Plant uses in Croatia

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Abstract. Despite the long history of plant usage, the economic values of the highly diverse Croatian vascular flora (5516 taxa) were never investigated. For the purpose of a survey of the useful and harmful species, the available information was accumulated in the Flora Croatica Database (FCD) and a new database module for economic botany has been developed. An Economic Botany Standard was adopted on the basis of TDWG conception. The most important references were studied and the data were transferred to the database. The results show that 1144 taxa (17 %) have some usage or other relationships with humans on the national territory. The highest number of useful plants (25 %) is related to medicine, followed by plants used for food (12 %), bee plants (12 %), plants for environmental uses (8 %), plants for materials (8 %), food additives (5 %), plants for social usage (4 %), etc. The vertebrates and non-vertebrates poisons were registered, as well as the plants used as animal food, non-vertebrates food, fuels, etc. Each category of use was further analyzed on 121 sublevels. A total of 128 useful taxa are at the same time threatened plants in their natural localities and poorly covered by the conservation legislation. Full publication of data on the useful plants was ensured by the web interface to FCD and the different queries provided different kind of information.

Key words: Croatia, ethnobotany, database, vascular plant uses

Introduction

Croatia has a long history of botanical research. Although the oldest works date back to the 17th century, leading and definitive works, which more or less cover the recent state area, were published during the 19th century and at the beginning of the 20th century. Amongst them are *Flora Dalmatica* (Visiani 1842–1852 and supplements 1872–1881), *Syllabus and Excursion Flora, Flora Croatica* (Schlosser & Vukotinović 1857, 1869, 1876), *Flora Velebitica* (Degen 1936, 1937, 1938a, b), and some general contributions by Hirc (1903–1912), Rossi (1930) and Hayek (1927–1933). Numerous papers and authors, whose overviews are not the subject of this paper, have contributed richly to the Croatian flora. A complete checklist of the Croatian flora, with nomenclatural and taxonomical updating, has been recently finished (Nikolić 1994, 1997, 2000). The checklist offers an opportunity to quantify and analyze the diversity of Croatian vascular flora and to relate it to the floras of other European countries (Nikolić 2001). According to these results, the Croatian flora consists of 4228 species and 1108 subspecies (5536 species and subspecies) belonging to 1086 genera and 184 families. The comparison with other countries, correlated to areas, demonstrate a very high floristic diversity and a high level of endemism, especially in a wider European context.

The long history of human presence on the Croatian national territory (Šoštarić 2004) is directly connected to plant resources: autochthonous, as well as alochthonous and naturalized. Archeobotanical evidence

shows that there are plants in culture (i.e. *Triticum* species) in the area of Croatia since the Neolithic period (Karg & Müller 1990). In the following periods new taxa appeared in cultivation: archaeological finds from the Bronze Age have added to the list of cultivated plants such species as *Avena* spp., *Lathyrus sativus* L., *Vicia faba* L. and *Vitis vinifera* L.; from the Iron Age – *Panicum milliaceum* L. and *Secale cereale* L.; and from the Antiquity – *Hordeum vulgare* L., *Lens culinaris* Medik., *Vicia ervilia* (L.) Willd., *Papaver somniferum* L., *Camelina sativa* (L.) Crantz, *Ficus carica* L., *Olea europea* L. and *Pinus pinea* L. (Hänsel & al. 1997; Šoštarić & Küster 2001; Šoštarić 2003). Recently, up to 90 taxa (excluding varieties) have been listed as common and widely cultivated plants on the Croatian national territory (Dubravec & Dubravec 1998).

Data on other early plant usages, mostly related to the development of medicine and pharmacy, could be traced back to the Antiquity, but became abundant in the 13th century, in numerous original domestic conventual manuscripts. The oldest vernacular names of medicinal plants in the Croatian language appeared in the middle of the 15th century, together with illustrations (i.e. *Liber de simplicibus* by Nicole Roccabonelle from Zadar). Further official progress in the area was related to the Dominican public *alma mater* established in Zadar in 1396 and to the establishment of the University of Zagreb in 1669, with a special study of pharmacy. Officially, the *Dispensatorium pharmaceuticum Viennense* of 1729 was used by the apothecaries, along with the first medical work in native language *Medicina ruralis illiti vrachtva ladanyszka* of 1776 produced by Ivan Lalanga. For example, the natural insecticide capacity of *Tanacetum cinerariifolium* (Trevir.) Sch. Bip. was discovered at the beginning of the 19th century. Furthermore, several societies were founded and specialized journals started to appear. At the end of the 19th and the beginning of the 20th century emerged the first comprehensive national compilations of medicinal plants, headed by the pioneer works of Domac (1899) and Kušan (1938), who unfortunately did not focus solely on the national flora, but rather produced a global overview.

The other areas of national economic botany are not covered so well. On the subject of forestry and timber production the first serious data could be found in Šafar (1946), on the wild edible plants in Grlić (1979, 1990), on the poisonous plants for animals in cattle breeding, etc. in Forenbacher (1998), and on the poisonous fruits and seeds in Grlić (1984). The lack of fundamental research in domestic literature had been partially covered by translations of the most popular foreign books and manuals.

However, despite the long history of plants usage and the fact that studies of the uses of plants have become increasingly important on a national and an international level, the utilisation and economic potential of the highly diverse Croatian vascular flora were never investigated from the national, i.e. systematic viewpoint. Information on particular human-plant interactions is scattered among the various disciplines, lacking complete accumulation and quantification. The total amount of useful and harmful plant taxa is still unknown, as well as the full range of their application.

