

Systematization of the Biodiversity of Crustaceans and Molluscs of the Aral Sea

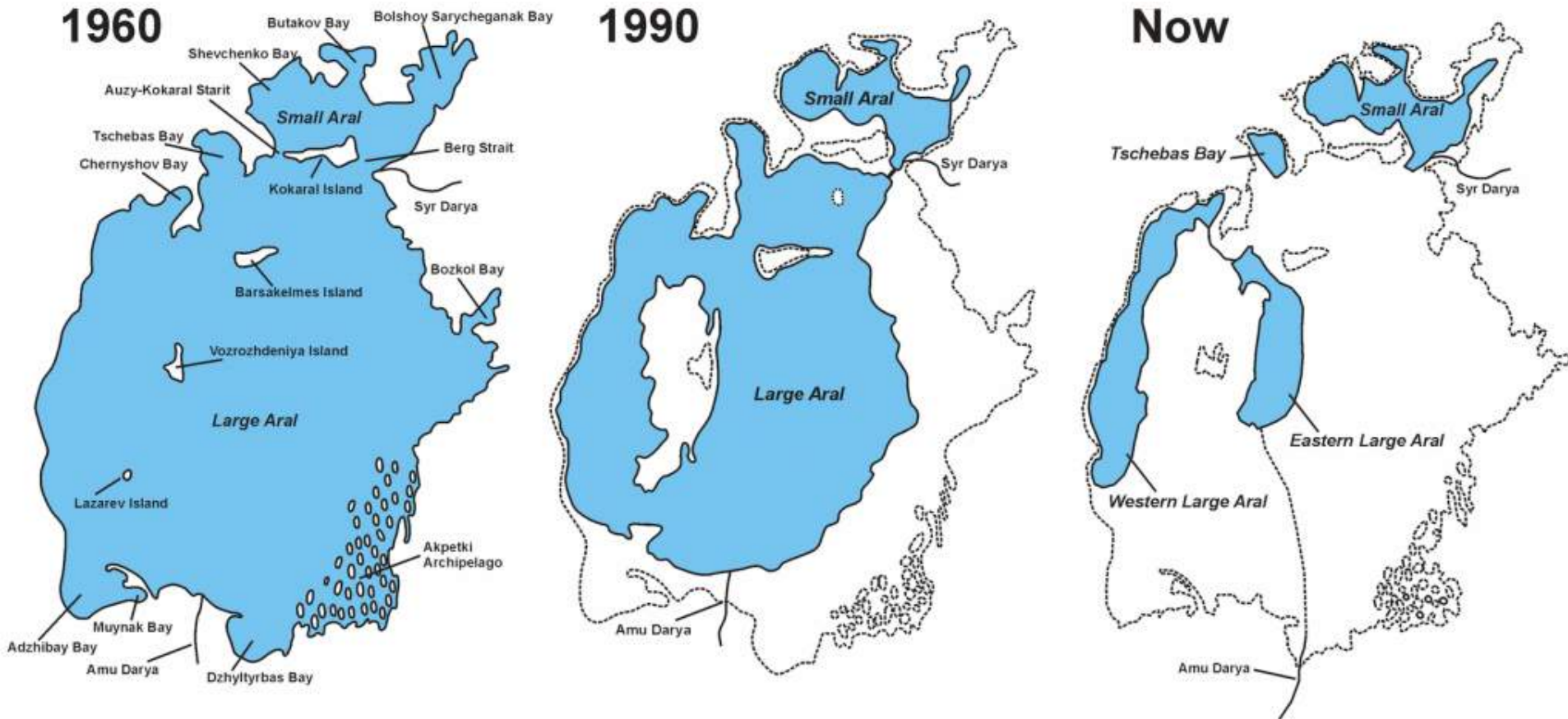
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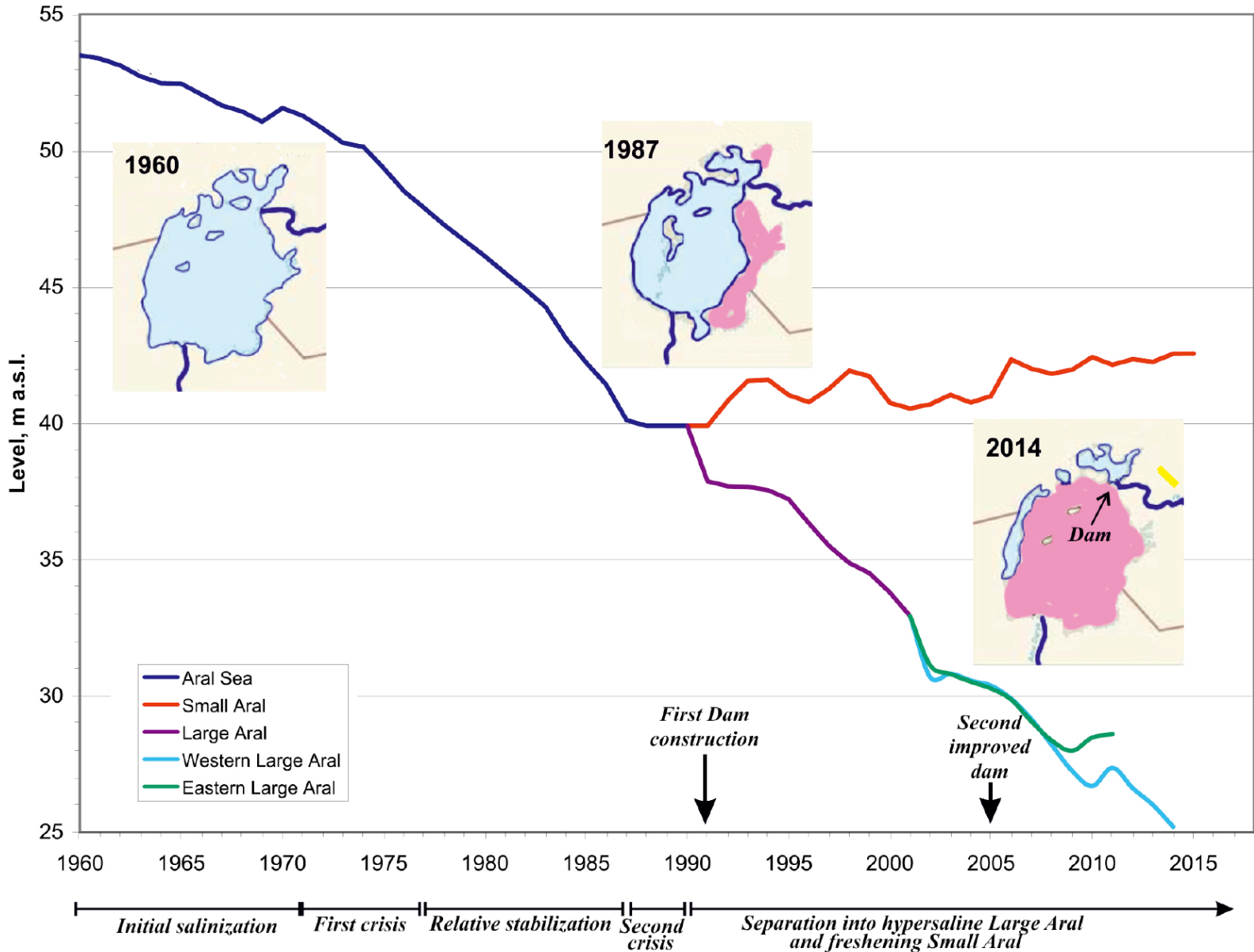
The Aral Sea and its regression



