Modulation of the freshwater diatom community structure by pollution and different climate characteristics (Antarctic vs temperate climate)

Toparceanu Florica [1], Ionescu Ioana [2], Kim Lidia [2], Stoica Catalina [2] and Nita-Lazar Mihai [2]

[1] Stefan S. Nicolau Institute of Virology, National Commission for Antarctic Research (NCAR), Romanian Academy, 125 Calea Victoriei, 010071, Bucharest, Romania

[2] National Research and Development Institute for Industrial Ecology (ECOIND), 71-72 Drumul Podu Dambovitei, 060652, Bucharest, Romania

This research is a tribute to Teodor Gheorghe Negoita, the Romanian leader of Antarctic Station Law-Racovita during 2005-2011.

BACKGROUND

The presence of the research stations, ice runways and turism in Antarctica could have a potentially risk of anthropic impacts on a pristine environment.

Larsemann Hills is a free-ice „oasis" area, nearby the ice cap, located along the Ingrid Christensen costline, Prydz Bay, East Antarctica, with more than 150 freshwater lakes well-mixed by katabatic winds in summer. This area, especially the freshwater lakes, are scientifically and environmentally significant and it was designed ASMA 6 in 2007.

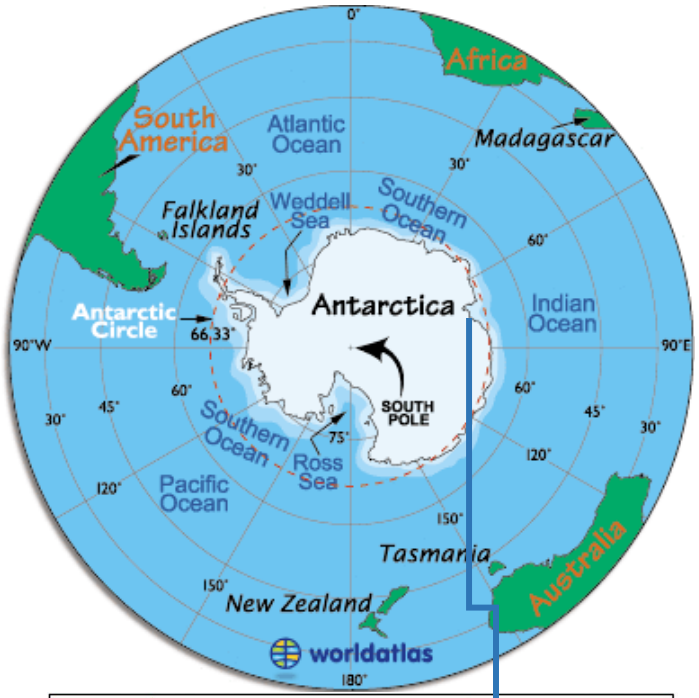
The diatoms have an ubiquitous presence in oceans, lakes, freshwater streams and soil and they are responsible for up to 50% oxygen production. Moreover, the diatoms are a indicator of the water quality, being very sensitive to antropic impacts and climate changes. Broknes Peninsula of Larsemann Hills contains endemic freshwater diatoms to Prydz Bay or Antarctica.

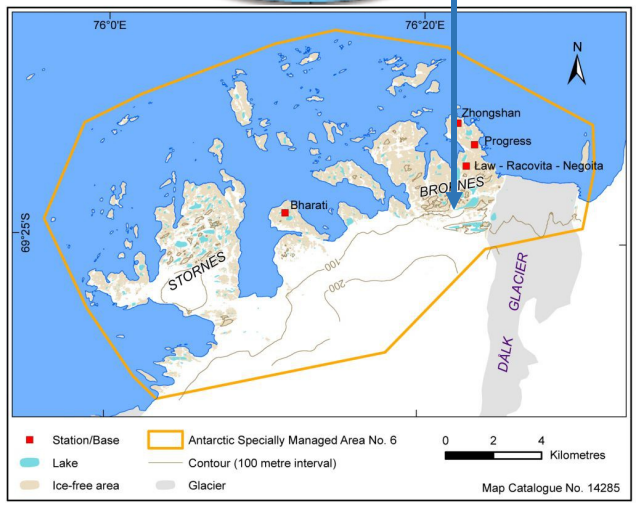
In the context of global warming, in the Antarctic summer 2019-2020 there was an increase in temperature in West Antarctica to 21 of degrees and algal blooms.

