


ORIGINAL PAPER

Intraspecific diversity of *Portulaca oleracea* s. l. (*Portulacaceae*) in Zhytomyr Polissia and Right-Bank Forest Steppe of Ukraine

Olena V. BULAKH¹  | Oleksandr O. ORLOV²  | Piotr SZKUDLARZ³  | Zbigniew CELKA³  | Myroslav V. SHEVERA^{1,4} 

Affiliation

¹M. G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine

²Institute of Environmental Geochemistry of National Academy of Sciences of Ukraine

³Adam Mickiewicz University, Poland

⁴Ferenc Rakoczi II Transcarpathian Hungarian College of Higher Education, Ukraine

Correspondence

Myroslav Shevera, e-mail: shevera.myroslav@ukr.net

Funding information

not support

Co-ordinating Editor

Anna Kuzemko

Data

Received: 20 March 2024

Revised: 15 June 2024

Accepted: 24 June 2024

e-ISSN 2308–9628

doi: 10.32999/ksu1990-553X/2024-20-2-5



ABSTRACT

Question: Which intraspecies diversity of *Portulaca oleracea* s.l. according analysis of micromorphology peculiarities of seeds?

Location: Zhytomyr Polissia and Right-Bank Forest Steppe of Ukraine (Zhytomyr Region).

Methods: micromorphological with used a SEM.

Nomenclature: POWO 2024.

Results: This paper presents results of micromorphological studies of seeds surface ultrastructure of *P. oleracea* s.l. (*Portulacaceae*) and its intraspecies diversity. According to the results of our research the following nine taxa of the *P. oleracea* s.l. from the studied region were noted: *P. daninii*, *P. granulatostellulata*, *P. nitida*, *P. oleracea* s. str., *P. papillatostellulata*, *P. rausii*, *P. trituberculata*, *P. macrantha*, *P. sardoa*. Two last taxa are new for Ukrainian flora. The most widespread morphotype in the studied region is *P. granulatostellulata* (50.4 % of investigated specimens), less common is *P. papillatostellulata* (20.6 %), significantly less – *P. macrantha* and *P. sardoa* (7.8 % each), very rare in the region as well as in Europe are *P. nitida*, *P. oleracea* s. str. and *P. rausii*. It was found that the widespread as well as in the studied region and in Ukraine are *P. granulatostellulata* and *P. papillatostellulata*; some taxa, e.g. *P. nitida*, *P. oleracea* and *P. rausii* are rare as well as in the region and in Europe in general. It was established that in some localities from the studied complex were presented plants of several morphotypes (e.g., two – *P. granulatostellulata* + *P. papillatostellulata*; *P. rausii* + *P. trituberculata* or three – *P. granulatostellulata* + *P. papillatostellulata* + *P. sardoa*) or even several morphotypes on one individual (e.g., *P. granulatostellulata* + *P. papillato-stellulata*; *P. macrantha* + *P. trituberculata*). The original scanning electron microscopy photographs of seeds surface ultrastructure of the studied morphotypes and key for its determination are suggested.

Conclusions: Intraspecific diversity of *P. oleracea* complex (nine morphotypes) was established in Zhytomyr Polissia and Right-Bank Forest Steppe zone of Ukraine. On studied territory was noted an essential dominance of intraspecific taxa of the complex with seed surface with different microsculptures (*P. granulatostellulata*, *P. macrantha*, *P. papillatostellulata*, *P. rausii*, *P. sardoa*, *P. trituberculata*) in contrast morphotypes to with smooth one (*P. nitida* and *P. oleracea*). The results of study indicate the complexity of *P. oleracea* s.l. and, accordingly, different views on the status of taxa. Further research of the complex in different regions of the country to establish its composition, natural-species differentiation, evolution and reconstruction of the ways of introduction and distribution is relevant.

KEYWORDS

biodiversity, alien species, *Portulaca*, seed surface ultrastructure, morphotype.

CITATION

Bulakh, O.V., Orlov, O.O., Szkudlarz, P., Celka, Z. & Shevera, M.V. (2024). Intraspecific diversity of *Portulaca oleracea* s. l. (*Portulacaceae*) in Zhytomyr Polissia and Right-Bank Forest Steppe of Ukraine (2024). *Chornomorski Botanical Journal* 20 (2): 190–208. doi: 10.32999/ksu1990-553X/2024-20-2-5

INTRODUCTION

Portulaca oleracea is one of the critical taxa which is currently being actively studied in various countries of the world (Danin 2011, Rupesh *et al.* 2015, Walter *et al.* 2015, Danin *et al.* 2016, Rad *et al.* 2017, Bulakh *et al.* 2022, 2024, Reichert 2023). It is an annual herbaceous plant, autogamous species with a cosmopolitan range, mainly distributed in anthropogenic habitats. This study is a continuation of a series of publications on micromorphological studies of Purslane (*P. oleracea* aggregate) seeds surface ultrastructure from Ukraine (Bulakh *et al.* 2019, 2020, 2023). Plants of these complex were investigated from Zhytomyr Polissia and Right-Bank Forest Steppe zone (Zhytomyr Region, Ukraine).

According to the Flora of Ukraine (Bordzilovsky 1952) the only *P. oleracea* was reported for the territory of the country and for the study area. Manual of Higher Plants of Ukraine (Morozuk 1987) elucidated *P. oleracea* and *P. grandiflora*. Later all available data concerning species of the genus *Portulaca* were summarized in the Checklist of vascular plants of Ukraine (Mosyakin & Fedoronchuk 1999) in which *P. oleracea* and *P. grandiflora* was reported as a spontaneous species, and as a cultivated *P. sativa* (*P. oleracea* subsp. *sativa*). A special research of the *P. oleracea* aggregate based on the micromorphological peculiarities of the seed surface were initiated by investigations of A. Danin with co-authors in different countries of the world (Danin 2011, Danin *et al.* 2016). Results of such research in Ukraine allowed to identify for the country some new microspecies (morphotypes) from the complex, in particular *P. rausii* (Raab-Straube & Raus 2015) – for the Black Sea region; *P. cypria*, *P. granulostellulata*, *P. papillatostellulata* and *P. oleracea* s. str. – for Transcarpathia (Bulakh *et al.* 2019); *P. nitida*, *P. trituberculata*, *P. tuberculata* (= *P. daninii*) – for Bukovinian Cis-Carpathian region (Bulakh *et al.* 2020). Continuing research in this direction, the authors for the Zhytomyr Polissia and Right-Bank Forest Steppe zone (Zhytomyr Region) proved two new morphotypes for Ukraine, e.g., *P. macrantha* and *P. sardoa* (Bulakh *et al.* 2023).

The aim of this study was 1) description and analysis of micromorphology peculiarities of seeds of *P. oleracea* aggregate, 2) determination of morphotypes composition of the complex, and 3) preparing a key for their differentiation for the Zhytomyr Polissia and Right-Bank Forest Steppe zone (Zhytomyr Region, Ukraine).

MATERIAL AND METHODS

The methodology used in this study follows that proposed by Danin *et al.* (1979, 2008, 2012), Danin & Raus (2012), Danin & Reyes-Betancort (2006), and Ocampo (2013), with modifications. Herbarium specimens (KW) of *P. oleracea* aggregate and alive plants (in total 154 specimens) from the Zhytomyr Polissia and Right-Bank Forest Steppe zone (Zhytomyr Region, Ukraine) collected during 2000–2023 were used in the present study. Information about the places of collection of plants is given according to the original label of the specimens (APPENDIX 1). 20 seeds of each specimen were studied. The seed micromorphology was studied using a scanning electron microscope (SEM) at magnifications of $\times 100$, $\times 200$, $\times 400$, and $\times 800$. For the scanning electron microscope (SEM, JSM-6060LA), seeds were fixed on the brass table, then samples were sputter-coated with gold according to the standard method used at the Center of Electron Microscopy of the M.G. Kholodny Institute of Botany, NAS of Ukraine. For size determination, 20 measurements were taken along the polar and equatorial axes for each specimen using AxioVision Rel.4.8 program (FIGURE 1, TABLE 1).

Identification was based on the general key for the *P. oleracea* complex provided by Danin and Raus (2012) which considers the following morphological features: 1) seed diameter; 2) shape of testa cells (elongated, isodiametric, star-shaped); 3) surface of testa cells (smooth or with swelling); 4) type of swelling (tubercles, papillae); 5) quantity and position of the swelling in the testa cells. The terminology of Danin *et al.* (1979, 2012, 2016) and of

Artyushenko & Fedorov (1986) was used in the study. The nomenclature of the studied taxa follows Plants of the World Online (POWO 2022).