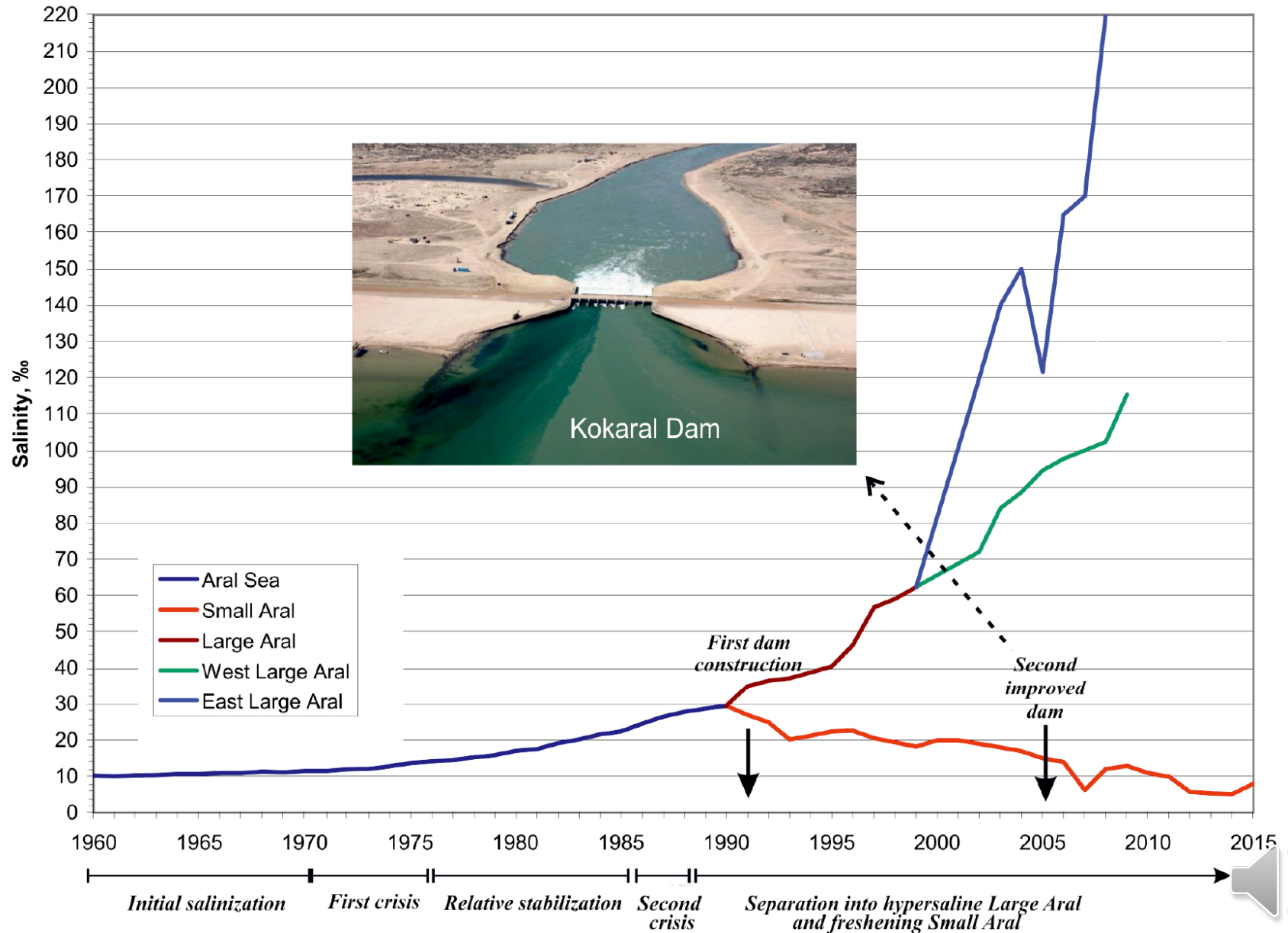
- The Aral Sea is terminal water body of Syr Darya and Amu Darya rivers, large endorheic saline lake.
- Before the modern anthropogenic regression, it was brackish water with an average salinity $\sim 10\%$.
- Since 1960s, mainly due to the increasing irreversible withdrawal of riverine water, the water level began to drop and salinity to grow.
- This resulted catastrophic decrease of the biodiversity.
- Growing salinity resulted disappearance of the most species-rich freshwater at first and then brackish-water invertebrates.



