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50th ANNIVERSARY OF THE BOTANICAL GARDEN (INSTITUTE) OF ASM AT THE CURRENT LOCATION - NATIONAL MONUMENT OF LANDSCAPE ARCHITECTURE (1965-2015). TASKS, ACHIEVEMENTS, PROSPECTS

Ciubotaru A.A. acad.
Botanical Garden (Institute) of the ASM

The day of September 27, 1965 will remain forever in the historiography of the Botanical Garden (Institute) of the ASM, marked by Decision № 919 of the Government of the Republic of Moldova, according to which, 104 ha of land in the south-western part of the city were allocated for the establishment of a botanical garden. The use of the words from the Holy Bible: "In the beginning was the word" in the context of the history of the Botanical Garden seems metaphorical, but it is quite appropriate! Something like that happened in this case – we said: "we want land; we want a new territory to build *de nova* a botanical garden". So we asked a new piece of land on 24.08.1964, when we were heard, and the "wheel" of renovation of botany in Moldova "moved".

The moment when we obtained the new land was a crucial one; it was followed by many changes, plans and actions in economic and financial terms and indicators. A retrospective of our achievements is evidence of an incredible marathon.

The starting point was the selection of the piece of land for the establishment of the Botanical Garden, approved by the above-mentioned Decision of the Government of the Republic of Moldova, 50 years ago. The demands of the BG team envisage obtaining an area of 80-140 hectares, within the administrative area of the city, with slopes with various exhibitions (S, N, W, E) and a variety of soils, rocks, including meadows, hills and a source of flowing water, etc. We needed soils with special pedological properties, favourable for the development of native and (especially) alien species. We demanded a territory linked to urban thoroughfares and communication channels, without any administrative or residential buildings. We were looking for a piece of land in the urban area, but as similar as possible to the unique natural Moldavian landscape.

People who have seen the current territory of BG can tell to what extent we succeeded.

The second point – the building concept of the Botanical Garden presented by us, was described in Design Tasks, completed with the requirements of the Department of Urban Architecture of Chisinau. Mentioned materials were part of the contract for the planning of the Botanical Garden Complex. General designer – the subsidiary from Leningrad (1966-1971). The general building plan of the Botanical Garden, developed in 1971, was analysed and accepted at the All-Union Session of Botanical Gardens (president – acad. N. Tsitsin, September 1971, Chisinau).

The construction works of the Botanical Garden started in the spring of 1972. We remind that the designing of the collections and exhibitions of herbaceous plants in open and protected ground was done by the Botanical Garden of the ASM.

When dividing the territory of the Botanical Garden into zones, it was decided that:

The **1st zone** should include the objects for exhibition, such as: the dendrarium, the exhibition "Flora of Moldova", exhibitions of ornamental plants, the rosary (garden of roses), the lianrium (garden of lianas), the garden of trees with guided crowns, the rokarium (Japanese garden), the syringarium (garden of lilac), the alpinarium (garden of alpine vegetation). In the central part, by embanking a little river, a system of decorative lakes with aquatic flora should be created, the East Asian flora sector. The central gate and the fund exhibition greenhouse (tropical and subtropical plants) were provided for on the NW side, and the main laboratory block including household facilities – on the SE side.

The **2nd zone** includes areas for the collections intended for experiments, allocated on the SW side of the territory bordered by the Chisinau Airport highway and simultaneously being intended for

different groups of plants and scientific researches, an area, which is accessible only to the employees of BG and to specialized tours. Here should also be built greenhouses to obtain seedlings, a plant house, hotbeds, a dendrological nursery, a pumping station etc. Overall, 12 objects, such as seed warehouses, plant drying rooms, a garage, a boiler room, a current transformer etc, were planned and built in this area.

The first stage also provided for the installation of the metal fence, the underground irrigation system on the entire surface of the BG, construction of the office block (the conference hall, the republican herbarium, the dining hall), ensuring access to public utility services, construction of paved and unpaved roads.

The second stage provided for the construction of the central entrance, the fund exhibition greenhouse (exhibition of tropical and subtropical plants), completion of the scientific library, the Republican Herbarium, the Botanical Museum, the conference hall, the decorative bridges between lakes etc.

By the beginning of 1988, most of the tasks set by the General Plan (de facto the first stage) had been completed, the construction of facilities being financed from budgetary and extra budgetary resources. The last resources were used to build the following items: the 3.4 km long metal fence, the greenhouse complex for tropical and subtropical plants, the biotechnology block, the decorative lakes, the underground irrigation system etc.

Some achievements from the first 22 years of construction and scientific activity. I became convinced that the establishment of the Botanical Garden on a new territory paved the way for the development of botany in Moldova. This bold idea gave rise to great expectations. So, let us remember what was done in the first 22 years:

1. the main building works were completed, 1st stage; 2) an extensive training programme for researchers was conducted (over 100 Ph.D.'s and 20 Dr. habil.'s) including the preparation of doctoral theses in scientific centres of the former Soviet Union and other countries; 3) the gene pool of the BG (I) of ASM, according to the number of species and taxa, took the 4th place in the rating of the former Soviet Union (about 12 thousand) after the Central BG (Moscow), Central BG (Kiev), or the BG from Minsk; 4) the great assortment of ornamental, aromatic, medicinal, food and fodder plants, over 400 species of economic importance for the Republic of Moldova, and the improvement of some cultivars, the creation of over 100 varieties, hybrids and acclimatized ecotypes, through hybridization and selection, speak about the results of introduction of non-native species; 5) obtaining the status of scientific institution offered by the State Committee on Science and Technology of the former USSR; 6) creation of the Specialized Scientific Council of the BG (I) for defending of doctoral and habilitation theses in biology; 7) foundation of the periodical "Revista Botanică" ("Journal of Botany"), of a series of monographs "Determinatorul plantelor vasculare" ("Identification Manual of Vascular Plants"), "Растительный мир Молдавии" ("The flora of Moldova") in five volumes, "Lumea vegetală" ("The Plant World") decorative book in 4 volumes, "Embriologia plantelor de cultură" ("Embryology of crop plants") in two volumes, preparation and publication of "Flora Basarabiei" ("Flora of Bessarabia") in six volumes, over 80 monographs on different crops, etc.; 8) creation of the Scientific Library of the BG (I) of the ASM; 9) organization of conferences, symposia, local and international conferences on botany, landscape planning, electronic microscopy, biotechnology etc.; 10) consolidation of 6 scientific schools (within the Botanical Garden) in the field of geobotany and floristics (founded by corresponding member T. Ghedeman), distant hybridization (founded by Acad. V. Rîbin), embryology and cytogenetics (founded by Acad. A. Ciubotaru), plant anatomy (founded by Acad. B. Matienco), paleobotany (founded by Acad. A. Negru) and algology (founded by corresponding member V. Șalaru); 11) establishment of the Botanical Garden as a monument of landscape architecture and a way of popularizing modern botany; 12) implementation of applied botanical research in the national economy of Moldova.

Prospects. The further development of the Botanical Garden consists in the maximum revival of public interest, 1) attracting financial means necessary for the second phase of building the BG.

2. The BG is meant to conduct the process of creating two Botanical Gardens with didactic and

educational purposes, in Balti and Cahul, of creating and protecting the dendrological parks from our country, with different purposes (rest, recreation, entertainment, education, etc.), in order to purify the environment and strengthen people's health. We were and still remain involved in the creation of the park Arboretum (or the park "Unirea" dedicated to the accession of RM to the European Union), a territory linked to the BG through the subway Botanical Garden – Arboretum.

3. The development of ornamental plant nurseries in rural areas, with the help of the BG (I) of the ASM, by implementing our experience in this field, by offering free planting material.

4. The development of research on agrophytocenoses: monitoring of pollination, quality and quantity of pollen, formation and development of seeds, monitoring of genome pollution and changes of the karyotype under the conditions of intensive technologies, use of herbicides, which often comes from the desire to achieve the maximum yield. The lack of decreed standards of yield on concrete soils, medico-sanitary certification, cytogenetic attestation (of mutability), fertilizers applied annually represent an increased risk. We remind that in the West this risk is under control, it is monitored by law.

5. It is necessary that botanists and doctors do further research in the field of medicinal botany, phytotherapy, which must be brought back into society, schools, higher education institutions, creation of pharmacies like "Fitofarm". At the first stage, the creation of the collections must be finished – exhibitions of medicinal, antihepatotoxic, anti-diabetic plants, used to treat different diseases: heart disease, arthritis, stressogenic diseases etc.

6. The expansion of botanical research by implementing new, economically valuable varieties of aromatic, medicinal, energy, food, fodder, ornamental plants etc., to help rural business and to train specialists in horticulture and maintenance, management and development of green areas.

7. Drafting a complex development program for the Botanical Garden in common with the municipal authorities of Chisinau, sharing the problems associated with the completion of phase II of the establishment of the BG (the central entrance, the fund exhibition greenhouse, construction and repair of paved roads, decorative bridges, pond landscaping, creation of the Botanical Museum etc.), the terms of the objectives, the volume of financing, the executants, the managers etc., the plans were coordinated and approved by the respective bodies (municipal authorities and ASM).

I want to remember the fact that the Botanical Gardens throughout history have substantially contributed to the progress and prosperity of civilizations. Their achievements and their number in the European countries point to this fact. Anca Sirbu (ex director of the Botanical Garden of Bucharest) said: "In a changing world, strongly affected by human impact, the tasks of these institutions amplify and diversify in order to contribute as effectively as possible to saving the natural heritage of our homeland". Over 400 botanical gardens, in Europe only, work in order to attain this objective (United Kingdom – 77, Austria – 13, Belgium – 25, France – 68, Germany – 78, Italy – 54, Netherlands – 43, Spain – 16 and in the former USSR – 120), where there are collections of well-identified plants, used for scientific research, conservation of plant diversity, information and education (International Association of Botanic Gardens, 1999). We emphasize again that plants are fundamental to our daily life and their sustainable use remains crucial for the future of mankind.

It is timely to mention that, throughout the years, I enjoyed support from many scientists and statesmen, and I would like to express my sincere thanks and gratitude to: the first president of the ASM, acad. I. Grosul, the president of the Union of Botanical Gardens, acad. N. Tsitsin, corresponding member P. Lapin (Moscow), acad. A. Grodzinskii (Kiev), acad. V. Smolskii (Minsk), acad. Emil Pop (Cluj-Napoca), acad. C. Toma, prof. M. Mititiuc (Iasi), prof. Andrei Marin, prof. Anca Sîrbu (Bucharest), acad. A. Spaskii, acad. Gh. Duca, M. Lupaşcu, acad. T. Furdui (ASM). I would like to thank the staff of the Botanical Garden: G. Costaş, N. Popescu, A. Negru, I. Comanici, A. Teleuță, A. Palancean, C. Andon. V. Florea, M. Bodrug, V. Ciocoi, P. Țurcan, V. Sava, V. Țîmbală, V. Codreanu et al., for their support.

I. STRUCTURAL AND FUNCTIONAL DIVERSITY OF PLANT ORGANISMS

DISTANT HYBRIDIZATION OF FRUIT AND NUT PLANTS

I. Comanici
Botanical Garden (Institute) of the ASM

The experiments on distant hybridization of fruit plants began at the Botanical Garden of the ASM in 1956, after the arrival of prof. V. A. Rybin. Initially, V. A. Rybin aimed at solving a theoretical problem – the genesis of common plum (*Prunus domestica L.*, 2n = 48). Rybin successfully solved this problem. He obtained an amphidiploid (2n = 48) by crossing: *Prunus cerasifera* (2n = 16) x *P. spinoza* (2n = 32), which, according to morphological characters, hardly differed from Prunus domestica L. (2n = 48) [Rybin, 1936].

Then, he went on to solving scientific and practical problems. With that end in view, he crosses the newly synthesized plum with the cultivated common plum. Thus he obtained trispecific hybrids: *Prunus cerasifera x P. spinoza x P. domestica* (newly synthesized) and established the possibility of hybridizing the amphidiploid (2n = 48): cherry plum x blackthorn *(Prunus cerasifera x P. spinoza)* with the cultivated plum varieties, and the fact that, in F1, the characters of cultivated parental forms, such as fruit size, taste, aroma, low to zero astringency peculiar to blackthorn etc., are present, has great significance for improving crop varieties.

In order to pass the high resistance to frost of spontaneous *Prunus* species to the cultivated varieties of common plum, V. A. Rybin chose, for hybridization, Ussuri plum, which can withstand temperatures below 50 °C.

The hybrid *Prunus* spinoza x *P. ussuriensis* is distinguished by rapid growth and high resistance to frost, but it proved to be triploid 2n = 3x = 24 and completely sterile. After numerous unsuccessful attempts to double the number of chromosomes by applying colchicine, Rybin resorted, already in Moldova, at the Botanical Garden, to grafting the sterile triploid hybrid onto a vigorous cherry plum tree. The grafted hybrid, which formed a large crown, flourished very abundantly, so that branches couldn't be seen, produced, however, six fruits. Two of the seedlings obtained from those six fruits (stones) proved to be hexaploid: 2n = 6x = 48. In the 3rd year, they produced several tens of flowers, and the next year, an amphidiploid hybrid (hexaploid, 2n = 48). And next year, the amphidiploid hybrid (hexaploid) *Prunus spinoza x P. ussuriensis* was crossed with the variety "Renclod Violet" and yielded well, reaching full maturity. In this experience, it is important that the trispecific hybrids *Prunus spinoza x P. ussuriensis x P. domestica*, already in F1, combine the high quality of the cultivated variety and the high resistance to frost of the spontaneous species.

In a relatively short time, at the Botanical Garden of ASM, a collection of distant hybrids was created, about 40 varieties. Some of these hybrids were studied in detail by dr. H. I. Rodenco.

The hybrid *Cydonia oblonga x Malus domestica* F1 No.1, obtained in Bulgaria (В. Панов и др., 1965), was grafted at the Botanical Garden of ASM, onto quince. In 1966, the grafted hybrid saplings were planted into their final place. The hybrid quince x apple F1 is of intermediate type according to certain characteristics (aroma, stony cells, shape of buds etc.). Morphologically, the flowers are similar to those of quince; the floral buds form a single flower, the flowering stage lasts about 20-25 days, which excludes, on one hand, the extensive formation of ovaries (premature fruits) and, on the other hand, avoids the danger of spring frosts. Fruits are large, the average weight in 1969 – 200 g (maximum – 300 g), the peel of the fruit – lemon-yellow with a thin layer of wax, the pulp (mesocarp) – white-yellowish-creamy, sweet-sour taste, medium to strong apple flavour. From the trees obtained by open pollination, 419 kg of fruits or about 2095 fruits were harvested; from these fruits, 628 seeds were extracted, more than half of the number of seeds proved to be stunted and, from the sown seeds, 93 seedlings were obtained in F2, or 14.8%. In 1972, 116 seeds of 146, or 79.4%, germinated. There were also obtained 187 seedlings in F3. The intergeneric hybrid *Cydonia x Malus* has been named by I. S. Rudenco – Cydolus.

Cydolus is important not only in that it combines, to a certain extent, the characteristics of quince and apple fruits and is able to form one-two flowers from buds, but also because it can be a universal rootstock for quince, apple and pear.

The hybrids between apple and pear are obtained with great difficulty and proved to be little promising. It produces little yield; the fruits are heterogeneous, small, with sour-sweet astringent taste, pear flavour.

The allodiploid hybrid *Prunus besseyi x Armeniaca vulgaris* (2n = 2x = 16) was created to increase the frost resistance of apricot. The hybrid is vigorous, more resistant to frost than apricot, blooms late, is characterised by low fertility, the pollen – completely sterile, the fruits, morphologically, resemble those of cherry plum.

The hybrid *Prunus besseyi x Armeniaca vulgaris* F2 proved to be allotriploid (2n = 3x = 24) (Rudenco, 1973). The hybrid grafted onto cherry plum reached 6 m in height at the age of seven, later, the annual growth rate decreases (8-15 cm). It blooms later than apricot, but produces very little yield; at the age of seven, it bore 52 fruits of different size, the average weight – 15.8 g. The mesocarp is green-yellowish, has sweet-sour taste with slight flavour of apricot.

The third generation (F3) of the hybrid *Prunus besseyi x Armeniaca vulgaris* is genomically heterogeneous. The cytological study revealed that 21 seedlings from this hybrid were:

allodiploid 2n = 2x = 16 – 1 hybrid,
allotriploid 2n = 3x = 24 – 5 hybrids,
allotetraploid 2n = 4x = 32 – 5 hybrids,
allopentaploid 2n = 5x = 40 – 5 hybrids,
allohexaploid 2n = 6x = 48 – 5 hybrids.

So, the hybrids of F3 generation, according to the number of chromosomes, comprise the entire allopolyploid series (2x; 3x; 4x; 5x; 6x) of the genus Prunus Mill. (Rudenco, 1978).

The hexaploid hybrids (2n = 6x = 48) are of importance for increasing the resistance of cultivated plum to frost and drought (*Prunus domestica L.*, 2n = 48) due to the genome of Prunus besseyi Bail.

Distant Hybridization of Walnut (*Juglans* L.)

The agrobiologic potential of common walnut *(Juglans regia L.)* is not satisfactory enough with regard to some characteristics, such as resistance to harsh frosts, late spring frosts, various diseases, and fruitfulness in the first fruitage period. In this regard, it is reasonable to apply distant hybridization with wild species of Juglans in order to enrich the genetic potential and to obtain new varieties of common walnut.

The experiments on hybridization of the species of the genus *Juglans L.* have been performed at the Botanical Garden of ASM since 1967 (Comanici, 1970, 1982, 1989). Reciprocal crosses were made: forms of common walnut *(Juglans regia L.)* as mother plants (direct crosses), and wild species of *Juglans (J. mandshurica Max.; J. sieboldiana Max.; J. cordiformis Max.; J. cinerea L.; J. nigra L.; J. rupestris Engelm.; J. hindsii Jeps.)* – as father plants, and reverse crosses – wild species of *Juglans* were used as mother plants, and forms of common walnut – as father plant.

During the experiments involving direct crosses, flowers of several varieties of common walnut were pollinated with pollen of wild species of *Juglans* – 8500 flowers, from which, 420 (4.9%) fruits (nuts) were obtained and 43 (0.50%) one year old saplings were grown.

During reverse crosses, 4877 flowers of wild species of walnut *(Juglans)* were pollinated with pollen of common varieties of walnut, and, 416 (8.5%) fruits and 132 (2.7%) one year old saplings were obtained.

The hybrids Common walnut x Japanese walnut *(Juglans regia x J. sieboldiana)*

As a result of direct hybridization of common walnut and Japanese walnut, 2483 flowers were pollinated, 130 (5.2%) fruits (nuts) were obtained, from which, 13 one year old saplings were grown, that is, 0.5% of pollinated flowers and 10 % of sown nuts. Nine of these plants survived. Out of nine plants, six are of maternal type and only three are of intermediate type. The intermediate hybrids have inherited to different extent the traits of both parental forms. At the age of 16, at their final place, they reached a height of 6.5-7.5 m. They are resistant to frost and diseases, bloom abundantly for 8-10 days. The fruitage is quite poor – 5-6 %. Fruits (nuts) – of intermediate type, with prevalence of traits inherited from the paternal form (Japanese walnut) thick and hard shell, uneven surface, with pronounced depressions and protrusions, the kernel yield – 21-25 %.

The karyological analysis, conducted by us, showed a diploid number of chromosomes – 2n = 72,

length – from 0.83 to 2.03 mcm, thickness – from 0.36 to 0.63 mcm.

The hybrids Common walnut x black walnut *(Juglans regia x J. nigra)*

1490 flowers were pollinated, 15 fruits were obtained (1.01%), 6 seeds germinated and 3 seedlings developed, two of which are of intermediate type and one has only traits inherited from the maternal form.

The intermediate hybrid common walnut x black walnut (27 – 6-7) at the age of 16 reached a height of 9.6 m and a diameter of the crown of 8.5 m. It bloomed in the third year after having been planted into its final place. It blooms profusely, but reaching the size of a pea, fruits start falling and only 2.3% reach maturity. Male flowers start developing normally, microsporogenesis takes place, pollen is produced, but it proved to be uneven in size and mostly sterile. All male flowers fall off before reaching full maturity and without releasing pollen. Fruits – of medium size (10.1 g), elongated, with discontinuous endocarp, deeply furrowed, dark pale brown; with thick and hard shell, poor kernel yield – 17.7%.

The diploid number of chromosomes is 2n = 32. Chromosome length is 0.83-1.46 mcm, thickness – 0.36-0.52 mcm. The total chromosome length is 36.35 mcm, it is by 15.13% shorter than the maternal form (common walnut) and by 28.19% shorter in comparison with the paternal form – black walnut.

Cytological studies revealed large disturbances in the process of microsporogenesis and pollen grain formation. Thus, in diakinesis, together with bivalent chromosomes, there are univalent chromosomes, in metaphase I, chromosomes are arranged disorderly, and their number (or rather the number of chromosomal combinations) can be 15-16-17-18; in anaphase I and anaphase II, there are disorders as a delayed movement (lagging) of chromosomes, which cannot be included in the daughter nuclei. These disturbances lead to the sterility of pollen.

The hybrids Japanese walnut x common walnut *(Juglans sieboldiana x Juglans regia)*

In the reverse crosses of common walnut with Japanese walnut, 3450 flowers were pollinated, 300 fruits were produced (8.7%). 90 plants germinated from the sown seeds, survived 64 plants, 30 of them have inherited to different extent the traits of both parental forms, at the age of 16, they were 6.5-8.8 m tall. They are resistant to frost and diseases, bloom profusely, but produce little fruit – 1.9-11.5%. Only the hybrid 2-1-2 produces up to 36 %. As for the nuts (endocarp), wild type characters prevail. The kernel yield – 20-21 %. The diploid number of chromosomes – 2n=32; h=0.78-2.03 mcm; D=0.31-0.62 mcm.

The hybrids Manchurian walnut x common walnut *(Juglans mandshurica x J. regia)*

During the hybridization of Manchurian walnut and common walnut, 519 flowers (of common walnut) were pollinated, 40 fruits were obtained (7.7%), from which, 16 seedlings were obtained. 11 seedlings survived, 6 of them have inherited traits from both parental forms. These intermediate hybrids grow slowly and look a little unhealthy. A sapling died at the age of 3 years, and another – at the age of 12. The surviving hybrids grew 1.5-3.5 m tall and only one was 5.5 m tall.

The hybrids White walnut x common walnut *(Juglans cinerea x J. regia)*

In the given combination, 250 flowers were pollinated, 36 (14.4%) fruits were obtained. 20 seedlings grew from the sown seeds. Most of the obtained plants are of maternal type, and only three plants have inherited traits of both parental forms. They have grown about 3.6-4.4 m tall. In cold winters, annual branches freeze and up to 1/3 of their length dies off. They bloom profusely, but produce little fruit – 5.0-7.5 %. The nuts are large, round, pale brown, resembling the fruits of common walnut, with thick and hard shell. The diploid number of chromosomes – 2n=32.

The presence of traits of the cultivated variety (common walnut) in the first generation (F1) is worth mentioning. However, in the fruit (endocarp), in F1, the traits inherited from the wild variety prevail. Thus, the first generation of (F1) walnut hybrids is of (practical) interest mostly as genetic basis for obtaining a second generation (F2), which is more varied and includes valuable forms from practical point of view.

The second-generation hybrids (F_2)

Black walnut x common walnut F_2 (22-6-2) *(Juglans nigra x J. regia F_2)*

The hybrid was obtained from Juglans nigra x J. regia F_1 by open pollination. The tree is 9.2 m tall. Its leaves – 40-45 cm long, with 3-4 pairs of leaflets, which are characteristic of common walnut. It blooms late – May 13-25, nearly two weeks later than the usual varieties of common walnut. It blooms profusely, fructifies well – 35-40%. The fruitage (yield) is assessed as average or slightly below average. In the male sphere, it is completely sterile, the male flowers after their differentiation, in mid-June, fall off completely. Any damage caused by frost or diseases hasn't been detected.

The nuts – of intermediate type, round, slightly flattened by the sutures, gray-brown, with finely corrugated surface, flat or slightly prominent suture, the size – average or below average, the nut weight – 8.2 g. Theoretically and practically, it is important that, already in F2, it is possible to combine in one and the same plant the high quality cultivated varieties – thin nut shell, about 1.3 mm, kernel which can be easily removed, high percentage of kernel, up to 55.5%, and the high resistance to frost and diseases of wild species, which indicates prospects of distant hybridization for improving common walnut varieties.

The diploid chromosome set of the hybrid – 2n = 32. The total chromosome length is 42.9 mcm, length – 0.78-1.93 mcm, thickness – 0.4-0.57 mcm [Comanici, 1989, p. 126].

Black walnut x common walnut F_2 *(21-6-1) (Juglans nigra x J. regia F_2)*

Hybrid of the same maternal form as the previous one. It is a vigorous tree, has reached a height of 16.5 m. After 30 years, annual growth began to decline. Its leaves are 40-50 cm long, with 9-11 leaflets (characteristic trait of the common walnut). It blooms profusely. Fruitage – 21-25 %. The hybrid bears about 2000 nuts annually, with high level of germination – 75-80 %. The endocarp is medium-sized, round, slightly flattened by the sutures, smooth, sutures – slightly prominent. Unlike the previous hybrid, the endocarp wall of this hybrid is very thick and hard, kernel percentage – 28-30%, which greatly reduces the practical value of production. Like the previous one, in the male sphere, it is completely sterile. The male flowers, which start growing in spring, fall off completely. The set of chromosomes – diploid 2n=32. This hybrid is of interest due to the high quality of its wood, growing rapidly in the first 20-30 years. The 2-year saplings can be used as rootstock for common walnut.

The hybrid Japanese walnut x common walnut F_2 (no. 1) *(Juglans sieboldiana x J. regia F_2)*

The hybrid was selected in the population of Japanese walnut x common walnut seedlings F1 (2-1-2), obtained by open pollination. The hybrid no. 1 is 5.4 m tall. Morphologically, the traits inherited from common walnut prevail. Its leaves grow up to 50 cm long, with 3-5 broad-elliptical leaflets, which are characteristic of common walnut.

It bloomed in the 5th year of vegetation. It blooms and bears a lot of fruit. The nuts (endocarp) are round, light brown with a shade of gray; with wrinkled surface, especially at the base around the peduncle junction, with obvious traces of the wild type traits, medium prominent. The nut size – average or below average. According to 5 year-old data, the average nut mass is 8.03 g, kernel mass – 4.02 g, kernel percentage – 50.06 %. The shell is thin, 1.3 mm, the kernel of white-yellowish colour, inherited from Japanese walnut, can be easily extracted without being damaged.

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STUDIES REGARDING MICROPROPAGATION OF HYBRID BERRY CULTIVARS TAYBERRY MEDANA AND TAYBERRY BUCKINGHAM

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Abstract. Objective: Here, we established the protocol for plant regeneration of *Rubus loganobaccus* L.H. Bailey via in vitro micro propagation. Methods: The Apical meristems was used as the explants cultured on Murashige and Skoog (1962) medium (MS) supplemented with different concentrations of plant growth regulators, 6-Benzylaminopurine (BAP). Results: For both cultivars, Tayberry Medana and Tayberry Buckingham, good results were obtained for 0.3 and 0.4 mg/l BAP concentration. The micro-shoots produced normal roots within two weeks of culture on the 50% MS medium with no supplement of plant growth regulators. Plantlets were transferred to celled trays where they grew well. Afterwards the plants were planted in the field where they continued the development. Conclusion: The micro propagation protocol reported here was characterized by a rapid proliferation of shoots, easy rooting of the micro-shoots and the plantlets were easily acclimatized to the external environment and undergoing normal physiological development.

Key words: Cytokinin, 6-Benzylaminopurine (BAP), Micropropagation, MS medium, *Rubus loganobaccus*, rooting, microshoots.

INTRODUCTION

In recent years the market of Moldova increased the requirement for the assortment of cultivated plants, that fact leaded to the introduction and cultivation of new species and varieties of plants, thus directly contributing to resolving Food and Health Programme of the country. Creation of industrial plantations of shrubs of productive cultivars in Moldova is an imperative of nowadays, which is part of the realization of this program. The necessity for the cultivation of these plants comes from the increasing interest for the fruit-bearing shrubs. One of these cultures is the hybrid berry. The hybrid berry *(Rubus loganobaccus* L.H. Bailey hybrid berry) in Moldova has a great demand, due to its medicinal qualities and its taste. At the same time, the plant is resistant to the unfavourable conditions (drought, frost, diseases and pests). Moldova's climatic conditions are relatively favourable to the introduction and cultivation of non-traditional fruit-bearing bushes, easily adapting to the environment, they can be introduced without great expenses in various sectors of national economy. The cultivars *Tayberry Medana* and *Tayberry Buckingham* currently enjoy the attention of many experts worldwide. For the Republic of Moldova, the cultivation of hybrid berry is a business with a future, an alternative of vineyards and orchards, requiring investments of the same scale but the results are more profitable.

The production of fruit bushes by in vitro micropropagation and developing technologies for obtaining healthy planting material is economically profitable.

Unlike blackberry and raspberry regarded as distinct crops, the hybrid of these two species, the hybrid berry, summarizes in itself all the qualities of these highly productive berry bushes. For example the cultivar *Tayberry*, that is a cross between the blackberry cultivar *Aurora* and the raspberry cultivar *Mailing Sport*. It has big fruits of intense red colour, with a rich aroma, stronger than the raspberry's and unlike the last has a caramel flavour. A fruit weighs 4-9 grams, and has a length of 3-4 cm. Tayberries may be eaten fresh without preparation, or used for juice or in jams, pies, crumbles, fruit syrups, and country wines. Tayberry Fruits are a dietary product, being low in calories, high in fibre and containing antioxidants [2, 4].

In Moldova, fruits begin to ripen in June (*Tayberry Medana*). A hybrid berry bush gives a yield of 6 kg and more per year.

The bushes of *Tayberry* cultivar like the bushes of *Loganberry* cultivar are robust; they have strong and long branches, which are preferable to be tied in order to have better aeration, and preventing diseases. Because the shrubs are plagiotropic they can be easily covered for winter. Regarding the issue of thorns – Tayberry has a thornless variety (Buckingham) and a variety with thorns (Medana), but the coverage rate (of thorns) is not higher than on the raspberry. It is resistant to drought and late spring frosts do not affect the hybrid berry because it blooms late. Tayberry is not demanding to soil types. But higher fruit productivity is obtained on sunny places, on drained soils rich in organic matter.

Hybrid berry like many other hybrids is showing strong resistance to various diseases, caused by viruses, bacteria, pests.

In vitro culture of Tayberry is cost effective to obtain healthy vitroplantlets in a short period of time. Micropropagation by in vitro culture aims to achieve a virus-free, homogeneous planting material, with the desired characters of donor plants, with increased resistance to diseases and pathogens [3].

MATERIALS AND METHODS

The material used in the study included two cultivars of hybrid berry, *Tayberry Medana* and *Tayberry Buckingam*, which were obtained at Botanical Garden (Institute) by vegetative material exchange from *In Vitro* Culture Laboratory, Fruit Research Station Cluj-Napoca, Romania.

Sterilization of explants. Shoot tip or apical meristems that are of 0.5-1.0 cm in length isolated from growing tips of current shoots of *Rubus loganobaccus* were used in the experiment as explants, being sterilized by the methods described by Cachita- Cosma [1] and modified in the laboratory. Explants were washed under running tap water to remove dust particles for 30 min and treated with liquid detergent for 10 min, then treated with Twin and rinsed three times with distilled water. Then, the explants were treated with KM_nO_4 for 10 min. Further, sterilization treatments were done under a laminar-flow chamber. The explants were treated with Hg_2Cl_2 for 7 min. After that, the explants were thoroughly washed 3-4 times with H_2O_2 followed by rinsing with sterilized double distilled water to remove the traces of Hg_2Cl_2. Now the explants being ready for inoculation on required medium [1].

Inoculation on culture medium. The explants were inoculated onto MS 100% culture medium [5] supplemented with different concentrations of growth regulator, 6-benzylaminopurine (BAP).

BAP is a substance of the cytokinin class that is commonly used in *in vitro* culture.

Phyto-physiological effects of cytokinin mainly can be summarized as: 1- stimulates cell division, determining rejuvenation of tissues and organs, maximum efficiency is ensured by the presence of auxin in cells, as auxin promotes DNA duplication, while kinetin promotes chromosome separation; 2 - cytokinins, depending on their type and concentration, in plant tissue culture, stimulates the formation of buds and shoots, being antagonistic to the rooting process; 3 - stimulates protein synthesis (cytokinins related to transfer RNA were found); 4 - protects endogenous compounds resulted from the metabolism, from hydrolases' action, a fact that gives them an important role in preventing senescence; 5 - exerts an antagonistic effect to auxin, annihilating the apical dominance of terminal bud, axillary buds treated with cytokinins enter into active growth, competing with terminal bud, but with the removal of cytokinin, their growth slows, and, gradually, it stops, buds falling again under inhibitory action of apical bud); 6 - cytokinins, ensure cell viability, maintaining survival capability of the inoculums, favouring cell differentiation and multiplication; 7 - prevent the senescence [1].

For *in vitro* culture stabilization and obtaining *in vitro* cultures in the proliferation stage, MS media gelled with plant agar with 0.4 mg/l BAP were used.

All cultures were incubated under 16 h photoperiod with light intensity of 55 μmolm–2 s–2 provided by cool white fluorescent lamps (Elmos) at 25 ± 2°C.

The regenerated shoots were transferred on fresh culture medium for shoot multiplication after 12 weeks. A part of microcuttings were transferred directly on 50 % liquid MS medium without growth regulators, for rooting.

Rooting of shoots and transfer of plantlets to soil.

Shoots of 2-3 cm in height with two or three leaflets derived from cultures were transferred to MS 50 % [5] medium for rooting. Along with root formation the shoot elongates, which then is fragmented and passed on fresh media, and the basal part with roots, after a rinsing with KM_nO_4 are transferred in cell trays filled with peat and covered with polyethylene for two weeks to maintain high humidity and subsequently exposed to low air humidity for increasing period and, finally, polyethylene was removed.

These acclimated plants, after 4-6 weeks, were transferred to larger cell trays, and afterwards, after two weeks of tempering in partial shade, planted in the field.

RESULTS AND DISCUSSIONS

The two cultivars, *'Tayberry Medana'* and *'Tayberry Buckingham'*, cultured *in vitro* by using the standard protocol elaborated in the Laboratory of Embryology and Biotechnology of the Botanical

Garden (Institute) showed no differences regarding *in vitro* growth and proliferation.

Plants were mobilized from *In Vitro* Culture Laboratory, Fruit Research Station Cluj-Napoca, Romania, already initiated in *in vitro* culture. After the successive stages of *ex vitro* acclimatization, tempering in partial shade and plantation in the field, the plants have reached the age of 3 years. From the field they have been introduced repeatedly in *in vitro* culture to avoid somaclonal variation.

Inoculation for shoot regeneration was done on MS 100% media gelled with plant agar with different concentration of BAP (0.3; 0.4; 0.5; 0.6 mg/l). Results were obtained on 0.3 and 0.4 mg/l conc. of BAP, at higher concentrations (0.5, 0.6 mg/l) the buds inhibited.

Table 1. Effect of BAP on shoot regeneration of inoculum of Tayberry cultivar

BAP mg/l	average plantlet height (cm)	№ of shoots resulted per test tube	№ of microcuttings resulted per test tube
0.3	5.7	1.2	20.1
0.4	6.1	1.4	21.5

Culture media were tested to determine the initiation of a larger number of shoots. It was determined that MS medium without growth regulator did not initiate shoot differentiation. The number of shoots per explants, at various concentrations of the growth regulator, was different. The highest shoot regeneration results were obtained on MS medium containing BAP (0.4 mg/l) generating a number of 8 shoots per test tube. When BAP concentration was increased above 0.5 mg/l, the multiplication rate of shoots was reduced. The increase of BAP concentration more than 0.5 mg/l leaded to the formation of weak and frail shoots.

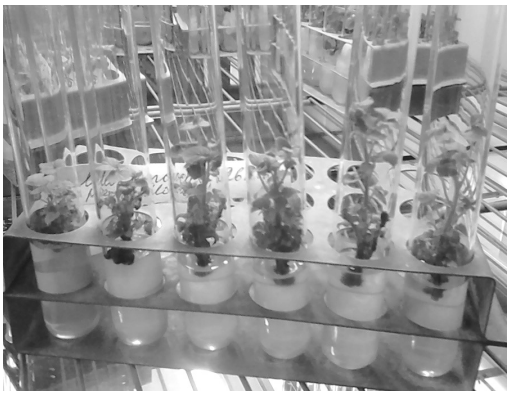

Figure 1: Shoot regeneration *(Tayberry Buckingham,Tayberry Medana)*

Table 2: Effect of cytokinin (BAP) on shoot formation (MS 100%, agar)

MS Medium + BAP mg/l	Number of shoots per test tube	Length of shoots (cm)
0.2	2±1	1.6±0.4
0.3	5±2	2.3±0.5
0.4	8±1	2.6±0.6
0.5	4±2	1.7±0.5
0.6	3±1	1.1±0.5

After 12 weeks, from the culture media used for regeneration, the shoots were transferred on liquid culture media (for rooting), and 12 days later the formation of first roots was observed. As culture medium for rooting, the MS 50 % was selected [5].

After 7 weeks, the plantlets (after the fragmentation of the superior part in microcuttings with two leaflets, followed by the plantation in the perlite), were transferred to cell trays filled with peat.

Direct *ex vitro* rooting and acclimatization

For both cultivars of Tayberry, direct *ex vitro* rooting in moist perlite yielded good results with rooting percentage of about 78 %.

Figure 2: Rooting of *Tayberry Medana*

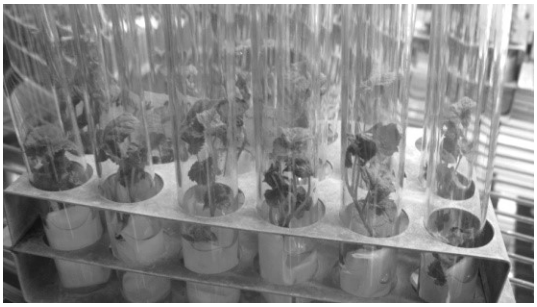

Figure 3: Rooting of *Tayberry Buckingham*

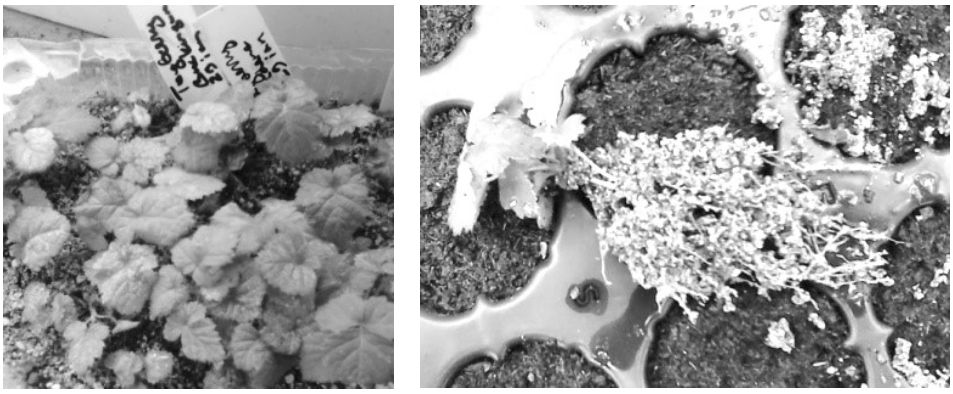

Figure 4: Shoots of *Tayberry Buckingham* rooted in perlite, after two months in ex vitro

Table 3: The results of ex vitro rooting and acclimatization in perlite of Tayberry cultivars

Cultivar	Total no. of shoots	No. of rooted shoots	Rooting percentages (%)
Tayberry Medana	41	32	78
Tayberry Buckingham	68	54	79.9

Hardening

Plantlets were transferred in cell trays filled with peat after the stages of development and acclimatization. Before transplanting grown plants in the field, it is recommended to temper them for a period of two weeks in partial shade. The planting is done in spring after the risk of frost passes. These crops do not like wetlands; therefore the lands where rainwater is retained should be avoided. Also the fields must be protected from cold winds, and is preferable to be in full sun.

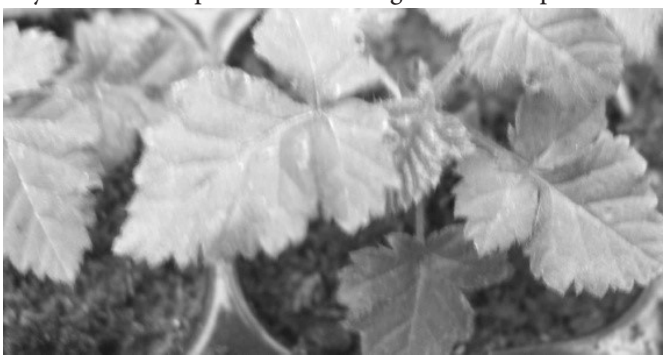

Figure 5: Plantlets of *Tayberry Medana were* transferred to trays

CONCLUSION

Micropropagation protocol reported here was characterized by a good proliferation of shoots, a good rooting of microcuttings and plants were easily acclimatized to the external environment proving a normal physiological development. This is advantageous for the production of plants of hybrid berry and the following application in agriculture.

The cultivars *Tayberry Medana* and *Tayberry Buckingham* showed a positive assertion in multiplication by *in vitro* culture.

The optimal culture medium for shoot multiplication is MS supplemented with BAP (0.4 mg/l), both for *Tayberry Medana* and *Tayberry Buckingham.*

The basic culture medium for rooting is half strength MS, without addition of growth regulators.

The plants' transfer from *in vitro* to ex vitro condition is done on two types of substrate: perlite and peat.

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MANIFESTATION OF APRICOT SELF-COMPATIBILITY AND SELF-(IN) COMPATIBILITY IN THE CONDITIONS OF THE REPUBLIC OF MOLDOVA

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Abstract. No significant differences have been observed between introduced (American and European) and Moldavian genotypes according to the time of flowering and viability of pollen. That's why it is possible to select good partners for successful pollination and high level of fruit set in industrial plantations. The highest level of efficiency was found with varieties: Auras, Bucuria, Detskii, Dionis, Krasnoshciokii, Kishiniovskii rannii, Kostiujenskii, Meteor, Melitopolskii pozdnii, Raduga, Saturn, Vimpel. Introduced varieties Cream ridge, Stark Early Orange, Goldrich, NJA-42, Patterson, Selena, Olimp, Krimskii amur have good potential for self-fruiting. Aurora, Burevestnik, Erevani, Goldrich, Gvardeyskyi, Harglow, Hargrand, Harostar, Nadejda, Orangered, Robada, Traian, Sun Glo, Veecot, 1B49 there are self-incompatible. Such varieties are interesting for effective utilization in intraspecific hybridizations, having the complex of valuable features which are favorably manifested in the conditions of the Republic of Moldova.

Key words: apricot, varieties, pollen, pollen tube, self-compatibility, self-(in)compatibility

INTRODUCTION

In the Republic of Moldova, cultivation of apricot has secular traditions. But apricot production has many risks, mainly manifested during the post-dormancy and flowering periods. For improvement of the yield stability it is necessary to develop (breeding and promotion) new varieties (1, 3, 4) with high adaptability to variable local micro climatic conditions. Apricot fruits are distinguished by valuable qualities, being considered as an important and primordial source of nutritional and therapeutic primordial substances for maintenance and fortification of the human health. Actually there are sophisticate apricot varieties which are characterized by genetic resistance to frost, fluctuations of winter and spring unfavorable temperatures; physiologic potential of equilibration of growth and fructification, especially high excitability of vegetative buds with the possibility of rehabilitation of crown after drastic manifestation of moniliosis (6). Therefore in the programs of variety amelioration regarding enlargement of fruit varietal conveyer there are indispensable multilateral experimental researches for evaluation of important genitors, including comparative studies of promising introduced varieties from international assortment. But always, when it is established an orchard there, it is indispensable to know the manifestation of level of autofertility (or auto in-fertility) potential in concrete area (1, 5), because such varieties can ensure more successful pollination, high level of fruit set, higher and more regular fructification. To elucidate the causes of the different level of fruit set, peculiarities of pollen tube growth into pistils during progamic phase of fertilization were investigated after experimental self-pollination and open-pollination (in the conditions of collection of local and introduced varieties).

MATERIALS AND METHODS

Experimental researches where effectuated in the national collection of apricot varieties and hybrids (Experimental Station "Codrul", Research and Practical Institute for Horticulture and Alimentary Technologies). Biologic material for investigations concerning experimental (hand) auto-pollination is represented by selected 30 introduced (American and European) varieties and selections, being compared with the main varieties created in Rep. Moldova. The apricot (*Prunus armeniaca* L.) biotype MVA served as rootstock. Distances of plantation: 5 x 4 m, in the absence of irrigation. During the investigations, there are employed methodical and methodological principles which are approved for breeding and genetics of fruit trees species (5, 6) and fluorescence microscopy (3, 4).

RESULTS AND DISCUSSIONS

As a result of microscopic investigations of floral bud initiation and embryonic development of floral parts of experimented genotypes in the summer-autumn period there are no distinguished principled differences between introduced (American and European) varieties and Moldavian ones. Practically within all varieties there are noticed the same morphogenetical dynamic of initiation and development of the whole perianth, commencement of the development of stamens, ovarian loge. Detailed observations concerning outgoing of floral buds from deep biological rest demonstrate the following results. No significant differences have been observed between introduced (American and European) and Moldavian ones according to the flowering time. Only some studied American genotypes have earlier beginning of blooming (1-2 days) in comparison to the Moldavian ones. There have also been found some Romanian varieties (Mamaia, Olimp) with late blooming period. The period of flowering of CR-263, NJA-42, Paterson, Tilton coincide with the principal Moldavian varieties (Bucuria, Krasnoshciokii, Nadejda, Detskii, etc.), serving as good pollinators for them. No significant differences have been observed between introduced (with American and European origin) and Moldavian genotypes according to flowering intensity degree, level of fruit set (fig. 1) and viability of pollen which as a rule is more than 50%.

Fig.1. A- Flowering intensity of Moldovan variety Bucuria.
B-Fruit maturation of Moldovan variety Vasile Cociu

There has been studied the progamic phase of the pollination of the local and introduced apricot *(Prunus armeniaca L.)* varieties using fluorescence microscopy (1, 2). Fluorescence microscopy provides a relatively rapid and reliable method to determine self-(in)compatibility of apricot genotypes after *in vivo* experiences regarding pollination. The investigations also included its open pollination variant as control. As a rule, in self-compatible genotypes, developed on stigma pollen tubes reach the ovary in the majority of pistils, and also often reach the ovule. In self-incompatible varieties, growth of pollen tubes in the style is stopped along with formation of characteristic swellings. The research on the *in vivo* growth dynamics of the pollen tubes in experimental auto-pollination showed that the highest level of efficiency was found in varieties: Auras, Bucuria, Detskii, Krasnoshciokii, Kishiniovskii rannii, Kostiujenskii, Meteor, Melitopolskii pozdnii, Raduga, Saturn, Vimpel, Dionis, etc. (tab. 1). Additionally the local varieties Kostiujenskii and Vasile Cociu were cross-pollinated with 2 autochthonous (Codrean and Raduga) and 2 introduced (Stark Early Orange and Dacia) varieties in order to investigate occurrence of auto-in-compatible pollen tubes in the style of other varieties, and their impact on fertilization success. Our results show that such pollen tubes usually have a difficult growth in the third quarter of the style length. Pollen tube penetration into the ovules via the obturator and micropyle was best when pistils were pollinated by variety Raduga pollen grains, although cross-pollination with Stark Early Orange pollen is more effective than self- and open-pollination.

Table 1: Pollen tube growth in the pistils of apricot varieties after experimental self-pollination. Type of compatibility.

Varieties	Country of origin	Percentage of pistils (P) with at least 1 pollen tube (PT)		Mean number of pollen tubes (PT)		Type of compatibility
		P with PT at the base of ovule	P with PT reached the ovule	At the basis of style	Reached the ovule	
Auras	Romania	97	72	3,0±1,0	1,50±0,50	Self-compatible
Burevestnik	Ukraine	0,0	0,0	0,00±0,00	0,00±0,00	Self-in-compatible
CR-263	USA	100	85	9,0±2,03	1,60±0,7 0	Self-compatible
Dionis	Ukraine	0,0	0,0	0,00±0,00	0,00±0,00	Self-in-compatible
Erevani	Armenia	0,0	0,0	0,00±0,00	0,00±0,00	Self-in-compatible
Hargrand	Canada	5,0	0,0	0,5±0,07	0,00±0,00	Self-in-compatible
Harostar	Canada	7,0	0,0	0,9±0,08	0,00±0,00	Self-in-compatible
Krasnosciokii	Ukraine	100	80	8,0±1,55	1,50±0,70	Self-compatible
Krimskii amur	Ukraine	100	80	9,0±1,09	1,50±0,40	Self-compatible
Luizet	France	100	75	7,0±1,04	1,40±0,30	Self-compatible
Meteor	Ukraine	100	80	7,0±1,00	1,30±0,20	Self-compatible
Olimp	Romania	100	75	6,0±1,40	1,40±0,50	Self-compatible
Orangered	France	0,0	0,0	0,00±0,00	0,00±0,00	Self-in-compatible
Robada	USA	0,0	0,0	0,00±0,00	0,00±0,00	Self-in-compatible
Traian	Romania	0,0	0,0	0,00±0,00	0,00±0,00	Self-in-compatible
Varieties created in Republic of Moldova						
Badark		100	80	9,55±1,09	7,0±1,07	Self-compatible
Bucuria		100	80	7,0±1,00	7,0±1,00	Self-compatible
Codrean		0,0	4,3	0,10±0,00	0,00±0,00	Self-in-compatible
Detskii		100	85	6,0±1,08	8,0±2,00	Self-compatible
Kisinevskii rannii		100	60	7,0±1,06	3,0±1,05	Self-compatible
Kostiujenskii		100	82	11,0±5,02	7,0±1,04	Self-compatible
Nadejda		0,0	0,0	0,00±,00	0,00±0,00	Self-in-compatible
Raduga		0,0	0,0	0,00±,00	0,00±0,00	Self-in-compatible
Gustos		0,0	0,0	0,00±,00	0,00±0,00	Self-in-compatible

The fruit set percentage was also the highest (57%) in pistils pollinated with Stark Early Orange pollen grains. As for the open pollination, percentages of incompatible pollen tubes in the upper part of the style by years were 12.0 - 14.0%, respectively. The occurrence of incompatible pollen tubes did not influence the fertilization success in studied interpollination variants. In those variants, pollen tubes reached the ovary in the majority (70-100%) of pistils. They also often (from 40 to 95%) reached the ovule. The average number of pollen tubes at the base of the style ranged from 2.8 to 15.1, and at the ovule ranged from 0.5 to 3.0.

Studied varieties were considered self-incompatible if the pollen tubes stopped their growth in the style, usually with forming swollen tips. Other important signs of incompatibility included twisted pollen tube growth and bifurcation of a pollen tube. Self-incompatibility was found in the following studied varieties: Aurora, Burevestnik, Erevani, Goldrich, Gvardeyskyi, Harglow, Hargrand, Harostar, Nadejda, Orangered, Robada, Traian, Sun Glo, Veecot, 1B49, etc. In these cultivars, pollen tubes rarely reached the base of the style, while no pollen tube was found in the ovules. The number of pollen tubes at the base of the style ranged from 0.0 to 1.0. Usually, pollen tubes mainly stop their growth in the upper third of the style. However, in our study, within most cases of self incompatibility, we observed that pollen tubes stopped growing in the lower half of the style. Maximal energy of pollen tube growth is noticed after open (free) pollination of all studied varieties being cultivated in the same collection of varieties and hybrids. The results obtained in this study conduct to the conclusion that self-incompatibility is frequent among new important apricot varieties from many international breeding programs. Self-incompatibility is an undesirable trait in fruit crop production, because self-incompatible varieties cannot be grown in single-variety plantations, and it is necessary to provide additional adequate pollinators. Considering that self-incompatibility occurs frequently among newly-created apricot varieties, care should be taken of varieties partner selection for establishment of new orchards.

