



# APPLICATION OF RUSSIAN ARCTIC LOCAL FLORA DATABASE TO THE ISSUES OF BIODIVERSITY CONSERVATION

Olga Khitun<sup>1</sup>, Tatjana Koroleva<sup>1</sup>, Svetlana  
Chinenko<sup>1</sup>, Vladik Petrovsky<sup>1</sup>, Andrei Zverev  
Elena Pospelova<sup>3</sup>, Igor Pospelov<sup>3</sup>

<sup>1</sup> Komarov Botanical Institute, Saint Petersburg, Russia

<sup>2</sup> Tomsk State University, Tomsk, Russia

<sup>3</sup> Nature Reserve "Taimyrsky"

Arctic Vegetation Archive Workshop,  
14-16 April 2013, Krakow, Poland





## **Concrete or Elementary Flora Concept**

**“Concrete flora” concept was suggested by A.I.Tolmatchev in 1931.**

**His idea - there is a minimal floristic unit really existing in nature which fulfills the request for being natural and comparable.**



**By Tolmatchev's definition, "concrete or elementary 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 elementarity is 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 km<sup>2</sup> (Tolmatchev, 1970; Yurtsev, 1975) in lowland parts and ca. 300 km<sup>2</sup> – in mountainous parts, in taiga it is an area of ca 600 km<sup>2</sup>.**



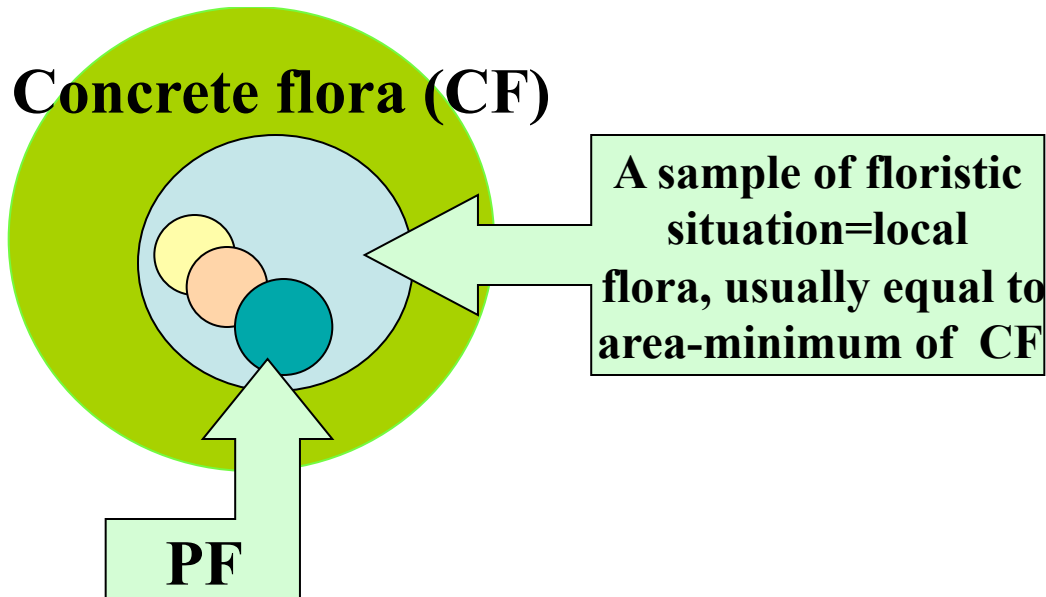
## **LOCAL FLORA (LF) VS CONCRETE FLORA (CF)**

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

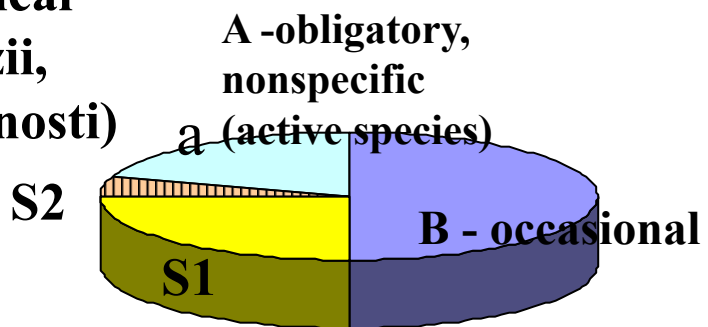
**In the field we just perform a selective floristic sampling of some locality, which Boris Yurtsev (1975) suggested to call “sample of floristic situation in a geographic point”, or “flora of vicinity of a geographic point”. Shelyag-Sosonko (1980) proposed a shorter name for it - “local flora” (LF).**

**In practice, study of CF/LF means that we examine the area around base camp by radial routes about 6-7 km long during 2-3 weeks as minimum, we compile species lists for different habitats (all existing in the area). 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.**

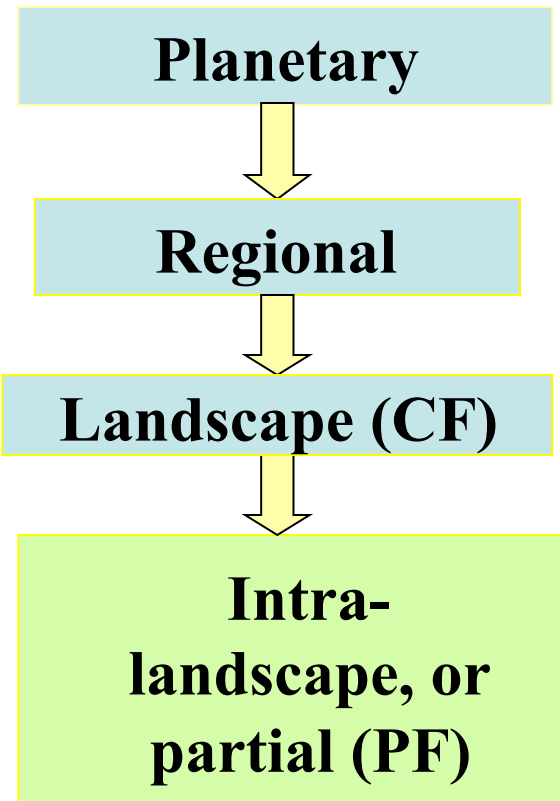




**Partial flora (PF)** – flora of intralandscape subdivision (micro, meso, macro habitats corresponding to geomorphological divisions into fazii, urochischa, mestnosti)



$S1+S2+a = \text{floristic nucleus}$   
 $S1+ S2= \text{florocoenotic complex}$





**Landscape activeness** (Yurtsev 1968, 1987, 1989, etc.) is estimated on the base of 3 characters: 1) species ecological amplitude (=tolerance); 2) abundance; 3) constancy in its habitats; 4) how common are the habitats where species exist in the area. It is estimated in 5 grades scale.

	Ecological tolerance									
Abundance	Euritopic		Hemi-euritopic		Hemi-stenotopic		Stenotopic			
							Common habitats		Rare habitats	
	Always	Sporadic	Always	Sporadic	Always	Sporadic	Constant	Non-constant	Constant	Non-constant
Copiosus	V	V	IV	IV	III	II	III	II	II	I
Sparsus	IV	IV	III	III	III	II	III	I	I	I
Solitarius	III	II	II	II	II	I	II	I	I	I

**I– non active, II– low active, III- medium active, IV- high active, V–superactiv**



# Study of flora of surroundings of Tiksi

- 1935. B.A.Tikhomirov and B.N.Gorodkov  
**180 species**

- 1966. B.A.Tikhomirov, V.V. Petrovsky,  
B.A.Yurtsev

- **281 species**



- 2004 . V.V. Petrovsky, N.A.Sekretareva,  
A.K. Sytin

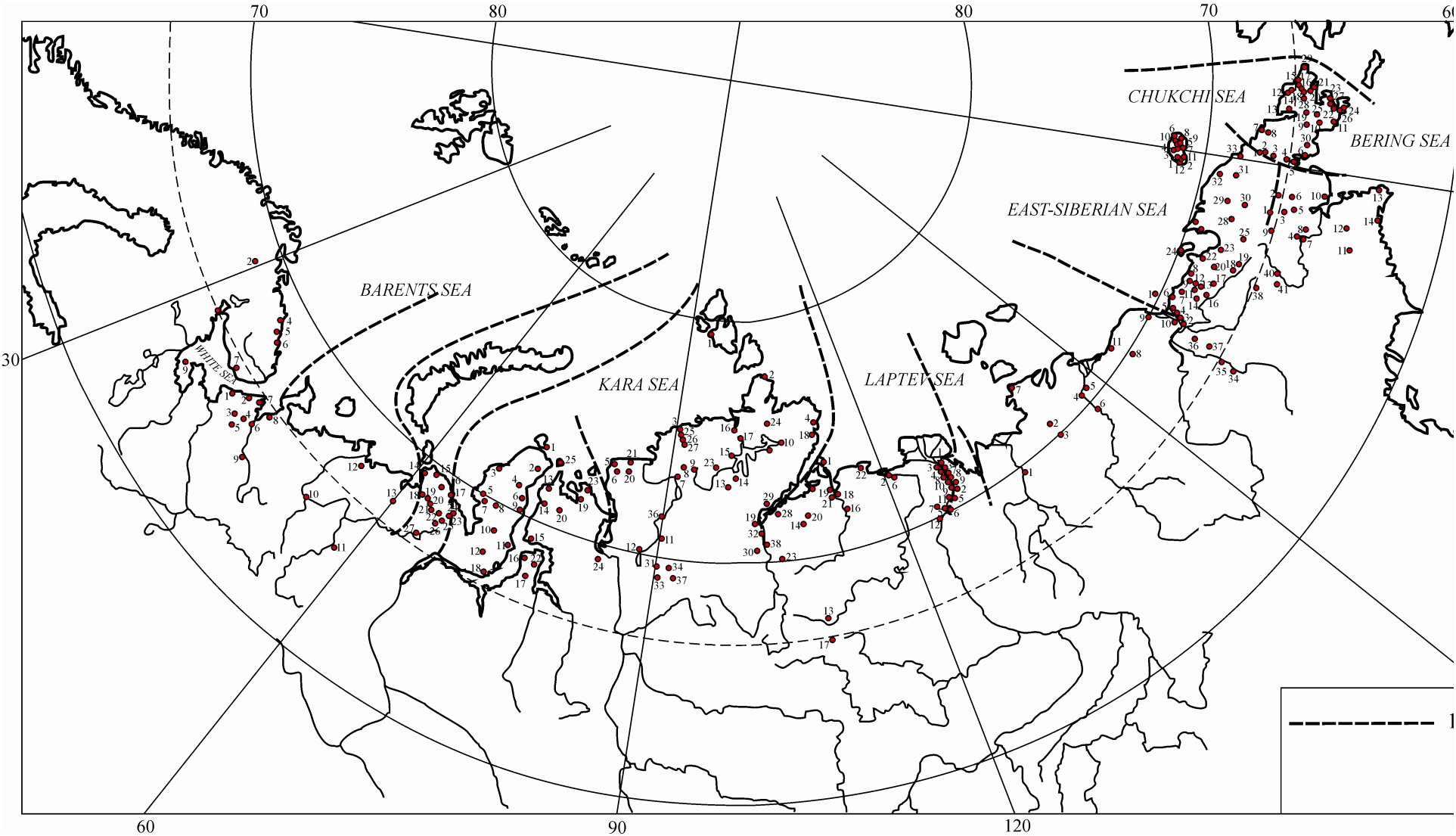
- **331 species**

## **Criteria for including local floras into the BD monitoring network**

- Representative for the sector ( subprovince, subzone, landscape)**
- 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**
- Several seasons of study, complex investigations with other specialists, especially if also mosses and lichens were studied**
- Presence of ecological-coenotic information about distribution of each species, its commonness, activeness**
- Coordinates for the most important findings**
- (map or airphoto)**



# The distribution of local floras included into the network of biodiversity monitoring sites in Russian Arctic,



## 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**



# System of longitudinal geographical groups and fractions

## **I. Circumpolar fraction**

1. Circumpolar group
2. Almost circumpolar group

## **II. Eurasian fraction**

3. Eurasian group
4. West Eurasian group
5. Asian (Siberian) group
6. East Asian (East Siberian)
7. Middle Siberian
8. Chukotian

## **III. Mainly Eurasian fraction**

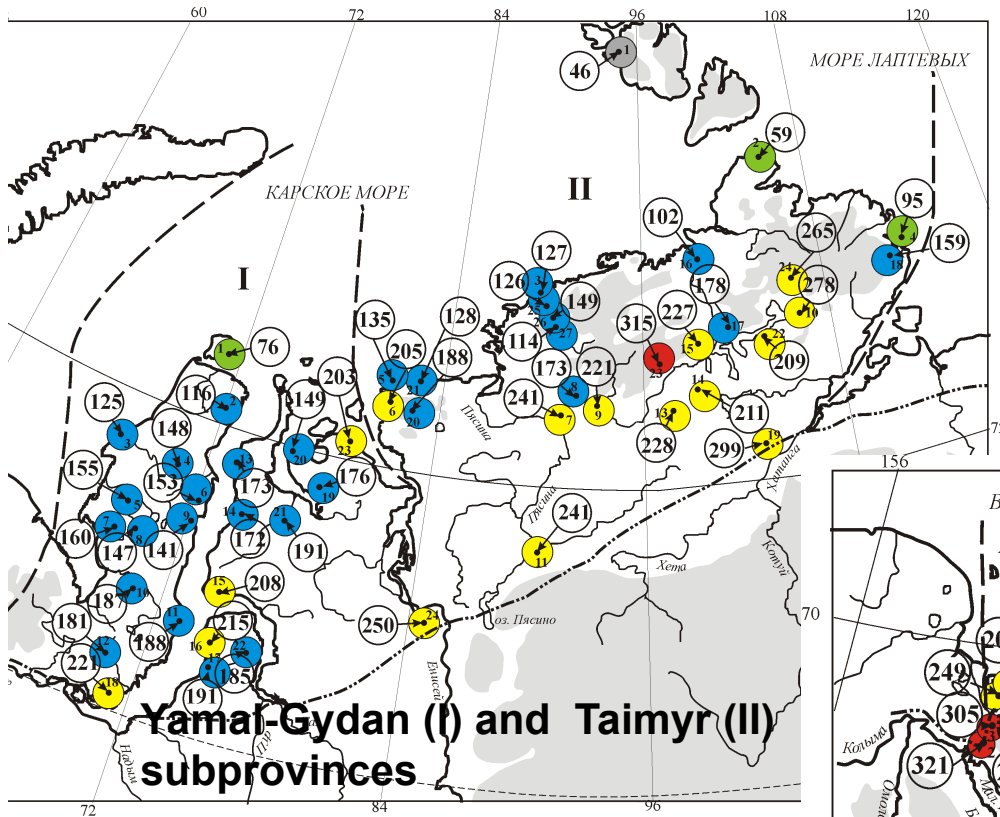
9. Eurasian - Western American group
10. Asian (Siberian) - Western American group
11. East Asian (East Siberian) - Western American group
12. East American – Eurasian group

