









ORIGINAL PAPER

Osmunda regalis (Osmundaceae) – a new species to the flora of Ukraine

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**ABSTRACT**

Question: Is there *Osmunda regalis* in the flora of Ukraine? What is the current spatial distribution and state of *O. regalis* populations in Ukraine?

Location: Tsumanska Pushcha Kivertsivskyi National Nature Park, Volyn Region, Ukraine.

Materials and methods: field surveys, morphological description, phytoindication.

Nomenclature: POWO 2025

Results: *Osmunda regalis* is a fern distributed in Atlantic and sub-Atlantic parts of Europe, Mediterranean, the Balkan Peninsula, and the Caucasus. In Central and Eastern Europe, this species occurs more rarely. According to the last checklists and other publications, *O. regalis* is absent in the flora of Ukraine. Nevertheless, the nearest population of this fern is quite close to Ukraine and is less than 0.5 km away from the border. Some authors assumed that *O. regalis* could potentially grow in adjacent territories of Ukraine, but previous investigations were resultless. In 2023, the first individual of *O. regalis* was revealed in Tsumanska Pushcha National Nature Park in Kivertsi (Kivertsivskyi District, Volyn Region). In 2024, the second one was found in the surroundings. Today, the population is represented by two individuals. Both of them are fertile and can produce spores. The population was discovered in a 30-years-old pine-birch secondary forest with low phytodiversity richness. The species was revealed in the plant community with narrow amplitudes of ecological tolerance. The habitat has wet soil conditions, acidic and poor on mineral nutrients (including nitrogen) sod-podzolic soils. Ombroregime is sub-aridic and the climate continentality regime is between hemi-oceanic and sub-continental. Among studied factors, soil acidity, nitrogen content in the soil, and climate humidity (ombroregime) were extremely limiting factors for that plant community. Such conditions indicate the revealed population is vulnerable because the plants grow on their ecological tolerance limit. Today, only one population, consisting of two individuals, is known to Ukraine. Considering that, *O. regalis* is recognised as a critically endangered (CR; B2ac(iii, iv) + D) plant species to the flora of Ukraine and should be included in the next edition of the Red Data Book. Because the studied species is the new one to the flora of Ukraine, there are morphological description of *O. regalis* and the key to identification in the article.

KEYWORDS

biodiversity, ferns, rare species, chorology, morphology, new locations, Polissian Lowland, Tsumanska Pushcha Kivertsivskyi National Nature Park

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INTRODUCTION

Osmunda regalis is an Atlantic-sub-Mediterranean fern species (POWO 2025) occurring in the Old World. The Atlantic part of the distribution range occupies Macaronesian, the western part of the Pyrenean Peninsula (Portugal and Western Spain), France, Belgium, The Netherlands, England, Scotland, and Ireland. The species mostly occurs in that part of Europe. The sub-Atlantic part of the range includes Luxemburg, Germany, Switzerland, the western and southern parts of Poland (Zajac & Zajac 2001), the western part of Czechia and Slovakia, and the western margins of Belarus (Parfenov 2009). In the North, the species occurs in Southern Scandinavia (Denmark, Norway, and Sweden) (Birks & Paus 1991). Generally, the frequency of occurrences decreases from West to East. The Sub-Mediterranean part of the range lies on the territory of Morocco, Algeria, Tunisia, the Submediterranean coast of Spain, France, Northern and Western Italy, Sardinia, Corsica, and Crete (Landi & Abgiolini 2008). The species occurs rarely in the eastern part of the Mediterranean. It grows in disjunctive localities in the Balkanian Peninsula (North-East Greece and Northern Macedonia) and the Middle East (Lebanon). The far exclave is known in the eastern coastal territories of the Black Sea (in the maritime marshes of Abkhazia, Georgia) (Fomin 1934).

The genus *Osmunda* includes some morphologically similar species. According to the Plants of the World Online (POWO 2025), the genus includes 13 accepted species and 4 taxa of hybrid origin. Though, modern study (Lehnert et al. 2024) based on morphology, biogeography, and molecular data reports that genus includes 5 species with wide morphological diversity: *O. regalis*, *O. japonica*, *O. lancea*, *O. spectabilis*, and *O. hybrida*. Other representatives accepted by POWO are replaced into other relative genera or recognised as synonyms. Moreover, study shows an ability of some representatives of *Osmunda* genus to form the intraspecies and intergeneric (with relative genera *Claytosmunda* and *Plenasium*) hybrids. Thus, in Europe, there is *O. regalis* «regalis» occurring.

