

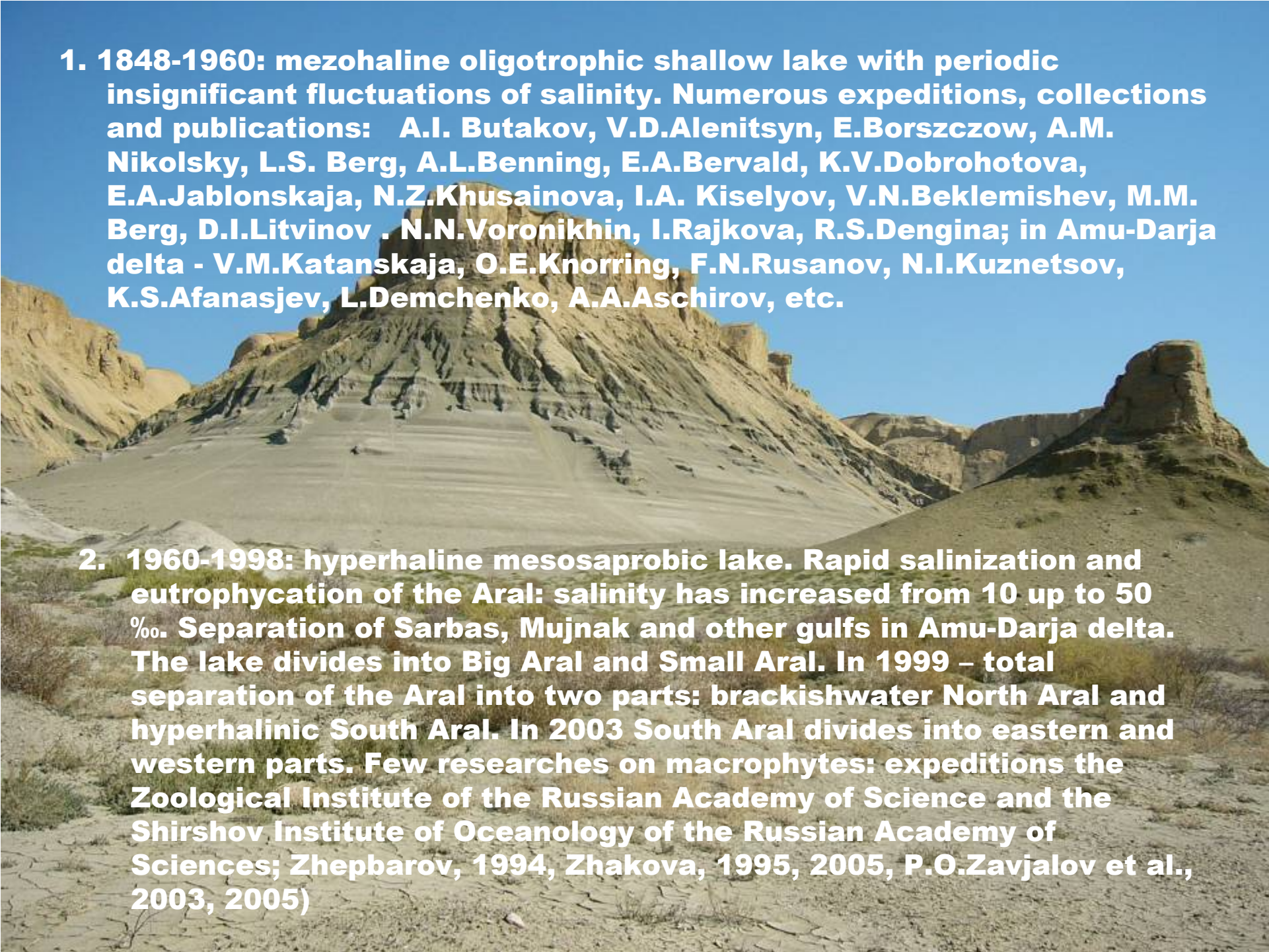
*Water flora composition and
distribution of macrophytes in the
Aral Sea: comparison for the present
and the past*

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foto by I. Plotnikov and D. Pirjulin



