Botanica Pacifica. A journal of plant science and conservation. 2023. 12(1): 3–20
DOI: 10.17581/bp.2023.12106

REVIEW PAPER

Carici arctisibiricae–Hylocomietea alaskani – a new class of zonal tundra vegetation

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Manuscript received: 20.11.2022
Review completed: 26.12.2022
Accepted for publication: 10.01.2023
Published online: 14.01.2023

ABSTRACT

A new class, *Carici arctisibiricae–Hylocomietea alaskani* **class nov.** is described for vegetation of the tundra zone on a circumpolar scale. This higher unit in the system of Braun-Blanquet floristic (= floristic-sociological) classification unites the zonal vegetation in the intermediate habitats with respect to the substrate moisture, pH and texture, the snow cover thickness and duration, the depth of seasonal frozen ground thawing, and the growing season length on the interfluves (upland surfaces) within the tundra zone (CAVM subzones B, C, D, E = arctic, typical and southern tundra subzones in Russian zonal subdivision). Communities of the class are distributed on plains north of the tree line on two continents (Eurasia and North America), as well as on the archipelagos (Spitsbergen, Novaya Zemlya, New Siberian Islands, the Canadian Arctic Archipelago) and the large and small islands (Kolguev, Dolgy, Vaygach, Bely, Bolshoy Begichev, Ayon, Wrangel, Greenland) in the Arctic Ocean. The class comprises 3 new orders and 6 alliances. The diagnoses of higher rank units are given. Difficulties in describing and classifying zonal communities due to the specificity of their species composition and horizontal and vertical structure are discussed. The criteria distinguishing the new class from the known ones in the Europe and Asia mountains, in which zonal tundra communities are being placed until now, are presented.

Keywords: Arctic, tundra zone, arctic, typical and southern tundra subzones in Russian zonal subdivision, CAVM, zonal vegetation, syntaxonomy, Braun-Blanquet approach

РЕЗЮМЕ

Матвеева Н.В., Лавриненко О.В. *Carici arctisibiricae–Hylocomietea alaskani* – новый класс зональной тундровой растительности. Для растительности тундровой зоны описан новый класс *Carici arctisibiricae–Hylocomietea alaskani* **class nov.** с циркумполярным распространением. Эта высшая единица в системе флористической (=флористико-социологической) классификации Браун-Бланке объединяет зональную растительность на слабо наклоненных поверхностях водоразделов в местообитаних со средними параметрами среды (увлажнение, кислотность и механический состав субстрата, мощность и длительность снежного покрова, глубина сезонного протаивания многолетнемерзлых пород протяженность вегетационного периода) в тундровой зоне (подзоны B, C, D, E в CAVM = арктические, типичные и южные подзоны тундры в зональном делении в России). Сообщества класса распространены на равнинах севернее границы леса на двух континентах (Евразия и Северная Америка), а также на архипелагах (Шпицберген, Новая Земля, Новосибирские острова, Канадский Арктический архипелаг) и больших и малых островах (Колгуев, Долгий, Вайгач, Белый, Большой Бегичев, Айон, Врангеля, Гренландия) в Северном Ледовитом океане. В классе описано 3 порядка и 6 союзов. Для всех высших синтаксонов приведены диагнозы. Обсуждаются трудности классификации зональной растительности, обусловленные особенностями флористического состава, горизонтальной и вертикальной структуры сообществ. Определены критерии, отличающие новый класс от других, в которые зональные тундровые сообщества помещали ранее.

Ключевые слова: Арктика, зона тундры, подзоны арктических, типичных и южных тундр в зональном делении в России, CAVM, зональная растительность, синтаксономия, подход Браун-Бланке

Two natural zones, the polar deserts and the tundra, are distinguished within the Arctic on the schemes of zonal subdivision in Russia (Gorodkov 1935, Aleksandrova 1971, 1979, 1983, 1988, Chernov & Matveyeva 1997, Matveyeva 1998), which on the Circumpolar Arctic Vegetation Map (CAVM) correspond to 5 subzones nominated by letters of the Latin alphabet – A, B, C, D, E (CAVM Team 2003, Walker et al. 2005, 2018, Raynolds et al. 2019).

For polar deserts, the northernmost of the natural zones, the class *Drabo corymbosae–Papaveretea dahliani* Daniëls, Elvebakk et Matveyeva in Daniëls et al. 2016 with the order *Saxifrago oppositifoliae–Papaveretalia dahliani* Daniëls, Elvebakk et Matveyeva in Daniëls et al. 2016 and the alliance *Papaverion dahliani* Hofmann ex Daniëls, Elvebakk et Matveyeva in Daniëls et al. 2016 was relatively recently proposed in the Braun-Blanquet floristic (= floristic-sociological) classification (Daniëls et al. 2016). This is a long-awaited event, since the long-term practice of classifying the zonal vegetation of the extreme natural zone within the class *Thlaspietea rotundifolii* Br.-Bl. 1948 (which unites vegetation in the scree habitats and on pebble alluvia) based mainly on the plant cover sparseness, could hardly be accepted as justified. The reasons for such peculiar horizontal structure of communities of this class are fundamentally different from those of the polar desert ones.

Similarly, the positioning of zonal tundra communities within the framework of this classification in 6 classes (see below) cannot be considered reasonable. In many publications, communities in zonal sites are left outside the units of higher ranks (class/order), sometimes alliances are proposed. The subject of this article is to argue the need to establish a new class for zonal tundra vegetation within the Braun-Blanquet classification and to describe its characteristics and hierarchy with units of lower ranks.

IMPORTANT CHARACTERISTICS OF THE TUNDRA ENVIRONMENT

The tundra zone (= CAVM subzones B, C, D, E) occupies plain areas north of the tree line on a vast territory of the circumpolar Arctic with continuous thick (hundreds meters) permanent frozen grounds. The mid-July temperature ranges from 10(12)ºC close to the forest-tundra ecotone up to 2–3ºC at the border with polar deserts (= CAVM subzone A).

Longitudinaly the tundra zone extends from the Kola Peninsula in the west to the Bering Strait in the east on the Eurasian continent and north of the Brooks Range in Alaska and in the northern Canada on the North American mainland. Fragmentary tundra landscapes exist on huge archipelagos (Spitsbergen, Novaya Zemlya, New Siberian Islands, Canadian Arctic Archipelago) and on the large (Wrangel, Greenland) and small (Kolguev, Dolgy, Vaygach, Bely, Bolshoy Begichev, Ayon) islands in the Arctic Ocean. The width in the latitudinal direction varies in different sectors: from few tens (70–80 km) to several hundred kilometers, with maximum (about 900 km) on Taymyr Peninsula. The lowest latitudinal limit of the southern tundra boundary is on 55ºN in Hudson Bay in Canada and on the 70–72ºN on Taymyr Peninsula in Russia; the northernmost border is on 77ºN (Chelyuskin Peninsula on Taymyr Peninsula, Russia).

CLASSIFICATION OF THE TUNDRA ZONE VEGETATION (A BRIEF HISTORY)

The vegetation of various regions within the tundra zone is described in different systems: the Braun-Blanquet classification, the Scandinavian school, the dominant system in the USSR/Russia. Over time, the most widely used became the first one (Braun-Blanquet), last but not least, due to the availability of information from the published relevés and the logical hierarchical system with the rules for names of syntaxa of all levels fixed already in the 4th version of the "International Code of Phytosociological Nomenclature" (Theurillat et al. 2021, hereinafter ICPN).

In the Arctic, following the Braun-Blanquet approach, European researchers have been working since the first half of the 20th century, primarily in West Spitsbergen Isl. (Svalbard) (Hadač 1946, 1989, Røning 1965, Hoffman 1968, Hartman 1980, Elvebakk 1985, 1994, Möller 2000, etc.), then in Greenland (Molenaar 1974, 1976, Daniëls 1975, 1982, 1994, 2013), Canadian Arctic (Thannheiser 1976, 1987, Kojima 1991, 1999, 2006, Vohnlanthen et al. 2008, etc.), and in Alaska (Walker et al. 1994, Kade et al. 2005).

On the territory of the Russia, where the study of tundra vegetation dates back to the second third of the 19th century (first in the Russian Empire, then in the Soviet Union), this approach was adopted and began actively developing after 1992, when the first International Meeting on the Classification and Mapping of Arctic Vegetation took place in Boulder, Colorado (USA). The first publications on the vegetation classification of the Russian Arctic according to the Braun-Blanquet approach appeared in 1993 (Zanokha 1993) and 1994 (Koroleva 1994, Matveyeva 1994, Razzhivin 1994, Sumina 1994). Much information has been accumulated on syntaxa of zonal vegetation from different provinces of the Russian Arctic – Kanin–Pechora and Polar Ural – New Zemlya (Lavrinenko & Lavrinenko 2018), Yamal–Gydan (Telyatnikov & Pristyazhnyuk 2012, Telyatnikov et al. 2019a, 2019b), Taymyr Peninsula (Matveyeva 1994, 1998, Zanokha 2001, Lapina & Lavrinenko 2023), Anabar–Olenyek (Telyatnikov et al. 2013), Yana–Kolyma (Telyatnikov et al. 2014, 2015), Wrangel Isl. (Sekretareva 1998, Kholod 2007), West, East and South Chukotka (Sinelnikova 2001, 2009).

From that moment, all northern phytosociologists began to work as a single international team, setting two main tasks: to prepare 1) a unified classification and 2) a map of circumpolar vegetation. The second task was successfully completed in 2003: a vector map was done on scale of 1 : 4 000 000 (CAVM Team 2003, Walker et al. 2005), also printed on paper where the tundra vegetation are shown on several maps reflecting zonation (with 4 units – subzones B, C, D, E) and provincial subdivision with 23 provinces; the raster version was prepared in 2019 (Raynolds et al. 2019). In the legend to the vector version the mapping units were given (with rare exceptions) as a short word description of the community general appearance and the elements of their horizontal structure, as well as dominant species sets. The legend of the raster version includes the most important syntaxonomic units of the Braun-Blanquet system (Walker et al. 2018).

WHY DO WE NEED A NEW CLASS FOR THE ZONAL TUNDRA VEGETATION

The problem for syntaxonomists working in the Arctic, not least of all, is that all higher syntaxa (including for communities on loamy soils in zonal sites) of class and order ranks and the majority of alliances, are taken from European vegetation classification (usually mountainous, less often plain). Only recently a similar situation has been corrected for the polar deserts (see above), but for the tundra zone the problem is still urgent.

The communities in the zonal sites within the tundra zone were positioned usually in the class *Loiseleurio procumbentis–Vaccinietea* Eggler ex Schubert 1960 (scrub and acidophilous dwarf-shrub heaths), less often in the *Carici rupestris–Kobresietea bellardii* Ohba 1974 (dwarf-shrub and small-herb heaths on base-rich substrates), sometimes in the *Salicetea herbaceae* Br.-Bl. 1948 (snowbed vegetation) and *Oxycocco–Sphagnetea* Br.-Bl. et Tx. ex Westhoff et al. 1946 (dwarf-shrub, sedge and peat-moss vegetation of ombrotrophic bogs), very rare (without trying to justify and comment) in the *Scheuchzerio palustris–Caricetea nigrae* Tx. 1937 nom. (sedge-moss vegetation of fens, mires and bog hollows), and *Juncetea trifidi* Hadač in Klika et Hadač 1994 (alpine acidophilous grasslands).

