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Senonian Globotruncanidae from Israel

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ABSTRACT

Fifty-four species of Globotruncanidae belonging to the genera *Dicarinella, Marginotruncana, Globotruncana, Globotruncanita, Rosita, Globotruncanella, Gansserina* and *Abathomphalus* are recorded from strata ranging in age from Coniacian to Maastrichtian. Their stratigraphic ranges in Israel are summarized in a range chart showing also the biostratigraphic zonation recognized (including a proposed *G. rosetta* zone), its chronostratigraphic interpretation as based on the taxa recorded, intercalibrated with benthic foraminifera, calcareous nannoplankton and especially with ammonites, as well as a correlation chart of the Senonian formations of Israel. The species are illustrated by SEM microphotographs on 10 plates. In order to facilitate reference to earlier records of taxa not figured previously from Israel, a number of camera lucida drawings of several important species prepared by one of the authors (Z. R.) in 1951 are included in one plate with notes on their revised taxonomy.

Introduction

Late Cretaceous (Coniacian to Maastrichtian) marine formations are widely distributed in Israel and are composed of a great variety of rock-types (carbonates, cherts and phosphorites with subordinate sandstones and evaporites).

These formations were deposited on a broad shelf, deepening from south to nord (Fig. 1), and on the upper slope with intra-shelf and -slope basins in a warm, highly fertile sea. Synsedimentary folding, faulting and differential subsidence, changes in sea-level, wind-stress pattern, upwelling, and in water-mass characteristics, as well as episodic apport of fresh waters greatly influenced the genetic and diagenetic environments and resulted in a great variability in space and time of litho- and biofacies.

A detailed paleoenvironmental analysis across these facies belts, now in progress, requires a high-resolution chronostratigraphic framework, based primarily on biostratigraphic criteria. A number of Israeli paleontologists are at present engaged in this task, analyzing from selected, closely sampled surface and subsurface sections the planktic and benthic foraminifera, the calcareous nannoplankton, megafossils, especially ammonites, as well as ostracodes, radiolarians and diatoms.

Some results of these studies have been already summarized in several publications (see among others REISS et al. 1985a, b; HAAS et al. 1985; LEWY, in press, with references).

Of foremost importance in the bio- and chronostratigraphic analysis of the Senonian of Israel are the planktic foraminifera which provide a powerful tool for interregional correlation, especially if intercalibrated with other important groups like nannoplankton,

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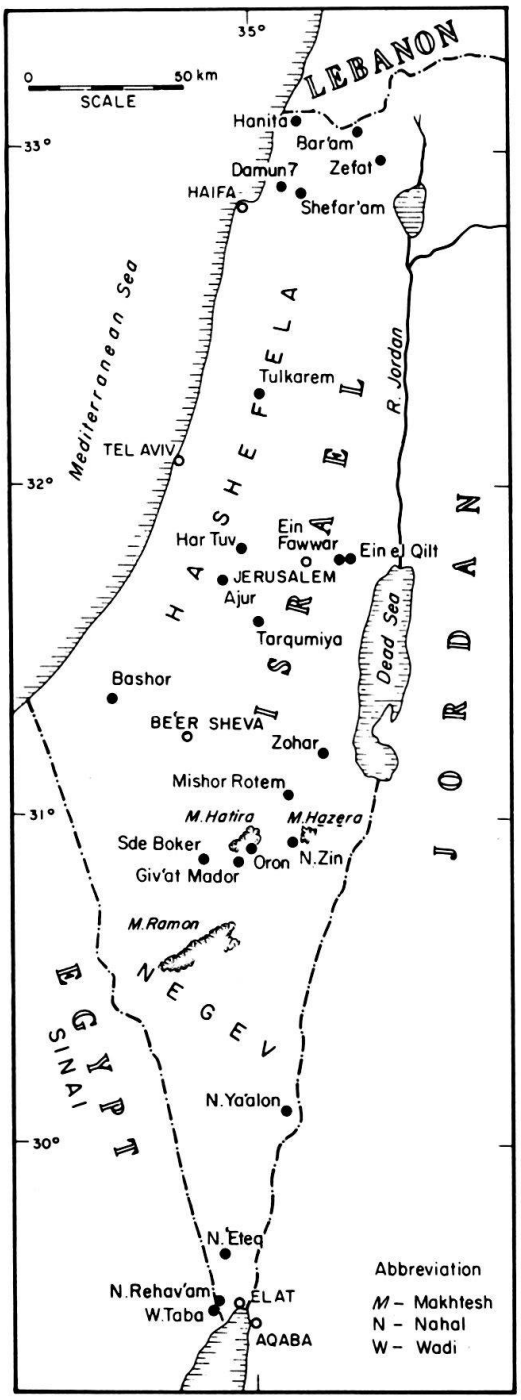

Fig. 1. Location map of sections.

ammonites or benthic foraminifera (see REISS 1985a, b). Generally, the frequency of Globotruncanidae decreases from the open sea in the north and northwest of Israel towards the inner shelf, in the SSE of the country.

Late Cretaceous planktic foraminifera from Israel

The first microbiostratigraphic scheme based on benthic and planktic foraminifera was proposed for the Late Cretaceous and Paleogene of Israel by REISS (1951, 1952a).

Informal zones were recognized by planktic foraminiferal associations and their chronostratigraphic interpretation was based on a survey of the then available literature on foraminifera from both hemispheres. Later work on Cretaceous planktic foraminifera from Israel (REISS 1952b, 1955a, b, 1957a, b, c, 1962, 1964; FLEXER 1964, 1968, 1971; LUZ 1970; LIPSON-BENITAH 1980; LIPSON-BENITAH et al. 1985) has clarified both their taxonomy and stratigraphic distribution leading to more well-documented chronostratigraphic interpretations (REISS et al. 1985a, b, with references). Despite the fact that planktic foraminifera were recorded from Israel since the early 1950's and a number of them figured in unpublished reports by REISS (1951), FLEXER (1964) and LUZ (1970), only very few illustrations were published (REISS 1952b, LIPSON-BENITAH et al. 1985).

The purpose of the present paper is to summarize the stratigraphic record of 54 species of Late Cretaceous Globotruncanidae from Israel and to illustrate the recorded species, mainly by SEM micrographs.

The record is based on numerous surface sections – eight of them specially sampled – and subsurface sections (continuous cores and percussion drill samples) from different regions of the country (Fig. 1) and comprising the En Zetim, Menuha, Mishash, Say'yarim, Ghareb and Taqiye Formations (Fig. 2) (see also REISS 1985a, b). In most cases the stratigraphic ranges of the Globotruncanidae were checked against those of co-occurring benthic foraminifera, calcareous nannoplankton and megafossils. In a number of subsurface sections important datums were checked against electric log markers (GVIRTZMAN et al. 1985).

The results presented here are in the main the outcome of a joint study during 1983–1985 by A. Almogi-Labin and Z. Reiss and of discussions of the material with M. Caron in 1984, 1985 and 1986.

Bio- and chronostratigraphy

Since BOLLI's (1966) proposal, various and slightly differing zonations of the Late Cretaceous with the aid of Globotruncanidae have been proposed in the past (see among other WONDERS 1980; WEIDICH 1984, with references). Of particular significance are the zonations defined by major biostratigraphic events in the Globotruncanidae (see MARKS 1984; ROBASZYNSKI et al. 1984 and see also CARON, in BOLLI et al. 1985). A comparison of the sequence and ranges of selected Globotruncanidae in Israel and elsewhere in the Tethyan province was given by REISS et al. (1985a), intercalibrated with benthic foraminifera, calcareous nannofossils, ostracodes and ammonites, while major selected biostratigraphic datums in the various groups were indicated by REISS et al. (1985b). Ranges and datums were compared with the zonation based on Globotruncanidae by ROBASZYNSKI et al. (1984). It was, however, emphasized that the rather sporadic occurrence in Israel of *Globotruncana ventricosa* makes it difficult to use the *G. ventricosa* Zone and for this reason REISS et al. (1985b) suggested the possibility of using a *Globotruncanita subspinosa*-Zone (VAN HINTE 1963), whose base is near that of the *G. ventricosa* Zone. Lately, however, rare specimens of what must be identified as *G. subspinosa* were found in two sections (Bar'am and Tarqumiye; Fig. 1) in strata doubtlessly belonging to the *Globotruncanita elevata* Zone and thus of late Early Campanian age. Although the possibility is not excluded that the chamber elongation characteristic of *G. subspinosa* is

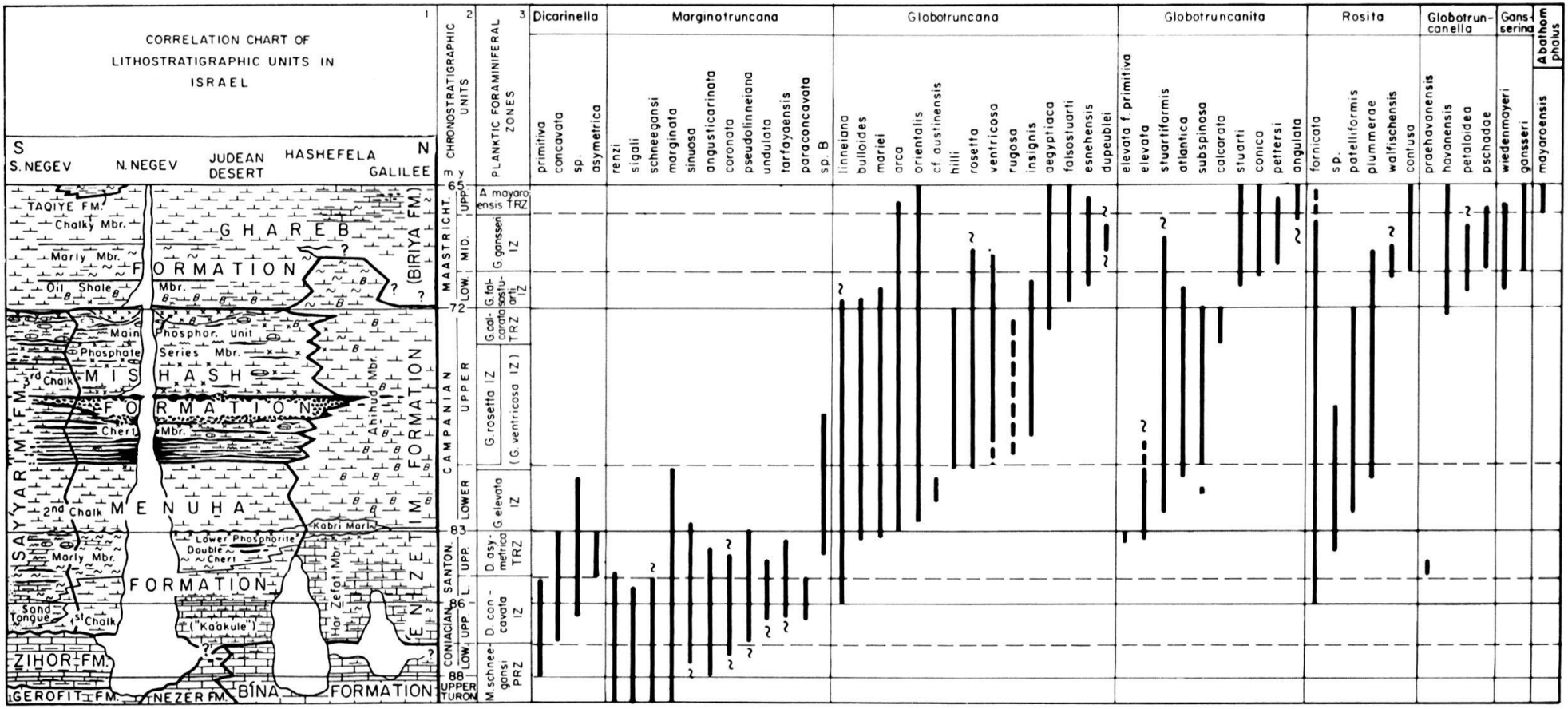

Fig. 2. Range chart of Senonian Globotruncanidae from Israel and correlation chart of Senonian formations in Israel (not to scale). With regard to the *G. rosetta* Zone see text. For discussion of the radiometric ages see chapter "Bio- and chronostratigraphy".

an iterative character (the strata with the Early Campanian specimens are followed by an interval in which no such forms occur and which in turn are overlain by strata bearing a continuous sequence of *G. subspinosa*), this species (as morphologically understood) cannot be used as a zonal marker. For this reason, a *Globotruncana rosetta* Zone is proposed here, defined by the interval from the first appearance of this taxon to the entry of *Globotruncanita calcarata*. This interval-zone is nearly coeval with the *G. ventricosa* Zone and is more easily recognized in Israel both by the nominate taxon and by the accompanying fauna (see Fig. 2).

The basic zonation accepted by ROBASZYNSKI et al. (1984) with the modification concerning the *G. rosetta* Zone is interpreted chronostratigraphically, following ROBASZYNSKI et al. (op. cit.) (see also MARKS 1984), especially as intercalibrated against ammonites (REISS et al. 1985a, b). Correlation of ammonite ranges between North America and Israel combined with radiometric ages (LEWY 1985) makes it also possible to attribute in somewhat greater detail such ages to the different planktic foraminiferal zones used here.

The radiometric ages indicated on Figure 1 are those used by ROBASZYNSKI et al. (1984) (see also REISS et al., in press a, b). Howevever, discrepancies between the radiometric ages attributed to stage boundaries (and the same biostratigraphic datums) by different authors exist, especially because of different methods employed or use of different decay constants (see also KENT & GRADSTEIN 1985). Thus, according to LEWY (1985) and based on unpublished information by J. D. Obradovicz on radiometric ages of ammonite zones in the USA, the *base* of the *G. calcarata* zone is at about 74 Ma, the top of the *Hoplitoplacenticeras marroti–H. vari* zone (top of the Main Chert Member of the Mishash Formation in the Negev) at about 78 Ma and its base at approximately 79 Ma. The Campanian–Maastrichtian boundary would be, therefore, in this case at about 72 Ma (as given by ROBASZYNSKI et al. 1984). A more recent publication by KENT & GRADSTEIN (1985) places the *top* of the *G. calcarata* zone and hence the Campanian/Maastrichtian boundary, at 74.5 Ma, while the Santonian–Campanian boundary (last occurrence of *Sigalia* and first occurrence of *Broinsonia parca*) is estimated at 84 Ma and the Coniacian–Santonian boundary at 87.5 Ma (compare Fig. 1, as well as PALMER 1983; LEWY 1985 and FLEXER et al. 1985). Note, however, the uncertainties pertaining to the radiometric ages of the Senonian stage-limits as indicated by PALMER (1983) and as discussed by KENT & GRADSTEIN (op. cit. pp. 1420–1421, 1426). Detailed work now in progress carried out by Z. Lewy, A. Almogi and Z. Reiss on sections with *Globotruncanita calcarata* seems to indicate that the top of the *G. calcarata* Zone is at about 74.5 Ma and its base at about 75.3 Ma, while the Campanian/Maastrichtian boundary is at about 73.5 Ma (Z. Lewy and Z. Reiss, in prep.).

The intercalibration of ranges of planktic and benthic foraminiferal species, calcareous nannoplankton and ammonites has facilitated correlation – across facies belts – of the various lithostratigraphic formations recognized in Israel (REISS et al. 1985a, b, and see Fig. 2). It may be noteworthy in this connection that the Main Chert Member of the Mishash Formation has apparently been deposited during a very short time span (approximately 1 Ma; i.e. during the *Hoplitoplacenticeras vari* zone; LEWY, in press), a fact with important implications for the interpretation of the high productivity, upwelling paleo-environment and rate of sedimentation of these biogenic siliceous deposits.

Material and methods

The samples used were mostly soft chalks, calcareous shales and friable phosphorites, which were washed after treatment with sodium carbonate and tetra natrium diphosphate over a 63-μ sieve and subsequently separated in dry state through a 149-μ sieve. Generally, the whole residue obtained was searched for Globotruncanidae which were picked and mounted.

In a few cases, indurated chalks were examined in thin-sections and species of Globotruncanidae identifiable in this manner recorded (see also SCHNEIDERMANN 1970).

The specimens illustrated on Plates 1–10 have been selected in accordance with their representing adequately the authors' taxonomic concepts, as well as with the state of preservation. Since often specimens are not well enough preserved or clean enough of adhering carbonate to show in an appropriate manner details of the test on all sides, we have depicted the different views (spiral, umbilical, lateral) of each species from different specimens.