According to the last nomenclatural and taxonomic checklists, other publications, and open databases (Prokudin et al. 1987, Mosyakin & Fedoronchuk 1999, Vasheka & Bezsmertna 2012, UkrBIN 2025, POWO 2025), *O. regalis* is absent in the flora of Ukraine. Nevertheless, it is mentioned that *O. regalis* possibly occurs in the Ratniv District of the Volyn Region (Terletskyi et al. 1995: 9). However, that statement was not confirmed by photos, herbarium specimens, or other researchers' observations. For many years, the presence of *O. regalis* in Ukraine was doubtful. This article resolves the issue of the presence of *O. regalis* in the flora of Ukraine.

MATERIALS AND METHODS

The field investigations were conducted during 2023–2024 in «Davydiv Lis» Forest, which is included in the territory of Tsumanska Pushcha National Nature Park in Kivertsi (Volyn Region).

We investigated herbarium specimens deposited in the herbaria of 55 scientific institutions of Ukraine (CHER, CWU, DNZ, DSU, KHER, KW, KWHU, KWHA, LW, LWS, LWKS, MELIT, MSUD, PWU, SOF, UU, YALT), Austria (GJO, GZU, W, WU), the Czech Republic (BRNU, PR, PRC), Hungary (BP), Poland (KRA, KRAM, WA, WABG, WRSL), Romania (BUC, CL, I, IAGB, IASI), the Slovak Republic (BRA, KO, SAV, SLO), and the herbaria from aggressor state, which were revised before the Russian aggression (LE, MSU, MW). Acronyms are given according to Index Herbariorum (Thiers 2016). We also reviewed other regional collections (without registered acronyms): Iasi Museum of Natural History (Romania), Taras Shevchenko National University of Kyiv (Ukraine), The National Forestry and Wood-Technology University of Ukraine, Lesya Ukrainka Volyn National University (Ukraine), Volyn Regional Museum (Ukraine), Rivne National University of Water and Nature Management (Ukraine), Rivne Natural History Museum (Ukraine), Ternopil

Volodymyr Hnatiuk National Pedagogical University (Ukraine), Kryvyi Rih Botanical Garden (Ukraine), T.H. Shevchenko National University “Chernihiv Colehium” (Ukraine), Ivan Ohienko Kamianets-Podilsky University (Ukraine), Vasyl Stefanyk Precarpathian National University (Ukraine), and Ferenz Rakoczy II Transcarpathian Institute (Ukraine). Additionally, we analysed the open databases (GBIF 2025, UkrBIN 2025) to find information about specimens of observations made in Ukraine.

We prepared a distribution map of *Osmunda regalis* in Ukraine and adjacent territories based on analysis of the literature data, open databases, herbarium specimens from the institutions mentioned above, and our field research data. We used Quantum GIS 3.40 Bratislava (<https://www.qgis.org/uk/site/>) to create the maps. Additionally, we used the GBIF Occurrences Plugin to import the data about georeferenced records of *O. regalis* from GBIF (Noé 2024).

The ecological analysis was provided according to Didukh's ecological scales (Didukh 2011). We analysed the plant communities by six abiotic factors: soil humidity, soil acidity, soil salinity, carbonate content in substrate, ombroregime, and climate continentality.

RESULTS AND DISCUSSION

Distribution in adjacent territories. According to literature and open databases (Fomin 1934, Zajac & Zajac 2001, Parfenov 2009, Osmunda 2023, UkrBIN 2025, www.inaturalist.org), the nearest to Ukraine localities of *O. regalis* are confirmed in Poland, Belarus, and the Caucasus regions of the aggressor state. In particular, some Polish populations are known in the Subcarpathian and Lublin Voivodeships on the border of the Lviv Region of Ukraine. The closest of them is approximately 4 km away from the Ukrainian border. Additionally, *O. regalis* populations are known in Belarus on the outskirts of the Ukrainian-Polish-Belarusian borders (Brest Region, Belarus). The Belarusian population is concentrated around Selyakhi Lake and less than 1 km from the Ukrainian border (FIGURE 1).

