Actiniscus pentasterias, an endoskeletal siliceous dinoflagellates from Southern Ocean sediments.

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Siliceous spicules of endoskeletal dinoflagellates constitute a very small fraction of siliceous microfossil assemblage from Southern Ocean. They are represented by a solitary genus Actiniscus with its type species A. pentasterias. They are bilaterally symmetrical. It is useful in deriving palaeoecological interpretations. Their association with age diagnostic calcareous nannofossil blooms along-with reworked Palaeogene nannofossils suggest transport of older age plankton laden current from close proximity.

Keywords: dinoflagellates, microfossil, Palaeogene, plankton, alveola, genera, endoskeletal

Introduction

The starry-spicules of siliceous dinoflagellates Actiniscus pentasterias (Ehrenberg) alongwith calcareous nannofossils and other siliceous microfloras represented by diatoms, silicoflagellates, radiolaria and ebridians from the southern Indian Ocean sediments (Latitude 44° 59.82’ S and Longitude 45° 00.83’ E) had been presented in the present study. Though the specimens are not abundant but their presence in all twenty-nine top sediment samples with a sample difference of one cm each is noteworthy.

The literature on this rare microfossil group is scarce and found either in a few European journals or in the reports of the Deep Sea Drilling Project. C. G. Ehrenberg1 originally published five species of the genus Actiniscus and since then systematic treatment has been attempted by few workers. Dumitrica2-3 provided detailed description and picturesque sketches and light microscopic illustrations of these microfossils from Oligocene to Quaternary sediments of SW Pacific. Perch – Nielsen4-5 recorded a rich assemblage from Late Cretaceous to Pleistocene sediments of Sub- Antarctic, the southwest Pacific and Eocene – Pliocene sediments of the Norwegian Sea. Orr & Conley6 provided the distribution of Actiniscus from Miocene to Recent from about a dozen sites in the northeast Pacific. Rai7 recorded Actiniscus from datable nannofossil bearing Late Miocene age sediments of Neill Island, Andaman Sea, India. Dumitrica3 noted the interval from the Middle Miocene to the Early Pliocene to be exceptionally rich in siliceous dinoflagellates. Sizeable variation has been found in the taxonomy of siliceous dinoflagellates.

The structure of most commonly recorded group of aetiniscids is very interesting. They are characterized by an alveolar structure, which pervades their skeleton from the center to the distal end of the arms. Species with this type of structures are common in Neogene than in Palaeogene. First row of 4-6 alveoli surrounds the central or apical alveola giving a ring-like or amphora- shaped appearance to the central alveola. This is known as apical plate8. The confusion between siliceous dinoflagellate spicules with other plankton groups like members of radiolaria, silicoflagellates, broken fragments of diatoms and discoasters exist. Their affinities are proved beyond doubt with dinoflagellates.

The objective of the present study is to document a well-preserved assemblage of endoskeletal siliceous dinoflagellates, represented by solitary population of Actiniscus pentasterias, from southern Indian Ocean.

Materials and Methods

A 7.60 meters long sediment core (SK 200/23) was collected onboard ORV Sagar Kanya using Piston Corer from the Southern Ocean at a water depth of
1423 meters (Fig. 1). The top 30 cm portion of this core has been analysed for siliceous dinoflagellates components. Out of thirty samples from top to downward with a sample difference of one cm. each showed the presence of siliceous dinoflagellates. Permanent strewn slides were prepared using standard techniques. Few milligrams of sample material was dissolved in distilled water and a drop of suspended material of each sample was spread evenly on two slides, one having a coarse fraction and the other having a fine fraction and dried over a hot plate, which were then mounted in Canada Balsam. Light microscopic documentation was carried out using oil immersion objective (100 ×) using the single polariser for siliceous dinoflagellates and both single polarized and crossed polarized illumination was employed for studying calcareous nannofossils.

Oceanography of the Study Area

The studied area is an integral part of Southern Oceans. The South Indian Ocean circulation is characterized by a subtropical Anticyclone gyre (Wyrtki, 1971). The pole ward flowing Agulhas Current lies on its west, the eastward flowing Antarctic Circumpolar Current (ACC) lies its south and equator ward flowing West Australian Current is on its east (Fig. 1). The Subtropical Front (STF) is located at approximately 40°S latitude in central south Indian Ocean. It is significant to note that between the fronts lie zones of relatively uniform water mass properties. From north to south, the fronts and zones of the Southern Ocean are: the Subtropical Front (STF), Sub Antarctic Zone (SAZ), Sub Antarctic Front (SAF), Polar frontal Zone (PFZ), Polar Front (PF) and Antarctic Zone (AZ).

Results and Discussion

Palaeontology

No data has so far been published from these sediments. The siliceous dinoflagellates are rare in the assemblage but are morphologically typical microfossils. The nannofossil bloom of all the samples is dominated by recent species of *Calcidiscus leptoporus*, *Coccolithus pelagicus*, *Emiliania huxleyi*, *Florisphaera profunda*, *Gephyrocapsa caribbeanica*, *Gephyrocapsa muellerae*, *Gephyrocapsa oceanica*, *Helicosphaera carteri* var. *wallichii*, *H. inversa*, *Reticulofenestra asanoi*. A number of reworked Palaeogene forms represented by *Coccolithos eopelagicus*, *Chiasmolithus altus*, *Cyclicargolithus floridanus*, *Discoaster mirus*, *Helicosphaera seminulum*, *Reticulofenestra bisecta*, *R. dictyoda*, *R. coenura* are recorded in the assemblage.

