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Algae in bottom sediments of deep Lake Teletskoye as indicators of climate change in Altai Mountains

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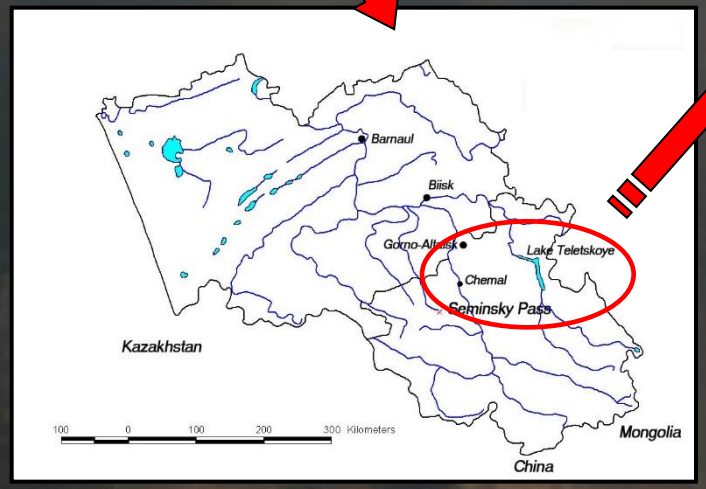
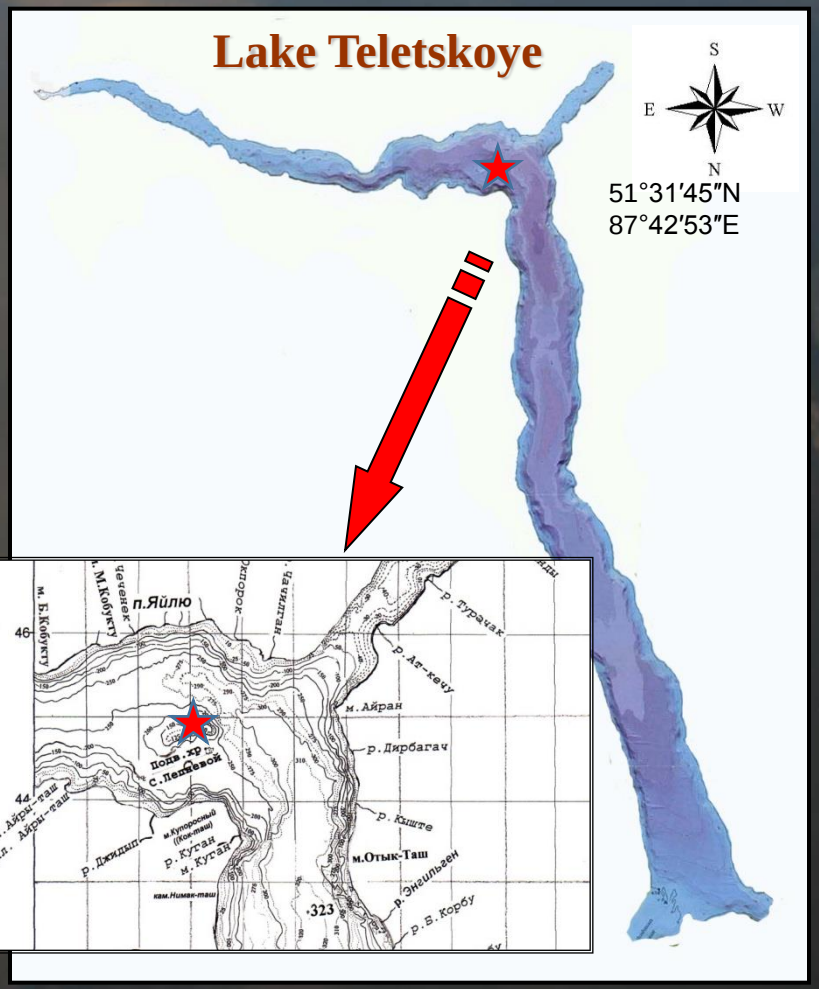
Study object - Lake Teletskoye



