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HOLOCENE AND PALEOCENE FORAMINIFERA OF BORING ALLIANCE-28 IN SURINAM (DUTCH GUIANA)

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(with a range chart of the Holocene and Paleocene Foraminifera and 15 fotoplates.)

SUMMARY

This paper presents a description of the Foraminifera of the marine part of the geological column of the coastal plain of Dutch Guiana (Surinam) derived from the cored waterwell Alliance 28 to a depth of 337.50 m.

INTRODUCTION

With the exception of the Holocene most of the sediments are continental or at least are lacking in Foraminifera. From 258.85 m. to 321.80 m. the sediments contain a marine fauna. Still, most of the samples are barren, or contain only a few Foraminifera with the exception of a few samples in which we found 5000 specimens in 50 grams of dry sediment (see range chart). The fauna is rather poor in species but the rich samples contain many specimens of the few species present. In many samples the specimens are in a bad state of conservation. The Paleocene age has been established by *Ranikothalia bermudezi, Storssella haastersi, Boldia carinata, Anomalinoides midwayensis, Anomalinoides* cf. *danica*.

New are *Eponides allianceae, Boldia toeringae, Nonion kooteni, Buliminella compacta* and *Trochammina triloba*.

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I HOLOCENE FORAMINIFERA

Systematic description

Quinqueloculina compta Cushman
(Pl. XIII, Fig. 2)

1947, Cushman, Contr. Cushm. Lab. Foram. Res., vol. 23, p. 87, pl. 19, fig. 2.

1958, Drooger and Kaasschieter, Verh. Kon. Ned. Ak. v. Wet., Afd. Natuurk., eerste reeks, Deel XXII, p. 61.

In the 3 Holocene samples the frequency is up to 9%. Phleger (1956) found 11 living species at 12 to 17 metres.

Quinqueloculina lamarckiana d'Orbigny
(Pl. XIII, Fig. 1)

1839, d'Orbigny, in Ramon de la Sagra, Hist. Fis. Pol. Nat. Cuba, Foraminifères, p. 189, pl. 11, fig. 14, 15.

1958, Drooger and Kaasschieter, Verh. Kon. Ned. Ak. v. Wet., Afd. Natuurk., eerste reeks, Deel XXII, p. 62, map 25.

The frequency of this species is up to 9%. Phleger (1956) found 4 living species at 14-30 m.

Lagena striata (d'Orbigny)
(Pl. XIII, Fig. 5)

1839, *Oolina striata*, d'Orbigny, Voyage dans l'Amérique Méridionale; Foraminifères, Strasbourg, France, Levrault, tome 5, pt. 5, p. 21, pl. 5, fig. 12.

1958, Drooger and Kaasschieter, Verh. Kon. Ned. Ak. v. Wet., Afd. Natuurk., eerste reeks, Deel XXII, p. 52.

Only 3 specimens have been found. Phleger (1956) found Lagena and related spp. living at 45-90 m; derived specimens at 17 to 19 m.

Reussella atlantica Cushman
(Pl. XIII, Fig. 7)

1947, *Reussella spinulosa* (Reuss) var. *atlantica* Cushman, Contr. Cushm. Lab. Foram. Res., vol. 23, p. 91, pl. 20, fig. 6, 7.
1958, Drooger and Kaasschieter, Verh. Kon. Ned. Ak. v. Wet., Afd. Natuurk., eerste reeks, Deel XXII, p. 63, map 26.

Only in the sample from 12.25 m. did we find three specimens of this species. Phleger mentioned this species as living from 12-110 m. They are badly conservated and decoloured, therefore most probably derived from deeper water.

Uvigerina proboscidea Schwager
(Pl. XIII, Fig. 6)

1866, Schwager, Novara Exp., Geol. Theil., vol. 2, pt. 2, p. 250, pl. 7, fig. 96.
1958, Drooger and Kaasschieter, Verh. Kon. Ned. Ak. v. Wet., Afd. Natuurk., eerste reeks, Deel XXII, p. 79, map 36.

We found only one specimen in our Holocene samples. As Phleger (1956) found living and dead specimens at 85 m. and deeper, this one specimen has most probably been derived from deeper water.

Nonionella atlantica Cushman
(Pl. XIV, Fig. 1)

1947, Cushman, Contr. Cushm. Lab. Foram. Res., vol. 23, p. 90, pl. 20, fig. 4-5.
1958, Drooger and Kaasschieter, Verh. Kon. Ned. Ak. v. Wet., Afd. Natuurk., eerste reeks, Deel XXII, p. 56, map 22.

