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I. STRUCTURAL AND FUNCTIONAL DIVERSITY OF PLANT ORGANISMS

INTRON LENGTH POLYMORPHISM OF β-TUBULIN GENES IN DIFFERENT REPRESENTATIVES OF PINACEAE LINDL. FAMILY

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Abstract: Intron lengths polymorphism of β-tubulin genes was studied using TBP-method in four species of conifers of Pinaceae L. family (Pinus sylvestris L., Abies alba Mill., Picea abies (L.) H. Karst., Picea pungens Engelm.). Unique patterns were identified and molecular profiles for each of these species were created. It was established that the main distribution area of amplicons ranged from 301 bp to 1133 bp. There were 57 amplified fragments of different lengths. The greatest amount of amplicons (25) was found in Abies alba. Also this species had a rather high PIC value (0.354) compared to other studied representatives of Pinaceae family. The lowest values of PIC were observed in P. pungens (0.063) and P. abies (0.107). Analysis of Pinus sylvestris by TBP-markers has shown that 14 fragments out of 18 analyzed ones were polymorphic and only 4 were monomorphic. Evaluation of PIC polymorphism in this species was 0.313. Shannon information index and expected heterozygosity, calculated using TBP analysis, were highest in Abies alba (0.472 and 0.311) and Pinus sylvestris (0.400 and 0.265), respectively, and the smallest in Picea pungens (0.083 and 0.056).

INTRODUCTION

Early studies of genetic relations among species were done by using qualitative phenetic techniques, seed protein electrophoresis, isozyme analysis (Pavlicek et al., 1999; Torimaru et al., 2009; Belletti et al., 2012; Nowakowska et al., 2014). More recently, molecular markers based on polymerase chain reaction (PCR) became popular. Microsatellite repeats (SSR markers) used in population genetics are among them (Soranzo et al., 1998; Aldrich et al., 2003; Sork et al., 2008; Ganea, Garcia Gil, 2011; Demkovich et al., 2014). At the same time, introns as the source of DNA-polymorphisms find ever widening applications. It is known that introns are involved in many important cell life events, namely control of gene expression through alternative splicing mechanism and other processes (Rose, 2002; Hir et al., 2003; Li et al., 2007; Morello, Breviario, 2008; Braglia et al., 2010). Evolution of exon and intron sequences has different rates, moreover introns are hypervariable genome regions comparable in polymorphisms to microsatellite loci. Introns have different nucleotide composition and length, even within one taxon (Sakurai et al., 2002; deSouza, 2003). Thus, the marker systems based on intron polymorphisms, such as intron length polymorphism of β-tubulin genes (Bardini et al., 2004) are useful for investigations at intra- and interspecific level.

Tubulin based polymorphism (TBP)-method is based on the presence of introns in the clearly defined areas of plant genomes. In particular, the first intron of β-tubulin gene in most cases begins with the 397-th nucleotide after ATG start codon. In most cases, plants have two or more introns of β-tubulin gene, with the exception of corn (ZeamaTUB1) and rice (OryzaTUB2) (Aldrich et al., 2003; Breviario et al., 2007), which have no second intron. During the PCR with specific primers to 1-st and 2-nd exons we can obtain many copies of introns which lie between them (Bardini et al., 2004; Braglia et al., 2010; Pirko, 2011). In general, intron length polymorphisms of β-tubulin genes are stable working systems of molecular genetic markers in different species of higher plants and can be useful in the genetic analysis (Breviario et al., 2007; Blume et al., 2010; Rabokon et al., 2015). It should be noted that molecular genetic diversity of Pinaceae Lindl. family with the use of this marker system is poorly understood (Pirko, 2011). In view of the economic value of conifers, it is very important of estimate their population genetic diversity.

MATERIAL AND METHODS

To study the intron length polymorphism of β-tubulin genes we used vegetative material (terminal buds with shoot fragments and needles) and seeds collected from natural populations and artificial plantings of four species of the Pinaceae family: *Pinus sylvestris L., Abies alba Mill., Picea abies* (L.) H. Karst., *Picea pungens* Engelm. Genomic DNA was extracted from vegetative and seed material by CTAB-method (Green, Sambrook, 2012). The quality and quantity of DNA was tested by electrophoresis in 1.5 % agarose gel and by spectrophotometry using «Eppendorf» biophotometer, determining the concentration and contamination degree of DNA. DNA samples were stored at -20°C. Sequences of primers were as follows (Breviario et al., 2007): TBP-F: 5'-AACTGGGCBAARGGNCAYTAYAC-3'; TBP-R: 5'-ACCATRCAYTCRTCDGCRTTYTC-3'. PCR was performed using Thermal Cycler 2720 (Applied Biosystems, USA). The reaction mixture (10 ml) contained five-fold PCR buffer with ammonium sulfate, 2.5 mM M_gCl_2, 50 ng of plant DNA, 1 mM each primer, 0.2 mm each dNTPs, 0,5 U Taq polymerase (Fermentas, Lithuania). Amplification was performed with following protocol: initial denaturation (94°C) – 3 min, 35 cycles of amplification (94°C denaturation – 30 sec, 55°C annealing of primers – 40 sec, 72°C extension – 1.5 min, 72°C final extension – 8 minutes, 15°C detension (Bardini et al., 2004).

Each PCR reaction was repeated thrice using negative control to be able to detect non-specific amplification products in the following electrophoretic analysis. PCR products (0.5 мL) were separated by electrophoresis in 6% non-denaturating polyacrylamide gel in 1x TBE buffer at 300 V for 4 hours (Green, Sambrook, 2012). Visualization of the fragments was performed by silver nitrate DNA staining (Rahman et al., 2000; Benbouza et al., 2006). After electrophoresis gel was photographed in visible light and images were subjected for further analysis. Images of electrophoretic gels were analyzed using program GelAnalyzer: (http://www.gelanalyzer.com/). The length of reproducible and clear bands were determined using DNA markers (O'gene Ruler™ 100bp Plus DNA Ladder, ready-to-use; Fermentas, Lithuania).

The level of polymorphism of TBP-markers was evaluated by PIC (Polymorphism Information Content) index using formula:

$$\mathbf{PIC} = \frac{\sum_{i=1}^{n}\left(1 - f_{ai}^2 - f_{bi}^2\right)}{n},$$

where n – is a general measured fragments' quantity, fa – the frequency of cases (organisms) with absent i-fragment and fb – the frequency of occurrence of organisms with this fragment presence (Hondrakul et al., 1997; Bardini et al., 2004).

RESULTS AND DISCUSSIONS

The analysis of four representatives of the *Pinaceae* family using TBP-method has shown that the main distribution area of amplicons ranged from 301 bp up to 2705 bp. Only fragments which ranged from 301 bp up to 1133 bp were analyzed (Fig. 1). Amplicons that visualized above 1200 bp were not taken into account, as further investigation of their origin is needed.

There were 57 amplified fragments of different lengths. In particular, analysis of fragments from P. pungens revealed seven amplicons, and 10 amplicons for *P. abies*, the length of which ranged between from 416 bp to 1113 bp and from 420 bp to 1126 bp, respectively. The study of *Pinus* sylvestris electrophoregram revealed 18 bands, the length of which was distributed from 307 bp to 580 bp. The highest amount of amplicons (25) was

found in A. alba with varying lengths of fragments ranging from 301 bp to 1116 bp.

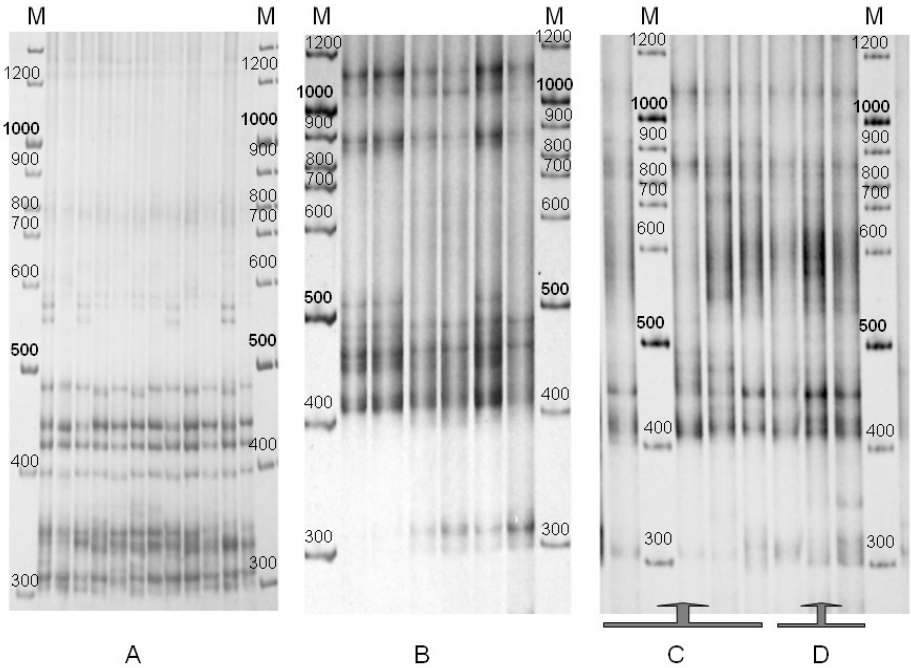

Figure 1. Electroforegrams of introns' amplicons of в-tubulin gene in representatives of the family Pinaceae: A – Pinus sylvestris L., B – Abies alba Mill., C – Picea abies (L.) H. Karst., D – Picea pungens Engelm., M – DNA marker.

No common fragments were detected when comparing the coniferous species studied together. However, three common monomorphic fragments with an approximate length of 453 bp, 840 bp and 863 bp were detected in *P. abie*s and *P. pungens.* This is probably due to the fact that these representatives belong to the same genus – *Picea.* Only two polymorphic fragments of 426 bp and 1032 bp were observed in *P. pungens.* The PIC value of this species was 0.063, which is quite low, given that the maximum PIC value is usually 0.5 (Hongtrakul et al., 1997).

Four polymorphic fragments were observed in *P. abies,* which is twice as much as in *P. pungens.* Their lengths were 476 bp, 490 bp, 929 bp, 947 bp. The PIC value of *P. abies* was 0.107, almost twice higher than in *P. pungens.* Overall, a fairly low level of polymorphism for these two species was observed possibly due to the origin of artificial plantations and to the small number of analyzed samples.

Analysis of *Pinus sylvestris* by TBP-markers has shown that 14 fragments out of 18 analyzed ones were polymorphic and only 4 were monomorphic (315 bp, 346 bp, 418 bp, 436 bp). A set of amplicons typical for polymorphic fragments was: 307 bp, 312 bp, 334 bp, 338 bp, 341 bp, 390 bp, 392 bp, 417 bp, 476 bp, 560 bp, 565 bp, 570 bp, 575 bp and 580 bp. Evaluation of PIC polymorphism in this species was 0.313.

The largest number of polymorphic fragments (24 of 25 available) has been noted in A. alba. Their length was the following: 301 bp, 308 bp, 314 bp, 402 bp, 406 bp, 412 bp, 428 bp, 436 bp, 442 bp, 444 bp, 454 bp, 458 bp, 472 bp, 480 bp, 488 bp, 500 bp, 527 bp, 682 bp, 865 bp, 875 bp, 1038 bp, 1046 bp, 1066 bp, 1116 bp. The PIC value of *A. alba* was 0.354, that is a rather high rate as compared with other plant species (Breviario et

al., 2007). It should be noted that a high level of polymorphism of *A. alba* samples is likely to be related to the natural origin of this species and representative sample of plants.

Overall, when comparing the electrophoretic profiles of four representatives of the Pinaceae family by TBP-method, one can notice that a significant amount of amplicons is distributed in the range from 300 bp to 500 bp in *Pinus sylvestris* (Fig.1). Most of the fragments visualized in the range from 400 bp to 500 bp and from 800 bp to 1200 bp in *A. alba, P. abies* and *P. pungens.* It can be assumed that using our method, based on intron length polymorphism of β-tubulin genes, we can clearly differentiate species and find some evolutionary linkage of similar species or families.

According to Fig. 2, the following polymorphism indicators as an Shannon index information and expected heterozygosity using TBP markers were the highest in A. alba (0.472 and 0.311) and *Pinus sylvestris* (0.400 and 0.265) and lowest in *P. pungens* (0.083 and 0.056), which in general is proved by the PIC values.

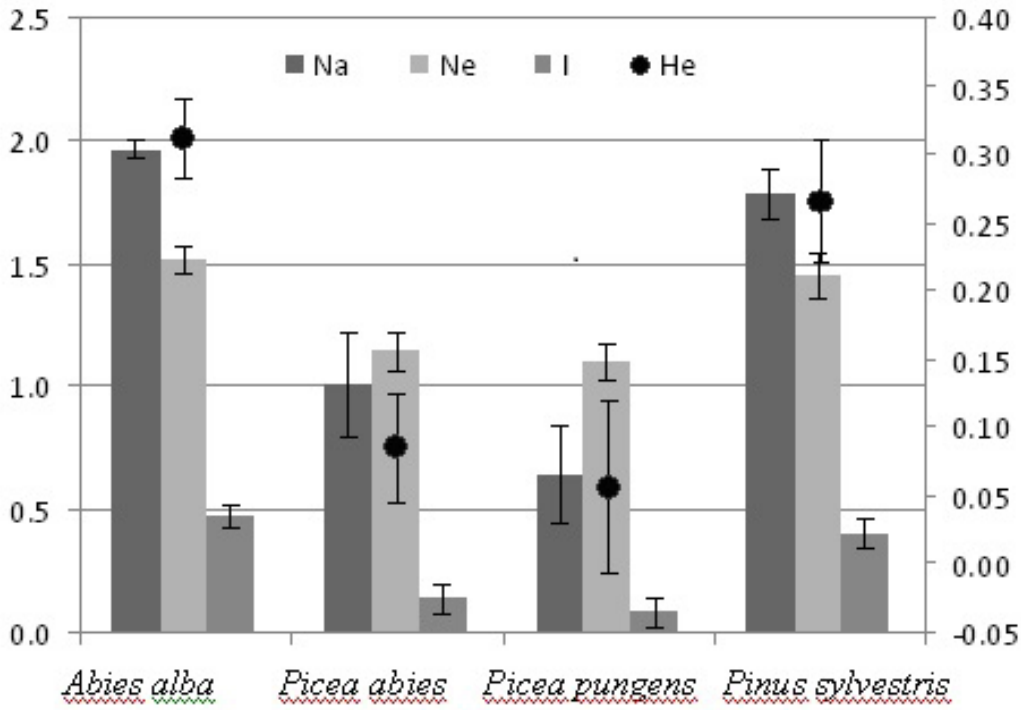

Figure 2. The main parameters of the genetic diversity for four coniferous species using TBP-markers

CONCLUSIONS

TBP method is rather useful and reliable for genetic marking without previous detection of certain sequences of β-tubulin introns. TBP enabled us to identify unique patterns for four conifer species of Pinaceae family we chose for our investigation. It also allowed us to identify molecular profiles of each species and common fragments typical of some genera within this family. Thus, this method based on estimation of the first intron length of β-tubulin is useful for molecular genetic analysis and differentiation of representatives of Pinaceae family.

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II. CONSERVATION OF BIOLOGICAL DIVERSITY

THE GENUS *CENTAURIUM* HILL (*GENTIANACEAE* JUSS.) IN FLORA OF BESSARABIA: TAXONOMY, ECOLOGY, CHOROLOGY

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Abstract: The paper contains information on the study of the genus *Centaurium* in the flora of Bessarabia. There are four species included in the list of vascular plants: *Centaurium spicatum* (L.) Fritsch, *C. pulchellum* (Sw.) Druce, *C. littorale* (D. Turner) Gilmour and *C. erythraea* Rafn. The two taxa: *Centaurium littorale* and *C. spicatum* are rare for the studied territory. The dichotomic key for *Centaurium* species, brief ecological, chorological and habitat characteristics for each species are given.

Key words: *Centaurium*, *Gentianaceae*, Bessarabia, flora, chorology, biology.

INTRODUCTION

The genus *Centaurium* Hill (*Gentianaceae*) consists of 50 species, widely distributed in temperate, warm and subtropical zones of Earth, mainly in mountainous regions [20, 21].

In the *Flora Europaea*, the genus *Centaurium* Hill is represented by 14 species [5]. According to main floristic works, the spontaneous flora of the Republic of Moldova comprises 4 species [6, 14], which are components of the herbaceous grassland stands of glades and woodland edges and of meadow phytocoenoses [15].

From the taxonomic point of view, it is a difficult genus. Numerous taxa have been described, but there is no uniformity in their treatment by various authors. Most intraspecific taxa hybridize freely in natural habitats, the hybrids being interfertile and producing swarms which obscure the limits between the involved taxa. [5]. The representatives of the genus *Centaurium* play a special role in human life, including medicinal species *(C. erythraea* Rafn. and *C. pulchellum* (Sw.) Druce), widely used as therapeutic remedies since ancient times.

MATERIALS AND METHODS

The present study was based on the field floristic research on the genus *Centaurium*, the analysis of literature and of collections from the herbaria. We studied all the specimens of *Centaurium* Hill collected from all the regions of Bessarabia and stored in the herbaria of the Botanical Garden (Institute) of the ASM and the Muzeum of Natural Sciences of the State University of Moldova. The correctness of the determinations was verified using the fundamental floristic literature [1, 5, 6, 10, 14, 17, 21]. The floristic research and the critical analysis of the species of the genus *Centaurium* Hill were conducted according to the classical methods [19].

The accepted names of the species were given according to *www.ipni.org* [23]. The analitical drowings are performed by Teleuta Stepan. The general Map of Bessarabia was taken from "Flora Basarabiei", Vol. I [3].

RESULTS AND DISCUSSIONS

Within the framework of the critical analysis of the genus *Centaurium* Hill in the flora of Bessarabia, the herbarized material and the published scientific papers on the given genus were examined. As a result, 4 species were identified on the territory under study: *Centaurium erythraea* Rafn., *C. pulchellum* (Sw.) Druce, *C. littorale*

(D. Turner) Gilmour and *C. spicatum* (L.) Fritsch. The last two are rare species, found only in the southern areas of the studied region. It has been found that the presence of the species *Centaurium spicatum* (L.) Fritsch and *C. littorale* (D. Turner) Gilmour in the Republic of Moldova is questionable, because there is no existing data or herbarized material to confirm the presence of these species in the mentioned territory.

The key to the determination of the species, the synonymy, the biological, ecological and chorological characteristics of the species are presented below.

Genus ***Centaurium*** Hill – Centaury
1756, Brit. Herb. : 62; Gilib. 1781, Fl. Lithuan. 1 : 35. – *Erythraea* Borkh. 1796,
in Roem., Arch. Bot. 1, 1 : 30

Annual or biennial plants, about 5-35 (45) cm tall, glabrous, rarely covered with short papillae. Leaves entire, opposite. Flowers grouped in dichasial, corymbose or spike-like cymose inflorescences. Calix segments liniar, acute, divided by 2/3 of lenght. Corolla 4 (5)-lobed, bright pink, rarely whitish, infundibuliform. Stamens 5, inserted at upper half of corolla tube. Anthers free, twisting spirally after dehiscence. Ovary with filiform style. Stigma bilobate. Fruit – narrow-elipsoid capsule, sessile. Seeds – orbicular, finely alveolate.

Lectotype: ***C. erythraea*** Rafn.

Key to species of *Centaurium*

1a. Inflorescence spike-like and spiciform ..... 4. ***C. spicatum***
1b. Inflorescence corymbouse or dichasial cyme ..... **2.**
2a. Stem without basal leaf-rosette, dichotomously branched in the lower part ..... 3. ***C. pulchellum***
2b. Stem with a basal leaf-rosette, branched in the upper part ..... **3.**
3a. Cauline leaves linear, usually 1-veined. Calyx equalling or nearly equalling the corolla-tube .... 1. ***C. littorale***
3b. Cauline leaves oblong-eliptical, 3-veined. Calyx 1/2-2/3 as long as the corolla-tube ..... 2. ***C. erythraea***

Section 1. ***CENTAURIUM***
Type: lectotypus generis

1. ***C. littorale*** (D. Turner) Gilmour, 1937, Kew Bull.1937 : 498; Melderis, 1972, Fl. Europ. 3: 58; Цвелев, 1978, Фл. евр. части СССР, 3: 60; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 421; Negru, 2007, Determ. pl. fl. R. Moldova: 187; Ciocârlan, 2009, Fl. ilustr. a României: 601. – *C. vulgare* Rafn, 1800, Danm. Holst. Fl. 2: 73, nom. illeg.; Гроссгейм, 1952, Фл. СССР, 18: 533. – **Seaside Centaury.**

Annual plant, Eurasian element. Flowers and fructifies in May-August. Grows in semi-salty, wet meadows, on coastal sands. On the Bessarabia´s territory the species was attested only in southern districts: VIII – "South Bugeac steppes" and X – "Chilia", characterized by coastal vegetation (Fig. 5.). The area of distribution of species is Central and Eastern Europe, Atlantic Europe and Scandinavian Peninsula.

Note: The species hasn't been confirmed on the territory of the Republic of Moldova and has been mistakenly included in the vascular plants list. In the

Fig. 1. *Centaurium littorale*

studied herbaria, there were several exsiccatae collected in Moldova, in the clearings and oak stand edges, determined mistakenly as *Centaurium littorale* (D. Turner) Gilmour., subsequently redetermined by us as *Centaurium erythraea* Rafn. The distinctive morphological characters that differentiate the species *C. littorale* from *C. erythraea* are given in the key presented above.

2. ***C. erythraea*** Rafn, 1800, Danm. Holst. Fl. 2: 75; Melderis, 1972, Fl. Europ. 3: 57; Цвелев, 1978, Фл. евр. части СССР, 3: 60; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 421; Чопик, 1999, Опред. высш. раст. Укр., изд. 2: 257; Negru, 2007, Determ. pl. fl. R. Moldova : 187; Ciocârlan, 2009, Fl. ilustr. a României : 601. – *C. umbellatum* Gilib. 1781, Fl. Lithuan. 1 : 135; Гроссгейм, 1952, Фл. СССР, 18: 533; Țopa, 1961, Fl. R. P. Române, 8: 441. – **Common centaury.**

Annual-biennial plant. Mediterranean element. Flowers and fructifies in July-September. It grows in glades, woodland edges, bright forests and thickets (Fig. 2). The species is distributed sporadically on almost the entire territory of Bessarabia. The natural area of distribution is Europe, Asia, South-Western Siberia and Caucasus. It has been introduced on the American continent.

The Common Centaury is a medicinal plant, its green mass contains erythaurin and erythrocentaurin, as well as erythrina alkaloids. It is used as a remedy for improving digestion and increasing appetite. Also, in various forms (powder, tinctures, etc.), this plant is used in veterinary medicine. All parts of the plant are rich in tannins [16].

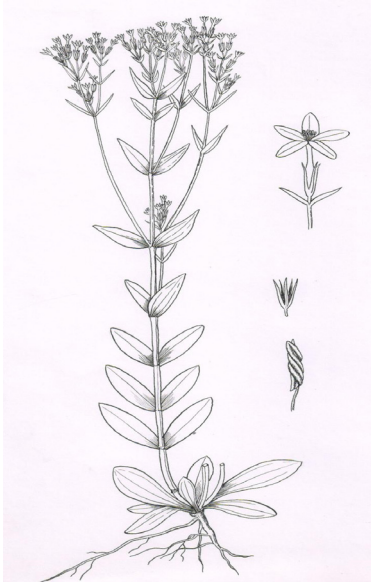

Fig. 2. *Centaurium erythraea*

3. ***C. pulchellum*** (Sw.) Druce, 1898, Fl. Berks. : 342; Гроссгейм, 1952, Фл. СССР, 18: 528; Țopa, 1961, Fl. R. P. Române, 8: 440; Melderis, 1972, Fl. Europ. 3: 59; Цвелев, 1978, Фл. евр. части СССР, 3: 62; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 421; Чопик, 1999, Опред. высш. раст. Укр., изд. 2: 257; Negru, 2007, Determ. pl. fl. R. Moldova : 187; Ciocârlan, 2009, Fl. ilustr. a României : 601. – *Gentiana pulchella* Sw. 1783, Kongl. Sv. Vet. Akad. Handl. 4: 85. – **Lesser Centaury.**

Fig. 3. *Centaurium pulchellum*

Annual-biennial plant. Eurasian element. Flowers and fructifies in June-September. Grows in wet, semi-salty meadows, on the banks of rivers and lakes (Fig. 3.). Is distributed sporadically in most districts of Bessarabia. Is found in Europe, the southern part of the Scandinavian Peninsula, Central Asia, Asia Minor, Mediterranean region, Caucasus.

Ornamental and medicinal plant. Its green mass contains a glycoside named erythrocentaurin, which can be used as a remedy to increase appetite and as alkaloid [18].

Note. In the investigated region, there are also specimens with white flowers, which, in the opinion of some authors, have the status of subspecies – *Centaurium pulchellum* subsp. *meyeri* (Bunge) Tzvel. [14, 21], and are considered, by other researchers, as a species – *Centaurium meyeri* (Bunge) Druce [18, 22], which in fact fits into the limits of *Centaurium pulchellum* (Sw.) Druce.

Section 2. ***SPICARIA*** (Griseb.) Ronniger
Type: ***C. spicatum*** (L.) Fritsch

Fig. 4. *Centaurium spicatum*

4. ***C. spicatum*** (L.) Fritsch, 1907, Mitt. Naturw. Ver. Wien, 5: 97; Гроссгейм, 1952, Фл. СССР, 18: 535; Țopa, 1961, Fl. R. P. Române, 8: 439; Melderis, 1972, Fl. Europ. 3: 59; Цвелев, 1978, Фл. евр. части СССР, 3: 63; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 421; Чопик, 1999, Опред. высш. раст. Укр., изд. 2: 257; Negru, 2007, Determ. pl. fl. R. Moldova : 187; Ciocârlan, 2009, Fl. ilustr. a României : 601. – *Gentiana spicata* L. 1753, Sp. Pl. : 230. – **Spiked Centaury.**

Annual-biennial plant. Pontic-Mediterranean element. Flowers and fructifies in May-October. Grows in wet, semi-salty stony meadows, in costal, marine sands (Fig. 4.). Rare species, detected only in Southern Bessarabia, in the district X – "Chilia", characterized by coastal vegetation (Fig. 5.). It is found in Central and Eastern Europe, Central Asia, Asia Minor, Mediterranean region, Caucasus, Iran.

Ornamental and medicinal plant. In the neighbouring countries – Romania and Ukraine – it is also a rare taxon, included in the Red Book of vascular plants of Romania and in the Danube Delta Biosphere Reserve [2].

Note. In the collections from the herbaria studied, there is no exsiccata of the species *C. spicatum,* collected in the Republic of Moldova. In literature, it was mentioned, for the first time, by T. Gheideman in 1954 [12]. In the subsequent editions of the "Catalogue" of plant species, published in 1975 and 1986, *C. spicatum* was cited, mentioning that "it can be found in the southern Bugeac" [13, 14]. The species is also indicated in monographs on rare plants and their habitats in the wild flora of the Republic of Moldova [4,7,8,9], but without specifying any new, veridical data regarding its presence on that territory. Being a coastal (Submediterranean) species [2], *C. spicatum* cannot be found in the flora of the Republic of Moldova because of the absence of specific habitats, thus, its exclusion from the list of vascular plants in the given territory is justified.

Fig. 5. The spread of rare species of *Centaurium* on the Bessarabia´s territory ● – *C. littorale* ▲ – *C. spicatum*

CONCLUSIONS

1. As a result of the research on the genus *Centaurium* Hill in Bessarabia´s flora it has been found that it comprises 4 wild growing species: *Centaurium erythraea* Rafn., *C. pulchellum* (Sw.) Druce, *C. littorale* (D. Turner) Gilmour and *C. spicatum* (L.) Fritsch, included in two sections.

2. *C. littorale and C. spicatum* are rare species, found only in the geobotanical districts from the South of Bessarabia, in wet, semi-salty, stony meadows and marine sands, in coastal areas.

3. The presence of the species *C. littoral*e and *C. spicatum* in the flora of the Republic of Moldova is doubtful, because there is no truthful and reliable data on the chorology of the taxa and no specimens in the existing herbaria that would confirm their presence on the territory of the republic. We consider they were mistakenly included in the list of the vascular flora of the Republic of Moldova.

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SYNOPSIS ON GENUS *ERODIUM* L`Her. (*GERANIACEAE* Juss.) IN THE DNIESTER-PRUT RIVER REGION

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Abstract: The article brings the list of the genus in *Geraniaceae* Juss. family – *Erodium* L`Her., which embodies 4 species in the Dniester-Prut region. The dichotomic key for genus *Erodium*, as well as brief ecological and habitat characters for each species are given.
Key words: flora, *Geraniaceae, Erodium,* biology, ecology, common and local distribution, illustration.

INTRODUCTION

The maintenance of floristical diversity nowadays is based on fundamental monographic studies and knowledge (in fundamental and practical aspect) on separate taxonomic groups.

Geraniaceae is a family of flowering plants placed in the order *Geraniales.* The family name is derived from the genus *Geranium.* The family comprises 830 species placed in five to seven genera. Numerically, the most important genera are *Geranium* L., *Pelargonium* L`Her. and *Erodium* L`Her.

Genus *Erodium* – variable in morphology and ecological characteristics, holds of the central position in system of family *Geraniaceae* Juss. The genus includes species, native to North Africa, Indomalaya, the Middle East and Australia. [6] They are perennials, annuals or subshrubs, with 5-petalled flowers in shades of white, pink and purple, that strongly resemble the species of better-known *Geranium* (cranesbill) genus.

MATERIAL AND METHODS

During our investigation concerning genus *Erodium* for the flora of Dniester-Prut region, we performed all necessary research on field and laboratory examination. Firstly we reviewed all published information on the presence of species in the territory and consulted specimen materials in different scientific herbaria (Herbarium of the Botanical Garden (Institute) of ASM, Herbarium of the State University of Moldova, Herbarium of the Botanical Institute Komarov (Sankt-Petersburg, Russian Federation), Herbarium of National Museum of Ethnography and Natural History of Moldova, etc. The illustrations have been performed by Vinogradscaia O. and Teleuta S.

RESULTS AND DISCUSSIONS

Genus *Erodium* L`Her. is one of the largest in the family *Geraniaceae* which comprises about 100 species, widespread in temperate, subtropical, and tropical zones of the northern and southern hemisphere, mainly in the Mediterranean region. [6, 13] In the flora of Europe it embodies 34 species [6], in Dniester-Prut river region – 4 species.

ERODIUM L`Her. – Stork's bill. – Priboi. – Аистник
C. L. L'Heritier de Brutelle, 1789, in Aiton, Hort. Kew. 2: 414

Annual to perennial herbs, usually with hermaphrodite flowers, rarely dioecious. Leaves mostly opposite, usually longer then wide, pinnatifid to pinnate or, rarely, undivided, usually with appressed hairs. Inflorescence an umbel (rarely reduced to a single flower), subtended by 2 or more usually scarious bracts.

Flowers actinomorphic or slightly zygomorphic. Stamens 5, antesepalous, with a nectary at the base of the filament, alternating with 5 scale-like staminodes. Fruits – indehiscent mericarps, separating from the base upwards, retaining during dispersal the outer part of the style as a long beak, which at maturity, in most species become twisted into a spiral, the spiral pitch is varying depending on air humidity. Stigmas 5, filiform.

Lectotypus: ***E. crassifolium*** Soland. ex Ait. (= *E. hirtum* (Forssk.) Willd.)

Key to species of *Erodium*

1a. Perennial, with thick rhizome (up to 2-4 mm in diameter) ..... ***4. E. ruthenicum.***

1b. Annual, with thin roots (less than 2 mm in diameter) ..... 2.

2a. Leaves with the lobes excurrent on rachis ..... ***3. E. hoefftianum.***

2b. Leaves with the lobes not excurrent on rachis ..... 3.

3a. Leaves oblong, without intercalary lobes. Sepals 4-5 mm. Mericarps 4-7 mm ..... ***2. E. cicutarium.***

3b. Leaves oblong-ovate up to triangular, with intercalary lobes. Sepals circa 7 mm. Mericarps 5-10 mm ..... ***1. E. ciconium.***

1. ***E. ciconium*** (L.) L`Her. 1789, in Aiton, Hort. Kew. 2: 415; Введенский, 1949, Фл. СССР, 14: 71; Доброчаєва, 1955, Фл. УРСР, 7: 39; Şerbănescu, 1958, Fl. R. P. Române, 6: 157; D.A. Webb a. Chater, 1968, Fl. Europ. 2: 201; Гейдеман, 1986, Опред. высш. раст. Молд.ССР, изд. 3: 336; Цвелев, 1996, Фл. Вост. Евр. 9: 386; Бойко, 1999, Опред. высш. раст. Укр., изд. 2: 222; Negru, 2007, Determ. pl. fl. R. Moldova: 161; Ciocârlan, 2009, Fl. ilustr. a României: 453. – *Geranium cyconium* L. 1755, Cent. Pl. 1: 21. – **Common stork's bill. – Pliscul berzei. – Аистник аистовый.**

Annual plant. Stems 10-70 cm, with short, usually deflexed and glandular hairs. Leaves up to 9 cm, pinnate at least near the base; leaflets pinnatisect, the ultimate segments dentate or pinnatifid; intercalary lobes present. Umbels with 3-10 flowers. Bracts ovate-lanceolate, densely pubescent. Sepals 12-15 mm, glandular-hairy. Petals c. 8 mm, bluish or lilac, with darker veins. Mericarps 9-11 mm, with numerous whitish hairs; apical pits deep, densely glandular, without a furrow at the base; beak 60-100 mm long. (Fig. 1) 2n = 18.

It is an annual therophyte. The plants bloom in April-June and fructify in May-July. Propagate by seeds.

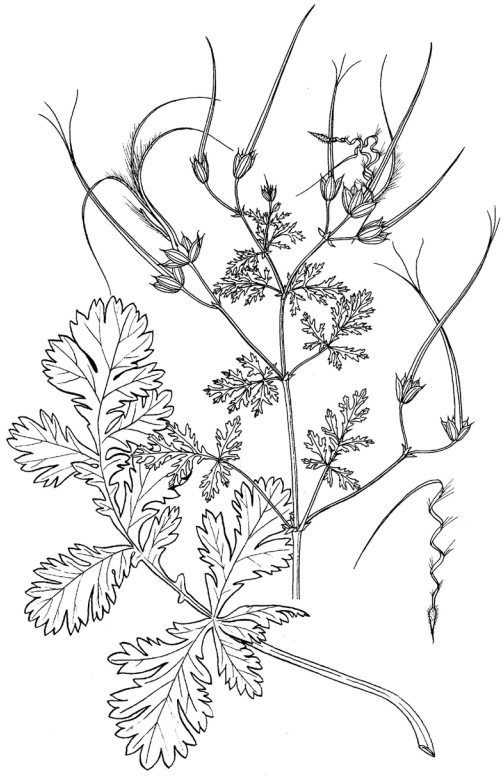

Fig. 1. *Erodium ciconium* (L.) L`Her.

The plants grow solitarily or in small groups with the number of 1-2, in habitats of edges of forests with *Quercus pubescens* Willd. and steppe vegetation with the dominance of *Festuca valesiaca* Gaudin and the species of genus *Stipa.* [14] The single recently registered (May 2013) population embraces a group of about 30 mature

specimens. The limitation factors of the distribution in the region are the reduced capacity of propagation and distribution, taking into account that it is an annual species that is less stable in comparison with perennial ones; extremely poor and isolated populations; afforestation of steppe clearings; excessive grazing.

In the Dniester-Prut River region, it is present in the Lower Dniester region (the areas between the commune of Copanca and the village of Leuntea (Causeni district). It is indicated on the base of herbarium materials, collected by T. Savulescu in 1934 and by C. Zahariadi in 1937, for the southern part of the zone of Bugeac steppe (in the outskirts of the villages Budaki, Sergeevka and Bolgrad town). Outside the country, Common stork's bill is met in the Atlantic, Central and Eastern (in the south) Europe, Crimea, Mediterranean region, Minor and Middle Asia, Iran, the Caucasus (Pannonian-Ponto-Sarmatian geographical element). [6, 13]

The species is rare; as critically endangered taxa **(CR)**, it has been included in the Red Book of Republic of Moldova. [3] The species is protected in the Wetland of international importance – Ramsar Site №1316, "The Lower Dniester" on the territory of the Forest Natural Reservation "Copanca". [7] The species has been transferred to the steppe sector of the Botanical Garden of the Academy of Sciences of Moldova and is successfully growing in *ex-situ* conditions.

Protection measures for the preservation of the species in the Republic of Moldova: inclusion in the list of the species protected by law; identification and protection of the new places of the species growth; monitoring of the populations status; the species propagation in *ex-situ* conditions and its repatriation to the natural habitats. [3]

Fig. 2. *Erodium cicutarium* (L.) L`Her.

2. ***E. cicutarium*** (L.) L`Her. 1789, in Aiton, Hort. Kew. 2: 414; Введенский, 1949, Фл. СССР, 14: 71; Доброчаєва, 1955, Фл. УРСР, 7: 38; Şerbănescu, 1958, Fl. R. P. Române, 6: 157; D.A. Webb a. Chater, 1968, Fl. Europ. 2: 202, p. max. p.; Гейдеман, 1986, Опред. высш. раст. Молд.ССР, изд. 3: 336; Цвелев, 1996, Фл. Вост. Евр. 9: 387; Бойко, 1999, Опред. высш. раст. Укр., изд. 2: 222; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 127; Negru, 2007, Determ. pl. fl. R. Moldova: 161; Ciocârlan, 2009, Fl. ilustr. a României: 453. – *Geranium cicutarium* L. 1753, Sp. Pl.: 680. – **Redstem stork's bill. – Priboi cicutifoliu. – Аистник обыкновенный.**

Usually caulescent, often somewhat fetid. Stems up to 60(-100) cm. Leaves up to 15 cm long, pinnate, without intercalary lobes, with variable indumentum; leaflets pinnatifid to pinnate, but always divided for more than half-way to midrib. Umbels with up to 12 flowers. Bracts brownish. Sepals 5-7 mm. Petals 4-11 mm, purplish-pink, lilac or white. Mericarps 4-7 mm, with ascending hairs; apical pits eglandular; beak 10-70 mm long (Fig. 2). 2n = 20, 30, 36, 40.

It is an annual therophyte. The plants bloom in May-August and fructify in June-September. Propagate by seeds.

The plants usually grow in small groups or form small thick stands, sometimes they occur solitary as a weed along roadsides and in field margins, pasture, in habitats of edges of arid forests, in steppe and calcareous slopes, dry meadows. The species is widely distributed throughout the region. The area of distribution covers the territory of Eurasia and North America, being introduced in other regions. [6, 13] Circumpolar geographical element.

3. ***E. hoefftianum*** C.A. Mey. 1855, Mém. Acad. Sci. Pétersb. 6, ser. 7: 3; Введенский, 1949, Фл. СССР, 14: 70; Доброчаєва, 1955, Фл. УРСР, 7: 37; D.A. Webb a. Chater, 1968, Fl. Europ. 2: 201; Цвелев, 1996, Фл. Вост. Евр. 9: 386; Бойко, 1999, Опред. высш. раст. Укр., изд. 2: 222; Ciocârlan, 2009, Fl. ilustr. a României: 454. – **Hoefft stork's bill. – Priboi Heft. – Аистник Геффта.**

Annual plant. Stems 15-50 cm, usually with patent hairs. Leaves not more than 6 cm, triangular-ovate, occasionally without free pinnae at the base, the upper part pinnatifid; lobes dentate or pinnatifid. Umbels with 1-8 flowers. Bracts several, linear-lanceolate, hairy, brown. Sepals 7-10 mm. Petals c. 8 mm, violet. Mericarps 6-7 mm long, densly hairy; apical pits more or less eglandular, without a furrow at the base; beak 50-75 mm (Fig. 3).

It is an annual therophyte. The plants bloom in April-May and fructify in May-June. Propagate by seeds.

It is met only in the south, in the sandy habitats on the banks of estuaries and lakes. The limitation factors in the region are: extremely poor and isolated populations; small territories of natural habitats; destruction of the growing sites due to recreational activities.