Since initial magnifications in the "Jeolco" SEM were chosen according to the size of the specimens and the requirements of the illustration and since (in absence of a built-in bar-scale) recalculation of magnification on the final positive invariably comprised some error, the actual size of the illustrated specimens as measured by micrometer in the stereoscopic microscope is given in the plate explanations.

All specimens figured are deposited at the Museum of Natural History, Basel, Switzerland. All the other material examined is deposited at the Dept. of Geology, Institute of Earth Sciences, The Hebrew University of Jerusalem.

In order to facilitate reference to the earliest unpublished records of Globotruncanidae from Israel, a number of camera lucida drawing from REISS (1951) with their original and revised taxonomic position are reproduced here (Pl. 11).

Remarks on the species

In the following brief discussion of taxonomic position and stratigraphic distribution of each species, only the absolutely necessary references to literature have been included. For a more exhaustive synonymy the reader is referred to the publications mentioned. In order to save space, the Atlases of Planktonic Foraminifera prepared by the European Working Group of Planktonic Foraminifera and edited by ROBASZYNSKI et al. (1979a, b, 1984) are referred to in an abbreviated manner as "Atlas 1, 2 or 3".

The species are discussed in the order of genera, from the stratigraphically earlier to the later ones, and within each genus in alphabetical order. This order is also preserved in the accompanying plates.

Order **Globigerinida** BLOW 1979

Superfamily **Globigerinacea** CARPENTER, PARKER & JONES 1862

Family **Globotruncanidae** BROTZEN 1942

Genus *Dicarinella* PORTHAULT 1970

Dicarinella asymetrica (SIGAL 1952)

Pl. 1, Fig. 1–5; Pl. 11, Fig. 1–6

1952 *Globotruncana asymetrica* SIGAL, p. 34–35, Fig. 35.
1955 *Globotruncana (Globotruncana) ventricosa carinata* DALBIEZ, p. 168–169, Fig. 8a–d.

1970 *Globotruncana carinata* DALBIEZ, KUHRY, p. 302–303, Pl. 2, Fig. 10–12, p. 19–21, Fig. 6.
1977 *Dicarinella concavata carinata* (DALBIEZ), LINARES RODRIGUEZ, p. 116–117, Pl. 9, Fig. 4, Pl. 10, Fig. 1–2.
1979 *Dicarinella asymetrica* (SIGAL), Atlas 2, p. 61–66, Pl. 51, Fig. 1 a–c, 2 a–c, Pl. 52, Fig. 1–2, Pl. 55, Fig. 2 a–c.

Although *D. asymetrica* is generally higher than *D. concavata* height is a variable character in *D. asymetrica* and cannot be used in distinguishing the latter from the former. The most important criterion is the presence of a well-developed periumbilical ridge on all chambers. Thickenings on the shoulder of one or two chambers may occur in specimens of *D. concavata* (BROTZEN) which are transitional to *D. asymetrica* (see below).

Placed by various authors into the genus *Marginotruncana* HOFKER (see also LIPSON-BENITAH et al. 1985; see, however, REISS et al. 1985 a) this species has been recorded from Israel together with *D. concavata* (BROTZEN) at first as *Globotruncana ventricosa* WHITE by REISS (1951, 1952 a) and later on (REISS 1955 b ff.) as *Globotruncana concavata*.

Dicarinella concavata (BROTZEN 1934)

Pl. 1, Fig. 6–9

1934 *Rotalia concavata* BROTZEN, p. 66, Pl. 3, Fig. b.
1955 *Globotruncana (Globotruncana) ventricosa ventricosa* WHITE, DALBIEZ, p. 168, Fig. 7 a–c.
1970 *Globotruncana concavata* (BROTZEN), KUHRY, p. 300–302, Pl. 2, Fig. 16–18, Fig. 6.
1970 *Praeglobotruncana (Dicarinella) concavata* (BROTZEN), PORTHAULT, p. 73, Pl. 10, Fig. 7–8.
1979 *Dicarinella concavata* (BROTZEN), Atlas 2, p. 71–78, Pl. 54, Fig. 1–2, Pl. 55, Fig. 1 a–c.

Some specimens possess a strong pustulate thickening on the umbilical shoulder of one or two chambers (e.g. Pl. 1, Fig. 9), but never the definite carina on all chambers characteristic of *D. asymetrica*.

This species has been placed by various authors into the genus *Marginotruncana* HOFKER (see also LIPSON-BENITAH et al. 1985). Described from the Mt. Carmel region (Israel), this species has been recorded [together with *D. asymetrica* (SIGAL)] by REISS (1951, 1952 a) as *Globotruncana ventricosa* WHITE and later on (REISS 1955 b ff.) as *Globotruncana concavata* (BROTZEN).

Dicarinella primitiva (DALBIEZ, 1955)

Pl. 1, Fig. 10–13

1955 *Globotruncana (Globotruncana) ventricosa primitiva* DALBIEZ, p. 168, Fig. 6.
1979 *Dicarinella primitiva* (DALBIEZ), Atlas 2, p. 93–96, Pl. 60, Fig. 1 a–c, 2
1985 *Marginotruncana primitiva* (DALBIEZ), LIPSON-BENITAH, p. 109, Fig. 5 a–c.

Most specimens are nearly plano-convex, indicating the close relationship with *D. concavata*.

The species has been placed by various authors into the genus *Marginotruncana* HOFKER (see also LIPSON-BENITAH et al. 1985).

Dicarinella sp.

Pl. 1, Fig. 14–19

The low spiroconvex test has 5–7, mostly 6, strongly inflated chambers per coil in the adult, with pustulose walls, especially on the umbilical side, and an interiomarginal,

extra-umbilical – umbilical aperture provided with a porticus. Equatorial periphery strongly lobate. The periphery is provided with a double carina, distinctly imbricated from chamber to chamber, and weakening considerably in the last one or two chambers. Chamber sutures on the umbilical side radial and depressed.

The characters of this – as yet unidentified – species place it into the genus *Dicarinella*. It resembles *Marginotruncana marginata* (REUSS) from which it differs in sutural characters and especially in the imbricated peripheral keels, as well as *Marginotruncana* sp. A (see below), which has usually more chambers per coil, u-shaped umbilical chamber sutures, and is provided mostly with a double strongly imbricated keel which merges in some specimens into a single broad carina.

Genus *Marginotruncana* HOFKER 1956

Marginotruncana angusticarinata (GANDOLFI)

Pl. 2, Fig. 1–4

1942 *Globotruncana linnei* (D'ORBIGNY) var. *angusticarinata (angusticarenata)* GANDOLFI, p. 126–127, Fig. 46/3a–c.
1966 *Globotruncana angusticarinata* GANDOLFI, CARON, p. 79–80, Pl. 4, Fig. 5.
1970 *Marginotruncana angusticarinata* GANDOLFI, PORTHAULT, p. 76–77, Pl. 10, Fig. 15–17.

Although this species is highly variable and shows many similarities with both *M. sinuosa* PORTHAULT and *Rosita fornicata* (PLUMMER), it is separated here from the former by the more regular and short-crescent chambershape and by the receding umbilical keel, and from the latter by its short-crescent shaped chamber, by its apertural characters, and merging peripheral keels in the last chambers.

M. angusticarinata (given as *M. angusticarenata*) has been recorded from Israel by LIPSON-BENITAH et al. (1985), but included in *M. sinuosa* PORTHAULT by REISS et al. (1985a). It is, however, now regarded as a separate species.

Marginotruncana coronata (BOLLI)

Pl. 2, Fig. 5–8; Pl. 11, Fig. 7–9

1945 *Globotruncana lapparenti* BROTZEN subsp. *coronata* BOLLI, p. 233, Fig. 1/21, Pl. 9, Fig. 14.
1967 *Marginotruncana coronata* (BOLLI), PESSAGNO, p. 305–306, Pl. 65, Fig. 11–13, Pl. 100, Fig. 6.
1979 *Marginotruncana coronata* (BOLLI), Atlas 2, p. 103–106, Pl. 62, Fig. 1–2.

This species differs from *M. angusticarinata* by its flat, symmetrical in profile view test, as well as by the persisting symmetrically placed double keels in all chambers, separated by a narrow peripheral band. It differs from *M. pseudolinneiana* mainly by this latter character. Most specimens from Israel, like from the southern Tethys region in general, possess 5½–6 chambers in the last coil, while material from higher latitudes seem to posses up to 9 chambers per coil (see also WEIDICH 1984). In the latest Santonian of Israel, specimens with characters of *M. coronata* with 4½ chambers occur.

This species has been recorded by REISS (1951, 1952a, 1964) and by LUZ (1970) as part of *Globotruncana* gr. *lapparenti* BROTZEN (including *G. tricarinata* Quereau) and as *G. lapparenti* BROTZEN *coronata* BOLLI, and by LIPSON-BENITAH (1980) as *M. coronata* (see also REISS et al. 1985a).

Marginotruncana marginata (REUSS)

Pl. 2, Fig. 9–11

1845 *Rosalina marginata* REUSS, p. 36, Pl. 8, Fig. 54, p. 74, Pl. 13, Fig. 68.
1956 *Globotruncana marginata* (REUSS), JIROVA, p. 241–242. Pl. 1, Fig. 1a–c.
1979 *Marginotruncana marginata* (REUSS), Atlas 2, p. 107–114, Pl. 10, Fig. 3, Pl. 11, Fig. 1–3.

This species is distinguished from *Globotruncana bulloides* VOGLER mainly by its extraumbilical–umbilical aperture, a feature difficult to discern in badly preserved specimens. Thus, the upper limit of *M. marginata* is still in doubt. Study of literature and material seems to indicate that there exists a geographical ecophenotypic variation in the number of chambers, i.e. a European type with 5–6 chambers per coil and an American one, with 4–5 chambers (see also PESSAGNO 1967). The specimens from Israel have generally 5 chambers per coil. *Marginotruncana* sp. A (see below) seems to be a close relative of *M. marginata,* but possesses about 7 chambers per coil on the average and strongly imbricate double and sometimes single keels. *Dicarinella* sp. (see above) may also be a close relative of *M. marginata.*

This species has been recorded from Israel by REISS (1951, 1952a ff.) and by LUZ (1970) in the group of *Globotruncana lapparenti* BROTZEN, together with what they referred to as *Globotruncana lapparenti bulloides* VOGLER.

Marginotruncana paraconcavata PORTHAULT

Pl. 2, Fig. 12–14

1970 *Marginotruncana paraconcavata* PORTHAULT, p. 77–78, Pl. 10, Fig. 21, 22a–b, 23.
1979 *Marginotruncana paraconcavata* PORTHAULT, Atlas 2, p. 119–122, Pl. 66, Fig. 1–2.

This species has a flatter profile than *Dicarinella concavata* (BROTZEN) and sigmoid umbilical chamber sutures. There are strong periumbilical ridges present.

The first record from Israel is by LIPSON-BENITAH et al. (1985) from the Damun 7 borehole, Galilee.

Marginotruncana pseudolinneiana PESSAGNO

Pl. 2, Fig. 15–18

1967 *Marginotruncana pseudolinneiana* PESSAGNO, p. 310, Pl. 65, Fig. 24–27, Pl. 76, Fig. 1–3.
1979 *Marginotruncana pseudolinneiana* PESSAGNO, Atlas 2, p. 123–128, Pl. 67, Fig. 1a–c, Pl. 68, Fig. 1–2.

This homoeomorph of *Globotruncana linneiana* (D'ORBIGNY) is distinguished from the latter by its extraumbilical–umbilical aperture. It differs from *M. coronata* by the wider peripheral band and the occasionally more convex umbilical side and from *M. marginata* by the flat chamber surfaces which are often slightly concave on the spiral side.

It has been recorded from Israel (REISS 1951, 1952a ff.; FLEXER 1964; LUZ 1970) as part of the *Globotruncana lapparenti* BROTZEN-group.

Marginotruncana renzi (GANDOLFI 1942)

Pl. 2, Fig. 19–21

1942 *Globotruncana renzi* GANDOLFI (part), p. 124–125, Pl. 3, Fig. 1, Pl. 4, Fig. 16.

1969 *Globotruncana renzi* GANDOLFI, CARON and LUTERBACHER, p. 27–29, Pl. Fig. 12a–c.
1979 *Marginotruncana renzi* (GANDOLFI), Atlas 2, p. 129–133, Pl. 69, Fig. 1–2.

The biconvex profile and the double carina merging into a single one in the last few chambers mainly separate this species from other similar ones, like e.g. *M. schneegansi.*

It has been recorded by REISS (1958a) from the Late Cenomanian–Turonian and by LIPSON-BENITAH (1980) from the Western Coastal Plain of Israel.

Marginotruncana schneegansi (SIGAL 1952)

Pl. 2, Fig. 22–25

1952 *Globotruncana schneegansi* SIGAL, p. 33, Fig. 34.
1979 *Marginotruncana schneegansi* (SIGAL), Atlas 2, p. 135–140, Pl. 70, Fig. 1a–c, 2a–c, Pl. 71, Fig. 1–2.

This species is well-defined by its keel with two closely set rows of pustules in the earlier chambers, terminating into a single carina, and the very slightly curved, depressed chamber sutures on the umbilical side. These characters also distinguish it from the somewhat similar *M. sigali* (REICHEL) and *M. renzi* (GANDOLFI).

M. schneegansi has been recorded from Israel together with *M. sigali* (REICHEL) from strata ranging from Turonian to Early Santonian (REISS 1958a; LIPSON-BENITAH 1980 et al., 1985; REISS et al. 1985a).

Marginotruncana sigali (REICHEL 1950)

Pl. 3, Fig. 1–5

1950 *Globotruncana (Globotruncana) sigali* REICHEL, p. 610–612, Fig. 5a–c, 6, Pl. 16, Fig. 7, Pl. 17, Fig. 7.
1979 *Marginotruncana sigali* (REICHEL), Atlas 2, p. 141–146, Pl. 72, Fig. 1–2, Pl. 73, Fig. 1a–d.

The specimens from Israel agree well with the description and figures given in the Atlas. Some specimens show a slight undulation of the last chambers on the spiral side (e.g. Pl. 3, Fig. 1, and compare Atlas 2, Pl. 73, Fig. 1), but can be separated from *M. undulata* (LEHMANN) mainly by the sigmoid sutures on the umbilical side, as well as by the prominent adumbilical ridges. Specimens of *M. sigali* from the Turonian possess, however, less sigmoid sutures and less prominent ridges.

M. sigali has been recorded from Israel from strata ranging in age from Turonian to Early Santonian (REISS 1958a; LIPSON-BENITAH 1980 et al., 1985; REISS et al. 1985a).

Marginotruncana sinuosa PORTHAULT

Pl. 3, Fig. 6–9

1970 *Marginotruncana sinuosa* PORTHAULT, p. 81–82, Pl. 11, Fig. 11–13.
1979 *Marginotruncana sinuosa* PORTHAULT (part), Atlas 2, p. 147–154, Pl. 74, Fig. 1–2, Pl. 75, Fig. 1a–c,? Fig. 2a–c.

The problem of the synonymy of *M. sinuosa* with *M. angusticarinata* (GANDOLFI) is a recurring one in literature. Following ROBASZYNSKY et al. (1979), REISS et al. (1985a, b) included *M. angusticarinata* in the synonymy of *M. sinuosa.* However, despite the problems surrounding the type of *M. angusticarinata,* we distinguish now *M. sinuosa* from

M. angusticarinata mainly by the latter's receeding umbilical keel which is weakening in the last chamber(s) (see Pl. 2, Fig. 2). *M. sinuosa* is extremely similar to *Rosita fornicata* (PLUMMER) from which it differs mainly by the extraumbilical–umbilical aperture. Since this latter feature is difficult to discern in badly preserved specimens, the exact first appearance of *R. fornicata* remains for the time being in doubt. *Marginotruncana "prefornicata"* of LIPSON-BENITAH (1980) belongs to *M. sinuosa*.

Marginotruncana tarfayaensis (LEHMANN)

Pl. 3, Fig. 10–12

1963 *Globotruncana tarfayaensis* LEHMANN, p. 146–147, Pl. 5, Fig. 4a–c, Fig. 2i.
1979 *Marginotruncana tarfayaensis* (LEHMANN), Atlas 2, p. 155–158, Pl. 76, Fig. 1–2.

