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GLOBOTRUNCANIDAE ZONES IN THE UPPER CRETACEOUS WITHIN THE ŢARA BIRSEI AREA (CRYSTALLINE-MESOZOIC ZONE, EASTERN CARPATHIANS)

(Pl. XXXVIII—XLV, 1 Fig.)

Consideratii asupra zonelor de Globotruncanidae din Cretacicul superior din Ţara Bîrsei (zona cristalino-mezozoic — Carpatii Orientali)

(Pl. XXXVIII—XLV, 1 fig.)

Abstract: In the Tara Bîrsei Region the Cenomanian-Maestrichtian is developed mainly as a continuous marly series. Abundant planctonic Foraminifera which occur in this series allow to study the evolution of the Globotruncanidae assemblages and to distinguish the Globotruncanidae zones.

The Globotruncanidae zones distinguished here are correlated with those differentiated by J. Sigal in the Mesogean area. Paleontological part of this paper contains the descriptions of species belonging to the subgenus Thalmanninella.

The Upper Cretaceous strata of the innermost part of the East Carpathians (Crystalline — Mesozoic zone) occurring on the border of the Tara Bîrsei depression are represented by a thick and generally continuous series. These deposits were studied by: Fr. Herbich (1878), I. Simionescu (1899), H. Wachner (1914), E. Jekelius (1938), G. Murgeanu and D. Patrulius (1957), E. Negreanu (1959), M. Săndulescu (1964, 1965, 1967) and J. Săndulescu (1967).

On the basis of a study of Globotruncanidae it has been possible to establish a detailed stratigraphy of the Upper Cretaceous deposits; the first results concerning the area investigated were mentioned in 1965 (J. Săndulescu, 1967).

In this paper, as a result of latest research work, the reviewed and completed chronostratigraphy, as well as the micropalaeontological zoning of these deposits are presented. In the descriptive micropalaeontological part, only species of the subgenus *Thalmanninella* are described.

GENERAL STRATIGRAPHIC CONSIDERATIONS

From considerations of Globotruncanidae in particular and also a few macrofaunal elements, it has been possible to determine the chronology of the above mentioned deposits. It was ascertained that the lithological

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units of Cretaceous strata within the area studied (illustrated on the geological sketch) are heterochronous and represent migration of facies. These facies are: the sandy-conglomerate facies, the marly facies showing some „Couches-rouges" type episodes and the calcareous-detrital facies. From the micropaleontological point of view only the last two facies are of real interest. These facies are present in three areas: Rîșnov, Tohan and Vlădeni.

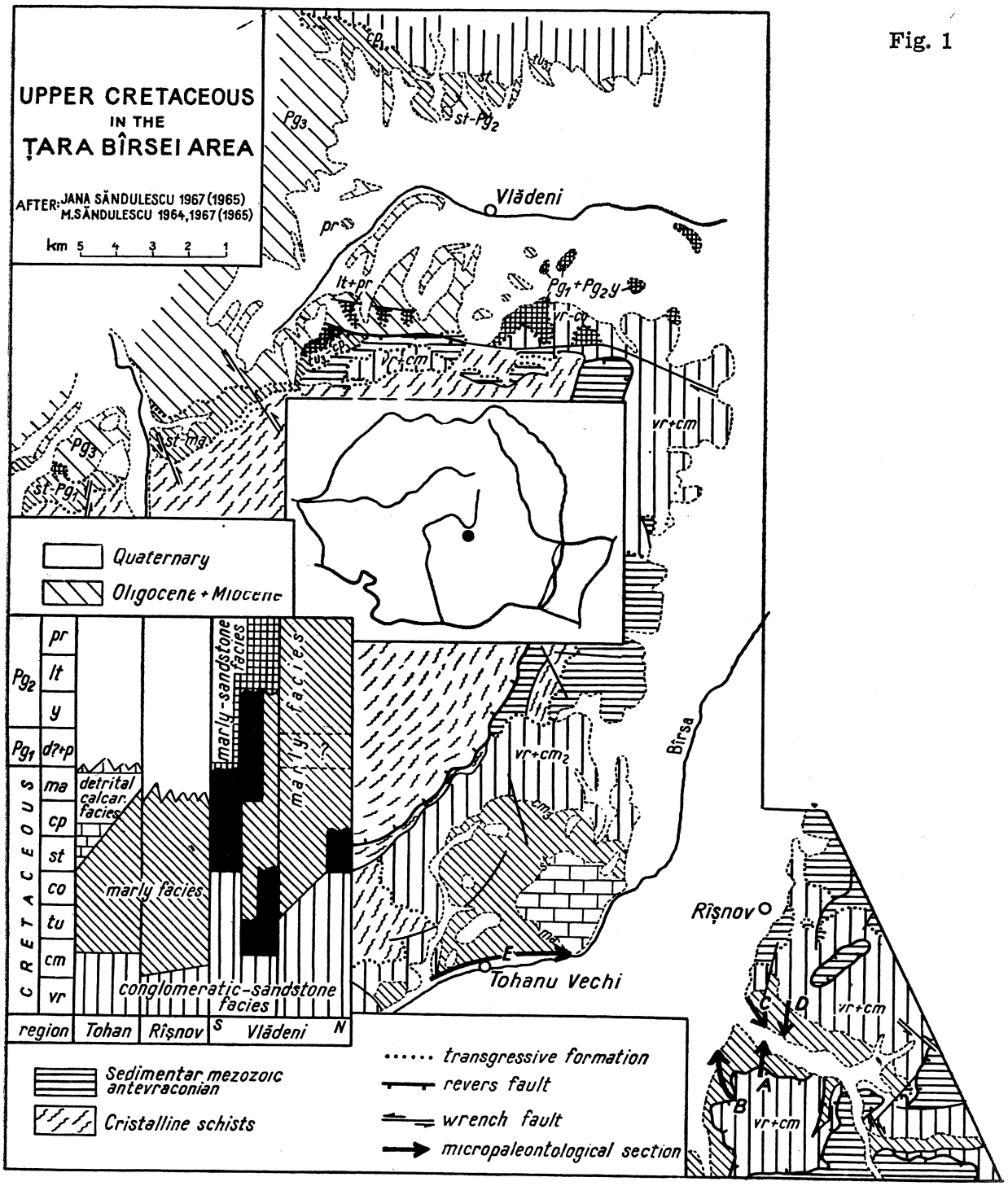

Fig. 1

The deposits of the sandy conglomerate facies transgressively overlie the crystalline schists and the various Mesozoic — pre-Upper Cretaceous beds. The deposits of this facies are generally assigned to the Vraconian

— Lower Cenomanian or to the Vraconian — Middle Cenomanian. In the Vlădeni area, this facies locally extends up to the Lower Senonian; in the uppermost part it contains *Siderolites* (North of Măgura Codlei). Owing to the presence of *Mantelliceras mantelli, Puzosia* sp. aff. *planulata,* in the Postăvaru Mts, the Cenomanian age of the sandy-conglomerate facies was proved. In the Tohan area, the sandy- conglomerate facies comprises numerous Vraconian Aucelline (E. Negreanu, 1959) [1]; in the same facies in the Dîmbovicioara basin, a rich Vraconian fauna was also identified (D. Patrulius, 1962).

The marly facies is largely developed in all areas enumerated and shows the following variations in age. At Rîșnov, sedimentation begins in the Lower Cenomanian and lasts up to the Campanian; in the Tohan hemisyncline, its deposition starts in the Upper Cenomanian. This facies extends up to the Campanian in the western limb of the hemisyncline and only up to the Coniacian in the northern one.

The passage between the sandy-conglomerate facies and the marly one was continuous; the sedimentation was also uninterrupted during deposition of the marly facies.

In the Vlădeni area the marly facies appears in the Upper Turonian — Coniacian and overlies the older deposits either continuously (at the northern border of the Vlădeni area) or transgressively (at the southern border of the Vlădeni area).

Both the Santonian and Campanian are transgressive and overlap the older rocks westwards; the Campanian-Maestrichtian passage is continuous. In the southern part of the Vlădeni area, Paleocene — Lower Eocene strata are developed in marly facies displaying „couches-rouges" characters (the Danian has been identified); in the northern part of the same area, the Middle and the Upper Eocene also display a marly facies.

Vertical lithological changes allow the separation of the marly facies into several lithostratigraphic units (listed in the Tables A—E):

The marly unit begins with a complex of (I, I′) Lower Cenomanian — Middle Turonian or Late Cenomanian — Middle Turonian age (60—400 m in thickness) consists of bedded, grey, sandy marls, with calcareous, sandy intercalations a few cm thick. Many local, lithological elements can be distinguished: conglomeratic sandstones (Tohan and Rîșnov areas) Lower and Middle Turonian in age, as well as red clays in the uppermost part of the Middle Turonian (Tohan area). These deposits comprise the following zones of Globotruncanidae: the *Rotalipora* (*Thalmanninella*) *brotzeni* and *R.* (*Th.*) *globotruncanoides* zone (only at Rîșnov); the *R.* (*Th.*) *deeckei* and *R.* (*Th.*) *reicheli* zone, the *R.* (*R*) *turonica* and *R.* (*R*) *cushmani* zone; the *Praeglobotruncana praehelvetica* zone, and the *P. helvetica* and *G. schneegansi* zone. The macrofauna is represented in the Lower Turonian by many species of *Inoceramus,* particularly by *Inoceramus labiatus,* and in the Upper Cenomanian by *Aucellina, Mariella* cf. *dorsetensis* and *Mantelliceras* sp.

A flysch-like complex (II and II′) 40—200 m thick follows (Upper Turonian — Coniacian) consists of graded beds made up of 3 cm — 1 m thick sandy limestone or calcareous sandstones, and grey whitish, greenish and red shaly or massive marls. The microfaunal assemblage of these

[1] E. Negreanu (1959). Rap. Arch. Institul Geologic.

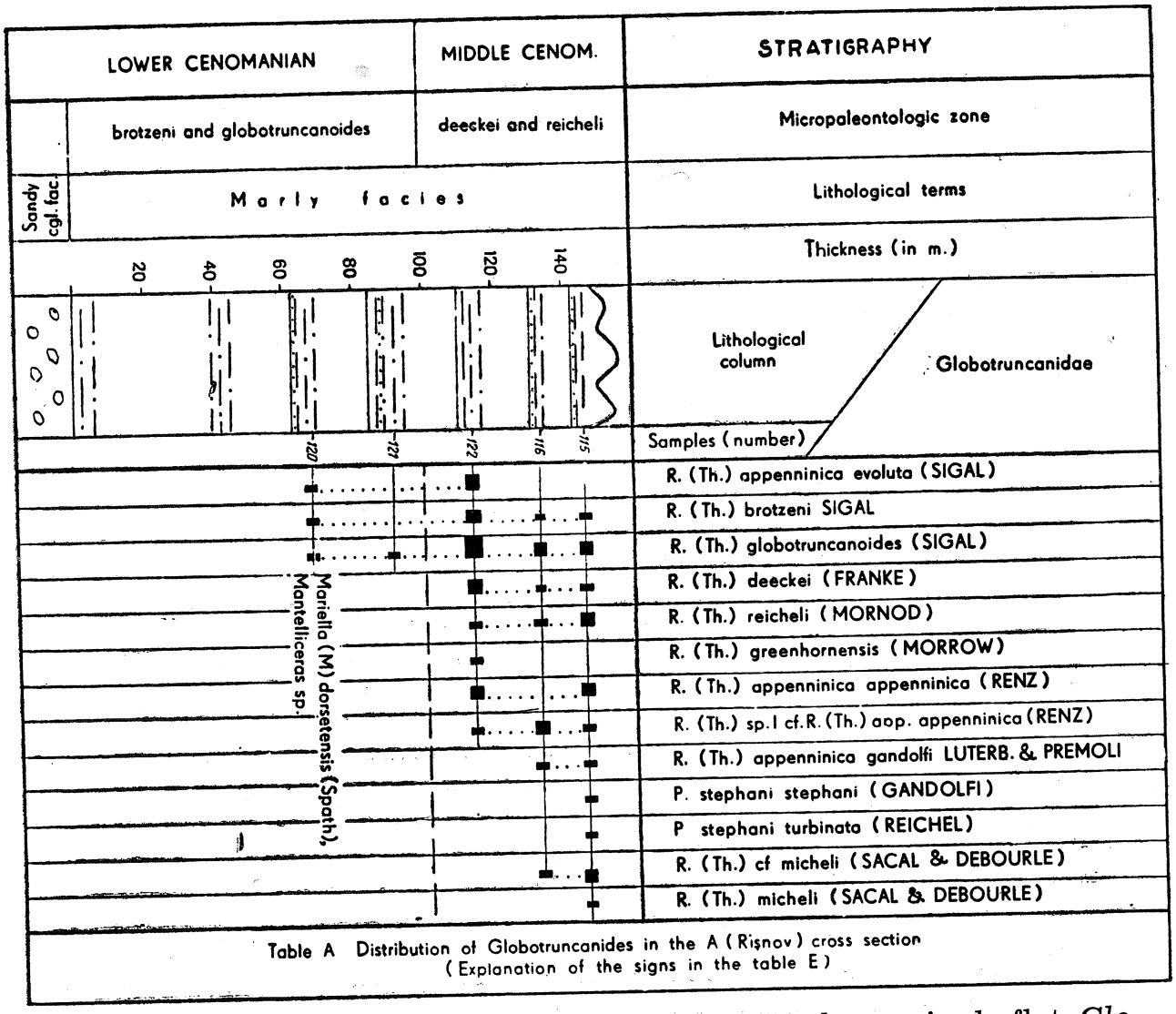

Table A Distribution of Globotruncanides in the A (Rișnov) cross section (Explanation of the signs in the table E)

deposits is characteristic for both the zone with large sized, flat *Globotruncana* and the *G. concavata* zone.