The major aims of this study are for the first time to (1) collect available data on the known plant uses of the native flora members, (2) customize collected data to a selected standard, (3) develop appropriate database for data input and analyses, and (4) ensure the availability of these data via an appropriate public service. This study should serve as a primary background and data source for the national economic botany and for further in-depth surveys of the particular aspects of plants usage in the future, along with promotion of data capacity and economic botany as a field of work.

Material and methods

Study area and community structure

Data collection and investigated flora cover the entire Croatian national territory, including the islands (56 610 km^2, without the maritime area of 31 067 km^2). An overview of the topography of the country shows that 53.4 % of the area lies at altitudes between 0–200 m, 25.6 % between 200–500 m, and 21 % at altitudes >500 m. The population numbers approx. 4 784 000 residents, with an average of 84.51 residents/km^2, inhabiting a total of 6694 settlements (80 % of the settlements have ≤ 500 inhabitants, 20 % of the residents inhabit the four largest towns).

Primary (natural) vegetation in Croatia is forest vegetation (Trinajstić 1987). Without human impact, the forests would have almost completely covered this region, with the exception of some comparatively small sections of steep rocks, water habitats,

screes and seashore, and a small steppe area in the east. Today, Croatia is an averagely wooded country, with a total woodland area accounting for about 44 % of the total national terrestrial area (Martinić 2001). Human activities generate a number of secondary (anthropogenic) habitat types, such as agricultural (arable land, grassland, orchards), urban, artificial water-related habitats, forest cultures etc., actually enriching the plant diversity in most cases. According to topography and climate, the national territory of Croatia could be separated into lowlands (wide areas of wet oak-woods, the rivers Sava, Drava and Danube and related broad valleys, wet meadows and pastures), highlands (mountains up to 1800 m, forests of beech and fir, relict mountain flora with high level of endemism, karst watercourses), and the Mediterranean coast with the insular areas (evergreen holm oak, mostly rocky limestone coastline, endemic insular flora, rivers of the Adriatic catchments).

Data collection and standardization

Data on the plant uses are related to the taxa included in the National Checklist of Vascular Flora (*Pteridophytes, Coniferophytina, Cycadophytina* and *Magnoliophytina*) (Nikolić 1994, 1997, 2000). The study was conducted in the period 2003–2004.

Data-sources on the known plant uses are mostly literary, as well as a number of personal communications and occasional notes on the herbarium specimen labels: Herbarium Croaticum (ZA) and Herbarium Ivo and Marija Horvat (ZAHO). The used sources include: Šafar (1946), Kvakan (1952), Kušan (1956), Willfort (1959), Grlić (1979, 1984, 1990), Jašmak (1980), Anonymous (1984), Pahlow (1989), Gelenčir & Gelenčir (1991), Šilješ & al. (1992), Bown (1995, 2002), Živković (1997), Dubravec & Dubravec (1998), Forenbacher (1998), Ortiz (1998), Schaffner & al. (1999), Wiersema & Blanca (1999), Chevallier (2001), Houdret (2002), Lemoine & Izrael (2002), and Biggs & al. (2003). The foreign sources on plant usages are taken into account only if confirmed on the national level. Numerous other sources with overlapping data are not cited.

In order to take account of the heterogeneous descriptions of plant uses and their relationship to humans, the Economic Botany Data Collection Standard (EBDCS) (Cook 1995) was adopted. This standard provides a system for the description of plant uses (in their cultural context) by means of standardized descriptors and terms, and for their storage in the taxonomic datasets (TDWG web site, http://www.tdwg.org/index.html). A total of 13 classes are recognized according to this Standard: food, food additives, animal food, bee plants, invertebrate food, materials, fuels, social uses, vertebrate poisons, non-vertebrate poisons, medicines, environmental uses, and gene sources. Vertebrate poisons do not represent the beneficial uses, but are mostly negative in their economic impact. The 13 classes are further subdivided into 121 subclasses outlined by 3736 so-called descriptors.

Data processing

For the purpose of data accumulation and assay, the Flora Croatica Database (FCD) is used (Nikolić & al. 2001). The FCD main purpose is accumulation, updating, reporting and analyzing of data on the Croatian vascular flora. It is based on the National Checklist with its contiguous data structure related to systematics (nomenclature, synonyms and authorization), chorology (distribution on the basis of literature, herbaria collections, field investigations, oral reports), collections, bibliography, etymology, ecological indices, threat assessment, vernacular names, etc. The Database enables processing of numerical, textual, audio and video documents. It is connected to the GIS applications, and several specialized data sets are incorporated on the basis of data standards following Brummitt & Powell (1992) for authors names, Brummitt & al. (2001) for the general distribution notes, Lindacher (1995) for ecological indices, and Greuter & al. (1993) for nomenclature. Systematic arrangement is adjusted and slightly modified according to Cronquist (1981).

FCD was upgraded by a new module, following the Entity-Relationship diagram used in SEPASAL (database on useful "wild" and semi-domesticated plants of tropical and subtropical dry lands, developed and maintained at the Royal Botanic Gardens, Kew). The sources of information were analyzed, the collected data adjusted according to standards and stored in the database.

Data analysis and availability

The data were analyzed using simple statistical indices, mostly presenting the percentage amount of the selected group of taxa in relation to the total number.

