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CONTENTS

ECOLOGY

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ECOPHISIOLOGICAL CHARACTERISTICS OF SOME SHRUB CULTIVARS IN THE LOWER LAYER GROWING UNDER CONDITIONS OF PARKS MICROCLIMATE ON SOUTH COAST OF THE CRIMEA

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Introduction

On the coastal strip of South Coast of the Crimea no more than 200 m above the sea level there are parklands. All parks of the coastal area can be classified into land for common and restricted use. These parks are located on the territory of sanatoria. Area of common use makes 270,3 ha, otherwise 20,1 m^2 per each local person. If to consider number of disorganized tourists, reaching maximum in the peak season – 250 thousand of people per month or more, this resource factor drops down till the critical range – 7 m^2 per person.

Laying out of parks is one of the most important means to optimize landscapes [1, 2]. Territory of architectural planting in recreational regions should extend and develop environment, the most comfortable for recreation, cure and tourism [9].

Rational resource usage for improvement of working conditions, everyday life and recreation conditions allows for either preservation of natural vegetation or laying of new and reconstruction of existent plantations [1]. At the same time a special attention should be paid to plants of the lower layer, which develop under conditions of environment microclimate.

Choosing of such plant species demands investigation of their ecophysiological characteristics under park conditions on South Coast of the Crimea [3].

We made an attempt to solve this problem in terms of Arboretum park in Nikitsky Botanical Gardens (NBG), where a lot of ornamental bushes of the lower layer grow.

Objective of this work is to research ecophysiological characteristics of some bush cultivars growing in the lower layer of Arboretum in NBG applying methodology and instrumental base of phytomonitoring. Such study results permit differentiate species according to peculiarities of their water regime, drought-resistance, shade tolerance and recommend them for cultivation in a certain region on South Coast of the Crimea.

Objects and research methods

Methodology and instrumental base of phytomonitoring were applied in these investigations [4, 5, 7]. The following express-methods were used:

- Mesasuring method of leaf plate changes (thickness);
- Determination of moisture xylem deficit (timber);
- Measuring of linear velocity of xylem stream in stems of arboreal plants.

Decreasing of water level in vegetative organs of plant is a result of transpiration, what causes diurnal changes of shoot and leaf thickness.

Relative changes of leaf thickness predominate changes of stem and shoot thickness having either soil moisture deficit or atmospheric drought [13].

Diurnal change of a leaf plate is a criterion of that phenomena. Range comparison of diurnal changes of leaf thickness of different plant cultivars allowing for external factors can serve as a method of water status assessment and in particular assessment of their relative drough-resistance [5]. The most drought-resistant cultivars have minimal changes.

Periodical measuring of leaf plate thickness was carried out manually applying special dial of mechanical micrometer "Turgormeter-1" [7]. Such measuring took place in the morning and afternoon, while a plant recreates turgor (6 – 7 o`clock in the morning) and during maximum intensity of external conditions (14:00 – 15:00 o`clock). According to methodology, measuring was conducted on leaves from the same layer allowing for their location in space.

Deficit of xylem moisture was determined by heat-pulse method. It is a matter of xylem because percentage of xylem stream makes 98-99% of total (xylem and phloem stream) and heat mark is brought up by xylem stream. The method of xylem moisture determination allowing for results of heat-pulse measuring was applied in this engineering solution [16, 17]. It`s a well-known fact the described method was used to define linear velocity of xylem stream (only temporal component of heat-pulse was used) [10, 14]. The amplitude component wasn`t of much importance. During this research a new method to find this quantity was developed and patented. [6].

Sensor of this parameter determination was fixed approximately 80sm above the soil surface.

The linear velocity of xylem stream was assessed by the same sensor [5]. This characteristic permits to identify correlation between coefficients of water stress and drough-resistance of study cases. Coefficient of water stress is calculated by formula:

$C_{w.s.} = V_{morning}/V_{afternoon}$, relative unit.

Where: $V_{morning}$ – linear velocity of xylem stream in the morning;

$V_{afternoon}$ – linear velocity of xylem stream in the afternoon.

Applied express-methods with synchronic measuring of environmental parameters under conditions of microclimate (total solar radiation, air temperature, humidity, soil temperature and moisture, deficit of air humidity) permitted to investigate some ecophysiological characteristics of studied bush cultivars growing in the lower layer. Parameters of environment were measured by standard methods, which are in use for meteorological measuring [12].

Out of 120 supposed objects, 10 bush cultivars were selected as study cases for this research. They differ by vital forms, peculiarities of their water regime, drought-resistance, shade tolerance. They are *Aucuba japonica* Thunb.; *Buxus sempervirens* L.; *Chimonanthus praecox* (L.) Link; *Cornus mas* L.; *Euonymus japonica* Thunb.; *Hedera helix* L.; *Laurocerasus officinalis* M. Roem.; *Mahonia aquifolium* (Pursh) Nutt.; *Pittosporum heterophyllum* Franch.; *Viburnum tinus* L.

These plant cultivars from the lower layer are found in upper and lower parks of Arboretum of Nikitsky Botanical Gardens, obviously growing under conditions of different microclimate.

Results and discussion

Studied bush species are cultivated in many parks and public gardens on South Coast of the Crimea. Some of their ecophysiological characteristics are covered in scientific literature (table 1).

Table 1

Some ecophysiological characteristics of studied arboreal and shrub plants aimed at cultivation in parks of South Coast of the Crimea

Plant cultivar	Vital form	Shade tolerance	Category of moisture requiring	Drought-resistance
1	2	3	4	5
Aucuba japonica	evergreen	+++	mesophyte	+
Buxus sempervirens,	evergreen	+++	xero - mesophyte	++
Chimonanthus praecox	deciduous	++		++
Cornus mas	deciduous	++	xerophyte	+++
Euonymus japonica	evergreen	++		++
Hedera helix	evergreen	+++		++
Laurocerasus officinalis,	evergreen	++		++
Mahonia aquifolium,	evergreen	+++		++
Pittosporum heterophyllum	evergreen	++		++
Viburnum tinus	evergreen	+++	xerophyte	++

Notes
Hereinafter:
Drought-resistance: +++ tolerate droughty conditions without visual damages and capable to grow without artificial irrigation in summer; ++ demand irrigation during droughty period (cultivars resistant to air drought, but requiring the soil moisture); + regular irrigation during the whole summer period is necessary; - plants suffering either from air drought or deficit of soil moisture even being irrigated regularly.
Shadow tolerance: +++ – extremely shadow tolerant, ++ – less shadow tolerant.

This table permits to differentiate these cultivars by peculiarities of their water regime, drought-resistance, shadow tolerance. So, *Aucuba japonica* is mesophyte and characterized by a high level of shadow tolerance, but not quite drought-resistant, irrigation is necessary. *Cornus mas* is extremely drought-resistant, but not so shadow tolerant*; Buxus sempervirens*, *Hedera helix*, *Mahonia aquifolium*, *Viburnum* tinus possess a high level of shadow tolerance but not quite drought-resistant.

Methodology and instrument base of phytomonitoring were applied to clarify these ecophysiological characteristics.

In terms of our experiments study cases are cultivated in different microclimatic conditions of Arboretum park. That`s why while investigating each of this plant cultivars it`s necessary to measure their ecophysiological characteristics synchronically with changeable factors of environment.

Table 2 presents measurement results of leaf thickness of study species under conditions of different microclimate of the park in the morning and afternoon. Their maximum and minimal values were fixed at that time.

Table 2

Interrelation between drought-resistance of studied plant cultivars and variations of leaf thickness (28-29.08.2014)

Plant cultivar	Maximum thickness, mkm	Minimum thickness, mkm	Difference, %	Ecological group	Drought-resistance, points
1	2	3	4	5	6
Hedera helix	250	230	8	xerophyte	10,0
Viburnum tinus	125	115	8	xerophyte	10,0
Cornus mas	110	100	9,09	xerophyte	9,5
Laurocerasus officinalis	210	190	9,52	xero-mesophyte	9,0
Mahonia aquifolium	155	140	9,67	xero-	8,9

				mesophyte	
Buxus sempervirens	135	120	11,1	xero-mesophyte	8,0
Euonymus japonica	280	245	12,5	xero-mesophyte	7,9
Chimonanthus praecox	190	170	13,1	xero-mesophyte	7,5
Pittosporum heterophyllum	155	130	16,1	xero-mesophyte	7,0
Aucuba japonica	270	210	22,2	mesophyte	2,0

Amplitude of diurnal variation of plant organs flooding is determined not only by changes of environmental conditions, but plant cultivar is important, that is its genotypical properties. Having other equal conditions even plants-aborigines from the same region possess different characteristics of the diurnal variation of water status, that is reaction to changes of environment. These differences are caused by different level of drought-resistance first of all. Formation of so-called xeromorphic leaf structure is a base of structural and functional organization of drought-resistance. The main character of this structure is a size reduction and hardness increasing of parenchymal and stomatal cells. Mechanical properties of xerophytes apoplast, provide more effective control of air humidity in stomatal bags of leaves and as a result stabilization of water potential of transpiring plant organs [5]. It serves as a basis for such functional organization of water-salt transportation in a plant, which provides relative drought-resistance. A visual indicator of a heightened hardness of cell walls and stabilization of the structure is a smaller range of water variation (thickness) in plant leaves. Taking into consideration that different cultivars participate in this investigation, amplitude comparison of plant leaf thickness can become an indicator of their water status and particularly assessment method of relative drought-resistance. Scientific literature covers results of similar investigations, conducted in different geographical regions with different plant cultivars [7]. Relative drought-resistance in this works is identified by coefficient of relative drought-resistance; ten-point scale was in use [7]. Percentage variation of leaf plate thickness, that is difference between maximum and minimum values, was a criterion.

Conducted investigations permitted to build the following line of relative drought-resistance for study cases, in descending order:

Hedera helix ← *Viburnum tinus* ← *Cornus mas* ← *Laurocerasus officinalis* ← *Mahonia aquifolium* ← *Buxus sempervirens* ← *Euonymus japonica* ← *Chimonanthus praecox* ← *Pittosporum heterophyllum* ← *Aucuba japonica*.

Comparing findings with data of table 1, an obvious coincidence of a line occurred, though table 1 mostly presents qualitative results. The least drought-resistant cultivar is *Aucuba japonica,* mesophyte; the most drought-resistant are *Hedera helix*, *Viburnum tinus* and *Cornus mas* - xerophytes according to their ecological group.

Range of thickness variation of a leaf plate makes from 22, 2% to 8 % (*Hedera helix*, *Viburnum tinus*), that is over 3 times more depending on drought-resistance level of plant cultivar.

Figure 1 presents natural thickness variations of a leaf plate for three study cultivars during the daylight. The most noticeable variation was marked for a leaf plate of *Aucuba japonica,* the least – *Hedera helix*. Maximum decrease of a leaf plate was observed at 14-15 o`clock.

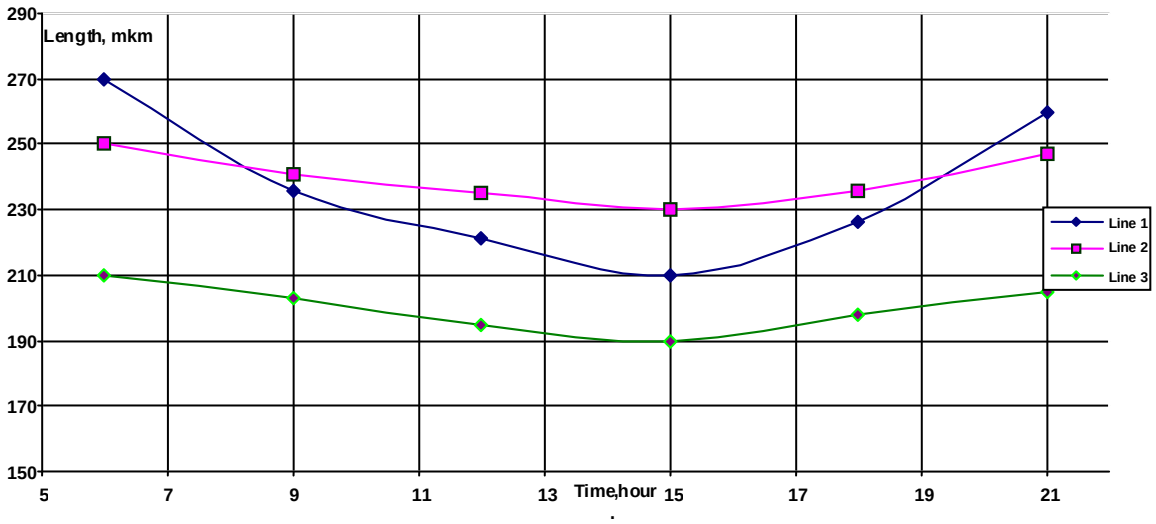

Fig.1 Natural thickness variation during the daylight (28.08.2014)
1- *Aucuba japonica*, 2 - *Hedera helix*, 3 - *Laurocerasus officinalis*

Investigations of relative drought-resistance for the same plant cultivars were carried out applying method of determination of xylem moisture deficit (timber). Table 3 covers these results.

Table 3

Interconnection between xylem moisture deficit (timber) and drought-resistance level of study plant cultivars (28-29.08.2014)

Plant cultivar	Max amplitude, Rel.unit	Min mplitude, Rel.unit.	Xmd,%	Ecological group
1	2	3	4	5
Cornus mas	75	64	14,6	xerophyte
Viburnum tinus	76	64	15,7	xerophyte
Chimonanthus praecox	80	67	16,2	xero-mesophyte
Buxus sempervirens	90	75	16,6	xero-mesophyte
Euonymus japonica	75	62	17,3	xero-mesophyte
Laurocerasus officinalis	80	66	17,5	xero-mesophyte
Pittosporum heterophyllum	98	80	18,9	xero-mesophyte
Aucuba japonica	120	90	25	mesophyte

8 plant cultivars participated in the investigations. Xylem moisture deficit was determined by formula (1):

$$Xd = (1 - \frac{A}{Amax})100\% \qquad (1)$$

Xd – xylem moisture deficite, %

A – current value of heat impulse amplitude, relative unit;

Amax – maximum value of heat impulse amplitude, relative unit.

Xylem moisture deficit depends upon trunk watering, which serves as a buffer container for arboreal plants. Up to intensity of external conditions moister from trunk xylem is spent for transpiration, while at night moisture reserve renews and reaches maximum point in the morning. Data analysis (table 3) shows that xylem moisture deficit ranges from 14,6%

(*Cornus mas*) till 25% *(Aucuba japonica)* depending on drought-resistance of study cultivar. The line of relative drought-resistance has the following order:

Cornus mas ← *Viburnum tinus* ← *Chimonanthus praecox* ← *Buxus sempervirens* ← *Euonymus japonica* ← *Laurocerasus officinalis* ← *Pittosporum heterophyllum* ← *Aucuba japonica*.

Study results obtained by suggested method coincide with results by measuring method of a leaf plate thickness.

One of parameters for drought-resistance determination is a coefficient of water stress. This parameter is measured by a sensor for measuring of linear velocity in a plant trunk in the morning and afternoon [5, 14].

Allowing for a definite geometry of elements linear velocity of xylem stream is calculated by the following formula (2):

$$V = C/to \qquad (2)$$

V – linear velocity, sm/h;

C – constant coefficient;

to – time of pulse advancing between heater and microthermocouple of the sensor (h).

Results of these investigations are presented in table 4. According to them, coefficient of water stress ranges from 0,68 (xerophytes, *Cornus mas)* up to 0,9 (mesophyte, *Aucuba japonica).*

Table 4

Interconnection between coefficient of water stress and drought-resistance of study plant cultivars (28-29.08.2014)

Plant cultivar	Vmorn., rel.unit.	Vnoon, Rel.unit	C, coefficient of water stress	Ecological group
Cornus mas	6,8	12,9	0,68	xerophyte
Viburnum tinus	9,6	13,8	0,69	xerophyte
Pittosporum heterophyllum	9	12,8	0,703	xero-mesophyte
Euonymus japonica	8,5	12	0,708	xero-mesophyte
Buxus sempervirens	9,3	12,8	0,72	xero-mesophyte
Laurocerasus officinalis	11	13,5	0,8	xero-mesophyte
Chimonanthus praecox	10	12	0,83	xero-mesophyte
Aucuba japonica	13,6	15	0,9	mesophyte

A line of drought-resistance for study plant cultivars:

Cornus mas ← *Viburnum tinus* ← *Pittosporum heterophyllum* ← *Euonymus japonica* ← *Buxus sempervirens* ← *Laurocerasus officinalis* ← *Chimonanthus praecox* ← *Aucuba japonica*.

This line keeps the same regularity of variations as previous measuring results have, though methods are different.

Having compared measuring data as a result of three different methods, it`s possible to assess level of their sensitiveness [4]: variation range of a leaf plate thickness for study cultivars makes 14,2% applying method of measuring of a leaf plate thickness; using method of determination of xylem moisture deficit variation range of this parameter made 10,4%;

having applied method of determination of water stress coefficient this range was 22%. Investigation of water regime and drought-resistance peculiarities demands to consider that the most sensitive for this measuring is method of determination of water stress coefficient, the least sensitive – determination of xylem moisture deficit.

These findings permit to clarify well-known facts about water regime and drought-resistance peculiarities of study plant cultivars presented in scientific literature and of course recommend them for cultivation in a certain geographical region.

Conducted investigations shows that solution of such task demands absolutely new methods in diagnostics of resistance relying on study points on physiology of adaptation.

One of such methods which makes it possible to investigate comprehensively state and functions of plant objects in the system soil – plant – atmosphere is phytomonitoring that is methodology of plant study applying informational and measuring systems [8]. Parallelism and wide diversity of fixed parameters in phytomonitoring methodology create material base for systematic analysis of plant properties and state. Such analysis permits to concentrate at basic functional plant subsystems, which are necessary in solution of scientific and practical problems of ecological physiology and make it possible to provide dedicated selection of such a complex of measuring values.

At the same time developed methods of diagnostics peculiarities of water regime and relative drought-resistance can be useful for assessment of properties and selection of cultivars, the most adapted to the certain conditions of cultivation.

Conclusions

Described scientific investigations permit to make the following conclusions.

Different amplitude of diurnal variation of plant organ watering is determined not only by external condition changes but plant cultivar otherwise their genotypical properties. It permitted to develop a new estimation method of xylem moisture deficit, which makes it possible to investigate some ecophysiological characteristics of arboreal plants.

Applying express-methods a line of study cultivars was successfully differentiated according to their peculiarities of water regime and drought-resistance. The line clarifies some ecophysiological characteristics presented in scientific literature.

The study results permit to recommend these plant species for cultivation under conditions of a certain region on South Coast of the Crimea allowing for its microclimatic characteristics.

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Plugatar Yu.V., Ilnitsky O.A., Kovalyov M.S., Kosakova S.P. Ecophysiological characteristics of some shrub cultivars in the lower layer growing under conditions of parks microclimate on South Coast of the Crimea // Bull.of the State Nikit.Botan.Gard. – 2015. - № 115. – P.5-12.

During this research water regime and drought-resistance of ten shrub cultivars growing in Arboretum parks in Nikitsky Botanical Gardens under conditions of lower layer microclimate were analyzed. There were three express-methods in use which permit to obtain plant ecophysiological characteristics. As a result of conducted investigations well-known from scientific literature peculiarities of their water regime and drought-resistance were clarified. According to these parameters relative drought-resistance of studied cultivars was differentiated. This differentiation makes it possible to recommend these species for cultivation in a definite region on South Coast of the Crimea allowing for its microclimatic characteristics. Relative sensitivity of applied methods was emphasized in terms of the scientific investigations. Phytomonitoring, as a new direction in science permits to solve the given tasks.

Key words: *express-methods; peculiarities of water regime; drought-resistance; sensitivity of methods; phytomonitoring.*

FLORA AND VEGETATION

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TRITICUM BOEOTICUM (*POACEAE*) AS A BOTANICAL AND HISTORICAL PHENOMENON OF THE CRIMEAN FLORA

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Introduction

Crops origin is considered as a process of wild cultivar selection being under human control or their evolution in a case of accidental hybridization. After laws of genetics were disclosed, centers of diverse of economically useful plants, which coincided with sites of ancient civilizations, were emphasized. As to another study direction it became a search of probable genetic combinations, which could cause breeding of modern agricultural cultivars.

In the Crimea there is a plant, probably the ancestor of cultivated wheat - *Triticum boeoticum* (Boiss.). Disjunctive areal of this species is traced from steppe outskirts of the Kerch and Feodosia till towns of the eastern foothills: Stary Krym, Sudak and further – to the western foothills in direction of Belogorsk region and to southwest – points of intermontane lowering between inside range and foothills of the Crimean mountains – to Bakhchisaray, Baidarskaya valley, Balaklava [6].

In the Crimea population of this cultivar was registered in XIX. On the start of XX wild einkorn was often found in the area of Baidarskaya valley. Later this cultivar was out of botanical field for decades. At the beginning of 80-ieth the largest population of this species, that is millions of plants, was fixed in outskirts of Orlinoye village (ex-Baidary) [2]. Till 90-ieth the species was “lost”. Nowadays it is spread all over the whole Baidarskaya valley, near Sevstopol [1, 3] and in the Eastern Crimea.

“Appearance” and “dropping” of this wheat cultivar in the Crimea demand special approach and understanding. In the end of 90-ieth when this species occurred very seldom, authors of this article started searching of *Triticum boeoticum* in Baidarskaya valley – the region where it was found most frequently. It was interesting to reveal it in ecotopes with similar origin, named as “outskirts”. As it turned out present outskirts of Orlinoye had moved to the central square of the village, where next to vegetable gardens many thousand population of wild-einkorn was found. This cultivar of wild einkorn, which was looked for in natural condition of phytocenosis on “dry and herbaceous slopes” [2, 6], quite selectively and abundantly occupied “outskirts” inside of the village [3], as well as on agricultural lands with a high level of underground water. It was revealed that such a circumstance characterizes and other villages of Baidarskaya valley and suburbs of Sevastopol [1].

Results and discussion

Wheat (*Triticum* genus) belongs to the family of bluegrass (*Poaceae).* Diversity of the wheat consists of 27 cultivars. Genetically 4 groups are strictly emphasized in the genus. *Triticum boeoticum* – belongs to diploid group, somatic cell of plants contains 14 chromosomes. This group includes the following cultivars: *Triticum aegilopoides* Link. –, *Tr. monococcum* L. –, *Tr. urarthu* Tum. [6].

Hard wheat (*Tr. durum* Desf.) – the group of tetraploid wheat (somatic cells contains 28 chromosome) is considered to appear after natural complicated synthesis of some cultivars and further integration of chromosome sets of wild einkorn and goat grass (Aegilops) in northeast Africa [5, 6].

Wheat species (einkorn, amelcorn, soft and club wheat) got in the Crimea before the beginning of Greek colonization during Late Neolithic and Eneolithic [7]. Later during ancient times wheat from the Kerch peninsula and northwest Crimea was in a great demand in Greece and West Mediterranean. Grains for export were provided by cities of Bosporan Kingdom (Mermiky, Panticapaeum, Tyritake and etc.) and west Crimea (Kalos-Lyman). Grain stores were in use during the whole ancient époque in Panticapaeum. Since 387 till 347 BC 125 thousand tones of wheat grain were exported from the Crimea. Sometimes this number reached 25 thousand tones. Bosporan cities paid tribute to Pontic king Mithridates – 8 thousand tones per year [5]. It means that crop capacity and nutritional value of any wheat culture[1] during ancient times considerably exceeded the same parameters for wheat in Asia Minor and Balkans.

Migration and cultivation of Caucasian wheat cultivars caused wheat spreading all over the Crimea during the early agriculture [7]. In the antique period cuvarslt from Balkans, Asia Minor and Transcaucasia were replenished to the Crimean wheat cultivars. In case if that was caused by Greek-colonists, then arrival from Asia Minor was the principal, as the largest and only Greek colonies in the Crimea were founded by emigrants from Miletus – Panticapaeum and Sinope - the Chersonese. Wheat species from Balkans could got the Crimea during Roman colonization of South and Piedmont Crimea [5]. Well-known wheat cultivars couldn`t yield so much in the Crimea to exceed needs of the local population. During Middle Ages export of wheat from the Crimea stopped and didn`t recommenced [5]. Growing of all modern wheat cultivars and varieties in the Crimea is limited by local ecological conditions.

