Petrozavodsk State University

Structure and dynamics of coastal ecosystems of the Russian Arctic

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ABOUT THE AUTHOR

Liudmila Sergienko, Petrozavodsk, Republic of Karelia, Russia

Graduated Botanical department Leningrad State University. Since 1971 took part in numerous expeditions in Kanin peninsula, Gulf of Finland, Kolyma river, Chukotka peninsula, White sea, Barents sea, East-Siberian sea, Chukchi sea, Bering sea.

Doctoral thesis devoted to salt marsh flora and vegetation of the Russian Arctic.

More than 25 years worked at the Komarov Botanical institute of Russian Academy of Sciences.

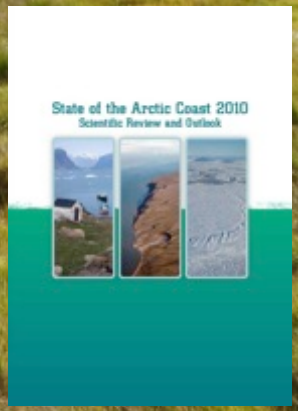
Since1997 full professor in Petrozavodsk State University.

Continues active investigations and teaching.

Published more than 80 articles, several monographs, manuals and tutorials.

Participates in number of national and international projects.

Contributed several comprehensive international reviews - State of the Arctic Coast 2010; Atlas of Marine and Coastal Biological Diversity of the Russian Arctic 2011.



Arctic coastal ecosystems

Arctic coastal ecosystems are vulnerable both to climate change and active industrial development. The "proactive ecosystem management" is one of many mitigation strategies in this case. This demands good background knowledge on ecosystem structural and functional characteristics. The ongoing global climate changes and the growing man impact influence lead to the disruption of functioning of natural complex of the Arctic coastal zone, which results in the disturbance of human activity affecting human health.

Kolyma river mouth (Chukotka peninsula)

Salt marshes in the Pechora river mouth

Salt marshes

Salt marshes are the part of coastal zone of the low-lying coasts of the seas, flooded during periods of high tides and surges of water. Sometimes marshes are below sea level, separated from it by a stripe of dunes. Usually marshes composed of clayey, silt or sandy-silt sediments. Salt marshes are the ecotone zone between marine and terrestrial ecosystems.

Near the mouth of the Kuznetskaya river (Barents Sea)

Coasts of Chukchi Sea

The coastal flora and vegetation

The coastal flora of open coasts and the estuaries of rivers, are an important element of the Arctic flora and represents the littoral halophytic floristic complex, possess the unique structural and functional integrity. Salt-marsh communities are sensitive to environmental change, including a rise in sea level and erosion from storm surges. Studies of the interactions between abiotic and biotic processes enable us to determine the state of coastal biogeocenoses (development of the ecosystem) and make predictions of future changes.

As marshes relate to wetlands, they are highly variable and dynamic: they are water bodies but also include land and they are on the “front-line” as development pressures increase.

The coastal flora and vegetation

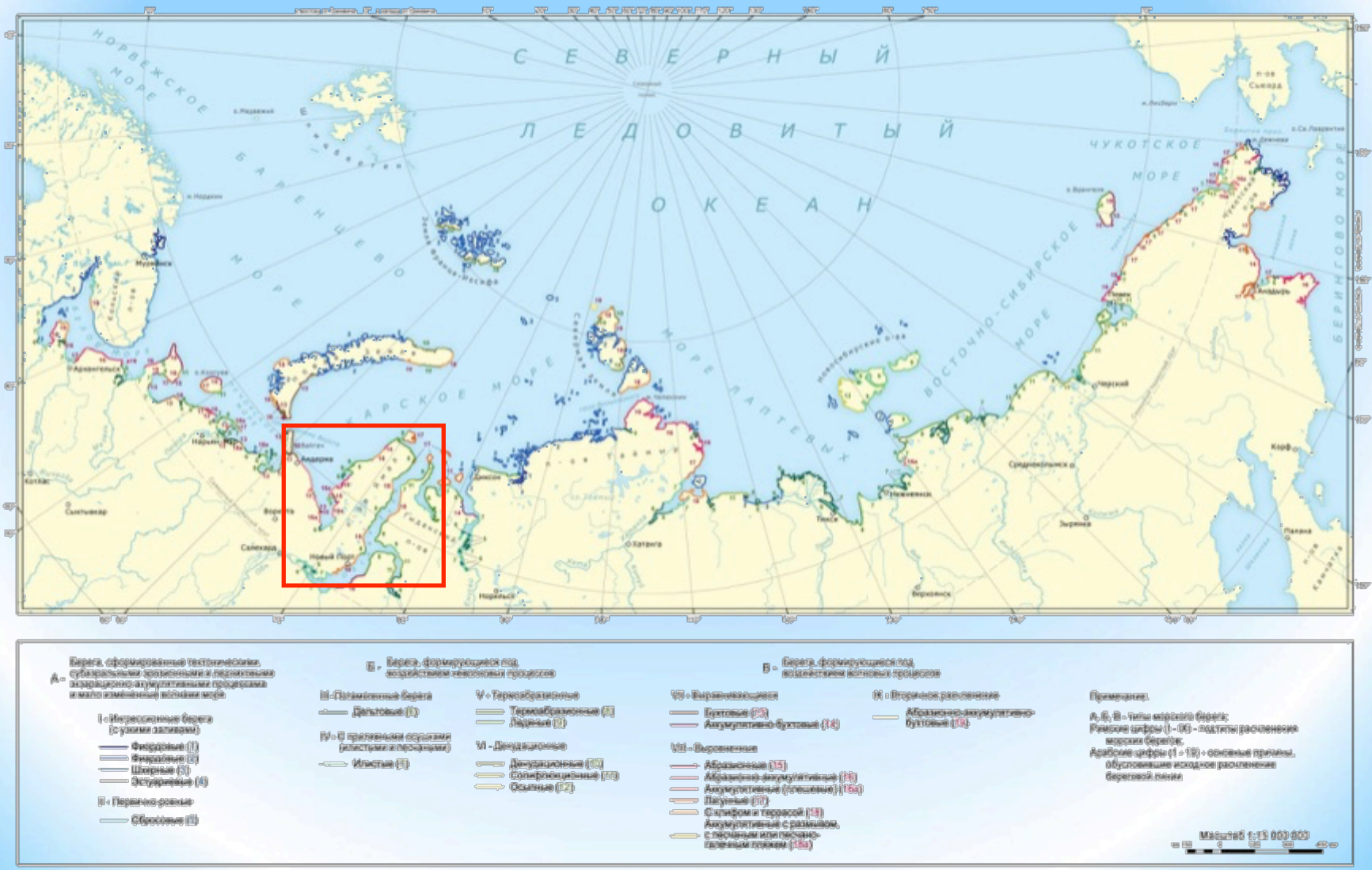
The halophytic floristic complex of coastal ecosystems in the Russian Arctic, allocated on the basis of the ecological-coenotic optimum of coastal species, has been investigated.

