Medicinal Plant Conservation

MEDICINAL PLANT SPECIALIST GROUP

Volume 14

Newsletter of the Medicinal Plant Specialist Group
of the IUCN Species Survival Commission

Chaired by Danna J. Leaman

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Particular thanks to Gerald Eilu, Archana Godbole, Tsewang Gonbo, Syed Kamran Hussain, Fanny Jamet, Dennis Kamoga, Peris Kariuki, Ashiq Ahmad Khan, Staline Kibet, Giridhar Kinhal, Rudy Lemmens, Frank Olwari, Cyprian Osinde, Ram C. Poudel, Suman Rai, Krishna Shrestha and Paul Ssegawa. Many thanks to Susan Manby for providing information on evidence-based medicine.

Plantlife's work on medicinal plants has been funded by the Allachy Trust, the Rufford Maurice Laing Foundation, the Gurney Charitable Trust, the Tanner Trust and Dr William Hamilton.

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Medicinal plants of Ukraine: diversity, resources, legislation

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Introduction

Maintenance of wild flora species and their natural habitats is a main aim of the Bern Convention on the Conservation of European Wildlife and Natural Habitats. This includes a focus on endangered and vulnerable plant species in order to limit the exploitation of these, as well as on restoration of plant communities (CCWNH 1979). The present paper presents the state and dynamics of Ukraine's wild plant resources, focusing on economically valuable species.

Wild-growing herbs and medicines produced from them have considerable impact on the preventive and effective treatment of many diseases in Ukraine, especially in the combined treatment with synthetic medicines. Herbal medicines are particularly useful for cardiovascular, gastro-enteric, and respiratory diseases and in rehabilitation after disease. At present about 20% of the drugs authorized by the Ukrainian

Ministry of Health (termed 'official medicine' and described in the State Pharmacopoeia and separate Pharmaceutical Regulations) are produced from raw materials of medicinal plants and almost 50% contain biologically active substances from plants (Minarchenko 2000).

Research has been carried out for more than 30 years in Ukraine on the distribution and state of the wild-growing plant resources and so far more than 80 scientific works have been published. Of major interest are the "Atlas of herbs of Ukraine" (Minarchenko & Tymchenko 2002) and the monograph "Vascular herbs of Ukraine: medicinal and resource value" (Minarchenko 2005). Partly in consequence of this, Ukraine has developed legislation directed at the regulation of use and protection of plant resources.

Overview of the medicinal plants of Ukraine

The vascular plant flora of Ukraine enumerates 6 086 species (including native, introduced, adventive, and some cultivated). Of these, 2 223 species contain biologically active agents and are, or can, be used for medicinal purposes (Minarchenko 2005). At the moment 202 species are considered rare and are listed by the Red Data Book of Ukraine (Didukh 2009). The following world-famous medicinal plants are listed: *Adonis vernalis* L., *Allium ursinum* L., *Asphodeline lutea* (L.) Reich., *Asplenium adiantum-nigrum* L., *Atropa belladonna* L., *Colchicum autumnale* L., *Galanthus nivalis* L., *Gentiana lutea* L., *Glycyrrhiza glabra* L., *Lycopodium annotinum* L., *Rhodiola rosea* L., and all species of the family *Orchidaceae*. A total of 102 species of medicinal plants are regionally rare, they are protected at the regional level and collecting their raw materials from the wild is banned in designated regions. Some of the species are rare in all regions, e.g. *Anemone sylvestris L.*, *Hypericum humifusum* L., *Polemonium caeruleum* L. Other species, such as *Convallaria majalis* L., *Ledum palustre* L., and *Alnus incana* (L.) Moench, are rare in some areas while in others they constitute a relatively abundant and valuable raw resource.

Altogether 1 217 species of the Ukrainian wild medicinal plants are of limited economic importance. More than 50% of them have widespread geographical distribution but grow scattered or occasionally, and though there are no destructive impacts on their habitats their populations do not supply raw material for production of, e.g. medicine. These species include: *Agrostemma githago* L., *Althaea officanalis* L., *Consolida ajacis* (L.) Schur, *Nigella arvensis* L., *Thalictrum aquilegifolium* L., *Berberis vulgaris* L., *Glaucium corniculatum* (L.) J. Rudolph, *Fumaria officinalis* L., *Gypsophila acutifolia* Fish. ex Spreng, *Melandrium album* (Mill.) Garcke, *Silene*

***Arnica montana* in the Ukrainian Carpathians (about 1400 meters above sea level). Photo: V. Minarchenko**

chlorantha (Willd.) Ehrh., *Pyrola media* Sw., *Bryonia alba* L., *Thymus marshallianus* Willd. and many other medicinal plants. About 10% of the medicinal plants listed by the Flora of Ukraine are characterized as alien (introduced) and cultivated plants.

