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A revision of lower Paleogene planktonic foraminifera described by K.H.A. Gohrbandt from the Northwestern Tethyan realm (Helvetic nappe system, Salzburg, Austria)

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Abstract

A revision of nine planktonic foraminifera species described by Gohrbandt (1963 and 1967) from the lower Paleogene of the Helvetic nappe system north of Salzburg (Austria) is presented. The taxonomic and biostratigraphic positions of the following species are discussed: *Globorotalia haunsbergensis* Gohrbandt – valid name *Globanomalina chapmani* (Parr); *Globorotalia ? traubi* Gohrbandt – valid name *Igorina lodoensis* (Mallory); *Truncorotalia marginodentata aperta* Gohrbandt – valid name *Morozovella marginodentata* (Subbotina); *Globorotalia mattseensis* Gohrbandt – valid name *Igorina broedermanni* (Cushman and Bermudez); *Globanomalina wilcoxensis globulosa* Gohrbandt – valid name *Pseudohastigerina wilcoxensis* (Cushman and Ponton); *Globorotalia wartsteinensis* Gohrbandt – valid name *Igorina wartsteinensis* (Gohrbandt); *Globorotalia salisburgensis* Gohrbandt – valid name *Igorina salisburgensis* (Gohrbandt); *Globorotalia pseudochapmani* Gohrbandt – valid name *Globanomalina pseudochapmani* (Gohrbandt); *Globigerina hagni* Gohrbandt – valid name *Parasubbotina hagni* (Gohrbandt).

1. Introduction

Gohrbandt (1963, 1964, 1967) studied micropaleontology and biostratigraphy of Paleogene deposits of the Helvetic nappe system to the north of Salzburg (Fig.1/3) and recognized nine new planktonic foraminiferal species. Some of these taxa were already discussed by Blow (1979), Olsson et al. (1999a), and Pearson et al. (2006). The aim of this paper is a taxonomic revision and documentation of the nine species using SEM images instead of the original pencil drawings. Furthermore, the samples are assigned to the current planktonic foraminiferal (Wade et al., 2011) and calcareous nannoplankton (Martini, 1971) zonation schemes.

2. Material and methods

The type specimens described in the publications of Gohrbandt (1963 and 1967) originate from two Paleocene (stations 32 and 192) and four Eocene (stations 36, 124, 130, and 184) outcrops (Fig. 1/4 and 5). The holo- and paratypes are stored in the Micropaleontological Collection of the Museum of Natural History Vienna (NHMW) and were studied together with additional paratypes and sample residues placed to our disposal by Gohrbandt. Smear slides of the Gohrbandt samples were already prepared by H. Stradner who published preliminary results in Gohrbandt (1963). These slides are stored in the Micropaleontological Collection of the Geological Survey of Austria and were re-studied now with the light microscope at a magnification of 1000x.

3. Geological setting and sample locations

The samples investigated originate from the neritic shelf (Helvetic domain) and the bathyal south-facing continental slope (Ultrahelvetic domain) of the European Plate. After the elimination of the Penninic Basin in the middle Eocene, the European and Adriatic Plates collided. Due to this continental collision, the sedimentary successions of the shelf and the slope were detached from their substratum and incorporated into the Helvetic nappe system (Fig. 1/3). The northward movement of this tectonic unit on the foreland basin lasted till the lower Miocene.

The lithostratigraphy of the lower Paleogene sedimentary record of the South Helvetic thrust unit was formalized by Rasser and Piller (1999). Using this lithostratigraphic scheme, the Paleocene samples of Gohrbandt (1963) can be attributed to the Olching Formation (outcrop 32- Kroisbachgraben, described in detail by Traub, 1938) and (outcrop192 - Trench NNW Bauerstatt, comp. Traub, 1953, p.11) to the upper part of the Kroisbach Member ("Gryphaeenbank") of the Kressenberg Formation. The Olching Formation essentially consists of dark grey, silty to sandy clayey marlstone and claystone, whereas the upper part of the Kroisbach Member is formed by glauconitic sandstone with abundant oysters.

To the south, the Helvetic shelf gradually passed into the Ultrahelvetic continental slope. Depending on the paleodepth at this slope, the pelitic rocks of the Ultrahelvetic unit display varying contents of carbonate. Since Prey (1952), these pelitic deposits were assembled to the informal lithostratigraphic unit "Buntmergelserie". The samples of Gohrbandt (1967) were taken from Eocene Buntmergelserie of outcrops 36 (Holzhäusl section NE of Mattsee), 124 (shore of lake Obertrum, at the western end of Mattsee), 130 (centre of town Mattsee, foundation trench on a construction site), and 184 (trench SW of cottage Hochberg, SE St. Pankraz - Traub, 1953, p. 28, point 4, described it as "Stockletten").

4. Biostratigraphy of the studied outcrops

Outcrop 32, Kroisbachgraben (type locality of *Globorotalia haunsbergensis*).

