Stop A2/1

HOLZHÄUSL OUTCROP NEAR MATTSEE

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Topics:
Plankton assemblages of the lower Lutetian

Tectonic unit:
Ultrahelvetic nappe complex

Lithostratigraphic unit:
Buntmergelserie

Chronostratigrapic unit:
Middle Eocene, Lutetian

Biostratigraphic units:
planktic foraminifera Zone E8, calcareous nannofossil sub-Zones NP14b and NP15b

Location:
Southern (coord.: 13° 07′ 09″ E, 47° 58′ 26″ N) and northern (coord.: 13° 07′ 11″ E, 47° 58′ 23″ N) Holzhäusl creeks near Mattsee

References:
Rögl & Egger, 2010

The Holzhäusl section consists of a number of temporary outcrops resulting from the erosion of two small tributaries to Lake Mattsee and is located 20 km north of the town of Salzburg. In the southern gully calcareous nannoplankton sub-Zone NP15b (outcrop 1) was found. Along the course of the northern creek grey marlstone of calcareous nannoplankton sub-Zone NP14b (outcrop 2) is exposed. The bathyal marlstone (average carbonate content 58 wt%) of both outcrops is part of the informal lithostratigraphic unit "Buntmergelserie" and was deposited at approximately 35° northern paleolatitude. In the Oligocene, the slope deposits were detached from their substratum and became part of the Ultrahelvetic thrust unit, which tectonically overlies the sedimentary infilling of the Alpine Molasse Basin.

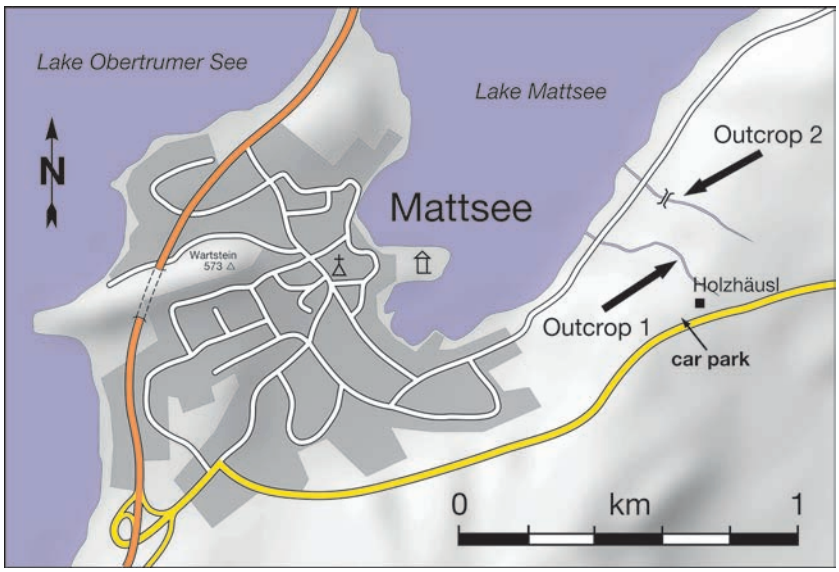


Figure A2.2 ▲
Locations of outcrops near Holzhäusl

Outcrop 1

The nannoplankton assemblages, which are dominated by *Reticulofenestra dictyoda*, *R. scrippsae*, *Coccolithus pelagicus*, and *Zygrhablithus bijugatus*, are diverse and show moderate preservation. Reworking of Cretaceous nannoplankton specimens is less than 1 %. All samples display similar compositions of the assemblages (Fig. A2.3), which are characterized by the occurrences of *Blackites spinosus*, *Chiasmolithus consuetus, C. expansus*, *C. gigas*, *C. grandis*, *C. solitus*, *Coccolithus mutatus*, *Discoaster barbadiensis*, *D. gemmifer*, *D. saipanensis*, *D. tanii*, *D. wemmelensis*, *Nannotetrina fulgens*, *N. cristata*, *Reticulofenestra umbilicus* (> 14 µm), *Sphenolithus moriformis*, *S. spiniger*, *S. radians.*

This assemblage is typical for the *Nannotetrina fulgens* Zone, which is defined by the stratigraphic range of the marker fossil. The *N. fulgens* Zone represents Zone NP15 in the zonation scheme of Martini (1971) and Zone CP13 in the zonation scheme of Okada and Bukry (1980). The latter authors suggested a three-fold subdivision of the *Nannotetrina fulgens* Zone using the range of *Chiasmolithus gigas* (Fig. A2.6), which is restricted to the middle part (CP13b) of the *Nannotetrina fulgens* Zone. Aubry (1991) has defined Subzone NP15a as the interval between the FO of *Nannotetrina fulgens* and the FO of *Chiasmolithus gigas*, Subzone NP15b as the total range of *Chiasmolithus gigas*, and Subzone NP15c as the interval between the HO of *Chiasmolithus gigas* and the HO of *Rhabdosphaera gladius*. Using these criteria, the entire Holzhäusl section can be assigned to the *Chiasmolithus gigas* Subzone.