With integration into the World economy the Ukrainian medicinal plant cultivation faced a crisis and amounts harvested decreased 10-20 times compared to the 1980s, where hundred of tonnes were harvested. Today, about 10–20 species and varieties of medicinal and aromatic plants are cultivated in considerable quantities. These include: *Althaea officinalis* L., *Calendula officinalis* L., *Echinacea purpurea* (L.) Moench., *Lavandula angustifolia* Mill., *Matricaria recutita* L. , *Mentha piperita* L., *Salvia officinalis* L., and *Thymus vulgaris* L.

Approximately 20-25% of the wild medicinal plants of Ukraine provide valuable raw material. This includes species with both large distribution and some growing within a single natural zone, but

with highly productive populations. Only about 200 plant species in Ukraine are used by the official medicine; almost twice as many provide raw materials for homoeopathic preparations. The raw materials of 20-30 species are used in large amounts (more than1 tonne) as a source of biologically active agents (plants which are sources of antioxidants, tocopherols, carotenoids, flavanoids and other useful substances) (Minarchenko & Tymchenko 2002). The folk (traditional) medicine of Ukraine uses the raw material from over one thousand species of vascular plants.

Resources

The condition of the raw material resources of wild medicinal plants depend on their biological potential (intensity of reproduction, coenotic activity, raw productivity, etc.), the availability of areas suitable for their growth, and the level of human pressure on them. The harvesting of wild plant resources depends on market demand and the state of their resources. The need for medicinal plants, especially for species having radioprotective and anti-inflammation effects, is constantly rising despite continued reductions in their natural basis. This is especially true for plants with limited distribution and resources, such as *Primula veris* L., *Pulmonaria officanalis* L., and *Rhodiola rosea* L.

A substantial reduction in the availability of many useful species in the Ukrainian flora (with the exception of synanthropic medicinal plants) is caused by: (i) continuous overharvesting of many valuable medicinal plant resources, (ii) increased farming on their native habitats, (iii) large concentration of the resources within areas contaminated by the Chernobyl accident, and (iv) devastating draining of swamplands, especially in forested regions.

The medicinal plants resources in Ukraine have been monitored by the M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine since the late 1970s, including the state and trends in populations and resource availability, and reasons for these. Evaluation of the state and trends of the dynamics for medicinal plant resources used methods developed on a geobotanical basis (Minarchenko & Sereda 2005) and recommendations for rational and sustainable medicinal plant use have been developed. As part of this endeavour the wild medicinal plants of Ukraine, which are officially used as raw materials for medicine and pharmaceutical purposes, are divided into five categories based on the state of the resources (Table 1).

Table 1. State-of-resource categories for Ukrainian medicinal plants.

1. Protected. Regionally rare species and threatened populations (if exploited). Preventive measures for protection are: prohibited harvesting in natural habitats, protection of habitats (*Melittis sarmatica, Arctostaphyllos uva-ursi*).

2. Endangered. Species for which resources tend to decrease due to environmental changes in their habitats. They have limited distribution and restricted resources (*Acorus calamus, Ledum palustre, Menyanthes trifoliata, Oxycoccus palustris*). Preventive protection measures are: limiting the use, preservation of habitats by reducing human pressure.

3. Disturbed. Species for which resources are limited due to small geographical area of habitats or low productivity of populations (*Convallaria majalis, Potentilla erecta, Origanum vulgare, Vaccinium uliginosum, Valeriana officinalis)*. Preventive measures: similar to those for category 1.

4. Limited. Species that have significant resources but a limited distribution (*Crataegus spp.,Frangula alnus, Helichrysum arenarium, Hypericum perforatum, Thymus serpyllum*). Preventive measures are: regulation of the use from the natural environment, decrease of human pressure.

5. Prospective. Species that have significant distribution and resources (most species of synanthropic flora; *Sambucus nigra, Alnus glutinosa* ets.). Preventive measures of protection: adhering to the rules of gathering raw materials.

