Reflections on botany teaching in primary school education based on the Emc2 Project 'Exploring white crowberry coastal habitats'

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Title

Reflections on botany teaching in primary school education based on the Emc2 Project 'Exploring white crowberry coastal habitats'

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Translation M. Alexandra Viegas Abreu Lima

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ABSTRACT

The Emc^2 Project 'Exploring white crowberry coastal habitats' is an educational project since 2016 aimed to raise awareness among children about the coastal zone natural heritage, based upon the white crowberry wild plant (in Portuguese '*camarinha*'). This book describes and discusses results of Emc^2 project initiatives, developed between 2016 and 2024, with school communities of five coastal zones, for primary school (1st cycle and 2nd cycle) students. The white crowberry species only exists in Portugal, Spain, and some Azorean islands (an Iberian endemism), which female plants bear edible fruits with a peculiar white color. For declining white crowberry populations, the project has empowered young people to act in their conservation, an initiative integrated, since 2021, in the 'Panorama Solutions' global portal. The project demonstrates that we can only protect what we know and that education about the diversity and importance of plants are essential components of their conservation (Sharrock, 2020). The project is currently relevant given the current biodiversity and climate change crises (IPCC, 2021); the disconnection of young people from nature (Louv, 2005); the disparity in knowledge about plants (Hiatt *et al*., 2021); and the decline in botany education (Stroud *et al*., 2022), which challenges educational systems to overcome them. Under the motto "*Nature is an excellent classroom*", project results demonstrate that in botany teaching, the school must open itself to the surrounding nature, where there is space and time for the curiosity and sense of place of young people to flourish and develop nature conservation actions.

Emc^2 Project is funded by FCT - Fundação para a Ciência e a Tecnologia, I.P., through: UID/04292/MARE- Marine and Environmental Sciences Centre and LA/P/0069/2020 (https://doi.org/10.54499/LA/P/0069/2020) assigned to the Associated Laboratory ARNET - Aquatic Research Network.

1 |INTRODUCTION

1.1. EMC² PROJECT VISION AND RELEVANCE

This book describes initiatives developed since 2016, within the Emc² 'Exploring white crowberry Coastal Habitats' educational project, funded by Fundação para a Ciência e Tecnologia (projects UIDB/04292/2020 and UIDP/04292/2020 from MARE- Marine and Environmental Sciences Centre and project LA/P/0069/2020 from ARNET - Aquatic Research Network). Project Emc2 main objective is to raise awareness among students about the white crowberry plant species - *Corema album* (L.) D. Don. This wild green shrub of coastal habitats, of ca. 1m height, is an iconic plant species as its female plants bear edible fruits, of peculiar white or pinkish color – the 'white crowberries' - in Portuguese 'camarinhas' (Figure 1).

Figure 1- White crowberry female plant with white fruits.

Nature is an excellent classroom

Emc² Project vision is inspired by a perspective of education that considers it as more than the acquisition of knowledge. In a changing world, it must be able to improve young people's understanding, skills, values and personal development (Winthrop & McGivney, 2016). In recent years, the ways by which brain works and the ways by which learning occurs have been studied. What we see, hear, taste, touch, smell and do constitutes the set of main learning pathways. According to António Damásio (2020), «*knowledge is built by sensory systems – vision, hearing, bodily sensations, taste and smell – with the help of memory*». Young people are curious, and we should give them the opportunity to explore the world around them (Figure 2).

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Figure 2- Students during a field trip observing white crowberry plants with a magnifying glass.

Education and awareness raising in nature are currently increasingly relevant due to the phenomena of: (1) 'nature deficit disorder in childhood' (Louv, 2005); (2) 'extinction of experience' (Finch, 2008); and (3) ‘disconnection from nature’ (Navarro-Perez & Tidball, 2012). Learning in nature, by allowing children to experience unique situations, is crucial for their cognitive, physical, and social development (Gill, 2019; Kemple *et al.,* 2016; Richardson *et al.,* 2017), with benefits for their health, creativity, confidence, communication, and problem-solving skills. The collaborative environmental education Emc2 project mission is to develop learning initiatives in nature, in coastal areas, which constitute a privileged space for science and botany teaching and learning.

Specifically, regarding the teaching of botany, several authors warn of a decrease in knowledge about plants and the extinction of botany education, with negative repercussions for biodiversity (Stroud *et al.,* 2022). According to these authors, the reduction in knowledge about plants feeds into a cycle of decreasing plant knowledge, at both specialized and general levels, which will consequently increase the risk of a biodiversity crisis and the potential for resilience and recovery in face of global anthropogenic change (Figure 3).

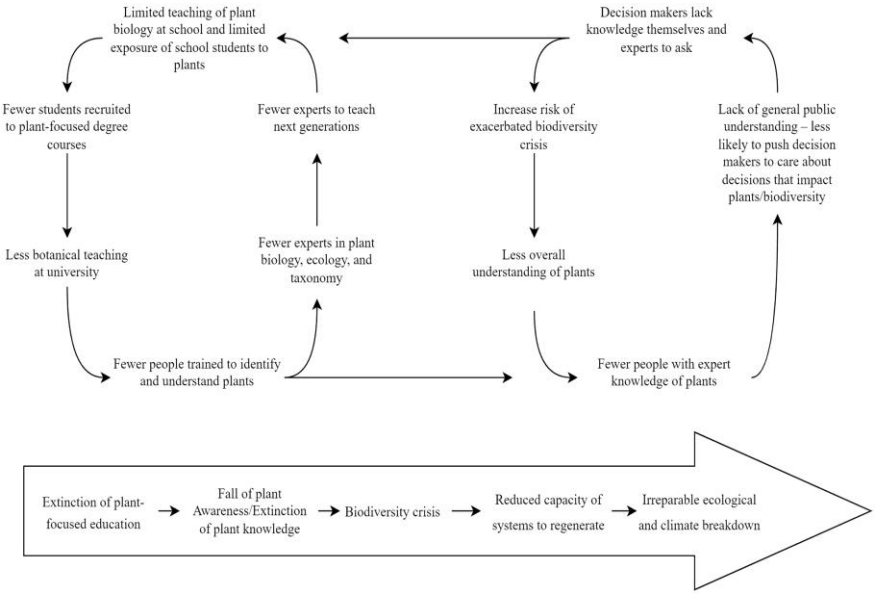

Figure 3- Diagram of extinction in botany education and its negative effects on biodiversity (source: Stroud *et al.,* 2022)

The Emc2 Project, by fostering direct contact of students with plants in nature and by ensuring that botany teaching in Primary Education is not so reduced, constitutes a way of 'nip in the bud' this problem of extinction of education about botany, since it interferes at the level of the first cycle of Figure 3 diagram ('Limited teaching of plant biology at school and limited exposure of school students to plants').

1.2. METHODOLOGY

1.2.1. FIELD TRIP ACTIVITY

«(…) *the emotional and motivating power of field trips is irreplaceable*»(Manuela Abreu, 1972)

The methodology followed in the Emc2 Project includes Field trips which, in pedagogical terms, and for various subjects, can complement classroom teaching, as they enrich student learning, and consequently, their emotional and motivational power was recognized as irreplaceable (Abreu, 1972).

The detailed methodology is described in the 'Field Trip' and 'Botany and Art' Activity Worksheets, published in the Book of Activities (Lima and Vasconcelos, 2017; www.mare-centre.pt/pt/society/educational-programs/emc2). In the 'Field Trip' Activity, students visit

dune habitats and observe white crowberries and other plants, being allowed to collect small, dried plant branches for their mini- herbarium (Figure 4). At field trip place, students complete an Activity Worksheet, in which they describe the place and record what they feel.

Figure 4- Field trip to a dune with white crowberry and collection by students of dried branches for a mini-herbarium.

During the field trip, students become aware of the worldwide geographical distribution of white crowberry, and of the concepts of endemic and invasive plants. The plant case studies include, as an endemic species, white crowberry and as an invasive species, the hottentot fig – *Carpobrotus edulis* (L.) N.E.Br – (Figure 5) which is a non-native species which can quickly out compete native plants particularly in coastal cliff and dune habitats, both globally (Campoy *et al.* 2016) and nationally. It has recently been reported for Portugal that «*the problem of invasive alien species has worsened and the pressure on coastal ecosystems has increased*» (RCM, 2018).

Figure 5 – Hottentot fig plant - *Carpobrotus edulis* (L.) N.E.Br.- near a young white crowberry plant (left corner) (©Lima, M.A., 2016)

In addition to these concepts, the following information is addressed during the field trips, regarding the functioning of coastal dune ecosystems, their importance, and aspects of plant adaptation to dune habitats:

1) Pollination and seed germination of white crowberry:

The pollination of white crowberry plant is carried out by the wind (anemophilous pollination), and in successfully pollinated female flowers, fruit formation can begin. These fruits are eaten by frugivorous animals (e.g., rabbits, foxes, seagulls, and blackbirds) which, after eat them, act as dispersal agents of white crowberry seeds through their faeces (Calvino-Cancela, 2005), being known that for the seed germination process, «*the fruit passage through the digestive system of these animals is beneficial (Alvarez, unpublished)*» (Clavijo *et al*., 2002).

2) White crowberry adaptation to dune habitat:

The strong winds, high salinity, luminosity, and extreme temperature ranges, along with poor water retention conditions (given the sand permeability), will require the plants to adapt to these difficult conditions. Therefore, the white crowberry plant has very small, curved leaves (called ericoid), covered on the upper surface by a very thick cuticle, which prevents the plant from losing water through transpiration via the stomata, which only exists on leaf under surface, allowing it to conserve water and withstand high temperatures.

3) Dune formation, its importance and threats:

For coastal zone dune formation, it is necessary to have sand, wind and plants. The sand deposited by the sea on the beach, after drying, is pushed inland by the wind and when it hits the plants existing there, it is retained in a mound. These small piles of sand with plants will grow and allow other plants that settle there to help capture and fix more sand brought in by the wind. Therefore, vegetation has a fundamental role in dune formation and stabilization, since plants are responsible for fixing mobile sands. If some of these plants exist only in one location and nowhere else in the world, we say they are endemic plants. The ecological value of dunes can also lie in their richness in endemism, both at the European level (Akeroyd & Heywood, 1994) and at the national or regional level (Lomba, Alves and Honrado, 2008). In addition to this value of dunes with vegetation in terms of biodiversity, they are also important in protecting against storms and extreme events (Figure 6), such as the 'Hercules' storm, which occurred in the Atlantic Ocean in 2014 winter, damaging the Portuguese mainland coast from North to South (Pinto, 2014) and other countries coastal areas (Santos, Mendes & Corte-Real, 2014).

Figure 6 - Erosion in Moledo beach dune after a storm in December 2019, showing both the geotextile (left side, placed after the 2014 storm) and the roots of the plants (right side), both exposed to the air after the existing sand was carried away by the sea.

In general, dunes are threatened by excessive trampling; vehicles; construction of roads and housing; sand extraction for construction; and coastal erosion. Regarding coastal erosion, it should be noted that worldwide, a substantial proportion of sandy beaches, which occupy more than a third of coastal areas, are prone to erosion, a situation that will worsen due to climate change (Vousdoukas *et al*., 2020). Several scientific studies have shown that coastal dunes with vegetation are 30% more resistant to erosion by marine storms (Feagin *et al.,* 2015; Sigren *et al.,* 2014; Ajedegba *et al.,* 2019b)(cit. Jackson *et al.,* 2019), so dune vegetation can help reduce shoreline retreat along coastlines. The trend of erosion and retreat of the national sandy coast was analyzed in the Coastal Working Group Report (Santos *et al.,* 2014), which will be refered in Part 2, in the brief characterization of each of the coastal zones visited in this project.

The chronology of the first field trips by school communities to coastal areas of mainland Portugal with white crowberry plants was, from North to South (Figure 7), the following: 1) Moledo Beach (Caminha), in September 2016; 2) Seixo Beach (Torres Vedras), in October 2019; 3) Moinho de Baixo Beach (Meco), in June 2017; 4) Monte Velho Beach (Sines), in May 2017 and 5) Cape St. Vincent (Sagres), in June 2024.

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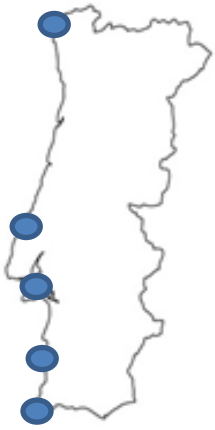


Figure 7 - Map of mainland Portugal with the five coastal zones visited in the Emc2 project (North -Caminha, Center - Torres Vedras and Meco, and Southwest and South - Sines and Sagres).

Thus, engaging young people in environmental education and raising awareness actions about the value of the natural and landscape heritage of dune habitats, and the need to act for their conservation, is of great current relevance.

After the field trip, students answer a questionnaire (Annex I), which main results are presented in Part 2.

