BIODIVERSITY RESEARCH BASED ON LOCAL FLORA APPROACH IN RUSSIAN ARCTIC

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“Concrete flora” (A.I. Tolmatchev 1931) = a minimal floristic unit really existing in nature which is natural and comparable. “Concrete or elementary flora (CF) is homogenous enough, differentiated only ecologically flora of a limited part of the Earth surface”.

Criteria of homogeneity = constancy of species composition in similar habitats throughout the area of the CF.

Criteria of elementarity = absence of any floristic boundaries within the area under investigation.

Species richness 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.
In practice, to study of CF/LF
= to examine the area around base camp by radial routes about 6-7 km long during 2-3 weeks.
We compile species lists for all habitats existing in the area.
Information of species

A sample of floristic situation=local flora, usually equal to area-minimum of CF

PF= partial flora= flora of a habitat

Tolmachev distinguished between concrete (or elementary) flora and the area selected for the revealing of it: area-minimum of CF.

Yurtsev: in the field we perform a selective floristic sampling of some locality = “sample of floristic situation in a geographic point” = “flora of vicinity of a geographic point” = “local flora” (LF).
**Landscape activeness** (Yurtsev 1968, 1987, 1989, etc.) is estimated on the base of 3 characters: 1) species ecological amplitude; 2) abundance; 3) constancy in its habitats; 4) how common are the habitats where species exist in the area.

<table>
<thead>
<tr>
<th>Abundance</th>
<th>Euritopic</th>
<th>Hemieuritopic</th>
<th>Hemi-stenotopic</th>
<th>Stenotopic</th>
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<tr>
<td></td>
<td>Always</td>
<td>Sporadic</td>
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<td>V</td>
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I– non active, II– low active, III- medium active, IV- high active, V–superactive
The distribution of local floras included into the network of biodiversity monitoring sites in Russian Arctic, Representative for the sector (subprovince, subzone); Specific, unique features of this particular landscape, presence of rare species, endemics; Situated at boundaries of subzones, phytochoria (ecotone position); flora should be revealed completely enough; information about distribution of each species, its activeness
Only few local floras were re-inventoried by now, results of re-inventory are not uniform. For several sites – no changes, for several – increase in boreal and hypoarctic species was noted.
Study of local floras allow to get new information about distribution of species and reconstruct the history of migrations. Species which were formerly considered as narrow endemics were found in local floras remote from known previously sites.

*Draba oblongata* (*D. groenlandica*)
Was considered endemic of Greenland and Canadian Arctic archipelago

*Oxytropis wrangelii* и *Puccinellia colpodioides*
Was considered as endemic of Wrangel Island

*Gastrolychnis ostenfeldii*
Was considered as endemic of NW Canada, but was found on Wrangel isl, Chukotka and Taimyr
Calamagrostis deschampsiioides (1) was mainly found along the coast of the European part of Arctic and along Chukotka coast, now it is not yet found only in Taimyr. Roegneria villosa (3) was considered as rare species with isolated populations in East Siberian Arctic, now we can confirm that its range is from Taimyr to Beringian coast.

Grey icons – locations shown in the ‘Arctic Flora of USSR’, black – later findings in local floras.
Scheme of floristic regionalization of the Arctic (Yurtsev et al. 1978, shorten English version Yurtsev 1994), since that - many new findings, revision of herbarium from studied earlier local floras.

<table>
<thead>
<tr>
<th>Species</th>
<th>Former status</th>
<th>Present status</th>
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<tbody>
<tr>
<td>Castilleja arctica</td>
<td>Yamal-Gydan subprovince, rare endemic, differential</td>
<td>Common in YA-G, found in Taimyr and Anabar</td>
</tr>
<tr>
<td>Lychnis sibirica</td>
<td>Yamal-Gydan eastern co-differential</td>
<td>Found in Kanin-Pechora</td>
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<tr>
<td>Draba pohlei</td>
<td>Endemic of ast Siberian province</td>
<td>Found in Ural-Nov. Zemlya subpr., co-dif</td>
</tr>
<tr>
<td>Carex trautvetteriana, C.williamsii</td>
<td>Differential for Kharaulakh</td>
<td>Found in Taimyr and Anabar-Olenek</td>
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</tbody>
</table>
Taraxacum semitubulosum, differential for Kharaulah, endem, now found in Anabar-Olenek.