Even from the brief word characteristics of the first two classes in the original papers, where these were described (Eggler 1952, Ohba 1974), it is obvious that they unite not zonal, but intrazonal (mountain) vegetation. The first class includes low shrub and dwarf-shrub–lichen alpine and subalpine heathlands with dominance of arctic-alpine and hypoarctic dwarf-shrubs (*Arctous alpina*, *Empetrum hermaphroditum*, *Loiseleuria procumbens*, *Salix nummularia*, *Vaccinium myrtillus*, *V. vitis-idaea*, *V. uliginosum*) sometimes with *Betula nana* small abundance, on slightly acidic soil of light texture in the north European mountains. The second class embraces dwarf-shrub and small-grass(sedge) heaths dominated by dwarf-shrubs (*Dryas octopetala/punctata* (the so-called dryad tundras), *Cassiope tetragona*) and xerophilous sedges (*Carex misandra*, *C. rupestris*) on snow-poor or snowless wind-blown gravelly/sandy substrates, predominantly basic rocks, in the alpine and subalpine belts of the Europe and Asia mountains.

Throughout the circumpolar territory communities on upland surfaces are primarily moss ones, in which the well developed (projective cover from 50–70 to 100 %) thick (up to 5–7 cm) layer of mesophilic mosses is a biotic habitat, which determines the conditions for the existing and development of all other community components, especially vascular plants. That is why within the Soviet/Russian dominant system (Andreev 1932, Bogdanowskaya-Guihéneuf 1938, Smirnova 1938, Dedov 2006 [1940]) the communities with multi-species moss cover (continuous or fragmented by bare ground patches) on gentle moraine slopes in the north-east European Russia were attributed to the moss vegetation type that reflects their physiognomy and horizontal structure, distinguishing these from the communities of the two classes discussed above.

Working in the north of West Spitsbergen Isl. in the arctic tundra subzone (= CAVM subzone B), Hartmann (1980) intended to put communities with well-developed moss layer and dwarf willow *Salix polaris* in a scarce “shrub” layer almost not rising above mosses, in special order (with possible name – *Salicetalia polaris* or *Salicetalia polaris-arcticae*) explaining that it is this structural feature (moss layer) is the reason to propose such unit (however in the lack of an appropriate higher unit – within the class *Carici rupestris–Kobresietea bellardii*).

In the practice of the Russian syntaxonomists, the situation is so far common when deciding to assign an association to a known class, the authors emphasize that they perforced to do this in the absence of an adequate unit of higher rank. For example, communities on the Wrangel Isl. (arctic tundra subzone = CAVM subzone B) are placed in the class *Loiseleurio procumbentis–Vaccinietea*, with note that there are no a single character class species (Kholod 2007). Analogous situation is in Alaska: zonal vegetation of the ass. *Sphagno–Eriophoretum vaginati* Walker M., Walker D., Auerbach 1994 on mesic acidic slopes throughout the Arctic Foothills was assigned within the class *Oxycocco–Sphagnetea* (Walker et al. 1994), while later (Kade et al. 2005) it was moved into the class *Loiseleurio–Vaccinietea*, which is the opposite to the first one in all environment features.

For the circumpolar Arctic, the establishment of new higher units of vegetation, other than known from the mountainous and alpine regions of Europe, is as relevant as ever. As data from plain tundra territories are being accumulated, their absence leads to syntaxonomic chaos, which we wrote about, proposing this class provisionally (Lavrinenko et al. 2016, 2017, Matveyeva 2016, Matveyeva & Lavrinenko 2021). The assignment of zonal communities to the above classes not only makes their boundaries unclear, but also confuses the entire syntaxonomy of Arctic vegetation. Perhaps the time will come when northern phytosociologists will find it useful to describe as well also new classes of intrazonal communities. In this article, this is done only for zonal one.

PROBLEMS OF DESCRIPTION OF ZONAL TUNDRA COMMUNITIES AND THEIR CLASSIFICATION

It is difficult to describe and problematic to classify zonal tundra communities due to the specificity of their species composition and structure.

Composition

The high community species richness (high α-diversity). Communities in zonal sites are the richest in species number in the whole biotope spectrum due to their best correspondence to macroclimate. In addition, the presence of various ecological niches provided by the complicated horizontal structure allows co-habitation of great amount of species, among which cryptogams (bryophytes and lichens) prevail both in species number and cover/abundance. The total number of species in some zonal communities of the ass. *Carici arctisibiricae–Hylocomietum alaskani* Matveyeva 1994 on the Taymyr Peninsula – 57–115 (Matveyeva 1994), the ass. *Carici lugentis–Hylocomietum alaskani* Sekretareva ex Kholod 2007 on the Wrangel Isl. – 61–86 (Sekretareva 1998), the ass. *Dryado octopetalae–Hylocomietum splendentis* Andreev 1932 in the East European tundra – 45–96 (Lavrinenko & Lavrinenko 2018). However, subject to a very careful analysis in different subzones on the Taymyr Peninsula the total number of species in the communities of the ass. *Carici arctisibiricae–Hylocomietum alaskani* is 110–182 per 100 m^2. Important is not only the high values of α-diversity, but also the density of species distribution: there are 129 species per 100 m^2, up to 40–50 species per 1 m^2, and up to 25 species per 100 cm^2 within a stand of the this association in the mid subzone (Matveyeva 1998, 2009).

It should be kept in mind, since the cryptogams are not very easy to not only determine but also even to find on a sample plot, there is a high probability of incomplete establishment of species number in a standard relevé. This may be the reason for a large number of species with low constancy in association, the total number of which is almost twice that of a community. The extensive work experience at long-term field stations (on the Taymyr Peninsula) showed that on permanent sample plots, where the species composition was identified very carefully, during the whole and often more than one growing season, all species listed in the association (in 10 or more stands) were present (Matveyeva 1994, 1998, 2009).

All zonal tundra communities are oligodominant. There are always several co-dominants (herbs and dwarf-shrubs (sometimes, low shrubs), mosses, and (infrequent) macrolichens) with similar (15–20 %) projective cover in each layer. This makes it difficult to give a preference to a particular species, when choosing a name-giving taxon for a syntaxon.

The width of the species habitat range. Just for communities in zonal sites common is the co-habitation of species, which not only outside the Arctic (in both boreal lowlands and mountains) but also in its latitudinal subzones occur in different, even contrast, biotopes. Among others, this concerns the species selected as character of various classes in the Braun-Blanquet classification. Only 4 examples of this matter – *Salix polaris* (*Salicetea herbaceae*), *Dryas octopetala/punctata* (*Carici–Kobresietea*), *Eriophorum vaginatum* (*Oxycocco–Sphagnetea*), *Betula nana* (*Loiseleurio–Vaccinietea*), which all four grow together on a sample plot in stands of the zonal ass. *Carici arctisibiricae–Hylocomietum alaskani*.

The dwarf willow *Salix polaris*, an arctic-alpine (meta-arctic) species, is the most remarkable example how the species distribution in the landscape and its occurence in the communities radically change on the latitudinal gradient: in the southern tundra subzone (= CAVM subzone E) it is a species rare in landscape which occur only on snowbeds, being reasonably a character species of the class *Salicetea herbaceae*; in both stripes of the typical tundra subzone (= CAVM subzones D and C) it is common on snowbeds and not abundant but constant in zonal communities; in the arctic tundra subzone (= CAVM subzone B) it is the most active species in landscape: not just constant but abundant in the wide range of habitats, including communities in zonal sites; in the polar deserts (= CAVM subzone A) it locally occurs in the warmest habitats during short growing season which are snow-poor or snow-less in winters.

The optimum habitats of the arctic-alpine **dwarf-shrubs *Dryas octopetala* and *D. punctata*** both in the south and the north of the tundra zone (CAVM subzones E, B) are gravel/sandy grounds at the outcrops of basic rocks snow-poor or snow-less in winter, those are ecotopes character of dwarf-shrub heaths of the class *Carici–Kobresietea*. In the mid of the tundra zone (CAVM subzones C, D) these species populate nearly all habitats from snow free tops down to snowbeds and mires, being ones of the co-dominants in the dwarf-shrub–herb layer in zonal communities with well-developed moss layer, as well as on the rims in rim-polygonal mires. Hence, it is hardly logical only because of the presence of the dryads to attribute such communities to this class how it was done in the tundra of European North (Koroleva & Kulyugina 2015).

In the boreal zone, **cotton grass *Eriophorum vaginatum*** (arctoboreal species) is a common component of the raised bogs with well-developed continuous peat horizon (the class *Oxycocco–Sphagnetea*). In the southern tundra subzone (CAVM = subzone D) of the Asian (Taymyr Peninsula, East Siberia, Chukotka) and North American (Alaska) Arctic, large areas on the interfluves with heavy loams are occupied by tussock stands dominated by this species. The ass. *Sphagno–Eriophoretum vaginati* was originally attributed to the named class, mainly due to the presence of some sphagnum species, but later (Kade et al. 2005) it was moved in the *Loiseleurio–Vaccinietea*, which is also not a good decision (see above). This cotton grass, although with low abundance, is constantly present on patches of bare ground (!) in zonal frost-boil communities of the ass. *Carici arctisibiricae–Hylocomietum alaskani* on medium and even light loam soils. Both these associations have many common species including mesophilic mosses. However, in the same tundra subzone in the European North (Kolguev Isl., Bolshezemelskaya and Malozemelskaya tundras) tussock cotton grass communities with continuous sphagnum cover on peaty-gley soils (peat layer 10–15 cm) are located in ecotones between zonal communities on loams and raised peat bogs (Lavrinenko et al. 2016, 2022). The cotton grass roots penetrate through peat to mineral horison, i. e., unlike in raised bogs, this species indicates the proximity of loams. The position of such communities, with no common species of communities in zonal sites but with character species of the class *Oxycocco–Sphagnetea* is in this bog class.

Low shrub *Betula nana*, a classic hypoarctic species, inhabiting raised bogs in the taiga zone; northwards in the forest-tundra and in the south of the tundra zone (= CAVM subzone E) is one of the most active species, growing with high abundance in a wide range of community types, including zonal ones; it is more or less abundant in shallow stream valleys in the southern stripe of the typical tundra subzone (= CAVM subzone D) and very rare in its northern stripe (= CAVM subzone C); its absence in the very north of the tundra zone is the most important criterion for identifying the arctic tundra subzone (= CAVM subzone B).