Frequencies of this species in all our Holocene samples are up to 10%. Phleger (1956) reports them as living between 10 and 73 m.

Elphidium poeyanum (d'Orbigny)
(Pl. XIV, Fig. 3)

1839, *Polystomella poeyana* d'Orbigny, in Ramon de la Sagra, Hist. Fis. Pol. Nat. Cuba, Foraminifères, p. 55, pl. 6, figs. 25-26.
1958, Drooger and Kaasschieter, Verh. Kon. Ned. Ak. v. Wet., Afd. Natuurk., eerste reeks, Deel XXII, p. 43, map 14.

In our Holocene samples the frequency of this species ascends to 20%. Phleger (1956) found living specimens between 7 and 44 m.

Rosalina floridana (Cushman)
(Pl. XIII, Fig. 3)

1922, *Discorbis floridana* Cushman, Carnegie Inst. Washington, Publ. 311, p. 39, pl. 5, fig. 11-12.
1958, *Discorbis floridana* Cushman, Drooger and Kaasschieter, Verh. Kon. Ned. Ak. v. Wet., Afd. Natuurk., eerste reeks, Deel XXII, p. 42, pl. 2, fig. 6.

In our Holocene samples frequencies of this form reaches 3%. Phleger (1956) found living species occasionally at 10 to 24 m.

Eponides repandus (Fichtel and Moll)
(Pl. XIV, Fig. 2)

1803, *Nautilus repandus* Fichtel and Moll, Test. Micr., p. 35, pl. 3, fig. a-d.
1958, Drooger and Kaasschieter, Verh. Kon. Ned. Ak. v. Wet., Afd. Natuurk., eerste reeks, Deel XXII, p. 46, pl. 2, fig. 8-9.

In our Holocene samples the frequency of this species varies a great deal; at 12.25 m. it is 3%, at 15.00 m. 26% and at 16.25 m. 2%. Phleger and Parker (1951) report this species as occurring in calcareous areas with depths ranging between 1 and 170 m. Drooger and Kaasschieter (1958) found frequencies up to 6% between 20 and 40 m.

Cibicides (Hanzawaia) concentricus (Cushman)
(Pl. XIII, Fig. 4)

1918, *Truncatulina concentrica* Cushman, U.S. Geol. Survey, Bull. 676, p. 64, pl. 21, fig. 3.
1958, Drooger and Kaasschieter, Verh. Kon. Ned. Ak. v. Wet., Afd. Natuurk., eerste reeks, Deel XXII, p. 49, map 17.

In our richest sample from 12.25 m. we found a percentage of 5%. The other two samples did not contain this species.

Globigerina bulloides d'Orbigny
(Pl. XIII, Fig. 8)

1826, d'Orbigny, Ann. Sci. Nat., vol. 7, p. 277, no. 1; Modèles, no. 76, no. 17 (juv.).

As the sedimentation took place in an inner shelf environment this planctonic species has most probably been derived. It occurs in insignificant quantities.

Globigerinoides cyclostoma (Galloway and Wissler)
(Pl. XIII, Fig. 9)

1927, *Globigerina cyclostoma* Galloway and Wissler, Journ. Pal., Vol. 1, p. 42, pl. 7, fig. 8-9.

These forms are most probably derived from the open ocean.

Ammonia beccarii (Linnaeus)
(Pl. XV, Fig. 1)

1758, *Nautilus beccarii* Linnaeus, Syst. Nat., e.d. 10, p. 710.
1958, Drooger and Kaasschieter, Verh. Kon. Ned. Ak. v. Wet., Afd. Natuurk., eerste reeks, Deel XXII, p. 67, map 29.

This species occurs only in our sample from 12.25 m. at a frequency of 5%. P h l e g e r (1956) found this species in abundant quantities at 4-37 m. with an average frequency of 10-25% (both living and dead).

Ammonia tepida (Cushman)
(Pl. XV, Fig. 4)

1926, *Rotalia beccarii* (Linnaeus) var. *tepida* Cushman, Carnegie Inst. Washington, Publ. no. 344 (Dept. Marine Biol., Papers, vol. 23), p. 79, pl. 1.

This is the most abundant species of our three Holocene samples with a rate of frequency between 32 and 54%. According to P h l e g e r and P a r k e r (1951) this form was found at 2 to 9 m. in the West Indian region.

