



## Radiolaria – Siliceous plankton through time

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### Preface

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Radiolaria are a very diverse marine siliceous microplankton group that have existed at least since the Cambrian to the Recent. Fossil Radiolaria were known since the middle of the 19th Century and studied by many scientists at the turn of the 19th/20th Century, in part as a consequence of the discoveries made in samples collected by the HMS Challenger expeditions. Intense biostratigraphic radiolarian research was spurred again in the early 1970's by the Deep Sea Drilling Project. Biochronologic zonations based on samples recovered by Ocean Drilling were first proposed for the Tertiary (Riedel & Sanfilippo 1978) and the Cretaceous (Foreman 1973, 1975). However, the radiolarites, cherty oceanic sediments associated with ophiolites, had so far only been studied in thin sections. This changed when radiolarian workers discovered the use of hydrofluoric acid to extract Radiolaria from chert and other siliceous rocks (Dumitrica 1970, Pessagno & Newport 1972). The new method allowed to work on land samples from mountain ranges that had undergone burial diagenesis or even metamorphism. As a consequence, radiolarian biochronology was rapidly extended into the Jurassic, Triassic and the Palaeozoic (Pessagno 1977, Pessagno et al. 1979, Yao et al. 1980, Nakaseko & Nishimura 1979, Holdsworth & Jones 1980). A major

obstacle to the elaboration of detailed biochronozones is the discontinuous nature of the radiolarian record, due to spotty preservation. Biogenous, opaline silica is unstable in the ocean and in the diagenetic environment. Large amounts of the more delicate radiolarian tests become dissolved already during their descent in the water column and in the bottom sediments (Takahashi & Honjo 1981). During early diagenesis, opaline silica dissolves and radiolarians become preserved either as casts of the mould that leaves the dissolved test, or as replacement by quartz, pyrite or other minerals. In Palaeozoic and Mesozoic samples, usually only robust forms are preserved. However, exceptionally well preserved samples from special diagenetic environments, such as Middle Jurassic manganese carbonate nodules (Yao 1997), or euxinic environments like the Late Jurassic Solnhofen Limestone (Zügel 1997, Dumitrica & Zügel 2002) show several hundred morphotypes, a diversity that rivals with the diversity of living radiolarians. These samples teach us, that the average radiolarian assemblage extracted by harsh chemical treatments from rocks is a poor residue of dissolution resistant forms. The consequence of this unavoidable fact is the discontinuous record of radiolarian ranges, which greatly hampers biochronologic correlation. A major

step in resolving this problem has been the use of the Unitary Associations method (Guex 1977, 1991). Already in early attempts for a Jurassic-Cretaceous radiolarian zonation (Baumgartner et al. 1980), we realised that this method allows integration of the data on mutual co-occurrence of all considered taxa from all studied sections, thus overcoming local gaps of preservation. Unitary Associations represent maximal sets of co-occurring taxa that are put in a stratigraphic sequence by their identification in all studied sections. Starting in 1984 (Baumgartner 1984a,b) computer programs (Guex and Davaud 1982) allowed the calculation of Unitary Associations from large data sets. The largest data set so far treated was the MRD database on Middle Jurassic to Early Cretaceous radiolarians (Baumgartner et al. 1995). A radiolarian biozonation including 22 Unitary Association Zones for the Middle Jurassic to Early Cretaceous interval was calculated with the Biograph software (Savary & Guex 1991). Today the majority of Mesozoic radiolarian biozonations are based on Unitary Associations. An excellent example is presented in this volume (Beccaro, this volume). A new software, UA-Graph (Hammer et al. 2001) has been developed.

Dating pelagic sediments by radiolarian biochronology has totally changed our understanding of the geology of Tethyan and Circumpacific mountain ranges. Suture zones and ophiolites, interpreted in the frame of plate tectonics as remnants of ancient oceans, needed to be dated. A vast campaign of sampling and dating radiolarites started in the 1980's and is still going on.

Today, Radiolaria are an important microfossil group used worldwide to date mostly basinal sediments of the entire Phanerozoic.

The spectacular diversity of Radiolaria has spurred biogeographic and palaeo-oceanographic studies based on radiolarian assemblages from Cenozoic (Hollis, this volume, Moore 1978) to recent samples (Yamashita et al. 2002) from all oceans. In the modern ocean about 400 known species occupy almost all ecologic niches from shallow water to the deep ocean. Many species are endemic to certain water masses and can therefore be used as oceanographic tracers (Casey 1971a,b). The distribution of Late Tertiary to Holocene Radiolaria in piston cores from the world's oceans have been widely used to trace paleo-oceanographic features, such as the upwelling zones (Caulet et al. 1992), the growth and vane of polar water masses through the Ice Ages (Romine and Moore 1981, Vénec-Peyré et al. 1997) as well as the major current systems, such as the Humbolt Current (Molina-Cruz 1977).

This volume gives a representative view of research topics discussed at the 10th International Meeting of Radiolarian Palaeontologists, held at the University of Lausanne in 2003. A large effort is currently made to refine and better understand Palaeozoic and early Mesozoic radiolarian biochronology (Feng et al. this volume, Marquez et al. this volume, Wonganan & Caridroit this volume). Cherts associated with basalts and other ophiolitic rocks are often the only remnants of Palaeozoic and Mesozoic ocean basins. Their reconstruction is

essentially based on biochronologic ages and palaeobiogeographic affinities of Radiolaria. Much work has dealt with radiolarian faunal changes related to major geologic boundaries in the Palaeozoic (Wang & Luo this volume), at the Permian-Triassic boundary (DeWever et al. this volume), and in the Cenozoic (Hollis, this volume). Mesozoic radiolarian biochronology continues to be improved and better calibrated (Danelian this volume, Beccaro this volume, Bandini et al. this volume).

For a number of years, the radiolarian community is concerned with the development of databases. With the rapid development of computer technologies, databases have become more and more sophisticated and for the last few years only, have become available online. There has been a common agreement among radiolarian specialists, that *Radiolaria.org* is the portal that provides links to most radiolarian databases and hosts a wealth of information on Radiolaria and radiolarian workers (Dolven, this volume).

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