CONCLUSIONS

The highest level of efficiency of experimental self-pollination was found in varieties: Auras, Bucuria, Detskii, Dionis, Krasnoshciokii, Kishiniovskii rannii, Kostiujenskii, Meteor, Melitopolskii pozdnii, Raduga, Saturn, Vimpel.

Varieties Cream ridge-263 (CR-263), Stark Early Orange, Goldrich, NJA-42, Patterson, Selena, Olimp, Krimskii amur have good potential for self-fruiting. Aurora, Burevestnik, Erevani, Goldrich, Gvardeyskyi, Harglow, Hargrand, Harostar, Nadejda, Orangered, Robada, Traian, Sun Glo, Veecot, 1B49 are self-incompatible in the conditions of Rep. of Moldova. Such varieties are interesting for effective utilization within intraspecific hybridizations, having the complex of valuable features which are favorably manifested in the conditions of the Republic of Moldova.

Self-compatibility continues to be considered one of the most important objectives in apricot breeding programs, because such varieties can ensure more successful pollination, higher and more regular fructification.

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WALNUT EMBRYOGENESIS. MORPHOLOGICAL AND HISTOCHEMICAL APPROACHES

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Abstract. In the article, there are presented results of morphological and histochemical researches of embryogenesis after direct and indirect experimental pollinations of all dichogamous types (homogamous, protandrous, protoginous) of walnut (Juglans regia L). It has been established that the tardiest period of passage of all developmental stages was noticed at protandrous genotypes after free pollination. According to the histochemical tests, the most intensive metabolism was observed at the stage of globular embryo of all dichogamous studied types not depending on the type of experimental pollination. Experimental heitonogamy provoke more rapid embriogenetic processes within all dichogamous types.

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

INTRODUCTION

Walnut is one of the most desirable cultivated crops in the Republic of Moldova. Sustainable fructification of walnut varieties in industrial plantations depends of different factors. One of the most important problems 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 embryo development depending. Studies were done with the scope of elucidation of nut development, as principal product of walnut culture within intravarietal hybridization of principal local dichogamous (protandrous, protoginous and homogamous) varieties and evaluated selections in the conditions of the Republic of Moldova.

MATERIALS AND METHODS

Experimental researches were carried out in the national walnut collection (Experimental Station „Codrul", Research and Practical Institute for Horticulture and Alimentary Technologies). Biologic material is represented by local varieties and selections. 16 Moldavian dichogamous varieties and promising selections were experimented in direct and indirect hybridizations (including hand auto-pollination). Moldavian walnut varieties, obtained after multiannual investigations, are characterized by high adaptability to diverse local environmental (edaphic and microclimatic) unfavourable conditions. In the Research Institute for Horticulture, the research activity has been directed towards the assessment of potential fructification of local varieties, selected from different areas of cultivation, mainly with terminal bearing. These varieties are productive, but adapted to the ecological conditions in the areas with vocation for this fruit crop culture and less susceptible to diseases. On the basis of utilization of cytoembryological, including histochemical methodology [2, 3, 5], it was tested the dynamic of contents and localisation of enzymes, polysaccharides, proteins and nucleic acids (DNA and RNA) during embryo and endospermogenesis after different type of hybridization, which could be also important for selection of pollinators for principal Moldavian varieties.

RESULTS AND DISCUSSIONS

Registered autochthonous varieties have higher level of resistance to temperature stresses and main diseases of walnut and low sensibility to blight. But the main trials are high potential of productivity and nut qualities. In comparative scientific researches, it has been established good ecological plasticity of the main Moldavian varieties also in the neighbouring countries. On the basis of utilisation of cytoembryological, including hystochemical methodology (1- 4), the dynamics of contents and localization of enzymes, pollysaccharides, proteins and nucleic acids (DNA and RNA) during embryo and endospermogenesis in relation with hybridization of all dichogamous types were tested.

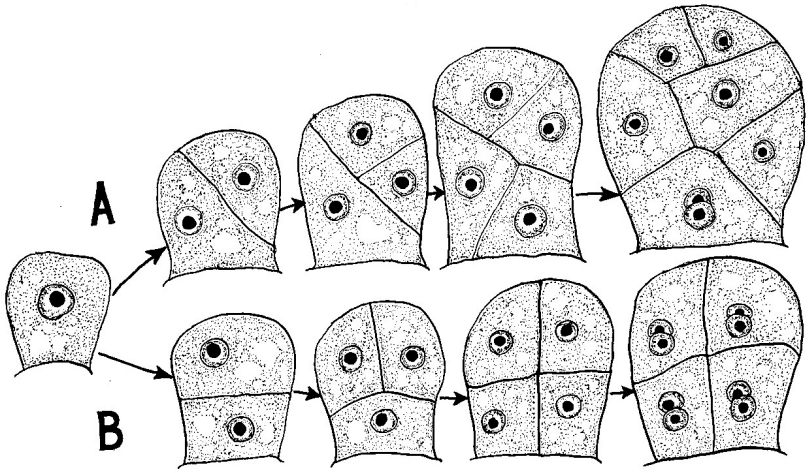

Fig.1. Two ways of segmentation during cell differentiation of walnut proembryo.

Table 1. Dynamics of embryogenetic processes after direct and indirect crossing of protogynous (p/g) and protandrous (p/a) varieties

Stage of development	Days after pollination					
	p/g x p/a	p/g x p/g	p/g free pollination	p/a x p/g	p/a x p/a	p/a , free pollination
Intensive development of nuclear endosperm	18	17	17	16	15	14
Bicellular proembryo	20	20	19	20	19	18
Passage of nuclear endosperm into cellular stage	37	34	35	35	37	33
Globular embryo	45	47	45	40	40	39
Beginning of embryo segmentation	50	53	50	45	45	43
Embryo in the stage “heart”	75	78	73	70	65	60
Intensive development of embryo vascular system	87	90	85	82	86	78
Differentiation of main embryo structures	95	110	100	95	97	92
Mature embryo	122	120	120	120	122	129

Table 2. Dynamics of embryogenetic processes after experimental intravarietal auto-pollination (A), heitonogamy (H) and free pollination (P)

Stage of development	Days after pollination		
	A	H	P
Bicellular proembryo	20	19	18
Passage of nuclear endosperm into cellular stage	29	27	25
Globular embryo	33	30	29
Beginning of embryo segmentation	48	50	45
Embryo in the stage “heart”	70	65	60
Intensive development of embryo vascular system	80	85	75
Differentiation of main embryo structures	95	97	92
Mature embryo	115	115	115

Cross pollination of protandrous, protogynous, and simultaneously flowering varieties (in direct and indirect crosses) shows a high combination ability of most studied varieties. At the same time, luminescent and histochemical analysis of free pollination shows morphophysiologically different quality flowers of solitary growing genotypes, which, however, at optimal orchard establishment and agronomical practices scarcely affect fruit-bearing rate. The analysis of obtained data shows that the development of the walnut endosperm at the first stages is related by negative PAS (insoluble polysaccharides) and maximal intensity of total protein reactions, a weak detection of ascorbic acid and enzymes. The most homogenous nuclear endosperm was established for the open pollination of all dichogamous genotypes. Transformation of endosperm nuclei in cellular structures occurs in 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 coenocyte 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 hypertrophic endospermal nuclei, as well as 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 increasing of 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 polysaccharides (PAS reaction). Transformations of the endosperm of walnut are inseparably linked with certain stages of embryo development. An intensive resorption of cellular endosperm is observed in the period of the appearance of embryo bilateral segmentation. Protogynous genotypes have a more accelerated rhythm of endosperm nuclei division compared to protandrous ones. Irrespective of dichogamy, formation of hypertrophic nuclei, as well as their fusion and conglomeration are detected. When pollination is absent, as well as in the same experimental pollinations, anomalous divisions or a full stop in endospermogenesis processes are established. It was established a gradual decrease of the metabolism of endosperm nuclei that is changed by the increasing activity of enzymes and the appearance of the polysaccharide granules in the approach of cellular state. The transition of

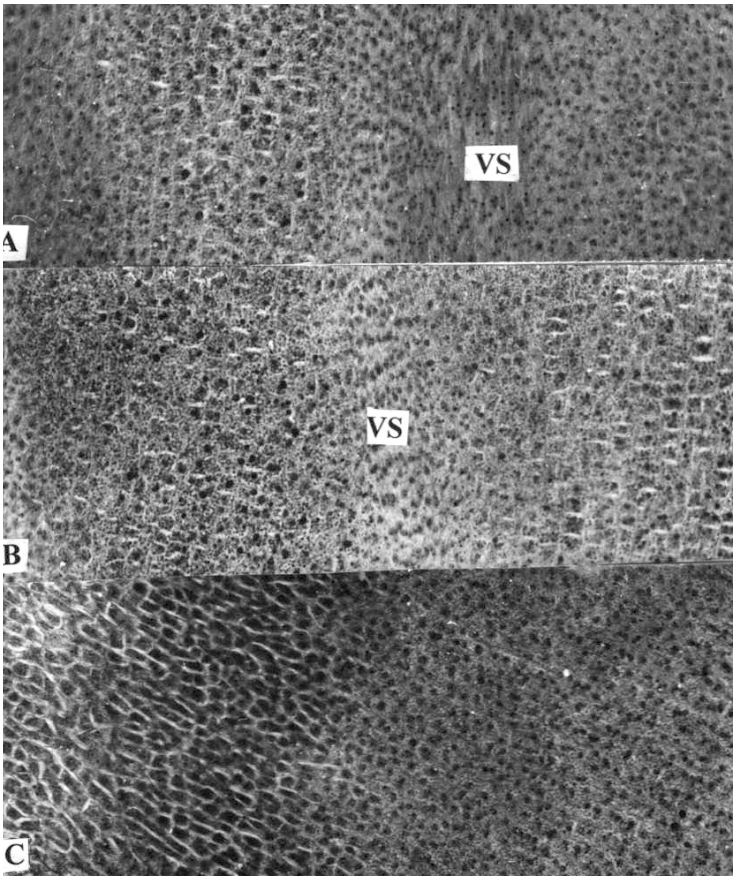

Fig.1. Accumulation of polysaccharide granules in different sectors of embryo: A-basal part; B, C – central part. VC- initiation of vascular system

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 resorption of cellular endosperm is observed in the period of the appearance of embryo bilateral segmentation. Storage of starch, proteins and 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 is reserved a high quantity of polysaccharides and enzymes.

We suggested that this tissue could be functionally considered a real obturator. In addition, obtained data revealed that marginal adjacent tissues are very similar histochemically with tegumental "packing" tissue – a demonstration that there is present possibility of function of signalling of direction of pollen tube growing. Obtained morphological and histochemical data referring to endospermogenesis and embryogenesis processes demonstrate that regardless of flowering type, the zygote of the species *Juglans regia L.*, at the end of latent period, is characterized by manifestation of more intensive reaction of nucleic acids and proteins comparatively with oosphere. We suppose that this phenomenon could be explained by homeostasis re-establishment after its disordering within the period of formation of embryo sac elements (Ciubotaru A. A., 1994). Our investigations clearly demonstrate that within all dihogamous types of walnut we could distinguish well organized morphophysiological structural stages (tab. 1, 2). 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 near the meristemic point of growing. The tardiest period of passage of all developmental stages of embryo was noticed at protandrous genotypes after free pollination. According to our researches, in the epidermal layer of the integuments at the initial stage of embryo development, as well as in the epidermal layer of mature embryo, there is developed an essential number of stomata cells. In our opinion, that phenomenon could suggest a high degree of embryo autonomy even at the initial period of development and manifestation of reciprocal system of co-adaptation with surrounding tissues. It is also important to notice that the intensive development of all embryo parts is signalled by intensification of peroxidise, succinate dehydrogenase, and especially, ascorbic acid. In the apical sector (around the meristemic point) of mature embryos, there is conserved for long time intensive manifestation of all representative histochemical reactions. In this part, endocarpic lignifications of nuts are usually coming up.

CONCLUSIONS

- The tardiest period of passage of all developmental stages was noticed at protandrous genotypes after free pollination.
- According to the histochemical tests, the most intensive metabolism was observed at the stage of globular embryo of all dichogamous studied types.
- Experimental heitonogamy provokes more rapid embryogenetic processes within all dichogamous types.

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II. CONSERVATION OF BIOLOGICAL DIVERSITY

THE BIOMORPHOLOGICAL PECULIARITIES AND TYPES OF "TRAPS" OF CARNIVOROUS PLANTS OF O. V. FOMIN BOTANICAL GARDEN COLLECTION

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Abstract: The results of the research on carnivorous plants from 5 families, 9 genera, 32 species, 6 varieties, 19 hybrids of O. V. Fomin Botanical garden collection have been given. The history of carnivorous plants studying has been analysed. The geographical distribution, biomorphological peculiarities, types of "traps", methods and conditions of the introduction into protected soil have been established. Methodological approach helped to create a "marshland" for carnivorous plants of North America, Australia, Madagascar and North-Eastern regions of South Africa, where the representatives of other families are also growing next to them.

Key words: carnivorous plants, introduction, collection, types of "traps", methods of the research.

INTRODUCTION

The first information about the ability of plants to catch insects, little birds and mice in their traps which had the form of "green bottles" and "eating leaves" was in the 18th century [10; 15]. The first description of *Dionaea muscipula* Ellis was done by a known English naturalist John Ellison in 1769. Amazing peculiarities of some plants were discovered by a German doctor A. V. Rot in 1782. Leaves of *Drosera L.* did original movements thanks to that they not only caught insects, but also ate ones. For the first time, the term "Insectivorous Plants" appeared in W. Bertram's book in 1791. Charles Darwin's work ("Insectivorous Plants, 1875"), which had been conducting for 15 years, became a turning point in a history of research of carnivorous plants [14]. His researches prepared a new scientific direction for the proper understanding and approach to those phenomena that were observed in carnivorous plants but his researches were poorly supported because of the traditional biological ideas of that period [16]. First of all, it was their exclusive super high sensitivity to touch and to chemical stimuli, and their transmission of received excitation to tissues, then different more or less quick prehensile movements for possession of prey, and finally, the way of food digestion and use of products of working digestive enzymes. All these are the features of the organization that earlier were considered only as the animal organisms' characteristics but not the plants' ones.

MATERIALS AND METHODS OF RESEARCH

The object of our research were carnivorous plants of O.V. Fomin Botanical garden collection introduced into protected soil: 5 families (Cephalotaceae Dum., Droseraceae Salisb., Lentibulariaceae Rich., Sarraceniaceae Dum., Nepenthaceae Dum.), 9 genera *(Cephalotus Labill., Darlingtonia Torr., Dionea Ellis, Drosera L., Heliamphora Benth., Nepenthes L., Pinguicula L., Sarracenia L., Utricularia L.),* 32 species, 6 varieties, 19 hybrids and their biomorphological and anatomical peculiarities, geographical distribution and introduction into protected soil. Species and varieties of this collection were determined according to A. Kerner von Marilaun [10]; W. Goebel [15] and A. Wagner [16]. The characteristic of the climate conditions of the natural distribution was given on the basis of scientific sources, such as: A. L. Takhtadzhian[11]; V. N. Gladkova [4]; G. A. Denysova [5; 6; 7], E. A. Zemskova [9], A. Kerner von Marilaun [10] W. Goebel [5]; A. Wagner [7].

RESULTS AND DISCUSSION

Most of carnivorous plants are widespread in countries with tropical climate in wet places near marshes and under springs in forests of tropical Asia, Australia and on Madagascar Island. The endemics of Atlantic coast of North America and South East of the USA, marshy areas of Alabama, Georgia, Louisiana, Mississippi, Texas and Florida are also among them. Some species are growing on the coast of the Gulf of Mexico, on the west of the Apalacha River, and there are some species that have little population near the Okefenokee Lake [5; 8; 9]. They are rare and endangered species [4; 5; 6; 7; 11].

All physiological and morphological peculiarities, which are observed in carnivorous plants, are the result of the adaptation. They are attracting insects with the help of smell, colour, and taste peculiarities; catching a prey with the help of sticky liquid and different grasping movements, different manifests of "sensitivity", allocation of enzymes that digest proteins and etc. There are the features of organization which are typical for all carnivorous plants. Only their biological sense or their role in the life of the organism can be changed according to the conditions of their existence. Already in 1888, the character of their adaptation for catching insects and other animals was discovered, and also the quantity of species of carnivorous plants was defined [10]. All known carnivorous plants belong to bilobed (Magnoliopsida) which are located definitely far from one another in flora system. There are no carnivorous plants among monocotyledonous Liliopsida. More than 500 species of plants belong to carnivorous plants [10]. Modern researches of carnivorous plants' taxonomy prove that this group of plants includes 14 genera and 630 species [4; 5; 6; 7; 9; 11].

Some carnivorous plants have green entirely coloured, metamorphosed leaves, others may have bright colouring of the organs which help to catch tiny animals, birds and insects, they can be partially coloured into bright colours or have bright sports (red, yellow, white etc.), which are used for attracting insects.

Aromatic and tasty substances which plants secret by special glands are used with the same purpose. The character of adaptation strategy of carnivorous plants for hunting insects and other animals is unique. There are certain groups in every family and genus according to the type of attracting and hunting animals, insects and various types of Crustacea under water etc. [10; 15].

The first group – sticky "traps" (flypaper trap [17]). This group combines plants, which have sticky surface of leaves or glands accommodated on it, which secrete glue substance. Among some representatives of this group *(Drosophyllum* Link.*)*, the methods of catching insects are limited only by glue substance [7].

Other representatives have leaves, which can do some movements, when insects stick to them, these movements help them to hold a prey tight and soak it with digestive saps better. Among them are *Drosera, Pinguicula and Byblis Salisb* genera (fig. 1).

The representatives of the second group have hunting leaves which look like "Pitcher traps" or "Amphora traps" (fig. 2; 3; 4) (Pitfall traps [17]). The plants which have a trap in a shape of hunting hole also refer to this group. Insects, attracted by the sugary secretions of special glands, climb through the opening foramina into these hollow organs and never get outside. These "leaf traps" don't do any active movements. They have a number of devices which firstly direct an insect to the place where it will be killed and where the digestive sap secretes, and secondly prevent an insect from getting out of the "trap." All representatives of *Sarraceniaceae* Dum., *Nepenthaceae* Dum. *Cephalotaceae* Dum. families

Fig. 1. Introduced *Drosera spathulata* Scheidw, general view

refer to this group [5; 6; 11].

Fig. 2. "Pitcher traps" of introduced plants of *Cephalotus follicularis* Labill. genus

Fig. 3 "Amphora traps" of introduced plants of *Heliamphora nutans* Benth genus

For a certain period of time, the genus *Utricularia,* which representatives have small blisters similar to pots, was ascribed to the second group. But after profound researches it was proved that these small blisters are able to swallow and this helps them to swallow or suck tiny animals up which swim near the opening foramina closed with a valve. That's why the representatives of *Utricularia* genus have traps of both types and they refer to both groups.

The third group is "sucking traps" (Bladder traps [17]). They are representatives of *Utricularia* and *Polypompholy* (Lehm.) P. Taylor genera and grow in water. They float freely or give underground shoots as "roots" (of the stem origin). Their leaves have small dangling blisters with holes which close a freely dangling valve. Special glands suck out from a small blister almost all water, for valve to close tight pressurized water from the outside. After that a sugary substance secretes attracting prey (Daphnia, Cyclops, fry fish and phytoplankton).

Bristles direct prey to the instantly opening valve as soon as the victim touches signal hairs. Pressure forces the valve to open inside that's why prey with water is sucked into the small blister. Then the valve closes quickly, the water is pumped out and digesting process of prey begins.

Fig. 4. "Pitcher traps" of introduced plants of *Sarracenia* L. genus

The fourth group is called "closing traps" (Snap traps [17]). These plants have snap-typed traps which make quick active movements. Leaves of *Aldrovanda L.* and *Dionea Ellis* have a shape of a half-opened book and both halves of their leaves close with more or less speed with the touch (of insects and their larvae, various types of Crustacea) and clamp prey as swan mussel's leaves. The most famous example of this trap is a plant *Dionaea muscipula Ellis* (fig. 5).

The "trap" is formed at the end of the leaf, a stalk serves as a hinge, and the leaf forms two parts (sheets) edged with teeth. Each of them has three sensitive hairs - triggers that set in motion the "trap". This happens when the insect touches one of the hair - triggers. With the second touch to the hair - trigger from the base of the plant comes a powerful electrical impulse that forces the "trap" to shut down.

Fig. 5. Introduced plants of *Dionaea muscipula* Ellis with open "traps", which are able to close, general view

The fifth group is "traps" not spilling out (Lobster-pot traps [17]). Hunting leaves of the plants of the genus *Genlisea* St-Hil. with short petioles divided into two tubes are directed into the water or mud. Along each of the coiled tube, there is a spiral cut on the inner surface of which there is a number of hairs directed inward. These special devices are destined only for preventing the caught animal from getting out. The nature of hunting "traps" does not depend on the position of plants in the system. In the same family, plants can have "traps" of different groups (combination group of "traps"). Thus, plants of *Lentibulariaceae* family have "traps" of three groups; plants of *Droseraceae* family have "traps" of two groups (fig. 6).

"Traps" of the representatives of such families as: *Sarraceniaceae, Nepenthaceae, Cephalotaceae* belong only to the second group (fig. 7). The only thing that unites all these plants is that after the capture of animals begins the process of hydrolytic decomposition of complex organic compounds found in them, mostly protein, and absorption of hydrolysis products. Hydrolysis takes place with the assistance of special glands that secrete proteolytic and other enzymes, and also additional substances needed for digestion (acid, water). The last stage is the absorption of dissolved substances which is accomplished by means of glands, most of which also secrete digestive saps. For the water supplying to the glands and removing from the glands the swallowed up nutrients, a well-developed and extensive grid of vascular bundles exists.

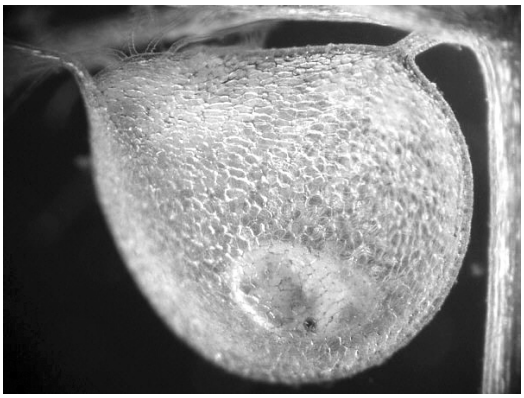

Fig. 6. Introduced *Utricularia* L. genus "trap" leaf

Fig. 7. *Darlingtonia californica* Torr. hunting "traps"

Carnivorous plants are also widespread in Ukraine. They belong to 4 genera: *Aldrovanda* (1 species), *Utricularia* (8 species), *Drosera* (3 species), *Pinguicula* (3 species). According to the latest information from the Red book of Ukraine, in the flora of Ukraine, carnivorous plants are presented by such species, as: *Aldrovanda vesiculosa* L., *Utricularia bremii* Heer, *U. minor* L., *U. australis R.* Br., *U. intermedia* Hayne, *Drosera anglica* Huds., *D. intermedia* Hayne, *Pinguicula alpine* L., *P. Bicolour* Wot. and *P. Vulgaris* L., except *U. Vulgaris* L., which is not included into the Red book [1; 2; 13]. For a long time, carnivorous plants were not introduced because people were afraid of them and didn't understand

them. For a long time, it was the only reason for not growing them inbotanical gardens and in home conditions, but they were used as medicinal plants in folk medicine from ancient times. In Ukraine, for the first time carnivorous plants were grown in O. V. Fomin Botanical garden in 1938. At first, they were representatives of *Aldrovanda, Drosera* and *Utricularia* genera which were grown in the open soil. Later the group of carnivorous plants was extended by *Drosophyllum. Nepenthes, Pinguicula,* which were grown in orchard's greenhouse [8]. According to the inventory of 1988 in O.V. Fomin Botanical garden, the collection of carnivorous plants was restored. It counted 30 species which were presented by 5 genera: *Byblis* (1), *Drosera* (22), *Nepenthes* (1). *Pinguicula* (2), *Sarracenia* (2) and *Utricularia* (1). In 1989, the collection had 24 species. So, 4 genera had constant number of species *(Byblis, Nepenthes, Pinguicula and Sarracenia)*, *Drosera* genus – 16 species, but *Utricularia* genus – lost [3; 8]. Later, on almost all collection, it was lost because of non-availability a curator and appropriate conditions of the maintenance.

Today, the Botanical garden collection of carnivorous plants counts 5 families, 9 genera, 32 species, 6 varieties, 19 hybrids. During the renovation which began in 2012–2013, in greenhouse of water and coastal-water plants, more than twenty new artificial compartments have been done and new collection of carnivorous plants has been launched. Compartments are filled up with necessary for these plants mixsoil and moss (representatives of *Sphagnum* L. and *Polytrichum* Hedw. genera). In protected soil, an average maximum temperature of air +28°C is supported, absolute maximum is +30.5°C; average minimum is +17°C, absolute minimum is +10°C. Average maximum temperature of water in ponds is + 22°C, absolute maximum is + 25°C; average minimum is + 17, absolute minimum is + 10°C. Maximum humidity of the air is 95 %, minimum is 75% (fig. 7, 8). Maximum lighting is 50000 lx (June), minimum is 500 lx (December, January). For optimization of the gas treatment, an additional supply of the air was carried out by compressor. The soil for growing carnivorous plants has to be crumbly. For creating such kind of soil peat, pearlite, river sand, cut sphagnum, charcoal were used in the following proportions: 4 : 2 : 1 : 0,5 : 0,5. This composition of the soil is most similar to the natural and corresponds to pH 5–6. Growing carnivorous plants in conditions of protected soil life, sphagnum is added to the upper layer of the substratum, but it should be under control because it can depress plants by its active overgrowth, in such case, it should be mechanically taken away. For growing these plants, plastic pots with holes are used. Transplanting of plants can be carried out in spring (the end of February, the beginning of March) before the budding period.

The aim of modelling the collection was to create the exposition which completely displays natural peculiarities and biodiversity of carnivorous plants considering their ecological amplitude of the growing and an environmental compliance. Five basic principles of growing this group of plants in protected soil have been determined with the help of methodological approaches: 1 – modeling ecotypes according to moisture of soils; 2 – environmental compliance considering ecological amplitude of the place of growing of carnivorous plants; 3 – environment-protecting, which provides implementation of rare, vanishing, endemic and relict species in the case of introduction; 4 – aesthetic, which provides the creation, in protected soil, of such expositions which match people's aesthetic demands; 5 – landscape approach, which demands the use of existing facility (greenhouse) for creating compositions of carnivorous plants in protected soil. Such methodological approach helped to create a "marshland" for carnivorous plants of North America, Australia, Madagascar and North-Eastern regions of South Africa, where the representatives of other families are also growing next to them.

CONCLUSIONS

The exposition of carnivorous plants of the Botanical garden consists of 5 families, 9 genera, 32 species, 6 varieties, 19 hybrids. They are rare and endangered species. The biomorphological peculiarities that are observed in carnivorous plants are the result of their development and adaptation. Attracting insects with the help of smell, colour, and taste peculiarities, hunting a prey with the help of sticky liquid and different grasping movements, different manifestations of "sensitivity", allocation of enzymes that digest proteins and etc., all these are the features of organization which are typical for all carnivorous plants. The plants of the collection have all 5 types of the "traps", and some of them have even several types. Methodological approach of care and complex research helped to create a "marshland" for carnivorous and coastal-water plants in protected soil. The artificial compartments have been created and substratum similar to the natural one has been placed. Watering and care are provided.

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SYNOPSIS ON THE SPECIES OF THE GENUS *TRIFOLIUM* L. *(FABACEAE)* IN DNIESTER-PRUT RIVER REGION

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Abstract: The article brings the list of one of the biggest genera in the *Fabaceae* Lindl. family – *Trifolium* L., which embodies 20 species in the Dniester-Prut region. The dichotomic key of the genus *Trifolium*, as well as brief ecological and habitat characters for each species are given.

Key words: flora, Fabaceae, Trifolium, biology, ecology

INTRODUCTION

The maintenance of floristic diversity nowadays is based on fundamental monographic studies and knowledge (in fundamental and practical aspect) on separate taxonomic groups. Genus *Trifolium* L. – heterogeneous, variable in morphology and ecological characteristics, takes tone of the central position in system of the family *Fabaceae* Lindl. It plays a significant role in vegetation cover and is an important component in structure of the grassland cover of the region. There are many fodder grass, melliferous, decorative and medicinal species in the given genus.

MATERIAL AND METHODS

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

RESULTS AND DISCUSSIONS

The genus *Trifolium* L. is one of the largest in the family *Fabaceae*, which comprises over 200 species; it is widespread in temperate and subtropical zones of the northern hemisphere, mainly in the Mediterranean region [3, 7, 8]. In the flora of Dniester-Prut river region it embodies 20 species.

Genus ***TRIFOLIUM L.*** – **TRIFOI – КЛЕВЕР**
Linnaeus, 1753, Sp. Pl.: 764; id. 1754, Gen. Pl., ed. 5: 337
LT.: ***T. pratense L.***

Key to species of *Trifolium*

1a. Calyx-teeth unequal, the 3 lower 2-4 times longer than the 2 upper. Standard obovate or obcordate (subgen. ***Chronosemium***) ***2***
1b. Calyx-teeth subequal or the 3 lower shorter than the 2 upper. Standard oblong ***4***
2a. All leaflets subsessile, with equal petioles, long up to 2 mm ..... ***18. T. aureum***
2b. Terminal leaflet petiolulate (petiole up to 7 mm long) and 2 lateral leaflets subsessile ***3***
3a. Corolla 2.5-3.5 mm; standard conduplicate. Inflorescence (5)10-20-flowered..... ***20. T. dubium***
3b. Corolla 4-6 mm; standard not conduplicate, but with prominent keel. Inflorescence 20-40-flowered ..... ***19. T. campestre***
4a. Calyx vesiculous, inflated in fruit ***5***
4b. Calyx vesiculous, not inflated in fruit ***7***

5a. Calyx actinomorphic, uniformly inflated in fruit. Corolla 15-20 mm (subgen. Mistyllus) .. .. ***17. T. vesiculosum***

5b. Calyx slightly zygomorph, not uniformly inflated in fruit. Corolla 6-8 mm (subgen. Galearia) ***6***

6a. Heads globose in fruit. Calyx 4.0-5.5 mm in flower and 8-10 mm in fruit, with teeth longer than the tube …..... ***16. T. fragiferum***

6b. Heads elliptic-elongated in fruit. Calyx 3.5 mm in flower and 4-6 mm in fruit, with teeth not longer than the tube ……..……..... ***15. T. bonannii***

7a. Flowers pediculate (pedicel 0.5-5.0 mm) with bracts. Calyx-throat without a ring of hairs or an annular callosity (subgen. ***Amoria***) ***8***

7b. Flowers sessile, ebracteate or only the lower flowers with very small bracts. Calyx-throat usually more or less closed with a ring of hairs or an annular callosity (subgen. Trifolium) ***12***

8a. Stem rooting at the nodes. Peduncles up to 6 cm ..... ***12. T. repens***

8b. Stem not rooting at the nodes. Peduncles up to 12 cm ***9***

9a. Stem densely hairy appressed..... ***10. T. montanum***

9b. Stem glabrous or hairy only in the upper part ***10***

10a. Corolla 4-5 mm, equal or slightly shorter than calyx. Legume obovoid ..... ***14. T. retuzum***

10b. Corolla 7-16 mm, 2-3 times longer than calyx. Legume elliptic ***11***

11a. Leaflets ovate-lanceolate or ovate-elliptical, 1-5(7) cm. Heads 2.5-4.0 cm length. Pedicels 1-2 mm, patent in fruit. Corolla 12-16 mm ..... ***11. T. ambiguum***

11b. Leaflets obovate or obcordate, 1-2(3) cm. Heads 1.5-2.5 cm length. Pedicels 4-5 mm, flexing down in frut. Corolla 7-10 mm ..... ***13. T. hybridum***

12a. Corolla yellowish-white ***13***

12b. Corolla pink, purple, red or white ***14***

13a. Leaflets emarginate, 1.5-3.0 cm x 3 mm. Corolla 10-18 mm ..... ***2. T. ochroleucon***

13b. Leaflets entire or slightly dentate, 3-9 cm x 1-2 mm. Corolla 20-25 mm ..... ***1. T. pannonicum***

14a. Calyx-throat usually with an annular callosity ..... ***3. T. incarnatum***

14b. Calyx-throat usually with a ring of hairs ***15***

15a. Flowers 5-6 mm. Heads numerous ..... ***9. T. arvense***

15b. Flowers 10-20 mm. Heads 1-2 ..... ***16***

16a. Plants with underground repent and branched stolons..... ***17***

16b. Plants without underground stolons ***18***

17a. Leaflets uniform, lanceolate or narrowly elliptical, hairy or glabrous ..... ***5. T. alpestre***

17b. Leaflets different: on the lower leaves ovate or elliptic, on the upper leaves broadly-lanceolate or lanceolate, glabrous above and hairy below ..... ***4. T. medium***

18a. Calyx-teeth subulate-filiform, ± equal and almost 2 times longer than the tube. Corolla not or slightly exceeding the calyx ..... ***8. T. diffusum***

18b. Calyx-teeth triangular with filiform apex, unequal (only the lower 2 times longer than the tube). Corolla 2 times as long as the calyx ***19***

19a. Stem with full internodes. Heads surrounded by stipules of upper leaves. Leaflets 1.5-3.5 cm ..... ***6. T. pratense***

19b. Stem with fistulous internodes. Heads without stipules of upper leaves. Leaflets 3-5 cm ....***7. T. sativum***

Subgenus 1. ***TRIFOLIUM***

T.: ***T. pratense*** L.

1. T. pannonicum Jacq. 1767, Obs. Bot. 2: 21, tab. 42; Coombe, 1968, Fl. Europ. 2: 171; Гейдеман,

1986, Опред. высш. раст. МССР, изд. 3: 310; Бобров, 1987, Фл. евр. части СССР, 6: 199; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 189; Negru, 2007, Determ. pl. fl. R. Moldova: 147; Ciocârlan, 2009, Fl. ilustr. a României: 377. – **T. panonian. – К. паннонский.** 2n = 96, 98, 126, 130, 180.

The area of distribution is Central (southern part) and Eastern (south-western part) Europe extending westwards to the Alps, occasionally cultivated elsewhere (Pan-Balc). Grows only in the forest areas of northern part under the trees, in clearings and forest edges, meadow-steppes and open scrub. Locations in the region determine the northeastern limit of its common area. Species rare, protected by law in the Republic of Moldova (ELRM[2], RBRM[3]).

2. ***T. ochroleucon*** Huds. 1762, Fl. Angl.: 283; Coombe, 1968, Fl. Europ. 2: 171, p. max. p.; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 310; Бобров, 1987, Фл. евр. части СССР, 6: 201; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 189; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 122; Negru, 2007, Determ. pl. fl. R. Moldova: 147; Ciocârlan, 2009, Fl. ilustr. a României: 377. – **T. alb-gălbui. – К. бледно-желтый.** 2n = 16.

The area of distribution is Europe and Mediterranean region (Eur-Medit). It is met in the central and southern districts of the region. Grows mainly in shady or somewhat damp habitats.

3. ***T. incarnatum*** L. 1753, Sp. Pl.: 769; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 310; Бобров, 1987, Фл. евр. части СССР, 6: 203; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 189; Ciocârlan, 2009, Fl. ilustr. a României: 381. – *T. incarnatum* subsp. *incarnatum;* Coombe, 1968, Fl. Europ. 2: 168. – **T. roșu-inchis. – К. мясо-красный**. 2n = 14.

The area of distribution covers Southern and Western Europe, including Mediterranean region; cultivated also in a large part of Europe and widespread as an escape except in the extreme north (Eur-Medit). Originated from the Western Mediterranean region. The species is rare in local flora, met only in central zone.

4. ***T. medium*** L. 1759, Amoen. Acad. 4: 105; Coombe, 1968, Fl. Europ. 2: 169; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 310; Бобров, 1987, Фл. евр. части СССР, 6: 203; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 190; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 122; Negru, 2007, Determ. pl. fl. R. Moldova: 147; Ciocârlan, 2009, Fl. ilustr. a României: 377. – **T. mediu. – К. средний.** 2n = 80.

The area of distribution covers the territory of Western Eurasia (EuaW). The species is widely distributed in the region in various habitat conditions (dry meadows, clearings and forest edge, shrubs, poor pastures).

5. ***T. alpestre*** L. 1763, Sp. Pl., ed. 2: 1082; Coombe, 1968, Fl. Europ. 2: 170; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 310; Бобров, 1987, Фл. евр. части СССР, 6: 203; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 190; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 121; Negru, 2007, Determ. pl. fl. R. Moldova: 147; Ciocârlan, 2009, Fl. ilustr. a României: 376. – **T. alpin. – К. альпийский.** 2n = 16, 20.

The area of distribution includes Europe, Mediterranean region, Asia Minor, the Caucasus (Eur-Medit). The species is widely distributed in the region. Grows in steppe and steppe slopes, dry open woods, scrub and pastures.

6. ***T. pratense*** L. 1753, Sp. Pl.: 768; . 1968, Fl. Europ. 2: 168; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 311; Бобров, 1987, Фл. евр. части СССР, 6: 203; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 190; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 122; Negru, 2007, Determ. pl. fl. R. Moldova: 147; Ciocârlan, 2009, Fl. ilustr. a României: 379. – **T. praticol. – К. луговой.** 2n = 14.

Distributed in Europe, Mediterranean region, Asia Minor, Middle Asia, Iran, the Caucasus, Western and Eastern Siberia (south), introduced in the Far East (EuaW). The species is widely distributed throughout the region in various habitat conditions (forest margins, clearings, shrub stands and different types of grasslands).

7. ***T. sativum*** (Schreb.) Crome, 1824, in Boenn. Prodr. Fl. Monast. Westph.: 222; Бобров, 1987,

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[1] *geoelement is given by references [3,4,5,6,7,8]*

[2] *Environmental legislation of Republic of Moldova (1996-1998) [5]*

[3] *Red Book of Republic of Moldova (2015) [2]*

Фл. евр. части СССР, 6: 204; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 190; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 123. – *T. pratense* var. *sativum* Schreb. 1804, in Sturm, Deutsch. Fl. 1, 4, 15: 12; Coombe, 1968, Fl. Europ. 2: 168. – *T. pratense* L. subsp. *eupratense* A. et G. Syn. var. sativum Afzel. 1791, in Trans. Linn. Soc. Lond. 1: 243; Ciocârlan, 2009, Fl. ilustr. a României: 379. – **T. roșu cultivat. – К. посевной**. 2n = 14.

Distributed in Europe, Mediterranean region, Asia Minor, the Caucasus, Western and Eastern Siberia (south) (EuaW). Cultivated and occasionally naturalized, met in different biotypes – grassy glades in the forests with oak, poplar and willow, meadows, along roadsides.

8. T. diffusum Ehrh. 1792, Beitr. Naturk. 7: 165; Coombe, 1968, Fl. Europ. 2: 169; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 308; Бобров, 1987, Фл. евр. части СССР, 6: 204; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 190; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 122; Negru, 2007, Determ. pl. fl. R. Moldova: 147; Ciocârlan, 2009, Fl. ilustr. a României: 379. – **T. difuz. – К. раскидистый.** 2n = 16.

The distribution area covers Central (south-east) and Eastern (south-west) Europe, Crimea, Mediterranean region, Asia Minor, the Caucasus (Pont.-Medit.). The species is widely met in the region, grows in margins and clearings of forests, as well as in shrub stands, meadow grasslands, steppe.

9. T. arvense L. 1753, Sp. Pl.: 769; Coombe, 1968, Fl. Europ. 2: 167; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 308; Бобров, 1987, Фл. евр. части СССР, 6: 204; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 190; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 121; Negru, 2007, Determ. pl. fl. R. Moldova: 147; Ciocârlan, 2009, Fl. ilustr. a României: 380. – **Papanaș. – К. пашенный, Котики.** 2n = 14.Distributed in Western Eurasia; introduced in southern part of Eastern Siberia and the Far East (EuaW (Medit.). The species is widely distributed in the region in margins and clearings of arid forests, on steppe slopes, dry meadows and pastures, as a weed along roadsides and in field margins.

Subgenus 2. ***AMORIA*** (C. Presl) Hossain

1961, Notes Roy. Bot. Gard. Edinb. 23, 3: 459. – *Amoria* C. Presl, 1832, Symb. Bot. 1: 47

LT.: ***T. repens*** L.

10. T. montanum L. 1753, Sp. Pl.: 770, non 772; Coombe, 1968, Fl. Europ. 2: 161; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 312; Бобров, 1987, Фл. евр. части СССР, 6: 205; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 189; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 122; Ciocârlan, 2009, Fl. ilustr. a României: 375. – *Amoria montana* (L.) Soják, 1979, Čas. Nár. Muz. Praze, řada přir. 148, 2: 78; Negru, 2007, Determ. pl. fl. R. Moldova: 149. – **T. montan. – К. горный, Белоголовка.** 2n = 16.

Distributed in Western Eurasia (EuaW); introduced in the Far East. The species is widely distributed in the region in various habitat conditions (forest margins, clearings, shrub stands and different types of grasslands, along roadsides).

11. T. ambiguum Bieb. 1808, Fl. Taur.-Cauc. 2: 208; Coombe, 1968, Fl. Europ. 2: 161; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 312; Бобров, 1987, Фл. евр. части СССР, 6: 205; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 189; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 121; Ciocârlan, 2009, Fl. ilustr. a României: 375. – *Amoria ambigua* (Bieb.) Soják, 1979, Čas. Nár. Muz. Praze, řada přir. 148, 2: 78; Negru, 2007, Determ. pl. fl. R. Moldova: 149. – **T. ambiguu. – К. сомнительный.** 2n = 16.

Distributed in the Central (Romania) and southern part of Eastern Europe, the Caucasus, Asia Minor (Pont.-Cauc.). The species is widely distributed in the region in forest margins, clearings, shrub stands and different types of grasslands, along roadsides, sometimes on salty soils. This species is rare, protected by law in Romania (RBR4).

12. T. repens L. 1753, Sp. Pl.: 767; Coombe, 1968, Fl. Europ. 2: 162; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 311; Бобров, 1987, Фл. евр. части СССР, 6: 205; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 189; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 122; Ciocârlan, 2009, Fl. ilustr. a României: 374. – *Amoria repens* (L.) C. Presl, 1832, Symb. Bot. 1: 47; Negru, 2007, Determ. pl. fl. R. Moldova: 147. – **T. repent. – К. ползучий, к. белый**. 2n = 32.

Area of distribution covers Eurasia (Eua). The species is widely met throughout the whole region in grassy places, mainly on well-drained soils.

13. T. hybridum L. 1753, Sp. Pl.: 766; Coombe, 1968, Fl. Europ. 2: 162; Гейдеман, 1986, Опред.

высш. раст. МССР, изд. 3: 311; Бобров, 1987, Фл. евр. части СССР, 6: 205; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 189; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 122; Ciocârlan, 2009, Fl. ilustr. a României: 375. – *Amoria hybrida* (L.) C. Presl, 1832, Symb. Bot. 1: 47; Negru, 2007, Determ. pl. fl. R. Moldova: 149. – **T. hibrid. – К. гибридный, к. розовый.** 2n = 16.

Area of distribution covers Eurasia (Eua); introduced into other regions of the Earth. The species is common in the studied region, inhabiting meadows, margins and clearings of the forests, grassy slopes and pastures.

14. ***T. retusum*** L. 1753, in Höjer, Demonstr. Pl.: 21; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 311; Бобров, 1987, Фл. евр. части СССР, 6: 206; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 189; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 123; Ciocârlan, 2009, Fl. ilustr. a României: 375. – *T. parviflorum* Ehrh. 1792, Beitr. Naturk. 7: 165; Бобров, 1945, Фл. СССР, 11: 214; Вісюліна, 1954, Фл. УРСР, 6: 392; A. Nyárády, 1957, Fl. R. P. Române, 5: 164. – *T. strictum* auct. non L.: Coombe, 1968, Fl. Europ. 2: 161. – *Amoria retusa* (L.) Dostál, 1982, Seznam Cévn. Rostl. Květ. Československ.: 143; Negru, 2007, Determ. pl. fl. R. Moldova: 147. – **T. retuz. – К. притупленнолистный.** 2n = 16.

Distributed in Western (northwards to Britain) and Eastern (south-west) Europe, Crimea, Mediterranean region, Asia Minor, the Caucasus (Pont.-Medit.). In the region met only in the central zone. Grows on grassy slopes and ±salty pastures; calcifuge.

Subgenus 3. ***GALEARIA*** (C. Presl) Hossain

1961, Notes Roy. Bot. Gard. Edinb. 23, 3: 446. – *Galearia* C. Presl, 1832, Symb. Bot. 1: 49

LT.: ***T. fragiferum*** L.

15. ***T. bonannii*** C. Presl, 1822, Delic. Prag.: 51; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 308; Бобров, 1987, Фл. евр. части СССР, 6: 206. – *T. neglectum* C.A. Mey. 1844, Index. Sem. Horti Bot. Petropol. 9, Suppl.: 21; Бобров, 1945, Фл. СССР, 11: 226; Вісюліна, 1954, Фл. УРСР, 6: 400; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 122. – *T. fragiferum* L. subsp. *bonannii* (C. Presl) Soják, 1963, Novit. Bot. Horti Bot. Univ. Prag. 1963: 50; Coombe, 1968, Fl. Europ. 2: 165; Ciocârlan, 2009, Fl. ilustr. a României: 373. – *Amoria bonannii* (C. Presl) Roskov; Negru, 2007, Determ. pl. fl. R. Moldova: 147. – **T. Bonani. – К. Бонанна.** 2n = 16.

Distributed in Eastern Europe (Moldova), Crimea, Mediterranean region, Asia Minor and Middle Asia, Iran, Caucasus (Cauc.-Medit.). In the region, it is met sporadically on the whole territory in meadows on wet and salty grounds.

16. ***T. fragiferum*** L. 1753, Sp. Pl.: 772; Coombe, 1968, Fl. Europ. 2: 165, quoad subsp. *fragiferum*; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 308; Бобров, 1987, Фл. евр. части СССР, 6: 206; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 189; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 122; Ciocârlan, 2009, Fl. ilustr. a României: 373 quoad subsp. *fragiferum*. – *Amoria fragifera* (L.) Roskov, 1990, Бот. ж. 75, 5: 719; Negru, 2007, Determ. pl. fl. R. Moldova: 147. – **T. fragifer. – К. земляничный, Пустоягодник**. 2n = 16.

Distributed in Western Eurasia (EuaW); introduced into other non-tropical areas of the Earth. It is met through the region as common species, in wet places – meadows and along the springs, lakes and roads in the forest, frequently on salty soils.

Subgenus 4. ***MISTYLLUS*** (C. Presl) Hossain

1961, Notes Roy. Bot. Gard. Edinb. 23, 3: 455. – *Mistyllus* C. Presl, 1832, Symb. Bot. 1: 49

LT.: ***T. spumosum*** L.

17. ***T. vesiculosum*** Savi, 1798, Fl. Pis. 2: 165; Coombe, 1968, Fl. Europ. 2: 164; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 308; Бобров, 1987, Фл. евр. части СССР, 6: 208; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 189; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 123; Ciocârlan, 2009, Fl. ilustr. a României: 373. – *T. turgidum* Bieb. 1808, Fl. Taur.-Cauc. 2:

[4] *Red Book of Romania (2009) [1]*

216. – *Amoria vesiculosa* (Savi) Roskov; Negru, 2007, Determ. pl. fl. R. Moldova: 147. – **T. veziculos. – К. пузырчатый.**

Distributed in Eastern Europe (Moldova, Ukraine), Crimea, Mediterranean region, Asia Minor, Caucasus (Medit.-Pont.-Cauc.). It is met only in the south as a rare species on steppe slopes in margins of arid oak forests. Locations in the region determine the northern limit of its common area. This species is rare, protected by law in Romania (RBR[4]).

Subgenus 5. ***CHRONOSEMIUM*** (Ser.) Peterm.

1847, Deutschl. Fl.: 140. – *Chronosemium* Ser. 1825, in DC. Prodr. 2: 204. – *Chrysaspis* Desv. 1818, Obs. Pl. Env. Angers: 164

T.: ***T. dubium*** Sibth.

18. ***T. aureum*** Poll. 1777, Hist. Pl. Palat. 2: 344; Coombe, 1968, Fl. Europ. 2: 166; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 307; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 188; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 122; Ciocârlan, 2009, Fl. ilustr. a României: 373. – T. strepens Crantz, 1769, Stirp. Austr., ed. 2, 2, 5: 411, nom. illeg.; Бобров, 1945, Фл. СССР, 11: 222; Вісюліна, 1954, Фл. УРСР, 6: 396; A. Nyárády, 1957, Fl. R. P. Române, 5: 156. – *Chrysaspis aurea* (Poll.) Greene, 1897, Pittonia, 3: 204; Бобров, 1987, Фл. евр. части СССР, 6: 211; Negru, 2007, Determ. pl. fl. R. Moldova: 149. – **Auraş. – К. золотистый.** 2n = 14.

Area of distribution covers the territory of Western Eurasia (EuaW (Medit.)); introduced in the southern parts of Far East. It is common plant for the whole territory of Bessarabia where it is met in dry grasslands, forest margins and clearings, shrub stands. Locations in the region determine the southern limit of its common area of distribution.

19. ***T. campestre*** Schreb. 1804, in Sturm, Deutschl. Fl. 1, 4: 16: sine pag.; Coombe, 1968, Fl. Europ. 2: 166; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 307; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 188; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 122; Ciocârlan, 2009, Fl. ilustr. a României: 372. – *Chrysaspis campestris* (Schreb.) Desv. 1818, Obs. Pl. Env. Angers.: 164; Бобров, 1987, Фл. евр. части СССР, 6: 211; Negru, 2007, Determ. pl. fl. R. Moldova: 149. – **T. campestru. – К. полевой.** 2n = 14.

The distribution area covers the territory of the Eurasia (Eua (Medit.)); introduced in the southern parts of Far East. The species is widely met in the region, grows in dry grasslands.

20. ***T. dubium*** Sibth. 1794, Fl. Oxon.: 231; Coombe, 1968, Fl. Europ. 2: 166; Шимкус, 1999, Опред. высш. раст. Укр., изд. 2: 188; Васильева и Коваленко, 2003, Консп. флори Півден. Бессарабії: 122; Ciocârlan, 2009, Fl. ilustr. a României: 372. – *Chrysaspis dubia* (Sibth.) Desv. 1818, Obs. Pl. Env. Angers.: 165; Бобров, 1987, Фл. евр. части СССР, 6: 212. – **T. dubios. – К. сомнительный.** 2n = 28, 32.

The area of distribution covers most of Europe except the extreme north, Caucasus (Eur.-Medit.). The species is common in the region, met sporadically, inhabiting pastures and clearings of arid forests.

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THE ROLE OF COENOTIC RELATIONS IN THE FORMATION OF PLANT COMMUNITIES (ON THE EXAMPLE OF THE LOWER LAYERS OF FORESTS OF THE NORTH-EAST OF UKRAINE)

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Abstract: The article focuses on the study of associativity and conjugation of 20 plant species of live ground cover of broad-leaved forests in the North-East of Ukraine. Two groups such as cenosis-forming species and species-intruders were determined based on the research findings.

Key words: broad-leaved forest, live ground cover, cenogenesis, associativity and conjugation of species.

INRTRODUCTION

The beginning of the twentieth century was marked by the formation of the two opposite points of view regarding the formation of plant communities. According to F. Clements and V. M. Sukachov, they are the integrities, formed on the basis of active coenotic relations among the species which comprise them, and according to H. Gleazon and L. G. Ramenskiy, they are segments of the vegetation continuum within which plant species are organized by the differentiation of ecological niches (Trass H. H., 1976).

Over the past few decades, a great number of works, showing that the interaction of plants is one of the most important components of cenogenesis, have appeared in the Ukrainian and foreign geobotanical literature. Confirmation of this view comes from the arrangement of a special discussion about the mechanisms of cenogenesis or, as they are sometimes called, "assembly rule", by one of the leading journals in the field of vegetation science "Journal of Vegetation Science", in 1994-1995, on the initiative of B. Wilson and E. van der Maarel (Solodukhina A., 2012, Devis M. A et al., 2015, Maarel van der E et al., 1995, Wilson J. B., 1994, Wilson J. B., 1995). Thus, the definition of role of coenotic relations in the formation of plant communities is an important scientific problem.

