Influence of radioactivity on microorganisms living in mineral springs

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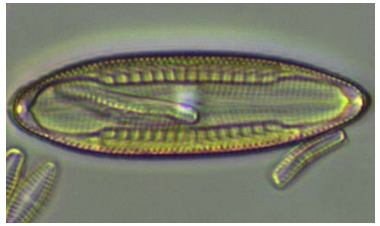
Research context

- Over the millennia, living organisms have evolved to manage the stress induced by ionizing radiation, but the evolutionary consequences of chronic exposure to natural radioactivity are not fully characterized.
- Due to its geology, the Auvergne region (part of the Massif Central) is particularly famous for its numerous mineral springs as Czech Republic.
- Because of granitic substrate, some of these springs are significantly radioactive like La Montagne and Plesna springs.
- The radioactive springs have received little attention regarding their biodiversity and particularly the diatom communities.
- To date, no study was done to evaluate how radioactivity influences these communities.
- Objective: survey to analyze the evolution of the physical & chemical variables and the diatom communities

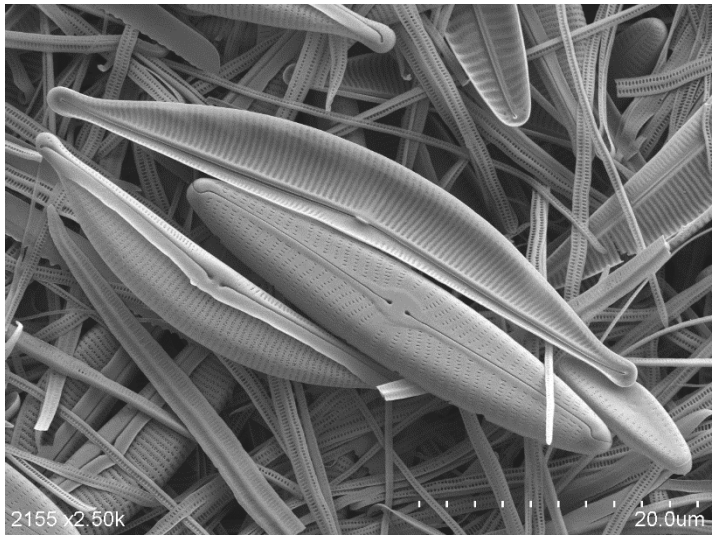
Research context

What are diatoms ?

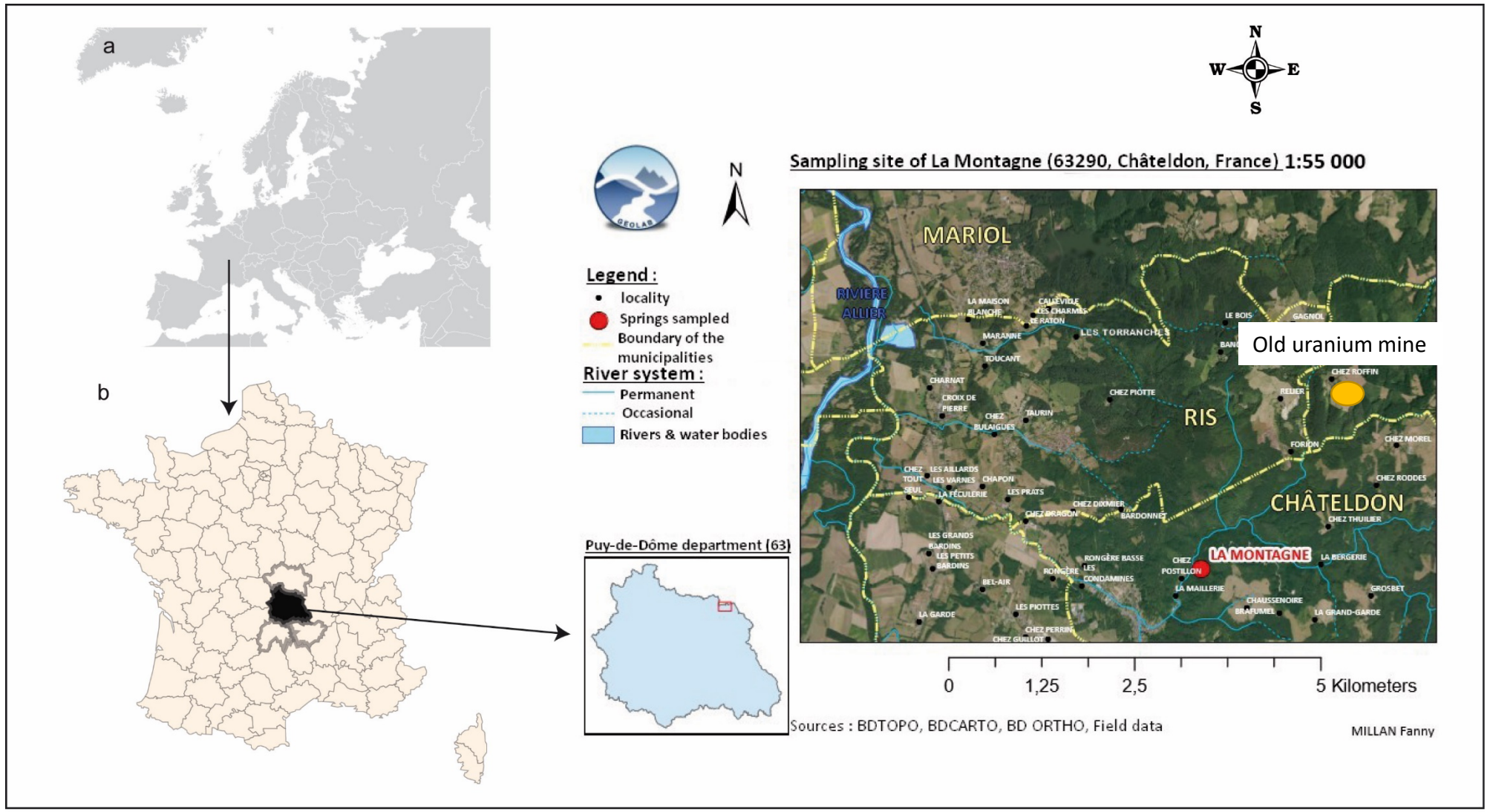
Diatoms are algae that live in houses made of glass. They are the only organism on the planet with cell walls composed of transparent, opaline silica. Diatom cell walls are ornamented by intricate and striking patterns of silica.



