

BATRACHIUM (RANUNCULACEAE) IN THE RIVERS OF LITHUANIA
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Abstract

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Batrachium (DC.) S.F.Gray is one of the most complicated taxonomic groups of aquatic plants. Identification to species level often is very difficult because of simplified morphology and variable taxonomic interpretation of the group. This paper reports the results of the revision of herbarium specimens of *Batrachium* from flowing waters. The occurrence and distribution of *Batrachium fluitans* and *Batrachium pseudofluitans* in the rivers of Lithuania are presented as well as morphological characters important for the separation of these taxa are discussed.

Keywords: *Batrachium fluitans*, *Batrachium pseudofluitans*, distribution, morphology, *Ranunculaceae*, variation.

INTRODUCTION

The genus *Batrachium* (DC.) S.F.Gray or *Ranunculus* L. subgenus *Batrachium* (DC.) A. Gray is one of the most complicated taxonomic groups of aquatic plants. The difficulties of identification according to morphological features arise mainly from extreme phenotypic plasticity, morphological reduction and frequent hybridization (COOK, 1966; WEBSTER, 1988; DAHLGREN, 1995). *Batrachium fluitans* (Lam.) Wimm. (*Ranunculus fluitans* Lam.) and *Batrachium penicillatum* Dumort. (*Ranunculus penicillatus* (Dumort.) Bab.) are typical plants of fast-flowing waters in Europe (COOK, 1966; TURALA, 1970; HOLMES, 1980; WIEGLEB, HERR, 1983; WEBSTER, 1988; DAHLGREN, JONSELL, 2001). These taxa and their communities are indicators of natural habitats of European importance (EUROPEAN COMMISSION, 2007) and also may be used for the water quality assessment (MEILINGER et al., 2005; HAURY et al., 2006;

BIRK, WILBY, 2010). *Batrachium penicillatum* s. l. is exceptionally taxonomically complex species. COOK (1966) proposed that the taxon called *Ranunculus penicillatus* is a complex of segmental amphidiploids that have arisen from hybrids of *B. fluitans* with *B. peltatum* Schrank, *B. trichophyllum* Chaix, and possibly *B. aquatie* L. He recognized three varieties: var. *penicillatus*, var. *calcareus* (Butcher) C.Cook and var. *vertumnus* C.Cook. After re-investigation of the varieties of *B. penicillatum* in Britain and Ireland, WEBSTER (1988) typified two subspecies: subsp. *penicillatus* having floating leaves and subsp. *pseudofluitans* (Syme) S.Webster, having only capillary leaves and comprised of two varieties, var. *pseudofluitans* (Syme) S.Webster and var. *vertumnus* C.Cook. The concept of two subspecies was accepted widely (DAHLGREN, 1993; DAHLGREN, JONSELL, 2001; TELFORD et al., 2011), however, the subspecies often are treated at species level (TZVELEV, 1998, 2012; BOBROV, 2003; LUMBRERAS et al., 2009).

Since the late 18th century only one species restricted to fast-flowing waters, i.e. *Batrachium fluitans*, was recorded in Lithuania (GILBERT, 1782; JUNDZILL, 1830; KUPREVIČIUS, 1934; MOWSZOWICZ, 1938, 1958; SNARSKIS, 1954; APALIA, LEKAVIČIUS, 1961; LEKAVIČIUS, 1989). After the revision of the herbaria material of East Baltic countries in 1977, the occurrence of this species was disclaimed. The results of this study were published considerably later with a remark that occurrence of *Batrachium fluitans* in the southern part of Lithuania is possible, however, not confirmed by herbarium specimens (LAASIMER et al., 1993). The occurrence of *Batrachium fluitans* and even *Batrachium pseudo-fluitans* in Lithuania were reported by TZVELEV, GRINTAL (2001), however, the actual distribution is still unknown.

After the publication of 'Flora of the Baltic Countries', a considerable herbarium material was collected from the rivers throughout the territory of Lithuania. This paper reports the results of the revision of available herbarium specimens of *Batrachium* from flowing waters in order to clarify the occurrence of *Batrachium fluitans* and *Batrachium penicillatum* s. l. and their distribution in the rivers of Lithuania. The identification of *Batrachium* species according to morphological features is the first step and the basis for more advanced studies.

MATERIALS AND METHODS

The collections of *Batrachium* specimens deposited at the Herbaria of Vilnius University (WI) and the Institute of Botany of the Nature Research Centre (BILAS) were revised together with those not deposited in the Herbaria. The specimens of *Batrachium circinatum* (Sibth.) Spach were reviewed and as clearly morphologically distinct were excluded from the further studies. Then, the specimens of mature (flowering or fruiting) plants were separated. A total of 130 herbarium sheets, not counting duplicates, were selected for the detailed studies. The selected specimens of *Batrachium* were checked using keys after COOK (1966), WEBSTER (1988), DAHLGREN, JONSELL (2001), BOBROV (2003), WEBSTER, RICH (1998). The specimens named *Batrachium aquatile* (L.) Dumort, *Batrachium trichophyllum* (Chaix) Bosch,

Batrachium fluitans, *Batrachium penicillatum* subsp. *penicillatum*, *Batrachium penicillatum* subsp. *pseudo-fluitans* were reviewed according to important morphological features, i.e. the occurrence of floating leaves, the number of furcations of capillary leaves, the length of terminal leaf segments, the length of petiole, hairiness of stipules, the length and number of petals, and hairiness of receptacle.

