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# Acid-resistant Cretaceous thecamoebian tests from the Arabian Peninsula: a suggestion for study of agglutinated rhizopods in palynological slides

ARUN KUMAR
Center for Petroleum and Minerals, Research Institute, King Fahd University of Petroleum and Minerals, Dhahran 31261, Saudi Arabia
(e-mail: arunkumarlko@hotmail.com)

**ABSTRACT** – Rare specimens of *Centropyxis aculeata* (Ehrenberg, 1832), cf. *Difflugia oblonga* (Ehrenberg, 1832), *Amphitrema flavum* (Archer, 1869) and an unidentified spherical form (similar to a protozoan 'cyst' in van Hengstum *et al*., 2007) were observed in the palynological preparations of cutting samples from a drill-hole in southern Saudi Arabia. These thecamoebians were found in Cretaceous formations in association with typical Cretaceous spore, pollen and dinoflagellate cysts. Since the youngest rock formation in this drill-hole is of Cretaceous age, contamination due to caving from post-Cretaceous sediments is thus ruled out. Although the oldest record of thecamoebians comes from Neoproterozoic strata, their pre-Holocene occurrences are rare and patchy. Since many thecamoebian tests are autogenous and are made of acid-resistant proteinaceous material, they occur in the palynological preparations of fossil sediments. It is suggested that careful observation and search for thecamoebians in palynological slides could potentially lead to new discoveries of these microfossils from Phanerozoic sediments from all over the world. *J. Micropalaeontol.* **30**(1): 1–5, May 2011.

**KEYWORDS:** *thecamoebians, Cretaceous, Arabian Peninsula, Palynology*

## INTRODUCTION

Thecamoebians are an artificial polyphyletic group of protozoans, also known as agglutinated rhizopods and testate amoebae, while arcellaceans are a group within thecamoebians. These are unicellular testate (shelled) protists that occur widely in a variety of freshwater habitats and also in marginal brackish-water environments (Kumar & Patterson, 2000). Patterson & Kumar (2000a, 2002) provide useful reviews of the morphology, taxonomy, palaeoecological utilities and analytical methods for studying. These microfossils have been widely studied from lacustrine and fluvial sediments of the tropics to the Arctic regions (Beyens *et al*., 1990; Dalby *et al*., 2000; Patterson and Kumar, 2000b), peat bogs (Woodland *et al*., 1998; Charman *et al*., 2000) and salt marshes (Charman *et al*., 2002; Roe *et al*., 2002).

## PREVIOUS STUDIES

Holocene thecamoebians are known globally but their older fossil records are rare (Table 1). The oldest thecamoebians, described as vase-shaped microfossils (VSMs), were reported from the Neoproterozoic (*c*. 742 Ma) Chuar Group, Grand Canyon, Arizona by Porter & Knoll (2000) and Porter *et al*. (2003). On the basis of morphological observations and taphonomic inferences, Porter *et al*. (2003) demonstrated VSM affinity with the modern thecamoebians. Porter & Knoll (2000) also reviewed world-wide occurrences of VSMs and concluded that they occur globally in Neoproterozoic rocks. Despite a long geological history, thecamoebian lineages have shown minimal evolution through geological time and demonstrate close resemblance to their Holocene forms (van Hengstum *et al*., 2007).

Fossil thecamoebians have been reported mainly from sediments but there are also a few reports from fossil amber (Poinar *et al*., 1993; Waggoner, 1996a, b; Schönborn *et al*., 1999; Schmidt *et al*., 2004). Since thecamoebian tests are secreted (autogenous) and are proteinaceous, they are acid resistant and have been reported in palynological preparations by Kumar & Patterson (2002), Farooqui & Gaur (2007) and Farooqui *et al*. (2010). Srivastava & Bhattacharya (1998) reported an assemblage of Early Permian-age palynomorphs from faunal coal balls of Arunachal Pradesh, northeastern Himalaya, India. A specimen referred to as '?Chitinozoa like vesicle' (Srivastava & Bhattacharya, 1998, pl. 1, fig. 11) is most likely a specimen of *Difflugia*. Likewise, Pande *et al*. (2004) reported a palynomorph assemblage from the Manjir Formation (Early Permian) from Himachal Pradesh in northern India. They too reported an 'unidentified specimen' (Pande *et al*., 2004, pl. 2, fig. 6), which is a well-preserved specimen of *Centropyxis*. Since palynologists are not usually trained in thecamoebian studies, they overlook valuable micropalaeontological information in their palynological slides. Distribution of fossil thecamoebian families from the Neoproterozoic through the Pliocene is patchy, with wide gaps in the fossil record (van Hengstum *et al*., 2007; Table 1 herein). Thus, it is argued that there are significant opportunities for discovering thecamoebian assemblages from Phanerozoic sediments globally in palynological preparations.

