

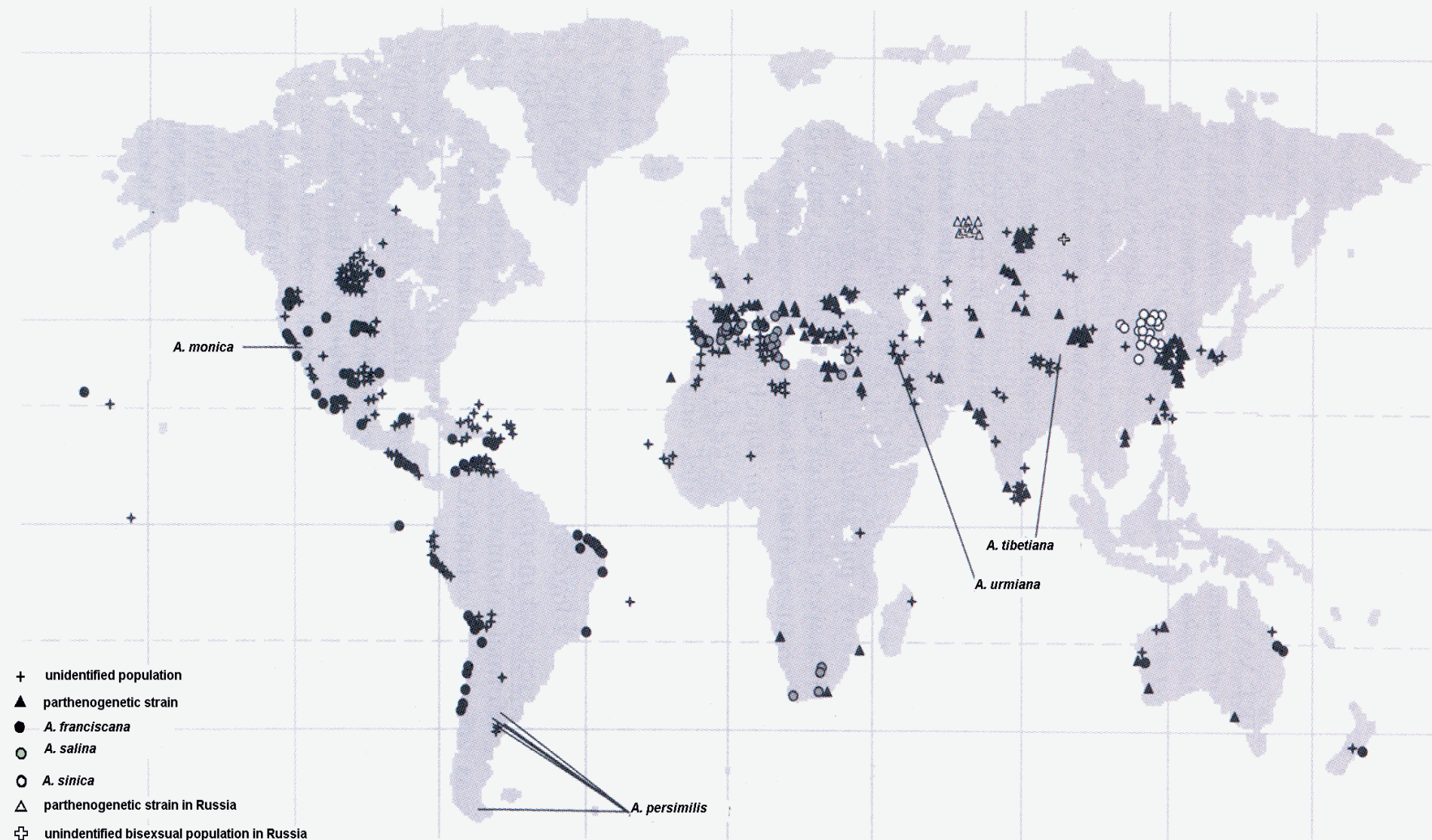
Brine shrimp *Artemia* in Western Siberia lakes



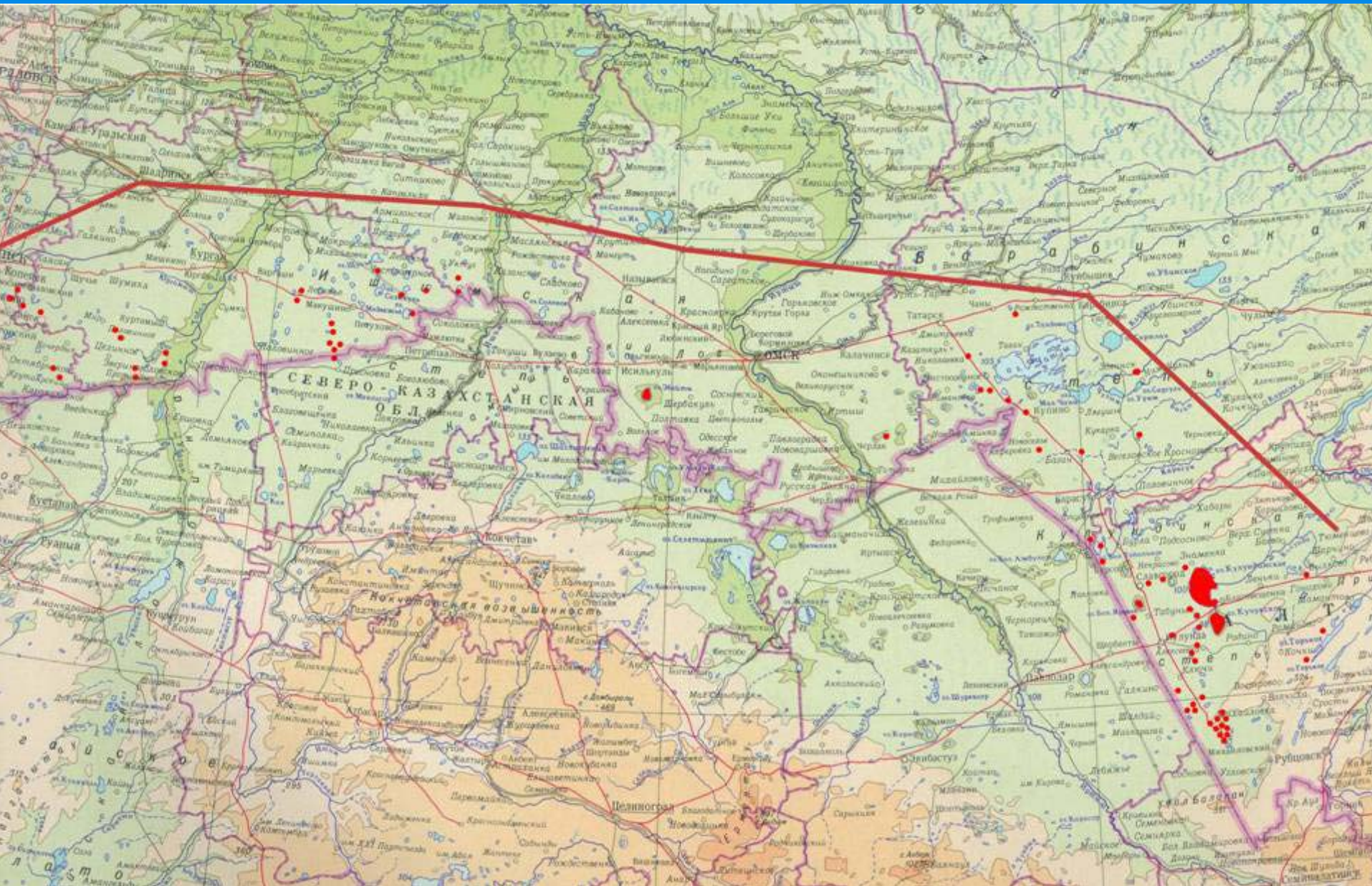
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Sorgeloos P., Marden B.,
Vdovchenko M.A.***



The world distribution of *Artemia* (modified from Gilbert Van Stappen, 2002)