For the purpose of distribution of the collected data, a web site was made as part of the FCD web in-

terface, structured so as to permit multiple searching of the useful plants dataset and enriched by additional information (i.e. image gallery). The FCD data are stored in Microsoft SQL Server 2000 database running on a Microsoft Windows 2003 Server platform. In order to efficiently use those data and create dynamically web pages, the Asp.Net technology was used as a server-side engine (using C+ as a programming language). Wherever it was necessary to enhance the user's interface, the JavaScript was applied as a client scripting language.

Results and discussion

Useful plants of the Croatian vascular flora

The first assessment of the collected data and sources on the useful and harmful plant species has shown a combination of traditional uses by indigenous populations, as well as "official" industrial, or organized on another scale, plant utilization, except for medical purposes. Plant uses, including harmful plants, have been found for a total of 1144 taxa, both species and subspecies, belonging to 143 families. Considering the total of 5516 taxa for the national flora, some usages have been established for 20.73 % of them, while 77.7 % of all families in the national flora have been represented by at least one useful taxon. In total, 35 222 species–usage relationships are described on all EBDCS levels. Over half of the useful and harmful plants belong to 10 families. The largest number of useful taxa has been recorded for the families *Poaceae* (109), *Fabaceae* (77), *Asteraceae* (76), *Rosaceae* (67), *Lamiaceae* (66), *Ranunculaceae* (51), *Brassicaceae* (46), *Apiaceae* (43), *Liliaceae* (38), *Scrophulariaceae* (27), and *Solanaceae* (22) (Fig. 1). If the families *Asteraceae* and *Cichoriaceae* are taxonomically treated as a joint family *Compositae*, which is not unaccustomed in literature, than this family would contain 89 taxa (7.5 %) and would become the second richest family in relation to useful taxa.

As the so far used taxonomic standard does not include the levels of cultivars and varieties common in agricultural and horticultural practice and forestry, the total number of taxa, as well as the number of taxa in the particular classes, should be taken consequently. For example, *Brassica oleracea* L. regarded here as one taxon, could actually be presented by several quite different varieties (similar for *Beta vulgaris* L., *Cucurbita pepo* L., etc.). Most of the species used by the community are native to the country, although a total of 103 recently introduced and more or less naturalized species have been found to be also in use.

In all 13 classes recognized by the Standard at least some species are recorded as useful or harmful (Fig. 2).

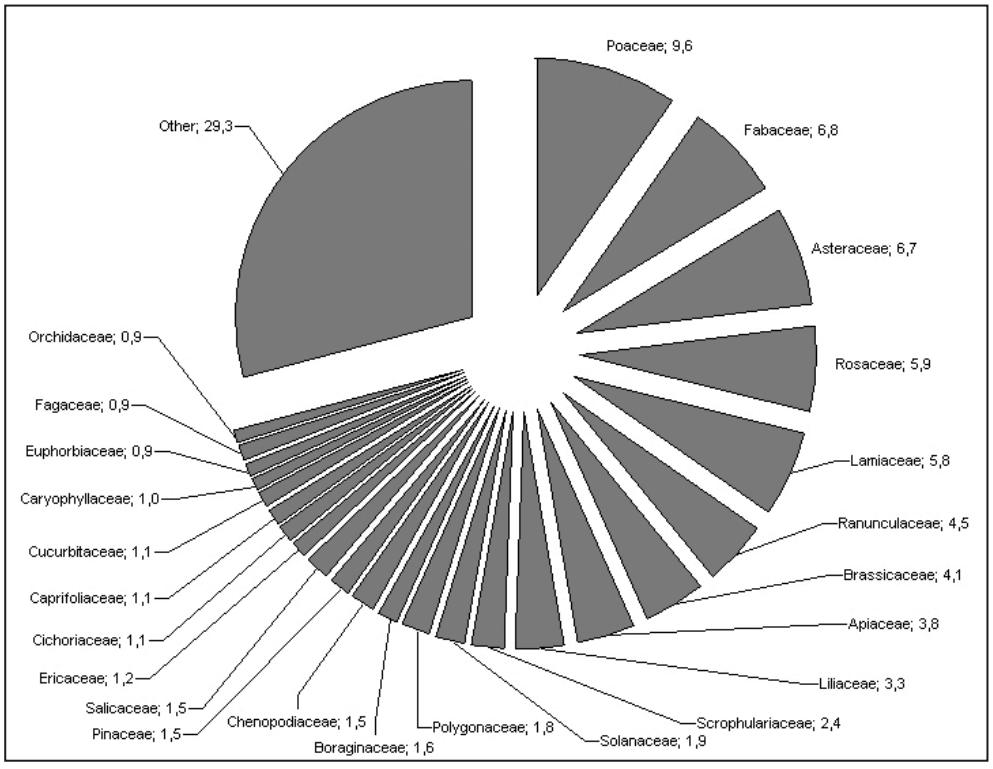

Fig. 1. Distribution of useful and harmful species and subspecies of the Croatian vascular flora among the families of Croatian vascular flora (%) (119 families are included in category *Other* – 29 %).

While some taxa appear in more than one class (for example, there are species that are both medicinal and poisonous, food and food additive, etc.), the total relative number of the useful and harmful taxa is greater than the absolute number of these taxa.

A high number of known uses does not necessarily mean that they are applied actively today. A small part of the collected data is outdated, i.e. the recognized plant uses are not in practice any more. During the last centuries, some distinct changes in the life style have taken place, mostly shifting from rural to a more urban way of life, and migration from inland to the coastal area, typical for most of Europe. Nevertheless, these data are kept in the database and analyzed, so as to show a broader picture of the plant uses and their total economic potential.