Ecological-phytocoenotic classification of saltmarsh communities, based on criteria - layer structure, the composition of dominants and subdominants, the constancy of species have been done.

The plots for investigation of vegetation cover and species richness; relative position within the intertidal zone have been studied using the general floristic and geobotanical methods.

Pechora river mouth –we describe the community, selected soil samples

Morphogenetic types of the Russian Arctic coasts



Morphogenetic types of the Russian Arctic coasts – Kara sea

А - Берега, сформированные тектоническими, субаэральными эрозионными и ледниковыми экзарационно-акумулятивными процессама и мало измененные волнами моря

I - Ингрессионные берега (с узкими заливами)
- Фиордовые (1)
- Фиардовые (2)
- Шхерные (3)
- Эстуариевые (4)

II - Первично-ровные
- Сбросовые (5)

Б - Берега, формирующиеся под воздействием неволновых процессов

III -Потамогенные берега
- Дельтовые (6)

IV - С приливными осушками (илистыми и песчаными)
- Илистые (7)

V - Термоабразионные
- Термоабразионные (8)
- Ледяные (9)

VI - Денудационные
- Денудационные (10)
- Солифлюкционные (11)
- Осыпные (12)

В - Берега, формирующиеся под воздействием волновых процессов

VII - Выравнивающиеся
- Бухтовые (13)
- Аккумулятивно-бухтовые (14)

VIII - Выровненные
- Абразионные (15)
- Абразионно-аккумулятивные (16)
- Аккумулятивные (плешевые) (16а)
- Лагунные (17)
- С клифом и террасой (18)
- Аккумулятивные с размывом, с песчаным или песчано-галечным пляжем (18а)

IX - Вторичное расчленение
- Абразионно-аккумулятивно-бухтовые (19)