- ✓ **Diatoms produce 40% of the air we breathe**
- ✓ **Diatoms are food for the entire food web, from zooplankton to aquatic insects to fish to whales.**
- ✓ **Diatoms tell us about the health of aquatic systems**



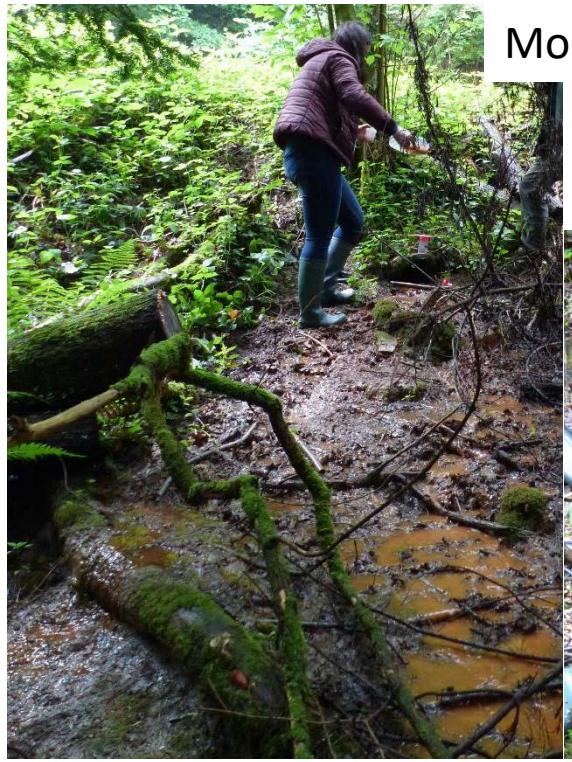
Châteldon: La Montagne spring



Châteldon: La Montagne spring

- The emergence of La Montagne spring is located in a former bottling factory that is presently ruined (Montagne 1). Standing water
- A large part of the spring is drained outside the building (Montagne 2). Running water

Montagne 2



Lead pipe

STUDY SITE

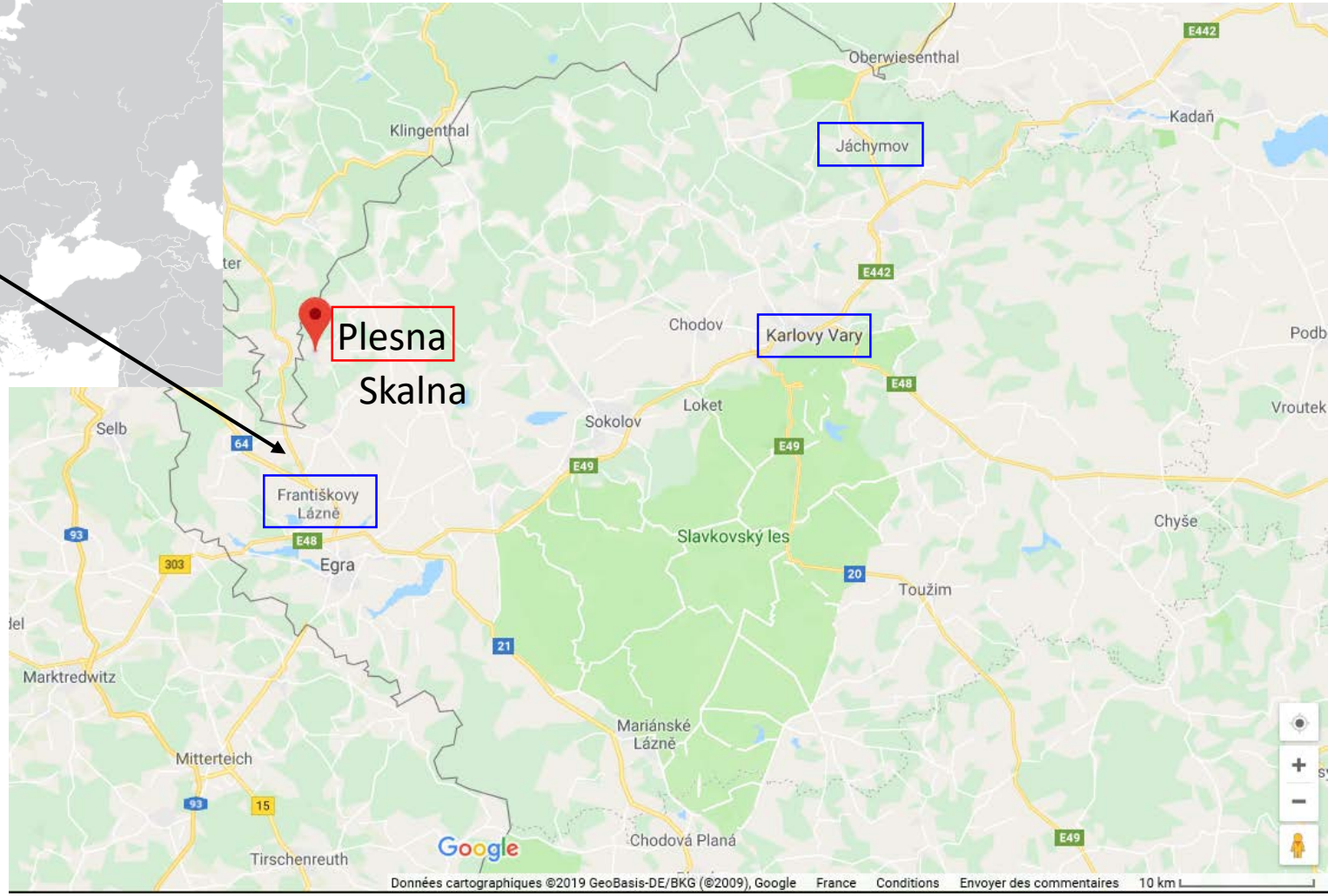
The water of La Montagne spring, in the early twentieth century, was sold in pharmacies. It was said of this radioactive water that "It rejuvenates the body, fights cancer" ...

Spring abandoned after 1940.

Currently, it is another spring that is exploited.

STUDY SITE


Plesna 1


Plesna
Skalna
Oberwiesenthal
Kadaň
Klingenthal
Jáchymov
Chodov
Karlovy Vary
Loket
Sokolov
Selb
Františkovy Lázně
Egra
Slavkovský les
Toužim
Chyše
Marktredwitz
Mariánské Lázně
Mitterteich
Tirschenreuth
Chodová Planá
Vroutek
Podb
Google
Données cartographiques ©2019 GeoBasis-DE/BKG (©2009), Google
France
Conditions
Envoyer des commentaires
10 km


Plesna 2

MATERIAL AND METHODS

- La Montagne spring: a first survey was conducted from May 2018 to January 2019
- Plesna spring: a survey was done in November 2018
- in order to: - evaluate the physical and chemical parameters (ionic concentrations and radioactivity)
  - investigate the diatom communities (species; % of teratological forms);
  - (no data in June for Montagne)

-***In-situ* were measured**:

- Temperature (°C)
- pH
- Conductivity (µS/cm)
- Dissolved oxygen (% and $mg.l^{-1}$)
- Ambient gamma radiation was measured using a COLIBRI portable device in the building in May 2018 and January 2019.

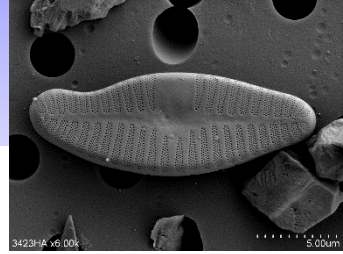
-**In laboratory**,

-the concentrations in lithium, sodium, ammonium, potassium, magnesium, calcium, fluoride, chloride, bromine, nitrate, phosphate and sulphate were measured ($mg.l^{-1}$) using the high pressure ion chromatography technique.

- Carbonate ($mg.l^{-1}$) was also measured using HACH Digital Titrator.

-Radon (Bq of radon.l^{-1} of water) was measured using a Germanium gamma spectrometer.