1. 1848-1960: mezohaline oligotrophic shallow lake with periodic insignificant fluctuations of salinity. Numerous expeditions, collections and publications: A.I. Butakov, V.D.Alenitsyn, E.Borszczow, A.M. Nikolsky, L.S. Berg, A.L.Benning, E.A.Berval, K.V.Dobrohotova, E.A.Jablonskaja, N.Z.Khusainova, I.A. Kiselyov, V.N.Beklemishev, M.M. Berg, D.I.Litvinov . N.N.Voronikhin, I.Rajkova, R.S.Dengina; in Amu-Darja delta - V.M.Katanskaja, O.E.Knorring, F.N.Rusanov, N.I.Kuznetsov, K.S.Afanasjev, L.Demchenko, A.A.Aschirov, etc.

2. 1960-1998: hyperhaline mesosaprobic lake. Rapid salinization and eutrophication of the Aral: salinity has increased from 10 up to 50 ‰. Separation of Sarbas, Mujnak and other gulfs in Amu-Darja delta. The lake divides into Big Aral and Small Aral. In 1999 – total separation of the Aral into two parts: brackishwater North Aral and hyperhalinic South Aral. In 2003 South Aral divides into eastern and western parts. Few researches on macrophytes: expeditions the Zoological Institute of the Russian Academy of Science and the Shirshov Institute of Oceanology of the Russian Academy of Sciences; Zhepbarov, 1994, Zhakova, 1995, 2005, P.O.Zavjalov et al., 2003, 2005)

List of species of macrophytes, 1849 - 2005

(literary data, herbarium collections of Botanical Institute of the Russian Academy of Science, author's data)

Hydrophytes:

1. *Nymphoides peltata* (G.S.Gmel.) O.Kuntze,
2. *Myriophyllum spicatum* L.,
3. *Najas marina* L.,
4. *Potamogeton crispus* L.,
5. *P.filiformis* Pers.,
6. *P.lucens* L.,
7. *P.macrocarpus* Dobroch.,
8. *P.nodosus* Poir.,
9. *P.pectinatus* L.,
10. *P.perfoliatus* L.,
11. *P.pusillus* L.,
12. *Ruppia cirrhosa* (Petagna) Grande,
13. *R.maritima* L.,
14. *Zanichellia palustris* L.,
15. *Z.pedunculata* Reichb.,
16. *Zostera marina* L.,
17. *Z.noltii* Hornem. (=Nanozostera noltii = Zostera nana)

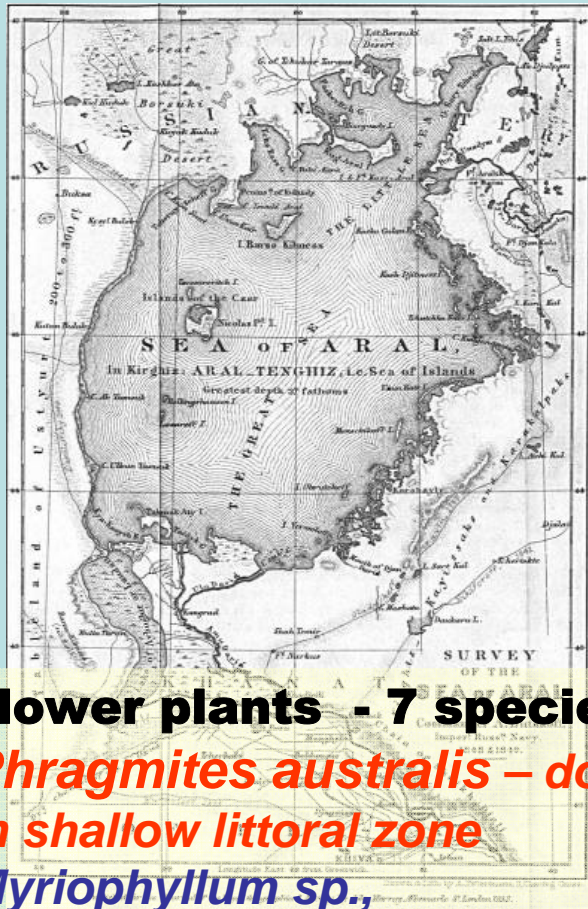
Helophytes:

1. *Butomus umbellatus* L.,
2. *Phragmites australis* (Cav.) Trin.ex Steud.,
3. *Sagittaria trifolia* L.,
4. *Scirpus kasachstanicus* Dobroch.,
5. *S.tabernaemontani* C.C.Gmel.,
6. *S.trigueter* L.,
7. *Typha angustifolia* L.