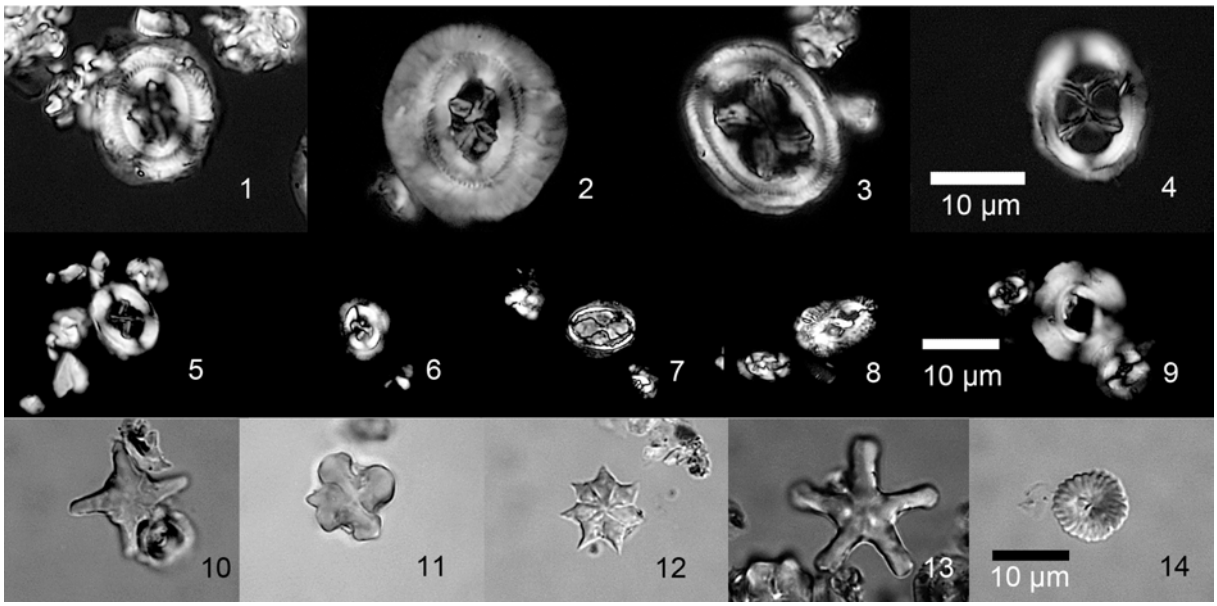
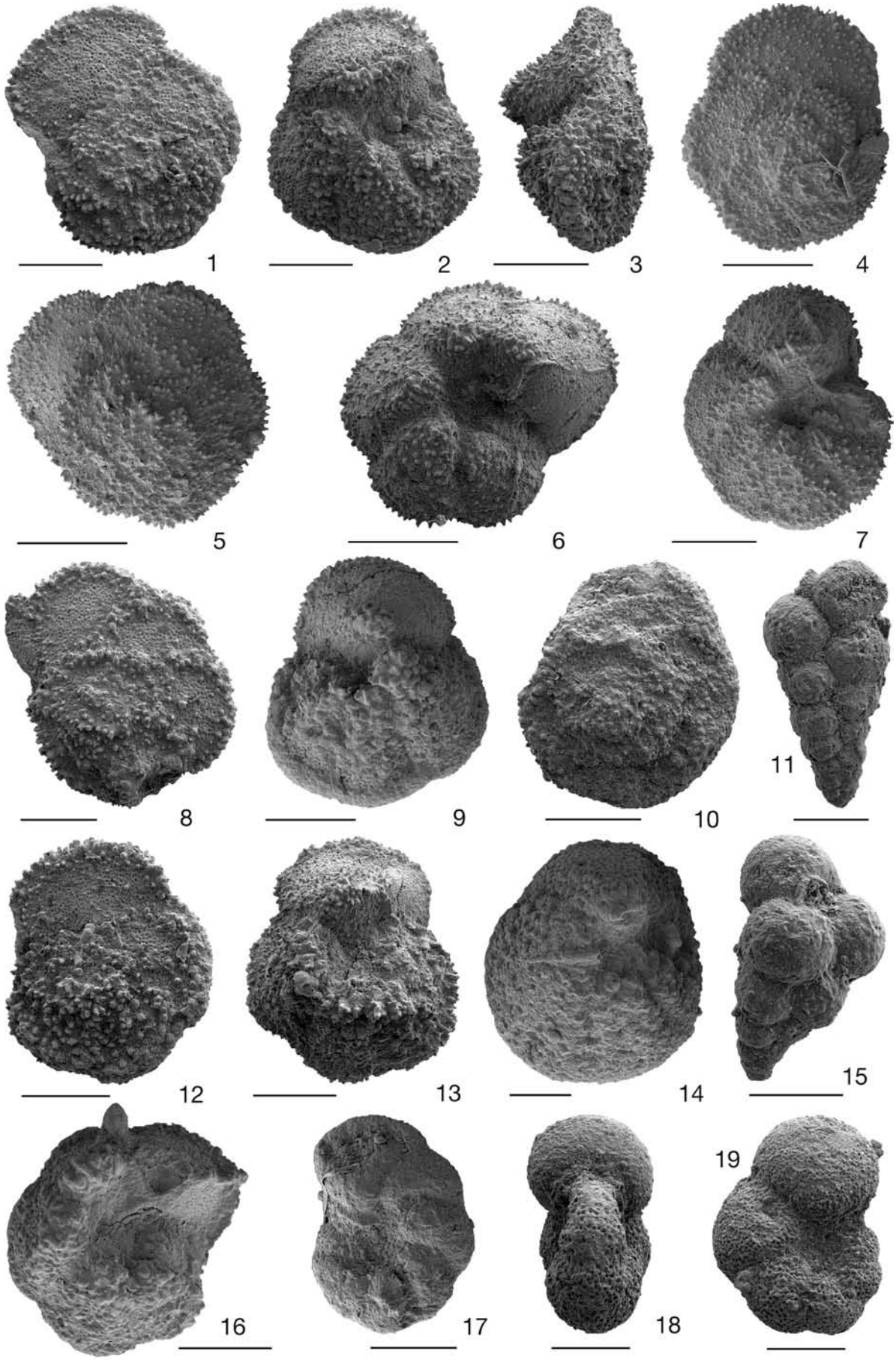