Starting with the uppermost part of the Coniacian, the lithology is somewhat differentiated in each of the above mentioned areas. In the Rîșnov area, starting with the Coniacian and especially the Santonian up to the Campanian, the marly facies is of a „couches rouges" type. This facies comprises (III) grey and massive marls with scarce thin calcareous sandstones and marly limestone intercalations.

At Tohan, on the Western flank of the hemisyncline, the Coniacian is represented by detrital, *Melobesiae*-bearing limestone up to 200 m thick and lenses of polygenic conglomerate. The Coniacian — Lower Campanian strata (400 m thick) consist of marly sandstones (III′). These deposits include both the *G. concavata* zone, and the *G. elevata elevata* and *G. elevata stuartiformis* zone.

In the Campanian, numerous *Inoceramus* — particularly *Inoceramus balticus* — are found; in the Upper Campanian — Maestrichtian strata (more than 1000 m thick) whitish greenish and red marls with sandy limestones and calcarenite intercalations are developed. The thickness of these intercalations ranges from a few cm up to about 1 m. These deposits contain *Orbitoides* and Globotruncanidae, belonging both to the *G. stuarti* and conical Globotruncanidae zone and to the uppermost part of the *Abathomphalus mayaroensis* zone.

The calcareous-detrital facies terminates the Upper Cretaceous; it displays some features of the Gosau facies and is present at Tohan where it comprises either the Maestrichtian (on the West limb of the hemisyncline) or the Santonian-Maestrichtian (on the Northern limb of the same hemisyncline); some indices of this facies may be noticed, owing to the presence of the detrital limestone breccia and conglomerate intercalations in the „couches rouges" deposits; these intercalations are assigned to the Santonian — Maestrichtian. The detrital calcareous facies includes whitish marls, with numerous Foraminifera, as well as Lamellibranchiata and Gastropoda-bearing calcareous microbreccia, brecciated conglomerates, clayey breccia, the latter containing a generally rich, reworked fauna, consisting of *Orbitoides, Radiolites,* Echinoids plates and radioles, Bryozoa, Thecidae, etc. In the Campanian, many forms of *Radiolites subsquamosus* Toucas, *R. styriacus* (Zittel) Toucas are found in situ (M. Lupu and D. Lupu, 1967) [1]; the Maestrichtian rocks contain numerous *Joufia reticulata* Boehm (M. Lupu and D. Lupu, 1967). The presence of the Mediterranean *Radiolites* is very characteristic for these deposits. The marly layers contain Globotruncanidae, belonging to the following zones: the uppermost part of the *G. concavata* zone, the *Globotruncana elevata elevata* and *G. elevata stuartiformis* zone, as well as the *Abathomphalus mayaroensis* zone (in the northern part of the Tohan area) or only the *A. mayaroensis* zone (in the western part of the same area).

GLOBOTRUNCANIDAE ZONES

With regard to the establishment of Globotruncanidae zones in the Upper Cretaceous strata from the Tara Bîrsei depression, the author considers that it is important to establish — at least for the mesogean area — the most uniform zone scale. For this reason, it is necessary to bring into agreement the field data with the various scales of the zones established by various research workers in the mesogean area. Therefore the works of the following authors proved helpful: J. Sigal (1955—1967), F. Dalbiez (1955), J. Klaus (1959, 1960), R. Lehmann (1962), H. Bolli (1966).

Taking into account the Rosalinae zones proposed by Sigal (1967), the author has been able to recognise without any difficulty, in the area investigated, the majority of these zones in the succession of Globotruncanidae within the Upper Cretaceous.

Since macrofauna is very scarce, the age determination of these zones is based especially on the stratigraphic value of Globotruncanidae, as it has been determined by correlation with macrofauna. On the basis of some ammonites and Inocerams, the author determined the age of several Cenomanian, Turonian and uppermost Cretaceous zones. In Tables A—E, the distribution of Globotruncanidae in some geological sections, and their corresponding zones in the area investigated are presented. Table F shows the general distribution of Globotruncanidae within the whole area.

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[1] M. Lupu and D. Lupu (1967). Studiul biostratigrafic al depozitelor in facies de Gosau din Carpatii Orientali. *Arch. Inst. Geologic,* Bucuresti.

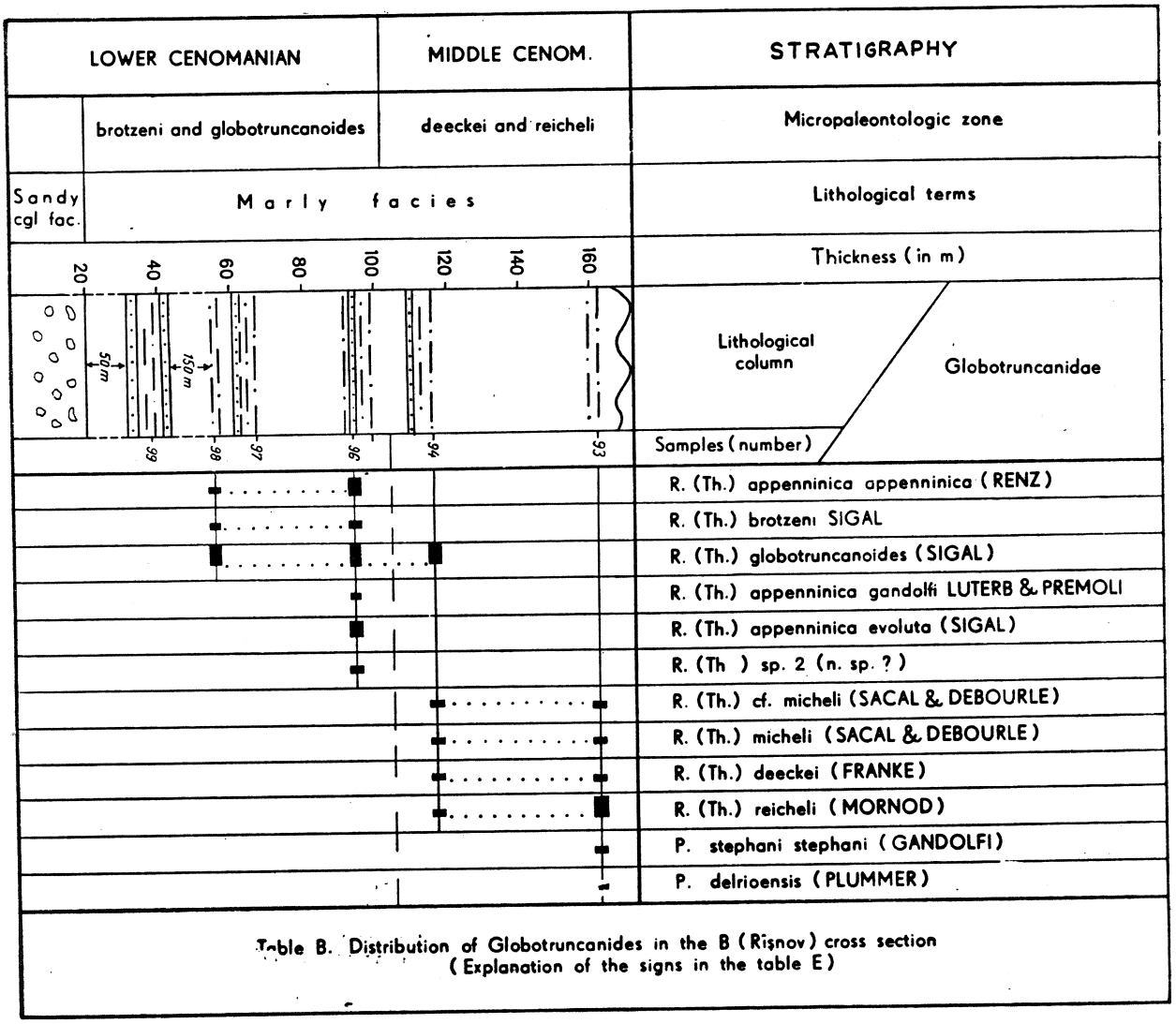

Table B. Distribution of Globotruncanides in the B (Rişnov) cross section (Explanation of the signs in the table E)

1. The *Rotalipora* (*Thalmanninella*) *brotzeni* and *Rotalipora* (*Thalmanninella*) *globotruncanoides* zone (Lower Cenomanian). This zone ends with the first occurrence of forms belonging to the *R.* (*Th.*) *deeckei. R.* (*Th.*) *reicheli* group; the most abundant form is *R.* (*Th.*) *globotruncanoides*, followed by *R.* (*Th.*) *brotzeni,* associated with *R.* (*Th.*) *appenninica appenninica* (R e n z), *R.* (*Th.*) *appenninica gandolfi* L u t e r b a c h e r and P r e m o l i - S i l v a, *R.* (*Th.*) *appenninica evoluta* S i g a l. In the uppermost part of this zone, we encountered a form (geological section B, Table B), which was noted as *R.* (*Th.*) sp. 2. If it is not a convergence phenomenon, due to morphological features, the above forms could illustrate the fact that *Globotruncana* may have originated from *Thalmanninella. R.* (*Th.*) sp. 2 shows both *Thalmanninella* characters and those indicating the appearance of *Globotruncana,* such as a *Thalmanninella*-type aperture; the first three chambers of the last whorl are as in *R.* (*Th.*) *brotzeni,* whereas the following chambers are elongated in the direction of their coiling, their outer keel-band being bifurcated and imbricated.

The marly facies including this zone belongs to the uppermost part of the Lower Cenomanian since it contains (Table A) in addition to many Inocerams the forms *Mariella dorsetensis* (S p a t h) and *Mantelliceras* sp.; the sediments of this facies overlie the sandy-conglomerate facies with *Mantelliceras mantelli* (S o w.) and are overlain by marly deposits con-

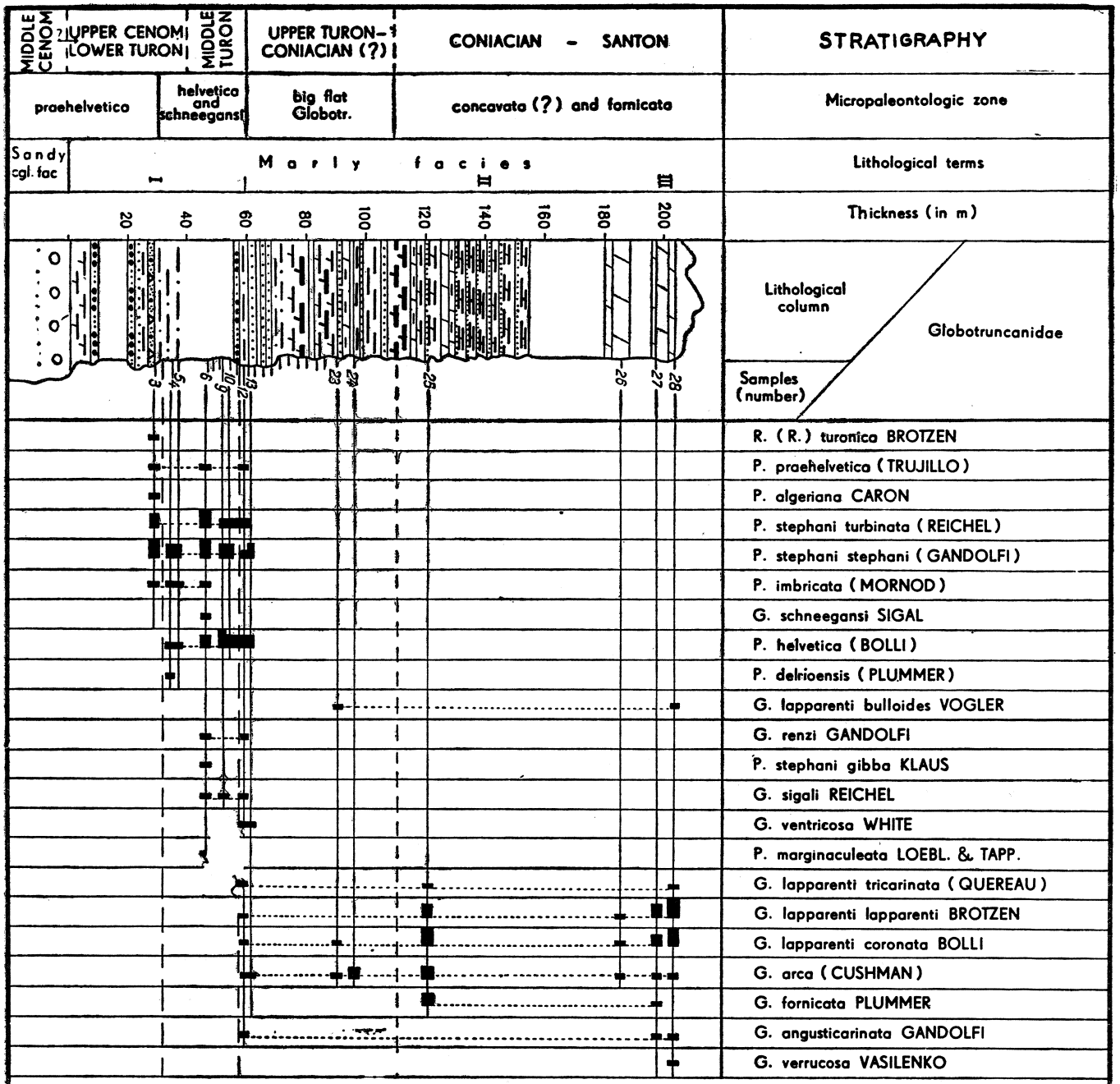

Table C. Distribution of Globotruncanides in the C (Rișnov) cross section
(Explanation of the signs in the table E)

taining the first specimens of *R. (Th.) reicheli* and *R. (Th.) deeckei* associated with *R. (Th.) appenninica*. Recent studies (B. Porthault, G. Thomel, O. de Villoutreys, 1966) show that this micropaleontological assemblage characterises the lowest part of the *Acanthoceras rothomagense* zone.