The largest amount of data is related to the medicinal plants usage. This is not surprising considering the long tradition and amount of published data in the area of pharmacy and medicine. Application in folk medicine or/and official medicine and pharmacy has been recorded for a total of 735 different taxa (species and subspecies, 64 % of all recognised taxa), mostly more than one application for a particular species or subspecies. This also includes the plants used widely as "folk" remedies and serving as a source of specific pharmaceutical agents. It is almost impossible to agree on the current commercial importance of many medicinal plants in Croatia; the most important ones are included, but certainly along with some other taxa that do not merit it. Within this group, the greatest share goes to the plant taxa used for medication of digestive (65.4 %) and genitourinary disorders (53.9 %), followed by those for infections/infestations (45 %), skin and subcutaneous cellular tissue complaints (41 %), respiratory ailments (36.9 %), injuries (33.3 %), metabolic system disorders (32.8 %), muscular-skeletal (31.7 %), nutritional (30.6 %), circulatory system (28.4 %), and unspecified medicinal ailments (27.1 %), inflammations (26.5), poisonings (23.8 %), nervous conditions (18.5 %), painkilling (17.4 %), mental disorders (17.1 %), blood system (12 %), sensory system (6.2 %) and endocrine system disorders (5.8 %), pregnancy, birth and puerpuerium conditions (4.1 %), neoplasms (3 %), abnormalities (2.8 %), and immune system ailments (1.8 %). Investigation of the catalogue of families has shown as richest in medicinal species the families of *Rosaceae* (54 taxa), *Asteraceae* (52), *Lamiaceae* (49), *Apiaceae* (36), *Ranunculaceae* (34), *Fabaceae* (33), and *Brassicaceae* (31), which contain nearly 40 % of all medicinal plants in the Croatian flora. The same group of families are particularly diverse on the national territory, especially in the Mediterranean area.

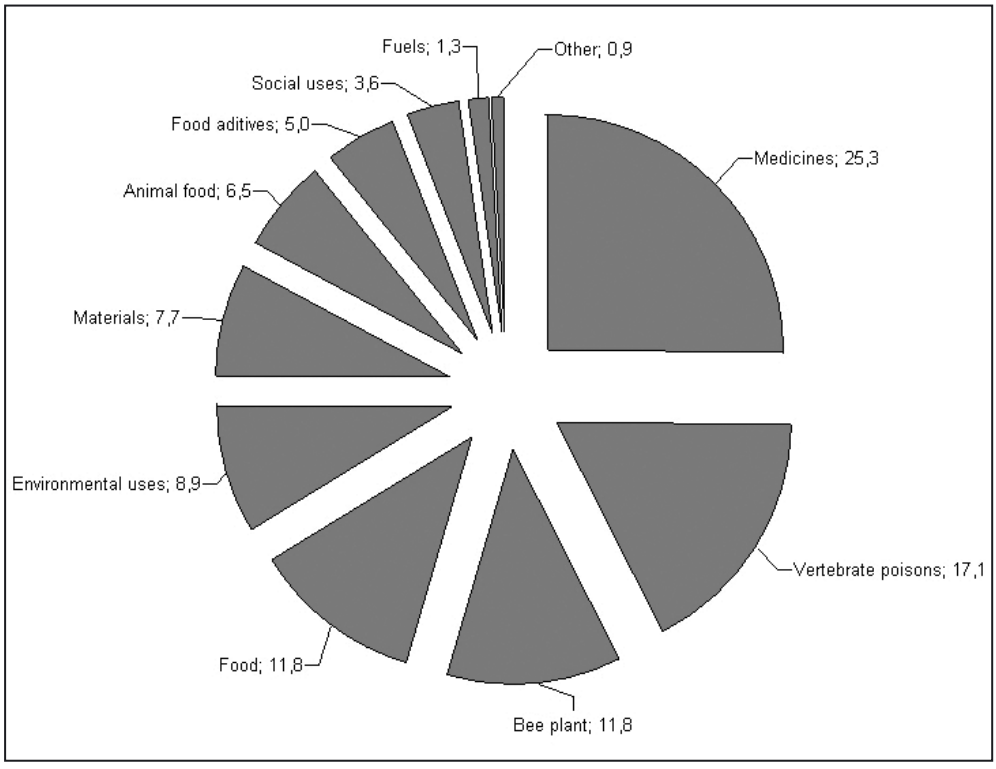

Fig. 2. Distribution of useful and harmful species and subspecies of the Croatian vascular flora among the main classes of the Economic Botany Data Collection Standard (EBDCS) (%) (class *Other* cover non-vertebrate poisons, invertebrate food and gene resources).

In relation to the well-distinguished poisonous plants in Croatia (Grlić 1984, Forenbacher 1998), mostly from the standpoint of cattle breeding and farming, the vertebrate poisonous plants class is well represented by 497 taxa (43.4 %). Of these, 87.5 % are poisonous to the mammals, 22 % to unspecified vertebrates, 8 % to birds, 1.8 % to fish, and 0.4 % to amphibians. The family *Ranunculaceae* contains the greatest number of toxic plants (45), followed by *Compositae* (39), *Fabaceae* (33), *Poaceae* (24), and *Apiaceae* (23). The economic impact of poisonous plants classified here is mainly negative (except in few cases). The list of poisonous plants is certainly incomplete, as many other unmentioned here would certainly be toxic to humans or domestic animals if consumed, but that effect has not been properly documented. This study is restricted to those species whose toxic effects have been established in the appropriate literature.