The problem of the character and differential species establishment

The fact that many species (including selected as diagnostic for the current higher units of the Braun-Blanquet classification) have the same constancy and abundance in associations of several classes is the reason for the deficiency of not only character, but also differential species of syntaxa. In the Arctic not only species with low abundance but also dominants occur in a wide range of habitats: the known phenomenon of superdominance (Chernov 1978, Matveyeva & Chernov 1978, Chernov & Matveyeva 1979). That is why here the lack of diagnostic syntaxa at all levels of the classification hierarchy makes the concept of character species (the key stone of the Braun-Blanquet approach) more vulnerable than in temperate regions.

The quite understandable skepticism about the possibilities of using character species is partly might be overcome if we accept their division into following gradations: faithful (exclusive, absolute), which are almost absent in the Arctic; selective – present in many syntaxa, but with the highest constancy in one; preferential – with similar constancy, but the most abundant in one; opulent – in addition to the latter with the best vitality (see: Braun-Blanquet 1932, Becking 1957, Barkman 1958, 1991, Molenaar 1976, Westhoff &

van der Maarel 1978, Daniëls 1982). For tundra scholars, various life forms of the same species (for example, shrub and dwarf-shrub forms of arctic willows) and even growth forms (creping or erect, tall or low shrubs of *Betula nana*) can be an equally important diagnostic feature. However, even such interpretation of character species is not always sufficient. Useful is the establishment of diagnostic species (character, differential, and some constant companions), together forming character species combination (Van der Maarel, 1975), but it helps for syntaxon characteristics but not in their distinguishing. Hence, in new class syntaxonomy we followed the concept of differential combination of taxa which as such (all taxa together) is specific for one syntaxon although each taxon separately may not be such, first suggested by Beeftink (1965). It was successfully used in the Arctic (Molenaar 1976, Matveyeva 2006, Lavrinenko & Lavrinenko 2018), and is employed here (d. c. t.) in syntaxon distinctiveness.

Taxonomy of character species of the class and units of lower ranks

A problem associated with some taxa selected as character/differential, including syntaxon name-giving ones, is the uncertainty of their taxonomy. These are, first of all, three vascular plant aggregate species and one moss. In the epithets of the names of new class and units of lower ranks (up to association), the species/subspecies names of the main co-dominants of two layers of the classified communities are sedges *Carex bigelowii* (*ensifolia*) subsp. *arctisibirica*/*lugens*, dwarf-shrubs *Dryas octopetala*/*punctata*/*integrifolia*, low shrubs *Betula nana*/*exilis*/*tundrarum* in dwarf-shrub–sedge layer and *Hylocominum splendens* var. *alaskanum* in moss one.

Throughout the discussion of their systematic status, the names and rank of these taxa have been changed repeatedly, and there is still no consensus on this matter. As for vascular plants, taking into account the multivolume proceeding "Arctic flora of the USSR" (Tolmachev et al. 1960–1987) [hereinafter AF], we are more guided by the Internet version of "Annotated checklist of the Panarctic Flora" (Elven et al. 2011) [hereinafter PAF], as for the most recent collective international work. Information on the status of moss *H. splendens* var. *alaskanum* is taken from various publications, links to which are given in the appropriate positions below. Leaving outside the discussion all the problems of their taxonomy, we consider only few key points that are important for understanding how to assess the differentiation of communities with these taxa on longitudinal/latitudinal gradients aiming to classify them at the order/alliance/association levels within new class.

Sedge *Carex bigelowii* Torr.

Carex bigelowii Torr. is represented in PAF as "...*Carex bigelowii* s. lat. is a polymorphic and widespread arctic-alpine complex. At least 11 names for species or subspecies have been in comparatively recent use for northern taxa ..." (PAF: online): *bigelowii* Torr. 1824 and *hyperborea* Drejer 1841 in North America and Greenland; *bigelowii*, *rigida* Gooden. 1794 in Europe; *bigelowii*, *rigida*, *ensifolia* Gorodkov 1930, *rigidioides* Gorodkov 1930, *soczavaeana* Gorodkov 1930 and *arctisibirica* Jurtz. 1965 in Russia (Siberia); *lugens* Holm 1900 in Beringia. One of the outcomes of the discussion on the complexity of this taxon taxonomy reads as follows: "... There has been no thorough circumpolar taxonomic revision of the *C. bigelowii* group. Published studies are more or less regional..." (PAF: online). Involvement of molecular research data did not solve the problem either. In PAF the decision has chosen follows the main results from the molecular investigations but without taking the nomenclatural consequences yet. Provisionally, for the Arctic is proposed one species – [3309084] *Carex bigelowii* with three subspecies: [3309084a] subsp. *bigelowii* (North American–amphi-Atlantic), [3309084b] subsp. *rigida* (Gooden.) W. Schultze-Motel (Amphi-Atlantic–European), and [3609081c] subsp. *ensifolia* (Turcz. ex Ledeb.) (European–Asian–amphi-Beringian) – whereas other taxa proposed from the Beringian regions are commented on under subsp. *ensifolia*. In the course of working with the text of PAF that unfortunately have never been published, which made it possible change it repeatedly, even in online version year 2011 there was an important for our species uncertainty situation the continuation of the previous sentence (let us bring it here) – "and three taxa (of subspecies rank) are listed with no number of sequential numbering: subsp. *lugens* (Holm.) T.V. Egorova s. str., subsp. *arctisibirica* (Jurtz.) Á. Löve & D. Löve, subsp. *rigidioides* (Gorodkov) T. V. Egorova, as well as taxon *soczavaeana* (Gorodkov)".

The molecular data suggest that the plants under the names "*arctisibirica*", "*lugens*", "*consimilis*", and probably also "*ensifolia*", "*rigidioides*", and "*soczavaeana*", should be merged within one subspecies of *C. bigelowii*. The priority name of this taxon at level of subspecies would be either subsp. *ensifolia* or subsp. *rigidioides* (both Gorodkov 1930: 182). We have provisionally chosen the name subsp. *ensifolia*" (PAF: online).

The names *Carex ensifolia* subsp. *arctisibirica* (or *C. arctisibirica*) on the Taymyr Peninsula and *C. lugens* east of the Olenek river are used in papers on the classification of zonal communities in the Asian part of the Arctic. In the field geobotanists distinguish these by the growth form: the first, a plant with long creeping rhizomes, is common in the communities of the ass. *Carici arctisibiricae–Hylocomietum alaskani*; the second, a dense-caespitose plant without creeping rhizomes or more or less loose-caespitose with short scarcely distinct creeping rhizomes, is common in the communities of the ass. *Carici lugentis–Hylocomietum alaskani*; both form sparse (15–20 %) herb layer.

According to many European taxonomists, "*C. bigelowii* subsp. *bigelowii* does not occur in Europe at all" (PAF: online), and the note that "…Subspecies *arctisibirica* was recently confirmed from Svalbard (Spitsbergen), with good help from Egorova. The Spitsbergen plants closely resemble those from Novaya Zemlya and Taymyr" (PAF: online) gives reason to perceive them as one unit with the Eurasian taxon *C. bigelowii* subsp. *arctisibirica* which is used in current geobotanical papers for the European North.

Based on the hitherto systematic uncertainty, we suggest accepting epithets *arctisibirica* and *lugens* (in PAF as one subspecies of *C. bigelowii*), already used in papers as *Carex ensifolia* subsp. *arctisibirica* and *C. lugens* in the Asian part, as *Carex bigelowii* subsp. *arctisibirica* in the European one.

Genus *Dryas* L.

There were two main approaches to the taxonomy of the small but widespread (and in the Arctic ecologically important) genus *Dryas*. Within one (hereafter named as Russian) up to 9 species were distinguished, while within the other (Hultén approach) fully accepted were only three species and some subspecies. Both approaches existed and developed in parallel, and the authors of PAF did not come to a consensus. What everyone agreed on was that throughout the circumpolar space hybridization between many taxa was and so far is very active. As a result in PAF for the entire Arctic 8 species are proposed, of which the following 3 are present in papers with zonal community relevés: [640801] *Dryas octopetala* L. – Amphi-Atlantic?–European–Asian; [640803] *D. punctata* Juz. – European–Asian–amphi-Beringian–Cordilleran; [600806] *D. integrifolia* Vahl – Amphi-Beringian–North American. The situation with the first two (both cited as independent species and as subspecies of the first species) is not too obvious.

Yurtsev (AF) "…assigned all arctic material of *D. octopetala* from eastern Greenland east to northwestern Siberia to subsp. *subincisa*. For the Atlantic regions, he specifically mentioned Greenland, Svalbard, northern Scandinavia... The molecular and phylogeographic results … could be used to support Yurtsev's proposal of two taxa at some rank but not with the ranges and morphological characters reported by him... If races are accepted, subsp. *octopetala* occurs as arctic in Iceland, mainland Norway, and in the Murman area in northwestern European Russia, whereas subsp. *subincisa* occurs in Svalbard, northeastern European Russia, northwestern and north-central Siberia, and perhaps very locally in northern Norway (and probably in the northernmost parts of the Murman area)" (PAF: online).

In syntaxonomic papers the names *D. octopetala* and *D. octopetala* subsp. *subincisa* are present in the zonal community relevés in Eurasia and *D. octopetala* var. *octopetala*, although rarely, in Alaska (Walker et al. 1994).

Dryas punctata with the subspecies [640803a] *punctata* and [640803b] *alaskensis* (A.E. Porsild) Jurtz., according to Yurtsev (AF), has an almost circumpolar distribution range. American researchers expressed doubt that *D. punctata* s. str. occurs on the American side, stating "... the recognition of *D. punctata* from non-Russian areas is based exclusively on presence of some punctate glands, i.e., one character ... We therefore restrict its range to the Urals, Siberia, and Chukotka", which is entering into some contradiction with a statement that "Sporadic occurrence of rather typical specimens of the taxon in Svalbard and eastern Greenland does not permit us to exclude these areas from the range of this species .... Neither it is possible to exclude Alaska and the Yukon Territory from the range of this taxon..." (PAF: online). This position does not well agree with the fact that in the Russian Arctic systematics record typical subspecies within the range from the Kola Peninsula to Chukotka. According to Yurtsev's data (AF), both *D. punctata* subsp. *punctata* and *D. octopetala* subsp. *subincisa* and their hybrid, *Dryas* × *vagans*, are found in the European North.

As it is impossible to guarantee that phytosociologists can easily distinguish these taxa, it is not reasonable the presence of one or another taxon in relevés be considered a sufficient reason for the differentiation of syntaxa of association and subassociation levels.

Dryas integrifolia with the subspecies [640806a] *integrifolia* and [640806b] *sylvatica* (Hultén) Hultén are Amphi-Beringian–North American species. Despite different interpretations and understanding of taxon circumscription as well as inter species hybridization, the typical form of subsp. *integrifolia* is recognized by all PAF authors, while Yurtsev did not accept the second subspecies. In papers on vegetation in Alaska, where the species occurs in a wide range of conditions, including zonal, the name *D. integrifolia* is used, without specifying the subspecies status.