1.2.2. BOTANY AND ART ACTIVITY

In the 'Botany and Art' activity, students draw, at classroom (or at the end of field trip), the landscape and/or the plants they have seen. This activity worksheet holds an image of a white crowberry plant herbarium specimen, which has been previously collected in the same coastal area that is visited during the Emc^2 project (Figure 8 and Annex II). This project follows in this activity a *'Place Based Education- PBE'* approach, which is a pedagogy with a potential to create a 'sense of place' in children (Orr, 2013).

Students are taught the value of specimens kept in herbaria, because the extirpation of white crowberry plants, or their disappearance locally, can be inferred by comparing herbaria records with their current occurrence or absence in nature. For instance, in Montedor, on the northern Portuguese mainland coast between Viana do Castelo and Caminha, where currently no white crowberry plants can be found at wild, there is an herbarium specimen record of a plant previously collected there. This is an example of extirpation, a process of plant local disappearance in nature, leading to their existence only in herbaria, and which we should publicize to prevent this process from occurring in future, in other coastal zones.

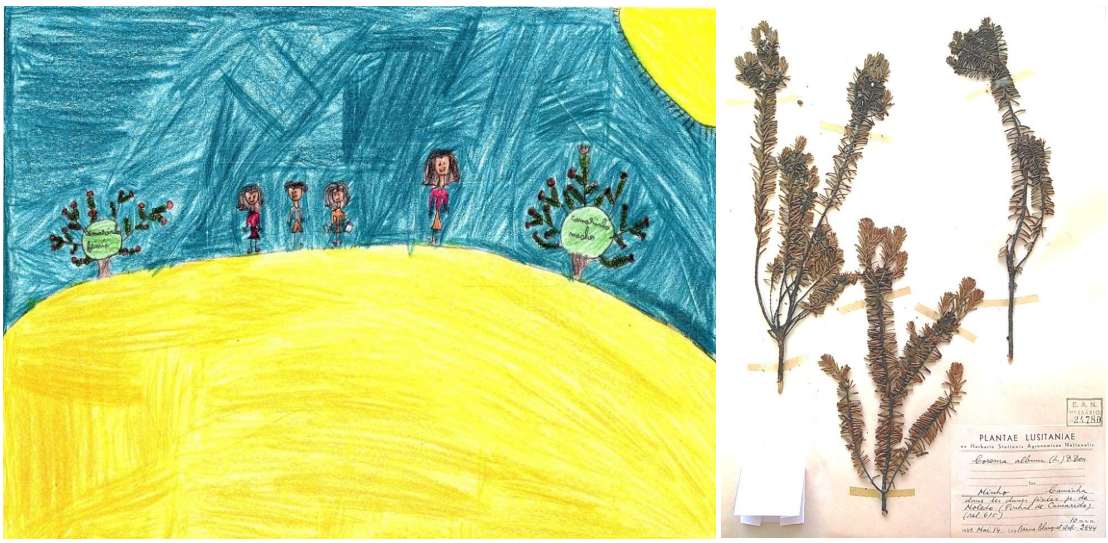


Figure 8 - Example of a student drawing (left) and a white crowberry herbarium specimen (right)

1.2.3. CONSERVATION ACTIVITY

«Restoring oceans and coasts means reducing the pressure on those ecosystems so they can recover, both naturally and by re-seeding or transplanting key species»

www.decadeonrestoration.org

Among the various coastal areas visited in the first phase of Emc^2 project - Moledo Beach, Moinho de Baixo Beach and Monte Velho Beach - only Moledo white crowberry population (which holds part of 'Foz do Minho' white crowberry population) was in decline. For this reason, within the scope of the Emc^2 project, it was decided to start its conservation through the propagation of stem cuttings, in collaboration with INIAV, I.P., Research Institute. A group of students from Caminha Schools who participate in this population conservation become their guardians and are working in collaboration with 'COREMA Association' (NGO) and local entities.

1.3. WHITE CROWBERRY - A 'NATIONAL TREASURY' AND DATA ABOUT ITS CONSERVATION STATUS

Students engaged in Emc2 project learn that white crowberry is part of Portuguese natural heritage and that in the 19th century it was even described by Andrada e Silva (1815) as a 'national treasure' as follows: «(…) *White crowberry lives and vegetates well in the maritime sandy areas (…) protects terrains from mobile sands incursion, (…), and additionally it gives a certain profit with its spontaneous fruits, it is a treasure for our Portugal*.» (Andrada & Silva,

1815). Although white crowberry is not widely known, it has been used as food by coastal populations, especially during World War II and is currently studied within the berry fruits research area (Oliveira & Dale, 2012; Oliveira *et al*., 2016; Oliveira, P. *et al.* 2020) and in gastronomy, food and health studies (Barroca & Moreira da Silva, 2021).

In terms of biodiversity, coastal areas contain endemic plant species, which are plants that exist there and nowhere else on Earth. As such, they represent a legacy of unique evolutionary histories, a natural genetic heritage for which, already in the 1980s, it was considered necessary to establish havens due to the threat of excessive human occupation of coastlines (Araújo, 1987). These endemic plants are threatened by one or more factors, such as: (1) climate change; (2) invasive species; and (3) habitat fragmentation. In fact, many of the natural and semi-natural habitats of coastal areas exist only as small fragments, in which biodiversity loss (IPBES, 2019) and ecosystem degradation have been increasingly pronounced. Figure 9 represents a map of the worldwide distribution of white crowberry - *Corema album* (L.) D. Don, with the subspecies *album* endemic to the Atlantic coast of the Iberian Peninsula and the subspecies *Corema album* subsp*. azoricum* Pinto da Silva, an Azorean endemic, present on most islands (absent on Santa Maria, Terceira, Flores and Corvo).

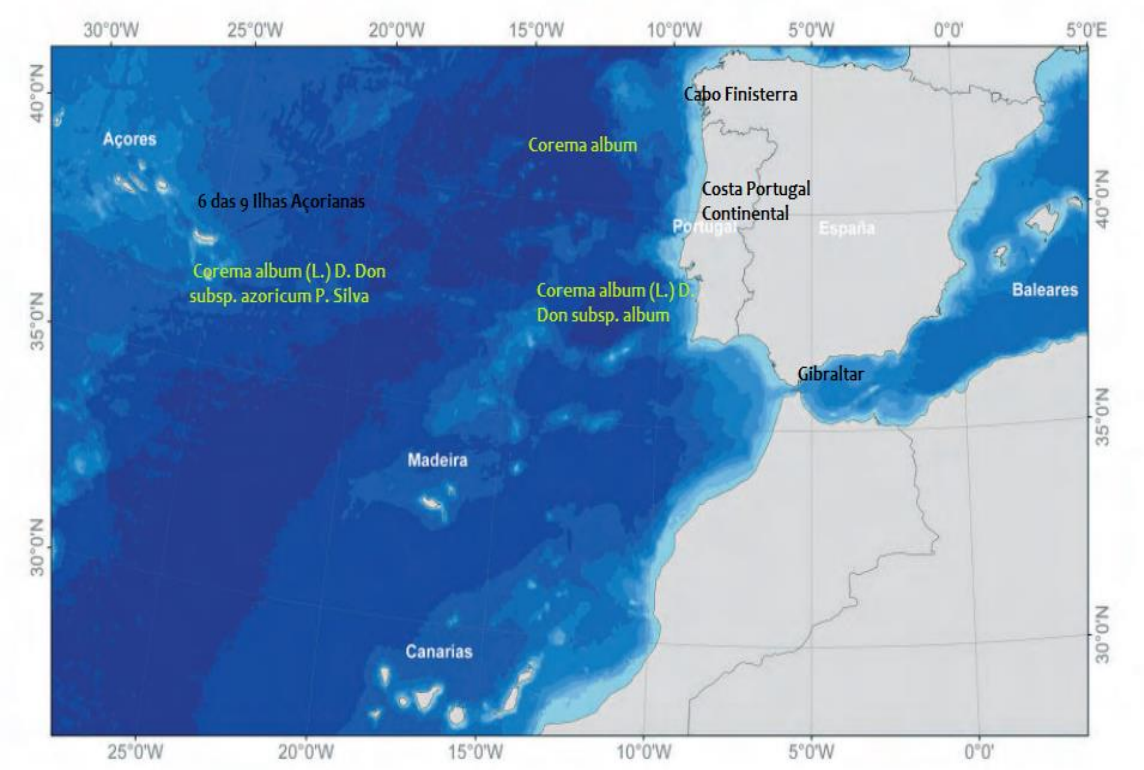


Figure 9 - Worldwide geographic distribution of *Corema album* (L.) D. Don and its two subspecies. Photo: Adapted from IPMA, 2011. (https://www.ipma.pt/export/sites/ipma/bin/docs/publicacoes/atlas.clima.ilhas.iberico.2011.pdf)

White crowberry plant - *Corema album* (L.) D. Don - is therefore an Iberian endemism, since worldwide it only occurs in Portugal and Spain, as described in the GBIF-Global Biodiversity Information Facility' platform at: www.gbif.org/species/8053367.

White crowberry plant - *Corema album* (L.) D. Don has the following taxonomic classification: Kingdom- *Plantae*; Phylum- *Tracheophyta*; Class- *Magnoliopsida*; Order- *Ericales*; Family- *Ericaceae*; Genus- *Corema*; Specific epithet- *album*; Scientific name- *Corema album* (L.) D. Don.

The generic name *Corema* derives from Greek word 'Korema' which means broom, an object that can be made from this plant dried branches, and the specific epithet '*album*' derives from Latin, meaning white, due to its fruits color.

In *Ericaceae* Family, the Genus *Corema* (L.) has only 2 species: (1) *Corema conradii* (Torr.) Torr. ex. Loudon - endemic in Atlantic coastal zones of USA (Maine, Massachusetts, New Jersey, New York) and Canada (New Brunswick, Nova Scotia, Prince Edward I., Québec); and (2) *Corema album* (L.) D. Don, *Corema album (L.) D. Don* – endemic in Iberian Peninsula Atlantic coast. In Azores – subspecies *C. album subsp. azoricum* Pinto da Silva (Figure 10).

Figure 10 - *Corema conradii* (Torr.) Torr. ex Loudon (left) with brown fruits (photo: www.repertoirequebecnature.com) and *Corema album* (L.) D. Don (right) with white fruits.

White crowberry – its conservation status and distribution in its habitat

White crowberry is a species from coastal habitats, especially dunes but also rocky sites, occurring in the **Azores** in lava and volcanic ash, being in this archipelago the *C. album* (L.) D. Don subsp. *azoricum* considered a priority species for conservation (DR, 2012: p1685). For **mainland Portugal**, the *C. album* (L.) subsp. *album* has not yet been evaluated for conservation purposes. However, in Camarido Forest Management Plan ('Mata Nacional do Camarido' - Caminha) it has been reported a regression in white crowberry population in this Forest (ICNF, 2010), based upon data from 1995 and 2007.

According to Gil-López (2011), in recent decades, due to various factors, **there has been a regression of white crowberry, with its disappearance in different areas of Iberian Peninsula western coast** (Fernández de la Cigoña, 1988; Sóñora, 1994; Díaz, 2000; Parra *et al*., 2000) (cit. Gil-López, 2011). In **Spain**, in the 1980s, it was considered a 'Vulnerable species' in the Red List of Vascular Flora (Barreno *et al*. 1984, cit. Sevillano, 2004). In the North of Spain, in Galicia, in 2004 it was considered to be in clear regression, occurring only in six localities (Sevillano, 2004) and in the South, it was considered a 'Vulnerable species' in the Red List of the Vascular Flora of Andalusia (Parra *et al*., 2000; Cabezudo *et al.,* 2005) (cit. Gil-López, 2011).

CONSERVATION OF WHITE CROWBERRY POPULATIONS AND DATA ABOUT THEIR HABITAT AT IBERIAN PENINSULA

The study entitled '*Fragmentation as the main cause of the reduction of the habitat of Corema album in its distribution area*' Clavijo *et al*., (2002: 119) reported that: «*The results show that there are only two zones with extensive populations of C. album presenting individuals of all age classes, one on the Portuguese coast between 'Nazaré' and 'Ovar', and the other on the coast of 'Huelva' (Spain) in the 'Asperillo' dune system (Donana Natural Park) and there is yet another well-preserved population in the dunes of 'Tróia'.*»

The dunes of Tróia, which, according to this 2002 study, held a well-preserved white crowberry population, belong to Tróia Peninsula which were described a decade before, in the Book '*Parks and Natural Reserves of Portugal*' as: «*one of the main dune structures of our coast, which bear, along with dozens of the most common plant species, as they occur throughout the Portuguese coast; some Portuguese, Iberian and European endemisms*» (Henriques, 1990).

According to Clavijo *et al.* (2002), «*the other populations are limited to sand areas on cliffs, such as the populations of 'Costa Vicentina' and 'Cabo Carvoeiro', or are reduced to fragments, especially the populations of the 'Foz Rio Minho', 'Monte Gordo', or those of 'Bolonia' in the province of Cadiz. (…) these fragmented populations of Corema album, reduced to sand islands without natural regeneration, are formed by old individuals, and their survival in the future depends on measures of protection and regeneration of habitats».*

In the map of figure 11, the white crowberry population of 'Caminha' was evaluated in Clavijo *et al.* (2002) study as a degraded population.

