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MD – 2002, 18 Padurii str., Chisinau, Republic of Moldova
tel./fax: (+373 22) 52-38-98; 55-04-43
www.gradinabotanica.asm.md
journalofbotany@gmail.com

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TAXONOMIC CHARACTERISTICS OF DIATOMS FROM THE BIC RIVER NEAR CHISINAU

Boris NEDBALIUC, Eugenia CHIRIAC, Sofia GRIGORCEA,
Rodica NEDBALIUC, Ana GÎȚU
Tiraspol State University, Chisinau, Republic of Moldova

Abstract: Diatoms are common in all types of aquatic basins, forming phytoplankton, phytobenthos and periphyton. These algal communities are directly or indirectly related to abiotic and biotic factors of the environment. As a result of the investigations, 104 species and varieties of diatoms were highlighted. The main role in the formation of algocoenosis is represented by representatives of the *Pennatophyceae* class, especially of the *Raphales* order (with 85 species and varieties). The greatest diversity is observed during the warm season of the year, but it is also quite intense in the cold season of the year.

Key words: diatoms, phytoplankton, phytobenthos, epiphyton, algal communities, diversity.

INTRODUCTION

Diatoms are monocellular or colonial organisms, microscopic with coccoid talus. They have a very diverse structure of the cell and colonies – with the appearance of filament, ribbon-chain, star, fan, bushes etc. They are distinguished from other algae due to the chromatophores yellow-brown color, determined by the chlorophyll pigment complex „a" and „c" carotene and fucoxanthin. All pigments, except chlorophyll, dissolve in water, which is why the dead diatoms have green color. They are covered with a siliceous layer, called shell.

Diatoms are spread across all types of pools (from freshwater to ultrasaline ones), forming the phytoplankton and the phytobenthos. Often, they are components of the periphyton, living on the surface of different substrates submerged in water, forming communities of epilithic, epiphytic, epipsammic, epipelic and epizoic algae.

Some species also are encountered in the soil - edaphic algae. They are of great importance in the aquatic ecosystems because they are primary producers in the trophic chain. They are producers of solvite and atmospheric O_2, actively participating in the cycle of chemical elements in the nature, in the processes of self-cleaning of surface waters (many species are indicative of the level of water and soil pollution). They are used in assessing and monitoring the quality of aquatic ecosystems [2; 5].

MATERIALS AND METHODS

During the years 2015-2018 there were collected and studied samples of periphyton algae from the Bic River from the three stations located in Chisinau. The collection and processing of algae samples was performed according to unified collection and processing methods of

field and experimental hydrobiological samples [1, 4, 8, 11]. Samples of algae were taken seasonally from some aquatic plants - *Phragmites australis* (Cav.) Trin. ex Steud., *Typha angustifolia* L., *Potamogeton pectinatus* L., etc., as well as on pieces of wood, stones and other objects immersed in water. The study of the species from the collected water samples was carried out using the MBL 2100 microscope. In total, over 50 qualitative and quantitative samples of algae were studied. Determiners were used to identify the species [8, 9, 10, 12].

RESULTS AND DISCUSSIONS

As a result of the investigations carried out during the years 2015-2018 of the periphytonic algae communities on some higher plants (*Carex riparia* Curt., *Phragmites australis* (Cav.) Trin. et Steud, *Polygonum amphibium* L., *Typha angustifolia* L., *Potamogeton pectinatus* L. etc.), as well as from the inanimate substrates (stones, submersible wood, etc.) there were found 104 species and varieties of diatoms (Table 1).

Table 1. Taxonomic structure of the diatoms from the Bic River

Class	Number				%
	Orders	Families	Genera	Species and varieties	
Centrophyceae	2	2	5	7	6.7
Pennatophyceae	2	6	25	97	93.3
Total	4	8	30	104	100

Of the total number of taxa, 7 (6,7%) belong to the *Centrophyceae* class. Usually most species of this class are widespread in the plankton of the seas and oceans, in lowland continental basins there are few taxa. The species highlighted by us from this class belong to the *Discoidales* order and to the families of *Coscinodiscaceae* and *Biddulphiaceae*. They prefer water basins with moderate and increased salinity - most are mezohalobes [3].

The most important role in the formation of diatomic algocenoses belongs to the representatives of the *Pennatophyceae* class and especially to the *Raphales* order (with 5 families, 21 genera and 85 species and varieties of algae).

The richest in the genera proved to be the *Naviculaceae* family (11 genera, 36.6% of the total identified genera). Relatively well represented are the families of *Coscinodiscaceae* (4 genera, 13.3%), *Fragilariaceae* (4 genera, 13.3%), *Achnanthaceae*, *Nitzschiaceae* and *Surirellaceae* with 3 genera, which make up 30% of the total genera, and the *Biddulphiaceae* and *Epithemiaceae* families were present with one genus (Table 2, Figure 1).

Regarding the distribution of species and varieties of diatoms by families, *Naviculaceae* was the most numerous. It consisted of 46 taxa (44.2% of the total number of species and varieties identified), followed by *Nitzschiaceae* (20 taxa, 19.2%), *Fragilariaceae* (12 taxa, 11.5%), *Surirellaceae* (11 taxa, 10.6%), *Coscinodiscaceae* (6 taxa, 5.8%) and *Achnanthaceae* (6 taxa, 5.8%).

Other families have a small number of species. Thus, the genera with the highest taxonomic value are: *Nitzschia* (17 taxa, 16.3% of the total of 104 identified taxa), *Navicula* (15 taxa, 14.4%), *Gomphonema* (9 taxa, 8.6%), *Surirella* (7 taxa, 6.7%), *Cymbella* (6 taxa, 5.7%), *Diatoma*, *Synedra*, *Amphora* and *Caloneis* with 4 taxa).

The structure of diatom communities is directly or indirectly related to abiotic and biotic factors such as light intensity, temperature, pH, water hardness and water movements,

Table 2. Taxonomic structure of the diatoms evidenced in the water of the Bic River

Systematic groups	Number of species
Centrophyceae Class	7
Order *Discoidales*	6
Coscinodiscaceae Kutz. Family	6
Coscinodiscus Ehr. Genus	1
Cyclotella Kutz. Genus	2
Melosira Ag. Genus	2
Stephanodiscus Ehr. Genus	1
Order *Biddulphioidales*	1
Biddulphiaceae Schutt. Family	1
Biddulphia S.F.Gray Genus	1
Pennatophyceae Class	97
Order *Araphinales*	12
Fragilariaceae (Kutz.) D.T. Family	12
Asterionella Hass. Genus	1
Diatoma D.C. Genus	4
Fragilaria Lyngb. Genus	3
Synedra Ehr. Genus	4
Order *Raphinales*	85
Achnanthaceae (Kutz.) Grun. Family	6
Achnanthes Bory. Genus	2
Cocconies Ehr. Genus	3
Rhoicosphenia Grun. Genus	1
Epithemiaceae Hust. Family	2
Epithemia Breb. Genus	2
Naviculaceae West. Family	46
Amphipleura Kutz. Genus	1
Amphora Ehr. Genus	4
Anomoeoneis Pfitz. Genus	2
Caloneis Cl. Genus	4
Cymbella Ag. Genus	6
Diploneis Ehr. Genus	1
Gomphonema Ag. Genus	9
Gyrosigma Hass. Genus	2
Navicula Bory Genus	15
Pinnularia Ehr. Genus	1
Pleurosigma W.Sm. Genus	1
Nitzschiaceae Hass. Family	20
Bacillaria Gmelin Genus	1
Hantzschia Grun. Genus	2
Nitzschia Hass. Genus	17
Surirellaceae (Kutz.) Grun. Family	11
Cymatopleura W. Sm. Genus	3
Stenopterobia Breb. Genus	1
Surirella Turp. Genus	7

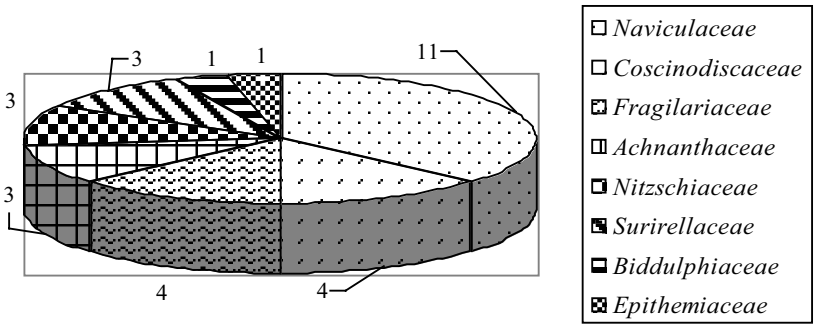

Figure 1. Families of diatoms and their number of genera

substrate characteristics, invertebrate and vertebrate animals, chemical nature and absolute and relative quantity of inorganic substances (especially silicon concentration) and organic solvents in water, etc. [7]. The qualitative structure of algal communities is changing as the impact of anthropogenic factors intensifies, with increasing eutrophication and ecosystem pollution [6]. Thus, the diversity of species is very dynamic in time and space. The greatest diversity of phytoplankton and phytobenthos species is observed during the hot summer months (July and August), when in the water of the river there are representatives of most algae phyla, forming chlorophyta-diatoms-cyanophyta-euglenophyta or chlorophyta-cianophyta-diatoms-euglenophyta coenosis.

In summer-autumn, chlorophyta and cyanophyta have a significant contribution to the formation of algae and the biomass, forming a biomass of up to 1.5-2.0 kg/m^2. The abundant development of cianophyta indicates an increase in the level of eutrophication of the river. Diatoms in this period have a more moderate development, with a population of about 32400-45000 mln. cells/m^2 with a biomass of 27.0-35.0 g/m^2. Common are among the chlorophyta filaments *Cladophora glomerata* (L.) Kutz., *Oedogonium* sp.*, Rhizoclonium hieroglyphicum* (Ag.) Kutz., *Ulothrix variabilis* Kutz., living fixed as second-order epiphyses – *Achnanthes affinis* Grun., *Amphora ovalis* var. *constricta* Skv., *Cocconeis placentula* var. *euglipta* (Ehr.) Cl., *Cymbella prostrata* (Berkeley) Cl., *Gomphonema parvulum* Kutz., *Melosira granulata* (Ehr.) Ralfs., *Navicula cryptocephala* var. *venete* Grun., *N. hungarica* var. *capitata* Cl., *N. vulpina* Kutz., *Nitzschia amphibia* Grun., *N. fonticola* Grun., *N. gracilis* Hantzsch., *Synedra acus* Kutz. etc.

Diatoms are present in plankton and periphyton throughout the year, but develop more intensely during the cold period of the year. Thus, in November-February, in the perimeter of the Bic River are abundantly growing the species: *Achnanthes hungarica* Grun., *Amphora ovalis* var. *pediculus* Kutz., *A. perpusilla* Grun., *Bacillaria paradoxa* Gmelin., *Cocconeis pediculus* Ehr., *C. placentula* Ehr. var. *placentula, Cyclotella meneghiniana* Kutz., *Cymbella lanceolata* (Ehr.) V.H., *C. turgida* (Greg.) Cl., *Diatoma vulgare* var. *lineare* Grun., *Epithemia sorex* Kutz., *Fragilaria capucina* var. *mesolepta* Rabenh., *Gomphonema constrictum* Ehr. var. *constrictum, G. olivaceum* (Lyngb.) Kutz., *Melosira varians* Ag., *Navicula confervacea* Kutz., *N. cryptocephala* Kutz. var. *cryptocephala, N. gracilis* Ehr., *N. radiosa* Kutz., *N. rhynchocephala* Kutz., *N. viridula* Kutz., *Nitzschia dissipata* (Kutz.) Grun., *N. palea* (Kutz.) W.Sm., *N. sigma* (Kutz.) W.Sm., *N. sigmoidea* (Ehr.) W.Sm., *N. vermicularis* (Kutz.) Hantzsch in Rabenh., *Rhoicosphenia curvata* (Kutz.) Grun., *Surirella ovalis* Breb., *S. ovata* Kutz. var. *ovata*, *Synedra tabulata* (Ag.) Kutz., *S. ulna* (Nitzsch) Ehr.

var. *ulna* ect. (Figure 2, 3), the number of cells of which constituted 60375 mln/m^2 and having a biomass of 52.6 g/m^2. More numerous were diatoms on submerged stones - 87200 mln. cells/m^2 with a biomass of 78.2 g/m^2.

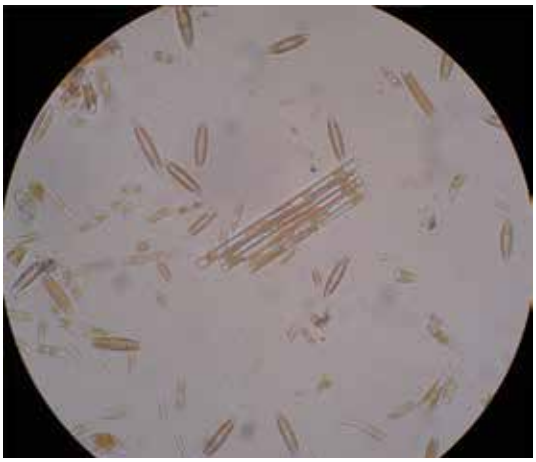

Figure 2. Species of genera *Synedra, Navicula, Nitzschia, Achnanthes* 400 x

Figure 3. Species of genera *Gomphonema, Navicula, Rhoicosphenia, Amphora, Cymbella* 1000 x

CONCLUSIONS

Following the study of the algal communities in the Bic River, 104 species and varieties of diatoms were identified. Primacy hold the *Pennatophyceae* class of the bacillariophyta, especially the *Raphales* order (85 taxa). The main factors influencing the development of diatoms are water temperature, degree of illumination, transparency, pH, water hardness, water movement, presence of biogenic elements and invertebrate animals. The greatest diatomic diversity is observed during the warm season of the year, forming a biomass of up to 27.0-35.0 g/m^2, but it also develops quite strongly in the cold period of the year with a bunch of cells 60375 mln/m^2 and biomass of 52.6 g/m^2. More numerous were diatoms on submerged stones of 87,200 million. cells/m^2 and with a biomass of 78.2 g/m^2.

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MORPHOLOGICAL AND HISTOCHEMICAL APPROACHES REGARDING WALNUT AUTOPOLLINATION

Maria PÎNTEA
Research Institute for Horticulture and Alimentary Technologies, Chisinau, Republic of Moldova

Abstract: In the article there are presented results of morphological and histochemical researches of embryogenesis after experimental autopollination of all dichogamous types (homogamous, protandrous, protoginous) of walnut (*Juglans regia* L.). Manual self-pollination confirms potential self-compatibility of English Walnut genotypes irrespective of flowering type. At the same-time, it should be noted that protogynous varieties have a higher fertilization percent. All varieties showed lower growing rate of" pollen tubes and delayed fertilization, at self-pollination. Experimental heitonogamy provoke more rapid embryogenetic processes within all dichogamous types.

Key words: walnut, histochemistry, embryogenesis, dichogamy, autopollination.

INTRODUCTION

Lately, walnut *(Juglans regia* L.*)* has been one of the most cultivated crops in the Republic of Moldova. Sustainable fructification of walnut varieties in industrial plantations depends of different factors. One of the most important problem is effective pollination and high level of fruit set [3-5] . In this paper there are presented the results of researches on the morphological and hystochemical peculiarities of experimental autopollination of all dichogamous types (homogamous, protandrous, protoginous). Studies were done with the scope of elucidation of fruit development in the cases of absence of pollinators (the case of singular tree growing, as well as in different types of orchard. Studies are also valuable for the clarification of walnut fruiting in the conditions of the Republic of Moldova and selection and introduction of new important genotypes for walnut breeding and genetics.

MATERIALS AND METHODS

Experimental researches where effectuated in the national walnut collection (Experimental Station "Codrul", Research and Practical Institute for Horticulture and Alimentary Technologies. The main biologic material is represented by local varieties and selections, including 16 Moldavian dichogamous varieties and promising selections and some introduced varieties were experimented in hand auto pollination. Moldavian walnut varieties, obtained after multiannual investigations, are characterized by high adaptability to diverse local environmental (edaphical and microclimatical) unfavorable conditions. In the Research Institute for Horticulture, the research activity has been directed towards the assessment of the potential of fructification of local varieties, selected from different areas of cultivation mainly with terminal bearing. These varieties are productive, adapted to the ecological conditions in the areas suitable for this fruit crop and less susceptible to specific diseases. On the basis of utilisation of cytoembryiological approaches, including hystochemical methodology [1-6] tested dynamic of contents and localisation of enzymes, pollysaccharides, proteins and nucleic acids (RNA and DNA) during embryo and endospermogenesis after experimental auto pollination, being compared with free pollination and in the absence of pollination.

RESULTS AND DISCUSSIONS

Registered autochtonous varieties have higher level of resistance to temperature stresses and main diseases of walnut and low sensibility to the main disease bacterial blight. But main trials demonstrated the high potential of productivity and qualities of nuts. In comparative scientific researches it was established the good ecological plasticity of the main Moldavian varieties also in the neighboring countries. On the basis of utilisation of cytoembryiological, including hystochemical methodology [1- 4], there were tested the dynamic of contents and localization of enzymes, pollysaccharides, proteins and nucleic acids (RNA and DNA) during embryo and endospermogenesis in relation with hybridization of all dichogamous types (Table 1, Figure 1).

Analysis of obtained field data shows that in the frame of homogamous genotypes fruit setting varied from 21,42 to 32,15 %, for protogynous genotypes -0,10-42,64% and for protandrous ones – 15,24-49,0% (Table 1). Practically analogical data was obtained within dichogamy aspect for their free pollination (Table 1). We should notice that after experimental auto pollination as well as after free pollination peculiarities of embryo and endosperm development was relatively uniform and common for all dichogamous types. At the same time, the most homogenous nuclear endosperm was established for the open pollination of all dichogamous genotypes. Transformation of endosperm nuclei in cellular structures occur in the same periods after open as well as after experimental auto pollination. As a rule, synchronic divisions of the first large endosperm nuclei lead to cenocyt formation, which is either a whole even layer, or haustorial bands. The transition of endosperm nuclei to cellular stage happens when the globular embryo reaches the maximal dimensions almost simultaneously in protogynous and protandrous genotypes. When pollination is absent, as well as in same experimental auto pollinations, anomalous divisions or a full stop in endospermogenesis processes are established (Figure 1, 2). Histochemically it was established that a gradual decreasing of the metabolism of endosperm nuclei is changed by increasing of enzymes activity and the appearance of the polysaccharide granules in the approach of cellular state. After auto pollination, as well as after free pollination, the transition of endosperm nuclei into cellular stage happens as a rule when the globular embryo reaches the maximal dimensions almost simultaneously in protogynous and protandrous genotypes. It was observed that the most intensive resorbtion of cellular endosperm is happen in the period of the appearance of bilateral segmentation of embryos. We suggested that this tissue functionally could be considered. Obtained morphological and histochemical data referring to endospermogenesis and embryogenesis processes demonstrate that indifferently of the type of flowering, at the end of latent period, the zygote is characterized by manifestation of more intensive reactions. Thereby, more intensive metabolism is observed at the stage of globular embryo. At the same time, we noticed that maximum of reserve substances accumulation coincide with the formation of all morphological structures. It is evident that maximal intensity of protein reactions, nucleic acids and oxido-reductive enzymes are manifested in vascular system, as well as in embryonic axis, immediately nearly of meristematic point of growing. The most tardily period of passage of all developmental stages of embryo was noticed at genotypes after free pollination of tardy flowering protandrous genotypes comparatively with theirs autopollination.

Within our experiences referring the problem of comparison of autopollination manifestation with absence of pollination were utilized 19 genotypes including all dichogamous types: protandry, protogyny and simultaneity (Table 1). Pistilate flowers were isolated with special material at the stage of non developed stigmas for 3 weeks. It is significant that in conditions of the Republic of Moldova, development of fruits wits differentiation of

normal embryo in the absence of pollination were established only for some protogynous genotypes (I-73 and Is-67, as well as for homogamous variety Kisinevskii). The others 5 protogynous genotypes, as well as protandrous variety Schinoskii showed the capacity of partenocarpic developed fruits I in proportion of 1,75 - 48,14%, depending of microclimatic conditions of the year (Table 1). Fruits were small without developed embryo. There are observed some anomalous processes during the development of embryo sac (Figure 1). According to obtained data, genotypes with tardy flowering period could develop more often and more fruits in comparison with the genotypes with early flowering ones. Also it is established that the growth rate of partenocarpic fruits is more accelerated than at fruits obtained from open pollination.

In the same time experimental investigations of heitonogamy of all investigated dichogamous genotypes shows that there are provoked more rapid embryogenetic processes within all dichogamous types.

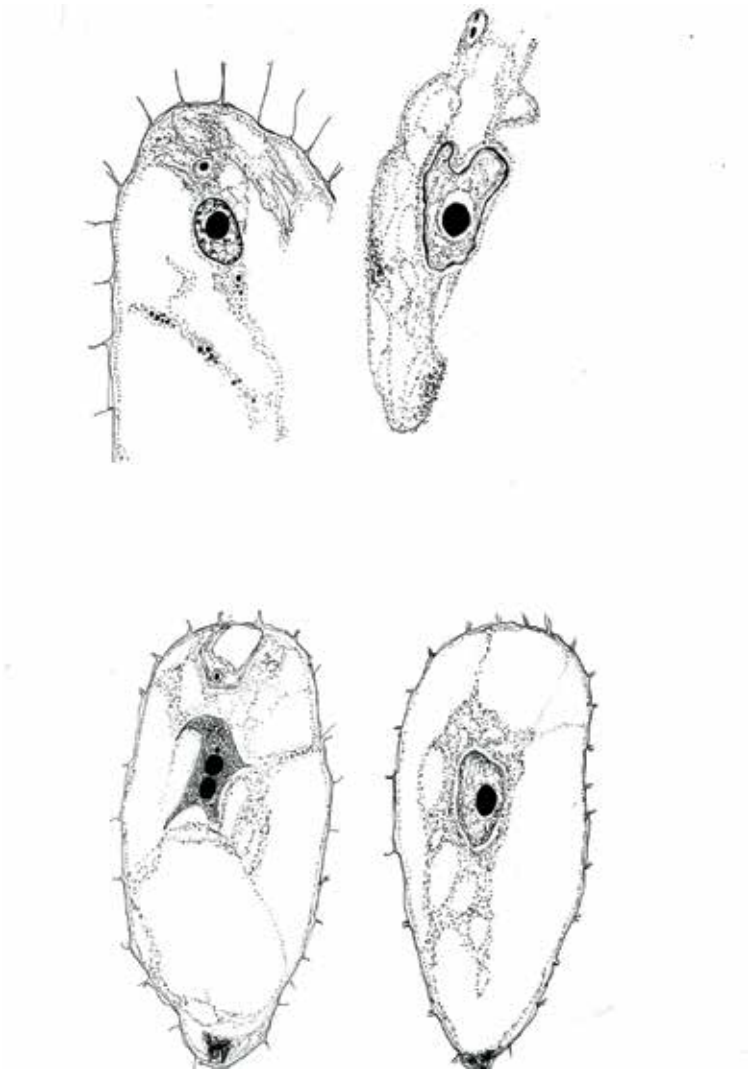

Figure 1. Anomalous transformation in embryo sac after experimental autopollination

In the case of protogynous studied genotypes there is established the end of apomictic embryo development when embryo main structures are not formed completely. There by as a rule for protogynous type, the absence of cotyledons is obvions. This way of development could sugest that the absence of endospermogenesis is is an important factor for development of embryo. In other cases, the development of embryo could be observed until endosperm became to pass in cellular stage.

Table 1. Development of fruits (nuts), % in the absence of pollination, open pollination and in the experimental autopollination

Type of flowering; genotype	Autopollination	Open pollination	Absence of pollination
HOMOGAMOUS			
Chişinevski, D-5, Franquette	21,42-32,15	23,54-60,00	0,00-32,63
PROTOGYNOUS			
Ti-23, Cazacu, Bomba, Cogâlniceanu, K-22, M-101 Is-67, Schinoski	0,10-42,64	0,40-45,15	0,00-48,14
PROTANDROUS			
I-30, G-51,T-39, I-73, 9x61$_{3,}$ Costiujenski, Corjeuţki, Pieral	15,24-49,00	10,0-49,30	0,00-39,15

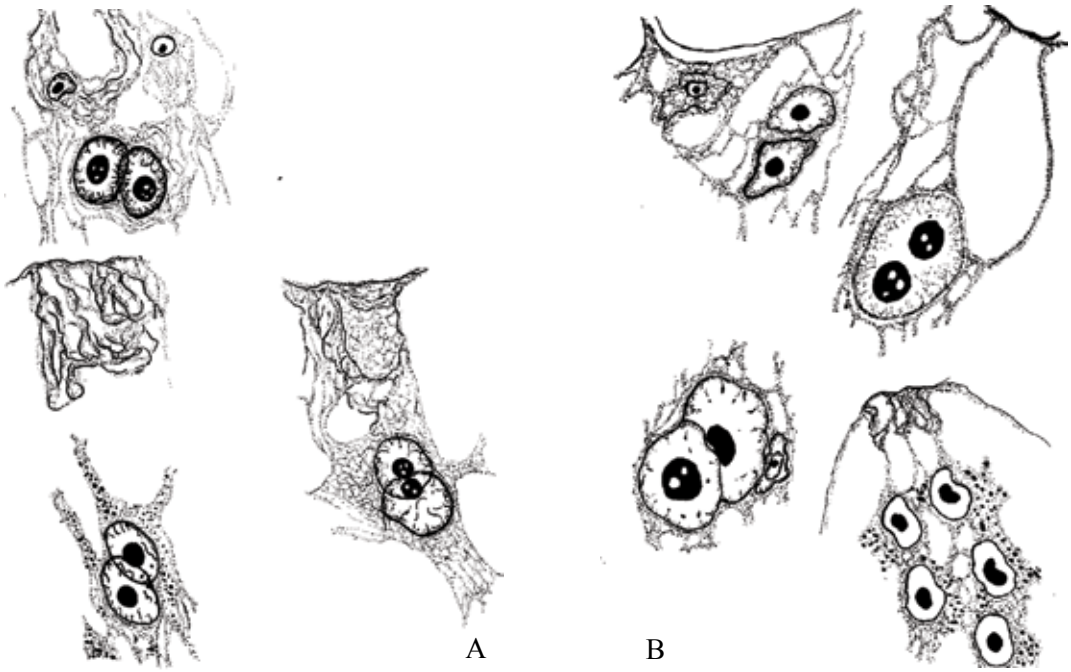

Figure 2. A– Absence of linkage of polar nuclei and accumulation of pollysaccharide granules. B – Some cases of formation of anomalous initial endospermal cenocyte

Obtained apomictic fruits of variety ′Chişinevski′ germinate good plants. As a result of cytologic investigation of chromosome number within somatic cells, there is determinate 32.

Luminescent and histochemical analysis of free pollinaton on shows morphophysiologically different quality flowers of solitary growing genotypes, which, however, at optimal orchard establishment and agronomical practices scarcely affect fruit-bearing rate. Analysis of obtained data shows that development of the walnut endosperm at the first stages is related by negative PAS (insoluble pollisaccharides) and maximal intensity of total proteins reactions, small amounts of ascorbic acid and enzymes were detected. The most homogenous nuclear endosperm was established for the open pollination of all dichogamous genotypes.

The transformation of endosperm nuclei in cellular structures occurs for all dichogamous types when are developed around one thousand of nuclei in open as well as within different kinds of hybridization. Synchronic divisions of the first large endosperm nuclei lead to cenocyte formation, which is either a whole even layer, or haustorial bands. All protogynous genotypes have a more accelerated rhythm of endosperm nuclei division compared to protandrous ones. Irrespective of dichogamy formation of hypertrophycal endospermal nuclei, their fusion and formation of its conglomerates are detected. In the absence of pollination and in same controlled experimental pollination, anomalous divisions or a full stop in endospermogenesis processes are established. A gradual decrease of the metabolism of endosperm nuclei is changed by an increase in enzyme activity and the appearance of the polysaccharide granules in the approach of cellular state. The transition of endosperm nuclei to cellular stage happens when the globular embryo reaches the maximal dimensions almost simultaneously in protogynous and protandrous genotypes. Initiation of cell membranes, first in separate seats, is brightly marked by some enzymes (especially succinate dehydrogenase and peroxidase) and disappearance of insoluble pollyssacharides (PAS reaction). Transformations of the endosperm of walnut are inseparably linked with certain stages of embryo development. An intensive resorbtion of cellular endosperm is observed in the period of the appearance of embryo's bilateral segmentation. Protogynous genotypes have a more accelerated rhythm of endosperm nuclei division as compared to protandrous ones. Irrespective of dichogamy formation of hypertrophycal nuclei, their fusion and formation of its conglomerates are detected. When pollination is absent, as well as in same experimental pollinations, anomalous divisions or a full stop in endospermogenesis processes are established. It was established that a gradual decrease in the metabolism of endosperm nuclei is changed by an increase in enzyme activity and the appearance of the polysaccharide granules in the approach of cellular state. The transition of endosperm nuclei to cellular stage happens when the globular embryo reaches the maximal dimensions almost simultaneously in protogynous and protandrous genotypes. Initiation of cell membranes, first in separate seats, is brightly marked by succinate dehydrogenase and peroxidase and disappearance of PAS reaction. Our investigations show that development of the endosperm of walnut is inseparably linked with main stages of embryo development. The most intensive resorbtion of cellular endosperm is observed in the period of the appearance of embryo's bilateral segmentation. Storage of starch, proteins, lipids in different part of embryo occurred approximately in the same period (end of August) for different dichogamous types. It was evaluated that during the gametogenesis, as well as in the period of maturation of zygote in tegumental "packing" tissue there are reserved high quantites of pollisaccharides and enzymes.

CONCLUSIONS

1. The most tard period of passage of all developmental stages was noticed at protandrous walnut genotypes after free pollination comparatively with their experimental autopollination.

2. According the histochemical tests, the most intensive metabolism was observed at the stage of globular embryo of all dichogamous studied types after autopollination as well as after the free pollination of walnut (*Juglans regia* L.).

3. Experimental heitonogamy causes more rapid embryogenetic processes within all walnut dichogamous types.

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PRELIMINARY EMBRYOLOGICAL RESEARCH ON SEEDLESS GRAPES

Maria PÎNTEA, Svetlana TOFAN, Gheoghe SAVIN
Research Institute for Horticulture and Alimentary Technologies,
Chisinau, Republic of Moldova

Abstract: In the article, there are presented preliminary results of embryological research on embryogenesis and endospermogenesis after free and self-experimental pollinations of seedless grapes (*Vitis vinifera* L.), introduced varieties: ′Centinal Seedless′, ′Romulus′, ′Tadv06′, ′Perlon′, ′Interlaikin′, ′Kishmish lucistii′. It is established different rhythm of endospermogenesis and embryogenesis after free and autopollination of different genotypes, including manifestation of anomalously developed nuclear endosperm.

***Key words*:** seedless, grape varieties, embryology, endospermogenesis, autopollination, free pollination.

INTRODUCTION

Market trends concerning grapes in Republic of Moldova is directioned to the diversifyication of seedless varieties. Therefore, one of the most important breeding programs of *Vitis vinifera* L. is a to the utilization of different conventional methods for the creation of new genotypes with marketable traits of table grapes, it limits the use of these varieties for grape improvement pro seeded varieties as female parents [1-5]. This greatly reduces the chances of the progeny being seedless and may contain not higher than 10-25 % seedless progeny [6-8]. Embryo germination is often one of the limiting factors for obtaining plantlets.

MATERIALS AND METHODS

Experimental researches where effectuated in the vineyard of Moldovan national grape collection (Research Institute for Horticulture and Alimentary Technologies, RIHAT) using seedless varieties: ′Centinal Seedless′, ′Romulus′, ′Tadv06′, ′Perlon′, ′Interlaikin′, ′Kishmish lucistii′. Breeding work was initiated by plants in the germplasm maintained at the vineyard of Experimental Station of RIHAT. On the basis of utilisation of cytoembryiological, including some histochemical methodology [1-5] during embryo and endospermogenesis after free pollination and auto (hand) pollination.

RESULTS AND DISCUSSIONS

Our investigations show that, under the conditions of the studied Central part of the Republic of Moldova, double fertilization takes place 3-4 days after free and hand auto pollination of seedless grape varieties: ′Centinal Seedless′, ′Romulus′, ′Tadv06′, ′Perlon′, ′Interlaikin′, ′Kishmish lucistii′ (Table 1-3). This process is followed by division of the nucleus of the primary endosperm and formation of nuclear endosperm, wich is very rapid in the case of auto pollination of ′Perlon′ variety. The zygote then begins to divide after 7 -10 days. The nucellus degenerated 25-35 days after anthesis, when the liquid endosperm in the embryo sac was copious, and went to the cellular stage. At ′Centinal Seedless′, cellular endosperm developed slowly and only within rare cases. The embryo reached the globular stage after 20-25 days and only for 30-60% of ovules (Table 1-3). The heart-stage and

torpedo stage also are observed for different percent of ovules: from with a rudimentary cotyledon after 30 days, and the 15-25% (variety ′Centinal Seedless′) to 55-75% (′Perlon′ variety, free pollination). The volume of the liquid (partially cellular) endosperm began to decrease after 25 days and it disappeared after 30-45 days. It is important to notice that, at experimental auto pollination of ′Perlon′ variety, there are observed comparatively more normal initial ways of embryo and endospermal development.

Table 1. General characterization of embryologic processes after free pollination and auto pollination. Variety ′Centinal Seedless′

Stages/developmental processes	′Centinal Seedless′ (free pollination)		′Centinal Seedless′ (auto pollination)	
	Days after pollination	Embryological characterization: Embryo Sac (ES); Embryo (EM); Endosperm (EN); Seeds (S)	Days after pollination	Embryological characterization: Embryo Sac (ES); Embryo (EM); Endosperm (EN); Seeds (S)
Pollen tube (PT) reach micropyle and/or ES	3-4 4	SE optimally developed , PT penetrates SE, Double fecundation – in optimal terms	4 5	SE optimally developed , PT penetrates SE, Double fecundation – in optimal terms
Development of nuclear EN	9	Normally developed nuclear EN	7	Normally developed nuclear EN
Passage of nuclear EN in cellular stage	15	Cellular EN – slow development and only in rare cases	12	Cellular EN – slow development and only in rare cases: as a rule around the ES
Two cellular pro embryo	10	Normally developed in whole ES	11	Partially normal development of ES
Globular embryo (EM)	20	Globular EM only in 50% of ovules	22	Globular EM only in 30% of ovules
Beginning of bilateral segmentation of EM. EM in stage “heart”, “torpedo”. State of EN	30-45	Stage “heart” and “torpedo” - only for 15-25% EM. Cellular EN is aprox. totally destroyed	35	Stage “heart” and “torpedo” - only for 15-25% EM. Cellular EN is aprox. totally destroyed
Intensive development of vascular system of EM. Differentiation of main EM structures	65	Development of all ovary tissues is stopped	65	Development of all ovary tissues is stopped

Table 2. General characterization of embryologic processes after free pollination and auto pollination. Variety ′Perlon′

Stages/developmental processes	′Perlon′ (free pollination)		′Perlon′ (auto pollination)	
	Days after pollination	Embryologic characterization: Embryo Sac (ES); Embryo (EM); Endosperm (EN); Seeds (S)	Days after pollination	Embryologic characterization: Embryo Sac (ES); Embryo (EM); Endosperm (EN); Seeds (S)
Pollen tube (PT) reaches micropile and/ or SE	3-4 4	ES optimally developed , PT penetrates ES, double fecundation – in optimal terms	4 5	ES optimally developed , PT penetrates ES, Double fecundation – in optimal terms
Development of nuclear EN	9	Normally developed nuclear EN	7	Normally and rapid developed nuclear EN
Passage of nuclear EN in cellular stage	15	Cellular EN – slow development and only in rare cases	12	Cellular EN – slow development and only in rare cases: as a rule around the SE
Two cellular pro embryo	10	Normal development in whole ES	11	Normal development of ES
Globular embryo (EM)	20	Globular EM only in 60% of ovules	22	Globular EM in 70% of ovules
Beginning of bilateral segmentation of EM. EM in stage “heart”, “torpedo”. State of EN	30-45	Stage “heart” and “torpedo” - only for 55-70% EM. Cellular EN is aprox. totally destroyed	35	Stage “heart” and “torpedo” for 5% EM. Cellular EN is normally developed
Intensive development of vascular system of EM. Differentiation of main EM structures	65	Embryogenesis and endospermogenesis are aprox. normally passed	65	Embryogenesis and endospermogenesis are aprox. normally passed
Mature embryo (EM)	75	There is no entirely developed embryo E with all structures within 70-80 cases.	75	There is entirely developed embryo E with all structures only for 50% of ovules.

Table 3. General characterization of embryologic processes after free pollination of Variety ′Centinal Seedless′, ′Kismis lucistii′ and ′Interlaikin′ free pollination

Stages/developmental processes	′Kismis lucistii′ (free pollination)		′Interlaikin′ (free pollination)	
	Days after pollination	Embryologic characterization: Embryo Sac (ES); Embryo (EM); Endosperm (EN); Seeds (S)	Days after pollination	Embryologic characterization: Embryo Sac (ES); Embryo (EM); Endosperm (EN); Seeds (S)
Pollen tube (PT) reaches micropile and/ or SE	2	ES optimally developed, PT penetrates ES. Double fecundation – in optimal terms	2-3 5	ES optimally developed, PT penetrates ES. Double fecundation – in optimal terms
Development of nuclear EN	7	Normally developed nuclear EN	7	Normally developed nuclear EN
Passage of nuclear EN in cellular stage	10	Cellular EN – slow development and only within rare cases	10	EN Cellular EN – uniform development
Two cellular pro embryo	12	Normal development in whole SE	11	Normal development of EN around zygote
Globular embryo (EM)	20	EM globular in 70% of ovules	20	EM globular in 60% of ovules
Beginning of bilateral segmentation of EM. EM in stage “heart”, “torpedo”. State of EN	35-45	Stage “heart” and “torpedo” - only for 25-30% EM. Cellular EN there is aprox. totally destroyed	35-37	Stage “heart” and “torpedo” - only for 35% EM. Cellular EN there is aprox. totally destroyed
Intensive development of vascular system of EM. Differentiation of main EM structures	65	Normal development in 10-30% cases. Only 3% of embryos reach the stage of cotyledon development with some anomalous structures	60-67	Normal development in 50% cases. Only 5-10% of embryos reach the stage of development of cotyledon initiales
Mature embryo (EM)	75	There is no entire developed embryo E with all structures.	75	There is no entire developed embryo E with all structures

In our investigations, we established that embryos aborted after the formation of the globular embryo on days 20-30, and also before the heart-stage on days 40-45 (Table 1-3). A microscopic study showed that cell division in the studied varieties was very active in the ovary wall before anthesis, but relatively quiescent during and after bloom. A second wave of cell division occurred in the pericarp 15-25 days after anthesis. Cell division ceased in various parts of the pericarp at different times: at day 17-20 for the inner mesocarp, day 30-40 for the outer mesocarp, and day 47-55 for the endocarp.