Live ground cover of broad-leaved forests with high species diversity, vegetation mosaic and sufficient length of forest gradients (Wilson J. B., 1982) acts as a convenient object to decide the issues of the role of coenotic relations in the formation of plant communities. Our research goal was to study associativity of plants and their role in cenogenesis of the lower layers of forests of the north-east of Ukraine, which comprise live ground cover in the forests, experiencing minimal anthropogenic load due to long stay (since 1974) in protected areas.

MATERIALS AND METHODS

Our research was conducted in the forests of the north-east of Ukraine. General characteristics of this region are presented in the works of Ya. P. Didukh and I. B. Sukhuy (Didukh Ya.P., 1994). Geobotanical descriptions are limited to the mixed broad-leaved forests, forest-forming species of which are *Acer platanoides* L., *Tilia cordata* Mill., *Ulmus glabra* Huds., *Fraxinus excelsior* L., *Quercus robur* L. 900 sampling plots of 1m x 1m were laid in order to establish relationships between the plant species of live ground cover. The projective cover of all plant species was determined within these plots. In most cases, the perennials such as *Aegopodium podagraria* L., *Asarum europaeum* L., *Stellaria holosteah*, *Galium odoratum* Scop., *Polygonatum multiflorum* (L.) All., *Glechoma hederaceah.*, *Urtica dioica* L. were the main cenosis-forming plant species of the 41 vascular plant species identified in live ground cover. They seem to "conserve" cenosis-forming relationships that develop over several years of joint growth in the same block group. This makes them the most informative ones in the study of coenotic relations in the layer of live ground cover.

Cenotic relations among species were estimated in two independent ways: by finding associativity and defining conjugation (in understanding of O. O. Uranov (Uranov A. A., 1935). Associativity was calculated based on the ratio of *Ass* with the usual notations of four-column table:

$$Ass = \frac{a-b-c}{a+b+c},$$

where a is the number of cases of common occurrence of A and B species;
b – is the number of cases of common occurrence of A species;
c – is the number of cases of common occurrence of B species.

The ratio of *Ass* has some advantages over other ratios of associativity: it is symmetric and adequately reflects the ability of species to grow together or to avoid each other. The conjugation of plants was calculated by the method of O. O. Uranov (Uranov A. A., 1955) in the form of regression of projective cover of the subordinate species with increase in cover of the existing species. In this form, associativity reveals the nature and extent of interaction of the species growing together. In the modern sense, (Zlobin Yu. A., 2005) associativity is the regression of one species to another. The species with the highest occurrence and abundance is always chosen as the existing species.

Coenotic prosperous species are mainly involved in the analysis (Didukh Ya. P., 1992). The associativity and the conjugation of species with low occurrence (less than 2%) and projective cover are largely statistically inaccurate, so we do not consider them. The computer program ASS (developed by Yu. A. Zlobin), to determine associativity, and the program TableCurve of the company Jandel Scientific, version 2.03, to determine conjugation, were used as well.

RESULTS AND DISCUSSION

The research covers 20 plant species of live ground cover. Table 1 shows the results of the calculation of associativity. Two groups such as cenosis-forming species and species-intruders can be picked out of the main species of live ground cover. The first group (cenosis-forming species) includes species with high occurrence and abundance *(Aegopodium podagraria, Asarum europaeum, Stellaria holostea, Polygonatum multiflorum, Glechoma hederacea, Pulmonaria obscura Dumort., Lamium maculatum (L.) L., Viola mirabilis L.)*. They are characterized by mutual positive associativity that reveals a significant trend towards common growth. The second group consists of species with negative associativity both among themselves and the species of the first group (*Actaea spicata* L., *Brachypodium sylvaticum* (Huds.) Beauv., *Adoxa moschatellina* L, *Mercurialis perennis* L., *Orobus vermis* (L.) Bernh., *Galium odoratum*, etc.).

The first group acts as cenosis forming one, and the second group includes the species-intruders that occupy free ecological niches and compete for them both with cenosis-forming species and with each other. Intermediate coenotic tactics is typical for *Carex pilosa* Scop. The obtained actual material generally confirms D. Tilman's idea (Didukh Ya. P., 1988) of the individual nature of interspecific plant relations as opposed to the opinion, which limits the diversity of plant relations to any diffuse competition in general. The discrepancy in the relationship of cenosis-forming species and intruders is illustrated in Fig. 1, which shows that the first group of species is characterized by the presence of a full range of associations with other components of aggregation – from strong repulsion to strong interdependence. Species-intruders, on the contrary, are marked by associations that lie entirely in the zone of negative values of the ratio of associativity.

Definition of species conjugation has allowed us to detail the nature of the relationship between plants of live ground cover (Tab. 2). It has been found that cases with positive, negative and neutral species conjugation comprise about the same percentage (34.2 %, or 25.3%, 31.0%, respectively). Double-valued conjugation has been found in 9.5% of cases. The nature of the relationship of species was always individual.

Table 1. Associativity of the main species of live ground cover

Species	Occurence in %	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Aegopodium podagraria L.	98.8	X																			
Asarum europaeum L.	97.8	0.978	X																		
Stellaria holostea L.	87.8	0.775	0.753	X																	
Polygonatum multiflorum (L.) All.	87.8	0.733	0.711	0.551	X																
Glechoma hederacea L.	86.7	0.753	0.773	0.609	0.489	X															
Pulmonaria obscura Dumort.	82.2	0.622	0.682	0.517	0.477	0.663	X														
Lamium maculatum (L.) L.	78.9	0.596	0.614	0.371	0.371	0.548	0.625	X													
Urtica dioica L.	76.7	0.551	0.528	0.364	0.326	0.419	0.287	0.415	X												
Viola mirabilis L.	71.1	0.438	0.455	0.365	0.326	0.302	0.366	0.293	0.023	X											
Geum urbanum L.	61.1	0.236	0.250	0.080	0.116	0.167	0.146	0.360	0.351	0.013	X										
Carex pilosa Scop.	51.1	0.034	0.045	0.125	-0.093	0.139	0.038	-0.214	-0.326	0.056	-0.475	X									
Geranium robertianum L.	48.9	-0.044	-0.067	-0.205	-0.036	-0.163	-0.190	-0.125	0.096	-0.300	-0.088	-0.568	X								
Dentaria bulbifera L.	47.8	-0.034	-0.023	-0.060	-0.163	0.025	0.039	-0.144	-0.165	-0.291	-0.278	-0.403	-0.303	X							
Galium odoratum (L.) Scop.	47.8	-0.067	-0.089	-0.095	-0.095	-0.218	-0.341	-0.286	-0.235	-0.221	-0.907	-0.549	-0.303	-0.676	X						
Orobus vernus L.	40.0	-0.191	-0.213	-0.125	-0.229	-0.185	-0.317	-0.482	-0.500	-0.260	-0.605	-0.647	0.216	-0.410	-0.127	X					
Mercurialis perennis L.	40.0	-0.191	-0.182	-0.229	-0.326	-0.185	-0.250	-0.358	-0.407	-0.222	-0.507	-0.612	-0.071	-0.322	-0.322	-0.222	X				
Adoxa moschatellina L.	13.3	-0.730	-0.753	-0.725	-0.725	-0.831	-0.877	-0.872	-0.718	-0.797	-0.906	-0.760	-0.811	-0.843	-0.500	-0.797	-0.659	X			
Brachypodium sylvatica (Huds.) Beauv.	6.7	-0.865	-0.864	-0.848	-0.848	-0.873	-0.838	-0.861	-0.826	-0.910	-0.860	-0.826	-0.878	-0.822	-0.870	-0.910	-0.846	-0.882	X		
Stellaria media (L.) Vill.	5.6	-0.888	-0.886	-0.900	-0.873	-0.872	-0.865	-0.889	-0.886	-0.877	-0.966	-0.958	-0.875	-0.867	-0.957	-0.877	-0.897	-0.875	-1.000	X	
Actaea spicata L.	2.2	-0.955	-0.955	-0.975	-0.975	-0.949	-0.973	-0.944	-0.942	-0.969	-0.927	-0.956	-0.957	-0.955	-0.907	-0.969	-0.889	-0.846	-1.000	-1.000	X

Table 2. Conjugation of the main species of live ground cover

Species	b	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Aegopodium podagraria L.	0.250	X																			
Asarum europaeum L.	0.191	∩	X																		
Stellaria holostea L.	0.030	∩	∩	X																	
Polygonatum multiflorum (L.) All.	0.099	↗	∩	↘	X																
Glechoma hederacea L.	0.089	↗	↗	↗	∩	X															
Pulmonaria obscura Dumort	0.049	∩	∩	↗	↗	∩	X														
Lamium maculatum (L.) L.	0.069	↗	↗	↘	↗	↗	∩	X													
Urtica dioica L.	0.112	↘	↗	↔	∩	↘	∩	↔	X												
Viola mirabilis L.	0.164	↗	↗	↔	↗	↔	↔	↗	↔	X											
Geum urbanum L.	0.023	↘	↗	↗	↘	↗	↘	↗	↗	↔	X										
Carex pilosa Scop.	0.066	↗	∩	↗	↘	∩	∩	↘	↘	↔	↔	X									
Geranium robertianum L.	0.060	↘	↔	↘	↗	↔	↔	↔	↔	↘	↔	↘	X								
Dentaria bulbifera L.	-0.008	↘	↗	↗	↗	↗	↗	↗	↗	↘	↗	↔	↔	X							
Galium odoratum (L.) Scop	-0.049	↘	∩	↘	↗	↘	↘	↘	↘	↔	↘	↘	↗	↔	X						
Orobus vernus L.	0.051	↗	↘	↔	↗	↗	↔	↔	↘	↗	↔	↔	↔	↗	↗	X					
Mercurialis perennis L.	0.037	∩	∩	∩	↔	↘	↗	↘	↘	↗	↘	↔	↘	↗	↗	↗	X				
Adoxa moschatellina L.	0.057	↘	↗	↘	↗	↔	↗	↘	↘	↗	↔	↘	↔	↔	↗	↔	↔	X			
Brachypodium sylvatica (Huds.) Beauv.	-0.001	↗	↗	↔	↗	↗	↗	↗	↘	↘	↗	↘	↔	↗	↗	↔	↗	↘	X		
Stellaria media (L.) Vill.	-0.000	↗	↘	↗	↔	↔	↔	↗	↘	↔	↔	↔	↔	↔	↔	↔	↔	↔	↔	X	
Actaea spicata L.	-0.000	↗	↘	↔	↔	↘	↔	↔	↔	↔	↔	↘	↘	↘	↗	↘	↗	↔	↔	↔	X

Note: ∩ – double-valued conjugation; ↘ – negative; ↗ – positive; ↔ – neutral.

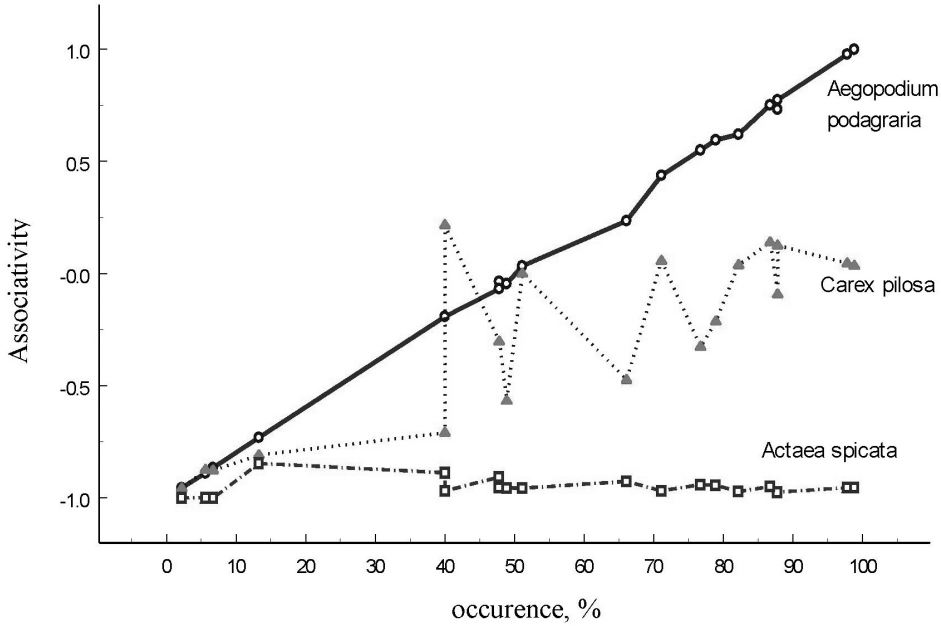

Fig. 1. Associativity of cenosis-forming species (*Aegopodium podagraria* L.), intermediate species *(Carex pilosa Scop.)* and species-intruder (*Actaea spicata* L.) in live ground cover

So, 4 cases of double-valued conjugation were defined for *Aegopodium podagraria:* 9 – positive, 6 – negative; for *Carex pilosa* – 3 – double-valued, 2 – positive, 8 – negative and 6 – neutral. Neutral conjugation is often observed among species-intruders with low occurrence.

A sufficiently large actual material on changes in projective cover of 20 species of herbaceous plants was used to test the hypothesis about diffuse competition (Giller P., 1988) as the main controller of the abundance of species in plant communities. Variability of projective cover of each studied species was separately determined by the gradient of change in the total projective cover of live ground cover. In this case, the curves of conjugation were approximated by a straight line, and the ratio "b" in the equation $y = a + bx$ was the degree of reaction of species to the general background of "diffuse competition". It has been revealed (Table. 2) that only 3 of 20 species (*Dentaria bulbifera* L., *Galium odoratum* (L.) Scop, Brachypodium sylvaticum (Huds.) Beauv.) perceive a diffuse background of live ground cover, which has a competitive impact on them. This background was neutral for the two species (*Stellaria media* (L.) Vill., *Actaea spicata* L.) and positive for the other 15 species (75%): with increase in the total projective cover of each of these species.

CONCLUSIONS

This can be seen as a high adaptability of the studied species to the ecological and coenotic conditions of the lower layer of broad-leaved forests. Thus, the concept of diffuse competition is not confirmed with respect to the live ground cover of broad-leaved forests. In the first stages, plant communities are formed by means of differentiation of plant species by ecological niches, but due to the high similarity of requirements of all plants for the light, water and mineral nutrients, and all in all, the active interactions of species with each other determine the floristic composition of phytocenoses and their composition. P. Grubb's opinion is obviously just (Devis M. A., 2015) that during the study of phytocenotic effects simple theories are gradually being replaced by integrated, more realistic ones and the theories which are more appropriate for the complex nature of plant communities.

A high proportion of positive interactions among plant species and their response to the general coenotic background (as in the case of pair interactions of species of live ground cover of the forest) is

not unexpected. In recent years, a number of researchers have drawn attention to the importance of relationships for facilitation of cenotic processes G. Brooker and T. Callighan consider the study of this type of plant relationship to be "unfairly ignored branch of ecology".

After conducting the study of associativity and conjugation of 20 species of live ground cover of broad-leaved forests, the two groups such as cenosis forming species and species-intruders were clearly determined. High adaptability of plants to joint existing is illustrated by the positive type of relations among plants that play a significant role in the formation of cenotic relations.

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"VOINOVA" NATURAL FORESTRY RESERVE

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Abstract. "Voinova" Natural Forestry Reserve (R.N.S.) with an area of 27.0/30.8 ha in O.S. Anenii Noi, parcel 1, is located in the meadow of Nistru River, Şerpeni village, Anenii Noi County. It contains natural stands, 16.8 ha (54.5%), with 60-100-year-old pedunculate oak, acacia plantations – 9.9 ha (32.1%). The floristic composition consists of 118 species of vascular plants including: trees – 20 species, bushes – 12, lianas – 3 and grass species – 83, rare plants species – *Aconitum lasiostomum* Reichenb., *Galanthus nivalis* L., *Asparagus tenuifolis* Lam., *Asparagus verticillatus* L., *Fritillaria meleagroides* Patrin ex Schult et Shult. fil. Natural forestry vegetation is represented by communities of ass. Ulmeto-Quercetum, Gheideman et al., 1964, with subassociation aegopodietosum & ass. Saliceto-Populetum, Meijer-Drees, 1936. This R.N.S. is hardly influenced by natural disasters (floods, landslides, hoary frost, late frosts), and also by anthropogenic and zoogenic factors.

Abstract. Rezervaţia naturală silvică (R.N.S.) „Voinova" cu suprafaţa de 27,0/30,8 ha O. S. Anenii Noi, parcela 1, este amplasate în lunca fl. Nistru s. Şerpeni, raionul Anenii Noi cuprinde arborete naturale 16,8 ha (54,5%) cu stejar pedunculat de 60-100 ani, plantaţii cu salcâm - 9,9 ha (32,1%). Componenţa floristică este alcătuită din 118 specii de plante vasculare din care arbori – 20 specii, arbuşti – 12, liane 3 şi ierburi 83 specii, din speciile de plante rare – *Aconitum lasiostomum* Reichenb., *Galanthus nivalis* L., *Asparagus tenuifolis* Lam., *Asparagus verticillatus* L., *Fritillaria meleagroides* Patrin ex Schult et Shult. fil. Vegetaţia naturală silvică este reprezentată prin comunităţile ass. Ulmeto-Quercetum Gheideman et al. 1964 cu subasociaţia aegopodietosum şi ass. Saliceto-Populetum Meijer-Drees 1936 R.N.S. dată este mult influenţată de presingul calamităţilor naturale (inundaţii, alunecările de teren, chiciura, înghețurile tardive), precum şi a factorilor de origine antropogenă şi zoogenă.

INTRODUCTION

"Voinova" Natural Forestry Reserve is located in the meadow of Dniester River, near Şerpeni village, Anenii-Noi county, with an area of 27.0 ha according to the Environmental Legislation of R. Moldova, but 30.8 ha according to forest arrangements (fig. 1). The land owner is Chişinău State Forestry Enterprise, Forest District Anenii-Noi, parcel 1. This protected area is formed by natural stands, covering an area of 16.8 ha (54.5%) and is formed by pedunculate oak (*Quercus robur* L.), 60-100 years old, 28 m in height and 70 cm in diameter, in subparcels b, c, i, j, k (fig. 2). There are also acacia plantations in subparcels a, d, l, m with an area of 9.9 ha (32.1%) (Fig. 3) [6].

MATERIALS AND METHODS

In order to carry out floristic and phytocenotic inventorying, and also to evaluate the protection state in "Voinova" Natural Forestry Reserve, have been made investigations of the maps and taxation of stands in the forest arrangements of the Forest Fund of R. Moldova, and also the field visits to appreciate the floristic and phytocenotic composition during spring and summer period. The state of protection and maintenance of the composition in "Voinova" Natural Forestry Reserve have been evaluated during the period 18.04.2012-15.07.2012.

RESULTS AND DISCUSSIONS

During the floristic and phytocenotic research have been found 118 species of vascular plants out of which: trees – 20 species, bushes – 12, lianas – 3 and herbaceous species – 83. *Trees: Acer campestre* L. (field maple), *Acer negundo* L. (boxelder maple), *Acer platanoides* L. (Norway maple), *Acer tataricum* L. (Tatar Maple), *Carpinus betulus* L. (common hornbeam), *Cerasus avium* L. (sweet cherry), *Fraxinus excelsior* L. (common ash), *Fraxinus lanceolata* Borkh. (green ash), *Gledicia triacanta* L. (honey locust), *Juglans regia* L. (common walnut), *Morus alb*a L. (white mulberry), *Populus alba* L. (white poplar), *Salix alba* L. (white willow), *Quercus pubescens* Willd. (downy oak), *Quercus robur* L. (pedunculate oak), *Robinia pseudacacia* L. (black locust), *Tilia cordata* Mill. (small-leaved lime), *Ulmus glabra* Huds

(Scots elm), *Ulmus laevis* Pall. (European White-elm), *Ulmus carpinifolia* Rupp. ex Suckow (Field Elm). Bushes: *Cornus mas* L. (Cornelian cherry), *Corylus avellana* L. (common hazel), *Cotinus coggygria* Scop. (European smoketree), *Crataegus curvisepala* Lindm. (hawthorn), *Crataegus monogyna* Jacq. (single-seeded hawthorn),

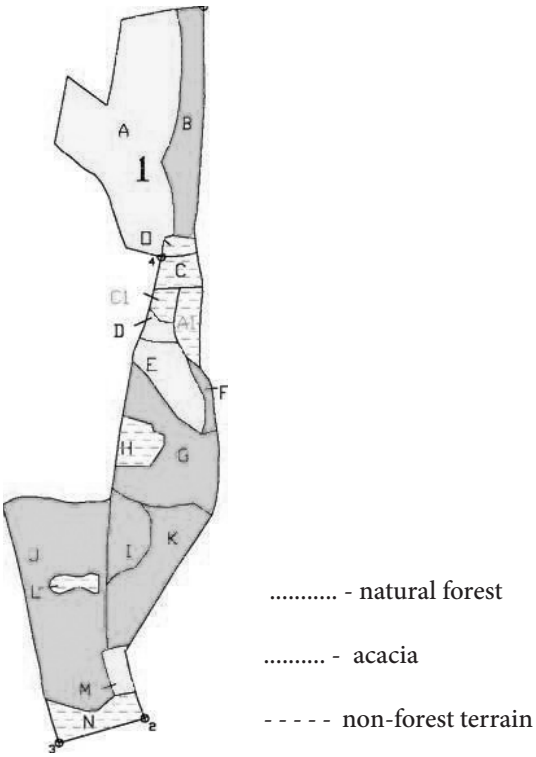

Fig. 1. Terrain map of "Voinova" Natural Forestry Reserve

Fig. 2. Secular pedunculate oak tree in "Voinova" Natural Forestry Reserve, parcel 1, subparc. b.

Fig. 3. Acacia in "Voinova" Natural Forestry Reserve, parcel 1, subparc. a.

Euonymus europaeus L. (common spindle), *Ligustrum vulgare* L. (wild privet), *Rosa canina* L. (dog-rose), *Rubus caesius* L. (European dewberry), *Sambucus nigra* L. (elderberry), *Swida sanguinea* (L.) Opez. (common dogwood), *Viburnum lantana* L. (wayfarer). Lianas: *Hedera helix* L. (common ivy), *Humulus lupulus* L. (common hop), *Parthenocissus quinquefolia* (L.) Planch. (Virginia creeper). Herbs: *Aconitum lasiostomum* Reichenb. (aconite), *Adoxa moschatellina* L. (moschatel), *Aegonychon purpureo-caeruleum* (L.) Holub (Purple Gromwell), *Aegopodium podagraria* L. (ground elder), *Agrimonia eupatoria* L. (common agrimony), *Anemonoides ranunculoides* (L.) Holub (yellow anemone), *Anthriscus sylvestris* (L.) Hofffm. (cow parsley), *Arctium lappa* L. (greater burdock), *Aristolochia clematitis* L. (birthwort), *Artemisia vulgaris* L. (common wormwood), *Asparagus tenuifolius* Lam., *Asparagus verticillatus* L. (Hardy Vining Asparagus Fern), *Astragalus glycyphyllos* L. (Liquorice milkvetch), *Ballota nigra* L. (black horehound), *Brachypodium sylvaticum* (Huds) Beauv. (false-brome), *Bromopsis beneckenii* (Lange) Holub, *Bromus arvensis* L. (field brome), *Campanula persicifolia* L. (peach-leaved bellflower), *Campanula rapunculoides* L. (creeping bellflower), *Campanula trachelium* L. (nettle-leaved bellflower), *Cannabis ruderalis* Janisch. (wild hemp), *Cannabis sativa* L. (hemp), *Carex brevicollis* DC., *Carex contigua* Hoppe (Spiked sedge), *Carex michelii* Host. (green-ribbed sedge), *Carex pilosa* Scop. (hairy sedge), *Chaerophyllum temulum* L. (rough chervil), *Chelidonium majus* L. (greater celandine), *Chenopodium album* L. (lamb's quarters), *Clinopodium vulgare* L. (wild basil), *Convallaria majalis* L. (lily-of-the-valley), *Convolvulus arvensis* L. (field bindweed), *Corydalis cava* (L.) Schweigg. et Korte (holewort), *Corydalis solida* (L.) Clarv. (spring fumewort), *Dactylis glomerata* L. (orchard grass), *Dentaria bulbifera* L. (coral root), *Erigeron canadensis* L. (Canadian horseweed), *Euphorbia amygdaloides* L. (wood spurge), *Ficaria verna* Huds. (lesser celandine), *Fragaria vesca* L. (wild strawberry), *Fritillaria meleagroides* Patrin ex Schult. & Schult.f. (chequered lily), *Gagea lutea* (L.) Ker-Gawl. (Yellow Star-of-Bethlehem), *Gagea minima* (L.) Ker-Gawl. (Small star-of-Bethlehem), *Gagea pusilla* (F.W.Schmidt.) Schult. et Schult. f., *Galanthus nivalis* L. (common snowdrop), *Galeobdolon luteum* Huds. (yellow archangel), *Galium aparine* L. (cleavers), *Geum urbanum* L. (wood avens), *Glechoma hederacea* L. (ground-ivy), *Glechoma hirsuta* Waldst. et Kit (creeping charlie), *Hypericum perforatum* L. (perforate St John's-wort), *Isopyrum thalictroides* L. (False Rue Anemone), *Lamium album* L. (white dead-nettle), *Lamium maculatum* L. (spotted dead-nettle), *Lamium purpureum* L. (red dead-nettle), *Lapsana communis* L. (common nipplewort), *Lathyrus vernus* (L.) Bernh. (spring vetchling), *Leonurus cardiaca* L. (motherwort), *Lysimachia nummularia* L. (creeping jenny), *Melica uniflora* Retz. (wood melick), *Mercurialis perennis* L. (dog's mercury), *Mycelis muralis* (L.) Dumort (wall lettuce), *Myosotis sparsiflora* Pohl (forget-me-not), *Origanum vulgare* L. (Oregano), *Plantago major* L. (broadleaf plantain), *Poa nemoralis* L. (wood bluegrass), *Polygonatum latifolium* Des, *Prunella vulgaris* L. (common self-heal), *Pulmonaria obscura* Dumort (unspotted lungwort), *Sambucus ebulus* L. (danewort), *Scilla bifolia* L. (alpine squill), *Scutellaria altissima* L. (tall skullcap), *Scutellaria galericulata* L. (common skullcap), *Sedum maximum* (L.) Hoffm. (Mossy stonecrop), *Solanum nigrum* L. (European black nightshade), *Stellaria media* (L.) Vill. (chickweed), *Tanacetum corymbosum* (corymbflower tansy), *Taraxacum officinale* Wigg. (common dandelion), *Urtica dioica* L. (stinging nettle), *Urtica urens* L. (dwarf nettle), *Veronica chamaedrys* L. (bird's-eye speedwell), *Veronica hederifolia* L. (Ivy-leaved Speedwell), *Vincetoxicum hirundinaria* Medik. (white swallow-wort), *Viola hirta* L. (hairy violet), *Viola mirabilis* L. (wonder violet).

Rare species such as *Aconitum lasiostomum* Reichenb. (aconite), *Galanthus nivalis* L. (common snowdrop), *Fritillaria meleagroides* (chequered lily), *Asparagus tenuifolius* and *Asparagus verticilatus* L. (Hardy Vining Asparagus Fern) have also been observed; *Galanthus nivalis* L., *Fritillaria meleagroides* are enlisted in Red Book of R. Moldova [5]. The presence of allogenic species has to be mentioned: boxelder maple *(Acer negundo)*, green ash *(Fraxinus lanceolata)*, honey locust *(Gleditsia triacanthos)*, English walnut *(Juglans regia)*, white mulberry *(Morus alba)*, black locust *(Robinia pseudacacia)*, Siberian peashrub *(Caragana arborescens)* and Virginia creeper *(Parthenocissus quinquefolia)*.

The associative character of "Voinova" Natural Forestry Reserve is presented by communities from *Ulmeto-Aceretum* associations Gheideman et al., 1964, with *aegopodietosum* subassociations, mainly constituted by *Aegopodium podagraria* al. *Quercion* (roboris-sesiliflorae) Borza 1937, ord. *Quercetalia*

robori-petraea Passarge et Hoffmann 1968, cl. *Querco-Fagetea* Br.-Bl. et Vlieger, 1937, and poplar with acacia associations *Saliceto-Populetum* Meijer-Drees, 1936, *aegopodietosum* subassociation, from al. *Salicion albae* Soó, 1930, ord. *Salicetalia purpureae* Moor, 1958, cl. *Salicetea purpureae* Moor, 1958, [1-4].

Both flora and vegetation of "Voinova" Natural Forestry Reserve is often affected by natural disasters: floods of Dniester River, landslides, hoary frost, late frosts and also by daily activities of anthropogenic and zoogenic factors (grazing, tourism, fruit and mushroom gathering etc.).

CONCLUSIONS

1. In order to stop the loss of natural stands we propose that regeneration of this forest to be carried out by taking care of seedlings till maturity (successive cuttings, highlighting and protection of seed trees, using local indigenous genetic material etc.).
2. In the places where oak is omitted from the stands' composition, we recommend to use rehabilitation procedures with local origin materials (taking care of seedlings, gathering and sowing the seeds of local origin).
3. To substitute allogenous tree species (acacia, conifers and also oak species planted in an inadequate and improper habitat) by forest-forming oak trees in pedoclimatic conditions specific to the habitat.
4. To reestablish indicative boards on all access roads to the Reserve, according to the Regulations for the natural forestry reserve (Government Decision N 784 dated 3/08/2000).
5. To carry out forest arrangements according to the objectives of the Regulations for the Landscape Reserves.
6. To increase the efficiency of the performed actions in order to protect forest fund in the Reserve (blocking or decreasing the numerous roads and other communication and access ways, limitations for animal grazing, spontaneous tourist stations, banning bonfires, downhole areas, garbage, waste etc).
7. To intensify ecological education of the local adult population, pupils and children by informing them on scientific value of the state protected area.
8. To establish touristic routes on areas less vulnerable for rare and endangered plant species protected by the state, and to install warning signs and road indicators.
9. Scientists from the Academy of Science to initiate periodical observations on forest vegetation for various vascular plant species, including rare and endangered ones.

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PRODUCTIVITY OF APPLE TREES CV. GOLDEN DELICIOUS UNDER HIGH DENSITY AND CANOPY MANAGEMENT CONDITIONS

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Abstract. Apple tree (designated as "*scion/rootstock* combination") development is closely linked to physiological processes and biochemical reactions. This action becomes disclosed by certain bioconstructive and phytometrical parameters conferral to the trees which more or less contribute to the realization of potential productivity of an apple orchard. The present paper contains materials of original research carried out during 3 years (2012- 2014). The experiences are aimed to find out the best mode of growth and cropping management of trees out of 34 variant/density combinations.

INTRODUCTION

Productivity (i.e., consistent high yield and fruit quality) of apple orchard plantings forms fruit value and marketable yield and defines the level of profitability of apple culture industrial production [8]. Higher incomes impend to increase productivity via enterprising various measures aimed to increase functional efficiency of agrophytocoenotic system [1].

Planting density is the single most important factor to increase (up to a breakeven point in conformity with economic law of diminishing returns) the productivity of apple plantings as it determines total cumulative yield of an orchard, at least, for the first 5 years [8]. High density (superintensive) plantings have proved to be much more productive agrophytocoenoses as compared to medium and low density (intensive and classic) ones [8]. No doubt, high density offers an increase in total yield per year on the average +10..+130% [6] owing to a greater number of trees per unit of production which from orchard establishment form continuous rows (hedgerows) of trees with mid season light interception of photosynthetically active radiation PAR close to 60% [1, 4, 8], total yield from fruiting wall is 15-20 t/ha at 2-3 years after planting, 40- 50t/ha (average yields) at 3-5 years [8] and up to 70 t/ha (high yields) at the period of full fruiting at 6-8 years [6], total cumulative yield over 5 years – 150 t/ha [8], over 8-10 years of economically profitable exploitation 250-300 t/ha [7].

The important role of canopy management, as pruning and secondary operations during various periods of the year, treating with growth and bloom-controlling phytohormonal bioregulators seems to be neglected as they provide an increase in productivity of just 2-5 t/ha [6] and represent just a mandatory necessity to contain the tree within shape and parameters allotted by planting scheme, priority for crop load management CLM being reposed in fruiting-induction pruning [4], chemical products, manual fruit thinning [2] etc. That's why to obtain just one single result – stable crops of fruits of programmed quality [1], one and the same orchard area is worked over many a time throughout the growing year increasing the volume of work and decreasing profitability of the orchard [8]. In view of the above, the tree, being an integral organism, necessities one single applying of proper measures which would be able to trigger endogenously all the processes with just one shot – application executed at a certain time of stage of tree phenology that will provide maximum efficiency upon the tree with a condition the tree is not nutrient deficient and physiologically unhealthy [5].

MATERIALS AND METHODS

Objective of researches: within the 3 year period (2012-2014) it was a high density apple plantation with advanced facilities and drip irrigation, established with trees from modern pome assortment (basic cultivar Golden Delicious, pollinator cv. Idared) which were planted in spring, 2007, at the homestead "M.I.Paciu", village Braviceni, district Orhei, Moldova. Used materials: trees, cv. Golden Delicious, grafted on M9; trees at peak time of fruiting. Structure of the experience (Tab.1): 4 variants in 3 repetitions for medium density scheme 4.0x1.5 m; 10 variants in 3 repetitions for each of high density schemes 3.0x1.0 m; 3.0x0.66 m; 3.0x0.33 m, in total 34 variants. Research methods and technique of work are those approved for pomiculture to carry out experiences with pome species [9].

Table 1. Canopy management modes

Index	Descriptin of variants
M*	Sample trees for scheme 4.0x1.5m- Dormant pruning
V2a*	Dormant pruning without 1/3sup. disrupt.+ FAGÉL (2013)
V6*	Dormant pruning + Regalis®10WG 2.5kg/ha (2012)
V6a*	Dormant pruning+Regalis®10WG 1.25+1.25kg/ha (2012)
M	Sample trees for 3.0x1.0-0.66-0.33m- Dormant pruning
V1	Dormant pruning+ 1/3 super. disruption + axis 90^0 (Solaxe
V2	Dormant pruning+ 1/3 superior disruption+ FAGÉL (2013
V3	Pruning after cropping (September)
V4	Pruning after flower petals' fall (May)
V5	Pruning within the longest days of the year (18-22 June)
V6	Dormant pruning + Regalis®10WG 2.5kg/ha (2012)
V6a	Dormant pruning+ Regalis®10WG 1.25+1.25kg/ha (2012)
V6b	Dormant pruning + Regalis®10WG 3.2kg/ha (2014)
V7	Summer hedging + pruning green shoots (August)

RESULTS AND DISCUSSIONS

Regardless planting scheme and canopy management mode, all the data vary throughout the years of study: a) within margin of error p=±5 at the assumed level of confidence 95%, in bioconstructive parameters (tree height, canopy width) as they are annually pruned to the parameters impended by the allotted planting scheme; b) within maximum conventionally accepted limit, p=±15 in biometrical indexes (current growth) owing to biennial bearing of the trees and as a result, patchy development of overground part of the trees, producing system "circle", c) under the conditions of alternate bearing in underload years we have registered untrue data beyond confidence interval, margin of error p=±15.99 for general values in proportion as: planting distance - flowers (yield) - leaves (rozette: long shoots) - trunk diameter, the level of fruiting periodicity index and foliar index value; all this characterizes the extent to what disequilibrium of energetic-physiologic balance between vegetative macrostructure – fruit bearing microstructure as well as yield – trunk diameter comes to.

1. Influence of in-row distance and planting scheme upon development of apple trees.

Table 2. Effect of density upon growth and cropping of apple trees

Planting scheme	Tree height		Flower number		Shoot number		Summed growth		L medium shoot		Canopy[2] Vol m^3*10^3/ha		Leaf area[2] m^2*10^3/ha		Yield per tree		Yield per hectare[2]	
	m	%	unit	%	nr	%	m	%	cm	%	m^3	%	m^2	%	kg	%	t/ha	%
4.0x1.5m	2.83	100	808	100	133	100	34.2	100	25.9	100	30.9	100	12.3	100	14	100	23.7	100
3.0x1.0m	2.87	+1.4	914	+13	131	-1.5	26.7	-22	20.0	-23	32.0	+3.4	11.7	-4.9	8.4	-40	27.7	+17
3.0x0.6m	2.92	+3.2	585	-28	92	-31	17.7	-48	18.8	-28	38.3	+24	14.5	+18	7.8	-45	39.0	+65
3.0x0.3m	2.98	+5.3	423	-48	64	-52	11.2	-67	17.5	-33	53.8	+74	18.3	+49	5.6	-60	54.6	+131

Each planting scheme confers specific traits of development to the planted trees, thus within one variant/one planting scheme combination we register insignificant differences p=±5, but when comparing values of the same variant in more planting schemes, there appears an increase of the reported margin of error equal to triple error p=±15 which cannot be considered just a case. That's why we may conclude that one and the same canopy maintenance mode doesn't output one and the same result for various planting schemes. Analyzed observations upon apple trees' phenology in four planting densities has proven their influence upon terms of start and end point of phenophases, so distanced trees started their

[1] *Data produced in table 2 are summed ones; the values repartitioned by planting schemes enclose a number of experimental variants (4 in 4.0x1.5m and 10 for the other schemes), margin of error for separate variants p=±15.*

[2] *Calculation of yield, leaf area and canopy volume per hectare was carried out by universal tree number per hectare (3.0x0.33 m – 9999 trees/ha; 3.0x0.66 m- 5016 trees/ha; 3.0x1.00 m – 3300 trees/ha; 4.0x1.50 m – 1675 trees/ha) without percent of perished trees which led to an increase of real[2a] yield, generating total calculated yield.*

growth with 2-3-4 days earlier and ceased their growth with 3-4-5 days later than trees planted closely to each other. Bio-physiological development of trees, namely, starting rate of growth of shoots, trunk growth in diameter, tendency to form large-sized fruits is higher at larger distances between the trees than at smaller in-row distances. Trees in various planting schemes show strong structural difference: according to the phytomass from short lateral shoots (rosettes and fruiting spurs) and phytomass from long shoots (fruiting and vegetative ones) a higher percentage is recorded at in-row spacing 0.33 m than at 0.66 m; 1.0 m and 1.5 m, respectively 16.7:83.3; 11.5:88.5; 2.6:97.4; 4.7:95.3. During three years of study (overload years 2012 and 2014, underload year 2013) there has been registered no alternate bearing in trees distanced at 1.5 m while, on the average at 1.0 m – 23.1%, at 0.66 m – 14.7%, at 0.33 m – 8.2% trees absolutely without fruits in underload year 2013.

The above-said entails that tree density is exogenous instrument which governs physiological processes and is able to adjust intensity of growth, bloom, fruiting and, respectively, bioconstructive and phytometrical parameters of the trees. Owing to the use of M9 rootstock of low vigour, parameters of vegetative mass can be contained at reduced canopy volume (height of trees 2.83-2.98 m, canopy width 0.9-1.3 m in-between row measurement (E-V) and 0.5-1.1 m in-row measurement (N-S), depending on soil and air spacing correspondent to each of the planting scheme (Tab. 2-3). Effect of density upon growth and cropping of apple trees: along with minimization of nutritive space, trees show restraint in annual growth of shoots, decrease in canopy volume, leaf area, quantity of flowers and yield per tree; yet, we register increase in height of trees, total canopy volume, leaf area per unit of production (hectare). When compared to medium density scheme, the total yield in 3.0x0.6 m is doubled whereas in 3.0x0.3 m +131% more (!) (Tab. 2). So, we can see the fact that limitation of nutritive space (tree's rooting area) doesn't affect vital processes necessary for normal physiological functioning of the trees. Since orchard establishment, the percentage of perished trees for 0.33 m has been 0...13.3%, mean value 4.7%. This is 2.7 times less than in 0.66 m – 2.2...37.8 %, mean value 12.7% and 1.5 times less than in 1.0 m – 1.8...17.1%, mean value 7.1%; in 1.5 m the phenomenon has not been present.

2. Effects from canopy management modes in experimental variants:

Table 3. Influence of canopy management mode upon biometrical parameters of apple trees

Variant	Tree height		Trunk diameter			Canopy width, m		Number of shoots		Summed shoots, L		Shoot med. length		Age of wood in tree structure, %				
	m	%	cm²	mm	%	N-S	E-V	unit	%	m	%	cm	%	<1	1	2	3	4
M*	2.58	100	15.61	446	100	1.31	1.52	121	100	27.1	100	22.9	100	0	61	29	8	2
V2a*	3.50	+36	19.78	502	+13	1.28	1.55	169	+40	59.3	+119	35.3	+54	—	—	—	—	—
V6*	2.72	+5	14.15	425	-5	1.45	1.50	135	+11	31.3	+15	23.6	+3	—	—	—	—	—
V6a*	2.89	+12	14.72	434	-3	1.46	1.48	124	+2	35.0	+29	29.2	+28	—	—	—	—	—
M	3.14	+22	11.59	385	-14	0.87	1.41	124	+2	26.7	-1.6	21.0	-8	0	61	30	7	2
V1	2.79	+8	12.32	396	-11	0.80	1.34	104	-14	22.2	-18	20.9	-9	0	59	32	8	1
V2	2.76	+7	11.45	382	-14	0.81	1.29	103	-15	23.6	-13	22.4	-2	0	69	21	8	2
V3[4]	2.58	0.0	10.38	364	-18	0.76	0.96	65	-46	9.6	-65	14.0	-39	0	72	20	7	1
V4	2.84	+10	10.34	363	-19	0.79	1.01	79	-35	14.1	-48	17.7	-23	11	61	19	8	1
V5	3.01	+17	10.66	369	-17	0.83	1.16	97	-20	15.3	-44	16.5	-28	7	59	26	7	1
V6	2.99	+16	9.92	356	-20	0.83	1.11	82	-33	17.5	-36	21.9	-5	—	—	—	—	—
V6a	2.94	+14	10.29	362	-19	0.78	1.09	78	-35	19.2	-29	24.1	+5	—	—	—	—	—
V6b	3.44	+34	14.86	435	-2	0.85	1.17	159	+31	26.8	-1.0	16.8	-27	0	63	27	7	3
V7	3.04	+18	12.17	394	-12	0.73	0.98	82	-32	13.5	-50	14.3	-37	14	56	24	6	1

1) Sample trees conducted by Superspindle training system were pruned in March as this timing is worldwide approved and is the most recommended one because contributes to productive potential maintenance. Summed growth of shoots per growing season for high density plantings in schemes 3.0x1.0-0.66-0.33 m is just (!) by -1.6% lower than in medium density scheme 4.0x1.5 m. Number of shoots is only (!) by +2% more than in medium density scheme (tab. 3). These data highlight the fact that one and the same number of shoots constitutes total volume of the tree with just one difference: at

[3]*Data produced in tables 3-6 are summed ones, grouped by canopy management modes within 3 high density schemes and 1 medium density scheme (sample scheme) for comparison; average margin of error for high density schemes p=±15.*

[4]*For V3 the data is reduced by 10-25-35% (depending on intensity of pruning) as compared to the remaining variants because the measurements were taken right away after trees were pruned after cropping*

higher densities overground space allotted for the trees is much more used when compared to medium density scheme. Ratio between phytomass from short fruit-bearing shoots and long shoots is 4.7:95.3 (tab. 4). Sample trees in 0.33 m register fruit weight 128 g, yield 47 t/ha, in 0.66 m fruit weight 130 g, yield 39 t/ha, in 1.0 m fruit weight 140 g, yield 27 t/ha (tab. 6). Biochemical fruit analysis (tab. 6) has shown that fruit pulp consistency represented by textural firmness for high density schemes M is 6.84 kg/cm^2, while for M* in medium density scheme 8.99 kg/cm^2 (optimum range is 7.5-8.8 kg/cm^2 [3]), so optimum moment of harvesting occurred 5-7 days earlier in 1.0-0.66-0.33 m distances when compared to 1.5 m. Biennial bearing in the underload year 2013 was manifested with 16.0 % uncropped trees. The periodicity index in high density plantings – 24.7%, while in medium density scheme 18.6% (tab.5). The percentage of perished trees – 1.8-2.2%.

2) Summer pruning provides the most dwarfing effect for both current year and the following season. That's why according to the data in Table 3, a restraint of current growth (maiden shoots) was attained in V7 – August pruning (-50% when compared to sample trees), with percentage of this year's side shoots (less than 1 year-old wood) in structure of the canopy – 14 %. Of approximately same values (-48% when compared to sample trees) with V7 is variant V4 – pruning after flower petals' fall, percentage of this year's side shoots – 11%. Summed growth during growing season in V5 – pruning within the longest days of the year is by -44 % less than in sample trees, the percentage of this year's side shoots – 7 %. Phytomass obtained from rosettes in V4 – pruning after flower petals' fall 18.9%, in V7 – August pruning 27.3%, V5 – pruning within the longest days of the year 42.7%, the latter being the highest percent out of all experimental variants (tab. 4). At in-row planting density of 0.33 m, fruit weight is 110 g, yield – 46 t/ha; in 0.66 m fruit weight is 131 g, yield – 40 t/ha, at 1.0 m, fruit weight is 136 g, yield 25 t/ha, which is inferior to the sample trees in the corresponding scheme (tab. 6). According to biochemical analysis of fruits (tab. 6), the fruits are at optimal moment of cropping. A strong effect of alternative bearing is seen: in V5 – 27.3%, in V4 – 41.5%, and in V7 – 49.5% uncropped trees in underload year 2013. Periodicity index is 11.6-15.9% (tab. 5). Percentage of perished trees in V4 and V5 is 8.9-14.4% and in V7 – 2.2-5.4%. Under constant action of summer pruning (3 subsequent years), in May and June and less marked in August, has increased the susceptibility to negative factors of medium causing pest spread (the European red mite – *Pannonycus ulmi* Koch), appearance of unpersisting physiological disorders in bud differentiation (sterile blossom clusters instead of annual shoots), leaves (2 apexes, red colour), shoots (two competing intergrown leaders) and fruits (June and pre-harvest fruit drop, remained fruits were attacked by Apple scab – *Venturia inaequalis* (Cocke) Wint.).

Table 4. Data on phytometrical parameters acquired by apple trees in the orchard

Variant	Weight of 50 leaf parts, mmg						Area of 50 leaves		rosette: long shoots phytomass ratio			Fruit: rosette m^2 percentage ratio		Leaf area m^2/tree	
	laminae	%	petioles	%	stipules	%	м^2	%	%	0:0	m^2:m^2	fruit number:m^2	fruit weight:m^2	m^2	%
M*	32.51	100	3.38	100	0.29	100	1.4	100	4.7:95.3	0:10	2.8:56.0	97.2:2.8	99.0:1.0	58.8	100
V2a*	36.26	11.5	3.87	+15	0.25	-14	1.8	+29	—	—	—	—	—	122	+108
V6*	33.97	4.5	3.27	-3.3	0.24	-17	1.4	0.0	—	—	—	—	—	68.6	+17
V6a*	32.99	1.5	3.45	+2.1	0.35	+21	1.5	+7.1	—	—	—	—	—	74.5	+27
M	33.25	2.3	3.28	-3.0	0.20	-31	1.3	-7.1	10.6: 89.4	1:10	4.29:36.2	96.9:3.1	98.4: 1.6	40.5	-31
V1	33.08	1.8	3.35	-0.9	0.14	-52	1.3	-7.1	9.9: 90.1	1:10	2.89:26.3	98.0:2.0	98.9: 1.1	29.2	-50
V2	31.22	-4	3.71	+10	0.18	-38	1.2	-14	27.5: 72.5	3:7	9.30:24.5	93.2:6.8	97.1: 2.9	33.8	-42
V3[4]	28.93	-11	3.41	+0.9	0.11	-62	1.1	-21	42.9: 57.1	4:6	7.64:10.2	94.3:5.7	97.3: 2.7	17.8	-70
V4	33.02	1.6	3.20	-5.3	0.16	-45	1.3	-7.1	18.9: 81.1	2:8	4.46:19.1	96.6:3.4	98.4: 1.6	23.6	-60
V5	30.18	-7.2	3.11	-8.0	0.16	-45	1.3	-7.1	42.7: 57.3	4:6	10.2:13.8	93.7:6.3	96.2: 3.8	24.0	-59
V6	35.60	9.5	3.48	+3.0	0.27	-6.9	1.5	+7.1	—	—	—	—	—	37.8	-36
V6a	37.63	+16	3.63	+7.4	0.21	-28	1.6	+14	—	—	—	—	—	36.8	-37
V6b	31.93	-1.8	3.27	-3.3	0.06	-79	1.3	-7.1	14.0: 86.0	1:9	2.23:13.7	96.4:3.6	99.1: 0.9	15.9	-73
V7	28.14	-13	2.81	-17	0.17	-41	1.3	-7.1	27.3: 72.7	3:7	4.89:13.0	96.6:3.4	98.1: 1.9	17.9	-70

3) The main goal of September pruning is to contain the tree within the allotted space. When carried out within 10 days after cropping, it contributes to a better wintering and even mixed bud pre-set, thus, in a way, being equal to the value of fruiting-induction pruning effect. In the variant V3, the growth was diminished by -30-40% when compared to sample trees (tab. 3), 25-30% phytomass was

obtained on short fruiting spurs (tab. 4), fruit weight 130-140 g with superior gustatory values (tab. 6), yield +1...12 t/ha, when compared to sample trees in correspondent schemes. Alternative bearing is not registered. Periodicity index is 6.2% (tab. 5). The percentage of perished trees in 1.0 m and 0.33 m is 7.2-11.1% and in 0.66 m – 20%

4) Axis positioning at 90^0 is growth controlling mode for Solaxe training system. At the 6th year after planting (in 2012) the trees trained by Superspindle training system were converted to Solaxe training system with 1/3 superior disruption and establishment of variant V1. As per experiments, there was registered a diminution of bio- and phytometrical values when compared to sample trees in correspondent scheme, namely, tree height by -15.4...-7.6 %; number of shoots by -11.8...-19.1 % (tab. 3). Both M-Superspindle and V1-Solaxe pruned in March produce the same percentage of rosette phytomass 9.9-10.6% (tab. 4). Fruit weight is 110-150 g, yield by +2...10 t/ha more than in sample trees in correspondent scheme. Assessed apple fruits' texture (firmness) is low 6.22 kg/cm^2, maturity of fruit at harvest determined by Joseph Streif index is low as well – 0.5 (optimum values are 0.12-0.08 [3]) (tab. 6); this testifies that optimum moment of cropping was attained 7-10 days earlier than in sample trees. The effect of alternative bearing is equal in M and V1 – 16.0 % uncropped trees in 2013. The periodicity index is 26.3 % (tab. 5). The percentage of perished trees is 3.6-11.1 %.