## MATERIALS AND METHODS

Standard palynological processing techniques were used to macerate cutting samples from drill-hole SSA 1 in the western Rub al Khali desert of the Arabian Peninsula. While scanning palynological slides under a transmitted light microscope (Olympus BH-2), rare specimens of thecamoebians were observed. The digital images ($\times 40$) of these microfossils were taken by an overhead camera and were downloaded to a computer for processing and plate preparation. The material studied is from the Biyadh Formation of Barremian age, from two samples at a depth of 1570–1580 feet and 1580–1590 feet below KB. The slides are deposited at the Center for Petroleum and Minerals, Research Institute, King Fahd University of Petroleum and Minerals, Saudi Arabia (catalogue number SSA-1; 1570–1580/2 and 1580–1590/1).

| Era | Period | Epochs | References |
|---|---|---|---|
| | | Pliocene | Köváry (1956) |
| | | Miocene | Foissner & Schiller (2001), Frenguelli (1933), Schiller (1998a) |
| Cenozoic | Tertiary | Oligocene | Schiller (1998b), Waggoner (1996a) |
| | | Eocene | Bradley (1931), Waggoner (1996a) |
| | | Paleocene | |
| | Cretaceous | | Medioli *et al*. (1990a), Waggoner (1996b), Schmidt *et al*. (2004), van Hengstum *et al*. (2007) |
| Mesozoic | Jurassic | | |
| | Triassic | | Schönborn *et al*. (1999), Poinar *et al*. (1993) |
| | Permian | | Wolf (1995), Farooqui *et al*. (2010) |
| | Carboniferous | | Vasicek & Ruzicka (1957), Wightman *et al*. (1992, 1994), Medioli *et al*. (1990b) |
| Palaeozoic | Devonian | | |
| | Silurian | | |
| | Ordovician | | |
| | Cambrian | | Scott *et al*. (2003) |
| Neoprotero-zoic | | | Porter & Knoll (2000), Porter *et al*. (2003) |

**Table 1.** Stratigraphic records of pre-Holocene thecamoebians.

| Era | Period | Epoch | Stage | Stratigraphy |
|---|---|---|---|---|
| | | | Maastrichtian | Aruma Formation |
| | | | Campanian | |
| | | Late | Santonian | *unconformity* |
| | | | Coniacian | |
| | | | Turonian | |
| Mesozoic | Cretaceous | | Cenomanian | Wasia Formation |
| | | Middle | Albian | *hiatus* |
| | | | Aptian | Shuaiba Formation |
| | | | Barremian | Biyadh Formation |
| | | Early | Hauterivian | Buwaib Formation |
| | | | Valanginian | Yamama Formation |
| | | | Berriasian | Sulaiy Formation |

*Source*: Al-Husseini & Matthews (2008)

**Table 2.** Cretaceous stratigraphy of Saudi Arabia.

## CRETACEOUS STRATIGRAPHY OF SAUDI ARABIA

Recent advances in the understanding of the Cretaceous stratigraphy of the Arabian Peninsula were summarized by Al-Husseini (2008) and Al-Husseini & Matthews (2008). These two papers provide stratigraphic details of various Cretaceous formations, intervening unconformities and hiatuses. Diverse geological and geophysical surface and subsurface data from a large number of drill-holes provide a very sound basis for time-rock units in a sequence stratigraphic framework in Saudi Arabia. Table 2 summarizes the Cretaceous stratigraphy of Saudi Arabia (Al-Husseini & Matthews, 2008).

## RESULTS

The following thecamoebian specimens were observed.