## **IV. Mainly American fraction**

13. East Asian (East Siberian) – American group
14. Chukotian – American group
15. Chukotian – American - West Eurasian group

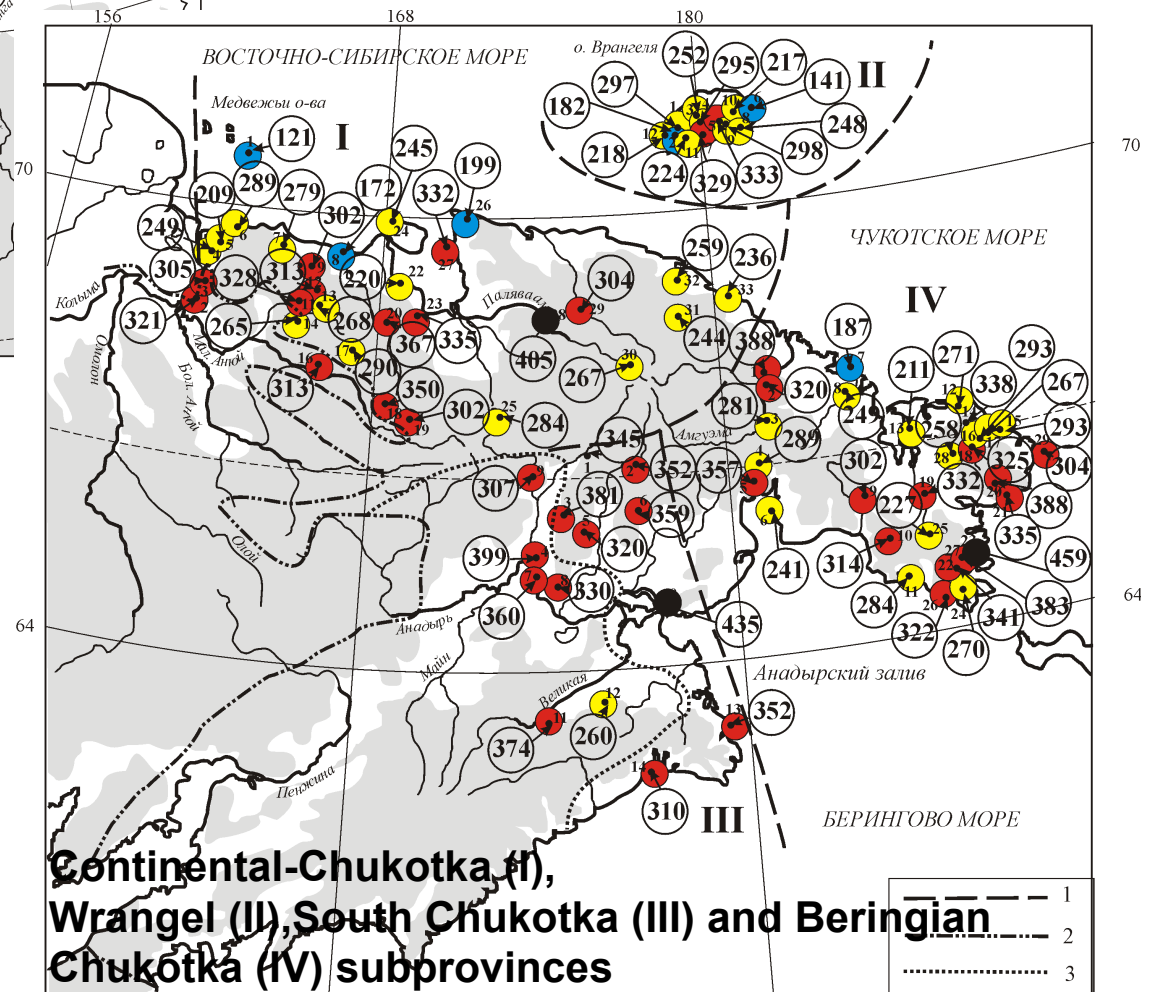
## **V. Oceanic fraction**

16. Amphi-oceanic group
17. Amphi-Pacific group
18. Amphi-Atlantic group



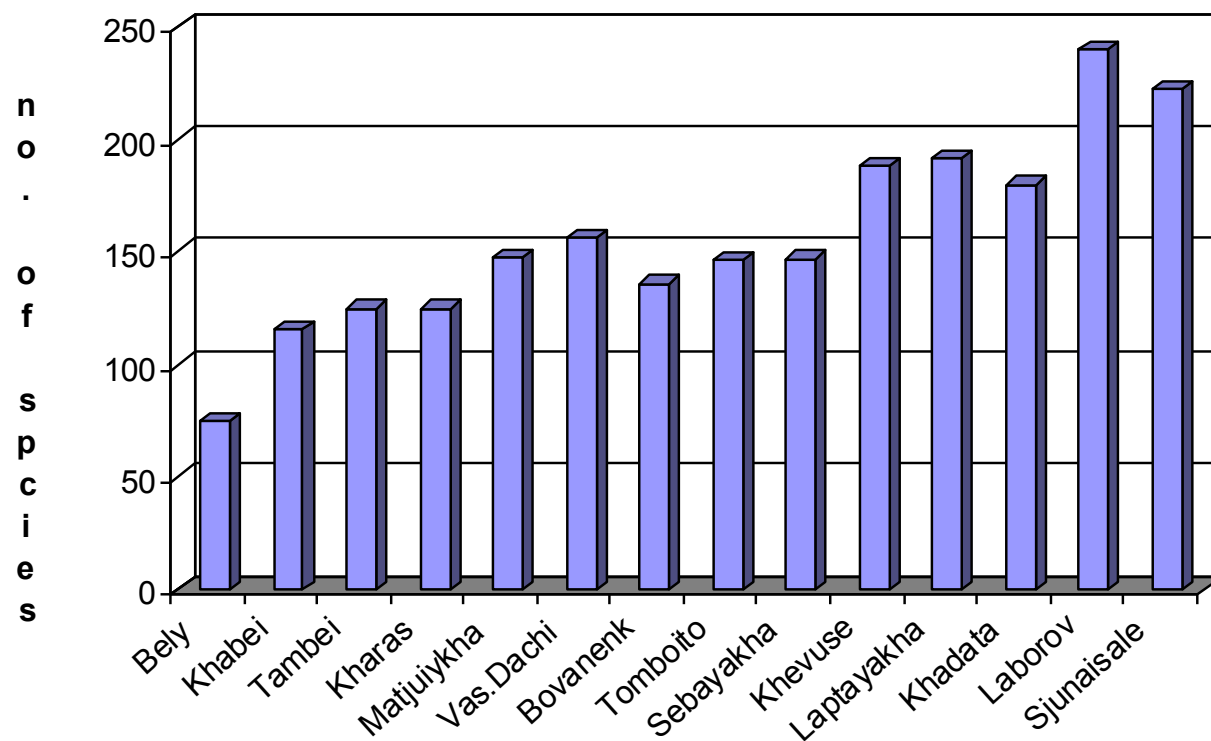
## Number of species in Yamal-Gydan, Taimyr and Chukotka sectors

Number of species:

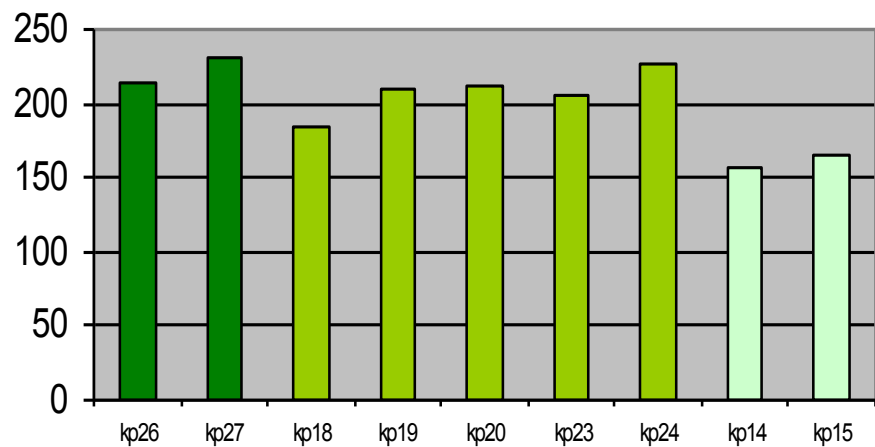




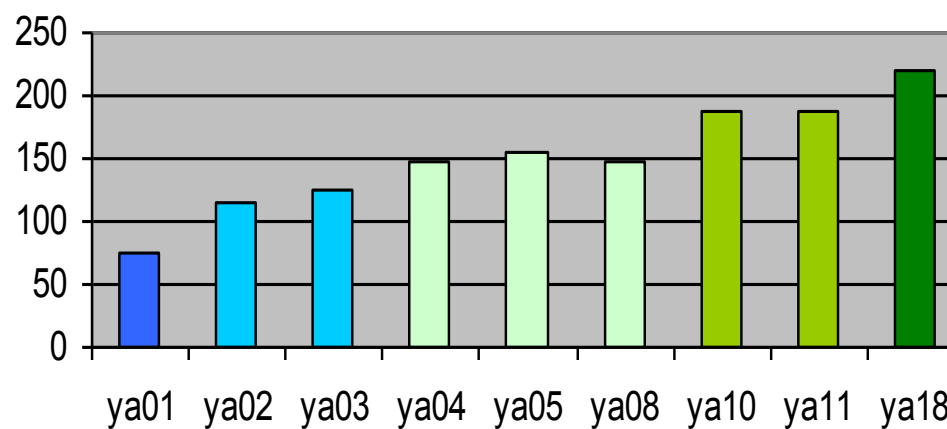
## Species richness of Yamal local floras



