MARE – Marine and Environmental Sciences Centre

White crowberry: a coastal plant to know and protect. Results and future challenges of Project Emc^2 `Exploring White crowberry Coastal Habitats'

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PREFACE

The white crowberry plant, one of the endemic species with great relevance in the Iberian Peninsula, sets the tone for awareness-raising about threats to biodiversity in coastal areas and is the anchor of the Emc2 project 'Exploring White crowberry Coastal Habitats' which engaged students, educators and other collaborators in the multiple activities developed. The photographs and written testimonials reveal the success of this project in achieving its goals:

1- awareness raising about white crowberry Coastal Habitats';

2- enriching the school curricula and the cultural agenda of visited communities;

3- motivating students and local communities to undertake actions for the conservation of declining white crowberry populations.

As so well referred in the book as an educational objective: "A challenge that must engage young people to whom we must give the opportunity to appreciate and feel nature so that they become aware of the need to reconcile the use(s) and occupation of the coastal zone with the conservation of nature and landscape values".

The seed was set and will continue to grow throughout and beyond 2021, with the engagement of educational communities and other civil society partners, in the midst of the United Nations Decade on Ecosystem Restoration (2021-2030). The opportunity could not be better suited to have the educational context and civil society prepared for present and future challenges.

Five years of ongoing Emc^2 project activities prepared these coastal communities for the relevance of this white crowberry habitat, but in doing so they also provided the framework for the threats faced today by coastal and littoral areas. Students, educators and partners had, therefore, the opportunity to follow the project, acquire tools based on a deeper knowledge of this species

function and how it can respond and mitigate the threats resulting from the growing pressure of occupation and consequent loss of biodiversity, and respond to climate change negative effects.

Only what is known is protected. This project had the merit of, starting from an endemic species, to provoke a broad debate on more holistic issues, such as biodiversity loss and ecosystem degradation, growth pressure and climate change negative effects. Finally, a panoply of issues that affect us today, especially in coastal areas, which require increasing positions to fight them.

From a micro knowledge – the "white crowberry" – those engaged have learned about this plant life cycle and development, and its active role in coastal dynamics. As the book very well states – "*Nature is an excellent classroom*". Allowing space and a chance to the youngests' curiosity, knowledge is built through education and awareness-raising. The coastal zones assume here "*a privileged space for science and botany teaching-learning*", enriching school curricula in a "*hands on*" perspective, changing the attitudes and behavior of those engaged and making them more active and interventionist in these environments conservation.

This training for natural heritage conservation, using a collaborative learning process, contributes and consolidates the collective intelligence of these coastal communities about the intrinsic value of natural heritage and its importance as a producer of environmental services, with repercussions for activities and human well-being.

Lia Teles Vasconcelos, Ph.D.

Lisboa, July 2021

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Part 01
Introduction

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1.1. WHITE CROWBERRY - A LONER SPECIES IN PLANT BIODIVERSITY?

This book describes initiatives developed within the scope of the Emc^2 educational project 'Exploring White crowberry Coastal Habitats', funded by 'Fundação para a Ciência e Tecnologia' FCT MARE - UIDB/04292/2020. Project Emc^2 main objective is to promote, among students who participate, an awareness raising about the white crowberry plant (in Portuguese '*camarinha*'), which occurs in some places along our coastal area and produces small edible fruits, of white or pink color, which are called '*camarinhas*' (Figure 1).

Figure 1- White crowberry female plant with fruits.

Coastal areas are constantly changing and the reality is that some are changing very quickly. In some of them, there is a growing pressure of occupation related to agricultural activities, infrastructure development and urban areas, in addition to tourist and recreational activities. As a result, many of the natural and semi-natural habitats of coastal zones exist as small fragments in which there has been an accentuated loss of biodiversity (IPBES,

2019) and a degradation of ecosystems along with the negative effects of climate change.

In terms of biodiversity, coastal areas hold some endemic plant species, which are plants that exist there and nowhere else on Earth. To that extent, endemic plants are a legacy of unique evolutionary histories, a natural genetic heritage about which, in the 1980s, it was considered necessary to ensure some effective refuges due to the threat of excessive coastal human occupation (Araújo, 1987). These endemic plants keep being threatened by one or more factors, such as: (1) habitat fragmentation; (2) invasive species and (3) climate change.

Figure 2 represents a map of the worldwide distribution of *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 endemism, which exists in all the Azores Archipelago islands except on Santa Maria, Terceira, Flores and Corvo.

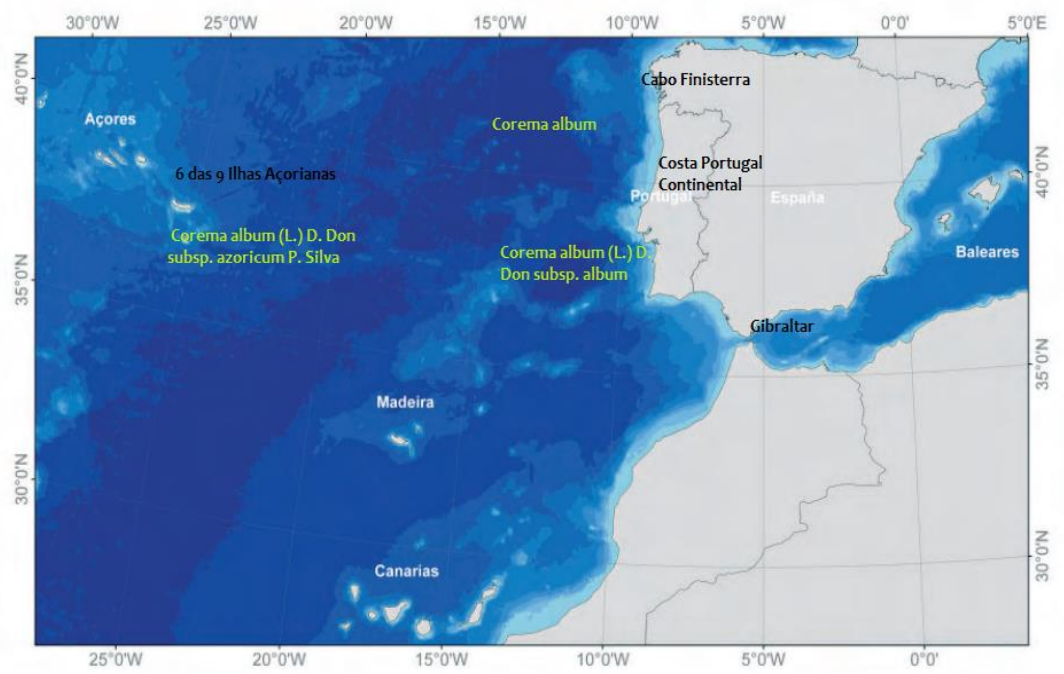


Figure 2 - Worldwide geographic distribution of *Corema album* (L.) D. Don and its two subspecies. Photo: Adapted from IPMA, 2011 (https://www.ipma.pt/export/sites/ipma/bin/docs/publicacoes/atlas.clima.ilhas.iberico.2011.pdf)

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

The white crowberry **taxonomic classification** is:

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 the Greek word '*Korema*' which means broom, an object that can be made with this plant dry branches and the specific epithet '*album*' derives from Latin and means white, alluding to its fruits color.

In Family *Ericaceae*, in Genus *Corema* (L.) there are only 2 species:

1► *Corema conradii* (Torr.) Torr. ex Loudon

Common name: Broom crowberry (EN); Corème de conrad (FR).

Endemic in the Atlantic coastal zones of USA (Maine, Massachusetts, New Jersey, New York) and Canada (New Brunswick, Nova Scotia, Prince Edward I., Québec) (Figure 3)

(more information:
https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.156445/Corema_conradii)

Figure 3 – *Corema conradii* (Torr.) Torr. ex Loudon - plant with brown fruits.
(photo: www.repertoirequebecnature.com)

2► *Corema album (L.) D. Don* –

Endemic in Iberian Peninsula Atlantic coast

In Azores – subspecies *C. album subsp. azoricum* Pinto da Silva.

White crowberry plant has very small leaves (called 'ericoids'), covered by a very thick cuticle to prevent water loss through transpiration, thus allowing the plant to live under high temperatures during summer. It is a dioecious species whose female plants bear small edible spherical fruits (5-8 mm in diameter) of white or pinkish color (Figure 4).

Figure 4 - *Corema album* (L.) D. Don - Female plant with white crowberry fruits

Jorge Paiva
Centre for Functional Ecology - Science for People & the Planet. University of Coimbra

GEOGRAPHIC DISTRIBUTION OF GENUS *COREMA* AND PLATE TECTONICS

«The Earth Globe is about 4,600 million years old (Ma). It was lifeless for almost 2,000 Ma. On this planet, the "Cage" where we live, there is life because there is water and energy, particularly solar energy. Therefore, water (H_2O) is the major chemical compound in any living cell.

Thus, it is understood that life began in Planet Earth in the bosom of heated water, the so-called "hot broth". That is, liquid water and energy, the fundamental principles of life. Many forms of life in the aquatic environment were differentiated, for about another 2,000 Ma, until living beings began to occupy the terrestrial environment (570-500 Ma), a large uninhabited ecological niche.

The transmigration of living beings from the aquatic environment to the terrestrial environment implied the need for the

diffusion of water throughout the body of multicellular organisms, which was achieved through a liquid (blood, in animals; sap, in plants), transported by vessels (veins and arteries in animals; phloem and xylem in plants).

These first vascular plants were extraordinarily simple, consisting only of underground (rhizomes) and green aerial stems, with primitive (dichotomous) branching and terminal sporangia. The most primitive organ of vascular plants is, therefore, the stem. The leaves resulted from the flattening of aerial branches and the roots of basilar branches by positive geotropism.

The first seed-producing plants (extraordinary adaptation to the terrestrial environment) still appear in the Carboniferous (359 to 299 Ma) and predominate during the opening of the Tethys ocean, which separated Laurasia from Gondwana, during the Jurassic (200 to 145 Ma) and Cretaceous (145 to 65 Ma), declining in the Tertiary, with the closing of this ocean. The seed contains a small plant in latent life [embryo, with a root (radicle), stem (caulicle) and leaves (cotyledons)] and reserve tissues, protected by a wall (forehead) that preserves the loss of water, vital for the survival of the latent embryo.

When plants with flowers and fruits appeared (adaptation to the high zoodiversity existing at the time), Angiosperms (late Jurassic and Cretaceous) began the separation of South America from the African continent. When Angiosperms were already in full expansion (Cretaceous - Tertiary) the disjunction of Australasia in the extreme South of America took place.

This is how the phytogeographic distribution of *Empetraceae* is understood [currently, after DNA studies, they constitute a tribe (*Empetreae*) of the *Ericaceae* family]. For instance, *Empetrum nigrum* occurs throughout the northern subarctic part of the Euro-Asian and North American continent, as these continents were united until there was already relative phytodiversity of Angiosperms. It is also understandable the existence of two species of *Corema* (also from the *Empetreae* tribe of *Ericaceae*) extremely similar, in the western extreme of the European Continent (western coast of the Iberian Peninsula), the white crowberry (*Corema album*, with white and edible berries) and in the northeast extreme of the North American Continent [southeast coast of Canada (States of Québec, New Brunswick and Nova Scotia) and northeast United States (States of Maine, New York, New Jersey and Massachusetts)], *Corema conradii*, with edible black berries (Figure 5).»

(Translated by Author. Original version in the Portuguese Book)

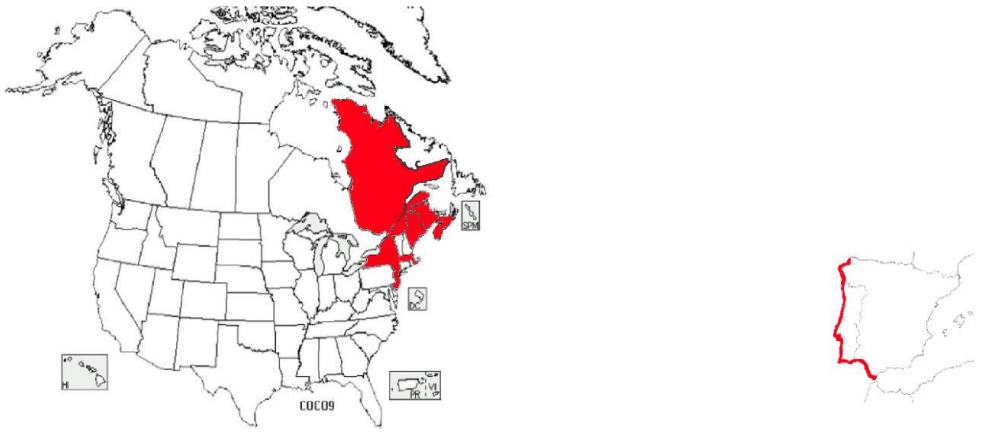


Figure 5- Geographic distribution of *Corema album* (W Europe) and *Corema conradii* (NE America) (Image: Jorge Paiva)

1.2. WHITE CROWBERRY- A 'TREASURE FOR PORTUGAL', A 'PHYTO-MONUMENT' AND DATA ABOUT ITS CONSERVATION STATUS

White crowberry plants of our coastal zone are part of our natural heritage and are described in the following paragraphs as a 'national treasure', in the 19th century, by Andrada & Silva (1815) or as a 'Phyto-Monument' by Carlos Pinto Gomes (see texts below).

White crowberry - a 'Treasure for Portugal':

«(…) *White crowberry lives and vegetates well in the maritime sandy areas (…) defends the terrain from the incursion of mobile sands, (…), in addition to this it gives a certain profit with its spontaneous fruits, it is a treasure for our Portugal*.» (Andrada & Silva, 1815).

Carlos Pinto Gomes
University of Évora

WHITE CROWBERRY - A 'PHYTO-MONUMENT'

«The White crowberry, being an endemism that only lives in some places of the Iberian coast, on sandy substrates and under the influence of an oceanic climate, must be considered a real PHYTO-MONUMENT. In addition to its high heritage interest, this wonderful

plant has always been widely used (and continues to be) at ethnobotanical level, namely at medicinal level, as it is considered to be antipyretic and vermicide.

However, if we do nothing, it is a plant that in the short medium term could be threatened with extinction in the national territory, given the changes in coastal land use that keep occurring, as well as the invasion of exotic species that dominate its habitat of occurrence.»

