Acta Bot. Croat. 60 (1), 31–48, 2001

CODEN: ABCRA 25
ISSN 0365–0588
UDC 581.9 (497.5): 303.432

CROFlora, a database application to handle the Croatian vascular flora

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CROFlora is a multi-user database application for species-oriented and specimen-oriented systematic and taxonomic work on Croatian flora. It is designed for dealing with all kinds of data that are commonly used in systematic botany and floristic work. CROFlora comprises several main modules: (1) taxonomy, (2) herbarium, (3) literature, (4) chorology and (5) related data, such as ecology and multimedia. CROFlora was built over a relational database. The database relies on the normalised data model, which is presented in the paper. Amongst other features, the client application provides the user with extended query by example (QBE) capabilities and with user-customised reports. The reports include taxon sheets, taxa checklists, herbarium labels, bibliography labels and other complex reports. The database can be connected to a geographical information system (GIS), which empowers easy production of distribution maps and other spatial analysis. The Web interface enables Internet searches.

Keywords: database, bioinformatics, taxonomy, flora, distribution, geographical data, Croatia, Internet

Introduction

Increasing concern for the Earth's biological resources, their inventory, protection and use, has prompted efforts to modernise practices and procedures to manage all types of botanical data. The biological systematic community has developed different strategies to build up new research databases containing derived data, rather than only primary data about collections, as was the case in the early days of biological databanking. The statement »The impacts of electronic data processing in the various fields of taxonomy and systematic ..., come to be looked upon, in retrospect, as one of the most curious episodes in the history of biology« (HEYWOOD 1984) nowadays seems to be true. Most herbaria, museums

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and institutions dealing with flora have database programs underway now. The essential groundwork for broader-scale information synthesis was initiated by several international organisations that have efforts underway in these areas. To facilitate data exchange, the International Working Group on Taxonomic Databases in the Plant Sciences (TDWG) has attempted to establish standards for various data elements in plant taxonomic work. A comprehensive information model for the taxonomic data recording was devised for the Global Plant Checklist database project of the International Organisation of Plant Information (IOPI) (BERENDSOHN 1997). From the early days of this dynamic field (reviews for instance CROVELLO and MACDONALD 1974 and JURY 1991), the bioinformatics has today »become a major growth industry almost in its own right« (SUGEDEN and PENNISI 2000).

The Flora Croatica Database (or CROFlora) enables the storage of taxa- and specimen-oriented data, the updating, and data analysis of Croatian vascular flora. CROFlora was developed through collaboration between the Department of Applied Mathematics, Faculty of Electrical Engineering and Computing and the Department of Botany, Faculty of Science, both from the University of Zagreb, Croatia.

The first version of CROFlora was developed as a multi-user database, handled by a client application and supplemented with a web interface. The taxonomic backbone is the newly developed Checklist of Croatian Flora (NIKOLIĆ 1994, 1997, 2000). The data is derived from taxonomy (nomenclature, synonyms, authorisation), chorology (distribution based on literature data, herbaria collections, field investigations, oral reports), bibliography, etymology, ecology (ecological indexes), etc. The database supports the processing of numerical, text and multimedia data and can be connected to GIS applications.

In addition to data management, the main purpose of the CROFlora database is to be used as a tool for flora analysis and the preparation of the Atlas of vascular flora, as well as the Flora Croatica, which need to be produced in the near future.

CROFlora is a part of a broader Croatian Information Service for Biodiversity – Database (CIS-B Database) (NIKOLIĆ et al. 1996), which also contains a raw species list for all other groups of living organisms in Croatia (*Animalia*, *Lichens*, *Monera*, *Mycota*, autotrophic *Protoctista*). The part of the database to handle the other groups of living organisms is still under development and therefore the paper presents only the CROFlora data structure and data origin.

Material and methods

The database server runs under Microsoft Windows NT. On the server side, Microsoft SQL Server manages the data. The client application is written in Microsoft Access, enhanced by some ActiveX controls (WILLIAMS 1997), such as Microsoft Common Controls and Microsoft Multimedia Control, and by some dynamic link libraries, for instance Microsoft Office Library and Microsoft Word Library. The client connects to the server by using the ODBC data source. Some database tables are replicated locally to ensure better response times of the user interface. The synchronisation of the local data is done automatically or the synchronisation can be forced by the user's request.

Internet Information Server 4.0 has been chosen as the platform for the web site hence it supports dynamically created web pages by using Active Server Pages technology (ASP). ASP provides a powerful scripting language (VBScript or JavaScript), and some built-in objects that can connect to the database by using the ODBC data source. The Web site sup-

ports multilingual features. Each web page contains phrases in all supported languages, and displays only phrases in the user-preferred language when the page is requested.

Some parts of the software were written in Visual Basic, for instance a program to acquire the pictures and video clips and a program to handle batch conversion of the pictures in various formats.