As a rare species, it is indicated for the region from 2 localities (in the outskirts of towns Belgorod-Dnestrovsky and Ismail, Odessa region, Ukraine) on the base of herbarium, collected by T. Savulescu in 1934 and C. Zahariadi in the 1937 and 1938. The species has not been found on the territory of the Republic of Moldova yet. Outside the Dniester-Prut river region it grows in Central (south-eastern part) and Eastern (southern part) Europe, Crimea, Mediterranean region (eastern part), the Caucasus, Middle Asia (Mediterranean-Ponto-Sarmatian geographical element). [6, 13]

It is rare on the territory of neighboring Romania and has been included in the Red Book of vascular plants in Romania [1] as critically endangered taxa **(CR).**

Protection measures for the preservation of the species in the Republic of Moldova: identification and protection of the new places of the species growth.

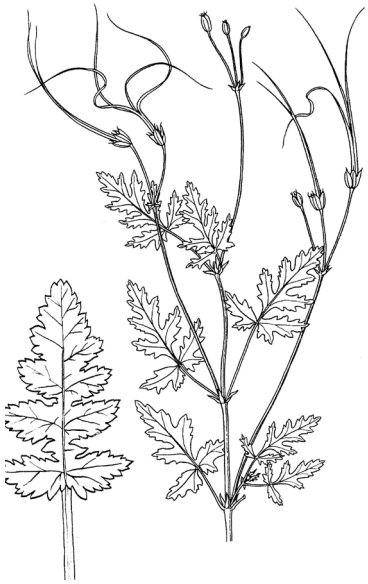

Fig. 3. *Erodium hoefftianum* C.A. Mey.

Fig. 4. *Erodium ruthenicum* Bieb.

4. ***E. ruthenicum*** Bieb. 1810, Cent. Pl. Rar. Ross. Merid. 1: tab. 48; Введенский, 1949, Фл. СССР, 14: 68; Доброчаєва, 1955, Фл. УРСР, 7: 35; Şerbănescu, 1958, Fl. R. P. Române, 6: 155; D.A. Webb a. Chater, 1968, Fl. Europ. 2: 201; Гейдеман, 1986, Опред. высш. раст. Молд.ССР, изд. 3: 336; Цвелев, 1996, Фл. Вост. Евр. 9: 386; Бойко, 1999, Опред. высш. раст. Укр., изд. 2: 222; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 127; Negru, 2007, Determ. pl. fl. R. Moldova: 161; Ciocârlan, 2009, Fl. ilustr. a României: 453. – *E. serotinum* Stev. 1811, Mém. Acad. Sci. Pétersb. 3: 297, tab. 15, fig. 2. – **Russian stork's bill. – Priboi rusesc. – Аистник русский.**

Perennial plant. Stems 15-50 cm, usually with patent hairs. Leaves up to 8 cm long, triangular-ovate, with one pair of free pinnae at the base, the upper part pinnatifid; lobes dentate or pinnatifid. Umbels with 3-13 flowers. Bracts linear-lanceolate, hairy, brown. Sepals 10-12 mm long. Petals about 12 mm, violet. Mericarps about 8 mm, densely hairy; apical pits glandular, without a furrow at the base; beak 30-70 mm long (Fig. 4).

It is a perennial hemicriptophyte. The plants bloom in May-August and fructify in June-September. Propagate by seeds.

The plants grow in dry open habitats of steppe and calcareous slopes, shrub stands, different types of dry grasslands with disturbed vegetation. The limitation factors of the distribution in the region are: extremely small and highly fragmented populations, with a small number of specimens; reduced specific habitats; destruction of the species' growing sites as a result of recreational activities and afforestation with allochtonous species; grazing.

It is met in the south-eastern part of Dniester river basin (Shtefan-Voda district) and southern district (in the outskirts of Tatar-Bunar town, Odessa region, Ukraine). It is indicated for the region on the base of herbarium specimens, collected by T. Savulescu in 1934 and by N.M. Zelenetzkii (without the date of collection). The area of distribution includes Central and Eastern (southern part) Europe, the Caucasus (Panonian-Pontic geographical element). [6, 13]

Protection measures for the preservation of the species in the Republic of Moldova: inclusion in the list of the species protected by law; identification and protection of the new places of the species growth; the species propagation in *ex-situ* conditions and its repatriation to the natural habitats.

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FLORISTIC NOTES IN BESSARABIA No. 62-69

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Abstract: Eight rare species of the flora of the Republic of Moldova are presented in the article: Alyssum caliacrae Nyár., A. tortuosum Willd., Anthriscus caucalis M.Bieb., Bombycilaena erecta (L.) Smoljan., Filago germanica L., Valerianella brachystephana (Ten.) Bertol., V. pumila (L.) DC. and Cerastium nemorale M. Bieb., the first six are new for the flora of the republic, and the last two have been documented for the first time.

Key words: flora, rare species, Republic of Moldova.

INTRODUCTION

"Floristic Notes in Bessarabia" is a new series of articles, proposed to the botanists from our country in order to publish news in the field of floristics, devised by the author in 2015 [9, 10]. These new floristic notes prove once again the need to continue the field research. According to the latest studies, the wild flora of the Republic of Moldova comprises 1835 species of vascular plants: 1751 species and 48 varieties are native, and 83 – adventive [12].

MATERIALS AND METHODS

The field research on floristics was conducted during 2015-2016. The species are pointed out on the basis of the traditional morphological-ecological method. The herbarized plants are found in the private collection of the author (CHIS-PP) and doublets will be passed on to the Herbarium of the Botanical Garden (I) of the ASM (CHIS).

Floristic notes refer to the new, rare species or the ones found for the first time in one of the regions of the territory of Bessarabia and localities from the left side of Dniester River of the Republic of Moldova. The presence of the species is indicated by "+" and their absence by "-", the distribution is indicated by region: **BasN** – includes the localities of northern Bessarabia (Cernăuți region: Khotin, Sokyriany, Kel'menetsi, Novosulitsa p.p., Zastavna p.p. districts); **BasS** – localities of southern Bessarabia (Odessa region between Dniester and Danube); **RMN** – the North of the republic: Ocnița, Briceni, Edineț, Dondușeni, Rașcani, Drochia, Soroca, Glodeni, Fălești, Sangerei, Florești,Șoldănești, Rezina, Telenești districts, Bălți municipality; **RMC** – central part of the republic: Ungheni, Călărași, Orhei, Criuleni, Strășeni, Nisporeni, Hancești, Ialoveni, Anenii Noi, Dubăsari districts (localities from the right bank of Dniester), Chișinău municipality, Tighina municipality; **RMS** – the South of the republic: Leova, Cimișlia, Căușeni, Ștefan-Vodă, Basarabeasca, Cantemir, Cahul, Taraclia, Comrat, Vulcănești, Ceadâr-Lunga districts; **RME** – Camenca, Rabnița, Dubăsari (localities from the left bank of Dniester), Grigoriopol, Slobozia districts and Tiraspol municipality; / **RAR** – rare species, / **A** – naturalized exotic species, /**A** – occasionally cultivated exotic species.

RESULTS AND DISCUSIONS

As a result of the field research on floristics and the study of herbarium collections from the republic, 6 new species for the flora of the Republic of Moldova have been pointed out, and other 2 species, which

were previously mentioned in literature [7, 15], without being documented by herbarium specimens, have been confirmed. In the article, there are data on the morphological characteristics of the species that have been collected for the first time in the Republic of Moldova, the locations where these plants grow and their distribution are also indicated. The enumeration of the species is a continuation of the "Floristic Notes" from 2015. [10]

New taxa for the flora of the Republic of Moldova

62. *Alyssum caliacrae* Nyár. 1926 (publ. 1927), Bul. Grad. Bot. Cluj, 6: 92 (*Brassicaceae*).

Syn.: - *Alyssum caliacrae* subsp. *prodanii* Nyár. 1926, Bull. Grad. Bot. Cluj, 4:172. - *A. caliacrae* var. *prodanii* (Nyár.) Ančev, 2007, Phytol. Balcan. 13: 157. - *A. tortuosum* ssp. *caliacrae* (Nyár.) Stoj. et Stef. 1948, Fl. Bulg. ed. 3: 530. - *A. eximium* Nyár. 1926, Bul. Grad. Bot. Cluj 6: 90. - *A. obtusifolium* subsp. cordatocarpum Nyár. 1926, Bul. Grad. Bot. Cluj, 4: 172. - *A. obtusifolium* var. *cordatocarpum* (Nyár.) Ančev, 2007, Phytol. Balcan. 13: 157.

Perennial, chamephyte plants, which grow about 10-25 cm tall. The stem is branched, with a rosette of basal leaves and several sterile shoots. The leaves are concolorous (white-tomentose on both sides), oblanceolate, the stems decrease gradually towards the top; the leaves of the fertile shoots are caducous in the fruiting stage. The sepals are pubescent, a little shorter than the petals, caducous in the fruiting stage. The petals are yellow. The silicles are 3-5 mm long and 2.5-4 mm wide, with a single seed. The seeds are narrowly winged, of 0.2-0.5 mm. The plants bloom in May-June.

Habitat. Steppe, calciphile, xerophile species. Grows sporadically on skeletal, stony soils, or on Middle Sarmatian friable limestone, in the valley of Taşlâc River, on the Podolian Plateau, in phytocoenoses of the association *Silenio supinae-Pimpenellietum* tragi P.Pânzaru 1997, this species is characteristic of the vegetation of the alliance *Genisto tetragonae-Seselion peucedanifolii* P. Pânzaru 1997.

Local distribution. +RME/RAR: Grigoriopol district (commune Taşlâc).

General distribution. Eastern sub-Mediterranean species: Bulgaria, Greece, Macedonia, Serbia, Romania, Crimea. [3, 13, 17]

63. *Alyssum tortuosum* Willd. 1800, Sp. Pl. 3, 1: 466 (*Brassicaceae*).

Syn.: - *A. serpyllifolium* M.Bieb., 1808, Fl. Taur.-Caucas. 2: 103. – *A. grintescui* Nyár. 1927, publ.1928, Bul. Grad. Bot. Univ. Cluj 7: 140. - *A. transiens* Nyár. 1927, publ.1928, l.c. 7: 160. – *A. decandolleanum* Nyár. 1929, Bul. Grad. Bot. Univ. Cluj 9: 43.

Perennial, chamephyte plants, which grow about 10-20 (-35) cm tall. The stem, without rosette of basal leaves, has few sterile shoots. The leaves are bicoloured (on the upper side – greyish-green, with scattered stellate hairs; on the lower side – white-tomentose), the basal ones are spathulate or oblanceolate; the leaves of the fertile shoots are persistent in the fruiting stage. The inflorescence is a panicle. The sepals are pubescent, shorter than the petals, caducous in the fruiting stage. The petals are yellow. The silicles are more or less elliptical, asymmetrical, densely pubescent, with grey hairs, and produce a single seed. The seeds are narrowly winged, of 1.5 mm. Bloom in April-June. 2n = 32.

Habitat. Steppe, calciphile, xerophile species. Grows sporadically on slopes with Middle Sarmatian limestone from the valley of Răut River and its tributary Cerniţa, on the Dniester Plateau, in phytocoenoses of the association *Thymo moldavici-Helianthemetum cani* P.Pânzaru 1997, the species is characteristic of the vegetation of the alliance *Genisto tetragonae-Seselion peucedanifolii* P. Pânzaru 1997.

Local distribution. +RMN/RAR: Floreşti district (Bobuleşti, Cenuşa, Ţâra, Prodăneşti) and Şoldăneşti district (Rogojenii Vechi).

Note. M. Kotov [16] indicated this species for the Moldovan botanic-geographical district (which also includes the South of Bessarabia), without specifying the locations; in other papers on the local flora, it was not indicated.[7, 15]

General distribution. Sub-Mediterranean species: Central and Eastern Europe, Mediterranean region (Balkans), Caucasus, Middle Asia, Asia Minor, Iran. [3, 13, 17]

64. *Anthriscus caucalis* M.Bieb. 1808, Fl. Taur.-Caucas. 1: 230. (*Apiaceae*).

Syn.: – *A. scandicina* (Web.) Mansf. 1939, Feddes Repert. 46: 309, comb. illeg.; - *A. vulgaris* Pers. 1805, Syn. Pl.1: 320, nom. illeg.

Annual, therophyte plants, which grow 15-80 (-100) cm tall. 2-3-pinnatisect leaves, with last-order leaflets, denticulate, pubescent, petiolate. The inflorescence has 3-6 axes. The involucre is absent. There are several lanceolate involucels. The umbellules have 3-7 flowers. The peduncles are short, pubescent. The petals are white. The fruits are ovoid, 4 mm long, smooth, uniformly covered with hairs, the rostrum is glabrous, 2 mm long. Blooms in May. 2n = 14, 18.

Habitat. Synanthropic, arenicole, xeromesophile-mesophile species. It is found in groups, on sandy soils, in thickets of *Elaeagnus angustifolia* L., on roadsides, grows in the presence of bushes or trees, characteristic for the vegetation of the alliance *Sisymbrion officinalis* Tüxen, Lohmeyer et Preising ex von Rochow 1951.

Local distribution. +RMS/RAR: in the districts Cahul (Alexandru Ioan Cuza) and Vulcăneşti (Etulia).

General distribution. Eurasian species: Atlantic, Central and Eastern Europe, Caucasus, Balkans, South-Western Asia, exotic species in North America, New Zeeland. [1, 3, 13, 14]

65. *Bombycilaena erecta* (L.) Smoljan. 1955, in Bot. Mater. Gerb. Bot. Inst. Komarova Akad. Nauk SSSR 17: 450 (*Asteraceae*).

Basio.: - *Micropus erectus* L. 1753, Sp.Pl. 2, nom. cons. prop.

Annual, therophyte plants, which grow about 5-20 cm tall, woolly-tomentose. The stems are usually branched. The leaves are oblong-spathulate, about 20 mm long and 1.4-5 mm wide, their margin is undulate. The anthodia are small, 2 mm in diameter, with biseriate involucre, grouped in sessile glomerules, of 8-10 mm in diameter, obviously shorter than the leaves, terminal or axillary. The flowers are tubular, white, the central ones – hermaphrodite, sterile, and the external ones – female, fertile. The fruits are obovate, glabrous achenes, without pappus. Blooms in June-July.

Habitat. Steppe, xerophile species. The plants grow on hills with sandy and sandy-loam soils, in phytocenoses with *Bothriochloa ischaemum* (L.) Keng and *Scabiosa argentea* L., the species is characteristic of the vegetation of the alliance *Festucion vaginatae* Soó 1938.

Local distribution. +RMS/RAR: districts Cahul (Alexandru Ioan Cuza) and Vulcăneşti (Etulia).

General distribution. Sub-Mediterranean species: Central Europe, South-West Asia, Iran, Caucasus. [1, 3, 13, 18]

66. *Filago germanica* L. 1763, Sp. Pl.2: 1311, non Huds. 1762, Fl. Angl. :328. (*Asteraceae*).

Annual, therophyte plants, which grow about 5-35 cm tall, ashy-white, with erect stems, dichotomically branched. The leaves are linear-lanceolate, 1.5-2.5 cm long and 1-3 mm wide, often with undulate margin. The anthodia are grouped by 20-35 in a glomerule, without leaves at the base. The external bracts are lanceolate, with straight awn on tip, maculate at the base; the internal ones are linear, yellowish and membranous at the margin. Blooms in July-August. 2n = 28.

Habitat. Steppe, arenicole, xerophile species. It grows on hills with sandy and sandy-loam soils, in phytocenoses with *Bothriochloa ischaemum* (L.) Keng and *Scabiosa argentea* L., the species is characteristic of the vegetation of the alliance *Festucion vaginatae* Soó 1938.

Local distribution. +RMS/RAR: it has been found in the districts Cahul (Alexandru Ioan Cuza) and Vulcăneşti (Etulia).

Note. This species was indicated by L. Krupkina [13], for the Moldovan botanic-geographical district, which included the administrative district Izmail, from the South of Bessarabia, without specifying the locations, and in the previous publications on the flora of the Republic of Moldova, it was not cited. [4, 10]

General distribution. Sub-Mediterranean species: Europe, Caucasus, Asia Minor, Iran. [1, 3, 13, 18]

67. *Valerianella brachystephana* (Ten.) Bertol. 1833, Fl. Ital. 1: 193 (*Caprifoliaceae*).

Basio.: *Fedia brachystephana* Ten. 1830, Succ. Rel. Viagg. Abruzzo: 43.

Syn.:- *Valerianella pumila* ssp. *brachystephana* (Ten.) Ciocârlan, 1992, Fl. ilustr. a României: 125. – *V. pumila* (L.) DC. ssp. *brachystephana* (Ten.) Ciocârlan: Sârbu & al. 2013, Pl. Vasc. România: 590.

Annual, therophyte plants, which grow about 10-25 cm tall. The stem is pubescent in the lower part, dichotomically branched. The leaves are narrow-linear, acute. The inflorescences are semi-umbellate. The calix is campanulate, reticulate, with triangular teeth, sometimes irregularly campanulate. The fruits are glabrous, with sterile locules larger than the fertile one, with a furrow between the sterile locules. Blooms in April.

Habitat. Steppe, calcephile, xerophile plant. It grows on limestone slopes with skeletal, stony soils, from the right bank of Dniester River, in herbaceous phytocoenoses of the association *Genisto tetragonae-Seselion peucedanifolii* P. Pânzaru 1997.

Local distribution. +RMC/RAR: Dubăsari district (between the communes Malovata and Marcăuți)

General distribution. Sub-Mediterranean species: Mediterranean region (Italia), Central Europe (Romania), Crimea. [3, 6, 13, 19]

Confirmed species

68. *Cerastium nemorale* M.Bieb. 1819, Fl. Taur.-Caucas. 3: 317 (*Caryophyllaceae*)

Annual, therophyte plants, which grow 10-35 cm tall, pubescent, with ascending or erect stem, dichotomically branched. The basal leaves are ovate-spathulate, small, those from the stem are larger, 2-7 cm long and 0.3-2.5 cm wide, lanceolate, acute. The inflorescence is a dichasium, dichotomically branched; the peduncles are 2-4 times longer than the calyx. The calyx is 6-10 mm long; the sepals are lanceolate, acute and pubescent. The petals are white, deeply divided, ± as long as the calix, with ciliate claw. The stamens with hairy filaments. The capsule is twice as long as the calix, more or less bent, the teeth – deflexed. The seeds are 0.7 mm long, reddish brown, densely tuberculate. Blooms in May-June.

Habitat. Synanthropic, mesophile species. It grows in fields with *Medicago sativa* L., is characteristic of the vegetation of the class *Stellarietea mediae* R.Tx., Lohmeyer et Preising in R. Tx. 1950.

Local distribution. +RMC/RAR: mun. Chișinău (Ghidighici), this is the first confirmation and the species has been found at the western border of the habitat.

Note. The presence of this species in the flora of the Republic of Moldova was mentioned before [7, 15], but there were no exsiccatae in the herbaria from our country.

General distribution. The species is native to Caucasus, but has also been found in the South of Ukraine and Russia [20]; in the flora of the Republic of Moldova, it is probably adventive.

69. *Valerianella pumila* (L.) DC. 1815, Fl. Franç. ed. 3, 5: 494 (*Caprifoliaceae*).
Basio.: *Valeriana locusta* L. η *pumila* L. 1767, Syst. Nat., ed. 12, 2: 73.

Syn.: V*alerianella tridentata* (Steven) Krok, 1864, Vet. Akad. Handl. Stokh. 5, 1: 73

Annual, therophyte plants, which grow about 10-40 cm tall, with dichotomically branched stem, pubescent on the lower part. The leaves are 2.5-5 cm long and 0.5-1.0 cm wide: the lower leaves are oblong-spathulate, entire, and the rest – lanceolate to linear, at the base – with 1-3 teeth or lacinia, the margin is ciliate. The inflorescences are semi-umbellate. The bracts are flat ovate, acute, with ciliate margin. The calyx is reduced to an unevenly toothed margin. The corolla is pink. The fruits are almost round, 3 mm, with large, swollen sterile locules, longer than the fertile locule, glabrous or with caducous hairs. Blooms in May-June. 2n = 14.

Habitat. Steppe, xeromesophile plant. Grows in groups, on hills with steppe vegetation.

Local distribution. +RMC/RAR: Anenii Noi district (Speia).

Note. It was indicated for the flora of the Republic of Moldova [5, 11], but there was no specimen in the collections of the herbaria from the country. This species was collected by C. Zahariadi in the South of Bessarabia (Bolgrad, 28 V 1929; Burnas, 22 V 1931; Curchi x Impuțita, 14 V 1933), [CHIS].

General distribution. Mediterranean species: Mediterranean region, Central Europe, Crimea, Caucasus, Middle and South-West Asia, Iran. [1, 3, 13, 19]

Note: In Journal of Botany, No 1(12), 2016, the presence of the species *Fritillaria meleagroides* Patrin ex Schult. et Schult. f., in the Natural Landscape Făurești-Goian [2] and in the Forestry Reserve "Voinova" [5], was indicated mistakenly. The indicated plants actually belong to the species *Fritillaria montana* Hoppe. Unfortunately, the author E. Chiriac [2] did not inform me about the content of the article (of which I am co-author) before publishing it, making reference to an older article, published in 2002 [8], when, in the republic, the plants of the genus *Fritillaria* L. were determined (wrongly) only as *F. meleagroides.* In more recent papers, the plants of the genus *Fritillaria* L. were attributed to two species *F. montana* Hoppe and *F. ruthenica* Wikstr. [4, 11, 12], but the presence of *F. meleagroides* in the territory of the Republic of Moldova still has not been recorded.

CONCLUSIONS

The newly recorded species of the flora of the Republic of Moldova are rare and are recommended to be included in the List of Species Protected by the State, at the indicated categories: *Alyssum caliacrae* Nyár. (Endangered – EN), *Alyssum tortuosum* Willd. (Vulnerable – VU), *Anthriscus caucalis* M. Bieb. (Vulnerable – VU), *Bombycilaena erecta* (L.) Smoljan. (Vulnerable – VU), *Filago germanica* L. (Vulnerable – VU), *Valerianella brachystephana* (Ten.) Bertol. (Endangered – EN), *Valerianella pumila* (L.) DC. (Vulnerable – VU), *Cerastium nemorale* M.Bieb (Vulnerable – VU).

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ANALYSIS OF THE PHENOLOGICAL SPECTRUM OF REPRESENTATIVES OF *HAWORTHIA* DUVAL IN THE GREENHOUSE COLLECTION OF BOTANICAL GARDEN (INSTITUTE) OF THE ACADEMY OF SCIENCES OF MOLDOVA

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Keywords: *Haworthia* Duval, acclimatization, phenological observations

INTRODUCTION

The introduction of the indoor plants of the genus *Haworthia* Duval in the Republic of Moldova started 1970s. According to Dvoryaninova, Sestak (1985), in the 70s, the famous collection consisted of eight species and grew up to 16 species in mid 80s. Currently, there are 31 taxa in the collection. The collection increased mainly due to the receipt of live material from various botanical gardens of the former USSR. The success of the introduction of plants was generally determined by evaluating their ability to produce flowers and fruits in a new environment. And as fruiting is often linked to specific pollinators of plants, the main criteria is the stable, in other words, regular, at the same time observed, bloom.

MATERIALS AND METHODS

The objects of our study were the species of the genus *Haworthia* Duval available in the greenhouse collections of the Botanical Garden (I) of the Academy of Sciences of Moldova. Currently, the genus *Haworthia* is represented, in the greenhouse collections, by 31 species samples and four hybrids. To assess the success of acclimatization, phenological observations were performed on the tested collectible plants for five years. The phenological observation technique is used as follows: the generative phase of plant development was observed every 10 days throughout the year: 1st, 10th and 20th of each month. We studied the following steps of generative development phases: the emergence of a visible bud, the growth of inflorescences, the development of colored buds, opening of the first flower, mass flowering and end of flowering.

RESULTS AND DISCUSSIONS

The study yielded the following data: From the 31 studied species there are two species that do not bloom: *H. mirabili*s Haw, *H. retusa* (L) Haw. Irregular blooming, i.e. plants do not produce flowers every year, was observed at 7 species: *H. herrei* v. *Poelln, H. lepida* GG Smith, *H. mucronata* Haw., *H. nitidula* v. *Poelln*, *H. radula* (Jacq.) Haw., *H. rigida* (Lam.) Haw., *H. ryderiana* v. *Poelln*. Regular and sustained flowering (in the same time frame) was observed at 14 species: *H. angustifolia* Haw., *H. angustifolia* Haw. v. *liliputana*, *H. aristata* Haw., *H. cassuta* Bak., *H. coarctata* (Salm.) Haw., *H. cymbiformis* (Haw.) Duv., *H. glauca* Bak., *H. limifolia* Marl., *H. margaritifera* (L.) Haw., *H. palida* Haw., *H. obtusa* Haw., *H. planifolia* Haw., *H. rigida* Haw. v. *rigida, H. tessellata* (Salm) Haw. The results are shown in the Table №1.

Phenological Spectrum of *Haworthia* Duval

No.	Species	Year	Month											
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1	*Haworthia angustifolia* Haw.	2011						■	■	■	■	■	■	■
		2012							■					
		2013						■						
		2014						■	■	■				
		2015							■	■				
2	*Haworthia angustifolia* var. liliputana Uitew.	2011						■	■					
		2012				■	■	■	■	■				
		2013						■	■					
		2014						■	■					
		2015							■	■				
3	*Haworthia aristata* Haw.	2011	■											■
		2012	■				■	■	■	■	■	■	■	
		2013						■	■	■	■	■	■	■
		2014	■	■	■	■	■	■	■	■	■		■	
		2015	■	■										
4	*Haworthia cassuta* Bak.	2011						■	■	■	■	■	■	■
		2012					■	■	■	■	■	■	■	
		2013					■	■						
		2014				■	■	■	■	■	■			
		2015					■	■	■	■	■	■		
5	*Haworthia coarctata* (Salm) Haw.	2011						■	■	■	■	■	■	
		2012				■	■	■	■	■	■			
		2013					■	■	■	■	■	■	■	
		2014				■	■	■	■	■	■			
		2015					■	■	■	■	■	■	■	
6	*Haworthia cymbiformis* (Haw.) Duv.	2011		■	■	■	■							
		2012			■	■	■							
		2013	■	■	■	■								
		2014	■	■	■									
		2015		■	■		■							
7	*Haworthia fasciata* (Willd.) Haw.	2011	■	■	■	■	■	■	■	■				
		2012					■	■	■	■	■			
		2013				■	■	■	■	■	■	■	■	
		2014				■	■	■	■	■				
		2015			■	■	■	■	■	■	■	■		

8	*Haworthia glabrata* (Salm) Bak.	2011	■	■	■	□	□	□	□	□	□	□	□	■
		2012	■	■	■	■	■	■	■	□	□	□	□	□	□
		2013	□	□	□	□	■	■	■	□	□	□	□	□	□
		2014	□	□	□	□	■	■	■	■	■	□	□	□	□
		2015	□	□	■	■	■	■	■	□	□	□	□	□	□
9	*Haworthia glauca* Bak.	2011	□	□	□	□	□	□	□	■	■	■	■	□	□
		2012	□	□	□	□	□	□	■	■	■	■	■	■	■
		2013	□	□	□	□	□	■	■	■	■	■	■	■	□
		2014	□	□	□	□	□	□	■	■	■	■	■	■	□
		2015	□	□	□	□	■	■	■	■	■	■	■	□	□
10	*Haworthia herrei* V.Poelln	2011	□	□	□	□	□	□	■	■	■	□	□	□	□
		2012	□	□	□	□	□	□	□	□	□	□	□	□	□
		2013	□	□	□	□	□	■	■	■	□	□	□	□	□
		2014	□	□	□	□	■	■	■	■	■	■	□	□	□
		2015	□	□	□	□	■	■	■	■	■	■	□	□	□
11	*Haworthia limifolia* Marl.	2011	□	□	□	□	□	■	■	■	■	□	□	□	□
		2012	□	□	□	□	■	■	■	□	□	□	□	□	□
		2013	□	□	□	□	■	■	■	□	□	□	□	□	□
		2014	□	□	□	■	■	■	■	■	■	■	□	□	□
		2015	□	□	□	□	■	■	■	■	■	□	□	□	□
12	*Haworthia lepida* G.G.Smith	2011	■	□	□	□	■	■	■	■	■	■	□	□	□
		2012	□	□	■	■	■	■	■	■	□	□	□	□	□
		2013	□	□	■	■	■	■	□	□	□	□	□	□	□
		2014	□	□	□	□	■	■	■	□	□	□	□	□	□
		2015	□	□	□	□	□	□	□	□	□	□	□	□	□
13	*Haworthia margaritifera* (L)Haw.	2011	□	□	■	■	■	■	■	■	□	□	□	□	□
		2012	□	□	□	■	■	■	■	□	□	□	□	□	□
		2013	□	□	■	■	■	■	□	□	□	□	□	□	□
		2014	□	□	□	■	■	■	■	■	■	□	□	□	□
		2015	□	□	□	□	■	■	■	□	□	□	□	□	□
14	*Haworthia mucronata* Haw.	2011	■	■	■	■	□	■	□	□	□	■	■	■	■
		2012	■	□	□	□	□	□	■	■	■	■	□	□	□
		2013	■	■	■	■	□	□	■	■	■	■	■	■	■
		2014	■	□	□	□	□	□	□	□	■	■	□	□	□
		2015	□	□	□	□	□	□	□	□	□	□	□	□	□
15	*Haworthia mirabilis* Haw.	2011	□	□	□	□	□	□	□	□	□	□	□	□	□
		2012	□	□	□	□	□	□	□	□	□	□	□	□	□
		2013	□	□	□	□	□	□	□	□	□	□	□	□	□
		2014	□	□	□	□	□	□	□	□	□	□	□	□	□
		2015	□	□	□	□	□	□	□	□	□	□	□	□	□

16	*Haworthia nitidula* v. Poelln	2011								■	■	■			
		2012							■	■	■	■			
		2013								■					
		2014	■												
		2015								■	■	■			
17	*Haworthia obtusa* Haw.	2011	■	■	■	■	■	■	■						
		2012	■	■	■	■	■					■	■	■	■
		2013		■	■	■	■								■
		2014	■	■	■	■									
		2015	■	■	■	■	■	■	■						
18	*Haworthia obtusa* Haw. Variegata	2011	■	■	■	■	■	■	■						
		2012	■	■	■	■	■								
		2013		■	■	■	■								
		2014	■	■	■										
		2015	■	■	■	■	■	■	■						
19	*Haworthia palida* Haw.	2011				■	■	■	■	■	■	■			
		2012					■	■	■	■	■	■			
		2013					■	■	■	■	■	■	■	■	
		2014				■	■	■	■						
		2015					■	■	■			■	■		
20	*Haworthia planifolia* Haw.	2011						■	■						
		2012		■	■	■	■	■	■	■	■				
		2013					■								
		2014				■	■								
		2015						■							
21	*Haworthia radula* (Jacq.) Haw.	2011							■						
		2012					■								
		2013													
		2014													
		2015													
22	*Haworthia rigida* (Lam.) Haw.	2011													
		2012													
		2013					■								
		2014													
		2015				■	■	■	■	■	■				
23	*Haworthia rigida* (Lam.) Haw. Var. rigida	2011						■	■	■	■	■	■		
		2012					■	■	■	■	■	■	■	■	
		2013					■	■	■	■	■	■	■		
		2014					■	■	■	■	■	■	■	■	
		2015				■	■	■	■	■	■	■	■	■	

24	*Haworthia reinwardtii* (S.D.) Haw.	2011						■	■	■	■	■	■	■
		2012				■	■	■	■	■	■	■		
		2013								■	■	■	■	■
		2014	■			■		■	■	■	■	■	■	
		2015												
25	*Haworthia retusa* (L.) Haw.	2011												
		2012												
		2013												
		2014												
		2015												
26	*Haworthia ryderiana* v. Poelln	2011												
		2012			■									■
		2013	■	■	■									
		2014	■	■	■									
		2015	■	■	■									
27	*Haworthia tessellata* (Salm) Haw.	2011						■	■	■	■	■	■	
		2012					■	■	■	■	■			
		2013					■	■	■	■	■	■	■	
		2014				■	■	■	■	■	■	■	■	
		2015			■	■	■	■	■	■	■	■	■	
28	*Haworthia tortuosa* Haw.	2011	■	■	■	■	■	■	■					
		2012		■	■	■	■	■						
		2013				■	■							
		2014				■	■	■	■	■	■	■		
		2015		■	■	■	■	■	■	■	■			
29	*Haworthia tuberculata* v. Poelln	2011					■	■	■	■	■	■		
		2012					■	■	■	■				
		2013					■	■	■	■	■	■	■	■
		2014	■	■			■	■	■	■	■			
		2015					■	■	■	■				
30	*Haworthia vitata* Bak.	2011	■	■	■	■	■				■	■	■	■
		2012	■	■	■			■			■	■	■	■
		2013	■	■	■								■	■
		2014	■	■				■	■				■	■
		2015	■	■		■		■				■	■	

CONCLUSIONS

The studied *Haworthia* species showed the most stable and regular flowering (*H. angustifolia* Haw., *H. angustifolia* Haw. v. *liliputana*, *H. aristata* Haw., *H. cassuta* Bak., *H. coarctata* (Salm.) Haw., *H. cymbiformis* (Haw.) Duv., *H. glauca* Bak., *H. limifolia* Marl., *H. margaritifera* (L.) Haw., *H. palida* Haw., *H. obtusa* Haw., *H. planifolia* Haw., *H. rigida* Haw. v. *rigida, H. tessellata* (Salm) Haw.), they can be considered the most adapted to the conditions maintained in the greenhouse collection of the Botanical Garden (I) of the Academy of Sciences of Moldova.

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CONTRIBUȚII LA STUDIUL GENULUI *ROSA* L. (*ROSACEAE* ADANS.) DIN FLORA BASARABIEI

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Abstract: The paper contains results on critical study in genus *Rosa* L. (*Rosaceae*) for the flora of Bessarabia. The genus is represented by 19 species included in three sections: *Caninae* DC., *Rosa*, *Pimpinellifoliae* DC. Biological, ecological and environmental peculiarities of the studied taxa have been highlighted; synonymy and the key to the identification of the species have been prepared. Also, the list of rare rose species has been drawn up, new locations where endangered species grow have been found and chorological data on species previously considered rare have been confirmed and updated.
Three of the indicated species (*R. pygmaea* Bieb., *R. tschatyrdagi* Chrshan., and *R. turcica* Rouy) are new for the list of Bessarabia's flora, seven – are rare and *R. frutetorum* Bess. and *R. pygmaea* Bieb. are included in the Red Book of the Republic of Moldova, 3rd edition.
Key words: *Rosa, Rosaceae,* flora, habitat, taxonomy, bioecology, chorology, Bessarabia.

INTRODUCERE

Speciile genului *Rosa* L. (Măceș) au atras atenția selecționerilor, botaniștilor taxonomiști și sistematicienilor de-a lungul multor secole, din antichitatea clasică până în prezent.

Primele date privind speciile de măceș spontane pentru teritoriul Basarabiei le semnalăm încă de la sfârșitul sec. XIX, începutul sec. XX în lucrările botaniștilor Lipski [19], Zeleneţki [20] și Okinșevici [18].

Mai târziu, în perioada interbelică, botaniștii Tr. Săvulescu și T. Rayss în lucrarea „Materiale pentru flora Basarabiei" au reușit să înregistreze și să descrie 12 specii spontane de măceș [7].

Un studiu amplu și complex cu cercetări intensive de teren, prelucrări critice ale materialelor anterior colectate a fost inițiat de către V. Chrshanovski pentru partea europeană a URSS, incluzând și teritoriul dintre Prut și Nistru. Astfel, au fost obținute date noi esențiale privitor la particularitățile ecologice și corologice ale speciilor de măceș din limitele spațiului basarabean. Aceste rezultate au fost publicate în monografia"Rozy" [17], unde sunt descrise 23 specii spontane pentru acest teritoriu, care ulterior au fost publicate integral în monografia profesorului V. Andreev „Derevi'a i kustarniki Moldavii" [12].

Mai târziu T. Ghejdeman, în lucrarea „Opredelitel' vâsșih rastenii Moldavscoi SSR" [15, 16] indică 22 specii spontane de măceș, iar acadimicianul A. Negru în „Determinator de plante din flora spontană a Republicii Moldova" prezintă 19 specii [5].

Investigații critice ulterioare asupra genului *Rosa* au fost efectuate de Buzunova O. [13] pentru „Flora Vostocinoi Evropî" în care menționează 20 de specii pentru flora spațiului dintre Prut și Nistru, dintre care șapte (*R. sherardii* Davies, R. *caesia* Smith, *R. subcanina* Dalla Torre, *R. solstitialis* Bess., *R. turcica* Rouy, *R. pygmaea* Bieb și *R tschatyrdagi* Chrschan.) sunt indicate pentru prima dată, iar prezența ultimilor trei taxoni, a fost confirmată în rezultatul cercetărilor de teren și sunt aduse ca specii noi pentru lista florei locale.

Așadar, acumularea de date noi și divergența de opinii privind interpretarea valorii taxonilor și conceptul speciei, impune necesitatea unei revizuiri critice a colecțiilor herbarizate și a unei ample analize a tuturor datelor acumulate în teren, privitor la genul *Rosa* L.

MATERIALE ȘI METODE

Pentru efectuarea cercetărilor complexe asupra speciilor genului *Rosa* ne-au servit colecțiile din Herbarul Grădinii Botanice (I) a AȘM, Herbarul Muzeului Științelor Naturii a USM, Herbarul Muzeului Național de Etnografie și Istorie Naturală și colectările proprii efectuate în cadrul cercetărilor de teren, conform metodei

de itinerar, pe parcursul anilor 2007-2015. Analiza critică a taxonilor specifici și identificarea lor a fost realizată conform metodei clasice comparativ-morfologice [14]. Elementele geografice și formele vitale au fost preluate din lucrările fundamentale de domeniu cu precizările de rigoare [6]. Nomenclatura și consecutivitatea aranjării taxonilor în cadrul genului a fost expusă conform lucrărilor floristice de specialitate [4, 13].

REZULTATE ȘI DISCUȚII

În flora spontană a Terrei genul *Rosa* L. este reprezentat de 300-500 specii răspândite exclusiv în limitele Emisferei de Nord [13]. Reprezentanții genului sunt frecvent întâlniți în comunitățile vegetale ale tuturor ecosistemelor terestre, fiind elemente constitutive a fitocenozelor forestiere, pietrofite, stepice. În tufărișurile pe care le formează, își găsesc adăpost și hrană, numeroase specii de viețuitoare. Unele specii ale genului devin chiar invazive, iar altele ocupă habitatele degradate de pe urma presingului antropogen puternic. Partea cărnoasă a hipantiilor este bogată în vitamine (vitamina C, B_1, B_2, P, K ș.a.), diferite substanțe zaharoase, acizi organici ș.a. fiind folosite pe larg în medicina alternativă. Indiscutabil este aportul genului *Rosa* în horticultură, unde prin selecție s-au realizat numeroase forme și varietăți apreciate și în industria uleiurilor eterice.

Ca rezultat al analizei profunde a literaturii, prelucrării critice a materialului botanic colectat de pe întreg teritoriul spațiului floristic basarabean păstrat în Herbarele indicate (cca 700 exsicate) și a materialului propriu (cca 300 exs.), a fost evidențiată structura și componența taxonomică a genului *Rosa* L. care enumără 19 specii incluse în 3 secții: *Caninae* DC., *Rosa* și *Pimpinellifoliae* DC.

Au fost evidențiate particularitățile biologice, ecologice și corologice ale taxonilor în studiu, întocmită sinonimia și cheia pentru determinarea speciilor. Cheia a fost elaborată în baza criteriilor morfologice distinctive, în special: mărimea tufei, poziția ramurilor, forma ghimpilor pe ramurile tinere (turioni), abundența ghimpilor aciformi pe ramurile florifere (mai ales pe pedicelii florali), caracterul inciziilor marginii limbului foliar, poziția sepalelor la fructele în coacere (la fructele coapte sepalele deseori cad) ș. a.

În cadrul studiului a fost elaborată lista speciilor rare de măceș, evidențiate 3 specii noi pentru flora Basarabiei (*R. pygmaea* Bieb., *R. tschatyrdagi* Chrshan., *R. turcica* Rouy), depistate locuri noi de creștere a unor specii periclitate. De asemeni, au fost confirmate și actualizate datele corologice ale unor specii anterior considerate rare.

