

Diversity of aquatic vegetation (*Lemnetea* O. de Bolòs et Masclans, *Potamogetonetea* Klika in Klika et Novák 1941) in the Russian Federation

Laura Kipryanova^{*1,2}, and Victor Chepinoga¹, and Sergey Rosbakh^{1,3}

¹Central Siberian Botanical Garden SB RAS, 630090, Novosibirsk, Russia

²Institute of Aquatic and Environmental Problems SB RAS, 656038, Barnaul, Russia

³Ecology and Conservation Biology Institute of Plant Sciences, Faculty of Biology and Preclinical Medicine, University of Regensburg, D-93040, Regensburg, Germany

Abstract. In a frame of the project “Vegetation classification of Russia”, we have compiled the prodromus of two classes of aquatic vegetation, i.e. *Lemnetea* O. de Bolòs et Masclans 1955 and *Potamogetonetea* Klika in Klika et Novák. The diversity of *Lemnetea* in the Russian Federation consists of 15 associations belonging to 3 alliances and one order. Diversity of *Potamogetonetea* is presented by 56 associations from 5 alliances and two orders. The presented version of the prodromus is a preliminary. We count all valid syntaxa revealed from the territory of the Russian Federation. The final prodromus will be obtained after the numerical data processing and considering the plurality of syntaxonomic decisions.

The project “Vegetation classification of Russia” launched in 2020 aims to inventory the plant community diversity of the Russian Federation and elaborate the entire classification of its vegetation [1]. At the first stage, it is necessary to collect all available information already known about the vegetation diversity of the target territory. For this purpose, we have compiled the prodromus of aquatic vegetation revealed in the Russian Federation. This paper presents the complete hierarchy of validly published syntaxa belonging to classes *Lemnetea* O. de Bolòs et Masclans 1955 and *Potamogetonetea* Klika in Klika et Novák.

Material and methods

We follow the ecological-floristic approach of phytosociology, also known as the Braun-Blanquet approach [2, 3], whose nomenclature is regulating by the International Code of Phytosociological Nomenclature [4]. At the highest levels of hierarchy, we follow the nomenclature of the EuroVegChecklist [5]. The nomenclature of association names was checked after the contemporary phytosociological literature. For the last purpose, the monograph on the aquatic and wetland vegetation of the Czech Republic [6] was especially

* Corresponding author: kipryanova@mail.ru

useful. Assignment of plant communities to the concrete association was conducted following such criteria as dominancy, physiognomy, and belonging to a particular functional group of aquatic plants [6, 7].

For a compilation of the prodromus, we took into account the results of numerous regional phytosociological studies carried out throughout the Russian Federation [8, 9, 10, 11, 12, 13, 14, 15, 16, 17, etc.].

Despite the practice by some Russian phytosociologists to use the shorter form of syntaxa names derived from the genus *Potamogeton* (*Potametea*, *Potametalia*, *Potamion*), we agree with arguments by authors of the EuroVegChecklist [5], while applying the full name of the genus (i.e. *Potamogetonetea*, *Potamogetonetalia*, *Potamogetonion*).

Results and Discussion

Although aquatic plant communities have a simple structure, many points complicate their classification: i.e. general floristic poverty, ecological and morphological plasticity of aquatic and wetland plants, insufficient taxonomic knowledge in some groups of plants, various concomitant species by the same dominant in different environmental conditions [18]. Besides that, there are various association concepts for species-poor vegetation: i.e. broad associations (synthetic concept), one dominant species – one association (pragmatic concept), and narrowly defined associations (splitting concept) [7, 19]. Additionally, it is not evident if to treat stands of interspecific hybrids as distinct associations?

According to the EuroVegChecklist [5], *Potamogetonetea* is split into two orders *Potamogetonetalia* Koch 1926 and *Callitricho hamulatae–Ranunculetalia aquatilis* Passarge ex Theurillat in Theurillat et al. 2015. The third order *Zannichellietalia pedicellatae* Schaminée, Lanjouw et Schipper ex Mucina et Theurillat ined. distinguished by some Russian phytosociologists, was synonymized with *Ruppietalia* J. Tx. ex Den Hartog et Segal 1964 within *Ruppietea maritimae* J. Tx. ex Den Hartog et Segal 1964.