Detailed morphological descriptions are available in the mentioned references and only most important morphological features are given in the following text. The records of the herbarium labels are presented in almost original form.

Distribution is mapped applying a grid system of squares used at the Nature Research Centre, Institute of Botany (RAŠOMAVIČIUS, 2007). The determined and undetermined specimens of *Batrachium* were used for the genus distribution map. For the mapping of separate species, only voucher herbarium records were used. All localities from the same square were marked by one point.

RESULTS

The collection of *Batrachium* (BILAS) consists of 119 specimen sheets from the period of 1933–2009 and of 11 specimens in WI from the period of 1921–1993. The oldest specimens of *Batrachium* in WI were collected by W. Sławinski in 1921 and by J. Mowszowicz in 1923. The main collectors from the period of 1933–1977 in both herbaria were: P. Snarskis, M. Natkevičaitė-Ivanauskienė, A. Minkevičius, D. Apalia and A. Lekavičius. The collection of 38 specimens of riverine *Batrachium* from both herbaria was revised in 1977 by L. Laasimer and Ž. Lazdauskaitė. After the revision, the collection in BILAS has permanently been accessioned. The largest number of *Batrachium* specimens were collected in the period of 2005–2009, during the special investigations on *Batrachium* in 2006 and the studies on macrophytes at 200 monitoring sites set up throughout the country in different-sized rivers. Main collectors and determinators were L. Laurinavičiūtė and the second author of this paper.

The mapped localities of the determined and undetermined species of *Batrachium* (excluding *Batrachium circinatum*) from the rivers of Lithuania are

concentrated in the southeastern part of the country and quite scattered elsewhere (Fig. 1). The localities of sparse herbarium records from the first half of the 20th century are covered by localities from the period of 1980–2009.

The revision of the herbarium material confirmed the occurrence of two species of *Batrachium* restricted to fast-flowing waters, i. e. *B. fluitans* and *B. pseudofluitans*. Both are perennial submerged plants with submerged dissected leaves. In the revised material, *Batrachium fluitans* differs from *Batrachium pseudofluitans* by complete sterility, sparse hairy receptacle (Figs 2, 3) and a few times divided leaves (Table 1). Furthermore, the longest first row of the segments of capillary leaves, the significant difference in the length of petioles of lower and upper leaves on mature *B. fluitans* plants and the multinumerary of petals sometimes are helpful characters for the separation of this taxon (Table 1, Fig. 4).

The specimens of *Batrachium fluitans*, determined as *B. trichophyllus* in 1977, were re-identified (see

specimens 2, 3, 36, 48, 52). The main reason of misidentification may be the collecting of upper part of the plants with leaves clearly shorter than internodes.



Fig. 2. Receptacle of *Batrachium fluitans*

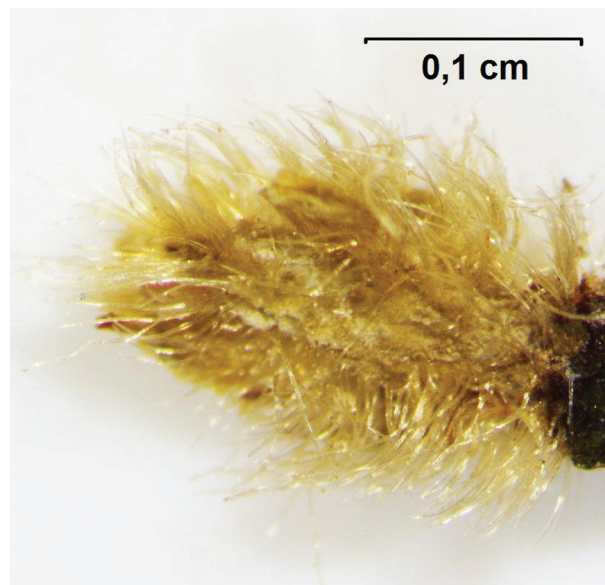


Fig. 3. Receptacle of *Batrachium pseudofluitans*

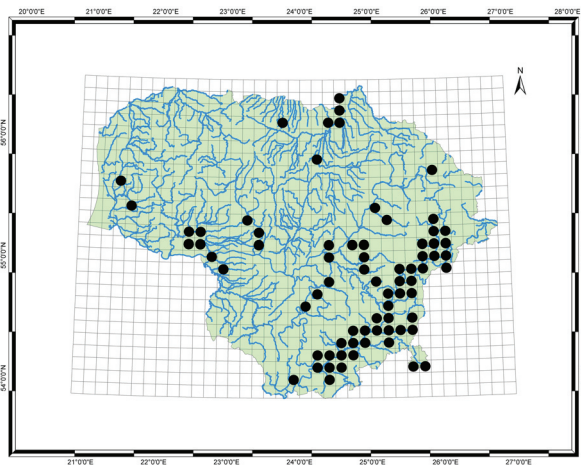


Fig. 1. Localities of *Batrachium* species in the rivers of Lithuania

Table 1. Comparison of the diagnostic characters of *B. fluitans* and *B. pseudofluitans*