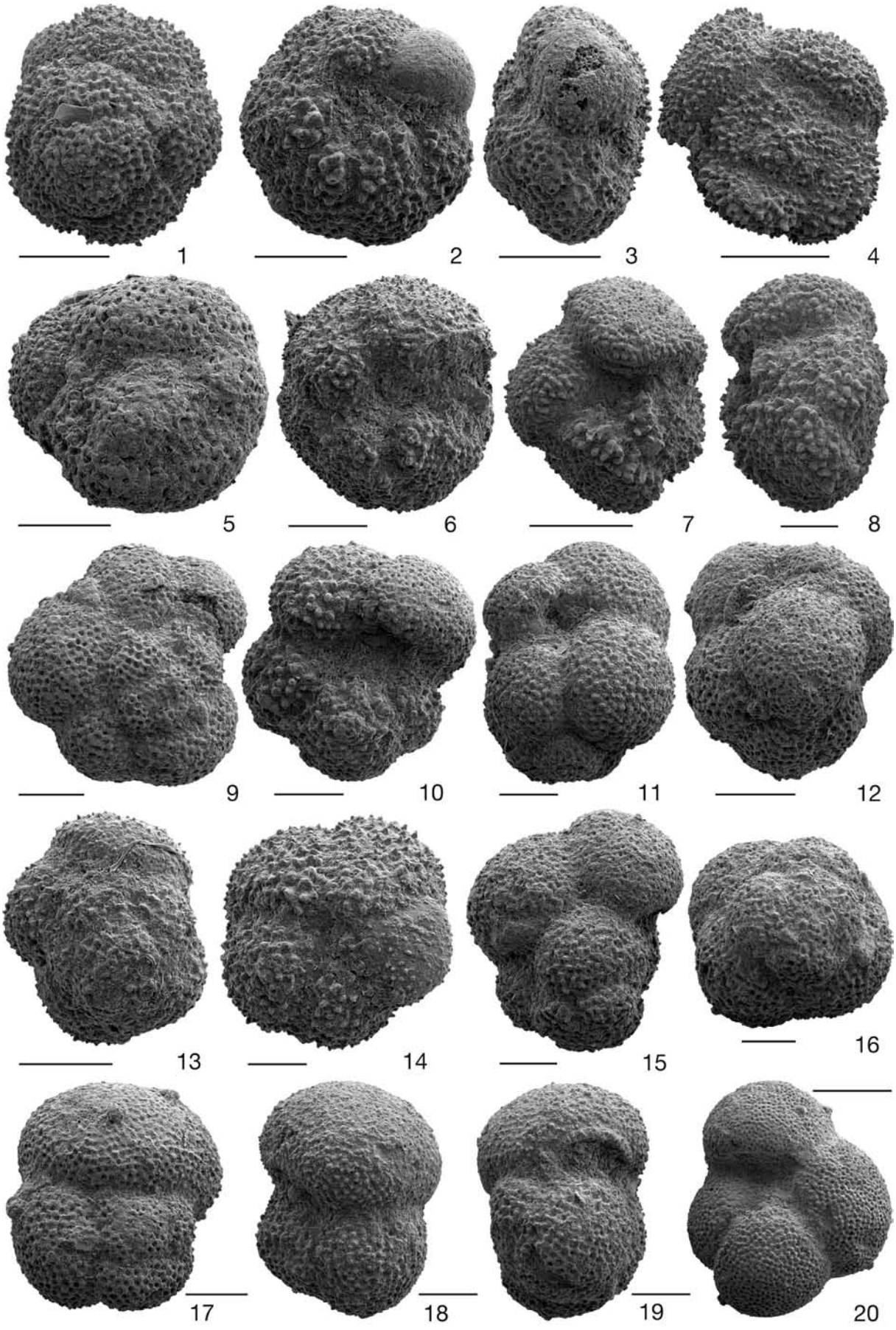
Figure A2.3 ▲
Selected calcareous nannoplankton from Holzhäusl outcrop 1
1 *Coccolithus mutatus*; **2** *Chiasmolithus gigas*; **3** *Chiasmolithus grandis*; **4** *Chiasmolithus expansus*; **5** *Chiasmolithus solitus*; **6** *Chiasmolithus nitidus*; **7** *Clausiococcus vanheckiae*; **8** *Helicosphaera bramlettei*; **9** *Reticulofenstra umbilicus*; **10** *Nannotetrina fulgens*; **11** *Nannotetrina cristata*; **12** *Discoaster saipanensis*; **13** *Discoaster tani*; **14** *Discoaster wemmelensis*.