Charophytes:

1. *Chara intermedia* (=Chara aculeolata Kutz.),
2. *Ch.polyacantha* A.Br.,
3. *Ch.tomentosa* L.,
4. *Lamprothamnium papulosum* (Wallr.) Gr.,
5. *Nitella hyaline* (DC.) Ag.,
6. *Nitellopsis obtusae* (Desv.in Lois.) Gr.

Hydrographic map of the Aral Sea A.I. Butakov, 1848-49



Flower plants - 7 species

Phragmites australis – dominant species
in shallow littoral zone

Myriophyllum sp.,

Potamogeton perfoliatus,

Potamogeton pectinatus,

Najas marina,

Zanichellia sp.,

Zostera sp. - dominant in depths 1.7 - 11 m

Characteristics of the ARAL 1848-1903

- mezohaline oligotrophic shallow lake
with high water transparency

- salinity:

in central areas 10-12 ‰,

in open shallow areas 5-10 ‰,

in estuaries - < 5 ‰,

In the bays of South-East coast - >30 ‰.

Aquatic flora composition :

Macroalgae – 30 species

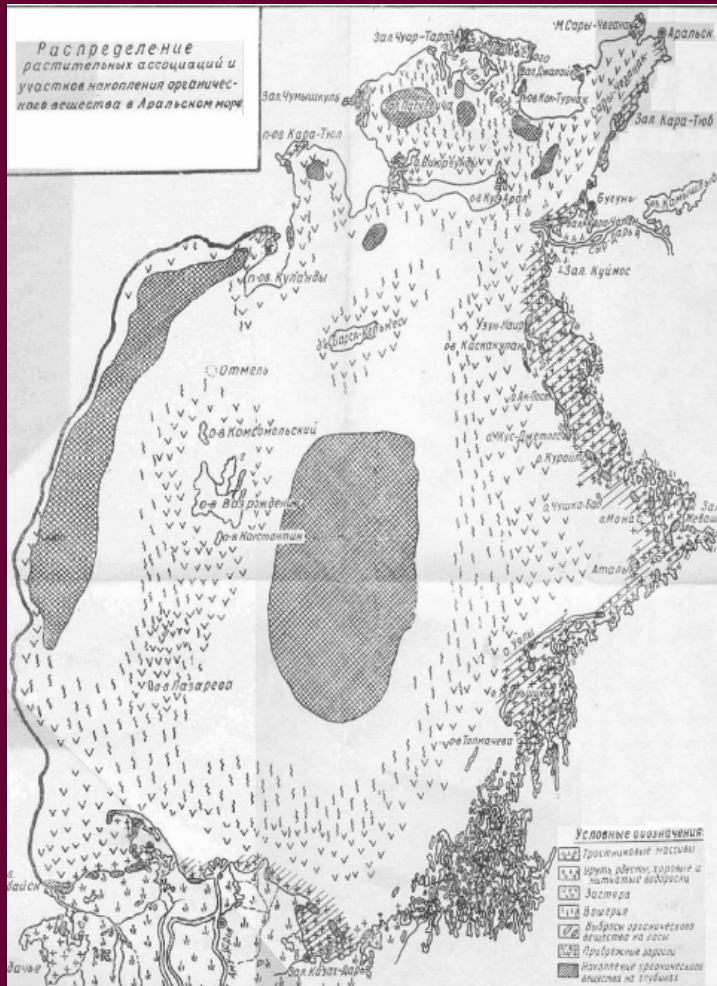
Charophyta – 1 sp.,
dominant deeper than 11 m

Rhodophyta - 10

Chlorophyta – 19

Distribution of water plant associations in Aral during 1946-1956. (E.A.Bervald, 1964)

