CONCRETE FLORA CONCEPT AS A BASE FOR FLORISTIC INVESTIGATIONS IN THE RUSSIAN ARCTIC

Olga Khitun, Olga Rebristaya

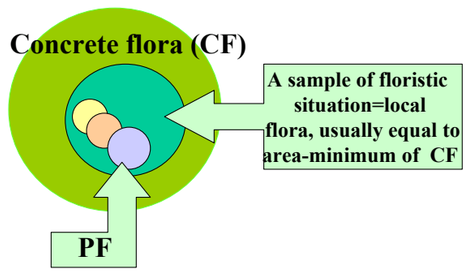
Komarov Botanical Institute Russian Academy of Science, Saint-Petersbrurg, Russia


Northern forest tundra in the Ob river estuary

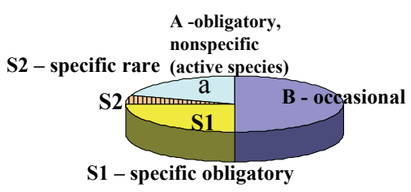

Northern hypoarctic tundra

Concrete Flora Concept

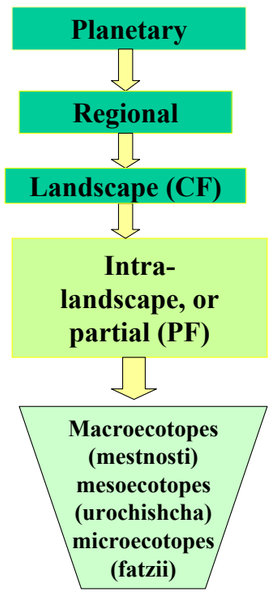
"Concrete flora" concept was suggested by A.I.Tolmatchev in 1932. The idea was that it is a minimal floristic unit really existing in nature which fulfills the request for naturality and comparability. By Tolmatchev's definition, "concrete flora (CF) is homogenous enough, differentiated only ecologically flora of a limited part of the Earth surface". Constancy of species composition in similar habitats throughout the area of the CF serves as criteria of homogeneity. Criteria of elementary is absence of any floristic boundaries within the area under investigation. Diversity of CF depends on the characteristic for the area set of habitats and historical factors. The size of the area should be big enough to reveal all possible habitat types and can vary in different geographic zones (Tolmatchev,1974; Schmidt, 1972; Yurtsev, 1975). For the Arctic it is equal ca 100 km² (Tolmatchev, 1970; Yurtsev, 1975) in lowland parts and ca. 300 km² – in mountainous parts, in taiga it is an area of ca 600 km2. Special methodic study carried out by O.Rebristaya (1987) showed that in Yamal due to chorological homogeneity and facial paucity of landscape smaller areas are representative. Comparison of number of species revealed within areas of increasing radii (0.5, 1, 2, 3, 5) km with total amount found within ca 300 km², showed that more than 90% of species were found within 1 km².



Partial flora (PF)



S1+S2+a = floristic nucleus
S1+ S2= florocoenotic complex



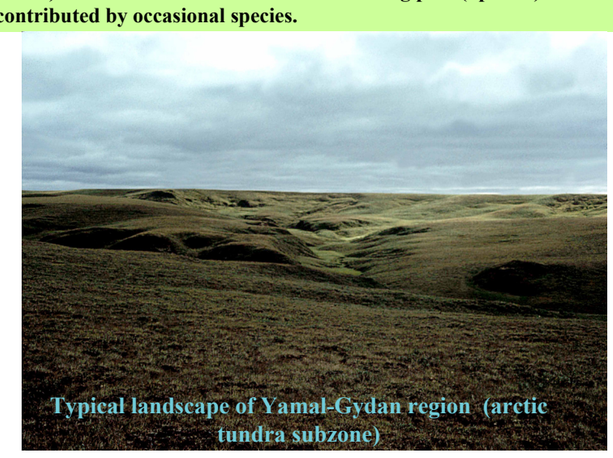
PARTIAL FLORAS

Applying of hierarchial approach to floristics allows to distinguish floristic systems of different level: planetary, regional, landscape and intralandscape. The latter are called partial floras (PF) and represent natural floras of any ecologically specific subdivisions of landscape. Their study logically arised from Tolmatchev method's demand of regular floristic inspection of full habitat diversity and compiling the lists of species of ecologically and floristically peculiar subdivisions of a landscape. Habitat hierarchy was worked out (Yurtsev, 1982, 1987) following landscape subdivision (Isachenko, 1965) with 4 steps: (1) microecotopes, or microhabitats roughly corresponding to floristically close plant communities types on similar topographic positions; (2) mesoecotopes uniting a number of neighboring microecotopes, controlled by the same or close set of ecological factors (e.g. a set of chionophilous or hemichionophilous communities in the whole nival depression, a complex of wind-swept microecotopes poor-in-snow or even snow-free in winter on tops of hills or mountain summits); (3) macroecotopes roughly correspond to macrorelief features, combining two or more ecologically related mesoecotopes (e.g. macrodepression with mire massif, flood-plains and river terraces and marginal snowbeds; (4) megaecotopes correspond to the whole landscape with its concrete (elementary) flora.

