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Cretaceous calcareous nannofossils from Tanot #1, Jaisalmer Basin, Rajasthan, Western India: morphotaxonomy and biostratigraphy

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ABSTRACT

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The present paper deals with the record of rich and highly diversified calcareous nannofossil assemblage of Late Albian to Early Maastrichtian age from the subsurface sediments of Jaisalmer Basin, western India. The nannofossil assemblage include, 222 species belonging to 86 genera and 22 families including 6 nannolith families which are Braarudosphaeraceae, Ceratolithaceae, Lapideacassaceae, Microrhabdulaceae, Nannoconaceae, Polycyclolithaceae and one holococcolith family Calyptrosphaeraceae. An alpha–numeric zonal scheme has been proposed in the present study which will be useful for shallow shelf areas of low latitude. 17 Zones are assigned on the presence of last occurrence (LO) of zonal markers and 5 subzones of basal most zone (TA1) are demarcated on the basis of first occurrence (FO) of subzonal markers with due nomenclature procedures.

Key–words—Nannofossils, Late Cretaceous, Biostratigraphy, Tanot well–1, Jaisalmer Basin, India.

पश्चिमी भारत में राजस्थान की जैसलमेर द्रोणी के तनोट # 1 से प्राप्त चाकमय चूनेदार परासूक्ष्मजीवाश्मः आकारवर्गिकी एवं जैवस्तरिकी

आभा सिंह एवं ज्योत्सना राय

सारांश

मौजूदा शोध–पत्र का सरोकार पश्चिमी भारत की जैसलमेर द्रोणी के उपपृष्ठीय अवसादों से प्राप्त अंतिम अल्बीयन से प्रारंभिक मास्ट्रीक्शियन काल के प्रचुर और उच्च रूप से विविध रूपायित चूनेदार परासूक्ष्मजीवाश्म समुच्चय के अभिलेख से हैं। परासूक्ष्मजीवाश्म समुच्चय में 6 नैनोलिथ कुटुंबों सहित 86 वंश एवं 22 कुटुंबों की 222 जाति सन्निहित है जो ब्रारूडोस्फेरेसी, सेरेटोलिथेसी, लैपिडियाकेस्सेसी, माइक्रोरहब्डूलेसी, नैनोकोनेसी, पॉलीसायक्लोलिथेसी और एक होलोकोक्कोलिथ परिवार कैलीप्ट्रोस्फैरेसी हैं। मौजूदा अध्ययन में अक्षरांकीय आंचलिक योजना प्रस्तावित की गई है जो निम्न अक्षांश के गाध उपतट के लिए उपयोगी होगी। आंचलिक चिह्नकों की आखिरी घटना (एल ओ) की विद्यमानता पर 17 अंचल निर्धारित किए गए हैं तथा नियत नामपद्धति प्रक्रियाओं सहित उपअंचल चिह्नकों की प्रथम घटना (एफ ओ) के आधार पर आधारीय व्यापक अंचल (टी ए 1) के 5 उपअंचल निर्धारित किए गए हैं।

सूचक शब्द—परासूक्ष्मजीवाश्म, अंतिम चाकमय, जैवस्तरिकी, तनोट कुआं–1, जैसलमेर द्रोणी, भारत।

INTRODUCTION

CALCAREOUS nannofossils are considered as representatives of modern day 'calcareous nannoplanktons'. Nannoplanktons include present day coccolithophores as well as a large variety of other forms (the nannoliths) produced by several distinct groups ranging from benthic ascidian spicules to calcispheres (calcareous dinoflagellates) and some *incertae sedis* forms (Bown & Young, 1998). Nannoplanktons are unicellular, flagellate, exclusively marine phytoplanktons, belonging to golden brown algae Chrysophyceae. They are amongst the most important pelagic calcifying organisms in the modern oceans (Baumann *et al*., 2004; Hay, 2004). They have the ability to carry out photosynthesis; making them as an important group of primary producers (Winter & Siesser, 1994; Bown & Young, 1998). Their wide geographic distribution, short stratigraphic range, minute size and prolific abundance makes them ideal biostratigraphic indicators from the Late Triassic to Recent (Moshkovitz, 1982; Jafar, 1983; Bown, 1985, 1987).

Nannofossils from the Cretaceous sediments are documented from several sedimentary basins of India (Kumar *et al*., 1977; Jafar, 1982; Sinha & Dimitrienko, 1983; Kale & Phansalkar, 1992a, b; Garg & Jain, 1995; Chungkham & Jafar, 1998; Perch–Nielsen & Saxena, 1998; Rai, 2006; Rai *et al*., 2013a, b, 2016; Saxena & Misra, 1995). However, only Albian age nannofossil data has so far been published from the Jaisalmer Basin. In the present study nannofossils are recorded from Late Albian to Early Maastrichtian age from subsurface succession of Tanot #1. This study is expected to provide a firm background and impetus for future researches on Cretaceous age calcareous nannofossils in other sedimentary basins of India.

GEOLOGICAL SETTING

Jaisalmer Basin is situated in the north–western part of Rajasthan, western India (Fig. 1). It displays nearly flat topography covered with recent desertic alluvium and some prominent hillocks of marine Mesozoic–Tertiary rocks in the form of cuestas ranging in age from early–middle Jurassic to Recent. These rocks are known since early nineteenth century and contain rich fossil fauna and flora. The Mesozoic rocks rest unconformably on Pre–Cambrian basement. The marine Mesozoic rocks on surface in ascending order are classified as Lathi, Jaisalmer, Baisakhi, Bhadasar, Pariwar and Habur formations with several members and Lathi, Jaisalmer, Baisakhi, Bhadasar, Pariwar, Goru and Parh formations in the subsurface (Das Gupta, 1975).

PREVIOUS WORK

Ammonites are the basic chronometers used to establish the marine Mesozoic stratigraphy of Jaisalmer Basin. Several workers have studied ammonites from this area (Feistmantel, 1877; Spath, 1933; Krishna, 1979, 1980a, b, 1983, 1987; Singh & Krishna, 1969; Chatterjee, 1990; Pandey & Krishna,

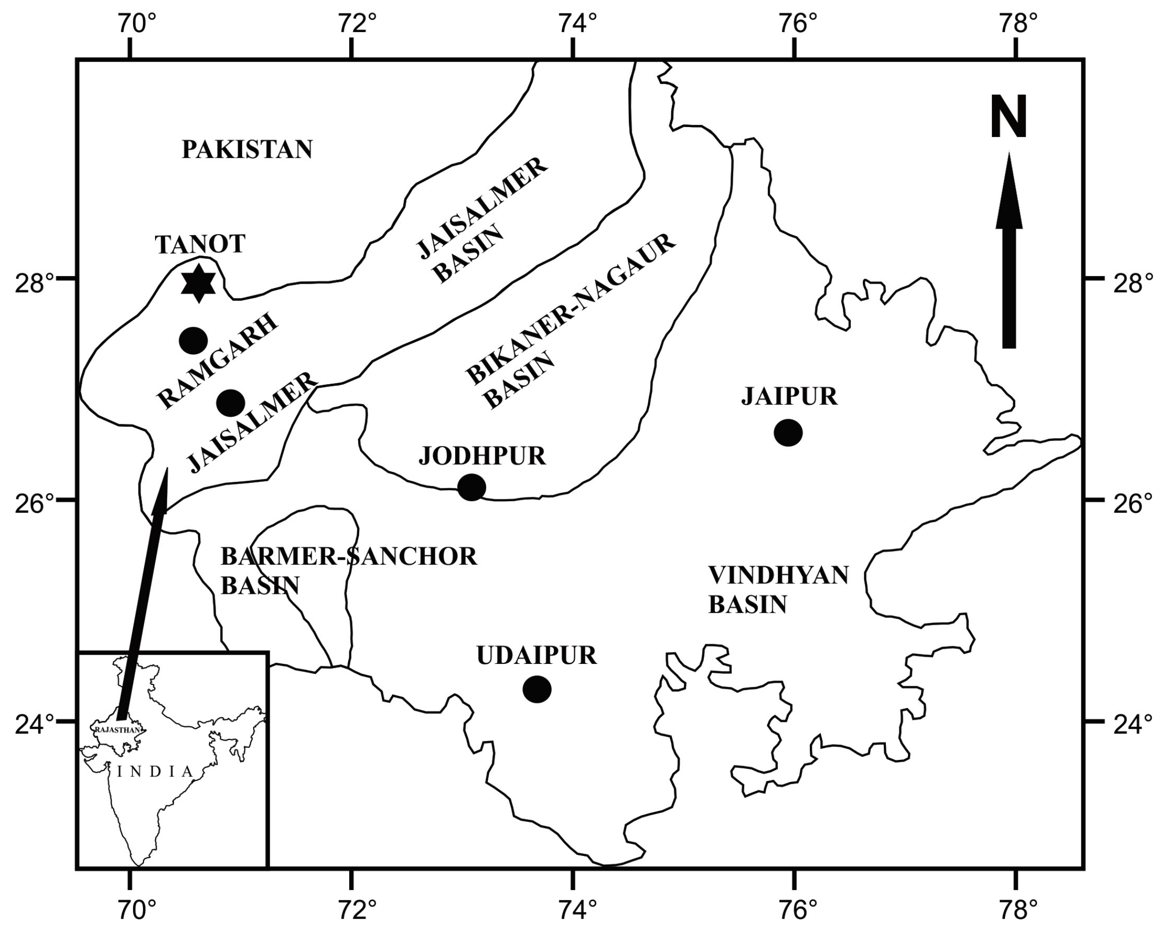

Fig. 1—Map showing the study area.

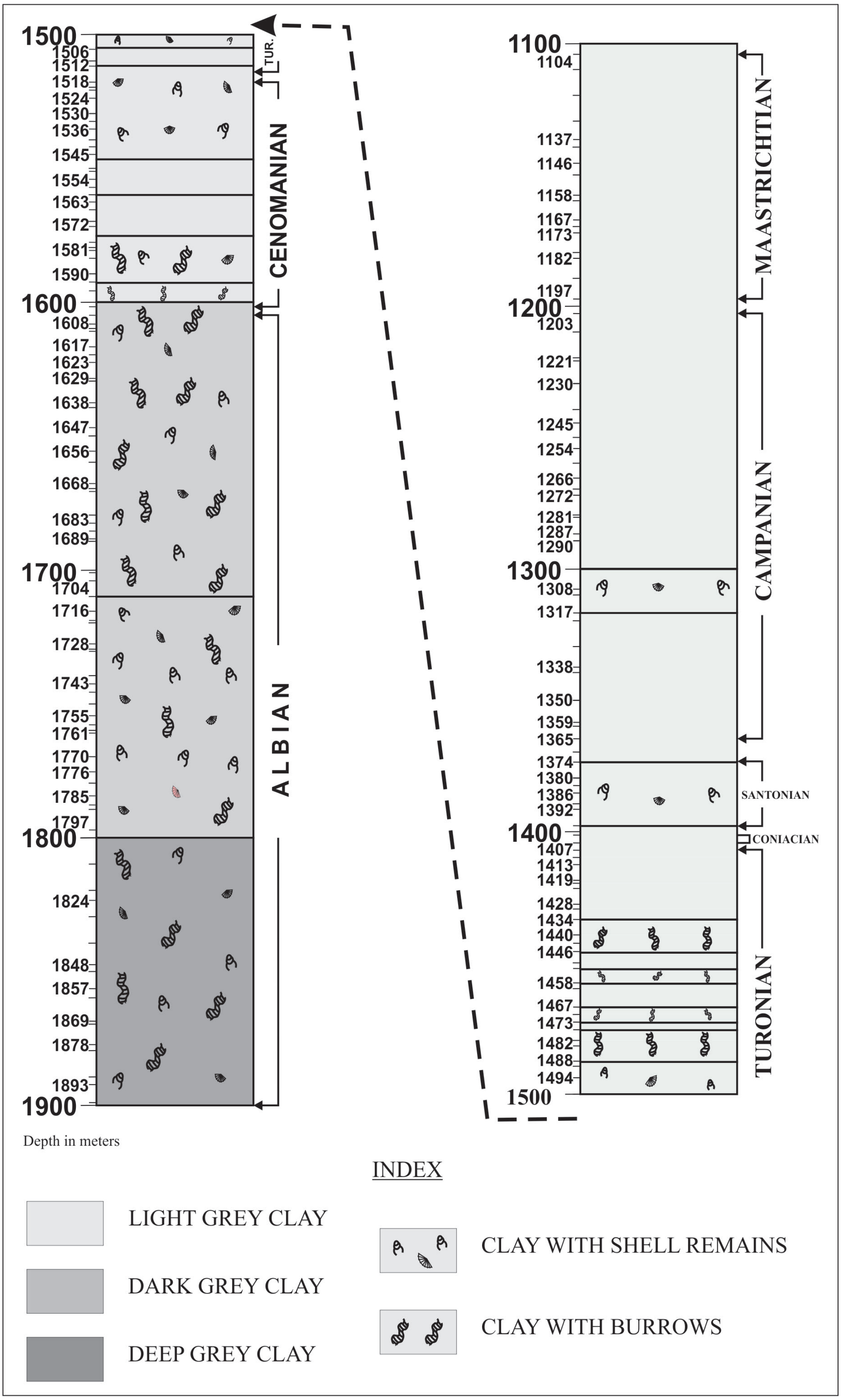

Fig. 2—Litholog of the Tanot well–1.

1996; Pandey *et al*., 2014; Pandey & Pooniya, 2015; Sharma & Pandey, 2016). Besides, ammonites some other fossil groups have also been studied from the Mesozoic sediments of the Jaisalmer Basin, viz. bivalves (Kachhara & Jodhawat, 1981), brachiopods (Singh & Mishra, 1980), echinoderms (Sahni, 1955, Sahni & Bhatnagar, 1958), small benthic foraminifers (Subbotina *et al*., 1953; Narayanan, 1959; Bhatia & Mannikeri, 1976; Garg & Singh, 1983, 1986; Kalia & Chowdhury, 1983; Singh & Sharma, 1991; Singh, 1996; Garg *et al*., 1998), ostracods (Lubimova *et al*., 1958; Khosla *et al*., 2006; Andreu *et al*., 2007), nannofossils (Rai & Garg, 2007; Rai *et al*., 2013a, b, 2016) corals (Pandey & Fursich, 1994; Pandey *et al*., 2009) and dinosaur footprints (Pieńkowski *et al*., 2015).

Fossil plant records from Lathi Formation are also available from the Mesozoic sediments of the Jaisalmer Basin. Blanford (1877) recorded dicotyledonous plant remains. Srivastava (1966) recorded some pollen from Lathi and Jaisalmer formations. Lukose (1972) recorded pollen and spores from the subsurface sediments of Lathi Formation. Maheshwari and Singh (1974) reported plant megafossils groups Filicales, Cycadales, Bennettitales and Coniferales from the lower part of the Pariwar Formation, Jaisalmer Basin. Guleria and Shukla (2008) have recorded fossil woods from Pariwar Formation.

MATERIAL AND METHODS

Oil India Limited drilled a number of exploratory wells for hydrocarbons in the Jaisalmer Basin at Bakhri–Tibba, Ghotaru, Kharatar, Manhera Tibba, Dandewala and Tanot. 114 well cutting samples from Tanot #1 (27°46’N and 70°17’E) at different intervals (between 1104 to 1899 m depths) (Fig. 2) were studied under present work.

Smear–slides were prepared for nannofossil study. 1 gm (dry weight) of material is taken and kept in a covered crucible. 10 ml of distilled water was poured to make an even suspension by stirring it. With the help of a clean dropper 5 drops of suspension was taken for making a thin film of sediment on the slide. Two slides, one containing fine and the other containing comparatively coarse fraction were prepared and allowed to dry on a hot plate. Few drops of mounting medium (canada balsam) was poured with the help of a glass rod and a cover slip of appropriate dimension was used to cover the slide containing dried suspension film. The cooked slide with the cover slip was picked with the help of a pincer and allowed to cool on a flat surface. The cover slip was evenly pressed so that permanent slide of uniform thickness was prepared. Nannofossils were observed with a Leitz make polarising microscope with x10 or x12.5 occulars and a x100 objective, the latter requiring immersion oil. Immersion oil and /or phase contrast objectives were used for the study of all of the forms. The gypsum plate was used in identification of some critical forms. The slides were deposited in the Birbal Sahni Institute of Palaeosciences Museum (BSIP Museum Slide No. 14280–14393)

SYSTEMATICS

The systematics of calcareous nannofossils are entirely based on the morphological structure and shape of the coccoliths and nannoliths. Braarud *et al*. (1966), Reinhardt (1966), Hay *et al*. (1966) and Bukry (1969) have compiled and published most of the terms with their definitions used herein for the morphological description of the coccoliths. The taxonomic classification applied herein is described in Bown and Young (1997).

The general construction of the margin of coccoliths is of primary importance to differentiate families. The

PLATE 1

Each bar represents 5 µm; xn–under cross polarized light; δ–under gypsum plate; nl–under normal light →

1a–c. *Arkhangelskiella confusa* Burnett, 1998 (sample 1167–1a xn, 1b δ, 1c nl).
2a–c. *Arkhangelskiella cymbiformis* Vekshina, 1959 (sample 1137–2a xn, 2b δ, 2c nl).
3a–c. *Broinsonia enormis* (Shumenko, 1968) Manivit, 1971 (sample 1404–3a xn, 3b δ, 3c nl).
4a–c. *Broinsonia matalosa* (Stover, 1966) Burnett *in* Gale *et al*., 1996 (sample 1203–4a xn, 4b δ, 4c nl).
5a–c. *Broinsonia parca constricta* Hattner *et al*., 1980 (sample 1137–5a xn, 5b δ, 5c nl).
6a–c. *Broinsonia parca expansa* Wise and Watkins *in* Wise, 1983 (sample 1137–6a xn, 6b δ, 6c nl).
7a–c. *Broinsonia signata* (Noël, 1969) Noël, 1970 (sample 1104–7a xn, 7b δ, 7c nl).
8a–c. *Axopodorhabdus albianus* (Black, 1967) Wind and Wise *in* Wise and Wind, 1977 (sample 1447–8a xn, 8b δ, 8c nl).
9a–c. *Cribrocorona gallica* (Stradner, 1963) Perch–Nielsen, 1973 (sample 1158–9a xn, 9b δ, 9c nl).
10a–c. *Cribrosphaerella ehrenbergii* (Arkhangelsky, 1912) Deflandre *in* Piveteau, 1952 (sample 1146–10a xn, 10b δ, 10c nl).
11a–c. *Nephrolithus corystus* Wind, (1983 sample 1137–11a xn, 11b δ, 11c nl).
12a–c. *Nephrolithus frequens* Górka, 1957 (sample 1146–12a xn, 12b δ, 12c nl).
13a–c. *Psyktosphaera firthii* Pospichal and Wise, 1990 (sample 1392–13a xn, 13b δ, 13c nl).
14a–c. *Tetrapodorhabdus decorus* (Deflandre *in* Deflandre and Fert, 1954) Wind and Wise *in* Wise and Wind, 1977 (sample 1158–14a xn, 14b δ, 14c nl).
15a–b. *Biscutum constans* (Górka, 1957) Black *in* Black and Barnes, 1959 (sample 1494–15a xn, 15b nl).
16a–b. *Biscutum* sp. cf. *B*. *coronum* Wind and Wise *in* Wise and Wind, 1977 (sample 1443–16a xn, 16b nl).
17a–b. *Biscutum dissimilis* Wind and Wise *in* Wise and Wind, 1977 (sample 1245–17a xn, 17b nl).

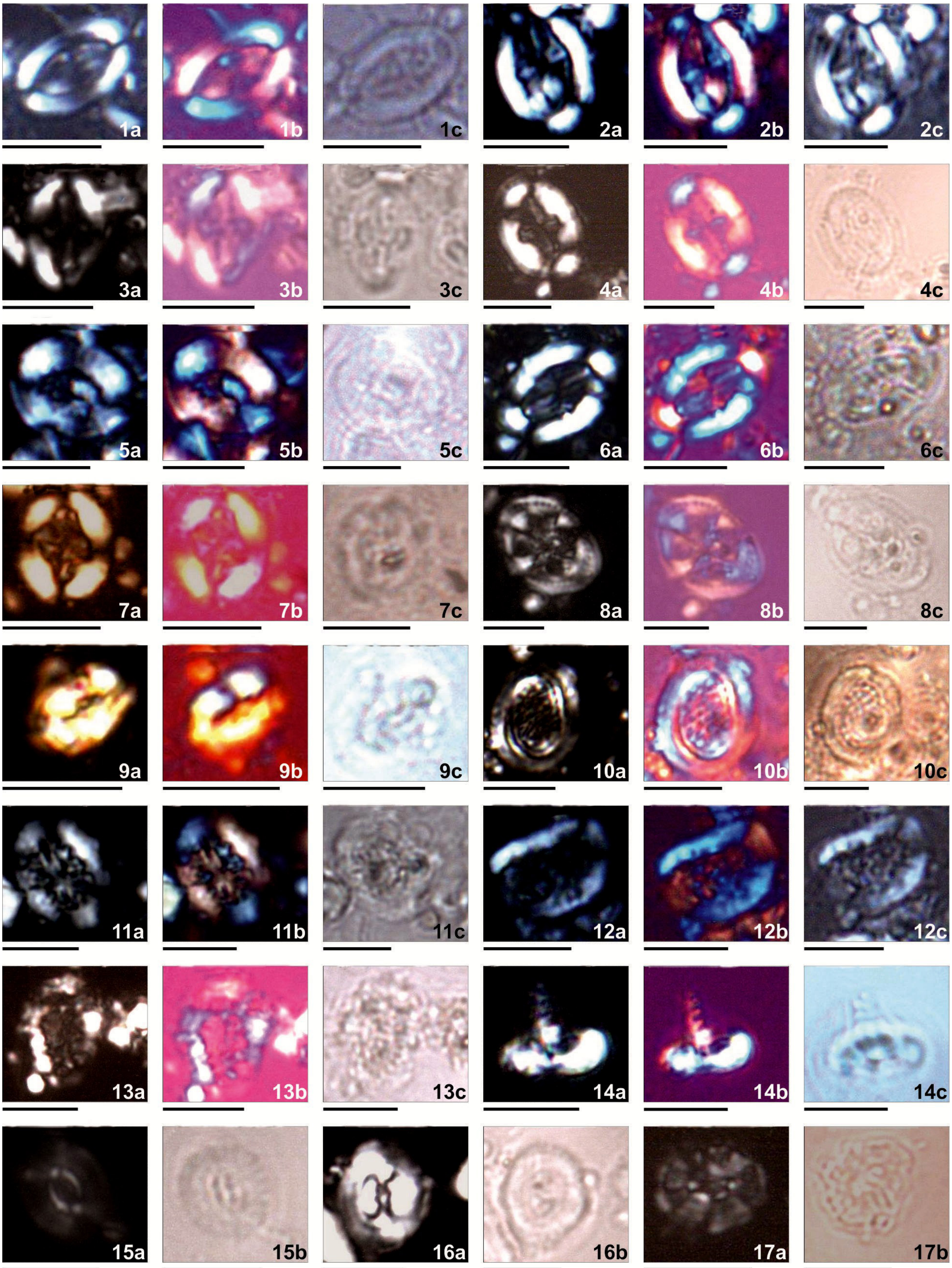
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PLATE 1

characterization of genera is based on rim features and the composition of the central structure. Systematic treatment of calcareous nannoplanktons is after Bown (1998). Families and genera recorded herein are arranged in alphabetical order. Except Family Calyptrosphaeraceae representing holococcoliths, other families are described under Heterococcoliths. Most of the references cited for genera, species and in synonmy list are given in Bown (1998). The remaining references are included in reference list.

Kingdom—PROTISTA (Eukaryot)

Division—HAPTOPHYTA

Class—PRYMNESIOPHYCEAE Hibberd, 1976

Family—ARKHANGELSKIELLACEAE Bukry, 1969 emend. Bown & Hampton *in* Bown & Young, 1997

Genus—ARKHANGELSKIELLA Vekshina, 1959

Type species—*Arkhangelskiella cymbiformis* Vekshina, 1959

Arkhangelskiella confusa Burnett, 1998

(Pl. 1.1a–c)

1959 *Arkhangelskiella cymbiformis* Vekshina, pp. 132, pl. 1, figs 5–8.
1998 *Arkhangelskiella confusa* Burnett, pp. 133.
1998 *Arkhangelskiella confusa* Burnett *in* Bown, pp. 182, pl. 6.8, figs 6a–7.
2004 *Arkhangelskiella confusa* Chira *et al*., pp. 96, pl. 2, figs 3a–b.

Remarks—Small to medium–sized *Arkhangelskiella* with a 1.0–1.5 µm thick rim. Plate perforates with typical Arkhangelskiellid segmentation. Forms recorded in sample number 1167 have very strong birefringent rim than specimens recorded in other samples. This species appears in Coniacian.

Occurrence—This species is recorded from Cenomanian to Maastrichtian in Tanot well–1. It seems that the forms recorded in Cenomanian are dropping from younger levels.

Dimensions—L/W 6.86 µm/4.54 µm.

Known stratigraphic range—Coniacian–Maastrichtian.

Arkhangelskiella cymbiformis Vekshina, 1959

(Pl. 1.2a–c)

1959 *Arkhangelskiella cymbiformis* Vekshina, pp. 66, pl. 2, figs 3a–b.
1963 *Arkhangelskiella cymbiformis* Stradner, pp. 12, pl. 1, figs 4a–b.
1964 *Arkhangelskiella cymbiformis* Bramlette & Martini, pp. 297, pl. 1, figs 3–9.
1965 *Arkhangelskiella cymbiformis* Reinhardt, pp. 31, pl. 2, fig. 6.
1966 *Arkhangelskiella cymbiformis* Reinhardt, pp. 31, pl. 6, figs 1–3, pl. 22, figs 14–19.
1967 *Arkhangelskiella cymbiformis* Moshkovitz, pp. 146, pl. 1, figs 6a, 7, 8.
1968 *Arkhangelskiella cymbiformis* Gartner, pp. 38, pl. 1, figs 1–6, pl. 4, figs 1–4, pl. 6, figs 1a–c.
1969 *Arkhangelskiella cymbiformis* Bukry, pp. 21, pl. 1, figs 1–3.
1971 *Arkhangelskiella cymbiformis* Manivit, pp. 103, pl. 1, figs 6–11.
1973 *Arkhangelskiella cymbiformis* Priewalder, pp. 45, pl. 1, figs 3–8.

PLATE 2

Each bar represents 5 µm; xn–under cross polarized light; δ–under gypsum plate; nl–under normal light →

1a–b. *Biscutum ellipticum* (Górka, 1957) Grün *in* Grün and Allemann, 1975 (sample 1245–1a xn, 1b nl).
2a–b. *Biscutum hattneri* Wise, 1983 (sample 1137–2a δ, 2b nl).
3a–b. *Biscutum* sp. cf. *B. magnum* Wind and Wise *in* Wise and Wind, 1977 (sample 1221–3a xn, 3b nl).
4a–c. *Biscutum melaniae* (Górka, 1957) Reinhardt, 1969 (sample 1137–4a xn, 4b δ, 4c nl).
5a–c. *Crucibiscutum hayi* (Black, 1973) Jakubowski, 1986 (sample 1398–5a xn, 5b δ, 5c nl).
6a–b. *Discorhabdus ignotus* (Górka, 1957) Perch–Nielsen, 1968 (sample 1146–6a xn, 6b δ).
7a–b. *Seribiscutum primitivum* (Thierstein, 1974) Filewicz *et.al. in* Wise and Wind, 1977 (sample 1281–7a xn, 7b nl).
8a–b. *Sollasites horticus* (Stradner *et al. in* Stradner and Adamiker, 1966) Cepek and Hay, 1969 (sample 1374–8a xn, 8b δ).
9a–c. *Braarudosphaera africana* Stradner, 1961 (sample 1797–9a xn, 9b δ, 9c nl).
10. *Braarudosphaera bigelowii* (Gran and Braarud, 1935) Deflandre, 1947 (sample 1338–10 δ).
11a–b. *Braarudosphaera stenorhetha* Hill, 1976 (sample 1770–11a xn, 11b δ).
12a–c. *Micrantholithus obtusus* Stradner, 1963 (sample 1104–12a xn, 12b δ, 12c nl).
13a–c. *Micrantholithus* sp. 1 (sample 1104–13a xn, 13b δ, 13c nl).
14a–c. *Micrantholithus stellatus* Aguado *in* Aguado *et al*., 1997 (sample 1443–14a xn, 14b δ, 14c nl).
15a–c. *Scapholithus fossilis* Deflandre *in* Deflandre and Fert, 1954 (sample 1146–15a xn, 15b δ, 15c nl).
16a–b. *Bifidalithus geminicatillus* Varol, 1991 (sample 1146–16a δ, 16b nl).
17a–18b. *Calculites obscurus* (Deflandre, 1959) Prins and Sissingh *in* Sissingh, 1977 (sample 1137–17a δ, 17b nl; sample 1221, side view–18a xn, 18b nl).
19. *Calculites ovalis* (Stradner, 1963) Prins and Sissingh *in* Sissingh, 1977 (sample 1197–19 xn).
20a–b. *Calculites percenis* Jeremiah, 1996 (sample 1245–20a xn, 20b nl).
21a–b. Holococcolith sp. 1 (sample 1104–21a xn, 21b nl)
22. Holococcolith sp. 2 (sample 1167–22 δ).

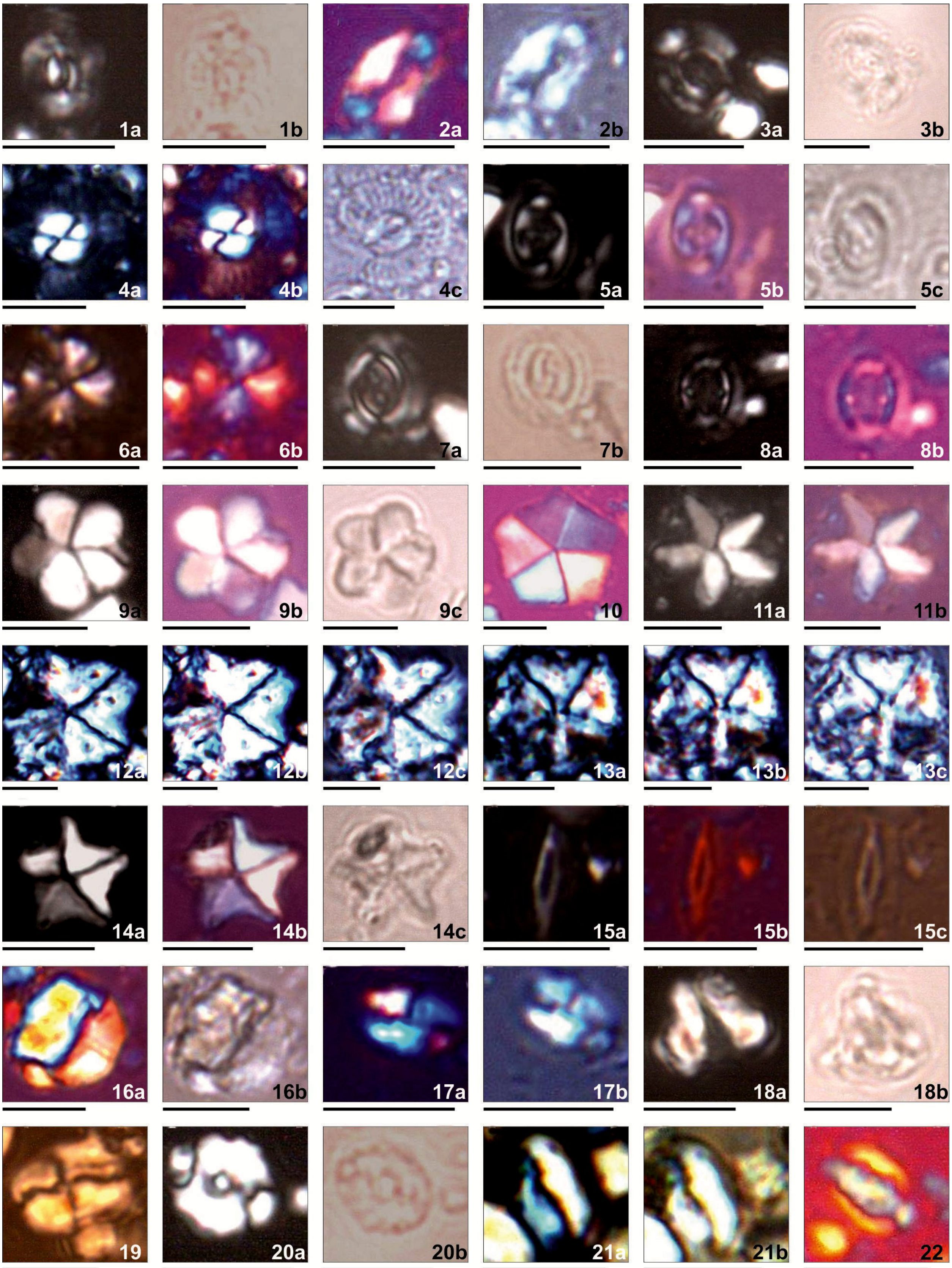
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PLATE 2

1973 *Arkhangelskiella cymbiformis* Kapellos & Schaub, pp. 729, pl. 10, fig. 8.
1978 *Arkhangelskiella cymbiformis* Shafik, pp. 213, pl. 2, figs Qa–Rb.
1980 *Arkhangelskiella cymbiformis* Barrier, pp. 300, pl. 3, figs 1–4.
1981 *Arkhangelskiella cymbiformis* Smith, pp. 28, pl. 1, figs 16–25, 31–32, 34.
1982 *Arkhangelskiella cymbiformis* Hanzlikova *et al*., pp. 132, pl. 1, figs 2–6, pl. 6, figs 6–8, 22, pl. 8, figs 1, 2, pl. 10, figs 22–23.
1982 *Arkhangelskiella cymbiformis* Abdelmalik, pp. 80, pl. 1, figs 15–16.
1982 *Arkhangelskiella cymbiformis* Siesser, pp. 342, pl. 8, figs K, k.
1985 *Arkhangelskiella cymbiformis* Perch–Nielsen, pp. 353, pl. 15, figs 5–7.
1989 *Arkhangelskiella cymbiformis* Moshkovitz & Osmond, pp. 88, pl. 4.1, figs 8–18, pl. 4.2, figs 9–12.
1995 *Arkhangelskiella cymbiformis* Mochi *et al*., pp. 70, pl. 1, figs 19–20.
1996 *Arkhangelskiella cymbiformis* Concheyro & Villa, pp. 296, pl. 1, fig. 4.
1998 *Arkhangelskiella cymbiformis* Burnett *in* Bown, pp. 182, pl. 6.8, figs 2–4, 8–9.
2001 *Arkhangelskiella cymbiformis* Ladner & Wise *in* Beslier *et al*., pp. 49, pl. 3, figs 1–2.
2003 *Arkhangelskiella cymbiformis* Tantawy, pp. 329, pl. 1, figs 5, 10.
2004 *Arkhangelskiella cymbiformis* Chira *et al*., pp. 96, pl. 2, figs 1a–c.
2012 *Arkhangelskiella cymbiformis* Farouk & Faris, pp. 58, figs 8.1–2.
2013 *Arkhangelskiella cymbiformis* Zahran, pp. 991, pl. 1, figs 12–14, pp. 992, pl. 2, figs 4–5.
2015 *Arkhangelskiella cymbiformis* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 12.

Remarks—Large sized *Arkhangelskiella* with perforations which may not have completely pierced the central area. Each quadrant of the central area contains 1 to 5 regularly arranged perforations. Secondary sutures within the quadrants are not quite perpendicular to the subaxial sutures.

Occurrence—In present study this species is observed (few to rare) in the Campanian–Maastrichtian sediments.

Dimensions—L/W 8.69 µm/6.57 µm.

Known stratigraphic range—Campanian–Maastrichtian.

Genus—BROINSONIA Bukry, 1969

Type species—*Broinsonia dentata* Bukry, 1969

Broinsonia enormis (Shumenko, 1968) Manivit, 1971

(Pl. 1.3a–c)

1968 *Arkhangelskiella enormis* Shumenko, pp. 33, pl. 1, figs 3.
1969 *Broinsonia bevieri* Bukry, pp. 21, pl. 1, figs 8–10.
1969 *Aspidolithus angustus* Noël, pp. 196, pl. 1, figs 1–2.
1970 *Broinsonia bevieri* Noël, pp. 75, pl. 23, figs 1, 5, pl. 24, figs 1–5, pl. 25, figs 1–3, 5.
1971 *Broinsonia enormis* (Shumenko, 1968) Manivit, pp. 105, pl. 1, figs 18–20.
1972 *Broinsonia bevieri* Roth & Thierstein, pl. 14, figs 14–17, 22–29.
1973 *Broinsonia enormis* Thierstein, pp. 35.
1998 *Broinsonia enormis* Burnett *in* Bown, pp. 182, pl. 6.8, figs 18a–19.
2013a *Broinsonia enormis* Rai *et al*., pp. 58, pl. 1, fig. 5.
2015 *Broinsonia enormis* Linnert & Mutterlose, pp. 731, fig. 4E'.

PLATE 3

Each bar represents 5 µm; xn–under cross polarized light; δ–under gypsum plate; nl–under normal light →

1a–b. *Isocrystallithus compactus* Verbeek, 1976 (sample 1158–1a xn, 1b nl).
2a–b. *Isocrystallithus* sp. cf. *I. compactus* Verbeek, 1976 (sample 1386–2a δ, 2b nl).
3a–b. *Lucianorhabdus arcuatus* Forchheimer, 1972 (sample 1146–3a δ, 3b nl).
4a–b. *Lucianorhabdus cayeuxii* Deflandre, 1959 (sample 1146–4a xn, 4b nl).
5a–b. *Lucianorhabdus maleformis* Reinhardt, 1966 (sample 1137–5a xn, 5b nl).
6a–b. *Munarinus marszalekii* Risatti, 1973 (sample 1104–6a xn, 6b δ).
7. *Octolithus multiplus* (Perch–Nielsen, 1973) Romein, 1979 (sample 1158–7 xn).
8a–b. *Okkolithus australis* Wind and Wise *in* Wise and Wind, 1977 (sample 1137–8a δ, 8b nl).
9. *Orastrum perspicuum* Varol *in* Al–Rifaiy *et al*., 1990 (sample 1197–9 xn).
10a–b. *Orastrum* sp. cf. *O. perspicuum* Varol *in* Al–Rifaiy *et al*., 1990 (sample 1173–10a xn, 10b nl).
11a–b. *Orastrum* sp. 1 (sample 1137–11a xn, 11b nl).
12a–b. *Owenia hillii* Crux, 1991b (sample 1494–12a xn, 12b δ).
13a–b. *Petrobrasiella* sp. 1 (sample 1146–13a xn, 13b δ).
14a–b. *Russellia bukryi* Risatti, 1973 (sample 1146–14a–b xn).
15a–b. *Saepiovirgata biferula* Varol, 1991 (sample 1167–15a–b xn).
16a–b. *Semihololithus priscus* Perch–Nielsen, 1973 sample 1158 (16a xn, 16b nl).
17a–c. *Ceratolithoides pricei* Burnett, 1998 (sample 1146–17a xn, 17b δ, 17c nl).
18a–c. *Ceratolithoides self–trailiae* Burnett, 1998 (sample 1158–18a xn, 18b δ, 18c nl).
19a–c. *Ceratolithoides ultimus* Burnett, 1998 (sample 1146–19a xn, 19b δ, 19c nl).
20a–c. *Ahmuellerella octoradiata* (Górka, 1957) Reinhardt, 1966 (sample 1446–20a xn, 20b δ, 20c nl).
21a–c. *Amphizygus brooksii* Bukry, 1969 (sample 1413–21a xn, 21b δ, 21c nl).
22a–c. *Bukrylithus ambiguus* Black, 1971 (sample 1317–22a xn, 22b δ , 22c nl).

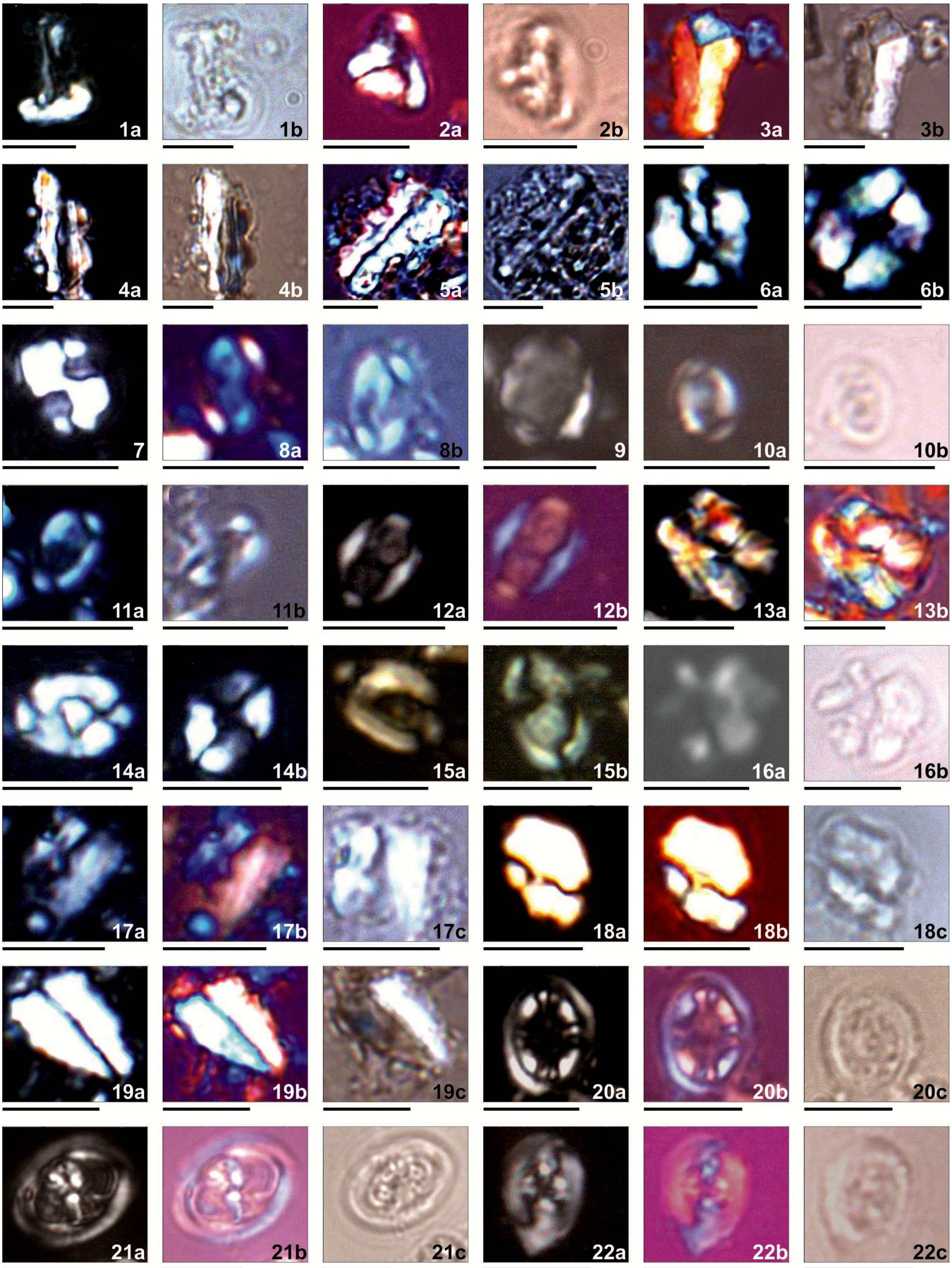
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PLATE 3

Remarks—In Tanot well–1 the forms show a broader outer rim and imperforated central plate may be due to overgrowth of calcite. An axial cross is seen with more distinct longest suture under the cross polarized light.

Occurrence—Few to common occurrences of this form are recorded from Cenomanian–Turonian sediments in Tanot well–1.

Dimensions—L/W 6.63 µm/5.15 µm.

Known stratigraphic range—Albian–? Maastrichtian.

Broinsonia matalosa (Stover, 1966) Burnett *in* Gale *et al*., 1996

(Pl. 1.4a–c)

1966 *Coccolithus matalosus* Stover, pp. 139, pl. 2, figs 1–2, pl. 8, fig. 10.
1968 *Coccolithus matalosus* Gartner, pp. 18, pl. 24, figs 5a–d.
1966 *Tranolithus gabalus* Stover, pp. 146, pl. 4, fig. 22, pl. 9, fig. 5.
1971 *Staurolithites matalosus* Manivit, pp. 84, pl. 24, figs 6–10.
1973 *Vagalapilla matalosa* Thierstein, pp. 37, pl. 3, figs 15–18.
1976 *Vagalapilla matalosa* Hill, pp. 159, pl. 12, figs 7–15.
1996 *Broinsonia matalosa* (Stover, 1966) Burnett *in* Gale *et al*., pp. 529.
1998 *Broinsonia matalosa* Burnett *in* Bown, pp. 182, pl. 6.8, figs 26a–c.

Remarks—Elliptical coccoliths consist of two closely appressed plates with the distal plate larger than the proximal one. The rim of the coccolith is of medium width, with its outer edge smooth or partially scalloped, and its inner edge smooth. The central opening is spanned by a cross. The bars of the cross are inclined centro–distally and may support a spine or boss at their intersection. The central area also contains a ring–like band of variable width–generally narrower opposite the expanded ends of the cross bars–that lies next to the rim.

Occurrence—This species occurs sparsely in Albian to Coniacian sediments of Bore well; however, its reworking is noted in Maastrichtian at 1146 m.

Dimensions—L/W 7.72 µm/5.92 µm.

Known stratigraphic range—Barremian–Campanian.

Broinsonia parca constricta Hattner *et al*., 1980

(Pl. 1.5a–c)

1966 *Arkhangelskiella cymbiformis* Stover, pp. 137, pl. 1, fig. 17.
1969 *Broinsonia parca* Bukry, pp. 23, pl. 3, figs 3–6.
1969 *Aspidolithus parcus* Noël, pp. 196, pl. 1, figs 3–4.
1980 *Broinsonia parca constricta* Hattner *et al*., pp. 41, pl. 2, figs 2–3.
1998 *Broinsonia parca constricta* Burnett *in* Bown, pp. 182, pl. 6.8, figs 14–15.
2001 *Broinsonia parca constricta* Ladner & Wise *in* Beslier *et al*., pp. 50, pl. 4, fig. 1.
2014 *Broinsonia parca constricta* Jelby *et al*., pp. 93, fig. 5A.

Remarks—This is the subspecies of *Broinsonia parca* with a very small central and constricted area whose width is approximately equal to or slightly less than the width of the shield margin. One to three rounded perforations per quadrant pierce approximately parallel to the major axis and these perforations are subdivided by fine membrane–like processes which resemble a sieve plate with more or less rounded openings.

PLATE 4

Each bar represents 5 µm; xn–under cross polarized light; δ–under gypsum plate; nl–under normal light →

1a–b. *Chiastozygus bifarius* Bukry, 1969 (sample 1146–1a δ, 1b nl).
2a–b. *Chiastozygus litterarius* (Górka, 1957) Manivit, 1971 (sample 1137–2a xn, 2b nl).
3a–b. *Chiastozygus trabalis* (Górka, 1957) Burnett, 1998 (sample 1554–3a xn, 3b nl).
4a–c. *Gorkaea operio* Varol and Girgis, 1994 (sample 1104–4a xn, 4b δ, 4c nl).
5a–c. *Loxolithus armilla* (Black *in* Black and Barnes, 1959) Noël, 1965 (sample 1137–5a xn, 5b δ, 5c nl).
6a–b. *Placozygus fibuliformis* (Reinhardt, 1964) Hoffmann, 1970 (sample 1182–6a δ, 6b nl).
7a–b. *Placozygus* sp. cf. *P. fibuliformis* (Reinhardt, 1964) Hoffmann, 1970 (sample 1146–7a δ, 7b nl).
8a–b. *Reinhardtites anthophorus* (Deflandre, 1959) Perch–Nielsen, 1968 (sample 1137–8a δ, 8b nl).
9a–b. *Reinhardtites levis* Prins and Sissingh *in* Sissingh, 1977 (sample 1230–9a xn, 9b nl).
10a–b. *Rhabdophidites parallelus* (Wind and Cepek, 1979) Lambert, 1987 (sample 1158–10a xn, 10b nl).
11a–b. *Staurolithites ?aenigma* Burnett, 1998 (sample 1245–11a xn, 11b nl).
12a–b. *Staurolithites crux* (Deflandre *in* Deflandre and Fert, 1954) Caratini, 1963 (sample 1758–12a xn, 12b nl).
13a–b. *Staurolithites dorfii* (Bukry, 1969) Burnett, 1998 (sample 1146–13a δ, 13b nl).
14a–b. *Staurolithites ellipticus* (Gartner, 1968) Lambert, 1987 (sample 1452–14a xn, 14b nl).
15a–b. *Staurolithites flavus* Burnett, 1998 (sample 1146–15a δ, 15b nl).
16a–b. *Staurolithites gausorhethium* (Hill, 1976) Varol and Girgis, 1994 (sample 1104–16a δ, 16b nl).
17a–b. *Staurolithites glaber* (Jeremiah, 1996) Burnett, 1998 (sample 1374–17a xn, 17b nl).
18a–b. *Staurolithites imbricatus* (Gartner, 1968) Burnett, 1998 (sample 1146–18a δ, 18b nl).
19a–b. *Staurolithites* sp. cf. *S. integer* (Bukry, 1969) Burnett *in* Bown, 1998 (sample 1137–19a xn, 19b nl).
20a–b. *Staurolithites laffittei* Caratini, 1963 (sample 1443–20a xn, 20b nl).
21a–b. *Staurolithites mielnicensis* (Górka, 1957) Perch–Nielsen, 1968 *sensu* Crux *in* Lord, 1982 (sample 1338–21a xn, 21b nl).
22a–b. *Staurolithites minutus* Burnett, 1998 (sample 1447–22a xn, 22b nl).
23a–b. *Staurolithites mitcheneri* (Applegate and Bergen, 1988) Rutledge and Bown, 1996 (sample 1758–23a xn, 23b nl).