Only some medicinal plants are available in large quantities (category 5, Table 2) and do not require use of preventive measures of protection. One of the ways to increase the resource basis for medicinal plants is their cultivation. However, cultivation of many medicinal plants is economically inefficient, and therefore conservation should be focused on restrictions of their use and protection of habitats.

Some aspects of use

The use of medicinal plant raw materials in Ukraine has decreased since the 1970s and 80s, where

TABLE 2. Status of medicinal plants in Ukraine by resource and harvesting categories (MINISTRY OF ENVIRONMENT OF UKRAINE 2002-2005, unpublished data).

Species	Resource category[1]	Harvest category[2]	W/C[3]
Achillea millefolium	5	L	W+C
Acorus calamus	2	A	W
Agrimonia eupatoria	4	Mi	W
Alnus glutinosa (+A. incana)	5	A	W
Althaea officinalis	3	A	W+C
Arctium lappa (+A. tomentosum)	3	A	W+C
Arctostaphyllos uva-ursi	1	-	W
Arnica montana	1	M	W
Artemisia absinthium	5	A	W
Asarum europaeum	3	M	W
Astragalus glycyphyllos	3	M	W
Berberis vulgaris	2	M	W
Betonica officinalis	3	M	W
Bidens tripartita	4	L	W+C
Bryonia alba	2	M	W
Calluna vulgaris	5	M	W
Capsella bursa-pastoris	4	A	W
Centaurium erythraea	3	Mi	W
Chamerion angustifolium	4	Mi	W
Chelidonium majus	5	A	W
Cichorium intybus	4	M	W+C
Comarum palustre	3	M	W
Convallaria majalis	3	A	W
Cotinus coggygria	5	A	W+C
Crataegus monogyna (+ C.oxycantha+ C. sanguinea)	4	L	W
Datura stramonium	2	M	W+C
Digitalis grandiflora	2	M	W+C
Ephedra distachya	1	M	W
Equisetum arvense	5	L	W
Eryngium campestre	3	M	W
Euphrasia stricta (+E. rostkoviana)	3	M	W
Filipendula ulmaria	3	Mi	W
Fragaria vesca	4	Mi	W
Frangula alnus	4	L	W
Galega officialis	2	M	W+C
Gnaphalium uliginosum	3	Mi	W
Hedera helix	1	M	W
Helichrysum arenarium	4	L	W+C
Hepatica nobilis Mill.	2	M	W
Herniaria glabra	3	M	W
Humulus lupulus	3	A	W+C
Hypericum perforatum	4	Max	W+C
Hyoscyamus niger	2	M	W+C
Hyppophae rhamnoides	5	A	W+C
Inula helenium	1	M	W+C
Juniperus communis	3	M	W
Juniperus sibirica	3	M	W
Lamium album	4	M	W
Ledum palustre	2	M	W
Leonurus cardiaca (+L. Quinquelobatus Gilib. (L. villosus)	4	Max	W+C
Lepidoteca suaveolens (Chamomilla suaveolens)	3	M	W
Linaria vulgaris	3	M	W
Lycopodium clavatum	2	M	W
Lythrum salicaria	4	M	W
Matricaria recutita (Chamomilla recutita)	5	Max	W+C
Melilotus albus (+M. officinalis)	5	A	W+C
Melittis sarmatica	2	M	W
Mentha longifolia	4	Mi	W+C
Menyanthes trifoliata	2	M	W
Nigella arvensis	3	M	W+C
Nuphar lutea	2	M	W
Nymphaea alba	2	M	W
Ononis arvensis	3	Mi	W+C
Origanum vulgare	4	A	W+C
Oxycoccus palustris	2	A	W
Pulmonaria officinalis	3	M	W
Quercus robur	5	Max	W
Rhamnus cathartica	3	M	W
Robinia pseudoacacia	4	Mi	W
Rubus caesius (+R. nessensis)	5	L	W
Rubus idaeus	4	L	W
Saponaria officinalis	3	M	W
Sambucus nigra	5	A	W
Sanguisorba officinalis	2	M	W
Sedum acre	3	M	W
Sedum maximum	3	M	W
Solidago canadensis	5	Mi	W
Sophora japonica	4	Mi	W
Sorbus aucuparia	4	A	W+C
Symphytum officinale	3	M	W
Tanacetum vulgare	4	A	W
Taraxacum officinale	4	A	W+C
Thymus serpyllum	4	A	W
Tilia spp	4	L	W
Tussilago farfara	4	L	W
Urtica dioica	5	L	W
Urtica urens	3	M	W
Vaccinium myrtillus	4	Max	W
Vaccinium uliginosum	3	Mi	W
Vaccinium vitis-idaea	3	M	W
Veratrum album (+V. lobelianum)	2	M	W
Verbascum phlomoides(+V. thapsus)	4	M	W
Valeriana officinalis L.	3	M	W+C
Veronica officinalis	3	M	W
Viburnum opulus	3	M	W+C
Vinca minor L.	2	M	W
Viola tricolor	4	L	W+C