Level variation



Salinity variation



Cladocera

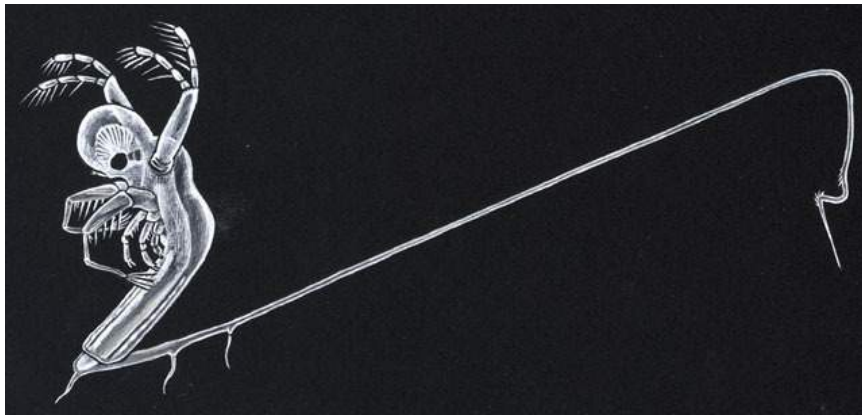
- In Aral 18 species of cladocerans are known.
- The most belongs to freshwater faunal complex.
- Others 5 are Ponto-Caspian endemics from order Onychopoda.



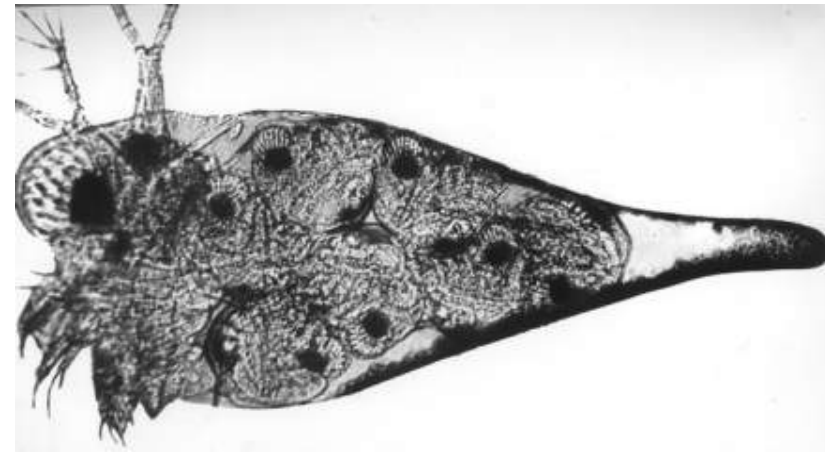
Coronatella rectangularis



Ceriodaphnia reticulata

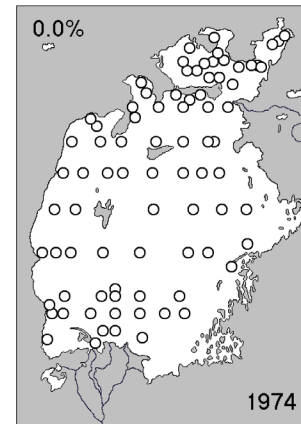
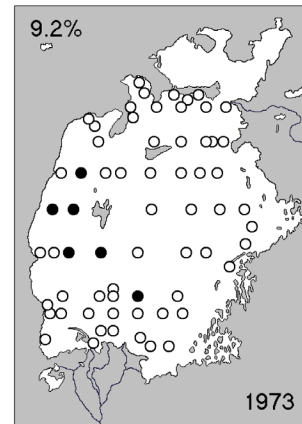
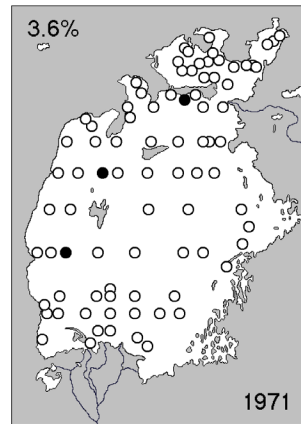
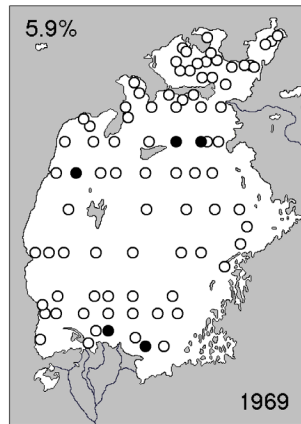