2. *Rotalipora (Thalmanninella) deeckei* and *R. (Th.) reicheli* zone (Middle Cenomanian). The lower limit of this zone coincides with the Lower/Middle Cenomanian boundary and is marked by the appearance of *R. (Th.) reicheli* group. The upper limit cannot be ascertained, because there are gaps in the profiles. Nevertheless, it may be presumed that this limit would coincide with the appearance of the species: *Rotalipora (Rotalipora) cushmani* (Morrow) and *R. (R.) turonica* Brotzen.

In the lowest levels of this zone prevail the forms: *R. (Th.) deeckei* Franke together with *R. (Th.) globotruncanoides* (Sigal) and *R. (Th.) brotzeni* Sigal; *R. (Th.) reicheli* (Mornod) is scarce and represented particularly by specimens which did not reach a typical form. The forms displaying intermediate features between *R. (Th.) deeckei* and *R. (Th.) reicheli* are frequently encountered; *R. (Th.) appenninica appenninica* (Renz), *R. (Th.) appenninica gandolfi* Luterb. & Premoli-Silva, *R. (Th.) appenninica evoluta* (Sigal) and *R. (Th.) greenhornensis* (Morrow) are still present, and the first specimens of *Praeglobotruncana* appear, represented by *P. stephani stephani* (Gandolfi), *P. stephani turbinata* (Reichel)[1], *P. delrioensis* (Plummer).

In the higher horizons, *R. (Th.) reicheli* is more frequent; the typical forms are abundant, whereas the species *R. (Th.) globotruncanoides* and *R. (Th.) brotzeni* become scarcer and both *R. (Th.) appenninica* and *R. (Th.) greenhornensis* disappear.

The faunal assemblage of this zone also includes the species *R. (Th.)* cf. *micheli, R. (Th.) micheli* (Sacal & Debourle), and the specimens of *Rotalipora (Thalmanninella)* sp. 1. The latter could represent the declining gerontic form of the species *R. (Th.) appenninica appenninica* (Renz).

The author regards as sufficiently proved the fact that the beginning of the *R. (Th.) deeckei* and *R. (Th.) reicheli* zone should be assigned to the Middle Cenomanian and that its lower limit coincides with the occurrence of specimens belonging to the *R. (Th.) deeckei — R. (Th.) reicheli* group, since it is generally admitted that these forms appear in the Middle Cenomanian. The presence of *R. (Th.) appenninica* even in the lowest part of the horizons with *R. (Th.) reicheli* also proves the existence of the Middle Cenomanian. There are still no data proving that the boundary between the Middle and the Upper Cenomanian would coincide with the limit between the zone with *R. (Th.) deeckei — R. (Th.) reicheli* and the following succeeding zone.

The zone with *R. (Th.) deeckei* and *R. (Th.) reicheli* zone within the Tara Bîrsei area has a larger stratigraphic content than the „*R. (Th.) deeckei* zone" proposed by J. Sigal (1967). The lower boundary of the latter zone is located higher than the corresponding limit of the zone with *R. (Th.) deeckei — R. (Th.) reicheli* zone; it also differs since it does not contain *R. (R.) turonica* and *R. (R.) cushmani* but only *R. (Th.) micheli* and *R. (Th.)* cf. *micheli* as does Sigal's zone. According to the author the latter forms gave origin to the former ones.

3. The zone with *Rotalipora (Rotalipora) cushmani* and *R. (R.) turonica* (Upper Cenomanian). Since the geological sections within the Tara Bîrsei area either end with „*R. (Th.) deeckei — R. (Th.) reicheli* zone" or begin with the *R. (R.) cushmani — R. (R.) turonica* zone, the limit between these two zones has been inferred. Undoubtedly there exists a lower complex of rocks, bearing the assemblage of the *R. (Th.) reicheli* and *R. (Th.) deeckei* group, without the *R. (R.) cushmani — R. (R.) turonica* group and an upper complex, which includes, besides the *R. (Th.)*

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[1] = *P. stephani gibba* Klaus; in the tables and sometimes in the text both denominations have been indicated (*P. stephani turbinata* and *P. stephani gibba*). These are in fact the same.

reicheli — *R.* (*Th.*) *deeckei* group, also the *R.* (*R.*) *cushmani* — *R.* (*R.*) *turonica* assemblage. The upper limit coincides with the occurrence of *Praeglobotruncana praehelvetica* (Trujillo).

This zone is characterized by high frequency of its key species, by the abundance, particularly in the lower part, of the *R.* (*Th.*) *reicheli* (Mornod) and by a general abundance of *Praeglobotruncana,* belonging to the *P. stephani* group. This zone also includes: *R.* (*R.*) *montsalvensis* Mornod, *R.* (*R.*) cf. *turonica expansa, R.* (*Th.*) *deeckei* (Franke), *R.* (*Th.*) *brotzeni* Sigal and *R.* (*Th.*) *globotruncanoides* (Sigal); the last species disappears in its upper part.

The microfaunal assemblage of this zone is Upper Cenomanian in age. The occurrence of *P. praehelvetica,* as an element of the „large-sized *Globigerina* group", frequently mentioned at the Cenomanian/Turonian boundary at its upper limit, also confirms this age.

4. The *Praeglobotruncana praehelvetica* zone (Lower Turonian). This zone starts at the Cenomanian/Turonian boundary, with the occurrence of *P. praehelvetica* (Trujillo); its upper limit coincides with the appearance of *P. helvetica* (Bolli). This zone lies, therefore, within the Lower Turonian. The same age is also shown by the rest of its microfaunal assemblage. In the lower part of this zone, the last representatives of the *Thalmanninella* subgenus, namely *R.* (*Th.*) *brotzeni* Sigal, *R.* (*Th.*) *reicheli* (Mornod), *R.* (*Th.*) *deeckei* (Franke) disappear; at the same time, the genus *Rotalipora* still persists, represented by *R.* (*R.*) *cushmani* (Morrow), *R.* (*R.*) *turonica* Brotzen (with various subspecies) and *R.* (*R.*) *montsalvensis* Mornod. The latter forms, except for the first one, vanish at the upper limit of this zone. It should be noted that here *Globotruncana renzi* appears and that the number of species of *Praeglobotruncana* is very great (besides those which persist from the lower zone: *P. stephani stephani* (Gandolfi), *P. stephani turbinata* (Reichel), *P. delrioensis* (Plummer), double — keeled Praeglobotruncanidae *P. hagni* Scheibnerova, *P. algeriana* Caron, *P. imbricata* (Mornod) occur.

5. The *Praeglobotruncana helvetica* and *Globotruncana schneegansi* zone (Lower Turonian — Middle Turonian). This zone begins with the appearance of *P. helvetica* (Bolli) and terminates with the appearance of *Globotruncana angusticarinata* Gandolfi, and of the Globotruncanidae belonging to the *G. lapparenti* group. As shown by the geological section C (Table C), *Globotruncana schneegansi* occurs at least 20 m higher than the basal part of this zone, and thus the existence both of a Lower Turonian zone with *P. helvetica* only and a Middle Turonian zone of „*G. schneegansi*" is to be presumed. But the possibility of separating these two zones must be checked.

The microfaunal assemblage of this zone includes in particular various *Praeglobotruncana* species persisting, mainly from the lower zone: *P. stephani stephani* (Gandolfi), *P. stephani gibba* Klaus, *P. stephani turbinata* (Reichel), *P. delrioensis* (Plummer), *P. praehelvetica* (Trujillo), *P. helvetica* (Bolli), *P. hagni* Scheibnerova, *P. algeriana* Caron, *P. imbricata* (Mornod).

The genus *Globotruncana* is represented by only a few species: *G. renzi* Gandolfi, *G. schneegansi* Sigal occurring in the lower horizons, *G. sigali* Reichel is present in the upper part of this zone.

The occurrence of these forms proves a Middle Turonian age. The genus *Rotalipora* is only represented by *R. (R.) cushmani* (Morrow) and *R. (R.) oraviensis oraviensis* Scheibnerova.

P. stephani (and its subspecies) is very abundant within this zone, while both *G. schneegansi* and *P. helvetica* are very frequent in the upper part of the same zone.

Both the *P. praehelvetica* zone and the *P. helvetica — G. schneegansi* zone correspond palaeontologically, as well as in age to the „*P. helvetica* zone" of the succession of zones, proposed by J. Sigal (1965, 1967). The *P. helvetica* zone, as first established by Dalbiez (1955) and taking into account changes of its age limits by J. Klaus (1960), might correspond to the „*P. praehelvetica* zone" together with the lower part of the „*P. helvetica — G. schneegansi* zone", as recognised by the author. The upper part of the last mentioned zone, characterized by the occurrence of both *G. schneegansi* and *G. sigali,* could be equivalent of the Dalbiez's (1955) „*G. schneegansi* zone", but is only restricted to the Middle Turonian.

6. The „large-sized, flat *Rosalina* zone" (Upper Turonian-Coniacian). The lower limit of this zone is characterized by the occurrence of numerous species of *Globotruncana.* In the first horizons *G. angusticarinata* Gandolfi appears and a little higher, *Globotruncana* of the *lapparenti* group; these forms prove the presence of the Upper Turonian. The upper limit coincides with the disappearance of the last forms belonging to the *P. stephani* group and of *P. helvetica* (an event showing to some extent the passage from Turonian to Coniacian), and the occurrence of *G. concavata* Brotzen (this species marks the beginning of the next zone).

In the lower part of the „large-sized, flat *Rosalina* zone" almost all the species of *Praeglobotruncana* which occurred during the Middle Cenomanian — Lower Turonian disappear: *P. delrioensis* (Plummer), *P. stephani gibba* Klaus, *P. hagni* Scheibnerova, *P. algeriana* Caron, *P. praehelvetica* (Trujillo). At the same time also the last forms of *Rotalipora, R. (R.) cushmani* (Morrow) and *R. (R.) oraviensis oraviensis,* vanish.

Both in the lower and the upper horizons the following species persist: *P. helvetica* (Bolli), *P. stephani stephani* (Gandolfi), *P. stephani turbinata* (Reichel) which in turn vanish at the boundary of the next zone, as well as *G. schneegansi* Sigal, *G. sigali* Reichel, *G. renzi* Gandolfi, *P. imbricata* (Mornod).

J. Sigal (1955) considers as „large-sized *Rosalina* zone" the zone marked in its lower part by the occurrence of *G. schneegansi, G. sigali* and species of *Globotruncana* belonging to the *G. lapparenti* group and which ends with the appearance of *G. concavata.* J. Sigal assigned this zone to the Coniacian. He somewhat modifies this zone in his succession of *Rosalina* proposed in 1967. He named it the „large-sized flat *Rosalina* zone"; it is Upper Turonian — Coniacian in age, and its upper limit coincides with the occurrence of *G. lapparenti lapparenti, G. lapparenti coronata, G. angusticarinata.* The „large-sized flat *Rosalina* zone" within the Tara Bîrsei area corresponds to the zone described by Sigal in 1967.

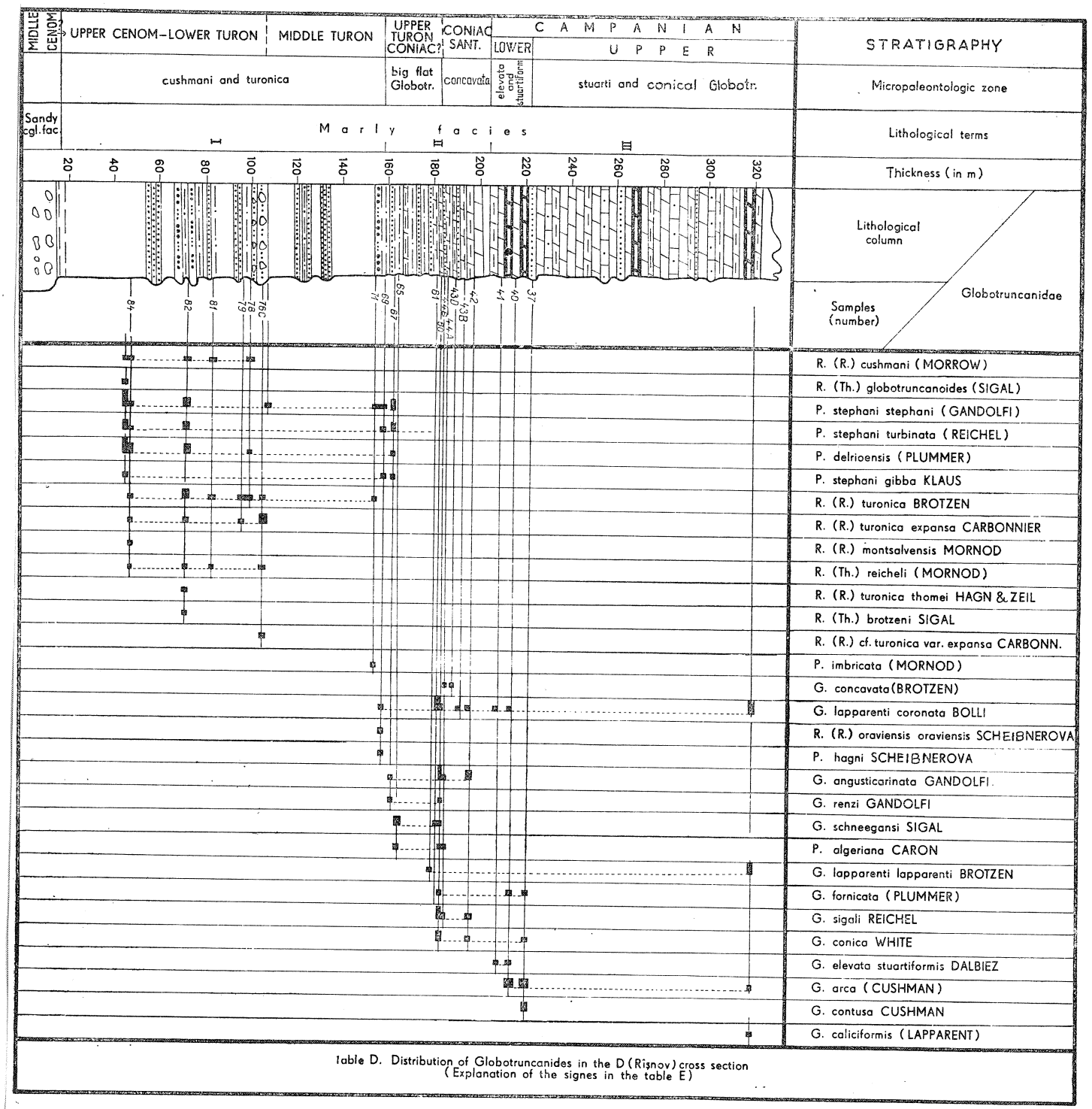

Table D. Distribution of Globotruncanides in the D (Risnov) cross section
(Explanation of the signes in the table E)

