

Territory defence throughout conservation of the plant diversity: the project of the Protected Sea Area of Capo Carbonara (South eastern Sardinia)

Gianluigi Bacchetta, Giuseppe Fenu, Gianluca Iiriti, Efisio Mattana,
Francesca Meloni, Paolo Mulè, Lina Podda
Centro Conservazione Biodiversità (CCB)
Dipartimento di Scienze Botaniche
Università degli Studi di Cagliari
Viale S. Ignazio da Laconi, 13 – 09123 Cagliari ITALY
bgsar@ccb-sardegna.it

Abstract – Contents, activities in progress and results achieved of a project on the conservation of the plant diversity of the Protected Sea Area of Capo Carbonara, funded in 2005 by the Ministry of Environment and Territory Protection are illustrated.

I. INTRODUCTION

The aim of the Sardinian Centre for Conservation of Biodiversity (CCB) is the study, conservation (*ex situ* and *in situ*) and management of the plant diversity of Sardinia and the insular territories of the Western Mediterranean Sea. The strategy of the *ex situ* conservation is realized in the Germplasm Bank of Sardinia (BG-SAR) and provides collecting and management of a great number of plant entities of the island, drawing particular attention to rare taxonomic units or threatened, endemic and which present phytogeographical interest.

At the same time the CCB works to guarantee the *in situ* conservation of *taxa* with the help of monitoring the populations and their conservation status.

Unifying these strategies and basing on the decree instituting the Protected Sea Area of Capo Carbonara it was possible to propose a project directed to the plant diversity conservation of the territories of south-eastern Sardinia.

II. THE PROJECT

The project, funded by the Ministry of the Environment and Territory Protection (MATT), was launched from the collaboration between the CCB of the Cagliari University and the Municipality of Villasimius, which runs the Protected Sea Area of Capo Carbonara.

The initiative has many objectives: on the one hand it is to acquire a profound knowledge of the species and habitat extinct and/or particularly sensible; on the other hand, being an applied project it will carry on for years both the seed collection and its *ex situ* conservation, the populations and habitats monitoring and the individualization of the territory planning and management.

To all this there joins an action directed to sensitize the population, local and non, on the thematics of the conservation and the sustainable development of the territory. Moreover, a possibility of careful and exact environmental information is given, in this way complying

with the directive 2003/4/CE that regards the access to the environmental information incorporated in Italy with the D.Lgs. 195/2005.

It is a three-year project which develops rapidly on all the pSIC of the Villasimius Municipality territory and has as its aim to provide elements concerning plant diversity to study and lastly to plan a harmonic development between both the coastal and sea areas. In this way, it aims at unifying the environmental protection secured by Protected Sea Area with that relative to the Sites of Comunitary Importance of the establishing net Nature 2000, waiting for the imminent activation of the pSIC Management Plans, funded by the Sardinia Region through the Structural Funds (POR 2000-2006, Axis I, measure 1.5).

All the rare, threatened and endemic species as well as those which present phytogeographical interest in the area under discussion will be collected, conserved and carefully studied. At the same time those activities are applied to the main entities of potential interest in restoration and environmental recovery through the techniques and methodologies of naturalistic engineering. It is necessary to point out the collaboration activated with the main local garden centre with the help of which autochthones seed is multiplied. That will make it available both for environmental restoration and recovering activities and for the urban greenery and possibly in the flower gardening sector.

Having different activities in the project, nine persons in the Centre, the personnel of the Municipality and of the Protected Sea Area and the operators of the “Centoverde Vivai” collaborate collecting and multiplying the germplasm. Moreover, they collaborate with the “Diomedea Società Cooperativa” that manages the services of the environmental information and increasing awareness in the Visiting Centre of the Protected Sea Area.

The results of the project will be useful in the territory planning on both the municipality and overmunicipality level according to the new regional and national prescriptive tendencies of the integrated environment projecting and planning. The management plan has its aim to identify the forms of the territory usage and in this way to promote the conservation and recovering of the naturalization and specific and ecosystemic biodiversity taking into consideration social and economic usage [1].