Table 5. Influence of canopy management mode upon productivity indexes of apple trees

Variant	Total volume		Lateral leaf area		Soil use		Foliar index	Trunk cross-section		Canopy volume		Fruit: leaf ratio				Periodicity index, %
	m^3/tree	%	m^2/tree	%	%	%	Fi=F1:F2	fruit/cm^2	kg/cm^2	kg/m^3	fruit/m^3	leaf/1fruit	m^2/1 fruit	fruit/1m^2	kg/1m^2	
M*	1.1	100	4.9	100	18.3	100	3.1 (2.7:0)	6.41	0.78	13.21	105	21.0	0.61	2.00	0.25	18.6
V2a*	4.7	+327	13.7	+180	78.7	+330	6.1 (5.3:0)	2.73	0.54	2.25	11.0	64.0	2.24	0.00	0.09	21.7
V6*	1.5	+36	6.2	+27	24.8	+36	3.4 (3.1:0)	14.3	1.58	17.19	147	12.5	0.35	3.00	0.33	-12.6
V6a*	1.6	+46	6.7	+37	26.5	+45	3.7 (3.5:0)	10.5	1.23	12.87	101	18.0	0.53	2.00	0.25	0.3
M	1.2	+9.1	6.1	+25	62.5	+242	3.4 (4.7:0)	5.69	0.60	6.23	58.0	44.8	1.26	1.89	0.19	24.7
V1	0.9	-18	4.9	0.0	48.8	+167	2.8 (3.6:0)	5.50	0.63	8.84	76.3	29.1	0.76	2.56	0.27	26.3
V2	1.1	0.0	5.5	+12	60.9	+233	3.4 (4.6:0)	5.15	0.78	8.85	60.3	22.1	0.52	2.00	0.30	11.5
V3[4]	0.5	-55	3.5	-29	28.1	+54	2.6 (3.3:0)	5.71	0.78	18.7	139	15.8	0.36	3.44	0.49	6.2
V4	0.6	-46	4.3	-12	35.6	+95	3.0 (3.8:0)	5.83	0.59	10.1	99.0	53.6	1.40	2.56	0.25	12.6
V5	0.8	-27	4.6	-6.1	45.7	+150	2.5 (3.4:0)	6.73	0.69	9.64	87.7	20.6	0.55	3.33	0.32	11.6
V6	0.8	-27	4.7	-4.1	42.2	+131	4.2 (6.0:0)	7.39	0.78	11.5	107	54.2	1.66	2.00	0.22	34.7
V6a	0.7	-36	4.6	-6.1	38.5	+110	4.5 (5.5:0)	6.68	0.68	9.37	90.7	33.5	1.14	1.83	0.20	53.3
V6b	0.7	-36	6.0	+22	55.3	+202	1.7 (2.5:0)	1.93	0.24	4.15	33.0	34.7	0.90	1.67	0.23	3.0
V7	0.7	-36	4.2	-14	33.2	+81	2.7 (3.1:0)	5.53	0.59	13.4	122	25.9	0.65	4.00	0.42	15.9

5) The application of organic acid-based products is considered promising and is being tested with the goal to direct physiological processes in favour of obtaining abundant bloom. In V2a* without superior disruption growth was by +119 % more than in sample trees, fruits of 196 g were retained on branches, yield by -3 t/ha less than in sample scheme. Positive effect produced after encircling with a 5 cm width stripe of jelly-like finger-paint for trees FAGÉL above first tier (scaffold limb) in 2013 was recorded in V2 – dormant pruning in March with 1/3 superior disruption which rendered an equilibrium of growth-fruiting balance, the summed growth was by -13 % less than in sample trees. The percentage of rosette phytomass was 27.5 %. For the 3 subsequent years fruit quality had been Extra (149 g) with superior gustatory values (tab. 6), yield was by +4...26 t/ha more than in the corresponding sample scheme. Alternative bearing is not registered. Periodicity index is 11.5 % (tab. 5). Variant V2 increases productive potential of the trees by consistent bloom and formation of short fruit-bearing branches. One single disadvantage is percentage of perished trees because of fire blight *Erwinia amylovora* (Burrill) Winslow and fungus *Leucostoma kunzei* (Fr.) Munk, which penetrates via ruptures produced after disruption: in 0.33 m – 13.3 %, in 0.66 m – 37.8 % (the highest out of all variants), in 1.0 m – 17.1 %; in V2a* at 1.5 m – 0 %. So, we may conclude that consistent fruiting influences genetic resistance and makes trees susceptible to pathogen agents.

6) The treatment with plant growth regulators (PGR) targets equilibration of processes of formation of fruit-bearing spurs and "useless" vegetative wood which is being formed to an excess in underload years contributing to a much higher growth rate in diameter of the trunk.

Table 6. Influence of canopy management mode upon fruiting indexes of apple trees

Variant	Flowers		Fruits		Fruit quality			Biochemical analyses of the fruits						Yield	
	number	%	number	%	Category	Weight, g	%	Diameter, mm	Firmness, kg/cm²	Soluble substance, Bx	Streif Ind ex	pH initial extract	Total titratable acidity,%	kg/ tree	%
M*	1058	100	100	100	I and II	131	100	61,0	8,99	17,8	0,08	0,364	0,399	12,2	100
V2a*	—	—	54.0	-46.0	70+mm	197	+50	—	—	—	—	—	—	10.6	-13
V6*	—	—	202	+102	No qual	112	-15	—	—	—	—	—	—	22.4	+84
V6a*	—	—	155	+55.0	I and II	125	-5	—	—	—	—	—	—	18.1	+49
M	806	-23.8	66.0	-34.0	I and II	133	+2	63.0	6.84	17.7	0.07	0.399	0.310	6.9	-43
V1	657	-37.9	67.7	-32.3	I and II	134	+2	63.0	6.22	19.2	0.05	0.391	0.347	7.7	-37
V2	634	-40.1	59.0	-41.0	Extra	149	+14	61.7	9.33	15.9	0.10	0.378	0.321	8.9	-27
V3[4]	235	-77.8	59.3	-40.7	I and II	135	+3	62.3	9.09	16.5	0.09	0.370	0.357	8.1	-34
V4	1124	+6.2	60.3	-39.7	I and II	135	+3	60.7	7.55	18.4	0.07	0.454	0.291	6.1	-50
V5	1177	+11.2	71.7	-28.3	I and II	126	-4	60.0	8.39	18.5	0.08	0.390	0.311	7.4	-39
V6	—	—	73.3	-26.7	I and II	127	-3	—	—	—	—	—	—	7.7	-37
V6a	—	—	68.7	-31.3	I and II	120	-8	—	—	—	—	—	—	7.0	-43
V6b	973	-8.0	28.7	-71.3	I and II	121	-8	61.3	7.16	18.7	0.07	0.381	0.402	3.6	-71

Out of V6, V6a, V6b, V6*, V6a* variants, in which the trees were treated after mass bloom with Regalis®10WG in various concentrations, the best size-controlling effect was registered in V6, by -36% less than in sample trees (tab. 3). The percentage of rosette phytomass is >14.0% (tab. 4). The concentration of 3.2 kg/ha gives way to June defoliation, i.e. large-scale fall of the middle-positioned leaves off 1 year-old shoots. The effect was the most clearly seen in 1.0 m when percentage of fallen leaves was by +20...25 % more when compared to the other variants. Fruit weight in 0.33 m is 80-90 g, in 0.66 m; 1.0 m and 1.5 m 90-100 g. According to biochemical analysis, the fruits are at current consumption maturity stage (tab. 6), yield in V6 and V6a is by 5-15t/ha more owing to fruit retention on branches (2-3-4 fruits per blossom cluster) and in V6b by -20...80% less than in sample trees, in the corresponding scheme, owing to fruit drop. The effect of alternative bearing in V6 is 33.0 %, in V6a – 49.5 %, in V6b – 41.3 % uncropped trees in 2013. The periodicity index in V6 is 34.7 %, in V6a – 53.3 % and in V6b – 3.0 % (tab. 5). The percentage of perished trees: in 0.33 m – 0 %, in 0.66 m – 4.4...14.3 %, in 1.0 m–1.8...5.3 %.

CONCLUSIONS

Summing up observations and experimental data, we may state that indexes of trees' productivity are dependent on both underlying and imposed conditions, the latter generating their "response-to-condition" behaviour. The application of certain measures at the time of maximum efficiency upon the tree, indeed, is able to trigger indogenically energetic-physiological processes and to direct them towards a less laborious formation of useful products (fruits).

On the ground of carried out research for industrial production, we may recommend in-row distance of 0.33 as a correct one, training system for this density – Tall Spindle TS. This planting scheme (3.0x0.33 m) with nutritive space of 0.99 m² imposes reduced canopy volume of about 0.7 m³ within which it is easy to increase the ratio of vegetative macrostructure-fruit-bearing microstructure in favour of the latter, thereby changing fruiting type III of the studied cultivar (which rather seldom bears fruits on fruiting spurs) to fruiting type II for which it is a common trait. Moreover, trees in this scheme are less prone to biennial bearing (8.2 % trees without fruits) and pass from existence (4.7 % perished trees). In order to increase the productivity (greater total yield and yield of commercially valuable fruits) of high density apple orchards comparing to corresponding sample scheme, out of 34 experimental variants, we recommend for implementation in descending priority (tab. 7):

Table 7. Variants recommend for apple culture industrial production

No	Canopy management mode	Planting scheme	Total yield [2] t/ha		Category of real yield	Productivity increase compar. to real yield		M- yield, t/ha for corresp. scheme	
			calculated [2]	real[2a]		t/ha	%	calculated[2]	real[2a]
without fruit thinning techniques									
1)	V2-Dorm.pr.+1/3dis.+FAGÉL	3.0x0.33m	73.8	64.0	Extra	+17.5	+37.6	47.6	46.5
2)	V3- Pruning after cropping	3.0x0.33m	59.1	52.5	I and II	+6.0	+12.9	47.6	46.5
crop load management CLM is impending									
3)	V6-Regalis®10WG 2.5kg/ha	3.0x0.33m	62.6	62.6	I and II	+16.1	+34.6	47.6	46.5
4)	V1- Solaxe+1/3 sup. disrupt.	3.0x0.33m	57.4	53.6	I and II	+7.1	+15.3	47.6	46.5
without fruit thinning techniques									
5)	V3- Pruning after cropping	3.0x1.0m	35.2	32.7	I and II	+6.0	+22.5	27.2	26.7

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PHYTOPATHOLOGIC ESTIMATION OF RESISTANCE OF VARIETIES OF A SUGAR BEET TO *ERYSIPHE COMMUNIS* GREV. AND CERCOSPORA BETICOLA SACC.

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Abstract. Researches of immunity and also selection of a sugar beet is conducted concerning the most harmful diseases. Such is *Cercospora beticola* Sacc. and *Erysiphe communis* Grev.
Phytopathologic estimation of resistance to *E. communis* Grev. and *C. beticola* Sacc. of varieties of a sugar beet on natural condition are a valuable material and can be used in selection as donors of resistance to these diseases.

Key words: sugar beet, phytopathologic estimation, diseases, resistance.

INTRODACTION

Creation of highly productive varieties of sugar beet resistant to diseases and their introduction in agriculture is very important link in the system of actions for struggle against them. Researches on immunity and also on selection of a sugar beet are conducted concerning the most harmful diseases. Such is powdery mildew, cercospora blight, peronosporosis, phoma leaf spot. This disease is caused by fungi *Erysiphe communis* Grev., *Cercospora beticola* Sacc., *Peronospora schachtii* Fuckel., *Phoma betae* Frank [1, 2].

The fungal pathogen *Cercospora beticola* causes the most destructive foliar disease of sugar beet, namely Cercospora leaf spot (CLS), which results in economically important yield losses. Current breeding efforts aim at developing sugar beet lines with lower fungal susceptibility as well as high productivity to ensure reduced fungicide applications in the context of integrated pest management. However, the main challenge remains to select sugar beet genotypes that produce the required yield quality and quantity, and to quantify their defense ability.

Plants of beet of the first and second year are affected. The disease appears on all above-ground parts of plant (on leaves, stalks, and glomes of beet) as a white bloom. In the beginning the bloom, it is gentle and web-like; then it quickly expands, becoming white, dense, and powdering. The affected parts of plants get a powdered kind. In the second half of vegetation the brown, later black dots are formed on a white strike, black points of fungal cleistocarpia are formed on white bloom. The affected leaves turn yellow and die off. Primary infection of beet plants is formed by ascospores, which are thrown out from wintered cleistocarpia having a size of 75-102 microns in diameter; the cleistocarpia form 6-8 asci (62-65 x 35-40 microns in size) with 4-6 ascospores in each one (20-24 x 13-14 microns in size). During vegetation of plants, the Powdery Mildew is distributed by conidia being formed on short conidiophores. Conidia are oval, colorless, 30-36 x 10-15 microns in size. The disease results in premature dying of plants, decrease of weight of roots, reduction of sugariness and bad safety at storage [3].

MATERIALS AND METHODS

We carried out a phytopathological estimation of resistance of varieties and forms of a sugar beet to *E. communis* Grev. and *C. beticola* Sacc. on a natural background. The resistance to disease was estimated using T. L. Dobrozrakova's method, that is, on a five-point scale. Varieties of a sugar beet in number of 48 samples were taken for research [4].

RESULTS AND DISCUSSIONS

The study of phytopathological resistance of samples of sugar beet to *E. communis* Grev. has shown that 6 varieties were immune to this disease, it has been found that 12.5 %, 29.2 % were highly resistant, 20.8 % were resistant, 35.4 % were tolerant. Only one variety appeared to be susceptible, that is 2.1 %, and there were no highly susceptible varieties to the disease.

The phytopathological estimation of the resistance of varieties of sugar beet has established that only one variety was immune to *C. beticola* Sacc., that is 2.1 %, 4.2 % were highly resistant, 10.4 % were resistant, 52.1 % were tolerant, 29.2 % were susceptible, and 2.0 % were highly susceptible varieties.

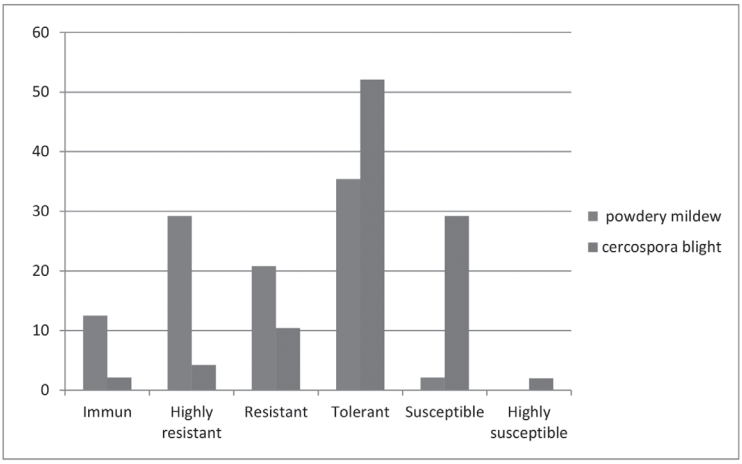

Figure 1. Phytopathological estimation of resistance to powdery mildew and cercospora blight varieties of sugar beet.

The comparative estimation of phytopathological resistance to *E. communis* Grev. and *C.beticola* Sacc. has shown that varieties of a sugar beet are more resistant to *E. communis* Grev. than to *C. beticola* Sacc., since the percentage of immune, highly resistant and resistant varieties to *E. communis* Grev. in total have made up 62.5 %, and to *C. beticola* Sacc. – 16.7 %. The percentage of susceptible and highly susceptible varieties in total has made up 2.1 % (*E. communis* Grev.) and 31.2 % (*C.beticola* Sacc.) respectively.

The weakened protective reactions of susceptible varieties on development activator of *C.beticola* Sacc. cause not only higher quantity of the damaged plants, but also more considerable pathological changes in the metabolism of the damaged plants. It sharply reduces the efficiency and technological qualities of sugar beet and the given developments of *E. communis* Grev. have shown that these varieties are not only resistant to the disease, but also productive [5, 6].

CONCLUSIONS

Comparative phytopathological assessment of infection by powdery mildew and cercospora blight in natural background of beet accessions was carried out.

As a result of this investigations, the resistance to *E. communis* Grev. and *C. beticola* Sacc. of sugar beet varieties are a valuable material and can be used in selection as donors of resistance to these diseases.

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FLORISTIC NOTES IN BESSARABIA No. 1-25

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Abstract: Data on the spread of new or rare species of the flora of Bessarabia are elucidated in the paper. The manner of presentation of floristic notes is described here. New growth areas for 25 rare species are pointed out, including 4 new taxa of the investigated wild flora: *Campanula glomerata* L. var. *selvagii* Pînzaru, *Cerastium sylvaticum* Waldst. & Kit., *Hieracium murorum* L. s.l, *Veronica dillenii* Crantz.

INTRODUCTION

Floristic notes presented in this paper were obtained during the floristic field research in 2014-2015 and as a result of determining the herbarium collected in previous years.

MATERIALS AND METHODS

The herbarized plants are found in the private collection of the author (CHIS-PP) and doublets will be passed on to the Herbarium of the Botanical Garden (I) of the ASM (CHIS). The exsiccata of the species in question from the Herbaria of R. Moldova (CHIS, CHIS-PP, CHIS-US – Museum of the State University from Chisinau), the collection of living plants grown in the private garden „Grădina Maria", from Codru town, which includes over 600 species, have been studied when determining the plants.

The species are pointed out on the basis of the traditional morphological-ecological method. Floristic nomenclature [9] – with some corrections according to modern systematic information [13]. Rare species of the flora of the republic – according to the recent literature [1, 2, 4, 8, 9].

Floristic notes refer to the new, rare species or the ones found for the first time in one of the regions of the territory of Bessarabia and Transnistria. The presence of the species is indicated by "+" and their absence by "-", the spread is indicated by region: **BasN** – includes the localities of northern Bessarabia (Cernăuți region); **BasS** – localities of southern Bessarabia (Odessa region); **RMN** – the North of the republic: Ocnița, Briceni, Edineț, Dondușeni, Râșcani, Drochia, Soroca, Glodeni, Fălești, Sângerei, Florești, Șoldănești, Rezina, Telenești districts, Bălți municipality; **RMC** – central part of the republic: Ungheni, Călărași, Orhei, Criuleni, Strășeni, Nisporeni, Hâncești, Ialoveni, Anenii Noi, Dubăsari districts (localities from the right bank of Dniester), Chișinău municipality, Tighina municipality; **RMS** – the South of the republic: Leova, Cimișlia, Cănari, Căușeni, Ștefan-Vodă, Basarabeasca, Cantemir, Cahul, Taraclia districts and Autonomous Territorial Unit of Gagauzia; **RME** – the East of the country: Transnistria autonomous territorial unit with the districts: Camenca, Râbnița, Dubăsari (localities from the left bank of Dniester), Grigoriopol, Slobozia, Tiraspol municipality; / **RAR** – rare species, / **A** – naturalized exotic species, /**A** – occasionally cultivated exotic species.

Results and Discussions

The recent floristic investigations revealed four new taxa of the studied flora: *Campanula glomerata* L. var. *selvagii* Pînzaru (the natural monument "Stânca Naslavcea", district Ocnița), *Cerastium sylvaticum* Waldst. & Kit., (the forest near Dobrynivtsy village, northern Bessarabia), *Hieracium murorum* L. s. l. (the forest near the villages Lomachintsi and Rașcov, northern Bessarabia), *Veronica dilenii* Crantz – in the districts: Florești (communes: Prodănești, Ștefănești), Rezina („Țipova" landscape reserve), Anenii Noi (Speia commune), new growth centres for 25 rare species. It is proposed to accept, in the local flora, the species *Genista elata* (Moench) Wender. instead of *G. tinctoria* L. var. *virgata* Koch [= *G. tinctoria* auct.

mold. non L.]. Scientific arguments are reported below.

New taxa:

1. Campanula glomerata L. var. ***selvagii*** **Pînzaru**, Novosti Syst. Vysh. Rast. 43:103, 2012 (*Campanulaceae*)

+ RMN/RAR: Ocnița district (Naslavcea commune, natural monument "Stânca Naslavcea", thickets of the plant association *Vinco herbaceae-Chamaecytisetum austriacae*, 23 VI 2014, leg. Pînzaru). It was recorded for the first time in R. Moldova.

Note. Perennial, xeromesophilic, described in Italy (Piedmont region, province of Turin, "Monti Pelati" reserve, alt. 495 m, 16 VIII 2008, leg. Pînzaru; Veneto region, province of Verona, Monte Pastello, alt.712 m, 07 VII 2019, leg. Pînzaru). Glabrous, glabrescent plants (leaves – ciliated only on the margins), corolla – 18 mm long, light violet.

2. Cerastium sylvaticum Waldst. & ***Kit.,*** Descr. Icon. Pl. Hung.: tab. 9, 1802 *(Caryophyllaceae)*

+ BasN/RAR: Cernăuți region (Dobrynivtsy village, beech forest of the association *Carpino-Fagetum* Pauca 1941, 25 VI 1996, leg. Pînzaru.)

Note. Southeast European hemicryptophyte, mesophile-mesohydrophile, which grows (especially) in forest. New species in the flora of Bessarabia. The species *C. sylvaticum* was indicated by T. Ghejdeman (1986) in "Codrii" forests, but there are no exsicatae in the herbarium, therefore, its presence cannot be confirmed.

3. Hieracium murorum L. s.l., Sp. Pl.: 802, 1753 *(Asteraceae)*

+BasN/RAR:, Cernăuți region (Lomachintsi village, forest of the association *Corno-Quercetum petraeae,* 03 VII 1996, leg. Pînzaru; Raşcov village, forest of the association *Corno-Quercetum petraeae,* 30 VI 1996, leg. Pînzaru).

Note. West Eurasian hemicryptophyte, xeromesophile, which grows (especially) in forest. New species for the flora of Bessarabia.

4. Veronica dillenii Crantz, Stirp. Austr. Fasc. ed. 2: 352, 1769 *(Plantaginaceae)*

+ RMN/RAR: Floreşti district (Prodăneşti commune, 26 IV 2009, leg. Pînzaru; Prodăneştii Vechi village from Ştefăneşti commune, 28 IV 2009, leg. Pînzaru; Ştefăneşti commune, 28 IV 2009, leg. Pînzaru; Floreşti town, 08 V 2015, leg. Pînzaru), Rezina district (Țipova village from Lalova commune, 29 V 2015, leg. Pînzaru).

+ RMC/RAR: Anenii Noi district (Speia commune, 46°58′ 753 ″ North Latitude, 029° 17′ 423″ East Longitude, altitude: 80-84 m, on steppe slope with soil rich in gravel, with southern exposition, 13 V 2015, leg. Pînzaru).

Note: East European and West Asian therophyte (Mediterranean region, Central and Eastern Europe, Scandinavia, Caucasus, Central and Southwest Asia, Iran), xerophile. It is a new species for the flora of the Republic of Moldova, proposed to be included in the Red Book of Moldova (category: vulnerable). It grows on the steep slopes of the tributaries: Răut, Blănăriță and of the river Dniester, on rendzina soils, rich in limestone gravel. It blooms in early April, fructifies in April-May. Plant height varies between 5 and 18 cm, plants grow in small groups.

Confirmed species:

5. Genista elata (Moench) Wender., Linnaea, 15:100, 1841; Šeljag-Sosonko in: Opred. vyssh. rast. Ukr.: 182, 1999.- *Genistoides elata* Moench, Methodus (Moench): 132, 1794.- *Genista tinctoria* var. *elata* (Moench) Achers. et Graebn., Syn. VI, 2:261, 1907. - *G. elatio*r W. D. J. Koch, Syn. Fl. Ger. ed. 2, 1: 441, 1943.– *Genista virgata* Willd., Berlin, Baumz.: 159, 1796. - *Genista tinctoria* var. *virgata* W. D. J. Koch, in Mert. et Koch, Deutschl. Fl.: 90, 1939; Kuzminov, Fl. Bulg. 6: 40-43, 1976; Pînzaru & Sîrbu, Fl. vasc. R Moldova: 24, 2014. Ghejdeman, Opred. vyssh. rast. MSSR, ed. 3: 299, 1986 *(Fabaceae).*

It is a 100-150 cm tall shrub, main stem – oblique, procumbent, up to 3 cm in diameter, with several 1st degree branches, about 1-1.5 cm thick, last grade branches are 50-70 cm long and 3-4 mm thick, sparsely pubescent. Leaves – lanceolate, short petiolate (1-2 mm), 4-5 cm long and 8-12 mm wide, with simple hairs on margin and along the midrib. Panicle inflorescence. Flowers – 25-30 mm in diameter. Fruits – glabrous, 4-5 mm wide. It blossoms and bears fruit twice a year. Balkan-Pannonian-Pontic nanophanaerophyte,

characteristic of xeromesophilic meadows, scrubs, sparse forests.

Genista tinctoria L. plants are dwarf shrubs, which grow 30-50 cm tall, cespitose with many thin stems, flowers – 12-15 mm in diameter, fruits – pubescent, 2-3 mm wide.

Genista elata has been found, in Moldova, in the northern and central districts; it rarely grows in glades in xeromesophilic forests. Because the glades are mown, plants don't grow very tall.

Note. For the study, *Genista tinctoria* plants, brought from Italy, and *G. elata*, collected in the "La castel" landscape reserve from R. Moldova, are grown in private gardens in Codru town.

6. Pilosella x bifurca (M. Bieb.) F. W.Schult. & Sch. Bip., Flora (Regensb.) 45: 423, 1862 *(P. echioides x P. officinarum) (Asteraceae)*

+ RMC/RAR: Ungheni district (Rădenii Vechi commune, "Plaiul fagului" scientific reserve, at the forest edge, 23 VI 1948, collected by de V.N. Andreev, determined by T. Ghejdeman as Hieracium pilosella L., corrected by V. Nicolaev in January 1990 as *Hieracium x bifurcum* M. Bieb.).

Note. Hybrid, mesophilic species, cited without indication of the growth place [7].

7. Pilosella x brachiata (DC.) F. W. Schultz & Sch. Bip., Flora 45: 424. 1862 *(P. officinarum x piloselloides) (Asteraceae)*

+ RMN/RAR: Ocnița district (Naslavcea commune, the natural monument "Stânca Naslavcea", on limestone with rendzina soil, 23 VI 2014, leg. Pînzaru), Florești district (Cașunca commune, calcareous slope on the right bank of Răut River, a clump of plants, 21 V 2009, leg. Pînzaru), Șoldănești district (Rogojeni commune, calcareous slope on the right bank of Cerniță River, a clump of plants, 20 V 2015, leg. Pînzaru), Rezina district („Țipova" landscape reserve, calcareous slope on the left bank of Jidauca River, a clump of plants, 27 V 2015, leg. Pînzaru, Lalova commune, calcareous slope on the right bank of Dniester River, a clump of plants, 27 V 2015, leg. Pînzaru)

Note. Hybrid, xerophilic species, cited as *Hieracium x bracteatum* Bertol. without indication of the growth place [7].

8. Viola x mixta A. Kerner, Oesterr. Bot. Z. 18: 21, 1868 *(V. reichenbachiana x V. canina) (Violaceae)*

+ RMN/RAR: Briceni district (Cotiujeni commune, under the crowns of trees in the "Rosoșeni" reserve, forest from the association *Veratro nigris-Quercetum roboris*, 06 VI 1995, collected by Pînzaru, determined by V. Nikitin, 18 V 2006).

Note. Hybrid, mesophilic, rare species, which grows especially in forest, found in our country only in the „Rosoșeni" reserve, cited in 2004 for the North of the republic, without indicating the locality.

New stations:

9. Actaea spicata L., Sp. Pl.: 504, 1753 *(Ranunculaceae)*

+RMN/RAR: Ocnița district (Călărășeuca commune, "Călărășeuca" landscape reserve, lot no. 71 and 72, this species is found in ravines, there are few specimens, 25 VI 2015, leg. Pînzaru).

Note. Eurasian, mesohydrophilic geophyte. It is rarely found in humid places in forests of the Centre and North of the country, it is a protected species [4].

10. Asplenium scolopendrium L., Sp. Pl.:1079, 1753. [= *Phyllitis scolopendrium* (L.) Newman] *(Aspleniaceae)*

+ RMC/RAR: Orhei district (Lopatna from the Jora de Mijloc commune, "Cobâleni" forest reserve, on rocks in a deep ravine, three bushes, 28 V 2015, leg. Pînzaru).

Note. Eurasian, mesophilic hemicryptophyte, grows on forested cliffs. It is a vulnerable species, included in the Red Book of the Republic of Moldova [1, 2].

11. Astragalus vesicarius L. var. ***vesicarius,*** Sp. Pl.: 760, 1753 [= *A. albidus Waldst*. & Kit.]*(Fabaceae)*.

+ RMN/RAR: Florești district (Mărculești commune, on sandy clay with gravel, 07 V 2015, leg. Pînzaru, it presents the most northern point of the specific spreading area of the species in the Republic of Moldova; south of Stârceni village in Vărvăreuca commune, on limestone, 08 V 2015, leg. Pînzaru; Ghindești town, on limestone, 08 V 2015, leg. Pînzaru).

Note. Pontic-Mediterranean chamaephyte, with two-coloured corolla, xerophile, found in R. Moldova only in Valea Răut [12].

12. Astragalus vesicarius L. var. ***angelicae*** Pînzaru, Nov. Syst. Vysh. Rast. 44: 219, 2013.

+ **RMN/RAR:** Floreşti district (Stârceni village in Vărvăreuca commune, on limestone, 08 V 2015, leg. Pînzaru), Rezina district (Lalova commune, on calcareous steppe slope, on the right bank of Dniester River, 28 V 2015, leg. Pînzaru).

+ **RMC/RAR:** Anenii Noi district (Delacău commune, on the right bank of Dniester River, calcareous hill at the edge of "Dubăsari" forest reserve, 13 V 2015, leg. Pînzaru; in glades in "Telița" landscape reserve, 26 V 2015, leg. Pînzaru); Orhei district (Păhărniceni commune, calcareous slope, 10 VI 2015, leg. Pînzaru).

Note. West-Pontic camephyte, with white or whitish corolla, xerophile. This variety has been found on the calcareous slopes from Valea Răut, Valea Icheli and Valea Ciorna [12].

13. Carex cuspidata Host, Gram. Austr. 1: 71, 1801 *(Cyperaceae)*

+ **RMN/RAR:** Floreşti district (Stârceni village in Vărvăreuca commune, in the meadow of Răut tributary, 08 V 2015, leg. Pînzaru).

Note. Mediterranean-Caucasian, mesohydrophilic hemicryptophyte, which grows in moist areas in meadow. On the territory of our country, it has been found only in the meadow of Bâc River, near Strășeni town, and in the meadow of Dniester River, near Speia commune, Anenii Noi district [11].

14. Carex remota L., Fl. Angl.: 24, 1754 *(Cyperaceae)*

+**RMN/RAR:** Ocnița district (Călărășeuca commune, "Călărășeuca" landscape reserve, plot no. 72, several specimens – in the valley of the creek, 25 VI 2015, leg. Pînzaru).

Note. European, mesohydrophilic hemicryptophyte. Rare species in the forests of the central region of the republic, in northern districts, it has been found only in "Rudi-Arionești" landscape reserve, Soroca district [11].

15. Cephalanthera damasonium (Mill.) Druce in Ann.Scott. Nat. Hist. 60: 225, 1906 *(Orchidaceae)*

+ **RMN/RAR:** Ocnița district (Naslavcea commune, "33 de vaduri" landscape reserve, forest of the association Querco petraeae-Carpinetum, 24 VI 2015, leg. Pînzaru; Călărășeuca commune, "Călărășeuca" landscape reserve, plot no. 72, forest of the association *Querco robori-Capinetum*, it is found very rarely, in small groups, 25 VI 2005, leg. Pînzaru).

Note. European, xeromesophilic geophyte, which grows especially in forests. Vulnerable species included in the Red Book of the Republic of Moldova [1, 2].

16. Colchicum triphyllum Kunze, Flora 29: 755, 1846 *(Colchicaceae)*

+ **RMC/RAR:** Chișinău municipality (Goian and Făurești villages, Ciorescu commune, Cricova town; grows sporadically on steppe calcareous slopes, over an area of about 5 ha, 28 II 2015, 05 III 2015, leg. Pînzaru).

Note. Pontic, xeromesophilic, steppe geophyte. Endangered species, included in the Red Book of R. Moldova [1, 2, 3].

17. Convolvulus lineatus L., Syst. Nat. (ed. 10): 923, 1759 *(Convolvulaceae)*

+ **RMC/RAR:** Orhei district (Piatra commune, steppe slope, grows sporadically and in small groups over an area of about 1600 m², 10 VI 2015, leg. Pînzaru).

Note. Mediterranean-Pontic, xerophilic hemicryptophyte. Vulnerable species, included in the Red Book of R. Moldova [1, 2].

18. Cotoneaster melanocarpus Fisch. ex Blytt, Enum. Pl.: 22, 1844 (Rosaceae)

+ **RMN/RAR:** Ocnița district (between Naslavcea commune and Verejeni village from Lencăuți commune, on purple shale, in scrubs growing on cliffs, 25 VI 2015, leg. Pînzaru); Rezina district (Țipova village, "Țipova" landscape reserve, scrubs growing on limestone cliffs, ass. *Corno-Cerasetum mahalebae,* 29 IV 2015, leg. Pînzaru)

+ **RMC/RAR:** Chișinău municipality (Ciorescu commune, scrubs of the plant association *Corno-Cerasetum mahalebae*, 02 VII 2003, leg. Pînzaru).

Note. Central European, xerophilic nanophanaerophyte. Vulnerable species, included in the Red Book of R. Moldova [2].

19. Crepis praemorsa (L.) Walther, Fl. Giessen: 584, 1802 *(Asteraceae)*

+ **RMN/RAR:** Râșcani district (Șaptebani commune, "Șaptebani" forest reserve, in glades, 25 V 1993, leg. Pînzaru).

Note. Eurasian, xeromesophilic hemicryptophyte, grows mostly in glades.

20. ***Cystopteris fragilis*** (L.) Bernh. in Neues J. Bot. 1(2): 27, 1805 (Woodsiaceae)

+ **RMC/RAR:** Orhei district (Lopatna village in Jora de Mijloc commune, "Cobâleni" forest reserve, grows in small groups, on rocks, under the canopy of trees of the association *Aceri tatarico-Quercetum* roboris, 28 v 2015, leg. Pînzaru; between Păhărniceni commune and Furceni village from Ivancea commune, in fissures in shaded rock, 10 VI 2015, leg. Pînzaru).

Note. Cosmopolitan, mesophilic geophyte. It is found rarely in fissures in shaded rock, in the districts from the North and Centre of the republic. Vulnerable species, protected by the state [4].

21. ***Cystopteris fragilis*** **(L.) Bernh. var.** ***pinnatipartita*** **W. D. J Koch,** Syn. Fl. Germ. Helv. (ed. 2) 2-3: 980.1845 *(Woodsiaceae)*

+ **RMN/RAR:** Ocnița district (Călărăşeuca commune, „Călărăşeuca" landscape reserve, lot nr. 72, small groups in fissures in shaded rock from the deep ravine of the creek, 26 VI 2015, leg. Pînzaru).

Note. Eurasian geophyte (mountain), mesophile. Rare species, new for the flora of the Republic of Moldova. It is indicated for Edineț district (Corpaci commune), Soroca district (Zastânca commune), Floreşti district (Vertiujeni commune) [10].

22. ***Doronicum hungaricum*** **Rchb. f.,** Icon. Fl. Germ.16. 34, 1854. *(Asteraceae)*

+ **RMC/RAR:** Criuleni district (Zolonceni village, "Zolonceni" forest reserve, forest of the plant association *Aceri tatarico-Quercetum roboris,* grows in small groups, 06 VI 2015, leg. Pînzaru).

Note. Balkan-Central European, xeromesophilic geophyte, which grows especially in forest. Vulnerable species, it has been included in the Red Book of the Republic of Moldova [1].

23. ***Epilubium dodonaei*** **Vill.,** Prosp. Hist. Pl. Dauphiné: 45, 1779 *(Onagraceae)* [= *Chamenerion dodonaei* (Vill.) Krist.; = *Chamerion dodonaei* (Vill.) Holub].

+ **RMN/RAR:** Dondușeni district (Arioneşti commune, „Rudi-Arioneşti" Landscape Reserve, plot 20, on roadsides, redzina soil, on limestone, about 10 specimens, 13 VIII 2015, leg. Pînzaru).

Note. South European hemicryptophyte, mesophilic-xeromesophilic. Endangered species, included in the Red Book of the Republic of Moldova, previously known only from Ocnița district (Naslavcea, Verejeni) [2].

24. ***Epipactis helleborine*** **(L.) Crantz,** Stirp. Austr. Fasc. ed. 2 : 467, 1769 *(Orchidaceae).*

+ **RMN/RAR:** Dondușeni district (Arioneşti commune, "Rudi-Arioneşti" Landscape Reserve, plot 21, obs. 13 VIII 2015, Pînzaru).

Note. Eurasian geophyte, mesophile, which grows especially in forest. Rare species, protected by the state [6].

25. ***Gentiana cruciata*** **L.,** Sp. Pl.: 231 1753 *(Gentianaceae)*

+RMN/RAR: Soroca district (Balinții Noi village from Iarova commune, at the forest edge, steppe slope, sporadically on an area of about 100 m², 15 VIII 2015, leg. Pînzaru)

Note. Hemicryptophyte, European/West Asian, xeromesophilic species that grows in steppes. It is a rare species, proposed to be included in the Red Book of the Republic of Moldova, category: vulnerable (VU).

CONCLUSIONS

1. The obtained results confirm the need for further field research on flora.
2. The monuments of geologic and paleontological nature "Tectonic fault near Naslavcea village" (82 ha) located in Ocnița forest district, Stânca forest, plot 1, and "A part of the steep bank of Dniester River" (308 ha), located in Otaci forest district, Lencăuți forest, plots 1-3, which are of floristic and phytosociological interest, are recommended to be included in the category of forest reserves named "Stânca Naslavcea" and "Lencăuți", respectively.

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THE PECULIARITIES OF DEVELOPMENT AND MULTIPLICATION OF *SOPHORA JAPONICA* L. SPECIES IN THE REPUBLIC OF MOLDOVA

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Abstract. In the present paper, the peculiarities of fructification and of reproduction, during the years 2012-2015, of *Sophora japonica* species from different green areas of the towns Chisinau and Orhei, and also the perspectives of cultivation as an ornamental, melliferous and forestry plant in the reconstruction of the non-corresponding arboretums of the Republic of Moldova are described.

Key-words: *Sophora japonica* L., productivity, fruit, germinative capacity.

INTRODUCTION

In relation with the climate change, the dangerous processes of vegetation degradation and the worsening conditions of existence of woody plant species, the continuity, the mobilization, the conservation and the rational use of biodiversity are more than necessary.

Sophora japonica L. *(Japanese acacia, Japanese pagoda tree)* it is an exotic species, native to China and Japan, from where it was introduced in America and Europe as ornamental and honey tree for gardens and parks. In the Republic of Moldova, the *Japanese pagoda tree* is cultivated in parks, green areas due to its ornamental characteristics during the whole growing season, as a highly resistant species (more than 4, 5) in polluted environmental conditions [1, 2], as a promising species for creating plantations for pharmaceutical purposes and as a melliferous plant.

The flowers of *Japanese acacia* are used in pharmaceutics for extracting *rutin* and other biological active substances which are contained therein. The *rutin* has properties of vitamin P, increasing the resistance of the capillaries and reducing their permeability, it plays an important role in the hydric and ionic metabolism. The flowers are used in recipes relating to mixes of plants for obtaining a decoction necessary for the treatment the edemas.

The wood can be used for furniture and parquets. The flowers are used for textile dyeing in yellow colour.

The *Japanese acacia* is appreciated as a honey plant for the quantity of nectar between 0.5-1.0 mg/flower with an average concentration of about 40 % glucides. Honey production constitutes 300-350 kg per hectare [4].

The purpose of the present paper is to study the particularities of fructification of trees from different zones of Chisinau town and the elaboration of the multiplication technology of present species.

MATERIAL AND METHODS

As study subjects served the trees of *Japanese acacia* from Botanical Garden (Institute) of A.S.M. and from the green spaces of the towns Chisinau and Orhei, from which fruits and seeds were collected. Phenological observations were made according to the methodology [6], during the years 2012-2015. The collected seeds were cleaned by various methods, kept in different variants and treated according to the methodology [3]. Before the incorporation into the well loose soil, the seeds were treated with hot water of 70 °C, with gibberellins (GA) solutions of 0.01 % and 0.03 %, and exposed for 24 hours. The sowing was carried out in spring, directly into seed beds. The fruits and seeds, collected during the year of study, were analyzed according to many morphological parameters, in the Dendrology Laboratory of the Botanical Garden (Institute) of A.S.M.

RESULTS AND DISSCUSIONS

The studied trees are form the territory of the Botanical Garden (Institute), also from the green spaces of the towns Chisinau and Orhei, they are about 40 years old, most of them possess large, dense crowns, grow and develop normally, reaching 25-30 m in height. In the heavy drought conditions of 2012, at *Japanese acacia* from the Botanical Garden territory, during the summer, it was registered an annual

average growth of stems, reaching 40-45 cm; during the 2013-2015 years, it was registered a higher growth of stems, the average being 60 cm. The glabrous shoots are green, with prominent cushion-like swellings, but being scratched, emit an unpleasant smell.

The buds are alternate, small, hairy, situated in the middle of the horseshoe-shaped scar, by three fascicular traces. The leaves are alternate, pinnate, consisting from 7 to 17 leaflets, at the end of the growing season reaching 11 to 25 cm in length.

Leaflets are ovoid-shaped to lance-ovate, acute, broad cuneate to rounded at base, reach 2.5-5.0 cm in length and are closely appressed-pubescent.

Flowers are greenish-white, relatively small (1.0-1.5 cm), fragrant, grouped in long panicles (35 cm), pyramidal, erect and terminal. The flowers are papilionaceous, with 5-toothed calyx, 5 greenish white petals, with yellow shades, which surround the 10 free stamens.

The *Japanese acacia* is characterized by a longer and more tardy flowering period than other species from the *Fabaceae* family, for this reason it is valued by beekeepers.

During the years of study, the species flourished in the first days of July and lasted until the first days of September. The fruits are some pods, bright green, fleshy, 5-10 cm long, polyspermous, narrowed between the seeds and indehiscent. For the trees included in the study, the number of pods in one inflorescence was 20-30 units in 2012, but varied between 87-97 units in 2015. The seeds are ovate, black, reach 8-10 mm in length. It has been established that 1 kg contained 800 units in 2014, up to 1176 fresh fruits, harvested in November 2012. The black seeds extracted from the green pods constitute 0.1 %. As productivity and quality of the seeds in 2012, it was not significant.

The *Japanese acacia* prefers warmer areas, deep soils up to sandy-clay. It supports salty soils. This species is resistant to drought and smog, and grows best in sunny locations. It is appreciated for its flowers in large panicles, melliferous qualities. Because they suffer a little from frost, these trees can be used in forest plantations. The species is appreciated for its ornamental and decorative appearance, ensured by the soft green foliage, late flowering, distinguished shape of the fruits and the preservation of the copper-coloured pods on trees until spring. Begins to blossom and fructifies from the age of 5-7 years. Trees are growing rapidly and at 15 years of age reach 10 meters in height and 30 cm in diameter, maintaining their decorative qualities more than 50 years [5]. During the current year, the climatic conditions had a positive impact on the growth and development of the mature *Japanese acacia* plants. As a result of phenological observations on the growth and development of *Japanese acacia* plants, obtained from seeds, treated and untreated, in the first and the second years, as well as on trees, taken in the study, from the green spaces of the towns Chisinau and Orhei, it was established that the trees have resumed their growth at the beginning of April and continued until November.

The trees from the green spaces of Chisinau town resumed their growth by 3-4 days earlier, than the plants from the territory of the Botanical Garden and with 10-15 days earlier than in 2013. The mature plants from the green spaces of Chisinau town flourished on 10.07.2014 (Railway Station), while the mature plants of *Japanese acacia*, which grew and developed in the Botanical Garden (Institute) of A.S.M. and the Dendrological Park (Arboretum) started flowering 7 days later (17.07.2014). The abundance of flowering on the plants of *Japanese acacia* was higher in the southern part of tree crowns and in the upper part of the trees, the number of flowers in inflorescences on the plants varied between 50-150 units. It has been established that, at the beginning of August, during the study years, on the territory of our republic, very hot weather with deficiency of precipitations persisted. The phenological observations carried out by our team allow us to conclude that the abundance of flowering and fructification of *Japanese acacia* depends on the sum of temperatures and on the quantity of precipitations during that period. Depending on the soil conditions and on the age of trees, the number of harvested fresh seeds, contained in the 1 kg, varies between 800-1300 seeds. The productivity and the quality of the seeds of *Japanese acacia* have a close link to the climatic conditions during flowering and fruit set. Climatic conditions have had a neutral impact on the process of fruit development.

The mass of 1000 fresh fruits of *Japanese acacia* was 810-1300 g, but the weight of 1000 fresh seeds, extracted from pods of *Japanese acacia* ranged between 110-165 g. 1 kg contained 800-1235 freshly collected pods, from which were extracted 6061-9091 fresh seeds (tab. 1). The seeds, which were extracted freshly from the pods, were gathered after the frost and ranged between 9 % and 35 %. The linking percent of the fruits gathered after the frost was approx. 50 %. At the trees of *Japanese acacia* from the green spaces of the towns Chisinau and Orhei, the number of pods in one inflorescence varied

between 26-78 units. One fruit of *Japanese acacia* contained from 1 to 11 seeds. From those reported above, we can conclude that seed productivity and quality at the studied species were higher in 2013 and 2015 comparatively with 2012 and 2014.

Table 1. The peculiarities of fructification of Sophora japonica L. in different green spaces of Chisinau and Orhei

The arameters	Years	Botanical Garden	Zone Metro 2	Zone Dacia-Burebista	Orhei
The mass of 1000 fresh fruits, g	2013	970	1300	810	1100
	2014	1200	1120	980	1250
	2015	955	1100	1000	1080
	average	1041.6	1173.3	930	1143
The mass of 1000 fresh seeds, g	2013	158	165	155	160
	2014	112	120	110	115
	2015	116.4	125.2	120.5	122.5
	average	128.8	136.7	128.5	132.5
The number of fruits in 1 kg, units.	2013	1031	869	1235	909
	2014	833	893	1020	800
	2015	1047	909	1000	926
	average	970	857	1085	878
The number of seeds in 1 kg, units.	2013	6329	6061	6452	6250
	2014	8929	8333	9091	8695
	2015	8934	8000	8333	8197
	average	8064	7465	7959	7714
The part of mass of the seeds in the freshly collected fruit, %	2013	16	13	19	15
	2014	9	11	11	9
	2015	12	11	12	11
	average	12.3	11.6	14	11.6

The data presented in Table 1 denote that the climatic conditions from 2013 had a positive impact on the process of ontomorphogenesis of the seeds. The weight of 1000 seeds was 155-165 g, comparatively with the 2014-2015 years, at the trees which grow and develop in different stationary conditions. The optimal conservation method of the germination capacity is to store the seeds in packets of paper, also in sacks or pouches made of natural materials. The seeds kept in jars and in plastic bags are not recommended. The seeds of *Sophora* were soaked in hot water (70 °C) and sown in pots, crates and seed beds. As a result of the treatment of *Sophora* seeds with 0.01 % solution of gibberellins, 0.03 % of gibberellins and 0.01 % of KM_nO_4, it has been established that the best variant was 0.03 % solution of gibberellins. The percentage of germination of the seeds treated with 0.03 % solution of gibberellins per 24 hours has reached 25-50 %, whereas in the variant of hydrothermal treatment of the seeds it was 10-15 %.

Our investigations for obtaining plantlets from the fruits of *Sophora*, treated with hot water, then squashed by different methods, manually or by sieves were not successful. In the first growing season, the height of *Sophora* plants, grown from seeds, treated hydrothermally and then grown in containers in substrate, slightly varied between 35-60 cm, accounting on average 50 cm, the length of the roots of first order was 15-30 cm, the average being 20 cm. The diameter of the plantlets of *Sophora*, grown in containers, in the first year of vegetation, ranged from 15 to 30 mm, averaging 20 mm. In the first year of vegetation, the height of the plants, obtained from the seeds treated with 0.03 % solution of gibberellins and grown in seed beds, according to the technology, varied between 35 and 182 cm, on average, 20 mm. The climatic conditions during 2013-2015 had a positive impact on the growth rate of the plantlets in

the first growing season.

A distinctive peculiarity of the seeds treated with solution of gibberellins is that the germination of seeds has been more uniform, the germination rate – higher (35-50 %) and the growth of the plantlets – more intensive. The plants at the end of the first year of vegetation are characterized by a more developed root system, the diameter of the root-collar reaching 15-50 mm, and by a greater leaf area.

Figure 1. Plants of Sophora obtained from spring crops:

a. seeds treated with gibberellins,
b. seeds sown without treatment.

The optimal and cost-effective option for obtaining qualitative and uniform seedlings of *Sophora* is when the seeds are kept in cold storage, soaked in hot water of 70 °C and then treated with 0.03 % solution of gibberellins, applied for 24 hours.

CONCLUSIONS

1. *Sophora japonica* L. is a species resistant to drought and frost, and can be used as an ornamental plant, for creating plantations for pharmaceutical purposes and as a melliferous plant.
2. The optimal and cost-effective option for obtaining qualitative and uniform seedlings of *Sophora* is when the seeds are kept in cold storage, soaked in hot water of 70 °C and then treated with 0.03 % solution of gibberellins for 24 hours.
3. The distinctive peculiarity of the seeds treated with solution of gibberellins is that the germination of seeds has been more uniform, the germination rate – higher (35-50 %) and the growth of the plantlets – more intensive. The plants at the end of the first year of vegetation are characterized by a more developed root system, the diameter of the root-collar reaching 15-50 mm, and by a greater leaf area.

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THE GENUS *POTENTILLA L. (ROSACEAE JUSS.)* IN THE FLORA OF BESSARABIA

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Abstract: The article contains results of the floristic research on *Potentilla* species in the flora of Bassarabia, which comprises 19 species. Dichotomic key for species detetrmination, the synonymy, habitat and chorology characters of highlighted species are given.

GENUL *POTENTILLA L. (ROSACEAE* JUSS.*)* ÎN FLORA BASARABIEI

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Abstract: Articolul include rezultatele studiului floristic a speciilor din genul *Potentilla* în flora Basarabiei, care enumeră 19 specii. În continuare se prezintă cheia de determinare, sinonimia, datele corologice și particularitățile ecologice a taxonilor evidențiați.

INTRODUCTION

The monographic studies on major taxonomic groups of plants, for regional floras, provide valuable information for understanding the origin and evolution processes of the given flora. These studies provide a scientific basis for maintaining diversity of flora and allow identifying species that require special protection.

The genus *Potentilla* L. is a difficult one, from systematic point of view. Interspecific hybridization and apomixis are of common occurrence within this genus. Some species or groups of species are known to be complexes composed both of amphimictic, usually diploid, plants and apomictic polyploid plants. [9]

The genus *Potentilla* L. comprises about 420 species, spread primarily in the temperate zone of the Northern Hemisphere [9]. In the local flora, it embodies 19 species that are part of the herbaceous layer of steppe, meadow and forest phytocoenoses. Many species are cultivated in gardens as ornamentals.

MATERIALS AND METHODS

For the detailed research on the genus *Potentilla*, we used herbarized plant collections from the herbaria of the Botanical Garden (I) of the ASM, State University of Moldova and our own collections made during 2007-2014. The critical analysis of specific taxa was performed according to the comparative-morphological method [10]. The nomenclature and sequence of taxa arrangement within the genus is presented according to the specialized literature on flora [1, 9].

RESULTS AND DISCUSSIONS

On the basis of processing of herbarized materials collected during expeditions, critical processing of the existing herbaria and after the documentation of published papers concerning the taxonomic composition of the genus *Potentilla,* we highlighted the diversity of this genus in Bessarabia, which includes 19 species belonging to 10 sections. The synonymy, chorological data and bioecological peculiarities of the highlighted species are given below.

Genus **POTENTILLA L.**
Linnaeus, 1753, Sp. Pl.: 495; id 1754, Gen Pl., ed. 5: 219.

Perennial, rarely annual or biennial herbaceous plants, or small shrubs. They have erect, creeping

or stoloniferous stems. Compound leaves, with three or more leaflets, palmate or pinnate (descriptions of leaves and leaflets refer only to the basal and lower cauline leaves). Bisexual flowers, pentamerous (rarely 4- or 6-merous), arranged in simple or compound inflorescences, rarely solitary in leaf axils. Double calyx, consisting of internal and external laciniae, usually entire. Emarginate petals, rarely with rounded tip, yellow, white or pinkish. The androecium consists of numerous stamens (15-30). Receptacle – hairy, often spongy and enlarged at maturity. The gynoecium consists of numerous, free carpels. Style nearly basal, lateral or terminal. Fruit is a head of achenes, usually glabrous, rarely hairy, smooth or with ribbed surface.

L e c t o t y p u s: *P. reptans* L.