Types of the coasts

Estuarine coast

White sea

Delta coast

Barents sea, mouth of Kuznetskaya river

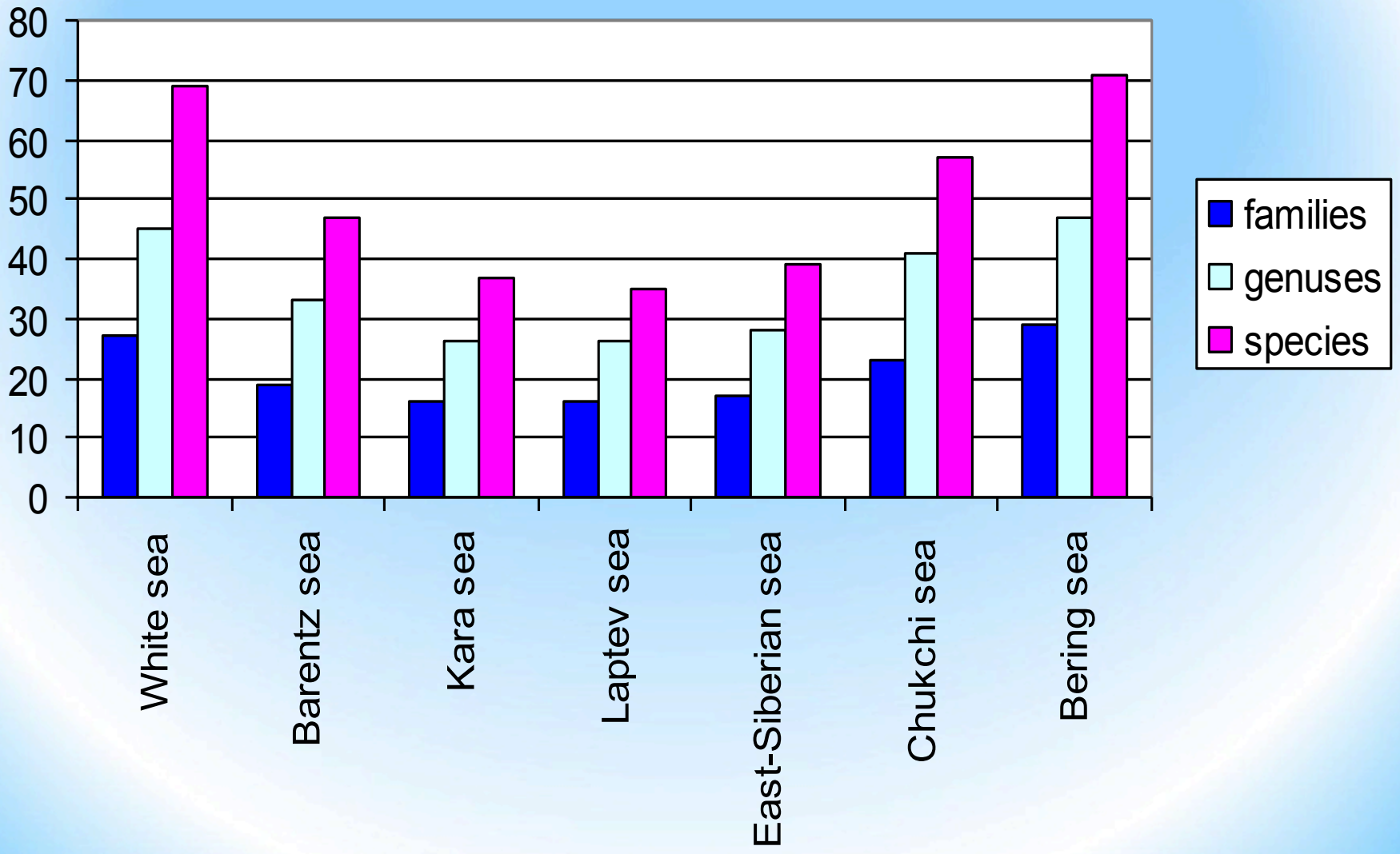
Muddy coast

Barents sea, mouth of Kuznetskaya river

Muddy coast

East-Siberian sea, mouth of Achim river

Amounts of the coastal species in the Russian Arctic

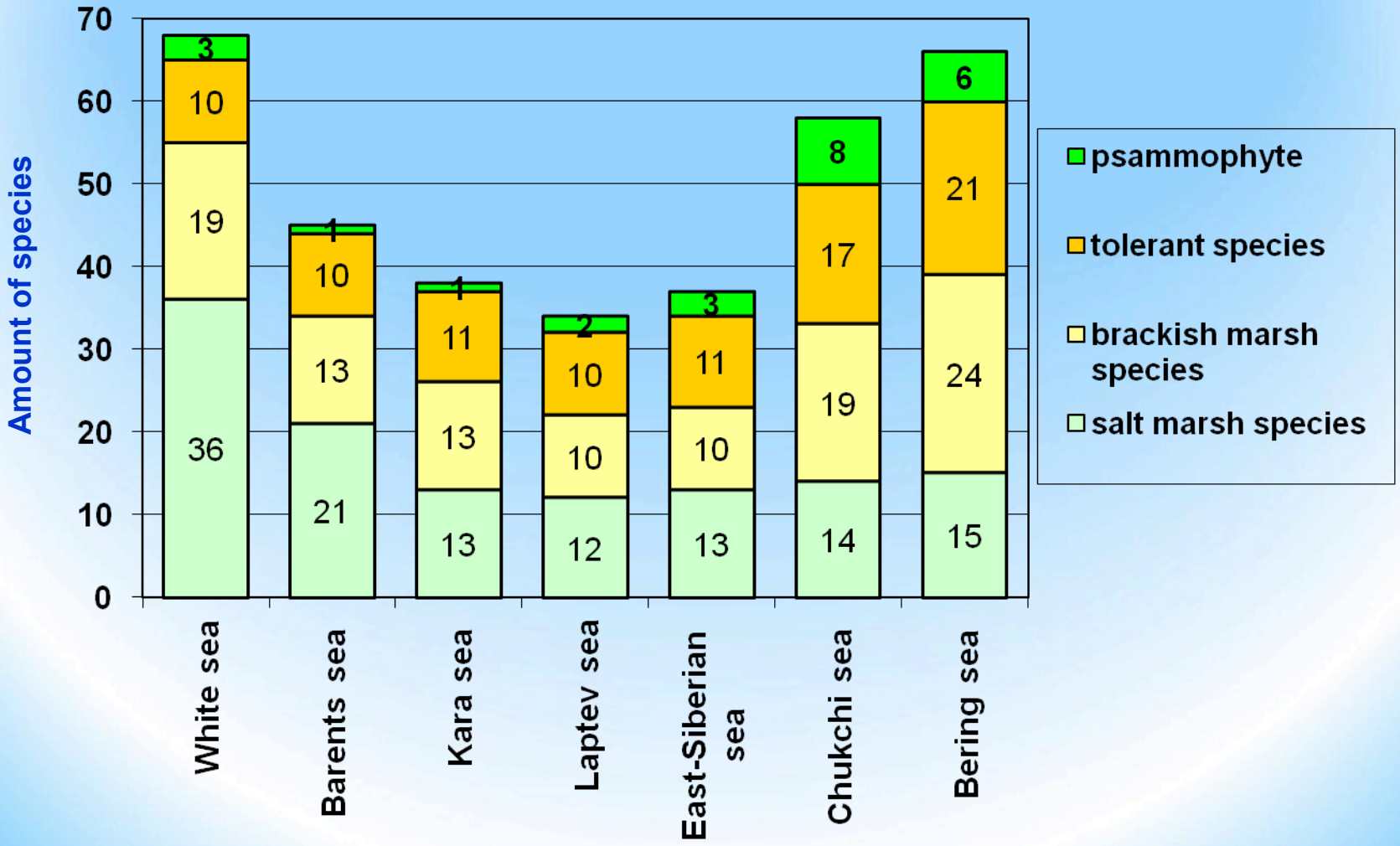


Amounts of the coastal species in the Russian Arctic

	White Sea	Barents Sea	Kara Sea	Laptev Sea	East-Siberian Sea	Chukchi Sea	Bering Sea
Сем. *Poaceae*	10	14	10	10	11	14	17
Сем. *Cyperaceae*	12	8	7	6	6	8	11
Сем. *Asteraceae*	6	4	2	2	3	4	5
Сем. *Caryophyllaceae*	3	3	3	3	3	4	5
Сем. *Brassicaceae*	3	3	2	2	2	2	3
Сем. *Chenopodiaceae*	5					2	1
Сем. *Rosaceae*	1	1	2	2	2	3	3
Сем. *Apiaceae*	3	2				1	2
Сем. *Plantaginaceae*	3	1					
Сем. *Hippuridaceae*	1	1	1	1	1	1	1

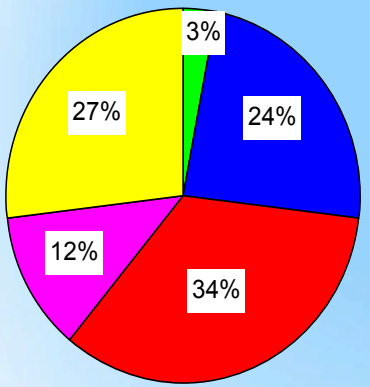
In the coastal flora of the Russian Arctic the number of the leading families consists of *Poaceae* (26 species, accounting for 23.4% of the total number of species), *Cyperaceae* (17 species - 15,3%), *Asteraceae* (8 species - 7.2%), *Chenopodiaceae* (7 species - 6.3%) and *Caryophyllaceae* (6 species - 5.4%); 2 families - *Brassicaceae, Apiaceae* have 4 species in their structure (3,6%); fam. *Juncaceae, Primulaceae, Rosaceae, Plantaginaceae* have 3 species in its composition.