Figure 11 – Map of white crowberry populations with their conservation status in the research carried out by Clavijo *et al*., 2002 (Source: Clavijo *et al*., 2002)

Among the three coastal areas visited in Emc^2 project first phase - Moledo Beach, Moinho de Baixo Beach and Monte Velho Beach - only in Moledo the 'Foz do Minho' white crowberry population was in regression. For this reason, within the scope of the Emc^2 project, it was decided to start its conservation, through the propagation of stem cuttings, in collaboration with the Research Institute, INIAV, I.P. Several students from Caminha Schools have been participating in this population conservation initiative, in collaboration with the COREMA Association (NGO), local entities and INIAV, I.P.

Therefore, environmental education and awareness of the value of the natural and landscape heritage of dune habitats, and the need to act for their conservation, are currently relevant due to present and future challenges. And this is an educational challenge. A challenge that should engage young people, to whom we must give the opportunity to appreciate and feel nature, so that they become aware of the need to adjust the use(s) and occupation of the coastal area with nature conservation and landscape values.

2 | DEVELOPMENT

2.1.1. DUNE OF MOLEDO DO MINHO BEACH

Moledo do Minho beach (Figures 12 to 14) is in the municipality of Caminha, district of Viana do Castelo (GPS: 41° 51' 09'' N 8° 51' 59'' W) near to Minho River estuary in a border area between Galicia (North, in Spain) and Minho (South, in Portugal).

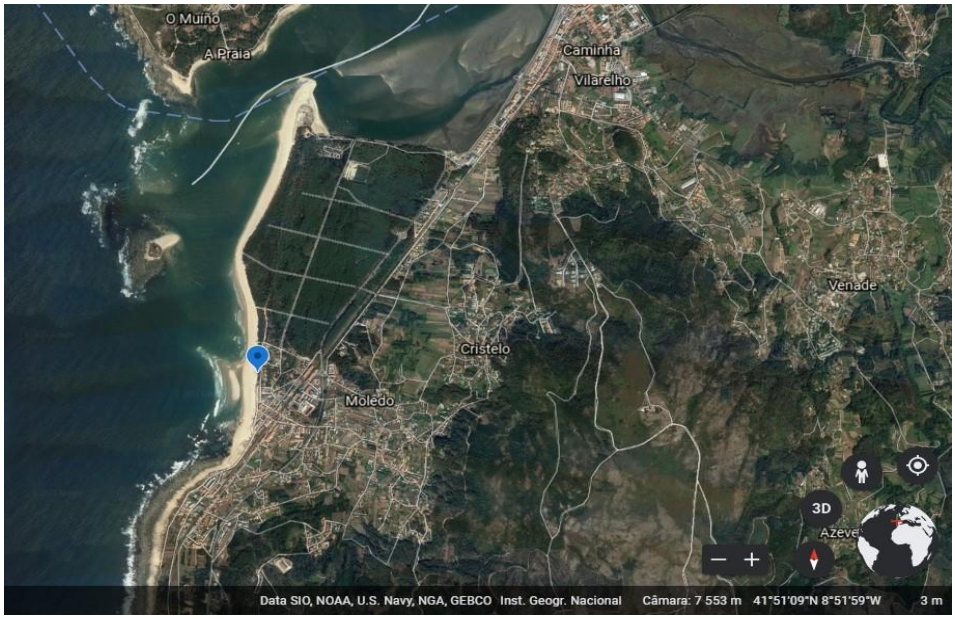


Figure 12- Aerial view of Moledo do Minho beach, Camarido National Forest, Minho River and Ínsua, with Galicia region in the Northern part of the river (Source: GoogleEarth, 2021)

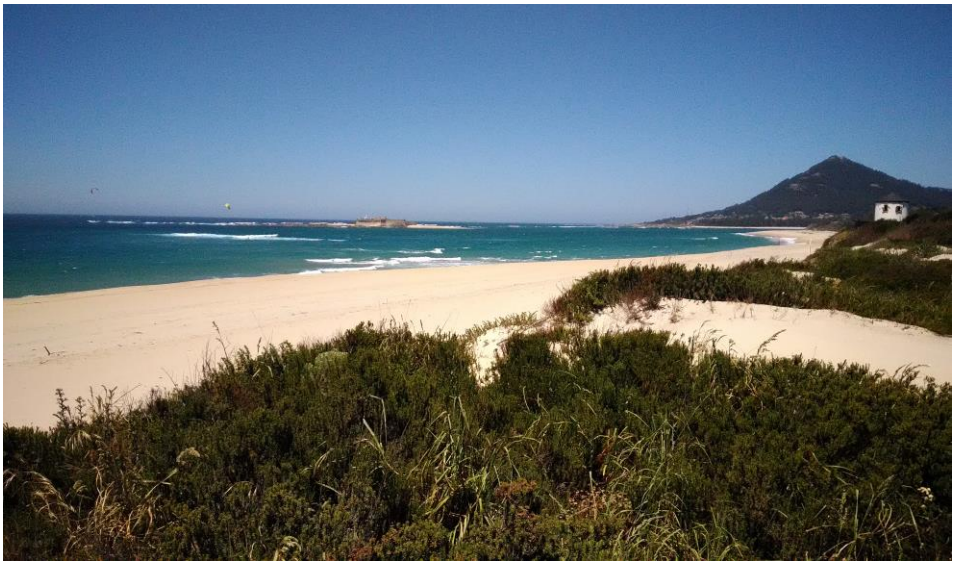


Figure 13 - Dune of Moledo do Minho with white crowberry plants where environmental education occurs.

Strong erosion events occur frequently at this beach (Figure 14) and in the Report of the Coastal Working Group (Santos *et al.*, 2014) this zone is included in the *'Littoral between Minho*

and Douro' - sedimentary cell 1a being cited as «a low rocky coast with sand and pebble beaches, (…) finds itself sometimes covered by dunes. (…) a particularly pronounced erosion trend and widespread retreat of sandy beaches».

This Report highlights for sedimentary cell 1a that «*the observed coastal erosion translates into a set of critical risk situations, identified in the Hydrographic Region Management Plans covering this coastal section* (APA 2012 a, b), *namely: 'Ponta do Camarido' and connection to Ínsua (...)*» (Santos *et al*., 2014).

Figure 14 - Aspect of Moledo do Minho beach area in August 2009 (left), before the 2014 'Hercules' storm, with a stone wall and wooden walkway (overthrown meanwhile) and the Mill surrounded by vegetation. The same place in December 2019 (right) after a storm which was partially exposed a geotextile tube previously installed there.

2.1.2. FIELD TRIP ACTIVITY - PHOTOGRAPHS AND STUDENT ANSWERS TO QUESTIONNAIRE

Figure 15 – Students from Caminha EB1 and EB2/3 Schools during field trips to Moledo beach dune.

Questionnaire Answers – 3rd grade Caminha School Students first field trip

Question 1 | Describe what pleased you most in this field trip

« To see with a magnifying glass the plants» (male student)

«To see with a magnifying glass the white crowberry and hottentog fig» (male student)

«To learn more about nature and plants» (female student)

«I enjoyed gathering white crowberry fruits and walking around the dune» (female student)

« It was the white crowberry fruit» (male student)

Questionnaire Answers– First field trip - 3rd grade students from EB1 Caminha School (T=14)

Question 2 | Would you like to pursue a career related with nature?

Yes- 11; No- 3

Question 3 | Did you already know the 'white crowberries' (PT 'camarinhas')?

Yes - 12; No - 2

Question 4 | Did you already know the plant we call 'hottentot fig' (PT 'chorão')?

Yes -12; No- 2

Question 5 | How do you evaluate the field trip

Very good- 10; Good- 4

Questionnaire Answers – 5th grade Caminha School Students first field trip

Question 1 | Describe what pleased you most in this field trip

«To have learned more about invasive plants and white crowberry plants» (male student)

«To know the white crowberry fruit which tastes like lemon» (female student) (male student)

«I enjoyed the smell of the sea and the wind» (male student)

«The sea smell and the fresh air» (male student)

«Go to the beach and learn new things» (female student)

Questionnaire Answers- First field trip – 5th grade Students from Caminha School (T=14)

Question 2 | Would you like to pursue a career related with nature?

Yes- 7; No- 6; NR- 1

Question 3 | Did you already know the 'white crowberries' (PT 'camarinhas')?

Yes- 2; No - 12

Question 4 | Did you already know the plant we call 'hottentot fig' (PT 'chorão')?

Yes- 6; No- 8

Question 5 | How do you evaluate the visit

Very Good- 9; Good- 5

2.1.3. BOTANY AND ART ACTIVITY

Figure 16 – Drawings of students from EB1 and EB2/3 Caminha Schools about white crowberry.

Figure 17- Poster of the Drawings Exhibition of Students from EB1 and EB2/3 Caminha Schools.

2.1.4. THE PROJECT FROM EDUCATORS' PERSPECTIVE: ANSWERS TO QUESTIONNAIRE

SUCCINCTLY DESCRIBE TO WHAT EXTENT THIS FIELD TRIP CONTRIBUTES TO THE TEACHING OF SCIENCE AND BOTANY TO STUDENTS.

Teacher Mª. Albina Passos – 3rd Grade, Caminha School

«This activity contributed to the teaching of science and botany as students are in contact with nature, namely with plants, developing their observational skills and their interest in experimentation and species preservation.» (26.09.2016)

Teacher Isilda Cunha – 5th Grade, Caminha School

«It was a very enriching field trip as it aroused students' interest in natural spaces, improved their ability to observe and communicate the observations made. It sparked interest in concepts of native and invasive species and the functions of dune flora in coastal habitats.»
(26.09.2016)

2.1.5. CONSERVATION ACTIVITY OF 'FOZ DO MINHO' WHITE CROWBERRY POPULATION

With collaboration of researchers from INIAV, I.P., white crowberry propagation was started in 2017, in greenhouses at Oeiras, through the rooting of stem cuttings – i.e. pieces of stem with leaves collected from dune plants. The propagation methodology was published in the Journal *Vida Rural* (Lima *et al*., 2020). The first succeeded rooted stem cuttings were reintroduced in Moledo, in November 2018, with collaboration of COREMA Association, the Union of Parishes of Moledo and Cristelo and the collaboration of students from Caminha Schools, who assess the growth and development of the white crowberry plants and are their guardians (Figure 18). In August 2000, one of the reintroduced female plants held its first fruits.

In May 2019, six months after the reintroduction of the first white crowberry plants, students evaluated their development, and their testimonials are described in the paragraphs of item 2.1.5.1.

Figure 18 - White crowberry Foz do Minho population conservation phases: (a) stem cuttings in the INIAV greenhouse (Oeiras); (b) rooted stem cuttings; (c) plant reintroduced into the wild; (d) measurements of plant growth carried out by Caminha Schools students.

In July 2021, a set of fourteen white crowberry plants were reintroduced in an initiative with the participation of students and teachers from EB 2/3 Caminha School, the collaboration of COREMA and the support of the U.F. of Moledo and Cristelo. By then, it was verified that in several previously reintroduced white crowberry female plants, some fruits have been formed.

This initiative has been published in the PANORAMA Global Platform since 24th November 2021, which promotes and shares examples of replicable and inspiring solutions across a diverse range of development and conservation topics, enabling collective learning from the cases presented. The activity is available in 'Snapshot Solution' format on the Species Conservation Portal (IUCN, EcoHealth Alliance) and the Marine and Coastal Portal (Blue Solutions), accessible at https://panorama.solutions/en/solution/project-emc2-exploring-white-crowberry-coastal-habitats

2.1.5.1. CAMINHA STUDENTS' WORKS ABOUT WHITE CROWBERRY CONSERVATION ACTIVITY

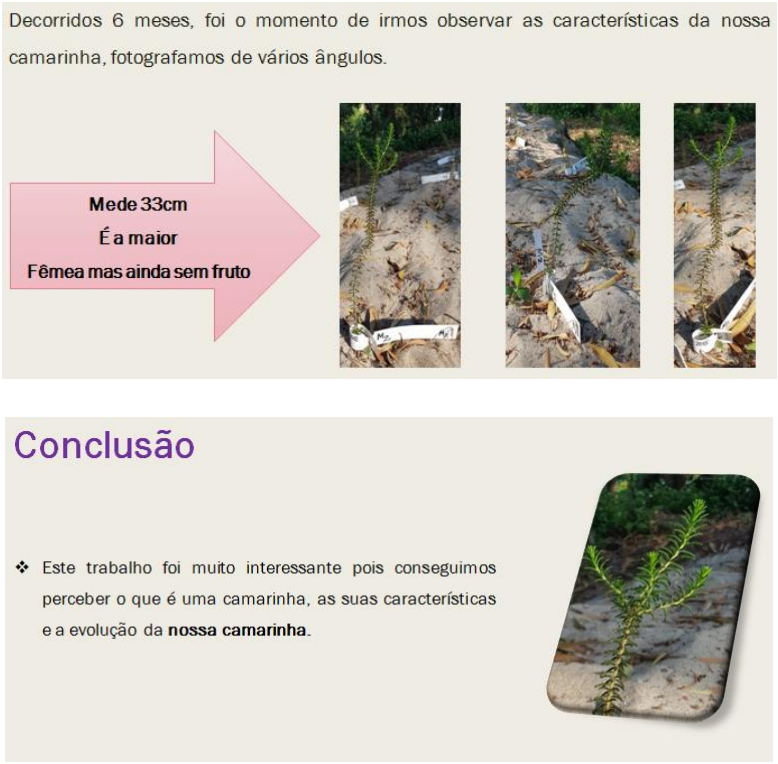


Figure 19 – Record of a work by a group of students from Caminha School about the reintroduction of white crowberry plants in 'Mata do Camarido'.