AIM

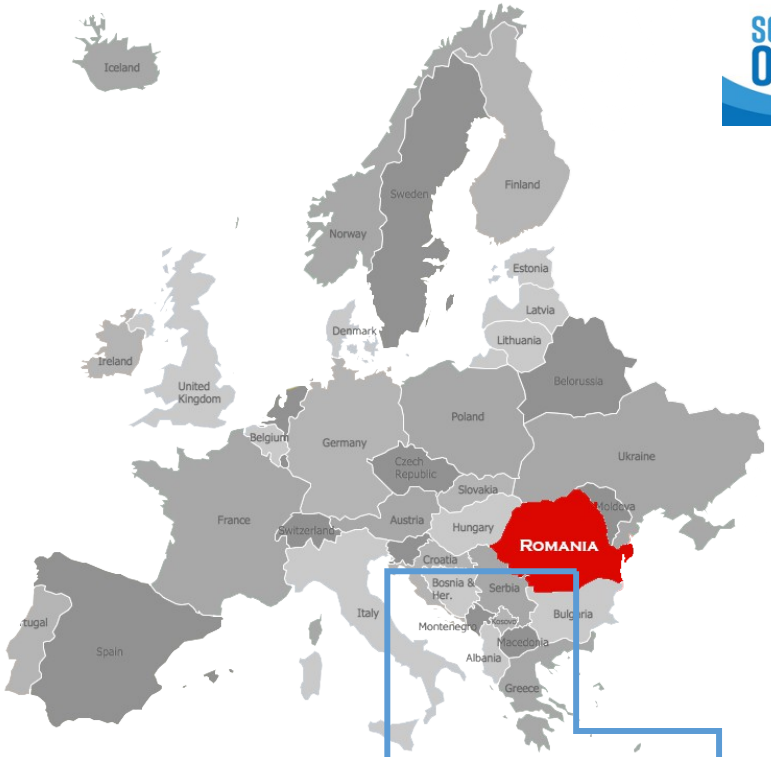
In this study, we analysed the diatom community structure in a stream from a lake catchment area from Broknes Peninsula in comparison to diatoms from Romanian glacial lakes (Balea and Capra of the Fagarasi Mountains) assuming that the temperature changes from Antarctic environmental conditions to temperate climate conditions mimics the global warming and they could be extrapolated to predict the environmental effects of the global warming.

Sampling areas





East Antartica - Larsemann Hills
69°23'S 76°22'E - water bodies



Balea Glacial Lake
45°36'N 24°37'E

Capra Glacial Lake
45°36'N 24°37'E

Sampling

Samples	Data	Temperature		Site description
		water	air	
ANTARCTIC LAKE	February 24, 2006	0.5ºC (under the frozen surface)	-11ºC	Small drinking-water lake of Law-Racovita Station, near the main vehicle road, next to secondary vehicle road, inside the facilities area in Broknes Peninsula, 65 m altitude.
ANTARCTIC STREAM	January 30, 2006	1.5ºC	>=6ºC (in the sun) -8ºC (in the shade)	Stream resulting from melting snow with abundant masses of green algae partially covered with water in the catchment area around Scandrett Lake, 50 m altitude.
BALEA LAKE	October 20, 2019	8ºC	15ºC	2,034 m altitude, water from the shore with algae on rocks.
CAPRA LAKE	October 20, 2019	10ºC	21ºC	2,230 m altitude, water from the shore with algal blooming on rocks.

Chemical composition of water samples

Content of major and trace elements in water bodies depends on rocks composition, aerosols, sea-spray input, leaching processes, weather conditions, biological activities (photosynthesis, respiration and decomposition), natural enrichment with excrements of birds and human impact.

Content (mg/L) of some major elements in water samples

Water samples	pH	Na	Mg	Ca	Mg/Ca
ANTARCTIC LAKE	6.39	137	149	90.53	1.65
ANTARCTIC STREAM	6.42	56	91	66.95	1.30
BALEA LAKE	6.77	1.23	2.34	18.72	0.125
CAPRA LAKE	6.97	0.71	0.35	8.10	0.043

Methods: pH - electrochimical, Na, Mg, Ca - ICP-MS

The content of some heavy metals in Antarctic water bodies

Elements	M.U.*	ANTARCTICA		WHO** Drinking-Water Quality
		Stream	Law-Racovita Station Drinking-water lake	
Arsenic	µg/L	16.36	0.18	10
Cadmium	µg/L	<1.5	<1.5	3
Chromium	µg/L	3.01	<1.3	50
Copper	µg/L	163.5	1.79	2000
Manganese	µg/L	130	10.70	100
Nickel	µg/L	62.5	5.69	70
Lead	µg/L	3.2	1.47	10
Zinc	µg/L	98	117	100

Methods: ICP-MS.

