

MARE - Marine and Environmental Sciences Centre
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Emc² Project 'Exploring White crowberry coastal habitats'. Training Guide for Teachers



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GUIDE STRUCTURE

This Training Guide for Teachers is published within the scope of the Emc² Project 'Exploring white crowberry coastal habitats' as a support book for face-to-face or on-line training activities, about white crowberry –*Corema album* (L.) D. Don. This is a plant from the coastal zone, with small edible fruits, white or pink in color, also known as white crowberries. This plant is an Iberian endemism, as it only exists in Spain and Portugal, being therefore, in this region, a natural heritage value. In Portugal, the white crowberry has even been referred in the 19th century, as a 'national treasure': «(...) *white crowberry grows well in maritime areas (...) it defends the land from the incursion of mobile sands, (...), additionally to this, it gives a certain profit with its spontaneous fruits, it is a treasure for our Portugal.*” (Andrada e Silva, 1815).

Part 1 of this Guide, the 'Introduction', includes a description of the Emc² Project (vision, objectives, and current relevance) and a description of the white crowberry (taxonomic classification, geographic distribution, conservation status and reduction of its habitat). This part also includes information about white crowberry morphology and life cycle and topics about climate change, coastal zone and dunes.

In Part 2, the general Methodology of Emc² Project is described with information about two Activities, planned since the beginning of Project, in 2016 (1- Field trip and 2- Botany and Art). Additionally, other two activities are described (3- Activity of 'Recovery of white crowberry populations in decline – case of Foz do Minho white crowberry population', since 2017/18 and 4- Activity 'Germination of white crowberry seeds', since 2021). Suggestion of 'Other Activities' include: 1) Writing of poems and/or texts about the white crowberry and 2) Video exhibition.

In Part 3, a Concluding Note is written, followed by the three Annexes (with additional data to the Guide's main text); the Project Team Contacts; the Acknowledgments and the Bibliography.

PART 1 INTRODUCTION

1.1. DESCRIPTION OF EMC² PROJECT- VISION, OBJECTIVES AND ACTUAL RELEVANCE

The vision of Emc² Project 'Exploring white crowberry coastal habitats' is inspired by a perspective of education that conceives it as being more than the acquisition of knowledge. In a changing world, it must contribute to improve young people's understanding, skills, values, and personal development (Winthrop & McGivney, 2016). In recent years, the ways by which the brain works and by which learning is processed has been investigated. According to Damásio (2020), «*knowledge is built by the sensorial systems – vision, hearing, bodily sensations, taste and smell – with the help of memory*». Young people are curious and should be given the opportunity to explore the nature around them (Figure 1).



Figure 1 - Students during a field trip.

“Young people are curious, and we should give them the opportunity to explore nature.”

Education and awareness in nature is currently relevant due to the phenomena of: (1) 'childhood nature deficit disorder' (Louv, 2005) and (2) 'disconnection from nature' (Navarro-Perez & Tidball, 2012). Emc² project aims to counteract these trends and has as its motto '**nature is an excellent classroom**'. Its mission is to promote learning initiatives in nature, in coastal areas, which are a privileged space for teaching and learning science and botany. Among students who are engaged in the Project, it aims to increase their awareness about the white crowberry plant, which has edible fruits, white or pink, known as 'white crowberries'. Besides this, the Project highlights not only the value of the natural, ecological and landscape heritage of dune ecosystems, but also the need to act for their conservation, due to the threats to which they are subject, some of which are worsened in the current context of climate change.

In the project, students (from elementary and secondary schools) participate in the activities 'Field Trip' and 'Botany and Art' about the white crowberry, whose methodology was published in the Book of Activities (Lima e Vasconcelos, 2017; www.mare-centre.pt/pt/society/educational-programs/emc2). In addition to these two activities, whenever it is evaluated as necessary to recover a white crowberry declining population (as it has happened in 2017 at Moledo beach dune), it is planned a conservation activity. For the case of 'Foz do Minho white crowberry population', the methodology followed was published in Vida Rural (Lima *et al.*, 2020). The results achieved in this conservation activity were integrated into the Panorama Solutions global platform (Lima, 2021; <https://panorama.solutions/en/solution/project-emc2-exploring-white-crowberry-coastal-habitats>) which document and promote examples of inspiring, replicable solutions across a range of conservation and sustainable development topics.

Raising awareness about the value of the natural and scenic heritage of dune habitats and the need to act in their conservation is an educational challenge that must engage young people so that they become aware about the

need to adjust the use(s) and occupation of the coastal zone with nature conservation and landscape values. Emc² project initiatives enrich school curricula and, as some of them are aimed for wider audiences (e.g., Exhibitions of Drawings, Video Exhibitions and Guided Tours), the project favors a greater visibility about the national coastal zone natural heritage, which includes the white crowberry plant.

This plant, although not widely known, has edible fruits, with slightly acidic taste and a high-water content, and was used as food by coastal populations, especially during World War II. Currently is part of small fruits agronomic research area (Oliveira & Dale, 2012).