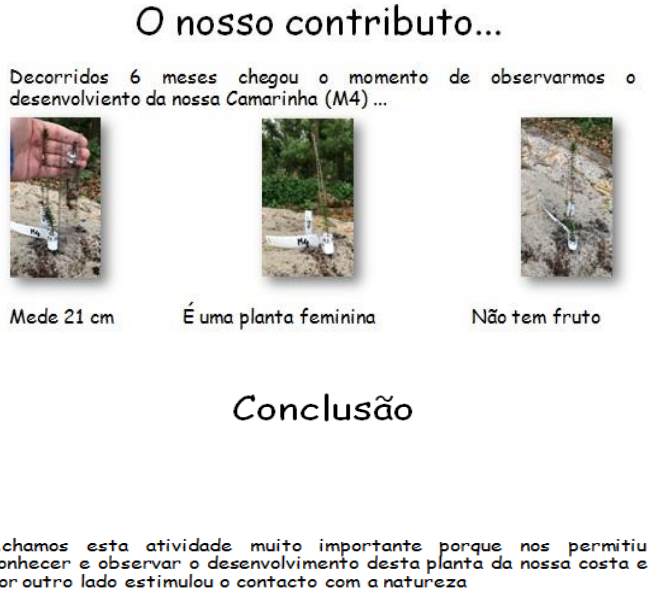
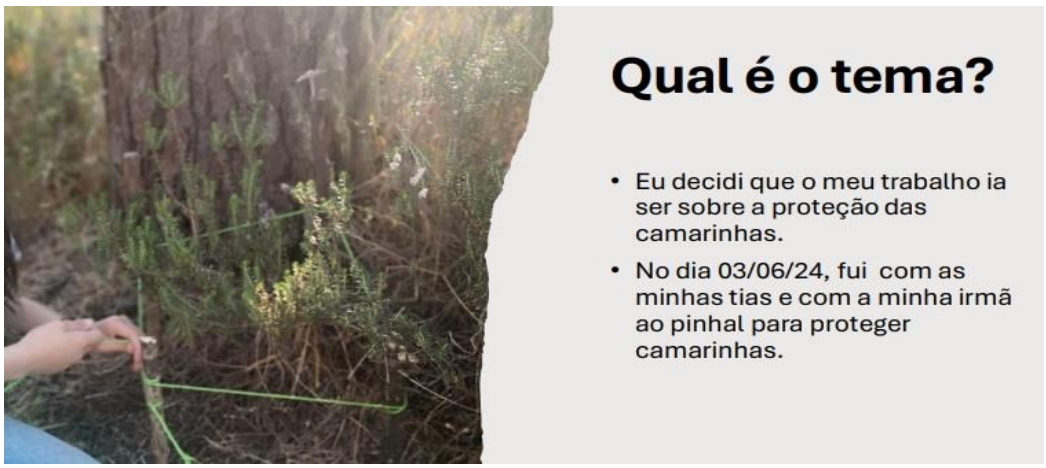


Figure 20 – Record of a work by a group of students from Caminha School about the reintroduction of white crowberry plants in 'Mata do Camarido'.

Figure 21– Record of a work by a group of students from Caminha School about the reintroduction of white crowberry plants in 'Mata do Camarido'.

Later, in June 2024, in a free-topic project, a student from the Caminha School decided to start an action about white crowberry plant conservation at 'Mata do Camarido' Forest, for which she invited her family members, and shared this action results in a presentation at school, partially documented in the following images (Figure 22).



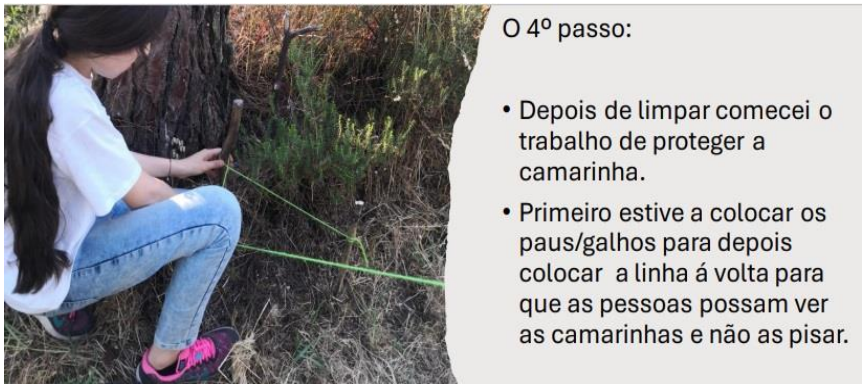


Figure 22 – Record of an initiative developed by a student about white crowberry conservation in Mata do Camarido (2024)

2.1.5.2. TESTIMONIALS OF PROJECT PARTNERS

Teachers Ana Pinto and Helena Gama

Coordinators of the Eco-Schools Program of the Sidónio Pais Group of Schools, Caminha

"Within the scope of the Eco-Schools Program of the Sidónio Pais Group of Schools (Caminha) student groups from some 8th, 9th, 10th and 11th grades of two schools, from 'Vila Praia de Âncora' and 'Caminha', participated, with great curiosity and enthusiasm, in the activities developed since 2017 in the Emc^2 Project.

Related with the themes 'Forest and Sea and Biodiversity' of Eco-schools, the census of the white crowberry plants in Mata do Camarido was started; along with the identification of invasive plants and their removal; and the planting and monitoring of white crowberry plants in 'Mata do Camarido', in Moledo (Caminha). These concrete actions developed by students are an important input to environmental education, encouraging the exercise of an active and responsible citizenship." (january 2021).

José Gualdino Correia, President of COREMA Association

Joaquim Guardão, Presidente of Union of Parishes of Moledo & Cristelo

"The white crowberry plant is a symbol of the 'Camarido National Forest' and the contiguous dune area of Moledo Beach. This endemic species has even given its name to this Atlantic pine forest. The ecological struggles emerged in Caminha precisely when it was necessary to defend the Camarido National Forest against its alienation and urbanization, in the late 70s of 20th century. The COREMA Association, by adopting the scientific name of the white crowberry plant, was, from the beginning, linked to its existence. The verification of the accelerated regression of this botanical species, existing only in the Iberian Peninsula, requires us to mobilize all existing resources to prevent its complete disappearance from Moledo dune area and Camarido National Forest. They constitute, as they are known in Spain, authentic "*perlas de las dunas*" ('dune pearls'), a natural and biogenetic heritage that we do not want to disappear.

Therefore, we started a series of actions in partnership with INIAV and MARE, with the support of the Union of Parishes (U.F.) of Moledo & Cristelo and the Caminha City Council, the

engagement of the educational community of Caminha and its student population. These actions aimed, firstly, to restore Moledo dune, and to recover the white crowberry plants, whose existence, in recent years, has declined. We do not want this botanical heritage to exist only in the memory of some of us, but we want it to be enjoyed by future generations. The U.F. of Moledo & Cristelo, as well as Caminha City Council, embraced this conjoint project from the beginning, which has been able to raise awareness among students about the importance of white crowberry conservation, as an endemic plant of our coastal area. Therefore, we deem it necessary and very urgent to gradually remove proliferating invasive plants at Moledo dune, and gradually replace them with small white crowberry and other autochthonous plants already present in the nursery, ready to be replanted; as well to create infrastructures in wood and other natural materials (e.g. elevated walkways and placement of informational signs) in order to minimize trampling and help protect these plants sustained growth, which will most certainly help sustain the sands which are dragged by the prevailing winds in this Atlantic coastal area, contributing to dune growth and consolidation." (22 February 2021).

2.2.1. DUNE IN CLIFF BETWEEN SEIXO BEACH AND MEXILHOEIRA BEACH

The dune in cliff between Seixo Beach and Mexilhoeira Beach (Figures 23 and 24) is located on the municipality of Torres Vedras (GPS: 39° 08' 56'' N, 9° 22' 20'' W), district of Lisbon.

Figure 23 - Aerial view of dune area on the cliff between Seixo Beach and Mexilhoeira Beach with white crowberry plants, where environmental education took place (Source: GoogleEarth, 2021)

Figure 24- Aspect of the dune area on the cliff between Seixo Beach and Mexilhoeira Beach with white crowberry plants, where field trip took place.

In the Report of the Coastal Working Group (Santos *et al.,* 2014: p24) this zone is included in Sedimentary Cell 3, described as the coastal sector between 'Peniche' and 'Cabo Raso' that develops "*generally on cliffs, with a general orientation N-S, and accommodates numerous embedded, sandy beaches, although with very different geometry*».

2.2.2. FIELD TRIP ACTIVITY - PHOTOGRAPHS AND STUDENT ANSWERS TO QUESTIONNAIRE

Figure 25- Photographs of a field trip to the dune on the cliff between Seixo Beach and Mexilhoeira Beach

Questionnaire Answers- 3rd grade Students from Póvoa Penafirme School (Torres Vedras)

Question 1 | Describe what pleased you most in this visit

« To know the white crowberry and taste its fruits» (male student)

« To feel the acid taste of the white crowberry fruits» (male student)

«I particularly enjoyed seeing the white crowberry and tasting their fruits and I liked seeing them with a magnifying glass» (female student)

«To taste the white crowberry fruits and see these plants.» (male student)

«It was learning how the white crowberry plants reproduce. The rabbits eat the white crowberry fruits and the rabbit excrements help the germination of white crowberry seeds." (male student)

Questionnaire Answers- 3rd grade Students from Póvoa Penafirme School (Torres Vedras) (T=19)

Question 2 | Would you like to pursue a career related with nature?

Yes-13; No- 5; NR- 1

Question 3 | Did you know the 'white crowberries' (PT 'camarinhas')?

Yes- 1; No- 16; NR- 3

Question 4 | Did you know the plant we call 'hottentot fig' (PT 'chorão')?

Yes- 17; NR- 2

Question 5 | How do you evaluate the visit

Very good- 16; Good- 1; NR- 2

Questionnaire Answers- 5th grade Students from Póvoa Penafirme Externato (Torres Vedras)

Question 1 | Describe what pleased you most in this visit

«To gather white crowberry fruits and taste their flavor.» (female student)

«To know the white crowberry plants» (female student)

«To discover male and female white crowberry plants.» (male student)

Questionnaire Answers- 5th grade Students from Póvoa Penafirme Externato (Torres Vedras) (T=17)

Question 2 | Would you like to pursue a career related with nature?

Yes- 12; No- 4; NR- 1

Question 3 | Did you know the 'white crowberries' (PT 'camarinhas')?

Yes- 4; No - 13

Question 4 | Did you know the plant we call 'hottentot fig' (PT 'chorão')?

Yes- 12; No- 5

Question 5 | How do you evaluate the visit

Very good- 14; Good- 3

2.2.3. BOTANY AND ART ACTIVITY

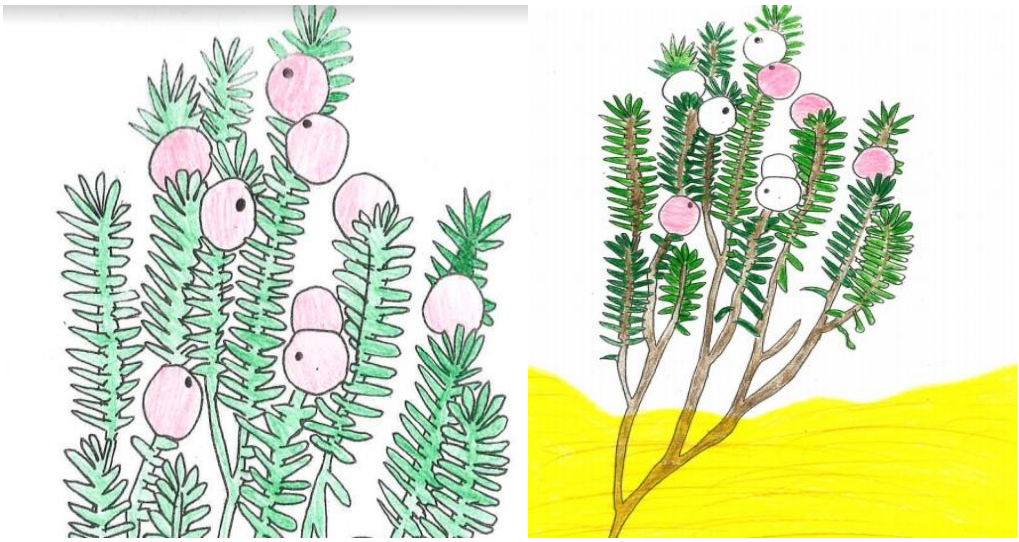


Figure 26- Drawings of students from Póvoa de Penafirme Primary School and the Póvoa de Penafirme College School

2.2.4. THE PROJECT FROM EDUCATORS' PERSPECTIVE: ANSWERS TO QUESTIONNAIRE

Teacher Ana Soares, 3rd Grade School Póvoa de Penafirme (Torres Vedras)

«A field trip, as a pedagogical activity, detaches itself from the old educational paradigms. This one, assumed itself to be relevant for teaching science and botany as it has gone beyond a standardized class in which definitions, observations and contents only happen in the classroom, between four walls. The teaching of science calls for much more than that, and close contact with Nature is urgent and necessary for learning to be truly meaningful.»