As a result, in the names of the new class syntaxa, most appropriate would be the use of three species: *Dryas integrifolia*, *D. octopetala* and *D. punctata*, as name-giving taxa, without giving differential syntaxonomic significance to two latter.

Genus *Betula* L.

As highlighted in the PAF, there has been no critical taxonomic review of this genus for the entire Arctic. We consider only shrub forms, which throughout the circumpolar space grow in different communities, including zonal ones. Two widespread taxa have been proposed as subspecies of [610212] *B. nana* L. – [610212a] *B. nana* subsp. *nana* – Amphi-Atlantic–European–Asian and [610212c] *B. nana* subsp. *exilis* (Sukaczev) Hultén – Asian–amphi-Beringian–North American. In the papers of Russian geobotanists, the names are used in species rank – *B. nana* and *B. exilis* Sukaczev, while of American ones the second is given in subspecies rank. Disputable taxon *B. nana* subsp. *tundrarum* (Perfil.) Á. Löve & D. Löve, shortly recognized on the territory of the Russian Arctic as an independent species *B. tundrarum* Perfil., is left in PAF as [400211b] *Betula nana* var. *tundrarum* (Perfil.) Elven comb. et stat. nov. recorded in West Spitsbergen Isl. but it was not noted in zonal community relevés.

Genus *Hylocomium* Br., Sch. et Gmb.

Dominanting moss in zonal communities in the tundra zone is the taxon *Hylocomium splendens* (Hedw.) Bruch et al. var. *alaskanum* (Lesq. et James) Limpr., widely distributed in the circumpolar Arctic. Its identification and systematic status were being discussed by many bryologists for a long time, and it was considered both as a species (*H. alaskanum*) and as a subspecies or a variety.

Originally (1880) described as species *Hypnum alaskanum* (Lesq. et James) Austin (= *Hylocomium alaskanum* Lindb.), later it was most often considered as a variety of the forest moss *Hylocomium splendens* with vast range, mostly in the Northern Hemisphere but also in South America, Australia, and New Zealand. In the forest zone this species is slightly variable, but in northern and high-mountain conditions there are populations with a specific growth form due to which they are regarded as the species (see above) or as a variety (*H. splendens* var. *obtusifolium* (Geh.) Paris, *H. splendens* var. *alaskanum*). A.J. Grout (1932), citing *H. alaskanum*, stipulates that it is better to consider it as an arctic subspecies of *H. splendens*, while W. Steere (1978), after many years of research in the Arctic, came to the conclusion that this taxon is an ecological form of the latter.

The obvious differences in their growth form are as follows: in *splendens* s. str. annually formed "floors" are expressed due to the sympodial growth; stem twice or thrice pinnately branching; stem leaves with a retracted tip; in var. *alaskanum* “floors” are not expressed, stem once-twice pinnately branching; stem leaves with more or less blunt tip (Abramova et al. 1961, Ignatov et al. 2006, 2019).

The intensive discussions on the systematical status of two distinctive growth forms became even a reason for experiments with the tundra *H. splendens* var. *alaskanum* in other climatic conditions. In the middle of the XX century, when in 1949 the living moss tufts, brought by B.A. Tikhomirov from Taymyr Peninsula (by request of bryologists), during a year were cultivated in the greenhouse of the Komarov Botanical Institute of the Academy of Sciences of the USSR (Leningrad), the differences turned out to be not stable enough. This allowed the researchers, who made such an experiment, to make a conclusion that it is still a variety of forest species, when discussing the problem of the species in bryology, including examples of Arctic populations (Savich-Lyubitskaya & Smirnova 1958). However, half a century later experiments on plant transplantation (Ross et al. 2001) showed that even after 14 years of cultivation of forest populations of the discussed taxon in tundra and vice versa, transplants did not show the same variation in growth form as shoots in natural populations and certain such differences are remained, what after the authors suggests that populations are genetically differentiated with respect to growth form.

The issue was never resolved, no one was going to look at the entire range, and no one found these occurring together in some ecotone strip, on the border of forest and tundra (Ignatov et al. 2019). The decision on the systematic status of the discussed taxa is out of our aimes and profession. For us, as phytosociologists studying the tundra plant cover and trying to classify its diversity, important is that these modifications are responsible for quite different cover: the loose sparse vertically standing tall (up to 15–20 cm in height) stems for the first and dense closed thick (up to 5 cm) layer of lying stems for the second. There is rather strong demarcation approximately at the tree line of these two taxon latitudinal distributions in zonal sites in the Eurasia and North America plains. North of this border only var. *alaskanum* is common in zonal tundra commubnities being the main dominatnt in moss cover. This is very important to keep in mind when the name *H. splendens* is given in text and tables in relevés of zonal associations without reference to intraspecies level. Also we prefer for names of several levels of the syntaxonomical hierarhy within the new class to use as name-giving taxon the var. *alaskanum* to keep the history of this taxon beginning its species status establishing in Alaska.

Structure

Patterned grounds (Washburn 1956) are widely developed, and nanorelief (measured by few decimeters) is everywhere formed as a result of cryogenic processes throughout the entire Arctic. Differences in the growing season lenght, in the substrate heat and moisture, in the thickness and duration of snow cover, as well as in the rate and depth of frozen grounds thawing on varies elements of nanorelief, result in complicated horizontal structure of almost all communities, particularly in zonal sites. The projective cover in communities on upland surfaces changes from 100 to 40–50 % along the latitudinal gradient from the south to the north within the tundra zone. Two main types of the horizontal structure have been proposed (Matveyeva 1988, 1998) – irregular mosaic and regular cyclic (2- and 3-element).

The irregular mosaic type due to hummock nanorelief of the cryogenic genesis with an excess of its elements of 10–20 cm (and similar sizes in width), is character for zonal communities in the southern half of the tundra zone. The aggregations of various species on elevated elements (hummocks) and in microdepressions (hollows) altogether form a continuous mosaic cover (Fig. 1A, B). Many of the most abundant species form synusia, what is also an input into the complicated mosaic.

The regular-cyclic type is characteristic for communities with non-continuous cover due to the presence of bare ground patches, also of cryogenic genesis (Sukachev 1911, Washburn 1956, Govorukhin 1960). The usual name of such communities in Russian literature is spotted tundras and polygonal communities, in English language papers – frost-boil stands, patch communities, patterned ground plant communities. There are 2 variants (Fig. 1C–F) of this structure type: 2-element one (patches of bare ground on the polygons (penta- or less often hexagons) of 0.5 to 1.0 m in diameter and vegetation in troughs above the frozen cracks (responsible for patterned grounds) and sometimes with a narrow (up to 0.05 m) thin bordure of the same species along the polygon edge) is character for the arctic tundra subzone (= CAVM subzone B); 3-element one (the same, but additionally there is a slightly (by ~ 0.1 m) raised and relatively wide (up to 0.2 m) rim along the polygon edge) with set of species different than in troughs) is mostly character of the of typical tundra subzone (= CAVM subzones C, D), but also occurs in the southern one (= CAVM subzone E).

The loam patches with crucked or spongy (due to the result of “frost boiling”) surface vary in shape and size: round or shapeless from 0.75 to 3.0 (in average 1.5–2.0) m in diameter on flat surfaces, oval (1.0–2.0 m long and 0.5–1.5 m wide) and elongated (3.0–4.0 m long and 1.0–3.0 m wide) on long gentle slopes.

Northwards, the sizes of the nanorelief elements and these of the vegetation mosaic decrease, while their number per unit area increases: thus, the number of soil patch+rim+trough modules per 100 m^2 in frost boils tundra increases from 20 in the southern tundra subzone up to 30–60 in the typical ones, and in polygonal (patch+trough) communities to 90–150 in the arctic tundra subzone (Matveyeva et al. 1973, Matveyeva & Chernov 1978, Matveyeva 1979, Matveyeva & Zanokha 1986).

Such complicated structure is the reason that contrasting types of microgroups are present at a short distance: 1) patches of bare ground with single vascular plants and small amount of mosses and liverworts and crustaceous lichens, and succesion stages on these in the frost boils

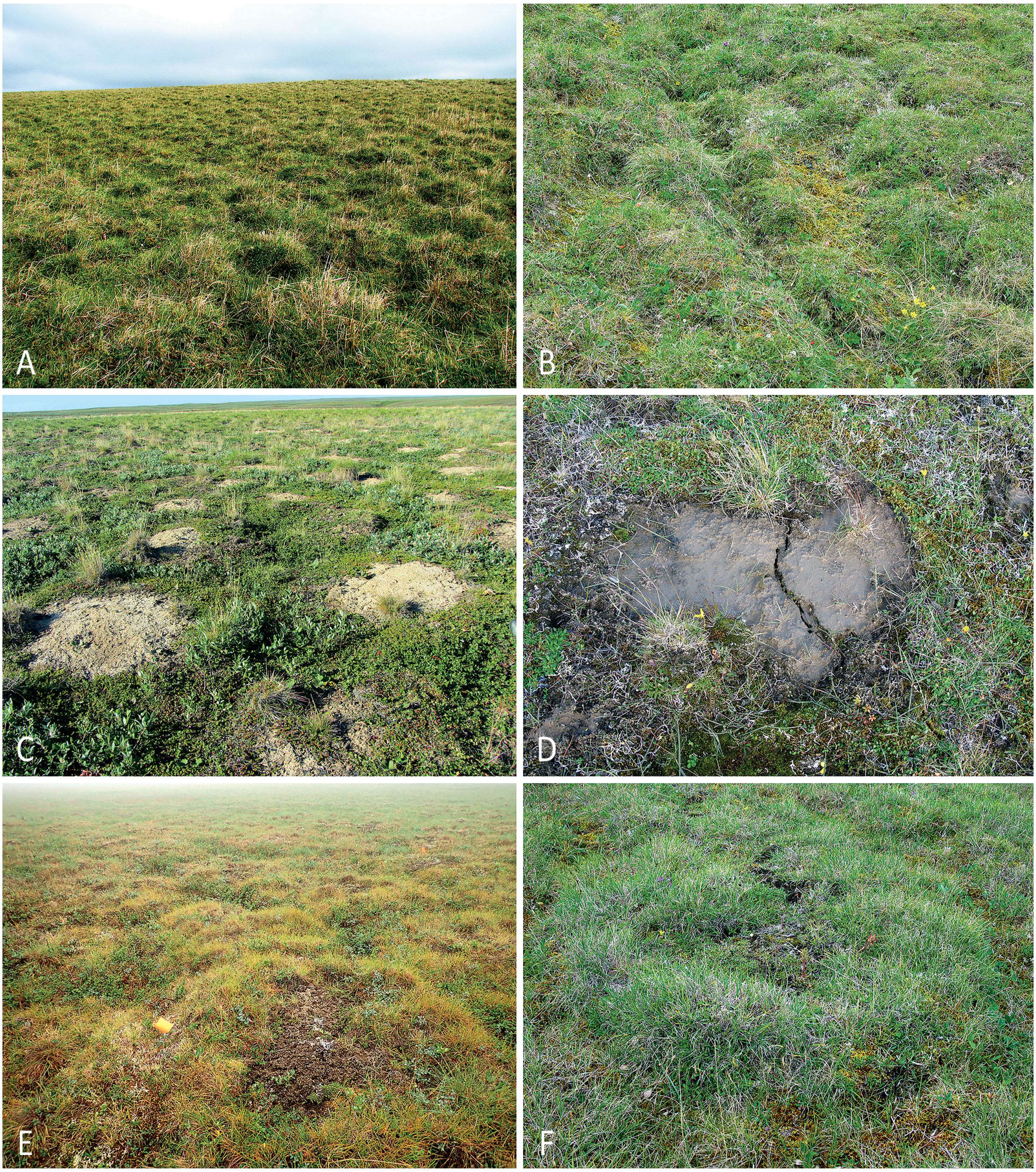

Figure 1 Views of zonal communities on Taymyr Peninsula. A – irregular mosaic type of structure (southern and typical tubdra subzones) and close-up veiw (B); C – 2-element regular-cyclic type of structure (arctic tundra – general (left) and D – module patch+trough (right); E – 3-element regular-cyclic type of structure (typical tundra) – general and F – patch+rim+trough module

