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The Seedbank database of the *Hortus Botanicus Panormitanus*

Abstract

Scialabba, A., Marino, P., Bazan, G. & Domina, G.: The Seedbank database of the *Hortus Botanicus Panormitanus*. — Bocconea 24: 327-334. 2012. — ISSN 1120-4060.

A database for the management of the Seedbank of the Palermo's Botanical Garden has been set up. Its structure and functioning are illustrated. Since November 2010 about 2000 records relating to 460 taxa have been inputted and are accesible via web. Links with other seedbank databases and with the database of the Herbarium Mediterraneum Panormitanum and of the Palermo's Botanical Garden are explained.

Introduction

The recent numeric increase of seedbanks in Europe is matched by the establishment of specific networks in response to the *ex situ* conservation demand by international conventions. In Italy, the RIBES association - Rete Italiana di Banche del germoplasma per la conservazione *Ex Situ* della flora spontanea (Italian network of seedbanks for *ex-situ* conservation of wild flora) - promotes and coordinates activities in 18 seed banks (Rossi & al. 2006).

The *Hortus Botanicus Panormitanus* (HBP) seed bank belongs to RIBES. It, since its foundation in 1993, is involved in the activities of the Palermo Botanical Garden and is carrying out activities concerning *ex situ* conservation of wild plants of the Mediterranean area. The aim of this seed bank is to preserve the phytogenetic resources of rare or threatened plants (Raimondo & al. 2011) and of the crop wild ancestors. The specific activities carried out in Palermo are: long and short term *ex situ* conservation of seeds, their exchange, the monitoring and reintroduction into their native wild environment. The storage process begins with the collection of the seeds, followed by their taxa identification, cleaning, phytopathological control, dehydration, low humidity and low temperature storage (Scialabba & Raimondo 1994) and vigour tests (Dell'Aquila & al. 2000). The bank also carries out researches on the germination ecophysiology, the biology of seed conservation and the genotypic characterization of those species which are endangered or particularly interesting from an economical standpoint.

The Sistema Madonie Laboratory supports the HBP bank restoring original ancient cultivars and preserving the local genetic resource of the Madonie area (N Sicily) through both traditional and innovative propagation techniques (Scialabba & al. 2007).

Gene-bank management is quite complex and concerns both internal organization and external exchanges that are provided through the Index Seminum (http://www.ortobotanico.unipa.it/germoplasma.html). In particular, new accessions need to be acquired, classified and characterized with respect to systematic interest or agronomic features; harvesting work has to be reduced by gatering of core collections; existing collections are to be maintained and identified; optimal methods of regeneration to avoid genetic erosion are to be defined.

Core collections conservation requires the knowledge of genetic and physiological characteristics of seeds, of ecological needs, of evolutionary processes of the species and the seed quality evaluation in relation to the efficiency of storage technique (Scialabba 2007). The world's biodiversity data freely and universally available by developing biodiversity informatics tools provide web access to primary information on the world's organism. The banks network needs links with museums, herbaria and other collections with specialized databases that maintain collateral natural history records such as photographs and descriptions, relevant ecological and genetic data, genomic data base, electropherograms associated with barcode sequences.

Therefore, the setting up of a database for practice standardizing among institutions working for *ex situ* conservation of wild plant biodiversity represents a focal step.

Two databases for seedbank management are running in Italy: The data base of the Seedbank project, derived from the Ensconet DB (Eastwood & al. 2009), working in Pavia at the Lombardy Seed Bank and in Trento at the Trentino seed bank and the DB of the project Genmedoc (Bacchetta & al. 2008) working in the Botanical Garden of Catania and in Cagliari at the Centro Conservazione Biodiversità. The need of developing a new database for the *Hortus Botanicus Panormitanus* (HBP Seed Bank) instead than using an existing one was justified by the need of an open, modular system, compatible with other DB already working in the Botanical Garden of Palermo (HBP Seed Bank) according to what has been done for the Millennium Seed Bank Project in Kew (Bone & al. 2003).

Materials and methods

The structure of the database of the Palermo's Botanical garden Seedbank has been designed in order to be compatible with both Seedbank project and project Genmedoc DB schemes. Its tables are related to accessions, treatments, germination data and exchanges with other structures.

Furthermore this database is linked with other databases of the *Herbarium Mediterraneum Panormitanum* and of the Botanical Garden in order to simplify the metadata flow among the offices of the structure. The link with the Herbarium database is the voucher specimen number or the number related to the taxon name, the link with the Botanical Garden Database is the number related to the taxon name.