It`s a well-known fact, that any certain cultivar has its own biological qualities grounded genetically, which reveal as its ecological and biological taxonomic characteristics. The characteristics serve as a cultivar response to complex of various ecological factors: favorable, neutral or unfavorable.

Chernozem and dark brown soils are the best ground for wheat cultivation. Not so favorable are chestnut alkaline and brackish soils – common for Steppe Crimea and the Kerch peninsula.

Autumn and spring in Steppe and Piedmont Crimea are quite auspicious for wheat cultivation. While in winter a lack of snow cover is often fixed and in summer dry conditions is a common phenomenon. Strong winds ablate above ground parts of plants by soil fractions and dehydrate roots by dry, hot or frosty air.

Summer aridity of climate in Steppe Crimea causes unstable wheat crop capacity even applying modern technology for its cultivation. As it grows demand for moisture rises as well; the most intensive need in moisture occurs during phase of stem elongation. If there is a lack of moisture the wheat plants are characterized by short stems, small leaf surface, low-yield ear. During ear-formation and blossoming phases moisture requirement is also high though formation and growth of above ground organs doesn`t occur. In case of moisture deficit a number of embryonate flowers in an ear reduces dramatically, conditions for grain formation become worse, weak grains develop. [5].

According to complex of the main soil and climatic indices conditions of wheat growing in Steppe Crimea give in the natural conditions in forest-steppe zone of Ukraine.

[1]According to paleontobotanical data during the ancient epoch in the Crimea *Triticum aestivo-compactum* Schiemann [7], club wheat was cultivated for export [7].

Crop capacity in the Crimea makes 28,0 centner/ha, while in Poltava – 29,5 centner/ha,

Cherkassy – 32,5 centner/ha, Chernigov – 35,6 centner/ha, Zakarpatye – 36,5 centner/ha (1991-1995) [5]. As to *Triticum boeoticum* it`s a quite warm and moisture-requiring cultivar during ear-formation and blossoming. Its ear-formation phase takes place in the second half of May, blossoming – in the end of May and June. It means that maximum moisture requiring for cultivar development in the Crimea falls at the beginning of droughty season.

Triticum boeoticum needs extra sources of moisture for yield formation. It belongs to ecological group of xeromesophytes [1, 2, 4], what makes this cultivar growing next to reservoirs, as a part of moisture-requiring vegetation, impossible. On the territory with more xerotic conditions – "on dry slopes" - *Triticum boeoticum* needs either repeating rainfalls or regular extra irrigation from other sources. Just this factor grounds location of wild einkorn within the Crimean piedmont areas, as there an amount of precipitation is larger in the beginning of summer.

North outskirts of cultivar growing are located in large cities – the Kerch and Feodosia. Perhaps here thermal regime is more favorable for wintering of *Triticum boeoticum*. It is known than bigger settlement is, than it radiates more thermal energy into environment, forming distinctive microclimate. To southwest settlements are smaller and climate is milder accordingly.

Ecological balancing of droughty for this cultivar development conditions in the beginning of summer serves occasionally moistened country roads – places of cattle driving, slightly moistened area of drainage systems, outskirts of irrigated cities.

There is a question if the wild einkorn is a native cultivar of the Crimean flora – autochthon or it is an alien – allochthon. According to nowadays climate this kind of wheat has an allochthonic origin. It`s worth to note its location: the Kerch, (Panticapaeum), Feodosia (Kafa), Sudak, Stary krym, Belogorsk (Karasubazar), Bakhchisarai, Balakklava, Sevastopol (the Chersonese). All these cities (besides Balaklava) were large trade centers in the Crimea during antique and Middle Ages. If to connect these cities in one line, it`s possible to follow the ancient land transit trade routes along the peninsula. Intensive usage of these routes by caravans with grain crops including could cause introduction and fixation of wild einkorn in the key points of stops and trading.

Conclusions

Therefore, taxon being included into Red Data book of Ukraine, connected with anthropogenic environment could be considered as an ordinary for regional flora cultivar of ruderal nature. That is why it doesn`t need to be protected by traditional for rare cultvars methods: limitation of "anthropogenic activity" on its locations, "reserving" of population growing – "dumps, country roads and forest belts", forbidding of cattle grazing [2, 5]. Quite the contrary, spreading and development of *Tr. boeoticum* completely depend upon the complex of various anthropogenic effects. Botanical value of wild einkorn differs from other cultivars with a special protective status. Cultivar of *Tr. boeoticum* in the Crimea is a botanical and historical phenomenon. It is as valuable for the Crimean nature as antique artifacts or medieval fortresses are for its History.

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Methods of rare species protection usually function as preservation of plant localities and minimization of anthropogenic influence on these ecotopes. These methods are not always effective concerning rare species of allochthonic origin. Study case of such a cultivar is *Triticum boeoticum* (Boiss.). North edge of this cultivar disjunctive area occupies regions of Steppe, Mountain and Piedmont Crimea. Present isolation of this wheat population in the Crimea is historically grounded. All well-known habitats have anthropogenic origin while townships where these plants were found, are nothing but settlements along ancient trade roads. These circumstances permit to suppose allochthonic origin of this cultivar in the Crimea. Special combination of factors, non-typical for the Crimean nature is necessary for growing of the studied wheat cultivar. These factors are formed sporadically being influenced by different local anthropogenic changes of environment.

Key words: *the Crimea; Triticum Boeoticum (Poaceae); origin; protection.*

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TAXONOMIC DIVERSITY OF FLORAL COMPLEXES ON THE TERRITORY OF GRAZING ECOSYSTEMS IN SOUTHEAST OF UKRAINE

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Introduction

One of the most important task for present science is revealing the scale and degree of changes in natural ecosystems caused by anthropogenic effects, determination the ways of balancing usage and renewal of natural resources, their renaturalization and return into the field of rational nature management. Grazing ecosystems, as historically generated under conditions of traditionally economical usage anthropogenic complexes of landscape, are of

great importance for formation and preservation of biodiversity. Southeast of Ukraine (Donetsk and Lugansk regions) – common anthropogenic transgenerated area where a high degree of tilled territory and unsystematic grazing determine natural steppe and meadow phytocenosis as they are [6]. Investigation of flora and vegetation in that area permitted to assess current status and develop bases of renewal and rational management of grazing ecosystems in Southeast of Ukraine [20]. This article presents analysis of taxonomic diversity of floral complexes of grazing ecosystems in that region.

Objects and research methods

Considering vegetation cover as an integral form of structural and functional organization of phytobiota from two sides (qualitative – floristic, and quantitative – phytocoenotical), it serves as a theoretical ground for investigations [14]. Basic category is considering phytosystem as an actual unlimited, relatively discrete, structural and functional element of vegetational cover, that is specimens, populations, cenosis, ecotopological floral complees, floras. Within our investigations we take "ecosystem" as "complex of coenotic heterogenic phytocenosis, developed under similar conditions of macroecotope and edaphotope". Grazing ecosystems are considered as natural and anthropogenic ecosystems, their status and development totally depend upon external factors (regulated and unregulated cattle pasture, mowing and etc.) [20]. According to concept of B.V. Vinogradov [5] such ecosystems belong to half-natural and transformed section of ecosystems. Investigated region consists of steppe and meadow lands out of protected territories, which play a great role for preservation of general biodiversity in the regional phytobiota [18, 19]. Southeast of Ukraine is situated in the subzone of rich in herbs-fescue-mat-grass steppes of Priazovsko-Chernomorskaya subprovince of Prichernomorskaya (Pontic) steppe province in European-Asian steppe region [15]. Total area of natural steppes and meadows in Donetsk region makes 705,9 thousand ha (14% of total area), while 652,3 thousand ha are used for grazing, 53,6 thousand ha – for haymowing [1].

Developed for Southeast of Ukraine classification of natural ecosystems [7] is based on methodological approaches, which determine ecotope ("actual ecosystem of topological (landscape) level… in geobotany it is phytocenosis" [9]), as the minimal key unit for classification [10, 11]. The main ecosystems of that region were marked out based on macroecotopical (water divide, ravine and gully, above-flood-terraced, flood) [2] and edaphotopical (advanced chernozems, eroded chernozems on clay, granite, limestone, sandstone and chalk outcrops and etc., sandy and meadow soils) connection applying of developed syntaxonomical scheme of the regional vegetation [17]. 10 of these ecosystems are grazing: 6 steppe (forming on watershed on advanced chernozem, ravine and gully (on slopes) – on eroded chernozem on clay, ravine and gully – on eroded chernozem on granite outcrops, ravine gully – on eroded chernozem on limestone outcrops, above-flood –terraced – on sandy soils, above-flood-terraced – on eroded chernozem on chalk outcrops) and 4 meadow (ravine and gully steppificated – on eroded chernozem, actual flood – on meadow soils, flood marsh – on over-moistened soils and flood – on salted soils).

Flora of grazing ecosystems is an anthropogenic variant of the regional flora, that unites types of anthropogenic and transformed floras: exhausted flora capable to renew and tame flora of half-natural ecotopes, which must consist of cultural or introduced plant species. In functional scheme of pointed forming of anthropogenic flora transformation they are balancing given loss [2, 3]. Flora is considered as a complex of cultivars, presented on that territory that is a system of local populations of all plant species.

So long as flora has geographical nature, but not topological or typological one, topological units of flora are named as floroecotopological complexes (or ecotopological florocomplexes). Ecotopological florocomplexes, by V.V. Novosad [16] with notes of A.A.

Kagala [12, 13], are floristic elements of internal landscape (topologic) level, formed due to complex of local plant populations with complementary adaptive properties; they form cenosis based on ecological correspondence to growing conditions. Classification of elemental floras into different topological branches by their quality [8] makes it possible to analyze ecotope parameter variations and dynamics of space and cultivar structure of cenosis. It`s possible to say if flora is considered as a system of interacting and simultaneous evolution of the local populations, therefore phytocenosis can be taken as a vegetation component of ecotopes.

Hence objects of our investigations were ecotopological floral complexes of grazing ecosystems, forming under certain conditions of macro- and edaphotope (for instance, floral complex of steppe ecosystems on watersheds with chernozem soil).

Researches had been carried out on Southeast of Ukraine since 1998 till 2001 applying route method with thorough half-stationed investigation of floras-isolates, diversity of the vegetation cover within them was also taken into account. According to inspections annotated summaries of plant cultivars of floral complexes from 10 variants of grazing ecosystems were made.

Taxonomic diversity was considered as a diversity of vascular plants according to phylogenetic similarity; it was determined due to its quantity and spectrum of taxons from different ranks – cultivar, family, order, class, and division. Occurrence of taxonomic diversity was revealed by species diversity which became the basic in terms of this investigation. Study of similarity degree of floral complexes was conducted applying method of group average with square of *Euclidean distance and similarity coefficient [4]*.

Results and discussion

According to results of critical investigation, flora of grazing ecosystems consists of 1104 cultivars from 357 genera 68 families and 46 orders. In floral complexes of steppe grazing ecosystems there are 731 cultivars of vascular plants (66% of total flora), in meadow – 597 cultivars (44%), 174 cultivars (15%) are common for meadow and steppe ecosystems.

The general species composition of flora is quite conservative and underreacts the environment transformation. The most informative and integral parameters of dynamical tendencies are structural connections of ecotopological floral complaxes. These complexes are possible to consider as formal systematic elements, their interconnections are reflected by regularities of structural and functional organization of phytobiota during adaptation to ecotopical differentiation of landscapes. Specific occurrence of their response to environmental variations is changing of their composition, structure and connections between floral coenotical complexes, developing in certain ecotopes.

The most various species composition is appropriate for floral complexes of steppe cenosis, forming on watersheds with advanced chernozem and on slopes with eroded chernozem on clay (399 cultivars of 191 genera and 49 families, 426 cultivars of 220 genera and 50 families respectively); floral complexes of meadows with over-moistened and saline soils (139 species of 63 genera and 28 families, 117 species of 63 genera and 21 families respectively) are characterized by the poorest species composition (table 1). As to steppe grazing ecosystems floral complex of sandy steppes are marked by the poorest species diversity: 242 cultivars of 148 genera and 34 families.

As well as floristic variety which is determined by quantity of cultivars, genera and families, systematic structure of floral complexes is a quite important characteristic. Systematic structure as a system of local geographical populations of all spontaneously grown plants, with hierarchical structure [22], is an indicator of vegetation cover state in a certain environment. Studied floral complexes are presented by angiosperm plants, mainly bilobular, which makes 5-7 times more than monocotyledonous in floral complexes of steppe

ecosystems and 10 times more in floral complexes of stepped meadows. In floral complexes of meadow ecosystems availability of *Liliopsida* cultivars is much higher. An average species diversity per 1 family ranges from 5 (floral complexes of ecosystems on marsh and saline meadows) up to almost 9 (floral complexes of steppes with eroded chernozems on clay). A number of cultivars per genus doesn`t increase 2 (see table 1).

Table 1

Systematic structure of floral complexes of grazing ecosystems

Parameter	Grazing ecosystems									
	WCh	RGCh	RGG	RGL	OTCh	OTS	SM	FAM	SM	MM
A number of divisions	3	3	3	3	3	3	2	2	2	2
classes	4	4	4	4	4	4	3	3	3	3
orders	33	34	29	31	29	27	32	31	19	26
families	49	50	42	40	39	34	40	39	21	28
genera	191	220	174	170	172	148	168	157	63	63
cultivars	399	426	336	303	322	241	296	296	117	139
A number of cultivars per a family	6,9	8,5	8	7,6	8,5	7,1	7,4	7,6	5,6	5,1
A number of cultivars per genus	2,1	1,9	1,9	1,8	1,9	1,6	1,8	1,9	1,8	2,2
Ratio of Magnoliopsida: Liliopsida	6 : 1	6 : 1	5 : 1	5 : 1	6 : 1	7 : 1	10 : 1	4 : 1	2 : 1	2 : 1
Asteraceae: Poaceae	2 : 1	2 : 1	2 : 1	2 : 1	2 : 1	2 : 1	3 : 1	1 : 1	1 : 1	1 : 1
Asteraceae: Fabaceae	3 : 1	3 : 1	3 : 1	3 : 1	3 : 1	5 : 1	2 : 1	1 : 1	1 : 2	-

Notes. *Hereinafter: steppe grazing ecosystems: WCh – on watersheds with advanced chernozem, RGCh – ravine and gully with eroded chernozem on clay and slates; RGG – ravine and gully with eroded chernozem on granites; RGL – ravine and gully with chernozem on limestones; OTCh – over-flood – terraced with eroded chernozem on chalk; OTS – over-flood – terraced on sands; meadow: SM – stepped on eroded chernozem, FAM - flood actual with meadow soils, SM – flood with saline soils, MM – flood-marsh with over-moistened (marsh) soils.*

In floral complexes of steppe ecosystems there are about 10-11 main families which number of cultivars is more than average; floral complexes of steppe meadows – 11, flood actual – 12, saline – 7, mars – 11 (table 2). Families *Asteraceae* (the first place in family spectrum of all floral complexes besides marsh meadow, where it takes the second stage) and *Poaceae* (the second-third place in all family spectrum besides floral complexes of stepped meados – the sixth stage) are characterized by the most various floral composition. A high rank is inherent for family *Brassicaceae* as well.

Table 2

Family spectrum of floral complexes in grazing ecosystems

Family	Grazing ecosystems*									
	WCh	RGCh	RGG	RGL	OTCh	OTS	SM	FAM	SM	MM
Asteraceae	**1** (80)	**1** (73)	**1** (50)	**1** (43)	**1** (51)	**1** (45)	**1** (50)	**1** (39)	**1** (19)	**2-3** (12)

Poaceae	**2** (40)	**3** (40)	**2** (36)	**2** (33)	**3** (30)	**3** (29)	**7** (15)	**2** (33)	**3** (14)	**1** (13)
Brassicaceae	**3** (37)	**2** (44)	**3** (29)	**4** (29)	**2** (38)	**4** (21)	**2** (37)	**6** (14)		
Lamiaceae	**4-5** (25)	**5** (28)	**6** (23)	**6** (19)	**4** (28)	**5-6** (10)	**10-11** (9)	**8-9** (11)		**4-5** (9)
Fabaceae	**4-5** (25)	**7** (25)	**7** (18)	**7** (17)	**5** (26)	**5-6** (10)	**3** (29)	**3** (31)	**4-6** (8)	
Rosaceae	**6** (22)	**8** (22)	**4** (27)	**5** (20)	**6** (20)	*11 (6)*	**9** (11)			
Scrophulariaceae	**7** (18)	**6** (24)	**8-9** (14)	**9** (12)	**8-9** (12)	**7-8** (8)	**6** (16)	**4-5** (16)	**6-9** (7)	
Caryophyllaceae	**8** (14)	**4** (29)	**5** (24)	**3** (32)	**7** (14)	**2** (40)	**4** (24)	**4-5** (16)	**7** (7)	
Boraginaceae	**9** (12)	**10** (14)	**10** (12)	**10** (10)	**10-11** (8)	**7-8** (8)	**8** (13)			
Ranunculaceae	**10** (11)	**9** (19)	**8-9** (14)	**8** (14)		**10** (7)	**5** (19)	**7** (12)		**6-9** (7)
Rubiaceae					**10-11** (8)	**9** (6)	**10-11** (9)	**5** (14)		**10** (5)
Polygonaceae								**10** (10)	**9** (5)	**6-9** (7)
Cyperaceae								**8-9** (11)	**4-6** (8)	**2-3** (12)
Juncaceae									**4-6** (8)	**4-5** (9)
Chenopodiaceae									**2** (15)	
Plantaginaceae									**8** (6)	
Apiaceae									**10-12** (3)	
Gentainaceae									**10-12** (3)	
Eguisetaceae									**10-12** (3)	
Orchidaceae										**6-9** (7)

**A number of cultivars is in brackets*

If agreed control variant is a steppe floral complex, developed on the watershed of advanced chernozem, having compared it with family and genus spectrum of other floral complexes, it makes possible to reveal adaptive properties of certain plant cultivars to definite conditions of macro- and edaphotope. So, in floral complexes of steppe grazing ecosystems, developed on slopes of gullies with eroded chernozem on clay, a number of cultivars belonging to the following families increases: *Brassicaceae* (2 stage/44 species) and *Caryophyllaceae* (4/29); while a number of cultivars of *Fabaceae* family decreases (7/25), which is caused by severe edaphic conditions. The same tendency and considerable increasing of *Rosaceae* rank occur in floral complexes of steppe ecosystems with eroded chernozem on limestone and granite outcrops (4/27 and 5/20 respectively). Rank of *Caryophyllaceae* has considerable trend to go up (2/40) in family spectrum of sandy steppe floral complexes, while *Rosaceae* family didn`t become a part of this floral complex family list, consisting of much more cultivars in comparison with average index. Family spectrum of floral complexes in steppe ecosystems on chalk outcrops is mainly identical to agreed control (see table 2).

As to floral complex of stepped meadow ecosystems the following families take leading positions: *Asteraceae* (1 place/50 species), *Brassicaeae* (2/37) and *Fabaceae* (3/29). *Poaceae* family takes only sixth place, at the same time *Lamiaceae* and *Rubiaceae* considerably goes down. The main families in floral complexes of flood actual meadows are *Asteraceae* (1 place/39 species), *Poaceae* (2/33), *Fabaceae* (3/31); *Cyperaceae* and

Polygonaceae appear in this spectrum as well. In floral complexes of saline and marsh meadows the following families takes confident leading positions: *Chenopodiaceae* (2/15 and 2-3/12 respectively), *Cyperaceae* (4-6/8 and 2-3/12) and *Juncaceae* (4-6/8 and 4-5/9); but family *Fabaceae* isn`t included into floral complex of marsh meadows (see table 2).

Species diversity indices of some family pairs being "indicators" of large floristic divisions are quite informative [21]. So, ratio of species number of *Asteraceae* to *Poaceae* in floral complexes of steppe ecosystems and floral complexes of stepped meadows makes 2:1, in other meadow floral complexes this ratio is 1:1 (see table 1). Ratio of *Asteraceae* and *Fabaceae* ranges from 3:1 (steppe ecosystems) up to 5:1 (stepped meadows) (for regional flora ratio of these families species number makes 2,3:1 [2]. In floral complexes of meadow ecosystems this ratio varies in favor of *Fabaceae* family (besides floral complexes of meadows with over-moistened soils, which don`t include species of this family). Therefore, floral complex of stepped meadows is close to floral complexes of steppe ecosystems according to study floristic parameters, while in other floral complexes of meadow ecosystems monocotyledonous plants prevail and a number of species belonged to *Fabaceae* and *Poaceae* families extends.

More complete internal structure and specific characteristics of floral complexes are presented in genus spectrum (table 3).

Table 3

Genus spectrum of floral complexes in steppe grazing ecosystems

Genus	Grazing ecosystems					
	WCh	RGCh	RGG	RG	OTCh	OTS
1	2	3	4	5	6	7
Centaurea	**1** (10)	**4-6** (7)	**5** (7)	**2-3** (8)	**8-10** (5)	**6-10** (4)
Rosa	**2** (9)	**7-10** (6)	**1** (11)	**1** (9)	**1** (9)	
Stipa	**3-5** (8)	**4-6** (7)	**3** (9)	**8-12** (5)	**2-7** (6)	**2-3** (6)
Veronica	**3-5** (8)	**1** (12)	**8–13** (5)		**2- 7**(6)	
Salvia	**3-5** (8)	**4-6** (7)		**5-7** (6)		
Galium	**6-7** (7)	**3** (8)	**4** (8)	**8-12** (5)		**4-5** (5)
Potentilla	**6-7** (7)	**2** (10)	**2** (10)	**4** (7)	**2-7** (6)	**2-3** (6)
Sisymbrium	**8-9** (5)					
Euphorbia	**8-9** (5)	**7-10** (6)			**8-10** (5)	
Astragalus	**8-9** (5)		**6-7** (6)	**2-3** (8)	**2-7** (6)	**6-10** (4)
Medicago	**8-9** (5)					
Vicia	**8-9** (5)					
Verbascum	**8-9** (5)	**7-10** (6)				
Cirsium	**8-9** (5)					
Inula	**8-9** (5)					
Dianthus		**7-10** (6)	**8–13** (5)		**2-7** (6)	**1** (7)
Elytrigia			**8–13** (5)			
Thymus			**8–13** (5)	**8-12** (5)		
Allium			**6-7 (**6)		**2-7** (6)	
Elythigia				**5-7** (6)		
Euphorbia			**8–13** (5)			
Isatis					**8-10** (5)	
Linum				**5-7**(6)		
Artemisia				**8-12** (5)		**6-10** (4)
Gypsophila						**6-10** (4)
Otites						**4-5** (5)
Tragopogon						**6-10** (4)

**A number of cultivars is in brackets*

The following genera include the largest number of cultivars in floral complexes of steppe ecosystems developing on watersheds with advanced chernozem: *Centaurea, Rosa, Stipa, Veronica, Salvia;* steppe ecosystems with eroded chernozem on clay*: Veronica, Potentilla, Galium, Salvia, Stipa, Centaurea.* As to ecosystems with granite, limestone and chalk soils the leading places is taken by *Rosa* genus with some differences appeared in the following genera: granite soil - *Potentilla, Stipa, Galium, Centaurea,* limestone soil - *Centaurea, Astragalus, Potentilla, Salvia, Linum, Elytrigia,* chalk soil - *Stipa, Veronica, Potentilla, Astragalus, Dianthus, Allium*. Peculiarity of floral complexes developing on sandy substrate, quite clearly reveals genus spectrum, which differs from floral complexes of steppe ecosystems considerably: *Dianthus Potentilla, Stipa, Galium, Otites*. Genus spectrum of floral complexes in meadow ecosystems are characterized by wide species diversity. The main genera of floral complexes in stepped meadows are *Trifolium, Galium, Euphorbia, Ranunculus, Artemisia*; in flood actual meadows - *Trifolium, Ranunculus, Juncus, Carex, Galium;* saline - *Plantago, Juncus, Puccinella, Lithrum, Atriplex, Xanthium,* marsh - *Juncus, Carex, Galium, Ranunculus* (16% of the total number of cultivars) (table 4).