MIDDLE CENOM	UPPER CENOM	LOWER TURON. – MIDDLE TURON.		UPPER TURON CONIAC (?)	CONIACIAN – SANTONIAN	LOWER CAMPANIAN	UPPER CAMPANIAN	MAESTRICHTIAN	STRATIGRAPHY
	cushmani and turonica	praehelvetica	helvetica and schneegansi	big flat Globotr	concavata	elevata elevata and elevata stuartiformis	stuarti and conical Globotruncanidae	mayaroensis	Micropaleontologic zone
sandy cgl.-lac	Marly facies							Detrital calcareous facies	Lithological terms
	I′		II′		III′		IV		Thickness (in m)
20 40 60 m	160		≈ 200	120	≈ 460		≈ 1000		
			60m		50m	400m	350m	70m 60m 40m 300m	Lithological column / Globotruncanidae / Samples (number)
					Inoceramus balticus		Orbitoides, Siderolites, Omphalocyclus	Orbitoides, Radiolites	
									R. (R.) turonica BROTZEN
									R. (R.) turonica thomei HAGN & ZEIL
									R. (R.) turonica expansa CARBONN.
									P. stephani turbinata (REICHEL)
									P. stephani gibba KLAUS
									P. stephani stephani (GANDOLFI)
									R. (R.) cushmani (MORROW)
									R. (Th.) reicheli (MORNOD)
									R. (Th.) deeckei (FRANKE)
									R. (R.) montsalvensis MORNOD
									R. (Th.) brotzeni SIGAL
									P. delrioensis (PLUMMER)
									G. schneegansi SIGAL
									G. sigali REICHEL
									G. renzi GANDOLFI
									G. angusticarinata GANDOLFI
									R. (Th.) globotruncanoides (SIGAL)
									P. imbricata (MORNOD)
									P praehelvetica (TRUJILLO)
									P. helvetica (BOLLI)
									G. concavata (BROTZEN)
									G. ventricosa WHITE
									G. lapparenti tricarinata (QUEREAU)
									G. lapparenti bulloides VOGLER
									G. lapparenti lapparenti BROTZEN
									G. lapparenti coronata BOLLI
									G. arca (CUSHMAN)
									G. fornicata (PLUMMER)
									G. elevata elevata (BROTZEN)
									G. elevata stuartiformis DALBIEZ
									G contusa scutilla GANDOLFI
									G. verrucosa VASILENKO
									G caliciformis (LAPPARENT)
									G. stuarti (LAPPARENT)
									G. conica WHITE
									G. citae BOLLI
									A. mayaroensis (BOLLI)
									G. contusa CUSHMAN
									G. rosetta (CARSEY)
									G. calcarata CUSHMAN
									G. falsostuarti SIGAL

TABLE E. DISTRIBUTION OF GLOBOTRUNCANIDES IN THE E (TOHAN) CROSS – SECTION

EXPLANATION OF THE SIGNS:

I Grey sandy marls with sandstone, glauconitic sandstone and glauconitic breccia intercalations

I′ Grey sandy marls with calcareous sandstone and glauconitic sandstone intercalations.

I II′ Calcareous sandy, sandy limestone, grey, greenish, and marl Flyschlike episode; detrital limestone and conglomerate lenses.

III Grey, whitish and thick marls with sandstone, sandy limestone and marly limestone intercalations

III′ Flyschlike episode (Sandstone and grey shaly marl alternation).

IV Whitish red and grey thick marls with sandstone, sandy limestone and calcarenite intercalations.

Scarce
Moderate
Abundant

Irregulary bedded grey sandy marls
Grey sbaly marls
Red shaly marls
Grey thick marls
Red thick marls
Marly limestones
Limestones
Sandy limestones
Calcareous sandstones
Glauconitic sandstones
Calcareous micro breccia
Glauconitic breccia
Inconsolidated clayey breccia
Conglomerates
Calcareous conglomerates

STRATIGRAPHY	← LOWER CENOM.	MIDDLE CENOM.		UPPER CENOM.	LOWER TURONIAN	MIDDLE TURON.	UPPER TURON	CONIACIAN – SANTONIAN	CAMPANIAN		MAESTRICHTIAN
micropaleontological zone	brotzeni and globotr.	deeckei and reicheli	?	cushmani and turonica	praehelvetica	helvetica and schneegansi	big flat Globotruncanidae	concavata	elevata and stuartiformis	stuarti and conical Globotr.	mayaroensis
R. (Th.) sp. 1											
R. (Th.) appenninica appenninica											
R. (Th.) appenninica gandolfi											
R. (Th.) appenninica evoluta											
R. (Th.) brotzeni											
R. (Th.) globotruncanoides											
R. (Th.) deeckei											
R. (Th.) reicheli											
R. (Th.) greenhornensis											
P stephani stephani											
P. stephani turbinata											
P. stephani gibba											
P. delrioensis											
R. (Th?) sp.2 (n. sp?)											
R. (Th.) cf. micheli											
R. (Th.) micheli											
R. (R.) montsalvensis											
R. (R.) cushmani			?								
R. (R.) turonica			?								
R. (R.) turonica expansa			?								
R. (R.) turonica thomei			?								
P. praehelvetica											
P. hagni											
P. algeriana											
R. (R.) oraviensis oraviensis											
P. helvetica											
P. imbricata											
G. schneegansi											
G. sigali											
G. renzi											
G. concavata											
G. angusticarinata											
G. lapparenti coronata											
G. lapparenti lapparenti											
G. lapparenti tricarinata											
G. fornicata											
G. elevata elevata											
G. conica											
G. arca											
G. contusa scutilla											
G. elevata stuartiformis											
G. stuarti											
G. contusa											
G. citae											
G. caliciformis											
G. falsostuarti											
G. rosetta											
G. gansseri											
Ab. mayaroensis											

Table F General sketch of the globotruncanides distribution in the Upper – Cretaceous from the Tara Birsei area

7. The *Globotruncana concavata* zone (Coniacian — Santonian). This zone starts with the occurrence of *G. concavata* (Brotzen), which appears for the first time in the Coniacian. The upper limit is marked by *G. elevata stuartiformis* Dalbiez. This species appeared in the Campanian. The following species are included in the zone mentioned above: *G. fornicata* (Plummer), which appears a little higher than *G. concavata*; *G. elevata elevata* (Brotzen) and *G. arca* (Cushman), which is noticed in its terminal part. In this zone persist: *Globotruncana renzi* Gandolfi, *G. schneegansi* Sigal, *Praeglobotruncana imbricata* (Mornod) (species which disappear in the lower horizons), *G. sigali* Reichel, *G. angusticarinata* Gandolfi, *G. lapparenti lapparenti* Brotzen, *G. lapparenti coronata* Bolli, *G. lapparenti tricarinata* (Quereau). This assemblage shows the Coniacian — Santonian age of this zone.

The above zone corresponds to the Sigal's „*G. concavata* zone" (1955), taking into account the age changes made by this author in 1967.

8. The *Globotruncana stuartiformis* and *G. elevata elevata* zone (lower part of the Campanian). This zone starts with the occurrence of *G. elevata stuartiformis* Dalbiez and closes with the appearance of *G. stuarti* (Lapparent), associated with *G. contusa* Cushman, *G. rosetta* (Carsey), *G. conica* White. It is characterized by great abundance of the species *G. elevata elevata* and *G. elevata stuartiformis* which occur together with *Globotruncana* species, belonging to the *G. lapparenti* group and *G. fornicata*. This zone comprises: *G. contusa scutilla* Gandolfi, *G. citae* Bolli, *G. caliciformis* (Lapparent). The following species persist: *G. lapparenti lapparenti* Brotzen, *G. lapparenti coronata* Bolli, *G. tricarinata* (Quereau), *G. concavata* (Brotzen), *G. fornicata* (Plummer), *G. arca* (Cushman); in the lower part *G. sigali* disappears.

Within the Tohan area (geological section E), the marly facies belonging to this zone contain numerous *Inocerams* among which the species *Inoceramus balticus* predominates.

This zone corresponds with Sigal's (1967) „*G. elevata* and *G. stuartiformis* zone".

9. The *Globotruncana stuarti* and conical Globotruncanidae zone (Upper Campanian — Maestrichtian). From the palaeontological and stratigraphical points of view, this zone corresponds with the Sigal's zone (1966) bearing the same denomination. It starts with the occurrence of following species: *G. stuarti* (Lapparent), *G. contusa* Cushman, *G. rosetta* (Carsey), *G. conica* White, and ends with the appearance of *Abathomphalus mayaroensis* (Bolli). The upper limit is also marked by the disappearance in the uppermost levels of nearly all the representatives of the *G. lapparenti* group (excepting *G. lapparenti tricarinata*, which persists in the *A. mayaroensis* zone). In the uppermost levels occur: *G. falsostuarti* Sigal and *G. gansseri* Bolli, which indicate a Maestrichtian age. In the assemblage of this zone still persist: *G. arca* (Cushman) and *G. citae* Bolli, (very abundant) and *G. fornicata*; *G. arca* is especially represented by large-sized forms having numerous small chambers, and *G. fornicata* by three-chambered forms, the morphological features mentioned (J. Sigal, 1952) being characteristic of these forms during the Campanian.

The microfaunal assemblage of this zone appears to be Upper Campanian — Maestrichtian in age.

Within the Tohan area, the deposits of both marly and calcareous detrital facies, comprising the „*G. stuarti* and conical Globotruncanidae zone" contain in their uppermost part numerous specimens of *Orbitoides, Siderolites* and *Radiolites* (the latter being usually reworked). The presence of *Joufia reticulata* Boehm in situ (identified by D. Lupu, 1968) shows the Maestrichtian age of the uppermost part of this zone.

10. The *Abathomphalus mayaroensis* zone (Maestrichtian). This zone corresponds to the Bolli's zone (1957) of the same name. Its lower limit is marked by the occurrence of *A. mayaroensis* (Bolli). Except for the last representatives of the *G. lapparenti* group, namely, *G. lapparenti tricarinata* — which disappears in the lower part of the zone — in the *A. mayaroensis* zone all the species of the preceding zone persisted. The numerical abundance of the species: *G. stuarti* (Lapparent), *G. arca* (Cushman), *G. contusa* Cushman and *G. rosetta* (Carsey) in addition to *A. mayaroensis* Bolli is to be noticed. The deposits of the marly facies or of the calcareous detrital one within the „*A. mayaroensis* zone" comprise at Tohan include numerous specimens, particularly of *Orbitoides, Siderolites, Omphalocyclus* and Radiolitidae.

SYSTEMATIC DESCRIPTION

Rotalipora (Thalmanninella) appenninica appenninica (Renz)

Plate XXXVIII, fig. 1a—c; 2a—c

Globotruncana (Rotalipora) appenninica Renz var. alfa Gandolfi, Reichel, 1949, *Ecl. geol. Helv.*, vol. 42, no. 2, p. 605, fig. 3; — Mornod, 1949, *Ecl. geol. Helv.*, vol. 42, no. 2, p. 578—579, fig. 3 (2), fig. 4 (4a—c,? 3a—c), fig. 6 (1a—c); pl. XV, fig. 1a—b.

Rotalipora appenninica (Renz). — Subbotina, 1953, Foraminiferi S.S.S.R., p. 159, pl. I, fig. 58, pl. III, fig. 1—2.

Globotruncana (Rotalipora) appenninica Renz. subsp. *balernaensis*, Gandolfi, 1957, Cushm. Found Foram. Res. Contrib. Ithaca N.Y., vol. 8, pt. 2, p. 60 (fide Ellis and Messina, *Catalogue of Foraminif.*).

Rotalipora (Thalmanninella) appenninica balernaensis (Gandolfi) — Klaus, 1959, *Ecl. geol. Helv.*, vol. 52, no. 2, p. 808, pl. III, fig. 2a—c.

Rotalipora balernaensis Gandolfi — Loeblich and Tappan, 1961, *Rev. microp.* vol. 7, no. 3, p. 297, pl. 8, fig. 11a—c.

Thalmanninella balernaensis (Gandolfi) — Salaj and Samuel, 1966, Foraminif. der Westkarp. Kreide, p. 178, pl. 12, fig. 1a—c.