Data and tables are standardized according to TDWG (Taxonomic Database Working Group) standards (http://www.tdwg.org) and comply with the The Global Biodiversity Information Facility (GBIF) data architecture.

User-friendly input forms have been designed for off-line use, periodically data are putted on the web. The database server on the University of Palermo Webiste is Mysql,

data conversion between MSAccess and Mysql is semi-automatic. Only 3 derived tables extracted by queries are putted online. The search engine is written in PHP language. The database is accessible at http://seedbank.unipa.it/.

Results

The Database runs on desktop personal computer, it is realized in MSAccess, similarly to Coan & al. (2010), it consists of 23 related tables. Three of them are the main tables and to them are related 3 main input forms (Fig. 1). The others are support or service tables in which are stored taxa, localities, collectors, quantities, etc. Inclusion of georeferenced sources, habitats, and sampling data in collection databases facilitates interpretation of genetic data for genebank accessions with wild origins as stressed by Volk & Richards (2011). Seeds photos are stored wit the same number as the single accession. The relation scheme and the main tables structure are reported in Fig. 2 and Tables 1-2. The Web Database is running in Palermo on the University Server since November 2010, about 2000 records relating to 461 taxa, mainly belonging to the wild flora of Sicily, have already been inputted and new accessions are imputed weekly.

The data are accessible via internet for both public and internal use. General public can read the accessions in the bank and can make query by a simple interface. Internal users can make query by an advanced interface, read the accessions in the bank, verify the seeds stock and look up at the germinability tests.

Conclusions

Different institutions hold their data in different formats and include different elements, according to their individual needs. The HBP seed bank long time stores 461 taxa, 144 of them rare, 93 threatened at regional level, 64 at national level, 1 worldwide (*Abies nebrodensis* (Lojac.) Mattei). At regional level the stored taxa are the 55% of the endemic flora and the 32% of threatened flora.

The HBP Seed Bank employs a simple model which allows institutions to share their data using structure formats for data exchange compatible with a wide variety of different data resources using the same interface and data standard.

31% of the HBP accessions are duplicated in other european seed banks, 602 accessions are duplicates coming from other banks, especially from the “Instituto Nacional de Investigaciones Agrarias” (INIA) of Madrd. This tool at the Botanical Garden of Palermo, as every software for warehouse and orders management, enable a faster and easier management of the Seed bank. The use of a specific designed tool offers full compatibility with the items and allow easy data import-export with similar databases by simple mapping protocols (De La Torre & al. 2005).

In addition this biodiversity data can be shared through specific networks (Berendsohn 2002; Berendsohn & al. 2000) already experienced in the *Herbarium Mediterraneum Panormitanum* (Domina & al. 2005).

