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## *Синантропізація рослинного покриву України*

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## **PORTULACA OLERACEA COMPLEX: THE MAIN TRENDS OF STUDY**

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**Abstract.** Within the *Portulaca oleracea* complex a number of taxa was distinguished, sometimes they are being considered as subspecies, varieties, microspecies or morphotypes. To date, 19 such taxa have been described within the *Portulaca oleracea* complex. The most widespread taxa of this complex in Europe are *P. granulatostellulata*, *P. papillatostellulata* and *P. trituberculata*. The highest taxonomic diversity of the complex, with 11 taxa, was recorded in Ukraine and Romania. It was found that several taxa can exist in one site at the same time, e.g. their highest number was found in Romania: *P. daninii*, *P. macrantha*, *P. rausii*, *P. sardoa*, *P. trituberculata*. Current directions of research are: development of methodological approaches for studying the structure of intraspecific taxa; inventory of intraspecific diversity of the complex in different regions; reconstruction of the ways of entry and identification of geographical and ecological peculiarities of spreading of taxa, etc.

**Keywords:** purslane, intraspecies taxa, current task of investigation, Europe.

**Introduction.** Purslane (*Portulaca oleracea* L.) is one of the critical and complex taxon in systematic terms. It is an annual herbaceous plant, autogamous species with a cosmopolitan area, mainly distributed in anthropogenic habitats. Now it is actively spreading. Danin et al. (2016) determined the intraspecific diversity of the *P. oleracea* complex, which consists of 19 taxa. So far, there is no agreed view on the taxonomic composition of this complex. The internal diversity of the *P. oleracea* complex was classified at the levels of varieties, subspecies, morphotypes, or microspecies (e.g., Danin et al. 2016; POWO, IPNI).

According to Danin et al. (2016), the morphological features of the vegetative organs of *P. oleracea* s.l. don't have diagnostic significance. The author used the following features for differentiation of taxa: 1) ploidy (in particular, diploid morphotypes (e.g. *P. nicaraguensis* (Danin

& H. G. Baker) Danin and *P. africana* (Danin & H. G. Baker) Danin) are widespread mainly in the tropics; tetraploids (e.g. *P. granulato-stellulata* (Poelln.) Ricceri & Arrigoni and *P. nitida* (Danin & H. G. Baker) Ricceri & Arrigoni) and hexaploids (e.g. *P. trituberculata* Danin, Domina & Raimondo, *P. papillato-stellulata* (Danin & H. G. Baker) Danin, *P. rausii* Danin and *P. cypria* Danin, etc.) – in the temperate zone); 2) the diameter of seeds (up to 0.85 mm in diploids and tetraploids, 0.85–1.1 mm in hexaploids); 3) micromorphological features of the seed surface. Some other researchers adhered to the opposite opinion, they think that micromorphological seed features as unreliable for taxa differentiation (Matthews et al., 1994). One of the debatable problem remains to establish the correlation of micromorphological features of seeds of intraspecific taxa of the complex with their other morphological and ecological features. According to our previous research such correlation was not observed. Different in-depth study of this group now is conducted in different countries of the world (Danin et al., 2016; Bulakh et al., 2020, 2022, 2023, 2024).

In many European countries *P. oleracea* is considered as an alien species (Lambdon et al., 2008), and even as an invasive one. Its origin and time of introduction to Europe are debatable (should *P. oleracea* be considered as an archaeophyte or a kenophyte?). There is information about its presence in the flora of North America until the 16th century (Byrne, McAndrews, 1975). The distribution of taxa of the complex, their habitats, biogeographical history, speciation peculiarities, etc., require further research, as well as their species and fractional affiliation or invasive status within certain territories. In our opinion, the inclusion of the taxa of *P. oleracea* complex to various databases and resources of invasive species based on information about modern intraspecific differentiation of the complex, demands a critical review.

**Material and methods.** Object of study is the *P. oleracea* complex. The methodology and terminology used follows that proposed by Danin et al. (1979). The seed micromorphology was studied using a scanning electron microscope (SEM, JSM-6060LA). The diversity of the complex in different regions of Ukraine (Transcarpathia, Bukovinian Cis-Carpatian, Polissia, Crimea, etc.) and neighboring European countries (Poland and Romania) was determined.

