

MESOZOIC AND CENOZOIC "CALCISPHERES" - UPDATE IN SYSTEMATICS

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INTRODUCTION

This note outlines the systematic concept used by the working group in Berlin for their research on Mesozoic and Cenozoic "calcispheres" during the last decade. This research has been supported mainly by the "Deutsche Forschungsgemeinschaft".

Many details and problems of this concept are not discussed here but in the references. Further discussions, questions and remarks (negative and positive) are expected.

THE NATURE OF CALCISPHERES

"Calcispheres" found in Mesozoic and Cenozoic calcareous nannofossil assemblages are mainly the skeletal remains of dinoflagellates. Dinoflagellates can produce various fossilizable remains during the different stages of their life-cycle.

In general, the life-cycle of dinoflagellates consists of a vegetative stage and a cyst stage. During the vegetative stage the motile cells are covered by a cellulosic, non fossilizable theca; the reproduction is asexual by mitosis. Before encystment, gametes are produced by mitotic division and after fusion of the gamete cells the planozygote reduces cell organelles and flagellae. Then encystment takes place by forming a thick cyst wall of acid-resistant organic material (sporopollenin ?); only a few living taxa use calcite (Dale 1983, Gao et al. 1989). These cysts are fossilizable, and fossil remains of dinoflagellates are usually assumed to be cysts. After a period of dormancy meiotic division and excystment takes place: the vegetative cells leave the cyst through the archaeopyle.

Tangen et al. (1982), Inouye & Pienaar (1983) and Bjornland (1990) found that *Thoracosphaera heimii* is an unusual dinoflagellate species with a calcareous shell during the vegetative stage. The occurrence of gametes, fusion and encystment has not been observed to date. *T. heimii* is the type species of the genus *Thoracosphaera* consequently only "calcispheres" which have the same distinctive wall structure, and which are likely to be shells of the vegetative stage can be placed in this genus. According to Tangen et al. (1982) the order Thoracosphaerales with until now only one species, *Thoracosphaera heimii*, may be a sister group of the order Peridiniales Haeckel 1894 (Keupp 1991).

All other "calcispheres" known and supposed to be calcareous dinoflagellate cysts should be placed into the family Calciodinellaceae Deflandre 1947 emend. Bujak and Davies 1983.

Most of the "calcispheres" found in recent sediments have been shown in cultures to be cyst stages of dinoflagellates (Wall et al 1970, Fütterer 1976, Montresor & Zingone 1988, Akselman & Keupp 1990, Matsuoka et al. 1990, Lewis 1991). The realization of paratabulation patterns in some fossil "calcispheres" shows their cyst nature. Paratabulation patterns in calcispheres always belong to the same orthohexa-formula, which supports the interpretation of the Calciodinellaceae as a monophyletic group (Keupp 1991).

SYSTEMATICS

Calcareous dinocysts are divided into three subfamilies based on the crystallographic orientation of the calcite crystals forming the outer layer of the cyst wall (see figure):

Subfam. Orthopithonelloideae Keupp 1987. C-axes of the calcite crystals perpendicular to cyst surface.

e.g.: *Sphaerodinella* ("*Thoracosphaera*") *albatrosiana* (Kamptner 1963) Keupp & Versteegh 1989

Subfam. Obliquipithonelloideae Keupp 1987. C-axes of the calcite crystals inclined (oblique to tangential) at various angles and directions (even in one specimen).

e.g.: *Obliquipithonella* ("*Thoracosphaera*") *operculata* (Bramlette & Martini 1964) Fütterer 1990

Subfam. Pithonelloideae Keupp 1987. C-axes of the calcite crystals inclined at the same angle and the same direction to cyst surface.

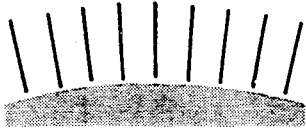
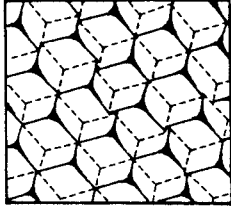
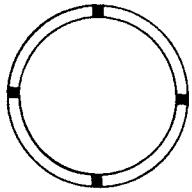

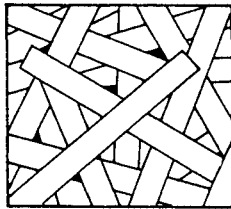

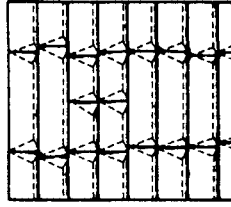
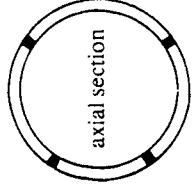
e.g.: *Pithonella sphaerica* (Kaufmann 1865) Lorenz 1902

Taxa which show paratabulation patterns are found in all three subfamilies (orthopithonelloid: *Calciodinellum operosum* Deflandre 1947, obliquipithonelloid: *Bicarinellum eulineatum* Keupp 1987, and pithonelloid: *Tetratropsis corbula* Willems 1990).

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Wall Structures of Calcareous Dinocysts

<i>ARRANGEMENT OF C-AXES</i>	<i>EXAMPLES OF SURFACE STRUCTURES</i>	<i>EXTINCTION PATTERNS</i>
<p>orthopithonelloid</p> 		
<p>obliquipithonelloid</p> 		<p>None</p>
<p>pithonelloid</p> 		

Complete hollow 'calcspheres' normally show no extinction patterns because the interference figures of the elements overlap. The most obvious extinction patterns can be seen when specimens have a mineral core (e.g. calcite, pyrite) or in ultra-thin sections.

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