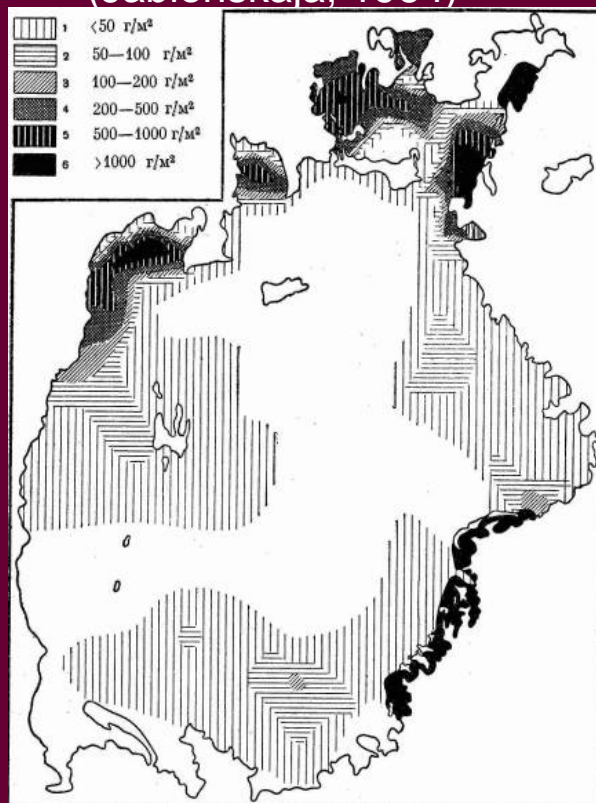
•1903-1960: mezohaline brackishwater lake with periodic insignificant fluctuations of salinity. Such fluctuations were favourable for existence of both freshwater and brackishwater biocenoses.



**Found:
24 species of vascular plants and
6 species of Charophyta
Water vegetation formed three belts:
helophytes,
hydrophytes,
macrophytobenthos**

- Phragmites stands**
- Myriophyllum sp., Potamogeton ssp., Charophytes and green macroalgae**
- Eelgrass (*Zostera sp.*) beds**
- Macroalgae *Vausheria sp.***
- Drifts of organic matter**
- Litoral water vegetation**
- Sediments of organic matter**

**Distribution of
macrophytobentos biomass
during the summer of 1956
(Jablonskaja, 1964)**



**Helophyte stands
production was
two times lower
than hidrophyte
and macroalgae
one**

Dominant communities production (1950-1960s):

- **Helophytes (0-2 m depth):**
Phragmites australis – max 4.5 m high, density up to 300 m⁻², average bm 0.8 kg/m² wet weight, max bm up to 23 kg/m² wet weight (=9.8 kg/m² dry weight)

Scirpus kasachstanicus - max 4 m high, density up to 25 m⁻², average bm 1.85 kg/m² dry weight

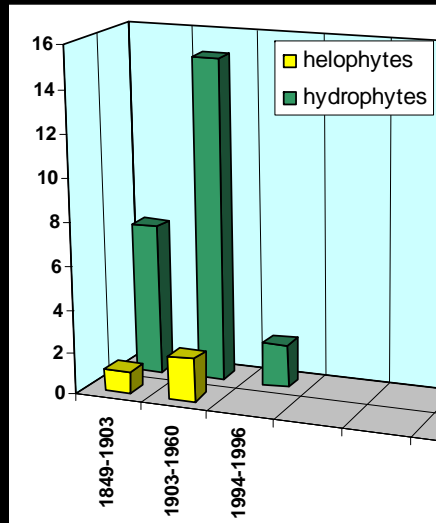
- **Submerged macrophytobentos (2-60 m depth):**

- Charophyta - > 70 %
- Vaucheria - 13 %
- Zostera - 9 %
- Other hydrophytes - < 1 %

Average bm - about 0.3 kg/m² wet weight (= 0.002 kg/m² dry weight)

Zostera noltii –bm 0.1 kg/m² dry weight,
Potamogeton pectinatus - bm 1.24-3.16 kg/m² dry weight,
Myriophyllum sp. - bm 0.86 kg/m² dry weight,
Charophyta – average bm 1.5 kg/m² dry weight.

