DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2004/34

Dinoflagellate cyst stratigraphy of the Ralegh N-18 well, Saglek Basin, Davis Strait, offshore eastern Canada

Henrik Nøhr-Hansen

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MINISTRY OF THE ENVIRONMENT

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Introduction

The present report describes the Palaeogene dinoflagellate cyst stratigraphy of the Ralegh N-18 well. The work was carried out by the Geological Survey of Denmark and Greenland (GEUS).

The results are based on the palynological study of 81 samples (4 sidewall core samples (SWC) and 77 ditch cuttinng samples (DCS)) kindly provided by the Canada Nova Scotia Offshore Petroleum Board (CNSOPB).

The samples were palynologically processed at GEUS by Yvonne Desezar (GEUS).

The palynological dating of the Palaeogene succession was carried out by Lic. scient. Henrik Nøhr-Hansen (GEUS).

The palynostratigraphy is described and illustrated in an enclosed range chart (Enclosure 1).

A summary of the dating and stratigraphically important events is presented in figure 3, and dinoflagellate cyst species with open nomeclature are illustrated on 26 plates.

The study is the second part of the project: Regional correlation of Mesozoic–Palaeogene sequences across the Greenland–Canada boundary. In the first part of the project Sønderholm *et al.* (2003) described the regional correlation based on data from the eastern Canadian wells: Ogmund E-72, Skolp E-07, Hekja O-71, Gjoa G-37 and the West Greenland wells: Qulleq-1, Kangâmiut-1, Ikermiut-1, GRO#3 and Umiivik-1 (Fig. 1). The biostratigraphy of Ralegh N-18 was not treated by Sønderholm *et al.* (2003).

Summary

1) Sediments of Late Eocene age are recorded from DCS 1365 m to DCS 1485 m.
2) Sediments of Middle Eocene age are recorded from DCS 1525 m to DCS 2565 m.
3) Sediments of Early Eocene age are recorded from DCS 2595 m to DCS 3445 m.
4) Sediments of Late Paleocene age are recorded from DCS 3465 m to DCS 3840 m.

Technical data

The Ralegh N-18 well was drilled in 1982 by Canterra on the position 62º 17' 57.16" N and 62º 32' 57.30" W at Saglek Basin, Davis Strait offshore eastern Canada (Fig. 1).

The well was drilled at a water depth of 339.0 m, the rotary table was 12.5 m above sea level, and the total depth was 3858 m below rotary table. The well terminated in Upper Paleocene shales/basalt. All sample depths are measured from rotary table datum.

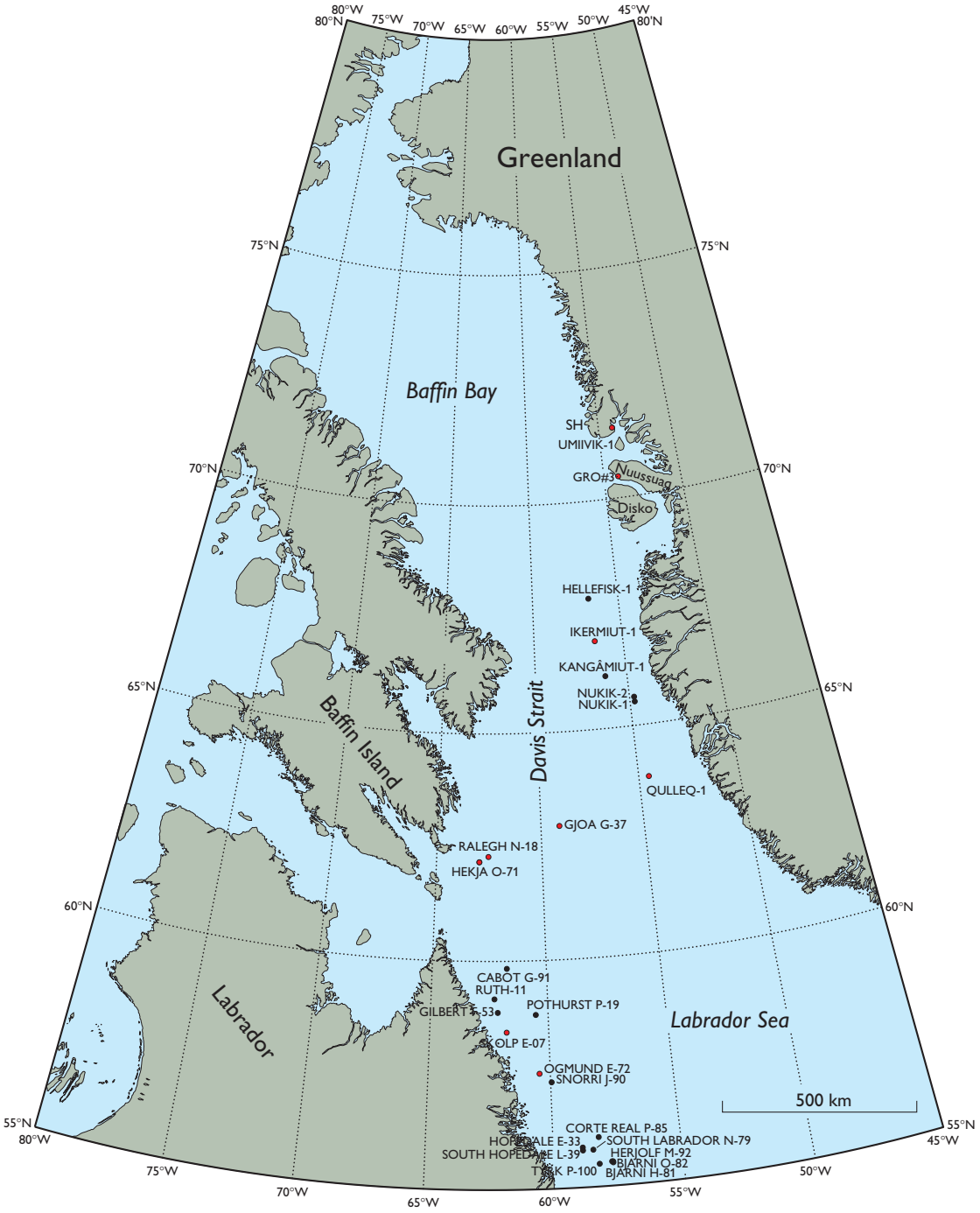


Fig. 1. Exploration wells drilled on the Labrador and South-East Baffin Island shelves and off- and onshore West Greenland.

Ralegh N-18, dinoflagellate cysts stratigraphy

Samples and methods

The analysed material includes 4 SWC samples and 77 DCS's.

Palynological preparation

Palynological preparation and studies were carried out at GEUS. Palynomorphs were extracted from approximately 20 g of sample by modified standard preparation techniques. Only the 1 to 4 mm fraction of DCS were used in order to reduce the effect of caving. The bulk of the minerals were dissolved by hydrochloric and hydrofluoric acids. A first slide was made after this treatment. A second slide was made of the organic residue after sieving using a 11 micron nylon mesh. A third slide was made after oxidation (3 to 20 minutes) with concentrated nitric acid and sieving with a 20 micron mesh. Oxidation was carried out in order to clean the samples of minor amorphous kerogen particles and pyrite. Finally, palynomorphs were separated from coal particles and woody material in most samples by swirling. After each of the steps mentioned above, the organic residues were mounted in glycerine gelly.

One to six palynological slides have been produced for each sample. A set of slides is stored at GEUS, Copenhagen, Denmark, another set is stored at The Geological Survey of Canada (Atlantic), Dartmouth, Nova Scotia, Canada and a third set of slides is stored at CNSOPB, Canada Nova Scotia Offshore Petroleum Board, Dartmouth, Nova Scotia, Canada.

Material and analyses

The palynological slides were studied in transmitted light using a Leitz Dialux 22 microscope (512 742/057691) and a Leitz DM RB (RS232C) microscope.

Dinoflagellate cysts, acritarchs and selected spores and pollen species were recorded from slides of the sieved, oxidised and swirled organic residue. In the study 81 samples were included, the majority revealed dinoflagellate cysts. From each sample 100 specimens were counted where possible, hereafter the remaining part of the palynological slide was logged for rare taxa.

The sample depths and relative abundance of species referred to in the biostratigraphic section (below) is illustrated on the range chart (Enclosure 1). The illustrations of dinoflagellate cysts from Ralegh N-18 (Plates 1–26) are marked with sample number, slide number and laser-video-record number (LVR) for later identification.

Previously palynological results

Palynostratigraphic correlation's of the Palaeogene West Greenland deposits have previously been presented by Nøhr-Hansen *et al*. (2000, 2002) and recently Nøhr-Hansen (2003) estab-

lishes twenty-one palynological intervals from the Early Paleocene to the Late Eocene (Fig. 2). These intervals were used by Sønderholm *et al.* (2003) in their regional correlation of the eastern Canadian wells with the West Greenland wells. There is no formal palynological zonation for the Palaeogene of the Labrador Shelf, but available data have been summarised by Williams *et al.* (1990).

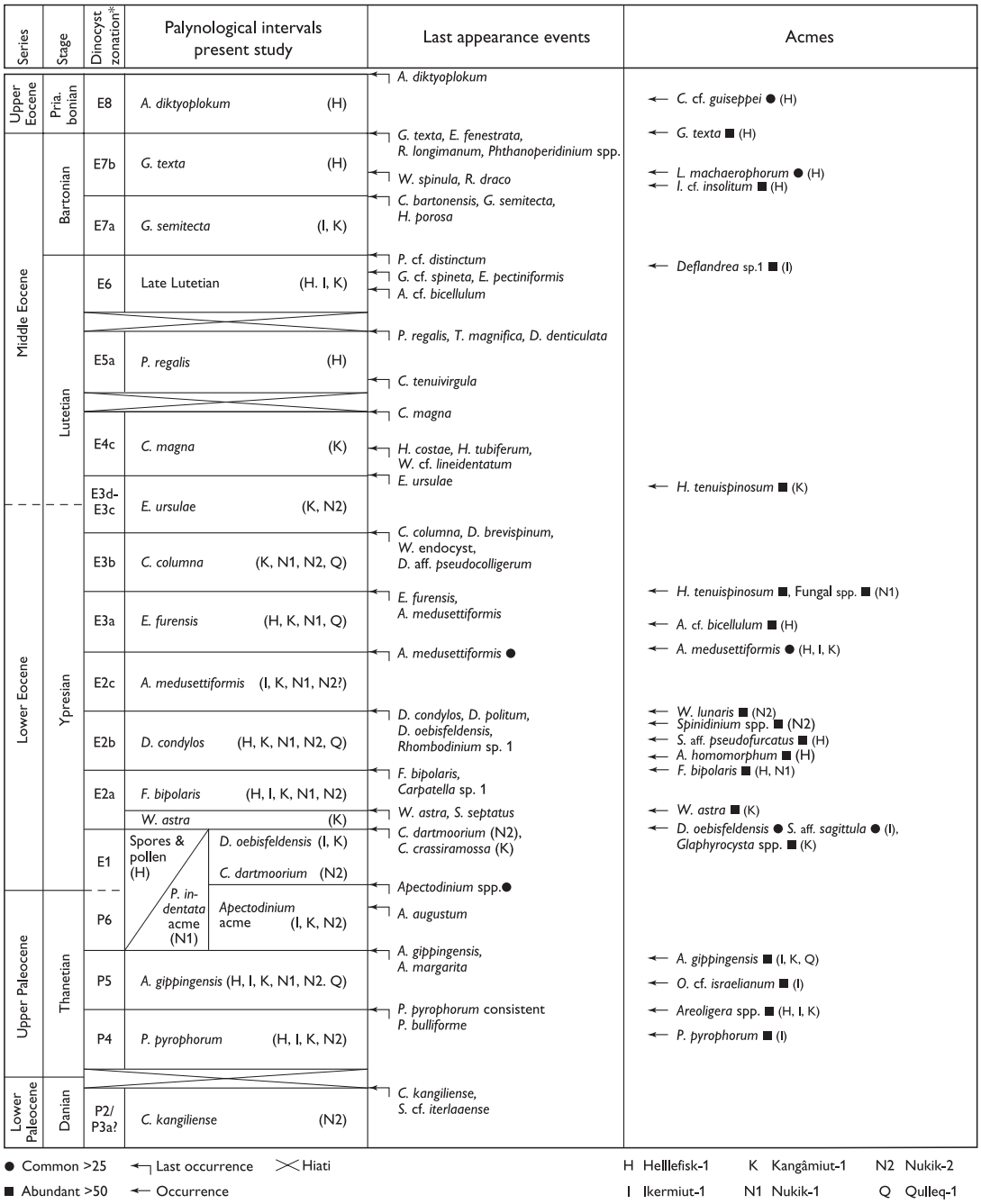


Fig. 2. Palaeogene palynological intervals and bioevents offshore West Greenland, correlated with the dinocyst zonations of Bujak & Mudge (1994) and Mudge & Bujak (1996). From Nøhr-Hansen (2003).

Stratigraphical results

The present stratigraphical result for Ralegh N-18 has been based on correlation of ranges and events of stratigraphical important marker species with species events known from the Davis Strait area and from the North Sea region. The results are illustrated on figure 3 and on enclosure 1.

Late Eocene

The Late Eocene has been divided into two intervals.

Interval 1, DCS 1365 m to DCS 1405 m
Age: The LO (last occurrence) of *Araneosphaera araneosa* at 1405 m indicate the top of Priabonian, latest Late Eocene, according to Williams and Bujak (1985) wich correspond to the *Areosphaeridium diktyoplokus* Subzone (E8b; Figs 2, 3) of Bujak and Mudge (1994).

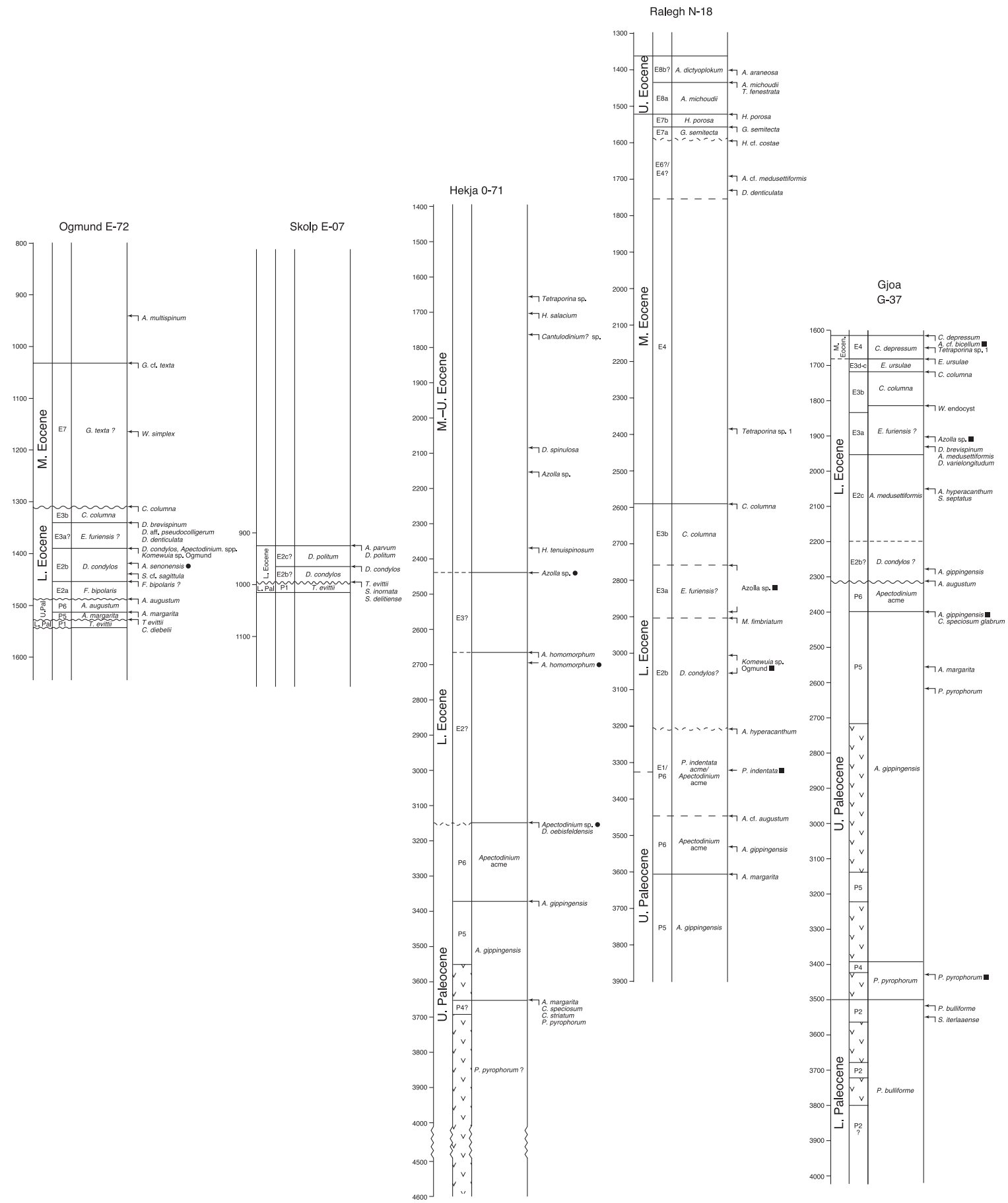
Interval 2, DCS 1445 m to DCS 1485 m
Age: The LO of *Areosphaeridium michoudii* and *Thalassiphora fenestrata* at 1445 m indicate the top of the lower Priabonian *Areosphaeridium michoudii* Subzone (E8a; Figs 2, 3) of Bujak and Mudge (1994). The LO of *Deflandrea* sp. 1 Nøhr-Hansen 2003 in the present interval expand the range of the informal species or indicate reworking. The informal species *Deflandrea* sp. 1 has previous only been recorded from the late Luthetian in the Ikkermiut-1 well, offshore West Greenland by Nøhr-Hansen (2003).

Reworking: Dinoflagellate cysts as *Senoniasphaera* cf. *rotundata*, *Chatangiella* spp., *Isabelidinium* spp. and *Odontochitina* spp. from the mid to Late Cretaceous have been recorded from the Late Eocene succession.

Middle Eocene

The Middle Eocene has been divided into four intervals.

Interval 1, DCS 1525 m
Age: The LO of *Heteraulacacysta porosa* at 1525 m indicate the top Bartonian, latest Middle Eocene, wich correspond to the *Heteraulacacysta porosa* Subzone (E7b; Figs 2, 3) of Bujak and Mudge (1994).


Ogmund E-72
Skolp E-07
Hekja 0-71
Ralegh N-18
Gjoa
G-37
M. Eocene
L. Eocene
U. Paleocene
M.–U. Eocene
L. Pal
U. Pal
E7
E3b
E3a?
E2b
E2a
P6
P5
P1
E2c?
E2b?
E8b?
E8a
E7b
E7a
E6?/
E4?
E4
E3d-c
E3a
E1/
P6
P4
P4?
P2
P2?
G. texta ?
C. columna
E. furiensis ?
D. condylos
F. bipolaris
A. augustum
A. margarita
T. evittii
C. diebelii
D. politum
S. inornata
S. delitiense
H. salacium
D. spinulosa
Azolla sp.
H. tenuispinosum
A. homomorphum
Apectodinium sp.
D. oebisfeldensis
Apectodinium acme
A. gippingensis
P. pyrophorum ?
H. porosa
G. semitecta
H. cf. costae
A. cf. medusettiformis
D. denticulata
A. araneosa
A. michoudii
T. fenestrata
A. dictyoplokum
Tetraporina sp. 1
Azolla sp.
M. fimbriatum
Komewuia sp.
Ogmund
P. indentata
A. cf. augustum
C. depressum
A. cf. bicellum
Tetraporina sp. 1
E. ursulae
C. columna
W. endocyst
Azolla sp.
D. brevispinum
A. medusettiformis
D. varielongitudum
A. hyperacanthum
S. septatus
D. condylos ?
A. gippingensis
A. augustum
C. speciosum glabrum
A. margarita
P. pyrophorum
P. bulliforme
S. iterlaaense
P. bulliforme

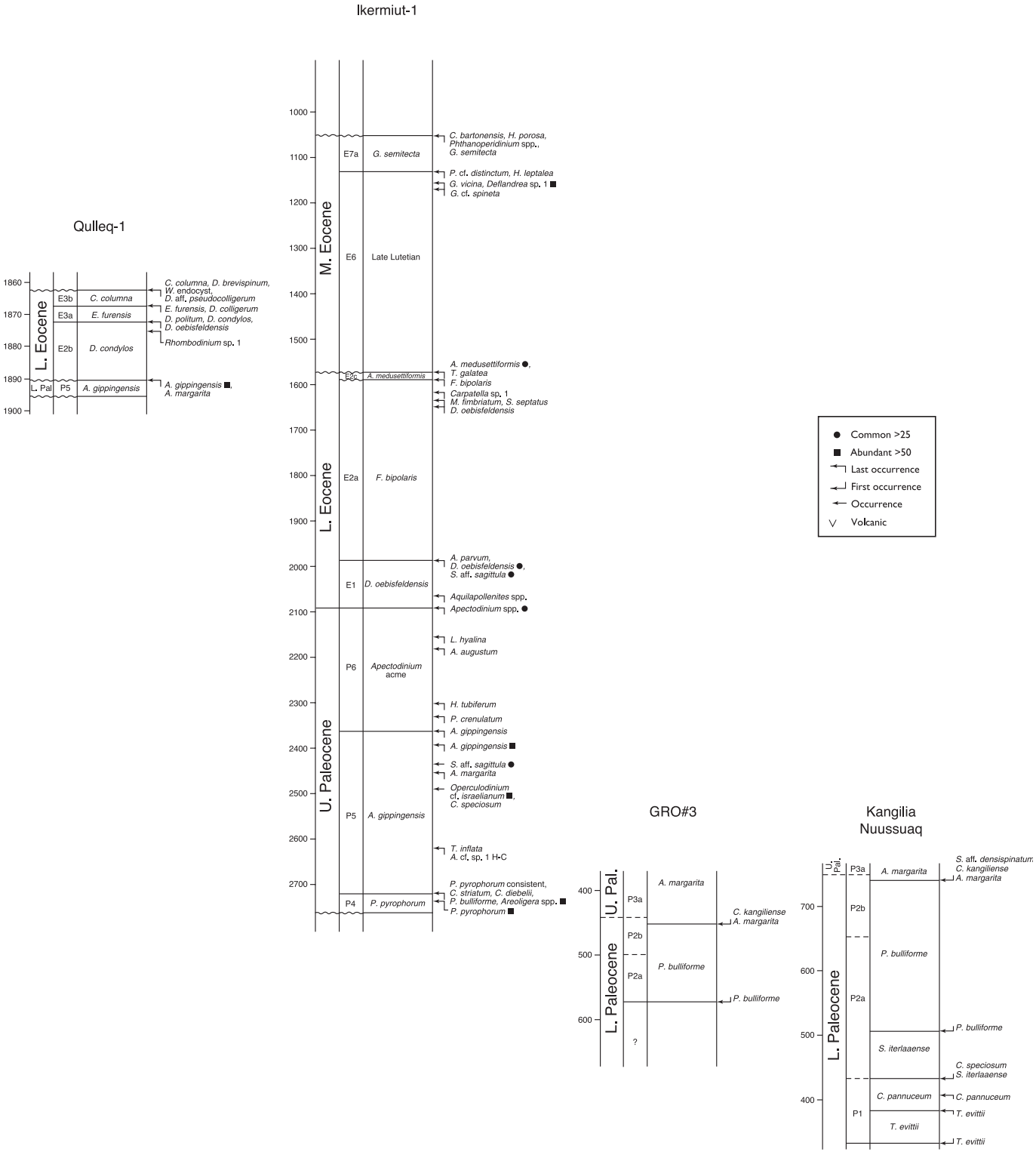


Fig. 3. Palaeogene palynological intervals and bioevents for the on- and offshore wells Eastern Canada and West Greenland (this study, Sønderholm *et al.* 2003) correlated with the dinocyst zonations of Bujak & Mudge (1994), Mudge & Bujak (1996) and Nøhr-Hansen (2003). The stratigraphy is based on last appearance datum, first appearance datum events and abundances of stratigraphical important species. Depth scales in meters.

