New data on the distribution and community ecology of the rare hygrophytic fern *Thelypteris palustris* in Bulgaria

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Abstract. Marsh Fern (*Thelypteris palustris*) is a hygrophytic plant uncommon to the flora of Bulgaria. It is also a vulnerable species, with small and isolated localities in several parts of the country. This paper provides new data on syntaxonomy of the communities in which this fern participates, as well as on a new important locality near Pleven town, Danubian Plain. The paper also attempts to summarize the published and more recent information on the distribution of this species in Bulgaria.

Key words: Marsh Fern, known localities, hygrophytic plant communities

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Introduction

Thelypteris palustris Schott is a perennial herbaceous plant with creeping blackish rhizomes. The leaf lamina is lanceolate, pinnate; pinnae are pinnatisect, linear-lanceolate (Jermy & Paul 1993). The sori are located between the midrib and the backward-curved edges of the leaf lobes, the spores are kidney-shaped (Achtarov & Jordanov 1963). This species was included in the first edition of *Red Data Book of Bulgaria* (Velev 1984) as Rare and in *Red List of Bulgarian Vascular Flora* (Ivanova 2009) as Vulnerable.

Thelypteris palustris has never been widespread in Bulgaria. For example, along the Danube River, Petkov (1911) had mentioned this species only for the Silistra Marshes (lake Srebarna). Achtarov & Jordanov (1963) had summarized information for the following localities of the Marsh Fern in the country: Black Sea Coast – in some lakes near the Black Sea and at the mouth of river Kamchia; Thracian Lowland – at river Marit-

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sa near Sadovo town; Znepole Region – Mt Konyavska (Choklyovo Marsh); Valley of River Struma (Kolarovo village); and Mt Strandzha (Kosti village). Stojanov & al. (1967) had mentioned also the localities Trevnensko (vicinity of town of Tryavna) (Balkan Range (*Central*)), above the town of Peshtera (Rhodopi Mts (*Western*)), and Samoranovo village (Rila Mts). According to Andreev (1992) and Stoyanov & al. (2021) this species also occurs in Mt Belasitsa and Rhodopi Mts (*Central*).

In 2021, the authors found a new locality (Fig. 1) of this species in Bulgaria: in the marshes (old riverbeds) and semi-artificial lakes around the former Plama Oil Refinery (Pleven district), near the river Vit between villages of Tarnene and Disevitsa. The identified new population is probably as numerous and stable as the one in lake Srebarna. In this locality, *Thelypteris palustris* dominated the hygrophytic plant communities. The newly-found locality has been investigated, plus several phytocenological relevés from other localities of this species (from the lake Srebarna), so as to classify those communities on the association and higher-rank levels.

Material and methods

The research was based on own collections and field studies in the identified locality of *Thelypteris palustris* as well as in some other known localities such as the lake Srebarna. The phytocoenological research was conducted in 2021-2022, using the classical Braun-Blanquet's methodology (Braun-Blanquet 1964). The localities were presented on a UTM grid map (10×10 km) of Bulgaria, following the recommendations of Kožuharov & al. (1983). Nomenclature of the vascular plants followed Delipavlov & Cheshemdjiev (2003). The syntaxonomic scheme followed the most complete checklist of European syntaxa (Mucina & al. 2016).

Results

Thelypteris palustris Schott

Bu Danubian Plain: in some marshes (old riverbeds) and small ponds close to river Vit, Tarnene and Disevitsa villages, Pleven Municipality and district, 63 m; 43°24'13.5"N, 24°30'13.5"E; 43°23'34.5"N, 24°30'01.0"E; KJ 90 (Fig. 2), 06.06.2022, coll. *R. Tzonev* (SOM 178003, 178004).

The newly-identidied population of *Thelypteris palustris* was located in old riverbeds and lakes formed after gravel excavation, between the former Plama Oil Refinery and the villages of Tarnene and Disevitsa, on the left bank of river Vit.

The identified communities (Table 1) in these lakes have been located mostly on their periphery. The Marsh Fern prefers *Phragmites australis* communities, but it also plays a pioneer role and can make monodominant, probably temporal communities (Fig. 2). Other typical species have been: *Typha angustifolia, Carex pseudocyperus, Lythrum salicaria, Lemna minor*, etc.

In the lake Srebarna the Marsh Fern is a typical, even codominant species (Fig. 3), along with *Phrag-*

Fig. 1. The population of *Thelypteris palustris* in the lake close to the former Plama Oil Refinery (Photo: *R. Tzonev*).