Characters	<i>Batrachium fluitans</i>	<i>Batrachium pseudofluitans</i>
Receptacle	Sparse pubescent	Densely pubescent
Flowers	Often with > 5 petals and rarely double flowers occur	With 5 petals
Fertility	Sterile	Fertile
Capillary leaves	3–4(5) times divided, lower leaves exceeding, upper longer than, as long as, or shorter as corresponding internodes on mature plants	> (4)5 times divided, shorter than, equaling, or exceeding corresponding internodes on mature plants
Capillary segments	The longest are segments of the first row of furcation, end segments < 1 cm long	The length of leaves segments of different furcations almost equal; sometimes end segments are the longest
Length of stem	1–3 up to 6 m	1–3 m



Fig. 4. The lower (a) and upper (b) leaves of *Batrachium fluitans*

***Batrachium fluitans* (Lam.) Wimm. in Fl. Schles. 9, 1840.**

Kuprev. Vadovas 89, 1934; Mowszowicz, *Conceptus florae Vilnensis* 2: 25, 1958; Apalia et Lekav. in *Liet. fl.* 3: 409, 1961; Lekav. Vadovas 103, 1989. – *Ranunculus fluitans* Lam. in *Fl. Franç.* 3: 164, 1778; Snarskis, Vadovas 336, 1954; Snarskis, Vadovas 209, 1968; Laasimer et al. in *Fl. Baltic Countr.* 1: 284–289, 1993. – *Ranunculus peucedanifolius* sine auct. Gilib. in *Fl. Lith.* 5: 261, 1782; J. Jundziłł *Opis. roślin.* 219, 1830.

Variation. Mainly varies in length of the stems, leaves and internodes. Stems usually 2–3 m long, but can reach 6 m especially in larger fast-flowing rivers. Lower leaves usually very long with long petioles and exceeding corresponding internodes. In contrast, upper leaves are almost sitting and longer or as long as corresponding internodes at the beginning of the flower, but usually shorter than internodes to the end of the flower. The lower leaves usually 3–4 times divided, but the upper ones can have five and even six short (< 1 cm) furcations. As mentioned above, the number of petals varies from five to seven and rarely double flowers occur.

Habitat. Fast-flowing, small, medium-sized and large rivers (mean catchment area respectively < 100 km², 100–1000 km² and > 1000 km²) with sandy or gravelly bottom.

Distribution in Lithuania. Recorded from 53 localities, which are concentrated in the Rivers Neris, Žeimena, Šventoji and their tributaries of different size. Only in scattered locations found elsewhere (Fig. 5).

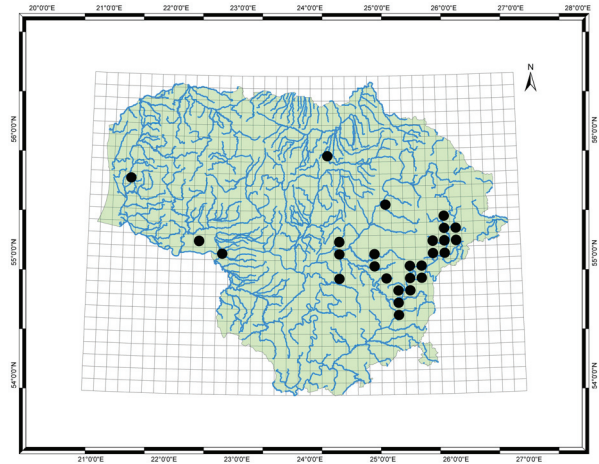


Fig. 5. Distribution of *Batrachium fluitans* in Lithuania

***Batrachium pseudofluitans* (Syme) Nym. 1878, *Consp. Fl. Eur.*, 16.**

TZVEL. in *Fl. Oriental.* 74, 1998; TZVEL. in 147, 2012; TZVEL., GRINT. in *Fl. Vost. Evr.* 170, 2001. – with notes about occurrence in Lithuania. No records in Lithuanian references.

Variation. Mainly varies in sizes. Most examined plants are slender, up to 2 m long. Relatively robust plants collected from the Rivers Santaka, Mera and Smardonė. The length of capillary leaves varies from exceeding to equalling or shorter than corresponding internodes on mature plants, but usually upper leaves are shorter on flowering plants. The lengths of leaves segments are almost equal, but sometimes the end segments are longest.

Specimens of completely sterile plants with moderate hairy receptacle and a few times dissected leaves (features intermediate between *B. fluitans* and *B. pseudofluitans*), collected in the River Merkys, were only preliminary attributed to *B. pseudofluitans*, but not included in the distribution map.