Phylum **Protozoa** Goldfuss, 1818
Subphylum **Sarcodina** Schmarda, 1871
Class **Rhizopoda** von Siebold, 1845
Subclass **Lobosa** Carpenter, 1861
Order **Arcellinida** Kent, 1880
Superfamily **Arcellacea** Ehrenberg, 1830
Family **Difflugidae** Stein, 1859
Genus *Difflugia* Leclerc in Lamarck, 1816

cf. *Difflugia oblonga* Ehrenberg, 1832
(Pl. 1, figs 5, 6)

**Dimensions**. It has a broken spine attached at the base; 75 × 35 μm (one specimen).

Family **Centropyxidae** Jung, 1942
Genus *Centropyxis* Stein, 1857

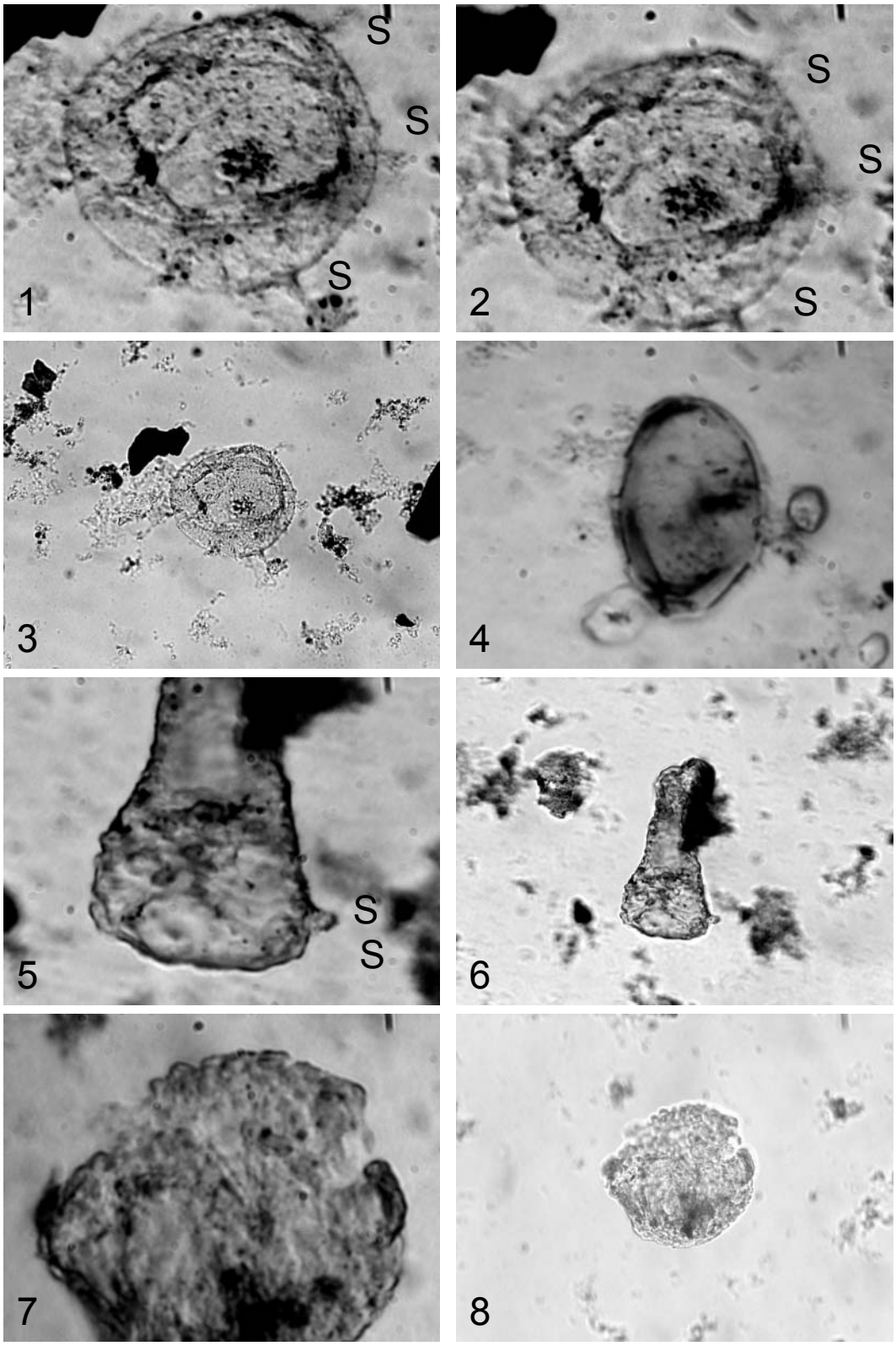
*Centropyxis aculeata* Ehrenberg, 1832
(Pl. 1, figs 1–3)