Cercopagis pengoi aralensis

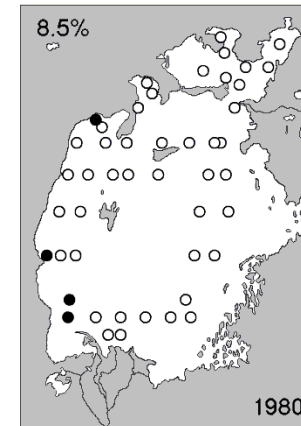
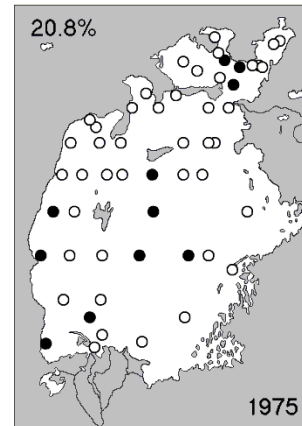
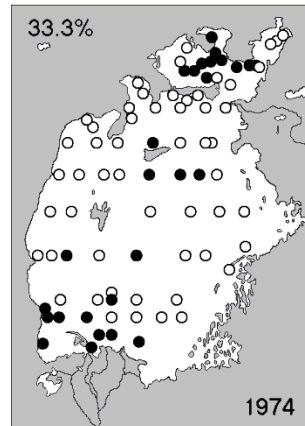
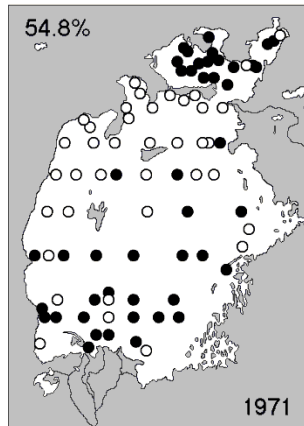


Evadne anonyx





Because of increasing salinity freshwater
Cladocera disappeared



Cercopagis pengoi also disappeared and now is extinct



Copepoda

- In the Aral Sea 17 native and alien species of Copepoda are known.
- Widely euryhaline calanoid copepod from continental saline waters, *Arctodiaptomus salinus*, dominated among planktonic crustaceans until late 1950s.
- Then its abundance decreased due to extermination by introduced planktivorous fishes, and since 1974 it is extinct.
- It was replaced by marine calanoid *Calanipeda aquaedulcis*, intentionally introduced from the Sea of Azov in 1965–1970.
- From Cyclopoida, only *Halicyclops rotundipes* belongs to marine fauna. All other belong to the freshwater complex.
- Before salinization freshwater *Mesocyclops leuckarti* was the most numerous among cyclopids.
- In Aral 15 species from Harpacticoida are known. Of them, *Schizopera aralensis*, *S. reducta*, and *Enhydrosoma birsteini* are endemics.