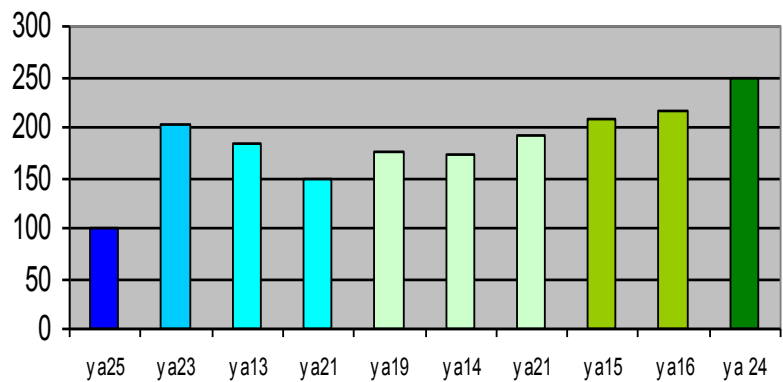
### East of Bolshezemelskaya tundra



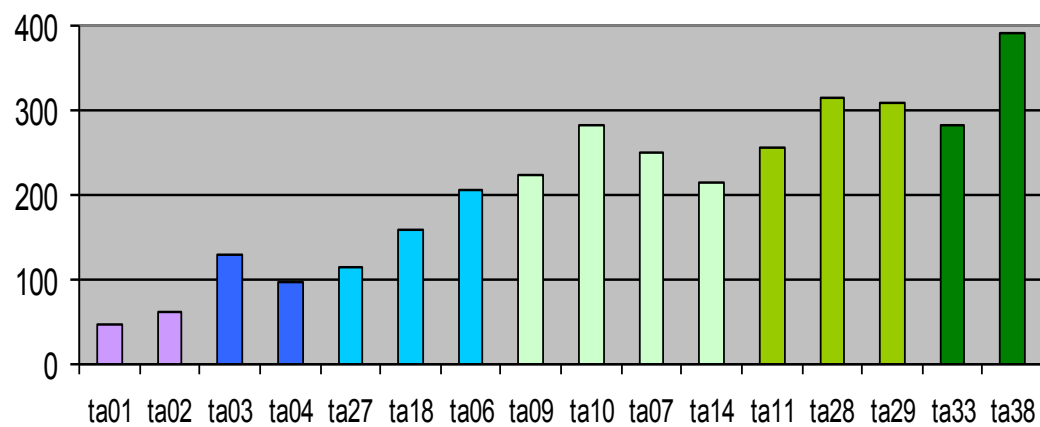
### Yamal



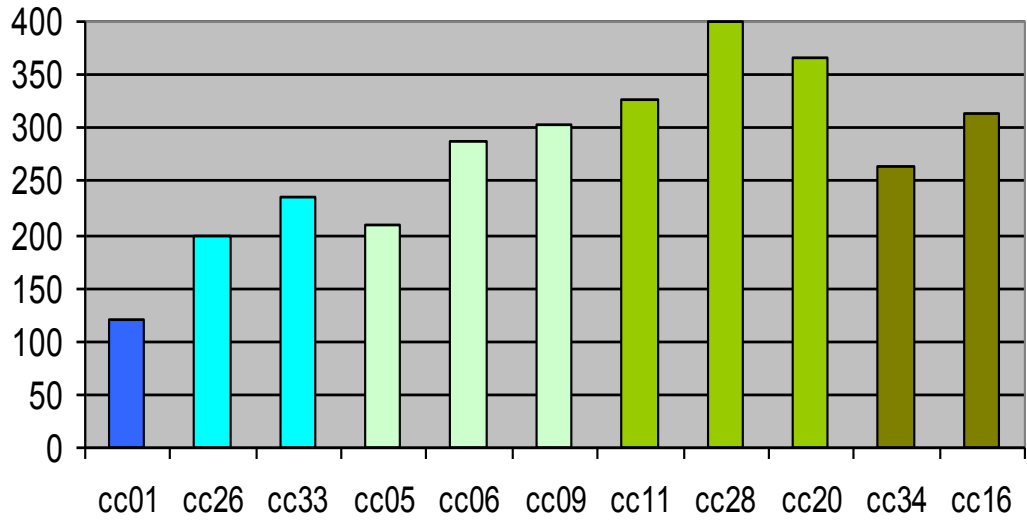
### Gydan



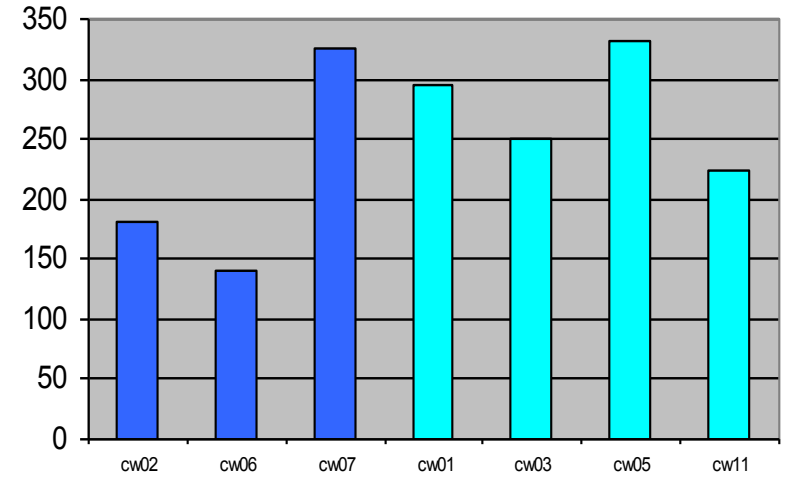
### Taimyr



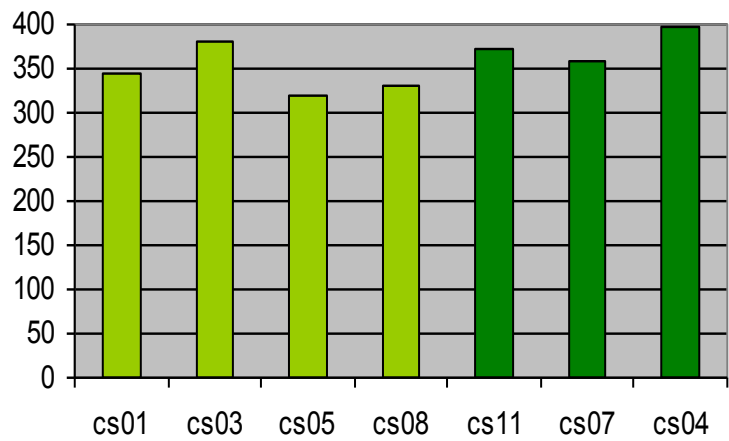
### Continental Chukotka



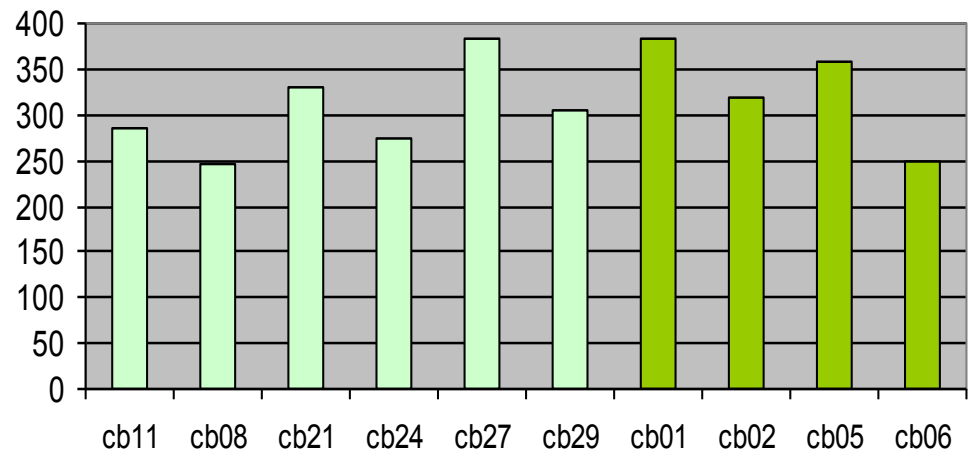
### Wrangel isl.



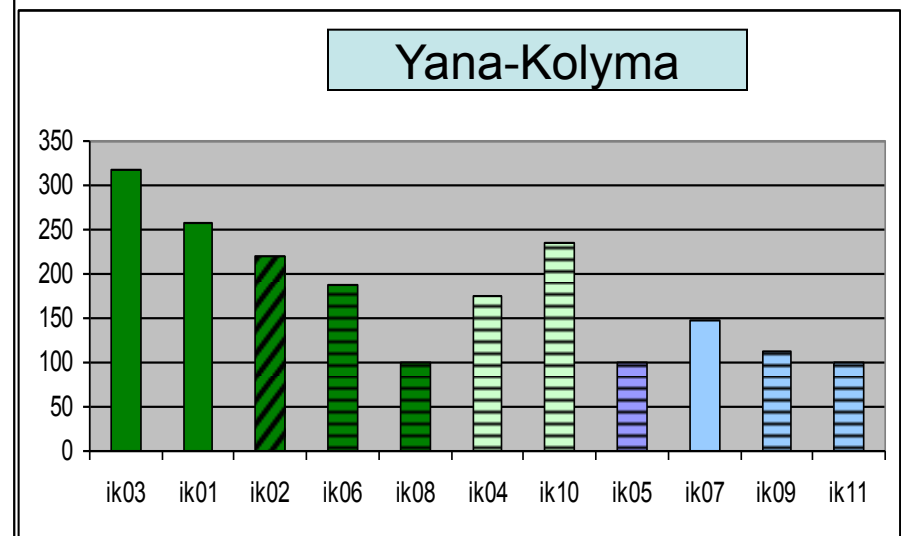
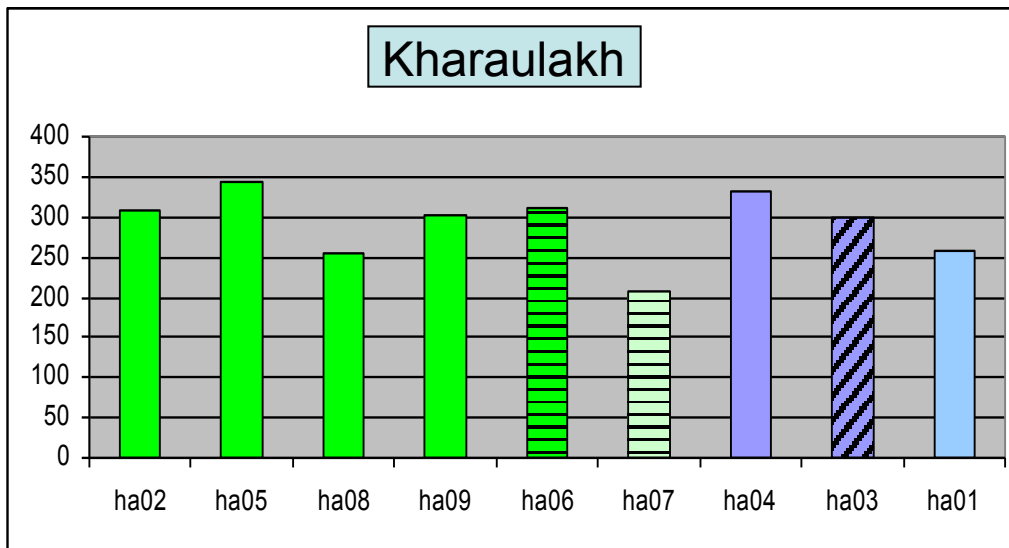
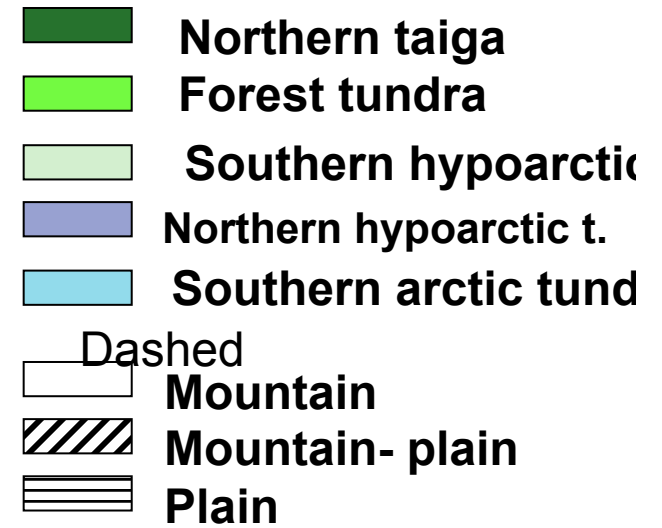
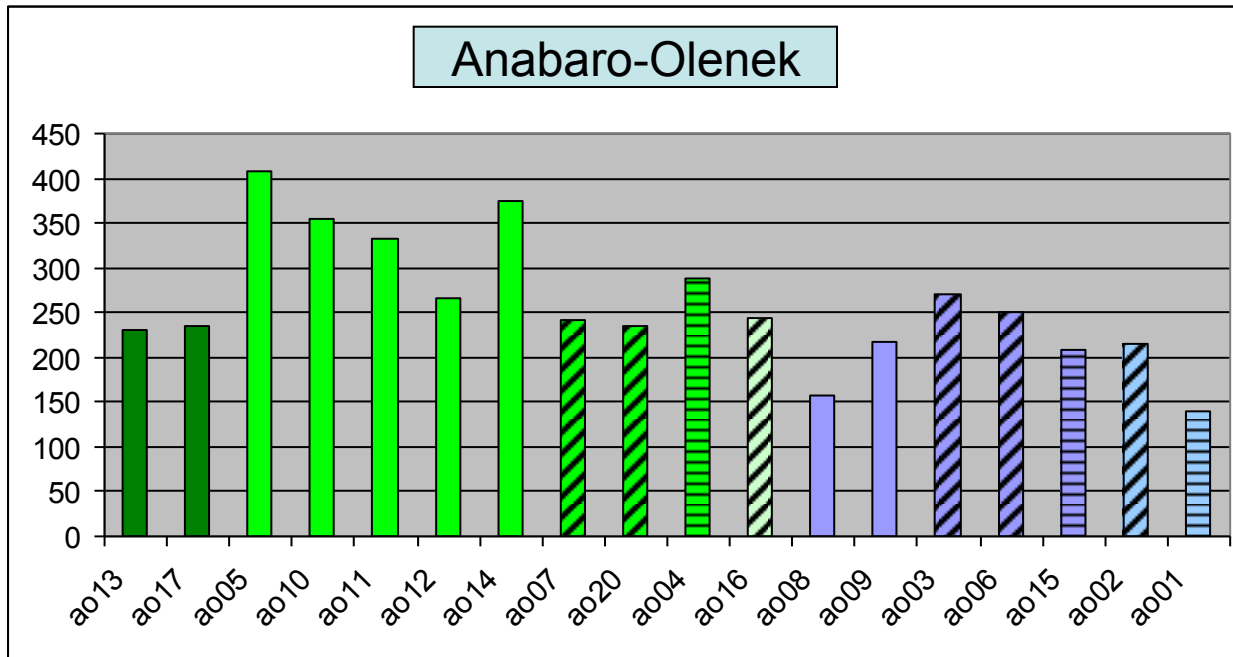
### South Chukotka



### Beringian Chukotka









**Mean species richness of local floras in Chukotka subprovinces varies between 273 to 346. In Yamal it is 164, in Taymyr – 172.**

**Typical landscape in Yamal-Gydan sector**

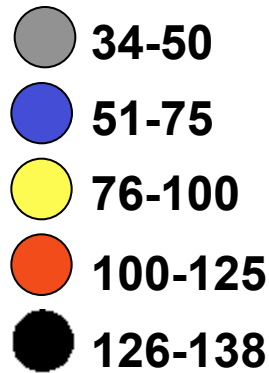
**The relatively high species richness of East-Asian floras is caused by the relief diversity, the floras history and close proximity of the region to the ancient speciation centers – Angarida and Beringia**