Systematic Descriptions

The systematics of endoskeletal dinoflagellate genera, recovered from Leg 21 of the southwestern Pacific Ocean was done by Dumitrica who assigned them to the family Actiniscidae. He described several new genera and species and provided detailed description of the species substantiating with the sketches and light micrograph illustrations with detailed synonymy list, showing their distribution and relationship in time and space, thus highlighting their biostratigraphical potential.

Perch – Nielsen employing both light and scanning electron microscopy illustrated several species of the genera *Actiniscus*, *Foliactiniscus*, *Carduifolia* and *Calciopedinium* from DSDP leg 38 of the Sub-Antarctic southwest Pacific.

Rai illustrated two species of *Actiniscus* represented by *A. pentasterias* and *A. elngatus* both under light and scanning electron microscope.

![Fig. 1—Geographical location of the core SK 200/23 in Southern Ocean](image-url)
associated with datable nannofossil assemblage of Late Miocene sequence of Neill Island, Andaman and Nicobar Islands, India.

The present material is restricted to the genus *Actiniscus* represented by the type species *A. pentasterias*. Their distribution generally ranges from rare to very rare and are seen 1-2 specimens in twenty fields of view (100 ×).

Fensome *et al*., 1993 dealt with the details of this group in their Catalogue of Dinoflagellates.

Division *Dinoflagellata* Fensome *et al*., 1993
Subdivision *Dinokaryota* Fensome *et al*., 1993

Fig. 2—Photographs of Siliceous dinoflagellates and reworked calcareous nannofossils in the subsurface sediments of Southern Ocean.
Class **Dinophyceae** Pascher, 1914  
Subclass **Gymnodiniphycidae** Fensome *et al.*, 1993  
Order **Gymnodiniales** Apstein, 1909  
Suborder **Actiniscineae** (Sournia, 1984)  
Suborder **Gymnodiniphycidae** Fensome *et al.*, 1993  
Family **Actiniscaceae** Kützing, 1844  
Genus **Actiniscus** (Ehrenberg, 1840) *emend.* Ehrenberg, 1843  
Type species **Actiniscus pentasterias** Downie & Sarjeant, 1965

**Occurrence**  
Actiniscaceans are marine planktonic and non-photosynthetic micro-organisms. The marine fossil record of the siliceous skeletal group ranges from the Palaeogene to the Recent and they showed their maximum diversity during the Late Tertiary. Dumitrica3 and 45 discussed their palaeoecological importance.

**Remarks**  
The genus **Actiniscus** is the earliest described form. Ehrenbergh1 indicated Actiniscus as a subgenus of the silicoflagellate *Dicyocha*. He described two subspecies, *Dicyocha (Actiniscus) pentasterias* and *D. (Actiniscus) siris* without designating a type species. *Actiniscus* was raised to generic level by Ehrenberg14. The type species of *Actiniscus* was validly and legitimately designated by Downie and Sarjeant15.

**Description** — A central amphora-shaped pentagonal alveola is surrounded by five peripheral alveoli. The star-shaped skeleton of *A. pentasterias* is composed of opaline silica with a basal concave plate containing five curved rays and alveolar structures throughout its length. They become extinct under crossed nicols. The arms of the specimens are of variable length and height, tricostate, triangular in cross section, curving down on the ventral side. The tapered arms contain alveolar structures and transverse wrinkles as ornamentation on the furrows and between the median and lateral crests.

**Dimensions** — The distance between two arms is between 10-22 µm.

**Stratigraphic range**  
Known to occur from Late Eocene to Recent, but it is recorded as the most common siliceous endoskeletal dinoflagellate in most Miocene and Pleistocene samples and is the only representative in the Pleistocene. Orr & Conley6 recorded gradual shift of dominance of robust forms at older intervals to thinner forms in the Pleistocene.

**Remarks**  
Dumitrica23 recorded them from Upper Oligocene to Quaternary sediments. The variation in the number of arms ranges from 4-6. Perch – Nielsen4 recorded forms with 5-8 arms. Orr & Conley6 and Rai7 recorded only five rayed forms from the northeast Pacific Rim and Neill Island of Andaman and Nicobar Islands, India respectively.

**Conclusions**  
Rare to very rare occurrences of siliceous dinoflagellates represented by the genus **Actiniscus** with solitary species *A. pentasterias* is recorded from recent sediments of Southern Ocean. These siliceous dinoflagellates occur in association with calcareous nannofossils, foraminiferal linings, and siliceous diatoms, silicoflagellates, radiolaria and ebridians. The nannofossil assemblage is dominated by *Emiliania huxleyi* blooms. The deepest sample shows presence of *Coccolithus pelagicus* in bloom abundance. The nannofossil assemblage shows reworking of Palaeogene sediments, implying plankton laden current bringing material from close proximity.

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