The distribution of ecological-coenotic groups of species in the coastal flora of the Russian Arctic

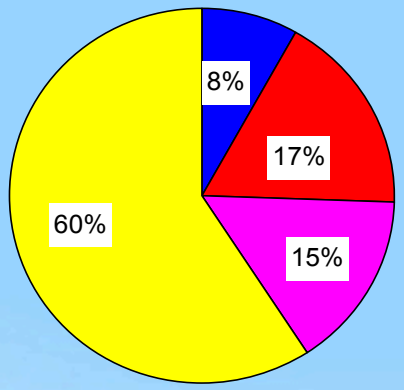


Proportions of latitudinal geographical elements in the coastal flora of the Russian Arctic

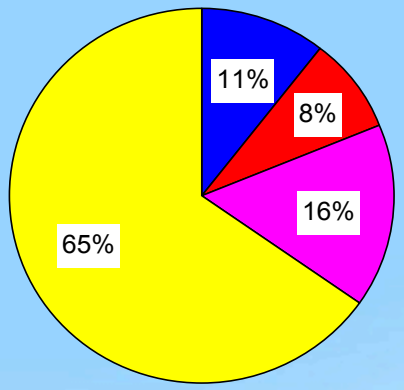
White Sea



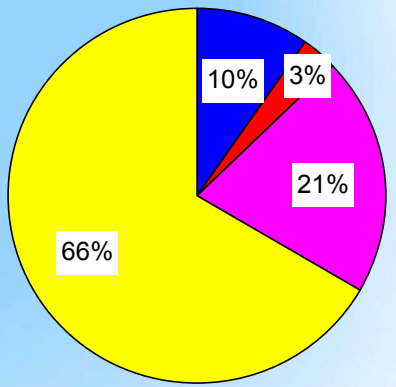
Barents Sea



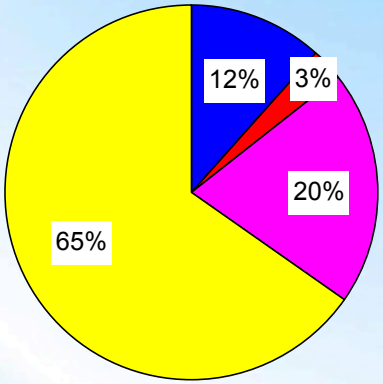
Kara Sea



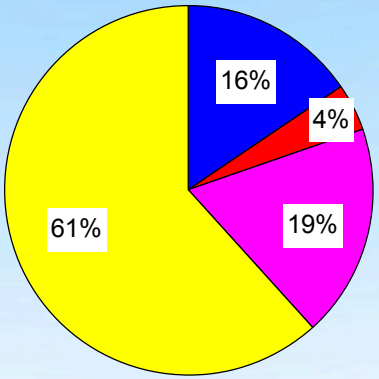
Laptev Sea



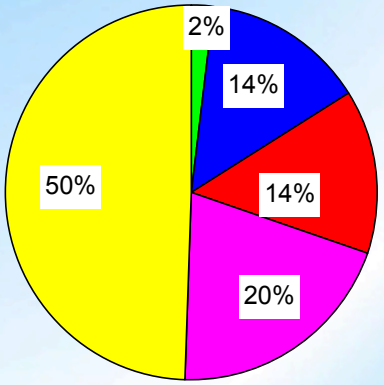
East-Siberian Sea

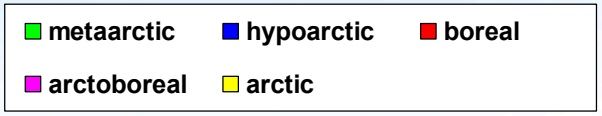


Chuckchi Sea



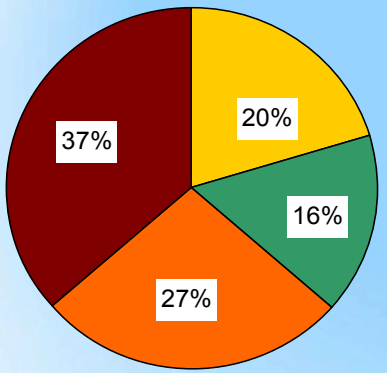
Bering Sea



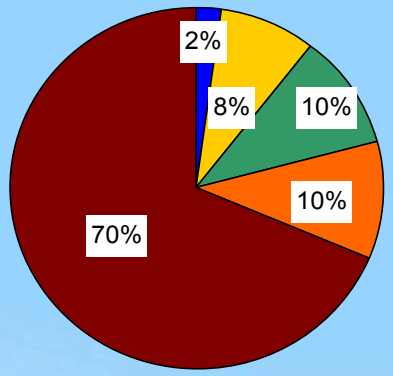


Proportions of longitudinal geographical elements in the coastal flora of the Russian Arctic