Changes in number of species of ecological groups of makrophytes in the Aral



•Small Aral:

•In the middle of 1990s the salinity have increased up to 26‰. Among flowering plants only *Zostera noltii* and *Ruppia cirrhosa* have survived, as well as green filamentous algae *Cladophora glomerata*, *Cl.fracta*, *Chaetomorpha linum*, *Ulva intestinalis* and some bentic diatoms and cyanophytes

1989



Big Aral:
only *Ruppia* sp., *Cladophora fracta*, *Vaucheria* sp. and some bentic diatoms have survived after the salinity increased up to 50‰ (Nauka I Zhizn magazine, 2003)

Catastrophic decrease of water level has caused destruction of the majority of biocenoses. By the end of 1970s land reed stands were twice reduced. During 1980s reed stands vanished entirely

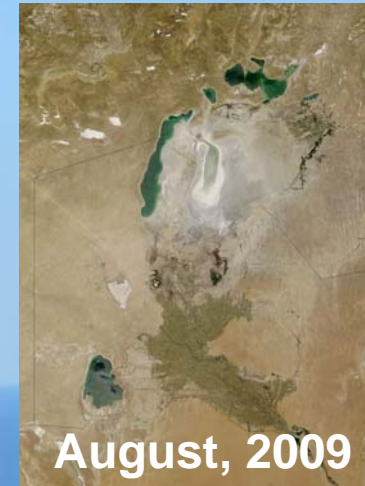
1998



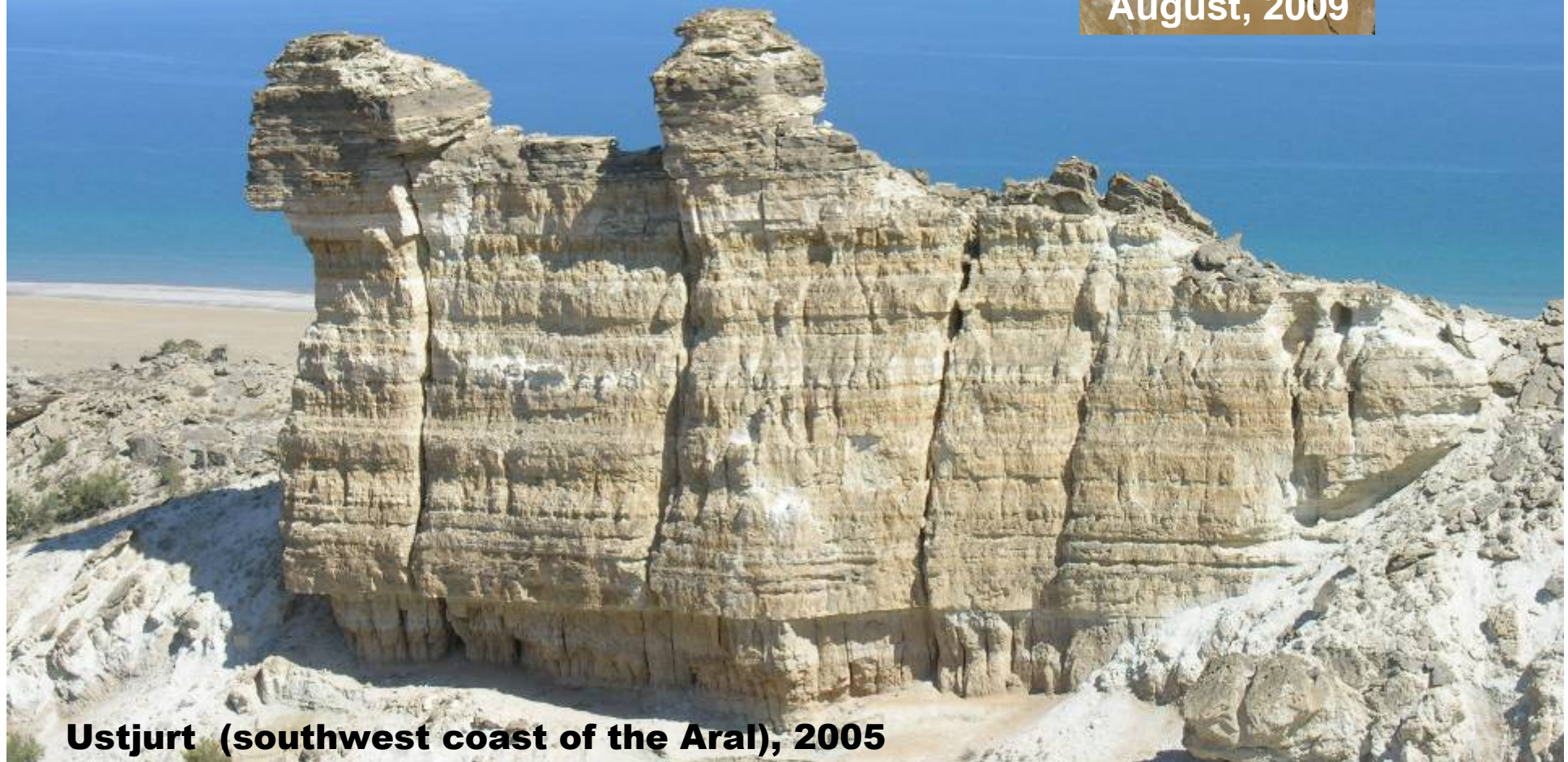
Some ecological characteristics of dominant species of macrophytobentos of the Aral Sea