The two closely spaced keels merging sometimes into one in the last chamber(s) and strongly v-shaped sutures distinguish this species from *M. sigali* (REICHEL). Although the profile is variable, it is flatter than that of *M. sigali* and more asymmetrical than that of *M. coronata* (BOLLI).

M. tarfayaensis has been recorded for the first time in Israel from strata of Early Senonian age by LIPSON-BENITAH et al. (1985) (see also REISS et al. 1985a).

Marginotruncana undulata (LEHMANN)

Pl. 3, Fig. 13–15

1962 *Globotruncana undulata* LEHMANN, p. 148, Pl. 9, Fig. 3a–c, t, Fig. 2t, u.
1979 *Marginotruncana undulata* (LEHMANN), Atlas 2, p. 159–162, Pl. 77, Fig. 1–2.

This species resembles *M. sigali* (REICHEL) from which it differs by the generally undulated shape of the chambers and usually larger umbilicus, and from *M. tarfayaensis* (LEHMANN) by both the undulated chambers and the "undifferentiated" keel (double row of pustules) merging into a single carina.

Marginotruncana sp. A

Pl. 3, Fig. 16–18

This as yet unidentified species has about 7 strongly inflated, nearly globular chambers in the last coil, provided with a double pustulated keel separated by a narrow peripheral band, which may however disappear, leading to a single carina with a double row of pustules. The keels are strongly imbricated from chamber to chamber, distinguishing this species from the very similar *M. marginata* (REUSS). It is also probably closely related to *Dicarinella* sp. (see above) from which it is distinguished by the umbilical chamber sutures which are rounded and beaded. The aperture is extraumbilical–umbilical. It occurs in the Santonian and Early Campanian of Israel, but its exact range requires further study.

Marginotruncana sp. B

Pl. 3, Fig. 19–21

The species is umbilico-convex, with 3½–4 slightly inflated chambers in the last coil, provided with two distinct keels throughout. Umbilical chamber sutures u-shaped, a periumbilical ridge present, aperture slightly extraumbilical–umbilical. Chamber walls pustulate on both sides. The species resembles somewhat specimens of *Globotruncana bulloides* VOGLER with very few chambers figured by PESSAGNO (1967). It also resembles somewhat *Globotruncana ackermanni* GANDOLFI, now included by ROBASZYNSKY et al. (1984) in *Rosita plummerae* (GANDOLFI) (see below). In Israel it seems to be stratigraphically significant.

Genus *Globotruncana* CUSHMAN 1927

Globotruncana aegyptiaca NAKKADY

Pl. 4, Fig. 1–10; Pl. 11, Fig. 10–12

1950 *Globotruncana aegyptiaca* NAKKADY, p. 690, Pl. 80, Fig. 20–22.
1984 *Globotruncana aegyptiaca* NAKKADY, Atlas 3, p. 178–181, Pl. 2, Fig. 1–5, Pl. 3, Fig. 1–4.

The broad species concept of ROBASZYNSKI et al. (1984) is followed here and thus includes *G. gagnebini* TILEV and *G. aegyptiaca duwi* NAKKADY. It has been recorded from Israel both as *G. aegyptiaca* (REISS 1951, 1952a) and as *Globotruncana gagnebini* (e.g. REISS 1962). However, additional study is necessary in order to determine whether a distinction between various (morpho)types may be useful in stratigraphy. This is particularly so, since *G. aegyptiaca* is widely recorded from the Maastrichtian only, whereas in Israel it occurs already in the uppermost Campanian (associated with *Globotruncanita calcarata* and important megafossils). Furthermore, the 3½-chambered forms (*G. aegyptiaca duwi,* Pl. 11, Fig. 10–12) seem to be stratigraphically restricted to the Maastrichtian (compare also LINARES RODRIGUEZ 1977). *G. aegyptiaca* is distinguished from the similar *G. ventricosa* WHITE by the generally smaller size, the smaller number of chambers per coil, the more rapid increase in size of chambers and fast pace of the spiral, by the more elongated crescentic chamber shape on the spiral side, and by the localized inflation of the chambers on the spiral side, present in most specimens.

Globotruncana arca (CUSHMAN)

Pl. 4, Fig. 11–14; Pl. 11, Fig. 13–15

1926 *Pulvinulina arca* CUSHMAN, p. 23, Pl. 3, Fig. 1a–c.
1962 *Globotruncana arca* (CUSHMAN), HERM, p. 65–66, Pl. 7, Fig. 3.
1984 *Globotruncana arca* (CUSHMAN), Atlas 3, p. 182–184, Pl. 4, Fig. 1–3.

The species concept of ROBASZYNSKI et al. (1984) is followed here. It agrees well with that of REISS (1951, 1952a ff.) used for Israel material (see Pl. 11, Fig. 13–15). Specimens intermediate between *G. arca* and *G. orientalis* EL NAGGAR (see ROBASZYNSKI et al. 1984, Pl. 5, Fig. 1–7) occur also in the Israel material and are figured on Pl. 4, Fig. 15–18.

Globotruncana cf. *G. austinensis* GANDOLFI

Pl. 4, Fig. 19–21

cf. 1955 *Globotruncana (Globotruncana) marginata* REUSS subsp. *austinensis* GANDOLFI; p. 29, Pl. 1, Fig. 6a–c.
1967 *Globotruncana austinensis* GANDOLFI, PESSAGNO, p. 323, Pl. 82, Fig. 12–15, Pl. 94, Fig. 9.

Although ROBASZYNSKI et al. (1984) included *G. austinensis* in *G. bulloides* VOGLER, the two species are provisionally distinguished here, by attributing to *G.* cf. *G. austinensis* [mainly in the sense of PESSAGNO (1967)] specimens resembling strongly *G. bulloides,* but having an asymmetrical, more umbilicoconvex profile.

Globotruncana bulloides VOGLER

Pl. 4, Fig. 22–24, Pl. 11, Fig. 16–18

1941 *Globotruncana linnei bulloides* VOGLER, p. 287, Pl. 23, Fig. 32–39.
1955 *Globotruncana bulloides bulloides* VOGLER, GANDOLFI, p. 32–33, Pl. 1, Fig. 9.
1970 *Globotruncana bulloides* VOGLER, PORTHAULT, p. 83, Pl. 11, Fig. 20–22.
1984 *Globotruncana bulloides* VOGLER, Atlas 3, p. 186–187, Pl. 6, Fig. 1–4.

The umbilical aperture separates this species from the very similar *Marginotruncana marginata* (REUSS), while the inflated chambers distinguish it from *Globotruncana linneiana* (D'ORBIGNY). *G. bulloides* has been recorded from Israel as *G. lapparenti bulloides* (REISS 1951, 1952a ff.) (see Pl. 11, Fig. 16–18), but the records definitely included *Marginotruncana marginata.*

Globotruncana dupeublei CARON, GONZALEZ DONOSO, ROBASZYNSKI & WONDERS

Pl. 5, Fig. 1–3

1969 *Globotruncana falsostuarti* SIGAL emend. DUPEUBLE, p. 156, Pl. 3, Fig. 10a–d.
1984 *Globotruncana dupeublei* CARON, GONZALEZ DONOSO, ROBASZYNSKI & WONDERS, Atlas 3, p. 188–190, Pl. 7, Fig. 1–2, Pl. 8, Fig. 1–2.

This species closely resembles both *G. falsostuarti* SIGAL and *G. orientalis* EL NAGGAR, but differs from both by being single keeled. It differs from the single keeled *G. esnehensis* NAKKADY in having much more numerous chambers per coil, from *Globotruncanita conica* (WHITE) both by the possession of tegilla and by a biconvex test, and from *G. stuarti* by the possession of tegilla and a clearly lobulate periphery.

Globotruncana esnehensis NAKKADY

Pl. 5, Fig. 4–7

1950 *Globotruncana arca*, (CUSHMAN) var. *esnehensis* NAKKADY, p. 690, Pl. 90, Fig. 23–26.
1984 *Globotruncana esnehensis* NAKKADY, Atlas 3; p. 192–193, Pl. 9, Fig. 1–4.

This is a characteristic and frequently occurring species in Israel material. Although there are in some specimens traces of a weak umbilical keel on the first one or two chambers of the last coil, most specimens are single-keeled. There are many similarities with *G. orientalis* EL NAGGAR which is, however, double-keeled in the early chambers,

and with *Globotruncanita conica* (WHITE) which is more spiroconvex and has more chambers per coil. (See also discussion in ROBASZYNSKI et al. 1984).

Globotruncana esnehensis has been recorded from the Maastrichtian of Israel by REISS (1951, 1952a ff.).

Globotruncana falsostuarti SIGAL

Pl. 5, Fig. 8–12

1952 *Globotruncana falsostuarti* SIGAL, p. 43, Fig. 46.
1984 *Globotruncana falsostuarti* SIGAL, Atlas 3, p. 194–195, Pl. 10, Fig. 1–3.

Although this species has generally more chambers per coil than *G. orientalis* EL NAGGAR and a narrowing of the peripheral band in the middle of the last few chambers, difficulties arise in distinguishing poorly preserved specimens, a matter of some importance in searching for the Campanian-Maastrichtian boundary.

Records of *Globotruncana cretacea* CUSHMAN from Israel (REISS 1951, 1952a ff.) include both *G. falsostuarti* and *G. orientalis* EL NAGGAR.

Globotruncana hilli PESSAGNO

Pl. 5, Fig. 13–15

1967 *Globotruncana hilli* PESSAGNO, p. 343, Pl. 64, Fig. 9–14, p. 21–23, Pl. 94, Fig. 1, Pl. 97, Fig. 7.

As noted under *G. linneiana* (D'ORBIGNY) specimens with a very broad peripheral band and very slightly inflated chambers are attributed here to *G. hilli,* regarded by ROBASZYNSKI et al. (1984) as a synonym of *G. linneiana* (compare, however, LINARES RODRIGUES 1977).

Globotruncana insignis GANDOLFI

Pl. 5, Fig. 16–19

1955 *Globotruncana (Globotruncana) rosetta* (CARSEY) subsp. *insignis* GANDOLFI, p. 6, Pl. 67, Fig. 6a–c.
1984 *Globotruncana insignis* GANDOLFI, Atlas 3, p. 196–198, Pl. 11, Fig. 1–3, Pl. 12, Fig. 1–3.

As pointed out by ROBASZYNSKI et al. (1984) the generic position of this species (*Globotruncana* or *Globotruncanita*) is uncertain, because of the occurrence of both portici and tegilla in the same specimen. Furthermore, there is a dispute between authors concerning the type specimen, a neotype having been chosen following the loss of the holotype (see CARON 1983).

The concept of ROBASZYNSKI et al. (1984) is followed here.

Globotruncana linneiana (D'ORBIGNY)

Pl. 5, Fig. 20–23, Pl. 11, Fig. 19–21

1839 *Rosalina linneiana* D'ORBIGNY (in RAMON DE LA SAGRA), p. 101, Pl. 5, Fig. 10–12.
1956 *Globotruncana linneiana* (D'ORBIGNY), BRONNIMANN & BROWN, p. 540–542, Pl. 20, Fig. 13–17, Pl. 21, Fig. 16–21, Fig. 16–18.
1984 *Globotruncana linneiana* (D'ORBIGNY), Atlas 3, p. 200–203, Pl. 13, Fig. 1–3, Pl. 14, Fig. 1–2, 4.

This species is distinguished from *Marginotruncana pseudolinneiana* mainly by its apertural characters. Specimens with an extremely broad peripheral band and slightly inflated chambers are distinguished here for the time being as *Globotruncana hilli* PESSAGNO (see above).

In Israel, *G. linneiana* has been recorded, together with *Marginotruncana pseudolinneiana* PESSAGNO, as *Globotruncana lapparenti* BROTZEN (REISS 1951, 1952a ff.; LUZ 1970).

Globotruncana mariei BANNER & BLOW

Pl. 6, Fig. 1–3

1938 *Globotruncana cretacea* CUSHMAN, 1938, Pl. 11, Fig. 6a–c.
1960 *Globotruncana mariei* BANNER & BLOW, p. 8.
1984 *Globotruncana mariei* BANNER & BLOW, Atlas 3, p. 204–205, Pl. 15, Fig. 1–5.

This species differs from *G. arca* (CUSHMAN) by having generally less chambers and mainly by its narrower peripheral band and recessed umbilical keel. It differs from *G. orientalis* EL NAGGAR by the presence of a double keel throughout.

Earlier records from Israel (REISS 1951, 1952a ff.) of *Globotruncana cretacea* (CUSHMAN) refer to both *G. mariei* and *G. orientalis* EL NAGGAR.

Globotruncana orientalis EL NAGGAR

Pl. 6, Fig. 4–7, Pl. 11, Fig. 22–24

1966 *Globotruncana orientalis* EL NAGGAR, p. 125, Pl. 12, Fig. 4a–d.
1984 *Globotruncana orientalis* EL NAGGAR, Atlas 3, p. 206–209, Pl. 16, Fig. 1–3, Pl. 17, Fig. 1–4.

The double peripheral keel passing into a single one distinguishes this species well from *G. arca* (CUSHMAN) and *G. mariei* BANNER & BLOW. However, as noted under *G. arca*, there occur specimens which are transitional between *G. arca* and *G. orientalis* (Pl. 4, Fig. 15–18). Difficulties also arise sometimes in differentiating poorly preserved specimens of *G. orientalis* from *G. falsostuarti* SIGAL, although the latter is generally larger and has the typical closure of the peripheral keels in the middle of the last chambers. As shown in Plate 6, Figures 6–7, the tegillum of *G. orientalis* is perforated.

G. orientalis (including *G. mariei* BANNER & BLOW) has been recorded from Israel as *Globotruncana cretacea* (CUSHMAN) (REISS 1951, 1952a ff.).

Globotruncana rosetta (CARSEY)

Pl. 6, Fig. 8–13

1926 *Globigerina rosetta* CARSEY, p. 44, Pl. 5, Fig. 3a–b.
1984 *Globotruncana rosetta* (CARSEY), Atlas 3, p. 210–211, Pl. 18, Fig. 1, 2, 4.

This species as now redefined by ROBASZYNSKI et al. (1984) is extremely useful for Senonian stratigraphy in Israel and here proposed as the guide to the *G. rosetta* Zone. It resembles among others *Globotruncanita elevata* (BROTZEN) forma *primitiva* LINARES RODRIGUEZ, which has, however, a double keel only in the earliest chambers of the last coil.

Globotruncana rugosa (MARIE)

Pl. 6, Fig. 14–16

1941 *Rosalinella rugosa* MARIE, p. 240, Pl. 36, Fig. 340a–c.
1984 *Globotruncana rugosa* (MARIE), Atlas 3, p. 212–213, Pl. 19, Fig. 1–5.

The heavy pustulation on both sides of the test, as well as the prominent and pseudospinose double keel make this a distinctive species. Since it occurs rather sporadically in the Israel material its stratigraphic range is not yet fully determined.

Globotruncana ventricosa WHITE

Pl. 6, Fig. 17–20

1928 *Globotruncana canaliculata* var. *ventricosa* WHITE, p. 248, Pl. 38, Fig. 5a–c.
1953 *Globotruncana ventricosa* WHITE, HAGN, Pl. 8, Fig. 15a–c, Fig. 26–27.
1984 *Globotruncana ventricosa* WHITE, Atlas 3, p. 214–217, Pl. 20, Fig. 1–3, Pl. 21, Fig. 1–4.

This species has been confused in many cases with such forms as *Dicarinella concavata* (BROTZEN), *Globotruncana rosetta* CARSEY, *G. linneiana* (D'ORBIGNY), etc. (synonymy in LINARES RODRIGUEZ 1977). Despite its range of variability (see Atlas 3) *G. ventricosa* is well defined and widely used as a zonal marker for the *G. ventricosa* Interval Zone. In Israel, this species occurs sporadically and cannot be used as a zonal marker (see *Globotruncana rosetta* and *Globotruncanita subspinosa*). *G. ventricosa* is distinguished from *G. aegyptiaca* NAKKADY by its greater number of chambers per coil (although specimens with 5–5½ chambers may occur), the slow pace of the spiral, the more semi-circular shape of the chambers on the spiral side, and by the absence of the localized inflation on the spiral side of the chambers which is present in most specimens of *G. aegyptiaca*.

Earlier records of *G. ventricosa* from the Santonian of Israel (REISS 1951, 1952a) refer to *Dicarinella concavata* (BROTZEN) and *D. asymetrica* (SIGAL).