Teacher Alda Santos, 5th Grade Externato de Póvoa de Penafirme (Torres Vedras)

«This field trip is very positive for teaching various curricular subjects. Direct contact with plants is very motivating for sparking knowledge»

2.2.5. TESTIMONIALS OF PROJECT PARTNERS

Vasco Batista e Rita Ramos

C.M. Environmental Education Center of Torres Vedras

Emc^2 Project on Camarinha in the municipality of Torres Vedras

The Municipality of Torres Vedras, through the Environmental Education Center, develops various awareness and education activities, and its main purpose is to promote knowledge of the biodiversity existing in the municipality's territory. It is considered that only by knowing the values and biodiversity can its conservation be promoted.

The first records of *Corema album* on the Torres Vedras coast report almost two centuries ago and, like other species whose habitats are more exposed to human action, white crowberry has been reducing its location/expansion area. The Emc^2 Project about white crowberry is extremely important, not only for its conservation role, but also because it encourages the study and dissemination of an endemic species, which has even a high economic potential. In the practice of Environmental Education, it is important that participants identify themselves with the problem and theme that they study, and this project is a practical example of that. Engagement of school students which are geographically near to this species distribution areas allows establishing a proximity connection and an active role in its dissemination and conservation.

2.3.1. MOÍNHO DE BAIXO BEACH DUNE

Moinho de Baixo beach is in municipality of Sesimbra (GPS: 38° 29’ 20’’ N; 9° 09’ 29’’ W), district of Setúbal (Figures 27 and 28).

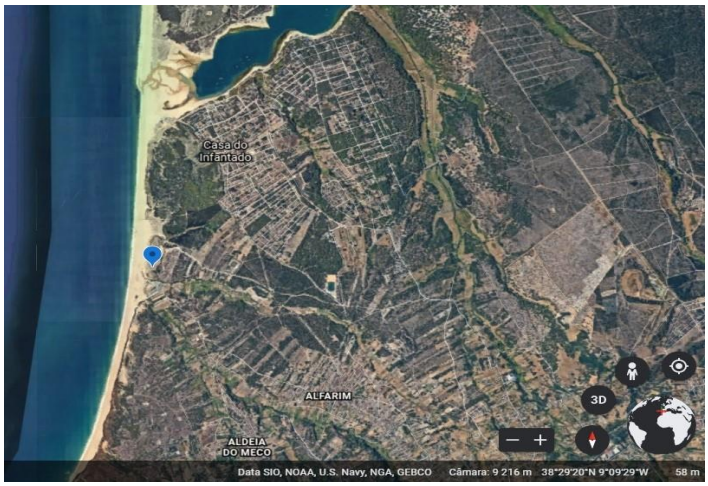


Figure 27- Aerial view of the Moinho de Baixo beach dune area, where environmental education took place (Source: GoogleEarth, 2021)

The Moinho de Baixo beach dune is included in sedimentary cell 4 of the Report of the Coastal Working Group (Santos *et al.,* 2014) which includes the littoral between 'Cabo Raso' and 'Cabo Espichel', which is divided into two sections, separated by the Tagus river estuary, and described in the above mentioned Report: «*south of the Tagus, the coast adopts an arched configuration, (...) forming a sandy and continuous coast from 'Costa da Caparica' to 'Praia das Bicas'*». This dune is located north to the 'Praia das Bicas' and is included in the sandy coast of cell 4, in its sub-cell 4c (from 'Costa da Caparica' to 'Cabo Espichel') which shows cliff erosion (Taborda and Andrade, 2014, cit. Santos *et al.,* 2014).

Figure 28- Aspect of Moínho de Baixo beach dune

2.3.2. FIELD TRIP ACTIVITY - PHOTOGRAPHS AND STUDENT ANSWERS TO QUESTIONNAIRE

Figure 29- Photographs of field trips of Conde de Oeiras School students to Moínho de Baixo beach dune.

Questionnaire Answers – 5th grade Students from Conde de Oeiras School (2016/17)

Question 1 | Describe what pleased you most in this visit

«To collect plant parts and explore all that bush.» (male student)

«To know new plants and to taste the white crowberry fruits.» (female student)

«To have freedom to explore the dunes.» (female student)

«The landscape and the variety of plants.» (female student)

«To collected unknown plants to a mini-herbarium.» (female student)

«Being connected to nature.» (female student)

«It was gathering plants we didn't know at all.» (male student)

Questionnaire Answers – 1st visit 5th Grade Conde de Oeiras School (T=28) (2016/17)

Question 2 | Would you like to pursue a career related with nature?

Yes- 22; No- 5; Maybe- 1

Question 3 | Did you know the 'white crowberries' (PT 'camarinhas')?

Yes- 10; No- 18

Question 4 | Did you know the plant we call 'hottentot fig'?

Yes- 15; No- 13

Question 5 | How do you evaluate the visit

Very Good- 24; Good- 4

Questionnaire Answers – 2nd visit 5th Grade Conde de Oeiras School (T=22) (2018/19)

Question 2 | Would you like to pursue a career related with nature?

Yes- 11; No- 10; NR- 1

Question 3 | Did you know the 'white crowberries' (PT 'camarinhas')?

Yes- 1; No - 21

Question 4 | Did you know the plant we call 'hottentot fig'?

Yes- 13; No- 9

Question 5 | How do you evaluate the visit

Very Good- 14; Good- 8

2.3.3. BOTANY AND ART ACTIVITY

Figure 30- Drawings of 5th Grade students from Conde de Oeiras School about white crowberry.

Figure 31- Poster of the Exhibition of Drawings made by Students from Conde de Oeiras School in Oeiras.

2.3.4. THE PROJECT FROM EDUCATORS' PERSPECTIVE: ANSWERS TO QUESTIONNAIRE

SUCCINCTLY DESCRIBE TO WHAT EXTENT THIS VISIT CONTRIBUTES TO THE TEACHING OF SCIENCES AND BOTANY TO STUDENTS.

Teacher Natércia Barbosa - 5th Grade Conde de Oeiras School

«*Field trips are very interesting activities for students and are also important for them to realize that in Science they can work in a diversified way. The field trip is part of the 5th Grade Program: Preservation of Plant Biodiversity; Distinguish native species from invasive species; Develop skills such as observation and communication; Awaken the taste and curiosity for Science*.» (2.06.2017)

SUGGESTIONS AND COMMENT

Teacher Natércia Barbosa - 5th Grade Conde de Oeiras School

«The fact that the class had 29 students is always a less favorable aspect of a field trip. However, the visit was well organized, and students showed interest and were engaged in the activities; 2) In my opinion this kind of partnership should be continued.»

2.3.5. TESTIMONIALS OF PROJECT PARTNERS

Sónia Costa Afonso, Oeiras Youth Center, Municipality of Oeiras

«Following a request for collaboration of the Municipality of Oeiras for this project, it was possible for me to participate as a technician in the Oeiras Youth Unit. Transport was provided to a class of 5th grade students and their Teachers, between Conde de Oeiras School and the Field trip area, in the Dune do Moínho de Baixo Beach (Meco). This initiative aimed at learning outdoors… stimulating and further intensifying students' knowledge through their senses, exploring their knowledge on a large scale and matching different fields of study, such as science, drawing, among others. The project promoted by MARE-NOVA in collaboration with INIAV and in partnership with various entities, not only allowed the students to become aware of something new (a living being, a specific species, a rare plant), but also allowed them to harvest, measure, distinguish (male from female) and observe the plant, as well as to photograph, note, smell and even taste the famous “berries”. The white crowberry fruits have something that distinguishes them from the other “berries”, as they look like “wild mini-grapes from the beach”, which are typical of dune areas and have a slight acidic taste of lemon. The white crowberry fruits, white and sometimes pink, aroused the curiosity of everyone present, from students, teachers and me. After this sunny day, which also contributed to a better observation of the species of white crowberry at dunes, there was a collection of testimonials and drawings, which were an integral part of the exhibition that was on display on the 1st Floor of the Youth Center of Oeiras, in Nova Oeiras. This Center made it possible to share the work of these students in the form of a collective exhibition and the research work carried out by the researcher M. Alexandra Abreu Lima, to raise population awareness about this unique research work. On

exhibition inauguration, along with the works of the 5th Grade (both drawings and herbarium sheets), it was still possible to taste a cake made with the white crowberry "berries" that had been collected by them and that was a delight for everyone. The collaboration of the Municipality contributed to the enrichment of the knowledge of these students, who were able to experience a different and unique class. These contributions are extremely important for the academic growth of our young people… "the men and women of tomorrow", in the mission of nature conservation, thus stimulating a better and greater coastal ecosystems sustainability.»

2.4.1. DUNE OF MONTE VELHO BEACH

Monte Velho Beach (GPS: 38° 05' 48'' N; 8° 51' 47'' W), is in the municipality of Santiago do Cacém, district of Setúbal (Figure 32 and 33).

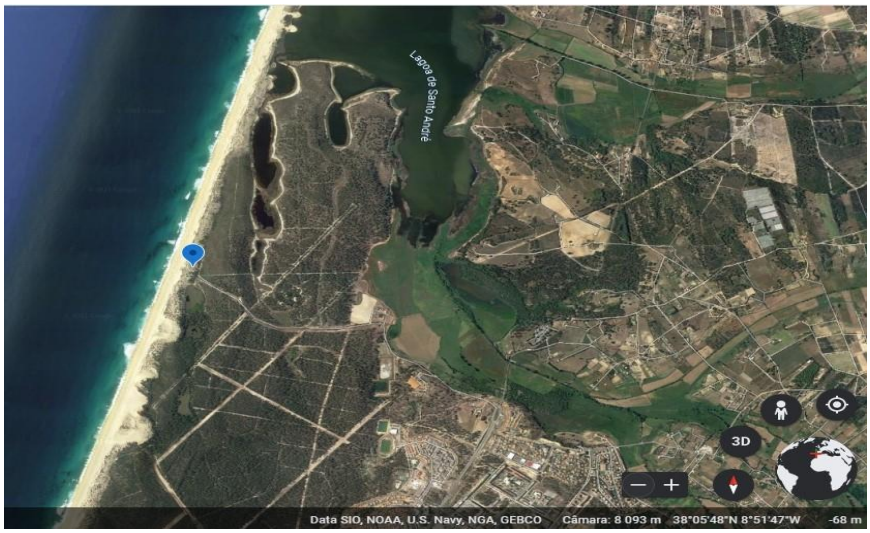


Figure 32- Aerial view of the dune area of Monte Velho Beach, with white crowberry plants, where the field trip took place (Source: GoogleEarth, 2021)

In the Coastal Working Group Report (Santos *et al.,* 2014) this zone is included in Sedimentary Cell 5, and it is stated that «*The coast between the mouth of the Sado river (Troia) and Sines corresponds to a sandy coastline, continuous, with an arc configuration*». This cell is subdivided into 3 sub-cells, with Monte Velho Beach in sub-cell 5c, 'Tróia – Sines' coastal arc.

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Figure 33- Aspect of the Monte Velho beach dune

2.4.2. FIELD TRIP ACTIVITY - PHOTOGRAPHS AND STUDENT ANSWERS TO QUESTIONNAIRE

Figure 34- Photographs of students from Sines School field trip to Monte Velho Beach dune.

Questionnaire Answers - 4th Grade Students of Sines School (2016/17)

Question 1 | Describe what pleased you most in this visit

«To see the cottonweed plants at beach.» (male student)

«What pleased me the most about this field trip was to know new things.» (male student)

«What pleased me most was seeing the white crowberry.» (female student)

«The plants I observed.» (female student)

«To know several plants from beach ecosystem.» (female student)

«To learn new things.» (female student)

Questionnaire Answers - 4th Grade Students of Sines School (T=19) (2016/17)

Question 2 | Would you like to pursue a career related with nature?

Yes- 15; No-4

Question 3 | Did you know the 'white crowberries' (PT 'camarinhas')?

Yes-3; No - 16

Question 4 | Did you know the plant we call 'hottentot fig'?

Yes-19; No- 0

Question 5 | How do you evaluate the visit

Very Good- 16; Good- 3

2.4.3. BOTANY AND ART ACTIVITY

Figure 35- Drawings of 4th Grade students from Sines School about white crowberry.