**Results.** We critically processed more than 360 samples of *P. oleracea* complex from different regions of Ukraine, Poland and Romania; material from Slovakia is currently being analyzed. The intraspecific diversity of the complex was defined: in Ukraine and Romania – *P. daninii* Galasso, Banfi & Soldano (= *P. tuberculata* (Danin & H.G. Baker) Danin), *P. cypria* Danin, *P. granulato-stellulata*, *P. macrantha* (Maire) C. Ricceri et P.V. Arrigoni, *P. nitida* (Danin & H.G. Baker) Ricceri & Arrigoni, *P. oleracea* L. s.str., *P. papillato-stellulata*, *P. rausii*, *P. sardoa* Danin, Bagella et Marrosu, *P. socotrana* Domina et Raimondo, *P. trituberculata*. Almost the same number of taxa is known for Italy and the surrounding islands

(Danin et al., 2016), in Poland – seven (Bulakh et al., 2023), and in Slovakia – eight, as potentially presented (Feráková, 2012). The most widespread in Europe are *P. granulatostellulata*, *P. papillatostellulata* and *P. trituberculata*, other taxa are noted much less often.

We also confirmed the existence of several intraspecific taxa of the *P. oleracea* complex within one site, which was previously found by Danin et al. (2016). It was shown that from 360 analyzed samples from different regions of Ukraine, Poland and Romania, several taxa were found in 133 localities, for example, in Ukraine – in 90 from 270 analyzed ones, in Romania – in 31 from 34 localities. The largest number of intraspecific taxa of the complex in one locality was recorded in Romania (*P. daninii*, *P. macrantha*, *P. rausii*, *P. sardoa*, *P. trituberculata*). The most common combinations are *P. granulatostellulata* – *P. papillatostellulata*. In particular, in the Zhytomyr region of Ukraine 27 such combinations were found in 100 investigated sites, in Poland – in one locality from 14 investigated ones. Other combinations of morphotypes occur less often.

For the first time we found different of morphotypes combination in one fruit (capsule), e.g, *P. granulatostellulata* and *P. papillatostellulata* from the Zhytomyr region and *P. granulatostellulata* and *P. macrantha* from the Chernihiv region of Ukraine.

**Conclusion.** The priority tasks for the further study of this complex are:

- establishing of taxonomic status of investigated intraspecific units: morphotypes – forms – varieties – microspecies – subspecies or species;
- taxonomic inventory of *P. oleracea* complex, assessment of importance and analysis of the morphological features of intraspecific taxa;
- identifying of peculiarities of the distribution of intraspecific taxa in Europe as a whole and in certain countries, clarification of the influence of natural and anthropogenic factors on their distribution for creation more or less complete picture of their modern distribution;
- establishment of autochthonous or allochthonous status, reconstruction of introduction routes (for an allochthonous element), prediction of further spreading;
- facilitating the identification of taxa of the complex in the field conditions and establishing a correlation among macromorphological features of plants (size, color, character of branching, peculiarities of location, size and shape of leaves; size, shape, color of flowers, size of capsule); macro- and micromorphological peculiarities of seeds;
- search of correlation of macromorphological characteristics (for example, habitus) and phenological rhythms (forms of early and late development of plants) with the micromorphological structure of seeds surface;
- study of the statistical regularities of all morphological parameters, limits and distribution of their values, interconnection among investigated parameters, etc.;

- the use of cytological and embryological, molecular and genetic, and other methods of research of the complex;
- investigation of the species' biology (including the processes of flowering, pollination, and fertilization) aimed at determining whether the production of seeds with diverse morphology occurs on a single individual;
- investigation of possibilities and results of hybridization of different intraspecific taxa; cultivation of «hybrids» in controlled conditions (in greenhouses) with further comprehensive analyses of the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, etc. generations;
- study of biotopes, since almost all taxa are common in ruderal and segetal biotopes, but some of them are also noted in natural and semi-natural habitats (*P. granulatostellulata*, *P. macrantha*, *P. rausii*, *P. trituberculata*, etc.);
- identification of edaphic specificity of taxa and other ecological features of plants related to their potential distribution;
- establishing of phylogenetic relationships of the taxa of the studied complex.

Solving these problems will reveal the relationship between the taxonomic, geno- and phenotypic diversity of the *P. oleracea* complex, directions of microevolutionary processes in this complex, migration routes, mechanisms of achieving competitive success, and other important questions.

Obtaining original results as well as activation of study of the complex in the different parts of the world indicates its complexity, different views on the taxa status and their distribution, different approaches for investigation, necessity of understanding and explanation of representation of different intraspecific taxa. All this requires generalization and causes the development of different directions of study for understanding natural-specific differentiation of the complex. We have formulated the main tasks for further study of the *P. oleracea* complex, which are proposed for discussion.

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