
KHOWAJA-ATEEQUZZAMAN & RAHUL GARG
Birbal Sahni Institute of Palaeobotany, 53, University Road, Lucknow-226 007, UP, India (e-mail: khowaja_ateeq@yahoo.com).


INTRODUCTION
Jain & Taugourdeau-Lantz (1973) and Jain (1977) described the dinoflagellate cysts, including several new taxa, from the Grey Shale Member, Dalmiapuram Formation (Upper Aptian–Middle Albian), Cauvery Basin, southern India. The present paper reports on a morphological re-investigation and taxonomic reallocation of one of the new species, viz. Hexagonifera scabrata Jain & Taugourdeau-Lantz (1973, p. 64, pl. 4, figs 11–12).

STRATIGRAPHIC STATUS AND AGE OF THE GREY SHALE MEMBER
A thick, highly fossiliferous marine Cretaceous succession is exposed in the Cauvery Basin along the southernmost part of the eastern margin of India. The succession, ranging in age from ?Barremian/Aptian to Maastrichtian, is best exposed in the Ariyalur area. Subsequent to the three-fold subdivision of these rocks by Blanford (1862) – Uttatar, Trichinopoly and Ariyalur Groups in ascending order – modifications in the lithostratigraphy have been proposed by several workers (Ramanathan, 1968; Banerji, 1973; Sundaram & Rao, 1979, 1986; Ramasamy & Banerji, 1991; Tewari et al., 1996; Sundaram et al., 2001). Subbaraman (1968) first reported the occurrence of grey shale below the ‘reefal’ limestone in the lowermost part of the Uttatuar Group from a quarry near Dalmiapuram. Bhatia & Jain (1969) named this grey shale unit as the Dalmiapuram Formation. Banerji (1972, 1973) extended the scope of the Dalmiapuram Formation by including the overlying ‘reefal’ limestone and proposed two members: a lower Shale Member and an upper Limestone Member. The Shale Member was later renamed as the Grey Shale Member (Banerji, 1982; Ramasamy & Banerji, 1991). Jain (1977), however, inadvertently first used the term Grey Shale Member, attributing it to Banerji (1972). Tewari et al. (1996) redefined the so-called ‘Grey Shale Member’ as the Grey Siltstone Member considering siltstone to be the main lithology of the unit.

The grey shale unit contains rich assemblages of terrestrial palynomorphs and dinoflagellate cysts (Jain & Subbaraman, 1969; Rao & Venkatachala, 1971; Jain & Taugourdeau-Lantz, 1973; Jain, 1977; Venkatachala & Kumar, 1980), nannofossils (Jafar & Rai, 1989; Kale & Phansalkar, 1992) besides smaller benthic foraminifera (Banerji, 1972; Venkatachalamapathy & Ragothaman, 1995), ostracods (Bhatia & Jain, 1969) and few ammonites, bivalves and ichnofossils (Chiplonkar & Tapaswi, 1975; Phansalkar & Kumar, 1983). A probable Late Aptian–Early Albian age is suggested on palynomorph (Jain, 1977) and foraminiferal evidence (Venkatachalapathy & Ragothaman, 1995), while nannofossils indicated a younger Early–Middle Albian age (Jafar & Rai, 1989; Kale & Phansalkar, 1992). Thus, the palaeontological evidence suggests an Early Albian age for the Grey Shale Member.

TAXONOMIC COMMENTS
Jain & Taugourdeau-Lantz (1973) described Hexagonifera scabrata from the Grey Shale Member exposed in the Kallakudi quarry II, near Dalmiapuram. The species was characterized as:

Shell globular, 50–80 µm diameter, without any horn or appendages, enclosed in a spongy, fiber-like covering extending 4–6 µm beyond shell. Shell wall 4–5 µm thick, inner surface scabrate. Archaeopyle apical, apical operculum uncertain.