Results and Discussion

The database contain 121 tables, 28 queries, 82 forms and 8 standardized reports placed in several related modules.

Taxonomy module

Taxonomically, the database deals with vascular flora, i.e. the *Pteridophyta* and *Magnoliophyta* divisions. The lowest level that can be defined in the database is subspecies. The lower levels, as varieties and forms, are included only as part of synonyms or in the taxa descriptions. CROFlora has the systematic arrangement according to (CRONQUIST 1981), with minor modification.

The data stored in the database were collected from several sources. Nomenclature and related data that form a basic list of about 12000 taxa originate from the database for middle Europe FLOREIN 4.1 (Interaktives Programm zur Bearbeitung floristischer Daten, Zentralstelle für die Floristische Kartierung Deutschlands) (ANONYMOUS 1995 c), which was used after the publisher's approval. These original data contained the taxa list of Central European Flora according to (EHRENDORFER 1973). As the work on the Checklist of Croatian vascular flora was going on, this original list has been successively modified according to new proprietary results (NIKOLIĆ 1994, 1997, 2000). The genera names were checked out by comparing with Names in Current Use in digital version (GREUTER et al. 1993, by courtesy of the author) and with family and genera list from digital version of *Flora Europaea Database*, which is part of the PANDORA taxonomic database system at the Royal Botanic Garden Edinburgh (http://www.rbge.org.uk/forms/fe.html, by courtesy of R. Pankhurst).

The taxa are classified in nine hierarchical levels (kingdom to genus) as presented by the conceptual data sub-model in Figure 1. Besides the officially recognised levels, the database contains aggregates (also known as complexes) – a group of mostly small, relative species, to facilitate work with difficult groups, as commonly practised (i.e. EHRENDORFER 1973).

The essential data about species or subspecies (Species/Subspecies) comprise values such as species name and subspecies name, place of publishing, taxa name abbreviation (for the purpose of filed trip taxa list preparing), affiliation to the higher taxonomical levels (family and order) or aggregate, and free-form taxa description (Fig. 2).

Information on doubtful data (taxonomically or chorologically), as well as on endemic, cultivated and naturalised taxa, are derived from the Checklist (see above).

Data on threatened taxa (Conservation Status) contain (and were obtainable abroad) a list of adjacent and other countries and areas. The threatened categories mostly follow marks according to the IUCN Conservation Monitoring Centre (ANONYMOUS 1993 b, or

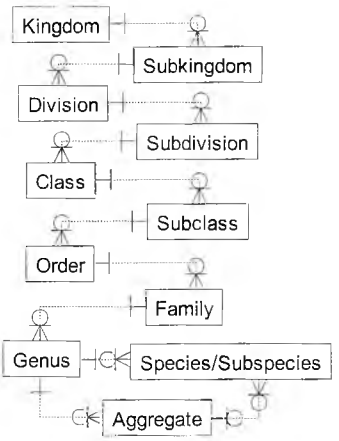


Fig. 1. The model of taxa hierarchy in the taxonomy module

newer), but also specific marks derived for a particular area. Besides the threatened category marks, there is also a special mark for taxa protected by the Nature Protection Law in the Republic of Croatia.

The data on threatened taxa currently cover the situations in Austria (NIKLFELD et al. 1986), Baden-Württemberg (HARMS et al. 1983), Bavaria (SCHÖNFELDER 1987), Berlin (BÖCKER et al. 1991), Bosnia and Herzegovina (ŠILIĆ 1996), Brandenburg (LINDACHER 1995), EU (ANONYMOUS 1991 a), Germany (KORNECK and SUKOPP 1988), Hungary (HORVÁTH et al. 1995), Italy (CONTI et al. 1997), Mittelfranken (LINDACHER 1995), Oberfranken (LINDACHER 1995), Slovenia (WRABER and SKOBERNE 1989), Switzerland (LANDOLT 1991), Türingen (LINDACHER 1995), Unterfranken (LINDACHER 1995), World Red List (WALTER and GILLETT 1998) and Yugoslavia (Serbia) (STEVANOVIĆ 1999). For Croatia, the database contains information about threatened flora from the Red Data book (ŠUGAR 1994), from the Red List included in Checklist and data for the new Red Data book (in preparation). The total amount of records on threatened plants is currently 10040.

The data on the authors of scientific names (AuthorOfName) is stored according to BRUMMITT and POWELL (1992). Initially, the data were obtained in digital form (by kindness of authors) and were imported into CROFlora with 30342 authors of plant names overall (supplemented by some Croatian authors).