1.2. WHITE CROWBERRY – AN IBERIAN ENDEMISM. TAXONOMIC CLASSIFICATION, GEOGRAPHIC DISTRIBUTION, CONSERVATION STATUS AND REDUCTION OF ITS HABITAT

TAXONOMIC CLASSIFICATION AND GEOGRAPHIC DISTRIBUTION

The taxonomic classification of White crowberry - *Corema album* (L.) D. Don is the following:

Kingdom-Plantae
Phylum- Tracheophyta
Class- Magnoliopsida
Order- Ericales
Family- Ericaceae
Genre- Corema
Specific epithet- album
Scientific name- *Corema album* (L.) D. Don

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

In the Family Ericaceae, the Genus *Corema* (L.) has only 2 species:

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

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

Endemic to areas of the Atlantic coast of the USA (Maine, Massachusetts, New Jersey, New York) and Canada (New Brunswick, Nova Scotia, Prince Edward I., Québec (Figure 2)

(More information:

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



Figure 2 - *Corema conradii* (Torr.) Torr. ex Loudon – Plant with brown fruits. (Photograph: www.repertoirequebecnature.com)

2► **Species** *Corema album* (L.) D.Don

Endemic to areas of the Atlantic coast of the Iberian Peninsula (Figure 3)

In the Azores there is the subspecies *C. album* subsp. *azoricum* Pinto da Silva.



Figure 3 – White crowberry female plant with white fruits.

Concerning biodiversity, in certain places of coastal areas we can have endemic plants, which are plants that exist in a certain place and nowhere else in the world. Therefore, endemic plants are a legacy of unique evolutionary histories, a natural genetic heritage about which, already in the 1980s, in Portugal, it was considered necessary to ensure some effective refuges due to coastal excessive human occupation threat (Araujo, 1987). Endemic plants are threatened by one or more factors, such as: (1) habitat fragmentation; (2) invasive species and (3) climate change.

Figure 4 represents a map of white crowberry plant worldwide distribution, with subspecies *album* endemic to the Atlantic coast of the Iberian Peninsula and subspecies *azoricum* Pinto da Silva, an Azorean endemism, present in all islands except Santa Maria, Terceira, Flores and Corvo.

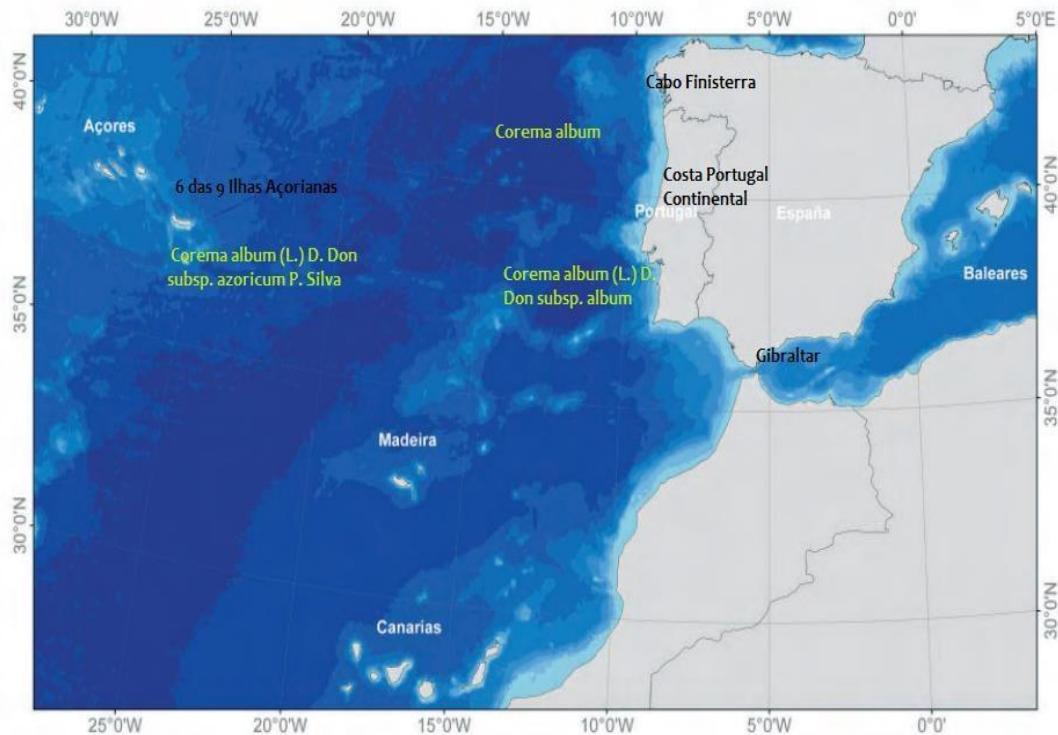


Figure 4- Worldwide geographic distribution map of *Corema album* (L.) D. Don and its two subspecies. Photo: Adapted from IPMA, 2011 (<https://www.ipma.pt/export/sites/ipma/bin/docs/publicacoes/atlas.clima.ilhas.iberico.2011.pdf>)

The white crowberry - *Corema album* (L.) D. Don - is, therefore, an Iberian endemism, as worldwide it only exists in Portugal and Spain. The GBIF platform - 'Global Biodiversity Information Facility' shows the worldwide geographic distribution of white crowberry in: www.gbif.org/species/8053367

“The white crowberry - *Corema album* (L.) D. Don – is an Iberian endemism, as worldwide it only exists in Portugal and Spain.”