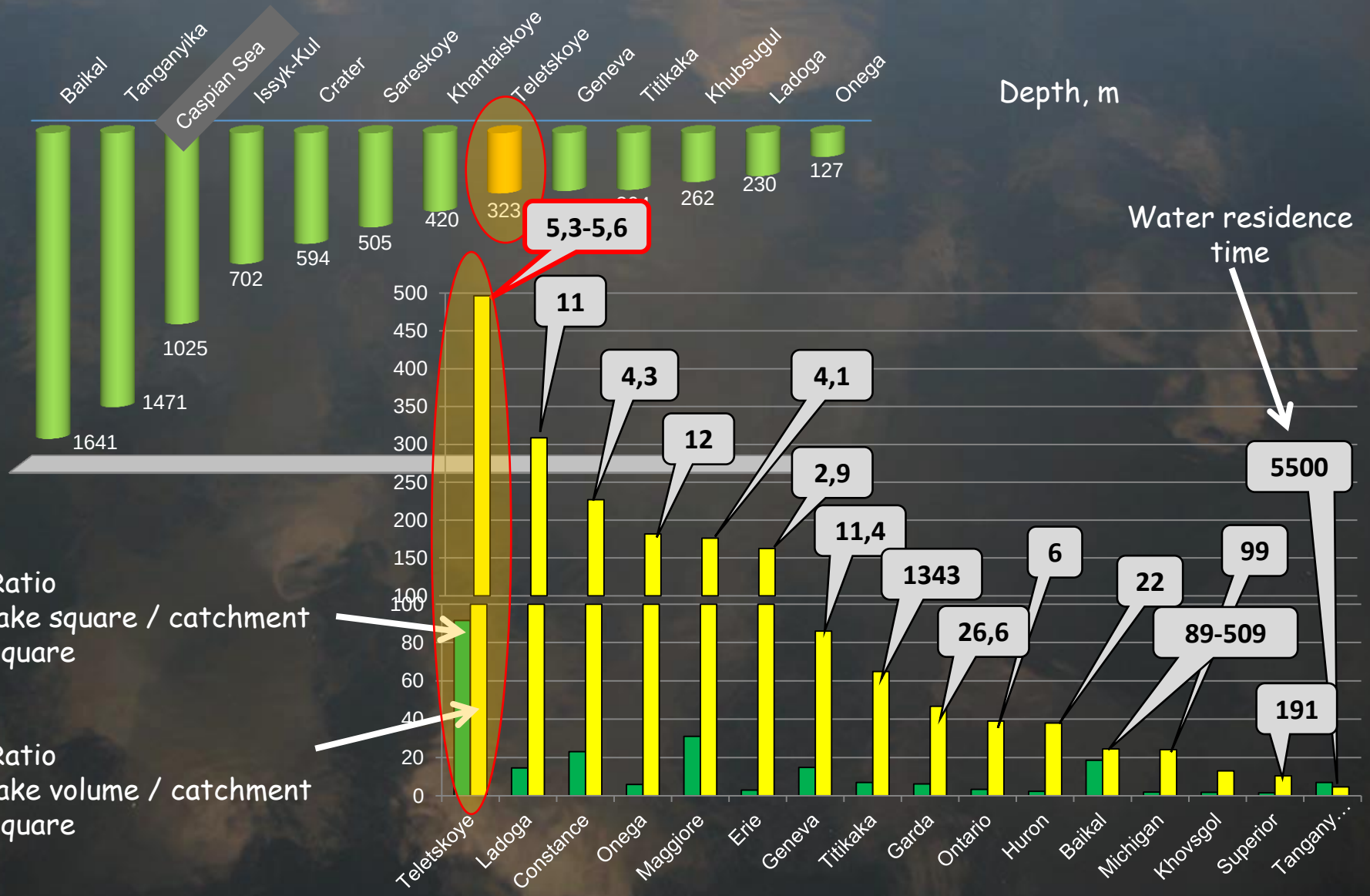


The core of 1940 mm long from the underwater Sophia Lepneva Ridge was divided into 5 mm layers (388 samples) - ~ 4000 years, and every layer - ~11 years.

Main characteristics of Lake Teletskoye

Characteristics	Unit	Value
Length	km	77,8
Maximum width	km	5,2
Average width	км	2,9
Maximum depth	m	323,3
Average depth	m	174
Volume	km^3	41,1
Mean year water temperature	^0C	4,6
Water mineralization	$\mu S/cm^3$	57-110
Number of constant / temporary tributaries	-	70 / 150
Ratio of lake square to catchment basin square	-	1 / 91
Basin height a.s.l.	m	2288-434
Water residence time	year	5,3-5,6

Lake Teletskoye among large and deep world lakes

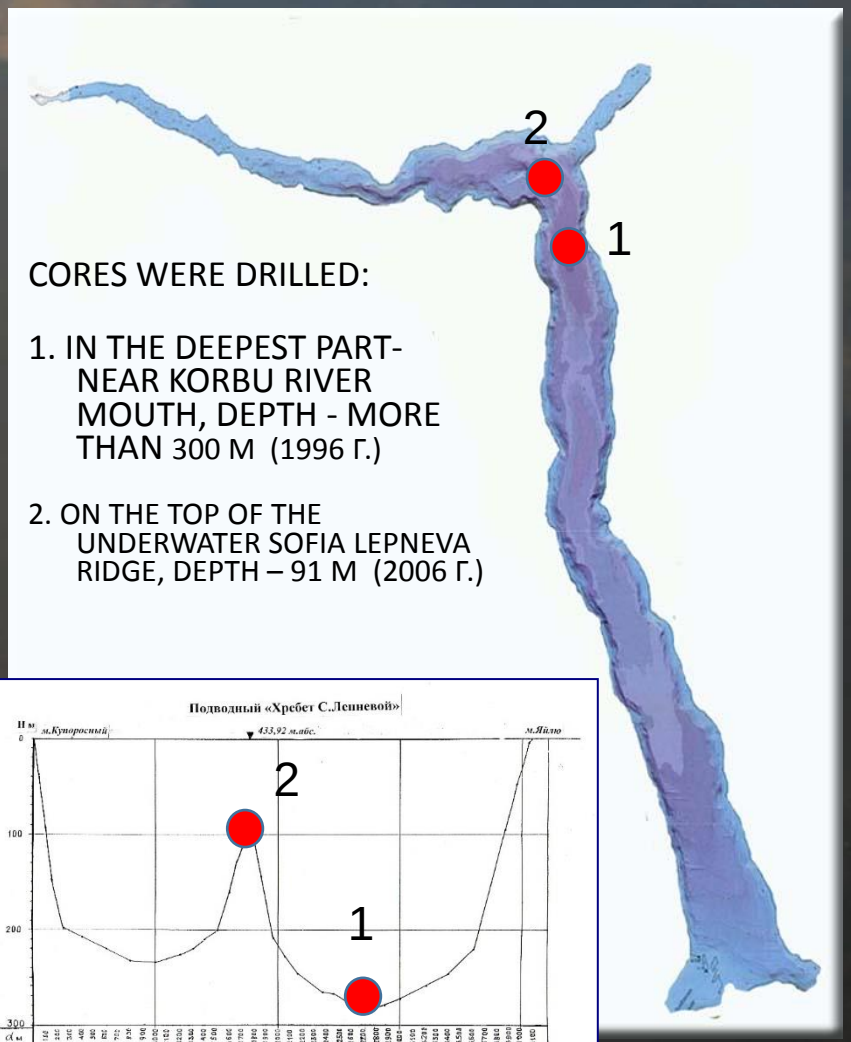


Bottom sediments

In the mid 1990s, Lake Teletskoye became the study object of the International Program for the Comparative Study of the Latest Tectonics and Sedimentation in the Large Rift Lakes of the World (CASIMIR).

