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Differentiation of the Climatic Niches of the Invasive O*enothera* l.(Subsect. *Oenothera*, Onagraceae) Species in the Eastern Europe

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ABSTRACT

This paper is concerned with the study of differentiation of the climatic niches of the North-American *Oenothera* L. (Onagraceae) that are invasive to the Eastern Europe by means of the Canonical Correspondence Analysis. On the basis of the critical analysis of the herbarium material, field research performed by the authors the limits of the climatic factors restricting the species distribution were determined, the differences between specimen from different sections, certain parental and hybrid species within the climatic niches were specified. As the result of the study the examined species were divided into three groups according to the invasiveness degree.

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INTRODUCTION

The effect of the non-native organisms on the flora, fauna and on the society in general gains the global importance since today the issues concerning their distribution in the world can be solved at the international level only. According to the experts' estimates the loss from invasion of the adventitious plant species worldwide makes billions of dollars annually [1, 2]. Importation and distribution of the alien species carry the direct threat to the existence of the local species and the crop losses caused by the ruderal species many of which are the adventitious ones make from 9 to 19% [3, 4, 5]. The study of the relevant species is also determined by the necessity of development of the practical methods for prevention of the species distribution and invasion control [6, 7, 8, 9, 10].

For the purpose of studying the features of distribution and invasion activity of the plant species we selected the model North-American genus *Oenothera* L. (subsect. *Oenothera*, Onagraceae) characterized by the intensive speciation processes taking place due to a special reproduction system, hybridization processes and high invasion potential of the species of this section in the Eastern Europe [11, 12, 13].

The objective of the research was the study of the climatic niches of *Oenothera* subsect. *Oenothera* (Onagraceae) species with regard to the various natural factors with the use of the multivariate statistics techniques.

Procedure:

The study of features of the distribution and invasions of species of the *Oenothera* (subsect. *Oenothera*, Onagraceae) genus in the Eastern Europe was conducted on the basis of critical review of the herbarium material in the Herbariums LE, MW, MHA, MOSP, BSU, RV, KW, DNZ, field research [4, 5, 11, 13] as well as review of the key publications on the research subject [13]. The study of features of the species spatial differentiation according to the natural factors values and determination of the relevant climatic niches was conducted by means of the Canonical Correspondence Analysis [14].

Main part:

Spontaneous importation and distribution of the North-American primrose species under the new European conditions occurs on a case-by-case basis depending on the set of the climatic factors [5]. It is known that the most thermophilic species prevailing in the Southern America today also propagate under the similar conditions in Portugal, Spain, in the southern France [5]. The humidity conditions are considered to be an important differentiating factor in terms of the species distribution [8]. In Germany the prevailing species are the

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mesophilic ones: *Oe. biennis* L. s. str., *Oe. fallax* Renner em Rostanski, *Oe. glazioviana* Micheli, *Oe. suaveolens* Desf. ex Pers. and *Oe. oehlkersii* Kappus [6, 11, 12]. In the arid steppe and forest-steppe zones of the European part of the Eastern Europe such species are absent or rather poorly distributed, primarily, in the flood plain as well as ruderal and technogenic localities [5, 8, 13].

The critical analysis of the herbarium material on the *Oenothera genus* allowed distinguishing the active invasive, medium-invasive and non-invasive species. The findings of the study on differentiation of the primrose ecological niches according to the natural-and-climatic factors conducted by means of the canonical correlation analysis are indicated on the figure. The centers of the ecological niches of the examined primrose species are arranged along the axis of the natural-and-climatic factors features: values of the northern latitude, eastern longitude, above sea level elevation, the annual rainfall, average, minimum and maximum annual temperatures, average annual temperature.

According to Ter Braak [14], the length of the factor on the scatter diagram indicates the degree of its impact on the species distribution along this gradient. That is why the most important for the distribution of the centroids of the primrose ecologic niches are the following natural-and-climatic factors (in descending order): amount of precipitations, values of the eastern longitude, above sea level elevation, northern latitude, maximum average.