The abbreviated author's name is used as basis to form valid names of taxa. Additional information about the authors of scientific names (AuthorOfSpecies, AuthorOfSubspecies) contains a prefix and a suffix (parenthesis, *et*, *non*, etc.) that are used to create the full scientific name of taxa. For example, the full scientific name »*Vitis vinifera* L. ssp. *sylvestris* (C. C. Gmelin) Hegi« is automatically created based on the values for genus: *Vitis*, species: *vinifera*, author of species: *L.*, subspecies: *sylvestris* and authors of subspecies: *C. C. Gmelin* (prefixed and suffixed by a rounded parenthesis) and *Hegi*.

The relationship between taxa (Species/Subspecies) and an universal set of synonyms (Synonym) carries information about the type of the synonym: (1) basionym, (2) exclusive, (3) inclusive, (4) nomen ambygum, (5) nomen nudum, (6) nomen illegitimum, (7) pro parte and (8) doubtful, and in addition information about the author(s) of non-valid name and

place of publishing. Currently, a total of 11585 nonvalid names are included, 4261 with place of publishing.

The majority of the vernacular names (CommonName) for families, genera and species (incl. subspecies) were included in the database according to literature and oral communication. In both cases, the input of information about area of use of specific vernacular name is specified together with language. The main incorporated literature sources of this type of data are VISIANI (1842, 1847, 1852), SCHLOSSER and VUKOTINOVIĆ (1869), ŠULEK (1879), HIRC (1903–1912) and DOMAC (1994), producing a total amount of 10961 vernacular names, mostly Croatian. Data entry for common names from several other sources is currently in progress.

The multimedia data (images and video clips) are stored as binary large objects (Blob). The additional data describe multimedia contents (Object): (1) population, (2) habitus, (3) leaf, (4) underground part, (5) inflorescence, (6) flower, (7) fruit, (8) seed, (9) androecium, (10) ginoecium, (11) pollen, (12) distribution map and (13) others. The applied method (*Technique*) can be (1) scan of herbarium sheet, (2) macro photo – camera (3) macro photo – digital camera, (4) macro photo – digital camcorder, (5) scan from publication, (6) photography – camera, (7) photography – digital camera, (8) photography – digital camcorder, (9) download from web site. Photo documentation is related to the Checklist, and originates from various sources. Nevertheless, the photo documentation was mostly produced by the associates of the Department of Botany. The production of multimedia is still in progress, with 4400 images and no video clips currently included.

Binding to the DEscription Language for TAxonomy (DELTA) standards is foreseen for future development. DELTA is adopted by the International Taxonomic Databases Working Group (TDWG) as a standard for data exchange. DELTA-format data can be used to produce natural-language descriptions, interactive or conventional keys, cladistic or phenetic classifications, and information-retrieval systems (DALLWITZ et al. 1993).

Other components of the model shown in figure 2 are discussed in subsequent chapters.

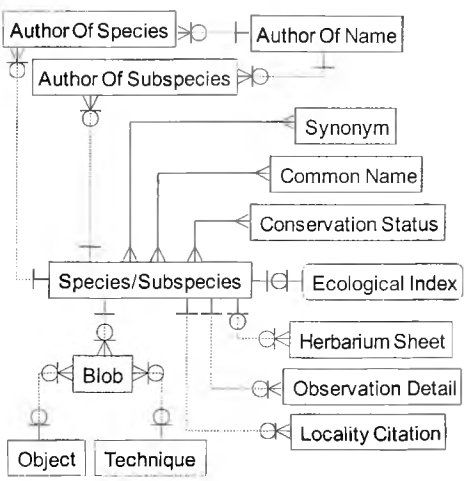


Fig. 2. Species/Subspecies and related data in the taxonomy module

Ecology module

Ecological data include index parameters (Fig. 3) according to KLAPP et al. (1953), LANDOLT (1977), KUNICK (1974), ELLENBERG (1979), SUKOPP et al. (1982), OBERDORFER (1983), DÜLL and KUTZELNIGG (1986), ROTHMALER (1987 a,b), KOWARIK (1988) and ELLENBERG et al. (1991, 1991–1996).

Altogether, thirty ecological parameters for 7300 taxa were obtained in digital form from two sources. The first part of data was obtained on a commercial basis from Verlag Erich Goltz Goltze / Co. KG, as a part of database SCRIPTA GEOBOTANICA XVIII Datenbank V 1.4. (Zeigewerte von Pflanzen in Mitteleuropa). The second part of data was imported from database PHANART ver. 10 and PHANSYS (Datenbank der Gefässpflanzen Mitteleuropas, Bern) (LINDACHER 1995, by kindness of the author).