Ammonia sobrina (Shupack)
(Pl. XV, Fig. 3)

1934, *Rotalia beccarii* (Linnaeus) var. *sobrina* Shupack, Am. Mus. Nat. Hist., Novitates, New York, N.Y., U.S.A., no. 737, p. 6, pl. 9, fig. 4a-c.

This species occur in all our three Holocene samples with frequencies up to 7%.

Ammonia sarmientoi (Redmond)
(Pl. XV, Fig. 2)

1953, *Rotalia sarmientoi* Redmond, Journ. Pal., vol. 27, p. 726, pl. 76, fig. 11.
1958, Drooger and Kaasschieter, Verh. Kon. Ned. Ak. v. Wet., Afd. Natuurk., eerste reeks, Deel XXII, p. 69, map 31.

This species occurs in one of our Holocene samples from a depth of 15 m. with a rate of 4%.

Ecology

A standard amount of 50 gr. of the two following core-samples was used. These samples were washed, sieved, and afterwards treated with carbon tetrachloride, for the purpose of getting a rough estimate of the actual occurrence of the Foraminifera.

Occurrences of species are listed below as percentages of the total populations (faunal diversity).

Sample from 12.25 m.	Number of Foraminifera per 50 grams	%
Ammonia sobrina	12	5
Ammonia beccarii	12	5
Ammonia tepida	75	33
Elphidium poeyanum	39	16
Quinqueloculina lamarckiana	21	9
Quinqueloculina compta	21	9
Nonionella atlantica	19	8
Globigerina bulloides	7	3
Cibicides (Hanzawaia) concentricus	11	5
Rosalina floridana	3	1
Eponides repandus	6	3
Reussella atlantica	3	1
Globigerinoides cyclostoma	4	1
Uvigerina proboscidea	1	–
Lagena striata	2	1
	236	100

Sample from 15.00 m.

Eponides repandus	79	26
Ammonia sarmientoi	13	4
Ammonia tepida	161	54
Ammonia sobrina	4	1
Elphidium poeyanum	11	4
Globigerina bulloides	1	–
Globigerinoides cyclostoma	1	–
Nonionella atlantica	9	3
Quinqueloculina lamarckiana	6	2
Quinqueloculina compta	8	3
Rosalina floridana	3	1
Lagena striata	1	–
	297	98

It is evident that these faunal associations placed under the heading of the most dominant genus and defined in terms of the two (or three) next common genera gives a faunal diversity called the *Ammonia-, Nonionella-, Elphidium*-group. This means a depth of 2-10 fathoms. Most probably *Eponides repandus, Globigerina bulloides, Globigerinoides cyclostoma, Uvigerina proboscidea* and *Reussella atlantica* are derived from other environments.

The Holocene fauna of our three samples consists of about 10 species. According to W a l t o n (1964) 100% of all faunas with less than 20 benthonic species occur in water shallower than 10 fathoms, which is in very good accordance with the faunal diversity mentioned above. Further W a l t o n (1964) states that 100% of all faunas whose dominant species constitutes over 35% of the entire fauna occur shallower than 10 fathoms. As the percentage of *Ammonia* in our samples is higher than 35% (43, 59 and 51), we may conclude that the faunal characteristics given by Walton indeed seem to point to a depth of water of less than 10 fathoms.

II PALEOCENE FORAMINIFERA

Systematic description

Haplophragmoides cf. *H. carinatum* Cushman and Renz (Pl. I, Fig. 2)

1941, Cushman and Renz, Contr. Cushm. Lab. Foram. Res., vol. 17, p. 2, pl. 1, fig. 1.

Only two rather badly preserved specimens. The specific determination is not certain.

Haplophragmoides sp. (Pl. I, Fig. 3)

Only two badly preserved specimens.

Ammobaculites cf. *A. expansus* Plummer (Pl. I, Fig. 1)

1933, Plummer, Texas Univ. Bull. 3201, p. 65, pl. 5, fig. 4-6.

Only a few badly preserved specimens were found. The specific determination is not certain.

Trochammina triloba n. sp. (Pl. I, Fig. 4, 5)

Description

Test small, spiral, slightly trochoid, more or less distinctly triangular, three chambers in each whorl, all visible from the spiral side; wall finely arenaceous; aperture an elongate slit at the base of the youngest chamber; colour yellowish grey. Size: diameter up to 0.38 mm.; thickness up to 0.08 mm. Holotypes: F 4114; Paratypoide: F 4114[a]; Locus typicus: well Alliance 28, Dutch Guiana; Stratum typicum: Paleocene.