On the Figure *Oe. laciniata* Hill occupies an isolated area within the factor space of the diagram which is not surprisingly since this species represent another subsection that includes the annual species. The species from the active invasive species group: *Oe. biennis, Oe. rubricaulis, Oe. depressa* hardly depend on the environmental conditions since the centroids of their ecologic niches are arranged at the zero

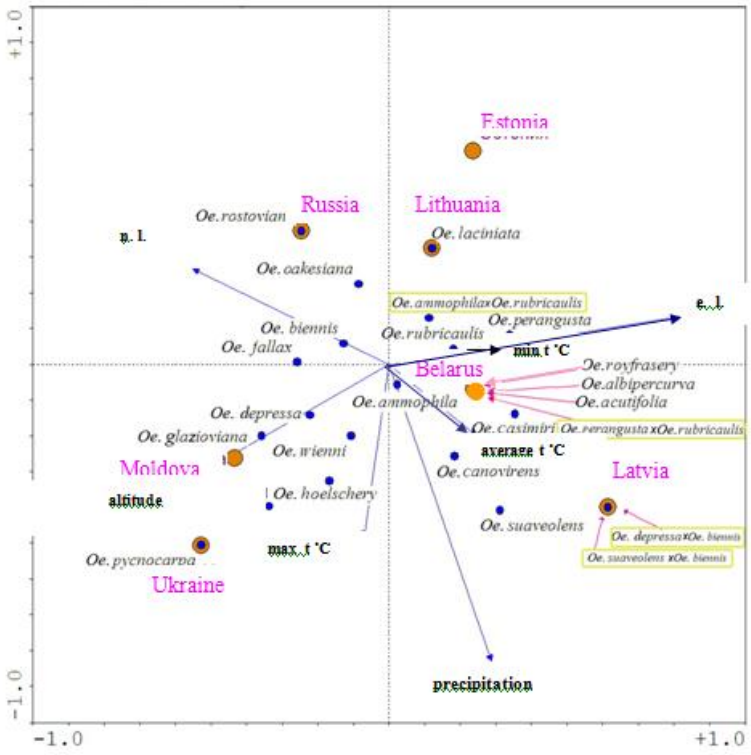

Fig. 1: Ordination diagram of interaction of the *Oenothera* L. species with the climatic factors in the Eastern Europe. Conventional notations of the climatic factors axes: n.l. – northern latitude, e.l. – eastern longitude.

Point wherefrom the factor axes originate. This confirms the relative species independency from these factors.

The small-, medium- and large-flowered species that are widespread in the Western Europe including, for example, *Oe. parviflora, Oe. suaveolens, Oe. glazioviana* prefer the warmer and more humid conditions. The most active invasive species are arranged at the factor axes center. The exclusion is represented by the uncommon species found in the single localities only. These are, for example, *Oe. albipercurva, Oe. acutifolia, Oe. royfraseri, Oe. rostoviania* (Fig.).

The group of the *Oe. glazioviana, Oe. parviflora* L., *Oe. suaveolens, Oe. pycnocarpa* Atk. et Bartl., *Oe. canovirens* Steele species primarily depends on the maximum annual temperature and amount of precipitations

and to a lesser degree – on the minimum annual temperature. In the Figure the climatic niches of the hybrid and parental species are located in the different areas. Thus, for example, *Oe. fallax* occupies the intermediate ecologic niche as compared to the ecologic niches of the parental *Oe. biennis* and *Oe. glazioviana* though it somewhat gravitates toward the ecologic niche occupied by *Oe. Biennis.* It is the evidence of the close relationships between these species and justifies their high invasive status. In the Western Europe *Oe. fallax* actively spreads its distribution area [4, 6, 11] while in the Eastern Europe this species is not common [8]. It appears that *Oe. fallax* is rather unpretentious in terms of the temperature and humidity conditions as well as *Oe. biennis*. That is why in the future this species may become easily naturalized in the steppe zone of Russia and become a potentially dangerous invasive species. No direct correlation between the location of the climatic niches of the hybrid and parental species was observed. They may be not intermediate but move toward one of the parental species, for example, x *Oe. hoelscheri* Renner ex Rostanski and x *Oe. wienii* towards *Oe. depressa* (Fig).