Habitat. Fast-flowing, small and medium-sized rivers (mean catchment area respectively < 100 km², 100–1000 km²) with sandy, gravelly and clay bottom.

Distribution in Lithuania. Recorded from 26 localities situated at the country's borders (Fig. 6). Most common in the upper reaches of the River

Merkys and its tributaries. It may be more widespread in the River Merkys, but, as mentioned above, doubtful specimens as well as specimens of plants in vegetative state were not included into the account. The basin of the Rivers Merkys and Gauja (south-eastern Lithuania) is the most important area of *Batrachium pseudofluitans* distribution. Other localities are sparse and usually confined to a single river.

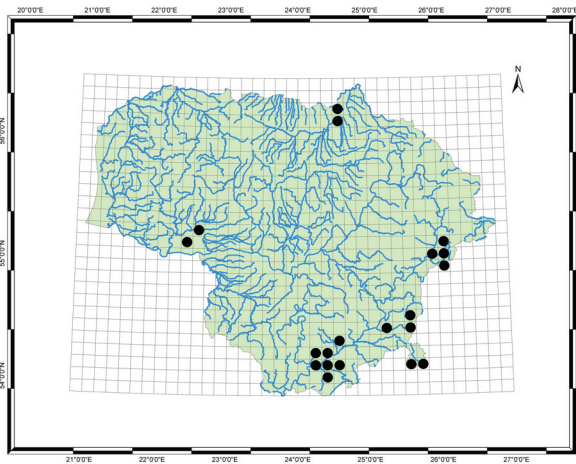


Fig. 6. Distribution of *Batrachium pseudofluitans* in Lithuania

DISCUSSION

Batrachium fluitans is one of the first water buttercups recorded for Lithuanian flora by GILBERT (1782) and J. JUNDZILL (1830) as *Ranunculus peucedanifolius* without exact locations. J. JUNDZILL (1830) called it “river buttercup” and described as a plant “caule natante; foliis omnibus submersis, di-trichotome repetuoto dissectis: laciniis longissimis, linearibus, parallelis; petalis calycem multo superantibus”. First locations in the rivers of Vilnius surroundings were reported by SLAWINSKI (1924) and MOWSZOWICZ (1938). After this, the species was treated as common throughout the country (KUPREVIČIUS, 1934; SNARSKIS, 1954, 1968; APALIA, LEKAVIČIUS, 1961; LEKAVIČIUS, 1989). The doubt concerning the occurrence of *Batrachium fluitans* in Lithuania was related mainly to insufficient herbarium material (LAASIMER et al., 1993) and morphological variation during the vegetation period. According to recent herbarium data, this species is most common in the River Neris basin and its largest (Žeimena, Šventoji) and small tributaries. *Batrachium*

fluitans may be or at least was more widespread in the largest River Nemunas (PIPINYS, 1961), but herbarium material is quite sparse from there as well as from the tributaries below the inflow of the River Neris. *Batrachium fluitans* in Lithuania reaches the north-eastern border of the distribution area – not recorded further north in Latvia, but occurs eastwards in Belarus (JALAS, SUOMINEN, 1989; SAUTKINA, 2007; TZVELEV, 2012). It may be that an important morphological feature, always sparsely hairy (not glabrous) receptacle of the material found in Lithuania and Sweden (DAHLGREN, JONSELL, 2001) is typical for the northern populations. Moreover, the plant sterility also may be related to the position at the northern edge of the distribution area.

From the group of *Batrachium penicillatum*, according to herbarium material, only plants without floating leaves, i.e. *Batrachium pseudofluitans*, occur in fast-flowing waters. Only specimens of fertile plants were restricted to this taxon and included into account. *Batrachium pseudofluitans* is less common than *Batrachium fluitans*. Most localities are concentrated in the River Merkys basin and with locations from the Rivers Mera and Gauja basins connect with the eastern part of distribution area in Belarus and Russia (JALAS, SUOMINEN, 1989; TZVELEV, GRINTAL, 2001; BOBROV, 2003; SAUTKINA, 2007). The northern population occurs in the rivers belonging to Mūša and Nemunėlis basin, covering part of the neighbouring territory of Latvia, where this taxon is also recorded (TZVELEV, 2012).

The localities of *Batrachium fluitans* and *Batrachium pseudofluitans* are quite isolated from each other, and, according to the analysed data, the species have not been recorded in the same river. The fertility and densely pubescent receptacle are the best features for the separation of *Batrachium pseudofluitans* from *Batrachium fluitans*, however, the characters of capillary leaves are overlapping. HOLMES (1980) noticed that *Batrachium fluitans* has four or less divisions of the capillary leaves compared with 7–8 in *Batrachium pseudofluitans*. However, she drew attention to flowering stems of *Batrachium fluitans* since these usually have more segmented leaves.

Based on morphological characters, the undetermined herbarium material enable to propose that the diversity of possible *Batrachium* hybrids has not been established yet and requires more advanced methods of investigations.