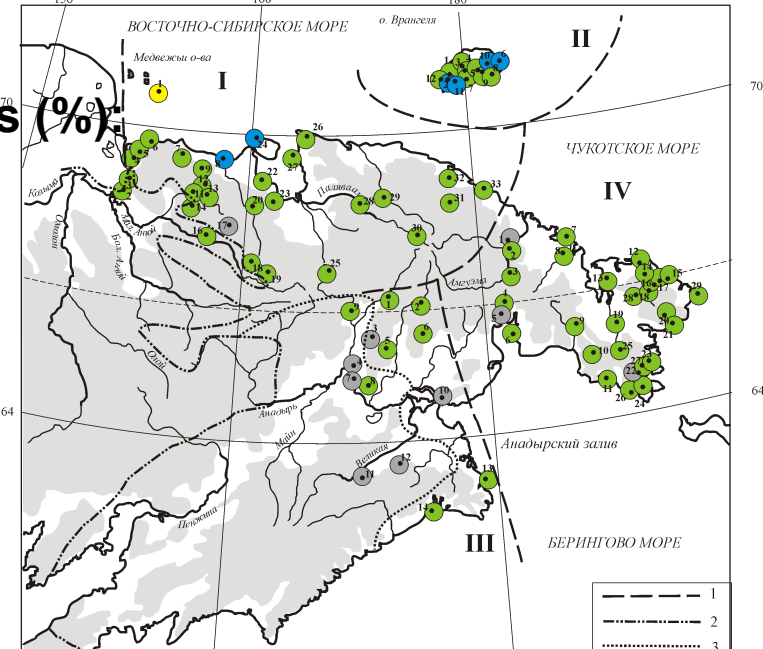
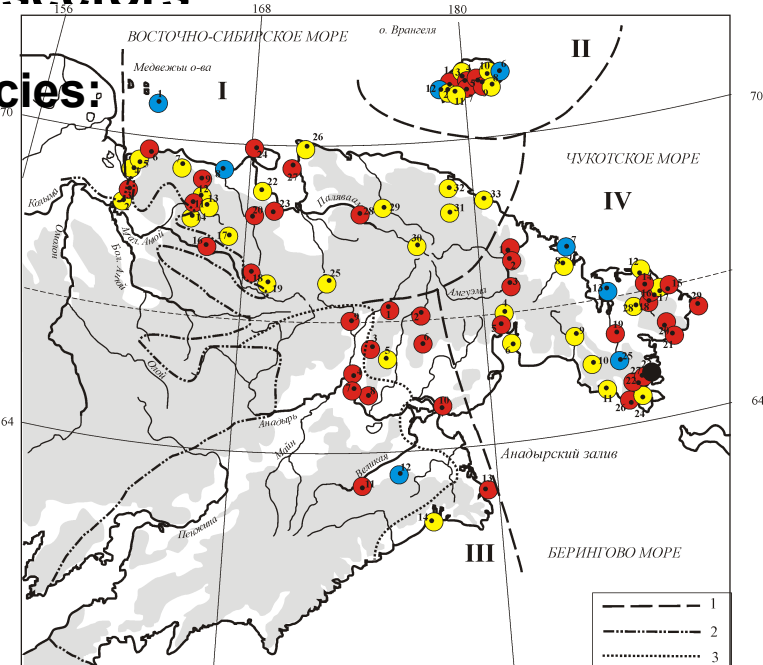
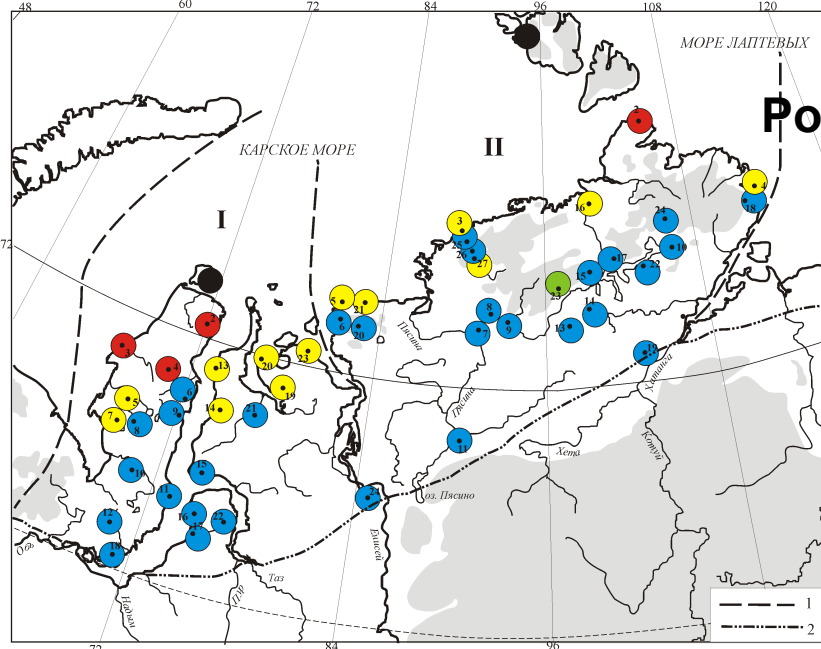
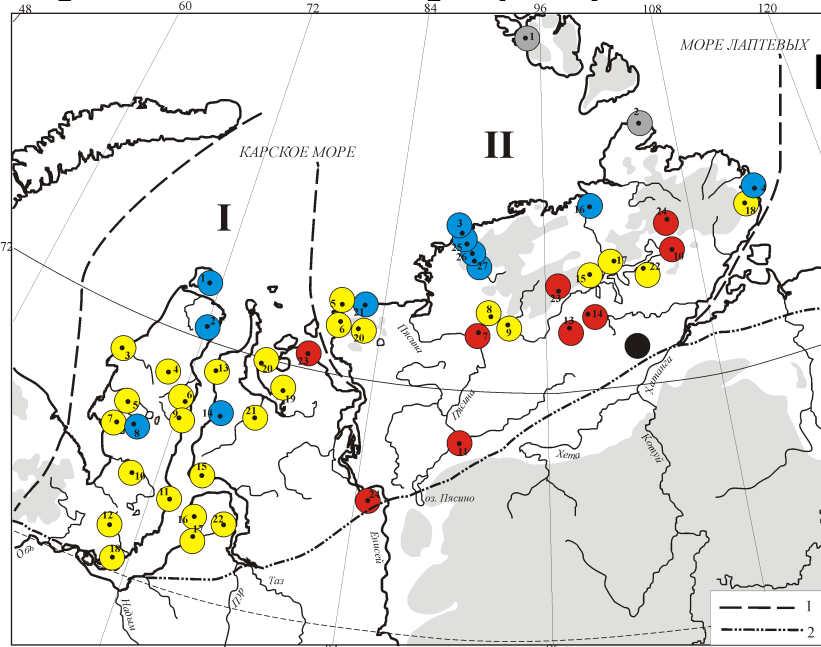
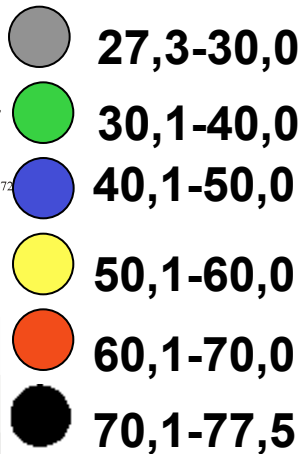
**Typical landscape in Chukotka sector**

# Number and portion of **circumpolar group** species in local floras of Yamal-Gydan and Taimyr (left) and Chukotka (right) sectors

## Number of species:

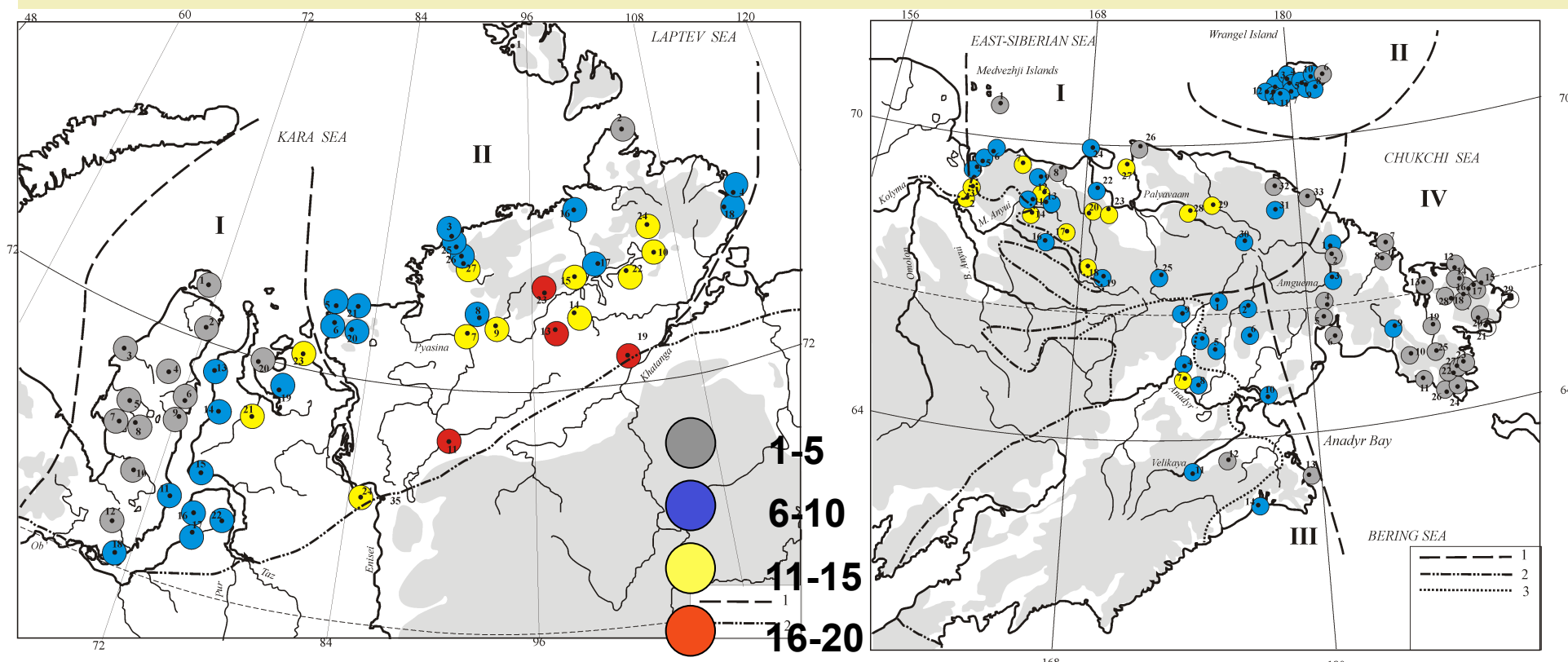


## Portion of species (%)





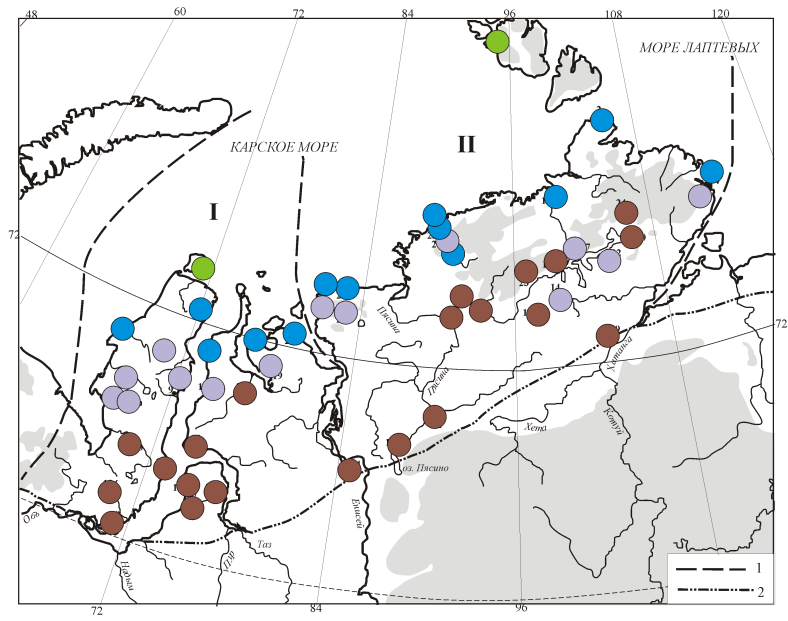
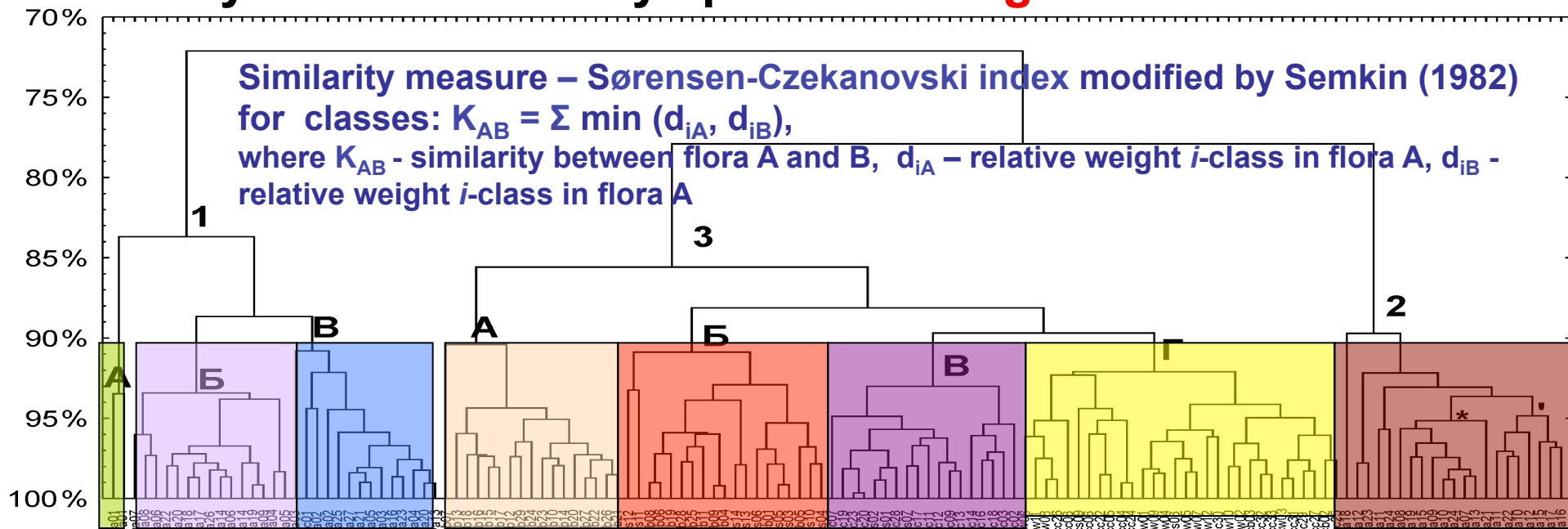
**Sharp gradients in longitudinal direction in number of species belonging to Asian group in local floras in different sectors of the Arctic.**



