

TMS Newsletter August 2004

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Radiolarians in the Sedimentary Record

De Wever, P., Dumitrica, P., Caulet, J.P., Nigrini, C. & Caridroit, M. 2002
Gordon & Breach Science Publishers in association with Société géologique de France
ISBN 90-5699-336-4

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For some time now there has been a need for a detailed text book on fossil radiolarians and De Wever et al. have produced a remarkably practical tome which will be of much use to those wanting an introduction to this group, as well as for seasoned researchers/biostratigraphers. The only previous modern publication was by Anderson (1983), who concentrated mainly on the biology of living radiolarians. This new volume is in the same league as Haynes' (1981) book on Foraminifera, or Bown's (1998) text on nannofossils.

Chapter 1 deals with the physiology and distribution of living radiolarians, and covers the same ground as Anderson (op. cit.), but updates it with more recent work carried out in the last 20 years on the physiology and skeletal growth patterns of the radiolarians. It is obvious that there is still much to be done on the actual distribution of modern taxa; even their method of reproduction is still under debate. Detailed coverage of skeletal growth is included here as it underpins the new hierarchical taxonomy developed within this volume.

Chapter 2 takes the radiolarian test from life as part of the plankton to death as a sedimentary particle and in doing so discusses vertical and geographical distribution, seasonality and productivity. Of importance for palaeoecologists is the radiolarian's susceptibility to dissolution and the result this may have on the final fossil assemblages.

The estimate is that less than 10% of siliceous material is deposited as sediment, and that spumellarian taxa are more abundant in sediments than in the water column, a ratio that is reversed for nassellarians. Diversity and geographical/vertical distribution has really only been studied over the last 20 years with the introduction of sediment traps, however there are some good examples included of the biogeography of bottom sediments. Overall, these studies are still patchy and the authors have not considered that there is an intrinsic problem in distinguishing between live and dead assemblages, as all organic matter is destroyed with the use of acids for preparing the material. This means that the Rose Bengal protoplasmic test cannot be used to differentiate between assemblages as in modern foraminiferal studies. Until there is a way of actually quantifying this ratio, the overriding assumption is still being made that the fossil record reflects the living distribution, even though there is likely to be a significant difference brought on by dissolution. However, temperature estimates and fertility studies will still prove to be of use for palaeoecologists/oceanographers.

Chapter 3 takes the next step from sediments to rocks via the various diagenetic processes (epigeny) and covers the more pervasive Palaeozoic and Mesozoic radiolarian rich rocks and cherts of the Tethyan regions of Europe, America and Japan. Radiolarite formation models are presented and discussed in detail, as well as sedimentation rates (slow) and conditions of deposition (shallow to deep). Of note is a short section on radiolarians as organic providers for hydrocarbon rich deposits.

Chapter 4, at over 200 pages, represents the most important part of this book covering the taxonomy and the advancement of a new, more integrated, natural hierarchical classification system. The authors, and in particular Dumitrica, the main instigator, have to be commended on their bold attempt to bring together several disparate taxonomic systems in use today. The status quo has been Haeckel's (1881; 1887) classification system which has held sway for over 100 years, and is still in use. However, it has long been recognised as being flawed with a division based solely on strict geometry which does not reflect the polyphyletic evolution of this group. To compound matters, there has been a polarisation of taxonomic approaches over the last 40 years between Mesozoic and Tertiary workers. This has arisen mainly due to preservational factors; Mesozoic forms have often been diagenetically altered, with internal features obscured, so reliance has been upon SEM and external features, hence

the erection of many species on minor morphological features. Tertiary workers have almost exclusively relied on the light microscope and therefore rely on distinguishing internal features such as the initial spicule and its relationship with subsequent features.

The present authors have tried to unify all existing systems, but problems still remain, for example the internal morphology of many Palaeozoic and Mesozoic types has not been preserved or observed and the jury is still out on the exact importance of the taxonomic features selected. To combat this, a combination of 2 or more key morphological characters is used, with the most important related to the initial test development. I have summarised the key features used (Table 1).

Character	Order	Superfamily	Family	Subfamily	Genus	Species
initial spicule '+/-						
Spicule structure						
Relation of spicule to first shell						
Morphology of spicule						
Skeletal growth pattern						
No. shells/chambers/segments			?			
No. spines/arms			?			
Aperture/pylome '+/-			?	?		

Table 1 Key morphological features

As far as possible, families are defined on the internal skeleton and the authors admit that a large number of families are still poorly defined, but the system appears to be robust enough to absorb any modifications/redefinitions needed; only time will tell.