Genus *Globotruncanita* REISS 1957, emend. ROBASZYNSKI et al. 1984

Globotruncanita angulata (TILEV)

Pl. 7, Fig. 1–3

1951 *Globotruncana lugeoni* TILEV var. *angulata* TILEV, p. 46, Pl. 3, Fig. 1a–c, Fig. 13a–c.
1984 *Globotruncanita angulata* (TILEV), Atlas 3, p. 220–221, Pl. 23, Fig. 1–5.

In the Israel material this species is not easily separated from *G. pettersi* (GANDOLFI), although it differs from the latter mainly in the slower pace of the spire, by the more prominently keeled umbilical chamber sutures, and especially by the more trapezoid (as opposed to elongated to triangular) chambers and straighter chamber sutures on the spiral side. It has been apparently recorded earlier from Israel material in part as "small" *Globotruncanita stuarti* (DE LAPPARENT) (REISS 1951).

Globotruncanita atlantica (CARON)

Pl. 7, Fig. 4–6

1972 *Globotruncana atlantica* CARON, p. 553, Fig. 1a–c.
1984 *Globotruncanita atlantica* (CARON), Atlas 3, p. 222–223, Pl. 24, Fig. 1–4.

This species resembles *G. conica* (WHITE), but differs from the latter by strongly elongated chambers, and *G. stuartiformis* (DALBIEZ) from which it is distinguished both by elongated crescentic chambers and by the highly spiroconvex test.

Globotruncanita calcarata (CUSHMAN)

Pl. 7, Fig. 7–11

1927 *Globotruncana calcarata* CUSHMAN, p. 115, Pl. 23, Fig. 10a–b.
1984 *Globotruncanita calcarata* (CUSHMAN), Atlas 3, p. 224–225, Pl. 25, Fig. 1–3.

This very characteristic species is of great stratigraphic importance, but occurs relatively rarely in Israel (see also REISS 1985a, b). In most specimens examined each of the later chambers bear two tubulospines. This is shown particularly well in internal sparite molds (Pl. 7, Fig. 8).

G. calcarata was recorded and figured for the first time from the Late Campanian of Israel by REISS (1952b; see also 1955a, b). Specimens recorded as *G. calcarata* or as transitional between *G. elevata* (BROTZEN) and *G. calcarata* from the Middle Campanian of Galilee by FLEXER (1964) belong to *G. subspinosa* (PESSAGNO).

Globotruncanita conica (WHITE)

Pl. 7, Fig. 12–14; Pl. 11, Fig. 25–27

1928 *Globotruncana conica* WHITE, p. 285, Pl. 38, Fig. 7a–c.
1984 *Globotruncanita conica* (WHITE), Atlas 3, p. 226–227, Pl. 26, Fig. 1–3.

The single-keeled, high spiroconvex test with trapezoidal chambers distinguishes this species from *G. stuarti* (DE LAPPARENT), *Globotruncana esnehensis* NAKKADY and *G. atlantica* (CARON).

G. conica was recorded in Israel at first by REISS (1951, 1952a).

Globotruncanita elevata (BROTZEN)

Pl. 7, Fig. 15–18, Pl. 11, Fig. 28–30

1934 *Rotalia elevata* BROTZEN, p. 66, Pl. 3, Fig. c.
1970 *Globotruncana elevata* (BROTZEN), KUHRY, p. 292–295, Pl. 1, Fig. 1–3.
1984 *Globotruncanita elevata* (BROTZEN), Atlas 3, p. 228–231, Pl. 27, Fig. 1–3, Pl. 28, Fig. 1–3.

This species has often been confused with other similar ones especially *Globotruncana rosetta* (CARSEY), *Globotruncanita stuartiformis* (DALBIEZ), *G. stuarti* (DE LAPPARENT), as well as possibly with *G. angulata* (TILEV) and *G. pettersi* (GANDOLFI) (see synonymy in LINARES RODRIGUEZ 1977). In its typical form (as compared with topotype material from Israel in Brotzen's collections; see also KUHRY 1970) this species occurs in the latest

Santonian and Early to early Middle Campanian. Higher in the Campanian sequence specimens occur which are intermediate between *G. elevata* and *G. stuartiformis*, while in the Maastrichtian specimens strongly resembling *G. elevata* should be probably attributed in part to *G. pettersi* (see the range of *G. elevata* in REISS et al. 1985a, b). Specimens with a double keel in the earliest chambers of the last coil are separated here as *G. elevata* "forma *primitiva*" LINARES RODRIGUEZ. These latter specimens occur only rarely in Israel, especially because of a widespread unconformity at the Santonian–Campanian boundary (see REISS et al. 1985a, b).

Globotruncanita elevata (BROTZEN) "forma *primitiva*" LINARES RODRIGUEZ

Pl. 8, Fig. 1–3

1977 *Globotruncanita elevata* (BROTZEN 1934) "formas primitivas" LINARES RODRIGUEZ, p. 335–337, Pl. 39, Fig. 1–4, Pl. 40, Fig. 1–3.

Specimens nearly identical with *G. elevata,* but having a double keel in the earliest chambers of the last coil, are included here. In Israel they occur rarely in Late Santonian strata with *Dicarinella asymetrica* (SIGAL) and *Globotruncanita elevata* (BROTZEN), i.e. at the same stratigraphic level like in Spain. The name adopted here is invalid and the "form" needs formal separation.

Globotruncanita pettersi (GANDOLFI)

Pl. 8, Fig. 4–8

1955 *Globotruncana (Globotruncana) rosetta* (CARSEY) subsp. *pettersi* GANDOLFI, p. 68, Pl. 6, Fig. 3a–c.
1984 *Globotruncanita pettersi* (GANDOLFI), Atlas 3, p. 232–233, Pl. 29, Fig. 1–4.

This species is very similar to such species as *G. elevata* (BROTZEN), *G. angulata* (TILEV), as well as *Gansserina gansseri* (BOLLI), which is nearly a homoeomorph. It is now well characterized by ROBASZYNSKI et al. (1984) and is a useful guide for the *G. gansseri* to *A. mayaroensis* Zones. It is probable that larger specimens of *G. pettersi* have been recorded earlier from Israel in part as *G. elevata.* It is distinguished from *G. angulata* (TILEV) mainly by the more rapid pace of spire and by the more triangular chambers and more curved sutures on the spiral side.

Globotruncanita stuarti (DE LAPPARENT)

Pl. 8, Fig. 9–11, Pl. 11, Fig. 31–33

1918 *Rosalina stuarti* DE LAPPARENT, p. 11, Fig. 4, lower 3 Figures.
1984 *Globotruncanita stuarti* (DE LAPPARENT), Atlas 3, p. 234–237, Pl. 30, Fig. 1–3, Pl. 31, Fig. 1–3.

The nearly symmetrical highly biconvex profile, trapezoidal shape of adult chambers on spiral side, and trumpet-shaped portici distinguish this species from *G. stuartiformis* (DALBIEZ) and *G. conica* (WHITE). The specimens from Israel are generally smaller and possess less chambers (about 6) than specimens from SW Europe or Tunisia. The periphery is also very slightly lobate.

Globotruncanita stuartiformis (DALBIEZ)

Pl. 8, Fig. 12–15

1955 *Globotruncana (Globotruncana) elevata* (BROTZEN) subsp. *stuartiformis* DALBIEZ, p. 169, Fig. 10a–c.
1984 *Globotruncanita stuartiformis* (DALBIEZ), Atlas 3, p. 238–239, Pl. 32, Fig. 1–4.

As noted under *G. elevata* (BROTZEN), *G. stuartiformis* has been often confused with the former and some authors (e.g. LINARES RODRIGUEZ 1977) have included both forms in *G. elevata*. A rigorous definition according to the original description and that of ROBASZYNSKI et al. (1984) allows usually to refer specimens without difficulty to *G. stuartiformis*. Nevertheless, there do occur specimens intermediate between *G. elevata* and *G. stuartiformis*. In Israel, *G. stuartiformis* appears later than *G. elevata* (see also REISS et al. 1985a), while records from other places of the world indicate *G. stuartiformis* appearing together with or even before *G. elevata*. Another problem is the development from *G. stuartiformis* into *G. subspinosa* (PESSAGNO) (see there).

Globotruncanita subspinosa (PESSAGNO)

Pl. 8, Fig. 16–20

1960 *Globotruncana (Globotruncana) subspinosa* PESSAGNO, p. 101, Pl. 1, Fig. 4–6.
1984 *Globotruncanita subspinosa* (PESSAGNO), Atlas 3, p. 240–243, Pl. 23, Fig. 1–3, Pl. 34, Fig. 1–3.

Regarded by some authors (see also PESSAGNO 1967), as a synonym of *G. elevata* (BROTZEN), this species has been separated as a valid one by ROBASZYNSKI et al. (1984). Its first appearance is recorded in the literature to be close to the first appearance of *Globotruncana ventricosa* WHITE and its stratigraphic range has warranted the establishment of a "*subspinosa* zone". Indeed, in Israel its continuous presence ranges from slightly above the first appearance of *G. ventricosa* to the top of *G. calcarata* (CUSHMAN) (Upper Campanian) (cf. also REISS et al. 1985a, b). Lately, however, single specimens attributable to *G. subspinosa* (Pl. 8, Fig. 18–19) have been found in surface sections at Bar'am and Tarqumiya (Fig. 1) in strata, belonging to the *G. elevata*-Zone of Early Campanian age, below the first *G. rosetta* and associated, among others, with *Ventilabrella eggeri* CUSHMAN.

The problem arises whether the chamber elongation is an iterative character or whether the true first appearance of. *G. subspinosa* is earlier than generally believed. It is noteworthy that between these early occurrences in Israel and the beginning of the continuous presence of *G. subspinosa* is an interval devoid of such forms. Whatever the interpretation, it seems now inopportune to use *G. subspinosa* as a zonal guide and for this reason a *Globotruncana rosetta* Zone is here proposed.

Specimens recorded and figured as *G. calcarata* (CUSHMAN) by FLEXER (1964, 1968, 1971) from the Middle Campanian of Galilee, Israel belong to *G. subspinosa*.

Genus *Rosita* CARON, GONZALEZ DONOSO, ROBASZYNSKI & WONDERS 1984

Rosita contusa (CUSHMAN)

Pl. 9, Fig. 6–11; Pl. 11, Fig. 34–37

1926 *Pulvinulina arca* CUSHMAN var. *contusa* CUSHMAN, p. 23.
1984 *Rosita contusa* (CUSHMAN), Atlas 3, p. 246–249, Pl. 36, Fig. 1–2, Pl. 37, Fig. 1–3.

The undulated, elongated chambers on the spiral side, two clearly separated keels and relatively high trochospire separate this species from the similar *R. fornicata* (PLUMMER), *R. patelliformis* (GANDOLFI) and *R. walfischensis* (TODD). Two types may be separated, a (Pl. 9, Fig. 6–8) with more undulated chambers, and b (Pl. 9, Fig. 9–11) with very elongated, less undulated chambers.

Records of *Globotruncana contusa* from Israel (REISS 1951, 1952a ff.) refer in addition to *R. contusa* also to *R. patelliformis* and *R. walfischensis*.

Rosita fornicata (PLUMMER)

Pl. 9, Fig. 12–17; Pl. 11, Fig. 38–40

1931 *Globotruncana fornicata* PLUMMER, p. 130, Pl. 13, Fig. 4a–c.
1984 *Rosita fornicata* (PLUMMER), CARON, GONZALEZ DONOSO, ROBASZYNSKI & WONDERS, Atlas 3, p. 250–251, Pl. 38, Fig. 1–5.

Despite the variability in chamber length, convexity of the test, and width of peripheral band, this species can be well distinguished from similar ones, like *Rosita contusa* (CUSHMAN), *R. patelliformis* (GANDOLFI), *R. plicata* (WHITE), *R. plummerae* (GANDOLFI), and *R. walfischensis* (TODD). Difficulties are encountered in separating poorly preserved specimens with no clearly observable apertures from *Marginotruncana sinuosa* PORTHAULT, near the Coniacian–Santonian boundary.

Earlier records of *Globotruncana fornicata* from Israel (REISS 1951, 1952a ff.) refer to both *R. fornicata* and *Marginotruncana sinuosa* PORTHAULT (see, however, REISS et al. 1985a, b).

Rosita patelliformis (GANDOLFI)

Pl. 9, Fig. 18–20

1955 *Globotruncana (Globotruncana) contusa* (CUSHMAN) subsp. *patelliformis* GANDOLFI, p. 54, Pl. 4, Fig. 2a-c.
1984 *Rosita patelliformis* (GANDOLFI), Atlas 3, p. 252–253, Pl. 39, Fig. 1–3.

The low trochospire, nearly polygonal outline and flat to concave umbilical side separate this species from the similar *R. fornicata* (PLUMMER), *R. contusa* (CUSHMAN) and *R. plicata* (WHITE).

Rosita plummerae (GANDOLFI)

Pl. 9, Fig. 1–2

1955 *Globotruncana (Globotruncana) fornicata* PLUMMER subsp. *plummerae* GANDOLFI, p. 340, Pl. 2, Fig. 3a–c.
1984 *Rosita plummerae* (GANDOLFI), Atlas 3, p. 256–257, Pl. 41, Fig. 1–6.

This species shows morphological similarities to *R. fornicata,* but has more inflated and pustulate chambers. It is also somewhat similar to *Globotruncana bulloides* VOGLER, but is separated from the latter mainly by less petaloid and more elongated chambers and the strong pustulation, especially on the umbilical side. *R. plummerae* has been recorded from Israel as *Globotruncana convexa* by REISS (1962).

Rosita walfischensis (TODD)

1970 *Globotruncana walfischensis* TODD, p. 153, Pl. 5, Fig. 8a–b.
1984 *Rosita walfischensis* (TODD), Atlas 3, p. 258–259, Pl. 42, Fig. 1–4.

Specimens, too poorly preserved to be figured here, and occurring in the Maastrichtian of Israel, agree well with the species concept of ROBASZYNSKI et al. (1984).

Rosita sp.

Pl. 9, Fig. 3–5

This species resembles *R. plummerae* (GANDOLFI), but is more umbilicoconvex and has flatter and less pustulate chamber surfaces on the spiral side. There are 4–5 chambers in the last coil.

It resembles *Rosita fornicata ackermanni* (GANDOLFI) of EL NAGGAR (1966). *R. fornicata ackermanni* is included by ROBASZYNSKI et al. (1984) in *R. plummerae* (GANDOLFI).

Genus *Gansserina* CARON, GONZALEZ DONOSO, ROBASZYNSKI & WONDERS 1984

Gansserina gansseri (BOLLI)

Pl. 10, Fig. 14–17

1951 *Globotruncana gansseri* BOLLI, p. 25, 196–197, Pl. 35, Fig. 1–3.
1984 *Gansserina gansseri* (BOLLI), Atlas 3, p. 294–296, Pl. 52, Fig. 1–5.

Most specimens are typical, although strongly concave on the spiral side specimens of this species occuring in the Middle Maastrichtian may have to be separated as a useful type (*Globotruncana arabica* EL NAGGAR). More study is needed to ascertain the latter's range.

The record of *G. gansseri* by REISS (1962) includes also *G. wiedenmayeri* (GANDOLFI).

Gansserina wiedenmayeri (GANDOLFI)

Pl. 10, Fig. 18–20

1955 *Globotruncana (Globotruncana) wiedenmayeri wiedenmayeri* GANDOLFI, p. 155, Pl. 7, Fig. 4a–c.
1984 *Gansserina wiedenmayeri* (GANDOLFI), Atlas 3, p. 298–299, Pl. 54, Fig. 1–6.

This species with a double keel in the first few chambers of the last whorl appears earlier than *G. gansseri* (BOLLI) (REISS et al. 1985a, b). It has been included in *G. gansseri* (BOLLI) by REISS (1962ff.) and as *Gansserina* sp. by REISS et al. (1985a).

Genus *Globotruncanella* REISS 1957, emend. ROBASZYNSKI et al. 1984

Globotruncanella havanensis (VOORWIJK)

Pl. 10, Fig. 1–3

1937 *Globotruncana havanensis* VOORWIJK, p. 195, Pl. 1, Fig. 25, 26, 29.
1984 *Globotruncanella havanensis* (VOORWIJK), Atlas 3, p. 265, Pl. 44, Fig. 4–5.

Although *G. havanensis* is distinguished from *G. petaloidea* (GANDOLFI) by ROBASZYNSKI et al. on the basis of number of chambers in the last coil and lobation of the periphery, transitional forms between these species are recorded by those authors (1984, Pl. 44, Fig. 4–5). It seems that another character may be helpful for separating these closely similar species, viz. the ornamentation which appears to be much more pronounced in *G. havanensis*.

