment. This linkage, coming from both evolution and ecology, is experienced by pupils involved in the project at least twice

during the project. The first time is in the field, during the botanical excursion, when the teacher randomly talks about the autoecology of main species, also based on the Rizzitano Trail Guide provided to students by Google classroom. Later, when pupil were asked to draw up the species files, they would find, in the literature, information consistent with what they have seen in nature. A fifth additional value is the project longevity. No project in this school can claim a so long history and continuity. This means that all students attending the school in the last eight years had the opportunity to experience the Calabrian Native Project educative proposal that, gradually, has become part of the school educative backbone. Hundreds of pupils have been involved in the project but, numbers apart, this longevity demonstrates how much the school believes in this kind of approach to environmental education. Finally, the project proved to be feasible with very low costs. Sand, soil, gravel, phytocells, water are commonly quite cheap. Moreover, the project needs very low technological inputs. These features make the project replicable practically everywhere.

5. Conclusions

The Calabrian Native Project allowed many students to become more aware about the responsibility linked to the conservation of environmental heritage of the region, and how to work on this, applying some re-introduced topics of botany, avoiding the introduction on new alien plant species. This objective has been achieved thanks to a theoretical-practical educational program which allows students to distinguish native and exotic species, as well as to practice the cultivation, from seed and by cutting, of some of these native species. The standard project includes only one excursion per class, carried out in the Mediterranean Biodiversity Park. Further excursion activities, moreover in places far from the school, would normally represent an unsustainable cost for the school funds. In the meantime, the school has received the financial support of Italian Government to develop Calabrian Native Project 2.0, consisting of 5 additional botanical excursions in the following locations in Calabria: Tirivolo-Monte Gariglione, Giganti di Fallistro, Bosco di S. Maria, Canyon Valli Cupe, and Sovereto Dunes. This expansion of the environmental training offer, with excursions planned only in areas belonging to the Rete Natura 2000 network, represents a positive evolution of the project towards a range of habitats not occurring in the Mediterranean Biodiversity Park.

In the future of the project there is also the gradual construction of a network (Calabrian Native Network) of schools (not just agriculture schools), which are interested in spreading principles and philosophy of Calabrian Native Project. The project, being relatively simple, cheap and virtually universal (changing target species according to the local flora), lends itself to be cloned potentially everywhere, first of all applied to the second class attending our school venue in Gizzeria. Our school should play a central role in this network, sharing its experience with partners and coordinating the exchange of didactic material, techniques, outdoor environmental education good practices. The next step is the promotion of a cooperation with the Mediterranean University of Reggio Calabria, in order to together propose a regional law against aliens, and to develop new methods to get native plants (e.g. micropropagation, increased germinability, etc.) and the introduction of new plant species as project targets.

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