Introduction to Cladocera (water fleas): Biology and Ecology

Dra. Edyta Zawaisa
Academia Polaca de Ciencias
Cladocera
(water fleas, los cladóceros)
since Jurassic 145 million years ago

and it seems that Cladocera are much more older
Since Ordovician
Cladocera is a monophyletic group with four suborders and 11 families:

1. Daphniidae
2. Moinidae
3. Bosminidae
4. Macrothricidae
5. Chydoridea
6. Sididae
7. Holopeidae
8. Polyphemidae
9. Cercopagidae
10. Podonidae
11. Leptodoridae

Around 400 species...
• The modern Cladocera developed in the Jurassic period (208 mil. y. ago) during the period of supercontinent Pangea.

• Evolutionary history of branchiopods began from Cambrian sea.

• Today only few Cladocera species are found in marine environmental
The split of Pangea (into Laurasia and Gondwana 180 million years ago) defined first geographical dispersal of the order.

It seems that some species are connected with the previous Laurasia or Gondwana.
Extinct species
From Jurassic period, from Chalunikha, Russia

Leposida ponomarenkoi
The geographical distribution of cladocera is a function of geological history of area:

▪ River networks,
▪ lake system,
▪ and other barriers
Nowadays Cladocera species richness is higher in mid-northern latitudes, decreases towards tropics and pools.
Today vast number of north lakes is exceptional and this is an effect of Pleistocene glaciations.
Nowadays freshwater aquatic ecosystem in the tropics are river-dominated systems, with oxbow lakes and temporary pools.
Apart of geography and geology the presence and absence of Cladocera in different regions of the World is controlled by biotic factors:

1. Competition and predation
2. Preliminary production
3. Nutrient regeneration
4. Oxygen availability

Recent study indicates that temperature is a factor controlling Cladocera population and it is the most important across latitudes.
Distribution of Cladocera is controlled mainly by two factors:

1. Capacity of dispersal
   ✓ Reproduction parthenogenetically
Trasportable resting eggs (ephippia)
Diapausing eggs are covered by several protective membranes
Distribution of Cladocera is controlled mainly by two factors:

2. Tolerance to various environmental condition

Organism ability to survive:

- physical
  - chemical
  - and biological pressures

Despite of very good ability for dispersal, very few species of Cladocera are cosmopolitan with the worldwide distribution !!!
Cladocera Biology
Left: bacteria, salmon-pink colour
Right: green algae, transparent with the gut green or yellow
Newborn Daphnia looks more or less like adult, except that the brood chamber is not yet development.
First eggs are deposited in the brood chamber c.a. 5-10 days in 20°C

Adults may produce parthenogenetic offspring every 3-4 days

Daphnia in the laboratory may live 2-3 months, in the lake . . . . ?
Reproduction of Cladocera
When do males appear?

- Reduced food availability
- High density of specimens
- Decreasing day length
- Lower temperature
- Dryness
- Strong predation
- Toxicity
When do males appear?

- Males are smaller by size
- Have larger antennules
- Postabdomen is modified by having hook used for fertilization
Ephippia can sink to the bottom or drift in the water, may disperse by the wind and animales.

May preserve unfavorable condition even a lot of seasons. Hatching is inducted by:
- appropriate photoperiod
- temperature
- availability of water or food
From resting eggs hatch only females which usually produce parthenogenetic eggs themselves

**BUT . . . . .**

When environmental condition is bad, females may start immediately sexual reproduction
The Daphnia habitats can be very widely:
- Between 6.5-9.5 pH (optimum 7.2-8.5 pH)
- Salinity below 5 promiles
Cladocera are often dominant zooplankton

Daphnia is predominant food for planktivorous fish
D. galeata

D. hyalina
Larvae of the Chaoborus (Phantom midge)
Daphnia behavior 😊

http://www.youtube.com/watch?v=RCbwaWxb-54&feature=related

Daily vertical migration

Horizontal migration
Habitat ecology of Cladocera
Offshore (pelagic)

Littoral

Bosminidae
Daphniidae

Chydoridae
The major ecological niches of Cladocera

- **LITTORAL (MEIOBENTHIC)**
  - *Scapholeberis*
  - Vegetation: *Graptoleberis*, *Eury cercus*, *Alona*, *Pleuroxus*, *Oxyurella*, *Acrornerus*, *Capmtocercus*, *Rynchotalona*, *Disparalona*, *Opisoxenus*, *Sida*, *Lutona*, *Acantholeberis*

- **NEUSTON**
  - *Scapholeberis*

- **LITTORAL (OPEN WATER)**
  - *Simocephalus*, *Bosmina*, *Polyphemus*, *Holopedium*

- **OPEN WATER (PLANCTONIC)**
  - *Daphnia*, *Bosmina*, *Diaphanosoma*, *Leptodora*

- **ROCK**
  - *Alona*, *Alonopsis*, *Chy dorus*

- **SAND**
  - *Alona*, *Chy dorus*

- **MUD**
  - *Ilyocryptus*, *Chy dorus*, *Leydigia*, *Monospisilus*
Many Cladocera are adopted to a wide range of temperature changes (seasonally) but their growing and reproduction is slower in the cold water.
Altitude by direct way (dispersal and colonization abilities) and by indirect way (by temperature and vegetation) is the main factor controlling Cladocera species composition. However, there are only few true cold stenothermal species.
✓ Temperature 15-20°C – maximizes parthenogentic reproduction

✓ Population can be multiplied many times in just few days under favorable temperature.

✓ Only produce one generation per season under marginal temperature or not reproduce at all if temperature is too low.
Ceriodaphnia quadrangularis

needs temperature over 8 °C to reproduce in boreal region
Daphnia middendorffiana

Max. temperature is 15°C
Daphnia umbra
cold mountain and
tundra lakes
Lake is natural archive of the past

Past environmental changes are recorded in the deposits of lakes and ponds

(Sturm, 1998)
LAKE SEDIMENTS REPRESENT NATURAL ENVIRONMENTAL ARCHIVE

Information about past environmental condition is provided by:

• lithology
• chemical composition
• plants fragments
• animals remains
Paleolimnology, analysis of remains deposited in freshwater sediments

- Diatoms
- Cladocera
- Ostracoda
- Chironomidae
- Mollusca
- Pediastrum
- Pollen
CLADOCERA – water fleas

- Subphylum CRUSTACEA, order CLADOCERA
- Body size 0.3 to 18 mm
- Cladocera mostly freshwater zooplankton
- Generally around world there are 450 species
- In Europe live c.a. 100 species
- In the lake Cladocera lives both in littoral and open water zones
- Filter feeders
- Breeding: parthenogenesis and sexual reproduction
WHY CLADOCERA?

- Cladocera remains are common in lacustrine sediments
- It is possible to identify remains to species or even subspecies level
- Requirements of Cladocera to the environment have not changed during the several thousands year
- Among Cladocera there are bioindicatior species
- They are sensitive to environmental changes
We can use subfossil Cladocera analysis to reconstruct:

- Trophy status
- Changes of water level
- Climatostratygraphy
- pH
- Salinity
- Climate changes
- Human impact
Materials and Methods

Sieve 40 µm
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Cladocera remains in lake sediments

headshield

shell

postabdominal claws

postabdomen

ephippium
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POSGRADO EN CIENCIAS DEL MAR Y LIMNOLOGÍA
Bosmina longispina
shell
Bosmina coregoni headshield
*Chydorus sphaericus*

headshield and shell