CONCLUSIONS

1. The most tardy period of passage of all developmental stages was noticed after free pollination.

2. According to the obtained results, the most intensive metabolism was observed at the stage of globular embryo of all studied genotypes.

3. Genotypes with the largest possibilities for embryo and endospermogenesis processes could have the greatest tendency to have the largest number of ovules with embryos for *in vitro* cultural experiments, more germinated embryos and more transplantable plants.

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SECONDARY METABOLITES OF *RHEUM RHAPONTICUM* L. ROOTS AND LEAVES AS A MEANS OF PROTECTING CUCUMBER SEEDLINGS FROM POWDERY MILDEW

Alla GLADCAIA, Vladimir TODIRAȘ, Lilia MERENIUC
Institute of Genetics, Physiology and Plant Protection,
Chisinau, Republic of Moldova

Abstract: In order to produce organic agricultural products, there is an obvious need to find new, alternative, environmentally friendly methods to control diseases and pests. For a more complete disclosure of the bioactive potential of substances contained in the rhubarb root and leaves, compositions based on them were created and tested as means of protecting cucumber seedlings from powdery mildew in greenhouse. As a result, it was found that the amount of flavonoids in the extract of *Rheum rhaponticum* L. (f. Polygonaceae) root, grown under the bioclimatic conditions of the Republic of Moldova, was 202.46 mg/100g, in the leaf extract - 86.45 mg/100g; the amount of phenols in the root extract was 1233.9 mg/100 g, in the leaf extract was 588.8 mg/100 g. The biological effectiveness of rhubarb root extract (from 68.2% to 92.8%) shows immunostimulating and fungicidal activity, while the leaf extract has an antiseptic and stimulating effect. The most promising and cost-effective is a rhubarb root and leaf extract composition, with a synergistic effect, which enhances its pesticidal effect and the risk of developing resistance to pesticides among plant-pathogenic strains is reduced.

Key words: *Rheum rhaponticum*, *Podosphaera fuliginea,* Cucurbitaceae vegetable cultures, seedlings.

INTRODUCTION

In order to produce organic agricultural products, an obvious need arose to search for new, alternative, environmentally friendly methods of disease and pest controlling. This has led to the acceptance of plant products (plant extracts) as highly effective, socially acceptable, biodegradable and pest-specific plant protection products. Phenolic compounds are valuable chemotaxonomic markers of the entire Polygonaceae family, and the synthesis of these various low-molecular substances is a characteristic feature of their metabolism [1]. Numerous methods of genus *Rheum* (Polygonaceae) bioactive substance application in medicine and food industry create tremendous perspectives for additional research and the creation of waste-free technology for its processing (bioconversion) in organic farming. International scientific studies of the rhubarb root properties in plant protection only fragmentarily outline the ways of its use, whereas the properties of leaves and inflorescences are practically not studied. The use of *Rheum* extracts and several preparations based on them (Kobe, 2005; VEgard, 2012) for pathogen biocontrol in the world does not completely reveal the significant potential of this plant raw material using [2-3]. The application of this kind of plant protection products will reduce the number of chemical treatments, and hence the residual amount of pesticides in organic agricultural products. In the Republic of Moldova, at the moment, not a single plant protection product has been registered on the basis of rhubarb root, leaf or inflorescence extract and the advantages of using bioactive substances of this plant are poorly understood. For a more complete disclosure of the bioactive substances potential of rhubarb roots and leaves, compositions based on them were created and tested as means of protecting cucumber seedlings from powdery mildew in greenhouse.

MATERIALS AND METHODS

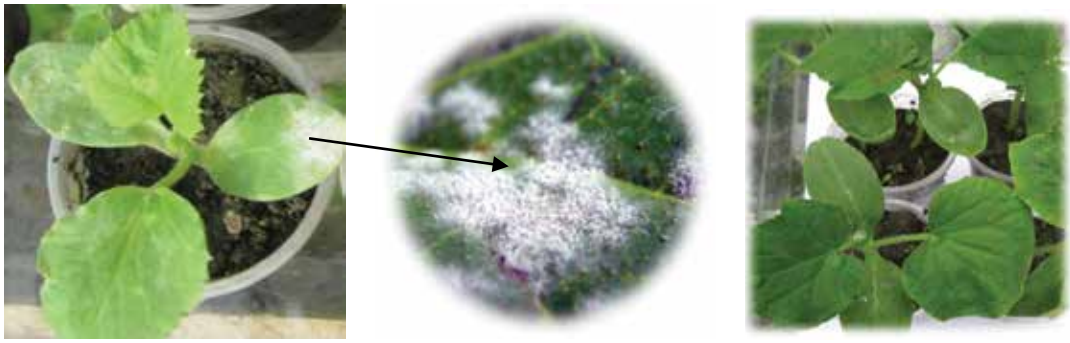
The subject of research was *Rheum rhaponticum* L. (Polygonaceae) root and leaf bioactive substances. Collection of biomaterial was carried out regularly: fresh petioles - in spring (360 g/m^2), seeds - in summer (27 g/m^2), roots - in autumn (dry, 125 g/m^2) and leaves - during the growing season (fresh, 420 g/m^2) (Figure 1).

a) b) c)

Figure 1. a) a general view of *Rheum rhaponticum* L.; b) leaves; c) root

The object of our research is *Podosphaera fuliginea* (Schltdl.) U. Braun & S. Takam. (=*Sphaerotheca fuliginea* (Schltdl.) Pollacci, (family Erysiphaceae, division Ascomycetes) which belongs to a group of diseases that are relatively persistently common and exhibiting harmfulness depending on the prevailing climate. Powdery mildew causative agent is distinguished in high genetic adaptability to the applied chemical fungicide preparations. So, preparations based on strobilurons (Kvadris, Strobe) lose their effectiveness after 2-3 treatments. Sulfur-containing products (Cumulus, Thiovit), due to increased phytotoxicity, cause very rapid aging of plants and the death of leaves. Without the ability to multiply outside a living plant, *P. fuliginea* requires special research methods. The identification of powdery mildew causative agents of pumpkin cultures on the basis of the conidial stage was carried out in accordance with the works of Y. V. Sokolov (2007) who proved that such identification of powdery mildew species is reliable [4] .

Evaluation of *R. raponticum* extract effectiveness, under greenhouse conditions, was carried out against *P. fuliginea* on Cucurbitaceae vegetable corp's seedlings. At the stage of four true leaves, the seedlings were treated with rhubarb root extract. Control plants were



a) b) c)

Figure 2. Plant damage score: a) control plants; b) *Podosphaera fuliginea* Poll., conidia on the leaves; c) treated plants

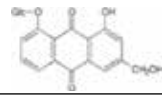
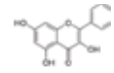
not treated. In order to determine the fungicidal and immunostimulating effect of rhubarb root extract, the seedlings were treated once at different time intervals (72 and 4 hours) before infection (Figure 2). The *P. fuliginea* conidia suspension was prepared by separating the diseased leaves of the cucumber plant and washing off the conidia in a container with water. Using a microscope, the aqueous suspension was adjusted to 2.0×10^5 conidia per *ml* and applied to the leaf surface by spraying. Once infected plants were placed in randomized blocks of the greenhouse, 3-4-fold repetition [21–23]. Cucumber seedlings, were treated with the following compounds: V1 - 1% L; V2 - 4% L; V3 - 1% R; V4 - 2% R; V5 - 1% L + 1% R; V6 - 2% R + 4% L; V7 - 1% L + 2% R; V8 - 4% L + 1% R; V9 - standard Recol (5%); V10 - control without processing. The prevalence of the disease - the number of diseased plants or its individual organs (leaves) in relation to all plants recorded, expressed as a percentage. Intensity of plant damage was determined by the area of the affected surface of plant organs [5]. Biological efficacy of protective measures was evaluated by comparing plant damage on treated and control plants. The difference in the prevalence of control and treated plants (Be,%) is determined by the formula $\mathbf{Be} = \frac{\mathbf{100\,(V_K - V0)}}{\mathbf{V_K}}$, where Vk - is the prevalence or progression of the disease in the control plot; Vo - a similar indicator on the experimental plot. Mathematical processing and evaluation of the reliability of the obtained scientific data was carried out using the ABC Pascal platform.

RESULTS AND DISCUSSIONS

Based on the presence of biologically active substances in the *R. rhaponticum* root and leaf composition (emodin, quercetin), a scheme of their extraction has been developed, consisting of collecting, drying and grinding plant material, mixing with a solvent (70% ethanol), extraction, maceration (5-6 hours), evaporation and preparation of soluble concentrate.

By using spectrophotometry method was defined, that the amount of flavonoids in the *R. rhaponticum* root extract was 202,5 mg /100g, and in the leaf extract it was 86,5 mg/100g. At the same time, it was proved that the amount of phenols in the root extract was 1233,9 mg/100g, and in the leaf extract – 588,8 mg/100g [6]. Based on the results obtained, we compiled a description of the properties of the main active substances extracted from *R. rhaponticum* for use in protecting plants against diseases and pests (Table 1).

Table 1. Characteristics of the properties of the main active bioactive substances in the *Rheum rhaponticum* L. extracts

Name / properties	**Emodin**	**Quercetin**
Structure		
formula	$C_{15}H_{19}O_5$	$C_{15}H_{10}O_7$
Chemical properties	soluble in ethanol, caustic soda	Soluble in ethanol, acetic acid
Properties in plant protection	pesticide, antiphidant, bactericide, fungicide.	peroxidase substrate, pesticide, anti-fidant, aldose reductase inhibitor.

The study of the treatment effect with rhubarb extracts was carried out in order to protect the seedlings of cucumber variety 'Rodnichok' from *P. fuliginea* according to the method described above (Table 2).

Table 2. Effect of *Cucumis sativus* L. seedling treatment with *Rheum rhaponticum* L. root and leaf extracts on suppressing *Podosphaera fuliginea* (Schltdl.) U. Braun & S. Takam.

№	Variant	Plant damage score	Prevalence of plant disease, %	Intensity of plant damage, %	Biological efficacy, %
		treatment 4 hours before infection			
1	Control	1,1	55,0	27,5	
2	Standard	0,5	25,0	12,5	54,6
3	V1	0,5	32,5	12,5	54,6
4	V2	0,2	25,0	5,0	81,8
5	V3	0,3	7,5	7,5	72,7
6	V4	0,1	32,5	2,5	90,9
7	V5	0,5	25,0	12,5	54,6
8	V6	0,2	32,5	5,0	81,8
9	V7	0,06	7,5	1,5	94,6
10	V8	0,06	7,5	1,5	94,6
	$DEM_{0,05}$			3,3	12,1
		treatment 72 hours before infection			
1	Control	1,1	55,0	27,5	
2	Standard	0,3	50,0	7,5	72,7
3	V1	0,6	32,5	15,0	45,5
4	V2	0,5	25,0	12,5	54,6
5	V3	0,4	25,0	10,0	63,6
6	V4	0,06	17,5	1,5	94,6
7	V5	0,7	25,0	17,5	36,4
8	V6	0,5	42,5	12,5	54,6
9	V7	0,3	32,5	7,5	72,7
10	V8	0,2	17,5	5,0	81,8
	$DEM_{0,05}$			4,5	13,2

The values of biological efficacy above the standard are presented in the following variants:

- V2 (4% L) - biological efficiency - 81,8% (at interval 4 hours before infection) is 27,2% higher than the effectiveness of the leaf extract at a concentration of 1%. It was noted that during processing 4 hours prior to infection, the biological efficacy of the leaf extract at a concentration of 1% was 9,1% higher, and at a concentration of 2% - 27,2% higher than the biological efficacy of the extract when processed for 72 hours before infection. This is due to the significant antiseptic effect of 4% concentration of the leaf extract, directly before the phytopathogen hits the leaves. It can be concluded that leaf extract has antiseptic, and not immunostimulating properties.

- V4 (2% R) - rhubarb root extract in a concentration of 2%, when processed 4 hours before infection, has efficiency of 90,9%, and when processed 72 hours before infection

has efficiency of 94,6%, stably and reliably protected seedlings from powdery mildew. The fungicidal and immunostimulating activity of rhubarb root extract was confirmed in concentrations of 1-2%, which reduced the degree of cucumber seedling damage by 17,7-26,0%. It was proved that the biological effectiveness of rhubarb root extract (from 68,2% to 92,8%) does not depend on the time between treatment and infection shows immunostimulating and fungicidal activity.

- V8 (4% L + 1% R) - a combination of rhubarb root extract and rhubarb leaf extract, when processed 4 hours before infection (94,6%), and when processed 72 hours before infection (81,8%), significantly showed a preventive effect in protecting seedlings (average 88,2%) and, at the same time, contributed to an increase in the size of plants and leaves. Finding that the fungicidal properties of rhubarb root extract are combined with the stimulating properties of the leaf extract, we concluded that the composition is polyfunctional.

In the standard efficiency was, in average, 63,8%. In the control, the degree of seedlings damage with powdery mildew was 27,5%. The effectiveness of other compositions of the root and leaves of rhubarb (V6 – 68,3% and V7 – 83,7%) was within the reference values. However, there was a clear advantage in efficiency values with the 4-hour interval, where the effectiveness of the V6 composition was 27,2% and the V7 composition — 21,9% higher than with the 72-hour interval. The results of the experiment confirm that the effect of these two compositions is more fungicidal than immunostimulating (Figure 3).

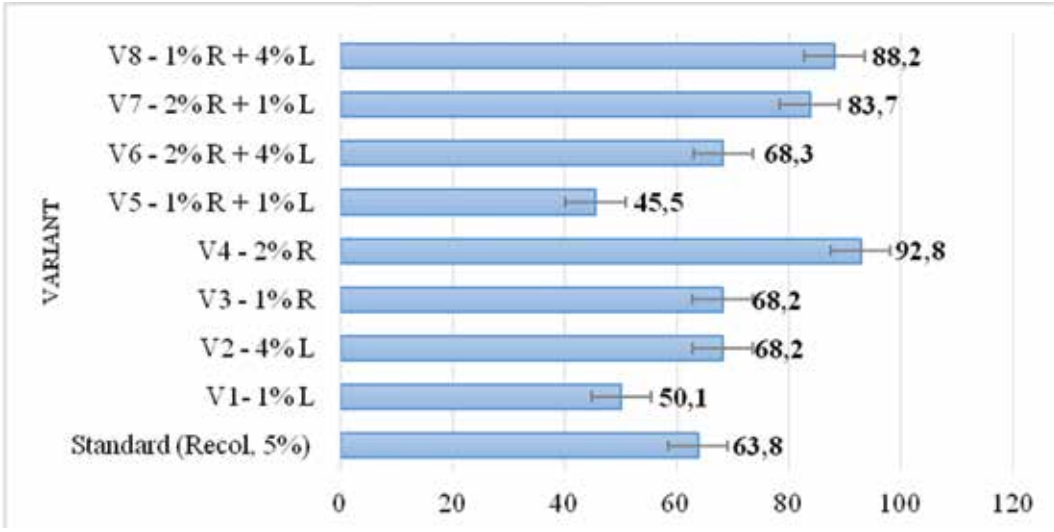


Figure 3. The average values of the *Rheum rhaponticum* L. root (R) and leaf (L) extracts biological efficacy in the control *Podosphaera fuliginea* (Schltdl.) U. Braun & S. Takam. on *Cucumis sativus* L. seedlings ($DEM_{0,05}$ = 10,2)

It should be noted that the use of polyfunctional compositions of rhubarb the root and leaf extracts in the control of powdery mildew on a cucumber culture in greenhouse conditions is very promising and cost-effective, since the extracts are created from the rhubarb petioles production waste. First, environmentally friendly means of protection can reduce the number of chemical treatments of the cucumber culture. The creation and application of extract-based remedies will reduce the pollution of the ecosystem, and induced resistance will allow plants to reduce the energy costs of protection against pathogens and save energy

for growth, development and fruit formation. Secondly, the composition showed, besides the direct fungicidal action, also a high efficiency in stimulating the plant resistance to the powdery mildew pathogens. As it is known, an "anti-phytopathogenic agent" is an agent that modulates the growth of a plant pathogen or prevents a pathogen from infecting a plant. The resistance of phytopathogens to fungicides is common. When the fungicide is often used, the target pathogen can adapt to it due to the high selection pressure. The combination of single- and multi-component fungicides in a mixture or in rotation can provide additive or even synergistic interactions. At the same time, a high level of disease control is achieved with a reduced dosage of each individual fungicide, which, in turn, reduces the risk of developing resistance to pesticides among strains that are pathogenic to plants.

CONCLUSIONS

1. The amount of bioactive substances in the *R. rhaponticum* L.: in the root extract, the amount of flavonoids was 202,5 mg /100g, in the leaf extract it was 86,5 mg /100g; the amount of phenols in the roots was 1233,9 mg /100 g, in the leaves it was 588,8 mg /100g.
2. It is proved that the biological effectiveness of *R. rhaponticum* L. root extract (from 68,2% to 92,8%) shows immunostimulating and fungicidal activity, while the leaf extract has an antiseptic and stimulating effect.
3. The most promising and cost-effective is a *R. rhaponticum* L. root and leaf extract composition, which has a synergistic effect (fungicidal and stimulating). The pesticidal effect is enhanced by synergism between the extracts, and the risk of developing resistance to pesticides among plant-pathogenic strains is reduced.

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II. CONSERVATION OF BIOLOGICAL DIVERSITY

CZU 582.972

SYNOPSIS ON SPECIES OF *ASPERULA* L. GENUS (RUBIACEAE) IN THE FLORA OF DNIESTER-PRUT RIVER REGION

Tatiana IZVERSCAIA, Veaceslav GHENDOV, Nina CIOCÂRLAN
National Botanical Garden (Institute), Chisinau, Republic of Moldova

Abstract: The article brings the list of one of the difficult in species diagnosing genus of Rubiaceae Juss. family – woodruff (*Asperula* L.), which embodies 7 species in the Dniester-Prut region. The dichotomic key for genus *Asperula*, as well as brief ecological habitat characters and original pictures for each species are given. Several *Asperula* species are taxa with melliferous, decorative or medicinal properties, as well used as a condiment and flavoring agents.

***Key words*:** flora, Rubiaceae, *Asperula*, biology, ecology, Bessarabia.

INTRODUCTION

There are groups of species in different taxa with unstable "vague" features and confusing nomenclature. The authors' opinions on the volume of taxa and the significance of taxonomic characters often do not coincide, which leads to significant differences in their interpretations in the regional "Floras" and the plant identifiers. The genus woodruff (*Asperula* L.) is among these groups. *Asperula* L. is one of the most difficult genera in the Rubiaceae family, which comprises over 200 species, widespread in Eurasia, North America, North Africa, temperate and subtropical Asia to Australasia, mainly in the Mediterranean region [2, 5-7, 9-13, 15]. Its proximity to the genus bedstraw (*Galium* L.) leads to a constant change in the number of species included in them and the boundaries of both genera. A characteristic feature of the genus *Asperula* – an extremely limited number of taxonomically important characters and their morphological variability, which was not previously taken into account [9, 10].

The maintenance of floristical diversity is based on fundamental monographic studies and knowledge (in fundamental and practical aspect) on separate taxonomic groups. Genus *Asperula* L. – heterogeneous, variable in morphological and ecological characteristics, takes the important position in system of Rubiaceae family. It plays a significant role in vegetation cover of steppe and limestone slopes, as well as plant communities on the sea coasts.

Among the representatives of the genus *Asperula* there are taxa with melliferous, decorative or medicinal properties. *Asperula* species are an important source of iridoid glycosides, cardenolides, flavonoids, and anthraquinone glycosides with valuable therapeutic effects [1]. Several *Asperula* species are used as a condiment and flavoring agents being used in culinary and in the production and aromatization of wine, liqueur and vodka products.

MATERIALS AND METHODS

During our investigation concerning genus *Asperula* L. 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 National Botanical Garden (Institute) of Republic of Moldova and Herbarium of the State University of Moldova).

When processing the data on the genus representatives, the comparative-morphological and geographical methods were used, which allows to consider the morphological variability of plants taking into account the geographical and ecological conditions of growth.

The taxonomy of *Asperula* species followed the recent taxonomical literature [4, 7, 9, 10, 14]. The illustrations have been performed by Teleuța S.

RESULTS AND DISCUSSIONS

In the flora of Europe the genus *Asperula* embodies 34 species [2], in Dniester-Prut river region there are 7 species.

Genus ***ASPERULA*** L.

Linnaeus, 1753, Sp. Pl.: 103

Dwarf shrubs, perennial herbs or annuals. Stems ±distinctly 4-angled and not retrorsely aculeolate. Leaves in pairs or in whorls of 4-8 (11). Inflorescence of panicles or capitula; ultimate branches with bracts and often bracteoles. Flowers hemaphrodite, (3)5-merous. Calyx absent or consisting of short teeth. Corolla usually infundibuliform (tube 2-4 times longer than lobes, rarely of their length). Stamine 4-5. Style with stigmas capitate or clavate. Ovary and fruit oblong to globose, never with hooked hairs. Fruit with 2 dry monosperm mericarps [2].

L e c t o t y p u s: ***A. arvensis*** L.

Key to species of *Asperula*

1a. Annual plants. Inflorescence of capitula. Flowers bluish-violet (Sect. *Asperula*) .... **1. *A. arvensis.***

1b. Dwarf shrubs or perennial herbs. Inflorescence of panicles. Flowers not bluish-violet (Sect. *Cynanchica*).....**2.**

2a. Fruit 1.2-2.5 mm long, densely covered with very small, semi-globular or conical tubercles (Subsect. *Cynanchica*)..... **4.**

2b. Fruit 3-4,5(7) mm long, glabrous or with a scattered squamiform tubercles (Subsect. *Graveolentes*)..... **3.**

3a. Fruit nearly 3 mm long, almost glabrous... .....**7. *A. leiograveolens.***

3b. Fruit 4-4,5 mm long, densely covered with squamiform tubercles ..... **6. *A. graveolens.***

4a. Corolla 2-4,5 mm long. Lobes as long as the tube or about 1.5 times shorter than the tube ..... **5.**

4b. Corolla 4-6 mm long. Lobes 2-3 times as short as the tube ..... **4. *A. tenella.***

5a. Lobes 1.5 times shorter than the tube. Corolla 2-3 mm, campanulate-infundibuliform .... **5. *A. rumelica.***

5b. Lobes about equalling the tube. Corolla 2-4,5 mm, narrowly infundibuliform or infundibuliform..... **6.**

6a. Bracts linear or elongated-lanceolate, entire, up to 1 mm wide. Flowers on expressed pedicels, arranged in lax inflorescence. Corolla whitish or pale purplish, broadly infundibuliform, 3-4,5 mm..... **2. *A. cynanchica.***

6b. Bracts ovoid-lanceolate, in the lower part ± dentate, exceeding 1 mm. Flowers ±sessile, arranged in the terminal dense clusters. Corolla rose, infundibuliform, 2-3 mm..... ..... **3. *A. supina.***

Section 1. *Asperula*. – § *Sherardiana* DC. 1830, Prodr. 4: 581. – Sect. *Sherardiana* (DC.) Gren. 1851, in Gren. et Godr., Fl. Fr. 2: 49. – Annuals. Leaves small, mostly in whorls of 4-8. Corolla 4-merous, whitish, papillose-puberulent outside, with ±short lobes.

T y p u s: ***A. arvensis*** L.

1. *A. arvensis* L. 1753, Sp. Pl.: 103; Шишкин, 1958, Фл. СССР, 23: 281; Клоков, 1960, Фл. УРСР, 10: 105; Paucă & E. I. Nyárády, 1961, Fl. R. P. Române, 8: 533; Ehrendorfer & Krendl, 1976, Fl. Europ. 4: 13; Победимова, 1978, Фл. евр. части СССР, 3: 94; Доброчаева, Котов, Прокудин и др., 1999, Опред. высш. раст. Укр., изд. 2: 259; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 165; Ciocârlan, 2009, Fl. ilustr. a României: 736. – *A. setosa* Jaub. & Spach, 1844, Ill. Pl. Or.: 152; Победимова, 1958, Фл. СССР, 23: 282.

Annual plants. Stems (5)10-55 cm. Leaves (4)10-25(30) × 0.6-4 mm, the lowest broadly lanceolate; cauline linear-lanceolate. Inflorescence of capitula. Flowers equalling or shorter than bracts. Corolla bluish-violet, ±salverform, 5-6.5 mm; tube 4-5.5 mm; lobes 0.5-1.5 mm. Filaments 0.2-0.3 mm; anthers 0.7-1 mm. Fruit 2-3 mm in diameter. (Figure 1), 2n=22.

It is an annual therophyte. The plants bloom in May-June and fructify in June-September. Propagate by seeds. It is a fodder, food, technique, tinctorial and ruderal plant. [8] *Asperula arvensis* is also an important source of flavonoids [3].

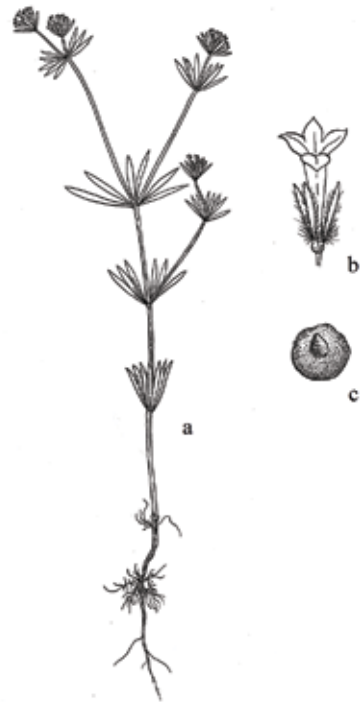

Figure 1. *Asperula arvensis* L.
(a – habitus, b – flower, c – mericarp)

The plants usually grow in small groups or sometimes it occurs solitary as a weed in steppe slopes with ruderalized vegetation. A xerophylous weed. The species is growing in the southern zone of Bessarabia [6]. The area of distribution covers the territory of Central Europe, Crimea, Mediterranean region, the Caucasus; being introduced in other regions [2, 12]. Adventive geographical element.

Section 2. *Cynanchica* DC. 1830, Prodr. 4: 582.

Dwarf shrubs or perennial herbs with taproot, usually without rhizomes or stolones, caespitose. Leaves in whorls of 4, linear-lanceolate, 1-veined, with a hyaline point or awn. Inflorescence pyramidal, corymbiform, or spicate to capitate. Flowers with short pedicels or sessile, subtended by bracts or bracteoles. Corolla 4-merous, hypocrateriform to infundibuliform, puplish, pink, greenish, yellowish or whitish, externally hairy, papillose or smooth. Anthers and stigma included. Ovary and fruit ovoid, more or less papillose or tuberculate, rarely hairy, never entirely smooth.

T y p u s: ***A. cynanchica*** L.

Cynanchica section is the most taxonomically difficult one. The number of species included in its composition varies greatly among different authors, depending on their approach to its volume and structure. For example, supporters of polytypical views [13, 15] believed that in the group *Cynanchica* there is one polymorphic species with a variety of subspecies and forms. On the contrary, Klokov [11] gave the rank of species to difficult distinguishing forms, that led to the emergence of many difficult to define "species". According to Ehrendorfer and Krendl (1976), the *Cynanchica* section consists of polymorphic races connected with each other by transitional forms and requiring careful study [10].

Based on studies of the genus *Asperula* L. in Crimea (Eastern Europe) [10] it was found that the most important diagnostic features in the *Cynanchica* section are the size of the corolla and the ratio of the length of the tube and the lobes of corolla [9, 10]. On the basis of studying the herbarium materials of the National Botanical Garden of RM, we came to the conclusion that the section in the region of the Dniester-Prut interfluve includes 2 subsections and 6 species. Subsection *Cynanchica* includes 4 species: *Asperula cynanchica* L., *A. supina* M.Bieb., *A. tenella* Heuff. ex Degen, *A rumelica* Boiss., and subsection *Graveolentes* (Klokov) Pjatunina – 2 species: *A. graveolens* M.Bieb. ex Schult. & Schult. fil. and *A. leiograveolens* Popov & Chrshan.

Subsection 1. *Cynanchica.* – Dwarf shrubs with lignifying and branched rhizome. Leaves in whorls of 4. Corolla infundibuliform or tubulous-infundibuliform, whitish, pink or chalky-wooly, with lobes as long as the tube or shorter [10].

T y p u s: ***A. cynanchica*** L.

2. ***A. cynanchica*** L. 1753, Sp. Pl.: 104; Клоков, 1958, Фл. СССР, 23: 224; id. 1960, Фл. УРСР, 10: 130; Paucă & E.I. Nyárády, 1961, Fl. R. P. Române, 8: 546, quoad syn. *A. cynanchica* L. subsp. *cynanchica*; Ehrendorfer & Krendl, 1976, Fl. Europ. 4: 10; Победимова, 1978, Фл. евр. части СССР, 3: 96; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 498; Доброчаева, Котов, Прокудин и др., 1999, Опред. высш. раст. Укр., изд. 2: 260; Васильева & Коваленко, 2003, Консп. флори Півден. Бессарабії: 165; Negru, 2007, Determ. pl. fl. R. Moldova: 183; Ciocârlan, 2009, Fl. ilustr. a României: 739. – *A. semiamicta* Klokov, 1958, Фл. СССР, 23: 694; id. 1960, Фл. УРСР, 10: 129¸ Доброчаева, Котов, Прокудин и др., 1999, l. c.: 260.

Laxly or densly caespitose, green, sometimes glaucous-pruinose, with more or less numerous non-flowering shoots,

Figure 2. *Asperula cynanchica* L. (a – habitus, b – calyx)

but without subterranean stolons. Stems 10-50 cm, ascending to erect, herbaceous at base, usually rough with short hairs at base, subglabrous above; middle internodes 1-3 times as long as the leaves. Leaves (15)20-35(40) x 0.8-1.5 mm, in whorls of 4 throughout, narrowly lanceolate to liniar, acute; midrib comprising less then ¾ of width of leaf; margin flat to weakly revolute. Inflorescence lax, usually much-branched. Bracts linear or elongated-lanceolate, entire, up to 1 mm wide. Pedicels up to 1 mm. Corolla 3-4.5 mm, broadly infundibuliform, whitish or pale purplish; lobes distinctly appendiculate, as long as tube. Fruit 1.5-2 mm, papillose, rarely hairy. (Figure 2), 2n=44.

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

The plants usually grow in small groups or forms small thick stands, sometimes it occurs solitary in steppe hills, forest glades and edges, limestone slopes, sandy places. The species is widely distributed throughout the region. The area of distribution covers the territory of Central and Eastern Europe (center and south) [2, 12]. Pannonian-Pontic geographical element.

Asperula cynanchica (Sweet woodruff) can be found being used medicinally and as a means of sweetening the air in records dating back as far as the 14th century. Medieval soldiers believed sweet woodruff promoted success in battle. So they carried it tucked in their helmets. In the Middle Ages Sweet woodruff was woven into wreaths and swags and hung and strewn in churches. Sweet woodruff was formerly used for treating quincy, a disease similar to tonsillitis. Literature data revealed the content of important biologically active compounds in the aerial part of the plants, such as coumarins, phenolic acids, anthraquinones, vitamins C, P [8].

3. *A. supina* M.Bieb. 1808, Fl. Taur.-Cauc. 1: 101; Клоков, 1958, Фл. СССР, 23: 229; id. 1960, Фл. УРСР, 10: 137; Paucă & E.I. Nyárády, 1961, Fl. R. P. Române, 8: 546; Ehrendorfer & Krendl, 1976, Fl. Europ. 4: 9, p. p.; Победимова, 1978, Фл. евр. части СССР, 3: 96; Доброчаева, Котов, Прокудин и др., 1999, Опред. высш. раст. Укр., изд. 2: 260; Васильева & Коваленко, 2003, Консп. флори Півден. Бессарабії: 165. – *A. cynanchica* β *supina* (M.Bieb.) Schmalh. 1897, Фл. Средн. Южн. Росс. 2: 9, p. p. – *A. vestita* V.Krecz. 1934, в Гроссг. Фл. Кавказа, изд. 1, 4:15; Клоков, 1958, Фл. СССР, 23: 243; id. 1960, Фл. УРСР, 10: 153; Доброчаева, Котов, Прокудин и др., 1999, l. c.: 260. – *A. praepilosa* V.Krecz. ex Klokov, 1958, Фл. СССР, 23: 702; Клоков, 1960, Фл. УРСР, 10: 154; Победимова, 1978, l. c.: 99; Доброчаева, Котов, Прокудин и др., 1999, l. c.: 260. – *A. cimmerica* V.Krecz. ex Klokov, 1958, Фл. СССР, 23: 702; id. 1960, Фл. УРСР, 10: 157; Победимова, 1978, l.

Figure 3. *Asperula supina* M.Bieb.
(a –habitus)

c.: 99; Доброчаева, Котов, Прокудин и др., 1999, l. c.: 260. – *A. praevestita* V.Krecz. ex Klokov, 1958, Фл. СССР, 23: 701; id. 1960, Фл. УРСР, 10: 151; Победимова, 1978, l. c.: 98; Доброчаева, Котов, Прокудин и др., 1999, l. c.: 260. – *A. kotovii* Klokov, 1969, Фл. УРСР, 10: 457; Победимова, 1978, l. c.: 98; Доброчаева, Котов, Прокудин и др., 1999, l. c.: 260.

Shoots green. Stems 10-25 cm, ±shortly hairy to glabrous; middle internodes 2-7 times as long as the leaves. Leaves 10-30 x 0.3-0.5 mm, with short awn. Inflorescence ovoid to corymbiform; partial inflorescences distinctly capitate. Bracts broadly lanceolate, in the lower part ±dentate, exceeding 1 mm wide. Flowers ±sessile, arranged in the terminal dense clusters. Corolla roze, infundibuliform, mostly rough outside, 2-3 mm; tube about equalling lobes. Fruit 1.5-2 mm (Figure 3), 2n=20.

It is a dwarf shrub, microphanerophitic plant. The plants bloom in June-August and fructify in July-September. Propagate by seeds. It is a decorative plant.

The plants grow on calcareous slopes. A typically stony steppe xerophylous species.

In the Dniester-Prut region in the past the species was met only in the southern part of the region, on the territory of Ukraine [6]. At present on the territory almost extinct species. Common area of species covers Eastern Europe (South), Crimea, Ciscaucasia (Northwest). Pontic geographical element. Endemic.

4. ***A. tenella*** Heuff. ex Degen, 1899, in A. Kerner, Fl. Exsicc. Austro-Hung. 8: 43; Paucă & E.I. Nyárády, 1961, Fl. R. P. Române, 8: 545; Ehrendorfer & Krendl, 1976, Fl. Europ. 4: 7; Negru, 2007, Determ. pl. fl. R. Moldova: 183. – A. *cynanchica* L. var. *elongata* Stev. 1830, in DC. Prodr. 4: 538. – *A. longiflora* C.Koch, 1850, Linnaea, 23:460, non Waldst. & Kt. 1804; Paucă & E.I. Nyárády, 1961, Fl. R. P. Române, 8: 545, p. p. – *A. stevenii* V.Krecz. 1934, в Гроссгейм, Фл. Кавказа, изд. 1, 4: 25; Клоков, 1958, Фл. СССР, 23: 232; Клоков, 1960, Фл. УРСР, 10: 140; Победимова, 1978, Фл. евр. части СССР, 3: 98; Доброчаева, Котов, Прокудин и др., 1999, Опред. высш. раст. Укр., изд. 2: 260. – *A. maeotica* Popov & Chrshan. 1945. Бюлл. Моск. общ. испыт. природы, Отд. биол. 50, 5-6: 97. – *A. bidentata* Klokov, 1958, Фл. СССР, 23: 697; id. 1960, Фл. УРСР, 10: 142; Доброчаева, Котов, Прокудин и др.,

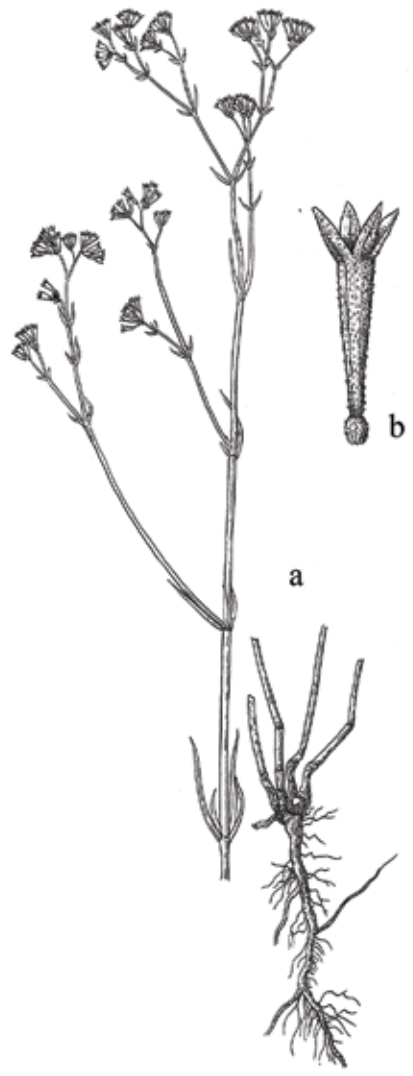

Figure 4. *Asperula tenella* Heuff. ex Degen (a – habitus, b – calyx)

1999, l. c.: 260. – *A. hypanica* Klokov, 1958, Фл. СССР, 23: 698, p. p.; id. 1960, Фл. УРСР, 10: 144; Доброчаева, Котов, Прокудин и др., 1999, l. c.: 260. – *A. attenuata* Klokov, Фл. СССР, 23: 698; id. 1960, Фл. УРСР, 10: 146; Доброчаева, Котов, Прокудин и др., 1999, l. c.: 260, (Figure 4).

Shoots woody at the base, usually green, rarely weakly glaucous-pruinose. Stems 35-45 cm, ±erect, shortly papillose-hairy especially below, often much-branched from base; middle internodes 2-3(4) times as long as the leaves. Leaves 25-35 × 0.5-1 mm, linear to acicular; midrib comprising less then ¾ of the width of the leaf; margin revolute. Inflorescence ovoid, with somewhat patent branches; partial inflorescences corymbiform. Bracts lanceolate. Pedicels 0.5-0.8 mm. Corolla 4-6 mm, reddish, narrowly hypocrateriform, finely papillose outside, 2-3 mm; lobes rather shortly appendiculate, 2-3 times as short as the tube. Fruit 1.2-1.7 mm (Figure 4).