III. STUDY AREA

The studied territory contains seacoast and insular areas of the Protected Sea Area of Capo Carbonara in south-eastern Sarrabus (Fig.1).



Fig. 1 Index-map of the territories of Protected Sea Area of Capo Carbonara.

The Protected Sea Area was founded by the Ministry Decree on 15/09/98 (modified on 3/08/99) with the participation of the Sardinian Region and Villasimius Municipality. It contains the sea area in front of the Cavoli and Serpentara Islands and the seacoast belonging to Villasimius. Its territory is limited by Capo Boi to the west, Secca di Libeccio to the south and Punta is Porceddus to the east. The protected territory is 8.598 hectares in size.

The coast length is 41 km long and it includes such beaches as Porto Giunco, Simius, Campu Longu, Campus etc., where rocky promontories alternate with such small bays as Porto Sa Ruxi or Punta Molentis.

The lithologies are essentially referred to ercinic batolite of Sarrabus emerged at the end of the ercinic orogenesis in the Middle Carboniferous. They were constituted mainly by granites and granodiorites subjected, during the alpine orogenesis, to tectonic movements that deformed according to the prevalent direction NW-SE. The veins present the same orientation. They are mainly of a basic nature, dominated by lamprophiric and spessartitic lithologies that assume a particular relief in the determination of the coastal and submarine landscape. In fact, the coast line is formed by promontories with the same orientation of those of Capo Carbonara [2].

The oldest organogenic deposits present in the area are formed by fossiliferous beaches conglomerates known as "tirrenian platform". The last one is signalled in various points of Capo Carbonara promontory. One of the most important outcrop is near Cava Usai in the locality of Portu su Forru and it has a total extension of about 400 metres.

This formation is surmounted by sandstones of aeolic origin (paleodunes), a reddish paleosoil (palexeralf), and in the submerged environment by the sedimentation and cementation of beach-rocks. In the surrounding landscape, ancient shapes of smoothing such as "inselberg" and "tor" ornament the ridges and the plateaux at an elevation around 400 and 500 m [2].

From the biotic point of view, the importance of the territory is testified by the presence of the 3 proposed Comunitary Importance Sites (code ITB040020: Isola dei Cavoli, Serpentara e Punta Molentis; code ITB040055: Campu Longu; code ITB040021: Costa di Cagliari) and 2 ZPS founded (code ITB043026: Isola di Serpentara; code ITB043027: Isola dei Cavoli) and one to be founded (code ITB 043028: Capo Carbonara e Stagno Notteri).

There is a great number of exclusive endemic plant or species with a limited spreading distributed prevalently on the Cavoli and Serpentara Islands. It is intended to plot the abundance of species *Brassica insularis* Moris (All. II and IV Directive Habitat 92/43/CEE) only on the Cavoli Island, where it constitutes one of the most important populations. The proof of this fact is that the island itself has the name of this species. So the Serpentara Island is considered locus classicus for recently described two endemisms [3]: *Ferula arrigonii* Bocchieri, sardinian-corsican endemism that can be found in a few coastal and insular areas and *Silene valsecchiaiae* Bocchieri, an exclusive endemism of eastern Sardinia. Also *Limonium retirameum* Greuter et Burdet distributed in all the coastal area results exclusive of this sector of the island.

Along the same coast other important endemisms can be found, among them the next ones can be quoted: *Verbascum conocarpum* Moris, *Helicodicerus muscivorus* (L. f.) Engler, *Bryonia marmorata* Petit, *Aristolochia tyrrhena* Nardi et Arrigoni, *Helichrysum microphyllum* (Willd.) Camb. ssp. *tyrrhenicum* Bacch., Brullo et Giusso.

The presence of *Rouya polygama* (Desf.) Coincy, monospecific genus and Central Mediterranean endemism present in the Directive All. II and IV, is signalled in the pSIC formularies. However, its presence is to be confirmed.