Rotalipora appenninica appenninica (Renz) — Luterbacher and Premoli Silva, 1962, *Rev. Ital. Paleont.*, vol. 68, no. 2, p. 266—267, pl. XIX, fig. 1a—c, 2a—c; pl. XX, fig. 1a—c, 4a—c; pl. XXI, fig. 1a—c, 4a—c.

Rotalipora (Thalmanninella) appenninica appenninica (Renz) — Caron, 1966, *Rev. microp.*, vol. 9, no. 2, p. 72, pl. 1, fig. 4a—c, 4b.

Thalmanninella appenninica (Renz) — Salaj and Samuel, 1966, Foraminifera der Westkarp. Kreide, p. 177, pl. 11, fig. 8 a, b, c.

Remarks: The specimens identified at Rîșnov display an increase in biconvexity of the test upwards in the stratigraphic succession.

Horizon and locality: Lower Cenomanian and Middle Cenomanian (lower horizons), marly facies — Rîșnov (Crystalline — Mesozoic zone, East Carpathians).
Hypotype: sample no. R. 96, R. 115, R. 122/1967; R. 229/1961.

Rotalipora (Thalmanninella) sp.1 cf. *appenninica appenninica* (Renz)
Plate XLI, fig. 1a—2b

Remarks: This forms differ from *Rotalipora (Thalmanninella) appenninica appenninica* (Renz) figured by H. Luterbacher and M. Bianca Cita as follows: larger sized; dorsal side more convex; last chamber either smaller than the others or more inflated. Presumably, these specimens represent the gerontic features of the *Rotalipora (Thalmanninella) appenninica appenninica.*

Horizon and locality: The upper part of the Middle Cenomanian, marly facies — Rîșnov (sample R. 122) (Crystalline — Mesozoic zone, East Carpathians).
Hypotype: sample R. 122/1967.

Rotalipora (Thalmanninella) appenninica gandolfi Luterbacher and Premoli Silva
Plate XXXVIII, fig. 3a—c

Rotalipora appenninica (Renz). — Loeblich and Tappan, 1961, *Rev. microp.*, vol. 7, no. 3, p. 296, pl. 7, fig. 12 a, b, c (non fig. 11 a, b).
Rotalipora appenninica gandolfi, Luterbacher and Premoli Silva, 1962, *Rev. Ital. Paleont.*, vol. 68, no. 2, p. 267—268, pl. XIX, fig. 3a—c; — Renz, Luterbacher, Schneider, 1963, *Ecl. geol. Helv.*, vol. 56, no. 2, p. 1088, pl. VIII, fig. 2a—c, 4a—c.
Rotalipora (Thalmanninella) appenninica gandolfii Luterbacher and Premoli Silva. — Caron, 1966, *Rev. microp.*, vol. 9, no. 2, p. 72, pl. 1, fig. 5a—c.
Horizon and locality: Lower Cenomanian and Middle Cenomanian, marly facies — Rîșnov (Crystalline — Mesozoic zone, East Carpathians).
Hypotype: sample R. 96, R. 115, R. 116/1967.

Rotalipora (Thalmanninella) appenninica evoluta (Sigal)
Plate XXXVIII, fig. 4a—c, 5a—c

Rotalipora cushmani (Morrow) var. *evoluta* Sigal, 1948, *Rev. Inst. Franc. Pétrol.*, vol. 3, no. 4, p. 100, pl. 1, fig. 3, pl. 2, fig. 2.
Rotalipora (Thalmanninella) evoluta (Sigal). — Klaus, 1959, *Ecl. geol. Helv.*, vol. 52, no. 2, p. 810, pl. IV, fig. 3a—c.
Rotalipora evoluta Sigal. — Loeblich and Tappan, 1961, *Rev. microp.*, vol. 7, no. 3, p. 298—299, pl. 7, fig. 2—3,? fig. 1; — Pessagno 1967, *Paleontographica Americana*, vol. V, no. 37, p. 294—295, pl. 53, fig. 6—8 (non pl. 49, fig. 12—14).
Rotalipora appenninica evoluta Sigal. — Luterbacher and Premoli Silva, 1962, *Rev. Ital. Paleont.*, vol. 68, p. 268, pl. XX, fig. 5.
Rotalipora (Thalmanninella) appenninica evoluta (Sigal). — Caron, 1966, *Rev. microp.*, vol. 9, no. 2, p. 72, pl. 1, fig. 3a—c.

Remarks: The specimens studied are both high- and narrow chambered forms and forms having the last sutural keels of the ventral side joined with the periumbilical ones (*R. (Th.) gandolfi* type) and the last chamber higher and wider.

Horizon and locality: Lower Cenomanian and Middle Cenomanian, marly facies — Rîșnov (Crystalline — Mezozoic Zone, East Carpathians).

Hypotype: sample no. R. 122/1967.

Rotalipora (Thalmanninella) brotzeni Sigal

Plate XXXIX, fig. 1a—4c

Thalmanninella brotzeni Sigal, 1948, *Rév. Inst. Franc. Pétrol.*, vol. 3, no. 4, p. 102, pl. I, fig. 5, pl. II, fig. 6—7.

Globotruncana (Thalmanninella) brotzeni Sigal — Mornod, 1949, *Ecl. geol. Helv.*, vol. 42, no. 2, p. 586—587, text-fig. 9 (1a—c).

Rotalipora (Thalmanninella) brotzeni Sigal — Klaus, 1959, *Ecl. geol. Helv.*, vol. 52, no. 2, p. 805, pl. III, fig. 1a—c.

Rotalipora greenhornensis (Morrow) — Loeblich and Tappan, 1961, *Micropaleont.*, p. 299—301, pl. 7, fig. 10 a—b.

Rotalipora brotzeni Sigal — Lehmann, 1962, *Notes Mém.* 156, p. 142, pl. I, fig. 1 a, b, c, 2 a, b, c.

Remarks: A great part of the specimens are similar to the holotype and the paratype figured by J. Sigal (1948). There are also specimens that differ from these in having a more convex ventral side. Others are similar to *R. (Th.) brotzeni* figured by L. Mornod (1949) in the rounded form of the test, the D/d ratio is about 1, and which have a more convex ventral side than the holotype.

Thus, some variations in the test morphology of this species with regard to D/d and $h'/h + h'$ ratios are to be noticed.

The rounded forms having a more convex ventral side represent specimens that morphologically show a close affinity to *R. (Th.) greenhornensis.*

Horizon and locality: Lower Cenomanian — Lower Turonian (first horizons), marly facies — Rîșnov ,Tohan (Crystalline — Mesozoic zone — East Carpathians).

Hypotype: R. 96, R. 115, R. 122/1967, R. 8c/1967.

Rotalipora (Thalmanninella) globotruncanoides Sigal

Plate XL, fig. 1a—4c

Rotalipora globotruncanoides Sigal, 1948, *Inst. Franc. Pétrol. Rev.*, vol. 3, no. 4, p. 100, pl. 1, fig. 4; pl. 2, fig. 3—5.

Rotalipora (Thalmanninella) globotruncanoides Sigal — Klaus, 1959, *Ecl. geol. Helv.*, vol. 52, no. 2, p. 805, pl. IV, fig. 1 a—c.

Remarks: At specimens attributed to this species all morphological variations, as mentioned by J. Sigal (1948), have been encountered. Most specimens (plate XL, fig. 1a—2b) are similar to the holotype (J. Sigal, 1948, plate 1, fig. 4); there are only a few specimens with the features of the paratypes (J. Sigal, 1948, plate 2, fig. 3—5); among the latter there are some specimens (Plate XL, fig. 4a—c) which, owing

to the features of their ventral side (neighbouring trapezoidal chambers slightly arched in the direction of the whorl coiling with keels having a weakly sinuous outline; the sutures between the chambers weakly marked), show a close affinity to *R. (Th.) brotzeni.*

Horizon and localies: Lower Cenomanian — Upper Cenomanian (*R. (Th.) globotruncanoides* and *R. (Th.) brotzeni* zone; *R. (Th.) deeckei* and *R. (Th.) reicheli* zone and *R. (R.) turonica* zone, marly facies — Rîșnov, Tohan (Crystalline — Mesozoic zone — East Carpathians).

Hypotype: Sample A. 115, R. 116, R. 122/1967.

Rotalipora (Thalmanninella) sp. 2 (n. sp.?)

Plate XXXVIII, fig. 6a—d

Studied material: sample no. R. 96/1967, 1 specimen.

Diagnosis: The test is biconvex in shape; there are seven chambers in the last whorl. On the dorsal side, the keels are evident and beaded, especially at the first chambers of the last whorl, being strongly arched onwards like at *R. (Th.) brotzeni.* On the ventral side (along the last chambers of the last whorl), the periumbilical, sutural and marginal keels join forming a single beaded keel as by *R. (Th.) brotzeni.* The third and the fourth chambers have only a periumbilical and a peripheral carina; the fifth and the sixth chambers are elongated in the direction of the coiling; their periumbilical keels are well marked and the marginal ones bifurcate and become resembling an imbricate double carinal band.

The aperture is distinct, as in *Thalmanninella.*

Discussions: This form shows both *Thalmanninella* characters and those indicating the appearance of the genus *Globotruncana*; if this is not a convergence phenomenon restricted to morphological features, this form could illustrate the fact that *Globotruncana* may have originated from *Thalmanninella.* This form was identified (table B, geological section B) in the Lower Cenomanian strata at about 15 m below the boundary of the Lower/Middle Cenomanian (within the *R. (Th.) globotruncanoides* and *R. (Th.) brotzeni* zone). Some authors, among them Porthault, 1966 (admitting their derivation from *Praeglobotruncana*) point out that the first double-keeled *Globotruncana* appear in the Upper Cenomanian. The author's specimen may indicate an earlier appearance of these forms.

Horizon and locality: the uppermost part of the Lower Cenomanian — Rîșnov (Crystalline — Mesozoic Zone, East Carpathians).

Rotalipora (Thalmanninella) deeckei (Franke)

Plate XLI, fig. 3a—b; plate XLII, fig. 1a—3b

Rotalia deeckei Franke, 1925, *Abh. Geol. Paläont. Inst.,* Greifswald, Deutschl., 6, p. 88, 90, pl. 8, fig. 7.

„*Rotalia*" *deeckei* Franke, Dalbiez, 1957, *Micropaleontology,* vol. 3, no. 2, p. 187—188, text-fig. 1—5.

Remarks: Many of the specimens studied (plate XLI, fig. 3) have the appearance of the form figured by Franke (1925). They have an almost flat dorsal side; on the ventral side (consisting of 7—8 chambers) the last chambers are high and narrow. Other specimens (plate XLII),

on the dorsal side have a marked central cone and the ventral side is made up of 7 chambers almost rounded that gradually increase in height.

Horizon and localities: Middle Cenomanian — Lower Turonian, marly facies — Rîșnov, Tohan (Crystalline — Mesozoic Zone, East Carpathians).

Hypotype: Sample R. 115, R. 120, R. 122/1967; V. 3322/1964.

Rotalipora (Thalmanninella) reicheli (Mornod)

Plate XLIII, fig. 1a—3c

Globotruncana apenninica Renz var. *gamma* Gandolfi, 1942, *Riv. Ital. Paleont.* XX (suppl.) p. 118, fig. 41 (1a-b); p. 119, fig. 42 (1); p. 122, fig. 44 (3—4); pl. 6, fig. 6; pl. 14, fig. 6 (p. parte).

Globotruncana (Rotalipora) reicheli Mornod, 1950, *Ecl. geol. Helv.*, vol. 42, no. 2 (1949), p. 583; p. 583, fig. 6 (1—6); p. 581, fig. 5 (4 a-c); pl. 25, fig. 2 a-p, 3, 8.

Rotalipora (Thalmanninella) reicheli (Mornod) — Klaus, 1959, *Ecl. geol. Helv.*, vol. 52, no. 2, p. 806—808, pl. IV, fig. 2 a-c; p. 807, t.fig. 7 (3 a-c).

Rotalipora reicheli Mornod — Loeblich and Tappan, 1961, *Micropaleont.* vol. 7, no. 3, p. 301, pl. 8, fig. 12; — non Subbotina, 1953, Iscopaem. foraminiferi. S.S.S.R., p. 162, pl. II, fig. 3—4.

Remarks: Most specimens (plate XLIII, fig. 2) in the lower horizons of the Middle Cenomanian do not display the typical aspect of the species: the last chambers are not high, the periumbilical keels are to some extent shifted towards the periphery of the chambers, the umbilicus is not so wide.

Horizon and localities: Middle Cenomanian — Lower Turonian, marly facies — Rîșnov, Tohan (Crystalline — Mesozoic Zone, East Carpathians).

Hypotype: Sample no. R. 93, R. 94, R. 122/1967; 228/1961.

Rotalipora (Thalmanninella) micheli (Sacal & Debourle)

Plate XLV, fig. 1a—3c

Rotalipora micheli Sacal & Debourle, 1957, *Mém. Soc. Geol. France.* N.S. no. 78, p. 58, pl. XXV, fig. 4, 5, 12.

Taking into account both the description given by the authors of the species and the characteristics of the specimens represented on the table XXV, fig. 4, 5, 12, the authors show that the species has the following morphology and shape as follows: the test is planoconvex, sometimes having a marked central knob, similar to the specimens of the *R. (Th.) deeckei — R. (Th.) reicheli* group; the dorsal side form an angle of about 90° with the ventral one, at the end of the final whorl; there are 6—7 chambers in the last whorl; the chambers are almost equally inflated and are separated by arched sutures.