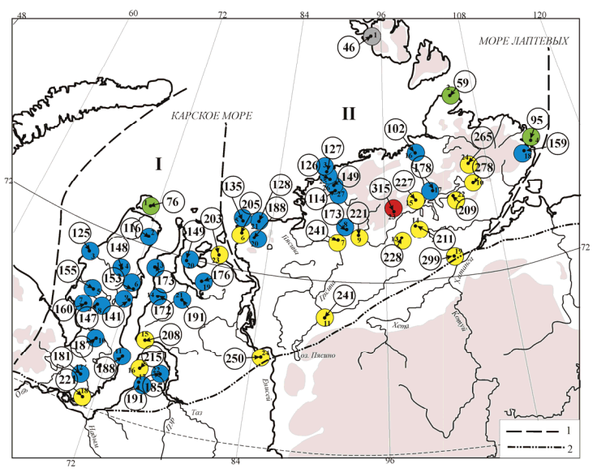
Composition of PF of any habitat type consists of its florocoenotic complex, that is specific for certain habitat species, they together with nonspecific, but commonly occurring ("active specie" sensu: Yurtsev, 1968, 1987, - wide spread and rather abundant in the area) floristic nucleus of each PF. Rather big part (up to ½) of PFs composition is contributed by occasional species.

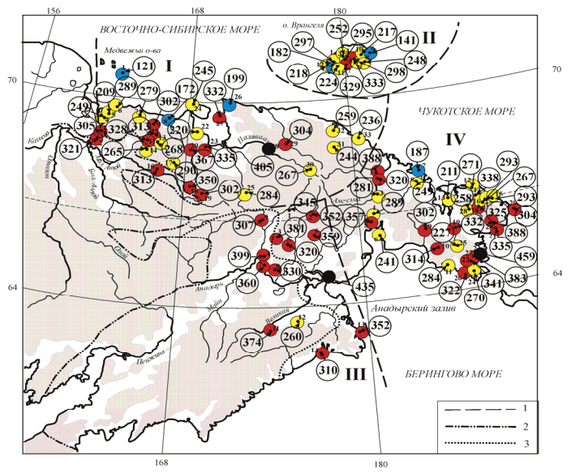
LOCAL FLORA VS CONCRETE FLORA

In his earliest publications on CF Tolmachev distinguished between concrete (or elementary) flora and the area selected for the revealing of it: area-minimum of CF. In the field we never pursue the task of drawing the boundaries of real CF, but perform a selective floristic sampling of some locality, which Boris Yurtsev (1975) suggested to call "sample of floristic situation in a geographic point", or " flora of vicinity of a geographic point". Shelyag-Sosonko (1980) proposed a shorter name for it - "local flora" (LF). Compare to the initial CF concept of Tolmatchev (as a part of discrete model of plant cover) the one developed by Yurtsev works in a floristic continuum as well. Commonly LF and CF coincide, but it is also possible to establish local flora within the area with different landscape, and respectively different concrete floras. Practically using the method of CF/LF means that we thoroughly examine the area around base camp by radial routes about 6-7 km long, apriory with the help of maps we choose the site for the camp in relatively homogenous landscape, we compile species lists for different habitats (all existing in the area). To achieve reliable data about floristic diversity investigations should continue at least 2-3 weeks (depending on the character of the landscape). Though the complete(100%) revealing of CF (LF) is probably never achieved (some rare species can always be missed), such detailed study gives very good approximates. The method is widely used by Russian botanists. At present the majority of the Russian botanists using the method prefer the term "local flora". The advantage of CF/LF approach is that we obtain highly comparable information, even negative features of flora can be considered, various characters can be studied on the level of concrete floras (taxonomical, geographical, biomorphological).

