Documentation System in Herbarium of Agricultural University of Plovdiv, Bulgaria

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Abstract. The paper deals with the development of a convenient system for herbarium management. We included 100 000 herbarium samples in the system. It is an useful tool for documentation and data analysis of the biodiversity collections.

Key words: herbarium, biodiversity collection, database, documentation.

INTRODUCTION

The Herbarium of Agricultural University of Plovdiv (SOA according to Index of Herbariorum) holds valued specimens. Some of them are collected during a century ago by different authors (Delipavlov et al., 1997).

SOA includes more than 100 000 specimens of the Bulgarian vascular flora, which are collected from different floristic regions. The accessions hold information on the biodiversity changes in Bulgaria and the Balkan Peninsula. The physical access to the herbarium materials is limited. Very often, direct search of information by definite criteria is needed.

Because of improving information technologies since the 60's of the XX century, many herbaria develop systems for electronic documentation (Skvortzov, 1977; Peat, 1998). The contemporarious herbarium databases are usually realized by specialized software. There should be pointed: BRAHMS used in many herbaria in Europe, Asia, Northern and Southern America; BG-BASE used in herbaria and botanical gardens of more than 22 countries; TRACY known in USA and Canada, DataX/FLORIN – herbaria in Russia and neighbour countries; PRECIS (South Africa), databases under MS-Access such as HERBAR, BIBMASTER, MS-FoxPro, dBASE or TAXIS (see Appendix 1).

Appendix 1. Herbarium documentation software cited in the article is:

BIBMASTER – A database application for nomenclature, literature and specimen management; http://www.rjb.csic.es/bibmaste/bibcaract.htm

BG-BASE, BG-BASE Inc. 1997. Royal Botanic Garden Edinburgh, UK and The Holden Arboretum, US. http://www.rbge.org.uk/BG-BASE/welcome.htm

BRAHMS – Botanical Research And Herbarium Management System 5.20 (12 Nov. 2001). University of Oxford. http://www.brahms.co.uk/

Data X/Florin – Florin Biological Information System. DataX/Florin Inc. http://www.florin.ru/florin/-gen/free.htm

HERBAR – Una applicaciyn en MS-Access para la destiyn de herbarios; http://www.rjb.csic.es/herbario/herbar.htm

HerbariumAccess. UC Davis Herbarium, Section of Plant Biology, University of California at Davis (1997); http://herbarium.ucdavis.edu/herbaccess/databaseinfo.htm

PRECIS. Pretoria, National Herbarium (PRE) Computerised Information System; http://www.sabonet.org/precis.html

TAXIS 2.06 Taxonomic Information System (Jevgeni Meike, 1999 – 2001), http://taxis.virtualave.net/

Tracy – Herbarium Management System. 2.2. (M. David Minnigerode, Center for the Study of Digital Libraries, The Texas A&M Bioinformatics Working Group, 1997 – 1998), Texas A&M Biology Department Herbarium and S. M. Tracy Texas A&M University Herbarium, http://www.csdl.tamu.edu/ FLORA/input/inputsys.html

WISCOMP Integrated Computer System, Wisconsin State Herbarium, University of Wisconsin – Madison; http://www.botany.wisc.edu/herbarium/wiscomp.html

Nowadays, the good herbarium practice includes particularly or com-

Appendix 2. Herbarium collections available via World Wide Web are as follows:

Type specimens of the SOA Herbarium, Department of Botany, Agricultural University of Plovdiv. http://www.botanica.hit.bg

The Antarctic Plant Database. http://www.antarctica.ac.uk/Resources/BSD/PlantDatabase/index.html

The Canadian Museum of Nature. National Herbarium; http://www.nature.ca/collections/botany_e.cfm

Carl W. Sharsmith Herbarium, San Jose State University, http://www.sisu.edu/depts/ herbarium/dbabout.html

Digital Type Collection Of The Herbarium Jutlandicum (AAU),
http://132.38.37.132:591/TypeBase/default.htm

Florida Museum of Natural History – University of Florida Herbarium (FLAS); http://www.flmnh.ufl.edu/natsci/herbarium

Forest Pathology Herbarium (DAVFP), Pacific Forestry Centre, Canada, http://www.pfs.cfs.nrcan.gc.ca/biodiversity/herbarium