Figure A2.4 ►
1 – 3 *Morozovelloides crassatus* (Cushman). Section Holzhäusl-2, sample Rö 10-91.
4 – 7 *Morozovelloides coronatus* (Blow). Section Holzhäusl-2, sample Rö 10-91.
8 – 9 *Morozovella crater* (Hornibrook). Section Holzhäusl-2, sample Rö 10-91.
10, **14** *Morozovella aragonensis* (Nuttall). Section Holzhäusl-2, samples Rö 17-91 and Egger N2/09.
11 *Chiloguembelina ototara* (Finlay). Section Holzhäusl-2, sample Rö 10-91.
12 – 13 *Morozovella caucasica* (Glaessner). Section Holzhäusl-2, sample Rö 10-91.
15 *Jenkinsina triseriata* (Terquem). Section Holzhäusl-2, sample Rö 10-91.
16 *Morozovella caucasica* (Glaessner). Mattsee, centre, sample Gohrbandt 64/1-130.
17 *Planoglobanomalina pseudoalgeriana* Olssson & Hemleben. Section Holzhäusl-2, sample Egger N4/09.
18 – 19 *Pseudohastigerina wilcoxensis* (Cushman & Ponton). Section Holzhäusl-1, sample Egger 3b/04

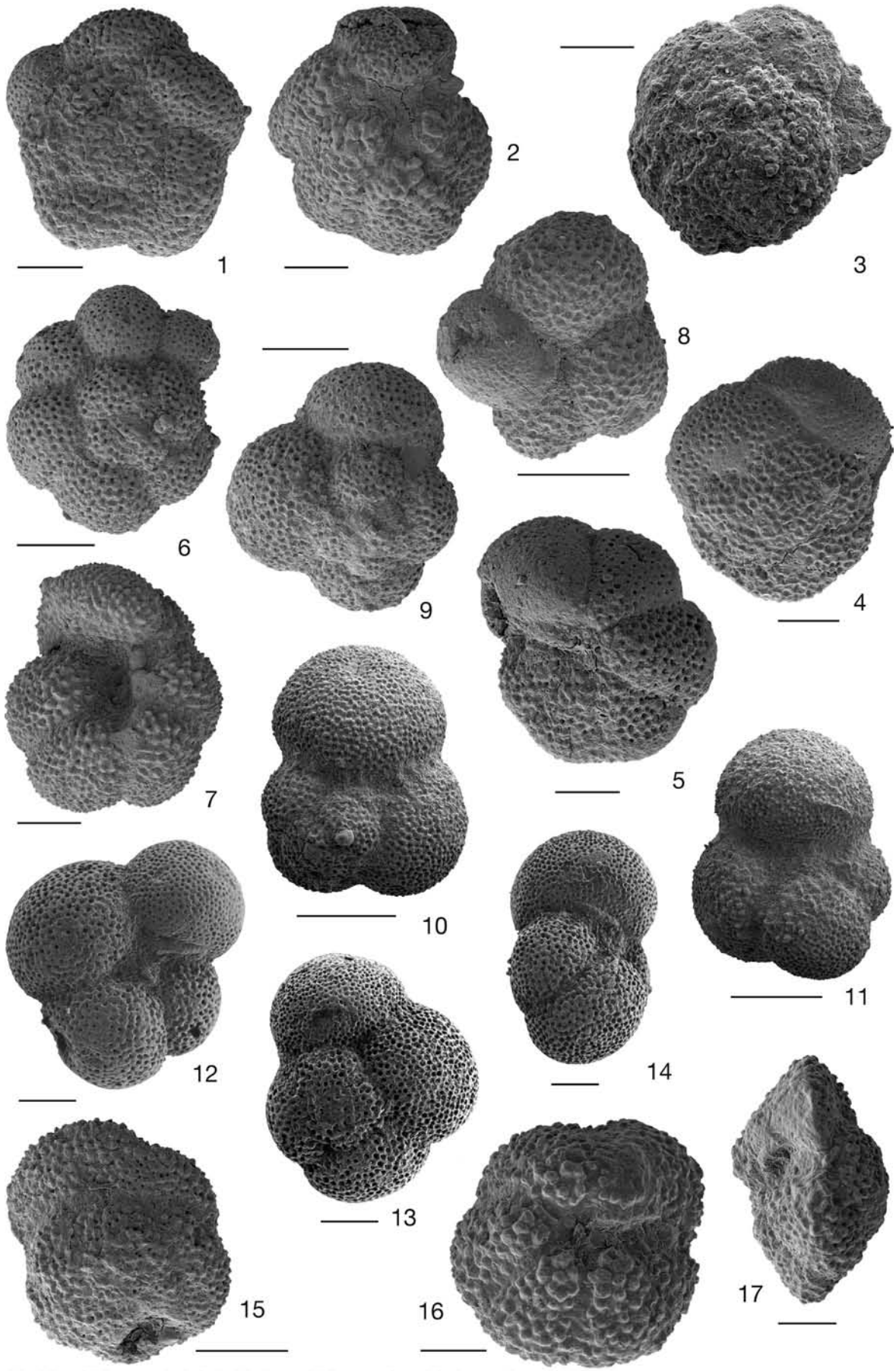
scale bar: figs 1 – 10, 12 – 13, 16 = 200 µm; figs 14, 17 – 19 = 100 µm; figs 11, 15 = 50 µm