Species	Salinity, ‰	Settlemen t depth, m	Substrates
<i>Ruppia maritima</i>	1-12	0.5-3.0	silt, sand
<i>Zanichellia pedunculata</i>	1-12	0.5-3.0	clay, silt, sand
<i>Myriophyllum spicatum</i>	1-12	1.5-6	silt, sand
<i>Najas marina</i>	1-12	0.5-4.5	silt, sand, shell rock
<i>Potamogeton pectinatus</i>	1-12	3.0-6.0	silt, sand, shell rock
<i>Scirpus kasachstanicus</i>	0-16 (19.1)	1.5-3	silt, sand
<i>Phargmites australis</i>	0-13,5 (24)	0.5-1.5	silt, sand
<i>Chara polyacantha</i>	15(26)	2.3-5.0	sand, silt
<i>Chara tomentosa</i>	15(26)	1.2-1.9	silt
<i>Zostera noltii</i> (=Z.nana)	8,3-26	1.7-13	silt, sand
<i>Lamprothamnium papulosum</i>	(6) 15.5-26(40)	2.0-3.2	sand
<i>Ruppia cirrhosa</i>	26 (60)	0.2-1.2	clay, silt, sand

In present Southern Aral Sea has turned into several hyperhaline reservoirs. Only *Cl. fracta*, bentic diatoms and cyanophytes were found there when the salinity in the surface layer has increased up to 98 g/kg (according to the observations of 2002-2005, P. O. Zav'yalov et al., 2006)



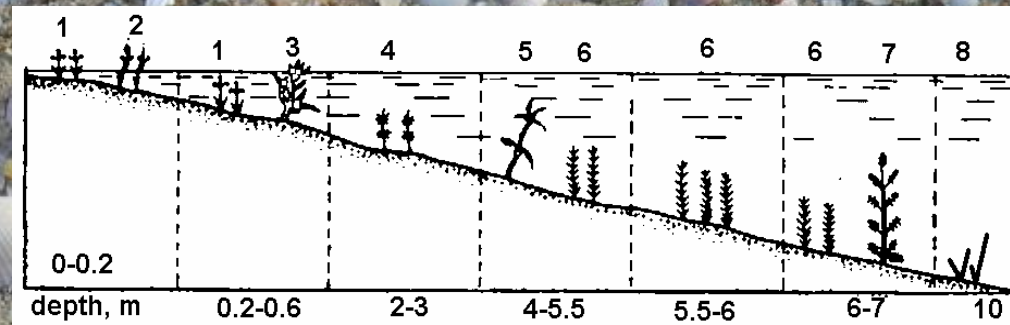
August, 2009



Ustjurt (southwest coast of the Aral), 2005

Littoral transects across water vegetation in Sarychaganak Gulf of the Aral Sea in different years

Fig.1. situation in 1948-1949
(Dobrochotova, 1971)



1. *Ruppia sp.*
2. *Salicornia europaea*
3. *Zanichellia pedunculata*
4. Charophytes
5. *Najas marina*
6. *Potamogeton pectinatus*
7. *Myriophyllum sp.*
8. *Zostera noltii*
9. Filamentous green macroalgae
10. *Ulva intestinalis*