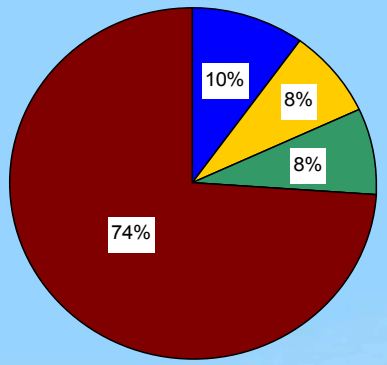
White Sea



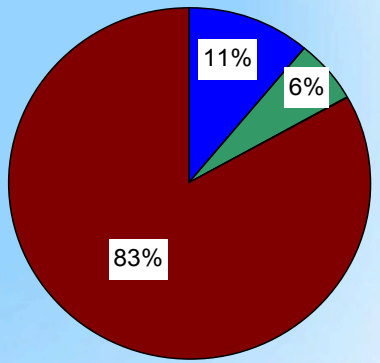
Barents Sea



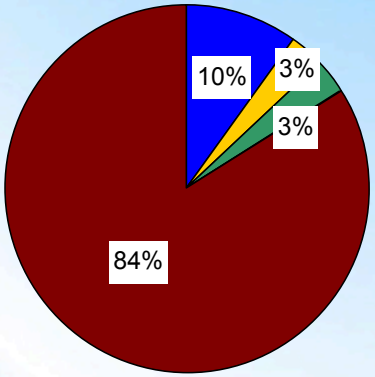
Kara Sea



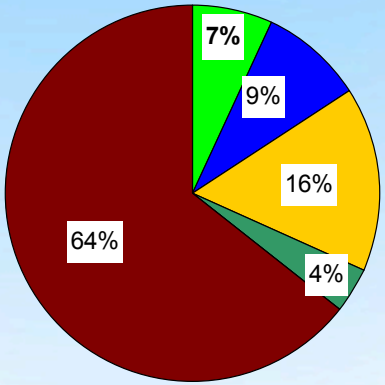
Laptev Sea



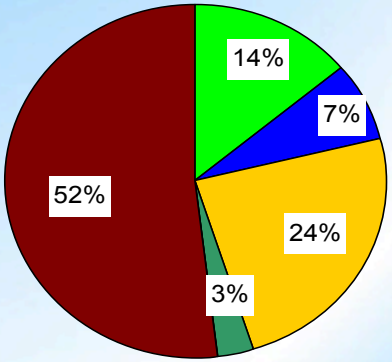
East-Siberian Sea

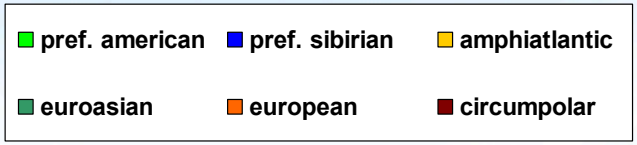


Chuckchi Sea



Bering Sea



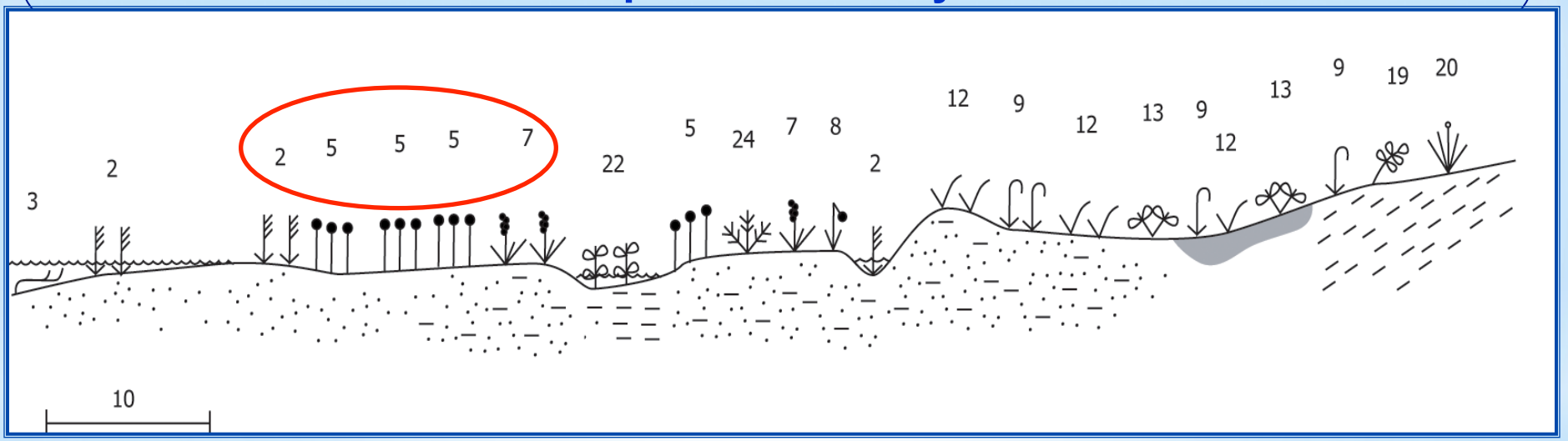


Main salt marsh communities of the Russian Arctic coasts

The dynamic changes of salt-marsh plant communities are site-specific: 1) in the initial stages of vegetational development mostly depend on the physical-chemical substrate properties and tidal action; 2) the spatial temporal processes of successional change over a long time result in the envelopment of the environment and changes in edaphic conditions.

Senecio congestus **- Pechora sea - through the mud to the sun**

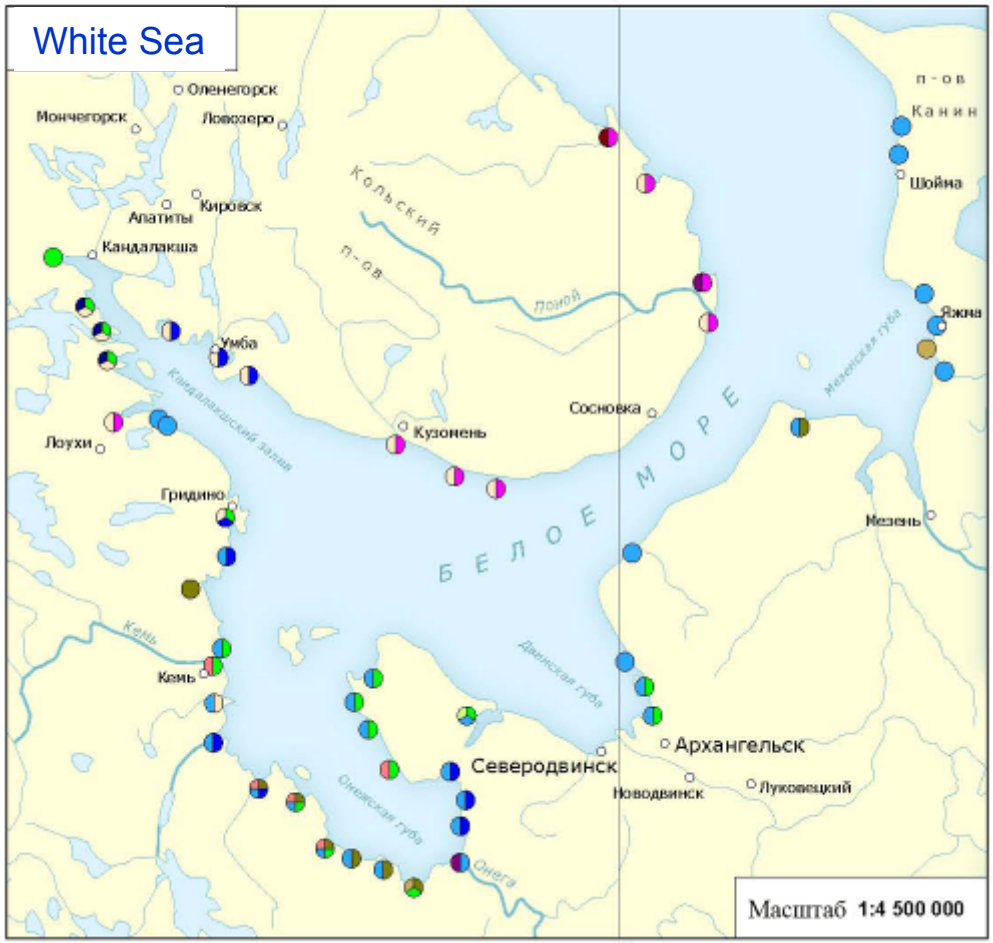
Landscape structure of muddy coasts of Pomorsky and Karelian coasts of White Sea – **greater species diversity**



Species:

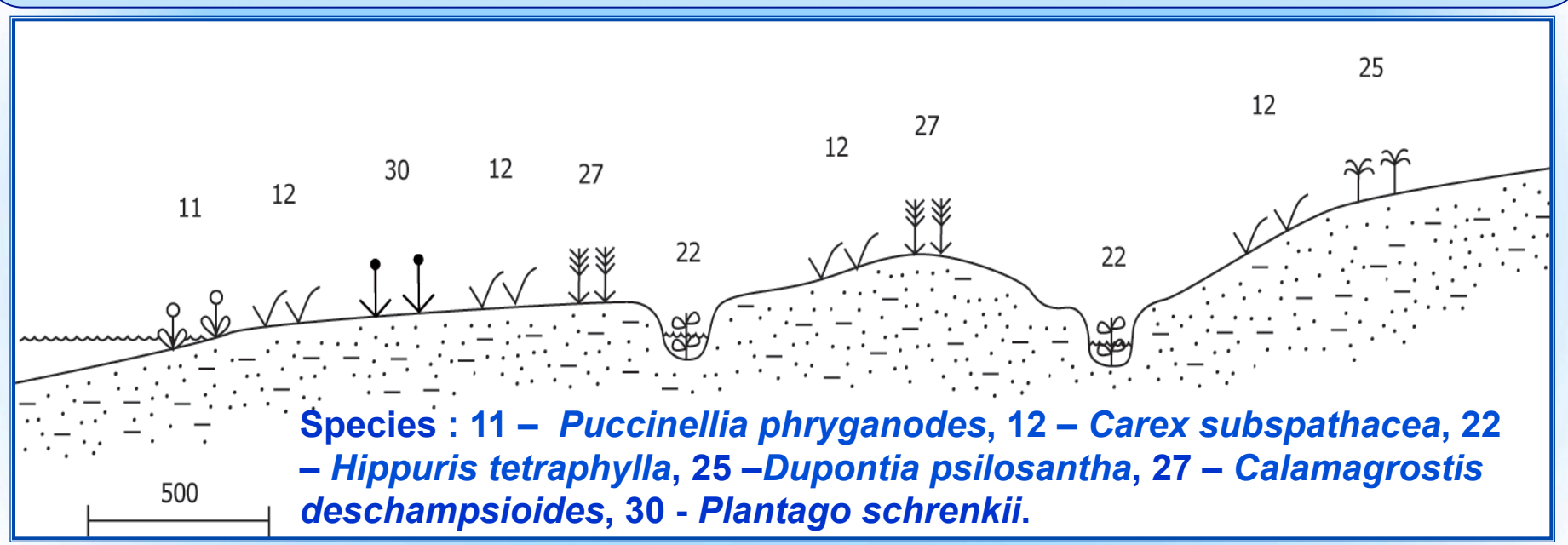
2 – *Bolboschoenus maritimus*,
3 – *Zostera marina*,
5 – *Eleocharis uniglumis*,
7 – *Triglochin maritima*,
8 – *Tripolium vulgare*,
9 – *Juncus gerardii*,
12 – *Carex subspathacea*,
13 – *Potentilla egedei s.l.*,
19 – *Lathyrus japonicus ssp. pubescens*,
20 – *Phragmites australis*,
22 – *Hippuris tetraphylla*,
24 – *Stellaria humifusa*.

Distribution of the saltmarsh communities on the coasts of White sea



- Salicornia pojarkovae
- Eleocharis uniglumis + Bolboschoenus maritimus
- Puccinellia phryganodes
- Puccinellia maritima
- Triglochin maritimum + Carex subspathacea
- Triglochin maritimum + Tripolium vulgare + Plantago maritima
- Carex glareosa + Potentilla egedii + Agrostis straminea
- Puccinellia phryganodes + Potentilla egedii + Carex subspathacea
- Potentilla egedii + Calamagrostis deschampsioides + Arctanthemum hultenii
- Potentilla egedii + Agrostis straminea + Festuca rubra
- Calamagrostis deschampsioides + Puccinellia phryganodes + Carex glareosa
- Leymus arenarius
- Honckenya oblongifolia + Elytrigia repens + Leymus arenarius
- Festuca rubra + Leymus arenarius
- Dupontia psilosantha+ Carex subspathacea
- Carex rariflora
- Carex subspathacea + Carex rariflora + Carex ursina
- Poa alpigena + Festuca rubra + Honckenya oblongifolia
- Saxifraga foliolosa + Luzila wahlenbergii + Festuca rubra
- Carex subspathacea + Carex ursina

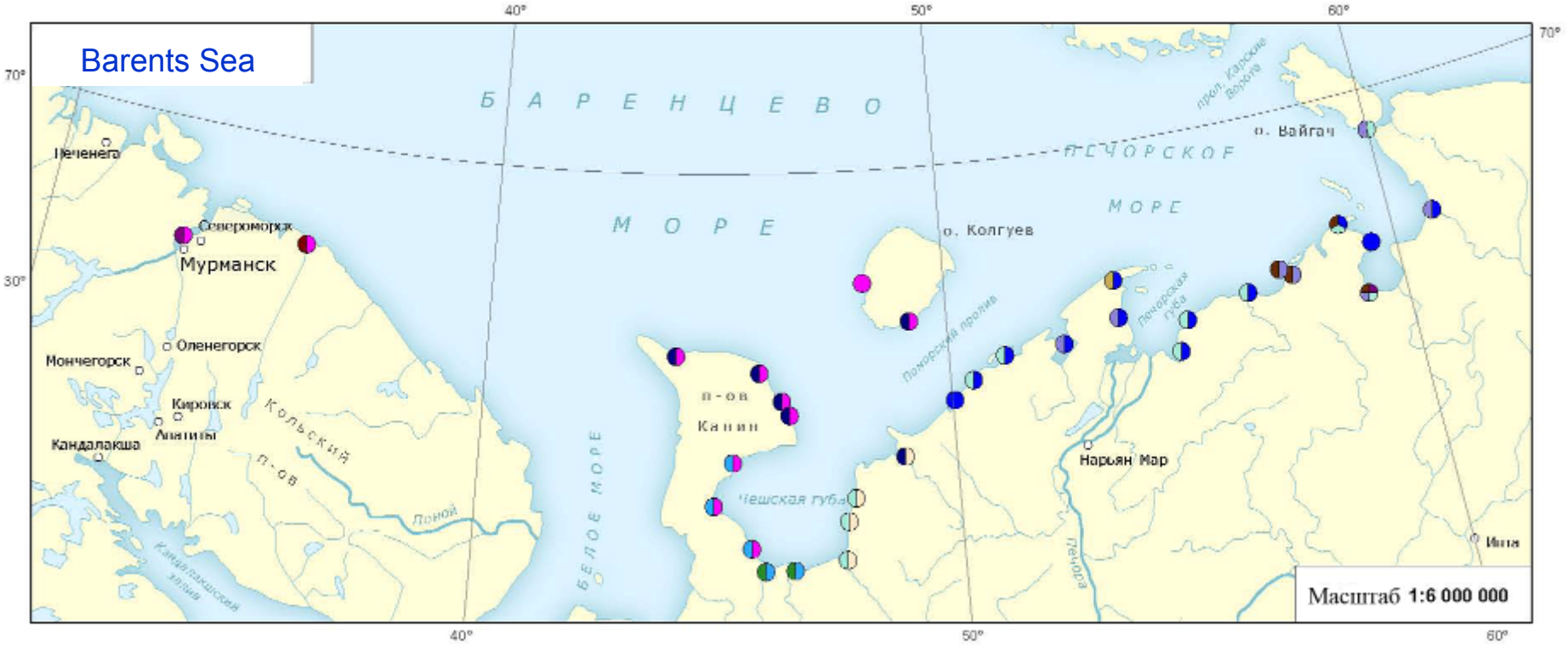
Landscape structure of coastal wetlands of the Barents Sea