The rate of sedimentation:
1.37 мм/year – in the north part
0.3 мм/year – on the underwater ridge
2.39 мм/year – in the south part,
4-6 mm/year – near the source of Chulyshman River

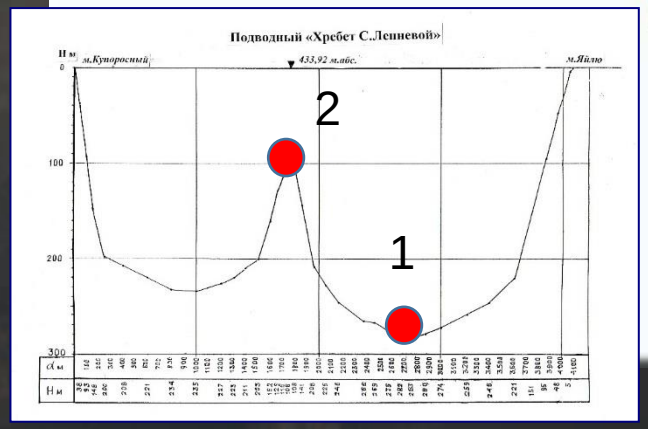
For Baikal:
0.015- 1 mm/year
Biogenic silica - ~2.5%,
For Baikal – 0-30%



CORES WERE DRILLED:

1. IN THE DEEPEST PART- NEAR KORBU RIVER MOUTH, DEPTH - MORE THAN 300 M (1996 Г.)

2. ON THE TOP OF THE UNDERWATER SOFIA LEPNEVA RIDGE, DEPTH – 91 M (2006 Г.)

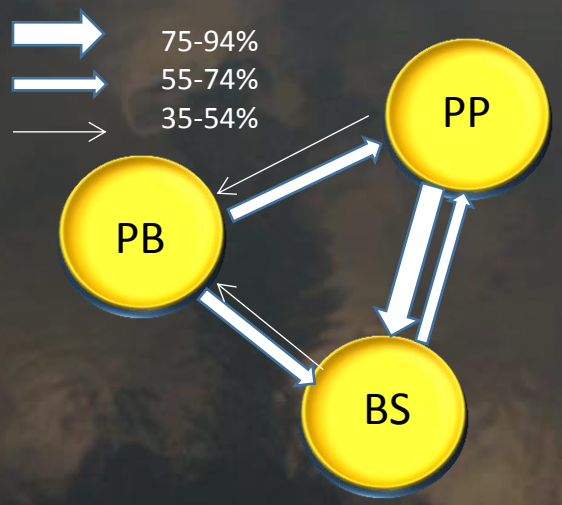


Taxa composition of diatoms in bottom sediments

350 species
Number of species per layer - 16-63, an average - 38±4.

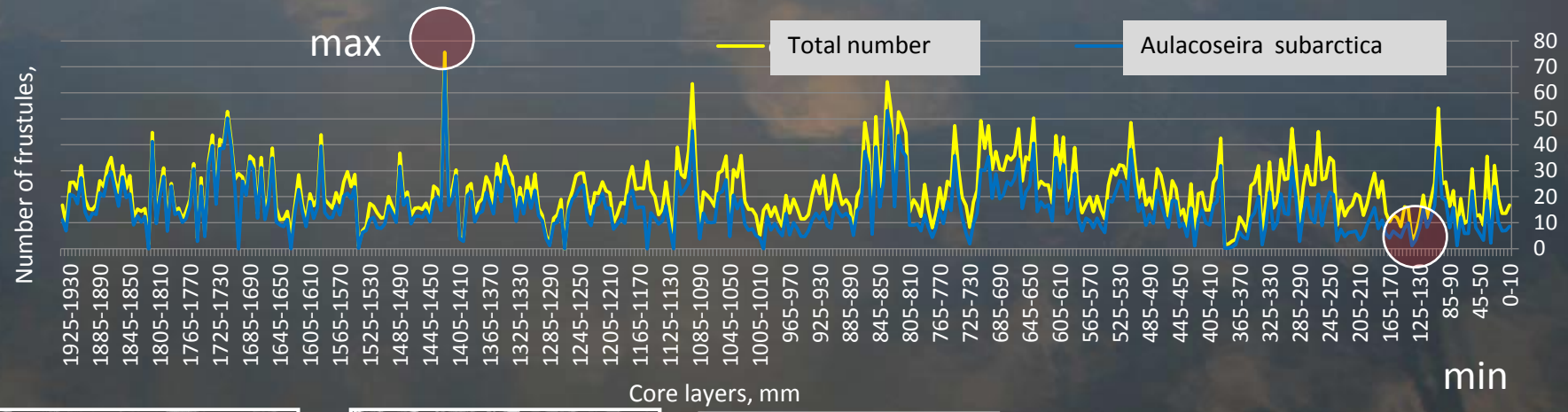
Analysis of diatom composition in bottom sediments suggests that the following species prevail

