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MEDICINAL PLANTS ADAPTED TO THE CONDITIONS OF STEPPE UKRAINE: CONSERVATION AND ENRICHMENT OF BIODIVERSITY

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Наведено результати експедиційного обстеження районів південних і центральних степових областей України, де зібрано 286 зразків генофонду культурних рослин та їх диких родичів для збереження та збагачення біологічного різноманіття рослин, адаптованих до умов степової зони України. Для збереження і закріплення у колекціях ex situ та ефективного використання лікарських рослин зібрано 119 зразків генофонду, зокрема для поповнення колекції рідкісних і цінних видів Дослідної станції лікарських рослин Інституту агроекології і природокористування НААН: Achillea graberrima Klok., Stipa cappillata L., Centaurea ruthenica L., Asparagus brachyphyiius Turez., Allium scythicum Zoz., Thymus litoralis Klok., Ephedra distachya L. Для таких видів, як Achillea graberrima Klok., Centaurea ruthenica L., Asparagus brachyphyiius Turez., Allium scythicum Zoz., Ephedra distachya L. визначено місця для облаштування резерватів з метою збереження in situ та репатріації.

Ключові слова: *Степ України, генофонд, збереження біорізноманіття.*

The plant gene pool conservation and enrichment is a topical question due to the anthropogenic pressure and catastrophic decrease in territories with almost undisturbed vegetation. Day by day, the extinction of species problem becomes more acute. The necessity of protection, conservation and enrichment of plant gene pool is recognized at all societal levels. The direct evidence of this fact is numerous conventions, memorandums

and multilateral agreements on conservation of biological diversity.

One of the methods of solving biodiversity loss is *ex situ* preservation, which involves formation of different collections of gene pool samples in form of live plants, seeds, and tissue or cell culture [2].

The collections of plants that can serve as donors of biologically active substances for medical purposes are especially valuable. Certain content and characteristics of biologically active substances, their combination, and presence of concomitant substances in each plant species, which is important for the quality of medicinal compounds produced from these plants.

The rough estimate shows that more than 52 thousand plant species are utilized as medicinal in the world. According to World Health Organization (WHO), nowadays at least 80% of the world's population use medicinal plants or biologically active compounds of plant origin for treatment and prevention of various diseases.

People use about 20 thousand plant species out of more than 400 thousand with medical purpose. Some experts state that the actual number is 50 or even 70 thousand species, including 15 thousand endangered plant species (IUCN) [4].

Introduction of rare and vanishing species enables a partial conservation of potential sources of biologically active compounds. It opens a possibility for their cultivation and preservation as a biological species. It is highly important for those plants, which lost, or are losing their habitats due to economic development of the territory. Introduction and cultivation of rare medicinal plants proved to be quite fruitful. *Astragalus dasyanthus* Pall., *Atropa belladonna* L., *Digitalis lanata* Ehrh., *Glaucium flavum* Crantz ,rare in the Ukrainian and European flora, have been successfully introduced and already cultivated. The introduction of *Adonis vernalis* L., *Pulsatilla nigricans* Storck., *Scopolia carniolica* Jacq., *Carex brevicolli*s DC., and other rare and vanishing species has also been effective [4–6].

The efficiency of flora diversity utilization varies among countries. In Ukraine, 2219 medicinal plant species are used in humane, veterinary and traditional medicine as well as in homeopathy and cosmetology. However, only 244 (10%) are cultivated and introduced species, which include 32 agricultural species, 29 fruit and berry crops, 150 species are cultivated for obtaining medicinal and essential oil raw material, the rest are introduced for planting in botanical gardens and parks.

Vascular plants in Ukraine comprise 6086 species including cultivated and introduced plants. Biologically active compounds, which are or can be used for medicinal purposes, were found in 2219 of them [4].

Species and forms of medicinal plants of native flora can serve as rich genetic source and selection material for introduction, creation of new cultivars, populations and forms. Each natural plant population is heterogeneous, but peculiar phenotype usually conceals this diversity. Ability to adapt to harsh conditions, such as low and high temperatures, soil salinization and densification, damage caused by parasites and diseases, is a key value of source material. Thus, there is a need for effective use of plants' genetic resources as well as collection of potentially valuable species and their fixation in the collections *ex situ*. Climate change and aridification of the Ukrainian territories demands the search for source material for cultivation among plant groups of Ukrainian Steppe [7].