Genul ***Rosa*** L. – *Măceș*
1753, Sp. Pl. : 491; id 1754, Gen. Pl., ed. 5: 217

Arbuşti cu tulpini erecte, curbate, repente sau agățătoare, de obicei cu ghimpi de diferite forme și dimensiuni. Frunze imparipenat-compuse, dispuse altern, caduce sau sempervirescente, la bază cu stipele concrescute cu pețiolul ghimpos. Flori bisexuate, actinomorfe, de tipul 5, cu stamine și carpele numeroase, solitare, sau grupate în inflorescențe corimbiforme. Receptacul globulos sau elipsoidal în partea superioară cu un orificiu îngust, înconjurat de un disc inelar. Sepale (4) 5, foliacee, întregi sau fidate, persistente sau caduce la maturizarea fructelor. Petale albe, rozee sau roșii. Stile libere sau concrescute, glabre sau păroase. Fruct – măceașă, constituită din numeroase nucule păroase, închise în hipantiu roșu, cărămiziu sau negricios.

Determinarea speciilor

1a. Arbuşti de obicei înalți de 1-3 (5) m ..... 2.

1b. Arbuşti de talie joasă, de 0,3-0,6 (0,8) m înălțime ..... 16.

2a. Frunze cu foliole pe ambele părți sau numai abaxial evident glanduloase ..... 3.

2b. Frunze cu foliole pe ambele părți lipsite de glande, uneori doar în lungul rahisului şi nervurii mediane abaxial prezintă peri glandulari rari ..... 10.

3a. Foliole pe ambele fețe catifelat tomentoase; abaxial şi cu peri glandulari ..... 4.

3b. Foliole glabre sau glabrescente, glanduloase, niciodată tomentoase ..... 6.

4a. Stile glabre sau dispers păroase, exserte din receptacul, împreună cu stigmatele de tipul unui racem; sepale reflecte, caduce până la coacerea fructelor ..... **9. *R. tomentosa.***

4b. Stile dens păroase, neevident exserte din receptacul, împreună cu stigmatele formează un capitul globulos; sepale după înflorire erecte sau patente, persistente ..... 5.

5a. Sepale după înflorire patente, frunze de 6-8 cm lungime, foliole de la îngust-eliptice până la eliptice, cu margini compus-serate; pediceli mai lungi decât receptaculul fructifer ..... **10. *R. andrzejowskii.***

5b. Sepale după înflorire erecte, frunze de 10-12 cm lungime, foliole lat-eliptice, biserate; pediceli aproape de lungimea receptaculului fructifer ..... **8. *R. villosa.***

6a. Stile glabre sau glabrescente, alungite, evident exserte din receptacul, împreună cu stigmatele de tipul unui racem; sepale după înflorire reflecte şi caduce. Foliole lat-eliptice până la subrotunde, de 0,7-1,5 (2) cm, vârf rotundjit sau acut ..... 7.

6b. Stile dens păroase, scurte, neevident exserte din receptacul, împreună cu stigmatele formează un capitul globulos; sepale erecte, parțial persistente după înflorire. Foliole subrotunde până la eliptice ..... 9.

7a. Tulpină cu spini conformi ..... **15. *R. balsamica.***

7b. Tulpină cu spini de diferite forme, unii mari arcuiți, alții aciculari şi cu numeroase sete glanduloase ..... 8.

8a. Ghimpi aciformi pe toată lungimea ramurilor florifere. Pediceli egali sau mai scurți decât fructul. Arbust foarte ramificat, de (0,8) 1-1,2 m înălțime ..... **11. *R. turcica.***

8b. Ghimpi aciformi numai în partea superioară a ramurilor florifere, imediat sub pedicel, în rest mari şi curbați. Pediceli egali sau mai lungi decât fructul. Arbust de 1,7-2 m înălțime .....**13. *R. micrantha.***

9a. Pedunculi dens glandulos-setoşi. Foliole ovate până la subrotunde, cu baza rotunjită, pe margini dublu serate, abaxial cu glande roşcate ..... **12. *R. rubiginosa.***

9b. Pedunculi glabri sau glabrescenți. Foliole eliptice, cu baza cuneată şi întreagă, spre vârf dințate .... **14. *R. inodora.***

10a. Foliole glabre, rareori cu perişori disperşi de-a lungul nervurii ..... 11.

10b. Foliole de ambele părți pubescente sau numai abaxial cu perişori simpli din abundență .... 13.

11a. Marginea foliolelor simplu serate sau neregulat dublu serate, de obicei, dinții foliolelor și rahisul frunzelor fără glande. Pediceli glabri. Sepale după înflorire reflecte, alipite de hipantiu .... **1. *R. canina.***

11b. Marginea foliolelor dublu sau compus dințată, dinții foliolelor cu glande ..... 12.

12a. Pedunculi, de regulă, mai lungi decât fructul, glandulos-setoși. Sepale după înflorire patente caduce până la coacerea fructelor ..... **2. *R. andegavensis.***

12b. Pedunculi, de regulă, de lungimea fructului sau mai scurți, glabri. Sepale după înflorire erecte până la patente, persistente ..... **4. *R. subafseliana.***

13a. Foliole cu marginea dublu dințată, unii dinți pot fi simpli sau glanduloși. Pedunculi, hipantiu și sepale dens glandulos-setoase. Sepale după înflorire orizontale, uneori oblice, către maturizarea fructelor caduce ..... **6. *R. schmalhauseniana.***

13b. Foliole cu marginea simplu sau neregulat dințată. Pedunculi glabri sau setos-glanduloși ..... 14.

14a. Pedunculi setos-glanduloși. Foliole (5)7, lat-eliptice, acuminate. Sepale după înflorire reflecte .... **7. *R. ciesielskii.***

14b. Pedunculi florali glabri ..... 15.

15a. Sepale după înflorire erecte sau patent-erecte, persistente. Foliole 5, îngust eliptice .... **5. *R. frutetorum.***

15b. Sepale după înflorire reflecte, alipite de hipantiu, de curând caduce, rareori se păstrează până la maturizarea fructului. Foliole de la ovate până la eliptice ..... **3. *R. corymbifera.***

16a. Sepale nedivizate. Flori solitare, crem. Hipantiu globulos, negricios ..... 17.

16b. Sepale externe evident penat-divizate ..... 18.

17a. Foliole pe ambele fețe glabre, cu margini simplu dințate ..... **18. *R. pimpinellifolia.***

17b. Foliole adaxial glabre, abaxial, cel puțin pe nervura principală, cu peri glandulari, dublu sau compus dințate, dinții foliolelor glanduloși ..... **19. *R. tschatyrdagi.***

18a. Tulpini cu ghimpi inegali, și sete glandulifere. Frunze de 12-13 cm lungime, cu 3 (5) foliole coriacei, lat-eliptice până la subrotunde, crenate. Flori roz-intens, de regulă solitare, de 6-8 cm în diametru ..... **16. *R. gallica.***

18b. Tulpini cu ghimpi conformi. Frunze de 5-6 cm lungime, cu 5-7 foliole, ovate până la eliptice, acuminate, dublu dințate. Flori roșiatice, de 4-5 cm în diametru ..... **17. *R. pygmaea.***

Secția 1. ***Caninae*** DC. 1818, in Ser., Mus. Helv. 1: 3
T y p u s: ***R. canina*** L.

1. ***R. canina*** L. 1753, Sp. Pl.: 491; Юзепчук, 1941, Фл. СССР, 10: 502, p. p.; Хржановский, 1958, Розы: 177, p. p.; Klášterský, 1968, Fl. Europ. 2: 29, p. p.; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 284; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 175; Бузунова, 2001, Фл. Вост. Евр. 10: 347; Negru, 2007, Determ. pl. fl. R. Moldova: 127; Ciocârlan, 2009, Fl. ilustr. a României: 335. – *R. prutensis* Chrshan. 1954, Фл.

УРСР, 6: 580, 220; Хржановский, 1958, Розы: 213; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 286; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 175; Negru, 2007, Determ. pl. fl. R. Moldova: 127. – *M. canin.*

Bioecologia. Arbust, specie xeromezofilă, stepică, element european-mediteranean. Înfloreşte în mai-iunie, fructifică în august-septembrie. **Staţiunea.** Vegetează în diverse tipuri de păduri, în preajma poienelor, în rarişti şi liziere, pe pante înţelenite, stâncării, pe marginea drumurilor. **Răspândirea locală.** Specie comună pe întreg teritoriul Basarabiei. **Răspândirea generală.** Eurasia, Africa de Nord.

Specie polimorfă în limitele căreia pot fi diferenţiate câteva varietăţi în dependenţă de forma spinilor, forma şi inciziile limbului foliar, forma receptaculului. Această specie este tratată de noi în *sensu lato (R canina* L. s. l.) şi este cea mai răspândită specie din secţia dată.

Specie ce poate pune eficient în valoare terenurile degradate. Alimentară, meliferă, medicinală, decorativă [12].

2. ***R. andegavensis*** Bast. 1809, Ess. Fl. Maine Loire: 189; Klášterský, 1968, Fl. Europ. 2: 29; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 175; Бузунова, 2001, Фл. Вост. Евр. 10: 347; Negru, 2007, Determ. pl. fl. R. Moldova: 127. – *R. litvinovii* Chrshan. 1950, Визн. росл. УРСР: 154, nom. invalid., descr. ucrain.; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 286. – *R. litvinovii* var. *slobodianii* Chrshan. 1954, Фл. УРСР, 6: 580, nom. invalid. – *R. slobodianii* (Chrshan.) Dubovic, 1977, Визн. росл. Укр. Карпат: 169, comb. invalid. – *M. andegavean.*

Bioecologia. Arbust, specie xeromezofilă, stepică, element pontico-mediteranean, Înfloreşte în mai-iunie, fructifică în septembrie. **Staţiunea.** Vegetează prin poieni şi margini de pădure, pante stepice, stâncării. **Răspândirea locală.** Sporadic pe întreg teritoriul „Florei". **Răspândirea generală.** Europa de Sud-Est, regiunea mediteraneeană, Caucaz.

Speci indicată pentru consolidarea pantelor degradate. Alimentară, meliferă, medicinală, decorativă.

3. ***R. corymbifera*** Borkh. 1790, Vers. Forstbot. Beschr.: 319; Хржановский, 1958, Розы: 184, p. p.; Klášterský, 1968, Fl. Europ. 2: 30; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 284; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 176; Бузунова, 2001, Фл. Вост. Евр. 10: 347; Negru, 2007, Determ. pl. fl. R. Moldova: 127; Ciocârlan, 2009, Fl. ilustr. a României: 338. – *R. dumetorum* Thuill. 1799, Fl. Paris, ed. 2: 250; Buia, 1956, Fl. R. P. Române, 4: 769. – *M. corimbifer.*

Bioecologia. Arbust, specie xeromezofilă, dumicolă, element european-mediteranean. Înfloreşte în mai-iunie, fructifică în august-septembrie. **Staţiunea.** Poieni şi rarişti de pădure, coaste însorite, pe marginea drumurilor. **Răspândirea locală.** Specie comună pe întreg teritoriul „Florei". **Răspândirea generală.** Eurasia, Africa de Nord.

Indicată pe terenurile degradate pentru fixarea solului. Specie meliferă, alimentară, medicinală, decorativă.

4. ***R. subafzeliana*** Chrshan. 1954, Фл. УРСР, 6: 583, 234; Хржановский, 1958, Розы: 244, Гейдеман, 1986, Опред. высш. раст МССР, изд. 3: 286; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 175; Бузунова, 2001, Фл. Вост. Евр. 10: 348; Negru, 2007, Determ. pl. fl. R. Moldova: 126. – *M. subafzeloid.*

Bioecologia. Arbust, specie xeromezofilă, silvicolă, element pontico-panonic. Înfloreşte în mai-iunie, fructifică în august-septembrie. **Staţiunea.** Poieni şi rarişti de pădure, coaste însorite, pe marginea drumurilor. **Răspândirea locală.** Specie rar întîlnită în districtele din centrul şi nordul regiunii. **Răspândirea generală.** Europa Centrală şi de Est.

Specie meliferă, decorativă, medicinală, alimentară (dintre speciile de măceş spontane autohtone, deţine

poziția a doua după conținutul de vit. C.) [17].

5. ***R. frutetorum*** Bess. 1814, Cat. Pl. Horto Cremen. Suppl. 3: 20; id. 1822, Enum. Pl. Volhyn.: 18; Бузунова, 2001, Фл. Вост. Евр. 10: 348. – *R. koso-poljanskii* Chrshan. 1950, Бот. мат. (Ленинград), 13: 116; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 288; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 176; Negru, 2007, Determ. pl. fl. R. Moldova: 126. – *R. coriifolia* auct. non Fries: Хржановский, 1958, Розы: 268, p. p. – *M. frutetos.*

Bioecologia. Arbust, specie xeromezofilă, petricolă, element central-european. Înfloreşte în mai, fructifică în august. **Stațiunea.** Pante stepizate, calcaroase, pietrofite, coaste însorite. **Răspândirea locală.** Specie rară, colectată din apropierea com. Naslavcea, r-nul Ocnița. **Răspândirea generală.** Europa Centrală şi de Est.

Este amenințată de distrugerea habitatelor prin terasarea şi împădurirea pantelor pietroase şi calcaroase, exploatarea carierelor şi valorificarea pantelor stepizate. Specie inclusă în Cartea Roşie a Republicii Moldova, ediția a 3-a [1]. Decorativă, meliferă, medicinală, alimentară (conține cea mai mare cantitate de vit. C, dintre rozele spontane, autohtone) [17].

6. ***R. schmalhauseniana*** Chrshan. 1954, Фл. УРСР, 6: 581, 222; Хржановский, 1958, Розы: 217; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 284; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 176; Бузунова, 2001, Фл. Вост. Евр. 10: 349; Negru, 2007, Determ. pl. fl. R. Moldova: 126. – *M. Şmalhausen.*

Bioecologia. Arbust, specie xeromezofilă, stepică, element pontico-panonic. Înfloreşte în mai-iunie, fructifică în septembrie. **Stațiunea.** Vegetează prin tufărişuri, pe pante, râpi, îndeosebi prin grohotişuri. **Răspândirea locală.** Este întâlnită rar în districtele din centrul şi nordul Basarabiei. **Răspândirea generală.** Europa Centrală şi de Est.

Poate fi folosită ca specie antierozională. Decorativă, meliferă, alimentară.

7. ***R. ciesielskii*** Błocki, 1889, Österr. Bot. Zeitschr. 39, 5: 189; Хржановский, 1958, Розы: 259; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 288; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 176; Бузунова, 2001, Фл. Вост. Евр. 10: 349; Negru, 2007, Determ. pl. fl. R. Moldova: 126. – *R. borysthenica* Chrshan. 1954, Фл. УРСР, 6: 584, 238; Хржановский, 1958, Розы: 258; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 176. – *M. Ceselski.*

Bioecologia. Arbust, specie xeromezofilă, silvicolă, element central-european. Înfloreşte în mai-iunie, fructifică în august-septembrie. **Stațiunea.** Liziera pădurilor, pante însorite, stepizate, grohotişuri, păşuni. **Răspândirea locală.** Sporadic, în districtele din centrul şi nordul regiunii. **Răspândirea generală.** Europa Centrală şi de Est.

Specie ce intră în compoziția floristică a subarboretelor din ecosistemele forestiere. Specie recomandată la crearea fâşiilor forestiere de protecție şi la fixarea terenurilor degradate. Decorativă, meliferă, alimentară.

8. ***R. villosa*** L. 1753, Sp. Pl.: 491; Klášterský, 1968, Fl. Europ. 2: 31; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 286; Бузунова, 2001, Фл. Вост. Евр. 10: 351; Negru, 2007, Determ. pl. fl. R. Moldova: 126; Ciocârlan, 2009, Fl. ilustr. a României: 337. – *R. pomifera* Herrm. 1762, Diss. Rosa: 16; Юзепчук, 1941, Фл. СССР, 10: 489; Хржановский, 1958, Розы: 226; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 175. – *M. lânos.*

Bioecologia. Arbust, specie xeromezofilă, petricolă, element european-mediteranean. Înfloreşte în iunie, fructifică în septembrie-octombrie. **Stațiunea.** Tufărişuri, liziera pădurilor pietrofite, malul râpilor. **Răspândirea locală.** Specie rară, colectată din apropierea localităților Verejeni, Corbul, Oclanda, Calaraşovca

r-nul Ocnița, Balasinești r-nul Briceni, Cosăuț și Rudi, r-nul Soroca. **Răspândirea generală.** Europa, Caucaz, Crimeea.

Este periclitată de distrugerea ecosistemelor pietrofite, nișa ecologică limitată. Specie decorativă, meliferă, alimentară.

9. R. ***tomentosa*** Smith, 1800, Fl. Brit. 2: 539; Săvulescu et Rayss, 1934, Mat. fl. Basarabiei, 3: 54; Хржановский, 1958, Розы: 251, p. p.; Klášterský, 1968, Fl. Europ. 2: 30, p. p.; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 386; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 176; Бузунова, 2001, Фл. Вост. Евр. 10: 352; Ciocârlan, 2009, Fl. ilustr. a României: 337. – *M. tomentos.*

Bioecologia. Arbust, specie xeromezofilă, silvicolă, element central-european. Înflorește în mai-iunie, fructifică în august-septembrie. **Stațiunea.** Liziera pădurilor, luminișuri, poieni, coaste însorite, stâncării. **Răspândirea locală.** Rară în nordul extrem al Basarabiei, indicată din preajma comunelor Cristinești și Nedibăuți, Hotin, regiunea Cernăuț [7]. **Răspândirea generală.** Europa, Asia Mică.

10. ***R. andrzejowskii*** Stev. ex Bess. 1814, Cat. Pl. Horto Cremen. Suppl. 3: 19, pro sp.; Săvulescu et Rayss, 1934, Mat. fl. Basarabiei, 3: 54; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 386; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 176; Бузунова, 2001, Фл. Вост. Евр. 10: 353; Negru, 2007, Determ. pl. fl. R. Moldova: 126. – *R. scabriuscula* auct. non Smith : Klášterský, 1968, Fl. Europ. 2: 30, p. p. – *M. Andrjeiovski.*

Bioecologia. Arbust, specie xeromezofilă, silvică, element european. Înflorește în mai-iunie, fructifică în septembrie-octombrie. **Stațiunea.** Pantele și râpile stepizate, îndeosebi pe dezgoliri de calcar. **Răspândirea locală.** Specie rară, indicată pe pantele Nistrului spre Vadul-Pașii, la sud de Hotin [7]. **Răspândirea generală.** Europa de Est.

11. ***R. turcica*** Rouy, 1896, III. Pl. Europ. Rar. 6: 45, tab. 134; Klášterský, 1968, Fl. Europ. 2: 32; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 174; Бузунова, 2001, Фл. Вост. Евр. 10: 353; Ciocârlan, 2009, Fl. ilustr. a României: 338. – *R. ferox* Bieb. 1810, Cent. Pl. Rar. 1: tab. 37, non Lawrence, 1799; Buia, 1956, Fl. R. P. Române, 4: 802. – *R. horrida* Bieb. ex Crép. 1872, Bull. Soc. Bot. Belg. 11: 86, non Spreng. 1825; Юзепчук, 1941, Фл. СССР, 10: 498; Хржановский, 1958, Розы: 279. – *M. turcesc.*

Bioecologia. Arbust, specie xeromezofilă, petricolă, element pontico-balcanic. Înflorește în mai-iunie, fructifică în septembrie. **Stațiunea.** Liziera pădurilor de gârneț, locurile deschise, aride, stâncoase, cu soluri carbonate. **Răspândirea locală.** Specie foarte rară pentru teritoriul în studiu, semnalată în preajma s. Unguri, r-nul Dondușeni (poiană în stejăret de stâncă) și în sectorul reprezentativ cu vegetație de stepă „Ciumai", r-nul Taraclia [10]. **Răspândirea generală.** Europa Centrală și de Est, regiunea mediteraneeană, peninsula Balcanică, Crimeea, Asia Mică.

Specie periclitată de valorificarea pantelor stepizate, exploatarea carierelor și distrugerea habitatelor naturale. Necesită a fi introdusă în Lista speciilor ocrotite de lege. Taxon inclus în Cartea Roșie a plantelor vasculare din România [3].

12. ***R. rubiginosa*** L. 1771, Mant. Pl. Alt.: 564; Klášterský, 1968, Fl. Europ. 2: 31, p. p. (excl. syn. *R. floribunda* Stev. ex Bieb.); Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 288; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 174; Бузунова, 2001, Фл. Вост. Евр. 10: 353; Negru, 2007, Determ. pl. fl. R. Moldova: 126; Ciocârlan, 2009, Fl. ilustr. a României: 338. – *R. eglanteria* L. 1753, Sp. Pl.: 491, p. p. nom. ambig.; Юзепчук, 1941, Фл. СССР, 10: 492; Хржановский, 1958, Розы: 276. – *R. bordzilowskii* Chrshan. 1952, Бот. журн. АН УРСР, 9, 4: 57; Хржановский, 1958, Розы: 280; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 288. – *R.*

volhyniensis Chrshan. 1952, Бот. журн. АН УРСР, 9, 4: 63; Хржановский, 1958, Розы: 281. – *M. ruginiu.*

Bioecologia. Arbust, specie xeromezofilă, petricolă, element european-mediteranean. Înfloreşte în mai, fructifică în septembrie. **Staţiunea.** Pante pietroase, însorite, poienile şi liziera pădurilor aride de stejar pufos. **Răspândirea locală.** Specie întâlnită rar pe întreg teritoriul Basarabiei. **Răspândirea generală.** Europa, Caucaz.

Distrugerea habitatelor prin păşunatul excesiv, valorificarea pantelor stepizate periclitează existenţa speciei.

13. ***R. micrantha*** Borrer ex Smith, 1812, in Sowerby, Engl. Bot. 35: tab. 2490; Хржановский, 1958, Розы: 273; Klášterský, 1968, Fl. Europ. 2: 32, p. p.; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 288; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 175; Бузунова, 2001, Фл. Вост. Евр. 10: 354; Negru, 2007, Determ. pl. fl. R. Moldova: 126; Ciocârlan, 2009, Fl. ilustr. a României: 339. – *M. micrant.*

Bioecologia. Arbust, specie xeromezofilă, petricolă, element central-european (mediteranean). Înfloreşte în mai-iunie, fructifică în septembrie. **Staţiunea.** Vegetează pe pante însorite, pietroase, calcaroase. **Răspândirea locală.** Specie rară pentru teritoriul cercetat. A fost înregistrată în cadrul rezervaţiei peisagistice "Ţâpova", în sectorul reprezentativ cu vegetaţie de stepă din sudul Bugeacului, în preajma com. Moscovei şi com. Badicul Moldovenesc r-nul Cahul [9]. **Răspândirea generală.** Europa Centrală şi de Est, regiunea mediteraneeană.

Este ameninţată de păşunatul excesiv, valorificarea pantelor stepizate. Necesită a fi introdusă în Lista speciilor ocrotite de lege.

14. ***R. inodora*** Fries, 1814, Nov. Fl. Suec. 1: 9; Бузунова, 2001, Фл. Вост. Евр. 10: 354; Negru, 2007, Determ. pl. fl. R. Moldova: 126. – *R. elliptica* Tausch, 1819, Flora (Regensb.), 2, 30: 465; Хржановский, 1958, Розы: 305; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 289; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 174; Ciocârlan, 2009, Fl. ilustr. a României: 338. – *R. agrestis* auct. non Savi : Klášterský, 1968, Fl. Europ. 2: 31. – *M. inodor.*

Bioecologia. Arbust, specie xeromezofilă, stepică, element european-mediteranean. Înfloreşte în mai-iunie, fructifică în august-septembrie. **Staţiunea.** Pante pietroase, însorite, rarişti şi margini de pădure, pe soluri scheletice. **Răspândirea locală.** Specie rară indicată anterior dintr-o singură localitate com. Bahmut r-nul Călăraşi, recent (a. 2015) a fost evidenţiat un loc nou de creştere s. Cîzlar, r-ul Leova [11]. **Răspândirea generală.** Europa Centrală şi de Est, regiunea mediteraneeană.

Specie periclitată de distrugerea locurilor de creştere prin valorificarea pantelor stepizate.

15. ***R. balsamica*** Bess. 1815, Cat. Pl. Horto Cremen. Suppl. 4: 18, non Willd. 1813, nom. nud., nec. Willd. ex Spreng. 1820; Бузунова, 2001, Фл. Вост. Евр. 10: 354; Negru, 2007, Determ. pl. fl. R. Moldova: 126. – *R. klukii* Bess. 1822, Enum. Pl. Volhyn.: 46, 67; Хржановский, 1958, Розы: 301. – *R. tomentella* Leman, 1818, Bull. Soc. Philom. Paris, 1818: 94; Ciocârlan, 2009, Fl. ilustr. a României: 338. – *R. fedoseevii* Chrshan. 1952, Бот. журн. АН УРСР, 9, 4: 65; Хржановский, 1958, Розы: 290; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 288; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 175. – *M. balsamic.*

Bioecologia. Arbust, specie mezofilă, dumicolă, element ponto-panonic. Înfloreşte în mai-iunie, fructifică în august-septembrie. **Staţiunea.** Pante pietroase, însorite, poienile şi liziera pădurilor aride de stejar pufos. **Răspândirea locală.** Specie rară pentru flora în studiu. Anterior cunoscută doar din Pădurea Hârbovăţ r-nul Anenii-Noi, iar în vara a. 2015, a fost depistată şi în rezervaţia peisagistică "Ţîpova", r-nul Rezina. **Răspândirea generală.** Europa Centrală şi de Est.

Existenţa taxonului în teritoriu este periclitată de distrugerea habitatelor naturale, prin valorificarea pantelor stepizate şi păşunatul excesiv.

Secţia 2. ***Rosa*** – *Rosa* sect. *Gallicanae* DC. 1818, in Ser., Mus. Helv. 1: 2. – R. sect. *Gallicae* Crép. 1889, Journ. Roy. Hort. Soc. (London), 11: 218.

16. ***R. gallica*** L. 1753, Sp. Pl.: 492; Юзепчук, 1941, Фл. СССР, 10: 483, p. p.; Klášterský, 1968, Fl. Europ. 2: 28, p. p.; Бузунова, 2001, Фл. Вост. Евр. 10: 357; Ciocârlan, 2009, Fl. ilustr. a României: 335. – *R. crenatula* Chrshan. 1949, Сборн. научн. тр. Львов. вет. инст. 2, 1: 266; Хржановский, 1949, Бот. журн. АН УРСР, 6, 4: 88; id. 1958, Розы: 390; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 282; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 174; Negru, 2007, Determ. pl. fl. R. Moldova: 126. – *M. galic.*

Bioecologia. Arbust, specie xeromezofilă, stepică, element ponto-mediteranean. Înfloreşte în mai-iunie, fructifică în august-septembrie. **Staţiunea.** Pante însorite, poieni, rarişti şi margini de pădure îndeosebi pe soluri calcaroase. **Răspândirea locală.** Specie sporadică aproape pe întreg teritoriul „Florei". **Răspândirea generală.** Europa, Caucaz, Asia Mică.

Specie ce intră în componenţa învelişului ierbos al fitocenozelor pădurilor aride şi subaride formate de diferite specii de stejar, precum şi a celor de stepă. Decorativă.

17. ***R. pygmaea*** Bieb. 1808, Fl. Taur.-Cauc. 1: 397; Хржановский, 1958, Розы: 372; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 173; Бузунова, 2001, Фл. Вост. Евр. 10: 358; – *R. subpygmaea* Chrshan. 1949, Сборн. научн. тр. Львов. вет. инст. 2, 1: 260; Хржановский, 1949, Бот. журн. АН УРСР, 6, 4: 82; id. 1958, Розы: 374; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 173. – *R. ucrainica* Chrshan. 1949, Сборн. научн. тр. Львов. вет. инст. 2, 1: 262; Хржановский, 1949, Бот. журн. АН УРСР, 6, 4: 80; id. 1958, Розы: 368. – *M. pitic.*

Bioecologia. Arbust, specie xeromezofilă, petricolă, element central-european. Înfloreşte în mai, fructifică în august. **Staţiunea.** Vegetează pe pante stepizate, însorite, calcaroase, abrupte, pe soluri scheletice. **Răspândirea locală.** Specie nouă şi foarte rară pentru teritoriul „Florei". A fost înregistrată în rezervaţia ştiinţifică "Iagorlâc" şi pe pantele calcaroase ale Nistrului din localitatea Hruşca, r-nul Camenca. **Răspândirea generală.** Europa Centrală şi de Est, Caucaz.

Este periclitată de distrugerea habitatelor prin împădurirea pantelor pietroase şi calcaroase cu specii antierozionale alohtone, ce modifică substanţial habitatele naturale. Specie inclusă în Cartea Roşie a Republicii Moldova, ediţia a 3-a [1].

Secţia 3. ***Pimpinellifoliae*** DC. 1818, in Ser., Mus. Helv. 1: 3.

18. ***R. pimpinellifolia*** L. 1759, Syst. Nat., ed. 10, 2: 1062; Klášterský, 1968, Fl. Europ. 2: 27, p. p.; Дубовик, 1999, Опред. высш. раст. Укр., изд. 2: 171; Бузунова, 2001, Фл. Вост. Евр. 10: 360; Negru, 2007, Determ. pl. fl. R. Moldova: 126. – *R. spinosissima* L. 1753, Sp. Pl.: 491, p. p., nom. ambig.; Юзепчук, 1941, Фл. СССР, 10: 470, p. p.; Хржановский, 1958, Розы: 408; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 281; Ciocârlan, 2009, Fl. ilustr. a României: 333. – *M. pimpinelifoliu.*

Bioecologia. Arbust, specie xeromezofilă, petricolă, element eurasiatic. Înfloreşte în mai, fructifică în august-septembrie. **Staţiunea.** Vegetează în pădurile de stâncării şi de gârneţ, prin poiene, rarişti şi liziere, pe pante însorite. **Răspândirea locală.** Sporadic pe întreg teritoriul Basarabiei. **Răspândirea generală.** Eurasia.

Constituent al subarboretului pădurilor dominate de stejar pufos. Indicată pentru fixarea pantelor degradate [12]. Specie meliferă, decorativă.

19. ***R. tschatyrdagi*** Chrshan. 1953, Бот. мат. (Ленинград), 15: 118; Хржановский, 1958, Розы: 413; Дубовик,

1999, Опред. высш. раст. Укр., изд. 2: 171; Бузунова, 2001, Фл. Вост. Евр. 10: 361. – *R. pimpinellifolia* auct. non L. : Klášterský, 1968, Fl. Europ. 2: 27, p. p. – *M.-de-Ciatârdag.*

Bioecologia. Arbust, specie xeromezofilă, petricolă, element eurasiatic. Înfloreşte în mai, fructifică în august-septembrie. **Staţiunea.** Pante însorite, poienile pădurilor subaride de stejar pufos, pe substrat calcaros. **Răspândirea locală.** Specie nouă şi rară pentru flora spaţiului basarabean, înregistrată în preajma com. Tălmaza, r-nul Ştefan-Vodă, com. Bujor, r-nul Hînceşti şi com. Geamăna, r-nul Anenii Noi [8]. **Răspândirea generală.** Europa de Sud-Est, Caucaz, Asia Mică.

Este ameninţată de degradarea habitatelor naturale, regenerarea insuficientă şi limita de Est a arealului.

CONCLUZII

- În urma investigaţiilor floristice şi taxonomice ale genului *Rosa* L. pe teritoriul Basarabiei au fost evidenţiate 19 specii de măceş: *R. canina* L., R. *andegavensis* Bast., *R. corymbifera* Borkh., *R. subafzeliana* Chrshan., *R. frutetorum* Bess., *R. schmalhauseniana* Chrshan., *R. ciesielskii* Błocki, *R. villosa* L., *R. tomentosa* Smith, *R. andrzejowskii* Stev. ex Bess., *R. turcica* Rouy, *R. rubiginosa* L., *R. micrantha* Borrer ex Smith, *R. inodora* Fries, *R. balsamica* Bess., *R. gallica* L., *R. pygmaea* Bieb., *R. pimpinellifolia* L. şi *R. tschatyrdagi* Chrshan.
- Dintre toate speciile de măceş evidenţiate, trei *(R. pygmaea, R. tschatyrdagi şi R. turcica*) sunt specii noi pentru flora Basarabiei, şapte sunt specii rare iar *R. frutetorum* şi *R. pygmaea* sunt incluse în Cartea Roşie, Ed. a 3-a.
- Majoritatea speciilor rare se află la limita arealului şi manifestă o vulnerabilitate ridicată faţă de factorii de mediu şi antropogeni. Aceşti taxoni necesită măsuri de conservare prin includerea în Lista speciilor protejate de stat; evidenţierea şi luarea sub protecţie a locurilor de creştere; activităţi de inventariere, cartografiere şi monitorizare a stării populaţiilor.
- Având în vedere pretenţiile modeste faţă de troficitatea solului, cultura măceşului pe terenuri degradate, în scop ameliorativ, poate să devină în acelaşi timp, rentabilă şi din punct de vedere economic.

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REPRODUCTION METHODS OF *HYACINTHUS ORIENTALIS* L. IN THE CONDITIONS OF THE BOTANICAL GARDEN (INSTITUTE) OF THE ASM

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Abstract. For the first time, in the conditions of the Botanical Garden (Institute) of the ASM, different methods of reproduction of *Hyacinthus orientalis* L. were studied in order to enrich the collection with new species of plants.

INTRODUCTION

Hyacinth (*Hyacinthus orientalis* L.) is the progenitor of all garden hyacinths, which refers to *Liliaceae* family. Genus *Hyacinthus* numbers more than 30 species; most of them are native to North Africa and to the Mediterranean Region.

In the wild forms, the hyacinths are widespread in the Balkans, Asia Minor, in Mesopotamia on the dry open mountain slopes, at the height of 1500 m above the sea level (Быховец, Гончарук, 2004).

Hyacinth (*orientalis*) is considered a bulbous plant with linearly, lanceolate, bright-green and fleshy leaves, which forms a basal rosette. The flowers are bell-shaped, with six separate corollas, simple or double, disposed in a straight cylindrical arrow-shaped spike, achieving up to 20-35 cm in height. The plants possess a strong flavour; meantime the contemporaneous varieties differ in a wide palette of colours from white, pink and violet, lilac, cream and yellow, blue, sky-blue and crimson, till plain and banded, of various shades.

The bulbodium is globular or wide-strobilaceous, with multiple succose and integumentary squamas. The colour of bulbodium squame integument depends on flower colours: there are white-flowered hyacinth where the squamas are grayish, at *Rosales* – lilac, yellowish or grayish-cream colored, at the species with blue and sky-blue flowers – lilac.

The bulbodium form and limit dimensions also, in a certain extent distinguishes, depending on the varieties. The most powerful distinctiveness between the varieties is the flower period. The roots are situated around the perimeter of bottom, have not ramifications and radicular hairs. In the culture persists from the year 1562. Are known more than 300 varieties spread from the entire world.

According to the structure of inflorescences, hyacinths are divided into a group of simple, of terry (double-telt) and fayeri-taip group (polycluster-flowered, small-flowered) (Быховец, Гончарук, 2004). The hyacinths are used in group plantings, flower beds. In the Republic of Moldova, the hyacinths are blooming early – in March-April during 10-15 days. The hyacinths are reproduced by seeds and by the vegetative method. On the base of vegetative reproduction, all the peculiarities of the mother plant are preserved.

There are many methods of vegetative reproduction of hyacinths, by the aid of which we can increase the amount of young bulbs; it means the multiplication by leaves and bulbous scales, dual scales, bulbodium discus preparation and dividing the clusters.

In the Botanical Garden (Institute) of the Academy of Sciences of Moldova, the representatives of *orientalis* were included in the composition of the collection of decorative bulbous plants. Their assortment is small and the reproduction, until recently, was carried out by dividing the bulbs naturally. Such a method does not provide a large number of planting materials, because of the formation of bulbils in hyacinths, which, usually, begins only in the fifth or sixth year. This explains the phenomena of poor natural reproduction of hyacinths into the floristic farms of the republic, also, among the amateur floriculturists. In connection with

this, in 2012, we have been started the study of different methods of vegetative reproduction of *orientalis*. Thus, the aim of our investigations was the identification of the most available and simple reproductive method of such crop, in order to increase the number of plants in the collections of the BG, under the given conditions.

MATERIAL AND METHODS

The investigations were carried out in the reserve of the greenhouses and in the experimental area of the Botanical Garden (Institute) of the Academy of Sciences of Moldova. The objects of our investigations were two varieties of *orientalis* – Amethyst and Blue Jascket. The hyacinths were reproduced by applying different growth stimulators according to the methodology (Быховец, Гончарук 2004). The treatment before planting, i.e. the steeping scales, separated from the bulbs, in aqueous solutions of growth stimulators (eight variants), was carried out. The solution of 0.4 % fundazol and water served as control.

RESULTS AND DISCUSSION

The annual developmental cycle of hyacinth consists of three basic stages. During the first stage, which lasts three months (from the spring re-growth, until the end of vegetation) the plants are persisting in open air. During that period, the accumulation of nutrients takes place in the bulb. The number of the scales and the mass of the bulb determine the number of leaves, the inflorescences and their flowers. The second stage (summer repose) begins after the termination of vital functions of the aerial organs and root system and continues two months (July and August). The third stage begins from the moment of plantation in collection and continues before the spring re-growth of the leaves.

During the propagation by leaves, in the cut places, may form offspring. The method of reproduction by bulbous scales is based on the plant's capacity of regeneration. When scales are divided, the mechanical damage, at the beginning, causes rapid cell division of meristematic tissue cells and as a result is producing the callus. After differentiation and the epidermis development it forms new bulbils. During the reproduction by double scales, at the hyacinths are cutting off the top (approx. one third of the height of the bulbs) into 8 sectors. Each of them is divided into double scales in such manner, which on the pair the piece of stems has been preserved. The disadvantage of the present method, in comparison with another, is that a lot of time is necessary for the preparation of the material.

The reproduction by preparation of stems is that one when the maternal bulbs are completely removed, and the rest of the part represents the reserve of scales, which under favourable conditions forms new young bulbils. Such method of reproduction, according to the methodology, is divided in multiple stages: selection and preparation of the bulbs, cutting of the stems, treating the cutting, incubations, which lasts 2.5-3.0 months, in the first year of cultivation, the division of nests, in the second and third years of cultivation. But although such method allows obtaining a great amount of planting material, however, it is associated with some complications – mastering of cutting the stems, incubations, and the expenditure of the biggest bulbs. In connection with this fact, we experienced two more simple methods referring to the propagation of hyacinths – by leaves and scales of the bulbs.

Because the capacity for bulb production on the leaf cuttings depends on the sorts, the varieties from our collection were unable to reproduce from leaves during two years, the experiments were laid out and special conditions were created for obtaining young planting material from the leaves.

Based on the methodology (Быховец, Гончарук, 2004), we propagated the hyacinths of two varieties: Amethyst (fig. 1) and Blue Jascket, applying different growth stimulators. According to the experimental

methods, from six bulbs of the above-mentioned varieties of hyacinths (fig. 2), the scales were separated (fig. 4) by dividing them into four parts by two perpendicular cuts (fig. 3). After that, the scales were placed in gauze sacks, and during 18 hours they were immersed in various solutions with biologically active substances for disinfection, stimulation of growth processes and of the immune system of plants (pre-planting treatment).

Figure 1. *H. orientalis.*

Figure 2. Hyacinth bulbs.

Figure 3.The division of bulbs.

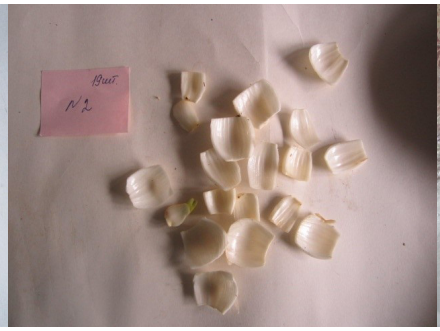

Figure 4. Scales of bulbs.

By 19-23 scales, in each variant, after pre-plant treatment, were placed in plastic containers (fig. 5) with the substrate of peat, fine clay and perlite in the ratio 1: 1: 1. In their turn, the containers were laid out in plastic bags (fig. 6), labelled and subsequently kept in diffuse light for 6 weeks at a temperature of +20.... + 25° C and 85 % relative humidity. During this period, at the base of the scales were formed by one or more offspring (fig.