Table 4

Genus spectrum of floral complexes in meadow grazing ecosystems

Genus	Grazing ecosystems			
	SM	OM	SM	MM
1	2	3	4	5
Galium	**2-3** (7)	**4-5** (8)		**3-4** (5)
Potentilla	**6-10** (3)			
Veronica	**6-10** (3)	**6** (7)		**5-8** (4)
Artemisia	**5** (4)			
Festuca	**6-10** (3)			
Plantago	**6-10** (3)		**2-3** (6)	
Trifolium	**1** (12)	**1** (13)		
Carex		**4-5** (8)	**7-12** (3)	**2** (8)
Ranunculus	**4** (5)	**2** (10)		**3-4** (5)
Euphorbia	**2-3** (7)			
Juncus		**3** (9)	**2-3** (6)	**1** (9)
Poa		**7-8** (5)		
Centaurium		**7-8** (5)		
Rumex		**9-12** (4)		
Vicia		**9-12** (4)		
Pilosella		**9-12** (4)		
Lithrym		**9-12** (4)		
Atriplex			**1** (7)	
Puccinella			**4-6** (4)	
Xanthium			**4-6** (4)	
Lythrum			**4-6** (4)	
Seneceo			7-12 (3)	
Spergularia			7-12 (3)	
Cripsis			7-12 (3)	
Sisimbrium			7-12 (3)	
Persicaria			7-12 (3)	**5-8** (4)
Epilobium				**5-8** (4)
Dactylis				**5-8** (4)
Alisma				**9-15** (3)
Eleocharis				**9-15** (3)
Lythrum				**9-15** (3)
Glyceria				**9-15** (3)
Poa				**9-15** (3)

Thypha				**9-15** (3)
Mentha				**9-15** (3)

Method of group average applying square of Euclidean distance the cluster analysis of species composition similarity of floral complexes was conducted which revealed accurate classification of floral complexes into 2 clusters: steppe (floral complexes of all steppe ecosystems and floral complexes of stepped meadows) and meadow (floral complexes of actual, marsh and saline meadows) (Figure).

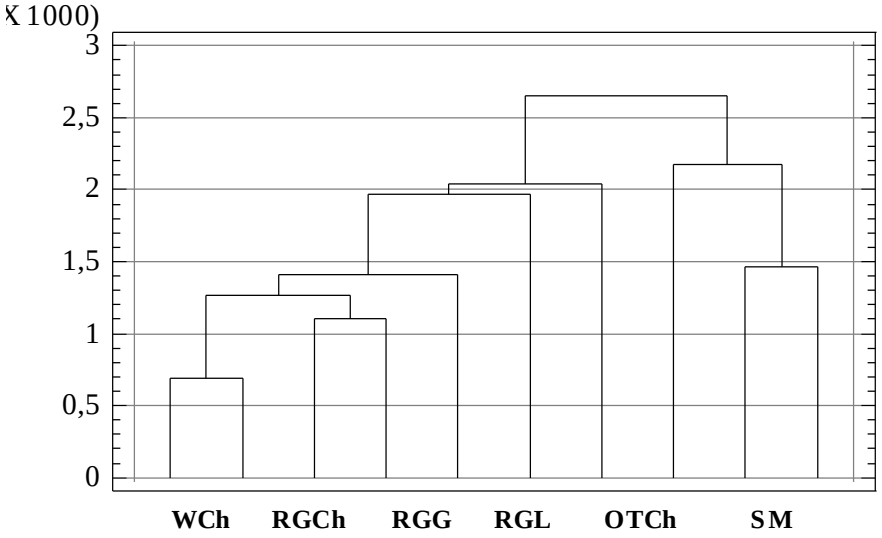

Figure. Similarity dendrite of floral complexes in grazing ecosystems in Southeast of Ukraine

Steppe cluster has a floral complex of steppes with sandy soil; meadow – saline soils, and that indicates specific conditions of their development. As a result of comparison analysis of floral complexes similarity applying similarity coefficient we have various diversity of floral complexes of meadows with saline and over-moistened soils, as well as floral complexes of sandy steppes (similarity index <0,3) (table 5). Similarity between floral complexes of actual and marsh meadows, stepped and steppe with eroded chernozem on clay is little bit higher (index <0,4). Similarity index for other floral complexes ranges from 0,5-0,6.

Table 5

Similarity indices of floral complexes in grazing ecosystems

	WCh	**RGCh**	**RGG**	**RGL**	**OTCh**	**OTS**	**StM**	**FAM**	**MM**	**SM**
WCh	1	0,6	0,5	0,5	0,5	0,3	0,4	0,07	0	0
RGCh	0,6	1	0,3	0,6	0,6	0,4	0,5	0,1	0	0
RGG	0,5	0,3	1	0,6	0,5	0,3	0,3	0,06	0	0
RGL	0,5	0,6	0,6	1	0,6	0,3	0,3	0,05	0	0
OTCh	0,5	0,6	0,5	0,6	1	0,3	0,3	0,05	0	0
OTS	0,3	0,4	0,3	0,3	0,3	1	0,2	0,08	0	0
StM	0,4	0,5	0,3	0,3	0,3	0,2	1	0,4	0,05	0,05
FAM	0,07	0,1	0,06	0,05	0,05	0,08	0,4	1	0,4	0,1
MM	0	0	0	0	0	0	0,05	0,4	1	0,1
SM	0	0	0	0	0	0	0,05	0,1	0,1	1

Conclusions

As a result of the conducted research of taxonomic diversity and systematic structure of floral complexes in grazing ecosystems of Southeast of Ukraine, the following should be noted: floral complexes of steppe ecosystems, developing on watersheds with advanced

chernozem and on slopes of ravines with eroded chernozem on clay are characterized by the largest floristic diversity (399 and 426 cultivars respectively), the poorest diversity is appropriate for floral complexes of meadow ecosystems with over-moistened and saline soils (139 and 117 species respectively). The following families include the largest number of species: *Astearceae, Poaceae* and *Brassicaceae. Fabaceae* family increases its rank in floral complexes of stepped and flood actual meadows, *Caryopyhyllaceae* family – in floral complexes of steppes with limestone and sandy soils. Floral complexes of steppe ecosystems with advanced chernozem include quite a lot of cultivar representatives of the following genera: *Centaurea, Rosa, Stipa, Veronica, Salvia;* for ecosystems with eroded chernozem on clay *Veronica, Potentilla, Gallium* take the leading positions; granite soils - *Rosa, Potentilla, Stipa;* limestone soils - *Rosa, Centaurea, Astragalus;* chalk soils - *Rosa, Stipa, Veronica, Potentilla, Dianthus, Allium;* sandy soils - *Dianthus, Stipa, Potentilla*; stepped meadows - *Trifolium, Galium, Euphorbia;* flood actual - *Trifolium, Ranunculus, Juncus;* flood with over-moistened soils - *Juncus, Carex, Galium, Ranunculus;* saline soils - *Juncus, Plantago, Lythrum, Puccinella, Atriplex, Xanthium*. Study of floral complexes similarity indicates the peculiarity of species composition of floral complexes in saline meadows and sandy steppes.

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Shevchuk O.M. Taxonomic diversity of floral complexes on the territory of grazing ecosystems in southeast of Ukraine // Bull. of the State Nikit. Botan. Gard. – 2015. – № 115. – P. 16-25.

The article covers study results of taxonomic diversity and systematic structure of ecotopological floral complexes on the territory of grazing ecosystems in southeast of Ukraine. In terms of the research it was determined that floral complexes of meadow grazing ecosystems are characterized by much less species diversity while a number of *Liliopsida* specimens increases there. Range peculiarities of families and genera and similarity measure of floral complexes were revealed. The most various range of families and genera are marked out for floral complexes of sandy steppes, bottomland meadows on over-moistened and saline soils.

Key words: *grazing ecosystems; ecotopological floral complexes; taxonomic diversity; systematic structure; range of families; range of genera.*

UDK 581.526.323 (477.75)

DEVOTED TO DISTRIBUTION OF FLOWERING PLANTS WITHIN OFFSHORE STRIP OF THE AZOV SEA (IN CONNECTION WITH THEIR INCLUSION INTO "RED DATA BOOK OF PRIAZOVSKY REGION")

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Introduction

Creating of Red Data Books and Lists is one of the most important elements in a complex of steps aimed at preservation and renewal the natural phytodiversity within separate countries and regions. "Red Data Book of Priazobsky region. Vascular plants / edited by PhD (doctor of biological sciences) V.M. Ostapko, PhD (candidate of biological sciences), docent V.P. Kolomijchuk. – Kiev: Alterpress , 2012. – 276 s.", which was published recently doesn`t have a legal status as the following publications have: "IUCN Red List of Threatened Species", "European Red List of Vascular Plants", "Red Data Book of Ukraine" and "Red Data Book Of Russia" [7, 33, 34]. At the same time role of "illegal" publications is important as well, as they, summarizing information on the regional level, are the basic to put rare taxons into international and national legal documents.

Publication of Red Data Book of Priazvsky region was preceded by a quite serious spadework, which involved specialists in Botany of leading scientific and research, scientific and pedagogical establishments of Ukraine and Russia. Supervisors of this project invited experts at expeditional and field investigations within Priazovye, and that permitted not only to compile published data but obtain original "first-hand" information. That`s why release of this publication is an extremely positive and global event. For sure it will favor efficiency and increasing of nature conservation steps which are taken on all possible levels to solve ecological problems of that region. At the same time this project has some faults as any serious one. Unfortunately on the stage of forming the book into essays devoted to flowering plants growing in coastal water area, false skeleton maps were used without agreement [23-27]. These figures have general idea neither with authorial versions of maps nor with real picture of taxon distribution. For example, *Ruppia maritime (*as other four "maritime taxons") cannot inhabit in the center of the Azov Sea , though published figure indicates the opposite [23: p.256]. As far as maps of rare species distribution are the most important element of nature conservation report, we made a list of corrections in this research (inset). But when mistakes were found out, a part of printed copies had been sold. Indicated incongruities have still mislead an unprepared reader (this book is intended for a wide audience) and naturally causes confusion of specialists.

That`s why purpose of this publication is to present distribution skeleton maps of five flowering plant taxons (*Ruppia cirrhosa* Petagna (Grande), *Ruppia maritima* L., *Zannichellia palustris* L. subsp. *polycarpa* (Nolte) K.Richt., *Zostera marina* L. and *Zostera noltii* Hornem.) in the coastal water area of the Azov Sea and the Kerch Strait.

Objects and research methods

In terms of this work analysis of the followings was carried out: private investigation results for 1990-2012 [15-22, 28-31] and literature data [1-6, 8, 10, 12, 13] concerning distribution of *Ruppia cirrhosa*, *Ruppia maritima*, *Zannichellia palustris* subsp. *polycarpa*, *Zostera marina* and *Zosterhe noltii* in Priazovsky region (coastal water area of the Azov Sea and north part of the Kerch Strait up to Tuzla island, including coastal lakes and lagoons)[2]. Applying nomenclature corresponds to "Vascular plants of Ukraine: A nomenclatural checklist" by Mosyakin S.L. [39]. Outline map of the region and approaches used for report "Red Data Book of Priazovsky region. Vascular plants" were applied during formation of skeleton maps.

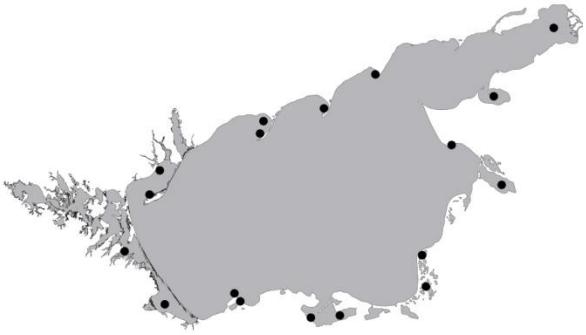
Results and discussion

Summary of original and literature data presents the following picture: *Ruppia cirrhosa*, *Ruppia maritima*, *Zannichellia palustris subsp. polycarpa*, *Zostera marina* and *Zostera noltii* – long-rhizomatous herbacious perinual plants with life cycle in aquatic environment (eugidatophytes) [9, 37, 41]. In Priazovsky region they don`t create dense growth and can be found in sublittoral of coastal water areas (mainly *Zostera* cultivars), and in coastal lakes and lagoons with different salinity level (besides seasonally drying up reservoirs as a rule) (fig.1). At depth of 0,2 – 3-5m their mono- and oligodominant cenosis occupy loose earth with different granulometric composition (from silt and sand, preferable environment for *Zostera* cultivars up to shell rock and gravel, more preferable medium for *Zannichellia*. Depending on biotope type, cenosis biomass ranges widely: from 0,2-05 – 3(5) kg/m^2. All mentioned taxons are characterized by fluctuation of biomass, number and morphometric parameters of shoots, which is connected with seasonal cyclic changes of the main hydrologic environmental characteristics; local changes caused by direct or mediated anthropogenic effect are registered as well. In general decreasing of growth area (either along the coast or going into depth) and reduction of principal population parameters take place in this region.

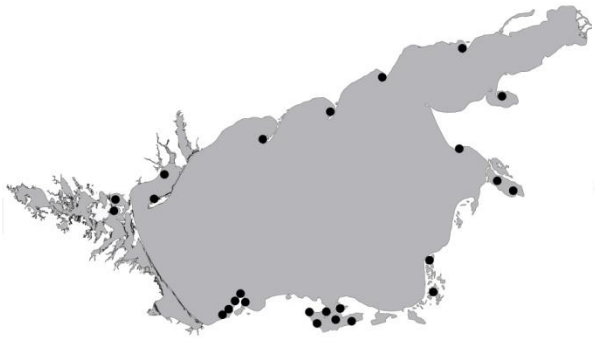
Cenosis of flowering plants create productional basis of coastal-marine and lagoon biotopes, which are characterized by abundant and diverse biota (including valuable marketable and rare cultivars of marine and coastal-marine fauna) which is preserved according to EU Habitats Directive (92/43/EEC; codes 1110, 1150 and 1160) [40]; growths slow down abrasion in the coastal zone and favor sedimentation and autopurification of water. Mass seasonal ejection of *Zostera* functions as a source of valuable raw materials to produce some components for building materials, fertilizers, feed additives and etc.

Anthropogenic activity as follows is as main threats as limiting factors which cause mechanical fragmentation and destruction of habitats or critical transformation of hydrologic regime of coastal marine water areas (regime of pumps and sedimentation, hydrodynamics, water transparency and other hydrophysical and hydrochemical parameters): build-up of the sea coastline including hydrobuilding, sand recovery and deposition, recreation, coastal fishery of hydrocoles by gears, eutrophication by household effluents and pollution from industrial enterprises and traffic infrastructure.

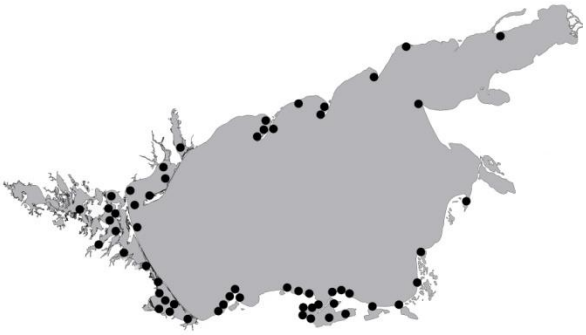
Distribution of *Ruppia cirrhosa Petagna* (Grande) fig.191.
(instead fig.190 p.254 [23])



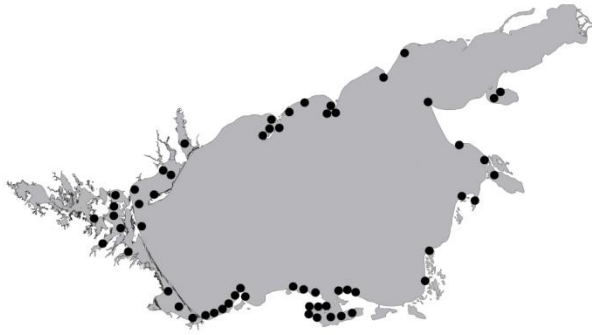
Distribution of *Ruppia maritima* L. (instead p.256, [24]).



Distribution of *Zannichellia palustris* L. subsp. *polycarpa* (Nolte) K.Richt. (instead fig.198 p.266, [25])



Distribution of *Zostera marina* L. (instead fig.199 p.268, [26]).



Distribution of *Zostera noltii* Hornem. (instead fig.200 p.271, [27]).

Fig.1 Maps of flowering plant distribution in Priazovsky region (coastal water areas of the Azov sea and north part of the Kerch strait up to Tuzla island including coastal lakes and lagoons)

Study taxons are presented in official and unofficial international, national and regional Red Data Books and Lists[3]: *Zostera marina* – ①③④⑤⑥⑦⑧; *Zostera noltii* – ①④⑤⑥⑦⑧; *Ruppia cirrhosa* – ①②⑥⑦; *Ruppia maritima* – ①②⑥⑦; *Zannichellia palustris* subsp. *polycarpa* – ②⑥⑦. They grow on boarders of preserve objects with different rank (from national up to local) [23-27]. Though protection in Priazovsky region is mainly declarative, special measures are not initiated.

Conclusions

Result analysis of private observations and special publications indicate that *Ruppia cirrhosa*, *Ruppia maritima*, *Zannichellia palustris* subsp. *polycarpa*, *Zostera marina* and *Zostera noltii* are still widespread in coastal water areas of Priazovsky region. But reduction of growth area, decreasing of the main population parameters as well as type of threats and protection level make them more and more vulnerable. As a result points of preservation and renewal of flowering plant growths along the sea coastline are of crucial importance in those countries where study taxons were considered as traditional object of trade. The most effective nature protective measure is making a reserve of water area where coastal biotopes with study taxons left (Directive 92/43/EEC). At the same time area of protected land and water objects with a high status should be increased.

[3]① - IUCN Red List of Threatened Species [38, 42-45]; ② – European Red List of Vascular Plants [34]; ③ - Convention on the Conservation of European Wildlife and Natural Habitats (Appendix I),; ④ – Black Sea Red Data Book [35]; ⑤ – Black Sea Red Data List [36]; ⑥ – Red data Book of Priazovsky region [23-27]; ⑦ – A list of plant cultivars being in need of species [otection on the territory of ARC (agreed res. VR ARC from 21.06.2013 № 1323-6/13), ⑧ –Red Data Book of Donetsk regon [32].

Creation of large national parks is the most effective measure. It will make possible to control and regulate forms and intensity of economic management not only within reserve territory but in region having touristic and recreational potential totally.

That is why publication of authentic information about their distribution within Azov and Black Sea region is actual and well-timed. Further researches make it possible to gain and clarify data in the matter. Creation of Red Data Books and Lists with different status is of great importance as well. Mentioned taxons were recommended for "List of plant cultivars being in need of special protection on the territory of Autonomous Republic of the Crimea" to include them into Red Data Book of the Crimea, which was renewed for development after 15-years break [11].

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Sadogursky S.E., Stepanjan O.V., Belych T.V., Sadogurskaya S.A. Devoted to distribution of flowering plants within offshore strip of the Azov Sea (in connection with their inclusion into "Red Data Book of Priazovsky Region") // Bull. of the State Nikit. Botan. Gard. – 2015. – № 115. – P. 26-31.

The article includes author`s versions of distribution skeleton maps of *Ruppia cirrhosa* Petagna (Grande), *Ruppia maritima* L., *Zannichellia palustris* L. subsp. *polycarpa* (Nolte) K.Richt., *Zostera marina* L., *Zostera noltii* Hornem. within offshore strips of the Azov sea and Kerch strait (coastal lakes and lagoons inclusive), so far as collective monograph "Red Data Book of Priazovsky region. Vascular plants" (2012) contains incorrect information.

Key words: *the Azov sea; the Kerch strait; flowering plants; distribution map.*

[3]① - IUCN Red List of Threatened Species [38, 42-45]; ② – European Red List of Vascular Plants [34]; ③ - Convention on the Conservation of European Wildlife and Natural Habitats (Appendix I),; ④ – Black Sea Red Data Book [35]; ⑤ – Black Sea Red Data List [36]; ⑥ – Red data Book of Priazovsky region [23-27]; ⑦ – A list of plant cultivars being in need of species [otection on the territory of ARC (agreed res. VR ARC from 21.06.2013 № 1323-6/13), ⑧ –Red Data Book of Donetsk regon [32].

ESSENTIAL OIL-BEARING AND MEDICAL PLANTS

UDC 633.812:577.118(477.75)

SOME ESSENTIAL ELEMENTS CONTAINED IN RAW MATERIALS OF LAVANDIN (*LAVANDULA HYBRIDA* REVERCHON) - NIKITSKY BOTANICAL GARDENS COLLECTION

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Introduction

Lavandin (*Lavandula hybrida* Reverchon) is an interspecific hybrid selected by natural or artificial crossing of *Lavandula angustifolia* Mill. and *L. latifolia* Medic. One of its distinctive features in comparison with origin cultivars is heterosis; that`s why it`s so interesting from the scientific point of view.

According to morphological, biological and economically valuable characteristics clones of lavandin occupy intermediary position between origin cultivars of *Lavandula angustifolia* Mill. and *L. latifolia* Medic.

The principal regions of lavandin cultivation are France, Spain, Italy, Morocco, Rumania [2, 10]. On the territory of CIS only Nikitsky Botanical Gardens deal with lavandin selection [13].

Favorable effect of lavandin on human is well-known for a long time. In the Ancient world and Middle Ages lavandin served as a medicine to treat contagious diseases, migraine, for wound and burn healing. Avicenne wrote in his work "The Canone of Medicine": "Lavandin decoction releases joint, nerve and rib pain. Its syrup is the most useful medicine to treat nerve disease. That`s why those who have weak nerves should take it regularly <…> Lavanda is a great helper to cope with melancholy and epilepsia …" (quote by Nuraliyev [11], p. 97).

Today literature also emphasizes sedative, anti-unflammatory and diuretic effect of lavender inflorescences [6], which are included into pharmacopoeia of 16 countries of the world [9].

Raw material used for medicine purposes is all over-ground part of lavender and its infloroscences which contain tanning agents, organic acids, flavonoids, coumarins, bitter stuff, furfural and essential oil.

Essential oil composition presents hydrocarbon, aldehyde, ketones, ethers and esters, oxides, more than 100 chemical compounds were identified. The principal components have the following concentration: α-pinene – 0,1 – 1,0%, limonene – 0,2 – 0,5%, 1,8-cineole – 0,1– 0,5%, linalool – up to 33%, linalilacetate – 32-53%, camphor – 0,2 – 1,5%, borneol – 1,4 – 3,0%, α- terpineol – 0,4 – 0,9%, nerol – 0,4 – 5,7%, lavandulol– up to 15%, geraniol – 0,5 – 1,8%, heranilacetate – up to 1,5%, bornilacetate – up to 0,7%, esters of linalool with valerianic, capronic, butyric and acetic acids (30-60%), tanning agents, coumarins, bitter stuff [3, 4, 12].

Lavender inflorescences are particularly popular in traditional Mediterranean cuisine for aromatization of smoked food, baked goods, sauces, preparation of aroma phytoteas. As a dressing it can be added to soups, snacks, fish dishes [6].

Lavender is a bee plant, 1 ha of plantations yields about 200 kg of honey [9].

Nowadays we have agrotechnology of lavandin cultivation, its morphological and biological properties, component composition of its essential oil having been thoroughly investigated. But lavandin plants of NBG selection haven't been studied for contain of essential [14] macro- and microelements, which are of value for human health.

It`s a well-known fact, a lack of essential macro- and microelements provokes disorder in absolutely all biochemical reactions of human body and work of organ system. <…> organism stops developing, isn`t capable to continue its biological cycle, as an instance it has disfunction of reproductive system. Introduction of missing element removes signs of its deficit and makes human organism viable again" [15]. For example, having a lack of iron a human body gets anaemia, deficit of calcium, magnesium and potassium causes heart attacks [1].

Therefore this research is aimed at investigating the ability of some vital for human mineral elements contained in over-ground part of marked out NBG selective forms Lavandin *(Lavandula hybrida* Rever.): Ca, Mg, K, Zn, Fe, Mn, Cu.

Concentration of this or that element capable to transform into extract, tincture, decoction or herb infusion wasn`t to study in terms of this work.

Objects and research methods

Investigation objects were interspecific hybrids F1 and F2 – results of True Lavender "Record" and "Prima" with amphidiploid lavandins.

Clone 71. (Amphidiplod x "Prima"). Plants are characterized by compact form, large size, height 85 sm, diameter up to 100 sm. Leaves are dark green, wide spear-shaped, by length 8-9 sm, width – 10-12 sm. Inflorescence is dense, discontinuous by length 9,5 – 12,5 sm. Flowers have a dark purple color. Yield makes 104,2 c/ha, mass fraction of essential oil is 2,7%, essential oil crop is 277,5 kg/ha.