HABITAT REDUCTION OF *C. ALBUM* IN ITS DISTRIBUTION AREA

In the study entitled 'Fragmentation as the main cause of habitat reduction for *Corema album* in its distribution area' Clavijo *et al.*, (2002) 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 (Parque Natural de Doñana) and there is another well-preserved population in Tróia dunes.*».

The Tróia dunes, cited in this 2002 study, as a location with a well-preserved population of white crowberry plant, are part of the Tróia Peninsula (Figure 5). This was described, in 1990, as: «*one of the main dune structures of our coast, it holds, along with dozens of the most common plant species, because they occur throughout the Portuguese coast, some Portuguese, Iberian and European endemisms.*» (Henriques, 1990).

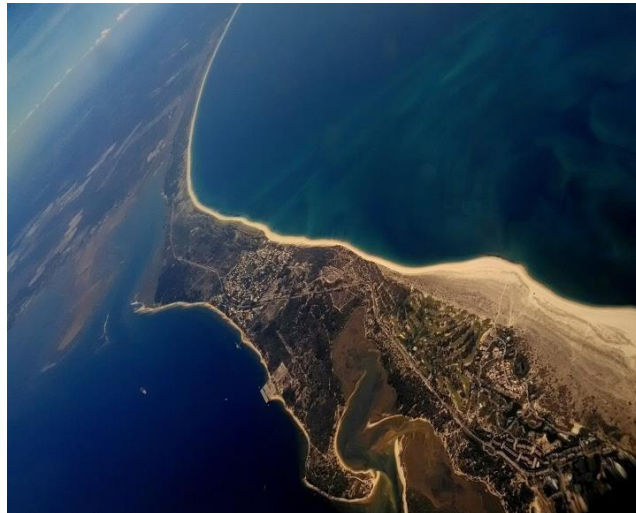


Figure 5- Aerial view of part of the Tróia Peninsula, with a dune area (Alexandra Abreu, 2019).

Key ideas about the **conservation status of white crowberry populations** on the Portuguese coast according to Clavijo *et al.* (2002) study:

- an extensive population between Nazaré and Ovar
- a well-preserved population at Tróia dunes
- populations reduced to fragments - Foz do Minho, Monte Gordo «(...) *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 protection measures and habitat regeneration.*»

In the Azores archipelago, *C. album* (L.) D. Don subsp. *azoricum* is included in the list of the 100 taxa for priority management in this archipelago (Cardoso *et al.*, 2008) and is considered a priority species for conservation (DR, 2012).

The *C. album* (L.) D. Don subsp. *album* has not been evaluated for mainland Portugal. However, in the Forestry Management Plan of the Mata Nacional do Camarido (Caminha) a decrease of white crowberry plant population in this Forest was reported (ICNF, 2010), based upon data from 1995 and 2007.

According to Gil-López (2011), in recent decades, due to various factors, there has been a regression of the white crowberry plant, with their 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).

“Several studies report that in recent decades there has been a regression of the white crowberry plant, with its disappearance in different areas of Iberian Peninsula western coast.”

In Spain, already in the 1980s, it was considered a Vulnerable species on the Red List of Vascular Flora (Barreno *et al.* 1984, cit. Sevillano, 2004). In the North of Spain, in Galicia, it was considered, in 2004, in clear regression with presence in only six localities (Sevillano, 2004) and, in the South of Spain, 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).

Key ideas about the conservation status of the white crowberry in recent decades:

- in the Azores it is a priority species for conservation and in mainland Portugal it has not yet been evaluated;
- there has been a regression of the white crowberry, with its disappearance in different areas of Iberian Peninsula western coast;
- in Spain, the white crowberry is included in the Red Lists of Vascular Flora in different regions (e.g. Galicia and Andalusia)

1.3. WHITE CROWBERRY – INFORMATION ABOUT ITS MORPHOLOGY AND LIFE CYCLE

The white crowberry is a species of coastal habitats, mainly dunes, but also rocky sites, occurring in the Azores in lava and volcanic ash. It has female and male plants (dioecious), bushy, very branched, about 30-75 cm (or 1m) tall. The female and male flowers are small, brownish in color (Figure 6) and the pollen formed in the male flowers is transported to the female flowers by the wind (aemophilous pollination).



Figure 6- *Corema album* (L.) D. Don with small brownish flowers

In the successfully pollinated female flowers, fruit formation begins, which ripen between late spring and during summer.

