



# Drastic change of peracaridan assemblage in Lake Dusia, Lithuania, after the introduction of Ponto-Caspian aliens

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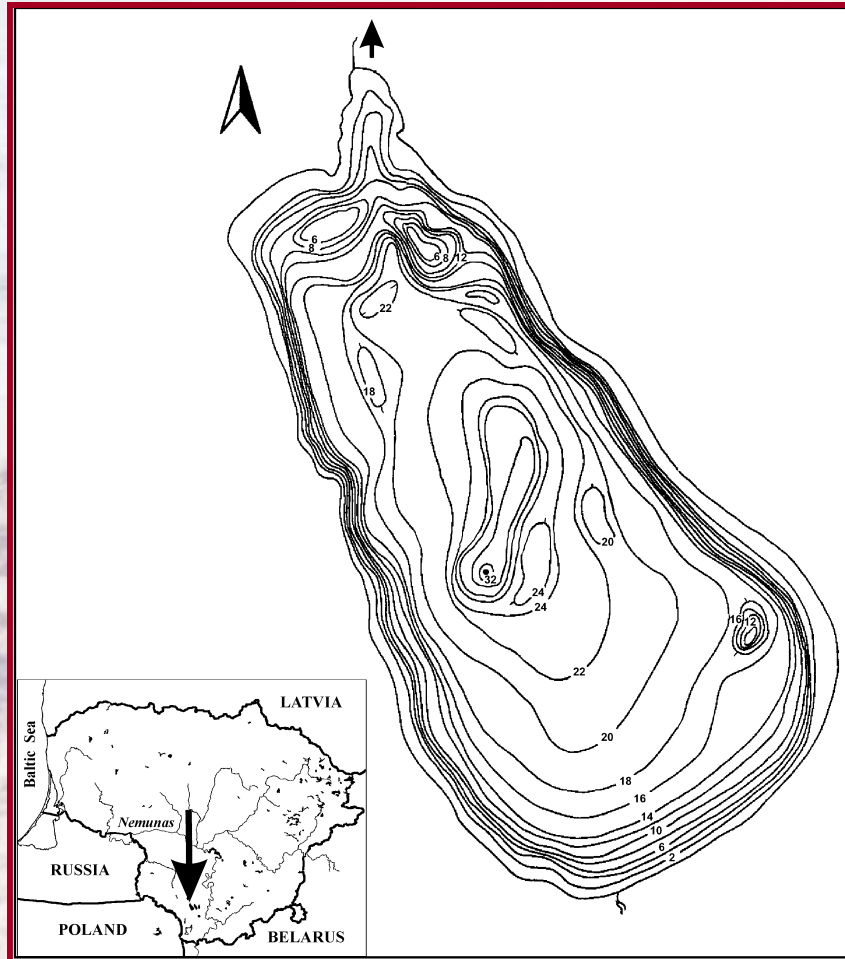
# Can peracaridans with different origin co-exist in the long term? And other invasion outcomes

**The Lake Dusia experiment –  
deliberate introduction of Ponto-Caspian aliens**



# Battlefield

Lake Dusia, a lake of glacial origin, is the third largest lake of Lithuania (area - 2316.8 ha, mean depth -14.6 m)



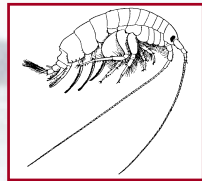
# Battlefield

Lake characteristics that might be important for Peracarida

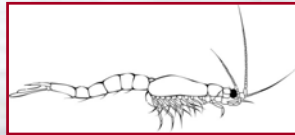
- maximal depth –32.4 m
- hypolimnion starts with a depth of 12-16 m
- annual water circulation - 6%
- **broad sandy-bottom littoral of 100-350 m width (12% of area)**
- **mean distance of wind racing - 4.2 km**
  
- **previously mesotrophic** (Secchi depth during summer 5.5-8.0 m, total P - 0.03-0.06 mg L<sup>-1</sup>, rare decreases of oxygen in hypolimnion)
  
- **recently mesotrophic with traits of eutrophy** (Secchi depth during summer 2.6-7.9 m, total P - 0.02-0.22 mg L<sup>-1</sup>, chlorophyll “a” concentration 3.9-7.7 mg m<sup>3</sup>, depletions of oxygen in hypolimnion)



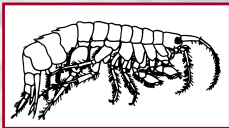
# Opposition



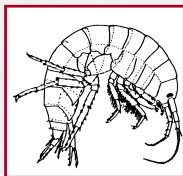
*Monoporeia affinis*



*Mysis relicta*



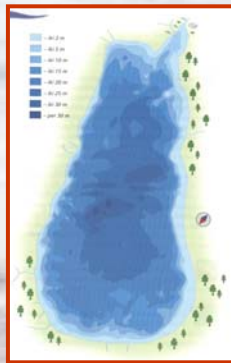
*Pallaseopsis quadrispinosa*



*Gammarus lacustris*



*Asellus aquaticus*



## Native species:

In 1952 (Gasiūnas 1957)

*Mysis relicta*

*Pallaseopsis quadrispinosa*

*Gammarus lacustris*

*Asellus aquaticus*

In 1975 detected (Grigelis 1980)

*Monoporeia affinis*

# Opposition

## Introduced alien species:

(Gasiūnas 1975)