Interval 2, DCS 1565 m

Age: The LO of *Glaphyrocysta semitecta* at 1565 m indicate the lower Bartonian, late Middle Eocene wich correspond to the *Glaphyrocysta semitecta* interval of Nøhr-Hansen (2003) which he correlated to the *Areoligera tauloma* Subzone (E7a; Figs 2, 3) of Bujak and Mudge (1994).

Interval 3, DCS 1605 m to DCS 1725 m

Age: The dinoflagellate cyst assemblage of the present interval does not indicate any unambiguios age. The LO of *Hystrichosphaeropsis* cf. *costae* indicate an early Lutetian age corresponding to the *Cerebrocysta magna* Subzone (E4c; Figs 2, 3) of Bujak and Mudge (1994), the LO of *Areoligera* cf. *medusettiformis* also indicate an early Lutetian age. The LO of *Deflandrea denticulata* indicate a middle Lutetian age corresponding to the *Systematophora placacantha* abundance Biozone (E5; Figs 2, 3) of Bujak and Mudge (1994), whereas the LO of *Glaphyrocysta vicina* indicate a late Lutetian age E6–E4 (Figs 2, 3) of Bujak and Mudge (1994).

Interval 3 is here tentatively dated as Lutetian E6–E4 (Figs 2, 3) of Bujak and Mudge (1994).

Interval 4, DCS 1765 m to DCS 2565 m

Age: The very sparse dinoflagellate cyst assemblage of the present interval (especially the midddle part) does not indicate any unambiguios age. The few stratigraphiacal usefull signals occur in the lower part where *Wetzeliella* spp. are common and where *Tetraporina* sp. 1 has it's LO at 2385 m. The LO of *Tetraporina* sp. 1 has been recorded from the middle Eocene in the Gjoa G-37 well (Sønderholm *et al.* (2003) in an interval corresponding to the *Diphyes ficusoides* Biozone (E4; Figs 2, 3) of Bujak and Mudge (1994).

Reworking: Dinoflagellate cysts as *Chatangiella* spp. *Chichouadinium vestitum*, *Heterosphaeridium difficile*, *Isabelidinium* spp. and *Odontochitina* spp. from the mid to Late Cretaceous have been recorded from the Middle Eocene succession.

Early Eocene

The Middle Eocene has been divided into four intervals.

Interval 1, DCS 2595 m to DCS 2745 m

Age: The LO of *Charlesdowniea columna* indicate the late Early Eocene, *Charlesdowniea columna* Subzone (E3b; Figs 2, 3) of Bujak and Mudge (1994). This is supported by the LO of *Hystrichokolpoma* sp. 1 Heilmann-Clausen 1989, which has its LO together with *C. columna* in the Qulleq-1 well offshore West Greenland (Nøhr-Hansen, 2003).

Interval 2, DCS 2765 m to DCS 2885 m

Age: The LO of *Apectodinium quinquelatum* together with the presence of common to abundant *Azolla* sp. indicate the late Early Eocene. Abundant *Azolla* sp. also occur in an inteval i the well Gjoa G-37, which Sønderholm *et al.*, 2003 correllated with the *Membranilarnacia compressa* Subzone (E3a; Figs 2, 3) of Bujak and Mudge (1994).

Interval 3, DCS 2910 m to DCS 3165 m

Age: The dinoflagellate cyst diversity of the present interval is very low. The LO of *Muratodinium fimbriatum* together with the presence of common to abundant *Komewuia* sp. Ogmund indicate the early Early Eocene. Abundant *Komewuia* sp. Ogmund also occur in an inteval i the Ogmund E-72 well, which Sønderholm *et al.* (2003) correllated with the *Dracodinium politum* Subzone (E2b; Figs 2, 3) of Bujak and Mudge (1994).

Interval 4, DCS 3210 m to DCS 3445 m

Age: The LO of *Apectodinium hyperacanthum* and the presence of more frequent *Apectodinium* sp. and *Areoligera* sp. indicate the latest Paleocene *Apectodinium augustum* Biozone (P6; Figs 2, 3) of Bujak and Mudge (1994). However the abundance of *Paralecaniella indentata* at 3329 m SWC may suggest that interval 4 is correllated with the earliest Eocene to latest Paleocene *Paralecaniella indentata* acme interval recorded from the well Nukik-1by Nøhr-Hansen (2003).

Azolla sp. and *Pediastrum* sp. are common in the Early Eocene Succession. This together with a low diverse *Komewuia* dominated interval may suggest that the Early Eocene succession was deposited close to a terrestrial source.

Reworking: A few specimen of *Heterosphaeridium difficile* and *Odontochitina* sp. from the mid to Late Cretaceous have been recorded from the Early Eocene succession.

Late Paleocene

The Late Paleocene has been divided into two intervals.

Interval 1, DCS 3465 m to DCS 3565 m

Age: The LO of *Apectodinium* cf. *augustum* indicate the latest Paleocene *Apectodinium augustum* Biozone (P6; Figs 2, 3) of Bujak and Mudge (1994) and Mudge and Bujak (1996).

Interval 2, DCS 3605 m to DCS 3840 m

Age: The LO of *Alisocysta margarita* indicate the Late Paleocene *Areoligera gippingensis* Biozone (P5; Figs 2, 3) of Mudge and Bujak (1996).

Reworking: A few specimen of *Alterbidinium acutulum Chatangiella* sp. *Laciniadinium arcticum* and *Odontochitina operculata* from the mid to Late Cretaceous have been recorded from the Late Paleocene succession.

Concluding remarks

The overall division into stages based on the present palynological dating does not differs remarcable from earlier studies of the well by the Bujak Davies Group (1987, GSC Open File Report #1935). However the present dating and zonation has been refined based on comparision with and correllation to the new zonations from the North Sea (Bujak and Mudge, 1994; Mudge and Bujak 1996) and West Greenland (Nøhr-Hansen, 2003). The restudy of the five Canadian wells Ogmund E-72, Skolp E-07, Hekja O-71, Gjoa G-37 and Ralegh N-18, has contributed with new detailed data that are very useful for establishing a general Paleogene stratigraphy for the Davis Strait area and for seismic correlation across the strait.

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Plates 1–26 Illustrations of palynomorphs from Ralegh N-18

RALEGH – PLATE 1

Figs 1–2 *Aranosphaeridium araneosa* 27.3-15.3, 1405m-2, LVR 26473–74

Fig. 3 *Glaphyrocysta inculta*? 30.2-17.5, 1405m-2, LVR 26475

Fig. 4 *Tityrosphaeridium cantharellum* ? 25.2-7.1, 1405m-2, LVR 26478

Fig. 5 *Phthanoperidinium comatum* 36.5-18.1, 1405m-2, LVR 26483

Fig. 6 *Cribroperidinium* sp. 1 HNH Ralegh 45.9-21.5, 1405m-2, LVR 26484

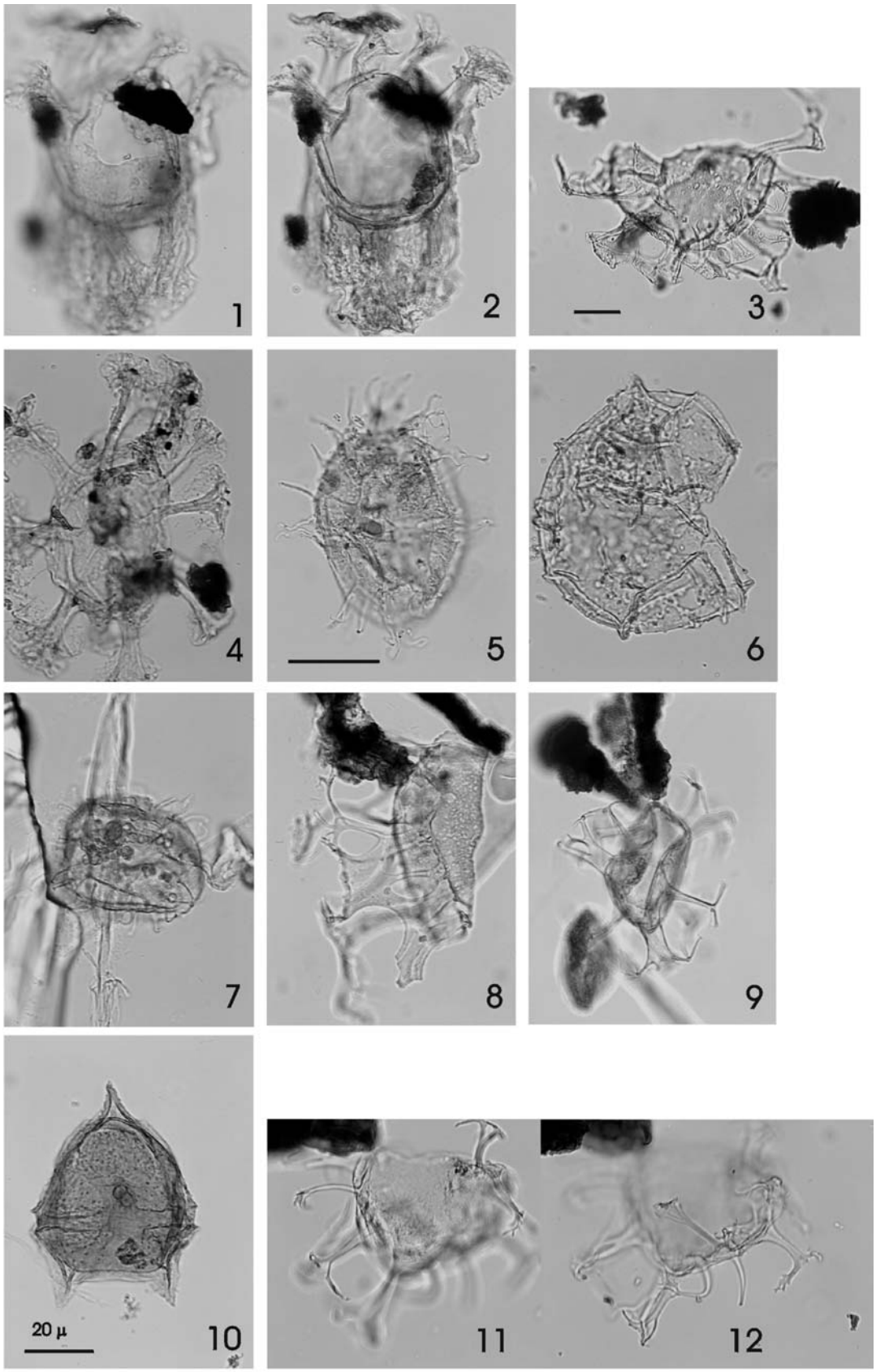
Fig. 7 *Operculodinium centrocarpum* 36.8-18.5, 1405m-3, LVR 26487

Fig. 8 *Glaphyrocysta inculta* ? 38.8-20.1, 1405m-3, LVR 26488

Fig. 9 *Spiniferites* sp. 1 HNH Ralegh 51.6-19.6, 1365m-2, LVR 26492

Fig. 10 *Lentinia serrata* 31.9-18.2, 1445m-2, LVR 26493

Figs 11–12 *Areosphaeridium* cf. *michoudii* 37.8-18.9, 1445m-2, LVR 26495–96



Ralegh N-18 Plate 1
1-8: 1405 m;
9: 1365 m;
10-12 1445 m

RALEGH – PLATE 2

Figs 1–3 *Senoniasphaera* cf. *rotundata* 51.7-17.8, 1445m-2, LVR 26500, 503 & 506

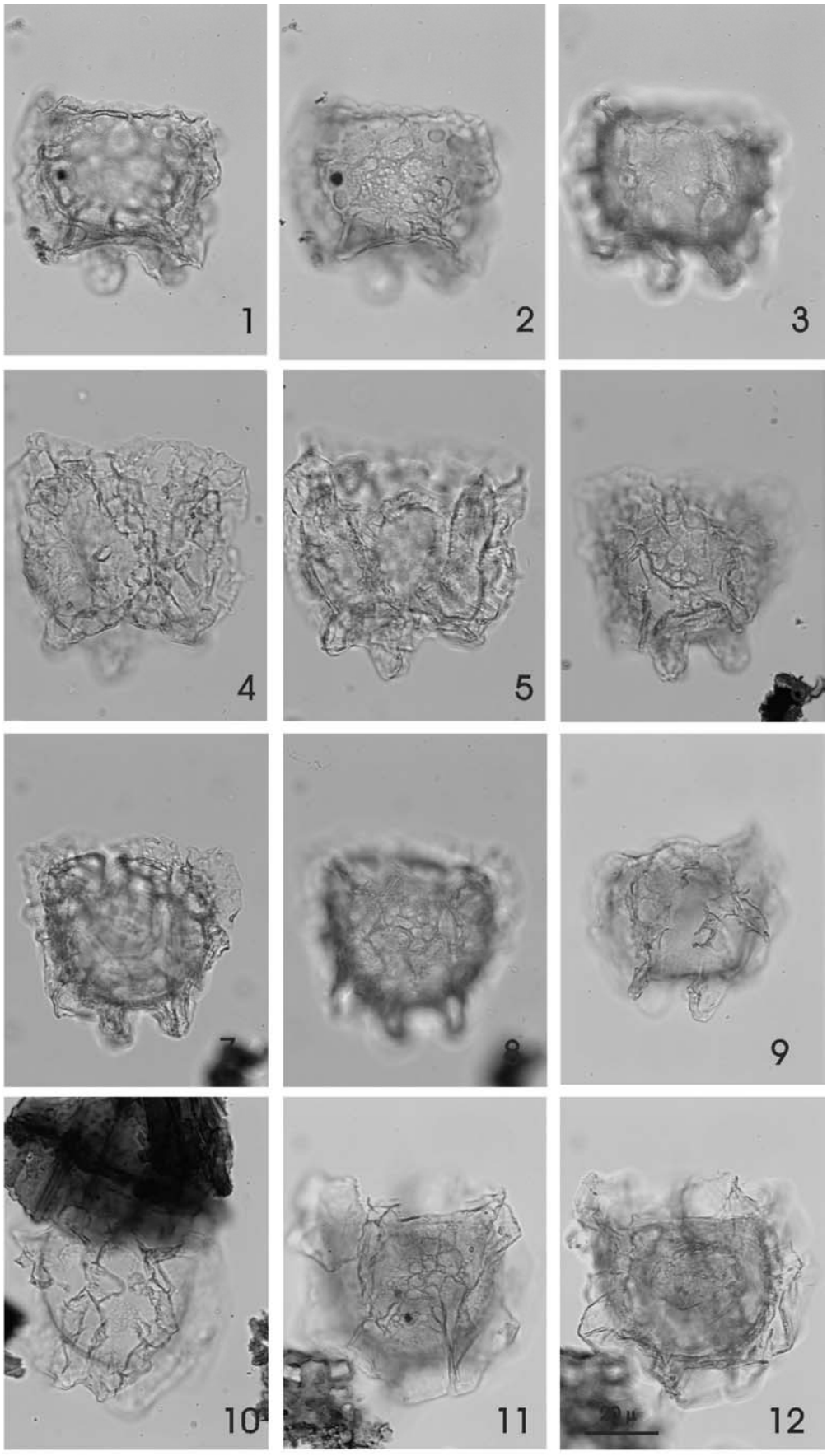
Figs 4–5 *Senoniasphaera* cf. *rotundata* 44.6-18.1, 1445m-2, LVR 26507–508

Figs 6–8 *Senoniasphaera* cf. *rotundata* 32.2-10.5, 1445m-2, LVR 26510, 512– 513

Fig. 9 *Senoniasphaera* cf. *rotundata* 27.7-11.3, 1445m-4, LVR 26542

Fig. 10 *Senoniasphaera* cf. *rotundata* 31.6-20.4, 1445m-4, LVR 26545

Figs 11–12 *Senoniasphaera* cf. *rotundata* 44.5-16.9, 1445m-2, LVR 26533–534



Ralegh N-18 Plate 2
1-12 1445 m

RALEGH – PLATE 3

Fig. 1 *Areosphaeridium* cf. *michoudii* 40.5-9.5, 1445m-2, LVR 26497

Figs 2–3 *Areosphaeridium* cf. *michoudii* 49.1-9.8, 1445m-2, LVR 26498–499

Figs 4 –5 *Areosphaeridium* cf. *michoudii* 31.2-19.2, 1445m-2, LVR 26537–438

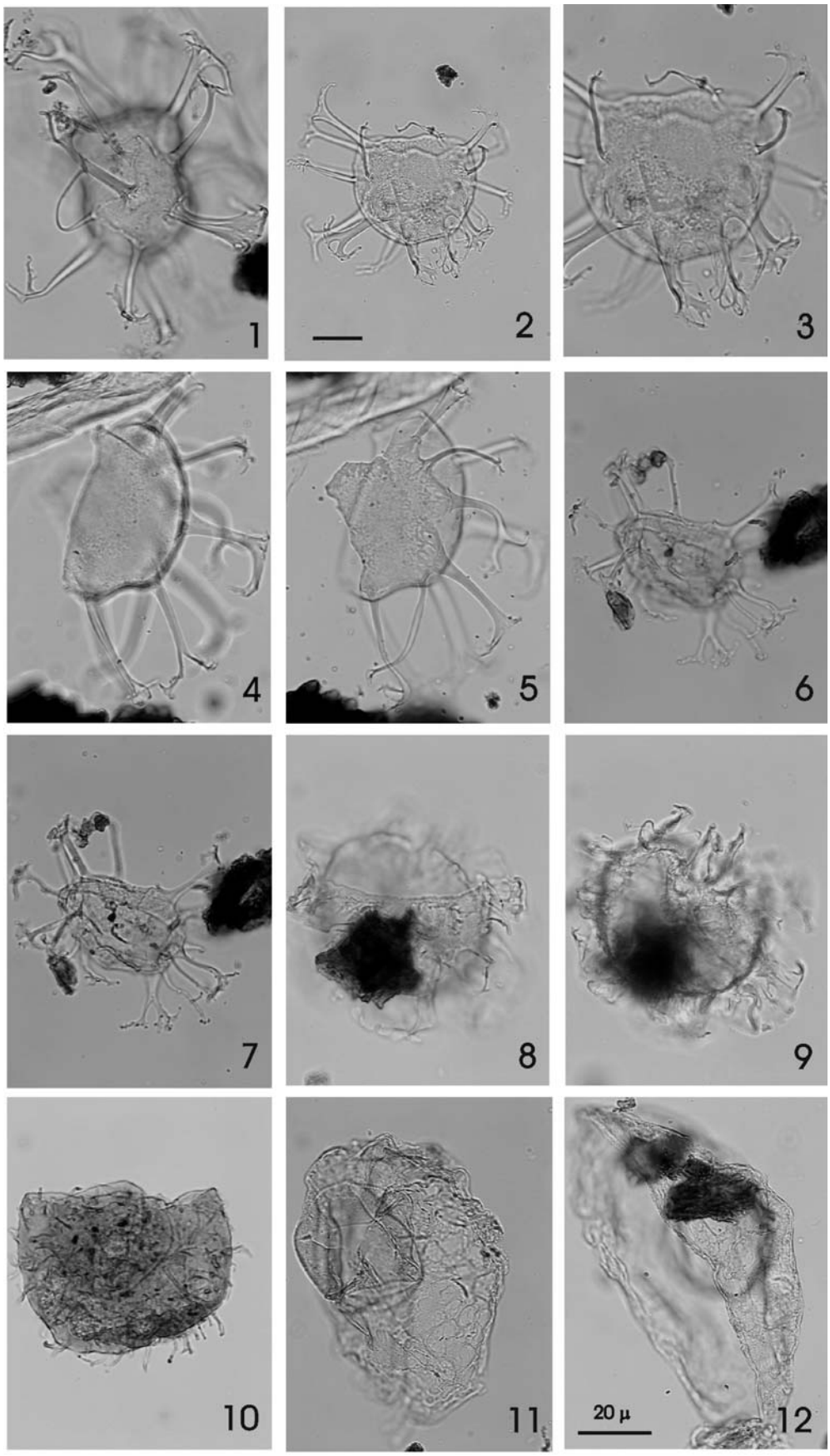
Figs 6–7 *Areosphaeridium* cf. *michoudii* 39.0-23.4, 1445m-2, LVR 26540–441

