Effects of metal mining effluents from abandoned mines on freshwater ecosystems. Frongoch mine as a case study.

Lidia Vendrell-Puigmitja[1], Meritxell Abril[1], Lorenzo Proia[1], Joan Gomà[2], Laia Llenas[1]

[1] BETA Technological Center. TECNIO Network, University of Vic-Central University of Catalonia, C.de la Laura 13, 08500, Vic, Spain.
[2] Faculty of Biology, Universitat de Barcelona, Av. Diagonal 643, 08028 Barcelona, Spain.

E-mail contact: lidia.vendrell@uvic.cat

OBJECTIVE OF THE STUDY

To assess the ecological status of watercourses downstream of Frongoch abandoned mine (Wales, UK), using aquatic biofilms as indicator.

STUDY SITE: FRONGOCH ABANDONED MINE

- Exploitation of lead and zinc from the late 1700s until the early 1900s, when it fell into disuse.
- It is a major source of metals pollution, causing a chemical and ecological impact on downstream watercourses that fails the WFD standards.

METHODOLOGY

Seven sampling sites on watercourses downstream Frongoch mine were assessed:
SITE 0: not affected, before the entrance of the mining effluent
SITE 1: mining effluent that reaches the main water course
SITE 2 to SITE 6: watercourses after the entrance of the mining effluent.
Nant Cell: not affected, reference stream.

Samples for water chemistry (nutrients and metals), biofilm structure (community composition and diatoms) and functioning (photosynthetic efficiency) were taken. Results were evaluated using one-way ANOVA and statistical significance was set at $p < 0.05$.

Fig. 1: Study area with selected sampling sites (denotated with tacks) in the Frongoch stream.

RESULTS

WATER CHEMISTRY

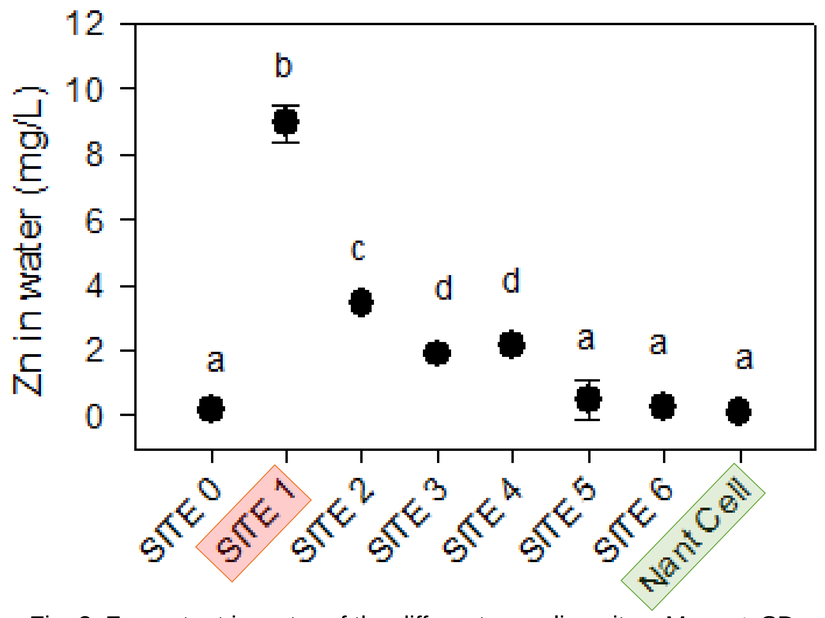

Fig. 2: Zn content in water of the different sampling sites. Mean ± SD (n=3).

Tab.1: Physico-chemical characteristics measured in the Frongoch stream (n = 3) (mean ± SD).

	pH	T (°C)	Conductivity (µS/cm)	Oxygen (%)
SITE 1	5.06	12.10	427.00	39.10
SITE 2	6.35	15.30	129.00	97.10
SITE 3	6.98	14.50	107.30	96.20
SITE 4	6.91	14.90	89.30	102.30
SITE 5	7.24	14.40	87.70	99.60
SITE 6	7.36	13.25	86.00	98.00
Nant Cell	7.66	14.30	97.20	95.60

Zn concentrations were significantly higher at SITE 1 and also in the following sites (2, 3 ,4), compared to the not affected sampling points. The pH and oxygen were much lower and the conductivity higher at SITE1 compared to the other sites.