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BATRACHIUM (RANUNCULACEAE) LIETUVOS UPĖSE

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Santrauka

Kurklės (*Batrachium* (DC.) S.F. Gray) gentis, kuriai priklauso vienmečiai ir daugiamečiai vandens augalai, taksonominiu požiūriu yra viena iš sudėtingiausių žiedinių augalų grupių. Šios genties taksonomijos problemų kyla dėl ypač didelio augalų fenotipinio plastiškumo, poliploidijos ir hibridizacijos. Europa yra svarbiausias *Batrachium* genties rūšių įvairovės centras, tačiau įvairių regionų iširtumas labai skirtingas. Lietuva priklauso prie prasčiausiai šiuo požiūriu iširtų teritorijų, kur *Batrachium* genties rūšių įvairovė iki šiol nėra nustatyta. Pakartotinė upėse augančių kurklių analizė patvirtino,

kad Lietuvoje aptinkamos dvi rūšys: *Batrachium fluitans* ir *Batrachium pseudofluitans*. Lietuvos botaniniuose literatūros šaltiniuose *B. fluitans* minima nuo 18 amžiaus pabaigos. Nuorodų apie *B. pseudofluitans* Lietuvoje yra Rusijos mokslininkų darbuose. Straipsnyje pateikiami pagrindiniai šių rūšių skiriamieji morfologiniai požymiai ir paplitimo žemėlapiai. Kadangi ne visus pavyzdžius galima buvo apibūdinti pagal morfologinius požymius, galimai paplitusios hibridinės kilmės rūšys gali būti nustatytos naudojant šiuolaikinius taksonominių tyrimų metodus.

APPENDIX I

Examined specimens of *Batrachium fluitans* (Lam.) Wimm.

BILAS:

1. The River Nemunas in Viešvilė (Jurbarkas district), depth 0.5 m, not abundant, 27 June 2002; leg. et det. Z. Sinkevičienė. N 55° 03' 14.6", E 22° 35' 46.1". S. n.
2. The River Neris in Verkiai (Vilnius city), 18 June 1950; leg. et det. P. Snarskis, sub *B. trichophyllum*, 1977, rev. L. Laasimer. S. n.
3. The River Neris in Turniškės (Vilnius city), 13 June 1954; leg. S. Bieliukienė, det. R. Maziliauskaitė sub. *B. divaricatum*, sub. *B. aquatile*, 1960, rev. A. Lekavičius, sub. *R. peltatus*, 1977, rev. L. Laasimer. No. 67922.
4. The River Neris in Skersabalai (Vilnius district), 17 June 1990; leg. A. Lekavičius, 2012, det. J. Makavičiūtė. N 54° 51' 42.11", E 25° 33' 16.71". S. n.
5. The River Neris in Žvėrynas (Vilnius city), depth 0.1–0.2 m, gravel and silt, 19 July 1995; leg. Z. Sinkevičienė, 2006, det. L. Laurinavičiūtė. N 54° 41' 17.69", E 25° 15' 30.42". S. n.
6. The River Neris in Vingis Park, (Vilnius city), abundant, 19 July 1995; leg. et det. Z. Sinkevičienė. N 54° 41' 29.87", E 25° 14' 29.85". S. n.
7. The River Neris by Ožkiniai Island (Vilnius city), silt, abundant, 21 August 1995; leg. Z. Gudžinskas, 2012, det. J. Makavičiūtė. N 54° 45' 59.7", E 25° 21' 33.58". S. n.
8. The River Neris by „Achema“ (Jonava distr.), 16 June 1998; leg. A. Balevičius, det. Z. Sinkevičienė. N 55° 4' 7.29", E 24° 16' 43.4". S. n.
9. The River Neris, by Trinapolis (Vilnius city), 21 July 2006; leg. L. Laurinavičiūtė, 2014, det. J. Makavičiūtė. N 54° 43' 52.41", E 25° 17' 31.64". S. n.
10. The River Žeimena downstream of Pabradė (Švenčionys district), 1 July 1986; leg. et det. Z. Sinkevičienė. N 54° 58' 29.44", E 25° 45' 15.96". S. n.
11. The River Žeimena downstream of Pabradė (Švenčionys district), 19 June 2005; leg. Z. Sinkevičienė, 2012, det. J. Makavičiūtė. N 54° 58' 29.44", E 25° 45' 15.96". S. n.
12. The River Žeimena downstream of Pabradė (Švenčionys district), depth 0.1–0.5 m, abundant, associated with *Potamogeton x fenicus* and *Potamogeton x salicifolius*, 27 August 2008; leg. et det. Z. Sinkevičienė. N 54° 57' 37.8", E 25° 42' 27.3". S. n.
13. The River Žeimena upstream of Pabradė (Švenčionys district), 15 July 2006; leg. et det. L. Laurinavičiūtė. N 54° 59' 27.54", E 25° 47' 44.01". S. n.
14. The River Žeimena by Švenčionėliai Bridge (Švenčionys district), 22 June 1988; leg. et det. Z. Sinkevičienė. N 55° 10' 18.47", E 25° 59' 11.29". No. 71523.
15. The River Žeimena in Liūlinė (Švenčionys district), 25 August 2005; leg. et det. Z. Sinkevičienė. N 55° 05' 56.3", E 25° 56' 46.6". No. 71480.
16. The River Žeimena near Liūlinė (Švenčionys district), 13 July 2006; leg. et det. L. Laurinavičiūtė. N 55° 6' 3.07", E 25° 56' 53.07". No. 71510.
17. The River Žeimena downstream of Družiliai (Švenčionys district), depth 1 m, abundant, 25 July 2006, leg. et det. Z. Sinkevičienė. N 54° 55' 44.1", E 25° 38' 37.4". No. 71508.
18. The River Žeimena in Pažeimenė (Švenčionys district), depth 0.1–0.7 m, abundant, 27 July 2008; leg. et det. Z. Sinkevičienė. N 55° 01' 52.9", E 25° 51' 42.5". S. n.
19. The River Žeimena downstream of Jaunadariai (Švenčionys district), associated with *Potamogeton x fenicus* and *P. lucens*, depth 0.5–1.0 m, 17 August 2009; leg. et det. Z. Sinkevičienė. N 55° 04' 57.3", E 25° 55' 29.3". S. n.
20. The River Kiauna in Kūriniai (Švenčionys district), 13 July 2006; leg. et det. L. Laurinavičiūtė. N 55° 16' 6.1", E 25° 56' 15.92". No. 71515.
21. The River Kiauna upstream of Kūriniai bridge (Švenčionys district), 23 August 2007; leg. et det. Z. Sinkevičienė. N 55° 16' 07.2", E 25° 56' 14.1". S. n.
22. The River Kiauna in Kūriniai, upstream of the bridge (Švenčionys district), depth 0.5–1.0 m, abundant, 27 July 2008; leg. et det. Z. Sinkevičienė. N 55° 16' 07.2", E 25° 56' 14.1". S. n.
23. The River Kiauna in Žvirbliškė (Švenčionys district), 27 August 2007; leg. et det. Z. Sinkevičienė. N 55° 16' 33.69", E 25° 55' 17.74". S. n.
24. The River Lakaja near the confluence (Švenčionys district), 13 July 2006, leg. et det. L. Laurinavičiūtė. 55° 6' 38.27", 25° 56' 45.26".