7, 8). Subsequently the "kid" bulblets have been separated and planted in boxes, which were filled with special substrate for growing. In such way, over a period of 14 weeks, in total from 6 hyacinth bulbs we obtained of more than 400 "kid" bulblets, which were planted in the open ground already in the third year of cultivation. In the table 1 and on the diagram (fig. 9), there are presented the results of studies on the effects of growth factors on the process of formation "kid" bulblets, during the reproduction of hyacinths by scales bulbs.

Figure 6. Container with scales bulbs.

Figure 7. The beginnings of "kid" bulblets.

Figure 8. Bulbs before planting in the ground.

Table No. 1. Influence of growth stimulators on the formation of "kid" bulblets from scales of *Hyacinthus orientalis* L. bulbs

Experimental variants	Quantity of scales, units	Duration of pre-plant treatment with growth stimulators, hours	Number of formed bulblets, units	Duration of maintenance in containers before planting, days	Date of planting scales for rooting
V_1(A)-powdering with charcoal	23	18	30	93	4.10.2012
V_2(A)-0,05% humate solution +7	23	18	36	93	4.10.2012
V_3(A)-0,05% zircon	20	18	27	93	4.10.2012
V_4(A)- control (0.4% fundazol	21	18	18	93	4.10.2012
V_5(B)-5% aqueous solution of aloe juice	20	18	27	98	4.10 2012
V_6(B)-0,05% solution Reglalg	20	18	41	98	4.10.2012
V_7(B)-0,05% ehpin's solution	23	18	35	98	4.10.2012

V_8(B) – control (water)	25	18	30	98	4.10.2012
Note: Hyacinths Amethyst: V_1(A) – 37 bulblets, V_2(A) – 35 bulblets, V_3(A) – 22 bulblets,V_4(A) – 20 bulblets, *Hyacinths* Jascket, V_5(B) – 23 bulblets,V_6 (B) – 20 bulblets, V_7(B) – 23 bulblets, V_8(B) – 26 bulblets.					

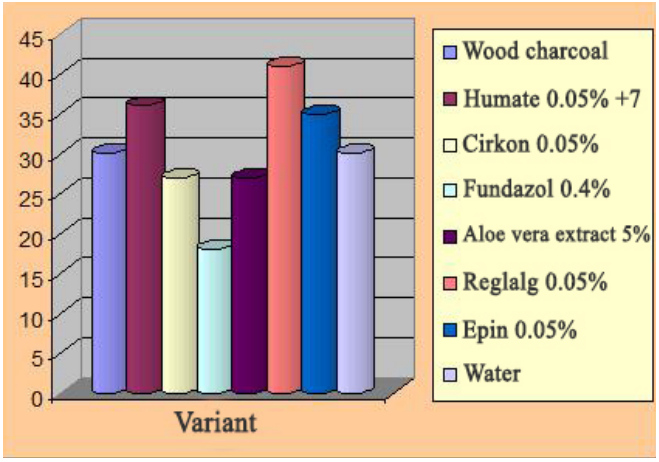

Fig. 9. Influence of different preparations on the formation of "kid" bulblets.
According to our data, the greatest number of bulblets was obtained after the treatment of scales with V_6(B) –Reglalg, V_2(A) – Humat +7 and V_7(B) – Epin.

CONCLUSIONS

1. On the basis of our investigations and obtained results, we can make conclusions about the successful reproduction of tested *hyacint*h bulb scales of the varieties grown in the conditions of the Botanical Garden (Institute) of the ASM.

2. The reproduction method of *Hyacinthus orientalis* L. by bulb scales gives the opportunity of obtaining from 20 to 100 "kid" bulblets from one bulb.

3. For obtaining a higher quantity of healthy planting material, such growth stimulators as Gumat+7, Reglalg, Epin were recommended.

4. In conditions of the Republic of Moldova, it is more efficient to apply autumnal reproduction of *orientalis*, because during this period of time, the *hyacinth* bulbs contain a large amount of stored materials and they are capable of forming reserves for the largest number of "kid" bulblets.

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III. INTRODUCTION OF PLANTS AND SUSTAINABLE USE OF PLANT RESOURCES

CZU 631.529:582.475.2

GENUS *ABIES* MILL.: RESULTS OF INTRODUCTION IN THE REPUBLIC OF MOLDOVA

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Abstract. The experimental results on the introduction of *Abies* Mill., in Moldova's conditions, indicate a great potential of enriching the assortment of new species and cultivars, with the target using them in ornamental horticulture.
Keywords: taxonomic composition, Pinophyta, Abies, genus, species, cultivars.

INTRODUCTION

Fir (*Abies* Mill.) is a genus of evergreen forest-forming woody plants, which includes more than 50 main species and is one of the oldest of the eleven existing genera of pine (*Pinaceae* Lindl.). The species of this genus are predominantly found in mountainous regions of the northern hemisphere, where they form dark coniferous forests. Most of them occur in the sub-zones of middle and southern taiga of Siberia and North America, as well as in the mountainous forests of the temperate and subtropical zones of Central and Southern Europe, North Africa and Asia.

The species of genus *Abies* Mill. have a number of valuable ornamental qualities necessary in green building – this is the durability and monumentality, the high sanitary and recreational properties and the emotional impact on people. These properties, in combination with a diversity of ecological peculiarities of different species of fir, can be successfully used to create parks, forest parks, and other types of green spaces.

The use of the introduced species in the composition of green plantings is one of the promising ways of enriching the biological diversity, as well as increasing the aesthetic value of cultural landscapes. The representatives of the genus *Abies* do not grow in natural conditions of the Republic of Moldova. The first steps on introduction of firs relate to the second half of XIX century – beginning of XX in the gardens and parks of the landlords [1, 8]. Furthermore, the experience on introduction of *Abies* species was accumulated in the botanical gardens and arboretums and, particularly active, fir has been implemented from the middle of XX century. However, up to now, the rich experience in creating and growing fir plantings in the Republic of Moldova has not been summarized.

MATERIALS AND METHODS

The species and cultivars of the genus *Abies*, which grow in the Botanical Garden (I) of the Academy of Sciences of Moldova (the old and new territory), arboretums, parks and squares of Chisinau, and also in the old parks, served as biological material for the investigations. For carrying out the actual researches, a number of known methods, recommendations for clarification of the species composition, determination of heat and drought resistance, winter hardiness, reproductive ability, level of adaptation and the perspective of introduction have been used [3, 4, 6, 7, 9, 10, 11].

RESULTS AND DISCUSSIONS

As a result of determining and clarifying the taxonomic composition of the genus *Abies* in the Republic of Moldova, we have established 23 species, 3 hybrids, 60 cultivars (tab. 1).

Table 1. Taxonomic composition of genus *Abies* Mill. in the Republic of Moldova

Species and hybrids	Cultivars
Abies alba Mill.	'Aurea', 'Bystřička', 'Columnaris', 'Pendula', 'Pyramidalis'
A. amabilis (Dougl. ex Loud.) Forb.	-
A. x arnoldiana Nitz.	'Ioan Pavel II'
A. balsamea (L.) Mill.	'Hudsonia', 'Kiwi', 'Nana', 'Piccolo', 'Pyramidalis'
A. borisii-regis Mattf.	-
A. cephalonica Loud.	'Meyer's Dwarf'
A. concolor (Gord.) Ldl. ex Hildebr.	'Archer's Dwarf', 'Argentea', 'Compacta', 'Nana Kalous' , 'Piggelmee', 'Violacea', 'Wintergold'
A. concolor var. *lowiana* (Gord.) Lemm.	-
A. fraseri (Pursh) Poir.	-
A. holophylla Maxim.	-
A. homolepis Sieb. et Zucc.	-
A. x insignis Carr. ex. Bailly	-
A. koreana Wils.	'Aurea', 'Blauer Eskimo', 'Blauer Pfiff', 'Brevifolia', 'Brilliant', 'Cis', 'Dark Hill', 'Doni Tajuso' , 'Frosty', 'Green Carpet', 'Horstmann's Silberlocke', 'Ice Breaker', 'Lumenetta', 'Oberon', 'Pancake', 'Piccolo', 'Silberkugel', 'Silberperl', 'Silberzwerg', 'Silver Star', 'Taiga', 'Tundra'
A. lasiocarpa (Hook.) Nutt.	-
A. lasiocarpa var. *arizonica* (Merriam) Lemmon	'Argentea', 'Compacta', 'Green Globe','Toenisvorst'
A. nephrolepis (Trautv.) Maxim.	-
A. nordmanniana (Stevn) Spach	'Ambolouri', 'Aurea', 'Filip's Goldheart', 'Golden Spreader', 'Pendula'
A. numidica de Lannoy ex Carrière	-
A. pinsapo Boiss.	'Glauca', 'Kelleriis'
A. procera Rehder	'Bizarro', 'Glauca', 'Glauca Prostrata', 'Obrighoven'

A. recurvata Mast.	-
A. sachalinensis (Fr. Schmidt) Mast.	-
A. sibirica Ledeb.	-
A. spectabilis (D.Don) Spach	-
A. veitchii Lindl.	'Fritsche', 'Heddergott', 'Jeddeloh Weeping', 'Kramer'
A. x vilmorinii Mast.	-

The highest number of forms is distinguished: *A. concolor* and *A. koreana.* Taking into account the global floristic reserves of the genus (56 species, 2 subspecies, 9 hybrids, 2 varieties and 625 cultivars) [2, 12, 13, 14], the assortment of used in the green building of the Republic of Moldova is comparatively poor. This basically it is *A. alba* and *A. concolor.* The other species are used for creating decorative groupings in botanical gardens, arboretums, old parks, as well as in private gardens. The seasonal growth of shoots is one of the main periods of woody plants' life, closely related with climatic conditions of growing. The study of growth and development of introduced plants in different soil and climatic conditions allows to judge about their adaptation to the new environment and to identify the existence of perspectives for the economy. Our observations showed that in the Central part of Moldova (Chisinau), at the investigated species of fir, the growth of axial shoots begins in late April – early May, with an average daily temperature of 8-16 °C. The end of growth in most species occurs at the end of June – beginning of July. The dates of the beginning and end of growth vary from year to year, so that the duration of growth is different. The most intensive growth of shoots is observed in May. Blossoming and seed production are important moments in the life of any plant. The entry into the generative phase is one of the criteria for assessing the success of plant introduction. Under the conditions of the Republic Moldova, "blossom" and form seeds 16 species of fir. Their strobilation occurs in the first half of May, with an average daily air temperature 9-18 °C and the sum of positive temperatures 290-480 ^{0}C. Strobilation period varies from year to year, depends on the weather and lasts from 6 to 12 days. Seed ripening begins in the first ten days of October. The whole period from flowering to maturity of cones, depending on the species, lasts from 100 to 130 days. The full development necessitates the sum of positive temperatures – 2150-2800 °C. The determination of the quality of seeds has shown high laboratory germination (over 70 %) in *A. concolor, A. nordmanniana* and *A. numidica,* average (40-50 %) in *A. alba, A. sibirica, A. pinsapo* and low (10-25 %) in other species. In our opinion, low seed germination is due to the insufficient number of trees of that species. As a result of the experimental study (the testing into the water chamber of ultra thermostat UT-15), it was determined the more expressed heat resistance of fir species with needles of blue colour as compared to green. It is known that an important role in the introduction is played by winter hardiness of plants, moreover in the process of acclimatization, it can change. Currently, 90 % of cultivated species of the genus *Abies* have the highest scale of hardiness – I. Some species have a transitional point, depending on the climatic conditions of the year – I-II. During the period of investigations, types and forms of fir showed a complete drought resistance, i.e. in all cases was observed the drought resistance – V by M. R. Duval-Stroev five-point scale [5]. We have also investigated the peculiarities of seed reproduction. In our experiment, seeds of the local reproduction were used. The research program included the identification of the optimal growing seedlings of some fir species, for this purpose, different variants and substrates and pre-sowing preparation of seeds, as well as different sowing dates were tested. The highest germination of seeds was up to 56 %, in *A. concolor* and *A. nordmanniana* on the substratum consisting of sod soil and river sand (3 : 1). The use of chemical solutions (potassium permanganate

– 1 %, heteroauxin – 0.01 %, superphosphate – 0.5 %) for pre-sowing preparation of seeds led to a significant increase in germination. Along with the seed method of reproduction, which for the most species of *Abies* was the main method, we carried out the experimental study on the impact of different growth factors on the rooting of cuttings of dwarf cultivars. We have specified and expanded the methods of fir propagation by cuttings. The following cultivars had the higher percentage of rooting, from 40 to 55 % of the cuttings: *A. balsamea* 'Nana', *A. concolor* 'Compacta', *A. koreana* 'Piccolo', *A. lasiocarpa* var. *arizonica* 'Compacta'. For the first time in the soil and climatic conditions of Republic Moldova, researches were carried out on inoculations of different species and cultivars of the genus *Abies.* The periods, optimal methods and the impact of chemicals on the intergrowth of inoculations were studied. In our country, great attention was paid to the transplantation methods of different fir species and cultivars. On the basis of the obtained data, we formulated the following conclusion that highly ornamental fir species and cultivars should be propagated by grafting. The optimal method for the reproduction is ***in the fissure of axial sprout through the apical buds by cambium on the very centre*** – method modified by us. The best results have been obtained by grafting during the spring period, at the beginning of the swelling of buds and in summer-autumn, after the end of shoot growth. The processing of the grafts' cut site with solution of succinic acid (0.01 %) and dimethyl sulfoxide (0.1 %), directly before inoculation leads to increasing the percentage of survival. On the basis of many years of study of the growth, development, sustainability and decorativeness for green building of our country, we recommend the following species of the genus *Abies: A. alba, A. amabilis, A. balsamea, A. cephalonica, A. concolor, A. concolor* var. *lowiana, A. holophylla, A. homolepis, A. koreana, A. lasiocarpa, A. lasiocarpa* var. *arizonica, A. nephrolepis, A. nordmanniana, A. numidica, A. pinsapo, A. procera, A. sibirica* and also their cultivars.

CONCLUSIONS

As a result of determining the taxonomic composition of the genus *Abies* in perennial plantations of the Republic of Moldova, 86 taxa have been revealed. Our studies concerning the growth and development of the genus *Abies* have shown that the soil and climatic conditions of the Republic of Moldova are favourable for the growth of many ornamental fir species and cultivars. The entry of 16 fir species in the generative phase indicates their adaptability to new environmental conditions. The good germinating capacity of seeds of some fir species creates the possibility of their mass reproduction and its following use in the ornamental gardening. On the example of blue fir species, it was proved that the last have a high heat resistance, in comparison with other types. Thus, when creating green plantations under conditions of increased heat, preference should be given to the species with a blue coloration of the needles. Based on the researches, it was proved the perspectivity of reproduction of fir species and cultivars by vegetative means: low growing forms – by cuttings and plants with tall stems – by grafting. For landscape gardening, we can recommend 17 fir species and their ornamental cultivars.

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STUDII BIOLOGICE ȘI FITOCHIMICE LA SPECIILE *AJUGA REPTANS* L. ȘI *A. GENEVENSIS L.* (*LAMIACEAE*)

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Summary: The current paper reflects the results regarding biological peculiarities and chemical composition of *Ajuga reptans* L. and *A. genevensis* L. naturally growing in Republic of Moldova. Four life periods (latent, pregenerative, generative, postgenerative) and 8 stages (plantlets, juvenile, immature, virginal, early generative, mid generative, late generative, senile) in the cycle of the development of *Ajuga reptans* L. and *A. genevensis* L. were evidenced. The phytochemical analysis highlighted a higher content of flavonoids in the methanol extract of *A. reptans* – 0,34 g% compared with 0,18g% identified in *A. genevensis*. The hydroxycinamic acids content is obviously higher in *A. reptans*: 0,33 g% compared to 0,1 g% identified in *A. genevensis*. The level of total polyphenols in both extracts is almost similar: 0,72g GAE% (expressed as gallic acid equivalents) in *A. reptans* and 0,71g GAE% in *A. genevensis*. The antioxidant activity of the extract of *A. reptans* is stronger (88,11%) than that of extract of *A. genevensis* (66,62%).

Key words: *Lamiaceae*, *Ajuga reptans*, *A. genevensis*, biology, chemical composition.

INTRODUCERE

Genul *Ajuga* L. (fam. *Lamiaceae*) cuprinde aproximativ 40-50 de specii originare din Africa și Eurasia [2, 4]. În flora spontană a Republicii Moldova genul *Ajuga* L. este reprezentat de 6 specii: *Ajuga reptans* L., *A. genevensis* L., *A. laxmannii* (L.) Benth, *A. chia* Schreb, *A. orientalis* L. și *A. salicifolia* (L.) Schreber [11].

Prezenta lucrare se referă la studiul particularităților ontogenetice și compoziției chimice la speciile *Ajuga reptans* și *A. genevensis*.

Ajuga reptans L. (vinețică repentă) este plantă erbacee, perenă cu rizom scurt de la care pornesc numeroase rădăcini și stoloni ce formează la noduri rădăcini adventive. Tulpină erectă, patrumuchiată. Frunze opuse, lanceolate cu marginea dințată; cele bazale adunate în rozetă (Fig. 1). Flori sesile, albastre grupate în verticile. Fruct – tetranucula. Crește prin păduri revene și liziere.

Fig. 1. *Ajuga reptans*

Ajuga genevensis L. (suliman), specie perenă cu rizom scurt, oblic cu numeroase rădăcini. Tulpini

Fig. 2. *Ajuga genevensis*

simple, uneori puțin ramificate, înalte de 10-40 cm, erecte (Fig. 2). Frunze ovate, puțin păroase, cu margini dințate sau crenate, cele inferioare și mijlocii scurt pețiolate, cele superioare aproape sesile. Flori de culoare albastră, sesile sau scurt pedicelate, grupate cate 6-8 în verticile la baza bracteilor. Se întâlnește mai frecvent în zonele de nord și centru a țării. Vegetează în fitocenozele erbacee din pădurile de gorunet, tufărișuri, în depresiunile umede din vii, livezi și câmpuri.

Speciile de *Ajuga reptans* și *A. genevensis* posedă proprietăți terapeutice importante. Deși, astăzi sunt mai puțin folosite, ele au o lungă istorie de utilizare în medicina populară. Infuzia din plante se folosește în caz de tuse, febră, angină, dureri în gât, tulburări biliare, ulcer, alcoolism, hemoroizii, afecțiuni cardiovasculare. Până în prezent planta se consideră un remediu efectiv în tratamentul extern al bolilor de piele (răni, arsuri, hemoragii subcutanate, lovituri). În literatura de specialitate este mentionat efectul antiinflamator, diuretic, tonic, cardiac, cicatrizant, carminativ, expectorant, antipiretic, antidiareic, antibacterial, antioxidant [15, 18, 20, 25] al extractelor din plantele de *Ajuga* L. Plantele conțin ajugavensine [10], ecdysteroide [1, 13], cumarine, rezine, ulei volatil, tanine, flavonoide, antociani, polifenoli, iridoide [8, 9, 12, 14,]. Extractul uscat obținut din herba de *A. genevensi*s posedă acțiune bactericidă influiențând pozitiv procesul de regenerare a pielii în cazul diverselor tipuri de răni [3].

Scopul prezentei lucrări este studiul particularităților biologice și ontogenetice a două specii autohtone din genul *Ajuga* L. (*Ajuga reptans* și *A. genevensis*), precum și identificarea conținutului de flavonoide, acizi hidroxicinamici, polifenoli totali și a conținutului de ulei volatil în materialul vegetal uscat.

MATERIAL ȘI METODE

Plantele de *A. reptans* și *A. genevensis* au fost colectate în faza de înflorire deplină din populații naturale (comuna Huliboaca, municipiul Chișinău și localitatea Merenii Noi, raionul Anenii Noi) în prima decadă a lunii mai, 2014. Exsicatele herbarizate sunt depozitate în Herbarul Grădinii Botanice (I) a AȘM. Pe parcursul perioadei de vegetație s-au efectuat observări fenologice [17, 19, 23] și măsurări biometrice [21]. Studiul particularităților ontogenetice ale plantelor cultivate a fost efectuat conform îndrumărilor metodologice utilizate pe larg în prezent [22, 24, 26].

Studiile fitochimice au fost efectuate în cadrul Disciplinei de Farmacognozie de la Facultatea de Farmacie, Universitatea de Medicină și Farmacie *"Grigore T. Popa"*, Iași, România.

Pentru analize s-au folosit părțile aeriene uscate. Studiul fitochimic al probelor investigate s-a realizat prin cuantificarea flavonoidelor, acizilor hidroxicinamici, polifenolilor totali și a uleiului volatil. Pentru primele 3

categorii de componente bioactive, analizele s-au efectuat în extractele metanolice obținute prin refluxarea materialului vegetal timp de 30 min, la 60 °C.

Determinarea flavonoidelor s-a realizat prin metoda spectrofotometrică bazată pe formarea de complecși colorați în galben cu clorura de aluminiu, care absorb la λ=430 nm. Curba de calibrare s-a realizat folosind rutozida (4-16 μg/mL). Conținutul în flavonoide totale s-a exprimat în g rutozidă/100 g material vegetal uscat [6].

Acizii hidroxicinamici totali au fost determinați spectrofotometric printr-o metodă ce se bazează pe formarea de complecși colorați în roșu-carmin în prezența nitritului de sodiu și molibdat de sodiu, în mediu alcalin, absorbanța măsurandu-se la λ=505 nm, iar acidul rozmarinic s-a folosit drept etalon. Curba de calibrare s-a realizat folosind acidul rozmarinic (3-6 μg/mL). Cantitatea totală de acizi hidroxicinamici s-a exprimat în g acid rozmarinic/100 g material vegetal uscat [5].

Conținutul în polifenoli totali s-a determinat printr-o metodă spectrofotometrică care se bazează pe proprietatea polifenolilor de a forma o colorație albastră cu reactivul Folin-Ciocâlteu. Absorbanța s-a citit la λ=765 nm, iar curba de etalonare s-a realizat folosind acid galic (0,39-12,5 μg/mL). Rezultatele s-au exprimat în g echivalenți acid galic (GAE)/100 g produs vegetal uscat [16].

Izolarea și determinarea cantitativă a uleiului volatil s-a realizat prin hidrodistilare timp de 3 ore a materialului vegetal uscat. Conținutul în ulei volatil al produsului vegetal s-a exprimat procentual (mL ulei volatil la 100 g produs vegetal) [6].

Evaluarea activității antioxidante in vitro s-a realizat prin determinarea activității de scavenger de radicali liberi difenilpicrilhidrazil (DPPH). DPPH este un radical stabil de culoare violet care în prezența unor antioxidanți, este redus la difenilpicrilhidrazină DPPH-H (galbenă), ceea ce determină o scădere a absorbanței măsurate la 517 nm. Pentru efectuarea testului antioxidant, din extractele uscate s-au realizat soluții 40 mg/mL, 20 mg/mL și 10 mg/mL în dimetilsulfoxid (DMSO): apă=7:3. Drept martor pozitiv s-a utilizat acidul galic.

Determinările spectrofotometrice s-au realizat la spectrofotometrul ABLE-JASCO V 550 UV-VIS (Tokio, Japonia).

REZULTATE ȘI DISCUȚII

Particularități biologice și ontogenetice.

În rezultatul studiului particularităților ontomorfogenetice la speciile *A. reptans* și *A. genevensis* nu au fost notate deosebiri esențiale în realizarea programului ontogenetic la speciile cercetate.

Astfel, în **ontogeneza** plantelor de *A. genevensis* se evidențiază 4 perioade de vârstă (latentă, pregenerativă, generativă, postgenerativă) cu 8 etape de vârstă (plantulă, juvenilă, imatură, virginală, generativă timpurie, generativă mijlocie, generativă târzie, senilă) (fig. 3).

Etapa de vârstă ***plantulă*** este reprezentată de plantule mici cu două cotiledoane eliptice sau ovate, scurt pețiolate, pubescente cu lungimea de 5-7 mm și lățime de 3-4 mm. Radicula pivotantă de 1,0-1,5 cm.

La plantele ***juvenile*** se păstrează cotiledoanele și începe dezvoltarea lăstarului suprateran ortotrop și a rădăcinii principale. Lăstarii vegetativi bazali cu 2-3 frunze bazale formează rozeta. Rădăcina principală atinge lungimea de 2,5 cm de la care pornesc în dezvoltare rădăcinile laterale de ordinul I și II.

Plantele ***imature*** sunt reprezentate printr-un singur lăstar ortotrop de 7-10 cm. La această etapă cotiledoanele se ofilesc și încep să dispară. Pe lăstarul vegetativ se află 4-7 perechi de frunze sesile, alungit-eliptice. Cele bazale alungit spatulate, spre bază atenuate în pețiol au marginea ușor dințată, uneori aproape întreagă, de 4-12 cm lungime și 2-5 cm lățime. Rădăcina este pivotantă cu numeroase rădăcini laterale de ordinul I și II, lungimea cărora atinge 4-6 cm.

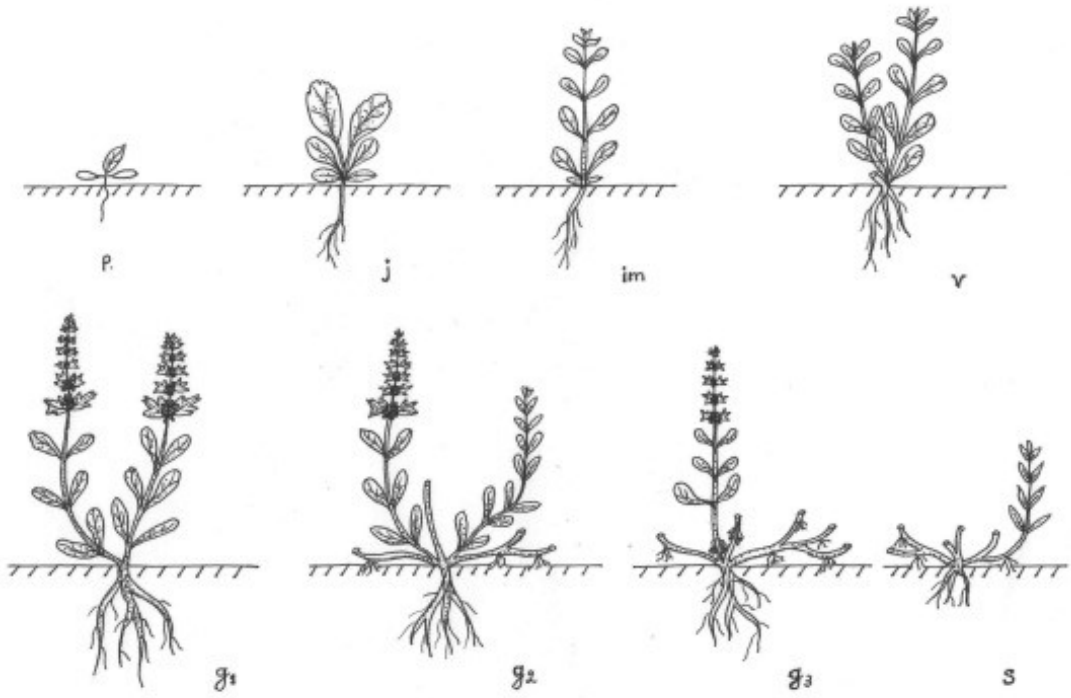

Fig. 3. Schema realizării programului ontogenetic la plantele de *Ajuga genevensis*

Pl - s – etapele de vârstă:

pl – plantulă, *j* – plante juvenile, *im* – plante imature, *v* – plante virginale, g_1 – plante generative tinere, g_2 – plante generative mature, g_3 – plante generative târzii, *s* - plante senile.

La etapa ***virginală*** plantele prezintă o tulpină principală solitară sau deseori 2-3 unite spre bază în rozetă. Frunzele se aseamănă mult cu ale plantei mature ca formă și dimensiuni. La această etapă începe dezvoltarea rizomului multicapitat care atinge 2-3 cm în lungime. Rădăcina principală este neevidentă, iar cele laterale de ordinul I și II continuă să se dezvolte și ating 6-8 cm în lungime.

Exemplarele la etapa de vârstă ***generativă timpurie*** constau din 2-3 lăstari erecți sau ascendenți de până la 15-25 cm înălțime, rareori spre vârf violet nuanțați. Frunzele bazale lipsesc definitiv, iar cele superioare trec în frunze bracteante tri-dințate sau deseori trilobate. Lungimea și lățimea rizomului continuă să se mărească, atingând spre sfârșitul fazei 5-6 cm lungime și rădăcinile laterale abundent dezvoltate.

La etapa de vârstă ***generativă mijlocie*** plantele înfloresc abundent cu formarea deplină a 2-3 lăstari generativi care se dezvoltă din mugurii bazali situați pe rizom. Lăstarii generativi prezintă 3-5 perechi de frunze și inflorescență formată din 8-15 verticile situate în axa bracteelor trilobate. Spre vârful inflorescenței distanța dintre verticile se micşorează formând o inflorescenţă piramidală spiciformă. Spre baza inflorescenței verticilii sunt mai distanțați. La această etapă încep să apară stoloni plagiotropi care rareori se înrădăcinează, dând naştere la noi lăstari vegetativi, care nu ating etapa generativă în perioada respectivă de vegetație. Organele subterane sunt reprezentate de rizomul care creşte în dimensiuni și rădăcinile laterale care cu lungimea de până la 15 cm.

La etapa ***generativă târzie*** planta prezintă 1-2 lăstari generativi în faza sfârşit de înflorire cu înălţimea de 30-40 cm. Inflorescenţa se alungeşte, verticilii florali se distanţează, începe maturizarea seminţelor. Potenţialul reproductiv al acestor plante este redus şi indică sfârşitul ontogenezei. Slăbeşte, de asemenea, potenţialul sistemului radicular.

Plantele ***senile*** sunt formate din 1-2 lăstari vegetativi, cu înălţimea de 10-15 cm. Lăstarii generativi lipsesc. Se observă dezintegrarea parţială a rizomului primar în câteva fragmente vii cu rădăcinile laterale în stare de putrefacţie.

Comparativ cu specia *A. genevensis,* pentru *A. reptans* este caracteristică dezvoltarea stolonilor de la rizomul scurt, care începe la etapa de vârstă ***virginală.*** Fiecare stolon pe toată lungimea care contactează cu solul dezvoltă la noduri rădăcini adventive ce se adâncesc treptat în sol şi respectiv se formează lăstarii aerieni (până la 20). Prin urmare, la această etapă de vârstă se complică structura formaţiunii subterane la care participă segmentele bazale de diferite dimensiuni ale lăstarilor aerieni cu numeroase rădăcini adventive şi muguri de regenerare. La etapa de vârstă ***generativă timpurie*** exemplarele constau din numeroşi lăstari aerieni erecţi sau ascendenţi şi un sistem subteran bine dezvoltat, care realizează următoarele etape ale programului ontogenetic într-un mod identic cu cel al speciei *A. genevensis.*

Rezultatele studiului chimic

Studiul chimic a evidenţiat o compoziţie polifenolică diferită în extractele de *A. reptans* şi *A. genevensis.* Extractul din *A. reptans* se caracterizează printr-o componentă flavonoidică mai bogată, aceasta prezentând un nivel aproape dublu faţă de cel identificat în extractul de *A. genevensis* (0,33 g% comparativ cu 0,18%) (Tab. 1).

Tabelul 1. Studiu chimic cantitativ al părţilor aeriene de *A. reptans* şi *A. genevensis*

Specia	**Flavonoide totale** g% (g la 100 g p.v. uscat exprimat in rutozida)	**Acizi hidroxicinamici** g% (g la 100 g p.v. uscat exprimat in acid rozmarinic)	**Polifenoli totali** g% (g la 100 g p.v. uscat exprimat in acid galic)	**Ulei volatil** mL% (mL la 100 g p.v. uscat)
Ajuga reptans	0,3396	0,3350	0,7200	0, 18
Ajuga genevensis	0,1817	0,0991	0,7154	0,13

Un conţinut mai sporit în flavonoide (0,455-0,501% exprimat în luteolină) a fost identificat în extractul din *A. reptans* şi valori cuprinse între 0,417 şi 0,839% în cel din *A. genevensis* în România [7]. Alţi autori [8] indică valori mai mici ale conţinutului de flavonoide (0,2449 şi 0,3090%) în plantele de *A. reptans* din flora spontană a României, iar pentru *A. genevensis* un conţinut mai sporit (0,2547-0,3323% exprimat în luteolină).

Conţinutul în acizi hidroxicinamici este evident mai mare la *A. reptans:* 0,33 g% faţă de aproximativ 0,1 g% identificat în *A. genevensis.* Concentraţia în polifenoli totali a celor 2 extracte este aproape similară: 0,72 g *GAE% în A. reptans* şi 0,71g GAE% în *A. genevensis.* Părţile aeriene de *A. reptans* sunt mai bogate în ulei volatil (0,18%) faţă de cele de *A. genevensis* (0,13%).

Activitatea antioxidantă este dependentă de concentraţie (Tab. 2). La cele mai mari concentraţii testate (40 mg/mL) s-au obţinut cele mai ridicate valori de inactivare a radicalului DPPH: extractul de *A. reptans* realizează o inactivare de peste 88%, în timp ce extractul de *A. genevensis* prezintă o activitate de scavenger de doar 66%. Chiar şi la concentraţii mai mici (20 mg/mL), extractul de *A. reptans* manifestă o activitate

antioxidantă bună, de peste 70%. În ambele cazuri, activitatea antioxidantă este mai mică prin comparație cu martorul pozitiv utilizat (acidul galic).

Tabelul 2. Activitatea de scavenger față de radicalul DPPH a extractelor de *A. reptans* și *A. genevensis*

Concentratia (mg/mL)	**Activitate de inhibare DPPH (%)**		
	Ajuga reptans	***Ajuga genevensis***	***Acid galic***
40	88,11±5,01	66,62±3,18	98,25±0,08
20	74,84±4,27	29,53±3,41	97,11±0,12
10	32,78±0,12	11,83±1,02	97,00±0,13

Deși, cele două extracte au practic același nivel al polifenolilor totali, potențialul antioxidant este diferit, chiar și la concentrațiile mici, cu toate că polifenolii sunt, în principal, răspunzători de efectele antioxidante.

Activitatea mai potentă a speciei *A. reptans* poate fi atribuită concentrațiilor ridicate de flavonoide și acizi hidroxicinamici: extractul de *A. reptans* prezintă un conținut în flavanoide aproape dublu, iar nivelul acizilor hidroxicinamici este de circa 4 ori mai mare față de concentrația înregistrată în extractul de *A. genevensis.*

Astfel, rezultatele obținute justifică continuarea studiilor în vederea utilizării extractelor obținute în special din părțile aeriene de *A. reptans* pentru obținerea de preparate cu acțiune antioxidantă, destinate profilaxiei și tratamentului adjuvant al afecțiunilor inflamatorii, precum și al altor afecțiuni însoțite de creșterea stresului oxidativ.

CONCLUZII

1. În ciclul de dezvoltare al plantelor de *A. reptans* și *A. genevensis* au fost evidențiate patru perioade de vârstă (latentă, pregenerativă, generativă, postgenerativă) cu opt etape de vârstă (plantulă, juvenilă, imatură, virginală, generativă timpurie, generativă mijlocie, generativă târzie, senilă).
2. Extractul din *A. reptans* se caracterizează printr-o componentă flavonoidică mai bogată (0,33 g%) comparativ cu 0,18 g% identificat în extractul de *A. genevensis.* Conținutul în acizi hidroxicinamici este evident mai mare la *A. reptans:* 0,33 g% față de aproximativ 0,1 g% identificat în *A. genevensis.*
3. Extractul de *A. reptans* manifestă o activitate antioxidantă mai pronunțată (88.11%) în comparație cu extractul de *A. genevensis* (66.62%) datorită concentrațiilor mai ridicate de flavonoide și acizi hidroxicinamici.

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RESEARCH ON *ARTEMISIA ANNUA* L. (*ASTERACEAE*) IN THE REPUBLIC OF MOLDOVA

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Abstract: This research refers to *Artemisia annua* L., a promising aromatic and medicinal species which is currently the subject of phytochemical investigation due to its chemical diversity and artemisisin content with important therapeutic effects. The aim of the study is focused on habitat evaluation, bio-productivity assessment, and volatile oil content of *A. annua* from natural populations in order to identify and capitalize their economic potential at local level. The biometric parameters, biomass production and essential oil content of studied species registers variations depending on the type of habitat, fact determined by different edaphic and climatic conditions from southern to northern parts of the country.

Key words: *Asteraceae, Artemisia annua, biology, biomss production.*

INTRODUCTION

In the flora of the Republic of Moldova *Artemisia* L. genus is represented by 9 species [14]. *Artemisia* L. genus includes important medicinal and aromatic plants used for the treatment of malaria, hepatitis, inflammation, cancer and a large spectrum of infections [27].

Fig. 1. *Artemisia annua*

This research refers to *Artemisia annua* L. – Sweet wormwood, a promising aromatic and medicinal species (fig. 1) which is currently the subject of phytochemical investigation due to its chemical diversity and artemisinin content with important therapeutic effects.

Artemisia annua L. is an annual species, 30-200(-250) cm in height. It has a pioneer strategy characterized by a high degree of morphological and reproductive plasticity and massive seed production. This species is a native of East Asia, most probably Inner Mongolia in China, where it is part of the grassland and steppe vegetation. *A. annua* has become widespread in temperate regions worldwide [19, 25].

In the flora of the Republic of Moldova *A. annua* is present in all parts of the country, but the distribution is very uneven. It regularly occurs in association with human settlements, in fields, ruderal habitats associated with transport infrastructure like roads and railways, as well as in semi-natural habitats [10, 12, 14].

Sweet wormwood is widely studied due to the biological activity of the extracts. The chemical composition of *A. annua* consists of volatile compounds, mainly represented by essential oils and non-volatile compounds

such as sesquiterpenoids, phenolics, flavonoids, coumarins, steroids [26].

A. annua is the main source of artemisinin, a sesquiterpene-lactone used for the treatment of malaria in many countries [5, 11, 17]. It was discovered in 1969 by the Chinese researcher Tu Youyou for which she received in 2015 the Nobel Prize in Physiology and Medicine. Artemisinin and artemisinin-derived compounds have been shown to exhibit antiviral, antimicrobial, anti-inflammatory, anti-parasitic, anti-allergic, immunoregulatory, cytotoxic, contraceptive and antioxidant actions [7, 8, 15, 18, 22-24, 28]. During the recent studies, artemisinin has also been identified as a substance with a strong anti-cancer potential [1, 6, 13, 21].

Artemisia annua has a large area of distribution in Republic of Moldova but there is little knowledge about it is content of bioactive compounds, in particular artemisinin and essential oil accumulated in our climatic and soil conditions. Being rich in bioactive compounds, it can be an important source of local plant material for pharmaceutical research and for development of new formulas of autochthonous medical preparations. For that reason, there are necessary more biological and biochemical investigations on this species in order to confirm the therapeutic action reported by traditional medicine and extend their utilization in national economy.

The present study aims to determine the variation of biometric parameters, the biomass production and the volatile oil content in *A. annua* depending on the type of habitat. This study was conducted under the project entitled "Capitalization of the natural potential of several medicinal and aromatic species in the *Artemisia* genus with economic and ecological value in Moldova" (supported by Swiss National Science Foundation) aiming at the capitalization of the genetic diversity of several native *Artemisia* species through the identification, chemical analyses, selection and propagation of high yielding genotypes.

MATERIALS AND METHODS

The research area covered all the territory of the Republic of Moldova. The study on flora and vegetation was carried out during the years 2014-2015, on 16 growing sites (distributed in the south, centre and north of the Republic of Moldova). The designation of Habitat types was made according to the Interpretation Manual of EU Habitats, 2007, Directive 92/43/EEC on the basis of scientific criteria defined in Annex III of the Directive [9]. The description of the associations was made based on characteristic, self-evident, dominant and differential species, according to the phytosociological research method of the central European school, based on the traditional ecological-floristic systems developed by Tüxen, 1955 [20] and J. Braun-Blanquet, 1964 [2].

Species identified on site were collected, dried, conditioned and inserted in the Herbarium of the Botanical Garden (Institute) of ASM. In parallel with the collection of the material for herbarium the specialty literature was studied. All the detected plant species are native to local flora and the taxonomy followed by the recent taxonomical literature [3, 4, 14].

The bio-morphological peculiarities of studied species were studied: for recording phenological phases (initial growth, budding, start of flowering, full flowering, start of seed setting, full seed set, fully mature) on a weekly basis. 10 individuals of each species were collected for the bioproductive assessment, in terms of biomass. The standard methodology [16, 29, 30] was used, following parameters were assessed: the number of individuals on surface unit, height of the individuals, number of shoots, inflorescence length. For these samples the fresh mass, the dry mass and the drying ratio were determined.