Figs 8–9 *Areoligera* sp. 1 HNH Ralegh 49.5-23.9, 1445m-2, LVR 26514 & 416

Fig. 10 Dinocyst sp. 1 HNH Ralegh 49.5-23.9, 1445m-2, LVR 26514

Fig. 11 *Thalassiphora fenestrata* 32.5-20.5, 1445m-2, LVR 26519

Fig. 12 *Thalassiphora fenestrata* 41.1-11.2, 1445m-2, LVR 26520



Ralegh N-18 Plate 3
1-12 1445 m

RALEGH – PLATE 4

Fig. 1–3 *Charlesdowniea clathrata* 37.6-14.5, 1445m-2, LVR 26522–524

Fig. 4 *Isabelidinium acuminata* reworked 39.2-8.4, 1445m-2, LVR 26525

Figs 5–6 Chorat cyst sp. 1 HNH Ralegh 39.1-15.5, 1445m-2, LVR 26527–528

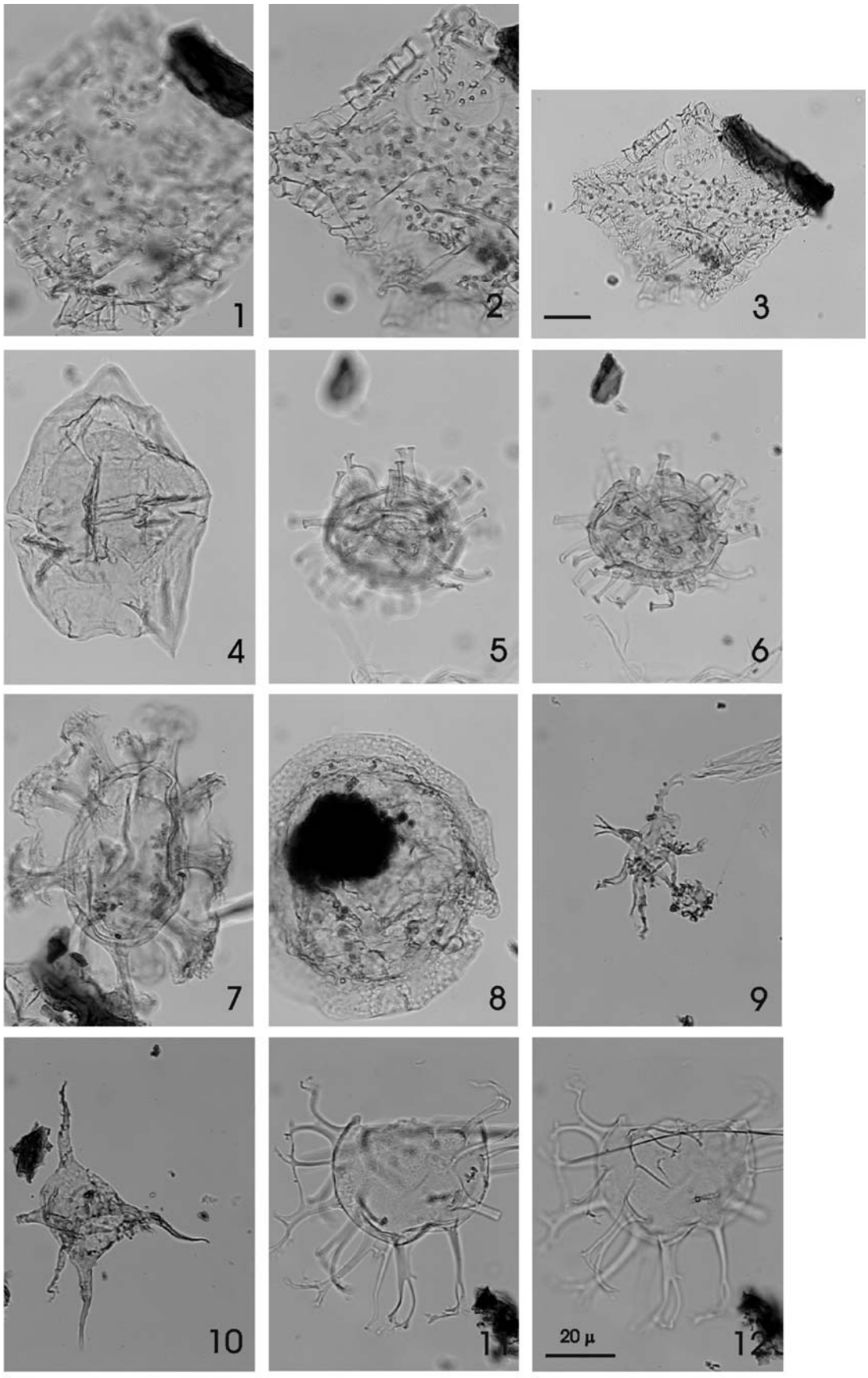
Fig. 7 *Tityrosphaeridium cantharellum* ? 45.7-11.6, 1445m-2, LVR 26529

Fig. 8 *Heteraulacacysta leptalea* 49.7-10.6, 1445m-2, LVR 26532

Fig. 9 Acritarch sp. 1 HNH Ralegh 24.2-11.4, 1485m-2, LVR 26548

Fig. 10 Acritarch sp. 2 HNH Ralegh 28.8-13.7, 1485m-2, LVR 26550

Figs 11–12 *Areosphaeridium* cf. *michoudii* 31.3-3.6, 1485m-2, LVR 26551–52



Ralegh N-18 Plate 4
1-8 1445 m
9-12 1485 m

RALEGH – PLATE 5

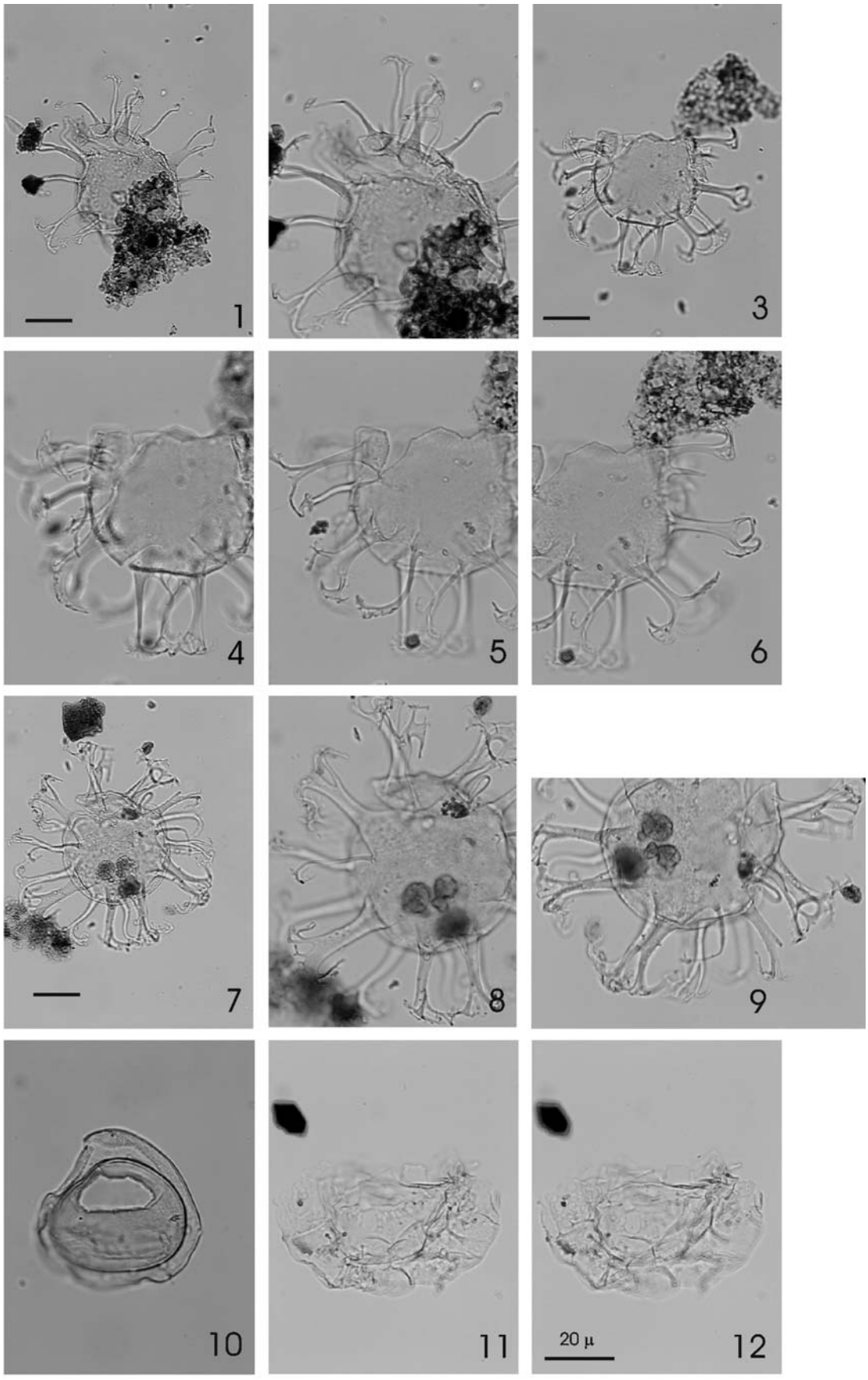
Figs 1–2 *Areosphaeridium* cf. *michoudii* 33.0-19.4, 1485m-2, LVR 26553–554

Figs 3–6 *Areosphaeridium* cf. *michoudii* 30.9-13.0, 1485m-2, LVR 26555–558

Figs 7–9 *Areosphaeridium* cf. *michoudii* 19.1-7.0, 1485m-4, LVR 26561–563

Fig. 10 *Deflandrea* sp. 1 HNH 2003 30.3-23.1, 1485m-2, LVR 26567

Figs 11–12 *Glaphyrocysta semitecta* 34.3-10.7, 1485m-2, LVR 26568–569



Ralegh N-18 Plate 5
1-12 1485 m

RALEGH – PLATE 6

Figs 1–3 *Chiropterigium* sp.1 HNH Ralegh 31.0-4.3, 1485m-4, LVR 26570–571 & 573

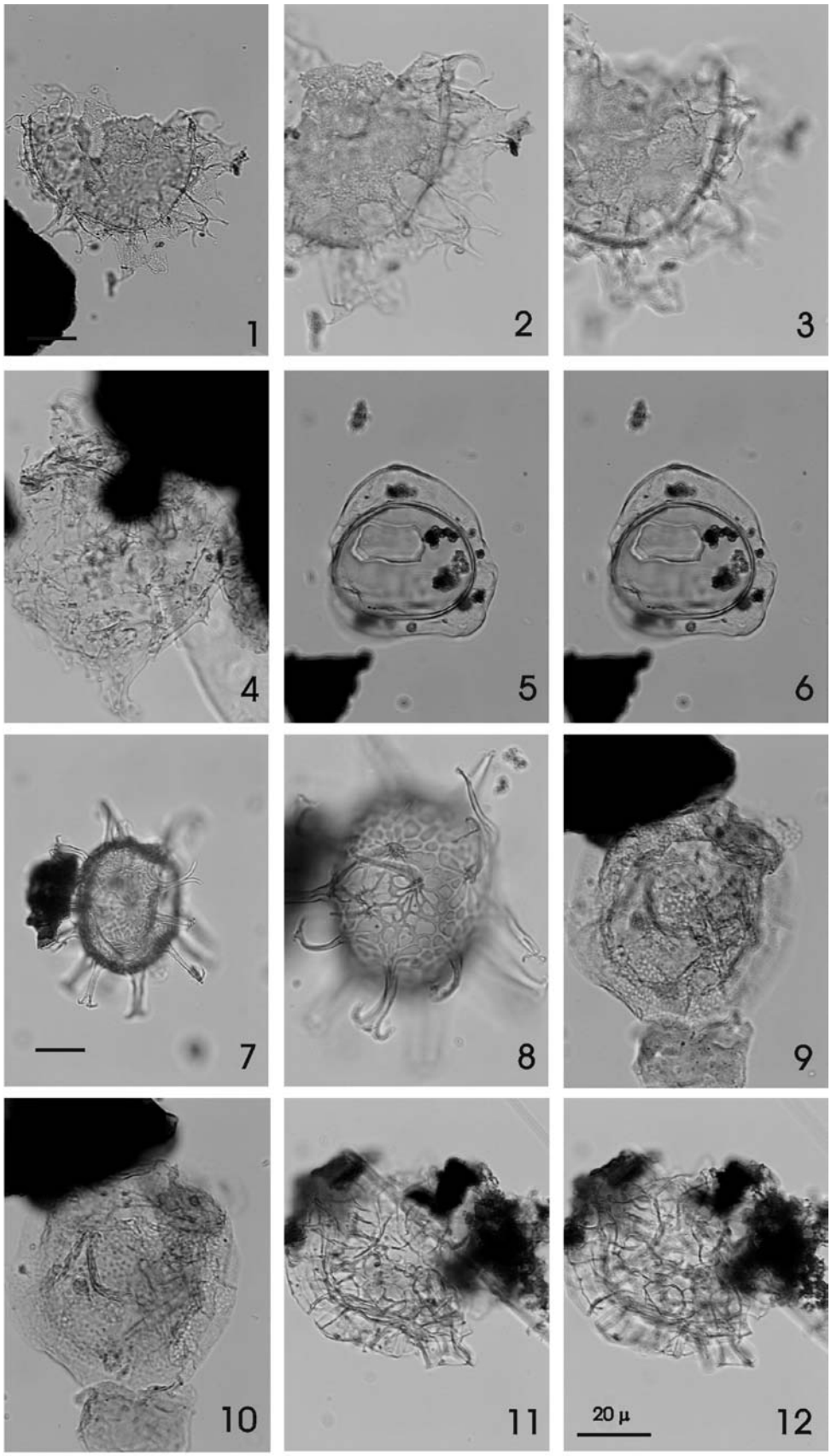
Fig. 4 *Wetzeliella* cf. *simplex* 38.2-16.1, 1485m-4, LVR 26574

Figs 5–6 *Deflandrea* sp. 1 HNH 2003 28.7-5.8, 1525m-2, LVR 26574–575

Figs 7–8 *Cordosphaeridium funiculata* 43.3-23.8, 1525m-2, LVR 26577–578

Figs 9–10 *Heteraulacacysta porosa* 36.3-20.5, 1525m-4, LVR 26579–580

Figs 11–12 *Glaphyrocysta* cf. *vicina* 37.1-13.3, 1565m-2, LVR 26581–582



Ralegh N-18 Plate 6
1-4 1485 m
5-10 1525 m
1-12 1565 m

RALEGH – PLATE 7

Figs 1–2 *Glaphyrocysta semitecta* 29.7-10.7, 1565m-3, LVR 26584–5585

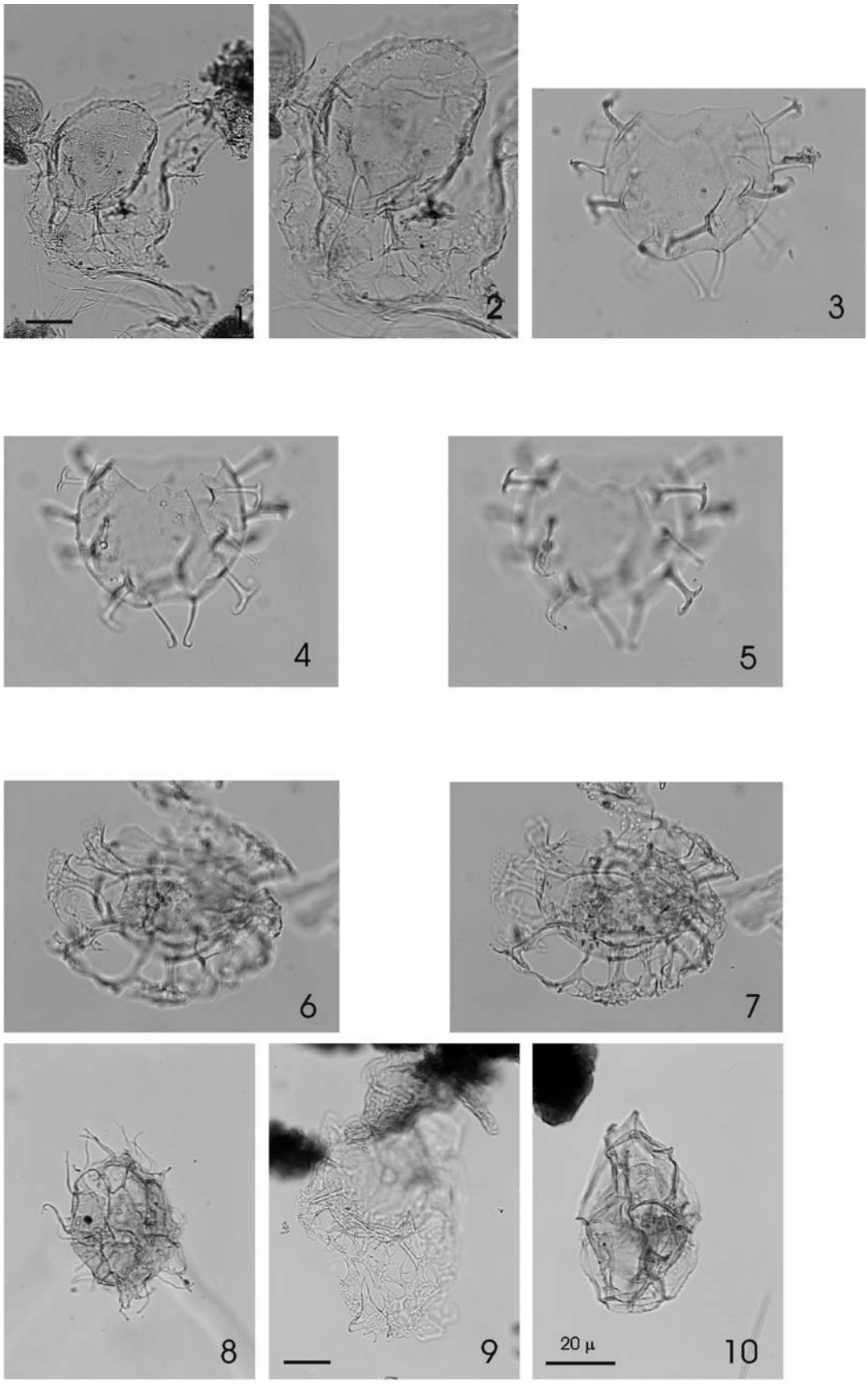
Figs 3–5 *Enneadocysta* sp. 29.0-6.8, 1565m-4, LVR 26586–588

Figs 6–7 *Enneadocysta* sp. 20.7-13.5, 1565m-4, LVR 26589–590

Fig. 8 *Phthanoperidinium comatum* 36.8-6.9, 1605m-4, LVR 26592

Fig. 9 *Glaphyrocysta semitecta* 25.6-19.0, 1605m-3, LVR 26594

Fig. 10 *Hystrichosphaeropsis* aff. *costae* 41.0-11.4, 1605m-3, LVR 26595



Ralegh N-18 Plate 7
1-5 1565 m
6-10 1605 m

RALEGH – PLATE 8

Figs 1–2 *Thalassiphora fenestrata* 32.8-6.2, 1605m-4, LVR 26596–597

Figs 3–4 *Deflandrea* sp. 1 HNH Ralegh 34.1-20.6, 1605m-4, LVR 26598–599

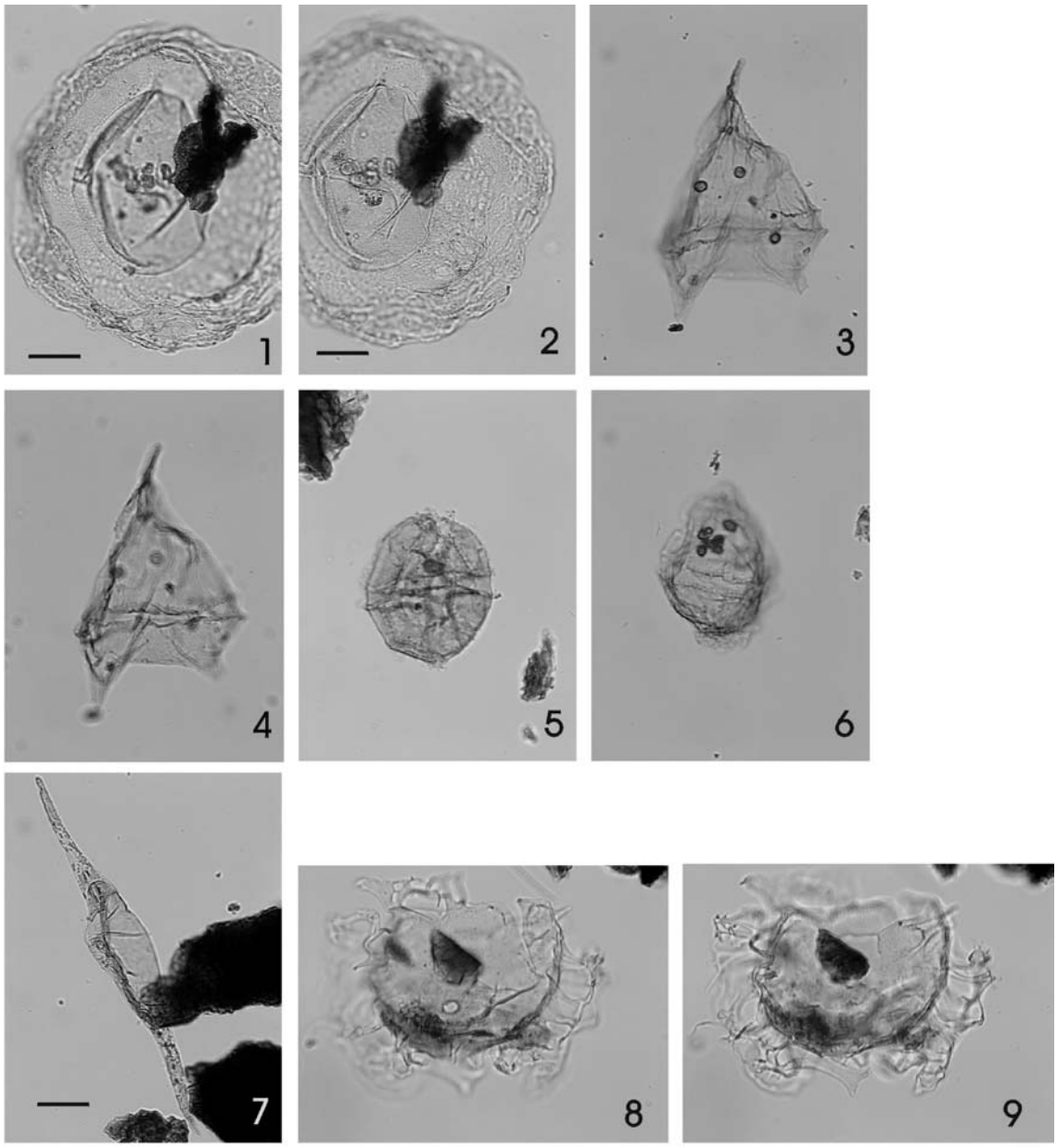
Fig. 5 *Phthanoperidinium geminatum* 27.9-11.7, 1645m-2, LVR 26600

