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Stratigraphic ranges of Mesozoic radiolarian families

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Abstract

The recent systematic and stratigraphic revision of all described Mesozoic radiolarian genera (O'Dogherty et al., 2009a,b,c) represents the state of the art in the taxonomy of this group. Using this information, we have improved the stratigraphy of Mesozoic families by redefining their ranges at the substage precision.

Our analysis shows a clear change in faunal composition at the Permo–Triassic boundary (only 15 families cross: 2 Albaillellaria, 4 Latentifistularia, 3 Entactinaria, 2 Nassellaria and 4 Spumellarian) followed by an explosion at the Middle Triassic. Through the Late Triassic, 32 families began to go extinct, leading to a drastic disappearance of typical Triassic morphotypes. However, the Triassic–Jurassic boundary does not record a similar extinction at the family level; 37 families and subfamilies apparently crossed the boundary. Paradoxically, the revision of genera has shown the survival of only 30 genera at this boundary belonging to 23 families. The reason of such a discrepancy is the virtual crossing of 14 families at Triassic–Jurassic boundary. That is, families having representatives in both the Triassic and Jurassic, but without any record close to the boundary.

Similarly, these discontinuities in the ranges are observed throughout the Jurassic and Cretaceous, but especially at the Cretaceous–Paleogene boundary, where 21 families are crossing virtually. Among the orders, Entactinaria presents proportionally the highest number of families with discontinuous ranges. The reason could be related to the scarcity of studies on this group whose systematic classification needs a good knowledge of the initial spicule. We analyze in detail the major discontinuities observed in the range of some families. Explanations considering discontinuous fossil record, limited knowledge on phylogenetic relationships, or possible homeomorphism are proposed.

Keywords: Families; Diversity; Mesozoic; Entactinaria; Spumellaria; Nassellaria

1. Introduction

Study of biodiversity at different taxonomic levels is a topic frequently evoked by media since it was popularized in Rio de Janeiro in 1992. It has nowadays infiltrated in all spheres of science, especially palaeontology as this discipline can exemplify how, and eventually why, some crises occurred on Earth through time and how biodiversity recovered after a biotic crisis. Calcareous and organic microfossils, especially foraminifers and palynomorphs, are far more abundant and widespread in sedimentary rocks than siliceous microfossils. They were thus preferred by micropalaeontologists in the 1950s. Interest on radiolarians began only in the 1970s. Three decades later, their knowledge was such that radiolarians are recognized as useful tools for stratigraphic studies, palaeobiology, and palaeoenvironmental reconstructions. Literature was scattered so that the need became apparent at the end of the twentieth century to work out the first comprehensive synthesis including a general review at the family level (De Wever et al., 2001). The homogeneity of the taxonomic sense being achieved allows synthesizing the evolution of the biodiversity of radiolarian

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families (De Wever et al., 2003, 2006). However, some missing occurrences and shortcomings are presented in these publications since these analyses on faunal turnovers were based upon an incomplete dataset of genera. It must be remembered that not all known radiolarian genera were treated and revised in the monograph of De Wever et al. (2001), even if this is the most complete work up to now since the Treatise of Campbell (1954).

More recently a full revision of Mesozoic genera has been carried out by the Mesozoic Working Group of InterRad and the result has been produced as an atlas (O'Dogherty et al., 2009a,b,c,d). Although the primary concern of this revision was to decide upon the validity of genera, their stratigraphic ranges were also carefully examined and the current family assignments were reviewed. The new set of data being homogeneously gathered allows encompassing the evolution of the biodiversity at the generic level and in turn this provides a precise analysis of Mesozoic families that we present in this paper. Among the five orders occurring in the Mesozoic we focus our analysis and discussion on the three main represented orders: Entactinaria, Spumellaria and Nassellaria. Albaillellaria and Latentifistularia are excluded, because they include essentially six Paleozoic families (Albaillellidae, Cauletellidae, Follicucullidae, Latentifistulidae, Ormistonellidae and Pseudolitheliidae) and do not extend beyond the Early Triassic. The main objective of this paper is to present the state of the art for the stratigraphic ranges of Mesozoic families of radiolarians, but at the same time to outline what are the remaining problems at the suprageneric classification of this group of marine microfossils.