A total of 343 taxa are registered as bee plants, with no subclasses used for this class. While many species maintain some importance as honey plants, no comprehensive treatment has been applied. Jašmak (1980) provides useful reference in relation to these data, while the results have shown that most bee plants have been recorded in the family *Lamiaceae* (40 species), followed by *Rosaceae* (30) and *Compositae* (24).

The data collected so far have shown that food plants in the Croatian flora are represented by 341 species and subspecies (30 % of all recorded taxa), both in culture and as edible wild species. This includes plants consumed by humans as major constituents of the food preparations and comprises the economically most important class. In relation to plant components used as food, the highest share goes to infructescences (39.9 %) and leaves (34 %), followed by roots containing different morphological subterranean parts of the plant (22 %), seeds (18.5 %), seedlings and germinated seeds (8.8 %), and inflorescences (7.6 %). Literature sources report another 27 taxa usable for food, but the plant components are unspecified. *Rosaceae* is the family with the largest number of edible species, 42 out of total 45 species have edible, world-wide known fruits. The *Rosaceae* are followed by *Brassicaceae* (32 edible taxa), *Compositae* (24), *Liliaceae* (incl. *Alliaceae*) (18), *Apiaceae* (14), *Fabaceae* (14), *Chenopodiaceae* (12), *Poaceae* (11), and *Cucurbitaceae* (9).

Two hundred and 57 taxa are put to environmental uses. As expected, the greatest share of environmentally used plants is claimed by the ornamentals, presented by 177 taxa (68.9 %). Other environmentally related uses are the revegetators (14.4 %), plants used in erosion control (10 %), soil improvers (9 %), plants used in agroforestry (6.2 %), fire brakes (1.9 %), and plants used for shade and shelter (1.5 %). The sources report nine taxa in the class of unspecified environmental uses and it should be mentioned here that these data could mask the real picture. The checklist of the Croatian flora used here as a taxonomic backbone contains mostly the autochthonous taxa, and other taxa only if they are efficiently naturalized or cultivated on larger spaces and to a significant extent. In other words, the number of ornamentals (as a subclass in the environmental uses) growing in the gardens and parks is certainly much higher than the one reported here on the basis of the adopted taxonomic dataset. The basic taxonomic dataset must be significantly broadened so as to cover the ornamentals in particular, i.e. the checklist of ornamental plants must be extended.

The plants used as materials in the Croatian flora are represented by 223 species and subspecies (19.5 %). This class includes a number of important economic plants, such as furnishing fibres, timber, gums, resins, and industrial or essential oils. Unfortunately, references to the Croatian territory are not abundant and data in this paper are mostly based on Šafar (1946), overlapping with other scattered information. About half of these plants are used as a source of timber (25 %), as well as tannins and dyestuff sources (24.2 %). The rest are plants used as a source of essential oils (19.3 %), fibrils (11.6 %), gums and resins (11.6 %), lipids (10.7 %), cane and similar products (4.9 %), waxes (4 %), alcohol (1.8 %), and latex and rubber (1.3 %). A total of 24 taxa fall into the materials class, but without any specified subclasses. This class shows some examples of traditional usages, without any «live» application today. For example, there is a tradition of long standing in the use of resin from several pine species, mostly *Pinus nigra* Arnold. s.l. This resin, popularly called «paklina», was obtained by slashing the pine-barks in a specific manner, and after appropriate preparation it was used for impregnation of the wooden boats and for protection against corrosion. This practice was so common and of such a long standing along the Adriatic coast (up to the 19th century) that it gave rise to several toponyms, e.g. the Pakleni islands or Paklenica Canyon,

where the marks of bark slashing are still evident on the old trees. Similarly, some other taxa were put to various practices (e.g. sources of pigments) which today do not exist anymore. Nevertheless, the data were added to the database and the stated numbers contribute to the overall plants capacity. *Rosaceae* is the family with the largest number of species usable as some kind of material, with a total of 15 species, chiefly falling within the genera *Prunus, Pyrus* and *Sorbus*, mostly due to the wood usage, and *Rosa,* due to the derivatives used in cosmetic industry. Timber production and wood products dominate for the rest of the most important families: *Pinaceae* (15 species), *Salicaceae* (10) and *Fagaceae* (9). Other important families within the class of materials are *Fabaceae* (12 species), *Asteraceae* (12), *Lamiaceae* (12), *Poaceae* (10), and *Apiaceae* (10), involving several different applications, such as resources of essential oils and tannins, fibres, pigments, etc.

A total of 189 taxa are used for livestock food. They relate to vegetation food for domestic animals cultivated for the purpose, but also to fodder plant material harvested and fed to domestic animals, and forage plant material upon which livestock feeds themselves. A closer look into the plant components used by animals shows that aboveground components dominate (79.9 %), followed by the fertile plant parts (20.6 %) and roots (4.2 %). For 16 taxa, unspecified parts have been cited. The most important families as animal food are definitely *Poaceae* with 93 species and *Fabaceae* with 25 species. All other families contribute much less to the animal food plants diversity.

Food additives are well represented by 145 species and subspecies. Here are included the plants that are consumed as minor constituents in the food preparations. In most cases the leaves (34.4 %) and infructescences (32.4 %) are used as food additives. In lesser percentage as additives appear the seeds (17.2 %), root components (15.2 %), inflorescences (11 %), and stems (4 %). Unspecified parts are reported for 25 % of all food additives taxa. The largest share of the food additive species goes to the well-known aromatic families *Lamiaceae* (20), well represented in the Croatian flora, especially in its Mediterranean component, followed by *Apiaceae* (16), *Rosaceae* (15), *Asteraceae* (12), and *Brassicaceae* (9).