It is a dwarf shrub, microphanerophytic plant. The plants bloom in April-August and fructify in May-September. Propagate by seeds.

The plants grow on steppe and calcareous slopes. A typicaly steppe xerophylous species.

In the Dniester-Prut region can be met in the Republic of Moldova in Rezina, Nisporeni Hânceşti, Cimişlia, Leova, Cahul districts, in the vicinity of Chişinău municipality; Comrat, Taraclia and Vulcăneşti (ATU Găgăuzia); Grigoriopol (Transnistrian region); and the southern part of the region on the territory of Ukraine [6]. Outside the country it is spread in the central and southern part of eastern Europe, Crimea, the Mediterranean region, Asia Minor (Turkey). Pontic-Mediterranean geographical element. The plant has medicinal properties due to the high content of iridoids and flavonoids [8].

Protection status. No measures have been taken in the region. Territorially protected in area with multifunctional management – sector with steppe vegetation in the south of Bugeac (Ciumai village) and natural forest reservation ”Sărata Galbenă”.

Protection measures. Inclusion in the list of the species protected by law in Republic of Moldova; monitoring the extant populations; identification of new places of the growth; conservation of the species in *ex-situ* conditions.

5. ***A rumelica*** Boiss. 1856, Diagn. ser. 2, 2:113; Клоков, 1958, Фл. СССР, 23: 236; Клоков, 1960, Фл. УРСР, 10: 146; Ehrendorfer & Krendl, 1976, Fl. Europ. 4: 10; Победимова, 1978, Фл. евр. части СССР, 3: 98; Доброчаева, Котов, Прокудин и др., 1999, Опред. высш. раст. Укр., изд. 2: 260; Ciocârlan, 2009, Fl. ilustr. a României: 739. – *A. cynanchica* L. var.

Figure 5. *Asperula rumelica* Boiss. (a – habitus, b – calyx)

graveolens (M.Bieb. ex Schult. & Schult. fil.) Stojan. et Stef. 1925, Fl. Bulg.: 1044, p. p. – *A. cynanchica* L. subsp. *rumelica* (Boiss.) Pjatunina, 1995, Бюлл. Моск. общ. испыт. прир. (отд. биол.), 100, 4: 71. – *A. hypanica* Klokov, 1958, Фл. СССР, 23: 698, 236; id. 1960, Фл. УРСР, 10: 144; Доброчаева, Котов, Прокудин и др., 1999, l. c.: 260. – *A. graniticola* Klokov, 1958, Фл. СССР, 23: 699, p. p.; id. 1960, Фл. УРСР, 10: 148; Доброчаева, Котов, Прокудин и др., 1999, l. c.: 260.

Not caespitose, more or less grey-green, without non-flowering shoots at anthesis. Stems 10-90 cm, erect, robust, sometimes woody at base, usually rough with short hairs at base, subglabrous above; middle internodes 1-3 times as long as the leaves. Leaves (15)20-35(40) × 0.5-1 mm, in whorls of 4 throughout, narrowly lanceolate to linear, acute; midrib comprising more than ¾ of width of leaf; margin distinctly revolute. Inflorescence lax, usually much-branched. Pedicels usually distinct and up to 2(4.5) mm. Corolla 2-3 mm, campanulate-infundibuliform, whitish or pale purplish, rough with dense, short hairs outside; lobes distinctly appendiculate, 1.5 times shorter than the tube. Fruit 1.5-2 mm, papillose, rarely hairy (Figure 5).

It is a dwarf shrub, microphanerophitic plant. Plants bloom in April-August and fructify in May-September. Propagate by seeds.

The plants grow on steppe and calcareous slopes. A typically steppe xerophylous species.

In the Dniester-Prut region can be met in the Republic of Moldova in Rezina, Sângerei, Râbnița, Orhei, Criuleni, Anenii Noi, Hâncești, Cahul districts, mun. Chișinău; Comrat and Vulcănești (ATU Găgăuzia), Grigoriopol and Slobozia (Transnistrian region), and the southern part of the region on the territory of Ukraine [6]. Outside the country is spread in the Balkans (Romania, Bulgaria), southern part of eastern Europe, Asia Minor (Turkey). Pontic-Eastern-Mediterranean geographical element.

Protection status. No measures have been taken in the region.

Protection measures. Monitoring the status of extant populations; identification of new places of the growth; conservation of the species in *ex-situ* conditions.

Subsection 2. *Graveolentes* (Klokov) Pjatunina, 1994, Род *Asperula* L. секция *Cynanchica* DC. в евр. части бывшего СССР: 11. – Sect. *Graveolentea* (Klokov) Pobed. 1978, Фл. евр. части СССР, 3: 99. – *Asperula* sect. *Cynanchica* ser. *Graveolentes* Klokov, 1958, Фл. СССР, 23: 706. – Dwarf shrubs. Leaves in whorls of 4-6. Corolla tubulous-infundibuliform or infundibuliform, pale pink, with lobes as long as the tube, rarely shorter. Fruit of 3-4.5 mm long, densely covered with a scattered squamiform tubercles or almost glabrous [10].

T y p u s: ***A. graveolens*** M.Bieb. ex Schult. & Schult. fil.

6. *A. graveolens* M.Bieb. ex Schult. & Schult. fil. 1827, in Roem. & Schult. Mant. ad Syst. veg. 3: 376; Клоков, 1958, Фл. СССР, 23: 262; id. 1960, Фл. УРСР, 10: 161; Ehrendorfer & Krendl, 1976, Fl. Europ. 4: 11; Победимова, 1978, Фл. евр. части СССР, 3: 99; Доброчаева, Котов, Прокудин и др., 1999, Опред. высш. раст. Укр., изд. 2: 259; Васильева & Коваленко, 2003, Консп. флори Півден. Бессарабії: 165. – *A. setulosa* Boiss. 1849, Diagn. Fl. Or. ser. 1, 10: 61; Клоков, 1958, Фл. СССР, 23: 260; id. 1960, Фл. УРСР, 10: 158; Paucă & E.I. Nyárády, 1961, Fl. R. P. Române, 8: 545; Ehrendorfer & Krendl, 1976, Fl. Europ. 4: 11; Победимова, 1978, Фл. евр. части СССР, 3: 99; Доброчаева, Котов, Прокудин и др., 1999, l. c.: 259; Васильева & Коваленко, 2003, Консп. флори Півден. Бессарабії: 165; Ciocârlan, 2009, Fl. ilustr. a României: 738. – *A. savranica* Klokov. 1958, Фл. СССР, 23: 707, 261; id. 1960, l. c.: 160; Ehrendorfer & Krendl, 1976,

l. c.: 11; Доброчаева, Котов, Прокудин и др., 1999, l. c.: 259. – *A. graveolens* subsp. *graveolens*: Pjatunina, 1995, Бюлл. Моск. общ. испыт. прир. (отд. биол.), 100, 4: 75.

Shoots green. Stems 10-35 cm, geniculate-ascending, ±weak, rough at the base, usually with conspicuous, short, non-flowering shoots at the nodes; middle internodes 1-3 times as long as the leaves. Leaves 25-30 × 0.4-1.2 mm, linear to acicular, acute, patent and falcate to recurved, usually shortly hairy; margin revolute. Bracts narrowly lanceolate, glabrous or ciliate, scarcely exceeding the fruits. Pedicels up to 1.5(3) mm. Corolla broadly crateriform to narrowly infundibuliform, 3.5-4 mm; tube 1-1.5 times as long as distinctly appendiculate lobes. Fruit 4-4.5 mm, densely covered with squamiform tubercles (Figure 6).

It is a dwarf shrub, microphanerophitic plant. The plants bloom in June-August and fructify in July-September. Propagate by seeds.

The plants grow on sea sand dunes. A typicaly psammophilous species of sea coasts.

In the Dniester-Prut region can be met only in the southern part of the region on the territory of Ukraine in the littoral zone [6]. Common area of species covers Central (Romania) and Eastern Europe (East Ukraine and South Russia). Pontic geographical element. Endemic.

Figure 6. *Asperula graveolens* M.Bieb. ex Schult. et Schult. fil. (a – habitus, b – fruit)

The aerial part of *A. graveolens* contains tannins, bitterness, coumarins, essential oil, ascorbic acid, fatty oil. It is used in folk medicine as a sedative, diaphoretic, astringent, diuretic, in skin diseases associated with metabolic disorders. Externally the plant is used for compresses for skin diseases, ulcers and wounds. The plant has toxic properties and is recommended to not overdose.

The plant has also a pleasant spicy-gingerbread smell and bitter taste, is used for flavoring fruits, tobacco and clothes. In the industry it is used in the production and aromatization of wine, liqueur and vodka products. The leaves are usually added to the culinary products.

7. *A. leiograveolens* Popov & Chrshan. 1945, Бюлл. Моск. общ. испыт. прир. (отд. биол.), 50, 5-6: 96; Клоков, 1958, Фл. СССР, 23: 69; id. 1960, Фл. УРСР, 10: 163; Ehrendorfer & Krendl, 1976, Fl. Europ. 4: 11; Доброчаева, Котов, Прокудин и др., 1999, Опред. высш. раст. Укр., изд. 2: 259. – *A. pseudograveolens* Popov & Chrshan. 1945, Бюлл. Моск. общ. испыт. прир. (отд. биол.), 50, 5-6: 94; id. Фл. УРСР, 10: 162. – *A. graveolens* M.Bieb. ex Schult. & Schult. fil. subsp. *leiograveolens* (Popov & Chrshan.)

Pjatunina, 1995, Бюлл. Моск. общ. испыт. прир. (отд. биол.), 100, 4: 76.

Shoots green. Stems 10-35 cm, geniculate-ascending, ±weak, rough at the base, usually with conspicuous, short, non-flowering shoots at the nodes; middle internodes 1-3 times as long as the leaves. Leaves 10-25 × 0.3-0.7 mm, linear to acicular, acute, patent and falcate to recurved, usually glabrous; margin revolute. Bracts narrowly lanceolate, glabrous, scarcely exceeding the fruits. Pedicels up to 1.5(3) mm. Corolla broadly crateriform to narrowly infundibuliform, 3.5-4 mm; tube 1-1.5 times as long as distinctly appendiculate lobes. Fruit nearly 3 mm, almost glabrous (Figure 7).

It is a dwarf shrub, microphanerophitic plant. The plants bloom in June-August and fructify in July-September. Propagate by seeds.

The plants grow on sea sand dunes, often together with *Asperula graveolens* M.Bieb. ex Schult. & Schult. fil. A typically psammophilous species of sea coasts.

In the Dniester-Prut region can be met only in the southern part of the region on the territory of Ukraine in the littoral zone [6]. The common area covers south-west of Eastern Europe (northern Black Sea coast and the territory along the middle course of the river Dnepr). Pontic geographical element. Endemic.

Figure 7. *Asperula leiograveolens* M.Pop. et Chrshan. (a – habitus, b – fruit)

CONCLUSION

For the territory of the Dniester-Prut region, seven species of the genus woodruff (*Asperula* L.) were identified: *Asperula arvensis* L., *A. cynanchica* L., *A. supina* M.Bieb., *A. tenella* Heuff. ex Degen, *A. rumelica* Boiss., *A. graveolens* M.Bieb. ex Schult. & Schult. fil. and *A. leiograveolens* Popov & Chrshan.

Three species (*Asperula supina* M.Bieb., *A. graveolens* M.Bieb. ex Schult. & Schult. fil., *A. leiograveolens* Popov & Chrshan.) are found only in the southern zone of the region (on the territory of Ukraine), one of which (*Asperula supina* M.Bieb.) may have disappeared.

We propose to include in the list of species protected by law in the Republic of Moldova the following 2 species of *Asperula* genus – *A. tenella* Heuff. ex Degen and *A. rumelica* Boiss.

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IRIDIO APHYLLAE-QUERCETUM PUBESCENTIS PÎNZARU – ASS. NOVA, IN THE REPUBLIC OF MOLDOVA AND UKRAINE

Pavel PÎNZARU
"Alexandru Ciubotaru" National Botanical Garden (Institute),
State Agrarian University of Moldova,
Tiraspol State University, Chisinau, Republic of Moldova
E-mail: p_panzaru@yahoo.it

Abstract: The description of the forests of *Quercus pubescens* Willd. with *Iris aphylla* L., on limestone slopes between Dniester and Prut, is presented in this paper. Based on 12 phytocenological relevés from Moldova and one from Ukraine, the author has identified a new association for science: *Iridio aphyllae-Quercetum pubescentis* ass. nova, included in the alliance *Quercion pubescenti-petraeae* Br.-Bl. 1932, the order *Quercetalia pubescenti-petraeae* Klika 1933, cl. *QUERCO-FAGETEA* Br.-Bl. et Vlieger in Vlieger 1937.

Key words: *Iridio aphyllae-Quercetum pubescentis* ass. nova, characteristics of phytocoenoses, ecology, range, R. Moldova, Ukraine.

INTRODUCTION

Downy oak forests (*Quercus pubescens* Willd.) occur, in the Republic of Moldova, mainly in the southern areas, sporadically in the central and rarely in the northern ones [1, 10-15, 17]. The first phytocoenological research on downy oak forests in central and southern Bessarabia was carried out by Alexandru Borza [1], who described two associations: *Querceto-Lithospermetum cotinosum* Borza 1936 and *Quercetum pubescentis bessarabicum* Borza 1937, grouping them in the alliance *Quercion pubescenti-sessiliflorae* Br.-Bl. 1931. Later, downy oak forests were studied according to the dominant species (ex-soviet phytosociological school), being included by L. Nikolaeva in the associations *Quercetum pubescentis herbosum* Nikolaeva 1963, *Quercetum pubescentis-andropogonosum*, *Quercetum pubescentis stepposum* Nikolaeva 1963 and *Quercetum pubescentis fruticosum* Nikolaeva 1963 [13]. In 1964, T. Gheideman and collaborators grouped downy oak forests in the associations: *Quercetum brachypodiosum* Gheideman et al. 1964, *Quercetum herbosum* Gheideman et al. 1964, *Quercetum pooso* (*angustifoliae*) – *andropogonosum* Gheideman et al. 1964 and *Quercetum stepposum* Nikolaeva 1963 [12]. In 1987-1990, the downy oak forests from the valley of Dniester River were studied according to the dominant species and, as a result, they were included in two associations: *Quercetum* (*pubescentis*) *cornoso-cotinosum* Pînzaru 1990 and *Quercetum* (*pubescentis*) *stepposum* Nikolaeva 1963 [15]; later, in 1994, these forests were included in the association *Quercetum pubescentis calcareum* Gergely 1962 [17]. In 2016, a study was focused on the forests of *Quercus pubescens* Willd. with *Paeonia peregrina* Mill. in Nisporeni district, included in the association *Paeonio peregrinae-Quercetum pubescentis* (Sârbu, 1982) Popescu et Sanda 1999 [10].

This article presents a new vision on the classification of downy oak forests on the limestone slopes of the Republic of Moldova and Ukraine and brings new data on the ecology, distribution and floristic composition of these phytocoenoses.

MATERIALS AND METHODS

The description of the association is based on the phytocoenological relevés, made by the author in 1987-2019, on the downy oak forests (*Quercus pubescens* Willd.) that occur on limestone slopes in the basins of the rivers Dniester and Prut (the tributary Draghişte). Twelve relevés from the Republic of Moldova and one from Ukraine were analyzed and were described according to the methods of the Central European School [Braun-Blanquet, 1964]. The list of plant species was presented according to the monograph "Vascular flora of the Republic of Moldova" (Flora vasculară din Republica Moldova" [Pînzaru, Sîrbu, 2016]. Rare plants – according to the Red Book of the Republic of Moldova and the Law on protected natural areas [3, 6, 7]. Air temperature and atmospheric precipitation – according to the Atlas of Climate Resources of the Republic of Moldova [8].

RESULTS AND DISCUSSIONS

The downy oak forests (*Quercus pubescens* Willd.) on limestone slopes are quite uncommon for the territory of the Republic of Moldova, they occur near eight localities in the centre and north of the country. These forests cover small areas and, mainly, have a have a much changed structure and floristic composition because of the inadequate care. The largest well-preserved area of such type of forest occurs on the right bank of Dniester, in Tîrgul-Vertiujeni commune, Floreşti district, and we would like to propose it as nomenclatural type of the described association. The *Quercus pubescens* forests are xerophilic, plenty of light gets in them, and such factors allow the development of numerous species characteristic of glades, steppe and scrubs. The constant presence of calcicoles: *Iris aphylla* L., *Viola sieheana* W. Becker, *Asparagus verticillatus* L., *Cerasus mahaleb* (L.) Mill., *Cotinus coggygria* Scop., *Polygonatum odoratum* (Mill.) Druce and the limestone-rich substrate, on which these forests develop, are peculiar features which make them a unique habitat, distinct from those formed by *Quercus pubescens* on hills with non-calcareous substrate. For these reason, we group these phytocoenoses into a new association – *Iridio aphyllae-Quercetum pubescentis*.

The phytocoenoses of the new association - *Iridio aphyllae-Quercetum pubescentis* are similar to those of the association *Galio dasypodi - Quercetum pubescentis* Doniţa 1970 [= *Cotino-Quercetum pubescentis* sensu Sârbu 1982, non Soo (1931) 1932] in the abundant presence of the species *Cotinus coggygria*, in the southern areas of Romania [5], but differ in the floristic composition (the absence of the species *Quercus petraea*, *Q. dalechampii*, *Fraxinus ornus*, *Carpinus orientalis*, *Pyrus eleagrifolia, Paeonia peregrina*, but the presence of *Iris aphylla*, *Viola sieheana*) and in the physical-geographical conditions (occur on steep slopes with alkaline soil, alternating with limestone rocks on slightly sloping terrains, with slightly acidic or neutral soil) [4].

The species *Iris aphylla* L. – is a Pontic-Pannonian-Caucasian element, which grows only in forests with a lot of light and in glades on rocks. It has two distinct forms, which differ in the colour of the corolla: *aphylla* (Figure 1) – purplish corolla and *iulitae* Pînzaru 2013 (Figure 2) – dark violet corolla [16].

Ass. *Iridio aphyllae-Quercetum pubescentis* Pînzaru, *ass. nova, h.l.*

T y p e h. l.: Tab. 1, rel. 2. 48°024'258''N, 28°533'085''E (Figure 2, 3)

Table synthetic h.l.: Tab. 1, 13 relevés

Syn.: *Quercetum* (*pubescentis*) *cornoso-cotinosum*: Пынзару, 1991; *Quercetum*

Figure 1. *Iris aphylla* forma *aphylla*

Figure 2. *Iris aphylla* forma *iulitae* Pînzaru

Figure 3, 4. Aspects of the type of the association *Iridio aphyllae-Quercetum pubescentis,* Tîrgul-Vertiujeni commune, Floreşti district

(*pubescentis*) *stepposum*: Пынзару, 1991; Quercetum *pubescentis calcareum* auct. non Gergely 1962: Пынзару, Попеску, 1994.

Locations: Altitude 70-150 m. Relief: Northern Moldovan Plateau, Dniester Hills, Central Moldovan Plateau, Podolian Upland, southern, south-western, eastern and northern exposure, the inclination of the slopes between 30° and 54°. Climate – temperate-continental, the average annual temperature is 9.0-10.5 °C, the average annual precipitation varies between 550 and 600 mm. Rocks: limestone. Soil – rendzinas, rich in limestone skeletal fragments, alternating with limestone rocks.

Characteristic species: *Quercus pubescens*, *Iris aphylla* forma *aphylla* and forma *iulitae*, *Viola sieheana*, *Polygonatum odoratum*, *Asparagus verticillatus.*

Constant species: *Cotinus coggygria*, *Cerasus mahaleb*, *Berberis vulgaris*, *Atnthericum ramosum*, *Buglossoides purpurocaerulea*, *Fragaria viridis*, *Glechoma hirsuta, Vincetoxicum hirundinaria*, *Sedum maximum*, *Teucrium chamaedrys*, *Thalictrum minus*, *Valeriana collina*, *Veronica chamaedrys*, *Vinca herbacea*.

Rare species protected by the state: *Cotoneaster malanocarpus* (EN), included in the Red Book of R. Moldova, *Fritillaria montana* (VU), included in the Red Book of R. Moldova, *Adonis vernalis* (NT), *Amygdalus nana* (VU), *Asparagus officinalis* (NT), *A. tenuifolius* (NT), *A. verticillatus* (NT), *Crocus reticulatus* (NT), *Hyacinthella leucophaea* (NT), *Iris pumila* (NT), *Pulsatilla montana* (VU), *Stipa pulcherrima* (VU), *S. zalesskii* (= S. *ucrainica*) (VU), *Tulipa biebersteiniana* var. *biebersteiniana* (VU).

Structure – three layers are distinguished in phytocoenoses:

1. The tree layer (A), with a height of about (4) 5 and 8 m, the coverage of the canopy is about 60-70 %. This layer consists of the dominant species *Quercus pubescens*, the diameter of the stems varies between 10 cm and 30 cm, accompanying species: *Cerasus mahaleb* and *Ulmus minor*. Trees of the species *Acer campestre*, *Pyrus pyraster*, *Fraxinus excelsior*, *Quercus robur* also occur, but very rarely.
2. The shrub layer (B) is 1-3 m high, well-developed and its coverage is about 50-80 %. Constant species: *Cotinus coggygria*, *Cornus mas*, *Crataegus monogyna*, *Euonymus verrucosus*, *Prunus spinosa*, *Rhamnus cathartica*, *Rosa canina*, *Viburnum lantana*, *Berberis vulgaris*.
3. The herbaceous layer (C) has very uneven coverage, depending on the abundance of the species *Cotinus coggygria*, which may create thickets at the level of this layer (4-5). Thus, its coverage varies between 10 and 15 % in glades, but in some places, it reaches even 80 %. There are few species of ephemerals, represented by an insignificant number of individuals *Crocus reticulatus*, *Hyacinthella leucophaea*, *Muscari neglectum*, *Corydalis solida*, *Scilla bifolia*, *Fritillaria montana*, *Tulipa biebersteiniana*. In summer, in this synusia, there are constantspecies, which grow in clusters: *Iris aphylla*, *Polygonatum odoratum*, *Convallaria majalis*, *Vinca herbacea*, *Teucrium chamaedrys*, *Buglossoides purpurocaerulea*, *Mercurialis ovata*, *Anthericum ramosum*, *Glechoma hirsuta*.

The dynamics of phytocoenoses. The structure and floristic composition of the phytocenoses of this association and others are influenced by the anthropogenic factor. The tree layer is dominated by *Quercus pubescens*, but it has a low coverage because trees have been cut, and this fact has allowed the shrub layer to develop. In some areas, as a result of the vegetative propagation of the species *Cotinus coggygria*, there is an obvious reduction in the grass layer. In the arboretum, although there are some specimens grown from seeds, the ones grown from vegetative shoots prevail.

Range. The plant communities of *Quercus pubescens* Willd. with *Iris aphylla* L., have been recorded (Figure 5) in:

Figure 5. Locations of the association *Iridio aphyllae-Quercetum pubescentis* ass. nova

- Republic of Moldova: Edineț district (Fetești commune), Florești district (Tîrgul-Vertiujeni commune), Chișinău municipality (Ciorescu commune), Orhei district (Lopatna village), Criuleni district (Zolonceni village), Anenii Noi district (Delacău commune), Territorial Units of the Left Bank of the Dniester (Hrușca and Goian villages).
- Ukraine, Kamianets-Podilskyi district (Jaryšiv village).

Conservation value / Conservation status. The studied association is protected in "Iagorlîc" Scientific Reserve, "Fetești" Landscape Reserve, in "Dubăsari", "Zolonceni" and "Vadul" Forest Reserves [7].

Protection measures. It has been proposed to include "Tîrgul-Vertiujeni" forest in the network of protected areas, in the category Forest Reserve, as the best-preserved forest sector, selected also as a nomenclatural type.

CONCLUSIONS

1. The association *Iridio aphyllae-Quercetum pubescentis* Pînzaru comprises West-Pontic downy oak forests (*Quercus pubescens* Willd.) with leafless iris (*Iris aphylla* L.), characterized by thermo-xerophilic vegetation, occurring usually on sunny slopes, with limestone substrate, rendzina soil, neutral to alkaline, rich in limestone skeletal fragments, with limestone outcrops.
2. The vertical structure of the phytocoenoses of the association consist of 2-3 layers, the most developed of which is the shrub layer. The abundance of *Cotinus coggygria* greatly reduces the presence of herbs.
3. The floristic composition comprises 251 species, of which 53 species are characteristic of *Quercion-Quercetalia pubescentis-petraeae*, 36 – *Querco-Fagetea*, 19 – *Rhamno-Prunetea*, 41 – *Trifolio-Geranietea*, 73- *Festuco-Brometea* and 29 – *Aliae*.
4. There are 14 protected species, including two species mentioned in the Red Book of the Republic of Moldova (2015): *Cotoneaster malanocarpus* (EN) and *Fritillaria montana* (VU).
5. *Iris aphylla* L. is a rare species, and it has been suggested to include it in the List of protected species of the Republic of Moldova, in the category (VU).
6. The association *Iridio aphyllae-Quercetum pubescentis* Pînzaru includes phytocoenoses of great interest, from scientific point of view, and it has been proposed to add it to the List of rare associations of the Republic of Moldova.
7. The association *Iridio aphyllae-Quercetum pubescentis* Pînzaru ass. nova belongs to the *Quercion pubescenti-petraeae* Br.-Bl. 1932, the order *Quercetalia pubescenti-petraeae* Klika 1933, cl. *QUERCO-FAGETEA* Br.-Bl. et Vlieger in Vlieger 1937.

Table 1. Ass. *Iridio aphyllae-Quercetum pubescentis* ass. nov

Relevé no.	1	*2	3	4	5	6	7	8	9	10	11	12	K	13
Surface of relevé (m²)	600	600	600	600	600	600	600	600	600	600	600	600		600
Altitudine	150	124	127	90	90	95	90	91	70	120	135	135		215
Aspect	E	E	E	SV	SV	S	E	N	S	SV	SV	SV		V
Slope (°)	35	35	55	35	40	35	54	35	30	30	30	35		35
Tree layer coverage (%)	70	60	65	55	60	50	65	65	55	70	50	55		55
Tree height (m)	8	7	8	4-6	5-7	5-8	8	5-7	5-6	5-6	5-7	5-6		5-7
Tree diameter (cm)	15-25	10-25	15-30	10-20	10-25	15-20	10-27	10-25	10-20	14-24	15-25	15-20		15-25
Shrum layer coverage (%)	50	70	80	60	65	80	65	60	65	70	65	70		80
Herbaceous layer coverage (%)	55	10-30	45	60	55	5-65	10-45	10-50	40	10-40	15-35	5-30		5-55
Plots no.	9	10	10	-	-	35	1	24	37	8	7	6		-
Number of species	83	124	127	141	145	106	140	66	53	81	74	100		70
Characteristic species														
Quercus pubescens	5	3	3	3	3	4	4	5	5	3	3	3	V	3
Iris aphylla forma aphylla	-	2	1	+	+	2	1	2	+	-	-	+	IV	2
Iris aphylla forma iulitae	-	+	+	-	-	-	-	-	-	-	-	-	I	-
Polygonatum odoratum	-	3	2	2	2	3	2	2	-	2	2	2	V	2
Asparagus verticillatus	+	2	1	1	1	1	1	1	r	+	+	+	V	1
Viola sieheana	+	+	+	1	1	+	+	-	-	-	-	+	IV	+
Quercion et Quercetalia														
pubescenti-petraeae														
Cerasus mahaleb	1	2	1	1	1	+	2	+	-	+	-	+	V	+
Cotinus coggygria	1	3	2	2	1	3	3	3	1	3	3	3	V	4
Euonymus verrucosus	-	1	1	1	1	+	1	2	+	1	1	1	V	1
Buglossoides purpurocaerulea	1	1	2	2	2	-	1	2	2	2	-	2	V	2
Sedum maximum	+	+	+	+	+	+	+	1	+	-	+	+	V	+
Vincetoxicum hirundinaria	+	1	+	+	+	+	+	+	+	+	+	+	V	+
Asparagus tenuifolius	+	+	+	+	+	-	+	+	+	+	+	+	V	+
Tanacetum corymbosum	+	+	+	+	+	-	+	-	1	+	-	-	IV	+
Clematis recta	+	1	1	1	+	+	1	+	-	+	-	-	IV	-
Arabis turrita	+	1	1	-	-	+	1	+	+	-	-	-	III	+
Laser trilobum	1	+	1	-	-	-	2	-	-	-	1	-	III	-
Clematis integrifolia	-	1	+	1	+	-	-	-	-	+	-	-	III	+
Poa nemoralis	3	-	-	-	-	-	1	1	-	-	-	-	II	-
Silene nutans	-	+	+	+	+	-	-	-	-	-	-	-	II	-
Galium schultesii	1	-	-	-	-	-	-	-	-	-	+	1	II	-
Mercurialis ovata	-	-	-	2	2	-	2	2	-	-	-	-	II	-

Piptatherum virescens	-	-	-	+	+	-	-	1	-	-	-	-	II	-
Campanula persicifolia	-	-	+	-	+	-	+	+	+	-	-	-	II	+
Alyssum murale	-	-	-	1	1	+	+	-	-	-	-	-	II	-
Lathyrus niger	+	-	-	-	-	-	+	-	-	-	-	-	I	+
Arabis recta	-	-	+	-	-	-	+	-	-	-	-	-	I	-
Viola jordani	-	-	-	-	-	-	+	-	-	-	-	-	I	-
Lathyrus pannonicus	-	-	-	+	+	-	-	-	-	-	-	-	I	-
Galium rubioides	-	-	-	+	+	-	-	-	-	-	-	-	I	-
Lembotropis nigricans	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Querco-Fagetea s.l.														
Glechoma hirsuta	1	1	1	1	2	1	2	2	2	2	1	2	V	2
Campanula rapunculoides	1	+	+	+	1	-	1	-	+	-	1	+	IV	1
Geum urbanum	+	+	+	+	+	-	+	+	r	-	-	+	IV	+
Ulmus minor	-	+	1	1	1	+	1	-	+	-	1	2	IV	-
Pyrus pyraster	-	r	r	r	r	-	r	-	-	-	+	+	IV	-
Convallaria majalis	2	3	-	2	2	-	2	3	-	-	-	-	III	2
Fraxinus excelsior	+	+	+	-	-	-	-	+	+	-	-	+	III	-
Euonymus europaeus	+	+	-	-	-	-	+	1	-	1	+	-	III	-
Scutellaria altissima	1	1	1	-	-	-	1	2	-	-	-	-	III	+
Quercus robur	r	-	+	-	-	-	-	-	r	-	+	+	III	-
Polygonatum hirsutum	2	-	-	-	-	-	2	-	2	1	2	-	III	1
Acer campestre	+	-		-	-	-	1	+	r	-	-	-	II	-
Scilla bifolia	1	-	-	-	-	-	1	1	-	-	-	-	II	-
Corydalis solida	2	-	-	-	-	-	2	1	-	-	3	-	II	-
Melica picta	1	-	-	-	-	-	1	1	-	-	-	-	II	-
Polygonatum multiflorum	1	-	-	-	-	-	-	1	-	+	-	-	II	-
Fritillaria montana	1	-	-	-	-	-	2	1	-	-	-	-	II	-
Dactylis glomerata	+	-	-	-	-	-	+	+	-	-	-	-	II	+
Corylus avellana	-	-		-	-	-	1	-	-	-	+	-	I	-
Pulmonaria officinalis	+	-	-	-	-	-	-	-	-	-	-	-	I	-
Chaerophyllum temulum	+	-	-	-	-	-	-	-	-	-	-	-	I	-
Iris graminea	-	1	-	-	-	-	-	-	-	-	-	-	I	-
Ulmus glabra	-	-	+	-	-	-	r	-	-	-	-	-	I	-
Carex digitata	-	-	-	-	-	-	+	1	-	-	-	-	I	-
Lapsana communis	-	-	-	-	-	-	+	-	+	-	-	-	I	-
Hypericum hirsutum	-	-	-	-	-	-	+	-	-	-	-	-	I	-
Carex brevicollis	-	-	-	-	-	-	-	1	-	-	1	-	I	-
Tulipa biebersteiniana var.	-	-	2	-	-	-	-	2	-	-	-	-	I	-
biebersteiniana														
Euphorbia amygdaloides	-	-	-	-	-	-	-	+	+	-	-	-	I	-
Viola suavis	-	-	-	-	-	-	-	1	-	-	-	-	I	-

Anemonoides ranunculoides	-	-	-	-	-	-	-	+	-	-	-	-	I	-
Acer platanoides	-	-	-	-	-	-	-	-	-	-	+	-	I	-
Cerasus avium	-	-	-	-	-	-	-	-	r	-	r	-	I	-
Geranium robertianum	+	-	-	-	-	-	-	-	-	-	1	-	I	-
Pulmonaria obscura	-	-	-	-	-	-	+	-	-	-	+	-	I	-
Gagea lutea	-	-	-	-	-	-	-	+	-	-	+	-	I	-
Rhamno-Prunetea s.l.														
Crataegus monogyna	1	1	1	1	2	1	2	1	1	1	1	2	V	2
Prunus spinosa	-	1	1	1	1	1	+	+	2	1	1	1	V	-
Cornus mas	+	2	1	+	1	1	3	2	-	1	1	+	V	1
Viburnum lantana	+	2	1	1	1	2	1	2	1	1	1	1	V	1
Rhamnus cathartica	-	+	1	1	1	+	1	1	1	1	-	+	V	-
Rosa canina	+	1	1	+	1	1	1	+	+	1	1	+	V	+
Cornus sanguinea	+	1	-	+	+	+	1	1	1	1	2	1	V	1
Berberis vulgaris	-	1	+	1	1	1	1	1	r	-	1	1	V	-
Acer tataricum	-	1	1	1	1	+	1	1	1	1	-	-	IV	-
Ligustrum vulgare	-	1	1	1	1	+	1	1	1	+	-	-	IV	-
Amygdalus nana	1	2	1	-	-	2	-	2	2	1	2	-	III	-
Caragana frutex	-	-	-	-	-	3	-	2	2	2	2	-	III	2
Cuscuta monogyna	-	-	-	-	-	-	2	1	-	2	-	-	II	-
Cotoneaster melanocarpus	r	-	-	-	r	-	-	-	r	-	-	-	II	-
Rosa pimpinellifolia	-	2	-	-	-	2	-	2	-	-	-	-	II	-
Rosa gallica	-	-	-	-	+	-	-	-	-	-	-	-	I	-
Erysimum cuspidatum	-	-	-	-	-	-	+	-	-	-	-	-	I	-
Rhamnus tinctoria	+	-	-	-	-	-	-	-	-	-	-	-	I	-
Spiraea crenata	-	-	-	-	-	-	-	-	1	-	-	-	I	-
Trifolio-Geranietea s.l.														
Vinca herbacea	1	3	2	2	2	3	2	1	2	2	3	2	V	-
Teucrium chamaedrys	2	2	2	2	2	3	2	1	2	2	2	3	V	2
Anthericum ramosum	1	2	2	1	2	3	2	-	-	1	2	2	V	2
Fragaria viridis	2	1	2	2	2	2	2	-	2	-	2	3	V	
Thalictrum minus	+	+	1	1	1	+	1	+	+	+	+	+	V	+
Asparagus officinalis	+	+	+	+	+	+	r	+	+	-	+	+	V	-
Veronica chamaedrys	+	+	+	1	1	+	+	+	+	-	-	+	V	+
Valeriana collina	+	1	1	+	1	+	1	-	+	1	-	+	V	+
Hypericum perforatum	+	+	+	+	+	+	+	-	-	-	-	+	IV	+
Carex michelii	-	2	2	2	2	3	2	-	3	2	2	-	IV	2
Clinopodium vulgare	+	+	+	+	+	+	1	-	-	-	-	+	IV	+
Agrimonia eupatoria	+	+	+	+	+	+	+	-	-	-	+	+	IV	+
Securigera varia	1	+	+	+	1	1	1	-	-	-	-	1	IV	-
Asyneuma canescens	-	+	-	+	+	+	+	+	-	+	-	r	IV	-
Hieracium virosum	-	+	+	+	+	+	+	-	-	+	+	+	IV	+
Inula ensifolia	-	2	1	-	-	-	-	-	-	1	2	2	III	2
Aster amellus	-	2	1	+	+	+	-	-	-	-	-	-	III	+
Pulsatilla montana	-	1	+	-	r	+	-	+	-	-	+	-	III	-

Leopoldia comosa	+	-	+	-	-	+	+	-	+	-	+	-	III	-
Vicia tenuifolia	-	1	2	1	1	-	2	-	-	-	-	-	III	-
Astragalus glycyphyllos	+	+	+	+	+	-	+	-	-	-	-	-	III	+
Inula hirta	-	-	-	2	2	+	2	-	-	+	-	+	III	-
Origanum vulgare	+	-	+	1	+	1	1	-	-	-	-	+	III	-
Peucedanum cervaria	-	+	+	+	+	2	-	-	-	-	-	-	III	-
Brachypodium sylvaticum	-	+	+	1	1	-	1	-	-	-	-	-	III	+
Geranium sanguineum	+	1	1	-	-	-	-	-	-	-	-	-	II	-
Phlomis tuberosus	+	-	1	-	+	-	-	-	-	-	-	-	II	-
Leopoldia tenuifolia	-	1	+	-	-	-	-	-	1	-	-	-	II	-
Campanula glomerata var.	+	-	-	+	+	-	-	-	-	+	-	-	II	-
cervicarioides														
Bupleurum falcatum	+	-	-	-	-	+	1	-	-	-	-	-	II	+
Chamaecytisus austriacus	1	+	2	-	-	-	-	-	-	-	-	-	II	-
Anchusa asurea	-	-	-	+	+	-	+	-	-	-	-	-	II	-
Anemone sylvestris	-	-	-	2	1	-	2	-	-	-	-	-	II	-
Inula oculus-christi	-	-	-	2	2	-	-	-	-	-	-	-	I	-
Vicia cracca	-	-	-	1	2	-	-	-	-	-	-	-	I	-
Rosa andegavensis	-	-	+	-	-	-	-	-	-	-	-	-	I	-
Galatella linosyris	-	1	-	-	-	-	+	-	-	-	-	-	I	-
Trifolium alpestre	-	-	-	2	2	-	-	-	-	-	-	-	I	-
Peucedanum alsaticum	-	+	+	-	-	-	-	-	-	-	-	-	I	-
Linum hirsutum	-	-	+	-	-	-	-	-	-	-	-	-	I	+
Melampyrum arvense	-	1	-	-	-	-	-	-	-	-	-	-	I	-
Festuco-Brometea s.l.														
Festuca valesiaca	1	+	+	+	+	1	+	-	1	1	1	1	V	-
Marrubium peregrinum	1	+	1	1	1	1	1	-	1	+	+	1	V	+
Salvia nemorosa	+	+	+	+	+	+	+	-	-	+	+	+	V	+
Campanula sibirica	+	+	+	+	+	+	+	-	-	+	+	r	V	-
Sanguisorba minor	-	+	+	+	+	+	+	+	+	+	-	+	V	+
Stachys recta	-	+	+	+	+	1	+	-	-	+	+	1	IV	+
Salvia verticillata	+	+	+	+	+	+	+	-	-	+	-	1	IV	
Linaria genistifolia	+	+	+	+	+	+	+	-	-	-	+	+	IV	+
Viola hirta	-	+	+	+	+	+	+	-	-	+	+	+	IV	+
Melica transsilvanica	-	+	+	+	+	1	+	-	-	+	1	1	IV	1
Medicago falcata	-	+	+	+	1	+	+	-	+	+	-	+	IV	+
Achillea collina	-	1	+	+	+	+	+	-	-	+	1	1	IV	+
Galium volchynicum	-	+	+	1	1	+	-	-	-	2	1	1	IV	+
Acinos arvensis	+	+	+	+	+	+	-	-	-	+	-	+	IV	-
Euphorbia agraria	-	+	-	+	+	+	+	+	+	-	-	+	IV	-
Potentilla argentea	-	+	+	+	+	+	+	-	-	-	+	+	IV	-
Viola odorata	-	-	1	+	1	1	1	1	2	-	1	-	IV	-
Allium flavum	-	+	+	+	+	+	-	-	-	+	+	+	IV	+
Sideritis montana	+	+	+	+	1	+	-	-	-	+	+	1	IV	+
Teucrium capitatum	-	+	+	+	+	+	+	-	-	+	+	+	IV	-