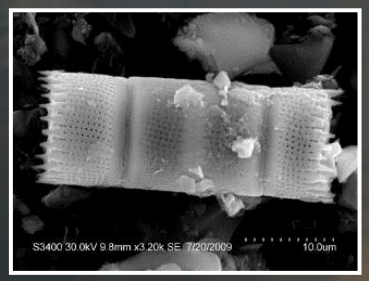
inhabitants of the bottom and fouling (70%),
widespread (43%) by geographical location,
indifferent to salinity (64%),
alkaliphilous (34%) and indifferent (30%) to pH,
beta-mesosaprobic (37%) among species-indicators of organic pollution.

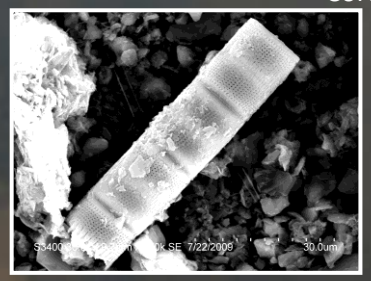


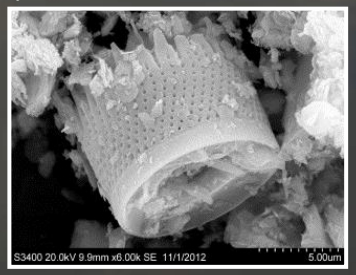
Comparison of diatoms composition in plankton, benthos and bottom sediments using "measures of inclusion" and "oriented multigraph" shows that pelagic planktocenoses contribute to the formation of tanatocenoses greatly.