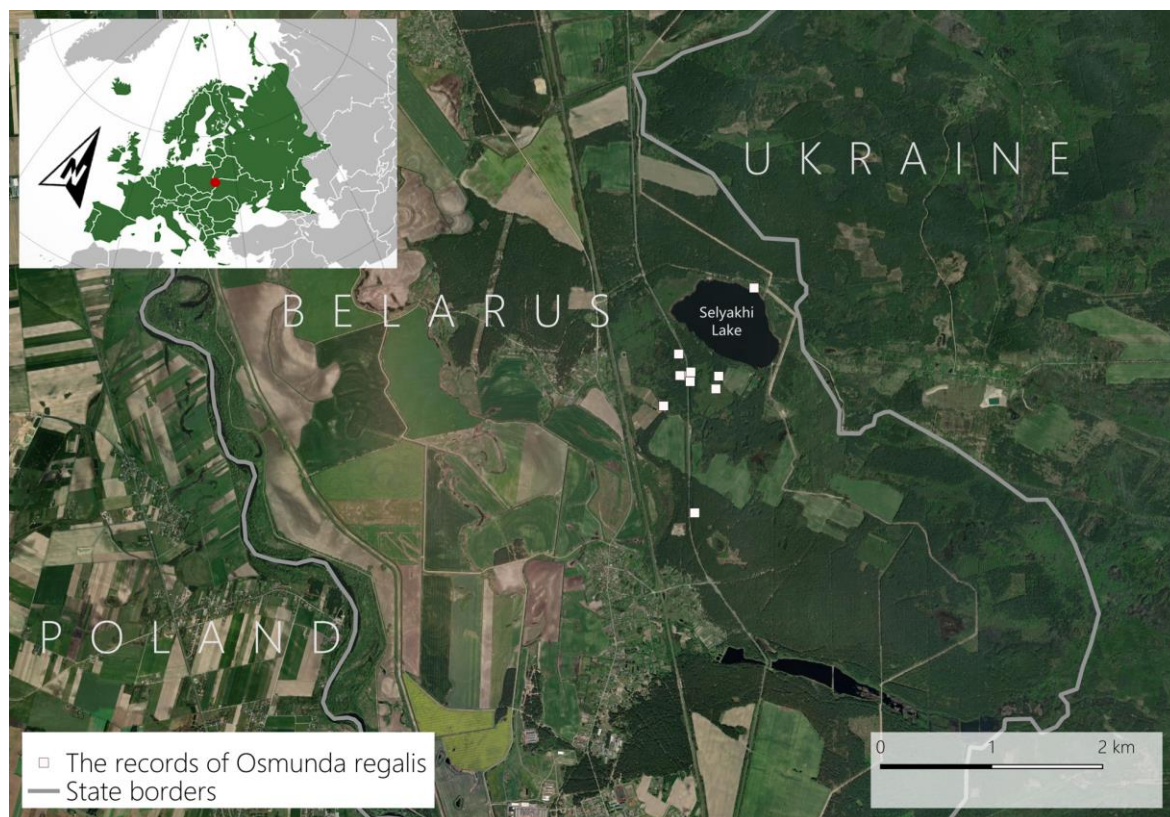


FIGURE 1. The spatial distribution of *Osmunda regalis* in Belarus (Parfenov 2009, Osmunda 2023). Base map: ESRI Satellite.

Distribution of *Osmunda regalis* in Ukraine and the state of the newly revealed population. As it has been mentioned before, N.Z. Romaniuk (Terletskyi et al. 1995) was the first who reported about the possible presence of *O. regalis* in Ratniv District (Volyn Region, Ukraine). However, that mention was believed to be doubtful because there was no evidence of the species occurring. A few expeditions were provided but their results did not confirm that *O. regalis* occurs in the Volyn Region. In 2003, O. Baranskyi organised a few expeditions to Shatsk District (Volyn Region) to find *O. regalis* in the vicinities of Selyakhi Lake – the nearest to Ukraine confirmed locality. These investigations were also unsuccessful.

On August 11 2023, V. Loiko found an individual of *O. regalis* in «Davydiv Lis» Forest (FIGURE 2). On June 26 2024, O. Baranskyi made a morphometric description of the revealed individual and estimated protection measurements. Later, on August 12 2024, H. Herasymchuk discovered one more individual of the species and made a morphometric description. On 15 August 2024, I. Danylyk studied the population. Today, only two individuals are revealed, and they are approximately 80 m from each other. Both individuals form sporangia and can breed.



FIGURE 2. *Osmunda regalis* in the revealed locality in Tsumanska Pushcha Kivertsivskyi National Nature Park (Kivertsivskyi District, Volyn Region, Ukraine). Photo by Olexandr Baransky (June 2024).