Valvulina triangularis d'Orbigny (Pl. II, Fig. 1)

1826, d'Orbigny, Ann. Sci. Nat., vol. 7, p. 270, no. 1.

1960, Drooger, Proc. Kon. Ned. Ak. v. Wet., series B, 63, no. 4, p. 451, pl. 1, fig. 1.

Only a few partly broken specimens.

Valvulina pupa d'Orbigny (Pl. II, Fig. 2)

1826, d'Orbigny, Ann. Sci. Nat., vol. 7, p. 270, no. 2.

1960, Drooger, Proc. Kon. Ned. Ak. v. Wet., series B, 63, no. 4, p. 452, pl. 1, fig. 2.

Only two badly preserved specimens.

Quinqueloculina cf. *Q. laevigata* d'Orbigny (Pl. II, Fig. 6)

1839, d'Orbigny, Foraminifères des Iles Canaries. In: Hist. Nat. des Iles Canaries par MM. P.

Barker-Webb et Sabin Berthelot. Bethune, Paris, tome 2, pt. 2, Zool., p. 143, pl. 3, fig. 31-33.

Only the calcitic internal mould of two specimens.

Triloculina sp. 1
(Pl. II, Fig. 3)

Many calcitic internal moulds at 270.50 m. and a few at 306.65 m.

Triloculina sp. 2
(Pl. II, Fig. 4)

Many calcitic internal moulds at 270.50 m.

Triloculina sp. 3
(Pl. II, Fig. 5)

Many calcitic internal moulds at 270.50 m. and a few at 306.65 m.

Lenticulina (Marginulinopsis) sp. 1
(Pl. III, Fig. 2)

A few specimens at a depth of 270.50 m.

Lenticulina (Marginulinopsis) sp. 2
(Pl. III, Fig. 3)

Two specimens at a depth of 270.50 m.

Vaginulina sp.
(Pl. III, Fig. 4)

Only one specimen at a depth of 307.50 m.

Lagena sp.
(Pl. III, Fig. 1)

One specimen at a depth of 284.50 m.

Guttulina hantkeni Cushman and Ozawa
(Pl. III, Fig. 5)

1930, Cushman and Ozawa, U.S. Nat. Mus. Proc., vol. 77, art. 6, p. 33, pl. 5, fig. 4-6.

A few specimens at a depth of 307.50 m.

Guttulina problema d'Orbigny
(Pl. III, Fig. 7)

1826, d'Orbigny, Ann. Sci. Nat., vol. 7, p. 266, No. 14.

A few specimens at a depth of 307.50 m.

Guttulina trigonula (Reuss)
(Pl. III, Fig. 6)

1845, *Polymorphina (Guttulina) trigonula* Reuss, die Versteinerungen der böhmischen Kreideformation, Stuttgart, Deutschland, E. Schweizerbart, Abth. 1, p. 40, pl. 13, fig. 84.

1946, Cushman and Renz, Contr. Cushm. Lab. Foram. Res., Spec. Publ. 18, p. 34, pl. 5, fig. 20.

Two specimens at a depth of 261.20 m.

Guttulina wilcoxensis Cushman and Ponton
(Pl. IV, Fig. 1)

1932, Cushman and Ponton, Contr. Cushm. Lab. Foram. Res., vol. 8, pt. 3, p. 60, pl. 8, fig. 1-2.

A few specimens at a depth of 307.50 m., and one at 321.80 m.

Globulina gibba d'Orbigny
(Pl. IV, Fig. 2)

1826, d'Orbigny, Ann. Sci. Nat., vol. 7, p. 266, No. 10, Modèles 63.

One or a few specimens at different depths.

Pyrulina sp.
(Pl. IV, Fig. 3)

Two specimens at a depth of 307.50 m.

Nonion grateloupi (D'Orbigny)
(Pl. IX, Fig. 4)

1826, d'Orbigny, Ann. Sci. Nat., vol. 7, p. 294, No. 19.

Two specimens at a depth of 310.00 m.