Explanation of Plate 1. Dinoflagellate cysts from the Grey Shale Member, Kallakudi Quarry II, near Dalmiapuram, Cauvery Basin, India. All photographs on BH2 Olympus microscope in DIC. Scale bar 20 µm. fig. 1. Ovoidinium scabratum (Jain & Taugourdeau-Lantz) emend. comb. nov., holotype (Hexagonifera scabrata Jain & Taugourdeau-Lantz, 1973, pl. 4, fig. 11; sl. no. 3938-40) re-photographed (E.F. no: X 40), showing archaeopyle sutures. figs 2–9. Other specimens of Ovoidinium scabratum (Jain & Taugourdeau-Lantz) emend. comb. nov.: 2, specimen in ventro-lateral position with attached operculum (sl. no. 5053, E.F. no: K67); 3, specimen in ventral view showing combination archaeopyle (4A3I) with operculum attached along the archaeopyle suture 1’-as (sl. no. 5063, E.F. no: M 33/4); 4, specimen showing archaeopyle margins and precingular parasutural thinning between paraplates 3?-4? and 4?–5?, in dorsal view (sl. no. 5063, E.F. no: M 40/3); 5, specimen showing archaeopyle sutures in ventral view (sl. no. 5056, E.F. no: D 42); 6, specimen showing combination archaeopyle (4A3I) with archaeopyle margins: 1’-as, 1?–1’, 1?–2’, 2?–1a, 3?–1a, 4?–2a, 5?–2a, 5?–3a, 6?–3a, 6?–4’, 7?–2a, 7?–2’ and 7?–1’, anticlockwise in apical view (sl. no. 5053, E.F. no: T 67/4); 7, specimen in dorso-lateral view with attached operculum (sl. no. 5056, E.F. no: O 40/2); 8–9, specimen in ventral and dorsal views respectively, showing archaeopyle sutures and precingular parasutural thinning (sl. no. 5054, E.F. no: O 51).
reinterpreting the dinoflagellate cyst Leberidocysta? scabrata


Helenes (1983) discussed the morphological features of Ascodinium and Ovoidinium and demonstrated that the two genera are similar with respect to the nature of the cyst (i.e. proximate, two layered), the relative thickness of the walls (i.e. thin periphragm and thicker endophragm), the shape of the endophragm (subpherical to ovoid) and the type of archaeopyle [combination (\textit{tA\text{\textit{H}}})]. They are, however, differentiated by wall relationships (bicavate vs. circumcavate) and the degree of angularity of the archaeopyle margins. He concluded (Helenes, 1983, p. 257) that ‘the morphological characteristics common to Ascodinium and Ovoidinium are more numerous – perhaps more basic morphologically and less likely to be influenced by differences in the state of preservation – than those characteristics used to separate them’. Helenes (1983, p. 257) proposed to ‘redefine Ascodinium, modifying slightly Cookson & Eisenack’s (1960) original description of this genus to include the species formerly assigned to Ovoidinium and make Ascodinium Cookson & Eisenack, 1960 emend. Helenes, 1983, a senior synonym of Ovoidinium Davey, 1970.

Bujak & Davies (1983, pp. 62–63) described the archaeopyle in the genus Ovoidinium as being \textit{4A3Ia}. At the same time they stated that:

some species that have been attributed to Ascodinium had the typical Ovoidinoidean archeopyle (Stover & Evitt, 1978), Ascodinium serratum and \textit{A. acrophorum} had an \textit{A1a} archaeopyle in which plate 3’ and 2a comprised the anteriorly attached operculum, as demonstrated by Lentin & Williams (1976).

Lentin & Williams (1985, p. 27) initially accepted the reasoning of Helenes (1983, p. 258), that Ovoidinium is a junior synonym of Ascodinium. Later, Lentin & Williams (1989, p. 28) followed Bujak & Davies (1983, pp. 62–63), retaining Ovoidinium as a separate genus (based on its distinctive archaeopyle), transferring species attributed to Ascodinium having an \textit{4A3Ia} archaeopyle to Ovoidinium, and restricting Ascodinium to include only the species \textit{A. acrophorum}, \textit{A. parvum} and \textit{A. serratum}.

This paper follows Lentin & Williams (1989) in retaining Ascodinium and Ovoidinium as two separate genera. Davey (1970, pp. 351–352) defined the genus Ovoidinium initially as being bicavate possessing one or two antapical horns and typically one apical horn. Later, he described a new species, Ovoidinium diversum, as

subspherical in shape with thin periphragm occasionally adhering so closely to the thick endophragm that no pericoel is formed or sometimes thin wrinkled, hyaline periphragm appears to form a loose enveloping cover around endocyst and the pericoel may be irregularly developed (Davey, 1979, p. 558).