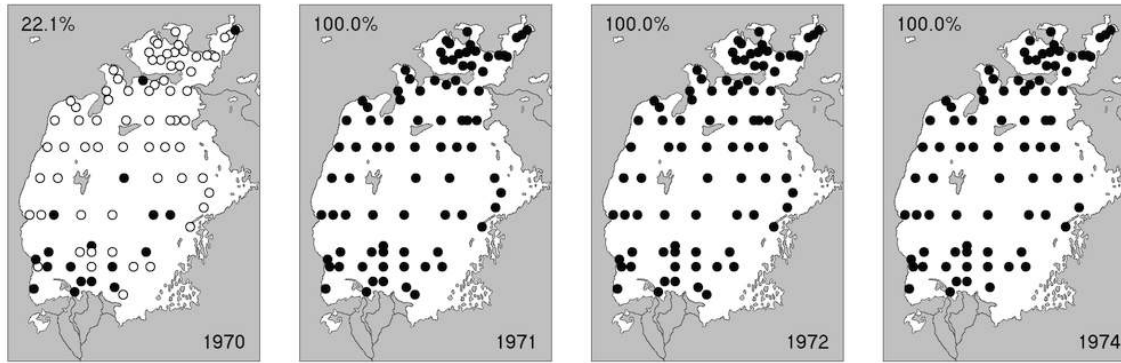


Arctodiaptomus salinus

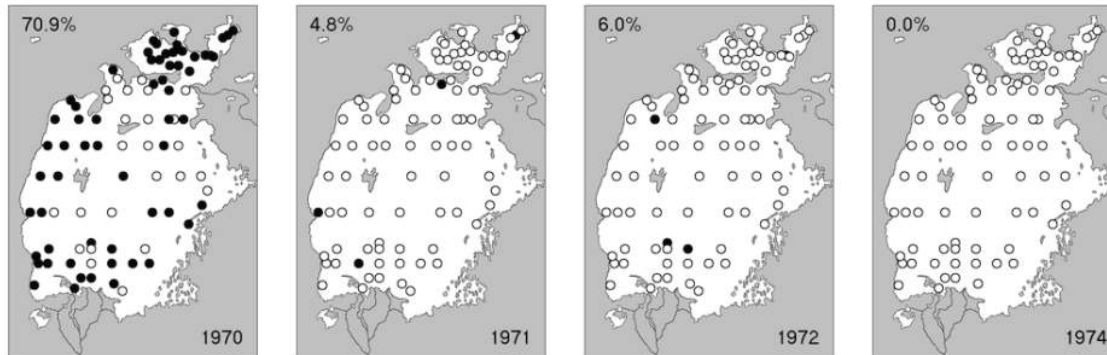


Mesocyclops leuckarti





Settling of *Calanipeda aquaedulcis*



Disappearance of *Arctodiaptomus salinus*

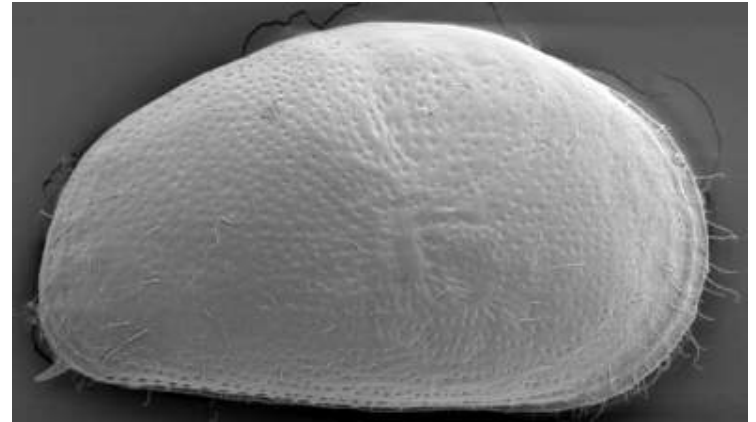


Calanipeda aquaedulcis



Ostracoda and Malacostraca

- Of 13 known species of Ostracoda, 11 are native and other 2 are apparently recent invaders. The most widespread is *Cyprideis torosa*.
- A total of 6 species of Malacostraca are known in Aral. Native is Ponto-Caspian amphipod *Dikerogammarus aralensis*. Others are invaders appeared in 1958–1970.



Cyprideis torosa



Dikerogammarus aralensis



Malacostraca

- Ponto-Caspian mysids *Paramysis* spp. were intentionally introduced from the Sea of Azov in 1958–1960 as food for fish.
- Marine crab *Rhithropanopeus harrisi* were introduced (only in the Large Aral) accidentally during acclimatization of *Calanipeda aquaedulcis*.



Paramysis lacustris



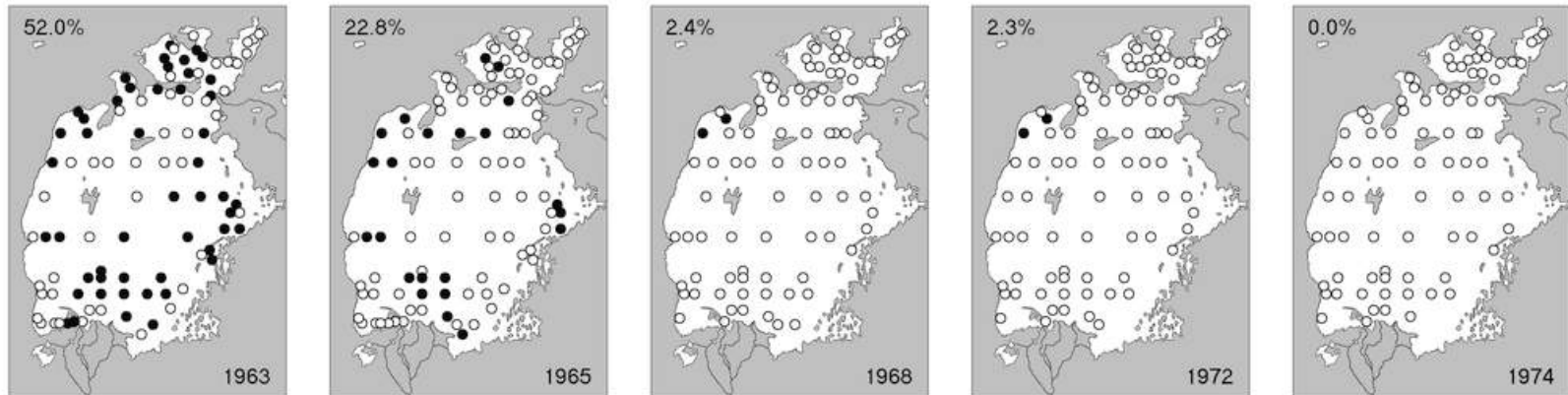
Rhithropanopeus harrisi



- Marine shrimp *Palaemon elegans* were introduced accidentally during acclimatization of fish from the Caspian Sea 1954–1956.
- The shrimp caused extinction of amphipod by 1973.



Palaemon elegans



Disappearance of native *Dikerogammarus aralensis*



Bivalvia

- In the Aral Sea fauna, 9 species and subspecies of Bivalvia are known, one of which is invader.
- Of them, bivalves *Adacna minima minima*, *A. m. sidorovi*, *A. vitrea bergi*, *Dreissena polymorpha aralensis*, *D. p. obtusecarinata* and *D. caspia pallasii* are endemics of the Aral Sea.