The samples prepared for the essential oil extraction (inflorescences) were collected at full flowering stage in September. A total of 48 samples (3 samples x 250 g d.w. x 8 sites/per year) were collected. The vegetal material was dried in the shadow, at room temperature. The volatile oil was obtained from dried and powdered aerial parts by hydrodistilation for 2 hours in a Clevenger apparatus.

RESULTS AND DISCUSSIONS

During the field expeditions over 2014-2015 vegetation periods, a total of 16 growing sites of *A. annua* were identified and characterized (Table 1, fig. 2, 3).

Table 1. The growing sites of *A. annua* identified in the Republic of Moldova (2014-2015)

	2014 vegetative period		2015 vegetative period	
	Location	District	Location	District
North	**Naslavcea** (N 48° 27' 39", E 27° 35' 14")	Ocnița	**Corjeuți** (N 48° 11' 42", E 27° 03' 05")	Briceni
	Cosăuți (N 48° 13' 37", E 28° 16' 32")	Soroca	**Arionești** (N 48° 22' 55", E 27° 50' 50")	Dondușeni
	Brânzeni (N 48° 05' 05", E 27° 09' 43")	Edineț	**Borosenii Noi** (N 47° 59' 14", E 27° 27' 49")	Râșcani
Central part	**Băcioi** (N 46° 54' 21", E 28° 54' 02")	mun. Chișinău	**Butuceni** (N 47° 18' 37", E 28° 58' 26")	Orhei
	Trebujeni (N 47° 19' 25", E 28° 57' 45")	Orhei	**Bujor** (N 46° 54' 39", E 28° 16' 13")	Hâncești
South	**Ciumai** (N 45° 47' 43", E 28° 33' 12")	Taraclia	**Troițcoe** (N 46° 30' 42", E 29° 01' 39")	Cimișlia
	Răscăieți (N 46° 35' 04", E 29° 45' 59")	Ștefan Vodă	**Crocmaz** (N 46° 27' 37", E 29° 59' 31")	Ștefan Vodă
	Colibași (N 45° 42' 49", E 28° 10' 16")	Cahul	**Cairaclia** (N 45° 46' 44", E 28° 36' 54")	Taraclia

Artemisia annua (for the first year, 2014) is tending to populate anthropogenic habitats with a high number of segetal and ruderalised vascular plants, such as: *Amaranthus deflexus* L., *Anagallis arvensis* L., *Anagallis foemina* Mill., *Anchusa pseudoochroleuca* Shost., *Atriplex tatarica* L., A*triplex oblongifolia* Waldst. et Kit., *Ballota nigra* L., *Berteroa incana* (L.) DC., *Bidens tripartita* L., *Brachyactis ciliata* (Ledeb.) Ledeb., *Capsella bursa-pastoris* (L.) Medik., *Cuscuta campestris* Yunck, *Cyclachaena xanthiifolia* (Nutt.) Fresen., *Daucus carota* L., *Descurainia sophia* (L.) Webb ex Prantl, *Diplotaxis muralis* (L.) DC etc., forming sometimes pure vegetal associations (*Artemisietum annuae*

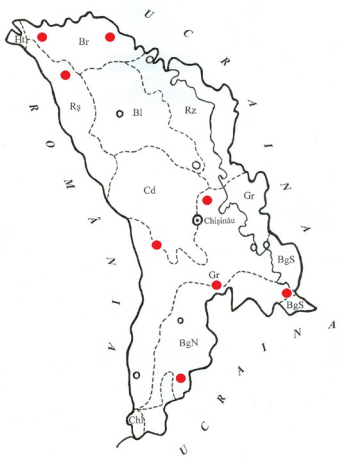

Fig. 3. The growing sites of *A. annua* (2014)

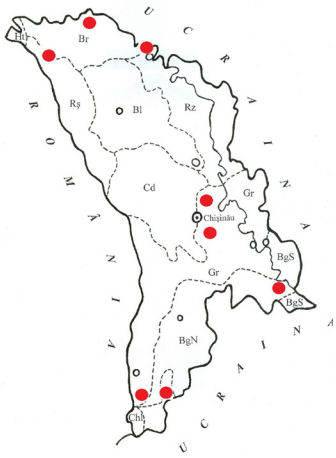

Fig. 2. The growing sites of *A. annua* (2015)

Fijalkowski 1967) where the species becomes mono-dominant in some ruderal phytocoenoses or being a part of the floristic component of other phytocoenoses: *Galinsogo-Euphorbietum pepli* Mititelu 1972, *Portulacetum oleracei* Felföldy 1942, *Portulacetum oleracei-Amaranthetosum deflexi* (Grigore 1968) Sanda et al. 2001, *Capsello-Descurainietum sophiae* Mucina 1993, *Hordeetum murini* Libbert 1939, *Chenopodio vulvariae-Urticetum urens* (Slavnić 1951) Soó, etc.

For the growing sites of the second year – 2015 were identified the anthropogenic habitats with a number of segetal and ruderalised vascular plants, such as: *Anagallis arvensis* L., *Atriplex tatarica* L., *Berteroa incana* (L.) DC., *Bidens tripartita* L., *Capsella bursa-pastoris* (L.) Medik., *Convolvulus arvensis* L., *Daucus carota* L., *Descurainia sophia* (L.) Webb ex Prantl, *Diplotaxis muralis* (L.) DC, *Euphorbia helioscopia* L., *Fallopia convolvulus* (L.) A.Love, *Fumaria officinalis* L., *Galinsoga parviflora* Cav., *Lamium amplexicaule* L., *Lamium purpureum* L., *Myosotis arvensis* (L.) Hill, *Setaria viridis* (L.) Beauv., *Setaria verticillata* (L.) Beauv., *Sisymbrium loeselii* L., *Stellaria media* (L.) Vill., *Thlaspi arvense* L., *Veronica hederifolia* L., etc., forming following vegetal associations: *Artemisietum annuae* Fijalkowski 1967, *Descurainietum sophiae* Passarge 1959, *Sisymbrietum loeselii* Gutte 1972, *Portulacetum oleracei* Felföldy 1942, *Portulacetum oleracei-Amaranthetosum deflexi* (Grigore 1968) Sanda et al. 2001, *Capsello-Descurainietum sophiae* Mucina 1993 and *Chenopodio vulvariae-Urticetum urens* (Slavnić 1951) Soó.

The biometric parameters, the biomass production and the essential oil content of the studied species registers variations depending on the type of habitat, fact determined by different edaphic and climatic conditions from southern to northern parts of the country.

After the evaluation of fresh and air-dried mass quantities of ten model plants (for instance Ciumai population), it was determined that it varies between 34.2g/12.4g (plant 2) and 109.6g/48.3g (plant 6); the average of the fresh/dry mass per plant is 66.3g/25.7 g (38.8 g d.w./100g f.w.) (Table 2).

Table 2. Fresh/dry weight per plant (Ciumai population, 2014)

Nr.	**Fresh weight, g/%**							**Dry weight, g/%**							**d.w. / 100g f.w.**
	stem		**leaf**		**impur.**		**total**	**stem**		**leaf**		**impur.**		**total**	
	g	**%**	**g**	**%**	**g**	**%**		**g**	**%**	**g**	**%**	**g**	**%**		
1	17.2	46.5	19.8	53.3	0	0	37.0	7.0	49.6	7.1	50.4	0	0	14.1	38.1
2	13.2	38.6	21.0	61.4	0	0	34.2	5.7	46.0	6.7	54.0	0	0	12.4	41.2
3	28.2	47.1	28.8	48.1	2.9	4.8	59.9	12.3	53.2	9.5	41.2	1.3	5.6	23.1	38.5
4	20.2	28.1	47.2	65.6	4.5	6.3	71.9	9.4	34.7	16.2	59.8	1.5	5.5	27.1	37.7
5	28.9	32.5	57.4	64.7	2.5	2.8	88.8	13.5	39.8	18.8	55.5	1.6	4.7	33.9	38.2
6	61.5	56.1	47.5	43.4	0.6	0.5	109.6	29.9	61.9	18.2	37.7	0.2	0.4	48.3	44.0
7	19.5	45.6	22.3	52.1	1.0	2.3	42.8	8.3	50.3	7.8	47.3	0.4	2.4	16.5	38.6
8	20.5	37.1	32.2	58.3	2.5	4.6	55.2	9.1	44.0	10.8	52.2	0.8	3.8	20.7	37.5

9	25.8	35.1	44.5	60.5	3.3	4.4	73.6	11.7	41.8	14.8	52.9	1.5	5.3	28.0	38.0
10	36.8	40.9	50.7	56.3	2.5	2.8	90.0	17.2	51.6	14.9	44.7	1.2	3.7	33.3	37.0
Ave rage		40.8		56.4		2.8	66.3		47.3		49.6		3.1	25.7	38.8

The ratio of stem/leaf/impurities, in terms of fresh biomass (for plant 2) represents 13.2 g (38.6 %) /21.2 (61.4 %) /0 and for plant 6 it constitutes 61.5 g (56.1 %) /47.5 g (43.4 %)/ 0.6 g (0.5 %). In terms of dry biomass the ratio of stem/leaf/impurities (plant 2) is 5.7 g (46.0 %)/6.7 g (54 %)/ 0 and for plant 6 it represents 29.9 g (61.9 %) /18.2 g (37.7 %)/ 0.2 g (0.4 %). The average of stem/leaf/ ratio per plant is 47.3 % /49.6 % (approximately 1:1). The rest of 3.1 % are represented by the impurities.

The results of biometric measurement (year 2014) showed that *A. annua* plants from central part of the country (Trebujeni population, *Artemisietum annuae* Fijalkowski 1967 ass.) registered the highest value of biometric parameters (56-182 cm high). In the southern part of the country (Ciumai population, *Portulacetum oleracei-Amaranthetosum deflexi* (Grigore 1968) Sanda et al. 2001 ass.) the height of the plants ranges between 62 and 171 cm. *A. annua* plants from the northern part of the country (Cosăuți population, *Chenopodio vulvariae-Urticetum urens* (Slavnić 1951) Soó ass.) reached up 120-160 cm. During the vegetation period in 2015, the most abundant populations with the most vigorous plants (up to 200 cm in height) were noted in the south of the country (Crocmaz population, *Capsello-Descurainietum sophiae* Mucina 1993 vegetal association). Minimum plant height (66 cm) was recorded for plants from Arionești population *(Sisymbrietum loeselii* Gutte 1972 association) from the northern part of the country.

The phenologic observations (2014) have revealed that the plants (Ciumai population) started blooming in the third decade of August; the peak of flowering period was noted in September and continued by the beginning of October. The seeds ripen in October – middle of November. There was no significant difference in the starting and duration of phenological phases of *A. annua* plants from the location situated in southern and central part of the country. In the north, the beginning of the phenologic stages was noted 6-8 days later. For the growing season of 2015, it was not noted a wide fluctuation in the phenology of *A. annua* species from southern, central and northern parts of the republic.

For the dry mass of *A. annua* herba, the highest value – 45.1 g d.w./100g f.w. (the average of three samples from the same location) was registered for Rascaieti population (ass. *Artemisietum annuae* Fijalkowski 1967). The lowest rate of the dry weight of *A. annua* herba (32.4g d.w./100g f.w. – the average of three samples from the same location) was registered in the northern part of the country (Cosauti population, *Chenopodio vulvariae-Urticetum urens* (Slavnić 1951) Soó ass.). The drying ratio for *A. annua* herba has values of 2.22 to 3.08 varying both between the samples from all studied populations.

Table 3. Variation of biomass production and volatile oil content in *A. annua* depending on growing conditions (2014-2015)

	2014 vegetative period						
			Nr/ sample	d.w./100g		Volatile oil content, mL /100 g d.w.	
	Location	Plant association			average		average
North	**Naslavcea**	*Capsello-Descurainietum sophiae* Mucina 1993	S1	39.0	38.6 g	1.08	1.20
			S2	36.9		1.40	
			S3	40.1		1.12	
	Cosăuți	*Chenopodio vulvariae-Urticetum urens* (Slavnić 1951) Soó	S1	31.4	32.4 g	1.32	1.25
			S2	33.2		1.24	
			S3	32.6		1.20	
	Brânzeni	*Hordeetum murini* Libbert 1939	S1	34.9	36.4 g	1.40	1.29
			S2	35.6		1.26	
			S3	38.6		1.20	
Central part	**Băcioi**	*Portulacetum oleracei* Felföldy 1942	S1	42.1	41.4 g	1.16	1.14
			S2	41.2		1.06	
			S3	40.9		1.20	
	Trebujeni	*Artemisietum annuae* Fijalkowski 1967	S1	39.0	39.6 g	1.14	1.10
			S2	39.8		0.84	
			S3	40.0		1.34	
South	**Ciumai**	*Portulacetum oleracei-Amaranthetosum deflexi* (Grigore 1968) Sanda et al. 2001	S1	39.3	41.0 g	1.12	1.15
			S2	42.0		1.18	
			S3	41.6		1.16	
	Răscăieți	*Artemisietum annuae* Fijalkowski 1967	S1	46.2	45.1 g	1.10	0.99
			S2	44.4		0.90	
			S3	44.7		0.98	
	Colibași	*Galinsogo-Euphorbietum pepli* Mititelu 1972	S1	41.5	41.3 g	1.00	1.08
			S2	40.3		1.22	
			S3	42.0		1.02	
	2015 vegetative period						

North	**Corjeuți**	*Chenopodio vulvariae-Urticetum urens* (Slavnić 1951) Soó	S1	34.8	38.8 g	0.94	0.72
			S2	41.2		0.76	
			S3	40.6		0.48	
	Arionești	*Sisymbrietum loeselii* Gutte 1972	S1	35.9	38.3 g	0.80	0.75
			S2	41.4		0.84	
			S3	37.6		0.62	
	Boroșenii Noi	*Artemisietum annuae* Fijalkowski 1967	S1	40.1	39.4 g	0.52	0.90
			S2	38.8		1.40	
			S3	39.4		0.78	
Central part	**Butuceni**	*Descurainietum sophiae* Passarge 1959	S1	45.2	44.1 g	0.98	0.96
			S2	44.6		1.02	
			S3	42.7		0.88	
	Bujor	*Portulacetum oleracei-Amaranthetosum deflexi* (Grigore 1968) Sanda et al. 2001	S1	39.1	42.5 g	0.96	0.95
			S2	42.2		0.92	
			S3	46.4		0.98	
South	**Troițcoe**	*Artemisietum annuae* Fijalkowski 1967	S1	48.0	46.7 g	0.86	0.90
			S2	47.4		1.14	
			S3	44.9		0.72	
	Crocmaz	*Capsello-Descurainietum sophiae* Mucina 1993	S1	39.7	38.2 g	0.98	0.90
			S2	34.2		0.80	
			S3	40.8		0.94	
	Cairaclia	*Portulacetum oleracei* Felföldy 1942	S1	44.3	42.5	1.10	1.17
			S2	42.8		1.04	
			S3	40.6		1.38	

The total essential oil content ranged from 0.84 to 1.40% (average 1.15%) for the samples collected in 2014 (Table 3). The highest content (1.40%) of essential oil was noted in *A. annua* plants collected in *Capsello-Descurainietum sophiae* Mucina 1993 vegetal association (Naslavcea population) and from Brânzeni population (*Hordeetum murini* Libbert 1939 ass.) occurred in the northern part of the country. *A. annua* plants from pure associations (*Artemisietum annuae* Fijalkowski 1967) in the south of the Republic of Moldova (Răscăieți population) had the lowest content (0.84%) of essential oil, fact that can be determined by the higher population density that affects nutrient absorption and exposure of plants to the light.

For the samples collected in 2015, the content of total essential oil varied from 0.48 to 1.40% (average 1.15%). The lowest content (0.48%) of essential oil was noted in Corjeuți population, north of the country, where *A. annua* represents a floristic component of *Chenopodio vulvariae-Urticetum urens* (Slavnić 1951) Soó vegetal association. Also in the north, it was found the lowest content (0.84%) of essential oil in *A. annua* plants from pure mono-dominant association (*Artemisietum annuae* Fijalkowski 1967, Borosenii Noi population), fact which can be also determined by the higher population density of plants.

The information on survey and mapping of *Artemisia annua* L. for the first time in the Republic of

Moldova made possible a local review of distribution and abundance estimation of natural populations of this species together with the evaluation of eco-biological and phytochemical data. The studied *A. annua* species, after it has been characterized both from the bio-ecological and phytochemical points of view and the most valuable accessions having been domesticated could be cultivated locally using sustainable methods and supply raw material for local pharmaceutical industry.

CONCLUSIONS

1. *Artemisia annua* is tending to populate some anthropogenic habitats, sometimes forms pure vegetal associations (*Artemisietum annuae* Fijalkowski 1967) or is a part of floristic component of other phytocoenoses.
2. The rate of the dry biomass of *A. annua* herba varied from 32.4 to 45.1 g d.w./100g f.w. in the vegetative period of 2014 and from 38.2 to 46.5 g d.w./100g f.w in 2015. The highest values of dry mass were registered for *A. annua* plants from central and southern part of the country where they form pure vegetal associations (*Artemisietum annuae* Fijalkowski 1967).
3. The volatile oil content in *A. annua* plants varied both depending on the site and region. For the samples collected in 2014, the content of total essential oil varied from 0.84 to 1.40%. The total essential oil content ranged from 0.48 to 1.40% for the samples collected in 2015.
4. The biometric parameters, the biomass production and the essential oil content of the studied species registers variations depending on the vegetal association, fact determined by different edaphic and climatic conditions from southern to northern parts of the country.

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BIOMETRIC AND ANATOMICAL STUDY OF THE SPECIES *POLYGONUM SACHALINENSE* F.SCHMIDT

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Abstract. The anatomical structures of the species *Polygonum sachalinense*, from the collection of the Botanical Garden, grown in the pedo-climatic conditions of the Republic of Moldova, were studied. The microscopic examination performed on cross sections and surface preparations revealed specific anatomical features: the presence of calcium oxalate druses and starch granules, collenchyma and sclerenchyma in stems, multicellular protective hairs and multicellular glands with browned content in leaves. The biometric study performed on a set of morphological indices (stem height, stem diameter, number of internodes, length of internodes, number of ramifications, number of leaves, length and width of leaves) indicates that *P. sachalinense* accumulates large amounts of biomass.

Key words: *Polygonum sachalinense*, biometry, anatomy, specific structures.

INTRODUCTION

The species *Polygonum sachalinense* F. Schmidt is native to East Asia (Sakhalin, Kuril, Hokkaido and Honshu Islands, North and South Korea). It is also known as: *Reynoutria sachalinensis* (F. Schmidt) Nakai, *Fallopia sachalinenses* (F. Schmidt) Ronse Decr., *Pleuropterus sachalinensis* (F. Schmidt) H. Gross, *Tiniaria Sachalinensis* (F.Schmidt) Janch., its synonyms [5, 8, 14]. The common names of this species, in Russian, are гречиха сахалинская, горец сахалинский, сибирский бамбук, in Romanian – hrişca de Sahalin and in English – giant knotweed and Sakhalin knotweed. *P. sachalinense* is a gynodioecious species, with hermaphrodite and female flowers on separate plants, both types of plants coexist in a population. Genetically, the populations of *P. sachalinense* can be tetraploid (2n=4x=44), hexaploid (2n=6x-66), octoploid (2n=8x=88) [7, 8], and sometimes – dodecaploid (2n=12x=132). The species named *P. sachalinense* is known as having a number of chromosomes 2n=44 and 2n=66, and named *Fallopia sachalinensis* – 2n=32, 44, 132 [1, 6].

P. sachalinense is an herbaceous perennial plant, growing up to 3-4 m tall, in its native countries, with underground organs represented by extensively spreading rhizomes, with thin adventitious roots and with erect fistulous stems. Young roots are white and elastic. At the beginning of the growing season, the stems are herbaceous, then become lignified [4, 9, 10]. In optimal conditions, the Sakhalin knotweed reproduces vegetatively (by segments of rhizomes and aerial stems) and by seedlings, both in its native countries and in the Republic of Moldova [12, 14].

P. sachalinense grows spontaneously in the Far East. It is a promising plant, which contains high amounts of proteins, macro- and micronutrients, vitamins and biologically active substances (alkaloids, phytoestrogens, phenolic compounds, including tannins, phlavanoids) [5, 20]. This species was introduced in the collection of the Botanical Garden (I) of the ASM by A. Teleuta, in 1982, from North Ossetia (Agricultural Institute, Vladikavkaz). Amino acids play an important role in the metabolism of living organisms, and the fresh mass of Sakhalin knotweed is rich in amino acids, it contains high amounts of glutaminic acid, aspartic acid and lysine, and the list continues with another 13 amino acids [19]. *P. sachalinense* is one of the most important sources of resveratrol, which is a natural phytoalexin, and of its glycosides. Resveratrol inhibits the formation and growth of cancer cells [21]. The plant can be cultivated for feed, energy, medicinal, ornamental and food purposes (you can eat the young twisted leaves and young shoots, which resemble those of asparagus) [17]. An important advantage of *P. sachalinense* plants is their longevity; they grow on the same land for 10-15 years, maintaining high biological productivity [18].

The purpose of this study has been to determine the biometric and morpho-anatomical features of *P. sachalinense* plants grown in the pedo-climatic conditions of the Republic of Moldova.

MATERIALS AND METHODS

Plants of *P. sachalinense*, the variety *Gigant* (approved and registered in the Catalogue of Plant Varieties of the Republic of Moldova, in 2012), from the collection of the Plant Resources Laboratory of the Botanical Garden (I) ASM, from which, leaves and stems were harvested at the beginning of flowering phase, served as biological material for research. The biometric study was performed on mature plants by analysing a set of indices: plant height, number of leaves, length and width of leaves, number of internodes, length of internodes, number of ramifications, according to the classic methodical indications [16]. The obtained data were systematized and processed statistically, according to the following parameters: average, dispersion, standard deviation, coefficient of variation and standard error.

The anatomical study was performed on cross sections of the stem and leaf, and on superficial preparations of clarified materials with NaOH 3% and chloralhydrate [11].

The sections were examined under microscopes *A. Kruss Optronic* and *Micros* (Austria) with digital camera connected to computers, at the Pharmacognosy and Pharmaceutical Botany department of the State University of Medicine and Pharmacy "Nicolae Testemitanu".

RESULTS AND DISCUSSIONS

Plant biometry. Under the pedo-climatic conditions of Moldova, the plants of sp. *P. sachalinense* are developed as herbaceous perennial plant, which can reach a maximum height of 6 m. The growing season begins with the development of dormant buds at the base of the stem, changing from reddish-brown to pink, starting to form green leaves.

The morphological research denotes that, in the pedo-climatic conditions of the Republic of Moldova, *P. sachalinense* develops a root system consisting of 1st, 2nd and 3rd order adventitious roots, which appear on the rhizomes and their function is to store reserve substances (fig.1). The young roots develop absorbent hairs, which appear in the 3rd or 4th day of seed germination.

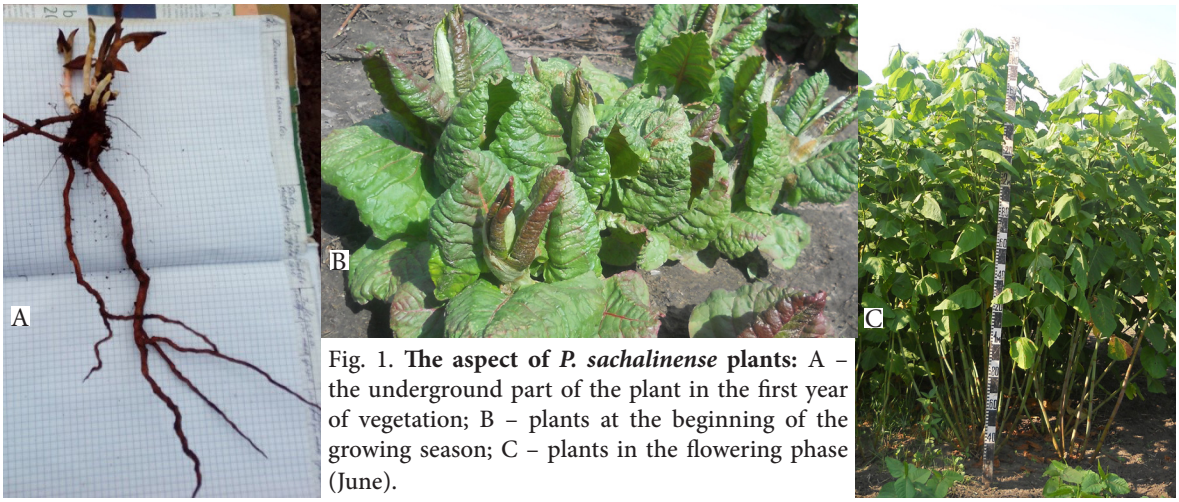

Fig. 1. **The aspect of *P. sachalinense* plants:** A – the underground part of the plant in the first year of vegetation; B – plants at the beginning of the growing season; C – plants in the flowering phase (June).

The phenological observations and the biometric analysis (plant height, number of leaves, length and width of leaves, number of internodes, length of internodes and number of ramifications) were performed dynamically during the entire vegetative season, and the results are presented in Table 1.

The Sakhalin knotweed developed vegetative shoots that grew slowly until the middle of April. At the beginning of the growing season, the shoots were green and then turned brown and lignified. In April-July, the plants were characterised by an intense and rapid development (a stem grew from 38.9 cm to 534.7 cm). The number and the length of internodes changed as the plants grew, their number varied from 4-6, in April, to 30-37, in July. The length of internodes reached in July the highest values – 25 cm. The development of the lateral ramifications, of 1st, 2nd and 3rd order, occurred later, in mid-May, in a period of 45-50 days from the beginning of the vegetative season. At the end of July 2016, the maximum plant height was recorded – 580±60.51 cm and the maximum ramification of the stem – 12 units.

The number of internodes and their growth also confirmed the intense development of the plant; their number grew from 4, in mid-April, to 37, at the beginning of July, during that period (April-July) the length of internodes varied from 6.7±0.22 cm to 21.7±0.76 cm.

The plants have simple, petiolate, alternate leaves, with ovate blade, cordate (heart-shaped) at the base, with slightly wavy, crenate margin and acuminate apex. The leaves from the basal part of the stem started withering and falling in June, and those from the middle and upper part of the plant remained until the end of the growing season. In the flowering phase, the highest number of leaves on a plant was of 69±1.95, and they reached a maximum size (44±0.49 cm long and 35±0.49 cm wide), developing an impressive leaf area.

The biometric study, carried out using millimetre paper, showed that the leaf area of a mature plant, in the flowering phase, varied between 27728 and 48288 cm^2 and was determined by the height and the degree of branching of the stem, as well as by the number and the size of leaves.

The flowers are actinomorphic, small (0.5-0.8 cm in diameter), with simple perianth, gathered in panicle inflorescences. The androecium consists of eight free stamens, with flattened, smooth filaments. The stigma is three lobed, and the ovary – superior. The fruit is dry, indehiscent, three-sided achene with pointed tip, shiny, brown; the pericarp is not fused with the seed coat. The seeds are about 2-3 mm long and 1-1.5 mm wide. One gram contains about 1047 seeds of Sakhalin knotweed. The seeds cannot be stored a long time, because they lose their potential to germinate [2].

The morphological analysis of the development of the shoots of *P. sachalinense*, during the growing season, has shown that this species has a high potential for producing green mass. This feature makes it more advantageous as compared with other, traditional species of forage plants.

Stem anatomy. The stem in cross-section is costate, with 6-13 angles. The following histological zones are easily distinguished in the cross-section of a stem: the epidermis, the primary cortex and the central cylinder. The epidermis consists of a single layer of tangentially flattened cells, covered with a well-defined cuticle. The exodermis consists of an angular collenchyma, which is developed very well at the angles. The mesoderm is formed of 4-5 layers of parenchymal cells with starch granules and with sporadic calcium oxalate druses. The endodermis consists of a layer of tangentially elongated cells (Fig. 2).

Table 1. Biometric analyses of the shoots of *P. sachalinense* during the growing season, April-July 2016

Date	Biometric indices	Statistical parameters					
		Min.	Max.	Average	Standard error (Sx)	Standard deviation (δ)	Coefficient of variation (CV)
15.04	Height of the stem (cm)	28	63	38.9	±3.26	10.29	26.45
	Diameter of the stem (cm)	2	4	2.6	±0.22	0.7	26.92
	Number of internodes	4	6	4.8	±0.20	0.63	13.13
	Length of internodes (cm)	6	8	6.7	±0.22	0.68	10.15
	Number of ramifications	-	-	-	-	-	-
	Number of leaves	3	7	4.6	±0.5	1.58	34.35
	Width of leaves (cm)	7	14	9.5	±0.69	2.17	22.84
	Length of leaves (cm)	8	13	9.5	±0.58	1.84	19.37
15.05	Height of the stem (cm)	260	315	290.3	±5.11	16.14	5.56
	Diameter of the stem (cm)	2	4	2.7	±0.37	1.17	43.33
	Number of internodes	13	24	14.6	±0.73	2.32	15.89
	Length of internodes (cm)	8	18	11.6	±1.03	3.24	27.93
	Number of ramifications	-	-	-	-	-	-
	Number of leaves	12	15	13	±0.36	1.15	8.85
	Width of leaves (cm)	17	22	18.7	±1.70	5.38	28.77
	Length of leaves (cm)	20	28	23.8	±1.18	3.73	15.67
15.06	Height of the stem (cm)	389	470	450	±10.34	32.68	7.26
	Diameter of the stem (cm)	3	6	4.4	±0.30	0.96	21.82
	Number of internodes	19	24	22.2	±0.66	2.10	9.46
	Length of internodes (cm)	11	19	15	±0.84	2.67	17.8
	Number of ramifications	3	6	4.6	±0.27	0.84	18.26
	Number of leaves	31	38	36	±0.68	2.16	6.00
	Width of leaves (cm)	26	32	29.3	±0.60	1.89	6.45
	Length of leaves (cm)	33	41	38	±0.73	2.31	6.03
15.07	Height of the stem (cm)	391	580	534.7	±21.10	66.65	12.46
	Diameter of the stem (cm)	3	7	5	±0.42	1.33	26.6
	Number of internodes	30	37	33.8	±0.68	2.15	6.36
	Length of internodes (cm)	17	25	21.7	±0.76	2.45	11.29
	Number of ramifications	10	12	11.1	±0.23	0.73	6.57
	Number of leaves	49	69	58.7	±1.95	6.17	10.46
	Width of leaves (cm)	30	35	33.2	±0.49	1.55	4.67
	Length of leaves (cm)	40	44	42	±0.49	1.56	3.71

The central cylinder occupies the largest volume in the cross section of the stem. The conducting vascular bundles are collateral open, arranged in a circle, bounded by narrow medullary rays (2 layers of cells, which are rich in starch granules). In every vascular bundle, there are 3-4 woody vessels with large diameter. The stem is also characterized by the presence of the lignified sclerenchyma, which forms a ring of 8-10 layers of cells, interrupted by the medullary rays from the external part of the vascular bundles. The woody sclerenchyma consists of only 4-6 layers of lignified cells. The medullary parenchymal cells are large, rich in starch granules, without intercellular spaces. The internal epidermis also consists of a single layer of tightly packed cells, but they are smaller than in the external epidermis.

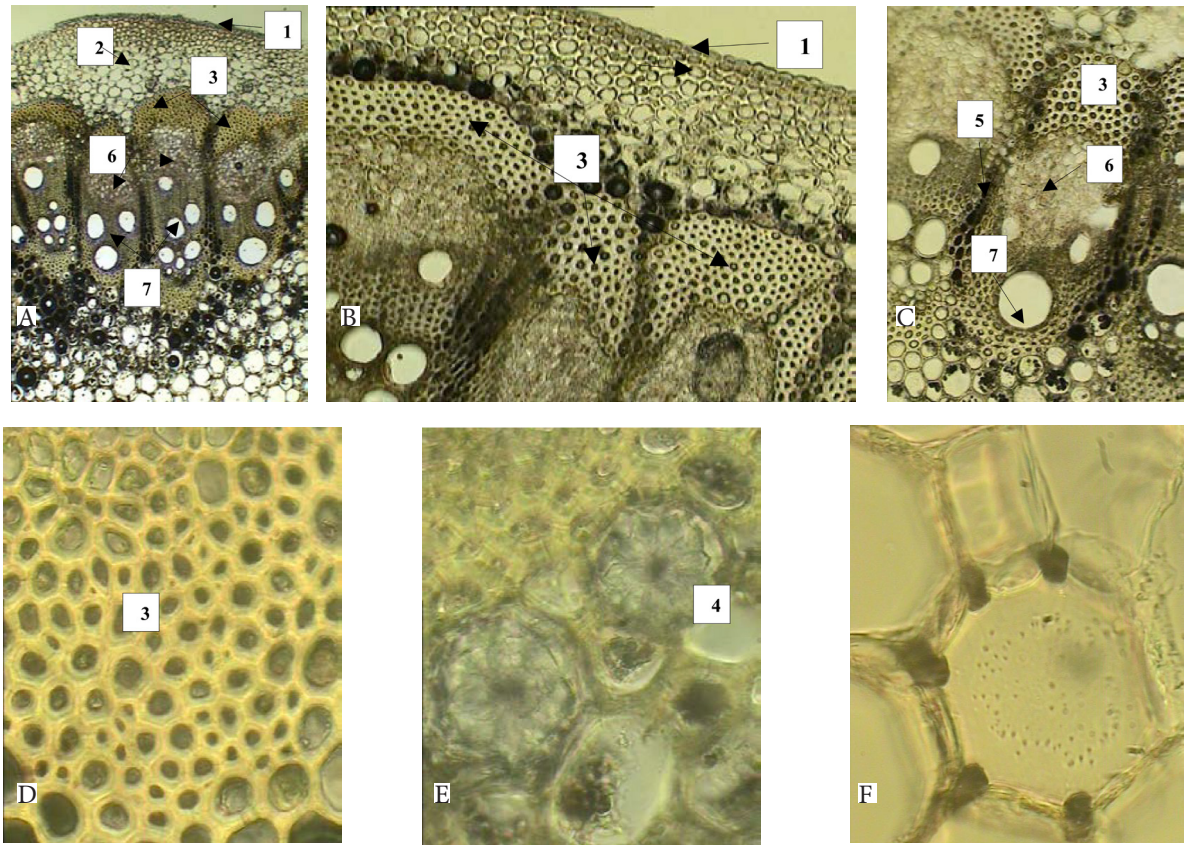

Fig. 2. **The anatomy of the stem:** A, B, C – cross sections; D – sclerenchymatous layer (bast fibre), x400; E – parenchyma with calcium oxalate druses, x400; F. – punctuated cell wall of parenchyma, x400; 1 – epidermis; 2 – angular collenchyma; 3 – sclerenchyma; 4 – calcium oxalate druses; 5 – medullary rays; 6 – phloem 7 – xylem.

Leaf anatomy. In the cross section of the leaf blade we distinguish: the upper epidermis, the dorsiventral mesophyll and the lower epidermis. The epidermis consists of slightly flattened, tightly packed parenchymal cells, with specific structures (stomata, protective hairs and glands). The leaves are amphistomatic with anomocytic stomata. On surface preparations, the upper epidermis differs from the lower one. The cells of the upper epidermis are larger, the cell walls are slightly wavy and the number of stomata is lower than in the lower epidermis. On the lower epidermis, the stomata are more rounded in shape and smaller, are numerous,

and the epidermal cells are characterized by markedly wavy cell walls, giving it a mosaic appearance (Figure 3).

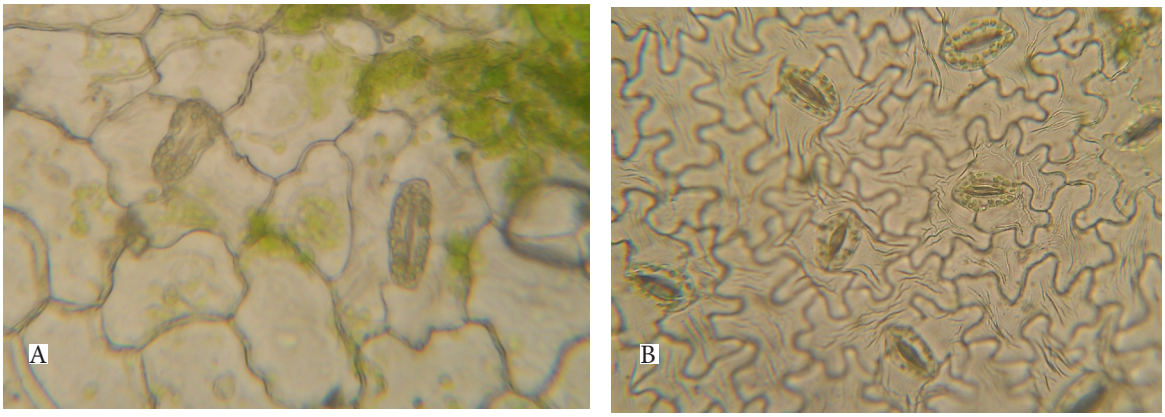

Fig.3. **Epidermis of the leaf blade;** A – upper, B – lower, x400.

The mesophyll is differentiated into palisade and spongy tissue. The palisade layer is situated beneath the adaxial (upper) epidermis, represented by two layers of elongated cells, with a large number of chloroplasts, located perpendicularly to the upper epidermis of the leaf blade. The spongy parenchyma is located behind the lower epidermis and consists of lobed cells, with fewer chloroplasts and with intercellular spaces. In the cells of spongy parenchyma, there are ergastic inclusions – druses of calcium oxalate. At the border of palisade and spongy parenchyma, the leaf mesophyll is perforated by collateral vascular bundles. Next to the largest vascular bundles, angular collenchyma is present.

The large, unbranched, multicellular tector hairs, formed of 3-5-7 uniseriate cells, covered with thick, sometimes corrugated cuticle, are characteristic of the leaf epidermis of Sakhalin knotweed. On the epidermis, there are also smaller multicellular tector hairs, with thick, but smooth cuticle. There are more protective hairs on the lower epidermis of the leaf blade than on the upper one, where they are found only along the veins. Some multicellular (6-8 cells) glands with browned content were found only on the lower epidermis (Fig. 4).

The data obtained as a result of the morphological study, carried out on a set of morphological indices, denotes that, in the Republic of Moldova, Sakhalin knotweed grows rapidly and has high capacity to produce very large amounts of biomass, expressed by the large leaf area, which determines a high photosynthetic potential that would allow the biosynthesis and the accumulation of natural chemical compounds.

The results of the anatomic study performed on surface preparations and cross sections of stems and leaves of *P. sachalinense*, analysed thought scientific literature data [15,19], allowed the elucidation of specific anatomical structures for plant organs: in stems – the presence of the calcium oxalate druses, the angular collenchyma at the angles, the sclerenchymatous ring and the collateral open vascular bundles; in leaves – the lower epidermis with cells with wavy walls, the amphistomatic leaf blade with anomocytic stomata, which are small and numerous in the lower epidermis, the two types of unbranched, multicelular protective hairs with corrugated and smooth cuticle, located mainly along the veins, the multicelular glands with browned content found in the lower epidermis, the dorsiventral mesophyll with calcium oxalate druses.

