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

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

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

INTRODUCTION

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

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

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

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

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

MATERIALS AND METHODS

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

RESULTS AND DISCUSSIONS

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

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

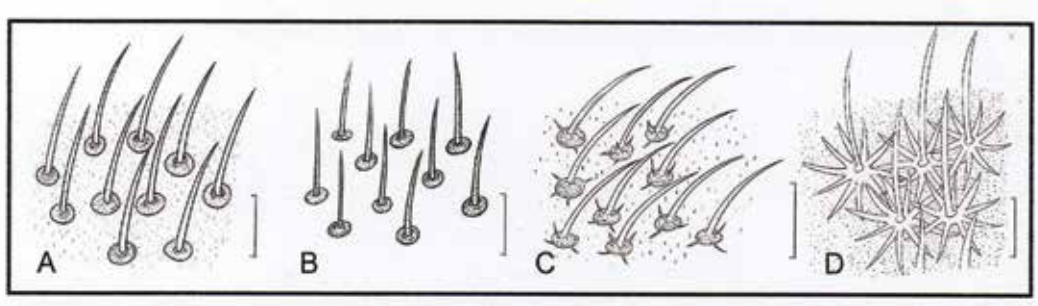

Figure 1. Position and structure of setae: A – *O. visianii* (scale bar, 3mm); B – *O. lypskii* (scale bar, 3mm); C – *O. borysthenica* (scale bar, 3mm); D – *O. rigida* (scale bar, 1mm)

Genus *ONOSMA* L. – Goldendrop

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

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

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

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

Identification key

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

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

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

T y p e: lectotype of the genus.

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

Setae on glabrous pustules, without stellate hairs.

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

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

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

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

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

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

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

Figure 3. *O. visianii*

Figure 4. *O. borysthenica*

Figure 5. *O. lipskyi*

Figure 6. *O. rigida*

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

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

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

Setae on stellate pubescent pustules.

T y p e : type of the section.

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

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

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

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

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

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

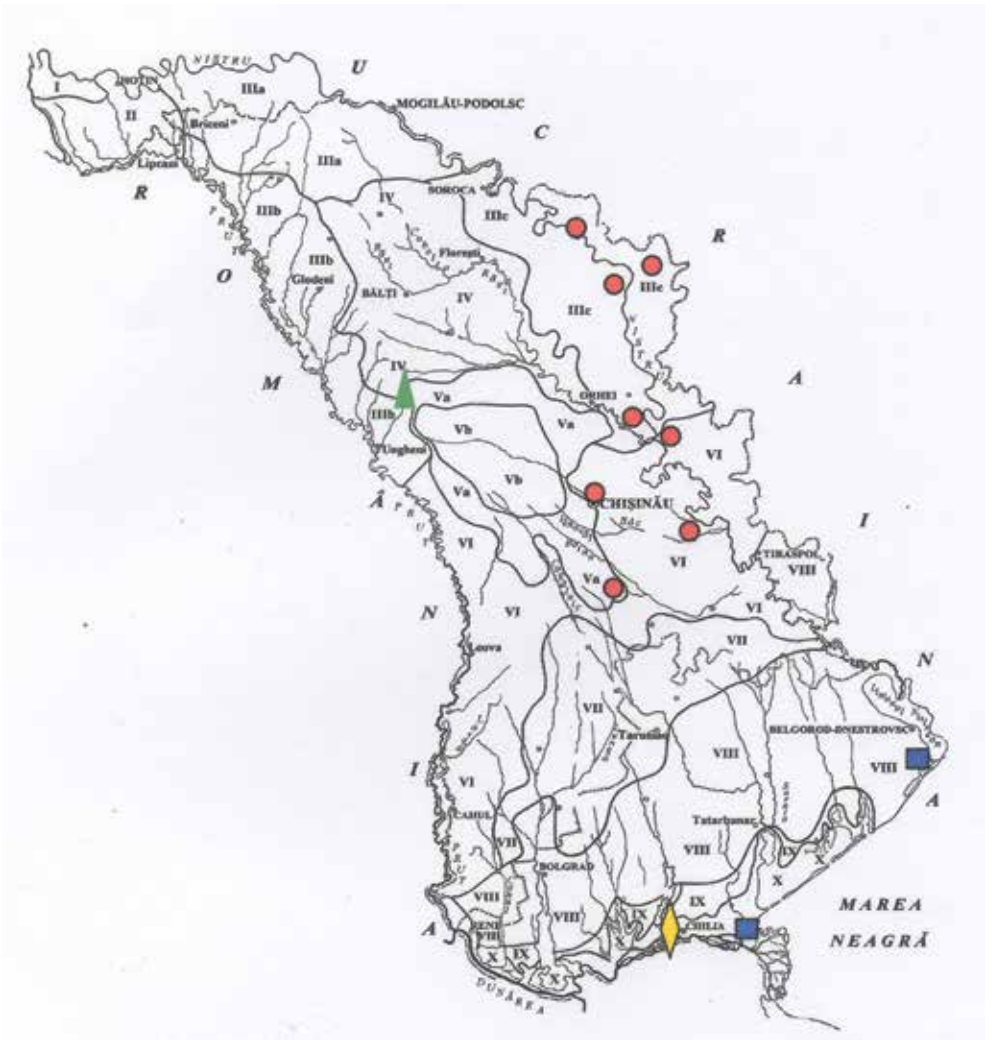

Figure 7. The distribution of *Onosma* species on the Bessarabia´s territory
● – *O. visianii*, ■ – *O. borysthenica*,
▲ – *O. lipskyi*, ◆ – *O. rigida*

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

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

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

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

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

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

CONCLUSIONS

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

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

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