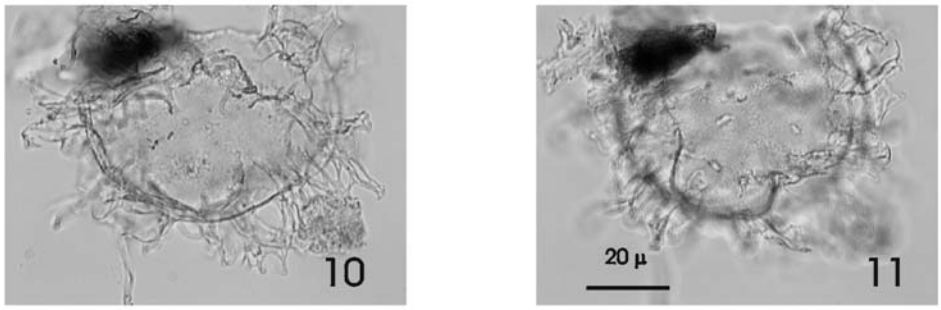
Fig. 6 *Phthanoperidinium geminatum* 26.8-16.3, 1645m-2, LVR 26601

Fig. 7 *Palaeocystodinium golzowense* 30.1-20.9, 1645m-2, LVR 26602

Figs 8–9 *Glaphyrocysta* sp. 1 HNH Ralegh 24.3-14.8, 1685m-2, LVR 26603–604

Figs 10–11 *Glaphyrocysta* sp. 2 HNH Ralegh 34.4-7.6, 1685m-3, LVR 26605–606





Ralegh N-18 Plate 8
1-4 1605 m
5-7 1645 m
8-11 1685 m

RALEGH – PLATE 9

Figs 1–2 *Glaphyrocysta* sp. 3 HNH Ralegh 22.6-21.1, 1685m-3, LVR 26607–608

Fig. 3 *Adnatosphaeridium multispinosum* 26.5-8.4, 1685m-2, LVR 26609

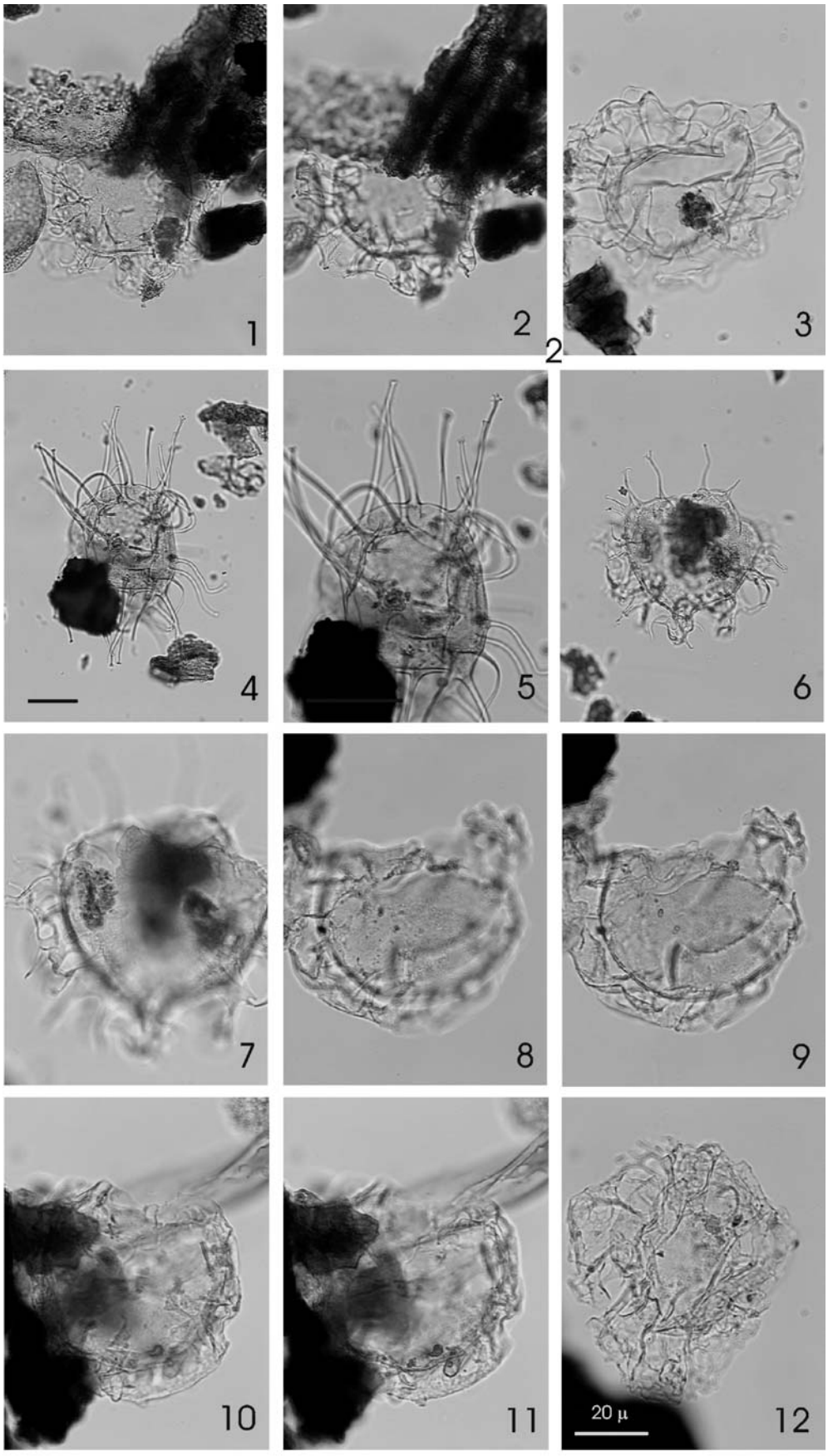
Figs 4–5 *Cordosphaeridium* sp. 1 HNH Ralegh 41.3-18.5, 1685m-2, LVR 26610–611

Figs 6–7 *Glaphyrocysta* sp. 4 HNH Ralegh 44.2-8.6, 1685m-2, LVR 26613–614

Figs 8–9 *Glaphyrocysta vicina* 34.9-22.0, 1685m-3, LVR 26615-616

Figs 10–11 *Glaphyrocysta vicina* 44.0-21.8, 1685m-3, LVR 26617-618

Fig. 12 *Glaphyrocysta semitecta* 37.0-5.0, 1685m-3, LVR 26619



Ralegh N-18 Plate 9
1-12 1685 m

RALEGH – PLATE 10

Fig. 1 *Micodinium* sp. 1 HNH Ralegh 36.2-20.9, 1685m-4, LVR 26621

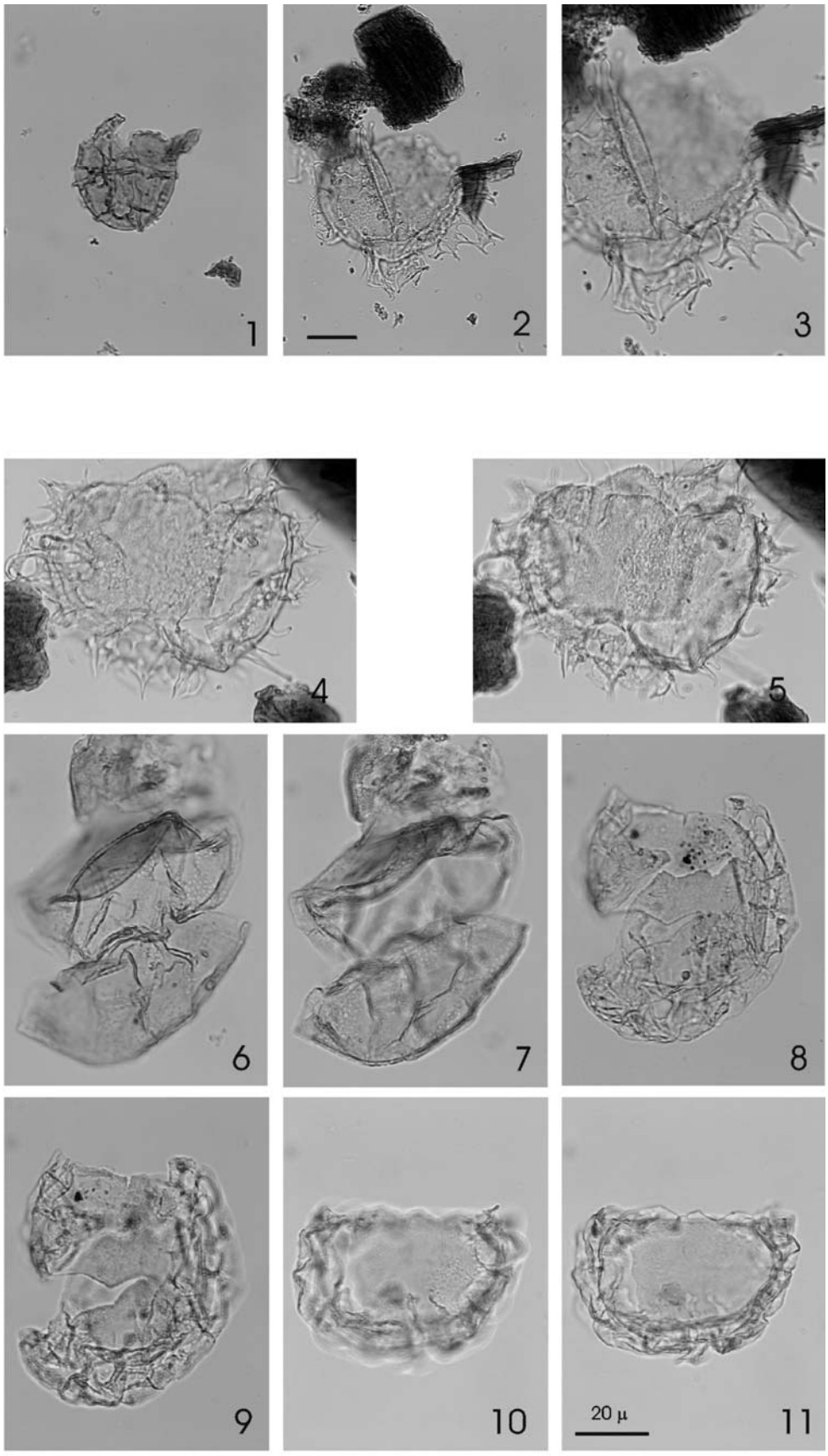
Figs 2–3 *Areoligera* cf. *medusettiformis* 39.0-20.9, 1685m-4, LVR 26622–623

Figs 4–5 *Glaphyrocysta* sp. 5 HNH Ralegh 38.9-5.0, 1685m-4, LVR 26624–625

Figs 6–7 *Dinopterigyum* sp. 1 HNH Ralegh 19.3-14.5, 1725m-3, LVR 26626–627

Figs 8–9 *Glaphyrocysta vicina* 39.8-14.1, 1725m-3, LVR 26628–629

Figs 10–11 *Glaphyrocysta vicina* 48.2-4.8, 1725m-3, LVR 26630–631



Ralegh N-18 Plate 10
1-5 1685 m
6-11 1725 m

RALEGH – PLATE 11

Figs 1–3 *Glaphyrocysta microfenestratum* 37.7-18.7, 1725m-2, LVR 26632 & 634–635

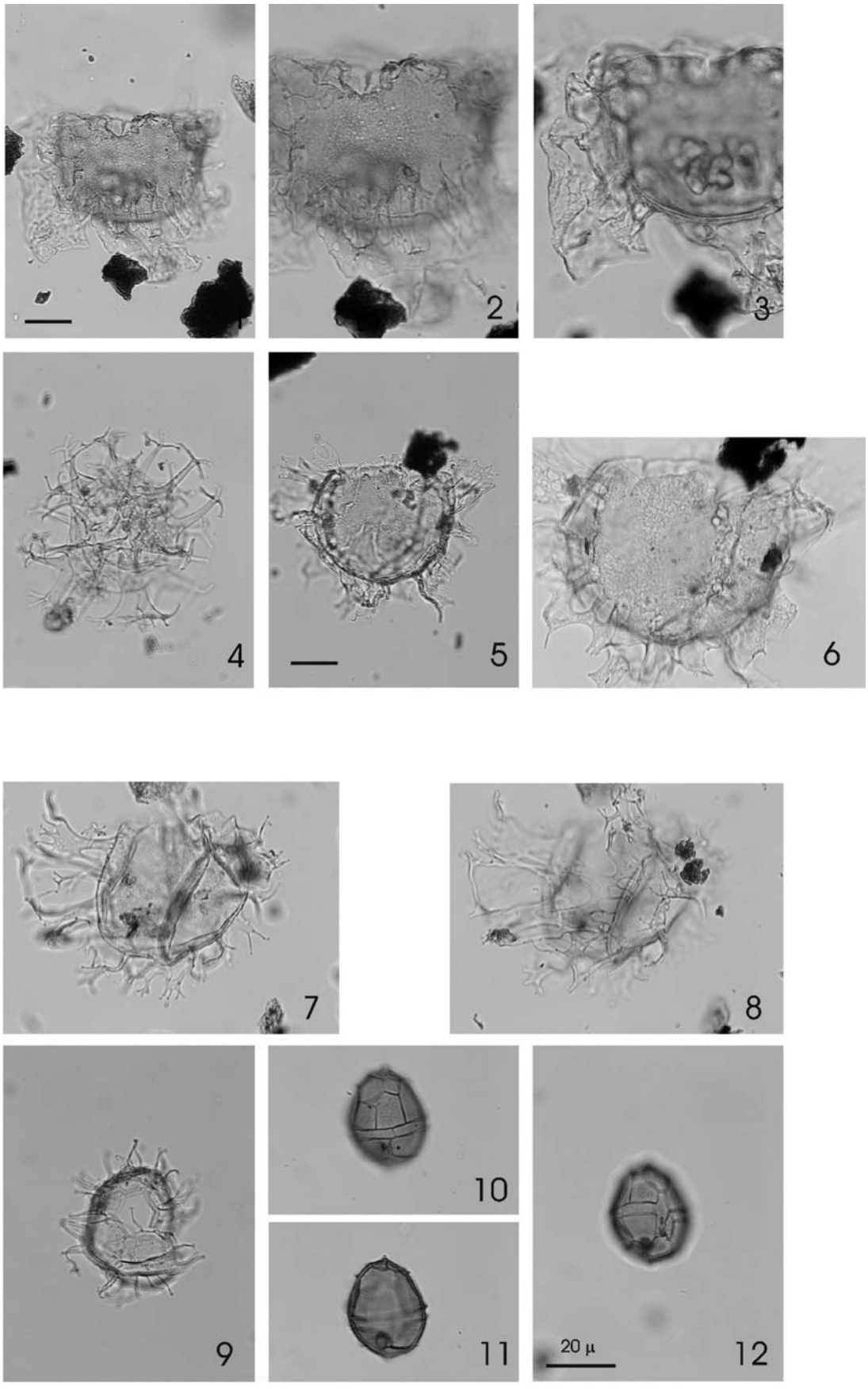
Fig. 4 *Spiniferites* sp. 2 HNH Ralegh 37.7-18.7, 1725m-2, LVR 26636

Figs 5–6 *Glaphyrocysta* sp. 6 HNH Ralegh 18.4-8.2, 1725m-2, LVR 26638–639

Figs 7–8 *Glaphyrocysta* sp. 7 HNH Ralegh 23.9-6.2, 1725m-2, LVR 26641–642

Fig. 9 *Phthanoperidinium comatum* 23.1-3.7, 1725m-4, LVR 26643

Figs 10–12 *Phthanoperidinium* cf. *regalis* 28.7-11.3, 1725m-4, LVR 26644–46



Ralegh N-18 Plate11
1-12 1725 m

RALEGH – PLATE 12

Figs 1–2 *Phthanoperidinium* cf. *regalis* 34.9-13.6, 1725m-4, LVR 26647–48

Figs 3–4 *Glaphyrocysta vicina* 45.9-7.7, 1725m-2, LVR 26649–650

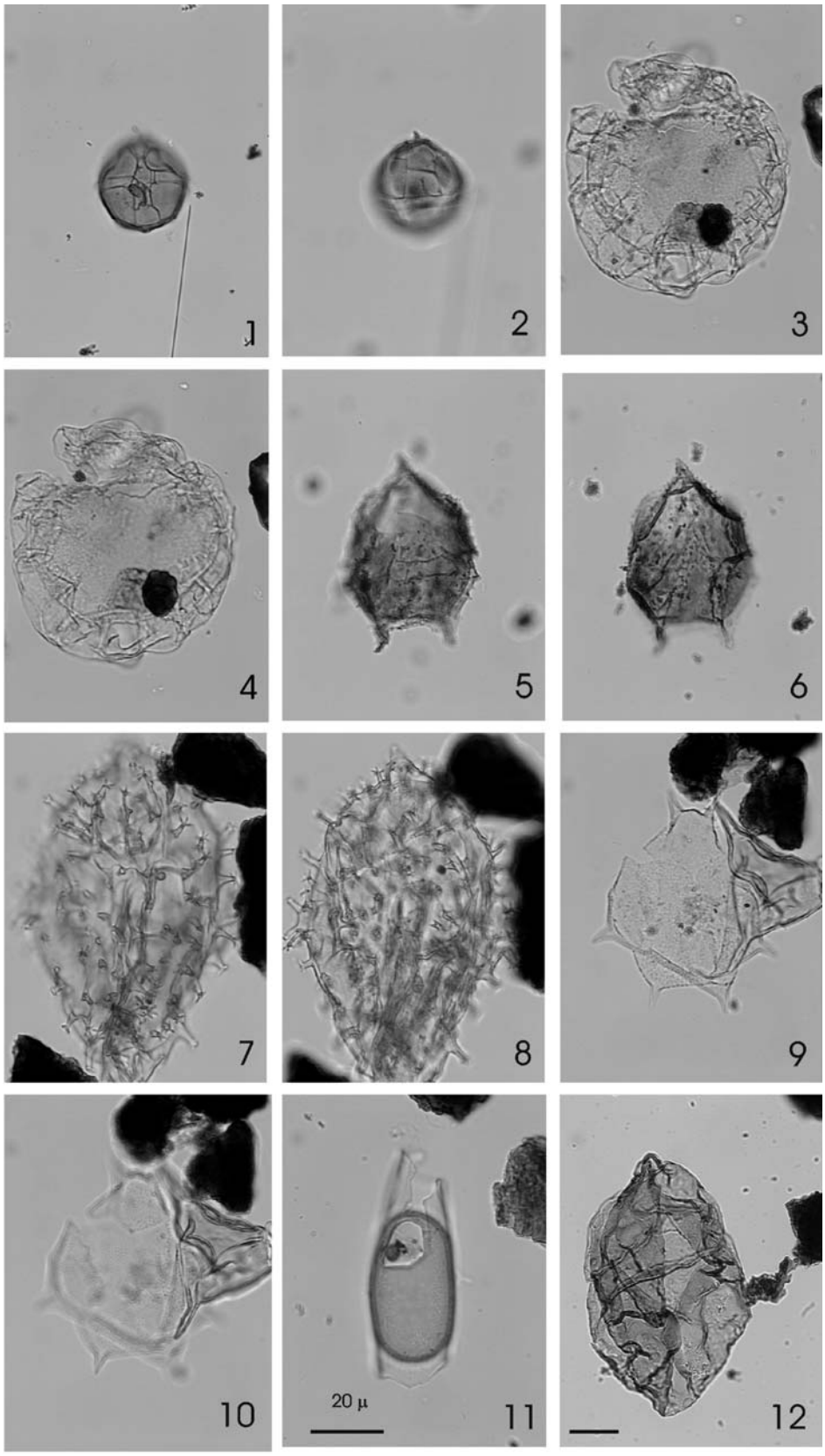
Figs 5–6 *Deflandrea denticulata* 50.0-11.0, 1725m-2, LVR 26651–652