Earlier records of *G. citae* (BOLLI) (REISS 1957, 1962ff.) refer mostly to *G. havanensis*.

Globotruncanella petaloidea (GANDOLFI)

Pl. 10, Fig. 4–6

1955 *Globotruncana (Rugoglobigerina) petaloidea* GANDOLFI subsp. *petaloidea* GANDOLFI, p. 52, Pl. 3, Fig. 13a–c.
1984 *Globotruncanella petaloidea* (GANDOLFI), Atlas 3, p. 266–268, Pl. 44, Fig. 1, 2a–c.

Although specimens attributed to this species posses 4 to 4½ chambers in the last coil they are much less ornamented and more spiroconvex than *G. havanensis* and thereby separated from the latter.

This species has been included in Israel (REISS 1957, 1962ff.) in *G. citae* (BOLLI).

Globotruncanella(?) *praehavanensis* SALAJ & GASPARIKOVA

Pl. 10, Fig. 7–10

1983 *Globotruncanella praehavanensis* SALAJ & GASPARIKOVA, p. 599–600, Pl. 2, Fig. 10–12, 14–16.

The precise generic position of this species requires scrutiny.

The relatively high trochospire, strong pustulation of the chamber surfaces and the pustulose keel present in the specimens from Israel places them best in *G. praehavanensis*, recorded from the Santonian of Tunisia and W. Carpathians (compare also REISS et al. 1985b). Possibly this species represents a link between *Whiteinella* and *Globotruncanella*.

Globotruncanella pschadae (KELLER)

Pl. 10, Fig. 11–13

1946 *Globorotalia pschadae* KELLER, p. 99, Pl. 2, Fig. 4–6.
1951 *Globotruncana citae* BOLLI, p. 25, 197, Pl. 35, Fig. 4–6.
1984 *Globotruncanella pschadae* (KELLER), Atlas 3, p. 269, Pl. 44, Fig. 7a–c.

This carinated species is extremely rare in the Israeli material.

Genus *Abathomphalus* BOLLI, LOEBLICH & TAPPAN 1957

Abathomphalus mayaroensis (BOLLI)

Pl. 10, Fig. 21–23

1951 *Globotruncana mayaroensis* BOLLI, p. 25, 198, Pl. 35, Fig. 10–12.
1984 *Abathomphalus mayaroensis* (BOLLI), Atlas 3, p. 274, Pl. 46, Fig. 5a–c.

The specimens from the Israel material appear to be typical and no transitional forms between *A. mayaroensis* and *A. intermedius* (BOLLI) – occuring elsewhere, but not yet identified in Israel – have been found.

A. mayaroensis has been recorded from Israel at first by REISS (1962).

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Plate 1

Fig. 1–5 *Dicarinella asymetrica* (SIGAL). 1: spv.[4]), 2–3: lv.; 4–5: uv. 1: 480 µ, BL 120, HU 3584. 2: 575 µ, BL 87, HU 3363. 3: 550 µ, BL 156, HU 3624. 4: 465 µ, BL 110, HU 3574. 5: 575 µ, BL 90, HU 3366; En el Qilt, Upper Santonian.

Fig. 6–9 *Dicarinella concavata* (BROTZEN). 6: spv.; 7–8: lv.; 9: uv. 6, 8: 430 µ, 305, N. Ya'alon, Upper Coniacian–Lower Santonian. 7: 400 µ; BL 100, HU 3376. 9: 460 µ; BL 87, HU 3363; En el Qilt, Upper Santonian.

Fig. 10–13 *Dicarinella primitiva* (DALBIEZ). 10–11: spv.; 12: lv.; 13: uv. 10: 500 µ; SMA 115, HU 6765; N. Zin, Upper Coniacian. 11: 560 µ; 13: 560 µ; BR 80; HU 6637; Bar'am, Upper Coniacian. 12: 510 µ; 305, N. Ya'alon, Upper Coniacian–Lower Santonian.

Fig. 14–19 *Dicarinella* sp. 14, 16: spv.; 15, 18: lv.; 17, 19: uv. 14: 480 µ; BL 115, HU 3579. 15: 500 µ; BL 156, HU 3624. 16, 19: 575 µ; BL 123, HU 3587. 17: 450 µ; 18: 460 µ, BL 87, HU 3363, En el Qilt, Upper Santonian.

[4]) spv.: spiral view; lv.: lateral view; uv.: umbilical view.

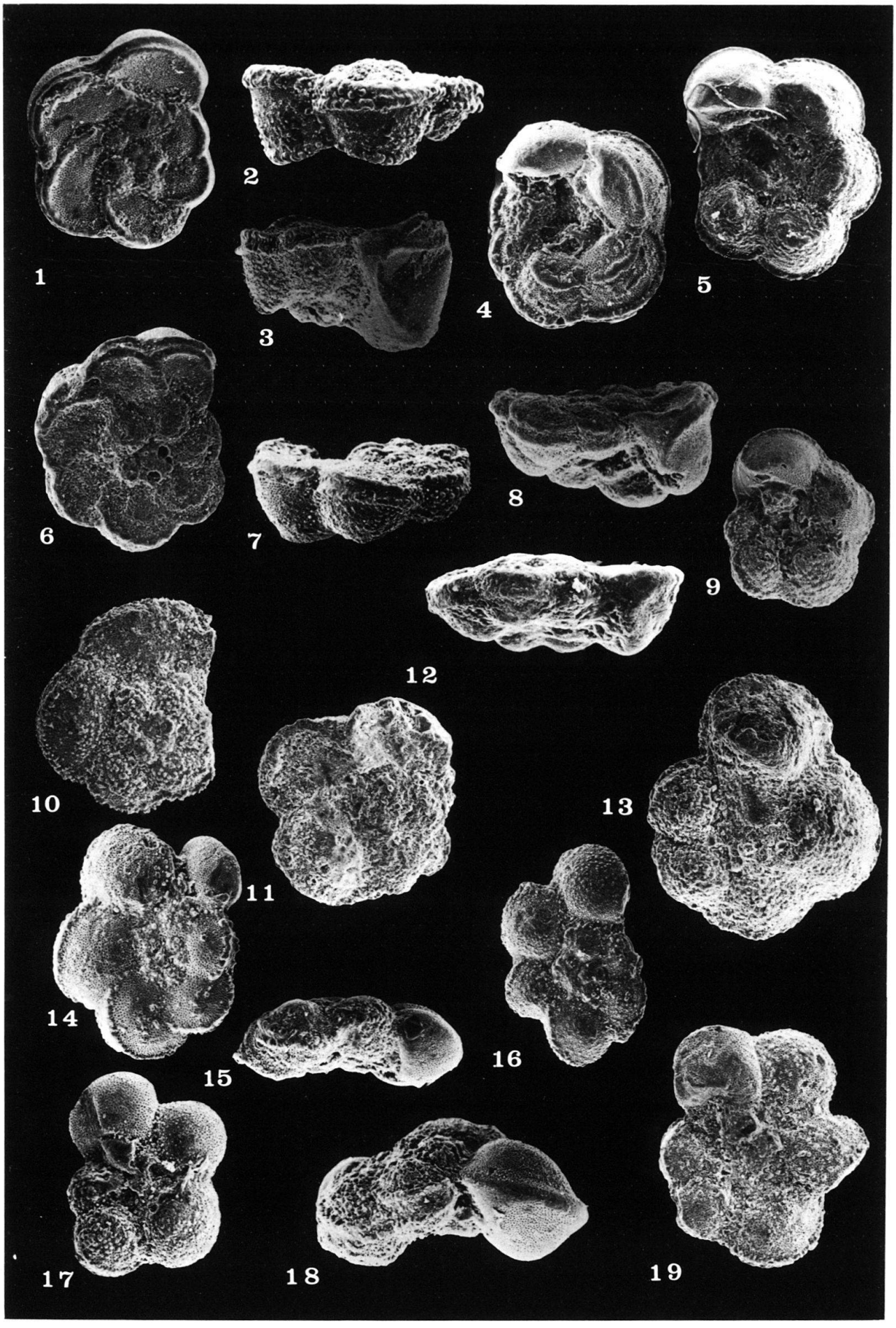
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Plate 2

Fig. 1–4 *Marginotruncana angusticarinata* (GANDOLFI). 1: spv.; 2: lv.; 3–4: uv. 1: 480 µ; CB 3899, HU 7205; Elat, Upper Santonian. 2: 510 µ; BR 83, HU 6640; Bar'am, Upper Santonian. 3: 560 µ; BL 83, HU 3359; En el Qilt, Upper Santonian. 4: 410 µ, 308, N. Ya'alon, Upper Coniacian–Lower Santonian.

Fig. 5–8 *Marginotruncana coronata* (BOLLI). 5: spv.; 6: uv.; 7–8: lv. 5: 540 µ; 6: 540 µ; 7: 460 µ; BL 110, HU 3574. 8: 500 µ; BL 120, HU 3584; En el Qilt, Upper Santonian.

Fig. 9–11 *Marginotruncana marginata* (REUSS). 9: spv.; 10: uv.; 11: lv. 9: 500 µ, BL 84, HU 3360, 10: 510 µ, BL 115, HU 3579. 11: 400 µ; BL 110, HU 3579; En el Qilt, Upper Santonian.

Fig. 12–14 *Marginotruncana paraconcavata* PORTHAULT. 12: spv.; 13: uv.; 14: lv. 12: 675 µ; OS-17443, 290–300 m., Shefaram, Uppermost Turonian–Lowermost Santonian[5]). 13: 560 µ; 302, N. Ya'alon, Upper Coniacian–Lower Santonian. 14: 510 µ; Damun 7, 180–183 m, Upper Coniacian[5]).

Fig. 15–18 *Marginotruncana pseudolinneiana* PESSAGNO. 15: spv.; 16, 18: uv.; 17: lv. 15: 480 µ, BL 120, HU 3584; 16: 420 µ; BL 100, HU 3376. 17: 370 µ; BL 110, HU 3574. 18: 450 µ; BL 103, HU 3379; En el Qilt, Upper Santonian.

Fig. 19–21 *Marginotruncana renzi* (GANDOLFI). 19: spv.; 20: uv.; 21: lv. 19: 450 µ; 20: 380 µ; 21: 420 µ, BL 120, HU 3584; En el Qilt, Upper Santonian.

Fig. 22–25 *Marginotruncana schneegansi* (SIGAL). 22: lv.; 23: spv.; 24–25: uv. 22: 625 µ; BR 80, HU 6637; Bar'am, Upper Coniacian. 23: 640 µ; 24: 420 µ, BL 500, HU 3727; Ein Fawwar, Upper Santonian. 25: 550 µ; 305; N. Ya'alon, Upper Coniacian–Lower Santonian.

[5]) Coll. S. Lipson Benitah.

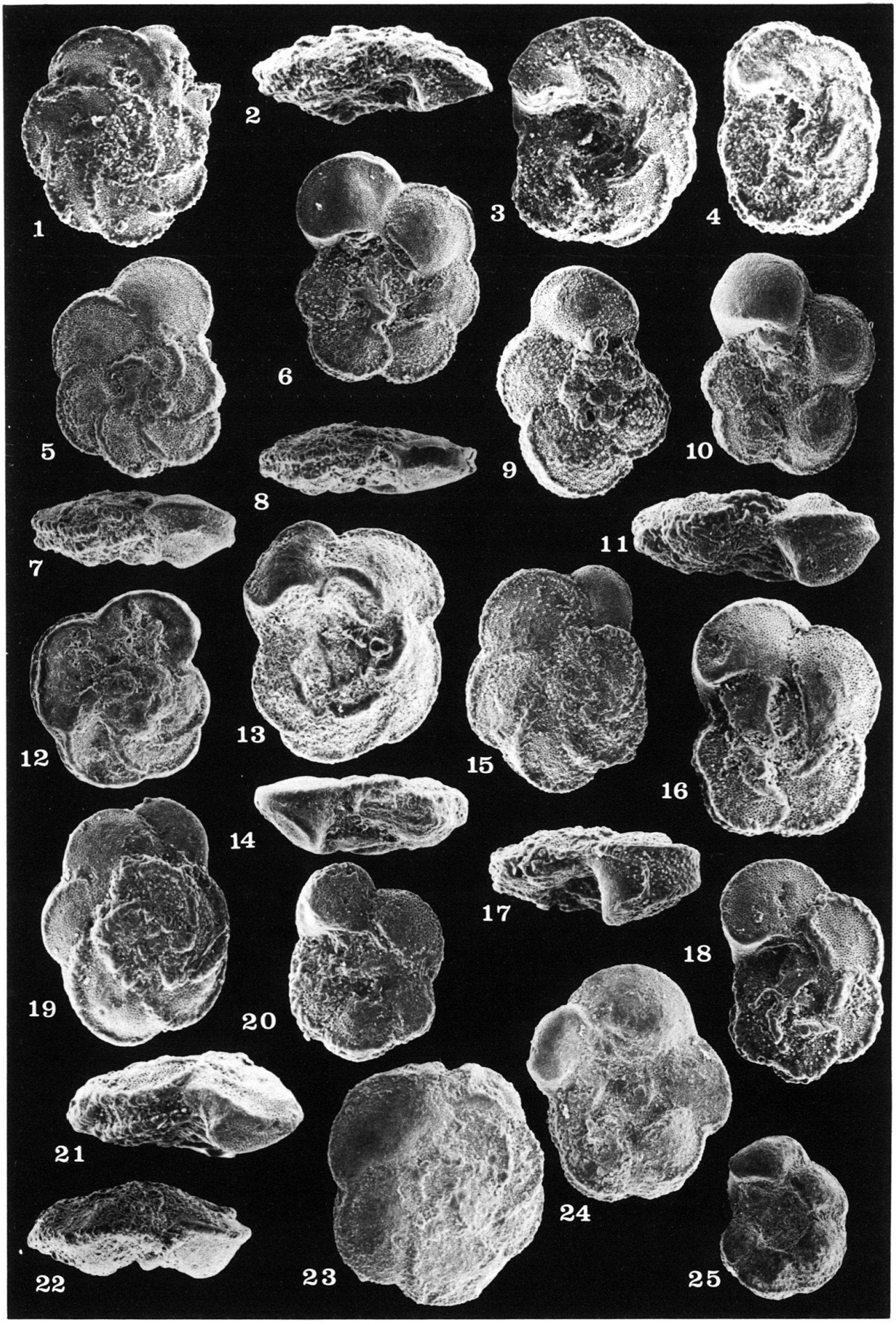
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Plate 3

Fig. 1–5 *Marginotruncana sigali* (REICHEL). 1, 3: spv.; 2, 5: uv.; 3: lv. 1: 675 µ; 2: 690 µ; SMA 115, HU 6765; N. Zin, Upper Coniacian. 3: 430 µ; 4: 420 µ. 5: 460 µ; Juli borehole, 1029 m, Bashor, Lower Turonian[6]).

Fig. 6–9 *Marginotruncana sinuosa* PORTHAULT. 6, 7: spv.; 8: lv.; 9: uv. 6: 500 µ; BL 90, HU 3366; 7: 510 µ; BL 120, HU 3584. 8: 450 µ; BL 110, HU 3574. 9: 600 µ; BL 93, HU 3369; En el Qilt, Upper Santonian.

Fig. 10–12 *Marginotruncana tarfayaensis* (LEHMANN). 10: spv.; 11: lv.; 12: uv. 10: 670 µ; BL 110, HU 3574; En el Qilt, Upper Santonian. 11: 480 µ; 307; N. Ya'alon, Upper Coniacian–Lower Santonian. 12: 640 µ; 302; N. Ya'alon, Lower Santonian.

Fig. 13–15 *Marginotruncana undulata* (LEHMANN). 13: spv.; 14: lv.; 15: uv. 13: 590 µ; 15: 830 µ; 307, N. Ya'alon, Lower Santonian. 14: 770 µ; BR 88, HU 6645; Bar'am, Upper Santonian.

Fig. 16–18 *Marginotruncana* sp. A. 16: spv.; 17: lv.; 18: uv. 16: 510 µ; 17: 420 µ; 18: 430 µ; 206, HU 6744; Ein Fawwar, Lower Campanian.

Fig. 19–21 *Marginotruncana* sp. B. 19: spv.; 20: lv.; 21: uv. 19: 370 µ; 20: 420 µ; 21: 420 µ; BL 149, HU 3618; En el Qilt, Upper Santonian.