Figure 36 - Poster of the Exhibition of Drawings from Sines School Students held in Sines

2.4.4. THE PROJECT FROM EDUCATORS' PERSPECTIVE: ANSWERS TO QUESTIONNAIRE

SUCCINCTLY DESCRIBE TO WHAT EXTENT THIS VISIT CONTRIBUTES TO THE TEACHING OF SCIENCES AND BOTANY TO STUDENTS.

Teacher Rosinda Lino, 4th grade Sines School

«It was field trip in which students learned to know new plants species, technical terms and it was an awakening for the realization of a herbarium». (25.05.2017)

2.4.5. TESTIMONIALS OF PROJECT PARTNERS

Flora Ferreira (Environment, Nature Conservation and Health Service of the Municipality of Sines)

«This Project brought us more knowledge about the white crowberry plant (Corema album (L.) D. Don), once abundant in the region and in extinction today, providing us with tools to keep working about this theme, within the scope of the Municipal Environmental Education Program, fostering exchange of knowledge about this species, its properties and uses and, consequently, about the importance of its conservation.»

Liliana Rodrigues
Technician of Educational and Cultural Service
Sines Arts Center SAC/ Municipality of Sines

«*This collaboration proposal was an excellent contribution and an example of a fruitful partnership, as the Sines Arts Center Educational and Cultural Service team was engaged to continue the Sea&Art (Mar&Art) project, aimed at Pre-School and 1st Cycle students of the Sines Schools Group. This project aimed to foster and raise awareness of the natural, material, immaterial, cultural and human heritage of the Alentejo coast, closely linked to the sea. It was intended to show the reality and characteristics of the sea, the fishing work, the fauna and flora, but also to promote various artistic interpretations and creations.*

Since all field trips included a moment of exploration in addition to practical and artistic expression (based on drawing and photography), besides allowing an exceptional and much more significant session/adventure/field class, it provided creative and colorful records. These were subsequently exhibited to the Sines Community and visitors, through the exhibition on display at the Sines Arts Center, during summer season. This allowed the presentation of the project, the experience provided, the artistic productions and, most relevant of all, raise awareness about "our white crowberry plants" and the need for their conservation. On behalf of the SAC Educational and Cultural Service team, I express our sincere thanks and best wishes for the continuation of this praiseworthy and essential work of investigation and conservation, about this 'wealth that is so much ours'.»

Carla Correia

Institute for the Conservation of Nature and Forests, I.P./

Alentejo Regional Directorate for Nature and Forest Conservation

The invitation addressed to ICNF, I.P./Regional Directorate for Nature Conservation and Forests of Alentejo, to participate in the collaborative project of environmental education about white crowberry coastal habitats, was immediately seen as an undeniable challenge.

The project managed to engage students, teachers and other educators, with a common purpose, to promote knowledge and value the richness and vulnerability of the existing coastal habitats biodiversity. We congratulate project coordination on the field activities developed in the Natural Reserve of 'Santo André and Sancha Lagoons' and express our full availability to collaborate in other future similar initiatives.

We wish to thank all those who directly or indirectly contributed to the success of the Emc^2 Project and, namely Dr. Maria Alexandra Abreu Lima, for her work of enthusiasm for the project.

2.5.1. DUNE IN CLIFF BETWEEN SAGRES AND CAPE ST. VINCENT

Figure 37 – Aspect of dune in cliff near Forte do Beliche, between Sagres and Cape St. Vincent

The dune in cliff near between Sagres and Cape St. Vincent (Figure 37) is included in sedimentary cell 7 of the Coastal Working Group Report (Santos et al., 2014) and belongs to the "coastal area of the Algarve's western coast, between Cape St. Vincent and Olhos de Água, which

presents an extremely varied morphology, where segments of cliffs carved into carbonate rocks (Mesozoic and Cenozoic) alternate with beaches contained between resistant promontories or dependent on the mouths of watercourses."

2.5.2. FIELD TRIP ACTIVITY - PHOTOGRAPHS AND STUDENT ANSWERS TO QUESTIONNAIRE

Figure 38- Photographs of field trips to dune in cliff between Sagres and Cape St. Vincent.

Questionnaire Answers – 1st Cycle Vila do Bispo Schools Group (2023/24)

Question 1 | Describe what pleased you most in this visit

«I enjoyed be in nature» (male student)

«To find the White crowberry plant» (female student)

«To see the White crowberry plants I didn't knew» (male student)

«To observe differences between plants of Natural Park » (male student)

«To go searching the White crowberry plant and find other plants» (male student)

Questionnaire Answers – 1st Cycle Vila do Bispo Schools Group (2023/24) (T=44)

Question 2 | Would you like to pursue a career related with nature?

Yes- 30; No- 13; NR- 1

Question 3 | Did you know the 'white crowberries' (PT 'camarinhas')?

Yes-5; No - 39

Question 4 | Did you know the plant we call 'hottentot fig'?

Yes-29; No- 15

Question 5 | How do you evaluate the visit

Very Good- 37; Good- 7

2.5.3. BOTANY AND ART ACTIVITY

Figure 39- Drawings about the White crowberry plants from students of Vila do Bispo Schools Group

2.5.4. THE PROJECT FROM EDUCATORS' PERSPECTIVE: ANSWERS TO QUESTIONNAIRE

SUCCINCTLY DESCRIBE TO WHAT EXTENT THIS VISIT CONTRIBUTES TO THE TEACHING OF SCIENCES AND BOTANY TO STUDENTS.

Teachers Regina Dias; Susana Xavier and Cristiana Monteiro – E.B. nº 2, Sagres

"We believe that field trips are always a valuable tool for students, as they allow them to be active agents in the construction of their knowledge, learning about plants and animals in the surrounding physical environment and comparing different landforms through direct observation. Furthermore, students acquire new vocabulary, are encouraged to discover, write, and appreciate art, and are given the opportunity to work cooperatively (discussions and reflections) among them. The field trip was a good experience for everyone involved." (Sept. 2024)

Teacher Ana João Silva –Vila do Bispo School

"*The field trip to the white crowberry plants, an edible plant typical of coastal regions, was an enriching opportunity for teaching science and botany. By directly observing the plant in its natural habitat, students were able to learn about ecology and the importance of native species, as well as understand concepts such as adaptation, biodiversity, and sustainability. The practical experience reinforced theoretical knowledge, sparking interest in local flora and promoting a deeper environmental awareness. This active and immersive approach facilitates learning, making scientific content more accessible and relevant to students*." (Sept. 2024)

Teacher Anabela Gaspar, Budens School

"*The field trip contributed to the teaching science and botany to students since they had direct contact with the environment, touching, handling, smelling the plants, and also hearing some animals. Students learn in a more playful way in informal spaces. It is important to awaken the students' interest in preserving and protecting the environment*." (Sept. 2024)

2.5.5. TESTIMONIALS OF PROJECT PARTNERS

Ana Carla Cabrita
Nature Guide of Walkin' Sagres

"*Walking the White crowberry trail with the local children was like taking them on a journey of discovery about white crowberry, allowing them to open themselves up to the local landscape. In this project, each child experienced seeing and feeling the nature around them, while touching the "white crowberry" for the first time, an iconic plant of our country dune areas. The joy and enthusiasm with which they sat on the sand, filling out their worksheets, clarifying doubts, and with which they said goodbye, shows how important in education are these activities in connection with natural landscape and its values*." (Sept 2024)

2.6. OTHER ACTIVITIES

2.6.1. POEMS ABOUT WHITE CROWBERRY

Students from Caminha School wrote, in 2016/17, some poems about white crowberry, as the following one:

The white crowberry

If I was a white crowberry
I would live by the sea.
I would be small and white,
the beach would be my partner.

My home is Caminha
and I have a known location.
I'm just a white crowberry
who lives in Camarido.

I'm a little fruit
I'm sweet and round.
My name is white crowberry
and I like being in Caminha.

(Poem from a 3rd year
Caminha School student)

2.6.2. OBSERVATION IN CLASSROOM OF GERMINATED WHITE CROWBERRY SEEDS

Students of 5th Grade at Caminha School were given the opportunity to observe in classroom, in November 2018, some white crowberry seeds that had germinated about a month earlier (Figure 40).

Figure 40 - Observation of germinated white crowberry seeds by 5th Grade students from Caminha School

2.6.3. OBSERVATION IN CLASSROOM OF WHITE CROWBERRY PLANTS AND VIDEO EXHIBITION

Due to COVID 19 pandemic, which according to the Human Development Report 2020 led to the closure of schools and affected approximately 90 percent of children worldwide (UNDP, 2020: p62), during 2019/2020 it was not possible to carry out outdoor field trips within the Emc^2 Project. However, at the Conde de Oeiras School, with the collaboration of Teacher Natércia Barbosa, other teachers and their students, it was possible for students to observe at classroom some branches of white crowberry plants with their fruits. In this initiative, included in October 2020, within the *European Sustainable Development Week -ESDW'2020*, 200 students, from 8 classes of 5th grade, answered a question to find out if they knew the white crowberry plant, before seeing the plant and a video about it.

Questionnaire Answers in classroom during the COVID pandemic, in October 2020 - (T=200)

Question 1 | Do you know what white crowberry is?

YES-16; NO- 182; NR-2; Percentage values YES- 8%; NO- 91%; NR-1%

INITIATIVE Link:

https://esdw.eu/events/project-emc2-environmental-education-about-white-crowberry-plant-camarinha-corema-album-ld-don-hands-on-activities-and-video-exhibition /

VIDEO Link 'White crowberry, a plant with small fruits of great potential':

https://youtu.be/k_EePxNqmb0

2.6.4. EMC² PROJECT PARTICIPATION IN OUTREACH EVENTS

European Researchers' Night, September 2018 (Lisbon)

S & T Week, November 2019 (Oeiras)

Sea Fair, June 2018 & June 2019 (Sines)

Business2Sea, November 2018 (Oporto)

Coastal Dune habitats Guided Visits (Lagoa Sancha, 2019; Almograve, 2021)

Figure 41- Poster of Visit to Lagoa da Sancha, organised in partnership with ICNF, I.P./*Direção Regional de Conservação da Natureza e Florestas do Alentejo*, in 5th june 2019, World Environment Day.

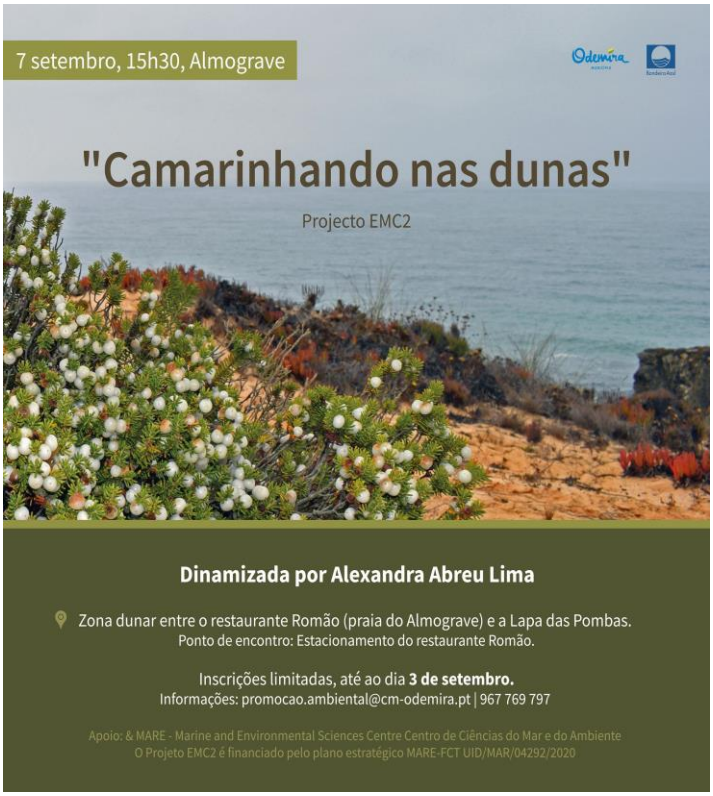
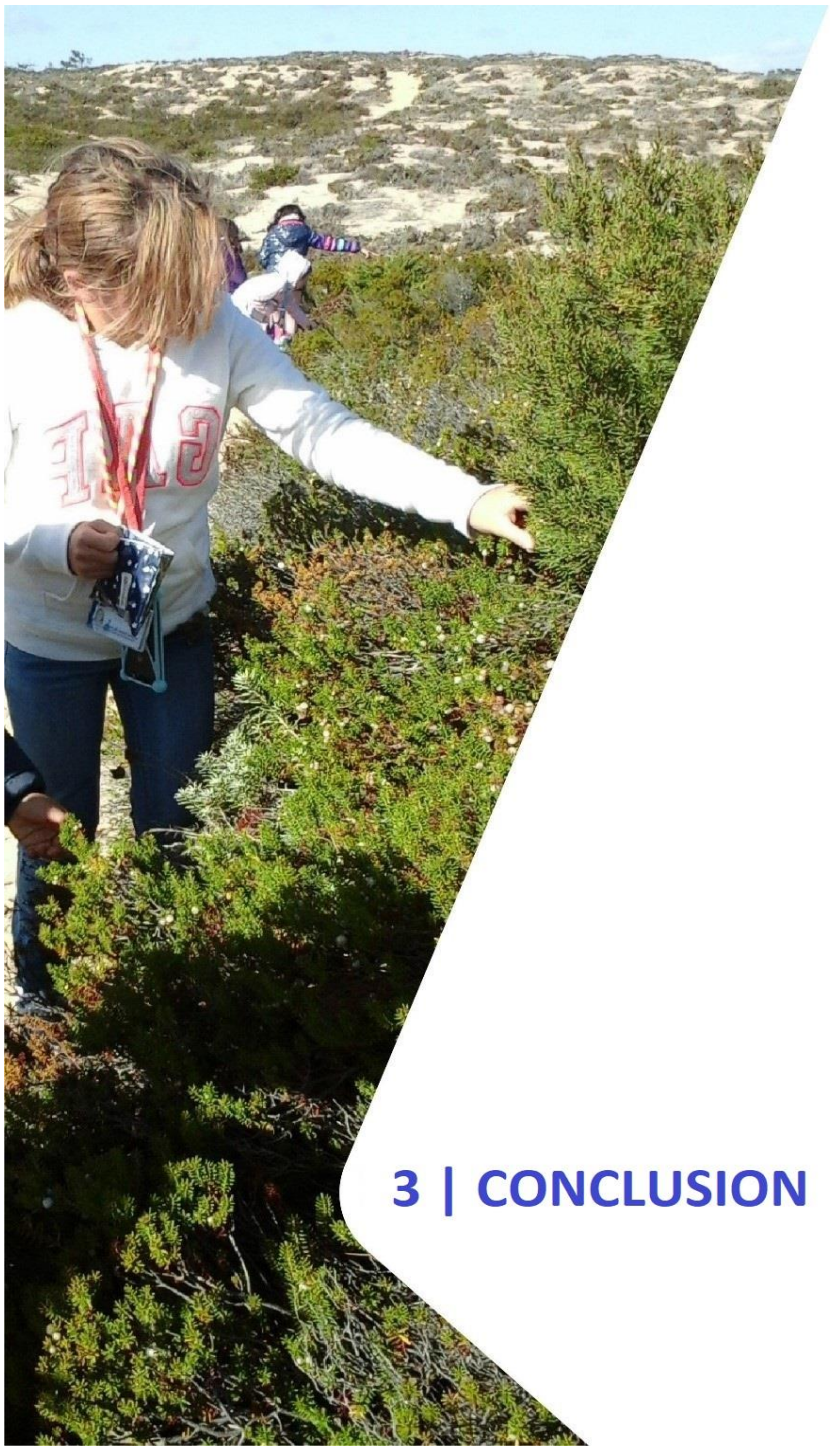