Adacna minima



Adacna vitrea



*Dreissena
polymorpha
aralensis*

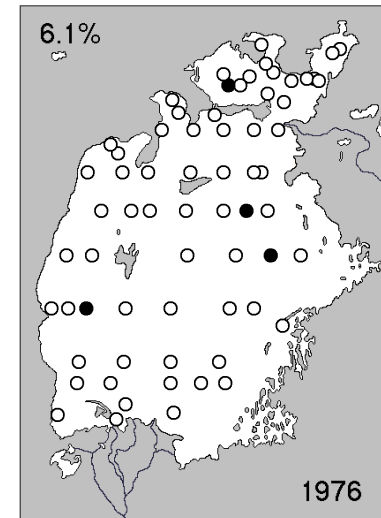
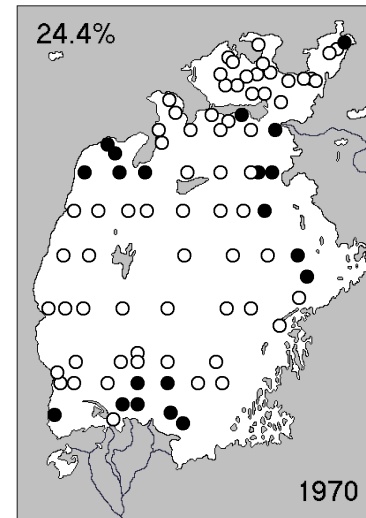
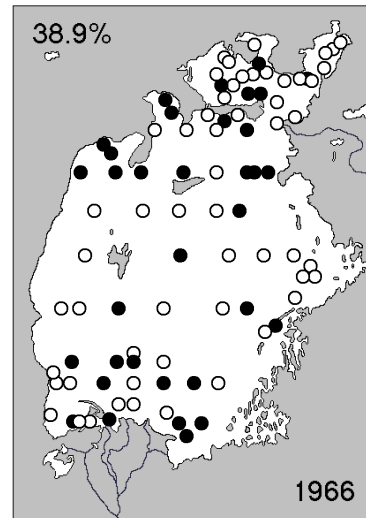
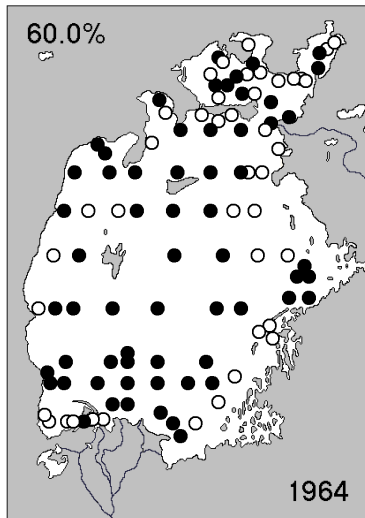


*Dreissena
polymorpha
obtusecarinata*



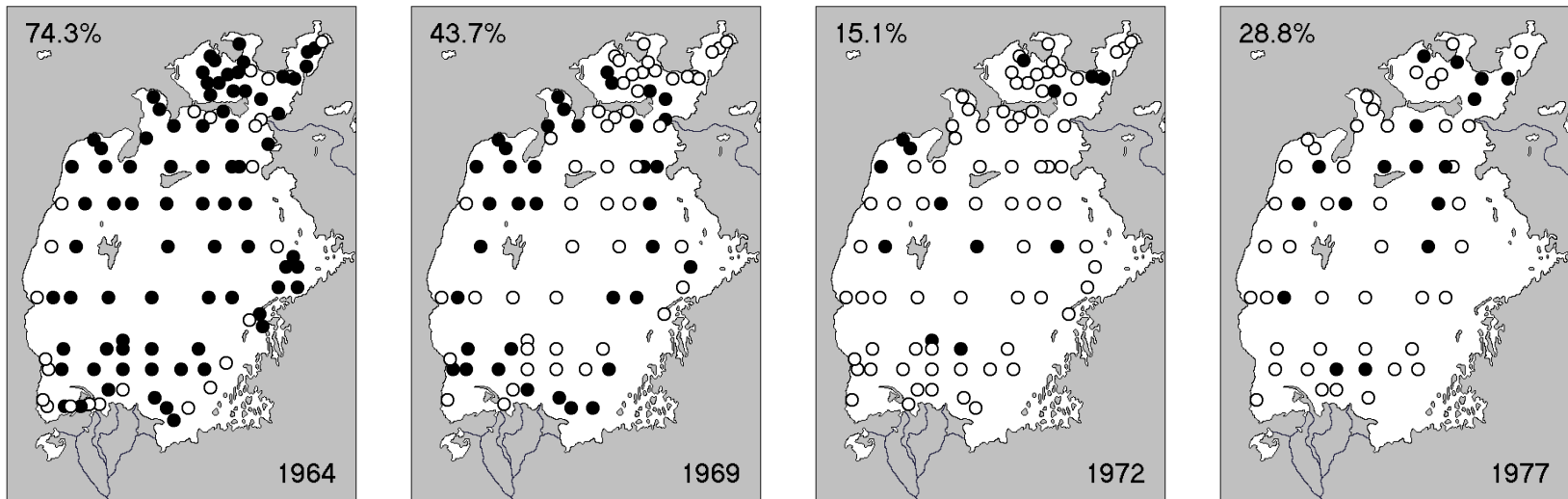
*Dreissena
caspia pall*





With increasing salinity all forms of bivalves *Adacna* became extinct.