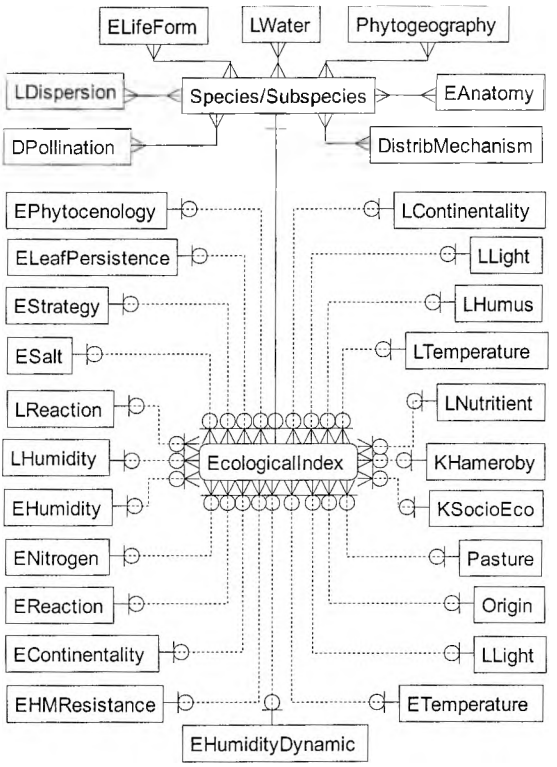


Fig. 3. Model of ecological index parameters connected with the species/subspcies table in the taxonomy module

Herbarium module

The herbarium module (Fig. 4.) stores the data about the herbarium collections (Collection) (i.e. ZA – Herbarium Croaticum, ZAHO –the Ivo and Marija Horvat Herbarium, etc.), herbarium sheets (HerbariumSheet) collected specimens (HerbariumSpecimen) and persons (Author) who collected (Collector), determined (Determinator) or re-determined

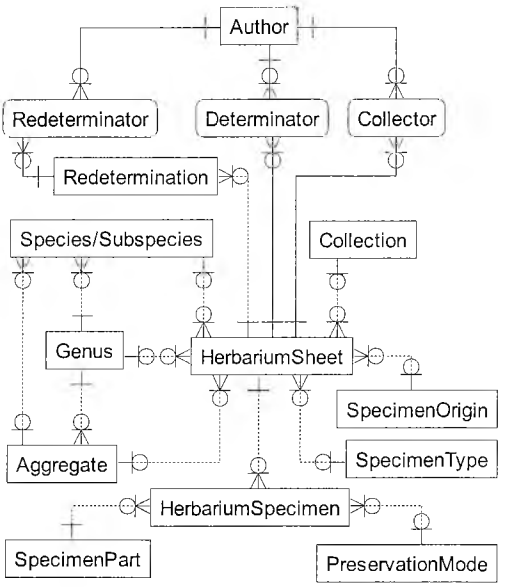


Fig. 4. Herbarium module, sub-model aimed at handling information about collections

(Redeterminator) the species. The re-determination data (Redetermination) include the re-determination date and the author's comments.

The HerbariumSheet stores all the data necessary for the management of herbarium, including internal identifier (ID), herbarium ID and collector personal sheet ID. For reasons of flexibility, the user is allowed to store only the information about the genus and/or the aggregate of the specimen (i.e. temporarily not determined below genus).

The information about the type of collected specimen (SpecimenType) is codified as (1) holotype, (2) isotype, (3) lectotype, (4) neotype, (5) paratype and (6) sintype. The origin of the specimens (SpecimenOrigin) can be designated as a (1) deposit, (2) a substitution, (3) a purchase or (4) a gift.

A collected specimen (HerbariumSpecimen) can be described (SpecimenPart) as (1) whole specimen, (2) seed, (3) root, (4) stem/wood, (5) leaf, (6) flower, (7) pollen and (8) fruit. The predefined preservation modes (PreservationMode) include (1) dried material, (2) liquid media, (3) silica gel media, (4) living specimen and (5) later on frost-bound.

The locality where the plant or plant parts were collected can be described in two ways (distinctly or altogether). The first one is to apply some geographical coding method by choosing predefined MTB squares and predefined UTM squares for Croatian area (see MTBSquare and UTMSquare in Fig. 6) or to input the real co-ordinates (longitude and latitude in degrees, minutes and seconds). The second method is to make a description of locality and habitat separately. Habitat preferences of the taxa could be taken in addition from a predefined set of values (Habitat in Fig. 6), such as different forest types, different types of meadows, marshes, etc. (in future according to the CORINE biotopes classification for Croatia, in progress). In addition, altitude is available in explicit values (from-to in meters) and/or in the form of predefined altitude classes (see chapter Chorology).

Literature module

Bibliographical data are stored in a database module presented by the data sub-model shown in figure 5. The bibliography of Croatian flora mostly contains references that are related to quotations or taxonomy of taxa of Croatian vascular flora.