Core of bottom sediments from the underwater Sophia Lepneva Ridge





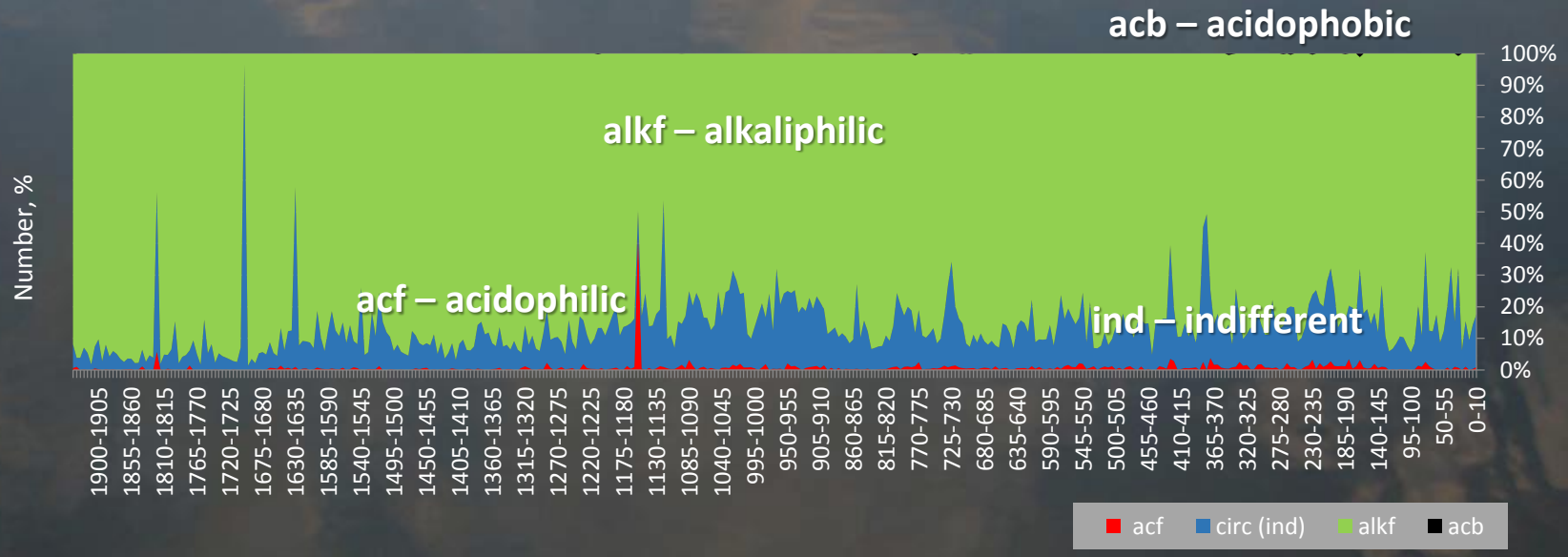


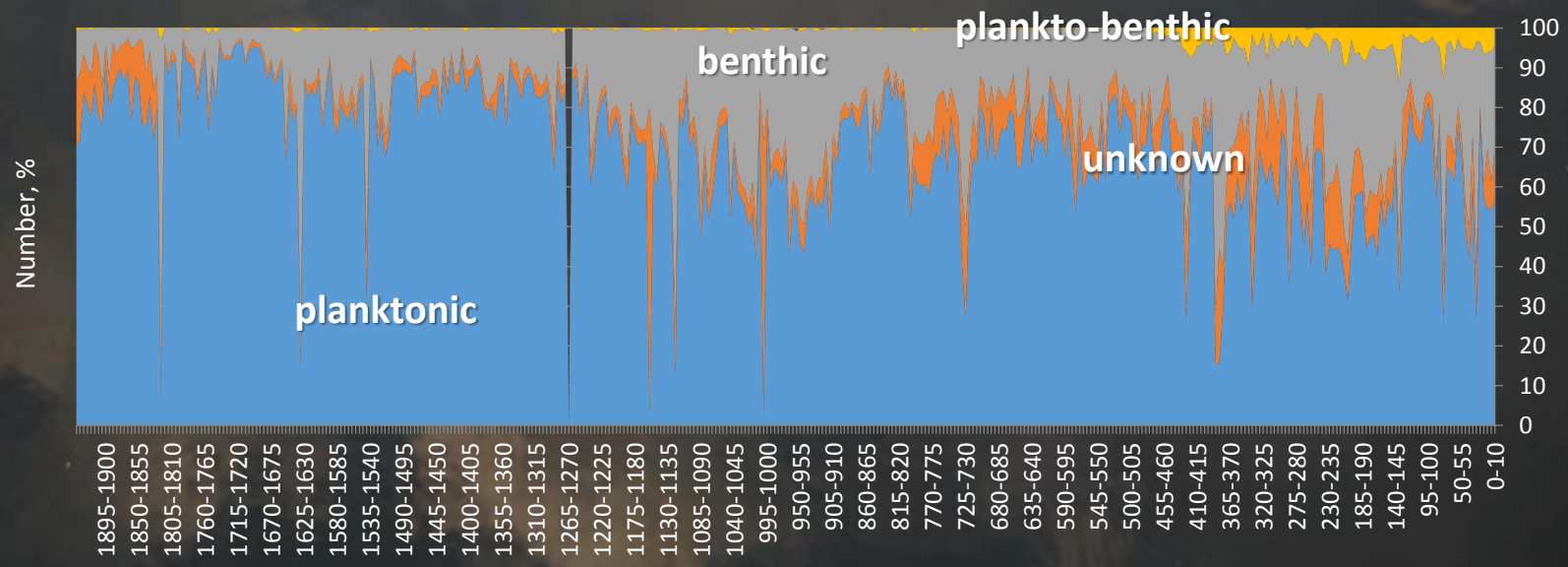


Aulacoseira subarctica **(O. Müll.) E. Y. Haw.**

- **The number of diatoms in different layers of the bottom sediments ranged from 0.86 (layer 135-140 mm) to 75.6 (layer 1425-1430 mm) mln fr./g, with an average of 22.3 ± 0.58 mln fr./g;**
- **The peaks of the diatom abundance, especially representatives of the cold-water assemblage including the main dominant *Aulacoseira subarctica* were in the periods with low water temperature;**
- **The conditions in the lake were and currently correspondence to a weakly alkaline environment (7 <pH <8.5) and slightly lower water level in the lake;**