(Translated by Author. Original version in the Portuguese Book)

Data about white crowberry conservation status

White crowberry- *Corema album* (L.) D. Don - belongs to the *Ericaceae* family and is a green shrub, about 1m (3.29 feet) tall, 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, the Forest Management Plan for the Camarido National Forest (Caminha) reported a decrease in the white crowberry population in this Forest based upon data from 1995 and 2007 (ICNF, 2010: p20).

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: 138).

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: p 256) 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: 138).

No species lives isolated

White crowberry pollination is carried out by the wind (anemophilous pollination) and successfully pollinated female flowers can begin to form fruits that ripen and then will be food for frugivorous animals (e.g. rabbits, foxes, seagulls and blackbirds). These animals, which consume them will act as dispersing agents for white crowberry seeds (Calvino-Cancela, 2005) and, furthermore, seed germination '*is facilitated by the passage through the digestive tract of these animals* (Alvarez, unpublished)' (Clavijo *et al.*, 2002: 118).

White crowberry - a small fruit with great potential

White crowberry, although not widely known, has been used as food by coastal populations, especially during World War II and is currently studied within the small fruits research area (Jacinto, J. *et al.*, 2019; Jacinto, J. *et al.*, 2020 ; Oliveira & Dale, 2012; Oliveira *et al.,* 2016; Oliveira, P.; Valdiviesso, T. and Rosado-da-Luz, F. 2020; Oliveira, P. *et al.* 2020) and in studies related to gastronomy, food and health (Barroca & Moreira da Silva, 2020; Barroca & Moreira da Silva, 2021).

Pedro Oliveira
INIAV, I.P., Oeiras, Portugal

WHITE CROWBERRY - A SMALL FRUIT WITH GREAT POTENTIAL

«The INIAV began the study of the species *C. album* in 2011, after an interesting discussion with Professor Adam Dale of the University of Guelph, Canada, about fruits relatively unknown, holding a high market potential, it was presented the white crowberry fruit, which from the start, fascinated him to the point of proposing the systematic beginning of its study.

Since the white crowberry is a species that can only be found in its natural ecosystem, field trips were carried out from north to south of the country to assess its diversity, with the main objective of

studying the possibility of marketing its fruits, and including them in the small fruits market. It was quickly understood that in order to fulfill this objective it would be necessary to rigorously study the morphology, floral biology and genetic diversity in order to select elite genotypes to introduce them in a genetic improvement program for this species. From the numerous field trips, it was possible to observe the enormous degradation of habitats in the Portuguese coastal zone in which this species is found, thus emerging, in 2017, the possibility of collaboration in the recovery of the Moledo (Foz do Minho) white crowberry population, through the multiplication* of stem cuttings collected there, later rooted at greenhouse, to be planted and reintroduced at wild, by students engaged in Emc^2 project.

Since then, studies have continued with the completion of several Master's Theses and scientific papers publication about this unique genetic heritage of Iberian Peninsula.»

(*) In INIAV, I.P., with collaboration of Teresa Valdiviesso and Francisco Rosado-da-Luz.
(Translated by Author. Original version in the Portuguese Book)

1.3. PROJECT EMC^2 VISION AND RELEVANCE

Nature is an excellent classroom

Project Emc^2 vision is inspired by a perspective of education that considers it as more than the acquisition of knowledge. In a changing world, it has to contribute to improving young people's understanding, skills, values and personal development (Winthrop & McGivney, 2016).

In recent years, the ways in which the brain works and the ways in 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 6).

Figure 6 - Students during a study visit observing white crowberry with a magnifying glass.

Education and sensitization 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); (3) 'disconnection from nature' (Navarro-Perez & Tidball, 2012).

The collaborative environmental education project Emc^2 aims to help counteract these trends. Its mission is to promote initiatives for learning in nature, in coastal areas, which constitute a privileged space for teaching-learning science and botany.

Fran Hughes
University of New England, Armidale, NSW, Australia

NATURE IS AN EXCELLENT CLASSROOM - WHITE CROWBERRY: A COASTAL PLANT TO KNOW AND PROTECT

«Childhood is the most influential time to foster an affinity with nature and all children have a right to develop their own, personal relationship with the natural world. With scarce resources, the Earth's capacity to recover from the effects of human actions is limited and we are now situated in a global climate change crisis (IPCC, 2021).

Direct contact with the natural world is diminishing for many children in modern society as they have fewer opportunities to spend time in nature compared to 20-30 years ago. Therefore, it is vital that children spend more time outdoors in nature to explore the world around them. Outdoor learning in natural environments is vitally important for young children and they need to be provided with immersive experiences in their local places. Current research recognises the value of children's learning in nature for their health, wellbeing, confidence, learning capacity, creativity, communication and problem solving skills. Through experiential education in nature, children are given opportunities to explore and connect with nature through hands on experiences and discoveries, learning to care for the Earth and one another. As Sobel (1996) suggests "*if we want children to flourish, to become truly empowered, then let us allow them to love the Earth before we ask them to save it*" (p. 39).

This book will promote awareness of the White Crowberry, a plant unique to Portugal (and Spain), considered part of the national heritage, which is currently, in some places, under threat of extirpation. Additionally, the book will enrich the school curricula and encourage advocacy and activism for the White Crowberry amongst students and the community.»

(References at the end of the Book)

The Emc^2 Project initiatives are aimed to enrich school curricula as a large part of schools "*focuses on transmitting knowledge rather than action skills, which is insufficient to change behavior*" (UNDP, 2020: p138).

Therefore, the project is an opportunity for students to appreciate nature and better understand the challenges that coastal areas face, enabling them to

act towards the conservation of their natural heritage, which includes the white crowberry plant (Figure 7).

Figure 7 - Students observing white crowberry plants during an outdoor visit in Emc^2 project.

Debra Harwood
Brock University, Canada

THE NATURE CLASSROOM

«Why might educators want to embrace the nature classroom, a learning context of equal importance to the four walled classroom? Nature offers endless opportunities for children of all ages to thrive, develop, and learn. Simply put, time spent outdoors in nature benefits the whole child. Research demonstrates that children's cognitive, physical, and social development, as well as their mental well-being are enhanced from experiences in a natural environment (Gill, 2019; Kemple *et al.*, 2016). The relationship between time spent outdoors and children's physical activity is well documented (Larouche *et al.*, 2019). Children are less sedentary while outdoors and have greater opportunities to move large muscles and engage in vigorous activities that sustain healthy heart rates (Harwood *et al.*,

2017). Moreover, studies suggest that nature provides important stress-buffering advantages (Wells & Evans, 2003) as well as boosts children's immune systems (Roslund *et al.*, 2021).

In terms of cognitive development, spending time in the nature has demonstrated benefits for children's executive function, fostering improvements to memory and attention levels, self-regulation, and working memory (Dadvand *et al.*, 2015; Wells, 2000). Time spent in natural spaces is also beneficial for children's social-emotional development (Richardson *et al.*, 2017), offering children opportunities to develop pro-social behaviours, resolve conflicts, build confidence, promote independence, resilience, and persistence. Thus, the natural outdoors supports all the important and foundational dispositions for later learning, directly contributing to academic success (Khan *et al.,* 2020).

Outdoor learning can be thought of as an educational approach that takes place outside the classroom walls, often in a natural environment and involving both structured and unstructured learning from planned and emergent curricular approaches (Oberle *et al.*, 2021). Given the advantages of children's encounters with nature discussed above, outdoor learning is an important and much-needed opportunity for children. Children's encounters with 'nature' offer a biodiversity of elements that are not typically encountered inside a classroom, with fields, forests, gardens, water, and the limitless array of flora and fauna outdoors provoking curiosity and creativity, two important caveats for learning.

Curiosity "involves the pursuit of new knowledge and experiences" and creativity "involves transforming existing knowledge, ideas, or objects into something novel and interesting" (Gross *et al.*, 2020, p. 77). Nature invites a type of cyclical curiosity where children move seamlessly throughout various overlapping phases of exploration, wonderment and questioning, experimenting and discovery, repetition to test discoveries, learning new ideas, and skills, building confidence, and generating new questions and ideas (Dietze, 2021). Creativity equates to a 'successful learner' fostering the importance of curiosity, open mindedness, imagination, and problem-solving (Education Scotland, 2013).

I invite all educators to take advantage of the unique and complex affordances of nature (Gibson, 1986) to provoke children's curiosity, ignite their imaginations, and stoke creativity. The benefits of the nature classroom for children are boundless! »

(References at the end of the book)

As some Emc^2 Project initiatives are aimed for wider audiences, such as Drawing Exhibitions, Video Exhibitions and Guided Tours, the project also contributes to a greater 'visibility of natural heritage values', whose importance was described in Resolution of the Council of Ministers, as follows:

"*Public information regarding the intrinsic value of the natural heritage and its importance as a producer of environmental services, with repercussions for activities and human well-being, is a matter of primary importance. A training and awareness-raising program for specific nature conservation issues aimed at society in general should be established. Special emphasis should be given to the environmental education component in the context of curricular and extracurricular programs and activities in various levels of education.*"(RCM, 2018: 1854).

During the project, students (from the 1st to the 3rd school Grades) participate in the activities 'Study Visit' and 'Botany and Art' about the White crowberry. A Book of Activities was published in the project (Lima and Vasconcelos, 2017; www.mare-centre.pt/pt/sociedade/programas-educativos/emc2) and, in addition to the activities it describes, a conservation initiative was planned to a declining white crowberry plant population of 'Foz do Minho' (in the northern mainland Portuguese coast, at Moledo Beach), with the participation of young people, researchers and civil society organizations and entities.

Catherine Kelly,
University of Brighton, United Kingdom

NATURE IS AN EXCELLENT CLASSROOM

«Nature is an excellent classroom and the role of outdoor education has never been more important. In the post-pandemic world, our appreciation of nature in its own right, and for our human wellbeing is at an all-time high. Research shows that environmental learning projects in nature bring huge cognitive, emotional and eco-stewardship benefits to young people (Ardoin *et al.*, 2020).

Learning about nature at a young age has many positive impacts, both for young people themselves as well as environmental conservation efforts. When children are outdoors their bodies and minds are opened in ways that allow for deep learning and connection. Connection comes in 3 main forms- connection to self, connection to others and connection to the environment itself. When our brains are fully oxygenated outdoors and our senses stimulated, our brains work better and we learn without effort. The kinesthetic aspects of learning are easily demonstrated in an outdoor classroom - look at these dunes! look at how these plants colonise this ecosystem! watch them grow! See how they feel and taste! look how important and special this place is! Teachers can instil passion, nurturing and pro-environmental behaviours by being out in nature with their students (Kelly, 2018). When there is a strong sense of 'place attachment' between children and environments they understand and love, then a sense of protective custodianship increases. The white crowberry project is testimony to this, as exemplified in the participants' comments.

The relationship between nature and human wellbeing is well-researched, and increasingly important. Psychologists refer to the idea of 'soft fascination' as a positive outcome of being in nature – the textures, colours, smells, sight, sound and feel of nature – its plants, its coastal zones, its water. Looking at and intentionally noticing special flora and fauna is a naturally mindful exercise. Our breathing slows and regulates as we engage our senses with the detail of a plant such as the white crowberry. Instilling a sense of nurture/care for endangered species gives children a sense of agency and responsibility that is hard to replicate in other indoor settings. This co-creative agency between environmental experts and young-people is an important connection for the future of our coastal zones. Children can become important advocates for environments they are taught about and experience through projects such as this. Coastal biodiversity is under threat – climate change, rising sea-levels, beach erosion and other factors paint a grim picture for our most precious ecosystems. Engaging children and educators is an accessible 'way in' to what may often seem like too big a global issues. Beginning locally, with plant species and coastal spaces on our own doorsteps is an important foundation for positive action. When we are outdoors in the natural spaces we love and where we feel happy (whether it is green, blue or liminal space) - we feel a sense of custodianship... a desire to look after the places that look after us.»

(References at the end of the Book)

Coastal zones – the land-sea interface with challenges to face

Coastal areas are home to some of the most beautiful places on Earth, but also some of the most altered ones. According to data from the European Environment Agency, between 1990 and 2000, at European level, Portugal was the country with the highest growth rate of artificial urban area in the coastal zone, with a value of 34% (EEA, 2006: 15).

These zones are constantly in change and it is estimated that approximately 40% of the world population lives within a radius of 62 Miles from the coast (Martínez, *et al.* 2007, cit. Ward, Megonigal, Bond-Lamberty e*t al.,* 2020). According to these authors, the close links between the coastal interface and human societies are a major challenge for the sustainable management of the resources that coastal ecosystems provide, especially when urban development and human populations along the coast are expected to keep being increasing trends. This issue is highly relevant due to current climate change context, with research being carried out to assess coastal vulnerability associated with the rise in Mean Sea Level (MSL) and floods caused by the occurrence of extreme events, crucial to support the definition of adaptation strategies to climate change (Andrade *et al*., 2006; Antunes, Rocha & Catita, 2017).

As examples of these extreme events that damage coastlines, we had the 2011 February strong tides which damaged Moledo beach dune (Ferreira, 2014: pp 54 and 61), and the 'Hercules' storm, which occurred in the Atlantic during 2014 winter, and hit several countries beyond Portugal (Santos, Mendes, & Corte-Real, 2014), damaging the coast from North to South (Pinto, 2014). These events have been followed by others, such as, for example, a storm that occurred in December 2019 at Moledo beach (Figure 8).

Figure 8 - Moledo beach dune after a storm in December 2019, with exposed geotube in a destroyed dune.

Added to this, is the erosion and retreat trend of Portuguese national sandy coast analysed in the Report of the Coastal Working Group (Santos *et al.*, 2014), which will be cited in Part 2, in the brief characterization of each of the visited coastal zones within this project.

Dunes – a partnership of sand, wind and plants

For coastal zone dune formation, it is necessary to have three elements: 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. In the study visits, students get aware of flora and vegetation fundamental role in dune formation and stabilization, since the plants are responsible for fixing mobile sands (Figure 9).

Figure 9 – White crowberry plant root system in an eroded sand dune at Praia das Camarinhas (Tróia Peninsula, Portugal, September 2021)

Key Ideas about Dunes

Dunes are a land-sea transition zone where variable sediment (sand) deposition occurs and therefore **are constantly changing**.

Most dune systems have several zones - the embryonic dune, the primary dune, interdune space, the secondary dune, and if the system is well preserved, the tertiary dune - zones that are distinguished by the different amounts of organic matter in the soil and different occurring species.