Communities of *Callitriche palustris* and *Callitriche cophocarpa* described as the associations *Lemno-Callitrichetum palustris* Bobrov et Chemeris 2006 and *Batrachio trichophylli–Callitrichetum cophocarpae* Soó (1927) 1960 respectively, are often incorporated into *Ranunculion aquatilis* alliance (*Potamogetonetea*) [10, 15]. However, the mentioned species prefer shallow waters and shoals. Therefore, we consider these community types have to be placed into the class *Littorelletea uniflorae* Br.-Bl. et Tüxen ex Westhoff et al. 1946.

Below, we present the prodromus of *Lemnetea* and *Potamogetonetea* registered on the territory of the Russian Federation.

LEM *Lemnetea* O. de Bolòs et Masclans 1955

Free-floating duckweed vegetation (incl. pleistophytes (free-floating) and hydatophytes (submerged)) of still and relatively nutrient-rich freshwater bodies of the Holarctic

LEM-01 *Lemnetalia minoris* O. de Bolòs et Masclans 1955

Vegetation of free-floating vegetation of still and relatively nutrient-rich freshwater bodies of temperate Europe and Asia

LEM-01A *Lemnion minoris* O. de Bolòs et Masclans 1955

Vegetation of free-floating duckweed vegetation (angiosperms (Lemnaceae), aquatic ferns and liverworts) of still and relatively nutrient-rich freshwater bodies of temperate Eurasia

LEM-01A01 *Lemnetum trisulcae* den Hartog 1963;

LEM-01A02 *Lemnetum minoris* von Soó 1927;

LEM-01A03 *Lemnetum minori–turioniferae* (Woff et Jentsch 1992) Passarge 1996;

LEM-01A04 *Lemno-Spirodeletum polyrhizae* Koch 1954;

LEM-01A05 *Lemnetum gibbae* Miyawaki et J. Tuxen 1960;

LEM-01A06 *Salvinio natantis–Spirodeletum polyrhizae* Slavnić 1956;
LEM-01A07 *Lemno minoris–Ricciatum fluitantis* Šumberová et Chytrý in Chytrý 2011;
LEM-01A08 *Ricciocarpetum natantis* Tüxen 1974;
LEM-01A09 *Lemno gibbae–Wolffietum arrhizae* Slavnić 1956.

LEM-01B *Utricularion vulgaris* Passarge 1964

Vegetation of free-floating bladderworts in mesotrophic and eutrophic waters of Europe and North Asia

LEM-01B01 *Lemno-Utricularietum vulgaris* Soó 1947;

LEM-01B02 *Utricularietum macrorrhizae* Chepinoga et Rosbakh 2012.

LEM-01C *Stratiotion* Den Hartog et Segal 1964

Vegetation of large free-floating macrophytes in relatively nutrient-rich shallow waters of Europe and North Asia

LEM-01C01 *Ceratophylletum demersi* Corillion 1957;

LEM-01C02 *Hydrocharitetum morsus-ranae* van Langendonck 1935;

LEM-01C03 *Potamogetono–Ceratophylletum submersi* Pop 1962;

LEM-01C04 *Stratiotion aloidis* Miljan 1933.

POT *Potamogetonetea* Klika in Klika et Novák 1941

Vegetation of rooted macrophytes with floating, submerged or towering above the water leaves of stagnant mesotrophic, eutrophic and brackish freshwater bodies and slowly flowing shallow streams of Eurasia

POT-01 *Potamogetonetalia* Koch 1926

Vegetation of rooted floating or submerged macrophytes of mesotrophic and eutrophic freshwater bodies with a more or less constant water level of Eurasia

POT-01A *Potamogetonion* Libbert 1931

Vegetation of rooted submerged floating macrophytes of freshwater bodies at low and mid-altitudes of temperate Eurasia

POT-01A01 *Charo asperae–Potamogetonetum filiformis* Spence 1964;

POT-01A02 *Elodeetum canadensis* Nedelcu 1967;

POT-01A03 *Hydrilletum verticillatae* Tomaszewicz 1979;