**Number of Asian species in LFs increases in the central parts of the Asian Arctic and notable decreases in the marginal sectors. The distribution of this group marks the boundary between Yamal and Gydan peninsulas, individualization of the eastern part of Gydan and central parts of Taimyr, of Western Chukotka and of Chukotka.**

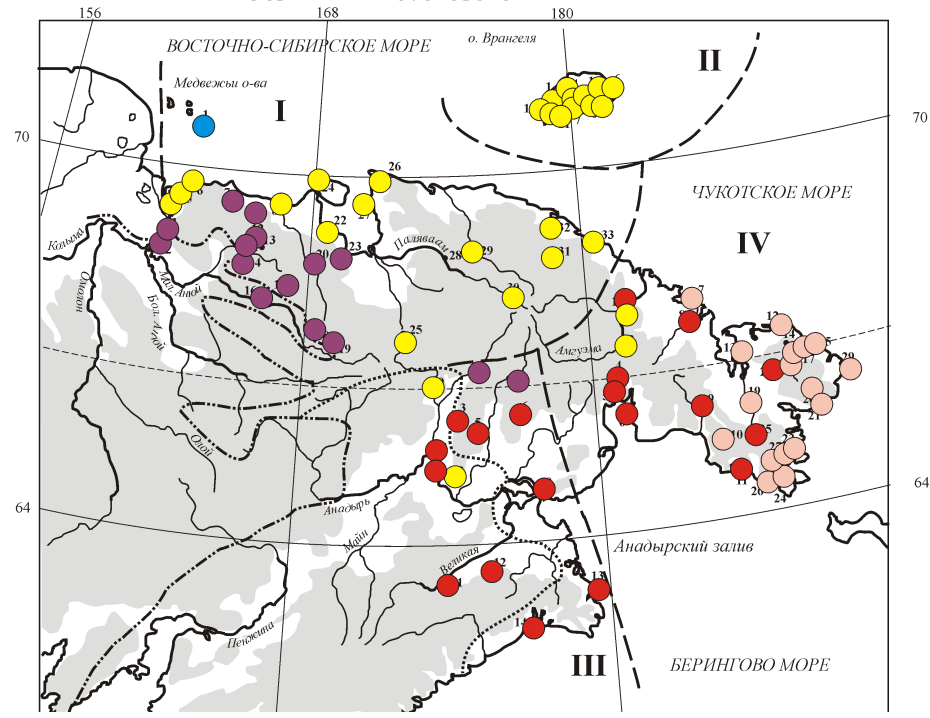


# Similarity of local floras by spectra of longitudinal fractions

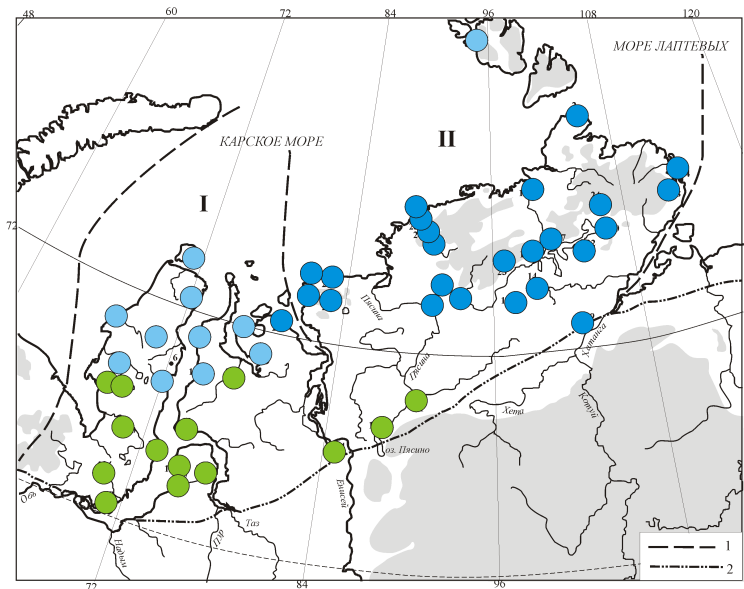
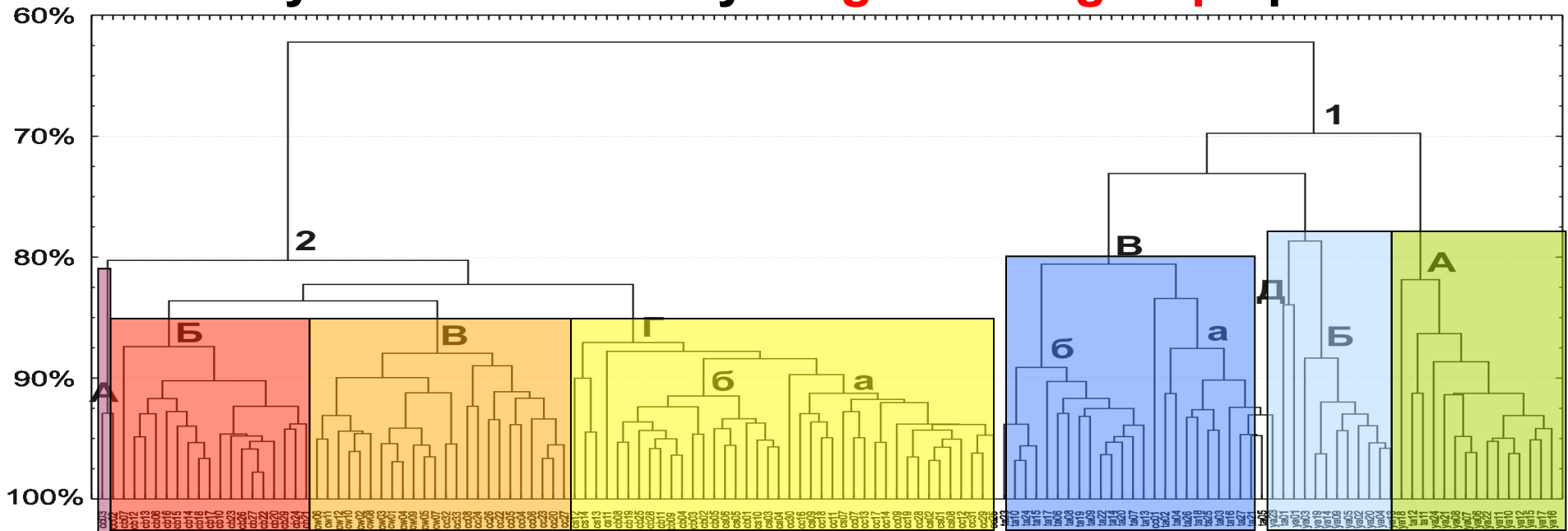


## Clusters:

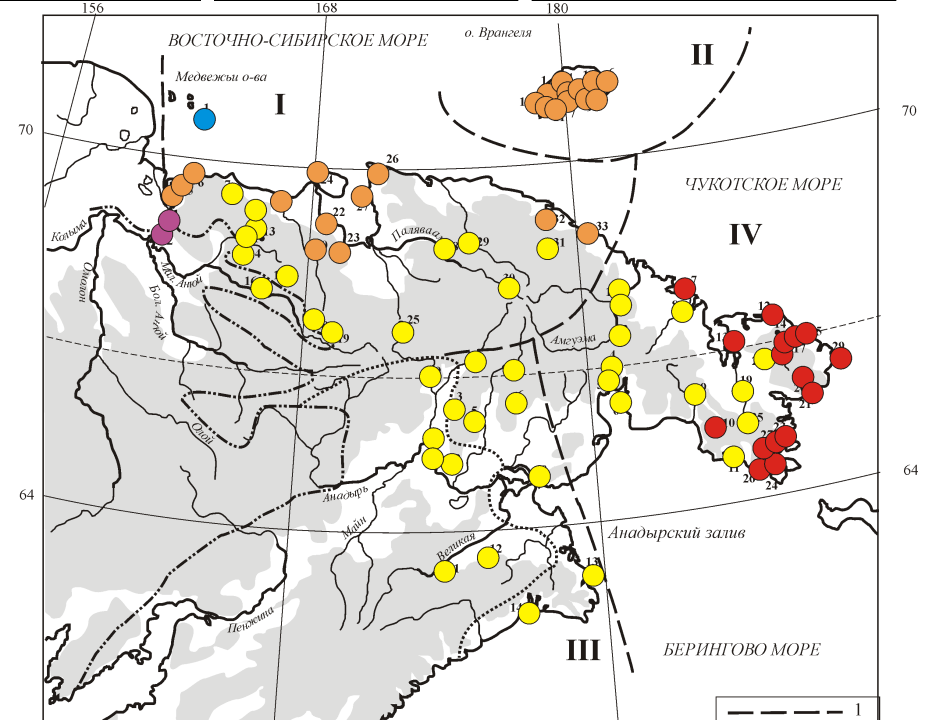
- 1A
- 1B
- 1B
- 2
- 3A
- 3B
- 3B
- 3Г

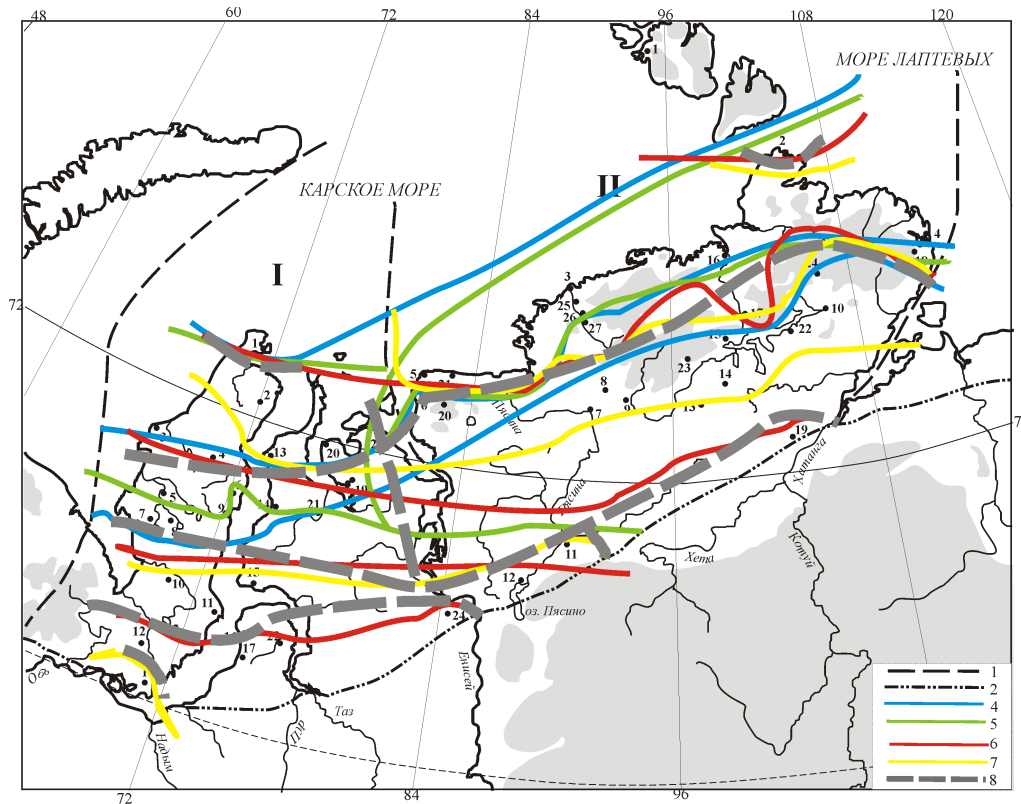


# Similarity of local floras by longitudinal group spectra



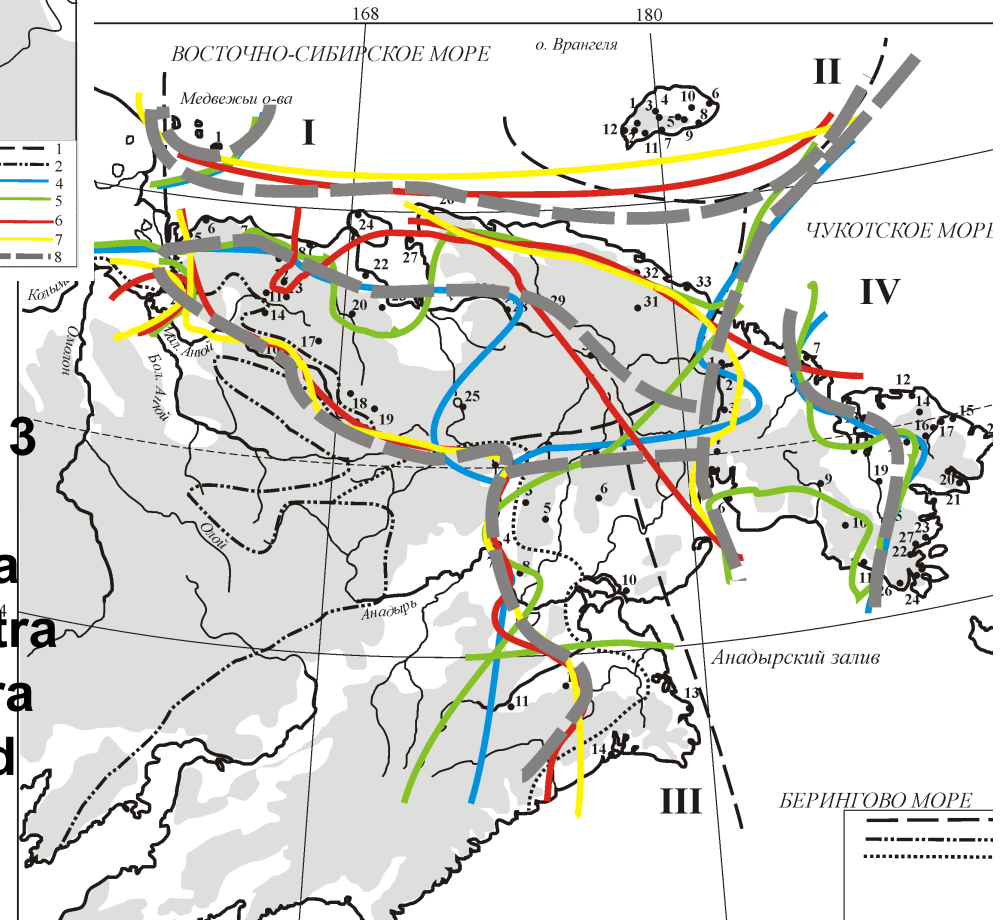
- Clusters:**
- 1A
  - 1Б+1Д
  - 1В
  - 2А
  - 2Б
  - 2В
  - 2Г