The secondary dune or gray dune is richer in organic matter, which allows the occurrence of shrub species, which are more exigent in terms of nutrition, such as **White crowberry** -*Corema album* subsp. *album* or the **Juniper-of-the-sands** - *Juniperus turbinata* subsp. *turbinata*.

Funding - FCT MARE - UIDB/04292/2020

Dune habitats – rich but at risk

If plants are an essential part in coastal dune formation, not all plants can live there because dune habitats, being exposed to strong winds, high salinity, extreme light and thermal amplitude and with poor conditions to retain water (given its permeability) only hold plants that adapt well to these difficult conditions. And some have adapted so well to these conditions that we can only find them there.

Sand dune systems characteristic of European West coastal areas are, according to Akeroyd & Heywood (1994: p41) almost always floristically rich and held several endemic *taxa* (Figure 10).

An example of this endemism richness is sand dune vegetation of the Iberian Peninsula northwestern zone, studied by Lomba, Alves and Honrado (2008).

Figure 10 – *Corema album* (an Iberian endemism) and *Armeria sp.* at Tróia beach dune.

Besides inherent biodiversity value of vegetated dunes, they are also important in protecting against storms and extreme events. Several scientific studies reported that coastal dunes with strong 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) and therefore, vegetation help reducing coastline retreat along coastal areas with dunes.

In terms of conservation, dunes are dynamic habitats of high value, especially concerning vegetation. However, they are subject to great pressure, as reported, for example, for Portugal, in Camarido National Forest Management Plan (ICNF, 2010: p38), or in a study about some dune habitats in a Mediterranean region of Italy (Sperandii *et al.*, 2020).

At the European level, the latest assessment by the European Environment Agency (EEA, 2020) identified that among the evaluated habitat groups (Art. 17, Habitats Directive 92/43/EEC), coastal habitats had the lowest proportion of 'good state of conservation' assessment category. In this report, dune and swamp habitats were often assessed with a 'poor conservation status' (over 50%).

In general, dunes can be destroyed due to one or more factors, such as: excessive trampling, existence of tracks for all terrain vehicles, roads and house construction, sand extraction for civil construction. Globally, sandy beaches occupy more than a third of the global coast and have a high socio-economic value linked to tourism, leisure and ecosystem services (Vousdoukas *et al.*, 2020). According to recent reports, these authors hold the view that a substantial proportion of the world's sandy coast is already eroded, and this situation could be worsened by climate change.

Therefore, young people education and sensitization about dune habitats natural and landscape values and the need to act for their conservation is currently highly relevant.

1.4. METHODOLOGY
1.4.1. ACTIVITIES 'STUDY VISIT' & 'BOTANY AND ART'

«(…) *the emotional and motivating power of visits is irreplaceable*.» Manuela Abreu (1972: p152)

The methodology followed in the Emc^2 Project encompasses 'Study Visits' which, in pedagogical terms, and for various subjects, can complement classroom teaching, as they enrich students' learning, having been recognized as irreplaceable due to their emotional and motivating power (Abreu, 1972).

The methodology is described in the 'Study Visit' 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 'Study Visit' Activity, students visit dune habitats and observe white crowberries and other plants, being allowed to collect small plant branches for their mini-herbarium (Figure 11). During the visit, students complete an Activity Worksheet, in which they describe the place and record what they feel.

Figure 11 - Visit to the dune with white crowberry and collection by students of branches for a mini-herbarium.

Following the visits, students reply to a Questionnaire (Annex I), whose main results are presented in Part 2.

During the visit, students become aware of worldwide geographical distribution of white crowberry plant and of concepts of endemic plant and invasive plant.

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 12) 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: 1843).

Helena Freitas
Director of *Centre for Functional Ecology - Science for People & the Planet*, Universidade de Coimbra, Portugal

BRIEF NOTE ABOUT COASTAL HABITATS AND BIOLOGICAL INVASION

«Coastal ecosystems are of an utmost relevance for nature conservation, due to the diversity of habitats they integrate and to the role they play in safeguarding coastal integrity, promoting the formation of dunes and the dynamics associated with extraordinarily adapted autochthonous species. Coastal habitats are characterized by particularly unstable biotic and abiotic conditions, which clearly affect the plant and animal communities that settle here. Factors such as solar irradiation, water availability, salinity, wind speed and direction or substrate mobility, determine a high variability in access to resources and affect the life cycle of plant species.

The need to stabilize the coastal dunes and allow the occupation and use of these territories for different human activities, has historically led, to the choice of introducing exotic plant species in coastal areas around the world. Some of these introduced species ended up thriving and contributing to the degradation of large areas

of coastal vegetation, being currently one of the most widely transformed ecosystems due to the expansion of invasive plants. Biological invasions are one of the most serious environmental threats in the world, modifying stability and functioning of ecosystems, displacing native species and accelerating the loss of biodiversity.

The Portuguese coastal zones were extensively invaded by several species of acacia, namely *Acacia longifolia* (Andrews) Willd. and *Acacia saligna* (Labill) H.L.Wendl., which were initially introduced to stabilize the dunes and control erosion. Restoring and conserving coastal ecosystems is currently a complex but imperative challenge, prioritizing its role as an important natural barrier against the advance of the sea. The dynamics of dune ecosystems are based on the high diversity of autochthonous plants, especially adapted to aggregate sand without preventing its characteristic mobility, and effective in minimizing the effects of erosion.

Corema album is a shrub characteristic of coastal habitats and may be the most abundant shrub in stabilized sand dunes and forests. These communities are of particular importance in the transition between the coastline and inland areas. The opportunity to study, protect and share information about this species is therefore of the utmost importance.»

(Translated by Author. Original version in the Portuguese Book)

Figure 12 – Hottentot fig plant - *Carpobrotus edulis* (L.) N.E.Br.- near a young white crowberry plant (left corner) (©Lima, M.A., 2016)

Gérard Rocamora
Scientific Director & Chair
Island Biodiversity & Conservation (IBC) centre, University of Seychelles.

THE IMPACT OF INVASIVE PLANT SPECIES IN COASTAL AND ISLANDS ECOSYSTEMS

«The last decades have seen a dramatic increase worldwide in the number of species qualified as invasive. Most of these species have been introduced, voluntarily or involuntarily, and their spread has often been facilitated by habitat degradation and disturbance created by human activities. These processes have been affecting particularly coastal and island ecosystems. In the Seychelles islands, for example, about 60% of the vascular plants are of exotic origin and more than 60 are considered high impact invasives (Senterre *et al.*, 2013; Bruno Senterre, unpublished). Similarly, a large majority of the archipelago's area is dominated by exotic vegetation.

Invasive alien plants have a much bigger impact than what we usually imagine, especially in islands, where ecosystems are less resilient to biological invasions. Competitive exclusion, loss or alteration of suitable habitat, and changes to ecological processes have a strong negative impact on natural ecosystems. The spread of invasive plants and their abundant regeneration have dramatic consequences on the diversity of native plants, but also on animal communities that interact with them (Traveset & Richardson, 2006). Many native animals, particularly endemic insects, avoid feeding on exotic plants and depend on a limited number of indigenous or endemic plants to which they are well adapted. This in turn impacts through the food chain upon the abundance of larger animals such as reptiles, birds and bats, some of which also act as pollinators or seed dispersers of native plants. Native vertebrates, often decimated by introduced alien predators such as rats and cats on islands, find it more difficult to encounter and interact with native plants and may no longer act as effective pollinating or seed dispersing agents.

A similar scenario combining invasion by alien plants and habitat fragmentation due to urbanistic and other human developments also affects Portugal, where two endemic subspecies of White crowberry, one in the Atlantic continental shores and one in the Azores, are threatened by the invasive Hottentot fig *Carpobrotus edulis*. In addition, the regression of *Camarinha* fragilizes dunes and reduces the resilience of coastal habitats to climatic change.

When dealing with invasive species, it is crucial to keep in mind two most important basic rules. The first one is "*prevention is better*

than cure", that emphasizes the importance of biosecurity to prevent additional invasive species to establish. The second is "*early detection and rapid reaction*", that requires an effective surveillance scheme to detect and when possible eradicate new invasive species before it is too late and they start spreading. Unfortunately, eradication is not always possible in which case other management options such as containment, exclusion, control and mitigation need to be developed to 'live with' the invasive species and bring their impact down to a tolerable level (Rocamora & Henriette, 2015).

The problems created by alien invasive species have become so widespread that they now affect every continent and nearly all countries. Therefore, it is essential for the survival of our native biodiversity that we all become knowledgeable about invasive species management principles, and that we integrate them into our policies but also our personal mindsets. This should be particularly the case in islands and vulnerable coastal habitats.

Setting up restoration programmes in areas that have been affected by habitat degradation is also part of the solutions. Island territories such as Seychelles have a long experience in developing and scaling up ecosystem restoration programmes, combining eradication or control of invasive animals and plants, replanting native vegetation and translocating rare and threatened animals (Rocamora, 2019). As an example, invasive Sisal *Agave sisalana* was recently successfully eradicated from the entire atoll of Aldabra (van Dinther et al., 2014; SIF, pers. comm.). In several mountain top sites of Mahé, removal of exotic vegetation allowed to restore pollinator networks and had a positive effect on fruit production of native plants (Kaiser et al. 2017).

It is reassuring that a comprehensive programme combining restoration and education activities is being developed to preserve the coastal native habitats of Portugal dominated by *Camarinha*. Projects such as the EMC^2 are crucial to raise awareness about invasive species and how they threaten endemic plant species and entire ecosystems. Through them, the young generation can be motivated and engaged in conservation initiatives that will contribute to the United Nations Decade on Ecosystem Restoration.»

(References at the end of the Book)

In the 'Botany and Art' activity, students draw at classroom 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 13 and Annex II), in a *'Place Based Education- PBE'* approach.

Rowena Kalloo
University of the West Indies, Trinidad and Tobago

'*PLACE BASED EDUCATION*' - A PEDAGOGY FOR CONSERVATION

«The appearance of the Covid 19 virus in 2019 and its rapid spread around the globe has brought untold damage to the personal and economic well-being of people everywhere. Very little good seems to have been derived from this pandemic as people remain locked in their homes, fearful of illness, forced into isolation, and separated from the outdoors. For Caribbean people, as for many island and coastal dwellers globally, the prohibition on visits to our wetlands – beaches, rivers, waterfalls – has been a source of psychological and emotional distress, though ironically the absence of human presence provided wildlife an opportunity to thrive in habitats now undisturbed by man's footprints (Burgess, 2020).

The distress experienced because of separation from our coastal wetlands is testimony to the bonds we form with this geographic space. That relationship between human beings and their environment has been described as a sense of place (SOP) and is premised on the cultural, and ecological knowledge associated with specific places, which makes them significant for those who dwell there (Avriel-Avni *et al*., 2010). Avriel Avni *et al*. (2010) argue that such emotional attachments can motivate citizens to be actively involved *"in protecting the quality of the social and the natural environment"* (p.241). Coastal wetlands are special places for all cultures, providing ecosystem services as well as recreational and financial opportunities. Yet despite the ecological, aesthetic, and cultural importance of these ecosystems man's interaction with coastal wetlands is often a harbinger of pollution and ecosystem destruction. Further, climate change has created rising sea levels and climatic conditions which have exacerbated habitat destruction and disappearance of coastal ecosystems and communities. It is estimated that "*coastal watersheds of the Atlantic, Pacific, the Gulf of Mexico and the Great Lakes, were lost at an average rate of about 80,000 acres per year between 2004 and 2009*" (UCDavis, n.d). The pressures on coastal systems emphasise the importance of engendering a Sense of Place; creating human-nature bonds which can fuel a desire for conservation of natural environments (Orr, 2012; MCauley, 2006; Avriel-Avni, 2010).

Place-based education emerges as a pedagogy which has the potential to create in children that sense of place. It is a multi-disciplinary pedagogy premised on participatory learning through real time, hands-on interaction with local communities and natural environments. Learning emerges through knowledge of the geography, ecology, sociology, politics, and other dynamics of the locale (Knapp & Woodhouse, 2000). In place-based education, as David Orr (2012) eloquently states, the classroom now becomes "*the ecology of the surrounding community*". Such interaction stimulates children's senses, provides opportunities for critical thinking, inquiry, aesthetic appreciation, and access to the cultural and ecological knowledge of natural places. (Orr, 2012; Ardoin, 2006). The enjoyment and curiosity emerging from interaction with wild places creates an identity that leads children to treasure nature. By providing young people with the opportunity for intimate, multi-disciplinary investigations of coastal places we encourage them to move beyond knowing, to develop that sense of place which motivates them to apply their knowledge as action for conservation of these ecosystems and their communities (Ardoin, 2006).

> "*Whatever landscape a child is exposed to early on, that will be the sort of gauze through which he or she will see all the world afterwards.*" ~ Wallace Stegner

(References at the end of the Book)

The extirpation of white crowberry plants in a certain area (i.e. their disappearance at a local level, although the species survives elsewhere) can be inferred by a comparative analysis between existing records in herbarium collections and their current occurrence in nature (e.g. in Colares -Sintra, Portugal, where we currently no longer have white crowberry plants at wild, there are, however, records in national herbaria of specimens previously collected there).

This is an example, at the local level, of plants that currently exist only in herbariums, and which should be an alert to prevent this from happening in the future in other places along our coastal zone.

Figure 13 - Example of a drawing made by a student (left side) and an image of a white crowberry herbarium specimen (right side).

Chronology of first visits by school communities to mainland Portugal coastal areas with white crowberry habitats were, from North to South (Figure 14) the following:

1) Moledo Beach (Caminha), in September 2016; 2) Seixo Beach/ Mexilhoeira Beach (Torres Vedras), in October 2019; 3) Moinho de Baixo Beach (Meco), in June 2017; 4) Monte Velho Beach (near Sines), in May 2017. Since these first visits, more visits were planned with classes from 3rd to 5th grades.

Figure 14 - Map of mainland Portugal with indication of the coastal areas visited in the Emc^2 project: since 2016/17 ● (North- Caminha, Centre- Meco and Southwest- Sines) and since 2019 ● (Centre-Torres Vedras).

Project activities objectives are the following:

1- awareness-raising about white crowberry plants of coastal areas;

2- to enrich school curricula and cultural agenda of visited communities;

3- to motivate students and local communities to engage in conservation activities of declining white crowberry populations.