Species : 11 – ***Puccinellia phryganodes*****, 12 –** ***Carex subspathacea*****, 22 –** ***Hippuris tetraphylla*****, 25 –*****Dupontia psilosantha*****, 27 –** ***Calamagrostis deschampsioides*****, 30 -** ***Plantago schrenkii*****.**

Photo: Lavrinenko I.

Diversity of salt marsh ecosystems of the of the Barents Sea coasts



The main landscapes on the coasts of Barentz Sea

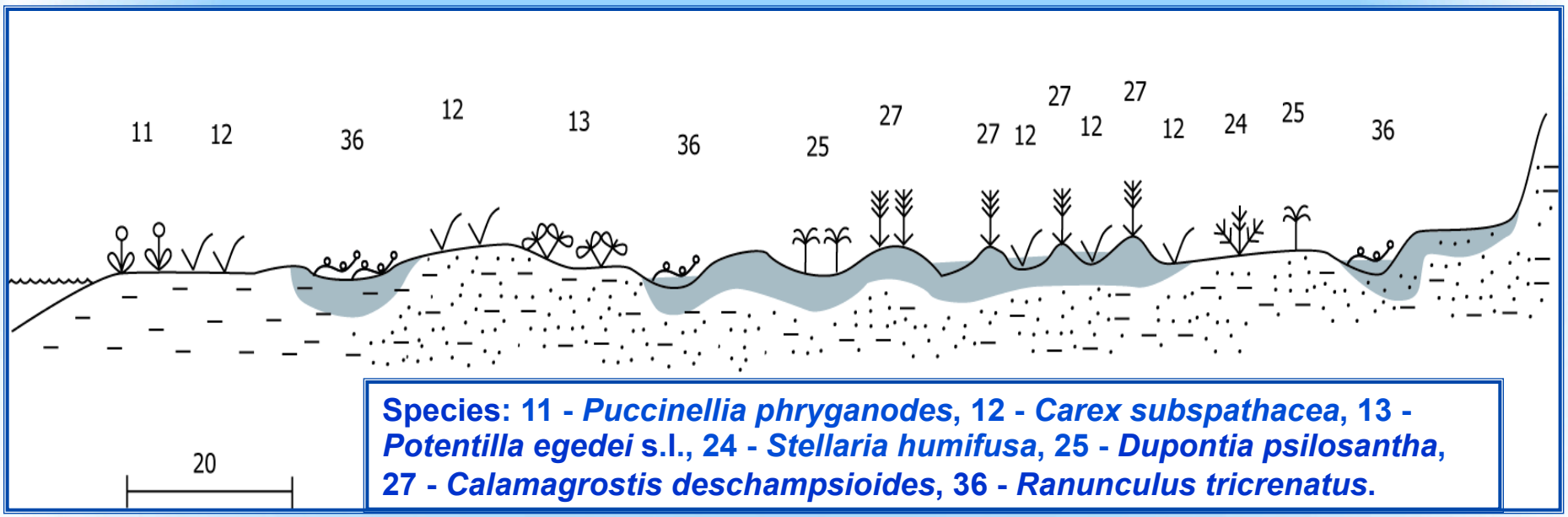
Kuznetskaja Bay (low marshes)

Chodovaricha low coast

River Kuznetskaja (coastal erosion)

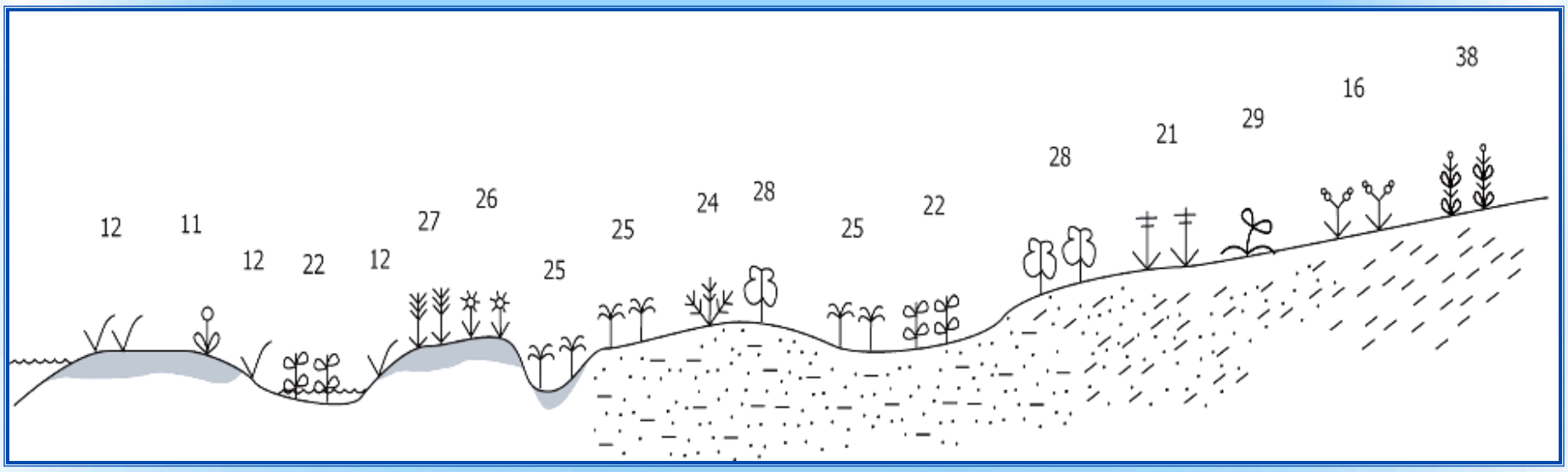
Chodovaricha coast
(sandy beach)

Landscape structure of the muddy coasts' habitats of the East- Siberian sea (Aachim peninsula)



Species: 11 - *Puccinellia phryganodes*, 12 - *Carex subspathacea*, 13 - *Potentilla egedei* s.l., 24 - *Stellaria humifusa*, 25 - *Dupontia psilosantha*, 27 - *Calamagrostis deschampsioides*, 36 - *Ranunculus tricrenatus*.