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[6]) see [5])

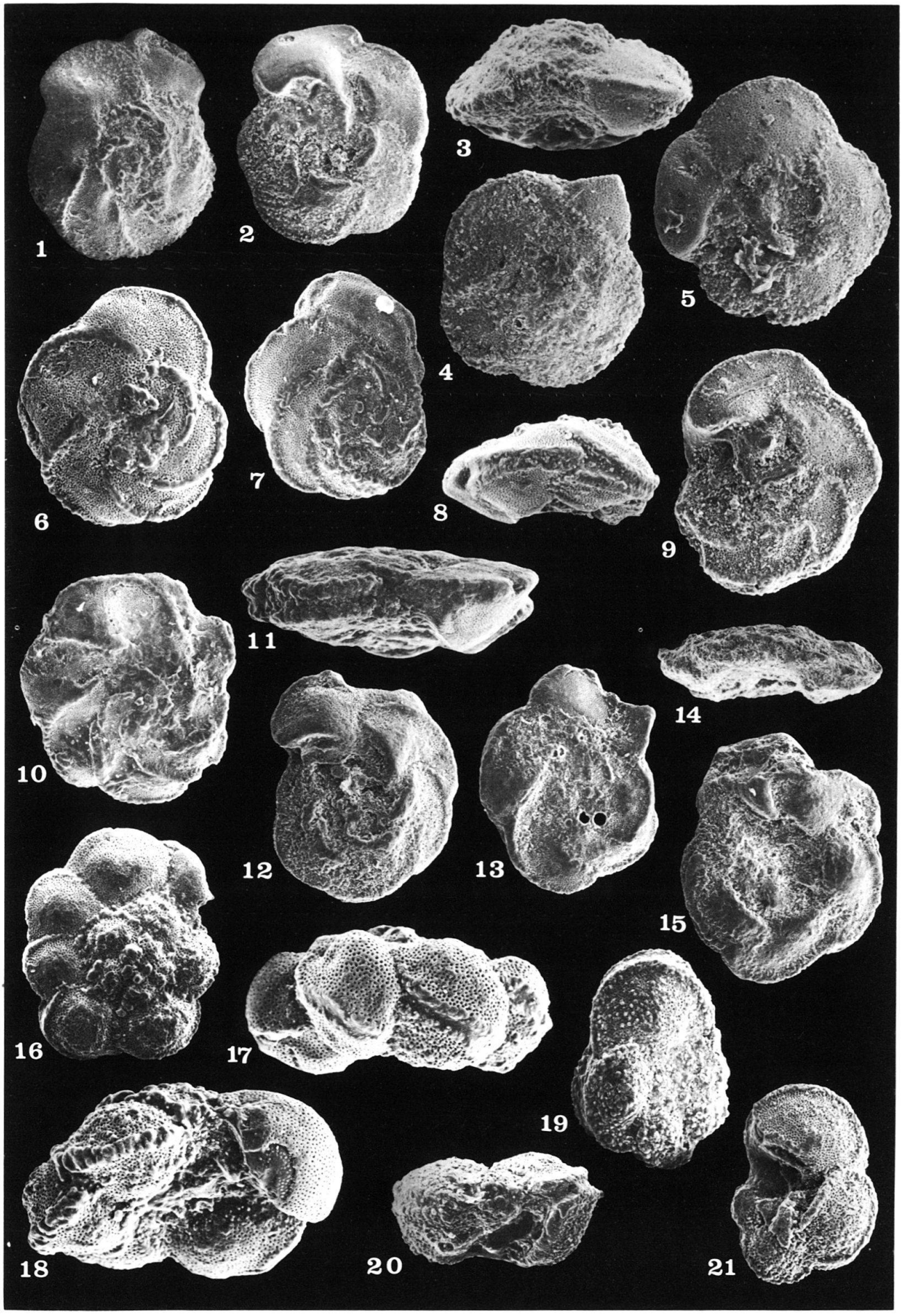
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Plate 4

Fig. 1–10 *Globotruncana aegyptiaca* NAKKADY. 1–4: spv.; 5–6, 9–10: uv.; 7–8: lv. 1: 430 μ; 5: 510 μ; 7: 370 μ; HU 7024, Givat Mador 44, Maastrichtian. 2: 480 μ; HU 6634; Mishor Rotem, Maastrichtian. 3: 420 μ; BL 780; HU 3841; Upper Campanian. 10: 350 μ; BL 818, HU 4189; Maastrichtian, Ein Fawwar. 4, 6: 380 μ; 8: 480 μ; 9: 575 μ, BR 71, HU 6731; specimen intermediate between *G. aegyptiaca* and *G. ventricosa;* Bar'am, Upper Upper Campanian.

Fig. 11–14 *Globotruncana arca* (CUSHMAN). 11: spv.; 12: lv.; 13–14: uv. 11, 13: 480 μ; 12: 500 μ, PP 1–10, HU 6206; Tarqumiya, Lower Campanian. 14: 510 μ; PP 1–72, HU 6192; Tarqumiya, Upper Upper Campanian.

Fig. 15–18 *Globotruncana arca-orientalis* intermediate. 15: spv.; 16, 18: lv.; 17: uv. 15: 460 μ; 17: 510 μ; 18: 575 μ; PP 1–10, HU 6206; Tarqumiya, Lower Campanian. 16: 370 μ; HU 7021; Givat Mador 36, Maastrichtian.

Fig. 19–21 *Globotruncana* cf. *G. austinensis* GANDOLFI (*fide* PESSAGNO, Pl. 82, Fig. 12–15). 19: spv.; 20: uv.; 21: lv. 19, 20: 450 μ; 21: 480 μ; PP 1–10, HU 6206, Tarqumiya, Lower Campanian.

Fig. 22–24 *Globotruncana bulloides* VOGLER. 22: spv.; 23: lv.; 24: uv. 22: 380 μ; 23: 510 μ; 24: 460 μ; PP 1–10, HU 6206, Tarqumiya, Lower Campanian.

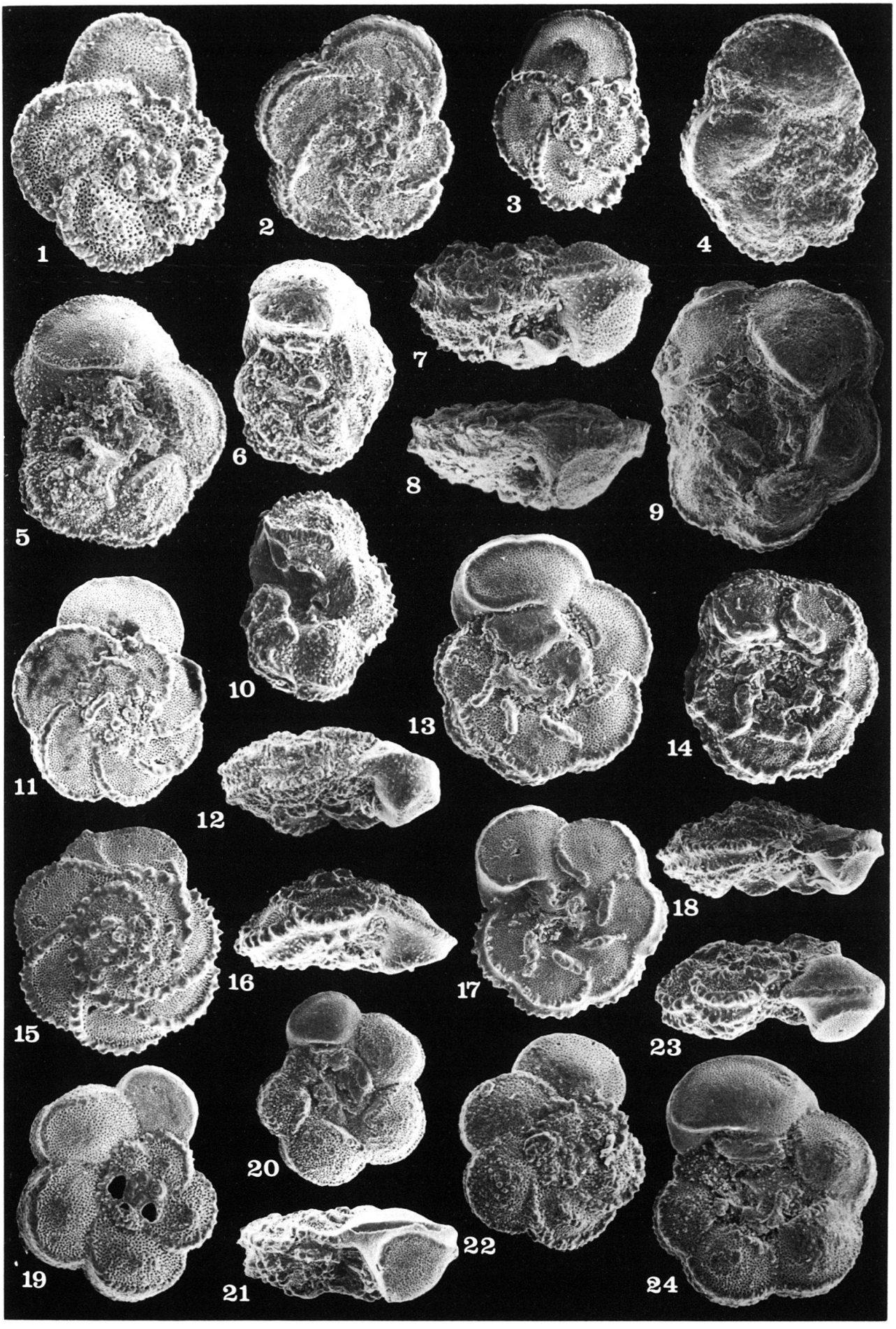
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Plate 5

Fig. 1–3 *Globotruncana dupeublei* CARON, GONZALEZ DONOSO, ROBASZYNSKI & WONDERS. 1: spv.; 2: lv.; 3: uv. 1, 3: 610 µ; 2: 640 µ; HU 7176, Sde Boqer, Middle Maastrichtian.

Fig. 4–7 *Globotruncana esnehensis* NAKKADY. 4: spv.; 5–6: lv.; 7: uv. 4: 480 µ; HU 1541 (GSI 12426); Hanita, Upper Maastrichtian. 5: 530 µ; HU 7024; Givat Mador, Lower Maastrichtian. 6: 380 µ; 7: 400 µ; BL 818, HU 4189; Ein Fawwar, Lower Maastrichtian.

Fig. 8–12 *Globotruncana falsostuarti* SIGAL. 8: spv.; 9: uv.; 10–12: lv. 8: 560 µ; 9: 560 µ; GSI 2139, HU 1412; Tulkarem well, Lower Maastrichtian. 10: 620 µ; HU 2415; Oron D 25–27 m, Middle Maastrichtian. 11, 12: 670 µ; HU 1579, GSI 9490; Khirbet Sumsumiye, Maastrichtian.

Fig. 13–15 *Globotruncana hilli* PESSAGNO. 13: spv.; 14: lv.; 15: uv. 13: 385 µ; PP 1–21, HU 6173; Tarqumiya, Upper Campanian. 14, 15: 430 µ; BR 72, HU 6732; Bar'am, Upper Upper Campanian.

Fig. 16–19 *Globotruncana insignis* GANDOLFI. 16: spv.; 17–18. lv.; 19: uv. 16: 640 µ; 17, 19: 700 µ; 18: 675 µ; BR 71, HU 6731; Bar'am, Upper Upper Campanian.

Fig. 20–23 *Globotruncana linneiana* (D'ORBIGNY). 20: spv.; 21: lv.; 22–23: uv. 20: 400 µ; 21: 400 µ; BL 130, HU 3599; 22: 540 µ; BL 85, HU 3361. 23: 500 µ; BL 84, HU 3360; En el Qilt, Upper Santonian.

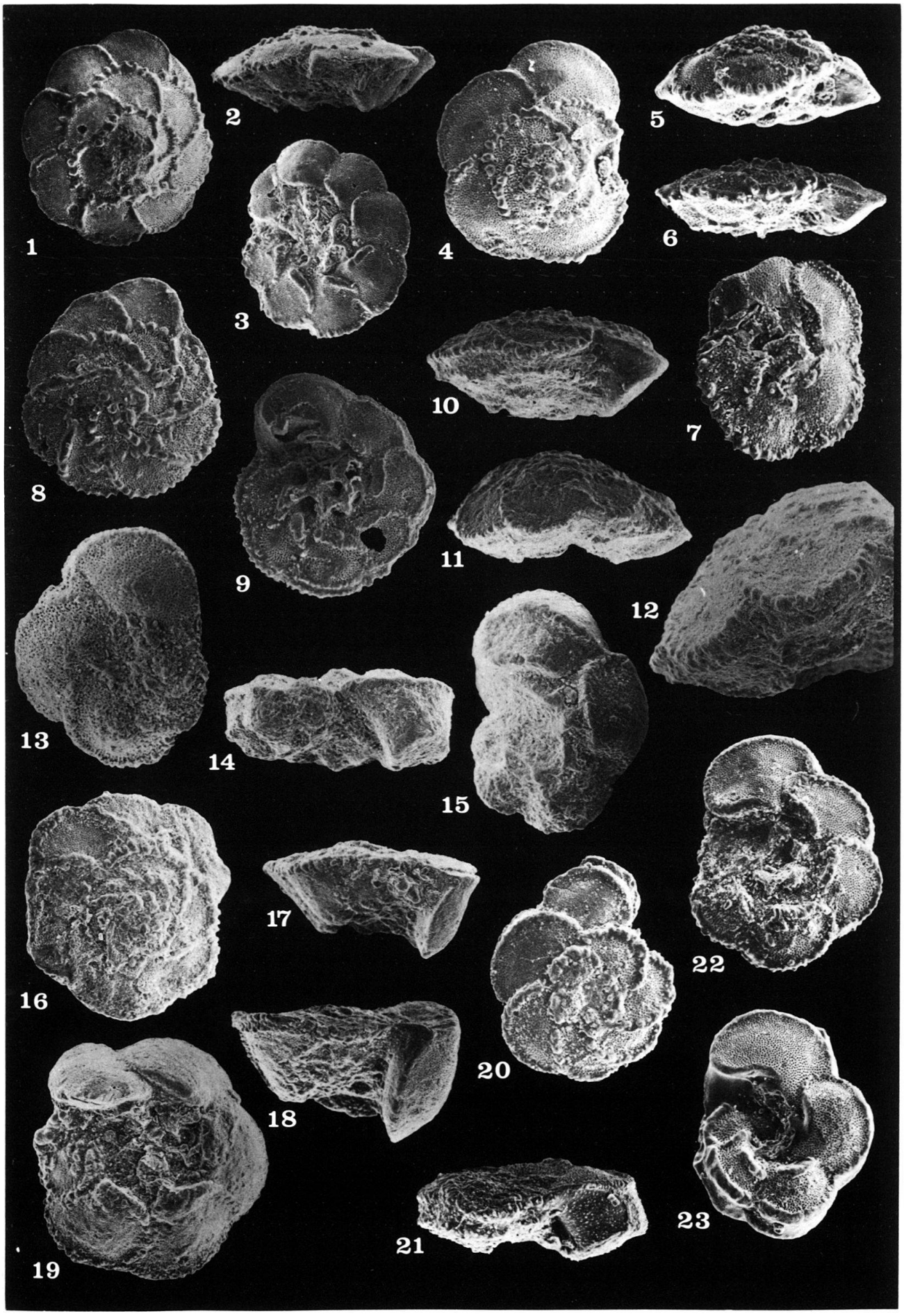
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Plate 6

Fig. 1–3 *Globotruncana mariei* BANNER & BLOW. 1: spv.; 2: lv.; 3: uv. 1: 300 µ; BL 143, HU 3612; En el Qilt, Upper Santonian. 2: 420 µ; BL 780, HU 3841; 3: 380 µ; BL 759, HU 3823; Ein Fawwar, Upper Campanian.

Fig. 4–7 *Globotruncana orientalis* EL NAGGAR. 4: spv.; 5: lv.; 6–7: uv. 4: 560 µ; 5: 510 µ; 6–7: 530 µ PP 1–10, HU 6206; Tarqumiya, Lower Campanian.