*Measurement Unit; ** World Health Organization, Guidelines for drinking-water Quality, 2011.

The content of some heavy metals in temperate freshwater lakes

Elements	M.U.*	ROMANIA		National legislation limits*** Quality Classs II / III / IV
		Balea Lake	Capra Lake	
Arsenic	µg/L	0.138	0.135	5 / 10 / 25
Cadmium	µg/L	<1.5	<1.5	1 / 2 /5
Chromium	µg/L	<1.3	<1.3	50 / 100 / 250
Copper	µg/L	<1.0	<1.0	20 / 40 / 100
Manganese	µg/L	0.95	<0.25	50 / 100 / 300
Nickel	µg/L	0.54	0.52	50 / 100 / 250
Lead	µg/L	0.57**	1.79**	5 / 10 / 25
Zinc	µg/L	<2.1	<2.1	100 / 200 / 500

Methods: ICP-MS.

*Measurement Unit; ** The concentrations of lead increase in the summer months due to road traffic (data not shown);

*** ORDER No 1146 of December 10, 2002: Class II - quality condition for the protection of aquatic ecosystems; Class III / IV - anthropic influence.

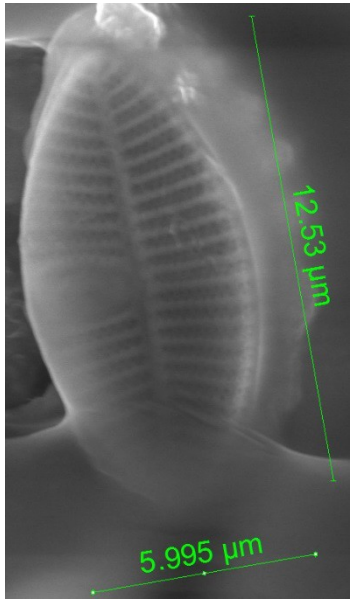
Order of the major elements and heavy metals by the values of exceedance in water samples

Water samples	Major elements	Heavy metals
ANTARCTIC STREAM	Mg > Ca > Na	Cu > Mn > Zn > Ni > As > Pb > Cr
ANTARCTIC LAKE	Mg > Na > Ca	Zn > Mn > Ni > Cu > Pb > As
BALEA LAKE	Ca > Mg > Na	Mn > Pb > Ni > As
CAPRA LAKE	Ca > Na > Mg	Pb > Ni > As

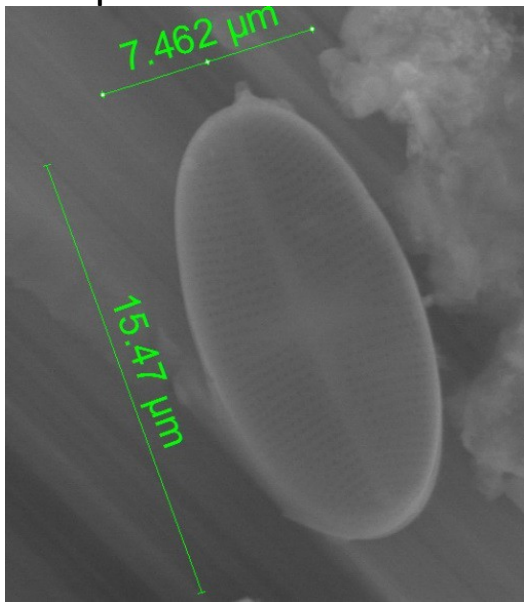
SEM investigations: Common species of diatoms

Antarctica

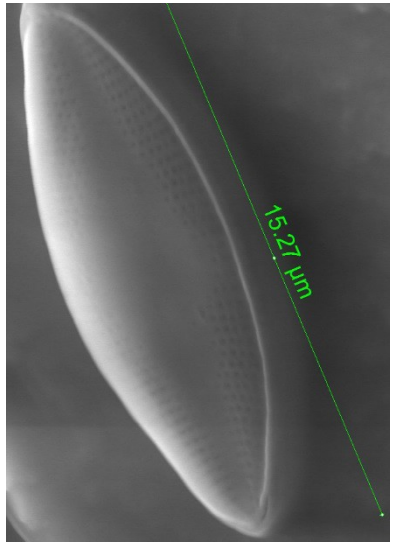
Achnanthes sp.