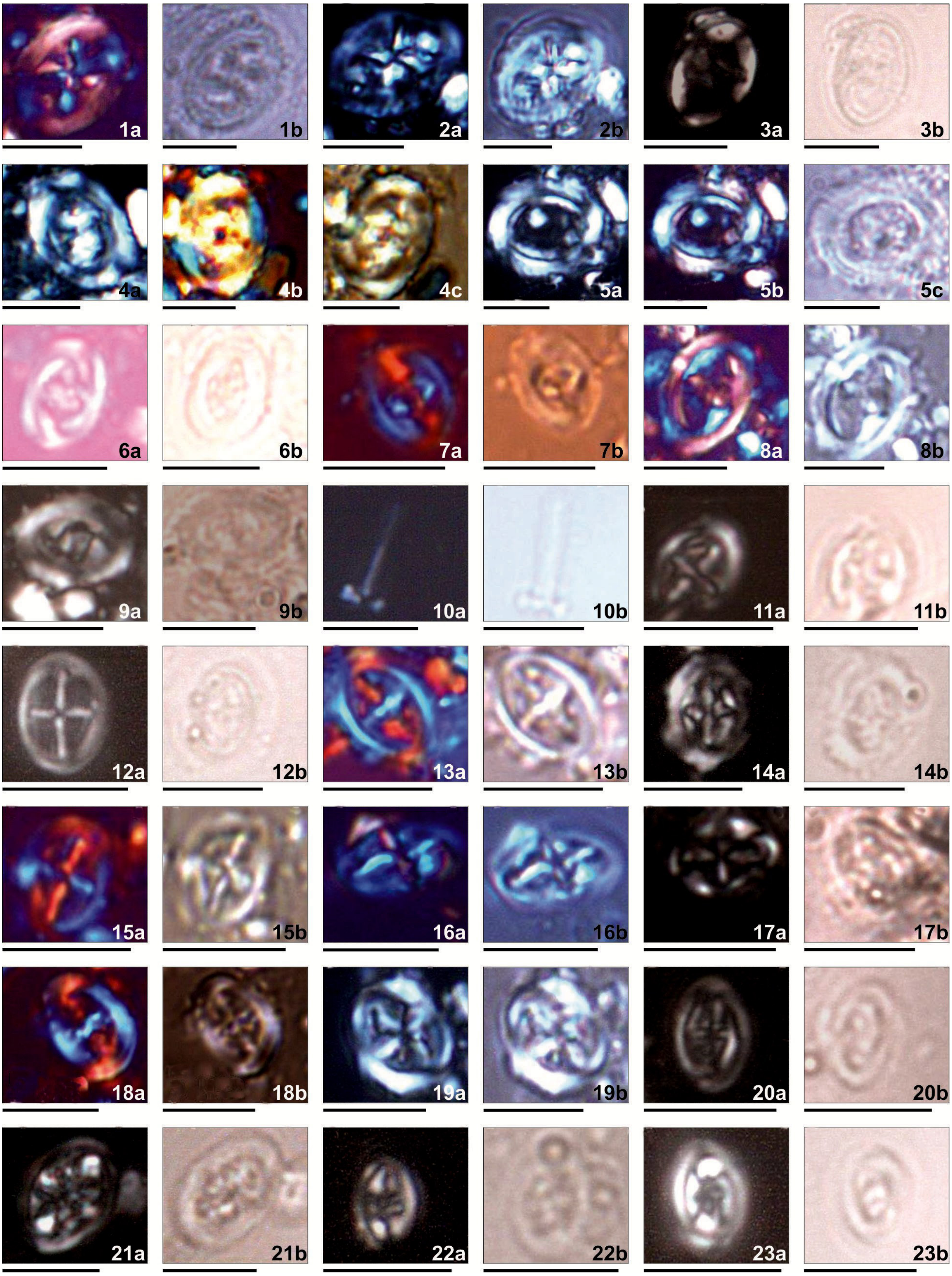
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PLATE 4

Occurrence—In the present study few occurrences of this species is observed only in Maastrichtian sediments and seems to be reworked because earlier known records are only from Campanian sediments.

Dimensions—L/W 7.71 µm/6.67 µm.

Known stratigraphic range—Campanian.

Broinsonia parca expansa Wise & Watkins *in* Wise, 1983

(Pl. 1.6a–c)

1983 *Broinsonia parca expansa* Wise & Watkins *in* Wise, pp. 506, pl. 9–11.
1998 *Broinsonia parca expansa* Burnett *in* Bown, pp. 182, pl. 6.8, fig. 11.

Remarks—Originally described from Santonian age sediments of Falkland Plateau of Southwest Atlantic Ocean. A subspecies of *Broinsonia parca* with a large central area whose width in distal view is approximately twice or more than twice the width of the shield margin. The width of the outer distal margin is less than that of the inner distal margin. Within the central area there exist two or more rounded perforations per quadrant along the major and minor axes. In atleast one quadrant perforations extend out along the periphery. The perforations are subdivided by fine processes which resemble a sieve plate with more or less rounded openings seen under SEM.

Occurrence—This species is recorded from the Coniacian–Campanian sediments of Tanot well–1. Few reworked forms are recorded in sample number 1146 of Maastrichtian age.

Dimensions—L/W 8.34 µm/5.92 µm.

Known stratigraphic range—Coniacian–Campanian.

Broinsonia signata (Noël, 1969) Noël, 1970

(Pl. 1.7a–c)

1968 *Arkhangelskiella enormis* Shumenko, pp. 33, pl. 1, fig. 1.
1969 *Aspidolithus signatus* Noël, pp. 197, pl. 2, figs 3–4.
1970 *Broinsonia signata* (Noël, 1969) Noël, pp. 78, pl. 25, figs 4–6.
1972 *Broinsonia signata* Roth & Thierstein, pl. 13, figs 12–20, pl. 14, figs 1–5.
1973 *Broinsonia signata* Thierstein, pp. 35.
1973 *Acaenolithus undatus* Black, pp. 58, pl. 21, figs 1–2, 4–5.
1998 *Broinsonia signata* Burnett *in* Bown, pp. 182, pl. 6.8, figs 22a–b, 24–25.
2015 *Broinsonia signata* Linnert & Mutterlose, pp. 731, fig. 4F'.

Remarks—*Broinsonia signata* is distinguished by a central structure composed of a cross of rather narrow bars, on which the sutures are situated, parallel to the axes of the elliptical disc. In the four open quadrants one to three little spokes may occur parallel to the shorter axis.

Occurrence—Thierstein (1973) provided range from Middle Albian–Late Campanian for this species, but in the present bore well material occurrence of this species is recorded from Cenomanian to Maastrichtian.

Dimensions—L/W 6.81 µm/5.23 µm.

Known stratigraphic range—Aptian?–Maastrichtian.

Family—AXOPODORHABDACEAE Bown & Young, 1997

Genus—AXOPODORHABDUS Wind & Wise *in* Wise & Wind, 1977

PLATE 5

Each bar represents 5 µm; xn–under cross polarized light; δ–under gypsum plate; nl–under normal light →

1a–b. *Staurolithites* sp. cf. *S. mutterlosei* Crux, 1989 12a–b (sample 1137–1a δ, 1b nl).
2a–b. *Staurolithites* sp. 1 (sample 1137–2a δ, 2b nl).
3a–b. *Staurolithites* sp. 2 (sample 1173–3a xn, 3b δ).
4a–b. *Staurolithites* sp. cf. *S. Zoensis* Burnett, 1998 (sample 1146–4a xn, 4b δ).
5a–b. *Tranolithus gabalus* Stover, 1966 (sample 1365–5a xn, 5b nl).
6a–b. *Tranolithus minimus* (Bukry, 1969) Perch–Nielsen, 1984 (sample 1104–6a δ, 6b nl).
7a–b. *Tranolithus orionatus* (Reinhardt, 1966a) Reinhardt, 1966 (sample 1137–7a δ, 7b nl).
8a–b. *Zeugrhabdotus bicrescenticus* (Stover, 1966) Burnett *in* Gale *et. al*., 1996 (sample 1104–8a xn, 8b nl).
9a–b. *Zeugrhabdotus biperforatus* (Gartner, 1968) Burnett, 1998 (sample 1158–9a δ, 9b nl).
10a–b. *Zeugrhabdotus diplogrammus* (Deflandre *in* Deflandre and Fert, 1954) Burnett *in* Gale *et al*., 1996 (sample 1182–10a δ, 10b nl).
11a–b. *Zeugrhabdotus 'elegans'* (Gartner, 1968) Burnett *in* Gale *et. al*., 1996 (sample 1350–11a xn, 11b nl).
12a–b. *Zeugrhabdotus embergeri* (Noël, 1958) Perch–Nielsen, 1984 (sample 1137–12a xn, 12b nl).
13a–b. *Zeugrhabdotus erectus* (Deflandre *in* Deflandre and Fert, 1954) Reinhardt, 1965 (sample 1146–13a xn, 13b nl).
14a–b. *Zeugrhabdotus kerguelenesis* Watkins, 1992 (sample 1350–14a δ, 14b nl).
15a–b. *Zeugrhabdotus noeliae* Rood *et al*., 1971 (sample 1494–15a xn, 15b nl).
16a–b. *Zeugrhabdotus scutula* (Bergen, 1994) Rutledge and Bown, 1996 (sample 1359–16a xn, 16b nl).
17a–b. *Zeugrhabdotus* sp. cf. *Z. sigmoides* (Bramlette and Sullivan, 1961) Bown and Young, 1997 (sample 1365–17a xn, 17b nl).
18a–b. *Zeugrhabdotus trivectis* Bergen, 1994 (sample 1245–18a xn, 18b nl).
19a–b. *Zeugrhabdotus xenotus* (Stover, 1966) Burnett *in* Gale *et. al*., 1996 (sample 1137–19a δ, 19b nl).
20a–b. *Coccolithus pelagicus* (Wallich, 1871) Schiller, 1930 (sample 1137–20a xn, 20b nl).
21a–b. *Crepidolithus crassus* (Deflandre *in* Deflandre and Fert, 1954) Noël, 1965 (sample 1104–21a xn, 21b δ).
22a–b. *Crepidolithus* sp. 1 (sample 1137–22a xn, 22b δ).
23a–b. *Cretarhabdus conicus* Bramlette and Martini, 1964 (sample 1221–23a xn, 23b nl).
24a–b. *Cretarhabdus striatus* (Stradner, 1963) Black, 1973 (sample 1167–24a xn, 24b δ).

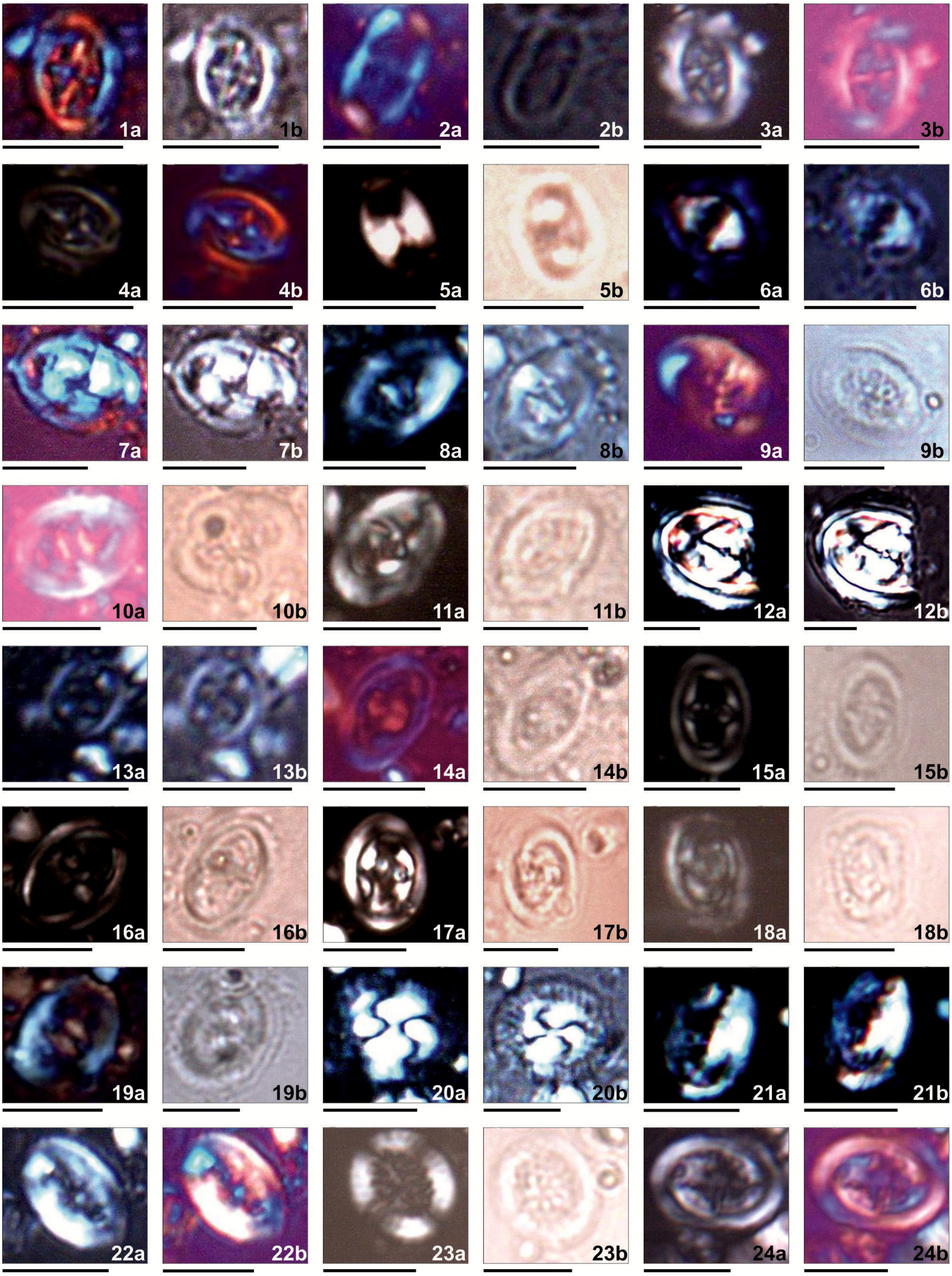
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PLATE 5

Type Species—*Podorhabdus albianus* Black, 1967

Axopodorhabdus albianus (Black, 1967) Wind & Wise *in* Wise & Wind, 1977

(Pl. 1.8a–c)

1965 *Rhabdosphaera* sp. Black, pp. 133, fig. 10.
1967 *Podorhabdus albianus* Black, pp. 143–144.
1971 *Podorhabdus orbiculofenestratus* Thierstein, pp. 478, pl. 8, figs 9–17.
1977 *Axopodorhabdus albianus* (Black, 1967) Wind & Wise *in* Wise & Wind, pp. 297.
1992 *Axopodorhabdus albianus* Kale & Phansalkar, pp. 88, pl. 1, fig. 19, pl. 2, fig. 7.
1998 *Axopodorhabdus albianus* Burnett *in* Bown, pp. 175, pl. 6.5, figs 1–2.
2013a *Axopodorhabdus albianus* Rai *et al*., pp. 58, pl. 1, fig. 1.

Remarks—This species of *Axopodorhabdus* has single ring of about forty petaloid elements in the distal shield, four buttresses of approximately equal width, and a thin–walled cylindrical and gently tapering spine about 1.0 µm in diameter at its base. In some specimens the rim shows presence of three layers which are in close contact. The distal layer shows well–formed petaloid elements which show no sign of imbrications except at the inner margin. The intermediate and proximal layers appear to be normal in having no visible imbrications. On the distal side, the buttresses are covered with thin rhombohedral scales of variable size.

Occurrence—In the present study this species is recorded from Albian to Turonian sediments. Rare occurrences observed in Turonian were considered as reworked.

Dimensions—L/W 10.24 µm/7.83 µm.

Known stratigraphic range—Middle Albian–Early Cenomanian.

Genus—CRIBROCORONA Perch–Nielsen, 1973

Type Species—*Coccolithus gallicus* Stradner, 1963

Cribrocorona gallica (Stradner, 1963) Perch–Nielsen, 1973

(Pl. 1.9a–c)

1963 *Coccolithus gallicus* Stradner, pp. 10, pl. 1, figs 8–8a.
1964 *Cylindralithus ?gallicus* Bramlette & Martini, pp. 308, pl. 5, figs 15–17.
1973 *Cribrocorona gallica* (Stradner, 1963) Perch–Nielsen, pp. 312, pl. 4, figs 1–4.
1998 *Cribrocorona gallica* Burnett *in* Bown, pp. 175, pl. 6.5, figs 14a–b.

Remarks—The grillate structure in the centre of the cylinder excludes the possibility to place this species in the genus *Cylindralithus* Bramlette and Martini, 1964, a view shared herein.

Occurrence—Rare occurrences of this species are recorded from only one sample at 1158 m (Maastrichtian age) from Tanot well–1.

Dimensions—L/W 5.21 µm/4.47 µm.

Known stratigraphic range—Coniacian–Maastrichtian.

Genus—**CRIBROSPHAERELLA** Deflandre *in* Piveteau, 1952

Type Species—*Cribrosphaerella ehrenbergii* Arkhangelsky, 1912

Cribrosphaerella ehrenbergii (Arkhangelsky, 1912) Deflandre *in* Piveteau, 1952

(Pl. 1.10a–c)

PLATE 6

Each bar represents 5 µm; xn–under cross polarized light; δ–under gypsum plate; nl–under normal light →

1a–c. *Cruciellipsis cuvillieri* (Manivit, 1966) Thierstein, 1971 (sample 1518–1a xn, 1b δ, 1c nl).
2a–c. *Grantarhabdus coronadventis* (Reinhardt, 1966) Grün *in* Grün and Allemann, 1975 (sample 1350–2a xn, 2b δ, 2c nl).
3a–c. *Helenea chiastia* Worsley, 1971 (sample 1557–3a xn, 3b δ, 3c nl).
4a–c. *Retecapsa angustiforata* Black, 1971 (sample 1173–4a xn, 4b δ, 4c nl).
5a–c. *Retecapsa crenulata* (Bramlette and Martini, 1964) Grün *in* Grün and Allemann, 1975 (sample 1383–5a xn, 5b δ, 5c nl).
6a–c. *Retecapsa ficula* (Stover, 1966) Burnett, 1998 (sample 1146–6a xn, 6b δ, 6c nl).
7a–c. *Retecapsa schizobrachiata* (Gartner, 1968) Grün *in* Grün and Allemann, 1975 (sample 1146–7a xn, 7b δ, 7c nl).
8a–c. *Retecapsa surirella* (Deflandre and Fert, 1954) Grün *in* Grün and Allemann, 1975 (sample 1137–8a xn, 8b δ, 8c nl).
9a–b. *Stradneria crenulata* (Bramlette and Martini, 1964) Noël, 1970 (sample 1137–9a xn, 9b δ).
10a–b. *Eiffellithus eximius* (Stover, 1966) Perch–Nielsen, 1968 (sample 1146–10a xn, 10b nl).
11a–b. *Eiffellithus gorkae* Reinhardt, 1965 (sample 1137–11a δ, 11b nl).
12a–b. *Eiffellithus? hancockii* Burnett, 1998 (sample 1380–12a δ, 12b nl).
13a–b. *Eiffellithus monechiae* Crux, 1991 (sample 1824–13a xn, 13b nl).
14a–b. *Eiffellithus pospichalii* Burnett, 1998 (sample 1146–14a δ, 14b nl).
15a–b. *Eiffellithus striatus* (Black, 1971) Applegate and Bergen, 1988 (sample 1788–15a xn, 15b δ).
16a–b. *Eiffellithus turriseiffelii* (Deflandre *in* Deflandre and Fert, 1954) Reinhardt, 1965 (sample 1137–16a δ, 16b nl).
17a–b. *Eiffellithus* sp. cf. *E. windii* Applegate and Bergen, 1988 (sample 1350–17a xn, 17b δ).
18a–c. *Helicolithus anceps* (Górka, 1957) Noël, 1970 (sample 1338–18a xn, 18b δ, 18c nl).
19a–c. *Helicolithus compactus* (Bukry, 1969) Varol and Girgis, 1994 (sample 1506–19a xn, 19b δ, 19c nl).

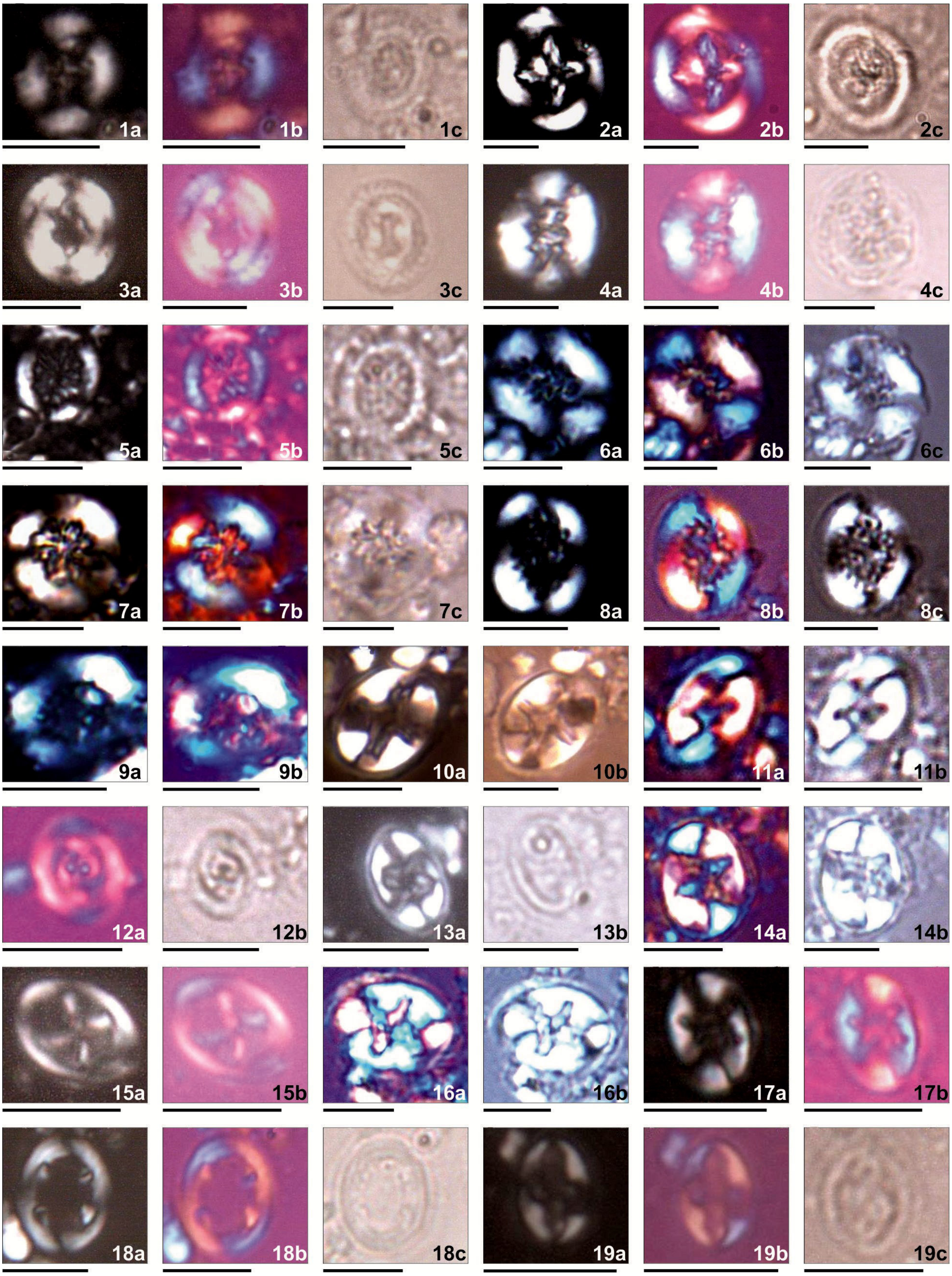
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PLATE 6

1912 *Cribrosphaera ehrenbergi* Arkhangelsky, pp. 142, pl. 6, figs 19–20.
1952 *Cribrosphaerella ehrenbergii* (Arkhangelsky, 1912) Deflandre *in* Piveteau, pp. 111, text figs 54a–b.
1964 *Favocentrum laughtoni* Black, pp. 313, pl. 53, figs 1–2.
1964 *Favocentrum mattewshi* Black, pp. 314, pl. 53, figs 5–6.
1964 *Discolithina* sp. cf. *D. numerosa* Bramlett & Martini, pp. 301, pl. 1, figs 23–24.
1968 *Cribrosphaerella ehrenbergii* Gartner, pp. 40, pl. 1, figs 14–15, pl. 3, fig. 2, pl. 6, fig. 7, pl. 12, fig. 2, pl. 15, fig. 11.
1968 *Cretadiscus colatus* Gartner, pp. 36, pl. 10, figs 7–8, pl. 12, fig. 5, pl. 19, fig. 10.
1968 *Cretadiscus polyporus* Gartner, pp. 36, pl. 1, figs 17–19, pl. 4, fig. 13, pl. 25, fig. 5.
1968 *Cribrosphaerella linea* Gartner, pp. 40, pl. 1, fig. 16.
1969 *Cribrosphaerella ehrenbergii* Bukry, pp. 44, pl. 22, figs 9.
1969 *Cribrosphaera laughtoni* Bukry, pp. 45, pl. 23, figs 4–5, 7–9.
1971 *Cribrosphaera ehrenbergii* Manivit, pp. 101, pl. 8, figs 1–5, 9–12.
1998 *Cribrosphaerella ehrenbergii* Burnett *in* Bown, pp. 175, pl. 6.5, figs 3–6.
2001 *Cribrosphaerella ehrenbergii* Ladner & Wise *in* Beslier *et al*., pp. 50, pl. 4, figs 11–12.
2004 *Cribrosphaerella ehrenbergii* Chira *et al*., pp. 95, pl. 1, figs 3, 13a–b.
2007 *Cribrospharella ehrenbergii* Lees, pp. 44, pl. 4, figs 32–36, 38.
2012 *Cribrospharella ehrenbergii* Farouk & Faris, pp. 58, fig. 8.7.
2013a *Cribrospharella ehrenbergii* Rai *et al*., pp. 58, pl. 1, fig. 13.
2013b *Cribrospharella ehrenbergii* Rai *et al*., pp. 1607, figs 4.2a–b.
2013 *Cribrospharella ehrenbergii* Zahran, pp. 991, pl. 1, fig. 16.
2015 *Cribrospharella ehrenbergii* Linnert & Mutterlose, pp. 731, fig. 4V.

Remarks—In this study, all specimens of *Cribrosphaerella* with a margin of two or three shields (of which the two distal ones are closely appressed) and with a central structure consisting of a plate wih more than two cycles of perforations are assigned to *C. ehrenbergii*. In Tanot well–1 this species is recorded from Late Albian to Early Maastrichtian.

Occurrence—This species is recorded throughout the succession from Late Albian to Early Maastrichtian.

Dimensions—L/W 7.97 µm/6.72 µm.

Known stratigraphic range—Late Albian–Late Maastrichtian.

Genus—NEPHROLITHUS Górka, 1957

Type Species—*Nephrolithus frequens* Górka, 1957

Nephrolithus corystus Wind, 1983

(Pl. 1.11a–c)

1977 *Nephrolithus frequens* (G**ó**rka, 1957) Wise & Wind, pl. 20, fig. 3.
1979 *Nephrolithus corystus* Wind, pl. 1, figs 3–4.
1983 *Nephrolithus corystus* Wind, pp. 160, pl. 1, figs 3C–G.

PLATE 7

Each bar represents 5 µm; xn–under cross polarized light; δ–under gypsum plate; nl–under normal light →

1a–b. *Helicolithus trabeculatus* (Górka, 1957) Verbeek, 1977 (sample 1146–1a δ, 1b nl).
2a–b. *Helicolithus turonicus* Varol and Girgis, 1994 (sample 1728–2a xn, 2b nl).
3a–b. *Tegumentum lucidum* Lees and Bown *in* Bralower, Premoli Silva and Malone, 2005 (sample 1401–3a xn, 3b δ).
4a–b. *Tegumentum stradneri* Thierstein *in* Roth and Thierstein, 1972 (sample 1533–4a xn, 4b δ).
5a–b. *Gartnerago praeobliquum*, Jakubowski, 1986 (sample 1557–5a xn, 5b nl).
6a–b. *Gartnerago segmentatum*, (Stover, 1966) Thierstein, 1974 (sample 1392–6a xn, 6b δ).
7a–b. *Lapideacassis asymmetrica*, (Perch–Nielsen *in* Perch–Nielsen and Franz, 1977) Burnett, 1998 (sample 1392–7a xn, 7b δ).
8a–b. *Lithraphidites carniolensis*, Roth, 1978 (sample 1413–8a δ, 8b nl).
9a–b. *Lithraphidites praequadratus*, Roth, 1978 (sample 1137–9a δ, 9b nl).
10a–b. *Microrhabdulus belgicus* Haye and Towe, 1963 (sample 1137–10a δ, 10b nl).
11a–b. *Microrhabdulus* sp. cf. *M. helicoideus* Deflandre, 1959 (sample 1137–11a δ, 11b nl).
12a–b. *Microrhabdulus* sp. cf. *M. undosus* Perch–Nielsen, 1973 (sample 1146–12a δ, 12b nl).
13a–b. *Nannoconus elongatus* Brönnimann, 1955 (sample 1146–13a δ, 13b nl).
14a–b. *Nannoconus inornatus* Rutledge and Bown, 1996 (sample 1137–14a δ, 14b nl).
15a–b. *Nannoconus ligius* Applegate and Bergen, 1988 (sample 1338–15a xn, 15b nl).
16a–b. *Nannoconus multicadus* Deflandre and Deflandre–Rigaud, 1959 (sample 1137–16a xn, 16b nl).
17a–b. *Nannoconus pseudoseptentrionalis* Rutledge and Bown, 1996 (sample 1230–17a δ, 17b nl).
18a–b. *Nannoconus quadriangulus* Deflandre and Deflandre, 1967 (sample 1338–18a δ, 18b nl).
19a–b. *Nannoconus quadricanalis* Burnett *in* Gale *et al*., 1996 (sample 1137–19a δ, 19b nl).
20a–b. *Nannoconus* sp. 1 (sample 1137–20a δ, 20b nl).
21a–b. *Nannoconus* sp. 2 (sample 1158–21a δ, 21b nl).
22a–b. *Nannoconus* sp. 3 (sample 1104–22a δ, 22b nl).
23a–b. *Nannoconus steinmannii* Kamptner, 1931 (sample 1104–23a δ, 23b nl).
24a–b. *Nannoconus truitti frequens* Deres and Acheriteguy, 1980 (sample 1137–24a δ, 24b nl).

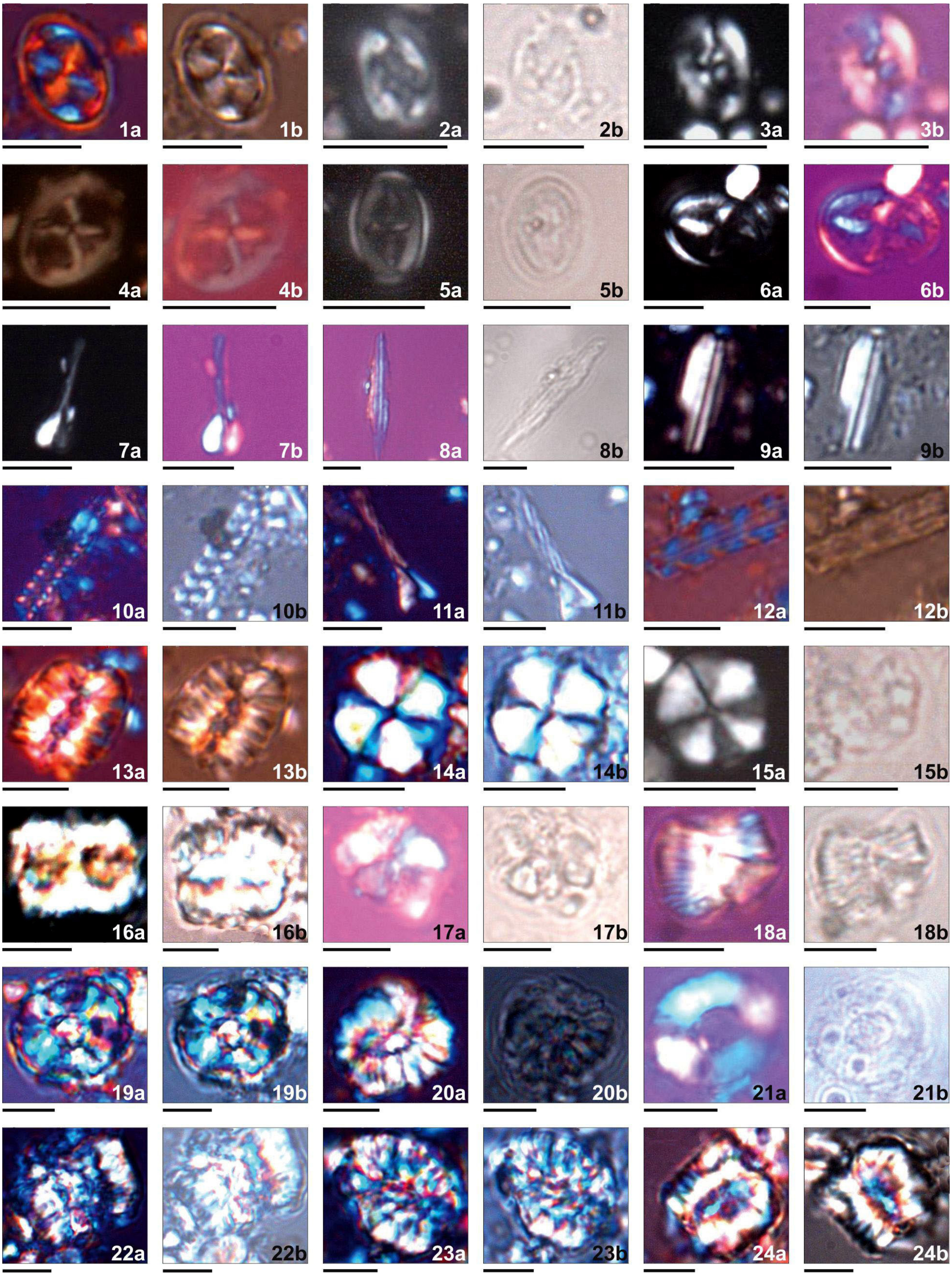
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PLATE 7

1998 *Nephrolithus corystus* Burnett *in* Bown, pp. 175, pl. 6.5, fig. 11.

Remarks—The species name is taken from Greek root *korystus* meaning helmeted. It is reniform or kidney shaped to elliptical in outline with 2–60 perforations present on the distal surface of the central area. Broad rim is constructed of 25–65 tabular elements in each of two concentric cycles. Outer cycle elements interfinger with those of the inner cycle; the relative width of each cycle varies from specimen to specimen. The central area is filled with sets of 6 or 7 tabular intergrown crystals which encircle each perforation. A lower set of flat–lying crystals constricts the diameter of each perforation, and paves the proximal surface of the central area. In crossed polarised light, the rim, stem and support rays are bright; the central area exhibits a cribrate light and dark pattern. This form is representative of high altitude.

Occurrence—Few occurrences of this species are recorded at depth 1137 m from Maastrichtian sediments of borewell.

Dimensions—L/W 8.91 µm/6.63 µm.

Known stratigraphic range—Campanian–Maastrichtian.

Nephrolithus frequens Górka, 1957

(Pl. 1.12a–c)

1957 *Nephrolithus frequens* Górka, pp. 282, pl. 5, fig. 7.
1957 *Nephrolithus barbarae* Górka, pp. 264, pl. 5, fig. 9.
1957 *Nephrolithus furcatus* Górka, pp. 263, pl. 5, fig. 8.
1957 *Nephrolithus trientis* Górka, pp. 263, pl. 5, fig. 18.
1966 *Nephrolithus gorkae* Åberg, pp. 65–67, pl. 1, pl. 2, figs 1–5, pl., figs 1–5, text fig. 1.
1967 *Nephrolithus gorkae* Reinhardt & Górka, pl. 32, figs 5–12.
1967 *Nephrolithus miniporus* Reinhardt & Górka, pp. 246–247, pl. 32, fig. 11, pl. 33, fig. 5.
1968 *Nephrolithus frequens* Perch–Nielsen, pp. 56–57, fig. 23, pl. 7, figs 12–14, pl. 18, figs 1–9.
1971 *Nephrolithus frequens* Shafik & Stradner, pp. 85, pl. 28, figs 1–3, pl. 29, figs 1–3.
1977 *Nephrolithus frequens* Wise & Wind, pl. 20, fig. 3.
1979 *Nephrolithus frequens* Wind, pl. 1, figs 1–2.
1998 *Nephrolithus frequens* Burnett *in* Bown, pp. 175, pl. 6.5, figs 12a–b, 13c–d.

Remarks—Characteristically reniform to elliptical in outline, central area dominated by 2–15 perforations ringed by several cycles of 7–10 calcite rhombs. *N. freqens* has been found in Late Maastrichtian sediments of high latitude regions of both hemispheres. Rarely specimens are seen in lower latitude sediments from the uppermost Maastrichtian (Perch–Nielsen, 1970). Since all the specimens showed more than two pores in the centre the distinction of *Nephrolithus frequens* into subspecies level can be ascribed to *N. frequens frequens* (vide Pospichal & Wise, 1990).

Occurrence— Few occurrences of this species is recorded from sample depth of 1158 m belonging to Maastrichtian age.

Dimensions—L/W 7.74 µm/5.27 µm.

Known stratigraphic range—Campanian–Maastrichtian.

PLATE 8

Each bar represents 5 µm; xn–under cross polarized light; δ–under gypsum plate; nl–under normal light →

11a–b. *Nannoconus truitti rectangularis* Deres and Acheriteguy, 1980 (sample 1137–1a δ, 1b nl).
2a–b. *Eprolithus floralis* (Stradner, 1962) Stover, 1966 (sample 1338–2a xn, 2b nl).
3a–b. *Eprolithus moratus* (Stover, 1966) (Stover, 1966) Burnett, 1998 (sample 1350–3a xn, 3b nl).
4a–b. *Eprolithus rarus?* Varol, 1992 (sample 1287–4a xn, 4b nl).
5a–b.. *Farhania varolii* (Jakubowski, 1986) Varol, 1992 (sample 1488–5a δ, 5b nl).
6a–b. *Micula adumbrata* Burnett, 1998 (sample 1146–6a δ, 6b nl).
7a–b. *Micula murus* (Martini, 1961) Bukry, 1973 (sample 1146–7a δ, 7b nl).
8a–b. *Micula praemurus* (Bukry, 1973) Stradner and Steinmetz, 1984 (sample 1146–8a xn, 8b nl).
9a–b. *Micula premolisilvae* Lees and Bown *in* Bralower, Premoli Silva and Malone, 2005 (sample 1146–9a δ, 9b nl).
10a–b. *Micula staurophora* (Gardet, 1955) Stradner, 1963 (sample 1104–10a δ, 10b nl).
11. *Micula swastika* Stradner and Steinmetz, 1984 (sample 1104–11 xn).
12. *Quadrum gartneri* Prins and Perch–Nielsen *in* Manivit *et al*., 1977 sample 1146 (12 δ).
13a–b. *Quadrum intermedium* Varol, 1992 (sample 1167–13a xn, 13b nl).
14a–b. *Quadrum svabenickae* Burnett, 1998 (sample 1317–14a xn, 14b nl).
15. *Radiolithus hollandicus* Varol, 1992 (sample 1518–15 xn).
16. *Radiolithus planus* Stover, 1966 (sample 1530–16 xn).
17a–b. *Uniplanarius clarkei* Lees and Bown *in* Bralower, Premoli Silva and Malone, 2005 (sample 1287–17a xn, 17b nl).
18a–b. *Uniplanarius gothicus* (Deflandre, 1959) Hattner and Wise, 1980 (sample 1137–18a δ, 18b nl).
19a–b. *Assipetra terebrodentarius* (Applegate *et al*. *in* Covington and Wise, 1987) Rutledge and Bergen *in* Bergen, 1994 (sample 1488–19a δ, 19b nl).
20a–b. *Hayesites irregularis* (Thierstein *in* Roth and Thierstein, 1972) Applegate *et al*. *in* Covington and Wise, 1987 (sample 1488–20a δ, 20b nl).
21a–b. *Rucinolithus hayi* Stover, 1966 (sample 1452–21a δ, 21b nl).
22a–b. *Prediscosphaera columnata* (Stover, 1966) Perch–Nielsen, 1984 (sample 1146–22a xn, 22b δ).
23a–b. *Prediscosphaera cretacea* (Arkhangelsky, 1912) Gartner, 1968 (sample 1137–23a xn, 23b δ).
24a–b. *Prediscosphaera grandis* Perch–Nielsen, 1979 (sample 1359–24a xn, 24b δ).
25a–b. *Prediscosphaera microrhabdulina* Perch–Nielsen, 1984 (sample 1317–25a xn, 25b δ).
26a–b. *Prediscosphaera ponticula* (Bukry, 1969) Perch–Nielsen, 1984 (sample 1146–26a xn, 26b δ).

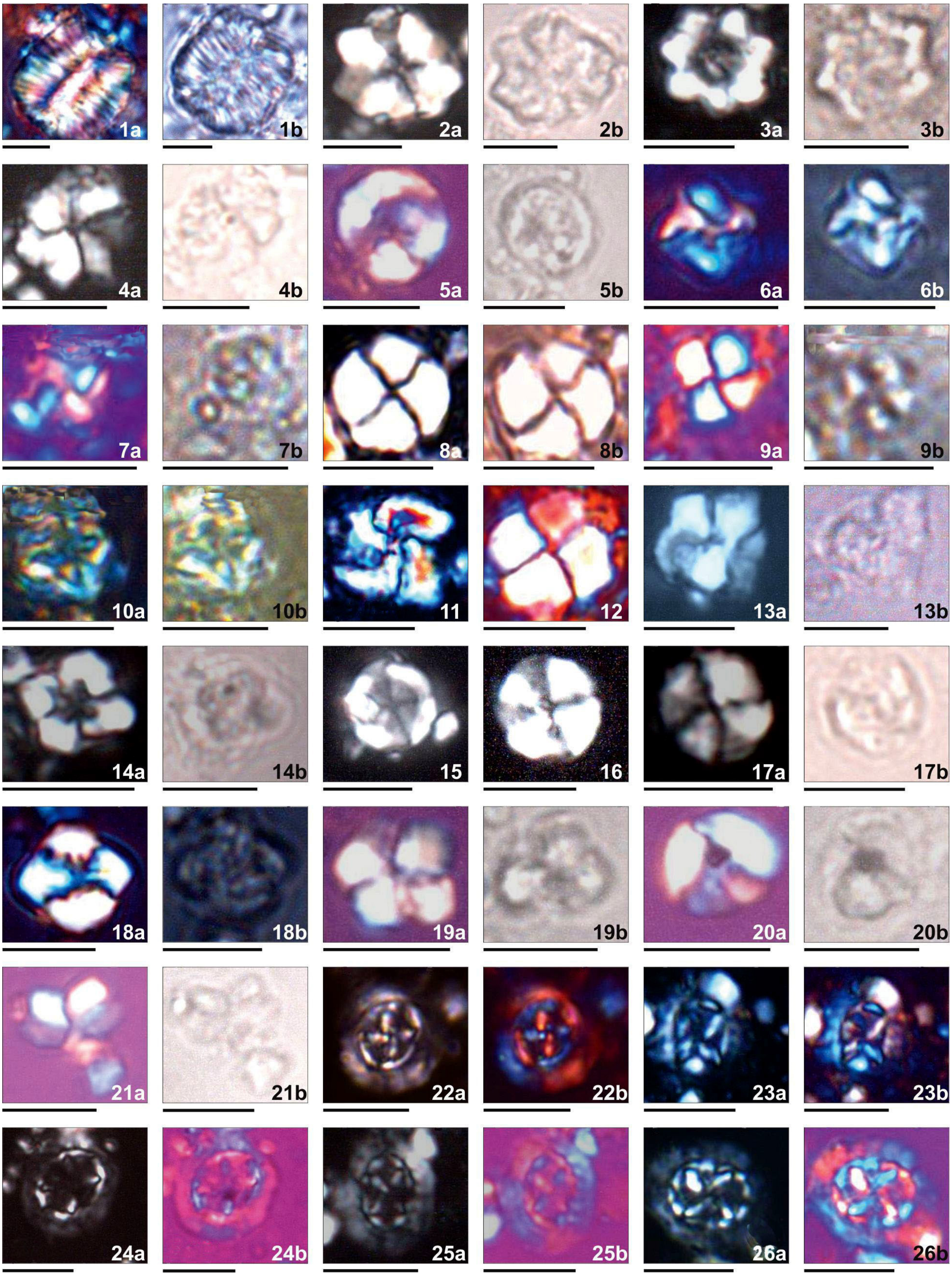
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PLATE 8

Genus—PSYKTOSPHAERA Pospichal & Wise, 1990

Type Species—*Psyktosphaera firthii* Pospichal & Wise, 1990

Psyktosphaera firthii Pospichal & Wise, 1990

(Pl. 1.13a–c)

1979 *Cribrosphaerella daniae* Wind, pp. 250, pl. 4, figs 1–3.
1990 *Psyktosphaera firthii* Pospichal & Wise, pp. 474, pl. 5, figs 1a–d.
1998 *Psyktosphaera firthii* Burnett *in* Bown, pp. 175, pl. 6.5, figs 7–8.

Remarks—This is a medium sized, elliptical coccolith in which the distal shield is verneered by an outer rim of ca. 40 or more strongly imbricate thin laths that surround an outer central area consisting of long thin vertical laths–shaped elements arranged in a concentric pattern around an imperforate inner central area. In phase contrast the rim of *P. firthii* is dark and in crossed polarized light, the rim displays low order grey colour birefringence. In crossed polarized light, the outer cycle of elements within the central area display a similar order of birefringence, and the perforate inner central area appears granular. The distal shield is comprised of an outer rim of two cycles. *P. firthii* first appears in the middle of the early Maastrichtian part of the *Biscutum coronum* Zone.

Occurrence—Rare leaked occurrences of this species are observed from one subsurface sample at 1392 m depth of Santonian age.

Dimensions—L/W 8.00 µm/6.19 µm.

Known stratigraphic range—Campanian?–Maastrichtian.

Genus—TETRAPODORHABDUS Black, 1971

Type Species—*Tetrapodorhabdus coptensis* Black, 1971

Tetrapodorhabdus decorus (Deflandre *in* Deflandre & Fert, 1954) Wind & Wise *in* Wise & Wind, 1977

(Pl. 1.14a–c)

1954 *Rhabdolithus decorus* Deflandre *in* Deflandre & Fert, pp. 159, pl. 13, figs 4–6.
1964 *Cretarhabdus decorus* Bramlette & Martini, pp. 300, pl. 3, figs 9–12.
1965 *Cretarhabdus decorus* Manivit, pp. 193, pl. 1, figs 4a–b.
1967 *Cretarhabdus decorus* Moshkovitz, pp. 48.
1973 *Podorhabdus decorus* Thierstein, pp. 39, 97.
1977 *Tetrapodorhabdus decorus* (Deflandre *in* Deflandre & Fert, 1954) Wind & Wise *in* Wise & Wind, pl. 59, figs 3–6.
1985 *Tetrapodorhabdus decorus* Perch–Nielsen, pp. 376, pl. 43, fig. 3.
1987 *Tetrapodorhabdus decorus* Jakubowski, pp. 114, pl. 1, figs 14–15.
1998 *Tetrapodorhabdus decorus* Burnett *in* Bown, pp. 175, pl. 6.5, figs 15a–b, 20.
2001 *Tetrapodorhabdus decorus* Bown, pp. 232, pl. 7, fig. 5.
2003 *Tetrapodorhabdus decorus* Tantawy, pp. 331, pl. 2, fig. 8.
2013a *Tetrapodorhabdus decorus* Rai *et al*., p. 71, pl. 1, fig. 46.

Remarks—This species has an elliptical rim and a perforated base plate which contains two small pores in the short axis and two larger pores in the long axis of the ellipse.

PLATE 9

Each bar represents 5 µm; xn–under cross polarized light; δ–under gypsum plate; nl–under normal light →

1a–b. *Prediscosphaera* sp. 1 (sample 1137–1a xn, 1b δ).
2a–b. *Prediscosphaera* sp. 2 (sample 1158–2a xn, 2b δ).
3a–b. *Prediscosphaera spinosa* (Bramlette and Martini, 1964) Gartner, 1968 (sample 1338–3a xn, 3b δ).
4a–b. *Prediscosphaera stoveri* (Perch–Nielsen, 1968) Shafik and Stradner, 1971 (sample 1137–4a xn, 4b δ).
5a–b. *Percivalia fenestrata* (Worsley, 1971) Wise, 1983 (sample 1146–5a δ, 5b nl).
6a–b. *Percivalia* sp. cf. *P. hauxtonensis* Black, 1973 (sample 1146–6a δ, 6b nl).
7a–b. *Percivalia imperfossa* Black, 1971 (sample 1158–7a xn, 7b nl).
8a–b. *Podorhabdus* sp. cf. *P. elkefensis* Perch–Nielsen, 1981 (sample 1137–8a δ, 8b nl).
9a–b. *Rhagodiscus achlyostaurion* (Hill, 1976) Doeven, 1983 (sample 1287–9a δ, 9b nl).
10a–b. *Rhagodiscus angustus* (Stradner, 1963) Reinhardt, 1971 (sample 1104–10a δ, 10b nl).
11a–b. *Rhagodiscus asper* (Stradner, 1963) Reinhardt, 1967 (sample 1197–11a xn, 11b nl).
12a–b. *Rhagodiscus dekaenelii* Bergen, 1994 sample 1512 (12a δ, 12b nl).
13a–b. *Rhagodiscus gallagheri* Rutledge and Bown, 1996 (sample 1173–13a xn, 13b nl).
14a–b. *Rhagodiscus indistinctus* Burnett, 1998 (sample 1221–14a δ, 14b nl).
15a–b. *Rhagodiscus plebeius* Perch–Nielsen, 1968 (sample 1338–15a xn, 15b nl).
16a–b. *Rhagodiscus reniformis* Perch–Nielsen, 1973 (sample 1146–16a δ, 16b nl).
17a–b. *Rhagodiscus* sp. 1 (sample 1137–17a xn, 17b nl).
18a–b. *Rhagodiscus* sp. 2 (sample 1146–18a δ, 18b nl).
19a–b. *Rhagodiscus splendens* (Deflandre, 1953) Verbeek, 1977 (sample 1167–19a δ, 19b nl).
20a–b. *Corollithion kennedyi* Crux, 1981 (sample 1428–20a δ, 20b nl).
21a–b. *Corollithion signum* Stradner, 1963 (sample 1413–21a δ, 21b nl).
22a–b. *Corollithion* sp. 1 (sample 1158–22a δ, 22b nl).
23a–b. *Cylindralithus biarcus* Bukry, 1969 (sample 1173–23a δ, 23b nl).
24a–b. *Cylindralithus sculptus* Bukry, 1969 (sample 1350–24a xn, 24b nl).