stands; 2) continuous bryophyte layer (mainly green acrocarpus mosses and liverworts) with foliolose lichens in wet cracks/troughs between polygons in such stands or between hummocks in small-hummock communities with continuous cover; 3) lichen-moss (with pleurocarpus mosses and fruticose lichens) layer on rims around patches or on hummocks. A wide variety of micro (from ≤100 cm^2 to several hundreds cm^2) niches, colonized by great variety of small plants, explains the high α-diversity of such communities.

An undoubted factor that allows a significant number of species to cohabit on small areas (on sample plots 100 m^2 and 25 m^2) is such phenomena as the ground cracking or compression, solifluction and soil expulsion, altogether leading to the plant cover destruction or changing. Frequently observed is the appearance of fresh soil patches among the closed plant cover both on the overgrown polygons and in between rims and troughs. The latter is very common in the arctic tundra subzone in Taymyr Peninsula, where among well-developed moss cover in trough up to 20 cm wide, and especially at the junction of three troughs, one can see a small patch of fresh loam up to 5–10 cm in diameter which is a new substrate for colonization by plants other than those growing around such microecotope (Matveyeva 2009).

Due to the activity of cryogenic processes, "point" destruction of vegetation, the break of endogenous succession and its beginning almost from the initial stage are common on small distances. Such multiple (in space and time) disturbances support the co-habitation of species both of pioneer and the later succession stages. This phenomenon is an analogue of the carousel model (Maarel & Sykes 1993), when stability at the macroscale (in our case, the stable existence of frost boils and polygonal communities) is provided by the total instability at the microscale – the concept of patch dynamics (White & Pickett 1985).

The cover mosaic is such great that in the absence of large-sized plants which could, at least physiognomically, pretend to be edificators, discussions arose about homogeneous areas that could be operated as the smallest units for syntaxon establishing. Different decisions have been proposed for various types of structure. The heterogeneity in small-hummock communities with closed cover is accepted by everybody as an intra-community mosaic, and the relevé is made on a sample plot (25 m^2, 100 m^2) making a single list of species. However, opinions on frost-boils tundras with 3-element and polygonal communities with 2-element structure type are diverge. Some researchers (the overwhelming majority) describe such mosaic community as a single one while the others establish on a standart sample plot (25 m^2, 100 m^2) three or two associations (Walker et al. 1994, Vohnlanthen et al. 2008). There is also such a situation – in cotton grass tussock stand dominated by *Eriophorum vaginatum*, established as the ass. *Sphagno–Eriophoretum vaginati*, an independent syntaxon *Anthelia juratzkana–Juncus biglumis* com. type is also distinguished on patches of loamy soil in between tussocks (Walker et al. 1994).

CLASS CHARACTERISTICS

The name of the proposed class was reserved as a preliminary one (Lavrinenko et al. 2016, Matveyeva 2016) when summarizing the classification of the vegetation of the European North area; in the same status, it was used in the recently published checklist of syntaxa in the Russian Arctic (Matveyeva & Lavrinenko 2021). The dominating species is the moss *Hylocomium splendens* var. *alaskanum* and co-dominant in the dwarf-shrub–herb layer is the sedge *Carex bigelowii* subsp. *arctisibirica*. Both were selected as the name-giving taxa for the class name. In both cases, subspecies epithets are used (see above). It is necessary to stress that the names of the class *Carici arctisibiricae–Hylocomietea alaskani*, the alliance *Carici arctisibiricae–Hylocomion alaskani*, the type (holotypus) of which is the ass. *Carici arctisibiricae–Hylocomietum alaskani* Matveyeva 1994 with moss name in second place does not conflict with Articles 3k, 10 and 29b of the ICPN. Name-giving taxa (moss and sedge) belong to different layers, and moss (as well as total moss layer) has the highest cover, therefore its position in second place in the syntaxon name does not contradict Articles 10b and 42. There is no difficulty in determining the dominant layer – it is a moss one, so there is no necessity to send a request for a binding decision from CCCN. Sedge belongs to the highest stratum which is however not explisitly espressed and not dominant (see Articles 3k, 29b).

There is a recommendation to put on the second place "a taxon of the highest dominant stratum determining the vertical structure" (Article 3k), since this will be the basis for judging the dominating stratum in a vertical structure.

All examples in the ICPN are given for multi-layer forest or high shrub communities, and in those cases the name in the second place should be a tree or high shrub species, respectively.

No such strong layering exists in tundra communities in zonal sites, and very often the vegetation is unistratal with slight differences in the plant heights. The dominating layer is the ground layer, formed by mosses (in some cases also by lichens), interspersed with a low (from 1–5 to 10–15 cm) sparse (up to 20–30 %) vascular species. Therefore, it is logical (and not in violation of the ICPN) to reflect this specific feature in the syntaxon name. In the case of the class name, in which the name-giving species are moss and sedge, it is important that these communities are mossy but not herbaceous. Formally, the ICPN Article 29b explains that the more "important" taxa of the dominating layer should have a higher abundance than the taxa of the second layer in all (or most) relevés, especially in the typus. In the type association (and in its holotypus) (Matveyeva 1994) of the class, in the mid of the tundra zone, the abundance of moss is twice as high as that of sedge. The latter is very rare or absent in zonal communities in the arctic tundra subzone (= CAVM subzone B) where sparse "upper layer" is formed by dwarf willows, whose leaves lie on the surface of the mosses (the alliance *Salici polaris–Hylocomion alaskani*). In all communities of the class, taller vascular plants have lower cover than the dominanting moss layer. Therefore, the putting the discussed moss in the second place in the syntaxon name does not contradict with the ICPN in cases like zonal tundra communities where slightly taller vascular plants do not form the highest dominating stratum. We believe that the names of syntaxa in proposed version are valid and there is no reason for these to be inverted.

Cl. ***Carici arctisibiricae–Hylocomietea alaskani*** **class. nov.**

Description. Zonal vegetation in the intermediate habitats with respect to substrate moisture, pH and texture, thickness and duration of snow cover, the depth of seasonal frozen ground thawing and and the growing season length on the interfluves in the tundra zone (CAVM subzones B, C, D, E) in Eurasia and North America.

Name-giving taxa: *Carex bigelowii* Torr. subsp. *arctisibirica* (Jurtz.) Á. Löve et D. Löve, *Hylocomium splendens* (Hedw.) Bruch et al. var. *alaskanum* (Lesq. et James) Limpr.

Synonym: *Carici arctisibiricae–Hylocomietea alaskani* Lavrinenko, Matveyeva et Lavrinenko 2016 prov. (ICPN Arts. 2b, 3b, 5; ICPN = Theurillat et al., 2021).

Holotypus: ord. *Caricetalia arctisibiricae–lugentis* **ord. nov.** (see below).

Differential combination of taxa (d.c.t.): vascular plants: *Arctagrostis latifolia*, *Carex bigelowii* subsp. *arctisibirica* (dominant = dom.), *C. bigelowii* subsp. *lugens* (dom.), *Dryas integrifolia*, *D. octopetala* s. l., *D. punctata* s. l., *Eriophorum vaginatum* (dom.), *Festuca brachyphylla*, *Juncus biglumis*, *Luzula arcuata* aggr. (*L. arcuata*, *L. confusa*), *L. arctica*, *L. nivalis*, *Parrya nudicaulis*, *Petasites frigidus*, *Poa arctica*, *Salix polaris*, *Saxifraga hirculus*, *S. nelsoniana*, *Stellaria longipes* coll. (*S. ciliatosepala*, *S. peduncularis*), *Valeriana capitata*; bryophytes: *Aulacomnium turgidum* (dom.), *Blepharostoma trichophyllum* s. l., *Distichium capillaceum*, *Ditrichum flexicaule*, *Hylocomium splendens* var. *alaskanum* (dom.), *Ptilidium ciliare* (dom.), *Racomitrium lanuginosum*, *Tomentypnum nitens*; lichens: *Dactylina arctica*. The main taxa in d.c.t. of subordinate orders and alliances (underlined) are listed here.

Constant taxa: vascular plants: *Bistorta vivipara*; bryophytes: *Dicranum elongatum*; lichens: *Cetraria islandica* s. l., *Flavocetraria cucullata*, *Thamnolia vermicularis* s. l.

Community structure. Cover varies from 50 to 100 %. Types of the horizontal structure: irregular mosaic and regular-cyclic (2- and 3-element) with 20–150 modules per 100 m^2. Dominants are marked (dom.) in the d.c.t. Comunitiers are two-layered: ground moss layer up to 7 cm thick and dwarf-shrub–herb layer of the up to 10 cm in height of vegetative mass with sparse generative shoots up to 15 cm.

Habitats. Flat and slightly sloping surfaces of moderately drained interfluves with clay and loamy soils; duration of snow cover of 20–30 cm thickness is September–May; the depth of seasonal frozen ground thawing is 50–70 cm; the growing season length is from the beginning of June to the first decade of September.

Zonal position. Tundra zone (= CAVM subzones B, C, D, E).

Geography. Mainlands: Eurasia and North America; archipelagos Spitsbergen, Novaya Zemlya, New Siberian Islands, the Canadian Arctic Archipelago, the large (Wrangel, Greenland) and small (Kolguev, Dolgy, Vaygach, Bely, Bolshoy Begichev, Ayon) islands in the Arctic Ocean.

Ord. ***Salici polaris–Hylocomietalia alaskani*** **ord. nov.**

Description. Zonal dwarf willow–moss vegetation in the intermediate habitats with respect to the substrate moisture, pH and texture, thickness and duration of snow cover, the depth of seasonal frozen ground thawing and the growing season length on the interfluves in the arctic tundra subzone (= CAVM subzone B) in mainland Eurasia, in archipelagos and on the large and small islands in the Arctic ocean.