The dune ecosystems at present are well conserved and it is possible to see in different places the whole psammophylus geosigmataxa from the annual herbaceous vegetation to forest vegetation of juniper thicket of the priority habitat 2250 "Coastal dunes with *Juniperus* spp." (Figg. 2 and 4).

The populations of *Crucianella maritima* L. are of a great value. Even if fragmented, they take the back side of the dune up and are in the habitat 2210 "Fixed dunes of the *Crucianellion maritimae* shore", as well as the formations of *Otanthus maritimus* (L.) Hoffmanns. et Link that can be found only in Cava Usai and a few other places of the south-eastern coast.



Fig. 2 A monumental exemplar of *Juniperus oxycedrus* ssp. *macrocarpa*.

The rocky surface and gorges in front of the sea are taken up by the association *Crithmo maritimi-Limonietum retiramei* (Mossa et Tamponi) corr. fittable in the habitat 1240 “Cliffs with the Mediterranean coastal vegetation with *Limonium* spp. endemic”.

The Notteri pond occupies the back side of the dune area of the Porto Giunco beach. It is about 34 ha great and presents an interesting halophyllous vegetation referring to the priority habitat 1510 “Mediterranean salt steppes (*Limonietalia*)”, while the muddy bottom is colonized by the association *Chaetomorpha ruppium* Br.-Bl. 1952 being a part of the habitat 1150 “Coastal lagoons” [4].

The sea areas are characterized by the continuity of the granite forms with emerging areas, while wide sandy expanses connect the islands interrupted by granitic shoals. A great part of the superficial movable bottom is colonized by prairies of *Posidonia oceanica* Delile, being a part of the priority habitat 1120 “*Posidonia* prairies (*Posidonion oceanicae*)”.

The framework of the sea areas is enriched by the presence of a permanent population of tursiops (*Tursiops truncatus* Mont.), frequent sightings of turtles (*Caretta caretta* L.) and those most recent (August, 2000) of monk seal (*Monachus monachus* Herm.)

IV. MATERIALS AND METHODS

According to various actions and interventions foreseen in the project it was firstly provided for the compiling of the floristic list based on bibliographical research and herbarium sample tests left at the *Herbarium CAG*; the checklist was integrated later with the observations deriving from numerous field excursions and harvests realized from June and November 2005.

The procedures and protocols recognized at the international level, in particular those of FAO/IPGRI [5] and ISTA [6], were applied to the *ex situ* management of the collected seeds.

The collecting campaigns were planned beforehand on the basis of the taxonomic units phenology selected starting from the existing studies and direct knowledge acquired during the years. The best moment for the seed collection, its methods, the quantity of the material were regulated by ethical and scientific criteria that guaranteed a high quality of the collected material and avoided the pauperization of the genetic resources *in situ* [7]. Contemporaneously, with the material collection, the data concerning the studied population were taken in the field with phenological, demographic, floristic, sociological and ecological studies.

The collected seed is not introduced in the bank before a quarantine period during which it is verified if the material is not contaminated by pathogena and/or parasites.

Entering the bank after the registration of the plots and the database insertion of all the data concerning each single sample the seed is placed in a room with controlled environmental parameters (T<20°C and r.h.<40%) that permits a slow and gradual post ripening. Reaching the suitable requirements, the material is cleaned manually and mechanically with the use of sieves with variable mesh or gravimetric separators.

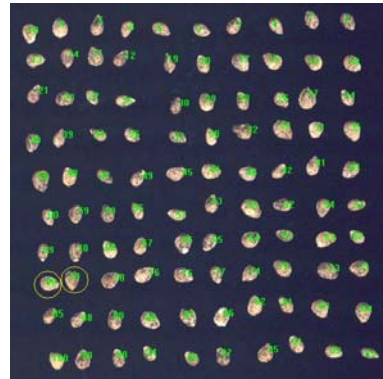


Fig. 3 Elaboration of scanning the accession of *Bryonia marmorata*.