No. 71521.

25. The River Lakaja, in Argirdiškė (Švenčionys district), depth 0.5 m, not abundant, 27 July 2008; leg. et det. Z. Sinkevičienė. N 55° 07' 46.5", E 25° 50' 26.2". S. n.

26. The River Peršokšna downstream of Januliškis (Švenčionys district), depth 0.1–0.2 m, not abundant, 26 July 2007; leg. et det. Z. Sinkevičienė. N 55° 09' 54.15", E 25° 50' 24.32". S. n.

27. The River Peršokšna downstream of Januliškis (Švenčionys district), 21 August 1984; leg. Z. Sinkevičienė, 2014, det. J. Makavičiūtė. N 55° 9' 59.14", E 25° 50' 15.28". S. n.

28. The River Vilnia in Markučiai (Vilnius city), 28 June 1989; leg. et det. Z. Sinkevičienė. N 54° 40' 58.0", E 25° 19' 24.37". S. n.

29. The River Vilnia near Belmontas (Vilnius city), 7 July 2006, leg. L. Laurinavičiūtė, 2014; det. J. Makavičiūtė. N 54° 41' 18.07", E 25° 21' 12.12". S. n.

30. The River Vilnia in Markučiai (Vilnius city), depth 0.2–0.5 m, abundant, 23 July 2007; leg. Z. Sinkevičienė, 2012, det. J. Makavičiūtė. N 54° 40' 29.92", E 25° 19' 19.5". S. n.

31. The River Vilnia downstream of Belmontas (Vilnius city), depth 0.0–0.5 m, abundant, 23 July 2007; leg. et det. Z. Sinkevičienė. N 54° 40' 58.0", E 25° 21' 03.6". S. n.

32. The River Vilnia downstream of Naujoji Vilnia (Vilnius city), depth 0.1–0.5 m, 23 July 2007; leg. et det. Z. Sinkevičienė. N 54° 41' 31.0", E 25° 22' 01.2". S. n.

33. The River Vokė by Vokė fish ponds (Vilnius city), abundant, depth 0.5 m, 29 July 2008; leg. Z. Sinkevičienė, 2012, det. J. Makavičiūtė. N 54° 37' 58.9", E 25° 07' 25.7". S. n.

34. The River Vokė in Naujakėmis (Vilnius city), depth 0.7 m, abundant, 29 July 2008; leg. et det. Z. Sinkevičienė. N 54° 36' 38.52", E 25° 8' 22.91". S. n.