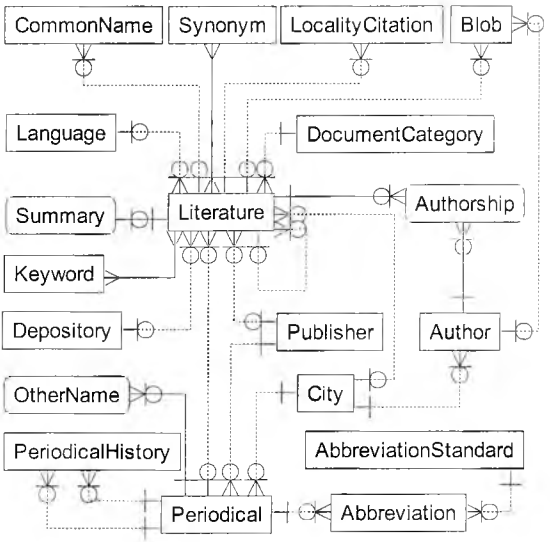


Fig. 5. Sub-model aimed at handling information about literature in the literature module

Similarly to the aforementioned generation of the full scientific name of the taxa, the full name of the reference (Literature) is generated automatically, based on the data on authors (Author, Authorship), year, title, volume, page range, publisher etc.

As a reference can be part of another reference, a recursive relationship has been implemented. The application preserves data consistency bythe use of predefined document types (DocumentType): (1) book, (2) PhD Thesis, (3) Habilitation, (4) MsC Thesis, (5) Thesis, (6) book of abstracts, (7) manuscript, (8) journal, (9) Scripta, (10) Bachelor Thesis and (11) expert study.

Common names, synonyms, locality citations, as well as the blob data can be referenced by literature (Fig. 5). The relationship between literature and synonyms holds the information about the citation type (citation, original description and original rejection).

The data about the periodicals are stored separately, extended by the history of periodical names (PeriodicalHistory), a set of abbreviated names and a standard (Abbreviation Standard) which was applied on abbreviations (BPH, ANSI, DIN, TS/10 etc.). Most of the journal title abbreviations were synchronised with the well-known Botanico-Periodicum-Huntianum/Supplementum (B-P-H/S, Bridson 1991). For example the history of the journal with the current name Plant Systematic and Evolution is stored in chronologically ascending order: (1) Österreichisches botanisches Wochenblatt (the oldest name), (2) Österreichische botanische Zeitschrift, (3) Wiener botanische Zeitschrift and (4) Österreichische botanische Zeitschrift (last name before the current name). These data were

partly imported into CROFlora from previously used database LITFAS 2.2 (Zentralstelle für die Floristische Kartierung Deutschlands).

The public part of the bibliography (i.e. web availability to floristic papers on Croatian flora) contains currently 6423 references. The total number of references available from LAN is currently 6952.

The bibliographical contents have been collected and processed by various collaborators during the last six years. Many active and retired botanists have made their contribution to the bibliography by sending their papers or their lists of publications. The subsequent necessary corrections and supplementation are in progress.

Chorology module

The part of the data model presented in Fig. 6 defines data about the on-site observations of the species (FieldObservation), issued by persons (Author). Every observation is further described by a set of gathering events (ObservationDetail) that take place on a wider geographical area (District). More precise information about the geographical positions is geocoded in separate database tables (MTBSquare, UTMSquare) (predefined according NIKOLIĆ et al. 1998). The same codes are applied to herbarium sheets and locality citations found in the literature. In this way an extensive cross checking can be performed. It is easy to produce a Prodromus of selected taxa, herbarium index, checklist of some area, etc. Both tables, the ObservationDetails and the HerbariumSheet, contain data about the altitude zones to which the taxa belong (AltitudeClass), such as Mediterranean, Sub-Mediterranean, montane, sub-Alpine and Alpine and so on.

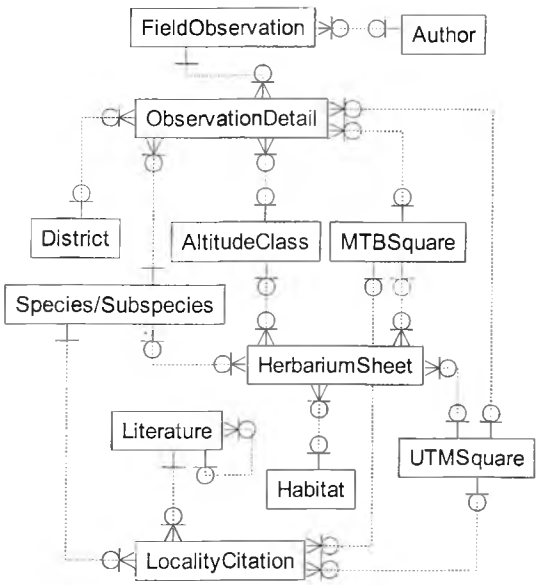


Fig. 6. Chorology module, sub-model to manage geographical data from herbarium, literature and filed observations

CROFlora can be connected to a GIS application (currently ArcView, ArcInfo) via ODBC link, which makes it possible to search for data in the database from the GIS side by using SQL (Structured Query Language) statements. The easy production of distribution maps is available (see Appendix). Usage of ecological indexes and other data with different GIS layers have made complex spatial analysis possible. Geographically, the data correspond to the area within the Croatian borders.