Name-giving taxa: *Salix polaris* Wahlenb., *Hylocomium splendens* (Hedw.) Bruch et al. var. *alaskanum* (Lesq. et James) Limpr.

Synonyms: *Salicetalia polaris* Hartmann 1980 (ICPN Arts. 2b, 3b, 5); *Salicetalia polaris-arcticae* Hartmann 1980 (ICPN Arts. 2b, 3b, 5).

Holotypus: all. *Salici polaris–Hylocomion alaskani* Matveyeva et Lavrinenko 2021.

D.c.t.: class d.c.t. plus vascular plants: *Alopecurus alpinus* s. l., *Cerastium arcticum*, *C. beeringianum* s. str., *C. beeringianum* subsp. *bialynickii*, *Cerastium regelii* subsp. *caespitosum*, *Deschampsia borealis*, *Lloydia serotina*, *Oxyria digyna*, *Potentilla hyparctica*, *Ranunculus sulphureus*, *Salix arctica*, *S. polaris*, *Saxifraga cernua*, *S. cespitosa*, *S. foliolosa*, *S. hieracifolia*, *S. nivalis*, *S. serpyllifolia*; bryophytes: *Polytrichastrum alpinum*, *Sanionia uncinata*; lichens: *Lobaria linita*, *Protopannaria pezizoides*, *Sticta arctica*.

Constant taxa: vascular plants: *Draba alpina*, *Papaver dahlianum* subsp. *polare*, *Saxifraga oppositifolia*.

Important and distinctive is the absence of shrubs (*Betula nana* subsp. *exilis*, *B. nana* subsp. *nana*, *B. nana* subsp. *tundrarum*) and hypoarctic dwarf-shrubs (*Empetrum hermaphroditum*, *E. subholarcticum*, *Vaccinium uliginosum* subsp. *microphyllum*, *V. vitis-idaea* subsp. *minus*).

Community structure. Cover is about 50 %. Types of the horizontal structure: regular-cyclic (2-element) with 90–150 modules per 100 m^2. The surface of polygons are bare with sungle vascular plants at their edge. Dominants (in troughs) are mosses *Hylocomium splendens* var. *alaskanum* and *Sanionia uncinata* and dwarf-shrubs *Salix polaris* (mainly) and *S. arctica*. The cover (in troughs) are two layered: closed up to 3–5 cm thick ground moss layer and dwarf-shrub layer up to 2 cm in height of vegetative mass with sparse generative shoots up to 5 cm.

Habitats. Flat and slightly sloping surfaces of moderately drained interfluves with clay and loamy soils; duration of snow cover of 20 cm thickness is September–June; the depth of seasonal frozen ground thawing is 50 cm; the growing season length is from the mid June to the beginning of September.

Zonal position. Arctic tundra subzone (= CAVM subzone B).

Geography. Mainland territories: shores of the Karskoe and Laptevykh seas on the Taymyr Peninsula (except the northern part of the Chelyuskin Peninsula) in Eurasia; archipelagos (Spitsbergen, Novaya Zemlya, New Siberian Islands, the Canadian Arctic Archipelago) and islands (Wrangel, Greenland).

Notes. Discussing the need to establish a new order within the class *Carici rupestris–Kobresietea* for the vegetation on West Spitsbergen Isl. and for the whole area in high Arcic latitudes (at least for Greenland), Hartmann (1980) suggested two probable names for it – *Salicetalia polaris* or *Salicetalia polaris-arcticae* noting that further investigations are necessary for the reliable choice of the name-giving species both for new asscociations and for the order as well as to determine character species for the latter. However, he himself did not make any steps on the new order establishing/validation. Important are his short notes that on the south-west of West Spitsbergen Isl. *S. polaris* is not common in dryad heaths, but on opposite this dwarf willow has the highest constancy and abundance in moss tundra including rather wet stands dominated by *Tomentypnum nitens*. That is why it was problematic for Hartmann to put his ass. Moostundra-Gesellschaften (Hartmann 1980) to the mentioned class, which contains communities without well developed moss layer. Having in mind, that the question on the restriction (both floristically and ecologically) the distribution of the new order was left open by Hartmann, we believe that there is no base to: 1) validate any one of two names and 2) put such moss stands with dwarf willows into the class *Carici rupestris–Kobresietea*. Their place is evidently in the new order (with moss in its name) within the new class of zonal tundra communities (geographically close to the northern border of the tundra zone), as this is done here.

All. ***Salici polaris–Hylocomion alaskani*** Matveyeva et Lavrinenko 2021

Zonal dwarf willow–moss vegetation in the intermediate habitats with respect to the substrate moisture and texture, the thickness and duration of snow cover, the depth of seasonal frozen ground thawing and the growing season length on the interfluves in the arctic tundra subzone (= CAVM subzone B) in mainland Eurasia, in archipelagos, and on large and small islands in the Arctic ocean.

Name-giving taxa: *Salix polaris* Wahlenb., *Hylocomium splendens* (Hedw.) Bruch et al. var. *alaskanum* (Lesq. et James) Limpr.

Synonyms: No.

Holotypus: ass. *Salici polaris–Hylocomietum alaskani* Matveyeva 1998 (Matveyeva 1998: 76–77; 204–205, Table 12, relevés no. 1–19, nomenclature type (holotypus) relevé – 19).

D.c.t.: = d.c.t. of the order.

Characteristics of **community structure, habitats, zonal position, and geography** are the same as for the order.

Regional associations: *Salicetum polaris* Gjarevoll 1930 *drepanocladetosum uncinati* Möller 2000, *Luzulo confusae–Salicetum polaris* Hadač 1989 and Moostundra-Gesellschaften (Hartmann 1980) (West Spitsbergen Isl.); *Salici polaris–Polytrichetum juniperini* Aleksandrova 1956, *Deschampsio borealis–Limprichtietum revolventis* Aleksandrova 1956 and *Flavocetrario nivalis–Dryadetum octopetalae* Aleksandrova 1956 (Novaya Zemlya); *Salici polaris–Hylocomietum alaskani* Matveyeva 1998 (Taymyr Peninsula); *Salici polaris–Sanionietum uncinatae* Kholod 2007, *Cladino arbusculae–Luzuletum nivalis* Kholod 2007 and *Oncophoro wahlenbergii–Deschampsietum borealis* Kholod 2007 (Wrangel Isl.).

All. ***Poo arcticae–Calamagrostion holmii*** **all. nov.**

Description. Dense thicket of grasses formed under lemming and predator bird impact in small (few square meters) exclosures in zonal communities as well as on positive elements in mire-tundra complexes and on the tops of isolated sandy or loamy hills and tops of rocky mounds.

Name-giving taxa: *Poa arctica* R. Br., *Calamagrostis holmii* Lange.

Synonyms: No.

Holotypus: ass. *Poo arcticae–Calamagrostietum holmii* Zanokha 2001 (Zanokha 2001: 9–13, Table 3, relevés no. 1–27, nomenclature type (holotypus) relevé – no. 23=20).

D.c.t.: = d.c.t. of the order plus *Artemisia arctica* subsp. *ehrendorferi*, *A. tilesii*, *Calamagrostis holmii* (dom.), *Poa alpigena*, *P. arctica* (dom.), *Rhodiola rosea*, *Saxifraga cernua* (dom.). After describing associations from the other sectors of the Arctic, an increase in the number of species of d.c.t. is most likely.

Regional associations: *Poo arcticae–Calamagrostietum holmii* Zanokha 2001 vicar. *typical* (Zanokha 2001) and vicar. *Vaccinium vitis-ideae* subsp. *minus* (Zanokha 2001) (Taymyr Peninsula); *Saxifrago cernuae–Alopecuretum alpini* Zanokha 2001 (Bolshevik Isl., (Severnaya Zelmlya Archipelago); *Artemisio tilesii–Deschampsietum borealis* Kholod 2007 (Wrangel Isl.).

Community structure. Dense (60–100 %) thicket mostly of vascular plants dominated by grasses (presumably name-giving syntaxon names) or herbs (*Artemisia tilesii*) on few square meters.

Habitats. Small exclosures formed under lemming and predator bird impact in communities in zonal sites as well as on positive elements in mire-tundra complexes and on the tops of isolated sandy or loamy hills and tops of rocky mounds.

Zonal position. Arctic and typical tundra subzones (= CAVM subzones B, C, D); rare in the polar deser zone (= CAVM subzone A).

Geography. Taymyr Peninsula, Bolshevik Isl. (Severnaya Zelmlya Archipelago), Wrangel Isl.

Notes. The alliance is proposed despite little information. There is no firm conviction of its position within this order because communities on various elements of landscape in different regions and zonal stripes initially are different in species sets determined by the entire composition of such exclosures with the same dominants. We do not exclude the suggestion to put such small fragments of zoogenically changed plant cover in the independent class *Saxifrago cernuae–Cochlearietea groenlandica* Mucina et Daniëls in Mucina et al. 2016.

Ord. ***Caricetalia arctisibiricae–lugentis*** **ord. nov.**

Description. Zonal dwarf-shrub–sedge–moss vegetation in the intermediate habitats with respect to the substrate moisture and texture, the thickness and duration of snow cover, the depth of seasonal frozen ground thawing and the growing season length on the interfluves in the typical and southern tundra subzones (= CAVM subzones C, D, E) in Eurasia and North America.

Name-giving taxa: *Carex bigelowii* Torr. subsp. *arctisibirica* (Jurtz.) Á. Löve et D. Löve, *Carex bigelowii* Torr. subsp. *lugens* (Holm.) T.V. Egorova s. str.

Synonyms: *Tomenthypno–Caricetalia arctisibiricae* Sinelnikova 2013 prov. (ICPN Art. 3b).

Holotypus: all. *Carici arctisibiricae–Hylocomion alaskani* **all. nov.** (see below).

D.c.t.: = d. c. t. of the class plus vascular plants: *Bistorta officinalis* aggr. (*B. elliptica*, *B. plumosa*), *Carex bigelowii* subsp. *arctisibirica* (dom.), *C. bigelowii* subsp. *lugens* (dom.), *Dryas octopetala* s. l., *D. punctata* s. l., *Lagotis glauca* subsp. *minor*, *Luzula tundricola*, *Pedicularis lapponica*, *Salix glauca* s. l., *S. lanata* s. l., *S. reptans*; bryophytes: *Rhytidium rugosum*.

Constant taxa: vascular plants: *Arctous alpina*, *Betula nana* subsp. *exilis*, *B. nana* subsp. *nana*, *B. nana* subsp. *tundrarum*, *Equisetum arvense* subsp. *boreale*, *Empetrum hermaphroditum*, *E. subholarcticum*, *Vaccinium uliginosum* subsp. *microphyllum*, *V. vitis-idaea* subsp. *minus*); bryophytes: *Stereodon bambergeri*; lichens: *Cladonia arbuscula* s. l., *C. rangiferina* s. l., *Peltigera aphthosa*.