35. The River Vokė upstream of the Pagiriai Bridge (Vilnius district), 54° 35' 2.28", 25° 12' 27.4", 15 August 2003; leg. Z. Sinkevičienė, 2012, det. J. Makavičiūtė. S. n.

36. The River Tenenys (Klaipėda district), 25 June 1933; leg. et det. P. Snarskis, sub. *B. trichophyllum*, 1977, rev. L. Laasimer. No. 27936.

37. The River Šventoji near the confluence (Jon-

ava district), not abundant, associated with *Potamogeton* sp., depth 0.05–0.1 m, 25 July 2006; leg. Z. Sinkevičienė, det. L. Laurinavičiūtė. N 55° 05' 39.3", E 24° 21' 12.9". S. n.

38. The River Viešvilė (Jurbarkas district), not abundant, 29 August 2002; leg. A. Uselienė; 2013, det. Z. Sinkevičienė. N 55° 03' 51.02", E 22° 21' 20.33". S. n.

39. The River Nevėžis in Varpučiai (Panevėžys district), 10 July 2008; leg. A. Balsevičius, det. Z. Sinkevičienė. N 55° 43' 31.08", E 24° 13' 31.06". S. n.

40. The River Virinta in Kurkliai (Anykščiai district), depth 0.3–0.5 m, abundant, 31 July 2007; leg. et det. Z. Sinkevičienė. N 55° 24' 16.4", E 25° 06' 19.1". S. n.

41. The River Strėva in Tadarava (Kaišiadorys district), depth 0.5 m, abundant, 17 August 2007; leg. et det. Z. Sinkevičienė. N 54° 48' 27.6", E 24° 16' 56.8". S. n.

42. The River Bražuolė downstream of the road Lazdėnai–Pugainiai (Trakai district), abundant, 2 August 2000; leg. et det. Z. Sinkevičienė. N 54° 45' 20.9", E 24° 57' 29.0". S. n.

43. The River Širvinta in Vindeikiai (Širvintai district), depth 0.2 m, abundant, 31 July 2007, leg. et det. Z. Sinkevičienė. N 54° 59' 12.8", E 24° 48' 18.2". S. n.

44. The River Bezdonė in Bezdonys (Vilnius district), 17 June 1992; leg. V. Rašomavičius, det. Z. Sinkevičienė. N 54° 48' 2.7", E 25° 30' 50.74". No. 71514.

45. The River Veržuva (Vilnius district), 23 June 1997; leg. V. Rašomavičius, 2006, det. L. Laurinavičiūtė. No. 71514.

46. The River Minija near Šernai (Klaipėda district), 16 July 1988; leg. Z. Sinkevičienė, det. L. Laurinavičiūtė. No. 71518.

47. The River Rudamina in Didžialaukis (Vilnius district), not abundant, 13 July 2009; leg. et det. Z. Sinkevičienė. N 54° 30' 52.68", E 25° 13' 33.26". S. n.

Herbarium WI:

48. The River Neris by Žalieji Ežerai, 6 June 1921; leg. et det. W. Slawinski, sub. *B. trichophyllum* 2007 rev. Ž. Lazdauskaitė. No. P11583.

49. The River Neris in Paneriai, 4 July 1923; leg. et det. J. Mowszowicz. No. P11589.

50. The River Neris in Nemenčinė, fast flowing water, 3 July 1993; leg. E. Nackyčė, det. Ž. Čvekienė. No. P11590.

51. The stream on the 13th km of the road Vilnius–Nemenčinė (Vilnius district), 12 June 1960; leg. et det. M. Natkevičaitė-Ivanauskienė, sub *B. trichophyllum*, 1977, rev. L. Laasimer. No. P11587.

52. The River Veršupis in Liepynė, 10 August 1959; leg. et det. M. Natkevičaitė-Ivanauskienė, sub *B. trichophyllum* 1977, rev. L. Laasimer. No. P11586.

53. The River Žeimena in Pabradė, 3 August 1954; leg. et det. M. Natkevičaitė-Ivanauskienė. No. P11588.

APPENDIX II

Examined specimens of *Batrachium pseudofluitans* (Syme) Nym.

Herbarium BILAS:

1. The River Tatula lower reaches (Pasvalys district), 10 August 1986; leg. Z. Sinkevičienė, 2006, det. L. Laurinavičiūtė. S. n.

2. The River Tatula in Raubonys (Pasvalys district), 21 July 1994; leg. Z. Sinkevičienė, 2006, det. L. Laurinavičiūtė. N 56° 7' 27.45", E 24° 28' 36.57". S. n.

3. The River Tatula in Juodeišiai (Biržai district), 21 July 1994; leg. Z. Sinkevičienė, 2006, det. L. Laurinavičiūtė. N 56° 9' 39.82", E 24° 33' 15.36". S. n.

4. The Stream Smardonė (Biržai district), 25 August 1998; leg. Z. Sinkevičienė, 2006, det. L. Laurinavičiūtė. S. n.

5. The River Mera in Zalavas (Švenčionys district), 1 July 1986; leg. Z. Sinkevičienė, 2006, det. L. Laurinavičiūtė. N 54° 57' 58.8", E 25° 58' 50.71". S. n.