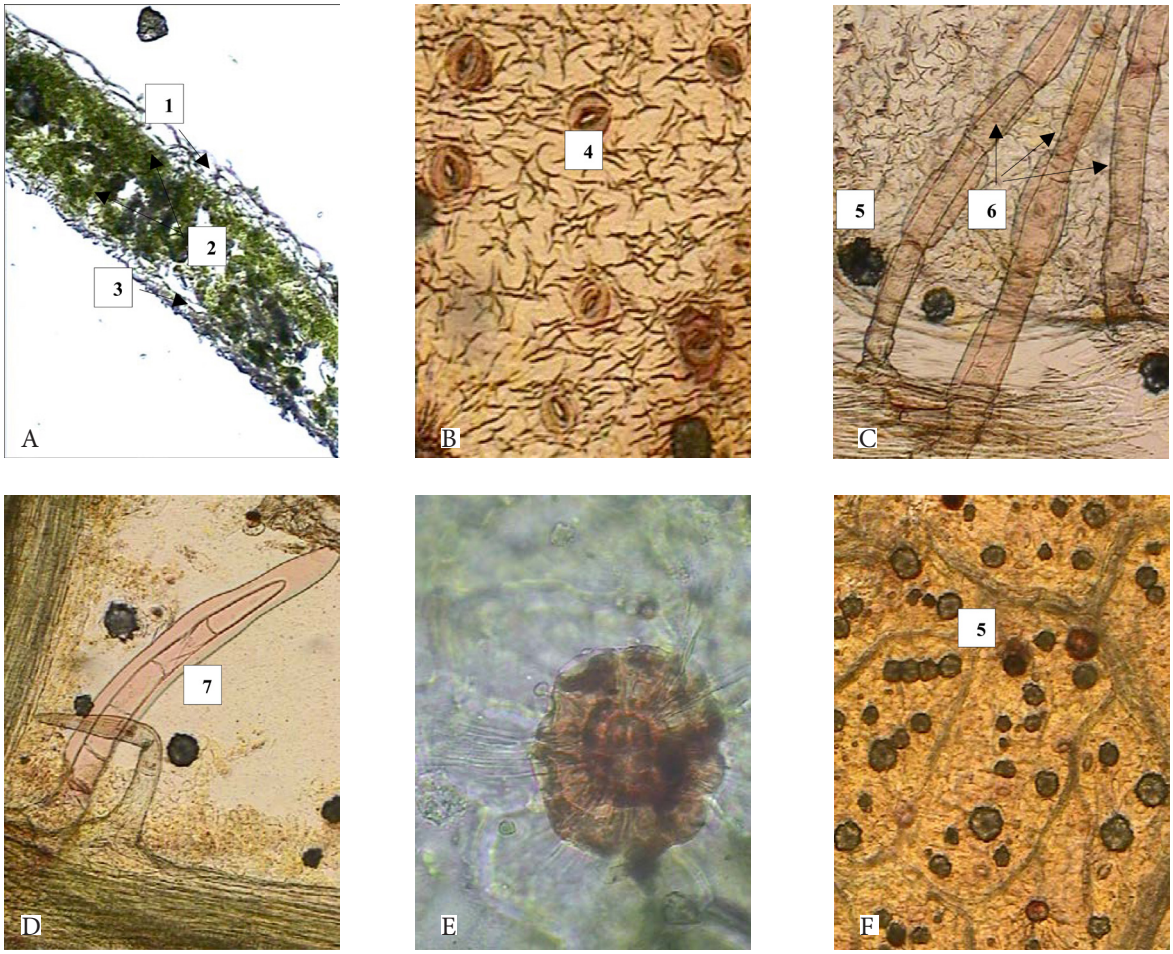

Fig. 4. **Leaf anatomy:** A. – Cross section of the leaf blade, x100; B, C, D. – lower epidermis, (surface preparation) x400; E, F – upper epidermis x400. 1 – upper epidermis x 100; 2 – differentiated mesophyll; 3 – lower epidermis; 4 – stomata; 5 – calcium oxalate druse; 6 –multicellular protective hairs with corrugated cuticle, 7 – protective hairs with smooth cuticle.

The pubescent leaves, protected by 2 types of protective hairs with thick cuticle and glands with browned content, the presence of calcium oxalate druses and other structural indices constitute the structural adaptive potential of plants to unfavourable conditions and ensure the ability to adapt to the specific pedo-climatic conditions of the Republic of Moldova, which are different from those of Far East (Eastern Asia) – the native area of *P. sachalinense.*

Thus, due to its morphological features and biometry of the most important indices for productivity (leaf area, height and ramification of the stem), *P. sachalinense* species, the variety Gigant, is a forage crop with certain advantages under the pedo-climatic conditions of the Republic of Moldova and can be recommended for cultivation on large areas in order to obtain fodder for animals and biomass for energy production.

CONCLUSIONS

1. In the conditions of the Republic of Moldova, *P. sachalinense* is a vigorous plant with a large leaf area (48288 cm^2), the maximum height – 580 cm, 8-10 ramifications, the highest number of leaves – 69, the maximum size of a leaf (44 cm long and 35 cm wide), which constitute a high photosynthetic potential that would ensure the capacity to accumulate large quantities of green biomass.
2. The following zones are specific to the anatomy of the stem of Sakhalin knotweed: the epidermis, which consists of a single layer, the cortex with collenchyma and storage parenchyma with starch granules, calcium oxalate druses, the sclerenchymatous layer and the central cylinder with collateral open vascular bundles, interrupted by amylogenous medullar rays.
3. The anatomy of the leaf is characterised by: the dorsiventral mesophyll, the amphistomatic leaf blade, the anomocytic stomata, the multicelular protective hairs of two types with corrugated and smooth cuticle, more numerous on the lower epidermis, the multicelular glands with browned content and presence of calcium oxalate druses.
4. The biometric data regarding the main morphological characteristics (plant height, ramifications, number and length of internodes, number of leaves, leaf area etc.) allow recommending the cultivation of the species *P. sachalinense* (variety *Gigant*) on large areas, under the pedo-climatic conditions of the Republic of Moldova.

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AMINO ACIDS IN *POLYGONUM SACHALINENSE* F.SCHMIDT

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Abstract: *Polygonum sachalinense* F. Schmidt (giant knotweed of Sakhalin knotweed) is a promising species in the Republic of Moldova, which can be used for various purposes, as forage, medicinal, ornamental and edible plant, with high content of vitamins, macro- and microelements, amino acids. 21 amino acids, 7 of which are essential for humans and animals, were found in the dry matter of Sakhalin knotweed. The amount of essential amino acids in leaves was about 10.0 g/kg and, in stems – 40.6 g/kg. The amino acids found in *P. sachalinense* were: threonine (Thr), valine (Val), isoleucine (Ile), leucine (Leu), phenylalanine (Phe) and lysine (Lys). In stems, leucine was found in higher amounts, as compared with other amino acids; it was followed by lysine and valine. In leaves, the first place, in terms of quantity, was also occupied by leucine, followed by valine and lysine. The amount of proteinogenic amino acids in the mixture of leaves and stems was about 50 g/kg.

INTRODUCTION

Amino acids are fundamental constituents of living matter and universal regulators of the metabolism and play an important role in the vital activity of living organisms. This class of organic compounds are the most important elements of the nutrition of human beings and animals [4, 11]. Amino acids are basic structural elements, which are part of the compounds of great biological importance – proteins, are involved in protein synthesis and in the structure of nucleotides, constitute the major substrate of some important enzymatic reactions, as well as important neurotransmitters at the cellular level [2].

Plant roots absorb amino acids, which are used as a source of nitrogen. For the synthesis of amino acids, plants need nitrogen and carbon. As a source of carbon, the green plants use CO_2, so they can synthesize entirely their nitrogenous organic matter on the basis of minerals, through the assimilation of nitrites or ammonia from the soil. The plants without chlorophyll, for the synthesis of ammonia, use carbon from organic substances taken from the environment, usually carbohydrates [1].

About 200 amino acids are known, but only 20 of them are incorporated into proteins and are called proteinogenic amino acids or primordial biomolecules of proteins, with the general formula $RCH(NH_2)COOH$, which are attributed to α-amino acids [10]. Proteinogenic amino acids are directly involved in protein synthesis, namely: Asp., Asn., Glu., Gln., Thr., Ser., Pro., Gly., Ala., Ile., Leu., Val., Cys., Met., Tyr., Phe., Lys., His., Arg., Trp. [4].

In animal feed, proteins, and especially their quality, play a basic role, because they are involved in all the vital activities of a living body. In addition to proteins, the fodder should also contain essential amino acids (Lys., His., Arg., Met., Val., Phe., Ile., Trp.) [6]. The daily dose of essential amino acids for adults is ≈ 1 g. In case of lack or insufficiency of an amino acid, such as tryptophan, lysine or methionine, in food, the synthesis of proteins and other biologically important substances would be impossible [5].

Some amino acids (histidine, arginine) are synthesized by the animal body, but in limited of insufficient quantities. Cysteine and tyrosine are formed only from methionine and phenylalanine, and can become irreplaceable because of their insufficiency [7].

MATERIALS AND METHODS

The dry matter of Sakhalin knotweed (*Polygonum sachalinense* F. Schmidt), the "Gigant" variety, cultivated in the GB ASM, registered in the Catalogue of Plant Varieties of the Republic of Moldova, served as research

subject. *P. sachalinense* is native to East Asia. It is tolerant to various climatic and pedological conditions. During a growing season, 2-4 harvests of high quality green mass can be obtained.

The samples were collected in the phase when the stem was forming (52 days from the beginning of the growing season). The leaves, the stems and the mixture of leaves and stems were studied separately. The material was dried in the drying stove and the hygroscopic moisture of each sample was determined in the laboratory of Plant Resources of the GB ASM. The amount and the number of amino acids in the leaves and stems of *P. sachalinense* were determined at the Institute of Physiology and Sanocreatology of the ASM.

The purpose of the carried out research was to determine the amino acid composition of plant organs, leaves and stems, in the stem formation phase, when they can be easily used as fodder for animals.

RESULTS AND DISCUSSIONS

The carried out analyses demonstrated that the plants of *P. sachalinense* could be an important source of amino acids. Various factors acting during the harvesting of plants, such as the humidity, the quantity and the quality of nutrients in the soil and the conditions of storage of the raw material, influence the quantity and the quality of amino acids in proteins.

21 amino acids were identified in the "Gigant" variety, which was adapted to the conditions from the Republic of Moldova (table 2). The amount of free, essential and non-essential amino acids, the amount of immunoactive acids, keto acids and the quantity of proteinogenic acids and sulphur-containing acids was researched (Figure 1).

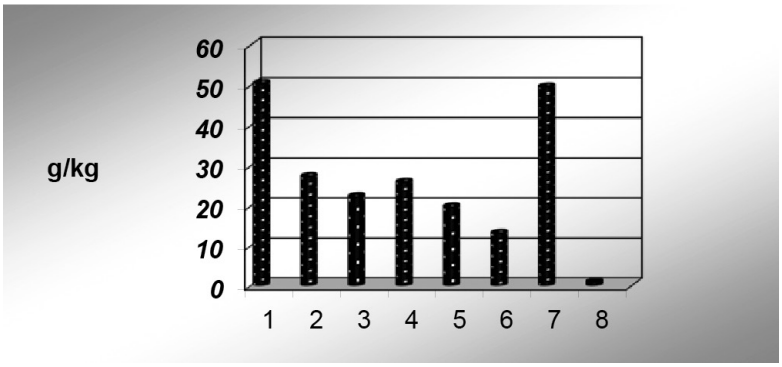

Figure 1. **The classification of amino acids from physiological and functional point of view, in the mixture of leaves and stems, dry matter, of *P. sachalinense* plants.** (1 - Σ of free amino acids; 2 – Σ of non-essential amino acids; 3 – Σ of essential amino acids; 4 - Σ of immunoactive acids; 5 – Σ of glycogenic acids; 6 – Σ of keto acids; 7 – Σ of proteinogenic acids; 8 – Σ of sulphur-containing acids)

The amount of free amino acids found in the dry matter of *P. sachalinense* constituted about 24.00 g/kg in leaves and 96.12 g/kg in stems. The amount of proteinogenic amino acids in stems reached 95 g/kg, and in leaves – 23.3 g/kg. The sulphur-containing amino acids (methionine and cysteine) were found in smaller quantities.

Essential, or indispensable, amino acids are those that cannot be synthesized by the organism, but can only be received from food [8]. There are 8 essential amino acids (threonine, valine, isoleucine, leucine, phenylalanine, tryptophan, lysine and methionine), and 7 of them were found in Sakhalin knotweed: threonine

(Thr), valine (Val), isoleucine (Ile), leucine (Leu), phenylalanine (Phe), lysine (Lys), methionine (Met) (table 1). Histidine can be synthesized by the animal organism, but in insignificant quantities, therefore it is also considered an essential amino acid [3]. In the studied dry matter, the amount of histidine constituted 0.9 g/kg.

Valine, leucine and isoleucine are indispensable amino acids for animals. In plants, these amino acids are synthesized from keto acids, as a result of transamination, usually with glutamic acid. The daily dose of leucine necessary for humans is of 1.1-2.2 g. Lysine contributes to the accumulation of calcium in the organism and facilitates its assimilation. The amount of methionine in proteins is usually small, but it plays an important role in the initial phase of protein synthesis.

Table 1. Essential amino acids found in the mixture of leaves and stems of *P. sachalinense*

No.	Essential amino acids	Dry matter, g/kg
1	Threonine – Thr	2.79
2	Valine – Val	3.34
3	Methionine – Met	0.53
4	Isoleucine – Ile	2.23
5	Leucine – Leu	4.48
6	Phenylalanine – Phe	2.35
7	Lysine - Lys	2.99

Eggs, fish, liver and corn can serve as natural sources of methionine. From threonine, such amino acids as glycine and serine are synthesized, and one of the end products of threonine metabolism is aspartic acid. Phenylalanine is part of all proteins and ferments of animal and plant origin. The amount of phenylalanine in proteins is about 3-8 % [4].

9 of the investigated amino acids are non-essential (aspartic acid, alanine, arginine, glycine, glutaminic acid, cysteine, proline, serine and tyrosine) and their amount reached 27.4 g/kg, in the mix of dry matter.

According to the chemical composition, amino acids are classified into 8 groups [9] and those found in *P. sachalinense* plants belong to 6 groups: 1. aliphatic amino acids: alanine, valine, isoleucine and leucine; 2. sulphur-containing amino acids: methionine and cysteine, their quantity in stems was of 1.7 g/kg; 3. aromatic amino acids: phenylalanine and tyrosine; 4. oxi amino acids: threonine and tyrosine; 5. dicarboxylic acids: aspartic acid and glutamic acid; 6. diamino acids: arginine, histidine, lysine. Proline, which was found in a significant amount in Sakhalin knotweed, is not assigned to this classification. Due to the cyclic group, proline forms angles in the polypeptide chain of proteins and plays an important role in their structure [9].

Another criterion that determines the importance and the biological value of amino acids is their degree of participation in the regulation of nitrogen level [9]. The amino acids with features that boost growth are also considered important, such acids are: arginine, glutamic acid, serine, tyrosine, tryptophan, proline and cysteine – all of them are present in the leaves and stems of *P. sachalinense.*

Table 2. The composition of amino acids from the leaves and stems of P. *sachalinense*

No.	Amino acids	Rational name	Leaves		Stems	
			Dry matter g/kg	Nitrogen g/kg	Dry matter g/kg	Nitrogen g/kg
1	Cysteic acid	α-amino β- thiopropionic acid	0.18	0.01	0.31	0.02
2	Aspartic acid	Aminosuccinic acid	2.09	0.22	8.60	0.90
3	Threonine	α-amino β-hydroxybutyric acid	1.26	0.15	5.03	0.59
4	Serine	α-amino β-hydroxypropionic ac.	1.34	0.18	4.13	0.55
5	Glutaminic acid	α-amino glutaric acid	4.91	0.47	16.99	1.62
6	Proline	-	1.62	0.20	8.42	1.02
7	Glycine	α-aminoacetic acid	1.30	0.24	6.39	1.20
8	Alanine	α-aminopropanoic acid	1.41	0.22	6.93	1.09
9	Valine	α-amino-isovaleric acid	1.75	0.21	5.44	0.65
10	Cysteine	-	0.03	0.01	0.60	0.14
11	Methionine	α-amino y-methylthiobutyric acid	0.15	0.01	0.78	0.07
12	Isoleucine	α-amino β-methylvaleric acid	1.03	0.11	3.85	0.41
13	Leucine	α-aminoisocaproic acid	1.96	0.21	7.92	0.85
14	Tyrosine	α-amino β-propionic acid	0.57	0.04	2.42	0.19
15	Phenylalanine	β-phenyl α-amino propionic acid	1.12	0.10	4.59	0.39
16	y-aminobutyric acid	-	0.50	0.07	0.65	0.09
17	Ornithine	α, ε-diaminovaleric acid	0.07	0.01	0.11	0.02
18	Lysine	α, ε-diaminocaproic acid	1.39	0.27	5.63	1.08
19	Histidine	α-amino β-imidazole propanoic acid	0.44	0.12	1.78	1.48
20	Arginine	α-amino δ-guanidinovaleric acid	0.88	0.28	5.58	1.80
21	Σ free amino acids		24.00		96.12	
22	Σ glycogenic amino acids		9.14		36.51	
23	Σ proteinogenic amino acids		23.25		95.05	
24	Σ sulphur-containing amino acids		0.37		1.70	

CONCLUSIONS

The composition of amino acids was studied in three samples prepared in advance: leaves of *P. sachalinense*, stems and the mixture of both, collected in the phase of plant development – formation of the stem. 21 amino acids were found, 7 of them – essential amino acids: threonine, valine, isoleucine, leucine, phenylalanine, lysine and methionine. Their quantity in stems was 40.6 g/kg. There were also found 9 non-essential amino acids

(aspartic acid, alanine, arginine, glycine, glutaminic acid, cysteine, proline, serine and tyrosine), their quantity in the dry matter was 27.4 g/kg. The quantity of proteinogenic amino acids constituted about 23 g/kg in leaves and 96 g/kg in stems. The nutritive value of the green mass of *P. sachalinense* was satisfactory.

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STEP-BY-STEP CREATION OF A LAVENDER PLANTATION

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Abstract: The cultivation of lavender is profitable both economically and technologically, since this crop is in high demand even in the conditions of economic crisis, because the raw material is harvested in the middle of June, when most field crops, including cereals haven't reached the technical maturity yet.

Key words: plant, essential oil, technology, cutting, layering, regeneration.

INTRODUCTION

Currently, the problem of rational use of plant resources is becoming more and more important. Obviously, this is because the use of plants in various sectors of national economy and in people's everyday life opens up new opportunities for health promotion and for the treatment and prevention of various diseases.

Aromatic crops are promising in this field, since they are sources of biologically active substances with prophylactic properties. One of the most popular aromatic species is *Lavandula angustifolia* Mill., commonly known as true lavender, English lavender or narrow-leaved lavender, which contains essential oil (1.7 %), is widely used in cosmetic industry, as fragrance in soaps, bubble bath products, detergents and ceramic paints, and it also possess antimicrobial, antiviral and antifungal properties. The active principles from flowers have antiseptic, slightly antispasmodic, depurative and calming effects. They are used to treat heart conditions, kidney diseases, rheumatism, biliary dyskinesia, cold, flu, cough, asthma, intestinal parasites, liver and spleen disorders, migraine and epilepsy. It is used internally for digestive problems due to its carminative properties, for headaches, as a general stimulant, as fragrance and provides comfort and relief after overwork and nervous irritability. The flowers and the essential oil of lavender can also be used in cooking to flavour various foods and drinks.

MATERIALS AND METHODS

In the Botanical Garden (I) of the ASM, there is a lavender plantation with an area of 0.8 ha, created over 10 years ago, from the variety Chisinau 90, a native variety of vigorous plants with strong root system that grows deep in the soil.

The lavender bushes grow up to 80-85 cm tall, are particularly resistant to drought and frost. This variety produces a lot of inflorescences (90-100 q/ha), containing a moderate amount of essential oil (1.10-1.40 % of dry matter). At the moment, it is considered as the mother plantation, from which, vegetative material and seeds are harvested for propagation (Fig.1).

Fig.1. Lavender plantation (*Lavandula angustifolia* Mill.)

RESULTS AND DISCUSSIONS:

Botanical description. Perennial subshrub with lignified and thick root, reaching 2.2 to 2.8 m deep in the ground. The stem is branched from the base, forming a bush that is almost globular, 30-70 cm tall. The stems are square, brown, with flaky bark. The leaves are opposite, linear-lanceolate, grey or greyish-green, tomentose on

both sides, with branched, stellate (star-shaped) hairs. The flowers are labiate, strongly flavoured, grouped in spike inflorescences, which consist of 4-5 to 12 overlaid pseudo-whorls, each of the pseudo-whorls is formed of 2-7 flowers. The calyx is tubular, hairy and glandular, of greyish-blue colour and the corolla is bluish-violet, sometimes blue and very rarely white. The fruits are small nutlets, brown, smooth and shiny, situated at the base of the persistent calyx. Usually only one nutlet reaches maturity. Lavender blooms from June to July.

Description of the raw material. The inflorescences of lavender are harvested (*Flores Lavandulae*). All the aerial parts of the plant, especially the inflorescences, have a pleasant, characteristic smell. Essential oil (*Oleum Lavandulae*) is produced from the flowers of lavender.

Chemical composition. The active principle of inflorescences is the essential oil, whose content varies between 0.5-1.5 %. The main component is linalool (40-60%), which occurs in free and in partly ester form as linalyl acetate. Other valuable components have also been identified, such as: free alcohols (geraniol, nerol, lavandulol, borneol, citronellol), acetate esters (of geraniol, bornyl), free acids (acetic, butyric, isovaleric), phenols, aldehydes, etc.

Choosing the plantation site. Lavender is a perennial species that can be cultivated on the same ground for 8-15 years. In order to maintain the productivity of the plantation for a longer period of time, the bushes need pruning. To meet the biological needs of the species, it is necessary to select a site that is protected from winds, warm and sunny, with deep and permeable soil. It is not recommended to plant lavender in strongly eroded and impermeable soil, in areas subjected to winds and strong air currents, because such conditions lead to a poor harvest. Lavender can be planted on slopes, since it can help prevent erosion, but the angle of inclination should not exceed 15°.

Fertilization. For a normal development, the plants of lavender need a series of nutrients, among which the most important are: nitrogen, phosphorus, zinc, boron and magnesium. Due to the fact that lavender is a perennial crop, it is recommended to use nitrogen-based fertilizers, which are less soluble. Superphosphate and other fertilizers with phosphorus increase almost twice the number of inflorescences on lavender bushes. The manure applied just before planting together with the mineral fertilizers applied later, during the growing season, act favourably on lavender plants. In conclusion, organic fertilizers are applied when the plantation is established, fertilizers based on phosphorus and potassium are applied both at the moment of establishment and in autumn, at the same time with the last hoeing and those based on nitrogen – in early spring, after snowmelt.

Preparing the soil. In spring, the land is harrowed and disked several times to maintain moisture and especially to remove annual weeds. It is recommended to cultivate fodder plants, with a short growing season, such as vetch, for green mass, or other crops (cereals), to which herbicides may be applied for weed control. After harvest, in July-August at the latest, the soil should be ploughed to a depth of 50-70 cm. Immediately after ploughing, the land needs to be perfectly levelled and then kept free of weeds by disking and harrowing repeatedly. In autumn, before planting, the land is disked again, deeper, and if it is not sufficiently mobilized, a shallow ploughing to a depth of 20 cm is necessary, after which it is prepared for planting using a disc harrow. If the land is affected by perennial weeds, the soil will be cleaned of weeds one more year by repeated ploughing followed by disking. The use of herbicides is recommended in order to remove the perennial weeds emerging on the field.

Propagation. Lavender can be propagated generatively: by producing new plants from seeds and vegetatively: by rooted cuttings, layering and by division of old bushes.

Propagation by seeds. Lavender seeds are small, hard, with low and slow germination rate, that's why they, usually, aren't sown directly in the field, but are cold-stratified in order to obtain seedlings. Sowing can be performed in late autumn, in October-November, or in early spring, in February-March, only in specially

prepared layers, which should have a width of 1-1.2 m and a length of 8-10 m, leaving a space of 40-50 cm between layers. 3-5 g of seeds, with a germination rate of at least 50 %, are necessary for 1 m². Before and after sowing, the soil should be well compacted. The seeds placed in very shallow grooves, left by the marker (0.5-1 cm), are covered with a layer of manure that must be clean of weeds, well grinded and sieved, 1-1.5 cm thick. The emergence of seedlings begins in spring, when the average air temperature reaches 14-15 °C. If sown in spring, the seeds germinate slowly, that's why it is necessary to soak them in water for 3-4 days or to stratify them, a process that should start 1.5-2 months before planting. For this purpose, seeds are mixed with river sand in ratio of 1:5-6 and are stored outside before sowing, and are stirred from time to time so that they don't become moldy. By the end of the stratification period, the seeds germinate and can be sown in warm soil. After sprouting, when the plants have 2-3 pairs of leaves, they are singled out, leaving a space of 3-5 cm between seedlings. Until the end of the growing season, the field needs to be kept clean by removing weeds repeatedly, needs to be irrigated, hoed and fertilizers need to be applied. Besides, all the flowering stalks should be removed at least twice to promote the growth of new shoots closer to the ground. The flowering stalks should be cut at 8-10 cm above the ground level.

The seedlings are ready to be transplanted to a permanent location at the end of September or beginning of October, when they are removed, sorted and stratified in sand or moist soil, until planting. Seedling production by seeds is an inexpensive and rapid method of propagation of lavender.

Propagation by cuttings. The cuttings are taken in autumn, in September-October, or in spring, in March-April, in the dormant season. The cuttings should be taken from healthy, well developed, 3- to 5-years-old plants. They are cut with a sharp knife or blade, below buds. Leaves are removed very carefully so as not to damage the vegetative buds.

Fig. 2. Lavender cuttings.

At the base of the cuttings, only one feather-shaped incision is made just below the bud.

The cuttings prepared by this method are about 5-6 cm long and are ready for planting, which should be carried out within 1-2 hours. If stored longer, but no more than one day, the cuttings are kept in pots with water. The land chosen for the layers in which cuttings will be planted will be clean of weeds, located near a source of water, but without the danger of flooding. It is ploughed to a depth of 30 cm, levelled and slightly compacted, and then, the sidewalls of the hotbeds are placed, leaving a space of 40-50 cm between them. These frames are filled with an 8-10 cm thick layer of well sieved sand, which after levelling, should be abundantly watered. After watering, to make planting easier, the rows are marked using specially prepared markers.

The cuttings are planted manually, at a distance of 10-15 cm. This process is carried out carefully, in order to avoid damaging the leaves from the tip of the cuttings. At the same time or immediately after planting, the

cuttings are abundantly watered and the sidewalls of the hotbeds are covered with sashes, of previously whitewashed glass, and then covered with cloth. After the cuttings produce roots, they should be hardened off by opening the hotbeds, at first, for a few hours, only in the morning or evening. When flower stalks develop, they are pruned, reducing their number to half, in order to stimulate branching of cuttings (Fig. 2).

Propagation by layering. This method (layering) has been used by other producers of planting material, but the material that we used, for the creation of the mother plantation, was selected according to several criteria: essential oil content, tolerance to diseases and pests, resistance to low temperatures, and particularly, to sudden changes in temperature. The initial material, used for the creation of the plantation, was grown on isolated land, where negative selection was applied – the exclusion of the plants that didn't meet the standards considered appropriate for the studied variety. The variety used for the foundation of the mother plantation was investigated anatomically, determining the density of oil-producing glands in the sepals of the flowers, this analysis allowed us to select material of high biological purity for the basic plantation. Layering is an easy, less costly, and thus economically advantageous method of propagation. The use of layering to propagate lavender from the mother plantation, created from pure biological material, allows obtaining plants that correspond fully to the studied variety, Chișinău – 90 (C-90), in the productivity of essential oil.

Fig. 3. Lavender layers.

Layering is a method that involves rooting a part of a stem or lignified branch while still attached to the parent-plant. The lavender bushes, selected initially, are propagated easily by ground (mound) layering. Some soil is shovelled from the space between the rows under the side shoots, making a 4-5 cm high mound. After that, the bush is spread from the centre outwards, through radial bending of stalks to the ground, and in the centre of the bush some soil is added and packed as much as possible, creating thus a mound of soil of 10-12 cm and ensuring a good contact of the bent stems with the soil. Mounding is done so that the leafy tips of the bent stems (8-10 cm) remain uncovered with soil.

The bushes can be covered with soil, for the rooting of stems and branches, in early spring or late autumn, when the plants are dormant. Mulching the area between the rows enhances rooting, increases the number of rooted stems that can be selected from a plant subjected to layering, helps obtaining standard, vigorous, high quality layers with well developed root system. A specially sharpened spade is used to sever the rooted stems from the parent-plant. The stems are detached quite easily, without causing any serious damage to the parent-plant. The detached stems are planted in small holes, at the chosen place. Before planting, the selected layers are stored in optimal conditions, their roots are pruned at a length of 15-20 cm, after which are soaked in solution of clay. The layers are buried in the ground with 5-6 cm lower than the root collar, so that the lower branches are covered with soil. When planting, the roots should be arranged well, covered with soil, watered and then covered again with a layer of soil, without compacting it. In late autumn, a layer of soil, of 3-5 cm, is mounded over the plantlets (Fig.3).

Maintenance. The gaps in the lavender rows must be filled immediately in the autumn of the next year, any delay is undesirable. It is recommended to shape the bushes of lavender only in the first year of vegetation; the purpose of this pruning is to create a globular shape of the bushes. The actual maintenance works begin in early spring and consist of hoeing the areas between the rows. The weeds from the lavender rows must be removed by hand hoeing, 2-3 times a year.

Regeneration of the plantation. When the bushes begin to dry and the productivity starts to decline, the regeneration of the plantation is necessary. According to the experimental data obtained by different authors, the optimal period for the regeneration of cuttings is the dormant season, February – before the growing season starts or November – after the growing season ends, but only when the soil has sufficient moisture and the clods can be crushed to cover the cut plants. It is preferable to cut the plants at 5-10 cm above the ground.

Fig. 4. Harvesting lavender during the flowering phase.

Harvesting. For the small areas, where lavender can be harvested rapidly, the flowering phase 75 % is the best time for harvesting (Fig.4). But if, for various reasons, the harvest period lasts longer (large areas, low processing capacity), it is recommended to start harvesting in the flowering phase 50 % and to finish it no later than in the flowering phase 100 %. The flowers of lavender are harvested by hand, with a sickle, or using special machines mounted on tractors. The harvested inflorescences are put in baskets and transported immediately to the distillation units.

Distillation. The essential oil of lavender is extracted industrially by water distillation, steam distillation or a combination of both. Steam distillation is the most common method.

The distillation process lasts about 90 minutes, but more than 90% of the amount of essential oil is distilled in the first 60 minutes. During the distillation process, the temperature of the steam from the apparatus mustn't exceed 150-160 °C. The essential oil, extracted and decanted, to remove water, is stored and transported in stainless barrels that are stored in cool, dry rooms, away from fire (E. Paun, 1998).

Drying and conditioning: The inflorescences harvested for the purpose of being used as dry flowers are placed in a thin layer in the shade, in clean and well-ventilated rooms. After drying, the flowers are easily removed from the stems by threshing and separated by sieving.

CONCLUSIONS

1. In our country, lavender has all the necessary climatic conditions to be cultivated for its inflorescences, rich in essential oil, used as fragrance in perfumery and cosmetics, but also as a remedy for some diseases.

The essential oil possesses carminative, sedative properties and has a calming effect on the central nervous system.

2. Lavender flowers in tea or other preparations have antiseptic, healing effects. Besides, they can be used as an insecticide, because due to the strong smell, lavender flowers protect the wardrobe from moths and leave a pleasant scent on the clothes. Lavender is also a very good honey plant.
3. The most recommended methods of propagation are layering and cutting, because they make possible to obtain a rich plantation, without any gaps, with vigorous plants and high productivity.
4. Lavender is also appreciated because it protects the soil from erosion and can be successfully planted on steep, sunny, calcareous slopes.

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THE PECULIARITIES OF REPRODUCTION AND CULTIVATION OF *CELTIS AUSTRALIS* L. SPECIES IN THE R. MOLDOVA

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Abstract. The paper includes the bioecological peculiarities of reproduction and cultivation of described *Celtis australis* L. species. The most effective method, considered the autumnal sowing by fresh seeds, harvested and treated with the 0.2 % Bi-58 solution, exposed during 60 min., was established. Additionally, the spring sowing by stratified seeds during 150-180 days and also one year and a half were performed.

Keywords: *Celtis australis,* generative propagation, seed treatment.

INTRODUCTION

The actual social, political, economic changes, developmental urbanization and the demands of population to the environmental medium bring on the forefront the necessity to create green plantings with a high architectural level, having a classic assortment of woody plants, resistant to biotic and abiotic factors. In relation with the climate changes, there have been identified processes of vegetation degradation and of worsening the persistence conditions of the plant species, that's why, the quotidian mobilization and conservation of the biodiversity, substitution of less resistant species to drought and other climatic factors are necessary.

The main impediment of multiplication and growing of present species consists in obtaining qualitative planting material, with minimal expenses, in order to recommend it to environmental reconstruction of the inappropriate arboretums.

MATERIAL AND METHODS

The trees which grow up and develop in the green plantings of Chisinau and particularly in the Botanical Garden, from which, fruits were harvested, in September and October, during the years 2012-2015, served as a study object. Some of the fresh seeds were treated with different solutions of 0.01 % of $KMnO_4$, where *Bi-58* solution was tested in two variants: 0.2 % and 0.3 %, but hydrogen peroxide – 10 % with the exhibition being of 30, 60 and 120 min. The second part of seeds has been preserved in cold rooms, and then stratified in the cold for 60-150 days, but over a longer period of time – *for 1 year and a half.* The fresh seeds, treated and untreated, and those stratified have been incorporated into the well loosened soil, in the mixture of soil compound of sand added with forest foliage, in vegetative beds, crates and channels, according the methodology [2]. Seed germination was determined in the Laboratory of Dendrology of the Botanical Garden (Institute) of ASM.

RESULTS AND DISCUSSIONS

Mediteranean Hackberry is a tree spread in the wild flora of Southern Europe, North Africa, Asia Minor, through the forests of Banat, Oltenia and Dobrogea Romania. In the Republic of Moldova, it is sporadically encountered in the woods of Forest District Hîrbovăţ and Olăneşti (1). *Mediteranean Hackberry* tree grows and develops well in the Botanical Garden of the ASM and in the municipal Dendrological Park from Chisinau. It is a forestry and ornamental species, of up to 20 m height, with diffuse and irregular crown, formed by thin and long arching branches. The bark is smooth and gray.

Celtis australis represents a tree with a strong root system, stretched out in parts and great depths, forming suckers at roots often with drooping branchlets. The trees possess alternate simple leaves, ovate to lanceolate, of 4-12 cm in length, acute to acuminate and asymmetrical at the base. Flowers with perigonium five-laciniate, comes with increasing leaves, little, greenish. The fruits are spherical drupes, 8-16 mm in diameter, at the beginning greenish and brown-purplish-blackish at maturity. The kernel is careen, strong, covered with a thin mesocarp, fleshy and sweetish (for this reason is called the tree of chocolate). Fruit maturation occurs in August-September and they persist long time on the trees. The trees fructify every year in early stage at the age of 10-15 years. It has been established that the seeds are preserved better in paper packages, also in natural cloth bags.

The seedlings of *Mediteranean Hackberry* in the second year of vegetation, at the Botanical Garden (Institute) of the ASM, have initiated budding phenophase in March 11, 2014, that is, with 3-7 days earlier than the 30-year-old trees from the Botanical Garden and Chisinau Dendrological Park, which have resumed their vegetation on 03/14/2014 and March 18, 2014 respectively.

The mass of 1000 fresh fruits was 360-384 g. 1 kg contains about 2000-3000 fresh fruits. The share of mass of the seeds in the fresh fruits of *Mediteranean Hackberry* constituted 55 %. The mass 1000 of dried seeds was 170-200 g. It was established that the productivity and the quality of seeds during 2013 and 2014 were higher than in 2012.

The climatic conditions in winter-spring, during the years of study, have had a positive impact on plant growth and development. As a result of phenological observations, it was found that the stable transition of daily average air of temperature by the value + 5°C, in ascendancy, on the large part of the national territory was optimal, so that the trees commence their vegetation period.

The trees from green plantings of Chisinau had resumed their vegetation period by 3-4 days earlier, than the plants on the territory of the Botanical Garden and by 10-15 days earlier than in 2013.

We have established that the seeds of *Celtis australis* L. gathered in October-November all these years, from Botanical Garden and Dendrological Park, being treated for 72 hours with 0.01% solution of $KMnO_4$, the germination capacity registered an average up to 90 %. After the gathering, cleaning and the choice of the type of substrate for the seeds, any significant changes in the germination capacity have not been identified. The seeds incorporated in light substratum with well loosened soil, in vegetative pots and in boxes, registered a uniform germination capacity and a percentage of approximately 95-100 % germination, whereas the seeds incorporated in pre-formed drills in seed beds, had uneven germination and a lower percentage of germination approx. 75-80 % because seeds had been eaten by rodents.

The cultivation of plantlets grown from seeds sown in autumn was normal and reached on June 27, 2014, the height of 14 to 26 cm (in pots, boxes), and those sown in pre-formed drills in seed beds – of 22-35 cm (fig. 3).

Our scientific experiments have established that the best option and cost is concluded in the seed treatment with the solution of 0.2 % Bi-58, with the exposition of 60 min, recording the value of maximum germination percentage of the seeds – 100 %.

The seeds treated with the solution of 0.2 % Bi-58 and incorporated into the well drained and loosened soil in fall, at a depth of 4-5 cm, achieved a uniform germination. The norm of seeds per 1 linear m of seed bed is equal to 15 g. The plants have achieved vigorous growth in the case where on 1 linear m was sown with 25-40 units. The seedlings become apt to be planted from 1 year, reaching the height of 70-80 cm (1 m).

It has also been confirmed that the transferring at the permanent place may be performed at the age of 1 year - up to 5 years. The plants obtained from the seeds after 1 year of vegetation, transferred in autumn in the open ground, had a survival rate of 95-100 %, while those transferred in spring reached only 50 %. With the

growth of seedlings, the transferring becomes more difficult.

Fig. 1. *Mediterranean Hackberry* plants grown in container (during 60 days).

Fig. 2. *Mediterranean Hackberry* plants grown in container (during 90 days).

Fig. 3. *Mediterranean Hackberry* plants obtained from non-stratified and stratified seeds (during 60 days).

1. *Mediterranean Hackberry* plants obtained from autumnal sowing without layering.
2. *Mediterranean Hackberry* plants obtained from spring sowing after layering.
3. *Mediterranean Hackberry* plants obtained from autumnal sowing without layering in pre-formed drills in seed beds.

Only 57 % of the 5-year-old plants of *Mediteranean Hackberry*, transferred in autumn in the open ground, acclimatized successfully. For further growth of seedlings, in the first year of vegetation, high containers are necessary, but with a mean diameter (fig. 1-2).

The seeds sown in spring after layering (60 days) germinated unevenly, the obtained plants reached 9-11 cm in height. The percentage of germination of seeds sown in spring was 25 %, after cold storage in packages of paper or natural cotton, followed by cold stratification (during 60 days).

CONCLUSIONS

1. The most effective method of *Celtis australis* L. propagation is considered the autumnal sowing, with fresh seeds, gathered and treated with 0.2 % Bi-58 solution, by exposition of 60 min. The best results have been obtained in the case of spring sowing after a period of 150-180 days and even a year and a half, establishing the germinative capacity of 95-100 %.
2. *Celtis australis* L. is a forest species used also as ornamental plant in landscape architecture, with great perspectives for the habitats of degraded steppes, on the soils of southern areas of Moldova. The mentioned species may be useful in the process of reconstruction of the acacia forests from those areas.

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INTERNATIONAL COOPERATION, DISSEMINATION OF RESULTS, SCIENTIFIC EXPERTISE AND CONSULTANCY

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Scientific research, experimental development and innovation are the main activities generating knowledge and creating economic and social progress. The challenges dictated by the market economy, by changing the structure of funding sources, require increasing, to a much greater extent, the national and international visibility of the conducted scientific research, coordination of activities and collaboration at national and international level in the respective fields, the integration in the regional and European space of research and the access to funds from projects and international grants, the openness to business for the transfer of knowledge and its transformation into innovations.

At national level, the Botanical Garden (Institute) of the ASM (BG ASM) has promoted an active collaboration on the research and rational use of resources of plant and animal world, with national institutes, such as: the Institute of Zoology of the ASM, the Institute of Genetics, Physiology and Plant Protection of the ASM, the Institute of Ecology and Geography of the ASM, the University of the ASM, the State Agricultural University of Moldova, Moldova State University, Tiraspol State University, the Free International University of Moldova, the Ministry of Environment, the Ministry of Education, the "Moldsilva" Association etc.

In the last decade, BG ASM has intensified the scientific collaboration with scientific institutions from Romania (University of Agronomic Sciences and Veterinary Medicine of Bucharest (USAMV B), University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine, Iasi, Banat's University of Agricultural Sciences and Veterinary Medicine "King Michael I of Romania" (BUASVM), Timisoara, Research-Development Institute for Grasslands, Brasov", Ukraine (M. M. Hryshko National Botanical Garden of the National Academy of Sciences, Kiev, and Kherson State Agrarian University), Czech Republic (Czech University of Life Sciences, Prague) and Slovak Republic (Slovak University of Agriculture in Nitra) etc.