Key to species of Potentilla

1a. Leaves pinnate.....**2**
1b. Leaves palmate or ternate.....**4**
2a. Plants with repent above-ground shoots.....**P. anserina**
2b. Plants without repent above-ground shoots.....**3**
3a. Flovers solitary. Petals shorter than sepals. Leaflets toothed or pinnatifid….....**P. supina**
3b. Flowers mostly in cymes. Petals longer than sepals. Leaflets entire or 2- to 3-fid at apex.....**P. bifurca**
4a. Plants with repent shoots, rooting at the nodes.....**P. reptans**
4b. Plants without repent shoots.....**5**
5a. Petals white, rarely pinkish. Achenes hairy.....**6**
5b. Petals yellow. Achenes glabrous.....**7**
6a. Basal leaves consisting of 5 leaflets, oblong lanceolate, with entire margin or a little toothed towards the tip. Petals usually longer than sepals.....**P. alba**
6b. Basal leaves consisting of 3 leaflets, broadly obovate, toothed. Petals shorter than sepals……**P. micrantha**
7a. Petals and sepals almost always 4.....**P. erecta**
7b. Petals and sepals 5.....**8**
8a. Leaflets densely tomentose, villous, with sericeous or stellate hair beneath, the indumentum completely covering the surface of the leaflet…….....**9**
8b. Leaflets green or grey-green beneath, the indumentum not completely covering the surface..**12**
9a. Leaflets with a dense tomentum of stellate hairs beneath.....**P. arenaria**
9b. Leaflets without stellate or branched hairs….....**10**
10a. Basal leaves (at flowering and fructification) arranged in a rosette.....**P. thyrsiflora**
10b. Basal leaves do not form rosettes.....**11**
11a. Leaflets evenly serrate from the base; margin of the leaf blade unconvoluted; some hairs crispate and some long and simple….....**P. canescens**
11b. Leaflets unevenly macroserrate; margin of the leaf blade convoluted; all hairs crispate……**P. argentea**
12a. Flowering stems lateral; stock with a terminal rosette of leaves….....**13**
12b. Flowering stems terminal; rosettes of leaves absent….....**14**
13a. Plants eglandular. Epicalyx-segments narrowly liniar.....**P. patula**
13b. Plants with sessile yellow glands. Epicalyx-segments lanceolate.....**P. humifusa**
14a. Epicalyx-segments up to 2 times as long as the sepals, about as wide as sepals at the base……**P. astracanica**
14b. Epicalyx-segments shorter or equal to sepals, narrower than sepals at the base…….....….....**15**

15a. Stems thin, 10-30 cm tall; indumentum with long, simple hairs, without or with very few short hairs…….....**P. pedata**

15b. Stems thick, 30-70 cm tall; indumentum with short glandular or eglandular hairs as well as with long, simple hairs…….....**16**

16a. Leaflets oblong-lanceolate, pinnate-partite or pinnate-finely divided. Nerves not prominent… …….....……...**P. laciniosa**

16b. Leaflets oblong-ovate or lanceolate, serrate. Nerves prominent on the underside.....**17**

17a. Leaves predominantly with 5 leaflets, oblong-obovate (at least the leaves from the lower part of the stems); the margin of the leaf blade with obtuse teeth.....**P. pilosa**

17b. Leaves predominantly with 7 leaflets, rarely with 5, lanceolate; the margin of the leaf blade sharply toothed.....**18**

18a. Petals pale yellow, obviously longer than sepals…….....…….....**P. recta**

18b. Petals yellow-orange, as equal as sepals …….....……..... **P. obscura**

Subgenus 1. FRAGARIASTRUM (Fabr. ex Ser.) Peterm. 1847, Deutschl. Fl.: 165.

Perennial herbaceous plants. Leaves trifoliate or digitate. Petals white, rarely pinkish or red. Ovary pubescent. Stamen filaments glabrous or glabrescent. Fruits pubescent.

L e c t o t y p u s: *P. sterilis* (L.) Garcke (=*Fragaria sterilis* L.)

Section 1. **Fragariastrum** Ser. 1825, in DC., Prodr. 2: 583.

1. ***P. micrantha*** Ram. ex DC. 1805, in Lam. et DC., Fl. Fr., ed 3,4: 468; Юзепчук, 1941, Фл. СССР, 10: 92; Pawlowski, 1968, Fl. Europ. 2: 47; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 276; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 164; Камелин, 2001, Фл. Вост. Евр., 10: 410; Negru, 2007, Determ. pl. fl. R. Moldova : 127; Ciocârlan, 2009, Fl. ilustr. a României : 315.

It can be found in white oak forests (with *Quercus pubescens*), meadows and forest edges. Grows in groups. Blooms in April-May. It is found rarely in the forests from the central region of Bessarabia and in the oak forests from the southeast. The spreading area of this species includes the Central and Eastern Europe.

Section 2. **Campestres** (Poeverl.) Poeverl. 1904, in Ashers. u. Graebn., Syn. Mitteleur. Fl. 6: 647.

2. ***P. alba*** L. 1753, Sp. Pl.: 498; Ledeb. 1844, Fl. Ross. 2, 1: 60; Юзепчук, 1941, Фл. СССР, 10: 91; Pawlowski, 1968, Fl. Europ. 2: 46; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 276; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 164; Камелин, 2001, Фл. Вост. Евр., 10: 411; Negru, 2007, Determ. pl. fl. R. Moldova : 127; Ciocârlan, 2009, Fl. ilustr. a României : 316.

It grows in forests, meadows, at the edge of the forests, in glades and thickets. This species is part of the cherry and oak forest phytocoenoses from the northern region of the country. Grows solitary and in small groups. Blooms in April-June. It is sporadically met in the northern districts of Bessarabia. The distribution area includes the Central and Eastern Europe.

Subgenus 2. SCHISTOPHYLLIDIUM Jus. ex Fed. 1958,
Фл. Армении, 3: 87; Юз. 1941, Фл. СССР, 10: 81, descr. ross.

Perennial, woody at base. Leaves pinnate. Petals yellow. Receptacle hairy. Style fusiform. Achenes glabrouse, rarely pubescent.

T i p u s: *P. bifurca* L.

Section 3. **Bifurcae** (Th. Wolf) Grossh. 1952, Фл. Кавк., изд. 2, 5: 68.

3. ***P. bifurca*** L. 1753, Sp. Pl.: 497; Юзепчук, 1941, Фл. СССР, 10: 81; Ball & Walters, 1968, Fl. Europ. 2: 39; Камелин, 2001, Фл. Вост. Евр., 10: 411; Ciocârlan, 2009, Fl. ilustr. a României : 315. – *P. orientalis* Juz. 1934, Сорн. раст. СССР, 3: 124; Юз. 1941, Фл. СССР, 10: 82; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 164.

It grows on rocky, limestone slopes, steppe slopes, rarely in glades and forest edges, as well as

in semi-natural habitats, especially along roadsides [9]. These plants grow in groups. They flower in June-September. This species has not been previously indicated in the lists of vascular plants from the Republic of Moldova [6, 8].

For the first time, *P. bifurca* L. was been found in June 1994, by N. Grabco, PhD, on an area of 50 m2, on the outskirts of Chisinau [5]. Its specific spreading area includes Eastern and Western Siberia, the Far East, Central and Minor Asia, Iran; the western limit of distribution being Eastern Europe. It is an endangered species included in the Red Book of Romania. [4]

Subgenus 3. CHENOPOTENTILLA Focke

1889, Beitr. Naturf. Ver. Bremen, 10: 415. – *Argentina* Hill, 1756, Brit. Herb. : 6.

Herbaceous, perennial plants with repent radicant shoots. Leaves pinnate. Flowers yellow, solitary in the axils of leaves. Ovary glabrous. Style lateral, short, thin. Fruits glabrous.

L e c t o t y p u s: *P. anserina* L.

Section 4. **Leptostylae** (Th. Wolf) Janch. 1957, Cat. Fl. Austr. 1, 2: 278.

4. P. anserina L. 1753, Sp. Pl.: 495; Юзепчук, 1941, Фл. СССР, 10: 221; Ball & Walters, 1968, Fl. Europ. 2: 39; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 276; Котов,1999, Опред. высш. раст. Укр., изд. 2: 164; Камелин, 2001, Фл. Вост. Евр., 10: 414; Negru, 2007, Determ. pl. fl. R. Moldova : 127; Ciocârlan, 2009, Fl. ilustr. a României : 315.

Grows in meadows, lakesides, wet meadows, riversides. Is part of the herbaceous layer of wet phytocoenoses. Grows in groups on the whole territory of Bessarabia. Flowers in May-June. Cosmopolite.

Subgenus 4. POTENTILLA

Perennial, herbaceous plants. Leaves digitate, pinnate or ternate. Flowers yellow, solitary or grouped in inflorescences. Style apical, rarely lateral, of various shapes. Fruits glabrous.

L e c t o t y p u s: *P. reptans* L.

Section 5. **Potentilla.** – *Potentilla* sect. *Tormentilla* (L.) Rydb. 1898, Mem. Dept. Bot. Columbia Coll. 2: 8. – Tomentilla L. 1753, Sp. Pl.: 500.

5. P. reptans L. 1753, Sp. Pl.: 499; Юзепчук, 1941, Фл. СССР, 10: 219; Ball & Walters, 1968, Fl. Europ. 2: 45; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 276; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 164; Камелин, 2001, Фл. Вост. Евр., 10: 415; Negru, 2007, Determ. pl. fl. R. Moldova : 127; Ciocârlan, 2009, Fl. ilustr. a României : 317.

This species grows in wet meadows, in river valleys, in glades and thickets, along roadsides. It is a pioneer species that is part of the lower level of the herbaceous layer of meadow phytocoenoses. It grows in groups. This species is common on the entire territory of Bessarabia. Its specific spreading area includes the Eurasian continent and North America.

6. P. erecta (L.) Raeusch. 1797, Nomemel. Bot., ed. 3: 152; Юзепчук, 1941, Фл. СССР, 10: 218; Ball & Walters, 1968, Fl. Europ. 2: 45; Котов, 1999, Опред. высш. раст. Укр. изд. 2: 164; Камелин, 2001, Фл. Вост. Евр., 10: 416; Ciocârlan, 2009, Fl. ilustr. a României : 316. – *Tomentilla erecta* L. 1753, Sp. Pl.: 500.

It grows in wet meadows, glades, mixed deciduous forests from the north of Bessarabia. It is part of the herbaceous layer of forest and meadow phytocoenoses. Grows in groups. It flowers in May-August. It is a rare species in the territory of Bessarabia. This species was collected near vill. Grozinti and vill. Blisceadi, Hotin county [7]. The specific spreading area includes Europe, the Caucasus, Asia Minor and Western Siberia.

Section 6. **Rectae** (Poeverl.) Juz. 1941, Фл. СССР, 10: 160.

7. P. astracanica Jacq. 1781, Misc. Austr. Bot. 2: 349; Юзепчук, 1941, Фл. СССР, 10: 163; Ball & Walters, 1968, Fl. Europ. 2: 42; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 277; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 166; Камелин, 2001, Фл. Вост. Евр., 10: 451; Negru, 2007, Det. pl. fl. R. Moldova : 129; Ciocârlan, 2009, Fl. ilustr. a României : 318.

This species is found on steppe slopes. It is part of the herbaceous layer of steppe phytocoenoses. Grows solitary and in small groups. Flowers in April-May. It is a rare species in the southern districts of Bessarabia, northwest of Talmaz commune, Stefan-Voda district and Giurgiulesti, Valeni and Slobozia Mare communes, Cahul district. The specific spreading area comprises the Central Europe and the

Caucasus. It is an endangered species included in the Red Book of Moldova, 3rd edition. [3]

8. P. pilosa Vill. 1789, Hist. Pl. Dauph. 3: 570; Камелин, 2001, Фл. Вост. Евр., 10: 420; – *P. pilosa* Willd. 1799, Sp. Pl. 2, 2: 1100, non Vill. 1789; Юзепчук, 1941, Фл. СССР, 10: 160, in syn.; 161, in adnot.; Станков, 1957, Опред. высш. раст. евр. части СССР, изд. 2: 233; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 278; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 167; Negru, 2007, Determ. pl. fl. R. Moldova : 129.

This species grows in glades, forest edges and steppes. It is part of the herbaceous layer of xerophytic phytocoenoses. Grows solitary and in small groups. Flowers in June-July. Found sporadically on the entire territory of Bessarabia. Spreading area includes Europe, the Caucasus and Asia Minor.

9. P. recta L. 1753, Sp. Pl.: 497; Юзепчук, 1941, Фл. СССР, 10: 160, excl. syn., p. p.; Ball & Walters, 1968, Fl. Europ. 2: 42, s. str.; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 278; Камелин, 2001, Фл. Вост. Евр., 10: 421; Negru, 2007, Det. pl. fl. R. Moldova : 129; Ciocârlan, 2009, Fl. ilustr. a României : 318. – *P. sulphurea* Lam. 1778, Fl. Fr., ed. 1, 3: 114; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 167.

Grows in sunny glades, edges of white oak forests, steppe areas, along roadsides, in thickets. Common in forest areas, especially in south. Grows solitary and in small groups. Flowers in June-August. Found sporadically on the entire territory of Bessarabia. The spreading area includes Europe, the Caucasus, Asia Minor and Western Siberia.

10. P. obscura Willd. 1799, Sp. Pl., ed. 4, 2, 2: 1100; Юзепчук, 1941, Фл. СССР, 10: 161, in adnot.; Станков, 1957, Опред. высш. раст. Европ. части СССР, изд. 2: 233; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 278; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 167; Камелин, 2001, Фл. Вост. Евр., 10: 422; Negru, 2007, Det. pl. fl. R. Moldova : 129.

Grows on sunny slopes, in ravines, thickets, windbreaks, fallow land. It is part of the herbaceous layer of xerophytic phytocoenoses, sometimes as a weed amongst crops. Grows solitary and in small groups. Flowers in June-August. Common species for the entire territory of Bessarabia. The distribution area is Central and Eastern Europe, the Caucasus, Asia Minor and Western Siberia.

11. P. pedata Willd. 1814, in Schlecht., Enum. Pl. Horti Berol. Suppl.: 38; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 277, cum auct. Nestl.; Камелин, 2001, Фл. Вост. Евр., 10: 422; Negru, 2007, Determ. pl. fl. R. Moldova : 129, cum auct. Nestl.; Ciocârlan, 2009, Fl. ilustr. a României : 318. – *P. hirta* auct. fl. ross. non L. Ledeb. 1844, Fl. Ross. 2, 2:46, p. max. p.; Гейдеман, 1975, Опред. высш. раст. МССР: 251.

This species is found in glades and forest edges, on steppe, limestone slopes, in thickets. It is part of the herbaceous layer of oak forest and the steppe phytocoenoses. Grows solitary. Flowers in June-July. Found sporadically on the entire territory of Bessarabia. The specific spreading area comprises the Central and Eastern Europe, the Caucasus, Asia Minor (West).

12. P. laciniosa Kit. ex Nestl. 1816, Monogr. Potent.: 45; Ball & Walters, 1968, Fl. Europ. 2: 42; Камелин, 2001, Фл. Вост. Евр., 10: 423; Negru, 2007, Determ. pl. fl. R. Moldova : 129. – *P. semilaciniosa* auct. non Borb. : Юзепчук, 1941, Фл. СССР, 10: 162, p. p.; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 277; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 166. – *P. recta* L. 1753, Sp. Pl.: 497; Ball & Walters, 1968, Fl. Europ. 2: 42.

It is found on steppe, rocky slopes, in ravines, thickets, steppe sectors. It is an element of the herbaceous layer of forest and steppe phytocoenoses. Grows solitary. Flowers in June-August. Grows sporadically on the entire territory of Bessarabia. The specific spreading area includes the Central and Eastern Europe, the Caucasus, Central Asia, Asia Minor, Iran.

Section 7. **Rivales** Th. Wolf, 1903, Potent. Stud. 2: 11.

13. P. supina L. 1753, Sp. Pl.: 497; Юзепчук, 1941, Фл. СССР, 10: 165; Ball & Walters, 1968, Fl. Europ. 2: 42; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 276; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 165; Камелин, 2001, Фл. Вост. Евр., 10: 426; Negru, 2007, Determ. pl. fl. R. Moldova : 127; Ciocârlan, 2009, Fl. ilustr. a României : 315.

Grows in wetlands, forest edges, near rivers or lakes. This species is part of the herbaceous layer of wetland phytocoenoses. The plants grow in groups forming clumps. It is a common species on the entire territory of Bessarabia. Flowers in May-August. The specific spreading area includes Eurasia, North Africa and North America.

Section 8. **Aureae** Th. Wolf, 1904, in Aschers. u. Graebn., Syn. Mitteleur. Fl. 6, 1: 671.

14. P. patula Waldst. et Kit. 1805, Descr. Icon. Pl. Rar. Hung. 2: 218, tab. 199; Ball & Walters, 1968, Fl. Europ. 2: 44; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 277; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 165; Камелин, 2001, Фл. Вост. Евр., 10: 435; Negru, 2007, Determ. pl. fl. R. Moldova : 127; Ciocârlan, 2009, Fl. ilustr. a României : 320. – *P. schurii* Fuss ex Zimm. 1884, Monogr. Potent.: 17; Юзепчук, 1941, Фл. СССР, 10: 203.

It grows on calcareous, rocky, steppe slopes, glades of dry and semi-arid forests, groves and edge of forests. It is part of the herbaceous layer of arid forest and steppe phytocoenoses. Grows solitary and in small groups. It is found sporadically in all geobotanical districts of Bessarabia. Flowers in April-May. Its specific spreading area includes the Central and Eastern Europe, Central Asia, West Siberia (South).

15. P. humifusa Willd. ex Schlecht. 1816, Mag. Naturf. Fr. Berlin, 7: 290; Юзепчук, 1941, Фл. СССР, 10: 207; Ball & Walters, 1968, Fl. Europ. 2: 44; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 277; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 165; Камелин, 2001, Фл. Вост. Евр., 10: 436; Negru, 2007, Determ. pl. fl. R. Moldova : 129.

Grows on calcareous, rocky, steppe slopes, in glades of oak forests. It is part of the herbaceous layer of xerophytic phytocoenoses. Grows solitary or in small groups. Rarely found in the central geobotanical districts of Bessarabia, Ungheni and Hînceshti districts. Flowers in April-May. Its specific spreading area includes Central and Eastern Europe, Central Asia, Siberia.

Section 9. **Fasciculato-pilosae** R. Kam. 2001, Fl. eur. orient., 10: 437.

16. P. arenaria Brokh. 1795, Fl. Graf. Catzenelenbogen : 96; Юзепчук, 1941, Фл. СССР, 10: 208; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 278; Котов, 1999, Опред. высш. раст. Укр. изд. 2: 164; Камелин, 2001, Фл. Вост. Евр., 10: 437; Negru, 2007, Determ. pl. fl. R. Moldova : 127. – *P. incana* Gaertn., Mey. et Scherb. 1800, Fl. Wett. 2: 248; Ciocârlan, 2009, Fl. ilustr. a României : 316. – *P. cinerea* auct. non Chaix ex Vill. : Ledeb. 1844, Fl. Ross. 2, 1: 54; Korsh. 1895, Tent. Fl. Ross. Or.: 140; Ball & Walters, 1968, Fl. Europ. 2: 45.

Grows on sunny, arid, steppe slopes, on sandy and rocky soils. Component of petrophytic and steppe plant communities. It grows in groups forming clumps. Found sporadically on the entire territory of Bessarabia. Flowers in April-September. The specific spreading area includes Central and Eastern Europe, the Caucasus.

Section 10. **Argenteae** Th. Wolf ex Juz. 1941, Фл. СССР, 10: 142.

17. P. argentea L. 1753, Sp. Pl.: 479; Юзепчук, 1941, Фл. СССР, 10: 145; Ball & Walters, 1968, Fl. Europ. 2: 41; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 279; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 165; Камелин, 2001, Фл. Вост. Евр., 10: 446; Negru, 2007, Determ. pl. fl. R. Moldova : 129; Ciocârlan, 2009, Fl. ilustr. a României : 317. – *P. impolita* Wahlenb. 1814, Fl. Carp. Princip.: 155; Юз. 1941, Фл. СССР, 10: 146; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 279; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 165; Negru, 2007, Determ. pl. fl. R. Moldova : 129.

Grows in forests, glades, forest edges, thickets, on open slopes with herbaceous plants, in meadows, on cliffs, along roadsides. This species is part of herbaceous phytocoenoses dominated by graminaceae, solitary or in small groups. Found sporadically on the entire territory of Bessarabia. Flowers in June-August. The specific spreading area is Eurasia.

18. P. canescens Besser 1807, Prim. Fl. Galic. 1: 380; Th. Wolf, 1908, Monogr. Potent.: 268; Юзепчук, 1941, Фл. СССР, 10: 147; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 165; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 279; Камелин, 2001, Фл. Вост. Евр., 10: 448; Negru, 2007, Determ. pl. fl. R. Moldova : 129. – *P. inclinata* auct. non Vill : Ledeb. 1844, Fl. Ross. 2, 1: 47; Ball. & Walters, 1968, Fl. Europ. 2: 41.

This species grows in forests, glades, forest edges, on steppe, stony slopes, in thickets. It is part of the herbaceous layer of arid and semi-arid forest phytocoenoses as well as steppes. Grows in small groups. It flowers from May to September. It is a rare species on the territory of Bessarabia. It has been identified near Mihailechti vill. Ocnița district, Poiana vill. Soldanesti district, Balasinesti vill. Sîngerei district, Congaz vill. ATU Gagauzia. The spreading area includes Central and Eastern Europe, the Caucasus, Asia Minor, Siberia.

19. P. thyrsiflora Huels. ex Zimmeter, 1882, in A. Xern., Sched. Fl. Exs. Austro-Hung. 2: 21;

Юзепчук, 1941, Фл. СССР, 10: 150; Ball & Walters, 1968, Fl. Europ. 2: 42, in adnot.; Котов, 1999, Опред. высш. раст. Укр., изд. 2: 165; Гейдеман, 1986, Опред. высш. раст. МССР, изд. 3: 278; Negru, 2007, Determ. pl. fl. R. Moldova : 127. – *P. leucopolitana* P. Muell, 1858, in F. Schultz, Herb. Norm. : N 256 et Arch. Flore: 272; Юз. 1941, Фл. СССР, 10: 151; Ball & Walters, 1968, Fl. Europ. 2: 42, in adnot.; Камелин, 2001, Фл. Вост. Евр, 10: 451; Ciocârlan, 2009, Fl. ilustr. a României. : 317.

Grows on calcareous slopes, dry meadows, forest edges, glades. It is a component of petrophytic and steppe plant communities. Grows in groups. Flowers from April to August. This species has rarely been found in the investigated territory. The specific spreading area includes Atlantic, Central and Eastern Europe.

CONCLUSIONS

As a result of the floristic, taxonomic and chorological investigations of the genus *Potentilla* L. in the flora of Bessarabia, 19 species included in 10 sections have been highlighted, the synonymy and the key to the identification of the indicated species have been prepared.

The species of the genus Potentilla still need further research, especially concerning the study of populations in the natural ecosystems.

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III. INTRODUCTION OF PLANTS AND SUSTAINABLE USE OF PLANT RESOURCES

CZU 631.529:582.47

INTRODUCTION OF *PINOPHYTA* IN THE REPUBLIC OF MOLDOVA

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Abstract. The issue of the introduction of *Pinophyta* in the pedoclimatic conditions of the Republic of Moldova is approached in the paper. The taxonomic structure, the number of species, subspecies, varieties, hybrids and cultivars, which are in specific collections, green plantings, forest cultures and private gardens etc., were established. As a result, 1094 taxa of *Pinophyta* were specified.

Keywords: taxonomic composition, classification, *Pinophyta,* family, genus, species.

INTRODUCTION

Woody plants, including conifers, are an important factor in optimizing the environment as a biological filter of the atmosphere, polluted by dust, and contributing to the improvement of sanitary-hygienic conditions and air cleanliness. The rational location of plants in urban areas leads to the regulation of temperature and relative humidity, contributes to the decoration of recreation facilities, landscape beautification and adds expressiveness to architectural ensembles. Urbanization has determined new requirements regarding the assortment of ornamental trees and shrubs, the quality and design of green spaces, especially of private ones. Currently, a wide range of aesthetically valuable species is necessary, particularly – conifers. Because of the climate change in recent years (several consecutive years of drought), it is necessary to find various ornamental species, including conifers, suitable for use in different types of green spaces.

Over several decades, about 160 species and 624 cultivars of conifers from different geographical regions of the Earth have been introduced in the Republic of Moldova [4]. In this vast gene pool, there are, especially, valuable species for use in landscaping and forestry. In order to use them rationally, deep knowledge about the adaptation of introduced species to new climatic conditions is necessary. In the previous years, bioecological peculiarities of several species have already been studied [13, 14, 15, 23, 24, 25, 26, 27, 28, 31].

The current research, during 1987-2015, was focused mainly on studying the morpho-biological, ecological and decorative characteristics of plants of division *Pinophyta*. The growth rates and development of species under the climatic conditions of our country and their reproductive capacity were studied. At the same time, the multiannual experience on the introduction of coniferous species, the evaluation of the profitability of using each of them and the determination of the most appropriate application into practice were summarized.

Considering the above and recognizing the importance of species and cultivars of division *Pinophyta* for landscaping and forestry,

the **main purpose** of this paper provides:

- the determination of the taxonomic composition on the basis of the modern classification and evaluation of the multiannual results of introduction of coniferous species in the Republic of Moldova;
- the identification of floristic resources and promising species for introduction.

Research objectives:

- the identification and determination of the taxonomic composition of conifers in different types of green spaces (including: dendrological collections, nurseries, private gardens);
- the study of coniferous species with the purpose of determining their resistance to new pedoclimatic conditions;

- the eco-geographic analysis of introduced species and identification of promising floristic regions for introduction;
- the development of recommendations on the propagation of coniferous species and cultivars;
- the determination of the most appropriate assortment of plants for different types of green spaces.

MATERIALS AND METHODS

Species and cultivars of conifers from old parks of landlords, the Botanical Garden of the ASM (old and new territory), arboreta, parks and squares from Chisinau, forests and private gardens were the objects of study. A number of well known methods, methodological approaches and recommendations for the clarification of the composition of species and cultivars, determination of the frost and drought tolerance, propagation success, level of adaptation, possibilities of introduction, phenological observations etc. were used for the research [15, 30].

The following sources were used in determining the taxonomic composition of conifers: "Деревья и кустарники Молдавии", vol. I [12], "Деревья и кустарники СССР", vol. I [22], "Деревья и кустарники Главного Ботанического сада им. Н.В. Цицина", Москва [21], "Дендрофлора України", vol. I, Київ [20], Каталог растений. Деревья, кустарники, многолетники. рекомендованные Союзом Польских Питомников. Варшава [29], Encyclopedia of Conifers: Comprehensive Guide to Cultivars and Species by Aris G. Auders and Derek P. Spicer, Hardcover [7], Farjon, A. Handbook of the World's Conifers. Leiden, Boston: Phytotaxa. Magnolia Press [8], Krüssmann G. Handbuch der Nadelgehölze. Berlin; Hamburg: Parey [10], Den Ouden P., Boom B.K. Manual of cultivated conifers. The Hague–Boston–London: Martinus Nijhoff [6], Palancean A., Comanici I. Dendrologie. Chișinău [11], etc. The names of coniferous plants were correlated with: International Code of Nomenclature for algae, fungi, and plants (Melbourne Code) adopted by the Eighteenth International Botanical Congress Melbourne. Australia. July 2011 [9].

RESULTS AND DISCUSSIONS

On the basis of the determination of the taxonomic composition of conifers from the cultivated dendroflora of the Republic of Moldova, according to our investigations, 181 species, subspecies, varieties, hybrids and 913 cultivars, in total 1 094 taxa, belonging to 6 families and 28 genera of division *Pinophyta* have been revealed (Table 1, families and genera are arranged in the table on the basis of the modern classification of conifers [5]).

Data analysis shows that not all families are equally represented numerically. Two larger families stand out: *Pinaceae* – with 124 species, subspecies, varieties, hybrids, 447 cultivars and 3 forms, and *Cupressaceae* – 43 species, subspecies, varieties, hybrids, 426 cultivars.

The share of these two families constitutes 95.5% of the total number of introduced taxa of the division *Pinophyta*. The greatest number of taxa belongs to the genera *Picea* Dietr. (28 species, subspecies, varieties and hybrids; 194 cultivars); *Thuja* L. (3; 113); *Juniperus* L. (22; 145); *Pinus* L. (51; 149); *Chamaecyparis* Spach (4; 121); *Abies* Mill. (25; 57); *Larix* Mill. (11; 21). The other genera contain fewer taxa.

The study of the growth rate of shoots reveals the basic vital period of decorative plants, closely related to the climatic conditions of the habitat. The growth and development rates of exotic plants in different climatic conditions constitute the index of adaptation under new conditions and evaluation of promising species for the national economy. As a result of the bio-ecological and phenological research on conifers, it was established that, under new conditions, the growth and development rates in most species correspond to seasonal climate changes [1, 2, 3, 18].

Flowering and seed production are important moments in the life of a plant. The presence (or absence) of the generative phase is one of the main criteria for assessing the success of plant introduction. In the Republic of Moldova, about 120 species of conifers bloom and produce viable seeds. 20 species produce seedlings naturally *(Ginkgo biloba, Pinus nigra, P. nigra ssp. pallasiana, P. strobus, P. sylvestris, Picea abies, P. pungens, Pseudotsuga menziesii, Larix decidua, L. decidua var. polonica, Abies concolor, A. nordmanniana, A. numidica, Thuja occidentalis, Th. plicata, Juniperus communis "Hibernica", J. virginiana, J. virginiana "Glauca", Platicladus orientalis, Taxus baccata).* The following species have not reached the

generative phase: *Abies borisii-regis, A. x insignis, A. recurvata, A. spectabilis, Larix x marschlinsii, Picea x lutzi, P. purpurea, P. smithiana, Pinus armandii, P. henryi, P. longaeva, P. monticola, P. quadrifolia, Tsuga diversifolia, T. mertensiana, Sciadopitys verticilata, Sequoiadendron giganteum, Juniperus procumbens, Taxus canadensis, T. chinensis, Cephalotaxus fortunei, Torreya nucifera, T. taxifolia etc. About 60 species and cultivars produce seeds with a high germination percentage: Ginkgo biloba, Abies alba, A. concolor, A. nordmanniana, A. numidica, Larix decidua, L. decidua var. polonica, Picea abies, P. glauca, P. koraiensis, P. omorika, P. pungens, Pinus mugo, P. nigra, P. nigra ssp. pallasiana, P. uncinata, Thuja occidentalis, Th. plicata, Juniperus virginiana, Platycladus orientalis* etc.

Table 1. Taxonomic composition and number of taxa of conifers cultivated in the Republic of Moldova according to the modern systematic position [5] (2016)

Systematic units	**The total number of species in existence today**		**Name of the taxa identified in the Republic of Moldova**
	In the world	**In the R. Moldova**	
Subclass *GINKGOIDAE* Engl. in H.G.A. Engler & K.A.E. Prantl	**1**	**1**	
Order *GINKGOALES* Gorozh.	**1**	**1**	
Family *Ginkgoaceae* Engl. in H.G.A. Engler & K.A.E. Prantl.	**1**	**1**	
Ginkgo L.	1	1	*G. biloba* L.
Subclass *GNETIDAE* Pax in K.A.E. Prantl	**71**	**3**	
Order *EPHEDRALES* Dumort.	**40**	**3**	
Familia *Ephedraceae* Dumort.	**40**	**3**	
Ephedra L.	40	3	*E. equisetina* Bunge, *E. gerardiana* Wallich, *E. intermedia* Schrenk et C.A. Mey.
Subclass *PINIDAE* Cronquist, Takht. & Zimmerm.	628	177	
Order *PINALES* Gorozh.	233	124	
Family *Pinaceae* Spreng. ex F.Rudolphi	233	124	
Cedrus Trew	4	3	*C. atlantica* (Endl.) Manetti ex Carrière, *C. deodara* (Roxb.) G. Don, *C. libanii* A. Rich.
Pinus L.	113	49	*P. aristata* Engelm., *P. armandii* Franch., *P. banksiana* Lamb., *P. brutia* Ten., *P. brutia* Ten. var. *brutia, P. brutia* var. *eldarica* (Medw.) Silba, *P. brutia* var. *pityusa* (Steven) Silba, *P. bungeana* Zucc. ex Endl. *P. cembra* L., *P. contorta* Douglas ex Loudon, *P. contorta* Douglas ex Loudon var. *murrayana* (Balf.) Engelm., *P. densiflora* Siebold & Zucc., *P. flexilis* E. James, *P.* x *funebris* Kom., *P. halepensis* Mill., *P. heldreichii* H. Christ, *P. henryi* Mast., *P. jeffreyi* Balf., *P. kochiana* Klotzsch ex C. Koch, *P. koraiensis* Siebold & Zucc., *P. longaeva* D.K. Bailey, *P. massoniana* Lamb., *P. monticola* Douglas ex D. Don, *P. mugo* Turra, *P. mugo* ssp. *mugo, P. mugo* ssp. *rotundata* (Link) Janch. & H. Neumayer, *P. nigra* J.F. Arnold, *P. nigra* ssp. *laricio* (Poir.) Maire, *P. nigra* ssp. *pallasiana* Lamb., *P. parviflora* Siebold & Zucc., *P. parviflora* Sieb. et Zucc. var. *pentaphylla* (Mayr) A. Henry, *P. peuce* Griseb, *P. pinaster* Aiton, *P. ponderosa* Douglas ex C. Lawson, *P. ponderosa* Douglas ex. Lawson var. *scopulorum* Engelm., *P. pumila* (Pall.) Regel, *P. quadrifolia* Parl. ex Sudw, *P. resinosa* Aiton, *P. rigida* Mill., *P.* x *schwerini* Fitschen, *P. sibirica* Du Tour, *P. strobus* L., *P. sylvestris* L., *P. sylvestris* var. *hamata* Steven, *P. tabuliformis Carrière*, *P. taeda* L., *P. thunbergii* Parl., *P. uncinata* Ramond ex DC., *P. wallichiana* A.B. Jacks.

Picea A. Dietr.	38	27	*P. abies* (L.) Karst., *P. alcoquiana* (Veitch ex Lindl.) Carrière, *P. asperata* Mast., *P. asperata* var.*notabilis* Rehder & E.H.Wilson, *P. breweriana* S. Watson, *P. engelmannii* Parry ex Engelm., *P. glauca* (Moench) Voss, *P. glehnii* (F. Schmidt) Mast., *P. jezoensis* (Siebold & Zucc.) Carrière ssp. *hondoensis* (Mayr) P.A. Schmidt, *P. jezoensis* (Siebold & Zucc.) Carrière ssp. *jezoensis* var. *jezoensis, P. koraiensis* Nakai, *P. likiangensis* var. *montigena* (Mast.) W.C. Cheng, *P. likiangensis* var. *rubescens* Rehder & E.N. Wilson*, P.* x *lutzi* Little, *P. mariana* (Mill.) Britton, Sterns et Poggenb., *P. neoveitchii* Mast., *P. obovata* Ledeb., *P. omorika* (Pančić) Purk., *P. orientalis* (L.) Peterm., *P. pungens* Engelm., *P. purpurea* Mast., *P. rubens* Sarg., *Picea* x *saaghji* NB, *P. schrenkiana* Fisch. & C.A. Mey., *P. sitchensis* (Bong.) Carrière, *P. smithiana* (Wall.) Boiss., *P. torano* (Siebold ex K. Koch) Koehne
Pseudotsuga Carr.	4	2	*P. menziesii (Mirb.) Franco*, *P. menziesii.* var. *glauca* (Beissn.) Franco
Larix Mill.	11	10	*L.*x *czekanowskii* Szafer, *L. decidua* Mill., *L. decidua*.var. *polonica* Racib., *L. gmelinii* (Rupr.) Kuzen., *L. kaempferi* (Lamb.) Carrière, *L. laricina* (Du Roi) K. Koch, *Larix* x *maritima* Suk., *L. occidentalis* Nutt., *L. sibirica* Ledeb., *L. sukaczewii* Djil.
Pseudolarix Gordon	1	1	*P. amabilis* (J. Nelson) Rehder
Tsuga (Endl.) Carr.	9	3	*T. canadensis* (L.) Carrière, *T. diversifolia* (Maxim.) Mast. *T. mertensiana* (Bong.) Carrière
Abies Mill.	48	23	*A. alba* Mill., *A. amabilis* (Dougl. ex Loud.) Forb., *A. balsamea* (L.) Mill., *A. borisii-regis* Mattf., *A. cephalonica* Loud., *A. concolor* (Gordon) Lindl. ex Hildebr., *A. concolor* var. *lowiana* (Gord.) Lemm., *A. fraseri* (Pursh) Poir., *A. holophylla* Maxim., *A. homolepis* Sieb. et Zucc., *A. koreana* E.H. Wilson, *A. lasiocarpa* (Hook.) Nutt., *A. lasiocarpa* var. *arizonica* (Merriam) Lemmon, *A. nephrolepis* (Trautv. ex Maxim.) Maxim., *A. nordmanniana* (Steven) Spach, *A. numidica* De Lannoy ex Carrière, *A. pinsapo* Boiss., *A. procera* Rehder, *A. recurvata* Mast., *A. sachalinensis* (Fr. Schmidt) Mast., *A. sibirica* Ledeb., *A spectabilis* (D.Don) Spach, *A. veitchii* Lindl.
Order *CUPRESSALES* Link	**159**	**53**	
Family *Sciadopityaceae* Luerss.	**1**	**1**	
Sciadopitys Siebold & Zucc.	1	1	*S. verticilata* Siebold & Zucc.
Family *Cupressaceae* Gray	**123**	**43**	
Cunninghamia R.Br. in L.C.M. Richard	2	1	*C. lanceolata* (Lamb.) Hook.
Metasequoia Hu & W.C. Cheng	1	1	*M. glyptostroboides* Hu & W.C. Cheng
Sequoiadendron J.Buchholz	1	1	*S. giganteum* (Lindl.) J.Buchholz
Cryptomeria D. Don	1	1	*C. japonica* (Thunb. ex L. f.) D. Don
Taxodium Rich.	2	1	*T. distichum* (L.) Rich.
Thujopsis Siebold & Zucc. ex Endl.	1	1	*Th. dolabrata* (Thunb. ex L. f.) Siebold & Zucc.
Thuja L.	5	3	*Th. occidentalis* L., *Th. plicata* Donn ex D. Don, *Th. standishii* (Gordon) Carrière
Chamaecyparis Spach	5	4	*Ch. lawsoniana* (A. Murray bis) Parl., *Ch. obtusa* (Siebold & Zucc.) Endl., *Ch. pisifera* (Siebold & Zucc.) Endl., *Ch. thyoides* (L). Britton, Sterns & Poggenb.
Cupressus L.	16	4	*C. arizonica* Greene, *C. lusitanica* Mill. *C. macnabiana* A. Murray bis, *C. nootkatensis* Hook.
x *Cuprocyparis* (A.B. Jacks. & Dallim.) Farjon	1	1	x *C. leylandii* (A.B. Jacks. & Dallim.) Farjon
Juniperus L.	53	22	*J. chinensis* L., *J. chinensis* L. var. *sargentii* (Henry) Takeda , *J. communis* L., *J. communis* var. *depressa* Pursh, *J. drupacea* Labill., *J. exelsa* M. Bieb., *J. foetidissima* Willd., *J. horizontalis* Moench, *J. oxycedrus* L., *J.* x *pfitzeriana* (Späth) P.A. Schmidt, *J. procumbens* (Siebold ex Endl.) Miq., *J. pseudosabina* Fisch. & C.A. Mey., *J. pygmaea* C. Koch., *J. rigida* Siebold & Zucc., *J. rigida* ssp. *conferta* (Parl.) Kitam., *J. sabina* L., *J. sabina* var. *davurica* (Pall.) Farjon, *J. scopulorum* Sarg., *J. sibirica* Burgsd., *J. semiglobosa* Regel, *J. squamata* Buch.-Ham. ex D. Don, *J. virginiana* L.
Calocedrus Kurz	4	1	*C. decurrens* (Torr.) Florin
Platycladus Spach	1	1	*P. orientalis* (L.) Franco
Microbiota Komarov	1	1	*M. decussata* Kom.
Family *Taxaceae* Gray	**35**	**9**	
Taxus L.	9	5	*T. baccata* L., *T. canadensis* Marshall, *T. chinensis* (Pilg.) Rehder, *T. cuspidata* Siebold & Zucc., *T.* x *media* Rehder
Cephalotaxus Siebold & Zucc. ex Endl.	11	2	*C. fortunei* Hook., *C. harringtonii* K. Koch. var. *drupacea* (Siebold & Zucc.) Koidz.
Torreya Arn.	7	2	*T. nucifera* (L.) Siebold & Zucc., *T. taxifolia* Arn.

Subclasses	**3**	**3**	
Orders	**3**	**3**	
Families	**6**	**6**	
Genera	**28**	**28**	
Species	**669**	**175**	
Hybrids		**6**	
Cultivars		**913**	
Total: *Pinophyta*		**1094**	

It is known that an important role in plant introduction is played by their winter hardiness, although it may vary in the process of acclimatization. Currently, about 90% of the cultivated species of the division *Pinophyta* are frost tolerant. During the study period, more than 80% of species and cultivars of conifers manifested complete drought tolerance.

We have also studied the peculiarities of reproduction by seed. In the experiment, we used the seeds obtained in our country. The study program included: the identification of the optimal method of growing seedlings of conifers, which were tested in different variants of substrates, and also the preparation of seeds for sowing and determination of the optimal sowing period. The highest seed germination coefficient (up to 80%) was recorded in the substrate consisting of forest soil and river sand (3:1). The use of solutions of chemical substances (potassium permanganate – 1 %, heteroauxin – 0.01 %, superphosphate – 0.5 %) contributed to a significant improvement in the germination of seeds.

Along with the reproduction by seed, a method that is considered optimal for the vast majority of species, we performed experiments to study the influence of different growth promoters on rooting of cuttings, perfecting and completing the method of propagation by cuttings of coniferous cultivars.

For the first time, under the climatic conditions of the Republic of Moldova, a research on grafting different species and cultivars of conifers was carried out. The optimal time, methods and the effects of chemicals on inosculation of rootstock and scion were determined. Much attention is paid to repatriation and adaptation of species and cultivars by transplantation (grafting) method [16, 17]. On the basis of the data analysis, we can conclude that it is rational to propagate highly decorative species and cultivars of *Ginkgo, Abies, Cedrus, Larix, Picea, Pinus, Pseudotsuga, Metasequoia* etc. by grafting method.

On the basis of a long-term research on growth, development, hardiness and decorative qualities of conifers, the following 100 species are recommended: ***Ginkgo*** *biloba,* ***Ephedra*** *equisetina,* ***Cedrus*** *atlantica, C. libani,* ***Pinus*** *aristata, P. banksiana, P. bungeana, P. cembra, P. contorta, P. densiflora, P. flexilis, P. heldreichii, P. jeffreyi, P. koraiensis, P. mugo, P. nigra, P. pallasiana, P. parviflora, P. peuce, P. ponderosa, P. pumila, P. rigida, P. scopulorum, P. sibirica, P. strobus, P. sylvestris, P. uncinata,* ***Picea*** *abies, P. asperata, P. breweriana, P. engelmannii, P. glauca, P. glehnii, P. koraiensis, P. obovata, P. omorika, P. orientalis, P. pungens, P. schrenkiana, P. torano, Pseudotsuga menziesii, P. menziesii. var. glauca,* ***Larix*** x *czekanowskii, L. decidua, L. decidua.*var. *polonica, L. gmelinii, L. kaempferi, L. laricina, L. occidentalis, L. sibirica, L. sukaczewi,* ***Tsuga*** *canadensis,* ***Abies*** *alba, A. amabilis, A. balsamea, A. cephalonica, A. concolor, A. concolor* var. *lowiana, A. fraseri, A. holophylla, A. homolepis, A. koreana, A. lasiocarpa, A. lasiocarpa* var. *arizonica, A. nephrolepis, A. nordmanniana, A. numidica, A. pinsapo, A. procera, A. sibirica,* ***Metasequoia*** *glyptostroboides,* ***Sequoiadendron*** *giganteum,* ***Taxodium*** *distichum,* ***Thuja*** *occidentalis, Th. plicata,* ***Chamaecyparis*** *lawsoniana, Ch. obtusa, Ch. pisifera,* ***Cupressus*** *nootkatensis,* ***Juniperus*** *chinensis, J. communis* var. *depressa, J. drupacea, J. exelsa, J. foetidissima, J. horizontalis, J.* x *pfitzeriana, J. procumbens, J. pygmaea, J. sabina, J. sabina* var. *davurica, J. scopulorum, J. sibirica, J. semiglobosa, J. squamata, J. virginiana,* ***Calocedrus*** *decurrens,* ***Platycladus*** *orientalis,* ***Microbiota*** *decussata,* ***Taxus*** *baccata, T. cuspidata, T.* x *media.* Highly decorative cultivars are also recommended for use in landscaping.

CONCLUSIONS

As a result of the determination and revision of taxonomic composition of conifers, 1087 taxa were identified in the green spaces of the Republic of Moldova. On the basis of the research on the growth and development of *Pinophyta* species, we have established that the climatic conditions of Moldova are favourable for the reproduction of many species and cultivars. The presence of the generative phase in 120 species of conifers indicates their good adaptation to new environment. High seed germination in some species of conifers makes possible to obtain large numbers of seedlings in order to use them later in

ornamental horticulture and forestry. As a result of carrying out an experimental research, the prospects of vegetative propagation of species and cultivars of conifers have been substantiated, 100 species have been recommended for different types of green spaces. The results of long-term experiments on the introduction of conifers in our country show a great potential for enriching the assortment with new species and cultivars.

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CONTRIBUTIONS TO THE STUDY OF HIGHER PLANTS WITHIN THE NATURAL AREA FĂUREȘTI-GOIAN

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Abstract: The river Ichel runs through reefal limestone massifs of Middle Sarmatian, while the vegetation in this region is unique. The fragmented relief of slopes, altitude difference and landscape diversity make this place a specifically picturesque region. There is a quite large number of cosmopolitan species, compared to most Mediterranean, including several European species.

Keywords: biocenosis, skeletal soil, vegetation, dicotyledonous species, monocotyledonous plants

INTRODUCTION

The area under study is a natural complex of great scientific, ecological, aesthetic, educational and instructive value. It is a typical rocky (limestone) landscape that includes the right and left slopes of the river Ichel valley. The fragmented relief of slopes, altitude difference, and landscape diversity make this place a specifically picturesque region. The specific component of biocenosis is conditioned primarily by abiotic conditions – geological structure and alternating geological rocks, hydric regime, climatic conditions, landscape particularities and genetic structure of the soil cover. The specific features of the landscape and altitudinal difference influence the redistribution of climatic conditions. The predominance of mainly steep slopes redistributes the precipitation and influences on the water flows. The altitudinal difference and the exposure of plants determine the thermal regimes. The landscape of the area under study is mainly formed in the result of the interaction of landslides and rolling limestone blocks. The vegetation in some sectors contributed to stop denudation processes, creating a local circuit of rainfall and stopping, partly, the erosion. This is the consequence of the interaction between abiotic factors and biogenic terrestrial formations [16]. The slopes are steep and only the lower parts are less steep and the valley bottom is rocky. The valley looks like a canyon. There are several types of soil: typical rendzinas (skeletal), which are largely found on the right slope and are formed on calcareous rocks; alluvial and layered, slightly salinized, which are found in the river Ichel floodplain under the grass hydrophilic cover made of different species. At the foot of the right slope in the area with a number of springs, there is a part consisting of swampy soils. There are also grey forest soils among the calcareous rocks. On these soils grow shrubs and herbaceous plants, including species listed in the Red Book (2002). The right slope is steeper and at the top are seen several steps resulting from fracturing and displacement of limestone blocks, which gradually sank. They were partly covered by a layer of skeletal soil. The slope has a southern exposition (S - E) and a slope inclination of 23-28°. The left slope is less steep, and has a northern exposition with a steep slope at an angle of approximately 30-60°. The exposition of slopes plays an important role in vegetation distribution. The temperate continental climate with its features led to the development of a grass carpet, adapted to these conditions. [17].

The River Ichel runs through reefal limestone massifs of Middle Sarmatian, while the vegetation in this region is unique. Being included in the endemic alliance *Genisto-Seselion peucedanifolii*, this type of vegetation still requires monitoring and assessment activities of its floristic composition and valuable elements of these surfaces of the vegetable patrimony of our country [18].

MATERIALS AND METHODS

The investigative practices included analysis of the vegetation cover using Braun-Blanquet method [5] and analysis of the bibliography referring to the area under study. The fieldwork was carried out in three periods: spring (March, April, May), summer (June, July) and autumn (September, October) in 2011-2015. Representative vegetation zones were initially evaluated by sight, in terms of site and vegetation characteristics. The following works have been used in determining and indentifying the species: "Determinant of higher plants in the Moldavian SSR" [9]; „Illustrated Flora of Romania" vol. 1,

2. [3]; Vegetal world of Moldova, Vol-le: 2; 3; 4 [14],[15],[7]; The Red Book of the Republic of Moldova [2]; "Determinant of plants of flora in the Republic of Moldova"[12]; "Rare taxa of flora in the Republic of Moldova [19]; Pînzaru P.&Sîrbu T. "Vascular flora of the Republic of Moldova" *(List of species and ecology)* [20]; "Rare plants of spontaneous flora of the Republic of Moldova" [13]. The categories of rare plant species have been established according to the International classification of endangered species (IUCN, 1994): EX (Extinct) – disappeared; disappeared taxon, not found for a long time in local flora; CR (Critically Endangered) – critically endangered; taxon facing a high risk of extinction in the wild of the country; EN (Endangered) – endangered; taxon in danger of extinction, but not critically endangered, whose survival is unlikely if causal factors continue operating; VU (Vulnerable) – vulnerable; taxon considered likely to pass in the category EN in the near future if causal factors continue operating; LR – lower risk; taxon whose extinction is a low risk; DD (Data deficient) – insufficiently known; not known enough to be included in the categories above [10].

RESULTS AND DISCUSSIONS

Limestone slopes of the Dniester river valley have drew the attention of many botanists. At the beginning of the 19th century, *Andrzeijowski* (the author of Flora of Ukraine, 1869) [1], collected a herbarium based on which *Besser* (1882), describes some new species from that place [6]. *Bieberstein* describing Flora *Taurico-Caucasica* (1808-1809), developed a supplement describing the species typical of Bessarabia [4]. We can also find data about species growing on calcareous soils in the works of *Seredinskii* (1872, 1873) [8], *Lindeman* (1882) [11], *Zapalowicz* (1906) [21].

Within the area under study were found 489 species of vascular plants, belonging to 79 families, including: higher spore plants – 2 species (2 families); gymnosperms – 1 species (one family); higher flowering plants – 486 species, 76 families respectively (Table 1).

Table 1. Taxonomic structure of the flora within the area under study

Taxon	**Flora of the area under study**	
	Number	**%**
Equisetopsida Class		
Family	1	1.3
Genus	1	0.2
Species	1	0.2
Polypodiopsida Class		
Family	1	1.3
Genus	1	0.2
Species	1	0.2
Pinopsida Class		
Family	1	1.3
Genus	1	0.2
Species	1	0.2
Magnoliopsida Class		
Family	60	78.9
Genus	363	86.0
Species	399	81.5
Liliopsida Class		
Family	13	17.2
Genus	56	13.4
Species	87	17.5

Dicotyledonous species are represented by 396 species, 60 families respectively, while

monocotyledonous plants include 87 species belonging to 13 families. Within the category of dicotyledonous species, the most numerous are the species that belong to the following families: *Asteraceae, Lamiaceae, Rosaceae, Fabaceae, Apiaceae, Ranunculaceae, Caryophyllaceae* (Fig. 1). The others contain a smaller amount of species, such as the families of: *Boraginaceae* – 14 species; *Plantaginaceae* – 12 species; *Polygonaceae* – 9 species; *Rubiaceae and Amaranthaceae* – 8 species; *Salicaceae, Campanulaceae* and *Caprifoliaceae* – 6 species; *Papaveraceae, Solanaceae and Violaceae* – 5 species; *Malvaceae, Oleaceae, Sapindaceae* – 4 species; *Adoxaceae, Apocinaceae, Betulaceae, Cannabaceae, Convolvulaceae, Hyperaceae, Linaceae, Primulaceae and Ulmaceae* - 3 species; other *Magnoliopsida* contain only 1-2 species.