6. The River Mera in Gužiai (Švenčionys district), 2 July 1986; leg. et det. Z. Sinkevičienė. N 55° 0' 3.18", E 25° 53' 21.27". S. n.

7. The River Santaka in Svirkiškės (Švenčionys district), 9 July 1988; leg. Z. Sinkevičienė, 2006, det. L. Laurinavičiūtė. N 54° 59' 27.61", E 25° 59' 49.82". S. n.

8. The straightened River Santaka in Svirkiškės

(Švenčionys district), depth 0.5–0.8 m, very abundant, 2 August 1997; leg. Z. Sinkevičienė, 2006, det. L. Laurinavičiūtė. N 54° 59' 27.61", E 25° 59' 49.82". S. n.

9. The River Viešvilė by the border of the Reserve (Jurbarkas district), depth 0.2–0.5 m, 4 July 2007; leg. L. Laurinavičiūtė, 2013, det. Z. Sinkevičienė. N 55° 5' 12.84", E 22° 24' 18.98". S. n.

10. The River Viešvilė between ponds (Jurbarkas district), depth 0.1 m, 4 July 2007; leg. L. Laurinavičiūtė, 2013, det. Z. Sinkevičienė. N 55° 4' 58.69", E 22° 23' 44.48". S. n.

11. The River Gauja downstream of the Verseka inflow (Šalčininkai district), depth 0.2–0.5 m, abundant, 1 August 2001; leg. et det. Z. Sinkevičienė. N 54° 10' 28.93", E 25° 41' 1.13". S. n.

12. The River Gauja in Girdžiūnai (Šalčininkai district), depth 0.5 m, abundant, 14 July 2009; leg. et det. Z. Sinkevičienė. N 54° 10' 22.02", E 25° 44' 36.06". S. n.

13. The River Merkys in Turgeliai (Šalčininkai district), depth 0.3–0.5 m, 14 July 2009; leg. et det. Z. Sinkevičienė. N 54° 26' 55.4", E 25° 30' 11.0". S. n.

14. The River Visinčia in Gudeliai (Šalčininkai district), 24 July 2007; leg. Z. Sinkevičienė, 2012, det. J. Makavičiūtė. N 54° 22' 13.67", E 25° 16' 18.1". S. n.

15. The River Grūda in Puvočiai (Varėna district), 1987; leg. O. Grigaitė, 2006, det. L. Laurinavičiūtė. N 54° 7' 9.17", E 24° 18' 17.08". S. n.

16. The River Grūda upstream of Puvočiai (Varėna district), 20 June 1995; leg. et det. Z. Sinkevičienė. N 54° 6' 58.59", E 24° 19' 11.49". S. n.

17. Varėna district, the lower reaches of the River Grūda in Puvočiai, 20 July 2006; leg. et det. L. Laurinavičiūtė. N 54° 7' 9.17", E 24° 18' 17.08". S. n.

18. The River Grūda upstream of Puvočiai (Varėna district), depth 0.5 m, abundant, 24 July 2008; leg. et det. Z. Sinkevičienė. N 54° 07' 06.3", E 24° 19' 23.0". S. n.

19. The River Skroblus in Margionys (Varėna district), 16 July 1983; leg. Z. Sinkevičienė, 2006, det. L. Laurinavičiūtė. N 54° 0' 14.47", E 24° 17' 20.01". S. n.

20. The River Skroblus upstream of Dubininkas (Varėna district), 23 June 1999; leg. Z. Sinkevičienė,

2006, det. L. Laurinavičiūtė. N 54° 5' 41.95", E 24° 17' 5.98". S. n.

21. The River Skroblus in Kapiniškės (Varėna district), 20 July 2006; leg. et det. L. Laurinavičiūtė. N 54° 2' 11.13", N 24° 17' 55.9". S. n.

22. The River Ūla in Žiūrai (Varėna district), 17 June 1995; leg. J. Balevičienė, 2006, det. L. Laurinavičiūtė. N 54° 8' 37.05", E 24° 24' 11.61". S. n.

23. The River Ūla upstream of Zervynos (Varėna district), 18 June 1995; leg. Z. Sinkevičienė, 2006, det. L. Laurinavičiūtė. 54° 6' 33.8", 24° 29' 49.75".

S. n.

24. The River Ūla by the spring „Ūlos akis“ (Varėna district), 20 July 2006; leg. et det. L. Laurinavičiūtė. N 54° 8' 31.05", E 24° 26' 21.64". S. n.

25. The River Derežna downstream of Mergežeris (Varėna district), depth 0.5 m, abundant, 20 July 2007; leg. et det. Z. Sinkevičienė. N 54° 11' 44.0", E 24° 29' 41.0". S. n.

Herbarium WI:

26. Stream Stangė in Merkinė (Varėna district), 2 July 1975; leg. et det. R. Gimžauskas sub. *B. fluitans*. No. P13620.