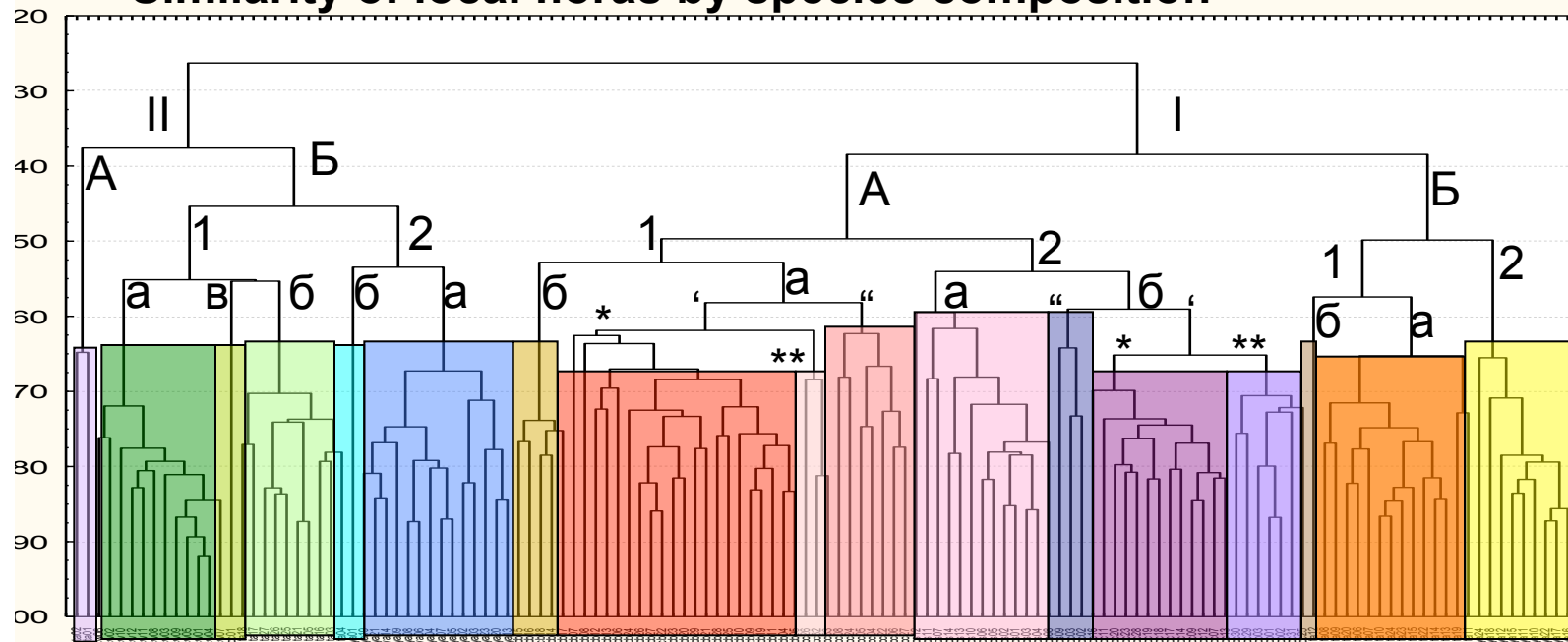


All boundaries by similarity of geographic structure spectra and areas of density of ranges of geographic groups and fractions in different sectors of the Arctic

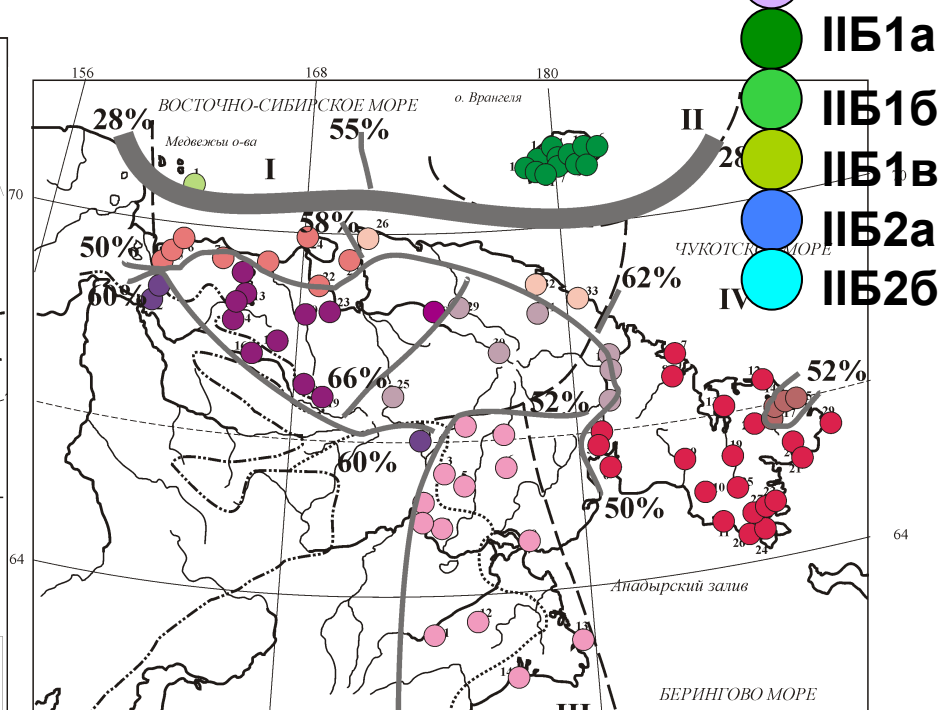
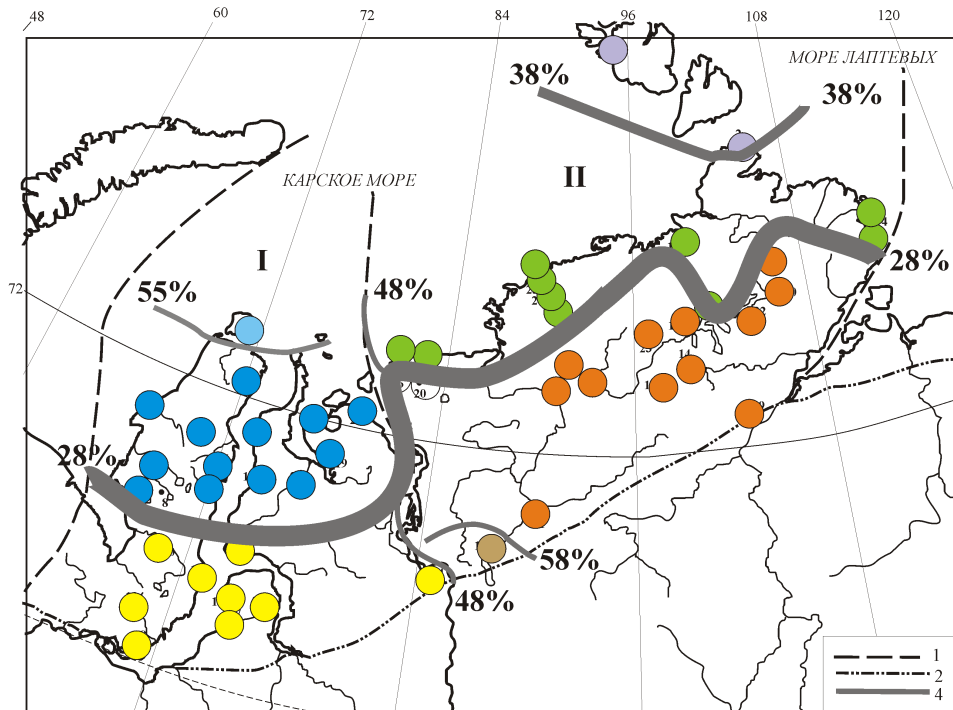
**Boundaries : 1- floristic subprovinces, 2 – open woodlands, 3 – stlanic subzone, 4 – by spectra of longitudinal fractions, 5 – by spectra of longitudinal groups, 6 – by spectra of latitudinal fractions, 7 – by spectra of latitudinal groups, 8 – generalized by density of all boundaries in distribution of groups and fractions**



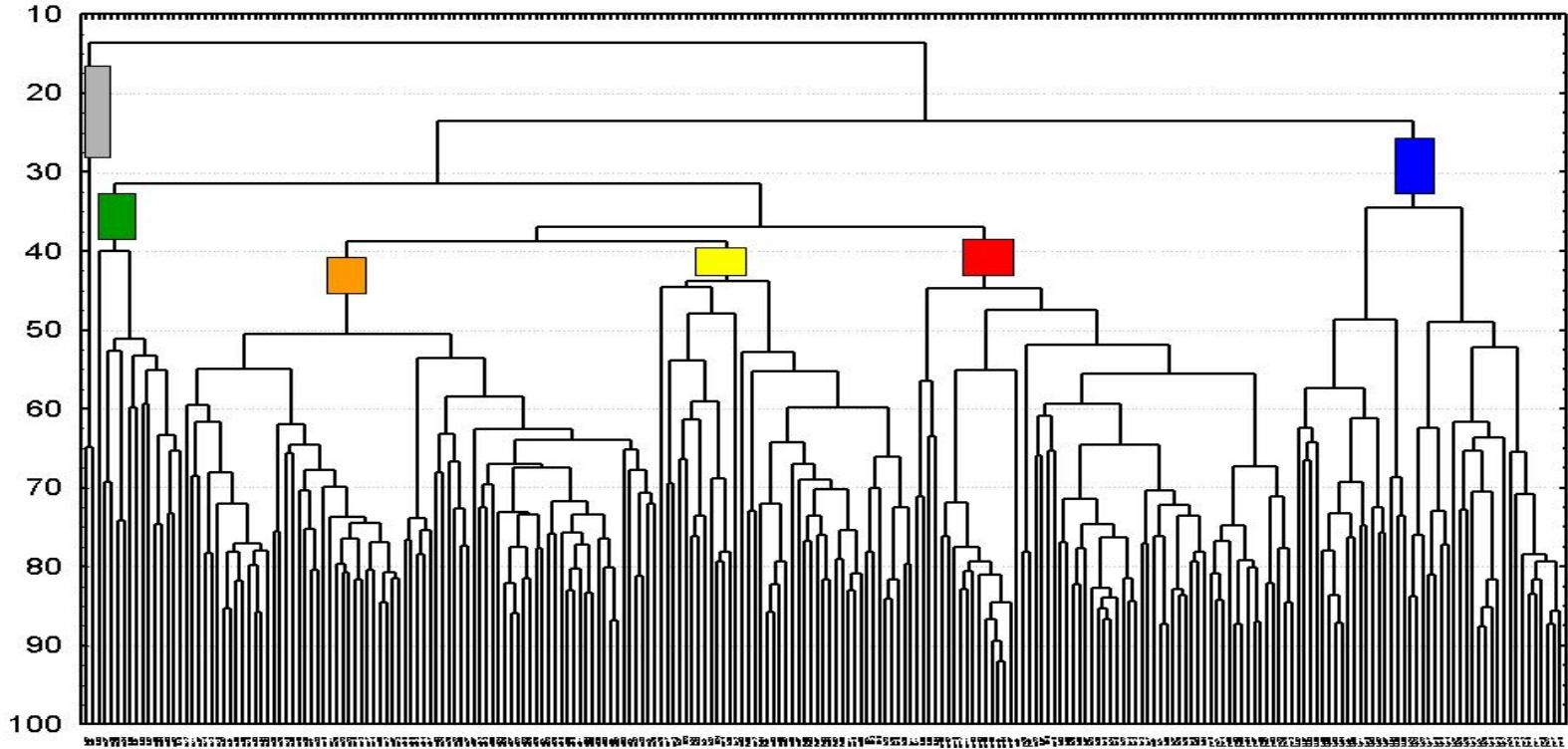
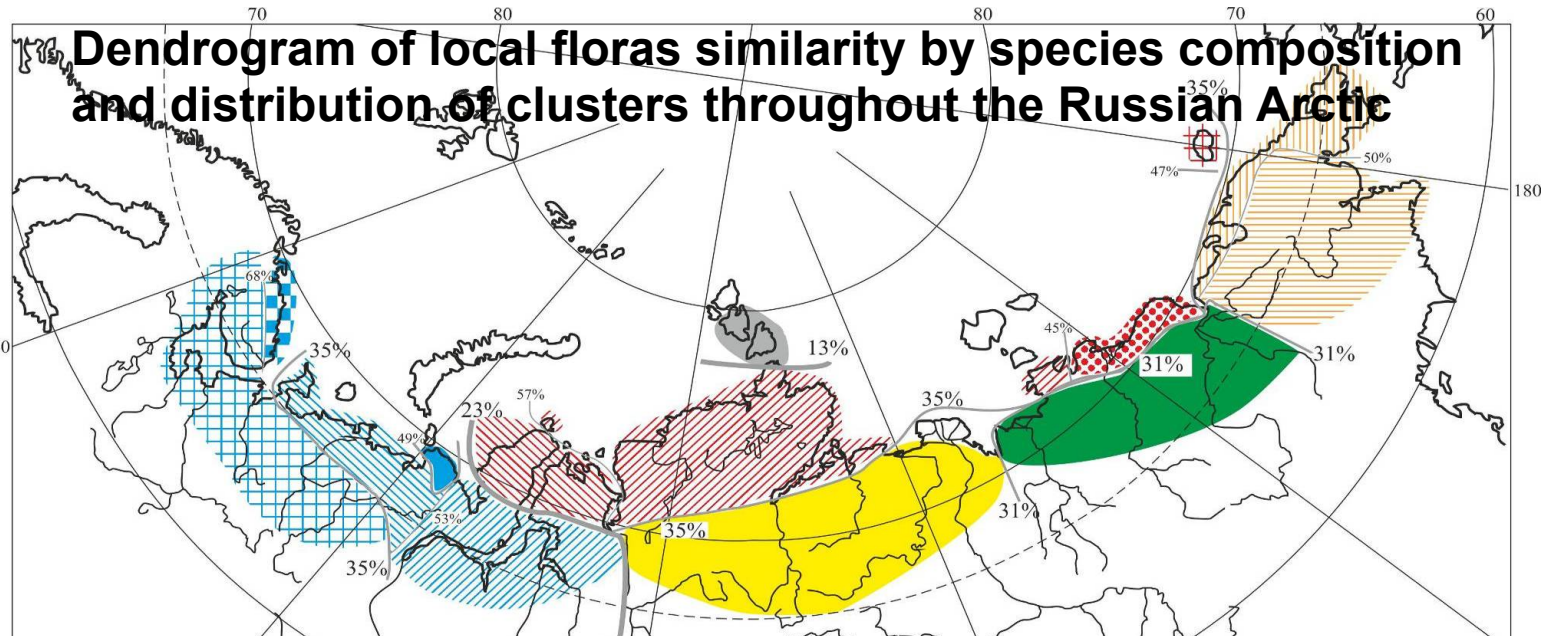
# Similarity of local floras by species composition