Fig. 8–13 *Globotruncana rosetta* (CARSEY). 8–9: spv.; 10–11: uv.; 12–13: lv. 8: 400 µ; 326; N. Ya'alon, Upper Campanian. 9: 350 µ; BL 718, HU 3810; 10: 450 µ; 13: 460 µ; BL 780, HU 3841; Ein Fawwar, Upper Campanian. 11: 540 µ; HU 6634; Mishor Roten, Lower Maastrichtian. 12: 510 µ; 1568 40; Zohar core 20244, Lower Maastrichtian.

Fig. 14–16 *Globotruncana rugosa* (MARIE). 14: spv.; 15: lv.; 16: uv. 14–16: 300 µ; PP 1–65, HU 6194; Tarqumiya, Upper Upper Campanian.

Fig. 17–20 *Globotruncana ventricosa* WHITE. 17: spv.; 18–19: lv.; 20: uv. 17: 510 µ; BR 34, HU 6695; Bar'am, Upper Campanian. 19–20: 610 µ; BR 69, HU 6729; Bar'am, Upper Upper Campanian. 18: (cf.) 480 µ; BL 818, HU 4189; Ein Fawwar, Lower Maastrichtian.

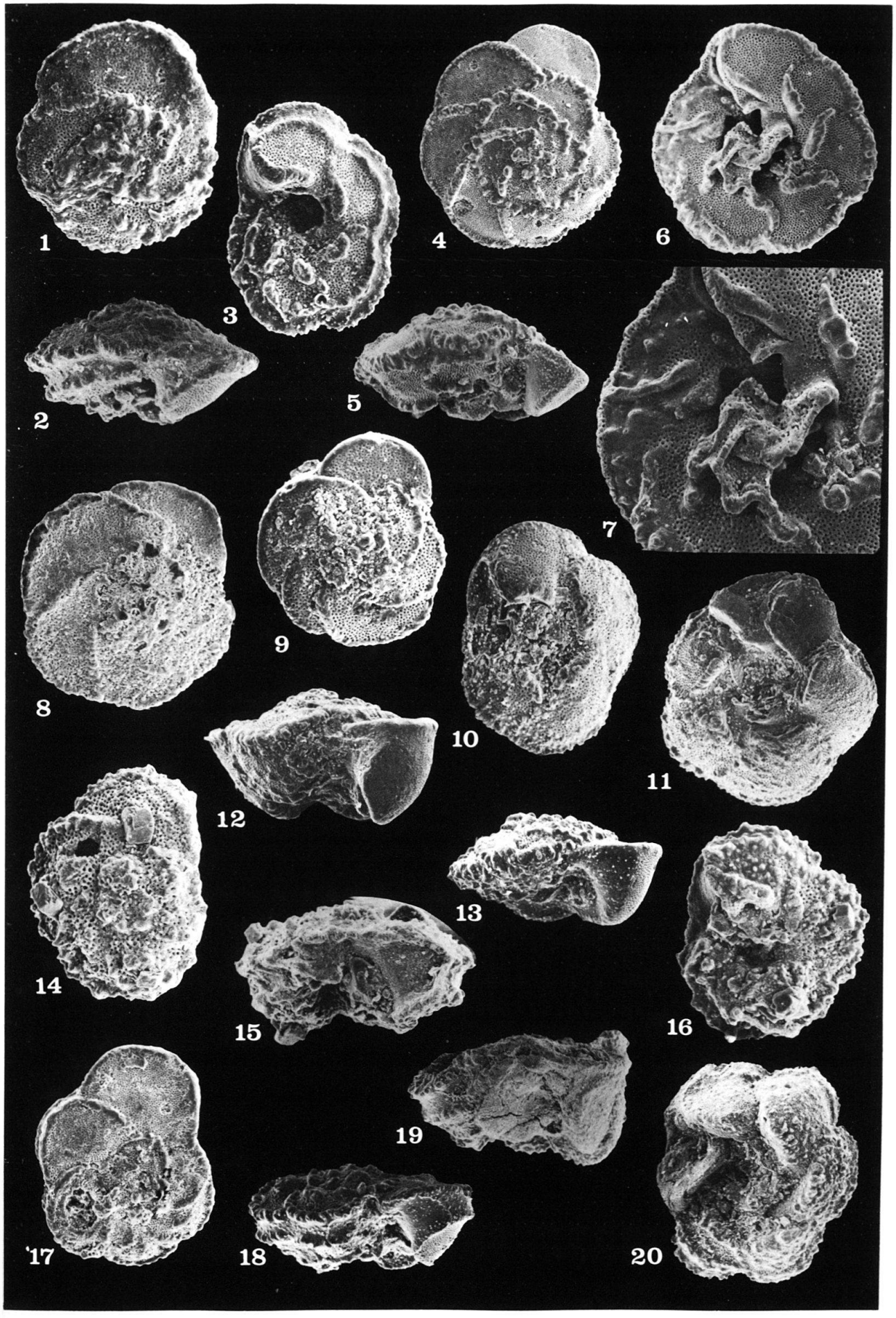
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Plate 7

Fig. 1–3 *Globotruncanita angulata* (TILEV). 1: spv.; 2: lv.; 3: uv. 1: 460 μ; GSI 3663, S/T 93; Oron, Upper Maastrichtian. 2, 3: 385 μ; HU 1545 (GSI 12426); Hanita ZN 106; Upper Maastrichtian.

Fig. 4–6 *Globotruncanita atlantica* (CARON). 4: spv.; 5: uv.; 6: lv. 4–6: 510 μ; BR 13, HU 6674; Bar'am, Lower Campanian.

Fig. 7–11 *Globotruncanita calcarata* (CUSHMAN). 7: spv.; 8–10: uv.; 11: lv. 7, 10: 480 μ; 8: 400 μ (internal mold); 11: 510 μ; PP 1–62, HU 6228; Tarqumiya, Upper Upper Campanian. 9: 600 μ; BR 71, HU 6731; Bar'am, Upper Upper Campanian.

Fig. 12–14 *Globotruncanita conica* (WHITE). 12: spv.; 13: lv.; 14: uv. 12–14: 560 μ; GSI 9203; 180–200 m, Ajur, Middle Maastrichtian.

Fig. 15–18 *Globotruncanita elevata elevata* (BROTZEN). 15: spv.; 16–17: lv.; 18: uv. 15–16: 610 μ; 17–18: 575 μ; PP 1–10, HU 6206; Tarqumiya, Lower Campanian.

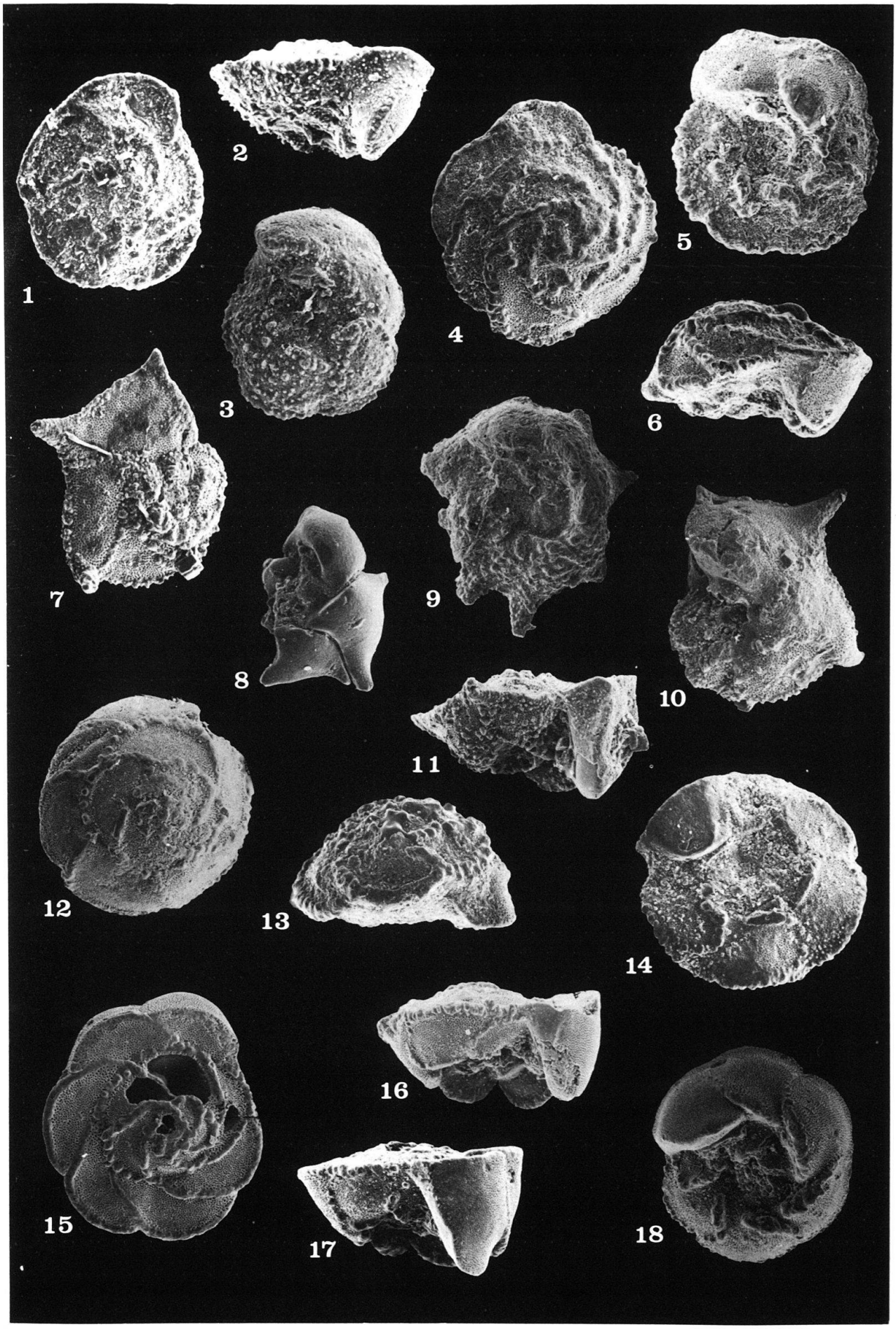
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Plate 8

Fig. 1–3 *Globotruncanita elevata* (BROTZEN) *"primitiva"* LINARES RODRIGUEZ. 1: spv.; 2: lv.; 3: uv. 1: 530 μ; 2, 3: 430 μ; HU 3010; En el Qilt, Uppermost Santonian.

Fig. 4–8 *Globotruncanita pettersi* (GANDOLFI). 4–5: spv.; 6: lv.; 7–8: uv. 4: 350 μ; HU 1541 (GSI 12426); Hanita, Upper Maastrichtian. 5: 450 μ; 8: 340 μ; GSI 2635/33.5–34.5 m, Oron D, Middle Maastrichtian. 6: 420 μ; GSI 2293/4–5 m; 7: 480 μ; GSI 2639, 34.5–35.5 m, Oron D, Middle Maastrichtian.

Fig. 9–11 *Globotruncanita stuarti* (DE LAPPARENT). 9: spv.; 10: uv.; 11: lv. 9–11: 670 μ; HU 7176; Sde Boker, Middle Maastrichtian.

Fig. 12–15 *Globotruncanita stuartiformis* (DALBIEZ). 12–13: spv.; 14: lv.; 15: uv. 12: 620 μ; 14: 500 μ; BL 780, HU 3841; 13: 500 μ; BL 678, HU 3747. 15: 480 μ; BL 682, HU 3750; Ein Fawwar, Upper Campanian.

Fig. 16–20 *Globotruncanita subspinosa* (PESSAGNO). 16–18: spv.; 19: uv.; 20: lv. 16: 580 μ; BL 780, HU 3841; Ein Fawwar, Upper Campanian. 17: 590 μ; 20: 540 μ; BR 72, HU 6732; Upper Upper Campanian. 18–19: 720 μ; PP 1–2, HU 6222, Tarqumiya, Lower Campanian.

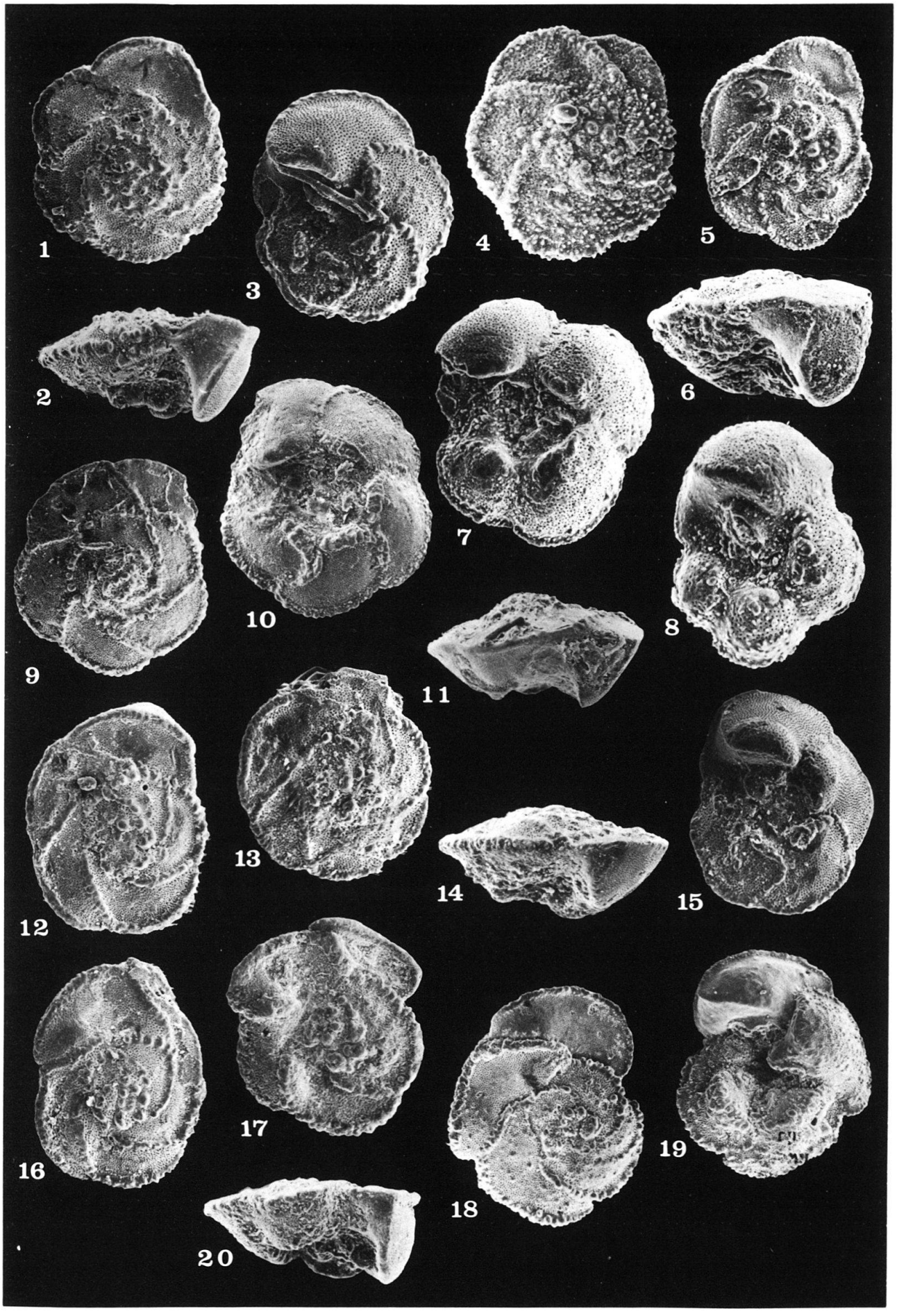
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Plate 9

Fig. 1–2 *Rosita plummerae* (GANDOLFI). 1: spv.; 2: lv. 1: 465 μ; GSI 2299; Oron D, 19–20 m, Middle Maastrichtian. 2: 450 μ; HU 7176; Sde Boker, Middle Maastrichtian.

Fig. 3–5 *Rosita* sp. *("ackermanni")*. 3: spv.; 4: uv.; 5: lv. 3: 480 μ; 4: 560 μ; 5: 480 μ; BL 156, HU 3624; En el Qilt, Upper Santonian.

Fig. 6–8 *Rosita contusa* (CUSHMAN) form a. 6: spv.; 7: lv.; 8: uv. 6–8: 560 μ; HU 7176, Sde Boker, Middle Maastrichtian.

Fig. 9–11 *Rosita contusa* (CUSHMAN) form b. 9: spv.; 10: lv.; 11: uv. 9–11: 430 μ; Har Tuv 21, surface, Middle Maastrichtian.