MATERIAL AND METHODS



- <u>La Montagne spring: Each month</u>:
  - diatoms were collected on the dominant substrates present at each site: mud for La Montagne 1 et stones for La Montagne 2 using pipette and toothbrush.

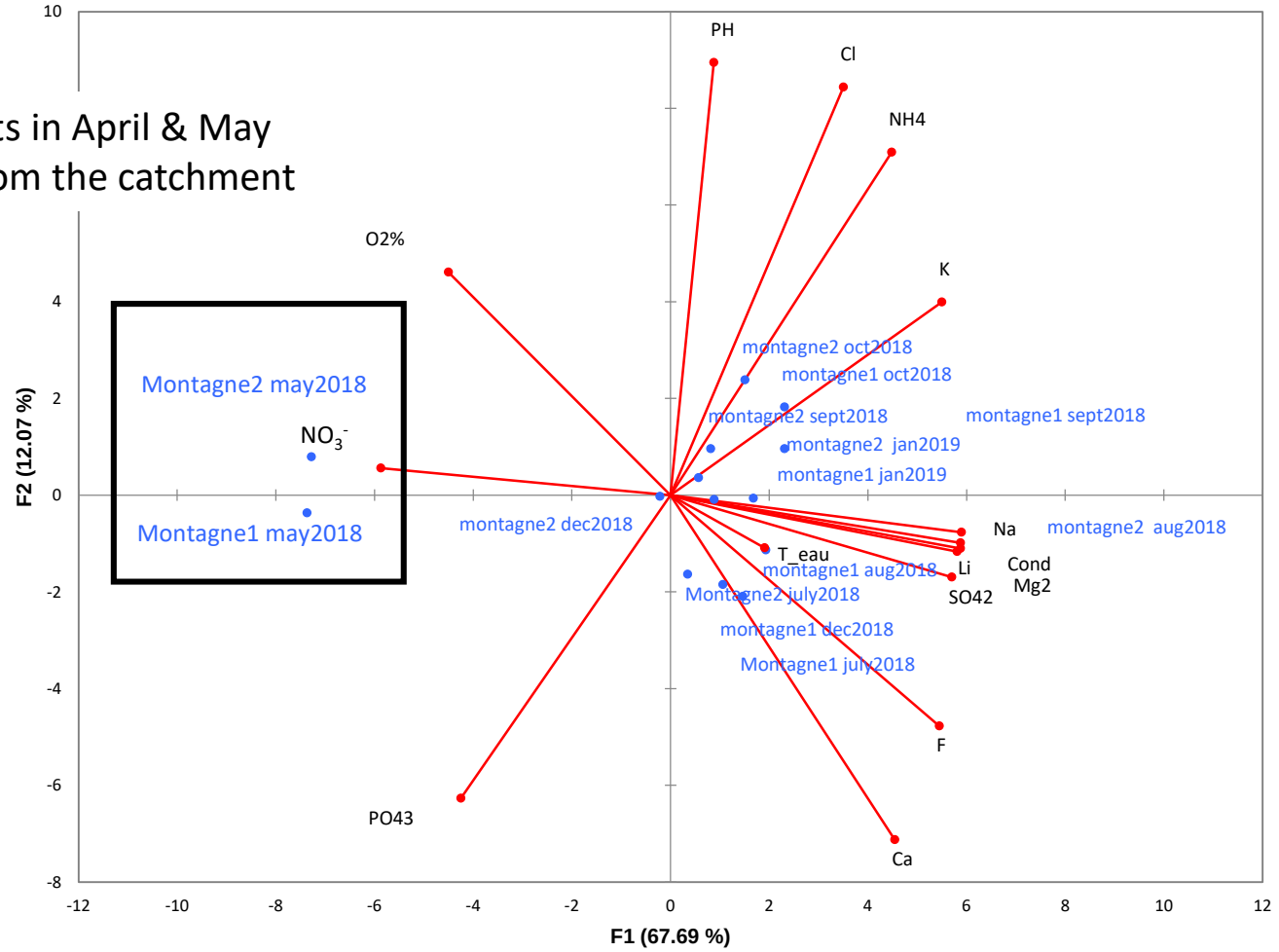
- <u>Plesna Spring</u>
  - diatoms were collected on the dominant substrates present at each site: stones for Plesna 1 and “peat” for Plesna 2.

RESULTS:

La Montagne spring: Physical and chemical variables

- Important rainy events in April & May
- Inputs of nutrients from the catchment

Principal Component Analysis
Biplot (axes F1 et F2 : 79.76 %)



RESULTS:

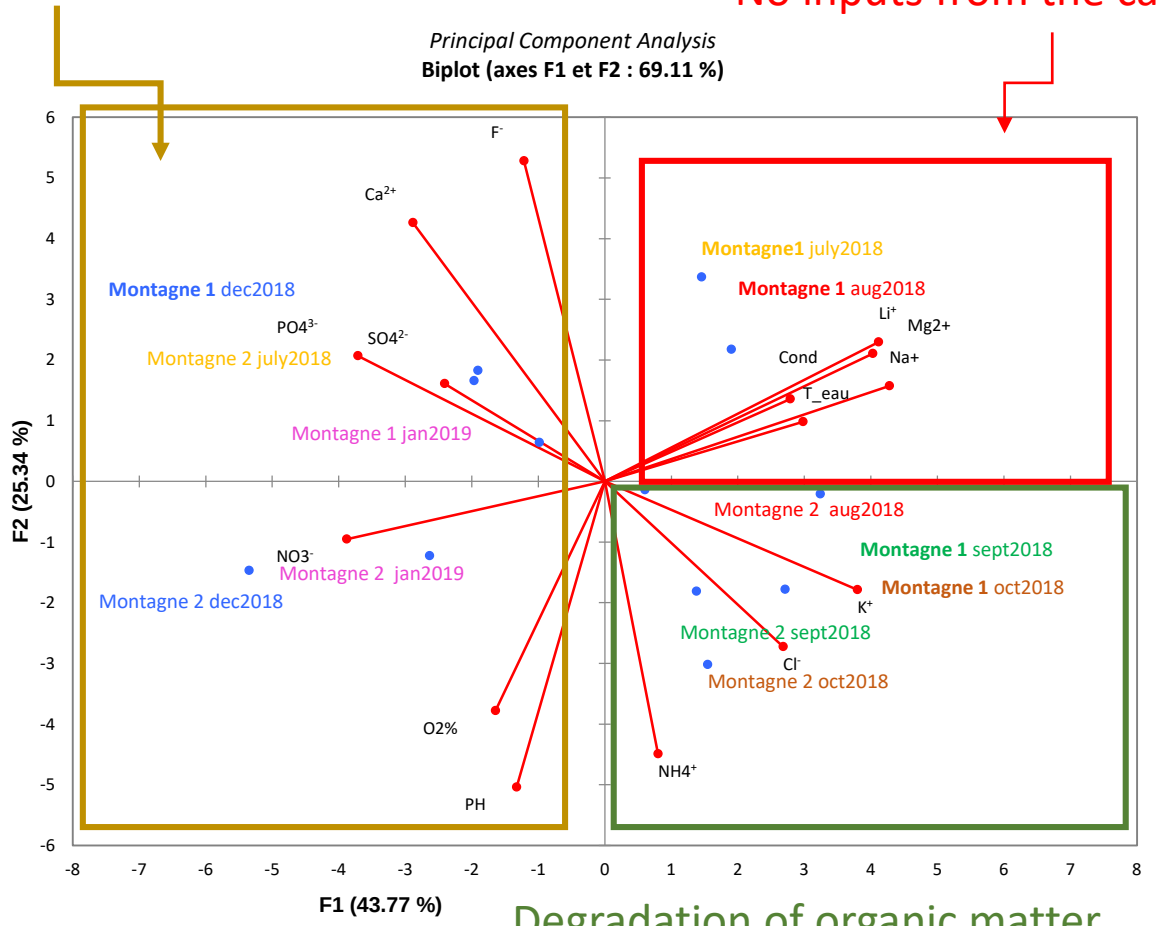
La Montagne spring: Physical and chemical variables

Inputs of nutrients from the catchment

No inputs from the catchment

- Presence of Fluoride due to Fluorite in sub-soil

- Difference between the month:
  - July & August (Mont 1)
  - September & October (Mont 1+2)
  - December & January + July (Mont 2: changes occurring in the building or the pipe?)