Figure 42- Poster of Visit to Almograve dunes, on 7th september 2021, in a partnership with Odemira Municipality and European Blue Flag Association (EBFA).

Figure 43 - Poster of Visit to Almograve dunes, on 27th september 2024, in a partnership with Odemira Municipality.



3 | CONCLUSION

3. CONCLUSION

«*Stewardship of nature requires the commitment and will of billions of people around the world (…). It can unleash a new sense of agency and responsibility through a connection with nature, with the planet and with all living things* »

Human Development Report 2020 (PNUD 2020)

3.1. STUDENTS' DEGREE OF KNOWLEDGE ABOUT THE WHITE CROWBERRY

In Emc2 project first phase, in the **2016/17** school year, for the **75 students** who participated in the Project (28 from Caminha Schools, 28 from Oeiras School and 19 from Sines School), the questionnaire revealed that **white crowberry was unknown for 75% of students**.

In the following academic years, questionnaires also revealed that white crowberry were unknown to most students: 1) **in 2018**, for an Oeiras class with 22 students, **the white crowberry was unknown to 21 students, with a percentage value of 95%**; 2) **in 2019**, for two classes in Torres Vedras Schools, with a total of **36 students, the white crowberry was unknown for 29 students, with a percentage value of 80%** and in 3) 2024, for students from Vila do Bispo (Sagres), for a total of **44 students, the white crowberry was unknown for 39 students, with a percentage value of 88,6%**.

In October 2020, due to restrictions caused by the COVID pandemic that prevented students from visiting dune habitats, results from a questionnaire carried out at Conde de Oeiras School, with participation of **200 students from 5th grade, also revealed that the white crowberry were unknown to 182 students, with a percentage value of 91%**.

Although questionnaire respondents sample size is small, it is possible to conclude that the white crowberry plant is a wild resource that keeps being mostly unknown. Therefore, during these years, the project activities developed in dune habitats, which are a privileged space for teaching and learning about botany, allowed an increase in students' knowledge about white crowberry plants, their habitat, as well as an awakening for discovery in nature.

The Emc^2 project awareness raising initiatives about white crowberry species have been able to highlight two peculiar features about this plant, namely those related to its:

(1) geographical distribution worldwide – with the subspecies '*album*' occurring only at Iberian Peninsula Atlantic coast (from Gibraltar to Finisterre) and the subspecies '*azoricum*' occurring only in some Azorean islands; being therefore called endemic (as they do not exist anywhere else in the world);

(2) fruit color - their white or pink color is unique among the berry edible fruits, whose most common colors vary between shades of red and bluish-purple.

Emc^2 project initiatives also raise awareness about dune flora value:

(1) in **environmental and ecological terms–** concerning the value of endemic plants and the important role of vegetation in coastal areas to sustain sands (namely in areas of severe erosion, where native plants should be used instead of exotic plants that may become invasive);

(2) in **economic terms–** concerning the multiple uses of wild plants and/or their cultivated relatives (from plant breeding) in food, pharmaceutical industry, among other sectors.

3.2. STUDENTS' DEGREE OF KNOWLEDGE ABOUT THE HOTTENTOT FIG

In the 2016/17 school year, for the 75 students who participated in the project (28 students from Caminha, 28 students from Oeiras and 19 students from Sines), the questionnaire revealed that **the invasive plant 'hottentot fig' was known to the majority (52 out of 75, percentage value of 69%) and unknown only for 31%**. In subsequent years, questionnaires also revealed this plant to be known to most students. In a total of seven questionnaires carried out with **133 students, this invasive plant was known to 96 students, with a percentage value of 72.2%.** In the most recent questionnaire, in the 2023/24 school year, among students from Vila do Bispo School Group, the '**hottentot fig' was known to the majority (29 out of 44, a percentage of 65.9%)** and unknown to 34.1%.

Despite being known to most students, which may be due to the its wide distribution, **its feature as an invasive plant was, in general, an unknown fact for students.**

3.3. LEARNING IN NATURE – STUDENT'S ENTHUSIASM AND TRAINING

Students' enthusiasm to explore dune habitats and discover new plants was evident in all field trips and was expressed in the answers given to the question about what pleased them most. Among several answers, the following ones are transcribed:

- 'To collect plant species I didn't know and 'make' an herbarium' (student from Oeiras);

- 'Have the freedom to explore the dunes' (student from Oeiras);

- 'I enjoyed the landscape and nature, and it is good to know that there are people who care about life on Earth'; (student from Oeiras)

- 'To discover new plants' (student from Sines);

- 'I enjoyed learning and picking plants' (student from Sines);

- 'To know nature and plants better' (student from Caminha);

- 'See, with the magnifying glass, the white crowberry and the hottentot fig (student from Caminha).

-' See the white crowberry plant, taste its fruits and see them with the magnifying glass' (student of Torres Vedras)

-' I enjoyed the white crowberry fruits taste and see the hottentot fig and the sea cottonweed' (student of Torres Vedras).

- 'I enjoyed searching the White crowberry at wild' (student of Sagres, Vila do Bispo).

At coastal dunes field trips, students filled out an Activity Sheet, in which they described the place and recorded what they felt. Among several answers, which reveal the connection between 'Feeling & Knowing', the following stand out:

'The place was big, with lots of plant species, it was nice and very beautiful.'

'(…) the sounds were magnificent, it was the sound of the sea, the smell was the smell of nature, the view was beautiful.'

'The place was full of hills, with sounds of various animals and smells of another world.'

'Smells of the sea, a beautiful landscape with wonderful flowers and plants.'

'In the dunes there are sounds of some animals such as crickets, grasshoppers… And there was the smell of the sea and of plants´

'(…) I saw white crowberry plants with their fruits, their very small leaves with a very pleasant smell.'

'The place was windy, between the grains of sand there are small plants growing, I could smell the plants, the sea and the view of the sea is wonderful.'

One of Emc^2 project most rewarding aspect was the **enthusiasm shown by students not only in coastal field trip activity** (in several areas of Portuguese mainland coast) **but also in the conservation activity of Foz do Minho white crowberry population** (at Moledo Beach, Caminha) in which, the reintroduction and growth data record of plants obtained by stem cutting propagation were made by students, who become their guardians. Students' records about this activity, described in the excerpts from group works below transcribed, reveal a **good appreciation for this activity**:

Group 1 work record:

«*After 6 months, it was time to go and observe the characteristics of our white crowberry plant, we photographed it from different angles. It measures 33 cm, it is the largest, it is a female plant*

but still without fruits. Conclusion: ***this work was very interesting because we were able to understand what a white crowberry plant is, its characteristics and development****.»*

Group 2 work record:

«*In the first observation, our group's plant measured 24 cm. In this observation, in November 2018,* ***we saw how white crowberry are fascinating****. On 05/28/2019, we had a field class that, in our opinion, was* ***very important for our learning. We were very pleased to know that our plant that once measured 24 cm has grown to 28 cm tall. Conclusion -*** *it was an activity: 1)* ***more enriching than a normal class; 2) it was a funny class****».*

Group 3 work record:

«*We think this activity is very important because it allowed us* ***to know and observe the development of this our coastal plant*** *and also* ***it stimulated our contact with nature****.*»

In addition to these work group projects, a student from Caminha School, as part of her Free Theme Work, carried out by herself, a conservation initiative for Camarido Forest white crowberry plants in June 2024. She invited her family for this initiative, a signal of her motivation and commitment to this species conservation, following the initiatives of Emc2 project.

These testimonials show **how authentic and meaningful learning is enhanced in nature. Students are given the opportunity to be protagonists, enabling them to act,** as evidenced by several studies, which reveal that:

1) students benefit when they are themselves involved in the learning process instead of just receiving information that is transmitted to them in the form of a lesson (Uno, 2009);

2) students should be given opportunities to carry out observations in nature, with data collection and interpretation (Uno, 2009);

3) the learning processes do not have to be painful and can even be pleasant "*if students feel the goals of school learning as their own, if school learning takes on a personal dimension and students understand that the knowledge and procedures learned at school can be useful* (...)" (Branco, 2004: p 91);

4) good education implies more than the intellect (...). Good education requires emotion. (Gottman & DeClaire, 1999).

Regarding this last aspect, we should also refer to the **perspectives** of Sobel (1996), "***if we want children to develop and become truly empowered, then let us allow them to love the Earth before we ask them to save it,"*** or that of **Finch (2008)**, according to whom ***"First we fall***

in love with nature and then we are motivated to learn more about it – including what needs to be done to protect it."

In students' questionnaire (Annex I), the question to evaluate field trip as 'Very good', 'Good', 'Weak' or 'Very weak', during **2016/17, 80% of the students considered it 'Very good' and 20% 'Good'.** In the **following years** most students considered them **as 'Very good' with percentage of 64% and 83% and as 'Good' with values of 36% and 17%.** For the field trip to Cape St. Vincent (Sagres), **in 2024,** for a total of 44 students, **84.1%** evaluated it **as 'Very good' and 15.9% as 'Good'.**

3.4. EDUCATORS' VISIT EVALUATION

Field trips to coastal areas with white crowberry plants were evaluated by all engaged Teachers as 'Very good' and their qualitative assessment revealed them as **good settings for contact with nature and an excellent place for science and botany teaching-learning, to enrich and complement classroom learning and awaken young students' curiosity for nature.**

Therefore, it was unanimously accepted its value and usefulness for botany teaching-learning and for students' motivation, aspects that are highlighted in the following testimonials:

M. Albina Passos - 3rd Grade Teacher (Caminha School)

«*This activity contributed to the teaching of science and botany as students are in contact with nature, namely with plants, developing their observation capacity and their interest in experiments and species conservation*.»

Isilda Cunha - 5th Grade Teacher (Caminha School)

«It was a very enriching visit as it aroused students' interest in natural spaces, improved the ability of observation and communication of observations made. It sparked interest in concepts of native and invasive species and the functions of dune flora in coastal habitats.»

Ana Soares, 3rd Grade Teacher (EB Póvoa Penafirme, T. Vedras)

«This field trip was considered relevant for science and botany teaching as it surpassed a standardized class in which definitions, observations and contents only happen within the classroom, between four walls. Science education calls for much more than that, and close contact with Nature is urgent and necessary for learning to be truly meaningful.»