The client application

The client application is divided into several modules, following the database organisation: (1) Taxa hierarchy, (2) Species/Subspecies, (3) Herbarium, (4) Field observations, (5) Bibliography, (6) Basic tables, (7) Reports (8) System administration and (9) Help.

Every application module supports a set of standard functions such as query by example (QBE), a data entry and data update, a deletion function, a browse function and a standard report.

QBE function allows a user to search for data by entering patterns in almost every form field. The patterns can include wildcards. The patterns are used to dynamically create SQL statements, which are further used as record sources for the data. For example, when searching for the species/subspecies, the user can type *fera into species name field and *Gmelin into the field that represents the short name of Author that is related to AuthorOfSubspecies. The following SQL statement is produced, where the word Taxon stands for Species/Subspecies:

```
SELECT DISTINCTROW Taxon.* FROM
Taxon INNER JOIN AuthorOfSubspecies
ON AuthorOfSubspecies.TaxonId
= Taxon.TaxonId)
INNER JOIN
AuthorOfName AS AuthorOfSubspeciesName
ON AuthorOfSubspecies.AuthorId =
AuthorOfSubspeciesName.AuthorId
WHERE Taxon.SpeciesName LIKE »*fera«
AND AuthorOfSubspeciesName.ShortName
LIKE »*Gmelin«
```

The resulting data set contains taxa having full the scientific name *Vitis vinifera* L. *ssp. sylvestris* (C. C. Gmelin) Hegi. Of course, for the given example it would be more appropriate to search for all species/subspecies having the full scientific name that matches the pattern *fera*Gmelin*. In that case, the SQL statement would be as follows.

```
SELECT DISTINCTROW Taxon.*
FROM Taxon
WHERE Taxon.FullName
LIKE »*fera*Gmelin*«
```

Query results data can be browsed record by record on predefined screen forms or the data can be browsed in a customisable grid. Queried data can be dynamically sorted by almost every attribute and in user-defined order.

The management of taxa can be performed by using the screen forms to handle separate database tables and an additional module has been developed to help users in navigation through the taxa hierarchy.

As described in previous chapters, the application automatically generates full scientific taxa names and literature references.

The re-determination data (Redetermination and Redeterminator) can be handled manually or the data can be automatically generated when the name of the taxon changes in the main species/subspecies form. In the latter case, the program generates a synonym that is equal to the previously stored valid name of the taxon. In addition, the user decides whether she/he wants to generate the re-determination data. Finally, the user decides about an automated modification of the related data (herbarium, literature citations and field observations). In addition, the user of the application is asked to select the type of the synonym.

Sophisticated reporting is provided for major groups of data (Herbarium, Species/Subspecies, and Literature). Sophisticated reports can be dynamically customised by selecting the groups of attributes for which the values are going to be printed. In addition, the user can decide whether to report the current record or all records selected by the last query (see Apendix 1 for example).

The administration module provides information about users of the application. The proprietary data transfer protocol has been defined and related data transfer routine has been implemented.

The web site

The web site was built to enable quick access to the CROFlora database via Intranet/Internet. The site is divided into three logical sections: CIS-B Database, CROFlora Taxonomy and CROFlora Bibliography. A navigation system enables users to find and browse for the species and bibliographies quickly and easily.

CIS-B database can be searched and browsed (URL http://hirc.botanic.hr/croflora/default.asp). Search fields are hierarchy fields (Subkingdom to Species/Subspecies) for all kingdoms and other fields like endangerment level in Croatia, endemic species, and species protected by law. Search fields can be combined and wildcards are allowed (e.g. division: Ascomycota AND genus: Arthop* AND Endemic in Croatia). The resulted species are listed in the table, and one can choose to see the details about any of them.

Browsing the database provides the users with quick access to any part of the species hierarchy. One frame shows the currently selected species hierarchy node and links to its child and parent nodes. The other frame shows the search form that is automatically filled with the currently selected hierarchy nodes. In that way it is possible to find the desired category and to search for species within that category without leaving the current frame set.

At the moment, via the CIS-B web site non-vascular flora, i.e. the divisions *Bryophyta*, *Dinophyta*, *Euglenophyta*, and also the kingdoms *Mycota* and *Lichenes* can be searched. The data are still incomplete, and are assembled for the development of the National Strategy for Biodiversity Conservation (MARTINIĆ 2000). Data input is currently throughout.

