



[[Home](#)] [[PAF News](#)] [[Checklist](#)] [[PAF Feedback](#)] [[PAF Search Page](#)]

[[General aspects](#)] [[Case studies](#)] [[Delimitation and subdivision](#)]

[[Information management](#)] [[Reports from taxonomic workshops](#)]

[[Back](#)] [[Up](#)]

DELIMITATION, ZONAL AND SECTORIAL SUBDIVISION OF THE ARCTIC

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[Bioclimatic zones within the Arctic](#)

[Sectorial subdivision of the Arctic](#)

[References](#)

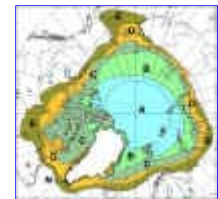
For the Panarctic Flora Project (PAF) the Arctic is delimited by the occurrence of the polar tree line. This criterion is applicable for northern Fennoscandia, Iceland - even if the forests there are only remnants of what has been before the Viking settlement - and the boreal enclave of South Greenland. It is not applicable to the Faeroe Islands, which have not had any known Holocene forests, but these islands are situated far to the south of the Arctic. Thus the tree line criterion only presents problem for the Aleutians and other Beringian islands. Here, instead, floristic criteria are used and the southern boundary of the Arctic is drawn north of the Pribyloff Islands.

Within the Arctic, PAF has decided to include five zonal units (Fig.1). They will be called 'zones' here; for those who prefer to regard the Arctic as one of several zones in a global context, the name 'subzone' can be used instead. The zones are designed as to indicate climate, and they are supposed to reflect a July mean temperature range of about 2° C each. However, July temperatures vary along the continentality gradient, and the arctic boundary as shown here correspond to a mean July temperature somewhat below 10° C in oceanic areas, and somewhat above 10° C in continental areas. A more detailed study on the correlation between zones and temperatures, including temperature sums, is in progress.

There is a large variety of zonal names to chose between. The solution for PAF is currently being discussed, and a nomenclature with acronyms and the most common synonyms will be added later. At present the zones are named A – E, starting in the north (Fig. 1-5).

The best criteria are represented by the communities, both those of zonal (ecologically 'intermediate') and azonal habitats, see their toposequence occurrences shown in [Elvebakk \(1999\)](#). For a

Fig. 1.



Zonal subdivision of the Arctic (explanation in text). Northern boreal enclave in South Greenland is indicated by 'N'.

Fig. 2.



Zonal subdivision of the Atlantic part of the Arctic (explanation in text). Northern boreal enclave in South Greenland is indicated by 'N'.

Fig. 3.

critical discussion about the traditional 'plakor' concept in USSR/Russian geobotany and supplementary information on Russian arctic community development along the toposequences, see [Razzhivin \(1999\)](#). From the community descriptions some easily accessible aspects of vegetation, like growth forms of lignified species and vegetation physiognomy can be abstracted. They are used much in the zone descriptions, although they are not sufficient alone to define all zones.

Zone A

Zone A has a desert-like appearance with widely scattered fanerogams which do not experience rhizosphere competition; the cover is mostly below 5 %. Locally, cryptogams can present a more closed cover, but this is clearly in azonal situations. This zone is most often called a 'polar desert' and it has a very short growth season and very low positive temperature sum allowing for plant growth. Scattered herbs of genera like *Saxifraga*, *Draba*, *Cerastium*, and *Phippsia* are the most common ones, and a species like *Papaver dahlianum* - the name *P. polare* dominating in Russian literature seems to be a synonym - is very characteristic on a circumpolar scale. Woody species of Cyperaceae are typically absent or only sporadically present in the zone. The zone is absent from a broad area around the Bering Strait (Fig. 4).

Zone B

This zone has a typical component of prostrate shrubs like *Dryas* spp. and *Salix* spp, especially *Salix arctica* and *S. polaris*. The plant cover is discontinuous, but not desert-like, except in azonal sites like extremely alkaline areas in arctic Canada. Peat accumulation occurs and mires with *Carex* and *Eriophorum* species are present, but not as well developed as further to the south. Many northern species are shared with zone A, and these are much rarer further south.