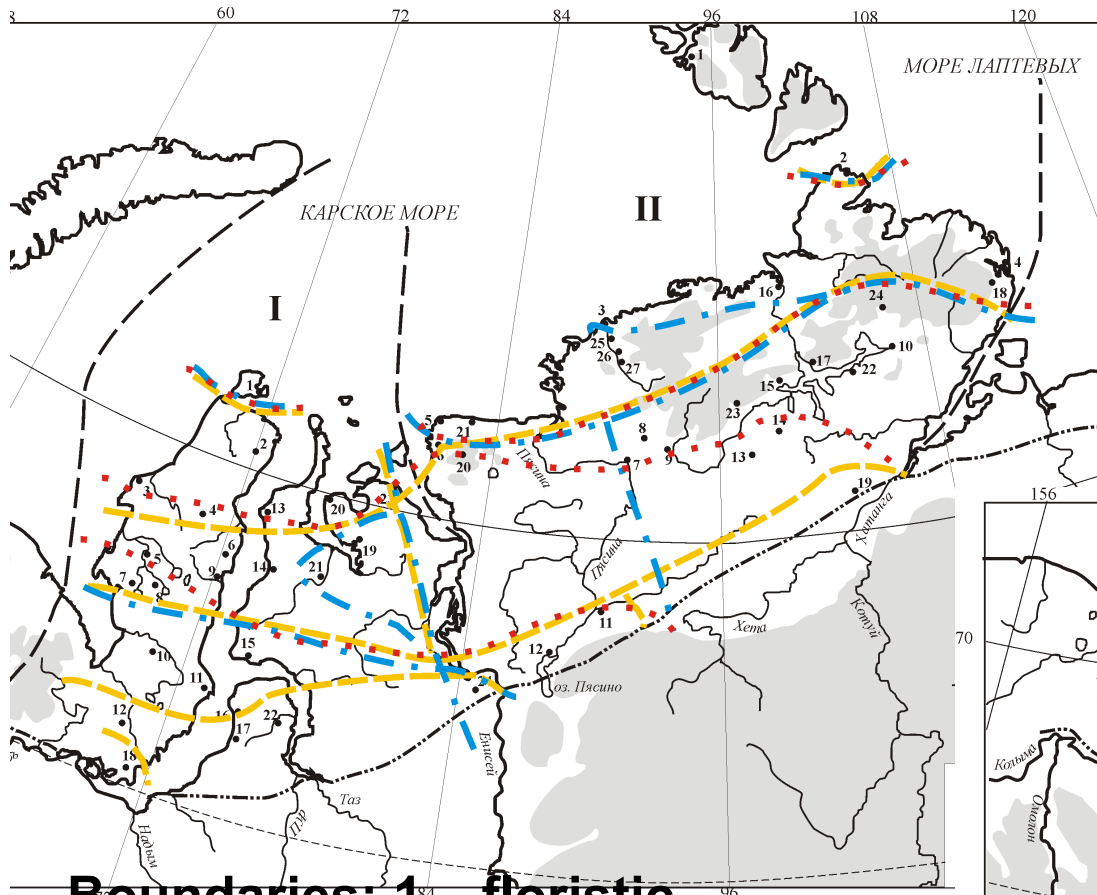


- IA1a\*\*
- IA1a'\*\*
- IA1a''
- IA16
- IA2a
- IA26'
- \*IA26'\*\*\*
- IA26''
- IB1a
- IB16
- IB2
- IIА
- IIБ1a
- IIБ16
- IIБ1В
- IIБ2a
- IIБ26



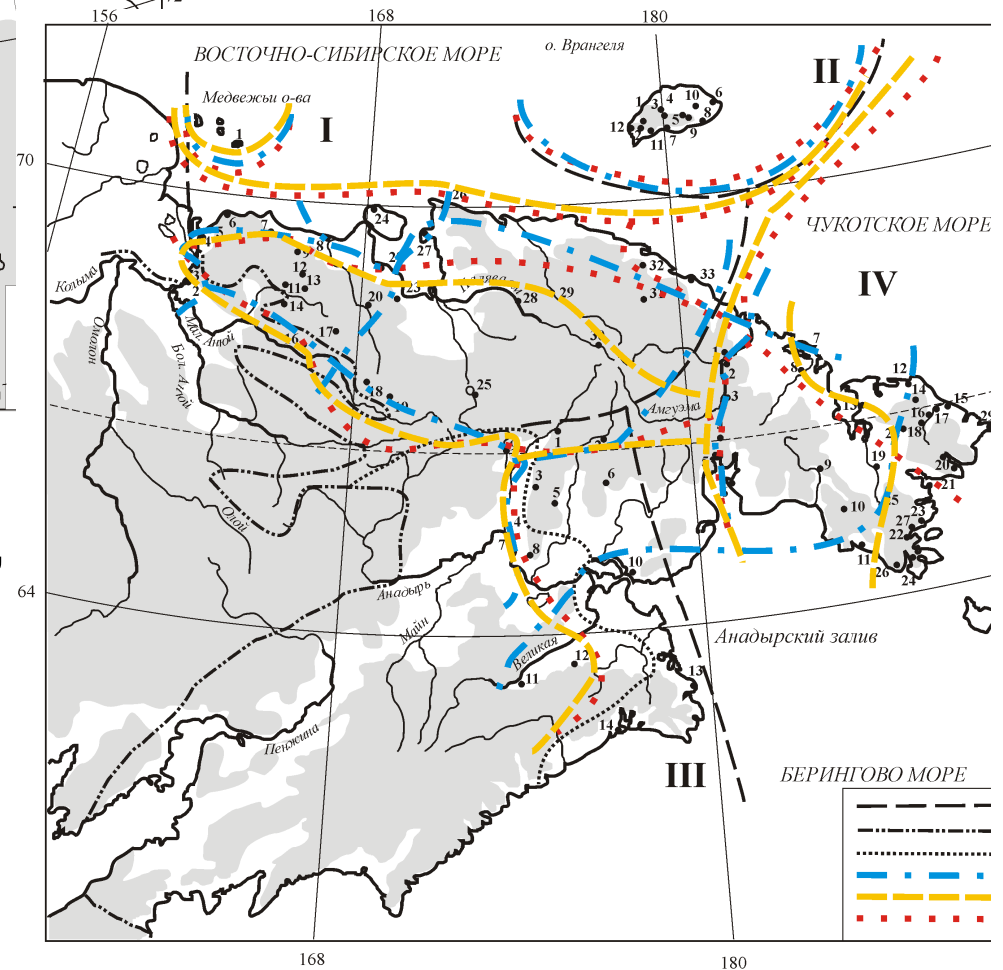






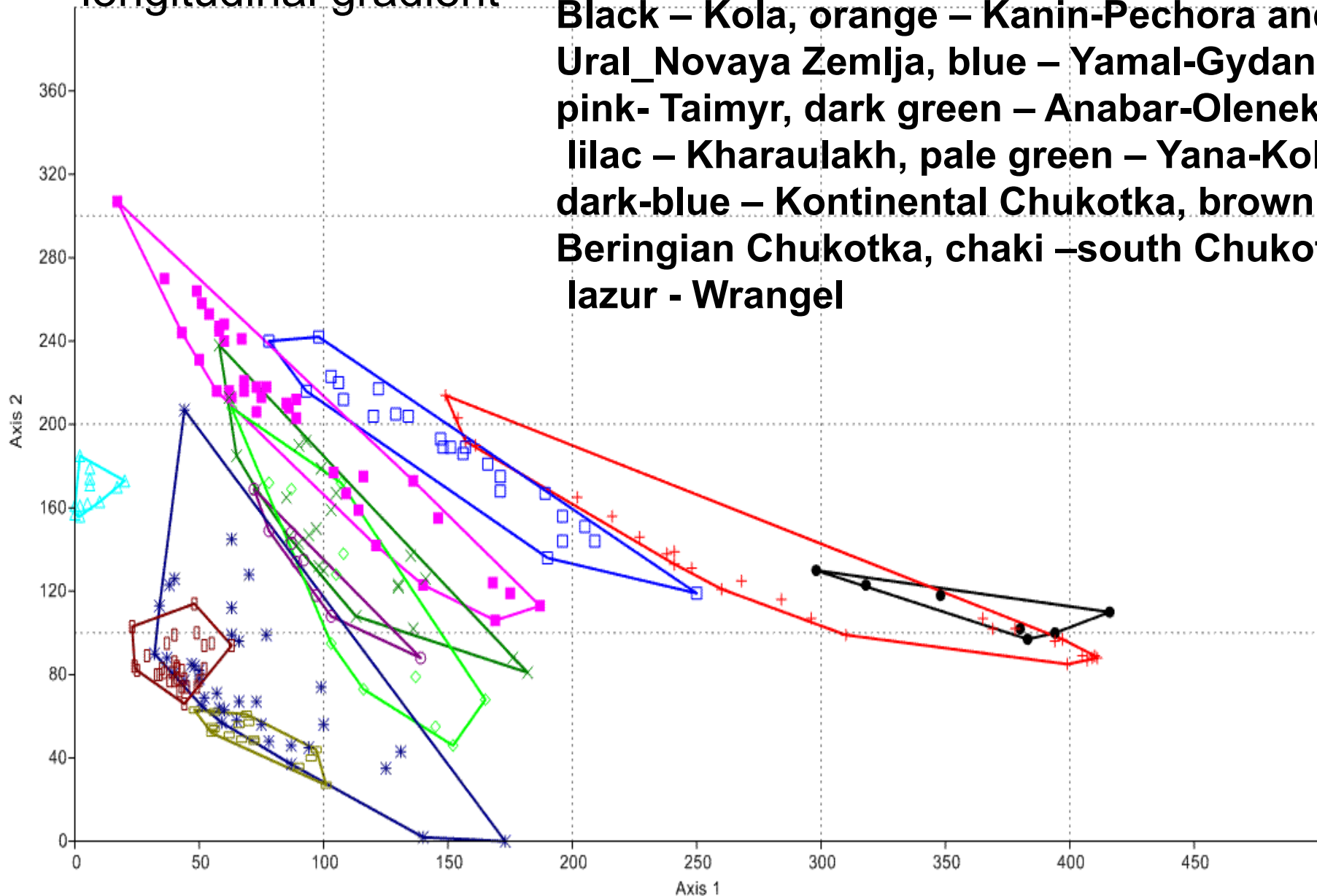
Combination of all boundaries by 10 parameters of geographical and taxonomical structure of local floras

**Boundaries: 1 – floristic subprovinces, 2 – open woodlands, 3 – subzone of stlanik, 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**