Edible fruits are spherical (5-8 mm in diameter) and with white or pink color. These fruits are food for frugivorous animals (e.g., rabbits, foxes, seagulls, and blackbirds) which, after ingesting them, act as dispersing agents for white crowberry seeds (Calvino-Cancela, 2005). Seed germination has been studied and a curious fact is that it is improved by the passage in the digestive system of animals that ingest the fruits (Alvarez, without publishing) (Clavijo *et al.*, 2002). Therefore, the white crowberry plant, like other species, does not live

in isolation and is an integral part of ecosystems, in which interdependent relationships between different living species are established. In nature it is possible to observe that there is some facility for *C. album* to take root after breaking branches or part of the plants stay buried in the ground (Oliveira *et al.*, 2022).

White crowberry has very small leaves, called ericoids (Figure 7) coated with a thick cuticle that reduces water loss through transpiration, allowing it to survive extreme heat during summer. Roots allow water and mineral salts absorption from sand (or other substrates) and retain mobile sands (Figure 8).



Figure 7- *Corema album* (L.) D. Don - Female plant with small fruits and leaves



Figure 8 – White crowberry root system in a dune with strong erosion at Moledo beach

Key ideas about White crowberry **morphology and life cycle**

- dioecious species (with female and male plants), bushy, very branched and about 30-75 cm tall (some can reach 1m);
- very small leaves (called ericoids), covered by a thick cuticle that reduces water loss through transpiration;
- plants flower between late February and late April, with the formation of small male and female flowers, being the pollen formed in male flowers carried out by the wind to the female flowers (aemophilous pollination);
- in summer, we can clearly distinguish the male bushes from the female ones, as only the female ones hold white or pinkish fruits (see figure 9);
- the edible fruits are formed in April or May, in female plants, and their maturation occurs during summer. They are spherical fruits (ca. 5-8mm diameter), rich in water and with very hard seeds (ca. 3);
- the fruits are food for dune animals (e.g. seagulls and rabbits) which, after ingesting them, act as dispersers of white crowberry seeds (seeds present in the animals' feces);
- mechanical and chemical scarification of the seed coat can enhance seed germination by increasing the permeability to water and gases (e.g., in animals that eat white crowberry fruits, their gastric acid promotes abrasion of seed);
- after germination, not all seedlings root, especially in conditions of water scarcity and high temperatures (e.g. in summer) which cause an increase in seedling mortality;
- the roots, which are thick and branched, allow water and mineral salts absorption and are beneficial in retaining mobile sands in dune systems.



Figure 9 – White crowberry bushes in summer, when distinction between male and female plants is facilitated by the presence of white (or pink) fruits only in female plants.

1.4. CLIMATE CHANGE, COASTAL ZONES, AND DUNES

CLIMATE CHANGE AND COASTAL ZONES

Coastal zones are constantly changing, and it is estimated that about 40% of the world's population lives within a radius of 100 km from the coast (Martínez, *et al.* 2007, cit. Ward, Megonigal, Bond-Lamberty *et al.*, 2020). Within climate change context and the increasing trend of urban development and human occupation pressure along the coast, it is important to assess coastal vulnerability associated with mean sea level rise (MSL) and floods caused by occurrence of extreme climate events, to support the definition of adaptation strategies to climate change (Andrade *et al.* 2006; Antunes, Rocha & Catita, 2017). As an example of these extreme climate events in coastal zones, it should be mentioned the 'Hercules' storm, which occurred in the Atlantic, in 2014 winter, at several countries besides Portugal (Santos, Mendes, & Corte-Real, 2014; Pinto, 2014). After this storm, other events occurred, such as a storm in December 2019 in Moledo beach (Figure 10). Added to these events is the erosion and retreat trend of the national sandy coast analyzed in the Report of the Coastal Working Group (Santos *et al.*, 2014). Coastal vegetation is also threatened by forest fires (eventually associated with heat waves).



Figure 10 - Moledo beach dune after a storm in December 2019, with dune erosion and exposed geotextile.

“Dunes with vegetation are dynamic habitats of high scenic and ecological value and are important in protection against extreme events.”

DUNES – A PARTNERSHIP OF SAND, WIND AND PLANTS

For coastal zone dune formation, we need 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, it is retained in a mound. In these mounds, over time, plants help to capture and fix more sands brought in by the wind. During field trips, students are told about the role played by plants in the formation and stabilization of dunes, and in fixing mobile sands (Figure 11).



Figure 11 - Root system of white crowberry plants in an eroded dune (Tróia, Portugal, September 2021)

Key Ideas about Dunes

The dunes are a land-sea transition zone where the variable deposition of sediments (sand) occurs and, therefore, are in constant change.

Most dune systems have several zones (with different amounts of organic matter in the soil and different existing species):

-the embryonic-dune, the primary dune, inter-dune space, the secondary dune, and if the system is well preserved, the tertiary dune.