Zone C

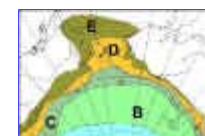
Here zonal habitats are dominated by the dwarfshrub *Cassiope tetragona*. This species occurs circumpolarly, except in Novaya Zemlya and in small oceanic areas, and it becomes less prominent or disappears from strongly alkaline, fine-textured soils. The vegetation in zonal situations is closed, and minerotrophic fens often cover large areas, including some southern types on alkaline soils. *Epilobium latifolium* communities are characteristic along rivers. The content of hypoarctic species, species occurring more or less evenly south and north of the arctic boundary, is small.

Zone D



Zonal subdivision of the continental Eurasian part of the Arctic (explanation in text).

Fig. 4.



Zonal subdivision of the Pacific part of the Arctic (explanation in text).

Fig. 5.



Zonal subdivision of the North American continental part of the Arctic (explanation in text).

The zonal vegetation of Zone D is still dominated by dwarfshrubs, but now *Cassiope tetragona* is replaced by species within the genera *Betula*, *Empetrum*, *Salix*, and *Vaccinium*, some of them only on acidic substrates. Hypoarctic species dominate over arctic and arctic-alpine species in zonal sites, and oligotrophic peat is being accumulated in mires, which have a more hummocky structure. In the amphi-Beringian area tussock tundra dominated by *Eriophorum vaginatum* dominates in the landscape. This is assumed to be the product of leaching from organic production through a longer time than elsewhere in the Arctic, as this area was largely icefree during the Weichselian glaciations.

Zone N

This zone features shrubs (taller than 0.5 m) in zonal habitats, the most common ones are in the genera *Salix*, *Alnus* and *Betula*, and a podzol profile is often developed in zonal positions unless the substrate is alkaline. Tall herbs dominate in snow-bed vegetation, and *Sphagnum* produces oligotrophic bogs. In the amphi-Beringian area tussock tundra still dominates. The large rivers flowing northwards bring warmer water masses, prevent permafrost formation and lead to local formation of very tall shrubland and even forests along rivers, mostly of *Populus* and, in Chukotka, of *Chosenia arbutifolia*.

[Contents](#)

Sectorial subdivision of the Arctic

A floristic division of the Arctic was proposed by [Yurtsev \(1994\)](#). This reflects partly the sectional variation due to the oceanic-continental gradient, partly the effects of past history with separate refugial areas and directions of immigration. Yurtsev's division has been accepted in principle for PAF purposes, but with several changes (Fig. 6-11). The main change is inclusion of additional areas around the North Atlantic: nearly all of Greenland (southern parts excluded by Yurtsev), the northernmost parts of Iceland and Norway, and the north coast of Kola Peninsula in Russia.

The recognized regions might be grouped in five: North Atlantic, European Russian - West Siberian, East Siberian, Beringian, and Canadian.

The North Atlantic group

This group of six regions (Fig. 7) partly contains regions recognized as Arctic by [Yurtsev \(1994\)](#), partly new or expanded regions. On the North American side are recognized three

Fig. 6.



Sectorial subdivision of the Arctic. Sectors and sectorial boundaries under discussion are highlighted by question marks.

Fig. 7.

regions. The **Baffin – Labrador** region consists of southern Baffin Island, the mainland peninsulas of northern Labrador and Ungava, and the coasts of Hudson Bay (excluding James Bay). The western limitation of this region is still disputed. The **West Greenland** and **East Greenland** regions are now extended to the southern tip of Greenland. We exclude two small boreal enclaves in the south-westernmost parts of West Greenland, with forest remnants and with isolated and aberrant occurrences of several species. In the mid-Atlantic is the **North Iceland** region of the northernmost peninsulas of Iceland, and also including Jan Mayen. The Norwegian island Jan Mayen is included here because it is negatively characterized floristically. Nearly all its species (97-98%) are in common with Iceland, East Greenland and North Norway, and it could equally well have been united with each of these. We have decided not to accept negatively characterized regions and therefore chose to unite Jan Mayen with Iceland because the distance to mainland Norway is much longer. On the European side are recognized two regions. The **North Fennoscandian** region is 'new' and includes the north-easternmost peninsulas and islands of Norway and the northernmost coastal parts of Kola Peninsula in Russia. In the Barents Sea, the **Svalbard – Franz Joseph Land** region consists of the Spitsbergen Islands, Bear Island and Franz Joseph Land. Franz Joseph Land is negatively characterized; all its species also occur in the Spitsbergen Islands.