[1]For Resource categories refer to TABLE 1.
[2]Harvest categories: - = no harvest; M = minimum, <0,1 t per year; Mi = minor, 0,1-1 t/ year; A = average 1.1-10.0 t/ year; L = large, 10.1 – 50 t/year; Max = maximum, > 50 t/year.
[3] Wild harvested (W) and/or cultivated (C)

the medicine and pharmaceutical industry used considerable amounts of raw materials from more than 80 wild plants and hemerophytes. The decline is partly a consequence of a reduced medicinal plant resource base as many plant species were overused and the natural ecosystems transformed. In 1980 about 17 thousand tonnes of raw materials from 68 species of medicinal plants (including 15 cultivated) were used. In 1990, 10 thousand tonnes from 60 species of medicinal plants (including 17 cultivated) were used, and in 1999 this had decreased to 1 thousand tonnes from 44 species (including 17 cultivated). In the early nineties more than 85% of the medicinal plant raw material was harvested from natural plant communities - in 1999 this proportion had decreased to 60% and in this year nearly 600 tonnes of raw materials from wild medicinal plants and almost 400 tonnes from cultivated plants in specialized farms were prepared. As natural stocks are continuously decreasing the proportion of raw materials from wild sources is declining. The demand for medicinal plant raw material of the Ukrainian pharmaceutical industry remains high, and the problem of declining supply is partially solved by import or augmentation of cultivated raw materials (Minarchenko 2005).

Legislation and mechanism of regulation

Unlike in Bulgaria, Ukraine does not have a uniform law on the use and conservation of medicinal and food plants (Evstatieva et al. 2007). The use and protection of the wild flora is governed by several legal instruments: the Constitution of Ukraine (GoU 1996, N 30 art. 141), the Laws on Environmental Protection (GoU 1991, N 42 art. 546), on Plant world (GoU 1999, N 22-23 art. 198), on Nature Reserve Fund of Ukraine (GoU 1992, N 34 art. 502) in areas of natural reserve fund, and by the Law of Ukraine on the Red Data Book of Ukraine (GoU 2002a, N 30 art. 201). A number of regulations in the use and protection of plants are covered by the Forest (GoU 1994, N 17 art. 99), Water (GoU 1995, N 24 art. 189) and Land (GoU 2002b, N 3-4 art. 27) Codes. Various aspects of liability for damage inflicted upon the environment, including plant resources, are covered by the Civil and Criminal Code of Ukraine (GoU 2001, N25-26 art. 131). The existing regulations are implemented through specific mechanisms which are elements of the overall strategy and sustainable use of plant resources of Ukraine.

A significant contribution to the protection and sustainable use of plant resources is adopted in the 1999 Law of Ukraine on Plant world (GoU 1999), and a number of subordinate legislations governing use and reproduction of natural plant resources, including the medicinal plants resources. In the Law on Plant world it is noted that plant resources are divided into resources of national and local significance. The natural plant resources of national significance include:

a) The objects of flora within: inland waters, the continental shelf and exclusive (maritime) economic zone of Ukraine; surface waters (lakes, reservoirs, rivers, canals) which are located and used in more than one area (oblast); and the Natural and Biosphere reserves, National parks, botanical gardens, and dendrological parks of national significance.

b) Forest resources of national importance.

c) Rare species and those that are threatened with extinction (vascular plants, mosses, algae, lichens and fungi species which are listed in the Red Data Book of Ukraine).

d) Rare species and those endangered species and types of natural plant communities that are listed in the Green Book of Ukraine.