DIATOM COMMUNITY STRUCTURE

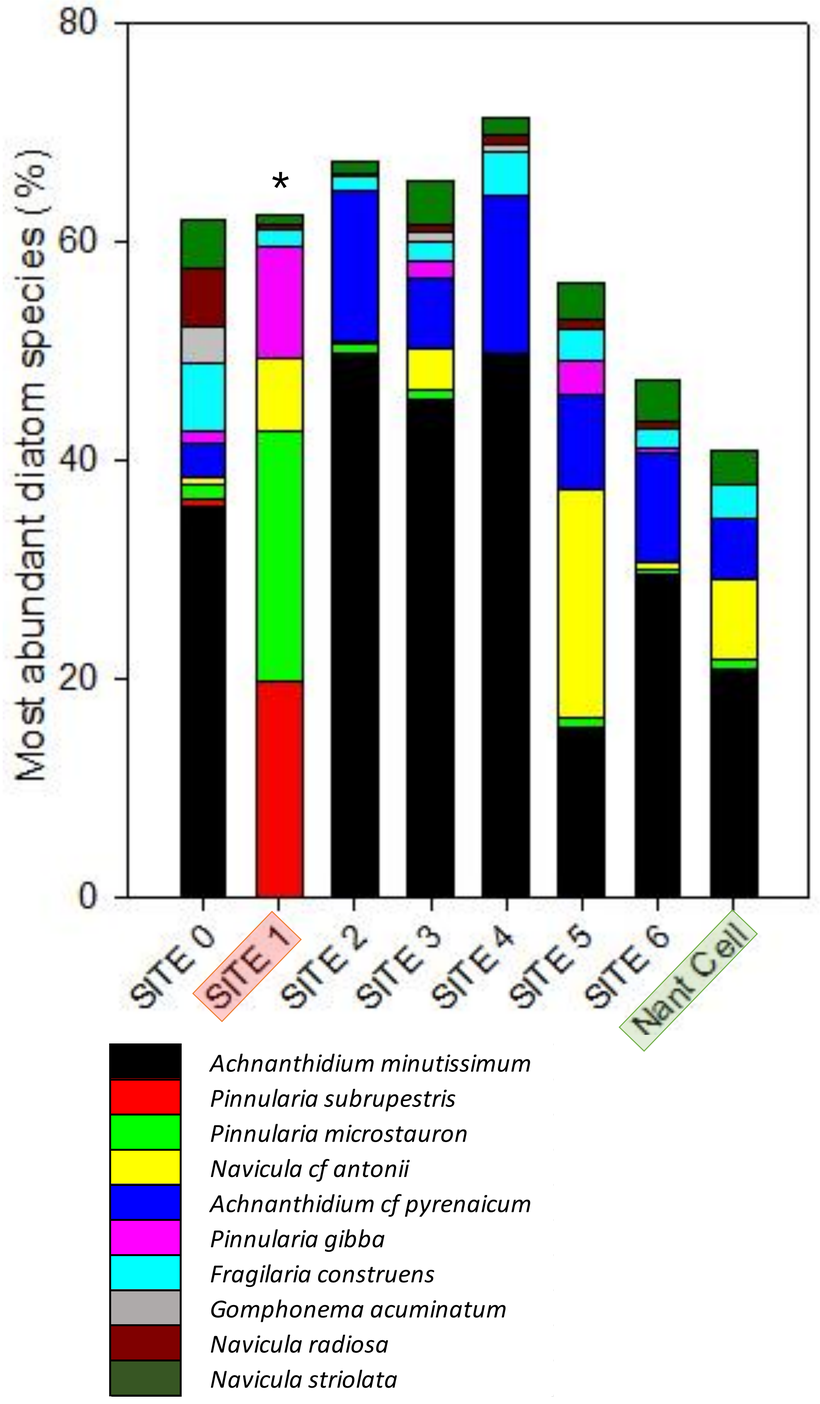

Fig. 3: Relative abundance (mean value, n=3) of the 10 major diatom species (>3%) within diatom communities collected at each sampling site.