During 1955, from Curonian Lagoon

***Chelicorophium curvispinum***

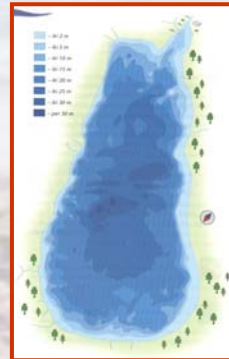
During 1963-1964, from Kaunas WR

***Paramysis lacustris***

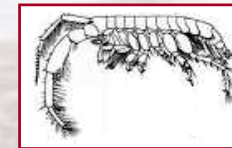
***Pontogammarus robustoides***

***Obesogammarus crassus***

***Chaetogammarus warpachowskyi***



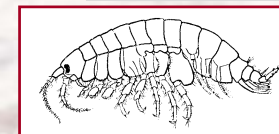
*Paramysis lacustris*



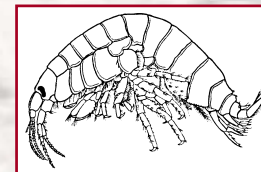
*Chelicorophium curvispinum*



*Chaetogammarus warpachowskyi*

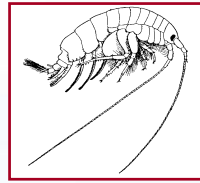


*Obesogammarus crassus*



*Pontogammarus robustoides*

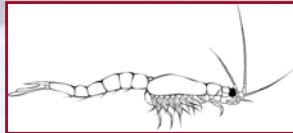
# Opposition



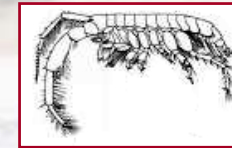
*Monoporeia affinis*



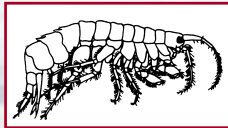
*Paramysis lacustris*



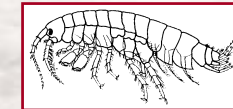
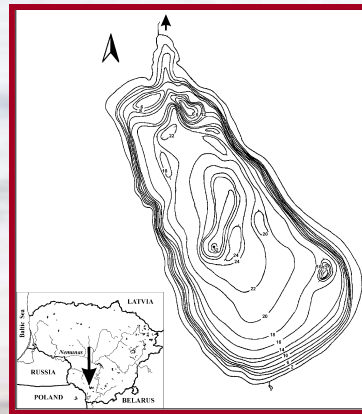
*Mysis relicta*



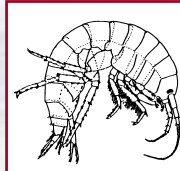
*Chelicorophium curvispinum*



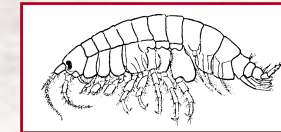
*Pallasea quadrispinosa*



*Chaetogammarus warpachowskyi*



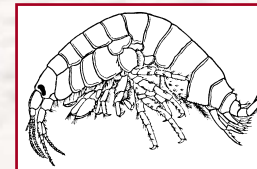
*Gammarus lacustris*



*Obesogammarus crassus*



*Asellus aquaticus*



*Pontogammarus robustoides*

During 1980-ies, **10 Peracarida species** inhabited Lake Dusia  
(Gasiūnas 1975, Grigelis 1980)

# Means

	Life cycle	Feeding	Refuge
<b>Natives</b>			
<i>Mysis relicta</i>	predominantly annual or biannual one brood	omnivory	hypolimnion
<i>Pallaseopsis quadrispinosa</i>	predominantly annual or biannual a few broods (?)	omnivory	hypolimnion
<i>Monoporeia affinis</i>	triannual one brood	deposit feeder	hypolimnion
<i>Gammarus lacustris</i>	annual one brood	omnivory	low oxygen (?)
<i>Asellus aquaticus</i>	semiannual one or a few (?) broods	herbi- detritovory	low-oxygen (?) vegetation (?)
<b>Ponto-Caspians</b>			
<i>Paramysis lacustris</i>	3 generations per year	omnivory	shallow waters
<i>Pontogammarus robustoides</i>	annual 3 broods	omnivory	shallow waters
<i>Obesogammarus crassus</i>	annual 3 broods (?)	omnivory	shallow waters
<i>Chaetogammarus warpachowskyi</i>	annual (?) 3 broods (?)	omnivory	shallow waters

# Data

## Did peracaridan assemblage change since 1980-ies?

### Previously

From Gasiūnas (1975), Grigelis (1980, unpublished results of 1966-1967) and Vaitonis (1994)

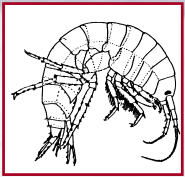
### Recently

Investigations of 1999-2000, 2002 and 2004-2005 performed during periods of thermal stratification.

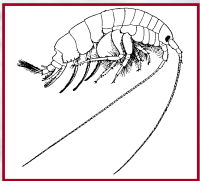
Results compiled from catches by sledge net, dredge, stovepipe sampler, vertical net tows and manual sampling.

# Outcome

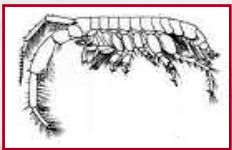
## Recently extinct species



*Gammarus lacustris* – declined even during the establishment of aliens, for the last time recorded during 1989-1991, recently absent