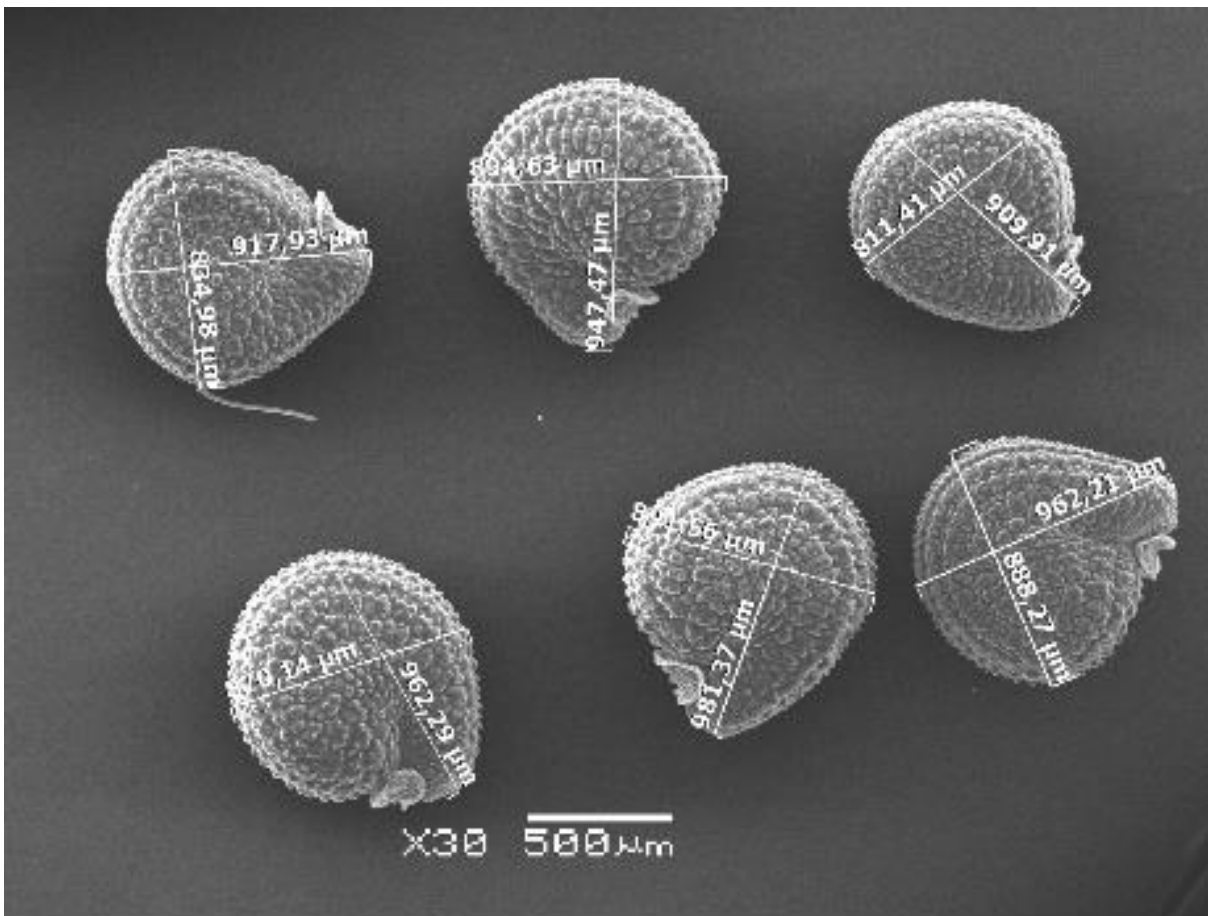


FIGURE 1. An example of length and width of seeds of *Portulaca rausii*.

RESULTS

As a result of the study *P. oleracea* aggregate from the territory of Zhytomyr Polissia and Right-Bank Forest Steppe of Ukraine (Zhytomyr Region) nine morphotypes were established: *P. daninii* (= *P. tuberculata*, *P. granulostellulata*, *P. macrantha*, *P. nitida*, *P. oleracea* L. s. str., *P. papillatostellulata*, *P. rausii*, *P. sardoa*, *P. trituberculata*, which analyzed in the publication.

We preliminarily identified several of the studied specimens as *P. socotrana*, which clearly differs from the closely related *P. granulostellulata*, but their characters from our studied region incomplete correspond to the protologue of the morphotype (Domina & Raimondo 2009). Therefore, it was not included in the analysis and needs further clarification on a wider material.

The micromorphological description of the surface of the seeds of the identified taxa is presented in TABLE 1 and previous publications (Danin et al. 2012, Bulakh et al. 2022).

Based on micromorphological characteristics seeds surface ultrastructure of *Portulaca oleracea* aggregate from the studied regions of Zhytomyr Region a key to identify morphotypes is presented.

TABLE 1. Characteristics of seeds surface ultrastructure of intraspecies taxa of *P. oleracea* s. l.

Taxon	Seed length (µm)	Rays V	Rays U	Rays Y	Long rays	Short rays	CP pap.	Ray pap. 1	Ray pap. 2	ID cells	EN cells
<i>P. daninii</i> (FIGURE 2)	750	0	+	0	+	+	+	+	0	+	+
<i>P. granulostellulata</i> (FIGURE 3)	750	+	+	+	+	+	+	+	0	+	+
<i>P. macrantha</i> (FIGURE 4)	900	0	+	+	+	+	+	+	0	+	+
<i>P. nitida</i> (FIGURE 5)	750	+	+	+	+	+	0	0	0	+	+
<i>P. oleracea</i> (FIGURE 6)	875	+	+	+	+	+	0	0	0	+	+
<i>P. papillatostellulata</i> (FIGURE 7)	900	+	+	+	+	+	0	+	+	+	+
<i>P. rausii</i> (FIGURE 8)	900	0	+	+	+	+	+	+	0	+	0
<i>P. sardoa</i> (FIGURE 9)	900	0	+	+	+	+	+	+	0	+	+
<i>P. trituberculata</i> (FIGURE 10)	900	0	+	+	+	+	+	0	0	0	+

Symbols indicate: CP pap. – papillae in the central parts of rays; Ray pap. 1 – ray papillae rare (single); Ray pap. 2 – ray papillae frequent; ID cells – isodiametric cells; EN cells – elongated cells

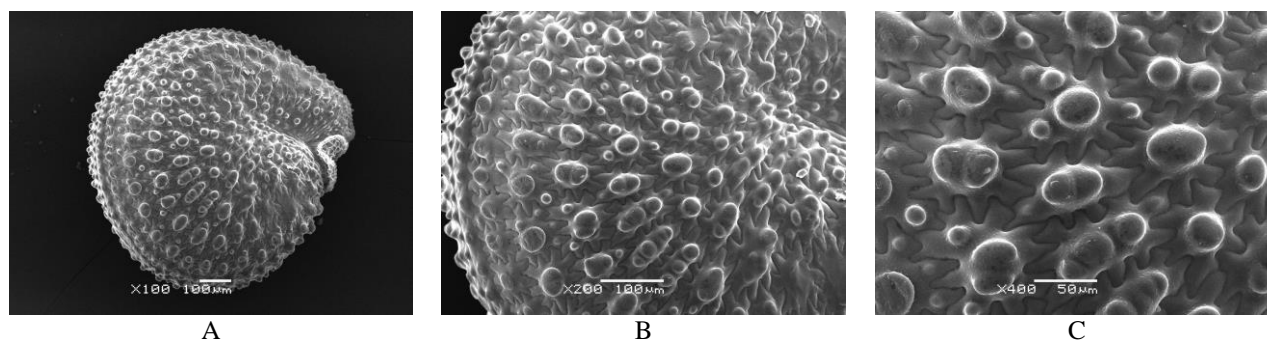


FIGURE 2. *P. daninii*, ultrastructural study of seed surfaces by SEM (Zhytomyr Oblast, Zhytomyr, railway, 27.07.2020, Shevera, KW): A: general view of the seed, ×100; B: seed surface with isodiametric and elongated cells, ×200; C: fragment of the seed surface, ×400. – Photographs by E. Bulakh & A. Terebilenko.

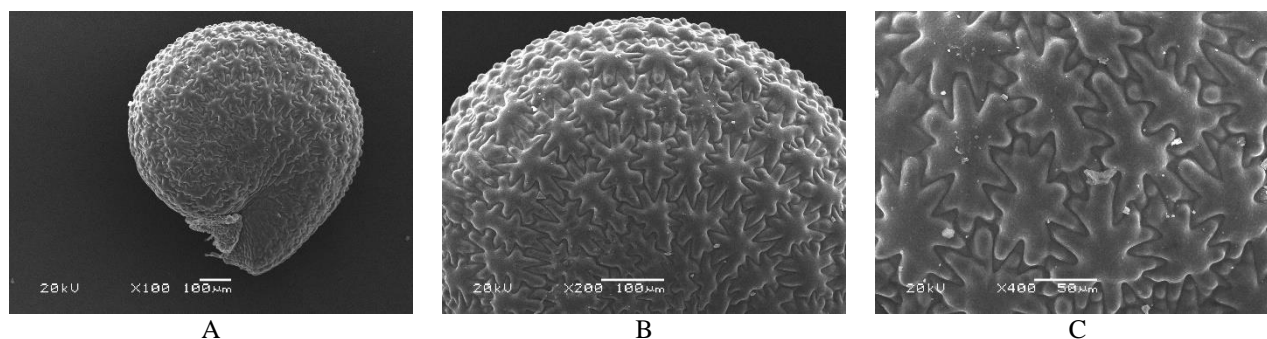


FIGURE 3. *P. granulostellulata*, ultrastructural study of seed surfaces by SEM (Zhytomyr Oblast, Zhytomyr, [Kroshnya], roadside near agricultural college, 09.03.2019, Orlov, KW): A: general view of the seed, ×100; B: seed surface with isodiametric and elongated cells, ×200; C: fragment of the seed surface, ×400. – Photographs by E. Bulakh & A. Terebilenko.

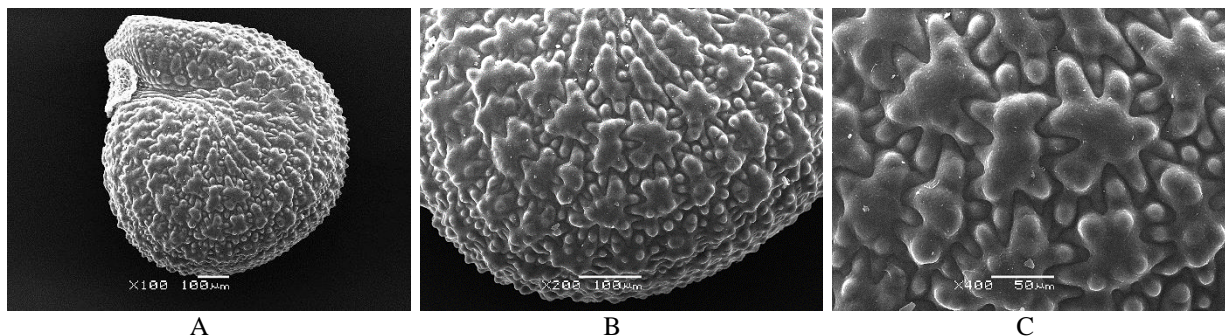


FIGURE 4. *P. macrantha*, ultrastructural study of seed surfaces by SEM (Zhytomyr Oblast, Zhytomyr, railway station, unloading yard, 10.08.2019, Orlov, KW): A: general view of the seed, $\times 100$; B: seed surface with isodiametric and elongated cells, $\times 200$; C: fragment of the seed surface, $\times 400$. – Photographs by E. Bulakh & A. Terebilenko.