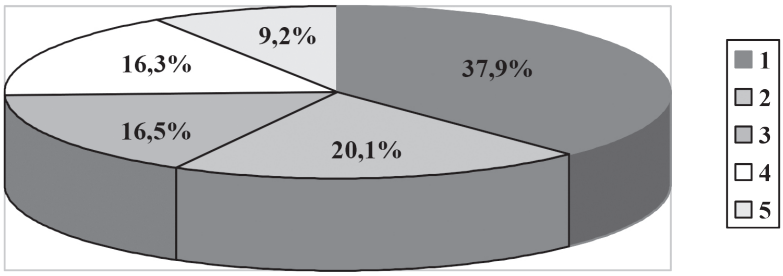

Fig. 1. The most numerous families (by number of species) within the class *Magnoliopsida: 1 – Asteraceae; 2 – Lamiaceae; 3 – Rosaceae; 4 – Fabaceae; 5 – Apiaceae, Ranunculaceae, Caryophyllaceae.*

Monocotyledonous plants are represented by 13 families, the most present being *Poaceae*, followed by *Asparagaceae, Cyperaceae*, etc. (Fig.2).

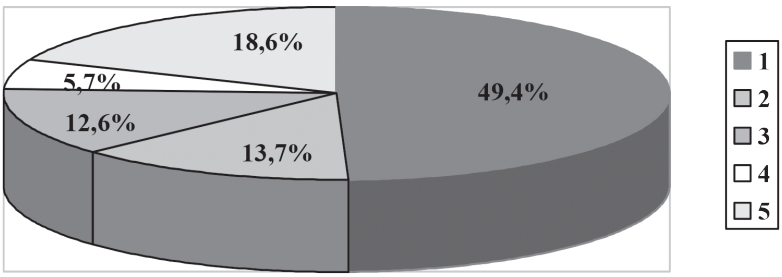

Fig. 2. The most numerous families (by number of species) within the class *Liliopsida: 1 – Poaceae; 2 – Asparagaceae; 3 – Cyperaceae; 4 – Amaryllidaceae; 5 – other families.*

Some families like *Amaryllidaceae, Liliaceae, Colchicaceae,* in spite of their small number of species (1-5), are important since most of these taxa belong to rare species.

Flora in the area consists of species of different origin. Species distribution analysis shows that most of them have Eurasian origin (Table 2).

Table 2. Geographical range of the flora in area under study

Area type	Number of species	%
Eurasian	95	19.4
European	79	16.1
Exotic	40	8.1
Cosmopolitan	40	8.1

Mediterranean	29	5.9
Ponto-Balkan	22	4.4
Pontic	21	4.2
Euro-Siberian	21	4.2
South East Europe	16	3.2
Ponto - Pannonian	15	3.0
European West Asian	14	2.8
Subcosmopolitan	10	2.0
Circumpolar	9	1.8
Ponto-Pannonian-Balkan	9	1.8
European East Asian	8	1.6
European Central - Asian	8	1.6
Pontic Mediterranean	7	1.4
Asian Mediterranean	7	1.4
Asian European	6	1.2
Southern European	5	1.0
South-eastern European – South-western Asian	5	1.0
Endemic Sarmatian	5	1.0
Asian European	3	0.6
Eastern European	3	0.6
Asian Mediterranean	2	0.4
Eastern - European - Siberian	2	0.4
Central European	2	0.4
Southern European – Western Asian	2	0.4
Central European	1	0.2
European - South-western Asian	1	0.2
Ponto - central European	1	0.2
Southern European Caucasian	1	0.2

European - South-eastern Asian Eurasian species are followed by the European ones, which are situated at a considerable distance from the rest of species. There is a quite large number of cosmopolitan species, compared to most Mediterranean, including several European species. There are fewer species that are found at the intersections: European - South-eastern Asian; central European; Ponto – central European; southern European – Caucasian.

Within the area under study were found 15 species of seldsame plants, which account for 3% of floristic composition. According to the classification of rare species of plants and endangered plants, under international classification of endangered species /12/, 10 species belong to the category of CR, 3 species are VU, 1 species is included in the category LR and 1 species in DD (Table 3).

Table 3. Categories of rare species, according to the international classification of endangered species (IUCN, 1994)

Name of species	**CR**	**VU**	**LR**	**DD**
Polystichum aculeatum (L.) Roth	+			
Seseli peucedanifolium Besser.		+		
Jurinea stoechadifolia (Bieb.) DC.,	+			
Tulipa biebersteiniana (Schult, et Schult, fil).		+		
Fritillaria meleagroides Patrin ex Schult. et Schult. Fil	+			

Fritillaria montana Hoppe		+		
Gypsophyla glomerata Pall. Ex Adams	+			
Thymus moldavicus Klok.et Schost.				+
Helianthemum canum (L.) Baumg.	+			
Cotoneaster melanocarpos Frisch. Ex Blytt	+			
Colchicum triphyllum G. Kunze	+			
Allium inaeguale Jank.	+			
Pulsatilla montana (Hoppe) Rchb			+	
Chrysopogon gryllus (L.) Trin.	+			
Koeleria moldavica M.Alexeenko	+			

CRITICALLY ENDANGERED SPECIES (CR) – are taxa facing a high risk of extinction and account for 66.8% of the total number of rare species, which are found in the area under study. VULNERABLE SPECIES (VU) – taxa that have a higher likelihood to become extinct in the near future, if certain factors continue their influence. They account for 20%. LOWER RISK SPECIES (LR) – taxa facing a lower risk and DATA DEFICIENT SPECIES (DD) – taxa that are not known enough to be included in one of the above categories, account for 6.6%.

This area is a refuge for many species encountered in this area, which are considered unique populations for the Republic of Moldova.

CONCLUSIONS

1. Within the area under study were found 489 species of vascular plants, belonging to 79 families, including: higher spore plants – 2 species, 2 families respectively; gymnosperms – 1 species, one family respectively; higher flowering plants – 486 species included in 76 families, of which 396 species and 60 families respectively belong to dicotyledenous, while 87 species belong to 13 families of monocotyledonous. The most numerous (in terms of species number) within the class of *Magnoliopsida* are the following families: *Asteraceae; Lamiaceae; Rosaceae; Fabaceae; Apiaceae; Ranunculaceae; Caryophyllaceae,* while from the class of *Liliopsida: Poaceae; Asparagaceae; Cyperaceae; Amaryllidaceae.*

2. Species distribution analysis shows that most of them have Eurasian origin. They are followed by the European ones, which are situated (quantitatively) at a considerable distance from the other species. There is a quite large number of cosmopolitan species, compared to most Mediterranean, including several European species. There are fewer and very few species that are found at the intersections: Asian Mediterranean; Eastern - European – Siberian, central European; Southern European – Western Asian, European - South-western Asian, Ponto – central European; southern European – Caucasian.

3. There were registered 15 species of seldsame plants within the area under consideration, which account for 3% of floristic composition. 10 species were assigned to the category CR: *Polystichum aculeatum; Jurinea stoechadifolia; Fritillaria meleagroides; Gypsophyla glomerata; Helianthemum canum; Cotoneaster melanocarpos; Colchicum triphyllum; Allium inaeguale; Chrysopogon gryllus; Koeleria moldavica;* 3 species were assigned to the category VU: *Seseli peucedanifolium; Tulipa biebersteiniana; Fritillaria montana;* 1 species is included in the category LP - Pulsatilla montana and 1 species in the category DD - *Thymus moldavicus.*

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CZU: 633.58:582.6 (478)

FAMILY *LAMIACEAE*: MAIN IMPORTANT SPONTANEOUS MEDICINAL AND AROMATIC SPECIES IN THE REPUBLIC OF MOLDOVA

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Abstract: In this research, medicinal and aromatic species of *Lamiaceae* family, spontaneously growing in local flora, were detected. In the flora of the Republic of Moldova, *Lamiaceae* family is represented by 28 genera and 82 species. Out of a total number of native *Lamiaceae* species, 57 have been documented for medicinal use. But much less of them are actually used in both official and folk medicine in our country. Thirteen genera, including therapeutically important species, are widely represented and distributed in all parts of the country. More than twenty species with high frequency and abundance can be recommended to be harvested and valorized without damaging their natural populations.

INTRODUCTION

The *Lamiaceae* plant family is one of the largest families among the dicotyledones including about 220 genera and almost 4000 species spread all over the world, most frequently in Mediterranean region [4, 7, 8]. The family is represented in flora of the Republic of Moldova by 28 genera and 82 species [11].This large family is known for the vast quantity of species with medicinal, aromatic, culinary and ornamental properties.

Lamiaceae species are very popular in folk medicine to treat various health problems such as throat infections, stomach disorders, ulcer, spasm, cold, hemorrhages and skin problems. Species of this botanical family contain a wide variety of bioactive substances that make them very important from pharmacological point of view. A large group of chemical compounds, such as mono-, di- and triterpenoids, iridoids, flavonoids, steroids, phenolic compounds, saponins, coumarins, alkaloids, tannins have been reported from the members of this family [12, 19, 21]. The family is also famous for the presence of essential oils. Their constituents have been found to be anti-inflammatory, hemostatic, cicatrizing, stomachic, sedative, spasmolytic, diuretic, expectorant, cardiac, hypotensive etc.

The medicinal properties of *Lamiaceae* species and their traditional use worldwide have attracted attention of many scientists in different parts of the world. This has led, in the last few decades to intensive phytochemical investigations on these plants in order to prove the bases of their ethnobotanical uses and to identify the structure of new compounds in hope of finding modern efficient drugs for various diseases. Recent studies [1, 2, 9, 10, 13] showed that the medicinal plants belonging to the *Lamiaceae* family, in particular to the subfamily *Lamioideae* are very important for the antimicrobial, antifungal, antibacterial and antioxidant activities. This family contains many species with potential therapeutic activity due to their content of essential oils. Numerous studies [3, 12, 19, 21] focus on isolation, chemical composition and biological activities of the essential oils recovered from the *Lamiaceae* species. The presence of volatile oil makes them very valuable in food, cosmetic and pharmaceutical industries.

Based on literature search [15, 16, 18, 19], more than 60 native species belonging to this family contain a wide variety of chemical compounds making them very important from pharmacological point of view. But, much less *Lamiaceae* species are used for medical purposes in the Republic of Moldova. Up to date there is no distinct reference on the ethnobotany and use of these species in modern medicine in our country. Although, there are some studies regarding several indigenous *Lamiaceae* species, this diverse family is still waiting to be explored. The goal of the present study is to identify the native species of this family and to complete preliminary informative studies on their potential use in pharmaceutical industry. The investigations are, also targeted at species that are insufficiently studied from bio-chemical viewpoint and to the possibilities of introduction into culture of some therapeutically important *Lamiaceae* species growing in the flora of the Republic of Moldova.

MATERIALS AND METHODS

The research included field observations at different time of the year, during the period 2010-2015. Selected plant species were collected and identified with the help of researchers of Native Flora and Herbarium Laboratory. An ample revision has been made in the Herbarium of the Botanical Garden (I) of ASM. The nomenclature of the taxa is given according to up to date scientific papers [5, 8, 11]. The field studies were preceded by an extensive literature survey regarding this large botanical family. An assessment of a large number of wild *Lamiaceae* species with medicinal properties was made through interviews with local people. Detailed ethnobotanical data along with Herbarium material were gathered to verify species identification and their uses. The investigations regarding cultivation of some therapeutically important species were carried out at the experimental fields in the Botanical Garden. Germplasm material of 16 selected species was obtained from natural population. Investigations include propagation aspects and research into cultivation techniques. The biological particularities and the phenologic rhythm are also recorded [14, 17, 20].

RESULTS AND DISCUSSIONS

In the native flora *Lamiaceae* family is represented by 82 species belonging to 28 genera. Among the richest genera we can enumerate: *Salvia* with 8 species; four genera with 6 species *(Mentha, Ajuga, Stachys and Teucrium); Galeopsis and Thymus* with 5 species and, *Lamium* and *Scutellaria* with 4 species. The less numerous genera with 3 species are *Leonurus, Marrubium, Nepeta* and *Prunella)*. Ten genera *(Acinos, Ballota, Clinopodium, Dracocephalum, Galeobdolon, Melissa, Melittis, Micromeria, Chaiturus* and *Origanum)* are monospecific. Other five *(Calamintha, Glechoma, Lycopus, Phlomis* and *Sideritis)* are represented by two taxa. Out of a total number of native *Lamiaceae* species, 57 have been documented for medicinal use. But much less of them are actually used in both official and folk medicine in our country.

The field investigations, the survey of the scientific references and the ethnobotanical studies allowed identifying the main important and usable medicinal and aromatic plants from *Lamiaceae* family, naturally growing in R. Moldova. They are listed, in the alphabetical order of their scientific names in the table 1. The information is completed by data concerning the plant parts used, therapeutic activities, utilization and method of preparation.

Most *Lamiaceae* plant family members are herbaceous, mainly perennial plants; however, some of them are small size shrubs (e.g., members of *Teucrium, Thymus, Nepeta* etc.). The raw materials are used in many different forms: fresh, powdered, infusions, decoctions, tincture etc.

In the most of the cases the vegetal matter is used as infusion. The most important medicinal properties of Lamiaceae species are anti-inflammatory, astringent, cicatrizing, expectorant, diuretic, cholagogic, hypotensive. Due to these therapeutic qualities they are mainly used for the diseases related to digestive system. The second common application is for treatment of respiratory problems with implication of diverse infections.

Out of the total number of 28, thirteen genera of this family *(Salvia, Mentha, Ajuga, Stachys, Teucrium, Thymus, Lamium, Marrubium, Leonurus, Prunella, Acinos, Ballota and Phlomis)* are widely represented and distributed in all parts the country. Among species with high frequency and abundance that can be harvested and valorized without damaging their natural populations are following: *Ajuga reptans, Ballota nigra, Glechoma hederacea, Lamium album, Leonurus quinquelobatus, Marrubium vulgare, Mentha spicata, Origanum vulgare, Phlomis pungens, Prunella vulgaris, Salvia aethiopis, S. nemorosa, Scutellaria altissima, Sideritis montana, Stachys annua, S. recta, Teucrium chamaedrys, Thymus marschallianus.* Some of them *(Ballota nigra, Glechoma hederacea, Lamium album, Leonurus quinquelobatus, Prunella vulgaris, Salvia nemorosa* and *Stachys annua)* showed wide distribution, frequently occurring as weeds around human settlements and considered as important medicinal plant resource not only for pharmacological research, but also for traditional use.

Table 1. The main important and usable spontaneous medicinal Lamiaceae species

N/o	Scientific name	Plant part used	Therapeutic effects	Utilization	Method of administration
1	*Ajuga reptans* L.	Fl L A. p.	anti-inflammatory, cicatrizing, hemostatic, expectorant, diuretic, anti-spastic, anti-diarrheic	infections (malaria, dysentery, tuberculosis), hepatitis, digestive affections (diarrhea, stomach ulcers, gallstones), respiratory infections, angina, sore throat, gynecologic problems, rheumatism, stomatitis, wounds, burns, hair loss, hemorrhoids, leucorrhea	infusion decoction
2	*Ajuga genevensis* L.	Fl L A. p	antioxidant, anti-inflammatory, hemostatic, cicatrizing	diarrhea, gastritis, pneumonia, bronchitis, rheumatism pains, wounds, stomatitis, angina, burns, asthenia, hair loss	infusion decoction
3	*Ajuga laxmanii* (L.) Benth.	Fl L A. p	spasmolytic, antitumor antioxidant	digestive problems, gastritis, respiratory affections, nervous illnesses, headache	infusion decoction
4	*Ballota nigra* L.	A. p.	sedative, antispasmodic stimulant, vermifuge	flatulence, vomiting, esophageal spasm, abdominal colic, psychic problems (hysteria, anxiety, psychic asthenia, palpitation), convulsive cough, rheumatism, skin conditions	infusion
5	*Calamintha nepeta* (L.) Savi	A. p.	antibacterial, diuretic, gastric, sedative	respiratory problems, gastrointestinal affections, kidney stones	infusion
6	*Galeopsis speciosa* Mill.	A. p.	cicatrizing, antibacterial	liver and kidney disorders, cardiac problems, bronchitis, asthma, pneumonia, stomach ulcer, female ailments, edema, angina, furuncles	infusion
7	*Glechoma hederacea* L.	A. p.	hypotensive, cicatrizing, antiseptic, diuretic, anthelmintic, stimulant, tonic, febrifuge, digestive	gastritis, enteritis, stomach and intestinal colic, rhinitis, laryngitis, angina, pneumonia, asthma, bronchitis, tuberculosis, hepatitis, cystitis, kidney and bladder stones, hypertension, thyroid gland dysfunction, hemorrhoids, wounds, trauma, skin ulcer, furuncles, toothache	infusion tincture
8	*Lamium album* L.	A. Fl. L	hemostatic, expectorant, sedative, diuretic, cicatrizing, anti-inflammatory, depurative, cholagogue	hepatic and urinary complaints, jaundice, stomach colic, leucorrhea, menstrual problems, amenorrhea, infections (tuberculosis, malaria, dysentery), chronic bronchitis, kidney and bladder problems, hysteria, spleen affections, convulsion, epilepsy, diabetes, stomatitis, gingivitis, dental caries, burns, eczema	infusion decoction tincture
9	*Lamium amplexicaule* L.	A. p. Fl	cicatrizing, tonic, hemostatic	hepatic and urinary complaints, chronic bronchitis, stomach colic, gynecological illnesses	infusion decoction
10	*Leonurus cardiaca* L.	A. p. R L	sedative, hypotensive, diuretic, hemostatic, anti-diabetic	neuroses, neuralgia, neurasthenia, hysteria, cardiac deficiency, heart attack, hypertension, cardio sclerosis, diabetes, impotence, menstrual dysfunctions, epilepsy, anemia, pneumonia	infusion decoction tincture extract
11	*Marrubium vulgare* L.	A. p. L	expectorant, diuretic, sedative, cholagogue, hemostatic, antiseptic, appetizing, spasmolytic	stomach tonic, gastritis, intestinal colic, renal stone, spleen disorders, dysmenorrhea, hypertension, arrhythmia, rheumatism, fever, bronchitis, coughs, asthma, malaria, hepatitis, scorbutic, eczema, ulcerations, hemorrhoids	infusion macerate
12	*Melissa officinalis* L.	A. p. L	sedative, antispasmodic, digestive, carminative, purgative, haemostatic,	headache, insomnia, neuralgia, migraines, digestive disorders, diarrhea, hyperacid gastritis, stomach colic, abdominal flatulence, cardiac deficiency, hypertension, respiratory problems, asthmatic crisis, bronchitis, rheumatism, anemia, skin eruptions, furuncles, burns	infusion decoction tincture extract powder
13	*Mentha longifolia* (L.) Huds.	A. p. L	diuretic, spasmolytic, hemostatic, antiseptic, purgative, sedative, analgesic, expectorant, antibacterial	gastric and hepatic illnesses, stomach colic, gastritis, nausea, flatulence, diarrhea, epilepsy, amenorrhea, respiratory infections, pulmonary tuberculosis, psychic illnesses, cardiovascular problems, hypertension, toothache, edema, rheumatism, neuralgia, dermatomycosis	juice infusion decoction
14	*Mentha pulegium* L.	A. p. L	antiseptic, sedative, anti-inflammatory, cicatrizing, anthelmintic, spasmolytic,	gastrointestinal affections, stomach colic, gastritis diarrhea, flatulence, hepatic and biliary problems, respiratory infections, asthma, bronchitis, neuralgia, headache	decoction infusion
15	*Nepeta cataria* L.	A. p. L	Antispasmodic, antitussive,	nervous affections, insomnia, anxiety, respiratory problems, cough, flu, bronchitis, hepatic and	infusion tincture
			astringent, carminative, tonic, sedative, diuretic	kidney disorders, gynecological illnesses, burns	syrup

16	*Origanum vulgare* L.	A. p.	cholagogue, anti-spastic, expectorant, antibacterial, tonic, antiseptic, diuretic, hemostatic, cicatrizing, anti-inflammatory, lactogenic, appetizing	gastritis, diarrhea, stomach colic, gallstones, flatulence, cholecystitis, nausea, obesities, chronic bronchitis, rhinitis, asthma, laryngitis, pyelonephritis, kidney and bladder stones, tumors, neuroses, asthenia, hysteria, insomnia, epilepsy, hypertension, stroke, paralysis, headache, toothache, rheumatism, gingivitis, eczema, skin eruptions, diathesis, furuncles	tea, tincture, infusion, decoction
17	*Phlomis pungens* Willd.	A. p. R	astringent, cicatrizing, tonic, immuno-stimulatory, sedative	urinary affections, stomach ulcer, chronic gastritis, pneumonia, bronchitis, respiratory infections, anemia, hypertension, asthenia, purulent wounds, hemorrhoids, edema	infusion decoction tincture
18	*Phlomis tuberosa* L.	A. p. Fl L	Tonic, hemostatic, antibacterial, antifungal, cicatrizing, antitumor	diarrhea, pneumonia, bronchitis, flu, respiratory problems, gynecological affections, gastritis, urethritis, tumors, hemorrhoids, purulent wounds, edema	decoction infusion powder
19	*Prunella vulgaris* L.	A. p. L	hypotensive, anti-inflammatory, expectorant, tonic, spasmolytic, hemostatic, antiseptic, diuretic, cicatrizing	malign tumor, lymphadenitis, angina, bronchitis, nephrites, hepatic and colic illnesses, gastroenteritis, flatulence, diarrhea, diabetes, hyperthyroidism, hypertension, hemorrhages, toothache, rheumatism, chronic arthritis, gingivitis, hemorrhoids, psoriasis, leucorrhea, seborrhea, diathesis, furuncles, dislocation	decoct tincture infusion extract
20	*Salvia aethiopis* L.	A. p. R	anti-inflammatory, cicatrizing, astringent	cardiac deficiency, pulmonary tuberculosis, hemoptysis, bladder papillomatosis, gastritis, furuncles	infusion
21	*Salvia nemorosa* L.	R L Fl	cicatrizing, antibacterial, antimycotic	diarrhea, hemoptysis, intestinal infections, dysentery, tachycardia, cardio-neurosis, neurasthenia, fever, furuncles	infusion
22	*Scutellaria altissima* L.	A. p.	antitussive, hemostatic	hypertension, edema, coughs	infusion
23	*Scutellaria galericulata L.*	A. p.	sedative, expectorant, antibacterial, anti-inflammatory, hemostatic, cicatrizing	cardiac affections, tachycardia, anemia, epilepsy, laryngitis, gastrointestinal disorders, hypertension, amenorrhea, flu, malaria	infusion
24	*Sideritis montana* L.	A. p.	antibacterial, carminative, diuretic, antitumor	gastrointestinal affections, gastroduodenal ulcer, respiratory problems, urinary stones	infusion
25	*Stahys officinalis L.*	A. p. L	hypotensive, sedative, anti-inflammatory, antibacterial, antifungal, laxative, expectorant, emetic	cardiac disorders, stomach and hepatic affections, respiratory problems, diarrhea, bronchitis, asthma, nephritis, cystitis, neuroses, rheumatism, anemia, gynecological illnesses, flatulence, angina, wounds	infusion
26	*Stachys recta* L.	A. p. L	sedative, cicatrizing, choleretic	hepatic illnesses, respiratory infections, epilepsy, hysteria, acne, skin problems, fever	infusion powder
27	*Teucrium chamaedrys* L.	A. p. L	cholagogic, purgative, appetizing, hemostatic, diuretic, tonic, sudorific, aromatic, lactogenic	stomach colic, appetizing, hyperacidities, flatulence, diarrhea, gallstones, spleen hypertrophy, respiratory problems, pneumonia, fever, gout, anemia, furuncles, purulent wounds, rheumatic pain, leucorrhea, hemorrhoids	infusion decoction powder
28	*Teucrium polium* L.	A. p.	antioxidant, antibacterial, antifungal, sedative, hemostatic, tonic,	gastrointestinal affections, enterocolitis, gynecological illnesses, mycosis, abscesses, anorexia, stomach problems, diarrhea, eczema, eye illnesses	infusion decoction
29	*Teucrium scordium* L.	A. p.	Diuretic, detoxifying, anti-inflammatory, antiseptic, cicatrizing	lymphadenitis, mycosis, gastrointestinal affections, appetizing, hyperacidity, flatulence, purulent wounds, rheumatic edema	infusion decoction
30	*Thymus marschallianus* Willd.	A. p.	cicatrizing, analgesic, sedative, expectorant spasmolytic	severe respiratory disorders, coughs, fever, amenorrhea, stomach cancer, headache, toothache, radiculitis, neuritis, stomatitis	infusion

A. p. – aerial part, Fl – flowers, L – leaves, R – roots

Based on literature search, it was possible to point out over twenty *Lamiaceae* species with a history of utilization in modern phytotherapy. Nineteen species belonging to 14 genera are recognized as official drugs in many European countries and some of them are listed in many pharmacopoeias, including the current European Pharmacopoeia [6]. Thus, our flora, being rich in *Lamiaceae* plants can be an important source of local plant material and, therefore, use of these species as essential supply of bioactive phytochemicals should be encouraged and extended.

The genus *Thymus* L. comprises five species of perennial plants, which are predominantly distributed in forest-steppe districts of the country, primarily in dry grasslands, forest margins and clearings. Traditionally, flowering plants and leaves of *Thymus* species are widely used as tea, for treating colds, coughs and digestive disorders. However, the majority of wild growing species belonging to this genus have not been fully assessed from their phytochemical point of view. Nowadays, many *Salvia* L. species are intensively screened and applied in pharmaceutical, cosmetic and perfumery industries. This genus is well represented numerically in native flora and represents a valuable source of raw vegetal material with antioxidant, antimicrobial and antifungal activities. *S. nemorosa* is widely spread in our flora and its large populations are present in forest edges and clearings, as well as in the sunny slopes almost throughout the country. But the composition and biological activities of essential oil isolated from this indigenous medicinally important species are insufficiently studied. For that reason, there are necessary more biochemical investigations on this species, in particular on essential oil accumulated in our conditions in order to extend its utilization. Also, we started research upon some *Ajuga* species in relation to their bio-chemical composition that is insufficiently known.

A number of genera *(Phlomis, Teuctrium, Lamium)* have a large area of distribution in the Republic of Moldova, but there is lack of information about their traditional applications. For example, *T. polium* acts as a diuretic, tonic and antispasmodic drug. As a result of ethnobotanical studies, there was not found any information of its traditional use in Moldova. That makes obvious the need of supplementary ethnobotanical studies in order to collect all the knowledge about the use of these plants in folk medicine. In this line we can mention the species belonging to genera *Lamium* L., such as *L. amplexicaule* and *L. maculatum*, which possess significant therapeutic qualities due to biological substances, in particular to iridoid glycosides. In spite of this, they are almost not used by local people.

The presence of essential oil in a good few of *Lamiaceae* species makes them very important in food and cosmetic industries. Species of *Origanum, Mentha, Melissa* and *Thymus* are cultivated in home gardens as culinary and flavoring plants. Some of them *(Mentha longifolia, M. spicata, Origanum vulgare)* are used as wild vegetables and culinary herbs. Not less significant are the decorative properties of many *Lamiaceae* species. Species of *Mentha, Nepeta, Teucrium, Salvia* and *Thymus* are used as ornamental plants for landscaping, in parks, rock gardens, borders etc. Thymus marschallianus has a great potential to be used as ground cover.

Several popular medicinal *Lamiaceae* plants (e.g. *Ajuga reptans, Teucrium chamaedrys, Leonurus cardiaca, Marrubium vulgare, Nepeta cataria, N. parviflora, Origanum vulgare, Phlomis pungens, Ph. tuberosa, Salvia aethiopis, S. austriaca, S. nemorosa, Scutellaria altissima, Stachys officinalis, Teucrium chamaedrys, T. polium, Thymus marshalianus* etc.) are cultivated on the experimental fields in the Botanic Garden of ASM. Experimental cultivation trials contributed to better understanding of their agronomic requirements. Most of them showed high cultivation aptitude with positive agronomic results.

Lamiaceae species, which despite the fact that they have a high economic efficiency have received less attention in our country, and still many of local people do not know much about the taxonomy, the benefits, the composition and the medicinal properties of these plants. In future studies, we plan to continue investigations regarding medicinal potential of this plant family. Accumulated knowledge will offer valuable information about the present status of medicinal and aromatic plants of *Lamiaceae* family in our native flora.

CONCLUSIONS

1. Out of the total number of eighty-two native *Lamiaceae* species, belonging to twenty-eight genera, fifty-seven have been documented for medicinal use. In the table 1 are listed the main important and usable medicinal and aromatic plants from this family, naturally growing in the Republic of Moldova.

2. Thirteen genera of this family including therapeutically important species are widely represented and distributed in all parts of the country. More than twenty species with high frequency and abundance can be recommended to be harvested and valorized without damaging their natural populations.

3. About twenty popular medicinal *Lamiaceae* plants are cultivated on the experimental fields in the Botanic Garden (I) of ASM in order to observe their reproductive behavior and accumulate experience on their agro-technical peculiarities. Most of them showed high cultivation aptitude with positive agronomic results.

4. The present study shows that our flora can provide a highly diversified source of local plant material for pharmaceutical research and for elaboration of new formulas of medical preparations.

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THE BIOLOGY OF FLOWERING AND THE POLLINATING INSECTS OF THE SPECIES *POLYGONUM SACHALINENSE* F. SCHMIDT UNDER THE CONDITIONS OF THE REPUBLIC OF MOLDOVA

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Abstract: The species *Polygonum sachalinense* F. Schmidt is native to Far East, and was introduced in Moldova in the 80s. This article describes the peculiarities of flowering of the given species under the conditions of our country, the length of the flowering period, the life of inflorescences and flowers and the number of inflorescences on a plant and on a shoot. We made a list of insect species that pollinate Sakhalin knotweed in the Republic of Moldova.

Key words: *Polygonum sachalinense,* biology, flowers, inflorescences, pollinating insects, phases of development.

INTRODUCTION

The study of biology of flowering is of particular interest in the research on plant biological characteristics, with the purpose of introducing and acclimatizing new, valuable species. Each species has developed individual characteristics that allow it to adapt to environmental conditions, such as morpho-anatomical or physiological changes in the structure of flowers that make pollination easier, regardless of its type – direct, indirect or cross pollination, carried out through various factors like: gravity, insects, wind, birds, water etc.

Flowering is usually defined as the development phase of a flower from the opening of the corolla until its withering, with the maturation of the gynoecium and androecium, followed by pollination and seed formation. Particular attention is paid to these phases in the study of plant development.

Without pollination carried out by insects, many plants would not be able to reproduce. Pollinating insects are of great use in agriculture. In order to obtain a stable seed yield, it is necessary to have a sufficient number of pollinators, because if flowers aren't pollinated, they will not form seeds. Pollination is nothing but the act of transferring pollen grains from anthers to stigma. Entomophile plants (from "entomos" - insect) are those that are pollinated by insects and have various adaptations of flower shape and structure [1].

MATERIALS AND METHODS

The research on the biology of flowering was conducted during the growing season of 2015, in August-October, on the experimental plot of the Plant Resources Laboratory of the Botanical Garden (I) of the ASM, planted with *Polygonum sachalinense* in 2013. The research was carried out according to: *Методические указания по семеноведению интродуцентов* (Methodical Guidelines for the Study of Seeds of Introduced Species), 1980, *Методика изучения фенологии растений и растительных сообществ* (Methods of Studying the Phenology of Plants and Plant Communities), Бейдеман И., 1974 [6, 7]. The pace of seasonal flowering and the pace within 24 hours were studied by analyzing about 50 plants.

The dynamics of flowering was studied during the flowering of the first 10% of all plants from the experimental plot, until the total completion of the flowering phase. The dynamics within 24 hours was examined during the mass flowering phase.

The examination of pollinating insects was done during the flowering phase, at different times of the day, by taking photos and collecting insects for further study in laboratory conditions. In order to identify the insects, the "Определитель насекомых" ("Insect Identification Manual"), 1994, and the encyclopaedia "Insectele" ("Insects"), 2010, were used [2].

RESULTS AND DISCUSSIONS

Polygonum sachalinense is one of the valuable plants for the Republic of Moldova, since it can be used as raw material in preparing fodder, medicines and food. It is a perennial, herbaceous plant with shoots that lignify and turn brown in winter, the leaves fall, and, in spring, they renew from the dormant buds located at the base of the stem. In the ontogenetic development of the plant, several phases of development have been highlighted:

1. *Juvenile phase* – includes the period of time from the germination of seeds to the formation of the first true leaves.
2. *Vegetative phase* – is characterized by an intense development of the aerial part of the plant and formation of the shoots of the 1st, 2nd and 3rd order on the stem. In this phase, the period of mass formation of seeds coincides with the period of seed ripening. The vegetative phase lasts 115-122 days from the beginning of vegetation. (Fig.1)
3. *Generative phase* – this phase, at Sakhalin knotweed, begins with the formation of flower buds, then – of inflorescences and fruits. This phase is characterized by less intensive growth of vegetative organs. Under the conditions of the Republic of Moldova, the generative phase lasts 58-62 days. Flower buds appear from the buds located in the axils of younger leaves, from the top of shoots, which then will form inflorescences.
4. *Senescence phase* – covers the period from the end of the fruit formation to natural death. The natural death of the plant takes place in late autumn, when temperatures below 0 °C are recorded; leaves turn brown, necrotize and fall from shoots. At this moment, the growing season of a plant ends.

Sakhalin knotweed has small flowers (0.5 cm in diameter), white-cream or green-cream coloured, grouped in compound inflorescences, branched, with 20-48 secondary inflorescences, they are 17-20 cm long, forming a compound, dense panicle with an abundance of small flowers (Fig. 2). *Polygonum sachalinense* is a species with hermaphrodite flowers and female flowers on separate plants, in a population, there are both types of individuals [3, 5]. The perianth is simple, haplochlamydeous, consisting of 5 petals, obovate or elliptical, the petal tip – obtuse or acute. A small percentage of flowers are fertilized during the flowering phase, but since there are a lot of flowers on a plant, relatively many seeds are produced [4].

Fig. 1 *Polygonum sachalinense* in the vegetative phase of development

Fig. 2 Inflorescences of *Polygonum sachalinense*

The flowering phase of the species *Polygonum sachalinense* is long (August - September), it lasts 37-40 days. In this period, about 650-2000 flowers bloom in an inflorescence, depending on the size and position of the inflorescence. There are inflorescences on every shoot, the number of inflorescences ranges between 20 and 85. The number of inflorescences on a plant can reach 350. A flower lives 2-4 days, an inflorescence – about 10-15 days (Tab.1).

Flowering begins with the better developed central stems, on which bigger inflorescences with a larger number of flowers are formed. The flowers open at 5-6 a.m., depending on light intensity and temperature fluctuations between 16 and 20 °C. At 9.30-10.00 a.m., up to 80% of all flowers open, and after 14.00 o'clock, 100% of the flowers open, according to their staggered maturation in inflorescences (Fig. 3).

Table 1. The biology of flowering of the species Polygonum sachalinense

1.	Number of inflorescences on a pant	300-350
2.	Number of inflorescences on a shoot	20-85
3.	Number of flowers per inflorescence	650-2000
4.	Lifetime of an inflorescence	10-15 days
5.	Lifetime of a flower	2-4 days

The beginning of flower bud formation, in the growing season of 2015, occurred in the first half of August, and flowering began 10-12 days later. On a Sakhalin knotweed plant, at the same time, can be found flower buds, flowers, unripe and ripe seeds, because flowering and fruitage are staggered.

As a result of the examination of generative shoots, we found out that if the inflorescences were slightly touched, the flowers fell, and on some inflorescences, flower abortion took place.

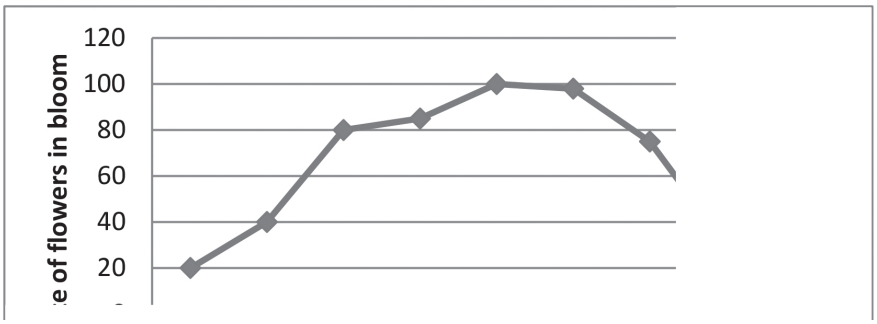

Fig. 3. The dynamics of flowering of Polygonum sachalinense during 24 hours

Formation and maturation of fruits are staggered. Fruit is a trigonal (three-sided) achene of green colour, which then gradually turns brown. The order of shoots is also important for seed production. On a plant, there are offshoots of 1st, 2nd, 3rd order, and seed formation occurs depending on their position, so, on the shoots of the 1st order, there will be more flowers that will produce more seeds, and on the shoots of the 2nd and 3rd order, fewer seeds will be produced. A plant with seven branches, in the conditions of the Republic of Moldova, bears fruits weighing about 90 g.

Pollinators. The Sakhalin knotweed is pollinated by wind and by insects. Its flowers, even if white, have strong smell to compensate for the lack of colour. The presence of nectar and pleasant, sweet smell attracts pollinating insects.

For the first time in the Republic of Moldova, the species of insects involved in the pollination of flowers of Sakhalin knotweed and their systematic classification were identified. The pollinators visiting the flowers of *Polygonum sachalinense* are usually insects with short proboscis, mostly bees and flies. A bee may visit 10 to 15 flowers a minute, and up to 5000 flowers a day.

The species of insects found on flowers of *Polygonum sachalinense,* 15 in total, belong to 3 orders, 10 families. The order Diptera is represented by 6 species, and the orders Hymenoptera and Coleoptera are represented by 5 species of insects each (Tab. 2; Fig. 4).

Table 2. List of species of pollinating insects of Polygonum sachalinense

	Order	Family	Species
1	**Diptera**	*Sarcophagidae*	*Sarcophaga carnaria*
2		*Califoridae*	*Lucilia caesar*
3		*Syrphidae*	*Syrphus ribesii*
4			*Eristalis tenax*
5			*Spherophoria scripta*
6		*Tachinidae*	*Tachina fera*
7	**Hymenoptera**	*Apidae*	*Apis mellifera*
8		*Scoliidae*	*Scolia hirta*
9		*Formicidae*	*Formica rufa*
10			*Lasius niger*
11		*Vespidae*	*Katamenes arbustorum*
12	**Coleoptera**	*Coccinelidae*	*Coccinella septempunctata*
13			*Adalia bipunctata*
14			*Adalia quadrimaculata*
15			*Harmonia axyridis*
16		*Cantharidae*	*Rhagonycha fulva*

Insects of the order Diptera are cosmopolitan species that easily adapt to different habitats, are of various types: pollinating, parasitic, predatory, saprofagous, haemophagous. The order Hymenoptera is represented by ants, bees, bumblebees, wasps, etc. Most adults are phytophagous, feeding on nectar and fruit juice, they are social species that live in large families. Beetles, or Coleoptera, are widely distributed in the world, they live in diverse terrestrial and aquatic habitats. By the mode of nutrition, they are zoophagous, saprofagous and phytophagous. Every third found species is a beetle [2].

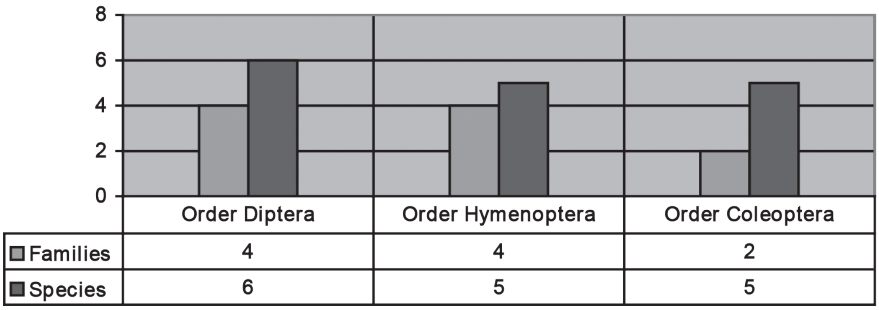

Fig.4. Systematic distribution of insect species

The following species were observed on flowers most often: *Sarcophaga carnaria, Lucilia caesar, Apis mellifera* and ladybirds. Coccinellidae are common species who live on plants, relatively small beetles, vividly coloured, by type of nutrition they are phytophagous and zoophagous species that feed on aphids. Ants are also often found on flowers. Being zoophagous and phytophagous species that also feed on sap, they participate in plant pollination while looking for food. Of the giant species, *Scolia hirta,* hairy flower wasp, was observed. This species feeds on the nectar of flowers. On the body of these insects there are numerous hairs with the help of which pollen is transferred to other flowers.

Pollinators are active on flowers from morning until sunset, 20.00-21.00, and near the plantation, a pleasant hum caused by insects can be heard. On sunny and warm days, flowers open very actively and are immediately "beset" by pollinators.

The species *Sarcophaga carnaria*

Representatives of the family *Coccinellidae*

The species *Eristalis tenax*

The species *Scolia hirta*

CONCLUSIONS

- Under the conditions of the Republic of Moldova, 4 phases of ontogenetic development of the species *Polygonum sachalinense* were highlighted: juvenile phase, vegetative phase, generative phase and senescence phase.
- The flowering period of *Polygonum sachalinense* lasts about 37-40 days.
- Flowering and seed formation are staggered, therefore flower buds, flowers and fruits can be found on a plant at the same time.
- For the first time in the Republic of Moldova, it was made a list of insect species that pollinate Sakhalin knotweed during the whole flowering period. There were found and identified 15 species of pollinating insects, belonging to 10 families and 3 orders: *Diptera, Hymenoptera, Coleoptera.*

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QUALITATIVE AND QUANTITATIVE STRUCTURE OF THE PERIPHYTONIC ALGOFLORA OF THE RISCANI LAKE (CHISINAU)

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Abstract: The article shows the results of floristic investigations on algoflora of the Riscani Lake. There were found 154 species and varieties of algae belonging to 6 phyla. These species belong to 77 genera, 39 families, 17 orders and 12 classes. The benthic algoflora develops abundantly on various types of substrates, forming a biomass from 10 g/m² up to 1.5 kg/m², where chlorophyta, cyanophyta and diatoms predominate. In general, Riscani Lake is characterised by a water pool with an algal vegetation described by an increased saprobic character. The saprobity index, calculated during the year is based on indicator species and amounts to 2.5-2.7.

Keywords: periphyton, algal communities, biomass, biodiversity, eutrophication.

INTRODUCTION

Algae have a primary role in the complicated processes of stabilizing water biological-sanitary qualities. Namely the communities of algae in symbiosis with bacteria create conditions for the use of inorganic pollutants from the polluted water and while producing oxygen they participate in the oxidation of organic substances [2; 8].

Recently, due to intensive water pollution, the productivity of many water bodies reduced. Thus, in the lakes from the territory of municipality of Chisinau are observed significant changes in the composition of communities of aquatic organisms that are manifested by the appearance of algae species resistant to the increased concentrations of organic substances dissolved in water. In the coastal zone of these lakes develop predominantly filamentous green algae *(Cladophora, Rhizoclonium, Mougeotia, Spirogyra)*, as well as numerous cyanophyta *(Oscillatoria, Anabaena, Phormidium, Aphanizomenon, Microcystis)*, producing a biomass of up to 10-15 kg/m² (fig. 1). Many species of algae serve as indicators of organic pollution of waterbeds. For example, the phenomenon of eutrophication can be estimated based on the growth of algal biomass of many species of cyanophyta, bacillariophyta, chlorophyta and euglenophyta [7].

MATERIALS AND METHODS

During the year 2015 samples of periphytonic and planktonic algae from the Riscani Lake were collected and studied. The collection and processing of algae samples were performed according to the unified methods of collecting and processing of the hydrobiological samples from the land and experimental samples [3; 4]. A part of the collected material was brought in the laboratory and analyzed fresh with the microscope MBL 2100, while another part was fixed in solution of formalin or ethanol. For the identification of the species there were used well recognized identification keys

RESULTS AND DISCUSSIONS

Riscani park was founded in 1970 in a green natural area. It is located in the north-east of Chisinau and has an area of about 32 hectares. It is situated between the regions Riscani and Ciocana and is divided into two parts by the Aleco Russo Street, which intersects it. In both parts of the park there are four lakes that are heavily polluted and bathing in them is forbidden. The fourth lake is located on an area of 12 hectares, it has a boat area and a sandy beach. In the park there were registered 320 species of vascular plants belonging to 231 genera, 73 families, including 61 non-indigenous species.

As a result of investigations on periphytonic and planktonic algae communities from the Rascani lake have been highlighted 154 species and varieties of algae belonging to 6 phyla: *Cyanophyta* – 28, *Bacillariophyta* – 74, *Xanthophyta* – 1, *Dinophyta* – 3, *Chlorophyta* – 43 and *Euglenophyta* – 5 (fig. 2).

According to the number of species and varieties of algae observed in the periphyton of the Riscani Lake, the diatoms predominate. Between the two classes of *Bacillariophyta* phylum, the representatives of the class *Pennatophyceae* (with 2 orders, 6 families, 19 genera and 68 species and varieties of algae)

have an important role in forming the lake algocenosis. *Naviculaceae* family with 27 species and varieties of algae proved to be the most numerous in species. The families *Fragilariaceae, Achnanthaceae* and *Nitzschiacea,* with the genera *Fragilaria, Achnanthes, Synedra, Cocconeis, Nitzschia* etc. have a great importance in forming algal communities (fig. 3).

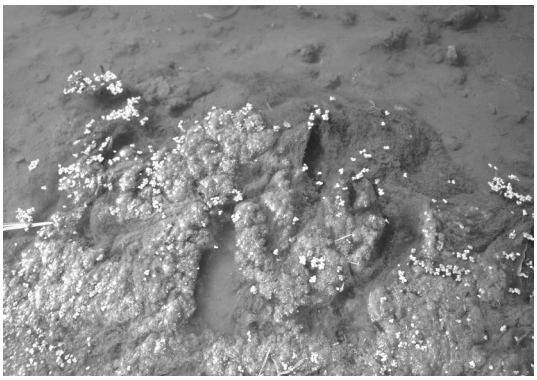

Fig. 1. Chlorophyta *(Cladophora, Rhizoclonium, Mougeotia, Spirogyra)*

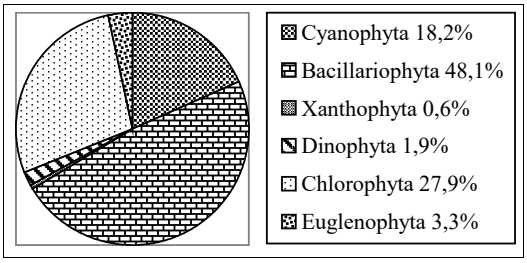

Fig. 2. Floristic spectrum of Riscani Lake (Chisinau), year 2015

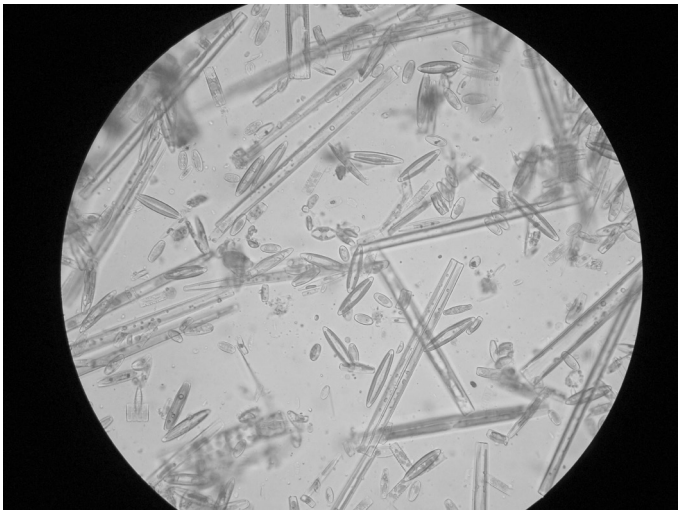

Fig. 3. Diatoms *(Synedra, Navicula, Nitzschia, Achnanthes 400 x)*

Green algae with 43 species and varieties belonging to 5 classes are to be found in periphyton. The representatives of the classes *Ulothrichophyceae, Siphonocladophyceae, Conjugatophyceae,* respectively with the species: *Stigeoclonium tenue* (Ag.) Kutz., *Coleochaete soluta* Pringsh., *Oedogonium cardiacum* (Hass.) Wittr., *Cladophora glomerata* (L.) Kutz., *Rhizoclonium hieroglyphicum* (Ag.) Kutz., *Ulothrix subtilissima* Rabenh., *Mougeotia* sp. etc. have a greater importance. The representatives of the classes *Volvocophyceae* and *Chlorococcophyceae,* although encountered in periphyton, present no interest in forming algal biomass, because they get in periphyton by chance – from plankton.

There were found 28 species and varieties of algae from the phylum *Cyanophyta* belonging to 2 classes, 4 orders and 12 families. *Hormogoniophyceae* class is the most numerous in taxa, it brings together more than 80% of the total number of species identified in the periphyton of Rascani Lake. The order *Oscillatoriales* from this class includes representatives of three families, more numerous in species is *Oscillatoriaceae,* with the genera *Oscillatoria, Phormidium* and *Lyngbya.*

The representatives of the phylum *Euglenophyta* don't play a substantial role in the formation of

algal periphyton communities in the lake and they are frequently encountered on the mud surface. Species as: *Trachelomonas verrucosa* Stokes, *Euglena viridis* Ehr., *Euglena polymorpha* Dang., *Euglena gracilis* Klebs. and *Phacus caudatus* Hübner were identified. Rarely can be met representatives of the phylum *Xanthophyta* and *Dinophyta*.

The periphytonic algoflora develops abundantly on various types of substrates, forming a biomass from 10 g/m^2 up to 1.5 kg/m^2, where chlorophyta, cyanophyta and diatoms predominate. The intensity of algal development reaches its maximum in autumn, decreasing in the cold period of the year.

The accumulation of large amount of biogenic elements causes abundant growth of phytoplankton. The water of the lake starts to "bloom" and often this process is accompanied by mass decomposition of algae in toxic substances [7; 9].

In the samples collected in winter was established an intensive development of the bacillariophyta with about 45-50 species and varieties, their number of cells was about 45865 million/m^2, having a biomass of 46.6 g/m^2 (tab. 1). The species Rhoicosphenia curvata (Kutz.) Grun., *Cocconeis pediculus* Ehr., *Diatoma vulgare* Bory., *Melosira varians* Ag., *Cyclotela meneghiniana* Kutz., *Synedra ulna* (Nitzsch) Ehr., *Navicula rhynchocephala* Kutz., *Navicula cryptocephala* Kutz., *Navicula confervacea* Kutz., *Cymbella tumida* (Breb.) V. H., *Gomphonema olivaceum* (Lyngb.) Kutz., *Gomphonema constrictum* var. capitatum (Ehr.) Cl., *Nitzschia dissipata* (Kutz.) Grun., *Nitzschia kuetzingiana* Hilse., *Nitzschia paleacea* Grun., *Nitzschia amphibia* Grun., *Bacillaria paradoxa* Gmelin., *Fragilaria capucina* var. mesolepta Rabenh., *Gyrosigma acuminatum* (Kutz.) Rabenh., *Pinnularia viridis* (Nitzsch.) Ehr., *Surirella ovata* Kutz. etc. were encountered frequently in periphyton. In the samples collected in winter also some cyanophyta, forming a biomass up to 1.3 g/m^2, were highlighted.