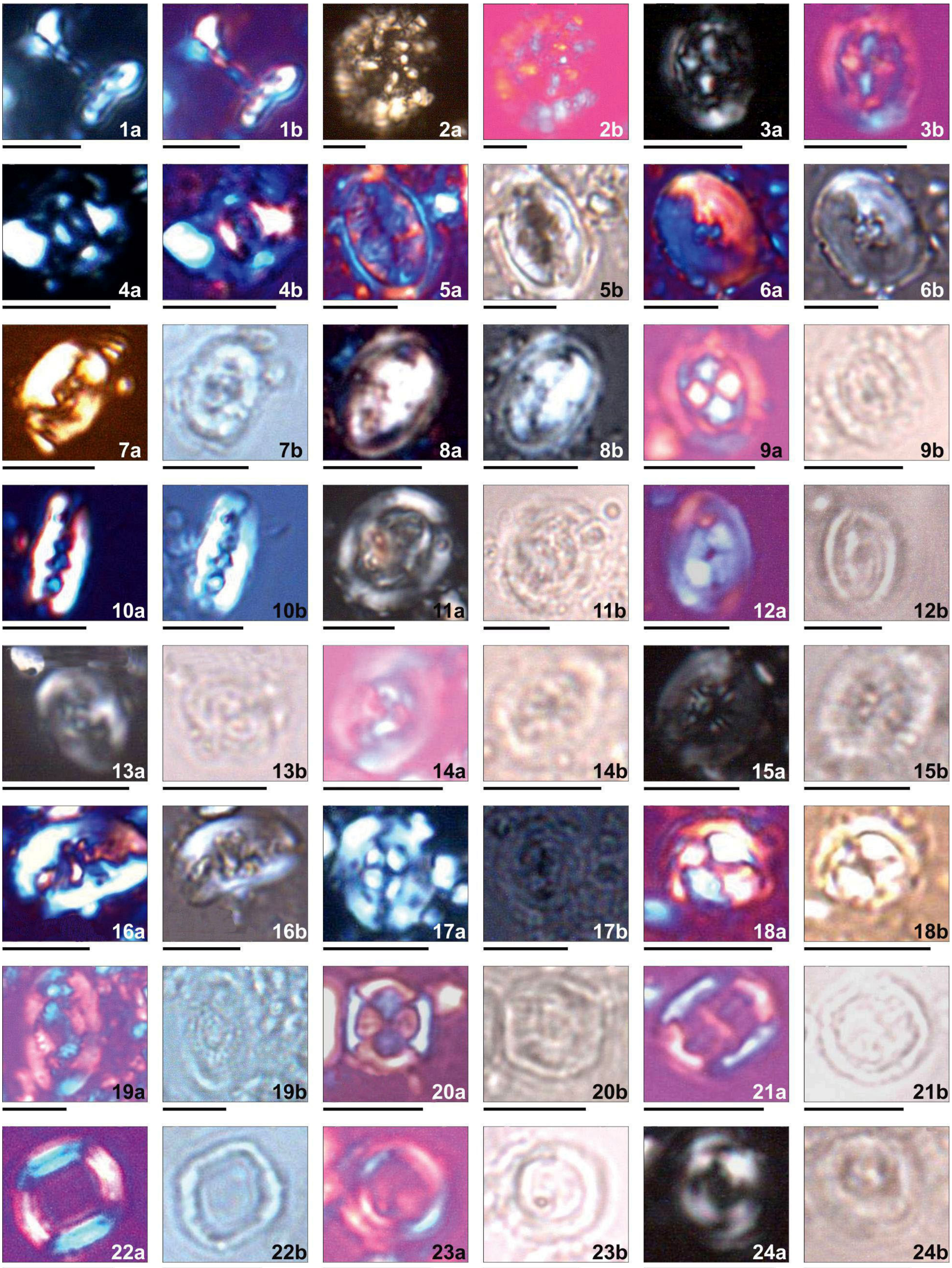
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PLATE 9

Occurrence—Rare occurrences of this species are observed from one subsurface sample at 1158 m depth belonging to Maastrichtian age.

Dimensions—L/W 4.89 µm/2.58 µm.

Known stratigraphic range—Berriasian?–Maastrichtian.

Family—BISCUTACEAE Black, 1971

Genus—**BISCUTUM** Black *in* Black & Barnes, 1959

Type Species—*Biscutum testudinarium* Black, 1959 (= *Discolithus constans* Górka, 1957)

Biscutum constans (Górka, 1957) Black *in* Black & Barnes, 1959

(Pl. 1.15a–b)

1957 *Discolithus constans* Gorka, pp. 279, pl. 4, fig. 7.
1959 *Biscutum testudinarium* Black *in* Black & Barnes, pp. 325, pl.10, fig. 1.
1959 *Biscutum castrorum* (Górka, 1957) Black *in* Black & Barnes, pp. 326, pl. 10, fig. 2.
1964 *Cribrosphaerella tectiforma* Reinhardt, pp. 758, pl. 2, fig. 4.
1965 *Coccolithus polycingulatus* Reinhardt, pp. 39, pl. 3, fig. 4.
1966 *Coccolithus oregus* Stover, pp. 139, pl. 1, figs 8–9, pl. 8, fig. 4.
1967 *Biscutum constans* Black, pp.139.
1968 *Biscutum constans* Perch–Nielsen, pp. 78, pl. 27, figs 1–11, text fig. 39.
1970 *Biscutum constans* Noël, pp. 91, pl. 33, figs 1–10, pl. 34, figs 1a–g.
1972 *Biscutum gartneri* Black, pp.27, pl. 2, figs 1–4.
1973 *Biscutum constans* Thierstein, pp. 41.
1985 *Biscutum constans* Perch–Nielsen, pp.357, pl. 19, figs 6, 7.
1987 *Biscutum constans* Jakubowski, pp. 114, pl. 1, figs 10–11.
1994 *Biscutum constans* Fiorentina, pp. 152, pl. 2, fig. 8.
1996 *Biscutum constans* Eshet & Labin, pp. 47, pl. 1, fig. 11.
1999 *Biscutum constans* Luciani & Cobianchi, pp. 146, pl. 8, fig. a.
2001 *Biscutum constans* Ladner & Wise *in* Beslier *et al*., pp. 49, pl. 3, figs 10–11.
2003 *Biscutum constans* Tantawy, pp. 329, pl. 1, figs 11, 12.
2013b *Biscutum constans* Rai *et al*., pp. 1607, figs 4.3a–b.
2015 *Biscutum constans* Linnert & Mutterlose, pp. 731, fig. 4W.

Remarks—Two closely appressed elliptical shields with scalloped margins. The distal shield is larger than the proximal shield. Both the surface and subsurface samples of Pariwar Formation contain *B*. *constans*. The distal shield in subsurface samples of Tanot well–1 is much larger than in the surface samples and the proximal shield appears much thicker in surface sample due to overgrowth.

Occurrence—Few to common continuous occurrence of this species is observed in Albian–Campanian borewell succession.

Dimensions—L/W 5.88 µm/5.04 µm.

Known stratigraphic range—Albian–Maastrichtian.

Biscutum* sp. cf. *B*. *coronum Wind & Wise *in* Wise & Wind, 1977

(Pl. 1.16a–b)

PLATE 10

Each bar represents 5 µm; xn–under cross polarized light; δ–under gypsum plate; nl–under normal light →

1a–b. *Rotelapillus crenulatus* (Stover, 1966) Perch–Nielsen, 1984 (sample 1158–1a δ, 1b nl).
2a–b. *Stoverius achylosus* (Stover, 1966) Perch–Nielsen, 1986 (sample 1308–2a xn, 2b nl).
3a–b. *Thoracosphaera operculata* Bramlette and Martini, 1964 (sample 1104–3a xn, 3b nl).
4a–b. *Thoracosphaera* sp. 1 (sample 1146–4a xn, 4b δ).
5a–b. *Thoracosphaera* sp. 2 (sample 1137–5a δ, 5b nl).
6a–c. *Manivitella pemmatoidea* (Deflandre ex Manivit, 1965) Thierstein, 1971 (sample 1158–6a xn, 6b δ).
7a–b. *Cyclagelosphaera margerelii* Noël, 1965 (sample 1104–7a δ, 7b nl).
8a–b. *Cyclagelosphaera reinhardtii* (Perch–Nielsen, 1968) Romein, 1977 (sample 1104–8a δ, 8b nl).
9a–b. *Cyclagelosphaera rotaclypeata* Bukry, 1969 (sample 1494–9a xn, 9b nl).
10a–b. *Diazomatolithus* sp. cf. *D. lehmanii* Noël, 1965 (sample 1488–10a xn, 10b δ).
11a–b. *Watznaueria barnesae* (Black, 1959) Perch–Nielsen, 1968 (sample 1167–11a xn, 11b δ).
12a–b. *Watznaueria biporta* Bukry, 1969 (sample 1770–12a xn, 12b δ).
13a–b. *Watznaueria britannica* (Stradner, 1963) Reinhardt, 1964 (sample 1158–13a xn, 13b δ).
14a–b. *Watznaueria fossacincta* (Black, 1971) Bown *in* Bown and Cooper, 1989 (sample 1590–14a xn, 14b δ).
15a–b. *Watznaueria ovata* Bukry, 1969 (sample 1590–15a xn, 15b δ).
16a–b. *Angulofenestrellithus snyderi* Bukry, 1969 (sample 1374–16a δ, 16b nl).
17a–b. *Tortolithus hallii* (Bukry, 1969) Crux *in* Crux *et al*., 1982 (sample 1338–17a δ, 17b nl).
18a–b. *Tortolithus pagei* (Bukry, 1969) Crux *in* Crux *et al*., 1982 (sample 1401–18a δ, 18b nl).
19a–c. *Haqius circumradiatus* (Stover, 1966) Roth, 1978 (sample 1173–19a xn, 19b δ, 19c nl).
20a–c. *Markalius inversus* (Deflandre in Deflandre and Fert, 1954) Bramlette and Martini, 1964 (sample 1245–20a xn, 20b δ, 20c nl).
21a–c. *Prolatipatella multicarinata* Gartner, 1968 (sample 1146–21a xn, 21b δ, 21c nl).
22a–c. *Repagulum parvidentatum* (Deflandre and Fert, 1954) Forchheimer, 1972 (sample 1146–22a xn, 22b δ, 22c nl).

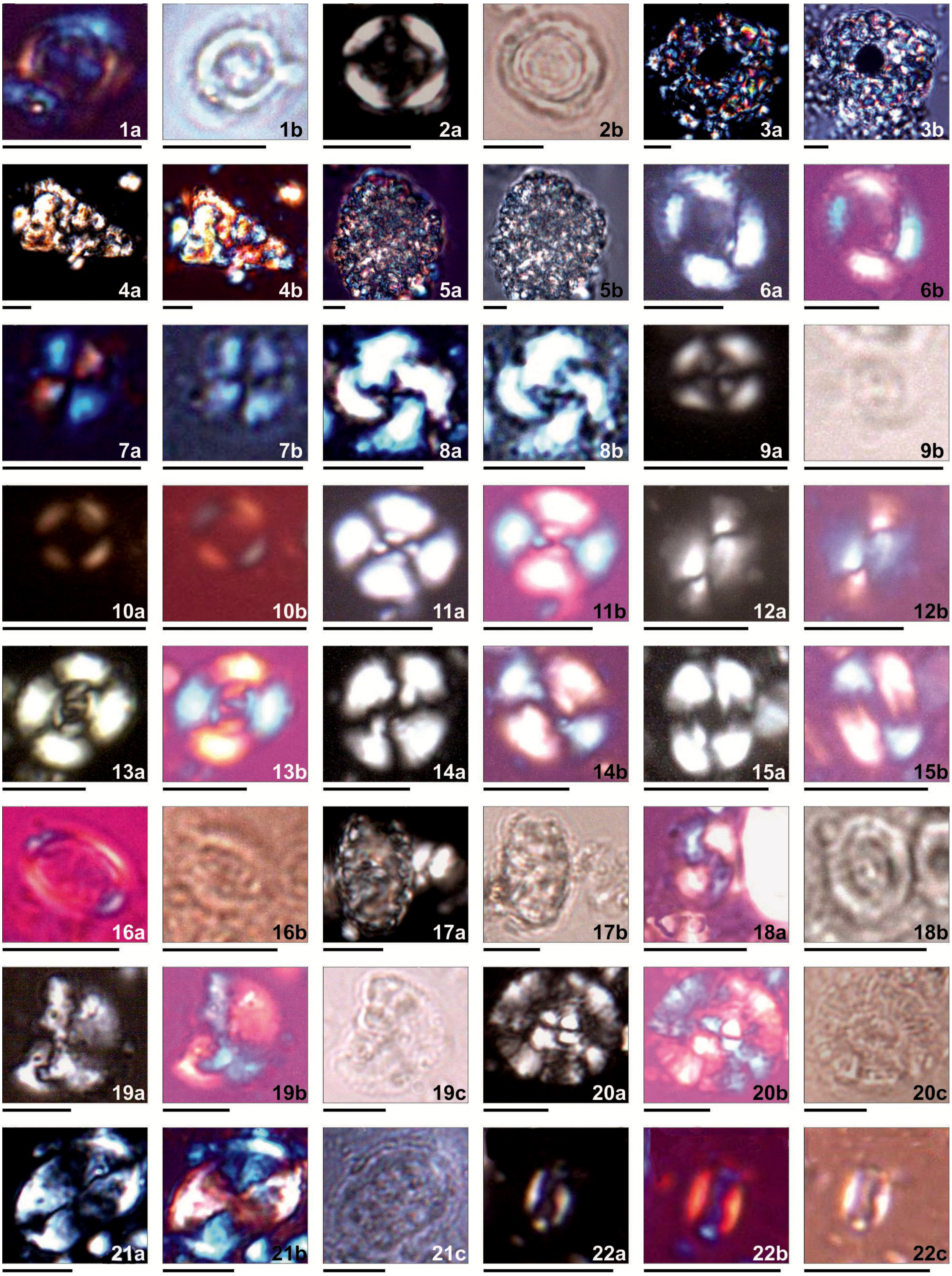
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PLATE 10

1977 *Biscutum coronum* Wind & Wise *in* Wise & Wind, pp. 297–298, pl. 24, figs 10–12.

Remarks—*B*. *coronum* is a large species having dextrally oriented distal shield elements and radial elements in proximal shield. The placoliths recorded from Tanot well–1 resembles with *B*. *coronum* in shape and size and the extinction pattern of the elements. The elements arranged in the inner part of the central area are much thickened and the range of this form is varied than the *B*. *coronum*.

Occurrence—This species is recorded from both surface and subsurface sediments in present study. The known range of *B*. *coronum* is Turonian?–Maastrichtian, however *Biscutum* sp. cf. *B*. *coronum* ranges from Albian to Cenomanian in the Tanot well–1, thus it appears to be precursor of *B*. *coronum* or a new species.

Dimensions—L/W 7.87 µm/6.42 µm.

Known stratigraphic range—Albian–Cenomanian.

Biscutum dissimilis Wind & Wise *in* Wise & Wind, 1977

(Pl. 1.17a–b)

1968 *Lithastrinus* sp. Forchheimer, pp. 58, text fig. 2, pp. 17, fig. 1, pl. 9, figs 1a–b, 5.

1977 *Biscutum dissimilis* Wind & Wise *in* Wise & Wind, pp. 298, pl. 23, figs 1–5, pl. 24, figs 3–6.

1998 *Biscutum dissimilis* Burnett *in* Bown, pp.176, pl. 6.5, figs 26–27.

Remarks—Strongly elliptical species of *Biscutum* with thick massive distal plate and thin, small proximal shield. Long axis extremities are usually dominated by one or two exceptionally broad, massive elements. Large elongate form constructed of 7–11 radial, strongly imbricate and massively constructed distal shield elements and a similar number of thin radial non imbricate elements in proximal shield. Largest dimension of specimens varies between 8.5 and 11 µm; ellipticity ranges from 1.3 to 1.5. The thin proximal shield has dimensions generally one half that of distal shield. The arrangement of elements is variable, one or two large crystalline elements may dominate one or both ends of the distal shield. The small central area appears to be lined with small number of thick plates.

Occurrence—Rare occurrences of this species are recorded from only one subsurface sample at 1245 m in the borewell belonging to Maastrichtian age.

Dimensions—L/W 5.47 µm/4.25 µm.

Known stratigraphic range—Albian–Maastrichtian.

Biscutum ellipticum (Górka, 1957) Grün *in* Grün & Allemann, 1975

(Pl. 2.1a–b)

1957 *Tremalithus ellipticum* Górka, pp. 245, 269, pl. 1, fig. 11.

1959 *Biscutum testudinarium* Black *in* Black & Barnes, pp. 325, pl. 10, fig. 1.

1969 *Biscutum testudinarium* Bukry, pp. 28, pl. 8, figs 7–12.

1975 *Biscutum ellipticum* (Górka, 1957) Grün *in* Grün & Allemann, pp. 154–156, pl. 1, figs 5–7, text fig. 3.

1998 *Biscutum ellipticum* Burnett *in* Bown, pp. 175, pl. 6.5, figs 21a–c.

2007 *Biscutum ellipticum* Lees, pp. 44, pl. 5, figs 1–10, 12–15.

Remarks—The broadly elliptical forms ranging in diameters of about 2 to 10 µm. The number of elements varies in each of the two rims (proximal and distal) between 14 and 22. The regular, granulate uncovered central area is relatively small. On the proximal side, the granules are present across the central area, covering parts of proximal disc elements. The central perforation is usually hidden; a central extension is not present.

Occurrence— Abundant to common occurrence of this species is observed throughout the bore well succession during Albian–Maastrichtian.

Dimensions—L/W 4.26 µm/3.65 µm.

Known stratigraphic range—Bathonian–Maastrichtian.

Biscutum hattneri Wise, 1983

(Pl. 2.2a–b)

1983 *Biscutum hattneri* Wise, pp. 506, pl. 17, fig. 7, pl. 20, figs 1–3.

1985 *Biscutum hattneri* Perch–Nielsen, pp. 356–357, pl. 19, fig. 18.

1998 *Biscutum hattneri* Burnett *in* Bown, pp. 176, pl. 6.5, figs 25a–b.

Remarks—Highly oval in outline with eccentricity. Elongate species with a wide central area filled by laths arranged in a narrow diamond shape that supports a small hollow central spine. The distal shield is composed of ca. 25 dimpled and tabbed elements. They are joined to the central area platform in part by an approximately equal number of thin imbricate laths which spiral in a counterclockwise pattern. The outer portion of the central platform is composed of squarish ridged and grooved elements in side of which are a set of long laths which form the narrow diamond around the central spine. The pores in the centre do not penetrate the central platform. The width of the central area is ca. 1.5 times the width of the margin.

Occurrence—Few occurrences of this species are observed from only one subsurface sample at 1104 m belonging to Maastrichtian age.

Dimensions—L/W 5.20 µm/3.90 µm.

Known stratigraphic range—Coniacian–Maastrichtian.

Biscutum sp. cf. _B. magnum_ Wind & Wise *in* Wise & Wind, 1977

(Pl. 2.3a–b)

1977 *Biscutum magnum* Wind & Wise *in* Wise & Wind, pp. 298, pl. 20, figs 4–6, pl. 21, fig. 2, pl. 24, figs 1–2, pl. 30, fig. 1, pl. 50, fig. 1.

Remarks—This coccolith shows similarity with *B. magnum* in shape, size and the characters of proximal shield and central area structure but the distal shield is much brighter in cross polarized light than the *B. magnum* and the range of this form is from Albian to Campanian in Tanot well–1 while the known range of *B. magnum* is Santonian to Maastrichtian.

Occurrence—Few occurrences of this species are recorded from Albian to Campanian age sediments of Tanot well–1.

Dimensions—L/W 5.84 µm/5.19 µm.

Known stratigraphic range—Albian–Maastrichtian.

Biscutum melaniae (Górka, 1957) Burnett, 1998

(Pl. 2.4a–c)

1957 *Tremalithus melaniae* Górka, pp. 245, 270, pl. 1, fig. 12.
1966 *Coccolithus oregus* Stover, pp. 139, pl. 1, figs 8–9, pl. 8, fig. 4.
1989 *Biscutum harrisonii* Varol, pp. 297, pl. 12, figs 1, 4, 16–20.
1998 *Biscutum melaniae* (Górka, 1957) Burnett, pp. 134.
1998 *Biscutum melaniae* Burnett *in* Bown, pp. 176, pl. 6.6, figs 3–4.
2013a *Biscutum melaniae* Rai *et al*., pp. 58, pl. 1, fig. 2.

Remarks—Medium to large size species of *Biscutum* which is broadly elliptical. Under crossed nicols it displays a wide dark distal shield and a small highly birefringent central area. Known to occur frequently in high latitude locations.

Occurrence—This species is recorded from Albian to Maastrichtian sediments in Tanot well–1. It seems that the forms recorded in Albian–Cenomanian are leaked from younger levels.

Dimensions—L/W 8.58 µm/7.88 µm.

Known stratigraphic range—Turonian–Palaeocene.

Genus—CRUCIBISCUTUM Jakubowski, 1986

Type Species—_Crucibiscutum salebrosum_ (Black, 1971) Jakubowski, 1986

Crucibiscutum hayi (Black, 1973) Jakubowski, 1986

(Pl. 2.5a–c)

1973 *Cruciplacolithus hayi* Black, pp. 66–67, pl. 23, figs 9–10.
1986 *Crucibiscutum hayi* (Black, 1973) Jakubowski, pp. 38.
1998 *Crucibiscutum hayi* Burnett *in* Bown, pp. 176, pl. 6.6, fig. 14.
2007 *Crucibiscutum hayi* Lees, pp. 44, pl. 5, figs 22–23.

Remarks—Originally described from Upper Gault at Folkestone of England. Distal shield rim is petaloid concentrically within which there is an inner cycle of plates sloping inward towards the central opening. The opening is spanned by an axial cross constructed of blocky rhombohedral outlines, with one or two crystals in the bredth of the arm. The proximal shield is smaller than the distal, and its petaloid elements extend inwards to the margin of the central opening. The arms of the cross appear to be at the level of lower surface of the proximal shield.

Occurrence—Few occurrences of this species are recorded from Albian to Turonian sediments of Tanot well–1. Its reworking is observed in Turonian age sediments.

Dimensions—L/W 5.25 µm/3.43 µm.

Known stratigraphic range—Albian–Cenomanian.

Genus—DISCORHABDUS Noël, 1965

Type Species—_Rhabdolithus patulus_ Deflandre & Fert, 1954

Discorhabdus ignotus (Górka, 1957) Perch–Nielsen, 1968

(Pl. 2.6a–b)

1957 *Tremalithus ignotus* Górka, pp. 248, pl. 2, fig. 9.
1965 *Biscutum tredenale* Reinhardt, pp. 32, pl. 1, fig. 3, text fig. 2.
1966 *Biscutum tredenale* Reinhardt, pp. 31, pl. 2, figs 3a–b, text figs 13a–b.
1967 *Biscutum ignotum* Reinhardt & Górka, pp. 245, pl. 31, figs 9, 13.
1970 *Biscutum ignotum* Reinhardt, pp. 18, text fig. 31.
1968 *Discorhabdus ignotus* (Górka, 1957) Perch–Nielsen, pp. 81, partim pl. 28, fig. 6, text figs 41–42.
1971 *Discorhabdus ignotus* Manivit, pp. 112, partim pl. 3, figs 1–3, 6–7.
1976 *Discorhabdus ignotus* Hill, pp. 137. pl. 6 figs 12–18, pl. 14, figs 4–5.
1998 *Discorhabdus ignotus* Burnett *in* Bown, pp. 176, pl. 6.6, fig. 6a.
2007 *Discorhabdus ignotus* Lees, pp. 44, pl. 5, figs 11, 16–17.
2013b *Discorhabdus ignotus* Rai *et al*., pp. 1607, figs 4.5a–b.

Remarks—This is a small species consisting of two closely appressed circular shields which have scalloped margins. The rim of the proximal shield is composed of a single cycle of non–imbricated or very slightly imbricated radially arranged petaloid elements. The distal shield is slightly larger than the proximal shield having similar arrangement and number of rim elements. The central area of the proximal shield is open whereas the central area of distal shield is partially closed by a depressed cycle of quadrilateral elements which appear to be the extensions of the rim elements.

Occurrence—This species is recorded from both surface and subsurface sediments in present study. Common to few occurrences are recorded from Albian to Maastrichtian in Tanot well–1, while in surface it is recorded from early–middle Albian age sediments.

Dimensions—Diameter 3.76 µm

Known stratigraphic range—Oxfordian–Maastrichtian

Genus—SERIBISCUTUM Filewicz *et al. in* Wise & Wind, 1977

Type Species—*Seribiscutum bijugum* Filewicz *et al. in* Wise & Wind, 1977

Seribiscutum primitivum (Thierstein, 1974) Filewicz *et al. in* Wise & Wind, 1977

(Pl. 2.7a–b)

1974 *Cribrosphaerella primitiva* Thierstein, pp. 637, pl. 1, figs 1–3.
1977 *Seribiscutum primitivum* (Thierstein, 1974) Filewicz, *et al. in* Wise & Wind, pp. 311, pl. 66, figs 4–6, pl. 67, figs 1–4.
1985 *Seribiscutum primitivum* Perch–Nielsen, pp. 357–358, pl. 20, fig. 15.
1998 *Seribiscutum primitivum* Burnett *in* Bown, pp. 176, pl. 6.6, fig. 9.
2013a *Seribiscutum primitivum* Rai *et al*., pp. 71, pl. 1, fig. 44.
2013b *Seribiscutum primitivum* Rai *et al*., pp. 1607, figs 4.6a–b.

Remarks—This is an elliptical coccolith having two closely appressed shields; each shield is constructed of radial, non–imbricate petaloid elements. The central area contains four large blocky elements in criss–cross manner.

Occurrence—In present study this species is recorded from both surface and subsurface. Abundant to rare occurrences are observed from Albian to Maastrichtian in subsurface. Reworking is reported in Maastrichtian sediments.

Dimensions—L/W 4.46 µm/3.06 µm.

Known stratigraphic range—Albian–Campanian.

Genus—*Sollasites* Black, 1967

Type Species—*Sollasites barringtonensis* Black, 1967

Sollasites horticus (Stradner *et al. in* Stradner & Adamiker, 1966) Čepek & Hay, 1969

(Pl. 2.8a–b)

1966 *Coccolithus horticus* Stradner *et al. in* Stradner & Adamiker, pp. 337, pl. 1, fig. 2, text figs 1–2.
1968 *Coccolithus horticus* Gartner, pp. 18, pl. 10, fig. 2, pl. 25, figs 6–8, pl. 26, fig. 1.
1967 *Sollasites barringtonensis* Black, pl. 144, fig. 4.
1968 *Sollasites horticus* Black, pp. 798, pl. 144, figs 1–2.
1969 *Costacentrum horticum* Bukry, pp. 44, pl. 21, fig. 12.
1969 *Sollasites horticus* (Stradner *et al. in* Stradner & Adamiker, 1966) Čepek & Hay, pp. 325, text fig. 4, fig. 2.
1971 *Sollasites horticus* Manivit, pp. 117, pl. 24, figs 1–5.
1998 *Sollasites horticus* Burnett *in* Bown, pp. 176, pl. 6.6, figs 15a–b.
2015 *Sollasites horticus* Linnert & Mutterlose, pp. 731, fig. 4Y.

Remarks—This species of *Sollasites* has three bars parallel to the longer axis of the disc, whereas the other species of the genus show one bar parallel and two sub–parallel to this axis.

Occurrence—Few occurrences are observed from Albian to Campanian in Tanot well–1 material.

Dimensions—L/W 4.45 µm/3.33 µm.

Known stratigraphic range—Oxfordian?–Campanian.

Family—BRAARUDOSPHAERACEAE Deflandre, 1947

Genus—BRAARUDOSPHAERA Deflandre, 1947

Type Species—*Pontosphaera bigelowi* Gran & Braarud, 1935

Braarudosphaera africana Stradner, 1961

(Pl. 2.9a–c)

1958 *Braarudosphaera* sp. Noël, pp. 189, fig. 47.
1961 *Braarudosphaera africana* Stradner, pp. 82, text fig. 44.
1961 *Braarudosphaera africana* Stradner & Papp, pp. 118, pl. 37, figs 4a–b, text figs 12, 2.
1968 *Braarudosphaera bigelowi* Gartner, pp. 45, pl. 4, fig. 5.
1969 *Braarudosphaera africana* Bukry, pp. 62, pl. 36, figs 9–10.
1970 *Braarudosphaera africana* Reinhardt, pp. 21, pl. 1, fig. 5, text fig. 36.
1971 *Braarudosphaera africana* Manivit, pp. 126, pl. 3, fig. 15.
1973 *Braarudosphaera africana* Black, pp. 89, pl. 28, figs 2–4, text fig. 11.
1976 *Braarudosphaera africana* Hill, pp. 124, pl. 2, figs 10–13, pl. 13, fig. 5.
1998 *Braarudosphaera africana* Burnett *in* Bown, pp. 190, pl. 6.11, fig. 26c.

2013a *Braarudosphaera africana* Rai *et al*., pp. 58, pl. 1, fig. 3.

Remarks—Stradner's original illustration of this form shows that it differs from *Braarudosphaera bigelowi* by having more equilateral elements and by having an indentation in each side of the pentagonal outline. The apex of these indentations occurs at the juncture of each element suture with the periphery.

Occurrence—Rare occurrences are recorded from Albian to Cenomanian in Tanot well–1.

Dimensions—Diameter 6.34 µm.

Known stratigraphic range—Albian–Cenomanian.

Braarudosphaera bigelowii (Gran & Braarud, 1935) Deflandre, 1947

(Pl. 2.10)

1935 *Pontosphaera bigelowi* Gran & Braarud, pp. 388, fig. 67.
1947 *Braarudosphaera bigelowii* (Gran & Braarud, 1935) Deflandre, pp. 439, figs 1–5.
1968 *Braarudosphaera bigelowii* Gartner, pp. 45, pl. 4, fig. 5, pl. 15, fig. 3, pl. 16, fig. 9, pl. 19, fig. 7, pl. 20, fig. 4, pl. 21, fig. 8.
1961 *Braarudosphaera bigelowii* Bramlette & Sullivan, pp.171, pl. 8, figs 1, 2, 5.
1964 *Braarudosphaera bigelowii* Bramlette & Martini, pp. 305.
1965 *Braarudosphaera bigelowii* Levin, pp. 268, pl. 42, figs 4, 5.
1965 *Braarudosphaera bigelowii* Manivit, pp. 194, pl. 2, fig. 16.
1967 *Braarudosphaera bigelowii* Moshkovitz, pp. 153.
1968 *Braarudosphaera bigelowii* Hekel, pp. 338, pl. 1, fig. 1.
1968 *Braarudosphaera bigelowii* Perch–Nielsen, pp. 85.
1972 *Braarudosphaera bigelowii* Bybell & Gartner, pp. 323, pl. 1.
1973 *Braarudosphaera regularis* Black, pp. 91, pl. 28, fig. 10.
1974 *Braarudosphaera bigelowii* Bukry, pp. 358, pl. 5, figs G, H.
1977 *Braarudosphaera bigelowii* Monechi, pp. 781.
1978 *Braarudosphaera bigelowii* Shafik, pp. 219, pl. 4, figs Sa–Sb.
1978 *Braarudosphaera bigelowii* Shafik & Chaproniere, pp. 144, pl. 8, figs 1a–b.
1982 *Braarudosphaera bigelowii* Siesser, pp. 344, pl. 10, fig. f.
1982 *Braarudosphaera bigelowii* Hanzlikova *et al*., pp. 134, pl. 6, figs 13, 14.
1985 *Braarudosphaera bigelowii* Perch–Nielsen, pp. 360, pl. 22, figs 1, 2.
1989 *Braarudosphaera bigelowii* Aubry, pp. 10, figs 1–7.
1998 *Braarudosphaera bigelowii* Burnett *in* Bown, pp. 190, pl. 6.11, fig. 27.
2003 *Braarudosphaera bigelowii* Tantawy, pp. 329, pl. 1, figs 8, 9.
2007 *Braarudosphaera bigelowii* Lees, pp. 50, pl. 2, fig. 28.
2015 *Braarudosphaera bigelowii* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 22.

Remarks—This species is characterized by its pentagonal outline and its trapezoidal shaped five elements each of which overlaps slightly onto the next one except one segment that is overlapped from both sides. *B. africana* differs from *B. bigelowii* by a star shaped outline.

Occurrence—Few to rare occurrences of this secies are observed from Turonian to Maastrichtian in Tanot well–1.

Dimensions—Diameter 9.28 µm.

Known stratigraphic range—Early Berriasian–Recent.

Braarudosphaera stenorhetha Hill, 1976

(Pl. 2.11a–b)

1976 *Braarudosphaera stenorhetha* Hill, pp. 125, pl. 2 figs 26–31, pl. 13, figs 7–9.
1998 *Braarudosphaera stenorhetha* Bown *in* Bown, pp. 128, pl. 5.14, figs 2–3.
2004 *Braarudosphaera stenorhetha* Chira *et al*., pp. 95, pl. 1, fig. 5.
2013a *Braarudosphaera stenorhetha* Rai *et al*., pp. 58, pl. 1, fig. 4.

Remarks—This species is composed of 5 narrow, elongated, quadrilateral elements so that the margin of the pentalith is in the form of a 5–rayed star. The segment edges which are exposed along the periphery of the pentalith are approximately twice the length of those which form the sutural boundaries between segments. The sides of the pentalith are deeply indented at the juncture of the radially oriented sutures and the margin. The surface of the pentalith is smooth.

Occurrence—Rare occurrences of this form is recorded only from Albian sediments in Tanot well–1.

Dimensions—Diameter 6.29 µm.

Known stratigraphic range—Albian.

Genus—MICRANTHOLITHUS Deflandre in Deflandre & Fert, 1954

Type Species—*Micrantholithus flos* Deflandre, 1950

Micrantholithus obtusus Stradner, 1963

(Pl. 2.12a–c)

1963 *Micrantholithus obtusus* Stradner, pp. 11, pl. 6, figs 11–11a.
1971 *Micrantholithus obtusus* Thierstein, pp. 482, pl. 5, fig. 9.
1998 *Micrantholithus obtusus* Bown *in* Bown, pp. 110, pl. 5.5, fig. 19.

Remarks—Star–shaped outline. Pentalith consists of five flat elements with sharp notched margins and blunt tips.

Occurrence—Few reworked occurrences of this species are observed in one subsurface sample at 1104 m depth belonging to Maastrichtian age.

Dimensions—Diameter 11.50 µm.

Known stratigraphic range—Barremian–Aptian.

***Micrantholithus* sp. 1**

(Pl. 2.13a–c)

Remarks—Five triangular elements are arranged in such a way that they form the pentagonal shape. May be there is a notch in every triangular element, but it is difficult to discern due to the poor preservation of the specimen.

Occurrence—Few occurrences of this species are recorded in one subsurface sample at 1104 m depth belonging to Maastrichtian age.

Dimensions—Diameter 8.73 µm.

Known stratigraphic range—Maastrichtian.

Micrantholithus stellatus Aguado *in* Aguado *et al*., 1997

(Pl. 2.14a–c)

1997 *Micrantholithus stellatus* Aguado *in* Aguado *et al*., pp. 64, pl. 5, figs 11–14.

Remarks—This small pentalith consists of broad V–shaped segments. The adjacent sides of the segments form tapering arms with acutely pointed tips. This star–shaped, small species has a thickness almost equal to the total diameter. The thickness of this form is distinctly seen in plan view from its high relief, strong birefringence and depth of focus.

Occurrence—Rare occurrences of this species are observed in one subsurface sample at 1443 m depth belonging to Turonian age.

Dimensions—Diameter 6.67 µm.

Known stratigraphic range—Turonian.

Family—CALCIOSOLENIACEAE Kamptner, 1927

Genus—SCAPHOLITHUS Deflandre *in* Deflandre & Fert, 1954

Type Species—*Scapholithus fossilis* Deflandre *in* Deflandre & Fert, 1954

Scapholithus fossilis Deflandre *in* Deflandre & Fert, 1954

(Pl. 2. 15a–c)

1954 *Scapholithus fossilis* Deflandre *in* Deflandre & Fert, pp. 51, pl. 8, figs 12, 16–17.
1964 *Scapholithus fossilis* Cohen, pp. 244, pl. 3, figs 4a–d, pl. 4, fig. 2a.
1965 *Scapholithus fossilis* Manivit, pp. 193, pl. 1, fig. 8.
1965 *Scapholithus* sp. Cohen, pp. 340, pl. 2.
1968 *Scapholithus* sp. Gartner, pp. 122, pl. 7, figs 4a–c.
1969 *Scapholithus fossilis* Bukry, pp. 64, pl. 38, figs 5–8.
1998 *Scapholithus fossilis* Burnett *in* Bown, pp. 174, pl. 6.4, fig. 18a.

Remarks—This form has an elongate rhomb–shaped frame made of numerous elements. In Tanot well–1 samples the forms have slightly narrower central area.

Occurrence—In the present study few to rare patchy occurrences of this species are recorded from Albian to Maastrichtian sediments of Tanot well–1.

Dimensions—L/W 5.68 µm/0.91 µm.

Known stratigraphic range—Hauterivian–Recent.

Family—CALYPTROSPHAERACEAE Boudreaux & Hay, 1969

Genus—BIFIDALITHUS Varol, 1991

Type Species—*Bifidalithus geminicatillus* Varol, 1991

Bifidalithus geminicatillus Varol, 1991

(Pl. 2.16a–b)

1991 *Bifidalithus geminicatillus* Varol, pp. 219, pl. 8, figs 6–8.
1998 *Bifidalithus geminicatillus* Burnett *in* Bown, pp. 190, pl. 6.11, figs 22a–c.

Remarks—A quadrilateral holococcolith consisting of two elements having rounded corners, which are surrounded by a narrow rim. The two simple, elements are connected by a distinct suture. Each element is almost square in outline in well preserved specimen but in Tanot well–1 due to the overgrowth of calcite, forms seem little bit distorted.

Occurrence—Rare occurrences of this species are recorded from Turonian to Maastrichtian. It seems that the forms recorded in Turonian are leaked from younger levels while the forms recorded in Maastrichtian are reworked.

Dimensions—L/W 2.53 µm/6.27 µm.

Known stratigraphic range—Campanian.

Genus—CALCULITES Prins & Sissingh *in* Sissingh, 1977

Type Species—*Tetralithus obscurus* Deflandre, 1959

Calculites obscurus (Deflandre, 1959) Prins & Sissingh *in* Sissingh, 1977

(Pl. 2.17a–18b)

1959 *Tetralithus obscurus* Deflandre, pp. 138, pl. 3, figs 26–29.
1963 *Tetralithus ovalis* Stradner, pp. 12, pl. 3, figs 26–29.
1964 *Tetralithus obscurus* Bramlette & Martini, pp. 320, pl. 4, figs 26–28.
1969 *Tetralithus obscurus* Bukry, pp. 63, pl. 37, figs 11–12.
1976 *Tetralithus obscurus* Theirstein, pp. 344, pl. 5, figs 10–11.
1976 *Tetralithus obscurus* Burns, pp. 279, pl. 4, fig. 8.
1977 *Calculites obscurus* (Deflandre, 1959) Prins & Sissingh *in* Sissingh, pp. 60.
1977 *Calculites obscurus* Sissingh, pp. 136, pl. 12.
1977 *Phanulithus obscurus* Wind & Wise *in* Wise & Wind, pp. 304, pl. 31, fig. 5.
1978 *Tetralithus obscurus* Shafik, pp. 217, pl. 3, figs A–D.
1981 *Tetralithus obscurus* Smith, pp. 72, pl. 13, figs 26–34.
1982 *Calculites obscurus* Hanzlikova *et al*., pp. 134, pl. 7, figs 1–5.
1982 *Calculites obscurus* Siesser, pp. 342, pl. 8, figs B, b, K, k.
1985 *Calculites obscurus* Perch–Nielsen, pp. 363, pl. 28, figs 9, 10, pp. 343, figs 19, 20.
1998 *Calculites obscurus* Burnett *in* Bown, pp. 188, pl. 6.11, figs 2a–c.
2007 *Calculites obscurus* Lees, pp. 47, pl. 9, figs 29–32.
2012 *Calculites obscurus* Farouk & Faris, pp. 58, fig. 8.14.
2013a *Calculites obscurus* Rai *et al*., pp. 58, pl. 1, fig. 8.
2013b *Calculites obscurus* Rai *et al*., pp. 1607, figs 4.9a–b.
2013 *Calculites obscurus* Zahran, pp. 991, pl. 1, fig. 15, pp. 992, pl. 2, fig. 15.
2014 *Calculites obscurus* Jelby *et al*., pp. 93, fig. 5F.

Remarks—All the forms of *Calculites* having four large elements in the central area are assigned to *Calculites obscurus* and *C. ovalis*. Both the forms are differentiated only on the basis of outer rim margin which is smooth in *C. obscurus* and crenulated in *C. ovalis*.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface common to few occurrences of this form are recorded from Albian to Maastrichtian.

Dimensions—L/W 3.55 µm/2.28 µm.

Known stratigraphic range—Turonian?–Maastrichtian.

Calculites ovalis (Stradner, 1963) Prins & Sissingh *in* Sissingh, 1977

(Pl. 2.19)

1963 *Tetralithus ovalis* Stradner, pp. 178, pl. 6, figs 7, 7a.
1978 *Tetralithus ovalis* Shafik, pp. 217, pl. 3, figs Fa–M.
1977 *Phanulithus ovalis* Wind & Wise *in* Wise & Wind, pp. 304, pl. 34, fig. 1.
1977 *Calculites ovalis* (Stradner, 1963) Prins & Sissingh *in* Sissingh, pp. 136, pl. 12.
1982 *Calculites ovalis* Siesser, pp. 343, pl. 9, figs L, l.
1985 *Calculites ovalis* Perch–Nielsen, pp. 363, pl. 28, figs 3–4, pp. 343, fig. 9.
1992 *Calculites ovalis* Passerini & Gadrin, pp. 558, pl. 8, fig. k.
1998 *Calculites ovalis* Burnett *in* Bown, pp. 188, pl. 6.11, figs 3a–b.
2004 *Calculites ovalis* Chira *et al*., pp. 96, pl. 2, figs 5a–b.

Remarks—This is a flat coccolith consisting of four blocky elements fitting closely together to form a plate with an oval circumference. The suture lines may lie in the main axis or diagonally or in between.

Occurrence—Few occurrences of this species are observed from Coniacian to Campanian sediments in Tanot well–1.

Dimensions—L/W 7.31 µm/5.30 µm.

Known stratigraphic range—Coniacian?–Maastrichtian.

Calculites percenis Jeremiah, 1996

(Pl. 2.20a–b)

1976 *Biscutum supracretaceum* Hill, pp. 124, pl. 2, figs 1–9.
1991 *Calculites* sp. 1 Crux, pp. 214, pl. 1, fig. 4, pl. 2, figs 5–9.
1996 *Calculites percenis* Jeremiah, pp. 125, pl. 2, figs 8–9.
1998 *Calculites percenis* Burnett *in* Bown, pp. 188, pl. 6.11, figs 4a–d.
2004 *Calculites percenis* Chira *et al*., pp. 96, pl. 2, fig. 8.
2007 *Calculites percenis* Lees, pp. 47, pl. 10, figs 46–53.
2013a *Calculites percenis* Rai *et al*., pp. 58, pl. 1, fig. 9.

Remarks—This holococcolith is composed of a narrow rim, a broad wall consisting of limited number of calcite blocks and a central pore. Under crossed nicols and with the axes of the ellipse aligned with the nicols, extinction gyres lie on the peripheral axes of the ellipse. With the axes rotated 45 degrees to the nicols, the gyres do not intersect but form arches about the acute ends of the ellipse.

Occurrence—Common to few occurrences of this species are observed from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 4.94 µm/4.25 µm.

Known stratigraphic range—Albian–Maastrichtian.

Holococcolith sp. 1

(Pl. 2.21a–b)

Remarks—This holoccolith has a thick high wall and a central area composed of one complete block, which lacks a central stem.

Occurrence—Few to rare patchy occurrences of this species are recorded from Cenomanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 4.88 µm/2.94 µm.

Known stratigraphic range—Cenomanian–Maastrichtian.

Holococcolith sp. 2

(Pl. 2.22)

Remarks—This species of holococcolith has two unequal blocks which are separated with each other by a longitudinal suture.

Occurrence—Rare patchy occurrences of this species are recorded from Turonian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 4.00 µm/2.99 µm.

Known stratigraphic range—Turonian–Maastrichtian.

Genus—ISOCRYSTALLITHUS Verbeek, 1976

Type Species—*Isocrystallithus compactus* Verbeek, 1976

Isocrystallithus compactus Verbeek, 1976

(Pl. 3.1a–b)

1976 *Isocrystallithus compactus* Verbeek, pp. 78, pl. 2, figs 1–4.
1998 *Isocrystallithus compactus* Burnett *in* Bown, pp. 186, pl. 6.10, figs 3a–4.
2013a *Isocrystallithus compactus* Rai *et al*., pp. 71, pl. 1, fig. 22.
2013b *Isocrystallithus compactus* Rai *et al*., pp. 1607, figs 4.1a–b.

Remarks—Rhabdolith consisting of bands of radially arranged crystals of the same size and shape. The hollow elliptical basal disc is not differentiated into a margin and a central structure. The spine is connected to the basal disc by four ridges separated by depressions. At the top there is a plug of four crystals, each crystal fitting into a groove of the spine and the fifth crystal is in the middle which closes the central canal.

Occurrence—This species is recorded from both surface and subsurface sediments. In subsurface few occurrences of this form are recorded in Cenomanian and some rare occurrences are recorded from one sample of Maastrichtian age at 1158 m depth.

Dimensions—L/W 8.64 µm/4.93 µm.

Known stratigraphic range—Albian–Cenomanian.

Isocrystallithus* sp. cf. *I. compactus Verbeek, 1976

(Pl. 3.2a–b)

1976 *Isocrystallithus* sp. cf. *I. compactus* Verbeek, pp. 78, pl. 2, figs 5–6.
1998 *Isocrystallithus* sp. cf. *I. compactus* Burnett *in* Bown, pp. 186, pl. 6.10, figs 5a–c.

Remarks—*Isocrystallithus* sp. cf. *I. compactus* is characterized by the wide proximal basal disc and a short stem which remains dark at 0º to the crossed nicols.

Occurrence—Rare occurrences of this species are recorded from Cenomanian to Santonian sediments in Tanot well–1.

Dimensions—L/W 3.97 µm/4.86 µm.

Known stratigraphic range—Cenomanian.

Genus—LUCIANORHABDUS Deflandre, 1959

Type Species—*Lucianorhabdus cayeuxi* Deflandre, 1959

Lucianorhabdus arcuatus Forchheimer, 1972

(Pl. 3.3a–b)

1959 *Lucianorhabdus cayeuxi* Deflandre, pp. 142, pl. 4. figs 20, 25.
1963 *Lucianorhabdus cayeuxi* Gorka, pp. 24, pl. 2, fig. 7, text pl. 2, fig. 8.
1972 *Lucianorhabdus arcuatus* Forchheimer, pp. 69, pl. 10, fig. 5.
1998 *Lucianorhabdus arcuatus* Burnett *in* Bown, pp. 186, pl. 6.10, figs 14–15.

Remarks—*L. arcuatus* is the only species of the genus showing a curved central process. A small basal disc and a plug may be present.

Occurrence—Few to rare patchy occurrences of this species are recorded from Cenomanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 11.39 µm/5.20 µm.

Known stratigraphic range—Coniacian–Campanian.

Lucianorhabdus cayeuxi Deflandre, 1959

(Pl. 3.4a–b)

1959 *Lucianorhabdus cayeuxi* Deflandre, pp. 142, pl. 4, figs 11–19, 21–24.
1961 *Lucianorhabdus cayeuxi* Stradner, pp. 82, text figs 45–48, 50.
1963 *Lucianorhabdus cayeuxi* Stradner, pp. 15, pl. 6, figs 6–6a.

1964 *Lucianorhabdus cayeuxi* Bramlette & Martini, pp. 312, pl. 5, figs 11–12.
1967 *Lucianorhabdus cayeuxi* Moshkovitz, pp. 155.
1968 *Lucianorhabdus cayeuxi* Gartner, pp. 45, pl. 10, figs 18–20, pl. 12. fig. 7, pl. 16, figs 3–4, pl. 18, figs 3–4.
1969 *Lucianorhabdus cayeuxi* Bukry, pp. 66.
1972 *Lucianorhabdus cayeuxi* Lauer, pp. 171, pl. 28, figs 7–8.
1976 *Lucianorhabdus cayeuxi* Theirstein, pp. 346, pl. 5, figs 6–7.
1978 *Lucianorhabdus cayeuxi* Shafik, pp. 217, pl. 3, figs Qa–Pb.
1981 *Lucianorhabdus cayeuxi* Smith, pp. 56, pl. 9, figs 37, 41.
1982 *Lucianorhabdus cayeuxi* Hanzlikova *et al*., pp. 139, pl. 8, figs 3–6.
1982 *Lucianorhabdus cayeuxi* Siesser, pp. 342, pl.8, figs H, h, I, I.
1985 *Lucianorhabdus cayeuxi* Perch–Nielsen, pp. 343, fig. 38, pp. 363, pl. 28, figs 14, 24.
1998 *Lucianorhabdus cayeuxi* Burnett *in* Bown, pp. 186, pl. 6.10, figs 7, 11, 12, 16.
2004 *Lucianorhabdus cayeuxii* Chira *et al*., pp. 96, pl. 2, figs 6a–b.
2012 *Lucianorhabdus cayeuxii* Farouk & Faris, pp. 58, fig. 8.20.
2013 *Lucianorhabdus cayeuxii* Zahran, pp. 991, pl. 1, figs 5–7; pp. 992, pl. 2, fig. 14.
2015 *Lucianorhabdus cayeuxii* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 33.