MATERIALS AND METHODS

In August 2014 the Plant Production Institute nd. a. V.Y. Yuriev of NAAS National Centre for Plant Genetic Resources of Ukraine held an expedition with participants from the Experimental Station of medicinal Plants of the Institute of Agroecology and Environmental Management of NAAS and Ustymivka Experimental Station of Plant Production of Institute nd. a. V.Y. Yuriev of NAAS. Among the expedition's goals was collection of gene pool samples adapted to Ukrainian Steppe conditions for marking out the sources of valuable features and their conservation in collections *ex situ* [3]. The total route length reached 2000 km. They

examined areas and location of samples include in Poltava, Dnipropetrovs'k, Zaporizhzhia and Kherson region [1.5]. Collection of local mild and cultivated plant gene pool samples adapted to the conditions of Ukrainian Steppe for following selection from them samples valuable according to economic and biological traits, use in breeding and research programs and conservation in the collections *ex situ* and *in situ*.

RESULTS AND DISCUSSION

We collected 286 gene pool samples in 48 locations after their evaluation in native conditions. The collected samples comprise 68 cultured and 218 wild plants, 117 species in total. Significant part of the plants is medicinal and essential oil-bearing ones (119 samples of 62 species) (Table 1).

We collected 200 herbarium sheets of 54 plant species for their identification and

Table 1

Collection of medicinal and essential oil-bearing plant gene pool samples in southern and central regions of Ukraine

Plant name	Number of samples
Cultivated plants	
Althaea officinalis L.	2
Dracocephalum moldavicum L.	1
Coriandrum sativum L.	1
Hyssopus officinalis L.	1
Echinacea purpurea (L.) Moench.	2
Cymbopogon flexuosus (Nees ex Steud) Will.Watson	1
Levisticum officinale L.	1
Origanum majorana L.	1
Origanum vulgare L.	2
Melissa officinalis L.	2
Monarda citriodora Cerv. ex Lag.	1
Mentha x piperita L.	3
Calendula officinalis L.	6
Trigonella foenum-graecum L.	1
Plantago major L.	1
Leonurus cardiac L.	3
Silybum marianum (L.) Gaertn.	1
Chamomilla recutita (L.)Rauschert	1
Thymus dimorphus Klok. et Shost.	3
Satureja hortensis L.	1
Salvia sclarea L.	1
Wild plants	
Astragalus sp.	11
Hyoscyanus niger L.	2
Conium maculatum L.	1
Buglossoides arvtnsis (L.) Johnst	9
Valeriana officinalis L.	1
Thalictrum minus L.	3
Veronica spicata L.	1
Centaurea ruthenica L.	1
Echinops ritro L.	1
Echinops sphaerocephalus L.	2
Litospermum officinale L.	1

End of Table 1

Plant name	Number of samples
Achillea sp.	2
Achillea ochroleuca Ehrh.	3
Achillea submillefolium L.	2
Achillea taurica M. Bieb.	1
Achillea collina Becker ex Heimerl s.l.	2
Ephedra distachya L.	3
Hypericum perforatum L.	4
Verbascum pinnatifidum Vahl.	1
Verbascum phoeniceum L.	1
Vincetoxicum scandens Somm.	1
Clematis sp.	1
Clematis tangutica (Maxim.) Korsh.	1
Linaria sp.	1
Euphorbia sp.	1
Digitalis sp.	1
Plantago sp.	2
Plantago salsa Pall.	1
Plantago scabra Moench.	2
Artemisia sp.	1
Glycyrrhiza glabra L.	3
Crinitaria linosyris (L.) Less.	1
Xeranthemum annum L.	1
Thymus tauricus Klok. et Des.-Shost.	1
Asparagus brachyphyllus Steven ex Ledeb.	2
Hierochloe odorata (L.) P.Beaub.	1
Salvia platensis L.	2
Alcea taurica Iljin.	3
Tribulus terrestris L.	1
Papaver sp.	3

definition of boundaries for morphological features variance. Some samples still need clarification of their systematic position.

One of the main goals of the expedition was the examination of nature reserves (objects of Nature Conservation Fund of Ukraine) for collection the seeds of rare and regionally rare species, especially the ones of medicinal value.

«Nyzhn'ovorsklyans'kyy» Regional Park and State Reserve «Luchkivskyy» (Poltava region) are located at the boundary of Forest Steppe and northern Steppe. There we examined the sandy meadows of river Vorskla right bank, the slopes of southern exposition and a crest at the right root bank. Overall 901 species of vascular plants grow in the Regional Park, 89 of them are endemic. We collected the seeds of *Salvia platensis* L., *Origanum vulgare* L., *Thalictrum minus* L., *Althaea officinalis* L., *Hypericum perforatum* L., *Conium maculatum* L., *Hierochloe odorata* (L.) P.Beaub and other species.

The left bank of Kahovkske reservoir and riverside of the river Konka were also rich in species diversity. This territory belongs to the area of southern continental Steppe, a lot of state reserves and Nature Conservation fund objects are located there, for example «Lysa hora», «Krutohory», «Prystiny» natural national parks, «Ivanove dzherelo» natural monument, «Ozero Synie» and others. After the preliminary evaluation of populations, we selected the seeds and planting material of

such medicinal species as *Centaurea ruthenica* L., *Hypericum perforatum* L., *Leonurus cardiac* L., *Veronica spicata* L., *Thalictrum minus* L., *Hyoscyanus niger* L.