The specimens, assigned by the author to this species, show all the above characteristics except for a larger variations in the ornamentation on the ventral side, variation in size of the test as well as in the number of the chambers. Thus, some forms, in the first two chambers of the last whorl, usually present weak periumbilical keels, whereas other forms have only a periumbilical rugosity; some specimens preserve this rugo-

sity on the other chambers too, except for the last two ones. As regards the number of chambers and the test size, the author mentions that she has encountered small — sized specimens, having only 5 chambers on the last whorl and sometimes a stronger rugosity of the test. These specimens occur either alone (geological section B, sample R. 93) or associated with *R. (Th.) micheli* specimens having normal size and 6—7 chambers on the last whorl (geological section A, sample R. 115).

It may be possible that these two types of *R. (Th.) micheli* represent dimorphic forms. As regards the aperture, Sacal and Debourle have shown that this species — besides the main aperture located on the apertural side of the last chamber — has also some accessory apertures situated „intra-suturally but less visible because of the aglomeration of strange material". At the specimen studied the position of these apertures, starting from the second chamber of the last whorl might be observed. They are of *Thalmanninella* type.

Horizon and locality: Middle Cenomanian (zone with *R. (Th.) deeckei* and *R. (Th.) reicheli*); marly flysch — Rîșnov (Crystalline — Mesozoic Zone, East Carpathians).

Hypotype: sample R. 115/1967.

Rotalipora (*Thalmanninella*) cf. *micheli* Sacal & Debourle

Plate XLIV, fig. 1a—3b

Rotalipora (*Thalmanninella*?) cf. *micheli* (Sacal & Debourle) — Klaus, 1959, *Ecl. geol. Helv.*, vol. 52, no. 2, p. 810, pl. IV, fig. 4 a, b, c.

Rotalipora cf. *micheli* Sacal & Debourle. — Renz, Luterbacher, Schneider, 1963, *Ecl. geol. Helv.*, vol. 56, no. 2, p. 1088, pl. III, fig. 3.

Studied material: sample no. R. 115, R. 116, R. 93, R. 94/1967, 15, specimens.

Dimensions: *D.* 0,731—0,537 mm; *d.* 0,714—0,442 mm; $h = 0{,}051—0{,}170$ mm.

Description: Test unequally biconvex, lobate in outline. The dorsal side of the shell forms an angle of about 60° with the ventral one. The dorsal side is convex, consisting of 2,3—3 whorls; the chambers, particularly the first chamber of the last whorl, are onwards arched; the keel bordering the chambers are conspicuous and beaded especially at the first chambers of the last whorl.

There are 6—7 chambers that gradually become higher and more inflated on the ventral side. In some specimens the periumbilical keels on 2—3 chambers of the last whorl join with the sutural and marginal keels forming continuous beaded keels, strongly arched in the direction of the whorl coiling similar to *R. (Th.) globotruncanoides*; at some specimens, instead of a periumbilical keel, only a rugosity of the first chambers is observed. The last chambers have a radial position with respect to the umbilicus; they are separated by strongly marked sutures particularly near the umbilicus where the chambers are more inflated; the surface of the last two chambers is generally smooth whereas that of the fourth and fifth chambers usually present a periumbilical rugosity. The umbilicus is sufficiently wide and depressed being overlapped by the chambers. The aperture is of *Talmanninella* type.

Remarks: In 1959 J. Klaus has figured and described a specimen of *R. (Th.)* cf. *micheli* showing differences from *R. (Th.) micheli* since its dorsal side, forms — in the last part of the final whorl — an angle

of only 60° with the ventral side. Besides this, characteristic feature the author shows also the following ones; the test is biconvex, or and flat dorsally and convex ventraly as may be noticed at *R. (Th.) micheli,* and the last chambers are less inflated; the presence on the first chambers of the last whorl at many specimens of a continuous, beaded keel, arched in direction of the whorl coiling similar to *R. (Th.) globotruncanoides.*

The last mentioned feature as well as the form of the test bring the specimen ascribed to *R. (Th.)* cf. *micheli* closer to *R. (Th.) globotruncanoides,* this latter form being considered as giving origin the former. Thus the *R. (Th.) globotruncanoides — R. (Th.)* cf. *micheli — R. (Th.) micheli* group is now outlined; within this group the evolution proceeded as follows; disappearance of the dorsal side convexity; the chambers of the ventral side become more inflated and the sutures deeper; the increasing of the radial position of the chambers with respect to the umbilicus; disappearance of the sutural keels and then of the periumbilical ones. Within the *R. (Th.) globotruncanoides — R. (Th.) deeckei — R. (Th.) reicheli* the same evolution trend is noticed, except that the periumbilical and sutural keels are preserved, being only shifted towards the peripheral part of the chamber. These two groups generated from the same source during the Middle Cenomanian, and have had an almost parallel evolution. In all the geological sections studied so far the *R. (Th.)* cf. *micheli* specimens occurred simultaneously with those of *R. (Th.) deeckei* and *R. (Th.) reicheli* while the specimens of *R. (Th.) micheli* occurred a little later. The author intends to check the moment of occurrence of these two forms also in other geological sections. Their heterochronous appearance may be an essential stratigraphic argument that (in addition to the above mentioned morphological differences) would allow to consider *R. (Th.)* cf. *micheli* as a subspecies of *R. (Th.) micheli.*
H o r i z o n and l o c a l i t y: Middle Cenomanian, marly facies — Rîșnov (Crystalline — Mesozoic Zone, East Carpathians).

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REZUMAT

In regiunea Tara Bîrsei, situată la interiorul Carpaților Orientali (zona cristalino-mezozoică) în segmentul sudic, Cenomanian-Maestrichtianul se dezvoltă în cea mai mare parte în serie continuă marnoasă și bogată în foraminifere planctonice. Aceasta a permis studierea evoluției asociațiilor de Globotruncanide și separarea de zone de Globotruncanide. Considerînd că este bine venită o tendință a unificării, pe cît posibil, a scării zonelor de foraminifere și avînd în vedere legea prioritaății, denumirea zonelor de Globotruncanide s-a făcut ținînd seama de zonele stabilite și cu același conținut și vîrstă. Se remarcă în cea mai mare parte asemănarea zonelar identificate în Tara Bîrsei cu zonele propuse de J. Sigal pentru domeniul mesogean.

In partea de micropaleontologie descriptivă sînt descrise speciile de *Thalmanninella* insistîndu-se asupra diferitelor aspecte evolutive; de asemenea sînt prezentate forme cu caractere noi: *Rotalipora (Thalmanninella)* cf. *micheli, R. (Th.)* sp. 1, *R. (Th.)* sp. 2 (n. sp. ?).

EXPLANATION OF PLATES

Plate XXXVIII

1a—c. *Rotalipora (Thalmanninella) appenninica appenninica* (Renz). Sample R. 229/1961. Middle Cenomanian, marly facies, Rîșnov (Crystalline-Mesozoic zone, Eastern Carpatians)

2a—c. *Rotalipora (Thalmanninella) appenninica appenninica* (Renz). Sample R. 96/1967. Lower Cenomanian, marly facies, Rîșnov (Crystalline-Mesozoic zone, Eastern Carpatians)

3a—c. *Rotalipora (Thalmanninella) appenninica gandolfi* Luterbacher and Premoli Silva. Sample R. 116/1967. Middle Cenomanian, marly facies, Rîșnov (Crystalline-Mesozoic zone, Eastern Carpatians)

4a—c, 5a—c. *Rotalipora (Thalmanninella) appenninica evoluta* (Sigal). Sample R. 122/1967. Middle Cenomanian, marly facies, Rîșnov (Crystalline-Mesozoic zone, Eastern Carpatians)

6a—d. *Rotalipora (Thalmanninella)* sp. 2 (n. sp. ?). Sample R. 96/1967. Lower Cenomanian, marly facies, Rîșnov (Crystalline-Mesozoic zone, Eastern Carpatians)

Plate XXXIX

1a—4c. *Rotalipora (Thalmanninella) brotzeni* Sigal. 1a—c sample R. 96/1967; 2a—c sample R. 122/1967; 3a—b sample R. 115/1967; 4a—c sample R. 8c/1967. Middle Cenomanian, marly facies, Rîșnov (Crystalline-Mesozoic zone, Eastern Carpatians)

Plate XL

1a—4c. *Rotalipora (Thalmanninella) globotruncanoides* Sigal. 1—2b sample R. 122/1967; 3a—b sample R. 116/1967; 4a—c sample R. 115/1967. Middle Cenomanian, marly facies, Rîșnov (Crystalline-Mesozoic zone, Eastern Carpatians)

Plate XLI

1a—2b. *Rotalipora (Thalmanninella)* sp. 1 cf. *R. (Th.) appenninica appenninica* (Renz). Sample R. 122/1967. Middle Cenomanian, marly facies, Rîșnov (Crystalline-Mesozoic zone, Eastern Carpatians)

3a—b. *Rotalipora (Thalmanninella) deeckei* (Franke). Sample R. 120/1967. Lower Cenomanian, marly facies, Rîșnov (Crystalline-Mesozoic zone, Eastern Carpatians)

Plate XLII

1a—3b. *Rotalipora (Thalmanninella) deeckei* (Franke). Sample V 3322/1964 and R. 122/1967. Middle Cenomanian, Lower Turonian, marly facies, Rîșnov (Crystalline-Mesozoic zone, Eastern Carpatians)

Plate XLIII

1a—3c. *Rotalipora (Thalmanninella) reicheli* (Mornod). 1a—b, 3a—c sample R. 228/1961; 2a—b sample R. 122/1967. Middle Cenomanian, marly facies, Rîșnov (Crystalline-Mesozoic zone, Eastern Carpatians)

Plate XLIV

1a—3b. *Rotalipora (Thalmanninella)* cf. *micheli* (Sacal & Debourle). 1a—c sample R. 94/1967; 2a—3b sample R. 115/1967. Middle Cenomanian, marly facies, Rîșnov (Crystalline-Mesozoic zone, Eastern Carpatians)

Plate XLV

1a—3c. *Rotalipora (Thalmanninella) micheli* (Sacal & Debourle). Sample R. 115/1967. Middle Cenomanian, marly facies, Rîșnov (Crystalline-Mesozoic zone, Eastern Carpatians)

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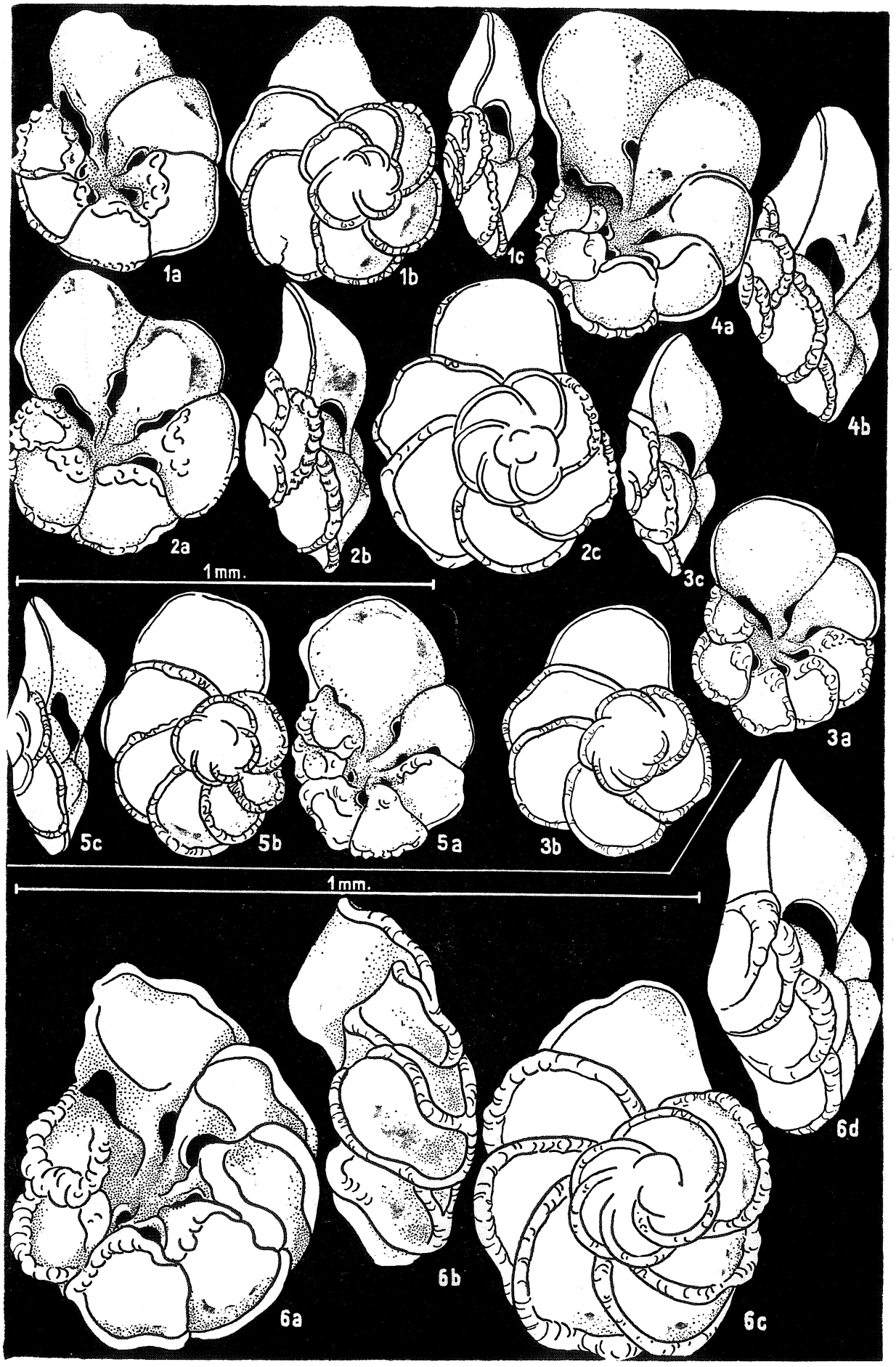

