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Sediment diatoms of Lake Garda, the largest Italian lake

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Lake Garda is the largest Italian lake. The deep basin (350 m) is relatively little impacted by human activities and is suitable for reconstructions of long term environmental variability, including climate change and its effect on lake ecology. In contrast, the shallow basin (81 m) is strongly affected by human activities and for this reason is more suitable for studies on lake eutrophication.

Lake Garda is one of the four large Central European lakes included in the EuLakes Project (Reg. Nr. 2CEZ43P3), launched in April 2010 within the Central European Initiative. The main project aims are to evaluate the lake vulnerability against specific human stressors (e.g. nutrients, hydroelectrical exploitation) in a climate change scenario, and to promote sustainable lake management. Sediment studies will be used to determine the lake reference conditions before stronger human impact during the 20th century.

The long term evolution of Lake Garda will be investigated in greater detail within a PhD program partially funded by the EuLakes project, which will focus on ecological reconstruction based on sedimentary diatom and cladocera remains. Information will be integrated by X-ray fluorescence (XRF) analyses for trace metal concentrations and Fourier transform infrared spectroscopy (FTIRS) for sediment bio-geochemistry. The reconstruction will be validated by combining palaeolimnological results with monitoring data collected during the last two decades.

This contribution presents results of the analyses carried out on one short sediment core (56 cm) collected from the deepest point of Lake Garda (Brenzone) in autumn 2009. The focus is posed on changes in sub-recent diatom assemblages since the early XX century, and in particular on the increase in planktonic Fragilariaceae and concomitant decrease in centric taxa, which has been observed since the documented nutrient enrichment in Lake Garda (i.e. since the early 1970ies).

[Talk]

Sexual Reproduction and Speciation

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Sexual reproduction has been known in diatoms since 1847, when Thwaites described conjugation in the raphid genera *Epithemia*, *Cymbella* and *Gomphonema*. Although most diatoms are probably sexual, details of the process are known in less than half of diatom genera and in only a tiny minority of species. Until recently, most reports were provided by a handful of researchers (especially Pfitzer, Karsten, Geitler, von Stosch) and there was a mystique about diatom sexuality, probably as a result of (1) a lack of studies of clonal cultures, (2) the much greater length of the vegetative phase than the sexual phase, and (3) the unrecognized prevalence of heterothally in pennates. It took a century to establish that sexual reproduction is oogamous in centric diatoms (by von Stosch in 1950) and there is still a critical gap in our knowledge with respect to araphid pennate lineages. Recent independent work by Sato et al. and Davidovich et al. on the heterothallic pennates *Pseudostaurosira* and *Tabularia* has revealed a novel type of sexual reproduction, involving male cells with a hitherto unknown type of motility. They are not like the flagellate sperm of centrics, nor like the locally contractile, amoeboid, or swelling gametes of raphid diatoms, and it is unclear whether they represent an intermediate stage in the evolution of the isogametes of other pennate diatoms, or a curious side-shoot. In *Pseudostaurosira*, sexualization is controlled via two pheromones, one produced constitutively by female clones (once they are small-celled) and the other by male clones stimulated by the female pheromone. The effect is that, as in centric diatoms, clones can be sexualized without cell-cell contact between the gametangia, offering new possibilities for studying the genetic basis of sexuality.

As well as being interesting in relation to diatom phylogeny, understanding sexual reproduction and gene flow is a prerequisite for understanding how diatoms speciate, i.e. how one interconnected set of populations splits into two independently evolving sets of populations. This was already a 'big' question 30 years ago, when the total number of diatom species seemed to be $\sim 10^4$, but experimental crosses and population genetic studies (in e.g. *Pseudonitzschia*, *Ditylum* and *Sellaphora*) suggest a much higher number of species. Furthermore, it seems remarkably easy to discover new species by morphology, including many apparent endemics. Thus, the gene pools of diatoms are much more fragmentary than was previously thought. How all this diversity has arisen is a puzzle: very similar, closely related species often occur together in the same lake or beach and it is hard to imagine their origin through divergent selection in sympatry. On the other hand, conventional models of allopatric speciation seem inadequate because diatoms appear to disperse rapidly over moderate geographical distances, though no-one knows how. To throw light on diatom speciation, new research programmes and methods are needed to examine the medium- and long-term dynamics and turnover of genes, populations, species and communities in selected well-characterized and well-circumscribed ecosystems.

[Talk]