The secondary dune or grey dune is richer in organic matter, which allows the existence of shrubby species, more demanding in terms of nutrition, such as **White crowberry - *Corema album*** subsp. *album* or **Juniper- of-the-sands-*Juniperus turbinata*** subsp. *turbinata*

Vegetated dunes are important in protecting against extreme climate events and can be destroyed by: excessive trampling, the existence of trails for all- terrain vehicles, sand extraction for civil construction, construction of roads and housing.

Concerning the conservation status assessment of various habitats carried out by the European Environment Agency, in 2020 (EEA, 2020), among various habitats assessed (Art. 17, Habitats Directive 92/43/EEC), coastal habitats obtained the lowest proportion in the 'good condition' category.

In this EEA report, the habitats of dunes and marshes/swamps were assessed to be in a poor state of conservation (more than 50%) which reveals the importance of acting in their recovery and conservation.

PART 2 METHODOLOGY

2.1. ACTIVITIES 'FIELD TRIP' AND 'BOTANIC AND ART'

The methodology of the activities 'Field Trip' and 'Botany and Art' is described in detail in the Book of Activities (Lima e Vasconcelos, 2017; www.mare-centre.pt/pt/sociedade/programas-educativos/emc2).

Their main data are summarized in the following paragraphs.

'FIELD TRIP' ACTIVITY

In the 'Field Trip' Activity, which is described in Annex 1, students participate in a visit to a coastal area with white crowberry plants (Figure 12), for about 2 hours, in which they can: 1) see the white crowberry plant and other plants; 2) collect small branches (preferably already fallen in the sand) for a mini-herbarium; 3) fill in the Activity Sheet (in which they describe the place and record what they feel - Annex 1).

During the visit, students should be referred to the geographic distribution of white crowberry worldwide and introduced to the concepts of endemic plant and invasive plant. The **plants chosen as project case studies** include, **as an endemic, the white crowberry and as an invasive, the hottentog fig – *Carpobrotus edulis* (L.) N.E.Br.** – (Figure 13 and annex 1 – Poster A3) with negative effects on ecosystems globally (Campoy *et al.* 2016) and nationally.

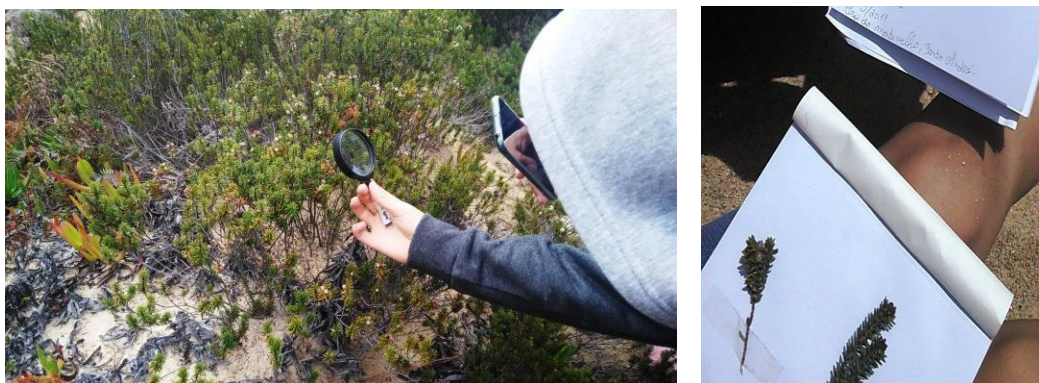


Figure 12 - Visit to dune with white crowberry plant and gathering of stems to a herbarium.



Figure 13 – Hottentog-fig plant - *Carpobrotus edulis* (L.) N.E.Br. overlapping a young white crowberry plant (left) (©Lima, M.A., 2016)

After the visit, at classroom, students answer a questionnaire, and the Teachers are asked to fill in a Field trip Evaluation Survey (see both documents in Annex 1).

'BOTANY AND ART' ACTIVITY

In the 'Botany and Art' activity, at classroom, students draw the landscape and/or plants they saw. This activity sheet (see Annex 1) has an image of a white crowberry herbarium specimen, previously collected in the same coastal area visited in Emc² Project (Figure 14 and Annex 2).

The **extirpation of white crowberry plants** (i.e., **their local disappearance**) in an area can be inferred by comparing their current occurrence in nature and the existing records in herbarium collections (e.g., in Colares-Sintra, PT, where currently we do not have white crowberry plants, there are records in national herbaria of specimens previously collected there). This is an example, at local level, of plants that currently only exist in herbariums, due to extirpation, a situation that people must be aware of and should not occur in other coastal places.