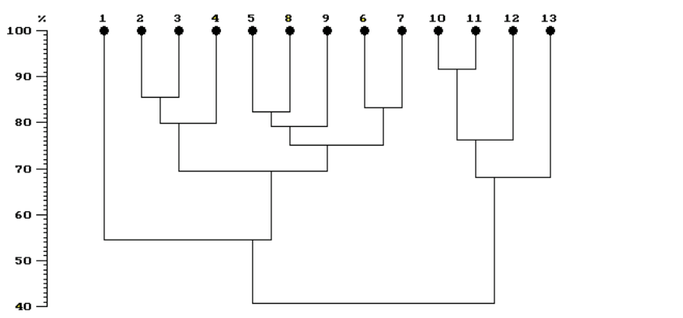

Typical landscape of Yamal-Gydan region (arctic tundra subzone)

Asian Arctic Local Floras Network





Dendrogramm shows result of weighted pair-group average clustering based on species composition similarity of local floras (Sørensen-Chekanovsky's index Ksc= 2c/a+b, c - species met in both compared floras, a - number of scecies in floraA, b – number of species in flora B)

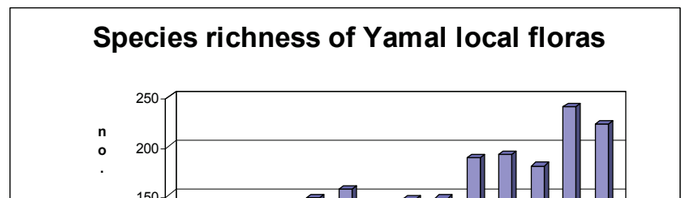


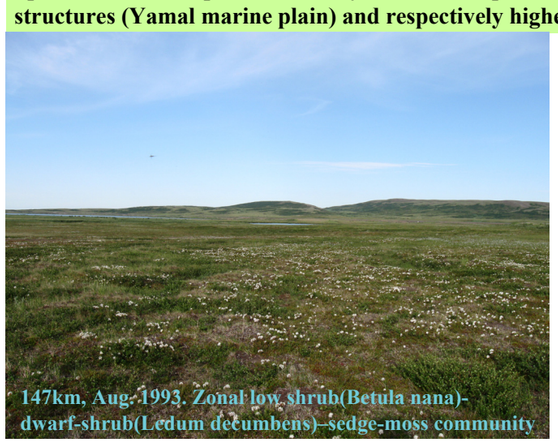
1 – subprovincial boundaries, 2 – tree-line, 3 - *Pinus pumila* boundary. Numbers and different color of circles – number of species in local floras

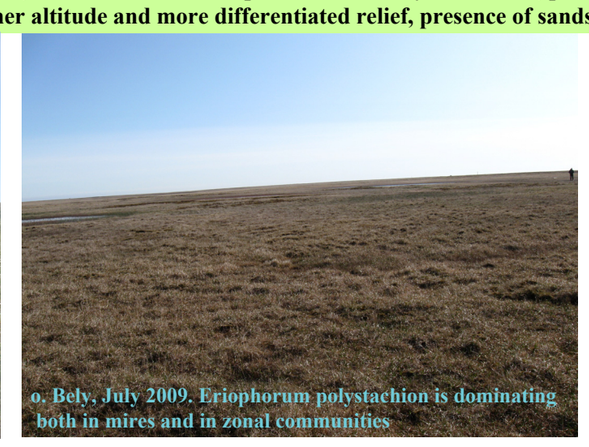
350 local floras were studied during the last 50 years in the Asian Arctic by the collaborates of the Far North Vegetation Laboratory Komarov Botanical Institute (St-Petersburg). 130 most detailed studied and most representative for their regions local floras were chosen from those 350 for the Biodiversity Monitoring Network (unfortunately due to financial reasons task of monitoring is abandoned nowadays and the net is renamed as Local Floras Network and used for studying gradients of different floristic parameters and a tool for analyzing floristic delimitation of the Asian Arctic (Yurtsev et al., 2001, 200; Koroleva et al., 2007, 2008 etc). Floras are located in 3 sectors of Asian Arctic – Yamal-Gydan, Taimyr and Chukotka. Totally floras of the network contain 1194 species from 257 genera and 65 families. Species richness increase from N to S, that is well known, but also from west to east (lowland Yamal and Gydan local floras number 100-200 species, the richest floras in southern Taimyr contain 200-300 species and Chukotka local floras are the richest numbering 300-400 species.

Totally about 40 LF were studied in Yamal-Gydan region (only part of sites are shown on the left map). Local floras are characterized by certain species richness in each bioclimatic subzone. LFs of Gydan are 20-30 species richer than such of Yamal in the same subzone. Diversity of CFs in southern hypoarctic tundra of Yamal is normally 175-190 species, in northern hypoarctic tundras 135-160 species and in arctic tundra (except Bely) - 115-125 sp. Species richness depends not solely on subzonal position, within subzone it depends on diversity of habitats, presence of the ancient geomorphological structures (Yamal marine plain) and respectively higher altitude and more differentiated relief, presence of sands.