The accessions are subjected to an image acquisition process using a plan scanner adequately standardised. Afterwards, the images are elaborated (Fig. 3) by the Laboratorio di Biologia della Stazione Consorziale Sperimentale di Granicoltura per la Sicilia of Caltagirone trough a macro application developed purposely in the KS400 language. With this application the morphometric and colorimetric parameters are measured, which, in addition to permitting a more detailed characterization of the examined taxonomic unit, allows evaluation of the quality of the entering plot.

Contemporaneously, each accession is analysed from the quantitative point of view, calculating its total weight, the medium weight of a seed and in sequence the number of the cleaned seeds.

After being selected, the seed is placed in a dehydration room (T 15 °C and r.h. 15%) [8] equipped with two dehumidifiers with chemical absorption and a temperature conditioner electronically commanded by a hygrotester.

The moisture content of the seeds is constantly monitored in order to estimate their degree of dehydration and the achievement of the optimum parameters of conservation for a long time.

After verifying that the moisture content of seeds is between 3.5 % (for seeds with high oils contents) and 6.5% (for seeds with low oils contents) [9], they are conserved at -25°C in a refrigerated cell (basic collection), but they can be also conserved at a temperature between 0 and 5°C (active collection) for studies and tests as germination tests.

The individuation of germination protocols is realised through the implementation of a decisional scheme that expects a preliminary bibliographical research, consultation of algorithms and germination protocols already experimented for similar taxonomic units [10], application of possible pre-treatments [6] and execution of germination tests with variable environmental parameters (T 15°C and 20°C with or without photoperiod of 12/12). For all the tests made the following parameters are determined: germinative capacity expressed as percentage value of the germinated individuals, germination retard that represents the occurring time (in days) to have the first germination and T50, that is the time necessary for reaching of the 50% of the final germinative capacity [11]. The individuation of the germination protocol optimum for each taxonomic unit permits, on the one hand, evaluation of the germinative

capacity of the accession and, on the other hand, their multiplication in the CCB structures (thermo heated benches and experimental fields).

As for the monitoring of the populations *in situ*, the individuated methodology considers their characterization from the demographic, floristic-sociological and ecological point of view. The choice of the *taxa* populations to be monitored was made on the base of criticality and real risk of their extinction, privileging rare entities, localized or of Comunitary interest.

The habitats study is run instead through phytosociological, ecological and corological research. The habitats selection was made according to the pSIC Standard Formularies of MATT, concentrating mainly on those coastal ones because of their risk of degradation linked to tourist summer pressure.

Operators of the Municipality, of the Protected Sea Area and nursery also participate in the activities of seed harvest and population and habitats monitoring. In this way it is supposed to form the personnel for monitoring activities through knowledge and operative methodologies transfer.

V. RESULTS

At the end of the first year the seed harvest was completed relatively to all the species with a greater risk of extinction. The studies and monitoring of the populations and of the sensitive habitat started. Afterwards, the principal obtained results were summarized, distinguishing the activities realized *in situ* from those *ex situ* and those of a popular character.

During the first phase of the project the realization of a floristic list was carried out. On its base taxonomic unities to conserve and monitor were selected. At present, the floristic checklist has 593 taxonomic units.

Despite the fact that the project was officially approved only in July, when the phenological season was at an advanced stage, numerous seed harvests were realized both on the islands and along the coast. During the first year priority was given to the *taxa* with a high risk of extinction, in particular, *Ferula arrigonii*, *Silene valsecchiae* and *Helicodicerus muscivorus*, the *ex situ* conservation of which is urgently to be assured.

Contemporaneously, the seed harvest of structural entities and their possible usage in environmental recovery and restoration was looked after. Among these entities the next ones can be nominated: *Juniperus phoenicea* L. ssp. *turbinata* (Guss.) Nyman, *Juniperus oxycedrus* L. ssp. *macrocarpa* (Sibth. et Sm.) Neirl., *Piptatherum miliaceum* (L.) Coss., *Ampelodesmos mauritanicus* (Poiret.) Durand et Schinz, *Lygeum spartum* L., *Asparagus albus* L., *Cakile maritima* Scop. and *Crithmum maritimum* L.