1.4.2. CONSERVATION ACTIVITIES OF WHITE CROWBERRY POPULATIONS IN DECLINE AND DATA ABOUT THEIR NATURAL HABITAT IN THE IBERIAN PENINSULA

> *« 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. (…) Growing coastal cities should protect, not replace, coastal ecosystems.»*
>
> www.decadeonrestoration.org

In 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 (Doñana 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 the Tróia Peninsula (Figure 15) 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: 195).

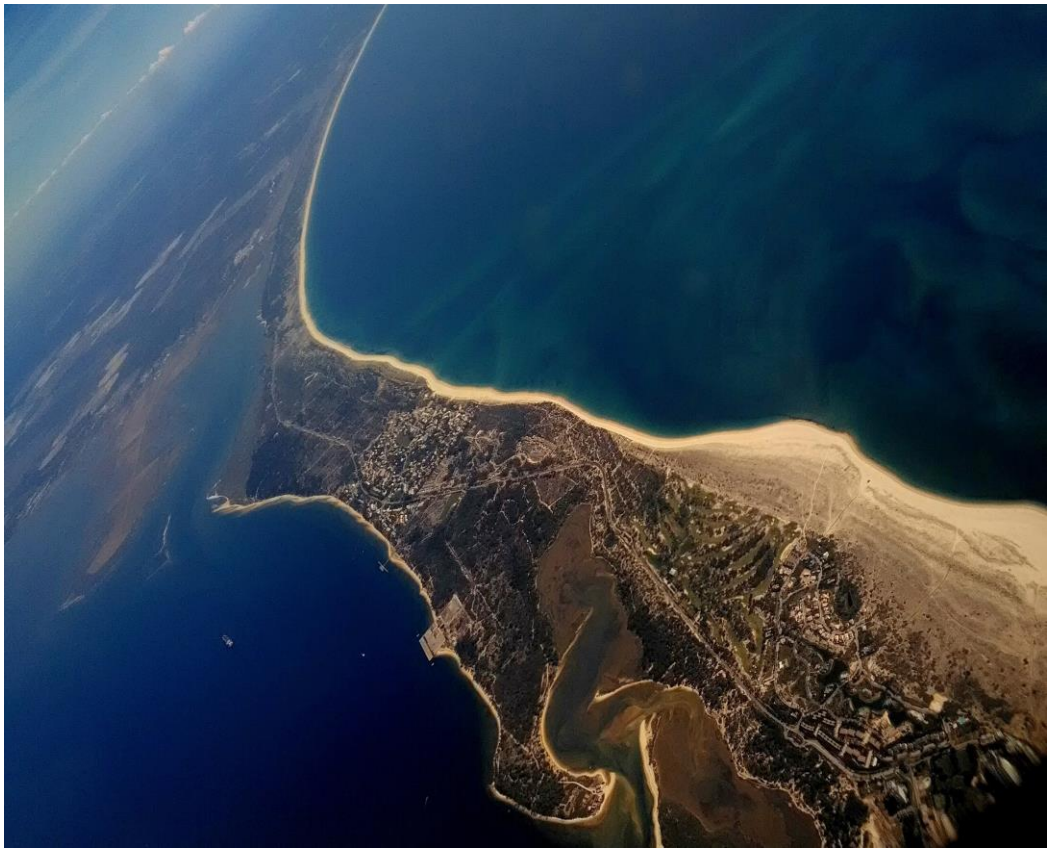


Figure 15 - Partial aerial view of Tróia Peninsula, with a dune area (Photo © Alexandra Abreu, 2019).

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

Figure 16 – Map of white crowberry populations indicating their status in the research carried out by Clavijo *et al.*, 2002 (Source: Clavijo *et al.*, 2002)

Key ideas about **White crowberry** in Portuguese mainland coast - some data from **Clavijo *et al.*, 2002**:

- an extensive population between 'Nazaré' and 'Ovar'
- a well-preserved population in the dunes of 'Tróia'
- populations reduced to fragments – 'Foz Rio Minho', 'Monte Gordo' «(…) *its survival in the future depends on measures of protection and regeneration of habitats*.»

Of the three coastal areas visited in the first phase of the Emc² project - Moledo Beach, Moinho de Baixo Beach and Monte Velho Beach - only Moledo (which holds part of 'Foz do Minho' white crowberry population) was in decline.

For this reason, within the scope of the Emc² project, it was decided to contribute to its recovery through the propagation of stem cuttings, in collaboration with Research Institute, INIAV, I.P. A group of students from

Caminha Schools who participate in this population conservation and are their guardians, are working in collaboration with 'COREMA Association' (NGO), local entities and INIAV, I.P., as a partnership has already been created between the school, local community and Research organizations.

As this case illustrates, education and awareness-raising about the value of the natural and landscape heritage of dune habitats and the need to act for their conservation is currently relevant due to present and future challenges (see text box 'Some news about Portuguese Coast').

This is clearly an educational challenge. A challenge that should engage young people, who must be given the opportunity to appreciate and feel nature so that they become aware of the need to reconcile the use(s) and occupation of the coastal zone with nature conservation and landscape values.

'Some news about Portuguese Coast':
(translated titles, links with texts in Portuguese)

01.11.2020 – Expresso 'Some beaches on the Central and North coast have retreated 30 meters in two years'. https://expresso.pt/sociedade/2020-11-01-Algumas-praias-no-litoral-Centro-e-Norte-recuaram-30-metros-em-dois-anos

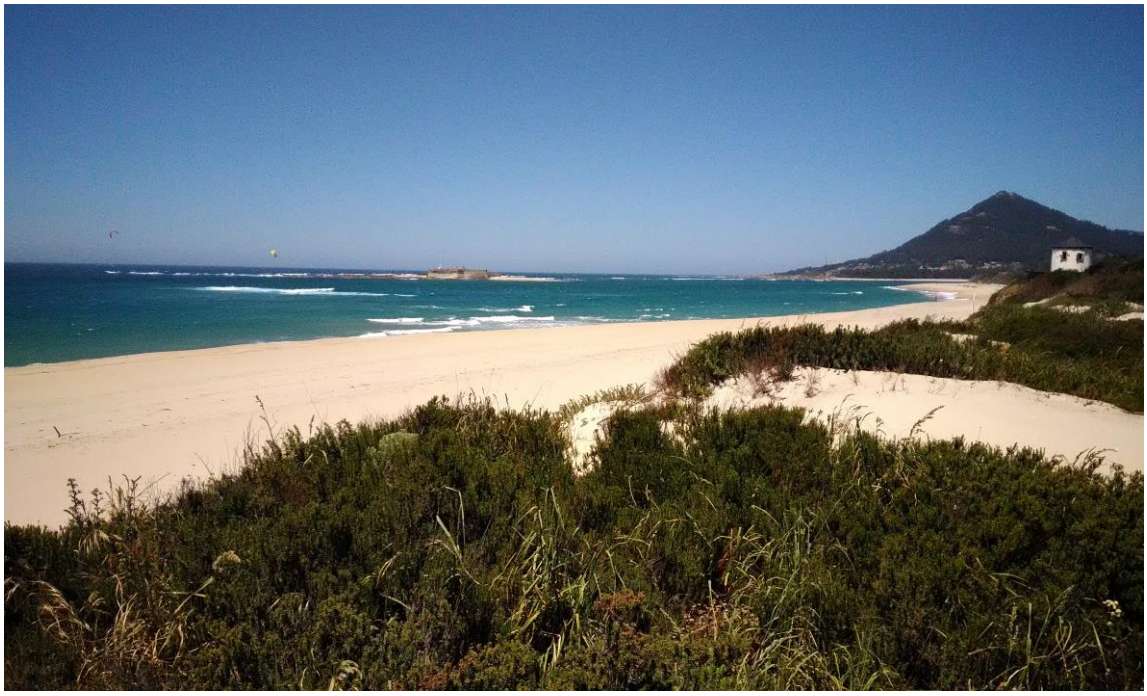
16.07.2020 – LPN News 'The lack of governance and degradation of the Portuguese coast continues'. https://www.lpn.pt/pt/noticias/o-desgoverno-e-degradacao-do-litoral-portugues-continua

17.10.2017 – Público 'Photogallery *Leiria's heart burned: the Pine Wood is reduced to ashes*. Photojournalist Adriano Miranda witnessed the devastating scenario. https://www.publico.pt/2017/10/17/fotogaleria/pinhal-de-leiria-378330

Part 02
Results

Funding - FCT MARE - UIDB/04292/2020

2.1.1. DUNE OF MOLEDO DO MINHO BEACH



41° 51′ 09″ N
8° 51′ 59″ W

The Moledo do Minho beach (Figures 17 to 20) is in the municipality of Caminha, district of Viana do Castelo (GPS: 41° 51' 09" N 8° 51' 59" W) and is close to the estuary of the river Minho in a border area between Galicia (North of the river, in Spain) and Minho (South of the river, in Portugal).

Figure 17 - 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)

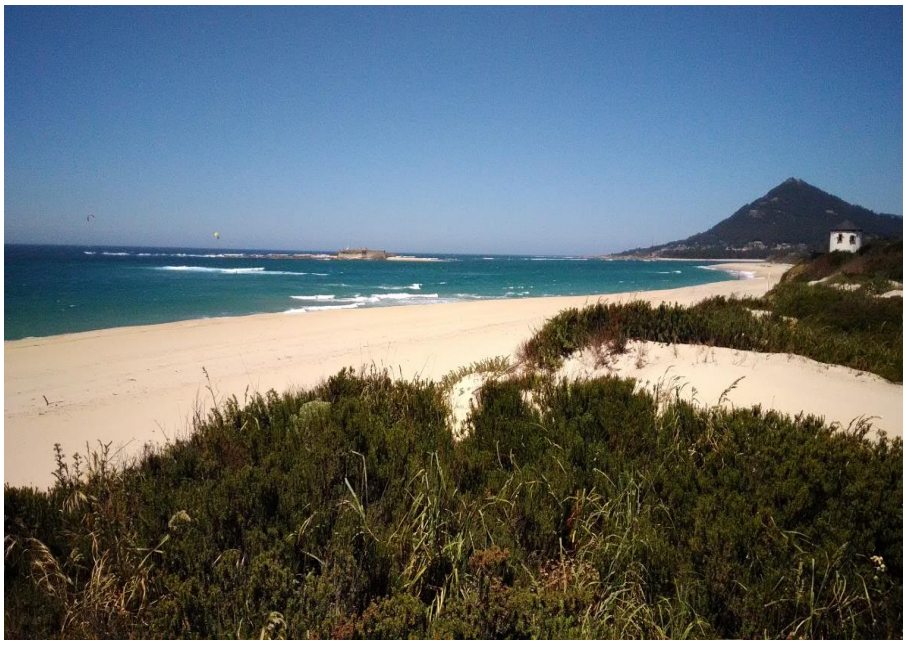


Figure 18 - Dune of Moledo do Minho with white crowberry plants where outdoor visits occurs

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: 14-15).

Figure 19- Aspect of the Moledo do Minho beach area in August 2009, before the 2011 February strong tides and the 2014 'Hercules' storm, with a stone wall and wooden walkway (overthrown meanwhile) and the Mill surrounded by vegetation.

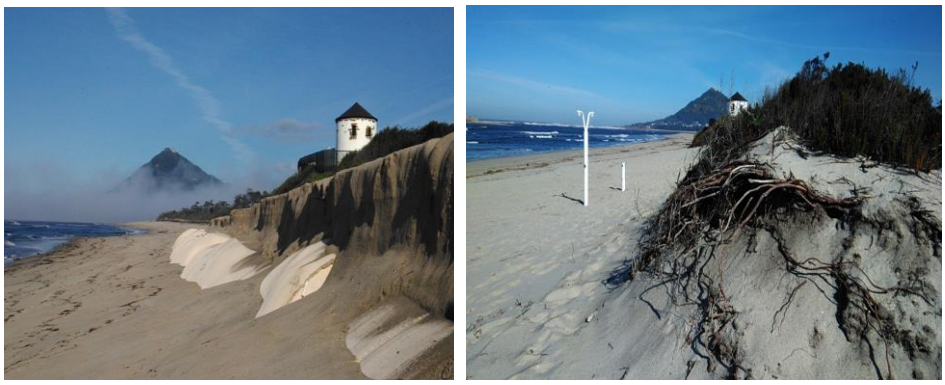


Figure 20- Aspect of erosion cliffs at Moledo dune in December 2019 after a storm that partially exposed the geotube placed there previously (left side), and in August 2020 (right side) with white crowberry roots exposed to the air.

2.1.2. STUDY VISIT ACTIVITY - PHOTOGRAPHS AND STUDENTS ANSWERS TO QUESTIONNAIRE




Figure 21 - Photographs of students from Caminha EB1 and EB2/3 Schools during study visits to Moledo beach dune.

Questionnaire Answers – 3rd grade Students from EB1 Caminha School

Question 1 | Describe what pleased you much in this visit

«It was to collect plants for my notebook.»

«What I liked most about the visit was that we had to see the plants with a magnifying glass.»

«To see with the magnifying glass the white crowberry and the hottentot fig.»

«It was to learn more about nature and plants.»

«I really enjoyed to fix with glue tape the white crowberry and the hottentot fig.»

«To see the sea, the plants and nature.»

«I enjoyed to gather fallen stems of white crowberry with my colleagues. I also enjoyed walking around the dune.»

« It was the white crowberry fruit.»

Questionnaire Answers– 1st Visit- 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 know the 'white crowberries' (PT 'camarinhas')?

Yes - 12; No - 2

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

Yes -12; No- 2

Question 5 | How do you evaluate the visit

Very good- 10; Good- 4

Questionnaire Answers –5th grade Students from Caminha School

Question 1 | Describe what pleased you much in this visit

«I enjoyed everything.»

«We have learned more about invasive plants and white crowberry plants.»

«What pleased me most about the visit was to know the fruit of white crowberry which tastes like lemon.»

«I enjoyed the smell of the sea and the wind.»

«The smell of the sea and the fresh air.»

«What I enjoyed most was learning.»

«I enjoyed to know the invasive plant.»

«Go to the beach and learn new things.»

Questionnaire Answers- 1st Visit – 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 know the 'white crowberries' (PT 'camarinhas')?