Asperula cynanchica	-	+	+	+	+	+	+	-	-	+	-	+	IV	-
Echium vulgare	+	+	+	+	+	+	+	-	-	+	-	r	IV	+
Muscari neglectum	-	1	1	1	1	-	1	-	-	-	-	-	III	-
Crocus reticulatus	-	1	1	+	+	1	-	-	-	-	1	-	III	-
Veronica prostrata	-	+	+	+	+	+	+	-	-	-	-	+	III	-
Alyssum alyssoides	-	+	+	+	+	+	-	-	-	-	-	+	III	-
Viola kitaibeliana	-	+	+	+	+	+	+	-	-	-	-	+	III	-
Verbascum phoeniceum	-	+	+	+	r	+	-	-	-	-	-	+	III	-
Phlomis pungens	-	+	+	+	+	+	-	-	-	+	-	-	III	-
Seseli tortuosum	-	+	-	+	+	+	-	-	-	-	-	+	III	-
Scabiosa ochroleuca	-	-	-	+	+	+	+	-	-	-	-	+	III	-
Potentilla recta	-	+	+	+	+	+	+	-	-	-	-	+	III	+
Erysimum canescens	-	+	+	+	+	+	-	-	-	-	-	+	III	+
Verbascum nigrum	-	+	-	+	+	+	+	-	-	+	-	+	III	-
Cota tinctoria	-	+	+	+	+	+	+	-	+	-	-	+	III	-
Xeranthemum annuum	-	+	+	+	+	+	+	-	-	-	-	-	III	-
Euphorbia stepposa	-	+	+	+	+	+	+	-	-	-	-	+	III	-
Bothriochloa ischaemus	-	+	-	+	-	+	-	-	-	+	-	+	III	+
Adonis vernalis	+	+	+	-	r	-	+	-	-	+	-	-	III	+
Ajuga laxmannii	+	+	+	-	-	-	+	-	-	+	-	-	III	-
Eryngium campestre	-	+	+	+	+	+	-	-	-	-	-	+	III	-
Centaurea orientalis	+	+	+	-	-	+	-	-	-	-	+	+	III	+
Thymus pannonicus s.l.	-	1	1	+	1	1	-	-	-	+	-	2	III	-
Euphorbia cyparisssias	-	+	-	+	+	+	+	-	-	+	-	-	III	-
Leontodon biscutellifolius	-	+	+	+	+	-	-	-	-	-	-	+	III	-
Iris pumila	-	-	-	+	+	-	+	-	-	1	-	1	III	-
Jurinea mollis	-	+	+	r	+	-	-	-	-	+	-	-	III	-
Stipa capillata	+	-	+	+	+	-	-	-	-	-	+	1	III	-
Filipendula vulgaris	-	1	1	2	2	-	-	-	-	-	-	-	II	-
Silene otites	-	-	r	+	+	-	-	-	-	-	+	-	II	-
Hyacinthella leucophaea	-	-	-	+	+	1	-	-	-	+	-	-	II	-
Elymus trichophora	-	-	-	+	2	-	-	-	-	-	2	2	II	-
Potentilla patula	-	-	-	+	+	-	+	-	-	-	-	-	II	-
Taraxacum serotinum	-	-	-	-	-	+	-	-	-	+	-	+	II	-
Silene vulgaris	-	+	-	+	+	-	+	-	-	-	-	-	II	-
Pilosella echinoides	-	-	-	+	+	-	+	-	-	-	-	+	II	-
Veronica barrelierii	-	+	-	+	+	-	-	-	-	+	-	-	II	-
Inula germanica	-	-	-	-	-	-	1	-	-	1	1	-	I	-
Stipa zalesski	-	-	-	+	1	-	-	-	-	-	-	-	I	-
Carlina vulgaris	-	-	-	-	-	-	r	-	-	+	-	-	I	-
Heriochloë australis	-	-	-	1	2	-	-	-	-	-	-	-	I	-
Poa angustifolia	-	-	-	2	-	-	-	-	-	-	-	-	I	-
Bupleurum affine	-	-	-	+	-	-	-	-	-	-	-	-	I	-

Veronica teucrium	-	+	+	-	-	-	-	-	-	-	-	-	I	-
Stipa pulcherrima	-	-	-	-	-	1	-	-	-	+	-	-	I	-
Cephalaria uralens	-	-	-	-	-	-	-	-	-	+	-	-	I	-
Linum perenne	-	-	-	+	+	-	-	-	-	-	-	-	I	-
Silene longifolia	-	-	-	-	-	-	+	-	-	-	-	-	I	-
Campanula macrostachya	-	-	-	-	-	-	-	-	-	+	-	-	I	r
Helianthemum nummularium	-	-	-	1	1	-	-	-	-	-	-	-	I	-
Centaurea scabiosa	-	-	+	-	-	+	-	-	-	-	-	-	I	-
Linum tenuifolium	-	-	-	-	-	-	-	-	-	+	-	+	I	-
Gagea pratensis									+					
Aliae														
Daucus carota	+	+	+	+	+	+	+	-	-	-	-	+	IV	+
Thlaspi amplexicaule	-	-	+	1	+	+	1	-	+	+	+	+	IV	-
Veronica arvensis	-	+	+	+	+	+	+	-	+	+	-	+	IV	-
Lamium purpureum	-	+	+	+	+	+	+	+	-	+	-	+	IV	-
Melilotus officinalis	+	-	+	+	+	+	+	-	-	-	+	+	IV	+
Allium rotundum	+	+	+	-	r	-	+	-	-	-	-	-	III	+
Veronica hederifolia	2	-	-	1	2	-	+	-	1	-	2	1	III	-
Galium mollugo	+	-	+	+	+	-	+	-	-	-	-	-	III	-
Buglossoides aervensis	-	-	1	1	1	+	+	-	-	-	-	+	III	-
Artemisia absinthium	-	-	+	+	+	-	+	-	-	-	-	+	III	-
Anchusa ochroleuca	-	-	+	+	+	-	+	-	-	-	+	-	III	-
Holosteum umbellatum	-	+	+	+	+	+	+	-	-	+	-	-	III	-
Senecio vernalis	-	+	+	+	+	+	+	-	-	-	-	+	III	-
Ajuga chamaepitys	-	+	+	+	+	+	+	-	-	-	-	+	III	-
Reseda lutea	-	+	+	-	+	+	-	-	-	-	+	r	III	+
Alliaria petiolata	1	-	-	-	-	-	1	-	+	-	1	-	II	-
Galium aparine	-	-	-	-	-	-	1	+	-	-	1	-	II	-
Papaver dubium	-	-	-	r	r	+	-	-	-	-	-	+	II	-
Armeniaca vulgaris	-	-	-	r	r	-	-	-	-	r	-	-	II	-
Urtica dioica	+	-	-	-	-	-	-	-	-	-	-	-	I	-
Echinops sphaerocephalus	-	-	-	-	-	-	+	-	-	-	-	-	I	-
Aristolochia clematitis	-	-	-	-	-	-	1	-	-	1	-	-	I	-
Ajuga reptans	-	-	-	+	-	-	+	-	-	-	-	-	I	-
Anthriscus longirostris	-	-	-	-	-	-	1	1	-	-	-	-	I	-
Geranium pusillum	-	-	-	-	+	-	+	-	-	-	-	-	I	-
Cerinthe minor	-	-	-	-	+	-	+	-	-	-	-	-	I	-
Ballota nigra	-	-	-	+	-	-	-	-	-	-	-	-	I	-
Fallopia convolvulus	-	-	-	-	-	-	+	+	-	-	-	-	I	-
Chelidonium majus	-	-	-	-	-	-	-	-	-	-	+	-	I	-

Place and date of the relevés: rel. 1, Feteşti commune, Edineț district, 18.IV.1994, 29.VII.2014; rel. *2 (typus)-3, Tîrgul-Vertiujeni commune, Florești district, 19.IX.1995, 29.IV.2009, 25.VIII.2017; rel. 4-5, Ciorescu comune, Chişinău municipality, 04.VII.2009, 03.X.2009, 11.V.2019; rel. 6, Trebujeni commune, Orhei district, 07.V.1988, 11.VI.2015; rel. 7, Lopatna village, Orhei district, 12.V.1988, 21.VI.2009, 14.V.2010, 28.V.2015; rel. 8, Zolonceni village, Criuleni district, 18.V.1988, 23.III.1989, 06.VI.2015; rel. 9, Delacău commune, Anenii Noi district, 05.VII.1988; 29.V.1994, 25.IV.2015; rel. 10, Goian village, Territorial Units of the Left Bank of the Dniester, rel. 29.III.1990, 11.V.1990, 17.VII.2003; rel. 11-12, Hruşca village, Territorial Units of the Left Bank of the Dniester, 17.VII.1987, 09.IV.1988, 07.VI.1997; rel. 13, Jaryšiv village, Kam'janec-Podolikij district, Ukraina, 19.VII.1988.

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THE SPECIES OF GENUS *ONOSMA* L. (BORAGINACEAE JUSS.) IN THE FLORA OF BESSARABIA

Olga IONIȚA
"Alexandru Ciubotaru" National Botanical Garden (Institute), Chisinau, Republic of Moldova

Abstract: The paper contains information on the study of the genus *Onosma* L. in the flora of Bessarabia. There are four species included in the list of vascular plants: *O. visianii* Clementi, *O. borysthenica* Klokov, *O. lipskyi* Klokov and *O. rigida* Ledeb. All taxa are rare for the studied territory. The dichotomic key for *Onosma* species, diagnostic characters, brief ecological, chorological and habitat characteristics for each species are given.

Key words: *Onosma* L., Boraginaceae, Bessarabia, flora, chorology, biology.

INTRODUCTION

The genus *Onosma* L. is one of the most numerous genera in the *Boraginaceae* Juss family and includes about 150 species distributed in Asia and Europe. It is particularly common in the flora of Turkey, which lists 108 taxa of this genus, and the endemism rate of indigenous species is about 50% [2]. In the *Flora Europaea*, there are 33 species mentioned. The genus is a taxonomically difficult group of plants, and experimental investigations are required to establish the taxonomic composition of the genus in a given territory [1].

The *Onosma* taxa are difficult to distinguish from each other, the main diagnostic criteria being the peculiarities of the indumentum of leaves, stems, corolla, calyx etc., based on which they have been divided into sections and subsections. The species that occur in the territory of Bessarabia are classified in the *Onosma* section, which includes predominantly steppe species, attributed to one of two subsections: subsection 1. *Haplotricha* (Boiss.) Guerke – setae on glabrous pustules, and subsection 2: *Asterotricha* (Boiss.) Guerke – setae on stellate pubescent pustules [14].

In the territory between Prut and Dniester rivers the genus *Onosma* L. has been insufficiently studied, the existing data being incomplete and contradictory. In the first synthesis work on the taxonomic composition of the flora of the Republic of Moldova [10], T. Gheideman (1954) mentioned 3 species: *Onosma tauricum* Willd., *O. calycinum* Stev. and *O. tinctorium* M.Bieb. In the second edition of the "Guide for determining higher plant species" [11], two species of *Onosma* are mentioned – *Onosma macrochaetum* Klok. et Dobrocz. (= *O. calycinum* Stev.), rarely found in the glades of oak forests and on slopes with steppe vegetation, and *O. lipskyi* Klok., found in the area of Codri (vill. Cornesti), in a steppe area. Dobroczajeva, in 1981 [14], mentioned the following species for the studied area: *Onosma macrochaetum* Klokov et Dobrocz., *O. visianii* Clementi, *O. borysthenicum* Klokov, *O. lipskyi* Klokov and *O. rigidum* Ledeb.

According to the data published by T. Gheideman in 1986, in the flora of the Republic of Moldova, rarely occur 2 species of *Onosma*: *Onosma macrochaetum* Klok. et Dobrocz. (= *O. visianii* Clementi) and *O. lipskyi* Klokov [12], both of which are included in the list of rare species published for local flora [7]. Later, in 2007, academician A. Negru, in the "Identification book of plants from the Republic of Moldova" mentioned the only species – *O. visianii* Clementi [8].

In order to desribe of the Boraginaceae family for the monography "Flora of Bessarabia", our aim was to study the taxonomical diversity as well as bioecological, phytogeographical and chorological peculiarities of the species of *Onosma* genus.

MATERIALS AND METHODS

The present study was based on the floristic field research on the genus *Onosma* L., the analysis of literature and of collections from herbaria. We studied all the specimens of *Onosma* L., collected from all the regions of Bessarabia and stored in Herbaria of the "Alexandru Ciubotaru" National Botanical Garden (Institute) and the Museum of Natural Sciences of the State University of Moldova. The correctness of the determinations was verified using the fundamental floristic literature [1, 6, 8, 12-16]. The analytical drawings were done by Vinogradscaia O. (Figure 3-6) and Teleuța S. (Figure 1). The general Map of Bessarabia was taken from "Flora Basarabiei", Vol. I [5].

RESULTS AND DISCUSSIONS

The floristic researches of the genus *Onosma*, carried out within the preparation for editing the monograph "Flora Basarabiei" in 6 volumes, allow us to make some taxonomic details. Based on the study carried out, which included field research, literature review and careful analysis of the herbal collections of *Onosma*, the taxonomic composition of the genus for the flora of Bessarabia was highlighted.

Although the territory between Dniester and Prut rivers is located at the interference of three biogeographical regions, characterized by a wide floristic diversity, the number of representatives of the genus *Onosma* comprises only 4 species: *Onosma visianii* Clementi, *O. borysthenica* Klokov, *O. lipskyi* Klokov and *O. rigida* Ledeb., which have specific morphological features (Figure 1). Based on the morphological features we have prepared the identification key of the *Onosma* species.

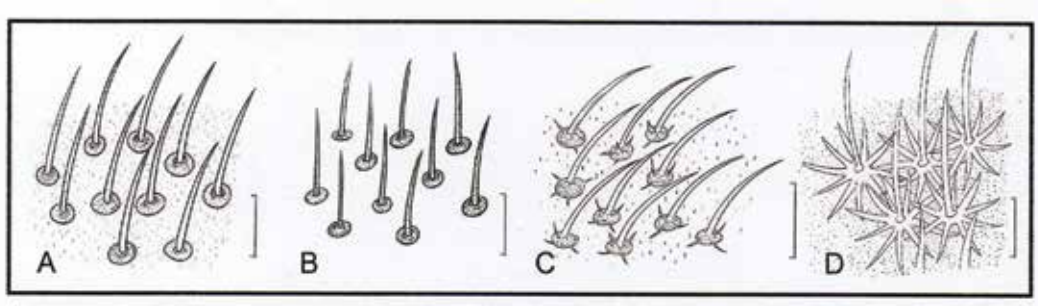

Figure 1. Position and structure of setae: A – *O. visianii* (scale bar, 3mm); B – *O. lypskii* (scale bar, 3mm); C – *O. borysthenica* (scale bar, 3mm); D – *O. rigida* (scale bar, 1mm)

Genus *ONOSMA* L. – Goldendrop

Linnaeus, 1762, Sp. Pl., ed. 2, 1: 196; id. 1764, Gen. Pl., ed. 6: 76

Biennial or perennial plants, herbaceous or subshrubs, scabrous, covered with long and stiff setaceous hairs, located on pustules (tubercles) – multicellular epidermal emergences (outgrowths), glabrous or covered with shorter hairs (setulae). Leaves petiolate or sessile,

margin entire. Flowers actinomorphic, pedicellate or sessile grouped in cymose, scorpioid inflorescences (cincinni), bracteate. Calyx 5-fid or partite. Corolla yellowish-white or otherwise coloured, infundibuliform (funnel-shaped) or tubuliform-campanulate, throat unappendaged. Stamens with anthers laterally coherent into a tube, appendiculate at the tip, equal or slightly exserted from the corolla. Style filiform, included or slightly exserted. Stigma capitates. Ovary 4-locular. Nutlets trigonous, oblique ovoid, smooth or slightly tuberculate verrucous, rostrate (beaked) at the apex, with flat hilum at the base [1,14,16].

L e c t o t y p u s: *O. echioides* L.

Identification key

1a. Setae on stellate pubescent pustules ..... 4. ***O. rigida***.
1b. Setae on glabrous or glabrescent pustules ..... **2**.
2a. Corolla glabrous or with several sparse hairs on the upper half (at the edge of teeth and on veins) …..... **3**.
2b. Corolla pubescent, with short and dense hairs on the upper half ..... 1. ***O. visianii***.
3a. The spaces between pustules glabrous. Anthers fused, conical-columnar, appendiculate ..... 3.***O. lipskyi***.
3b. The spaces between pustules with short setulae. Anthers free, connivent .... 2. ***O. borysthenica***.

S e c t i o n ***Onosma***

Calyx 5-fid or partite, slightly accrescent at fruit maturity.

T y p e: lectotype of the genus.

S u b s e c t i o n 1. ***Haplotricha*** (Boiss.) Guerke, 1895, in Engl. u. Prantl, Nat. Pflanzenfam. **4**, 3a: 127. – § *Haplotricha* Boiss. 1875, Fl. Or. 4: 179; Попов, 1953, Фл. СССР, 19: 194.

Setae on glabrous pustules, without stellate hairs.

Figure 2. *Onosma visianii*: A – general habitus; B – inflorescence. Photographed by O. Ioniță

L e c t o t y p e : *O. simplicissimum* L.

1. ***O. visianii*** Clementi, 1842, Atti Riun. Sci. Ital. Firenze, 3: 519; Попов, 1953, Фл. СССР, 19: 241; Клоков и Доброчаева, 1957, Фл. УРСР, 8: 359; Grinţescu, 1960, Fl. R. P. Române 7: 217; Ball & Riedl, 1972, Fl. Europ., 3: 91; Доброчаева, 1981, Фл. евр. части СССР, 5: 130; id. 1999, Опред. высш. раст. Укр., изд. 2: 270; Negru, 2007, Determ. pl. fl. R. Moldova: 197; Ciocârlan, 2009, Fl. ilustr. a României: 507. – *O. macrochaetum* Klokov et Dobrocz. 1957, Фл. УРСР, 8: 527, 360; Доброчаева, 1981, l. c.: 130; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 434; Доброчаева, 1999, l. c.: 270 (Figure 2, 3).

Biennial species. Petricolous. Grows on rocky slopes with soil containing gravel, with petrophilous, steppe vegetation, in glades of arid forests, steppes (Figure 8). Blooms and fruits in May-August (sometimes until September).

It is a rare species for the flora of the studied region, occurs mainly in the districts from the centre and south of Bessarabia (Figure 7). The range of the species includes Central and Southeast Europe, the Mediterranean Basin (the Balkans), Crimea, Asia Minor (Ponto-Pannonic-Balcanic geographical element).

2. O. borysthenica Klokov, 1953, Бот. Мат. (Ленинград), 15: 243; Клоков и Доброчаева, 1957, Фл. УРСР, 8: 362; Доброчаева, 1981, Фл. евр. части СССР, 5: 130; Доброчаева, 1999, Опред. высш. раст. Укр., изд. 2: 270. – *O. arenarium* auct. Fl. URSS, non Waldst. et Kit.: Попов, 1953, Фл. СССР, 19: 219; Ball & Riedl, 1972, Fl. Europ., 3: 92 (Figure 4).

Biennial species. Riparian. Grows on sandy soils, on banks of watercourses. Blooms and fruits in June-August. Rare species, identified only in the south of Bessarabia, in the district X – Chilia (Vegetation of seaside lakes), not far from lake Bugaz (Figure 7). The range of the species includes Ukraine, north coast of the Black Sea (Pontic (Endemic) geographical element).

Figure 3. *O. visianii*

Figure 4. *O. borysthenica*

Figure 5. *O. lipskyi*

Figure 6. *O. rigida*

3. O. lipskyi Klokov, 1953, Бот. Мат. (Ленинград), 15: 241; Клоков и Доброчаева, 1957, Фл. УРСР, 8: 365; Доброчаева, 1981, Фл. евр. части СССР, 5: 131; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 434; Доброчаева, 1999, Опред. высш. раст. Укр., изд. 2: 269. – *O. visianii* Clementi subsp. *lipskyi* (Klokov) Ciocârlan 2009, Fl. ilustr. a României: 626 (Figure 5).

Biennial, steppe species. Grows on slopes with steppe vegetation, steppe sectors. Blooms and fruits in June-August. Rare species, found from a single location, the district V – Codrii (vill. Corneşti, distr. Ungheni), (Figure 7). The range of the species includes Central and Southeast Europe (Podolia and Odesa region), (Pontic geographical element).

S u b s e c t i o n 2. ***Asterotricha*** (Boiss.) Guerke, 1895, in Engl. u. Prantl, Nat. Pflanzenfam. **4**, 3a: 127. – § *Asterotricha* Boiss. 1875, Fl. Or. 4: 180; Попов, 1953, Фл. СССР, 19: 227.

Setae on stellate pubescent pustules.

T y p e : type of the section.

4. O. rigida Ledeb. 1820, Beitr. Naturk. (Dorpat), 1: 67; Попов, 1953, Фл. СССР, 19: 229; Клоков и Доброчаева, 1957, Фл. УРСР, 8: 373; Ball & Riedl, 1972, Fl. Europ., 3: 93; Доброчаева, 1981, Фл. евр. части СССР, 5: 131; id. 1999, Опред. высш. раст. Укр., изд. 2: 270 (Figure 6).

Perennial species. Petricolous. Grows on slopes with calcareous, rocky soil, with steppe vegetation, in areas with clayey soil, on rocks. Blooms and fruits in May-July. Rare species in the flora of Bessarabia, found only in the district X - Chilia, in the vicinity of Vilcov town (Figure 7). The range of the species includes Southeastern Europe, the Caucasus, Asia Minor, (Pontic geographical element).

Some main morphological characteristics of the *Onosma* species are given in the Table 1.

Table 1. Distinctive morphological characteristics of the *Onosma* L. species

	Name of the species			
	O. visianii	*O. borysthenica*	*O. lipskyi*	*O. rigida*
Stem	stiff, patently setose; setae on glabrous, whitish pustules, among which there are short hairs	densely covered with soft bristle-shaped hairs, mixed with short hairs	abundantly hispid (1-4 mm long setae in combination with setulae)	patently setose (hairs on stellate-bristly pustules), lignified at the base
Leaves	lower cauline leaves – linear-lanceolate, obtuse, gradually narrowed to the base, 12-20 cm x 5-10 mm; middle cauline – sessile, 7-18 cm x 6-12 mm; upper cauline – lanceolate or ovate-lanceolate, 3-4 cm x 4-7 mm, all of them abundantly setaceous	middle and upper cauline leaves – from oblong, obtuse, to ovate-lanceolate, 2-12 cm x 4-12 mm, sessile, abundantly setose. Hairs bristle-shaped, 3-4 (6) mm long, mounted on glabrous or on very short setaceous pustules (with 1-6 setulae per pustule). The space between pustules with short, stiff setae	lower cauline leaves – narrow oblong, obtuse, gradually narrowed at the base transforming into petiole; the middle and upper cauline – narrow-lanceolate to ovate-lanceolate, obtuse, sessile, 2,5-10 cm x 4-9 mm, all abundantly whitish hispid	basal leaves – linear or spatulate-lanceolate, 3-4 cm x 3-6 mm, nearly obtuse, narrower at the base; cauline leaves 2-4 cm x 2-5 mm, hispid on both sides, nearly obtuse, whitish-green, rigid, pointing upwards
Calyx	16-18 mm in flower, 20-25 mm in fruit, deeply divided, sepals linear-lanceolate free or fused, with dense whitish hairs	15-20 mm in flower, 22-24 mm in fruit, laciniae linear, free or fused by 2 (3)	10-15 mm x 1-2 mm in flower, accrescent in fruit, deeply divided, linear-lanceolate, with dense whitish hairs, free or, sometimes, fused in pairs almost till the tip	7-10 mm in flower, ~ 14 mm in fruit, with rusty yellow setae, as a rule, dense. The calycine laciniae linear, acute, connivent
Corolla	tubuliform-campanulate, yellowish-white, 12-20 mm long, glabrous in the lower part, pubescent in the upper half; the teeth of the corolla broadly triangular, reflexed	infundibuliform, pale yellow, 18-21 mm long, dispersedly pubescent in the upper half, with 5 broadly triangular teeth, reflexed at the tip	tubuliform-infundibuliform, yellowish, 15-22 mm long; the teeth of the corolla triangular, elongated acute, glabrous or dispersedly pubescent on margins	tubuliform-campanulate, yellow, later brownish, 15-20 mm long, 1,5-2 times longer than the calyx, on the adaxial side glabrous or dispersedly pubescent
Nutlets	ovate-trigonous, 3-4 mm long, beaked, glabrous, verrucous	2,5-4 mm long, smooth, lustrous, ashy-yellow, brown spotted	2,5-3 mm long, ovate-trigonous, shortly beaked, verrucous, olive-coloured	~ 3 mm long, ovate-trigonous, pale yellow, glossy, glabrous, smooth, sometimes foveolate

Note: In "Flora of Ukraine", published in 1957, Klokov and Dobroczajeva mentioned the presence of the species *Onosma pseudotinctorium* Klokov on the territory of Bessarabia [15], collected in Hotyn raion, Caracușani village. Later, in 1981, Dobroczajeva, in Flora partis europae URSS [14], mentions the presence of *O. pseudotinctorium* Klokov in the Hotyn raion as well as in the municipality of Chișinău and Vulcănești village, Cahul district. This endemic species indicated for the Republic of Moldova hasn't been re-collected so far, therefore there is a necessity for additional study of the *Onosma* taxa in the flora of Dniester-Prut region.

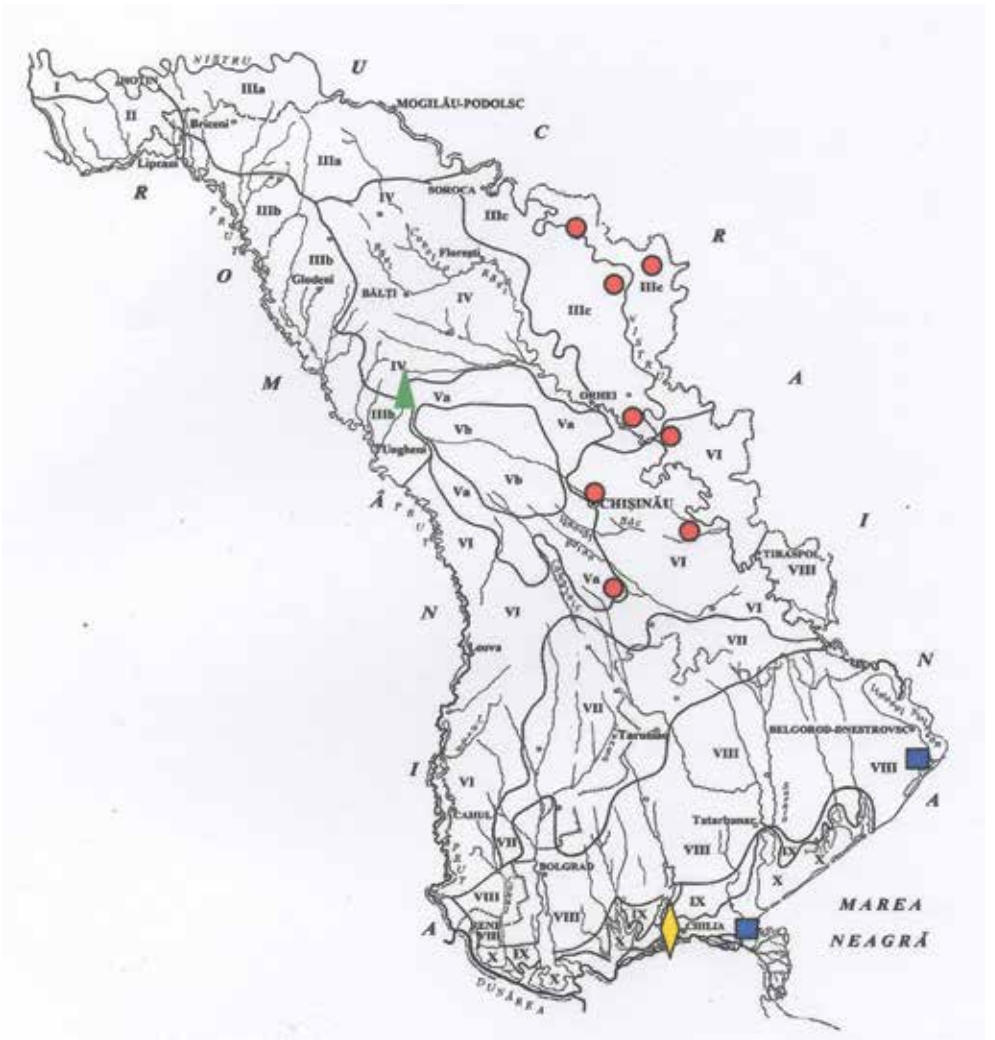

Figure 7. The distribution of *Onosma* species on the Bessarabia´s territory
● – *O. visianii*, ■ – *O. borysthenica*,
▲ – *O. lipskyi*, ◆ – *O. rigida*

Conservation status. All four species of the genus *Onosma*: *O. visianii* Clementi, *O. borysthenica* Klokov, *O. lipskyi* Klokov and *O. rigida* Ledeb. are rare for the flora of Bessarabia and are of special interest from a scientific point of view. *Onosma rigida* is at the

northern limit of its natural range, being a very rare taxon in the flora of Romania, included in the Red Book of Romania, in the category "Vulnerable" [4]. The species *O. borysthenica*, *O. lipskyi* and *O. macrochaetum* (= *O. visianii*) are included in the Official lists of regional rare plants in different regions of Ukraine [17]. *Onosma borysthenica* Klokov is an endemic species with a restricted range, which needs specific environmental conditions for survival, thus being at high risk of extinction. The degradation of specific habitats, their fragmentation, the loss of steppe areas, the limited spread and the expansion of invasive species are the main limiting factors that have contributed to the drastic reduction in the number of species of the genus *Onosma* L. in the Republic of Moldova.

According to the results of the recent research on the rare species of the Boraginaceae family, *Onosma visianii* and *Onosma lipskyi* have been categorized, according to IUCN criteria, as "Vulnerable" species and have been proposed to be included in the List of species protected by law and in the Red Book of the Republic of Moldova, 4th edition [3].

Figure 8. The habitat of *Onosma visianii* species. Photographed by O. Ioniță

As a result of the critical analysis carried out by us, we found that *Onosma lypskii* is represented, in the Herbarium of the "Al. Ciubotaru" National Botanical Garden (Institute), by a single specimen (exsiccata), collected in 1956 (number 84636). *Onosma visianii* is represented by 40 specimens, of which only 6 have been collected over the last 20 years. Territorially, this species is protected in the Republic of Moldova in the Scientific Reserve "Iagorlîc", in the Landscape Reserves "Cărbuna", "Saharna" and "Trebujeni". Recent floristic investigations have indicated a reduction in the number of sites where the species *O. visianii* grows, satisfactory populations being identified predominantly in places that are hardly accessible or protected.

We consider it necessary to protect the steppic areas where the species of *Onosma* occur, to monitor the state of the populations, to develop and apply conservation measures for the given taxa. And within the protected areas, the strict observance of their regulations must be an essential condition for *in-situ* conservation of populations of endangered species.

CONCLUSIONS

As a result of the research, the taxonomic composition of the genus *Onosma* in the flora of Bessarabia was established, which includes 4 species: *O. visianii* Clementi, *O. borysthenica* Klokov, *O. lipskyi* Klokov and *O. rigida* Ledeb. The distinctive diagnostic criteria were highlighted and the key for determining *Onosma* species was drawn up.

From the analysis of the chorological data obtained, all taxa of the genus *Onosma* highlighted for Bessarabia are rare, important from the nature conservation point of view, which requires monitoring the status of populations, breeding conditions and applying effective conservation measures to stop the decline of species populations.

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CZU 582.951.4 + 502/504(478)

SCOPOLIA CARNIOLICA JACQ. (SOLANACEAE) ÎN ARIA PROTEJATĂ „DOBRUȘA”

Victor SFECLĂ
Universitatea Agrară de Stat din Moldova, Chișinău, Republica Moldova
Grădina Botanică Națională (Institut) „Alexandru Ciubotaru”

Abstract: This paper refers to the information about distribution of rare species *Scopolia carniolica* Jacq. in the protected area “Dobrușa”. Has been identified 20 locations of the species found within the boundaries of landscape reservation “Dobrușa” for the entire period of floristic studies (2009-2019). During study period we have studied the distribution and ontogenetic phases, numeric and density features for 5 Scopolia populations. observed fluctuations of density and age structure of populations.

Key words: *Scopolia carniolica* Jacq., rare plant, Red Book of Republic of Moldova, protected area “Dobrușa”, chorology.

INTRODUCERE

Studiile privind răspândirea și condițiile ecologice ale cenozelor de plante rare sunt necesare în dezvoltarea principiilor științifice pentru protejarea acestora. Actualmente este cunoscut arealul pentru majoritatea speciilor rare din flora Europei de Est. Totodată, pentru multe dintre acestea sunt necesare studii aprofundate privind corologia, atât la nivel regional, cât și local [20]. Printre aceste specii se regăsește și mutulica (*Scopolia carniolica* Jacq., Solanaceae Juss.), specie rară în Republica Moldova, protejată prin Lege [4], inclusă în Cartea Roșie, atribuită la categoria de raritate vulnerabilă [Vulnerable (VU)] [3, 13]. La nivel european, această specie este ocrotită în mai multe state, precum: Italia, Slovenia, Croația, Serbia, Ungaria, Slovacia, Polonia, Ucraina [19, 22].

Scopolia carniolica este o specie central-european-caucaziană (Figura 1). Arealul se extinde din nord-estul Italiei (regiunile Friuli și Veneto), prin sud-estul Austriei (statul Stiria),

Figura 1. Arealul speciei *Scopolia carniolica* Jacq.: 1 – locuri de creștere actuale; 2 – locuri înregistrate în trecut din care a dispărut; 3 – limita secundară a arealului speciei [25]

Slovenia, Serbia, Croația, Cehia, Slovacia, Polonia, Ungaria, România, Republica Moldova, Ucraina, Lituania, Caucazul de Nord și până în estul Transcaucaziei. Mutulica este naturalizată și cultivată ca plantă medicinală în Germania și Danemarca [5].

În Europa de Est, crește în păduri și tufărișuri, în locuri umede și umbroase, preferințial în asociații caracteristice ordinului *Fagetalia sylvaticae* [5], întâlnită la altitudini de la 100 până la 1600 metri [18]. Pe teritoriul Republicii Moldova *Scopolia carniolica* a fost semnalată în raioanele din centru și nord [9] și se află la limita sud-est Europeană a arealului, ce traversează prin Hîncești, Strășeni, Orhei și Șoldănești [18] (Figura 2).

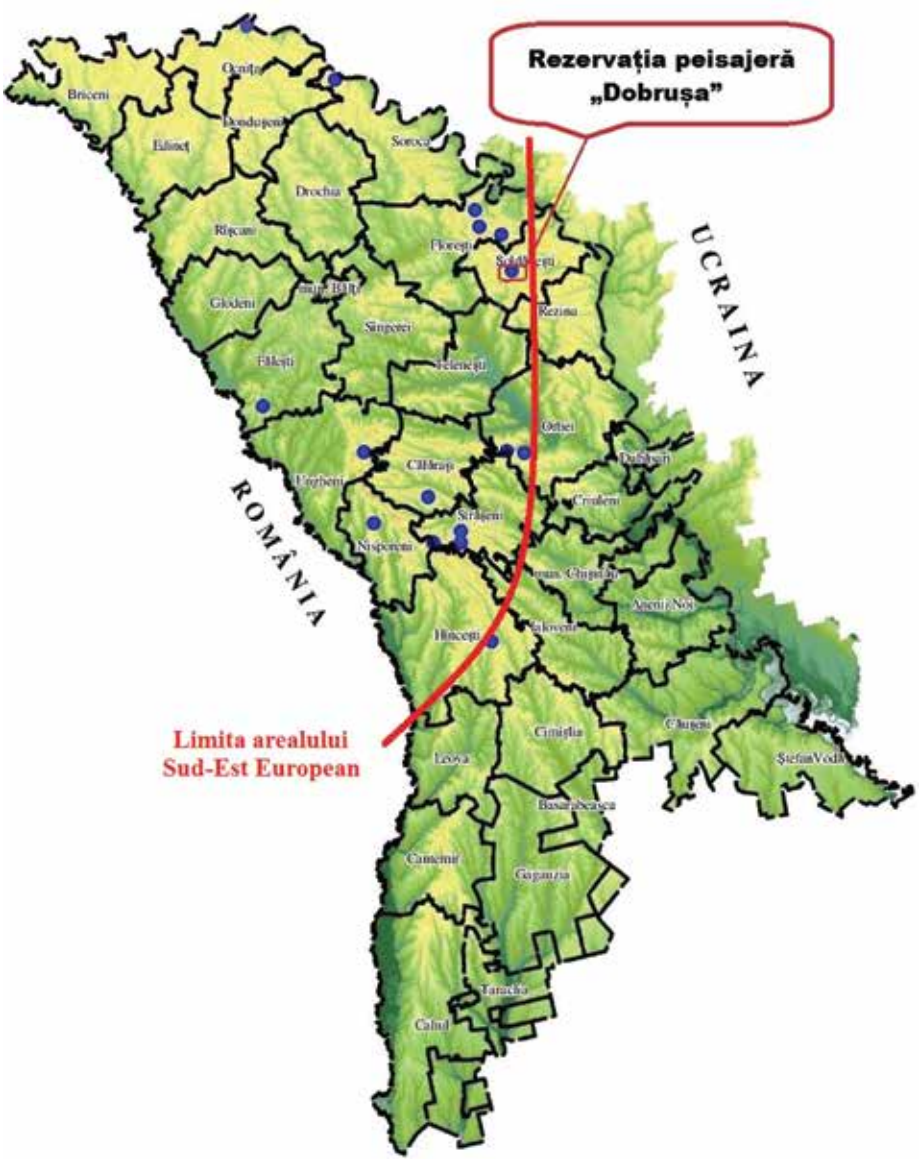

Figura 2. Răspândirea speciei *Scopolia carniolica* Jacq. pe teritoriul Republicii Moldova

Teritorial este ocrotită în Rezervațiile științifice „Codru" și „Plaiul Fagului", în Rezervația naturală de plante medicinale „Seliște-Leu", în monumentul naturii geologic și paleontologic „Stînca Naslavcea" [10, 11].

