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

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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

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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 Chipper 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–Riccietum fluantis* Šumberová et Chytrý in Chytrý 2011;
LEM-01A08 *Riccio-carpetum 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 macrorhizae* 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** *Stratiotetum aloidis* Miljan 1933.

**POT**

*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-01**

*Potamogetonetalia* Libbert 1931

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

**POT-01A**

*Charo asperae–Potamogetonetum filiformis* Spence 1964;

**POT-01A01**

*Elodeetum canadensis* Nedelcu 1967;

**POT-01A02**

*Hydrilletum verticillatae* Tomaszewicz 1979;

**POT-01A03**

*Potamogetonetum acutifolii* Segal ex Šumberová et Hrivnák in Chytrý 2011;

**POT-01A04**

*Potamogetonetum berchtoldii* Krasovskaja 1959;

**POT-01A05**

*Potamogetonetum crispi* von Soó 1927;

**POT-01A06**

*Potamogetonetum crispobtusifolii* Sauer 1937;

**POT-01A07**

*Potamogetonetum graminei* Lang 1967;

**POT-01A08**

*Potamogetonetum lucents* Hueck 1931;

**POT-01A09**

*Potamogetonetum maackiani* Cheminoga et al. 2013;

**POT-01A10**

*Potamogetonetum maackianum* Chepinoga et al. 2013;

**POT-01A11**

*Potamogetonetum pectinatum* Carstensen ex Hilbig 1971;

**POT-01A12**

*Potamogetonetum perfoliati* Miljan 1933;

**POT-01A13**

*Potamogetonetum praelongi* Hild 1959;

**POT-01A14**

*Potamogetonetum pusilli* von Soó 1927;

**POT-01A15**

*Potamogetonetum tenuifolii* Kipriyanova et Lashchinsky 2000;

**POT-01A16**

*Potamogetonetum trichoidis* Tx. 1974;

**POT-01A17**

*Potamogetonetum vaginati* Chepinoga et al. 2013;

**POT-01A18**

*Potamogetonoceratophylletum 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 Brasenio 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 Nymphaetum albae Vollmar 1947;  
POT-01B05 Nymphaeatetum candidae Miljan 1958;  
POT-01B06 Nymphaetum 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. vallisnerifolius, 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 zizi 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 cirriniti Sauer 1937;
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 **Lemnetaea** and **Potamogetonetea** diversity within the vast territory of the Russian Federation. We appreciate any additions and comments from the readers.

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