Foraminifera demonstrate an inner shelf environment with calcareous benthic and a higher content of planktonic foraminifera. The occurrences of *Subbotina triangularis*, *S. triloculinoides*, *Parasubbotina pseudobulloides*, *P. varianta*, *Morozovella angulata*, *M. apanthesma*, *Igorina tadjikistanensis*, *Globanomalina ehrenbergi*, *G. chapmani*, *Chiloguembelina subtriangularis*, *Woodringina hornerstownensis* are indicative for *Morozovella angulata* Lowest-occurrence Zone, Zone P3 (Olsson et al., 1999a; Berggren and Pearson, 2005). This assignment is consistent with the calcareous nannoplankton assemblage that indicates the upper portion of the *Ellipsolithus macellus*-Zone (Zone NP4) by the occurrences of *Ellipsolithus macellus*, *Neochiastozygus perfectus*, *Cruciplacolithus subrotundus*, *Cruciplacolithus tenuis*, *Chiasmolithus danicus*, *C. edentulus* and *Ericsonia robusta*.

Outcrop 192, Trench NNW Bauerstatt (type locality of *Truncorotalia marginodentata aperta*):

A comparative sample from top of the "Gryphaeenbank" was investigated, which contains planktonic foraminifera, e.g., *Subbotina velascoensis*, *Acarinina coalingensis*, *A. mckannai*, *A. strabocella*, *Morozovella aequa*, *M. apanthesma*, *M. occlusa*, *M. subbotinae*, *Globanomalina pseudomenardii*. This assemblage is characteristic for the *Globanomalina pseudomenardii* Taxon-range Zone, Zone P4 of Olsson et al. (1999a) and Berggren and Pearson (2005). *Morozovella marginodentata* was missing in our samples. Larger foraminifera, bryozoa, echinodermata and a low number of planktonic foraminifera show a shallow water depositional depth.

From the calcareous nannoplankton assemblage of this outcrop Stradner (in Gohrbandt, 1963) mentioned *Heliolithus riedelii*, which is indicative for Zone NP8 in the zonation scheme of Martini (1971). Additionally, we found *Discoaster multiradiatus* in sample 192/7, which is the marker species for the *Discoaster multiradiatus*-Zone (Zone NP 9).

Outcrop 184, Trench SW of cottage Hochberg (type locality of *Globorotalia? traubi* and *Globorotalia salisburgensis*).

The planktonic foraminiferal assemblage consists of *Acarinina coalingensis*, *A. pseudotopilensis*, *A. quetra*, *A. wilcoxensis*, *Morozovella aequa*, *M. gracilis*, *M. lensiformis*, *M. margi-*

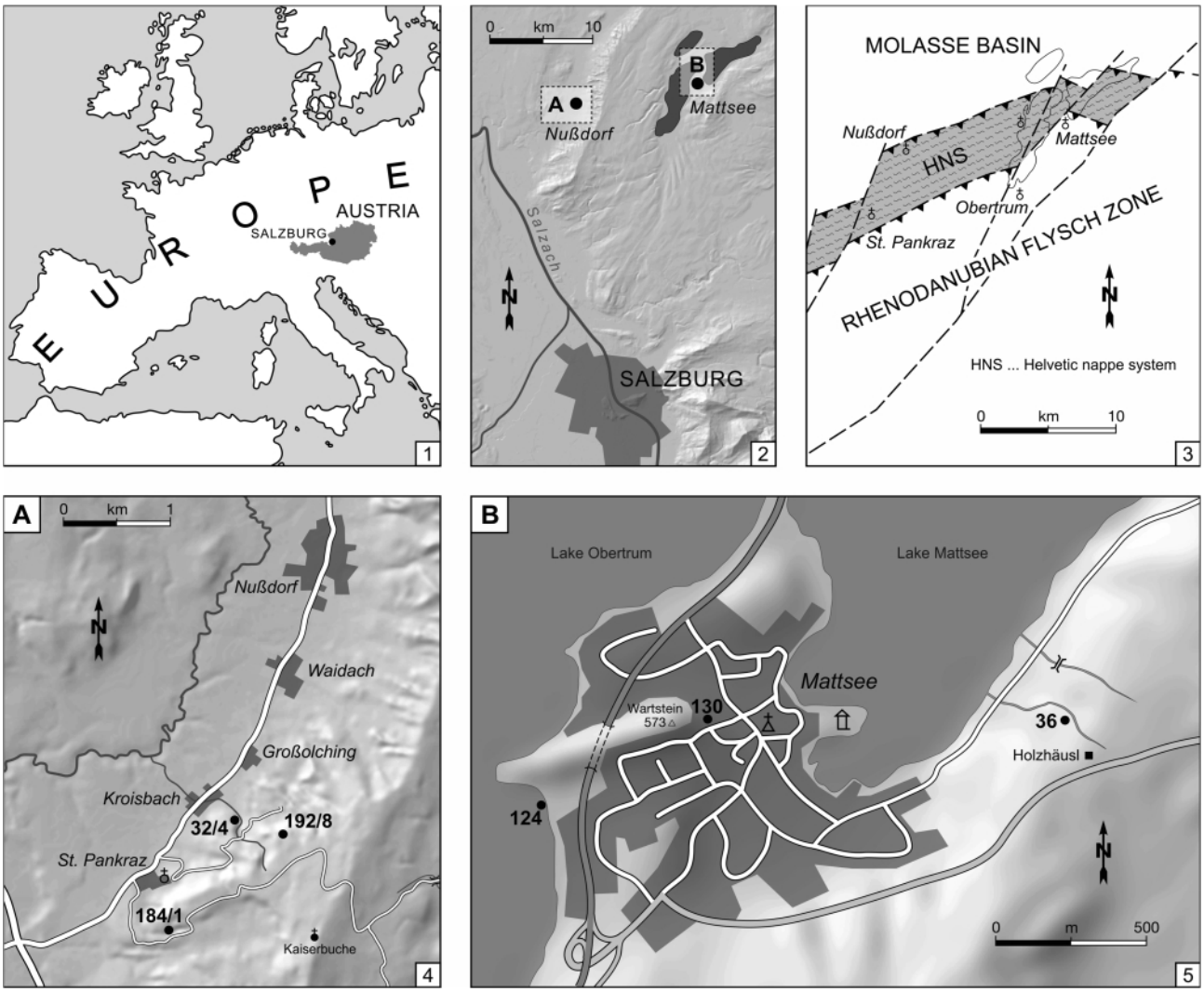

Figure 1: Sample locations of Gohrbandt´s foraminifera type specimens in the Helvetic Nappe Sytem (HNS) north of Salzburg (Austria).