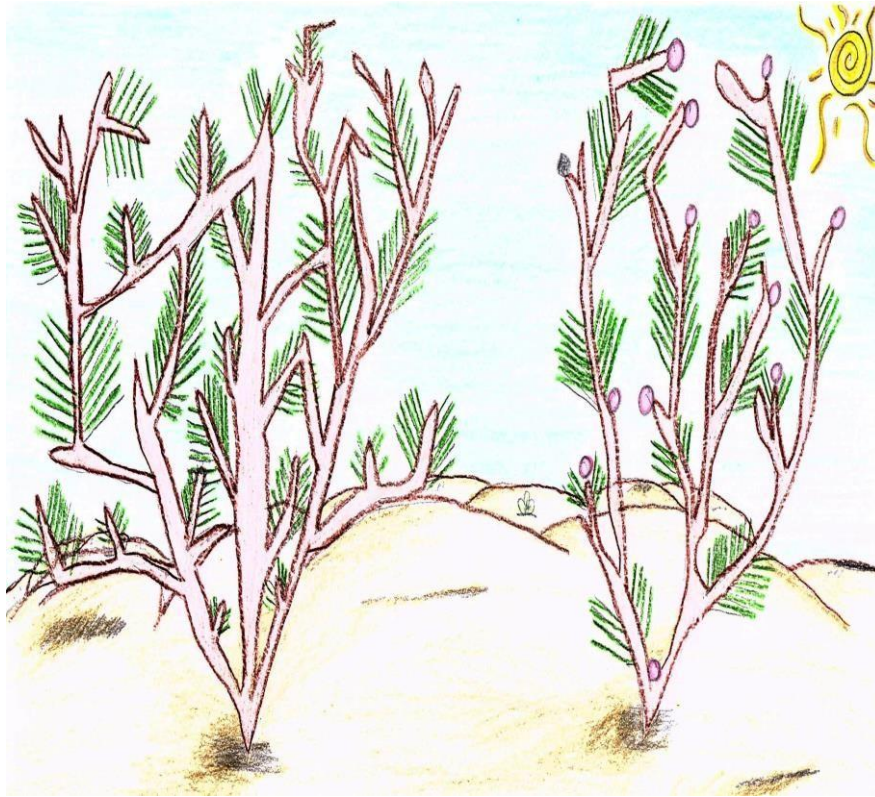


Figure 14 – Example of a student drawing (above) and an image of a white crowberry herbarium specimen (bottom).

2.2. CONSERVATION ACTIVITY OF DECLINING WHITE CROWBERRY POPULATIONS – THE CASE OF FOZ DO MINHO WHITE CROWBERRY POPULATION

«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

Within Emc² Project it was verified that Foz do Minho white crowberry population was declining, and for that reason it was decided to start its conservation. This population declining situation is in agreement with the assessment of Clavijo' *et al.* (2002) study, which has identified it as a degraded population. Therefore, with the support of researchers from INIAV, I.P., the propagation of the white crowberry started in 2017, in greenhouses at Oeiras, through rooting of stem cuttings – i.e., pieces of stem with leaves collected from dune plants. The propagation methodology followed was published in the Journal *Vida Rural* (Lima *et al.*, 2020). Students from Caminha Schools have participated in plant reintroduction at Camarido Forest, within a partnership with COREMA (a local NGO) and the Union of Parishes of Moledo and Cristelo, with main steps (figure 15) and chronologic phases below described.

CHRONOLOGY

- 1) october 2017- harvesting of stem cuttings (female and male) at Moledo dune. Stem cuttings were kept in refrigerator during 7 days before they were put in turf substrate. After 75 days they were evaluated and 5 and ½ months later they were potted (March' 2018);
- 2) november 2018- the first stem cuttings rooted at INIAV, I.P. greenhouse (Oeiras) were reintroduced in Moledo;
- 3) may 2019- evaluation of reintroduced plants growth made by students;
- 4) august 2000- in one of the reintroduced female white crowberry plants occurred fruit formation;
- 5) july 2021- reintroduction of more plants obtained by stem cuttings rooting and, in several previously reintroduced white crowberry plants, some fruits have been formed.



Figure 15- 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.

2.3. OTHER ACTIVITIES

2.3.1. WRITING OF TEXTS AND/OR POETRY ABOUT WHITE CROWBERRY

Students can be proposed to write texts and/or poetry. In 2016/17 this activity took place at a School in Caminha, with part of a poem 'A white crowberry' here transcribed:

If I were a white crowberry / I would live by the sea / I was small and white / The beach was my partner.

2.3.2. SEED GERMINATION

Students of a 5th grade class at Caminha School were given the opportunity to see, in the classroom, in November 2018, some white crowberry seeds that had germinated a month before (Figure 16). The seed germination protocol (see Annex 3) uses materials that can be safely handled by students and was tested in 2021/22 at a School, in Caminha. The germination percentage is generally low (values ca. 5-10%). It should be highlighted that in stem cuttings propagation, the plants obtained are all genetically identical to the plant from which the cuttings were taken, whereas in seminal propagation (by seeds) the plants are genetically different from each other. This genetic variability is beneficial to populations in several ways (for example, in disease resistance, this variability produces plants with different degrees of resistance, which prevents all of them from being equally affected and eventually all population being decimated).