Figs 7–8 *Wetzeliella articulata* 31.6-15.0, 1765m-2, LVR 26653–654

Figs 9–10 Gen *et* sp. indet SP/HNH 40.2-22.5, 1765m-3, LVR 26656–657

Fig. 11 *Svalbardella* cf. *hampendensis* 38.9-16.1, 1775m-3, LVR 26658

Fig. 12 *Leiosphaera* sp. 34.3-13.9, 1845m-2, LVR 26659



Ralegh N-18 Plate12
1-6 1725 m
7-10 1765 m
11 1775 m
12 1845 m

RALEGH – PLATE 13

Fig. 1 *Implectosphaeridium* sp. 1 HNH Ralegh 28.8-21.6, 1885m-3, LVR 26660

Figs 2–3 *Chiropterigium* sp. 1 HNH Ralegh 37.7-5.0, 1905m-2, LVR 26661–662

Fig. 4 *Dinopterigyum* sp. 1 HNH Ralegh 24.8-10.1, 1925m-2, LVR 26663

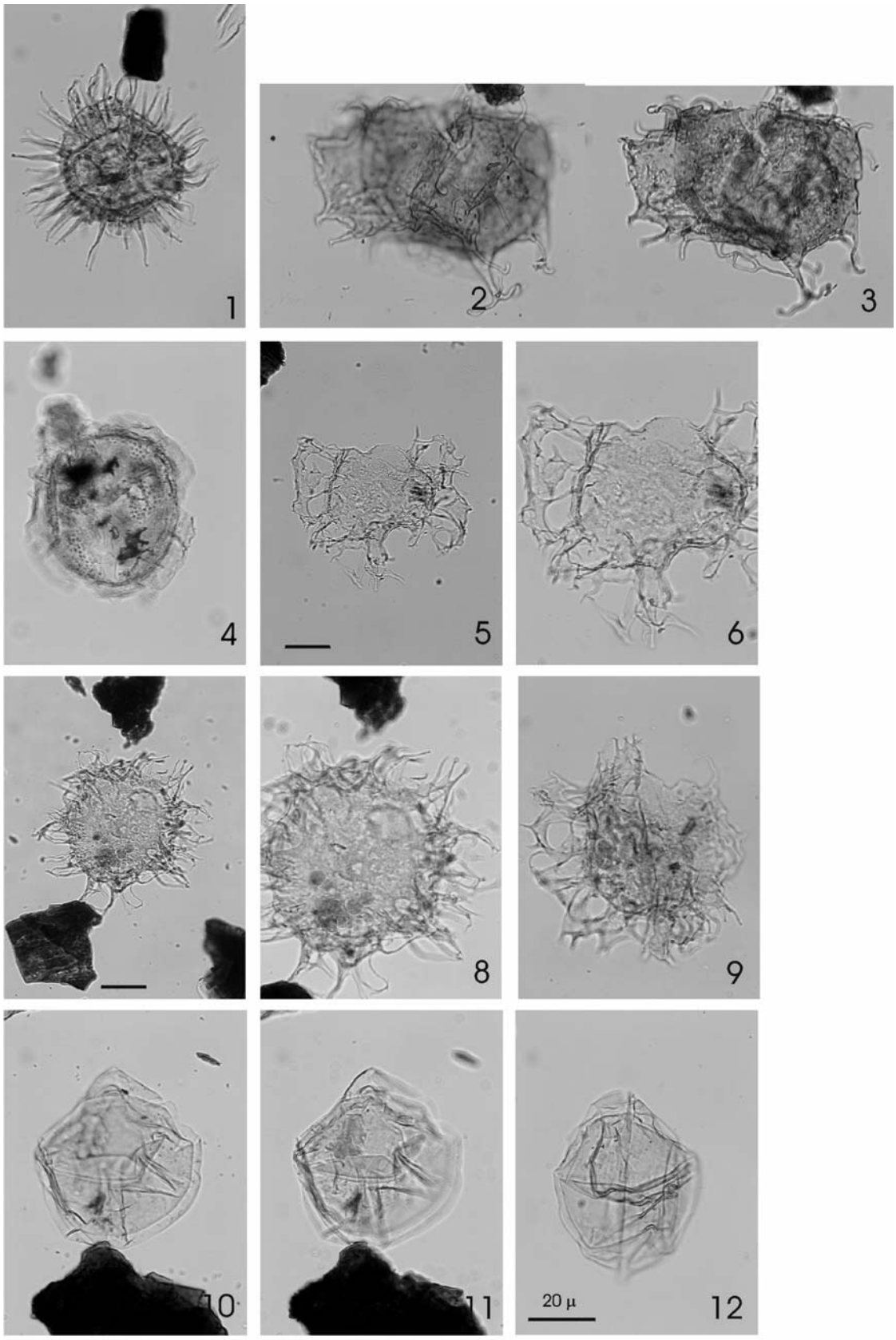
Figs 5–6 *Glaphyrocsta spineta* 19.3-10.3, 2205m-3, LVR 26664–665

Figs 7–8 *Glaphyrocsta ordinata* 27.9-19.1, 2205m-4, LVR 26667–668

Fig. 9 *Areoligera* cf. *medusettiformis* 32.8-11.3, 2205m-4, LVR 26669

Figs 10–11 *Deflandrea* sp. 2 HNH Ralegh 50.5-8.7, 2205m-4, LVR 26671–672

Fig. 12 *Deflandrea* sp. 1 HNH Ralegh 38.5-23.6, 2205m-2, LVR 26673



Ralegh N-18 Plate13
1 1885 m
2-3 1905 m
4 1925 m
5-12 2205 m

RALEGH – PLATE 14

Fig. 1 *Deflandrea denticulata*? 22.9-5.3, 2277m-3 SWC, LVR 26675

Fig. 2 *Spinidinium* sp. 1 HNH Ralegh 22.5-4.5, 2277m-3 SWC, LVR 26676

Fig. 3 *Deflandrea* sp. 1 HNH Ralegh 50.1-10.6, 2355m-4, LVR 26677

Fig. 4 *Deflandrea* sp. 1 HNH Ralegh 54.8-11.1, 2355m-3, LVR 26679

Fig. 5 *Tetraporina* sp. HNH Ralegh 20.5-23.4, 2385m-3, LVR 26680

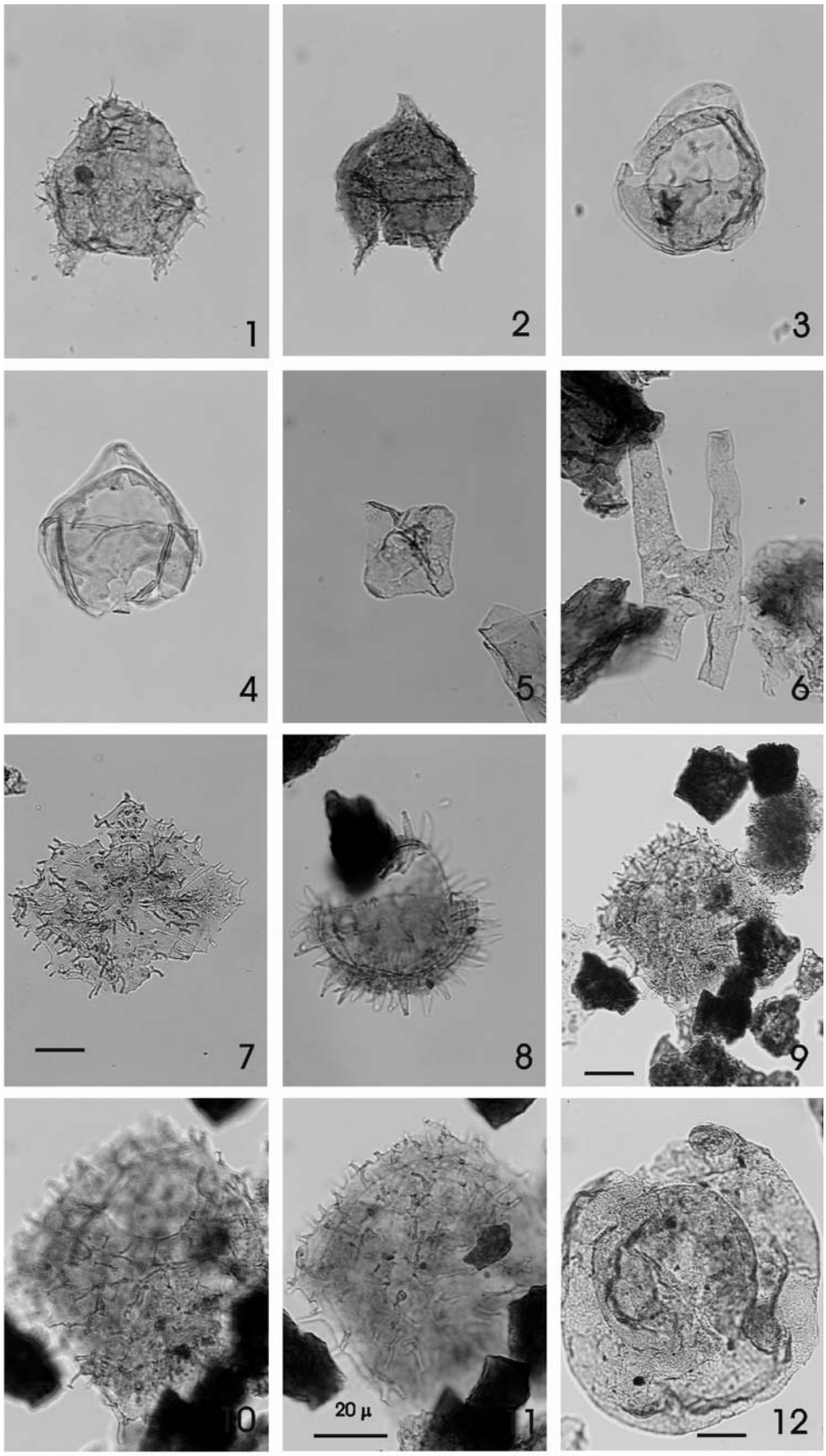
Fig. 6 *Tetraporina* sp. 1 HNH Ralegh 28.8-23.0, 2385m-3, LVR 26681

Fig. 7 *Wetzeliellsa* sp. 1 HNH Ralegh 52.9-9.6, 2385m-3, LVR 26682

Fig. 8 *Lingulodinium machaerophorum* 40.2-17.8, 2385m-3, LVR 26683

Figs 9–11 *Wetzeliella articulata* 27.8-14.1, 2385m-3, LVR 26684–685 & 687

Fig. 12 *Thalassiphora pelagica* 36.0-21.5, 2385m-3, LVR 26685



Ralegh N-18 Plate 14
1-2 2277 m SWC
3-4 2355 m
5-12 2385 m

RALEGH – PLATE 15

Figs 1–2 *Wetzeliellsa* sp. 1 HNH Ralegh 17.2-16.6, 2385m-4, LVR 26689–690

Figs 3–4 *Dracodinium* cf. *pachydermum* 25.6-15.9, 2385m-4, LVR 26693–694

Figs 5–7 *Dracodinium* cf. *pachydermum* 33.4-18.6, 2385m-4, LVR 26695 & 26698–699

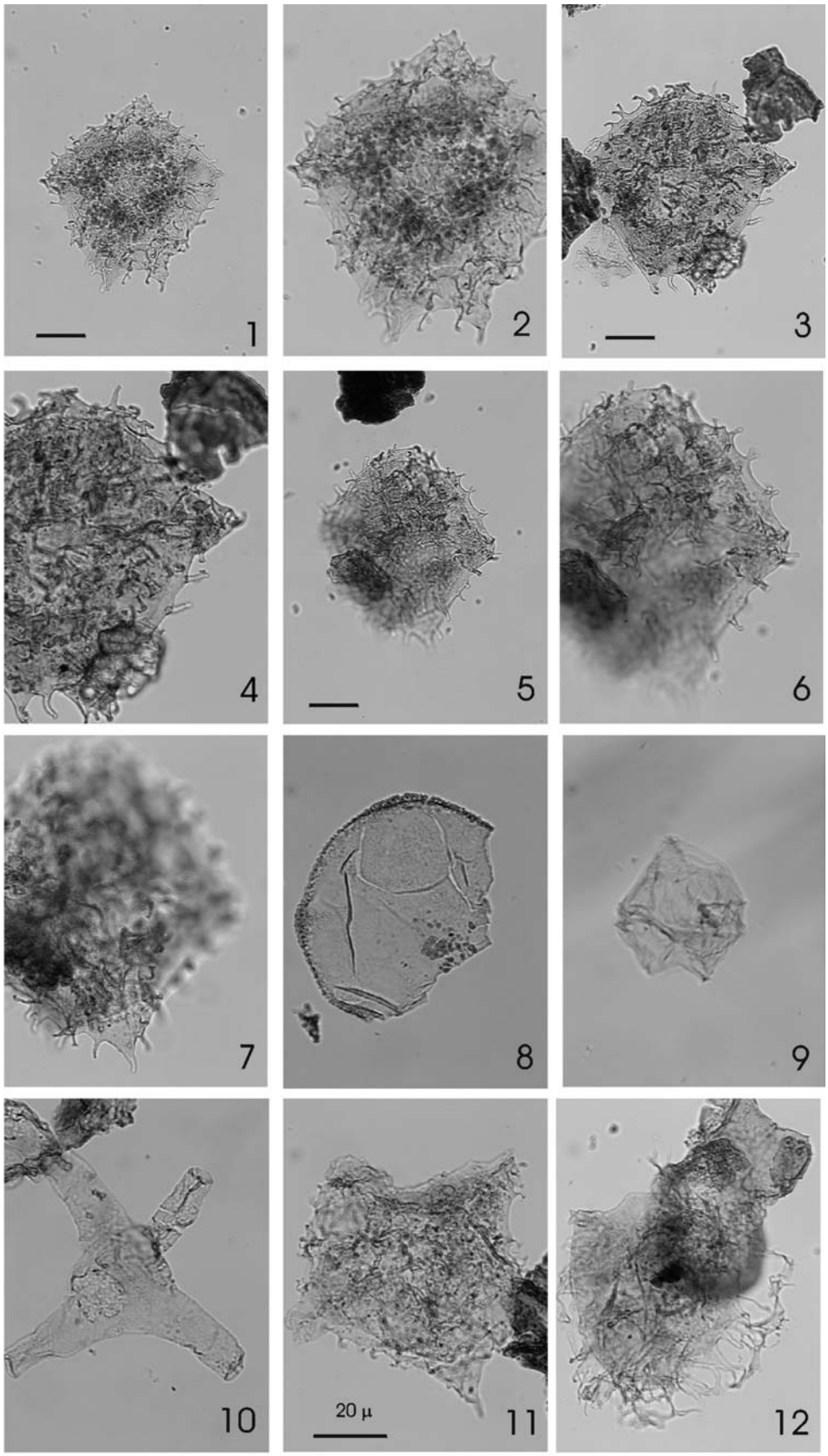
Fig. 8 *Wetzeliella* endocyst 26.3-6.3, 2385m-4, LVR 26700

Fig. 9 *Alterbidinium* sp. 18.7-19.9, 2405m-3, LVR 26701

Fig. 10 *Tetraporina* sp. 1 HNH Ralegh 54.7-7.1 2405m-3, LVR 26702

Fig. 11 *Dracodinium* sp. 1 HNH Ralegh 38.6-24.0, 2405m-3, LVR 26703

Fig. 12 *Glaphyrocsta spineta* 38.0-7.6, 2405m-3, LVR 26704



Ralegh N-18 Plate 15
1-8 2385 m
9-12 2405 m

RALEGH – PLATE 16

Figs 1–2 *Dracodinium* sp. 1 HNH Ralegh 44.3-23.0, 2405m-4, LVR 26708–709

Figs 3–4 *Dracodinium* sp. 1 HNH Ralegh 33.7-17.3, 2405m-4, LVR 26710–711

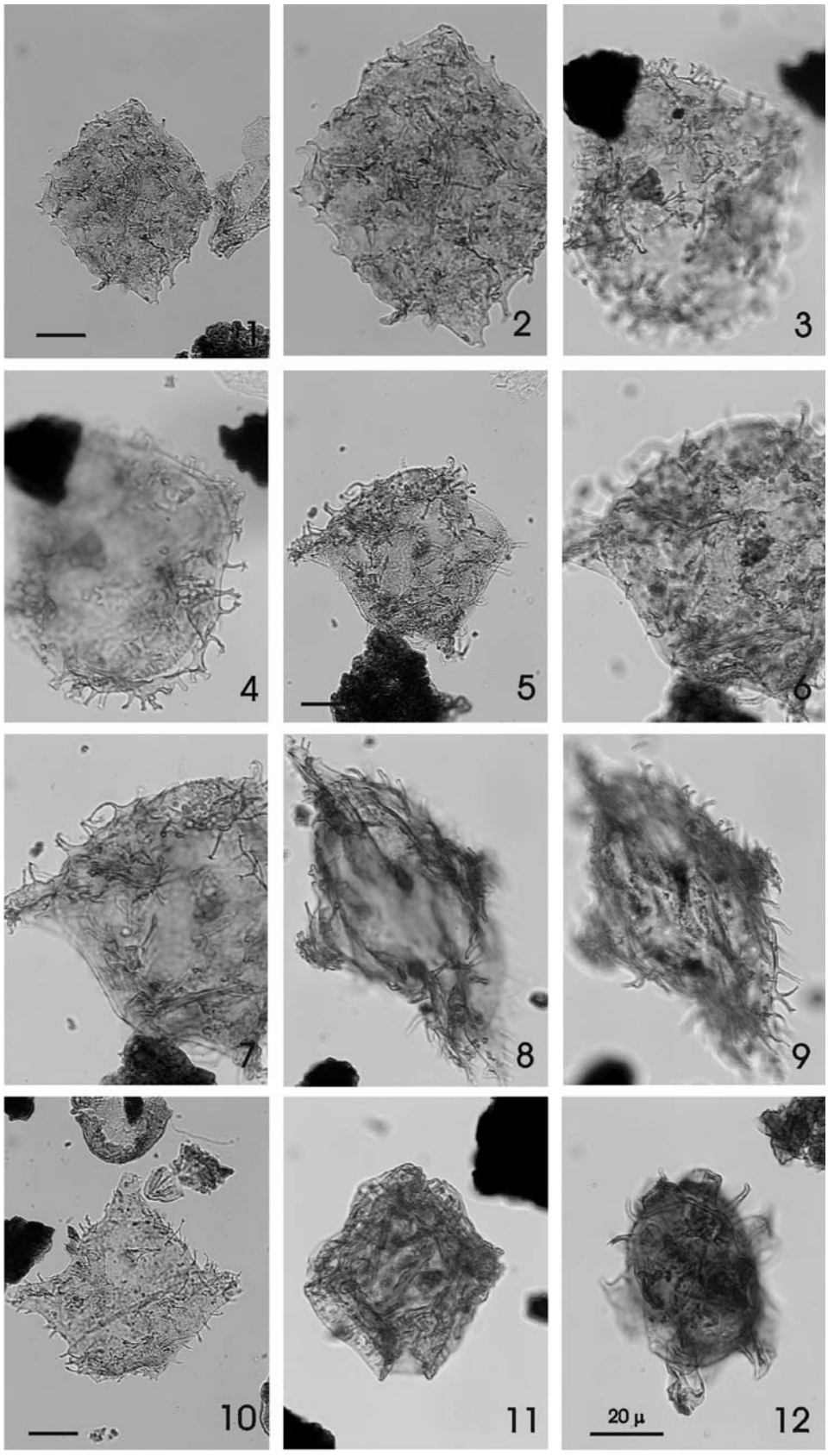
Figs 5–7 *Dracodinium* cf. *pachydermum* 45.4-6.8, 2565m-4, LVR 26712–713 & 26715