Diatoms – indicators of pH and habitats



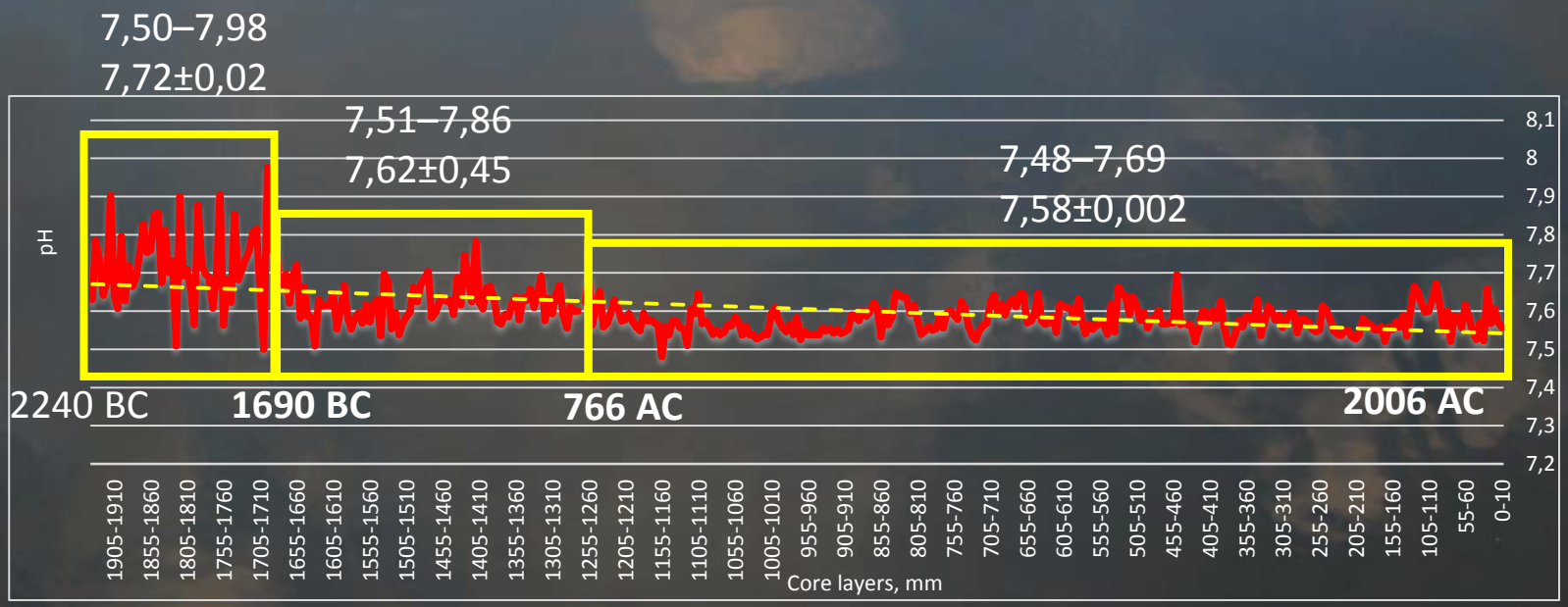


Reconstruction of pH

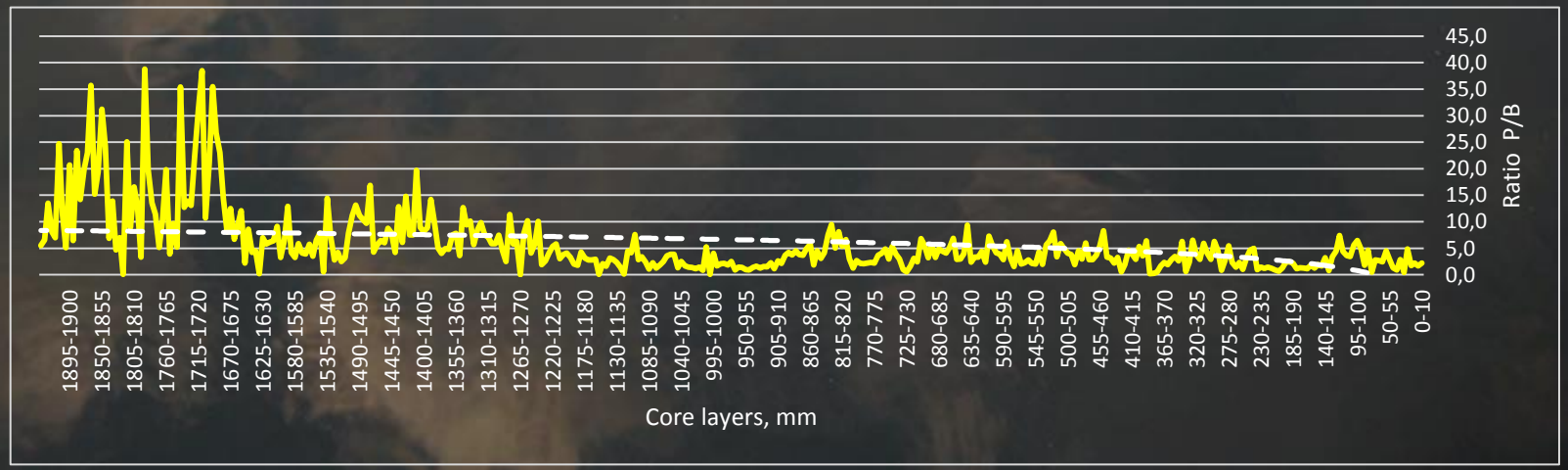
pH = 7,5 – 0,85 log B, where B = (% circ + 5% acf + 40% acb) / (% circ + 3,5% alkf) (Moiseenko et al., 1999)