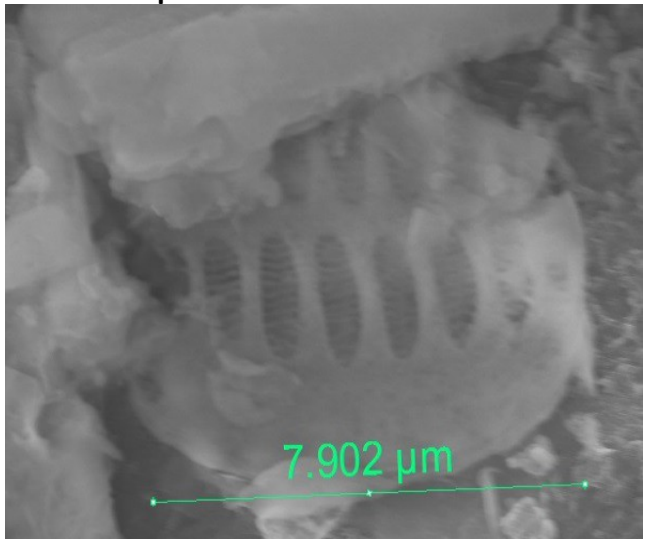


Romania



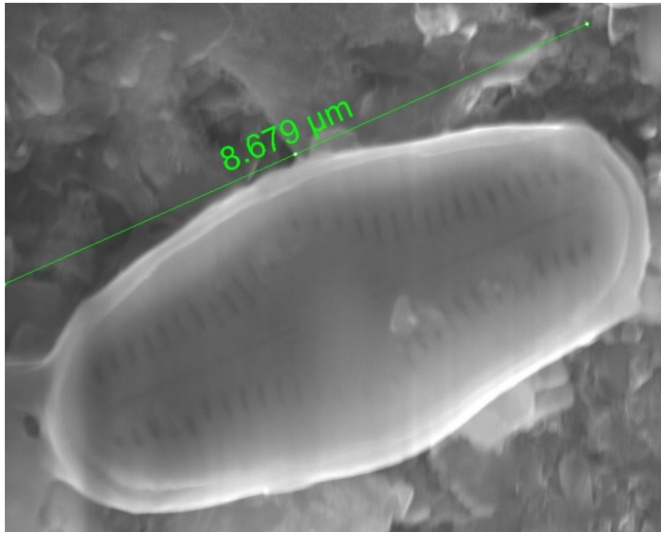
Planothidium sp.



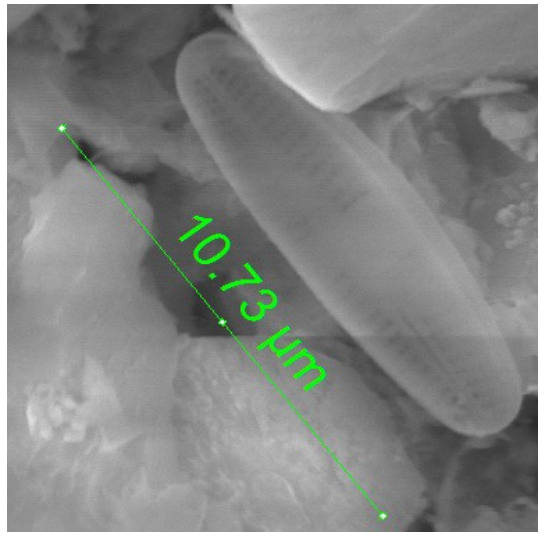


Antarctica

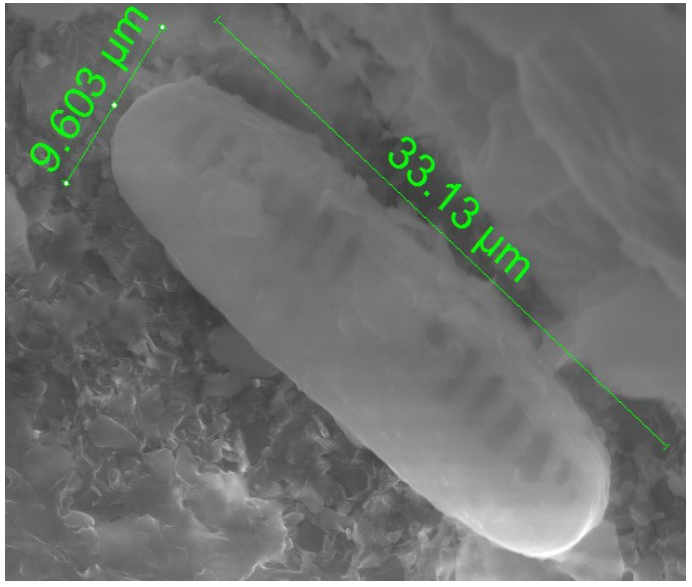
Navicula sp.