**Dimensions**. Diameter 65 × 55 μm; length of spines 6–8 μm (one specimen).

Family **Trinematidae** Hoogenraad & Groot, 1940
Genus *Amphitrema* Archer, 1869

*Amphitrema flavum* Archer, 1869
(Pl. 1, fig. 4)

**Dimensions**. 38 × 24 μm (one specimen).




**Explanation of Plate 1.**

**figs 1–3**. *Centropyxis aculeata* Ehrenberg, 1832, sample 1580–1590 ft, slide 1, 142.5 × 12.5: **1, 2**. (same specimen focusing on different spines indicated by S) ×1000; **3,** ×400. **fig. 4**. *Amphitrema flavum* Archer, 1869, sample 1580–1590 ft, slide 1, 157.5 × 14: ×1000. **figs 5, 6**. cf. *Difflugia oblonga* Ehrenberg, 1832, sample 1570–1580 ft, slide 2, 143 × 18: **5,** ×1000; **6,** ×400. **figs 7, 8**. Test of a protist 'cyst', sample 1580–1590 ft, slide 1, 146.4 × 5: **7,** ×1000; **8,** ×400).

Incertae Sedis

Unidentified spherical form
(Pl. 1, figs 7, 8)

**Dimensions**. 60 μm (one specimen).

**Remarks**. This form is morphologically comparable to the protist 'cyst' illustrated by van Hengstum *et al*. (2007, pl. 2, fig. 17).

## DISCUSSION

Rare specimens of *Centropyxis aculeata*, cf. *Difflugia oblonga*, *Amphitrema flavum* and an unidentified spherical form similar to the protist 'cyst' described by van Hengstum *et al*. (2007) were observed in palynological preparations from southern Saudi Arabia. These specimens were found in two samples from the Biyadh Formation (Barremian), which is a sandstone unit. Since these fossils were found in drill-hole cuttings it is possible that they might be caved from younger up-hole strata. This well was spudded in the Aruma Formation (Maastrichtian) – a limestone unit, which is underlain unconformably by the Wasia Formation (Late Albian–Cenomanian) and Shuaiba Formation (Aptian) (Table 2). The Biyadh Formation underlies these three younger Cretaceous formations, so – if caved – these microfossils could belong to any one of these stratigraphic units encompassing part of the younger Cretaceous. Important associated palynomorphs are *Classopollis*, *Callialasporites*, *Eucommiidites*, *Cycadopites*, *Ephedripites*, *Deltoidospora*, *Cicatricossporites*, *Gleicheniidites* and several other types of trilete spores and *Laevigatoporites*. Rare poorly preserved dinoflagellate cysts, acritarchs and foraminiferal linings are also present. This assemblage comprises typically long-ranging Cretaceous palynomorphs. It is not possible to offer any comments on the palaeoenvironmental significance of thecamoebians recorded here because they are from cutting samples. *Centropyxis aculeata*, cf. *Difflugia oblonga* and an unidentified spherical form comparable to the protist 'cyst' described by van Hengstum *et al*. (2007) are known from Holocene lacustrine environments (Dalby *et al*., 2000) and Cretaceous sediments of Nebraska (van Hengstum *et al*., 2007). *Amphitrema flavum* has a smooth proteinaceous test and occurs in peat bogs of Europe and North America.

## CONCLUSIONS

Rare specimens of Cretaceous thecamoebians from the Arabian Peninsula are reported from the cutting samples of a drill-hole. These specimens were found in the palynological preparations and thus their tests are acid-resistant. It is suggested that searching for thecamoebian tests in palynological preparations has significant potential for new findings of these microfossils from pre-Quaternary sedimentary rocks.

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