During the expedition in the southern Steppe area, we also examined the coenoses of Ivanivsky and Genichesky districts in Kherson region and Pryazovsky district in Zaporizhzhia region. Among the examined plant groups, the most fascinating were the ones located along reservoirs and canals of irrigation systems. Among the collected samples were the *Carthamus tinctorius* L. seeds.

Of a special interest were the collection process at Azov sea spits (Berdyanska, Obytichna, Fedotova with Biryuchi island and Arabat Arrow). There the soils are formed by sand and shell sediments and fed by salty Azov sea water, thus the coenoses of salt- and heat-resistant plants were formed, a significant part of species there are endemics and valuable medicinal plants. At Berdyansk spit and Arabat Arrow we determined the population structure at the areas of mass growth of valuable medicinal species of *Glycyrrhiza glabra* L., *Ephedra distachya* L., *Asparagus brachyphyiius* Turez., *Echinops sphaerocephalus* L., *Achillea ochroleuca* Ehrh.i *Achillea taurica* M. Bieb., *Verbascum pinnatifidum* Vahl., *Thymus dimorphus* Klok. et Shost., *Plantago salsa* Pall. and *Plantago scabra* Moench. We selected the seed and planting samples from them. The *Clematis tangutica* (Maxim.) Korsh. population was discovered at the Obytichna spit. These gene pool samples will be included to breeding as the sources of resistance to salty soils, draught, heat and diseases.

In the relatively short period we collected the seeds for replenishing the collection of rare and valuable medicinal plant species of Experimental Station for Medicinal Plants of Institute of Agroecology and Environmental Management of NAAS. *Achillea graberrima* Klok., *Stipa cappillata* L., *Centaurea ruthenica* L., *Asparagus brachyphyiius* Turez., *Allium scythicum* Zoz., *Thymus litoralis* Klok., *Ephedra distachya* L. are now available for introduction, conservation of their gene pool and further repatriation.

Orientation of Ukraine's pharmaceutical market for meeting European Union demands is the reason for re-evaluation of species composition, qualitative indicators and other characteristics of medicinal plant raw material. For most of essential oil-bearing species the important quality features comprise not only the content of essential oil, but also such qualitative indicators as the content of peculiar components and their proportions, distribution of biologically active compounds in the raw material, etc. Thus, introduction and selection specialists currently aim to search sources and donors for new features. For selection process we collected the species of genera *Achillea* L., *Hypericum* L., *Mentha* L., *Leonorus* L., *Plantago* L., *Althea* L.

For replenishing the collections of genus complexes with further study of ecological, biological and phytochemical features we collected gene pool samples of the following species: *Verbascum* L., *Echinops* L., *Veronica* L., *Conium* L., *Salvia* L., *Linaria* Mill., *Tribulus* L. *Glycyrrhiza* L., *Artemisia* L., *Thymus* L., *Origanum* (Tourn.) L.

For the species such as *Achillea graberrima* Klok., *Centaurea ruthenica* L., *Asparagus brachyphyiius* Turez., *Allium scythicum* Zoz., *Ephedra distachya* L. we defined the locations for the establishment of nature reserves, with the aim of conservation *in situ* and repatriation.

CONCLUSIONS

During the expedition, we examined southern and central steppe areas of Ukrainian steppe regions. There we collected 286 gene pool samples of cultured and wild plants for further conservation and enrichment the biodiversity of plants adapted to the conditions of Steppe zone of Ukraine.

For conservation and fixation in the collections *ex situ* as well as effective use of gene resources of medicinal plants we collected 119 samples. They belong to 62 species of essential oil-bearing and medicinal plants (36 samples of 21 cultivated species and 83 samples of 41 wild species).

We selected certain seeds for replenishment of the rare and valuable species of medicinal plant collection of Experimental

Station for Medicinal Plants of Institute of Agroecology and Environmental Management of NAAS. They include such species as *Achillea graberrima* Klok., *Stipa cappillata* L., *Centaurea ruthenica* L., *Asparagus brachyphyiius* Turez., *Allium scythicum* Zoz., *Thymus litoralis* Klok., *Ephedra distachya* L. This will allow the introduction of these species for conservation of their gene pool and further repatriation to the natural phytocoenoses.

We also defined the locations for the establishment natural reserves for preservation *in situ* and repatriation of the following species: *Achillea graberrima* Klok., *Centaurea ruthenica* L., *Asparagus brachyphyiius* Turez., *Allium scythicum* Zoz., *Ephedra distachya* L.

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