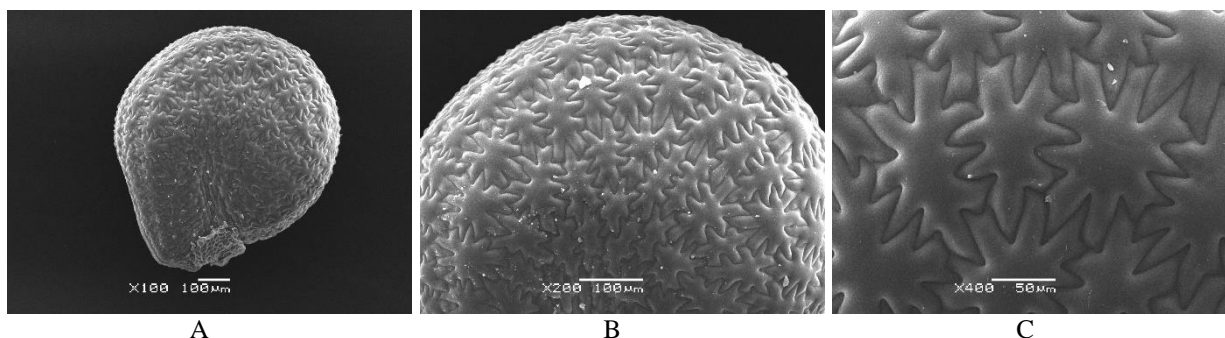


FIGURE 5. *P. nitida*, ultrastructural study of seed surfaces by SEM (Zhytomyr Oblast, Zhytomyr, st. Dombrovsky, in the cracks of the asphalt pavement, 12.10.2019, Orlov, KW): A: general view of the seed, $\times 100$; B: seed surface with isodiametric and elongated cells, $\times 200$; C: fragment of the seed surface, $\times 400$. – Photographs by E. Bulakh & A. Terebilenko.

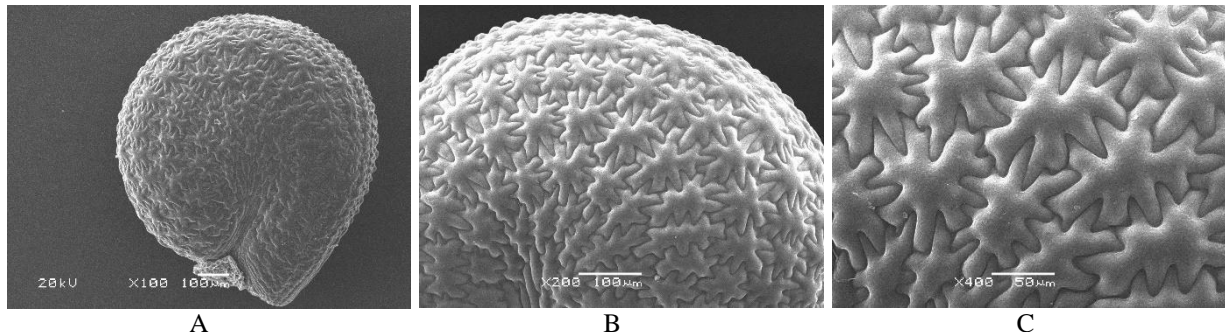


FIGURE 6. *P. oleracea*, ultrastructural study of seed surfaces by SEM (Zhytomyr Oblast, Zhytomyr, st. Transit, on asphalt sidewalks, in crevices. 03.09.2019, Orlov, KW): A: general view of the seed, $\times 100$; B: seed surface with isodiametric and elongated cells, $\times 200$; C: fragment of the seed surface, $\times 400$. – Photographs by E. Bulakh & A. Terebilenko.

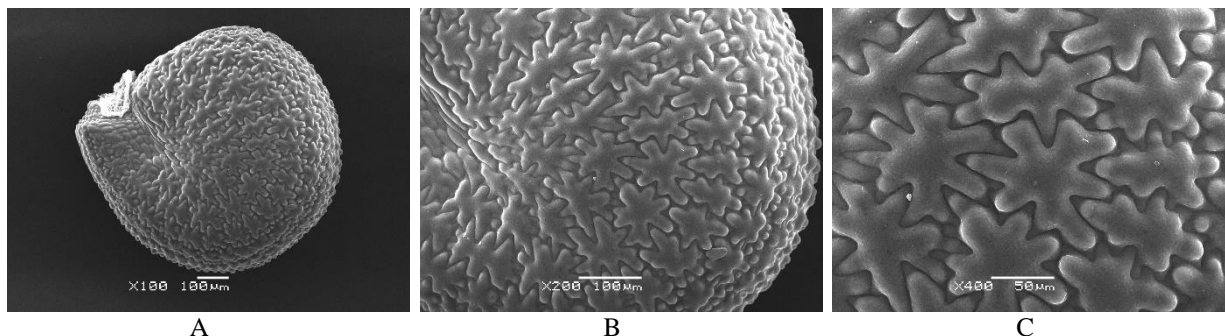


FIGURE 7. *P. papillatostellulata*, ultrastructural study of seed surfaces by SEM (Forest Steppe, Zhytomyr Oblast, Zhytomyr district, village Lubar, in the garden, 14.07.2021, Orlov, KW): A: general view of the seed, $\times 100$; B: seed surface with isodiametric and elongated cells, $\times 200$; C: fragment of the seed surface, $\times 400$. – Photographs by E. Bulakh & A. Terebilenko.

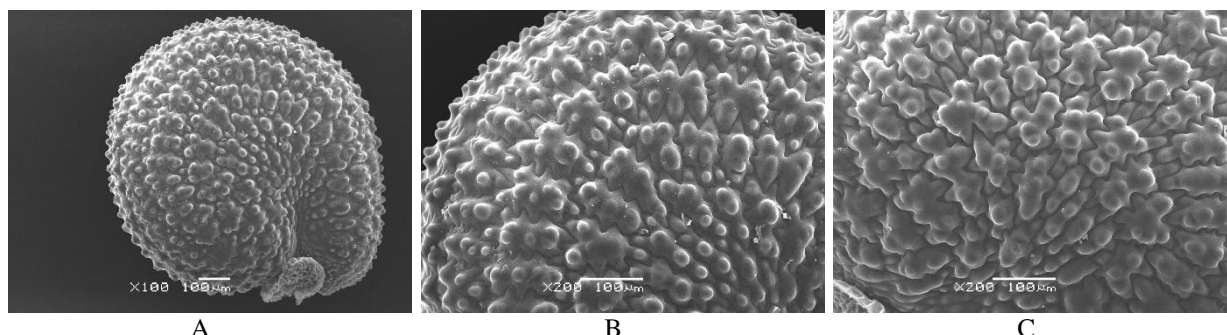


FIGURE 8. *P. rausii*, ultrastructural study of seed surfaces by SEM (Zhytomyr Oblast, Zhytomyr, railway, 27.07.2020, Shevera, KW): A: general view of the seed, $\times 100$; B: seed surface with isodiametric and elongated cells, $\times 200$; C: fragment of the seed surface, $\times 400$. – Photographs by E. Bulakh & A. Terebilenko.

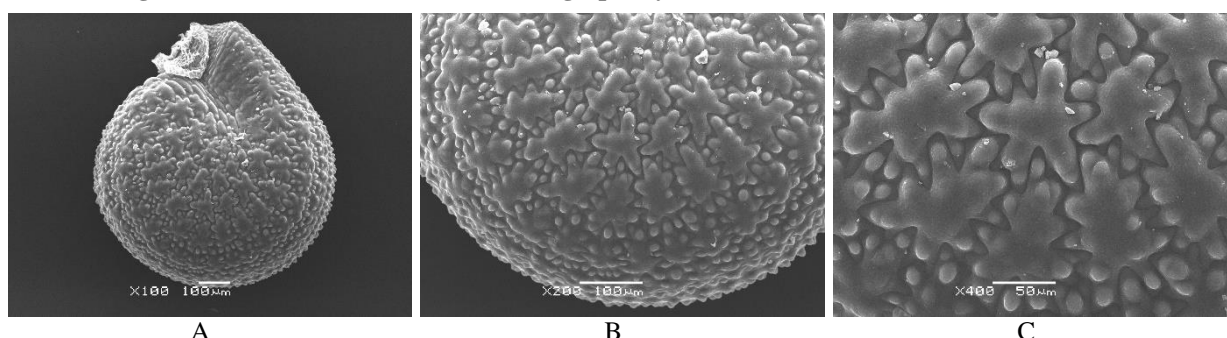


FIGURE 9. *P. sardoa*, ultrastructural study of seed surfaces by SEM (Zhytomyr Oblast, Zhytomyr, center, near the Zhytomyr hotel, in a flowerbed, small plant with small leaves, 18.09.2019, Orlov, KW): A: general view of the seed, $\times 100$; B: seed surface with isodiametric and elongated cells, $\times 200$; C: fragment of the seed surface, $\times 400$. – Photographs by E. Bulakh & A. Terebilenko.