The discovered population is approximately 160 km from the nearest population around Selyakhi Lake (Brest Region, Belarus) and 185 km away from Polish populations (Lublin Voivodeship, Poland) (FIGURE 3). Such distance provokes the question about the origin of the revealed population. We tried to find the species in villages around. We assumed it could be used as an ornamental plant, but the preliminary investigations of the surroundings were resultless. The molecular-genetic investigations need to be provided to resolve those issues.

Morphology. Stems short, stout, covered by persistent leaf bases. Leaves in a dense crown, not persistent, 2-pinnate. Leaves 30–150 cm, densely tufted, only the upper (inner) ones of each year's crop being fertile; sterile pinnules 3–5 × 1–1.5 cm, oblong, obtuse, sessile, sometimes pinnatifid at the base, otherwise usually entire (rarely serrulate), with conspicuous, dichotomous, non-anastomosing lateral veins. Sporangia confined to a few terminal pinnae of the fertile leaves, not occupying more than a quarter of the leaf; fertile pinnules c. 12×3 mm, pale green, rapidly turning brown. $2n = 44$. Sporangia globular or pyriform, massed in dense clusters on certain pinnae of the fertile fronds, where they entirely replace the photosynthetic tissue. Sporangia 0.5 mm in diameter (Webb 1964, Parfenov 2009) (FIGURE 4).

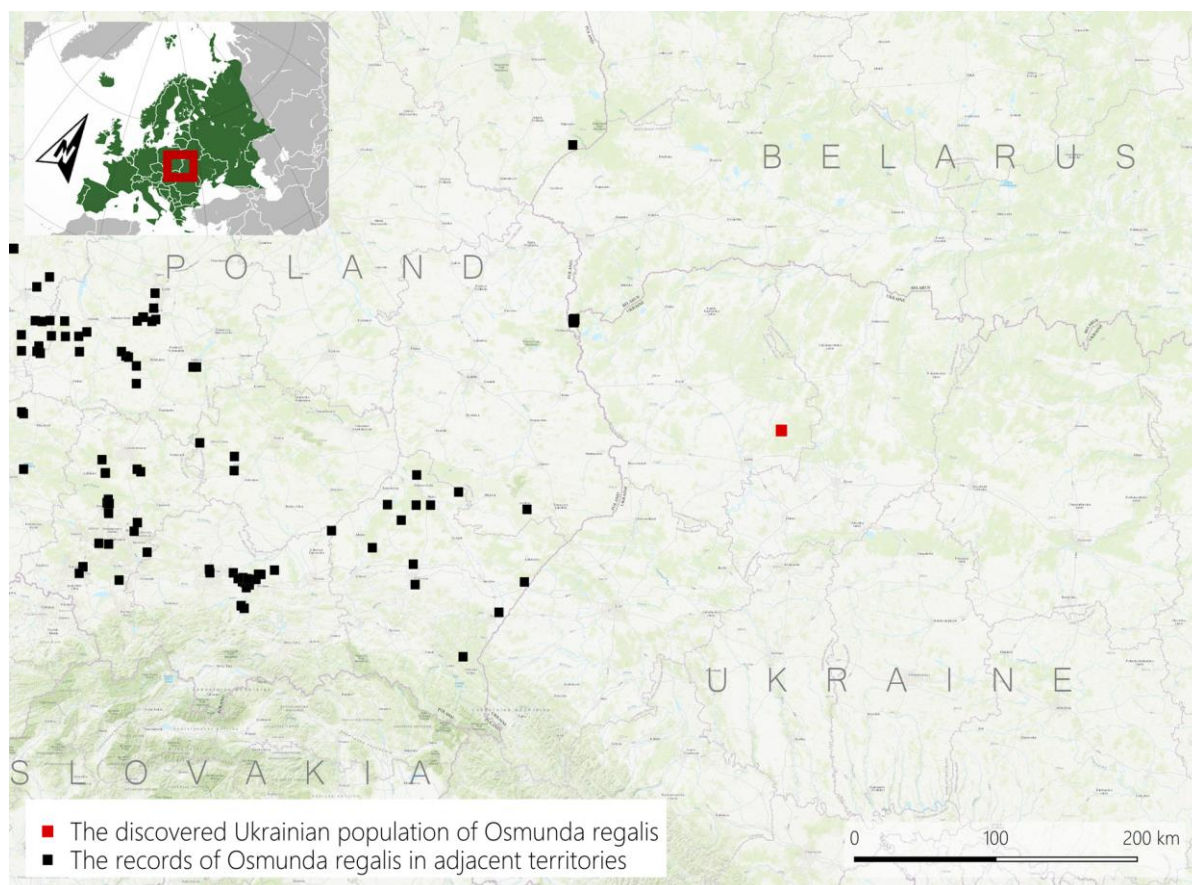


FIGURE 3. The spatial distribution of *Osmunda regalis* in Ukraine and adjacent territories. Base map ESRI World Topo.