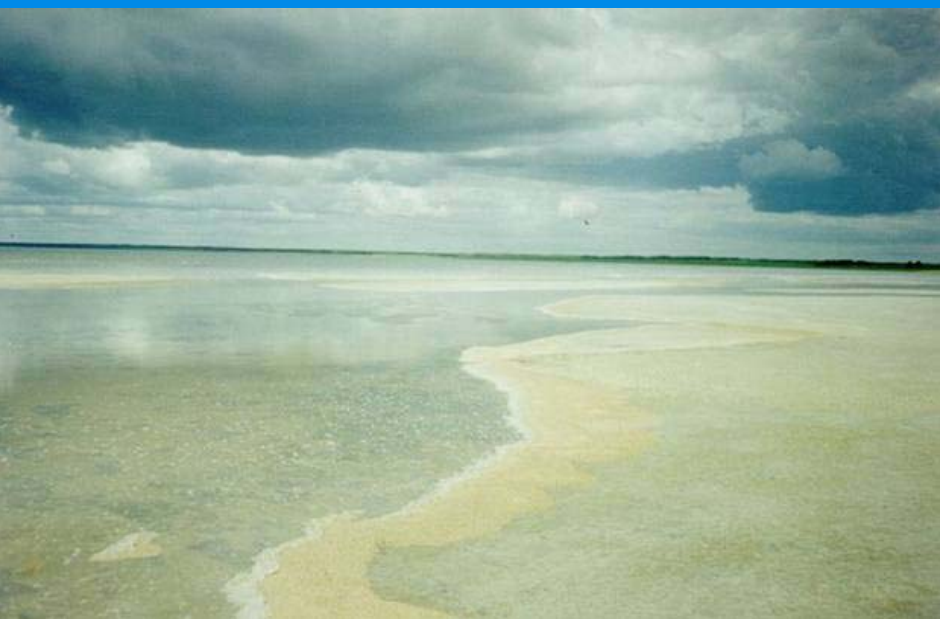


Geographical distribution of Artemia brine shrimp in Western Siberia

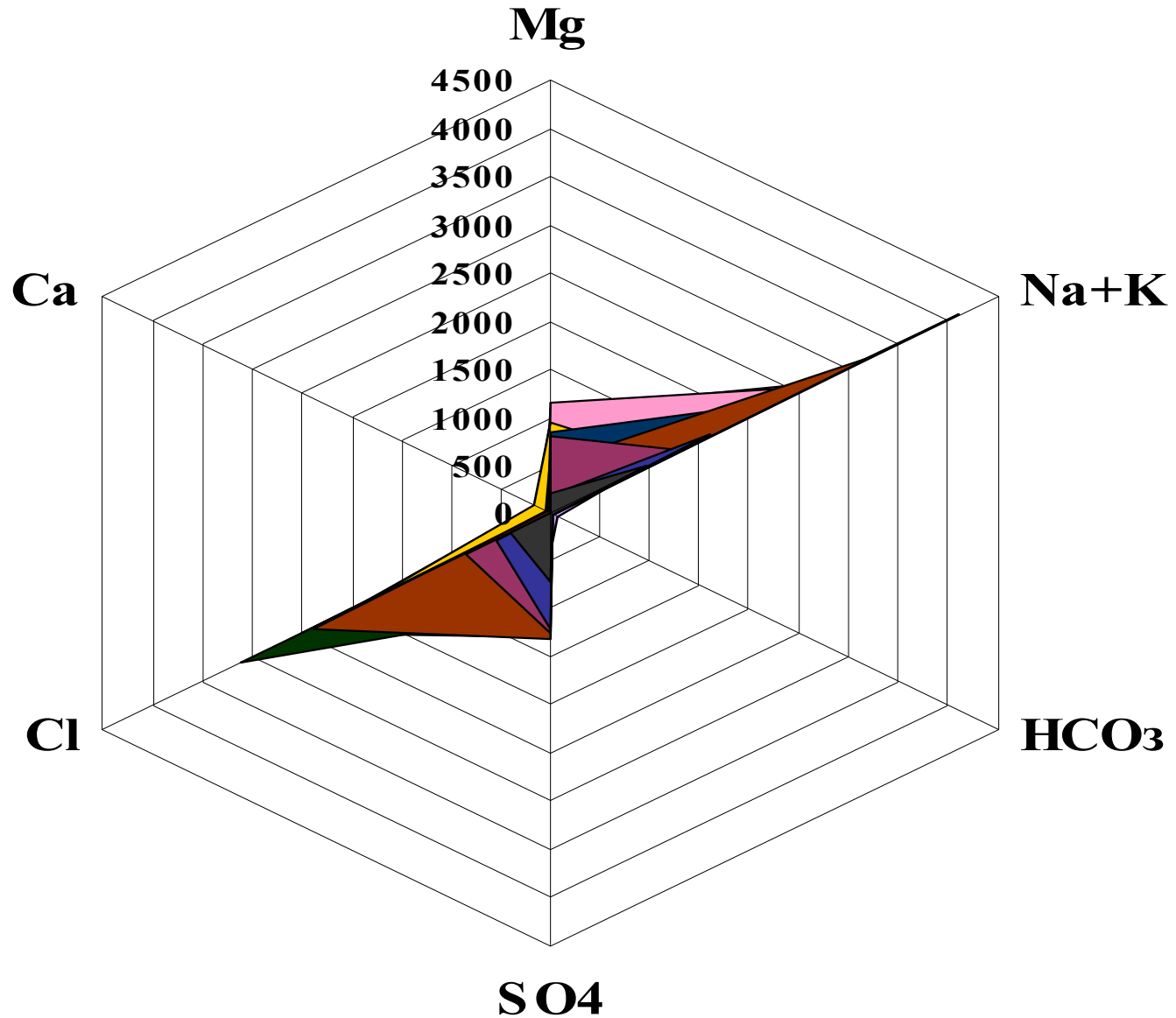


The characteristic of the Western-Siberian geographic range of *Artemia* (in limits of Russia) and a temperature regime of *Artemia* lakes

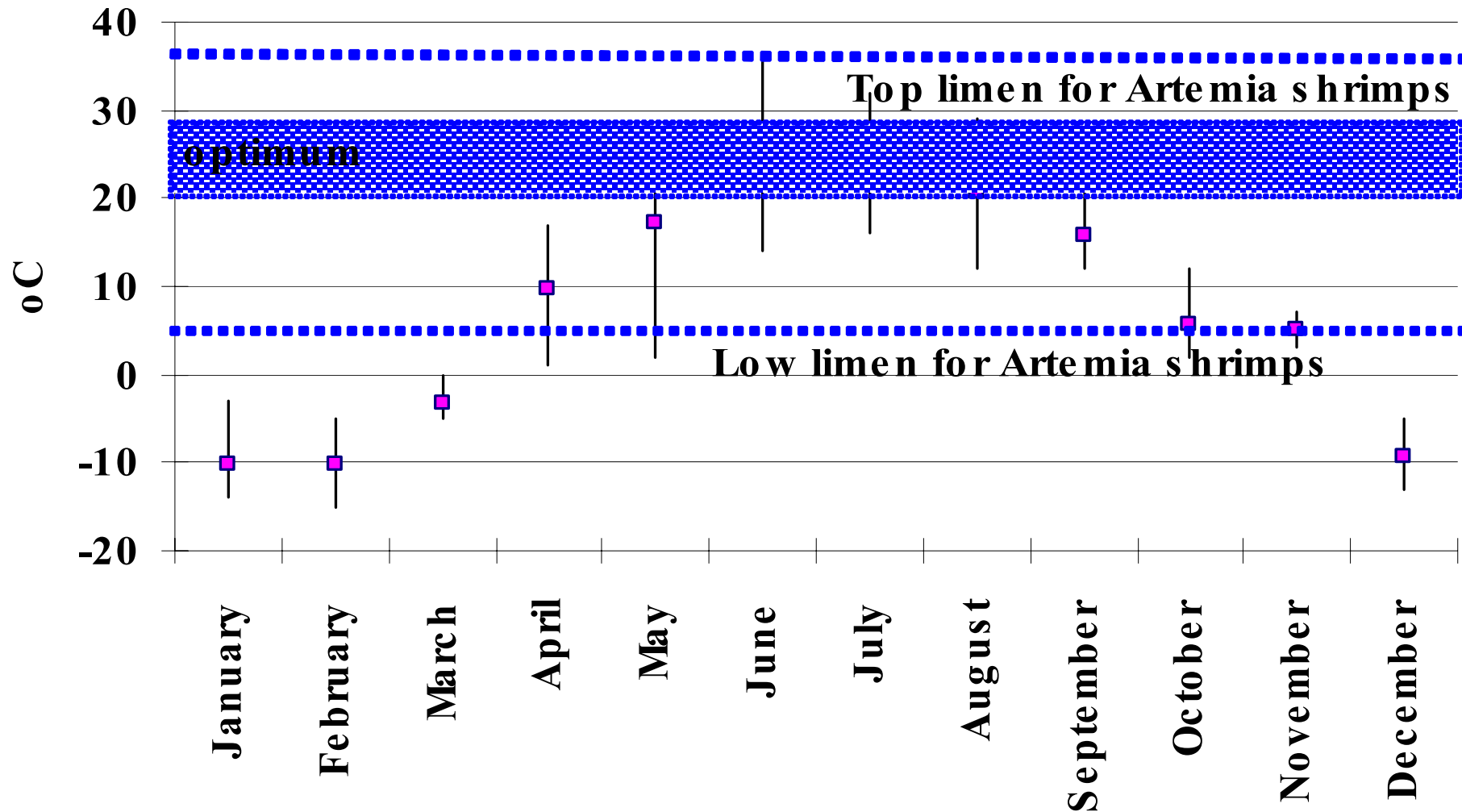
The parameter	Unit	Limits of fluctuations
The annual solar radiation	kcal/sm ²	36-45
Annual temperature	°C	0,1-1,8
Average January temperature	°C	Minus 15,7-minus 19,7
Average July temperature	°C	18,3-18,9
The sum of temperatures of air more 10°C	°C	1900-2400
Annual quantity of deposits	mm	250-400
Evaporative power per year	mm	About 600
Annual deficiency of deposits	mm	100-300
Hydrothhermal index	-	0.6-1.0
Having warmed up waters up to 4-5°C	-	April, 15-30
Refrigerating of water down to 4-5°C	-	October, 1-20
Duration of a vegetative season	days	180
The sum of temperatures of water more 4-5°C	°C	2800-3300