Fowler Herbarium Database, http://biology.queensu.ca/~fowler/data.htm

Harvard University Herbaria, USA, http://huh.harvard.edu

Herbarium COLO, http://www.colorado.edu/CUMUSEUM/research/botany/botany.html

Herbarium KW, National Herbarium of Ukraine; http://www.nbuv.gov.ua/herbar

Herbarium RNG. The University of Reading, U.K.; http://www.herbarium.reading.ac.uk

IPK Gatersleben Herbarium, Deutschland, http://www.ipk-gatersleben.de/herbarium/

J.F.Bell Museum of Natural History. University of Minnesota - Herbarium, http://biosci.cbs.umn.edu/herbarium

The John Clayton Herbarium, The Natural History Museum, U.K. http://www.hnm.ac.uk/botany/clayton

Liehen Herbarium (Herb.Nimis,TSB), University of Trieste; http://www.univ.trieste.it/cgibin/g/bot/leggi

Linnaeus Herbarium (S-LINN), Sweden, http://linnaeus.nrm.se/botany/fbo/welcome.html.en

Oregon State University Herbarium: OSU Mycology Collection and Vascular Plant Type Collection; http://www.orst.edu/dept/botany/herbarium/database.html

Oxford Botanical Collections, Oxford University, U.K. http://www.plants.ox.ac.uk/

National Herbarium Netherlands, http://www.nationalherbarium.nl/

National Herbarium of New South Wales, http://www.rbgsyd.gov.au/html/science/Systematics/Herbarium.html

The Virtual Herbarium of New York Botanical Garden; http://www.bybg.org/bsci/hcol/

Northern Praire Herbarium, USA, http://www.npwrc.usgs.gov/resource/othrdata/herbar/HERBAR.HTM

The Paul Hermann Herbarium, The Natural History Museum, U.K., http://www.nhm.ac.uk/botany/databases/hermann/index.htm

Sareyshtikov Herbarium of Moscow State University; http://herba.msu.ru/russian/departments herbarium/

SEWANEE – The University of South, Herbarium Database,
http://www.sewanee.edu/biology/databases/herbarium.html

The Sloane Herbarium; http://www.nhm.ac.uk botany/databases/sloane/index.htm

UC Davis Herbarium; http://herbarium.ucdavis.edu

University of British Columbia - Herbarium Databases, http://herbarium.botany.ubc.ca/index.html

University and Jepson Herbaria, University of California, Berkeley; http://ucjeps.herb.berkeley.edu

pletely information available via Internet (Appendix 2). In this order, we should pointed CASSIA – database created in the New York Botanical Garden, which consists of 417 183 records with 36 385 specimen photos. Another example for better applicability of herbarium documentation system is the Antarctic database consisting of more than 50 000 records. It has begun as a database of the British Antarctic Survey Herbarium (AAS) and further supplemented with data of other herbaria as well of literature sources (Peat, 1998).

The aim is to develop an electronic database for documentation and search in SOA herbarium, Plovdiv.

EXISTING HERBARIUM SYSTEM

The existing plate arrangement system in SOA is used to develop the electronic documentation system. About 100 000 exemplars of vascular plants are stored in boxes and shelfs according to the index of "Genera Syphonogamarum ad Systema Englerianum" by De Dalla-Torre et Harms, 1900 – 1907 (Delipavlov et al., 1997). In the database, we used the same system for taxonomic description in the database as well the accepted taxonomy in Flora Republicae Bulgaricae.

As geographic characterization, we

accepted the alphanumeric codes of the UTM grid sets (50 × 50 km) from Atlas Florae Europeae Project 2002 and the adapted set (10 × 10 km) for Bulgaria (Kozhuharov et al., 1983). For description of floristic geographic data, we used also the map of 20 floristic regions, which is accepted in "Flora Republicae Bulgaricae" III – X, 1963 – 1995. The altitude is shown in meters (m) above the sea level. As description of the plate origin, we used the international herbarium codes from Index Herbariorum.

The system is realized using PC Hewlett-Packard: Pentium 100 MHz, RAM 16 MB, SVGA 512 KB, HDD 2GB; with MS Windows 95 operating system.

The program module (dSOA) is compiled in the Botanical department of Agricultural University using RapidQ BASIC Compiler ver. 1.0.0. (William Yu, 1999 – 2000; http://www.basicguru.com/abc/rapidq).