Table 1. Qualitative and quantitative dynamics of the periphytonic algoflora from the Riscani Lake

Date	**The number of species and varieties of algae**					**(million cells/m^2) g/m^2**			
	Cyanophyta	***Bacillariophyta***	***Chlorophyta***	**Other phyla**	**Total**	***Cyanophyta***	***Bacillariophyta***	***Chlorophyta***	**Total**
14.02.2015	3	56	1	-	60	1285 1.4	44580 45.2	-	45865 46.6
23.04.2015	11	52	22	6	91	78100 19.4	22350 21.0	6950 37.6	107400 78.0
28.07.2015	26	47	43	9	82	49900 24.2	9720 10.3	12540 167.0	72160 201.5
15.10.2015	27	62	42	9	140	22300 15.7	18550 23.4	8670 49.9	49520 89.0
Total	28	74	43	9	154				

In spring, intensifies the process of development of cyanophyta and chlorophyta: *Micractinium quadrisetum* G. S. Smith., *Pediastrum boryanum* (Turp.) Menegh., *Monoraphidium irregulare* (G. M. Smith) Kom.-Legn., *Didymocystis planctonica* Korch., *Chlorella vulgaris* Beier., *Scenedesmus quadricauda* (Turp.) Breb., *Stigeoclonium tenue* (Ag.) Kutz., *Oedogonium* sp., *Coleochaete soluta* Pringsh. etc., producing together a biomass of 50-80 g/m^2. During this period the number of diatoms decreases and constitutes about 22350 million/m^2 with the biomass 21 g/m^2. This situation is conditioned by the increase in the temperature of the water and the intensive development of the cyanophyta as well.

In summer, in the periphyton of the lake predominate chlorophyta (*Chlorella vulgaris* Beier., *Coelastrum microporum* Nag., *Closterium acerosum* (Schrank.) Ehrenb. var. elongatum, *Cosmarium humile* (Gay.) Nordst., *Scenedesmus quadricauda* (Turp.) Breb., *Scenedesmus spinosus* Chod., *Chlamydomonas ehrenbergii* Gorosch., *Cladophora glomerata* (L.) Kutz., *Coleochaete scutata* Breb., *Eudorina elegans* Ehr., *Monoraphidium contortum* (Thur.) Kom.-Legn., *Oedogonium* sp., *Tetraedron triangulare* Korsch., *Ulothrix variabilis* Kutz., *Zygnema* sp., *Mougeotia* sp. etc.), in the chlorophyta-diatoms-cyanophyta complex, with the medium number of cells of 72160 mln/m^2, with the biomass of 201,5 g/m^2. At a depth of 10-20 cm in the bank of the lake are seen agglomerations of conjugatophyceae (*Sprogyra* sp., *Zygnema* sp., *Mougeotia* sp. (fig. 4) and ulotrichaceae (*Ulothrix subtilissima* Rabenh., *Rhizoclonium hieroglyphicum* (Ag.) Kutz., *Cladophora glomerata* (L.) Kutz.), in combination with epiphytic diatoms, which is why these communities have a brown tint.

In autumn, in the periphyton of the lake, is observed the mass development of cyanophyta (species from the genera *Microcystis, Anabaena, Aphanizomenon, Oscillatoria, Phormidium, Calothrix, Lyngbya, Spirulina* etc.). During this period of time, among filaments of cyanophyta *Oscillatoria chalybea* Gom. and *Oscillatoria terebriformis* (Ag.) Elenk., very abundantly were developing some euglenophyta: *Trachelomonas verrucosa* Stokes, *Euglena viridis* Ehr., *Euglena gracilis* Klebs., *Euglena polymorpha* Dang., *Phacus caudatus* Hübner. etc. (fig. 5). In this period, the number of cells constituted 49520 million/m^2 with the biomass 89.0 g/m^2.

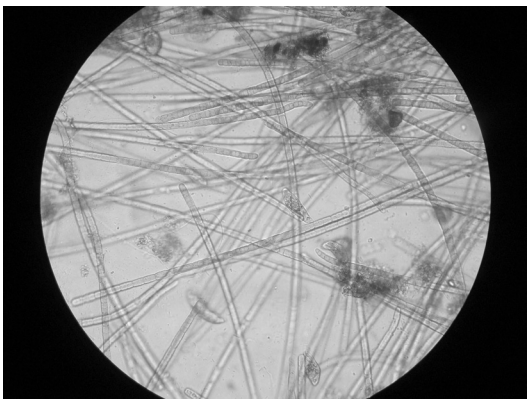

Fig. 4. *Cladophora glomerata, Mougeotia sp.* (conjugation) 400 x

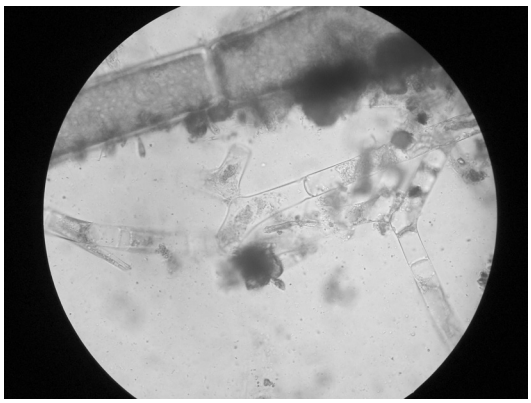

Fig. 5. Cyanophyta and euglenophyta *(Oscillatoria irrigua Kutz., Euglena viridis* Ehr. 400 x)

Many species of algae serve as indicators of organic pollution of water bodies. For example, the phenomenon of eutrophication can be estimated based on the growth of algal biomass of some species of the genera: *Merismopedia, Phormidium, Anabaena, Oscillatoria* (phyla *Cyanophyta*); *Cyclotella, Gomphonema, Anomoeoneis, Achnanthes, Navicula, Nitzschia, Hantzschia* (phyla *Bacillariophyta*); *Chlamydomonas, Gonium, Chlorella, Stigeoclonium* (phylum *Chlorophyta*); *Euglena* (phylum *Euglenophyta*) etc. Following the intensive development of such algae populations, a number of changes occur in the physicochemical characteristics of the aquatic environment [6].

The factors leading to water pollution are especially numerous and various: 1 – demographic, depending on the number of population and its activity in a given area, is directly proportional to the pollution; 2 – urban, corresponding to the human community development, which uses large amounts of water and produces great amounts of wastewater; 3 – industrial, depending on the level of economic, industrial and agricultural development of a given region. The pollution increases simultaneously with the industrial growth [1; 5].

Generally, based on the indices of abundance of algal indicators of pollution levels, Riscani Lake is characterized as a water body with high saprobic algal vegetation. The saprobiological analysis showed the growth in number of betamesosaprobic, beta-alpha mesosaprobic and alpha mesosaprobic species throughout the year. The saprobity index calculated based on indicator species during the year amounts to 2.5-2.7.

Thus, as the pollution level of the water of the lake increases, a sudden drop of qualitative and quantitative indicators of oligosaprobic and betamesosaprobic algae occurs, while the species from the saprobity groups like alpha mesosaprobic, polyalpha saprobic and polysaprobic increase in number, because they prefer heavy polluted water with organic substances dissolved.

In the warm season, outbursts of water "blooming" often take place. This phenomenon is caused by cyanophyta *Anabaena variabilis* Kutz., Microcystis aeruginosa Kutz., *Aphanizomenon elenkinii* Kissel. and others. During autumn and winter periods the vegetation of diatoms and euglenophyta intensifies.

CONCLUSIONS

1. As a result of the investigations carried out on the communities of periphytonic algae of the

Riscani lake (Chisinau) 154 species and varieties of algae belonging to 6 phyla were identified. The most numerous are the pennatophyceae, especially the ones from the *Naviculaceae* family (27 species and varieties of algae), followed by the chlorophyta and cyanophyta.

2. The highlighted algocenoses are dynamic and throughout the year change depending on the season. In the cold period (winter) prevail the diatoms, to which in spring join the chlorophyta and cyanophyta, in the late summer and early autumn it was observed an intensive development of chlorophyta and cyanophyta, with the medium number of cells of 72160 mln/m^2 and with the biomass of 201.5 g/m^2. On submerged stones algal biomass reached 1.5 kg/m^2.

3. Being tolerant to high concentrations of organic compounds and nitrogen, some species often cause the phenomenon of "water blooming", more often cyanophyta *Anabaena variabilis* Kutz., *Microcystis aeruginosa* Kutz. and *Aphanizomenon elenkinii* Kissel.

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THE EFFECT OF ECOLOGICAL FOLIAR FERTILISING ON THE YIELD OF *OCIMUM BASILICUM* L.

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Abstract. The knowledge about medicinal plants, including *Ocimum basilicum* L., regarding their utilization soared in the past century. Cultivation of such plants is wide spread today due to their outstanding medicinal properties owing to their biological active compounds. The aim of the present research is to determine the agro-productive potential of *Ocimum basilicum* L. under ecological fertilizer treatments. The field experiment was conducted from June to August, 2015. Plants were grown randomly, in a Latin square arrangement, in 3 replications.

Results show that the ecological fertilizer treatments augmented the values of all the analyzed parameters: the height of the plants, the number of lateral stems, the fresh and dried mass of plants. These results indicate that the ecological fertilizer used can significantly increase productivity in *Ocimum basilicum* L.

Key words: Organic farming, basil, productivity, medicinal herbs

INTRODUCTION

The agriculture, which is directly influenced by the quality of the environment and also significantly impacts the environment, has been the subject of numerous regulations dictated by national and international legislations and practice standards. Meanwhile, because of the major impact on the environment factors, the agriculture became an important contributor to the environment conservation. One major problem of the conventional agriculture is the intensive utilization of chemical products with nitrogen and phosphorous. Through levigation, such products reach water streams and underground waters and such, drinking water can become contaminated, constituting a human health risk. Also synthetic fertilizers can lead to algal blooms, hypoxia and finally to the reduction of biodiversity by the death of the organisms (Altieri, 1995). Synthetic fertilizers can also be regarded as air pollutants and lead to the destruction of the ozone layer and to global warming. Their excessive use can also induce acidification of soils and higher numbers of insect pests and diseases through mediation of negative nutritional changes in crop plants (Altieri and Rosset, 1995).

Because of the negative effects caused by the conventional agriculture, the market of organic products is increasing, despite the higher costs for the organic farming and such the medium and long term investments become feasible (Enache, 2012).

When speaking of ecological agro-production, it is often associated with the lack of the chemical treatments. This may cause yield reduction, increased number of diseases and a doubtful quality of fruits and vegetables. Therefore, fruits and vegetables of higher quality, obtained without chemical fertilization, are considered premium products also with premium prices. This is the reason why, when practicing eco-agriculture with international certification, additional funding and the registration of the farmers with an ecological certification registrar are required (Onofrei, 2008; Enache, 2012).

According to IFOAM (2009), eco-agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Eco-agriculture combines tradition, innovation and science to sustain the environment and promote fair relationships and a good quality of life for all involved.

The topic of this paper was selected because there is a lack of information regarding the outputs of the eco-agriculture of medicinal and aromatic plants, which can make these technologies appealing to farmers. In this regard, the organic fertilizers are essential for the proper development of plants, vegetables, flowers and fruits, as they offer rapid growth with superior quality to all species. They have

the nutrients necessary for better development. In addition, the organic matter serves as nutrients and energy sources for soil microorganisms (Silva et al., 2012). Expanding the knowledge on the role of some characteristics of the cultivation technologies that positively influence the crop yield and quality may lead to the expansion of the areas cultivated with aromatic plants and spices.

Such positive influence was proved for both soil applied and foliar ecological fertilizers (Kumar et al., 2014), also for medicinal plants (Davidescu et al., 1994; Malik et al., 2011), and agricultural crops: sesame – *Sesamum indicum* L. (Umar et al., 2011), pepper crop (*Capsicum annuum* L.) (Zayed et al., 2013). Also, Berbeć et al. (2003) obtained a 25% increase in thyme herb yield under the influence of Asahi SL fertilizer. In the study of Król (2009), the application of Asahi SL, in combination with a foliar fertilizer Mikromol, resulted in increased productivity of the above-ground parts of thyme by 13.6%. Kołodziej (2004) also demonstrated the positive effect of this bio stimulator on American ginseng yield. Also, Pulkrábek (1996) as well as Czeczko and Mikos - Bielak (2004) reported a stimulating effect of spraying with Asahi SL on yields of vegetables and root crops (sugar beet and potato).

The importance and necessity of aromatic and medicinal plants cultivated under organic conditions are driven from the fact that these plants are used in human alimentation or in cosmetics, perfumery, pharmaceutics etc. (Robu et al, 2004; Malik et al, 2011; Cernei-Manea et al, 2013). Particularly, the therapeutic properties of basil are determined by a complex of biologically active substances that are found in herb and essential oil (Onofrei, 2015; Robu, 2004; Crăciun, 1976; Roman, 2012). *Ocimum* L. genus, belonging to the *Lamiaceae* family, includes about 160 species (Kalita and Khan, 2013) and varieties. *Ocimum basilicum* L. is widely used both in traditional and in scientific medicine, in the perfume and food industry, in cosmetics, organic farming, landscaping etc. This plant product has also profound religious significance, serving as an object used in religious practices. Because of the importance of the species and the opportunity to enhance the yield, the purpose of the current research is to establish the agro-productive value of *Ocimum basilicum* L. cultivated under ecological fertilization.

MATERIAL AND METHODS

To meet the objectives, an analysis of productivity was undertaken on *Ocimum basilicum* L., unfertilised and fertilised with a solution of 0.1% concentration of the ecological foliar fertilizer Fitokondi (Volanpack Zrt., Budapest, Hungary).

The plant material consisted of seedlings of *Ocimum basilicum* L., which were purchased from the Ecological farm BioFarmland, Firiteaz, Arad County, Romania (biofarmland.com).

The experiment was located on the research field of the University of Agricultural Sciences and Veterinary Medicine Iaşi, (UASVM) (Fig.1) and it was initiated on 12 June, 2015. The Latin square method was used for the cultivation of basil plants, 81 plants per variant in a complete randomized design with 3 repetitions. The distance between rows was 45 cm, 15 cm between plants and the total area was 6.4 m^2.

The ecological foliar fertilizer Fitokondi is an aqueous solution made from medicinal plants, bio-humus, vegetal and essential oils. It has a brown colour, specific odour, with a density close to the one of the water. The physico-chemical parameters are: pH 4.5; 1.0 kg/dm^3 density; 1.0 % dry substance; 0.02 % N; 0.01 % P_2O_5, 0.26 % K_2O, 0.02 Ca %, 0.01 % Mg (w/v) (fitokondi.ro, 2015).

Figure 1. Experimental field (*Ocimum basilicum* L.), UASVM, Iasi

The fertilization was done twice in relation with the vegetative stage: at the beginning of the vegetative period on 30 of June and on 18 of July before the bloom. The watering was performed daily in the first 7 days of transplantation until the plants were fully accommodated to the experimental field conditions, then twice a week.

Plants were harvested on 7 August at the middle of the blooming period, between 10.00-15.00 h when the plants have the highest content of the biologically active principles. The investigated morphological parameters were plant height, lateral stem numbers, flower weight, leaves weight, stems weight for 5 plants per variant.

The collected data are expressed as means ± standard errors and were subjected to statistical analysis by ANOVA and Tukey test in order to assess differences between variants at a significance level of $p \leq 0.05$.

RESULTS AND DISSCUSIONS

Following the application of Fitokondi ecological foliar treatment, an increase of the values of the analysed morphological parameters in *Ocimum basilicum* plants was observed. The basil plants registered a significant increase in height, with approximately 11 cm compared to the unfertilized plants that were used as control (Table 1). Meanwhile, the number of lateral stems (Table 1) was greater in fertilized plants than in control ones leading to increased fresh mass (106 g) of the treated basil plants, an increase of more than 100% compared to the control plants (48 g) (Fig. 3), results which are statistically significant.

Table 1. Height and number of lateral stems of unfertilized and fertilized plants (- statistical significant differences for p<0.05)*

Parameter	Unfertilized plants	Fertilized plants
Height	24.39±1.63	35.76*±1.63
No. of lateral stems	13.93±0.44	18.87*±1.73

Similar results were obtained by Taie et al. (2010), who showed that plant height significantly increased at a concentration of 75% fertilizer. The number of branches also increased when 100% organic manure (compost) and biofertilizer was used, compared to control.

In 2010, Kwiatkowski and Juszczak also demonstrated that spraying the basil plantation with Asahi SL and Tytanit resulted in a ca. 12% increase in the height of the plant (4.3 cm), compared to the control treatment, and a ca. 10% increase (3.4 cm) compared to the plants treated with the sea algae extract (Bio-algeen).

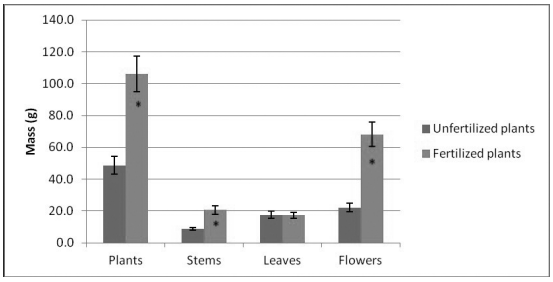

Figure 2. Fresh mass of unfertilized and fertilized plants (* - statistical significant differences for p<0.05)

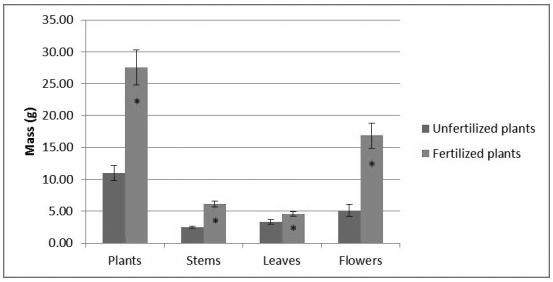

Figure 3. Dry mass of unfertilized and fertilized plants (* - statistical significant differences for p<0.05)

There is no difference between the mass of leaves for both treated and untreated plants (Figure 2), but there are significant differences for stem and flower weight. This is due to the increased number of lateral stems of the fertilized plants. The increased weight of inflorescences has certain significance as they contain large amounts of essential oil. The values of the dry mass of the basil plants follow the same

trend as the fresh mass. Increased values of dry mass imply that they contain larger amount of mineral substances (Figure 3).

Similar studies revealed that basil plants grown with organic fertilizer were more productive than those grown with conventional fertilizer (Berbeć et al., 2003; Succop et al, 2004; Taie et al, 2010). Kwiatkowski and Juszczak (2010) mentioned that the growth stimulators used had a significant effect on the increase in basil herb yield compared to the control treatment: Asahi (on average by 31%), Tytanit (28%), Bio-algeen (22%).

Larger productions of herb were also obtained by Coiciu and Rácz (1962, cit. Păun 1988) by application of 100 kg/ha of nitrogen based fertilizer in two stages (3-4 leaves and before bloom). Bazinov (1963, cit. Păun, 1988) revealed that by application of manure based fertilizer or waste from the distillation of sage plants *(Salvia sclarea),* herb production increased with 35% and the volatile oil contents with 21%. Serebiakova and Kaidas (1956, cit. Păun, 1988) concluded that the utilization of organic and mineral fertilization can increase the herb and essential oil yield. Also, the *Ocimum basilicum* L. plants cultivated under organic and mineral fertilization and nitrogen rate (Nitrogen (kg/ha) N (g/kg) K (g/kg) Ca (g/kg) P (g/kg) Mg (g/kg) Fe (mg/kg) Mn (mg/kg) Zi (mg/kg) Cu (mg/kg) B (mg/kg) have high content of macronutrients and micronutrients (Bufalo J., 2015) improved essential oil composition (Singh, 2013; Singh, 2014).

The higher productivity of *Ocimum basilicum* crop following the application of ecological fertilizers is similar to other reports and can be assigned to elevated amounts of nitrogen, phosphorus and potassium, trace elements and also organic substances present in the product (Kwiatkowski and Juszczak, 2010). In the same time, the natural origin of the product can imply reduced negative effects on the environment and also a stimulation of microbiota present in soil (Altieri and Rosset, 1995). The use of organic fertilizers can thus enhance the yield of basil also with other beneficial effects under experimental field conditions.

CONCLUSIONS

The ecological fertilizer treatment positively influenced the crop of *Ocimum basilicum* L., causing significant increases of the investigated parameters. Such bio-fertilizers can be recommended to increase agro productivity of *Ocimum basilicum* L. and the results from this study recommend further analyses regarding productivity parameters and volatile oil yield under ecological fertilization of basil.

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GENOTYPIC DIVERSITY OF GRAPEVINE GENE POOL

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Abstract: The diversity of genetic resources is the basis for creating a competitive grapevine assortment. Accumulation and preservation of this diversity in the Republic of Moldova has a rich history and over the past 30 years in the Institute's Grapevine Gene Pool were introduced about 1100 genotypes, diverse by genotypic origin and with necessary useful traits for breeding programs. The diversity of genus *Vitis* L. is represented by about 20 species, along with *V. vinifera* L. is numerically the best represented (92% from all accessions). Introduced genetic resources, new varieties and diversified biological material recently created in institute, including new seedless varieties, are valuable source for continuous modernization of viticulture: diverse direction of grape's use, including technological processing, seedlessness, early ripening, advanced biological resistance to restrictive factors.

Keywords: grapevine, genetic resources, introduction, diversity, breeding

INTRODUCTION

The progress of viticulture, one of the traditional and economically important branches of agro-industrial complex in the Republic of Moldova, is indispensably linked with the diversity of genetic resources – the basis for creating a competitive assortment with improved quality/productivity, seedlessness, diverse direction of use, including technological processing, advanced biological resistance to stressful factors [2, 12, 13]. Genotypic diversity of the family *Vitaceae* Juss., as a whole and, in particular, of the genus *Vitis* L., including various species [14], gives us this possibility. In Grapevine Gene Pool (Genofond) of Research and Practical Institute of Horticulture and Food Technologies, it was accumulated a large diversity, mainly of species *Vitis vinifera* L., the most widespread due to its practical use. This species is represented by varieties from all ecological groups (proles) *(Proles occidentalis, Proles pontica* and *Proles orientalis* according classification of Negrul' [16]), diverse by geographic origin, morphological and agro-biological characteristics. New interspecific varieties and hybrids, created in the Republic of Moldova, introduced from other viticulture centers of the word, also represent valuable resources: quality and productivity, seedlessness, advanced resistance to restrictive factors.

MATERIALS AND METHODS

Grapevine Gene Pool (Ampelographic Collection and associated fields) of Research and Practical Institute for Horticulture and Food Technologies, Republic of Moldova, is located in the south of Chisinau city (46°58'39.65"N and 28°46'21 .68" E, elevation 201 m). Each genotype is represented by 5-10 plants. Training system is a horizontal bilateral cordon, planting distance is 3.00 x 1.25 m, used rootstock – 101-14. Management of plantation is performed according to the technological scheme recommended for industrial vineyards.

Passport data and ampelographic description are performed according to the Multi Crop Passport Data (MCPD) [1], OIV Descriptor List [7] and the protocols adopted in the frame of project GENRES 081 (http://www.eu-vitis.de/docs/descriptors).

RESULTS AND DISCUSSIONS

The creation of the first Ampelographic Collections in Basarabia, near Cetatea Alba (Akkerman, or actually Belgorod-Dnestrovskii), is attested in 1832 and the activity over the subsequent years of various institutions (educational schools, experimental stations, research institutes) favored the foundation of series of collections, permanently being diversified the origin and composition of accumulated resources [15, 17]. The richest diversity of genotypes by ecological-geographic and genotypic origin, agrobiological and technological traits and characters was accumulated in Ampelographic Collection founded in 1952 (so called "Old Collection") and in the current Gene Pool, founded in 1980.

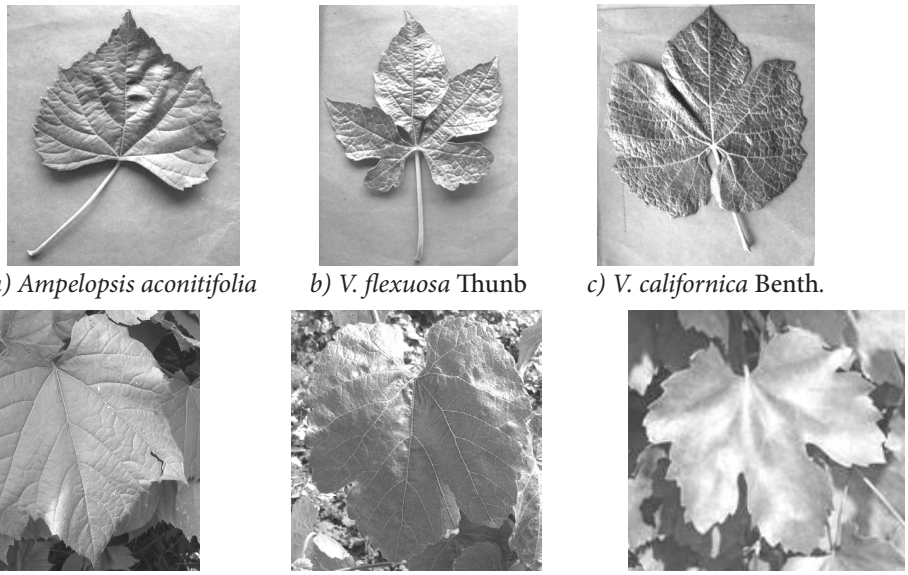
The principles adopted in the foundation and in the completion of Old Collections were focused on the creation and promotion of modern viticulture in the Republic of Moldova. The biological material was mobilized from 57 principal viticulture centers of the world, including research institutions from the former Soviet Union, Europe and Asia [15, 17]. This collection had a significant contribution in amelioration of grapevine assortment and modernization of viticulture in the Republic of Moldova, in foundation of ampelographic collections in other centers in the world, in the development of grapevine breeding programs [11, 15, 17]. In the result of this genetic improvement were created some new varieties,

of which Moldova, Codreanca, Kishmish lucistyi, Pamiati Negrulea and other were homologated and included in the Catalogue of Plant Varieties [3].

The objectives in the foundation of the actual Gene Pool were determined by the new requirements of improvement of the assortment, especially the absence of a large diversity of varieties of table grapes with various ripening, vulnerability of the existing assortment to restrictive factors (winter conditions, diseases). It was necessary, in this regard, the introduction of genitors with extra-early and early time of ripening, seedlessness and resistance to unfavorable abiotic and biotic factors of environment. These properties were present in varying degrees in separate varieties and was formulated the objective to identify the sources and to introduce the genotypes that combine 2 or more of mentioned characters, as well as with high quality and productivity. Accumulation of grapevine genetic resources over the years, thanks to continuity in time and space, ensuring their preservation and storage, ultimately allowed the formation of the current Gene Pool.

As a result of expeditions and exchange of biological material, the existing gene pool was supplemented with varied and valuable genotypes and, at present, includes 78 old and newly created local varieties, about 500 varieties from Western Europe, more than 800 genotypes from Eastern Europe (ex-USSR), 270 from Central Asia, 74 from North America and other new creations [11]. Along with old autochthonous varieties, in the collection, there are genotypes from the principal viticulture centers over the world – Europe, Caucasus, Central Asia, North America – about 2700 accessions representing more than 2500 genotypes. The diversity of the genus *Vitis* L. is represented by accessions belonging to species: *V. solonis* Planch.; *V. willsone* Veitch.; *V. sylvestris* Gmel. (Republica Moldova); *V. flexuosa* Thunb.; V. aestivalis Michx.; V. candicans Engelm.; V. californica Benth.; V. riparia Michx.; V. monticola Buckl.; V. *vulpina* L.; *V. cinerea* Engelm.; *V. rupestris* Seheele; *V. champinii* Planch.; *V. palmata* Vahl.; *V. lincecumii* Buckl. (Figure 1, a) – c)).

The largest representation has *V.vinifera* L. (about 92% from the total number of accessions), one of the most widespread species due to its practical use. This species is represented by varieties from all ecological groups (proles, according to the classification of Negrul' [16]), diverse by geographic origin, morphological and agro-biological characteristics (Table 1). *Proles occidentalis* Negr. is represented by the varieties originated from Western Europe, mainly with grapes for qualitative wine production, *Proles orientalis* Negr. – by varieties originated, mainly, from Central Asia, as well as from Caucasus, they have medium and large berries and grapes, diverse color, pulp with a crunchy consistency. This proles is widely represented by seedless varieties. *Proles pontica* Negr., numerically, is as well represented in the Gene Pool by local old autochthonous varieties (41 genotypes) and varieties from the Caucasus region, especially from Georgia.



a) Ampelopsis aconitifolia *b) V. flexuosa* Thunb *c) V. californica* Benth.

d) wild grapevine, Institute's Genofond e) wild grapevine, Nature Reserve "Pădurea Domnească" f) wild grapevine, collected from Kopet-Dag Mountains

Figure 1. Morphological diversity of leaves of grapevine species

The species *V. labrusca* L. is represented by a number of varieties, most of them for mixed-use of grapes: Columbia, Campbell, Seneca (with yellow-green berries), Delaware, Captivate, Cempion, Cristina, Clinton, Beta, Brilliant, Cempion, Buffalo, Edna, Extra, Isabela etc. (with colored berries). In the Gene Pool, there is also a wide diversity of direct producer hybrids (HDP) and interspecific hybrids of III-rd generation (Seyve Villard's) possessing high resistance and better quality compared to HPD.

Newly created in institute and in different breeding centers of the world interspecific varieties are well represented in the Gene Pool and represent valuable genetic sources that combine the quality of grapes and the increased resistance to restrictive factors (Table 1). In the Republic of Moldova, more than 90 new varieties were created, and about 30 of them were homologated and included in the standard assortment [3]. The created seedless varieties Apiren alb, Apiren roz, Apiren extratimpuriu, Apiren negru de Grozeşti, Apiren roz Basaraben, which combine seedlessness and productivity with advanced resistance to unfavorable environmental factors (wintering, diseases), represent an innovation for our (and not only) viticulture zone.

Populations of wild grapevine on the territory of our republic represent other potential source of germplasm insufficiently inventoried and studied. Our preliminary estimations of populations in 3 sites (Bărboieni, Zberoaia and Nature Reserve "Pădurea Domnească") confirm the dioecious character of populations [9]. Samples have small or medium leaves, entire or with three lobes, small bunches with round black berries. The same characteristics are specific for the sample of wild grapevine presented in the Gene Pool. The estimated 18 wild vine forms from Middle Asia (Kapet Dag Mountains) denote a morphological difference compared to samples from Moldova (Figure 1).

Table 1. Diversity of V.vinifera L. presented in Gene Pool [4, 6, 10, 11] (fragment)

Genotype	Country of origin	Berry color	Direction of use
V.vinifera L. *proles occidentalis* Negr.			
Aligote	France	Green-yellow	Wine
Cabernet Sauvignon	France	Black	Wine
Grenache noir	Spain	Black	Wine
Riesling de Rhin	Germany	Green-yellow	Wine
Silvaner	Austria	Green-yellow	Wine
V.vinifera L. *proles pontica* Negr.			
Alexandrouli	Georgia	Black	Wine
Budeshiri Tetri	Georgia	Green-yellow	Wine
Cabasma	R. Moldova	Green-yellow	Wine
Coarnă albă	R. Moldova	Green-yellow	Table
Galabura	R. Moldova	Green-yellow	Wine
Ojaleshi	Georgia	Black	Wine
Rkaţiteli	Georgia	Green-yellow	Wine
Turba plotnaia belia	R. Moldova	Green-yellow	Wine
Turba rihlaia belia	R. Moldova	Green-yellow	Wine
V.vinifera L. *proles orientalis* Negr.			
Agadai	Russia	Green-yellow	Table
Alen'kii	Russia	Black	Table, Wine
Ararati	Armenia	Green-yellow	Table
Askeri	Azerbaijan	Green-yellow	Table, seedless
Băbească neagră	R. Moldova	Black	Wine
Coarnă coşie	R. Moldova	Rose	Table
Copceac	R. Moldova	Black	Wine
Madrasa	Azerbaijan	Black	Wine
Marmari	Armenia	Green-yellow	Table, seedless
Rzgi	Armenia	Green-yellow	Table

Sev Areni	Armenia	Black	Table
Shaani belai	Azerbaijan	Green-yellow	Table
Voskehat	Armenia	Green-yellow	Wine
New interspecific varieties			
Apiren roz	R. Moldova	Rose	Seedless, diverse use
Apiren negru de Grozesti	R. Moldova	Black	Seedless, diverse use
Apiren roz extratimpuriu	R. Moldova	Rose	Seedless, diverse use
Bianca	Hungary	Green-yellow	Wine
Hibernal	Germany	Green-yellow	Wine
Prezentabil	Bulgaria	Green-yellow	Table
Regent	Germany	Black	Wine
Original	Ukraine	Green-rose	Table

In the process of elaboration, evaluation and diversification of the actual Fund of Grapevine Genetic Resources, we had participated in the following international projects: GENRES-081 "European Network for Grapevine Genetic Resources Conservation and Characterization"; IPGRI (BIOVERSITY International) "Conservation and Sustainable Use of Grapevine *(Vitis vinifera)* Genetic Resources in the Caucasus and Northern Black Sea Region"; GrapeGen06 "Management and Conservation of Grapevine Genetic Resources"; SEEDNet "Identification, Characterization and Conservation of Old and Autochthonous Vine Varieties in Eastern European Countries"; COST Action FA 1003 "East-West Collaboration for Grapevine Diversity Exploration and Mobilization of Adaptive Traits for Breeding". The results of this collaboration were presented in various publications, including monographs "Caucasus and Northern Black Sea Region Ampelography" [6] and "Ameliorarea sortimentului viticol al Republicii Moldova" (Improvement of the Viticultural Assortment of the Republic of Moldova) [11], awarded in 2013 by OIV Award Jury.

Mobilization and introduction of the initial biological material is the most responsible and important stage for the future development of assortment and creation of competitive viticulture. Introduction is a source of germplasm for specific traits and/or after respective documentation and testing – for direct use in production. Plant introduction undoubtedly enriches the assortment of crops, improves plants in terms of productivity, quality, resistance to diseases and pests, giving them superior qualities of adaptability, because every progress in cultivation, provided by the introduction of new, more productive, plant varieties and species is roughly equivalent by significance with the implementation of major technical discoveries and inventions [18]. To achieve such varieties and hybrids, it is necessary that in concrete climate and soil conditions of each country or natural areas to develop their own programs of improvement, using as initial material especially local forms of plants, that are best suited to conditions of the country or area. Old autochthonous grapevine varieties represent valuable sources of adaptability to local conditions of environment [4, 5, 10].

The diversity of the family *Vitaceae* Juss. presented in the Gene Pool must be evaluated and completed with new genotypes, especialy with resistance to stress factors: drought, extreme temperatures and weather fluctuations (especially on sharp change from heat to cold in small exposure, sometimes even over 24 hours). In these circumstances, the resistance of some genotypes becomes very vulnerable, such as *V.amurensis* L, which in the climatic conditions of the region of origin (the Far East) withstand temperatures of -40°C (which does not fluctuate significantly during the winter), but in the Republic of Moldova is affected at temperatures of up to -18°C in conditions of frequent sharp change of temperature (even by 10-15°C during 24 hours). From our point of view, the resistance to extreme temperatures, frosts in early autumn or late spring, and generally winter hardiness represents a complex mechanism, requiring a separate approach. In this purposes, it is actual the exploration of *Vitis* L. species and selection of more appropriate individuum coresponding to dinamic climatic needs. There are necessary a large collaboration and new interdisciplinary studies, including ones based on modern biotechnologies and coupled with an energetic and smart introduction, study of genotypes and immediate introduction in prebreeding and breeding programs, in order to corresponds to acctual and new challenges.

CONCLUSIONS

As a result of introduction of new genotypes, the exchange and diversification of biological material in the actual grapevine gene pool, a significant diversity of grapevine genetic resources has

been accumulated – strategic potential for future improvement of assortment and modernization of viticulture.

For the efficient utilization of genotypic potential of this resources, there are necessary a large collaboration and new interdisciplinary studies.

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MOBILIZATION, ACCLIMATIZATION AND USE OF FODDER AND ENERGY CROPS

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Abstract. The stages of the scientific research on mobilization, acclimatization, introduction, creation and maintenance of the collections of fodder and energy crops, during the 66 years of the Botanical Garden (Institute) of the ASM, are described in this article. The biological peculiarities of growth and development, productivity, biochemical composition and nutritional value of the fodder obtained from about 150 species and varieties, as well as the mechanical and energy properties of the biomass of 20 species have been determined. To restore eroded and saline lands, suitable plant species have been identified and agro-technical means have been developed. Six new plant varieties with multiple utility have been created and patented ("Speranța", *Galega orientalis;* "Gigant", P*olygonum sachalinense;* "Vital", *Silphium perfoliatum;* "Energo", *Sida hermaphrodita;* "Solar", *Helianthus tuberosus* and "Melifera", *Phacelia tanacetifolia*) and have been awarded gold medals at various national and international fairs and exhibitions.

Key words: agro biological peculiarities, biochemical composition, caloric value, energy crop, fodder species, fodder value

Continued population growth, reduction of agricultural lands, technical and economic development require the identification of new sources to overcome global problems caused by climate change, food shortages and scarcity of fossil energy resources. The sector responsible for food security of the population is agriculture, which is responsible for harnessing the productive potential of traditional crops by implementing new technologies and identification, acclimatization and introduction of new species of plants that use more efficiently solar energy, soil and water, providing food for people and animals, and, on the other hand, serve as a source for obtaining raw materials for various industries (food, textile, pharmaceutical, cosmetic etc.) and, last but not least, a source of biomass for renewable energy production. Agriculture plays an important role in the Republic of Moldova, taking into account the rural population and the employment rates. Restoring and increasing the livestock numbers encourage sustainable development of the agricultural-food sector and rural areas in terms of the need to establish a balance between economic growth and environmental impacts of agriculture. Livestock and its production potential play an important role in rebalancing the trade with food products. One of the major problems of revitalization and development of the animal breeding sector, both globally and locally, is growth and diversification of fodder production, balanced in terms of quantity and quality throughout the year, according to the physiological needs of animals and productivity indices. The growth prospects of agro food market depend on solving the problem regarding proteins. An increase in production of protein substances can be achieved by broadening the diversity of crops, by extending the areas for cultivation, by creating new varieties with increased genetic potential of productivity, quality and increased resistance to biotic and abiotic harmful factors.

In the world's flora, there are over 50 000 species of plants that animals use as food and about 150 species are cultivated. This huge reserve allows the mobilization of new species that would expand the range of crops, increase the productivity and elevate the quality of feed. Mobilization and research of new plant species, their cultivation, including the production of feed has been a strategic direction since the foundation of the Botanical Garden. In 1954, the "Introduction of Crops" group was organized under the leadership of dr. Janushevich Z.V. Professor Derevitskii N.F., the initiator of scientific research on forage plants, also worked within this group. The fodder plant collection has been founded: annual and perennial legumes, annual *Poaceae,* artichoke *Helianthus tuberosus,* being identified promising botanical taxa of species of *Lathyrus sylvestris, Vicia angustifolia, Astragalus cicer,* as well as oat, *Avena sativa* and pea, *Pisum sativum* with high resistance to frost [15, 25]. Within this group, academician Mihal Lupașcu began his scientific career, being guided by Professor Derevitskii N.F., he researched the corn used for silage with different species of forage legumes [16]. During that period of time, Nesterenco V.G., who researched biological peculiarities and possibilities of using of *Sida hermaphrodita* in feed and fibre production, contributed to the research on fodder crops [17]. Since 1975, the "Introduction of Food and Fodder Plants" group worked within the Department of Applied Botany, and in the 80s of the last century, the Laboratory of Introduction of Oleaginous, Medicinal, Food and Fodder Plants, led by dr. L. Crețu was organized in order to expand the research on fodder plants. As a result of the research on

1200 varieties of the global collection of *Glycine max* Merrill., 230 valuable varieties for improving soy in Moldova have been found, they are rich in protein and amino acids, essential oil, have a low content of trypsin inhibitors, are adapted to mechanical harvesting [18]. In 1987-1992, the research on fodder plants was organized by the Laboratory of Mobilization and Introduction of Useful Plants, led by dr. hab. Bodruc M., and in 1993, the Laboratory of Fodder Plants was founded under the leadership of dr. A. Teleuță.

Scientific researches were focused on: mobilization of plant genetic resources, study of adaptive capacity and determination of the nutritional value of fodder plants, identification of new fodder crops resistant to salts, study of biological peculiarities and development of recommendations for their cultivation on saline soils, identification and study of fodder crops with erosion-protective properties, identification of promising varieties, works on plant improvement and creation of new plant varieties, development of new cultivation techniques.

The sharp increase in fuel prices, the reserves of which are depleting, and the global warming, caused by the greenhouse gases emitted from burning fossil fuels, make the mankind search new, stable, environmentally friendly and advantageous energy sources. The complex problems of the development of renewable energy have become a global political dimension that determines the orientation of research and innovation policy towards identifying new plant species by analyzing productivity, environmental impact, economic efficiency and ensuring that the food supply of population is not affected. For biomass production at industrial scale, the most efficient crops that are tolerant to harmful factors, use to a great extent the photosynthetically active solar energy during the vegetation period, accumulate a considerable amount of dry matter and demand optimal expenses for establishment and low expenses for maintenance, harvesting and processing should be selected and implemented [13,23]. Mobilization, acclimatization and exploitation of plant resources for biofuel production are a new research direction within the Botanical Garden, initiated in 2009.

As a result of the research conducted over a quarter century, we could mention the transfer of the collection of fodder plants to a new area, the foundation of the collection of energy crops and the study of biological peculiarities, productivity and nutritional value of fodder plants, physical and mechanical properties of the biomass of energy crops.

It is well known that forage legumes contribute to the accumulation of biological nitrogen in soil, improvement of physical and chemical properties of the soil, formation and restoration of its structure, play an important role in increasing the quality of feed, containing a significant amount of protein, vitamins and minerals, thereby raising the nutritional value of feed and livestock production. Of the approximately 19 000 species of the world's flora, few are used, alfalfa is the most widely grown crop, being cultivated on an area of over 35 million hectares. The genus *Medicago* L. comprises 87 species, 6 species are known in the wild flora of our country. Over the years, 25 species native to different regions of the Earth were mobilized and studied: *Medicago agropyretorum* Vass., M. *arabica All.*, *M. arborea, M. borealis* Grossh., *M. caerulea* Less. ex Ledeb., *M. cancellata* M. B., *M. carstiensis* Wulfen, *M. difalcata* Sinsk., subsp. kazachstanica Sinsk., *M. glandulosa* David., *M. glutinosa* M. B., *M. guasifalcata* Sinsk, *M. falcata* L., *M. hemicycla* Grossh., *M. intertexta* (L.) Miller, *M. lupulina* L., *M. minima* Bartalini, *M. polychroa* Grossh., *M. polymorfa* L., *M. orbicularis* (L.), *M. sativa* L., *M. trautvetteri* Sumn., M. *tianschanica* Vass., *M. transoxana* Vass., *M. varia* Mart. As a result of research on mobilization of the species of the genus *Medicago,* it has been established that *M. agropyretorium, M. polychroa, M. trautvetteri, M. tianschanica* and *M. varia* reach, at the first harvest, a productivity of 1.79 -2.14 kg/m², exceeding the control with 8-27%, the nutritional value of the fodder is 0.20-0.25 nutritive units/kg and the digestible protein content – 170.0-211.6 g/nutritive unit. The species *M. polychroa, M. agropyretorium, M. trautvetteri* and *M. tianschanica* are distinguished by a high content of carotene, a precursor of vitamin A, and M. varia is distinguished by a high content of phosphorus and iron – deficient elements in the metabolism of animals. It has been found that *M. agropyretorium, M. trautvetteri* and *M. tianschanica* are characterised by a higher degree of tolerance to abiotic factors and live longer [12].

The genus *Astragalus* includes about 2 500 species, being the largest genus of angiosperms, in the spontaneous flora of the Republic of Moldova there are 16 species, 849 species vegetate in Eurasia, 152 species of which are of interest as fodder crops, the most widely cultivated is *A. cicer,* due to its long life of 20-35 years. As a result of studies, promising species have been identified. Thus, *A. galegiformis,* native to the Caucasus Mountains grows 1.9 m tall, can be harvested 10-12 days earlier than alfalfa.

6.42-7.12 kg/m² fresh mass with digestible protein content of 127.0-145.8 g/nutritive unit can be obtained at the first harvest. *A. ponticus,* which is characterized by a very high content of raw protein (23.40%), fat (2.75%) and phosphorus (4.5 g / kg) in dry matter, can be used for grassland reseeding, *A. sulcatus* is suitable to saline soils [10, 11].

The genus *Lathyrus* in the world's flora includes 160 species, including 22 fodder crops; only 10 species were studied in our collection. We determined that the studied perennial species *L. latifolius, L. pisiformis, L. sylvestris* need a 25-35 day longer period of time to reach the optimal harvest time in comparison with alfalfa and sainfoin, but the harvested fodder contains more leaves, which influence positively the protein content in dry matter (20.31-28.60%), the digestible protein content of a nutritive unit (166.68- 259.00 g), the increase in the content of phosphorus and nitrates. The harvested fodder is rich in essential amino acids: methionine (227-350 mg/100 mg), lysine (1.282-1.467 mg/100 mg), threonine (1.066-1.221 mg/100 mg), valine (1.096-1.229 mg/100 mg), isoleucine (0.741-0.864 mg/100 mg), phenylalanine (0.741-0.864 mg/100 mg) and leucine (1.752-1.934 mg/100 mg), and is very poor in tyrosine (0.660-0.672 mg/100 mg).

As a promising species of the genus *Coronilla, C. varia* yields 9.3 t/ha nutritive units and 1600 kg/ha digestible protein, and the species of the genus *Onobrychis, O. tanaitica* Spr. and *O. inermis* Stev. – about 10 t/ha nutritive units and 1800 kg digestible protein [14, 21].

The family *Poaceae* (Gramineae) includes 869 species belonging to 155 genera, several species are found in our country, they are annual or perennial plants, which play a very important role in human nutrition (cereals) and are also a source of fodder for ruminants. The value of a fodder crop depends on growing conditions, stage of development at the moment of consumption, type of conservation and processing of feed etc. Biological peculiarities, fodder productivity and nutritional value of the following perennial species: *Agropyron desertorum* (Fisch. ex Link) Schult, *Agropyron cristatum* (L.) Gaertn., *Agropyron sibiricum, Agrostis alba* L., *Agrostis gigantea* Roth , *Alopecurus arundinaceus* Poir., *Bromopsis inermis* (Leyss.) Holub, *Bromus riparius* Rhem., *Bromus secalinus* L. , *Dactylis glomerata* L. *Elytrigia intermedia* (Host) Nevski, *Festuca arundinacea* Schreb, Leymus, *Lolium multiflorum* Lam., *Panicum virgatum* L., *Psathyrostachys juncea* (Fisch.) Nevski, *Roegneria fibrosa* (Schrenk) Nevski, *Sorghum almum* Parodi and annual species: *Echinochloa frumentacea* Link, *Pennisetum glaucum* R.Br., *Sorghum bicolor* (L.) Moench, *Sorghum chinense* Jakusch., *Sorghum durra* (L.) Moench, *Sorghum sudanese* (Piper) Stapf. have been estimated. Higher digestible protein content (50-78 g/nutritive unit) has been found in the harvested fodder of the species *Pennisetum glaucum* (L.) R. Br., *Psathyrostachys juncea* (Fisch.) Nevski, *Alopecurus arundinaceus* Poir., *Bromopsis inermis* (Leyss.) Holub, *Lolium multiflorum* Lam., *Sorghum almum* Parodi.

The following species of the family *Asteraceae Bercht.* & J.Presl have been studied: *Cynara scolymus* L., *Helianthus tuberosus* L., *Rhaponticum carthamoides* (Willd.) Iljin, *Silphium perfoliatum* L., *Inula helenium* L., *Echinacea purpurea* (L.) Moench. We have identified valuable varieties of *Helianthus tuberosus* L. and *Silphium perfoliatum* L. with a productive potential of 130-140 t/ha green mass and 10-16% raw protein content in dry matter [6, 7, 9, 13].

The species of the family *Amaranthaceae Juss*. contribute a lot to providing animals with protein. In our collection, the species of the genus *Amaranthus* L. *(A. caudatus L., A. cruentus L., A. hypochondriacus L., A. mangostanus L., A. retroflexus L., A. spinosus L.)* and the subfamily *Chenopodioideae* Burnett, the genus *Atriplex (A. hortensis L., A. nitens Schkuhr.,)* the genus *Kochia (K. scoparia* (L.) Schrad.) and the genus *Chenopodium* (*Ch. quinoa* Willd.) have been studied. It has been found that the studied species go through all stages of ontogenetic development, the growing season lasts 100-125 days, and the optimal harvest time of green mass comes after 60-75 days since emergence. It has been established that the species *A. cruentus* and *A. mangostanus* are tolerant to drought and have a high productivity of fresh mass that allows obtaining 5.31-6.68 t/ha nutritive units and 841-926 kg/ha digestible protein [3, 4].

The species *Polygonum sachalinense* F. Schmidt, *Polygonum weyrichii* Fr. Schmidt, *Polygonum divaricatum* L., *Rumex patientia* L., *Rumex tianschanicus* Losinsk., shavnat RUMEX K-1 (*R. tianschanicus* x *R.patientia*) of the family *Polygonaceae* Juss. have also been studied. The studied species grow fast, after 20 days since the resumption of growth, the height of the plants of the species *P. sachalinense, R. patientia, R. tianschanicus* and the hybrid RUMEX K-1 *(R. tianschanicus x R.patientia)* exceeds 80 cm, while *P. weyrichii, P. divaricatum* – 40 cm. The studied species of the genus *Rumex* develop very early, so that at the end of April they are forming floral buds and can be used fresh in animal feed until the

middle of May, when the plant height reaches 1.5 - 1.7 m. The fresh mass productivity of these species is of 3.2-4.5 kg/m², the leaf content – 50%. The hybrid RUMEX K-1 has higher productivity. Among the species of the genus *Polygonum*, more intensive growth and development has been observed at *P. sachalinense,* which at the first harvest (May-June) yields 5.4 – 6.5 kg/m² fresh mass, being distinguished by a fast revival after harvest, which allows obtaining, from three harvests, a productivity of 12.42 kg/m² fresh mass or 3.09 kg/m² dry matter. 1 kg natural fodder at the species of the genus *Rumex* contains 0.13-0.14 nutritive units and 1.78-2.13 Mj metabolizable energy, and that of the genus *Polygonum* – 0.18-0.19 nutritive units and 2.30-2.51 Mj/kg metabolizable energy. The plants the genus *Polygonum* have a high content of protein, phosphorus and calcium [8, 24].

The family *Malvaceae* is represented by the species *Kitaibelia vitifolia* Willd., *Malva crispa* L., *M. mauritiana* L., *M. parviflora* L., *M. sylvestris* L., *M. verticillata* L., *Sida hermaphrodita* (L.) Rusby. As a result of our research, valuable forms of Sida hermaphrodita with a productive potential of about 10.3-11.9 kg/m² fresh mass and a content of 16% raw protein in the dry matter have been identified. The fresh mass is processed into silage easily without applying any preservatives.

In the Republic of Moldova, the areas of saline soils are expanding, also the concentration of salts increases on the background of frequent and prolonged droughts, which are attested more often lately, that's why it is necessary to identify new fodder crops resistant to salts, to research their biological peculiarities and to develop recommendations for their cultivation in saline soils. As a result of the conducted research, it has been found that the implementation of the species *Echinochloa frumentacea,* Indian barnyard millet, in saline soils contributes to their phytoamelioration and the fresh mass has a high content of digestible protein (124 g/nutritive unit) and is rich in essential amino acids, which indicates that the adaptation to excess salts occurs by accumulation of reduced macromolecular compounds that act as bioprotectors and osmoregulators. It has been developed and implemented the technology of cultivation of Indian barnyard millet in soils of sulfate-chloride salinization [19, 20]. It has been found that increased sulphur and chlorine content in soil makes the *Melilotus albus* and *Sorghum sudanense* plants accumulate dry matter rich in protein and nitrogen-free extractive substances that influence positively the nutritional value of the collected fodder, increase the protein content of the hybrid *Sorghum bicolor* x *Sorghum sudanese* when planted in salinated black earth. In order to use the saline soils, the species *Psathyrostachys juncea* and *Roegneria fibrosa* can be planted, which makes possible to obtain a yield of to 3.0 kg/m² nutritive units of green mass with a content of 53.0-73.3 g digestible protein [5].

The study and identification of fodder crops with erosion-protective properties allowed mentioning that perennial plants contribute to halting soil erosion and increase soil fertility. A special role is played by the species *Festuca arundinacea* of the family *Poaceae,* which is very drought tolerant.