Yes- 2; No - 12

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

Yes- 6; No- 8

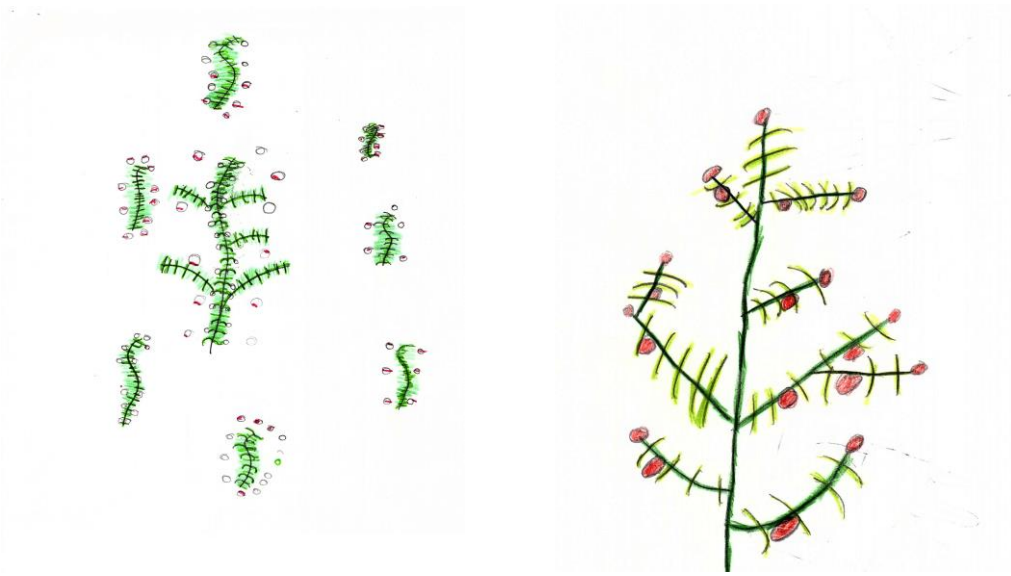
Question 5 | How do you evaluate the visit

Very Good- 9; Good- 5

2.1.3. ACTIVITY BOTANY AND ART

DRAWINGS

3rd Grade 5th Grade



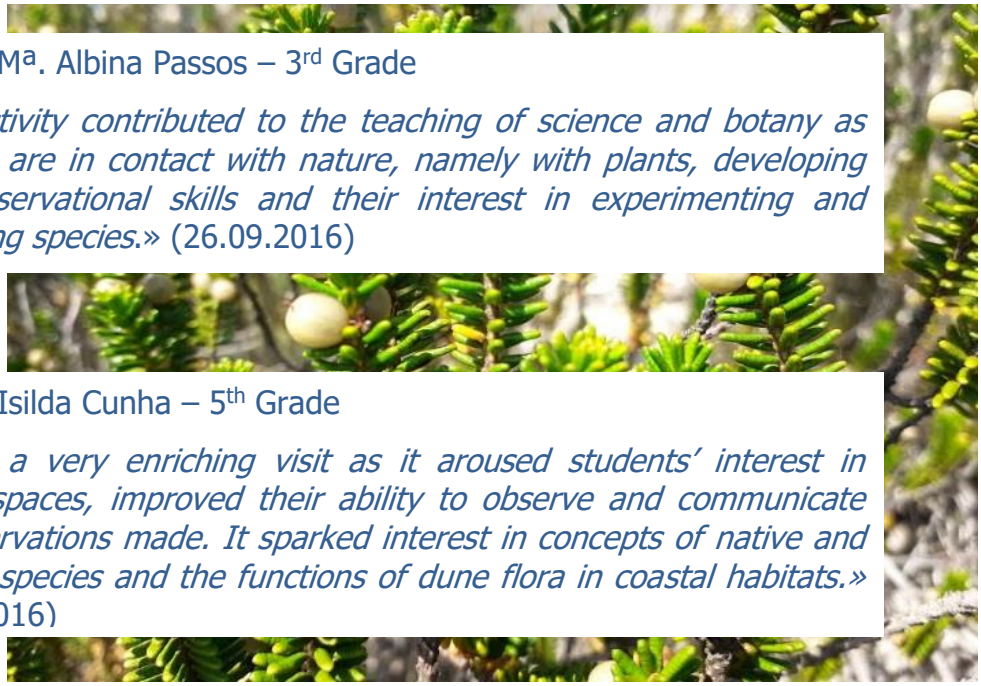
3rd Grade 5th Grade

Figure 22 – Drawings of students from EB1 and EB2/3 Caminha Schools about white crowberry.

Figure 23 - Poster of the Exhibition of Drawings of Students from EB1 and EB2/3 Caminha Schools.

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

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



Teacher Mª. Albina Passos – 3rd Grade

«*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 experimenting and preserving species.*» (26.09.2016)

Teacher Isilda Cunha – 5th Grade

«*It was a very enriching visit 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 the support of researchers from INIAV, I.P., the propagation of the white crowberry 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 followed 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 the support of the 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 24). 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 visited them to evaluate their development and their testimonials are described in the following paragraphs.

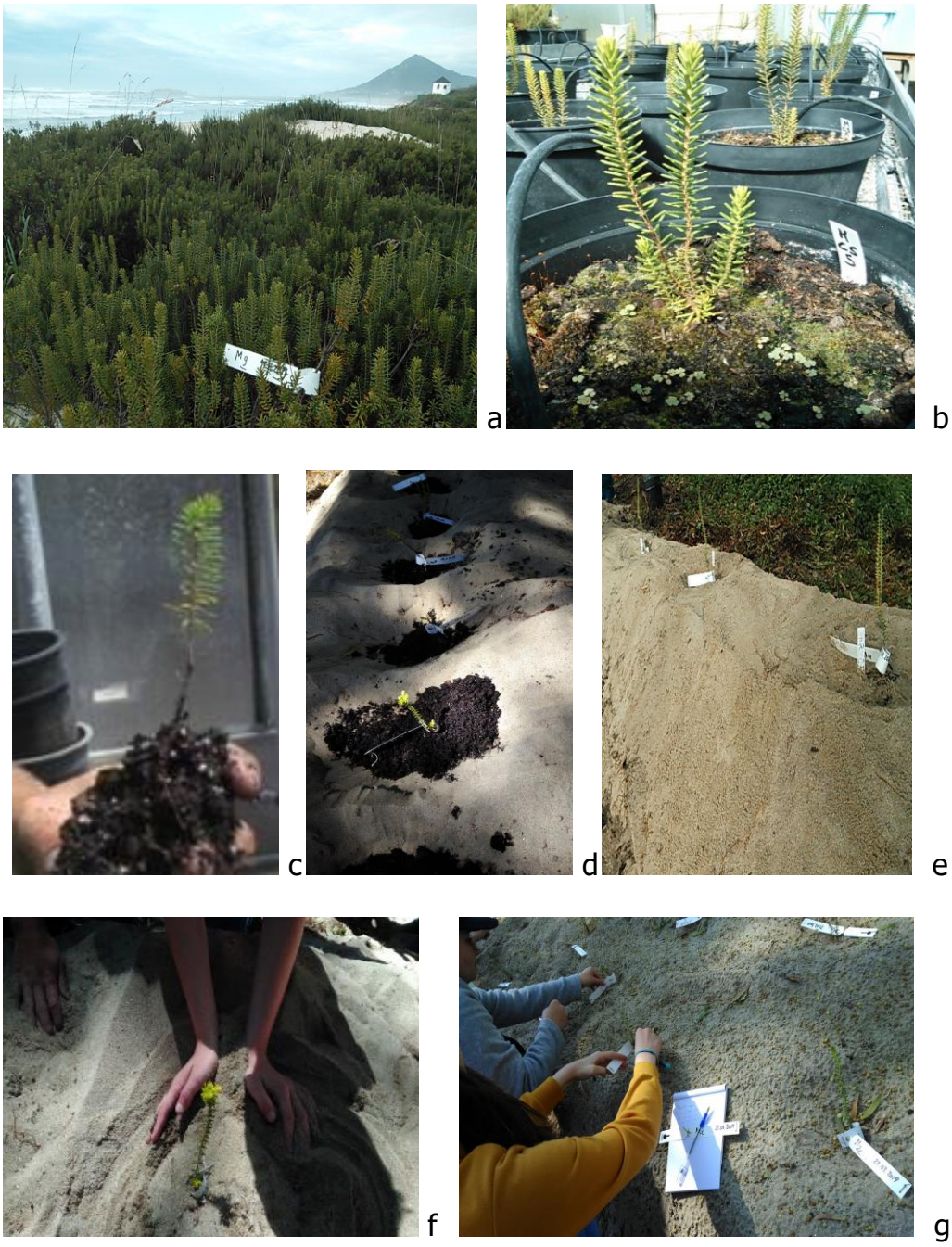


Figure 24 - White crowberry Foz do Minho population conservation measures- (a) Moledo dune; (b) stem cuttings in the INIAV greenhouse (Oeiras); (c) rooted stem cuttings; (d, e, f) plants reintroduced into the wild; (g) measurements of plant growth carried out by students from Caminha Schools.

In July 2021, another 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 (Figure 25 a, b, c). By then, it was verified that in several previously reintroduced white crowberry plants, some fruits have been formed (Figure 25 d).

Figure 25 - Foz do Minho white crowberry population - (a) Potted plants to be reintroduced; (b) plant reintroduced by student; (c) plant stem measurements made by student; (d) Fruit formed in a previously reintroduced white crowberry plant.

2.1.5.1. TESTIMONIALS OF STUDENTS FROM CAMINHA SCHOOL

Figure 26 – Record of a work by a group of students from Caminha School about the reintroduction of white crowberry plants in 'Mata do Camarido'.

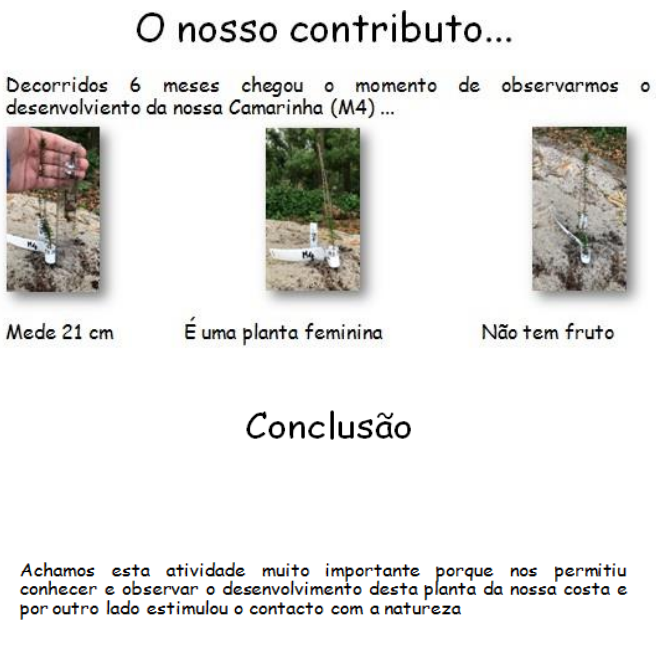


Figure 27 – Record of a work by a group of students from Caminha School about the reintroduction of white crowberry plants in 'Mata do Camarido'.

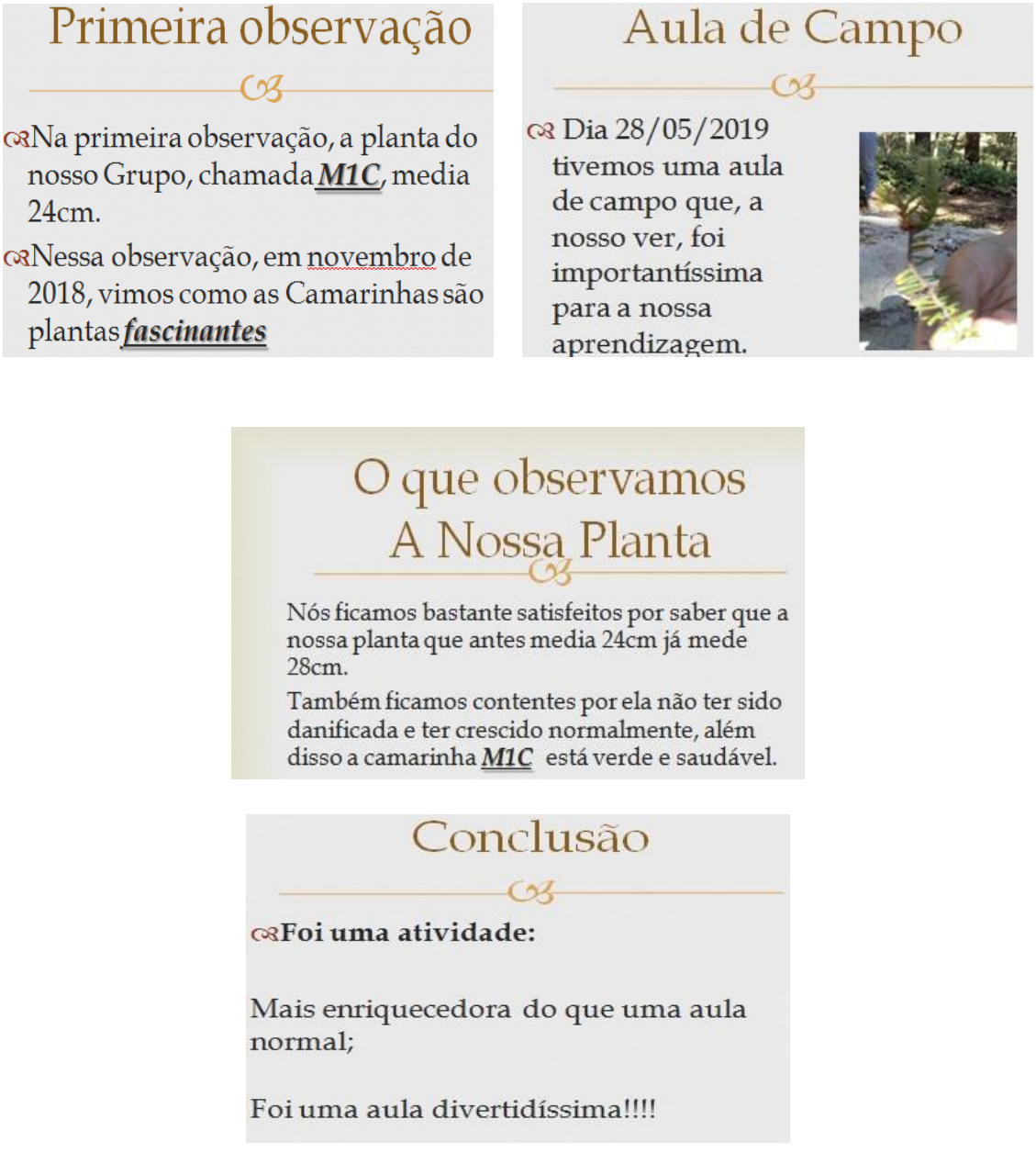


Figure 28– Record of a work by a group of students from Caminha School about the reintroduction of white crowberry plants in 'Mata do Camarido'

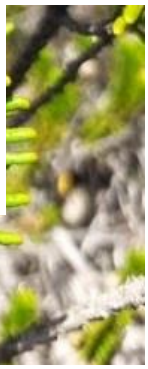
p.s.-These three group work reports are translated in page 93.