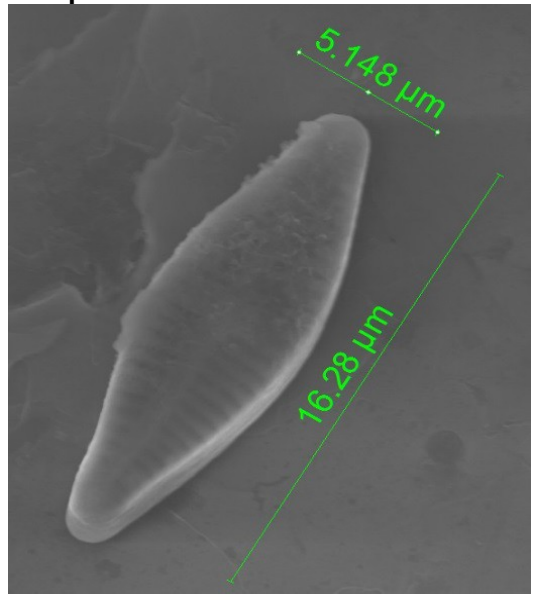


Romania



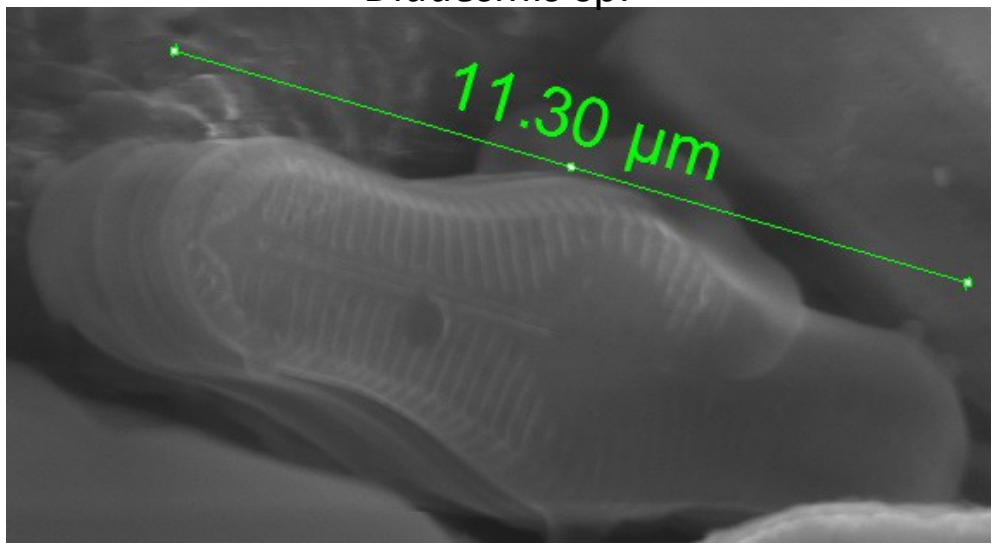
Pinnularia sp.