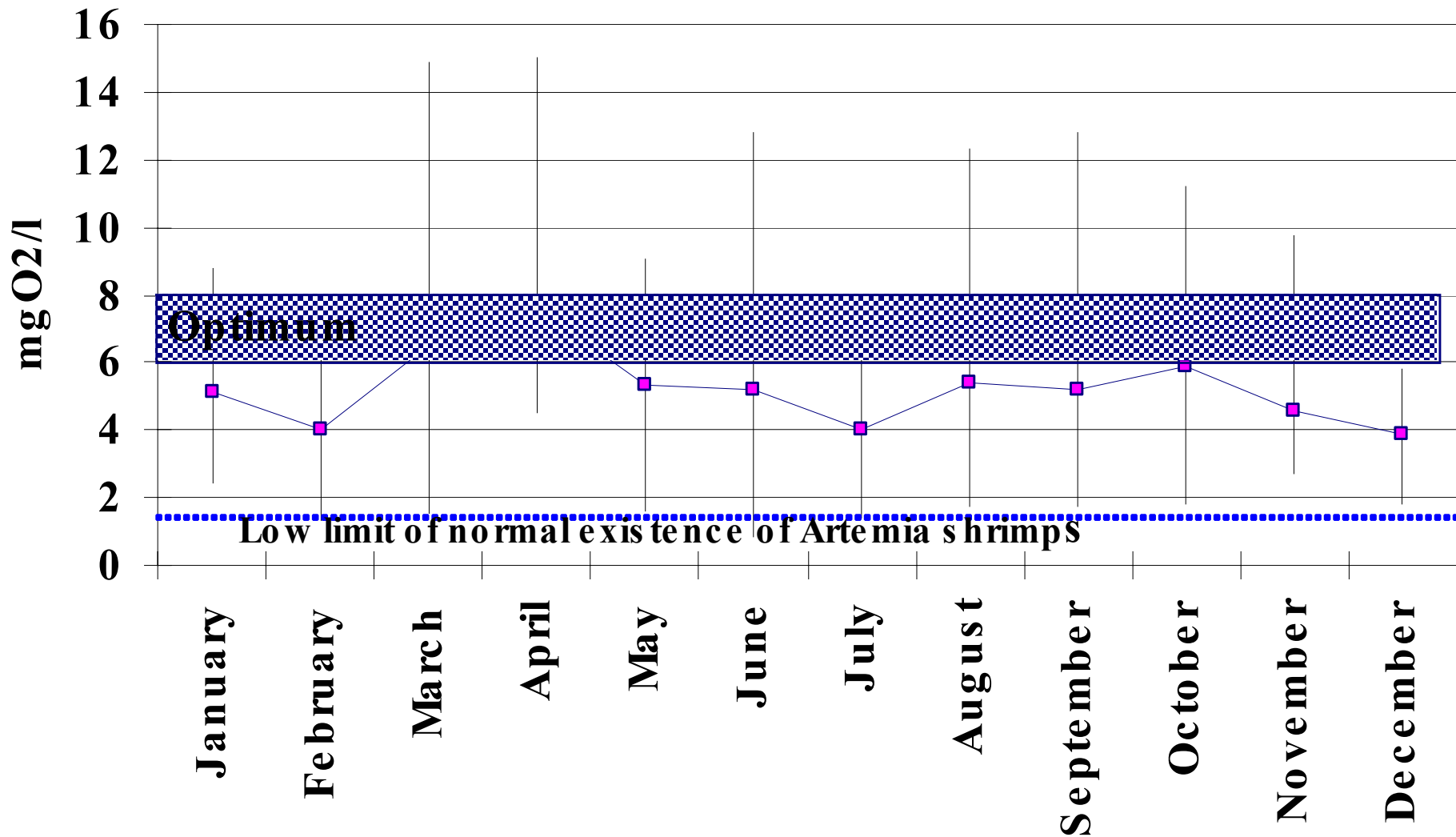
Water ion composition



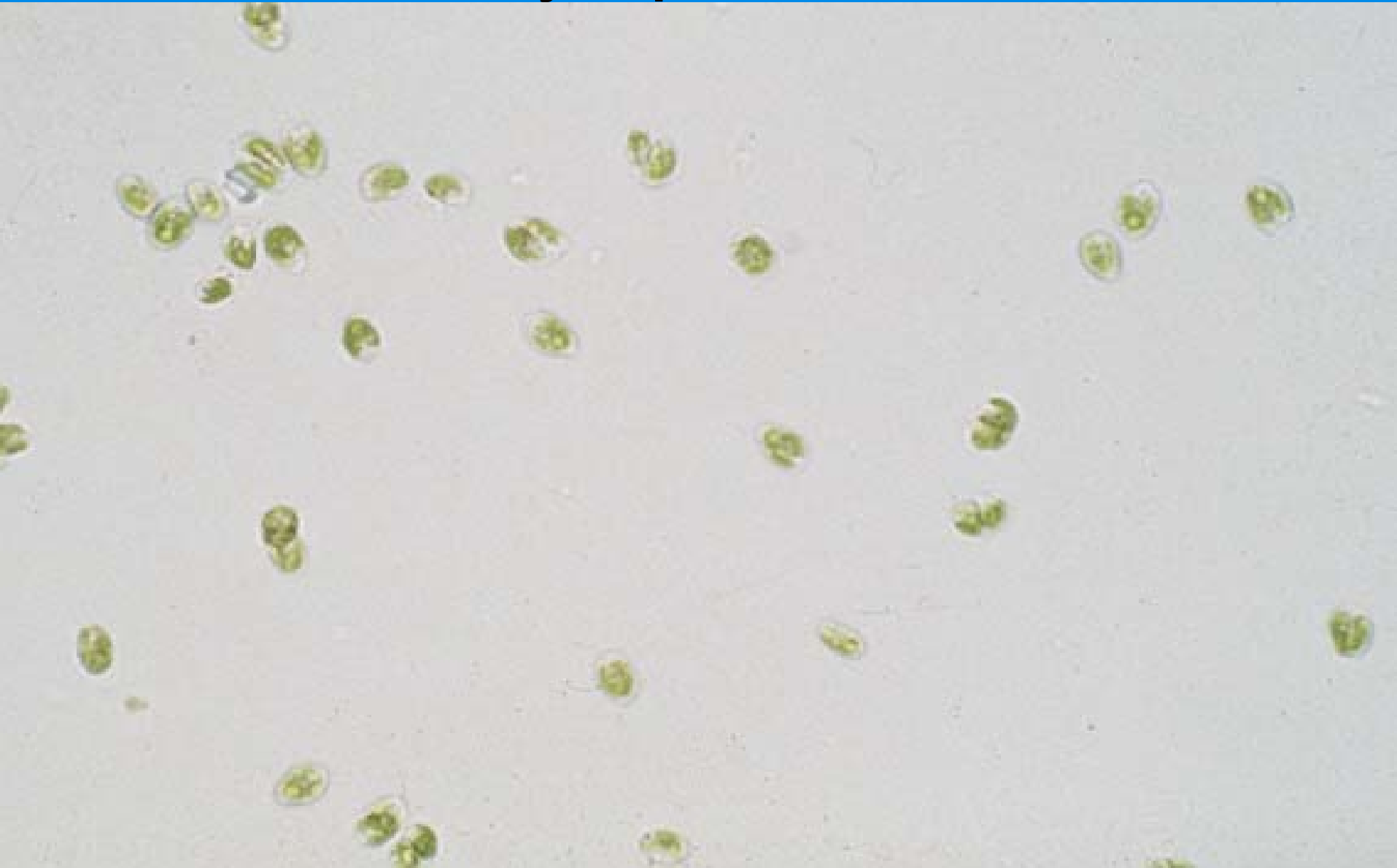
Annual dynamics of temperature average month indexes in investigated lakes from 2000 to 2003



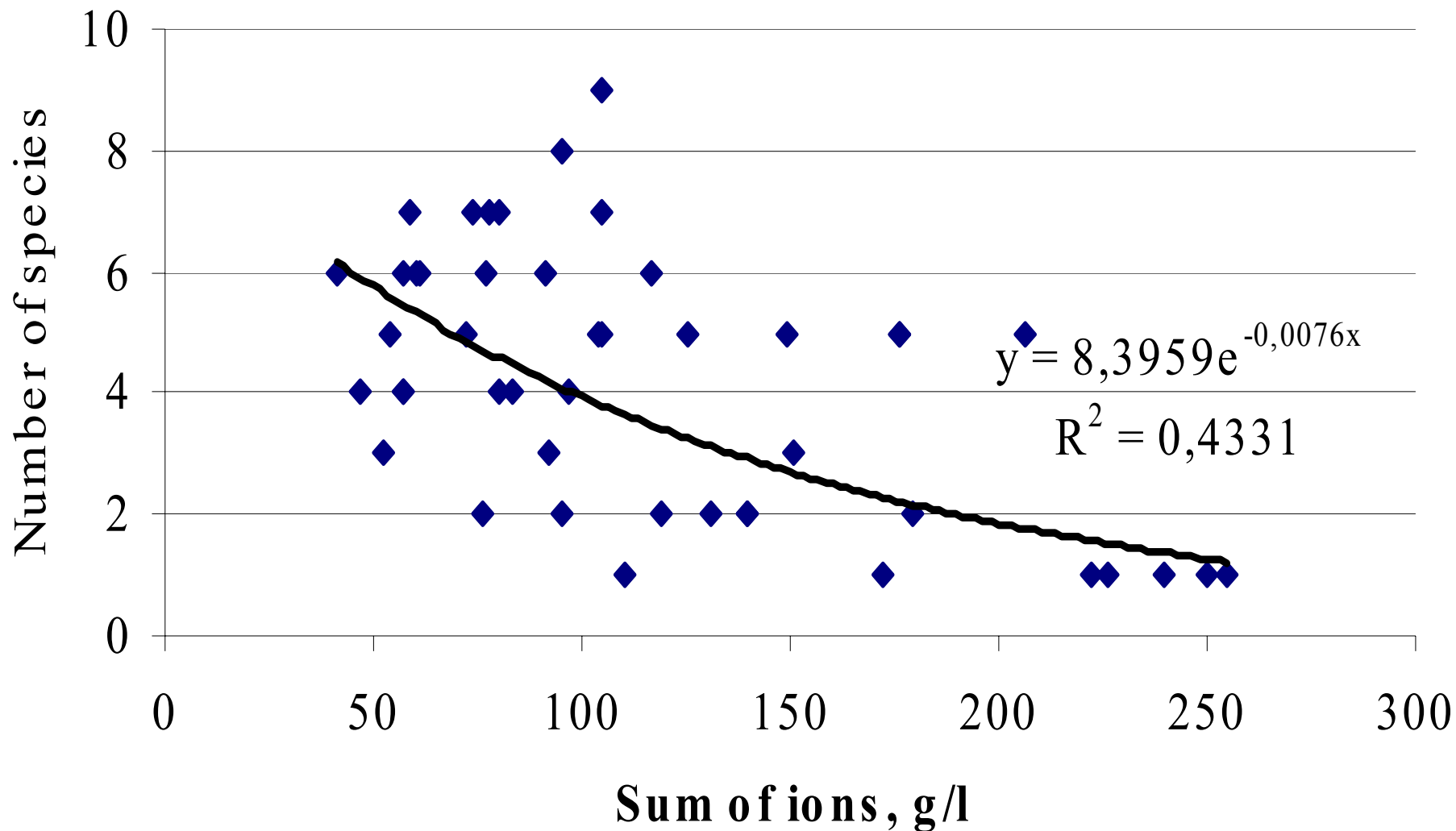
Annual dynamics of average indexes of oxygen, dissolved in water reservoirs, from 2000 till 2003