For the last 4000 years

7,48–7,98
average
7,61±0,004

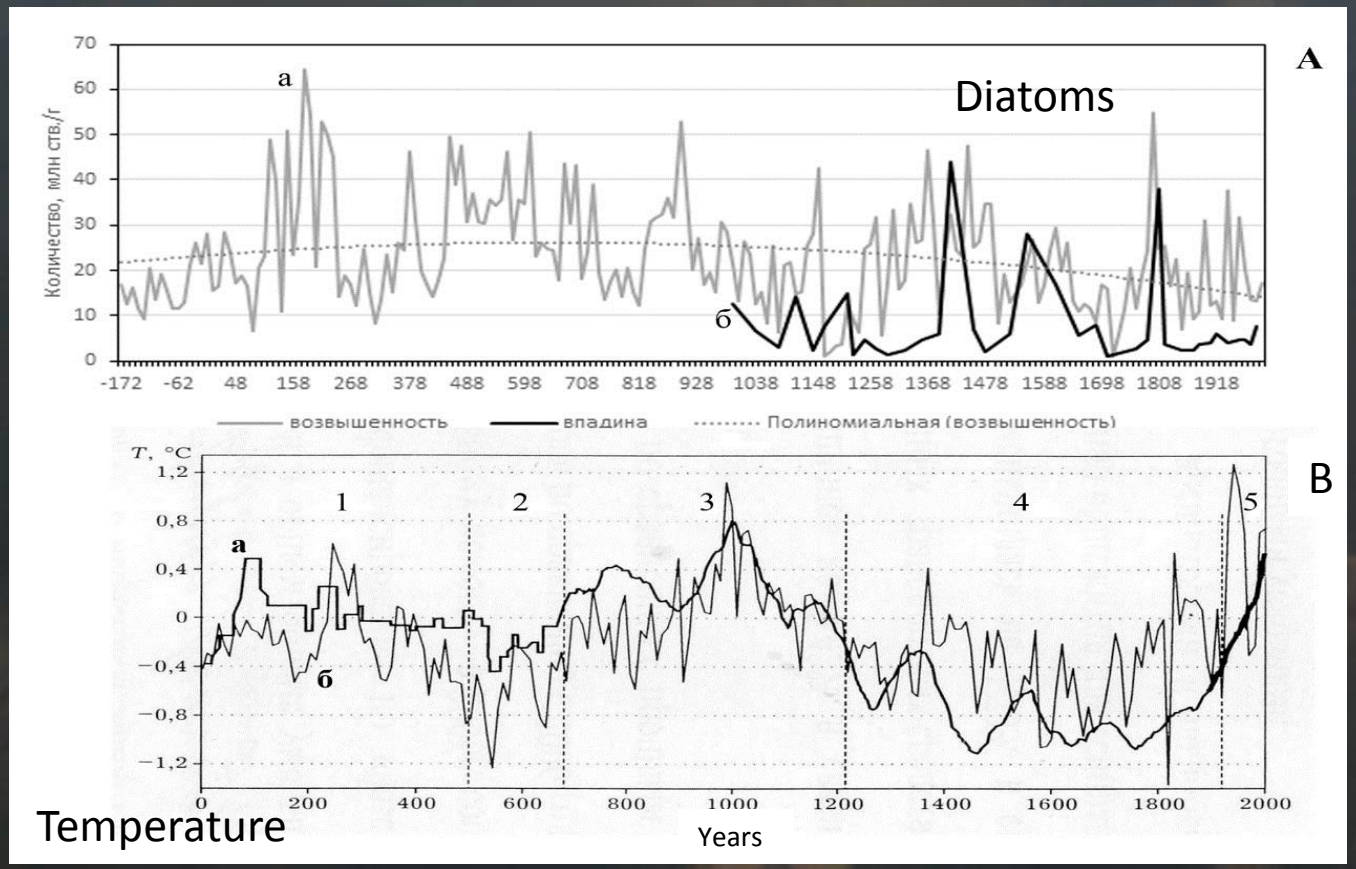


P/B - ratio of planktonic and benthic forms



Distribution of diatoms and reconstructed temperatures

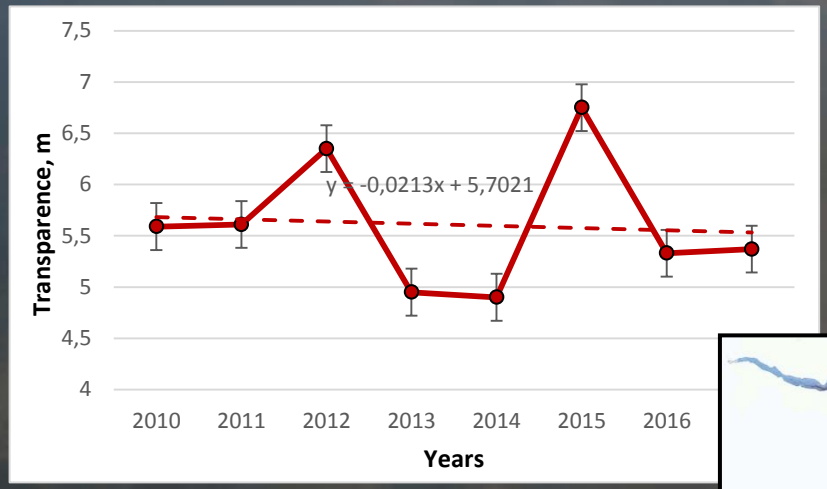
(A) Number of diatom frustules with a trend line in the bottom sediments from the underwater Sophia Lepneva Ridge (1) and in the deepest part of the lake (near Korbu River mouth) (2, by Skabitchevskaya, 2000),
(B) Reconstructed average 100-year temperatures for the region of Lake Teletskoye (a) and ten-day temperatures for North-Eastern Europe (b)



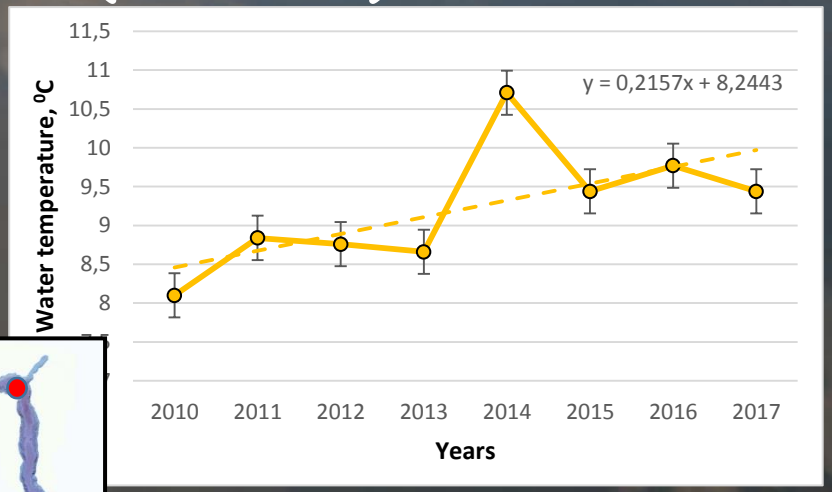
The most significant climatic events:
1, Roman optimum;
2, early Middle Ages (Migration Period) climatic pessimum;
3, Middle Ages optimum;
4, cooling, with the Little Ice Age;
5, recent warming.

Temperature anomalies are given in deviations from the average for 1961–1990 AD (Babich et al., 2015).