nodentata, *M. subbotinae*, *Globanomalina ovalis*, *Planorotalites pseudoscitula*, *Pseudohastigerina wilcoxensis*. These species indicate Morozovella formosa Lowest-occurrence Zone (Zone E4) of Berggren and Pearson (2005) and Wade et al. (2011). The marker species of the following planktonic foraminiferal Zone E5, *Morozovella aragonensis* is missing. The foraminifera assemblage demonstrated the greatest depositional depth in a bathyal environment, dominated by planktonic foraminifera, few deep water agglutinates and rare calcareous benthic forms.

The calcareous nannoplankton assemblage of sample 184/1 is indicative for the uppermost part of the *Tribrachiatus contortus*-Zone (Zone NP10; Sub-Zone NP10d of Aubry, 1991) due to the common occurrences of *Tribrachiatus contortus* and *T. orthostylus* (A and B-types). Beside these marker species *Campylosphaera eodela*, *Chiasmolithus bidens*, *Coronocyclus bramlettei*, *Discoaster barbadiensis*, *D. binodosus*, *Ellipsolithus macellus*, *Lophodolithus nascens*, *Neochiastozygus concinnus*, *N. junctus*, *N. rosenkrantzii*, *Sphenolithus moriformis*, *S. radians*, *Sullivania consueta*, and *Zygrhablithus bijugatus* are typical elements of the assemblage.

Outcrop 36, Holzhäusl section (type locality of *Globanomalina wilcoxensis globulosa*, *Globorotalia mattseensis*, and *Globigerina hagni* of Gohrbandt, 1967, and the recently described *Hantkenina gohrbandti* Rögl and Egger, 2011).

The planktonic foraminiferal assemblage of the light grey to yellowish grey marlstone corresponds to assemblages of the *Guembelitrioides nuttalli* Lowest-occurrence Zone, Zone E8 of Wade et al. (2011). It contains *Acarinina bullbrooki*, *A. collactea*, *A. cuneicamerata*, *Morozovella aragonensis*, *Igorina broedermanni*, *Planorotalites capdevillensis*, *Globorotaloides quadrocameratus*, *Clavigerinella caucasica*, *C. eocanica*, *C. jarvisi*, *Hantkenina gohrbandti*, *H. singanoae*, *H. mexicana*, and the stratigraphically important species *Turborotalia frontosa*, *Guembelitrioides nuttalli*, *Globigerinatheka subconglobata*. *Globigerinatheka kugleri*, the marker for Zone E9 is not present. With a high number of planktonic foraminifera (up to 80%) and a corresponding assemblage of agglutinated and calcareous benthics a middle bathyal depositional depth can be assumed.

The nannoplankton assemblages, which are dominated by *Reticulofenestra dictyoda*, *R. scrippsae*, *Coccolithus pelagicus*, and *Zygrhablithus bijugatus*, are diverse and show moderate preservation. Typical elements of the assemblage are *Blackites spinosus*, *C. expansus*, *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*, *Sullivania consueta* and *S. gigas*. 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 *Sullivania gigas*, 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 *Sullivania gigas*, Subzone NP15b as the total range of *Sullivania gigas*, and Subzone NP15c as the interval between the LO (last occurrence) of *Sullivania gigas* and the LO of *Blackites gladius*. Using these criteria, the entire Holzhäusl section can be assigned to the *Sullivania gigas* Subzone of the *Nannotetrina fulgens*-Zone (Zone NP15; Sub-zone NP15b).

Outcrop 124, shore of lake Obertrum (type locality of *Globorotalia wartsteinensis*).

The marlstone of this subaqueous outcrop in lake Obertrum contains *Acarinina cuneicamerata*, *A. bullbrooki*, *A. soldadoensis*, *Morozovella aragonensis*, *M. crater*, *M. caucasica*, *Morozovelloides bandyi*, *Pseudohastigerina micra*, *P. wilcoxensis*. This composition correlates to *Acarinina cuneicamerata* Lowest-occurrence Zone (Zone E7) of Berggren and Pearson (2005). The absence of *Turborotalia frontosa* indicates *Acarinina cuneicamerata* Lowest-occurrence Subzone (Zone E7a) of Wade et al. (2011). The foraminiferal assemblage is dominated by planktonic species together with agglutinated and calcareous benthics of a middle bathyal environment.

The diverse calcareous nannoplankton assemblage of sample 64/1/124 suggests an assignment to Zone NP14b: *Blackites inflatus*, *Chiasmolithus grandis*, *Ch. solitus*, *Cyclicargolithus floridanus*, *Discoaster saipanensis*, *D. sublodoensis*, *Girgisia gammation*, *Lanternithus minutus*, *Nannotetrina cristata*, *Pemma basquense*, *Sphenolithus spiniger*.