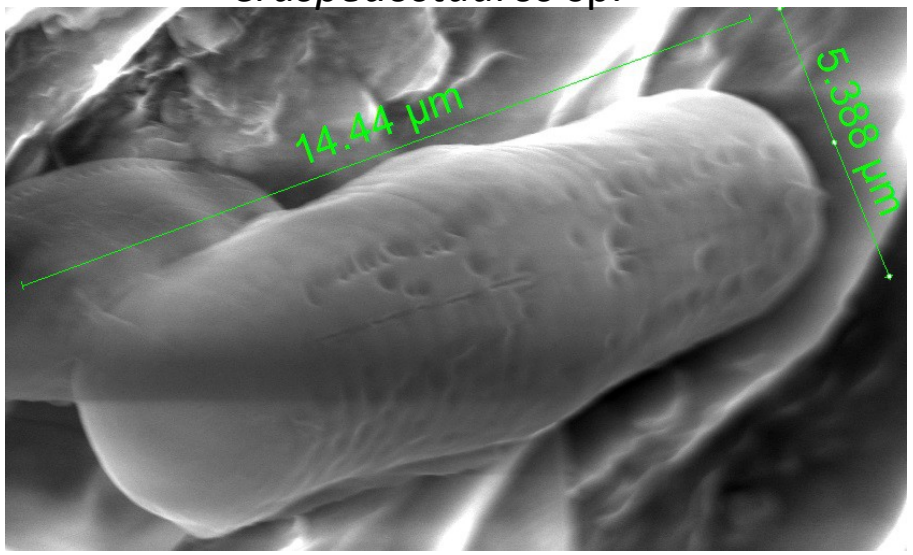


SEM investigations: Antarctica - diatoms

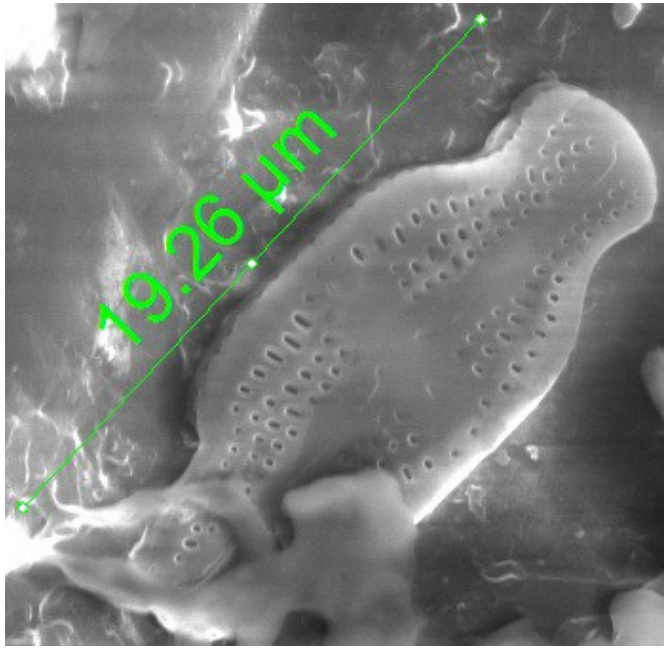
Diadesmis sp.



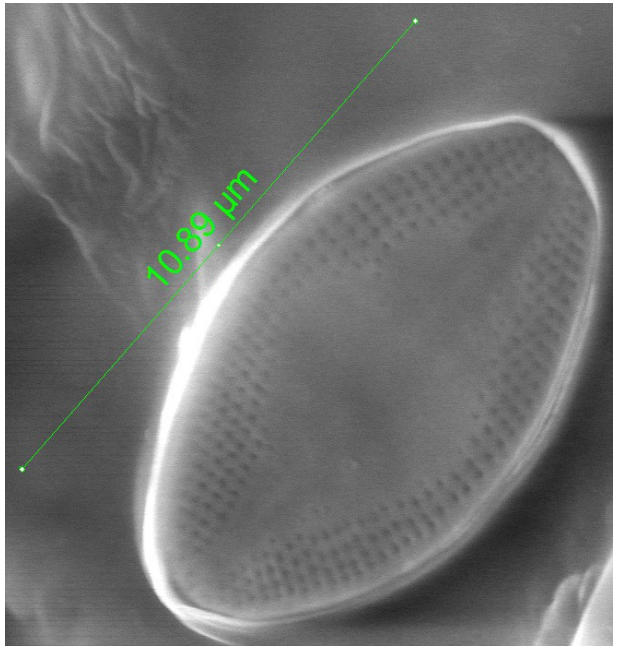
Craspedostauros sp.



Luticola sp.