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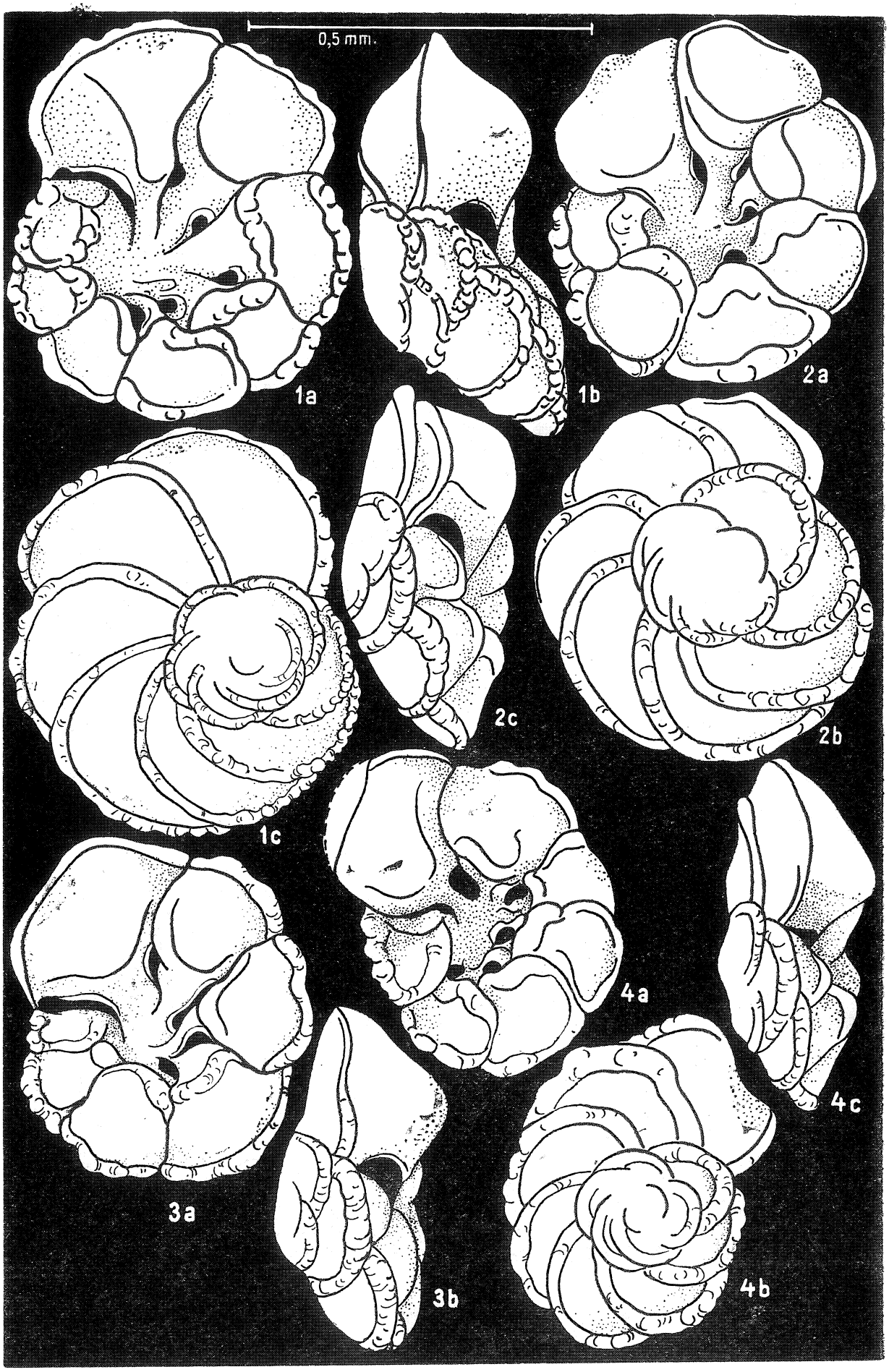

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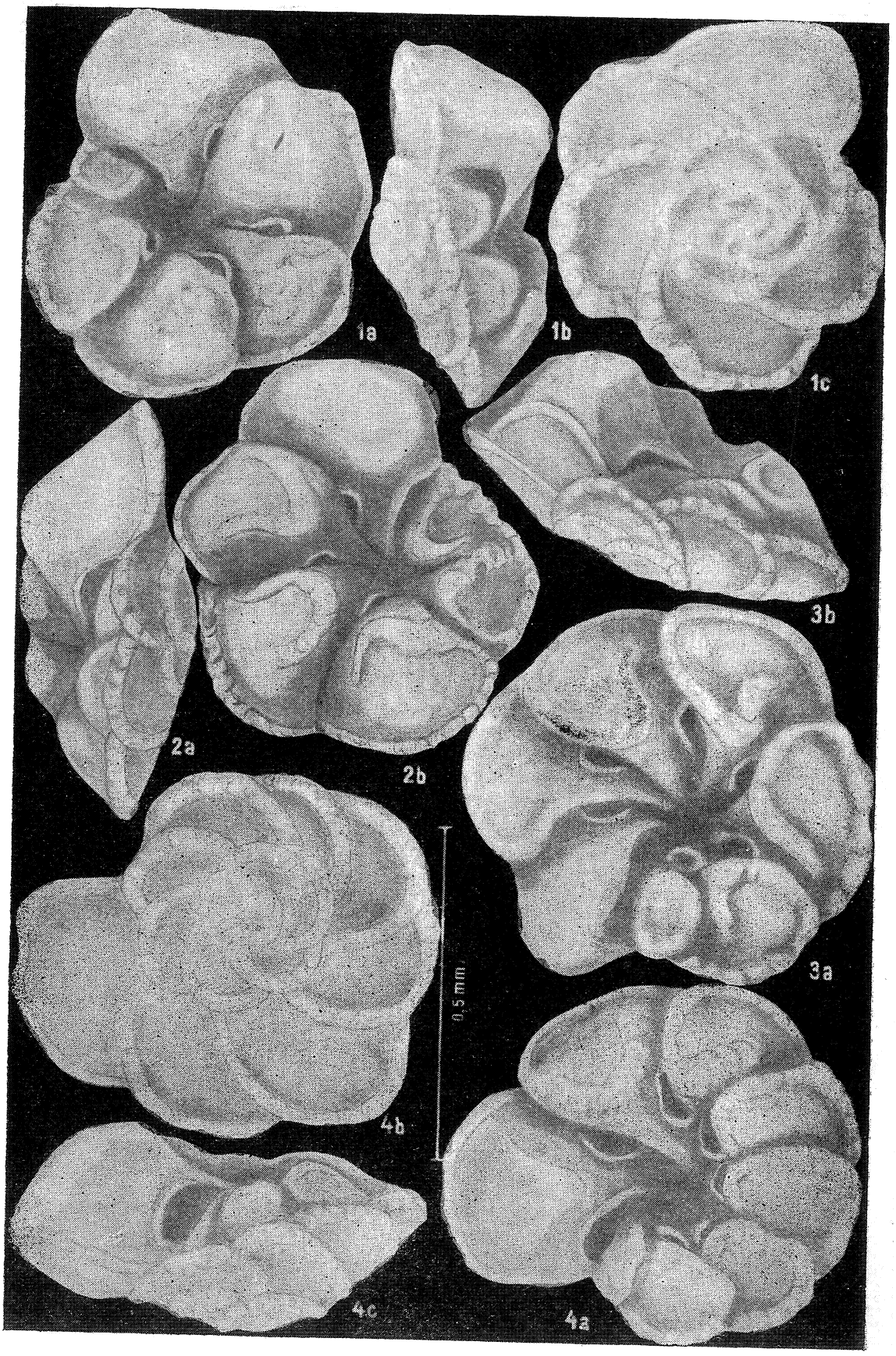
Tabl. XL



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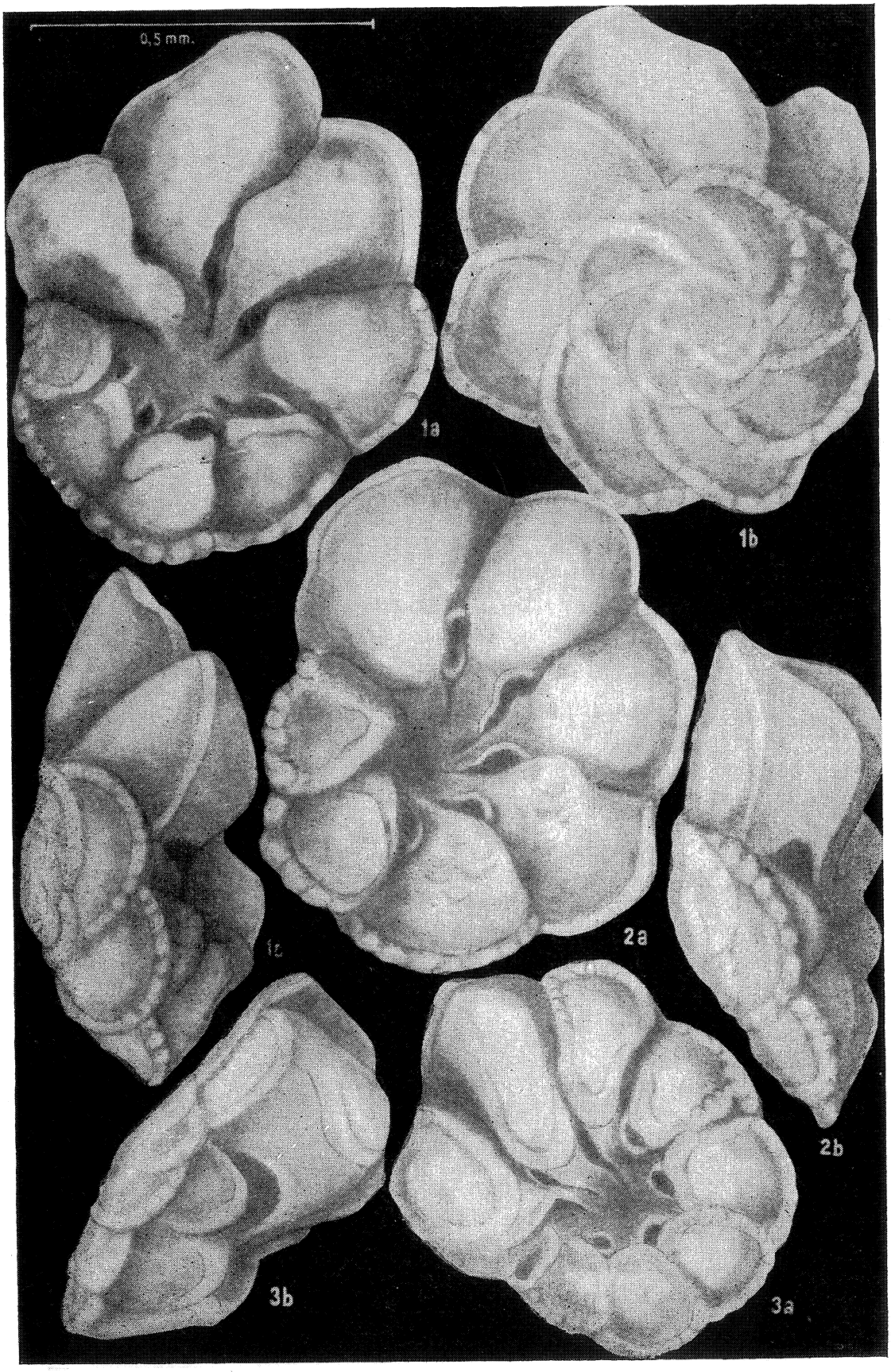