Clone 53 (amphidiploids x "Prima"). Plants are compact, big-sized, length 85 sm, diameter - up to 100 sm. Leaves are dark green, wide spear-shaped with length 8-9 sm and width 10-12 sm. Inflorescence is dense, discontinuous by length 9,5 – 12,5 sm. Flowers are dark purple. Yield capacity is 77,7 c/ha, mass fraction of eesential oil makes 3,05%, essential oil crop capacity – 239,5 kg/ha.

Allotriploid № 101-84. (Amphidiploid "Record"). Plants are compact, big-sized, 85 sm by length, diameter is up to 100 sm. Leaves are oblong spear-shaped, length 7-10 sm and width 9-11 mm, dark green. Inflorescence is dense, discontinuous by length 6-7 sm with 10-12 verticils and 22-26 flowers on verticil. A number of flowers in an inflorescence reaches up to 300 units. Flowers have light blue color. Yield capacity makes 165-170 c/ha. Mass fraction of essential oil is 2,8%, essential oil crop capacity is 250 ha.

Allotriploid № 175-84. (Amphidiploid x "Prima"). Plants are compact, big-sized, height is up to 150 sm and diameter reaches 140 sm. The floral stems are long (85 sm), radiating from the bottom with branching of the 1st, 2nd, 3rd orders. Leaves are grey and green, oblong spear-shaped, 9-11 sm by length, width – 6-8 mm. Inflorescences are discontinuous, friable, 10-13 sm by length. An inflorescence contains 11-14 verticils, in turn one verticil has 14-24 light purple flowers. Yield capacity makes 75 c/ha. Mass fraction of essential oil is 3,0%, essential oil crop is 240 kg/ha.

Dry ashing of the plant inflorescences during the full blossom was carried out by method of Grishyna and Samoilova [5]. Contain of vital for human elements such as Ca, Mg, K, Zn, Fe, Mn, Cu was identified in the given hydrochloric acid solution applying atomic absorption spectrophotometer C-115 PKC.

Human need in this or that essential elements is quite individual and depends upon gender, age, physical activity, metabolism level and health in general. Nevertheless there are approved by dietology norms of the daily need in macro- and microelement ranged from

minimal necessary till maximum permissible. Contain of the study essential elements were compared with these norms in analyzed Lavandin specimens.

Results and discussion

According to our researches all analyzed specimens of lavandin deposit a lot of potassium [table 1).

Table 1

Concentration of some essential elements in lavandin specimens in mg/kg of the raw material

№	Specimen	Fe	Zn	Cu	Mn	K	Ca	Mg
1	Clone 71	0,82	0,33	0,11	0,164	13912,9	110,0	399,4
2	Clone 53	1,09	0,39	1,10	0,163	15988,5	109,0	70,0
3	Allotriploid №101-84	1,10	0,35	1,31	0,187	16063,0	111,0	139,0
4	Allotriploid № 175-84	1,03	0,28	0,12	0,170	27021,5	109,0	65,7
5	Daily human need* in mg	10-20	12-20	1,00 – 2,00	2,00 – 5,00	1300 – 3000	800 – 1600	500 – 750
*** Daily human need depends upon his age, gender and physical condition.**								

Even clone 71 with the smallest concentration of K among study specimens, deposits more than 4,6 maximum norms of the daily human need (NDHN) in this extremely important macroelement, what is much more than concentration in such recognized potassium sources as peaches, dried apricots, haws. Allotriploid № 175-84 has the highest content of potassium in comparison with all study cases – more than 9 maximum norms of the daily human need, what is twice as much than in dried apricots and 1,7 times much than in fruits of papaw, cultivar Victoria (Fig.1).

It`s a well-known fact that potassium is the most important intracellular element-electrolyte and an activator of some ferments functions. It`s necessary for cellular nutrition, muscle activity including myocardium, nervous control of heartbeats, support of the stable level of blood pressure, water-salt and acid-base balances, function of neuroendocrinal system. The principal signs of potassium deficit are hyperexcitability, hyperhidrosis, neurocirculatory dystonia, arrhythmia, intestinal colics and asthenia [8].

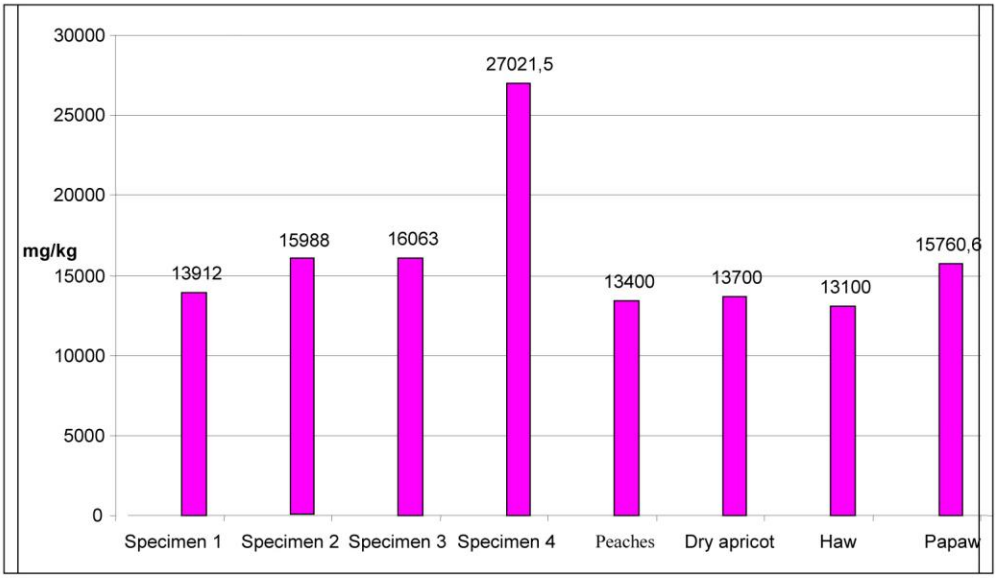

Fig.1 Comparative potassium content in recognized sources and in NBG collection lavandin raw material

Probably a high concentration of potassium caused this plant use for treatment of heart rate disorder as a sedative and spasmolytic remedy for a long time. [9].

The study specimens have a considerable difference in copper content. Its concentration rates from minimal – in Clone 71 (1/9 of minimal NDHN) – up to maximum – Clone 53 and Allotriploid №101-84, what is more than minimal norm of the daily need (Fig.2). So high concentration is of great interest, as in previous study specimens of fruit cultures copper content was registered and measured by hundredth of mg [7, 16]. Even in Clone 71 and Allotriploid № 175-84 with copper concentration of much less than in specimens 2 and 3,this number is 6-8 times as much than in fruits of ebony and 3 times as much than in fruits of papaw – a leader in content of biologically active substances (Fig.2). Copper is of great value for human health, as it participates in synthesis of haemoglobin, tissue respiration, connecting tissue metabolism, favors copper digestion, possesses bright anti-inflammatory effect. Copper guarantees normal function of nervous and immune systems. Copper deficit causes hyperexcitability of nervous system, mental and physical retardation of children, disorder of blood formation, scoliosis, osteoporosis and heart diseases [15].

Allowing for mentioned above popularity of lavender tincture on vine since Hippocrates days is quite understandable, as it has been used to treat nervous breakdown, vertigo, cough and cold [9].

In all study lavandin specimens a small concentration of iron was revealed, ranged from 1/12 up to 1/9 from minimal norm of the daily human need.

Almost the same content of iron is deposited in Clone 53 and Allotriploid № 101-84, a little bit less in Allotriploid № 175-84. Minimal concentration of this essential element is accumulated in clone 71 (see table 1).

Researching fruits of NBG collection 3 ebony cultivars for mineral composition minimal iron content was registered in fruits of the cultivar “Nikitskaya Bordovaya”. It`s approximately 1,4 time as much than maximum iron quantity contained in study lavandin specimens (Fig.2).

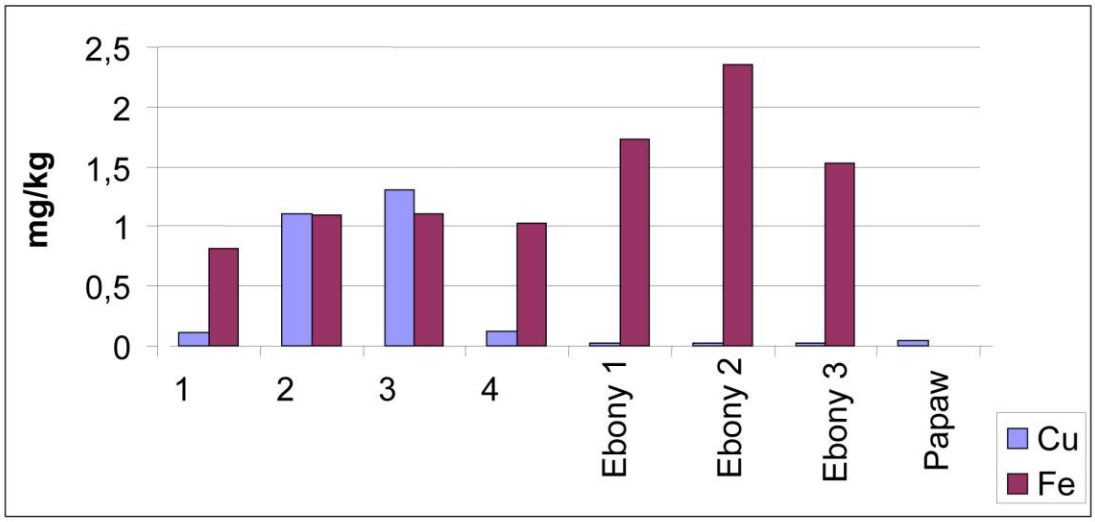

Fig.2 Copper and iron content in lavandin, papaw and ebony fruit raw material, NBG collection

Being the key microelement for blood formation iron has a considerable effect on human health, efficiency: about 75% of general iron content go to make up haemoglobin, others 25% deposit in liver, spleen and bone marrow.

Iron deficit causes anemia, changes in myocardium and skeletal muscles, inflammatory and atrophic changes of mouth and nose mucous membrane, esophagus disease, chronic gastroduodenitis and immunodeficiency state as well [15].

Iron deficit is the most often phenomena in organism of girls during pubertal period due to physiological peculiarities.

Calcium is a vital macroelement: state of musculoskeletal system and cardiovascular systems are in a direct demand on its concentration in body.

In study inflorescences of lavandin calcium content is approximately equal for all specimens and makes a bit more than 1/7 of the minimal norm of the daily human need (see table 1), what is 2,5 times as much than in ebony fruits of the cultivar "Souvenir Oseni" and 3,3 times as much than in fruits of "Nikitskaya Bordovaya" cultivar [16].

Magnesium concentration in study specimens is various: the minimal – Allotriploid № 175-84 (0,13 from the minimal norm of the daily human need), the maximum – Clone 71 (0,8 from the minimal norm of the daily human need (see table 1)). In general lavandin accumulates much more magnesium than ebony does. As the maximum concentration of magnesium in ebony fruits is almost equal to its concentration in Clone 53 and 5,7 times as much than in Clone 71 [16].

Magnesium is an extremely important macroelement for human vital functions, as it takes part in regulation of neurochemical transmission and muscle excitability, reliefs unstriated muscles, decreases arterial tension [8].

Magnesium deficit is typical for those people who are chronically stressed, suffer from depression and autism, for hyperactive children with syndrome of attention deficit, teenagers with deviant behavior [8]. Magnesium deficit can cause flaccidity, irritability, myotonia, diarrhea, immunodeficiency [15].

Microelement manganese is of great importance for human health which favors bony tissue strength, improves reproductive function and normalizes work of central nervous system, activates ferments necessary for carbohydrate and protein metabolism [14].

In study fruits of three ebony cultivars and 2 cultivars of large-fruited hawthorn and papaw manganese ability wasn`t registered because of extremely low concentration [7, 16]. Lavandin specimens have this element in approxiamately equal concentration from 1/12 from the minimal daily norm in Clone 53 up to the highest value – 1/10 of the minimal norm of the daily human need – in Allotriploid № 101-84 (see table 1).

Significance of zinc is hard to overrate, as it is an integral part of sex and gonadotropic hormones synthesis, many ferments, possesses immunomodulatory effect, antioxidental properties and anticarcinogenic activity. Zinc deficit causes mental insanity, diabetes, cataract, cardio diseases, damage of brain and nervous system, disorder of immunal system, food allergy, skin diseases, chronic tiredness, hearing disorders, indigestion and bad wound healing [15].

Zink concentration in study lavandin specimens is not considerable and ranges from 1/31 of the minimal norm of the daily human need in Clone 53 up to 1/42 in Allotriploid № 175-84 (table 1). It`s worth to note that in previously studied for mineral composition specimens of 3 ebony cultivars from NBG collection the maximum zink concentration was in fruits of "Souvenir Oseni" [16]. It`s roughly equal to minimal zink content in lavandin study specimens.

Conclusions

In terms of our investigation the following was determined:

- Iflorescences of all lavandin study forms have the highest potassium concentration;
- Allotriploid № 175-84 deposits maximum potassium concentration in comparison with 4 lavandin forms;
- Allotriploid № 101-84 is a leader not only by crop capacity but also by some essential elements concentration such as Fe, Cu, Mn;
- Clone 71 has the maximum magnesium concentration among study lanandin plants.

Gratitudes

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Dunayevskaya Ye.V., Rabotyagov V.D. Some essential elements in raw materials of lavandin (*Lavandula hybrida* Reverchon) - Nikitsky Botanical Gardens collection // Bull. of the State Nikit. Botan. Gard. – 2015. – № 115. – P. 32-38.

Inflorescence mineral composition (dry combustion) of four selective forms of lavandin was investigated for the first time. These forms were sorted out in Nikitsky Botanical Gardens during full bloom. It was determined, that Allotriploid №101-84 has the best characteristics not only by crop, but also by concentration of some essential elements, such as: ferrous, copper and manganese. Allotriploid № 175-84 accumulates maximum content of potassium in comparison with studied forms of lavandin. Clone 71 contains the highest concentration of magnesium, while clone 53 is a leader by the highest content of essential oil.

Key words: *lavandin; macro- and microelements.*

HUMAN PHYTOREHABILITATION

UDC 547.913:634.334:331.103.2:599.89

EFFECT OF *JUNIPERUS VIRGINIANA* AND *LAVANDULA ANGUSTIFOLIA* ESSENTIAL OIL COMPOSITION IN VARIOUS CONTENTS ON HUMAN PSYCHOEMOTIONAL STATE, MENTAL CAPACITY AND MEMORY

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Introduction

Essential oil (EO) of *Juniperus virginiana* L. (trade name is cedarwood oil) including such dominant elements as α- and β-cedren, cedrol, tuyopsen, has to be investigated much more concerning its effect on human than it had been done, though it`s widespread in perfumery [2]. According to scientific experiments it was proved this EO content, 1,0 mg/m^3, improves human psychoemotional condition and mental activity [1].

EO of *Lavandula angustifolia* Mill. has mainly the same effect on human as EO of *Juniperus virginiana* L. does, in spite of difference in their composition [1]. It founded the research of compositional oil effect of *Juniperus virginiana* L. and *Lavandula angustifolia* Mill. on human psychoemotional condition, mental activity and memory. This study was carried out having vapor concentration of this composition 1,0 mg/m^3 and it was revealed that effects of the study composition and essential oils separately are close [1].

The study purpose is to investigate effect of the EO composition in various concentrations on human psychoemotional condition, mental activity and memory. Essential oils of *Juniperus virginiana* L. and *Lavandula angustifolia* Mill. are in equal proportions.

Objects and metods of the research

60 workers of locomotive depot at age of 20-60 years old participated in this research. They were divided into 3 groups, 20 people in each of them. Control group was a group of the same size and composition. Test people of the control group were left for 20 minutes resting and listening to the psychorelaxing record. Participants of the experimental groups were left in the same conditions during the same period but evaporation of EO composition in different concentrations was added.

For the first group concentration of EO volatile components in the air made 0,5 mg/m3, the second group – 1,0 mg/m3, the third – 2,0 mg/m3. Testing was conducted before and after procedures.

In assessment of EO influence on the nervous system it was used proofreading trial: “Landolt rings”, WAM test (well-being, activity, mood), Spilberg test, memory test using 10 words,

simple complex sensomotor reactions [4, 5]. The data were processed using t Student`s test for conjugate and independent sorting [3].

Results and discussions

According to dynamics of WAM test, EO composition of *Juniperus Virginiana L.* and *Lavandula angustifolia* Mill. has a positive effect on psychoemotional condition of test people in spite of its content (table 1). In the control group reliable dynamics wasn`t registered.

General condition becomes better if the EO content makes 0,5 and 1,0 mg/m^3; 2,0 mg/m^3 keeps this tendency. Well-being improves under EO effect of 0,5 and 2,0 mg/m^3 contents. Concentration of 1,0 mg/m^3 didn`t result any effect. Mood level rises under 0,5 and 2,0 mg/m^3 contents, 1,0 mg/m^3 keeps this tendency. Psychological tension considerably relieves under EO effect of all contents.

Table 1

Influence of *Juniperus Virginiana L.* and *Lavandula angustifolia* Mill. essential oil on psychoemotional human state. Contents 0,5-1,0-2,0 mg/m^3 (parameters of WAM test, standard unit).

Parameter		Before procedure	After procedure	P b/a<
General condition	0,5 mg/m^3	134,92±9,16	160,10± 8,81	0,0001
	1,0 mg/m^3	144,65±7,63	157,25±6,77	0,02
	2,0 mg/m^3	133,10±6,82	147,30±6,56	0,06
	control	137,50±3,68	137,85±4,37	>0,1
Well-being	0,5 mg/m^3	145,58±8,96	159,00±8,71	0,0008
	1,0 mg/m^3	148,65±7,70	155,00±7,54	>0,1
	2,0 mg/m^3	147,95±8,04	163,04±7,12	0,05
	control	146,80±6,38	150,45±6,15	>0,1
Mood	0,5 mg/m^3	146,36±9,24	160,32±8,88	0,009
	1,0 mg/m^3	151,35±7,20	161,75±6,85	0,07
	2,0 mg/m^3	149,05±7,04	161,70±6,10	0,02
	control	148,40±7,14	154,95±7,55	>0,1
Tension–relief	0,5 mg/m^3	137,94±10,43	176,40± 9,13	0,0009
	1,0 mg/m^3	139,20±10,75	160,55±7,02	006
	2,0 mg/m^3	133,10±8,95	155,48±7,40	0,007
	control	135,15±5,84	142,75±3,76	>0,1

Situational anxiety was reliably decreased under effect of EO composition of *Virginiana L.* and *Lavandula angustifolia* Mill. in all contents, personal anxiety – 0,05 mg/m^3 (table 2). In control group reliable dynamics wasn`t marked out.

Table 2

Influence of *Juniperus Virginiana L.* and *Lavandula angustifolia* Mill. essential oil composition on situational and personal anxiety (Spilberg test). Contents 0,5-1,0-2,0 mg/m^3

Parameter		Before procedure	After procedure	P b/a<
Situational anxiety, standard unit	0,5 mg/m^3	38,60±1,62	33,90±1,66	0,01
	1,0 mg/m^3	38,58±2,42	36,12±2,79	0,03
	2,0 mg/m^3	38,81±2,52	31,75±2,16	0,001
	control	38,90±0,83	37,90±1,03	>0,1
Personal anxiety, standard unit	0,5 mg/m^3	39,45±1,49	36,95±1,66	0,02
	1,0 mg/m^3	38,45±1,63	36,80±1,89	>0,1
	2,0 mg/m^3	38,95±2,42	36,80±2,56	>0,1
	control	39,40±0,47	37,90±1,25	>0,1

Effect of EO composition on people workability self-rating occurred, but not so considerable, than on self-rating of psychoemotional condition (table 3).

Table 3

Influence of EO composition of *Juniperus Virginiana* L. and *Lavandula angustifolia* Mill. on human workability self-rating (parameters of WAM test, standard unit). EO content – 0,5-1,0-2,0 mg/m^3.

Parameter		Before procedure	After procedure	P b/a<
1		2	3	4
Weakness-capacity to work	0,5 mg/m^3	137,92±9,45	151,31±9,59	0,05
	1,0 mg/m^3	134,60±5,53	134,37±7,47	>0,1
	2,0 mg/m^3	138,64±9,78	150,17±8,42	>0,1
	control	140,15±5,68	146,85±5,72	>0,1
Weakness-vivacity	0,5 mg/m^3	144,84±9,35	158,18±10,28	0,04
	1,0 mg/m^3	147,80±8,09	151,30±9,45	>0,1
	2,0 mg/m^3	146,30±10,15	167,80±9,87	0,001
	control	142,30±7,62	149,60±7,24	>0,1
Abcent-mindedness-attantiveness	0,5 mg/m^3	137,71±9,26	143,59±9,18	>0,1
	1,0 mg/m^3	137,31± 7,17	146,66±7,26	>0,1
	2,0 mg/m^3	135,20±9,32	152,10±9,05	0,0006
	control	139,00±4,83	143,00±6,92	>0,1

Reliable parameters were the following: increasing of workability self-rating (EO content – 0,05 mg/m^3), vivacity (EO content – 0,05 and 2,0 mg/m^3), attentiveness – 2,0 mg/m^3.

Effect EO composition of *Juniperus Virginiana* L. and *Lavandula angustifolia* Mill. on the velocity of simple and complex sensomotor reactions (lightly slowdown) was registered only for 0,05 mg/m^3 content (table 4).

Table 4

Influence of EO composition of Juniperus Virginiana L. and *Lavandula angustifolia* Mill. on velocity of simple (Tsimp) and complex (Tcomp.) sensomotor reactions and number of their mistakes (Msimp and Mcomp accordingly). Content of the EO composition– 0,5-1,0-2,0 mg/m^3.

Parameter		Before procedure	After procedure	P b/a<
Tsimp, msec	0,5 mg/m^3	291,71±6,30	294,53±6,12	0,03
	1,0 mg/m^3	303,00±11,78	300,31±8,23	>0,1
	2,0 mg/m^3	285,46±10,06	285,69±8,24	>0,1
	control	297,28±2,89	296,35±5,80	>0,1
Msimp, units/test	0,5 mg/m^3	0,65±0,27	0,50±0,18	>0,1
	1,0 mg/m^3	0,60± 0,15	0,67±0,28	>0,1
	2,0 mg/m^3	0,58±0,16	0,38±0,14	>0,1
	control	0,55±0,15	0,70±0,23	>0,1
Tcomp, msec	0,5 mg/m^3	361,31±13,51	372,99±13,59	0,09
	1,0 mg/m^3	368,75±11,13	372,94±9,53	>0,1
	2,0 mg/m^3	352,40±9,57	357,76±9,85	>0,1
	control	362,83±1,87	363,80±9,67	>0,1
Mcomp, units/test	0,5 mg/m^3	0,70±0,21	0,65±0,20	>0,1
	1,0 mg/m^3	0,75±0,16	0,58±0,13	>0,1
	2,0 mg/m^3	0,75±0,16	0,46± 0,12	0,05
	control	0,80± 0,14	0,85±0,18	>0,1

At the same time the study EO composition increases volume of processed data and velocity of its processing (table 5). Reliable increasing of volume of processed information was registered with EO composition in content 1,0 mg/m^3, velocity of information processing increases under effect of EO composition in content 0,5 mg/m^3, the tendency keeps under 2,0 mg/m^3.

Table 5

Influence of the EO composition of *Juniperus Virginiana L.* and *Lavandula angustifolia* Mill. on general volume of processed information (GVPI) and velocity of information processing (VIP) in proofreading trial (Landolt`s rings). Content of the EO composition – 0,5-1,0-2,0 mg/m^3.

Parameter		Before procedure	After procedure	P b/a<
GVPI, bit	0,5 mg/m^3	150,25±3,18	153,20±2,37	>0,1
	1,0 mg/m^3	144,55±4,65	153,50±2,73	0,02
	2,0 mg/m^3	150,05±4,28	150,75±3,20	>0,1
	control	141,15±0,99	143,65±2,00	>0,1
VIP, bit/sec	0,5 mg/m^3	1,46±0,12	1,55±0,11	0,05
	1,0 mg/m^3	1,36±0,12	1,50±0,12	>0,1
	2,0 mg/m^3	1,64±0,16	1,77±0,14	0,10
	control	1,50±0,05	1,49±0,07	>0,1

Influence of the EO composition on short-term memory was revealed with its worsening (less number of memorized words): reliable parameter was under effect of the EO composition in content of 2,0 mg/m^3 and this tendency keeps having EO composition content of 1,0 mg/m^3 (table 6).