In the class of plants put to social uses, there are recorded 105 taxa. Almost half of these species (48.6 %) are used for different religious purposes. Mostly historical data show that 38 taxa were used as anti-fertility agents (36 %). For smoking purposes and as drugs are listed 18 taxa (17 %), nine taxa have miscellaneous social uses (8.6 %) and four taxa have unspecified social uses (3.8 %).

The plants recorded as fuel (37 taxa) are mostly species used for charcoal production (32 taxa) and as fuel wood (26 taxa).

The last three classes, the non-vertebrate poisons, invertebrate food and gene sources, are represented by a much smaller number of species (under 2.5 %), mostly because of the scarce and non-systematic data accumulation. This part of the dataset awaits for the most prominent changes and inputs.

Useful plants, threats and conservation

Does collection of useful plants in the wild on any scale bring about some extra threats to their natural populations in Croatia? An analysis of the threat causes attributed to each taxon according to the IUCN Threats Authority File (Hilton-Taylor 2000, and update to version 2.1 on IUCN web site) shows the dominant negative factors (Nikolić & Topić 2005). Immediate losses, mostly related to excessive collection of plants for ornamental and medicinal purposes, account for 7 % of the total number of recorded causes. Not so much in percentage, but in the group of 10 regionally extinct taxa (RE category), for all is detected usage in folk medicine and picking praxis in the wild. In the group of 90 critically endangered taxa (CR category) and 62 endangered taxa (EN category) for most is established the same. In the group of 71 vulnerable taxa (VU category), medicinal usages dominate. The other EBDCS classes appear very seldom in relation to the Red List species. Furthermore, traditional usages are recorded for six endemic taxa. Could it be claimed that collection of medicinal plants causes regional or local extinction of some species or, at any rate, increases the risk of their extinction? It is difficult to say, owing to the impact of a cascade of other mutually related factors of influence, with habitat degradation in the lead. However, plant collection of any amount accelerates the erosion of population, especially of the already threatened species. For example, *Gentiana lutea* L. subsp. *symphyandra* (Murb.) Hayek (EN) is a plant actually threatened by collection in the wild. Its underground parts are continuously excavated for pharmaceutical purposes. Thus, the large quantities

of plants approved for gathering for pharmaceutical purposes in the following years (coupled with the even larger quantities that may be collected illegally), in a ten-year period may develop into threats to the taxa that are currently not at risk. Positive changes may occur only if supported by legal requirements for mandatory certificates for the products manufactured from plants with pharmaceutical usage, as in the other European countries. On the other hand, the numbers related to the threatened taxa also refer to some known uses that are no longer in practice, so the real pressure does not exist any more. For example, the use of the various orchid species for mucilage (locally known as *salep*) is almost a completely outdated tradition.

In order to regulate the collection of autochthonous plants in the wild localities and to prevent a possible threat increase for certain taxa, the Croatian Government has recently adopted a Rulebook (Nature Protection Act, Official Gazette 100/2004). This document covers the subject of management of medicinal plants, food plants, ornamentals, or plants used for material in their natural localities, for the purpose of processing, trade or other applications, and list a total of 542 strictly protected and 740 protected taxa. Some plant species listed for protection by the national legislation overlap with the list of species mentioned here, known for their partial usage. Uses have been detected for a total of 346 species and subspecies from this list of protected taxa, so the list needs revision to be operational. This does not necessarily mean that gathering of medicinal herbs for personal use should be prohibited, since gathering of flowers of such species as *Achillea millefolium* L., *Arnica montana* L. (VU), *Solidago virgaurea* L., etc. certainly cannot pose any alarming risk for their survival. The same is valid for certain ornamental plants. Vernal plants are especially popular, if people pick only their aboveground parts. Bulbs, tubers and rhizomes of *Galanthus nivalis* L., *Leucojum vernum* L., *Fritillaria* sp., *Scilla* sp., etc. remain intact and ready for the next year's blossoming. A ban on their collection in this case does not refer to any threats that they might be exposed to, but to environmental degradation that can spoil the pleasure of nature-lovers. Alpine plants are inaccessible to most people. Hikers, who are quite nature-conscious today, do not collect alpine plants, not even *Leontopodium alpinum* Cass. (VU, edelweiss): their well-known emblem.

On-line approach to useful plants in the Croatian vascular flora database

As part of FCD, a web interface was developed enabling multiple search in the useful plants dataset (URL http://hirc.botanic.hr/fcd/KorisnoBilje/). Bilingual approach (English and Croatian) is available, wild card (*) is supported as multiple field queries with logical "AND" function, too. It is possible to set up the queries against the background of the taxonomic dataset (family, genus, species, common name, naturalized) or/and for the first two expandable EBDCS classes and the 3736 so-called descriptors. The first result screen will show a taxon or taxa list with tabular and graphical presentation of their usages on the first 13 levels of EBDCS, with the appropriate legend and pop-up windows. Selection of a particular species would lead to a fully detailed taxon screen containing the taxon's name and authorization, affiliation to family and order, place of publication, author(s) full name, vernacular names in several languages, with an active link to the literature source, photo-documentation with authorization (if available), full economic botany data set with an active link to source reference, and a possibility to search the other databases for already selected species (ePIC-Electronic Plant Information Centre in Kew, GRIN taxonomy, Flora Europaea Database of the Royal Botanical Garden Edinburgh, Mansfeld's World Database and Google).