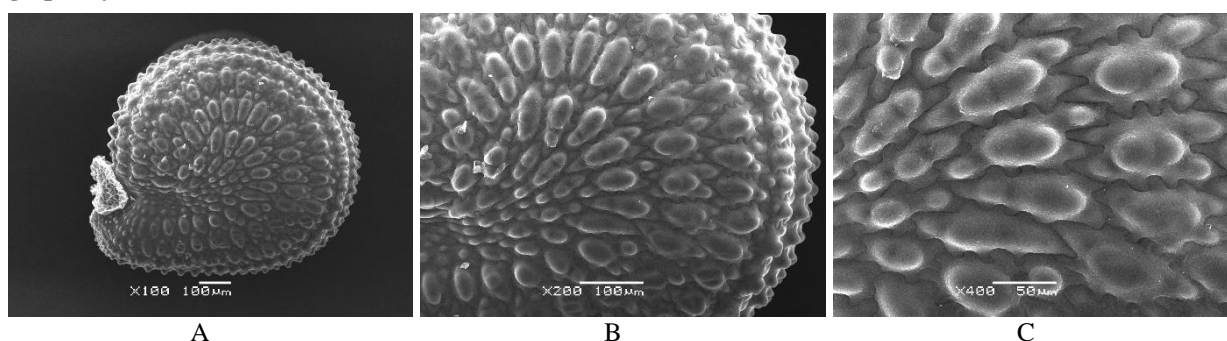


FIGURE 10. *P. trituberculata*, ultrastructural study of seed surfaces by SEM (Zhytomyr Oblast, approx. with. Nova Borova, on the side of the highway, 24.08.2020, Orlov, KW): A: general view of the seed, $\times 100$; B: seed surface with isodiametric and elongated cells, $\times 200$; C: fragment of the seed surface, $\times 400$. – Photographs by E. Bulakh & A. Terebilenko.

1. Major seed diameter < 0.85 mm 2
- Major seed diameter > 0.85 mm 4
2. Testa cell mainly isodiametric, star-shaped, with long rays, nearly flat to slightly convex, without papillae and tubercles, with long rays in isodiametric cells and shorter rays in elongated ones *P. nitida*
– Testa cells isodiametric and elongate, convex or domed, with swelling (papillae and tubercles)..... 3
3. Testa cells mainly elongated and rarely isodiametric, with several tubercles in the center of the cells and papillae at the ends of some rays *P. daninii*
– Testa cells mainly isodiametric, star-shaped and rarely elongated, rays elongated, 1,5–2 as long as wide, papillate, with papillae located at the end of the cell rays or papillae in a few cells at the bases of the rays *P. granulatostellulata*

- 4 (1). Testa cells star-shaped, flat, with long rays, their surface is smooth, without tubercles or papillae *P. oleracea* s. str.
 – Testa cells isodiametric and elongate, convex or domed, with swelling (papillae and tubercles) 5
5. Testa cells covered with small papillae of almost equal size *P. rausii*
 – Testa cells with at least one kind of tubercle or papillae 6
6. Testa cells mainly elongated, with 2(3) tubercles located in the center of the cells and almost overlapping each other, and with papillae at the ends of some rays *P. trituberculata*
 – Testa cells isodiametric and elongate, without tubercles, only with papillae 7
7. Testa cells isodiametric, convex or domed, with 2–7 papillae in the center, rays short, with terminal papillae on the rays *P. macrantha*
 – Central parts of cells smooth, without papillae, rays long, with or without terminal papillae 8
8. The cells isodiametric and elongated, the central parts of cells smooth, without papillae, rays long, many with terminal papillae, but not all papillate, papillae more inflated than the body of cells *P. papillatostellulata*
 – The cells mostly isodiametric, rarely elongated, with rays, the length of which is equal to the width, most of the rays with papillae at the base and at the end, forming circles or ellipses together with papillae on the rays of adjacent cells *P. sardoa*

DISCUSSION

On the basis of the conducted micromorphological study of the seeds of plants of *P. oleracea* complex from the territory of the Zhytomyr Polissia and Right-Bank Forest Steppe zone (Zhytomyr Region) were defined nine taxa (morphotypes). Moreover, established from the localities of investigated region *P. macrantha* and *P. sardoa* are noted at the first time for the flora of Ukraine (Bulakh et al. 2023). *Portulaca macrantha* is characterized with convex or dome cells with 2–7 papillae in their center and short rays in contrast to the morphologically close *P. papillatostellulata* with smooth central parts of the cells and long rays. Also, the seed surface of *P. macrantha* is similar to that of *P. rausii*, but these two morphotypes differ in cell shape (a set of isodiametric and elongated cells in *P. macrantha* and mostly elongated in *P. rausii*) and microsculpture features (*P. macrantha* with several papillae and numerous papillae of *P. rausii*). The other new morphotype for the study area, *P. sardoa*, has predominantly isodiametric cells with dome central parts and rays with papillae that form circles together with the papillae of adjacent cells. The closely related microspecies, *P. papillatostellulata*, has isodiametric and elongated cells with smooth central parts and long rays with terminal papillae. Both morphotypes are known from isolated localities in Mediterranean region.

The other studied morphotypes in the study area, *P. daninii*, *P. granulato-stellulata*, *P. macrantha*, *P. nitida*, *P. oleracea*, *P. rausii*, *P. trituberculata*, were already noted as well as for the different regions of Europe (Danin 2011, 2012, Bulakh et al. 2022) and also for the territory of Ukraine (Bulakh et al. 2019, 2020, 2023).

Based on the peculiarities of the structure of the seed surface, we distinguished three groups of *P. oleracea* morphotypes, which correspond to the previously given data in the literature (Danin et al. 2016): 1) seed surface cells are almost smooth, without tubercles and papillae (*P. nitida*, *P. oleracea*); the following two groups have cells with microsculptures, which have different location on the surface: 2) microsculptures are represented by either 1–2 tubercles in the central part of the cell (*P. cypria*) or cells with papillae on the surface (*P. granulato-stellulata*, *P. papillatostellulata*, *P. sardoa*); 3) cells with numerous (up to 6) tubercles over the entire cell surface (*P. macrantha*, *P. rausii*, *P. trituberculata*).

From groups was established *P. granulostellulata* with seeds less than 1 mm in diameter and with convex or domed surface cells, covered with papillae at the base and at the ends of the cell rays. This morphotype was noted for 69 localities from the territory of Zhytomyr Region. *Portulaca papillatostellulata*, which is close to the characteristics of the seed surface of *P. granulostellulata*, but larger in diameter (more than 1 mm), was established by us for 28 growth sites in studied region. Plants of other morphotypes are represented in the Zhytomyr Region in a smaller number of localities, for example, *P. macrantha* – in 12, *P. nitida* – in 8, *P. oleracea* – in 3, *P. rausii* – only in 2, *P. sardoa* – in 11, *P. trituberculata* – in 7 (APPENDIX 1).

Based on our studies, *P. granulostellulata* and *P. papillatostellulata* to be the most widespread on the territory of the Zhytomyr Region, these morphotypes are also known and most common ones in many countries of Europe, Africa and the Middle East (Danin 2011, 2012, Danin et al. 1979, 2014, 2016). Also, we noted for the studied territory a clear dominance of taxa of *P. oleracea* complex with more seed sculptures, that is *P. granulostellulata*, *P. macrantha*, *P. papillatostellulata*, *P. sardoa* and *P. trituberculata*. For the studied territory we also noted a clear dominance of taxa of the *P. oleracea* complex with pronounced ultrasculpture of the seed surface with various ornamentation (*P. granulostellulata*, *P. macrantha*, *P. papillatostellulata*, *P. rausii*, *P. sardoa* and *P. trituberculata*), in contrast to *P. nitida* and *P. oleracea* with smooth one.

There were previously noted examples of simultaneous existence of several morphotypes of *P. oleracea* complex (sometimes up to five) within one locality (Soltis & Soltis 1999, Danin et al. 2016). We also found simultaneous presence at least two morphotypes of the investigated complex in one locality. According to the results of our research from the territory of the Zhytomyr Region the occurrence of the following morphotype within one locality or often per one individual was established: for example, *P. granulostellulata* and *P. papillatostellulata*; *P. nitida* and *P. oleracea*; *P. rausii* and *P. trituberculata*; *P. granulostellulata*, *P. papillatostellulata* and *P. sardoa*.

According to the results of our research, the presence in the territory of Zhytomyr Region of two morphotypes in one locality was recorded (for example, *P. granulostellulata* + *P. papillatostellulata* – 27 such combinations were found in 154 investigated sites); *P. nitida* + *P. oleracea*; *P. rausii* + *P. trituberculata*) or three morphotypes (for example, *P. granulostellulata* + *P. papillatostellulata* + *P. sardoa*, etc.).

For the first time we found different of morphotypes combination in one fruit (capsule), e.g, *P. granulostellulata* and *P. papillatostellulata* or *P. granulostellulata* and *P. macrantha*. According to the literature data it is known that heterocarpy and heterosemy has been found in many groups of vascular plants (Artyushenko & Fedorov 1986, Matilla et al. 2005, Vojtenko 1989, Zhilyaev 2005, Zlobin 2009). This is characteristic mainly for annual plants including alien species, related mainly with ruderal habitats. In the future special attention will be paid to the study of this phenomenon for the investigated species complex.

The probability of further establishment of new morphotypes of the *P. oleracea* complex in the studied region, as well as in others, especially in the border regions, is quite high. However, the distribution of these morphotypes requires further research. The availability of more extensive information will allow establishing the biogeographic features of the complex, its current and/or potential intraspecific composition.

CONCLUSION

Intraspecific diversity of *P. oleracea* complex was established in Zhytomyr Polissia and Right-Bank Forest Steppe zone, which counts nine morphotypes, including two new ones for the flora of Ukraine – *P. macrantha* and *P. sardoa*. The most widespread morphotype in the

studied region is *P. granulostellulata* (50.4 % of investigated specimens), less common is *P. papillatostellulata* (20.6 %), significantly less – *P. macrantha* and *P. sardoa* (7.8 % each), very rare in the region as well as in Europe are *P. daninii*, *P. nitida*, *P. oleracea* and *P. rausii*. On studied territory was noted an essential dominance of intraspecific taxa of the complex (*P. granulostellulata*, *P. macrantha*, *P. papillatostellulata*, *P. rausii*, *P. sardoa*, *P. trituberculata*) with seed surface with different microsculptures. It was established that in some localities from the studied complex were presented plants of several morphotypes (for example, two – *P. granulostellulata* + *P. papillatostellulata*; *P. nitida* + *P. oleracea*; *P. rausii* + *P. trituberculata* or three – *P. granulostellulata* + *P. papillatostellulata* + *P. sardoa*, etc.) or even several morphotypes on one individual (*P. granulostellulata* + *P. nitida*; *P. granulostellulata* + *P. papillatostellulata*; *P. macrantha* + *P. trituberculata*, etc.).