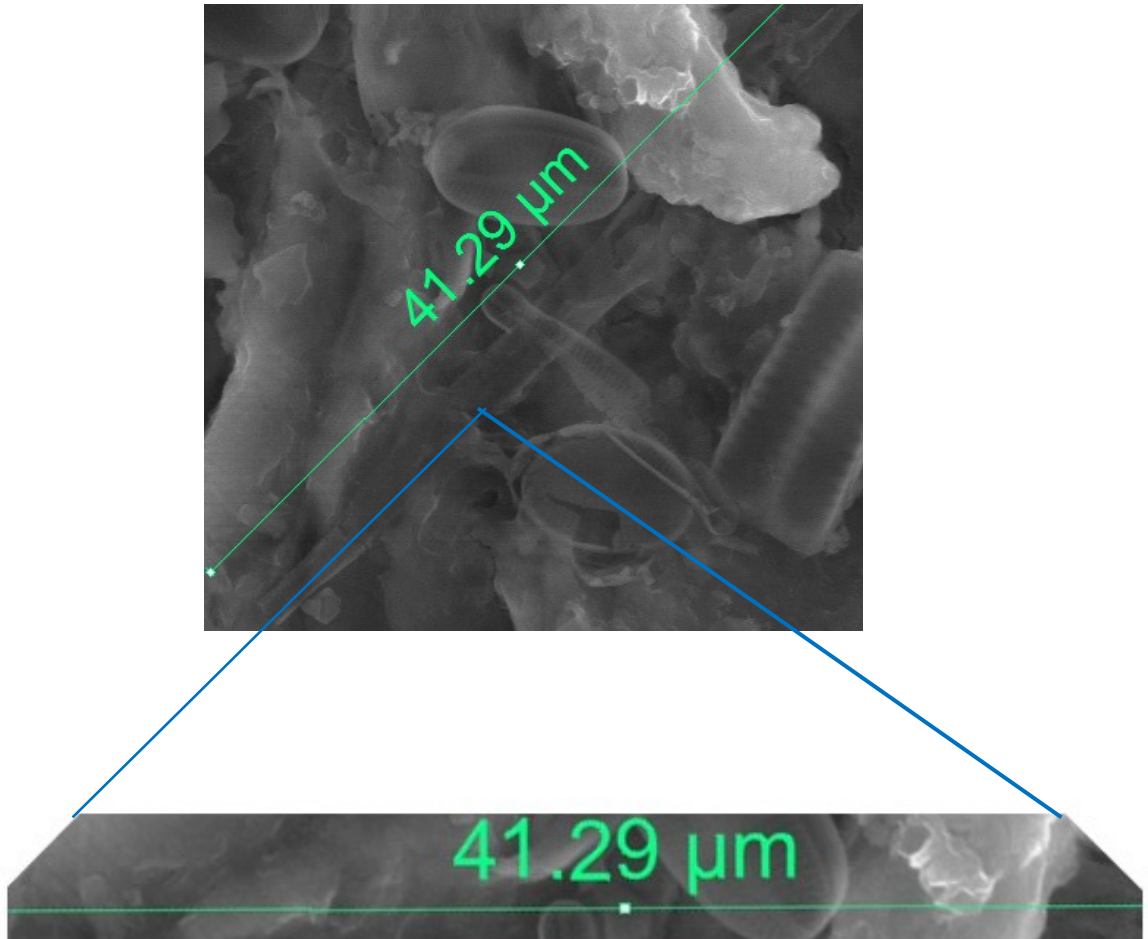


Psammothidium sp.