Moreover, thanks to the authorization given to CCB by the Direction of Nature Protection of MATT, as derogation of DPR 357/97, modified by 120/03, the seed harvest of *Brassica insularis* was carried out.

The activities of *ex situ* conservation for these species were further on implemented through the duplication of the samples to be conserved in other structures accredited on the international level, so that it could guarantee the seed availability if the collections kept in BG-SAR were lost in

the case of an incident or calamity.



Fig. 4 Fruits of *Juniperus oxycedrus* L. ssp. *macrocarpa*.



Fig. 5 An exemplar of *Ferula arrigonii*.

Particularly, a seed sample of *Brassica insularis* is at present kept near the structures of the *Conservatoire Botanique National Méditerranéen* (Porquerolles – France) and the *Banc de Germoplasma - Jardí Botànic* (València - Spain).

Moreover, the harvest of genetic material of numerous species with a possible nursery usage was carried out and monitoring of the populations of the selected entities was started, in particular, those of *Ferula arrigonii* (Fig. 5), *Silene valsecchiae*, *Helicodicerus muscivorus* and *Brassica insularis*.

During the first annual much information regarding the distribution and phenology of these species was collected.

The first analyses regarding the populations of *Ferula arrigonii* indicate the diffusion of this entity mostly on the Serpentara Island, where a population of about a thousand individuals is present. This species is sporadic on the Cavoli Island where a hundred of its examples was found, while in the coastal area it is completely absent.

The situation of *Silene valsecchiae* is very particular. Only a small population of it was individuated (less than 50 individuals) on the Cavoli Island while it was not found on Serpentara, that is *locus classicus* for this entity. It should be mentioned that the monitoring operations started at an advanced stage of the phenological season, and so the same population of the Cavoli Island was formed by individuals at the end of the biological cycle. In the course of the project all the sites potentially suitable for receiving populations of this entity present on the islands will be analyzed.

The serpentry herb, *Helicodicerus muscivorus*, is, like

ferula, greatly diffused on Serpentara and localized on the Cavoli Island in a small population of about 50 individuals near a small harbour.

Particular attention was paid to the study of the habitats. Among them there were chosen those in which populations of *taxa* selected were found, as well as those having priority according to the Directive and mainly subjected to degradation and pauperization. The aim of the intervention is to make their characterization, verify the status and arrange a strategy for preserving them and at the same time make them available.

On the basis of the important tourist vocation of the territory, extremely fragile habitat and localized in the dunal systems were selected. They are an object of direct and indirect impact of the tourist activity. Thanks to the realization of the permanent squares the study through the techniques of phytosociological survey and monitoring was started.

The habitats for which *in situ* surveys were undertaken are the following: “Mobile dunes of the littoral cordon with the presence of *Ammophila arenaria* (white dunes)”, 2210 “Fixed dune of the littoral of *Crucianellion maritimae*” and 2250 “Coastal dunes with *Juniperus* spp.” that is a priority habitat.

At the same time, the data regarding the main causes of degradation of this habitat were surveyed on the field. These causes are mainly linked to antropic pressures but also to the phenomenons of the invasivity of alien species. In fact, all the areas where invasive alien species were found, were surveyed in order to propose a plan of progressive elimination and substitution with structural autochthonous species of the psammophyla geoserries.

The harvests done during the first year permitted the preservation of the seed of taxonomic units wich were risking extinction near the BG-SAR structure.

The accessions after being cleaned, dehydrated and analyzed, were conserved at low temperature of +5°C for carrying out germination test and environmental recovery and/or restoration. The germination tests are still going on. The data analyzed by now allowed to individuate effective protocols for *Brassica insularis*, *Linaria arcusangeli* Atzei et Camarda and *Pancratium maritimum* L.