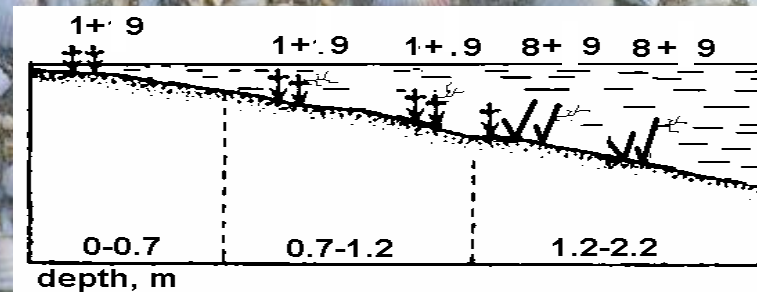
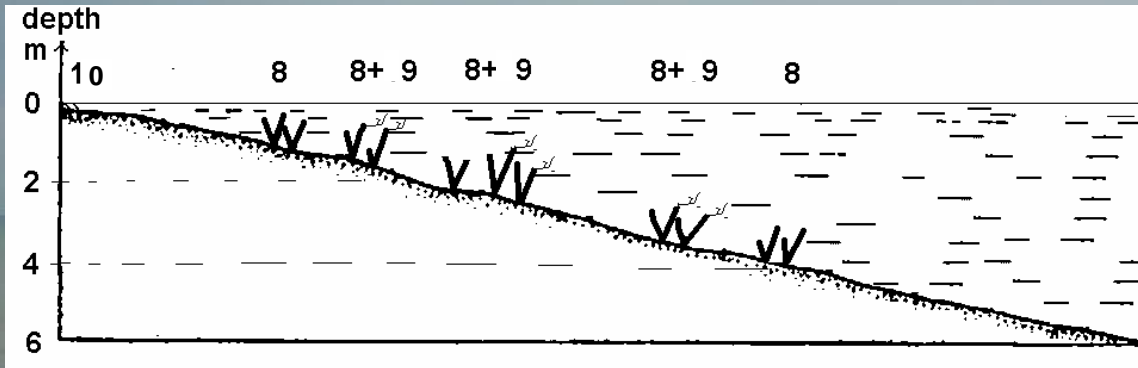
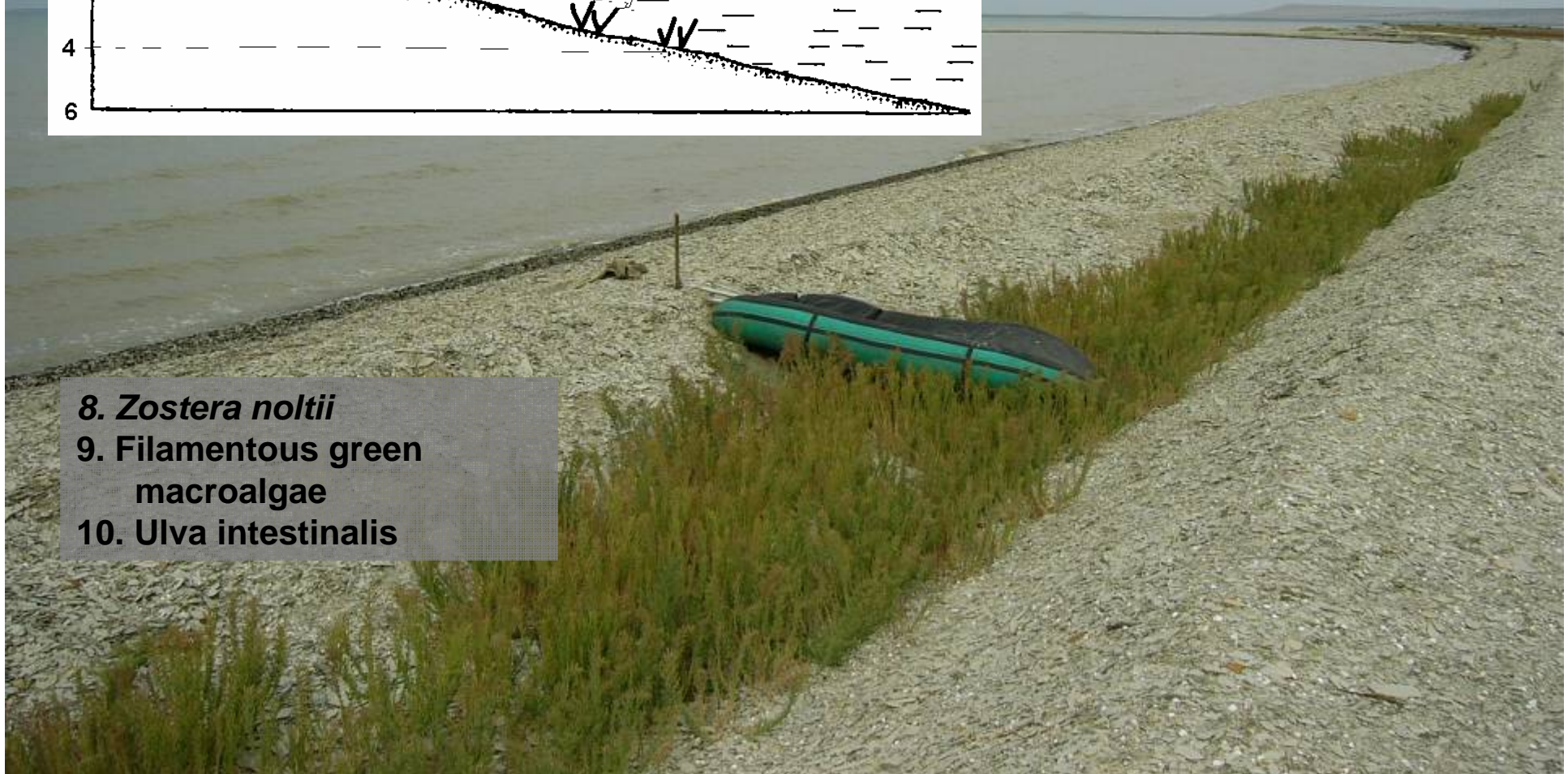