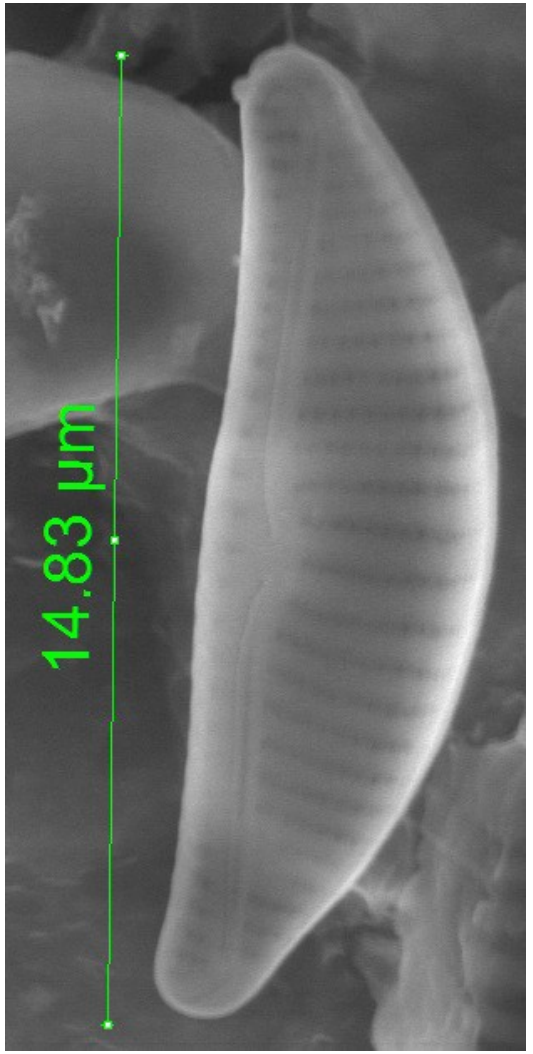


SEM investigations: Romania - diatoms

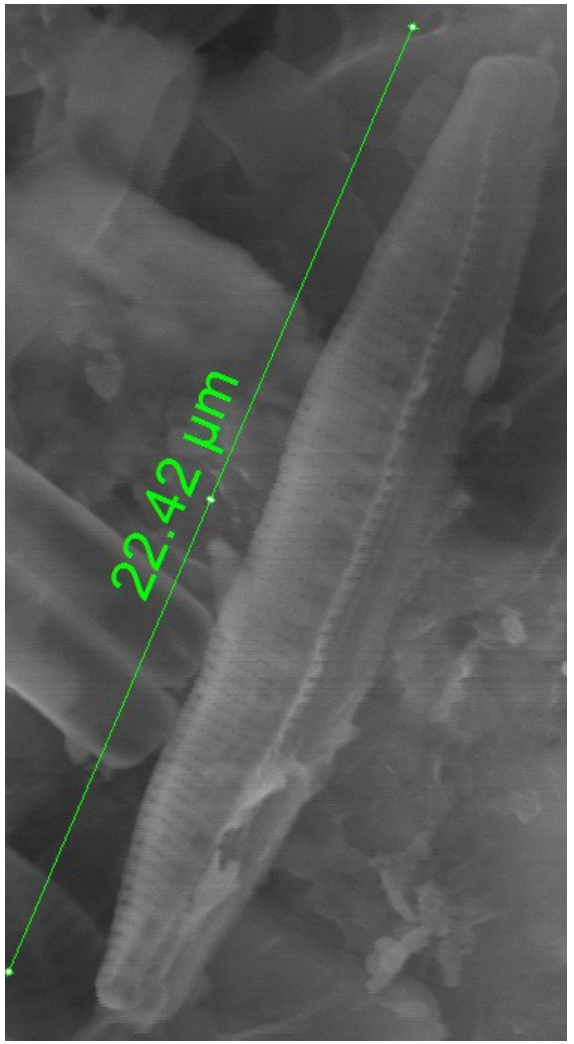
Fragilaria sp.



Amphora sp.



Hantzchia sp.



The presence of some diatoms (morphology types and genera) in specific locations

No	Morphology Type	Identified Genus	ANTARCTICA	ROMANIA	
				Balea Lake	Capra Lake
1	Araphid	*Fagilaria*			+
2	Monoraphid	*Achnanthes*	+	+	+
		Planothidium	+	+	
		Psammothidium	+		
3	Naviculoid	*Navicula*	+	+	
		Pinnularia	+	+	+
		Luticola	+		
		Craspedostauros	+		
		Diadesmis	+		
4	Amphoroid	*Amphora*			+
5	Nitzschioid	*Hantzschia*			+

CONCLUSIONS

The chemical analysis of water samples showed that magnesium (Mg) was the dominant cation in the two Antarctic water bodies while calcium (Ca) was dominant cation in the two temperate glacial lakes in Romania.

The Antarctic water bodies had higher concentrations of heavy metals compared to temperate lakes.

Through SEM analysis, we identified 2 morphology types of diatoms in the Antarctic stream (monoraphid and naviculoid) and 5 morphology types in temperate glacial lakes (araphid, monoraphid, naviculoid, amphoroid and nitzschoid).

The presence of 4 common genera of diatoms in Antarctic stream and temperate Balea Lake (*Achnanthes, Planothidium, Navicula, Pinnularia*) is associated with presence of manganese (Mn) in chemical composition of waters. The absence of 2 genera of them in temperate Capra Lake is associated with undetectable value of Mn.

The 4 genera of naviculoid type diatoms present only in Antarctic stream (*Luticola*, *Craspedostauros, Diadesmis, Psammothidium*) suggest their adaptation to extrem polar climate and a freshwater chemical composition more riched in metals: Cu>Mn>Zn>Ni>As>Pb>Cr.

The presence of another 3 genera of diatoms (*Fragilaria* - type araphid, *Amphora* - type amphoroid, *Hantzchia* - type nitzschoid) only in temperate glacial lake Capra suggest a possible adaptation to contamination with lead: Pb>Ni>As.

Thank you for your attention !

Contact:
Florica Toparceanu, PhD
florisci@hotmail.com

Acknowledgement
Iulia Nita, PhD
Adviser on Environmental Chemistry,
Romanian National Commission for Antarctic Research