Resource estimation: *Thymus serpyllum*. Photo: V. Minarchenko

The harvesting of plant resources of national significance is regulated by the Ministry of Environment of Ukraine. Use of the wild resources of local value (wild vascular and other non-wood

and non-agricultural plants, mosses, algae, lichens and mushrooms which do not to belong to natural resources of national significance) is governed by local authorities. The harvesting of wild medicinal and other valuable plants is categorised as either "general" or "special" use of plant resources.

The general use of plant resources is the gathering of wild plants for personal consumption (i.e. non-profit); this includes gathering of flowers, berries, fruits, mushrooms, etc. The legislation of Ukraine guarantees citizens the right to the general use of natural plant resources in order to meet vital needs without the need for collection permits or payment of fees. The collection of species listed in the Red Book of Ukraine and species under regional protection is prohibited. The special use of natural resources includes all commercial use (extraction, gathering, etc.) from the natural environment. This use requires special permits and (or) other documents, is subject to limitations on amounts, and usually involves a fee. The purchase of unlicensed vegetable raw material is illegal.

State regulation of the natural resources of medicinal and other useful groups of plants involves setting limits on the use of these resources. The administrative authority approves the list of useful plants for exploitation as well as the permitted quantity of harvest, and issues a list of species for which use is prohibited. Both lists are revised annually. The accounting of the medicinal plant natural resource base should be updated at least once every five years to allow for updated estimates of annual allowable harvest amounts taking into account the dynamics of the resource under exploitation (Minarchenko & Sereda 2005).

In order to ensure the sustainable use and optimise the production of medicinal and other useful plants in Ukraine, the creation of the State plants Cadastre with the use of geo-information technologies was initiated. The structure of this Cadastre includes three main sections: flora, vegetation and plant resources. The information for cadastres is provided by academic institutions engaged in relevant research and the main institution conducting and coordinating such research is the M.G. Kholodny Institute of Botany of the National Academy of Sciences of Ukraine. The studies of plant resources are made based on the administrative (in the context of administrative areas) or regional (in the context of separate natural areas) principle. Maintaining the natural resource accounting includes the execution of:

- Identification of specific areas (regions), where the inventory will be conducted, processing official and literary materials that contain information about the flora, fungi, plant communities and plant resources of certain territory.
- Accounting diversity of objects, identifying their main characteristics directly in the natural environment.
- Analysis of data obtained during the field works, determination of their qualitative and quantitative characteristics, including setting allowable harvestable amounts by species, and analysis of the determining factors that threaten their existence of the natural resource in a transformed environment.
- Maintaining and updating the online database of flora, plant communities and resources, summarizing the received information, and publication of the materials of the State Cadastre.

For a detailed study of all objects of flora and their natural resources, including fungi, lichens, algae, moss, and vascular plants, a long time period, a large number of skilled professionals, and considerable expenses are required. Therefore, the State Cadastre has both primary and future tasks. The primary task is largely determined by the Law on Plant world: "Government accounting and inventory of the plant world is to take account of quantitative, qualitative and other characteristics of natural plant resources, scope, nature and mode of their use, as well as for systematic monitoring of the qualitative and quantitative changes in the plant world" (GoU 1999, Article 38). As of 2005 the main coordinating body for the establishment and maintenance of the State Cadastre of the plant world is the Ministry of Environment of Ukraine. At the time of establishment a structure of an electronic version of the Cadastre was designed in which were included the basic data and the methods for accounting of flora, vegetation and plant resources for purposes of the Cadastre. Regional investigations of the flora, vegetation and

non-wood plant resources are currently carried out on a periodical basis.

Conclusion

Recently in Ukraine increasing attention is devoted to the sustainable use of natural plant resources; therefore, the collection of wild-growing medicinal plants is strictly monitored and annual limits on use of raw materials from certain plant species are prepared at the national and local levels. These limits, according to the legislation of Ukraine, are established on the basis of species-wise estimation of the condition of the natural resources (Minarchenko & Sereda 2005).

The studies of wild medicinal, food and aromatic plants in Ukraine are carried out in the following directions:

- Identification of species diversity.
- Estimation of the resources of raw plant material.
- Studies of the dynamics of resources and populations of the species with limited distribution.
- Development of an institutional basis for governing the use and protection of the natural resources.
- Development of programs and textbooks for studying the plant resources.
- Introduction and cultivation of medicinal plants.

Except for the last two, these are developed at the M.G. Kholodny Institute of Botany.

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