Figs 8–9 *Dracodinium* cf. *varielongitudum* 41.4-15.6, 2595m-2, LVR 26723–724

Fig. 10 *Dracodinium* sp. 39.9-14.3, 2595m-2, LVR 26725

Fig. 11 *Charlesdowniea collumna* 46.4-16.5, 2595m-4, LVR 26721

Fig. 12 *Hystricokolpoma* sp. 1 CHC 23.0-8.1, 2595m-5, LVR 26719



Ralegh N-18 Plate 16
1-4 2405 m
5-7 2565 m
8-12 2595 m

RALEGH – PLATE 17

Figs1–2 *Wetzeliella articulata* 44.1-18.4, 2605m-4, LVR 26726–727

Figs 3–4 *Homotryblium tenuispinosum* 37.0-14.0, 2605m-4, LVR 26728–729

Figs 5–6 *Apectodinium homomorphum* 49.2-13.4, 2645m-4, LVR 26730–731

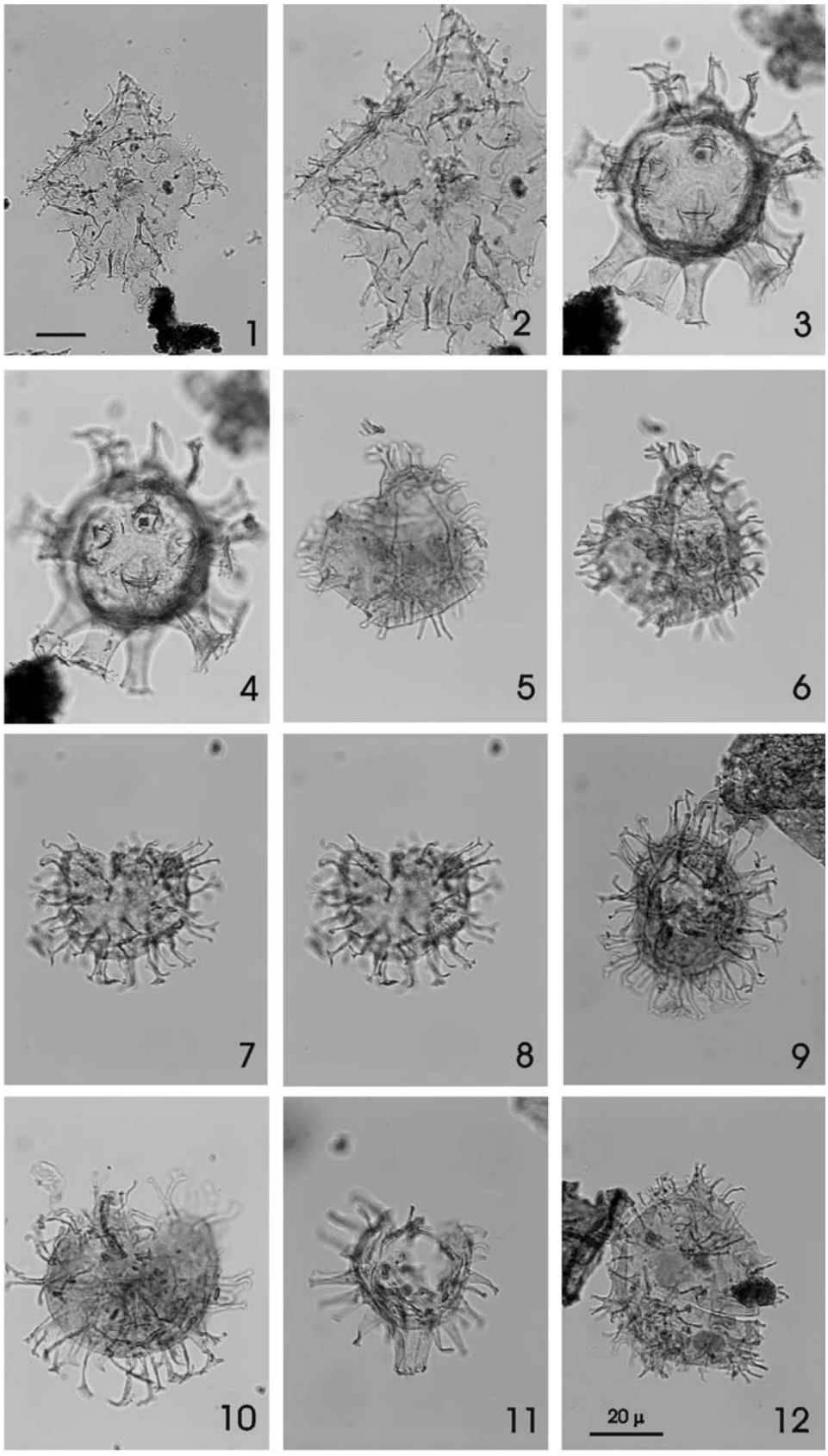
Figs 7–8 *Systematophora* cf. *placacantha* 17.3-21.7, 2680m-3, LVR 26732–733

Fig. 9 *Systematophora* cf. *placacantha* 20.2-10.9, 2680m-3, LVR 26734

Fig. 10 *Systematophora* cf. *placacantha* 20.6-3.5, 2680m-3, LVR 26735

Fig. 11 *Diphyes colligerum* 42.5-11.1, 2680m-4, LVR 26736

Fig. 12 *Apectodinium homomorphum* 29.9-7.6, 2680m-5, LVR 26737



Ralegh N-18 Plate 17
1-4 2605 m
5-6 2645 m
7-12 2680 m

RALEGH – PLATE 18

Figs 1–2 *Wetzeliella articulata* 26.3-3.4, 2725m-5, LVR 26738 & 741

Fig. 3 Gen *et* sp. indet SP/HNH 30.0-10.5, 2765m-3, LVR 26743

Fig. 4 *Wetzeliella* endocyst 39.4-10.5, 2765m-3, LVR 26744

Fig. 5 *Apectodinium quinquelatum* 48.3-12.2, 2805m-4, LVR 27796

Fig. 6 *Areoligera gippingensis/medusettiformis?* 17.1-16.3, 2835m-3, LVR 26748

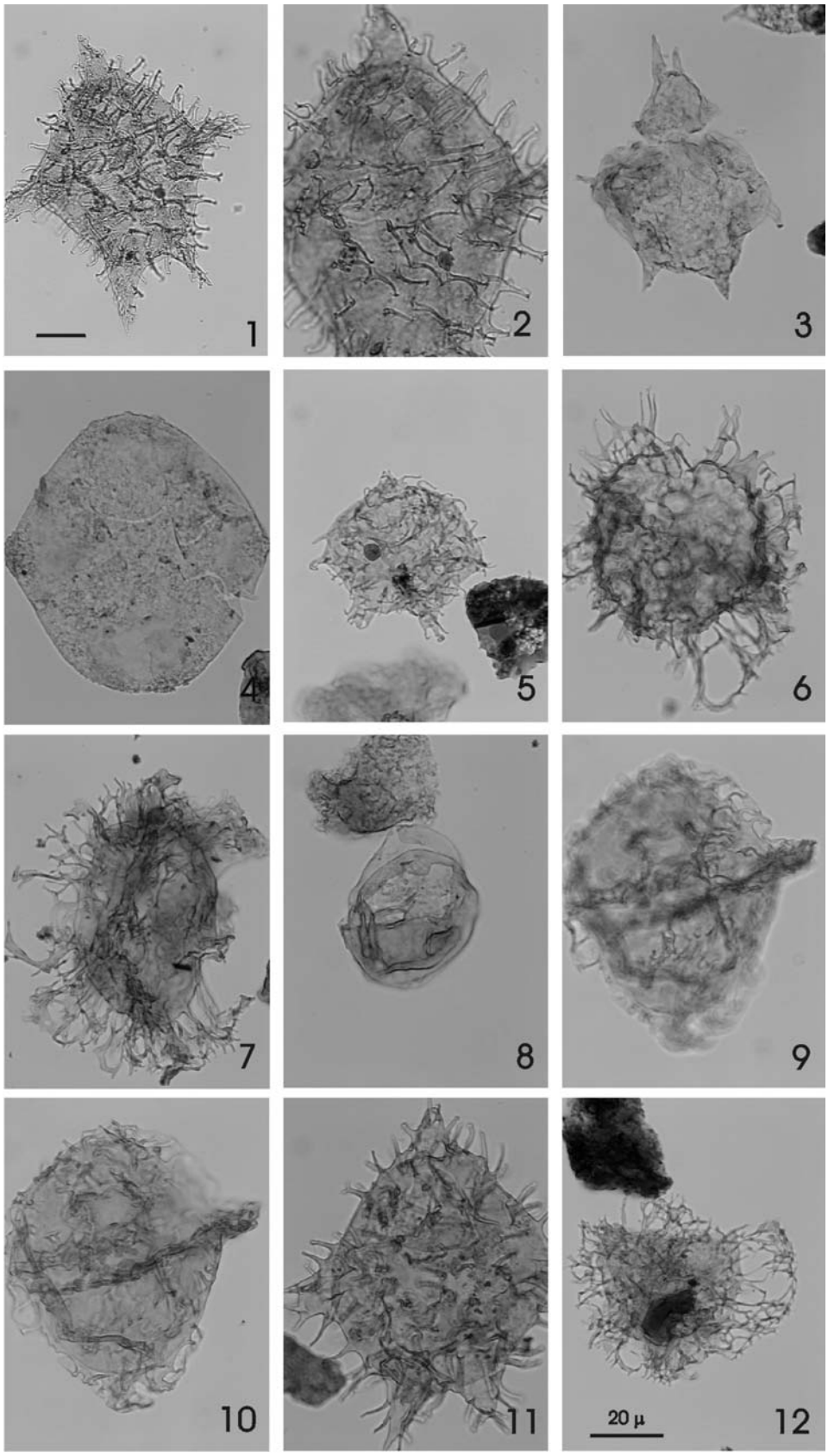
Fig. 7 *Areoligera gippingensis/medusettiformis?* 39.4-15.2, 2835m-3, LVR 26750

Fig. 8 *Deflandrea* sp. 2 HNH Ralegh 30.6-6.0, 2835m-3, LVR 26751

Figs 9–10 *Charlesdowniea coleothrypta* 19.8-2.9, 2835m-4, LVR 26752–753

Fig.11 *Wetzeliella articulata* 26.7-19.0, 2835m-5, LVR 26756

Fig. 12 *Glaphyrocysta* sp. 8 HNH Ralegh 36.3-15.0, 2835m-4, LVR 26757



Ralegh N-18 Plate 18
1-2 2725 m
3-5 2765 m
6-12 2835 m

RALEGH – PLATE 19

Fig. 1 *Azolla* sp. HNH Ralegh 25.1-8.3, 2885m-3, LVR 26758

Fig. 2 *Fibrocysta bipolaris*? 29.6-12.3, 2885m-3, LVR 26759

Fig. 3 *Glaphyrocysta spineta*? 42.2-13.7, 2885m-3, LVR 26761

Figs 4–5 *Wetzeliella articulata* 26.3-3.4, 2885m-3, LVR 26762 & 763

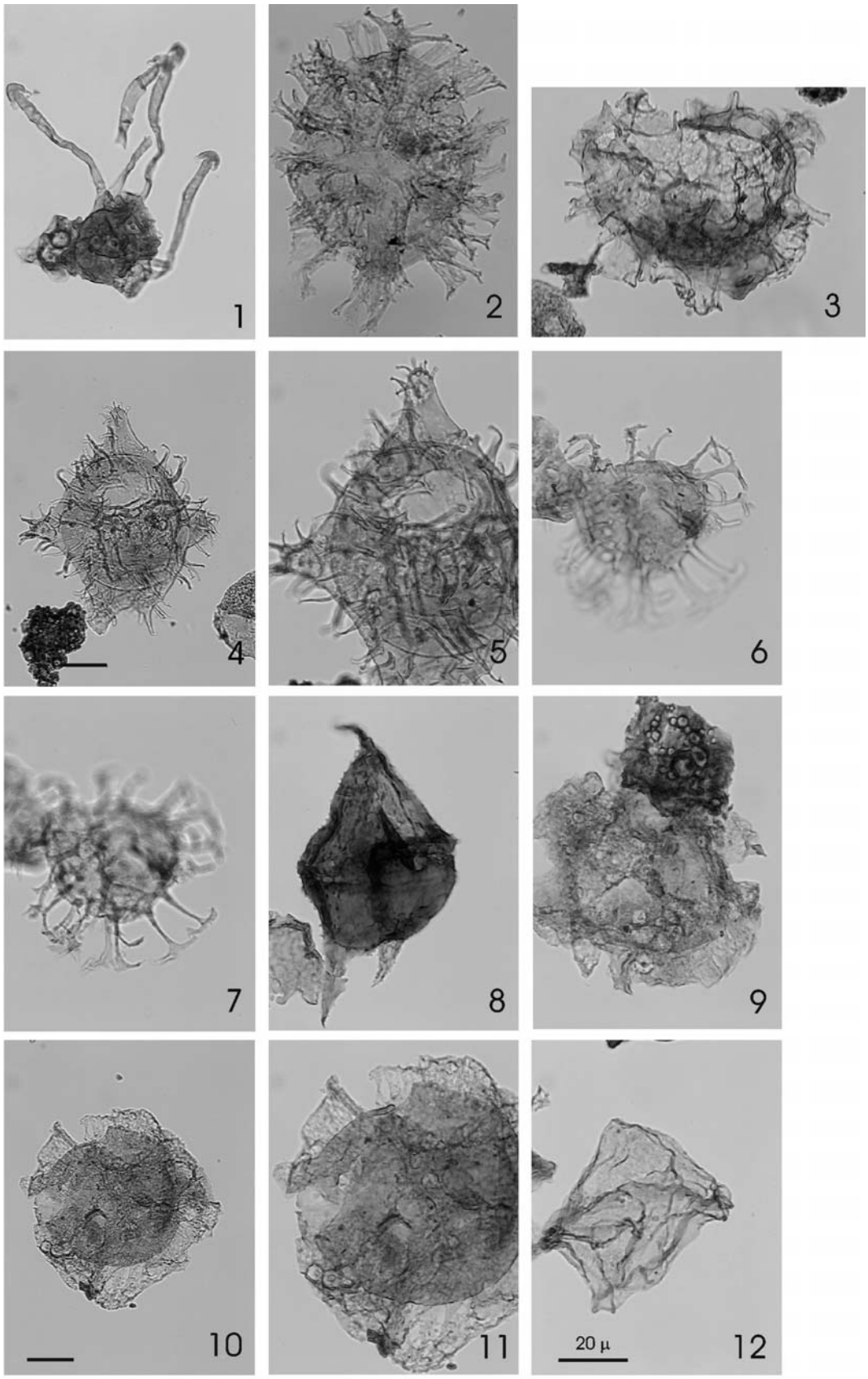
Figs 6–7 *Enneadocysta multicornuta* 23.2-13.4, 2885m-5, LVR 26764 & 765

Fig. 8 *Deflandrea denticulata* 21.3-4.4, 2910m-3, LVR 267566

Fig. 9 *Muratodinium fimbriatum* 18.1-21.4, 2910m-5, LVR 267568

Figs 10-11 *Muratodinium fimbriatum* 52.1-9.6, 2910m-4, LVR 267569–770

Fig. 12 *Lejeunecysta* sp. 1 HNH Ralegh 20.4-11.3, 2910m-5, LVR 267571



Ralegh N-18 Plate 19
1-7 2885 m
8-12 2910 m

RALEGH – PLATE 20

Fig. 1 *Areoligera senonensis* 33.9-13.8, 2955m-5, LVR 26772

Fig. 2 *Komewuia* sp. Ogmund 38.1-17.3 3005m-3, LVR26773

Fig. 3 *Komewuia* sp. Ogmund 50.2-4.7 3005m-3, LVR26774

Fig. 4 *Komewuia* sp. Ogmund 27.2-22.0 3005m-4, LVR26775

Fig. 5 *Komewuia* sp. Ogmund 41.6-6.9 3005m-4, LVR26776

Figs 6–7 *Komewuia* sp. Ogmund 28.4-21.5 3005m-5, LVR26777–778

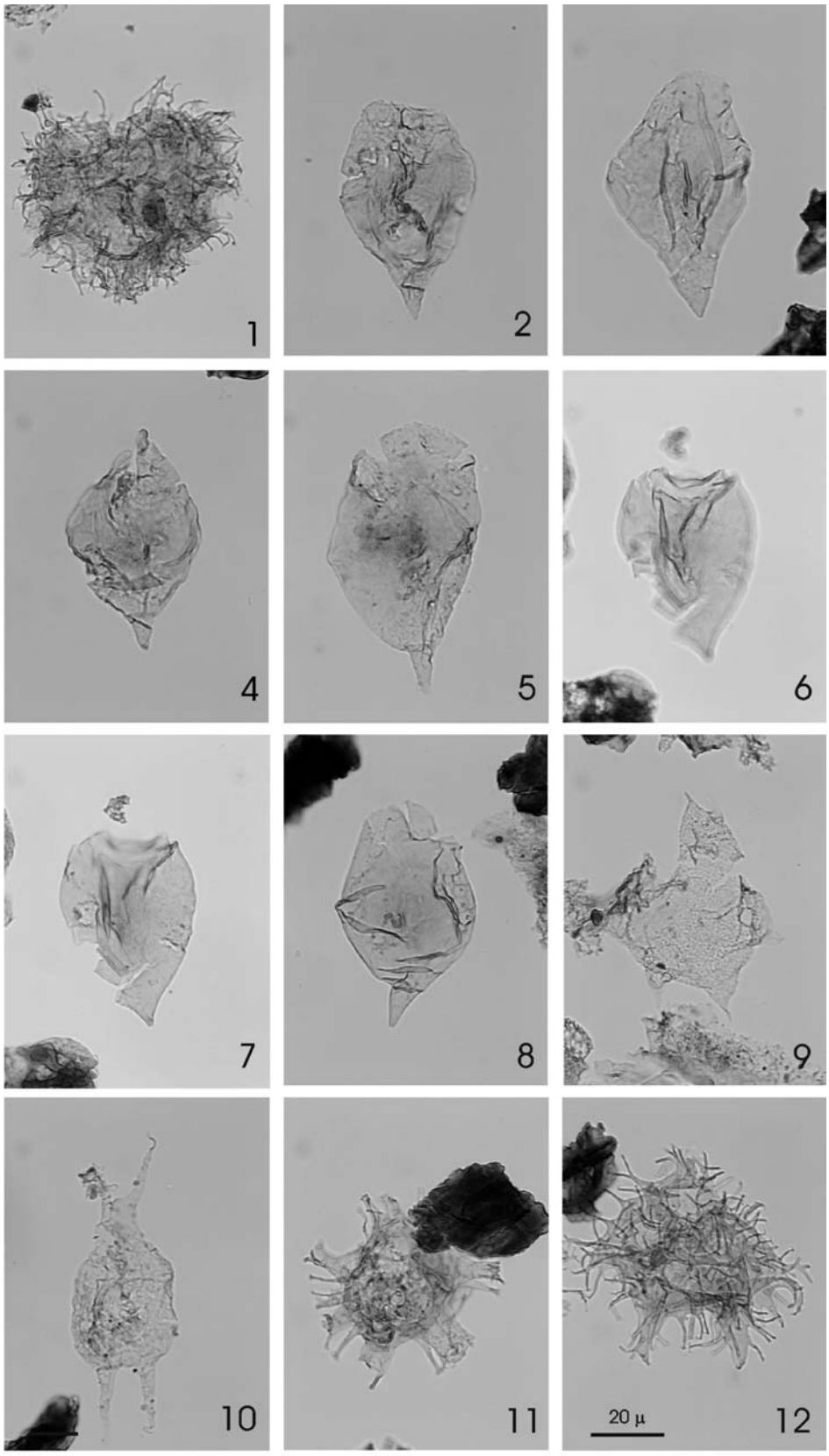
Fig. 8 *Komewuia* sp. Ogmund 28.9-19.9 3045m-3, LVR26779

Fig. 9 Gen *et* sp. indet SP/HNH 39.1-8.7 3045m-3, LVR26780

Fig. 10 Gen *et* sp. indet SP/HNH 23.6-14.8 3045m-3, LVR26782

Fig. 11 *Hystrichokolpoma* sp. 1 HNH Ralegh 44.0-21.2 3045m-3, LVR26783

Fig. 12 *Apectodinium hyperacanthum* 19.0-15.3 3210m-3, LVR26784



Ralegh N-18 Plate 20
1 2955 m
2-7 3005 m
8-11 3045 m
12 3210 m

RALEGH – PLATE 21

Fig. 1 *Glaphyrocysta ordinata* 44.3-22.5, 3210m-3, LVR 26785

Fig. 2 *Areoligera senonensis* 22.3-14.0, 3210m-3, LVR 26786

Fig. 3 *Enneadocysta multicornuta* 19.4-23.3, 3210m-4, LVR 26787

Fig. 4 *Areoligera* cf. *medusettiformis* 25.4-16.7, 3245m-3, LVR 26788

Fig. 5 Chorat cyst sp. 2 HNH Ralegh 29.1-8.2, 3245m-3, LVR 26789

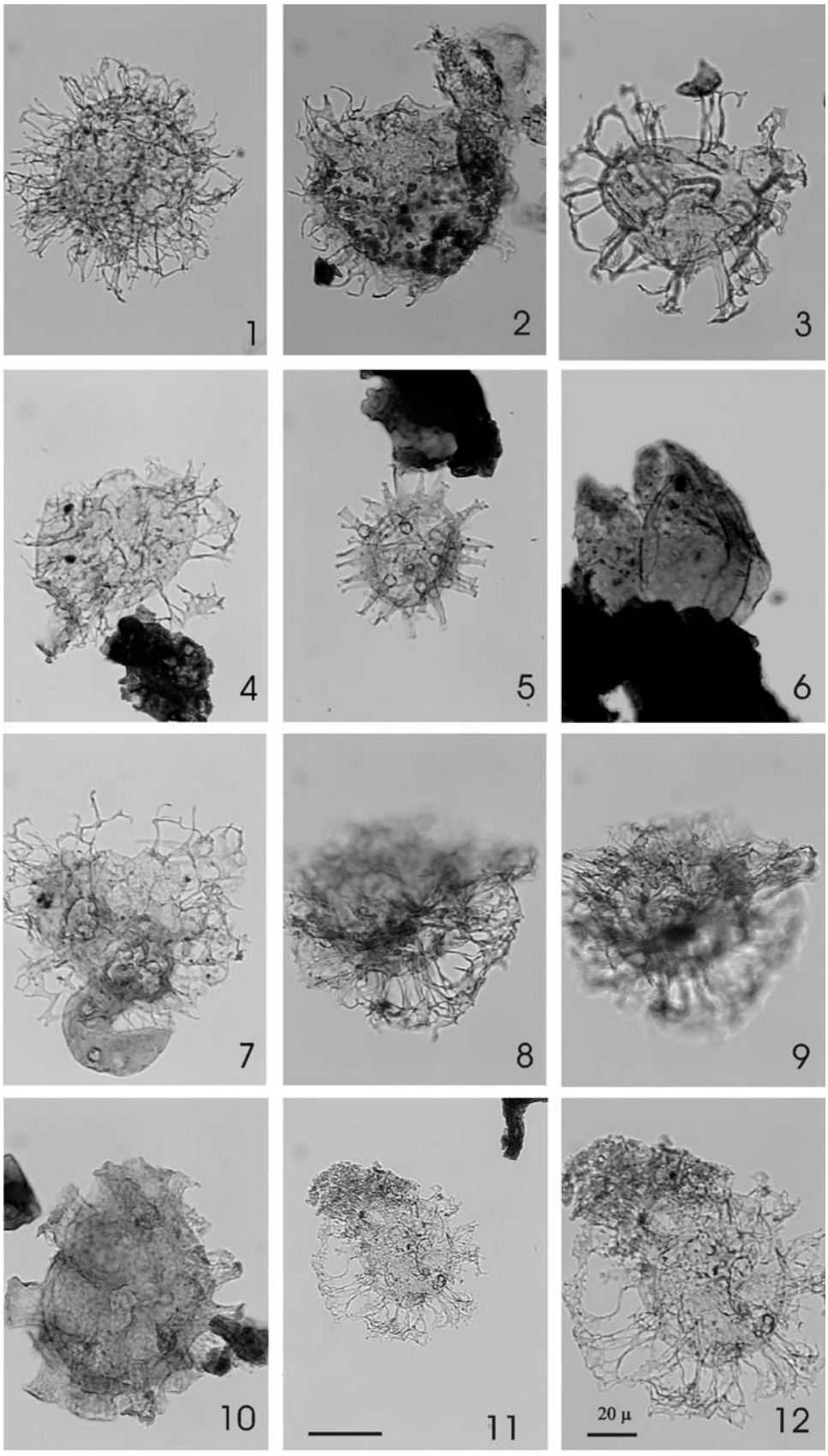
Fig. 6 *Dracodinium condylos ?* 36.0-3.5, 3245m-3, LVR 26790