Scopolia carniolica este o plantă erbacee, perenă, cu rizom viguros, orizontal. Tulpină erectă, înaltă de 30-60(80) cm, furcat-ramificată, glabră sau dispersat-păroasă. Frunze bazale sesile, cele tulpinale eliptice, de 3-15 cm lungime, întregi, atenuate într-un pețiol lung. Flori pentamere, actinomorfe, bisexuate, solitare, axilare. Caliciu campanulat, albăstrui, cu lacinii triunghiulare. Corolă campanulată, în interior galben-verzuie, la exterior brun-roșcată. Androceu din 5 stamine mai scurte decât corola. Stil drept. Fruct – capsulă globuloasă, biloculară, polispermă. Semințe reniforme [8, 9, 10]. Vegetează prin păduri, în locuri umede și umbroase, prin tufărișuri. Formează pâlcuri cu grad de abundență până la 4, rareori crește solitar. Înflorește în lunile aprilie-mai. Polenizarea entomofilă. Fructele se coc în iunie. Se înmulțește prin rizomi, rareori prin semințe. Specie geofită, sciofilă, mezofilă, mezotermă, ce preferă solurile neutre-bazice, bogate în humus. Plantă toxică. În medicina umană sunt utilizați rizomii pentru obținerea atropinei și scopolaminei [9].

Cercetările noastre au avut drept scop evidențierea particularităților corologice și populaționale ale speciei *Scopolia carniolica* în Aria protejată „Dobrușa", amplasată în raionul Șoldănești, între satele Olișcani, Chipeșca, Dobrușa și râul Ciorna, cu o suprafață de 2634 ha gestionată de Ocolul Silvic Olișcani, Întreprinderea pentru Silvicultură Șoldănești [2, 4].

MATERIALE ȘI METODE

Prezentul studiu se bazează pe investigațiile floristice efectuate în decursul anilor 2009-2019, prin parcurgerea unor itinerarii care să acopere cât mai reprezentativ zona de studiu din cadrul Rezervației peisajere „Dobrușa", precum și pe analiza colecțiilor de Herbar din cadrul Grădinii Botanice Naționale (Institut) „Alexandru Ciubotaru" (HGBN (I) și cel al Facultății de Biologie și Pedologie, Universitatea de Stat din Moldova (HUSM). Au fost examinate publicațiile științifice care conțin informații despre ecologia, corologia și fitosociologia speciei *Scopolia carniolica*, atât în limitele țării, cât și peste hotarele ei. Pentru punctele de răspândire preluate din herbar, se notează în paranteze numele cercetătorului și data colectării, iar pentru cele din literatură se citează autorul și anul publicației.

Determinarea apartenenței taxonomice, precizarea caracterelor morfologice, bioecologice și corologice au fost realizate în concordanță cu lucrările acceptate și utilizate de cercetătorii în domeniul floristic [1, 3, 7-12, 14].

Studiul populațional s-a axat pe principalele caracteristici ale acestora (corologie, efectivul numeric, particularitățile ontogenetice, precum și ambianța eco-cenotică), fiind realizat conform metodologiei utilizate în prezent [15, 17, 23, 24, 26]. Efectivul a fost determinat prin extrapolarea densității medii a indivizilor la suprafața totală a populației. Densitatea medie a lăstarilor a fost determinată în suprafețe de probă de 1 m^2 (3-5 suprafețe de probă, în funcție de mărimea populației), iar pentru identificarea etapelor ontogenetice (juvenilă – *j*, imatură – *im*, virginală – *v* și generativă – *g*) am utilizat lucrarea autorilor Negrash & Shcherbakova [21], analizându-se caracterele morfologice ale plantei, fără deteriorarea acestora.

Pentru caracterizarea ambianței eco-cenotice în care vegetează populațiile de mutulică, au fost efectuate descrieri floristice în suprafețe de probă de 1000 m^2. Descrierea arboretelor

s-a făcut conform metodelor utilizate în cercetarea ecosistemelor forestiere, prin înregistrarea pe teren a principalelor caracteristici structurale (compoziţia, consistenţa, vârsta), dar şi a datelor din descrierea parcelară pentru Ocolul Silvic Olişcani [2, 6].

Coordonatele punctelor de creştere, altitudinea şi expoziţia au fost stabilite, utilizându-se dispozitivul GPS de model GPSMAP® 64s marca GARMIN. Harta privind răspândirea speciei *Scopolia carniolica* pe teritoriul Republicii Moldova a fost elaborată utilizând aplicaţia gratuită cu sursă deschisă QGIS (GIS – Sistem de Informaţii Geografice).

Exemplarele herborizate, colectate din Rezervaţia peisajeră „Dobruşa" sunt depozitate în Herbarul Grădinii Botanice Naţionale (Institut) „Alexandru Ciubotaru".

REZULTATE ŞI DISCUŢII

Analizând exsicatele din herbarele menţionate anterior, am constatat că în herbarul (HUSM) sunt prezente 10 exemplare din 9 puncte de creştere, după cum urmează: 2 exsicate din parcela 165, Î.S. Dobruşa, pădure de stejar cu carpen (Андреев, 04.08.1947); s. Izvoare, r-nul Făleşti (Школьникова, Андреев, 30.05.1952); s. Cornești, r-nul Ungheni (Андреев, 27.06.1948); s. Rădenii Vechi, r-nul Ungheni, pădure de carpen cu stejar (Гейдеман, Андреев, 27.06.1948; Иванков, 08.05.1949); şi în pădure de carpen în amestec cu fag (Пожарисская, Гейдеман, 05.05.1955); între satele Cornești şi Bahmut în pădure de stejar (Кононов, 02.05.1958); la 5 km direcţia nord-vest de la s. Sadova, r-nul Călăraşi, pădure de stejar cu frasin (Lupuşor, 24.06.1987).

În HGBN(I) sunt păstrate 60 de exsicate, din 20 de puncte de creştere, după cum urmează: Hînceşti (Zahariadi, 02.05.1939); Rezervaţia „Codru" pădure de stejar (Николаева, 16.06.1973; Гейдеман, 06.07.1984; Гочу, 19.07.1977); s. Stejăreni, r-nul Străşeni, pădure de stejar (Гейдеман, Николаева, 20.05.1956, Киртока, Гочу, 20.07.1977); Î.S. Nisporeni, trupul de pădure Selişte-Leu, pădure de tei-frasin-stejar (Райлян, 23.07.1981); la nord-vest de s. Bălăneşti, r-nul Nisporeni, pădure de carpen cu stejar (Гейдеман, Сапко, 09.07.1957); s. Bursuc, r-nul Nisporeni, pădure de amestec cu frasin, gorun şi tei (Николаева, Гейдеман, 05.07.1953); la est de s. Selişte, r-nul Nisporeni, pădure de carpen cu stejar (Гейдеман, Николаева, 07.07.1957); spre sud-vest de s. Poruceni, r-nul Nisporeni, pădure de frasin cu gorun şi tei (Постолаке, 20.05.1966; Истратий, 26.05.1981); la 3 km nord-vest de s. Vălcineţ, r-nul Călăraşi, pădure de amestec (Пожарисская, 10.06.1954); s. Rădenii Vechi, r-nul Ungheni, pădure de gorun cu tei, carpen, parcelele 35, 36, 39, 13; arborete de fag cu stejar (Иванков, 08.05.1949; Пожарисская 10.06.1954; 02.05.1955; Гейдеман, Сапко, 19.06.1957; Николаева, Гейдеман, 23.05.1958; Киртока, 30.06.1977; Истратий, 14.04.1982; 04.04.1985); s. Cornești, r-nul Ungheni (Андреев, 27.06.1948); la 3 km nord-vest de s. Izvoare, r-nul Făleşti în pădure de stejar cu frasin (Гейдеман, Пожарисская, Матиенко, 31.05.1952); s. Curchi, r-nul Orhei, pădure de carpen cu stejar (Гейдеман, 09.06.1966); s. Vatici, r-nul Orhei, pădure de stejar cu carpen (Гейдеман, Николаева, 29.05.1956); s. Dobruşa, r-nul Şoldăneşti, pădure de stejar cu carpen (Андреев, 04.08.1947); s. Olişcani, r-nul Şoldăneşti (Гейдеман, 13.07.1965); s. Cuhureştii de Sus, r-nul Floreşti, pădure de stejar cu carpen (Николаева, 05.06.1958); s. Temeleuţi, r-nul Floreşti, pădure de stejar (Николаева, 24.06.1976); s. Văscăuţi, r-nul Floreşti, trupul de pădure „Văscăuţi" (09.05.1987); Rezervaţia peisajeră „Rudi-Arioneşti" (Izverscaia, Ghendov, Şabanova, 23.04.2006); s. Naslavcea, r-nul Ocniţa, trupul de pădure „Stînca" (Pînzaru, 09.06.1988);

Rezervația peisajeră „Hologniță” (Изверская *et al.*, 2007) [16]; Rezervația peisajeră „Dobruşa” (Sfeclă, 22.04.2009); s. Pruteni, r-nul Fălești și s. Codreanca, r-nul Strășeni (Pînzaru, 2017) [10].

Conform informației din literatură și a datelor din herbare, s-a constatat că în limitele teritoriului Rezervației peisajere „Dobruşa”, specia *S. carniolica* a fost colectată pentru prima dată de către savantul V. Andreev (04.08.1947). Ca punct de creștere, pentru teritoriul cercetat, a fost indicată în lucrările savanților I. Krîlova (1996) și P. Pînzaru (2017) [18, 10].

Ca rezultat al cercetărilor de teren, în cadrul Ariei protejate „Dobruşa” au fost identificate 20 de puncte de creștere în subparcelele: 14N, 21E, 22G, 23E, 29B, 31H, 37I, L, K, 38E, 39M, 48E, 50C, 55H, 57G, 67I, O, 70M, 75K, 82K. Au fost localizate coordonatele și amplasate pe harta rezervației (Figura 3).

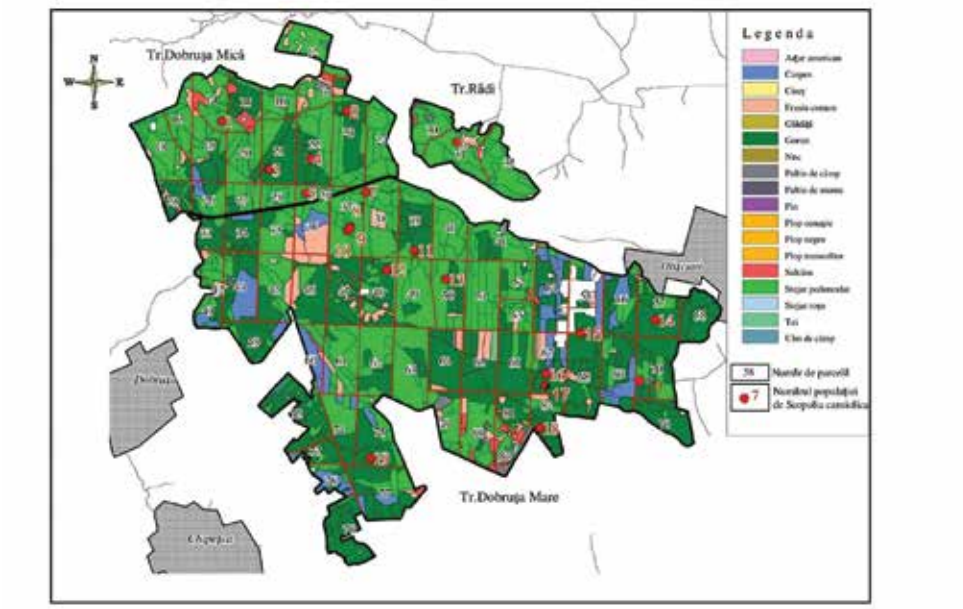

Figura 3. Răspândirea speciei *Scopolia carniolica* Jacq. în rezervația peisajeră „Dobruşa”

Pentru evidențierea stării actuale a populațiilor acestei speciei în limitele teritoriului cercetat, au fost luate în studiu cele mai reprezentative 5 populații. Amplasarea acestora pe teren este prezentată în figura 3, indicate cu numerele 5 (subparcela 22G), 7 (subparcela 38E), 9 (subparcela 37I), 11 (subparcela 39M) și 20 (subparcela 70M).

Populația cu numărul (5) din subparcela 22G vegetează pe un versant ondulat cu expoziție nord-estică, altitudine 254 m, arboret natural fundamental de productivitate mijlocie, cu consistență aproape plină (K=0,8), vârsta medie 80 de ani. Stratul arborilor este bietajat cu stejar pedunculat (*Quercus robur* L.), frasin (*Fraxinus excelsior* L.) în etajul superior și carpen (*Carpinus betulus* L.), jugastru (*Acer campestre* L.), cireș (*Prunus avium* L.), în etajul inferior. Stratul arbuștilor este reprezentat de exemplare solitare de clocotiș (*Staphylea pinnata* L.), dârmoz (*Viburnum lantana* L.), salbă râioasă (*Euonymus verrucosus* Scop.), păducel (*Crataegus monogyna* Jacq.) și soc negru (*Sambucus nigra* L.). Stratul erbaceu este

dens și acoperă solul pe aproximativ 70-80% din suprafață și este constituit din: *Aegopodium podagraria* L., *Anemone ranunculoides* L., *Arum orientale* M. Bieb., *Asarum europaeum* L., *Brachypodium sylvaticum* (Huds.) P. Beauv., *Campanula trachelium* L., *Carex brevicollis* DC., *Carex pilosa* Scop., *Convallaria majalis* L., *Corydalis cava* (L.) Schweigg. & Körte, *Corydalis solida* (L.) Clairv., *Cardamine bulbifera* (L.) Crantz, *Dactylis glomerata* L., *Euphorbia amygdaloides* L., *Ficaria verna* Huds., *Gagea lutea* (L.) Ker-Gawl., *Galium odoratum* (L.) Scop., *Geranium robertianum* L., *Geum urbanum* L., *Glechoma hirsuta* Waldst. & Kit., *Isopyrum thalictroides* L., *Lamium galeobdolon* L., *Mercurialis perennis* L., *Polygonatum hirtum* (Bosc. ex Poir.) Pursh, *Polygonatum multiflorum* (L.) All., *Pulmonaria obscura* Dumort., *Pulmonaria officinalis* L., *Scilla bifolia* L., *Scopolia carniolica* Jacq., *Stellaria holostea* L., *Viola reichenbachiana* Jord. ex Boreau. Pe lângă *S. carniolica*, în stratul erbaceu au fost identificate și alte specii rare: *Galanthus nivalis* L., *Actaea spicata* L. și *Tulipa biebersteiniana* Schult. & Schult.f.

Această populație este formată din 3 grupuri cu suprafețe ce variază în limitele 0,25-2 m^2, cu câte 7, 37 și respectiv 67 de exemplare. Densitatea lăstarilor la 1 m^2, în medie constituie 28 de exemplare. Ponderea lăstarilor imaturi este de 10,7%, virginali – 17,9% și generativi – 71,4% (Figura 4). Lăstarii generativi sunt bine dezvoltați, având câte 5-9 flori. Populația vegetează în condiții relativ stabile, iar impactul factorului antropic este minim.

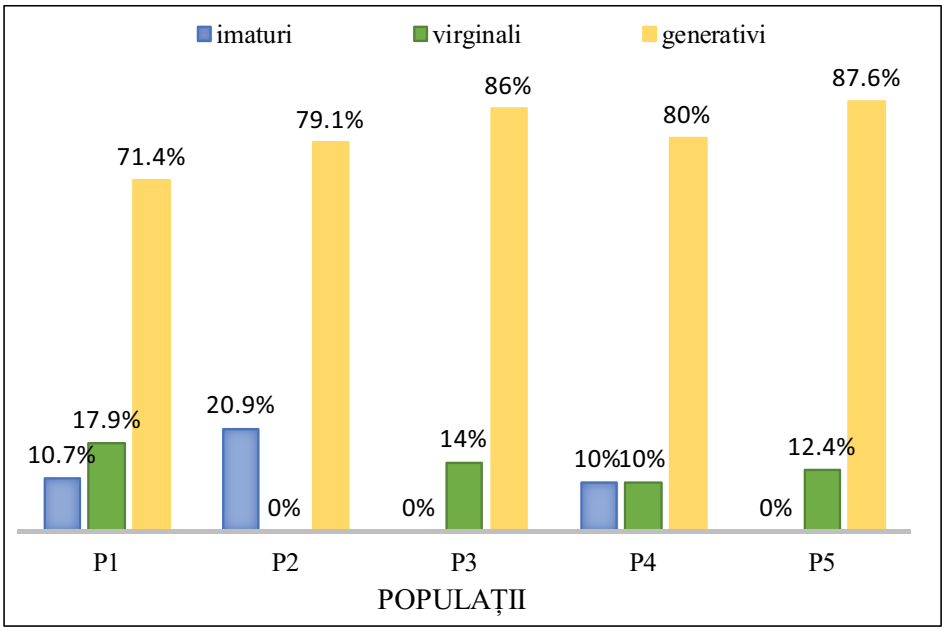

Figura 4. Spectrul ontogenetic al populațiilor de *Scopolia carniolica* Jacq. în rezervația peisajeră „Dobrușa”

A 2-a populație studiată (nr. 7) din subparcela 38E vegetează pe un versant inferior, ondulat cu expoziție nord-estică, altitudine 250 m, arboret natural fundamental subproductiv, cu consistență aproape plină (K=0,8), vârsta medie de 110 ani. Stratul arborilor este bietajat constituit din stejar pedunculat cu vârsta de 120 ani (*Quercus robur* L.), în etajul superior și în

etajul inferior cu frasin (*Fraxinus excelsior* L.), tei pucios (*Tilia cordata* Mill.), carpen (*Carpinus betulus* L.), paltin de câmp (*Acer platanoides* L.), jugastru (*Acer campestre* L.) și ulm de câmp (*Ulmus minor* Mill.). În stratul arbuștilor se întâlnesc solitar următoarele specii: corn (*Cornus mas* L.), alun (*Corylus avellana* L.), păducel (*Crataegus monogyna* Jacq.), salbă moale (*Euonymus europaeus* L.), soc negru (*Sambucus nigra* L.), clocotiș (*Staphylea pinnata* L.), dârmoz (*Viburnum lantana* L.). Stratul erbaceu acoperă solul pe aproximativ 60-70% din suprafață și include: *Aegopodium podagraria* L., *Alliaria petiolata* (M. Bieb.) Cavara & Grande., *Anemone ranunculoides* L., *Anthriscus sylvestris* (L.) Hoffm., *Arctium lappa* L., *Arum orientale* M. Bieb., *Brachypodium sylvaticum* (Huds.) P. Beauv., *Campanula trachelium* L., *Corydalis cava* (L.) Schweigg. & Körte, *Corydalis solida* (L.) Clairv., *Cardamine bulbifera* (L.) Crantz, *Dactylis glomerata* L., *Euphorbia amygdaloides* L., *Ficaria verna* Huds., *Galeopsis speciosa* Mill., *Galium odoratum* (L.) Scop., *Geranium robertianum* L., *Geum urbanum* L., *Glechoma hirsuta* Waldst. & Kit., *Lamium galeobdolon* (L.), *Mercurialis perennis* L., *Polygonatum hirtum* (Bosc. ex Poir.) Pursh, *Pulmonaria obscura* Dumort., *Scilla bifolia* L., *Scopolia carniolica* Jacq., *Stellaria holostea* L., *Urtica dioica* L., *Viola reichenbachiana* Jord. ex Boreau.

Populația este amplasată în jurul unui arbore de stejar pedunculat și se extinde pe aproximativ 40 m^2, cu o densitate medie de 24 de lăstari la 1 m^2. Lăstari imaturi nu au fost identificați, ponderea celor virginali este de 20,9% și generativi – 79,1%. Lăstarii generativi (cu 5-7 flori) sunt viguroși și bine dezvoltați. Reprezintă o populație relativ tânără, ce vegetează în condiții optime, nefiind supusă riscurilor antropice.

A 3-a populație de *S. carniolica* (nr. 9) este amplasată în subparcela 37I, vegetează într-un arboret parțial derivat cu vârsta medie 80 de ani, amplasat pe versant mijlociu ondulat cu expoziție nord-vestică, altitudinea de 260 m și consistența (K=0,9). Stratul arborilor este structurat în 2 etaje, cu frasin (*Fraxinus excelsior* L.), gorun (*Quercus petraea* (Matt.) Liebl.) și stejar pedunculat (*Quercus robur* L.) în etajul superior și carpenul (*Carpinus betulus* L.), în etajul inferior. Subarboretul este constituit din exemplare solitare de clocotiș (*Staphylea pinnata* L.), salbă râioasă (*Euonymus verrucosus* Scop.) și păducel (*Crataegus monogyna* Jacq.). Învelișul ierbos este slab reprezentat, acoperind solul în proporție de 40-50%, constituit din speciile: *Arum orientale* M. Bieb., *Carex brevicollis* DC., *Corydalis cava* (L.) Schweigg. & Körte, *Corydalis solida* (L.) Clairv., *Dactylis glomerata* L., *Galium odoratum* (L.) Scop., *Mercurialis perennis* L., *Polygonatum multiflorum* (L.) All., *Pulmonaria obscura* Dumort., *Scilla bifolia* L., *Scopolia carniolica* Jacq., *Stellaria holostea* L., *Urtica dioica* L.

Este o populație matură ce regenerează vegetativ. În urma lucrărilor de exploatare forestieră (reconstrucție ecologică selectivă), efectuate în anul 2011 în subparcela 37B, prin care s-a redus consistența arboretului de la K-0,9 până la K=0,5, ulterior în anul 2015 au fost extrași toți arborii maturi. Aceasta a dus la creșterea intensității luminii și temperaturii, factori ce au contribuit la sporirea evapotranspirației și diminuarea condițiilor de dezvoltare. Schimbarea condițiilor habitatului a dus la reducerea efectivului populației, fapt constatat în urma monitorizării acesteia în perioada 2009-2018. Respectiva populație, identificată în anul 2009, era formată din 3 grupuri a câte 21, 38 și 47 fitoindivizi. Amplasată în jurul unui arbore de frasin cu vârstă înaintată (90-100 de ani), la intersecția a 3 subparcele (37I, B și J). Densitatea medie la 1 m^2 a fost de 32 lăstari, dintre care cei imaturi constituiau 12,5%, virginali – 18,7% și generativi – 68,8%, având câte 7-9 flori. În urma cercetărilor efectuate în primăvara anului 2018, am constatat că efectivul populației a scăzut considerabil în cele 3 grupuri (constituind 12, 24 și respectiv 36 de fitoindivizi). Densitatea medie la 1 m^2 este de 22 lăstari, dintre care 14% lăstari virginali și generativi – 86%, cu 7-9 flori. Această populație prezintă semne de îmbătrânire.

Populația cu numărul 11 din subparcela 39M, vegetează pe un versant ondulat cu expo-

Figura 5. Habitatul speciei *Scopolia carniolica* Jacq. în Rezervația peisajeră „Dobrușa”, subparcela 39M

ziție sud-estică, altitudine 255 m, arboret total derivat, de productivitate mijlocie, cu consistență aproape plină (K=0,8), vârsta medie 90 de ani (Figura 5).

Stratul arborilor este bietajat. Etajul superior este constituit din gorun (*Quercus petraea* (Matt.) Liebl.), stejar (*Quercus robur* L.) și frasin (*Fraxinus excelsior* L.). Etajul inferior alcătuit din tei pucios (*Tilia cordata* Mill.), carpen (*Carpinus betulus* L.), jugastru (*Acer campestre* L.). Stratul arbuștilor este reprezentat de exemplare solitare de corn (*Cornus mas* L.), dârmoz (*Viburnum lantana* L.), salbă râioasă (*Euonymus verrucosus* Scop.) și păducel (*Crataegus monogyna* Jacq.). Stratul erbaceu acoperă 80-90% din suprafață solului și include: *Aegopodium podagraria* L., *Anemone ranunculoides* L., *Arum orientale* M. Bieb., *Asarum europaeum* L., *Campanula trachelium* L., *Carex brevicollis* DC., *Carex pilosa* Scop., *Convallaria majalis* L., *Corydalis cava* (L.) Schweigg. & Körte, *Dactylis glomerata* L., *Euphorbia amygdaloides* L., *Geum urbanum* L., *Glechoma hirsuta* Waldst. & Kit., *Lathyrus vernus* (L.) Bernh., *Polygonatum multiflorum* (L.) All., *Pulmonaria obscura* Dumort., *Scilla bifolia* L., *Scopolia carniolica* Jacq., *Stellaria holostea* L., *Viola reichenbachiana* Jord. ex Boreau.

Această populație este formată din mai multe grupuri cu suprafețe de 1-100 m^2, care se extind pe o suprafață de aproximativ 5000 m^2. Numărul de lăstari la 1 m^2 variază între 22-38 de exemplare, în medie densitatea constituie 28 exemplare la 1 m^2. Ponderea lăstarilor generativi este de 80% și a celor vegetativi de 20% (im – 10%, v – 10%). Această populație poate fi considerată una matură și viguroasă, vegetează în condiții de dezvoltare stabile, iar impactul factorului antropic este minim.

Populația cu numărul 20 din subparcela 70M vegetează pe un versant ondulat cu expoziție nord-estică, altitudine 260 m, arboret natural fundamental de productivitate mijlocie, cu vârsta medie 70 de ani, consistență aproape plină (K=0,8). Stratul arborilor este bietajat,

cu frasin (*Fraxinus excelsior* L.) în etajul superior, cu carpen (*Carpinus betulus* L.) și jugastru (*Acer campestre* L.), în etajul inferior. Stratul arbuștilor este reprezentat de corn (*Cornus mas* L.), sânger (*Cornus sanguinea* L.), salbă râioasă (*Euonymus verrucosus* Scop.), păducel (*Crataegus monogyna* Jacq.), măceș (*Rosa canina* L.) și dârmoz (*Viburnum lantana* L.). Stratul ierbos acoperă solul pe aproximativ 70-80% din suprafață și include: *Aegopodium podagraria* L., *Arum orientale* M. Bieb., *Asarum europaeum* L., *Brachypodium sylvaticum* (Huds.), *Carex brevicollis* DC., *Carex pilosa* Scop., *Convallaria majalis* L., *Corydalis cava* (L.) Schweigg. & Körte, *Corydalis solida* (L.) Clairv., *Cardamine bulbifera* (L.) Crantz, *Dactylis glomerata* L., *Euphorbia amygdaloides* L., *Ficaria verna* Huds. P. Beauv., *Galanthus nivalis* L., *Gagea lutea* (L.) Ker-Gawl., *Galium odoratum* (L.) Scop., *Geranium robertianum* L., *Geum urbanum* L., *Glechoma hirsuta* Waldst. & Kit., *Hedera helix* L., *Isopyrum thalictroides* L., *Lamium galeobdolon* (L.) L., *Mercurialis perennis* L., *Platanthera bifolia* (L.) Rich., *Polygonatum multiflorum* (L.) All., *Pulmonaria obscura* Dumort., *Scilla bifolia* L., *Scopolia carniolica* Jacq., *Stellaria holostea* L., *Viola reichenbachiana* Jord. ex Boreau.

Această populație se extinde pe o suprafață de aproximativ 500 m^2 și este formată din multiple grupuri cu suprafețe de la 0,5 până la 4 m^2, în care numărul fitoindivizilor variază de la 10 la 80. Densitatea medie a lăstarilor la 1 m^2 este de 22 exemplare. Lăstari imaturi nu au fost identificați, cei virginali constituie 12,4% și generativi – 87,6%, aceștia sunt bine dezvoltați, având câte 7-9 flori. Populația este bine structurată și vegetează în condiții de dezvoltare stabile, nefiind amenințată de factorul antropic.

CONCLUZII

În baza datelor din literatură, a materialelor din Herbare, dar și a propriilor studii efectuate, am constatat că *Scopolia carniolica* Jacq., în Rezervația peisajeră „Dobrușa" (Republica Moldova) crește la limita sud-estică a arealului natural.

În rezultatul cercetărilor de teren, au fost pentru prima dată stabilite punctele de creștere cu GPS-ul și elaborată rețeaua de răspândire a celor 20 de populații identificate în cadrul rezervației, ce ne permite monitorizarea stării populațiilor în evoluție.

Populațiile de *S. carniolica* sunt bine reprezentate atât prin numărul total de exemplare, cât și prin numărul lăstarilor generativi.

Arboretele ce adăpostesc aceste populații sunt cantonate pe soluri de tip cenușiu-deschis și oferă, prin formele de microrelief și prin ambianța eco-cenotică, condiții optime pentru dezvoltarea speciei.

Ca factor limitativ putem menționa distrugerea habitatului natural, prin aplicarea lucrărilor de exploatare forestieră ce duce la diminuarea efectivului populațiilor.

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III. INTRODUCTION OF PLANTS AND SUSTAINABLE USE OF PLANT RESOURCES

CZU 630*27

BAZELE TEORETICE ALE INTRODUCȚIEI PLANTELOR LEMNOASE

Alexei PALANCEAN, Ion ROŞCA
Grădina Botanică Naţională (Institut) „Alexandru Ciubotaru”,
Chișinău, Republica Moldova

Abstract: The theoretical basis for the introduction of plants includes acclimatization, which is the expression of adaptive, dynamic and complex changes and which can be highlighted at the population's genetic level. The introduction of plants is a field of scientific research that develops theoretical bases and methods of breeding, mobilization and cultivation of exotic plants under new pedoclimatic conditions, studies their response to changes in environmental factors and gives an analytical appreciation of the results of introduction. Introduction is a continuous, unique, integral process that takes place under the conditions of cultivation under the direct influence and active involvement of man. The process of introduction consists of three key steps: mobilization, adaptation and use. Acclimatization and naturalization are not human activities or methods of influence, but they are complex processes of adaptation that take place in the body of plants under the influence of environmental factors under man-made artificial conditions. Acclimatization and naturalization are states of the plant population at a given moment, under the new pedoclimatic conditions.

Key words: woody plants, introduction, acclimatization, adaptation, naturalization, mobilization, population, range.

În secolul al XX-lea introducţia a diversificat şi îmbogăţit esenţial asortimentul plantelor folosite de om în viaţa cotidiană. Componenţa taxonomică a dendroflorei, în diferite ţări sau regiuni, s-a lărgit esenţial datorită introducerii şi aclimatizării speciilor noi de arbori, arbuşti şi liane [2]. Mai mult de jumătate din componenţa florei ţărilor membre ale C.S.I. constă din plante introduse [10-12], iar în Republica Moldova ponderea speciilor exotice în dendroflora cultivată este de circa 90 % [1, 4].

În pofida faptului că introducţia a înregistrat rezultate considerabile, dezvoltarea teoriei introducţiei plantelor se află abia în desfăşurare.

1. Evoluţia teoriei introducţiei şi aclimatizării plantelor

În decursul istoriei sale omenirea a fost preocupată de procesul de introducţie şi aclimatizare, proces legat de selecţia ulterioară a speciilor şi formelor reieşind din caracteristica proprietăţilor noilor plante. Acest proces decurge cu diferite intensificări şi este determinat de nivelul dezvoltării societăţii în general, a agriculturii şi a noilor condiţii climatice.

Teoriile actuale privind procesul de aclimatizare sunt, în mare parte, unilaterale şi chiar controverse. Acest fapt pune problema aclimatizării mereu în discuţie, prezentând un mare interes în plan evolutiv, discutat încă de clasicii teoriei evoluţioniste care cunoşteau două căi prin care se realizează aclimatizarea: obţinerea varietăţilor cu o nouă organizare genetică; deprinderea la condiţiile noi fără schimbări radicale ale organizării plantelor.

Scopul principal al introducţiei contemporane, care presupune cultivarea plantelor eco-

nomic preţioase în afara arealelor naturale, ar fi îmbogăţirea resurselor naturale ale ţării din contul resurselor floristice mondiale. Perspectivele activităţii de introducţie sunt determinate de existenţa în flora mondială a unui foarte bogat genofond de plante preţioase şi a posibilităţilor de schimb între regiuni al speciilor, formelor, soiurilor noi de plante cultivate.

Dacă definim termenul de introducţie ca adaptare a plantelor în condiţii noi pedoclimatice, ca proces final, este necesar să precizăm obiectul introducţiei, deoarece planta este o entitate completă şi atunci întrebarea este, ce introducem – un exemplar, un grup, o populaţie ori o specie? Etapa iniţială a procesului de introducţie a reprezentanţilor din flora spontană îşi ia începutul de la cultivarea unui individ sau a unui grup de indivizi în afara arealului speciei.

În cazul unui individ, unui exemplar este clar că în procesul de ontogeneză în condiţiile noi pedoclimatice se declanşează mecanismul de adaptare, de transformare a proceselor fiziologice şi biochimice, se modifică ritmurile fazelor fenologice ale etapelor de creştere şi dezvoltare. Deci, în procesul vieţii individul se adaptează în limitele normei de reacţie. Dar, posibilitatea şi gradul adaptării depind atât de natura speciei şi de originea ei, cât şi de specificul noilor condiţii pedoclimatice.

În cazul introducţiei unui grup de plante ale aceleiaşi specii, cea mai răspândită variantă a procesului de introducţie, adaptarea, poate fi oglindită din două părţi: ca suma adaptabilităţii fiecărui individ în ontogeneză; ori ca adaptabilitatea grupului în întregime, în cazul existenţei panmixiei în şirul generaţiilor. În primul caz, au loc schimbări fenotipice ale plantelor în parte. În al doilea caz, schimbările se efectuează la nivel de populaţie, iar în procesul de adaptare a grupului la condiţiile noi pedoclimatice participă genotipurile tuturor membrilor grupului care au atins maturitatea sexuală. De aici, adaptarea, în cazul introducţiei unui grup de plante, se petrece în decursul mai multor generaţii prin acţiunea selecţiei naturale şi/sau artificiale. Durata acestui proces este destul de lungă, poate depăşi viaţa a două – trei generaţii şi depinde de specie, numărul de indivizi în grup, originea lor, deosebirile dintre climatul de origine al speciei şi climatul nou de introducţie şi, nu mai puţin, de intensitatea selecţiei artificiale, dirijate, deoarece în cazul introducţiei unui grup mic de plante din populaţia naturală, în condiţii noi de mediu se măreşte diferenţierea intraspecifică, se măreşte rolul selecţiei naturale şi eliminarea exemplarelor slab rezistente. În acelaşi timp, creşte semnificativ rolul selecţiei artificiale, care este îndreptată spre obţinerea descendenţilor mai rezistenţi, cu calităţi şi caractere mai evidente pentru care au fost luate plantele în procesul de introducţie. Structura şi componenţa genetică a noilor populaţii introduse a ecosistemelor artificiale în mare măsură va fi dependentă de totalitatea fenotipurilor care au trecut selecţia dirijată.

Reacţiile de adaptare, în dinamică, în şirul generaţiilor obţinute pe cale generativă (schimbările externe şi interne) a plantelor introduse se racordează cu procesul de aclimatizare [19]. Astfel, bazele teoretice ale introducţiei plantelor cuprind şi pe cele ale aclimatizării, acestea fiind expresia schimbărilor adaptive, dinamice şi complexe, care pot fi evidenţiate la nivelul genetico – populaţional [21], totodată constatând că teoriile introducţiei şi aclimatizării plantelor expuse în lucrările mai multor autori sunt contradictorii şi în sensul determinării ştiinţifice a procesului de introducţie şi aclimatizare [6, 9, 17, 20, 22]. Aceste divergenţe de opinii pot fi explicate prin faptul că lipseşte o interpretare unică a terminologiei şi conţinutului termenilor introducţie şi aclimatizare, adaptare şi naturalizare cuprinzând sub termenul de introducţie toate cazurile de cultivare a indivizilor oricărei specii (forme, varietate) pentru prima dată într-un anumit teren.

Deseori introducţia se consideră drept cultivarea plantelor în afara arealului natural, ori apreciată şi ca un complex de metode de aclimatizare care pot ajuta decurgerea procesului de aclimatizare, grăbind acest proces sau forţând plantele să parcurgă procesul în cauză [14, 20]. În acelaşi timp, se subliniază că aclimatizarea plantelor este problema-cheie în procesul de introducţie [5, 6, 15, 16, 19, 22], rămânând problema cea mai complicată şi discutabilă de a lămuri esenţa şi mecanismul procesului de adaptare, având de la bun început divergenţe în felul de înţelegere şi tratare a termenilor – aclimatizare, naturalizare, adaptare care constă în a considera aceste procese de acomodare ca având loc sub acţiunea activă a omului ori acestea sunt procese de adaptare naturală însăşi a plantelor în condiţii noi [3, 6, 15]. În majoritatea cazurilor, după o analiză a condiţiilor naturale de creştere, putem concluziona că majoritatea plantelor introduse au o plasticitate ecologică cu mult mai mare, decât se crede, care poate fi determinată de prezenţa în genotip a informaţiei care se realizează în condiţii extremale.

2. Etapele procesului de introducţie

Generalizând procesul de introducţie, acesta apare în următoarea schemă: selectarea plantelor pentru introducţie – analiza ecologică prealabilă – caracteristica biologică a plantelor selectate – prognoza introducţională – introducţia experimentală – creşterea şi dezvoltarea – prognoza fitochimică – cultivarea. Se evidenţiază trei componente principale: prognoza ştiinţifică, experimentarea (modelarea) şi aprecierea rezultatelor. Deci, acest lung şi anevoios proces de introducţie poate fi oglindit în trei etape consecutive: mobilizarea plantelor, adaptarea şi valorificarea.