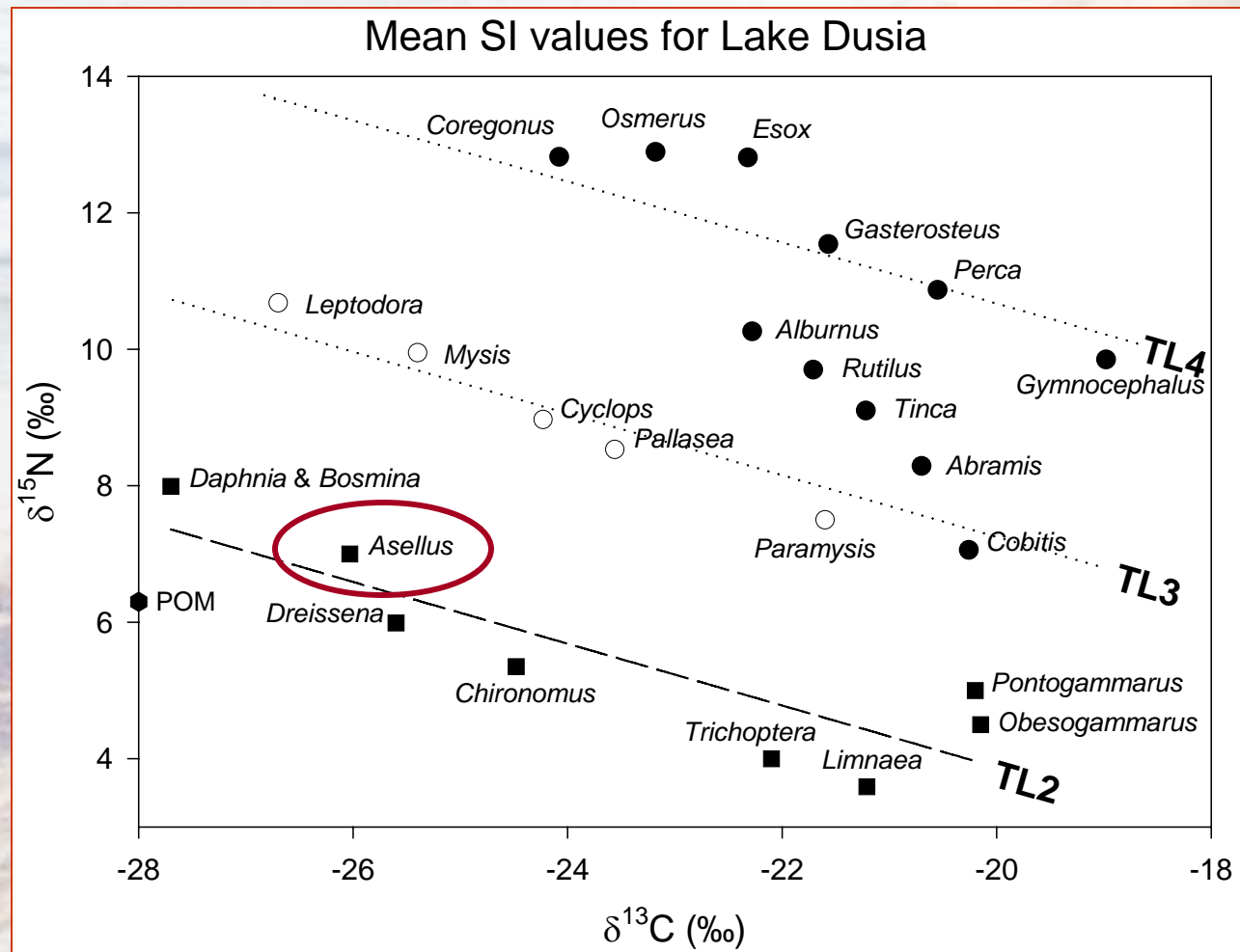
*Monoporeia affinis* – recorded just once, in 1975



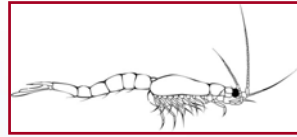
*Chelicorophium curvispinum* - recorded just once, in 1971

# Outcome

*Asellus aquaticus* – dominated among peracaridans during 1966-1967, recently occurs in low numbers only at depths between 3 and 10 m



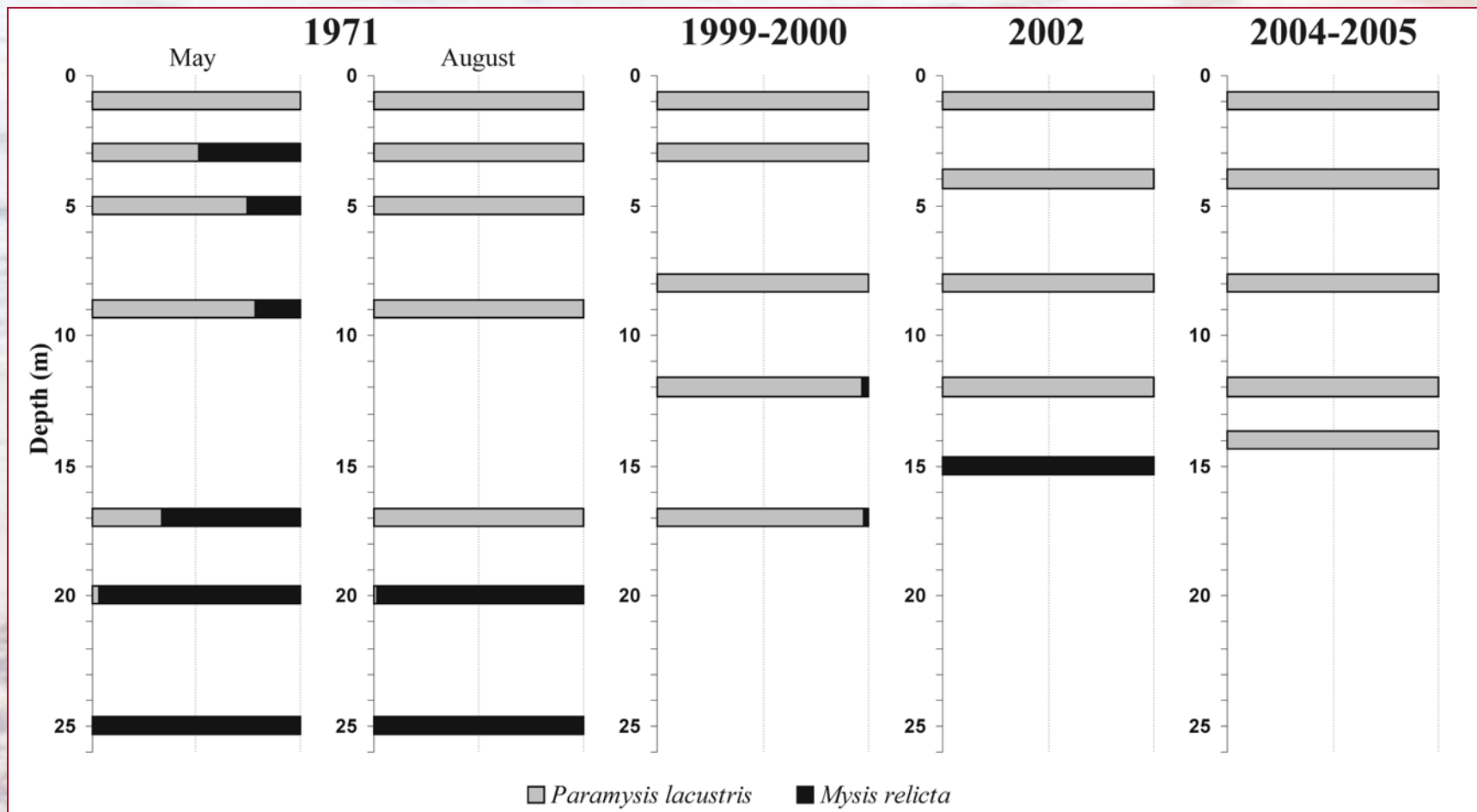
# Outcome



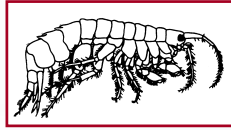
*Mysis relicta*

(in 1989-1991 still abundant, 35-47 ind. m<sup>-2</sup>)