ACKNOWLEDGMENTS

Authors would like to thank the Anastasiya Terebilenko (M. G. Kholodny Institute of Botany, NAS of Ukraine) for technical assistance during the study, Anonymous Reviewers and Editorial board member for critical comments and support of the manuscript.

REFERENCES

- Artyushenko, Z.T. & Fedorov, A.A. (1986). *Atlas on descriptive morphology of higher plants*. Fruits. Leningrad: Nauka, 392 p.
- Bordzilovsky, Ye. I. (1952). *Genus 253. Portulaca* L. In: Flora Ucr.RSR, vol. IV. Kyiv: Academy of Sciences of Ukrainian SSR press: 419–420 (in Ukrainian).
- Bulakh, E. V., Shevera, M. V., Celka, Z., Skudlarz, P. & Bulakh, P. Ye. (2022). *Identification of new taxa of Portulaca oleracea* L. aggregate from Poland based on seed coat micromorphological characteristics. *Acta Societatis Botanicorum Poloniae* **91**: 1–14. <https://doi.org/10.5586/asbp.9118>
- Bulakh, O. V., Protopopova, V. V. & Shevera, M. V. (2019). *Portulaca cypria* Danin, *P. granulostellulata* (Poelln.) Ricceri & Arrigoni, *P. papillatostellulata* (Danin & H. G. Baker) Danin (Portulacaceae Juss.) – new for the Ukrainian flora taxa from the territory of Transcarpathia. *Scientific Herald of Chernivtsi University. Biology (Biological systems)* **11** (1): 87–92 [in Ukrainian]. <https://doi.org/10.31861/biosystems2019.01.087>
- Bulakh, O. V., Volutsa, O. D., Tokaryuk, A. I., Budzhak, V. V., Korzhan, K. V., Zavialova, L. V., Kucher, O. O. & Shevera, M. V. (2020). *Portulaca oleracea* aggregate (Portulacaceae) from the Chernivtsi Region (Ukraine). *Scientific Herald of Chernivtsi University. Biology (Biological systems)* **12** (2): 251–262. [In Ukrainian]. <https://doi.org/10.31861/biosystems2020.02.251>
- Bulakh, O., Orlov, O., Bulakh, P. & Shevera, M. (2023). *Portulacaceae* (Ukraine). In: Raab-Straube E. von & Raus Th. (ed.), Euro+Med-Checklist Notulae, 16. *Willdenowia* **53**: 57–77. <https://doi.org/10.3372/wi.53.53104>
- Bulakh, E., Sirbu, C., Oprea, A., Volutsa, O. & Shevera, M. (2024). *Portulacaceae* [Romania]. In: Raab-Straube E. von & Raus Th. (ed.), Euro+Med-Checklist Notulae, 17. *Willdenowia* **54**: 5–45. <https://doi.org/10.3372/wi.54.54101>
- Danin, A. (2011). *Portulacaceae*. In: Greuter W., von Raab-Straube E. (ed.). Euro+Med Notulae, 5. *Willdenowia* **41**: 129–138. <https://doi.org/10.3372/wi.41.41117>
- Danin, A. (2012). *Portulacaceae*. In: Greuter W, Raus T (eds.). Med-Checklist Notulae, 31. *Willdenowia* **42** (2): 287–295. <https://doi.org/10.3372/wi.42.42215>
- Danin, A., Baker, I. & Baker, H. G. (1979). Cytogeography and taxonomy of the *Portulaca oleracea* L. polyploid complex. *Israel Journal of Botany* **27**: 177–211.
- Danin, A., Buldrini, F., Bandini Mazzanti, M. & Bosi, G. (2014). The history of the *Portulaca oleracea* aggregate in the Emilia-Romagna Po Plain (Italy) from the Roman age to the present. *Plant Biosystems* **148** (4): 622–634. <https://doi.org/10.1080/11263504.2013.788098>
- Danin, A., Buldrini, F., Bandini Mazzanti, M., Bosi, G., Caria, M. C., Dandria, D., Lanfranco, E., Mifsud, S. & Bagella, S. (2016). Diversification of *Portulaca oleracea* L. complex in the Italian peninsula and adjacent islands. *Botany Letters* **163**: 261–272. <https://doi.org/10.1080/23818107.2016.1200482>
- Danin, A., Caria, M. C., Marrosu, G. M. & Bagella, S. (2012). A new species of *Portulaca oleracea* aggregate from Sardinia, Italy. *Plant Biosystems* **146** (1): 137–141. <https://doi.org/10.1080/11263504.2012.681319>
- Danin, A., Domina, G. & Raimondo, F. M. (2008). Microspecies of the *Portulaca oleracea* aggregate found on major Mediterranean islands (Sicily, Cyprus, Crete, Rhodes). *Flora Mediterranea* **18**: 89–107.

- Danin, A. & Raus, T. (2012). A key to 19 microspecies of the *Portulaca oleracea* aggregate. In A. K. Timonin, A. P. Sukhorukov, G. H. Harper, & M. V. Nilova (eds.). Caryophyllales: New insights into phylogeny, systematics, and morphological evolution of the order, Lomonosov State University press: 70–83.
- Danin, A. & Reyes-Betancort, J. A. (2006). The status of *Portulaca oleracea* L. in Tenerife, the Canary Islands. *Lagascalia* **26**: 71–81.
- Domina, G. & Raimondo, F. M. (2009). A new species in the *Portulaca oleracea* aggregate (*Portulacaceae*) from the island of Soqatra (Yemen). *Webbia* **64**: 9–12. <https://doi.org/10.1080/00837792.2009.10670848>
- Levina, R. E. (1987). Morphology and ecology of fruits. Leningrad: Nauka, 260 p. (in Russian).
- Levina, R. E. (1981). Reproductive biology of seed plants. Moscow: Nauka, 96 p. (in Russian).
- Matilla, A. J., Gallardo, M. & Puga-Hermida, M. I. (2005). Structural, physiological and molecular aspects of heterogeneity in seeds: a review. *Seed Science Research* **5**(2): 63–76. <https://doi.org/10.1079/SSR2005203>
- Morozyuk, S. S. (1987). *Genus 1. Portulaca* L. In: Guide of Higher Plants of Ukraine. Kiev: Naukova Dumka, 65. (in Russian).
- Mosyakin, S. L. & Fedoronchuk, M.M. (1999). Vascular plants of Ukraine. A nomenclatural checklist. Kiev: Institute of Botany, 345 p.
- Ocampo, G. (2013). Morphological characterization of seeds in Portulacaceae. *Phytotaxa* **141** (1): 1–24. <https://doi.org/10.11646/phytotaxa.141.1.1>
- POWO (2022). Royal Botanic Gardens, Kew. Retrieved June 14, 2022, <https://powo.science.kew.org/>
- Raab-Straube, E. & von Raus, Th. (ed.). (2015). Euro+Med-Checklist Notulae, 5 [Notulae ad floram euro-mediterraneam pertinentes 34]. *Willdenowia* **45**: 458–459. <http://dx.doi.org/10.3372/wi.45.45312>
- Rad, M. A., Sajedi, S. & Domina, G. (2017). First data on the taxonomic diversity of the *Portulaca oleracea* aggregate (*Portulacaceae*) in Iran. *Turkish Journal of Botany* **41**: 535–541. <https://doi.org/10.3906/bot-1611-43>
- Reichert, H. (2023). Morphologisch unterscheidbare Sippen von *Portulaca oleracea* s. l. – bestimmt anhand von Lackabdrücken der Samen. *Kochia* **16**: 55–72. <https://doi.org/10.21248/kochia.v16.165>
- Rupesh, M., Umerfaruq, M. Q., Jaivi, P. & Hitesh, S. (2015). *Portulaca granulato stellulata* (Poelln.) Ricceri & Arrigoni: A new record for flora of Gujarat, India. *Journal of Bombay Natural History Society* **12** (3): 188–189. <https://doi.org/10.17087/jbnhs/2015/v112i3/114439>
- Soltis, D. E. & Soltis, P. S. (1999). Polyploidy: Recurrent formation and genome evolution. *Trends in Ecology & Evolution* **14** (9): 348–352. [https://doi.org/10.1016/S0169-5347\(99\)01638-9](https://doi.org/10.1016/S0169-5347(99)01638-9)
- Vojtenko, V. F. (1989). Heterocarpy (heterodiasporia) in angiosperms: concept analysis, classification, terminology. *Botanical Journal* **74** (3): 281–297.
- Walter, J., Vekslyarska, T. & Dobeš, C. (2015). Flow cytometric, chromosomal and morphological analyses challenge current taxonomic concepts in the *Portulaca oleracea* complex (Portulacaceae, Caryophyllales). *Botanical Journal of the Linnean Society* **179**: 144–156. <https://doi.org/10.1111/boj.12309>
- Zhilyaev, G. G. (2005). *Viability of plant populations*. Lvov: Institute of Ecology of the Carpathians, NAS of Ukraine, 304 p. (in Russian)
- Zlobin, Yu. A. (2009). *Population ecology of plant: current state and point of growth*. Sumy: University book, 263 p. (in Ukrainian)

РЕЗЮМЕ

Булах О.В., Орлов О.О., Шкудлаж П., Целька З., Шевера М.В. (2024). Внутрішньовидове різноманіття *Portulaca oleracea* s. l. (*Portulacaceae*) в Житомирському Поліссі та Правобережному Лісостепу України. *Чорноморський ботанічний журнал* 20 (2): 190–208. doi: 10.32999/ksu1990-553X/2024-20-2-5