REQUIREMENTS FOR DATA REARRANGEMENT

The development of herbarium documentation system according to the presented above should response to the following requirements:

- creation of database tables aimed to support the most completed and accurate available information;
- introduction of unlimited number of stored records;
- creation of main information structure aimed for filtering and sorting of records by accepted criteria;
- elimination of cases for duplication of specimen numbers;
- realization of compatibility with the system used till now. That means no changes in the proper arrangement of specimens in herbarium rooms and shelfs;
- creation of database and program module, quick running and user-friendly interface;
- developing information protection: data access control depending on the user level and user documentation by name and time;
- possibility for data exportation in suitable format for exchange or publication, data statistics and mapping;
- prediction of future improvements of the database by number of tables or fields as well by upgrade of the program module.

The plant accessions (totally 100 000) and fungal samples (5000) are assigned by their serial number. This number is used in the scientific publications describing the specimens (Delipavlov et al., 1997). We accept the serial number of herbarium plate as an unique number or primary key index in the database. In this way, we answer to the both requirements: searching by serial number and limiting the record/number duplication. We should point that searching by serial number is not possible by common access to herbarium specimens till now.

The material arrangement of the herbarium plates is according to the index of De Dalla-Torre et Harms, i.e. by taxonomical position, as accepted in the major herbaria. That is why, the genus index from this system have to be included in database, together with the standard of Bisby (1994).

The type specimens are the most important samples for every herbarium collection. They are stored in separate boxes outside of the general collection. One field aimed at showing the specimen status is required in the database.

Although the proper geographic coordinates (lattitude and longitude) are not known, the collecting sites are

described in free style as geographic names, altitudes, ecologic descriptions and other information. Appropriate descriptors for the Bulgarian geographic data, which relate to the existing information, are the altitude and the number of 20 floristic areas as accepted in "Flora Republicae Bulgaricae" III-X, 1963 – 1995. More accurate description can be achieved using coordinates of UTM grid set as presented both in Atlas Florae Europeae Project, 2002 and in the set addapted for Bulgaria by Kozhuharov et al. (1983).

To describe the country of origin, where the material is collected, we used ISO standard country codes. This international coding is accepted in many herbaria, botanical gardens and genebanks (Walter, 1995; Hintum, 1995).

We should point that often the herbarium samples contain data, which can not be structured. That is why, it is needed to keep the label information from the label in a text field. In this way, the original information is available as initially entered by the collector. Useful approach for practical application is the arrangement of photos or text descriptions of specimens in the electronic database.

Plates received from other herbaria have to be assigned in new data field with international herbarium code (Index Herbariorum). So, new criteria for search of plates by their origin are available.

COMPLETING DOCUMENTATION SYSTEM

The Documentation system of SOA is realized as a relational database according to the requirements above. The protection of the entered data is achieved by three access levels (Fig. 1).

The taxonomic description of the specimens is divided in four fields (Fig. 1). The fields "family", "genus" and "species" are coded and related to the corresponding index tables. The collecting site is described using several fields: "country code", "floristic region", "altitude", "UTM grid".

Coding and linking the fields with uniform values to external tables (Fig. 1 – box 8, 9, 10, 11, 12), we achieve not only better compacity but also we avoid technical errors on data input. The data on the original labels, revision data, additional notes, plate photos and text descriptions are linked as external files. So, the main table is made simple and available for more detailed information (Fig. 1 – box 3, 4, 5, 6, 7). As additional files, we included tables of country codes (ISO), herbarium codes and addresses (Index Herbariorum), maps of the floristic regions, UTM grids and geographic gazetteer (Fig. 2).

The user interface of the program module (dSOA) is realized in Bulgarian language. To reach compatibility with other systems, we predicted that dSOA system could export and import text (CSV) tables. They could be processed by any office software. The specimen data can be exported to HTML or plain text documents, too. dSOA could prepare complete report by number of stored records as well their relation to users, families, genera, authors and type secimens. The program module is able to display the distribution of selected specimens as UTM map using the defined maps (Fig. 3). The system is successfully tested with 630 stored records.