CROFlora Taxonomy deals only with data on vascular flora (the divisions *Magnoliophyta* and *Pteridophyta*) and can be searched and browsed by using similar web forms as for the CIS-B database (URL http://hirc.botanic.hr/croflora/ tax_default.asp). Some addi-

tional fields are shown such as tags for spurious, naturalised and cultivated species, species with pictures, IUCN category, etc. Additional visible fields connected to the taxon name are synonyms, place of publishing, vernacular names, etc. There can be several pictures shown for species/subspecies (i.e. habitus, inflorescence, etc., and other photo details).

CROFlora Bibliography can be searched by author, title, keywords, reference identifier and date of publication (URL http://hirc.botanic.hr/croflora/bib_default.asp). Search results are displayed in a list, which can be viewed one page at a time. The details about a single reference can be shown on a separate page.

Web availability of CROFlora datasets is a contribution to the massive development of the biodiversity-related information systems on the Internet.

Conclusion

CROFlora Database is designed to assist those working with taxon-based and specimen-based information on Croatian vascular flora. It is primarily intended for use by taxonomists, ecologists, collection managers and bio-geographers. It is suitable for use by individual researchers, as well as teams of global collaborators.

CROFlora manages taxon-based information such as nomenclature, distribution, classification, ecology, literature, and multimedia. Specimen-based information includes field observation and herbarium data with all collection details (sites, collectors and collection dates, storage locations, loans and accession, catalogue numbers). Preformatted reports are provided for material for a taxon (»material examined«), site species lists, specimen labels, reference cards, synonym lists and other complex user customised reports.

In the near future there will be new modules and related data entry. The first one is the economic use module and the inclusion of the data about taxa economic use locally and wider starting with World Economic Plants in GRIN dataset and related standards (USDA 2001). The second is Europe and world distribution data for Croatian flora representatives following the World Geographical Scheme for Recording Plant Distribution (HOLLIS and BRUMMITT 1992).

The developed database model and the algorithmic methods will become powerful tools for storing, displaying and analysing taxonomic and floristic data. The database ensures the building of several basic floristic works which were lacking for the Croatian area. A connection with a GIS application has made feasible the production of an Atlas of Croatian Vascular Flora with different types of spatial analyses connected with ecological indexes. User-customised reports can be developed to produce complex publications such as checklists, catalogues, revisions, monographs, raw data exports and finally, *Flora Croatica*. To date, the Checklist of Croatian flora with related data is also available on the web site for both public and professional use (botany, ecology, forestry, and agronomy) as a contribution to the global effort at biodiversity indexing (i.e. Species 2000, The Global Biodiversity Information System; BISBY 2000, EDWARDS et al. 2000).

Acknowledgements

Flora Croatica Database (CROFlora) has been developed as part of the project »Biological database and GIS II« with financial support from the Ministry of Science and Technol-

ogy of Republic of Croatia (Grant no. 119116). The authors wish to give thanks for kind support and provision of the data in digital format to Mr. W. Greuter (Botanischer Garten und Botanisches Museum Berlin-Dahlem, Freie Universität Berlin) for NCU-3 data, to Mr. R. J. Pankhurst (Royal Botanic Garden Edinburgh) for data from Flora Europaea Database, to Mr. R. K. Brummitta (Royal Botanic Gardens, Kew) for data about authors' names and to Mr. R. Lindacher for ecological data from the PHANART and PHANSYS databases, to Mr. John H. Wiersema from United States Department of Agriculture/Agricultural Research Service, Systematic Botany & Mycology Laboratory for the data on taxa economic uses, world distributions and common names.

Appendix 1. Example of CROFlora database report type – portion of taxon sheet for species *Lycopodium clavatum* L. (in original all English text is on Croatian)

FLORA CROATICA taxon sheet (ver. 1)CROFlora Database 2000. April 14

Species name: ***Lycopodium clavatum* L.**
Published in: *Sp. Pl. 1101 (1753)*
Species ID: *181*
Species name short: *Lycop'um clav*
Synonym(s): *Lepidotis clavata* (L.) P. Beauv.. Mag. Encycl. 9(5): 480 (1804)
Family: *Lycopodiaceae*
Order: *Lycopodiales*
Common family name: *crvotočine*
Common genus name: *crvotočina, vilin vinac*
Common species name: *kijačasta crvotočina, lisičnik, mah od zemlje, mahovina zmijina, mašina od zemlje, obična crvotočina, prečica, preprat divji, samolja, zminja mahovina, Almindelig Ulvefod (Swe), Katinlieko (Fin.) Burstajafni (Ice.) Stag's-horn Clubmoss (Eng.) Keulen-Bärlapp (Ger.)*

Endemic: *no*; **IUCN**: *R*; **Protected by law**: *no*; **Spurious**: *no*; **In culture**: *no*; **Naturalised**: *no*

Ecological indexes:

Humidity value – Landolt: *plant chiefly occurring on dry soils; usually avoiding very dry and very wet areas; in general not able to compete in dump situations. Indicator of medium dryness.*

Reaction value- Landolt: *plant occurring chiefly on very acid soils (pH 3 – 4.5); never found on neutral or alkaline soils. Definite acid soil indicator.*

Light value – Landolt: *plant often growing in half-shade (but usually not under 10% relative strength of illumination); more rarely met with in full light.*

Temperature value – Landolt: *plant occurring chiefly in the sub-alpine zone; found also in the alpine zone in sunny places and in cool situations with little competition, occasionally even in low regions. Alpine and boreal plant.*

….. etc.