Remarks—Only conical or pillar shaped forms are included in this species. The basal disc is thin and approximately as broad as the central process or at times the basal disc is absent.

Occurrence—Few occurrences of this species are recorded from one sample in Tanot well–1 at 1146 m depth belonging to Maastrichtian age.

Dimensions—L/W 15.08 µm/5.42 µm.

Known stratigraphic range—Coniacian–Maastrichtian.

Lucianorhabdus maleformis Reinhardt, 1966

(Pl. 3.5a–b)

1965 *Lucianorhabdus cayeuxi* Cohen, pp. 35, pl. 5, figs a–c.
1966 *Lucianorhabdus maleformis* Reinhardt, pp. 42, pl. 21, figs 5, 7.
1971 *Lucianorhabdus maleformis* Thierstein, pp. 36, pl. 3, figs 52–53.
1973 *Lucianorhabdus maleformis* Risatti, pp. 29, pl. 7, figs 15–16.
1976 *Lucianorhabdus cayeuxi* Thierstein, pp. 350, pl. 5, figs 6–7.
1978 *Lucianorhabdus maleformis* Shafik, pp. 217, pl. 3, figs Qb–Ra.
1982 *Lucianorhabdus maleformis* Siesser, pp. 343, pl. 9, figs F, f.
1985 *Lucianorhabdus maleformis* Perch–Nielsen, pp. 343, fig. 38.
1998 *Lucianorhabdus maleformis* Burnett *in* Bown, pp. 186, pl. 6.10, figs 17a–c.
2004 *Lucianorhabdus maleformis* Chira *et al*., pp. 96, pl. 2, fig. 7.
2007 *Lucianorhabdus maleformis* Lees, pp. 48, pl. 11, figs 17–18.
2015 *Lucianorhabdus maleformis* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 32.

Remarks—*L. maleformis* is characterized by its rather short and conical central process and the distinct basal disc.

Occurrence—Abundant to few occurrences of this species are recorded from Turonian to Maastrichtian in Tanot well–1. Few leaked occurrences of this form observed in Cenomanian sediments at 1545 m depth.

Dimensions—L/W 8.65 µm/4.91 µm.

Known stratigraphic range—Turonian–Maastrichtian.

Genus—MUNARINUS Risatti, 1973

Type Species— *Munarinus lesliae* Risatti, 1973

Munarinus marszalekii Risatti, 1973

(Pl. 3.6a–b)

1973 *Munarinus marszalekii* Risatti, pp. 30, pl. 5, figs 15–16.
1998 *Munarinus marszalekii* Burnett *in* Bown, pp. 188, pl. 6.11, figs 10a–d.

Remarks—Long elliptical form consisting of two roughly equal elements which enclose a third irregularly shaped element. The sutures formed by the junction of the rim elements lie in the major axis and are very pronounced.

Occurrence—Common to few occurrences of this species are recorded from Turonian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 5.61 µm/4.46 µm.

Known stratigraphic range—Cenomanian–Maastrichtian.

Genus—OCTOLITHUS Romein, 1979

Type Species—*Tetralithus multiplus* Perch–Nielsen, 1973

Octolithus multiplus (Perch–Nielsen, 1973) Romein, 1979

(Pl. 3.7)

1973 *Tetralithus multiplus* Perch–Nielsen, pp. 326–327, pl. 9, figs 6–7, pl. 10, figs 17–18.
1977 *Tetralithus multiplus* Romein, pp. 276, pl. 2, fig. 7.

1979 *Octolithus multiplus* (Perch–Nielsen, 1973) Romein, pp. 185.
1998 *Octolithus multiplus* Burnett *in* Bown, pp. 188, pl. 6.11, figs 7c–8e.
2015 *Octolithus multiplus* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 14.

Remarks—The outline of the coccoliths is elliptical to polygonal. The plates which compose the coccoliths have the form of trapezes or triangles and are of unequal size. Four large main plates can distinguish and are clearly visible in the light microscope.

Occurrence—Common to few occurrences of this species are recorded from Cenomanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 4.97 µm/3.18 µm.

Known stratigraphic range—Campanian–Palaeocene.

Genus—OKKOLITHUS Wind & Wise *in* Wise & Wind, 1977

Type Species—*Okkolithus australis* Wind & Wise *in* Wise & Wind, 1977

Okkolithus australis Wind & Wise *in* Wise & Wind, 1977

(Pl. 3.8a–b)

1977 *Okkolithus australis* Wind & Wise *in* Wise & Wind, pp. 302–303, pl. 37, figs 1–2.
1998 *Okkolithus australis* Burnett *in* Bown, pp. 190, pl. 6.11, figs 19a–b.

Remarks—Elliptical coccolith constructed of a broad crenulated rim of approximately 20 trapezoidal elements surrounding a large elliptical central area filled with two or more trapezoidal or triangular elements. Dark sutures outline the central area and occasionally mark the contacts of adjacent rim elements.

Occurrence—Few occurrences of this species are observed in one subsurface sample at 1137 m depth belonging to Maastrichtian age.

Dimensions—L/W 3.82 µm/2. 68 µm.

Known stratigraphic range—Campanian–Maastrichtian.

Genus—ORASTRUM Wind & Wise *in* Wise & Wind, 1977

Type Species— *Orastrum asarotum* Wind & Wise *in* Wise & Wind, 1977

Orastrum perspicuum Varol *in* Al–Rifaiy *et al*., 1990

(Pl. 3.9)

1990 *Orastrum perspicuum* Varol *in* Al–Rifaiy *et al*., pp. 32, pl. 1, figs 6–8.
1998 *Orastrum perspicuum* Burnett *in* Bown, pp. 190, pl. 6.11, figs 15c–d, 21a–c.
2007 *Orastrum perspicuum* Lees, pp. 49, pl. 10, figs 55–58.

Remarks—Elliptical coccolith consisting of two plates surrounded by thin partially complete calcite rim. A small elongate slit may be present at the centre of the coccolith. In Tanot well–1 this species shows range from Coniacian to Maastrichtian.

Occurrence—Abundant to few occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 5.53 µm/4.15 µm.

Known stratigraphic range—Albian–Cenomanian.

Orastrum* sp. cf. *O. perspicuum Varol *in* Al–Rifaiy *et al*., 1990

(Pl. 3.10a–b)

1990 *Orastrum* sp. cf. *O. perspicuum* Varol *in* Al–Rifaiy *et al*., pp. 33, pl. 1, figs 9–10.
1998 *Orastrum* sp. cf. *O. perspicuum* Burnett *in* Bown, pp. 188, pl. 6.11, figs 15a–b.

Remarks—Elliptical outline, consisting of two plates surrounded by comparatively thick partially complete calcite rim. A small pore is present at the centre of the coccolith. Boundaries between adjacent component plates are marked by dark sinuous sutures.

Occurrence—Few patchy occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 3.37 µm/2.32 µm.

Known stratigraphic range—Cenomanian.

***Orastrum* sp. 1**

(Pl. 3.11a–b)

Remarks—Elliptical in outline, crystallographically continuous central plate with a central pore or spine. Broad rim plates of varying length surround central crystal. Portions of rim structure along major and minor axes have similar crystallographic orientation.

Occurrence—Few occurrences of this species are observed in one subsurface sample at 1137 m depth belonging to Maastrichtian age.

Dimensions—L/W 3.84 µm/2.83 µm.

Known stratigraphic range—Maastrichtian.

Genus—OWENIA Crux, 1991

Type Species—*Owenia hilli* Crux, 1991

Owenia hilli Crux, 1991

(Pl. 3.12a–b)

1976 *Amphizygus brooksii nanus* (Bukry, 1969) Hill, pl. 1, figs 16—24.
1991 *Owenia hilli* Crux, pp. 214, pl. 1, figs 3, 6, pl. 2, figs 1–4, 8.
1996 *Owenia hilli* Jeremiah, pl. 1, figs 1–4.
1998 *Owenia hilli* Burnett *in* Bown, pl. 6.10, figs 6a–b.
2007 *Owenia hilli* Lees, pp. 49, pl. 12, figs 1–8, 10–13.
2013a *Owenia hilli* Rai *et al*., pp. 71, pl. 1, figs 31a–b.
2013b *Owenia hilli* Rai *et al*., pp. 1607, figs 4.8a–b.

Remarks—Narrow birefringent rim with transverse protrusions into the central area. The central structure consists of two perforate blocks joined along a transverse suture. The single perforation in each block may be closed because of overgrowth. In side view the narrow rim continues proximally; the central area structure comprises two lateral blocks but occasionally a smaller, two–part, internal block array may be visible. A variably developed spine extends distally and may be closed by a distal plug.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. Abundant to few continuous occurrences of this species are observed from Albian to Maastrichtian in Tanot well–1.

Dimensions—L/W 4.93 µm/3.47 µm.

Known stratigraphic range—Albian–Cenomanian.

Genus—**PETROBRASIELLA** Troelsen & Quadros, 1971

Type Species— ***Petrobrasiella venata*** Troelsen & Quadros, 1971

***Petrobrasiella* sp. 1**

(Pl. 3.13a–b)

Remarks—This form is tentatively placed in *Petrobrasiella* due to the presence of basal plate (composed of elements) which form an indistinct rim (probably a preservational feature) and a perforated distal part. The perforations are subhexagonal.

Occurrence—Rare occurrences of this species are observed in one subsurface sample at 1146 m depth belonging to Maastrichtian age.

Dimensions—L/W 6.56 µm/4.31 µm.

Known stratigraphic range—Maastrichtian.

Genus—**RUSSELLIA** Risatti, 1973

Type Species—*Russellia bukryi* Risatti, 1973

Russellia bukryi Risatti, 1973

(Pl. 3.14a–b)

1973 *Russellia bukryi* Risatti, pp. 31, pl. 5, figs 17–18.
1998 *Russellia bukryi* Burnett *in* Bown, pp. 188, pl. 6.11, figs 6a–b.
2004 *Russellia bukryi* Chira *et al*., pp. 96, pl. 2, figs 10a–b.
2007 *Russellia bukryi* Lees, pp. 50, pl. 10, figs 28–32.

Remarks—Large form, elliptical in outline, constructed of about 9–12 irregularly sized elements which imbricate towards a small circular central element. The specimens recorded in Tanot well–1 show lower range upto Turonian.

Occurrence—Common to few occurrences of this species are recorded from Turonian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 5.02 µm/3.78 µm.

Known stratigraphic range—Maastrichtian.

Genus—**SAEPIOVIRGATA** Varol, 1991

Type Species—*Saepiovirgata biferula* Varol, 1991

Saepiovirgata biferula Varol, 1991

(Pl. 3.15a–b)

1991 *Saepiovirgata biferula* Varol, pp. 227, pl. 6, figs 11–12.
1998 *Saepiovirgata biferula* Burnett *in* Bown, pp. 190, pl. 6.11, figs 16a–d.

Remarks—An elliptical holococcolith made up of 8 to 12 elements in its outer rim. The central area is almost completely filled with 2 parallel rods which are aligned slightly off the long axis of the ellipse. The whole specimen is strongly birefringent under cross polarized light.

Occurrence—Few to rare occurrences of this species are recorded from Campanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 5.53 µm/4.08 µm.

Known stratigraphic range—Campanian.

Genus—**SEMIHOLOLITHUS** Perch–Nielsen, 1971

Type Species—*Semihololithus biskayae* Perch–Nielsen, 1971

Semihololithus priscus Perch–Nielsen, 1973

(Pl. 3.16a–b)

1973 *Semihololithus priscus* Perch–Nielsen, pp. 324–325, pl. 9, figs 1, 3, 5, pl. 10, figs 21–22.

1998 *Semihololithus priscus* Burnett *in* Bown, pp. 190, pl. 6.11, fig. 25c.

Remarks—The proximal part of the coccolith consists of an elliptical ring. The distal rim consists a structure of four–split elements forming a central process having an opening which is formed by the joining of the acute ends of hexagon.

Occurrence—Few occurrences of this species are recorded from Turonian to Maastrichtian sediments in Tanot well–1. It seems that the forms recorded in Turonian and Campanian are leaked from younger levels.

Dimensions—L/W 5.05 µm/4.94 µm.

Known stratigraphic range—Maastrichtian–Eocene.

Family—CERATOLITHACEAE Norris, 1965

Genus—CERATOLITHOIDES Bramlette & Martini, 1964

Type Species—*Ceratolithoides kamptneri* Bramlette & Martini, 1964

Ceratolithoides pricei Burnett, 1998

(Pl. 3.17a–c)

1998 *Ceratolithoides pricei* Burnett, pp.125, pl. 1, figs 13a–14.

1998 *Ceratolithoides pricei* Burnett *in* Bown, pp. 196, pl. 6.14, figs 22a–b.

Remarks—Small form of *Ceratolithoides* with a squarish, blocky outline, the horns forming an extremely obtuse angle. The two horns enclose the very small cone which appears button–like. The internal horn length is long. The base: cone ratio is ca.5: 1.

Occurrence—Rare occurrences of this species are observed in one subsurface sample at 1146 m depth belonging to Maastrichtian age.

Dimensions—L/W 5.27 µm/4.38 µm.

Known stratigraphic range—Campanian–Maastrichtian.

Ceratolithoides self–trailiae Burnett, 1998

(Pl. 3.18a–c)

1998 *Ceratolithoides self–trailiae* Burnett, pp.126, pl. 1, figs 15a–e.

1998 *Ceratolithoides self–trailiae* Burnett *in* Bown, pp. 196, pl. 6.14, figs 23a–b.

Remarks—Small form of *Ceratolithoides* with a blocky, squarish outline, the horns forming an extremely obtuse angle. The two horns enclose a very small cone. The internal horne length is moderate. The base: cone ratio is ca. 2.5: 1. Distinguished from *C. ultimus* by the presence of a small cone at the anterior end.

Occurrence—Few to rare occurrences of this species are recorded from Turonian to Maastrichtian. It seems that the forms recorded in Turonian–Coniacian are leaked from younger levels.

Dimensions—L/W 5.49 µm/4.41 µm.

Known stratigraphic range—Campanian–Maastrichtian.

Ceratolithoides ultimus Burnett, 1998

(Pl. 3.19a–c)

1998 *Ceratolithoides pricei* Burnett, pp.126, pl. 1, figs 16a–d.

1998 *Ceratolithoides pricei* Burnett *in* Bown, pp. 196, pl. 6.14, figs 24a–b.

Remarks—Large form of *Ceratolithoides* with a blocky, squarish outline, the horns forming an extremely obtuse angle. Possesses a parallel–sided cone which extends down the entire length of the nannolith, which is completely enclosed between the horns. The base: cone ratio is ca. 1: 1.

Occurrence—Rare occurrences of this species are recorded from Coniacian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 7.45 µm/5.18 µm.

Known stratigraphic range—Maastrichtian.

Family—CHIASTOZYGACEAE Rood *et al*., 1973 emend. Varol & Girgis, 1994

Genus—AHMUELLERELLA Reinhardt, 1964

Type Species—*Ahmuellerella limbitenuis* Reinhardt, 1964 [=*Ahmuellerella octoradiata* (Górka, 1957) Reinhardt, 1966]

Ahmuellerella octoradiata (Górka, 1957) Reinhardt, 1966

(Pl. 3.20a–c)

1957 *Discolithus octoradiatus* Górka, pp. 259, pl.4, fig. 10.

1963 *Zygolithus octoradiatus* Stradner, pp. 14, pl. 5, figs 2–2a.

1964 *Zygolithus octoradiatus* Bramlette & Martini, pp. 304, pl. 4, figs 15–16.

1964 *Ahmuellerella limbitenuis* Reinhardt, pp. 751, pl. 1, fig. 6, pl. 12, fig. 6.

1966 *Ahmuellerella limbitenuis* Reinhardt, pp. 24, pl. 14, figs 1a–b, 3, 4a–b.

1966 *Ahmuellerella octoradiata* (Górka, 1957) Reinhardt, pp. 24, pl. 22, figs 3–4.

1969 *Vagalapilla octoradiata* Bukry, pp. 58, pl. 33, figs 5–7.

1971 *Ahmuellerella octoradiata* Manivit, pp. 93, pl. 1, figs 1–5.

1992 *Ahmuellerella octoradiata* Kale & Phansalkar, pp. 86, pl. 1, fig. 1.

1998 *Ahmuellerella octoradiata* Burnett *in* Bown, pp. 165, pl. 6.1, figs 1–2.
2001 *Ahmuellerella octoradiata* Ladner & Wise *in* Beslier *et al*., pp. 49, pl. 3, figs 20–22.
2015 *Ahmuellerella octoradiata* Linnert & Mutterlose, pp. 731, fig. 4A.

Remarks—Medium–sized murolith with a narrow, unicyclic rim and a wide central area filled with a variably birefringent plate. The rim is dark under cross–polarised light. The central area plate is characterized by eight radial segments of alternating bright and dark areas divided by axial and diagonal sutures. The centre portion of the central plate appears to show narrow, near–axial cross bars that bear a short but broad spine. The bars do not appear to extend to the rim.

Occurrence—In the present study this species is recorded from Cenomanian–Maastrichtian sediments of Tanot well–1.

Dimensions—L/W 7.16 µm/4.86 µm.

Known stratigraphic range—Cenomanian–Maastrichtian.

Genus—**AMPHIZYGUS** Bukry, 1969

Type Species—*Amphizygus brooksii brooksii* Bukry, 1969

Amphizygus brooksii Bukry, 1969

(Pl. 3.21a–c)

1969 *Amphizygus brooksii* Bukry, pp. 47, pl. 25, figs 1–3.
1970 *Bipodorhabdus tesselatus* Noël, pp. 50–52, pl. 13, figs 7–8, pl. 14, figs 1–4, pl. 15, fig. 1, text fig. 10.
1971 *Reinhardtites brooksii* Reinhardt, pp. 114, pl. 21, text figs 5–6.
1982 *Bipodorhabdus brooksii* Crux, pp. 114, pl. 5.2, fig. 10.
1998 *Amphizygus brooksii* Burnett *in* Bown, pp. 166, pl. 6.2, figs 1a–3.
2007 *Amphizygus brooksii* Lees, pp. 41, pl. 6, figs 38–42.
2009 *Amphizygus brooksii* Blair & Watkins, pp. 378, pl. 2, figs 2–3.
2015 *Amphizygus brooksii* Linnert & Mutterlose, pp. 731, fig. 4B.

Remarks—This elliptical coccolith is characterized by a bicyclic rim, a transverse bar and two symmetrical circular openings that occupy the central area. This form is distinguished from *Zygodiscus* Bramlette and Sullivan and *Chiastozygus* Gartner by its distinctive yoke of elements around the perforations and by the intermediate nature of the stem support structure. In *Zygodiscus* the support has the form of a short axis crossbar and in *Chiastozygus* it is an X–shaped crossbar.

Occurrence—This species is recorded from Turonian to Campanian sediments of Tanot well–1.

Dimensions—L/W 8.69 µm/7.09 µm.

Known stratigraphic range—Albian–Maastrichtian.

Genus—**BUKRYLITHUS** Black, 1971

Type Species—*Bukrylithus ambiguus* Black, 1971

Bukrylithus ambiguus Black, 1971

(Pl. 3.22a–c)

1971 *Bukrylithus ambiguus* Black, pp. 416, pl. 33, fig. 6.
1985 *Bukrylithus ambiguus* Perch–Nielsen, pp. 351, pl. 12, fig. 23.
1998 *Bukrylithus ambiguus* Burnett *in* Bown, pp. 165, pl. 6.1, figs 4a–c.
2013a *Bukrylithus ambiguus* Rai *et al*., pp. 58, pl. 1, fig. 6.

Remarks—*B*. *ambiguus* contains a floor with a circular opening at the centre and a broad fibrous cross covering most of the floor. The structure of cross is complex and consists of parallel laths of calcite elements.

Occurrence—Few to rare occurrences of this species are recorded from Cenomanian to Campanian sediments in Tanot well–1.

Dimensions—L/W 5.52 µm/4.01 µm.

Known stratigraphic range—Berriasian–? Campanian.

Genus—**CHIASTOZYGUS** Gartner, 1968

Type Species—*Zygodiscus? amphipons* Bramlette & Martini, 1964

Chiastozygus bifarius Bukry, 1969

(Pl. 4.1a–b)

1964 *Zygodiscus? amphipons* Bramlette & Martini, pp. 302, pl. 4, figs 9–10.
1968 *Chiastozygus amphipons* (Bramlette & Martini, 1964) Gartner, pp. 26, pl. 8, figs 11–14, pl. 11, figs 9a–c, pl. 22, figs 10–11.
1969 *Chiastozygus bifarius* Bukry, pp. 49, pl. 27, figs 10–12.
1970 *Eiffellithus anceps* Hoffmann, pp. 850, pl. 1, figs 3–4.
1982 *Helicolithus bifarius* Crux, pp. 116, pl. 5.3, figs 6, 10.
1998 *Chiastozygus bifarius* Burnett *in* Bown, pp. 170, pl. 6.3, figs 4a–b.
2015 *Chiastozygus bifarius* Linnert & Mutterlose, pp. 731, fig. 4C.

Remarks—Rim generally broad and serrate, crossbars broad, 2–part, smooth well–defined oval centre and slender central stem. Tanot well–1 forms shows variation in size from ~9 µm to ~6 µm.

Occurrence—Few occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 8.63 µm/6.98 µm.

Known stratigraphic range—Albian–Maastrichtian.

Chiastozygus litterarius (Górka, 1957) Manivit, 1971

(Pl. 4.2a–b)

1966 *Discolithus fessus* Stover, pp. 142, pl. 2, figs 17–21, pl. 8, fig. 16.
1968 *Chiastozygus plicatus* Gartner, pp. 27, pl. 16, figs 10–11, pl. 17, fig. 9, pl. 19, fig. 9, pl. 20, fig. 6, pl. 21, fig. 9, pl. 22, fig. 12.
1969 *Chiastozygus plicatus* Bukry, pp. 50, pl. 28, fig. 3.
1971 *Chiastozygus litterarius* (Górka, 1957) Manivit, pp. 92, pl. 4, figs 1–5.
1971 *Chiastozygus litterarius* Thierstein, pp. 476, pl. 2, figs 17–21.
1972 *Discolithus litterarius* Górka, pp. 251, pl. 3, fig. 3.
1972 *Chiastozygus litterarius* Roth & Thierstein, pl. 1, figs 1–6.
1972 *Helicolithus stillatus* Forchheimer, pp. 48, pl. 11, figs 1–4, pl. 16, figs 5–6.
1992 *Chiastozygus litterarius* Kale & Phansalkar, pp. 87, pl. 1, figs 5–6, pl. 2, fig. 2.
1998 *Chiastozygus litterarius* Burnett *in* Bown, pp. 170, pl. 6.3, fig. 5.
2013a *Chiastozygus litterarius* Rai *et al*., pp. 58, pl. 1, fig. 10.
2013b *Chiastozygus litterarius* Rai *et al*., pp. 1607, figs 4.15a–b.

Remarks—The penetration of the ends of the bars into the proximal side of the inner margin cycle is characteristic for *C. litterarius*.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface common to few occurrences of this form are recorded from Albian to Maastrichtian.

Dimensions—L/W 9.30 µm/6.72 µm.

Known stratigraphic range—Barremian–Maastrichtian.

Chiastozygus trabalis (Górka, 1957) Burnett, 1998

(Pl. 4.3a–b)

1957 *Discolithus trabalis* Górka, pp. 252, 257, pl. 3, fig. 2.
1996 *Chiastozygus* sp. 2 Burnett *in* Gale *et al*., pp. 523, figs 4s–t.
1998 *Chiastozygus trabalis* (Górka, 1957) Burnett, pp. 135.
1998 *Chiastozygus trabalis* Burnett *in* Bown, pp. 170, pl. 6.3, figs 2a–b.
2015 *Chiastozygus trabalis* Linnert & Mutterlose, pp. 731, fig. 4D.

Remarks—This species is distinctive in having a fragile looking, generally highly birefringent, ragged inner rim and cross. Cross has perforation at the centre.

Occurrence—Few to rare occurrences of this species are recorded from Albian to Coniacian sediments in Tanot well–1.

Dimensions—L/W 8.13 µm/6.21 µm.

Known stratigraphic range—Albian–Maastrichtian.

Genus—*Gorkaea* Varol & Girgis, 1994

Type Species—*Zygodiscus? pseudanthophorus* Bramlette & Martini, 1964

Gorkaea operio Varol & Girgis, 1994

(Pl. 4.4a–c)

1994 *Gorkaea operio* Varol & Girgis, pp. 230, pl. 11, figs 9–12.
1998 *Gorkaea operio* Burnett *in* Bown, pp. 168, pl. 6.2, fig. 16a.

Remarks— Elliptical coccolith made of a zeugoid outer wall, wide inner wall, proximal rim and a short thick bridge which shows signs of a distal process. The inner wall and the bridge are birefringent, whereas the proximal rim and the thin outer wall are non–birefringent under cross–polarised light. The ends of the transverse bridge do not onlap with the wall.

Occurrence—Few reworked occurrences of this species are observed in one subsurface sample at 1104 m depth belonging to Maastrichtian age.

Dimensions—L/W 8.57 µm/6.17 µm.

Known stratigraphic range—Albian–Cenomanian.

Genus—LOXOLITHUS Noël, 1965

Type Species—*Cyclolithus armilla* Black *in* Black & Barnes, 1959

Loxolithus armilla (Black *in* Black & Barnes, 1959) Noël, 1965

(Pl. 4.5a–c)

1959 *Cyclolithus armilla* Black *in* Black & Barnes, pp. 327, pl. 12, fig. 2.
1965 *Loxolithus armilla* (Black *in* Black & Barnes, 1959) Noël, pp. 67–68, text fig. 3.
2015 *Loxolithus armilla* Linnert & Mutterlose, pp. 731, fig. 4E.

Remarks—Ring–shaped coccolith having broad open central area. Central area may contain delicate, easily damaged membrane, difficult to preserve in fossil forms.

Occurrence—Common to few occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 9.39 µm/8.14 µm.

Known stratigraphic range—Hauterivian–Maastrichtian.

Genus—PLACOZYGUS Hoffman, 1970

Type Species—*Glaukolithus ?fibuliformis* Reinhardt, 1964

Placozygus fibuliformis (Reinhardt, 1964) Hoffmann, 1970

(Pl. 4.6a–b)

1964 *Glaukolithus(?) fibuliformis* Reinhardt, pp. 758, pl. 1, fig. 4.
1964 *Zygodiscus spiralis* Bramlette & Martini, pp. 303, pl. 4, figs 6–8.
1966 *Glaukolithus fibuliformis* Reinhardt, pp. 41, pl. 9, figs 1–3, pl. 22, fig. 22.
1968 *Zygodiscus nanus* Gartner, pp. 33, pl. 14, fig. 17, pl. 18, figs 12–14.
1970 *Placozygus fibuliformis* (Reinhardt, 1964) Hoffmann, pp. 24, pl. 3, figs 4–7.
1981 *Zygodiscus fibuliformis* Smith, pp. 82, pl. 16, figs 16–24.
1985 *Placozygus fibuliformis* Perch–Nielsen, pp. 407, pl. 82, figs 12–15.
1998 *Placozygus fibuliformis* Burnett *in* Bown, pp. 168, pl. 6.2, fig. 26a.
2007 *Placozygus fibuliformis* Lees, pp. 41, pl. 7, figs 27–30.
2015 *Placozygus fibuliformis* Linnert & Mutterlose, pp. 731, fig. 4F.

Remarks—Recognised only in proximal views, this form has an outer and secondary cycle, each containing 28 to 36 radial elements. Proximal rim made up of imbricated elements.

Occurrence—Abundant to few occurrences of this species are recorded from Albian to Maastrichtian. It seems that the forms recorded in Albian–Cenomanian are leaked from younger levels.

Dimensions—L/W 5.56 µm/3.62 µm.

Known stratigraphic range—Turonian?–Maastrichtian.

Placozygus* sp. cf. *P. fibuliformis (Reinhardt, 1964) Hoffmann, 1970

(Pl. 4.7a–b)

1964 *Glaukolithus(?) fibuliformis* Reinhardt, pp. 758, pl. 1, fig. 4.
1970 *Placozygus* sp. cf. *P. fibuliformis* (Reinhardt, 1964) Hoffmann, pp. 24, pl. 3, figs 8–11.
1998 *Placozygus* sp. cf. *P. fibuliformis* Burnett *in* Bown, pp. 168, pl. 6.2, figs 26b–27b.

Remarks—The proximal outer rim of the elliptical coccolith consists of about 24–28 relatively steeply dipping, imbricated, leaflets like elements arranged at the edge. The central area is spanned by a large blocky prism like element seen under light microscope.

Occurrence—common to few occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 5.63 µm/4.36 µm.

Known stratigraphic range—Albian–Maastrichtian.

Genus—REINHARDTITES Perch–Nielsen, 1968

Type Species—*Rhabdolithus anthoporus* Deflandre, 1959

Reinhardtites anthophorus (Deflandre, 1959) Perch–Nielsen, 1968

(Pl. 4.8a–b)

1959 *Rhabdolithus anthophorus* Deflandre, pp. 137, pl. 1, figs 21–22.
1964 *Cretarhabdus? anthophorus* Bramlette & Martini, pp. 299, pl. 3, figs 1–4.
1966 *Discolithus cryptochondrus* Stover, pp. 142, pl. 2, figs 8–9, pl. 8, fig. 13.
1968 *Reinhardtites anthophorus* (Deflandre, 1959) Perch–Nielsen, pp. 38, pl. 5, figs 1–8, text figs 13–14.
1969 *Amphizygus brooksii nanus* Bukry, pp. 47, pl. 25, figs 4–7.
1971 *Reinhardtites? anthophorus* Manivit, pp. 89, pl. 20, figs 9–10, 12–14.
1977 *Zygodiscus anthophorus* Wind & Wise *in* Wise & Wind, pp. 398, pl. 43, figs 1–4.
1977 *Reinhardtites anthophorus* Sissingh, pp. 61, pl. 1, figs 5a–d.
1978 *Reinhardtites anthophorus* Shafik, pp. 225, pl. 7, fig. P.
1982 *Reinhardtites anthophorus* Siesser, pp. 342, pl. 8, figs C, c.
1985 *Reinhardtites anthophorus* Perch–Nielsen, pp. 407.
1992 *Reinhardtites anthophorus* Bralower & Siesser, pp. 546, pl. 5, figs 21–22, pl. 6, figs 12–14.
1998 *Reinhardtites anthophorus* Burnett *in* Bown, pp. 166, pl. 6.2, figs 10, 14a.
2014 *Reinhardtites anthophorus* Bodaghi & Hadavi, pp. 4004, pl. 1, figs 1–2.

Remarks—This species is characterized by moderately large openings surrounded by a wide plate–lining at both sides of the central bridge structure. The plate–lining often has a blocky or pitted microstructure.

Occurrence—Few occurrences of this species are recorded from Coniacian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 8.65 µm/6.63 µm.

Known stratigraphic range—Turonian?–Campanian.

Reinhardtites levis Prins & Sissingh *in* Sissingh, 1977

(Pl. 4.9a–b)

1973 *Zygodiscus* sp. Risatti, pl. 10, figs 18–19.
1977 *Reinhardtites levis* Prins & Sissingh *in* Sissingh, pp. 61, pl. 1, figs 1–3.
1985 *Reinhardtites levis* Perch–Nielsen, pp. 343, figs 3–4.
1998 *Reinhardtites levis* Burnett *in* Bown, pp. 166, pl. 6.2, figs 8a–9.
2012 *Reinhardtites levis* Farouk & Faris, pp. 58, figs 8.15–17.
2014 *Reinhardtites levis* Jelby *et al*., pp. 93, fig. 5C.
2014 *Reinhardtites levis* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 7.

Remarks—A well developed rim with radiating rim elements surrounds at its proximal side. At distal side it is connected to a broad, smooth plate–lining, leaving sometimes two small openings at both sides of the central bridge structure. In plan view the bridge is broadly rhombical and it extends less far in the direction of the rim. The bridge carries a short and broad spine.

Occurrence—Few to rare occurrences of this species are recorded from Campanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 6.27 µm/5.25 µm.

Known stratigraphic range—Campanian–Maastrichtian.

Genus—RHABDOPHIDITES Manivit, 1971

Type Species—*Rhabdophidites moeslensis* Manivit, 1971

Rhabdophidites parallelus (Wind & Čepek, 1979) Lambert, 1987

(Pl. 4.10a–b)

1972 *Eurhabdus luciformis* Wilcoxon, pl. 10, fig. 4.
1979 *Rhabdolekiskus parallelus* Wind & Čepek, pp. 232, pl. 3, figs 3–6.
1987 *Rhabdophidites parallelus* (Wind & Čepek, 1979) Lambert, pp. 79, pl. 11, figs 15–17.
2013b *Rhabdophidites parallelus* Rai *et al*., pp. 1607, figs 4.16a–b.

Remarks—Long, straight–sided stem constructed of four elongate elements arising from a small tabular base. Width of stem is about half of the width of the base.

Occurrence—In the present study reworked forms of this species is recorded from both surface and subsurface sediments.

Dimensions—L/W 13.29 µm/2.93 µm.

Known stratigraphic range—Aptian.

Genus—STAUROLITHITES Caratini, 1963

Type Species—*Staurolithites laffittei* Caratini, 1963

Staurolithites ? aenigma Burnett, 1998

(Pl. 4.11a–b)

1996 *Staurolithites?* sp. 1 Burnett *in* Gale *et al*., pp. 523, figs 4l–m.
1998 *Staurolithites? aenigma* Burnett, pp. 139, pl. 1, figs 1a–b.
1998 *Staurolithites? aenigma* Burnett *in* Bown, pp. 166, pl. 6.1, figs 28a–b.

Remarks—Small sized elliptical coccolith with a bicyclic rim. The rims are equally narrow, the outer one being dark and the inner one bright. The central area contains a plate. The axial cross is composed of laths and sits partially within the plate. This cross tends to be highly birefringent in the light microscope.

Occurrence—Common to few occurrences of this species are recorded from Albian to Campanian in Tanot well–1. Reworking of this species is observed in Santonian–Campanian sediments.

Dimensions—L/W 4.87 µm/3.06 µm.

Known stratigraphic range—Albian–Cenomanian.

Staurolithites crux (Deflandre *in* Deflandre & Fert, 1954) Caratini, 1963

(Pl. 4.12a–b)

1954 *Discolithus crux* Deflandre *in* Deflandre & Fert, pp. 143, pl. 14, fig. 4. text fig. 55.
1961 *Zygolithus crux* (Deflandre *in* Deflandre & Fert, 1954) Bramlette & Sullivan, pp. 149, pl. 6, figs 8–10.
1963 *Zygolithus crux* Stradner, pp. 9, pl. 4, figs 6–7.
1963 *Staurolithites crux* (Deflandre *in* Deflandre & Fert, 1954) Caratini, pp. 25.
1966 *Zygolithus crux* Stover, pp. 147, pl. 3, figs 17–18, 22A.

Remarks—A medium–sized elliptical species of *Staurolithites* having straight crossbars with the axis of coccolith. Thickening at the intersection of crossbars absent. Under cross nicols the rim is seen to be constructed of two concentric rings, the inner one being narrower and commonly interrupted by the crossbars.

Occurrence—Common to few occurrences of this species are recorded from Albian to Turonian sediments in Tanot well–1.

Dimensions—L/W 5.25 µm/4.00 µm.

Known stratigraphic range—Hauterivian?–Maastrichtian.

Staurolithites dorfii (Bukry, 1969) Burnett, 1998

(Pl. 4.13a–b)

1969 *Vagalapilla dorfii* Bukry, pp. 57, pl. 32, figs 7–8.
1998 *Staurolithites dorfii* (Bukry, 1969) Burnett, pp 139.
1998 *Staurolithites dorfii* Burnett *in* Bown, pp. 165, pl. 6.1, fig. 24.

Remarks—A medium–sized elliptical to circular species of *Staurolithites* having smooth narrow rim in distal view, is composed of a single cycle of elements that imbricate dextrally and incline clockwise along their inner margin. The large open central area occupies two perpendicular crossbars which are composed of a multitude of small elements and are aligned with the long and short axes of the ellipse. Margins of the crossbars are very linear. At the intersection of the crossbars is a circular hollow stem. In proximal view dextrally imbricate and counterclockwise inclined elements compose the rim.

Occurrence—Common to few occurrences of this species are recorded from Campanian sediments in Tanot well–1.

Dimensions—L/W 5.91 µm/5.04 µm.

Known stratigraphic range—?Campanian.

Staurolithites ellipticus (Gartner, 1968) Lambert, 1987

(Pl. 4.14a–b)

1968 *Vekshinella elliptica* Gartner, pp. 30, pl. 17, fig. 5, pl. 25, figs 26–27, pl. 26, fig. 7.
1987 *Staurolithites ellipticus* (Gartner, 1968) Lambert, pp. 83, pl. 12, fig. 10.
2007 *Staurolithites ellipticus* Lees, pp. 41, pl. 8, figs 28–35.
2015 *Staurolithites ellipticus* Linnert & Mutterlose, pp. 731, fig. 4G.

Remarks—The elliptical disc is constructed of 38 to 40 dextrally imbricated elements. The inclination of the sutures is slightly counter–clockwise at the periphery but bends sharply and becomes inclined clockwise at the inner margin. A wide low rim is developed on the distal periphery of the disc. The elements terminate in sharp points that protrude beyond the periphery and give the disc a serrate outline. The relatively small elliptical opening in the centre is spanned by two thick crossbars that are aligned with the major and minor axes of the ellipse. The crossbars cover nearly the entire central area and at their intersection crossbars are perforated and surmounted by a hollow stem. The stem generally is broken near its base.

Occurrence—Few occurrences of this species are observed in one subsurface sample at 1452 m depth belonging to Turonian age.

Dimensions—L/W 6.42 µm/5.06 µm.

Known stratigraphic range—Albian?–Maastrichtian.

Staurolithites flavus Burnett, 1998

(Pl. 4.15a–b)

1998 *Staurolithites flavus* Burnett, pp. 140, pl. 1, figs 2a–b.
2007 *Staurolithites flavus* Lees, pp. 41, pl. 8, figs 40–43.

Remarks—This medium–sized species has a unicyclic murolith rim. An axial cross spans the open central area. The bars of the cross appear to be composed of single blocks of calcite and in the light microscope these are highly birefringent. It is not clear wheather the species bears a spine or not.

Occurrence—Few occurrences of this species are observed in one subsurface sample at 1146 m depth belonging to Maastrichtian age.

Dimensions—L/W 4.83 µm/4.07 µm.

Known stratigraphic range—Cenomanian–Maastrichtian.

Staurolithites gausorhethium (Hill, 1976) Varol & Girgis, 1994

(Pl. 4.16a–b)

1976 *Vagalapilla gausorhethium* Hill, pp. 157, pl. 3, figs 25–30.
1994 *Staurolithites gausorhethium* (Hill, 1976) Varol & Girgis, pp. 238, pl. 11, fig. 19.
1998 *Staurolithites gausorhethium* Burnett *in* Bown, pp. 166, pl. 6.1, figs 29a–30.

Remarks—The species has an elliptical rim which is smooth in outline. The open central area is spanned by an axially or nearly axially aligned central cross. A central spine may be present. Under bright field illumination, the rim appears to be constructed of a single cycle of elements. The arms of the central cross appear parallel–sided or very slightly tapered and are offset slightly in a counterclockwise direction about the central juncture.

Occurrence—Common to few occurrences of this species are recorded from Albian to Maastrichtian in Tanot well–1. Reworking of this species is observed in Turonian–Maastrichtian sediments.

Dimensions—L/W 5.62 µm/3.95 µm.

Known stratigraphic range—Albian–Cenomanian.

Staurolithites glaber (Jeremiah, 1996) Burnett *in* Bown, 1998

(Pl. 4.17a–b)

1966 *Coccolithus matalosus* Stover, pp. 139, pl. 2, figs 1–2, pl. 8, fig. 10.
1973 *Vagalapilla matalosa* (Stover, 1966) Thierstein, pp. 37–38, pl. 3, figs 15–18.
1994 *Bownia matalosa* (Stover, 1966) Varol & Girgis, pp. 237, pl. 11, fig. 1.
1996 *Bownia matalosa* Jeremiah, pp. 125, pl. 3, fig. 20.
1998 *Staurolithites glabra* Burnett, pp. 140.
1998 *Staurolithites glaber* (Jeremiah, 1996) Burnett *in* Bown, pp. 166, pl. 6.1, fig. 26.

Remarks—The coccoliths are elliptical and consist of two closely–appressed zeugoid walls. The central opening is bridged by a narrow cross parallel to the principal axes of the ellipse with flaring, arrowhead–like ends. Under crossed nicols the inner cycle is highly birefringent and appears brighter than the rim.

Occurrence—Common to rare patchy occurrences of this species are recorded from Albian to Maastrichtian in Tanot well–1. Reworking of this species is observed in Santonian–Maastrichtian sediments.

Dimensions—L/W 4.67 µm/3.33 µm.

Known stratigraphic range—Aptian–Cenomanian.

Staurolithites imbricatus (Gartner, 1968) Burnett, 1998

(Pl. 4.18a–b)

1968 *Vekshinella imbricata* Gartner, pp. 30–31, pl. 9 figs 16–17, pl. 13, figs 8–9.

1998 *Staurolithites imbricatus* (Gartner, 1968) Burnett, pp. 140.

1998 *Staurolithites imbricatus* Burnett *in* Bown, pp. 165, pl. 6.1, figs 16–17.

Remarks—The disc is constructed of 40 to 50 dextrally imbricate elements that incline slightly counterclockwise when viewed distally. The rim on the distal side of the periphery is wide and prominent. The cross bar spanning the elliptical central opening are aligned very nearly with the major and minor axes of the ellipse. They are sturdy and are constructed of numerous small calcite rods aligned with the long dimension of the crossbars. At their intersection the crossbars are surmounted by a spine or stem, which may have a square cross section and appears to be constructed of radially arranged calcite rhombs.

Occurrence—Rare occurrences of this species are observed in one subsurface sample at 1146 m depth belonging to Maastrichtian age.

Dimensions—L/W 6.50 µm/4.63 µm.

Known stratigraphic range—Santonian?–Maastrichtian.

Staurolithites* sp. cf. *S. integer (Bukry, 1969) Burnett *in* Bown, 1998

(Pl. 4.19a–b)

1969 *Vagalapilla compacta integra* Bukry, pp. 56, pl. 31, fig. 12.

1998 *Staurolithites integra* Burnett, pp. 140.

1998 *Staurolithites integer* (Bukry, 1969) Burnett *in* Bown, pp. 165, pl. 6.1, figs 11–12.

Remarks—This species is placed in *Staurolithites* sp. cf. *S. integer* because it is comprised of a simple murolith rim and an axial cross like *S. integer*.

Occurrence—Common to few patchy occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 6.73 µm/5.53 µm.

Known stratigraphic range—Albian–Maastrichtian.

Staurolithites laffittei Caratini, 1963

(Pl. 4.20a–b)

1963 *Staurolithites laffittei* Caratini, pp. 25, pl. 2, figs 32–33.

1998 *Staurolithites laffittei* Burnett *in* Bown, pp. 165, pl. 6.1, figs 25c–d.

Remarks—Consist of a single zeugoid wall, proximal rim and a central cross with or without a distal process. The central cross is made of fibrous and/or non–fibrous elements.

Occurrence—Common to few occurrences of this species are recorded from Albian to Turonian sediments in Tanot well–1.

Dimensions—L/W 5.03 µm/3.20 µm.

Known stratigraphic range—Albian?–Maastrichtian.

Staurolithites mielnicensis (Górka, 1957) Perch–Nielsen, 1968 *sensu* Crux *in* Lord, 1982

(Pl. 4.21a–b)

1957 *Discolithus mielnicensis*, Górka, pp. 273, pl. 2, fig. 14.

1968 *Zygolithus mielnicensis* (Górka, 1957) Perch–Nielsen, pp. 67, pl. 10, figs 17–18.

1982 *Zygolithus mielnicensis sensu* Crux *in* Lord, pp. 183, pl. 30, figs 20–25.

1985 *Staurolithites mielnicensis* (Górka, 1957) Perch–Nielsen.

Remarks—A large elliptical coccolith with two crossbars bridging the central area and showing slight imbrication at their junction point. The outer rim is broad and bright and the inner rim is thin. The crossbars meet at the inner margin of the inner rim at four points and having large 'arrowhead' shape at the ends.

Occurrence—Few occurrences of this species are observed in one subsurface sample at 1338 m depth belonging to Campanian age.

Dimensions—L/W 6.99 µm/5.29 µm.

Known stratigraphic range—Santonian–Maastrichtian.

Staurolithites minutus Burnett, 1998

(Pl. 4.22a–b)

1998 *Staurolithites minutus* Burnett, pp. 140, pl. 1, figs 4a–b.

Remarks—This is a very small species of *Staurolithites* which is distinctively highly birefringent with a virtually closed central area and an indistinct extremely small axial cross.

Occurrence—Few to rare patchy occurrences of this species are recorded from Cenomanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 4.00 µm/2.72 µm.

Known stratigraphic range—Cenomanian?–Maastrichtian.

Staurolithites mitcheneri (Applegate & Bergen, 1988) Rutledge & Bown *in* Bown, 1998

(Pl. 4.23a–b)

1987 *Eiffellithus*? Sp. 2 Covington & Wise, pp. 34, pl. 22, figs 7–9.

1988 *Vekshinella mitcheneri* Applegate & Bergen, pp. 317, pl. 23, figs 7–9.

1998 *Staurolithites mitcheneri* (Applegate & Bergen) Rutledge & Bown *in* Bown, pp. 114, pl. 5.7, fig. 16.

Remarks—The distal rim of this species is constructed of highly inclined, imbricate elements that give this species a bright birefringence under crossed polars. The ends of the central cross flare at the rim, resulting in a small central opening. The crossbars exhibit a bright white birefringence. The upper range of this form in Tanot well–1 is extended from Early Aptian to Turonian.

Occurrence—Few occurrences of this species are recorded from Albian to Turonian sediments in Tanot well–1.

Dimensions—L/W 4.48 µm/3.42 µm.

Known stratigraphic range—Early Valanginian?–Early Aptian.

Staurolithites* sp. cf. *S. mutterlosei Crux, 1989

(Pl. 5.1a–b)

1989 *Staurolithites mutterlosei* Crux, pp. 56, pl. 4, fig. 14.

Remarks—A species of *Staurolithites* having offset central cross and smooth outline. The rim has a complex structure composed of two superimposed cycles of imbricating elements.

Occurrence—Common to rare patchy occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 4.19 µm/3.12 µm.

Known stratigraphic range—Albian–Maastrichtian.

***Staurolithites* sp. 1**

(Pl. 5.2a–b)

Remarks—A much elongated species of *Staurolithites* having straight central cross and smooth outline. It is not possible to differentiate both the rims under light microscope.

Occurrence—Few to rare occurrences of this species are recorded from Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 6.08 µm/3.83 µm.

Known stratigraphic range—Maastrichtian.

***Staurolithites* sp. 2**

(Pl. 5.3a–b)

Remarks—A species of *Staurolithites* having offsetted central cross and irregular broad outer rim.

Occurrence—Few to rare patchy occurrences of this species are recorded from Turonian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 4.89 µm/3.62 µm.

Known stratigraphic range—Turonian–Maastrichtian.

Staurolithites* sp. cf. *S. zoensis Burnett, 1998

(Pl. 5.4a–b)

1998 *Staurolithites zoensis* Burnett, pp. 140, pl. 1, figs 5–7b.

1998 *Staurolithites zoensis* Burnett *in* Bown, pp. 165, pl. 6.1, figs 18a–20b.

Remarks—This species is morphologically similar to *Staurolithites zoensis* described by Burnett, 1998, but it is smaller in size and have extended lower stratigraphic range from Santonian to Cenomanian.

Occurrence—Common to few occurrences of this species are recorded from Cenomanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 4.61 µm/3.37 µm.

Known stratigraphic range—Cenomanian–Maastrichtian.

Genus—TRANOLITHUS Stover, 1966

Type Species—*Tranolithus manifestus* Stover, 1966 (=*Tranolithus orionatus* Reinhardt, 1966)

Tranolithus gabalus Stover, 1966

(Pl. 5.5a–b)

1966 *Tranolithus gabalus* Stover, pp. 146, pl. 4,fig. 22, pl. 9, fig. 5.

1971 *Glaukolithus bitabulatus* Worsley, pp. 1310, pl. 2, figs 40–42.

1972 *Tranolithus gabalus* Roth & Thierstein, pl. 10, figs 1–5.

1973 *Tranolithus gabalus* Thierstein, pp. 38.

1976 *Tranolithus gabalus* Hill, pp. 156, pl. 11, figs 36–41, pl. 15, fig. 13.

1998 *Tranolithus gabalus* Burnett *in* Bown, pp. 166, pl. 6.2, figs 4b–c.

Remarks—The coccoliths have an elliptical outline in proximal or distal view and a narrow smooth rim. The central opening is spanned transversely by a relatively wide, slightly distally arched bar commonly with a small central perforation. Components of the transverse bar and adjacent parts of the rim have the same or nearly the same crystallographic orientation. The curvature of extinction lines across the rim is sinistral in distal view.

Occurrence—Common to rare occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 5.16 µm/3.49 µm.

Known stratigraphic range—Early Valanginian–Maastrichtian.

Tranolithus minimus (Bukry, 1969) Perch–Nielsen, 1984

(Pl. 5.6a–b)

1969 *Zygodiscus minimus* Bukry, pp. 61, pl. 35, figs 9–11.
1984 *Tranolithus minimus* (Bukry, 1969) Perch–Nielsen, pp. 43.
1998 *Tranolithus minimus* Burnett *in* Bown, pp. 166, pl. 6.12, figs 5a–d.