We provide a fragment of the dichotomous key for the identification of the families of vascular spore plants occurring in Ukraine. The key steps lead to the identification of *Osmunda regalis*, which is the only representative of the Osmundaceae family in the Ukrainian flora.

Key to the families of the vascular spore plants in Ukraine (a fragment):

1. Aquatic or amphibious plants. Sporangia gathered in sporocarp or bases of linear basal leaves.....**others**
– Terrestrial plants, growing in quite dry or humid habitats.....2
2. Plants with developed overground stems. Leaves on stems, acicular or scale-like. Sporangia clustered in strobili or in base of principal leaves.....**others**
– Overground stems not developed. Plants with more or less well-developed rhizomes. Leaves basal. Sporangia gathered in clusters (sori).....3
3. Leaves monomorphic – sori on green trophic leaves.....**others**

- Leaves dimorphic or hemi-dimorphic – Leaves functionally divided into trophophylls (green ones, sterile) and sporophylls (usually brownish, fertile) or leaf has well-distinguishable sterile and fertile parts4
- 4. Leaves hemidimorphic5
- Leaves dimorphic.**Onocleaceae**
- 5. Plants less than 60 cm.....**Ophioglossaceae**
- Plants 60–150 cm tall.....**Osmundaceae** (*Osmunda regalis*)

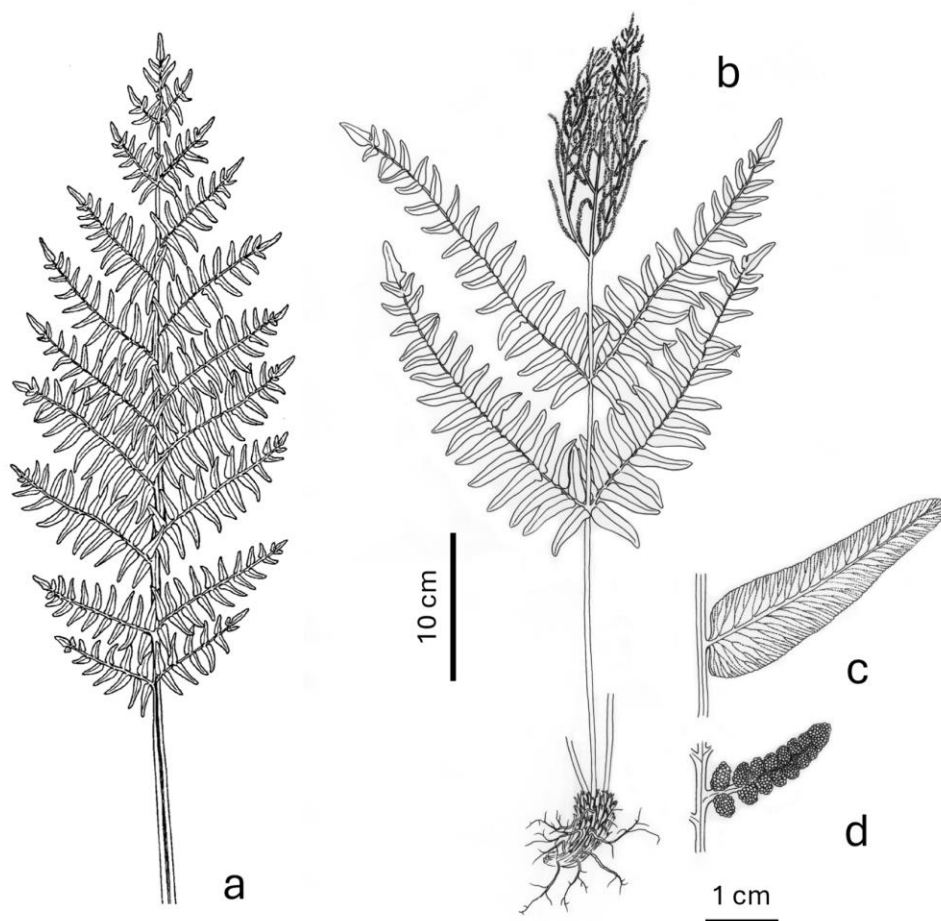


FIGURE 4. *Osmunda regalis*: a – trophophyll leaf; b – trophosporophyll; c – leaf segment; d – leaf segment with sporangia. Original illustration by Heorhii Bondarenko.