Papaver gorodkovii, was differential for Chukchi province, found in Taimyr.

Oxytropis putoranica – endemic of Taimyr.

Artemisia lagopus ssp. abbreviata Co-dlf Kharaulakh and Anabar-Olenek
## East Siberian Province

### Taimyr subprovince
- Puccinellia byrrangensis
- Puccinellia gorodkovii
- Puccinellia jenissejensis
- Roegneria lenensis
- Cerastium regelii subsp. caespitosum
- Draba taymyrensis
- Oxytropis putoranica
- Cortusa matthioli subsp. altaica
- Dracocephalum nutans
- Castilleja tenella
- Claytonia joanneana
- Ptarmica impatiens
- Taraxacum platylepium

### Anabaro-Olenek subprovince
- Arctopoa trahtvetteri
- Helictotrichon schellianum
- Taraxacum semitubulosum
- Potentilla lenensis
- Artemisia lagopus subsp. triniana
- Artemisia lagopus ssp. abbreviata
- Caragana jubata

### Kharaulakh subprovince
- Saxifraga lactea
- Spirea dahurica
- Oxytropis sordida subsp. arctolenensis
- Taraxacum semitubulosum
- Potentilla lenensis
- Artemisia lagopus ssp. abbreviata
- Caragana jubata

### Both Taimyr and Anabaro-Olenek
- Deschampsia vodopjanoviae, Festuca jacutica, Trisetokoeleria taimyrica
- Juncus longirostis, Oxytropis czekanowskii, Oxytropis tichomirovii
- Taraxacum byrrangica, Taraxacum taimyrense
Both in Yana-Kolyma and Continental Chukotka

**Yana-Kolyma subprovince**

- Arctopoa petrovskyi
- Elytrigia villosa
- Gorodkopia jacutica
- Astragalus penduliflorus
- Oxytropis middendorffii
- Oxytropis middendorffii subsp.jarovoi
- Papaver stubendorfii
- Androsace gorodkovii
- Artemisia gmelinii
- Artemisia gmelinii subsp.scheludjakoviae (-)
- Artemisia lagopus
- Artemisia lagopus subsp.jarovoi
- Taraxacum jacutucum (-)
- Artemisia jacutica (-)

**Continental Chukotka**

- Roegneria nepliana
- Suaeda arctica
- Carex sordida = C.hirta
- Hedinia czukotica
- Chrysosplenium alternifolium
- Potentilla anjuica
- Oxytropis middendorffii
- Oxytropis middendorffii subsp.coerulescens
- Oxytropis schmorgunovii
- Oxytropis sverdrupii
- Plantago canescens
- Plantago canescens subsp.jurtzevii
- Artemisia flava
- Taraxacum anadyricum
- Taraxacum chaunense
- Taraxacum leucocarpum

**Both in Yana-Kolyma and Continental Chukotka**

- Festuca kolymensis
- Oxytropis ochotensis
- Oxytropis vasskovskyi
- Veronica incana
Beringian Chukotka

Botrychium pinnatum
Puccinellia beringensis
Puccinellia czukczorum
Rumex beringensis
Rumex krausei
Claytonia sarmentosa
Aconitum delphinifolium
subsp paradoxum
Anemone parviflora (-)
Papaver walpolei (-)
Aphragmus escholtzianus (-)
Arabidopsis tschuktschorum
Potentilla beringensis
Potentilla czegetunica
Oxytropis berengensis
Dodecatheon frigidum
Artemisia senjavinensis
Variables studied with Russian Arctic local floras database