Remarks—The elliptical rim cycle of this small species is composed of 22 to 30 dextrally imbricated elements inclined clockwise. Rim margins are smooth or serrate. The central area is filled by a multi–element central stem flanked by a two large, flat elements which completely occupy the remaining area.

Occurrence—Abundant to rare occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 4.13 µm/3.24 µm.

Known stratigraphic range—Valanginian?–Maastrichtian.

Tranolithus orionatus (Reinhardt, 1966a) Reinhardt, 1966b

(Pl. 5.7a–b)

1966a *Discolithus orionatus* Reinhardt, pp. 42, pl. 23, figs 22, 31, 33.
1966b *Tranolithus orionatus* (Reinhardt, 1966a) Reinhardt, pp. 522.
1966 *Tranolithus exiguous* Stover, pp. 146, pl. 4, figs 19–27, pl. 9, figs 3–7.
1968 *Zygolithus exiguus* Manivit, pp. 279, pl. 1, fig. 11.
1968 *Zygolithus phacelosus* Manivit, pp. 280, pl. 1, fig. 12.
1969 *Zygolithus? phacelosus* Bukry, pp. 61, pl. 35, fig. 12.
1970 *Zygostephanos orionatus* Hoffmann, pp. 178, pl. 1, fig. 5, pl. 3, fig. 3, text fig. 3, fig. 6.
1971 *Tranolithus exiguous* Manivit, pp. 85, pl. 26, figs 10–12, 18.
1971 *Tranolithus orionatus* Manivit, pp. 85, pl. 26, figs 13–17.
1972 *Tranolithus exiguous* Roth & Thierstein, pl. 10, figs 6–10.
1972 *Tranolithus gabalus* Roth & Thierstein, pl. 10, figs 1–5.
1972 *Tranolithus orionatus* Roth & Thierstein, pl. 10, figs 11–15.
1976 *Tranolithus orionatus* Thierstein, pp. 352, pl. 1, figs 7–8, pl. 4, figs 11–12.
1998 *Tranolithus orionatus* Burnett *in* Bown, pp. 166, pl. 6.2, figs 6a–7b.
2004 *Tranolithus orionatus* Chira *et al*., pp. 95, pl. 1, figs 14a–b.
2013a *Tranolithus orionatus* Rai *et al*., pp. 71, pl. 1, fig. 47.
2013b *Tranolithus orionatus* Rai *et al*., pp. 1607, figs 4.17a–b.
2014 *Tranolithus orionatus* Jelby *et al*., pp. 93, fig. 5D.
2015 *Tranolithus orionatus* Linnert & Mutterlose, pp. 731, fig. 4H.

Remarks—Elliptical coccolith having outer rim consisting of a broader distal rim cycle and a narrower proximal rim cycle and a central structure composed of four elements, two at each of the longer side of the margin. The shape of these elements depends on the amount of secondary calcite. They even may have become fused in overgrown material.

Occurrence—Abundant to few continuous occurrences of this species are recorded from Albian to Maastrichtian in Tanot well–1. Reworking of this species is observed in Late Maastrichtian sediments.

Dimensions—L/W 7.83 µm/6.18 µm.

Known stratigraphic range—Late Aptian–Maastrichtian.

Genus—ZEUGRHABDOTUS Reinhardt, 1965

Type Species—*Zygolithus erectus* (Deflandre *in* Deflandre & Fert, 1954) Reinhardt, 1965

Zeugrhabdotus bicrescenticus (Stover, 1966) Burnett *in* Gale *et al*., 1996

(Pl. 5.8a–b)

1966 *Discolithus bicrescenticus* Stover, pp. 142, pl. 2, figs 5–7, pl. 8, fig. 11.
1996 *Zeugrhabdotus bicrescenticus* (Stover, 1966) Burnett *in* Gale *et al*., pp. 529.
1998 *Zeugrhabdotus bicrescenticus* Burnett *in* Bown, pp. 168, pl. 6.2, figs 12a–c.
2004 *Zeugrhabdotus bicrescenticus* Chira *et al*., pp. 96, pl. 2, figs 18a–18b.
2007 *Zeugrhabdotus bicrescenticus* Lees, pp. 42, pl. 9, figs 1–2.
2013a *Zeugrhabdotus bicrescenticus* Rai *et al*., pp. 71, pl. 1, fig. 50.
2013b *Zeugrhabdotus bicrescenticus* Rai *et al*., pp. 1607, figs 4.18a–b.
2014 *Zeugrhabdotus bicrescenticus* Jelby *et al*., pp. 93, fig. 5E.
2015 *Zeugrhabdotus bicrescenticus* Linnert & Mutterlose, pp. 731, fig. 4I.

Remarks—Elliptical coccolith having smooth to finely striate rim of medium width. The centre of the coccolith has a prominent boss surrounded by an elliptical band of variable width that is not in contact with the boss across the narrow ends of coccolith. The central boss appears nearly ortholithic under crossed nicols and is formed of four parts with each part of the components in same crystallographic orientation. The curvature of extinction lines across the rim is sinistral in distal view.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface abundant to rare occurrences of this form are recorded from Albian to Maastrichtian.

Dimensions—L/W 6.31 µm/4.59 µm.

Known stratigraphic range—Albian–Maastrichtian.

Zeugrhabdotus biperforatus (Gartner, 1968) Burnett, 1998

(Pl. 5.9a–b)

1968 *Zygodiscus biperforatus* Gartner, pp. 73, pl. 14, figs 15–16, pl. 17, figs 1a–c, 2a–d, pl. 18, figs 21, pl. 19, figs 4a–d, pl. 20, figs 19–20, pl. 21, figs 5a–d.
1969 *Zygodiscus biperforatus* Bukry, pp. 58, pl. 33, fig. 12.
1998 *Zeugrhabdotus biperforatus* (Gartner, 1968) Burnett, pp. 141.
1998 *Zeugrhabdotus biperforatus* Burnett *in* Bown, pp. 166, pl. 6.2, fig. 11.
2007 *Zeugrhabdotus biperforatus* Lees, pp. 42, pl. 9, figs 8–9.
2013a *Zeugrhabdotus biperforatus* Rai *et al*., pp. 71, pl. 1, fig. 51.

Remarks—Small close–set perforations and high rim count give this species a unique appearance.

Occurrence—Abundant to few occurrences of this species are recorded from Turonian to Maastrichtian in Tanot well–1. Reworking of this species is observed in Maastrichtian sediments.

Dimensions—L/W 6.58 µm/4.40 µm.

Known stratigraphic range—Turonian–Campanian.

Zeugrhabdotus diplogrammus (Deflandre *in* Deflandre & Fert, 1954) Burnett *in* Gale *et al*., 1996

(Pl. 5.10a–b)

1954 *Zygolithus diplogrammus* Deflandre *in* Deflandre & Fert, pp. 148, pl. 10, fig. 7, text fig. 57.
1964 *Glaukolithus diplogrammus* (Deflandre *in* Deflandre & Fert, 1954) Reinhardt, pp. 758.
1966 *Zygolithus ponticulus* (Deflandre *in* Deflandre & Fert, 1954) Stover, pp. 148, pl. 4, figs 2–5.
1966 *Zygolithus stenopous* Stover, pp. 148, pl. 4, figs 6–9, pl. 8, fig. 25.
1969 *Zygodiscus compactus* Bukry, pp. 59, pl. 34, figs 1–2.
1996 *Zeugrhabdotus diplogrammus* (Deflandre *in* Deflandre & Fert, 1954) Burnett *in* Gale *et al*., pp. 530.
1998 *Zeugrhabdotus diplogrammus* Burnett *in* Bown, pp. 168, pl. 6.2, figs 13a–b.

Remarks—The *Zeugrhabdotus diplogrammus* forms recorded in Tanot well–1 show strong variation in the width of the bar, which has a distinct groove and occasionally a central process.

Occurrence—Few to rare patchy occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1. Maastrichtian occurrences are attributed to reworking.

Dimensions—L/W 8.18 µm/6.04 µm.

Known stratigraphic range—Early Valanginian–Campanian.

Zeugrhabdotus 'elegans' (Gartner, 1968) Burnett *in* Gale *et al*., 1996

(Pl. 5.11a–b)

1969 *Zygodiscus elegans* Gartner, 1968, pp. 32, pl. 10, figs 3–6, pl. 12, figs 3–4, pl. 27, fig. 1, emend. Bukry, pp. 59, pl. 34, figs 6–8.
1972 *Glaukolithus elegans* Roth & Thierstein, pl. 10, figs 16–20.
1973 *Glaukolithus elegans* Thierstein, pp. 36, pl. 2, figs 8–11.
1976 *Zygodiscus fibuliformis* (Bukry, 1969) Verbeek, pp. 76, pl. 1, fig. 2.
1996 *Zeugrhabdotus 'elegans'* (Gartner, 1968) Burnett *in* Gale *et al*., pp. 530.
2004 *Zeugrhabdotus elegans* Chira *et al*., pp. 95, pl. 1, figs 2a–b.
2015 *Zeugrhabdotus elegans* Linnert & Mutterlose, pp. 731, fig. 4J.

Remarks—This species differs from *Zeugrhabdotus spiralis* by having a proximal margin cycle, which does not extend into the central area. In the light microscope the corresponding spiral–shaped extinction pattern is less distinct, than in *Z. spiralis*.

Occurrence—Abundant to few occurrences of this species are recorded from Albian to Turonian sediments in Tanot well–1.

Dimensions—L/W 6.16 µm/3.92 µm.

Known stratigraphic range—Early Berriasian?–? Campanian.

Zeugrhabdotus embergeri (Noël, 1958) Perch–Nielsen, 1984

(Pl. 5.12a–b)

1958 *Discolithus embergeri* Noël, pp. 164–165, pl. 1, figs 1, 7–8.

1961 *Discolithus embergeri* Stradner, pp. 80–81, figs 20–24.
1963 *Parhabdolithus embergeri* Stradner, pl. 4, fig. 1.
1965 *Discolithus embergeri* Manivit, pp. 190, pl. 2, figs 6a–6b.
1967 *Parhabdolithus embergeri* Moshkovitz, pp. 149–150, pl. 1, figs 15–16.
1968 *Zygodiscus lacunatus* Gartner, pp. 333, pl. 17, figs 6a–d.
1972 *Parhabdolithus embergeri* Roth & Thierstein, pl. 9, figs 1–6.
1972 *Parhabdolithus embergeri* Lauer, pp. 168, pl. 30, figs 10–12.
1973 *Parhabdolithus embergeri* Roth, pl. 25, fig. 2.
1976 *Parhabdolithus embergeri* Hill, pp. 147, pl. 10, figs 1–5.
1976 *Parhabdolithus embergeri* Burns, pp. 293, pl. 4, fig. 2.
1977 *Parhabdolithus embergeri* Wind & Wise *in* Wise & Wind, pp. 454, pl. 71, figs 7, 8, pl. 88, fig. 11.
1984 *Zeugrhabdotus embergeri* (Noël, 1958) Perch–Nielsen, pp. 40, pl. 5, figs 2, 6.
1985 *Zeugrhabdotus embergeri* Perch–Nielsen, pp. 409, pl. 84, figs 14–15.
1987 *Zeugrhabdotus embergeri* Crux, pp. 204, pl. 8.12, figs 34–35.
1998 *Zeugrhabdotus embergeri* Burnett *in* Bown, pp. 168, pl. 6.2, figs 23–24.
2004 *Zeugrhabdotus embergeri* Chira *et al*., pp. 96, pl. 2, fig. 19.
2005 *Zeugrhabdotus embergeri* Bown *in* Bralower *et al*., pp. 24, pl. P2, figs 2–12.
2007 *Zeugrhabdotus embergeri* Lees, pp. 42, pl. 7, figs 1–12.
2013b *Zeugrhabdotus embergeri* Rai *et al*., pp. 1607, figs 4.19a–b.
2015 *Zeugrhabdotus embergeri* Linnert & Mutterlose, pp. 731, fig. 4K.

Remarks—These are large, bicyclic loxolith coccoliths with an open central area spanned by a broad transverse bar. Specimens often display distinctive orange birefringence under cross polarized light. Majority of the specimens documented in Tanot well–1 are broken.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface few to rare occurrences of this form are recorded from Cenomanian to Maastrichtian.

Dimensions—L/W approx.18.30 µm/10.72 µm.

Known stratigraphic range—Tithonian–Maastrichtian.

Zeugrhabdotus erectus (Deflandre *in* Deflandre & Fert, 1954) Reinhardt, 1965

(Pl. 5.13a–b)

1954 *Zygolithus erectus* Deflandre *in* Deflandre & Fert, pp. 150, pl. 15, figs 14–17, text figs 60–62.
1965 *Zeugrhabdotus erectus* (Deflandre *in* Deflandre & Fert, 1954) Reinhardt, pp. 37.
1966 *Zygolithus erectus* Stover, pp. 147, pl. 3, figs 19–20.
1974 *Zeugrhabdotus erectus* Barnard & Hay, pl. 4, fig. 10.
1979 *Zeugrhabdotus erectus* Medd, pp. 46, pl. 10, figs 1–3.
1980 *Zeugrhabdotus erectus* Grün & Zweili, pp. 295, pl. 15, figs 6–8.
1998 *Zeugrhabdotus erectus* Burnett *in* Bown, pp. 168, pl. 6.2, figs 30c–d.
2005 *Zeugrhabdotus erectus* Bown *in* Bralower *et al*., pp. 25, pl. P2, figs 13–18.
2007 *Zeugrhabdotus erectus* Lees, pp. 42, pl. 9, figs 19–24.
2013a *Zeugrhabdotus erectus* Rai *et al*., pp. 71, pl. 1, fig. 52.
2013b *Zeugrhabdotus erectus* Rai *et al*., pp. 1607, figs 4.20a–b.

Remarks—This species is small and has a single bridge with a central knob. The grill structure that generally fills the central area between the bridge and the margin is not visible under the light microscope.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface common to rare continuous occurrences of this form are recorded from Albian to Maastrichtian.

Dimensions—L/W 4.05 µm/3.57 µm.

Known stratigraphic range—Pliensbachian–Maastrichtian.

Zeugrhabdotus kerguelenesis Watkins, 1992

(Pl. 5.14a–b)

1992 *Zeugrhabdotus kerguelenesis* Watkins, pp. 363, pl. 1, figs 1–6, pl. 2, figs 1–12.
1998 *Zeugrhabdotus kerguelenesis* Burnett *in* Bown, pp. 168, pl. 6.2, fig. 18.

Remarks—A large species of *Zeugrhabdotus* bearing a broad, short, cylindrical to conical stem composed of vertical prisms with terminations that form a linear pattern spiraling distally upward and inward. The stem fills the entire central area in distal view and is supported by a simple bridge running parallel to the minor axis.

Occurrence—Rare occurrences of this species are recorded from Coniacian to Campanian in Tanot well–1. Reworking of this species is observed in Campanian sediments.

Dimensions—L/W 6.58 µm/4.96 µm.

Known stratigraphic range—Turonian–Coniacian.

Zeugrhabdotus noeliae Rood *et al*., 1971

(Pl. 5.15a–b)

1954 *Zygolithus erectus* Deflandre *in* Deflandre & Fert, text fig. 62.
1965 *Zygolithus erectus* Noël, pp. 62–64, fig. 2, pl. 1, figs 3–4.
1968 *Zygolithus erectus* Stradner *et al*., pp. 34–35, pl. 25, pl. 26, figs 1–2.

1971 *Zeugrhabdotus noeliae* Rood *et al*., pp. 252–253, pl. 1, fig. 4.
1977 *Zeugrhabdotus noeliae* Wise & Wind, pp. 308, pl. 82, figs 1–4, pl. 83, fig. 1, pl. 89, fig. 12.
1998 *Zeugrhabdotus noeliae* Burnett *in* Bown, pp. 168, pl. 6.2, figs 19a–b.
2007 *Zeugrhabdotus noeliae* Lees, pp. 42, pl. 8, figs 10–17.
2013a *Zeugrhabdotus noeliae* Rai *et al*., pp. 71, pl. 1, fig. 53.
2015 *Zeugrhabdotus noeliae* Linnert & Mutterlose, pp. 731, fig. 4L.

Remarks—This species is readily separated from *Zeugrhabdotus erectus* by the relative proportions of the central openings. The margin in distal view seems constructed of 16–22 overlapping wedges. The bridge is constructed of a few large elements. The stem is hollow, pierced by a circular opening.

Occurrence—Common to few occurrences of this species are recorded from Albian to Santonian sediments in Tanot well–1.

Dimensions—L/W 6.76 µm/4.67 µm.

Known stratigraphic range—Jurassic?–Santonian.

Zeugrhabdotus scutula (Bergen, 1994) Rutledge & Bown, 1996

(Pl. 5.16a–b)

1989 *Zeugrhabdotus sisyphus* Crux, pp. 198, pl. 8.7, fig. 1, pl. 8.12, fig. 30.
1994 *Reinhardites scutula* Bergen, pp. 64, pl. 1, figs 24a–c, 25a–b.
1996 *Zeugrhabdotus scutula* (Bergen, 1994) Rutledge & Bown, pp. 56.
1998 *Zeugrhabdotus scutula* Burnett *in* Bown, pp. 168, pl. 6.2, figs 14b, 15, 20.
2013a *Zeugrhabdotus scutula* Rai *et al*., pp. 71, pl. 1, fig. 54.
2015 *Zeugrhabdotus scutula* Linnert & Mutterlose, pp. 731, fig. 4M.

Remarks—Medium to large species of *Zeugrhabdotus* having a smooth narrow rim and a central, elevated transverse bar supporting a distal boss of equal width. A bright, elongated diamond–shaped extinction figure is observed on the central portion of the faintly birefringent, transverse bar.

Occurrence—Abundant to few occurrences of this species are recorded from Albian to Maastrichtian in Tanot well–1. Reworking of this species is observed in Campanian–Maastrichtian sediments.

Dimensions—L/W 8.14 µm/5.47 µm.

Known stratigraphic range—Hauterivian–Santonian.

Zeugrhabdotus* sp. cf. *Z. sigmoides (Bramlette & Sullivan, 1961) Bown & Young, 1997

(Pl. 5.17a–b)

1961 *Zygodiscus sigmoides* Bramlette & Sullivan, pp. 149, pl. 4, figs 11a–d.
1997 *Zeugrhabdotus sigmoides* (Bramlette & Sullivan, 1961) Bown & Young, pp. 14, pl. 2, figs 23–24.

Remarks—The species show sigmoid crossbar and short solid stem like *Zygodiscus sigmoides* originally described by Bramlette and Sullivan, 1961, but its distal rim is broader than the *Z. sigmoides* and in Tanot well–1 it shows much extended stratigraphic range than *Z. sigmoides*.

Occurrence—Few to rare patchy occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 7.65 µm/5.39 µm.

Known stratigraphic range—Albian–Maastrichtian.

Zeugrhabdotus trivectis Bergen, 1994

(Pl. 5.18a–b)

1994 *Zeugrhabdotus trivectis* Bergen, pp. 65, pl. 1, figs 26–27.
1998 *Zeugrhabdotus trivectis* Burnett *in* Bown, pp. 168, pl. 6.2, figs 30a–b.

Remarks—A species of *Zeugrhabdotus* exhibiting bicyclic rim extinction pattern of contrasting birefringence (inner cycle is bright); optically, the transverse bar gives the impression of three element bundles arranged at slightly oblique angles to each other.

Occurrence—Common to rare occurrences of this species are recorded from Albian to Campanian sediments in Tanot well–1.

Dimensions—L/W 5.84 µm/4.34 µm.

Known stratigraphic range—Early Valanginian–Maastrichtian.

Zeugrhabdotus xenotus (Stover, 1966) Burnett in Gale *et al*., 1996

(Pl. 5.19a–b)

1966 *Zygolithus xenotus* Stover, pp. 149, pl. 4, figs 16–17, pl. 9, fig. 2.
1996 *Zeugrhabdotus xenotus* (Stover, 1966) Burnett *in* Gale *et al*., pp. 530.
1998 *Zeugrhabdotus xenotus* Burnett *in* Bown, pp. 168, pl. 6.2, figs 25b–c.
2007 *Zeugrhabdotus xenotus* Lees, pp. 43, pl. 9, figs 12, 17–18.

Remarks—A species of *Zeugrhabdotus* having elliptical rim in both proximal and distal view. The rim is smooth and wide or of medium width. The central opening is spanned by two transverse bars that usually support a hollow spire. Under cross nicols the rim is divided by a dark line into two concentric rings of nearly equal width.

Occurrence—Few to rare occurrences of this species are recorded from Albian to Maastrichtiann in Tanot well–1. Reworking of this species is observed in Santonian–Maastrichtian sediments.

Dimensions—L/W 7.07 μm/5.93 μm.

Known stratigraphic range—Early Valanginian–Cenomanian.

Family—COCCOLITHACEAE Poche, 1913 emend. Young & Bown, 1997

Genus—COCCOLITHUS Schwarz, 1894

Type Species— ***Coccolithus pelagicus*** (Wallich, 1877) Schiller, 1930

Coccolithus pelagicus (Wallich, 1877) Schiller, 1930

(Pl. 5.20a–b)

1877 *Coccosphaera pelagica* Wallich, pp. 348, figs 1–2, 5, 11–12.
1930 *Coccolithus pelagicus* (Wallich, 1877) Schiller, pp. 249, figs 123–124.

Remarks—Large placolith with medium to small sized central area and broad distinctly striate rim. In crossed polarized light the central area and proximal shield are bright, however, the distal shield is dark.

Occurrence—Rare leaked occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 8.58 μm/7.88 μm.

Known stratigraphic range—Palaeogene–(NN21).

Family—CREPIDOLITHACEAE Black, 1971

Genus—CREPIDOLITHUS Noël, 1965

Type Species— ***Discolithus crassus*** Deflandre *in* Deflandre & Fert, 1954 = *Crepidolithus crassus* Noël, 1965

Crepidolithus crassus (Deflandre *in* Deflandre & Fert, 1954) Noël, 1965

(Pl. 5.21a–b)

1954 *Discolithus crassus* Deflandre *in* Deflandre & Fert, pp. 144, text fig. 49, pl. 15, figs 12–13.
1961 *Discolithus crassus* Stradner, pp. 79, figs 16–18.
1961 *Coccolithus crassus* Bramlette & Sullivan, pp. 139, pl. 1, figs 4a–d.
1963 *Discolithus crassus* Stradner, pp. 7, pl. 2, fig. 14.
1963 *Coccolithus crassus* Stradner *in* Gohrbandt, pl. 8, figs 13–15.
1964 *Coccolithus crassus* Sullivan, pp. 180, pl. 3, figs 4a–b.
1965 *Crepidolithus crassus* (Deflandre *in* Deflandre & Fert, 1954) Noël, pp. 5, figs 19–21.
1969 *Crepidolithus crassus* Prins, pp. 551, pl. 1, figs 5A–5C.
1998 *Crepidolithus crassus* Bown & Cooper *in* Bown, pp. 70, pl. 4.9, figs 1–2.

Remarks—This species is elliptical in outline. The central area of this form is very conspicuous between cross nicols, whereas the thin margins of the larger plate are indistinct. This form is considered reworked in Tanot well–1.

Occurrence—Reworked rare occurrences of this species are observed in one subsurface sample at 1104 m depth belonging to Maastrichtian age.

Dimensions—L/W 6.78 μm/5.01 μm.

Known stratigraphic range—Early Toarcian.

Crepidolithus **sp. 1**

(Pl. 5.22a–b)

Remarks—This species is also elliptical in outline and the central area is conspicuous between cross nicols, but in this form a thin distinct outer rim is present covering the central plate.

Occurrence—Rare occurrences of this species are recorded from Santonian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 7.52 μm/5.27 μm.

Known stratigraphic range—Santonian–Maastrichtian.

Family—CRETARHABDACEAE Thierstein, 1973

Genus—CRETARHABDUS Bramlette & Martini, 1964

Type Species—*Cretarhabdus conicus* Bramlette & Martini, 1964

Cretarhabdus conicus Bramlette & Martini, 1964

(Pl. 5.23a–b)

1964 *Cretarhabdus conicus* Bramlette & Martini, pp. 299, pl. 3, figs 5–8.
1969 *Cretarhabdus conicus* Bukry, pp. 35, pl. 13. figs 7–12.
1971 *Cretarhabdus conicus* Thierstein, pp. 477, pl. 6, figs 7–12.
1972 *Cretarhabdella lateralis* Black, pp. 46, pl. 14, figs 4–6.
1972 *Cretarhabdella spectabilis* Black, pp. 47, pl. 16, figs 1–5.
1973 *Cretarhabdus barremianus* Black, pp. 50, pl. 18, figs 9–11.
1973 *Cretarhabdus* sp. Black, pp. 56, pl. 17, figs 12–14.
1973 *Cretarhabdus conicus* Black, pp. 49, pl. 17, figs 1–2, 15.
1978 *Cretarhabdus conicus* Shafik, pp. 223, pl. 6, figs I, J.

1985 *Cretarhabdus conicus* Perch–Nielsen, pp. 384, pl. 51, fig. 1.
1987 *Cretarhabdus conicus* Crux, pp. 188, pl. 8.4, fig. 1, pl. 8.11, figs 12–13.
1998 *Cretarhabdus conicus* Burnett *in* Bown, pp. 180, pl. 6.7, figs 1–2.
2001 *Cretarhabdus conicus* Bown, pp. 232, pl. 7, fig. 11.

Remarks—*C. conicus* is recognized by its two or three cycles of perforations in the central structure. Especially in specimens from Campanian and Maastrichtian, the central structure is highly conical. Under crossed nicols, both base and stem are quite distinctive and characterstic of this species.

Occurrence—Few occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 6.13 µm/5.75 µm.

Known stratigraphic range—Kimmeridgian–Maastrichtian.

Cretarhabdus striatus (Stradner, 1963) Black, 1973

(Pl. 5.24a–b)

1963 *Arkhangelskiella striata* Stradner, pp. 176, pl. 1, fig. 1.
1966 *Arkhangelskiella striata* Stover, pp. 137, pl. 2, figs 3–4.
1968 *Cretarhabdus loriei* Gartner, pp. 21, pl. 24, figs 9–10.
1969 *Cretarhabdus loriei* Bukry, pp. 36, pl. 15, figs 1–3.
1970 *Cretarhabdus loriei* Reinhardt, pp. 48, text figs 18–19.
1971 *Cretarhabdus loriei* Manivit, pp. 96, pl. 6, figs 11–14.
1973 *Cretarhabdus loriei* Thierstein, pp. 40, pl. 4, figs 1–5.
1973 *Cretarhabdus striatus* (Stradner, 1963) Black, pp. 53, pl. 17, figs 3–6, 10–11.
1974 *Cretarhabdus loriei* Proto Decima, pp. 591, pl. 5, figs 1–3.
1976 *Cretarhabdus striatus* Hill, pp. 134, pl. 5 figs 7–14.
1998 *Cretarhabdus striatus* Burnett *in* Bown, pp. 180, pl. 6.7, figs 3–4.

Remarks—This species has an elliptical margin which is smooth or slightly serrate in outline. The distinguishing features of this species are the narrow axial cross and the inclined parallel rows of pores and bars in the central area. This species is superficially resembles *Cretarhabdus conicus* but differs by having central area pores and bars aligned in parallel rows and inclined to the central cross.

Occurrence—Few to rare occurrences of this species are recorded from Cenomanian to Maastrichtian in Tanot well–1. Reworking of this species is observed in Maastrichtian sediments.

Dimensions—L/W 8.32 µm/5.83 µm.

Known stratigraphic range—Albian–Cenomanian.

Genus—CRUCIELLIPSIS Thierstein, 1971

Type Species—*Coccolithus cuvillieri* Manivit, 1966

Cruciellipsis cuvillieri (Manivit, 1966) Thierstein, 1971

(Pl. 6.1a–c)

1966 *Coccolithus cuvillieri* Manivit, pp. 268, text figs 2–3.
1969*? Cruciplacolithus* sp. Bukry & Bramlette, pp. 374, pl. 3, figs C–D, pl. 5, fig. C.
1971 *Coccolithus cuvillieri* Worsley, pl. 2, figs 34–36.
1971 *Cruciellipsis cuvillieri* (Manivit, 1966) Thierstein, pp. 477, pl. 5, figs 4–8.
1978 *Cruciellipsis cuvillieri* Roth, pl. 1, figs 5–6.
1982 *Cruciellipsis cuvillieri* Taylor, pl. 4.3, figs 17–18, pl. 4.7, fig. 20.
1983 *Cruciellipsis cuvillieri* Roth, pp. 608, pl. 5, figs 4–7.
1998 *Cruciellipsis cuvillieri* Bown *et al. in* Bown, pp. 122, pl. 5.11, fig. 10.

Remarks—*C. cuvillieri* shows a central process composed of more than four elements and bars constructed of more than one row of elements. The known stratigraphic range and the state of preservation of the Tanot well–1 specimens demonstrate their reworked nature.

Occurrence—Few reworked occurrences of this species are observed in one subsurface sample at 1518 m depth belonging to Cenomanian age.

Dimensions—L/W 6.86 µm/5.62 µm.

Known stratigraphic range—Valanginian.

Genus—GRANTARHABDUS Black, 1971

Type Species—*Grantarhabdus meddii* Black, 1971

Grantarhabdus coronadventis (Reinhardt, 1966) Grün *in* Grün & Allemann, 1975

(Pl. 6.2a–c)

1966 *Cretarhabdus coronadventis* Reinhardt, pp. 26, pl. 23, figs 29–30.
1966 *Cretarhabdus unicornis* Stover, pp. 140, pl. 5, figs 15–16, pl. 9, fig. 15.
1969 *Cretarhabdus unicornis* Bukry, pp. 36, pl. 15, figs 7–9.
1970 *Cretarhabdus unicornis* Noël, pp. 59, text fig. 15, pl. 18, figs 1–3.
1970 *Podorhabdus coronadventis* Reinhardt, pp. 86.
1975 *Grantarhabdus coronadventis* (Reinhardt, 1966) Grün *in* Grün & Allemann, pp. 184.
1998 *Grantarhabdus coronadventis* Burnett *in* Bown, pp. 180, pl. 6.7, fig. 15.

Remarks—This species has buttresses in the diagonal direction and a distal shield consisting of two cycles. The distal shield is highly birefringent in cross polarized illuminations.

Occurrence—Few occurrences of this species are observed in one subsurface sample at 1350 m depth belonging to Santonian age.

Dimensions—L/W 12.12 µm/10.60 µm.

Known stratigraphic range—Aptian?–Campanian.

Genus—HELENEA Worsley, 1971

Type Species— *Helenea staurolithina* Worsley, 1971

Helenea chiastia Worsley, 1971

(Pl. 6.3a–c)

1971 *Helenea chiastia* Worsley, pp. 1310, pl. 1, figs 42–44.
1998 *Helenea chiastia* Burnett *in* Bown, pp. 180, pl. 6.7, figs 13–14.
2005 *Helenea chiastia* Bown *in* Bralower *et al*., pp. 30, pl. P7, fig. 31.
2013a *Helenea chiastia* Rai *et al*., pp. 71, pl. 1, fig. 19.
2013b *Helenea chiastia* Rai *et al*., pp. 1607, figs 4.23a–b.

Remarks—This species has two slightly elliptical shields with serrate margin. The smaller proximal shield is composed of single cycle of sinistrally imbricated, clockwise inclined, arcuate elements. The distal shield is composed of two cycles each of rectangular or slightly arcuate elements. Elements in the outer rim cycle are clockwise inclined whereas in the inner rim cycle they are counterclockwise inclined. The central area of the proximal shield is open and lacks any structure whereas the distal shield contains an axially aligned cross and four oval openings which are symmetrically situated between the crossbars.

Occurrence—Few occurrences of this species are recorded from Albian to Cenomanian sediments in Tanot well–1.

Dimensions—L/W 8.26 µm/6.86 µm.

Known stratigraphic range—Tithonian–? Turonian.

Genus—RETECAPSA Black, 1971

Type Species—*Retecapsa brightoni* Black, 1971

Retecapsa angustiforata Black, 1971

(Pl. 6.4a–c)

1971 *Retecapsa angustiforata* Black, pp. 409, pl. 33, fig. 3.
1971 *Cretarhabdus crenulatus* Thierstein, pp. 476–477, pl. 6, figs 10–14.
1973 *Cretarhabdus angustiforatus* Bukry, pp. 677, pl. 2, figs 4–6.
1978 *Retecapsa angustiforata* Roth, pp. 748, pl. 1, figs 3–5.
1998 *Retecapsa angustiforata* Burnett *in* Bown, pp. 180, pl. 6.7, fig. 6.
2015 *Rhagodiscus achlyostaurion* Linnert & Mutterlose, pp. 731, fig. 4Z.

Remarks—This species has a larger elliptical central area which is surrounded by a cycle of elements separated from the rim by a series of shallow pits.

Occurrence—Few to rare occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 7.13 µm/7.13 µm.

Known stratigraphic range—Berriasian–Maastrichtian.

Retecapsa crenulata (Bramlette & Martini, 1964) Grün *in* Grün & Allemann, 1975

(Pl. 6.5a–c)

1964 *Cretarhabdus crenulatus* Bramlette & Martini, pp. 300, pl. 2, figs 21–24.
1975 *Retecapsa crenulata* (Bramlette & Martini, 1964) Grün *in* Grün & Allemann, pp. 175–176, pl. 4, figs 4–6, text fig. 18.
1998 *Retecapsa crenulata* Burnett *in* Bown, pp. 180, pl. 6.7, fig. 7.
2001 *Retecapsa crenulata* Ladner & Wise *in* Beslier *et al*., pp. 49, pl. 3, figs 6–7.
2012 *Retecapsa crenulata* Farouk & Faris, pp. 58, fig. 8.11.
2013a *Retecapsa crenulata* Rai *et al*., pp. 71, pl. 1, fig. 36.
2015 *Retecapsa crenulata* Linnert & Mutterlose, pp. 731, fig. 4A'.

Remarks—Elliptical base has a conspicuous groove around periphery which may be considered a partial separation into two plates, with the proximal side smaller. The relatively broad peripheral part of base is finely striate, and the broad central area is perforated, with the result crenulate appearance of the border between them is conspicuous under cross nicols. The curvature of the extinction lines is sinistral from the distal side. Central stem with canal has sinistral upward spiral striae and end of stem broadens to form a calyx like tip.

Occurrence—Few occurrences of this species are recorded from Turonian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 6.43 µm/5.51 µm.

Known stratigraphic range—Berriasian?–Maastrichtian.

Retecapsa ficula (Stover, 1966) Burnett, 1998

(Pl. 6.6a–c)

1966 *Coccolithites ficula* Stover, pp. 138, pl. 5, fig. 5–6, pl. 9, fig. 11.
1998 *Retecapsa ficula* (Stover, 1966) Burnett, pp. 138–139.
1998 *Retecapsa ficula* Burnett *in* Bown, pp. 80, pl. 6.7, fig. 8.
2013a *Retecapsa ficula* Rai *et al*, pp. 71, pl. 1, fig. 37.
2013b *Retecapsa ficula* Rai *et al*, pp. 1607, figs 4.21a–b.

Remarks—The coccoliths are elliptical in proximal or distal view and consist of a single plate with a wide rim of approximately 32 ribs. The grooves or striae between ribs are straight and are discernible across most of the rim. The outer margin of the rim is scalloped, the inner margin smooth. The small central opening is filled by a plate constructed of numerous small irregularly shaped calcareous pieces that are closely spaced or have openings between them. The curvature of extinction lines across the rim is sinistral in distal view.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface common to few occurrences of this form are recorded from Cenomanian to Maastrichtian. It seems that the forms recorded in Cenomanian are leaked from younger levels.

Dimensions—L/W 8.53 µm/7.12 µm.

Known stratigraphic range—Turonian–Maastrichtian.

Retecapsa schizobrachiata (Gartner, 1968) Grün *in* Grün & Allemann, 1975

(Pl. 6.7a–c)

1968 *Vekshinella schizobrachiata* Gartner, pp. 31, pl. 13, figs 10–11.
1975 *Retecapsa schizobrachiata* (Gartner, 1968) Grün *in* Grün & Allemann, pp. 175.
1998 *Retecapsa schizobrachiata* Burnett *in* Bown, pp. 180, pl. 6.7, figs 5.
2009 *Retecapsa schizobrachiata* Blair & Watkins, pp. 379, pl. 2, figs 7–9.

Remarks—In Tanot well–1 this form is considered under *Retecapsa schizobrachiata* because of its four axial bars which have three arms and its presence in Campanian–Maastrichtian sediments. However, In Tanot well–1, it has almost circular outer rim and small central area which is fully covered by axial bars.

Occurrence—Few to rare occurrences of this species are recorded from Cenomanian to Maastrichtian. It seems that the forms recorded below Campanian are leaked from younger levels.

Dimensions—Diameter 8.34 µm.

Known stratigraphic range—Campanian–Maastrichtian.

Retecapsa surirella (Deflandre & Fert, 1954) Grün *in* Grün & Allemann, 1975

(Pl. 6.8a–c)

1954 *Discolithus surirella* Deflandre & Fert, pp. 144, figs 30–31.
1970 *Cretarhabdus surirellus* Reinhardt, pp. 144, figs 30–31.
1975 *Retecapsa surirella* (Deflandre & Fert, 1954) Grün *in* Grün & Allemann, pp. 176–177.
1998 *Retecapsa surirella* Burnett *in* Bown, pp. 180, pl. 6.7, figs 9–10.
2013a *Retecapsa surirella* Rai *et al*., pp. 71, pl. 1, fig. 38.
2013b *Retecapsa surirella* Rai *et al*., pp. 1607, figs 4.22a–b.

Remarks—The elliptical coccolith consists of a single central plate with a wide ribbed rim having scalloped outer margin and smooth inner margin. The broad central area consists of a plate constructed by numerous small irregularly shaped calcareous pieces that are closely spaced or have perforation between them.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface common to few occurrences of this form are recorded from Albian to Maastrichtian.

Dimensions—L/W 7.27 µm/5.84 µm (figs 9a–c).

Known stratigraphic range—Berriasian?–Maastrichtian.

Genus—STRADNERIA Reinhardt, 1964

Type Species—*Stradneria limbicrassa* Reinhardt, 1964

Stradneria crenulata (Bramlette & Martini, 1964) Noël, 1970

(Pl. 6.9a–b)

1964 *Cretarhabdus crenulatus* Bramlette & Martini, pp. 300, pl. 2, figs 21–24.
1970 *Stradneria crenulata* (Bramlette & Martini, 1964) Noël, pp. 55, pl. 17.
1985 *Stradneria crenulata* Perch–Nielsen, pp. 385, pl. 8, figs 88–89, pl. 51, fig. 25.
2013a *Stradneria crenulata* Rai *et al*., pp. 71, pl. 1, fig. 45.

Remarks—This species has a conical central area with a central cross supporting a solid stem. A crown of relatively large elements surrounds the comparatively small distal part of the central area. The upper cycle of the distal shield elements is smaller than the lower.

Occurrence—Common to few patchy occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 7.48 µm/5.94 µm.

Known stratigraphic range—Albian–Maastrichtian.

Family—EIFFELLITHACEAE Reinhardt, 1965

Genus—EIFFELLITHUS Reinhardt, 1965

Type Species—*Zygolithus turriseiffeli* Deflandre, 1954

Eiffellithus eximius (Stover, 1966) Perch–Nielsen, 1968

(Pl. 6. 10a–b)

1966 *Clinorhabdus eximius* Stover, pp. 138, pl. 2, figs 15–16, pl. 8, fig. 15.
1968 *Eiffellithus turriseiffeli* Gartner, pp. 26, pl. 16, figs 1–2, pl. 17, fig. 3, pl. 18, figs 9–10, pl. 19, figs 1–2, pl. 23, figs 8–11, pl. 24, figs 1–2, pl. 26, figs 3–4.
1968 *Eiffellithus eximius* (Stover, 1966) Perch–Nielsen, pp. 30, pl. 3, figs 8–10.
1969 *Eiffellithus angustus* Bukry, pp. 51, pl. 28, figs 10–11, pl. 29, fig. 1.
1971 *Eiffellithus turriseiffeli* Manivit, pp. 90, pl. 11, figs 1–4, 12–13.
1971 *Eiffellithus eximius* Manivit, pp. 91, pl. 11, figs 10–11.
1972 *Eiffellithus* aff. *E. eximius* Perch–Nielsen, pp. 1008, pl. 22, figs 4, 6.
1976 *Eiffellithus eximius* Theirstein, pp. 346, pl. 5, figs 28–29.
1978 *Eiffellithus eximius* Shafik, pp. 219, pl. 4, figs Wa–Wb, Ta–Tb.
1982 *Eiffellithus eximius* Siesser, pp.342, pl. 8, figs N, n.
1985 *Eiffellithus eximius* Perch–Nielsen, pp. 368, pl. 35, figs 3–4, pp. 343, figs 32–33.
1987 *Eiffellithus eximius* Hill & Bralower, pp. 94, pl. 1, figs 2–8, pl. 2, figs 1–4.
1998 *Eiffellithus eximius* Burnett *in* Bown, pp. 172, pl. 6.3, figs 22–24.
2004 *Eiffellithus eximius* Chira *et al*., pp. 96, pl. 2, fig. 11.
2012 *Eiffellithus eximius* Farouk & Faris, pp. 58, figs 8.5–6.

Remarks—The species has an elliptical rim which is smooth or slightly serrate in outline. Under light microscope two rim cycles can be distinguished. The outer rim cycle is very narrow whereas the inner rim cycle is broad and appears to extend into the central area. The central area appears cruciform in outline and is spanned by broad cross bars which are slightly rotated from the principal axes of the ellipse. A hollow central spine extends distally from the centre of the crossbars.

Occurrence—Abundant to few occurrences of this species are recorded from Turonian to Maastrichtian in Tanot well–1. Reworking of this species is observed in Maastrichtian sediments.

Dimensions—L/W 8.36 µm/7.35 µm.

Known stratigraphic range—Middle Turonian–Campanian.

Eiffellithus gorkae Reinhardt, 1965

(Pl. 6.11a–b)

1965 *Eiffellithus gorkae* Reinhardt, pp. 36, pl. 2, fig, 2, text fig. 6.
1998 *Eiffellithus gorkae* Burnett *in* Bown, pp. 170, pl. 6.3, figs 16a–c, 17.
2004 *Eiffellithus gorkae* Chira *et al*., pp. 96, pl. 2, figs 13a–b.
2013a *Eiffellithus gorkae* Rai *et al*., pp. 58, pl. 1, fig. 16.
2013b *Eiffellithus gorkae* Rai *et al*., pp. 1607, figs 4.24a–b.
2015 *Eiffellithus gorkae* Linnert & Mutterlose, pp. 731, fig. 4N.

Remarks—This species of *Eiffellithus* have broad margin which covers the ¾ part of the central area and surrounds basal disc. At its inner margin set of eight elements is present showing sigmoidal suture under light microscope. In the central area 32–34 superimposed elements are present.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. However, in subsurface it is recorded from Albian to Maastrichtian but its common to few continuous occurrences are observed in Cenomanian–Maastrichtian sediments and in Albian one sample shows rare occurrences at 1758 m depth.

Dimensions—L/W 5.50 µm/4.67 µm.

Known stratigraphic range—Albian–Maastrichtian.

Eiffellithus? hancockii Burnett, 1998

(Pl. 6.12a–b)

1996 *Staurolithites?* sp. 2 Burnett *in* Gale *et al*., pp. 523, fig. 4z.
1998 *Eiffellithus? hancockii* Burnett, pp. 135, pl. 1, figs 3a–b.
1998 *Eiffellithus? hancockii* Burnett *in* Bown, pp. 172, pl. 6.3, figs 25a–b.
2003 *Eiffellithus? hancockii* Watkins & Bergen, pp. 246, Pl. 3, figs 9–12, Pl. 4, fig. 1.

Remarks— A small to medium sized, elliptical coccolith with a thick bicyclic rim. The outer rim is relatively wide and dark and the inner rim is broader and highly birefringent. A very small, axial cross completely occupies the central area of the coccolith.

Occurrence— Few reworked occurrences of this species are observed in one subsurface sample at 1380 m depth belonging to Coniacian age.

Dimensions— L/W 5.22 µm/4.27 µm.

Known stratigraphic range— Albian–Cenomanian.

Eiffellithus monechiae Crux, 1991

(Pl. 6.13a–b)

1976 *Eiffellithus eximius* Hill, pl. 6, figs 19–23, 30–33.
1985 *Eiffellithus* sp. 3 Perch–Nielsen, pp. 367, pl. 35, figs 5–6.
1987 *Eiffellithus eximius* Hill & Bralower, pl. 1, figs 2a–e, pl. 2, fig. 3.
1991 *Eiffellithus monechiae* Crux, pp. 216.
1998 *Eiffellithus monechiae* Bown *et al*. *in* Bown, pp. 116, pl. 5.8, fig. 14.

Remarks—This species has a broadly elliptical rim which is smooth in outline. The outer rim is thin and the inner rim is composed of blocky elements. The rims exhibit first order birefringence. A small hole characterizes the middle of the central area. The central hole is spanned by an asymmetrical diagonal cross that may have supported a small hollow stem.

Occurrence—Few occurrences of this species are recorded from Albian sediments in Tanot well–1.

Dimensions—L/W 6.14 µm/4.23 µm.

Known stratigraphic range—Albian–Cenomanian.

Eiffellithus pospichalii Burnett, 1998

(Pl. 6.14a–b)

1998 *Eiffellithus pospichalii* Burnett, pp. 136, pl. 1, figs 11a–b.
1998 *Eiffellithus pospichalii* Burnett *in* Bown, pp. 170, pl. 6.3, figs 19–20.

Remarks—This form is distinct from other species of *Eiffellithus* in being large, very highly birefringent and having a broad thick cross filling the central area.

Occurrence—Few reworked occurrences of this species are observed in one subsurface sample at 1146 m depth belonging to Maastrichtian age.

Dimensions—L/W 8.59 µm/6.55 µm.

Known stratigraphic range—Campanian.

Eiffellithus striatus (Black, 1971) Applegate & Bergen, 1988

(Pl. 6.15a–b)

1971 *Chiastozygus striatus* Black, pp. 433, pl. 34, fig. 7.
1982 *Tegumentum striatum* Taylor, pl. 4.4, fig. 11.
1988 *Eiffellithus striatus* (Black, 1971) Applegate & Bergen, pp. 315, pl. 9, figs 1–7.
1998 *Eiffellithus striatus* Bown *et al. in* Bown, pp. 116, pl. 5.8, fig. 16.
1991 *Tegumentum tripes* Mutterlose, pl. 12, figs 15–19.
1994 *Rothia striata striatus* Varol & Girgis, pp. 235–236, fig. 11.2.

Remarks—Large species of *Eiffellithus* (> 6.4 µm) with a wide central area spanned by distinctive diagonal cross–bars. The rim structure differs from *Chiastozygus* and *Tegumentum* in having an inner cycle of plate which is formed by elements with a thin outer rim of highly inclined elements.

Occurrence—Few occurrences of this species are observed in one subsurface sample at 1788 m depth belonging to Albian age, which may be reworked.

Dimensions—L/W 6.42 µm/4.66 µm.

Known stratigraphic range—Early Hauterivian.

Eiffellithus turriseiffelii (Deflandre *in* Deflandre & Fert, 1954) Reinhardt, 1965

(Pl. 6.16a–b)

1954 *Zygolithus turriseiffelii* Deflandre *in* Deflandre & Fert, pp. 149, pl. 13, figs 1, 15–16, text fig. 65.
1959 *Zygrhablithus turriseiffelii* Deflandre, pp. 135.
1964 *Zygrhablithus turriseiffelii* Bramlette & Martini, pp. 304, pl. 3, figs 18–19, pl. 4, figs 1–2.
1965 *Zygrhablithus turriseiffelii* Manivit, pp. 191, pl. 1, figs 1a, 1d.
1965 *Eiffellithus turriseiffeli turriseiffelii* (Deflandre *in* Deflandre & Fert, 1954) Reinhardt, pp. 36.
1965 *Eiffellithus turriseiffelii* Reinhardt, pp. 32.
1969 *Eiffellithus turriseiffelii* Bukry, pp. 52, pl. 29, figs 2–5.
1976 *Eiffellithus turriseiffelii* Thierstein, pp. 344, pl. 4, figs 15–16.
1976 *Eiffellithus turriseiffelii* Burns, pp. 286, pl. 3, fig. 6.
1978 *Eiffellithus turriseiffelii* Shafik, pp. 217, pl. 3, figs Ta–U, Ja–Jb.
1982 *Eiffellithus turriseiffelii* Siesser, pp. 344, pl. 10, figs E, e.
1985 *Eiffellithus turriseiffelii* Perch–Nielsen, pp. 343, figs 56–57, pp. 376, pl. 43, fig. 15, pp. 368, pl. 35, fig. 12.
1987 *Eiffellithus turriseiffelii* Jakubowski, pp. 114, pl. 1, figs 22–23.
1987 *Eiffellithus turriseiffelii* Hill & Bralower, pp. 94, pl. 1, fig. 10.
1992 *Eiffellithus turriseiffelii* Kale & Phansalkar, pp. 88, pl. 1, figs 7–8, pl. 2, fig. 3.
1998 *Eiffellithus turriseiffelii* Burnett *in* Bown, pp. 170, pl. 6.3, fig. 18.
2001 *Eiffellithus turriseiffelii* Bown, pp. 230, pl. 5, figs 21–22.
2001 *Eiffellithus turriseiffelii* Ladner & Wise *in* Beslier *et al*., pp. 50, pl. 4, figs 8–10.
2003 *Eiffellithus turriseiffelii* Tantawy, pp. 329, pl. 1, figs 16–17.
2004 *Eiffellithus turriseiffelii* Chira *et al*., pp. 96, pl. 2, fig. 12.
2012 *Eiffellithus turriseiffelii* Farouk & Faris, pp. 58, figs 8.3–4.
2013a *Eiffellithus turriseiffelii* Rai *et al*., pp. 58, pl. 1, fig. 17.
2013 *Eiffellithus turriseiffelii* Zahran, pp. 992, pl. 2, fig. 6.
2015 *Eiffellithus turriseiffelii* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 11.
2015 *Eiffellithus turriseiffelii* Linnert & Mutterlose, pp. 731, fig. 4O.