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) students 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; the identification of invasive plants and their removal; and the planting and monitoring of white crowberry plants in this Pine wood '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."
(Translated by Author. Original version in Portuguese Book)



José Gualdino Correia, President of COREMA NGO
Joaquim Guardão, President of UF - Moledo and 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 the last 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 had 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 and also with the engagement of the educational community of Caminha, in particular, of its student population. These actions aimed, firstly, to restore the Moledo dune, creating conditions to recover the white crowberry plants, whose existence, in recent years, has increasingly 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 sensitizing students to 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 weeds 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." February 22nd, 2021
(Translated by Author. Original version in Portuguese Book)

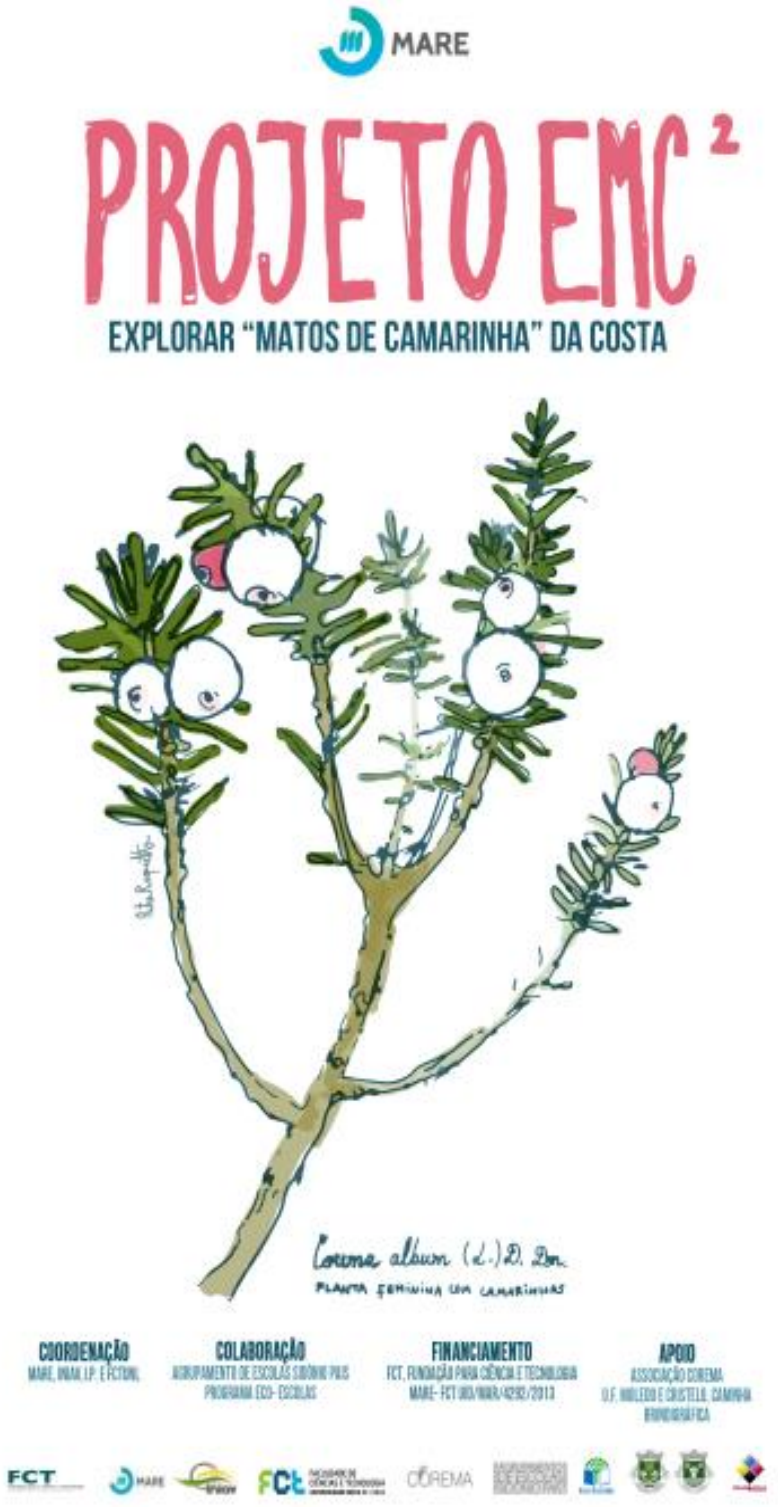


Figure 29 - Design of T-shirts for students engaged in white crowberry conservation initiatives in Moledo (drawing by Rita Roquette).

2.2.1. DUNE IN CLIFF BETWEEN SEIXO BEACH AND MEXILHOEIRA BEACH

39° 08’ 56” N
9° 22’ 20” W

The dune in cliff between Seixo Beach and Mexilhoeira Beach (Figures 30 and 31) is located in the municipality of Torres Vedras (GPS: 39° 08' 56" N, 9° 22' 20" W), district of Lisbon.

Figure 30 - Aerial view of the dune area on the cliff between Seixo Beach and Mexilhoeira Beach with white crowberry plants, where environmental education took place (Source: GoogleEarth, 2021)

Figure 3 1– Aspects of the dune area on the cliff between Seixo Beach and Mexilhoeira Beach with white crowberry plants, where the study visits 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, resuming a general orientation N-S, and accommodates numerous embedded, sandy beaches, although with very different geometry*».

2.2.2. STUDY VISIT ACTIVITY - PHOTOGRAPHS AND STUDENT ANSWERS TO QUESTIONNAIRE

Figure 32 - Photographs of study visits to the dune on the cliff between Seixo Beach and Mexilhoeira Beach by students from the Póvoa de Penafirme Basic School and Externato School.

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

Question 1 | Describe what pleased you much in this visit

« To know the white crowberry and taste its fruits. »

« To feel the acid taste of the white crowberry fruits. »

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

«To taste the white crowberry fruits and see these plants. »

« Eating white fruits and sitting on the sand. »

«It was learning how the white crowberry plants reproduce. The rabbits eat the white crowberry fruits and the rabbit droppings help the germination of white crowberry seeds."

«To see the white crowberry and Armeria sp. plants. »

«To feel white crowberry fruits flavor and to see other plants on the beach. »

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 much in this visit

«To gather white crowberry fruits and taste their flavor.»

«To know the white crowberry plants»

«To discover male and female white crowberry plants.»

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. ACTIVITY BOTANY AND ART

DRAWINGS

Figure 33 - Drawings of students from Póvoa de Penafirme Basic School (above) and the Póvoa de Penafirme Externato School (below)

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

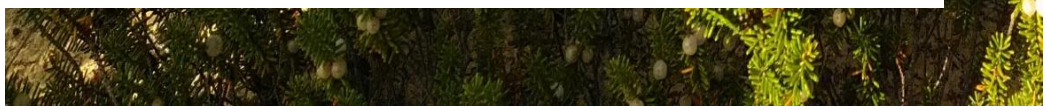
SUCCINCTLY DESCRIBE TO WHAT EXTENT THIS VISIT CONTRIBUTES TO THE TEACHING OF SCIENCES AND BOTANY TO STUDENTS.

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

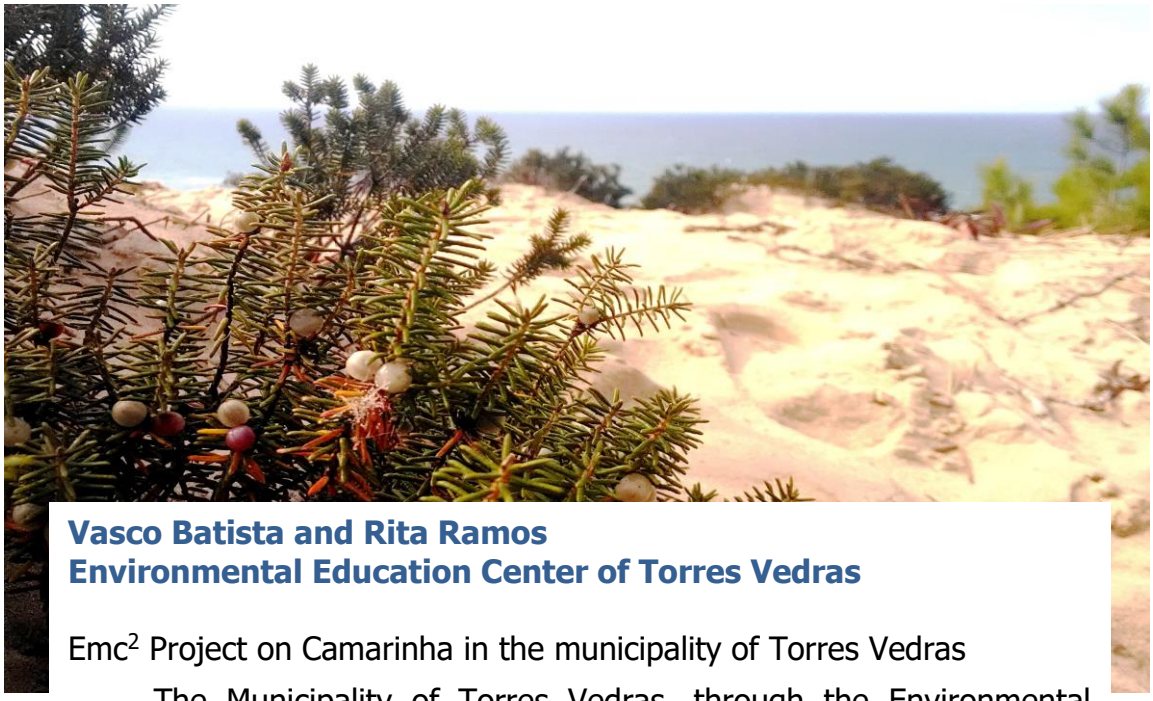
«A visit, as a pedagogical activity, detaches itself from the old educational paradigms. This one, assumed itself to be relevant for teaching science and botany as it has gone beyond a standardized class in which definitions, observations and contents only happen in the classroom, between four walls. 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 visit contributes in a very positive way to the teaching of different curricular contents. Direct contact with plants is very motivating for the awakening of knowledge.»



2.2.5. TESTIMONIALS OF PROJECT PARTNERS



Vasco Batista and Rita Ramos
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 thematic that they study, and this project is a practical example of that.

Engagement of school population which is geographically near to the distribution areas of this species allows establishing a proximity connection and an active role in its dissemination and conservation.
(Translated by Author. Original version in Portuguese Book)

2.3.1. MOÍNHO DE BAIXO BEACH

38° 29’ 20” N
9° 09’ 29” W

Moinho de Baixo beach is located in the municipality of Sesimbra (GPS: 38° 29' 20" N; 9° 09' 29" W), district of Setúbal (Figures 34 and 35).

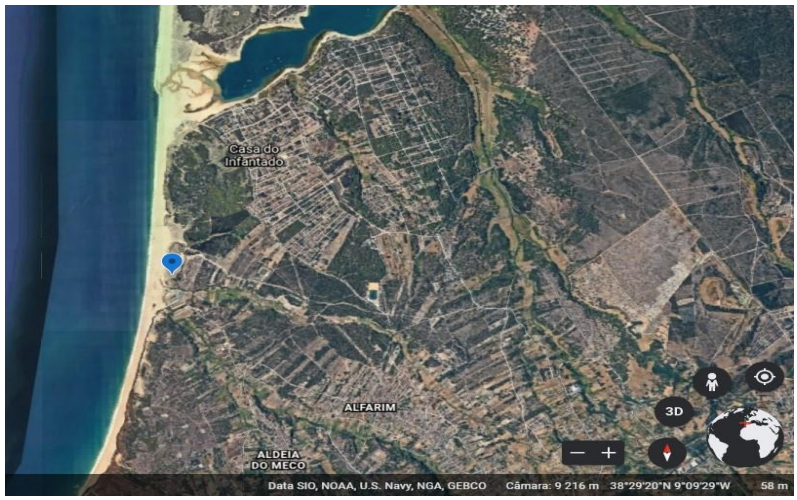


Figure 34- Aerial view of the Moinho de Baixo beach dune area, where environmental education took place (Source: GoogleEarth, 2021)

The Moinho de Baixo beach dune is included in sedimentary cell 4 of the Report of the Coastal Working Group (Santos *et al.,* 2014: p26) 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: p28).

Figure 35- Aspect of Moínho de Baixo beach dune

2.3.2. STUDY VISIT ACTIVITY - PHOTOGRAPHS AND STUDENT ANSWERS TO QUESTIONNAIRE

Figure 36 - Photographs of study visits of students from Conde de Oeiras School to Moínho de Baixo beach dune.

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

Question 1 | Describe what pleased you much in this visit

«To collect plant parts and explore all that bush.»

«To become aware of new plants to taste the white crowberry fruits.»

«Be able to have the freedom to explore the dunes.»

«The landscape and the variety of plants.»

«It was exploring the forest and the dunes.»

«To collected plants that I had only seen very few times.»

«Being connected to nature.»

«It was picking up plants we didn't know about in order to make a herbarium.»

«The landscape and the variety of plants.»

«Being connected to nature.»

«It was picking up plants we didn't know about and then to make a herbarium.»