Diatom taxa composition of diatom community composition differed between sampling sites. The number of species identified at the not pollutes sites were 35 (SITE 0) and 37 (Nant Cell), while at SITE 1 the number of taxa identified were 17.

PHOTOSYNTHETIC COMMUNITY COMPOSITION AND FUNCTION

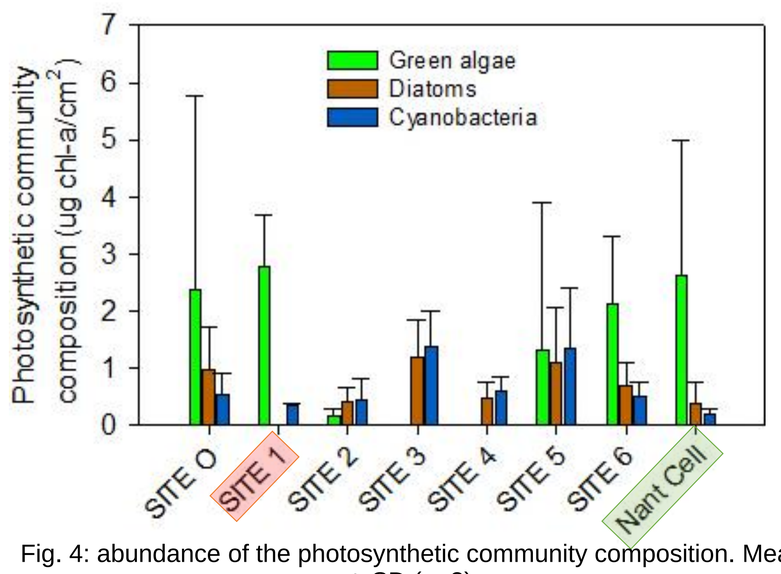

Fig. 4: abundance of the photosynthetic community composition. Mean ± SD (n=3).

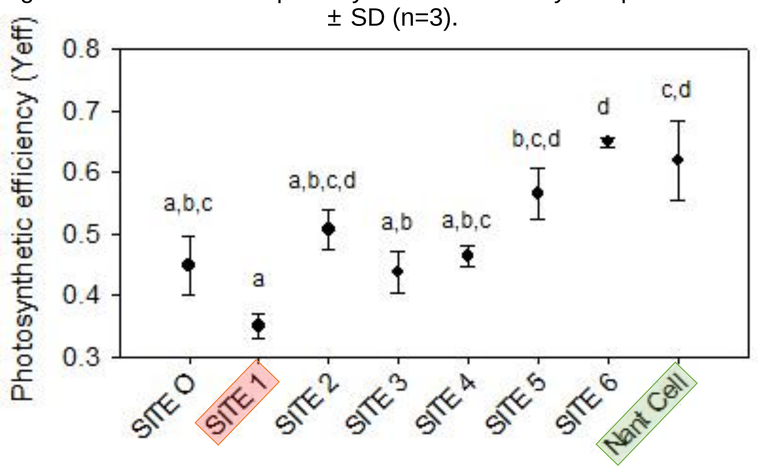

Fig. 5: Photosynthetic efficiency (Yeff). Mean ± SD (n=3).

A shift on the community composition were appreciated from SITE 1 to SITE 4.
The photosynthetic efficiency (Yeff) decreased significantly from SITE 0 to SITE 1

CONCLUSIONS

- The mining effluent severely affects the biofilm communities with potential consequences at ecosystem level;
- The downstream sampling points are affected by the metal content in water, decreasing the diatom species richness and changing the stream chemistry, photosynthetic community composition and function;
- Along the river, with the dilution factor, the river is able to recover its ecological quality.

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