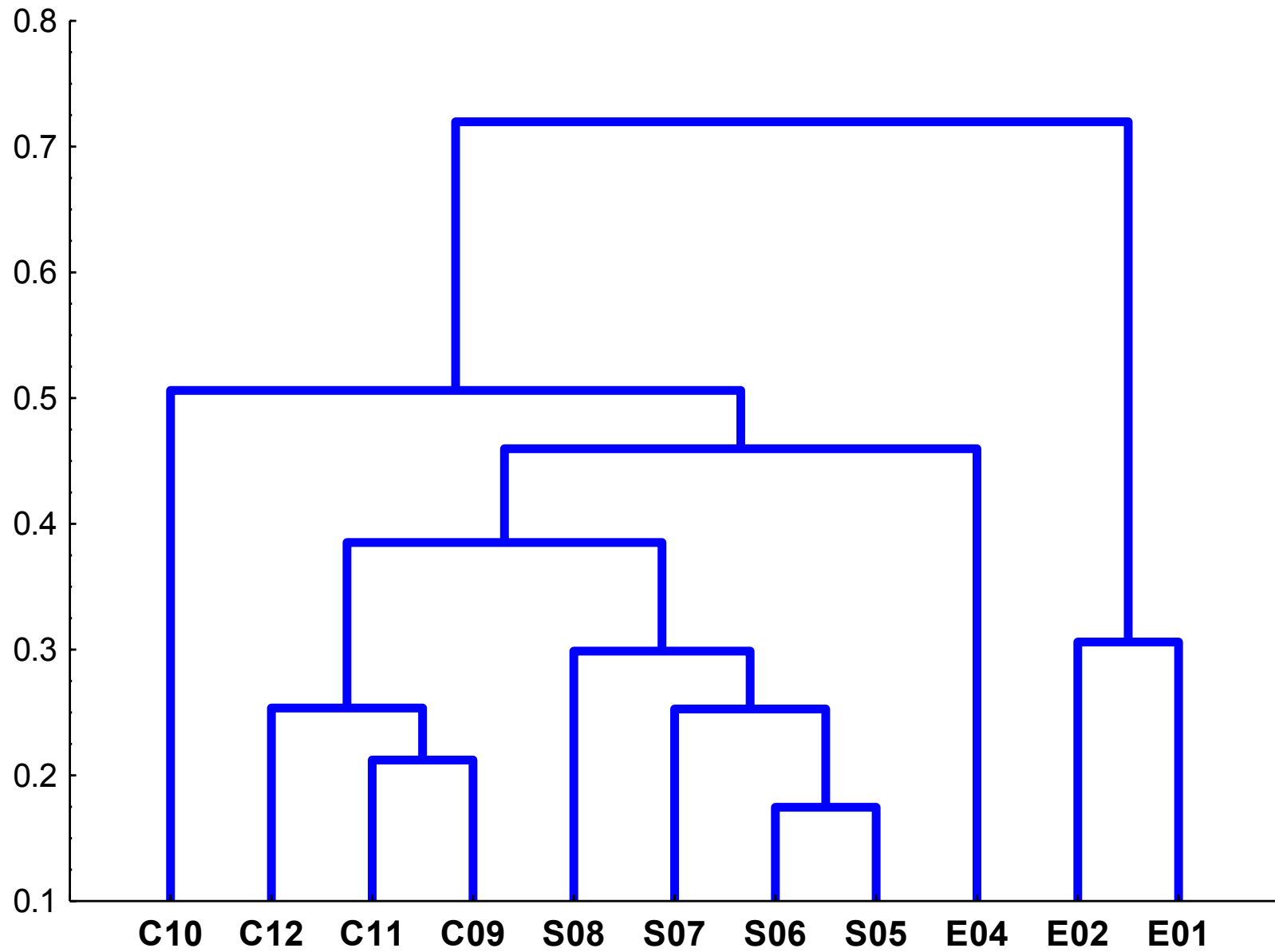


DCA ordination of 238 lists of species (LF), axis 1 reflects longitudinal gradient

**Black – Kola, orange – Kanin-Pechora and Ural\_Novaya Zemlja, blue – Yamal-Gydan, pink- Taimyr, dark green – Anabar-Olenek, lilac – Kharaulakh, pale green – Yana-Kolyma dark-blue – Kontinental Chukotka, brown – Beringian Chukotka, chaki –south Chukotka, lazur - Wrangel**



# 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

**Papaver gorodkovii**



If endemic species is found somewhere botanists often try to search for it in neighboring territories and nor seldom found and prove that the real range of the species is broader than it was thought from the beginning. Local flora was the perfect method to find them.

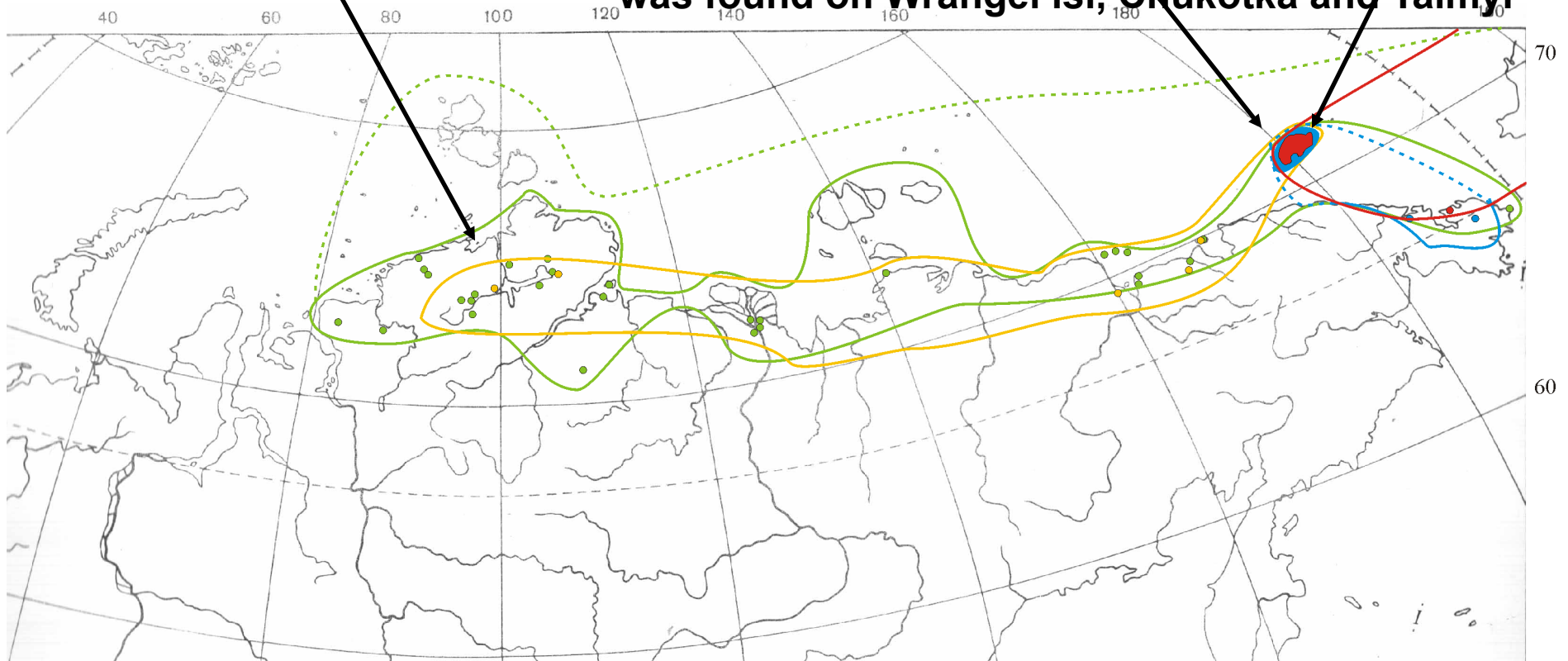
*Draba oblongata*  
(*D. groenlandica*)

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



**Castilleja arctica – was considered as an endemic of West Siberian Arctic, listed in the Red Data Book, but it is rather wide spread in Yamal and found in Taimyr**



*Pedicularis  
hyperborea,  
Hieracium  
tazenze,  
Pedicularis  
palustris  
subsp. Karoi,  
Aconitum  
Czekanowsky  
Lychnis  
sibirica subsp.  
samoedorum*

## East Siberian Province

### Taimyr subprovince

Puccinellia byrrangensis,  
Puccinellia gorodkovii,  
Puccinellia jensisejensis,  
Roegneria lenensis,  
Cerastium regelii subsp.  
caespitosum,  
Draba taymyrensis  
Oxytropis putoranica  
Cortusa matthioli subsp.altaica  
Dracocephalum nutans  
Castilleja tenella  
Claytonia joanneana  
Ptarmica impatiens  
Taraxacum nova-zemliae  
Taraxacum platylepium

### Anabaro-Olenek subprovince

Arctopoa trautvetteri  
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



## Representatives of Middle Siberian group



*Artemisia lagopus* ssp. *abbreviata*



*Gorodkovia jacutica*



*Androsace gorodkovii*



*Oxytropis arctica* ssp. *taimyrensis*



## **Yana-Kolyma subprovince**

**Arctopoa petrovskyi**  
**Elytrigia villosa**  
**Gorodkovia jacutica**  
**Astragalus penduliflorus**  
**Oxytropis middendorffii**  
**subsp.jarovoi**  
**Papaver stubendorffii**  
**Androsace gorodkovii**  
**Artemisia gmelinii**  
**subsp.scheludjakoviae (-)**  
**Artemisia lagopus**  
**subsp.jarovoi**  
**Taraxacum jacuticum (-)**  
**Artemisia jacutica (-)**

## **Continental Chukotka**

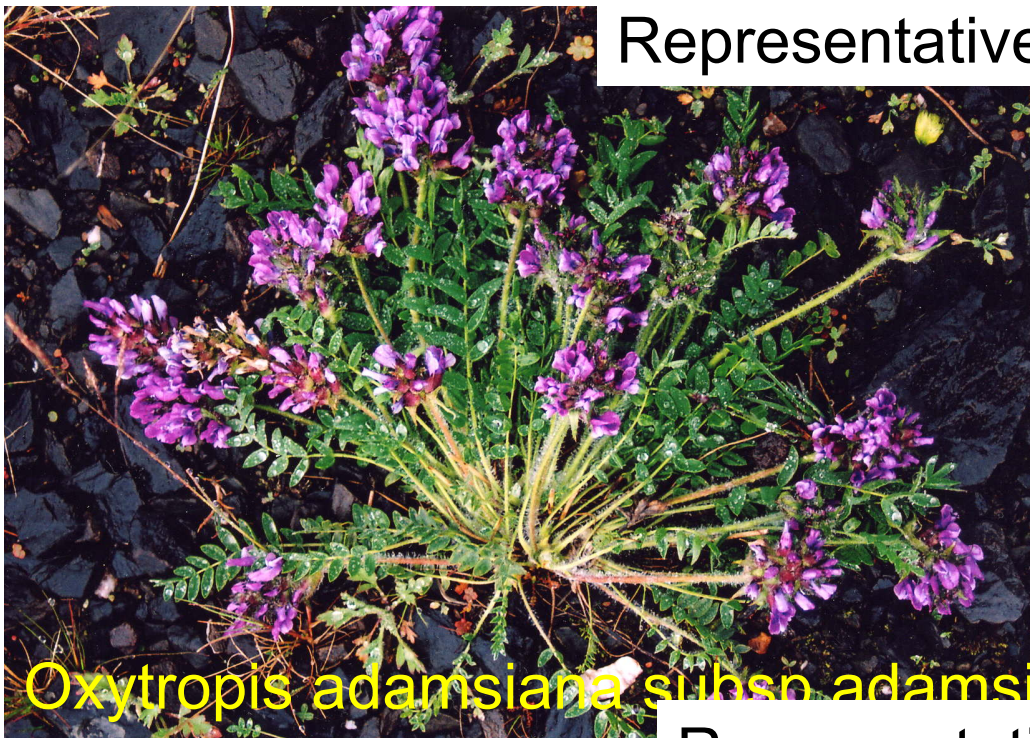
**Roegneria nepliana**  
**Suaeda arctica**  
**Carex sordida= C.hirta**  
**Hedinia czukotica**  
**Chrysosplenium alternifolium**  
**subsp arctomontanum**  
**Potentilla anjuica**  
**Oxytropis middendorffii**  
**subsp.coerulescens**  
**Oxytropis schmorgunovii**  
**Oxytropis sverdrupii**  
**Plantago 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**



Representatives of Middle Siberian group



*Oxytropis adamsiana* subsp. *adamsiana* & *Rhododendron adamsii*

Representatives of East Asian group



*Salix berberifolia* ssp. *fimbriata*



*Saxifraga*





**Artemisia flava -endemic of Anuj highlands**



***Oxytropis ochotensis* –East-Siberia  
metaarctic species characteristic  
for Verkhojan-Kolyma mountains  
In the Arctic present only in low  
floods of Kolyma river and in Anuj  
highlands where it is a common  
plant**



***Papaver pulvinatum* subsp.*lenaense*  
– endem of northern Yacutia. It  
occurs in isolated populations, the  
biggest one in low floods of Lena**



## Wrangel island

(Mainly endemics)

**Hierochloe wrangelica**  
**Poa vrangelica**  
**Puccinellia wrightii**  
**subsp colpodioides (-)**  
**Claytoniella vassilievii**  
**subsp.petrovskii**  
**Papaver atrovirens**  
**Papavert chionophilum**  
**Papaver gorodkovii (-)**  
**Papaver nudicaule**  
**subsp.insulare**  
**Papaver uschakovii**  
**Potentilla wrangelii**  
**Oxytropis uniflora**  
**Senecio hyperborealis**  
**subsp.wrangelica**  
**Taraxacum tolmaczevii**  
**Taraxacum wrangelicum**

## South Chukotka

**Athyrium cyclosporum**  
**Calamagrostis sesquiflora**  
**Poa pekulnejensis**  
**Poa platyantha**  
**Poa zhukoviae**  
**Ranunculus eschscholtzii**  
**Papaver anadyrense**  
**Sorbus anadyrensis**  
**Mertensia pubescens**  
**Cardamine umbellate (-)**  
**Axifraga merkii**  
**Oxytropis revoluta**  
**Cardamune victoris**  
**Potentilla fragiformis**  
**Androsace semiperennis**

## 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**



**Dodecatheon frigidum**



A photograph of a snowy mountain landscape. In the foreground, a white tent is set up on a snow-covered field. The tent is supported by a central pole and ropes. In the background, there are snow-covered mountains and a forest of evergreen trees. The sky is clear and blue.

Thank you!

Работа выполнена при поддержке  
грантов РФФИ № 05-04-49583, 10-04-01087, и др.;  
программы «Биоразнообразие»





## Эндемичные виды

показывают районы формообразования и флорогенеза

***Saxifraga lactea*** – эндемик северо-востока Азии. Основная часть ареала – бассейн реки Алдан.

***Hedinia czukotica*** – сформировалась в районе Чукотского и Анюйского нагорий. Ближайшие таксоны этого рода обитают в горах Центральной Азии