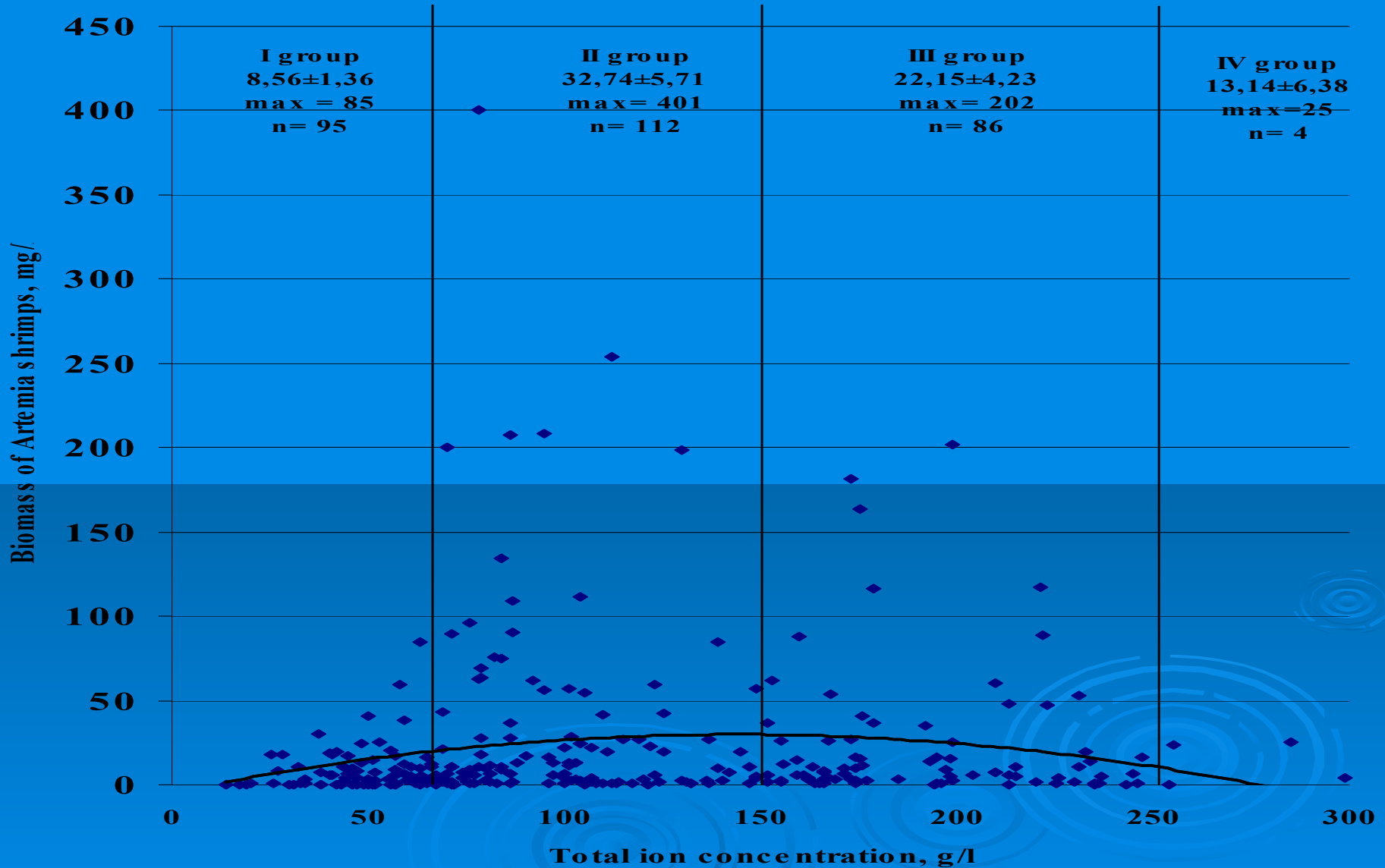
Phytoplankton



Number of zooplankton species in dependence on salinity (average data on every lake during four years of investigations)



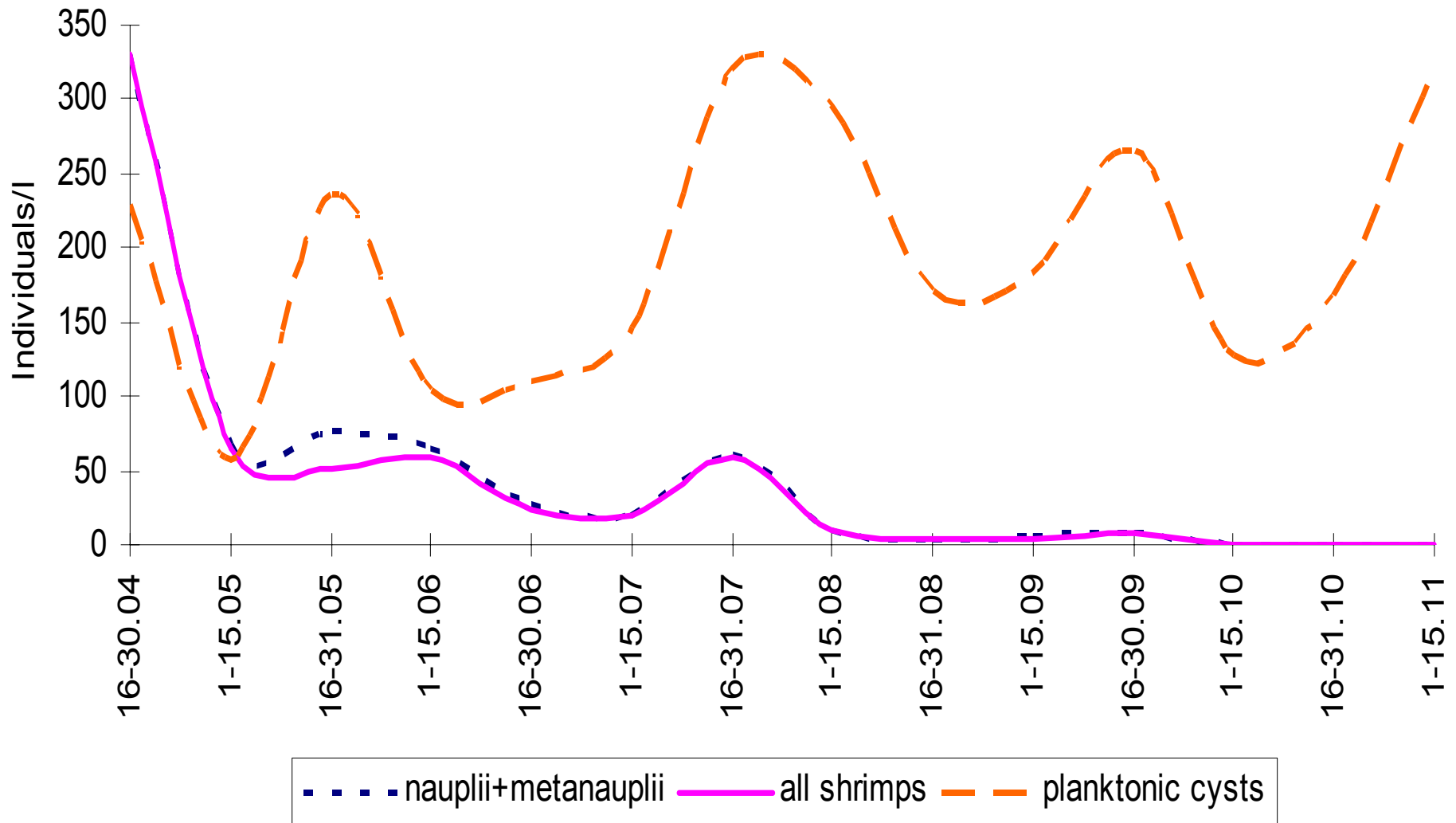
Artemia biomass in lakes with different salinity