У статті представлено результати дослідження внутрішньовидового різноманіття *P. oleracea* s.l. (*Portulacaceae*) в Житомирському Поліссі та Правобережному Лісостепу України (Житомирська область) на підставі мікоморфологічного вивчення його ультраструктури поверхні насіння. Встановлено дев'ять внутрішньовидових таксонів (морфотипів) *P. oleracea* s.l. у дослідженому регіоні: *P. daninii*, *P. granulatostellulata*, *P. nitida*, *P. oleracea* s. str., *P. papillatostellulata*, *P. rausii*, *P. trituberculata*, *P. macrantha*, *P. sardoa*; останні два таксони є новими для флори України. Найбільш поширеним морфотипом у регіоні є *P. granulatostellulata* (50.4 % із досліджених екземплярів), рідше – *P. papillatostellulata* (20.6 %), значно рідше – *P. macrantha* та *P. sardoa* (по 7.8 % кожен), дуже рідкісними в регіоні, як і в Європі в цілому, є *P. daninii*, *P. nitida*, *P. oleracea* s.str. та *P. rausii*. Відзначено істотне домінування внутрішньовидових таксонів комплексу з поверхнею насіння з різними мікроскульптурами (*P. granulatostellulata*, *P. macrantha*, *P. papillatostellulata*, *P. rausii*, *P. sardoa*, *P. trituberculata*) на відміну від таких з гладкою поверхнею (*P. nitida* та *P. oleracea* s. str.). Встановлено, що в деяких локалітетах із досліджуваного комплексу представлені рослини кількох морфотипів (наприклад, двох – *P. granulatostellulata* + *P. papillatostellulata*; *P. rausii* + *P. trituberculata* або трьох – *P. granulatostellulata* + *P. papillatostellulata* + *P. sardoa*) або навіть кілька морфотипів на одній особині (наприклад, *P. granulatostellulata* + *P. papillatostellulata*; *P. macrantha* + *P. trituberculata*). Представлено оригінальні

фотографії ультраструктури поверхні насіння досліджуваних морфотипів за допомогою скануючої електронної мікроскопії (SEM), складено ключ для визначення таксонів. Результати дослідження свідчать про складність *P. oleracea* s.l. і відповідно різні погляди на статус внутрішньовидових таксонів. Актуальним є подальше дослідження комплексу в різних регіонах країни для встановлення його складу, природно-видової диференціації, еволюції та реконструкції шляхів поширення.

Ключові слова: біорізноманіття, адвентивні види, *Portulaca*, ультраструктура поверхні насіння, морфотипи.

APPENDIX 1

The specimens of *Portulaca oleracea* aggregate examined from Zhytomyr Polissia and Right-bank Forest Steppe of Ukraine

№	Taxon	Locality	Habitat	Date of collection	Author of collection
1	2	3	4	5	6
1	<i>P. daninii</i>	Zhytomyr Region, Zhytomyr	railway	27 Jul 2020	M. Shevera
2	<i>P. granulostellulata</i>	ibid., Zhytomyr district, village Teterivka	in the garden, medium leaves 0.7–0.8 cm	09 Oct 2019	O. Orlov
3	<i>P. granulostellulata</i>	ibid., Zhytomyr district, village Dovzhik	on the road like a weed	22 Aug 2019	O. Orlov
4	<i>P. granulostellulata</i>	ibid., Zhytomyr district, village Sadky	on the road like a weed	01 Sep 2019	O. Orlov
5	<i>P. granulostellulata</i>	ibid., Zhytomyr, Avenu Myru, 1	on the sidewalk, in the cracks	3 Sep 2019	O. Orlov
6	<i>P. granulostellulata</i>	ibid., Zhytomyr, street Transitna	on asphalt sidewalks, in crevices	3 Sep 2019	O. Orlov
7	<i>P. granulostellulata</i>	ibid., Zhytomyr, Station market	plant with large leaves (2.5–3.0 cm)	04 Aug 2019	O. Orlov
8	<i>P. granulostellulata</i>	ibid., Romanivskiyi district, village Romanov	on the flower bed	11 Sep 2019	O. Orlov
9	<i>P. granulostellulata</i>	ibid., Zhytomyr district, village Dovzhik-2	under the fence	12 Oct 2019	O. Orlov
10	<i>P. granulostellulata</i>	ibid., Zhytomyr, street Maksyutova	on the side of the road	12 Oct 2019	O. Orlov
11	<i>P. granulostellulata</i>	ibid., Zhytomyr, street Dombrovskiyi	in the cracks of the asphalt pavement	12 Oct 2019	O. Orlov
12	<i>P. granulostellulata</i>	ibid., Zhytomyr district, approx. with. Barashivka	wet sandy loam on the shore of the quarry	11 Oct 2019	O. Orlov
13	<i>P. granulostellulata</i>	ibid., Berdychiv	center, on the side of the road	09 Oct 2019	O. Orlov
14	<i>P. granulostellulata</i>	ibid., Zhytomyr, Railway station	unloading yard	08 Oct 2019	O. Orlov
15	<i>P. granulostellulata</i>	ibid., Zhytomyr district, village Stanyshivka	on the side of the Zhytomyr–Andrusivka highway	09 Sep 2019	O. Orlov
16	<i>P. granulostellulata</i>	ibid., Malynskiyi district, Malyn, State Enterprise “Malynske LG”, Malynske forestry	at the base nursery	29 Aug 2019	O. Orlov
17	<i>P. granulostellulata</i>	ibid., Novograd-Volynskiyi district, village Chizhivka	on the hill	19 Sep 2019	O. Orlov
18	<i>P. granulostellulata</i>	ibid., Zhytomyr district, Zhytomyr, west vicinity, Polisky branch of UkrNDILGA	on the flowerbed	12 Aug 2019	O. Orlov
19	<i>P. granulostellulata</i>	ibid., Zhytomyr district, village Berezina	in a clearing near a dirt road	29 Aug 2019	O. Orlov
20	<i>P. granulostellulata</i>	ibid., Zhytomyr district, village Velyki Kosharyshcha	on the side of a dirt road	29 Aug 2019	O. Orlov
21	<i>P. granulostellulata</i>	ibid., Zhytomyr, [Kroshnya]	roadside near the agricultural college	3 Sep 2019	O. Orlov

1	2	3	4	5	6
22	<i>P. granulatostellulata</i>	ibid., Narodytskyi district, village Zvizdal, Drevlyanskyi Nature Reserve	on the sandy side of the road	05 Jul 2019	O. Orlov
23	<i>P. granulatostellulata</i>	ibid., Narodytskyi district, village Lyubarka, at the Drevlyanskyi Nature Reservate	support point	07 Jul 2019	O. Orlov
24	<i>P. granulatostellulata</i>	ibid., Zhytomyr, Zhytomyr Market district	in the courtyard of a high-rise building, on a flower bed	01 Aug 2019	O. Orlov
25	<i>P. granulatostellulata</i>	ibid., Zhytomyr, along street Velyka Berdychivska	on grassy lawns	01 Aug 2019	O. Orlov
26	<i>P. granulatostellulata</i>	ibid., Luhynskyi district, village Luhyny	on the side of the road	03 Sep 2019	O. Orlov
27	<i>P. granulatostellulata</i>	ibid., Zhytomyr district, village Ivanivka	on the side of the highway	04 Aug 2019	O. Orlov
28	<i>P. granulatostellulata</i>	ibid., Zhytomyr district, village Dvirets	on the side of the Zhytomyr–Berdychiv highway	8 Oct 2020	O. Orlov
29	<i>P. granulatostellulata</i>	ibid., Zhytomyr district, village Huyva	on the side of the Zhytomyr–Berdychiv highway	08 Oct 2019	O. Orlov
30	<i>P. granulatostellulata</i>	ibid., Zhytomyr, Bohunia residential area	under the walls of the houses, near the Stocking Factory	23 Sep 2020	O. Orlov
31	<i>P. granulatostellulata</i>	ibid., Novohrad-Volynskyi district, village Mala Tsvilya	in the yard	18 Aug 2020	O. Orlov
32	<i>P. granulatostellulata</i>	ibid., Lyubarskyi district, village Lubar	in the yard	12 Aug 2020	O. Orlov
33	<i>P. granulatostellulata</i>	ibid., Romanivskyi district, village Myropol	in the garden, leaves are large, 2–3 cm	10 Aug 2020	O. Orlov
34	<i>P. granulatostellulata</i>	ibid., Zhytomyr district, village Perlivka	in the garden, medium leaves 0.7–1.2 cm	09 Oct 2019	O. Orlov
35	<i>P. granulatostellulata</i>	ibid., Romanivskyi district, village Romaniv	in the garden	10 Aug 2020	O. Orlov
36	<i>P. granulatostellulata</i>	ibid., Novohrad-Volynskyi district, village Kurchiza	in the yard	14 Aug 2020	O. Orlov
37	<i>P. granulatostellulata</i>	ibid., Korostyshivskyi district, Korostyshiv	in the garden, leaves are large, 2.5–3.0 cm	01 Aug 2020	O. Orlov
38	<i>P. granulatostellulata</i>	ibid., Zhytomyr district, village Velyki Kosharyscha	on the meadow	29 Aug 2019	O. Orlov
39	<i>P. granulatostellulata</i>	ibid., Korostenskyi district, village Ushomyr	in the garden	16 Jul 2020	O. Orlov
40	<i>P. granulatostellulata</i>	ibid., Zhytomyr district, Nova Bystra railway station	over the railway tracks	18 Aug 2020	O. Orlov
41	<i>P. granulatostellulata</i>	ibid., Rodomyshl'skyi district, village Krymok	in the garden	03 Sep 2020	O. Orlov
42	<i>P. granulatostellulata</i>	ibid., Zhytomyr district, approx. with Nova Borova	on the side of the highway	24.08.2020	O. Orlov