Fig. 12–17 *Rosita fornicata* (PLUMMER). 12–13: spv.; 14–15: uv.; 16–17: lv. 12: 530 μ; 16: 540 μ; BL 130, HU 3599; 15: 540 μ; BL 149, HU 3618; En el Qilt, Upper Santonian. 13: 530 μ; HU 7024; Givat Mador 44, Lower Maastrichtian. 14: 420 μ; 17: 450 μ; BL 759, HU 3823; Ein Fawwar, Upper Campanian.

Fig. 18–20 *Rosita patelliformis* (GANDOLFI). 18: spv.; 19: lv.; 20: uv. 18: 625 μ; BL 199, HU 3660; Lower Campanian. 19: 480 μ; BL 222, HU 3684; 20: 540 μ; BL 225, HU 3687; Upper Campanian, En el Qilt.

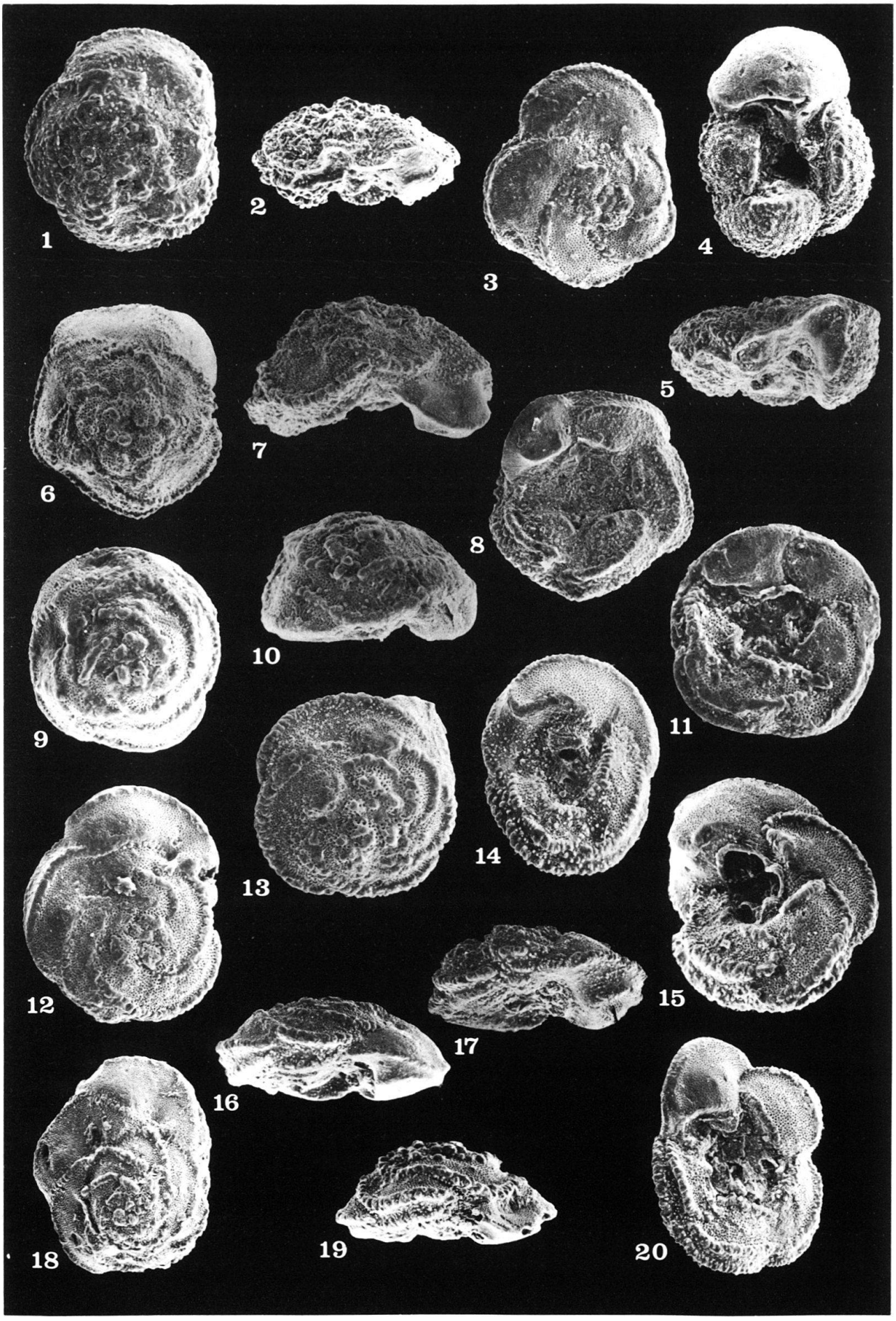
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Plate 10

Fig. 1–3 *Globotruncanella havanensis* (VOORWIJK). 1: spv.; 2: lv.; 3: uv. 1, 3: 300 μ; BL 818, HU 4189; Ein Fawwar, Lower Maastrichtian. 2: 340 μ; GSI 2639, 34.5–35.5 m, Oron D, Middle Maastrichtian.

Fig. 4–6 *Globotruncanella petaloidea* (GANDOLFI). 4: spv.; 5: uv.; 6: lv. 4: 300 μ; 5: 290 μ; 6: 350 μ; HU 6634, Mishor Rotem, Lower Maastrichtian.

Fig. 7–10 *Globotruncanella praehavanensis* SALAJ & GASPARIKOVA. 7: spv.; 8–9: lv.; 10: uv. 7: 385 μ; 9: 430 μ; 10: 400 μ; BL 84, HU 3360; En el Qilt, Upper Santonian. 8: 510 μ; CB 3899, HU 7205; Elat, Upper Santonian.

Fig. 11–13 *Globotruncanella pschadae* (KELLER). 11: spv.; 12: uv.; 13: lv. 11: 400 μ; HU 1541 (GSI 12426); Hanita, Upper Maastrichtian. 12–13: 450 μ; GSI 2636; Oron D 33–34 m, Middle Maastrichtian.

Fig. 14–17 *Gansserina gansseri* (BOLLI). 14: spv.; 15–16: lv.; 17: uv. 14: 370 μ; 15: 385 μ; HU 7152; Givat Mador 71; 16: 370 μ; 17: 400 μ; HU 7156; Givat Mador 75, Upper Maastrichtian.

Fig. 18–20 *Gansserina wiedenmayeri* (GANDOLFI). 18: lv.; 19: spv.; 20: uv. 18: 420 μ; 2630/3810; Oron 31–32 m, Middle Maastrichtian. 19: 500 μ; HU 7154; Givat Mador 73, Upper Maastrichtian. 20: 370 μ; HU 7024; Givat Mador 44, Lower Maastrichtian.

Fig. 21–23 *Abathomphalus mayaroensis* (BOLLI). 21: lv.; 22: spv.; 23: uv. 21: 660 μ; 22: 610 μ; Oron surface S/T 91, Upper Maastrichtian. 23: 560 μ; HU 7165; Givat Mador 84, Upper Maastrichtian.

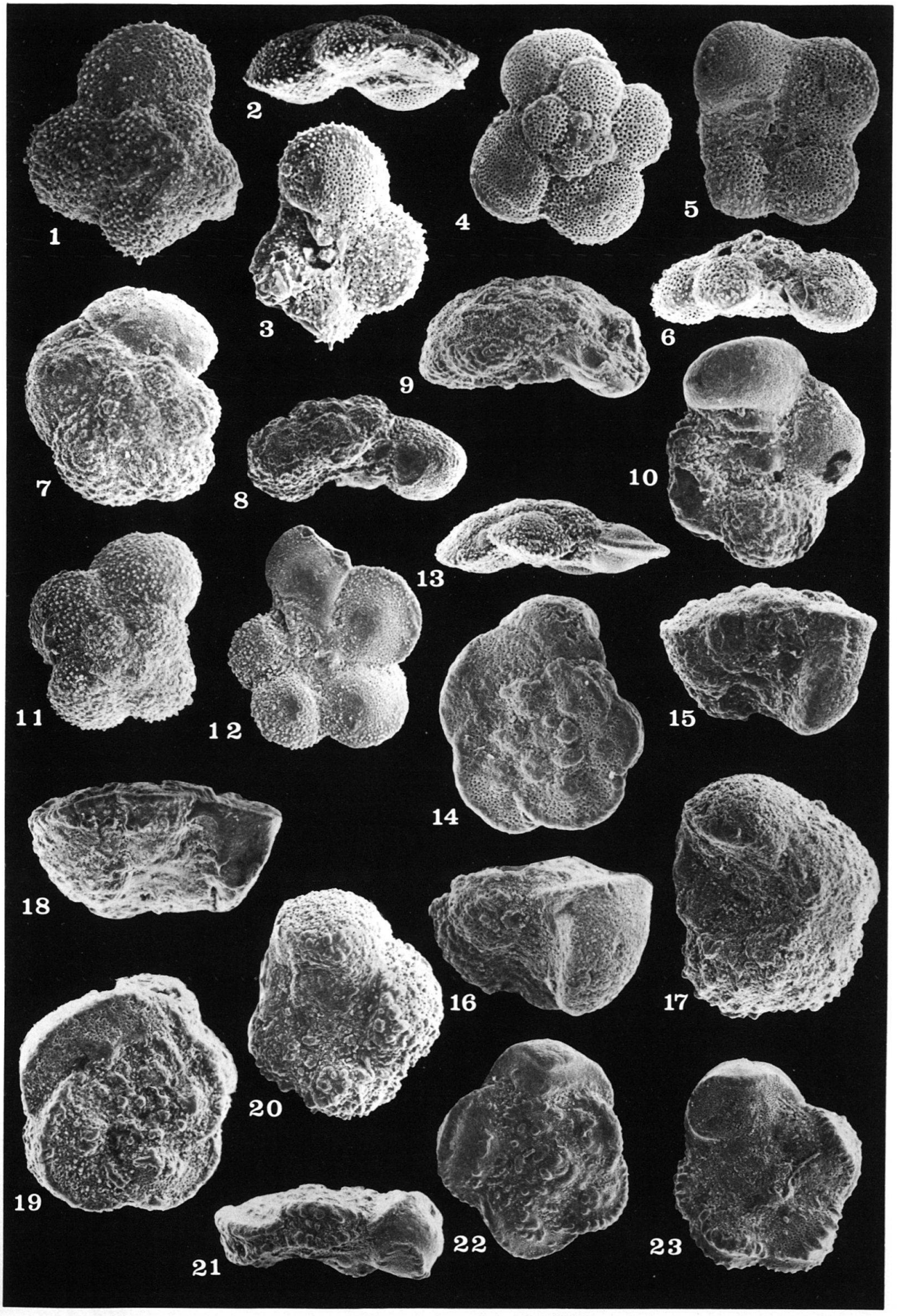
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Plate 11

All specimens from the Har Tuv area. Camera lucida drawings from REISS (1951). Magnification: approx. 50×. – Ages indicated as noted on specimen slides and as used in report by REISS (1951) (compare also REISS 1952a).

Fig. 1–6 *Dicarinella asymetrica* (SIGAL). Given as *Globotruncana concavata* (BROTZEN). Santonian.

Fig. 7–9 *Marginotruncana coronata* (BOLLI). Given as *Globotruncana lapparenti* BROTZEN *tricarinata* QUEREAU. Santonian–Low. Campanian.

Fig. 10–12 *Globotruncana aegyptiaca* NAKKADY. Maastrichtian.

Fig. 13–15 *Globotruncana arca* (CUSHMAN). Campanian.

Fig. 16–18 *Globotruncana bulloides* (VOGLER). Santonian–Low. Campanian.

Fig. 19–21 *Globotruncana linneiana* (D'ORBIGNY). Given as *Globotruncana lapparenti lapparenti* BROTZEN. Santonian–Lower Campanian.

Fig. 22–24 *Globotruncana orientalis* EL NAGGAR. Given as *Globotruncana cretacea* Cushman. Campanian.

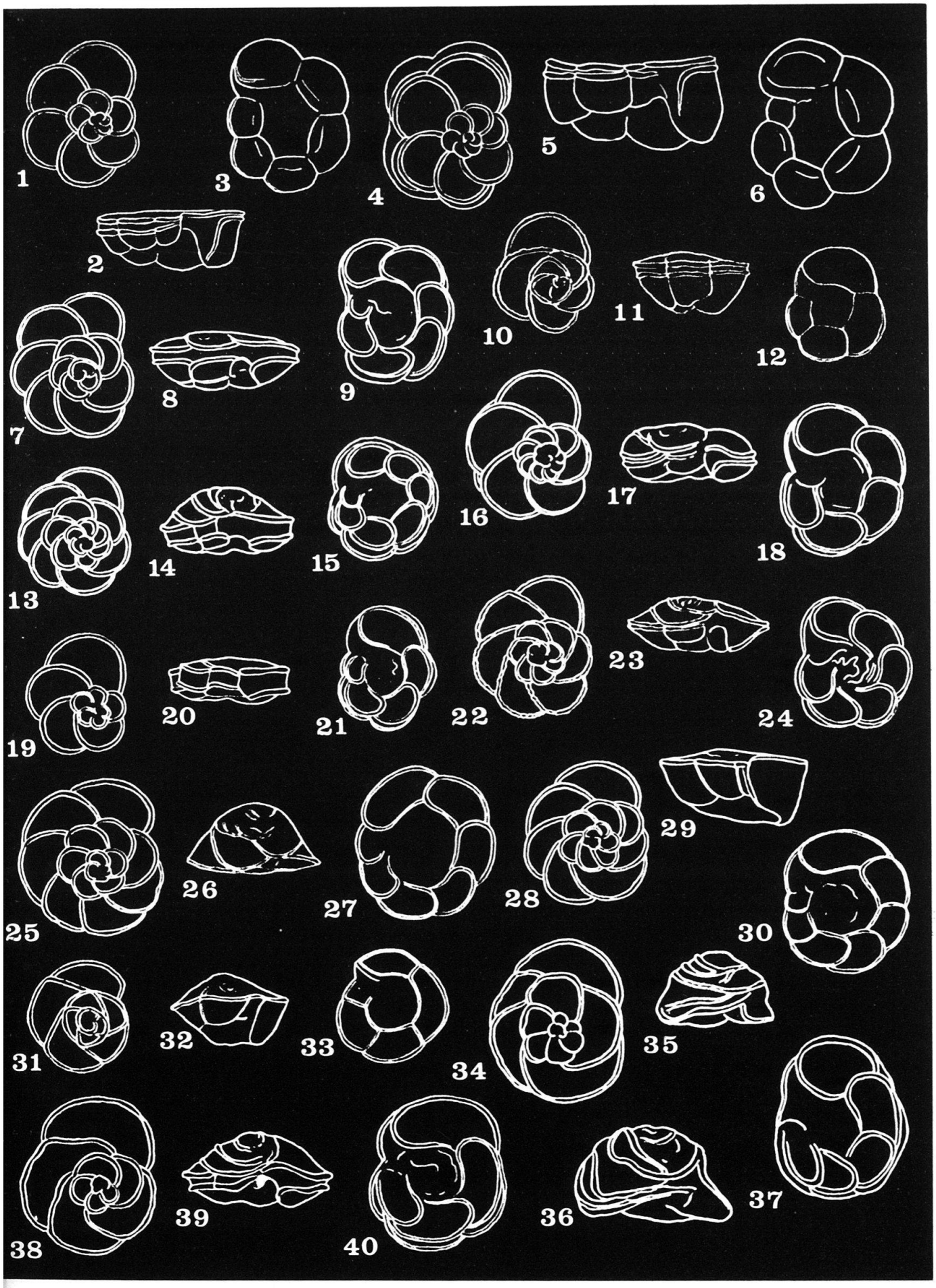
Fig. 25–27 *Globotruncanita conica* (WHITE). Given as *Globotruncana conica* WHITE. Maastrichtian.

Fig. 28–30 *Globotruncanita elevata* (BROTZEN). Given as *Globotruncana elevata* (BROTZEN). Campanian.

Fig. 31–33 *Globotruncanita stuarti* (DE LAPPARENT). Given as *Globotruncana stuarti* (DE LAPPARENT). Maastrichtian.

Fig. 34–37 *Rosita contusa* (CUSHMAN). Given as *Globotruncana contusa* CUSHMAN. Maastrichtian.

Fig. 38–40 *Rosita fornicata* (PLUMMER). Given as *Globotruncana fornicata* PLUMMER. Campanian.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