Ecology. *Osmunda regalis* grows in habitats with constantly moist, rich in mineral nutrients, and acidic soils (Webb 1964). The ecological and phytosociological conditions of the habitats of *O. regalis* in Europe differ in different parts of the range, depending on climatic and edaphic conditions. In Portugal and Spain, the species is sporadically distributed on the banks of rivers and streams on acidic soils; in the undergrowth of alder and ash (Amigo et al. 2009). In Italy, *O. regalis* grows at altitudes from 65 to 620 m (most often 300–400 m) above sea level; in moist forests with a predominance of *Alnus glutinosa*, in marshes and along streams (Landi & Angiolini 2008). In the isolated Caucasian exclave, *O. regalis* grows in the coastal marshes of Abkhazia in alder thickets, peat, and forest bogs (Fomin 1934). The increase in continentality and aridity of the climate are the reasons for the decrease in the total population in the Eastern Mediterranean. These climatic factors limit the eastward spread of *O. regalis*. In the northern part of the range, in United Kingdom, Ireland,

and Norway, the species grows in the coastal areas on the ledges of sea cliffs, near waterfalls, and sea caves. In places remote from the sea coast, *O. regalis* is distributed in depressions on open, well-drained bogs and heaths (Birks & Paus 1991). In more continental regions of Europe, the species' habitats tend to be forest areas with a well-developed network of lakes, rivers, and marshes. In Poland, the species grows in spruce, pine, and pine-spruce forests on acidic soils (Gdula et al. 2014). As mentioned above, the only Belarusian population is confined to a pine forest near Selyakhi Lake. The species grows in pine forests with coverage of Bryopsida, *Vaccinium myrtillus*, and *Pteridium* sp. Due to preferred habitat conditions, the Belarusian population is characterised by a high density of individuals, and the development of individuals (height reaches 2 m). Somewhat less often, the species grows in humid habitats directly near the shore of Selyakhi Lake and in wetlands adjacent to the western part of the lake in groups of depressed pine swamp and sphagnum-sedge forests (Parfenov 2009, GBIF 2025).

The Ukrainian population of *O. regalis* was discovered in the pine-birch forest up to 30 years old. That young forest formed on the territory of the former deforestation. The tree-shrub layer was represented by *Salix aurita* and *Frangula alnus* (FIGURE 4).

Moss layer:

- *Polytrichum commune* – 70 %
- *Pleurozium schreberi* – 2 %

Herb layer:

- *Dryopteris carthusiana* – 20 %
- *Poa nemoralis* – 3 %
- *Dryopteris filix-mas* – 2 %
- *Calluna vulgaris* – 1 %
- *Vaccinium myrtillus* – 1 %
- *Rumex acetosa* – <1 %
- *Dryopteris cristata* – <1 %

According to the National Habitat Catalogue of Ukraine (Kuzemko et al. 2018), the revealed population of *O. regalis* was formed in Acidophilous mesic and moist Scots pine forests (the National habitat code is Д 2.2.2).

Besides, we determined the common tolerance ranges by six abiotic factors (soil humidity, soil acidity, soil salinity, carbonate content in substrate, ombroregime, and climate continentality) for the revealed locality (FIGURE 5).

The investigated plant community has narrow amplitudes for each studied factor. The common diapason of soil humidity lies between values 13 and 15 corresponding to quite fresh habitats ($W_{np} = 150\text{--}250$ mm). The soil on the studied site is acidic and its pH level is in diapason 4.5–5.5. The total salt content of the substrate is between values corresponding to semi-oligotrophiphic and mesotrophic regimes (75–150 mg/l). It is typical for pine forests sod-podzolic soil characterised by low concentration of HCO_3^- and absence of SO_4^{2-} and Cl^- . Soils on the studied site are characterised by quite low mineral nitrogen content (0.05–0.3 %). According to calculated values of the ombroregime, we established that conditions are sub-aridic and do not correspond to *O. regalis*.