Community structure. Cover varies from 60 to 100 %. Types of the horizontal structure: irregular mosaic (when 100 %) and regular-cyclic (3-element with 20–60 modules per 100 m^2). Dominants are sedges and pleurocarpous mosses. Comunitiers are mainly two layered: ground moss layer up to 7 cm thick and dwarf-shrub–herb layer of the up to10 cm in height of vegetative mass with sparse generative shoots up to 15 cm. Scarce low shrubs (willows and *Betula nana*) do not form a layer.

Habitats. Flat and slightly sloping surfaces of moderately drained interfluves with clay and loamy soils; duration of snow cover of 30 cm thickness is September–May; the depth of seasonal frozen ground thawing is 60–70 cm; the growing season length is from the beginning of June to the first decade of September.

Zonal position. Typical and southern tundra subzones (= CAVM subzones C, D, E).

Geography. Mainland territories: Eurasia (except the northern part of the Chelyuskin Peninsula, Taymyr Peninsula), North America; archipelagos: Spitsbergen, Novaya Zemlya, New Siberian Islands, the Canadian Arctic Archipelago), the large (Greenland, Wrangel) and small (Kolguev, Dolgy, Vaygach, Bely, Bolshoy Begichev, Ayon) islands.

Notes. Besides 3 alliances suggested below, probable (desirable) is an alliance of zonal communities in the typical and southern tundra subzones (= CAVM subzones C, D, E) in Alaska (north of the Brooks Range), with the same set of bryophytes and co-dominating sedge *Carex bigelowii* subsp. *lugens*, cotton grass *Eriophorum angustifolium* subsp. *triste* and dwarf-shrub *Dryas integrifolia* as well as the presence of most taxa from d.c.t. of the order (plus *Pedicularis capitata*, *P. lanata*, *Rhododendron lapponicum*, *Saussurea angustifolia*). The alliance establishment, based on the analysis of the known associations, would have been carried out by specialists actively working in the region. The holotypus of the alliance might be the ass. *Dryado integrifoliae–Caricetum bigelowii* Walker et al. 1994 (Alaska).

All. ***Carici arctisibiricae–Hylocomion alaskani* all. nov.**

Description. Dwarf-shrub–sedge–moss communities on the interfluves in the typical and southern tundra subzones (= CAVM subzones C, D, E) in the East European and West and Central Siberian sectors of the Russian Arctic.

Name-giving taxa: *Carex bigelowii* subsp. *arctisibirica* (Jurtz.) Á. Löve et D. Löve, *Hylocomium splendens* (Hedw.) Bruch et al. var. *alaskanum* (Lesq. et James) Limpr.

Synonyms: No.

Holotypus: ass. *Carici arctisibiricae–Hylocomietum alaskani* Matveyeva 1994 (Matveyeva 1994: 816–820, Table 1, nomenclature type (**holotypus**) relevé – no. 34).

D.c.t.: = d.c.t. of the order plus vascular plants: *Carex bigelowii* subsp. *arctisibirica* (dom.), *Deschampsia glauca*, *Epilobium davuricum*, *Eriophorum brachyantherum*, *Eutrema edwardsii*, *Myosotis asiatica*, *Pedicularis oederi*, *Saussurea alpina*, *S. tilesii*; bryophytes: *Stereodon holmenii*; lichens: *Cladonia pocillum*, *Myxobilimbia lobulata*, *Nephroma expallidum*, *Psoroma hypnorum*.

Regional associations: *Calamagrostio lapponicae–Hylocomietum splendentis* Lavrinenko et Lavrinenko 2018, *Carici arctisibiricae–Hylocomietum splendentis* Andreev 1932, *Dryado octopetalae–Hylocomietum splendentis* Andreev 1932 and *Oxytropido sordidae–Hylocomietum splendentis* Lavrinenko et Lavrinenko 2018 (European North of Russia); *Tephrosero atropurpureae–Vaccinietum vitis-idaeae* Telyatnikov et Pristyazhnyuk 2012 (Yamal Peninsula); *Hierochloo alpinae–Hylocomietum splendentis* Telyatnikov, Troeva, Ermokhina et Pristyazhnyuk 2019, *Luzulo tundricolae–Hylocomietum splendentis* Telyatnikov, Troeva, Ermokhina et Pristyazhnyuk 2019, *Parryo nudicaulis–Tomentypnetum nitensis* Telyatnikov, Troeva, Ermokhina et Pristyazhnyuk 2019 (Gydan Peninsula); *Arctagrostio latifoliae–Caricetum arctisibiricae* Telyatnikov et al. ex Lavrinenko in Lapina et Lavrinenko 2023, *Carici arctisibiricae–Hylocomietum alaskani* Matveyeva 1994 and *Dryado octopetalae–Eriophoretum vaginati* Telyatnikov 2010 (Taymyr Peninsula); *Astragalo frigidi–Salicetum reptantis* Telyatnikov et Troeva in Telyatnikov et al. 2015 and *Pediculari oederi–Aulacomnietum turgidi* Telyatnikov, Troeva, Gogoleva, Cherosov, Pestryakova et Pristyazhnyuk 2013 (Arctic Yakutia).

Community structure. Cover varies from 70–80 to 100 %. Types of the horizontal structure: irregular mosaic (when 100 %) and regular-cyclic (3-element with 20–60 modules per 100 m^2). Dominants are *Carex bigelowii* subsp. *arctisibirica* and pleurocarpous mosses (*Aulacomnium turgidum*, *Hylocomium splendens* var. *alaskanum*, *Tomentypnum nitens*) and liverwort *Ptilidium ciliare*. Comunities are mainly two layered: well-developed ground moss layer composed of mesophilic pleurocarpous mosses up to 7 cm thick and dwarf-shrub–herb layer of the up to 10 cm in height of vegetative mass with sparse generative shoots up to 15 cm. Not abundant low shrubs (willows and *Betula nana*) do not form a layer. Types of the horizontal structure: rarely irregular mosaic (when 100 %) and regular-cyclic (2- and 3-element with 20–60 modules per 100 m^2).

Habitats. The same as for the order.

Zonal position. Typical and southern tundra subzones (= CAVM subzones C, D, E).

Geography. East European sector (Malozemel'skaya Tundra, Bol'shezemel'skaya Tundra, Pay-Khoy Ridge, Kolguev, Dolgy and Vaygach Islands) and West and Central Siberian (up to the Indigirka River) one in the Russian Arctic.

Notes. In the checklist of syntaxa in the Russian Arctic (Matveyeva & Lavrinenko 2021), we placed the above associations in the alliance [KOB-01B] *Dryado octopetalae–Caricion arctisibiricae* Koroleva et Kulyugina in Chytrý et al. 2015. For a number of reasons here we have abandoned this decision and are proposing a new alliance. The main arguments on the failure of the union described in the order *Thymo arctici–Kobresietalia bellardii* Ohba 1974 within the class *Carici rupestris–Kobresietea bellardii*, which its authors positioned as "dryad tundras on the well drained and well heated uplands, occupies clayey, sandy and gravelly soils in the north-east European Russia" (Chytrý et al. 2015, Koroleva & Kulugina 2015), are detailed in the paper by O. Lavrinenko & I. Lavrinenko (2018). To the main inconsistencies (definition, vegetation type, diagnostic taxa, habitats, geography), here we add that the choice of the name-giving type of the ass. *Dryado octopetalae–Caricetum arctisibiricae* Koroleva et Kulyugina in Chytrý et al. 2015, as the holotype of the alliance, is not good for zonal vegetation. In this community the grass cover exceeds the moss one (for *Carex bigelowii* subsp. *arctisibirica*, the abundance is 4, for *Hylocomium splendens* – 3), whereas zonal vegetation is positioned as moss-type vegetation.

All. ***Salici pulchrae–Caricion lugentis*** Sinelnikova 2021

Description. Zonal dwarf-shrub–tussock-sedge–moss vegetation in the intermediate habitats with respect to the substrate moisture and texture, the snow cover thickness and duration, the depth of seasonal frozen ground thawing, and the growing season length on the interfluves in the typical and southern tundra subzones (= CAVM zubzones C, D, E) in the East Siberian and Chukotka sectors in the Russian Arctic.

Name-giving taxa: *Salix pulchra* Cham., *Carex bigelowii* Torr. subsp. *lugens* (Holm.) T.V. Egorova.

Synonyms: *Caricion lugentis* Kholod 2007 prov. (ICPN Arts. 2b, 3b, 5).

Holotypus: ass. *Caricetum lugentis* Sinelnikova 2009 (Sinelnikova 2009: 47–49; 137–138, Table 7, relevés no. 11–20, nomenclature type (**holotypus**) relevé – 16=358F).

D.c.t.: = d.c.t. of the order plus vascular plants: *Carex bigelowii* subsp. *lugens*, *C. soczavaeana*, *Salix pulchra*.

Regional associations: *Festuco brachyphyllae–Hylocomietum alaskani* Lashchinskiy in Telyatnikov et al. 2014 (Arctic Yakutia); **Carici lugentis–Hylocomietum alaskani* Sekretareva ex Kholod 2007 and *Salici pulchrae–Caricetum lugentis* Kholod 2007 (ICPN Arts. 31, 32d) (Wrangel Isl.); *Caricetum lugentis* Sinelnikova 2009 and *Caricetum soczavaeanae* Sinelnikova 2009 (Kolyma River, Magadan region); *Carici lugentis–Salicetum pulchrae* Sinelnikova 2001 and *Eriophoro vaginati–Caricetum lugentis* Sinelnikova 1992 (ICPN Arts. 2b, 3b, 5) (Chukotka).

Community structure. Cover varies from 60 to 100 %. Types of the horizontal structure: irregular mosaic (when 100 %) with *Carex bigelowii* subsp. *lugens* and *Eriophorum vaginatum* tussocks (25–30 cm in height), and regular-cyclic (3- and 2-element) with patches of ground (25–40 up to 120 cm in diam.), rims with *Carex bigelowii* subsp. *lugens* tussocks and ground hummocks and mossy troughs.

Habitats. Gently sloping plains (from 2–5 to 6–7°) and accumulative slopes (trails), high floodplain terraces, low saddles; loam substrates with an admixture of crushed stone.

Zonal position. Typical and southern tundra subzones (= CAVM subzones C, D, E).

Geography. East Siberian and Chukotka sectors in the Russian Arctic.

Notes. *Association was placed within the *Caricion lugentis* Kholod 2007 prov. in the order *Salicetalia polaris-arcticae* Hartmann 1980 prov.

All. ***Carici concoloris–Aulacomnion turgidi*** Telyatnikov, Troeva, Gogoleva, Cherosov, Pestryakova et Pristyazhnyuk 2013

Description. Dwarf-shrub–lichen–moss cover on the rims in the rim-polygonal mires in the Siberian sector in the Russian Arctic.

Name-giving taxa: *Carex concolor* R. Br. (= *Carex aquatilis* Wahlenb. subsp. *stans* (Drejer) Hultén), *Aulacomnium turgidum* (Wahlenb.) Schwägr.