The EO composition didn`t change short-term aural memory.

Table 6

Influence of the EO composition of *Juniperus Virginiana* L. and *Lavandula angustifolia* Mill. on short-term visual and aural memories (test 10 words, average number of memorized words). Content of the EO composition – 0,5-1,0-2,0 mg/m^3.

Parameter		Before procedure	After procedure	P b/a<
Short-term visual memory	0,5 mg/m^3	5,62±0,41	5,22±0,33	>0,1
	1,0 mg/m^3	6,04±0,34	5,38±0,23	0,08
	2,0 mg/m^3	6,30±0,29	5,67±0,31	0,05
	control	5,95±0,09	5,60±0,35	>0,1
Short-term aural memory	0,5 mg/m^3	4,95±0,25	4,90±0,25	>0,1
	1,0 mg/m^3	5,00±0,40	4,50±0,36	>0,1
	2,0 mg/m^3	5,08±0,37	4,95±0,32	>0,1
	control	4,95±0,14	5,10±0,32	>0,1

Therefore EO composition of *Juniperus Virginiana* L. and *Lavandula angustifolia* Mill. has an euphoric effect on psychological human condition almost in all study concentrations: improvement of general condition, mood, test people feel much better, decreasing of psychological tension and situational anxiety. Personal anxiety goes down only in case of the smallest EO composition content.

EO composition hardly effected on sensomotor reactions. There was only some acceleration of simple and complex sensomotor reactions under influence of the smallest content of the EO composition and decreasing of mistakes in the complex sensomotor reaction having the highest EO composition content.

Effect of the EO composition on workability self-rating of test people was registered as positive but not so expressed: some increasing of processed data volume and velocity of its processing without definite content dependence.

As to short-term memory EO composition had not so bright but selective (only visual memory) and worsening influence.

Conclusions

1. Dominant effect of the EO composition of *Juniperus Virginiana* L. and *Lavandula angustifolia* Mill. on human in all study contents of vapor in the air is euphoric.

2. Its influence on sensomotor reactions and mental activity was positive as well but not so bright.

3. Short-term visual memory became worse being effected by EO composition.

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Effect of *Juniperus virginiana* and *Lavandula angustifolia* essential oils composition (EOC) with contents of 0,5, 1,0 and 2,0 mg/m^3 on human psychoemotional state, mental capacity and memory was the main objective of this research. In all study cases EOC effected euphorically on subjects, not so pronounced but positive effect on self-efficiency and its real state was marked, though short-term visual memory became worse a little.

Key words: *essential oils composition; Juniperus virginiana; Lavandula angustifolia; psychoemotional state; mental capacity; memory.*

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POTENTIAL FROST-RESISTANCE OF CHAENOMELES ON SOUTH COAST OF THE CRIMEA

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Introduction

Chaenomeles (*Chaenomeles* Lindl.) is not so large (05,-1,5 sometimes it reaches 3 m by height), early-blooming, fruit and decorative bush, its homelands are China and Japan. Blooming period lasts from March up to April till the leaves appear. This plant is characterized by early ripeness and annual fruiting, functions as phytoameliorative element. Chaenomeles fruits are valuable raw material for food, pharmaceutical and perfumery industries due to their various chemical composition [6, 7]. Wide ecological plasticity of chaenomeles determines its large introduction areal. Considerable variability of this culture by most morphological and biological, economically valuable parameters, dependence of its crop capacity from biotical and abiotical factors in different regions of cultivation require thorough investigation of the plant respond to new ecological conditions. Successful introduction mainly depends upon correspondence of the cultivar ecological characteristics to new growing conditions. [2, 9]. Assortment selection for each of ecological zones is a quite actual task, what is extremely important for breeding, green building and areal expansion.

Originality of the Crimean climatic conditions can guarantee full ripening and preservation of chaenomeles crop, opportunity to have various and rich by vitamins, medicinal and dietetic production. Besides it makes possible to grow not enough winter-hardy, but the most large-fruited cultivars [6]. The principal factor of worsening *Chaenomeles* ornamental characteristics and crop capacity under conditions of South Coastal Crimea can be damages by negative temperatures. Winter winds, mainly east and northeast result temperature dropping till -5°…-15°C. According to data of many years the first frost weather occurs in the end of November, last – in the end of March, the coldest month is January. Winter weather is characterized by changeability of thermal regime, often probability of tissue damage due to provocative thaws in January-February, what has negative effect for plant wintering. As a critical spring factor, especially early spring, returnable colds should be noted, which are very dangerous for plants with early vegetative period. High humidity in cold season aggravates this situation. Plants having obtained cold acclimatization (resistance to cold) during autumn and in the beginning of winter, lose it starting to grow before frost-dangerous period comes to the end [1]. That`s why study object became researching the potential frost-resistance of Chaenomales some selective forms belonging to different cultivars to breed the most prospective, capable to keep viability of vegetative and generative buds to maximum after low-thermal stress, what could guarantee the light loss of ornamental characteristics and a high crop capacity.

Objects and research methods

Selection Chaenomales fund of Nikitsky Botanical Gardens includes more than 400 forms [8]. During autumn-winter-spring period of 2011-2013 26 selective forms, belonging to

3 cultivars were being studied: *Ch. japonica* (forms 2-1, 2-2, 2-3, 2-4, 2-5, ПХ 2/5, ПХ 2/6, ПХ 2/7, ПХ 7/7, ПХ 7/10), *Ch. spesiosa* (forms 3-1, 3-2, 3-3, 3-4, ПХ 8/3, ПХ 8/5, ПХ 8/6), *Ch. cathayensis* (forms 4-1, 4-2, 4-3, 4-4), and one hybrid group *Ch. x superba* (forms1-1, 1-2, 1-3, 1-4, 1-5). In our research method of phased direct freezing of annual shoots in the cool room was applied. The experiment took place under low temperatures [4], lasting 12-20 hours. Gradient of temperature dropping was 2°C/hour, preliminary conditioning to the cold was lasting for 10-18 hours with 0°C. Taking into consideration disability of Chaenomeles to general bud developing, their different quality on shoots, simultaneous freesing shoots of those specimens where buds are on the same development stage was used for correct interpretation of results. Damage degree was determined visually and by binocular, frost resistance was measured by degree of survived buds (percentage). Resting period was determined during field works and under conditions of laboratory [3], watering of buds and shoots tissue – by gravimetric method.

Results and discussion

In researches of 2011 high water level was registered in buds and therefore some specimens of each cultivar were damaged a lot by negative temperatures. For example, *Ch. Spesiosa* buds of seedling 3-1 contained 80% of water in a damp mass, while buds of seedling specimens 3-2 – 58%. Difference in a degree of low-temperature damages made 45%. Moisten content in buds is much higher than in shoots, parameters of watering for specimens of intraspecies is differed much. The least content of water was registered in shoots of *Ch. x superba* 1-1 and *Ch. japonica* 2-1, while form *Ch. japonica* 2-2 was characterized by highest water level.

After freezing (temperature regime -8-10°C), about 8% of buds on seedlings *Ch. x superba* 1-1, 1-4; *Ch. japonica* 2-1, 2-2 and *Ch. spesiosa* 3-2 started to develop after resting period, what indicates relatively high level of resistance to low temperatures. The smallest percentage of bud survival was fixed for seedlings 3-3 and 3-4 of *Ch. Spesiosa (damages – 65 and 89% relatively).* Form *Ch. x superb* 1-5 lost 49,5% of buds; specimens *Ch. japonica* 2-4, 2-5 – 24,5 - 41%. Freezing in February and the first decade of March didn`t cause any loss for forms *Ch. japonica* 2-2 and *Ch. spesiosa* 3-1, but in April they were damaged a lot. In the end of March and middle of April the following cultivars had damages of generative sphere under influence of temperature -5°C: *Ch. x superba* – from 10 up to 17% (forms 1-5, 1-4, 1-3), *Ch. japonica* –30-32% (forms 2-2, 2-4), *Ch. spesiosa* – up to 45% (forms 3-3, 3-1). In April vegetative buds reduced their frost-resistance. The highest loss percentage was fixed for forms: *Ch. spesiosa* 3-3 (necrosis 50%), *Ch. japonica* 2-2, 2-4 (45,5% and 32%), *Ch. x superba* 1-5 (17,6%). The most typical damages on plants of *Chaenomeles* genus subjected to imitation of spring light frosts is blackening of the edge on the external leave plates (especially it concerns *Ch. japonica* 2-5 and *Ch. spesiosa* 3-2) and necrotic spots (seedlings *Ch. x superba* 1-5 up to ⅓ of leaf area). The least resistant to negative temperatures were specimens of *Ch. japonica* 2-3 and *Ch. spesiosa* 3-4 – bud damages of different character was 87 and 62%. As a results in winter-spring period of 2011 according to potential frost-resistance *Ch. spesiosa* (3-2), *Ch. x superba* (1-4, 1-2, 1-1), *Ch. japonica* (2-2, 2-1) are the most resistant forms of *Chaenomeles* which were arranged in decreasing order.

In experiments of 2012 *Ch. spesiosa* 3-1 (table 1) presented the lowest indicator of bud survival after being influenced by negative temperature (-10°C) in the climatic room – 42%.

Table 1

Potential frost-resistance of forms of *Chaenomeles* cultivars (2012)

Form	Water content in buds, % in a moistened mass	Water content in shoots, % in a moistened mass	Living buds,% (climatic room, January, 14 hours -10°C	Living buds, % (open ground, February, -11,9°C	General plant status, %
1	2	3	4	5	6
Chaenomeles x superba					
1-1	72,7	46,4	83,0	96,0	96
1-2	79,2	46,5	91,8	100	100
1-3	62,5	46,8	88,0	100	100
1-4	60,0	43,8	100	99,8	99,8
1-5	68,2	45,5	100	100	100
Chaenomeles japonica					
2-1	71,4	45,0	100	75,0	75
2-2	71,4	50,6	100	82,0	82
2-3	81,0	48,0	95,5	93,0	93
2-4	80,0	48,3	100	97,5	97,5
2-5	70,0	46,3	99,0	0	100
Chaenomeles spesiosa					
3-1	88,1	45,5	42,0	81,5	78
3-2	72,2	45,0	100	91,6	86
3-3	68,7	42,5	91,5	98,0	98
3-4	71,9	47,7	100	87,0	87
Chaenomeles cathayensis					
4-1	50,0	51,4	96,2	99,5	99,5
4-2	68,6	51,8	99,9	100	100
4-3	65,2	52,5	100	100	100
4-4	70,0	57,7	100	99,0	99,0

Specimens *Ch. x superba* 1-1 and 1-3 had 83-88% of survived different buds without any damages; seedling of the same cultivar 1-2 and *Ch. spesiosa* 3-3 – about 92%. Other selective forms of study cultivars with not so considerable damages or their absence made 5%. Results of artificial shoot freezing and assessment of plant damages in natural environment (especially after winter minimum -11,9°C and -19°C on the ground) made it possible to determine thresholds of damage temperatures for Chaenomales cultivars under conditions of South Coast of the Crimea. The initial damage temperature is that one which damages no more than 15% of buds, while critical temperature could damage future crop [5]. For convenience acceptable fruiting is kept even if 60% of buds were damaged.

Quite short period of biological rest (it`s over up to the II and III decades of December) and high sensitivity to low temperatures was registered for cultivars *Ch. spesiosa* and *Ch. Japonica* – bush frosting-up can reach 17-25% with partial or complete damage of shoots. -7-9°C are damage temperatures. It was found out that damage percentage correlates the number of generative buds, which started to develop after biological rest. Due to resting

buds (as a rule there is a majority of such buds) decorative characteristics and crop capacity are kept in spite of any damages. Biological rest of *Ch. x superba* is much longer – till the I-II decades of January, frost damages make no more than 4%, borders of damage temperatures are -8-10°C. Forms of this hybrid group are seldom blooming in winter, what gives an opportunity to keep ornamental properties. Seedlings of *Ch. Cathayensis* finish their biological rest later than others (from the III decades of January till the II decade of February), that`s why almost all of them stay undamaged if temperature drop makes 11-12°C below zero. Blooming period is late as well, that`s why ornamentality and crop capacity have good characteristics.

Applying model experiment of returnable light frosts imitation within climatic room, the maximum damage degree of Chaenomales plants in phenophases of the closed buds and beginning of blooming after negative temperature (-10°C) effect was determined (table 2).

Table 2

Bud potential frost-resistance of Chaenomeles cultivars (living buds, %)

Form	22.02.2013 0°C (18 h), -11°C (20 h)	19.03.2013 0°C (18 h), -10°C (19 h)	
1	2	3	4
	Buds of different purpose	Vegetative buds	Generative buds
Chaenomeles superba			
1-1	98,0	100	70,2
1-2	51,4	44,5	40,0
1-3	47,7	75,0	38,9
1-4	100	100	100
1-5	38,0	90,6	26,3
Chaenomeles japonica			
2-1	78,8	50,2	0
2-2	86,7	76,4	12,5
2-3	65,5	100	7,5
2-4	76,2	80,0	54,5
2-5	84,6	100	63,6
ПХ 2/5	80,0	90,5	100
ПХ 2/6	92,4	88,3	97,2
ПХ 2/7	91,0	93,1	100
ПХ 7/7	35,5	5,1	5,5
ПХ 7/10	32,8	90,0	10,3
Chaenomeles spesiosa			
ПХ 8/3	85,0	80,1	45,0
ПХ 8/5	77,8	77,3	69,0
ПХ 8/6	63,7	70,6	42,4
3-4	100	100	10,0
Chaenomeles cathayensis			
4-1	73,6	85,0	10,2
4-2	72,8	81,4	10,0
4-3	75,0	64,2	10,1
4-4	71,4	62,0	9,8

Vegetative buds of almost all *Ch. x superba* plants survived, in some areas insignificant border necrosis was registered, only some specimens had 60% of damaged leaves [10]. On the leaf area there were necrotic spots (10-45% of the leaf area). Sometimes damage of inside leaves. Survival of flower buds ranged from 26,3 – 100%.

Specimens of *Ch. Japonica* had maximum index in vegetative buds damage – 94,9%. All plants had necrotic spots (from 13,8% up to 50% of the whole leaf area), damage of

outside (up to 18,2%) or inside leaves (8-12%), necrosis of leaf plate borders and top (10-27,3%), partial necrosis of veins (till 20%), not so often – dotted necrosis. Loss of ornamental characteristics by some forms made 80-95%.

Ch. Spesiosa had 20-29,4% of damaged vegetative buds, survived buds got partial necrosis of leaf plate borders, necrotic spots of different size were registered as well. Flower buds had more serious defects as from 4,1 up to 69,0% left undamaged on the shoot, and as a fact ornamentality of some plants worsened.

As to *Ch. Cathayensis*, it had 90% of damaged generative sphere and up to 36% of damaged vegetative buds on different parts of shoots. As period of biological resting finished earlier than ever before due to quite warm average daily temperatures in winter 2013, damaged reached such indices.

For previous study period in spite of moisture concentration, neither of specimens had damaged shoots. Only after negative temperature effect (-15°C) necrosis on tops of annual shoots (1-6 sm) was fixed, which involved even core of some forms: *Ch. x superba* (1-3), *Ch. spesiosa* (ПХ 8/5) and *Ch. japonica* (2-2, ПХ 7/7). Level of bud watering for more frost resistant seedlings of *Ch. x superba* in January-February ranged from 60,0-68,8% (according to moistened mass) and 69,2-75,0% in March. Specimens of *Ch. Japonica* cultivars this parameter made 71,4-72,0% in January-February and 77,8-78,3% in March; *Ch. Spesiosa* – 72,2-88,1% - in January-February and 58,3-60,2% in March; *Ch. Cathayensis* – 65,2-68,6% in January-February and no more than 70% in March. Moisture level in buds of the same cultivars can be quite various.

Conclusions

According to data analysis applying different regimes of low-temperature affect (from -5 up to -15°C) and quantitative analysis of different functions shoots and buds damage it was determined that first of all generative buds are subjected to injury then vegetative buds and in the end – shoots. Therefore ornamental characteristics and crop capacity of Chaenomeles bushes directly depends upon adaptive ability of generative buds. Typical damage for cultivars of Chaenomeles genus subjected to imitation of spring light frosts is blackening of borders on outside leaf plates and necrotic spots. The following specimens were sorted out as plants with relatively high level of low-temperature resistance under conditions of South Coast of the Crimea: *Ch. x superba* 1-1, 1-2, 1-4; *Ch. japonica* 2-4, 2-5, ПХ 2/6, ПХ 2/7; *Ch. spesiosa* 3-2, ПХ 8/3, ПХ 8/5; *Ch. cathayensis* 4-1, 4-2.

Warm temperatures of autumn months favor fast development of some generative buds after biological resting, what determines degree of frost-resistance and wintering in general. Changes of frost-resistance reflect the followings: its indices in November-December are higher than in January-February for all study cultivars, what probably caused by depth of plant biological rest. Seedlings of some specimens in different years show various frost-resistance depending upon environmental conditions.

Investigation of water regime of plants being in biological rest in the beginning of vegetation showed that dropping of moisture level in such tissues is one of the most important factors specifying frost-resistance of *Chenomeles* plants. In winter-spring over moistened buds and as a result high percentage of damages by negative temperatures is typical for some specimens of each cultivar. Frost-resistant forms are characterized by deeper and longer biological rest, which comes to an end approximately since the II decade of January up to the II decade of February and rather low level of moisture in bud tissues.

Considerable variability of Chaenomeles cultivars gives an opportunity to sort out the most adaptive forms according to frost-resistance. Frost-resistant selective forms are of scientific interest for breeding and industry adoption, in the field of ornamental gardening and introduction. That`s why sorting out not only among cultivars but individual sorting out

within each cultivar would be more prospective for large-scale industrial testing and successful cultivation of Chaenomeles crop.

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Pilkevych R.A. Potential frost-resistance of Chaenomeles on South Coast of the Crimea // Bull. of the State Nikit. Botan. Gard. – 2015. – № 115. – P. 44-49.

The article presents results of comprehensive analysis of 26 selective forms which belong to 3 cultivars: *Ch. japonica*, *Ch. spesiosa*, *Ch. Cathayensis* and hybrid group *Ch. x superb*. A character of injured buds with various specialization and a range of damaging temperature were determined under conditions of different low-temperature regimes. In terms of investigation it was revealed frost-resistance depends upon watering level of shoots and bud tissue, depth and duration of biological rest. Specimens with high potential resistance to negative temperatures were marked out: *Ch. x superba* 1-1, 1-2, 1-4; *Ch. japonica* 2-4, 2-5, ПХ 2/6, ПХ 2/7; *Ch. spesiosa* 3-2, ПХ 8/3, ПХ 8/5; *Ch. cathayensis* 4-1, 4-2.

Key words: *Chaenomeles, frost-resistance, watering, necrosis, biological rest.*

PLANT REPRODUCTIVE BIOLOGY

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CORRELATION OF DEVELOPMENTAL STAGE AND ANTHERS SIZE OF SOME *HEMEROCALLIS* X *HYBRIDA* HORT. CULTIVARS

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Introduction

According to current conception, anther of angiosperm plants is considered as an integral and self-regulatory system, which includes coordinated processes happening consecutively and condition its development and creation of male gametophyte [2, 11]. Correlation in genesis processes of anther`s wall and male gametophyte [12, 15] allows to suppose interconnection between growth and development of male generative structures of flowering plants. Studies in such a field are usually aimed at determination of maximum stage when anther is possible to introduce into culture in vitro to get haploid plants [1, 4, 8, 10, 14], what is high-usage in breeding [4, 6]. Though data of development periodization of male generative structures allowing for genesis of a flower and anther elements are also of great importance for cytological analysis of microsporogenesis and prognostication of pollen quality, what is necessary for sorting out the parent forms of selection material. One of the main ornamental cultures which is selected in Nikitsky Botanical Gardens is *Hemerocallis* x *hybrida* Hort. That is why it`s extremely important to investigate regularities peculiarities of the high quality material genesis. Purpose of this study is to determine interconnection between morphometric parameters of anthers and developmental stage of male generative structures of some *H.* x *hybrida* cultures with different type o ploidy.

Objects and research methods

Four cultivars of *Hemerocallis* x *hybrida* Hort. were used as objects of the investigation. They are cultivated in genefund collection of Hemerocallis hybrida in Nikitsky Botanical Gardens (supervisor of the collection is I.V. Ulanovskaya), where Pandora's Box and Wally Nance are diploid and Anna Warner and Cherry Eyed Pumpkin – tetraploid. Different sized buds of study cases (minimum was 0,1 sm) were used to determine morphometric parameters of anthers and developmental stages of male generative elements. Development stages of anther were determined on temporary preparations stained with 1% acetoorseine. Preparation analysis was carried out with microscopes "Jenaval" (Carl Zeiss) и AxioScope A.1 (Carl Zeiss) applying method of light field. Statistic data processing was conducted using a set of application programs Statistica 6.0. Reliability of differences between variants was assessed by Student`s t-criterion on 5% level of significance which guarantees 95% confidence probability.

Results and discussion

Genesis of microsporangium wall and pollen grain are thoroughly described before [7], within this research we emphasized just key stages of anther`s structure development. Morphometric data of anthers belonging to four cultivars of *H.* x *hybrida* are presented in the table below according to periodization of sporangium development and main stages of male

gametophyte formation. In accordance with agreed periodization of anther development three periods were marked out: premeiotic, meiotic and postmeiotic [5, 12]. During premeiotic period thanks to intensive mitotic division formation of microsporangium wall occurs and sporogenous tissue is founded for further microsporocytes development. Differentiation of cellular wall layers of anther takes place on meiotic stage, while microsporocytes start for meiotic division and as a result it conduces to development of tetrads with haploid microspores. Postmeiotic period begins with the decay of microspores tetrads and finishes by process of gametophytogenesis that is development of a pollen grain and anther ripening.

Study cultivars of *H.* x *hybrida* on the starting stages of microsporangium development are fixed in anthers at height of 0,1 sm. On this stage anthers of diploid and tetraploid cultivars don`t differ by height. Though reliable differences of anther morphologic parameters of diploid and tetraploid cultivars are typical in meiotic period (t=3,12).

Table

Anther morphometric characteristics of some *Hemerocallis* x *hybrida* cultivas during development of male gametophyte

Period of microsporangium development	Stages of anther and male gametophyte development	Anther`s height, sm			
		Diploid cultivars		Tetraploid cultivars	
		Pandora's Box	Wally Nance	Anna Warner	Cherry Eyed Pumpkin
Premeiotic	Microsporangium formation, foundation of sporogenous tissue	0,15±0,02 0,1–0,2	0,15±0,01 0,1–0,15	0,15±0,02 0,1–0,2	0,15±0,01 0,1–0,2
	Formed microsporangium wall, microsporocytes	0,3±0,04 0,25–0,4	0,31±0,05 0,20–0,35	0,35±0,04 0,25–0,5	0,33±0,03 0,2–0,45
Meiotic	Degeneration of the middle wall layer of microsporangium and tapetum; meiosis, formation of microspores tetrads	0,51±0,02 0,38–0,6	0,41±0,05 0,36–0,45	0,64±0,02 0,6–0,69	0,59±0,04 0,5–0,7
Postmeiotic	Formation of fibrous bulges in microspore endothecium, formation of sporoderm, differentiative mitosis	0,69±0,01 0,6–0,75	0,63±0,03 0,5–0,7	0,8±0,03 0,7–0,9	0,89±0,03 0,8–0,97
	Formed anther`s wall Bicellular pollen grains	0,83±0,01 0,79–0,9	0,79±0,01 0,78–0,8	1,00±0,02 0,9–1,1	1,1±0,02 1–1,2

Note: there are an arithmetic average and a standard mistake (m±x) above the line; under the line there are limits of a character variation (min-max).

Thus, meiosis and formation of microspores tetrads of such diploid cultivars as Pandora's Box and Wally Nance occurs when anthers are 0,4-0,5 sm by height, while for tetraploid cultivars - Anna Warner Cherry Eyed Pumpkin – this period happens to be when height of anthers reaches 0,5-0,7 sm.

It`s a well-known fact the optimal stage when anthers are possible to introduce in culture in vitro is a stage of microspores [3, 9, 14], when autonomy of microspores takes place and they start for realization of gamotophytogenesis determinate program, or under conditions of culture in vitro – sporophytogenesis [1, 12, 13, 15]. In this period anther height of diploid cultivars of *Hemerocallis* x *hybrida* ranges from 0,5 – 0,75 while tetraploid cultivars get 0,7-1 sm.