## Mysid proportions at different depths of Lake Dusia



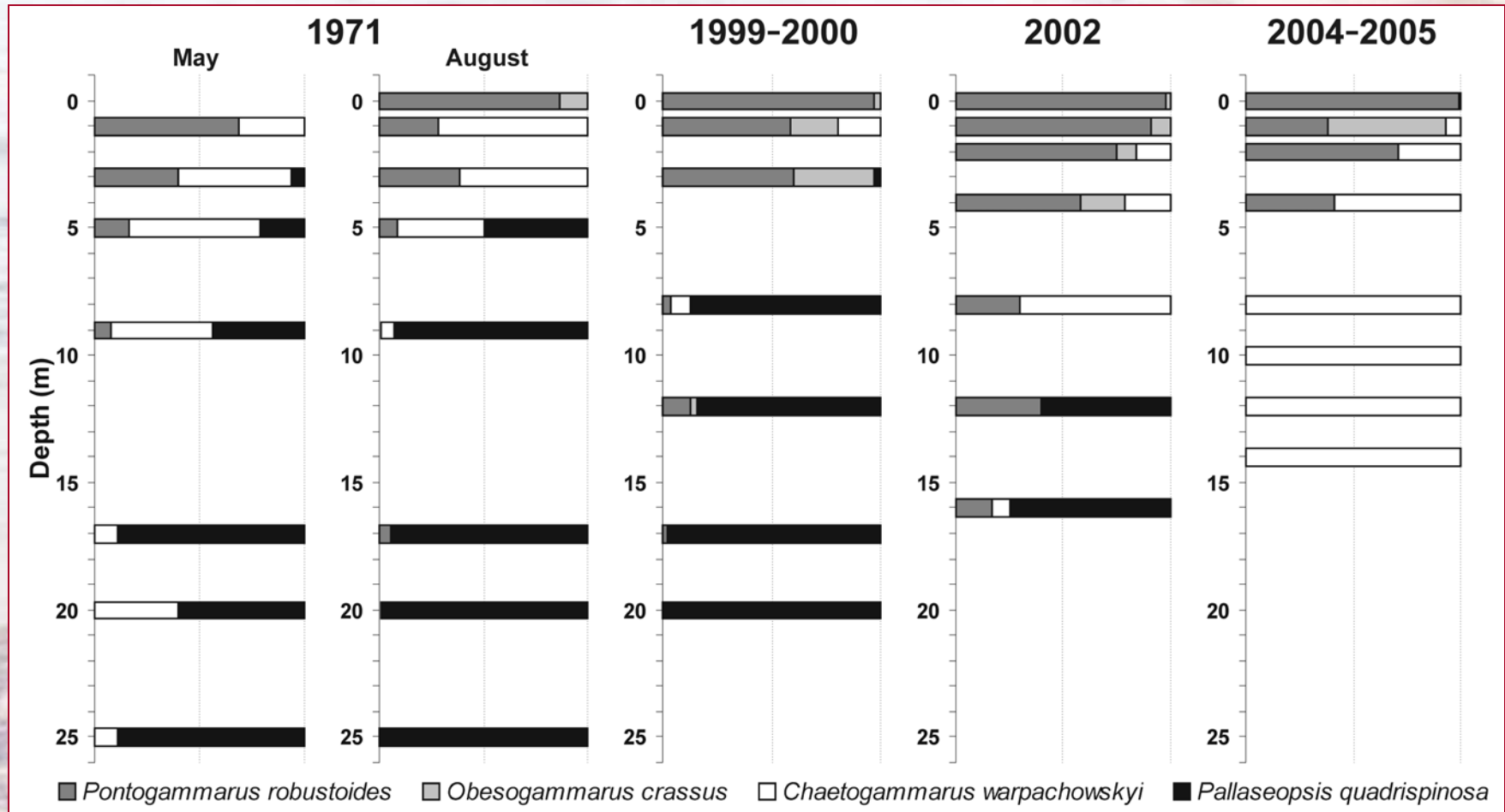
# Outcome



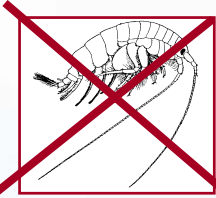
## *Pallaseopsis quadrispinosa*

(in 1989-1991 still abundant, 13-33 ind. m<sup>-2</sup>)