Outcrop 130, centre of town Mattsee (type locality of *Globorotalia pseudochapmani* of Gohrbandt and of the calcareous nannoplankton species *Braarudosphaera undata*, *Discoaster currens*, *D. gemmeus*, *D. gemmifer* and *D. kuepperi* described by Stradner (1959a; 1959b; 1961 in Stradner and Papp).

The planktonic foraminiferal assemblage is similar to that of station 124 displaying *Acarinina cuneicamerata*, *A. bullbrooki*, *A. pseudotopilensis*, *A. soldadoensis*, *Morozovella aragonensis*, *M. crater*, *M. caucasica*, *Igorina broedermanni*, *Planorotalites capdevillensis*, *Pseudohastigerina micra*, *P. wilcoxensis*. The absence of *Turborotalia frontosa* in this assemblage indicates also *Acarinina cuneicamerata* Lowest-occurrence Subzone (Zone E7a) of Wade et al. (2011). In the residue a higher number of calcareous benthic foraminifera, mainly lagenids indicate a depositional depth of outer shelf to upper bathyal.

The stratigraphically important species of the moderate preserved calcareous nannoplankton assemblage are *Cyclicargolithus floridanus*, *Discoaster wemmelensis*, *D. septemradiatus*, *D. lodoensis*, *D. kuepperi*, *Girgisia gammation*, *Campylosphaera eodela*, *Ellipsolithus distichus*, *Chiasmolithus grandis*, *Lophodolithus mochloporus*. According to Perch-Nielsen (1985) the latter species has its first occurrence in the upper part of the *Discoaster lodoensis*-Zone (Zone NP13).

5. Revision of Gohrbandt's species

Globorotalia haunsbergensis Gohrbandt (1963)

valid name: *Globanomalina chapmani* (Parr, 1938)
Pl. 1, Figs 1-4

1938 *Globorotalia chapmani* Parr, p.87, pl. 3, figs 9a-b.
1963 *Globorotalia haunsbergensis* n. sp. Gohrbandt, p. 53, pl. 6, figs 10-12.
1979 *Globorotalia (Turborotalia) haunsbergensis* Gohrbandt – Blow, p. 782 (checklist no. 401), p. 1075, pl. 88, figs 6,8,9.
non 1999b *Globanomalina ehrenbergi* (Bolli, 1957) – Olsson, Hemleben and Liu, p. 42, pl. 14, figs 4,8,12; pl. 35, figs 14-16.
Discussion: Blow (1979) interpreted the morphogenetic trends in the *G. compressa* lineage, which produced morphotypes of *G. haunsbergensis* with a lax coiling mode and a subacute peripheral margin. The rapidly increasing chamber size, especially visible in the paratypes, compressed test and an imperforate peripheral band (visible in SEM figures) point more to a synonymy with *Globanomalina chapmani* (Parr, 1938) than to that with *G. ehrenbergi*, as proposed by Olsson et al. (1999b).
Type level: Kroisbachgraben, sample 63/2-32/4, Paleocene, Zone C of Gohrbandt (1963), planktonic foraminiferal Zone P3, nannoplankton Zone NP4; Olching Formation.

Globorotalia ? traubi Gohrbandt (1963)
valid name: *Igorina lodoensis* (Mallory, 1959)
Pl. 1, Figs 5-11

1959 Globorotalia broedermanni Cushman and Bermudez var. lodoensis Mallory, p. 253, pl. 23, figs 3a-c.
1963 *Globorotalia ? traubi* n. sp. Gohrbandt, p. 56, pl. 3, figs 16-18.
1979 *Globorotalia ? traubi* Gohrbandt – Blow, p. 823 (checklist no. 652).
2006 *Igorina lodoensis* (Mallory, 1959) – Berggren, Olsson and Premoli Silva, p. 388, pl. 12.3, figs 1-16.
2011 *Igorina lodoensis* – Soldan, Petrizzo, Premoli Silva and Cau, p. 265, fig. 5.5a-c; p. 281, fig. 18.2a-b.
Discussion: Blow (1979) has seen a resemblance to *Globorotalia (Acarinina) convexa* Subbotina, but mentioned uncertainties because of inadequate illustration of the apertural system. Therefore he considered in his discussion the species as a junior synonym of *G. convexa*. Restudy of the types shows a planoconical loosely coiled form where the initial whorl on the spiral side is somewhat elevated above the final whorl, the umbilical side is conical with a small umbilicus. Sutures are depressed, slightly curved on the spiral side and straight on the umbilical side. In contrast to *Igorina broedermanni* the axial view shows the earlier part of the test angled. The muricate wall texture with small pustules corresponds to that of *I. broedermanni*. Re-description of the holotype and variation in *Igorina lodoensis* (Berggren et al., 2006; Soldan et al., 2011) place *Globorotalia ? traubi* in synonymy of this species.
Type level: trench SW of cottage Hochberg, sample 63/2-184/1, lower Eocene, Zone F of Gohrbandt (1963), planktonic foraminiferal Zone E4, calcareous nannoplankton Zone upper part of NP10; Buntmergelserie, Ultrahelvetic Unit.