He modified the original concept of the genus Ovoidinium to accommodate \textit{O. scabratum}, referring to the shape of the cyst and wall relationship but placing more emphasis on the unique \textit{4A3Ia} archaeopyle type. Restudy of the specimens described by Jain & Taugourdeau-Lantz (1973) from the Grey Shale Member of the Dalmiapuram Formation, Cavery Basin, southern India clearly indicates the presence of combination type of archaeopyle formed by the total removal of the apical paraplates (4) and all the three anterior intercalary paraplates (\textit{4A3Ia}) and, hence, needs assignment to the genus Ovoidinium. Therefore, the reattribution of Hexagonifera scabrata Jain & Taugourdeau-Lantz, 1973 to the genus Leberidocysta by Stover & Evitt (1978, p. 60) is rejected. Hexagonifera scabrata Jain & Taugourdeau-Lantz, 1973 is emended herein and a new combination is proposed below.

SYSTEMATIC PALAEOONTOLOGY

Figured specimens described in this paper are from the type slides of Jain & Taugourdeau-Lantz (1973) and Jain (1977), based on the material collected from the Grey Shale Member, exposed in Kallakudi Quarry II, near Dalmiapuram, Cavery Basin, southern India. The type slides are stored in the museum – Birbal Sahni Institute of Palaeobotany (BSIP), Lucknow, India. Specimen location refers to the England Finder position on the respective slides.

SYSTEMATIC DESCRIPTION

\begin{tabular}{l}
Division \textit{Pyrophycaceae} Pascher, 1914  \\
Class \textit{Dinophyceae}, 1929  \\
Subclass \textit{Peridiniphycidae} Fensome et al., 1993  \\
Order \textit{Peridiniinae} Hauckeck, 1894  \\
Suborder \textit{Peridiniinae} Fott, 1959 emend. Bujak & Davies, 1983  \\
Family \textit{Peridiniaceae} Ehrenberg, 1831  \\
Subfamily \textit{Ovoidinoideae} (Norris, 1978) Bujak & Davies, 1983  \\
Genus \textit{Ovoidinium} Davey, 1970, emend. Lentin & Williams, 1976  \\
\end{tabular}

\textit{Ovoidinium scabratum} (Jain & Taugourdeau-Lantz, 1973) emend. \textit{comb. nov.}  
(Pl. 1, figs 1–9)

1973 \textit{Hexagonifera scabrata} Jain & Taugourdeau-Lantz: 64, pl. 4, figs 11–12  
1977 \textit{H. scabrata} Jain & Taugourdeau-Lantz \textit{in} Jain: 179, pl. 4, fig. 46  
1978 \textit{Leberidocysta}? \textit{scabrata} (Jain & Taugourdeau-Lantz) \textit{Stover & Evitt}: 60


Emended diagnosis. Cyst spherical to sub-spherical, without apical or antapical horns; proximate, two layered; periphragm spongy, fibre-like covering extending 4–6 μm beyond shell, variably developed; endophragm thick, about 4–5 μm, scabrate; endophragm and periphragm appressed, sometimes periphragm covers endophragm loosely, leaving irregularly developed pericoels; paratabulation indicated by archaeopyle alone and occasionally by parasutural thinning; archaeopyle combination
type, 4A3I, with hexa 2a, operculum simple, free or attached along the archaeopyle suture 1 '-as; cyst size range 50–80 μm.

Holotype. Hexagonifera scabrata Jain & Taugourdeau-Lantz (1973, pl. 4, fig. 11).

ACKNOWLEDGEMENTS
The authors are grateful to Prof. Anshu K. Sinha, Director, BSIP for providing facilities and encouragement. Sincere appreciation is expressed to K. P. Jain, former Deputy Director, BSIP for constructive suggestions. The authors acknowledge the helpful comments of two reviewers.

Manuscript received 3 October 2002
Manuscript accepted 14 November 2003

REFERENCES