Figure 16- Observation in classroom of white crowberry germinated seeds

2.3.3. VIDEO EXHIBITION

Whenever useful, the VIDEO (3 minutes) 'White crowberry. A plant with small fruits of great potential' can be seen by students. Video link: https://youtu.be/k_EePxNqmb0

PART 3 CONCLUDING NOTE

«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 all living things.»

Human Development Report 2020 (PNUD 2020)

Emc² project awareness raising initiatives about white crowberry plant (Figure 17) highlight two peculiar features about this plant, namely those related to its:

(1) **worldwide geographical distribution** – 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 pinkish color is uncommon among the small edible fruits, whose most common colors vary between shades of red and bluish-purple.



Figure 17- Aspect of Emc² Project Field trip about white crowberry plants.

Emc² project also raise awareness about dune flora importance in:

(1) **environmental and ecological terms**– concerning the value of endemic plants and the crucial role of coastal vegetation to sustain mobile sands;

(2) **economic terms**– concerning multiple uses of wild plants and/or their cultivated relatives (resulting from their genetic breeding) within food and pharmaceutical industries, among other sectors.

The Emc² Project, started in 2016, has contributed over the last years to raise awareness about white crowberry plant and to foster conservation of the declining Foz do Minho white crowberry population. **Conservation actions for other declining white crowberry plant populations are important because in recent decades, due to various factors, their disappearance has occurred in different areas of Iberian Peninsula western coast** (Fernández de la Cigoña, 1988; Sónora, 1994; Díaz, 2000; Parra *et al.*, 2000)(cit. Gil-López, 2011).

During the United Nations Decade for the Recovery of Ecosystems (2021-2030) Emc² Project will continue to raise awareness about white crowberry plant and foster its conservation, through its initiatives and Teacher training, for which this Guide is a useful resource.

ANNEX 1

MARE – Marine and Environmental Sciences Centre

Project Emc² -Exploring White crowberry coastal habitats

FIELD TRIP – ACTIVITY DESCRIPTION

Activity description

Teacher Name _____

Local, date _____

Duration- 2H

Ages- from 7 years

Nº. Participants- 30

Activity type - multi-sensory approach, playful. Working perception.

Material - Record sheets. Poster with two species to look for. Pencils, magnifying glasses. Self-adhesive tape 2 to 3 cm wide.

Goals- Motivate for discovery in natural spaces. Improve the ability of observation and communication of observed material. Disseminate the concepts of endemic and invasive species and dune flora role in coastal habitats.

Visit- Observation of different plants and data registration through description and/or drawings. Teacher explains what should be seen, which behavior rules to respect and activity duration. Students observe different plants, which are described and/or draw, and some material is gathered and kept in an envelope. At the end, all participants gather in a circle to see the collected materials. The Teacher can ask some questions and start conversation.



'White crowberry' (P. Oliveira, INIAV)

'Hottentot fig' (H. Hillewaert, Creative Commons)

After field trip- To evaluate this activity students fill a survey. Observation of students' behavior also gives information about the progresses made.

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FIELD TRIP- POSTER

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Corema album (L.) D. Don - white crowberry female plant with fruits (©Lima, M.A, 2015)



A White crowberry plant (left side) Corema album (L.) D. Don – and the invasive plant Hottentog-fig- Carpobrotus edulis (L.) N.E.Br. (center and right side) (©Lima, M.A, 2016)

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FIELD TRIP– ACTIVITY WORKSHEET

FILL OUT THIS FORM

Name _____

Date _____

Mark with a cross in this Portugal map the location of this field trip.



Brief description of place (e.g., hilly or flat, dry or wet; sounds and smells)

Gathered material

List:

Drawing(s) – in notebook and use legend(s)

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FIELD TRIP– STUDENT SURVEY

Name _____

School _____

Local, date _____

1. Describe what pleased you most in this visit.

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

2.1. Yes ____

2.2. No ____

Justify your answer:

3. Did you know the white crowberry fruits (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	Bad
-----------	------	-----

You have finished the survey. Thanks for the collaboration.

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FIELD TRIP– TEACHER SURVEY

Teacher Name _____

School _____

Local, date _____

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

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

Very good	Good	Bad

Suggestions and comments:

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BOTANY AND ART ACTIVITY

Around the world botanists keep a record of plant species and are helped in this task by illustrators who draw studied plants. Illustrations can be done in digital format, with illustration software, or in paper with pencil or brush.