Description: *Stems long, procumbent; branches ascending. Leaves 3–5 mm, bright green, linear, acute, subappressed, prolonged apically as a hyaline hair 2–3 mm (sometimes deciduous in older leaves). Cones 1–4, 2.5–6 cm; peduncules 1.5–15 cm, with remote, yellowish, bract-like leaves; sporophylls ovate, with long, hyaline hair at the apex. 2n=68.*
..... etc.

Distribution (short version):

Literature

Locality description	MTB	4	16	UTM	Author(s)	Year	Ref. ID
(Hrvatska, Zagrebačka gora, Medvednica), sastojine formacije bukve (Fagus silvatica L.)					*Forenbacher, A.*	*1908*	*49*
između Brloga i Ozlja	*0358*				*Hirc, D.*	*1905*	*663*
Klempina duliba u podnožju Šatorine, Velebit					*Forenbacher, S.*	*1990*	*50*
Hrvatska, Medvednica (Zagrebačka gora), istočni dio, Bedrenik					*Hulina, N.*	*1994*	*4683*
... etc.							

Field observations

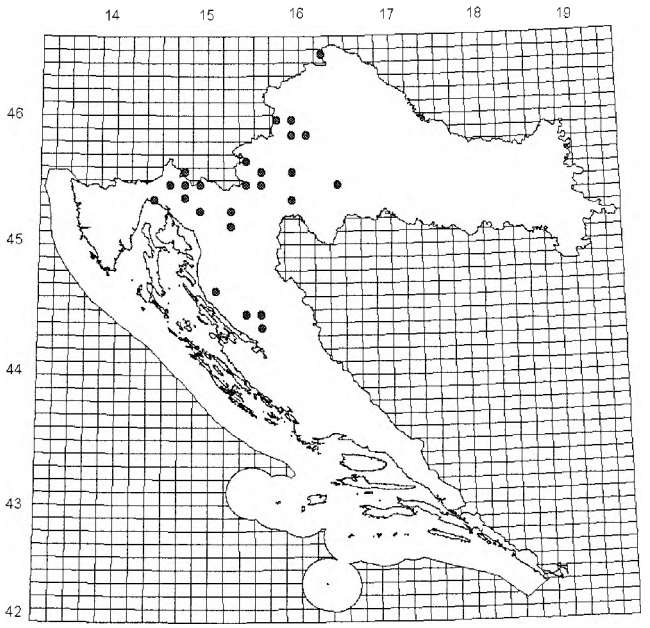
Locality description	MTB	4	16	UTM	Author(s)	Year	Ref. ID
(Hrvatska, Zagrebačka gora, Medvednica), sastojine formacije bukve (Fagus silvatica L.)					*Forenbacher, A.*	*1908*	*49*
između Brloga i Ozlja	*0358*				*Hirc, D.*	*1905*	*663*
Klempina duliba u podnožju Šatorine, Velebit					*Forenbacher, S.*	*1990*	*50*
Hrvatska, Medvednica (Zagrebačka gora), istočni dio, Bedrenik					*Hulina, N.*	*1994*	*4683*
... etc.							

Herbarium

Locality description	MTB	4	16	UTM	Observer(s)	Field trip ID
Medvednica, Park prirode Medvednica, Zagreb, Hrvatska. Rakova noga.	*0061*	*4*	*24*		*Nikolić T.*	*23*
Medvednica, Park prirode Medvednica, Zagreb, Hrvatska. Vrapčeva gora	*0161*	*1*	*42*		*Nikolić T.*	*144*
Ploha 21, Beli kamen, Medvednica, Park prirode Medvednica, Zagreb, Hrvatska	*0061*	*4*	*21*		*Jelaska S. D.*	*228*
... etc.						

Image documentation:
source 1.: *Rothmaler W. (1987) Ref. ID 5862;*
source 2.: http://www.mpiz-koeln.mpg.de/~stueber/thome/band1/tafel_019_;This image is part of Thomé – Flora von Deutschland, Österreich und der Schweiz; Comment: Photographer and owner: Kurt Stüber; Submitted by: Kurt Stüber; entry date: 1999–08–30
source 3.: *... etc.*

Distribution map



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