Mobilizarea plantelor în procesul de introducţie constă în identificarea speciilor de perspectivă în acest proces. Experienţa acumulată a arătat că strămutarea plantelor dintr-o regiune în alta se realizează după legitatea „planta – condiţiile de mediu". Evidenţierea acestor legităţii şi în baza lor efectuarea mobilizării speciilor de perspectivă constituie scopul principal al primei etape a procesului de introducţie. Acest deziderat poate fi realizat pe două căi.

Prima cale prevede prognoza ştiinţifică în baza analizei rezultatelor multianuale ale introducţiei, determinarea regiunilor floristice de perspectivă, evidenţierea tipurilor ecologice ale speciilor introduse şi în baza acestora se determină materialul iniţial pentru introducţie. Aceasta prevede mobilizarea plantelor nemijlocit din flora donatoare cu precădere din mai multe locuri ale arealului, ceea ce ar mări diversitatea specifică şi populaţională a materialului iniţial pentru introducţie.

Cei mai importanţi factori ai mediului ambiant, care acţionează asupra plantelor, provoacă şi stimulează adaptarea genetică, sunt factori climatici. Din această cauză, din toate metodele de mobilizare a plantelor, în procesul de introducţie – ecogeografică, ecoistorică, edificatorilor, dominanţilor, complexe fitocenotice şi altele până acum n-a pierdut importanţa metoda analogilor climatici. Evaluarea ştiinţifică a grupei iniţiale pentru introducţie, în mare măsură, determină reuşita procesului de introducţie. Folosirea în procesul de introducţie a plantelor din populaţiile care dispun de o diversitate de forme şi ecotipuri măreşte garanţia reuşitei procesului de introducţie şi obţinerea generaţiilor mai rezistente.

A doua cale de mobilizare a materialului iniţial este cea a arealelelor secundare – grădini botanice, parcuri şi colecţii dendrologice, pepiniere ornamentale etc. din care putem atrage în procesul de introducţie plantele deja mobilizate de centrele respective, unde sunt

reprezentate printr-un număr mic de biotipuri care sunt fragmente artificial izolate [7]. Din această cauză speciile introduse din arealele secundare parcurg acest proces mai anevoios.

Etapa a doua a procesului de introducţie începe de la cultivarea în condiţii noi pedoclimatice a unui grup de exemplare a speciei selectate la etapa de mobilizare şi formare a grupei introducţionale în afara arealului natural în condiţiile izolării geografice impuse de om. În majoritatea cazurilor, de la asemenea nucleu este început procesul de adaptare – aclimatizare şi crearea populaţiei introducţionale unde se petrec transformări adaptive. Aceasta este etapa ecologo – fitotehnică, unde rolul principal îl au metodele şi tehnologiile eco-agrotehnice, pe când prima etapă poate fi numită etapă ecologică, deoarece la baza acestei etape sunt puse metodele şi metodologia autoecologică şi sinecologică. Finalitatea acestei etape foarte importante constituie naturalizarea speciei şi formarea unei noi populaţii naturale.

Grupa de plante, care este transferată în afară arealului natural, în condiţii noi de mediu, se deosebeşte radical de populaţiile naturale prin componenţa şi structura genetică. În primul rând, în procesul de introducţie este luată o grupă mică de plante care în populaţia naturală prezintă un număr limitat de genotipuri. În cazul când grupa introductivă prezintă un număr mare de genotipuri prin numărul respectiv de indivizi, iar condiţiile staţionare stimulează creşterea şi reproducerea sexuată cu asigurarea încrucişării libere (panmixie), genofondul populaţiei introductive se restabileşte în şirul generaţiilor. Hibridarea liberă asigură heterogenitatea populaţiei introductive, iar recombinarea permanentă a genelor asigură variabilitatea genetică. Putem afirma că adaptarea în natură este rezultatul intercalării recombinaţiei genelor şi a selecţiei naturale, care în procesul de introducţie este îndreptată spre păstrarea exemplarelor mai rezistente (mai adaptive) la noile condiţii. Acest procent, în general, se asigură şi de selecţia artificială. Reproducerea generativă asigură schimbul de generaţii, iar acţiunile comune ale selecţiei naturale şi selecţiei artificiale aduc la formarea populaţiei introducţionale.

Procesul de adaptare a populaţiei introducţionale la condiţiile noi de mediu durează o perioadă lungă şi depinde de schimbările în ontogeneza care influenţează mai multe caractere ereditare în şirul generaţiilor incontestabil modifică structura genetică la nivel de populaţie, o importanţă majoră având numărul de generaţii al populaţiei introducţionale şi numărul de exemplare în fiecare generaţie.

În procesul de introducţie, la rând cu influenţa condiţiilor climatice asupra populaţiei introducţionale, o are izolarea geografică, care în natură pune în mişcare factorii care facilitează crearea unei noi populaţii neasemănătoare celei iniţiale. Volumul cantitativ şi calitativ al diferenţelor dintre populaţia iniţială – grupa introducţională şi cea nouă – populaţia introducţională este determinată de genofondul exemplarelor izolate şi de diferenţa condiţiilor pedoclimatice care influenţează radical intensitatea procesului micromutagenez şi a presingului selecţiei naturale.

Aclimatizarea populaţională şi apogeul ei, naturalizarea, se realizează datorită transformării adaptive a genofondului, când din materialul eterogen, în condiţii de izolare, se segregheză şi se multiplică unele genotipuri noi, pre – adoptive şi se formează populaţia introducţională, cu un genofond sărăcit. Numai în generaţiile următoare aceste populaţii devin din nou înalt eterogene, din contul rezervei de variabilitate, intensificării mutagenezei, hibridizării, selecţiei naturale şi artificiale [4, 8, 13, 18].

Această etapă au parcurs-o sau o parcurg majoritatea speciilor introduse încă din secolul trecut, care azi sunt prezente în asortimentele recomandate.

În etapa a treia, care poate fi numită „fitotehnica", deoarece sunt folosite în exclusivitate metode şi tehnologii agrotehnice, se efectuează procesul de evaluare a rezultatelor introducţiei, se apreciază faza de adaptabilitate a plantelor la noile condiţii de mediu şi se constată schimbările calitative şi proprietăţile economice preţioase pentru care au fost introduse plantele.

CONCLUZII

1. Bazele teoretice ale introducţiei plantelor le cuprind şi pe cele ale aclimatizării, acestea fiind expresia schimbărilor adaptive, dinamice şi complexe, şi care pot fi evidenţiate la nivel genetico-populaţional. În acelaşi timp, constatăm că în pofida faptului că introducţia a înregistrat rezultate practice impunătoare, teoriile introducţiei şi aclimatizării plantelor sunt contradictorii în sensul determinării ştiinţifice a acestor procese.
2. Introducţia plantelor este o direcţie ştiinţifică care elaborează bazele teoretice şi metodele de selectare, mobilizare şi însuşire a plantelor exotice în condiţii noi pedoclimatice, studiază reacţia acestora la schimbările factorilor de mediu şi dă o apreciere analitică rezultatelor introducţiei. Introducţia apare ca un proces continuu, unic, integru, care se realizează în condiţii de cultură sub influenţa şi implicarea nemijlocită şi activă a omului.
3. Procesul de introducţie şi aclimatizare poate fi de scurtă şi lungă durată şi depinde de specie, numărul de indivizi atraşi în procesul de introducţie care formează grupa introducţională; originea lor, deosebirile dintre climatul de origine al speciei şi climatul nou de introducţie şi nu mai puţin de intensitatea selecţiei artificiale.
4. În procesul de introducţie pot fi evidenţiate mai multe etape: mobilizarea plantelor pentru procesul de introducţie şi formarea grupei introducţionale; formarea populaţiei introducţionale – aclimatizarea, naturalizarea; evaluarea procesului de introducţie, aprecierea analitică şi perspectivele folosirii plantelor introduse etc., care pot fi reduse la trei etape principale - mobilizarea, adaptarea şi valorificarea.
5. Aclimatizarea, naturalizarea nu este activitatea omului sau metoda de influenţă, dar este procesul complex de adaptare care se petrece în organismul plantelor sub acţiunea factorilor de mediu în condiţiile artificiale create de om. Aclimatizarea, naturalizarea sunt stări ale populaţiei de plante la momentul dat în noile condiţii pedoclimatice.
6. Cultivarea plantelor autohtone şi a celor tropicale şi subtropicale în spaţiu protejat nu se înscrie în definiţia procesului de introducţie. În primul caz putem vorbi numai despre tehnologiile efective de cultivare. În al doilea caz, deoarece în procesul de cultivare în spaţiu protejat se modelează condiţiile de întreţinere apropiate condiţiilor din areal şi nu se obţin varietăţi cu o nouă organizare genetică, putem vorbi de „domesticire", „culturalizare" etc. a plantelor exotice.

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PARTICULARITĂŢILE CREŞTERII, DEZVOLTĂRII ŞI CULTIVĂRII PLANTELOR DE *SAMBUCUS NIGRA* L. ÎN REPUBLICA MOLDOVA

Ion ROŞCA, Alexei PALANCEAN, Elisaveta ONICA
Grădina Botanică Naţională (Institut) „Alexandru Ciubotaru”,
Chisinau, Republic of Moldova

Abstract: The characteristics of the growth, development of *Sambucus nigra* L. and the prospects for its cultivation in the Republic of Moldova are given below. The optimal and the most effective method of propagation of this species was the generative one. The seeds, freshly extracted from fruits and sown, in autumn, in loose soil at a depth of 1.5-2.0 cm, germinated evenly in spring. Their germination rate constituted 90 %, but the rooting percentage of semi lignified cuttings treated with rhizogenesis stimulators constituted 55-65 %, depending on the compliance with the appropriate technology throughout the growing season. At one hectare of land, 400-600 seedlings were planted at a distance of 4-5 m between rows and 3-3.5 m between plants, depending on the machine used to loosen the soil.

Key words: *Sambucus nigra* L., multiplication, cultivation.

INTRODUCERE

Interesul pentru cultura arbuştilor fructiferi netradiţionali în republica noastră sporeşte an de an, astfel că în prezent tot mai mulţi horticultori îşi dedică activitatea cultivării diverselor bacifere. Agricultorii au conştiintizat că înfiinţarea plantaţiilor de arbuşti fructiferi pe suprafeţe mici pot aduce venituri net superioare comparativ cu cele obţinute din valorificarea pe suprafeţe mari a culturilor agricole tradiţionale.

Socul negru – *Sambucus nigra* L. este un arbust răspândit de la câmpie până la zona montană pe la marginea pădurilor, drumurilor, lizierelor şi gospodăriilor părăsite şi este cunoscut de toată lumea.[3] Mai puţin se cunoaşte importanţa şi proprietăţile benefice ale socului negru, care este util pentru sănătate, acţionând asupra unui spectru larg de boli şi afecţiuni.

Proprietăţile terapeutice ale acestei plante sunt cunoscute încă din antichitate. În Grecia antică, Hippocrates îi atribuia proprietăţi diuretice, în Evul Mediu, la vechii germani, era considerată o plantă sfântă şi folosită cu scopuri medicinale.

Florile conţin rutozid, ulei volatil, glucide, mucilagii, sambunigrozidă, vitamina C, sambucina, taninuri, saponine, acizi organici, flavonozide. Fructele conţin tirozină, pentozani, rutozide, izo-cvercitină, antociani, aminoacizi,acizi organici, taninuri, glucide, vitamina C şi cele din complexul B. Frunzele conţin sambunigrină, aldehide glicolice, oxalaţi, vitamina C [2, 5, 11, 14, 15].

Părţile comestibile ale socului negru sunt florile şi fructele, bine coapte. Frunzele pot fi folosite în agricultura ecologică, în preparate cu efect repelent. Decoctul concentrat de frunze şi muguri se utilizează la distrugerea dăunătorilor plantelor de grădină.

Această specie este folosită ca plantă medicinală, fructiferă, ornamentală şi de mare importanţă cinegetică. În scop medicinal şi fructifer, se recoltează florile şi fructele – negre, dulci-acrişoare, cu aromă de afine. Fructele necoapte au un anumit grad de toxicitate, intoxicaţiile manifestându-se prin vomă şi diaree. Toate părţile componente ale plantei, cu excepţia florilor şi fructelor coapte, sunt otrăvitoare, deoarece conţin glicozidă cianogenică,

sambunigrină. Scoarţa conţine cristale de oxalat de calciu [5, 11]. Florile, fructele şi frunzele de soc negru sunt utilizate în medicină pentru efectul lor purgativ, diaforetic, diuretic, expectorant, hemostatic, depurativ şi emolient atunci, când sunt aplicate extern.

Florile se administrează intern sub formă de ceai, infuzie în tratamentul gripei, bronşitelor acute, febrelor eruptive. Infuzia din flori este un excelent tonic de primăvară şi purificator al sângelui. Infuzia din flori se recomandă extern în tratarea inflamaţiei ochilor. Fructele au acţiune depurativă şi uşor laxativă, fiind benefice în caz de colici, afecţiuni biliare şi diaree [5-9, 11]. Preparatele din flori de soc au acţiune sudorifică, diuretică, emolientă, antireumatică, antinevralgică şi stimulează rezistenţa organismului [11, 12, 14, 15].

Din flori se poate prepara o băutură răcoritoare care este foarte cunoscută şi apreciată în România – socata. Inflorescenţele de soc se amestecă cu apă, miere şi lămâie, se lasă la fermentat, obţinându-se socata. Reţetele de socată cu drojdie şi zahăr nu sunt sănătoase. Florile mai pot fi conservate în miere, macerate sau uscate pentru ceai. Fructele folosite ca laxativ nu trebuie administrate în cantităţi mari, deoarece pot să apară efecte adverse: greaţă, vomă, arsuri la stomac, îngreunarea respiraţiei, convulsii. Fructele şi sucul obţinut din fructe au o acţiune laxativă şi antinevralgică [1, 5, 11].

Farmacia naturistă afirmă că extractul de fructe este un concurent redutabil al medicamentelor antivirale. Preparatele din fructe ajută la vindecarea bolilor degenerative, au un rol dovedit în prevenirea bolilor canceroase şi combaterea tumorilor benigne şi, conform unor cercetări recente, prelungesc tinereţea biologică.

Pentru curele de slăbire şi combaterea obezităţii, constipaţiei administrarea tincturii din flori se asociază cu un regim alimentar care exclude carnea, produsele prăjite, zahărul şi margarina. Fructele se pot păstra proaspete în frigider, dar nu mai mult de 36-48 ore de la recoltare, după care se trece la prepararea sucului, siropului, pulberii sau tincturii.

Socul negru aparţine genului *Sambucus* L. din familia Sambucaceae Batsch ex Borkh., care cuprinde circa 40 de specii răspândite în zona temperată şi subtropicală a Terrei, în afară de Africa Centrală şi de Sud. Socul negru este specie indigenă cu areal natural în Europa, fără părţile nordice Caucaz şi Crimeea, Africa de Nord, Siberia Vestică. Preferă staţiunile cu sol fertil şi suficientă umiditate în sol şi în atmosferă, solurile umede, bogate şi zonele însorite ori puţin umbrite.

Scopul acestei lucrări a fost cercetarea particularităţilor de multiplicare, creştere a materialului săditor calitativ, pentru înfiinţarea plantaţiilor productive de *Sambucus nigra* L.

MATERIALE ŞI METODE

Cercetările s-au efectuat în aa. 2017 -2019 în pepiniera laboratorului de Dendrologie. În calitate de material de studiu au servit plantele mature, care cresc şi se dezvoltă în colecţiile Grădinii Botanice, de la care s-au prelevat seminţele şi butaşii. Seminţele recoltate au fost separate în 2 părţi. O parte de seminţe au fost semănate toamna direct în lăzi în amestec de sol, nisip, resturi vegetale fermentate, câte 200 de seminţe în fiecare variantă. A doua parte de seminţe a fost pusă la stratificare şi semănate primăvara conform metodicii [4]. Butaşii s-au prelevat în iunie-iulie şi au fost trataţi cu stimulatori de rizogeneză (soluţii de 0,01 % de IBA, IAA şi $KMnO_4$) conform metodicii [13]. Butaşii trataţi cu apă distilată au servit ca martor. Observaţiile fenologice au fost efectuate conform metodei elaborate de Grădina Botanică din Moscova [10] şi perfectată de A. Palancean [3].

REZULTATE ȘI DISCUȚII

În mod natural, socul negru este un arbust puternic până la 5-6 m înălțime, dar cultivat poate fi condus ca arbore până la 10 m înălțime cu trunchi înalt, cu diametrul tulpinii de 30-40 cm. Are o înrădăcinare profundă cu multe ramificaţii, care pe soluri uscate sunt mai mari. Tulpina în majoritatea cazurilor este încovoiată, adesea de la bază formează numeroase ramuri lungi şi drepte. Acearsă particularitate este pusă la baza formării plantelor roditoare în plantaţii. Tulpina are o scoarţă cenuşie în tinereţe, apoi se transformă într-un ritidom suberos.

Coroana tufoasă, rară, rotunjită. Lujerii groşi, puţin muchiaţi, verzi-cenuşii sau verzi-gălbui, cu nişte nigei mici (lenticele) proeminente pe suprafaţa lor, în interior cu o măduvă mare, spongioasă, albă-gălbuie, cauza fragilităţii lor. Prin culoarea măduvei se deosebeşte de socul roşu, care are măduva de culoare brun-roşcată. Mugurii sunt mari, dispuşi opus. Frunzele sunt penat compuse, cu câte 3-7 foliole scurt peţiolate, eliptice, pe dos de-a lungul nervurilor – păroase. Scoarţa şi frunzele au un miros specific respingător, neplăcut. Florile mici, actinomorfe, de culoare albă, unite în inflorescenţe umbeliforme cu diametrul de 15-20 cm, cu o aromă pătrunzătoare, proaspătă, foarte plăcută. Sunt formate din caliciu cu 5 sepale, corolă cu 5 petale, 5 stamine cu anterele galbene, ovar trilocular. Înfloresc în mai-iunie (Figura 1).

Figura 1. *Sambucus nigra* L. în faza de înflorire

Fructele drupe-baciforme negre, de 6-8 mm, globuloase, lucitoare, în interior cu 3 (5) seminţe lunguieţe (Figura 2). Se coc în septembrie şi au un gust dulceag, se păstrează pe ramuri după căderea frunzelor, până la devorarea lor de păsări.

Figura 2. *Sambucus nigra* L. în faza de maturare a fructelor

Socul negru poate fi

cultivat cu uşurinţă în plantaţii, grădini şi condus prin tăieri regulate ca şi copac cu tulpină şi coroană sau lăsat să se dezvolte ca arbust. Este destul de exigent faţă de temperatura aerului în perioada de vegetaţie, dar suportă destul de bine temperaturile scăzute din perioada rece a anului. Plantă nitrofilă care preferă solurile fertile, bogate în humus, afânate, reavăne, chiar şi umede. Temperament de semiumbră.

În genul *Sambucus* L. nu mai sunt specii care au o importanţă alimentară sau medicinală. O specie apropiată, *Sambucus racemosa* L. – soc roşu este un arbust cu calităţi ornamentale care se deosebeşte de socul negru prin înălţime (până la 3-4 m) cu înrădăcinarea mai superficială. Florile gălbui, în panicule ovoid-alungite, apar înainte sau odată cu frunzele, prin aprilie-mai. Fructele drupe baciforme, roşii, cu diametrul de circa 5 mm, oferind plantei un aspect decorativ.

Printre cele mai frecvent răspândite soiuri de soc negru în România [1] sunt:

′Ina′ – se caracterizează prin tufe de vigoare mare, care intră pe rod în anul patru de la plantare. Inflorescenţele sunt mari şi compacte, de culoare negru intens, strălucitor. Este un soi autosteril, care înfloreşte la începutul lunii iunie în mod eşalonat. Producţia de fructe poate ajunge la 9 t/ha.

′Nora′– se caracterizează prin vigoarea de creştere medie. Fructele sunt mai mici decât la soiul ′Ina′ şi se maturizează la mijlocul lunii august. Procentajul de legare a fructelor – 80 %.

′Bradet′– soi vechi, viguros. Se caracterizează prin conţinutul foarte ridicat de vitamina C. Înfloreşte şi rodeşte timpuriu şi are un procentaj de legare a fructelor de 88 %.

Soiurile de soc: ′Mărăcineni′, ′Flora′, ′Ina′, ′Nora′, ′Bradet′ – sunt autosterile, pentru polenizare se plantează soiuri diferite în acelaşi teren [1]. În R. Moldova se cultivă biotipuri de soc negru alimentar. În grădinile private sunt răspândite 2 forme ornamentale: *Sambucus nigra* ′Laciniata′ – cu foliole direct sectate și *S. nigra* ′Aurea′ – cu frunze galbene-aurii [3].

Socul negru a fost înmulţit atât generativ, cât şi vegetativ (prin butaşi). Fructele se spală, se extrag seminţele care, de asemenea, se spală şi se zvântează. Seminţele au o perioadă lungă de conservare. Seminţele au fost semănate câte 200 de unităţi în fiecare ladă, într-un amestec uşor alcătuit din sol de pădure, nisip și resturi vegetale fermentate în 2 perioade, toamna și primăvara. Cercătările au demonstrat că procedeul optim şi mai eficient a fost semănatul de timpuriu, îndată după recoltare. Semințele răsar mai uniform (Figura 3) și posedă un coeficient de germinare mai mare de 3 ori, comparativ cu cele semănate primăvara, după stratificare (Tabelul 1).

Figura 3. Puieți obținuți din semințe în prima perioadă de vegetație

Coeficientul de germinare a semințelor proaspăt curățate și semănate a variat de la 85 % până la 95 % , media fiind de 90%. Semințele stratificate, semănate primăvara, au răsărit neuniform și s-au caracterizat printr-un coeficient de germinare mai mic, care a variat de la 25% până la 35 %, media fiind de 30% (Tabelul 1).

Figura 4. Puieți repicați în prima perioadă de vegetație

Greutatea a 1000 de seminţe a variat între 3,2-4,0 g. Norma de semănare a constituit 1,0-1,5 g la metru liniar. Plantulele răsărite în primăvara următoare au nevoie de umbrire. Pentru semănatul de primăvară, seminţele s-au stratificăt timp de 150-160 zile, începând îndată ce au fost culese. Semănaul de primăvară trebuie să se efectueze târziu, când solul este bine încălzit (cel puţin 20ºC). Adâncimea de semănare a constituit 1-1,5 cm, primăvara, şi 1,5-2,0 cm, toamna. Desimea optimă de cultivare este de 25 de puieţi pe metru de rigolă.

Repicajul plantelor din lăzi s-a efectuat în primul și al doilea an de la răsărirea puieților în vase vegetative,într-un amestec de sol ușor (Figura 4). Coeficientul de prindere a puieților repicați a variat de la 80 -90 % , în funcție de condițiile climatice în acea perioadă și respectarea tehnologiei. Durata ciclului de producţie pentru puieţi din semănătură este de un an.

Înmulţirea vegetativă este posibilă din marcoți, dar se practică mai mult pentru formele decorative, deoarece varianta optimă şi eficace a fost cea generativă.

Randamentul înrădăcinării butaşilor semilignificaţi trataţi cu stimulatori de rizogeneză în condiţii de ceaţă artificială a constituit 55-65 %, în funcţie de respectarea tehnologiei pe toată perioada de vegetaţie. S-a constatat că soluția de 0,01 % IBA a fost mai eficientă de 3 ori, puțin costisitoare și rentabilă pentru tratarea butașilor semilignificați pe o perioadă de 16 ore, comparativ cu impactul altor soluții cercetate (0,01% IAA și 0,01 % $KMnO_4$).

Socul negru este recunoscut deopotrivă în folclorul românesc şi european drept plantă de leac şi plantă magică. Nenumărate mituri despre soc sunt până acum purtate din Orientul Mijlociu şi până în Nordul Europei şi al Africii, dar cultivarea lui a apărut acum recent.

Socul negru este o cultură profitabilă, mai ales că este una dintre plantele care se pretează foarte bine pentru producţia bio, întrucât nu este pretenţioasă şi nici sensibilă la boli şi

Tabelul 1. Coeficientul de germinare a semințelor de *Sambucus nigra* L. în diferite perioade ale anului

Anii	Varianta	Perioada semănării	Numărul		Coeficientul de germinare a semințelor	
			semințelor	plantelor răsărite	pe variante,%	media,%
2017	V.1	11.X	200	190	95,0	90,0
	V.2		200	180	90,0	
	V.3		200	170	85,0	
2018	V.1	09.X	200	180	90,0	89,6
	V.2		200	184	92,0	
	V.3		200	174	87,0	
2017	V.1	20.IV	200	70	35,0	30,0
	V.2		200	60	30,0	
	V.3		200	50	25,0	
2018	V.1	25.IV	200	68	34,0	30,1
	V.2		200	62	31,0	
	V.3		200	51	25,5	

dăunători. Se cultivă pentru fructe şi flori, care au un miros caracteristic, plăcut, iar din ele se extrag arome, utilizate în amestecuri de băuturi, dar şi ca plantă medicinală.

La 1 ha se sădesc 400-600 puieţi şi chiar 950 puieţi (cu distanţa de plantare 3,5 x 3,0 m), în funcţie de densitatea plantării. Distanţele de plantare recomandate sunt de 4,0-5,0 m, între rânduri, şi 3,0-3,5 m, între plante. Dacă solul este mai sărac în humus se recomandă administrarea suplimentară a îngrăşămintelor organice. Socul negru creşte repede în primele 1-3 perioade de vegetaţie. Lăstarii apăruţi din colet la plantele tinere ating lungimea de 0,6-0,8 m încă la sfârşitul lunii aprilie, depăşind ca ritm de creştere celelalte specii pomicole. Plantele se conduc ca tufă, cu 8-15 tulpini crescute din zona coletului, sau cu trunchi la dorinţă. Întrucât creşte neechilibrat şi are talia redusă, este de preferat forma de tufă.

Este o plantă foarte precoce. Înfloreşte şi fructifică din anul al doilea de la plantare. O tufă viguroasă în cultura intensivă poate produce până la 60 kg de fructe şi mai mult. Fiind grupate în inflorescenţe mari, fructele se recoltează foarte uşor. Producţia de fructe de soc la 1 ha poate depăşi 20 tone în cultura intensivă. Pomii ajung la maturitate în 3-4 ani, iar media de viaţă a unei plantaţii este de 30-40 de ani.

Socul negru, în unele cazuri, este atacat de afide, singurele insecte care îi dăunează, care se instalează în special pe inflorescenţe. La primele semne de apariţie a afidelor, planta trebuie stropită cu ceai de pelin, cunoscut pentru gustul său foarte amar.

Deşi nu este predispus la boli şi dăunători şi nu necesită tratamente fitosanitare, fructele de soc au un mare duşman – păsările, care au o mare atracţie pentru fructele mustoase.

Uneori se întâlnesc aşa boli la socul negru ca ulceraţia ramurilor – *Nectria galligena* şi foarte rar sancrul – *Cytospora* spp. sin. *Valsa* spp.

CONCLUZII

1. Socul negru este o cultură fructiferă profitabilă utilizată în alimentație și medicina populară pentru fortificarea sănătății organismului uman, conținând multiple substanțe biologic active, meliferă și ornamentală. Este rezistent la boli și dăunători, ajunge la maturitate în a III –IV-a perioadă de vegetație, nu cere îngrijiri speciale, de aceea are mare perspectivă de a fi cultivat în Republică Moldova.

2. Procedeul optim și rentabil de multiplicare a fost semănatul cu semințe proaspete toamna timpuriu, la o adâncime de 1,5 -2 cm. Coeficientul germinării semințelor a constituit 90 % ,dar a celor semănate primăvara – 30%. Randamentul înrădăcinării butașilor semilignificați, tratați cu stimulatori de rizogeneză, a constituit 55-65 %, dar a celor netratați numai 20%, cu respectarea tehnologiei pe toată perioada de vegetație.

3. Pentru înființarea unei plantații de un hectar sunt necesari cca 400-500 sau chiar 950 de puieți, în funcție de densitatea plantării și tipul agregatului de afânare a solului. Plantația de soc negru își păstrează viabilitatea 30-40 de ani.

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THE POTENTIAL GROWTH AND THE BIOMASS QUALITY OF SOME HERBACEOUS SPECIES FOR THE PRODUCTION OF RENEWABLE ENERGY IN MOLDOVA

Victor ŢÎŢEI
"Alexandru Ciubotaru" National Botanical Garden (Institute),
18 Padurii str., MD 2002, Chisinau, Republic of Moldova
e-mail: vic.titei@gmail.com, vtitei@mail.ru

Abstract: Energy is the dominant factor that determines the welfare of the country and people; it influences the level of development of all spheres of activity in society. In recent years, at global and national level, greater attention has been paid to the use of biomass for the production of renewable energy. To determine the plant species that are the most suitable for biomass production, their biological peculiarities and productivity, the biochemical composition and the thermophysical properties, the social and the ecological impact must be investigated thoroughly. The study of local as well as introduced herbaceous plant species for further processing into various types of bio fuels is an important objective. We have investigated some agro-biological peculiarities, the biochemical composition of the harvested green mass and prepared silage, the thermophysical properties of the dry biomass and the solid fuel of the perennial plant species: *Silphium perfoliatum* cv. *Vital, Sida hermaphrodita* cv. *Energo* and *Inula helenium* cv. *Ileana.* It has been established that the biogas potential of green mass substrates varied from 440 to 532 l/kg ODM and from 443 to 452 l/kg ODM of silage substrates; the methane potential in green mass substrates varied from 236 to 275 l/kg ODM and from 228 to 244 l/kg ODM of silage substrates. The briquettes produced from *Silphium perfoliatum* and *Sida hermaphrodita* reached a specific density of 949-1162 kg/m^3, but from *Inula helenium* – 813 kg/m^3, versus maize briquettes, which reached a specific density of 923 kg/m^3.

Key words: agrobiological characteristics, biochemical composition, thermophysical properties, *Inula helenium, Sida hermaphrodita, Silphium perfoliatum*

INTRODUCTION

Energy is the dominant factor that determines the welfare of the country and people, and influences the level of development of all spheres of activity in society. The industrial progress has caused a sudden increase in energy consumption. The International Energy Agency estimates that the world energy consumption will continue to grow on average by 2 % per year, and this may lead to a doubling in 2050. Energy security, the decline of fossil fuel resources, climate change mitigation and conservation of ecosystems have especially stimulated the advancement of sustainable and renewable energy production. In recent years, at global and national level, greater attention has been paid to the use biomass for energy production. Plant species are efficient users of solar energy for converting CO_2 into biomass, energy from phytomass can be produced by different thermochemical (combustion, gasification and pyrolysis), biological (anaerobic digestion and fermentation), or chemical (esterification) processes, where direct combustion can provide a near-term solution to the problem of renewable energy (El Bassam, 2010).

The Republic of Moldova has few fossil energy resources, so being forced to import near 95 %, depending entirely on the supplying countries. Therefore, the issue of renewable energy sources is still relevant. According to the Energy Strategy of the Republic of Moldova (2013), the total amount of energy produced from renewable sources should be increased to 20 % by the year 2020 and ¾ of this amount will make energy from biomass. Forests in Moldova cover less than 13 % of the territory, and it is necessary to study the feasibility

of using different types of biomass as renewable energy sources. Maize, *Zea mays* L., is known and appreciated as food, fodder and energy crop, but frequent droughts, rising prices of seeds, agricultural equipment, fuel and fertilizers have a negative impact on the productivity and the cost of maize. Besides, high proportions of maize in crop rotations can have negative impacts on biodiversity, accompanied by further negative consequences such as erosion or decreasing amount of organic matter in soil. The range of plant biomass can be increased by including new plant species, which grow in poor quality soil and produce large quantities of dry biomass (El Bassam, 2010).

Over 70 years of research on the mobilization, introduction and acclimatization of plants, collections and exhibitions of species with multiple uses, necessary for the development of the national economy, were founded in the National Botanical Garden (Institute). The use of the gene pool of local and introduced plant species as feedstock for renewable energy production is a new direction of research (Teleuță, Țîței, 2016).

The family Asteraceae Dumort. is one of the two largest families of flowering plants, thus *The Plant List* mentions approximately 27.773 species, belonging to 1.765 plant genera. Some of these species are of particular interest due to their biological characteristics, productivity and tolerance to biotic and abiotic factors. The genus *Inula* includes more than one hundred species, widespread in temperate regions of Europe and Asia. In the wild flora of the Republic of Moldova, it is represented by 9 species (Negru, 2007), the most common being *Inula helenium* L. (syn. *Aster helenium* (L.) Scop; *Aster officinalis* All.; *Corvisartia helenium* (L.) Mérat; *Helenium grandiflorum* Gilib.), commonly named elecampane, also called horse-heal or marchalan. It has erect stems up to 2.5 m in height, angular, thick, upright and furrowed, at the top little branchy, highly resistant to mechanical damages, resistant to precipitations and strong wind during winter. It blooms in July-August, the flower heads measuring 3-7cm in diameter. It is adapted well to different types of soils and habitats, highly resistant to frost and drought. Elecampane is used in medicine due to the inulin, essential oil, alantolactone and helenin contained in its root, the aqueous extract from its aerial parts has anticancer properties (Koc et al., 2018). It is used as a melliferous plant (Ion et al., 2018) and has been considered for the production of fodder and energy (Medvedev and Smetannikova, 1981; Ivanova et al., 2013). In Germany, a mix of wild plants *'Biogas mehrjährig'*, consisting of different flowering species (annual, biennial and perennial), including *Inula helenium*, was developed and implemented for soil conservation and energy biomass production on marginal lands (Schmidt et al., 2018).

Silphium perfoliatum L., fam. Asteraceae, common name – Sylph or Cup plant, belongs to the genus *Silphium* L. which includes the 23 species. It is native to North America, the East Coast of the United States of America and Canada. *Silphium perfoliatum* is an erect herbaceous perennial plant with strong, 4-angled (square) stem (150-350cm) and its flowers are very similar to sunflower, measuring about 2.5cm in diameter, produces from 20 to 30 seeds in each flower head. The plant has an extensive root system, is able to establish colonies due to its central taproot system and shallow rhizomes. It was introduced as an ornamental plant in botanical gardens in France and in the UK in the second half of the 18th century and in the 20th century – in Russia, France, Poland and Romania, in other regions of the Earth – as a fodder, melliferous, medicinal and energy plant (El Bassam , 2010; Boe et. al., 2012; Pichard, 2012; Franzaring et al., 2014; Stolarski et. al., 2014; Gansberger et. al., 2015; Herrmann et. al., 2016; Schmidt et al., 2018).

Another promising herbaceous perennial plant species of the family Malvaceae Juss. is *Sida hermaphrodita* (L.) Rusby (syn. *Sida napaea* Cav.; *Napaea hermaphrodita* L.) commonly named Virginia mallow, Pennsylvanian malva, River mallow and Virginia fanpetals. It is native

to south-eastern parts of North America, where it naturally grows in moist riverine habitats. It is bushy, has dense root system, a few dozen of stems with a length of 400 cm and diameter of 5 to 35 mm. The plant reproduces by root cuttings, stem cuttings or seeds. The species lives for 15-20 years, providing a good harvest on all kinds of lands. Its multi-directional cultivation appears to be an advantage of *Sida hermaphrodita*, as well as its great capacity of adaptation to changing climate and soil conditions, including chemically degraded areas. For the first time, Virginia mallow was brought to Europe in 1930 and introduced in Ukraine as fodder and fibre crop. *Sida hermaphrodita* is a fodder, fibre and energy crop (Rakhmetov, 2011; Oleszek et al., 2013; Franzaring et al., 2014; Jablonowski et.al 2016; Nahm, Morhart, 2018; Schmidt et al., 2018). In Moldova *Sida hermaphrodita* was introduced from Ukraine in the 1960s (Teleuţă, Ţîţei, 2016).

The objective of this research was to evaluate some biological characteristics, the quality of green mass and silage as feedstock for biogas production, some thermophysical properties of the dry biomass and the briquettes prepared from new cultivars of *Silphium perfoliatum*, *Sida hermaphrodita* and *Inula helenium*.

MATERIALS AND METHODS

The cultivars created in the National Botanical Garden (Institute): *'Vital'* of cup plant (*Silphium perfoliatum*), *'Energo'* of Virginia mallow (*Sida hermaphrodita*), registered in the Catalogue of Plant Varieties** and patented by the State Agency on Intellectual Property of the Republic of Moldova (BOPI 9/2016) *, and *'Ileana'* of elecampane (*Inula helenium*), which were cultivated in the experimental plot of the Plant Resources Laboratory of NBGI, Chisinau, latitude 46°58′25.7″N and longitude N28°52′57.8″E, served as subjects of study. One of the most frequently used energy crops maize (*Zea mays*) was used as control variant.

The growth and development of plants and their productivity were assessed according to methodical indications (Novoselov et al., 1983). The green mass of the studied varieties of perennial plant species was harvested in 3 growing seasons, in the flowering stage, *Zea mays* – in kernel milk-wax stage. The biomass yield was measured by weighing. The silage was prepared and evaluated in accordance with the Moldavian standard SM 108***. Dry matter or total solid (TS) content was detected by drying samples up to constant weight at 105°C, crude protein – by Kjeldahl method; crude fat – by Soxhlet method, crude cellulose – by Van Soest method; ash – in muffle furnace at 550°C, nitrogen-free extract was mathematically appreciated. Organic dry matter (ODM) was calculated through differentiation, the crude ash being subtracted from dry matter. The biogas and biomethane, were calculated using the biogas potential of degradable nutrients according to Baserga 1998, and the digestibility index of nutrients – according to Medvedev and Smetannikova 1981. Harvestable dry stems of the studied cultivars of perennial species and *Zea mays* were chopped into chaff using the stationary forage-chopping unit, and then they were milled in a beater mill equipped with a sieve with the diameter of openings of 1mm. The moisture content of chopped material was determined by CEN/TS 15414 in an automatic hot air oven MEMMERT100-800. The content of ash was determined at 550°C in a according to CEN/TS 15403. Automatic calorimeter LAGET MS-10A with accessories was used to determine the heating value, according to CEN/TS 15400. The cylindrical containers were used to determine the bulk density, calculated by dividing the mass over the container volume. The briquetting was carried out by hydraulic piston briquetting press BrikStar model 50-12 (Briklis). The specific density of the briquettes was determined immediately after removal from the mould as a ratio of measured mass over calculated volume.

