RIVEAL PROJECT

RIPARIAN FOREST VALUES AND ECOSYSTEM SERVICES – DIATOMS

DIATOMS ARE…

… eukaryotic, microscopic, unicellular or colonial organisms, belonging to the Bacillariophyceae. They are mainly photosynthetic, with golden-brown chloroplasts (Fig. 1). These microalgae colonize all types of aquatic habitats, from freshwaters to marine environments. They are grouped according to the morphological patterns of their silica cell walls (frustules): centrics and pennates. Pennates include araphids, monoraphids, symmetric biraphids, eunotioid, naviculoid asymmetric biraphids, (e.g. cymbelloid, gomphonemoid), symmetric canal raphe biraphids (e.g. nitzschioid) and assymetric canal raphe biraphids (e.g. epithemioid, and some some surirelloid (Fig. 2).

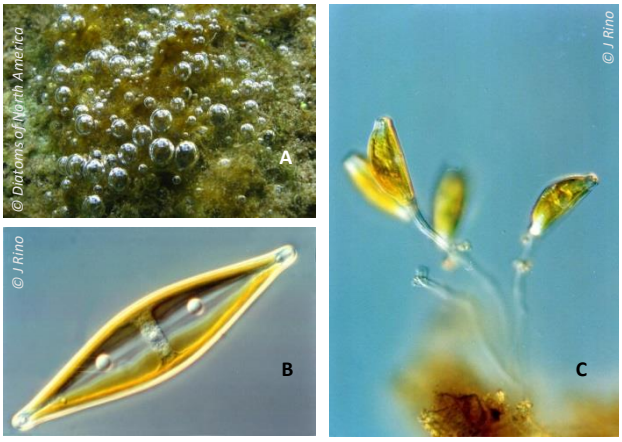

Fig. 1. A) Oxygen release from biofilm. Source: Diatoms of North America website. B) Craticula cuspidata and C) Cymbella sp.

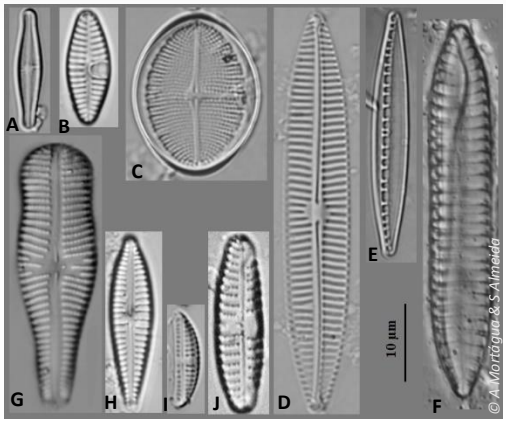

Fig. 2. A) Achnanthidium minutissimum, B) Planothidium frequentissimum, C) Cocconeis pediculus, D) Navicula tripunctata, E) Nitzschia dissipata, F) Surirella angusta, G) Gomphonema truncatum, H) Gomphonema parvulum, I) Amphora pediculus e J) Reimeria uniseriata.

WHAT ARE THEIR FUNCTIONS?

Through photosynthesis, diatoms use their light-absorbing molecules (chlorophylls a and c and fucoxanthin) to collect energy from the sun and release a great amount of oxygen to the atmosphere. They are also responsible for 20 to 25% of all organic carbon fixation on the planet representing an important food resource for marine and freshwater organisms. Diatoms produce long-chain fatty acids, supplying the entire food web with these energy rich molecules, from zooplankton to aquatic insects to fish and whales.

DIATOMS AS BIOINDICATORS

Diatoms are considered good water quality indicators due to the easy sampling, handling and preservation of the frustules, their ubiquity, vast diversity and sensitivity to several stress factors, which is a consequence of their short generation time (fast response to environmental changes). Those environmental changes can be eutrophication, acidification, light intensity, pH, hydrological alterations (such as flow velocity), presence of metals, among others.

Due to these features, several biological diatom indices have been improved over the years and used to assess water quality (Fig. 3).

The European Water Framework Directive established diatoms as one of the 'Biological Quality Elements' for the ecological evaluation of waterbodies and Portugal adopted the IPS (*Indice de Polluosensibilité Spécifique*) as the national diatom index.

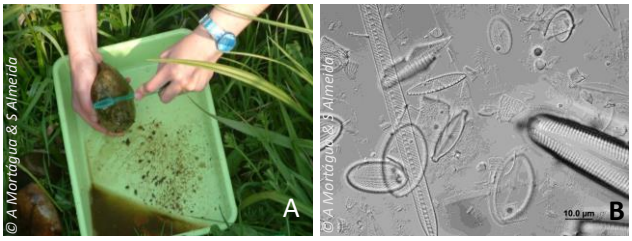

Fig. 3. A) Scraping of hard substrate for biofilm sampling (diatoms); B) Diatom frustules observed with DIC microscopy (scale = 10 µm).

DIATOMS AND CONTAMINATION

Diatoms adapt and modify towards new environmental conditions by changing their morphological appearence (teratologies) and reproductive cycle, as well as producing high lipidic content and other physiological alterations. Some studies show that the presence of metals or acid conditions in waters are important causes of valve deformations.

Pollution by organic components, on the other hand, has an impact mostly on the community structure. One can verify a shift in the abundance of certain species when nutrients such as nitrates and phosphates in high quantities are present in the water. Tolerant species (e.g. *Eolimna minina, Nitzschia palea, Gomphonema saprophilum*) are more abundant when those conditions are present.

DIATOMS IN RIVEAL

In RIVEAL two case studies were selected (Fig. 4), i.e. two rivers impaired by dams with different operation rules: a run-of-river dam (Touvedo) and a reservoir dam (Fronhas). We found **155** different species of diatoms across all sampling sites. From those results, we found:

- **10** to **40** taxa per sample, with an average of about **23**

- ***Achnanthidium minutissimum*** was the most abundant species, with and average relative abundance of **38%** for all samples

- Other frequent taxa were *Achnanthidium rivulare, Aulacoseira granulata* and *Cocconeis lineata*

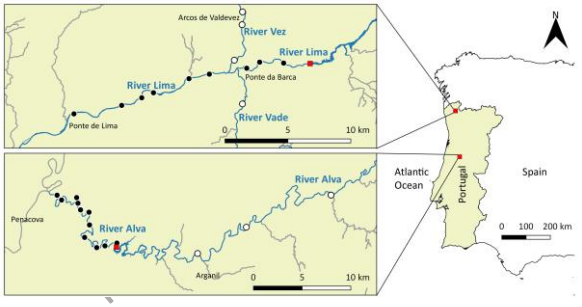

Fig. 4. Sampling sites of the RIVEAL project in Lima and Alva Rivers (black dots are on regulated reaches and white dots are on free-flowing streams) (from Lozanovska et al., 2020; doi:10.1016/j.scitotenv.2020.141616).

TRAITS

Regulation of the case study rivers showed impact on diatom communities and traits. Decreases in regulation leads to communities with species presenting lower biovolume, showing also higher abundance of *pioneer* and low profile taxa. Lesser river regulation determines equal proportion of colonial (more of those forming ribbon colonies) and non-colonial taxa.
The randomization tests confirm significant relationships between environmental variables and traits for diatoms.

ANALYSES

Statistical tests reveal that species distribution along the sampling sites is influenced by the environment.
Diatom analyses present a positive relationship between traits and regulation, habitat and geomorphologic variables. Increased regulation (discharges) is related with decreased thickness of valves, as well as higher abundance of elliptic cylinder shape and filamentous colonies.

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