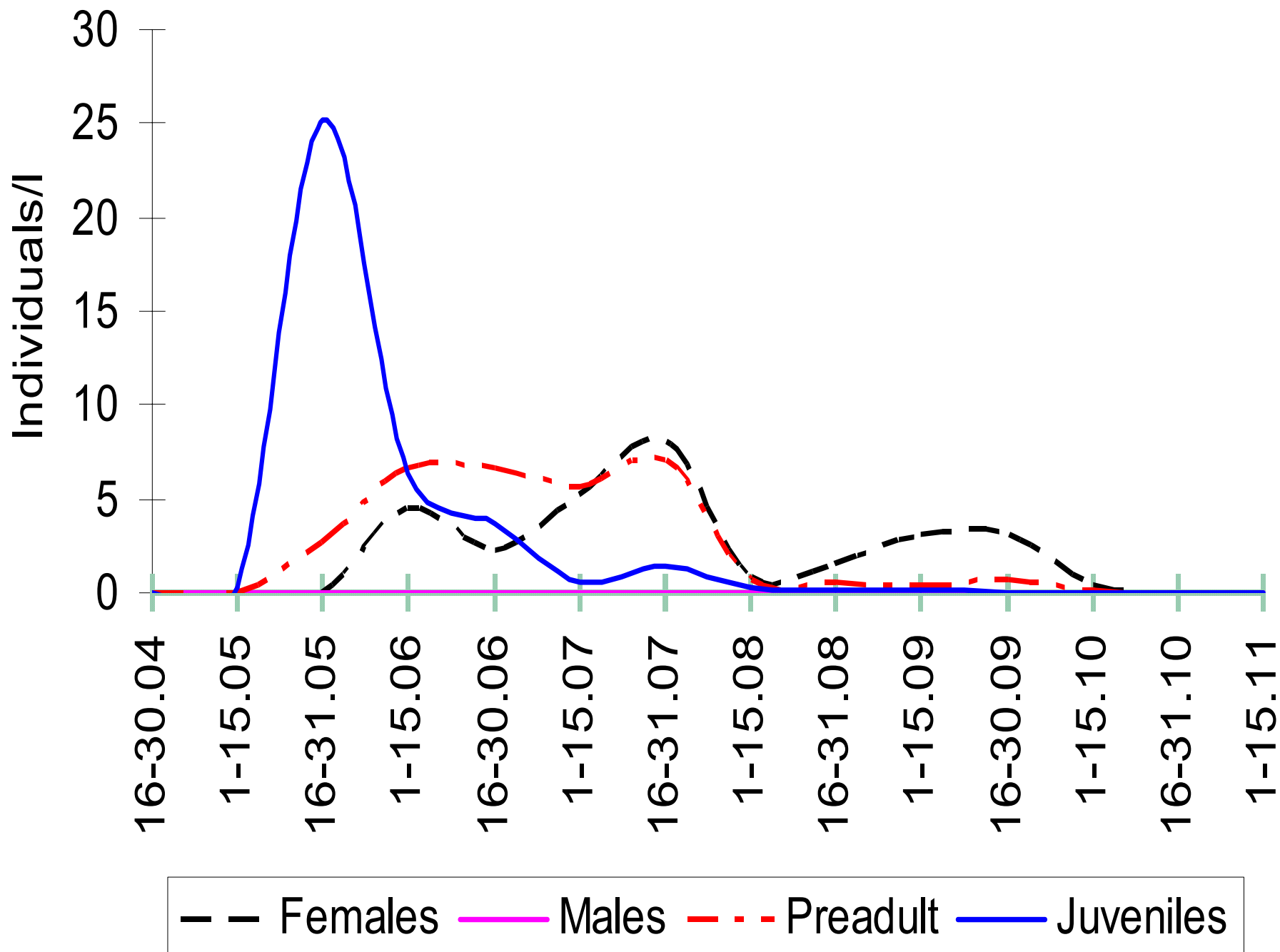


Features of Artemia biology in Siberia biotops

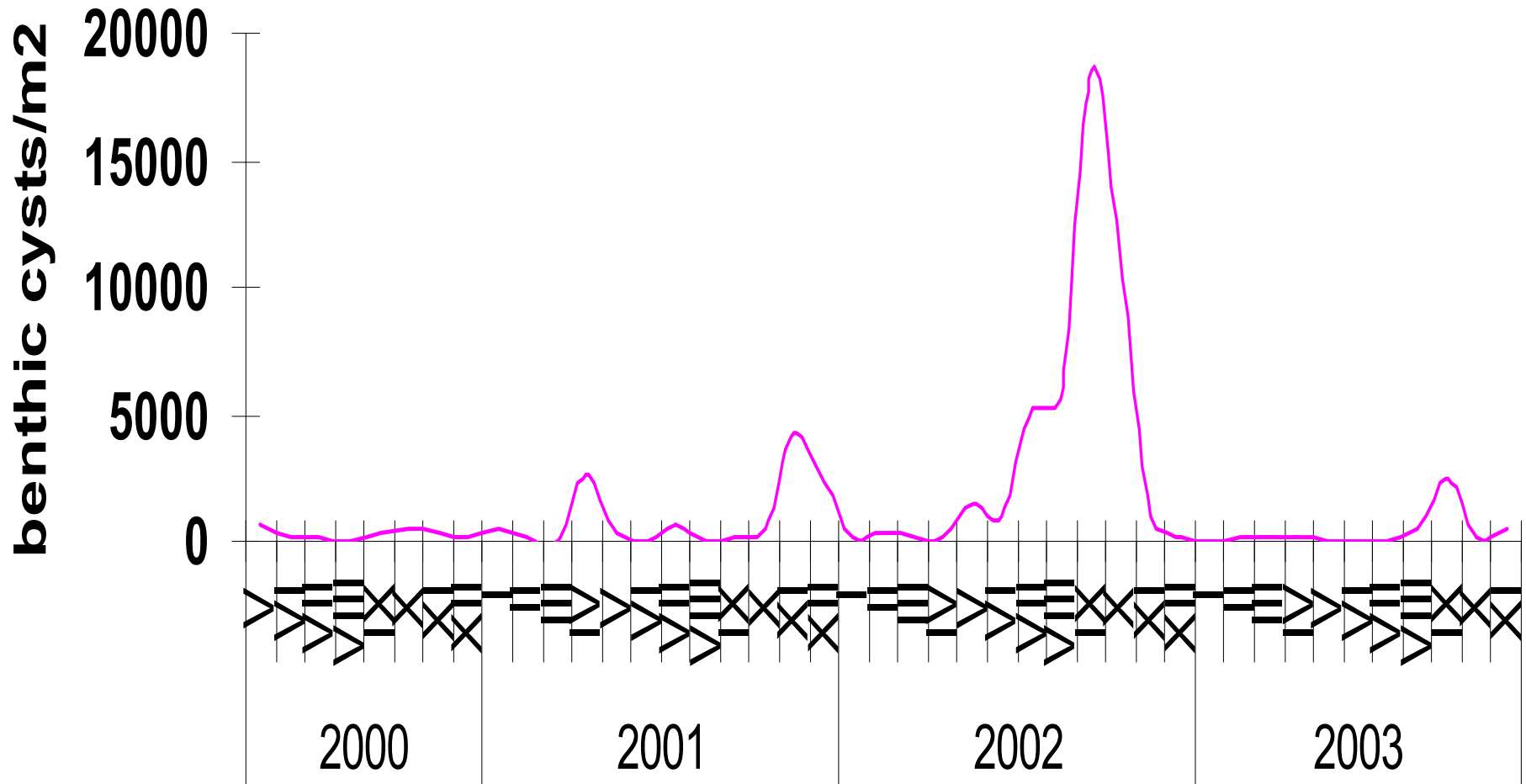
- 1- influence of parthenogenesis
- 2- average fecundity – 20-50 embryos/brood
- 3- High variability of shrimp adults biomass and individual fecundity during different years (cv nearly 30 %)
- 4- cyst sizes 0.24-0.29 mm, horion thickness – from 4 to 12 mkm

Dynamic of Artemia population density in lakes of Western Siberia (average data; 2000-2003)