The climate continentality regime of the site lies between values that correspond to the diapason between hemi-oceanic and sub-continental (Didukh 2011). Based on calculated values, it should be considered, in the revealed locality, *O. regalis* grows on the limit of its ecological tolerance. Only one relevé is not enough to determine the amplitudes of the ecological tolerance of *O. regalis* and specify the niche of the Ukrainian populations. Further investigations of other localities should be conducted to estimate it more accurately.

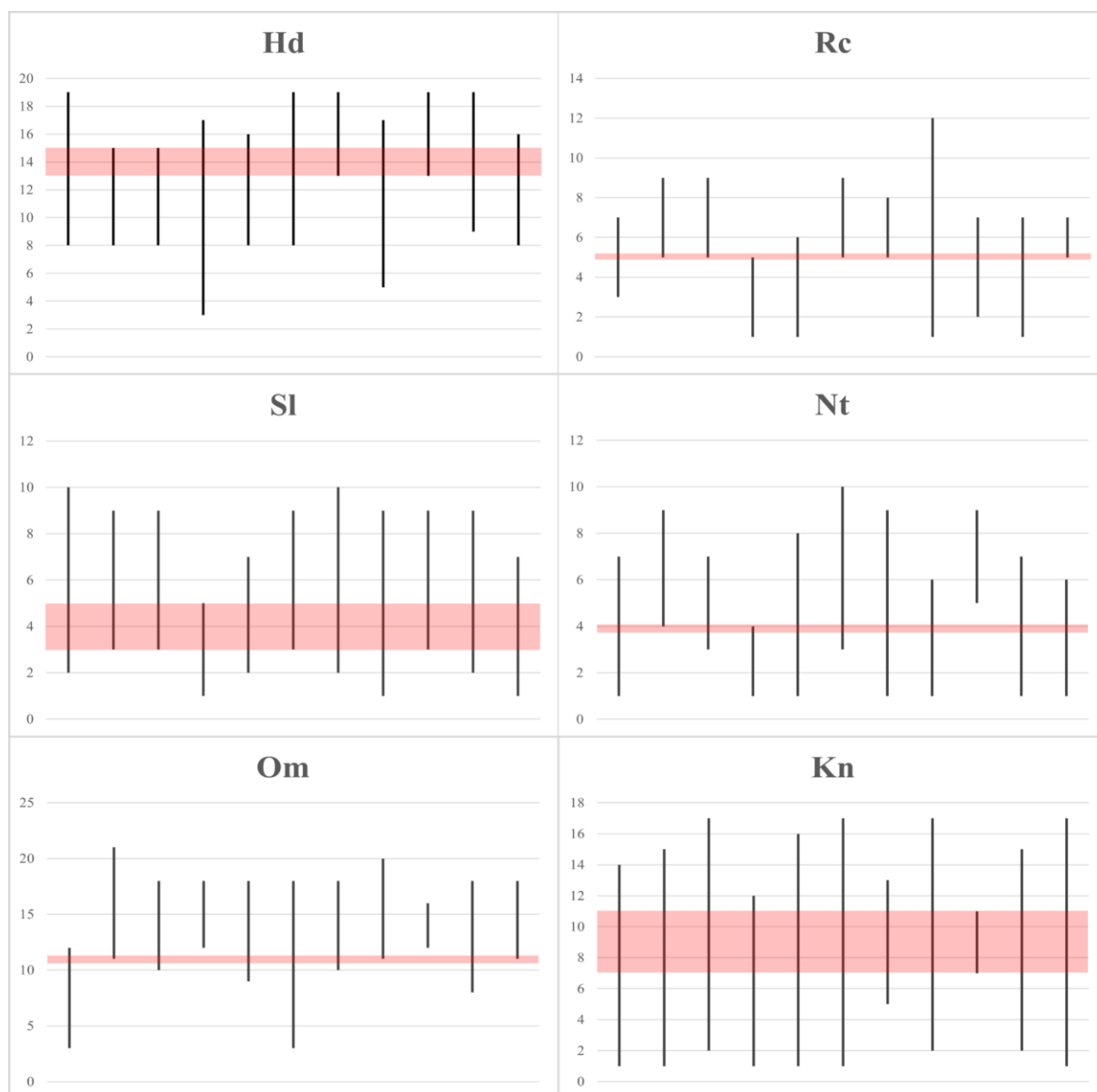


FIGURE 5. Phytoindicative scale of the habitat of the Ukrainian *Osmunda regalis* population: Hd – soil humidity; Rc – soil acidity; Sl – soil salinity; Nt – nitrogen content in soil; Om – the climate humidity (ombroregime); Kn – continentality of climate; numbers in ordinate correspond to values in Didukh's ecological scales (Didukh 2011); vertical lines – the amplitude of the ecological tolerance of each species revealed in the site; red box – common tolerance range of all revealed species in the site.