Truncorotalia marginodentata aperta Gohrbandt (1963)
valid name: *Morozovella marginodentata* (Subbotina, 1953)
Pl. 1, Figs 12-14

1953 *Globorotalia marginodentata* Subbotina, p.212, pl. 17, figs 15a-c.
1963 *Truncorotalia marginodentata aperta* n. sp. Gohrbandt, p. 63, pl. 5, figs 10-15.
1979 *Truncorotalia marginodentata aperta* Gohrbandt – Blow, p. 760 (checklist no. 261).
2006 *Morozovella marginodentata* (Subbotina, 1953) – Berggren and Pearson, p. 368.
Discussion: Blow (1979) considered this form as a junior synonym of *Globorotalia (Morozovella) occlusa occlusa* Loeblich and Tappan, because of the open umbilicus, the umbilical conical chambers, and the small muricate knobs. The specimens have a thick murico-carina and strongly curved limbate sutures, typical for *M. marginodentata*. The holotype with a wide umbilicus falls in the variety of this species (comp. Berggren and Pearson, 2006). This variation is rather rare. There exist only the figured specimens, and in comparative samples no additional specimens have been found.
Type level: Trench NNW Bauerstatt, "Gryphaeenbank", sample 63/2-192/8. Comparative samples from this locality have an assemblage of planktonic foraminiferal Zone P4 and nannoplankton Zone NP9; upper Paleocene, Kressenberg Formation, Kroisbach Subformation.

Globanomalina wilcoxensis globulosa Gohrbandt (1967)
valid name: *Pseudohastigerina wilcoxensis* (Cushman and Ponton, 1932)
Pl. 1, Figs 22-24

1932 Nonion wilcoxensis Cushman and Ponton, p. 64, pl. 8, figs 11a-b.
1967 *Globanomalina wilcoxensis* (Cushman and Ponton) subsp. *globulosa* Gohrbandt, new subspecies Gohrbandt, p. 321, pl. 1, figs 16-17.
1979 *Globanomalina wilcoxensis globulosa* Gohrbandt – Blow, p. 780 (checklist no. 390).
2006 *Pseudohastigerina wilcoxensis* (Cushman and Ponton, 1932) – Olsson and Hemleben, p. 427.
Discussion: The species was considered by Blow (1979) a junior synonym of *Pseudohastigerina sharkriverensis* Berggren and Olsson (1967), from which it is distinguished by the apertural character and the faster increase in chamber size. In the studied material of the Ultrahelvetic Unit there is a great variety in the inflation of the final chamber and the curved sutures, which were as typically described for the species. The specimens show variations in the sutures from straight to slightly curved.
Type level: Holzhäusl section NE of Mattsee (sample 64/1-36/9); middle Eocene, planktonic foraminiferal Zone E8, nanno-

plankton Zone NP15b; Buntmergelserie, Ultrahelvetic Unit.

Globorotalia mattseensis Gohrbandt (1967)
valid name: *Igorina broedermanni* (Cushman and Bermudez, 1949)
Pl. 1, Figs 15-21

1949 *Globorotalia (Truncorotalia) broedermanni* Cushman and Bermudez, p. 40, pl. 7, figs 22-24.
1967 *Globorotalia mattseensis* Gohrbandt, new species – Gohrbandt, p. 322, pl. 1, figs 25-30.
2006 *Igorina broedermanni* (Cushman and Bermudez, 1949) – Berggren et al., p.384.
Discussion: In contrast to *I. wartsteinensis*, the umbilicus is open, the umbilical side less high, and a rounded peripheral shoulder is developed. The species falls entirely in the variation of *I. broedermanni*.
Type level: Holzhäusl section NE of Mattsee (sample 64/1-36/5); middle Eocene, planktonic foraminiferal Zone E8, nannoplankton Zone NP15b; Buntmergelserie, Ultrahelvetic Unit.

Globorotalia wartsteinensis Gohrbandt (1967)
valid name: *Igorina wartsteinensis* (Gohrbandt, 1967)
Pl. 2, Figs 1-6

non 1949 *Globorotalia (Truncorotalia) broedermanni* Cushman and Bermudez, p. 40, pl. 7, figs 22-24.
1967 *Globorotalia wartsteinensis* Gohrbandt, new species - Gohrbandt, p. 322, pl. 1, figs 18-24.
1979 *Globorotalia wartsteinensis* Gohrbandt – Blow, p. 827 (checklist no. 679).
2006 *Igorina broedermanni* (Cushman and Bermudez, 1949) – Berggren et al., p.384.
Discussion: The spiral side of the test is flat to slightly vaulted, with the few last chambers of the final whorl commonly in lowered position compared with the earlier chambers. Umbilical side high conical with flat chamber walls, strongly appressed 6-7 chambers, and a narrow umbilicus. Spiral sutures curved, umbilical sutures straight, somewhat depressed. Peripheral shoulder subangular. Aperture a low arch with thin lip. Wall texture muricate, normal perforate.
Blow (1979) saw difficulties based on the illustrations but placed the form within the *Acarinina lodoensis – A. broedermanni* group. Berggren et al. (2006) see a general tendency in the broedermanni group with an increase in the number of chambers. In comparison with *I. broedermanni* this planoconical form has a much higher conical umbilical side and a narrow umbilicus. Specimens of *I. broedermanni* from the type locality and different levels of Trinidad Eocene, placed at disposal by H.M. Bolli to K. Gohrbandt have not been in agreement with the revised species.
Type level: shore of lake Obertrum, at the southwestern end of the Wartstein hill, Mattsee, sample 64/1-124; lower Eocene, planktonic foraminiferal Zone E7a, nannoplankton Zone NP14b; Buntmergelserie, Ultrahelvetic Unit.