All numbers already presented in the text above could be checked out and looked up in the particular species list using this service. Inconsistencies may appear owing to possible new data inputs.

Conclusion

Basic data on the known uses of the Croatian vascular plants are collected and standardized for the first time. A database is organized and results are available through an Internet browser on data distribution and usage in different biological and related disciplines (agronomy, forestry, pharmacy), as well as for educational purposes. This service should promote economic botany as a field of work in Croatia.

The results show the actual status and data contents of the available resources, mostly published, as well as a survey of the plant uses. These results should be regarded as dynamic. Despite the new data-sources, decrease in contribution to the main data pool and

increasing overlapping with the earlier data, the accumulated knowledge is not final yet. Certainly, there are still some published data that have not been elaborated yet, and what is more important, some indigenous plant usages have not been even recorded. This study is based on the *recorded* and not on the *observed* uses truly practiced today on a community level, which requires further data collection from all sources and division of the input information into at least three subgroups: (1) currently practiced known uses, (2) no longer practiced known uses, and (3) formerly known or forgotten uses extinct in the cultural groups (as suggested for other area and plant groups by Campos & Ehringhouse 2003). Also, geographically related data should be collected on the basis of the known and expected different plant uses practiced in various Croatian regions (i.e. highlands and the Mediterranean). Plant uses should be also segregated from cultivation and from the wild resources. The Flora Croatica Database and the web interface should be duly adapted too. The results should reveal the necessity of combining data on the threat status and plant use practices and of the need for a better adjustment of the legal conservation tools to situation in the field.

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References

Anonymous 1984. Allergenic Plants. Pharmacia d.d., Uppsala (in Croatian).

Biggs, M., McVicar, J. & Flowerdew, B. 2003. The Complete Book of Vegetables, Herbs and Fruit. Silverdale Books, Wigston Leicester.

Bown, D. 1995. The Royal Horticultural Society Encyclopaedia of Herbs and their Uses. Dorling Kindersley Limited, London.

Bown, D. 2002. The Royal Horticultural Society New Encyclopaedia of Herbs and their Uses. Dorling Kindersley Limited, London.

Brummitt, R.K. & Powell, C.E. 1992. Authors of Plant Names. Royal Bot. Gardens, Kew.

Brummitt, R.K., Pando, F. & Hollis, S. 2001. World Geographical Scheme for Recording Plant Distributions. Ed. 2. Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh.

Campos, M.T. & Ehringhouse, C. 2003. Plant virtues are in the eyes of the beholders: A comparison of known palm uses among indigenous and folk communities of Southwestern Amazon. – Econ. Bot., **57**(3), 324-344.

Chevallier, A. 2001. Encyclopaedia of Medicinal Plants. Dorling Kindersley Limited, London.

Cook, F.E.M. 1995. Economic Botany Data Collection Standard. Prepared for the International Working Group on Taxonomic Databases for Plant Sciences (TDWG). Royal Bot. Gardens, Kew.

Cronquist, A. 1981. An Integrated System of Classification of Flowering Plants. Columbia Univ. Press, New York.

Degen, A. 1936. Flora Velebitica. Vol. **1**. Ung. Akad. Wiss., Budapest.

Degen, A. 1937. Flora Velebitica. Vol. **2**. Ung. Akad. Wiss., Budapest.

Degen, A. 1938a. Flora Velebitica. Vol. **3**. Ung. Akad. Wiss., Budapest.

Degen, A. 1938b. Flora Velebitica. Vol. **4**. Ung. Akad. Wiss., Budapest (in Hungarian).

Domac, J. 1899. Guide to Pharmacognosy with comments on the pharmacognostic part of the 2nd edition of Croatian Pharmacopoeia. Naklada Kr. Sveučilišne knjižare Sr. Suppana (Rob. Ferd. Auer), Zagreb (in Croatian).

Dubravec, K. & Dubravec, I. 1998. Cultivated Plants of Croatia and Surrounding Areas. Školska knjiga, Zagreb (in Croatian).

Forenbacher, S. 1998. Poisonous Plants and Plant Poisoning of Animals. Školska knjiga, Zagreb (in Croatian).

Gelenčir, J. & Gelenčir, J. 1991. Atlas of Medicinal Plants. Prosvjeta, Zagreb (in Croatian).

Greuter, W., Brummitt, R.K., Farr, E., Kilian, N., Kirk, P.M. & Silva P.C. 1993. NCU-3. Names in Current Use for Extant Plant Genera. Regnum Veg., **129**. Koeltz Scientific Books, Knigstein.

Grlić, Lj. 1979. Wild Edible Plants. Prosvjeta, Zagreb (in Croatian).

Grlić, Lj. 1984. 99 Edible and Poisonous Berries. Educational Pocket Guides series 1. Prosvjeta, Zagreb (in Croatian).

Grlić, Lj. 1990. Encyclopaedia of Wild Edible Plants. August Cesarec, Zagreb (in Croatian).

Hänsel, B., Mihovilić, K. & Teržan, B. 1997. Monkodonja, fortified protourbanic settlement of older and middle Bronze Age in the vicinity of Rovinj in Istria. – Histria Archeol., **28**: 37-107 (in Croatian).

Hayek, A. 1927-1933. Prodromus Florae Peninsulae Balcanicae. Vols 1-3. – Repert. Spec. Nov. Regni Veg. Beih., **30**(1, 2, 3).