2. Making the family ranges

The dataset revised by O'Dogherty et al. (2009a,b,c,d) has considered radiolarian genera and species described as new since 1876, a total of 915 genera and 6296 species described in 446 publications. This revision summarised quantitatively the progress made on the taxonomy of Mesozoic radiolarians over the last 140 years and it provides an overview of over 170 years of radiolarian literature. A special care was given to the analysis of valid vs. invalid genera (synonyms, homonyms, *nomina dubia*), so that the final number of valid genera in the Mesozoic now accounts for 593 in total. These genera have been systematically grouped by superfamilies and families following the main classification and guidance given in De Wever et al. (2001) and are listed in the final appendix with indications to the original publications and synonymies.

The stratigraphic range of each family was compiled using the first appearance, intermediate presence, and last recorded appearance of all genera included in a given family (see Fig. 1). Obviously, our first intention was to show the family FADs and LADs compiled after the most detailed and updated stratigraphic data available for Mesozoic genera. However, during this process we discovered some striking discontinuities inside some families. These kinds of stratigraphic gaps within the FAD to LAD interval of the family are either long or short (Fig. 1). The short gaps are those limited to the duration of one stage (ca. 2–3 m.y.), whereas the long gaps can cover several stages or even an entire Mesozoic period.

3. Results and discussion

The stratigraphic ranges of 128 Mesozoic families and subfamilies belonging to Entactinaria, Spumellaria, and Nassellaria are presented and discussed by order (Figs. 2–4). In general, Mesozoic families have long durations. However, two different parts can be clearly differentiated: the Triassic with shorter duration families as compared to the Jurassic–Cretaceous with longer duration families. This characteristic is also observed in the range of genera through the Triassic (O'Dogherty et al., 2009b, 2010). Indeed, the ranges of families are short because the ranges of genera are short, too. Such a correlation emerges in the consistent systematic framework carried out in the Mesozoic review of genera. During the Triassic, the time interval of many genera is relatively short, i.e., nearly 75% of genera show a duration of less than four Triassic substages (O'Dogherty et al., 2010). This allows for dating samples at substage level during the Triassic by using the identification of characteristic taxa at the generic level. The reason is not only the close relationship with the accurate taxonomy used in the systematics of genera but also undeniably the rapid evolution of radiolarians since the Middle Triassic (De Wever et al., 2003, 2006).

It seems obvious that the range of a family should cover the entire stratigraphic interval of their genera. However, as we have already explained, this is not always the case, denoting some shortcomings of the existing information of many groups. This explains the discontinuous records displayed by some families' ranges in the three orders, and hence the dashed lines in Figs. 2–4 represent virtual occurrences.

The disconnections are common in the three main Mesozoic orders, with 41 affected families. The gaps are characterized by: (a) their location, most often occurring around critical boundaries of major faunal turnovers in the marine realm, and (b) the different time span, long intervals vs. short intervals. Herein we focus only on long disconnections, because we observe a larger number of long disconnections and because the shortest disconnections (limited to the duration of one stage, ca. 2–3 m.y.) can in most cases be explained by a lack of stratigraphic record and are therefore less meaningful at family level.

3.1. Entactinaria

The Entactinaria is an order of Polycystinea having as initial skeleton a spicule with a variable number of spines, known from the Paleozoic to Recent. Classically the representatives of this order have been classified under the Spumellaria because externally the morphology of the shell is quite similar. From a systematic point of view, however, they are closer to Nassellaria (Dumitrica, 1978a,b; De Wever et al., 2001). The external resemblance to spumellarians is so remarkable that for the correct identification of the internal spicule, special slicing techniques are required. Although this group occurs more frequently in the Paleozoic than in the Mesozoic, the laboriousness of the technique should be the likely reason for the low number of families and subfamilies (only 20) in the Mesozoic being recognized to date (Fig. 2). This group has the lowest number of families among radiolarians. Proportionally, the Entactinaria families