1-10, 12-13, 16 = 200 µm 11,15 = 50 µm 14, 17-19 = 100 µm



1-3, 5-6,8-19 = 100 µm 4,7,20 = 200 µm



10-11 = 200 µm 1-2,6-9,12-15 = 100 µm 3-5,16-17 = 50 µm

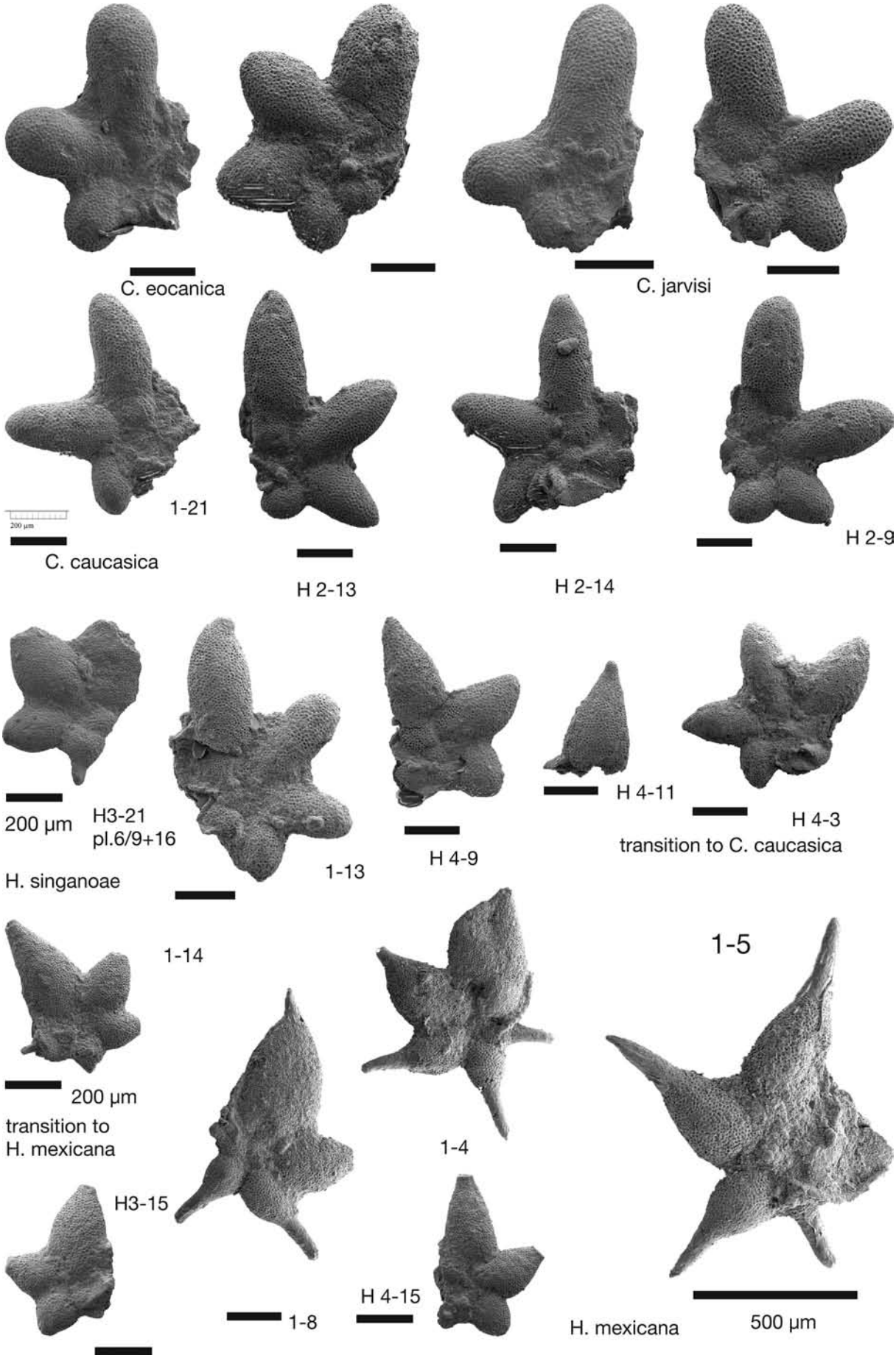


Figure A2.5 (Page 52)