Nonion kooteni n. sp.
(Pl. X, Fig. 1, 2)

Description

Test small, slightly longer than broad; 9 to 11

narrow chambers, periphery acute and more or less lobulate, sutures distinct, slightly curved, wall coarsely perforated, apertural face distinctly triangular, aperture a narrow slit at the base of the apertural face. Dimensions of the holotype; length: 0.30 mm., breadth: 0.22 mm., thickness: 0.10 mm.

Discussion

The dimension is small for the genus. Moreover it is not exactly bilaterally symmetric, but it does not belong to the genus Nonionella. It has some affinity to *N. fayoumensis* Ansary from the Eocene of Egypt, but it is distinctly of a smaller dimension, possesses fewer chambers, does not posses a swollen projection in the umbilical region, and is coarsely perforated. This species has been named after Mr. C. van Kooten, former Director of the Petrographical, Mineralogical Institute of the Geological Survey of Dutch Guiana (Surinam).

Holotypus: F 4112; Paratypoide: F 4112[a]; Locus typicus: Well Alliance 28, Dutch Guiana; Stratum typicum: Paleocene.

Buliminella compacta n. sp.
(Pl. IV, Fig. 4, 5)

Description

Test very small, composed of about two and a half whorls, increasing very rapidly in size as added, initial end bluntly rounded, greatest width at the youngest chamber; chambers 7-8 in the youngest whorl, very slightly inflated, increasing gradually in size as added, apertural face concave; sutures distinct, very slightly depressed: aperture a rather broad slit near the base of the apertural face. Length: 0.18-0.23 mm; diameter: 0.15-0.23 mm.

Discussion

The individuals of this new species are in a rather bad state of preservation; the species resembles *B. peruviana* Cushman and Stone (Contr. Cushm. Lab. Foram. Res., Spec. Publ. 20, p. 12, pl. 2, fig. 7-9, 1947) from the Eocene Chira shale in NW Peru, but it is of a smaller dimension, and distinctly lower conoidal.

Holotypus: F 4113; Paratypoide: F 4113[a]; Locus typicus: Well Alliance 28, Dutch Guiana; Stratum typicum: Paleocene.

Rosalina midwayensis (Cushman) var. *soldadoensis* (Cushman and Renz)
(Pl. VIII, Fig. 5)

1942, Cushman and Renz, Contr. Cushm. Lab. Foram. Res., vol. 18, pt. 1, p. 10, pl. 3, fig. 4.

At 270.50 m. and 306.65 m. we found internal moulds consisting of calcite or pyrite which most probably belong to this species.

Eponides allianceae n. sp.
(Pl. V, Fig. 1, 2)

Description

Test small (up to 0.30 mm.), circular in outline, typically conoidal, spiral side almost flat, umbilical side rather high, conoidal. Peripheral margin sharply acute and distinctly lobate; chambers 4 or 5 in the youngest whorl, mostly 4, on the spiral side crescent, on the umbilical side chambers slightly inflated, sutures curved, distinctly depressed, umbilicus lacking. Aperture on the umbilical side, between the umbiliculus and the periphery under a narrow lip; wall smooth, rather coarsely perforated.

Discussion

This species possesses some affinity to *E. lunata* Brotzen from the Swedish Paleocene and to *E. monterelensis* Marie from the Upper Cretaceous of the Paris Basin (Campanian). Our species, however, is higher conoidal, and may specimens have 4 chambers instead of 5, in the youngest whorl.

Holotypus: F 4110; Paratypoide: F 4110[a]; Locus typicus: Well Alliance 28, Dutch Guiana; Stratum typicum: Paleocene.

Eponides elevatus (Plummer)
(Pl. V, Fig. 3)

1927, Plummer, Texas Univ. Bull. 2644, p. 142, pl. 11, fig. 1.

Only one partly broken specimen found at a depth of 306.65 m.

Eponides cf. *E. kirki* Bermudez
(Pl. V, Fig. 4)

1949, Cushm. Lab. Foram. Res., Spec. Publ., No. 25, p. 247, pl. 17, fig. 7-9.

Only one specimen found at a depth of 270.50 m. It resembles *E. kirki* from the Lower Eocene of Haiti.

Siphonina prima Plummer
(Pl. VI, Fig. 1, 2, 3)

1927, Plummer, Texas Univ. Bull. 2644, p. 148, pl. 12, fig. 4.
1960, Drooger, Proc. Kon. Ned. Ak. v. Wet., Series B, 63, No. 4, p. 452, pl. 1, fig. 4.

With *Boldia carinata, Anomalinoides midwayensis* and *A.* cf. *danica* one of the most frequent species throughout the profile.