Answers Questionnaire – 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

Answers Questionnaire – 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. ACTIVITY BOTANY AND ART

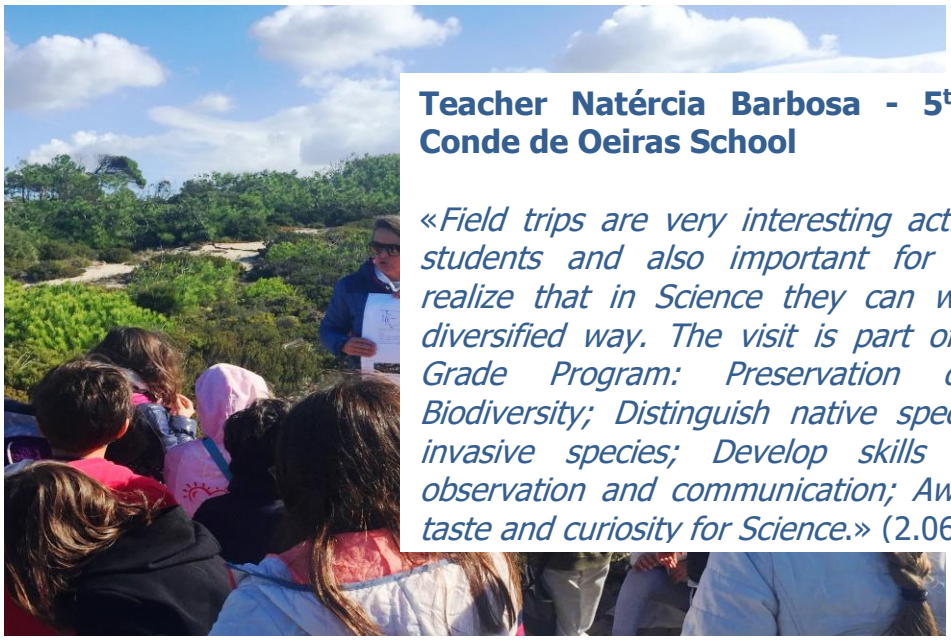
DRAWINGS

Figure 37- Drawings of 5th Grade students from Conde de Oeiras School about white crowberry.

Figure 38 - 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

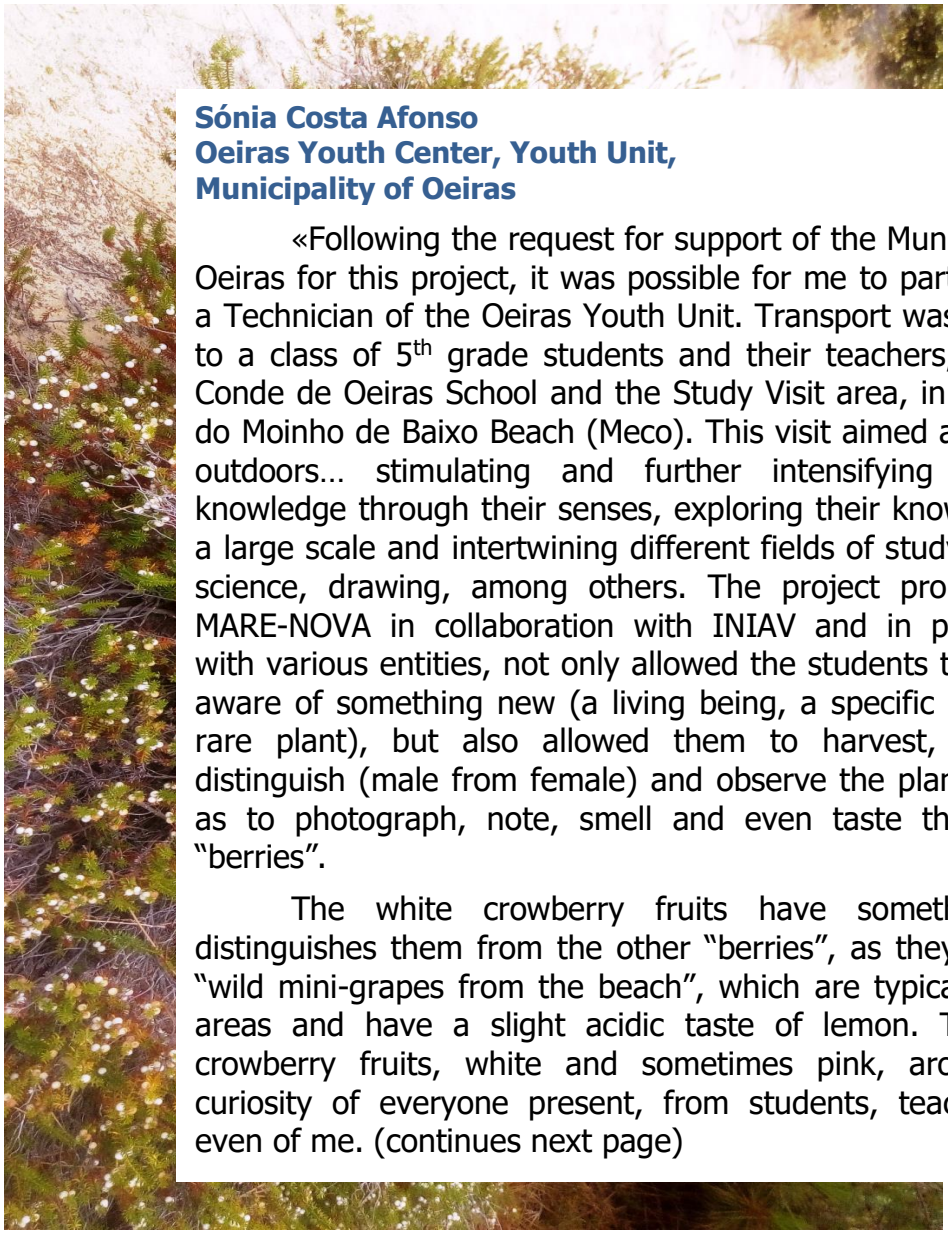
«*Field trips are very interesting activities for students and also important for them to realize that in Science they can work in a diversified way. The visit is part of the 5th Grade Program: Preservation of Plant Biodiversity; Distinguish native species from invasive species; Develop skills such as 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, Youth Unit,
Municipality of Oeiras

«Following the request for support of the Municipality of Oeiras for this project, it was possible for me to participate as a Technician of the Oeiras Youth Unit. Transport was provided to a class of 5th grade students and their teachers, between Conde de Oeiras School and the Study Visit area, in the Dune do Moinho de Baixo Beach (Meco). This visit aimed at learning outdoors… stimulating and further intensifying students' knowledge through their senses, exploring their knowledge on a large scale and intertwining 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 even of me. (continues next page)

Sónia Costa Afonso (continuation)

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, in order to make the entire population aware of this unique research work.

On the opening day of the exhibition, 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 support 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 preserving the environment, thus stimulating a better and greater sustainability of these ecosystems.»
(Translated by Author. Original version in Portuguese Book)

2.4.1. MONTE VELHO BEACH

38° 05′ 48″ N
8° 51′ 47″ W

Monte Velho Beach (GPS: 38° 05' 48" N; 8° 51' 47" W), is located in the municipality of Santiago do Cacém, district of Setúbal (Figure 39 and 40).

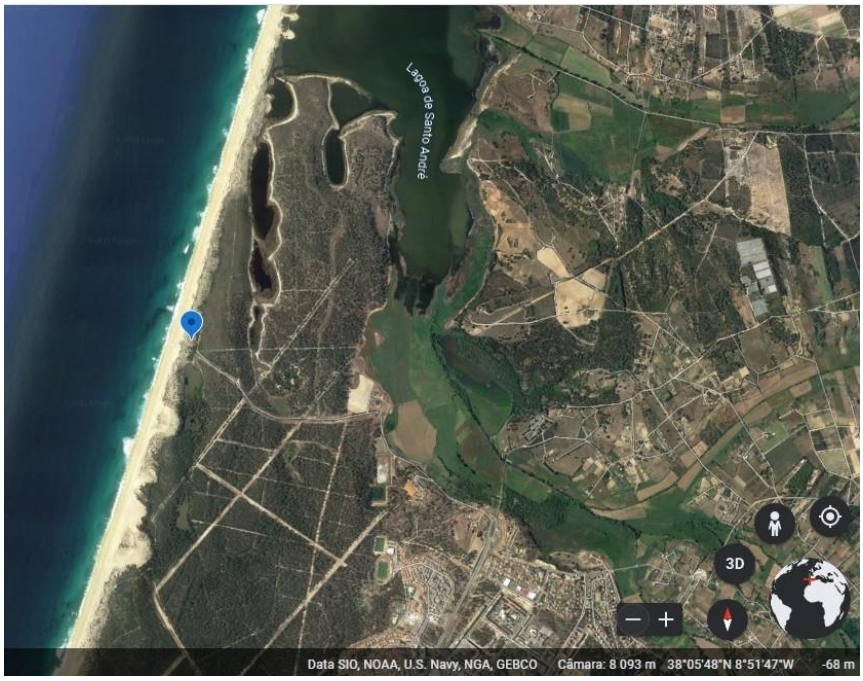


Figure 39 - Aerial view of the dune area of Monte Velho Beach, with white crowberry plants, where the visit took place (Source: GoogleEarth, 2021)

In the Report of the Coastal Working Group (Santos *et al.,* 2014: p29) 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.

Figure 40- Aspect of the Monte Velho beach dune

2.4.2. STUDY VISIT ACTIVITY - PHOTOGRAPHS AND STUDENT ANSWERS TO QUESTIONNAIRE

Figure 41 - Photographs of study visits of students from Sines School to Monte Velho Beach dune.

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

Question 1 | Describe what pleased you much in this visit

«To see cotton weed plants at beach.»

«What pleased me the most about this visit was getting to know new things.»

«What pleased me most was seeing the white crowberry.»

«The plants I observed.»

«It was to know that there were several plants on the beach.»

«To learn new things.»

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. ACTIVITY BOTANY AND ART

DRAWINGS

Figure 42 - Drawings of 4th Grade students from Sines School about white crowberry.

Figure 43 - Poster of the Exhibition of Drawings of Sines School Students held in Sines.

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

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

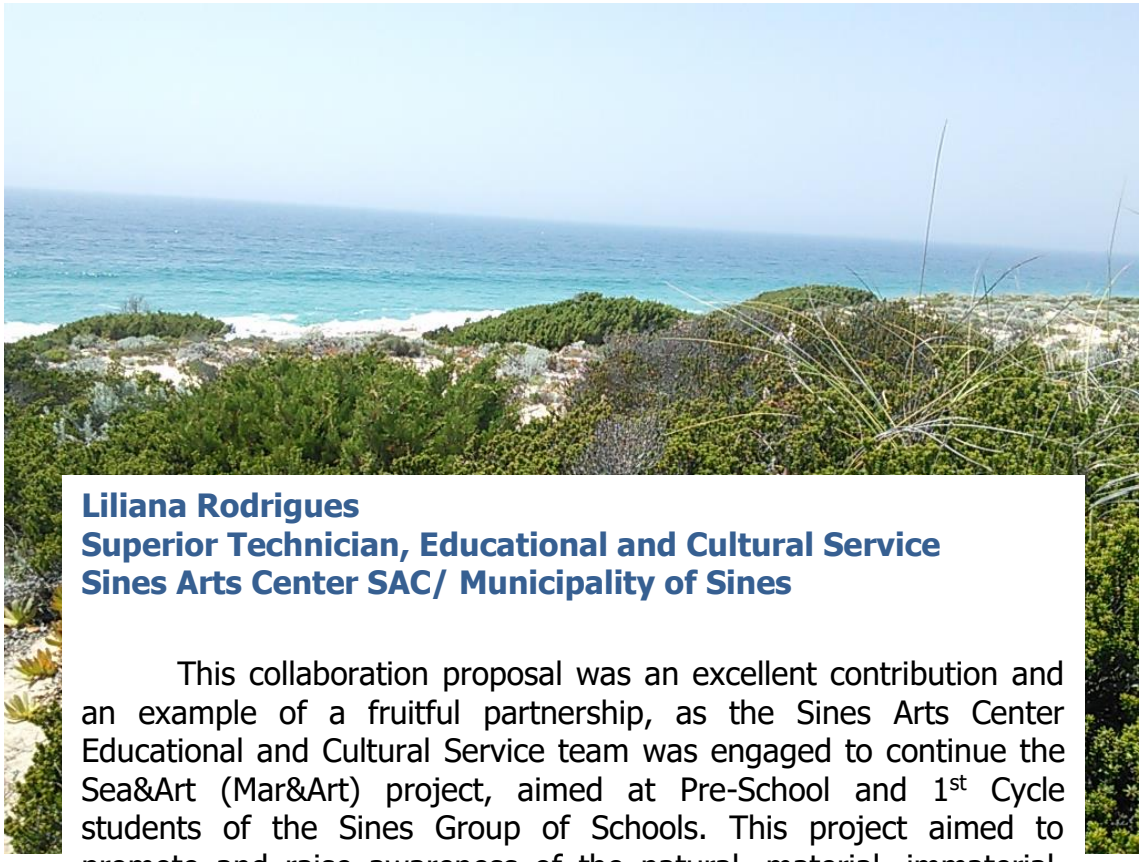
Teacher Rosinda Lino, 4th grade Sines School

«It was an outdoor study class 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,
Sines City Council Service of Environment, Nature Conservation and Health