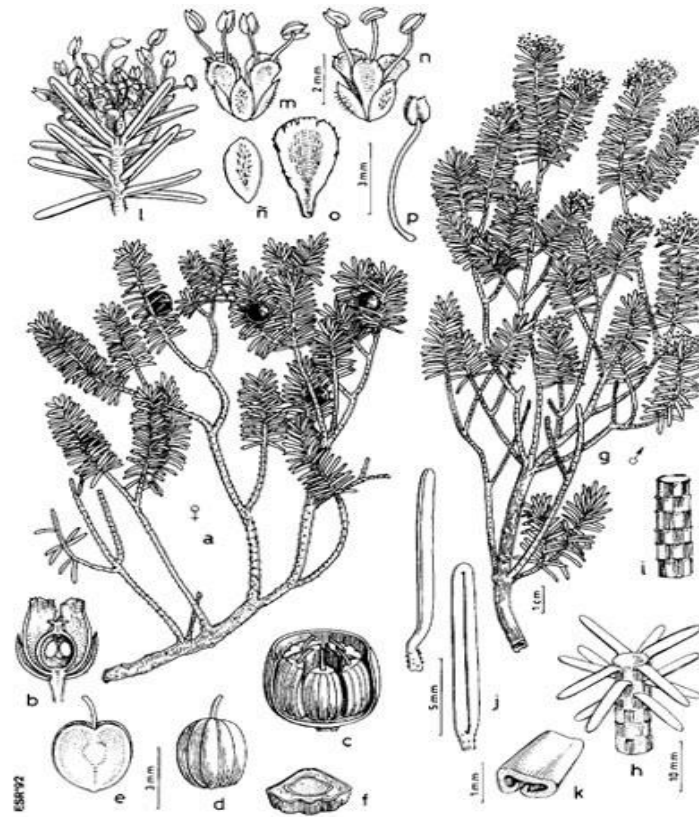
Drawing activity: Based upon Figures 1 and 2, as well as upon white crowberry plants you may have seen in nature, make a **drawing, with pencils, about this species in a A4 paper sheet.**



Photo of white crowberry specimen- *Corema album* (L.) D. Don held at Herbarium LISE (E.A.N.- Estação Agronómica Nacional) – nº 24780

Collector – Braun Blanquet et al.; **Date** – 14 May 1949; **Location** – Moledo beach dunes (Camarido)(Photo: Alexandra Abreu, 2016)

(page 1 of 2)



Lám. 192. - *Corema album*, Almonte, Huelva (MA 328460): a) hábito en ejemplar femenino fructificando; b) sección longitudinal de una flor; c) fruto abierto; d-f) semillas. Sanlúcar de Barrameda, Cádiz (MA 248833): g) hábito en ejemplar masculino en flor; h) detalle de la inserción de las hojas; i) ramilla con las cicatrices de las hojas; j, k) hojas; l) ramilla con flores masculinas; m, n) flores masculinas; o) pétalo; p) estambre.

Figure 2- White crowberry illustration from Flora Vascular

(link: <http://www.floravascular.com/index.php?spp=Corema%20album>)

INTERESTING INFORMATION:

LEAVES - White crowberry shrubs, usually between 30-75 cm tall, can reach 1 m and their very small **leaves** (called 'ericoid') are covered by a very thick cuticle to minimize water loss by transpiration, allowing them to survive summer high temperatures.

FRUITS - White crowberry female shrubs produce spherical small **fruits** (5-8 mm diameter) – known as 'camarinhas'- of white or pinkish color.

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ANNEX 2

Example of a white crowberry Herbarium specimen image used in Botany and Art Activity



Image of a White crowberry- *Corema album* (L.) D. Don specimen from Herbarium LISE (E.A.N.- Estação Agronómica Nacional)– nº 24780

Colector – Braun Blanquet *et al.*; **Date** – 14 may 1949; **Local** – Moledo Dunes (Camarido)

p.s.: Herbarium images of *Corema album* (L.) D. Don from other Portuguese coast can be requested by message (see below the contact of project team members).

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ANNEX 3

MARE – Marine and Environmental Sciences Centre

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SEED GERMINATION - ACTIVITY WORKSHEET

Group/Class and Teacher _____

Name(s) _____

Date _____ School, Place _____

Material collected: _____

List of material: Cotton, Water, Tray, Glass Cup, Lemon juice.

Protocol:

1. Collect fruit seeds, rinse, clean with absorbent paper or cotton cloth and store them in an envelope in the refrigerator (2-3 months).
2. Place seeds in a glass of lemon juice (1 to 2 days) until it changes from yellowish to brownish color (lemon juice is acidic and it is used for acid scarification of the seed)
3. Place seeds on a tray, with humid cotton under and over the seeds.
4. Keep the cotton humid (spray). Record appearance of germinating seeds.
5. Change the germinated seeds to sand mixture before their introduction into nature.



Fig. 1- Germination of white crowberry seeds on humid cotton

p.s.- use a page to record the number of germinated seeds and dates.

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COLLABORATION:

- Filipa Lacerda, Elsa Cabral, Mafalda Mascarenhas & João Pequeno (MARE);
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- Herbaria colleagues: Isabel Saraiva & Jorge Capelo (LISE, EAN-Oeiras); Ana Isabel Correia (LISU, U. Lisboa-MUHNAC); Pedro Arsénio (LISI, U. Lisboa); Cristiana Vieira (PO, MHNC-UP); Fátima Sales (COI, U. Coimbra) and M. Manuela David (ALGU, U. Algarve).

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