In a little detail, seven orders are erected (Archaeospicularia, Albaillellaria, Latentifistularia, Spumellaria, Collodaria, Entactinaria and Nassellaria). Two orders are relatively new, namely Archaeospicularia (Palaeozoic and ancestral) and Latentifistularia (Early Carboniferous-end Permian). Some confusion may arise as the latter order includes 3-rayed forms which superficially look like Mesozoic forms such as Paronaella. Another surprise comes with the order Entactinaria, which resemble spumellarians but possess an initial spicule and as a result of this redefinition many families and taxa previously included in Spumellaria have been relocated. This leaves the spumellarians somewhat emended and denuded which may cause problems for more conservative

taxonomists. Additionally, most of the remaining spumellarians have been placed into the Superfamily Actinommeacea which has been informally divided into three morphogroups.

Of the new system, 23 groups have been emended (mainly families) and 4 are new (family and subfamily) (I have produced a summary of the complete hierarchical listing, Table 2). All orders and groups down to family level are briefly defined and the families/subfamilies are well illustrated with either SEMs, or line drawings of several typical genera. All formalised genera have additionally been listed with their type species and author, but are not discussed in detail, nor are the author references included in the bibliography.

Chapters 5 and 6 provide an overview of the biostratigraphical uses of radiolarians and overall evolutionary changes through the Palaeozoic, Mesozoic and Tertiary. Chapter 5 begins with the basics of biostratigraphy and zonal definition through to a detailed description of Unitary Association (UA) techniques prevalent in radiolarian biostratigraphy. Each geological interval is presented in turn with the most detailed and up to date zonation available. The Palaeozoic is broken up into discrete intervals of interest, namely the Cambrian-Ordovician, the Silurian-Middle Devonian, the Late Devonian-Middle Carboniferous and the Late Carboniferous to the end of the Permian. The Mesozoic is covered in more detail with all UA zones discussed in terms of defining events and assemblages developed and also reflects the divisions into the Boreal and Tethyan regions for the Jurassic. The only comment I have, and it is certainly not a complaint, is that the authors have not addressed the areas which are not within their immediate experience, so the more marginal areas such as the Jurassic and Early Cretaceous of the North Sea (Dyer and Copestake, 1989), the Barents sea, Russia (Blueford and Murchey, 1993), and the Antarctic regions (Kiessling, 1999) are either scantily covered, or not at all. Whilst not important in terms of the total assemblages recovered, these more marginal areas may have significance when it comes to investigating rates of species migration and palaeoceanographic consequences.

The Tertiary is split into low and middle/high latitudinal areas with various problems such as diachrony and the problems of regional zonations against palaeomagnetic data touched upon. The tropical area is best known and this is reflected in the detail with all zones defined and described briefly. The lesser studied mid/high latitude areas warrant only a couple of pages of the more complete zonal schemes.

Chapter 6 on evolution provides an excellent overview for each era and also discusses in some detail specific radiolarian responses (at order, family and even specific level) to crises and boundary events (muted or non-existent), including the P/T, T/J, Cretaceous events (i.e. the oceanic anoxic events; OAEs), K/T and the Eocene/Oligocene.

The appendices are comprehensive and include the preparatory techniques available for processing rock and sediment types including cherts. It must be noted, however, that radiolarians can also be retrieved from many lithologies via normal paraffin/white spirit micropalaeontological processing techniques, particularly the more argillaceous, less indurated shales and claystones.

The most ambitious preparatory method is the slicing technique which has been used by Dumitrica to analyse the internal structures of individual radiolarian tests; possibly not one to attempt after a heavy night out! The glossary is also comprehensive running to 22 pages.

The bibliography is comprehensive, with the exception that the generic author citations are not included, which is a shame (but excusable due to book size/cost limitations) as many users of the book will undoubtedly want to follow up on initial identifications. The final section is a taxonomic index, which is essential for navigating around the taxonomy section.

In conclusion, this volume has been well researched, well illustrated and achieves all its stated aims and is noteworthy for introducing a novel and robust taxonomic classification. The book also includes significant summaries of Palaeozoic to Tertiary biostratigraphy and evolution.

An additional use for this book may arise as many micropalaeontology courses do not cover radiolarians due to a lack of specialists to teach and so this volume could be used by any competent micropalaeontologist to put together a very complete course. Hopefully, this volume may even tempt more people to work on this diverse group, and it will certainly prove to be an invaluable source for biostratigraphy and interpreting palaeoenvironments from the Palaeozoic to the modern day.

I would not hesitate to recommend this book to anyone who needs to utilise radiolaria in their work, as well as students who need to get a good grasp on this important group. As with all volumes partly aimed at students, the cost may prove

prohibitive, but certainly all university libraries should obtain a copy. This volume would not disgrace any professional/academic micropalaeontologist's bookshelf either.

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