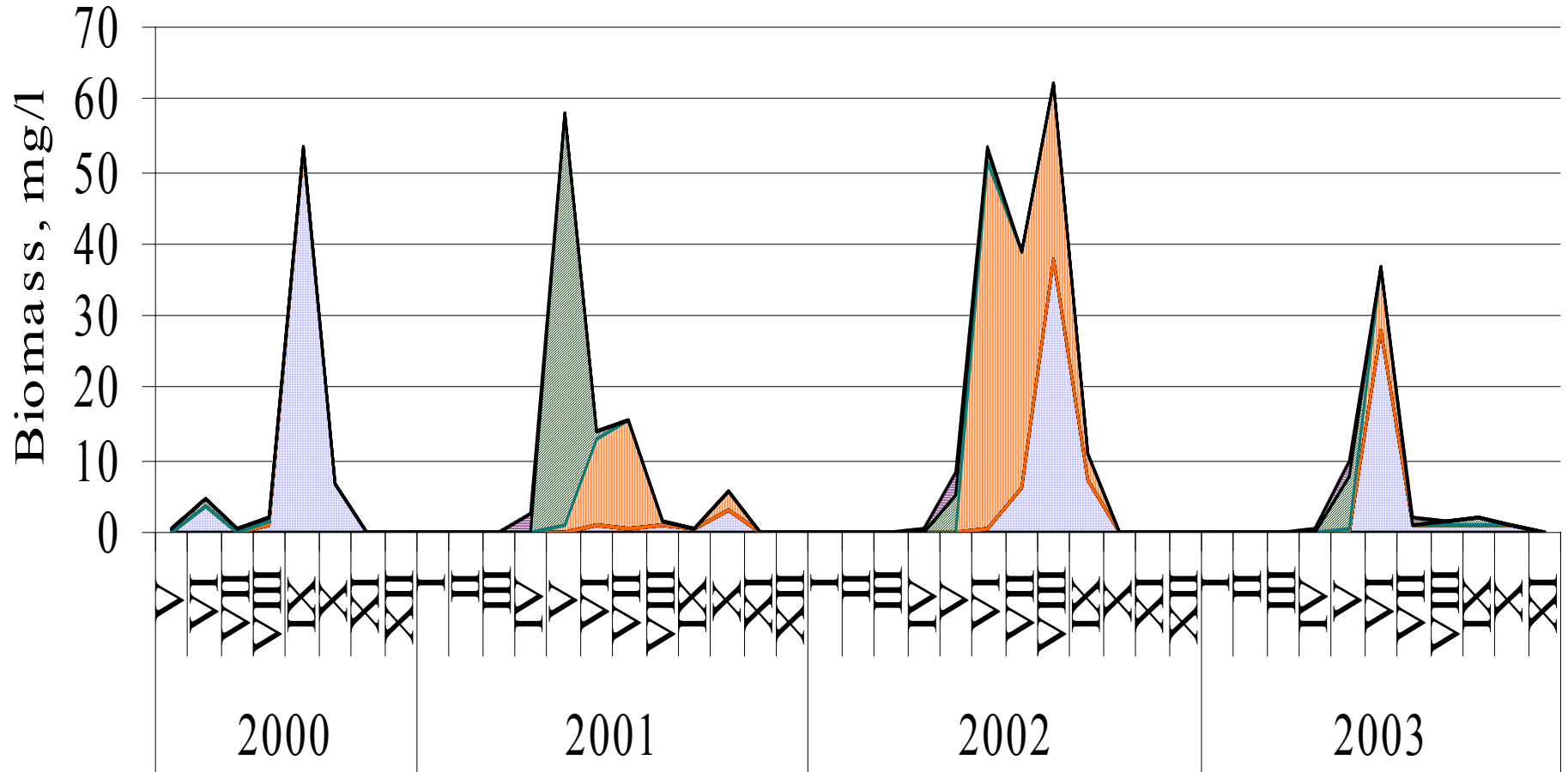




Long-term year dynamic of benthos cysts in Bolshoe Medvezhje Lake



Bolshoe Medvezhje



Females

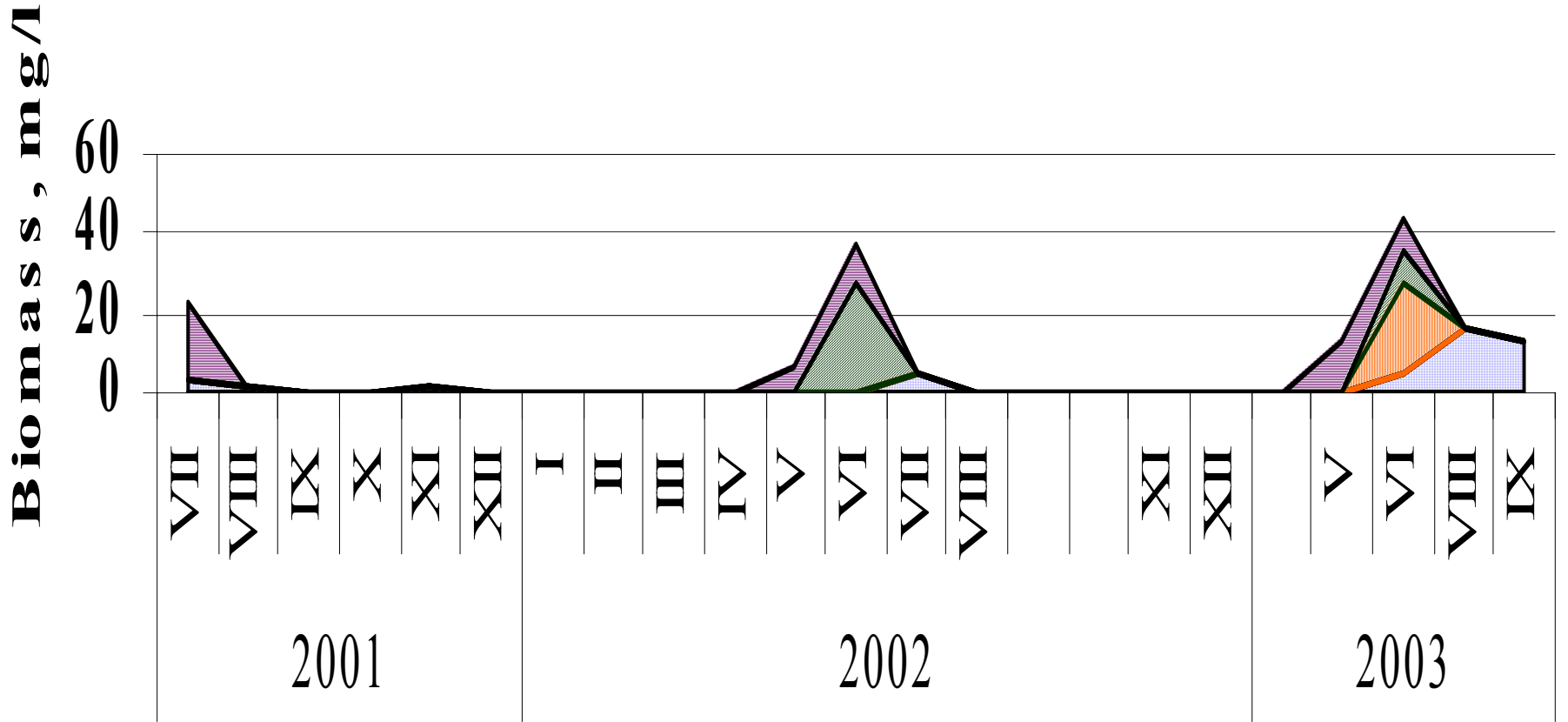
Males

Preadult

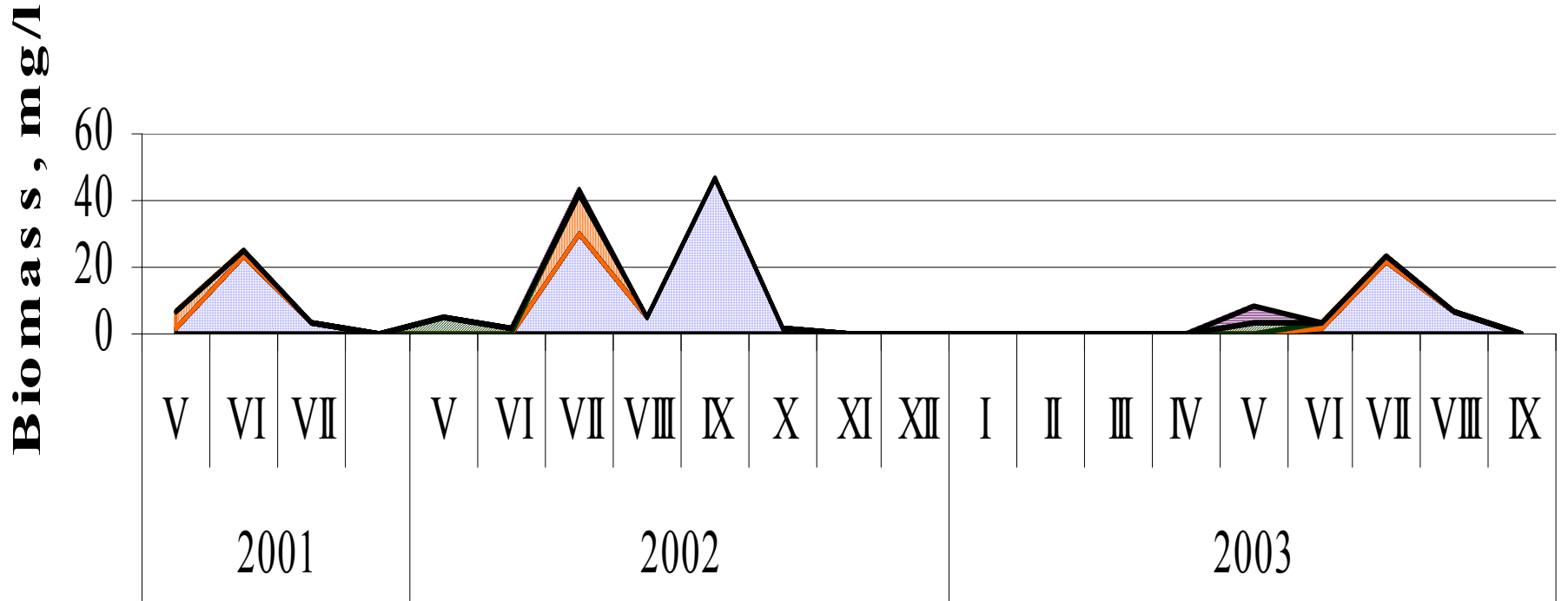
Juveniles

Nauplii+matanauplii

Vis hnykovs koe



Ebeity



■ Females ■ Nales ■ Pre adult ■ Juvenils ■ Nauplii+Metanauplii

Correlation matrix between indexes of productivity of Artemia populations ($p < 0,05$; $n=37$) (*red color - is trustworthy connection under 5% level of meaningfulness*)