POT-01A04 *Lemno trisulcae–Sparganietum graminei* Chepinoga et al. 2013;

POT-01A05 *Myriophylletum sibirici* Taran 1998;

POT-01A06 *Myriophylletum verticillati* Gaudet ex Šumberová in Chytrý 2011;

POT-01A07 *Myriophyllo spicati–Potamogetonetum compressi* Chepinoga et al. 2013;

POT-01A08 *Myriophyllo verticillati–Hippuridetum vulgaris* Julve et Cateau 2008

POT-01A09 *Najadetum minoris* Ubrizsy 1961 nom. cons. prop.;

POT-01A10 *Potamogetonetum acutifolii* Segal ex Šumberová et Hrivnák in Chytrý 2011;

POT-01A11 *Potamogetonetum berchtoldii* Krasovskaja 1959;

POT-01A12 *Potamogetonetum crispum* von Soó 1927;

POT-01A13 *Potamogetonetum crispum-obtusifolii* Sauer 1937;

POT-01A14 *Potamogetonetum graminei* Lang 1967;

POT-01A15 *Potamogetonetum lucentis* Hueck 1931;

POT-01A16 *Potamogetonetum maackiani* Chepinoga et al. 2013;

POT-01A17 *Potamogetonetum pectinati* Carstensen ex Hilbig 1971;

POT-01A18 *Potamogetonetum perfoliati* Miljan 1933;

POT-01A19 *Potamogetonetum praelongi* Hild 1959;

POT-01A20 *Potamogetonetum pusilli* von Soó 1927;

POT-01A21 *Potamogetonetum tenuifolii* Kipriyanova et Lashchinsky 2000;

POT-01A22 *Potamogetonetum trichoidis* Tx. 1974;

POT-01A23 *Potamogetonetum vaginati* Chepinoga et al. 2013;

POT-01A24 *Potamogetono–Ceratophylletum demersi* (Hild et Rehnelt 1965) Passarge 1995;

POT-01A25 *Potamogetono pectinati–Myriophylletum spicati* Rivas Goday 1964;
POT-01A26 *Ranunculo circinati–Potamogetonetum friesii* Weber-Oldecop 1977;
POT-01A27 *Sparganio minimi–Utricularietum intermediae* Tüxen 1937.

POT-01B *Nymphaeion albae* Oberd. 1957

Vegetation of rooted floating-leaf macrophytes of sheltered nutrient-rich freshwaters of Eurasia

POT-01B01 *Brasienio schreberi–Nymphaeetum tetragonae* Okuda in Miyawaki 1983;
POT-01B02 *Lemno trisulcae–Sagittarietum natantis* Taran et Tyurin 2006;
POT-01B03 *Nupharetum pumilae* Miljan 1958;
POT-01B04 *Nymphaeetum albae* Vollmar 1947;
POT-01B05 *Nymphaeetum candidae* Miljan 1958;
POT-01B06 *Nymphaeetum tetragonae* Ito et Umezawa 1970;
POT-01B07 *Nymphaeo–Nupharetum luteae* Nowiński 1927;
POT-01B08 *Nymphoidetum peltatae* Bellot 1951;
POT-01B09 *Potamogetonetum natantis* Hild 1959;
POT-01B10 *Potamogeto natantis–Polygonetum natantis* Knapp et Stoffers 1962;
POT-01B11 *Potamogetono–Nupharetum* Th. Müller et Görs 1960;
POT-01B12 *Scirpo lacustris–Nupharetum luteae* Kipriyanova 2008;
POT-01B13 *Trapetum natantis* Kárpáti 1963.

POT-01C *Salvinio–Nelumbion* Golub et Lifirenko 2015

Vegetation of rooted floating or towering above the water leaves macrophytes of sheltered nutrient-rich freshwater bodies of southeastern Europe and Asia

POT-01C01 *Salvinio–Nelumbetum nuciferae* Golub et Lifirenko 2015

POT-02 *Callitricho hamulatae–Ranunculetalia aquatilis* Passarge ex Theurillat in Theurillat et al. 2015

Vegetation of crosswort, crowfoot and milfoil rooted macrophytes in shallow and intermittent freshwater streams and ephemeral water bodies of Europe and North Asia. Plant communities assigned to this ordo are growing in conditions of frequent and significant fluctuations of water level. The presence or absence of water currency determines the division of the ordo into two alliances: *Batrachion fluitantis* and *Ranunculion aquatilis*, respectively.