- **Number of:** species (=sp. richness), genera, families in local and regional floras;
- **Mean± SE, min, max number of sp., gen., fam. for local floras of the region**;
- **Percent portion** of species richness of a certain local flora to species richness of respective regional flora;
- **Mean; min; max number of species in:** family, genus; **number of genera in family**;
- **Number and portion of single species, genera and families**;
- **Number and portion of differential species and genera**;
- **Number of species in 5 and 10 richest families** and their portion in the flora;
- **Ratio Asteraceae/Poaceae; Cyperaceae/Poaceae**;
- **Composition** of the richest and poorest families;
- **Ratio of different divisions of vascular plants**;
- **Presence, number and portion of rare species** (occur in 1-2 local floras);
- **Number and portion of species with 100% occurrence** in local floras of a subprovince;
- **Similarity** of local floras by species composition (Sørensen similarity index);
- **Index of complexity of the taxonomic structure** (Shmidt, 1984);
- **Index of autonomy (autochtonity-allochtonity)** (Malyshev, 1976);
- **Portion of woody plants species**;
- **Presence and composition of trees**;
- **Number and ratio of longitudinal and latitudinal groups and fractions**;
- **Similarity of local floras by geographical structure**.
Mean species richness of local floras in Chukotka subprovinces varies between 273 to 346. In Yamal it is 164, in Taymyr – 172.

The relatively high species richness of East-Asian floras is caused by the relief diversity, the floras history and close proximity of the region to the ancient speciation centers – Angarida and Beringia.
YAT study sites

1–southern boundary of Yamal peninsula полуострова; 2–northern boundaries of geobotanical subzones (I – forest-tundra; II – southern hypoarctic tundra; III – northern hypoarctic tundra; IV – arctic tundra); 3 – Polar circle; 4 – local flora study sites studied by Olga Rebristaya alone or together with Olga Khitun:


Without number sites studied by Olga Khitun only (blue circles): 144 km, Mus Kamennui, Yara-yakha, Bovanenko, Bely-west.
Clear dependence between zonal position and floristic diversity is exhibited in the region as well. Floras’ diversity decreases gradually from ca 240 species at “Laborovaya” (E), 156 – at “Vaskiny Dachi” (D), 125 – at “Kharasavei” (C) and 65-75 at “Bely” (B). Variation in species richness and, partly, in composition and coverage depends also on local relief, soil and drainage conditions.

Average number of species (+/- SE) in local floras in different subprovinces and in different subzones

1= Kola-Karelia (KK); 2= Kanin-Pechora (KP); 3= Ural-Novaya Zemlya (UN); 4= Yamal-Gydan (YG); 5= Taimyr (T); 6= Anabar-Olenek (AO); 7= Kharaulakh (K); 8= Yana-Kolyma (YK); 9 = Continental Chukotka (CC); 10= Chukotka, Wrangel Island (CW); 11= Southern Chukotka (CS); 12= Beringian Chukotka (CB)
Similarity of local floras by spectra of longitudinal fractions

Similarity measure – Sørensen-Czekanovski index modified by Semkin (1982) for classes: 

$$K_{AB} = \sum \min (d_{iA}, d_{iB})$$

where $K_{AB}$ - similarity between flora A and B, $d_{iA}$ – relative weight $i$-class in flora A, $d_{iB}$ - relative weight $i$-class in flora A

Clusters:
All boundaries by similarity of geographic structure spectra and areas of density of ranges of geographic groups and fractions in different sectors of the Arctic

Boundaries: 1 - floristic subprovinces, 2 - open woodlands, 3 - stlanic subzone, 4 - by spectra of longitudinal fractions, 5 - by spectra of longtitudinal groups, 6 - by spectra of latitudinal fractions, 7 - by spectra of latitudinal groups, 8 - generalized by density of all boundaries in distribution of groups and fractions
Similarity of local floras by species composition
Dendrogram of local floras similarity by species composition and distribution of clusters throughout the Russian Arctic.
Combination of all boundaries by 10 parameters of geographical and taxonomical structure of local floras

Boundaries: 1 – floristic subprovinces, 2 – open woodlands, 3 – subzone of stланик, 4 – by condensation of ranges of distribution of longitudinal groups and fractions, 5 – by similarity of spectra of geographic structure 6 – by similarity of spectra of taxonomic structure
DCA ordination of 238 lists of species (LF), axis 1 reflects longitudinal gradient.

Similarity of floras of 11 subprovinces by species composition
Use of our data for nature conservation:

- Revealing of rare and endemic species
- Revealing of the territories with abundance of rare species
- Suggestion of objects for the Red and Green Data Books;
- Writing the essays for the Red and Green Data Books

Salix berberifolia ssp. fimbriata
THANK YOU!!!