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Original Article

Family Pseudoaulophacidae (Radiolaria) from the Upper Cretaceous (Coniacian-Maastrichtian) of Cyprus

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Abstract

Well-preserved Late Cretaceous (Coniacian–Early Maastrichtian) radiolarians from the Perapedhi, Moni and Kannaviou formations (Cyprus) were investigated. Abundant and diverse members of the family Pseudoaulophacidae are recognized and studied. The description of the species *Pseudoaulophacus lenticulatus* and *Pseudoaulophacus pargueraensis* are emended. A new radiolarian genus *Pseudoalievium* with two new species (*P. parekklisiense* and *P. inflatum*), one new species of the genus *Alievium* (*A. mangalensiense*) and one new species of the genus *Pseudoaulophacus* (*P. decoratus*) are described. Geographical and stratigraphical ranges of the studied taxa of the family Pseudoaulophacidae are more exactly defined. Several rare species of this family are traced in the Tethyan Realm.

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Keywords: Radiolarians; Pseudoaulophacidae; Upper Cretaceous; Cyprus; Biostratigraphy; Taxonomy

1. Introduction

After the discovery of the method of extracting radiolarians from siliceous rocks with diluted hydrofluoric acid (Dumitrica, 1970; Pessagno and Newport, 1972) Mesozoic radiolarians became widely used to date deep-water sediments and to reconstruct the history of oceanic basins and their margins (Bragina and Bragin, 2016; Sandoval et al., 2015; Urquhart and Robertson, 2000 and others). Deep-water radiolarian cherts are common in the Mesozoic ophiolite complexes of various mobile belts and numerous works were done to establish and develop radiolarian zonal scales of the Cretaceous (O'Dogherty, 1994; Pessagno, 1976, 1977; Sanfilippo and Riedel, 1985; Hashimoto et al., 2015; Kopaevich and Vishnevskaya, 2016).

Recently Bragina (2016a) proposed a new radiolarian zonal scale for the Upper Albian to Santonian based on various radiolarian-bearing sections of the Eastern Mediterranean and adjacent areas. 13 zones were erected and traced over large areas encompassing Cyprus, Crimea, Greater Caucasus, Serbia, Turkey and other areas. Radiolarians were recovered from

various lithologies including deep-water radiolarian cherts and bentonite clays as well as shallow-water limestones where radiolarians occurred together with planktonic and benthic foraminifers and macrofossils. This rich material can be used for detailed morphological studies with taxonomic implications, for constructing evolutionary lineages and for further improvement of the Upper Cretaceous radiolarian biostratigraphy. And for these purposes some groups of the Late Cretaceous radiolarians need detailed studies and taxonomic revisions. The aim of this work is to present new and comprehensive data on the Spumellarian family Pseudoaulophacidae from the Coniacian to Maastrichtian deposits of southern Cyprus, with reflection of their taxonomy and evolution in the studied interval.

The family Pseudoaulophacidae was broadly used in the Upper Cretaceous stratigraphy. The Turonian–Santonian interval of the Californian zonal scheme (Pessagno, 1976) is based on the phylogeny of the genus *Alievium* Pessagno. Three phylozones were established in this scale: *Alievium superbium* Zone (Turonian), *Alievium praegallowayi* Zone (Coniacian) and *Alievium gallowayi* Zone (Santonian). It should be noted that the taxonomic insight of these species is broad and variable. For example, O'Dogherty synonymized *Alievium praegallowayi* Pessagno with *Alievium superbium* (Squinabol) (O'Dogherty, 1994; p. 322). The species *Alievium gallowayi* (White) is

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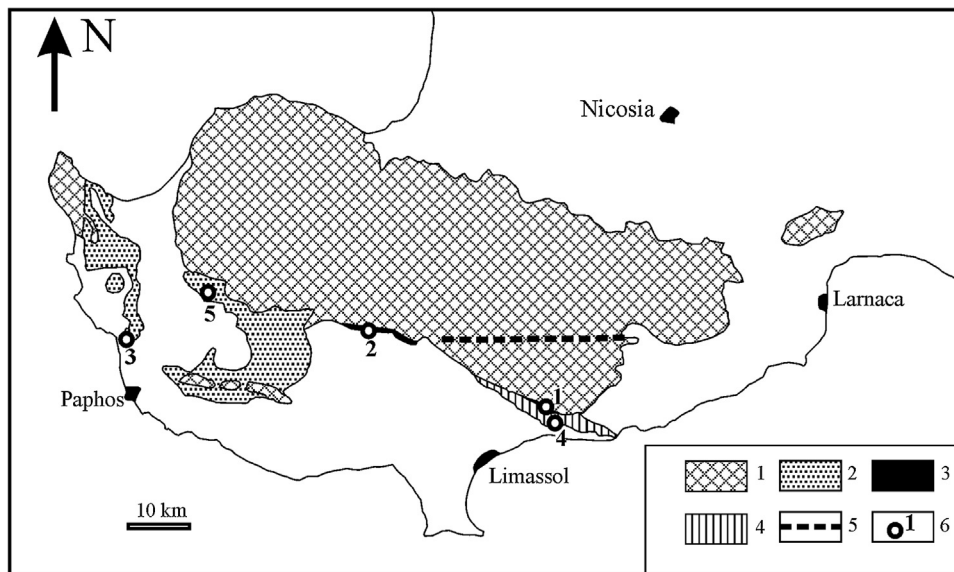


