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Original article

Late Cenozoic silicoflagellates from Zakynthos and Aegina Islands, Greece, and their comparison to C.G. Ehrenberg's microgeological collection

Silicoflagellés du Cénozoique supérieur des îles Zakynthos et Égine (Grèce) et leur comparaison avec la collection microgéologique de C.G. Ehrenberg

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ABSTRACT

The aim of this work is to present both the precise place of the outcrops on the islands Zakynthos and Aegina from where C.G. Ehrenberg (1795–1876) illustrated the silicoflagellates, as well as the stratigraphy of these associations that have an important stratigraphical value according to some index microfossils. The silicoflagellate associations belong to the local subzones *Distephanus speculum minutus* (Zakynthos) and *Dictyocha stapedia stapedia* (Aegina), respectively. These subzones correspond to the biozone CN11 (*Discoaster quinqueramus*) of Tortonian-Messinian age and the subzone CN12a (*D. tamalis*) of lower Piacenzian age of the calcareous nannofossils, respectively.

Mots clés :
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RÉSUMÉ

Le but de ce travail est, d'une part, la présentation précise des coupes levées dans les îles de Zante et d'Égine d'où C.G. Ehrenberg (1795–1876) avait illustré des silicoflagellés et, d'autre part, l'étude stratigraphique et taxonomique des associations qui présentent une valeur stratigraphique importante due à quelques microfossiles marqueurs. Ces associations de silicoflagellés appartiennent aux sous-zones locales à *Distephanus speculum minutus* (Zakynthos) et à *Dictyocha stapedia stapedia* (Égine). Ces sous-zones correspondent respectivement à la zone de nannoplancton calcaire CN11 à *Discoaster quinqueramus* du Tortonien/Messinien et à la sous-zone CN12a à *D. tamalis* du Plaisancien inférieur.

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1. Introduction

Zakynthos (Zante) is one of the Ionian Islands situated off the west coast of Greece (Fig. 1). It comprises part of the external Hellenides, which form a NNW-SSE trending orogenic belt. According to Aubouin (1959), Jacobshagen (1986), and Katsikatsos (1993), the Zakynthos Island belongs to the Ionian and Paxi geotectonic zones, the latter comprising the eastern slope of the foreland block, the Apulian ridge. The Ionian and Paxi zones are separated by a major thrust that transects several Ionian Islands.

In the Paxi zone, pre-Neogene rocks consist of pelagic to reefal limestone that range in age from Jurassic through Peleogene. Neogene sedimentary rocks of the same zone occupy the central-southeastern part of Zakynthos Island, forming a monoclinal succession, which deepens to the east. The Neogene deposits can roughly be subdivided into two units: a lower unit, predominantly composed of calcareous and siliceous sedimentary rocks of early to middle Miocene age, and an upper unit, consisting of terrigeneous clastic deposits of late Miocene to Pliocene age with local occurrences of evaporites (Horstmann, 1977; De Mülder, 1975; Dermitzakis, 1978). The Neogene sedimentary rocks overlie middle to upper Eocene reefal limestone, which crops out to the west of the Neogene successions (Stamatakis et al., 1988). Immediately overlying the reefal limestone is a strongly faulted carbonate-siliceous succession, which in turn is overlain by marls, claystones, and evaporates of Laghian-Serravalian to Pliocene age (Heimman, 1977; Dermitzakis, 1978; Heimann et al., 1979). The calcareous nannoplankton assemblages from the sections Romiri, Keri, Macherado, Aghios Sostis, and Zakynthos (part) (Fig. 1) were assigned to the biozones NN6, NN9/NN10-NN10-NN12/NN13 and NN18 (*sensu* Martini, 1971a), respectively from Middle Miocene to Uppermost Pliocene (Frydas, 1986).

Aegina Island is situated 16.5 miles SW of the port of Piraeus. Aegina belongs to the Plio-Pleistocene volcanic arc of Aegina-Milos-Thira (Santorini)-Nissyros-Kos and is consists of volcanic and sedimentary rocks, predominantly of Cretaceous and Neogene age (Fytikas et al., 1976).

Ehrenberg (1854) described and illustrated rich microfloras and faunas from Aegina but did not mention the location of the section from where he had received the samples. van Leyden (1940) published a review about the Geology of Aegina and a geological map of it, on a scale of 1:44,000. Neogene sediments consisting of marls, clays and limestones are found below and between the volcanic rocks (Tsoli, 1972). Caillère and Tsoli (1972) studied the marls of the hill Aghios Thomas and placed these sediments at the transition from the Miocene to Pliocene. Symeonidis and Dermitzakis (1973) studied the Pliocene/Pleistocene benthic foraminiferal fauna of the near islands Angistri and Metopi, as well, for the correlation of the stratigraphic sequences of the western coast of the town of Aegina. Benda et al. (1970) studied the marine microfossils and sporomorphs found in the section Aghios Thomas, which have been placed to the Early Pliocene. Frydas (1983) studied the calcareous and siliceous phytoplankton assemblages from the sections Aghios Thomas and Marathovounno (Fig. 2), which belong to the biozones *Reticulofenestra pseudoumbilica* (NN16) and *Distephanus speculum*, respectively.