Remarks—*E. turriseiffelii* is developed from *Vekshinella angusta* (Stover) by rotation of the bars and the closing of the central area. The longest bar of *E. turriseiffelii* always makes an angle of more than 20° with the longer axis of the elliptical disc. The central area is never completely open.

Occurrence—Abundant to few occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 9.16 µm/7.65 µm.

Known stratigraphic range—Albian–Maastrichtian.

Eiffellithus* sp. cf. *E. windii Applegate & Bergen, 1988

(Pl. 6.17a–b)

1988 *Eiffellithus windii* Applegate & Bergen, pp. 315, pl. 10, figs 1–6, 8.

Remarks—Small species of *Eiffellithus* with a narrow central area almost filled by the diagonal, cross–bars, morphologically very similar with *Eiffellithus windii*, it differs from the *E. windii* by having non–fibrous cross–bars.

Occurrence—Abundant to rare occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 5.25 µm/3.65 µm.

Known stratigraphic range—Albian–Maastrichtian.

Genus—HELICOLITHUS Noël, 1970

Type Species—*Discolithus anceps* Gorka, 1957

Helicolithus anceps (Górka, 1957) Noël, 1970

(Pl. 6.18a–c)

1957 *Discolithus anceps* Górka, pp. 252, pl. 3, fig. 4.
1965 *Eiffellithus turriseiffeli inturratus* Reinhardt, pp. 38, pl. 8, fig. 2, pl. 11, figs 3 a, b, text fig. 19.
1967 *Eiffellithus anceps* Reinhardt & Górka, pp. 251, pl. 31, figs 15–16, text–fig. 6.
1970 *Helicolithus anceps* (Górka, 1957) Noël, pp. 43, pl. 6, figs 2–8.
1982 *Helicolithus anceps* Crux, pp. 116, pl. 5.3, figs 7–8, 11.
1994 *Helicolithus anceps* Varol & Girgis, pp. 232,234, pl. 9, figs 6, 15, pl. 10, fig. 8.
1998 *Helicolithus anceps* Burnett *in* Bown, pp. 172, pl. 6.3, figs 25c, 26a–b.
2004 *Helicolithus anceps* Chira *et al*., pp. 96, pl. 2, figs 14a–b.

Remarks—Elliptical rim composed of up to 70 dextrally imbricate elements. Inner cycle consisting of heavy blocks, which are readily recrystallized, X–shaped crossbars, composed of two elements of equal size.

Occurrence—Few occurrences of this species are recorded from Coniacian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 6.18 µm/4.93 µm.

Known stratigraphic range—Cenomanian–Maastrichtian.

Helicolithus compactus (Bukry, 1969) Varol & Girgis, 1994

(Pl. 6. 19a–c)

1969 *Vagalapilla compacta compacta* Bukry, pp. 56, pl. 31, fig. 11.
1972 *Eiffellithus trabeculatus* Roth & Thierstein, pl. 12, figs 14–18.
1982 *Helicolithus trabeculatus* Crux, pp. 116, pl. 5.3, fig. 4, pl. 5.9, fig. 15.
1994 *Helicolithus compactus* (Bukry, 1969) Varol & Girgis, pp. 234, pl. 10, figs 9–11.
1998 *Helicolithus compactus* Burnett *in* Bown, pp. 172, pl. 6.3, figs 27a–d.

Remarks—Strongly elliptical form, in distal view the rim cycle elements are dextrally imbricated and have inner margins inclined clockwise. The rim outline is slightly serrate. Inside the rim cycle a narrow cycle of about 8 elongate elements lines the central area. This cycle has relatively large adcentrally sloping faces. The central area is filled by a set of subaxial crossbars. Median sutures divide each crossbar into 2 rows of a few large irregular elements. No central stem occurs. In proximal view the rim cycle elements are dextrally imbricated and inclined counterclockwise.

Occurrence—Few occurrences of this species are recorded from Albian to Santonian. It seems that the forms recorded in Albian are leaked from younger levels.

Dimensions—L/W 4.32 µm/3.11 µm.

Known stratigraphic range—Cenomanian–?Santonian.

Helicolithus trabeculatus (Górka, 1957) Verbeek, 1977

(Pl. 7.1a–b)

1957 *Discolithus trabeculatus* Górka, pp. 277, pl. 3, fig. 9.
1966 *Discolithus disgregatus* Stover, pp. 142, pl. 2, figs 11–12, pl. 8, fig. 12.
1967 *Eiffellithus trabeculatus* Reinhardt & Gorka, pp. 250, pl. 31, figs 19, 23, pl. 32, fig. 1.
1969 *Chiastozygus disgregatus* Bukry, pp. 49, pl. 27, figs 1–4.
1972 *Chiastozygus disgregatus* Roth & Thierstein, pl. 12, figs 7–18.
1977 *Helicolithus trabeculatus* (Górka, 1957) Verbeek, pp. 90.
1994 *Helicolithus trabeculatus* Varol & Girgis, pp. 234, pl. 9, fig. 5.
1998 *Helicolithus trabeculatus* Burnett *in* Bown, pp. 172, pl. 6.3, figs 28a–c, 29.
2013a *Helicolithus trabeculatus* Rai *et al*., pp. 71, pl. 1, fig. 21.
2015 *Helicolithus trabeculatus* Linnert & Mutterlose, pp. 731, fig. 4P.

Remarks—This species has a narrow elliptical rim with a smooth to slightly serrate margin. Both the proximal and distal rims are composed of a single cycle of dextrally imbricated elements. Four blocky bars, each composed of at least two rectangular elements separated by a median suture, span the central area. The central bar lacks a common point of juncture so that a true cross is not formed.

Occurrence—Common to few continuous occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 7.01 µm/5.52 µm.

Known stratigraphic range—Albian–Maastrichtian.

Helicolithus turonicus Varol & Girgis, 1994

(Pl. 7.2a–b)

1969 *Vagalapilla compacta compacta* Bukry, pp. 56, pl. 31, fig. 11.

1994 *Helicolithus turonicus* Varol & Girgis, pp. 235, pl. 10, figs 1–7.

1998 *Helicolithus turonicus* Burnett *in* Bown, pp. 172, pl. 6.3, fig. 30.

Remarks—This species has a zeugoid outer wall made up of dextrally imbricated elements. Proximal rim, protolith inner wall made of six to eight subquadrate elements and an axial cross whose arms consist of two parallel elements. The inner wall and the axial cross are birefringent, whereas the outer wall and proximal rim are non–birefringent under cross–polarised illuminations.

Occurrence—Few leaked occurrences of this species from younger levels are observed in one subsurface sample at 1728 m depth belonging to Albian age.

Dimensions—L/W 5.05 µm/3.61 µm.

Known stratigraphic range—Turonian–Coniacian.

Genus—TEGUMENTUM Thierstein *in* Roth & Thierstein, 1972

Type Species—*Tegumentum stradneri* Thierstein *in* Roth & Thierstein, 1972

Tegumentum lucidum Lees & Bown *in* Bralower *et al*., 2005

(Pl. 7.3a–b)

2005 *Tegumentum lucidum* Lees & Bown *in* Bralower *et al*., pp. 16, pl. P2, figs 24–30.

Remarks—The rim of this coccolith is highly distinctive having a broad bright inner cycle and a very narrow dark outer cycle. The light microscope appearance is most reminiscent of *Tegumentum* but is also similar to *Eiffellithus*. The broad, rounded, diagonal cross bars almost fill the narrow central area and are of similar birefringence to the inner rim cycle. Differentiated from other species of *Tegumentum* by its narrower central area and broad rounded cross bar. Somewhat similar to the early Cretaceous forms but the cross bar morphology is distinct and outer rim cycle narrower.

Occurrence—Few leaked patchy occurrences of this species from younger levels are recorded from Cenomanian to Campanian in Tanot well–1.

Dimensions—L/W 4.85 µm/3.73 µm.

Known stratigraphic range—Early Campanian–Late Maastrichtian.

Tegumentum stradneri Thierstein *in* Roth & Thierstein, 1972

(Pl. 7.4a–b)

1968 *Zygolithus litterarius* Stradner *et al*., pp. 39, pl. 34, figs 1, 4–7.

1972 *Tegumentum stradneri* Thierstein *in* Roth & Thierstein, pp. 437, pl. 1, figs 7–15.

Remarks—Under the light microscope this species shows asymmetrical extinction figures on its cross arms. A grey outer cycle of plates is faintly visible in well preserved specimens.

Occurrence—Few patchy occurrences of this species are recorded from Cenomanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 6.59 µm/5.27 µm.

Known stratigraphic range—Early Barremian–Maastrichtian.

Family—KAMPTNERIACEAE Bown & Hampton *in* Bown & Young, 1997

Genus—GARTNERAGO Bukry, 1969

Type Species—*Arkhangelskiella concava* Gartner, 1968 (= *Gartnerago obliquum* (Stradner, 1963) Reinhardt, 1970).

Gartnerago praeobliquum Jakubowski, 1986

(Pl. 7.5a–b)

1986 *Gartnerago praeobliquum* Jakubowski, pp. 39, pl. 1, figs 2–3, 12–13.

1998 *Gartnerago praeobliquum* Burnett *in* Bown, pp. 184, pl. 6.9, figs 4–5.

Remarks—A species of *Gartnerago* in which the central area is divided into four quadrants by an axial cross. Each of the four bars making up the axial cross, terminates at the margin of the central area in a flaring arrowhead and is divided into two halves by a central suture. Under the light microscope the species has a characteristic bright outer cycle visible both under phase contrast and cross–polarized light, as is typical of the genus *Gartnerago*.

Occurrence—Rare occurrences of this species are observed in one subsurface sample at 1554 m depth belonging to Cenomanian age.

Dimensions—L/W 6.08 µm/4.36 µm.

Known stratigraphic range—Albian–Cenomanian.

Gartnerago segmentatum (Stover, 1966) Thierstein, 1974

(Pl. 7.6a–b)

1966 *Discolithus segmentatus* Stover, pp. 143–144, pl. 3, figs 3–6, pl. 8, fig. 19.
1968 *Arkhangelskiella concava* Gartner, pp. 37, pl. 14, figs 2–3, pl. 16, figs 5–7.
1969 *Gartnerago concavum* Bukry, pp. 24, pl. 4, figs 2–6.
1974 *Gartnerago segmentatum* (Stover, 1966) Thierstein, pp. 640, pl. 5, figs 1–2, pl. 6, figs 1, 3–10, pl. 7, fig. 6.
1998 *Gartnerago segmentatum* Burnett *in* Bown, pp. 184, pl. 6.9, figs 6–10.
2015 *Gartnerago segmentatum* Linnert & Mutterlose, pp. 731, fig. 4G'.

Remarks—The coccolith has an elliptical outline. Characteristic features of *Gartnerago segmentatum* include the irregularly segmented rim, the narrow, smooth or finely seriate proximal flange. The construction of the base plate is slightly arched distally and appears coarsely granular in bright field illumination.

Occurrence—Few occurrences of this species are recorded from Albian to Campanian. It seems that the forms recorded in Albian are leaked from younger levels.

Dimensions—L/W 11.69 µm/9.31 µm.

Known stratigraphic range—Cenomanian–Maastrichtian.

Family—LAPIDEACASSACEAE Bown & Young, 1997

Genus—LAPIDEACASSIS Black, 1971

Type Species—_Lapideacassis mariae_ Black, 1971

Lapideacassis asymmetrica (Perch–Nielsen *in* Perch–Nielsen & Franz, 1977) Burnett, 1998

(Pl. 7.7a–b)

1977 *Scampanella asymmetrica* Perch–Nielsen *in* Perch–Nielsen & Franz, pp. 853, pl. 2, figs 3–6, 9–10, pl. 6, figs 7–9, text fig. 3.16.
1998 *Lapideacassis asymmetrica* (Perch–Nielsen *in* Perch–Nielsen & Franz, 1977) Burnett, pp. 136.
1998 *Lapideacassis asymmetrica* Burnett *in* Bown, pp. 191, pl. 6.11, fig. 1.

Remarks—The proximal tier is short and the proximal collar is reduced. The distal tier is very high and separated from the apical cone by a row of perforations. A long apical process sits asymmetrically on the apical cone.

Occurrence—Rare leaked occurrences of this species from younger levels are observed in one subsurface sample at 1392 m depth belonging to Santonian age.

Dimensions—L/W 8.71 µm/2.99 µm.

Known stratigraphic range—Santonian–Palaeogene.

Family—MICRORHABDULACEAE Deflandre, 1963

Genus—LITHRAPHIDITES Deflandre, 1963

Type Species—_Lithraphidites carniolensis_ Deflandre, 1963

Lithraphidites carniolensis Deflandre, 1963

(Pl. 7.8a–b)

1963 *Lithraphidites carniolensis* Deflandre, pp. 3486, text figs 1–10.
1965 *Lithraphidites carniolensis* Manivit, pp. 194, pl. 2, fig. 19.
1967 *Lithraphidites carniolensis* Moshkovitz, pp. 155, pl. 5, figs 7a–b.
1968 *Lithraphidites carniolensis* Stradner *et al*., pp. 45, pl. 47, figs 1–5.
1969 *Lithraphidites carniolensis* Bukry, pp. 66, pl. 39, figs 1–2.
1971 *Lithraphidites carniolensis* Manivit, pp. 130, pl. 16, figs 13–15.
1976 *Lithraphidites carniolensis* Theirstein, pp. 40, pl. 2, figs 33–34.
1976 *Lithraphidites* cf. *L. quadratus* (Bramlette & Martini, 1964) Verbeek, pp. 145, pl. 3, fig. 4.
1978 *Lithraphidites carniolensis* Shafik, pp. 225, fig. 7.
1985 *Lithraphidites carniolensis* Perch–Nielsen, pp. 375, pl. 42, figs 3–4.
1987 *Lithraphidites carniolensis* Crux, pp. 194, pl. 8.7, fig. 12.
1998 *Lithraphidites carniolensis* Burnett *in* Bown, pp. 191, pl. 6.12, figs 16–18.
2003 *Lithraphidites carniolensis* Tantawy, pp. 331, pl. 2, figs 1–2.
2007 *Lithraphidites carniolensis* Lees, pp. 51, pl. 2, figs 1–7.
2015 *Lithraphidites carniolensis* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 34.
2015 *Lithraphidites carniolensis* Linnert & Mutterlose, pp. 731, fig. 4I'.

Remarks—This elongate stick–like form consists of four blades which intersect at 90º angles along a common axis. The width is greatest in the mid region and diminishes towards each end to a blunt point. The length is 8 to 10 times greater than width. Each of the blades is optically identically oriented so that the entire form behaves as a single crystal when viewed under crossed nicols.

Occurrence—Abundant to few occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 18.10 µm/1.94 µm.

Known stratigraphic range—Berriasian–Maastrichtian.

Lithraphidites praequadratus Roth, 1978

(Pl. 7.9a–b)

1978 *Lithraphidites praequadratus* Roth, pp. 749, pl. 3, figs 1–3.
1992 *Lithraphidites praequadratus* Bralower & Siesser, pp. 548, pl. 4, fig. 12, pl. 8, figs 7–10.
1998 *Lithraphidites praequadratus* Burnett *in* Bown, pp. 191, pl. 6.12, figs 19–20.

Remarks—An elongated nannolith composed of four keel–like ridges at right angles to each other. The keels have parallel sides over more than two–third of their total length. The keels are either truncated or taper at one or both ends.

Occurrence—Few occurrences of this species are recorded from Coniacian to Maastrichtian. It seems that the forms recorded in Coniacian–Turonian are leaked from younger levels.

Dimensions—L/W 10.24 µm/4.02 µm.

Known stratigraphic range—Campanian–Maastrichtian.

Genus—MICRORHABDULUS Deflandre, 1959

Type Species—*Microrhabdulus decoratus* Deflandre, 1959

Microrhabdulus belgicus Hay & Towe, 1963

(Pl. 7.10a–b)

1963 *Microrhabdulus belagicus* Hay & Towe, pp. 95, pl. 1.
1963 *Microrhabdulus margaritus* Deflandre, pp. 3486, text figs 12–18.
1963 *Microrhabdulus nodosus* Stradner, pp. 11, pl. 4, fig. 13.
1968 *Microrhabdulus belagicus* Gartner, pp. 44, pl. 6, fig. 13, pl. 10, figs 21–22, pl. 12, fig. 13, pl. 22, fig. 27.
1969 *Microrhabdulus belagicus* Bukry, pp. 66, pl. 39, figs 9–11.
1985 *Microrhabdulus belagicus* Perch–Nielsen, pp. 376, pl. 43, figs 20–23.
1998 *Microrhabdulus belagicus* Burnett *in* Bown, pp. 191, pl. 6.12, figs 28–31.
2012 *Microrhabdulus decoratus* Farouk & Faris, pp. 58, fig. 8.19.

Remarks—This fusiform nannolith is found with variable sizes and numbers of node–cycles appear ornamenting its surface. The small blocky elements on the surface of the rod are typical for this species.

Occurrence—Common to few occurrences of this species are recorded from Cenomanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 10.17 µm/2.05 µm.

Known stratigraphic range—Albian–Maastrichtian.

Microrhabdulus* sp. cf. *M. helicoideus Deflandre, 1959

(Pl. 7.11a–b)

1959 *Microrhabdulus helicoideus* Deflandre, pp. 141, pl. 4, figs 9–10.

Remarks—This species is morphologically similar to *Microrhabdulus helicoideus* but it differs from *M. helicoideus*, having closely arranged helical structure in rod and its stratigraphic range is also differing from parent species.

Occurrence—Abundant to few occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 11.92 µm/2.76 µm.

Known stratigraphic range—Albian–Maastrichtian.

Microrhabdulus* sp. cf. *M. undosus Perch–Nielsen, 1973

(Pl. 7.12a–b)

1973 *Microrhabdulus* sp. cf. *M. undosus* Perch–Nielsen, pp. 318–319, pl. 10, figs 1, 10–12.

Remarks—A species of *Microrhabdulus*, morphologically similar to *Microrhabdulus undosus* but differs in stratigraphic range from the parent species. The preservation of both shaft and disc together is rare.

Occurrence—Few occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 6.70 µm/5.54 µm.

Known stratigraphic range—Albian–Maastrichtian.

Family—NANNOCONACEAE Deflandre, 1959

Genus—NANNOCONUS Kamptner, 1931

Type Species— *Nannoconus steinmanni* Kamptner, 1931

Nannoconus elongatus Brönnimann, 1955

(Pl. 7.13a–b)

1955 *Nannoconus elongatus* Brönnimann, pp. 38, pl. 1, figs 10–14, text figs 2v–y.
1960 *Nannoconus elongatus* Deflandre & Deflandre–Rigaud, pp. 176, pl. 1, figs 14–17.
1960 *Nannoconus colomi* Caratini, pp. 106, figs 1, 3, 6.
1965 *Nannoconus elongatus* Manivit, pp. 196, pl. 2, fig. 17.
1998 *Nannoconus elongatus* Burnett *in* Bown, pp. 192, pl. 6.12, fig. 39.
2004 *Nannoconus elongatus* Bown & Concheyro, pp. 81, pl. 6, figs 22–23.
2013b *Nannoconus elongatus* Rai *et al*., pp. 1608, figs 5.1a–b.

Remarks—Cylindrical nannoconids with wide central cavities and walls formed from moderately high angled (20º–45º) and moderately thick cycles. The cavity is similar in width to that of the wall but is generally narrower than those of *Nannoconus quadricanalis*. The overall shape is more elongate than that of *N. quadricanalis*.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface few to rare patchy occurrences of this form are recorded from Albian to Maastrichtian. Reworking of this species is observed in Maastrichtian sediments.

Dimensions—L/W 10.68 µm/7.71 µm.

Known stratigraphic range—Barremian–Campanian.

Nannoconus inornatus Rutledge and Bown, 1996

(Pl. 7.14a–b)

1982 *Nannoconus abundans* Taylor, pl. 4.6, fig. 19.
1987 *Nannoconus abundans* Thomsen, pl. 6, figs 10–11.
1996 *Nannoconus inornatus* Rutledge & Bown, pp. 54, pl. 1, figs 8–12, 14–18.
1998 *Nannoconus inornatus* Bown *et al*. *in* Bown, pp. 128, pl. 5.14, figs 16–18.

Remarks—The sides of this nannoconid are convex and the ends unflared, slightly concave and identical, thus apical and basal ends cannot be distinguished. The height is generally less than the diameter. The axial canal is very much narrower than the wall of the nannoconid. The outer surface of the wall is smooth, giving a circular profile in plan view. The thin plates composing the wall are arranged in a very low–angled spiral.

Occurrence—Few patchy occurrences of this species are recorded from Cenomanian to Maastrichtian sediments in Tanot well–1, which are apprantly reworked.

Dimensions—Diameter 7.43 µm.

Known stratigraphic range—Barremian.

Nannoconus ligius Applegate & Bergen, 1988

(Pl. 7.15a–b)

1988 *Nannoconus ligius* Applegate & Bergen, pp. 315–316, pl. 13, figs 1–10, 15.
2004 *Nannoconus ligius* Bown & Concheyro, pp. 81, pl. 6, figs 26–30.

Remarks—A petaloid nannolith with eight ‘rays’ having layered nature of the wall structure was evidenced by Applegate and Bergen (1988). There appears to be one kind of cycle only, and these are flat, not spiral. These features are fundamentally different from all other species in the genus.

Occurrence—Few to rare reworked occurrences of this species are recorded from Cenomanian to Campanian sediments in Tanot well–1.

Dimensions—Diameter 5.15 µm.

Known stratigraphic range—Late Valanginian–Early Barremian.

Nannoconus multicadus Deflandre & Deflandre–Rigaud, 1960

(Pl. 7.16a–b)

1959 *Nannoconus multicadus* Deflandre & Deflandre–Rigaud, pp. 2374, figs 4–5 (invalid ICBN Art. 37).
1960 *Nannoconus multicadus* Deflandre & Deflandre–Rigaud, pp. 177, pl. 1, figs 10–13.
1967 *Nannoconus multicadus* Lyul’eva, pp. 210, text figs 7–9.
1971 *Nannoconus multicadus* Manivit, pp. 135, pl. 32, fig. 4.
1972 *Nannoconus multicadus* Lauer, pp. 173, pl. 33, fig. 3.
1976 *Nannoconus multicadus* Hill, pp. 164, pl. 9, figs 7–9.
1998 *Nannoconus multicadus* Burnett *in* Bown, pp. 192, pl. 6.12, fig. 40.
2013b *Nannoconus multicadus* Rai *et al*., pp. 1608, figs 5.2a–b.

Remarks—This species appears to be composed of two or more individuals of *N. truitti* stacked one above the other. Deflandre and Deflandre–Rigaud (1959, 1960) noted two variations of this form, one with a single constriction in the cylindrical outer test wall and a second with two constrictions. Specimens with more than two constrictions have so far not been observed.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface few occurrences of this form are recorded from Campanian to Maastrichtian. Reworking of this species is observed in Maastrichtian sediments.

Dimensions—L/W 11.35 µm/8.46 µm.

Known stratigraphic range—Albian–Campanian.

Nannoconus pseudoseptentrionalis Rutledge & Bown, 1996

(Pl. 7.17a–b)

1987 *Nannoconus quadriangulus?* Thomsen, pl. 16, figs 6–7, 9.
1989 *Tegulalithus septentrionalis* Crux, pl. 8.9, figs 5–6.
1996 *Nannoconus pseudoseptentrionalis* Rutledge & Bown, pp. 54, pl. 1, figs 20–22.
1998 Bown *et al*. *in* Bown, pp. 128, pl. 5.14, fig. 20.

Remarks—This species is so short that it has only been seen in plan view. The thin shallowly–spiralling plates composing the test overlap irregularly to give a ragged margin. This form lacks regularly–spaced vertical ribs and thus its margin is not regularly scalloped. The axial canal is much narrower than the width of the wall. It is highly birefringent in the light microscope.

Occurrence—Rare reworked occurrences of this species are recorded from Campanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 6.67 µm/5.97 µm.

Known stratigraphic range—Barremian.

Nannoconus quadriangulus Deflandre & Deflandre–Rigaud, 1962

(Pl. 7.18a–b)

2004 *Nannoconus quadriangulus* Bown & Concheyro, pp. 81, pl. 6, figs 24–25.

Remarks—Short–cylindrical (quadriangular) nannoconids with wide central cavities. Details of the wall structure was not seen due to the poor preservation.

Occurrence—Rare patchy occurrences of this species are recorded from Cenomanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 6.85 µm/6.88 µm.

Known stratigraphic range—Albian–Maastrichtian.

Nannoconus quadricanalis Bown & Concheyro, 2004

(Pl. 7.19a–b)

2004 *Nannoconus quadricanalis* Bown & Concheyro, pp. 77, pl. 6, figs 1–20.

Remarks—Short–cylindrical (quadriangular) to elongate nannoconids with wide central cavities and walls formed from moderately high–angled and moderately thick cycles. In Tanot well–1 most of the forms preserved in plan view and all of them are considered reworked.

Occurrence—Few to rare patchy occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—Diameter 11.68 µm.

Known stratigraphic range—Late Valanginian–Maastrichtian.

***Nannoconus* sp. 1**

(Pl. 7.20a–b)

Remarks—Reworked small flat species of *Nannoconus* which is squarish in outline with rounded corners, central canal is very small and thin.

Occurrence—Rare occurrences of this species are observed in one subsurface sample at 1137 m depth belonging to Maastrichtian age.

Dimensions—L/W 11.13 µm/10.68 µm.

Known stratigraphic range—Maastrichtian.

***Nannoconus* sp. 2**

(Pl. 7.21a–b)

Remarks—A reworked species of *Nannoconus* with smooth elliptical outline and very broad central canal is seen in plan view.

Occurrence—Rare occurrences of this species are observed in one subsurface sample at 1158 m depth belonging to Maastrichtian age.

Dimensions—L/W 8.89 µm/8.26 µm.

Known stratigraphic range—Maastrichtian.

***Nannoconus* sp. 3**

(Pl. 7.22a–b)

Remarks—A reworked species of *Nannoconus* whose width is greater than length and the central canal is very broad almost half of the total width.

Occurrence—Few occurrences of this species are observed in one subsurface sample at 1104 m depth belonging to Maastrichtian age.

Dimensions—L/W 11.18 µm/12.29 µm.

Known stratigraphic range—Maastrichtian.

Nannoconus steinmannii Kamptner, 1931

(Pl. 7.23a–b)

1931 *Nannoconus steinmannii* Kamptner, pp.289–291, figs 1–3.

2004 *Nannoconus steinmannii* Bown & Concheyro, pp. 77, pl. 4, figs 1–15.

2004 *Nannoconus steinmannii* Chira *et al*., pp. 95, pl. 1, figs 7a–b.

Remarks—Large, elongate, tapering nannoconids with narrow central canal and walls formed from low–angled, narrow cycles.

Occurrence—Few reworked occurrences of this species are observed in one subsurface sample at 1104 m depth belonging to Maastrichtian age.

Dimensions—L/W 11.72 µm/9.98 µm.

Known stratigraphic range—Late Valanginian.

Nannoconus truitti frequens Deres & Acheriteguy, 1980

(Pl. 7.24a–b)

1980 *Nannoconus truitti frequens* Deres & Acheriteguy, pp. 24–25, pl. 1, fig. 10.

1998 *Nannoconus truitti frequens* Burnett *in* Bown, pp. 192, pl. 6.12, fig. 41.

2013a *Nannoconus truitti frequens* Rai *et al*., pp. 71, pl. 1, fig. 29.

Remarks—This hollow nearly cylindrical nannoconid species has a diameter nearly equal to the height so that it is square in outline when viewed in longitudinal section.

Occurrence—Common to few reworked occurrences of this species are recorded from Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 9.65 µm/9.50 µm.

Known stratigraphic range—Aptian–Campanian.

Nannoconus truitti rectangularis Deres & Acheriteguy, 1980

(Pl. 8.1a–b)

1980 *Nannoconus truitti rectangularis* Deres & Acheriteguy, pp. 25, pl. 1, fig. 11.
1998 *Nannoconus truitti rectangularis* Burnett *in* Bown, pp. 192, pl. 6.12, fig. 43.
2013a *Nannoconus truitti rectangularis* Rai *et al*., pp. 71, pl. 1, fig. 30.

Remarks—This species of *Nannoconus* is morphologically very similar with *Nannoconus truitti frequens*. It differs from the *N. truitti frequens* by having a slightly rectangular outline.

Occurrence—Few occurrences of this species are recorded from Santonian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 12.21 µm/11.00 µm.

Known stratigraphic range—Albian–Campanian.

Family—POLYCYCLOLITHACEAE Forchheimer, 1972 emend. Varol, 1992

Genus—ASSIPETRA Roth, 1973

Type Species—*Assipetra infracretacea* Roth, 1973

Assipetra terebrodentarius (Applegate *et al*. *in* Covington & Wise, 1987) Rutledge & Bergen *in* Bergen, 1994

(Pl. 8.19a–b)

1987 *Rucinolithus terebrodentarius* Applegate *et al*. *in* Covington & Wise, pp. 632–633, pl. 17, figs 7–8, pl. 18, figs 5–7, pl. 19, figs 1–5.
1989 *Rucinolithus terebrodentarius* Bralower *et al*., pp 223, pl. 7, figs 1–6.
1994 *Assipetra terebrodentarius* (Applegate *et al*. *in* Covington & Wise, 1987) Rutledge & Bergen *in* Bergen, pp. 60.
1998 *Assipetra terebrodentarius* Bown *et al*. *in* Bown, pp. 130, pl. 5.15, figs 2–3.
2004 *Assipetra terebrodentarius* Chira *et al*., pp. 95, pl. 1, figs 4a–c.
2005 *Assipetra terebrodentarius* Lees & Bown *in* Bralower *et al*., pp. 17, pl. P5, figs 19–21.

Remarks—A globular to oblate spheroidal form composed of about ten blocky euhedral interpenetrating elements that may rotate (usually counterclockwise) about a central axis. A terminal element may project as a knob at pole so that when viewed axially the object appears as a rosette in plan view.

Occurrence—Rare reworked occurrences of this species are recorded from Cenomanian to Santonian sediments in Tanot well–1.

Dimensions—Diameter 4.81 µm.

Known stratigraphic range—Late Hauterivian–Early Barremian.

Genus—EPROLITHUS Stover, 1966

Type Species— *Lithastrinus floralis* Stradner, 1962

Eprolithus floralis (Stradner, 1962) Stover, 1966

(Pl. 8.2a–b)

1962 *Lithastrinus floralis* Stradner, pp. 370, pl. 2, figs 6–11.
1966 *Eprolithus floralis* (Stradner, 1962) Stover, pp. 149, pl. 7, figs 4–7, 9, pl. 9, fig. 21.
1968 *Polycyclolithus brotzenii* Forchheimer, pp. 41, pl. 6, figs 6a–b, 7a–b, SEM photos 15–16, text fig. 3.
1973 *Rhombogyrus stellatus* Black, pp. 104, pl. 32, figs 5–7.
1992 *Eprolithus floralis* Kale & Phansalkar, pp. 89, pl. 1, figs 22–25, pl. 2, fig. 6.
1998 *Eprolithus floralis* Burnett *in* Bown, pp. 192, pl. 6.13, figs 3a–b.
2013a *Eprolithus floralis* Rai *et al*., pp. 58, pl. 1, fig. 18.
2013b *Eprolithus floralis* Rai *et al*., pp. 1608, figs 5.3a–b.
2014 *Eprolithus floralis* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 3.
2015 *Eprolithus floralis* Linnert & Mutterlose, pp. 731, fig. 4N'.

Remarks—Calcareous nannofossils that have circular outline in plan view. The rim is composed of nine or more segments of uniform width, surrounding a circular heliolithic central plate located at approximately mid–height.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface common to few occurrences of this species are recorded from Cenomanian to Maastrichtian in Tanot well–1. Reworking of this species is observed in Maastrichtian sediments.

Dimensions—Diameter 6.55 µm.

Known stratigraphic range—Aptian–? Campanian.

Eprolithus moratus (Stover, 1966) Burnett, 1998

(Pl. 8.3a–b)

1966 *Lithastrinus moratus* Stover, pp. 49, pl. 7, fig. 20.
1998 *Eprolithus moratus* (Stover, 1966) Burnett, pp. 138, pl. 1, figs 19–21.
1998 *Eprolithus moratus* Burnett *in* Bown, pp. 192, pl. 6.13, figs 5a–b, 6.

Remarks—In plan view it appears as a rosette having seven inclined partly overlapping and twisted segments. The outline of the segments in plan view is lanceolate with slightly rounded outer margin. Specimens may either lack or have a very small axial pit or opening.

Occurrence—Abundant to few occurrences of this species are recorded from Turonian to Maastrichtian in Tanot well–1. Reworking of this species is observed in Campanian–Maastrichtian sediments.

Dimensions—Diameter 5.20 µm.

Known stratigraphic range—Turonian–?Santonian.

Eprolithus rarus? Varol, 1992

(Pl. 8.4a–b)

1992 *Eprolithus rarus* Varol, pp. 117, pl. 1, fig. 1, pl. 6, fig. 7.
1998 *Eprolithus rarus* Burnett *in* Bown, pp. 192, pl. 6.13, fig. 8.

Remarks—A species of *Eprolithus* which appears as a rosette having six inclined partly overlapping and twisted segments in plan view. The outline of the segments in plan view is lanceolate with pointed outer margins. Axial pit or central opening if present is very small or absent.

Occurrence—Few occurrences of this species are recorded from Turonian to Santonian sediments in Tanot well–1.

Dimensions—Diameter 5.66 µm.

Known stratigraphic range—Turonian–?Campanian.

Genus—FARHANIA Varol, 1992

Type Species— ***Eprolithus varolii*** Jakubowski, 1986

Farhania varolii (Jakubowski, 1986) Varol, 1992

(Pl. 8.5a–b)

1986 *Eprolithus varolii* Jakubowski, pp. 38–39, pl. 1, figs 16–17.
1992 *Farhania varolii* (Jakubowski, 1986) Varol, pp. 118. pl. 1, figs 6–8.
1998 *Farhania varolii* Bown *et al*. *in* Bown, pp. 128, pl. 5.14, figs 25–27.
2013b *Farhania varolii* Rai *et al*., pp. 1608, figs 5.4a–b.

Remarks—This species of *Farhania* have sixteen to twenty four brick–like clockwise imbricating elements in each cycle of the wall.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. All the forms recorded from surface and subsurface are reworked.

Dimensions—Diameter 6.50 µm.

Known stratigraphic range—Aptian.

Genus—HAYESITES Manivit, 1971

Type Species—*Hayesites albiensis* Manivit, 1971

Hayesites irregularis (Thierstein *in* Roth & Thierstein, 1972) Applegate *et al*. *in* Covington & Wise, 1987

(Pl. 8.20a–b)

1971 *Hayesites albiensis* Manivit, pp. 138, pl. 14, figs 1–7.
1971 *Hayesites albiensis* Thierstein, pp. 45, pl. 6, figs 1–5.
1972 *Rucinolithus irregularis* Thierstein *in* Roth & Thierstein, pp. 438, pl. 2, figs 10–19.
1987 *Hayesites irregularis* (Thierstein *in* Roth & Thierstein, 1972) Applegate *et al*. *in* Covington & Wise, pp. 634, pl. 20, figs 7–8.
1998 *Hayesites irregularis* Bown *et al*. *in* Bown, pp. 130, pl. 5.15, figs 6–7.

Remarks—Star–shaped to compact petaloid nannolith composed of about six to eleven dextrally imbricated elements. This species is rarely recorded in Tanot samples. Poor preservation in Tanot samples causes hinderance in identification at times.

Occurrence—Few reworked occurrences of this species are observed in one subsurface sample at 1488 m depth belonging to Turonian age.

Dimensions—L/W 5.02 µm/4.03 µm.

Known stratigraphic range—Barremian–?Albian.

Genus—MICULA Vekshina, 1959

Type Species—*Micula decussata* Vekshina, 1959

Micula adumbrata Burnett, 1998

(Pl. 8.6a–b)

1998 *Micula adumbrata* Burnett, pp. 137, pl. 1, figs 23a–d.
1998 *Micula adumbrata* Burnett *in* Bown, pp. 194, pl. 6.13, figs 24a–c.

Remarks—This species appears to be an intermediate form between *Quadrum* and *Micula* but is placed in *Micula* due to the much similar appearance with *M. staurophora* in light microscope.

Occurrence—Few reworked occurrences of this species are observed in one subsurface sample at 1146 m depth belonging to Maastrichtian age.

Dimensions—Diameter 3.63 µm.

Known stratigraphic range—Coniacian.

Micula murus (Martini, 1961) Bukry, 1973

(Pl. 8.7a–b)

1961 *Tetralithus murus* Martini, pp. 4, pl. 1, fig. 6, pl. 4, fig. 42.
1964 *Tetralithus murus* Bramlette & Martini, pp. 320, pl. 6, figs 18–21.
1973 *Micula murus* (Martini, 1961) Bukry, pp. 679.
1998 *Micula murus* Burnett *in* Bown, pp. 194, pl. 6.13, figs 28–29.
2003 *Micula murus* Tantawy, pp. 331, pl. 2, figs 18–21.
2005 *Micula murus* Lees & Bown *in* Bralower *et al*., pp. 19, pl. P7, figs 22–30.
2013 *Micula murus* Zahran, pp. 992, pl. 2, figs 7–8.
2015 *Micula murus* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 13.

Remarks—This species of *Micula* is composed of two superimposed and complexly intergrown cycles, one much reduced in size, and each cycle twisting in opposite directions. In "normal view" the elements are broadly triangular in shape and point/twist consistently in one direction; the elements protrude significantly away from the edges of the cube. Side views of *M. murus* are thinner than the normal view and clearly show the two superimposed, differently sized cycles.

Occurrence—Few leaked occurrences of this species from Late Maastrichtian are recorded in Early Maastrichtian sediments of Tanot well–1.

Dimensions—Diameter 3.42 µm.

Known stratigraphic range—Maastrichtian.

Micula praemurus (Bukry, 1973) Stradner & Steinmetz, 1984

(Pl. 8.8a–b)

1973 *Tetralithus praemurus* Bukry, pp. 308, pl. 2, figs 6–9.
1984 *Micula praemurus* (Bukry, 1973) Stradner & Steinmetz, pp. 595.
1998 *Micula praemurus* Burnett *in* Bown, pp. 194, pl. 6.13, figs 27a–b.
2005 *Micula praemurus* Lees & Bown *in* Bralower *et al*., pp. 20, pl. P8, figs 13–21.

Remarks—A highly distinctive, circular, disc–like *Micula*, originally described from Shatsky Rise (Bukry, 1973), is composed of a single cycle of four elements joined along curving, S–shaped sutures. Much flatter than the other species of *Micula* but with comparable crystallographic orientation.

Occurrence—Few occurrences of this species are recorded from Santonian to Maastrichtian sediments in Tanot well–1.

Dimensions—Diameter 5.27 µm.

Known stratigraphic range—Campanian–Maastrichtian.

Micula premolisilvae Lees & Bown *in* Bralower *et al*., 2005

(Pl. 8.9a–b)

2005 *Micula premolisilvae* Lees & Bown *in* Bralower *et al*., pp. 19, pl. P8, figs 22–30.

Remarks—A near square to cruciform, flat *Micula*, composed of a single cycle of four elements joined along distinct straight, or gently curving, sutures. Similar in morphology to *M. praemurus* but the outline is square or cruciform rather than circular.

Occurrence—Few to rare occurrences of this species are recorded from Campanian to Maastrichtian sediments in Tanot well–1.

Dimensions—Diameter 2.90 µm.

Known stratigraphic range—Late Campanian–Early/Late Maastrichtian.

Micula staurophora (Gardet, 1955) Stradner, 1963

(Pl. 8.10a–b)

1955 *Discoaster staurophorus* Gardet, pp. 534, pl. 10, fig. 96.
1959 *Micula decussata* Vekshina, pp. 71, pl. 1, fig. 6.
1963 *Micula staurophora* (Gardet, 1955) Stradner, pp. 8, figs 12a–c.
1964 *Micula staurophora* Bramlette & Martini, pp. 318, pl. 6, figs 7–11. pl. 4, fig. 18, pl. 9, figs 18–20.
1968 *Micula decussata* Gartner, pp. 47, pl. 2, figs 5–8.
1971 *Micula staurophora* Shafik & Stradner, pp. 84, pl. 50, figs 1–4.
1998 *Micula staurophora* Burnett *in* Bown, pp. 194, pl. 6.13, fig. 25.
2004 *Micula staurophora* Chira *et al*., pp. 96, pl. 2, figs 4a–b.
2013b *Micula staurophora* Rai *et al*., pp. 1608, figs 5.6a–b.

Remarks—*Micula staurophora* has preference to *Micula decussata* Vekshina, 1959 in nomenclature, hence followed in this study. In its type species, two cycles of elements are joined together in different planes and strongly twisted. No diaphragm is present.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface common occurrences of this form are recorded from Maastrichtian.

Dimensions—Diameter 3.26 µm.

Known stratigraphic range—Coniacian–Maastrichtian.

Micula swastica Stradner & Steinmetz, 1984

(Pl. 8.11)

1984 *Micula swastica* Stradner & Steinmetz, pp. 565.
1985 *Micula swastica* Perch–Nielsen, pp. 391, pl. 58, fig. 29.
1998 *Micula swastica* Burnett *in* Bown, pp. 194, pl. 6.13, fig. 26.
2005 *Micula swastica* Lees & Bown *in* Bralower *et al*., pp. 20, pl. P7, figs 25–42.
2015 *Micula swastika* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 21.

Remarks—This species of *Micula* is composed of two equidimensional, superimposed, and complexly intergrown cycles. In "normal view" the elements are broadly triangular in shape and the point twist consistently in one direction on each surface; the elements may protrude slightly beyond the cube. While focusing through the structure under light microscope, the two cycles twist in opposite directions. Side views of *M. swastica* are thinner than the normal view and clearly show the two superimposed cycles.

Occurrence—Few to rare occurrences of this species are recorded from Maastrichtian sediments in Tanot well–1.

Dimensions—Diameter 5.82 µm.

Known stratigraphic range—Coniacian–Maastrichtian.

Genus—QUADRUM Prins & Perch–Nielsen *in* Manivit *et al*., 1977

Type Species—*Quadrum gartneri* Prins & Perch–Nielsen *in* Manivit *et al*., 1977

Quadrum gartneri Prins & Perch–Nielsen *in* Manivit *et al*., 1977

(Pl. 8.12)

1968 *Tetralithus gothicus* Gartner, pp. 42, pl. 24, fig. 4.
1971 *Quadrum gartneri* Prins & Perch–Nielsen *in* Manivit *et al*., pp. 177, pl. 1, figs 9–10.
1974 *Micula staurophora* Thierstein, pl. 12, figs 4–8.
1976 *Tetralithus pyramidus* Verbeek, pl. 1, figs 4, 6.
1985 *Quadrum gartneri* Perch–Nielsen, pp. 391, pl. 58, figs 1–2.
1992 *Quadrum gartneri* Kale & Phansalkar, pp. 90, pl. 1, fig. 26.
1998 *Quadrum gartneri* Burnett *in* Bown, pp. 192, pl. 6.13, figs 12a–b.
2012 *Quadrum gartneri* Farouk & Faris, pp. 58, fig. 8.18.
2015 *Quadrum gartneri* Linnert & Mutterlose, pp. 731, fig. 4P'.

Remarks—The cube–shape and the absence of protuberances on the corners are characteristic for this species, which may be constructed of one or two layers.

Occurrence—Few occurrences of this species are recorded from Maastrichtian sediments in Tanot well–1.

Dimensions—Diameter 5.34 µm.

Known stratigraphic range—Turonian–?Maastrichtian.

Quadrum intermedium Varol, 1992

(Pl. 8.13a–b)

1982 *Quadrum gartneri* Crux, pl. 5.7, fig. 7, pl. 5.10, fig. 18.
1992 *Quadrum intermedium* Varol, pp. 119. pl. 2, figs 3–5, pp. 127, pl. 7, fig. 3.
1998 *Quadrum intermedium* Burnett *in* Bown, pp. 192, pl. 6.13, figs 12c–d.
2015 *Quadrum intermedium* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 15.

Remarks—This species has four large ray–like elements of equal size and one to three small ray like elements of equal size in each cycle of the wall. The small elements insert between the large elements.

Occurrence—Few to rare reworked occurrences of this species are recorded from Maastrichtian sediments in Tanot well–1.

Dimensions—Diameter 5.25 µm.

Known stratigraphic range—Cenomanian–Turonian.

Quadrum svabenickae Burnett, 1998

(Pl. 8.14a–b)

1998 *Quadrum svabenickae* Burnett, pp. 138, pl. 1, figs 22a–b.
1998 *Quadrum svabenickae* Burnett *in* Bown, pp. 194, pl. 6.13, figs 21–22a.

Remarks—A species of *Quadrum* which has an excavated central area having four elements per face which appears to be thickened at the edges particularly around outer corners.

Occurrence—Few occurrences of this species are recorded from Campanian to Maastrichtian. It seems that the forms recorded in Campanian are leaked from younger levels.

Dimensions—Diameter 3.78 µm.

Known stratigraphic range—Coniacian–Maastrichtian.

Genus—RADIOLITHUS Stover, 1966

Type Species—*Radiolithus planus* Stover, 1966

Radiolithus hollandicus Varol, 1992

(Pl. 8.15)

1992 *Radiolithus hollandicus* Varol, pp. 120, pl. 3, figs 9–14, pp. 123, pl. 5, figs 7–13.
1998 *Radiolithus hollandicus* Burnett *in* Bown, p. 192.
2004 *Radiolithus planus* Chira *et al*., pp. 95, pl. 1, figs 17a–b.

2013b *Radiolithus planus* Rai *et al*., pp. 1608, figs 5.7a–b.

Remarks—A low wall species of *Radiolithus* having ten to sixteen brick like elements in each cycle of the wall.

Occurrence—Few occurrences of this species are recorded from Albian to Santonian in Tanot well–1. Reworking of this species is observed in Turonian–Santonian sediments.

Dimensions—Diameter 5.13 µm.

Known stratigraphic range—Aptian?–Cenomanian.

Radiolithus planus Stover, 1966

(Pl. 8.16)

1966 *Radiolithus planus* Stover, pp. 160, pl. 7, figs 22a–c, 24a–b, pl. 9, fig. 23.
1973 *Radiolithus minutus* Black, pp. 102, pl. 33, figs 3, 8.
1973 *Radiolithus caliciformis* Black, pp. 103, pl. 33, figs 1–2, 4–5.
1992 *Radiolithus planus* Varol, pp. 120, pl. 3, figs 5–7, pp. 123, pl. 5, figs 5–6.
1998 *Radiolithus planus* Burnett *in* Bown, pp. 192, pl. 6.13, fig. 11.
2013a *Radiolithus planus* Rai *et al*., pp. 71, pl. 1, fig. 34.

Remarks—A low walled species of *Radiolithus* having nine brick like elements in each cycle of the wall. *R. planus* has a narrow, weakly birefringent wall under cross–polarised light.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface common to few occurrences of this form are recorded from Cenomanian to Campanian. Reworking of this species is observed in Campanian sediments.

Dimensions—Diameter 6.01 µm.

Known stratigraphic range—Aptian–Turonian.

Genus—RUCINOLITHUS Stover, 1966

Type Species—*Rucinolithus hayi* Stover, 1966

Rucinolithus hayi Stover, 1966

(Pl. 8.21a–b)

1966 *Rucinolithus hayi* Stover, pp. 156, pl. 7, fig. 21, pl. 9, fig. 22.
1969 *Discoaster? hayi* Bukry, pp. 65, pl. 38, figs 10–12.
1971 *Rucinolithus* sp. cf. *R. hayi* (Stover, 1966) Manivit, pp. 142, pl. 25, figs 16–17.
1998 *Rucinolithus hayi* Burnett *in* Bown, pp. 194, pl. 6.14, fig. 1a.

Remarks—The species consists of slightly inclined, thick, blocky, radial segments having the appearance of rosette of five to seven imbricated pieces in plan view. The segments are diamond–shaped to lanceolate in plan view; the inner margins of the segments may surround a small axial opening, closed at one end.

Occurrence—Rare leaked occurrences from younger levels of this species are recorded from Cenomanian to Turonian sediments in Tanot well–1.

Dimensions—Diameter 5.40 µm.

Known stratigraphic range—Santonian–Campanian.

Genus—UNIPLANARIUS Hattner & Wise, 1980

Type Species—*Tetralithus gothicus* Deflandre, 1959

Uniplanarius clarkei Lees & Bown *in* Bralower *et al*., 2005

(Pl. 8.17a–b)

2005 *Uniplanarius clarkei* Lees & Bown *in* Bralower *et al*., pp. 21, pl. P9, figs 1–12.

Remarks—Small, square *Uniplanarius* with rounded corners, formed from four blocks which are joined along axial sutures that are marked under cross polarized light by relatively broad zones of darker birefringence, together resembling the blades of a propeller. The outer edges of the nannolith may show slightly higher birefringence.

Occurrence—Rare occurrences of this species are recorded from Campanian to Maastrichtian. It seems that the forms recorded in Campanian are leaked from younger levels.

Dimensions—Diameter 4.34 µm.

Known stratigraphic range—Campanian–Maastrichtian.

Uniplanarius gothicus (Deflandre, 1959) Hattner & Wise, 1980

(Pl. 8.18a–b)

1959 *Tetralithus gothicus* Deflandre, pp. 138, pl. 3, fig. 25.
1980 *Uniplanarius gothicus* (Deflandre, 1959) Hattner & Wise, pp. 68, pl. 32, fig. 4, pl. 42, figs 4–5.
1985 *Quadrum sissinghii* Perch–Nielsen, pp. 390, figs 9, 13.
1987 *Lithastrinus quadricuspis* Farhan, pp. 59, pl. 1, figs 1–4, pl. 2, fig. 1.
1998 *Uniplanarius gothicus* Burnett *in* Bown, pp. 194, pl. 6.13, figs 14–15.
2005 *Uniplanarius gothicus* Lees & Bown *in* Bralower *et al*., pp. 21, pl. P9, figs 13–24.
2015 *Uniplanarius gothicus* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 8.