- X1 – average shrimp biomass for season
- X2 – maximal shrimp biomass for season
- X3 – biomass of the first generation
- X4 – biomass of the second generation
- X5 - biomass of the third generation
- X6 – seasonal average amount of plankton cysts
- X7 -seasonal average amount of benthic cysts
- Y1 – total stores of cysts g/m³
- Y2 – total stores of cysts g/m²
- Y3 – stores of cysts, available for harvest, g/m³
- Y4 – stores of cysts, available for harvest, g/m²

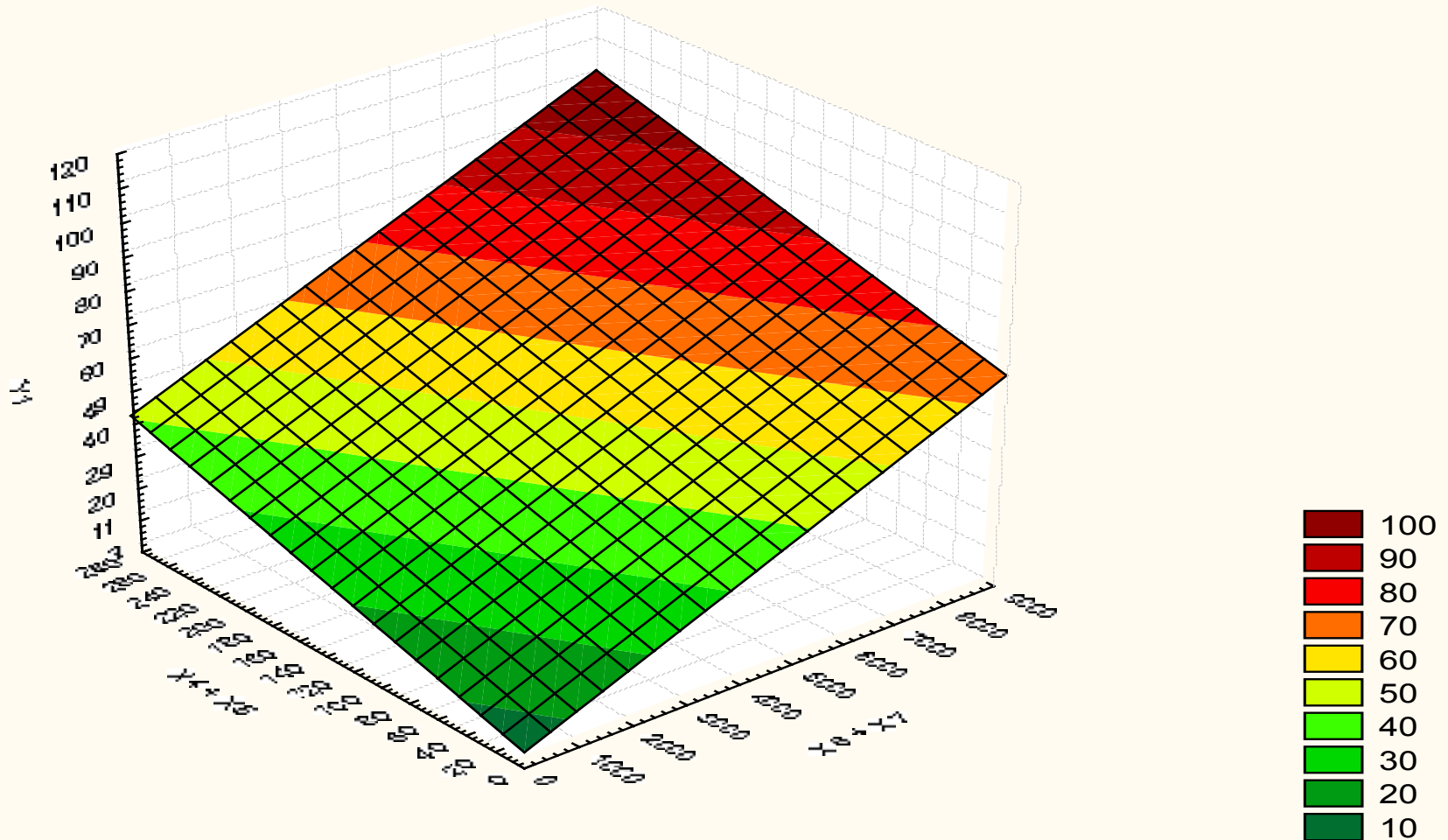
	Y1	Y2	Y3	Y4
X1	0,22	0,21	-0,03	-0,04
X2	0,27	0,24	0,03	0,01
X3	0,11	0,13	-0,02	-0,03
X4	0,39	0,33	0,09	0,06
X5	0,40	0,41	0,29	0,33
X6	0,49	0,42	0,50	0,45
X7	0,74	0,78	0,28	0,31

➤ $Y1 = 4,359 + 0,114 * X4 + 0,147 * X5 + 0,015 * X6 + 0,006 X7$
($R = 0,81$; $R2 = 0,66$);

➤ $Y2 = 2,705 + 0,084 * X4 + 0,137 * X5 + 0,005 * X6 + 0,006 * X7$
($R = 0,82$; $R2 = 0,67$);

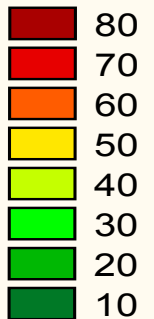
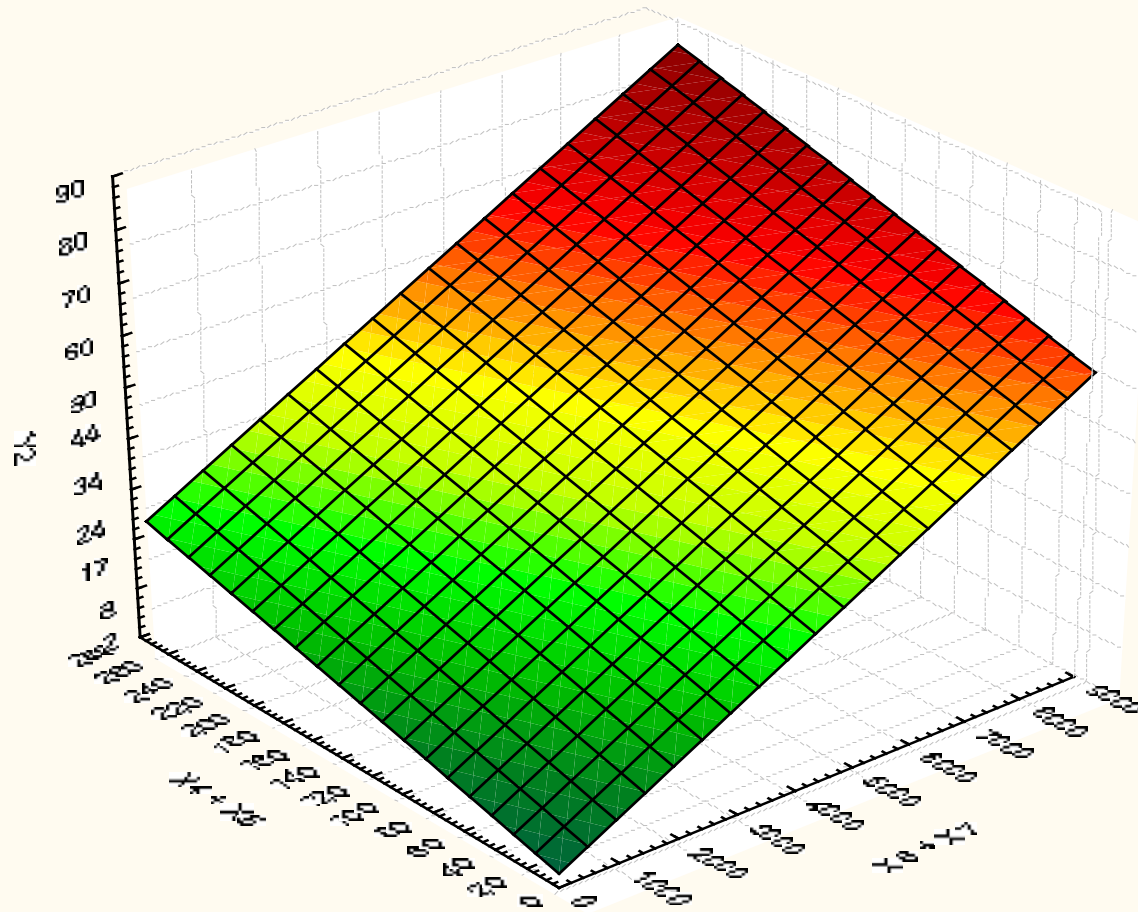
Dependence between total store of cysts (Y 1), shrimp biomass of 2nd and 3rd generation and amount of cysts in plankton and benthos

$$Y1 = 4,902 + 0,127(X6 + X7) + 0,007(X4 + X5)$$



Dependence between total store of cysts (Y 2), shrimp biomass of 2nd and 3rd generation and amount of cysts in plankton and benthos