Globorotalia salisburgensis Gohrbandt (1967)
valid name: *Igorina salisburgensis* (Gohrbandt, 1967)
Pl. 2, Figs 7-15

1967 *Globorotalia salisburgensis* Gohrbandt, new species – Gohrbandt, p.323, pl. 1, figs 31-39.
1979 *Globorotalia salisburgensis* Gohrbandt – Blow, p. 813-814 (checklist no. 597).
non 1979 *Globorotalia (Acarinina) nicoli ? salisburgensis* Gohrbandt – Blow, p. 939, pl. 97, figs 3-5.
non 2006 *Globorotalia salisburgensis* Gohrbandt, 1967 – Huber et al., p.503.
Discussion: Blow (1979) considered a relation with *Globorotalia nicoli* Martin (1943). He observed differences between the more and less biconvex holo- and paratypes of *G. salisburgensis*. Blow's figures are more similar to *G. nicoli*, with 7 chambers in the final whorl. In contrast the 7-8 chambers in *I. salisburgensis* are separated by strongly curved sutures, and the test is distinctly biconvex. Huber et al. (2006) placed the species under "problematica" as an indeterminate morozovellid, probably reworked from the Paleocene.
In our material the species does not posses a muricocarina but an angled limbate periphery. The spiral side is characteristic with strongly curved intercameral sutures and commonly slightly imbricated chambers. The test is biconvex. The wall texture is muricate with small pustules as in *I. broedermanni*. Compared with the *Igorina* species studied and figured by Soldan et al. (2011) there is no similarity. A comparison with *I. laevigata* (Bolli) shows differences in curvature of spiral sutures and in axial view. A reworking from the Paleocene seems unlikely by the high frequency of the species and missing of other reworked forms.
Type level: trench SW of cottage Hochberg, sample 63/2-184/1, lower Eocene, Zone F of Gohrbandt (1963), planktonic foraminiferal Zone E4, nannoplankton Zone NP10d; Buntmergelserie, Ultrahelvetic Unit (same sample as for *Igorina traubi*).

Globorotalia pseudochapmani Gohrbandt (1967)
valid name: *Globanomalina pseudochapmani* (Gohrbandt, 1967)
Pl. 2, Figs 16-21

1967 *Globorotalia pseudochapmani* Gohrbandt, new species – Gohrbandt, p. 323, pl. 1, figs 10-15.
1979 *Globorotalia pseudochapmani* Gohrbandt – Blow, p. 807 (checklist no. 557).
Discussion: Blow (1979) considered the species a junior synonym of *Globorotalia (Turborotalia) planoconica* Subbotina, 1953. Olsson and Hemleben (2006, p.418) discussed this opinion under the chapter of *Globanomalina planoconica*, but did not make a decision about the validity of the species. Our material exhibits a form which is different from *G. planoconica* by a much smaller and depressed initial whorl on the spiral side. Additionally, chambers are lower and in higher number in the final whorl.

Type level: centre of town Mattsee, 64/1-130; lower Eocene, planktonic foraminiferal Zone E7a, nannoplankton Zone NP 13; Buntmergelserie, Ultrahelvetic Unit.

Globigerina hagni Gohrbandt (1967)
valid name: *Parasubbotina hagni* (Gohrbandt, 1967)
Pl. 2, Figs 22-27

1967 *Globigerina hagni* Gohrbandt, new species – Gohrbandt, p. 324, pl. 1, figs 1-9.
1979 *Globigerina hagni* Gohrbandt – Blow, p. 781-782 (checklist no. 398).
2006 *Subbotina hagni* (Gohrbandt, 1967) – Olsson et al., p. 142, pl. 6.11, figs 1-17.
Discussion: Blow (1979) considered it as a junior synonym of *Globigerina bakeri* Cole (1927), but there is no similarity with description and figures given by Blow for *G. bakeri*. Olsson et al. (2006) figured topotypes of *Subbotina hagni* but did not correctly describe the position of the aperture. The species shows an umbilical-extraumbilical aperture (comp. pl. 2, figs 26-27) in all samples of the Holzhäusl section, if not covered by a displaced final chamber. This is the main characterisitic of the genus *Parasubbotina* and therefore the species is placed therein.
Type level: Holzhäusl section NE of Mattsee (sample 64/1-36/9); middle Eocene, planktonic foraminiferal Zone E8, nannoplankton Zone NP15b; Buntmergelserie, Ultrahelvetic Unit.

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Plate 1:

Figure 1-4: *Globorotalia haunsbergensis* Gohrbandt (1963) – valid name *Globanomalina chapmani* (Parr, 1938). Figs 1, 4 paratypes from the Gohrbandt collection, sample 63/2-32/5, Kroisbachgraben; figs 2-3 holotype (refigured from pl. 6, figs 10-11).

Figure 5-11: *Globorotalia ? traubi* Gohrbandt (1963) – valid name *Igorina* lodoensis (Mallory, 1959). Figs 5, 7, 8 from the type sample; fig. 6 paratype from the Gohrbandt collection, sample 63/2-184/1, trench SW cottage Hochberg; figs 9-11 holotype (refigured from pl. 3, figs 16-18).