Remarks—Small, square–shaped, simply constructed *Uniplanarius*. The elements are bright under cross polarized light when the sutures and sides of the square nannolith are parallel to the polarizing directions and all in extinction when rotated to 45°. Similar in appearance to *Quadrum gartneri*, but the latter is blocky, cubiform, and constructed of two superimposed cycles of elements.

Occurrence—Common to rare occurrences of this species are recorded from Turonian to Maastrichtian sediments in Tanot well–1.

Dimensions—Diameter 6.50 µm.

Known stratigraphic range—Santonian–Maastrichtian.

Family—PREDISCOSPHAERACEAE Rood *et al*., 1971

Genus—PREDISCOSPHAERA Vekshina, 1959

Type Species—*Prediscosphaera decorata* Vekshina, 1959 (=*Prediscosphaera cretacea* (Arkhangelsky, 1912) Gartner, 1968)

Prediscosphaera columnata (Stover, 1966) Perch–Nielsen, 1984

(Pl. 8.22a–b)

1966 *Deflandrius columnatus* Stover, pp. 141, pl. 6, figs 6–10, pl. 9, fig. 16.
1967 *Deflandrius cantabrigensis* Black, pp. 140, text fig. 1.
1969 *Deflandrius columnatus* Bukry & Bramlette, pp. 372, pl. 2, fig. E.
1971 *Deflandrius columnatus* Manivit, pp. 100, pl. 21, figs 13–15.
1977 *Deflandrius columnatus* Manivit *et al*., pp. 177, pl. 1, figs 2–3.
1984 *Prediscosphaera columnata* (Stover, 1966) Perch–Nielsen, pp. 43, pl. 1, figs 5–6.
1992 *Prediscosphaera columnata* Kale & Phansalkar, pp. 90, pl. 1, figs 31–35, pl. 2, figs 10–11.
1998 *Prediscosphaera columnata* Burnett *in* Bown, pp. 178, pl. 6.6, figs 23a–b.
2013a *Prediscosphaera columnata* Rai *et al*., pp. 71, pl. 1, fig. 32.
2013b *Prediscosphaera columnata* Rai *et al*., pp. 1608, figs 5.10a–b.
2015 *Prediscosphaera columnata* Linnert & Mutterlose, pp. 731, fig. 4B'.

Remarks—This species differs from *Prediscosphaera cretacea* (Arkhangelsky) by its small and circular basal disc.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface abundant to few occurrences of this form are recorded from Albian to Maastrichtian.

Dimensions—L/W 6.05 µm/5.50 µm.

Known stratigraphic range—Albian–Turonian.

Prediscosphaera cretacea (Arkhangelsky, 1912) Gartner, 1968

(Pl. 8.23a–b)

1912 *Coccolithophora cretacea* Arkhangelsky, pp. 410, pl. 6, figs 12–13.
1968 *Prediscosphaera cretacea* (Arkhangelsky, 1912) Gartner, pp. 21, pl. 2, figs 10–11.
1969 *Prediscosphaera cretacea cretacea* Bukry, pp. 38, pl. 16, fig. 12, pl. 17, figs 1–6.
1969 *Prediscosphaera cretacea lata* Bukry, pp. 39, pl. 17, figs 7–9.
1969 *Prediscosphaera cretacea ponticula* Bukry, pp. 39, pl. 17, figs 10–12.
1969 *Deflandrius catinus* Shumenko, pp. 153, pl. 2, figs 1–2.
1970 *Deflandrius cantabrigensis* Forchheimer, pp. 37, figs 34–40.
1971 *Prediscosphaera cretacea* Manivit, pp. 99, pl. 22, figs 1–14.
1971 *Prediscosphaera cretacea* Perch–Nielsen, pl. 7, figs 3, 5.
1972 *Prediscosphaera cretacea cretacea* Roth & Thierstein, pl. 16, fig. 5.
1972 *Prediscosphaera cretacea ponticula* Roth & Thierstein, pl. 16, figs 1–4.
1973 *Prediscosphaera majungae* Perch–Nielsen, pp. 321. pl. 8, figs 1–6, pl. 10, figs 37–38.
1998 *Prediscosphaera cretacea* Burnett *in* Bown, pp. 178, pl. 6.6, figs 22a–b.
2001 *Prediscosphaera cretacea* Ladner & Wise *in* Beslier *et al*., pp. 49, pl. 3, figs 3–5.
2003 *Prediscosphaera cretacea* Tantawy, pp. 31, pl. 2, figs 25–26.
2004 *Prediscosphaera cretacea* Chira *et al*., pp. 95, pl. 1, figs 16a–b.
2015 *Prediscosphaera cretacea* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 10.

Remarks—This species shows a very strong variation in size, but the distal shield of the margin always contains sixteen elements, the basal disc has an oval to circular outline and contains an inner margin cycle, the bars are always radial, the central process has always the same typically twisted structure and wings at the top. All coccoliths with these features are included in this species. The largest variation is found in assemblages from Campanian and Maastrichtian sediments. The oldest specimens are rather small.

Occurrence—Common to few occurrences of this species are recorded from Albian to Maastrichtian in Tanot well–1. It seems that the forms recorded in Albian are leaked from younger levels.

Dimensions—L/W 10.44 µm/2.39 µm.

Known stratigraphic range—Cenomanian–Maastrichtian.

Prediscosphaera grandis Perch–Nielsen, 1979

(Pl. 8.24a–b)

1954 *Coccolithus grandis* Bramlette & Riedel, pp. 391–392, pl. 38, figs 1a–b.
1979 *Prediscosphaera grandis* Perch–Nielsen, pp. 267, pl. 2, fig. 8.
1992 *Prediscosphaera grandis* Bralower & Siesser, pp. 547, pl. 3, figs 23–24.
1998 *Prediscosphaera grandis* Burnett *in* Bown, pp. 178, pl. 6.6, fig. 21.
2004 *Prediscosphaera grandis* Chira *et al*., pp. 95, pl. 1, figs 15a–b.
2015 *Prediscosphaera grandis* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 9.

Remarks—This species is almost circular in outline and differentiated from the other species of *Prediscosphaera* on the basis of its size. It has a diameter greater than 8 µm which may reach upto 10 µm in some forms.

Occurrence—Few to rare patchy occurrences of this species are recorded from Albian to Campanian in Tanot well–1. It seems that the forms recorded in Albian–Cenomanian are leaked from younger levels.

Dimensions—L/W 8.96 µm/8.43 µm.

Known stratigraphic range—Turonian?–Maastrichtian.

Prediscosphaera microrhabdulina Perch–Nielsen, 1984

(Pl. 8.25a–b)

1984 *Prediscosphaera microrhabdulina* Perch–Nielsen, pp. 42, pl. 7, figs 1, 4, pl. 10, figs 35–36.
1998 *Prediscosphaera microrhabdulina* Burnett *in* Bown, pp. 178, pl. 6.6, figs 19a–b.

Remarks—The basal disc consists of two approximately equal–sized sliced edges. These edges consist of 16 elements, the edges are notched laterally, and so they give impression of two discs. In the central area four trims are present to keep the central projection, which is slightly broadened distally and composed of four long rods. The rod carries no more distal structure. In the light microscope the bar appears widest at the base.

Occurrence—Common to rare occurrences of this species are recorded from Campanian to Maastrichtian sediments in Tanot well–1.

Dimensions—Length of disc–6.93 µm, Length of rod–7.56 µm.

Known stratigraphic range—Santonian–Maastrichtian.

Prediscosphaera ponticula (Bukry, 1969) Perch–Nielsen, 1984

(Pl. 8.26a–b)

1969 *Prediscosphaera cretacea ponticula* Bukry, pp. 39, pl. 17, figs 10–12.
1984 *Prediscosphaera ponticula* (Bukry, 1969) Perch–Nielsen, pp. 43.
1998 *Prediscosphaera ponticula* Burnett *in* Bown, pp. 178, pl. 6.6, fig. 23c.

Remarks—This species has almost circular, broad proximal and distal rim of about same size. Four single crystallite elements extend from the margin of the central area to the inner end of the crossbars. Though not in contact with each other, these slender auxillary elements are perpendicular to the adjacent two, they make an angle of 60º to 70º with the major crossbar that they join.

Occurrence—Few occurrences of this species are recorded from Cenomanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 7.80 µm/7.24 µm.

Known stratigraphic range—Albian–Maastrichtian.

Prediscosphaera sp. 1

(Pl. 9.1a–b)

Remarks—This is beautifully preserved form in side view. The disc and the stem both are complete. Disc is small and probably circular in shape. Stem has three–pair of elements in columnar manner. The top most pair is larger than other two and flaired on the distal side.

Occurrence—Rare occurrences of this species are observed in one subsurface sample at 1137 m depth belonging to Maastrichtian age.

Dimensions—Length of whole body–8.92 µm, Length of disc–4.75 µm.

Known stratigraphic range—Maastrichtian.

Prediscosphaera sp. 2

(Pl. 9.2a–b)

Remarks—Slightly elliptical species of *Prediscosphaera* which is very large in size, may be due to the overgrowth of calcite at this level.

Occurrence—Rare occurrences of this species are observed in one subsurface sample at 1158 m depth belonging to Maastrichtian age.

Dimensions—L/W 16.25 µm/14.63 µm.

Known stratigraphic range—Maastrichtian.

Prediscosphaera spinosa (Bramlette & Martini, 1964) Gartner, 1968

(Pl. 9.3a–b)

1964 *Deflandrius spinosus* Bramlette & Martini, pp. 301, pl. 2, figs 17–20.
1965 *Eiffellithus cretaceous cretaceous* Reinhardt, pp. 35, pl. 2, fig. 4, text fig. 4.
1966 *Discolithus incohatus* Stover, pp. 143, pl. 2, figs 23–24, pl. 8, fig. 17.
1968 *Prediscosphaera spinosa* (Bramlette & Martini, 1964) Gartner, pp. 20, pl. 2, figs 15–16, pl. 3, figs 9–10, pl. 5, figs 7–9, pl. 6, fig. 16, pl. 11, fig. 17.
1972 *Deflandrius* sp. cf. *D. stoveri* Forchheimer, pp. 46, pl. 6, figs 10–11.
1998 *Prediscosphaera spinosa* Burnett *in* Bown, pp. 178, pl. 6.6, figs 30a–b.
2013a *Prediscosphaera spinosa* Rai *et al*., pp. 71, pl. 1, fig. 22.
2015 *Prediscosphaera spinosa* Linnert & Mutterlose, pp. 731, fig. 4C'.

Remarks—This species differs from *P. cretacea* in having bars parallel to the axes of the elliptical basal disc and from *Prediscosphaera quadripunctatus* (Górka) by the larger central area. The central process is not twisted.

Occurrence—Few to rare occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 6.76 µm/4.93 µm.

Known stratigraphic range—Aptian–Maastrichtian.

Prediscosphaera stoveri (Perch–Nielsen, 1968) Shafik & Stradner, 1971

(Pl. 9.4a–b)

1968 *Deflandrius stoveri* Perch–Nielsen, pp. 66, pl. 6, figs 11–13.
1971 *Prediscosphaera stoveri* (Perch–Nielsen, 1968) Shafik & Stradner, pp. 126, pl. 22, fig. 1.
1976 *Prediscosphaera stoveri* Wind & Wise, pp. 305, pl. 42, fig. 3.
1990 *Prediscosphaera stoveri* Pospichal & Wise, pp. 525, pl. 5, fig. 9.
1998 *Prediscosphaera stoveri* Burnett *in* Bown, pp. 178, pl. 6.6, figs 31a–b.
2001 *Prediscosphaera stoveri* Ladner & Wise *in* Beslier *et al*., pp. 49, pl. 3, figs 15–16.

Remarks—Elliptical placolith with an outer rim consisting of clockwise imbricated laths similar to *Biscutum*. The inner cycle is thin and much brighter in Light microscope. Central area is occupied by a central cross.

Occurrence—Common to few occurrences of this species are recorded from Turonian to Maastrichtian in Tanot well–1. It seems that the forms recorded in Turonian are leaked from younger levels.

Dimensions—L/W 5.82 µm/4.94 µm.

Known stratigraphic range—Campanian–Maastrichtian.

Family—RHAGODISCACEAE Hay, 1977

Genus—PERCIVALIA Bukry, 1969

Type Species—*Percivalia porosa* Bukry, 1969

Percivalia fenestrata (Worsley, 1971) Wise, 1983

(Pl. 9.5a–b)

1966 *Zygolithus fenestratus* Stover, pp. 147, pl. 3, figs 21–22C, pl. 4, fig. 1, pl. 8, fig. 24.
1971 *Arkhangelskiella? fenestrata* Worsley, pp. 1305, pl. 1, figs 33–35.
1972 *Reinhardites fenestratus* Thierstein *in* Roth & Thierstein, pp. 437, pl. 8, figs 1–12.
1983 *Percivalia fenestrata* (Worsley, 1971) Wise, pp. 508, pl. 28, fig. 6.
1998 *Percivalia fenestrata* Burnett *in* Bown, pp. 172, pl. 6.4, fig. 3.

Remarks—Overgrowths have apparently altered the ultrastructural characteristics of the central area of the specimen although a crude concentric elliptical pattern of elements seems to be present.

Occurrence—Few occurrences of this species are recorded from Cenomanian to Maastrichtian in Tanot well–1. Reworking of this species is observed in Maastrichtian sediments.

Dimensions—L/W 7.48 µm/5.45 µm.

Known stratigraphic range—Berriasian?–Campanian.

Percivalia* sp. cf. *P. hauxtonensis Black, 1973

(Pl. 9.6a–b)

1973 *Percivalia* sp. cf. *P. hauxtonensis* Black, pp. 105, pl. 31, figs 10–14.

Remarks—This species consists of a zygodiscoid rim and a prominent lozenge–shaped knob in the central area. It is morphologically very similar with *Percivalia hauxtonensis*, which is very common at mid latitudes and a useful Mid–Late Albian marker. However in Tanot well–1 this specimen ranges from Turonian to Maastrichtian. So, it is identified as *Percivalia* sp. cf. *P. hauxtonensis*.

Occurrence—Few to rare occurrences of this species are recorded from Turonian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 9.22 µm/7.52 µm.

Known stratigraphic range—Albian–Cenomanian.

Percivalia imperfossa Black, 1971

(Pl. 9.7a–b)

1971 *Percivalia imperfossa* Black, pp. 416, pl. 33, fig. 5.
1998 *Percivalia imperfossa* Burnett *in* Bown, pp. 172, pl. 6.4, figs 8–9.

Remarks—This species is structurally more primitive than the other species of the genus *Percivalia* having a gradual transition from the outer concentric zone to a pattern of more nearly equidimensional granules at the centre.

Occurrence—Few to rare reworked occurrences of this species are recorded from Campanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 6.37 µm/4.92 µm.

Known stratigraphic range—Hauterivian–Cenomanian.

Genus—PODORHABDUS Noël, 1965

Type Species—*Podorhabdus grassei* Noël, 1965

Podorhabdus* sp. cf. *P. elkefensis Perch–Nielsen, 1981

(Pl. 9.8a–b)

1981 *Podorhabdus elkefensis* Perch–Nielsen, pp. 223, pl. 6, figs 6–7.

Remarks—In both sides of the lining arch there is a small opening. No evidence was observed for a spine on the lining arch. The whole specimen is non birefringent.

Occurrence—Few to rare occurrences of this species are recorded from Turonian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 7.80 µm/5.98 µm.

Known stratigraphic range—Maastrichtian.

Genus—RHAGODISCUS Reinhardt, 1967

Type Species—*Rhagodiscus asper* (Stradner, 1963) Reinhardt, 1967

Rhagodiscus achlyostaurion (Hill, 1976) Doeven, 1983

(Pl. 9.9a–b)

1976 *Parhabdolithus achlyostaurion* Hill, pp. 145, pl. 9, figs 24–29.
1983 *Rhagodiscus achlyostaurion* (Hill, 1976) Doeven, pp. 86, pl. 7, figs 2–6.
1998 *Rhagodiscus achlyostaurion* Burnett *in* Bown, pp. 172, pl. 6.4, fig. 10.
2013a *Rhagodiscus achlyostaurion* Rai *et al*., pp. 71, pl. 1, fig. 39.
2015 *Rhagodiscus achlyostaurion* Linnert & Mutterlose, pp. 731, fig. 4Q.

Remarks—This species has an elliptical rim which is smooth in outline. In plan view under bright field illumination, the rim appears to be elevated above the central area and the circular cross section of the central spine is distinct. Under crossed nicols, the outer wall of the rim appears dark and smooth in contrast to the middle part, the rim which is distinctly brighter and is circumscribed by a crenulated extinction line. The central spine appears as a bright ring which is traversed by four sharply defined extinction gyres of a small X–shaped cross. The central ring is brighter than the rim. In Tanot well–1 the upper range of this form is extended from Coniacian to Maastrichtian.

Occurrence—Common occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 6.26 µm/4.81 µm.

Known stratigraphic range—Aptian–Coniacian.

Rhagodiscus angustus (Stradner, 1963) Reinhardt, 1971

(Pl. 9.10a–b)

1963 *Rhabdolithus angustus* Stradner, pp. 12, pl. 5, fig. 6.
1966 *Parhabdolithus elongates* Stover, pp. 144, pl. 6, figs 16–19, pl. 9, fig. 18.
1966 *Ahmuellerella angusta* (Stradner, 1963) Reinhardt, pp. 25, pl. 22. figs 9–12.
1967 *Rhabdolithina angusta* (Stradner, 1963) Reinhardt, pp. 168, pl. 7. figs 4–5.
1968 *Parhabdolithus angustus* Stradner *et al*., pp. 32, pl. 20, figs 1–5.
1970 *Rhabdolithina extans* Hoffmann, pp. 187, pl. 3, fig. 5.
1971 *Rhagodiscus angustus* Reinhardt, pp. 23, text fig. 10.
1992 *Rhagodiscus angustus* Kale & Phansalkar, pp. 90, pl. 1, fig. 9.
1998 *Rhagodiscus angustus* Burnett *in* Bown, pp. 172, pl. 6.4, figs 12b–c.
2013a *Rhagodiscus angustus* Rai *et al*., pp. 71, pl. 1, fig. 40.
2013 *Rhagodiscus angustus* Zahran, pp. 992, pl. 2, fig. 11.
2015 *Rhagodiscus angustus* Linnert & Mutterlose, pp. 731, fig. 4R.

Remarks—Specimens from Campanian and Maastrichtian rocks often do not show a ridge, whereas older specimens always have a ridge parallel to the shorter axis of the disc.

Occurrence—Abundant to few occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 7.74 µm/3.55 µm.

Known stratigraphic range—Aptian–Maastrichtian.

Rhagodiscus asper (Stradner, 1963) Reinhardt, 1967

(Pl. 9.11a–b)

1963 *Discolithus asper* Stradner, pp. 11, pl. 2, figs 4–5.
1966 *Discolithus vagus* Stover, pp. 144, pl. 3, figs 10–11, pl. 8, fig. 20.
1966 *Parhabdolithus granulatus* Stover, pp. 144, pl. 6, figs 11–15, pl. 9, fig. 17.
1967 *Rhagodiscus asper* (Stradner, 1963) Reinhardt, pp. 167.
1971 *Parhabdolithus asper* Manivit, pp. 87, pl. 23, figs 4–7.
1972 *Parhabdolithus asper* Roth and Thierstein, pl. 7, figs 7–17.
1998 *Rhagodiscus asper* Burnett *in* Bown, pp. 172, pl. 6.4, fig. 11.
2013a *Rhagodiscus asper* Rai *et al*., pp. 71, pl. 1, fig. 41.
2013b *Rhagodiscus asper* Rai *et al*., pp. 1608, figs 5.24a–b.

Remarks—The species is characterized by a broad oval to elliptical basal disc with a rather irregular pattern of ridges on the plate closing the central area.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface common to few occurrences of this form are recorded from Albian to Maastrichtian.

Dimensions—L/W 9.23 µm/7.95 µm.

Known stratigraphic range—Tithonian–Cenomanian.

Rhagodiscus dekaenelii Bergen, 1994

(Pl. 9.12a–b)

1979 *Parhabdolithus swinnertonii* Wind & Čepek, pp. 231, pl. 11, figs 8–16.
1994 *Rhagodiscus dekaenelii* Bergen, pp. 54, pl. 1, fig. 7.
1998 *Rhagodiscus dekaenelii* Bown *et al*. *in* Bown, pp. 118, pl. 5.9, figs 10–11.
2005 *Rhagodiscus dekaenelii* Bown *in* Bralower *et al*., pp. 28, pl. P5, figs 22–23.

Remarks—This species is brightly birefringent with solid distal stem. The stem tapers distally and its horizontal periphery extends outside the central area margin.

Occurrence—Few reworked occurrences of this species are observed in one subsurface sample at 1512 m depth belonging to Turonian age.

Dimensions—L/W 7.69 µm/5.47 µm.

Known stratigraphic range—Early Valanginian–Early Hauterivian.

Rhagodiscus gallagheri Rutledge & Bown, 1996

(Pl. 9.13a–b)

1987 *Rhagodiscus angustus* Thomsen, pp. 77, pl. 16, figs 6–8.
1996 *Rhagodiscus gallagheri* Rutledge & Bown, pp. 55, pl. 1, figs 1–3.
1998 *Rhagodiscus gallagheri* Burnett *in* Bown, pp. 172, pl. 6.4, figs 13c–d.
2013a *Rhagodiscus gallagheri* Rai *et al*., pp. 71, pl. 1, fig. 42.

Remarks—Small elliptical *Rhagodiscus* with straight or slightly convex longer sides. The central area is filled with a proximally situated granular plate and spanned by short transverse struts which support a relatively large, hollow spine base.

Occurrence—Few to rare patchy occurrences of this species are recorded from Albian to Maastrichtian in Tanot well–1. Reworking of this species is observed in Maastrichtian sediments.

Dimensions—L/W 4.17 µm/2.83 µm.

Known stratigraphic range—Aptian–Cenomanian.

Rhagodiscus indistinctus Burnett, 1998

(Pl. 9.14a–b)

1998 *Rhagodiscus indistinctus* Burnett, pp. 139, pl. 1, figs 16a–b.
1998 *Rhagodiscus indistinctus* Burnett *in* Bown, pp. 172, pl. 6.4, fig. 19.

Remarks—A small sized elliptical coccolith with a moderately broad rim and a narrow central area which contains a spine–base. It is unclear whether the central area contains a floor or not. The coccolith is of low birefringence and the spine–base is often difficult to discern which gives it an overall appearance of indistinction. The indistinct appearance of this form differentiates it from other species of *Rhagodiscus*.

Occurrence—Few to rare occurrences of this species are recorded from Campanian sediments in Tanot well–1.

Dimensions—L/W 5.84 µm/4.78 µm.

Known stratigraphic range—Campanian–Maastrichtian.

Rhagodiscus plebeius Perch–Nielsen, 1968

(Pl. 9.15a–b)

1968 *Rhagodiscus plebeius* Perch–Nielsen, pp. 44–45, pl. 7, figs 2–6.
1968 *Rhagodiscus bispiralis* Perch–Nielsen, pp. 45–46, pl. 7, fig. 7.
1969 *Parhabdolithus granulatus* Bukry, pp. 53, pl. 30, figs 4–7.
1971 *Rhagodiscus plebeius* Shafik & Stradner, pp.88, pl. 26, figs 2–4, pl. 27, figs 1–2, 4.
1976 *Parhabdolithus melanoarachion* Hill, pp. 148, pl. 10, figs 16–21.
1982 *Parhabdolithus plebeius* Crux, pp. 124, pl. 5.6, fig. 6.

1998 *Rhagodiscus plebeius* Burnett *in* Bown, pp. 172, pl. 6.4, figs 13a–b.

Remarks—This species of *Rhagodiscus* having rim composed of imbricated plates. Central area filled with a granulated conical structure, which is perforated in the centre.

Occurrence—Common to rare occurrences of this species are recorded from Cenomanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 6.81 µm/5.72 µm.

Known stratigraphic range—Cenomanian–Maastrichtian.

Rhagodiscus reniformis Perch–Nielsen, 1973

(Pl. 9.16a–b)

1973 *Rhagodiscus reniformis* Perch–Nielsen, pp. 323, pl. 3, figs 2, 4, 6, pl. 10, figs 45–46.
1976 *Nephrolithus frequens* Verbeek, pp. 145, pl. 3, fig. 6.
1982 *Parhabdolithus reniformis* Crux, pp. 124, pl. 5.6, fig. 4.
1998 *Rhagodiscus reniformis* Burnett *in* Bown, pp. 172, pl. 6.4, fig. 14.

Remarks—The specimens found in Tanot well–1 show a more coarsely granulate central structure, than figured by Perch–Nielsen, 1973. *R. reniformis* differs from the other species of the genus, because of the absence of ridges and a central structure, and from *N. frequens* by the absence of a thick proximal margin cycle.

Occurrence—Common to rare patchy occurrences of this species are recorded from Albian to Maastrichtian in Tanot well–1. It seems that the forms recorded in Albian–Turonian are leaked from younger levels.

Dimensions—L/W 6.82 µm/4.59 µm.

Known stratigraphic range—Turonian–Maastrichtian.

***Rhagodiscus* sp. 1**

(Pl. 9.17a–b)

Remarks—A large elliptical coccolith with a very broad rim and a small central area which contains a spine–base. The outer and inner distal shields are highly birefringent.

Occurrence—Rare occurrences of this species are observed in one subsurface sample at 1137 m depth belonging to Maastrichtian age.

Dimensions—L/W 6.65 µm/5.28 µm.

Known stratigraphic range—Maastrichtian.

***Rhagodiscus* sp. 2**

(Pl. 9.18a–b)

Remarks—A small almost circular species of *Rhagodiscus* having thin distal outer rim and a broad central area containing a hollow spine base.

Occurrence—Rare occurrences of this species are observed in one subsurface sample at 1146 m depth belonging to Maastrichtian age.

Dimensions—L/W 6.56 µm/5.98 µm.

Known stratigraphic range—Maastrichtian.

Rhagodiscus splendens (Deflandre, 1953) Verbeek, 1977

(Pl. 9.19a–b)

1953 *Rhabdolithus splendens* Deflandre, pp. 1785, figs 4–6.
1954 *Rhabdolithus splendens* Deflandre & Fert, pp. 158, pl. 13, figs 1–3, text figs 88–89.
1964 *Cretarhabdus splendens* Bramlette & Martini, pp. 300, pl. 3, figs 13–16.
1967 *Rhabdolithina splendens* Reinhardt, pp. 1678.
1968 *Actinozygus splendens* Gartner, pp. 25, pl. 5, figs 15–16, pl. 7, figs 1–2, pl. 11, fig. 15.
1969 *Parhabdolithus splendens* Noël, pp. 476, pl. 1, figs 1–4, 7, text figs 1–2.
1972 *Parhabdolithus splendens* Roth & Thierstein, pl. 7, figs 2–6.
1977 *Rhagodiscus splendens* (Deflandre, 1953) Verbeek, pp. 94, pl. 6, fig. 9.
1998 *Rhagodiscus splendens* Burnett *in* Bown, pp. 172, pl. 6.4, figs 12a, 15.
2013a *Rhagodiscus splendens* Rai *et al*., pp. 71, pl. 1, fig. 43.

Remarks—The plate enclosing the central area and its radial ridges enable the differentiation of this species from *R. asper*.

Occurrence—Common to rare patchy occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 10.66 µm/6.62 µm.

Known stratigraphic range—Aptian–Maastrichtian.

Family—STEPHANOLITHIACEAE Black, 1968

Genus—COROLLITHION Stradner, 1961

Type Species—*Corollithion exiguum* Stradner, 1961

Corollithion kennedyi Crux, 1981

(Pl. 9.20a–b)

1981 *Corollithion kennedyi* Crux, pp. 634, pl. 1, figs 4–5, pl. 2, figs 4–5.
1992 *Corollithion kennedyi* Kale & Phansalkar, pp. 91, pl. 1, fig. 17.

1998 *Corollithion kennedyi* Burnett *in* Bown, pp. 174, pl. 6.4, fig. 16a.
2007 *Corollithion kennedyi* Lees, pp. 45, pl. 1, figs 21–22.

Remarks—This species of *Corollithion* have hexagonal to elliptical rim, the central area contains a broad cross, each bar of which appears in distal view to be composed of 4 elements aligned parallel to the bar. The preservation of *C. kennedyi* from Tanot well–1 is exceptional.

Occurrence—Common to few occurrences of this species are recorded from Cenomanian to Turonian in Tanot well–1. Reworking of this species is observed in Turonian sediments.

Dimensions—L/W 5.02 µm/4.50 µm.

Known stratigraphic range—Cenomanian.

Corollithion signum Stradner, 1963

(Pl. 9.21a–b)

1963 *Corollithion signum* Stradner, pp. 11, pl. 1, fig. 13.
1968 *Zygolithus achylosus* Stradner *et al*., p. 39, pl. 35, figs 5–6.
1969 *Corollithion signum* Bukry, pp. 41, pl. 19, figs 5–8.
1971 *Corollithion signum* Manivit, pp. 110, pl. 5, fig. 6.
1971 *Corollithion signum* Thierstein, pp. 480, pl. 8, figs 18–22.
1992 *Corollithion signum* Kale & Phansalkar, pp. 91, pl. 1, fig. 18.
1998 *Corollithion signum* Burnett *in* Bown, pp. 174, pl. 6.4, figs 17a–b.
2007 *Corollithion signum* Lees, pp. 45, pl. 1, figs 23–24.
2015 *Corollithion signum* Linnert & Mutterlose, pp. 731, fig. 4S.

Remarks—This species is distinguishable from all other known species of this genus by a square to hexagonal outline and a central structure composed of four bars.

Occurrence—Common to few occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 4.99 µm/4.30 µm.

Known stratigraphic range—Albian–Campanian.

***Corollithion* sp. 1**

(Pl. 9.22a–b)

Remarks—This form shows typical *Corollithion* squarish outer rim. Distal rim is very broad in comparison of proximal rim and bright.

Occurrence—Rare occurrences of this species are recorded from Santonian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 5.00 µm/4.98 µm.

Known stratigraphic range—Santonian–Maastrichtian.

Genus—CYLINDRALITHUS Bramlette & Martini, 1964

Type Species—*Cylindralithus serratus* Bramlette & Martini, 1964

Cylindralithus biarcus Bukry, 1969

(Pl. 9.23a–b)

1969 *Cylindralithus biarcus* Bukry, pp. 42, pl. 20, figs 1–3.
1998 *Cylindralithus biarcus* Burnett *in* Bown, pp. 174, pl. 6.4, fig. 23.
2015 *Cylindralithus biarcus* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 8.

Remarks—Approximately circular form in both proximal and distal views. The cylindrical wall flares out towards the distal and proximal openings. At the centre two large and two small perforations are formed by the two arcuate crossbars.

Occurrence—Few to rare occurrences of this species are recorded from Albian to Maastrichtian in Tanot well–1. It seems that the forms recorded in Albian are leaked from younger levels.

Dimensions—Diameter 4.90 µm.

Known stratigraphic range—Cenomanian–Maastrichtian.

Cylindralithus sculptus Bukry, 1969

(Pl. 9.24a–b)

1969 *Cylindralithus sculptus* Bukry, pp. 43, pl. 20, figs 9–10.
1998 *Cylindralithus sculptus* Burnett *in* Bown, pp. 174, pl. 6.4, figs 26–28.

Remarks—The coccolith of this species consists of a cylinder having nine or ten external vertical flared ridges at one end and is somewhat constricted near the other end, the flaring end of the cylinder is probably the distal end.

Occurrence—Few to rare occurrences of this species are recorded from Cenomanian to Maastrichtian sediments in Tanot well–1.

Dimensions—Diameter 4.73 µm.

Known stratigraphic range—Cenomanian–Maastrichtian.

Genus—ROTELAPILLUS Noël, 1972

Type Species—*Rotelapillus radianus* Noël, 1972

Rotelapillus crenulatus (Stover, 1966) Perch–Nielsen, 1984

(Pl. 10.1a–b)

1966 *Stephanolithion crenulatum* Stover, pp. 16, pl. 7, figs 25–27, pl. 9, figs 25–27.
1984 *Rotelapillus crenulatus* (Stover, 1966) Perch–Nielsen, pp. 43.
1985 *Rotelapillus crenulatus* Perch–Nielsen, pp. 402, pl. 74, pl. 75, figs 5–6.
1998 *Rotelapillus crenulatus* Burnett *in* Bown, pp. 174, pl. 6.4, figs 21a–b.
2015 *Rotelapillus crenulatus* Linnert & Mutterlose, pp. 731, fig. 4T.

Remarks—This species is characterized by having circular rim with high walls, lateral rim spines and the central area is spanned by eight thorns like elements distributed along the circular periphery.

Occurrence—Few to rare occurrences of this species are recorded from Campanian to Maastrichtian sediments in Tanot well–1.

Dimensions—Diameter 4.57 µm.

Known stratigraphic range—Tithonian–Maastrichtian.

Genus—STOVERIUS Perch–Nielsen, 1986

Type Species—*Stoverius achylosus* Perch–Nielsen, 1986

Stoverius achylosus (Stover, 1966) Perch–Nielsen, 1986

(Pl. 10.2a–b)

1966 *Chiphragmalithus achylosus* Stover, pp. 137, pl. 6, fig. 26, pl. 7, figs 1–3, pl. 9, fig. 20.
1986 *Stoverius achylosus* (Stover, 1966) Perch–Nielsen, pp. 431, pl. 12, figs 12–15.
1998 *Stoverius achylosus* Burnett *in* Bown, pp. 174, pl. 6.4, fig. 22.
2015 *Stoverius achylosus* Linnert & Mutterlose, pp. 731, fig. 4U.

Remarks—Coccoliths having circular to broadly elliptical outline in proximal or distal view. The rim is composed of two concentric rings. The outer ring commonly indistinct, smooth or finely striate and the inner ring is distinct. The central cavity is spanned by intercepting septa.

Occurrence—Abundant to few occurrences of this species are recorded from Santonian to Campanian sediments in Tanot well–1.

Dimensions—L/W 6.05 µm/5.83 µm.

Known stratigraphic range—Aptian?–Turonian.

Family—THORACOSPHAERACEAE Schiller, 1930

Genus—THORACOSPHAERA Kamptner, 1927

Type Species—*Thoracosphaera pelagica* Kamptner, 1927

Thoracosphaera operculata Bramlette & Martini, 1964

(Pl. 10.3a–b)

1964 *Thoracosphaera operculata* Bramlette & Martini, pp. 305, pl. 5, figs 3–7.
1982 *Thoracosphaera operculata* Siesser, pp. 344, pl. 10, fig. l.
1985 *Thoracosphaera operculata* Perch–Nielsen, pp. 525, pl. 75, figs 6–7.
2013a *Thoracosphaera operculata* Rai *et al*., pp. 71, pl. 1, fig. 55.
2013b *Thoracosphaera operculata* Rai *et al*., pp. 1608, figs 5.28a–b.

Remarks—Complete specimens were found to be rare, generally only fragments were observed. The species differs from other *Thoracosphaera* sp. by having an irregular extinction pattern caused by the smaller units. In Tanot well–1 this species is recorded from Campanian and Maastrichtian sediments.

Occurrence—This species is very common and recorded from both surface and subsurface samples of Jaisalmer basin. In subsurface common to rare occurrences of this form are recorded from Campanian to Maastrichtian.

Dimensions—Diameter 23.46 µm.

Known stratigraphic range—Campanian–Danian.

***Thoracosphaera* sp. 1**

(Pl. 10.4a–b)

Remarks—Large to medium–sized conical test having finger–like projections on the surface.

Occurrence—Common to few occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 27.15 µm/15.03 µm.

Known stratigraphic range—Albian–Maastrichtian.

***Thoracosphaera* sp. 2**

(Pl. 10.5a–b)

Remarks—Almost spherical test. The outer surface is composed of numerous crystallites, each forming three sided pointed pyramid.

Occurrence—Abundant to rare occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 20.47 µm/18.23 µm.

Known stratigraphic range—Albian–Maastrichtian.

Family—TUBODISCACEAE Bown & Rutledge *in* Bown & Young, 1997

Genus—MANIVITELLA Thierstein, 1971

Type Species—*Cricolithus pemmatoideus* Deflandre ex Manivit, 1965

Manivitella pemmatoidea (Deflandre ex Manivit, 1965) Thierstein, 1971

(Pl. 10.6a–c)

1965 *Cricolithus pemmatoideus* Deflandre ex Manivit, pp. 197, pl. 2, fig. 8.
1966 *Cyclococcolithus granosus* Stover, pp. 140, pl. 1, figs 1–3, pl. 8, fig. 8.
1969 *Apertapetra gronosa* Bukry, pp. 26, pl. 6, figs 6–9.
1971 *Manivitella pemmatoidea* (Deflandre ex Manivit, 1965) Thierstein, pp. 480, pl. 5, figs 1–3.
1973 *Manivitella pecten* Black, pp. 79, pl. 23, figs 6–8.
1973 *Manivitella granosa* Black, pp. 79, pl. 23, figs 4–5.
1975 *Tubodiscus verenae* Grün *in* Grün & Allemann, pp. 197, pl. 10, figs 1–2, 4–5, 9–10.
1976 *Manivitella pemmatoidea* Hill, pl. 14, figs 18–19.
1982 *Manivitella pemmatoidea* Crux, pl. 5.1, fig. 4.
1982 *Manivitella pemmatoidea* Taylor, pl. 4.5, figs, 17–18, pl. 4.8, fig. 12.
1998 *Manivitella pemmatoidea* Burnett *in* Bown, pp. 180, pl. 6.7, fig. 16.
2013b *Manivitella pemmatoidea* Rai *et al*., pp. 1608, figs 5.13a–b.

Remarks—The proximal shield consists of two separate cycles of elements. The narrow inner cycle has a smooth border and is often overgrown and gives a bright white appearance in cross–polarized light. There is no indication of a central structure.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface few to rare occurrences of this form are recorded from Albian to Maastrichtian.

Dimensions—L/W 10.07 µm/7.18 µm.

Known stratigraphic range—Tithonian–Maastrichtian.

Family—WATZNAUERIACEAE Rood *et al*., 1971

Genus—CYCLAGELOSPHAERA Noël, 1965

Type Species—*Cyclagelosphaera margerelii* Noël, 1965

Cyclagelosphaera margerelii Noël, 1965

(Pl. 10.7a–b)

1965 *Cyclagelosphaera margerelii* Noël, pp. 130, pl. 17, figs 4–9, pl. 18, figs 1–2, pl. 20, figs 2–4, text figs 44–46.
1968 *Cyclagelosphaera margerelii* Black, pl. 144, fig. 5.
1969 *Cyclagelosphaera margerelii* Bukry, pp. 29, pl. 9, figs 5–6.
1971 *Cyclagelosphaera margerelii* Rood *et al*., pp. 270, pl. 5, figs 8–9.
1972 *Cyclagelosphaera margerelii* Roth & Thierstein, pl.16, figs 19–22.
1973 *Cyclagelosphaera virgatus* Black, pp. 75, pl. 25, figs 11–13.
1973 *Cyclagelosphaera casaburensis* Black, pp. 76, pl. 25, figs 1–3.
1998 *Cyclagelosphaera margerelii* Burnett *in* Bown, pp. 180, pl. 6.7, fig. 19.
2013b *Cyclagelosphaera margerelii* Rai *et al*., pp. 1608, figs 5.15a–b.

Remarks—Essentially circular form having three cycles of elements visible in distal view. The outer cycle elements imbricate dextrally and incline counterclockwise. The central area is completely closed or has a central perforation made by small irregular cycles of elements.

Occurrence—In the present study this species is recorded from both surface and subsurface sediments. In subsurface common to few continuous occurrences of this form are recorded from Albian to Maastrichtian.

Dimensions—Diameter 2.63 µm.

Known stratigraphic range—Bajocian–Palaeocene.

Cyclagelosphaera reinhardtii (Perch–Nielsen, 1968) Romein, 1977

(Pl. 10.8a–b)

1966 *Tergestiella barnesae* Reinhardt, pp. 15, pl. 1, figs 2a–b, pl. 12, fig. 2, pl. 23, fig. 6, text figs 2a–c.
1968 *Markalius reinhardtii* Perch–Nielsen, pp. 76, pl. 23, figs 6–8, text fig. 38.
1969 *Markalius reinhardtii* Perch–Nielsen, pp. 63, pl. 3, figs 2–4, pl. 7, figs 13–14
1969 *Podorhabdus reinhardtii* Bukry, pp. 38, pl. 16, fig. 7.
1977 *Octocyclus reinhardtii* Wise & Wind, pp. 302, pl. 57, fig. 6, pl. 58, figs 1–2.
1977 *Cyclagelosphaera reinhardtii* (Perch–Nielsen, 1968) Romein, pp. 274.
1998 *Cyclagelosphaera reinhardtii* Burnett *in* Bown, pp. 180, pl. 6.7, fig. 18.
2013b *Cyclagelosphaera reinhardtii* Rai *et al*., pp. 1608, figs 5.16a–b.
2013 *Cyclagelosphaera reinhardtii* Zahran, pp. 991, pl. 1, fig. 4, pp. 992, pl. 2, fig. 1.

Remarks—Between crossed nicols, the central area shows strong dextrogyre extinction lines in distal view. On the shields these lines widen into radial dark zones.

Occurrence—Few to rare occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—Diameter 5.25 µm.

Known stratigraphic range—Albian–Palaeocene.

Cyclagelosphaera rotaclypeata Bukry, 1969

(Pl. 10.9a–b)

1968 *Markalius circumradiatus* Perch–Nielsen, pp. 23, pl. 25, figs 2–7, pl. 26, figs 1–7, text figs 36–37.
1969 *Cyclagelosphaera specioclypeata* Bukry, pp. 30, pl. 9, fig. 9.
1969 *Cyclagelosphaera rotaclypeata* Bukry, pp. 30, pl. 9, figs 7–8.
1970 *Markalius circumradiatus* Noël, pp. 93, pl. 26, figs 1–7.
1998 *Cyclagelosphaera reinhardtii* Burnett *in* Bown, pp. 180, pl. 6.7, fig. 20.
2013a *Cyclagelosphaera rotaclypeata* Rai *et al*., pp. 58, pl. 1, fig. 14.
2013b *Cyclagelosphaera rotaclypeata* Rai *et al*., pp. 1608, figs 5.17a–b.

Remarks—*C. rotacalypeata* is characterized by its rather large central area and the narrow second cycle of the distal shield. It differs from other species of the genus *Markalius* in having two cycles in the distal shield.

Occurrence—Few occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—Diameter 3.20 µm.

Known stratigraphic range—Albian–Palaeocene.

Genus—DIAZOMATOLITHUS Noël, 1965

Type Species—*Diazomatolithus lehmanii* Noël, 1965

Diazomatolithus* sp. cf. *D. lehmanii Noël, 1965

(Pl. 10.10a–b)

1965 *Diazomatolithus lehmani* Noël, pp. 96, text figs 25–27, pl. 6, figs 6–10.
2013b *Diazomatolithus* sp. cf. *D. lehmanii* Rai *et al*., p. 1608, figs 5.19a–b.

Remarks—This species of *Diazomatolithus* is morphologically very similar with *Diazomatolithus lehmanii* but in Tanot well–1 it is recorded from much younger sediments. Therefore they are assigned as *Diazomatolithus* sp. cf. *D. lehmanii*.

Occurrence—Few patchy occurrences of this species are recorded from Albian to Coniacian sediments in Tanot well–1.

Dimensions—Diameter 2.53 µm.

Known stratigraphic range—Valanginian.

Genus—WATZNAUERIA Reinhardt, 1964

Type Species—*Watznaueria angustoralis* Reinhardt, 1964 (= *Watznaueria barnesae* (Black *in* Black & Barnes, 1959) Perch–Nielsen, 1968)

Watznaueria barnesae (Black *in* Black & Barnes, 1959) Perch–Nielsen, 1968

(Pl. 10.11a–b)

1959 *Tremalithus barnesae* Black *in* Black & Barnes, pp. 325, pl. 9, figs 1–2.
1964 *Watznaueria angustoralis* Reinhardt, pp. 753, pl. 2, fig. 2, text fig. 4.
1964 *Coccolithus* sp. cf. *C. barnesae* Bramlette & Martini, pp. 298, pl. 1, figs 13–14.
1964 *Colvillea barnesae* Black, pp. 311.
1967 *Coccolithus* sp. cf. *C. barnesae* Moshkovitz, pp. 46.
1968 *Watznaueria barnesae* Perch–Nielsen, pp. 96, pl. 22, figs 1–7, pl. 23, figs 1, 4–5, 16, text fig. 32.
1971 *Watznaueria barnesae* Reinhardt, pp. 32, text figs 31–33.
1976 *Watznaueria barnesae* Burns, pp. 298, pl. 5, figs 3–8.
1976 *Watznaueria barnesae* Martini, pp. 398, pl. 1, figs 6–7.
1977 *Watznaueria barnesae* Wind & Wise *in* Wise & Wind, pp. 448, pl. 68, figs 3–4.
1978 *Watznaueria barnesae* Shafik, pp. 223, pl. 6, figs Aa–Ab.
1985 *Watznaueria barnesae* Perch–Nielsen, pp. 343, figs 10–11.
1987 *Watznaueria barnesae* Crux, pp. 182, pl. 8.1, figs 1–2.
1998 *Watznaueria barnesae* Burnett *in* Bown, pp. 180, pl. 6.7, fig. 28.
2003 *Watznaueria barnesae* Tantawy, pp. 329, pl. 1, figs 21–24.
2004 *Watznaueria barnesae* Chira *et al*., pp. 95, pl. 1, figs 1a–b, 10a–b, 11.
2012 *Watznaueria barnesiae* Farouk & Faris, pp. 58, fig. 8.9.
2013a *Watznaueria barnesae* Rai *et al*., pp. 71, pl. 1, fig. 48.
2013b *Watznaueria barnesae* Rai *et al*., pp. 1608, figs 5.20a–b, 21a–b.
2013 *Watznaueria barnesae* Zahran, pp. 991, pl. 1, figs 1–3, pp. 992, pl. 2, figs 2–3.
2015 *Watznaueria barnesae* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 23.
2015 *Watznaueria barnesiae* Linnert & Mutterlose, pp. 731, fig. 4D'.

Remarks—This is the most frequent and resistent nannofossil species of Cretaceous rocks. It is easily recognizable by its slit like central area without a central structure. The central area of *W. barnesae* is much narrower than the oval to elliptical central area of *W. prolongata* Bukry.

Occurrence—In the present study this is the most common form recorded from both surface and subsurface sediments ranging in age from Albian to Maastrichtian.

Dimensions—L/W 8.57 µm/6.50 µm.

Known stratigraphic range—Bajocian–Maastrichtian.

Watznaueria biporta Bukry, 1969

(Pl. 10.12a–b)

1969 *Watznaueria biporta* Bukry, pp. 32, pl. 10, figs 8–10.
1970 *Coccolithus bornholmensis* Forchheimer, pp. 12, text figs 5–7, 12.
1971 *Watznaueria cynthae* Worsley, pp. 1314, pl. 2, figs 23–25.
1973 *Margolatus bornholmensis* Black, pp. 81, pl. 24, figs 6, 11–12.
1973 *Watznaueria biporta* Thierstein, pp. 43, p. 6, fig. 6.
1998 *Watznaueria biporta* Burnett *in* Bown, pp. 180, pl. 6.7, figs 21–22, 26.
2015 *Watznaueria biporta* Bodaghi & Hadavi, pp. 4004, pl. 1, fig. 25.

Remarks—The two large perforations with several processes and diagonally arranged central area elements distinguish this form.

Occurrence—Few to common occurrences of this form are recorded from the Albian to Maastrichtian sediments of Tanot well–1.

Dimensions—L/W 6.18 µm/5.09 µm.

Known stratigraphic range—Albian?–Maastrichtian.

Watznaueria britannica (Stradner, 1963) Reinhardt, 1964

(Pl. 10.13a–b)

1963 *Coccolithus britannicus* Stradner, pp. 10, pl. 1, figs 7–7a.
1964 *Watznaueria britannica* (Stradner, 1963) Reinhardt, pp. 753–755, pl. 2, fig. 3.
1968 *Ellipsagelosphaera britannica* Perch–Nielsen, pp.71.
1976 *Watznaueria britannica* Wise & Wind, pl. 86, fig. 4, pl. 88, fig. 8.
1998 *Watznaueria britannica* Burnett *in* Bown, pp. 180, pl. 6.7, fig. 23.

Remarks—*Watznaueria britannica* (Stradner, 1963) differs from *W. biporata* by a larger central area transversed by a bar parallel to the shorter axis of the elliptical disc.

Occurrence—Few reworked forms are recorded from the Turonian–Maastrichtian age sediments of Tanot well–1.

Dimensions—L/W 7.58 µm/6.19 µm.

Known stratigraphic range—Bajocian–?Coniacian.

Watznaueria fossacincta (Black, 1971) Bown *in* Bown & Cooper, 1989

(Pl. 10.14a–b)

1971 *Ellipsagelosphaera fossacincta* Black, pp. 399, pl. 30, fig. 8.
1980 *Ellipsagelosphaera fossacincta* Grün & Zweili, pp. 253, pl. 2, figs 4–5.
1989 *Watznaueria fossacincta* (Black, 1971) Bown *in* Bown & Cooper, pp. 193, pl. 4, fig. 19.
1998 *Watznaueria fossacincta* Burnett *in* Bown, pp. 180, pl. 6.7, fig. 24.

Remarks—A species of *Watznaueria* with a conspicuous unbridged pore less than twice as long as broad and a narrow groove making off an elliptical central area on the proximal side.

Occurrence—Few to rare occurrences are recorded from the Albian–Cenomanian sediments of Tanot well–1. Few froms are also recorded from sample 1104 and 1146 of Maastrichtian age.

Dimensions—L/W 7.84 µm/7.10 µm.

Known stratigraphic range—Bajocian–Maastrichtian.

Watznaueria ovata Bukry, 1969

(Pl. 10.15a–b)

1969 *Watznaueria ovata* Bukry, pp. 33, pl. 11, figs 11–12.
1973 *Ellipsagelosphaera ovata* Black, pp.71, pl. 26, figs 10–12.
1998 *Watznaueria ovata* Burnett *in* Bown, pp. 180, pl. 6.7, fig. 25.
2013a *Watznaueria ovata* Rai *et al*., pp. 71, pl. 1, fig. 49.