BG ASM is an associate member of the Association of Botanical Gardens of Romania and participates actively in meetings of the administrative board of the Association (Bucharest 2010, 2012, 2016 and Iasi 2011, 2016).

In the context of the integration in the European space of research, the collaborators of the BG ASM submitted 11 projects to the Centre for International Projects of the ASM. During recent years, two joint bilateral projects between Romania and Republic of Moldova were financed and carried out: in 2010-2012, in collaboration with the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca – "Substantiation of principles and methodologies of planning experimental models in order to exploit green areas and degraded land, reducing the impact of environmental pollution, in the context of the European platform for sustainable resource management and ecological restoration, in accordance with EU norms and standards" project manager – Nina Ciorchină, Ph.D., and in 2013-2014, in collaboration with the National Institute of Research and Development for Biological Sciences-"Stejarul" Research Biological Centre, Piatra Neamț – "Evaluation and characterization of genetic resources of Lamiaceae species, with anti-inflammatory potential, regarding i*n situ* and *ex situ* conservation" is unfolding, in collaboration with the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, the manager of this project is Ion Roșca, Ph. D.

In 2011-2012, the project "Cross-border initiative for developing playful topiary art for education and

leisure" (Topart) was implemented within the framework of the Joint Operational Programme Romania-Ukraine-Republic of Moldova 2007-2013, financed by European Union, project manager – Alexandru Teleuță, Ph. D.

Proposals to participate in the programme Horizon 2020 with the project: "Energy potential of over-ground forest biomass for sustainable environmental development of rural areas", the call: H2020-ISIB-2015-2, subcall: H2020-ISIB-2014-2015, were submitted in 2014.

On the basis of cooperation agreements, researchers from the BG ASM had the opportunity to do internships and to make working visits to the University of North Carolina, USA, (producing and processing energy-generating biomass), the Czech University of Life Sciences, Prague, Czech republic (evaluation of mechanical and physical properties of energy-generating biomass) and the Research-Development Institute for Grasslands, Brașov, Romania (study of new methods and laboratory equipment for assessing the quality of forage).

Over the past five years, the researchers from the BG ASM were invited and participated with reports and presentations in scientific congresses, symposia and conferences in Romania (Bucharest, Brasov, Cluj, Iasi, Piatra Neamț, Craiova, Timisoara, Tulcea), Ukraine (Kiev, Kherson, Odessa, Bila Tserkva), Belarus (Minsk), Russian Federation (Sankt Petersburg, Moscow), Bulgaria (Sofia), Turkey (Antalya), Switzerland (Geneva).

They also presented reports at symposia and conferences organized in Romania (Botanical Garden of Bucharest (2010-2013,2016), the Botanical Garden of Iasi (2011, 2016), the Botanical Garden of Cluj-Napoca (2014), the Universities of Agricultural Sciences and Veterinary Medicine from Cluj-Napoca (2011-2016), Bucharest (2014-2016), Iasi (2014-2016) and Timisoara (2015-2016), Transylvania University of Brasov (2011, 2013, 2015), "Stejarul" Research Biological Centre, Piatra Neamț (2014,2015,2016)), Ukraine (M. M. Gryshko National botanical garden, Kiev (2010, 2013), Donetsk Botanical Garden of the National Academy of Sciences of Ukraine (2011, 2012, 2014), Nikitsky Botanical Garden (2010, 2012), Kherson State Agrarian University (2010, 2012, 2014, 2016), the arboreta "Sofiyivka", Uman and "Alexandria", Bila Tserkva) and Belarus (Central Botanical Garden of NAS of Belarus, Minsk).

Over the last decade, 16 projects of technology transfer have been submitted to the Agency for Innovation and Technology Transfer, and 9 of them were financed and implemented:

1. Implementation of technologies for the production of seedlings of homologated walnut varieties in the open field and protected area (project code - 08.164.71T), implemented in 2008, beneficiary: Iargara Forestry Enterprise, district Leova, project manager: Ion Comanici, Dr. Habil. The used technologies of production of seedlings of homologated walnut varieties by the method of patch budding had a success rate up to 60 %, contributing significantly to the expansion of industrial areas for the production of walnut, a highly demanded product on the foreign market.

2. Implementation of technologies for the production of lavender for industrial plantations, (project code - 09.824.04.95T), implemented in 2009, project manager: Maricica Colțun, Ph. D., realised at "RESENDJER" L. L. C. Obtaining lavender plantlets by layering is an advantageous and profitable method. The results obtained by this project were awarded at the International Specialized Exhibition "INFOINVENT" 2013 with Gold Medal (Photo 1).

3. Development of tourist facilities within the Botanical Garden and provision of necessary informative materials, (project code - 09.824.08.98T), implemented in 2009, project manager: Eugen Alexandrov, Ph. D. As a result of the implementation of this project, amusement areas for children of different age were created, some outdoor exercise equipment was installed, guides were selected and trained to organize excursions on the territory of BG ASM, an informative brochure for visitors was published and a new design of the website

of the BG ASM was created.

4. Implementation of the technology for the production of decorative seedlings in containers with drip irrigation, (project code - 10.824.08.106T), project manager: Alexandru Teleuță, Ph. D. In 2010, the basis was laid for the industrial production of planting material in the nursery of the BG ASM, using mist and drip irrigation methods. The technology of production of ornamental planting material in containers, using drip irrigation, aroused interest in Romania too, being awarded a Gold Medal.

5. Implementation of innovative technologies of cultivation of spicy and aromatic species necessary for the production of balsamic vinegar, (project code - 10.824.04.109T), project manager – Lilia Chisnicean, Ph. D. It was implemented in 2010, by creating the plantation of spice and aromatic species, at "TRIODOR" L. L. C., in order to obtain raw materials in accordance with company standards on producing balsamic vinegar.

6. Implementation of innovative technologies for the production of decorative seedlings in containers, (project code - 10.824.08.115T). In 2010, the project manager – Ion Roșca and the team implemented, at "TERRA ARB GRUP" L. L. C., the technology of growing ornamental planting material in containers, based on new growing media, types of fertilizers and methods of applying them. The proposed technology was highly appreciated by the Romanian Inventors Forum and was awarded a Gold Medal in 2013.

7. Implementation of innovative technologies of cultivation of spicy and aromatic species necessary for

Photo 1

Photo 2

the production of coarse salt and flavoured oil (Implementarea tehnologiei inovative de cultivare a soiurilor speciilor condimentar-aromatice, necesare la producerea sării grunjoase şi uleiului aromatizat alimentar), (project code - 11.824.04.138T). The team lead by Lilia Chisnicean, Ph. D., in 2011-2012, initiated the establishment of industrial plantations, using organic technologies for growing spicy-aromatic varieties, in order to obtain raw material in accordance with company standards applied by ROVAZENA L. L. C. Some advantages of this achievement are: the new native varieties with a high content of biologically active substances, with high productivity and resistance to drought and heat, and the organic technology that was used to establish the plantations for the production raw materials. The results of this project were awarded at the International Specialized Exhibition "INFOINVENT" 2013 with Bronze Medal (Photo 2).

8. Development and implementation of techniques for *in vitro* propagation of high-productive varieties of blackberry (Rubus fruticosus), to establish an industrial plantation in the Republic of Moldova, (project code - 13.824.14.178T), project manager - Nina Ciorchina, Ph.D. During the project implementation, in 2013-2014, an industrial plantation of blackberry was created at "ROTOR" L. L. C., a training course on micropropagation and regeneration of fruit shrubs was organized for a large number of beneficiaries involved in the creation and exploitation of blackberry plantations.

9. Implementation of innovative technologies for the creation of energy plantations and the use of biomass for heating the facilities of the BG ASM, (project code - 13.824.16.183T), project manager - Alexandru Teleuță, Ph. D, project assistant - V. Țîței, Ph. D. During the project implementation, in 2013-2014, the sectors for the production of propagation material (seeds, rhizomes, tubers) of patented varieties of perennial herbaceous energy plants were established. Sectors for the production of high quality planting material of the varieties: "Speranța" of fodder galega (*Galega orientalis* Lam.) and "Vital" of cup plant (*Silphium perfoliatum* L.), were created. Biomass and propagation materials were collected from the most promising varieties of 14 energy plant species. The necessary equipment for the establishment, maintenance and harvest of energy crops and the use of biomass for the production of heat was purchased: plough PN-3-35, milling machine SM-175, mowing machine CR-1.75 and boiler Multiplex MCL 180. The plant varieties selected in BG ASM and patented in RM possess valuable properties for energy production and can help strengthening the country's energy security and contribute to the rational use of degraded land.

In 2008-2010, the project: "Landscaping of "Curchi" monastic complex" was implemented, v. Curchi,

Photo 3

Photo 4

district Orhei. The total cost of the project: 2 800 thousand lei. Project manager: Teleuță A., Ph. D.; project implementer: academician Ciubotaru A. (Photo 3).

The purchase and installation of the automatic irrigation system on the territory of BG ASM, which cost 2 500 thousand lei, (project manager: Teleuță A., Ph. D.), (Photo 4), has essentially contributed to the maintenance of the collections and exhibitions of BG ASM.

Besides, over 10 years, planting material of about 15.0 million MDL was sold to economic agents.

In order to promote the national and international visibility of the results of the scientific research, BG (I) ASM participated in national and international exhibitions: "FABRICAT ÎN MOLDOVA" (2011-2016), "INFOINVENT", Chisinau, (2009, 2011, 2013, 2015), "EUROINVENT", Iasi, Romania (2014, 2015, 2016), "PRO INVENT", Cluj-Napoca, Romania (2013, 2015), "TRAIAN VUIA", Timisoara, Romania (2016) and the International Exhibition of Inventions of Geneva, Switzerland (2016).

At the European Exhibition of Creativity and Innovation "EUROINVENT", Iasi, Romania (2014, 2015) and the International Exhibition of Inventions and Innovation "Traian Vuia" (Timișoara Romania, 2016), new fodder and energy plant varieties (Melifera, Vital, Gigant, Energo and Solar), medicinal and aromatic varieties (Crețișor and Lavinia de Grădină) ornamental varieties (Melancolie, Alecsandrina, Regina), food plants (Eliza, Caterina), the monographs "The Red Book of the Republic of Moldova" 3rd edition, "Flora of Bessarabia" 1st volume, "Ancient Trees", "Medicinal Plants" etc. were awarded Gold, Silver and Bronze medals, diplomas etc. Through the National Agency for Rural Development (ACSA) the collaborators participate to the promotion of

scientific results by providing information services, consulting and training for farmers and rural entrepreneurs, participate in trainings on promoting renewable energy, organized by ACSA in Poland (2009, 2012, 2015) and by the Energy Efficiency Agency of the Republic of Moldova – in the USA (2013).

BG ASM participated in the elaboration and expertise of normative acts on biodiversity conservation (laws on the development of protected natural areas, plant kingdom, the Red Book, the Strategy on Biological Diversity of the Republic of Moldova for 2015-2020 and the Action Plan for its implementation, National Programme on the establishment of the National Ecological Network etc.), green space planning and landscaping, establishment of Orhei National Park and Lower Prut Biosphere Reserve, submit proposals on extending the natural areas protected by the state etc.

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IV. LANDSCAPE ARCHITECTURE

THE EFFECT OF EROSION IN RURAL AREA AND RECOMMENDATIONS FOR DIMINISHING THE NEGATIVE CONSEQUENCES

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Abstract. The fertile soil is limited and irreplaceable resource. Nevertheless, every year, 12 million hectares of lands are lost because of the erosion processes. In the Republic of Moldova, soil degradation processes are conditioned both by natural conditions as well as anthropogenic factors. From the natural conditions, there are highlighted climatic phenomena (heavy rain, frequent periods of dryness and drought, strong winds), difficult terrain, lithogenesis and rock composition of the surface. Currently, on territory of the Republic of Moldova, about 40 % of agricultural lands are eroded soils of various degrees: weakly eroded – 23.2 %, moderately eroded – 11.7 % and strongly eroded – 4.9 % (Andrieș et al, 2008; Cerbari, 2007). Every year eroded land area increases by an average of 0.9 % and annual losses of fertile soil are estimated at 26 million tons. The balance of humus is profoundly deficient, the reserves of humus decrease annually by about 1 t/ha, nutritional elements – with 180-200 kg/ha. The aim of our research was pointing out the particularities spread in Negrea village, assessing changes and negative aspects of the characteristics of these soils as a result of erosion and appreciation of pretability to different agricultural uses. Pedological researches performed in the village Negrea have shown that the favorable climatic conditions, relief and soil, have led to total practical use of its agricultural land under perennial plantations. The high pretability for vineyards and orchards prevents the total silting of the land area. The order of the natural ordering of genetic horizons was derogation. The morphological description of the profiles was performed and it was elaborated the map of soils obtained from 1:5000 scale mapping, which demonstrates spatial distribution of soils with different degree of erosion. The data obtained confirmed that erosion in the territory of village Negrea is the main factor of irrecoverable destruction of agricultural soil profile and reduced its production capacity (Cojocaru, 2015).

Keywords: erosion, soil, pretability, morphological composition, rural area from the Republic of Moldova.

INTRODUCTION

Moldovan soils are rated as some of the most fertile in the world - about 1 billion tons of humus, 50 million tons of nitrogen, 60 million tons of phosphorus, 700 million tons of potassium. These soils represent the main natural wealth of the country and deserve unconditional, permanent attention of the state, of the profile institutions and, apart, of every inhabitant. In the years of reforms in Moldova, there were produced structural changes in the forms of land ownership, possession and use of agricultural land. Peasant farms have appeared, citizens have received the plots of land for fruit growing, vegetable growing and construction of houses, over a million new owners and users of agricultural land have appeared (Brânduș et al, 1999; Cerbari et al, 2005; Neamțu, 1996). To date, agriculture has become quite diversified from the point of view of organizational and institutional framework. Thus, soil erosion at present poses a threat and a risk phenomenon, which conditions the enormous losses for the economy, population and diminishes essentially the land fund of the republic.

The negative processes that lead to the degradation of the physical and chemical properties of soils (destructuring, compaction, salinisation, humus content, erosion, etc.) are intensifying. Every year, for social and economic needs, from agricultural land, considerable areas are taken out, this fact contributes to reducing the areas of land per capita (0.43 ha), while the norm is 0.60 ha. Issues of combating soil erosion in post-privatization period on Moldovan territory, in the villages, require special attention. Pedological researches performed in the village Negrea have shown that the favorable conditions of climate, relief and soil, have led to total practical use of its agricultural land under perennial plantations. The high pretability for vineyards and orchards prevents the total silting of land area (Cerbari, 2010; Puiu, 1980; Ungureanu et al, 2006).

The soil cover in the village Negrea consists of ordinary chernozems with varying degrees of erosion and delluvial soils. The main restrictive factors of the productive capacity of chernozems on the investigated territory are erosion, decreasing humus content, the gradual decrease of nutrient content for plants, irrational

exploitation, inadequate cultivation of soil and drought. The research was conducted in order to assess soil degradation by erosion and the danger of erosion on the village territory. Based on the results, measures to reduce the occurring negative consequences were proposed.

MATERIALS AND METHODS

The research aim consists in the prominence of morphological composition, evaluating the negative changes of soil characteristics in the village Negrea as a result of erosion and appreciation of their pretability at different agricultural use. The research was conducted on the lands of reception basin within the limits the village Negrea, Hincesti district. This reception basin is typical for the whole totally reception basins, formed as a result of fragmentation by erosion of high terraces of the Prut river and its tributary streams on the left. The object of study occupies the north-east and middle of the agricultural land of the village Negrea.

The methods of doing pedological field researches and analyses included: - detailed soil cover mapping at scale 1:5000 according to the existing instructions; - location and morphological description of soil profiles; - determination of morphometric indices of soil; - soil sampling for laboratory analysis; - determining the degree of soil erosion and others (Cojocaru, 2015).

RESULTS AND DISCUSSIONS

The damage caused to the national economy by soil erosion is colossal. The losses of weighted average of the annual harvest of eroded lands constitutes: arable land – 27 percent; lands with perennial plantations – 30 percent; grasslands – 37 percent.

From the above mentioned, we consider that in the conditions of Moldova, erosion control is a decisive measure in diminishing the soil degradation process (Cerbari, 2007; Cojocaru, 2015; Zaslavschii, 1979).

Fig. 1. Map of soils in the village Negrea, research scale 1:5000, in 2014.

According to legend of the soil map (Fig. 1), the diversity of soil units in territory of village Negrea, is formed mainly from soils with different degrees of erosion (Tab. No.1).

Table 1. The surface of soils that haven't been eroded and soils with varying degrees of erosion in territory of village Negrea

№	Name of soils	Area	
		ha	%
Agricultural land used for growing crops, vineyards and orchards			
1	not eroded	36.0	10.5
2	delluvial	22.1	6.4
3	weakly eroded	95.7	27.9
4	moderately eroded	93.5	27.3
5	strongly eroded	49.8	14.5
6	very strongly eroded, erodosoils	2.5	0.7
Total of eroded soils of cultivated agricultural lands		**241.5**	**70.4**
Total of cultivated agricultural lands		**299.6**	**87.3**

The pedological research showed that in the areas of the village Negrea (Cojocaru, 2015) that were used in the past completely under orchards and vineyards located on micro-terrace slopes and correctly organized territorially, the erosion process of soils was partially stopped (Fig. 2.).

Fig.2. Orchard on the micro-terrace slope

Fig. 3. The manifestation of erosion process on slopes after the deforestation of perennial plantations and levelling the micro-terraces

Currently the perennial plantings are largely deforested and the lands are planted with annual crops and used for arable farming, fact that leads to the intensification of the erosion processes (Fig. 3).

Soil erosion control measures will be planned in the fields – on some elementary agricultural territorial units. The problem of combating erosion and soil protection in the post-privatization period in Moldova is not given due attention. As a result, the area damaged by this process increases continuously; erosion affects the physical, chemical and biological soil properties becoming the main cause of degradation of agricultural lands (Câmpeanu et al, 2006; Cerbari et al, 2005; Dobrovolschi et al, 2007; Florea et al, 1987; Neamțu, 1996; Ungureanu et al, 2006).

For the investigated area, there are proposed general principles, the order of execution and the set of works for the implementation of erosion control measures under the terms of studied territory. They serve as a basis for the development and organization of erosion control in the territory and the application of agro-technical processes, phyto-reclamation, forestry and the most simple hydraulic erosion control measures.

Under the principles of anti-erosion protection of soils, it is understood the assessment of the danger of erosion, drawing up measures and technologies to combat erosion processes, their implementation in agricultural practice. In the territory of the village Negrea, according to the legend of the map in question, the fields, according to the danger of erosion, are divided into three groups: low, moderate and high (Table No. 2). For each group of soils, depending on the danger of erosion, control measures are recommended, given the concrete situation of groups (Cojocaru, 2015).

Table 2. Legend of the map of erosion danger for agricultural land in the territory of the village Negrea

№	The danger of erosion on agricultural land	Proposed erosion control measures
1	weak	Superficial flow regulation on the roads surrounding the lands by building grassed ditches along them. Introducing, on fields, agro-technical measures: erosion control crop rotations; subsoiling; implementation of the system of works for soil conservation; harmless fertilization.
2	moderate	Superficial flow regulation on the roads surrounding the lands by building grassed ditches along them. Introducing, on fields, agro-technical measures: erosion control crop rotations; subsoiling; implementation of the system of works for soil conservation; work with preservation of stubble; harmless fertilization. Mole drainage systems with a series of soil fissures on lands with hoed crops. Cultivation of alternative crops into strips.
3	high	Superficial flow regularization on the roads surrounding the lands by building grassed ditches along them. Cultivation of alternative crops into strips with grass strips. The structuring crops on slopes with consideration of the degree of soil protection. Mole drainage systems with a series of soil fissures on lands with hoed crops. Building on the investigated area of a system of grassed ditches necessary to evacuate the excess rainwater.

At the recommendation of measures to combat erosion within the land, parallel to soil map, it will also be used the erosion hazard map, developed on the basis of the soil map and of the existing plan of land use.

On this map, taking into account the structure of the soil cover, of the slope of the land, the kind of

agricultural use and others, all of lands were separated into groups according to the danger of erosion: absent, reduced, moderate, high and very high (Brânduș et al, 1999; Câmpeanu et al, 2006; Cojocaru, 2015; Florea et al, 1987; Zaslavschii, 1979).

CONCLUSIONS

1. Currently there is a risk that gullies will evolve into ruts and ravines, destroying the agricultural fields and contributing to their degradation and their desertification, with serious social consequences for the local population.
2. On the researched lands, the following processes of soil degradation are widespread: water erosion into the surface and depth, silting of soils with sediments poor in humus, destructuring and compaction of the secondary, recently arable layer, decreasing the reserves of nutrients.
3. Erosion control works in the village Negrea, must be carried out on the basis of a reasoned scientific project that provides a systematic approach to the problem.

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PROLOGUE

FOREWORD TO "SELECTED PAPERS" IN ELEVEN TOMES. EVOLUTION AND STRATEGY OF SEXUAL REPRODUCTION IN THE PLANT WORLD

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For the first time, generalized results of a long-term scientific research in the field of structural botany by optical (light) microscopy and electron microscopy techniques are set before the reader in the monograph "Selected papers". It is a question of embryology, karyology, karyosystematics, cytogenetics, anatomy and morphology of cultivated (grain cereals etc.) and wild-growing species in Moldova. A concise retrospective displayed in chronological order concerns scientifically organizational works spearheaded by me and in which I participated for many years like the director of the Botanical Garden (Institute) of the Academy of Sciences of Moldova (1964-1987; 1996-2006) and in capacity of Chief of Sector and the director of the Nikitsky Botanical Garden (Yalta, Crimea, 1988-1995). I would like to remark that an imposing part of both scientific research and scientific organizational works were carried out in at the Botanical Garden of AS of Moldova and the Nikitsky Botanical Garden (Yalta, Crimea). A part of the experimental and investigative work was performed during long-lasting traineeships and scientific official journeys to the worldwide known laboratories: Institute of Genetics of the University of Lund (Sweden, Lund town, supervisor – the renown cytogenetician, the author of university textbook "Genetics", prof. Arne Müntzig (1967- 1968)); Institute of Molecular Biology of the AS of USSR (Moscow, the director academician A. Engelgard (1968)) and other scientific centres of the former USSR: Institute of Botany of the AS of the Ukrainian SSR (Head. of embryology lab., member of the AS of the Ukrainian SSR, acad. Modilevsky Ya. S.), Main Botanical Garden of the AS of USSR (the director academician Tsitsin N., Head of Embryology and Distant Hybridization Laboratory, prof. V.A. Poddubnaya-Arnoldi); Komarov V.L. Institute of Botany in Leningrad (Head of Embryology Laboratory, prof. Gerasimova-Navashina E. and subsequently prof. Yakovlev M.).

In the capacity of director of the Botanical Garden of the AS of Moldova (1964-1987; 1996-2006) and director of the Nikitsky Botanical Garden (NBG) (Yalta, 1988-1995): 1) our suggestion on selecting and constructing the Botanical Garden of ASM on a new territory was accepted and we were in charge of its implementation; 2) when I have been assigned to the post of director of the NBG, after inspecting the steppe Crimea (1989), there were concluded more than 20 economic contracts and we started the construction of a new nursery station for growing dendrological plants (in Kherson oblast).

What and how has been realised (1956-2016) is described in the I-XI tomes of this work. The research papers describe the organization and development of the new research directions, publishing activity, training of scientific staff, organization of scientific stations and laboratories as well as landscape design projects.

Each tome separately contains more detailed information on this and other issues, as well as on how we have expanded our studies, without which it would be impossible to carry out the scientific research. Although we managed to publish more than 750 scientific papers, including articles, monographs, anthologies, biographical sketches (essays), which appeared on more than 150 symposia, conferences, congresses in the country and abroad, the materials presented in “Selected Papers” have been largely reconsidered, new data in the field of comparative, experimental, ultrastructural, agro-ecological and evolutionary embryology of plants, karyology, cytogenetics of cultivated and wild monocots from Moldova are provided. A new vision of the role

that embryology will play in deepening the evolutionary understanding of the origin of life on our planet has been formed.

Below, we give a short historical sketch of the major stages of advancement of embryological science, recall the names of authors of scientific developments and discoveries.

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Embryology, as theoretical basis of general biology, even before the times of Aristotle has weaved its roots with embryology of plants. Pollination of some plant species, for the purpose of obtaining a constant crop of fruits and seeds, is imprinted on antique low relief of the ancient populations. They depicted the inherited practice of artificial pollination by Assyrians, Sumerians and Egyptians. In such a way, they provided themselves with annual fruitage of date palms, persimmon, fig tree and other plants. At the same time, in those far times, the thought that sexual division can exist in plants never crossed one's mind. Well-known Indian embryologist P. Maheshwari (1954) mentions that antique philosopher Aristotle who did not admit existence of sex at plants, considered that "male and female beginnings are constantly transforming one into another in plants so that they are capable to reproduce by themselves, giving progenies at surplus of nutrition". It is known that Aristotle bequeathed his scientific legacy to his favourite pupil botanist Theophrastus who continued Aristotle's researches in the field of embryology and in "Enquiry into Plants", written in III century BC, mentions pollination of a date palm, apparently, on the basis of a report by Herodotus who in V century BC travelled to East. According to Herodotus, Arabs and Assyrians in a certain season of year performed sacred ceremonial rite consisting in following: "men climbed on male exemplar of a palm tree, broke inflorescences and handing them to the Supreme Priest who touched with them female inflorescences to provide a good harvest of fruits". Later on, nearly three hundred years after Theophrastus, Pliny the Elder, in his encyclopaedic work "Naturalis Historia", mentions male plants of palm with their vertically arranged leaves which for him resembled soldiers while female exemplars womanly inclined to them with their gentle foliage as though asking to save them from disgrace of virginity or widowhood. However, Pliny did not observe it by himself. His descriptions and ideas were based on messages from other persons..." (by Maheshwari, 1954, p. 6).

Similar statements are provided by P.A. Baranov (1955) in his work "History of Embryology of Plants", mentioning the works by R. J. Camerarius – the inspector of botany (director) of the Tübingen Botanical Garden which in the treatise "Letters on the sex of plants" (De sexu plantarum epistola, 1694) specified that "when stamens touch stigmas of ovules in inflorescences of *Mercurialis annua* L., *Ricinus communis* L., *Zea mays* L., they guarantee formation of fruits and seeds". He also noted that "Formation of seeds in the plant world represents the most perfect gift of the nature, the usual way of preservation of a species can't occur unless stamens in advance prepare young plantlet enclosed in ovary". Even in 1775, J. Kölreuter wrote about the value of his works: "R. J. Camerarius is undoubtedly the first to prove the existence of sex at plants by setting up his own experiences to solve specially this research task … scientific world is obliged to him for this great truth which is of overall importance and which produced a great impact on natural and agricultural sciences too". (P. A. Baranov, same book, p. 113).

Speaking about the importance of embryology of plants and animals, P. A. Baranov (1955) noted that since ancient times, man has been deeply interested, chiefly from practical point of view, in questions on reproduction and development in plants and animals. This is testified by various plant cultivars and animal breeds bred (introduced) in culture and created with understanding of processes of reproduction long before sex was discovered in plants.

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Modern embryology of plants has become a science only in the second half of the XIX century. A leading role in its formation was played by C. Linnaeus's work "Nature's systems" (Systema Naturae, 1735) and, of

prime significance, Darwin's Theory of origin and evolution of plants and animals (1859) as well as Cell Theory (Schwann, 1838). A special place is beheld by works of W. Hofmeister, J.-L. Guignard, S. Navashin, I. Gorojankin, V.A. Poddubnaya-Arnoldi et al. about whom it will be told in more detail in the first series of the work (tomes I - VI).

"A new breath" in modern embryology of plants, undoubtedly, was brought by electron microscopy and molecular biology, the success of which confirmed that the steps of progress of natural sciences depended on the success of research methods. Effect was also produced when before the public were brought research results on the ultrastructural world of cells and in addition to this – publication of a work by A. Frey-Wyssling and K. Mühlethaler "Ultrastructural Plant Cytology" (1968), and also the monograph "Genetics" by the well-known cytogenetician Arne Müntzing (1967).

Selected papers in eleven tomes, in the main, describe experimental embryological investigations which are considered to be fundamental in the field of structural botany in post-war Moldova. We bring forth extensive information about the research on comparative, experimental, ultrastructural, agrarian and evolutionary embryology, and also, karyology and cytogenetics of one of the most important crops, which is maize, as well as the main cereals: *Triticum, Secale, Hordeum, Avena, Panicum, Sorghum* and related wild species.

As to the volume of factual and informational material, these researches of monographic character represent a unique work in Russian- and Romanian-language literature of the XX century. The historical way of the first results of cytoembryological researches, which in those years answered to the objectives of practical selection, is traced in these tomes. These researches tell about professional skill gained at scientific centres of the Republics of the former Soviet Union.

In the organization of cytoembryological researches in post-war Moldova, a special role belongs to the Head of Section of Selection of Field Cultures of the Agricultural Institute in Chisinau, prof. A. Kovarsky. Thanks to him, in the early sixties of the last century, a group of specialists and PhDs was established (S. Pînzaru, T. Cialîc, V. Siminel, M. Borovschi, V. Lîsicov, S. Colesnicov, V. Krîlova, A. Ciubotaru, S. Pașcari). At that time, as a result of expeditions to regions of Bessarabia, rich selection material consisting of local populations of plants was collected: maize, wheat, barleycorn, oat, rye, millet, sorghum; sunflower, kidney bean, chickpea, peas, etc.; and also allochthonous species, varieties, hybrids and inbred lines, as well as crops, cultivars and ecotypes that are new for Moldova: and allochthonous species, cultivars and hybrids as: sweet potato, okra, kenaf, dogbane, watermelon, as well as relatives of maize: *Teosinte* L., *Tripsacum* L., *Coix* L.. With this material, our selective-genetic work has begun. Karyological analysis was necessary for determination of pairs for crossing and also for studying meiosis in F_{1-2} hybrids. In 1956, in the Department of Genetics of the Academy of Sciences of the Moldavian SSR, Cytoembryology Laboratory was organized and began to study a number of important field crops (1954-1955).

Particular significance was paid to joint searches of breeders and cytologists in the creation of homozygous (self-pollinated) lines of maize and in the analysis of interlinear hybrids, the study of male sterility, the study of phenomena of heterosis (arising by crossing of long-term induced lines (Shell's phenomenon).

The need for cyto-embryological researches has increased in parallel with the expansion of introductive works, which in their turn, have considerably developed in connection with exploiting the new territory of the Botanical Garden of the AS of Moldova. And there, in the Department of Genetics (1956), in the Botanical Garden of the ASM (1964), the central issue remained the biology of seed formation, i. e. the formation of the crop.

In this connection, it is worth recalling how much the academician, botanist and plant breeder Peter Zhukovsky (1971) was concerned with the food problem and calculated that by the end of the first half of the XXI century, when population on Earth would reach 13 billion, food security would be one of the most

pressing problems for mankind and the significance of biological sciences would reach the highest demand.

Tome I. (1) Comparative Embryology of Maize (*Zea mays* L.) and Other Cultivated Plants (2) Experimental Embryology of Maize (*Zea mays* L.) and Other Cultivated Plants

Section I of Tome I delivers the most comprehensive information on biology of development of vegetative and generative organs, apical meristems, formation of reproductive organs; biology of flowering, pollination and quality of pollen; microsporogenesis and male gametophyte; macrosporogenesis and female gametophyte; double fertilization; embryogenesis and endospermogenesis, processes that take place under normal conditions of development in various subspecies (ssp.) and varieties (var.) of maize.

Section II "Experimental embryology of maize" considers processes of pollination-fertilization (progamy and gametogamy), including early embryogenesis which were undergone under strictly controlled (modified) experimental conditions (1) against the background of different types of pollination (intravarietal, intervarietal – between varieties; self-pollination or inbreeding (SP) and SP + foreign pollen). More than 130 variants of 8 experiences are that indispensable groundwork that constitutes the second section. The influence on pollination-fertilization and early embryogenesis of (2) various physical, chemical, hormonal stimulating, organic acids, effect produced by gases, lighting, air humidity, high and low temperatures (around inflorescences – incipient cobs) and also autumn conditions (naturally decreased temperature, light dimming, relative air humidity raise etc.) is described and illustrated.

The first and the second section comprise 36 tables with figures, charts and are supported by 306 original drawings and microphotographs.

In Section III, there are about 20 abridged scientific articles (early publications within the period 1956-1966), amongst which can be found articles in English: (1) "The experience of mass production of cyto-embryologic specimens from fixed material (research output for 1954-1959)"; (2) "Formation of generative organs, flowering and pollination biology of maize"; (3) "About macrosporogenesis and development of the embryo sac in maize (Micro- and macrosporogenesis is the material basis of early ontogenesis)"; (4) "Influence of some factors of environment on processes of fertilization and embryogenesis in maize".

Tome II. "Ultrastructural Embryology of Maize (*Zea mays* L.)"

Our electron microscopy researches marked the beginning of an important direction in the study of sexual reproduction in the plant world, in the second half of the XX century. We focused our researches in the direction of comparative and evolutionary embryology. The material for experiments – sweet corn – *Z. mays* L. ssp. *saccharata* (Sturt) L. H. Bailey served as experimental material and was grown in experimental greenhouses of the Institute of Genetics of the University of Lund (Sweden, 1967-1968). Tome II comprises the papers from Doctor habilitatus thesis "Cytoembryological and electron microscopy researches of maize *Zea mays* L." defended in 1971 in Academy of Sciences in Kiev, Ukraine.

Chapters I-XI provide detailed description of apical meristems' ultrastructure (embryonic root and growing point), vegetative and generative organs, elements of female gametophyte and embryo sac, male gametophyte, pollen grain and pollen tube, anther wall and growing PT, double fertilization, early embryogenesis. In the final chapter "The main provisions of the work" we have developed concepts: "About pollen grain (PG) and pollen tube (PT) as a whole biological system"; "About sperm cell self-dependent movement"; "About homeostatic hypothesis of Double fertilization"; "About embryogeny of cell organelles",

and "About embryonic aromorphosis".

At the end of Section II, we give some shorthand materials of doctor habilitatus dissertation defence, critical reviews of official opponents (V.P. Zosimovici, V.A. Poddubnaya-Arnoldi, A.A. Shahov) and texts of reviews for the synopsis of the thesis.

The textual part of Tome II contains 124 original electronographs, 19 tables, 3 graphs and 1 chart.

Tome III. Organellogenesis – Ontogeny of Cell Organelles of *Zea mays* L. ssp. *saccharata* (Sturt.)

Section I: The ultrastructure of organelles of embryo root cap cells of *Zea mays* L. ssp. *saccharata* (Sturt.) includes chapters 1-5, where the ultrastructure of organelles of cells of different zones (I-IV) of root cap is described. Each chapter includes specific comments, and each electronograph – a detailed analysis, the method of colour fixation and impregnation and amplification. A conclusion to the whole section is given.

Section II: The ultrastructure of organelles of apical meristems of *Zea mays* **L. ssp.** *saccharata* **(Sturt)** includes chapters 6-9 and comments for each chapter. Organelles of apical and lateral meristem of male and female inflorescences; cell organelles of floral tubercle, cells of embryonic leaf primordium, stigma and pistil hair strands are described.

Section III: The ultrastructure of organelles of ovule and embryo sac cells of *Zea mays* L. ssp. *saccharata* (Sturt) includes chapters 10-19. The organelles of ovule tubercle cells, ovule integuments, micropylar cells, nucellus cells, synergid cells, filamentous apparatus, egg cell, central cell, antipodals and "shell" of the embryo sac are shown. There are comments to each chapter and a conclusion to the section.

Section IV: The ultrastructure of organelles of anther wall cells of *Zea mays* L. ssp. *saccharata* (Sturt) includes chapters 20-24, where the it is presented the ultrastructure of organelles of cells of the epidermis (exotecium – for the first time, a detailed ultrastructure of chromoplast ontogeny is provided), fibrous layer (endotecium – showing the chloroplast-to-chromoplast transition), organelles of cells of the intermediate layer and organelles of tapetum cells, which show that: nuclei (2-4) of tapetum cells do not merge, cells are limited only by plasma membrane, it is demonstrated the mechanism of formation of sporopollenin and special morpho-modified mitochondria and other organelles. There are comments to each chapter and a conclusion to the section.

Section V: The ultrastructure of sporoderm and pollen grain cells of *Zea mays* L. ssp. *saccharata* (Sturt) includes chapters 25-29 (+ a, b, c – new structures, described by us for the first time): the ultrastructure of exine, intine, germ pore of pollen grain, organelles of the vegetative cell of pollen grain, organelles of the cytoplasm of the microspore of single-nucleus pollen grain, ultrastructure of organelles of generative cell, ultrastructure of organelles of sperm cell, as well as the organelles Pariosoma described for the first time by us (Ciubotaru, 1969), multilamellar body (Ciubotaru, 1972) and intine-phagocytic are presented in detail. There are comments to each chapter and a conclusion to the section.

Section VI: The ultrastructure of organelles of growing pollen tube of *Zea mays* L. ssp. *saccharata* (Sturt) includes chapters 30-32. The ultrastructure of pollen grains before germination, the cross sections of a growing pollen tube in the system: pollen grain – pollen tube, the process of self-propulsion of male gametes

[1] The papers published by us and our students are at the basis of this monograph: I – «Эмбриология зерновых, бобовых и овощебахчевых возделываемых растений». Authors: A.A. Ciubotaru, V.A. Celak, A.M. Moshkovici, M.G. Archipenko, Chisinau, 1987, 224 p.; II – «Эмбриология плодово-ягодных технических и стимулирующих возделываемых растений», Chisinau, 1987, 203 p.

in the system pollen grain – pollen tube are described in this section.

Section VII: Ultrastructural aspects of the double fertilization of *Zea mays* L. ssp. *saccharata* (Sturt) includes chapters 33-37. It shows the ultrastructure of organelles of the egg cell of the embryo sac before fertilization, organelles of sperm cells entered into the embryo sac, the cytoplasm-hyaloplasm of sperm cells and double fertilization, ultrastructure of chromosomes from the embryo sac, the ultrastructure of the neoplasm of the zygote.

Tome IV. Agroecological Embryology of Cultivated Crops[1]

Our embryological and cytogenetic studies have demonstrated the mutagenic effects of chemical fertilizers and especially herbicides on the crops cultivated in agrocenoses. The real threat of a premature exclusion from agro-biological turnover of the best varieties, created over many years and at great expense, is explained here. All this is due to the lack of information on the mutagenic potency of agricultural chemicals, the lack of control, trying to achieve the maximum yield, lack of certification of chemical products, their mutagenicity and accumulation in the soil and agricultural products, lack of a law on the admissibility to produce a crop depending on the fertility of and other characteristics of soils of Moldova. [2]

In **Section I: The subject and methods of research and in Section II: On the history of agroecological embryology of cultivated crops**, it is explained how dangerous was the uncontrolled doctrine, proclaimed in the middle of the second half of the last century, "chemicalization of agriculture in Moldova"!

In the following chapters, there is the characteristic of 89 the most important crops (see P. Zhukovsky., 1971) on the following parameters: (1) botanical belonging; (2) origin (the native distributional area of the crop and other parameters.); (3) formation of the reproductive organs; (4) anther; (5) microsporogenesis, microgametogenesis, pollen grain; (6) flowering and pollination; (7) megasporogenesis and megagametogenesis , embryo sac; (8) double fertilization; (9) embryogenesis; (10) endospermogenesis; (11) development of seeds (fruits), environmental and other factors.

In **Section III: Agroecological embryology of the cereals** (fam. *Poaceae* L.) **in agrocenoses**, there is information about: maize (*Zea mays* L.), teosinte (*Euchlaena Mexicana* L.), wheat (*Triticum* L.), triticale (*Triticale* L.), rye (*Secale* L.), barley (*Hordeum* L.), oat (*Avena* L.), panicgrass (*Panicum* L.), sorghum (*Sorghum* L.), rice (*Oryza* L.) and buckwheat (*Fagopyron* L.).