Figure 12-14: *Truncorotalia marginodentata aperta* Gohrbandt (1963) – valid name *Morozovella marginodentata* (Subbotina, 1953). Trench NNW Bauerstatt, sample 63/2-192/8. Holotype refigured from pl. 5, figs 13-15.

Figure 15-21: *Globorotalia mattseensis* Gohrbandt (1967) – valid name *Igorina broedermanni* (Cushman and Bermudez, 1949). Figs 15, 17, 18 from the type sample; fig. 16 paratype from the Gohrbandt collection, sample 64/1-36/5, Holzhäusl section; figs 19-21 holotype (refigured from pl. 1, figs 28-30).

Figure 22-24: *Globanomalina wilcoxensis globulosa* Gohrbandt (1967) – valid name *Pseudohastigerina wilcoxensis* (Cushman and Ponton, 1932). Fig. 22 paratype from the Gohrbandt collection, sample 64/1-36/9, Holzhäusl section; figs 23-24 holotype (refigured from pl. 1, figs 16-17).

Magnification: scale bar for all SEM figures 100 µm; magnification for refigured holotypes as in publication for 1963 is 75x, for 1967 is 67x.

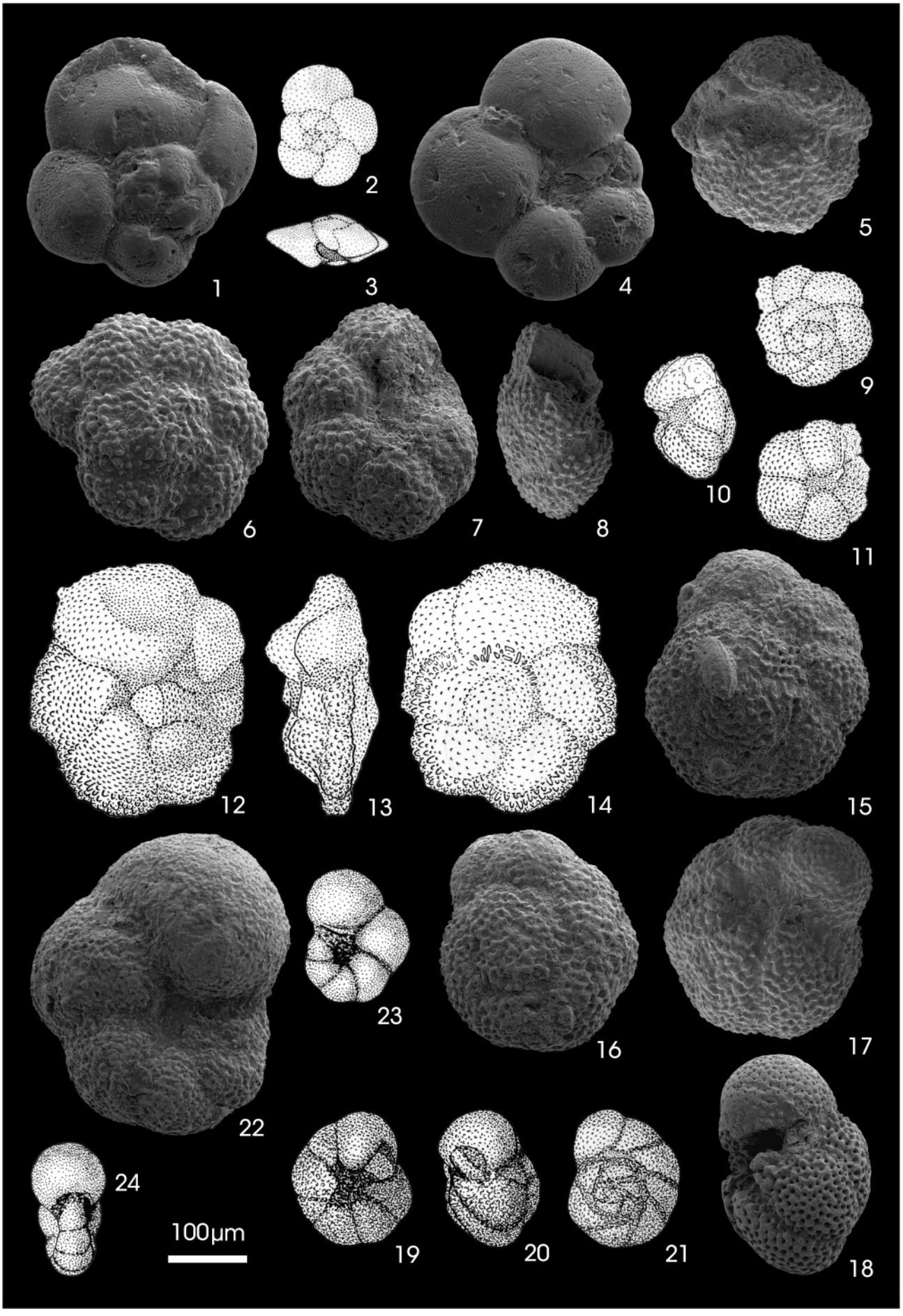
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Plate 2:

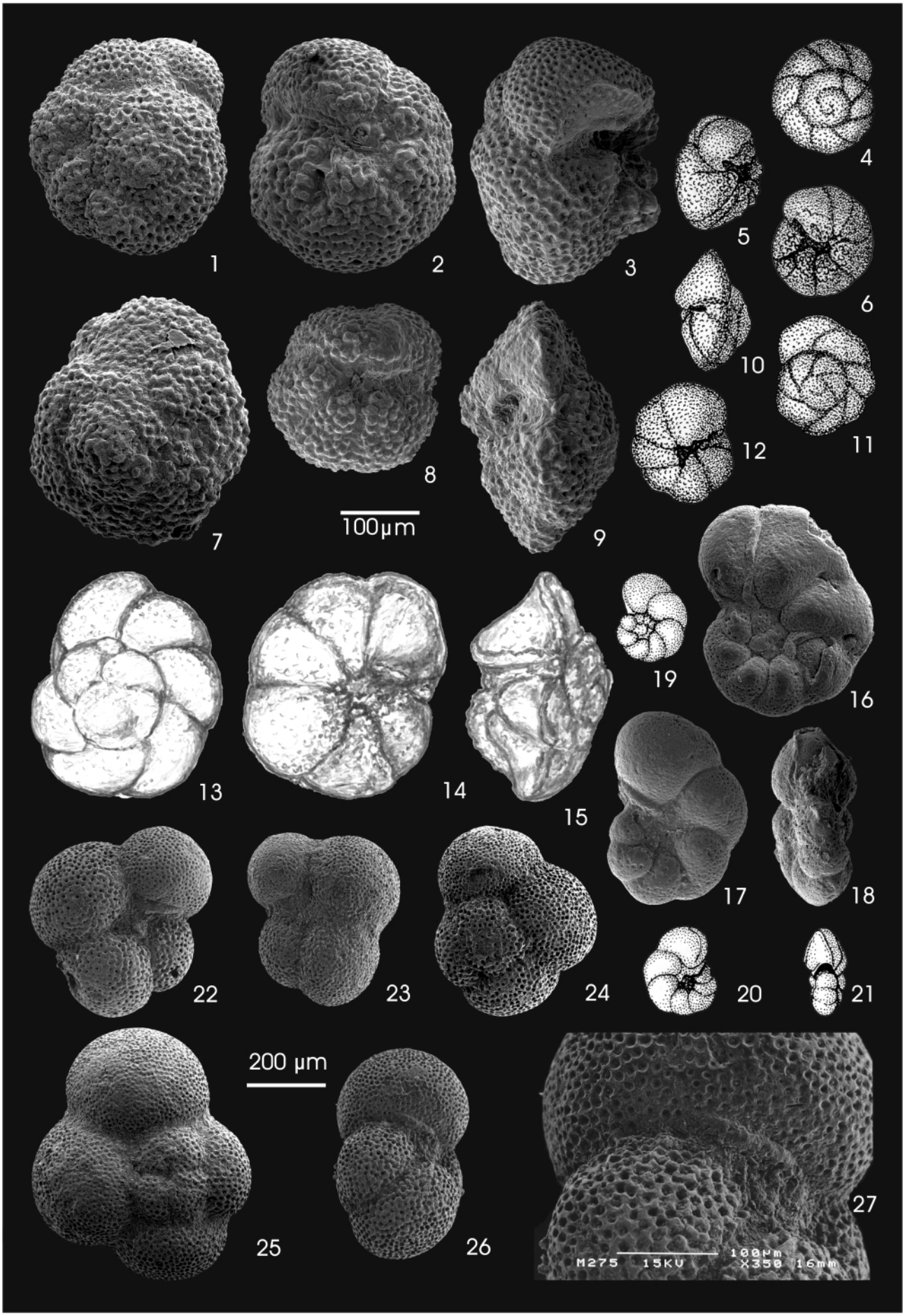
Figure 1-6: *Globorotalia wartsteinensis* Gohrbandt (1967) – valid name *Igorina wartsteinensis* (Gohrbandt, 1967). Figs 1-2 paratypes from the Gohrbandt collection; fig. 3 from type sample 64/1-124, shore of lake Obertrum, Mattsee; figs 4-6 holotype (refigured from pl. 1, figs18-20).

Figure 7-15: *Globorotalia salisburgensis* Gohrbandt (1967) – valid name *Igorina salisburgensis* (Gohrbandt, 1967). Fig. 7 paratype from the Gohrbandt collection; figs 8-9 from type sample 63/2-184/1, trench SW cottage Hochberg; figs 10-12 holotype (refigured from pl. 1, figs 34-36); figs 13-15 sketch of paratype inv. no. 1966/683/2 (Gohrbandt's figs 37-39).

Figure 16-21: *Globorotalia pseudochapmani* Gohrbandt (1967) – valid name *Globanomalina pseudochapmani* (Gohrbandt, 1967). Figs 16-17 paratypes from the Gohrbandt collection; fig. 18 type sample 64/1-130, Holzhäusl section, Mattsee; figs 19-20 holotype (refigured from pl. 1, figs 13-15).

Figure 22-27: *Globigerina hagni* Gohrbandt (1967) – valid name *Parasubbotina hagni* (Gohrbandt, 1967). Figs 22-24, 26-27 from the type section, sample Gohrbandt 64/1-36/4a; fig. 25 paratype from the Gohrbandt collection, sample 64/1-36/9, Holzhäusl section, Mattsee.

Magnification: scale bar for SEM figs 1-3, 7-9, 16-18 and sketch figs 13-15 is 100 µm, for figs 22-26 is 200 µm; magnification for refigured holotypes as in publication 1967 is 67x.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