Protection. *Osmunda regalis* is a widely distributed species in Western and South-Western Europe. In Ukraine and adjacent territories of Central and Eastern Europe, *O. regalis* is rare. For instance, among neighbour countries, the species is included in the “red lists” of Poland, Hungary, and Belarus. In Poland, it has Vulnerable status (B2b(iii, iv, v)) (Każmierczakowa 2016). In Hungary, *O. regalis* has the same protection status (Vulnerable) (Gergely 2007). In Belarus, *O. regalis* is considered as endangered species that has category of protection – I (Resolution 2025). The eastern limit of the species' range lies in Ukrainian Polissia. According to species rarity in Ukraine and narrow ecological tolerance, we propose to include *O. regalis* in the next edition of The Red Data Book of Ukraine. According to IUCN criteria (IUCN 2012), *O. regalis* should be considered a Critically Endangered (CR) plant species for the Ukrainian flora (B2ac(iii, iv) + D).

CONCLUSION

Osmunda regalis, a new fern species to the flora of Ukraine, was discovered. It was found in the 30-year-old pine-birch forest in the territory of the Tsumanska Pushcha National Nature Park in Kivertsi (Kivertsivskyi District, Volyn Region, Ukraine). The population consists of two individuals 80 m away from each other. Considering the distance between the revealed locality and the nearest population around Selyakhi Lake (Brest Region, Belarus), which is approximately 160 km, the origin of the Ukrainian population needs to be investigated.

The calculated values of the ecological tolerance of the studied plant community show that *O. regalis* grows on its ecological limit. In the discovered locality, *O. regalis* is vulnerable. Considering the number of individuals, populations, and population area, *O. regalis* should be included in the Red Data Book of Ukraine as a Critically Endangered species. Moreover, it needs additional protection measures such as planting in botanical gardens and further repatriation into natural habitats.

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РЕЗЮМЕ

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Osmunda regalis – вид папоротей, поширений в атлантичній та субатлантичній частинах Європи, Середземномор'ї, на Балканському півострові та Кавказі. У Центральній і Східній Європі цей вид трапляється рідше. Згідно з останніми номенклатурними списками та іншими публікаціями, *O. regalis* відсутній у флорі України. Тим не менш, найближча популяція цієї папороті знаходиться досить близько від України – менш ніж за 0,5 км від кордону. Деякі автори припускали, що *O. regalis* потенційно може зростати на прилеглих територіях України, але попередні дослідження не дали результатів. У 2023 році в Ківерцівському Національному природному парку «Цуманська пуща» (Ківерцівський район, Волинська область) виявлено першу особину *O. regalis*. У 2024 році неподалік знайшли другу. На сьогоднішній день популяція представлена двома особинами. Обидві вони фертильні та здатні утворювати спори. Популяцію виявлено в 30-річному сосново-березовому вторинному лісі з низьким видовим багатством. Вид виявлено у рослинному угрупованні з вузькими амплітудами екологічної толерантності. Місцезростання характеризуються вологими, кислими та бідними на мінеральне живлення (зокрема азот) дерново-підзолистими ґрунтами. Омброрежим є субаридним, а режим континентальності клімату знаходиться між геміокеанічним і субконтинентальним. Серед досліджених факторів кислотність ґрунту, вміст азоту в ґрунті та вологість клімату (омброрежим) були лімітуючими факторами для цього рослинного угруповання. Такі умови вказують на те, що виявлена популяція вразлива, оскільки рослини ростуть на межі екологічної толерантності. На сьогодні в Україні відома лише одна популяція, що складається з двох особин. Враховуючи це, *O. regalis* визнано критично зникаючим (CR; B2ac(iii, iv) + D) видом рослин флори України та має бути включений до наступного видання Червоної книги. Оскільки досліджуваний вид є новим для флори України, у статті подано морфологічний опис *O. regalis* та ключ до його ідентифікації.

Ключові слова: біорізноманіття, папороті, рідкісний вид, хорологія, морфологія, нові місцезнаходження, Поліська низовина, Ківерцівський Національний природний парк «Цуманська Пуща»