Fig. 2. A *Thelypteris palustris* community in a lake close to the former Plama Oil Refinery (Photo: *R. Tzonev*).

Fig. 3. "Kochki" with *Phragmites australis* and *Thelypteris palustris* in the lake Srebarna (Photo: *R. Tzonev*).

mites australis, on the small floating reed islets named "kochki". There, it forms the second layer, about 1 m tall. These communities are diverse and many hydrophytic and hygrophytic species participate in their floristic structure, namely, *Calystegia sepium, Lythrum salicaria, Salix cinerea, Urtica dioica, Rumex palustris*, etc. These "kochki" are the only habitat in Bulgaria of the critically endangered (possibly extinct) species *Cicuta virosa* (see Kochev & Jordanov 1981).

In the Petrich region (Kolarovo village), *Thelypteris palustris* participates in the floristic structure of alkaline fens (Fig. 4), together with another rare fern species, *Osmunda regalis*. According to Hajek & al. (2008), that community belongs to the association *Eleochariti uniglumis-Caricetum distantis* Hajek & al. 2008 from the *Caricion davallianae* Klika 1934 alliance. However, in the drier parts of that locality (tall-herb moist meadows on the wetland peripheries), both fern species may exist in mixed communities with a significant cover, known from the Monospitovsko Marsh in N. Macedonia (also at the foot of Mt Belasitsa) as association *Osmundo-Thelypteridetum* (Micevski 1988; Melovski & al. 2008). This association was included in the alliance *Magnocaricion*. However, this may be invalid because its holotype was not indicated in the paper.

Based on data from eight phytocoenological relevés (Table 1), we could conclude that the communities of lake Srebarna and river Vit belong to the association *Thelypterido palustris-Phragmitetum australis* Kuiper ex van Donselaar & al. 1961, reported for the first time for Bulgaria. However, in the newly-identified locality near river Vit, there are some pioneer phytocoenoses without participation of *Phragmites australis*, probably an initial stage of development of the phytocoenoses of this association.

Fig. 4. A community with *Thelypteris palustris* in the Petrich region (Photo: *S. Tsoneva*).

The association *Thelypterido palustris-Phragmitetum australis* is represented by communities dominated by *Phragmites australis*, with the participation of *Thelypteris palustris*. It is a rare vegetation type of mesotrophic to eutrophic wetlands, where it occurs as floating islets in 30–100 cm deep water. It is reported from several European countries, including neighboring Romania (Šumberová 2011). The association is included in the following syntaxomomic scheme:

Class *Phragmito-Magnocaricetea* Klika in Klika & Novák 1941

Order *Magnocaricetalia* Pignatti 1953

Alliance *Carici-Rumicion hydrolapathi* Passarge 1964

Association *Thelypterido palustris-Phragmitetum australis* Kuiper ex van Donselaar & al. 1961

The communities in SW Bulgaria are of a different type and they are a mixture of alkaline fens and tall-herb moist meadows.

Discussion

The newly-identified locality of *Thelypteris palustris* is very far (several hundreds of kilometers) from the closest known localities of this species in Bulgaria. The known localities of *Thelypterido-Phragmitetum* in Romania (Coldea 1997) are mostly in the Danube's Delta, and the closest ones in the Wallachian Plain (Cernica, Mogosoaia, Caldarusani), are in the vicinities of Bucharest city. The lakes and marshes at the former Plama Oil Refinery have been comparatively well studied and many hydrophytic and hygrophytic syntaxa have been described from that area (Tzonev 2002, 2017). The region has been monitored since the early 1990s, but the Marsh Fern has never been found there so far. Most likely, this is a distant