In Section IV: Agroecological embryology of legumes (fam. Fabaceae L.) in agrocenoses, there is information about: pea (Pisum L.), bean (Phaseolus L.), soybean (Glycine Willd.), garbanzo bean (Cicer L.), vetch (Vicia L.), peanut (Arachis hypogaea L.), broad bean (Faba L.), sweet pea (Lathyrus L.), alfalfa (Medicago L.), clover (Trifolium L.), sainfoin (Onobrychis Mill.), bird's-foot trefoil (Lotus L.), lupine (Lupinus L.) and yellow sweet clover (Melilotus officinalis L.).

In **Section V: Agroecological embryology of vegetables and melons** (fam. *Solanaceae* L., *Curcubitaceae* L., *Apiaceae Linde* L. etc.) **in agrocenoses**, there is information about: potato (*Solanum tuberosum* L.), cabbage (*Brassica oleracea* L.), tomato (*Lycopersicum* Mill.), turnip (*Brassica rapa* L.), pepper (*Capsicum* L.), aubergine (*Solanum* L.), onion (*Allium cepa* L.), garlic (*Allium sativum* L.), carrot (*Daucus* L.), parsnip (*Pastinaca* L.), celery (*Apium* L.), parsley (*Petroselinum* Hill.), dill (*Anethum* L.), fennel (*Foeniculum* Mill), caraway (*Carum* L.), radish (*Raphanus* L.), watermelon (*Citrullus* Schrad), muskmelon (*Mello* Mill.), pumpkin (*Cucurbita* L.), cucumber (*Cucumis* L.), momordica (*Momordica* L.), bottle gourd (*Lagenaria* Ser.), luffa (*Luffa* Mill), summer

[2] Agroecological embryology – a direction formulated by us in order to implement the morphogenetic control of mutagenic action of chemical agents (fertilizers, herbicides, fungicides, etc.), used in agrocenoses, on the formation of healthy crops.

squash (*Cucurbita* L.).

In **Section VI: Agroecological embryology of fruit crops** (fam. *Rosaceae* L., and others) **in agrocenoses**, there is information about: apple (*Malus* Mill.), pear (*Pyrus* L.), sweet cherry (*Cerasus* Juss.), sour cherry (*Cerasus* Juss.), apricot (*Armeniaca* Mill.), plum (*Prunus* L.), peach (*Persica* Mill.), quince (*Cydonia* L.), almond (*Amygdalus* L.), Cornelian cherry (*Cornus* L.), silverberry (*Elaeagnus* L.), hawthorn (*Crataegus* L.), chokeberry (*Aronia* Medic.), strawberry (*Fragaria* L.).

In **Section VII: Agroecological embryology of fruit and berry crops** (fam. Vitaceae L., Juglandaceae L. and others) **in agrocenoses**, there is information about: walnut (*Juglans* L.), grapevine (*Vitis* L.), pistachio (*Pistacia* L.), (*Hippophaë* L.), sea buckthorn (*Hippophaë* L.), jujube (*Ziziphus jujube* L.), mulberry (*Morus* L.), fig (*Ficus* L.), gooseberry (*Grossularia* Mill.), currant (*Ribes* L.), blackberry (*Rubus* L.), raspberry (*Rubus* L.), citrus (*Citrus* L.), tea (*Thea* L.), persimmon (*Diospyros* L.), serviceberry (*Amelanchier* Medic.).

In **Section VIII: Agroecological embryology of technical and other crops** (fam. *Astraceae* L., *Cannabiaceae* L. and others) **in agrocenoses**, there is information about: sunflower (*Helianthus* L.), sugar beet (*Beta* L.), cotton (*Gossypium* L.), tobacco (*Nicotiana* L.), hemp (*Cannabis* L.), sesame (*Sesamum* L.), jute (*Corchorus* L.), flax (*Linum* L.) and castor-bean (*Ricinus* L.).

Basic data about the reproductive cycle of each crop are accompanied by pictures. The total volume of the tome is more than 680 pages, including 460 pictures.

Tome V. Evolutionary Embryology

The first part of the tome consists of five chapters and begins with a brief analysis of the evolution of the haploid (n) homosporous gametophyte (Phase-I) and the evolution of the diploid (2n – a zygote or embryo) homosporous generation (Phase-II).

In **Section I** we analyze **Characteristics of sexual reproduction (in lower plants)** (Thallobionta) in fungi, the example of Zygomycetes, Ascomycetes, as well as green algae Spirogyra, Volvox and Charophyta. **In Section II: Characteristics of sexual reproduction of cryptogams** – *Marchantia*, hornworts and true mosses. In **Section III**: Characteristics of sexual reproduction in *Psilotum* (whisk ferns), *Lycopodium* (ground pines), *Selaginella* (spikemosses), *Equisetum* (horsetail) and *Pteridium aquilinum* (common bracken). **Section IV: Characteristics of sexual reproduction of gymnosperms:** conifers, cycads, *Ginkgo* and *Ephedraceae*. **Section V: Characteristics of sexual reproduction of angiosperms** (*Magnoliphyta*), we examine the similarities and differences between the main embryological elements in dicotyledonous and monocotyledonous flowering plants: ovule, archesporial cell, embryo sac, anther, pollen grain, pollen tube, double fertilization, embryo, endosperm (nuclear, cellular and helobial endosperm) the evolution of embryonic structures of dicotyledons, the evolution of embryonic structures of monocotyledons.

The concept "Evolution and strategy of sexual reproduction (CESER) in the plant world" is considered in **Section IV** of **Tome V. Theoretical aspects of the problem** include different periods (levels) of embryonic evolution, such as: 1) **primitive** – the initial period, which is **dominated by haplophase,** adaptive to the aquatic environment; 2) the second period – **transitional** one, when an **alternation of haplophase and diplophase occurs;** 3) **gymnosperm** period and 4) **angiosperm** period – the last period is accompanied by the occurrence of double fertilization.

At the present stage, in the evolution of Angiosperms, the decisive role was played by triploid tissue of endosperm which had become the aromorphous accelerator of development in angiosperms. The concept of **"Evolution and strategy of sexual reproduction in the plant world"** reveals also the adaptive potential of heterozygosity, which is created when the act of double fertilization is present. The evolutionary inherited

process of heterozygotization and micromutation in populations "triggers" "internal incipiencies" of adaptogenesis considered to be the cornerstone on which rests an inexhaustible source of biological diversity.

The concept of "**Evolution and strategy of sexual reproduction (CESER)**" explains the progress of eukaryotes as a result of successful convergent adaptogenesis of archaically ancient statute of morpho-embryogenesis to geological and pedoclimatic changes.

Tome VI

Karyology and Systematics of Cultivated and Wild Species of Cereals in Moldova
Cytogenetic Studies on Pachytene Chromosomes (*Zea mays* L.), Hybrids (*Secale* L.) and Mutants (*Datura* L.).

In **Section I: Karyology and systematics of cultivated and wild-growing species of cereals in Moldova**, after the first chapter: **Materials and methods of studying chromosomes**, in the second chapter: **The morphology and the number of somatic chromosomes (2n) of 9 varieties of the genus *Zea mays* L.,** we analyzed: haploid (n = 20), triploid (n = 30) and tetraploid (n = 20) varieties of maize (in all, 3 varieties, Chapter III), karyotypes, types of mutants (n = 10), mutants of selected varieties (lines and hybrids) of *Zea mays* L. (in all, 7 varieties, Chapter IV); Karyology and systematics of cultivated and wild species of the genus *Triticum* L.: diploid species of the genus *Triticum* L. (2 species); tetraploid species of the genus Triticum L. (11 species) and hexaploid species of the genus *Triticum* L. (6 species, Chapter V).

In **Chapter VI: Karyology and systematics of cultivated and wild species of *Avena* L.,** the karyotypes of diploid (2n – 2 species); tetraploid (2n = 28 – 2 species) and hexaploid species (2n = 42 – 6 species) are analyzed. The **karyology and systematics of cultivated and wild species (n. var.) of the genus *Secale* L.** are examined in **Chapter VII:** diploid species (2n = 14 – 9 species), tetraploid (2n = 28 – 9 species). In **Chapter VIII: Karyology and systematics of cultivated and wild species of the genus *Hardeum* L.,** diploid species (2n = 14 – 7 species). **In Chapter IX: Karyology and systematics of cultivated and wild species of the genus *Panicum* L.**, varieties of panicgrass with open panicle (2n=36 + 1B – 2 forms); ssp. *Efusum* Al. with intermediate panicle (2n=36…+1-2B, 4 varieties); varieties with compact panicle (*Compactum* Körn) (2n=36, 3 varieties). **In Chapter X: Karyology of cultivated species and varieties of the genus *Sorghum* L.,** the chromosomes of 21 varieties (2n = 20) are analyzed.

In **Section II: Karyology of monocotyledonous species of the wild flora of Moldova** we present results of the karyosystematic study on some wild-growing species of the genera: *Roegneria* C. Koch, *Elytrigia* Desv., *Agropyron* Gaertn., *Typha* L., *Schoenoplectus* (Rchb.) Palla, *Carex* L., *Arum* L., *Juncus* L. and also **species of the families:** *Liliaceae* Juss., *Convallariaceae* Horan., *Alliaceae* J. Agardh, *Amaryllidaceae* J.St.-Hil., *Orchidaceae* Juss., *Iridaceae* Juss., *Asteraceae* Bercht. Specifications were made for some (autochthonous) species and for others, for the first time, the number of chromosomes was determined.

In **Section III: Cytogenetic researches on *Zea mays* L., *Secale* L. and *Datura* L. (chapters I, II and III)** the cytomorphology of meiotic pachytene of maize, and, in particular, the chromomeric organization of three varieties of maize (var): Z. m. var. saccharata (Sturt.); *Z. m.* var. *indurata* (Sturt.); *Z. m.* var. *indentata* (Sturt.) and one intergeneric hybrid – *Zea mays* L. x *Euchlaena mexicana* L. are analyzed in detail. Studies of chromomeric structure of pachytene chromosomes (research that for the first time has been carried out in the USSR) enabled us to reveal individual characteristic of each pachytene chromosome. On this basis (also for the first time), cytological maps of chromosomes A and B for sweet corn *Zea mays* var. *saccharata* (Sturt.) L. H. Bailey were constructed (all drawings are original and documented). At the end of the section, the list of chromosomal genes and phenotypic traits of maize *Zea mays* L. is supplemented. Also, a short review of basic

statements, including hypotheses of origin and evolution of modern maize is put at the disposal of readers.

At the end of **Section III, Cytogenetic researches on *Secale cereale* L. and Cytogenetic researches of induced mutants of *Datura stramonium* L. and D. *innoxia* L.** are described.

"Publication of scientific works" includes articles and reports on the introduction and proper harnessing of the gene pool of wild plants (1980-2010).

Tome VII. Pages from the History and Creation of the First Botanical Garden (Institute) (1964-1987) and "Arboretum" of BG (I) AS of Moldova (1978-1987)

Section I.

A. Capital construction

Whether I was asked what I longed for, exactly 52 years ago, when there was posed a question of me to be appointed the director of a Botanical garden? The answer was unambiguous: to get the permission for a choice of a new territory and construction of a modern Botanical Garden on it. I decided firmly on that. And I had a run of good luck! Sequenced successes, unimaginable difficulties and years of work without rest – all this, in general, was intermingled with my irreversible desire to go to the planned purpose; I succeeded in many ways and this proved to be an amazing source of inspiration.

On how everything had started and in what way the employees of the Botanical Garden, Academy of Sciences of Moldova, government and municipal authorities, as well as Botanical Gardens of other republics helped to move "a train of constructions" was consistently described in tome VII of "Selected papers".

In **Chapter I,** we unfold how we were choosing a new territory within the city area but not under housing stock and which could meet our requirements and objectives of the future Botanical Garden. We produce the ordinance of the Council of Ministers of Moldova (No. 919 from September, 27, 1965), on the allocation of the territory, and the Resolution of the Moldavian Government (1976) on prescriptions concerning the exploitation of the new territory under the Construction of the Botanical Garden.

In **Chapter II,** we recount our concept of construction and creation of the Botanical Garden as a scientific and educational institution. In "Assignment for projecting the Botanical Garden", we enumerated the suggestions for projecting capital premises of scientific-experimental facility etc.

In **Chapter III,** we adduce the difficulties that were faced when opening budgetary financing questions on competence of the State Planning Committee of the USSR. We give an account on the achievement of financing and the beginning of capital construction, as well as the creation of a temporary base and the subsequent transfer of the administration and the introductive laboratory to the new territory.

In **Chapters IV** and **V**, of Section I, of Tome VII, we speak of exploiting the new territory and what modifications were made to SRW (scientific-research work) and on how projecting and building of objects of first priority as well as landscaping, construction of the road and utility network, establishment of the irrigation system, creation of lawns and construction of the laboratory-administrative building were accomplished. It was very difficult to obtain a permit to build the decorative metal fence around the garden area, and especially to receive hundreds of tons of steel and cast iron from the funds of the former USSR. We met similar difficulties during the construction of the cascade of ponds, paving the shores of decorative ponds with 6-meter slabs, building the greenhouses and the biotechnological complex.

Section II - Green construction

We consider issues on designing the Arboretum of the Botanical Garden, the creation, in nature, of collections of woody plants (deciduous and coniferous species) and scientific collections of autochthonous and allochthonous herbaceous species; as well as the exhibition of Moldavian Flora; the exhibition of ornamental, medicinal, aromatic, edible, fodder plants etc. In the same section, we present the results of the undertaken expeditions for collecting and bringing planting material.

Tome VII ends with a summary of the main results of 30 years' work of the Botanical Garden (1971-2001). Let's underline some of them: conferring the Statute of the Scientific-Research Institute of the AS of Moldova upon the BG (that, in essence, meant the foundation of a new academic institute); creation of a ten-thousand gene pool of autochthonous and allochthonous species of plants; preparing and publishing serial editions of monographic works, including the edition of the six-tome monograph "Flora Basarabiei" (Bessarabia's Flora), the periodical "Revista botanică" (The Journal of Botany) etc.; establishment of scientific schools in the field of distant hybridization, geobotany, cytoembryology, anatomy, algology, paleobotany; organization of the Specialized Scientific Council for the defence of doctoral (Ph.D.) and habilitation (Dr. habil.) theses; training highly qualified scientific staff.

In the Supplement we provide: the list of species – the gene pool of BG, maps of exhibitions and collections, the list of species, ecotypes and cultivars (varieties) for indoor/outdoor environments.

Section III. Planning. The beginning of construction of the "Arboretum" of the Botanical Garden (1978-1987)

We set forth the concept of creation of the "Arboretum" on eroded lands, to the right of the highway, at the exit from Chisinau. The ordinance of the Council of Ministers in MSSR "Concerning the construction of the "Arboretum" on the eroded lands in the proximity of the BG (I) ASM" is given. In Section III, Tome IV, of "Selected papers", we narrate briefly what we have achieved.

The creation of a new Botanical Garden (Institute) on an area of 104 hectares, in a short time, is a unique case. Our experience of the continuous multifaceted process, the creation of the complex structure of the Moldovan Botanical Garden is worthy of being shared.

Tome VIII. Landscape Architecture of the Botanical Garden of the ASM (1974-2012). Creation of Arboretums in the Republic of Moldova (1996-2012)

Section I. Scientific and practical decisions in the domain of landscape design and park construction. Successes and failures of landscaping, in droughty years, in Moldova (1964-1997): concepts, materials, requirements, responsibility when choosing the territory, design, park construction. We say about long-term tasks during greening works.

About some finalized projects on landscaping in Moldova (1966-2000) and on the territory of the Botanical Garden of the ASM. We are saying about the restoration and the enlargement of the Arboretum of the BG of the AS of Moldova. Works on the creation of **Arboretum** – a recreation park for citizens of Chisinau and, also, a source of seeds for plant propagation; a) design and creation of: (1) The Memorial Park "Serpeni Bridgehead" on the Dniester river; (2) The central and the lower parks of the Monastery Curchi (Orhei district, Moldova); (3) The Memorial Park on the burial ground of German soldiers of the Second World War (1941-1945), cemetery Doina, Chisinau; b) planning and creation of micro botanical gardens: (1) Rosary; (2) Lianary; (3) garden of trees with artificially shaped crowns; (4) Rockery (Japanese garden); (5) Alpinery; (6) Syringary;

[3] During Gorbachev's "Perestroika", on July 17, 1988, I was elected director by staff of the Nikitsky Botanical Garden (NBG, Yalta, Crimea), (on contract concluded with the superior organization – the All-Union Academy of Agricultural Sciences of the Soviet Union (VASKhNIL)). At the same time (1988-1995), I acted as head of the

(7) collection of essential oil-bearing and medicinal plants; (8) collection of coniferous plants, including exotic ones (a project); (9) glade of fairy tales (a project); (10) creation of the central triangle, in the lower part of the BG, and of the double alley; (11) hedgerows etc.

Section II. (A) Speeches (texts) held at various congresses, symposia in the country and abroad (republics of the former Soviet Union, USA, France, Italy, India, Poland, Austria, Holland, Romania, Turkey, Bulgaria, Cyprus, England and other countries during 1958-2010). In total, more than 150 speeches; the partial content of about 40 reports is provided here.

(B) List of inventions, methods and techniques in (light and electron) microscopy and in landscaping (28 of headings).

(C) List of allochthonous species of medicinal, decorative and wild-growing plants being brought by us and undergoing introduction in Moldova (in total more than 20 species).

Reports on the work during business trips abroad: (Kiev, Moscow, Leningrad, 1957-1971, Sweden, 1967-1968; United States, 1969; India, 1976; France 1976; Cyprus, 1990-1991, 1992; Bulgaria, 1990-1991, Turkey, 1990, Romania, 1996).

Tome IX.

Part I. Nikitsky Botanical Garden. The Years of "Perestroika" (1988-2005)[3]

First of all, I had to formulate urgently – the priority scientific and organizational tasks regarding the improvement and development of **Nikitsky Botanical Garden** in the coming years. This and other matters are referred to, in chronological order, in the following (I-IX) chapters.

The first chapter – I was elected director of Nikitsky Botanical Garden. What's next? The question was put by the Board of Working Collective (BWC) of NBG and by the Council of Young Scientists of NBG, in order to get acquainted with the candidate for the post of Director, before I was elected: "What would I do if I became the director of Nikitsky Botanical Garden?" One of my answers was: How to direct the creative energy and a lot of experience of the staff of Nikitsky Botanical Garden to a new, at this stage, creative path?

In the second chapter – on the measures taken to strengthen the research base of the sections of NBG: (1) improvement of budgetary and self-supporting financing of different sections (Frunzeni Section, Steppe Section and Central Section) and of scientific subdivisions, due to the expansion of commercial production. (2) organization of a joint scientific-producing enterprise "Agrof", together with the private company “Kulermus”, in Cyprus, for the cultivation of aromatic plants and commercialization of essential oils; (3) sale, on license, of the best cultivars of fruiting plants (selected in the NBG) to a French firm "Le Gonie", (4) preparation of assignments for planning social-economic and scientific development of the NBG for the next 20 years (General planner – Moscow Institute GIPRONII). The work was done and the documentation was received by NBG; (5) creation of a base for introduction of medicinal, aromatic, ornamental and fruiting cultivars, varieties and hybrids (selected in the NBG) in Kirgizia, Russian Far East and Central Russia.

In the third chapter, we talk about planning and construction of the Biotechnology complex (BTC), in Yalta, on the NBG territory. In the fourth chapter – about participation in the tender for funded research projects and bilateral research and production programs (including foreign ones); planning and construction

Department of Cytogenetics and Embryology of Plants. The difficulties and successes of that period are briefly discussed in the first part of this tome.

Returning (by invitation) to the previous job, fate brought me (at the Academy of Sciences of Moldova, 1995) in a similar situation, about which I am going to tell in the second part of this tome.

of parks in the steppe Crimea; creation of a new nursery station for growing dendrological plants in v. New Kakhovka, Kherson oblast, Ukraine; training of the scientific personnel, organization of the Specialized Scientific Councils for the defence of doctoral theses at NBG (over the years, at NBG, about 10 doctoral theses and about 10 habilitation theses were defended). My merit is that I aroused interest and belief in the importance of the generalization, systematization and presentation of the experimental material for defence. I created conditions and, on several occasions, I gave scientific advice for the completion and defence of doctoral theses. Those who defended, in those years, doctoral dissertations (Rabotyagov, Podgorny, Klimenko, Yakimov, Lishchuk, Kuznetsov, Bukin, Shevchenko, Mitrofanov, Ilnitsky, Shefiristov, Avgeev) are leading today research departments of NBG. I met many of them, in 2012, at Nikitsky Botanical Garden, where I had been invited to celebrate the 200th anniversary of NBG.

During the years when I worked at NBG (1988-1995), I developed the concepts of "morphofunctional status of gametogenesis", "evolution and strategy of sexual reproduction in the plant world", "tapetogenesis on the example of anthers of flowering plants" and "embryonic aromorphosis". On the basis of the chromomeric structure of pachytene chromosomes of sweet corn, I made (for the first time in USSR) cytological maps of pachytene chromosomes A and B. I published over 200 scientific papers (articles, theses, collected articles) in the country and abroad, I presented over 30 reports.

The first part of Tome IX ends with Chapter IX, where the situation created in the NBG after the dissolution of USSR and its transfer to the jurisdiction of Ukraine is briefly described.

Part II.

Botanical Garden (Institute) of the Academy of Sciences of Moldova. "Years of Market Economy" (1995-2006)

Here, I talk about my return to the post of head of the Embryology and Biotechnology Laboratory and my election as director of the Botanical Garden (Institute) of the Academy of Sciences of Moldova.

The priority issues:

1. to return the former name, i.e., instead of Institute of Botany – Botanical Garden (Institute) and, accordingly, to restore the statute of the Botanical Garden with the consequent characteristics;
2. to return the "Arboretum", with an area of 172 ha, (transferred to the Ministry of Culture) to the Botanical Garden (Institute) of the ASM;
3. to complete the work on the preparation and opening of the Botanical Garden for the citizens of the capital and of the whole country;
4. to start the construction of secondary objects (the central entrance, the greenhouse, the Botanical Museum, the National Herbarium, decorative bridges, as well as landscaping around the ponds, paving roads, creating new mini-collections of plants etc.);
5. to submit to the government a proposal on the establishing the northern Botanical Garden, in the city of Balti, and the southern Botanical Garden, in the city of Cahul.
6. to submit a proposal on granting the status of filial branch of the Botanical Garden (I) of the ASM to

[4] See "Cercetările botanice asupra Basarabiei" (1993), which shows that the first list of plants collected in Bessarabia was made up by the Swiss researcher Charles Tardent (1812-1859) and the first consistent and reliable floristic (and paleobotanical) data from Bessarabia have been offered by Prof. I. Şmalgauzin (1849-1894) (Kiev). We also mention the great contribution of other famous personalities, who researched the flora of Bessarabia: acad. V. Lipski (1863-1937), prof. N. Zeleneţkii (1837-1910), J. Poczoski, T. Săvulescu, T. Rayss, A. Bozza, I. Prodan, C. Zahariadi (1901-1989), I. Barbu etc.

Tsaul Park.

7. to finish writing and to publish "Flora of Bessarabia", in 6 volumes;

8. to achieve the status of National Botanical Garden;

9. to obtain the decision of the government on supplying the Botanical Garden with water, electricity, heating in winter, regardless of the possibility of financing;

10. to publish the periodical "Revista Botanică" in Romanian and other languages;

11. to perform the reconstruction of the collections of ornamental, medicinal and aromatic plants of floriculture sector;

12. to provide, as director and scientific advisor, maximum assistance in the completion and defense of doctoral theses (Postolachi D., Romanciuc Gabriela, Roșca I., Trifauțan Viorica) and habilitation theses (Toderaș L., Pîntea M., Palancean A., Teleuță A.);

13. as deputy editor of the monograph in 8 volumes "Lumea animală" (4 volumes) and "Lumea vegetală" (4 volumes), to organize preparation and publishing;

14. to make a detailed plan for the preparation and publication of "Selected Papers" in eleven tomes, including the work presented in "Prologue";

15. to find a way out of the financial crisis, to preserve the plant collections and to keep the employees of the Botanical Garden motivated, even in a situation of shortage of funds necessary for the payment of monthly salaries.

How the above-mentioned and other important issues and concerns were solved, and how the difficulties were overcome, it is described in Part II of the IX-th tome.

Tome X. The Years When Botany Became an Academic Science in Moldova (1946-2016)
Part I
From the History of the First Botanical Studies of the Flora of Bessarabia

At the end of the first half of the XX century, as a result of the organization of the Moldavian Research Center of the Academy of Sciences of the USSR, the botanical sector became part of it and the planned floristic studies were initiated. The last became a starting point in the development of academic science. Which were the first steps in this field, how new directions were created, how the botanical sector became the Botanical Garden (1950), how a new territory was obtained and how construction works took place, how the scientific staff was trained, how the Botanical Garden (sector) received the status of research institute, this and much more is narrated, in chronological order, in Tome X.

A brief historical sketch shows that the first data on the flora of Bessarabia were mentioned by the scientist, the philosopher and the encyclopaedist Dimitrie Cantemir in "Descrierea Moldovei" (1716). The first authors who conducted researches on the flora of Bessarabia are mentioned in the works of T. Gheideman (1975, 1986), D. Mititelu and N. Costic (1993), G. Postolache (1995) and A. Negru (2011) .

Part II includes the first stage in the formation of future directions of botanical research. These are the years (1046-1964) of the planned studies of the flora and the geobotany of Moldova (T. Gheideman, G. Postolache, Nicolaev, L. Chirtoacă, Ș. Manic, Ș. Lazu, G. Simonov, K. Vitco, Af. Istrati, P. Pînzaru.); distant hybridization of fruit and other crops (V. Rîbin, I. Rudenco, I. Comanici, M. Nicolaeva, G. Dubcaia, Ș. Topală); morphology and

Some other noteworthy works: C. Dobrescu «Dezvoltarea cercetărilor botanice în Moldova și Bucovina Moldovei», 1987; T. Seghedin «Istoricul cercetărilor cu privire la flora și vegetația munțiolr din Bazinele Moldovei», 1980; T. Săvulescu «Die Vegetation von Bessarabien», București, 1927; Наталия Агасиева «Биологическая мысль в Молдавии», Кишинев, 1984.

anatomy (B. Matienco V. Codreanu, E. Ciobanu-Zagornianu, G. Rotaru, V. Tcaciuc, Maximova); embryology, cytology, karyology and cytogenetics (A. Ciubotaru, V. Celac, A. Moșcovici, V. Grati, L. Toderaș, A. Surugiu, A. Chiricenco, T. Azema, M. Arhipenco, R. Botnarenco, L. Ludnicova); paleobotany (A. Negru, V. Cantemir, A. Ștefîrță et al.); introduction of trees and shrubs (V. Andreev, B. Holodenco, I. Junghietu, I. Comanici, A. Palancean, V. Bucațel, P. Tarhon, P. Leontev, I. Roșca); introduction of flowering ornamental plants (N. Șarova, K. Dvorianicova, V. Savva, T. Sîrbu, E. Dașcheev, E. Manea-Cernei, E. Zagorcea, L. Cleșnina, E. Constantinov, I. Voineac); introduction of aromatic and medicinal plants (now: Plant Resources) (B. Ivanova, V. Florea, M. Bodrug, L. Chisnicean, M. Colțun, V. Țîței, N. Ciocîrlan, L. Bondari, L. Bîrcă); introduction of tropical and subtropical plants (Șevinscaia, E. Cernei, C. Dvorianicova, V. Țîmbalî, N. Toderaș, L. Gheorgița, E. Murzac, N. Iațco, O. Ionescu). The main results of the work (of groups, laboratories) as well as the analysis of the scientific and organizational activity of heads of laboratories and of employees are also mentioned in this chapter.

In the end of the second part of Tome X, we briefly summarize the work on the creation of the material and technical basis, training specialists (doctors, habilitate doctors, technicians, gardeners etc.), the development of the scientific and organizational structure, the results of the obtained data, including the results of the construction of the Botanical Garden on a new territory, the conferment of the status of Research Institute on the Botanical Garden, the creation and the activity of the specialized Academic Council for the Attestation of Scientific Personnel, the publication a series of monographs and of "Revista Botanică", "Flora of Bessarabia", "Selected Works", the participation in international forums, the creation of cultivars, the use of the results for the benefit of the national economy.

The botanical research, including the regional and the theoretical one, in the post-war Moldova has enabled the Botanical Garden of the Academy of Sciences of Moldova to participate in solving all-union scientific problems: 1) Biological basis of the study of plant resources, their conservation and sustainable use; 2) Introduction and acclimatization of plants; 3) Creation of the experimental base of the Botanical Garden of Academy of Sciences of Moldova, the creation of scientific collections of native and alien, cultivated and wild plants.

Tome XI. Life and Work in the Mirror of Time (1956-2016)

The ninth tome "In honorem" begins with a short autobiographical sketch followed by the "Curriculum vitae" and the list of published scientific papers – more than 740 headings, including 28 monographs, collected articles, bibliographic indexes (1957-2016); projects, grants, lectures, presentations on structural botany, karyology, karyosistematics, sexual reproduction in plants, comparative, experimental, ultrastructural, agrarian, ecological biotechnological and evolutionary embryology. The title, years, place and opponents at the defence of my doctoral and habilitation theses are also given here. The list of inventions, the name of the plant varieties created by me (co-author), rational proposals in capital construction of the BG (1971-1978); methods and techniques of transplantation of trees, transportation of large trees, with clod of earth, on vehicles, stimulation of root growth and tree planting can also be found in this tome.

We bring forward a chronologically arranged list of doctoral candidates (they are more than 60) that had been trained under my supervision. We provide titles of theses, years of doctoral studies and of thesis defence; some theses are briefly commented. We present the list of doctoral dissertations (habilitate doctor) to which I had been scientific supervisor both officially and unofficially and also Ph.D. theses that I had greatly contributed to (drew up a plan, carried out scientific editing, justification etc.) and those doctoral dissertations which were prepared and defended in the years of my directorship at BG (I) ASM (1964-1987; 1996-2006) and at the Nikitsky Botanical Garden (1988-1995).

In a separate chapter, it is spoken about my work at the Council of Experts VAK (Higher Attestation

Commission of USSR, Moscow, 1972-1988), about organizing and superintending the activity of Specialized Scientific Councils for the defence of habilitation (Dr. habil.) and doctoral (Ph.D.) theses of the Botanical Garden (I) ASM (1975-1987; 1996-2006) and of the Nikitsky Botanical Garden (1991-1995) and about my addresses with critical reviews on habilitation and doctoral dissertations in the following cities: Chisinau, Tbilisi, Chernovtsy, Kiev, Erevan, Leningrad, Chernigov, Kharkov, Minsk, Tashkent, Samarkand, Iasi, Bucharest and in many others.

Tome XI also provides: 1) reports on the work done in the course of research and business trips abroad; 2) excerpts from references, quotations from my works in publications in the country and abroad; 3) comments and remarks about my activity on the occasion of various anniversaries. The tome ends with words of memory and gratitude to my parents, sisters, family members, friends, teachers, colleagues, students and workers with whom I worked for many years and established myself as a researcher, as a scientific adviser, we built together a botanical garden and enjoyed our successes.

The chronology of the most important events and results of my activity are provided in the section "Life and Work" (1956-2016). The reverse side of the history of everyday life hasn't been passed over in silence; it is described at the end of this tome, in the section "On the zigzags and stones at the crossroads of life path".

We display the full text of biographic sketches (essays) written by me: Linnaeus C., Darwin Ch., Jucovschi P., Zahariadi K., Grosul Ya., Gheideman T., Navashin S., Steven Ch., Tsitsin N., Kovarsky A., Poddubnaya-Arnoldi V., Vavilov N., Müntzig A., Lupan A., Lupan N., Ciubotaru T., Matienco B., Jacota A., Toma K., Toma C., Furdui T., Dediu I., Constantinov T., Micu V., Lupașcu M., Yakovlev M., Marin A., Mititiuc M., Gorya V., Kostriukova K., Ribin V., Modilevsky Ya., Cernoyarov M., Gerasimova-Navashina E., Negru A. et al.

Further we make known fragments of the texts that cite our works, titles and plans (projects) for writing monographs and articles (unpublished works), we provide the full text of articles, essays, statements about the activity of A.A. Ciubotaru, we impart short comments of the outspoken warm wishes on the occasion of the 50th, 55th, 60th, 65th, 70th, 75th, 80th birthday celebration.

Family photos as well as moments from scientific and organizational activity in the country and abroad make part of this work.

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In addition to the above, it is necessary to remind that the first six tomes of "Selected papers" are devoted to a general problem, formulated by us: "Biology of sexual reproduction in the plant world". At the head of these researches, we had put cytoembryological (light microscopy and electron microscopy) researches of subspecies of the genus *Zea* L. Let me refresh your memory by saying that maize still remains to be amongst the most important agricultural, forage, edible crops for the world economy.

During the last decades, our cytoembryological researches have been developing from the point of view of "Biology and strategy of sexual reproduction in the plant world" and enabled us to consider anew earlier settled questions, such as morphogenetic diversity of systems of sexual reproduction in the plant world. This refers to the level of adaptability and similarity of the reproductive hierarchy in their phylogenetic connection.

Many questions which in their time had been left unanswered resulted, to some extent, in the stagnation of important directions of biology and determination of phylogenetic links between *Angiospermae* and *Gymnospermae*. In such cases, it can be seen a heightened interest and a more detailed embryological study, initially, of individual groups, and definitely more courageous assumptions, concepts and hypotheses that have been formulated on the basis of new facts acquired by methods of electron microscopy, biology and astrobiology.

Electron microscopy enabled us to link up structural-functional processes, for instance, gametogenesis (gametophytogenesis) with biochemical and pre-archesporial processes. With this, it is important not to

forget about ontophylogenetic actions of exogenous factors on apical meristems, and, also, about archesporial cells and their genetic pre-programming. Here, the doors to previously known processes were found to be opened, for example, the transitional process from diploid state (level of work of genes) to the haploid level (state), arisen as a result of meiotic process (reduction of genome) and undoubtedly in disturbance of morphophysiological homeostasis. The ultrastructural analysis of the morphophysiological state of gametes permitted a deeper understanding of the biological essence of the act of fertilization, the triple fusion and the role of endospermogenesis as accelerator of embryogenesis. We have revealed, and this is the most important, that the reduction of chromosomes (genome) leads to ontogenetic rejuvenation, renewal of haploid gametes in course of formation and, at the same time, to hormonal changes in the generative organs and inception of holozoic state of gametes (sex cells) that explains their tendency to reciprocal phagocytosis and, accordingly, to formation of diploid genome capable to give vent to genetic aromorphosis – the potential of new-formation.

In search for an explanation to other facts, we recurred to the formulation of the morpho-functional status which ensured differentiation and embryonic development in normal conditions, to formulation of concepts, principles and hypotheses. We had been inspired by a well-aimed statement (which has never lost its value) by Thomas Morgan saying that "Evolution is germinal in origin and not somatic as had been earlier taught ". According to our belief, suchlike oriented statements could introduce embryology to the circle of indispensable developers of the problem of biology of sexual reproduction, in the development of the evolution and the strategy of maintaining biodiversity. The last point is very important since embryology of plants remains "linked" to so-called problems of the XX century.

The remaining (VII-X) tomes of "Selected papers", in the main, contain data on scientific and organizational work, activity of those years, correct planning and more effective development of scientific researches on applied and theoretical botany in concrete regions of the country. We talk about governmental tasks: about the construction of a Republican (Academic) Botanical Garden in Moldova (Tome VII); planning and construction of parks in the steppe Crimea and in Moldova (Tome VIII); about adjustment of research and production processes in one of the largest institutions – the Nikitsky Botanical Garden in the period of Gorbachev's "Perestroika" and rescue of another – Botanical Garden of AS of Moldova (being invited to return to Moldova) at the peak of the "market-oriented economy" period when workers and staff were not remunerated for the whole year but still went on working (volume VIII)?!

Although tome XI, in a sense, is autobiographical in nature, "Life and work in the mirror of time", for the most part, is instructive in many respects, especially for young scientists, who in their early years tie their personal and family life up with science.

At the same time, "Selected papers", towards which I have been consciously approaching for more than a half of the century, in a way, resembles Irving Stone's novel "The Agony and the Ecstasy", i.e., it focuses on non-standard and difficult work, in my case – of one of the directors of Botanical Gardens who one day firmly decided to polarize his destiny of researcher in administrator-researcher and researcher-administrator. We present to the reader what we aspired for and what we have achieved. And let everything remain in the mirror of time.

În memoriam Mihai Bodrug
(4.12.1941-24.11.2007)

La 4 decembrie 2016, distinsul savant Mihai Bodrug, plecat dintre noi la 24 noiembrie 2007, după o boală grea, ar fi împlinit 75 de ani.

Mihai Bodrug s-a născut la 4 decembrie 1941, într-o familie de țărani din comuna Hârceşti, judeţul Bălţi (astăzi r-nul Ungheni). După absolvirea şcolii medii din satul natal, devine student la Facultatea de Geografie şi Biologie a Institutului din Tiraspol, pe care o absolveşte cu succes în 1963. În 1966, susține examenul de admitere la doctorantură şi este delegat să-şi continue studiile de doctorat în cadrul Institutului de Botanică „V. L. Comarov" din Sanct-Petersburg, unde sub îndrumarea profesorului V. S. Socolov susține teza de doctor în biologie pe profilul „plantelor medicinale şi aromatice".

Timp de peste trei decenii a muncit cu silință, elan şi optimism consacrându-se activității sale ştiințifice în cadrul Grădinii Botanice, parcurgând toate treptele ştiințifice – de la cercetător ştiințific inferior (1970), cercetător ştiințific superior (1975), şef de laborator Plante aromatice şi medicinale (1986) până la director adjunct pentru activitatea ştiințifică. În 1990 susține teza de doctor habilitat în ştiințe biologice la tema „Implementarea plantelor eterooleaginoase în Republica Moldova".

Un merit inestimabil al marelui savant este fondarea unei colecții de plante aromatice în Grădina Botanică, care număra la începutul anilor 90 peste 500 de specii, forme şi soiuri. Pe parcursul îndelungatei sale activități ştiințifice a efectuat cercetări de introducere a plantelor aromatice, a reliefat particularitățile lor ontogenetice, a evidențiat factorii ce limitează adaptarea lor în condiții noi. A implementat peste 20 de specii de plante medicinale şi aromatice în industria de vinificare, alimentară şi farmaceutică. În acest context a publicat numeroase recomandări pentru toți cei interesați în cultivarea plantelor aromatice, de altfel, contribuind nemijlocit la crearea plantațiilor industriale de plante aromatice pe teritoriul republicii.

În decursul activității ştiințifice a publicat peste 270 de lucrări ştiințifice, inclusiv 3 cărți, a fost autor a 15 brevete de invenții cu aplicare practică în economia națională. A elaborat compoziția ingredientelor pentru vinuri aromatice, unde a inclus peste 25 de plante aromatice.

A dat dovadă de aptitudini deosebite în domeniul pregătirii cadrelor ştiințifice, reuşind sa organizeze cu multă rigurozitate activitatea colectivului pe care l-a condus. Sub îndrumarea şi participarea directă a doctorului habilitat Mihai Bodrug au fost pregătiți 4 doctori în ştiințe biologice, consultate numeroase lucrări anuale şi de licență, servind o bună şcoală pentru tineretul studios.

Fiind un om de mare probitate profesională a rămas până în ultimul moment devotat ştiinței şi istovitoarei munci de cercetare. În ultimii ani de viață a activat în cadrul Universității de Stat de Medicină şi Farmacie „N. Testemițanu", concomitent şi Director al Grădinii de Plante Medicinale a USMF unde tonul strict ştiințific a dominat activitatea sa până în ultimele clipe.

Mulți dintre cei care au avut posibilitatea sa-l cunoască și să muncească alături de el, au constatat că pe lângă calitățile lui de bun specialist în domeniul biologiei, era un om prietenos, generos, atent față de colegi, înzestrat cu un extraordinar simț al umorului, un om care gusta din plin glumele și care avea replică atunci când încercai sa-l pui în dificultate.

Așa l-am știut pe Mihai Bodrug – om de o aleasă ținută morală și profesională, doctor habilitat în științe biologice, profesor universitar, mare admirator a culturii naționale și bun prieten. Îi vom purta o vie amintire prin prisma fiecărui rând scris cu deosebită erudiție în lucrările sale, prin prisma fiecărei plante asupra căreia s-a aplecat distinsul savant, prin profunzimea și competența care a dominat în tot cea ce a realizat.

Colectivul Grădinii Botanice a Academiei de Științe

4 decembrie 2016