### Amphipod proportions at different depths of Lake Dusia



# Outcome



*Monoporeia affinis*



*Paramysis lacustris*



*Mysis relicta*



*Chelicorophium curvispinum*



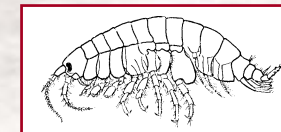
*Pallaseopsis quadrispinosa*



*Chaetogammarus warpachowskyi*



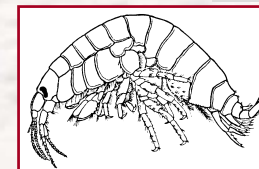
*Gammarus lacustris*



*Obesogammarus crassus*



*Asellus aquaticus*



*Pontogammarus robustoides*

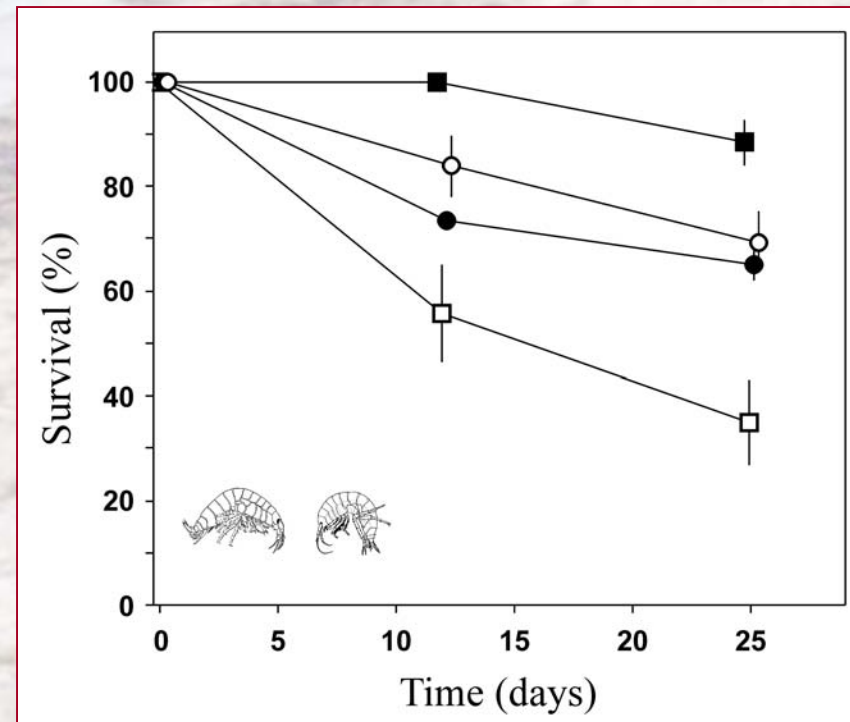
Recently, **5 Peracarida species** inhabit Lake Dusia

# Causes

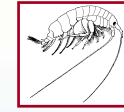
For native littoral species - *Gammarus lacustris* and *Asellus aquaticus*?

Predation of *Pontogammarus robustoides* must be responsible.

Survival of *G. lacustris* (squares) and *P. robustoides* (circles) under control (closed symbols) and experimental (open symbols) conditions, i.e. when raised separately and together on filamentous algae *Cladophora* sp. as sole food. The highest and the lowest survival was in *G. lacustris* under control and experimental conditions, correspondingly (Cox-Mantel test,  $P \leq 0.009$ ), and did not differ in *P. robustoides* between treatments (Gumuliauskaitė and Arbačiauskas 2007).

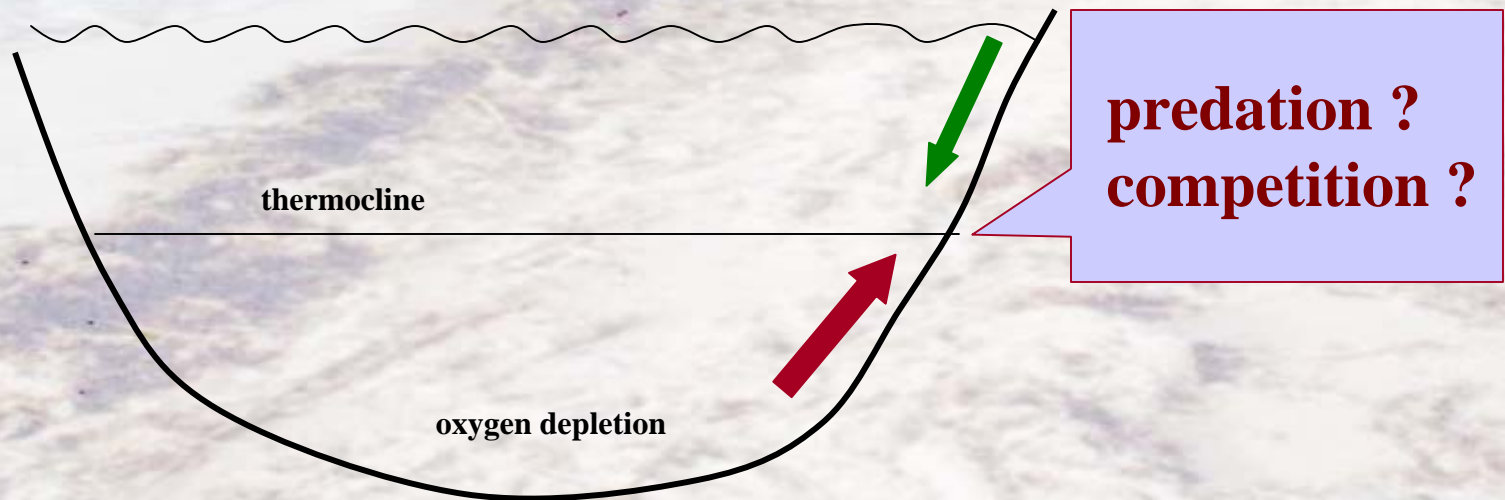


# Causes



What had affected the decline and consequent extinction of glacial relict species – *Mysis relicta*, *Pallaseopsis quadrispinosa* and *Monoporeia affinis*?

- depletions of oxygen in cold waters of hypolimnion during periods of thermal stratification
- interaction with aliens ???