1 – 3, **5 – 6**	*Igorina broedermanni* (Cushman & Bermudez). Figs 1, 3 section Holzhäusl-2, sample Rö 10-91, figs 3, 5-6 section Holzhäusl-1, sample Egger 3b/04.
7 – 8	*Acarinina bullbrooki* (Bolli). Section Holzhäusl-2, sample Rö 10-91.
9 – 10	*Acarinina pentacamerata* (Subbotina). Section Holzhäusl-1, sample Egger 3b/04.
11 – 12, **15 – 16**	*Guembeltrioides nuttalli* (Hamilton). Figs 11, 15-16 section Holzhäusl-1, sample Rö 1-98; fig. 12 section Holzhäusl-2, sample Rö 17-91.
13 – 14	*Acarinina collactea* (Finlay). Section Holzhäusl-1, sample Egger 3b/04.
17 – 19	*Turborotalia frontosa* (Subbotina). Section Holzhäusl-1, sample Egger 3b/04.
20	*Subbotina* cf. *eocaena* (Guembel). Section Holzhäusl-1, sample Egger 2b/04.

scale bar: figs 1 – 3, 5 – 6, 8 – 19 = 100 µm; figs 4, 7, 20 = 200 µm

Figure A2.6 (Page 53)

1 – 2	*Acarinina cuneicamerata* Blow. Mattsee, centre, sample Gohrbandt 64/1-130.
3 – 5	*Planorotalites capdevilensis* (Cushman & Bermudez). Fig. 3 section Holzhäusl-1, sample Egger 3b/04; figs 4-5 sample Gohrbandt 64/1-130.
6 – 7	*Acarinina aspensis* (Colom). Section Holzhäusl-2, fig. 6 sample Egger N2/09, fig. 7 sample Rö 10-91.
8 – 9	*Globorotaloides quadrocameratus* Olsson, Pearson & Huber. Section Holzhäusl-2, sample Rö 10-91.
10 – 11	*Subbotina eocaena* (Guembel). Section Holzhäusl-1, sample Egger 2b/04.
12 – 14	*Parasubbotina hagni* (Gohrbandt). Section Holzhäusl-1, sample Gohrbandt 64/1-36-4a.
15 – 17	*Igorina salisburgensis* (Gohrbandt). Hochberg S of St. Pankraz, sample Gohrbandt 63/2-184-1.

scale bar: figs 10 – 11 = 200 µm; 1 – 2, 6 – 9, 12 – 15 = 100 µm; 3 – 5, 16 – 17 = 50 µm

Figure A2.7 ◄

1 – 2	*Clavigerinella eocanica* (Nuttall). Fig. 1 sample Gohrbandt 36/1, fig. 2 sample Egger A3/08.
3 – 4, **8**	*Clavigerinella jarvisi* (Cushman). Fig. 3 sample Gohrbandt 36/0, figs 4,8 Egger B2/08.
5 – 7	*Clavigerinella caucasica* (Subbotina). Fig. 5 sample Egger B4/08, figs 6-7 sample Egger B2/08.
9 – 12	*Hantkenina gohrbandti* Rögl & Egger (in press). Figs 9, 11 sample Egger A2h, fig. 10 sample Gohrbandt 36/4b.
13	*Hantkenina mexicana* Cushman forma *nuttalli* Toumarkine. Sample Egger A1/08.
14	*Hantkenina mexicana* Cushman. Sample Rö 2-98.
15	*Hantkenina singanoae* Pearson & Coxall. Sample Egger B3/08.

All specimens from section Holzhäusl-1.
scale bar: figs 1 – 13, 15 = 200 µm; fig. 14 = 500 µm

About 90 % of the foraminifera assemblage consist of planktonic species. Planktonic foraminiferal Zone E8 is indicated by the occurrences of *Guembelitrioides nuttalli* and *Globigerinatheka subconglobata*. Other stratigraphically important species are *Clavigerinella caucasica, Clavigerinella eocanica, Clavigerinella jarvisi, Hantkenina gohrbandti, Hantkenina mexicana,* and *Hantkenina singanoae* (Figs. A2.4 – 7). The evolutionary transition between *Clavigerinella* and *Hantkenina* was documented in this outcrop (Rögl & Egger, 2010). Remarkably, from the morozovellid assemblage only *Morozovella aragonensis* was found in small numbers.

Three samples were processed for palynology at Utrecht University following standard procedures of the Laboratory of Palaeobotany and Palynology (see, e.g., (Sluijs, Brinkhuis et al. 2003). Biostratigraphically important taxa include *Areosphaeridium diktyoplokum*, *Homotryblium floripes*, *Apectodinium homomorphum*, *A. hyperacanthum*, *Cordosphaeridium cantharellus* and *Wilsonidinium echinosuturatum*. The Wetzeliellioid genera such as *Apectodinium* (Fig. A2.8/B) and *Wilsonidinium* (Fig. A2.8/J) places the section in the Eocene. The best calibrated dinocyst species is *Areosphaeridium diktyoplokum* (Plate 1, A; First Occurence (FO) at 50.2 Ma in Northern mid-latitudes (Stover and Williams 1995; Williams, Brinkhuis et al. 2004)), which occurs throughout the section. That makes the maximum age for the section upper Ypresian. The consistent presence of *Homotryblium floripes* (Fig. A2.8/E) in all samples may indicate an age younger than 48 Ma, although the FO of this species is poorly calibrated, and may range slightly older in the Tethys Ocean.The FO of *Wilsonidinium echinosuturatum* (Fig. A2.8/J) is of