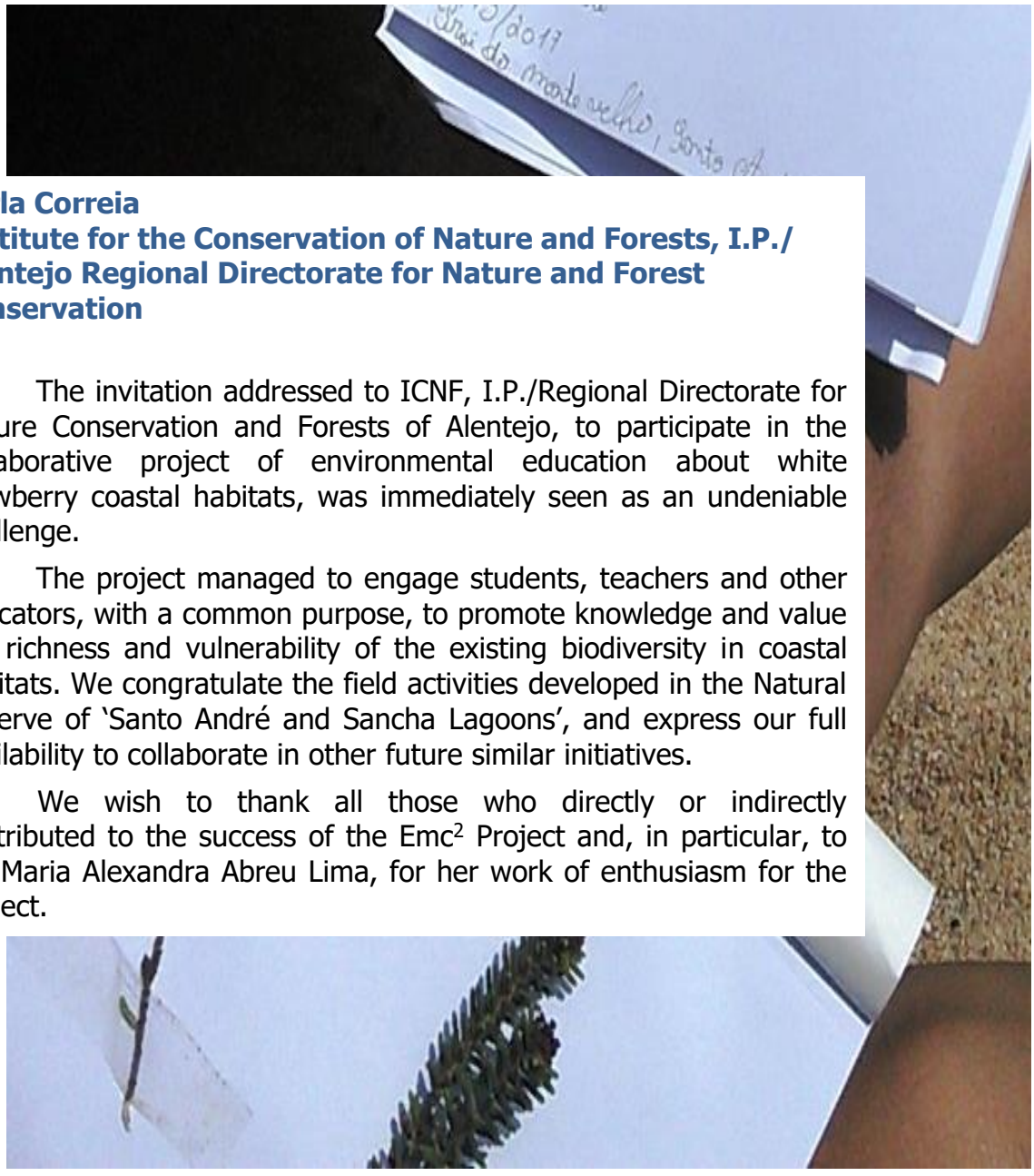
«It was a great pleasure to be engaged in Emc^2 Project and be able to participate and collaborate in it. This Project brought us more knowledge about the White crowberry (*Corema album* (L.) D. Don), once abundant in the region and today in extinction, providing us with tools to continue, within the scope of the municipality's Environmental Education Program, to work on this theme, promoting the exchange of knowledge about the species, its properties and uses and, consequently, about the importance of its conservation.»



Liliana Rodrigues
Superior Technician, 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 Group of Schools. This project aimed to promote 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 visits 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, the call to attention to "our white crowberry plants" and the need for their conservation. On behalf of the SAC Educational and Cultural Service team, I write here our sincere thanks and best wishes for the continuation of this praiseworthy and essential work of investigation and conservation, of 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 biodiversity in coastal habitats. We congratulate 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, in particular, to Dr. Maria Alexandra Abreu Lima, for her work of enthusiasm for the project.

Figure 44 - Poster of the Visit to 'Sancha Lagoon', held in partnership with the Institute for Nature and Forest Conservation, IP/Regional Directorate for Nature and Forest Conservation of Alentejo, on 5th June 2019, World Environment Day.

2.5. OTHER ACTIVITIES

2.5.1. POEMS ABOUT THE WHITE CROWBERRY

Students from Caminha School wrote, in 2016/17, some poems about the 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)

(Translated by Author. Original version in Portuguese Book)

2.5.2. OBSERVATION IN CLASSROOM OF GERMINATED WHITE CROWBERRY SEEDS

Students of a 5th Grade class at Caminha School were given the opportunity to observe in the classroom, in November 2018, some white crowberry seeds that had germinated about a month earlier (Figure 45).

Figure 45- Observation of germinated white crowberry seeds by students from a Caminha School 5th Grade Class

2.5.3. 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 study visits within the Emc^2 Project. However, at the Conde de Oeiras School, with the support 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 (Figure 46). 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, before seeing the plant and a video about it.

Figure 46 – A white crowberry branch used for classroom observation

Questionnaire Answers - (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 'A plant with small fruits of great potential':

https://youtu.be/k_EePxNqmb0

2.5.4. PROJECT EMC² 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 Guided Visits (Lagoa Sancha, 2019; Almograve, 2021- Figure 47)

Figure 47 - Poster of the Visit to the dunes in the Almograve Beach area, held on 7th September 2021, in partnership with C.M. de Odemira and the Blue Flag programme.

Part 03
Analysis of Results and Conclusion

Funding - FCT MARE - UIDB/04292/2020

3. ANALYSIS OF RESULTS AND 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: p93)

3.1. STUDENTS' DEGREE OF KNOWLEDGE ABOUT THE WHITE CROWBERRY

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%**.

In October 2020, due to restrictions caused by the COVID 19 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 very little known. 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.

Project Emc^2 awareness raising initiatives about white crowberry plant 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 a unique case among the small edible fruits, whose most common colors vary between shades of red and bluish-purple.

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

(1) **environmental and ecological terms**– referring to 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) **economic terms**– referring to the multiple uses of wild plants and/or their cultivated relatives (resulting from their genetic 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 that this plant was 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%**. Despite being known to most students, which may indicate the fact that it is very common in the coastal area, **its feature as an invasive plant was, in general, an unknown fact for students** engaged in the project.

3.3. LEARNING IN NATURE – STUDENTS' ENTHUSIASM AND TRAINING

Students' enthusiasm for exploring dune habitats and discovering new plants there was evident in all visits and was expressed in the answers given to the question about what pleased them most. Among several answers, the following ones are transcribed:

- 'What I liked the most was picking plants I didn't knew about and then making a herbarium' (student from Oeiras);

- 'What pleased me most was having the freedom to explore the dunes' (student from Oeiras);

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

- '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);

- 'I really enjoyed to see with the magnifying glass the white crowberry and the hottentot fig (Caminha student).

-'I particularly enjoyed to see the white crowberry plants, to taste their fruits, and see them see with the magnifying glass' (Torres Vedras student)

-'What I liked the most was to feel the flavor of white crowberry and to see other plants' (Torres Vedras student).

At outdoor visit setting, students filled out an Activity Sheet, in which they described the place and recorded what they felt. Among several answers, which illustrate 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 is the smell of the sea and the smell 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 project Emc^2 most rewarding aspect was the **enthusiasm shown by students not only in coastal outdoor visit 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 fruit. 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 plants are fascinating****. On 05/28/2019, we had a field class that, in our view, 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 really 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 plant of our coast*** *and, on the other hand,* ***it stimulated our contact with nature****.»*

These records illustrate **how authentic and meaningful learning is favored 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) a "***good education implies more than the intellect*** *(...).* ***Good education requires emotion.***" (Gottman & DeClaire, 1999)

Concerning this last item, it should be highlighted **Finch's (2008), perspective** which posits 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***».

In students questionnaire (Annex I), in the question for their evaluation of the study visit as 'Very good', 'Good', 'Weak' or 'Very weak', **during 2016/17, 80% of the students considered it 'Very good' and 20% 'Good'**.

The visit was also considered by most students in the **following years as 'Very good' with percentage values of 64% and 83% and as 'Good' with values of 36 % and 17%**.

3.4. EDUCATORS' VISIT EVALUATION

Study visits were evaluated by all engaged Teachers as 'Very good' and their qualitative assessment of these visits to coastal areas with white crowberry revealed that these are **good settings for contact with nature as well as a privileged space for science and botany teaching-learning, to enrich and complement classroom learning and awaken the curiosity of young people for nature.**

Therefore, it was unanimously expressed its **value and usefulness for this topic teaching-learning and for the motivation of students**, 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 insofar 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 visit was considered relevant in the teaching of science and botany as it went beyond 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 a diversified way.»

Rosinda Lino, 4th Grade Teacher (Sines School)

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

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 who participated in the Emc^2 project illustrates the current relevance of developing projects that provide places for action, in which young people are given the opportunity to better know 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 others, engages the participants of this following testimony, which is 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 sensitizing students to the importance of white crowberry conservation, as an endemic plant of our coastal area.»

Ana Pinto and Helena Gama (Coordinators of the 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 study visits 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, white and sometimes pink, aroused the curiosity of all those present, from students, teachers and even me.»

Testimonials of Torres Vedras and Sines coastal areas partners also illustrate the relevance of actions for awareness-raising and conservation of white crowberry populations:

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

«It is considered that only by knowing the values and biodiversity can its conservation be promoted. 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 the white crowberry plant (Corema album (L.) D. Don), once abundant in the region and in extinction today, providing us with tools to continue to work about this theme, within the scope of the Municipal Environmental Education Program, promoting the exchange of knowledge about this species, its properties and uses and, consequently, about the importance of its conservation.»

3.6. A COLLABORATIVE PROJECT AT SCHOOL AND SOCIETY INTERFACE

In order to publicize drawings made by students within the 'Botany and Art' Activity, Drawing Exhibitions were held in various cultural institutions or museums located nearby coastal habitats where project visits took place. Between 2016 and 2019, the following exhibitions were organized: Caminha (2016/17), Sines (2018) and Oeiras (2018/19).

By contributing to the inclusion of topics about natural heritage and environmental issues of coastal habitats in students' curricula and in local community(ies) cultural agenda(s) this project is 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, awareness-raising about 'our white crowberry plants' and the need for their conservation."*

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

In addition to these initiatives, the Emc^2 project collaborated on 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, in 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 the Schools and local communities, which are important in environmental education projects, in terms of their continuity**, namely with regard to issues of current relevance, such as those related to climate change and biodiversity crisis, which are occurring in coastal areas.

3.7. FUTURE CHALLENGES AND GENERAL CONCLUSION

FUTURE CHALLENGES

The Portuguese coast - 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, economical, social, cultural and recreational terms, the articulation of multiple interests of different stakeholders, 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 the Council of Ministers, 2009).

As **only what is known is protected, the need to protect natural values implies the need to study, to better know and raise social awareness about them,** in order to fill in the 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 past 5 years, not only to raise social awareness about white crowberry plant, but also to promote conservation of the declining 'Foz do Minho' white crowberry population. The project will continue, in the coming years, in the coastal areas to be visited, with the assessment, in collaboration with the 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 in different areas of the 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, in order to avoid their local extirpation, with participation of current team (MARE, INIAV., I.P., the local education community, COREMA Association and U.F. of Moledo and Cristelo);

- **to engage more students** in 'Foz do Minho' white crowberry population conservation and **add to propagation from stem cuttings, the propagation by seed germination, 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, exhibitions of drawings and/or photographs, etc.).

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

Knowledge about the values of nature (and in particular those of Protected Areas) was recently considered by the 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 safeguarding*." (CNADS, 2021: p42).

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*».

GENERAL CONCLUSION

Project Emc², with its awareness raising initiatives about white crowberry in nature, in dune habitats, enriches school curricula and contributes to students' learning process. Young people are curious and we should give them the opportunity to also learn in nature (and not just in the classroom), 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 the Emc² project, the students showed, in general, a great enthusiasm during the study visits, in agreement with Abreu (1972: p152) *who highlighted* ***«the emotional and motivating power of study visits as irreplaceable»***. Also about this aspect Finch (2008) 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 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 promoting **conservation actions of a declining white crowberry population** with students' engagement, **Emc² project also empowers and mobilizes youth in nature conservation, within the United Nations Decade on Ecosystem Restoration (2021-2030).**

Therefore, **Emc² project fulfilled its proposed goals** and is a '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 unleash agency*" in favour of environment (UNDP, 2020: p138-139).

Therefore, **education and awareness raising about the value of nature and landscape heritage of dune habitats (often rich in endemisms, 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) assertion that «***progress can also be measured by our interactions with nature and its conservation***», we conclude that, **in this half decade, the Emc² project registered a double progress, due to the various participants interactions with nature,** either in the **awareness raising initiatives**, or in the **conservation actions** of white crowberry plants, which were referred by the students as **fascinating**.

Emc² project message for the future is therefore a message of hope, as hope is known to arouse whenever people recognize their capacity for action for something that motivates and fascinates them, as it has happened, and we hope that it will continue to happen, with white crowberry: fascinating plants.

ANNEX I

STUDENTS AND TEACHERS QUESTIONNAIRES

I.1. OUTDOOR VISIT – STUDENT QUESTIONNAIRE

QUESTIONNAIRE
Name _____
School _____
Local, date _____

1. **Describe what pleased you much in this visit.**

_____
_____
_____
_____

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 (PT 'camarinhas')? If so, do you know how are they used by local populations?
3.1.Yes_____
_____
3.2.No_____
_____

4. Did you know the plant we call 'Hotentot fig' (PT 'chorão')? 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	Weak	Very Weak

You have finished the questionnaire. Thanks for the collaboration.

I.2. OUTDOOR VISIT – TEACHER QUESTIONNAIRE

1. Describe briefly by which means this visit may have contributed for science and botany students' learning process.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

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

Very good	Good	Weak	Very Weak

Suggestions and comments:

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)

Figure 1– Photo of white crowberry specimen from S^{ta} Cruz Beach (T. Vedras) - *Corema album* (L.) D. Don – Herbarium COI (University of Coimbra) - nº COI00072652
Colector – Zimmermann, S.J.; **Date** – August 1889; **Local** – S^{ta}. Cruz Beach

Figure 1– Photo of white crowberry specimen from Sines - *Corema album* (L.) D. Don - Herbarium LISE (E.A.N.- Estação Agronómica Nacional) – nº 41438 **Coletor** – P. Silva *et a*l.; **Date** – 8th May 1957; **Local** – Sines (Baixo Alentejo)

ADDITIONAL INFORMATIONS ABOUT EMC² PROJECT

The awareness-raising initiatives about the white crowberry in our coastal area keep going on and we would like to thank anyone for any questions and comments that may be sent to us. If you would like to join the list of schools and collaborators who receive Emc² project developments updates, please contact:

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