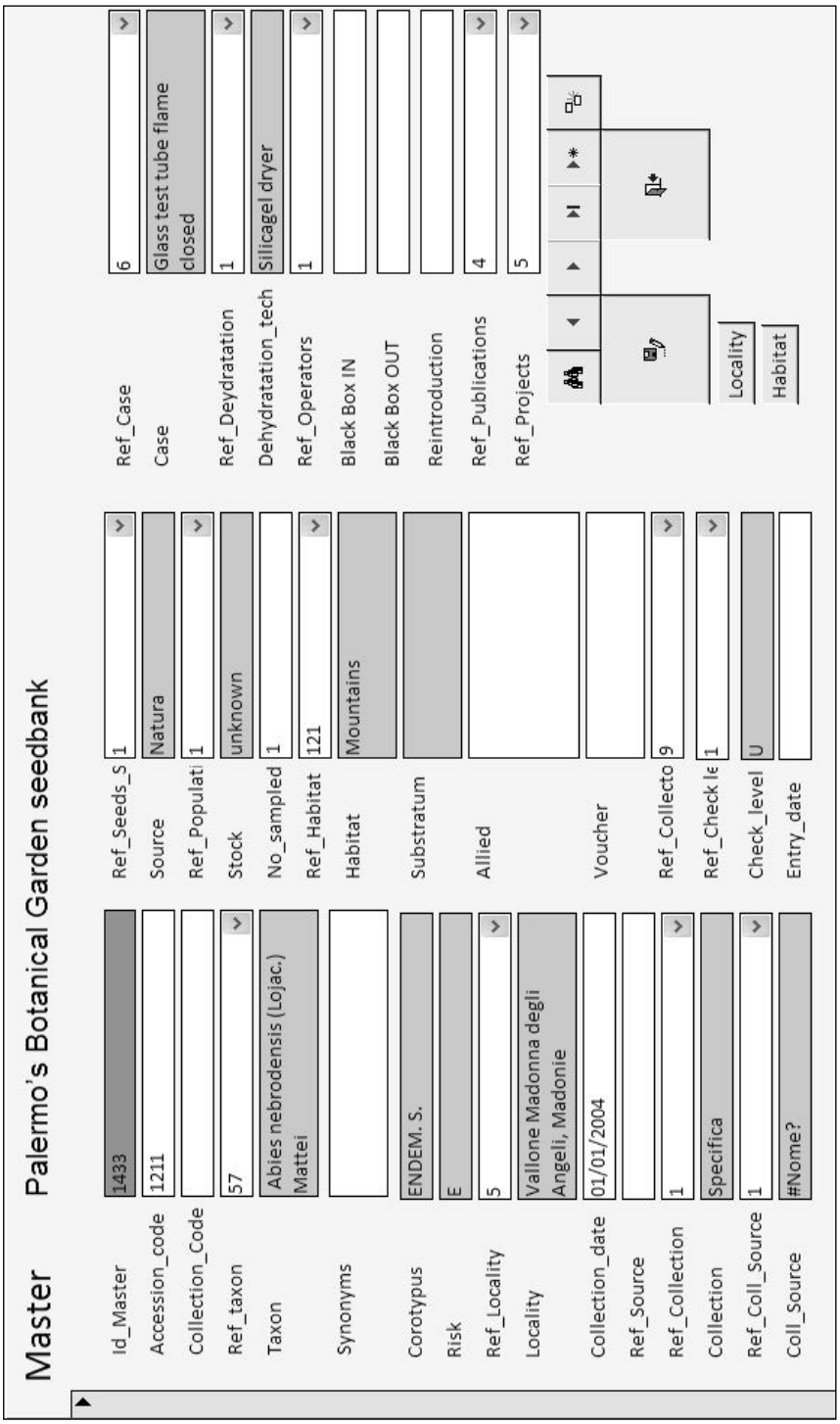

Fig. 1. A sample processing data screen from the Database. In grey automatic field, in white field to be filled.