With increasing salinity all *Dreissena* disappeared.

Only *Dreissena polymorpha aralensis* survived salinization in rivers and connected with them lakes. *D. p. obtusecarinata* and *D. caspia pallasii* became extinct.



- Bivalve mollusk *Cerastoderma* sp. (earlier identified as *C. rhomboides*) initially inhabited the entire Aral, except for heavily salinized areas.
- Due to salinization, it disappeared by 1978.
- Other species, marine *C. glaucum*, originally lived only in salinized areas, but with increasing salinity, it spread throughout the sea.

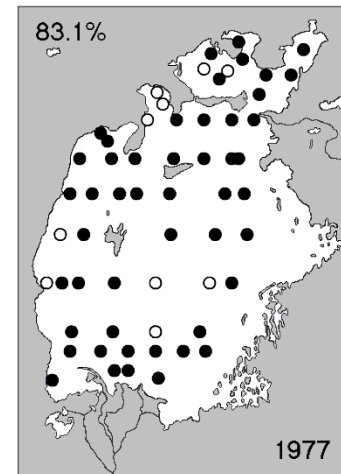
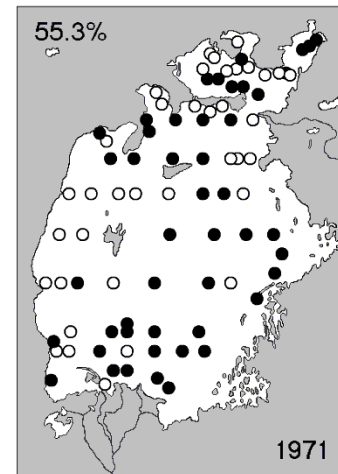
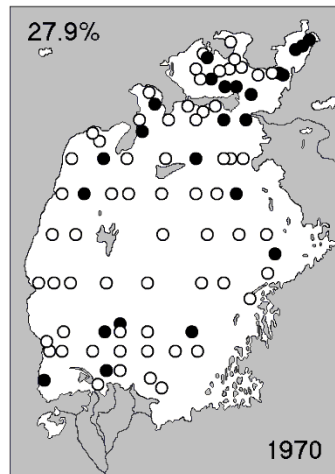
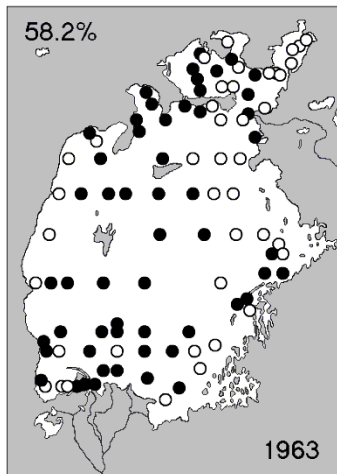


Cerastoderma sp.



Cerastoderma glaucum



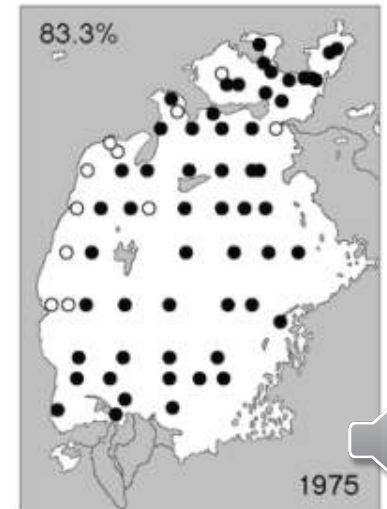
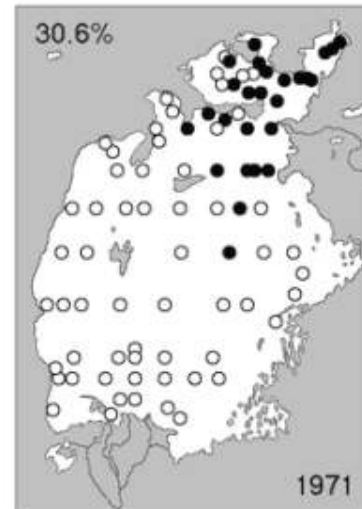
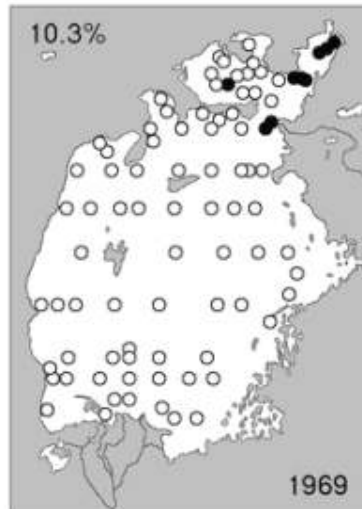


Due to salinization, *Cerastoderma* sp. disappeared from Aral by 1978. The rest of presences correspond to the marine *C. glaucum*





- Widely euryhaline marine bivalve *Abra segmentum* was introduced in 1960–1963 as valuable food for fish.
- To the mid 1970s it settled the whole Aral Sea.