Degradation of organic matter in the former building → increase NH_4^+ concentration

RESULTS:

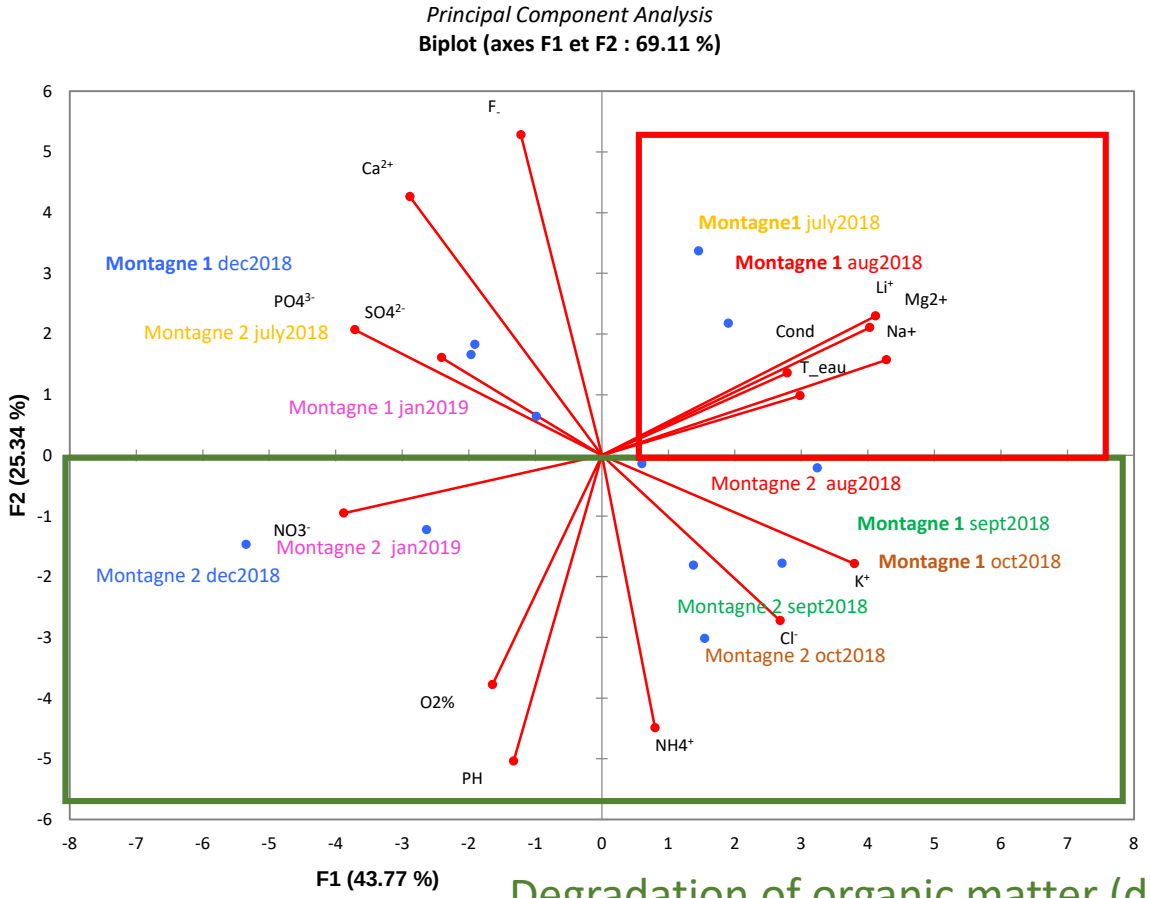
La Montagne spring: Physical and chemical variables

Globally, there is more nutrients (NH4, NO3) at Montagne 2 due to:

- Degradation of organic matter in the former building / pipe
- Inputs from the catchment

<u>High level of **radioactivity** both in the water and in the sediments</u>:

- 800 nSv/h of ambient gamma radiation in May 2018 and January 2019;
- around 4500 Bq of radon per litter of water



Degradation of organic matter (death animals, leaves) in the former building → increase NH_4^+ concentration

RESULTS:

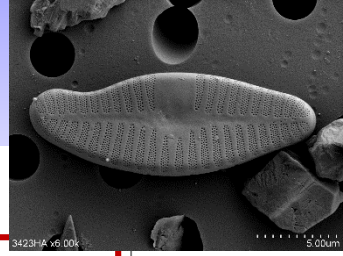
Plesna spring: Physical and chemical variables

ID	date	Li	Na	NH4	K	Mg2	Ca	F	Cl	NO3	PO43	SO42	HCO3	Cond	pH	O2 %	Water T°C
plesna1	13/11/2018	0.006	10.77	0.08	4.47	3.17	17.83	0.13	4.77	0.98	0.07	70.99	10	191	5.49	69.1	8.2
plesna2_pond	13/11/2018	0.005	9.84	0.08	4.15	3.18	17.66	0.11	5.04	0.74	0.06	67.60	7	191	5.29	55.7	8.3
montagne1	04/12/2018	0.794	149.86	0.90	16.77	18.46	209.77	1.96	4.86	1.55	0.06	16.16	1030	1849	5.89	0.1	11.6
montagne2	04/12/2018	0.721	137.57	0.82	15.67	17.21	204.31	1.83	4.60	2.85	0.09	15.58	938	1628	6.88	44.9	10.6

Plesna: not mineral spring (no influence of the sub-soil – no deep origin → low Lithium concentration and low conductivity)

Radon: 7250 ± 13 Bq/l

RESULTS:



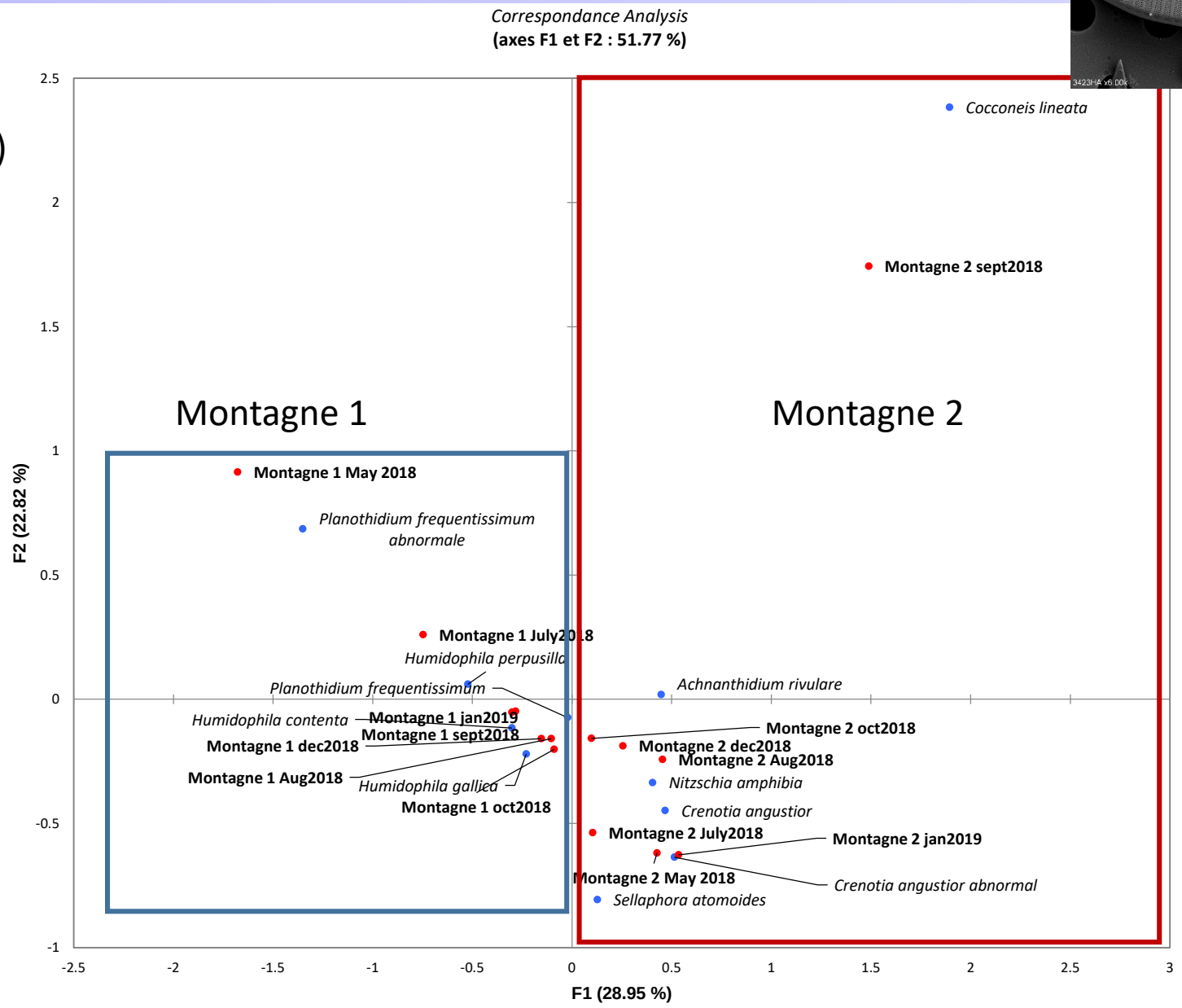
La Montagne spring: Diatom communities

Dominant taxa (relative abundance >1%)

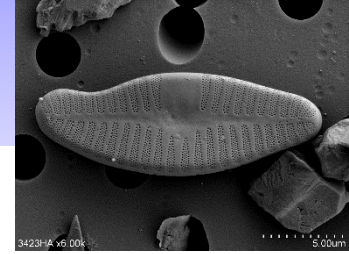
In the ruined building:
- *Planothidium frequentissimum*
- Different *Humidophila* already observed in « cavern »

In the running site:
- *Crenotia angustior*
- *Cocconeis lineata*
- *Nitzschia amphibia*
- *Sellaphora atomoides*