POT-02A *Batrachion fluitantis* Neuhäusl 1959

Vegetation of crowfoot and milfoil rooted macrophytes and rheophilous forms of helophytes (e.g. *Butomus umbellatus* f. *vallisneriifolius*, *Sparganium emersum* f. *emersum*) in shallow moving freshwaters of Eurasia [e.g. 10, 20, etc.].

POT-02A01 *Batrachio kauffmannii–Sparganietum emersi* Bobrov 2001

POT-02A02 *Fontinali antipyreticae–Scirpetum lacustris* Kipriyanova 2008

POT-02A03 *Fontinali–Batrachietum kauffmannii* Bobrov 2001;

POT-02A04 *Hottonietum palustris* Tx. ex Roll 1940;

POT-02A05 *Potamogetonetum bottnici* Chepinoga et al. 2013;

POT-02A06 *Potamogetonetum meinshausenii* Bobrov 2001;

POT-02A07 *Potamogetonetum nitentis* W. Koch 1926;

POT-02A08 *Potamogetonetum salicifolii* Chepinoga et al. 2013;

POT-02A09 *Potamogetonetum zizii* Černohous et Husák 1986.

POT-02B *Ranunculion aquatilis* Passarge ex Theurillat in Theurillat et al. 2015

Vegetation of crosswort rooted macrophytes in shallow, stagnant freshwaters with unstable water level

POT-02B01 *Batrachietum rionii* Hejný et Husák in Dykyjová et Květ 1978;

POT-02B02 *Callitrichetum hermaphroditicae* Černohous et Husák 1986;

POT-02B03 *Potamogetono crispi–Ranunculetum trichophylli* Imchenetzky 1926;

POT-02B04 *Potamogetono perfoliati–Ranunculetum circinati* Sauer 1937;

POT-02B05 *Ranunculetum aquatilis* Géhu 1961;

POT-02B06 *Zannichellietum palustris* Nordhagen 1954.

As the first approximation, we do not adhere strictly to any association concepts noted above; we instead count all valid syntaxa revealed on the territory of the Russian Federation. The solution, which association concept should be applied, will be made later, after the numerical data processing and considering the plurality of syntaxonomic decisions [21]. Ecological peculiarities of plant communities, the presence of stable combinations of diagnostic taxa, and their vicariant combinations in longitudinal sectors of Northern Eurasia will also be considered. The presented version of the prodromus is a preliminary view of *Lemnetea* and *Potamogetonetea* diversity within the vast territory of the Russian Federation. We appreciate any additions and comments from the readers.

The research was carried out in the framework of projects AAAA-A21-121011290026-9 of the Central Siberian Botanical Garden SB RAS and 121031200178-8 of the Institute of Aquatic and Environmental Problems SB RAS supported by the Russian Federal Budget.