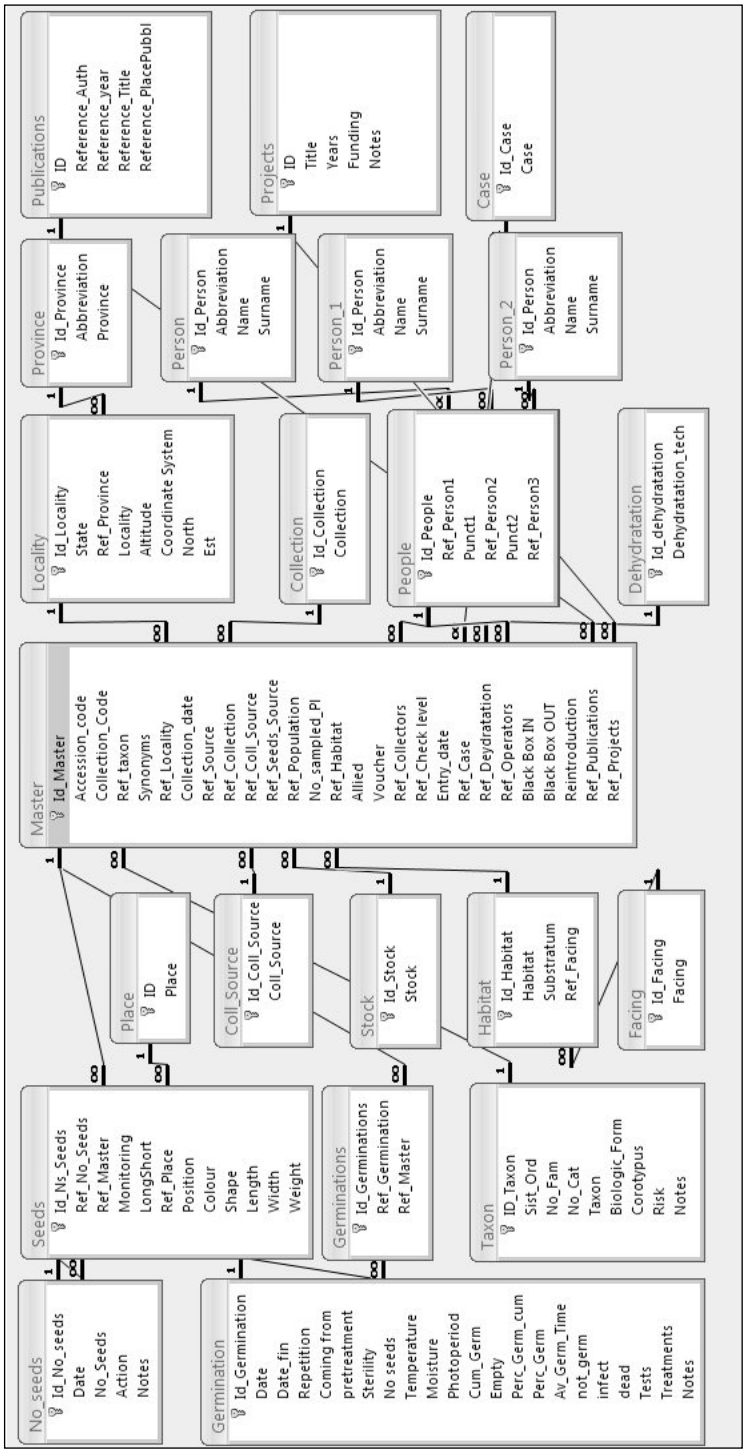

Fig. 2. Table relationships in the Database.

Table 1. Structure of the Master table.

Master table		
Id Master	Number	ID
Accession code	Number	Accession code of the Seed Bank
Collection Code	Number	Collection number
Ref taxon	Number	Reference to Taxon Table
Synonyms	Text	Nomenclatural or taxonomic Synonyms
Ref Locality	Number	Reference to Locality Table
Collection date	Date	Collection Date
Ref Source	Number	Reference to Source Table
Ref Collection	Number	Reference to Collection Table
Ref Coll Source	Number	Reference to Collection Source Table
Ref Seeds Source	Number	Reference to Seed Source Table
Ref Population	Number	Reference to Population Table
No sampled Pl	Number	Number of Sampled Plants
Ref Habitat	Number	Reference to Habitat Table
Allied	Memo	Allied Species found
Voucher	text	Herbarium specimen
Ref Collectors	Number	Reference to Collector Table
Ref Check level	Number	Reference to Check Level Table
Entry date	Date	Date of Sample entry in the Seed Bank
Ref Case	Number	Reference to the Case Table
Ref Deydratation	Number	Reference to the Dehydratation Table
Ref Operators	Number	Reference to the Operators table
Black Box IN	Text	Structure from where the duplicates are coming
Black Box OUT	Text	Structure where the duplicates were sent
Reintroduction	Text	Reintroduction done with this accession
Ref Publications	Number	Reference to Publication Table
Ref Projects	Number	Reference to Projects Table

Table 2. Structure of the Germination table.

Germination table		
Id Germination	Number	ID
Date	Date	Initial date of the test

Table 2. continued.

Date fin	Date	Final date of the test
Repetition	Number	Repetition number test
Coming from	Text	room temperature, cold room, freezer, etc.
Pretreatment	Text	Pre-treatment carried out
Sterility	Text	Test sterility (yes, no)
No seeds	Number	Number of seeds per repetition
Temperature	Text	°C
Moisture	Number	Seed moisture content in %
Photoperiod	Number	Nours
Cum Germ	Number	Cumulative Germination in %
Empty	Number	Percentage of empty seeds
Perc Germ cum	Number	Percentage of Cumulative Germination
Perc Germ	Number	Percentage of average Gemination
Av Germ Time	Number	Medium Germination Time
not germ	Number	No. living seeds not germinated
infect	Number	No. infect seeds
dead	Number	No. dead seeds
Tests	Text	Colorimetric Test, date (dd/mm/yyyy), % potential Germination, conductivity test
Treatments	Text	Antimycotic Test, date (dd/mm/yyyy), % Germination
Notes	Memo	Notes

The link with the Herbarium and Botanical Garden databases make easier the management and the item movements among the three structures.

Future developments of the system will allow online data imputing to give easy multi-user imputing all over the net avoiding long time consuming appending / merging procedures in case of multi-user offline data imputing. A full merging of the Seedbank, Herbarium and Botanical Garden databases of Palermo will be included in coming project proposals.

Acknowledgements

Financial support by the Italian MIUR (PRIN 2007) is gratefully acknowledged. We thanks prof. Pietro Pavone and prof. Graziano Rossi for providing us the schemes of the Genmedoc and Seedbank project DBs respectively.

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