Fig. 7 *Areoligera* cf. *medusettiformis* 28.6-11.6, 3255m-4, LVR 26791

Figs 8–9 *Glaphyrocysta pastielsii* 46.0-6.6, 3285m-3, LVR 26792–793

Fig. 10 *Muratodinium fimbriatum* 19.3-23.3, 3325m-3, LVR 26794

Figs 11–12 *Glaphyrocysta pastielsii* 53.6-19.9, 3325m-3, LVR 26795–796



Ralegh N-18 Plate 21
1- 3 3210 m, 4-6 3245 m,
7 3255 m, 8-9 3285 m,
10-12 3325 m
26785-26796

RALEGH – PLATE 22

Figs 1–2 *Glaphyrocysta pastielsii* 23.6-9.3, 3325m-4, LVR 26797–798

Fig. 3 *Glaphyrocysta pastielsii* 18.4-4.7, 3325m-5, LVR 26799

Fig. 4 *Glaphyrocysta pastielsii* 21.5-19.6, 3325m-5, LVR 26800

Fig. 5 *Paralecaniella indentata* 35.8-3.7, 3329m-3 SWC, LVR 26801

Fig. 6 *Apectodinium homomorphum* 27.3-5.5, 3365m-3, LVR 26802

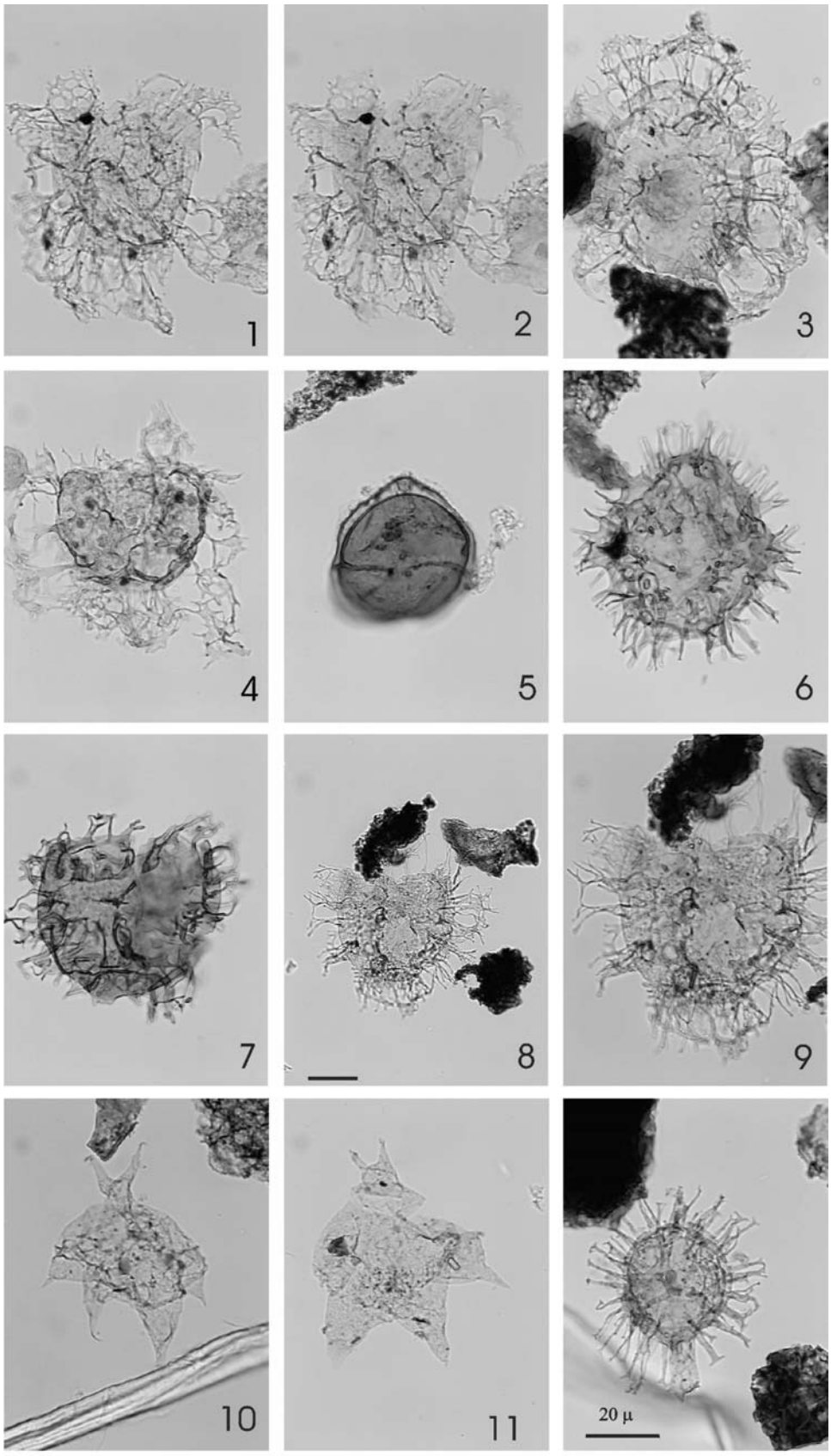
Fig. 7 *Areoligera senonensis* 24.2-20.3, 3365m-3, LVR 26804

Figs 8–9 *Glaphyrocysta ordinata* 21.3-22.2, 3405m-3, LVR 26809–810

Fig. 10 Gen *et* sp. indet SP/HNH 20.8-16.9 3405m-3, LVR26813

Fig. 11 Gen *et* sp. indet SP/HNH 33.0-18.6 3425m-4, LVR26814

Fig. 12 *Diphyes colligerum* 44.5-19.9, 3425m-3, LVR 26816



Ralegh N-18 Plate 22
1- 4 3325 m, 5 3329 m,
6-7 3365 m, 8-10 3405 m,
11-12 3425 m
26797-26816

RALEGH – PLATE 23

Fig. 1 *Areoligera senonensis* 15.5-13.1, 3445m-3, LVR 26817

Figs 2–3 *Muratodinium fimbriatum*? 19.1-20.2, 3465m-5, LVR 26818–19

Fig. 4 *Areoligera senonensis* 44.5-14.9, 3465m-5, LVR 26820

Fig. 5 *Areoligera senonensis* 16.9-18.0, 3465m-4, LVR 26821

Fig. 6 *Areoligera senonensis* 15.6-14.8, 3465m-3, LVR 26822

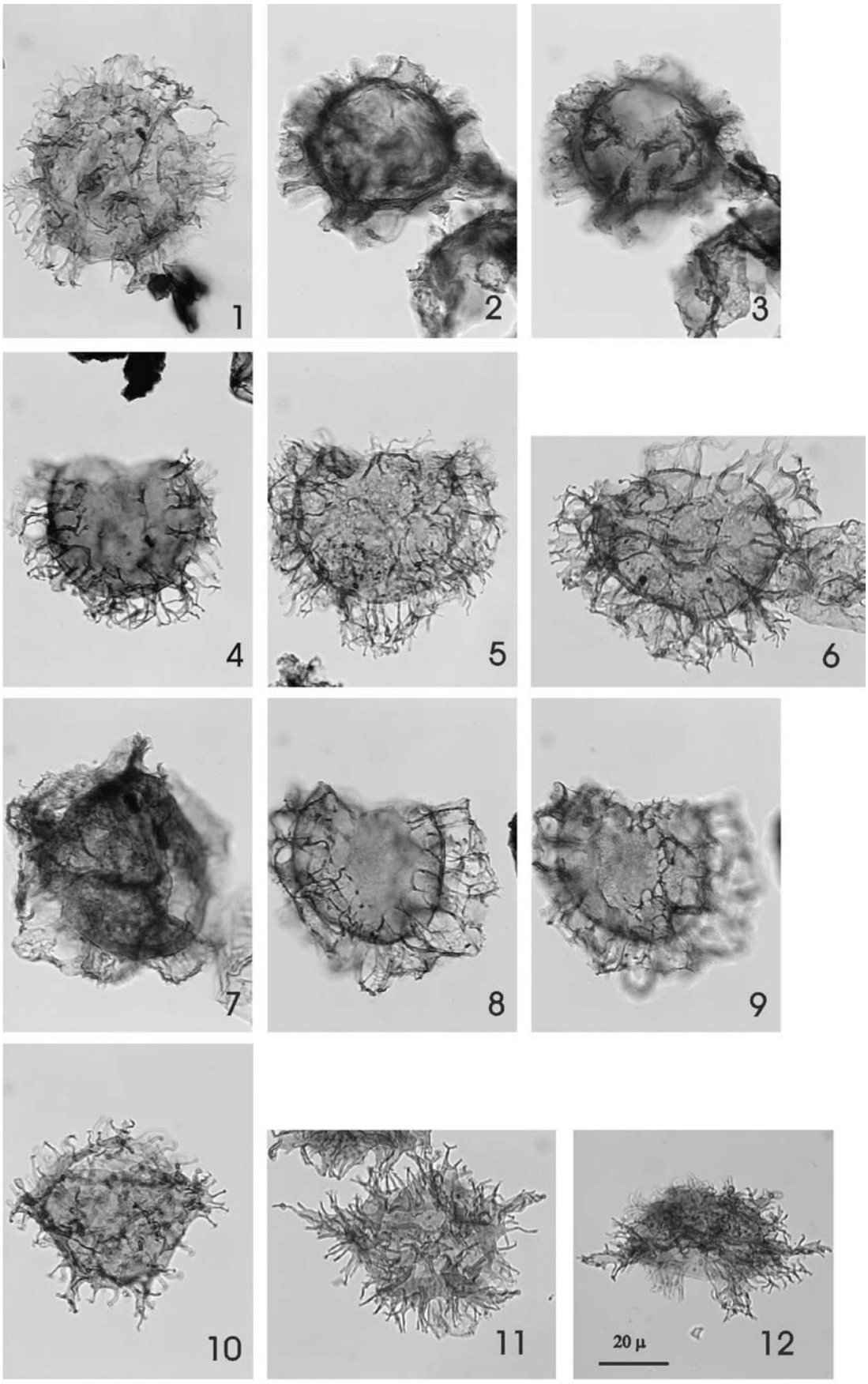
Fig. 7 *Muratodinium fimbriatum* 22.9-26.0, 3465m-3, LVR 26823

Figs 8–9 *Glaphyrocysta pastielsii* 17.8-12.6, 3465m-4, LVR 26824–825

Fig. 10 *Apectodinium quinquelatum* 31.7-25.3, 3465m-3, LVR 26826

Fig. 11 *Apectodinium* cf. *augustum*? 21.6-8.1, 3465m-3, LVR 26828

Fig. 12 *Apectodinium* cf. *augustum*? 18.1-4.6, 3465m-3, LVR 26829



Ralegh N-18 Plate 23
1 3425 m, 2-12 3465 m
26817-26829

PLATE 24

Fig. 1 *Muratodinium fimbriatum* 20.5-12.7, 3480m-3, LVR 26830

Fig. 2 *Muratodinium fimbriatum* 28.0-12.8, 3480m-3, LVR 26832

Fig. 3 *Apectodinium hypercanthum* 23.3-6.5, 3480m-3, LVR 26833

Fig. 4 *Fibrocysta bipolaris* 21.4-21.1, 3480m-3, LVR 26834

Fig. 5 *Fibrocysta bipolare* 47.0-23.1, 3480m-4, LVR 26835

Fig. 6 *Spiniferites septatus* 47.4-3.9, 3480m-3, LVR 26836

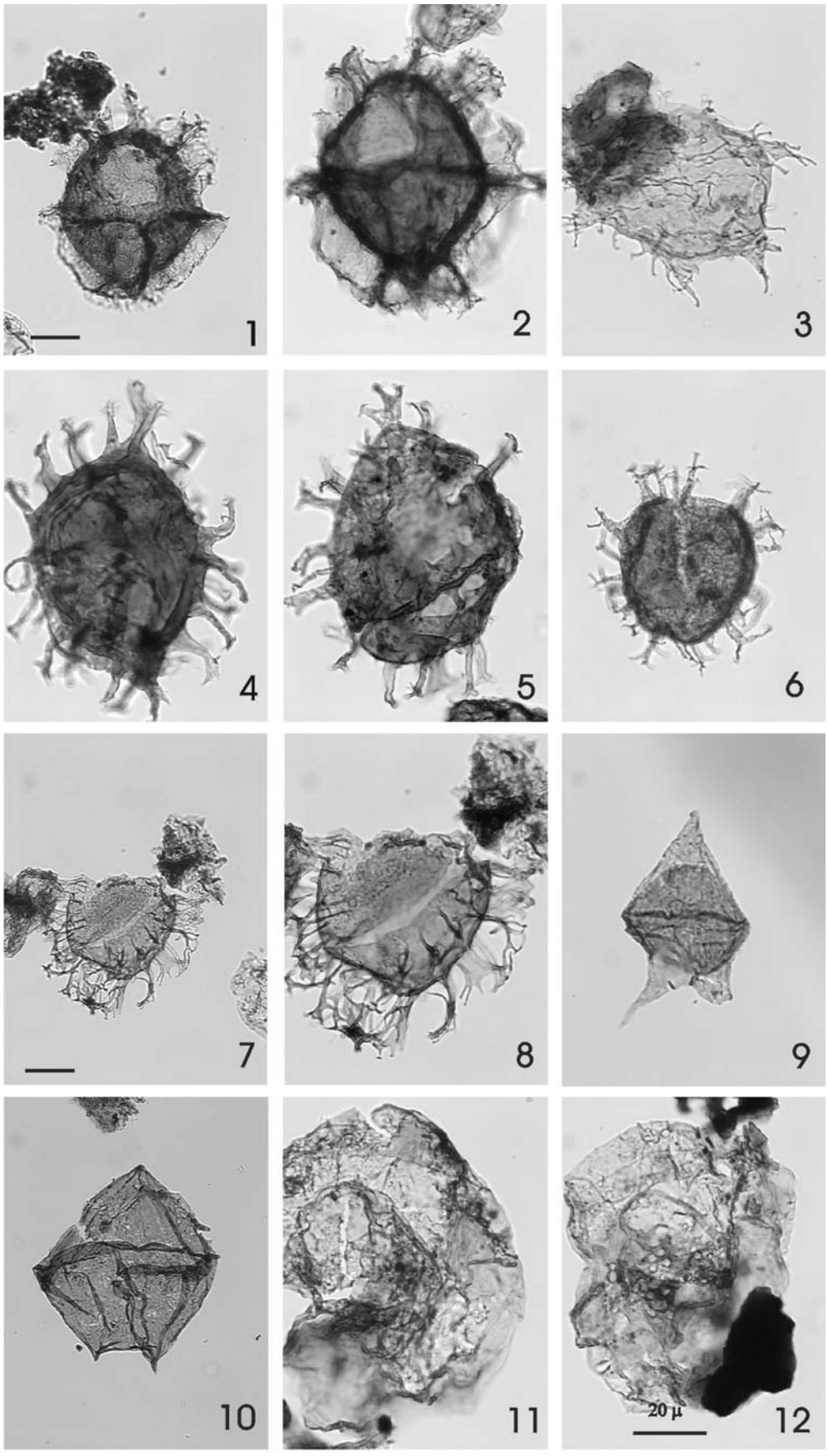
Figs 7–8 *Glaphyrocysta ordinata* 21.2-9.8, 3480m-4, LVR 26837–838

Fig. 9 *Cerodinium depressum* 46.4-23.8, 3480m-4, LVR 26839

Fig. 10 *Lejeunecysta hyalina* 33.2-13.6, 3480m-5, LVR 26840

Fig. 11 *Thalassiphora delicata* 22.2-6.9, 3515m-5, LVR 26841

Fig. 12 *Thalassiphora delicata* 46.3-18.7, 3515m-3, LVR 26843



Ralegh N-18 Plate 24
1-10 3480 m, 11-12 3515 m
26830-26843

RALEGH – PLATE 25

Figs 1–2 *Areoligera gippingensis* 37.9-16.9, 3535m-3, LVR 26844–845

Fig. 3 *Cerodinium speciosum*? 26.2-20.5, 3535m-3, LVR 26847

Fig. 4 *Areoligera gippingensis* 20.7-15.3, 3565m-3, LVR 26848

Fig. 5 *Cerodinium speciosum glabrum* 45.8-20.1, 3605m-3, LVR 26849

Fig. 6 *Cerodinium speciosum glabrum* 20.7-13.9, 3605m-4, LVR 26850

Fig. 7 *Deflandrea oebisfeldensis* 23.6-12.4, 3605m-4, LVR 26851

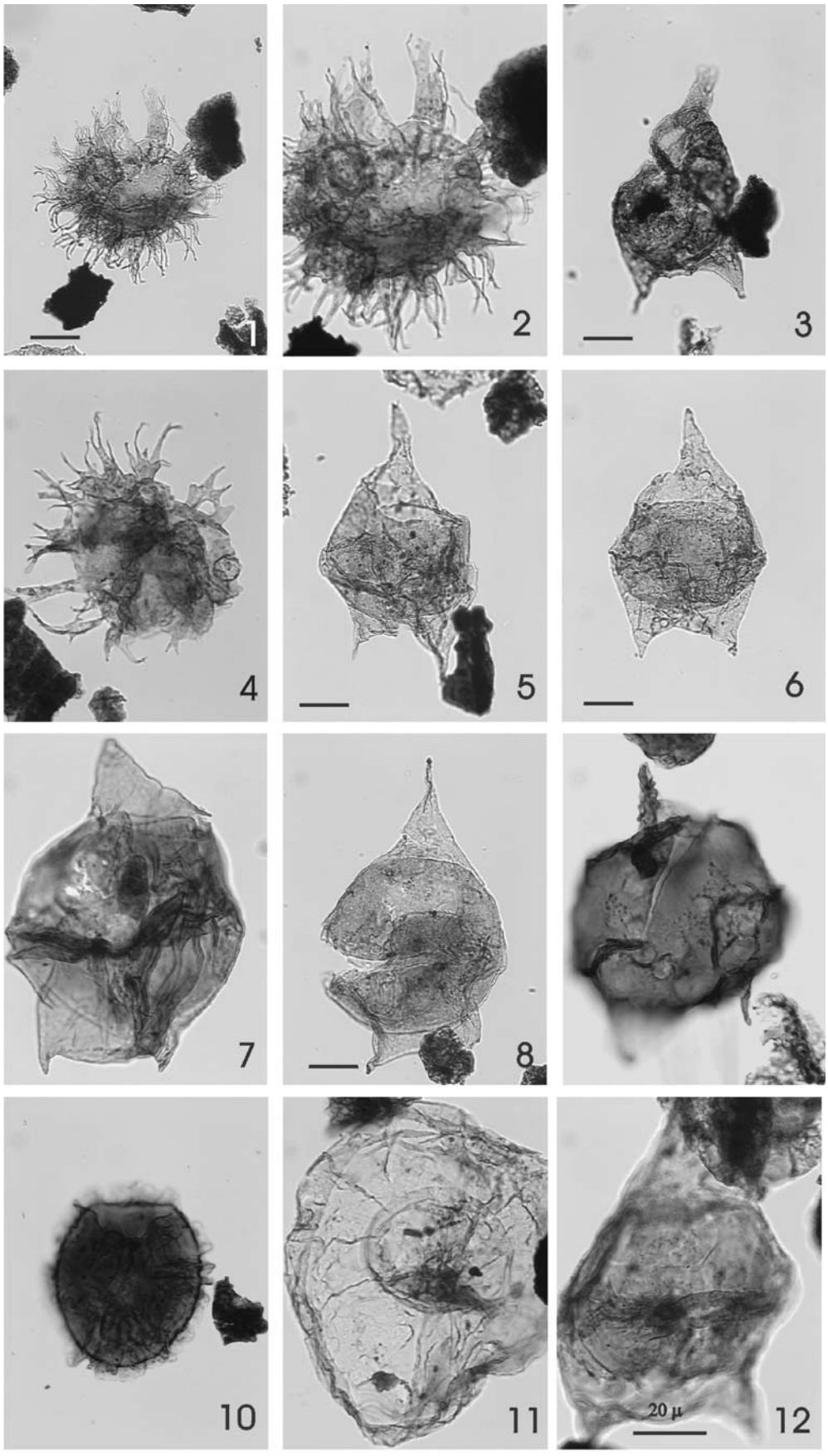
Fig. 8 *Cerodinium speciosum glabrum* 35.0-21.0, 3605m-4, LVR 26852