RESULTS AND DISCUSSIONS

Analysing the results of the research on the biological peculiarities of growth and development, we can mention that in the first year, *Silphium perfoliatum* (cv. *Vital*) and *Inula helenium* (cv. *Ileana*) passed 2 stages of ontogenetic development: the development of plantlets and the juvenile phase, did not develop shoots. *Silphium perfoliatum* plants developed up to 16-18 dark green triangular leaves, but *Inula helenium* – 6-8 oblong leaves of intense green colour, the growth and development of the rosette lasted up to early autumn frosts, the green mass productivity reached up to 16-23 t/ha. The experimental results revealed that *Sida hermaphrodita* (cv. *Energo*) in the first 45 days had a slow rate of growth and development of aerial parts, and then the rate was accelerating, the development of flower buds started in the middle of September, the stems grew about 171 cm tall and 6-13 mm thick at base. The productivity of green mass was 28.3 t/ha or 6.2 t/ha dry matter, with high content of about 48 % leaves.

In the second year and the in further years of growth, *Silphium perfoliatum* and *Sida hermaphrodita* plants started developing from generative buds in spring, when air temperature exceeded 6°C, and *Inula helenium* – when temperature exceeded 12°C. Then, the plants went through all stages of ontogenetic development finishing with seed maturation, developing a larger number of shoots per plant. A high rate of growth of stems was observed in May and June (5-6 cm/day). In general, the studied plants grew about 230-350 cm tall, depending on species. We observed that plants of cv. *Energo* of *Sida hermaphrodita* and cv. *Vital* of *Silphium perfoliatum* were significantly taller than *Inula helenium*. The plants recovered fast after being mowed for the first time (in July), so that *Silphium perfoliatum* and *Sida hermaphrodita,* until the end of the growing season, developed 150-175 cm tall stems, but *Inula helenium* – a rosette of leaves. Research data demonstrated that the studied plants were characterized by fast growth and development, which allowed obtaining up to 50.9-142.1 t/ha annual yield of green mass with 14-25 % dry matter and 36-51 % leaves, but the yield largely depended on the weather conditions and on when and how many times per year plants were cut.

A high productivity of aerial biomass of *Silphium perfoliatum* and *Sida hermaphrodita* has also been mentioned in other studies. So, Medvedev and Smetannikova (1981) mentioned that *Silphium perfoliatum* green yield in irrigated land, in Kyrgyzstan, was 234 t/ha; Rakhmetov (2011) stated that, under the conditions of Ukraine, *Sida hermaphrodita* could have a productivity of 123.9-187.7 t/ha natural fodder, depending on the genotype.

Biogas is a product of anaerobic fermentation of organic products. Among the fuels from plant biomass, biogas has a great importance and can successfully replace fossil fuels to obtain electric power and heat. The quantities of biogas and the methane content depend mainly on carbohydrates, fats and proteins, the biodegradability and ratio of carbon and nitrogen (C/N) from the substrates. The results of the determination of the quality of harvested green mass and prepared silages, Table 1, show that the nutrient composition of the studied perennial species differs from that of *Zea mays*. Organic dry matter content and its digestibility (biodegradability) is an important factor influencing biogas and methane yield. We found that the amount of digestible organic dry matter in *Silphium perfoliatum* substrate (672.8 g/kg) was about the same as in maize (673.3 g/kg) and in the other species – lower. The dry matter of *Sida hermaphrodita* and *Inula helenium* substrate contained high amounts of digestible proteins and fats, but lower amounts of digestible carbohydrates than *Silphium perfoliatum*. The biogas potential of the digestible organic dry matter from the studied green mass substrates varied from 440 to 532 l/kg versus 536 l/kg ODM – maize

green mass substrate. The calculated methane content in the biogas ranged from 51.7 to 53.8 %. The biochemical methane production potential of the studied green mass substrates ranged from 2443 m^3/ha (*Inula helenium)* to 4235 m^3/ha (*Silphium perfoliatum)* versus 3296 m^3/ha of maize green mass substrate.

In order to supply biogas plants over the entire year, it is necessary to preserve the material. Silages are the main feedstock for anaerobic digestion in European countries with a dynamic development of agricultural biogas plants (Oleszek et al., 2013; Mast et. al., 2014; Herrmann et. al., 2016). During the organoleptic assessment of the silages prepared from green mass of the studied cultivars, it was found that plant structure was well preserved, the silage from cv. *Vital* contained dark green leaves and yellow-green stems, had pleasant smell like pickled tomatoes; cv. *Energo* – yellow-green leaves and stems, which smelled like pickles; cv. *Ileana* – green-olive leaves and yellow-green stems, characterized by a pleasant smell of pickled apples, but maize – yellowish-green, with pleasant smell of cabbage. As a result of the performed analysis, it was determined that the pH index of the prepared silage varied: *Silphium perfoliatum* – 4.29, *Inula helenium* – 4.29, *Sida hermaphrodita* – 4.76 and maize – 4.25, it met the quality standard SM 108. The prepared silages were characterised by optimal concentration of organic acids (20-49 g/kg). Lactic and acetic acids were present in all the samples of silage, being predominantly in fixed state, which is desirable because organic acids in the fixed state contribute more to the preservation of nutrients in the silage. The share of lactic acid from the total amount of organic acids accumulated in the silage was obviously higher and varied from 73 % in the *Inula helenium* silage to up to 76-78 % in the *Silphium perfoliatum* and *Sida hermaphrodita* silages. The silage prepared from new plant species contained high amount of digestible proteins (48.4-88.9 g/kg), but low amount of digestible fats (13.9-20.5 g/kg) and digestible carbohydrates (436.6-531.3 g/kg). There was

Table 1. Biochemical composition and biogas potential of substrates from the studied perennial species

Indices	*Silphium perfoliatum*		*Sida hermaphrodita*		*Inula helenium*		*Zea mays*	
	green mass	silage	green mass	silage	green mass	silage	green mass	silage
Organic dry matter (ODM), g/kg	892.0	893.6	926.9	912.3	887.9	861.4	954.5	957.4
Digestible ODM , g/kg	672.8	711.3	577.0	579.3	556.8	546.0	673.3	695.6
Digestible proteins, g/kg	50.6	48.4	95.4	75.6	88.2	88.9	41.5	34.6
Digestible fats, g/kg	10.5	13.9	15.1	14.4	18.6	20.5	17.4	23.3
Digestible carbohydrates, g/kg	611.7	531.3	466.5	489.3	450.0	436.6	614.4	637.7
Biogas, l/kg ODM	532	471	454	458	440	433	536	557
Biomethane, l/kg ODM	275	245	244	243	236	228	278	292
Methane, %	51.7	52.4	53.7	53.1	53.8	52.6	51.9	52.4
Methane production, m^3/ha	4235	3675	4050	4000	2443	2111	3296	3127

a very high content of digestible proteins and a low amount of digestible carbohydrates in *Inula helenium* silage. All silages from new cultivars were rich in minerals (107.0-138.6 g/kg) in comparison with the control; a higher content was in *Inula helenium* silage. The calculated biogas potential ranged from 433 to 471 l/kg ODM in the silage substrate of the studied cultivars and, for comparison, 557 l/kg ODM in *Zea mays* silage substrate; the biochemical methane potential ranged from 228 to 244 l/kg and 292 l/kg ODM respectively. The best results concerning the methane production potential were achieved by the silage from cv. *Energo* of *Sida hermaphrodita* – 4000 m^3/ha, but the methane production potential of maize silage (*Zea mays*) was 3127 m^3/ha. The cv. *Ileana* of *Inula helenium* had low biogas potential (433-440 l/kg), but it was characterized by higher content of methane (53.1-53.8 %). The biogas batch-tests of *Sida hermaphrodita* showed a potential of 435 l/kg ODM of the silage made from biomass harvested in July (Oleszek et al., 2013). The Hohenheim Biogas Yield Test showed that the specific methane yield of *Silphium perfoliatum* was 232-274 l/kg ODM, depending on the harvest time, the methane yield per hectare was up to 4301 m^3/ha (Mast et al., 2014). Schmidt et al., 2018, reported that the biochemical methane potential of the silage substrate of *Silphium perfoliatum* was 288.31-345.21 l/kg ODM and the silage substrate of *Sida hermaphrodita* – 213.40–315.37 l/kg ODM, respectively, as compared with the biochemical methane potential of maize, which was 333 l/kg ODM.

The stems of the studied perennial species dried fast in autumn-winter. They are strong,

Table 2. Thermophysical properties of the dry biomass and the briquettes prepared from new cultivars

Indices	*Silphium perfoliatum*	*Sida hermaphrodita*	*Inula helenium*	*Zea mays*
Moisture content of stems December, %	25	17	13	16
Moisture content of stems January, %	20	13	13	12
Moisture content of stems March, %	14	9	10	8
Bulk density of the chopped stems, kg/m^3	241	268	259	100
Gross heating value, MJ/kg	18.3	18.7	18.5	17.8
Specific density of briquettes, kg/m^3	949	1162	813	923
Ash content of briquettes, %	3.0	1.5	2.6	4.6
Potential for energy production, GJ/ha	380	350	240	90
- *coal equivalent, t*	14	13	9	3.3
- *conventional oil equivalent, t*	10	9	6	2.2

cannot be flattened easily and can be used to produce solid biofuels with high heating value. The heating value of solid biofuel depends on its moisture and mineral contents. The leaves contain higher amount of ash than the stems. The rate of tissue dehydration and fall of the leaves from stems were studied in order to determine the optimal time for harvesting biomass. At the end of the growing season, when the average temperature was below 0°C, most of the leaves of the studied plants fell and the tissues dehydrated very fast. At the end of the growing season (October), the *Silphium perfoliatum* and *Inula helenium* plants had only about 35 % of the leaves still on the stems, while *Sida hermaphrodita* plants – 20 %. Over 15-35 days, depending on weather conditions, *Sida hermaphrodita* stems were completely defoliated, while the leaves of *Silphium perfoliatum* and *Inula helenium* were kept on the stems longer (in March, dry leaves on the stems constituted 7-9 % of biomass). *Inula helenium* and *Sida hermaphrodita*, in the field, dehydrated faster than *Silphium perfoliatum* (Table 2). The compression of biomass into durable, compact briquettes is an effective solution to increase the bulk density of the collected biomass from an initial bulk density of 40-200 kg/m^3 to a final compact density of 600-1200 kg/m^3. The bulk density influence the transportation and storage expenses. The biomass from *Sida hermaphrodita, Inula helenium* and *Silphium perfoliatum* was characterized by high bulk density (241-268 kg/m^3), moderate gross heating value (18.3-18.7 MJ/kg) and moderate ash content (1.5-3.0 %), but *Zea mays* biomass was characterized by low bulk density (100 kg/m^3) and heating value (17.8 MJ/kg) and high content of ash (4.6 %). The briquettes produced from *Silphium perfoliatum* and *Sida hermaphrodita* reached specific density of 949-1162 kg/m^3, but from *Inula helenium* – 813 kg/m^3, but maize briquettes – 923 kg/m^3. The potential for energy production was 240-380 GJ/ha. The best results were achieved by cv. *Vital,* followed by cv. *Energo.*

As for the plants grown in Poland, the respective gross heating value of *Sida hermaphrodita* and *Silphium perfoliatum* was 18.71-18.91 MJ/kg and 18.66-18.90 MJ/kg (Stolarski et al., 2014), in Germany, *Sida hermaphrodita* – 19.5 MJ/kg, the net heating value was 440 GJ/ ha (Jablonowski et al., 2016).

CONCLUSIONS

The studied new cultivars of perennial species differ in the rates of growth and development, productivity and chemical composition of the harvested mass, which influence the methane yield. The biogas production potential of green mass varies from 440 to 532 l/kg and 443-452 l/kg ODM of silage, the methane content varies from 51.7 to 53.8 %. The best results of methane production can be achieved by the green mass of cv. *Vital* of *Silphium perfoliatum* (4235 m^3/ha) and by the silage of cv. *Energo* of *Sida hermaphrodita* (4000 m^3/ha), as compared with maize *Zea mays* (3127-3296 m^3/ha), the lowest – by the biomass cv. *Ileana* of *Inula helenium* (2111-2443 m^3/ha).

The biomass of the studied perennial species *Sida hermaphrodita, Inula helenium* and *Silphium perfoliatum* is characterized by high bulk density (241-268 kg/m^3), moderate gross heating value (18.3-18.7 MJ/kg) and moderate ash content (1.5-3.0 %), but the biomass of *Zea mays* – by low bulk density (100 kg/m^3) and heating value (17.8 MJ/kg) and by high amount of ash (4.6 %). The briquettes produced from *Silphium perfoliatum* and *Sida hermaphrodita* have a specific density of 949-1162 kg/m^3, from *Inula helenium* – 813 kg/m^3, but maize briquettes – 923 kg/m^3. The potential for energy production of the studied species is about 240-380 GJ/ ha. The best results can be achieved by cv. *Vital* of *Silphium perfoliatum,* due to the high productivity of biomass.

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METHODS OF GROWING AND CARING FOR *ARGYRANTHEMUM FRUTESCENS* L.

Ina VOINEAC
"Alexandru Ciubotaru" National Botanical Garden (Institute),
Chisinau, Republic of Moldova

Abstract: This paper presents the results a study on several cultivars of *Argyranthemum frutescens* L. under the conditions of the National Botanical Garden (Institute) "Alexandru Ciubotaru". Under the given climatic conditions, *Argyranthemum frutescens* L. can be easily propagated by cuttings, grows fast and blooms for a long time. According to the methods of cultivation developed by us, it can be grown in various types of flowerbeds or in containers, but only as an annual plant, because it cannot tolerate low temperatures.

***Key words*:** *Argyranthemum frutescens* L., biological features, propagation, care, observations

INTRODUCTION

Flowering plants, planted in the ground, require systematic, thorough maintenance. Watering, removal of weeds, loosening of the soil, systematic feeding with organic and mineral fertilizers, removal of wilted flowers, control of diseases and pests are necessary to keep the plants healthy and beautiful.

Argyranthemum frutescens L. (subkingdom Magnoliophyta, class Magnoliopsida, order Asterales, family Asteraceae, genus *Argyranthemum* L. Sch. Bip) is known as Paris daisy, marguerite or marguerite daisy. This species was formerly placed in the genus *Chrysanthemum*, now it is considered part of an independent genus, *Argyranthemum*, which includes 23 species. Paris daisy is native to the Canary Islands and Madeira Island. The representatives of the genus *Argyranthemum* have adapted to various biotopes, they occur in almost all plant communities of the Canary Islands – from thickets of xerophytic shrubs to rainforests. They also live on dry slopes among xerophytic shrubs and on volcanic plateaus, at an altitude of more than 2 km above sea level. Some species of the genus *Argyranthemum* started being cultivated more than 200 years ago, they are perennial plants, appreciated for the abundant, long-lasting bloom, but are grown as annuals, because they do not tolerate low temperatures [3,6].

All the species of the genus *Argyranthemum* are small shrubs and subshrubs, 40-100 cm tall. The leaves are opposite or alternate, pinnately dissected or twice dissected, bright-green or silver-green. The inflorescences are numerous small flower heads (capitula), simple or double, with numerous ray florets. The marguerite daisy plants produce lax, irregular cymes with daisy-like flowers or anemone-like, with prominently featured disc florets, sometimes with two rows of ray florets, white, pink, yellow or peach. The fruit is a triangular, winged achene. These are fast-growing plants, which are appreciated for the long-lasting and abundant bloom; standard shapes are very popular [6].

Under the conditions of Moldova, *A. frutescens* L. is grown as annual shrub in open ground and in containers. Marguerites grow well in full sun, thrive in cool and stable warm weather, but do not tolerate heat. They grow well in nutrient-rich soil. The soil pH is also important, *A. frutescens* L. plants prefer neutral and slightly acidic soils. It is better to choose loams. *A. frutescens* L. was introduced in the "Alexandru Ciubotaru" National Botanical Garden (Institute), from the Netherlands, in 2013. We studied the adaptive and biological

features, the ontogenetic stages of various cultivars of *A. frutescens* L. and worked on the development of the agrotechnics of cultivation of the given crop under the climatic conditions of our country.

MATERIALS AND METHODS

The research was conducted in the greenhouse and on the experimental plot of the Floriculture Laboratory of the "Alexandru Ciubotaru" National Botanical Garden (Institute). Eight varieties of *A. frutescens* L. (′Pompon white′, ′Angelic™′, ′Lemon′, ′Magenta′, ′Neptun′, ′Pink Delight′, ′Perfection pink′, ′Burgundy′, ′Giant Pink′) served as research subjects. The research was carried out following the methodology of Krasnovoy, Visyashchevoy, Yuskevich (1990). The phenological observations, the study of the biometric indicators in the open field, as well as the description of ontogenetic features were carried out according to the generally accepted "Methodology of Phenological Observations in the Botanical Gardens of the USSR" (1979) [4], Makarova, Vorobyova (1978).

RESULTS AND DISCUSSIONS

Propagation. As mentioned in the specialized literature on this topic, *A. frutescens* L. propagates by seed and vegetatively. We received our plants as rooted cuttings, which were subsequently planted in the ground. During the entire growing season, we made observations on the plants and concluded that, under the given conditions, *A. frutescens* L. does not produce seeds. Therefore, the main method of propagation of this species in Moldova is a vegetative one, namely, by green cuttings. In horticulture, a cutting is a piece of a stem, 3-10 cm long, with two or three nodes, separated from the mother plant, which, under favourable conditions, produces new roots and develops into a new, independent plant. To preserve all the main characteristic traits of a certain variety, marguerite daisy is propagated by green cuttings. This method is convenient, effective and makes it possible to produce a large amount of high quality and uniform planting material.

Figure 1. Mother plants of *Argyranthemum frutescens* L., the variety Giant Pink

The method consists of the following steps. During the flowering period, typical plants, for this variety (Figure 1), not affected by any disease or pest, are selected as mother plants. Cuttings are taken from young vegetative shoots, grown from a dormant bud.

Because we took cuttings of *A. frutescens* L. in autumn (October, November), we cut them directly from plants grown in open field. The plants intended for taking cuttings in early-spring were transferred to a heated greenhouse and planted in the ground. The mother plants were kept in a cool greenhouse where the air temperature was not higher than +15° C and did not fall below +5°C. Plant care consisted in moderate, rare watering during winter. From March, as the temperature was rising, the frequency of irrigation increased, besides, it became necessary to apply fertilizers and to remove the weeds.

When the air temperature was above +15°C, intensification in the shoot growth was observed. Under such conditions, at the end of February or at the beginning of March, one can start propagating marguerite daisy.

Propagation by cuttings. The vigorous, fast-growing vegetative shoots are the best source of cuttings. It has been found that the species and varieties of plants have different regenerative capacity. Depending on it, the plants are considered difficult, medium and easy to root. While studying the ability of *A. frutenscens* L. to propagate vegetatively, we also studied the regenerative capacity of its varieties. According to the results of our research, *A. frutescens* L. is easy to root and has a high percentage of rooting (90-100%). However, there are certain differences in this feature among the varieties of this species (Table 1).

Table 1. The duration of rooting of different varieties of *Argyranthemum frutescens* L.

Variety	The average duration of rooting of cuttings (days), by month						
	October 2017	November 2017	January 2018	February 2018	March 2018	April 2018	May 2018
Pompon white	45	45	30	30	30	28	28
Angelic™Lemon	40	45	35	32	30	30	**25**
Angelic™Magenta	**54**	45	38	30	26	28	28
Neptun	48	43	28	28	26	26	28
Pink Delight	45	45	30	32	30	28	**24**
Giant Pink	42	45	30	28	**25**	28	28
Angelic™Burgundy	40	48	42	40	32	30	26
Sole Mio improved	**50**	**51**	45	30	32	28	**25**

Figure 2. Cuttings of *Argyranthemum frutescens* L. ready for planting

In autumn, rooting occurs more slowly, but in spring – faster. Although in October-November it took two weeks longer to produce roots, the percentage of rooting was high. It is important that the cuttings are of the same length – 10-12 cm (Figure 2).

The removal of a large number of leaves is undesirable, since a decrease in the leaf surface leads to a decrease in the amount of nutrients, in the cuttings, required for rooting. The cuttings taken from the mother plants are immediately planted in the rooting substrate without any preliminary treatment. Good aeration is necessary for the rooting process, and it is better achieved by shallow plantings of cuttings to a depth of 1-1.5 cm. The substrate compaction is not necessary right after planting, because, at the first irrigation, it happens spontaneously. The cuttings should be planted according to the scheme 5x5 cm or 6x6 cm, depending on the size of leaves (Figure 3).

Figure 3. Cuttings of *Argyranthemum frutescens* L., planted for rooting

The cuttings can be planted for rooting in different types of containers: pots, cell plug trays or seedling racks, depending on the number of cuttings. The time of propagating *A. frutescens* L. by cuttings depends on the need for rooted cuttings by a specific date.

A. frutescens L. can be propagated by cuttings almost all year round, because their rooting percentage is always very high. The only difference is the duration of the rooting process.

In autumn and in the middle of summer, they need more time to take root (10-15 days longer) than in early spring. However, taking into account the peculiarities of growing *A.*

frutescens L. in open ground, it is preferable to take cuttings in autumn, to obtain young plants with a better-developed and stronger root system, at the time when they have to be transferred outdoors. The medium for rooting cuttings should be light, well drained and not compacted during irrigation. Good results have been obtained by us when rooting daisy marguerite in a mixture of sand and perlite (1:1), sand and peat (1:0.5) or sand with perlite and peat (1:0.5:0.5). In the absence of the listed components, the cuttings can be rooted in clean sand. During the rooting period, the cuttings should not be shaded constantly, especially in autumn. Under conditions of low light intensity and low air temperatures, the rate of photosynthesis and the formation of nutrients are reduced and the rooting process slows down. In spring, when the air temperature is significantly higher than in autumn and winter, to prevent moisture loss, it is recommended to protect the cuttings from direct sunlight in the first 3-4 days after planting. During the first days, the cuttings planted for rooting must be covered with plastic film and mandatory daily ventilation must be provided. The moisture in the rooting environment should not exceed 85-90%, because overwatering, moisture stagnation and large amounts of water on the leaves contribute to the development of fungal diseases and the cuttings may die because of them.

The rooted cuttings can stay in containers for a long time, until they are needed for planting outdoors. In containers they grow, develop and, by the time of planting, they are often in the stage of flower buds or the beginning of flowering (Figure 4).

If the young plants remain in the containers for rooting for a long time, a weak solution of fertilizers can be added, using half the dose of fertilizers necessary for mature plants.

Taking care of young plants. Before planting the cuttings in the open ground, they are watered abundantly and carefully removed from the substrate, so as not to damage the root

Figure 4. Rooted cuttings of *Argyranthemum frutescens* L. on a rack

system. Then, they are sorted by height and number of leaves and planted in the ground (Figure 5).

Figure 5. Rooted cuttings of *Argyranthemum frutescens* L., ready for planting

Soil. The cultivation of beautiful, abundantly flowering plants of *A. frutescens* L. depends largely on the correct choice of the place for planting. Marguerite daisy is sun loving and demanding in terms of soil, it should be planted in open areas, protected from strong winds with a fence, buildings, plantings and other obstacles, but not in shady areas. They grow better on loams with moderate structure, well-drained soils, rich in organic matter. Therefore, when they are planted, directly into the hole, prepared to place the rooted cutting in it, a little peat and humus can be added.

Of all the nutrients, peat contains only nitrogen in significant amount. Peat is a slow-acting fertilizer, the effect of which lasts for 4-5 years. In case of all-over preparation of the soil for planting *A. frutescens* L., in order to increase the content of organic matter, about 12-15 kg (2-3 buckets) per 1 m^2 are applied. It is advisable to use only well-ventilated peat from lowland marshes. As compared with the peat from upland marshes, it contains more nutrients, is characterized by lower acidity and greater degree of decomposition.

Humus, which is formed by the complete decomposition of manure, increases the nutritional value of the substrate. It is used as a potent component to soil mixes, for most potted plants and growing seedlings.

It is important to create optimal conditions for plants. *A. frutescens* L. is planted outdoors, after all danger of frost has passed, in Moldova, the best time is the end of April, the beginning of May. They are planted not too close to each other, 60-70 cm apart, depending on the variety,

Figure 6 (A, B, C, D). Flowerbeds with *Argyranthemum frutescens* L.

Figure 7 (A, B). *Argyranthemum frutescens* L. in vases

taking into account the features of growth and the habit of the bush, because after 3-4 months, the marguerite daisy bushes are from 30 to 50 cm in diameter, therefore, tight spacing must be avoided. *A. frutescens* L. does not tolerate even the slightest overwatering, but still requires systematic irrigation. The soil should always be slightly moist, and during the periods with dry weather, it should be watered regularly, but avoiding excessive moisture.

Fertilizers. During our observations, we found that *A. frutescens* L., without adding fertilizers, blooms poorly, even if planted in a fertile substrate. That is why, in order to obtain abundant and long-lasting flowering, nitrogen fertilizers are applied under the marguerite daisy bushes, 15-20 days after planting. Then, once a month, an universal mineral fertilizer (superphosphate) or a complex mineral fertilizer with trace elements ("Polyfeed", "Kristalon", "Kristalin") are applied to the root zone of the bushes, growing in open ground, until the end of the flowering stage. To potted plants, fertilizers should be applied every week, starting with the flower bud stage.

A. frutescens L. plants keep blooming even if there are withered flowers and buds on them, but in order to prolong the flowering stage, it is necessary to remove them regularly. Within 10-12 days, the plants produce new inflorescences. The growing season ends, for *A. frutescens* L., when the temperature drops below -2°C. Before the onset of frost, the plants, selected as mother plants, should be moved into a cool, light, heated greenhouse for overwintering. Some of the plants of *A. frutescens* L. are in the flower bud stage at this time and, under favourable conditions, bloom within a month. However, at this time, the bloom is less abundant than in summer.

The cultivars of *A. frutescens* L., tested by us, have no serious disease and pest problems

and they are relatively drought-tolerant. They can be used in various types of flower beds (mixed borders, rabattes, rock gardens etc.), can be grown in containers and look great when planted alone.

Marguerite daisy is an undemanding plant, which doesn't need complicated care, with an interesting texture of leaves and various colours of inflorescences. It takes root easily, grows rapidly and flowers abundantly, for a long time; therefore, it can wonderfully embellish various types of flower gardens (Figure 6 A, B, C, D; Figure 7 A, B).

CONCLUSIONS

1. *Argyranthemum frutescens* L. does not produce seeds under the conditions of the "Alexandru Ciubotaru" National Botanical Garden (Institute), therefore, the main method of reproduction is vegetative, namely, by green cuttings.
2. *A. frutescens* L. can be propagated by cuttings practically all year round, but the optimal time for this process, under the given conditions, is autumn (October, November) and spring (March).
3. The cuttings of the studied varieties of *A. frutescens* L. are characterized by high percentage of rooting (90-100 %).
4. Marguerite daisy plants are sun loving and demanding in terms of soil. They grow better on loams with moderate structure, well-drained soils, rich in organic matter.
5. For an abundant and long-lasting flowering of *A. frutescens* L., nitrogen fertilizers are applied under the bushes, 15-20 days after planting. Then, once or twice a month, it is necessary to apply a complex mineral fertilizer with trace elements, until the end of flowering.
6. In Republic of Moldova, *A. frutescens* L., can be planted alone or in various types of flower beds and in containers, as an annual plant, because it does not tolerate low temperatures and cannot overwinter in open ground, although it is a perennial plant.

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APPLICATION OF BACULOVIRUS BIOPESTICIDES FOR PEST DENSITY CONTROL IN THE REPUBLIC OF MOLDOVA

Aurelia STÎNGACI
Institute of Genetics, Physiology and Plant Protection,
MD 2002, 26/1 Padurii str., Chisinau, Republic of Moldova
e-mail: aurelia.stingaci@gmail.com

Abstract: Biopesticides have attracted attention in pest management in recent decades, and have long been promoted as prospective alternatives to synthetic pesticides. Biopesticides have also attracted great interest in the international research community, with a significant increase in the number of publications devoted to the subject. Recently, new substances, products of the baculovirus have been reported in the literature as promising compounds for use as biopesticides, but more field research is required to assess the effects on specific pest problems under diverse cropping systems. This study investigated the potential of baculovirus isolates obtained in IGFPP in the Republic of Moldova for the control of *Hyphantria cunea*, a dangerous invasion pest which has quickly settled in the territory of the Republic of Moldova. This study aimed to highlight new agents for biological control of invasive pest on local baculovirus. The results of the present study revealed the larvicidal potential of baculovirus isolates found in the larvae of *H.cunea*, local production of biopesticides, which will reduce the final cost of the product and will be more accessible to farmers.

***Key words*:** biological control, *baculovirus*, invasive insects, Republic of Moldova.

INTRODUCTION

In the Republic of Moldova, there are several chemical insecticides available and authorized for the current regulation of *Hyphantria cunea* on ornamental plants. Chemical use in the parks from the Republic of Moldova leads to environmental condition worsening. But due to the large-scale application of broad-spectrum insecticides, *H. cunea* has already developed some level of resistance in the Republic of Moldova. Furthermore, frequent applications of pyrethroids and neonicotinoids may cause severe negative effects on organisms that provide ecosystem services including pollination and natural pest control [4].

The legal basis for plant protection in the Republic of Moldova and Europe focuses on an Integrated Pest Management (IPM) strategy, that should limit the application of chemical plant protection products to a necessary extent by using a combination of procedures which are under the primary consideration of plant breeding and cultivation measures as well as biotechnical and biological methods (PflSchG 2012). Biopesticides are natural materials derived from animals, plants, and bacteria, as well as certain minerals, that are used for pest control [5]. Currently, biopesticides comprise a small share of the total crop protection market globally, with a value of about $3 billion worldwide, accounting for just 5% of the total crop protection market [6, 7]. In the United States (US) market, more than 200 products are available, compared to 60 analogous products in the European Union (EU) market [6]. Because of this pest characterisation, efficient pest management is required. Preparations based on baculoviruses are eco-friendly and specifically effective against lepidopteran larvae.

On a global scale, microbial pesticides only account for approximately 1–2% of all pesticides sold; however, they have shown long term growth over the past decade in contrast to chemical pesticides, which have consistently declined in the global market [1]. Some

sources have recently estimated that the growth in microbial pesticides could reach 3% of the pesticide market in 2014 [5]. The development and use of baculovirus biopesticides as classical, conservation and augmentative biological control agents have included a number of successes and some setbacks in the past 15 years.

Insect pathogenic viruses are a fruitful source of microbial control agents, particularly for the control of lepidopteran pests. Most research is focused on the baculoviruses, important pathogens of some globally important pests for which control has become difficult due to either pesticide resistance or pressure to reduce pesticide residues. Baculoviruses are accepted as safe, readily mass produced, highly pathogenic and easily formulated and applied control agents. New baculovirus products are appearing in many countries and gaining an increased market share.

Mass production of baculoviruses at a cost most potential users can bear remains a significant issue. Production of commercial baculovirus insecticides is still dependent on in vivo systems utilizing specially reared or wild collected insects [7]. In vivo systems for production of baculoviruses in live larvae remain the normal production method for commercial companies and for public sector programs [2] but the relatively high cost of producing baculoviruses in living insects compared to their chemical insecticide counterparts remains a constraint as farm prices are difficult to reduce below $20 per ha and scaling up in vivo baculoviruses production with its demands for high quality disease-free insects is also a challenge [7]. The use of automation and mechanization in inoculation, rearing, and harvesting has facilitated mass production and made baculoviruses a viable commercial option for the current range and usage scale.

However, the absence of a practical in vivo mass production system, generally higher production costs, limited post application persistence, slow rate of kill and high host specificity currently contributes to restricted use in pest control. Overcoming these limitations are key research areas for which progress could open up use of insect viruses to much larger markets.

The objective of the study was aimed to highlight new agents for biological control of insects with baculoviruses. This study investigated the potential of baculovirus isolates obtained in IGFPP in the Republic of Moldova for the control of *Hyphantria cunea Dr.*, a dangerous invasion pest which has quickly settled in the territory of the Republic of Moldova during the last three years. This study aimed to highlight new agents for biological control of invasive pest on local baculovirus strains. The results of the present study revealed the larvicidal potential of baculovirus isolates found in the larvae of *H. cunea*, local production of biopesticides, which will reduce the final cost of the product and will be more accessible to farmers. This study was addressed to find an environmentally and user friendly, effective control method, which is commercially available and does not require permitting or testing for introduction.

MATERIALS AND METHODS

The researches have been realised on the caterpillars of 2-3 ages of the *H. cunea.* In the study, we used the Nuclear Polyhedrosis Virus, selected and identified in the laboratory of the insect viruses. For the contamination of the laboratory insect, we used the dosed feeding, which contains 10 polyhedrons for each caterpillar. The monitoring of the insects lot and the

estimation of the dead caterpillars has been carried out daily, beginning with the 3rd day of the contamination. The caterpillars *H. cunea* were kept under laboratory conditions at 27˚C.

For infection of larvae, there was necessary a preliminary preparation of viral suspensions, using for that purpose pure or initial suspensions and applying dosed infection of insects according to the Vago C. procedure (1972) and its different modifications [3].

During the process of identification and determination of biological activity of baculoviruses, there was necessary its purification. At initial phases, purification of VPN and VG does not differ substantially. Dead larvae were soaked with the help of a mixer, and the biological mass was mixed with sterile filtered bidistilate through an apron screen.

For purification of VPN were used several methods, for which we have used the modifications developed at our institute, consisting of the following phases. Filtered viral suspension is centrifuged within 30 min at 1000 rpm in ŢLN-2 centrifuge. The obtained deposition is washed three times with water. The obtained suspension is centrifuged in the gradient of sucrose concentration (70-20%) and is centrifuged at 3000 rpm within 10 min. Zones with concentration of 40-50% were put together and layered in the gradient of 50-60% and after 15 min of centrifugation, there was obtained the fraction of SPVC.

For determination of concentration of baculoviral suspensions, there were used different methods, especially electronic microscope [3, 8].Titration of baculoviruses with the help of quantum microscopy depends on the kind of virus. Thus, if VPN may be examined with all kinds of optical microscopes, because they have relatively big size (0,5-10 mcm), then VG having much smaller size (0,01-0,5 mcm), is at the edge of optical microscope resolution, that's why they were mostly treated with the help of electronic microscopes.

For the determination of baculoviral concentration, there are used different methods, especially of electronic and optical microscopy [3, 8]. Titration is carried out with the help of Goreaiev chamber or in the fixed and colored preparations. There were elaborated different methods of determination of biological activity of baculoviruses. At the initial phase, viral suspension is titrated, determining its concentration. Then there is prepared a series of successive dilutions with the help of which are infected larvae of the second age (it is rational to use 40 larvae of the same physiological state). After the third day, there is determined the mortality of larvae by options, and is being prepared the diagram of "dose-effect" relation. For that reason, there is applied the method of sample analysis. Then are made some additional calculations, which allow transformation of axis for obtaining of the "dose-effect" relation in the form of straight line, and not in the form of asymmetrical curve. Construction of diagram allows us to determine the logarithm of the viral suspension dose, which ensures the death of 50% of the experimental larvae. Knowing the virus concentration and volume of viral suspension, it is easy to determine lethal concentration (CL_{50}). The mathematical treatment was registered on the 15th day after contamination; the statistical treatment was made according to [9].

RESULTS AND DISCUSSIONS

Reproduction of baculoviruses on the basis of plant feeding insects remains the main way of insect production. That was confirmed by the researches carried out in different scientific and production centres (Bekage, et al., 1993; Chukhrii & Voloshchyuk, 1988).

Results placed in the above table show the difference between the parameters of

Table 1. Biological activity of Virin-ABB-3 for control of the fall webworm moth (*Hyphantria cunea* Drury)

No.	Year testing Virin-ABB-3	Virus preparation and biological standard	Treatments, kg/ha	Biologic efficacy of treatments, %
1	2012	Virin-ABB-3	0,1	92,0
2		Lepidocid	1,0	-
3	2013	Virin-ABB-3	0,1	84,86
4		Lepidocid	1,0	87,26
5	2014	Virin-ABB-3	0,1	87,1
6		Lepidocid	1,0	87,21
7	Average	Virin –ABB-3		87,0

Table 2. The effectiveness of the biological treatment with virus preparation Virin-ABB-3

No.	Variant	Rate of consume, kg/ha	Before treatments, larvae	Attacked after treatment larvae	Biological efficacy, %
				day 9	day 9
1.	Control	-	42	65	-
3.	St. Actara 25WG	0.06	38	3	93,7
4.	Virin-ABB-3	0.1	41	7	86,9
5.	Virin-ABB-3	0.15	38	5	89,9
6.	$DEM_{0,05}$				1,02

biological activity of biological mass obtained on the different years from the infection with baculoviruses. There are not noticed any substantial differences of biological activity in the case of viral suspension with the same concentration (10^7 pol./ml). Analyzing the biological effectiveness of the baculoviruses we, obtained a value of 87-92%.

In the terms of that aspect, biological mass obtained from dead larvae after these days is characterized by parameters specific to wild strains obtained from natural conditions, that aspect induces the difference of biological activity of biological mass obtained from dead larvae on different years of infection and denotes the possibility of application baculoviral preparation and will be very useful for the baculovirus treatments managment.

Results having been analyzed, we may observe, that reduction of attack in comparison with witness in the chemical variant Actara 25WG at the 9 day was 93,9%, but the degree of attack in the biological variant with Virin-HS-P at a rate of consume 0,15 kg/ha constituted 89,9%.

In terms of that aspect, biological mass obtained from dead larvae after these days is characterized by parameters specific to wild strains obtained from natural conditions, that aspect induces the difference of biological activity of biological mass obtained from dead larvae on different years of infection and denotes the possibility of application baculoviral preparation and will be very useful for the baculovirus treatments management.

CONCLUSIONS

The insect virus pesticide is only one method to construct and restore the stable ecosystem, other methods can also be applied as the effective methods as long as they are useful to the control of target pest insects and do not cause destruction of the environment.

From the results, it can be concluded that this method of fighting, in addition to the doses of viral preparation, special importance has and choosing the most favorable treatment times, about larval development and overgrowth of foliage of trees. Treatments should be applied only during the period when larve are in the first two age groups and trees are leafy. The method put forward in this paper is the preliminary result of the experiments by wich have been trying to control the foliage feeding insects for many years. And this method consists in taking the virus as the main measure to restore and construct the stable ecosystem where the pest insects had occurred.The researches point out *H. cunea* critical stage and will be very useful for the baculovirus treatments management. Climatic conditions have influenced negatively the development of the culture and at the same time, the fast development of the pest *Hyphantria cunea*. The preparation Virin-ABB-3 does not negatively act on physiology development of the culture and on formation of plants. Testing of the preparation Virin-ABB-3 at a rate of 0,15 kg/ha for control development, II generation, on plants has demonstrated a significant biological efficacy of 89,9% in comparison with that of the chemical etalon Actara of 92,6%.