Natércia Barbosa, 5th Grade Teacher (Conde de Oeiras School)

«Field trips are very interesting activities for students and also important for them to realize that in Science they can work in diversified ways.»

Rosinda Lino, 4th Grade Teacher (Sines School)

«It was a field trip in which students learned to know new plant species, technical terms and it was an awakening for the realization of an herbarium.»

Ana João Silva, 1st e 3rd Grades (Vila do Bispo School)

«The field trip to habitats with white crowberry, an edible plant typical of coastal regions, was an enriching opportunity for science and botany teaching. By directly observing the plant in its natural habitat, students were able to learn about the ecology and the importance of native species, as well as understand concepts such as adaptation, biodiversity, and sustainability."

3.5. LEARNING IN NATURE - THE PARTNERS' VISION

The testimonials presented in this book by members of NGOs and other partners from various national and local entities engaged in Emc^2 project show the current relevance of project development that provide places for action, in which young people are given the opportunity to better know the dune habitats and to develop conservation actions of declining white crowberry populations.

This is already happening at Moledo beach (Caminha) in a partnership that, among other stakeholders, engages the partners of the following testimony, below partially transcribed:

José Gualdino Correia (President of COREMA) and

Joaquim Guardão (President of UF Moledo and Cristelo)

«(…) We do not want this botanical heritage to exist only in the memory of some of us (…) this conjoint project has been raising awareness among students about the importance of white crowberry conservation, as an endemic plant of our coastal area.»

Ana Pinto and Helena Gama (Coordinators of Eco-Schools Program of the Sidónio Pais School Group, Caminha)

«These concrete actions developed by students are an important input to environmental education, encouraging the exercise of an active, and responsible citizenship.»

In this other testimonial by a partner from Oeiras, the contribution of dune field trips to arouse curiosity for nature and for plants, such as white crowberry, is highlighted:

Sónia Costa Afonso (Oeiras Youth Center, Municipality of Oeiras)

«This visit was aimed at learning outdoors… stimulating and further intensifying students' knowledge through their senses (…). The white crowberry fruits, white and sometimes pink, aroused the curiosity of all those present, from students, teachers and even for me».

Testimonials of Torres Vedras, Sines and Sagres partners also revealed the project actions valuable input for awareness-raising and conservation of white crowberry populations:

Vasco Batista and Rita Ramos (C.M. Torres Vedras Environmental Education Center)

«It is considered that only by knowing the values and biodiversity, can its conservation be implemented. The Emc² Project about white crowberry is extremely important, not only for its conservation role, but also because it encourages the study and dissemination of an endemic species (…).»

Flora Ferreira (Environment, Nature Conservation and Health Service of the Municipality of Sines)

«This Project brought us more knowledge about white crowberry plant (Corema album (L.) D. Don), once abundant in the region and in extinction today, providing us with tools to keep working about this theme, within the scope of the Municipal Environmental Education Program, to exchange knowledge about this species, its properties and uses and, consequently, about the importance of its conservation.»

Ana Carla Cabrita (Nature Guide Walkin' Sagres)

«*Walking the White crowberry trail with the local children was like taking them on a journey of discovery about white crowberry plant, allowing them to open themselves up to the local landscape. In this project, each child experienced seeing and feeling the nature around them, while touching the "white crowberry" for the first time, an iconic plant of our country dune areas. (…) these activities in connection with natural landscape and its values, are important in education.*» (Sept'2024)

3.6. A COLLABORATIVE PROJECT AT SCHOOL AND SOCIETY INTERFACE

The drawings made by students within the 'Botany and Art' Activity were included in Drawing Exhibitions held in various cultural institutions or museums located nearby coastal habitats, where project field trips took place. Until 2024 the following exhibitions were organized: Caminha (2016/17), Sines (2018), Oeiras (2018/19) and Torres Vedras (2022). Emc2 project inclusion of topics about natural heritage and environmental issues of coastal habitats in students' curricula and in local community(ies) cultural agenda(s) is an input intended to inspire citizens to act in their conservation, as reported in this following testimonial:

Liliana Rodrigues (Educational and Cultural Service, Sines Arts Center/ Sines Municipality)

(the drawings) *«(…) were subsequently displayed to the Sines Community and visitors*

through the Exhibition at the Sines Arts Center during the summer season. This allowed the project presentation, the experience provided, the artistic productions and, most relevant of all, an awareness-raising about 'our white crowberry plant' and the need for its conservation."

Therefore, the project allows students to act collaboratively with local entities, not only in conservation actions, but also in initiatives to raise awareness to society.

In addition to these initiatives, the Emc^2 project collaborated in a Guided Visit to Sancha Lagoon to raise social awareness about the white crowberry in this coastal area, in partnership with ICNF, IP/Regional Directorate for Nature Conservation and Forests of Alentejo, as mentioned in the following testimonial excerpt:

Carla Correia (Institute for Nature and Forest Conservation, I.P./Regional Directorate for Nature and Forest Conservation of Alentejo)

«The project managed to engage students, teachers and non-teaching staff, for a common purpose, promoting knowledge and valuing the richness and vulnerability of the existing biodiversity in coastal habitats.»

Therefore, **activities developed within the project foster the creation of synergies between Schools and local communities, which are important in environmental education projects, in terms of their future continuous development**, namely about issues of current relevance, such as those related to climate change and biodiversity crisis, which occur in coastal areas.

3.7. FUTURE CHALLENGES AND GENERAL CONCLUSION

FUTURE CHALLENGES

The Portuguese littoral - spread across mainland, the archipelagos of Azores and Madeira - is classified as a protection and conservation zone only in certain areas. As coastal zones are very important in environmental, economic, social, cultural and recreational terms, the articulation of several stakeholders multiple and diversified interests, from different economic sectors, is not always an easy task.

Therefore, it is important to emphasize the **need to safeguard coastal landscapes from loss of their natural values,** which was mentioned, among other documents, in the National Integrated Coastal Zone Management Strategy – ENGIZC (Presidency of Council of Ministers,

2009). As **only what is known is protected, the need to protect natural values implies the need to better know and raise social awareness about them,** to fill in existing information gaps at national level, about habitats and species to be protected (CNADS, 2017).

The Emc^2 project, started in 2016/17, has contributed over the last 8 years, not only to raise social awareness about the white crowberry plant, but also to foster conservation of the declining 'Foz do Minho' white crowberry population. The project will proceed, in future years, in coastal areas to be visited, with an assessment, in collaboration with school communities and collaborators, of adequate measures for conservation of declining white crowberry populations. **Initiatives of this species conservation** are **important because in recent decades**, due to various factors, **there has been a regression of white crowberry, with its disappearance at different areas of Iberian Peninsula western coast** (Fernández de la Cigoña, 1988; Sóñora, 1994; Díaz, 2000; Parra *et al*., 2000) (cit. Gil-López, 2011: 138).

Therefore, future challenges of Emc^2 project are:

- **to keep the ongoing conservation of 'Foz do Minho' white crowberry population** (Moledo, Caminha), through the reintroduction of white crowberry plants propagated by stem cuttings, to avoid their local extirpation, with participation of actual team members (MARE, INIAV., I.P., local education community, COREMA Association and U.F. of Moledo and Cristelo) and the *pro bono* participation of a local Plant Nursery Company, for which there were collected more white crowberry stem cuttings for propagation, in july 2024, and autumn 2024;

- to engage more students in 'Foz do Minho' white crowberry population conservation (and, also more young people, such as Scouts) and **add to the stem cuttings propagation process, the seed germination propagation, through an already tested protocol**.

- to develop more awareness raising initiatives about white crowberry plant and coastal zone biodiversity, through multiple channels, in digital platforms and others (e.g. podcasts, video exhibitions, drawings and/or photographs exhibitions, etc.).

- to **develop with other school communities in Portugal, more awareness raising initiatives about white crowberry plant conservation good practices**.

Knowledge about the values of nature (and namely those of Protected Areas) was recently considered by the Portuguese National Council for the Environment and Sustainable Development as an «*essential piece of citizenship: for the integral development of people, especially young people, in a urban and excessively artificial world; in order to create a collective awareness in society that Nature is an essential 'asset' deserving conservation*." (CNADS, 2021). Concomitantly, the Human Development Report (UNDP, 2020: p72) highlighted that «*instilling*

a sense of stewardship of nature can empower people to rethink values, reshape social norms and steer collective decisions in ways that ease planetary pressures.»

The Emc2 project, by raising awareness about white crowberry during initiatives at nature, in dune habitats, enriches school curricula, and is a positive input to counteract the increasing trend of botany education extinction in schools, with the negative effects on societies described by Stroud *et al.* (2022).

Young people are curious and we should give them the opportunity to also learn in nature (and not only in the classroom, in a textbook-based teaching), both in the teaching of botany and in the teaching of geology, as mentioned in a recent article by Professor Galopim de Carvalho (Carvalho, 2024), as nature stimulates curiosity and the senses, and «*knowledge is built by sensory systems – vision, hearing, bodily sensations, taste and smell – with the help of memory*" (Damasio, 2020). In Emc^2 project, the students showed, in general, great enthusiasm during field trips, in agreement with Abreu (1972) *who highlighted «**the emotional and motivating power of field trips as irreplaceable**.*». About this, Finch (2008) also mentioned that «*first we fall in love with nature and then we are motivated to learn more about it – including what to do to protect it*».

As this passion for nature is personal, it is concluded to be crucial to (r)establish the connection between the youngest generation and nature, in agreement with Louv (2005) assertion that: «*Passion does not arrive on videotape or on a CD; passion is personal*", arousing from direct contact with nature, from where it travels "*to the heart*".

Simultaneously, by fostering **conservation actions of a declining white crowberry population** with students' engagement, **Emc^2 project also empowers and mobilizes youth in nature conservation, within the United Nations Decade on Ecosystem Restoration (2021-2030).**

Therefore, the ongoing **Emc^2 project accomplish its proposed goals** and is 'living proof' that, as stated in the Human Development Report 2020, *«Action solutions need to be suggested, tried and practised in schools as living labs in order to empower students (…) and to make them aware of their own power to act"* (UNDP, 2020).

Therefore, **education and awareness raising about the value of nature and landscape heritage of dune habitats (often rich in endemic species, such as the white crowberry), and the need to act for their conservation is an educational challenge** that should engage young people, as future decision makers in decision-making processes about the use(s) and occupation of coastal zones compatible with nature conservation and landscape values.

If we agree with Louv' (2005) opinion that **«*progress can also be measured by our interactions with nature and its conservation*»,** we conclude that, **over these eight years, the Emc2 project** is living proof that schools and the teaching of botany must open themselves to the surrounding nature, where there is space and time for the curiosity and sense of place of young people to flourish and promote nature conservation (Orr, 2013), **as it is happening with the white crowberry conservation, referred to by young people as fascinating plants.**

The project has also contributed to a greater 'visibility to the value of natural heritage' since some initiatives of Emc2 Project are aimed at wider publics (e.g., Drawing Exhibitions, Video Screenings and Guided Tours). Therefore, the project is an input to broad the dissemination of the value of natural heritage to society in general, which is recognized as relevant as described in Council of Ministers Resolution: "*Public information regarding the intrinsic value of natural heritage and its importance as a producer of environmental services, with repercussions for human activities and well-being, is a matter of paramount importance. A training and awareness program on specific nature conservation issues should be established, aimed at society in general. Special emphasis should be placed on the environmental education component within the context of curricular and extracurricular programs and activities at various levels of education*." (RCM, 2018).

It is concluded that the future of botany education will benefit from place-based learning that fosters greater contact between young people and nature, and that encourages collaboration and networking with civil society organizations, to develop an attitude of collective responsibility for biodiversity safeguarding. This project has demonstrated that young people have the capacity to act on something that excites and fascinates them, as has happened, and we hope it will continue to happen, with white crowberry: fascinating plants.

ANNEX I

Questionnaries for Students and Teachers

I.1. FIELD TRIP – STUDENT QUESTIONNARY

1. Describe what pleased you most in this field trip.

_____

_____

_____

2. Would you like to pursue a career linked to nature?

2.1. Yes ___

2.2. No ___

Justify your answer.

_____

_____

_____

3. Did you know the white crowberries? If so, do you know how they are used by local populations?

3.1. Yes _____

3.2. No ___

4. Did you know the plant we call 'Hottentot fig'? Describe what you have learned about it.

4.1. Yes _____

4.2. No ___

5. How do you evaluate the visit (mark with a cross)

Very Good	Good	Poor	Very poor

I.2. FIELD TRIP - TEACHER QUESTIONNARY

1. Describe briefly by which means this field trip may have contributed to science and botany students' learning process

_____

_____

_____

_____

_____

2. How do you evaluate the visit (mark with a cross)

Very Good	Good	Poor	Very poor

ANNEX II

Photos from White crowberry Herbarium specimens used in Project Work Sheets

Figure 1 – Photo of white crowberry specimen from Moledo Beach- *Corema album* (L.) D. Don - Herbarium LISE (E.A.N.- Estação Agronómica Nacional) – nº 24780
Colector – Braun Blanquet *et al*.; **Date** – 14th May 1949; **Local** –Moledo Dunes (Camarido)

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