The European Russian – West Siberian group

In this group are recognized three regions. The **Kanin – Pechora** region is the lowlands in northernmost mainland Russia, including Kolguev Island. The **Polar Ural – (Vaigach) – Novaya Zemlya** region is the arctic extension of the Ural Mountains. The **Yamal – Gydan** region is the lowlands in northernmost West Siberia. The characterization and delimitation of these regions is not disputed.

The East Siberian group

Four regions are recognized. Westernmost is the large **Taimyr** region, consisting both of old eroded mountains and lowlands and including the Severnaya Zemlya Islands. The **Anabar – Olenek** region reaches east to the Lena delta and is a lowland region. The very small **Kharaulakh** region is the arctic extension of the large Verkhoyansk mountain ranges, with a strong element of Central Asian montane and alpine plants not reaching the Arctic elsewhere. The **Yana – Kolyma** region is the easternmost arctic Siberian lowlands. The characterization and delimitation of these regions is not disputed.

The Beringian group



The North Atlantic group of sectors. Sectors and sectorial boundaries under discussion are highlighted by question marks.

Fig. 8 .



The European Russian – West Siberian group of sectors.

Fig. 9 .



The East Siberian group of sectors.

Fig. 10.



This is a highly diverse and floristically rich group of four to six regions (Fig. 10), the number depending on some decisions still to be made. The importance of the group is that it contains all the important areas assumed to have been unglaciated through all or large parts of Quaternary times, including the islands in the shelf areas now submerged. On the Asiatic side are two undisputed regions, **West Chukotka** along the East Siberian Sea, including Wrangel Island, and **East Chukotka** facing the Bering Strait and Sea, the latter region with the strongest Beringian elements on the Asiatic side. Yurtsev also proposes a **South Chukotka** region on both sides of the Anadyr Basin, based on a floristic element connecting it to the more southern mountains and the Koryak Coast. An alternative proposal is to unite this with West Chukotka as it is a small area with insufficient characterization. Another option is to split it into the oceanic and continental parts to be assigned to the West and East Chukotka correspondingly. On the North American side are recognized the **Beringian Alaska** region facing the Bering Strait and Sea, with the strongest Beringian elements on the American side, and the **North Alaska** region of Brooks Range and the northern coast, also extending into Canada. The eastern delimitation of North Alaska is disputed. Yurtsev proposes to draw the line west of Mackenzie River whereas others argue for including parts of the coast east of Mackenzie and western parts of Banks Isl. and Victoria Isl. in the region. The reason is mainly that parts of these islands and the mainland have been unglaciated and have subendemic plants in common with Beringian regions. The decision will depend on how the remaining of the Canadian Arctic will be subdivided (see below). Yurtsev proposes a separate **North Beringian Islands** region, which includes Big Diomede Island (Russian), Little Diomede Island, St. Lawrence Island, and St. Matthew Island (all North American). This region is mainly negatively characterized, except for a very few Pacific oceanic species more frequent here than on the mainlands. The islands would have been a natural part of a larger region including Pribyloff Islands, the Aleutian Islands and the Commodore Islands, but we have decided to exclude these from the Arctic. The alternative proposal is to join the islands with the neighboring regions: Big Diomede with East Chukotka, the others with Beringian Alaska.

The Canadian group

In the northernmost parts, we have agreed to lump two regions initially recognized by Yurtsev into the one **Ellesmere – North Greenland** region, consisting of Axel Heiberg Island, Ellesmere Island, part of Devon Island, and the northern part of Greenland. This region is justified by a small element of endemic species, which might indicate some glacial refugia in the area. The more southern continental parts of arctic Canada pose the main

The Beringian group of sectors. Sectors and sectorial boundaries under discussion are highlighted by question marks.

Fig. 11.



The Canadian group of sectors. Sectors and sectorial boundaries under discussion are highlighted by question marks.

problems not yet solved. Yurtsev's proposal was to recognize fairly restricted regions in the west (North Alaska) and east (Baffin – Labrador). He then proposed to divide the remaining arctic Canada into West Hudsonian and Central Canadian sectors. Canadian and West European participants in the debate proposed to extend those Atlantic and Beringian regions, both on the mainland and in the islands, as far as there are a significant Atlantic and Beringian elements in their floras. Then there would be room only for one **Central Arctic Canada** region.

[Contents](#)

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[Contents](#)

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