The two *Brassica insularis* accessions taken in the Cavoli Island were tested in three different conditions: 15°C without photoperiod, 20°C without photoperiod and 20°C with a photoperiod 12/12. The analysis of the results (Fig. 6) evidenciates the elevated germinative capacity of the harvested plots in all the tested conditions, with values equal to 95% for the seeds at 15°C, 96% at 20°C and 97% at 20°C with 12/12.

The data regarding *Pancratium maritimum* refer to the only accession harvested in the Punta Molentis. The seeds were tested at the temperature of 15°C and 20°C without photoperiod. The analysis of the germination curve (Fig.7) puts in evidence the elevated germinative capacity of the accession (95% at 15°C and 98% at 20°C) and it can be seen that its speed is higher at 20°C (T50 of 17 days and total time of 36 compared to T50 of 22 days and total time of 56 at 15°C).

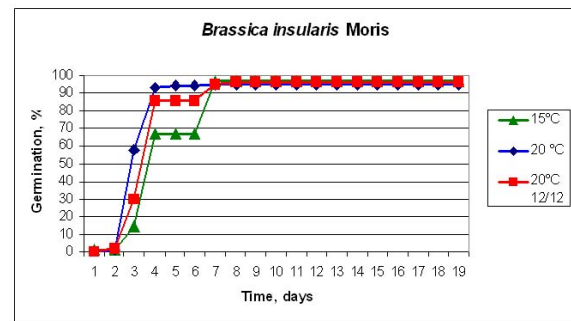


Fig. 6 – Development of the germination of *Brassica insularis*.

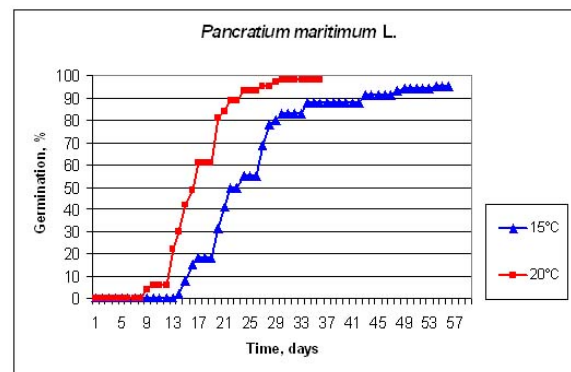


Fig. 7 – Development of the germination of *Pancratium maritimum*.

As far as *Linaria arcusangeli* is concerned, tests on the accessions from territories outside of the project area because of the small seeds quantity harvested *in situ* were carried out. For these accessions there was individuated a protocol that provides the sowing at 20°C, without photoperiod, in Petri capsules with germination paper and GA3 solution with the concentration of 120 ppm. There are tests in course on the accessions concerning the studied area for verifying the real efficacy of this protocol.

The small plants germinated during the tests are brought on the sterile soil with controlled environmental conditions (growth room with photoperiod of 12/12 and constant temperature of 20°C). Afterwards, they are transplanted into the soil with variable composition on the thermo heated benches in order to individuate the optimum substrate necessary for their cultivation and multiplication.

Training of the personnel of the Protected Sea Area and Municipality, as well as collaboration with local operators of the nursering sector are carried out. Operators of the CCB go out in the fields with the personnel of “CentroVerde Vivai” of Villasimius in order to transmit the knowledge and work methodologies. This permits learning of the harvest techniques and seed preparation. The multiplication protocols done by the BG-SAR were given to the company.

The obtained results and the project itself were presented through manifestations and publications with a scientific and divulgative character and other initiatives realized with the collaboration with “Diomedea Società Cooperativa”.

In summer 2005 there was a press conference for presenting the project and a divulgative conference at

Visiting Centre of the Protected Sea Area. There was also presented a depliant, printed on recycled and ecological paper in order to illustrate briefly to people various actions of the project.

On the web site of the CCB (<http://www.ccb-sardegna.it/html/amp.htm>) it is possible to find its description, updated on the bases of the obtained partial results.

VI. FUTURE ACTIVITIES

During the first annual the works were carried out only in the coastal and insular areas and, in particular, in those inside pSIC. For the continuation of the project, instead, realization of floristic list regarding the whole territory of Villasimius will be done.