Synonyms: No.

Holotypus: ass. *Carici concoloris–Hylocomietum splendentis* Telyatnikov, Troeva, Gogoleva, Cherosov, Pestryakova et Pristyazhnyuk 2013 (Telyatnikov et al. 2013: 68–69; 70–74, Table 1, relevés no. 1–16; nomenclature type (**holotypus**) relevé – no. 5).

D.c.t.: = d.c.t. of the order plus vascular plants: *Carex aquatilis* subsp. *stans* (dom.); bryophytes *Dicranum laevidens*, *Polytrichum strictum*.

Regional associations: *Aulacomnio turgidi–Eriophoretum angustifolii* Troeva et Telyatnikov in Telyatnikov et al. 2017 and *Carici concoloris–Hylocomietum splendentis* Telyatnikov, Troeva, Gogoleva, Cherosov, Pestryakova et Pristyazhnyuk 2013 (Arctic Yakutia).

Community structure. Closed (100 %) moss layer and rather sparse (15–20 %) dwarf-shrub–sedge layer. Type of the horizontal structure: irregular mosaic. Comunitiers are two layered: well developed ground moss layer composed of mesophilic pleurocarpous mosses (*Aulacomnium turgidum*, *Hylocominum splendens* var. *alaskanum*, *Tomentypnum nitens*) up to 7 cm thick and relatively low dwarf-shrub–sedge layer dominated by sedge *Carex aquatilis* subsp. stans up to 10 cm in height and presense of dwarf-shrub *Dryas punctata* and prostrate form of the low shrub *Betula nana*.

Habitats. Realativle drained rims (up to 50 cm in width), formed on the periphery of polygons and raised up to 20–30 cm above their the wet/watered central parts, in the rim-polygonal mires.

Zonal position. Typical tundra subzone (= CAVM subzones C, D).

Geography. Siberian sector of the Russian Arctic.

Notes. Communities of recently described association are widespread in the vast plains of the Siberian sector in the Russian Arctic where this vegetation is so far almost not described. The species set, including dominating species, and community structure are quite similar to the zonal communities of the ass. *Carici arctisibiricae–Hylocomietum alaskani*. The main (if not the only) difference is sedge *Carex aquatilis* subsp. *stans* which is main dominant in the ass. *Meesio triquetris–Caricetum stantis* Matveyeva 1994 in the wet/watered central parts of polygons in the rim-polygonal mires, but not *C. bigelowii* subsp. *arctisibirica* as in zonal communities on interfluves.

Ord. ***Eriophoretalia vaginati*** **ord. nov.**

Description. Tussock communities with dominance of *Eriophorum vaginatum* and participation of *Sphagnum* species on poorly drained heavy loams on flat, slightly concave or slightly convex surface of the interfluves in the southern (mostly) and typical (less often) tundra subzones in the Arctic (with optimum in Beringian sectors).

Name-giving taxa: *Eriophorum vaginatum* L.

Holotypus: all. *Cassiopo tetragonae–Eriophorion vaginati* **all. nov.** (see below).

Synonyms: No.

D.c.t.: = d.c.t. of the class plus vascular plants: *Calamagrostis holmii*, *Cassiope tetragona*, *Eriophorum angustifolium*, *E. vaginatum*, *Tephroseris atropurpurea* aggr. (*T. atropurpurea*, *T. frigida*), *Salix pulchra*; bryophytes: *Sphagnum angustifolium*, *S. fimbriatum*, *S. girgensohnii*, *S. rubellum*, *S. squarrosum*, *S. warnstorfii.*

Constant taxa: vascular plants: *Betula nana* subsp. *exilis*, *B. nana* subsp. *nana*, *B. nana* subsp. *tundrarum*, *Empetrum subholarcticum*, *Ledum palustre* subsp. *decumbens*, *Rubus chamaemorus*, *Salix glauca*, *S. pulchra*, *Vaccinium uliginosum* subsp. *microphyllum*, *V. vitis-idaea* subsp. *minus*; lichens: *Cladonia arbuscula* s. l., *Cladonia rangiferina* s. l. Low shrubs (*Betula nana* subsp. *exilis*, *B. nana* subsp. *nana*, *Salix* spp.) and hypoarctic dwarf-shrubs (*Empetrum subholarcticum*, *Ledum palustre* subsp. *decumbens*, *Vaccinium uliginosum* subsp. *microphyllum*, *V. vitis-idaea* subsp. *minus*) are rather common.

Community structure. Cover is up to 95 %. Structure type is irregular mosaic. The cotton grass forms large, dense tussocks of 10–20 cm in height and 20–30 cm in diameter. Tussocks occupy 40–60 % of the stand area. In the dense lower part of the tussocks between the living leaves a large number of standing-dead and prostrrate-dead leaves and weakly/moderately decomposed remnants of previous year leaves are preserved. Such organogenic substrate is an optimal biotope for colonization by different species of both vascular plants and bryophytes forming the microgroups of phytogenic origin (Polozova 1970). The intertussock depressions are occupied by green mosses and some sphagnums and lichens. There are patches of bare soil (up to 5 %), small, irregular, without epigeous lichen crust, but also commonly with liverworts and other types of cryptobiotic soil crusts.

Habitats. Weakly drained heavy loams on flat, slightly concave or slightly convex surfaces of interfluves.

Zonal position. Southern (predominantly) and typical (less often) tundra subzones (= CAVM subzones E, D)

Geography. Siberian part of the Russian Arctic (east of Yamal Peninsula) with the optimum in Chukotka; Alaska.

Notes. There were doubts whether to classify the tussock communities with cotton grass *Eriophorum vaginatum* (ass. *Sphagno–Eriophoretum vaginati* M.D. Walker, D.A. Walker et Auerbach 1994) on heavy loams in the interfluvess within new class of zonal communities suggested here, or to distinguish such communities as an independent class, as it was mentioned in the Walker et al. (1994) with link on paper by Komarkova & McKendrick (1988), where the name of the class "*Ledum palustre* subsp. *decumbens–Eriophorum vaginatum* subsp. *spissum*/uplands" (within 12 classes for vegetation units classified in a Braun-Blanquet hierarchy, Atkasook, Alaska) was placed in a table in the column "Classes/landscape units". Unfortunately the V. Komarkova' field data from that region were never published because of her early death, and no further steps were made to establish the syntaxonomy. A large number of common species, both vascular and bryophyte, of tussock communities and those stands which are indisputably attributed to the new class, led us to the decision to suggest a new order within it. However it is necessary to have in mind, that there are other communities dominated by *E. vaginatum* on peat-gley soils (peat layer up to 40 cm) on the landscape ecotone between zonal communities (on loams) and peat palsa massifs in the East European Russia (Lavrinenko et al. 2022) and on Tazovsky Peninsula (Telyatnikov et al. 2021) in the southern tundra subzone (= CAVM subzone E). Their position in the higher units requires further analysis however their place is definitely not in a new class but in the bog class *Oxycocco-Sphagnetea*.

All. ***Cassiopo tetragonae–Eriophorion vaginati*** **all. nov.**

Description. Tussock communities with dominance of *Eriophorum vaginatum* and participation of *Sphagnum* species on poorly drained heavy loams on flat, slightly concave or slightly convex surface of the interfluves in the sothern (mostly) and typical (less often) tundra subzones in the Arctic (with optimum in the Beringian sector).

Holotypus: ass. *Sphagno girgensohnii–Eriophoretum vaginati* Walker M., Walker D. et Auerbach ex Walker M. in Matveyeva et Lavrinenko (Walker et al. 1994: 849–852, Table 4, relevés 1–26, nomenclature type (**holotypus**) relevé – no. 6=IC03).

Synonyms: No.

D.c.t.: = d. c. t. of the order. Characteristics of community structure, habitats, zonal position, and geography are the same as for the order.

Regional associations: *Arctagrostio latifoliae–Eriophoretum vaginati* Lavrinenko O. et Lapshina in Lavrinenko et al. 2021 (Taymyr Peninsula), *Sphagno girgensohnii–Eriophoretum vaginati* Walker M., Walker D. et Auerbach ex Walker M. in Matveyeva et Lavrinenko (Yamal Peninsula, Taymyr Peninsula, Arctic Yakutia, Wrangel Isl., Alaska); *Bryorio nitidulae–Vaccinietum minoris* Telyatnikov et Troeva in Telyatnikov et al. 2014 and *Tephrosero atropurpureae–Salicetum pulchrae* Telyatnikov et Troeva in Telyatnikov et al. 2015 (Arctic Yakutia).

Notes. The original ass. *Sphagno–Eriophoretum vaginati* Walker M., Walker D. et Auerbach 1994 invalidly described in Walker et al. (1994: 849–852) due to the presence of several *Sphagnum* species in the original diagnosis without the indication, which species is the name-giving one (ICPN Art. 3g). In this paper, M. Walker corrected only the name of the ass. *Sphagno–Eriophoretum vaginati* to *Sphagno girgensohnii–Eriophoretum vaginati*. The nomenclature type (holotypus) remained unchanged and there is full diagnosis of the association in the original publication. The ICPN Art. 6, example 2 allows not to give here a new diagnosis of the association, since the 1994 publication contains all the necessary provisions.

CONCLUSION

The new class *Carici arctisibiricae–Hylocomietea alaskani* is described based on the characteristics of habitats, physiognomy/structure of communities, and the differentiating combination of taxa. It includes associations which previously were positioned in different, (opposite in habitats and species composition) classes. It contains 3 orders and 6 alliances:

Class
  Order
    Alliance

Carici arctisibiricae–Hylocomietea alaskani **class. nov.**
  Salici polaris–Hylocomietalia alaskani **ord. nov.**
    Salici polaris–Hylocomion alaskani Matveyeva et Lavrinenko 2021
    Poo arcticae–Calamagrostion holmii **all. nov.**
  Caricetalia arctisibiricae-lugentis **ord. nov.**
    Carici arctisibiricae–Hylocomion alaskani **all. nov.**
    Salici pulchrae–Caricion lugentis Sinelnikova 2021
    Carici concoloris–Aulacomnion turgidi Telyatnikov, Troeva, Gogoleva, Cherosov, Pestryakova et Pristyazhnyuk 2013
  Eriophoretalia vaginati **ord. nov.**
    Cassiopo tetragonae–Eriophorion vaginati **all. nov.**

The communities of new class occupy zonal sites where due to the soil drainage/moisture and mineral content, the thickness of snow cover and the depth of seasonal frozen ground thawing the amount of solar radiation and heat conditions are mostly correspond to macroclimate of the tundra zone (CAVM = subzones B, C, D, E) on a circumpolar scale. An establishment at least of one more alliance is expected. There are 34 associations described in 11 provinces of the CAVM on the territory of Russian Arctic.

ACKNOWLEDGEMENTS

The research was conducted under a public contract within the thematic plan of the Komarov Botanical Institute RAS, theme No. 122041100242-5. The research was funded from a grant issued by the Russian Science Foundation (Project No. 20-17-00160).

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