Gastropoda

- In the Aral fauna, 2 species of Gastropoda are known. All of them are native.
- Native gastropod *Ecrobia grimmi* now lives only in Small Aral, and is absent in hyperhaline Large Aral.

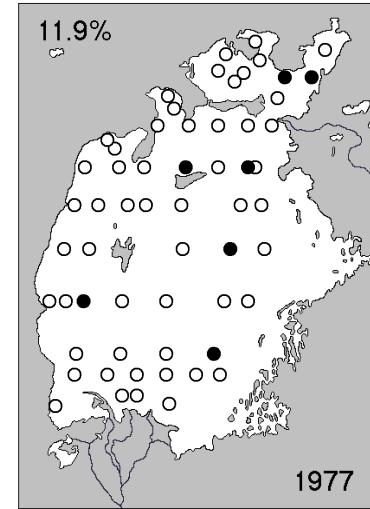
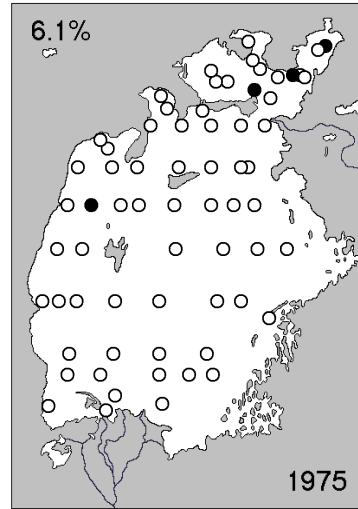
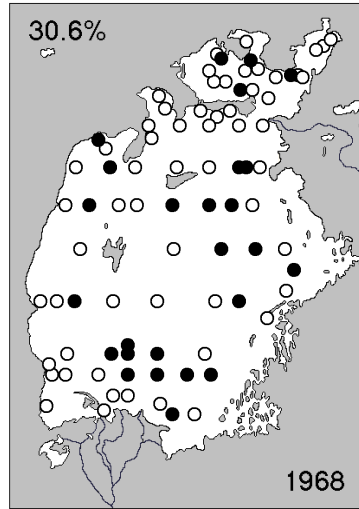
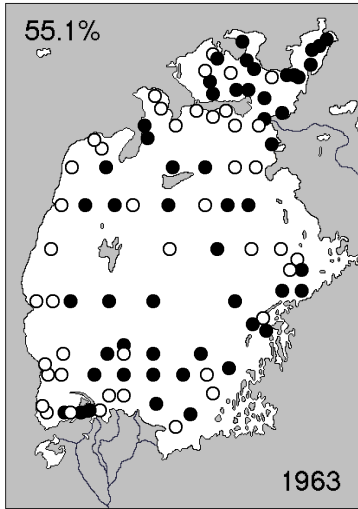


Theodoxus pallasii



Ecrobia grimmi





Ponto-Caspian gastropod *Theodoxus pallasii* disappeared from Aral in 1980s due to salinization.



- By the end of 1980s biodiversity of crustaceans and mollusks decreased catastrophically. All freshwater Cladocera, Copepoda and Mysida disappeared.
- Only about 10 species of Crustacea and 3 species of Mollusca survived salinization.
- With the level fall, Aral divided into two water bodies, Small (Northern) Aral and Large (Southern) Aral.
- Construction of the dam in former Berg Strait became possible to decrease of Small Aral salinity and gradual restoration of biodiversity.



The first dam in Berg Strait was built in August 1992



New Kok-Aral dike built by Russian company "ZARUBEZHVDSTROY"



**Kok-Aral
Dam**



- Freshening of the Small Aral and formation of freshened zone at Syrdarya delta made possible natural reintroduction of many disappeared invertebrates which also inhabit Syrdarya and lakes in its lower reaches.
- Now biodiversity of crustaceans increased. Many freshwater and brackish water species are found in the Small Aral.
- By the 2000s, gastropod *Theodoxus pallasii* and bivalve *Dreissena polymorpha aralensis* appeared in freshened area at Syrdarya delta.



Crustacea and Mollusca in the Small Aral now

Copepoda

Phyllodiaptomus blanci

Cyclops vicinus

Mesocyclops leuckarti

Megacyclops viridis

Cladocera

Bosmina longirostris

Chydorus sphaericus

Diaphanosoma brachyurum

Ceriodaphnia reticulata

Evadne anonyx

Podonevadne camptonyx

P. angusta

Mysida

Paramysis intermedia

Bivalvia

Dreissena polymorpha aralensis

Cerastoderma glaucum

Abra segmentum

Gastropoda

Theodoxus pallasii

Ecrobia grimmeri



Large Aral

- Large Aral has turned into hyperhaline water body inhabited by only a few species.
- Crustaceans are represented in Large Aral only by one species of Cyclopoida, at least one species of Harpacticoida, one of Ostracoda and naturally introduced in the late 1990s brine shrimp *Artemia*.
- All 3 species of molluscs disappeared until 2010.



Crustaceans survived or appeared in the hyperhaline residual water bodies of the Large Aral

- *Artemia parthenogenetica* – appeared in 1998
- *Apocyclops dengizicus* – appeared in 2004
- *Eucypris mareotica* – appeared before 2005
- *Nitocra lacustris* – survived



At the end of 20th century brine shrimp *Artemia parthenogenetica* appeared in the Large Aral Sea.



Thank you for your attention