References

1. Yu. V. Plugatar., N. B. Ermakov, P. V. Krestov, N. V. Matveyeva, V. B. Martynenko, V. B. Golub, V. Yu. Neshataeva, V. Yu. Neshataev, O. A. Anenkhonov, I. A. Lavrinenko, O. V. Lavrinenko., V. V. Chepinoga., N. V. Sinelnikova, O. V. Morozova., E. A. Belonovskaya., A. A. Tishkov, T. V. Chernenkova, I.V. Krivobokov, M. Yu. Telyatnikov., E. D. Lapshina, V. G. Onipchenko, N. E. Koroleva, M. M. Cherosov, Yu. A. Semenishchenkov., L. M. Abramova., T. M. Lysenko, M. A. Polyakova, *Vegetation of Russia* **38** (2020)
2. J. Braun-Blanquet, *Pflanzensoziologie. Grundzuge der Vegetationskunde* **3** (Aufl. Wien. New York, 1964)
3. V. Westhoff, E. van der Maarel, *The Braun-Blanquet approach* (R. H. Whittaker (ed.)), in *Classification of plant communities* (The Hague, 1978)
4. J. P. Theurillat, W. Willner, F. F. González, H. Bültmann, A. Čarni, D. Gigante, L. Mucina, H. Weber et al., *Appl. Veg. Science*, **24** (2021)
5. L. Mucina, H. Bültmann, K. Dierßen, J.-P. Theurillat, T. Raus, A. Čarni, K. Šumberová, W. Willner, J. Dengler, R. Gavilán García, M. Chytrý, M. Hájek, R. Di. Pietro, D. Iakushenko, J. Pallas, F. J. A. Daniëls, E. Bergmeier, A. Santos Guerra, N. Ermakov, M. Valachovič, J. H. J. Schaminée, T. Lysenko, Y. P. Didukh, S. Pignatti, J. S. Rodwell, J. Capelo, H. E. Weber, A. Solomeshch, P. Dimopoulos, C. Aguiar, S. M. Hennekens, L. Tichý, *Appl. Veg. Science*, **19** (1) (2016)
6. *Vegetace České republiky. 3. Vodní a mokřadní vegetace* (Praha, 2011)
7. F. Landucci, L. Tichý, K. Šumberová, M. Chytrý. *J. Veg. Sci.*, **26** (2015)
8. V. B. Golub, G. A. Losev, B. M. Mirkin, *Phytocoenologia*, **10** (1991)
9. K. O. Korotkov, O. V. Morozova, E. A. Belonovskaya, *The USSR vegetation syntaxa prodromus* (Moscow. 1991)
10. A. A. Bobrov, E. V. Chemeris, *Syntaxonomic overview of plant communities of streams, small and medium rivers of the Upper Volga Region*, in *Proceedings of the VI-th all-Russian workshop-conference on aquatic macrophytes «Hydrobotany 2005» Borok, 11–16 October 2005* (2006)
11. G. S. Taran, *Ras. Ross.*, **12** (2008)
12. L. M. Kipriyanova, *Ras. Ross.*, **22** (2013)

13. L. M. Kipriyanova, Aquatic and semiaquatic vegetation of the southeast of Western Siberia: syntaxonomy and ecological-geographical distribution patterns (Yalta, 2019)
14. B. Yu. Teteryuk, *Syntaxonomical overview of vegetation of water bodies of the Vychegda river Basin (European north-east of Russia)*, in Proceedings of the Komi Science Centre of the Ural Division of the Russian Academy of Sciences, **1** (29) (2017)
15. S. M. Yamalov, V. B. Martynenko, L. M. Abramova, V. B. Golub, E. Z. Baisheva, A. V. Bayanov, Prodrumus of plant communities of the Republic of Bashkortostan (Ufa, AN RB, Gilem, 2012)
16. V. V. Chepinoga, Flora and vegetation of waterbodies in Baikal Siberia (Irkutsk, 2015)
17. P. A. Gogoleva, M. M. Cherosov, S. I. Mironova, E. I. Burtseva, N. P. Sleptsova, B. N. Pestryakov, P. I. Kharlampiev, L. D. Gavriljeva, S. I. Poiseeva, N. B. Ermakov, M. Yu. Telyatnikov, E. I. Troeva, E. G. Nikolin, V. A. Filippova, Prodrumus of plant communities of the Republic of Sakha (Yakutsk, NEFU Publishing House, 2017)
18. A. A. Bobrov, E. V. Chemeris, *Problems of ecological-floristic classification of aquatic and semiaquatic vegetation in Russia*. In Hydrobotany 2015: materials of the VIII all-Russian. conf. with int. participation in aquatic macrophytes, 16–20 October 2015, Borok (2015)
19. V. V. Chepinoga, E. Bergmeier, S. A. Rosbakh, K. M. Fleckenstein, *Phytocoenologia*, **43**, 1-2 (2013)
20. A. A. Bobrov, *Bull. of the Moscow Society of Naturalists. Dept. biol.*, **106**, 1 (2001)
21. B. M. Mirkin. *J. Veg. Sci.*, **5** (1994)