Fig.2. situation in 1994 (Zhakova)

Littoral transect across eelgrass bed (*Zostera noltii*) Kokturnak peninsula, Northern Aral Sea , situation in 1996 (Zhakova)



- 8. *Zostera noltii*
- 9. Filamentous green macroalgae
- 10. *Ulva intestinalis*



- **Northern Aral Sea is gradually freshening by waters of Syr-Darja river. In the autumn of 2005 the salinity in many areas did not exceed 15‰. The majority of production of phytobentos belongs to both microphytobentos and macroalgae - *Chaetomorpha linum*, *Cladophora fracta*.**
- **Macrophytes are presented by 4 species of flowering plants - *Phragmites australis*,
Ruppia cirrhosa,
Ruppia maritima,
Zostera noltii,**
- **and 2 species of Charophytes - *Lamprothamnium papulosum*,
*Chara intermedia***

Reed stands near Syr-Darja delta, 2005

CONCLUSIONS

- During researches since 1848 till 2000 the Aral has changed significantly: mezohaline oligotrophic shallow lake has turned into hyperhaline mesosaprobic one.
- In the earliest researches (1849-1903) the homogeneous vegetation was covering shallow coastal areas of brackishwater Aral : large areas were occupied with dominant communities of reed (*Phragmites*) and eelgrass (*Zostera*).
- The initial stage of salinization (till 1960) was characterized by division of existing biocenoses into a number of new ones, smaller in their areas and more varied in specific structure. By the end of this period charophytes and green macroalgae were dominant among submerged macrophytobentos.
- Catastrophic drying of the Aral Lake during 1960-1990s has led to subdivision of the Lake into two basins: Big Aral and Small Aral as well as has caused degradation of the most of macrophyte communities. Only associations of *Zostera noltii*, *Ruppia cirrhosa*, green filamentous macroalgae and bentic diatoms have survived.
- In South Aral conditions are unsuitable for existence of macrophytes now.
- North Aral is gradually populated by widespread euryhaline, mesohaline and oligohaline, cosmopolitan and extremely polymorphic species of hydrophytes, which are penetrating into the Aral Lake from other continental brackishwater reservoirs of Central Asia.

**Thanks for your
attention !**



foto by D.Pirjulin (1996)