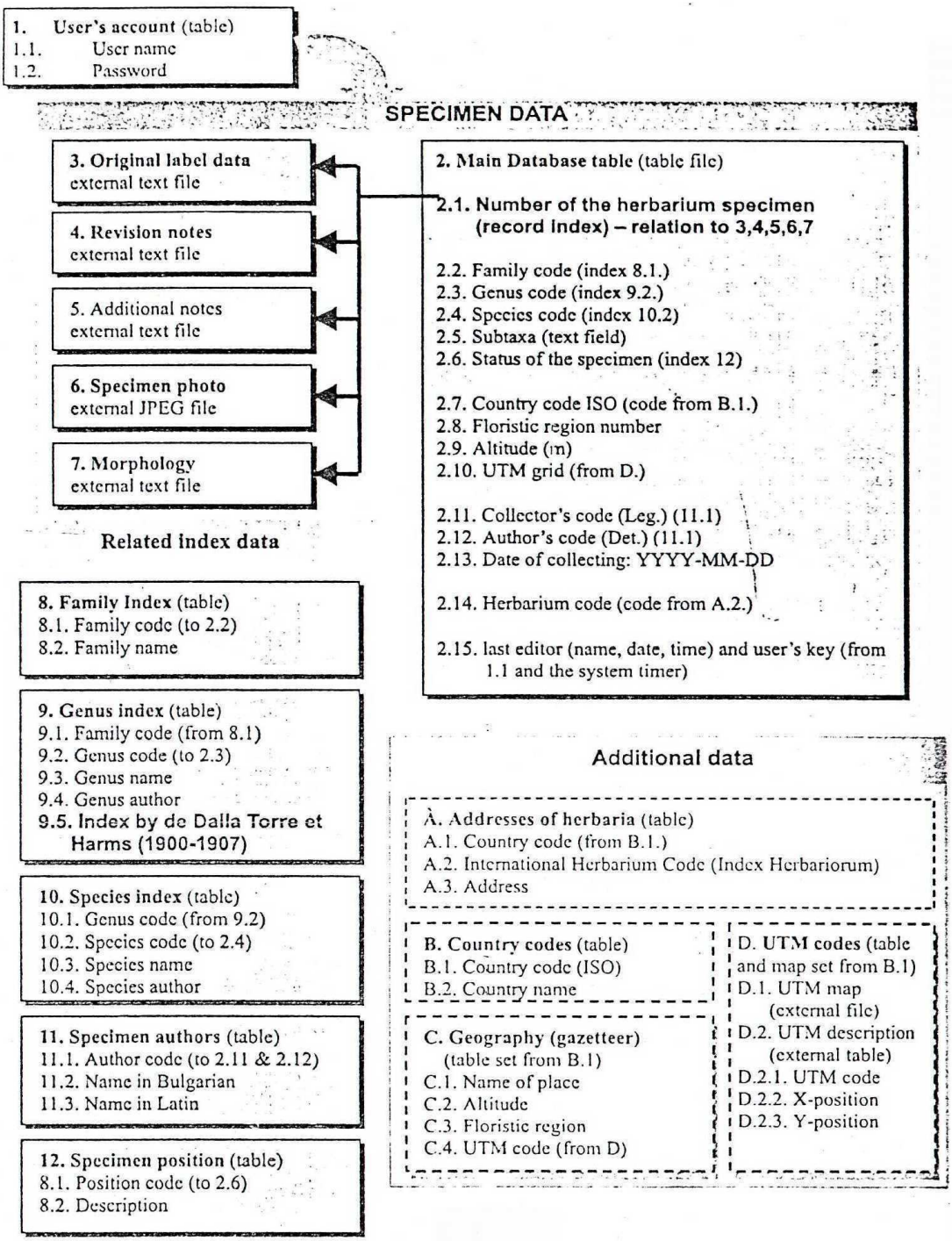

Fig. 1. Functional chart of database structure

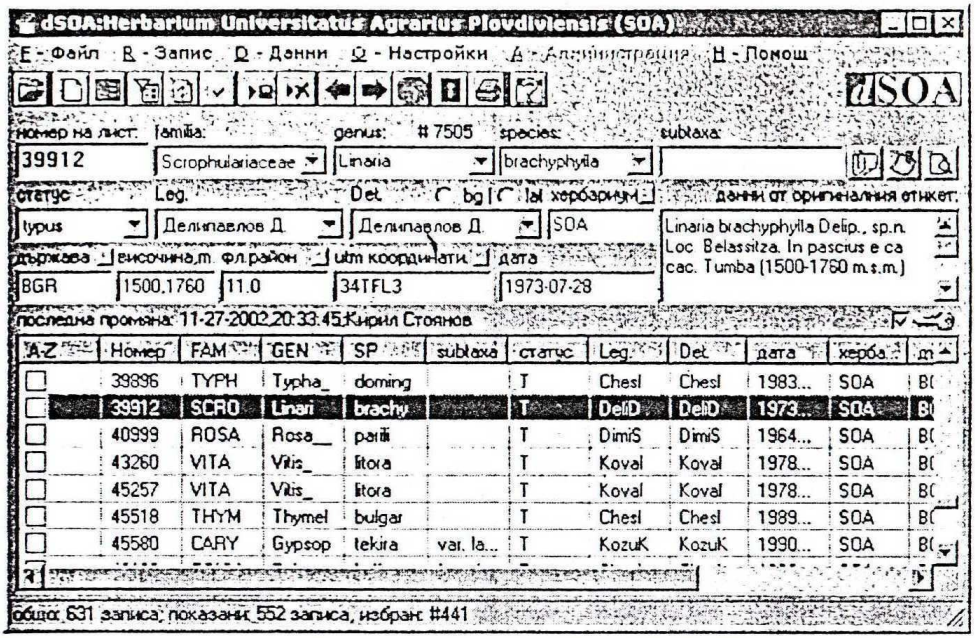

Fig. 2. Main window of dSOA. The selected record from the table can be edited and reviewed in the form. The user could prevent each record of further updates

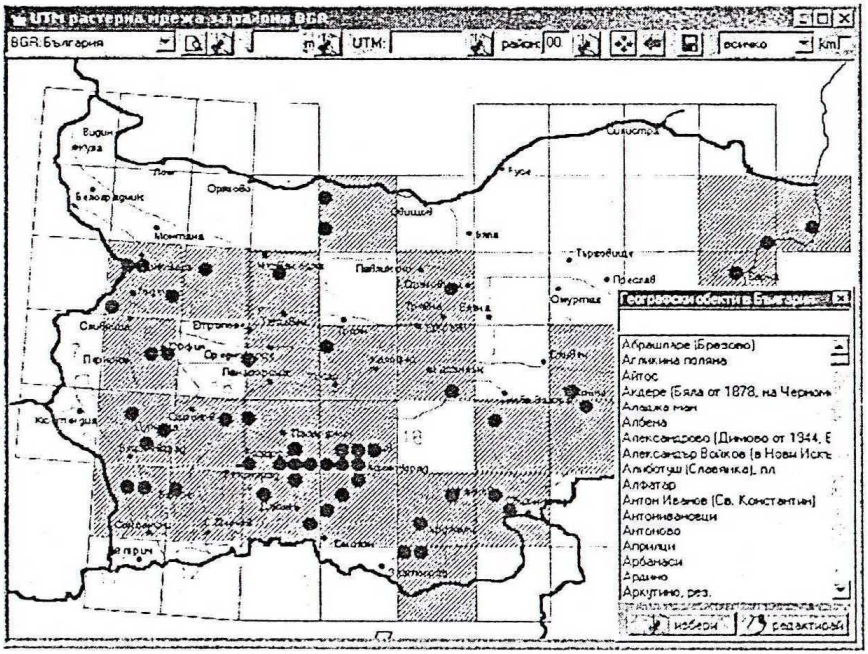

Fig. 3. Geographic gazetteer and automatically drawn distribution map built using the information from selected records. The records saved on 50 × 50 km UTM compatible grid are signed with hatch. The records saved on 10 × 10 km UTM grid are signed with dots. The floristic regions (Flora Repiblicae Bulgaricae III-X) are drawn on the base map

CONCLUSION

The electronic documentation system of SOA Herbarium is an useful tool for maintenance of collected information. Using dSOA, the information could be retrieved and sorted by a definite criterion or complex of criteria. It allows creation of UTM maps for stored specimens or maps for distribution by periods and various geographic data.

The program module of dSOA runs on any workstation under Windows. It is applicable for herbarium work, horologic databases, for specific research in the areas of botany or environmental monitoring. The same module could be used in other biodiversity collections.

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