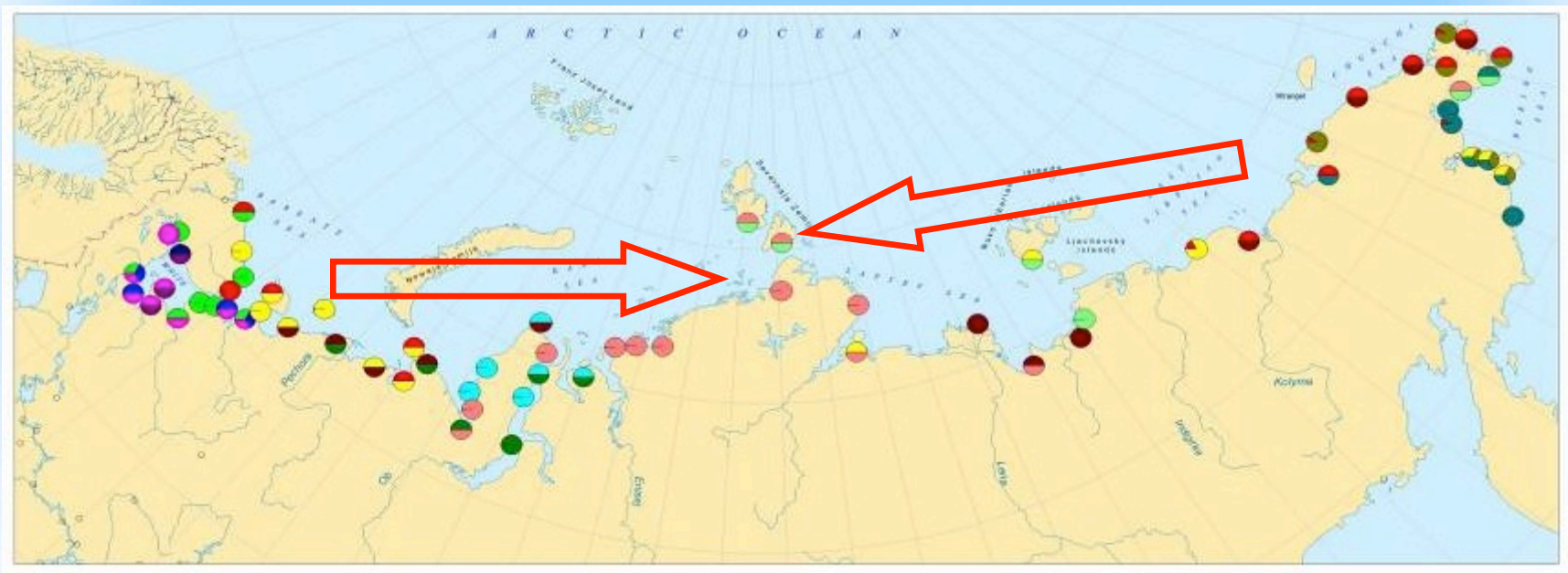
Landscape structure of coastal wetlands of the Chukchi Sea



Species: ***11 - Puccinellia phryganodes, 12 - Carex subspathacea, 16 – Leymus villosissimus, 21 – Festuca rubra, 22 – Hippuris tetraphylla, 24 - Stellaria humifusa, 25 – Dupontia psilosantha, 26 – Arctanthemum hultenii, 27 – Calamagrostis deshampsioides, 28 –Salix ovalifolia, 29 – Carex glareosa, 38 – Rhodiola integrifolia.***

Distribution of salt marsh plant communities on the coast of the Chukotka Autonomous District (eastern part of the East Siberian, the Chuckchi and the Bering seas) and nesting areas of endangered and rare species of water birds

Main salt marsh communities of the Russian Arctic coasts



- ***Puccinellia phryganodes + Carex subspathacea + Stellaria humifusa + Potentilla egedii***
- ***Triglochin maritimum + Tripolium vulgare + Plantago maritima***
- ***Eleocharis uniglumis + Bolboschoenus maritimus***
- ***Potentilla egedii + Arctanthemum hultenii + Calamagrostis deschampsioides***
- ***Carex glareosa + Carex minuscula***
- ***Carex subspathacea + Carex ursina + Puccinellia phryganodes***
- ***Dupontia psilosantha + Carex rariflora***
- ***Puccinellia phryganodes + Carex subspathacea***

CONCLUSION

Azonality is the main peculiarity of the halophytic floristic complexes of marshes wetland of the Russian Arctic coasts. The species are highly adaptable to varying climatic conditions. Only not numerous cosmopolitan circumpolar species such as *Carex subspathacea, Puccinellia phryganodes, Potentilla egedei, Stellaria humifusa* are the kernel and initial pathfinger of the communities. The changes in the biodiversity of the coastal flora on the marshes are related to the historical development of the coenosis, geochemistry of landscape, climate, and, in the modern period, anthropogenous pollutions. The biodiversity the Arctic coastal and salt-marsh communities is directly linked to the geological history of the Arctic. The latitude botanical-geographical structure of the coastal arctic species depends on the zonal region's positions; therefore there is the absence of the species with plurizonal areas in the Kolyma regions, in the Lena and Taimyr regions. During glacial periods the seas were regressed, their level went down; shelves of the seas became a land.

CONCLUSION

During interglacial periods there were seas transgressions, the sea level raised. In the period of warming at the end of the last glacial period, circumpolar arctic plant species became widely distributed over the continental shelf. Other species probably migrated by seed, dispersed by coastal currents. However, the Taymyr Peninsula and Baffin Land served as barriers against the migration of amphi-atlantic species into the Beringia area.

The basic changes of vegetative cover of salt marsh communities connected with the change of level of the Arctic Seas and with the geostatic raising of coasts, are the following: the area of plant communities with domination of boreal – European, and boreal – Eurasian species on the marshes wetland of the Russian Arctic coasts is constantly expanding.

Thank you for your attention!

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Schemes by Maria Schreders, Maria Golomonosova,
Photo by: Minaeva Tatiana (Wetlands International), author.