Cancris cf. *C. claibornensis* Howe
(Pl. V, Fig. 5)

1939, Howe, Geol. Surv., Geol. Bull., New Orleans, La., U.S.A., no. 14, p. 78, pl. 10, fig. 20-21.

Only one whole, and ten partly broken specimens have been found.

Anomalinoides cf. *A. danica* Brotzen
(Pl. IX, Fig. 1)

1942, Brotzen, Sver. Geol. Unders., ser. C, no. 435, p. 31, textfig. 7:2.
1960, Drooger, Proc. Kon. Ned. Ak. v. Wet., Series B, 63, no. 4, p. 453, pl. 1, fig. 5.

This form is rather frequent throughout the profile, and abundant at 300.60 m. and 307.50 m.

Anomalinoides midwayensis (Plummer)
(Pl. IX, Fig. 2)

1926, *Truncatulina midwayensis*. Plummer, Texas Univ. Bull. 2644, p. 141, pl. 9, fig. 7, pl. 15, fig. 3.
1960, Drooger, Proc. Kon. Ned. Ak. v. Wet., Series B, 63, No. 4, p. 453, pl. 1, fig. 6-7.

This is, with *Boldia carinata*, the most abundant species throughout the profile. In the sample from 265.80 m. we counted in 50 gr. dry material 1543 specimens. (Total number of Foraminifera 4590 specimens).

Cibicides cf. *C. minusculus* Bermudez
(Pl. VIII, Fig. 3)

1949, Bermudez, Cushm. Lab. Foram. Res., Spec. Publ. 25, p. 303, pl. 26, fig. 28-30.

At 284.50 m. we found three specimens which show rather much resemblance to *C. minusculus* from the Oligo-Miocene of the Dominican Republic. Due to the bad state of preservation the specific determination is not certain.

Cibicides matanzasensis (Hadley)
(Pl. VII, Fig. 2)

1934, *Planulina matanzasensis*, Hadley, Bull. Amer. Pal., vol. 20, no. 70A, p. 27, pl. 4, fig. 1-3.

This form has been originally described from the Upper Oligocene of Cuba. Only a few specimens could be found.

Cibicides spp.
(Pl. VI, Fig. 4, 5, Pl. VII, Fig. 1, 4, 5, 6)

The genus Cibicides is not frequent in this profile. Some forms resemble *C. lobatulus* (Walker and Jacob), others show affinity to *C. concentricus* (Cushman) and to *C. browni* (Kline), and possibly one or two other forms.

Boldia carinata Cushman and Bermudez
(Pl. VIII, Fig. 1)

1948, Cushman and Bermudez, Contr. Cushm. Lab. Foram, Res., vol. 24, p. 75, pl. 11, fig. 11-13.
1960, Drooger, Proc. Kon. Ned. Ak. v. Wet., Series B, 63, No. 4, p. 454, pl. 1, fig. 9-13.

This is the most abundant species in our profile. In the sample from 265.80 m. we counted in 50 gr. dry material 2102 specimens, together with 1543 specimens of *Anomalina midwayensis*.

Boldia toeringae n. sp.
(Pl. VIII, Fig. 2, 3, 4)

Description

Test in the early stages trochoid, in the adult becoming almost planispiral, periphery in the adult becoming truncate, both spiral and umbilical sides somewhat concave; chambers inflated, 7 or 9 in a whorl, increasing gradually in size as added; on the spiral side they may end in a distinct spine; sutures distinct, curved, depressed; wall smooth, finely perforated on the umbilical side, with the exception of the umbilical region, which is more or less papillate, or may have little points; on the spiral side there is a

tendency to form little knots and spines at random; aperture badly exposed, probably a low opening at the peripheral margin, extending on to the spiral side. Diameter of the holotype 0.33 mm.; thickness: 0.14 mm.

Discussion

We found 27 specimens in the above-mentioned, very rich sample from 265.80 m., and a few at 269.25 m. This species has been named after my assistant Miss K. Toering, who was the first to recognise this form as a new one.

Holotypus: F 4111; Paratypoïde: F 4111[a]; Locus typicus: Well Alliance 28, Dutch Guiana; Stratum typicum: Paleocene.

Globorotalia centralis Cushman and Bermudez
(Pl. IX, Fig. 3)

1937, Cushman and Bermudez, Contr. Cushm. Lab. Foram. Res., vol. 13, pt. 1, p. 26, pl. 2, fig. 62-65.