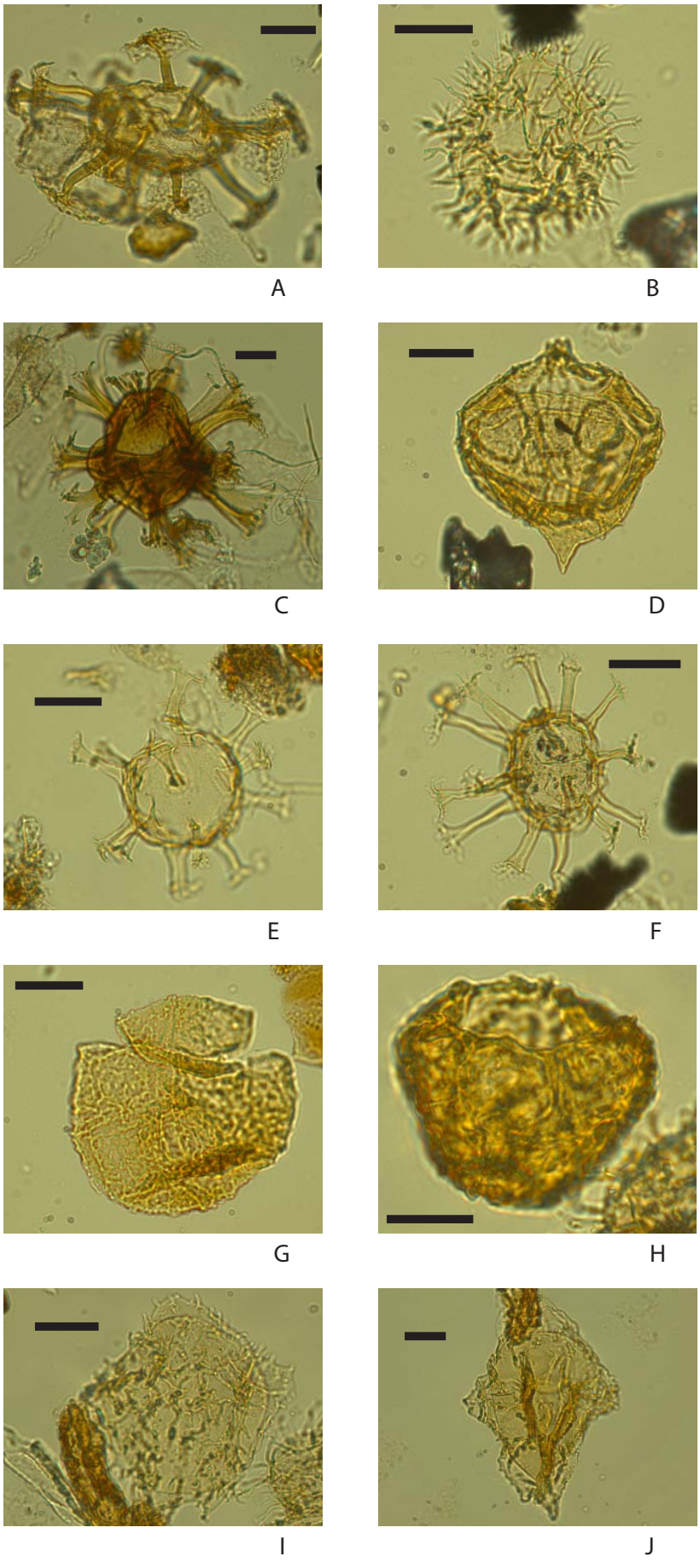


Figure A2.8 ◄
A selection of (stratigraphically) important dinocyst species from the Holzhäusl sections.
Scale is 20µm
A: *Areosphaeridium diktyoplokum.*
B: *Apectodinium homomorphum.*
C: *Cordosphaeridium cantharellus.*
D: *Damassadinium sp.*
E: *Homotryblium floripes* cpx.
F: *Oligosphaeridium* sp.
G: *Schematophora* cf. *obscura*.
H: *Schematophora* cf. *obscura*.
I: *Wetzeliella articulata*.
J: *Wilsonidinium echinosutratum*

early Lutetian age in the Southwest Pacific Ocean (Brinkhuis, Sengers et al. 2003). *W. echinosuturatum* as well as *Cordosphaeridium cantharellus* (Fig. A2.8/C) have first occurrences within NP15 (magnetochron C20r) in southwestern Siberia (Iakovleva and Heilmann-Clausen 2010), but these records are correlated from far outside the Tethys Ocean. In Northwestern Europe, *C. cantharellus* is found to have a first occurrence at around 40.1 Ma (Bujak, Downie et al. 1980), much younger than other sections. The LO of *Apectodinium* spp. was correlated to the Ypresian-Lutetian Boundary in the Southern Ocean (Brinkhuis, Sengers et al. 2003) and southwestern Siberia (Iakovleva and Heilmann-Clausen 2010), but no well-calibrated last occurrences are reported of *Apectodinium* from Tethyan successions, so it may very well be that the subtropical-tropical taxon *Apectodinium* spp. ranges much higher into the Lutetian in the likely warm Tethyan Ocean. The combined dinocyst events would thus tentatively place the entire section within the early Lutetian. One surprising finding is the common occurrence of a species closely resembling the early Eocene *Schematophora obscura* (Fig. 7, G, H) described from the Southern Ocean (Wilson 1988). There, this species has a short range in magnetochron C24n. Furthermore it has, to our recollection, not been recognized outside of the Southern Ocean thus far.