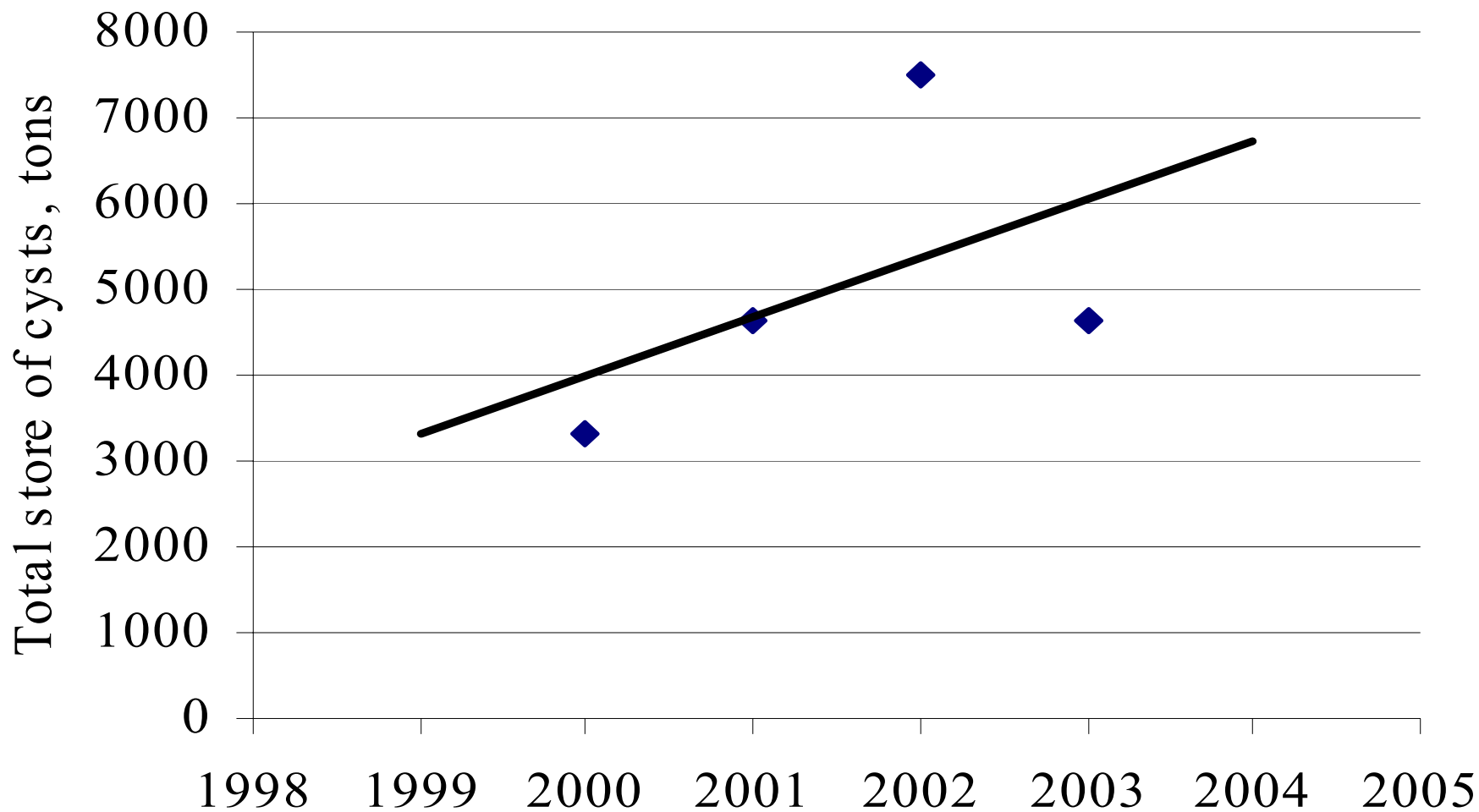
$$Y2 = 2,789 + 0,006 \cdot (X6 + X7) + 0,087 \cdot (X4 + X5)$$



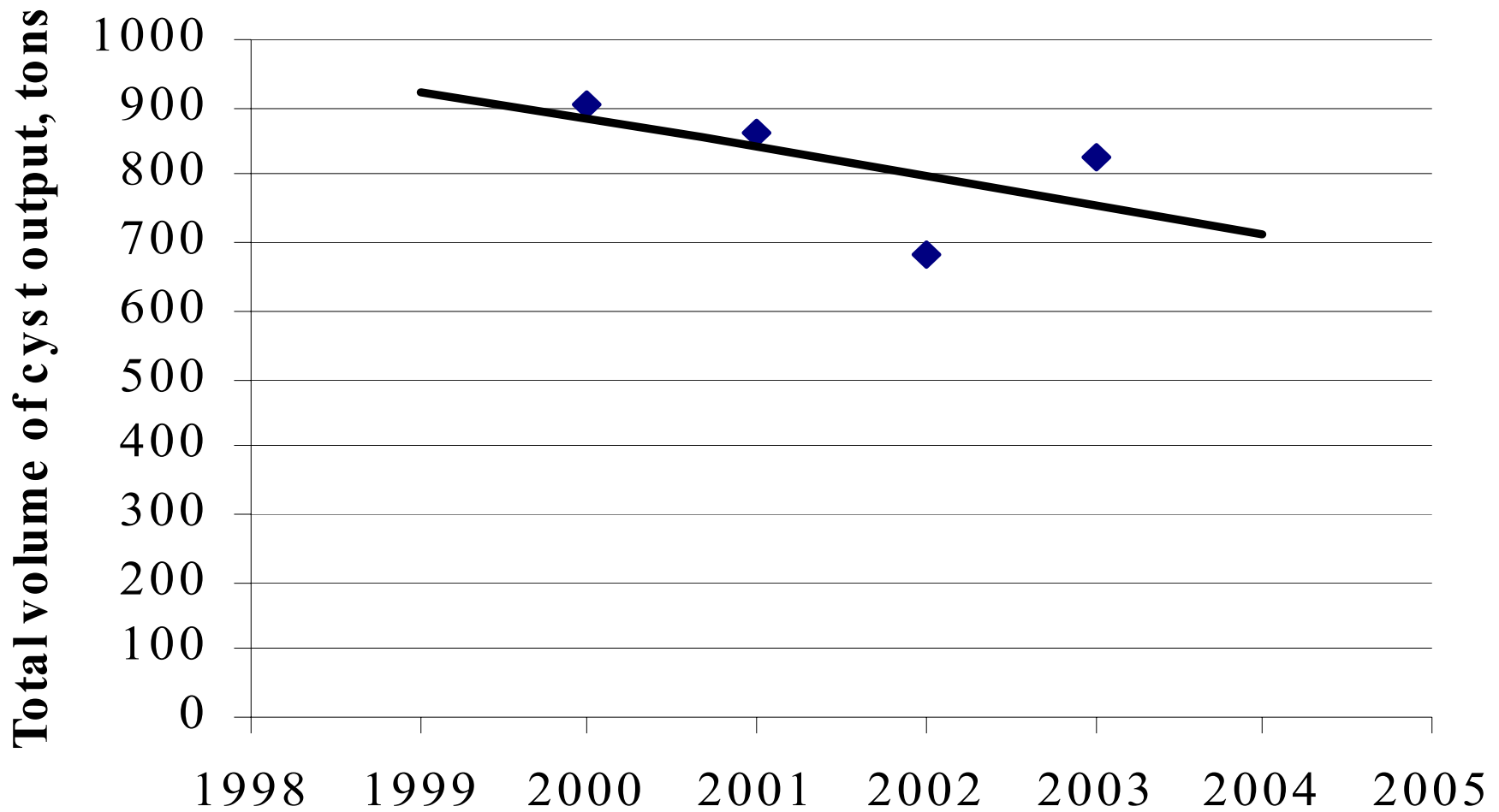
Commercial output of Artemia cysts in Western Siberia lakes, in tons of wet weigh

Year	Total stores of cysts, tons	Amount of lakes	Amount of government purveyors	Allowed quota, tons	Volume of output, tons
2000	3308	21	15	1720	905
2001	4631	30	21	1848	865
2002	7485	12	9	1308	684
2003	4625	9	7	1236	826
average	5012	18	13	1528	820
CV	35	53	49	20	12

A trend line of long-term –year dynamic of cyst total store in Western Siberia lakes (Russian area)



Trend line of long-term-year dynamic of total volume of cyst output



Conclusion

- In Russia from Ural to Altai there are nearly 80 Artemia lakes with total area 1563 km².
- The most part of these lakes are shallow, chloride-sodium, hydrochloric, with rich organic and poor phytoplankton.
- Vegetative season begins in the middle of April and finishes in the middle of October.
- In summer time the temperature and oxygen, as a rule, don't limit Artemia development. The density of phytoplankton is low.
- Increasing of water salinity is accompanied by decreasing of species diversity.
- Water salinity nearly 150‰ is an optimum for the highest development of Artemia in natural conditions.

- The method of reproduction is parthenogenetic, rarely (in some lakes) – bisexual.
- High instability of productive characteristics (fecundity, individual biomass and length of adults, population density) are taken place because of shallow waters.
- The density of 2nd and especially 3rd shrimp generation has influence on amount of cyst store.
- Average annual cyst store is about 5 thousand tons. Every year they are stored nearly 800 tons.
- During last years there is a tendency of cyst store increase and simultaneously decrease of yield volumes.

Thanks for your attention!