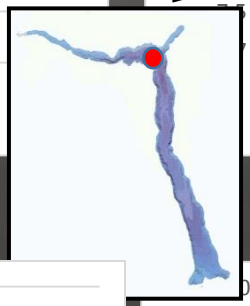
Trends in hydrological and meteorological parameters for 2010-2017 (St. Yailu)

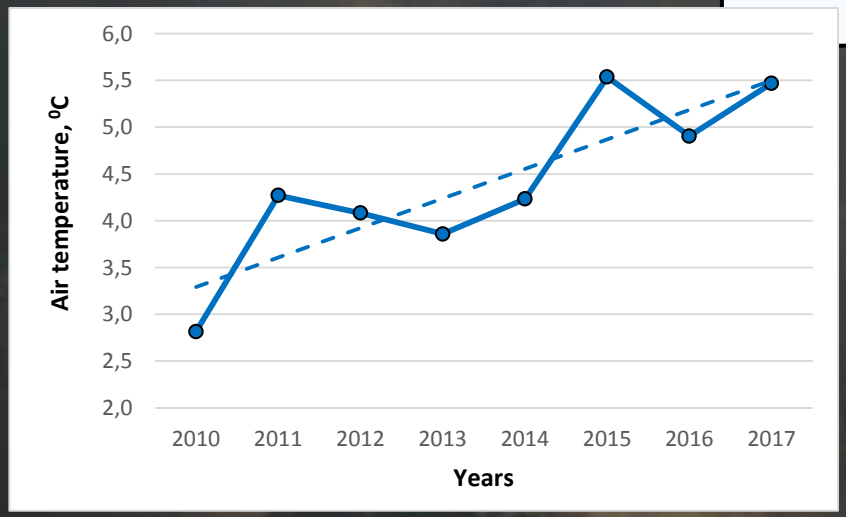


Water transparence

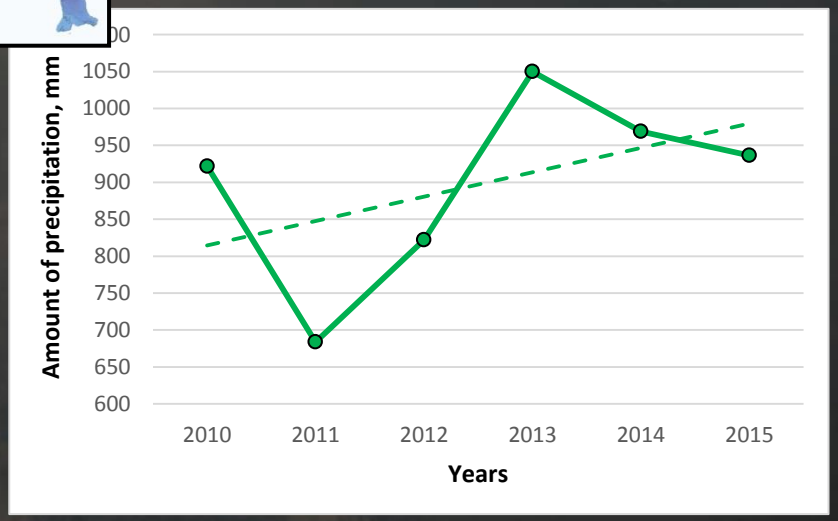


Water temperature





Air temperature



Annual precipitation

Prognosis

Air temperature

Annual precipitation

Water temperature

Water transparence

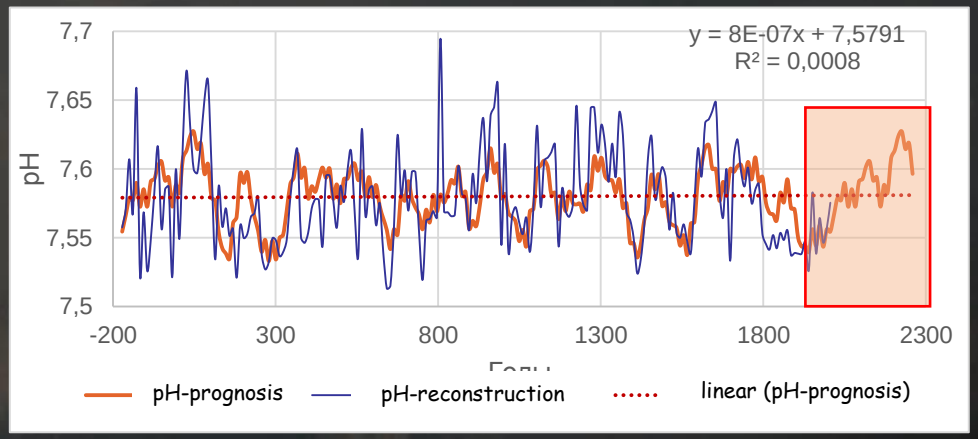
pH

For the last 4000 years — 7,48–7,98 average 7,61±0,004

For the last 2000 years — 7,51-7,69 average 7,58±0,003

For 2006-2220 — 7,56-7,61 average 7,58±0,003

Stability of the lake ecosystem during the last 4000 years



Conclusion

- In the bottom sediments sampled from the underwater Sofia Lepneva Ridge of Lake Teletskoye, a total of 350 species of diatoms were identified;
- Number of diatom frustules varied greatly; i.e. from 0.86 (layer 135-140 mm) to 75.6 mln fr./g (layer 1425-1430 mm) with an average for the core of 22.3 ± 0.58 mln fr./g .
- The pH value reconstructed by composition and number of pH indicator species over the past 4000 years varied within 7.48–7.98 with an average of 7.61 ± 0.004, i.e. within the slightly alkaline zone - 7.51-7.69;
- In the lower core layers, the change in pH and the ratio of planktonic and benthic forms were more significant, which may indicate an increase in both the water level and pH. Currently, there is a decrease in the total number of diatoms, planktonic forms and pH;
- Environmental changes in the lake (more than 300 m of depth and about 40 km3 of volume) are not so dramatically over the past 4000 years due to, perhaps, some inertia all processes in the deep reservoir.

Thank you for attention

The author thanks I.A. Kalugin (IGG SB RAS, Novosibirsk) for coring of bottom sediments in Lake Teletskoye.