Reliable difference in anther height of diploid and tetraploid species was determined in postmeiotic period [t=9,24). Pollen grains of diploid cultivars get ripening when anther height

is 0,8 sm on average, tetraploid species - 1-1,2 sm. Thus *H. x hybrida* cultivars as ploidy degree increases anther morphometric parameters rise up during meiotic and postmeiotic periods; anthers of tetraploid species are much larger.

Analysis of anther`s height and stage of its formation define the anther`s growth and its development are conjugated, what helps to identify critic stages of its development, allowing for anther`s morphometric parameters. Applying the most available morphometric methods for assessment the stages of the male generative sphere development of *H. x hybrida* cultivars material optimizes process of material sorting out for cytologic analysis of microsporogenesis in order to reveal anomalous cases during pollen formation and while introducing the anthers into culture in vitro.

Conclusions

In terms of the study anther`s morphometric parameters of diploid (Pandora's Box, Wally Nance) and tetraploid (Anna Warner, Cherry Eyed Pumpkin) *H.* x *hybrida* cultivars were determined during the principal periods and stages of sporogenous tissue foundation and formation of male generative structures.

It was presented that anther`s height of study diploid cultivars in meiotic period makes 0,4-0,4 sm on average, while tetraploid – about 0,6 sm. Phase of microspores takes place when anther`s height reaches 0,6 sm and 0,8 sm, relatively for study diploid and tetraploid cultivars.

Reliable difference between anthers of diploid and tetraploid cultivars was revealed during meiotic and postmeiotic periods.

Findings allow to consider anther`s height of study *H.* x *hybrida* cutivars as an indirect indicator of anther development stage, necessary for visual assessment the material for cytologic analysis of mictosporogenesis of the species material, as well as for introduction the anthers into culture in vitro.

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Main genesis stages of microsporangium and elements of male generative sphere were determined for diploid (Pandora’s Box, Wally Nance) and tetraploid (Anna Warner, Cherry Eyed Pumpkin) cultivars of *Hemerocallis* x*hybrida* Hort. during anther`s development.

Key words: *anther; pollen-grain; microsporogenesis; microspore; ploidy; Hemerocallis x hybrida hort.*

PLANT PHYSIOLOGY

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STEM AND LEAF SUCCULENTS WITH CONTRASTING FROST-RESISTANCE LEVEL: ACCUMULATION PECULIARITIES OF SOME BIOLOGICALLY ACTIVE SUBSTANCES

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Introduction

Plant cultivars capable to keep their ornamental properties during the whole year are quite important aesthetic element of parks and recreational zones of the Crimea and other southern regions. Group of succulents is rather perspective in this point. One of the reasons which makes difficult its wide usage in landscape design is a lack of information about resistance degree to unfavorable environmental conditions. Limited species variety of these ornamentally valuable plants is inconstant way of researching their frost- and winter-resistance, which took place before. Literary sources present data of visual observations [1, 2, 6]. During some years frost-resistance of some specimens from families Crassulaceae and Cactaceae was investigated. As a result of these study cultivars of stem and leaf succulents with a high level of frost-resistance were revealed. Efficiency of introduction work needs not only borders of low-temperature resistance but a number of physiological and biochemical characteristics, which determine development of adaptive syndrome under influence of unfavorable wintering conditions. Such information makes possible to determine a number of characteristics for indirect and objective diagnoses of resistance to unfavorable wintering conditions.

Therefore study objective was to reveal storage peculiarities of some biologically active substances in tissues of stem and leaf succulents with different degree of frost-resistance.

Objects and research methods

The following cultivars were studied to investigate storage peculiarities of biologically active substances and their function in development of cryostress for stem and leaf succulents (table 1).

Table 1

Frost-resistance of stem (*Opuntia* Mill., *Cylindropuntia* (Eng.) Knuth. Emeng.Backbg.) and leaf (*Sedum* L.) succulents, its characteristic

***Sedum* genus**	***Opuntia* genus**	***Cylindropuntia* genus**
Frost-resistant cultivars		
S. reflexum L. Low critical temperature -16 ^{0}C… -18 ^{0}C	*O. engelmannii* Eng. Low critical temperature -20 ^{0}C…-22^{0}C	*C. leptocaulis* (Haw.) Knuth. Low critical temperature – 18^{0}C …-23^{0}C
S. album L., Genuina Low critical temperature -18 …-24^{0}C	*O. lindhimtrii* SD. Low critical temperature -18 ^{0}C…-20^{0}C	*C. tunicata* (Lehm.) Pfeiff. Low critical temperature -18^{0}C…-20^{0}C
S. acre L. Low critical temperature -18^{0}C…- 20^{0}C		
Mediofrost-resistant cultivars		

S. luteovyride Low critical temperature -10^{0}C…-12^{0}C	*O. robusta* Wendl. Low critical temperature -15 ^{0}C…-16^{0}C	*C. imbricata* (Haw.) Knuth. Low critical temperature -14^{0}C…-18^{0}C
S. palidum L. Low critical temperature -12^{0}C…-14^{0}C	*O. leucotricha* Eng. Low critical temperature -14^{0}C…-17^{0}C	
S.rubrotinctum R.T. Glausen. Low critical temperature -10^{0}C…-12^{0}C	*O. microdasis* (Lehm.) Pfeiff. Low critical temperature -12^{0}C …-15^{0}C	

Methods of artificial shoot freezing in freezing chamber were applied to find out degree of frost-resistance. Gradient of temperature decreasing and increasing was 2°C per hour. Assessment was carried out on 7th, 10th and 13th days [3].

Ascorbic acid concentration in tissue was determined with the help of 0,001 n 2,6 dichlorophenolindophenol solution [5]. Content of phenol compounds was found out photocolorimerically with Folin-Chicolteo reagent [5]. Correlation of growth-inhibiting and growth-stimulating substances were determined according to intensity of *Lepidium sativum* seeds sprouting on aqueous-alcoholic extracts made of tissues of study cultivars.

Results and discussion

As a study results of storage dynamics of ascorbic acid in water-saving tissues of stem and leaf succulents, which belong to *Sedum, Opuntia* and *Cylindropuntia* genera, a number of peculiarities was revealed in connection with their cryotemperaure resistance (table 2). In particular, concentration of ascorbic acid in tissues of both stem and leaf succulents has two maximum points; the first maximum is connected with blooming period (*Sedum* species – 3rd decade of May, 1st decade of June; *Opuntia and Cylindropuntia* – 1-2 decades of June), the second – with beginning of physiological rest. Frost-resistant cultivars (*S. reflexum, O. lindhimtrii C. tunicata)* are characterized by quite short vegetative period and as a result – early terms of physiological rest – autumn maximum of ascorbic acid content happens in the 2-3 decades of September.

Table 2

Variations of ascorbic acid content in water-saving tissues of stem and leaf succulents characterized by different degree of frost-resistant in a circannian cycle

Cultivars	Ascorbic acid mg % per green weight									
	March	April	May	June	July	August	September	October	November	December
O. engelmannii	21,5± 2,1	26,± 2,6	30,1± 2,6	33,8± 1,9	35,4± 2,0	35,5± 3,0	39,4± 2,3	42,5± 2,6	54,2± 3,0	46,1± 2,7
O. lindhimtrii	23,1± 3,0	24,02± 2,1	22,5± 1,9	29,7± 2,0	35,0± 2,1	25,12± 2,1	25,0± 2,1	34,6± 2,3	43,1± 2,3	38,8± 3,1
O. robusta	27,1± 2,5	25,3± 2,0	24,8± 1,7	27,4± 2,0	45,1± 3,4	37,5± 2,3	35,6± 2,7	34,85 ±3,7	41,7± 3,1	29,31± 2,4
C. tunicata	18,1± 1,4	16,2± 1,3	17,4± 1,1	16,4± 1,5	20,8± 2,5	21,50± 2,1	23,1± 2.3	30,28 ±2,72	31,6± 1,7	27,36± 2,0
C. imbricata	13,0± 1,3	13,5± 1,4	14,0± 2,2	13,8± 1,1	19,2± 1,3	20,6± 1,8	19,4± 1,1	17,2± 1,9	22,1± 2,2	16,6± 1,7
S. reflexum	36,8± 2,3	38,4± 2,5	65,1± 2,6	68,6± 3,3	54,2± 2,8	57,0± 2,6	58,3± 2,6	73,5± 3,7	72,3± 2,9	67,2± 2,4
S. palidum	39,9± 3,5	40,8± 3,0	57,8± 3,4	72,1± 3,2	54,8± 4,9	56,6± 3,9	55,5± 2,9	66,4± 3,8	56,3± 3,4	48,2± 3,3

For cultivars with quite low resistance to negative temperatures and continuous vegetative periods this phenomena occurred later – the end of October – beginning of November.

It was determined that stem (*O. engelmanii, C. molesta*) and leaf (*S. reflexum, S. acre*) cultivars of succulents with high level of frost-resistance are characterized by high content of ascorbic acid in tissues during autumn-winter periods; on average 15-20% more than cultivars with low frost-resistance.

Analyzing concentration of phenol compounds in water-saving tissue of stem and leaf succulents with different level of frost-resistance it was found out, leaf succulents contain more of these substances than stem cultivars. *Sedum* species mainly contains quercitin and its derivatives, while for *Opuntia* and *Cylindropuntia* species principal substances are xanthones.

Two maximum of phenol compounds storage are registered for both cases: May-June and November-December. Probably, activization of phenol compounds synthesis is connected not only with quantitative but with qualitative factors of these processes. As it`s known a number of phenol substances contained in plants are capable to function as growth-controlling factor (depending upon structure and concentration - either inhibiting or stimulating functions) we suppose their storage in spring period is caused by beginning of growth processes, while in November-December – by realization of adaptive mechanisms to negative temperatures effect. Experiments results (sprouting of *Lepidium sativum* seed on aqueous-alcoholic extracts made of tissues of succulents, which contain phenol compounds) can prove this conclusion. It was found out that if air temperature regime has steady tendency of decreasing passing point of +5°C (the 1st decade of November) tissue extracts of frost-resistant cultivars *Sedum* and *Opuntia* increase concentration of growth-inhibiting substances while cultivars with low frost-resistance this phenomena takes place after first frosts (the 2nd decade of November).

It turned out that frost-resistant cultivars, either stem (*O. engelmannii*) or leaf (*S. reflexum*) succulents, have more intensive synthesis of phenol compounds in comparison with not so frost-resistant cultivars such as *O. robusta and S. palidum* (Fig.1).

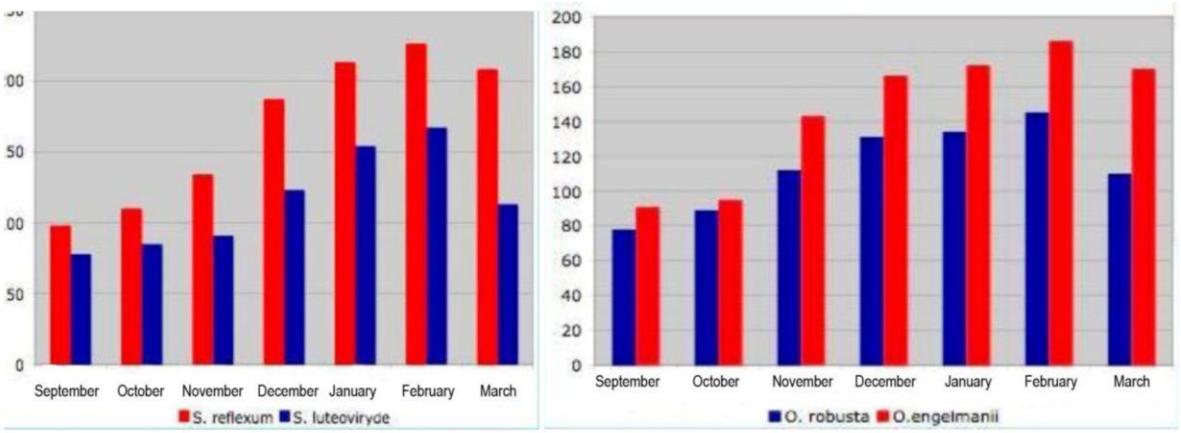

Fig.1 Concentration of phenol compounds in tissues of cultivars of *Opuntia u Sedum* genera characterized by different degree of frost-resistance

These findings allowed to conclude frost-resistance of stem (cultivars of *Opuntia, Cylindropuntia* genera) and leaf (cultivars of *Sedum* genus) succulents is caused by peculiarities of their secondary metabolism: dynamics of ascorbic acid and phenol compounds

storage in water saving tissues. Tissues of plant cultivars with relatively high cryotemperature resistance contain 20-25% more during cold period than cultivars with low resistance to negative temperature do.

Analysing long-term observation of dynamics the ascorbic acid storage in study cultivars it was concluded that its concentration depends upon weather conditions of a certain year. So, warm winter 2012-2013 with a high humidity but without hardening temperature parameters caused decreasing of frost-resistance degree of stem and leaf succulents on average this difference made 5…8°C, that`s why ascorbic acid storage in tissues of wintering organs decreased its intensity (Fig.2).

Nevertheless, thanks to two contrasting by cryotemperature-resistance study cases of *Opuntia* genus it was revealed that tendency to more intensive storage of ascorbic acid in tissues of frost-resistant cultivars keeps its parameters.

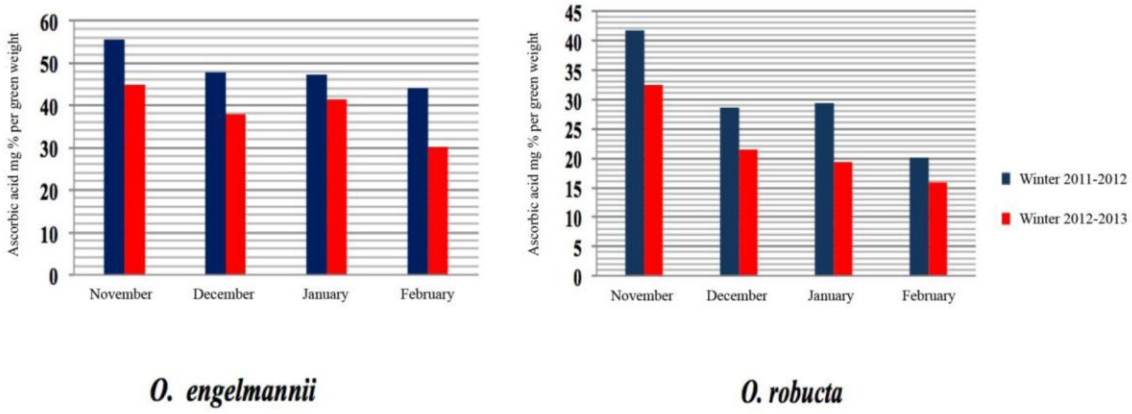

Fig.2 Ascorbic acid concentration in tissue of cultivars of Opuntia genus during winter periods of 2011-2012 and 2012-2013

Similar pattern takes place in comparison of phenol compounds in tissues of study cultivars during winter periods of 2011-2012 and 2012-2013. Probably there is cryoprotecting function of this substances with their antioxidant properties and possible participation in control of lipids peroxidation.

Conclusions

1. In terms of this research it was found out that ascorbic acid concentration in tissue of succulents has two maximum points, the first one is connected with blooming period (Sedum species – the 3rd decade of May – the 1st decade of June; species of *Opuntia* and *Cylindropuntia* – the 1-2nd decades of june), the second maximum point is explained by beginning of physiological rest (depending upon cultivar classification – October-November).

2. Frost-resistant cultivars of *Sedum*, *Opuntia* and *Cylindropuntia* genera are characterized by increasing of phenol compounds concentration in the beginning of cold period. Maximum content of phenols of stem and leaf succulents was registered in the coldest month on South Coast of the Crimea – February.

3. It was revealed that endogenic growth-regulators and frost-resistance level are connected. If air temperature regime has steady tendency to decreasing passing the point of 10°C (the 2nd and 3rd decades of November), tissues of frost-resistant cultivars of *Sedum* and *Opuntia* increase concentration of growth-inhibiting substances while cultivars with low frost-resistance have this phenomena after daily average temperatures go down passing the point of +5°C (the 2nd decade of December).

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Gubanova T.B. Stem and leaf succulents with contrasting frost-resistance level: accumulation peculiarities of some biologically active substances // Bull. of the State Nikit. Botan. Gard. – 2015. – № 115. – P. 54-58.

The article presents dynamics results of ascorbic acid and phenol compounds storage in tissue of cultivars of *Sedum, Opuntia and Cylindropuntia* genera with contrasting frost-resistance level. It was found out that cultivars with a high resistance to low temperature have synthesis of phenol compounds and ascorbic acid activated as soon as cold season begins. Perhaps these substances participate in protective mechanisms under conditions of low-temperature stress.

Key words: *frost-resistance; succulents; ascorbic acid; phenol compounds.*

MYCOLOGY

UDC 502.73:582.28(477.75)

NEW FUNGAL SPECIES INHABITING ON *DAPHNE TAURICA* KOTOV (THYMELAEACEAE) IN THE CRIMEA

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Introduction

Daphne taurica Kotov is an endemic plant of the Crimea. It is a deciduous shrub 40-80 sm (120 sm), stems in the bottom part can reach 28 mm across diameter. Bark on stems and lower branches is dark-brown, last-year`s branches have dark-purple color, shoots of the current year are greenish. Leaf length makes 4-48 mm, width – 2-10 mm. Leafs are sessile, bare, leathery, quite hard, oblong - inversely egg-shaped, edges are folded, bottom is wedge-shaped short (large leaves) oblong without visible footstalk. Flowers are aromatic, yellow-white or cream-colored by length of 1-3 sm, densely growing and shape heads (3-9 flowers) on the ends of short fruiting woods with thick foliage. Bloom period is in May-June. Fruits are dark red ripened drupes, young fruits have red color. Fruiting takes place in August [2, 4, 5].

Daphne taurica Kotov prefers sod-brown soils, formed on limestones of Jurassic period, characterized by poor alkaline reaction (pH=7,5). It is found in light forest with density of 0,2 mixed with meadow-steppe and petrophyte elements, which belong to association *Laserpitio-hispodi-Quercetum petrae, Querco-Carpinifolia betuli* order, and in shrub aggregations of *Rhamno-Prunetea* class.

Two localities were found being included into three cenoses of 17, 42 and 2m^2. Population size is relatively 157, 75 and 24 specimens, totally – 256 plants. The first locality with area of 0,5 ha is situated on the right bank of the river Bolshaya Burulcha, among limestones, exposed on the plateau surface, where strata steeply directed to North, as numerous rocks uncover on the surface of slopes forming caves, cliffs and screes. *Daphne taurica* Kotov growing here forms small branchy bushes, diffused among herbaceous and shrub cenoces, mainly in well-illuminated areas. The second locality is situated on the left slope of the river (Bolshaya Burulcha) valley. This slope begins 200 m higher than broom Gniloy mouth and spreads 800-900 m down along the main valley. The slope is steep, stony with a number of limestone outcrops which cross it till the bottom of mountain range ressembling ridges, cliffs of 30-40m and isolated peaks. *Daphne taurica* Kotov can be found along the very edges of rock, where illumination conditions are favorable; also some growths are found at the bottom of rocks covered by *Juniperus Sabina* [3].

Daphne taurica Kotov is a plant of RDBU [2], ERL (V) [7].

It was described as a new species in 1970 that`s why data of fungi weren`t presented at all.

Objects and research methods

The author investigated population of this species on “Mokrousov rocks” within two localities (Isikov, 2013). One of localities is situated at the foot of rocky steep before yaila area of the mountain, among light forest where the following group of plants grows: *Ligustrum vulgare, Rhamnus cathartica, Berberis vulgaris, Rosa spinosissima, Amygdalus nana, Acer campestre, Cotinus coggygria* and *Cornus*. On the area of 200 m^2 there were found 70 specimens; plants grow sparsely by single plants. Locality coordinates: n.l. 44°50'997", e.l. 34°25'815". The second locality is situated above the first one on yaila part of the mountain among growth of *Juniperus Sabina* and inside of its spacious cushions. On the area of 100 m^2 there were found 90 specimens. Locality coordinates: n.l. 44°51'014", e.l. 34°25'859". In terms of this study phytopathological inspection of all specimens and population was carried out, total number is 160 specimens. 20 patterns with mycological material were selected.

Results and discussion

New fungal species were found on leaves and shoots with different type of branching. These fungi have well-marked ecological niches according to organs and parts of plants, what is typical for symbiotic way of life. Fungi belong to the group of highly specialized biotrophic species, associated with a certain plant species. That is way we are sure to classify them as new fungal species.

Phyllosticta daphnae Isikov sp. nova

Maculatio effusa, raraest, maculae confluentes, amphigenae, ad 1 cm diam., sine marginatione sunt. Pycnidia gregaria, globosa, orbiculato-globosa, nigra, ad 100 µ diam. amphigena sunt. Conidiophora simplicia, recta, inramosa, angustata ad apices, 12-15 x 1.5-2 µ. sunt. Conidia decolorata, cylindrica, parve incurvata, 6-7(9) x 2-2.5 µ. sunt.

T y p u s: in Russia, regionis Crimeae, in declivibus montium, in parte superiore vallis fluminis Burulytsha locatasunt. In foliis *Daphne taurica* Kotov (Thymelaeaceae) occurrunt, 18.09.2013, V.P.Isikov, in Horto Botanico Nikitensis conservantur (Yalta).

Blotch is sparcely, spots take place on both sides of a leaf, blend, 1 sm across diameter without bordering. Pycnidiums grow on both leaf sides in groups, have a globe and rounded-globe shapes, black, till 100 mkm across diameter. Conidium-baring parts are simple, straight, unbranched, tapered to the top, 12-15 x 1,5-2 mkm. Conidiums are colourless, cylindric, lightly incurvate, 6-7(9) x 2-2,5 mkm (Fig.1).

Type: Russia, the Crimea, mountain slopes, upper part of the river Bolshaya Burulcha. Place of growth: leaves of *Daphne taurica* Kotov (Thymelaeaceae), 18.09.2013, V.P. Isikov. It is preserved in Nikitsky Botanical Gardens.

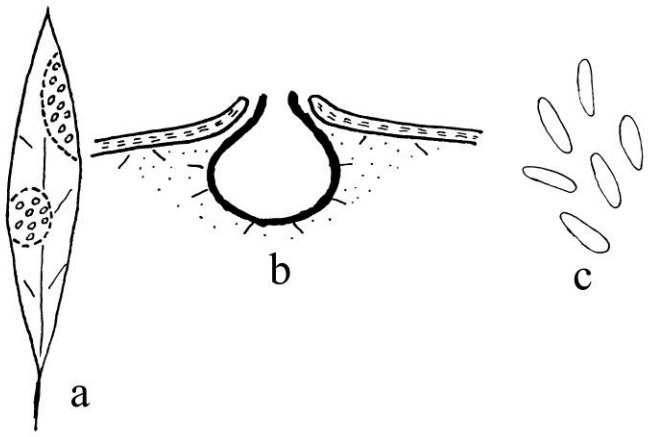

Fig. 1 Leaf damage by fungus Phyllosticta daphnae Isikovsp. nova (α), cross-section of the fungal fruit (b) and conidium (c)

Phomopsis daphnae Isikov sp. nova

Pycnidia gregaria circulatim, immersa, 200-300 μ in diam. sunt. Apices obtusas conicasin faciem prominent, tunica picnidii nigratenuis, decoloratain medio est. Picnidia camera magna una aut pseudoloculosa plura habent. Conidiophora sumplicia, filiformia, 30-45 x 3-4 μ sunt. Conidia decolorata hyaline sunt, typiduo occurrunt: α-conidia elongato-ovalia, extremitates obtusae aut sub acuminatae, 8-10(12) x 2.5-3 μ, decolorata, cum 2 guttas magnas sunt; in cormis 2 mm diam. occurrunt. β-conidia filiformia, uncinata, 25-30(33) x 1.5-2 μ sunt; in cormis 1-1.5 mm diam. occurrunt. Conidia α+β in cormis ab 3 mm diam. et magis occurrunt.

T y p u s: in Russia, regionis Crimeae, in declivibus montium, in parte superiore vallis fluminis Burulytsha locatasunt. In cormis exsiccates *Daphne taurica* Kotov (Thymelaeaceae) occurrunt, 18.09.2013, V.P. Isikov, in Horto Botanico Nikitensis conservantur (Yalta).