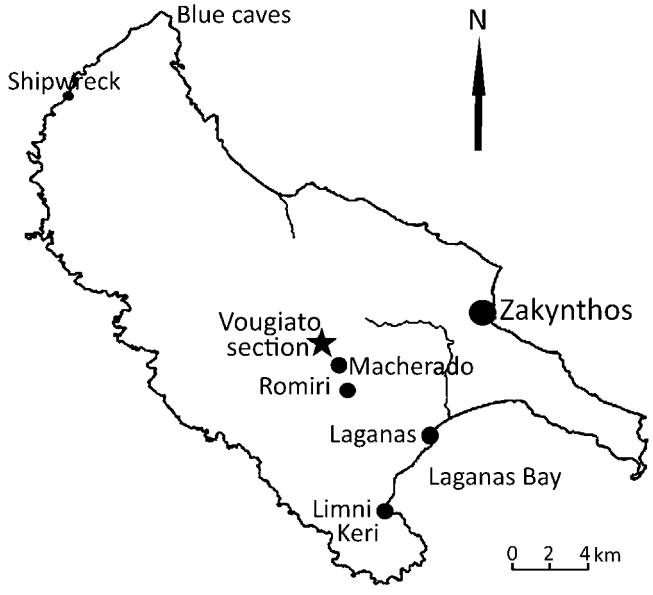

Fig. 1. Location of Vougiato section in Zakynthos.
Localisation de la coupe Vougiato dans l'île de Zakynthos.

1.1. Zakynthos – Vougiato section

According to Stamatakis et al. (1988), the Romiri Formation (Cretaceous to upper Miocene/Pleistocene) in Zakynthos Island consists of well-bedded limestone, marl, marly diatomite and porous unstratified limestone with chert in the form of nodules, lenses and thin laminated intercalations.

The presence of diatom frustules as well as of other siliceous microskeletons has been reported by Heimann et al. (1979) from the Messinian deposits of the Kalamaki area (SE Zakynthos).

Near the village of Vougiato (Fig. 1) – longitude 20° 48′20″(E), latitude: 37° 45′48″(N) – thin laminated diatomite layers from a succession of about 1.8 m thick and belonging to the Romiri Formation, have been examined by the author. A rich siliceous microflora and fauna has been observed in the diatom bearing layers with diatom frustules, coccoliths, silicoflagellates, radiolarians and sponge spicules. In addition, the samples 7br, 13br, 13er containing silicoflagellates (Fig. 3) have been examined in this study from Ehrenberg's microgeological collection stored in the Museum of Natural History, Berlin.

1.2. Aegina-Aghios Thomas section

Aghios Thomas hill has a height of about 70 m, and is situated SSW of the village of Messagros (23° 30′38″E/37° 45′32″N) (Fig. 2), (Frydas, 1983).

The section consists of silty clays, marls and diatomites, and it is topped by about 10 m of andesite breccia (Benda et al., 1970).

The lower 40 m of the marine succession are composed of grey to brownish green silty clays and marls with some finely bedded to laminated brownish intercalations. Upwards, yellowish to white, often calcareous marls are exposed. They have a thickness of about 30 m and often contain diatomite intervals, more than 2.0 m thick, bearing well preserved silicoflagellates (Frydas, 1983). Seven representative samples, one from each diatomite intercalation, were examined in this work (samples: Th.1 to Th.7, Fig. 4 and Fig. 7).

In the upper layers of the section, the calcareous nonnoplankton assemblages of a marl-diatomite layer belong to the *Discoaster tamalis* subzone CN12a (Okada and Bukry, 1980). A rich diatoms microflora has been observed in the diatomite layers (pl. 1, Frydas, 1983) with moderately preserved specimens of *Actinoptychus senarius* Ehrenberg, *Coscinodiscus asteromphalus* Ehrenberg, *C. lineatus* Ehrenberg, *C. vetustissimus* Pantocsek, *Roperia tesselata* (Roper), as well as many sponge spicules of various size and form of *acanthostyle*, *anatrianene*, *calthrop*, *dichotrianene* and *oxea* types (Frydas, 1983, pl. 3 and 4).