Fig. 1. Geology of studied area and position of the Turonian-Maastrichtian radiolarian-bearing sections. Map compiled with data of Swarbrick and Robertson (1980). 1 – Troodos Ophiolite Complex, igneous sequence; 2 – Kannaviou and Kathikas formations; 3 – Perapedhi Formation; 4 – Moni Formation; 5 – Arakapas Fault; 6 – position of studied sections (1 – Mangaleni quarry, 2 – Perapedhi Village, 3 – Mavrokolimbos River, 4 – Parekklissha Village; 5 – Kannaviou Village).

commonly interpreted very broadly. This situation can cause problems in biostratigraphic dating. For example, the Coniacian with *Alievium praegallowayi* can be considered Santonian if *Alievium praegallowayi* is determined as *Alievium gallowayi*. The stratigraphic importance of the species of *Pseudoaulophacus* increases due to the introduction of the *Pseudoaulophacus lenticulatus* Zone (Middle Cenomanian) (Bragina, 2016a).

Taxonomic studies of the Late Cretaceous species of the genera *Alievium* Pessagno and *Pseudoaulophacus* Pessagno (family Pseudoaulophacidae) continued during several decades (Pessagno, 1962, 1963, 1972, 1976; Riedel, 1967; Empson-Morin, 1981; Górká, 1989; Vishnevskaya, 1991; O’Dogherty, 1994; Urquhart, 1995) up to recent time (Bragina, 2004, 2014; Vishnevskaya, 2007). Despite these studies, many problems still exist: the stratigraphic ranges of many taxa need to be further specified and several morphotypes must be better studied. The Upper Cretaceous radiolarian assemblages of Cyprus are well preserved and are abundant in many stratigraphic levels. They represent a good opportunity to analyze species composition of the genera *Alievium* and *Pseudoaulophacus* and their stratigraphic distribution in the Coniacian–Maastrichtian interval.

2. Geological setting

The Cretaceous Troodos ophiolite massif is situated in the central part of Cyprus. The upper pillow lavas and their associated volcanoclastic breccias are present in the uppermost part of the ophiolite igneous sequence and are covered by sedimentary deposits. The lower part of this sedimentary cover represents the main interest for radiolarian investigations. It is composed of three formations: Perapedhi Formation (Turonian–Santonian), Kannaviou Formation (Upper Campanian–Lower Maastrichtian) and Moni Formation (Upper Campanian–Lower Maastrichtian).

The Perapedhi Formation has the lowermost position in the sedimentary cover of the Troodos Complex (Wilson, 1959; Robertson and Hudson, 1974; Swarbrick and Robertson, 1980). It is bounded at the base by the upper pillow lavas of the Troodos Complex, or in some sections by a volcanoclastic breccia composed of basalt and diabase fragments and tuffaceous matrix (Osozawa and Okamura, 1993; Bragina and Bragin, 1996), and at the top by the clayey Kannaviou Formation, or by the olistostromal Moni Formation, or even by the pelagic chalks of the Lefkara Formation (Upper Maastrichtian–Paleogene) (Mantis, 1970; Swarbrick and Robertson, 1980). The Perapedhi Formation is composed of metalliferous umbers, radiolarian cherts and cherty mudstones. Typically, its thickness is no greater than a few meters, but locally it can reach 35–40 m. The age of the Perapedhi Formation was estimated as Turonian (Blome and Irwin, 1985) or Santonian–Campanian (Swarbrick and Robertson, 1980; Thurow, 1991), resulting to a wide stratigraphic range – from the Turonian to the Lower Campanian – for its age. According to our data, the Perapedhi Formation is characterized by radiolarian assemblages ranging from the Upper Turonian to uppermost Santonian (Bragina, 2016a). It crops out discontinuously at the highest levels of the Troodos Complex, from the Akamas Peninsula to the east of the city of Nicosia (Fig. 1).

The Kannaviou Formation overlies conformably the Perapedhi Formation or pillow lavas and volcanoclastic breccias of the Troodos Complex (Robertson, 1977b) and is conformably overlain by the olistostromal Kathikas Formation (Upper Maastrichtian) (Swarbrick and Robertson, 1980) or by the Lefkara Formation. It consists of bentonite clays, radiolarian mudstones and tuffaceous sandstones. Its thickness is variable – from a few to over 150 m. The age of this formation is Late Campanian–Maastrichtian (Swarbrick and Robertson, 1980; Urquhart and Banner, 1994; Bragina and Bragin, 1995). The Kannaviou Formation is present in southwestern Cyprus, from Akamas Peninsula to Petra tou Romiou area.

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