We found two specimens at a depth of 270.50 m. This species was originally described from the middle Eocene of Cuba.

Rotalia cf. *R. hensoni* Smout
(Pl. X, Fig. 3, 4, 5)

We are not certain about the specific determination, due to the fact that the fissures radiating from the central granule are greater in number than figured in the holotype. If the specimens had shown dorsal pilars, we should determine them as *R. dukhani* Smout.

Rotalia hensoni was originally described by Smout (Publ. British Mus. Nat. Hist., p. 45, pl. 15, fig. 8, 1954) from the lower part of the Paleocene of Quatar (Arabia), and later by D r o o g e r (Proc. Kon. Ned. Ak. v. Wet., Series B, 63, No. 4, p. 458, pl. 2, fig. 1, 1960) from the "Basses Plains" of French Guiana.

Spirillina cf. *S. perforata* (Schultze)
(Pl. IV, Fig. 6)

1854, *Cornuspira perforata*, Über den Organismus der Polythalamien (Foraminiferen) nebst Bemerkungen über die Rhizopoden im allgemeinen, Leipzig, Deutschland, Engelmann, p. 41, pl. 2, fig. 22.

Only one specimen at a depth of 265.80 m.

Ranikothalia bermudezi (Palmer)
(Pl. XI, Fig. 2)

1934, *Operculina bermudezi*, Mem. Soc. Cub. Hist. Nat., vol. 8, p. 238, pl. 12, fig. 3, 6-9.

From 258.85-259.20 m., we found only the above-named species and *Storssella haastersi* with hardly any other species. Sachs (Contr. Cushm. Found. Foram. Res., vol. 8, pt. 3, 1957) published on p. 107 an exhaustive list of synonyms of these species.

Storssella haastersi (van den Bold)
(Pl. XII, Fig. 2)

1946, *Cibicides haastersi*, van den Bold, Thesis Utrecht, p. 125, pl. 18, fig. 9.

1960, Drooger, Proc. Kon. Ned. Ak. v. Wet., Series B, 63, No. 3, p. 296, pl. 1, fig. 10, pl. 2, fig. 1-12.

From 258.85-259.20 m. practically the entire fauna consists of this species and *Ranikothalia bermudezi*. It has been found in the Paleocene-Lower Eocene series of Guatemala, British Honduras and in the Paleocene of the "Basses Plaines" of French Guiana.

Smoutina cruysi Drooger
(Pl. XI, Fig. 3, Pl. XII, Fig. 1)

1960, Drooger, Proc. Kon. Ned. Ak. v. Wet., Series B, 63, No. 3, p. 307, pl. 4, fig. 1-13.

Only two badly preserved specimens found at a depth of 310 m. It was found by Drooger in the Paleocene "Basses Plaines" of French Guiana.

Lockhartia sp.
(Pl. XI, Fig. 1)

Only one badly preserved specimen at a depth of 310 m. together with *Smoutina cruysi*.

Ecology

The Paleocene is for the greater part marine, at least shallow marine, with a depth of water most probably not more than 20 m. but probably less.

This could be determined from data supplied by W a l t o n (1964). Considering the Foraminifera, we found that the number of species is very low and varies from 1 to 13 per sample. Walton found

empirically that 100% of all faunas with less than 20 species occurs in waters shallower than 20 m. (10 fathoms). He called this the *faunal diversity*. We can check this depth in another way with the *faunal dominance* of Walton. He found that 100% of all faunas whose dominant species constitutes over 35% of the entire fauna occurs shallower than 20 m. Most samples of the glauconitic marine Paleocene contain but a few Foraminifera. Some samples are rich in specimens, however. In the sample at 265.80 m., for instance, we found in 50 grams of dry sediment 4590 specimens distributed over not more than 10 species. There are 2102 specimens of the species *Anomalinoides midwayensis*. This means a percent dominance of 46%.

manuscript closed May 1966

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PALEOCENE

Explanation of Plate I

Fig. 1 – *Ammobaculites* cf. *A. expansus* Plummer. a, c, side views, b, apertural view, 75x
Fig. 2 – *Haplophragmoides* cf. *H. carinatum* Cushman and Renz, a, c, side views, b, apertural view, 100x
Fig. 3 – *Haplophragmoides* sp. a, c, side views, b, apertural view, 100x
Fig. 4 – *Trochammina triloba* n. sp. holotype, a, c, side views, b, apertural view, 100x
Fig. 5 – *Trochammina triloba* n. sp. paratypoid, a, c, side views, b, apertural view, 100x