In Ucraina species similis *Phomopsis delogneana* Petr. in *Daphne mezereum* L. occurrit [1]. Ab specie descriptivadis similitudinem habere cum serie characterum morphologicorum sunt.

Picnidiums are submersed, grow in groups, 200-300 mkm across diameter; visible on surface thanks to blunt cone-shaped top in thin black capsula; they are colorless inside, have one big chamber or several false chambers. Conidium-baring parts are simple, confervoid, 30-45 x 3-4 mkm. Conidiums are colorless and divided into 2 types: α – oblong-oval, ends are blunt or ligtly mucronate, 8-10(12) x 2,5-3 mkm, colorless with two drops, place of growth is shoots of 2mm across diameter; β – filamentous, hamiform, 25-30(33) x 1,5-2 mkm, can be found on shoots of 1-,5 mm across diameter. Conidiums of α+β are found on shoots of 3 mm and more across diameter (Fig.2).

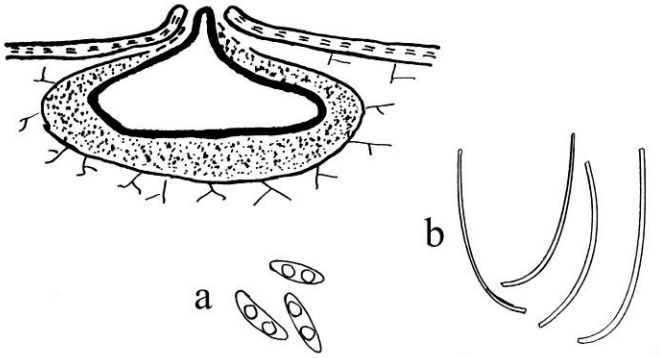

Fig.2 Across-section of fungal fruit of Phomopsis daphnae Isikov sp. nova and α- и β-conidiums

Type: Russia, the Crimea, mountain slopes, upper part of the river Bolshaya Burulcha. It is found on sphacelated shoots of *Daphne taurica* Kotov (Thymelaeaceae), 18.09.2013, V.P. Isikov, included into collection of Nikitsky Botanical Gardens.

In Ukraine affind species *Phomopsis delogneana* Petr. is found on *Daphne mezereum* L. (Prikarpatye). It has a number of considerable morphological characteristics which differ it from the study case.

Cytospora taurica Isikov sp. nova

Pycnidia ad 4 mm in diam., solitaria, raro 3-4 occurrunt, conica, nigra, depresso-globosa, in medio papillaro-porrecta sunt. Picnidia e fissuris corticis emergentia sunt. prominent e fissuris corticis emergentia. Stoma unum est. Endostroma olivaceum, pseudoloculosum est; parietes septifereindis tincti sunt. Conceptaculum nigrum, 50-100 μ crassitudinis, benedictinctum est. Conidiophora simplicia, decolorata, fruticulosa, 20-24(30) x 1.5-2 μ sunt. Conidia decolorata, allantoidea, 7-8(9) x 2.5-3 μ sunt.

Fungus inextremitatibus cormorum I, 1.5 mm in diam. occurrit.

T y p u s: in Russia, regionis Crimeae, in declivibus montium, in parte superiore vallis fluminis Burulytsha locatasunt. In cormis exsiccates *Daphne taurica* Kotov (Thymelaeaceae), 18.09.2013, occurrunt, 18.09.2013, V.P. Isikov, in Horto Botanico Nikitensis conservantur (Yalta).

Picnidums till 4 mm across diameter are single, rarely make groups of 3-4 ones, cone-shaped, black, flattened - globe-shaped, inside – papillary-oblong come out of bark cracks. There is one stoma. Endostoma is olive green, falsly multi-chambered, septa are not well-marked. Conceptaculum is black, 50-100 mkm by thickness, well-marked. Conidium-bearing parts are simple, colorless, bushy, 20-24(30) x 1,5-2 mkm. Conidiums are colorless, allantoids, 7-8(9) x 2,5-3 mkm. The fungus is found on the ends of shoots of the 1st order 1,5 mm across diameter (Fig.3).

Type: Russia, the Crimea, mountain slopes, upper part of the river Bolshaya Burulcha, on sphacelated shoots of *Daphne taurica* Kotov (Thymelaeaceae), (Thymelaeaceae), 18.09.2013, V.P. Isikov, included into NBG collection.

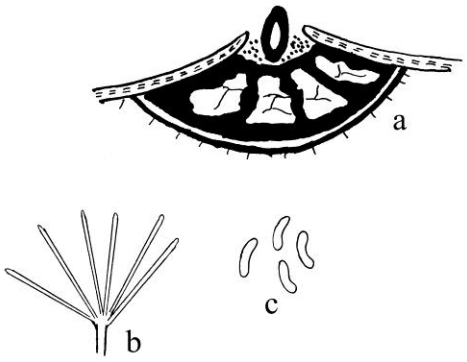

Fig.3 Across section of fungal fruit of Cytospora taurica Isikov sp. nova (α), conidium-bearing parts (b) and conidiums (c)

Macrophoma daphnae Isikov sp. nova

Pycnidia 100-200 μ in diam., substrato immersa, forma conica sunt, apex papilliformis niger in 3-4 mm in faciem prominet. In loco exitus fungi in facie cortex pallidior est. Carposomata gregaria in facie omnia substratidis posita sunt. Conidiopora parva, 5-10 μ longitudinis sunt. Conidia decolorata seu olivacea, 10-12(15) x 5-6 μ sunt. Picnidium tunicam tenuissimam et subhyalinam habet, interdum guttae oleosae occurrunt. Fungus per plantam totam, incormis I-IV, 0.5-7 mm in diam. occurrit; fungus distributissimus in planta est.

T y p u s: in Russia, regionis Crimeae, in declivibus montium, in parte superiore vallis fluminis Burulytsha locatasunt. In cormisexsiccatis *Daphne taurica* Kotov (Thymelaeaceae) occurrunt, 18.09.2013, V.P. Isikov, in Horto Botanico Nikitensis conservantur (Yalta).

Pycnidiums are of 100-200 mkm across diameter, cone-shaped, submersed into substrate; exude with black papilliform tops 3-4 mm above the surface. On the place where fungus develops bark is lighter. Fruit bodies grow in big groups all over the substrate surface. Conidium-bearing parts are small, 5-10 mkm by length. Conidiums are colorless or have olive green color, 10-12(15) x 5-6 mkm; capsular is very thin, almost transparent, sometimes oil drops. Fungus develops across the whole plant, on shoots of I-IV orders, 05-7 mm across diameter. It takes the first place among fungi growing on this plant (Fig. 4, 5).

Type: Russia, the Crime, mountain slopes, at the upper part of the river Bolshaya Burulcha, on sphacelated shoots of *Daphne taurica* Kotov (Thymelaeaceae), 18.09.2013, V.P. Isikov, included into NBG collection.

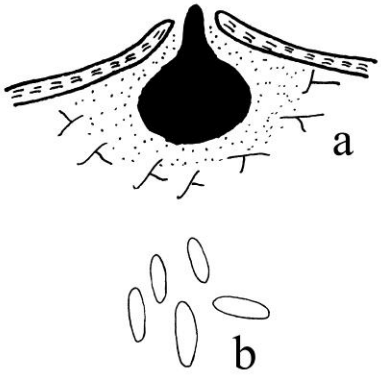

Fig.4 Across section of a fruiting body of Macrophoma daphnae Isikov sp.nova (α)and conidium (b)

Fig.5 Fruiting bodies of Macrophoma daphnae Isikov sp. Nova on the central shoot *Daphne taurica* Kotov

As to other fungal species registered on study plant, xylotrophic fungus-polyphag **Byssomerulius corium (Fr.) Parm.** was found there as well. It grows on central shoots 5 mm and more across diameter. It is wide-spread in natural ecosystems and artificial stands, in the Crimea this species was revealed on 30 species of arboreal plants.

Conclusions

Therefore, on rare protected plant cultivars *Daphne taurica* 5 fungal species were found, 4 of them are new for this plant. Almost all these fungi belong to phytopathogenic species, only one of them is xylotroph. Biotrophic fungi belong to Deuteromycetes class, Sphaeropsidales order and *Phyllosticta*, *Phomopsis*, *Cytospora*, *Macrophoma* genera, while xylotrophic fungus is of Basidiomycetes class, Aphyllophorales order, *Byssomerulius* genus.

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Isikov V.P. New fungi species inhabiting on *Daphne taurica* Kotov (Thymelaeaceae) in the Crimea // Bull. of the State Nikit. Botan. Gard. – 2015. – № 115. – P. 58-63.

This work covers study results of mycoflora of *Daphne taurica* Kotov, rare endemic plant in the Crimea. Totally it was found out 5 fungi species of 2 classes and 5 genera. 4 new species that belong to *Phyllosticta, Phomopsis, Cytospora and Macrophoma* genera, class Deuteromycetes were described.

Key words: *endemic; shrubs; fungi; new species; Daphne taurica.*

AGROECOLOGY

UDC 631.41:582.746.66:631.367

LAUROCERASUS OFFICINALIS ROEM. SEEDLINGS AND THEIR RESPONSE TO COMPOSITION AND PROPERTIES OF SUBSTRATES BEING CULTIVATED IN CONTAINERS

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Introduction

Introduction of Strange ornamental cultivars improve productivity of green plantations, parks ornamentality, optimize their species composition and increase biological diversity. *Laurocerasus officinalis* Roem. is a perspective exotic cultivar which possesses such properties as fast growth, drought- and frost-resistance.

Moreoften to get planting stock in an open soil is to come across bad quality plants, irrational planning of nursery area, damaged root-system while digging up, large labour resources for digging up plants with soil, difficult transportation. Cultivation of seedlings with closed root system is one of reliable methods to get high-quality planting stock of ornamental arboreal-shrub plants, what favors their intensive growth. According to common standards of growing planting stock in containers it`s recommended to use a lot of various substrates for either cultivars of arboreal ornamental plants, but detailed soil and agrochemical characteristics of composition and properties of both substrates and their components are absent in scientific literature, biometrical parameters of *Laurocerasus officinalis* Roem. seedlings are not presented as well [3, 5, 7-10, 16-18, 20-21]. That`s why it was extremely important to carry out soil-biological investigations of *Laurocerasus officinalis* Roem. growth being cultivated in different substrates.

Study objective is to determine optimal substrate for cultivation of high-quality planting stock of *Laurocerasus officinalis* Roem. in containers. Among study tasks there were researching the granulometric, structural, chemical, physical and chemical properties, and agrochemical parameters.

Objects and research methods

The investigations took place at experimental farm "Primorskoye" NBG-NSC (urban village Partenit, the city of Alushta). Research objects were 6 substrate variants intended for *Laurocerasus officinalis* Roem. cultivation in containers. Traditionally used in EF "Primorskoye" substrate was chosen as control variant (variant 1).

Standardized methods were applied to study substrates and plants [11, 14]. Granulometric (patterns were treated by sodium pyrophosphate before analysis) and microaggregate composition of substrates and their components were determined by method of N.A. Kachynsky [12], structural composition – by method of N.I. Savvinov [6]. Humus was analyzed by Tyurin`s method [19], ammonia nitrogen – by phenol method, nitrate nitrogen – by method of ion-selective electrodes [2], mobile phosphorus and exchangeable potassium – by Michigin method in modification CINAO [2], slightly soluble salts in aqueous extract – by method of Arinushkina [4], calcium carbonates – by Golubev acidimetric method [15], pH of aqueous suspensions – potentiometricaly, base saturation – by Pfeffer [1]. Plant condition was assessed according to their biometric parameters and ornamentality.

Results and discussion

The most intensive way of *Laurocerasus officinalis* Roem. growth was fixed for variants 4 and 5, which were composed of 2 fertile ingredients and bank sand. Let`s analyze properties of these variants and control.

Substrate, commonly used in work of EF "Primorskoye" (control), was characterized by loamy sandy-silt granulometric composition. This composition mainly consisted of large and small dust fractions, silt fractions made 29%. Substrates of 4 and 5 variants were characterized by light granulometric composition – middling loamy sandy-silt. These substrates contained 66% of sandy-large-middling silt fractions and 33% of silt and powdery dust; 39% of physical dust while substrate of control included 50% of it (table 1). It was found out that alternative substrates are either lighter by granulometric composition than control variant is, or more favorable for root system.

Structural condition of substrates is one of the most considerable parameters of their fertility. Size and correlation of aggregates are of great importance in creation of optimal water-air and nutrient soil regimes. Structure of study substrates was assessed according to percentage of aggregates there ranged from 0,25 up to 10 mm [13]. In control variant content of such aggregates made 72 %, while coefficient of structural properties of variants 4 and 5, calculated according to correlation of aggregates content (10-0,25 mm) and amount of dust and blocky partings, made 2,5 and 2,2 relatively. Therefore, study substrates were characterized by perfect aggregate properties.

All substrates contained calcium carbonate, which caused alkalescent and alkaline reaction of aqueous suspension. In control substrate with beach sand concentration of $CaCO_3$ was high and reached 21%, while in substrates 4 and 5 with bank sand there were only 7-9% of carbonates (table 2). In both cases chlorosis symptoms were not revealed.

Table 2

Chemical and physical-chemical composition of substrates

Variant	Humus, %	$CaCO_3$, %	$pH_{aqueous}$
Variant 1 (control)	2,05	21,46	7,60
Variant 4	4,50	9,45	7,32
Variant 5	2,98	7,25	7,15

According to analysis of aqueous extract substrates of control and 4 variants were not saline (Table 3). Substrate of variant 5 had a slight sulfate salinization (content of slightly soluble salts made 0,36%) , though calcium sulfate (gypsum) harmless for plants prevailed in salt composition.

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Table 1

Granulometric fine earth composition of substrates components

Pattern	Content of fractions (mm), %						Amount of fractions (mm), %		
	1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01	>0,05	0,01-0,001
Variant 1 (control	18,2	12,36	19,04	3,5	17,81	29,09	50,4	30,56	21,31
Variant 4	19,4	26,61	15,68	5,2	11,19	21,92	38,31	46,01	16,39
Variant 5	20,77	25,51	13,98	5,95	12,06	21,72	39,73	46,29	18,01

Table 3

Cationic-anionic structure of substrates aqueous extract

Pattern	Amount of salts, %	CO_3		HCO_3		CL		SO_4		Ca		Mg+		Na+
		ME*	%	ME*	%	ME*	%	ME*	%	ME*	%	ME*	%	ME*
Variant 1 (control)	0,115	0	0	0,29	0,017	0,46	0,016	2,48	0,019	2,29	0,046	0,46	0,006	0,48
Variant 4	0,289	0	0	0,58	0,035	33	0,012	3,43	0,165	2,5	0,05	1,41	0,017	0,43
Varinat 5	0,35	0	0	0,46	0,028	0,17	0,006	4,58	0,22	4,45	0,089	0,46	0,006	0,3

Table 4

Composition of substrates absorbed bases

Pattern	Exchangeable cations, % of total				Absorbed bases, mg/eq/100 g of sample	Exchangeable cations, % of total			
	Ca	Mg+	Na+	K+		Ca	Mg+	Na+	K+
Variant 1 (control)	14,2	2,9	0,12	0,59	17,81	79,7	16,3	0,7	3,3
Variant 4	12,8	1,6	0,08	0,37	14,85	86,2	10,8	0,5	2,5
Variant 5	23,6	2,8	0,1	0,48	26,98	87,4	10,4	0,4	1,8

*ME – mg/equivalent/ 100 g of soil

The most dangerous for plants salts are sodium carbonate (soda) and chlorides. Sodium and magnesium sulphates have toxical effect on plants being in large concentrations, but not so dangerous as sodium and magnesium bicarbonates. In study substrates the most toxic for plants salt, soda, wasn`t found out, while concentration of harmful for ornamental arboreal-bushy plants chlorides, bicarbonates and sulphates Na+ and Mg+ didn`t exceed the permitted limits even under conditions of subhumid.

Amount of absorbed bases in substrate of control variant made 18, while variants 4 and 5 made 15 and 27 mg/eq/100 of a sample relatively (table 4). Calcium concentration in composition of absorbed bases in study substrates exceeded magnesium content. Concentration of absorbed Ca^{2+} of control variant made 80%, Mg^{2+} - 16%, Na^{2+} - 0,7%, K+ - 3,3% of total base amount. In substrates of 4 and 5 variants absorbed Ca^{2+} made 86 and 87%, Mg^{2+} - 11% for both, Na^{+} - 0,5 and 0,4%, K^{+} - 2,5 and 1,8% of exchangeable cations amount, relatively. This content of absorbed magnesium and sodium didn`t cause alkalinity of substrates or damage the plant growth.

Mobile forms of the principal nutrient substances and their content in period from May to September 2013 were determined in the study substrates for *Laurocerasus officinalis* seedlings of 2010, 2011 and 2012 planting years (fig.).

Control variant of substrate presented 0,93 mg/kg of nitrate nitrogen in the beginning of vegetation. Substrates of 4 and 5 variants contained 2,86 and 2,06 mg/kg relatively. In the middle of vegetation concentration of nitrate nitrogen in control variant increased up to 3,28 mg/kg, and till 6,79 and 7,47 mg/kg in substrates 4 and 5 relatively. Such a phenomenon during period of intensive plant growth is explained by optimal hydrothermal conditions for ray fungus, oligonitrophils and other micro organisms. By the end of vegetation concentration of nitrate nitrogen in study substrates went down. Variations of nitrate nitrogen content through the vegetative period in substrates of control variant had minimal parameters. In September NO_3 reached 0,91 mg/kg in control variant, while in variants 4 and 5 it made 4,80 and 5,21 mg/kg relatively.

Dynamics of ammonium nitrogen content in substrates is similar to nitrate nitrogen. In the beginning of vegetative period ammonium nitrogen concentration made 6,67 in control variant but in July it increased up to 12,75 mg/kg. By the end of vegetation it decreased till 11,36 mg/kg. In May variants of substrates 4 and 5 had minimal content of ammonium nitrogen in comparison with the middle or end of vegetation – 6,67 and 9,64 mg/kg relatively. In July concentration of this component increased up to 18,78 mg/kg (variant 4) and 22,84 mg/kg (variant 5). By the end of vegetation nitrogen content reduced till 17,71 and 21,65 mg/kg in variants 4 and 5 relatively. As to NH_4^{+} substrate of the 4^{th} variant had much less than variant 5, but more than control variant. According to the leaf apparatus, plants didn`t suffer from the lack of nitrate or ammonium nitrogen, at the same time registered concentration of nitrogen indicates that it`s quite sufficiently for *Laurocerasus officinalis* cultivation in containers.

Seasonal dynamics of mobile phosphorus in substrates developed in another way in comparison with nitrogen. Maximum content of mobile phosphorus was fixed in May further its concentration gradually went down as *Laurocerasus officinalis* absorbed intensively. In the end of vegetation period substrates trended to increasing of mobile phosphorus as process of growth and development went down. In the beginning of vegetation period in substrate of the control variant concentration of mobile phosphorus made 4,66 mg/kg, but in July it increased up to 9,80 mg/kg. By the end of vegetation mobile phosphorus reduced till 6,57 mg/kg. In substrate of variant 4 maximum concentration of mobile phosphorus was fixed in May – 51,16 mg/kg, but in July it decreased till 46,23 mg/kg, what was also explained by plant intensive consumption. By the end of vegetation phosphorus went up again and reached 50,21 mg/kg. In the beginning of vegetation mobile phosphorus was registered at 63,64 mg/kg in

substrate of variant 5, in July – 59,51, in the end of vegetation – 56,20 mg/kg. On average through the whole period of vegetation the highest concentration of mobile phosphorus was fixed in variant 5, which was 8,5 times more than in control variant. Visual diagnostics of leaves proved phosphorus was sufficient for plant growth and such a nutrient regime was favorable to cultivate *Laurocerasus officinalis* in containers.

Mobile potassium in substrate of control variant made 36,48 mg/kg in the beginning of vegetation, variants 4 and 5 – 43,58 and 49,17 mg/kgrespectively. In July having favorable hydrothermal conditions concentration of potassium in all study substrates increased: control – 43,32, variant 4 – 56,38, variant 5 – 102,79 mg/kg. By the end of vegetation mobile potassium resources went down till 38,15 mg/kg in control variant, 52,14 and 89,50 mg/kg in variants 4 and 5 relatively.

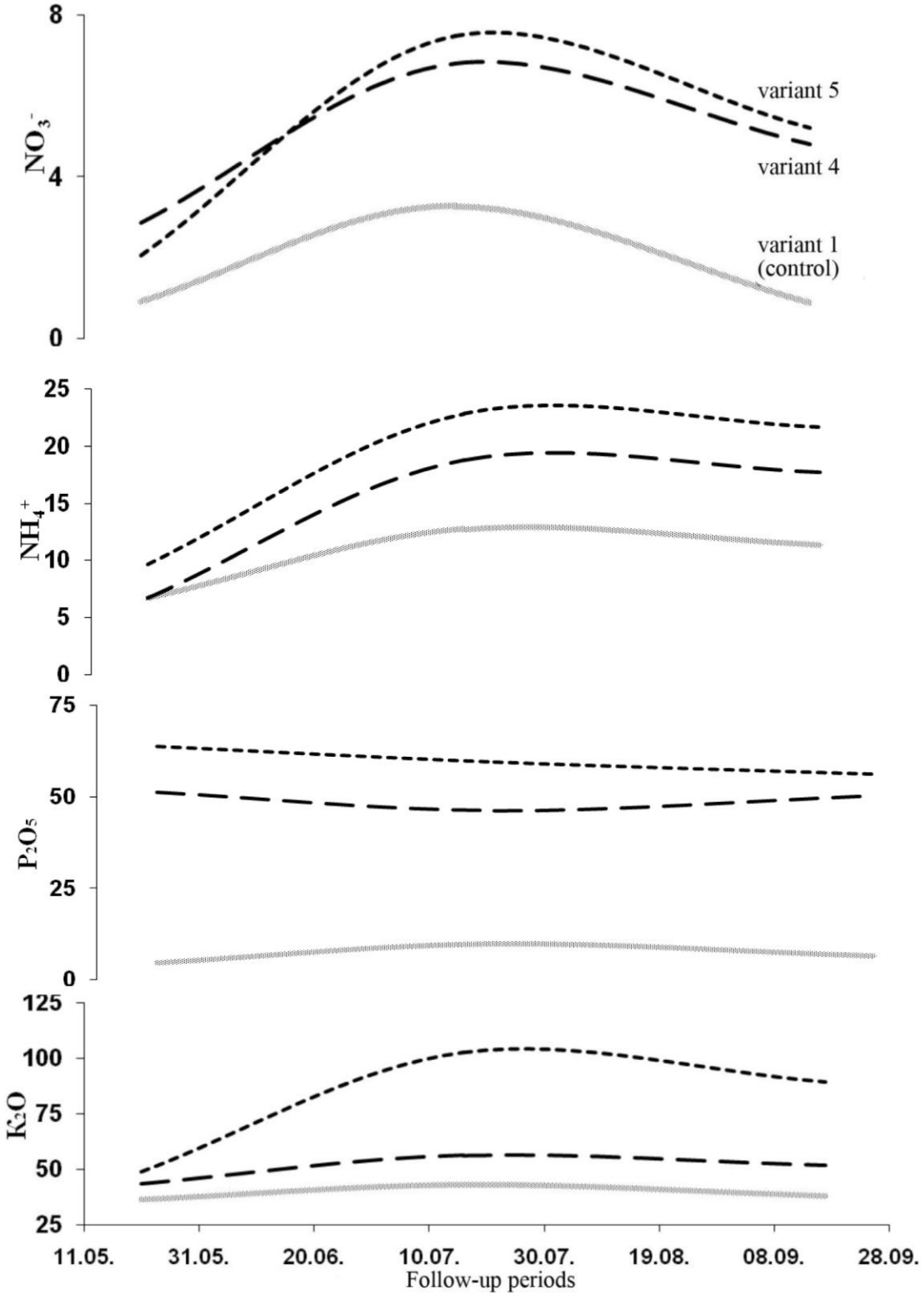

Fig. Dynamics of N, P and K mobile forms (mg/kg) in study substrates for *Laurocerasus officinalis* Roem. (2013)

Variant 5 the most favorable substrate by mobile potassium content for *Laurocerasus officinalis* cultivation was marked out. Therefore allowing for potassium nutrition substrate variants 4 and 5 occurred the best for *Laurocerasus officinalis* cultivation in containers.