**Probably predation**

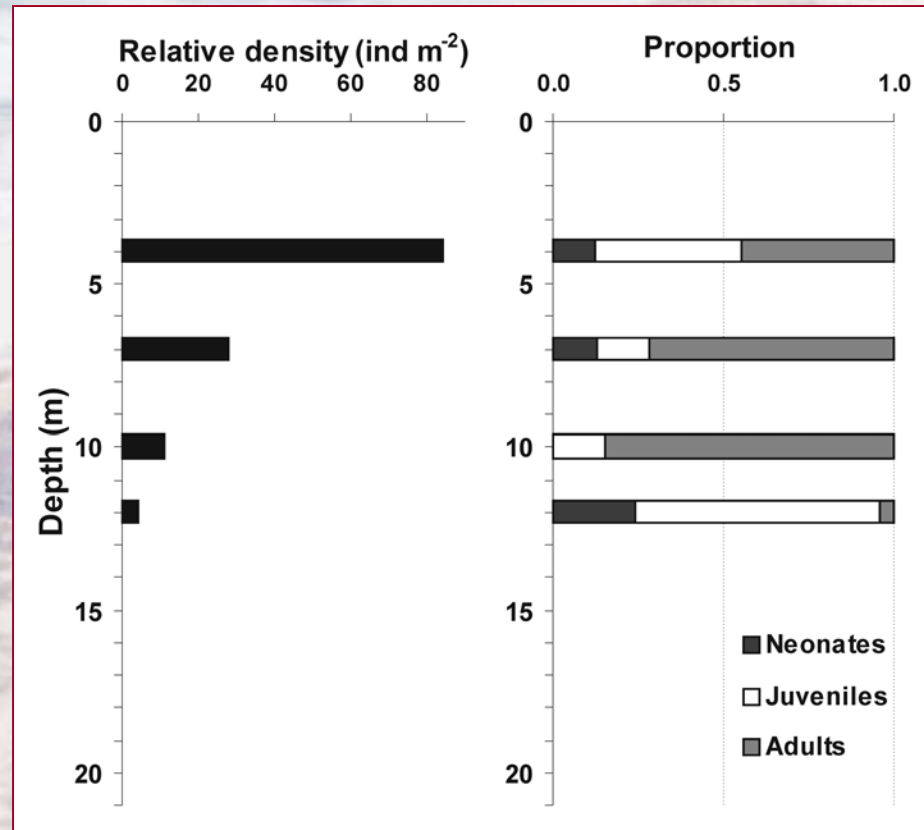
# Evidences

*Pontogammarus robustoides* is capable to feed on mysids

(100% of analysed guts of large specimens contained remains of mysids)

Indirect evidence of adult cannibalism in *Paramysis lacustris*

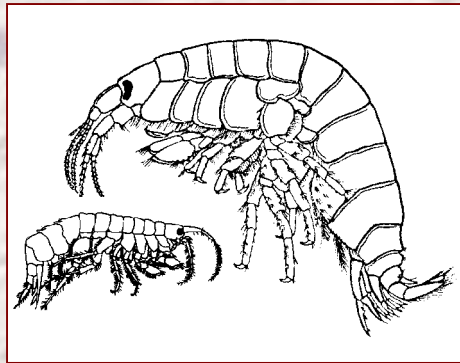
Proportions of neonates (< 4.5 mm), juveniles and adults of *Paramysis lacustris* at different depths of Lake Dusia



# Conclusion

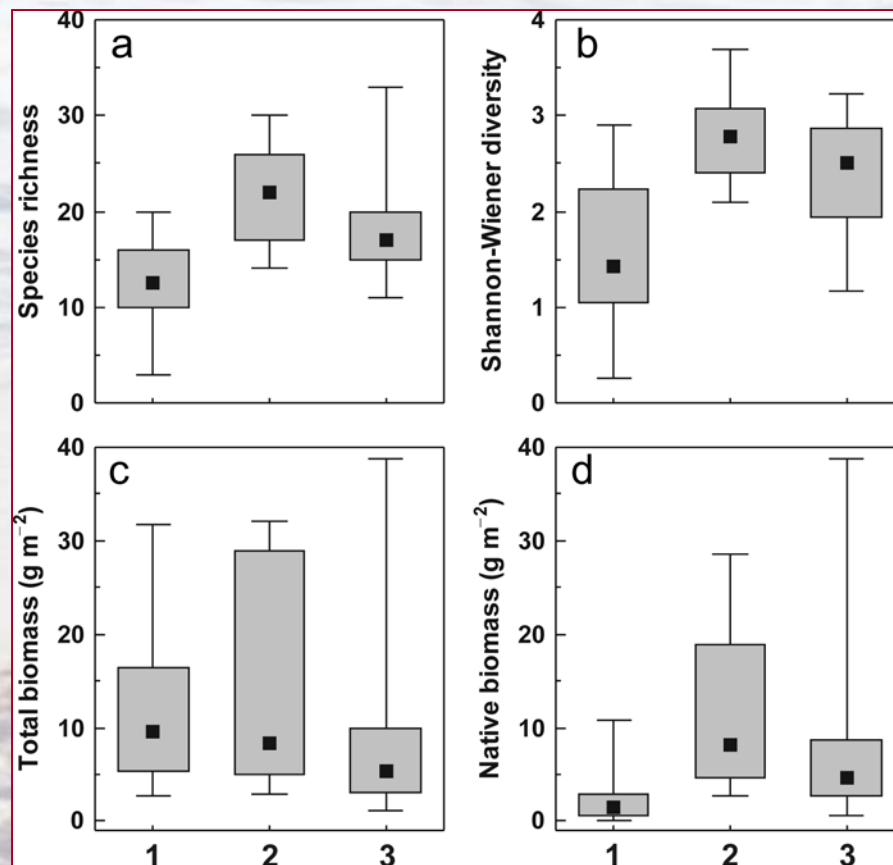
Alien Ponto-Caspian species are, at least partly, responsible for the decline of *Asellus aquaticus* and extinction of *Gammarus lacustris* and glacial relict species in Lake Dusia

Long-term co-existence of peracaridans with different evolutionary histories should not be expected when their habitats substantially overlap



# Other outcomes

- pontogammarids exterminated *Cladophora* overgrowths
- pontogammarids reduced diversity and abundance of native littoral macroinvertebrates