Species associated with the presence of nutrients

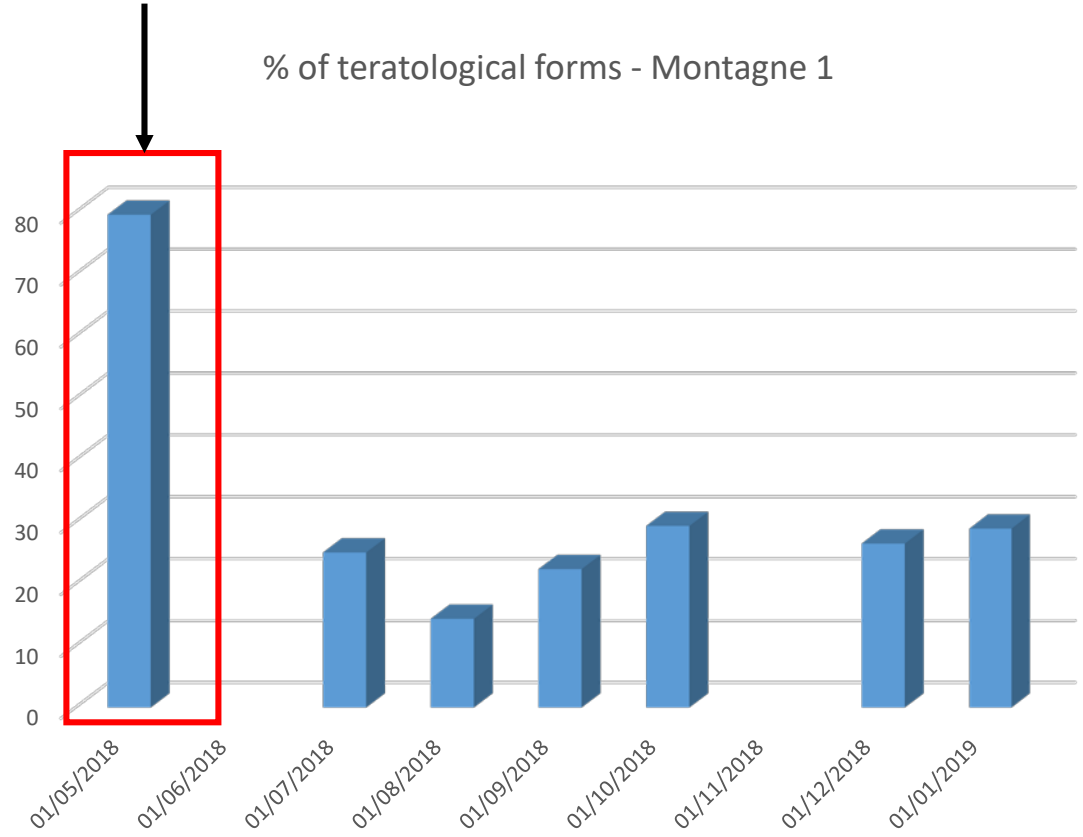


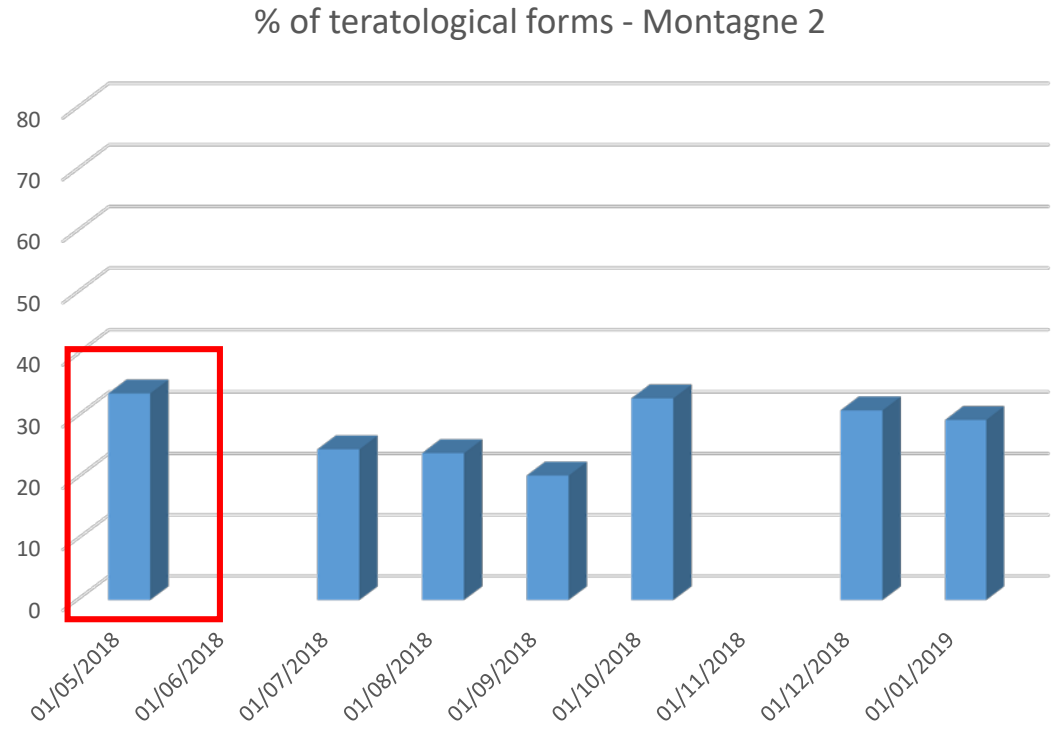
RESULTS:



La Montagne spring: Diatom communities

Presence of nitrates at this time

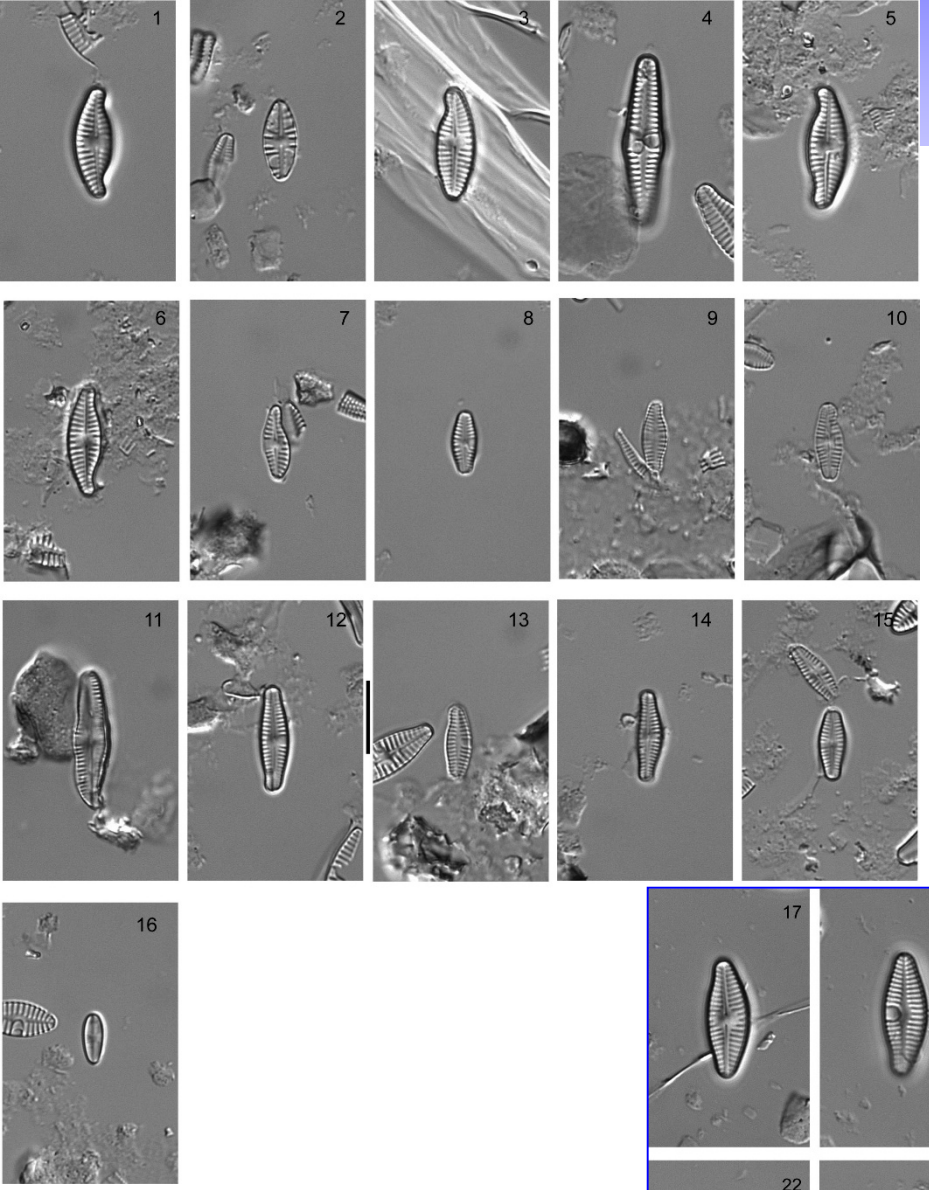




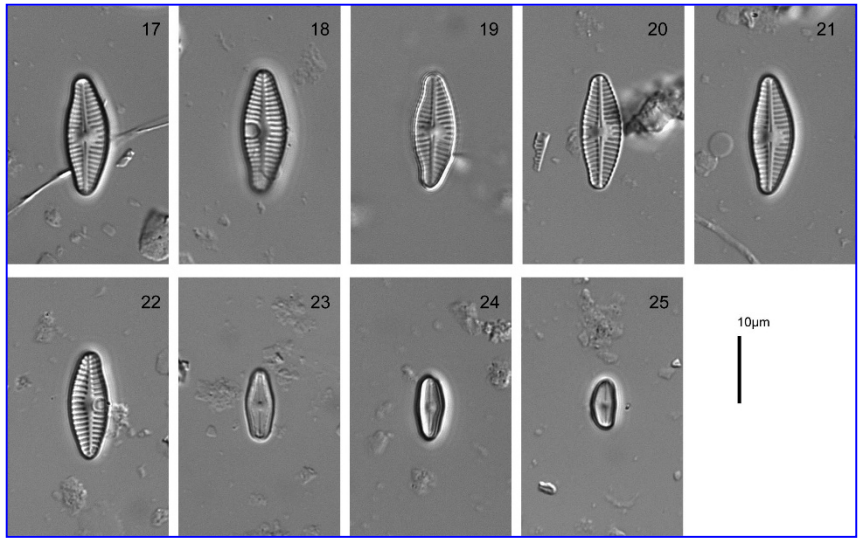
RESULTS:

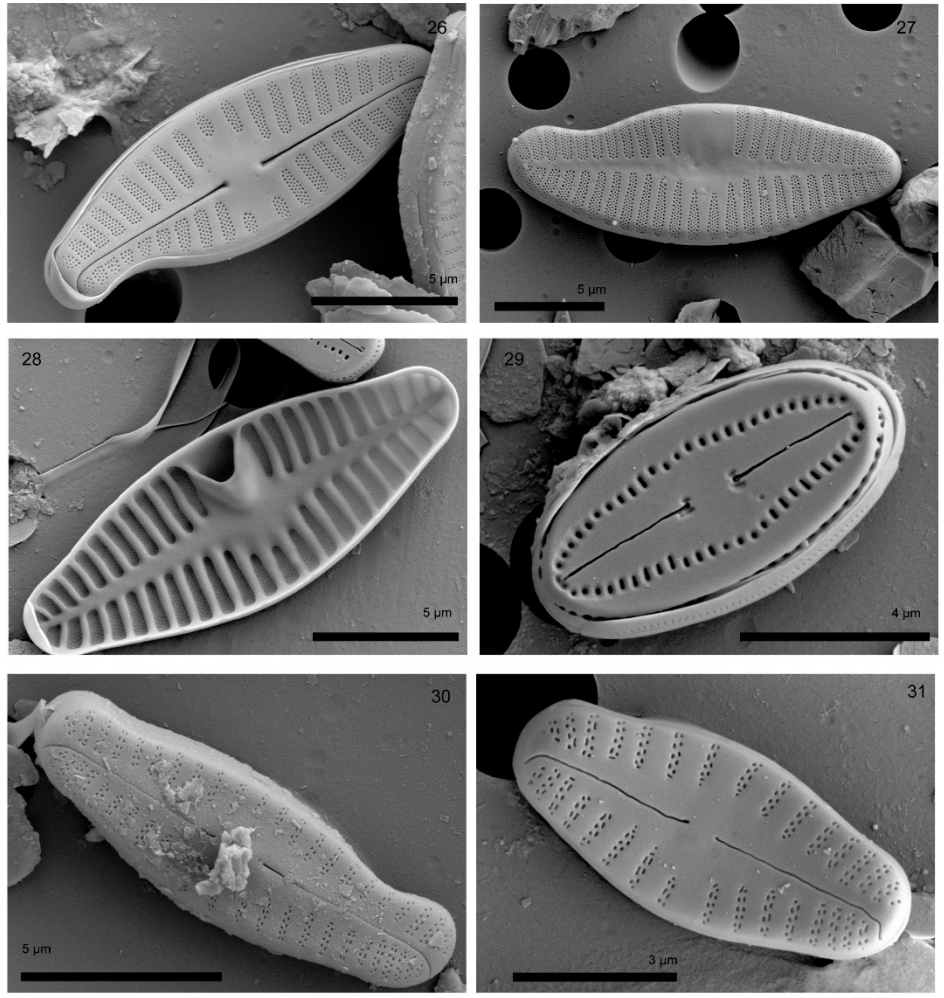
La Montagne spring: Diatom communities

- Deformed valve outlines
- Deformed ornamentation patterns



Montagne 1





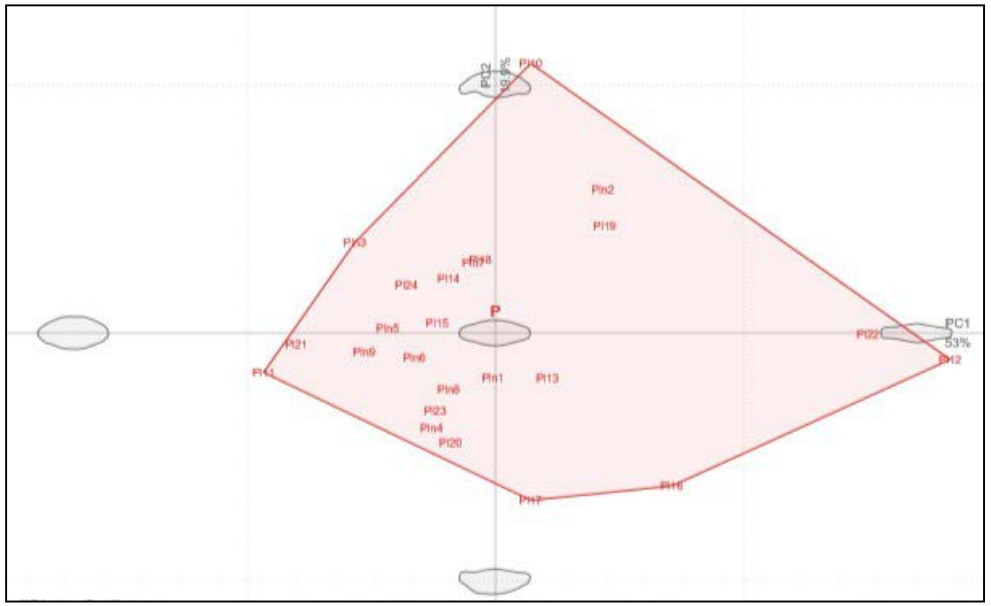
RESULTS:

La Montagne spring: Diatom communities

Using DiaCurv and R on the *Planothidum frequentissimum*

- July 2018

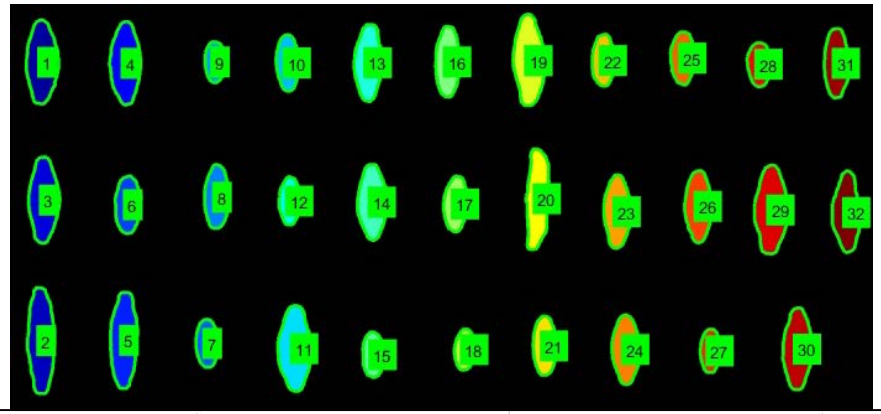
Deformed valve outlines

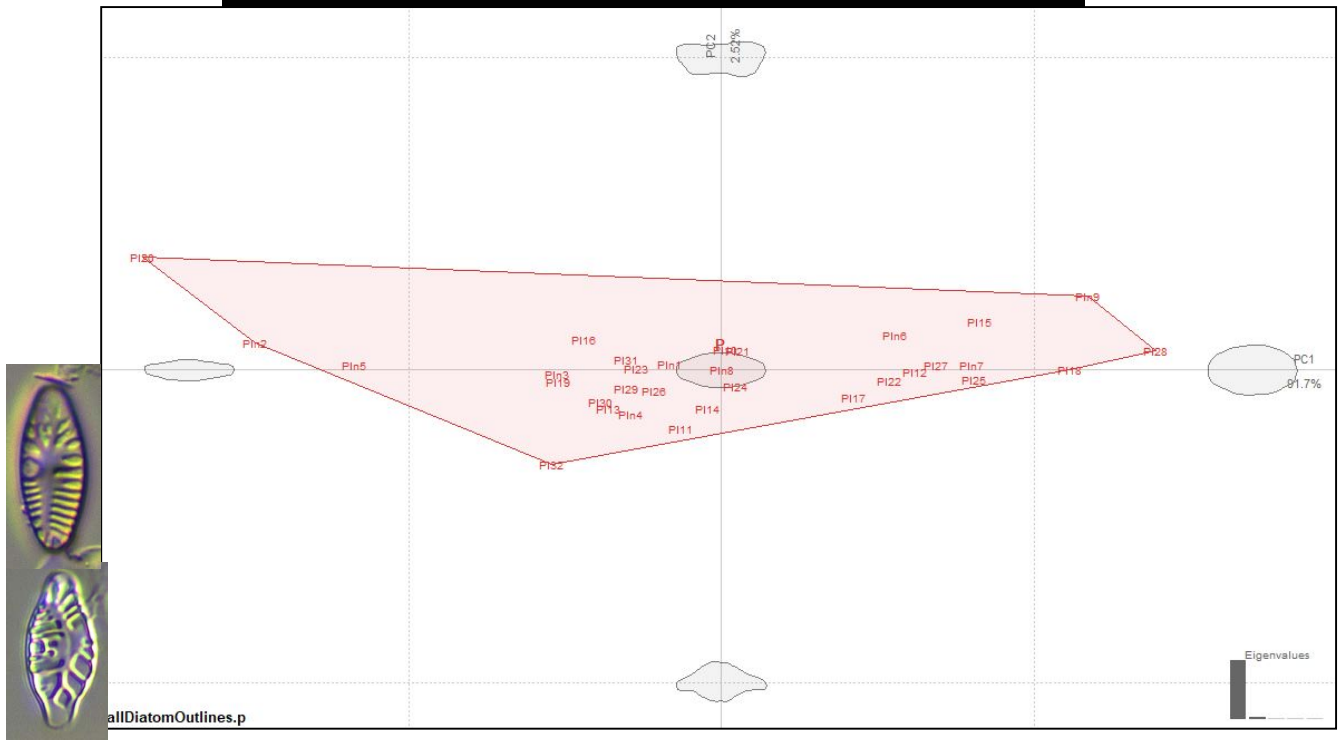


Abnormalities on deformed ornamentation patterns and on modifications of the raphe are not taken into account.

Fanny Millan – Master 2

- September 2018



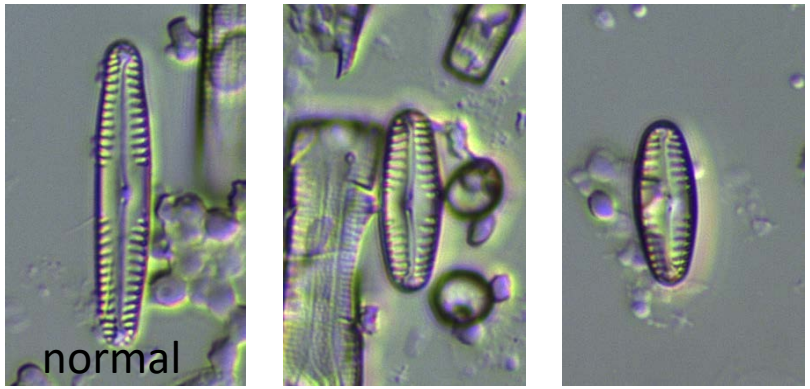


RESULTS:

Plesna 1 spring: Diatom communities

Deformed valve outlines
Deformed ornamentation patterns

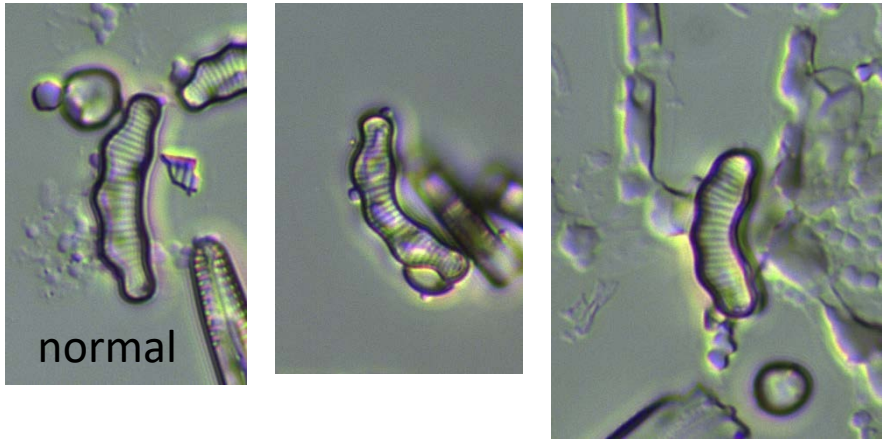
Pinnularia perirrorata



L/w accepted =
between 5 and 9.5

Here, L/w around 3 for some individuals

Eunotia paratridentula

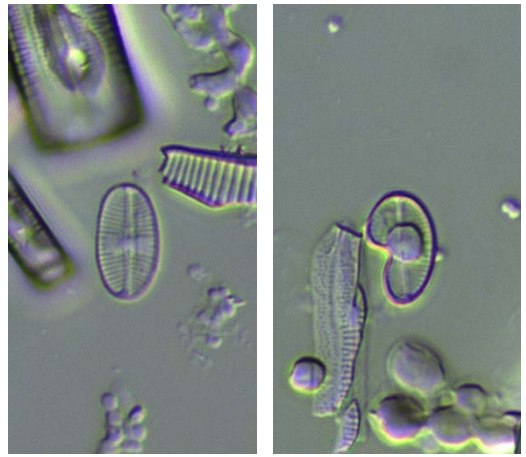


For some individuals the number of striae is > 20 .
number of striae accepted : 14-18 striae/10µm

Eunotia minor 75%

31% of teratological forms

Psammothidium grischunum



RESULTS:

Plesna 2 spring: Diatom communities

Deformed valve outlines

Eunotia nymanniana

This species is the dominant taxa. Species presenting deformed valve outlines (around 25%).

Eunotia paratridentula

For some individuals the number of striae is > 20 and some other < 14.
number of striae accepted : 14-18 striae/10µm

CONCLUSION:

- It seems that the natural radioactivity induced a restrictive environment on diatoms.
- **Montagne spring:** in May, the inputs from the catchment induced higher nutrients concentrations and could explained the highest percentage of teratological forms.
- However, the percentage of abnormalities seems to be around 25% during dry period.
- No important change of diatom communities
- **Plesna spring:** low mineralisation and presence of teratological forms also.

- Identifying the determinants of biodiversity and their respective weight on diatoms (physical-chemical variables vs radioactivity).
- Effect of these determinants on the presence of teratological forms.


THANK YOU FOR YOUR
ATTENTION
http://sources-diatomees.univ-bpclermont.fr/?p=383