During 2013 seedlings of *Laurocerasus officinalis* cultivated in containers responded to fertility of substrates in different ways. Low vital condition of plants, their ornamentality, small amount of growth were fixed in control variant of substrate. The best variant which consists of 2 fertile ingredients and sand (variant 5) annual growth made 75,42±1,26 sm what is 244 times more than in control one. Plants of 2011 and 2012 in the best variant of substrate exceeded control variant 100 and 115 times.

Maximum branching were registered for plants of 2010 in variant 5 – 37,21±1,13, while for plants of 2011 and 2012 it made – 28,35±1,89 and 22,16±2,02 relatively. Diameter of plant crown (plantation of 2010) made 28,12±2,62 in control variant, 41,14±14 and 45,99±2,59 sm – variants 4 and 5 relatively. Plants of 2011 and 2012 had maximum diameter of crown being cultivated in substrate of 5 variant – 37,28±1,77 and 30,28±1,01 sm relatively. Such a biometrical parameter as stem diameter was maximum for variant 4 (plantation of 2010) – 2,21±0,74 sm, plantation of 2011 and 2012 – 1,77±1,12 and 1,31±3,03 relatively. The optimal ratio of biometrical parameters was fixed for plants in substrate of variant 5.

Parameters *of Laurocerasus officinalis* biomass were the most suitable to compare qualitative characteristics of its seedlings. Maximum weight of the root part was registered for variants 4 and 5 – 69 and 78 g relatively, minimum – 38 g – control variant. Ratio between underground and overground components of the plant substance made 1:3 for variants 4 and 5, while control one presented 1:4. The highest resource of overground phytomass was fixed for variants 4 and 5 – 194 and 229 g relatively. In comparison with control pattern, variant 5 exceeded this parameter 1,5 times.

Integrated study of substrates composition, properties and *Laurocerasus officinalis* response to their fertility level permitted to propose optimal ratio of substrate ingredients for cultivation of standard seedlings with close root system.

Conclusions

1. Studied substrates are characterized by favorable for plant cultivation middling loamy and granulometric composition with optimal ratio of sandy, dusty and silty fractions.
2. Substrates have a good structure and there were no considerable differences between them according to this parameter.
3. Substrates were not slated by readily soluble salts, alkalinity wasn`t registered.
4. The most favorable nutrient regime by nitrate and ammonium nitrogen, mobile phosphorus and potassium consisted of 2 fertile ingredients and sand – variants 4 and 5.
5. Substrates of patterns 4 and 5 presented a high degree of fertility, where *Laurocerasus officinalis* revealed a good level of ornamentality, best parameters of growth and more powerful root system.

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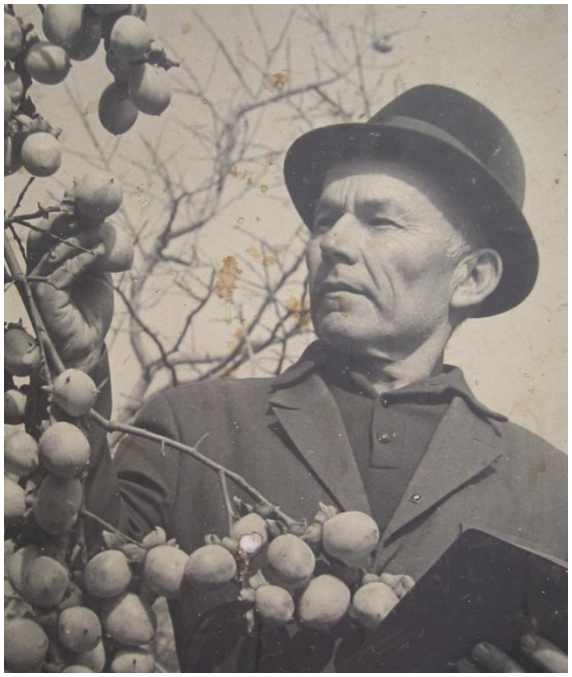
It terms of this research the following was investigated: granulometric, structural-aggregate and chemical composition, physicochemical properties, agrochemical parameters and nutrient regime of (N, P, K) substrates, assessment of their fertility and adaptability for cultivation of *Laurocerasus officinalis* Roem. in containers.

BIOGRAPHIES

UDC 634.45:631.526.3(477.75)(092)



ORIGINATOR OF THE FIRST CRIMEAN CULTIVARS OF *DIOSPYROS*

(devoted to the 100 anniversary of A.K. Pasenkov)

On February the 20th in 2014 it would be the 100th birthday anniversary of Pasenkov Arkadiy Konstantinovich. He was born in Kazakhstan, got education at comprehensive school and the State Pedagogical University in Pavlodarsk, biological department named after V.V. Kuibyshev. He successfully graduated university in 1937 and got his first degree diploma of "botanist-biologist". Later he occupied a position of director at Aktyubinsky state fruit nursery, and from the beginning of 1939 he started for scientific work as a research assistant and head of fruit and berrie nursery of Tomsk botanical garden. Since July of 1941 he served in military units of Pacific navy, participated in battles for liberation of Manchzhuriya. He was awarded with medal "For Victory over Japan". After demobilization in 1946 Arkady Konstantinovich resumed his scientific work and got a job of research assistant at introduction and selection department of Batumy botanical garden.

Working in Batumi Pasenkov A.K. considerably enlarged collection of the *Diospyros kaki* with new hybrid forms, 7 of them were referred to department of the state species test.

In summer of 1951 as subtropical fruit farming developed in the Crimea, A.K. Pasenkov was transferred to Nikitsky botanical garden, where he had worked for 23 years. He was engaged in collection and selection of such rare for the Crimea species, as *Diospyros* and *Feijoa*, as well as hybridization and adaptation in industry of nut-bearing cultures. Taking direct part 12 ha of collection nursery garden with *Circassian walnut* were founded in Steppe Crimea, most of its species and forms belonged to a group of early-maturing.

Vegetative fixation of 16 new cultivars of *Circassian walnut* from native selection and 4 cultivars from Bulgarian selection was conducted in that nursery.

While investigating *Circassian walnut* plantations in the Crimea, Arkadiy Konstantinovich found out 38 valuable for that region super late by beginning of vegetation forms of *Circassian walnut* which were characterized by high crop capacity, commercial and diseases-resistance.

Fruit belts and selective-nursery gardens of early-maturing *Circassian walnut* forms were planned thanks to his own initiative. Total area made 30 ha including such state farms as "Starokrymsky", "Vinogradny", "Zhemchuzhny" and collective farm "Ukraina".

As a result of distant hybridization with pennant of early-maturing and divided –leaf forms of walnut Arkady Konstantinovich obtained dwarf early-maturing hybrids characterized by high crop capacity, large fruits and ability to early ripening.

In terms of intergeneric hybridization of walnut and pecan 1960 he found out economically valuable hybrid 60-1, which differed by heterotic development, relatively early phase of fruiting, high crop capacity and good commercial qualities of fruits.

According to order № 310 MSH USSR dated by 21.11.1968, 5 new cultivars of walnut selected in NBG thanks to A.K. Pasenkov as well were zoned and recommended for commissioning: "Starokrymsky 913", "Bakhchisaraisky 491", "Pervomisky 559", "Vysokogorny 619", and "Krymsky Yrozhainy 17-9".

A.K. Pasenkov carried out scientific research with feijoa. He conducted agrobiological study of 200 feijoa fruiting selective forms, bred out of hybrid seeds, marked out 16 cultivar forms, perspective by crop capacity and commercial fruit qualities. He initiated development of vegetative propagation methods for the best feijoa forms – grafting on seedling stock of myrtle.

Anyway favorite culture of A.K. Pasenkova was *Diospyros*. In 1969 he successfully defended Master`s dissertation named "Biology of flowering and fruiting of *Diospyros kaki*". As a result of cultivar form study of Diospyros in 1970 he wrote and published work "Resume of cultivar form study of *Diospyros kaki* growing on the South Coast of the Crimea" and besides it he developed and prepared for publishing "Diospyros. Methodic of primary cultivar form study".

As a result of intraspecific and interspecific hybridization A.K. Pasenkov created selective fund of *Diospyros kaki*, its hybrids with *Diospyros virginiana* and *Diospyros lotus*. In 1968 it made possible to present 3 *Diospyros* cultivars of NBG selection to department of the State Strain Test: Mechta, Nikitsky Prevockhodny and Rossiyanka. Cultivar "Rossiyanka" possesses high level of frost-resistance (survives under conditions of 30°C below zero); moreover it is cultivated not only in the Crimea, but in south region of Ukraine as well.

"Working in the Garden, - head of subtropical cultures department A.A. Rykhter wrote, - A.K. Pasenkov acted as thoughtful, initiative and disciplined collaborator". He participated actively in social and political life of the establishment, rendered assistant to state and collective farms in adaptation of subtropical fruit cultures in the Crimea. Besides scientific work A.K. Pasenkov was in social activities. He took position of Commander Deputy of the Garden volunteer public order squad, was a member of popular control group, Council Chairman of the first organization of scientific and technical Community, unchallenged agitator and political informator of the department.

A.K. Pasenkov published 24 scientific works. I remember him as a very active, kind and energetic person, full of new ideas and intention to improve scientific researches. PhD (Candidate of Agricultural Science), A.K. Pasenkov was an inexhaustible toiler and a real patriot of Nikitsky Garden.

A.K. Pasenkov passed away on November the 17th in 1974.

Principal directions of A.K. Pasenkov`s scientific researches are presented in his published works:

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Z.K. Klymenko

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The article covers the main stages of life and scientific activity in Nikitsky Botanical Gardens of Pasinkov A.K., the candidate of Agricultural Science.

INFORMATION FOR AUTHORS

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1. Articles should be in Russian or English, not published or registrated in other journals, collections of works before (exept thesis reports and material of conferences, symposiums, meetings and etc.).

2. Articles must contain brief and clear summery about current state of the subject, description of research methods, issue and discussion of findings. Article title should correspond its contain. An article must be divided into structural parts, cited in the pattern below. Part "Introduction" should include research currency (problem statement and its connection with important scientific and/or practical tasks), analysis of references, used while solving the problem, and research objective.

3. Article is typed in MS Word for Windows (*.doc or *.docx). The following page setup should be used: format – A4, page orientation is book, border size is 2,5sm, print – Times New Roman 12 pt (except summeries, key words, figures and tables, which are typed in 10pt – see patterns below), indent – 1,25 sm, line spacing of the main text is 1 (single spacing), text is typed without word division, justified alignment, text is not paged. During execution and formatting of the text or its structural elements, please follow patterns carefully!

4. Publication size shouldn`t be more than 8 pages. Relative volume of illustrations mustn`t surpass 1/3 of total. The list of references shouldn`t contain more than 30 sources in survey articles and only 15 sources in articles with author`s own research results. Initials are not spaced, but initials and surname are separated by spacing. It`s not allowed to carry over surname to another line (I.I. Ivanov,

Ivanov I.I.).

5. Summeries are presented in two languages (Russian and English). Summery and key words are placed before "Introduction" in language the article was written (type – 10pt, **"Key words"** are bolded, key words are italicized). Key words or word combinations are separated by semicolon. After references summery and key words in English are placed. Summery size is 500 characters; a number of key words is 5-7. Execution and formatting setup of these elements should correspond to the pattern (see below).

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7. The manuscript is signed by all authors. One page is taken for authors` data: place of work, position, academic degree, address of establishment, contact details for feedback (telephone number and e-mail of all authors). An article is attached by assignment from establishment where the work was carried out. Articles of postgraduates and candidates are attached by review of research supervisor.

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PATTERN OF ARTICLE EXECUTION

UDC 635.055:504.753:712.253(477.75)

ANCIENT TREES OF ARBORETUM OF NIKITSKY BOTANICAL GARDENS

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For the first time analysis of vital state and ecologic and ornamental characteristics … (summery)…

Key words: *key words, key words, key words, key words, key words, key words, key words, key words*

Introduction

Text text text text text text text text text text text text text text text text text text text text text text text text text text text text text text text text text text text text

Objects and research methods

Text.

Results and discussion

Text.

Conclusions

Text.

Gratitudes (optional)

Text

References

1. Hydrochemistry… Literary source…

2. *Ivanov I.I.* Literary source source source source source source source source source source source source source source source source source source

3. Determiner of higher…Literary source…

4. *Petrov P.P.* Literary source…

5. *Sidorov S.S.* Literary source…

Uleiskaya L.I., Kushnir A.I., Krainyuk E.S., Gerasimchuk V.N., Kharchenko A.L. Centuries-old trees of Arboretum in Nikitsky Botanical Gardens // Works of the State Nikit. Botan. Gard. – 2012. – Vol. 134. – P. 168 – 174.

The analysis of vital state, ecological and ornamental characteristics of….

Key words: *key word; key words; key words; key words; key words; key words; key words; key words; key words.*

END OF PATTERN

Typing and correction of the text should be carried out in accordance with the following rules:

1. MS Word is used to create tables.
2. Words shouldn`t be hand-carried.
3. **Don`t put full stop after:** UDK, title of article, authors` surnames, organization name, heading, figure captions, names of tables, notes and references to tables, dimensions (h-hour, s-second, g-gram, min-minute, day, C - degree centigrade, m-meter) and in subscripts as well. Full stop should be put after contractions (mes. – mesyats (month), ned. – nedelya (week), g. – god (year), mln. – million).
4. Names of species and genera of plants and animals are presented in Latin in Italics according to actual international codes of biological nomenclature, together with author`s name and (if necessary) year of description (author and year of description are typed in usual print), for instance: *Quercus pubescens* Willd. But further mention of the same taxon, its generic name is contracted, author`s name isn`t typed (*Q. pubescens*). If the article contains taxonomic list with full names (including taxons` authors) it`s possible not to indicate author`s name. Authors` names are typed either fully or in standard contractions (Recommended!) in accordance to Authors of plant names (2001). References to authorities of either nomenclature combinations are necessary. Latin names of taxons which belong to higher class than genus are not italicized. Names of plant cultivars are single quoted (**'**…**'**), if there is no the word "cultivar" before them; all words in cultivar name begin with capital letters (for instance, peach 'Zolotoj Yubilej', but cultivar Zolotoj Yubilej).
5. **Requirements for quotation:**

- ellipsis in quotation is enclosed in curly brackets <…>. If there was a punctuation mark before or after omitted text, it is dropped;
- if an author uses a quotation and emphasizes some words in it, after explanatory text of these words there must be full stop, then dash and article author`s initials (first letters of his/her name and surname), warning text is taken in parentheses. For example: (italics added. – A.S.), (underlined symbols added. – A.S.), (spacing added. – A.S.).

6. Decimal fractions are separated by commas: 0,1 or 0,5.
7. Dash isn`t put in the beginning of line.
8. Double or multiple space isn`t allowed.
9. Such contractions as "i t.d., i t.p.", indices, subscripts and mathematical signs are not spaced.
10. Numerals and signs %, ° are not spaced.
11. Before measures and signs №, §, © there is a space.
12. Hiphen is used only in compound words such as „vsyo-taki" (anyway), „khimiko-

pharmatsevticheskij" (chemical and pharmaceutical), which are not spaced. Dash is used in all other cases and two-sided spaced (18 – 30, 1999 – 2014).

13. Tables and illustrations are put into the text after their first mention. Optimal table size is one page.

14. Before figure, after it and its caption (before text) there are indents of 1 line. Figure caption is centering and typed in lower-case bold letters 10pt, single-space (**Fig. 1** – there is no full stop after numeral). Figures and captions should be placed into a table of 1 column and 2 lines, option "Remove table borders" should be activated to avoid their display when printing (see pattern below).

15. There is an indent of 1 line before table and after it. Word **"Table"** with its number is placed on the right side, table caption is centering below; lower-case bold letters of 10pt, single-space (**Table 1 –** there is no full stop after numeral). Table text is typed in lower-case non-emphasized letters of 10pt with single-space. The first words of table column headings are started with the capital letters, subheadings are started with lower-case letters if they are combined in one sentence with heading, with capital letters if subheadings are independent. Measures are pointed after commas. Execution and formatting parameters must correspond to the pattern – see below.

Repeated text in a table column may be replaced by quotation marks (« - »). Quotation marks instead of numerals, notes, signs, mathematical and chemical symbols are not recommended.

If a table size exceeds 1 page all its columns are numbered by Arabic figures, its continuation on the next pages is typed on the right side in 10pt print (for example, "Continuation of table 1").

FIGURE PATTERN

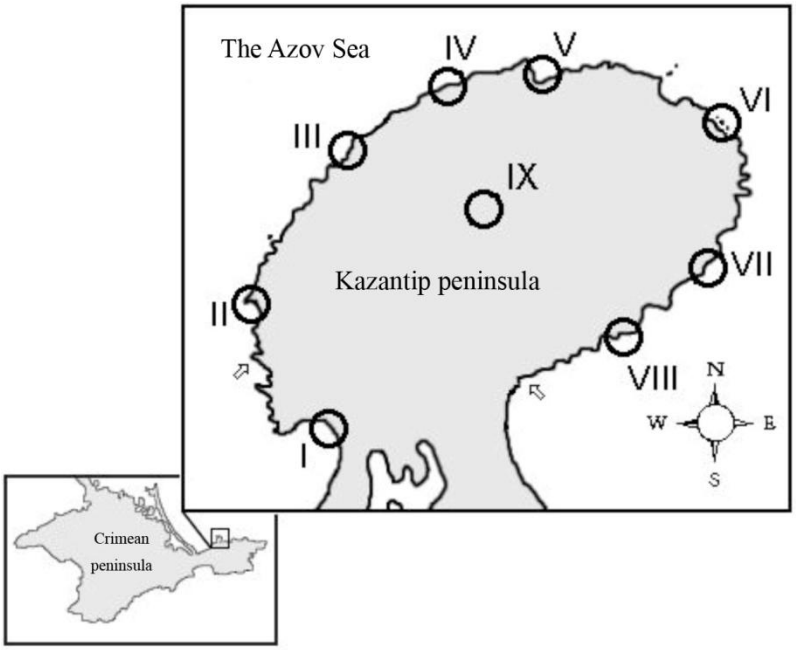

Fig. 1 Sketch map of inspected region (stations I-VIII)

TABLE PATTERN

Table 1

Cultivar composition and biomass of macrophytobenthos within offshore zone of Blessed Trinity Cape

Cultivar	Biomass, g/m^2 (stations I-IV)					
	PLR (±0,25 m)		SLR(–0,5-5 m)			
	I	II	III	IV	V	VI
Ulothrix flacca (Dillwyn) Thur.	F		F			
Chaetomorpha aërea (Dillwyn) Kütz.	F	F	15,00 ±3,92	1,67±0,72		F

Notes:
Hereinafter: PLR – pseudolittoral, SLT – sublittoral. F – few (less than 0,01 g in a sample).
Empty table cells mean absence of cultivar in samples.

16. Bibliographical references in article text are taken in square brackets, several sources are separated by commas in the order of number increasing.

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List of references is made alphabetically, firstly works typed in Cyrillic symbols are enumerated and after it works in Latin. Bibliographical descriptions of works, published in other languages (for example Arabic, Chinese and etc.) should be presented in English and point origin language (in brackets after page number).

17. In the list of references names of cultivars and genera are italicized; numbers of volumes (issue, № or no) are typed by Arabic figures.

18. Line drawings, maps, graphics and photos are enumerated by Arabic figures as they are mentioned in the text. References to drawings and tables in a text are taken in parentheses and pointed in shorthand form with a small letter (tab. 1, fig. 1), if they are mentioned again, add the word “see” (see tab. 1, see fig. 1)

Examples of bibliographical descriptions in references:

Books:

1. *Novosad V.V.* Flora Kerchensko-Tamanskogo regiona. – K.: Naukova dumka, 1992. – 275 s.
2. *Ostapkp V.M., Boiko A.V., Mosyakin S.L.* Sosudistiye rasteniya yugo-vostoka Ukraini. – Donetsk: Noulidzh, 2010. – 247 s.
3. Ekologichesky atlas Azovskogo morya / Gl.red.akad. G.G. Matyshov. – Rostov-na-Donu: Izd-vo UNC RAN, 2011. – 328 s.
4. Authors of plant names: A list of authors of scientific names of plants, with recommended standard forms of their names, including abbreviations / Eds. R.K. Brummitt and C.E. Powell. – Kew: Royal Botanical Gardens, 1992, reprinted 2001. – 732 p.

Periodicals and serials:

5. *Bagrikova N.A.* Analiz adventivnoj fraktsii flori prirodnih zapovednikov Kerchenskogo poluostrova (Krym) // Ekosystemi, ih optimizatsiya i ohrana. – 2011. – Vyp. 4(23). – S. 3 – 9.

6. *Nikiforov A.R.* Elementarnij pobeg i sezonnoye razvitiye rastenij *Silene jailensis* N.I.Rubtzov (Caryophyllaceae) – reliktovogo endemika Gornogo Kryma // Ukr.botan.journ. – 2011. – T. 68, № 4. – S. 552 – 559.

7. *Sadogurskij S.E.* Makrophitobentos vodoyomov ostrova Tuzla i prilegayushchih morskih akvatorij (Kerchenskij proliv) // Algologiya. – 2006. – T. 16, № 3. – S. 337 – 354.

8. *Hayden H.S., Blomster J., Maggs C.A., Silva P.C., Stanhope M.J., Waaland J.R.* Linnaeus was right all along: *Ulva* and *Enteromorpha* are not distinct genera // European Journal of Phycology. – 2003. – Vol. 38. – P. 277 – 294.

Abstract of a thesis:

9. *Belich T.V.* Raspredeleniye makrophitov psevdolitoralnogo poyasa na Yuzhnom beregu Kryma: Avtoref. Diss…kand. biol. nauk: 03.00.05 / Gosudarstvennij Nikitskij Botanicheskij Sad. – Yalta, 1993. – 22 s.

10. *Yena An.V.* Phenomen Florystychnogo endemizmu ta yogo proyavi u Krymu: Avtoref.dys. … d-ra boil. nauk: 03.00.05 / Instytut botaniki im. M.G. Kholodnogo NANU. – K., 2009. – 32 s.

Abstract of a paper:

11. *Sadogurskaya S.A., Belich T.V.* Algoflora pribrezhnoj akvatorii u mysa Troitsi (Chornoye morye) // Aktualniye problemi sovremennoj algologii: materialy IV mezhdunarodnoj konferentsii (Kiev, 20-23 aprelya 2012 g.). – K., 2012. – S. 258-259.

12. *Bagrikova N.A.* Syntaxonomical checklist of weed communities of the Ukraine: class Stellarietea mediae // 19-th International Workshop of European Vegetation Survey Flora, vegetation, environment and land-use at large scale (Pécs, 19.04–2.05, 2010): Abstr. – Pécs, 2010. – P. 51.

Section in a collective monograph:

13. *Bagrikova N.A., Kolomijchuk V.P. Astragalus reduncus* Pall. // Krasnaya kniga Priazovskogo regiona. Sosudistiye rasteniya / Pod red. d.b.n., prof. V.M. Ostapko, k.b.n., dots. V.P. Kolomijchuka. – K.: ALterpres, 2012. – S. 198 – 199.

14. *Korzhenevskij V.V., Rudenko M.I., Sadogurskij S.Yu.* PZ Krymskij // Phytoriznomanittya zapovidnykiv i natsionalnyh pryrodnyh parkiv Ukrainy. Ch.1. Biospherni zapovidnyky. Pryrodni zapovidnyky / Pid red. V.A. Onyshchenko i T.L. Andriyenko. – K.: Phytosotsiotsentr, 2012. – S. 198 – 220.

Multivolume editions:

15. Hydrometeorologiya i hydrokhimiya morej SSSR, T. IV. Chornoye morye. Vyp.1.Hydrometeorologicheskiye usloviya / Pod red. A.I. Simonova, E.N. Altmana. – SPb: Hydrometeoizdat, 1991. – 426 s.

16. Algae of Ukraine: Diversity, Nomenclature, Taxonomy, Ecology and Geography. Vol. 1. Cyanoprocaryota – Rhodophyta / Eds. Petro M. Tsarenko, Solomon P. Wasser, Eviator Nevo. – Ruggell: A.R.A.Gantner Verlag K.G., 2006. – 713 p.

Internet resources:

17. *Guiry M.D., Guiry G.M.* 2013. AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. – http://www.algaebase.org. – Searched on 05 August 2013.

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