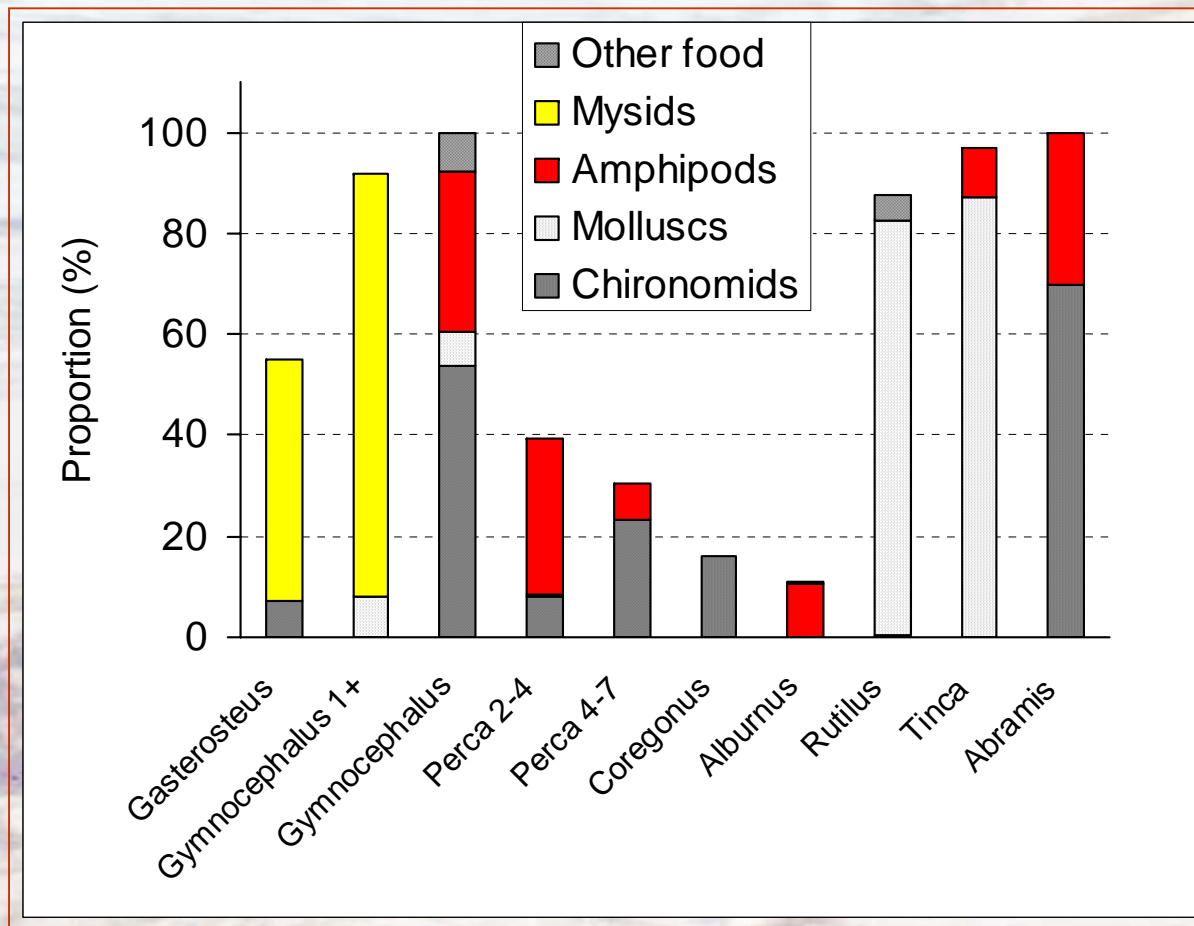


Variation of species richness (a), Shannon-Wiener diversity index (b), total benthic biomass (c) and biomass of native macroinvertebrates (c) for the three types of lake littoral communities during a two year study period. 1 – communities with well-established population of *Pontogammarus robustoides* (5 study sites); 2 – communities where pontogammarid and indigenous gammarid *Gammarus lacustris* co-occur (2 sites); 3 – communities devoid of alien species (6 sites). Mixed-model nested ANOVAs: **Pontogammarid effect  $P < 0.02$** . (Gumuliauskaitė and Arbačiauskas in press)