Summary:

Thus, the study of features of distribution of the *Oenothera* species within the different natura-and-climatic conditions with the use of the multivariate statistics methods allowed distinguishing the active invasive plant species and specifying the factors primarily affecting the distribution processes and formation of the primrose climatic niches.

Conclusions:

On the basis of the research findings it was found that the active invasive species in the Eastern Europe are: *Oe. biennis, Oe. rubricaulis, Oe. depressa*, medium-invasive – *Oe. hoelscheri, Oe. canovirens, Oe. glazioviana, Oe. suaveolens, Oe. fallax*, non-invasive – *Oe. perangusta, Oe. wienni, Oe. laciniata, Oe. parviflora, Oe. rostoviana* Rostanski, *Oe. pycnocarpa*. The most important factors differentiating the distribution of species of the *Oenothera* genus in the Eastern Europe are the temperature and humidity factors. The areas of the medium-invasive and non-invasive species feature a narrower range of the temperature and humidity conditions which apparently confirms the degree of the species tolerance to these factors.

REFERENCES

[1] Tokhtar', V.K., S.A. Groshenko, 2008. Global invasions of the adventitious plant species: issues and prospects for research. Belgorod State University Journal, 7(47): 50-54.
[2] Burda, R.I., V.K. Tokhtar', 1998. Thread of the biological pollution of the Ukrainian environment by the North-American species. Ukrainian Biological Magazine, 55(2): 127-132.
[3] Nikitin, V.V., 1983. Weed plants of the USSR flora. Nauka, pp: 454.
[4] Wittig, R., K.H. Lenker, V.K. Tokhtar', 1999. Zur Soziologie von Arten der Gattung *Oenothera* L. Im Rheintal von Arnheim (NL) bis MÜlhouse (F). Tuexenia, 19: 447-467.
[5] Tokhtar, V.K., Vinogradova, K. Yu, A.S. Groshenko, 2011. Microevolution and invasiveness of *Oenothera* L. species (subsect. *Oenothera*, Onagraceae) in Europe/ Russian Journal of Biological Invasions, 2(4): 273-280.
[6] Wittig, R., Tokhtar, V.K. *Oenothera*, 2002. Arten auf industriebrachen im westfalischen Ruhrgebiet. Nature u. Heimat, 62(1): 29-32.
[7] Tokhtar, V.K., 2002. Study of the quantitative characters of species of the *Oenothera* L. genus. Industrial botany, 2: 204-210.
[8] Tokhtar, B.K., 2003. Anthropochorous distribution of species of the *Oenothera* L. (Onagraceae) genus in the anthropogenic ecotopes of Europe. V: Issues of studying the adventitious and synanthropic flora in the CIS-regions: Proceedings of the Moscow International Conference – Tula: 100-102.
[9] Tokhtar, V.K., R. Wittig, 2003. Variability and correlative structure of morphological floral characters in European *Oenothera* L. populations. Ukrainian Botanical Magazine, 60(6): 698-705.
[10] Burda, R.I., V.M. Ostapko, V.K. Tokhtar', 1995. Appendix to the "Summary on the flora of the Southern-Eastern Ukraine". Plant introduction and establishment, 24: 31-36.
[11] Wittig, R., V.K. Tokhtar, 2003. Die Haufigkeit von *Oenothera*-Arten im westlichen Mitteleuropa. Feddes Repertorium, 114 (5-6): 372-379.
[12] Wittig, R., V.K. Tokhtar, 2003. Vorkommen und relative Haufigkeit von Arten der Gattung *Oenothera* im Raum Frankfurt. Main.-Schriftenreihe, Amtfur Stadtokologie. Abt. Umweltder Wissenschaftsstadt Darmstadt, XVII (2): 10-19.
[13] Rostanski, K., A. Rostanski, M.V. Shevera & V.K. Tokhtar, 2004. *Oenothera* in Ukraine. In: The genus *Oenothera* L. in Eastern Europe, Kracow: W. Szafer Institute of Botany, pp: 134.
[14] Ter Braak, C.J.F., P.F.M. Verdonschot, 1995. Canonical correspondence analysis and related multivariate methods in aquatic ecology. Aquatic Sciences, 57/3: 153-187.