As previously mentioned, during the mobilization, acclimatization and introduction processes, new valuable plant species, which are characterised by stable productivity and tolerance to abiotic harmful factors, have been identified. On the basis of identified varieties and improvement works carried out, the following plant varieties [1, 22] with multiple utility were created and approved.

The variety "Speranța" of the leguminous fodder species eastern galega (*Galega orientalis* Lam.), registered in the Catalogue of plant varieties of the Republic of Moldova in 1997, has a productive potential of 70-80 t/ha of natural forage or 17-23 t/ha hay obtained from 2-3 harvests, the best time for the first harvest is in May, 10-15 days earlier in comparison with alfalfa, when hay is produced, the dried leaves remain on the stem. Its productivity reaches 11 t/ha nutritive units, 1781 kg/ha digestible protein, 135 894 MJ metabolizable energy. It is a melliferous plant; its pollen is collected by bees in May-June and 200-400 kg/ha of honey can be obtained. A plantation can be used for 15-22 years.

The variety "Gigant" of Sakhalin knotweed (*Polygonum sachalinense* F. Schmidt) was registered in the Catalogue of plant varieties of the Republic of Moldova in 2012. It has a productive potential of 124.2 t/ha fresh mass or 30.9 t dry matter containing 17-19% raw protein, can be used as natural forage or silage. Biochemical composition of the dry matter from fodder: 18.28% protein, 3.80% fat, 31.27% cellulose, 38.78% nitrogen-free extractive substances, 7.86% minerals. 100 kg of silage contains 20.7 nutritive units with 215 MJ of metabolizable energy for cattle, and a nutritive unit contains 157 g digestible protein.

Production of renewable energy: biogas – 420-560 m³/t dry matter. The potential of biogas production reaches 13-17 thousand m³/ha/year, as well as a considerable amount of digest that can be

used as fertilizer in organic agriculture.

Solid biofuel (briquettes and pellets) with superior calorific value of 19.3-19.5 MJ/kg dry matter. The potential of energy production is 390 GJ/ha/year, equivalent to 14 t of coal or 9.3 t of conventional oil.

Medicinal plant: the extracts from different organs (leaves, roots, flowers) possess antioxidant activity directly proportional to the content of polyphenolic substances, higher in flower extracts.

It is also a source for production of phytosanitary products used for combating plant diseases.

Late melliferous plant: 30-60 kg/ha honey.

Figure 1, 2. *Polygonum sachalinense* F. Schmidt, variety "Gigant"

The variety "Vital" of cup plant *(Silphium perfoliatum* L.) was registered in the Catalogue of plant varieties of the Republic of Moldova in 2012. It has a productive potential of 142.8 t/ha fresh mass or 24.1 t dry matter containing 14-16% raw protein, it can be used as natural forage or silage. A nutritive unit contains 134 g digestible protein. Production of renewable energy: solid fuel: briquettes and pellets with a calorific value of 18.3 MJ/kg. The potential of 25 t/ha of dry matter can contribute to obtain 380 GJ/ha. Biogas: 450 l/kg of dry matter with a methane content of 70%. It is a late melliferous plant that provides 120-190 kg/ha of honey. This plant is used for the production of phytosanitary products, production of pharmaceutical products. It is also used for landscaping, phyto-improvement and restoration of degraded and contaminated lands.

Figure 3,4. *Silphium perfoliatum* L.,variety "Vital"

The variety "Melifera" of lacy phacelia (*Phacelia tanacetifolia* Benth.) was registered in the Catalogue of plant varieties of the Republic of Moldova in 2014. It has a productive potential of 50 t/ha fresh mass or 10 t dry matter. A nutritive unit contains 125 g digestible protein. The productivity of digestible protein – 776 kg/ha. It is an early melliferous plant that allows obtaining 200 - 400 kg/ha honey, it can also be used as successive crop that allows bees to collect pollen late in the season. It provides food for entomophagous birds. It can be used as green manure, when it is incorporated into soil, the fresh mass provides an equivalent to 180 kg/ha of nitrogen.

The variety Energo has been created by individual selection of introduced populations of Virginia mallow (*Sida hermaphrodita* Rusby), registered in the Catalogue of plant varieties of the Republic of Moldova in 2014. This crop is grown for different purposes: as a source of fodder for animals, nectar for beekeeping, biomass for energy production. Natural fodder: 104-112 t/ha annually, dry matter content: 19-23%. Biochemical composition of the dry matter: 15.94% of protein, 3.99% of fat, 32.86% of cellulose, 38.78% of nitrogen-free extractive substances and 8.43% of minerals. Nutritive value of 1 kg of natural fodder: 0.21 nutritive units and 2.11 MJ metabolizable energy, 131.9 g/nutritive unit of digestible protein.

Figure 5. *Phacelia tanacetifolia* Benth., variety "Melifera"

It can be given to animals fresh or as silage. Harvest: 21-24 t/ha nutritive units and 2.7 – 3.2 t/ha digestible protein.

Production of renewable energy: Biogas – 478 m3/t dry matter. The potential of biogas production is 11 000 m3/ha, equivalent to 5.0-5.5 thousand m3 of natural gas.

Solid biofuel (briquettes and pellets) with superior calorific value of 18.7 MJ/kg and 1.5% of ash. Energy potential of solid biofuel – 380 GJ/ha.

As a late melliferous plant, it provides 30-60 kg/ha of honey. It is useful in phytoamelioration of eroded land and phytoremediation of contaminated land.

Figure 6, 7. *Sida hermaphrodita*
Rusby, variety Energo

The variety "Solar" of Jerusalem artichoke (*Helianthus tuberosus* L.) was registered in the Catalogue of plant varieties of the Republic of Moldova in 2014. Its productivity of natural fodder is about 150 t/ha, tubers – 44 t/ha. The dry matter in the natural fodder constitutes 25-28% and consists of 9.32% protein, 1.93% fat, 21.29% cellulose, 8.75% minerals and 58.71% nitrogen-free extractive substances.

The calorific value of the dry matter of the variety "Solar" of Jerusalem artichoke reaches 18.5- 18.7 MJ/kg. The ash content – 2.2%. The harvest of tubers allows obtaining 3850 l/ha bioethanol, and the aerial dry biomass has an energy potential of 470 GJ/ha.

Figure 8, 9. *Helianthus tuberosus* L.,
variety "Solar"

The varieties Gigant, Vital, Melifera, Energo and Solar are in process of patenting at the State Agency on Intellectual Property of the Republic of Moldova [2].

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IV. LANDSCAPE ARCHITECTURE

CALCIUM AND MAGNESIUM IN PLANTS AND SOIL, "CODRI" RESERVATION

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Abstract: This paper presents an assessment of the mineral elements Ca^{2+} and Mg^{2+} studied simultaneously in soil and herbaceous plants in three forest biocenoses from "Codrii" reservation. Around 41 plant species belonging to 35 genera and 20 families were analyzed. It has been established: studied soils were characterized by a high degree of base saturation; variations in exchangeable Ca^{2+} and Mg^{2+} are relevant on layers depending on granulometric composition and other characteristics; calcium accumulating groups of plants were found as well as groups of plants that can manage and distribute Mg in space and time.

INTRODUCTION

It is known that some plants can serve as indicators of environmental factors, including harmful ones, which may alter the genotype of these plants. The knowledge currently gained by botanical, pedological, and ecological sciences has established that classification of species in different environmental categories is based on complex research of flora and soil [1 to 7.12, 13]. The fact that herbaceous species from natural systems (being quantitatively at a lower rank than arboreous layer) are very sensitive to the stationary factors [2] and the dynamics of nutrients in the soil is regulated mostly by phytocoenosis [13] imposes a broader research of ecosystem's indices. It is important to mention that most forest herbaceous species are managed as medicinal and animal feed species.

Our research was directed toward quantitative evaluation of seasonal dynamics of Ca and Mg in herbaceous plants and soil, to highlight the relationship soil-plants: establishing tolerance limits for two elements depending on seasonal factors; migration and their accumulation in the soil and plants; to determine tentatively the ecological group of plants with preferences to degree of base saturation. Plants from herbaceous layer may give important indications for station factors. Most studied plant species are known in literature as mesotrophic and eutrophic *(Asarum europaeum, Dentaria bulbifera, Euphorbia amigdaloides, Isopirum thalectroides, Galium odoratum, Mercurialis perennis, Dactylis glomerata* etc.) and fewer eurimezotrophic *(Campanula ranunculoides, Melica uniflora)*. But adaptability of species to the environmental conditions, make it difficult to find the right indicator species. *For this reason quantitative assessments are necessary in order to appreciate more clearly the role of species or groups of species. The knowledge of Ca^{2+} and Mg^{2+} content in soil and plants may help assess more certainly the degree of* ***toxicity or deficiency*** *of the mineral elements in relation to temporal and annual variations occurred in the past, compared to the current state.*

MATERIALS AND METHODS

The investigations were conducted on three European forest ecosystems, experimental plots demarcated territorial area of 1800 m^2: *common oak with hornbeam forest on typical gray clay forest soils over clay-sandy loam* **(A);** *durmast oak with linden and ash forest on brown clay soils over deeply gleyed clay* **(B)**; *beech with durmast oak forest on brown sandy loam soil over clay-sand* **(C).** The samples were taken from each of eight allotted 1 m2 areas in each type of forest. The soil was analyzed in layers (0 + 40 and 0 + 60 cm) of the semiprofiles, plants – the above-ground part. The ranges of calcium and magnesium in plants in (Tables 1 and 4) show the limits of these elements variation in plants, collected in summer and autumn 2000-2001, March 2001-2002, April 2001. Plants were determined according to Identification Manual T.Gheideman [11].

The elements studied in plants and soils were determined: Ca and Mg in plants – the complexometric method; exchangeable cations (Ca^{++}, Mg^{++}) in soil – complexometric titration of ammonium chloride extract [8]. Mathematical analysis – according to statistical methods [9,10].

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RESULTS

We analyzed 41 species belonging to 35 genera and 20 families *(Apiacea* - 1 sp., *Araceae* – 1 sp., *Aristolochiaceae* – 1 sp., *Boraginaceae* – 2 sp., *Brassicaceae* – 3 sp., *Campanulaceae* – 1 sp., *Caryophylaceae* – 1 sp., *Convallariaceae* – 2 sp., *Cyperaceae* – 2 sp., *Euphorbiaceae* – 2 sp., *Fumariaceae* – 3 sp., *Hyacintaceae* – 1 sp., *Lamiaceae* – 6 sp., *Liliaceae* - 2 sp., *Poaceae* - 5 sp., *Ranunculaceae* - 3 sp., *Rosaceae* - 1 sp., *Rubiaceae* - 1 sp., *Scrophulariaceae* - 1 sp., *Violaceae* - 3 sp.). 5 of these species were recorded in the 2nd edition of Red Book of Moldova (RBM) as a rare species with diverse conservation status: *Lunaria rediviva* (EN), security stage of CRM, *Convallaria majalis* (R), *Corydalis bulbosa* (R), *Corydalis marschaliana* (R), *Tulipa biebersteiniana* (R), OS, CRU, *Lunaria rediviva* did not change its status.

CALCIUM CONTENT IN HERBACEOUS PLANTS AND SOIL

The importance of calcium for the sustainability and development of the living world is indisputable. Calcium participates in the formation and development of the living organisms, accumulates in the protoplasm, vacuoles, chloroplasts, mitochondria. One of the most important properties of calcium is to set negative charges on the surface of protoplasm [1, 6]. Calcium is a basic indicator of soil fertility; it participates in forming the structure and composition of organic aggregates etc.

The analysis of calcium in forest herbaceous species, studied in sample areas of 1 m^2, showed values falling in rather small intervals (mean values) of 0.48% - 0,7% (min. 0.3% , max.1,9%) for *Carex brevicollis* L. and *Carex pilosa* Scop., up to 3.6% for *Mercurialis perennis* L. (min. 1.1%, max. 3.8%) and 4.0% for *Lunaria redeviva* L. (min. 3.8 max. 4.2%).

In an interval with values less than 1% (Table 1), *Hordelymus europaeus* (forest B) and *Melica uniflora* Retz. (forests A, B) fall in line with common species *Carex pilosa* Scop. and *Carex brevicollis* L. (forests ABC).

Most studied species have Ca^{2+} within 1-2%. *Alliaria species petiolata* (Bieb.) Cavaria et Grande (forest B), *Gallium odoratum* (L.) Scop. (Forests A, B, C), *Lamium maculatum* L. *Symphytum tauricum* Willd. (Forest B) fit in the limits of 2-3%. Just for the species *Mercurialis perennis* L. (ABC forests) and *Lunaria redeviva* L. (forest B), as mentioned, Ca values are in the range of 3-4% (Table 1).

Table 1. **Ca** *values of herbaceous species, biocoenosis ABC, %*

Family, Species	Type of forest	**March**	**April**	**June**	**September**
		Apiaceae			
Aegopodium podagraria L.	**C**	0.92	1.23-1.5	1.24-1.96	1.6
		Araceae			
Arum orientale Bieb.	**A**	1.2			
		Aristolochiaceae			
Asarum europaeum L.	**A**		1.22-1.73	2.72-2.32	2.44
	C		1.25-1.5	1.94	2.04
Boraginaceae					
Pulmonaria officinalis L.	**A**		1.28	1.57	
	B		1.41	1.4	
	C			1.6 1.34	1.6
				0.91-1.78	
Symphytum tauricum Willd.	**B**			2.5	1.98
		Brassicaceae			
Alliaria petiolata (Bieb.) Cavara et Grande	**B**	2.12		2.2-2.64	2.24-2.72

Dentaria bulbifera L.	**A**	1.5	1.2-1.98		
	B	1.08-1.72	2.1-2.48		
	C	1.1-1.56	1.68-2.67		
Lunaria redeviva L.	**B**			3.8	4.2
Canpanulaceae					
Campanula rapunculoides L.	**A**		1.45	1.97	
Caryophyllaceae					
Stellaria holostea L.	**A**	0.88-1.3	0.9-1.25	1.1-1.32	1.31-1.87
	B	0.90-1.52	1.2-1.5	1.3-2.8	1.33-1.88
Convallariaceae					
Convallaria majalis L.	**B**		1.45-1.72	1.82	
	B			1.47-2.0	
Polygonatum latifolium Desf.	**A**		0.75-1.18	1.3-2.08	
	B	0.79	1.15-1.58	2.14-2.48	
	C		1.32-1.5	1.36	
Cyperaceae					
Carex brevicollis L.	**A**	0.58-1.08	0.62	0.31-0.75	0.63
	B	0.78	0.78-1.2	0.79	0.86
	C				1.07
Carex pilosa Scop.	**A**	0.88	0.61	0.28- .77	0.68
	B				0.81
	C	0.7-1.02	0.78-1.9	0.8	0.59-1.0
Euphorbiaceae					
Euphorbia amygdaloides L.	**A**		1.3	1.58	
	B				1.64
Mercurialis perennis L.	**A**	1.45	2.1	1.72-3.64	
	B	1.35	1.12-2.15		
	C		3.4	3.84 1.53	
Fumariaceae					
Corydalis bulbosa L.	**A**		1.42-1.95		
	C		2.02		
Corydalis marschaliana Pers.	**A**	1.14-1.52	1.25-2.25		
	B	1.18-1.65	1.75-2.28		
Corydalis solida (L.) Clairv.	**A**	0.88-1.38	1.52-1.88		
	B	1.48-1.78	1.62-2.74		
	C	0.95-1.25	1.98		
Hyacinthaceae					
Scila bifolia L.	**A**	1.05-1.28	1.12-1.52		
	B	1.0-1.52	1.5-2.02		
	C	1.18			
Lamiaceae					
Ballota nigra L.	**B**			3.6	
Galeobdolon luteum Huds.	**C**	1.52	1.7	1.2-1.52	1.33-1.65
Glechoma hirsuta Waldst.et Kit.	**A**		1.25-1.52	1.58-1.96	2.15
	B	2.18	1.32-2.22	1.24-1.87	2.34

	C		1.32		
Lamium maculatum L.	**B**	2.28	2.33	1.251	
Scutellaria altissima L.	**B**			1.8	
Stachys sylvatica L.	**C**			1.1 0.97	1.47
Liliaceae					
Gagea lutea (L.)Ker.Gawl.	**A**	1.18-1.4			
	B	0.72-1.5			
Tulipa biebersteiniana Schult. et Schult. fil.	**B**	0.48-0.96			
Poaceae					
Bromopsis benechenii (Lange) Holub.	**B**		1.04	0.78	1.07-1.45
Dactylis glomerata L.	**B**			0.59	1.11
Hordelymus europaeus (L.)Harz.	**B**			0.551	
Melica uniflora Retz.	**A**			0.54-1	
	B		0.55-0.75	0.74-1.2	1.15
Roegneria canina (L.)Nevski	**B**				0.82
Ranunculaceae					
Anemonoides ranunculoides (L.) Holub.	**A**	0.8-1.43	1.05-1.52		
	B	1.06-1.62	1.0-1.82		
	C	0.94 -1.6	1.32-1.92		
Ficaria verna Huds.	**A**		1.22		
	B		2.12		
	C	0.8-1.12	1.2		
Isopyrum thalictroides L.	**A**	1.09-1.22			
	C	1.46			
Rosaceae					
Geum urbanum L.	**B**				1.88
Rubiaceae					
Galium odoratum (L.) Scop.	**A**				2.52
	C	1.1-1.3	1.5-1.85	1.69-2.22	1.93
Scrophulariaceae					
Veronica hederifolia L.	**B**	1.0-1.20			
Violaceae					
Viola hirta L.	**A**		0.8-1.32	2.26	1.73-2.21
	B			1.74-2.16	2.1
Viola odorata Bieb.	**A**		1.32-1.5	1.8 1.41	
	B	1.1-2.12	1.5	1.44	
	C		1.5		
Viola reichenbachiana Jord. ex Boreau	**A**			1.7 1.41	
	C			1.42	

The soil in the same land sample was analyzed concurrently with plants, exchangeable Ca^{2+} was lower in brown sandy loam soil over clay-sand (C), mean – in typical gray clay forest soils over clay-sandy loam (A) and large – in brown clay soils over deeply gleyed clay (B). Soils in the areas of sampling A, B (1m^2), in some cases, show enormous accumulations of Ca^{2+}, which were not directly reflected in the large accumulations in plants (Tables 2). It is important to note that variations in soil calcium of forests B and C are average and high during the whole growing season, quite significantly in the layers of gray soil, typical silty clay-clay (Tab. 3).

Table 2. Dynamics of Ca^{++} (me/100g soil) content in the forest soils

Depth cm	Type of forest	Spring		Summer		Autumn	
		2001	2002	2000	2001	2000	2001
0-10	**A**	29.99-39.83	27.23	27.6	26.39-36.0	32.26	29.0-35.0
	B	24.83-52.67	37.25	35.01	23.7-61.0	38.03	18.0-60.0
	C	8.5-18.33	10.63	9.94	7.6-17.9	12.62	8.9-20.0
10-20	**A**	15.33-31.16	18.25	18.26	16.0-25.0	20.35	14.0-27.0
	B	18.6-45.0	28.30	26.03	18.2-41.5	31.95	15.1-43.0
	C	5.17-12.66	7.80	6.45	4.1-15.6	6.77	4.3-11.7
20-30	**A**	15.16-29.0	17.68	16.39	14.9-20.79	18.13	13.0-22.1
	B	15.33-41.67	24.08	23.24	14.0-31.8	26.58	14.4-40.0
	C	4.83-13.0	7.60	5.68	5.4-14.8	6.37	4.0-13.5
30-40	**A**	15.66-23.0	17.68	16.03	17.3-20.2	17.12	14.5-19.9
	B	15.0-39.99	22.50	21.09	13.2-32.0	24.89	12.3-37.0
	C	4.33-14.66	7.93	6.19	6.7-14.99	7.44	6.0-13.0
40-50	**A**	17.0-22.83		16.85		17.91	
	B	13.83-40.15		22.89		26.72	
	C	4.33-15.33		7.60		8.91	
50-60	**A**	16.67-21.66		16.26		18.54	
	B	13.33-40.33		24.81		34.46	
	C	4.00-17.5					

Table 3. Ca^{++} coefficient of variation in the forest soils, %.

Depth, cm	Type of forest	Spring		Summer		Autumn	
		2001	2002	2000	2001	2000	2001
0-10	**A**	12.74	17.15	17.37	14.08	12.07	7.59
	B	30.18	47.87	35.49	43.52	41.61	42.57
	C	33.22	67.1	44.87	35.41	36.36	25.16
10-20	**A**	28.36	18.1	25.54	17.74	28.27	25.27
	B	33.39	43.61	38.07	36.11	34.18	37.95
	C	35.63	62.69	49.3	66.35	55.4	28.66
20-30	**A**	26.36	17.73	21.07	15.27	17.85	17.7
	B	43.46	41.15	38.11	33.53	42.21	42.16
	C	40.56	63.04	47.44	53.27	47.49	34.99
30-40	**A**	15.81	17.14	17.38	8.63	15.04	13.2
	B	40.98	38.48	43.69	37.98	42.91	45.07
	C	44.38	51.39	45.39	45.37	38.7	29.36
40-50	**A**	14.48		9.94		9.68	
	B	38.75		48.47		48.25	
	C	38.89		39.4		40.88	
50-60	**A**	11.08		17.88		5.86	
	B	37.45		44.28		33.61	
	C	38.63		36.37		46.53	

MAGNESIUM CONTENT IN HERBACEOUS PLANTS AND SOIL

Magnesium is at the border between macro and micronutrients. Its predominant role is catalytic; Mg participates in biomass formation, photosynthesis, activation of enzyme systems, enters into constitution of chlorophyll [1].

Mg content in studied plants ranged mostly within the limits of up to 1%, most plants had values less than 0.5% (Table 4). *Campanula Rapunculoides* L. species (forest A) *Carex brevicolis* L., *Carex pilosa* Scop. (A, B, C) are characterized by relatively low values of 0.3%. Only *Asarum europaeum* L. (forests A, C), *Dentaria bulbifera* L. (forests A, B, C), *Euphorbia amigdaloides* L. (forests A, B), *Mercurialis perennis* L. (forests A, B, C), *Viola hirta* L. (forests, B) contain more than 0.5% Mg (Tab. 4)

Table 4. Mg values of herbaceous species, biocoenoses A, B, C (%)

Family, Species	Type of forest	March	April	June	September
Apiaceae					
Aegopodium podagraria L.	**C**	0.14-0.38	0.28-0.5	0.19-0.46	0.64
Aristolochiaceae					
Asarum europaeum L	**A**		0.1-0.7	0.35	0.42-0.71
Boraginaceae					
Pulmonaria officinalis L	**A**		0.57	0.28	
	B		0.45	0.29	
	C			0.16	0.48
Symphytum tauricum Willd	**B**			0.38	0.31
Brassicaceae					
Alliaria petiolata (Bieb.) Cavara et Grande	**B**	2.12		0.23-0.58	0.56
Dentaria bulbifera L.	**A**	0.58	0.34-1.12		
	B	0.12-0.69	0.5-0.76		
	C	0.21-0.52	0.35-0.05		
Lunaria redeviva L.	**B**			0.31	0.6
Campanulaceae					
Campanula rapunculoides L.	**A**		0.06	0.34	
Caryophyllaceae					
Myosoton aquaticum (L.) Moench	**B**	0.09-0.33	0.32-1.2		
Stellaria holostea L.	**A**	0.21-0.39	0.21-0.42	0.53	0.31-0.72
	B	0.16-0.4	0.33-0.68	0.54	0.41-0.8
Convallariaceae					
Convallaria majalis L.	**B**		0.41	0.5	
Polygonatum latifolium Desf.	**A**		0.12-0.66	0.16-0.42	
	B	0.14-0.6	0.18-0.63	0.22-0.65	
	C		0.6	0.49	
Cyperaceae					
Carex brevicollis L.	**A**	0.12-0.32	0.08	0.41	0.14-0.31
	B	0.28	0.22	0.26-0.32	0.36
	C			0.09	0.86
Carex pilosa Scop	**A**	0.18-0.32	0.09-0.24	0.26-0.49	0.28
	B				0.54
	C	0.06	0.48		0.12-0.3

Euphorbiaceae					
Euphorbia amygdaloides L.	**A**		0.76	0.7	
	B				0.4-0.84
Mercurialis perennis L.	**A**	0.45	0.69	0.7	
	B	0.1			
	C		0.66	0.58	
Fumariaceae					
Corydalis bulbosa L.	**A**		0.12-0.68		
Corydalis marschaliana Pers.	**C**		0.15-0.72		
	A		0.27-0.75		
	B	0.21-0.44	0.27-0.62		
Corydalis solida (L.) Clairv.	**A**	0.08-0.54	0.44-0.7		
	B	0.14-0.4	0.38-0.93		
	C	0.24-0.48	0.38		
Hyacinthaceae					
Scila bifolia L.	**A**	0.09-0.54	0.39		
	B		0.40-1.0		
	C	0.66			
Lamiaceae					
Ballota nigra L.	**B**			0.22	
Galeobdolon luteum Huds.	**C**	0.58	0.54	0.12-0.35	0.24-0.49
Glechoma hirsuta Waldst.et Kit.	**A**		0.15-0.38	0.48	0.26-0.55
	B	0.2		0.44-0.62	0.47
	C		0.36		
Lamium maculatum L.	**B**	0.24	0.45		
Scutellaria altissima L.	**B**			0.12	
Stachys sylvatica L.	**C**			0.26	0.49
Liliaceae					
Gagea lutea (L.)Ker.Gawl.	**A**	0.12-0.27			
	B	0.16-0.56	0.36-1.0		
Tulipa biebersteiniana Schult. et Schult. fil.	**B**			0.28-0.62	
Poaceae					
Bromopsis benechenii (Lange) Holub.	**B**		0.4	0.13	0.34-0.6
Dactylis glomerata L.	**B**			0.27	0.54
Melica uniflora Retz.	**A**			0.59	
	B		0.16	0.28	0.36
Roegneria canina (L.) Nevski	**B**				0.19
Ranunculaceae					
Anemonoides ranunculoides (L.) Holub.	**A**	0.08-0.5	0.2-0.6		
	B	0.15-0.52	0.32-0.6		
	C	0.15-0.3	0.53		
Ficaria verna Huds.	**A**	0.27	0.18		
	B		0.44		
	C	0.38	0.48		
Isopyrum thalictroides L.	**A**	0.2			

Rosaceae					
Geum urbanum L.	**B**				0.92
Rubiaceae					
Galium odoratum (L.) Scop.	**A**				0.33
	C		0.4-0.75	0.43	0.45
Violaceae					
Viola hirta L.	**A**		1.59	0.61	0.44-0.84
	B				0.4-0.69
Viola odorata Bieb.	**A**		0.72-1.22	0.73	
	B	0.57	0.78-1.02		
	C		0.46		
Viola reichenbachiana Jord. ex Boreau	**A**			0.28	
	C			0.28	

The studied soils were characterized by a high base saturation, the ratio between calcium and magnesium is mostly quite narrow, and exchangeable magnesium maintains high values in soils of oak and hornbeam and oak, linden and ash forests (Tables 5). Variations of Mg^{2+} by layers are the biggest on typical gray clay forest soils over clay-sandy loam (A) and brown clay soils over deeply gleyed clay (B) and small for soils of beech forest with oak (Table 6). It is notable that in the case of huge variations by layers, because of their characteristics and specific diversity of vegetation in the analyzed biocoenoses, it is necessary to find other methods of calculation.

Table 5. Dynamics of Mg^{++} (me/100g soil) content in the forest soils.

Depth cm	**Type of forest**	**Spring**		**Summer**		**Autumn**	
		2001	**2002**	**2000**	**2001**	**2000**	**2001**
0-10	**A**	7.83-17.0	4.98	6.40	3.39-4.7	5.66	3.6-8.2
	B	4.17-16.0	4.75	6.58	2.5-6.7	4.92	2.7-8.4
	C	2.83-8.67	2.65	4.59	1.2-4.1	4.00	1.2-4.8
10-20	**A**	8.84-15.5	3.80	6.13	3.0-3.89	4.58	3.1-5.1
	B	5.5-21.5	4.35	6.82	2.7-9.3	4.88	2.0-8.1
	C	1.84-4.84	1.60	3.28	0.9-2.9	2.71	0.8-4.1
20-30	**A**	6.5-12.83	3.55	6.21	3.0-3.8	4.67	2.3-6.6
	B	5.15.5	5.05	6.19	2.2-11.1	4.58	2.1-10.0
	C	2.16-3.5	1.48	2.97	1.4-2.8	2.96	0.9-4.2
30-40	**A**	6.66-13.5	3.45	5.64	2.7-3.9	4.92	3.0-5.5
	B	4.0-16.67	4.10	6.74	2.6-12.0	5.69	3.0-11.1
	C	1.67-4.33	1.43	3.08	1.0-4.0	2.85	0.5-4.0
40-50	**A**	6.0-13.00		6.11		4.84	
	B	3.67-20.33		7.94		5.86	
	C	1.34-4.16		3.79		2.75	
50-60	**A**	8.5-15.0		7.56		4.63	
	B	2.17-18.49		8.55		6.07	
	C	1.67-6.0		3.10		3.48	

Table 6. Mg^{++} coefficient of variation in the forest soils, %.

Depth cm	Type of forest	Spring		Sammer		Autumn	
		2001	2002	2000	2001	2000	2001
0-10	**A**	33.02	32.84	46.91	14.53	20.70	25.15
	B	45.71	46.71	24.23	44.61	26.41	38.01
	C	44.75	50.86	max.	56.48	43.21	60.12
10-20	**A**	25.77	26.75	32.46	11.66	18.44	41.86
	B	51.02	55.51	34.96	63.78	25.83	46.53
	C	34.99	48.68	max.	42.49	14.70	51.45
20-30	**A**	27.90	30.64	34.72	10.81	22.35	30.92
	B	42.10	43.88	36.36	76.75	31.23	56.92
	C	21.42	41.56	max.	38.40	32.39	53.57
30-40	**A**	32.79	37.31	24.84	10.81	21.03	24.62
	B	56.79	58.98	39.59	78.63	27.06	54.65
	C	40.76	48.07	max.	49.82	43.66	62.77
40-50	**A**	33.04		26.66	16.50	22.81	
	B	49.41		45.16		47.89	
	C	44.33		max.		41.33	

As a result of analyzed materials we conclude that:

- The studied soils were characterized by a high degree of base saturation.
- The degree of variation in Ca^{2+} and Mg^{2+} is more related to the characteristics of soil layers and vegetation type, significantly depending on the seasonal period (spring and fall);
- The species *Mercurialis perennis* L. (ABC forests), *Lunaria redeviva* L. (forest B) and *Ballota nigra* L. have higher values of Ca^{2+}, in the range of 3-4%, and may be characterized as species which accumulate this element;
- *Carex brevicollis* L., *Carex pilosa* Scop., *Dentaria bulbifera* L., *Euphorbia amigdaloides* L. and Glechoma hirsute Waldst. et Kit. form the group of plants that can administer poorly soluble Ca reserves in the ground without accumulating it.
- The species *Asarum europaeum* L. (forests A, C), *Dentaria bulbifera* L. (forests A, B, C), *Euphorbia amigdaloides* L. (forests A, B), *Mercurialis perennis* L. (forests A, B, C) and *Viola hirta* L. (forests A, B) have values of Mg greater than 0.5% and in turn form the group of plants that can manage and distribute this element into the ground vertically and horizontally (within the superficial layers);
- The studied species of *Poaceae* family administered calcium and magnesium in relatively small amounts.

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HOTĂRĂREA

Simpozionul Ştiinţific Internaţional
„Conservarea diversităţii plantelor”,
consacrat aniversării a 65-a de la fondarea Grădinii Botanice (Institut)
ediţia a IV-a, 28-30 septembrie 2015, Chişinău, Republica Moldova

Conservarea diversităţii biologice este o condiţie esenţială a dezvoltării durabile şi constituie de asemenea una din provocările erei moderne.

Republica Moldova acordă o deosebită importanţă protecţiei naturii, ca argument fiind şi aprobarea Strategiei cu privire la diversitatea biologică pentru anii 2015-2020, care evidenţiază problemele prioritare şi defineşte obiectivele strategice.

Grădinile Botanice, de-a lungul timpului au jucat un rol esenţial în conservarea diversităţii plantelor, prin implicarea cu precădere la ocrotirea fitodiversităţii, acumularea unui genofond bogat şi de interes ştiinţific, aprofundarea proceselor de cercetare în domeniu la un nivel calitativ sporit, monitorizarea, intensificarea activităţilor cu privire la educaţia şi instruirea ecologică, sensibilizarea populaţiei, sporirea eficienţei energetice şi diminuarea impactului schimbărilor climatice, dezvoltarea culturală a popoarelor.

Participanţii acestui for ştiinţific susţin obiectivele Convenţiei cu privire la Diversitatea Biologică şi depun eforturi conjugate pentru realizarea programelor naţionale în domeniu, circulaţia liberă a informaţiei ştiinţifice destinate utilizării durabile a biodiversităţii.

Audiind rapoartele participanţilor la Simpozionul Ştiinţific Internaţional „*Conservarea diversităţii* plantelor” (Grădina Botanică (Institut) a Academiei de Ştiinţe a Moldovei; Univertsitatea din Bucureşti, Grădina Botanică “D. Brândză”, Bucureşti (România); Grădina Botanică Centrală a AN Belarusi, Minsk; Grădina Botanică Naţională „N.N.Grişko” şi Grădina Botanică „O. Fomin” din Kiev (Ucraina), Parcul dendrologic „Alexandria” din Ukraina, Grădina Botanică din Krivoy-Rog (Ukraina), Grădina Botanică (Institut) Ufa (Rusia), Grădina Botanică „Nikita” din Ialta (Ukraina); Institutul de Resurse Genetice din Baku (Azerbaijan), Institutul de Cercetări Forestiere şi Agroforestiere din Kazakhstan, Centrul de Cercetări biologice „Stejarul” din Piatra-Neamţ (România), Staţiunea de cercetări agricole şi dezvoltare din Secuieni (România)), constatăm faptul prezentării rezultatelor investigaţiilor recente, având ca subiecte conservarea lumii vegetale, introducerea plantelor şi utilizarea durabilă a resurselor vegetale, amenajarea spaţiilor verzi urbane şi rurale, instruirea şi educaţia ecologică a populaţiei etc.

Rapoartele ştiinţifice ale participanţilor au reflectat o etapă superioară în elaborarea şi implementarea metodelor de cercetare în domeniu, evaluarea rezultatelor şi implementarea elaborărilor performante în ramurile economiilor naţionale, promovarea cunoştinţelor în societate. De asemenea au fost abordate probleme ştiinţifice de viitor, soluţionarea căror vor contribui la sporirea eficacităţii măsurilor de conservare a diversităţii biologice, a mobilizării fitogenofondului şi utilizării durabile a resurselor vegetale.

Grădina Botanică (Institut) a AŞM, Grădina Botanică „D.Brândzâ” din Bucureşti (România), şi Grădina Botanică Naţională „N.N.Grişko” din Kiev (Ucraina) precum şi Universităţile reprezintă centre ştiinţifico-culturale de importanţă atât naţională cât şi internaţională, privind: conservarea *in situ* şi *ex situ;* aclimatizarea şi regenerarea speciilor valoroase de plante autohtone şi alohtone; înfiinţarea băncilor de seminţe şi ţesuturi etc. Colecţiile de plante servesc drept depozite ale fitogenofondului şi resurse genetice de material reproductiv şi au ca scop păstrarea lui pentru generaţiile prezente şi viitoare.

Este semnificativ faptul că cercetările botanice din Republica Moldova au primit un impuls considerabil după aprobarea Codului cu privire la Ştiinţă şi Inovare al Republicii Moldova, aderarea Republicii Moldova la Programul Cadru 7 al Uniunii Europene care a mobilizat potenţialul creativ al cercetătorilor, a deschis oportunităţi pentru integrarea în Programul Orizont 2020, a creat oportunităţi pentru instruirea şi promovarea tinerilor cercetători, precum şi condiţii de implementare a elaborărilor valoroase în ramurile economiei naţionale, atragerea investiţiilor pentru înzestrarea cu utilaj ştiinţific performant.

Simpozionul Ştiinţific Internaţional „*Conservarea diversităţii plantelor*”, consacrat aniversării a 65-a de la fondarea Grădinii Botanice (Institut) *ediţia a IV-a, 28-30 septembrie 2015, Chişinău, Republica*

Moldova, CONSTATĂ că:

1. Republica Moldova a întreprins unele măsuri cu privire la conservarea lumii vegetale din țară:
   - editată seria de carte în patru volume „Lumea vegetală a Moldovei";
   - au continuat cercetările științifice ale florei și vegetației din RM;
   - sunt editate primele volume din seria de carte „Flora Basarabiei" și „Ariile naturale protejate de stat din RM";
   - a fost elaborată și se află în proces de editare cartea Roșie a Republicii Moldova, ediția a 3-a;
   - extins fondul de arii naturale protejate de stat până la 5,61% din teritoriul național (189,4 mii ha);
   - au fost elaborate fundamentările științifice cu privire la fondarea Parcului Național „Orhei" și a Rezervației Biosferei „Prutul de Jos";
   - colecțiile de plante menținute în instituțiile naționale de profil au fost extinse și constituie cca 70 mii de specii de plante și varietăți;
   - resursele genetice din aceste colecții au contribuit la ameliorarea a mai mult de 1600 soiuri de plante alimentare, furagere, medicinale, aromatice, textile etc.
   - în ultimii ani a fost îmbunătățit cadrul legal cu privire la conservarea lumii vegetale: au fost elaborate și aprobate 50 de acte legislative și normative etc.

2. Cu toate aceste menționăm, cu regret, că:
   - obiectivul Convenției privind Diversitatea Biologică ce ține de diminuarea la nivel național a declinului populațiilor speciilor de plante din flora spontană nu a fost realizat; numărul speciilor de plante rare și periclitate crește vertiginos, iar măsurile întreprinse de Guvern nu asigură reducerea presingului antropic asupra ecosistemelor naturale;
   - promovarea cerințelor legislative și normative în domeniul protecției resurselor naturale și conservării biodiversității este la un nivel foarte scăzut și din această cauză tăierile ilicite ale pădurilor, distrugerea ecositemelor naturale și a habitatelor speciilor de plante rare a luat o amploare periculoasă și amenință securitatea ecologică a țării;
   - volumul finanțării din bugetul de stat a cercetărilor științifice se micșorează pe an ce trece și penuria financiară a devenit un impediment serios în realizarea programelor de cercetare științifică în domeniu la nivelul cerințelor actuale;
   - salariile mici ale tinerilor cercetători științifici în domeniu nu permit formarea unui potențial științific uman autohton, care va putea contribui ulterior la dezvoltarea economică a țării;
   - colecțiile de plante tropicale și subtropicale (mai mult de 2500 specii) se mențin în condiții neadecvate cerințelor și cu o uzură foarte puternică a utilajului, ce pune în mare pericol menținerea acestui genofond de importanță națională;
   - colecția națională a genotipurilor de viță-de-vie (cca 3000 taxoni, inclusiv cei autohtoni) care se află în gestiunea Institutului Național de Viticultură și Vinificație se află pe calea de distrugere totală;
   - a fost stopată faza II a construcției capitale și verzi a Grădinii Botanice (Institut) a AȘM (Întrarea Centrală a GB(I) AȘM, Oranjereia Expozițională de Fond, Herbariul, Muzeul Botanic, Sala de Conferințe, Blocul Tehnic, drumuri, poduri, cascade, sculpturi, expoziții etc);
   - componentele de menținere a funcționalității Blocul de laboratoare (sistemele de aprovizionare cu apă, gaz, agent termic) nu corespund cerințelor tehnice de exploatabilitate;

3. Simpozionul Științific Internațional „*Conservarea diversității plantelor*", consacrat aniversării a 65-a de la fondarea Grădinii Botanice (Institut) *ediția a IV-a, 28-30 septembrie 2015, Chișinău, Republica Moldova* consideră oportun:
   - elaborarea și promovarea proiectului de lege cu privire la atribuirea Grădinii Botanice (I) a AȘM a statutului de Grădină Botanică Națională;
   - alinierea Grădinii Botanice (I) a AȘM la standardele internaționale privind misiunea, structura, managementul și organizarea pe compartimente, care reflectă de fapt misiunea ce revine acestei instituții în cadrul sistemului social;
   - sporirea nivelului de conștientizare a populației cu privire la conservarea biodiversității și menținerii echilibrului ecologic prin organizarea diferitor acțiuni, concursuri, seminare etc;

- integrarea aspectelor privind conservarea diversității plantelor și utilizarea durabilă a resurselor vegetale în sectoarele economice;
- extinderea sistemului de arii naturale protejate pentru asigurarea funcționalității optime a ecosistemelor naturale;
- adoptarea măsurilor privind recuperarea și refacerea speciilor amenințate și reintroducerea lor în habitatele lor naturale, în condiții adecvate;
- continuarea și extinderea tematicilor științifice și tehnice cu privire la studierea diversității plantelor și utilizarea durabilă a resurselor vegetale, introducerea și îmbogățirea colecțiilor existente, înființarea de noi colecții prin schimbul internațional a fondului de semințe, promovarea expedițiilor complexe în comun cu instituțiile de profil internaționale;
- extinderea colaborării și cooperării științifice cu Centrele științifice regionale din România, Ucraina, Belarusia, Rusia cu privire la promovarea arhitecturii peisajere și planificării teritoriale în calitate de instrument activ în conservarea și utilizarea rațională a lumii vegetale, educarea și conștientizarea ecologică a populației;
- antrenarea specialiștilor în promovarea proiectelor de cercetare științifică la nivel național și internațional, menite să asigure fluxul de informație între centrele științifice, orientate către evaluarea, conservarea diversității plantelor și utilizarea durabilă a resurselor vegetale;
- perfecționarea potențialului științific în conformitate cu politica Europeană privind cercetarea științifică, conservarea și managementul diversității vegetale în baza extinderii colaborării cu centrele internaționale și regionale, utilizării în comun a utilajului performant din aceste centre;
- intensificarea cooperării cu instituțiile de învățământ superior în pregătirea profesională a cadrelor științifice tinere prin diverse specializări de masterat, doctorat, post-doctorat;
- implementarea prin intermediul agențiilor de transfer tehnologic a elaborărilor științifice performante în ramurile economiei naționale;
- elaborarea și promovarea unui plan de construcție și dezvoltare a Grădinii Botanice (Institut) a AȘM cu privire la Intrarea Centrală, Oranjereia Expozițională de Fond, Muzeul Botanic, Rețeaua de Drumuri și Poduri ornamentale.

Aprobată la 30 septembrie 2015

SCIENTIFIC CHRONIC

TEODOR MARUŞCA LA ONORABILA ANIVERSARE DE 75 ANI

Vede lumina zilei la 17 august 1941 în comuna Zece Hotare judeţul Bihor, România, apoi cu familia se mută în localitatea Jebel judeţul Timişoara unde îşi petrece copilăria şi anii de şcoală. Din anii de şcoală este pasionat de biologie. Studiază la Institutul Agronomic Timişoara, facultatea de Agricultură (1959-1964). Este Doctor în Ştiinţe, specializarea Agronomie, din 1982, cu teza:*" Studiul geobotanic şi tipologic al nardetelor din judeţul Braşov".* Membru titular al Academia de Ştiinţe Agricole şi Silvice din România (2014). Activează de peste cinci decenii în producţia agricolă şi cercetarea ştiinţifică având un spectru larg de preocupări, dintre care se pot menţiona: Botanică, geobotanică, tipologia pajiştilor; Gradientică ecologică montană; Protecţia mediului prin mijloace biologice şi biotehnice, combaterea eroziunii, Resurse genetice, introducerea în cultură, studiul şi testarea soiurilor de ierburi perene; Îmbunătăţirea pajiştilor prin fertilizare, amendare, supraînsămânţare, reînsămînţare combaterea buruienilor; Folosirea pajiştilor, conveiere pentru păşunat, comportamentul animalelor, randament în producţie animală. Parcurge treptele ştiinţifice şi didactice de la Cercetător ştiinţific gr. III la Cercetător ştiinţific principal gradul 1, conferenţiar la Universitatea Transilvania Braşov, Director general Institutul de Cercetare – Dezvoltare pentru Pajişti (ICDP) Braşov. Perfecţionarea profesională continuă, ilustrată prin specializări în centre europene de prestigiu, precum, 1969 - Sisteme pastorale în zona montană, producţie de furaj şi agricultură altitudinală, Elveţia; 2006 - Studiul filierei agriculturii biologice în Franche- Comte, Programul Leonardo da Vinci şi numeroasele participări la conferinţele, simpozioanele, seminariile internaţionale din domeniul pajiştilor în diferite colţuri ale Terrei la care se adaugă activitatea laborioasă depusă în domeniul creării şi omologări mai multor soiuri de plante furajere şi extensiei rezultatelor ştiinţifice, fiind cunoscut pe plan naţional şi internaţional iau oferit posibilitatea valorificării experienţei dobândite prin abordarea unor cercetări complexe, derulate în cadrul programelor naţionale şi internaţionale (CEEX, Orizont, Relansin, Agral, PHARE, 2004, ECO-NET , FAO – TCP/ROM/0168, PIN –MATRA), unde a deţinut funcţia de director sau coordonator de proiect. Activitatea publicistică a domniei sale cuprinde peste 350 titluri, inclusiv 160 lucrări ştiinţifice: (prim autor: 129, în limbi străine: 44, publicate în străinătate: 28.); 2 cursuri universitare, 9 broşuri de popularizare şi 142 articole de popularizare (extensie) a rezultatelor cercetării.

Cărţi şi îndrumare de specialitate : *Ameliorarea pajiştilor din Elveţia Agricultura pe glob* (1972); *Elemente de gradientică şi ecologie montană* (Gradient elements and mountain ecology) (2001); *Managementul tehnologic al culturilor de câmp* (2005); *Îndrumar metodologic de gospodărire ecologică a pajiştilor în ariile protejate* (2006); *Pajiştile montane din Carpaţii României* (2007); *Arii speciale pentru protecţia şi conservarea plantelor în România* (2007); *Reconstrucţia ecologică a pajiştilor degradate* (2008) ; *Ghid de producere ecologică a furajelor de pajişti montane* (2010); *Recurs la tradiţia satului – opinii agrosilvopastorale* (2012); *Însemnări şi mărturii agrosilvopastorale* (2015); *Tratat de reconstrucţie ecologică a habitatelor de pajişti şi terenuri degradate montane* (2010); *Ghid de producere ecologică a furajelor de pajişti montane* (2010); *Principalele soiuri de graminee şi leguminoase perene de pajişti* (2011); *Ghid de întocmire a amenajamentelor pastorale* (2014).

D-l Teodor MARUŞCA este membru titular al Academieia de Ştiinţe Agricole şi Silvice (2014), preşedinte fondator al Asociaţiei Renaturopa (2004), membru fondator al Societăţii Române de Pajişti (2009), membru în Consiliul Director al Forumului Montan (2005) din România, Euromontana Association (2004); Forumul Montan, Harrisonburg VA-USA (2001); Balkan Environmental Association – Salonic, Grecia (2000); – IPGRI, ECP / Resurse Genetice – Italia, Roma (1999); Federaţia Internaţională de Fitotosociologie – Franţa (1994) membru în Consiliul consultativ al revistei FERMA, Timişoara, din 2006; membru colaborator redacţie al revistei LUMEA SATULUI, Bucureşti, din 2006; editor permanent la revista PROFITUL AGRICOL.

La această semnificativă aniversare de 75 de ani de la naştere şi 50 de ani de activitate ştiinţifico-practică rodnică, îi adresăm membrului titular al Academia de Ştiinţe Agricole şi Silvice Teodor MARUŞCA cele mai alese urări de prosperare, sănătate, fericire şi multe succese notabile.

IN MEMORIAM

IN MEMORIUM Mihail LUPAȘCU
(27.08.1928 – 21.06.2016)

doctor habilitat în agricultură (1971), profesor universitar - 1972,
membru titular al Academiei de Ştiinte a Moldovei (1978)

Născut la 27 august 1928 într-o familie de tărani răzeşi din satul Cuizăuca, judeţul Orhei Regatul României, studiază la scoala primară din satul natal (1935-1943). Fiind îndrăgostit de pământ continue studiile la vestita şcoală agricolă din Cucuruzeni (1945-1948), la absolvire este recomandat să-şi continue studiile la facultatea de Agronomie a Institutului Agricol din Chisinau (1948-1953). În perioada studiilor Mihail LUPAŞCU manifestă interes de cercetarea ştiinţifică, face cunoştinţă cu profesorul, doctor în ştiinţe agricole Nicolai Dereviţki savant în domeniul fitotehniei, care la finalizarea facultăţii îl invită să-şi aprofundeze cunoştinţele la aspirantură, fiind înscris la Grădina Botanică a Filialei Moldoveneşti a A.S. a U.R.S.S. (1954-1957). Sub conducerea profesorului Nicolai Dereviţki, fondatorul cercetărilor ştiinţifice în domeniul plantelor furajere participă activ la fondarea şi extinderea colecţiei de plante furajere: legumenoase anuale şi perene, gramenee anuale, topinambur, cercetează porumbul pentru silos în amestic cu diferite specii de leguminoase furajere, iar în baza rezultatelor obţinute susţine cu succes teza de candidat (doctor) în ştiinţe agricole (1958). Rezultatele cercetărilor fundamentale acumulate în cadrul Grădinei Botanice au stat la temelia manifestării potenţialului didactic, organizatoric şi ştiinţific pe parcursul activităţii sale ca conferenţiar la Institutul Agricol din Chişinău (1959-1961); director al Institutului Moldovenesc de Cercetări Ştiinţifice în domeniul Culturilor de Cîmp din Bălţi (1962-1974) şi director general al A.S.P. "Selecţia" (1974-1978), academician coordonator al Secţiei de Ştiinţe Biologice şi Chimice a A.Ş.M. (1978-1980); ministru al agriculturii al R.S.S.M. (1980-1985); deputat al Sovietului Suprem al R.S.S.M. (1980-1985, 1985-1986) şi preşedinte al Sovietului Suprem al R.S.S.M. (1985-1986); vicepreşedinte al A.Ş.M. (1978-1986, 1990-1995); deputat în Parlamentul R.M.(1994-1998).

Academicianul Mihail Lupaşcu este fondatorul şcolii ştiinţifice în domeniul biologiei plantelor furajere şi programării recoltelor. A elaborat bazele teoretice şi practice de producere a nutreţurilor şi proteinei vegetale, bazele modelării fitocenozelor culturilor de nutreţ şi ale programării recoltelor lor. A avut o contribuţie substanţială la constituirea sectorului de producere a furajelor într-o ramură separată, care facilitează realizarea în practică a conceptului de dezvoltare a agriculturii Moldovei pe baze ecologice, atribuind un rol însemnat perfecţionării structurii suprafeţelor însămânţate cu culturi de câmp. A demonstrat eficienţa economică şi ecologică a prezenţei culturilor de nutreţ în agrolandşaftul republicii şi a fundamentat ştiinţific rolul culturii de lucernă în sporirea fertilităţii solului, în soluţionarea problemei proteinei vegetale şi în atenuarea eroziunii de suprafaţă a solului provocate de apă şi de vânt. A publicat în ţară şi în străinătate cca 400 de lucrări ştiinţifice, inclusiv 28 de monografii, manuale, broşuri, în care a abordat probleme de agricultură şi ecologie.

A pregătit 10 doctori în ştiinţe agricole. Este membru titular al Academiei Agricole din Federaţia Rusă, membru de onoare al Academiei Agricole şi Silvice din România şi al Academiei Central-Europene pentru Ştiinţe şi Arte. Doctor Honoris Causa al Universităţii Agrare de Stat din Moldova. Om emerit, laureat al Premiului de Stat al Republicii Moldova şi al Premiului „Gheorghe Ionescu-Şişeşti (România), a fost decorat cu „Insigna de Onoare", „Drapelul Roşu de Muncă", Ordinul „Lenin" şi „Ordinul Republicii".

Colectivul Grădinei Botanice exprimă sincere condoleanţe familiei, colegilor, apropiaţilor în legătură cu trecerea la cele veşnice a celui care a fost academicianul Mihail LUPAŞCU.

Dumnezeu să-l odihnească în pace