Remarks—This form is structurally allied to the *Watznaueria barnesae* group of coccoliths, but is distinct because of its large, smooth central opening.

Occurrence—Few occurrences of this form are recorded from the whole succession of Tanot well–1 ranging Albian–early Maastrichtian in age.

Dimensions—L/W 4.93 µm/3.33 µm.

Known stratigraphic range—Albian?–Maastrichtian.

HETEROCOCCOLITH OF UNCERTAIN AFFINITIES–MUROLITHS

Genus—**ANGULOFENESTRELLITHUS** Bukry, 1969

Type Species—*Angulofenestrellithus snyderi* Bukry, 1969

Angulofenestrellithus snyderi Bukry, 1969

(Pl. 10.16a–b)

1969 *Angulofenestrellithus snyderi* Bukry, pp. 48, pl. 26, figs 1–3.
1998 *Angulofenestrellithus snyderi* Burnett *in* Bown, pp. 184, pl. 6.9, figs 18–19.

Remarks—This species is characterized by a narrow rim, a broad central area with large polygonally framed perforations arranged in one to three cycles, having a small hollow stem at centre.

Occurrence—Few leaked occurrences of this species are observed in one subsurface sample at 1374 m depth belonging to Coniacian age.

Dimensions—L/W 5.41 µm/3.88 µm.

Known stratigraphic range—Campanian–Maastrichtian.

Genus—TORTOLITHUS Crux *in* Crux *et al*., 1982

Type Species—*Tortolithus caistorensis* Crux *in* Crux *et al*., 1982

Tortolithus hallii (Bukry, 1969) Crux *in* Crux *et al*., 1982

(Pl. 10.17a–b)

1969 *Discolithina? hallii* Bukry, pp. 46, pl. 24, figs 2–4.
1982 *Tortolithus hallii* (Bukry, 1969) Crux *in* Crux *et al*., pp. 100.
1998 *Tortolithus hallii* Burnett *in* Bown, pp. 184, pl. 6.9, figs 23a–b.

Remarks—This is an elliptical coccolith. It is monolamellar with low relief. A narrow rim cycle contains 14 to 18 elements which have radial sutures; within the cycle another narrower cycle of 14 elongate, elevated elements is present which seperates the rim cycle from the central area. The central area is composed of 2 or 3 cycles of flat plates. The outer cycle imbricates sinistrally, while the innermost cycle imbricates dextrally. No clear boundary is seen between the 2 cycles. It is estimated that 20 to 30 plates make up the entire central area.

Occurrence—Rare occurrences of this species are recorded from Campanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 11.07 µm/6.62 µm.

Known stratigraphic range—Campanian.

Tortolithus pagei (Bukry, 1969) Crux *in* Crux *et al*., 1982

(Pl. 10.18a–b)

1969 *Discolithina? pagei* Bukry, pp. 46, pl. 24, figs 5–6.
1982 *Tortolithus pagei* (Bukry, 1969) Crux *in* Crux *et al*., pp. 100.
1998 *Tortolithus pagei* Burnett *in* Bown, pp. 184, pl. 6.9, figs 24–25.

Remarks—This is a small, simply constructed, monolamellar elliptical coccolith. The narrow, scalloped rim cycle is made of 14 elements inclined slightly clockwise in distal view. A cycle of 10 or 11 large flat plates composes the entire central area. In distal view, these plates imbricate sinistrally and incline clockwise. In proximal view, the sutures incline slightly counterclockwise.

Occurrence—Rare occurrences of this species are recorded from Turonian to Coniacian sediments in Tanot well–1.

Dimensions—L/W 4.68 µm/3.33 µm.

Known stratigraphic range—Campanian–Maastrichtian.

HETEROCOCCOLITH OF UNCERTAIN AFFINITIES–PLACOLITHS

Genus—HAQIUS Roth, 1978

Type Species—*Haqius circumradiatus* (Stover, 1966) Roth, 1978

Haqius circumradiatus (Stover, 1966) Roth, 1978

(Pl. 10.19a–c)

1966 *Coccolithus circumradiatus* Stover, pp. 138, pl. 5, figs 2–4, pl. 9, fig. 10.
1968 *Markalius circumradiatus* (Stover, 1966) Perch–Nielsen, pp. 73, pl. 25, figs 2–7, pl. 26, figs 1–7, text figs 36–37.
1971 *Markalius circumradiatus* Manivit, pp. 116, pl. 26, figs 1–5.
1971 *Markalius circumradiatus* Thiestein, pp. 479, pl. 4, figs 1–5.
1976 *Markalius circumradiatus* Hill, pp. 145, pl. 8, figs 26–27.
1978 *Haqius circumradiatus* (Stover, 1966) Roth, pp. 746, 748.
1998 *Haqius circumradiatus* Burnett *in* Bown, pp. 184, pl. 6.9, fig. 26.

Remarks—Hill (1976) gives an excellent description of this species in the light microscope. The elements of the distal shield are narrow, slightly imbricate dextrally and separated by straight suture lines. The central area may or may not contain small crystallites, depending on preservation.

Occurrence— Rare occurrences of this species are observed in one subsurface sample at 1173 m depth belonging to Maastrichtian age.

Dimensions—Diameter 9.02 µm.

Known stratigraphic range—Berriasian–Campanian.

Genus—MARKALIUS Bramlette & Martini, 1964

Type Species— *Cyclococcolithus leptoporus* Murray & Blackman var. *inversus* Deflandre *in* Deflandre & Fert, 1954

Markalius inversus (Deflandre *in* Deflandre & Fert, 1954) Bramlette & Martini, 1964

(Pl. 10.20a–c)

1954 *Cyclococcolithus leptoporus* Deflandre *in* Deflandre & Fert, pp. 150, pl. 9, figs 4–5.
1963 *Cyclococcolithus astroporus* Stradner *in* Gohrbandt, pp. 75, pl. 9, figs 5–7, text fig. 3, fig. 2.
1964 *Markalius inversus* (Deflandre *in* Deflandre & Fert, 1954) Bramlette & Martini, pp. 302, pl. 2, figs 4–9.
1985 *Markalius inversus* Perch–Nielsen, pp. 432, pl. 2, figs 39–40, pl. 23, fig. 49.
1998 *Markalius inversus* Burnett *in* Bown, pp. 98, pl. 6.15, fig. 2, pp. 184, pl. 6.9, fig. 27.
2001 *Markalius inversus* Ladner & Wise *in* Beslier *et al*., pp. 49, pl. 3, figs 12–13.
2003 *Markalius inversus* Tantawy, pp. 329, pl. 1, fig. 20.

Remarks—This species is characterized in distal view by a central depression with a small diameter and sharp edges. In cross–polarized light the central structure shows a stronger birefringence than the margin.

Occurrence—Few to rare occurrences of this species are recorded from Turonian to Maastrichtian in Tanot well–1. It seems that the forms recorded in Turonian are leaked from younger levels.

Dimensions—Diameter (Whole body)–9.65 µm, Diameter (Central area)–3.55 µm.

Known stratigraphic range—Campanian–Palaeocene.

Genus—PROLATIPATELLA Gartner, 1968

Type Species—*Prolatipatella multicarinata* Gartner, 1968

Prolatipatella multicarinata Gartner, 1968

(Pl. 10.21a–c)

1968 *Prolatipatella multicarinata* Gartner, pp. 41, pl. 7, figs 10–11.
1998 *Prolatipatella multicarinata* Burnett *in* Bown, pp. 184, pl. 6.9, figs 28–29.
2007 *Prolatipatella multicarinata* Lees, pp. 45, pl. 3, figs 13–16.

Remarks—The central plate of this elliptical disc is divided into two equal parts by a median suture. This suture is aligned with the major axis of the ellipse and can best be seen in the light microscope between crossed nicols. The narrow rim consists of at least three tiers, of which the proximal tier is smallest and the second and third tiers are progressively larger. The central plate appears to be on the level of the distal rim tier and is probably continuous with it.

Occurrence—Rare occurrences of this species are recorded from Campanian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 10.43 µm/6.60 µm.

Known stratigraphic range—Campanian–Maastrichtian.

Genus—REPAGULUM Forchheimer, 1972

Type Species—*Discolithus parvidentatus* Deflandre & Fert, 1954

Repagulum parvidentatum (Deflandre & Fert, 1954) Forchheimer, 1972

(Pl. 10.22a–c)

1954 *Discolithus parvidentatus* Deflandre & Fert, pp. 143, text figs 28–29.
1959 *Tremalithus burwellensis* Black & Barnes, pp. 324, pl. 8.
1966 *Coccolithus parvidentatus* Reinhardt, pp. 20, pl. 20, figs 1–2.
1969 *Watznaueria? parvidentata* Bukry, pp. 33, pl. 12, figs 5–8.
1972 *Repagulum parvidentatum* (Deflandre & Fert, 1954) Forchheimer, pp. 38, pl. 3, figs 6–8.
1998 *Repagulum parvidentatum* Burnett *in* Bown, pp. 184, pl. 6.9, figs 30a–b.
2007 *Repagulum parvidentatum* Lees, pp. 45, pl. 1, figs 21–22.
2013a *Repagulum parvidentatum* Rai *et al*., pp. 71, pl. 1, fig. 35.

Remarks—Very small coccolith. The grid formed by opposing calcite bars in the central area is situated at the level of the highest point in the distal shield. In proximal view the bars appear recessed and difficult to see in light microscope. The central terminations are always enlarged into knobs. The long narrow rim elements are disposed radially with little apparent imbrication.

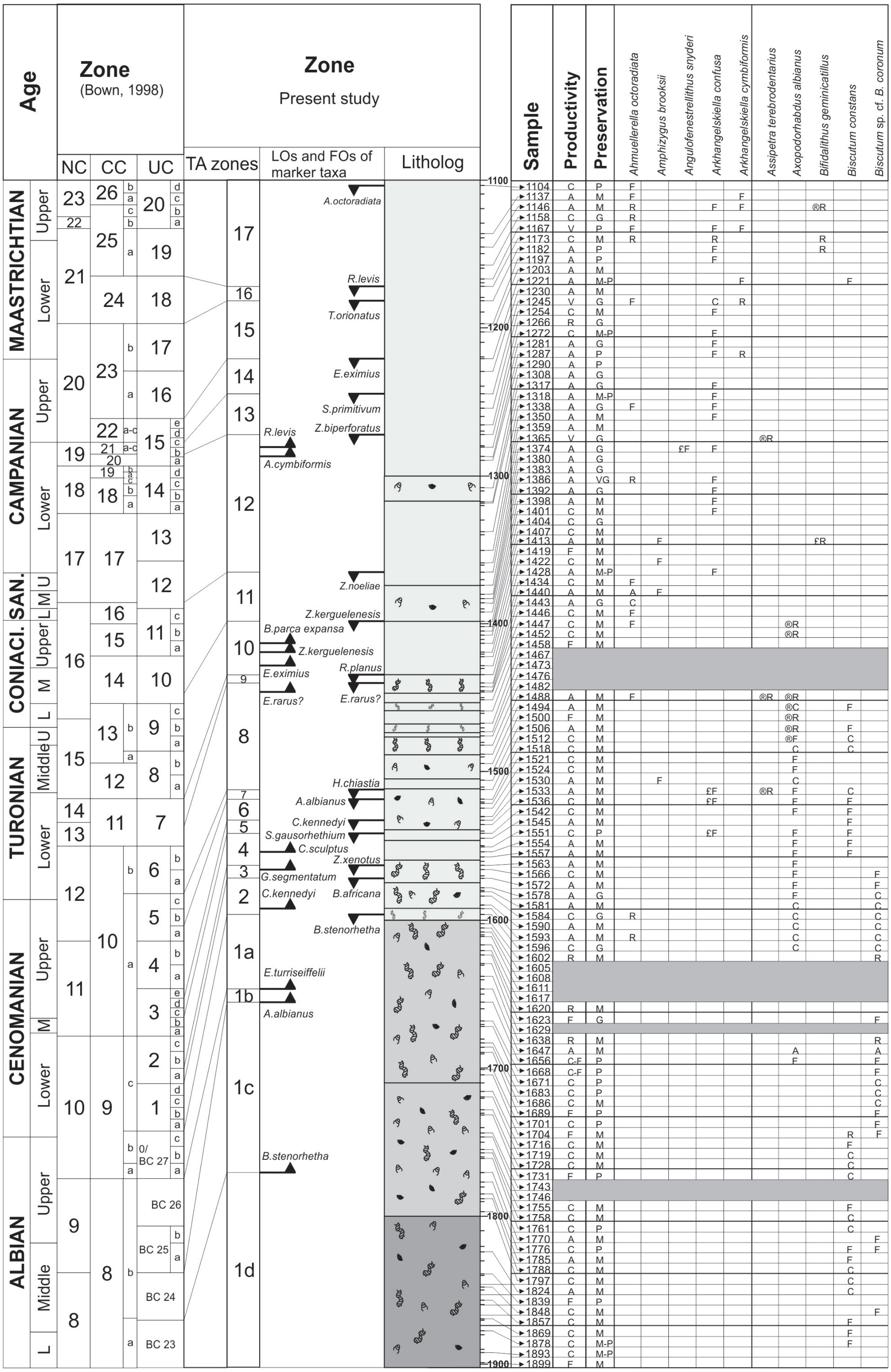
Occurrence—Abundant to few occurrences of this species are recorded from Albian to Maastrichtian sediments in Tanot well–1.

Dimensions—L/W 2.56 µm/2.00 µm.

Known stratigraphic range—Hauterivian–Maastrichtian.

BIOSTRATIGRAPHY

Over a period of last forty years a number of different Late Cretaceous calcareous nannofossil zonal schemes have been proposed by various workers. These schemes are mostly based on individual sections or only cover restricted time intervals (Verbeek, 1977; Crux, 1982; Mortimer, 1987; Watkins *et al*., 1996; Bralower & Bergen, 1998). Others have been modified and incorporated into newer zonal schemes (Čepek & Hay, 1969; Thierstein, 1976). The most widely applied scheme for outcrop sections, developed by Sissingh (1977) and modified by Perch–Nielsen (1985), was based on land sections mainly in Europe and northern Africa. The zonal scheme of Roth (1978), traditionally used in deep–sea sections, is based mainly on Deep Sea Drilling Project (DSDP) sites. This scheme was modified by Bralower *et al*. (1995),



Appendix - A. Nannofossil distribution from Tanot Bore Well-1. ® interpreted as reworked; £ interpreted as leaked; horizontal grey blocks indicate barren samples.

Fig. 3—Chart showing the distribution of recorded nannofossil taxa from Tanot well–1.

Biscutum dissimilis	*Biscutum ellipticum*	*Biscutum hattneri*	*Biscutum* sp. cf. *B. magnum*	*Biscutum melaniae*	*Braarudosphaera africana*	*Braarudosphaera bigelowii*	*Braarudosphaera stenorhetha*	*Broinsonia enormis*	*Broinsonia matalosa*	*Broinsonia parca constricta*	*Broinsonia parca expansa*	*Broinsonia signata*	*Bukrylithus ambiguus*	*Calculites obscurus*	*Calculites ovalis*	*Calculites percenis*	*Ceratolithoides pricei*	*Ceratolithoides self-trailiae*	*Ceratolithoides ultimus*	*Chiastozygus bifarius*	*Chiastozygus litterarius*	*Chiastozygus trabalis*	*Coccolithus pelagicus*	*Corollithion kennedyi*	*Corollithion signum*	*Corollithion* sp.1	*Crepidolithus crassus*	*Crepidolithus* sp.1	*Cretarhabdus conicus*
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Cretarhabdus striatus	Cribrocorona gallica	Cribrosphaerella ehrenbergii	Crucibiscutum hayi	Cruciellipsis cuvillieri	Cyclagelosphaera margerelii	Cyclagelosphaera reinhardtii	Cyclagelosphaera rotaclypeata	Cylindralithus biarcus	Cylindralithus sculptus	Diazomatolithus sp. cf. D. lehmanii	Discorhabdus ignotus	Eiffellithus eximius	Eiffellithus gorkae	Eiffellithus? hancockii	Eiffellithus monechiae	Eiffellithus pospichalii	Eiffellithus striatus	Eiffellithus turriseiffelii	Eiffellithus sp. cf. E. windii	Eprolithus floralis	Eprolithus moratus	Eprolithus rarus?	Farhania varolii	Gartnerago praeobliquum	Gartnerago segmentatum	Gorkaea operio	Grantarhabdus coronadventis	Haqius circumradiatus	Hayesites irregularis
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Helenea chiastia	*Helicolithus anceps*	*Helicolithus compactus*	*Helicolithus trabeculatus*	*Helicolithus turonicus*	Holococcolith sp.1	Holococcolith sp.2	*Isocrystallithus compactus*	*Isocrystallithus* sp. cf. *I. compactus*	*Lapideacassis asymmetrica*	*Lithraphidites carniolensis*	*Lithraphidites praequadratus*	*Loxolithus armilla*	*Lucianorhabdus arcuatus*	*Lucianorhabdus cayeuxii*	*Lucianorhabdus maleformis*	*Manivitella pemmatoidea*	*Markalius inversus*	*Micrantholithus obtusus*	*Micrantholithus* sp.1	*Micrantholithus stellatus*	*Microrhabdulus belgicus*	*Microrhabdulus* sp. cf. *M. helicoideus*	*Microrhabdulus* sp. cf. *M. undosus*	*Micula adumbrata*	*Micula murus*	*Micula praemurus*	*Micula premolisilvae*	*Micula staurophora*	*Micula swastica*
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			C							C					F							F	F						
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		F	F							C					C							F	F						
			F							C		F	F		C	F						F	F						
			F							C		C			C							F	F			F	£R		
			F							A	£F	C			C	F					F	F	F						
		F	F							A					F							F	F						
		F	C					R		A		F			F	F							F						
			F					F		A		F			C	F						F	F			F			
			F						£R	C		F			F	F						F							
			F							C		F			F	F						F	F						
			F							F		F			F						F	F	R						
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			F							F		F			F								F						
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Munarinus marszalekii	Nannoconus elongatus	Nannoconus inornatus	Nannoconus ligius	Nannoconus multicadus	Nannoconus pseudoseptentrionalis	Nannoconus quadriangulus	Nannoconus quadricanalis	Nannoconus sp.1	Nannoconus sp.2	Nannoconus sp.3	Nannoconus steinmannii	Nannoconus truitii frequens	Nannoconus truitii rectangularis	Nephrolithus corystus	Nephrolithus frequens	Octolithus multiplus	Okkolithus australis	Orastrum perspicuum	Orastrum sp. cf. O. perspicuum	Orastrum sp.1	Owenia hillii	Percivalia fenestrata	Percivalia sp. cf. P. hauxtonensis	Percivalia imperfossa	Petrobrasiella sp.1	Placozygus fibuliformis	Placozygus sp. cf. P. fibuliformis	Podorhabdus sp. cf. P. Elkefensis	Prediscosphaera columnata
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	®F	F		®F			F	R				®F	®F	F			F			F		®F					F	F	C
F	®F														F							®C	F		R	F	C	F	C
							R		R							F		F					R	®R		F	F		C
	®R															F					R	®C	R				F		C
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C		R											R			C						®F				C			C
C							R									C		C				®F				C		R	C
	R																	F			C						C		C
		R														C		C			A		R			F	C	R	A
	F			F	R											C		C			C		R			F			C
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	F	F														C		C			C		F						F
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Prediscosphaera cretacea	*Prediscosphaera grandis*	*Prediscosphaera microrhabdulina*	*Prediscosphaera ponticula*	*Prediscosphaera* sp.1	*Prediscosphaera* sp.2	*Prediscosphaera spinosa*	*Prediscosphaera stoveri*	*Prolatipatella multicarinata*	*Psyktosphaera firthii*	*Quadrum gartneri*	*Quadrum intermedium*	*Quadrum svabenickae*	*Radiolithus hollandicus*	*Radiolithus planus*	*Reinhardtites anthophorus*	*Reinhardtites levis*	*Repagulum parvidentatum*	*Retecapsa angustiforata*	*Retecapsa crenulata*	*Retecapsa ficula*	*Retecapsa schizobrachiata*	*Retecapsa surirella*	*Rhabdophidites parallelus*	*Rhagodiscus achlyostaurion*	*Rhagodiscus angustus*	*Rhagodiscus asper*	*Rhagodiscus dekaenelii*	*Rhagodiscus gallagheri*	*Rhagodiscus indistinctus*
C		C						R										F				C			F				
C		C		R			F								F				F			C			F				
F			F			R	F	R		F		F					F			F	F	F			F	F			
C		F	F		R	F	R										F		F			F	®F		F				
C		F	F							F	®F				F			F			F	C		F	F				
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Rhagodiscus plebeius	*Rhagodiscus reniformis*	*Rhagodiscus* sp.1	*Rhagodiscus* sp.2	*Rhagodiscus splendens*	*Rotelapillus crenulatus*	*Rucinolithus hayi*	*Russellia bukryi*	*Saepiovirgata biferula*	*Scapholithus fossilis*	*Semihololithus priscus*	*Seribiscutum primitivum*	*Sollasites horticus*	*Staurolithites? aenigma*	*Staurolithites crux*	*Staurolithites dorfii*	*Staurolithites ellipticus*	*Staurolithites flavus*	*Staurolithites gausorhethium*	*Staurolithites glaber*	*Staurolithites imbricatus*	*Staurolithites* sp. cf. *S. integer*	*Staurolithites laffittei*	*Staurolithites mielnicensis*	*Staurolithites minutus*	*Staurolithites mitcheneri*	*Staurolithites* sp. cf. *S. mutterlosei*	*Staurolithites* sp.1	*Staurolithites* sp.2	*Staurolithites* sp. cf. *S. zoensis*
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		R							R		®F										F					F	F		
	R		R		R		F		R	F	®F						F	®F	®R	R								R	
				R	R		F		R	F	®C																		
				F			F	F			®F																		F
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Stoverius achylosus	*Stradneria crenulata*	*Tegumentum lucidum*	*Tegumentum stradneri*	*Tetrapodorhabdus decorus*	*Thoracosphaera operculata*	*Thoracosphaera* sp.1	*Thoracosphaera* sp.2	*Tortolithus hallii*	*Tortolithus pagei*	*Tranolithus gabalus*	*Tranolithus minimus*	*Tranolithus orionatus*	*Uniplanarius clarkei*	*Uniplanarius gothicus*	*Watznaueria barnesae*	*Watznaueria biporta*	*Watznaueria britannica*	*Watznaueria fossacincta*	*Watznaueria ovata*	*Zeugrhabdotus bicrescenticus*	*Zeugrhabdotus biperforatus*	*Zeugrhabdotus diplogrammus*	*Zeugrhabdotus 'elegans'*	*Zeugrhabdotus embergeri*	*Zeugrhabdotus erectus*	*Zeugrhabdotus kerguelenesis*	*Zeugrhabdotus noeliae*	*Zeugrhabdotus scutula*	*Zeugrhabdotus* sp. cf. *Z. sigmoides*	*Zeugrhabdotus trivectis*	*Zeugrhabdotus xenotus*
	F				F	F	F			R	F	®C		F	A	C		F		A	®A				F			®F			®R
	C		F		F	F	F				F	®C		F	A	C			F	A	®A			R	F						®F
	F				F						F	®C		F	V	C		F	F	F	®C				R						
				R	R		R	R			F	®F	R		C	F	®F		F	F	®F	R			F			®R			
					R						F	®C			V	F			F	A	®A			R	F				F		®R
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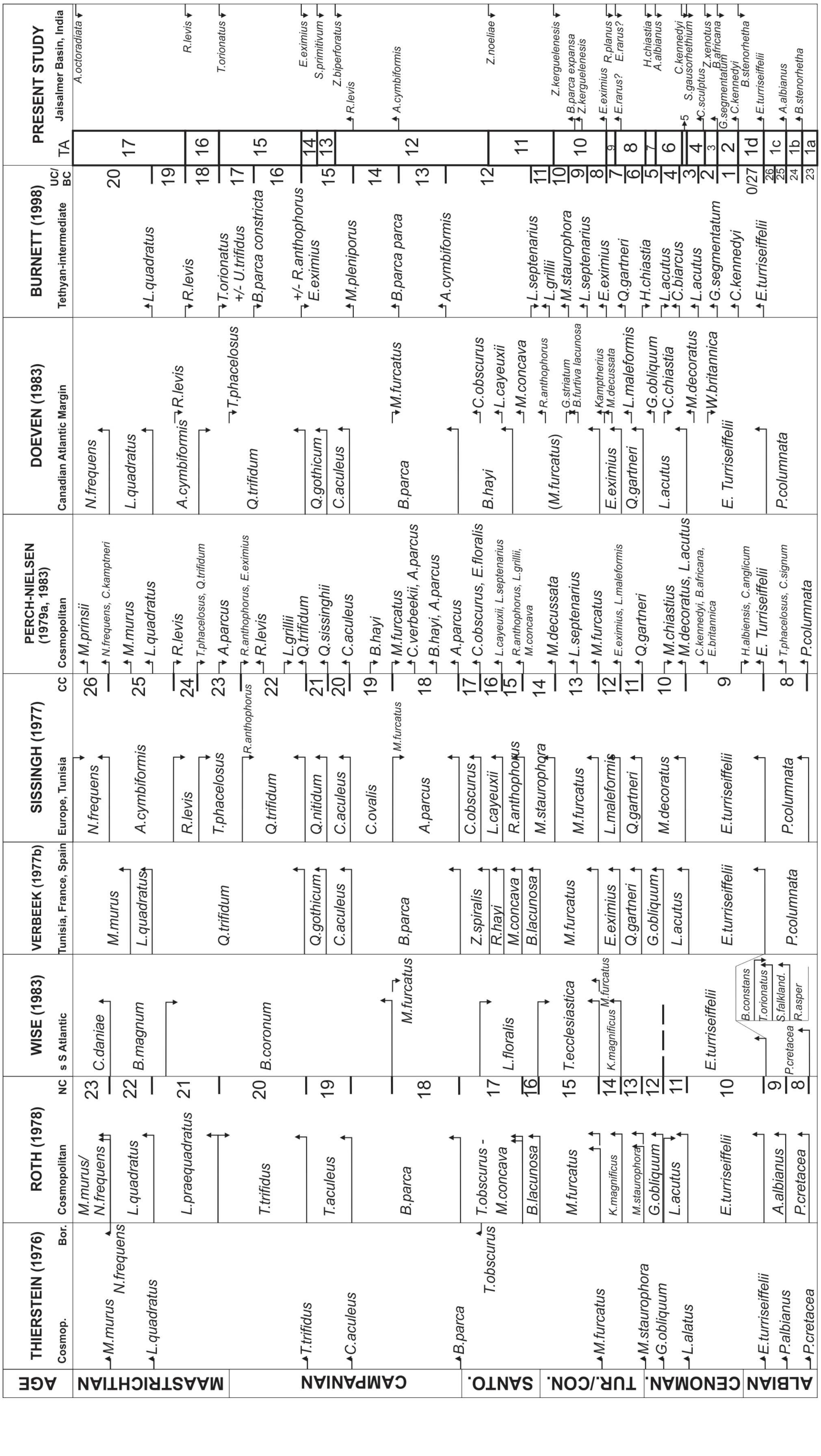

Fig. 4—Zonation chart showing comparison of various zonation schemes with present study.

who also developed an integrated nannofossil–foraminiferal zonal scheme. Slightly different zonal schemes were proposed by Wise (1983) for the South Atlantic and Doeven (1983) for the north Atlantic area. The most recent and detailed zonations have been published by Burnett (1998).

Application of standard calcareous nannofossil zonal schemes to the Tanot well–1 in the present study is limited as investigations are based on well–cutting samples only. In general, nannofossils are moderately preserved which did not hinder identification of important markers. Two hundred and Twenty two species are recorded throughout the studied interval. The nannofossil assemblages are exceptionally well preserved and highly diverse at some levels and low to moderately diverse at other levels in the Tanot well–1 is noted with rare to abundant occurrences of selected number of species (Fig. 3). Besides marker species of traditional zonal schemes, several other substitute marker taxa have been recorded which facilitate biostratigraphic subdivision of the studied interval and their comparison with global zonation schemes. In the present study, an informal alpha–numeric zonal scheme has been proposed for the Tanot well–1 which should prove useful for shallow shelf areas of low latitude (‘TA’ stands for Tanot). Marker species have been chosen that are morphologically distinctive and resistant to dissolution. 17 Zones are assigned on the presence of last occurrence (LO) of zonal markers (vide Burnett, 1998; Perch–Nielsen, 1985; Bergen & Sikora, 1999) and 5 subzones of basal most zone (TA1) are demarcated on the basis of first occurrence (FO) of subzonal markers (vide Burnett, 1998). The proposed biozones are summarized in the zonation chart and are correlated and calibrated with the ‘CC’ zones of Roth, 1978 ‘NC’ zones of Sissingh, 1977 and ‘UC’ zones of Burnett, 1998 (Fig. 4). These zones are described below in stratigraphically descending order:

TA 17 *Ahmuellerella octoradiata* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *R. levis* and the Top is marked by the LO of *A. octoradiata*.

Calibration—Equivalent to zone UC19–UC20 of Burnett, 1998 and approximately zone CC25 of Sissingh, 1977.

Range—Early Early Maastrichtian to late Early Maastrichtian (Tanot Bore Well–1 depth 1167–1104 m).

Remarks—Large sized forms mainly *Chiastozygus litterarius*, *Cribrosphaerella ehrenbergii*, *Heliocolithus trabeculatus* and *Prediscosphaera* sp. cf. *P. columnata* dominates with reworked forms of *Eiffellithus eximius Tranolithus orionatus* and *Zeugrhabdotus biperforatus*.

TA 16 *Reinhardtites levis* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *T. orionatus* and the Top is marked by the LO of *R. levis*.

Calibration—Equivalent to zone UC18 of Burnett, 1998 and zone CC24 of Sissingh, 1977.

Range—Late Early Maastrichtian (Tanot Bore Well–1 depth 1173 m).

Remarks—Dominance of large size forms continued in this zone. Common taxa are *Microrhabdulus* sp. cf. *M. helicoideus*, *Calculites obscurus*, *Cyclagelosphaera margerelii*, *Eiffellithus eximius*, *Lithraphidites carniolensis*, *Lucianorhabdus maleformis*, *Tranolithus orionatus* and *Watznaueria barnesae*.

TA 15 *Tranolithus orionatus* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *E. eximius* and the Top is marked by the LO of *T. orionatus*.

Calibration—Equivalent to zone UC16–UC17 of Burnett, 1998 and zone CC23 of Sissingh, 1977.

Range—Late Late Campanian to late Early Maastrichtian (Tanot Bore Well–1 depth 1203–1182 m).

Remarks—Acme of *Cribrosphaerella ehrenbergii* and dominance of other nannotaxa of small size are recorded in this zone. Common taxa include *Chiastozygus litterarius*, *Cribrosphaerella ehrenbergii*, *Eiffellithus eximius*, *Heliocolithus trabeculatus Prediscosphaera* sp. cf. *P. columnata*, *Tranolithus orionatus*, *Watznaueria barnesae* and *Zeugrhabdotus biperforatus*.

TA 14 *Eiffellithus eximius* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *S. primitivum* and the Top is marked by the LO of *E. eximius*.

Calibration—Approximates with upper part of zone UC15c–UC15e of Burnett, 1998 and zone CC22 of Sissingh, 1977.

Range—Approximately early Late Campanian to approximately early to late Late Campanian (Tanot Bore Well–1 depth 1230–1221 m).

Remarks—Acme of *Lucinorhabdus maleformis* and dominance of small size forms recorded in this zone. Other common taxa are *Calculites obscurus*, *Chiastozygus litterarius*, *Cribrosphaerella ehrenbergii*, *Cyclagelosphaera margerelii*, *Eiffellithus eximius*, *Eprolithus floralis*, *Heliocolithus trabeculatus*, *Lithraphidites carniolensis*, *Lucinorhabdus maleformis*, *Octolithus multiplus*, *Orastrum* sp.1, *Owenia hilli*, *Tranolithus orionatus* and *Watznaueria barnesae*.

TA 13 *Seribiscutum primitivum* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *Z. biperforatus* and the Top is marked by the LO of *S. primitivum*.

Calibration—Approximates with zone UC15b–lower part of zone UC15c of Burnett, 1998 and zone CC21 of Sissingh, 1977.

Range—Approximately early Late Campanian (Tanot Bore Well–1 depth 1266–1245 m).

Remarks—Dominance of small size forms recorded in this zone. The common taxa include *Arkhangelskiella confusa*, *Chiastozygus litterarius*, *Heliocolithus trabeculatus*, *Lithraphidites carniolensis*, *Lucinorhabdus maleformis*, *Orastrum* sp.1, *Owenia hilli*, *Placozygus fibuliformis*, *Repagulum parvidentatum*, *Retecapsa surirella*, *Rhagodiscus angustus*, *Russellia bukryi*, *Seribiscutum primitivum*, *Tranolithus minimus*, *Watznaueria barnesae*, *Zeugrhabdotus bicrescenticus* and *Zeugrhabdotus erectus*.

TA 12 *Zeugrhabdotus biperforatus* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *Z. noeliae* and the Top is marked by the LO of *Z. biperforatus*.

Calibration—Equivalent to zone CC17 to CC20 of Sissingh, 1977.

Range—Approximately early Middle Santonian to approximately late early Campanian (Tanot Bore Well–1 depth 1359–1272 m).

Remarks—This zone contains the FOs of *R. levis* (Depth 1281 m) and *A. cymbiformis* (Depth 1287 m). Acme of *Helicolithus trabeculatus* recorded at the upper part of this zone. Common taxa are *Arkhangelskiella confusa*, *Broinsonia parca expansa*, *Calculites obscurus*, *Calculites percenis*, *Chiastozygus litterarius*, *Cribrosphaerella ehrenbergii*, *Cyclagelosphaera margerelii*, *Eiffellithus eximius*, *Eiffellithus gorkae*, *Eiffellithus turriseiffelii*, *Heliocolithus trabeculatus*, *Lithraphidites carniolensis*, *Lucinorhabdus maleformis*, *Microrhabdulus* sp. cf. *M. helicoideus*, *Octolithus multiplus*, *Orastrum* sp.1, *Owenia hilli*, *Placozygus* sp. cf. *P. fibuliformis*, *Prediscosphaera* sp. cf. *P. columnata*, *Prediscosphaera cretacea*, *Repagulum parvidentatum*, *Retecapsa surirella*, *Rhagodiscus achylostaurion*, *Rhagodiscus angustus*, *Rhagodiscus asper*, *Seribiscutum primitivum*, *Tranolithus minimus*, *Tranolithus orionatus*, *Uniplanarius gothicus*, *Watznaueria barnesae*, *Zeugrhabdotus bicrescenticus*, *Zeugrhabdotus biperforatus* and *Zeugrhabdotus erectus*.

TA 11 *Zeugrhabdotus noeliae* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *Z. kerguelenensis* and the Top is marked by the LO of *Z. noeliae*.

Calibration—Equivalent to approximately lower part of zone CC14 to approximately CC17 of Sissingh, 1977.

Range—Approximately Middle Coniacian to approximately early Middle Santonian (Tanot Bore Well–1 depth 1392–1365 m).

Remarks—Acme of *Lithraphidites carniolensis* recorded. Other common taxa are *Biscutum ellipticum*, *Broinsonia signata*, *Calculites obscurus*, *Calculites percenis*, *Corollithion signum*, *Cyclagelosphaera margerelii*, *Cylindralithus biarcus*, *Discorhabdus ignotus*, *Eiffellithus gorkae*, *Eiffellithus turriseiffelii*, *Eiffellithus windii*, *Eprolithus moratus*, *Heliocolithus trabeculatus*, *Lithraphidites carniolensis*, *Loxolithus armilla*, *Lucinorhabdus maleformis*, *Orastrum* sp.1, *Owenia hilli*, *Placozygus fibuliformis*, *Placozygus* sp. cf. *P. fibuliformis*, *Prediscosphaera* sp. cf. *P. columnata*, *Prediscosphaera cretacea*, *Repagulum parvidentatum*, *Retecapsa surirella*, *Rhagodiscus achylostaurion*, *Rhagodiscus angustus*, *Rhagodiscus asper*, *Rhagodiscus splendens*, *Seribiscutum primitivum*, *Staurolithites* sp. cf. *S. zoensis*, *Stoverius achylosus*, *Tranolithus minimus*, *Tranolithus orionatus*, *Watznaueria barnesae*, *Zeugrhabdotus bicrescenticus*, *Zeugrhabdotus biperforatus*, *Zeugrhabdotus erectus* and *Zeugrhabdotus scutula*.

TA 10 *Zeugrhabdotus kerguelenensis* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *R. planus* and the Top is marked by the LO of *Z. kerguelenensis*.

Calibration—Equivalent to UC8 of Burnett, 1998 and CC12 of Sissingh, 1977 to approximately lower part of zone CC14 of Sissingh, 1977.

Range—Late Turonian to approximately Middle Coniacian (Tanot Bore Well–1 depth 1428–1398 m).

Remarks—This interval additionally contains FOs of *B. parca expansa* (Depth 1413 m), *Z. kerguelenensis* (Depth 1419 m) and *E. eximius* (Depth 1428 m). Common taxa include *Corollithion signum*, *Cyclagelosphaera margerelii*, *Eiffellithus windii*, *Eprolithus moratus*, *Heliocolithus trabeculatus*, *Lucinorhabdus maleformis*, *Orastrum* sp.1, *Owenia hilli*, *Placozygus fibuliformis*, *Placozygus* sp. cf. *P. fibuliformis*, *Rhagodiscus achylostaurion*, *Rhagodiscus angustus*, *Staurolithites* sp. cf. *S. zoensis*, *Tranolithus minimus*, *Tranolithus orionatus*, *Watznaueria barnesae*, *Zeugrhabdotus bicrescenticus*, *Zeugrhabdotus biperforatus*, *Zeugrhabdotus erectus* and *Zeugrhabdotus scutula*.

TA 9 *Radiolithus planus* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *E. rarus* and the Top is marked by the LO of *R. planus*.

Calibration—Approximately equivalent to upper part of UC7 of Burnett, 1998.

Range—Middle–Late Turonian (Tanot Bore Well–1 depth 1476–1473 m).

Remarks—Common nannofossils in this zone are *Calculites obscurus*, *Lithraphidites carniolensis*, *Munarinus marszalekii*, *Owenia hilli*, *Placozygus* sp. cf. *P. fibuliformis*, *Retecapsa surirella*, *Rhagodiscus achylostaurion*, *Rhagodiscus angustus*, *Tranolithus orionatus*, *Watznaueria barnesae* and *Zeugrhabdotus 'elegans'*.

TA 8 *Eprolithus rarus* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *H. chiastia* and the Top is marked by the LO of *E. rarus*.

Calibration—Equivalent to UC6 to aproximately middle part UC7 of Burnett, 1998.

Range—Late Late Cenomanian to Middle–Late Turonian (Tanot Bore Well–1 depth 1506–1440 m).

Remarks—Acme of *A. octoradiata*, *Corollithion signum* and *Eiffellithus windii* are recorded in this zone. Other common taxa recorded in this zone are *Biscutum ellipticum*, *Calculites obscurus*, *Calculites percenis*, *Eiffellithus turriseiffelii*, *Owenia hilli*, *Placozygus* sp. cf. *P. fibuliformis*, *Prediscosphaera* sp. cf. *P. columnata*, *Prediscosphaera cretacea*, *Rhagodiscus achylostaurion*, *Rhagodiscus angustus*, *Rhagodiscus asper*, *Tranolithus orionatus*, *Watznaueria barnesae*, *Zeugrhabdotus erectus* and *Zeugrhabdotus scutula*.

TA 7 *Helenea chiastia* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *A. albianus* and the Top is marked by the LO of *H. chiastia*.

Calibration—Equivalent to UC5b–c of Burnett, 1998.

Range—Late Late Cenomanian (Tanot Bore Well–1 depth 1512 m).

Remarks—Common taxa include *Biscutum ellipticum*, *Calculites percenis*, *Owenia hilli*, *Rhagodiscus achylostaurion*, *Rhagodiscus asper*, *Tranolithus orionatus*, *Watznaueria barnesae*, *Zeugrhabdotus 'elegans'*, *Zeugrhabdotus erectus* and *Zeugrhabdotus scutula*.

TA 6 *Axopodorhabdus albianus* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *C. kennedyi* and the Top is marked by the LO of *A. albianus*.

Calibration—Equivalent to UC3e–UC5a of Burnett, 1998.

Range—Late Cenomanian (Tanot Bore Well–1 depth 1530–1518 m).

Remarks—Acme of *Biscutum ellipticum* recorded in the lower part of this zone. Common taxa include *Axopodorhabdus albianus*, *Broinsonia enormis*, *Calculites percenis*, *Owenia hilli*, *Rhagodiscus achylostaurion*, *Thoracosphaera* sp. 2, *Tranolithus orionatus*, *Watznaueria barnesae*, *Zeugrhabdotus 'elegans'*, and *Zeugrhabdotus scutula*.

TA 5 *Corollithion kennedyi* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *S. gausorhethium* and the Top is marked by the LO of *C. kennedyi*.

Calibration—Equivalent to UC3c–d of Burnett, 1998.

Range—Late Cenomanian (Tanot Bore Well–1 depth 1536–1533 m).

Remarks—Dominance of small sized forms is recorded in this zone. Common taxa are *Biscutum constans*, *Biscutum ellipticum*, *Broinsonia enormis*, *Calculites percenis*, *Corollithion kennedyi*, *Cyclagelosphaera margerelii*, *Eiffellithus turriseiffelii*, *Helicolithus compactus*, *Owenia hilli*, *Placozygus* sp. cf. *P. fibuliformis*, *Radiolithus planus*, *Retecapsa surirella*, *Rhagodiscus achylostaurion*, *Tranolithus gabalus*, *Tranolithus orionatus*, *Watznaueria barnesae*, *Zeugrhabdotus 'elegans'*, *Zeugrhabdotus erectus* and *Zeugrhabdotus scutula*.

TA 4 *Staurolithites gausorhethium* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *Z. xenotus* and the Top is marked by the LO of *S. gausorhethium*.

Calibration—Equivalent to UC2b–UC3b of Burnett, 1998.

Range—Early–Middle Cenomanian (Tanot Bore Well–1 depth 1557–1542 m).

Remarks—This zone contains the FO of *C. sculptus* (Depth 1554 m). Acme of *C. kennedyi* and dominance of larger size forms is recorded in this zone. Common taxa are *Biscutum ellipticum*, *Broinsonia enormis*, *Corollithion kennedyi*, *Discorhabdus ignotus*, *Eiffellithus turriseiffelii*, *Helicolithus compactus*, *Owenia hilli*, *Placozygus* sp. cf. *P. fibuliformis*, *Rhagodiscus achylostaurion*, *Staurolithites gausorhethium*, *Staurolithites laffittei*, *Tranolithus gabalus*, *Tranolithus orionatus*, *Watznaueria barnesae*, *Zeugrhabdotus 'elegans'*, *Zeugrhabdotus erectus* and *Zeugrhabdotus scutula*.

TA 3 *Zeugrhabdotus xenotus* Nannofossil Zone

Authors—Rai & Singh; proposed herein.

Definition—Base marked by the LO of *B. africana* and the Top is marked by the LO of *Z. xenotus*.

Calibration—Equivalent to UC2a of Burnett, 1998.

Range—Early–Middle Cenomanian (Tanot Bore Well–1 depth 1566–1563 m).

Remarks—This zone contains FO of *G. segmentatum* (Depth 1566 m). Common taxa are *Corollithion kennedyi*, *Eiffellithus turriseiffelii*, *Loxolithus armilla*, *Rhagodiscus* *achylostaurion*, *Rhagodiscus angustus*, *Staurolithites crux*, *Staurolithites laffittei*, *Thoracospharea* sp. 2, *Tranolithus gabalus*, *Tranolithus orionatus*, *Watznaueria barnesae*, *Zeugrhabdotus 'elegans'* and *Zeugrhabdotus scutula*.

TA 2 *Braarudosphaera africana* Nannofossil Zone

Authors—Rai & Singh; proposed herein.
Definition—Base marked by the LO of *B. stenorhetha* and the Top is marked by the LO of *B. africana*.
Calibration—Equivalent to UC1 of Burnett, 1998.
Range—Early Cenomanian (Tanot Bore Well–1 depth 1593–1572 m).
Remarks—This zone contains FO of *C. kennedyi* (Depth 1593 m). The sudden decrease in the size of *W. barnesae* is also recorded in this zone. Common taxa are *Axopodorhabdus albianus*, *Biscutum* sp. cf. *B. coronum*, *Eiffellithus turriseiffelii*, *Helicolithus trabeculatus*, *Owenia hilli*, *Rhagodiscus achylostaurion*, *Rhagodiscus angustus*, *Rhagodiscus asper*, *Staurolithites gausorhethium*, *Tranolithus gabalus*, *Tranolithus orionatus*, *Watznaueria barnesae*, *Zeugrhabdotus 'elegans'*, *Zeugrhabdotus erectus* and *Zeugrhabdotus scutula*.

TA 1 Nannofossil Zone

Authors—Rai & Singh; proposed herein.
Definition—Base marked by the occurrence of nannofossils at the base of section and the Top is marked by the LO of *B. stenorhetha*.
Calibration—Equivalent to BC23 to BC27 of Burnett, 1998.
Range—Albian to Early Cenomanian (Tanot Bore Well–1 depth 1596–1899 m).
Remarks—This zone is further subdivided into 4 subzones on the basis of First Occurrence (FO) of marker taxa.

TA 1d Nannofossil Subzone

Authors—Rai & Singh; proposed herein.
Definition—Base marked by the FO of *E. turriseiffelii* and the Top is marked by the LO of *B. stenorhetha*.
Calibration—Equivalent to BC27 of Burnett, 1998.
Range—Late Albian to Early Cenomanian (Tanot Bore Well–1 depth 1647–1596 m).
Remarks—Dominance of small size forms and acme of *Axopodorhabdus albianus* and *Biscutum* sp. cf. *B. coronum* recorded in this zone. Other common taxa are *Biscutum ellipticum*, *Eiffellithus turriseiffelii*, *Rhagodiscus angustus*, *Tranolithus orionatus*, *Watznaueria barnesae* and *Zeugrhabdotus scutula*.

TA 1c Nannofossil Subzone

Authors—Rai & Singh; proposed herein.
Definition—Base marked by the FO of *A. albianus* and the Top is marked by the FO of *E. turriseiffelii*.
Calibration—Equivalent to BC25–BC26 of Burnett, 1998.
Range—Late Albian (Tanot Bore Well–1 depth 1656–1647 m).
Remarks—Dominance of small sized forms continued in this zone. The nannofossil assemblage of this zone includes *Biscutum ellipticum*, *Braarudosphaera africana*, *Braarudosphaera stenorhetha*, *Prediscosphaera cretacea*, *Rhagodiscus angustus*, *Staurolithites crux*, *Tranolithus orionatus*, *Watznaueria barnesae*, *Watznaueria biporata*, *Zeugrhabdotus erectus* and *Zeugrhabdotus scutula*.

TA 1b Nannofossil Subzone

Authors—Rai & Singh; proposed herein.
Definition—Base marked by the FO of *B. stenorhetha* and the Top is marked by the FO of *A. albianus*.
Calibration—Equivalent to BC24 of Burnett, 1998.
Range—Middle Albian (Tanot Bore Well–1 depth 1770–1656 m).
Remarks—Acme of *Biscutum ellipticum* at the lower part of the subzone recorded. Dominance of small size forms at upper part of the subzone and dominance of large size forms at lower part of the subzone recorded. Nannofossil assemblage of this subzone includes *Braarudosphaera africana*, *Discorhabdus ignotus*, *Repagulum parvidentatum*, *Rhagodiscus achylostaurion*, *rhagodiscus angustus*, *Rhagodiscus asper*, *Staurolithites crux*, *Staurolithites glaber*, *Tranolithus orionatus*, *Watznaueria barnesae*, *Watznaueria biporata*, *Zeugrhabdotus erectus*, *Zeugrhabdotus scutula* and *Zeugrhabdotus trivectis*.

TA 1a Nannofossil Subzone

Authors—Rai & Singh; proposed herein.
Definition—Base marked by the earliest occurrence of nannofossils at the base of section and the Top is marked by the FO of *B. stenorhetha*.
Calibration—Equivalent to BC23 of Burnett, 1998.
Range—Early Albian (Tanot Bore Well–1 depth 1899–1728 m).
Remarks—Nannofossil assemblage of this subzone commonly includes *Biscutum constans*, *Biscutum ellipticum*, *Discorhabdus ignotus*, *Repagulum parvidentatum*, *Rhagodiscus achylostaurion*, *Rhagodiscus angustus*, *Rhagodiscus asper*, *Staurolithites crux*, *Staurolithites laffittei*, *Tranolithus orionatus*, *Watznaueria barnesae* and *Zeugrhabdotus trivectis*.

CONCLUSIONS

Overall nannofossil species diversity is good to moderate in the entire bore well succession. In Campanian–Maastrichtian interval assemblages are highly diversified, most of the samples lying in this age bracket contain an average more of than 50 species in individual sample in 500 fields of view. In Turonian to Santonian diversity is moderate and the number of species ranges from 45 to 60 in each sample. During Albian–Cenomanian diversity is low ranging from 10 to 40 species in each sample which, however, may be due to the poor preservation of nannofossils at this level.

Based on the occurrence of several global zonal marker taxa and other age diagnostic species, biozonation of the 795 m thick subsurface Cretaceous succession (1104–1899 m depth) has been proposed. The succession has been dated from late Albian to early Maastrichtian. Seventeen biozones (Zones TA–1 to TA–17) have been proposed on Last Appearance Datum (LAD) of nannofossil species and their calibration with global zonation schemes. However, in the lowermost ~300 m interval (late Albian) First Appearance Datum (FAD) of the species has also been utilized, primarily to subdivide the thick interval for local and/or regional correlation purposes.

The Zones TA–1 to TA–17 in the Tanot well–1 have been calibrated with global nannofossil zonation schemes, viz. CC Zones (Sissingh, 1977), NC Zones (Roth, 1978) and UC/BC Zones (Burnett, 1998).

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