Moreover, studies of taxonomic units and habitats for the same territory will be started, paying particular attention to the analyses of demographic and ecological type.

Particularly, the study of the soil seed bank is to be started and so the capacity of the plants to bury seed stock in order to define better the auto ecology of the species, estimate the resilience capacity of the community, carefully examine the study of the vegetational dynamics and obtain the information for supporting planning of managing activities [12].

In addition to the activities of in situ and ex situ conservation and study the initiatives of a divulgative character and training will be carried out and implemented.

Ways of conservation will be put forward and at the end of the activities of the project a summary of proposals both for threatened species and habitat will be elaborated.

Acknowledgment – Thanks to MATT and Protected Sea Area of Capo Carbonara for giving contribution necessary for the development of the research, the Administration of the Municipality of Villasimius and “Diomedea Società Cooperativa” for constant help and sensitivity demonstrated and the Laboratorio di Biologia della Stazione Consorziale Sperimentale di Granicoltura per la Sicilia of Caltagirone for the realized seed morphometric analyses.

VII REFERENCES

[1] E. Biondi, S. Bagella, S. Casavecchia S., M. Pinzi, R.

- Calandra, – “Analisi geobotaniche integrate per l’elaborazione del Piano di Gestione Naturalistica del Parco Naturale Regionale del Conero. Atti Seminario “Gestione delle risorse agro-forestali in aree protette”. *Inform. Bot. Ital.*, 33(1) 2001, pp. 130-133.
- [2] P. Orrù, A. Cocco, V. Panizza, 1994 – *Rilevamento geomorfologico subacqueo del settore compreso tra Capo Boi e Punta Is Cappuccinus (Sardegna Sud-Occidentale)*. Mem. Descr. Carta Geol. d’It., 52:163-176.
- [3] E. Bocchieri, “*Silene valsecchiae* e *Ferula arrigonii*, due specie nuove della Sardegna”. *Boll. Soc. Sarda Sci. Nat.*, 26, 1988, pp. 305-310.
- [4] L. Mossa, F. Curreli., M.C. Fogu, “La vegetazione degli habitat terrestri della riserva marina protetta di Capo Carbonara (Sardegna Sud-Orientale)”. *Rend. Sem. Fac. Sci. Univ. Cagliari*, 70, 2000, pp. 163-185.
- [5] FAO/IPGRI, *Genebanks Standards*. FAO/IPGRI, Roma: 1994.
- [6] ISTA, “International rules for seed testing”. *Seed Sci. & Technol.*, 27, Supplement., 1999, pp. 333.
- [7] L. Guarino, V. Ramanantha Rao, R. Reid, “*Collecting Plant Genetic Diversity – Technical guidelines*”. CABI. Wallingford, Oxon: 1995.
- [8] IBPGR, – *The design of seed storage facilities for genetic conservation. Handbooks for genebanks: N. 1. Revised 1985 and 1990*. International Board for Plant Genetic Resources. Rome, Italy: 1982.
- [9] S.H. Linington, “*The Design of Seed Banks*”. In: R.D. Smith., J.B. Dickie, S.H. Linington, H.W. Pritchard, R.J. Probert (Eds.), “*Seed Conservation: turning science into practice*”. Royal Botanic Gardens, Kew: 2003.
- [10] IBPGR, “*Handbook of seed technology for genebanks. Vol. II. Compendium of Specific Germination Information and Test Recommendations Handbooks for genebanks: N. 3*”. International Board for Plant Genetic Resources. Rome, Italy: 1985.
- [11] D. Côme, “*Les obstacles à la germination*. Masson & CIE, Paris: 1970.
- [12] B. Cerabolini, R.M. Ceriani, M. Caccianiga, R. De Andreis, B. Raimondi., “Seed size, shape and persistence in soil: a test on Italian flora from Alps to Mediterranean coasts”. *Seed Sci. Res.*, 13, 2003, pp. 75-85.