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PRODUCTIVITY OF AUTUMN WHEAT IN DEPENDENCE OF THE METEOROLOGICAL CONDITIONS AND THE WORKING OF THE SOIL APPLIED IN AGROECOSYSTEM

Rodica MELNIC
Agrarian State University of Moldova, Chisinau, Republic of Moldova

Abstract: Agriculture had been and remains the only source of food for ever-increasing population, especially in the wake of demographic bursts in poorer countries. Its incidence with the global food crisis is increasing the efforts of all the world's states in the more accelerated development of agriculture, in order to liquidate the great food gaps and to ensure the living conditions of all the inhabitants of the Earth. The Republic of Moldova has a considerable agricultural sector that ensures a variety of animal and vegetal products characteristic of the area. The level of harvest of crop plants depends of many factors: climatic, pedological, biological, economical, agro-technical, the way that agricultural lands are exploited, etc. However, in the country's pedo-climatic conditions, the minimal natural factor for high yields is soil moisture (Andrieş, 2009). The productivity of autumn wheat is assessed in dependence of the weather conditions of the agricultural year 2017-2018, the average annual temperature was 12.1 ° C and the annual rainfall amount of 544.6 mm.

***Key words*:** autumn wheat, crop rotation, agrocenoses, harvest structure, soil work.

INTRODUCTION

Soil represents an integral result of the long-term interaction of pedogenic factors - parental rocks with living organisms and their residues, under certain conditions of relief and climate (Andrieş A., 2015). The soil throughout history continues to be a valued object as well as other riches and objects, but the Republic of Moldova does not have substantial natural wealth and therefore soil was, is and will be the main means of productivity in agriculture. Agriculture is and will remain one of the important branches of many national economies, the development of which depends not only on ensuring a balanced food structure but is also an important source of raw materials for many other economic branches.

The main property of the soil is fertility - the productive potential, the possibility to ensure the harvest of agricultural crops (Andrieş, 2015). Soil fertility is one of the main issues for any farming system, including sustainable agriculture. The higher the fertility of the soil is, the higher the productivity of the agricultural crops are per unit area (Boincean, Stadnic, 2015).

Productivity of crop plants depends of multiple factors: natural, biological, technological, economical, managerial, etc. The main natural factors, which ensure high and stable yields in the conditions of the Republic of Moldova, are the atmospheric precipitation (the degree of moisture supply of the plants) and the level of soil fertility. The soils of Moldova are characterized by high fertility. However, in the last 20-25 years, all factors and forms of soil degradation have intensified and expanded (Lungu, Andrieş, Leah, 2015).

The extensive system existing in Moldovan agriculture leads both to the decrease of the agricultural production volume and to the degradation of the physico-chemical features of the soil. The assessment of effective soil fertility allows to develop and implement a plan of actions to increase soil production capacity, effective use of local organic and chemical

fertilizers to optimize the mineral nutrition of crop plants and to prevent environmental pollution with nutrients (Leah, 2000, Cerbari, 2010). However, the modernization of agriculture has led to a multitude of serious negative effects on the environment. The conventional soil cultivation system (the plow-headed plow), along with a high degree of chemicals, has led to a spectacular increase in productivity, but some disadvantages have also emerged over time. Conservation and maintenance of natural soil fertility has been and is being sustained and promoted by researchers and specialists, taking into account the current requirements for the development of sustainable agriculture.

MATERIALS AND METHODS

The experience was carried out on moderately humid clay chernozem, under agrocenosis with autumn wheat in crop rotation plain, having a long standing character in Chetrosu district of Anenii Noi with the conventional work - Ploughing and conservative - No-till. The determination of the productivity and structure of the autumn wheat harvest was carried out in the field - on 2 research plots per 1 m^2, in 4 repetitions and laboratory, according to the morphological and productive characteristics. The meteorological data were collected from the SDE Chetrosu data base.

RESULTS AND DISCUSSIONS

Agriculture is an important branch for country's economy, it is the main source of food for the population of the country and in the case of developing countries. The concept of soil cultivation and technological soil cultivation systems have evolved much over in the past decades, both in the conceptual plan and in the extension of conservative methods of soil cultivation. In conceiving the development of sustainable agriculture, it is accepted that there is no universal valid system for soil cultivation due to local differences, especially climate and soil, but also because of the technical gifted level. Soil conservation systems in different areas must have specific characteristics in conection with ecological features and the technological characteristics of the cultivated plants, so that differentiation becomes mandatory (Canarache, 1999). The influence of the soil working system is an important indicator for soil fertility conservation and the evaluation of the sustainability of the agricultural system (Guş, 1997; Rusu, 2001, Mark et al., 2004, Jitareanu et al., 2006).

Intensive agriculture in the years 1950 - 1994 led to the destruction and deterioration of the physical condition of soils. The plowing of the soil with the plow in Moldova is done at a depth of 30-35 cm and following this soil cultivation system, the arable layer has lost its compaction resistance. Under the newly worked layer of 10-18 cm, thickness was formed a very thick layer. The partial decrease of the negative influence of the secondary compaction of the arable soil layer in the first 5-7 years of the implementation of the conservative farming system, based on the processes of soil cultivation No-till or Mini-till, can be done by the simultaneous using of phyto-ameliorative and agro-technical processes, but, for transition period of 5-7

years, it is necesary to keep the conservative farming balanced system. The research was carried out at the Experimental Didactic Station "Chetrosu" of the SAUM, located on the eastern outskirts of the Codrilor Plateau, on the high terraces of the Bâc River, in long-term stationary. The purpose of this study was to assess the productivity of autumn wheat in crops with conventional Soil and Conservative Soil, No-till and to determine the structural elements of autumn wheat harvest in dependence on weather conditions. In the study was included agrocenosis with autumn wheat with conventional and Conservative - No-till, agricultural year 2017-2018 (Figure 1).

Figure. 1. Autumn wheat

Wheat is an important cereal crop with a high level of mechanization of technological operations, and for its cultivation, it needs a fertile field with a rich content of nutrients, that directly influences the harvest.

Wheat is pretentious to the precursor plant and it is recommended that the early harvest crops leave the structured soil rich in nutrients, and wheat monoculture is usually accepted only 1 year and only in crops for consumption, in no case wheat will be sown after wheat, on seedlings, or on fields that are heavily infested with diseases. The rotation of crops over time and space is necessary to diversify the remaining soil impact of each crop, to cause competition between pests, weeds, and to contribute in a complex way to the balanced functionality of the biotic and abiotic components of the agroecosystem. Agrocenes of autumn wheat (Antonovca variety) studied in crop rotation are shown in Figure 2. The organization of a natural crop rotation should take into account the economical and organizational conditions and the agro biological conditions of the plants. The country's economy and the welfare of the population largely depend of the country's main natural wealth - soil resources (Ursu, 2011).

Figure 2. Autumn wheat in crop rotation, DES Chetrosu

The soil of the studied object is humid sub moderate humus carbonate chernozem and had been described in the Department of Agroecology and Soil Science (SAUM) and published in the doctoral thesis (Gîrlă, 2010, Macrii, 2018). At the studied chernozem, the differentiation of the genetic horizons in the profile is slow. The horizons are highlighted: Ahp - Ahk - Bhk - BCk - Ck (Table 1).

The effervescence of this type of chernozem is observed from 22 cm. Soil rating by properties - 71 points. Underground water is situated in depth. In general this soil is suitable for field crops (Gîrlă, 2010, Macrii, 2018).

Conservation of soil fertility requires the application of a system of work that optimizes the plant's cultural requirements with soil-induced changes, ensuring the improvement of soil characteristics and the achievement of large and constant productions. In the paper the data of the actual fertility of the carbonate chernozem, expressed in the studied crops, were generalized. The comparative productivity of autumn wheat in crops was studied depending of the applied soil system and performed in several rehearsals, averaging (Table 2).

Table 1. Morphological description of carbon black chernozem, DES Chetrosu

Horizon	Morphological description
horizon Ahpk	The submoderated arable Ahpk humid layer has a horizon thickness of 0-22 cm, dark gray with brown hue color. The transition to the Ahk horizon is well seen by cutting the soil from the plow knife. Slight, loose (1-3 mm) placement. The structure of the soil is more dusty and more unstable than the soil structure under more or less unstable granular cultures, often under the lucerne, where it becomes moderately grainy, granular and less prone, moderately stable. From the neoformations, we observe vegetal organic residues, to various extent under putrefaction, rows of roots (pore diameter less than 1 mm). Thick texture. Efficiency from lean HCl. The moisture content of the soil in the upper part - dry, in the lower part - dilapidated.
horizon Ahk	It has a thickness of 22-46 cm. Dark gray color, slow passage. Dried, poorly compacted, porous (diameter 1-3 mm), spongy (pore diameter 3-5 mm). Structure - granular, moderately stable. Neoformations - roots, earthworms, insects, rare crotovines, from 20-35 cm (rarely) mold, carbonate yarns. Thick texture. Efficiency with HCl (10%) - poor. Moisture amount - wet.
horizon Bhk	Thickness 46-90 cm. The gray color with brown nuances, the slow passage. Slightly compacted settlement, porous (1-3 mm in diameter). Grain structure, poorly stable. Neoformations - crowds of mold, yarn, carbonate mycelium, rare - roots, earthworms, crotovines. Thick texture. Effervescence with HCl (10%) - Moderate. Humid soil moisture, less humid than the Ahk horizon.
horizon BCk	Thickness 90-105 cm, brown color, slow passage, more compact than Bhk, fine pores (dimensions <1 mm), granular structure, unstable, glossy humus scratches, rarely mold, yarns, crotovine, roots. Effervescence from the 10% moderate HCl solution. Much more accentuated than Bhk.
horizon Ck	The Ck horizon starts at 105 cm. Pale yellow with brown nuances, fine pores (sizes <1mm), granular, unstable, small carbonaceous concretes scattered in space without focusing deeply, lutely, effervescence from the 10% HCl solution.

Table 2. Influence of the soil type on the productivity of autumn wheat, DES Chetrosu, 2018

Plot number	Forerunner		Variant	Productivity, t/ha
	2017	2018		
1	autumn wheat (s. Antonovca)	autumn wheat (s. Antonovca)	Ploughing	**4,79**
	autumn wheat (s. Antonovca)	autumn wheat (s. Antonovca)	No-till	**5,29**

Table 3. Structure elements of autumn wheat harvest (1 m^2), year 2017-2018

Plot number	Stem number	Stem weight, g	Ear number	Grain weight on 1 m^2, g	Weight of 1000 grains, g	Grain weight on 1 ha, kg
1	variant Ploughing					
	453	462	431	429,3	46,2	4293
	variant No-till					
	589,6	543,9	576,8	529,1	57,4	5291

A higher productivity of winter wheat in crop rotation, prior to autumn wheat, was recorded on the conservative soil work, No-till - 5.29 t/ha compared to conventional soil work, plowing - 4.29 t/ha. In the laboratory, were carried out the structure elements of the winter wheat harvest on both research variants (Table 3).

The harvest of autumn wheat in the years (2015-2016) was based on the conservative soil work, No-till of 2.43 t / ha and on the variant with conventional soil work, plowing - 3.48 t / ha (researches carried out in Department of Agroecology and Soil Science). Compared to previous years, winter wheat harvesting on the conservative soil version is larger than the conventional soil work, which demonstrates that the conservative soil system works beneficially both on soil properties and on productivity. The productivity of autumn wheat has been assessed in relation to the weather conditions of the agricultural year 2017-2018 (Table 4).

The agrometeorological conditions of the agricultural year 2017-2018 were largely beneficial for the development of autumn wheat and contributed to a good harvest level. In September, temperatures higher than 18.3° C were recorded, compared to the multianual

Table 4. Meteorological conditions in the agricultural year 2017-2018, DES Chetrosu

	Air temperature, ºC			**Atmospheric precipitations, mm**		
Months	average	multiannual average (1881-2003)	± comparative multiannual average	average	multiannual average (1881-2003)	± comparative multiannual average
September	18,3	16,2	+2,1	45,3	42,2	+3,1
October	10,9	9,2	+1,7	114,1	29,5	+84,6
November	6,6	4,4	+2,2	29,9	38,9	-9,0
Total autumn	***11,9***	***10,2***	***+1,7***	***189,3***	***110,6***	***+78,7***

December	3,9	-0,3	+1,2	67,4	34,4	+33,0
January	+0,1	-2,6	+2,7	36,0	28,5	+7,5
February	0,0	-1,3	+1,3	45,9	29,8	+16,1
Total winter	***1,3***	***-1,4***	***+2,7***	***149,3***	***92,7***	***+56,6***
March	2,1	3,0	-0,9	88,1	24,3	63,8
April	14,8	10,4	+4,4	0	33,0	-33,0
May	19,0	16,3	+2,7	34,8	48,8	-14,0
Total spring	***12,1***	***9,9***	***+2,2***	***122,9***	***106,1***	***+16,8***
June	22,9	19,9	+3,0	29,9	71,9	-42,0
July	22,8	21,8	+1,0	50,2	58,4	-8,2
August	24,0	21,1	+2,9	3,0	51,3	-48,3
Total summer	***23,2***	***20,9***	***+2,3***	***83,1***	***181,6***	***-98,5***
Total agricultural year	**12,1**	**9,9**	**2,2**	**544,6**	**492,0**	**+52,6**

average - 16.2° C, while a higher quantity was recorded than the multianual average, which had a beneficial effect on soil and sowing. Due to the increased rainfall (+16.8 mm versus the multianual average) in the spring of 2018, they allowed a very good increase and development of autumn wheat and good productivity. Lack of drought is one of the important factors in obtaining a rich harvest.

CONCLUSIONS

The highest productivity of autumn wheat in crop rotation, prior to autumn wheat, was recorded on the conservative soil work, No-till - 5.29 t/ha compared to conventional soil work, plowing - 4.29 t/ha, with about 1.0 t/ha more. Autumn wheat harvest was evaluated in the weather conditions of the agricultural year 2017-2018, the annual temperature average was 12.1° C and the annual rainfall of 544.6 mm, +52.6 mm higher than the multianual average, which has greatly influenced the harvest. At the same time, the higher yield is due to soil moisture conservation on the research version with the application of the No-till Soil Conservation System, being a beneficial agricultural technique to conserve humidity, increase fertility and improve soil structure. The practice of the No-till soil conservation system in Moldova needs a specific and complex adaptation to the climatic conditions, soil, agrocenosis, plant protection technologies, integrated land management, soil work for soil water conservation, which would increase agricultural productivity and maintain long-term soil productivity.

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IV. LANDSCAPE ARCHITECTURE, ENVIRONMENTAL PROTECTION

CZU 58 : 712.253(477)

WINDTHROW AND WINDSNAP OF TREES AND THEIR DETERMINING FACTORS IN THE "ALEXANDRIA" DENDROLOGICAL PARK OF THE NAS OF UKRAINE

Nina DRAGAN, Natalia BOIKO, Natalia DOIKO, Igor MORDATENKO, Yuri PIDORICH
«Alexandria» State Dendrological Park, National Academy of Sciences of Ukraine, Ukraine, Bila Tserkva

Abstract: Windthrow and windsnap, which periodically occur in the "Alexandria" Dendrological Park lead to the death of a large number of trees. The largest number of trees in the total fall is represented by middle-aged Acer platanoides and Fraxinus excelsior. The key factors of the fall were the direction of wind gusts and the phytopathological state of trees, and also the phytocenotic state of stands.

***Key words*:** "Alexandria" Dendrological Park, windthrow, windsnap, phytopathological characteristic, determining factors.

INTRODUCTION

Among the natural environmental factors that determine the state of tree stands, wind plays a substantial role. At certain speed, it can cause great damage to forest stands, such as windthrow (uprooting) and windsnap (breakage of the trunk).

Windthrow and windsnap cause significant damage to plantations in botanical institutions, where even a small number of fallen trees may result in the loss of unique specimens from collections, to the disturbance of landscape design and in areas with forest vegetation – to the formation of clearings, with all the ensuing consequences. In the "Alexandria" Dendrological Park, trees constantly fall for various reasons, but periodic natural disasters, which include storm winds, cause the simultaneous death of a large number of plants.

The goal of our research was to identify the species and age composition fallen trees, their phytopathological characteristics, as well as to determine the factors that lead to the loss of woody plants because of wind in the "Alexandria" Dendrological Park.

MATERIALS AND METHODS

The main characteristics of the age of plants (age groups) have been given according to A. A. Rozhkov [5]. Diseases have been diagnosed according to external macroscopic features (presence of fruiting bodies, cancer wounds, hollows, ulcers etc.) [3, 6]. Wind speed has been indicated according to the data obtained by the Bila Tserkva Hydrometeorological Service. The names of the species have been indicated according to Plant List [8].

RESULTS AND DISCUSSIONS

In less than the last two decades, the stands of the "Alexandria" Dendrological Park have suffered strong windthrow and windsnap damage four times. Four cases of storm winds were recorded (November 29, 2002 – 15 m/s with gusts up to 24 m/s; August 1, 2005 – 14 m/s with gusts up to 19 m/s; August 7, 2005 – 16 m/s with gusts up to 22 m/s and March 13, 2019 – wind gusts of 25-30 m/s), which led to the death of hundreds of trees (Table 1).

The number of dead trees during each disaster was significantly different and did not correlate with the speed of the wind and its gusts over the years. The greatest number of dead trees, as well as their largest species diversity, was recorded in 2002, the smallest – in 2005 (Table 1).

From the descriptions of the first two windthrow events made by the engineering service, only data on the number of dead trees and their species have been preserved, so we will give further analysis focused on the last event, from 2019, which we have studied.

Table 1. Trees uprooted or broken by storm wind in the "Alexandria" Dendrological Park

Species	Number of dead trees			∑, pcs.
	2002г.	2005*г.	2019 г.	
Acer platanoides L.	41	22	25	88
Acer pseudoplatanus L.	-	2	-	2
Acertataricum L.		1	1	2
Aesculus hippocastanum L.	-	1	-	1
Alnus glutinosa (L.) Gaertn.	2	-	1	3
Betula pendula Roth	3	-	-	3
Carpinus betulus L.	-	1	-	1
Catalpa bignonioides Walter	3	1	-	4
Crataegus monogyna Jacq.	2	-	-	2
Fraxinus excelsior L.	10	7	20	37
Padus avium Mill.	1	-	-	1
Robinia pseudoacacia L.	2	3	4	9
Picea abies (L.) H.Karst.			3	3
Pinus sylvestris L.	1	2	1	4
Populus nigra L.	-	5	-	5
Quercus robur L.	8	5	2	15
Salix alba L.	22	7	2	31
Thuja occidentalis L.	-	2	-	2
Tilia cordata Mill.	2	4	1	7
Ulmus laevis Pall.	2	1	8	11
*Juglans regia*L.	-	-	1	1
∑	98	64	69	231

Where * - total results for August 1 and 7, 2005

In 2019, 69 trees of 12 species died. Most dead trees belonged mainly to two species: *Acer platanoides* and *Fraxinus excelsior* (Table 1).

We observed that most of the deaths of trees occurred in certain areas. Single trees in the central and north-western parts of the arboretum were frequently affected by storm winds. In the south-east direction, a trail was noticed from west to east, from which two "branches" extended to the south, where the fall of trees was massive and whole groups of trees died (Figure 1).

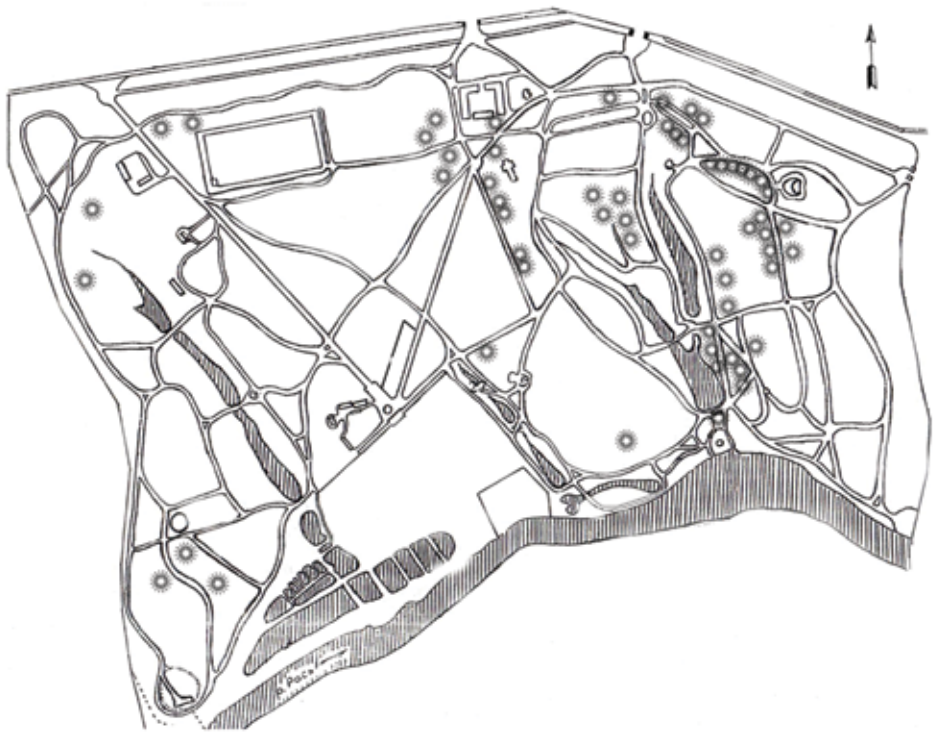

Figure. 1. The location of the fallen trees in the territory of the "Alexandria" Dendrological Park, 2019

The vast majority of dead trees were of middle age – 44 trees (63.8 %), fewer were semi-mature – 10 (14.5 %), only 7 trees were mature and senescent (10.1 %). Eight trees did not die, but one or another part of the crown was destroyed because of the windsnap. Mature and senescent trees (7 pcs.) were part of the landscape design. The trees of other age groups were of natural origin and grew in areas with typical forest vegetation.

Of the 69 trees destroyed by storm wind, 48 (69.6 %) were uprooted and 13 (18.8 %) were wind-snapped – their trunk was broken at different height. Another 8 (11.6 %) affected trees, the crown of which was heavily damaged, were also considered in the wind-snapped group. The vast majority of *Fraxinus excelsior* trees were uprooted, but among *Acer platanoides* trees, the uprooted ones just slightly prevailed.

The phytopathological analysis of the dead trees showed that almost all of them had been affected by diseases before their death (Figure 2).

Figure 2. Windthrow and windsnap of trees affected by rot in the "Alexandria" Dendrological Park

Acer platanoides trees were affected mainly by rot and cancer-necrosis. In the root zone of several trees, there were fruiting bodies of wood-decay fungi or hollows (the last stage of heart rot). Such trees died from windthrow. Several trees affected by trunk rot were wind-snapped. Among the *Acer platanoides* trees that died because of storm wind, there were no healthy trees. We noticed that most deaths of *Acer platanoides* trees occurred in certain foci.

All of the dead *Fraxinus excelsior* trees had initial or well-developed symptoms of ash dieback (a disease caused by *Hymenoscyphus fraxineus*), which is the main cause of large-scale fall of trees of this species in the dendrological park [2] and in Ukraine in general[4], as well as root rot. The windthrow of all *Fraxinus excelsior* trees occurred at the epicentre and new foci of infection with ash dieback, where trees of this species were drying out because of this disease. In the same area, over the past two years, 17 *Fraxinus excelsior* trees have been uprooted even in the absence of strong wind gusts, which indicates a heavy spread of root rot in the foci of ash dieback.

The trunk of a middle-aged *Picea abies* tree was broken by the wind at the height of 0.5 m, and that tree suffered from annosus root rot (*Heterobasidion annosum*). In the same place, there were 3 more fresh snags (standing dead trees) of the same age, which indicates a focus of infection of trees of this species. Two more dead trees of this species (in other areas) were affected by stem rot.

Two senescent dead trees of *Carpinus betulus*, in the northern part of the Park, had signs of severe infection with wood-decay fungi, while a group of 6 middle-aged trees of this species in the eastern part of the park died because of windthrow, but had no visible signs of fungal infection.

The 200-year-old *Pinus silvestris* tree that died from windthrow was affected at the top by bark beetle in association with *Ophiostoma* fungi. Over the past few years, old *Pinus silvestris* trees have fallen in this area after being affected by these pathologies, which also indicates focal infections and loss of trees of this species.

The peculiarities of the damage caused by storm wind in 2019 include the windthrow of a small number of *Quercus robur* trees, while even in the absence of strong gusts, from 7 to 15 oak trees die from windthrow and windsnap every year. This phenomenon can be explained partly by the fact that the strongest gusts of wind were observed in the areas of the park with no oak trees.

It is also difficult to explain why within the above-mentioned “branches”, in recent years, a large number of *Betula pendula* trees dried out, but none of the trees of this species was damaged during storms. The reason for this may be the absence of signs of rotting on the drying trees.

The large majority of trees grew at the edge of forest areas or along the alleys. In plantations, only the death of *Fraxinus excelsior* was noted in areas where such trees were drying out from ash dieback associated with root rot.

The monitoring of the current situation concerning the death of trees of the main park-forming species of the arboretum indicates that every year in “Alexandria”, from 70 to 160 trees of various species dry out in the absence of storm winds [1]. Strong gusts of wind are an accelerating factor, leading to a faster death of trees affected by rot.

CONCLUSIONS

1. Thus, storm winds, which are periodically observed on the territory of the dendrological park "Alexandria", lead to the simultaneous death of a large number of trees.
2. There is no correlation between the strength of the wind and its gusts and the number of dead trees.
3. In certain years, centers of death of trees are formed in the territory of the park, which are determined, apparently, by the direction of wind gusts and the condition of trees along the wind streams, with the largest number of trees dying on forest edges and along the alleys.
4. The mechanical fall of trees was carried out exclusively due to rotted specimens growing along the wind streams: 69.6% of the dead trees had root rot, 30.4% - stem, or rot of large skeletal branches.
5. The predominance in the mechanical fall of *Fraxinus excelsior* and *Acer platanoides*, as well as in the age-old ratio of middle-aged specimens, is determined by the significant predominance of these species and this age-old category in the stands.

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V. SCIENTIFIC CHRONIC

ONICA ELISAVETA – MODEL DE IMPLICARE, DEDICARE ŞI ENERGIE

(la a 60-a aniversare)

Ion ROŞCA, Alexei PALANCEAN, Alina CUTCOVSCHI-MUŞTUC
Grădina Botanică Naţională (Institut) „Alexandru Ciubotaru”, Chişinău, Republica Moldova

Onica Elisaveta s-a născut la finele iernii, 26 februarie 1959, într-o familie simplă de muncitori, pe nume Polixenia şi Ion Negru, din comuna Balatina, raionul Glodeni.

În 1976 a absolvit şcoala din satul natal şi a continuat studiile la Institutul Pedagogic de Stat din Tiraspol, Facultatea de Biologie şi Chimie pe care l-a absolvit în 1981 cu diplomă roşie. În acelaşi an, 1981 este angajată la Grădina Botanică (I) a AŞM (actualmente Grădina Botanică Naţională (Institut) „Alexandru Ciubotaru”), activând cu dedicare şi implicare până în prezent. În perioada 1981-1985 urmează studiile de doctorat în cadrul instituţiei.

Teza de doctorat cu tema: „Особенности анатомической структуры гибридов айва × яблоня” a fost susţinută cu succes în 1993. Ca rezultat al cercetărilor efectuate au fost stabilite unele legităţi de moştenire a caracterelor morfo-anatomice la hibrizii intergenerici *Cydolus* şi selectate formele cele mai preţioase de *Cydolus*.

După obţinerea doctoratului ocupă funcţia de cercetător ştiinţific superior la Grădina Botanică contribuind la introducerea, conservarea şi utilizarea eficientă a genofondului autohton şi alohton de plante lemnoase. Au fost realizate cercetări de introducere, ameliorare şi evidenţiere a speciilor de perspectivă pentru diferite tipuri de spaţii verzi, agricultură şi silvicultură. Pe parcursul activităţii sale, s-a urmărit protejarea şi îmbunătăţirea stării ecologice a arealurilor de plante utile pentru lucrări intensive de introducere şi completare a colecţiilor, expoziţiilor cu noi specii; evidenţierea celor de perspectivă; elaborarea tehnologiilor de multiplicare şi cultivare a noilor taxoni. Coordonează activităţile şi lucrările agrotehnice în pepiniera laboratorului dendrologie. Pe perioada activităţii ştiinţifice din cadrul Grădinii Botanice (I), dna Onica Elisaveta a contribuit la valorificarea şi îmbogăţirea fondului genetic al plantelor lemnoase; introducerea, studierea şi utilizarea raţională; conservarea diversităţii specifice şi intraspecifi-

ce, implementarea celor mai valoroase în economia naţională. În cadrul cercetărilor au fost elaborate tehnologii de multiplicare şi cultivare a arbuştilor decorativi şi fructiferi netradiţionali, selectate forme preţioase de arbuşti fructiferi netradiţionali, coautor a 3 brevete pentru soi de plante. În decursul anilor a stabilit unele legităţi de moştenire a caracterelor morfoanatomice la hibrizii intergenerici poliploizi la *Cydolus (Cydonia x Malus)*.

În aceşti ani a participat activ, promovând realizările laboratorului de dendrologie la numeroase conferinţe, seminare, simpozioane ştiinţifice naţionale şi internaţionale, unde a fost înalt apreciată. În cadrul expoziţiilor tematice din Iaşi, Timişoara şi Chişinău a fost menţionată cu numeroase diplome, 2 medalii de aur, 2 medalii de argint, 1 medalie de bronz şi Premiul AGEPI „Cel mai de succes soi de plantă", pentru soiurile naţionale de arbuşti fructiferi. Împreună cu echipa de cercetare a realizat numeroase proiecte: naţionale, internaţionale, bilaterale, amenajarea spaţiilor verzi.

Cele mai relevante sunt:

1. Proiect internaţional: „Iniţiativa trans-frontalieră pentru dezvoltarea unui spaţiu ludic prin intermediul artei Topiare pentru scopuri educative şi de relaxare" (România-Ucraina-Republica Moldova, 2007-2013);

2. Proiecte instituţionale: „Valorificarea şi îmbogăţirea fondului genetic al plantelor lemnoase" (2006-2010); „Introducerea, studierea şi utilizarea raţională a plantelor lemnoase" (2011-2014); „Conservarea diversităţii specifice şi intraspecifice a plantelor lemnoase, implementarea celor mai valoroase în economia naţională" (2015 -2018).

3. Proiecte de colaborare: cu Institutul de Genetică, Fiziologie şi Protecţie a Plantelor la tema „Impactul reglatorilor naturali asupra procesului de rizogeneză a arbuştilor fructiferi netradiţionali"; cu Institutul de Cercetări şi Amenajări Silvice la tema „Reconstrucţia ecologică a arboretelor necorespunzătoare"; cu Institutul de Chimie la tema „Influenţa nanocompozitelor asupra creşterii plantelor speciilor forestiere".

4. Proiectarea şi amenajarea spaţiilor verzi din preajma gimnaziului din satul Ratuş, raionul Criuleni şi în preajma Primăriei satului Şâşcani, raionul Nisporeni.

Rezultatele ştiinţifice ale cercetărilor efectuate de dna Elisaveta Onica au fost publicate în cca 100 lucrări ştiinţifice. O parte din ele au fost publicate în reviste internaţionale cu impact factor, reviste naţionale şi internaţionale recunoscute, coautor la 3 soiuri noi de plante, etc.

În baza hotărârii Consiliului Naţional pentru Atestare şi Acreditare din R.Moldova în 2016 i se conferă titlul ştiinţific de cercetător conferenţiar la specialitatea 164.01 - Botanica. Dna Elisaveta Onica obţine meritul Academic a AŞM în 2015.

În mod activ contribuie la formarea specialiştilor în domeniu, fiind consultant la teze de doctorat, masterat şi licenţe. Educaţia ecologică a populaţiei, în special a tinerei generaţii o realizează atât prin lecţii, excursii la colecţiile de plante lemnoase tradiţionale şi netradiţionale, cât şi emisiuni tematice la posturile naţionale de televiziune şi radio. Coordonează lucrările practice şi de producere ale studenţilor de la Instituţiile cu profil de biologie din ţară.

Pentru activitatea prodigioasă în cadrul Grădinii Botanice Naţionale (I) „Alexandru Ciubotaru„ şi rezultate ştiinţifice, dnei Elisaveta Onica i se conferă diploma de onoare din partea Ministerului Educaţiei, Culturii şi Cercetării al Republicii Moldova.

Cu ocazia frumosului jubileu de 60 ani de la naştere şi 38 de ani de activitate în cadrul Grădinii Botanice Naţionale (Institut) „Alexandru Ciubotaru" îi transmitem acestui model de implicare, dedicare şi energie, sănătate din plin şi putere de a realiza lucruri măreţe în continuare.

LA MULŢI ANI, DISTINSĂ DOAMNĂ!

BOTANISTUL PAVEL PÎNZARU LA CEA DE-A 60 - A ANIVERSARE

Ştefan MANIC, Valentina CANTEMIR
Grădina Botanică Națională (Institut) „Alexandru Ciubotaru”, Chișinău, Republica Moldova

Pavel Pînzaru, născut la sfârşit de vară augustină (26.08.1959), din dragostea părinților Iustina și Iacob Pînzaru, vine de pe meleaguri floreştene, satul Cernița, raionul Florești. După absolvirea Școlii Medii din satul Pridnestrovsk, actualmente Tîrgul-Vertiujeni, raionul Florești, în anul 1976 se înscrie la Școala Profesională nr. 7 din același sat. În perioada anilor 1977-1982 continuă studiile la Institutul Pedagogic „Taras Șevcenco” din Tiraspol, Facultatea de Geografie, specialitatea Geografie și Biologie. Fiind student, a manifestat un mare interes față de lumea plantelor, interes alimentat şi dezvoltat de doamna doctor în științe biologice Eugenia Pulbere, sub conducerea căreia susține teza de licență cu tema „Biologia galelor în Moldova”. În anii 1982-1986 lucrează în calitate de pedagog în satele Voinova, raionul Strășeni și Cuhureștii de Sus, raionul Camenca. În anul 1986 se înscrie la doctorat în Grădina Botanică a Academiei de Științe din Chișinău, Laboratorul Floră și Geobotanică, unde sub conducerea doamnei doctor în științe biologice Xenia Vitko studiază pădurile din cursul mijlociu al fluviului Nistru. În anii 1989-1998 activează în calitate de cercetător științific în cadrul Laboratorului Floră și Geobotanică, ulterior Floră spontană și Herbar. În anul 1991 susține teza de doctor în științe biologice, iar în 1995 obține titlul de cercetăror științific superior, actualmente cercetător conferențiar. Între timp, în anul 1991, a activat în calitate de vicedirector pentru probleme științifice în Rezervația științifică „Codru”.

În perioada anilor 1998-2014, cu excepția anului 2009, se află la muncă peste hotare, în Italia. Aici, la Institutul de Plante Lemnoase și Mediu (IPLA) din Torino și Parcul „Collina Torinese” din comuna Castagneto Po (provincia Torino), activează în calitate de consultant științific pe problema florei și vegetației, participând la descrierea florei și vegetației din Alpii de Sud-Vest și a Colinelor Torineze din Regiunea Piemonte, în cadrul Proiectului Internațional Interreg III „Flora e Habitat” Alpi Occidentali. În anul 2014 revine în țară și până în prezent continuă activitatea sa științifică în Laboratorul Floră spontană și Herbar „Andrei Negru” al Grădinii Botanice Naționale (I) „Alexandru Ciubotaru”.

În decursul activității științifice, Pavel Pînzaru a efectuat cercetări asupra florei și vegetației din Republica Moldova, Basarabia de Nord și de Sud, Italia (Regiunile Piemonte, Liguria, Lombardia, Valle d’Aosta și Veneto). Rezultatele cercetărilor sunt expuse în circa

160 de lucrări ştiinţifice. Este autor şi coautor la 9 monografii – „Taxoni rari din flora Republicii Moldova" (2000), „Cartea Roşie a Republicii Moldova" (ed. 2, 2001; ed. 3, 2015), „Flora Basarabiei" (vol. 1, 2011; vol. 2, 2016), „Flora vasculară din Republica Moldova (Lista speciilor şi ecologia)" (ed. 1, 2014; ed. 2, 2016), „Plante rare ale raionului Floreşti din Republica Moldova" (2017), „Flora e vegetazione di Sala Monferrato (AL)" (2017). Actualmente sunt pregătite pentru editare monografiile „Pteridofitele din Republica Moldova" şi „Plantele rare de stâncării din Republica Moldova".

Descrie specii noi pentru ştiinţă din flora Italiei: *Saussurea italica* Pînzaru, *Gentiana annaverae* Pînzaru, *Viola danielae* Pînzaru, *Thalictrum delponteanum* (Pînzaru) Pînzaru; din flora Republicii Moldova – *Centaurea x pulberiana* Pînzaru şi un şir de varietăţi şi forme noi. Evidenţiază peste 30 de specii noi pentru flora Republicii Moldova şi 12 specii noi pentru flora Basarabiei de Nord şi de Sud. Drept recunoştinţă, pentru activitatea fructuoasă în cercetare, botanistul rus Vladimir Nikitin, pe baza exsicatelor colectate de omagiat din Rezervaţia peisajeră „Rudi-Arioneşti" şi prezentate la Sanct-Petersburg pentru identificare, denumeşte specia – *Viola pynzarii* V. Nikit. (1991) în numele omagiatului.

Ca rezultat al cercetărilor fitocenologice, descrie 3 alianţe noi pentru ştiinţă: *Sempervivo ruthenici-Schivereschion* Pînzaru et Ruschuk, 2009 (cuprinde vegetaţia fisurilor de stâncării, a toltrelor), *Epilobion dodonaei* Pînzaru, 2006 (vegetaţia şisturilor argiloase stratificate), *Genisto tetagonae-Seselion peucedanifolii* Pânzaru, 1997 (vegetaţia actuală a calcarelor sarmaţiene) şi un şir de asociaţii şi subasociaţii noi.

În calitate de conferenţiar universitar activează la Catedra de Silvicultură şi Grădini Publice a Facultăţii de Horticultură a Universităţii Agrare din Moldova şi la Catedra de Biologie vegetală a Facultăţii de Biologie şi Chimie a Universităţii de Stat din Tiraspol (la Chişinău).

Pentru a facilita observaţiile asupra dezvoltării plantelor şi a reintroducerii celor rare în habitatele naturale, a creat în grădina proprie o colecţie de peste 600 de specii de plante.

Cu ocazia frumosului jubileu, domnule Pavel Pînzaru, colegii de breaslă, Societatea de Botanică din Republica Moldova, al cărui membru sunteţi, vin cu cele mai frumoase şi calde urări de sănătate, fericire, satisfacţii sufleteşti şi profesionale, iar pasiunea şi dragostea pentru natură să vă fie catalizatorii vieţii şi ai reuşitelor. Mulţi ani fructuoşi pe tărâmul ştiinţific şi didactic întru prosperarea ştiinţei botanice naţionale.

LA MULŢI ANI CU SĂNĂTATE!