1	2	3	4	5	6
43	<i>P. granulatostellulata</i>	ibid., Khoroshivskiyi district, village Khoroshiv	on the flower bed	27 Aug 2020	O. Orlov
44	<i>P. granulatostellulata</i>	ibid., Zhytomyr, center, district of Rye Market	between the pavement tiles	01 Aug 2019	O. Orlov
45	<i>P. granulatostellulata</i>	ibid., Zhytomyr, center, near the Zhytomyr Hotel	in a flower bed, a large plant with large leaves of 2–3 cm	18 Sep 2019	O. Orlov
46	<i>P. granulatostellulata</i>	ibid., Korosten, center	on the grass lawn	24 Aug 2020	O. Orlov
47	<i>P. granulatostellulata</i>	ibid., Malyn	in the garden	11 Aug 2020	O. Orlov
48	<i>P. granulatostellulata</i>	ibid., Korostenskiy district, village Poliske	in the garden, large leaves 2–3 cm	24 Aug 2020	O. Orlov
49	<i>P. granulatostellulata</i>	ibid., Zhytomyr district, south. approx. with Dovzhyk	on the side of the road near the construction mixture plant	25 Aug 2020	O. Orlov
50	<i>P. granulatostellulata</i>	ibid., Chernyakhivskiyi district, village Divochki	in the garden	24 Aug 2020	O. Orlov
51	<i>P. granulatostellulata</i>	ibid., Zhytomyr	the side of the Kyiv highway near the railway bridge	20 Sep 2020	O. Orlov
52	<i>P. granulatostellulata</i>	ibid., Zhytomyr	on the side of the Kyiv highway near the “Epicentr” commercial center	20 Sep 2020	O. Orlov
53	<i>P. granulatostellulata</i>	ibid., Zhytomyr, along the street Kyivska	on the side of the road across the railway	20 Sep 2020	O. Orlov
54	<i>P. granulatostellulata</i>	ibid., Zhytomyr	on the grass lawn near the Global shopping center	20 Sep 2020	O. Orlov
55	<i>P. granulatostellulata</i>	ibid., Lugynskiyi district, village Luhyny	in the yard of the Luhyny DPG	27 Sep 2020	O. Orlov
56	<i>P. granulatostellulata</i>	ibid., Zhytomyr district, village Levkiv	on the sand in the floodplain of the Teteriv River	07 Oct 2020	O. Orlov
57	<i>P. granulatostellulata</i>	ibid., Forest-Steppe, Berdychivskiyi district (former Ruzhynskiyi district), village Trubiivka	wet sand near the bridge over the Rastavyshe River	23 Sep 2021	O. Orlov
58	<i>P. granulatostellulata</i>	ibid., Forest-Steppe, Berdychivskiyi district (former Andrushivskiyi district), village Mala Pyatihirka	in the garden	04 Sep 2021	O. Orlov
59	<i>P. granulatostellulata</i>	ibid., Forest-Steppe, Berdychiv	railway station, next to the tracks, leaves are large	24 Jul 2021	O. Orlov
60	<i>P. granulatostellulata</i>	ibid., Forest-Steppe, Zhytomyr district (former Lyubarskiy district), village Lubar	in the garden	14 Jul 2021	O. Orlov
61	<i>P. granulatostellulata</i>	ibid., Forest-Steppe, Zhytomyr district (former Chudnivskiyi district), village Troscha	in the garden	20 Aug 2021	O. Orlov

1	2	3	4	5	6
62	<i>P. granulatostellulata</i>	ibid., Forest-Steppe, Zhytomyr district (former Popilnyanskyi district), village Holubyatyn	at the railway station	14 Aug 2021	O. Orlov
63	<i>P. granulatostellulata</i>	ibid., Forest-Steppe, Berdychivskyi district (former Ruzhynskyi district), village Derganivka	at the railway station	22 Sep 2021	O. Orlov
64	<i>P. granulatostellulata</i>	ibid., Forest-Steppe, Zhytomyr district (former Chudnivskyi district), Chudniv	on wet sand on the right bank of the Teteriv River	19 Sep 2021	O. Orlov
65	<i>P. granulatostellulata</i>	ibid., Forest-Steppe, Zhytomyr district (former Popilnyanskyi district), village Popilnya	at the railway station in the platform crevices	17 Sep 2021	O. Orlov
66	<i>P. granulatostellulata</i>	ibid., Forest-Steppe, Zhytomyr district (former Lyubarskyi district), village Motovylovka	on the side of the highway	15 Sep 2021	O. Orlov
67	<i>P. granulatostellulata</i>	ibid., Forest-Steppe, Berdychivskyi district, village Terekhovo	in the garden	20 Sep 2021	O. Orlov
68	<i>P. granulatostellulata</i>	ibid., Forest-Steppe, Berdychivskyi district, village Ivankivtsi	along the railway track on gravel	20 Sep 2021	O. Orlov
69	<i>P. granulatostellulata</i>	ibid., Radomyshlskyi district, Radomyshl	private sector, in the garden, completely	08 Sept 2020	O. Orlov
70	<i>P. granulatostellulata</i>	ibid., Zhytomyr district, village Kamianka	in the center, on the side of the highway	23 Aug 2019	O. Orlov
71	<i>P. granulatostellulata</i>	ibid., Zhytomyr District, St. approx. with Berezhivka	on the side of the highway	04.08.2019	O. Orlov
72	<i>P. granulatostellulata</i>	ibid., Korostenskyi district, Drevlyanskyi Nature Reservate Sukhariv branch, village Velyki Klishzi	on the side of the road	27 Aug 2023	O. Orlov
73	<i>P. granulatostellulata</i>	ibid., Korostenskyi district, Drevlyanskyi Nature Reservate, Sukhariv branch, village Poliske	on the side of the road	27 Aug 2023	O. Orlov
74	<i>P. granulatostellulata</i>	ibid., Korostenskyi district, Drevlyanskyi Nature Reservate, Sukhariv branch, village Peremoga	on the side of the road	29 Aug 2023	O. Orlov
75	<i>P. granulatostellulata</i>	ibid., Korostenskyi district, Drevlyanskyi Nature Reservate, Sukhariv branch, village Mali Minjki	on the side of the road	27 Aug 2023	O. Orlov

1	2	3	4	5	6
76	<i>P. granulatostellulata</i>	ibid., Korostenskyi district, Drevlyanskyi Nature Reserve, Sukhariv branch, village Chriplja	on the side of the road	27 Aug 2023	O. Orlov
77	<i>P. granulatostellulata</i>	ibid., Korostenskyi district, Drevlyanskyi Nature Reserve, Sukhariv branch, village Shishelivka	on the side of the road	29 Aug 2023	O. Orlov
78	<i>P. macrantha</i>	ibid., Zhytomyr district, Dovzhyk village	weeds in the market garden	31 Aug 2019	O. Orlov
79	<i>P. macrantha</i>	ibid., Glybochytsia village	on the side of the Zhytomyr–Kyiv highway	18 Sep 2019	O. Orlov
80	<i>P. macrantha</i>	ibid., Barashivka village	private market garden, on the hill, as weed	2 Oct 2019	O. Orlov
81	<i>P. macrantha</i>	ibid., Zhytomyr, railway station	yard unloading	8 Oct 2019	O. Orlov
82	<i>P. macrantha</i>	ibid., Golubiatyn village	at the railway station	14 Aug 2021	O. Orlov
83	<i>P. macrantha</i>	ibid., Motovylovka village	on the side of the highway	15 Sep 2021	O. Orlov
84	<i>P. macrantha</i>	ibid., Zhytomyr, street Mykhailivska	on the grass lawns near the street	1 Aug 2019	O. Orlov
85	<i>P. macrantha</i>	ibid., Zhytomyr, Kamianka village	the intersection of the district road in the village, on the side of the highway	11 Aug 2019	O. Orlov
86	<i>P. macrantha</i>	ibid., Velyki Korovyntsi village	on the railway station, on the gravel	19 Sep 2021	O. Orlov
87	<i>P. macrantha</i>	ibid., Zhytomyr district, village Stanyshivka	on the side of the Zhytomyr–Andrushivka highway	09 Sep 2019	O. Orlov
88	<i>P. macrantha</i>	ibid., Korostenskyi district, Drevlyanskyi Nature Reserve, Sukhariv branch, village Mali Klishchi	on the side of the road	08 Sep 2023	O. Orlov
89	<i>P. macrantha</i>	ibid., Zhytomyr	railway	27 Jul 2020	M. Shevera
90	<i>P. nitida</i>	ibid., Zhytomyr, street Transitna	on asphalt sidewalks, in potholes	03 Aug 2019	O. Orlov
91	<i>P. nitida</i>	ibid., Zhytomyr, Kroshnia	the side of the road near the agricultural college	03 Aug 2019	O. Orlov
92	<i>P. nitida</i>	ibid., Zhytomyr, street Dombrovsky	in the cracks of the asphalt pavement	12 Oct 2019	O. Orlov
93	<i>P. nitida</i>	ibid., Zhytomyr, railway station	unloading yard	08 Oct 2019	O. Orlov
94	<i>P. nitida</i>	ibid., Zhytomyr, Hay market	along the sidewalks, many	25 Aug 2020	O. Orlov
95	<i>P. nitida</i>	ibid., Berdychivskyi district (former Andrushivskyi district), village Mala Pyatyhirka	in the garden	04 Sept 2021	O. Orlov