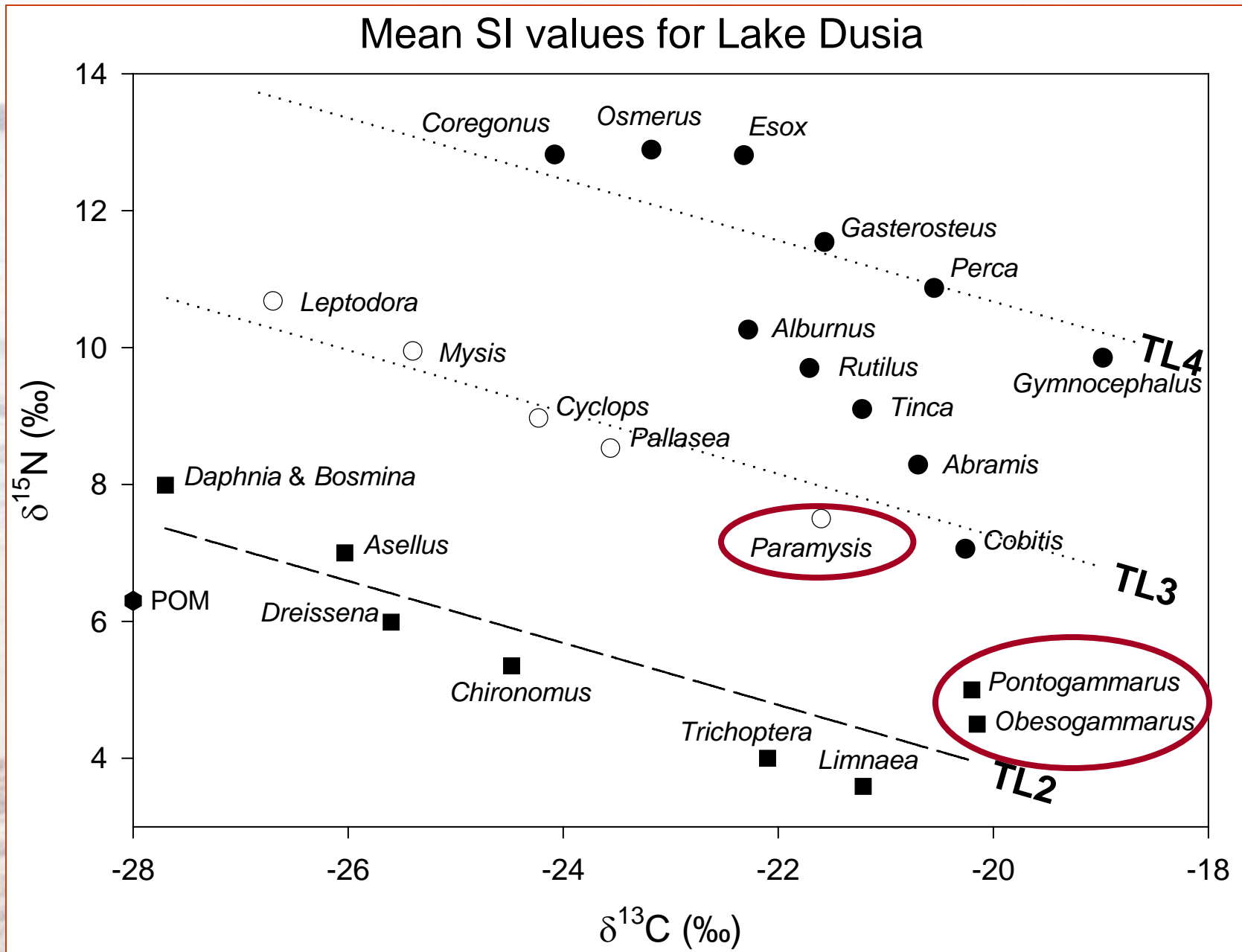
# Other outcomes

- aliens were included into the fish diet

Composition of benthic food from gut content analysis



# Other outcomes



## Other outcomes

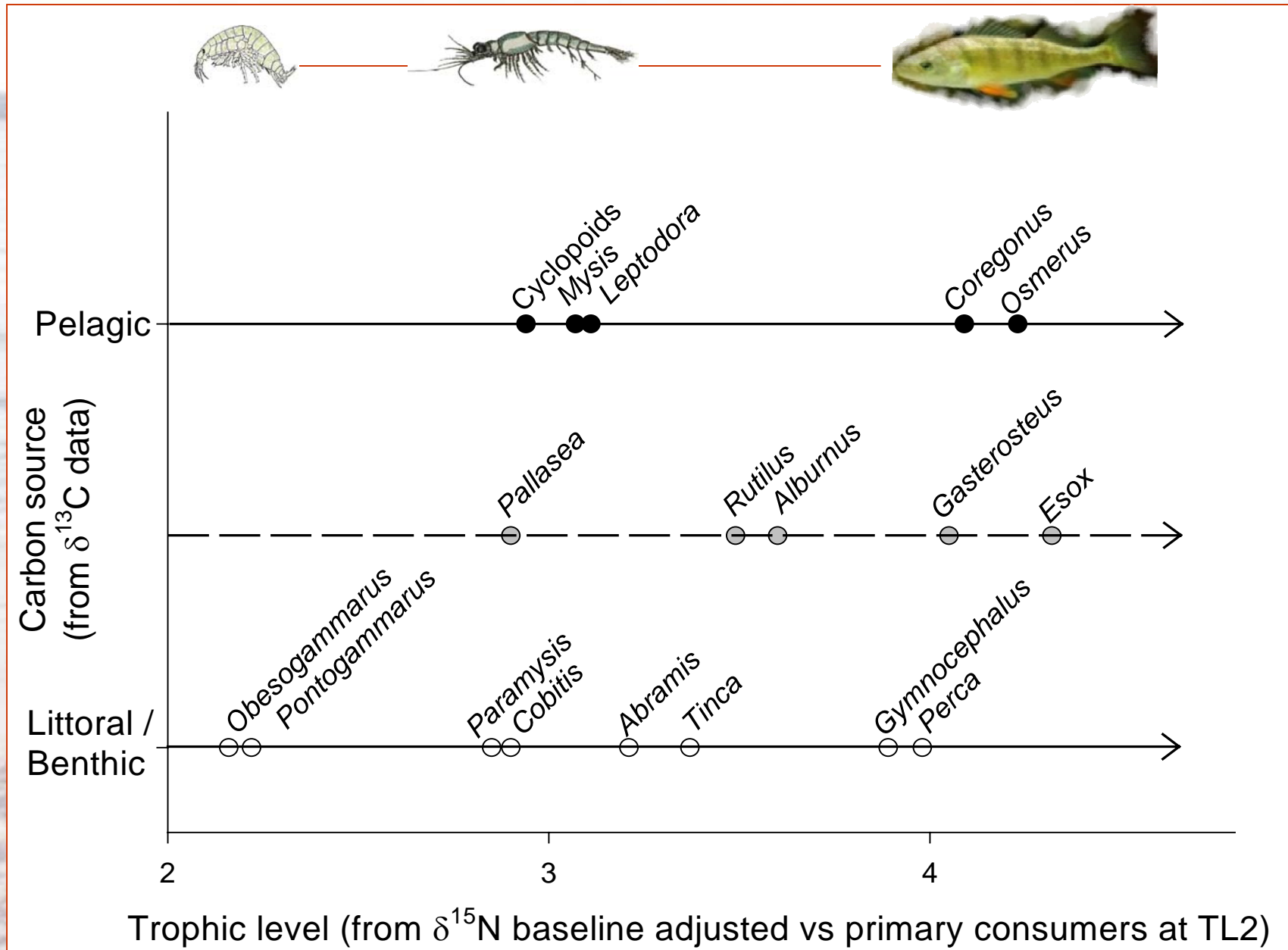
- changed the composition of food of some fish species in comparison with 1952

Perch (3-5 year): aquatic insects (excluding chironomids) and peracaridans comprised 89.5 and 5.0 %, while recently 0 and 46.5 %, correspondingly.

Roach: vegetation comprised 72.4 %, while recently 5.0 %.

**Invasion increased the food chain length?**

# Other outcomes



# Conclusion

Invasion of Ponto-Caspian aliens

reduced diversity and abundance of native littoral macroinvertebrates

altered the food web of Lake Dusia what may have resulted in the change of food chain length

Thank you for attention



I also thank Asta Audzijonytė and Vytautas Rakauskas for assistance with the field work and Jonathan Grey for collaboration.  
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