Local floras from different subzones group in clusters according to their zonal position. 1 - LF "Ostrov Bely" (73°15' N, 71°30' E) , northern variant of arctic tundra; 2 and 3 – LF "Khabeiyakha" (72°25' N, 72°E) and "Tambei" (71° 45' N, 70° 25' E) , 4 – LF "Kharasavei" (71° 10' N, 67° 10' E) – southern variant of arctic tundra. (Low level of connection of "O. Bely" explains by big difference in species richness with other floras). 5– 9 - LF from northern hypoarctic tundra subzone: "Matuiyakha" (70° 55' N, 70° 20' E), "Vaskiny Dachi" (70° 15' N, 68° 55' E) , "Bovanenkovo" 70° 20' N, 68° 20' E), "Tomboito"(70° 18' N, 69° 40' E) , "Sebasyakha"(69° 37' N, 69° 27' E) ; 10-12 – LF from southern hypoarctic tundra: "Khevese" (68° 35' N, 73° 20' E), Laptayakha (68° 20' N, 73° 15' E), Khadyta (67° 35' N, 70° 25' E); 13- LF "Sjunaisale" 66° 55' N, 71° 20' E)- from northern forest-tundra.




147km, Aug. 1993. Zonal low shrub(Betula nana)-dwarf-shrub(Ledum decumbens)–sedge-moss community


o. Bely, July 2009. Eriophorum polystachion is dominating both in mires and in zonal communities

Very high (for southern Yamal) diversity of "Laborovaya" (=147 km) LF (ca.240 species) is explained by its location near the boundary of 2 floristic subprovinces: Ural-Novaya Zemlya and Yamal-Gydan, big number of species found here are common in Polar Urals, absent in Yamal proper and appear again in Taimyr, some of them we found in Gydan (*Eritrichium villosum, Saxifraga spinulosa, S. hirculus, Androsace chamaejasme, Senecio resedifolius*).

Extreme poverty of "o.Bely" is caused first of all by its relief, soil and hydrology features (along with "short time" of flora formation), and not only by its high latitude position, many arctic herbaceous species occurring further northwards are absent due to absence of suitable habitats.

Along with tendency of dropping out of boreal and hypoarctic species northwards, 26 species of arctic fraction appear in northern hypoarctic and arctic tundra. Specific of geographic structure of West Siberian LFs compare to Taimyr ones is high portion of boreal and hypoarctic species. Though arctic fraction prevails in number in total flora (158 from 400 species), its role in the plant cover is low on the biggest part of the territory, only few arctic or metaarctic species dominate in some habitats (*Alopecurus alpinus, Dupontia fisheri, Arctagrostis latifolia, Carex concolor, Salix polaris*) whereas arctic-alpine species are more active within all subzones and dominate in different habitats.


Bovanenkovo, SU-33, aug. 1989

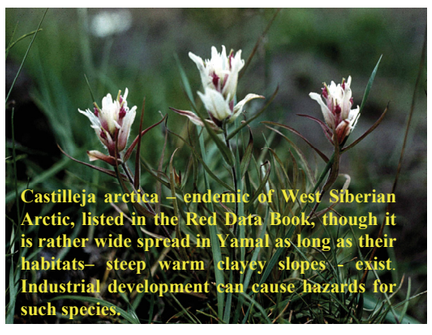
Heavily impacted by industrial activities LF "Bovanenkovo" (left foto) numbers 136 species, whereas nearby at relatively intact "Vaskiny Dachi"(right foto) it is 156. Similarity of species composition of these floras is 88%. *Arnica iljinii, Erigeron eriocalix, Viola biflora, Castilleja arctica, Linnaea borealis* are absent in "Bovanenkovo". These species are characteristic for southern slopes, many such habitats were deteriorated in Bovanenkovo. At Bovanenko increased abundance of grasses (*Calamagrostis lapponica, C.neglecta, Alopecurus alpinus, Deschampsia glauca*) were recorded in zonal communities (compare to similar communities at VD). We consider it as response to increased anthropogenic pressure (construction of facilities, winter roads and recreation, along with long-term overgrazing) (Rebristaya, Khitun,1998).


Lake Ngaranato, August 1991. Zonal vegetation is Betula nana-Salix glauca-Carex arctisibirica –lichen-moss tundra. Willow copses are very widespread in depressions.