1	2	3	4	5	6
96	<i>P. nitida</i>	ibid., Zhytomyr district, village Levkiv	on the sand in the floodplain of the Teteriv River	07 Oct 2020	O. Orlov
97	<i>P. nitida</i>	ibid., Zhytomyr district (former Liubarskyi district), village Nova Chortoria	on the side of the highway	14 Jul 2021	O. Orlov
98	<i>P. oleracea</i> s.l.	ibid., Zhytomyr, street Transitna	on asphalt sidewalks, in crevices, plant leaves – 3–4 cm	03 Sept 2019	O. Orlov
99	<i>P. oleracea</i> s.l.	ibid., Zhytomyr, Hay market	along the sidewalks, a lot	25 Aug 2020	O. Orlov
100	<i>P. oleracea</i> s.l.	ibid., Radomyshl'skyi district, Radomyshl	private sector, in the garden, completely	08 Sept 2020	O. Orlov
101	<i>P. papillatostellulata</i>	ibid., Zhytomyr district, Zhytomyr, railway station	in the unloading yard, under the fence	05 Aug 2019	O. Orlov
102	<i>P. papillatostellulata</i>	ibid., Zhytomyr district, village Sadky	on the road like a weed	01 Sept 2019	O. Orlov
103	<i>P. papillatostellulata</i>	ibid., Zhytomyr district, village Kamianka	in the center, on the side of the highway	23 Aug 2019	O. Orlov
104	<i>P. papillatostellulata</i>	ibid., Zhytomyr district, village Davydivka	in the garden, the leaves are large, 2.0–2.5 cm	05 Oct 2020	O. Orlov
105	<i>P. papillatostellulata</i>	ibid., Popilnyanskyi district, village Popilnia	in the garden	17 Aug 2020	O. Orlov
106	<i>P. papillatostellulata</i>	ibid., Zhytomyr district, village Velyki Kosharyshchya	on the meadow	29 Aug 2019	O. Orlov
107	<i>P. papillatostellulata</i>	ibid., Rodomyshl'skyi district, village Krymok	in the garden	03 Sept 2020	O. Orlov
108	<i>P. papillatostellulata</i>	ibid., Korosten city, center	on the grass lawn	24 Aug 2020	O. Orlov
109	<i>P. papillatostellulata</i>	ibid., Zhytomyr city, street Transitna	on asphalt sidewalks, in potholes	03 Sept 2019	O. Orlov
110	<i>P. papillatostellulata</i>	ibid., Zhytomyr district, village Berezina	in a clearing near a dirt road	29 Aug 2019	O. Orlov
111	<i>P. papillatostellulata</i>	ibid., Zhytomyr district, Zhytomyr city, Polisky branch of UkrNDILGA	west vicinity, on the flowerbed	12 Aug 2019	O. Orlov
112	<i>P. papillatostellulata</i>	ibid., Zhytomyr district, Dvirets village	on the side of the Zhytomyr–Berdychiv highway	08 Oct 2020	O. Orlov
113	<i>P. papillatostellulata</i>	ibid., Korosten city	center, between the pavement slabs, the leaves are small, 3–4 mm in length	24 Aug 2020	O. Orlov
114	<i>P. papillatostellulata</i>	ibid., Chernyakhiv district, Divochki village	in the garden	24 Aug 2020	O. Orlov
115	<i>P. papillatostellulata</i>	ibid., Zhytomyr city, industrial zone near the plant “Promavtomatyka”	north-east part, on the grass lawn	25 Aug 2020	O. Orlov
116	<i>P. papillatostellulata</i>	ibid., Zhytomyr city, “Epicentr” commercial center	on the side of the Kyiv highway	20 Sept 2020	O. Orlov
117	<i>P. papillatostellulata</i>	ibid., Zhytomyr city, Global shopping center	on the grass lawn	20 Sept 2020	O. Orlov

1	2	3	4	5	6
118	<i>P. papillatostellulata</i>	ibid., Zhytomyr district, village Levkiv	on the sand in the floodplain of the Teteriv River	07 Oct 2020	O. Orlov
119	<i>P. papillatostellulata</i>	ibid., Zhytomyr district (former Lyubarskyi district), Lubar village	in the garden,	14 Jul 2021,	O. Orlov
120	<i>P. papillatostellulata</i>	ibid., Zhytomyr district (former Lyubarskyi district), Nova Chortoria village	on the side of the highway	14 Jul 2021	O. Orlov
121	<i>P. papillatostellulata</i>	ibid., Zhytomyr district (former Chudnivskyi district), Chudniv city	on wet sand on the right bank of the Teteriv River	19 Sept 2021	O. Orlov
122	<i>P. papillatostellulata</i>	ibid., Berdychivskyi district, Ivankivtsi village	along the railway track	20 Sept 2021	O. Orlov
123	<i>P. papillatostellulata</i>	ibid., Zhytomyr District, St. approx. with Berezhivka	on the side of the highway	04.08.2019	O. Orlov
124	<i>P. papillatostellulata</i>	ibid., Zhytomyr, Zhytomyr Market district	in the courtyard of a high-rise building, on a flower bed	01 Aug 2019	O. Orlov
125	<i>P. papillatostellulata</i>	ibid., Luhynskyi district, smt. Luhyny	on the side of the road	03 Sep 2019	O. Orlov
126	<i>P. papillatostellulata</i>	ibid., Romanivskyi district, village Myropol	in the garden, leaves are large, 2–3 cm	10 Aug 2020	O. Orlov
127	<i>P. papillatostellulata</i>	ibid., Khoroshivskyi district, village Khoroshiv	on the flower bed	27 Aug 2020	O. Orlov
128	<i>P. papillatostellulata</i>	ibid., Forest-Steppe, Zhytomyr district (former Popilnyanskyi district), village Popilnya	at the railway station in the platform crevices	17 Sep 2021	O. Orlov
129	<i>P. papillatostellulata</i>	ibid., Zhytomyr district, Zhytomyr city	the intersection of the district road, Kamianka village, on the side of the highway	11 Aug 2019	O. Orlov
130	<i>P. papillatostellulata</i>	ibid., Korostenskyi district, "Drevlyanskyi" Nature Reserve, Sukhariv branch, village Veliki Klishzi	on the side of the road	27 Aug 2023	O. Orlov
131	<i>P. papillatostellulata</i>	ibid., Korostenskyi district, Drevlyanskyi Nature Reserve, Sukhariv branch, village Poliske	on the side of the road	27 Aug 2023	O. Orlov
132	<i>P. papillatostellulata</i>	ibid., Korostenskyi district, Drevlyanskyi Nature Reserve, Sukhariv branch, village Peremoga	on the side of the road	29 Aug 2023	O. Orlov
133	<i>P. papillatostellulata</i>	ibid., Korostenskyi district, Drevlyanskyi Nature Reserve, Sukhariv branch, village Mali Minki	on the side of the road	27 Aug 2023	O. Orlov

1	2	3	4	5	6
134	<i>P. papillatostellulata</i>	ibid., Korostenskyi district, Drevlyanskyi Nature Reserve, Sukhariv branch, village Chryplja	on the side of the road	27 Aug 2023	O. Orlov
135	<i>P. rausii</i>	ibid., Zhytomyr district, Kamianka village	in the garden, a lot	26 Aug 2020	O. Orlov
136	<i>P. rausii</i>	ibid., Zhytomyr	railway	27 Jul 2020	M. Shevera
137	<i>P. sardoa</i>	ibid., Zhytomyr, center, near “Zhytomyr” Hotel	in flowerbed, small plant with small leaves	18 Sep 2019	O. Orlov
138	<i>P. sardoa</i>	ibid., Zhytomyr district, Teterivka village	in the market garden, with large leaves 2,5–3,0 cm	6 Oct 2019	O. Orlov
139	<i>P. sardoa</i>	ibid., Radomyshl'skyi district, Radomyshl city, private sector	in the market garden, completely	9 Aug 2020	O. Orlov
140	<i>P. sardoa</i>	ibid., Berdychiv, railway station	near the track	24 Jul 2021	O. Orlov
141	<i>P. sardoa</i>	ibid., Troshcha village	in the market garden	20 Aug 2021	O. Orlov
142	<i>P. sardoa</i>	ibid., Velyka Volytsia village	on wet clay on the shore of a pond	16 Sep 2021	O. Orlov
143	<i>P. sardoa</i>	ibid., Velyki Korovyntsi village	on the railway station, on the gravel	19 Sep 2021	O. Orlov
144	<i>P. sardoa</i>	ibid., Berdychiv'skyi district, Derganivka village	at the railway station	9 Oct 2021	O. Orlov
145	<i>P. sardoa</i>	ibid., Zhytomyr, center, on Peremogy Square	between the pavement tiles	02 Aug 2019	O. Orlov
146	<i>P. sardoa</i>	ibid., Zhytomyr, street Transitna	on asphalt sidewalks, in potholes	03 Sep 2019	O. Orlov
147	<i>P. sardoa</i>	ibid., Zhytomyr, Kyiv'ska street	on the side of the road across the railway line on street	20 Sep 2020,	O. Orlov
148	<i>P. trituberculata</i>	ibid., Zhytomyr district, village Barashivka, dacha	on the hill as a weed	02 Oct 2019	O. Orlov
149	<i>P. trituberculata</i>	ibid., Volodarsko-Volyn'skiy district, approx. with Nova Borova village	on the side of the highway	24 Aug 2020	O. Orlov
150	<i>P. trituberculata</i>	ibid., Berdychiv'skyi district (former Ruzhyn'skyi district), Derganivka village	at the railway station	22 Sept 2021	O. Orlov
151	<i>P. trituberculata</i>	ibid., Zhytomyr district, Teterivka village	in the garden, medium leaves 0.7–0.8 cm	09 Oct 2019	O. Orlov
152	<i>P. trituberculata</i>	ibid., Zhytomyr district, Oliyivka village	in the garden, large leaves 2–3 cm	23 Aug 2020	O. Orlov
153	<i>P. trituberculata</i>	ibid., Zhytomyr district, Kamianka village	in the garden, a lot	26 Aug 2020	O. Orlov
154	<i>P. trituberculata</i>	ibid., Berdychiv'skyi district (former Ruzhyn'skyi district), Trubiyivka village	wet sand near the bridge over the Rostavytsia River	23 Sept 2021	M. Shevera