Table 1. Diagnostic table of *Thelypteris palustris* communities

Relevé number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
Locality	**Lake Srebarna**	**Lake Srebarna**	**Lake Srebarna**	**Lake Srebarna**	**Lake Srebarna**	**Lake Srebarna**	**Lake Srebarna**	**Marsh near Tarnene, Pleven district**	**Constancy (%)**
Date	**8.9.2021**	**8.9.2021**	**8.9.2021**	**8.9.2021**	**8.9.2021**	**8.9.2021**	**8.9.2021**	**6.6.2021**	
Latitude	**44.10497**	**44.10530**	**44.10868**	**44.10885**	**44.11815**	**44.10946**	**44.10752**	**43.39187**	
Longitude	**27.06963**	**27.06801**	**27.06499**	**27.06638**	**27.06497**	**27.06438**	**27.06365**	**24.49965**	
Total cover	**95**	**95**	**95**	**95**	**95**	**95**	**95**	**95**	
Sample area - square meters	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**4**	
Diagnostic species for the association *Thelypterido-Phragmitetum* Kuiper ex van Donselaar & al. 1961									
Phragmites australis	5	5	5	4	5	5	5		88
Thelypteris palustris	3	4	2	4	3	3	3	4	100
Diagnostic species for *Carici-Rumicion hydrolapathi* Passarge 1964									
Lycopus europaeus	+	+	1				2		50
Solanum dulcamara			2				2		25
Carex pseudocyperus								+	13
Diagnostic species for *Magnocaricetalia* Pignatti 1953 and *Phragmito-Magnocaricetea* Klika in Klika & Novák 1941									
Calystegia sepium	2	2		2	2		2		63
Lythrum salicaria		+				1	2		38
Typha latifolia				2					13
Typha angustifolia								2	13
Rumex hydrolapathum						+			13
Lysimachia vulgaris								1	13
Other species									
Persicaria lapathifolia		1	1		+	+			50
Ceratophyllum demersum	+		+			+			38
Salix cinerea		1		1			+		38
Urtica dioica	+	1	2						38
Epilobium hirsutum		1			+				25
Bidens cernua		1	2						25
Cyperus odoratus		+					+		25
Bidens frondosus					+	+			25
Hydrocharis morsus-rannae	+								13
Rumex palustris			2						13
Pycreus flavescens						+			13
Eupatorium cannabinum							2		13
Carex otrubae								1	13
Lemna minor								2	13

transfer of spores, which has taken place recently in that region. Similarly unexpected appearance of this species in some remote localities is already known from Sicily, Italy (Sciandrello & al. 2021). According to its dispersal strategy, Sadlo & al. (2018) have classified this species as of V. *Lycopodium* type. The type includes mostly anemochoric species, but they also use autochory, endozoochory, epizoochory, and hydrochory. Such dispersal strategy relies on light, very small spores and seeds dispersed by a wide range of vectors. However, Sadlo & al. (2018) have emphasized that spore-producing wetland fern species in particular could rely more heavily on the hydrochoric dispersal modes, where whole plants or their rhizomes are spread by floods, and thus, it is unclear whether the new populations are initiated by spores. Therefore, it could be expected for this species to also appear in other wetlands, far from its earlier known localities. The large number of individuals in the newly-identified population evidences that the speed of reproduction and spread of these ferns is very high. The expansion of the species observed in recent years, for example in Bulgaria and Italy, could be possibly related to some favorable conditions for its development, due to climate changes, or some other unknown reasons. However, at this level of knowledge such conclusions remain quite speculative.

Below is given a summary of the latest information about the localities of this species in Bulgaria (Fig. 5) by floristic regions.

— **Black Sea Coast**

The population around lake Beloslav (Stojanov & al. 1967, Velev 1984) has not been confirmed in the last decades and, very probably, the locality does not exist anymore. The surroundings of Varna and Beloslav lakes have been significantly transformed and negatively affected by heavy industrialization. The locality in the mouth of river Kamchia has also not been confirmed for many years. However, person-