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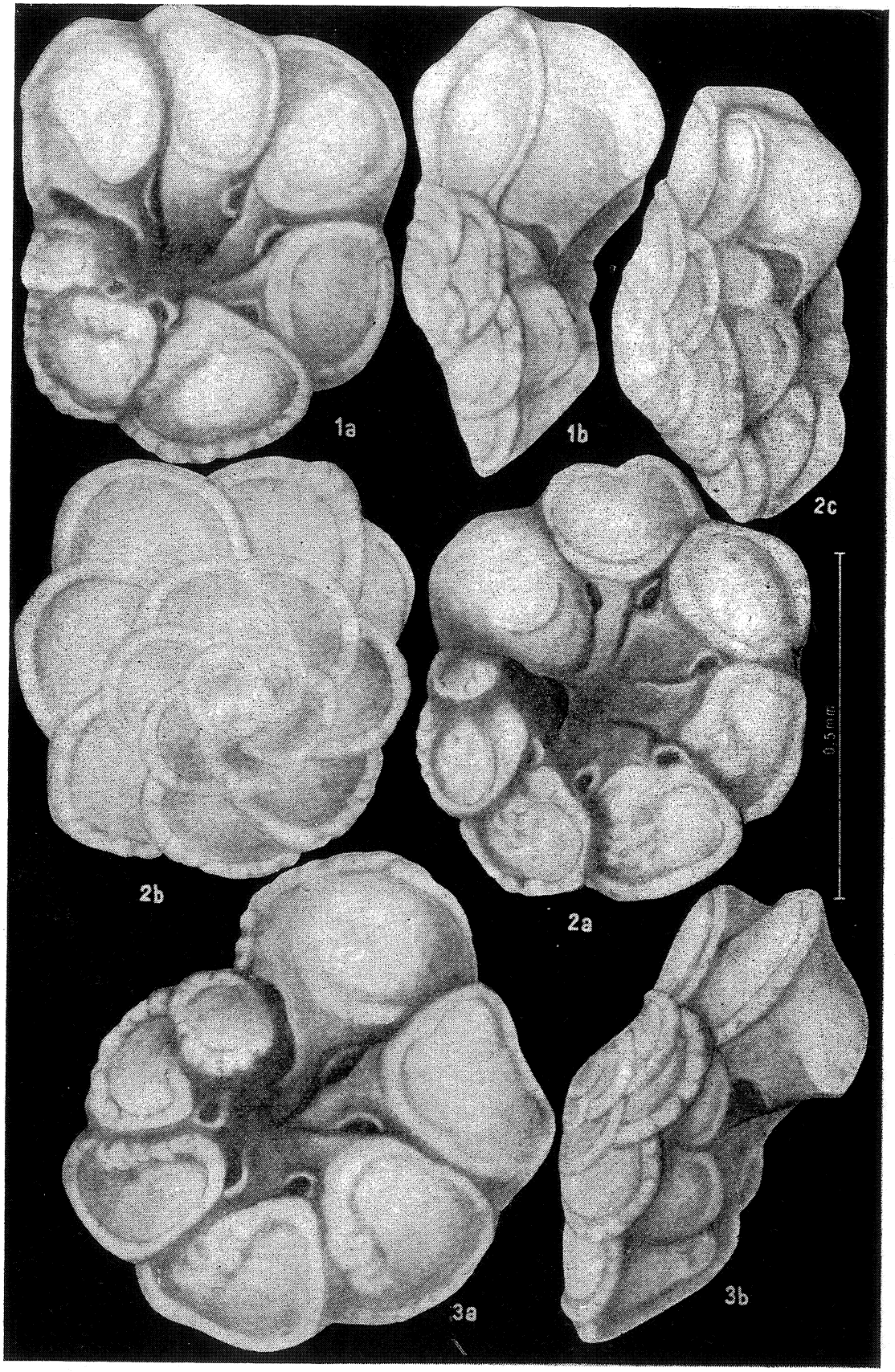

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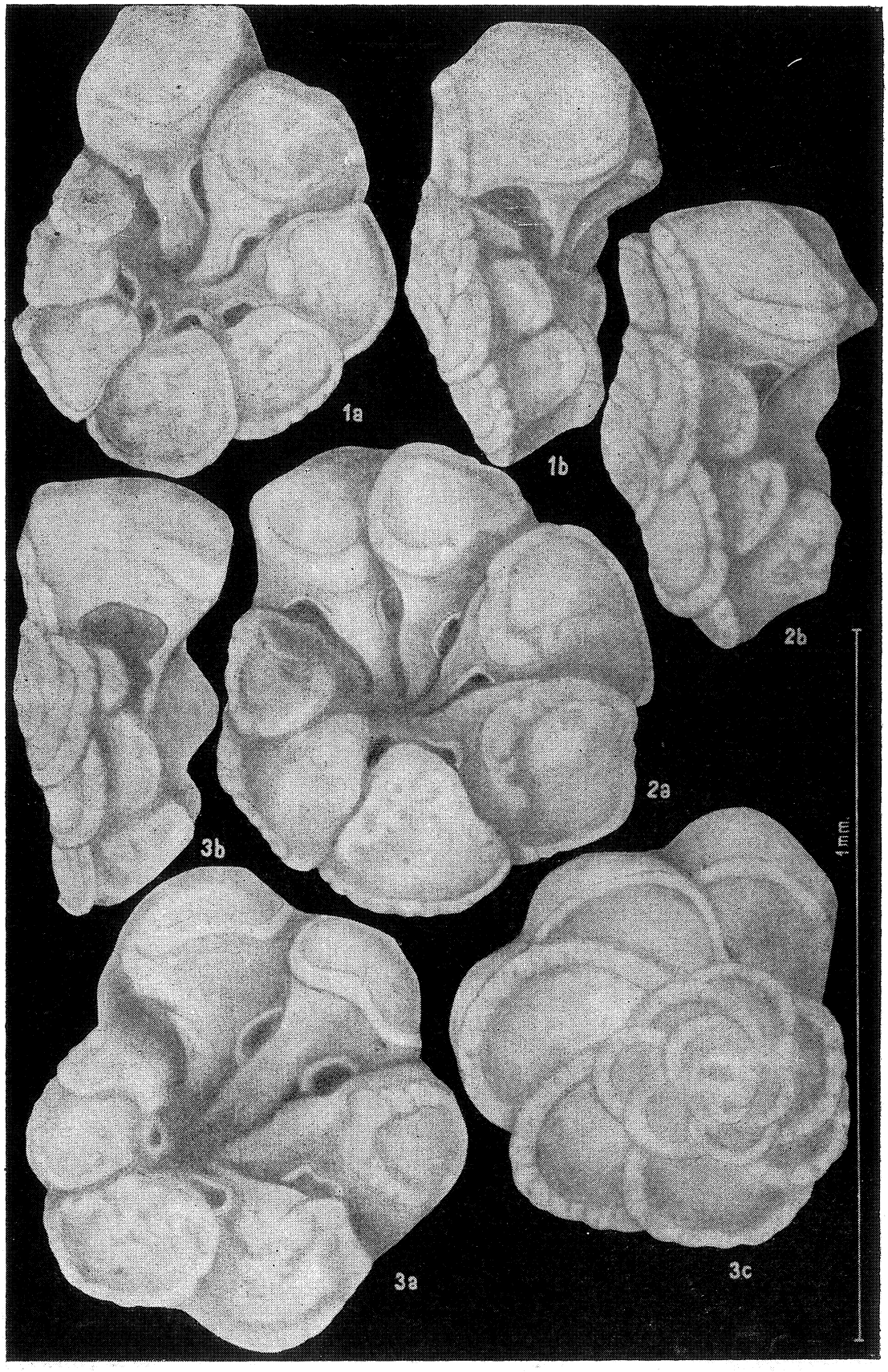

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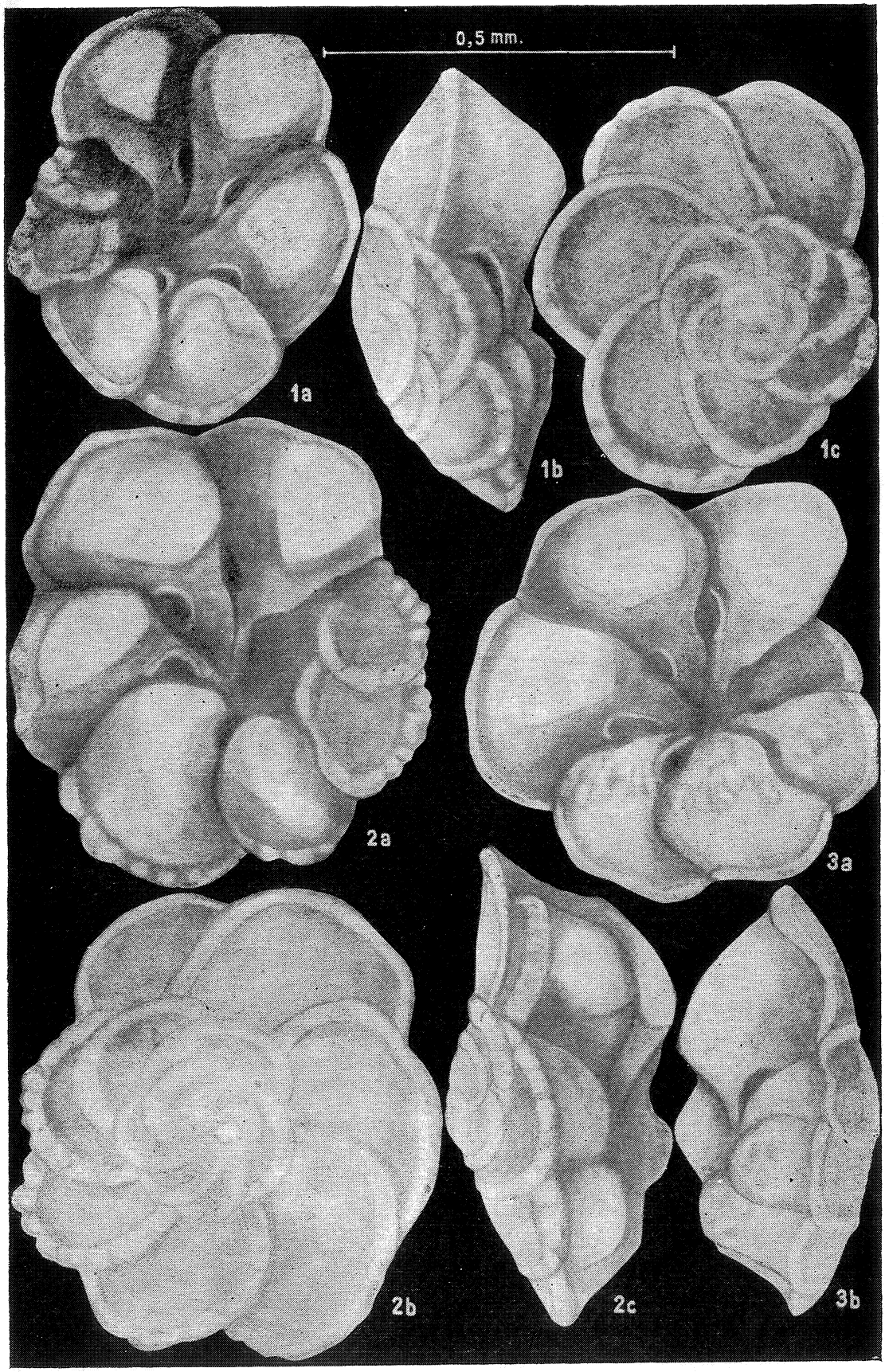

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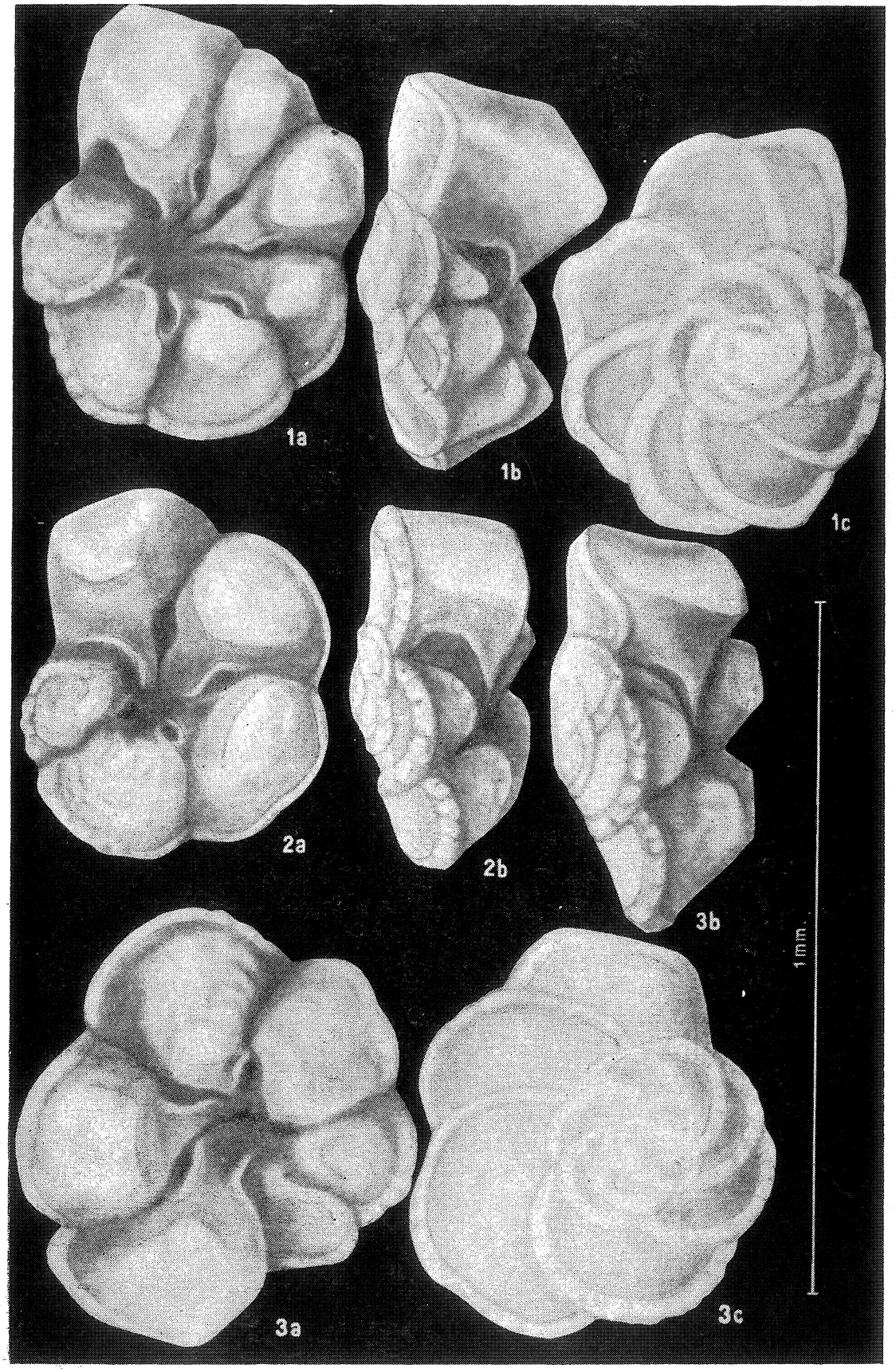

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