Fig. 9 *Cerodinium speciosum*? 23.5-18.6, 3605m-3, LVR 26853

Fig. 10 *Alisocysta margarita* 32.3-14.9, 3605m-3, LVR 26855

Fig. 11 *Thalassiphora delicata* 34.0-14.0, 3605m-5, LVR 26855

Fig. 12 *Deflandrea oebisfeldensis* 40.1-22.8, 3605m-5, LVR 26860



Ralegh N-18 Plate 25
1-3 3535 m, 4 3565 m, 5-12 3605 m
26844-26860

RALEGH – PLATE 26

Fig. 1 *Cerodinium striatum* 29.2-18.1, 3645m-3, LVR 26861

Fig. 2 *Cerodinium striatum* 19.0-24.1, 3645m-4, LVR 26862

Fig. 3 *Deflandrea* sp. 3 HNH Ralegh 49.3-15.0, 3805m-3, LVR 26863

Fig. 4 *Deflandrea* sp. 3 HNH Ralegh 33.5-15.4, 3805m-4, LVR 26864

Fig. 5 *Deflandrea* sp. 3 HNH Ralegh 46.7-19.5, 3805m-4, LVR 26865

Fig. 6 *Deflandrea* sp. 3 HNH Ralegh 48.6-12.9, 3805m-4, LVR 26866

Fig. 7 *Alisocysta margarita* 52.7-22.9, 3835,9m-3 SWC, LVR 26867

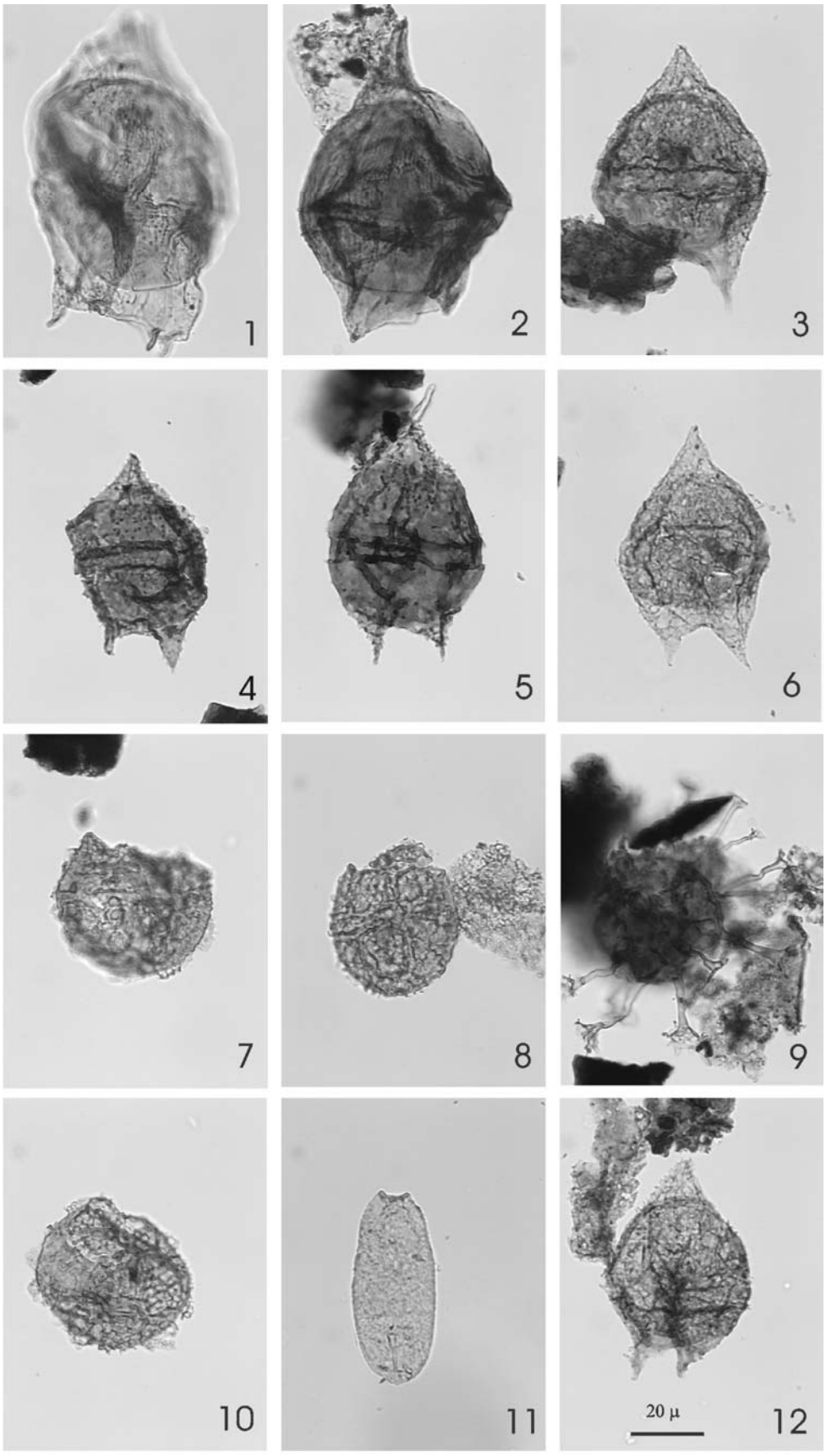
Fig. 8 *Alisocysta margarita* 55.2-23.2, 3835,9m-3 SWC, LVR 26868

Fig. 9 *Hystrichosphaeridium tubiferum* 42.7-15.8, 3835,9m-4 SWC, LVR 26869

Fig. 10 *Alisocysta margarita* 21.0-22.0, 3835,9m-2 SWC, LVR 26870

Fig. 11 *Fromea laevigata* 25.5-19.9, 3840m-4, LVR 26871

Fig. 12 *Deflandrea* sp. 3 HNH Ralegh 33.5-14.3, 3840m-4, LVR 26872



Ralegh N-18 Plate 26
1-2 3645 m, 3-6 3805 m, 7-10 3835 m,
11-12 3840 m
26861-26872

GEUS
Report file no.
Enclosure
25614 (01/01)

ENCLOSURE 1 | SHEET: 1 | SCALE: 1: 4000 | Groups: A D S P E J | Complete spp. set

GEUS

RALEGH N 18 (1365 - 3840m)

DEPTH | SYSTEM | STAGE | PALYNO. ZONES | SAMPLES

PALAEOGENE
N EOCENE — U EOCENE — E4 — E3b — E3a — E2b — E1/P6 — P6 — P5
L EOCENE — U PALEOCENE

1365.00 — 1405.00 — 1445.00 — 1485.00 — 1525.00 — 1565.00 — 1605.00 — 1645.00 — 1685.00 — 1725.00 — 1765.00 — 1779.00 — 1785.00 — 1805.00 — 1845.00 — 1885.00 — 1905.00 — 1925.00 — 1965.00 — 2005.00 — 2032.00 — 2045.00 — 2125.00 — 2165.00 — 2205.00 — 2240.00 — 2277.00 — 2285.00 — 2325.00 — 2355.00 — 2385.00 — 2387.00 — 2405.00 — 2445.00 — 2485.00 — 2495.00 — 2565.00 — 2595.00 — 2605.00 — 2645.00 — 2650.00 — 2680.00 — 2725.00 — 2745.00 — 2765.00 — 2805.00 — 2835.00 — 2885.00 — 2910.00 — 2955.00 — 3005.00 — 3045.00 — 3085.00 — 3125.00 — 3165.00 — 3210.00 — 3245.00 — 3265.00 — 3285.00 — 3329.00 — 3365.00 — 3385.00 — 3405.00 — 3425.00 — 3445.00 — 3465.00 — 3480.00 — 3515.00 — 3535.00 — 3565.00 — 3605.00 — 3645.00 — 3685.00 — 3725.00 — 3765.00 — 3805.00 — 3835.00 — 3840.00

1 Acritarch spp.
2 G.et sp indet Piasecki 1992
3 Leiosphaera spp.
4 Schizocystia spp.
5 Spiniferites spp.
6 Areoligera cf.medusettiformis
7 Glaphyrocysta inculta
8 Glaphyrocysta cf.texta
9 Phthanoperidinium comatum
10 Cribroperidinium spp.
11 Operculodinium centrocarpum
12 Dinocyst 01 HNH
13 Charlesdowniea clathrata
14 Charlesdowniea coleothrypta
15 Areosphaeridium cf.michoudii
16 Lentinia serrata
17 Thalassiphora fenestrata
18 Heteraulacacysta leptalea
19 Deflandrea phosphoritica
20 Wetzeliella cf.articulata
21 Deflandrea? sp 1 HNH
22 Glaphyrocysta cf.vicina
23 Chiropteridium spp.
24 Systematophora placacantha
25 Achomosphaera spp.
26 Areosphaeridium diktyoplokus
27 Phthanoperidinium geminatum
28 Heteraulacacysta porosa
29 Cordosphaeridium funiculatum
30 Cordosphaeridium spp.
31 Enneadocysta spp.
32 Glaphyrocysta semitecta
33 Charlesdowniea columna
34 Hystrichosphaeropsis cf.costae
35 Hystrichokolpoma spp.
36 Lejeunecysta spp.
37 Microdinium spp.
38 Glaphyrocysta vicina
39 Admetosphaeridium multispinosum
40 Phthanoperidinium spp.
41 Areoligera cf.medusettiformis
42 Glaphyrocysta spp.
43 Cordosphaeridium minimum
44 Cordosphaeridium funiculatum
45 Phthanoperidinium aff.regalis
46 Dinopterygium spp.
47 Thalassiphora pelagica
48 Deflandrea denticulata
49 Lingulodinium machaerophorum
50 Glaphyrocysta ordinata
51 Operculodinium spp.
52 Svalbardella cf.hampdenensis
53 Deflandrea spp.
54 Impletosphaeridium spp.
55 Charlesdowniea spinata
56 Spiniferites septatus
57 Spinidinium spp.
58 Dracodinium cf.pachydermum
59 Wetzeliella endocyst
60 Wetzeliella spp.
61 Alterbidinium spp.
62 Glaphyrocysta sp.
63 Impletosphaeridium implicatum
64 Charlesdowniea columna
65 Hystrichokolpoma sp 1 Heilmann-Clau
66 Dracodinium cf.variolongitudum
67 Homotryblium spp.
68 Hystrichosphaeridium tubiferum
69 Dinopterygium cf.cladoides
70 Palaeoperidinium sifforum
71 Apectodinium homomorphum
72 Systematophora cf.placacantha
73 Diphyes colligerum
74 Hystrichosphaeridium tubiferum
75 Homotryblium spp.
76 Apectodinium quinquelatum
77 Admetosphaeridium spp.
78 Areoligera spp.
79 Enneadocysta multicornuta
80 Glaphyrocysta pastielei
81 Muratodinium fimbriatum
82 Areoligera senonensis
83 Komewuia sp Ogmund
84 Carodinium spp.
85 Apectodinium hyperacanthum
86 Apectodinium parvum
87 Apectodinium spp.
88 Paralecaniella indentata
89 Glaphyrocysta pastielei
90 Dinocyst sp 2 hnh 2000
91 Apectodinium cf.augustum
92 Fibrocysta bipolaris
93 Carodinium speciosum
94 Spiniferites septatus
95 Lejeunecysta hyalina
96 Thalassiphora delicata
97 Hystrichostrogylon membraniphorum
98 Areoligera gippingensis
99 Areoligera senonensis
100 C.speciosum glabrum
101 Deflandrea obtusifeldensis
102 Alisocysta margarita
103 Carodinium striatum
104 Fromea laevigata
105 Isabelidinium spp. <<
106 Odontochitina operculata<<
107 Chatangiella spp.<<
108 Chlamydophorella nyei<<
109 Trithyrodinium spp.<<
110 Areosphaeridium fenestratum<<
111 Areosphaeridium fenestratum<<
112 Isabelidinium acuminatum<<
113 Chatangiella ditissima<<
114 Nyktericysta davisii<<
115 Xiphoridium alatum<<
116 Palaeocystodinium sp. <<
117 Surculosphaeridium longifurcatum<<
118 Palaeocystodinium sp. <<
119 Palaeohystrichophora infusoricioides<<
120 Nyktericysta sp. <<
121 Circulodinium distinctum<<
122 Circulodinium compactum<<
123 Chatangiella decorosa<<
124 Circulodinium vestitum<<
125 Impagidinium spp.<<
126 Ocsisucysta spp.<<
127 Carodinium cf.striatum<<
128 Heterosphaeridium difficile<<
129 Florentinia spp.<<
130 Diphyes spp.<<
131 Odontochitina spp.<<
132 Pterodinium condylos<<
133 Dinogymnium spp.<<
134 Ovoidinium verrucosum<<
135 Lacinidinium arcticum<<
136 Alterbidinium acutulum<<
137 Alisocysta circumtabulata<<
138 Azolla spp.
139 Saccate pollen
140 Angiosperm pollen spp.<<
141 Rugubivesiculites rugosus<<
142 Fungal hyphae
143 Pediastrum spp.
144 Tetraporina sp 1 HNH 2002
145 Tetraporina spp
146 Palambages spp.

ALPHABETICAL SPECIES LIST

25 Achomosphaera spp.
1 Acritarch spp.
39 Admetosphaeridium multispinosum
77 Admetosphaeridium spp.
137 Alisocysta circumtabulata
102 Alisocysta margarita
136 Alterbidinium acutulum
61 Alterbidinium spp.
91 Apectodinium cf.augustum
71 Apectodinium homomorphum
85 Apectodinium hyperacanthum
86 Apectodinium parvum
76 Apectodinium quinquelatum
87 Apectodinium spp.
140 Aquilapollenites spp.
6 Areosphaera areaosa
41 Areoligera cf.medusettiformis
98 Areoligera gippingensis
82 Areoligera senonensis
78 Areoligera spp.
15 Areosphaeridium cf.michoudii
111 Areosphaeridium fenestratum
138 Azolla spp.
100 C.speciosum glabrum
127 Carodinium cf.striatum
93 Carodinium depressum
99 Carodinium speciosum
84 Carodinium spp.
103 Carodinium striatum
13 Charlesdowniea clathrata
33 Charlesdowniea coleothrypta
64 Charlesdowniea columna
123 Chatangiella decorosa
113 Chatangiella ditissima
107 Chatangiella spp.
124 Chichsouadinium vestitum
23 Chiropteridium spp.
108 Chlamydophorella nyei
55 Chorate spp.
121 Circulodinium distinctum
115 Circulodinium spp.
29 Cordosphaeridium funiculatum
43 Cordosphaeridium minimum
30 Cordosphaeridium spp.
10 Cribroperidinium spp.
48 Deflandrea denticulata
101 Deflandrea obtusifeldensis
19 Deflandrea phosphoritica
53 Deflandrea spp.
21 Deflandrea? sp 1 HNH
12 Dinocyst 01 HNH
90 Dinocyst sp 2 hnh 2000
133 Dinogymnium spp.
69 Dinopterygium cf.cladoides
46 Dinopterygium spp.
73 Diphyes colligerum
130 Diphyes spp.
58 Dracodinium cf.pachydermum
66 Dracodinium cf.variolongitudum
132 Dracodinium condylos
62 Dracodinium spp.
79 Enneadocysta multicornuta
31 Enneadocysta spp.
92 Fibrocysta bipolaris
129 Florentinia spp.
104 Fromea laevigata
142 Fungal hyphae
2 G.et sp indet Piasecki 1992
110 Glaphyrocysta aff.texta
22 Glaphyrocysta cf.vicina
7 Glaphyrocysta inculta
44 Glaphyrocysta microfenestrata
50 Glaphyrocysta ordinata
89 Glaphyrocysta pastielei
32 Glaphyrocysta semitecta
56 Glaphyrocysta spinata
42 Glaphyrocysta spp.
38 Glaphyrocysta vicina
18 Heteraulacacysta leptalea
28 Heteraulacacysta porosa
128 Heterosphaeridium difficile
75 Homotryblium spp.
67 Homotryblium tenuispinosum
65 Hystrichokolpoma sp 1 Heilmann-Clau
35 Hystrichokolpoma spp.
74 Hystrichosphaeridium tubiferum
34 Hystrichosphaeropsis cf.costae
97 Hystrichostrogylon membraniphorum
125 Impagidinium spp.
63 Impletosphaeridium implicatum
54 Impletosphaeridium spp.
112 Isabelidinium acuminatum
105 Isabelidinium spp.
83 Komewuia sp Ogmund
135 Lacinidinium arcticum
3 Leiosphaera spp.
95 Lejeunecysta hyalina
36 Lejeunecysta spp.
16 Lentinia serrata
49 Lingulodinium machaerophorum
37 Microdinium spp.
81 Muratodinium fimbriatum
114 Nyktericysta davisii
120 Nyktericysta spp.
126 Ocsisucysta spp.
106 Odontochitina operculata
131 Odontochitina spp.
122 Oligosphaeridium complex
80 Oligosphaeridium spp.
11 Operculodinium centrocarpum
51 Operculodinium spp.
134 Ovoidinium verrucosum
26 Palaeocystodinium golzowense
118 Palaeocystodinium spp.
119 Palaeohystrichophora infusoricioides
70 Palaeotetradinium silicorum
146 Palambages spp.
88 Paralecaniella indentata
143 Pediastrum spp.
45 Phthanoperidinium aff.regalis
9 Phthanoperidinium comatum
27 Phthanoperidinium geminatum
40 Phthanoperidinium spp.
141 Rugubivesiculites rugosus
139 Saccate pollen
4 Schizocystia spp.
14 Semoniasphaera cf.rotundata
57 Spinidinium spp.
94 Spiniferites septatus
5 Spiniferites spp.
117 Surculosphaeridium longifurcatum
52 Svalbardella cf.hampdenensis
72 Systematophora cf.placacantha
24 Systematophora placacantha
144 Tetraporina sp 1 HNH 2002
145 Tetraporina spp
96 Thalassiphora delicata
17 Thalassiphora fenestrata
47 Thalassiphora pelagica
8 Tityrosphaeridium cantharellus
109 Trithyrodinium spp.
68 Wetzeliella articulata
20 Wetzeliella cf.simplex
59 Wetzeliella endocyst
60 Wetzeliella spp.
115 Xiphoridium alatum

BIOSTRATIGRAPHICAL EVENTS

T: top M: max B: base I: influx
+ 5-9 ++10-24 +++25-59 ++++ >59

- 1405.00 — *Areosphaera areaosa* T
- *Glaphyrocysta inculta* T
- *Phthanoperidinium comatum* T
- 1445.00 — *Areosphaeridium cf.michoudii* T
- *Semoniasphaera cf.rotundata* T+
- *Charlesdowniea clathrata* T
- *Heteraulacacysta leptalea* T
- 1485.00 — *Lentinia serrata* T+
- *Thalassiphora fenestrata* T
- *Deflandrea? sp 1 HNH* T
- 1525.00 — *Azolla spp.* T
- *Cordosphaeridium funiculatum* T
- *Heteraulacacysta porosa* T
- 1565.00 — *Enneadocysta spp.* T
- *Glaphyrocysta semitecta* T
- 1605.00 — *Hystrichosphaeropsis cf.costae* T
- 1645.00
- 1685.00 — *Areoligera cf.medusettiformis* T
- *Admetosphaeridium multispinosum* T
- *Glaphyrocysta vicina* T
- 1725.00 — *Phthanoperidinium aff.regalis* T
- *Deflandrea denticulata* T
- *Glaphyrocysta microfenestrata* T
- *Thalassiphora pelagica* T
- 1765.00 — *G.et sp indet Piasecki 1992* T
- 1779.00 — *Svalbardella cf.hampdenensis* T
- 1785.00
- 1805.00
- 1845.00
- 1885.00
- 1905.00
- 1925.00
- 1965.00
- 2005.00
- 2032.00
- 2045.00
- 2125.00
- 2165.00
- 2205.00 — *Glaphyrocysta spinata* T
- 2240.00
- 2277.00
- 2285.00
- 2325.00
- 2355.00
- 2385.00 — *Dracodinium cf.pachydermum* T
- 2387.00 — *Wetzeliella endocyst* T
- 2405.00 — *Tetraporina sp 1 HNH 2002* T
- *Tetraporina spp* T
- 2445.00
- 2485.00
- 2495.00
- 2565.00
- 2595.00 — *Charlesdowniea columna* T
- 2605.00 — *Homotryblium tenuispinosum* T
- *Hystrichokolpoma sp 1 Heilmann-Clau* T
- *Wetzeliella articulata* T
- 2645.00
- 2650.00 — *Apectodinium homomorphum* T
- 2680.00 — *Systematophora cf.placacantha* T+
- *Diphyes colligerum* T
- *Hystrichosphaeridium tubiferum* T
- 2725.00
- 2745.00
- 2765.00 — *Apectodinium quinquelatum* T
- 2805.00
- 2835.00
- 2885.00 — *Enneadocysta multicornuta* T
- 2910.00 — *Muratodinium fimbriatum* T
- 2955.00
- 3005.00 — *Komewuia sp Ogmund* T+++
- 3045.00
- 3085.00
- 3125.00
- 3165.00
- 3210.00 — *Apectodinium spp.* T+
- *Apectodinium hyperacanthum* T
- *Apectodinium parvum* T
- 3245.00
- 3265.00
- 3285.00 — *Glaphyrocysta pastielei* T
- 3329.00
- 3365.00
- 3385.00
- 3405.00
- 3425.00
- 3445.00
- 3465.00 — *Apectodinium cf.augustum* T
- 3480.00 — *Fibrocysta bipolaris* T
- *Lejeunecysta hyalina* T
- *Spiniferites septatus* T
- 3515.00 — *Thalassiphora delicata* T
- 3535.00 — *Areoligera gippingensis* T
- *Carodinium speciosum* T
- 3565.00 — *Hystrichostrogylon membraniphorum* T
- 3605.00 — *Alisocysta margarita* T
- *C.speciosum glabrum* T++
- *Deflandrea obtusifeldensis* T
- 3645.00 — *Carodinium striatum* T
- 3685.00
- 3725.00
- 3765.00
- 3805.00
- 3835.00
- 3840.00 — *Fromea laevigata* T