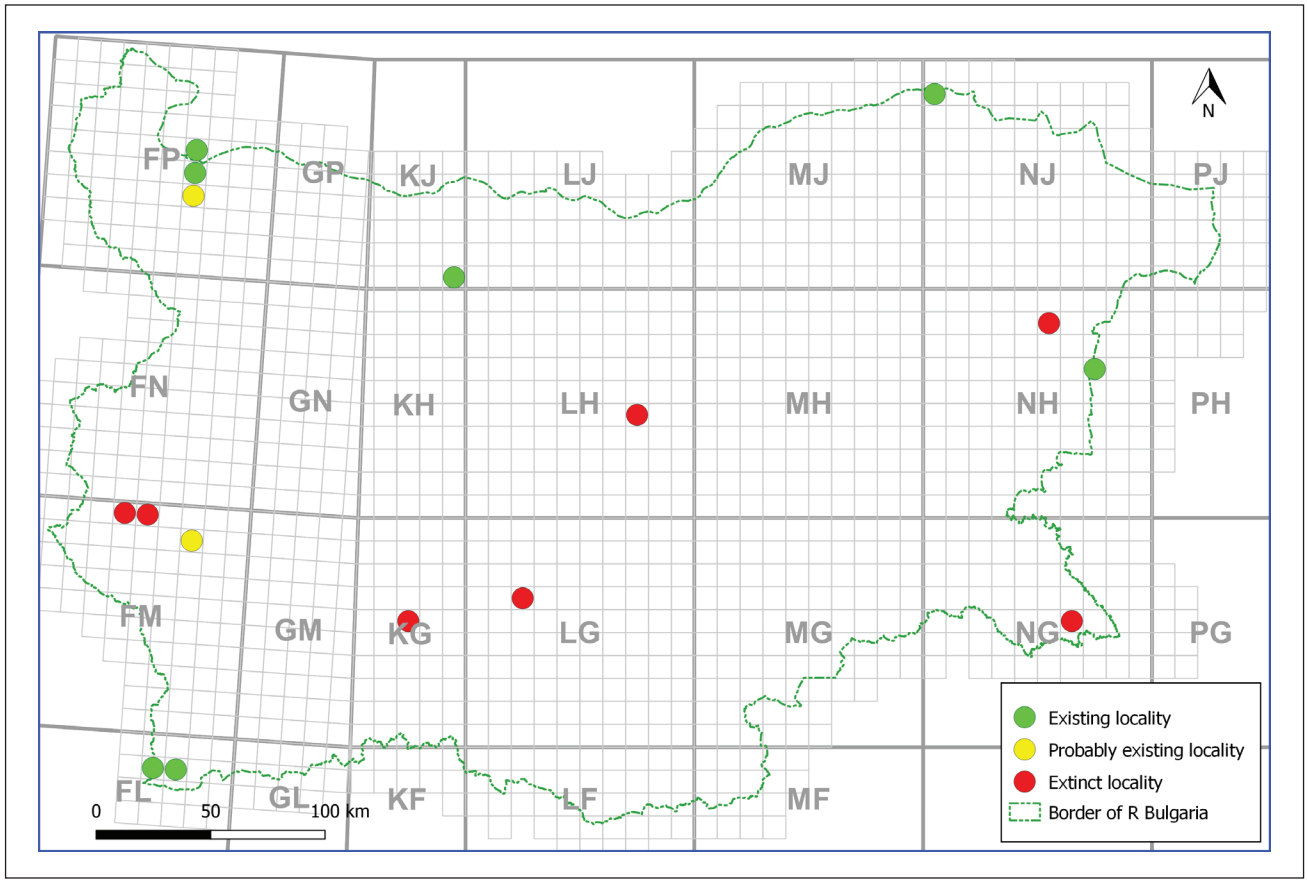

Fig. 5. The past and present distribution of *Thelypteris palustris* in Bulgaria, presented in UTM grid (10×10 km).

al data collected by Dr. Georgi Kunev northwards of Shkorpilovtsi village (42°25'53.1"N, 27°53'25.5"E; 8.10.2022) have recently confirmed the existence of a population in that area and probably also stand evidence to a recent expansion, because this old river bed was repeatedly checked across the years.

— **Northeast Bulgaria**

The population in lake Srebarna was numerous and the species was dominant in some communities, as it has been already mentioned here.

— **Danubian Plain**

Only the newly-identified locality near the villages of Tarnene and Disevitsa (Pleven district) was stable and the population of *Thelypteris palustris* was numerous there. The species also occured in the Orsoya Lowland, as mentioned above. However, only single plants or small groups have been seen there in the last ten years. They grew mostly in the drainage canals in the place of the former, partially drained wetlands.

— **Balkan Range (*Central*)**

The Trevnensko locality (Stojanov & al. 1967) near Tryavna town has not been confirmed in the last decades.

— **Znepole Region**

The Choklyovo Marsh locality is extinct now. *Thelypteris palustris* used to inhabit sporadically the deeper parts of the marsh (Jordanov 1931), but the marsh was transformed into a dam.

— **Valley of River Struma**

The locality with numerous population still existed between Kolarovo and Gabrene villages, Blagoevgrad district.

— **Rila Mts**

The population near Samoranovo village, Kyustendil district (Stojanov & al. 1967, Velev 1984) has not been confirmed in the last decades.

— **Rhodopi Mts (*Western*)**

The locality above the town of Peshtera (Stojanov & al. 1967) has not been confirmed in the last decades.

— **Thracian Lowland**

The information on the locality along river Maritsa, near Sadovo town, was very old (Velenovsky 1898), and that locality did not exist anymore.

— **Mt Strandzha**

The locality near the village of Kosti was also destroyed after drainage of the small spring marsh and presently the species is extinct there.

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