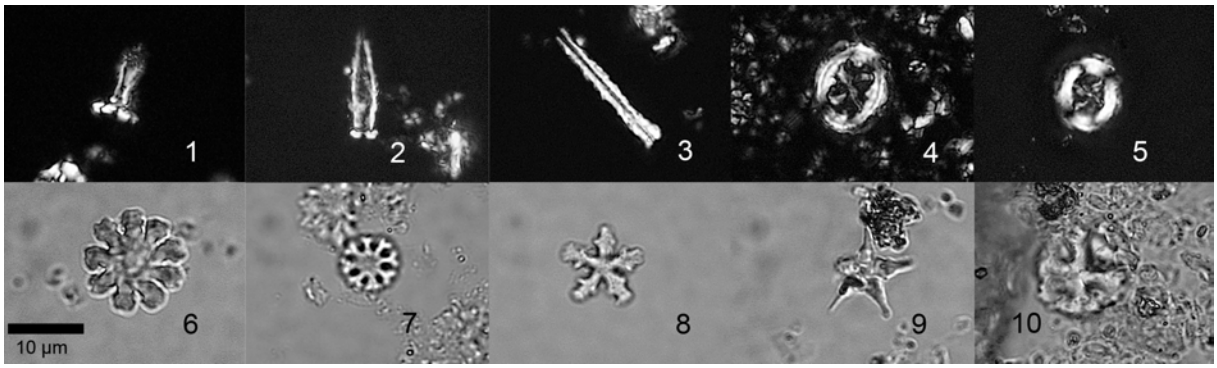


Figure A2.9 ▲
Selected calcareous nannoplankton from Holzhäusl outcrop 2
1 *Blackites gladius*; **2** *Blackites inflatus*; **3** *Blackites stilus*; **4** *Chiasmolithus grandis*; **5** *Chiasmolithus solitus*; **6** *Discoaster deflandrei*; **7** *Discoaster nonaradiatus*; **8** *Discoaster tani nodifer*; **9** *Discoaster sublodoensis*; **10** *Nannotetrina cristata*.

Outcrop 2

The nannoplankton assemblages, which are dominated by *Reticulofenestra dictyoda*, *R. scrippsae*, *Coccolithus pelagicus*, and *Zygrhablithus bijugatus*, are diverse and show moderate preservation. Reworking of Cretaceous nannoplankton specimens is less than 1%. Stratigraphically important species (Fig. A2.9) are *Blackites inflatus*, *B. gladius*, *Chiasmolithus solitus*, *C. grandis*, *Discoaster sublodoensis, Nannotetrina cristata* and *Sphenolithus spiniger*. This assemblage indicate the upper part of Sub-Zone NP14b. Interesting rare species are *Discoaster nonaradiatus* and *D. tani nodifer*.

The marlstone of outcrop 2 contains a rich planktonic fauna and a characteristic benthic deep-water assemblage. Stratigraphically important species are predominantly morozovellids with *Morozovella aragonensis* (E5-E9), *M. crater* (E4-E9), *M. caucasica* (E6-E8), *Morozovelloides bandyi* (E7-E10), *Ms. coronatus* (E8-E12), *Ms. crassatus* (E8-E13). The genus *Morozovelloides* is not as well developed as in Trinidad or in deep-sea drilling cores, tests are more blunt. Other important species are *Parasubbotina inaequispira* (E1-E8), *Turborotalia frontosa* (E7-E11), and in rare numbers *Pseudoglobanomalina pseudoalgeriana* (E6-E8). In the samples continuously *T. frontosa* is present, only in the uppermost part of the section *G. nuttalli* occurs but the occurrences of *Morozovelloides coronatus* and *Ms. crassatus* suggest an assignment to planktonic foraminiferal Zone E8. In contrast to outcrop 1, where only rare specimens of *Morozovella aragonensis* occur, specimens of *Morozovella* and *Morozovelloides* are common in all samples of outcrop 2.

The presence of *Oligosphaeridium* spp. (Fig. A2.8/F) in the dinoflagellate assemblage of this outcrop makes those samples older than 48.0 Ma when correlated to Northwestern European sections (Bujak and Mudge 1994; Williams, Brinkhuis et al. 2004). This species and *Wetzeliella articulata* were not found in the samples of outcrop 1. *Apectodinium homomorphum*, *Areosphaeridium diktyoplokum* and *Schematophora* cf. *obscura* occur in both outcrops.