Hilton-Taylor, C. 2000. 2000 IUCN Red List of Threatened Species. IUCN, Gland, & Cambridge.

Hirc, D. 1903-1912. Revisio Florae Croaticae. Vols **155, 158, 159, 161, 169, 173, 179, 181, 183, 190.** Rad Jazu (in Croatian).

Houdret, J. 2002. Therapeutic Plants: Cultivation and Application. Duševic & Kršovnik, Rijeka (in Croatian).

Jašmak, K. 1980. Honey Plants. Nolit, Beograd (in Serbian).

Karg, S. & Müller, J. 1990. Neolitische Getreidefunde aus Pokrovnik, Dalmatien. –Archäol. Korespondenzblatt, **20**: 373-386.

Kušan, F. 1938. Therapeutic Plants: Systematic Review of the Most Important Therapeutic, Poisonous and Industrial (Technical) Plants of the World. Self-published, Zagreb (in Croatian).

Kušan, F. 1956. Therapeutic and Other Useful Plants. Poljoprivredni nakladni zavod, Zagreb (in Croatian).

Kvakan, P. 1952. Grasses. Knowledge of Forage Grasses and Manufacture of Grass Seeds. Vol. 8. Poljoprivredni nakladni zavod, Zagreb (in Croatian).

Lemoine, E. & Izrael F.F. 2002. Vegetables, Then and Now. Chartwell Books Inc., New Jersey.

Lindacher, R. 1995. PHANART, Datenbank der Gefässpflanzen Mitteleuropas. Erklärung der Kennzahlen, Aufbau und Inhalt. Veröffentlichungen des Geobotanischen Institutes der ETH, Stiftung Rübel, **125**: 3-436.

Martinić, I. (ed.). 2001. An overview of the state of biological and landscape diversity of Croatia with the protection strategy and action plans. Ministry of Environmental Protection and Physical Planning, Zagreb.

Nikolić, T. (ed.). 1994. Index Florae Croaticae. Pars **1**. – Nat. Croatica, **3**(Suppl. 2): 1-116.

Nikolić, T. (ed.). 1997. Index Florae Croaticae. Pars **2**. – Nat. Croatica, **6**(Suppl. 1): 1-232.

Nikolić, T. (ed.). 2000. Index Florae Croaticae. Pars 3. – Nat. Croatica, **9**(Suppl. 1): 1-324.

Nikolić, T. 2001. The diversity of Croatian vascular flora based on the Checklist and CROFlora database. – Acta Bot. Croatica, **60**(1): 49-67.

Nikolić, T., Fertalj, K., Helman, T., Mornar, V. & Kalpić, D. 2001. CROFlora, a database application to handle the Croatian vascular flora. – Acta Bot. Croatica, **60**(1): 31-48.

Nikolić, T. & Topić J. (eds). 2005. Red Data Book of Vascular Flora of Croatia. Ministry of Culture and State Institute for Nature Conservation, Zagreb.

Ortiz, E.L. 1998. Encyclopaedia of Plants, Condiments and Spices. Knjiga trgovina d.o.o., Zagreb (in Croatian).

Pahlow, M. 1989. Great Book of Medicinal Plants. Cankarjeva založba, Ljubljana (in Croatian).

Rossi, Lj. 1930. Review of the flora of Croatian Primorje. – Prir. Istraž. Kral. Jugoslavije, **17**: 1-368 (in Croatian).

Schaffner, W., Häfelfinger, B. & Ernst, B. 1999. Phytopharmaka Kompendium. Arbois Verlag, Hinterkappelen, Bern.

Schlosser, K.J. & Vukotinović, Lj. 1857. Syllabus Florae Croaticae. Zagreb.

Schlosser, K. J. & Vukotinović, Lj. 1869. Flora Croatica. Zagreb.

Schlosser, K. J. & Vukotinović, Lj. 1876. Flora Excursioria. Hartmàn L., Zagreb (in Croatian).

Šafar, J. 1946. Forestry Guide II. Poljoprivredni nakladni zavod, Zagreb (in Croatian).

Šilješ, I., Grozdanić, Đ. & Grgesina, I. 1992. Knowledge, cultivation and processing of therapeutic plants. Školska knjiga, Zagreb (in Croatian).

Šoštarić, R. 2003. Changes in vegetation during the postglacial period in Croatia. *PhD Thesis*. University of Zagreb (in Croatian, unpubl.).

Šoštarić, R. 2004. The development of vegetation in the inland area of Croatia during the postglacial period. – Nat. Croatica, **13**(4): 357-369.

Šoštarić, R. & Küster, H. 2001. Roman plants remains from Veli Brijun (island of Brioni), Croatia. – Veg. Hist. & Archaeobot., **10**(4), 227-233.

Trinajstić, I. 1987. The map of natural potential vegetation. 1:100000. Glas. Šumske Pokuse, Posebno Izd. 3 (in Croatian).

Visiani, R. 1842-1852. Flora Dalmatica, 1-3. F. Hofmeister, Lipsiae.

Visiani, R. 1872-1881. Supplementum Florae Dalmaticae 1-2. F. Hofmeister, Lipsiae.

Wiersema, J.H. & Blanca, L. 1999. World Economic Plants: A Standard Reference. CRC.

Willfort, R. 1959. Gesundheit durch Heilkräuter. Rudolf Trauner Verlag, Linz.

Živković, R. 1997. Natural therapy of digestive organs with therapeutic plants and dieting. Školska knjiga, Zagreb (in Croatian).