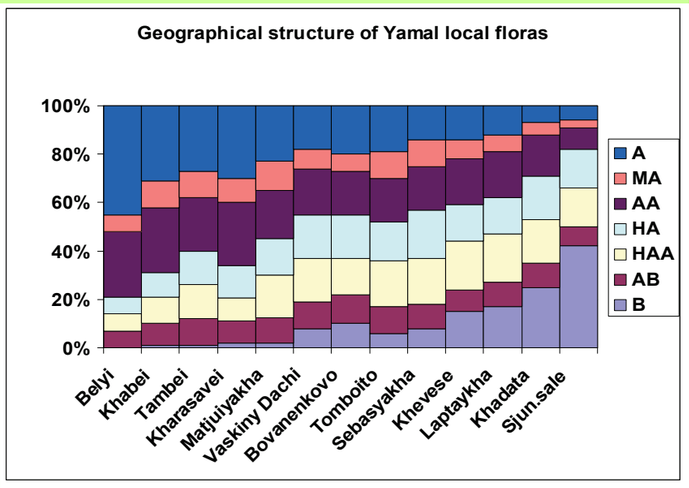
Intralandscape diversity of local floras (Tazovsky and Gydansky peninsulas) :

habitat types, total amount of species in their partial floras (PF) and number of species in floristic nuclei (FN).

Habitat type		S. hypoarctic tundra				N. hypoarctic		Arctic tundra			
		Laiyakha		Poilova		Tinikyakha		Khonorasale		Matyuisale	
#	Name	PF	FN	PF	FN	PF	FN	PF	FN	PF	FN
1	Flat interfluves and their gentle slopes with zonal communities	49	28	34	26	47	29	48	30	67	43
2	Convex marginal parts of the flat tops of the hills with frost-boiled polygonal tundra	35	21	32	20	44	27	48	28	62	43
3	Slightly elevated better drained surfaces on river terraces	43	25	34	20	39	22	60	37	60	30
4	Long gentle slopes with moss tundra with low willows	43	25	33	20	46	30	57	38	65	47
5	Long gentle foots of hills, with some mineral enrichment	30	21	32	20	55	39	55	35	56	37
6	Peat high centered polygons in polygonal bogs	25	18	30	22	29	16	36	18	33	19
7	Wet olygotrophic troughs (interstrang) in polygonal bogs	20	11	16	11	20	13	28	14	22	13
8	Steep sandy slopes with dwarf-shrub-grass communities	70	43	45	35	50	30	61	39	45	30
9	Steep, clayey or sandy well-drained slopes with herbaceous meadows	70	50	54	35	65	43	73	49	69	45
10	Drained parts of floodplain	55	33	51	32	37	24	37	21	49	24
11	Sand beaches, sand blow-outs on hills with sparse vegetation	32	15	24	15	33	17	37	17	-	-
12	Steep sandy failures of active banks of the rivers	-		33	18			47	28	30	20
13	Bottoms of wide hollows, concaves on slopes with willow copses	54	38	57	41	42	27	39	25	35	23
14	Little hollows on slopes and foothills with snowbeds	69	44	61	37	43	25	55	23	58	23
15	Clayey landslides with pioneer vegetation	36	17	42	16	43	20	48	20	37	17
16	Old entirely recovered landslides' amphitheatres	56	27	-	-	-	-	39	19	-	
17	Wet depressions in the valleys with mires or wet meadows	52	38	40	30	33	24	37	26	37	22
18	Aquatic habitats	17	16	17	16	15	14	12	12	16	13
19	Coastal marshes	-		-		-		31	16	20	16
20	Convex parts of hills' slopes with dense alder thickets	40	5	45	3	-	-	-		-	


Castilleja arctica – endemic of West Siberian Arctic, listed in the Red Data Book, though it is rather wide spread in Yamal as long as their habitats– steep warm clayey slopes - exist. Industrial development can cause hazards for such species.

Examples from Gydan and Tazovsky peninsulas show that in contrast to local floras, number of species in PFs does not decrease northwards, contrary, it increases in some habitats (including zonal) in arctic tundra. The reasons are:(1) appearance of a group of arctic and arctic-alpine herbs, which were absent southerner (acidic pH-conditions in the hypoarctic parts of Yamal-Gydan region are not favourable for these species, in Taimyr they occur much southerner). (2) Change of landscape positions of species, they occupy all possible habitats. (3) Simultaneously with growth of climate severity difference between habitats decreases. (Ex. on Bely island, where snowbed species like *Solorina crocea* occur on wind-swept sandy bluffs).



Geographic elements: A - arctic, MA – metaarctic, AA – arctic-alpine, HA – hypoarctic, HAA –hypoarctic-alpine, AB – arctic-boreal, B- boreal.