Explanation of Plate II

Fig. 1 – *Valvulina triangularis* d'Orbigny, a, side view, b, apertural view, 75x
Fig. 2 – *Valvulina pupa* d'Orbigny, 75x
Fig. 3 – *Triloculina* sp. 1, a, apertural view, b, side view, 100x
Fig. 4 – *Triloculina* sp. 2, side view, 100x
Fig. 5 – *Triloculina* sp. 3, a, apertural view, b, side view, 100x
Fig. 6 – *Quinqueloculina* cf. *Q. laevigata* d'Orbigny, a, b, side views, 100x

Explanation of Plate III

Fig. 1 – Lagena sp., 100x
Fig. 2 – *Lenticulina (Marginulinopsis) sp. 1*, 100x
Fig. 3 – *Lenticulina (Marginulinopsis) sp. 2*, 100x
Fig. 4 – *Vaginulina* sp., a, apertural view, b, side view, 100x
Fig. 5 – *Guttulina hantkeni* Cushman and Ozawa, a, apertural view, b, side view, 100x
Fig. 6 – *Guttulina trigonula* (Reuss), 75x
Fig. 7 – *Guttulina problema* d'Orbigny, a, b, c, side views of different specimens, 100x

Explanation of Plate IV

Fig. 1 – *Guttulina wilcoxensis* Cushman and Ponton. a, b, c, side views of different specimens, 75x
Fig. 2 – *Globulina gibba* d'Orbigny, 100x
Fig. 3 – *Pyrulina* sp., 100x
Fig. 4 – *Buliminella compacta* n. sp., holotype, a, side view, b, apertural view, c, basal view, 100x
Fig. 5 – *Buliminella compacta* n. sp., paratypoid, a, side view, b, apertural view, c, basal view, 100x
Fig. 6 – *Spirillina* cf. *S. perforata* (Schultze), a, c, side views, b, apertural view, 100x

Explanation of Plate V

Fig. 1 – *Eponides allianceae* n. sp., holotype, a, umbilical view, b, peripheral view, c, spiral view, 100x
Fig. 2 – *Eponides allianceae* n. sp., paratypoid, a, umbilical view, b, peripheral view, c, spiral view, 100x
Fig. 3 – *Eponides elevatus* (Plummer), a, umbilical view, b,

spiral view, 75x
Fig. 4 – *Eponides* cf. *E. kirki* Bermudez, a, umbilical view, b, peripheral view, c, spiral view, 100x
Fig. 5 – *Cancris* cf. *C. claibornensis* Howe, a, umbilical view, b, peripheral view, c, spiral view, 100x

Explanation of Plate VI

Fig. 1 – *Siphonina prima* Plummer, flat form, a, umbilical view, b, peripheral view, c, spiral view, 100x
Fig. 2 – *Siphonina prima* Plummer, flat form, a, umbilical view, b, peripheral view, c, spiral view, 100x
Fig. 3 – *Siphonina prima* Plummer, thick form, a, umbilical view, b, peripheral view, c, spiral view, 100x
Fig. 4 – *Cibicides browni* (Kline), a, umbilical view, b, peripheral view, c, spiral view, 100x
Fig. 5 – *Cibicides concentricus* (Cushman), a, umbilical view, b, peripheral view, c, spiral view, 75x

Explanation of Plate VII

Fig. 1 – *Cibicides lobatulus* (Walker and Jacob), a, umbilical view, b, peripheral view, c, spiral view, 75x
Fig. 2 – *Cibicides matanzasensis* (Hadley), a, umbilical view, b, peripheral view, c, spiral view, 75x
Fig. 3 – *Cibicides* cf. *C. minusculus* Bermudez, a, umbilical view, b, peripheral view, c, spiral view, 75x
Fig. 4 – *Cibicides sp. 1,* a, umbilical view, b, peripheral view, c, spiral view, 75x
Fig. 5 – *Cibicides sp. 2,* a, umbilical view, b, peripheral view, c, spiral view, 75x
Fig. 6 – *Cibicides sp. 3,* a, umbilical view, b, peripheral view, c, spiral view, 75x

Explanation of Plate VIII

Fig. 1 – *Boldia carinata* Cushman and Bermudez, a, umbilical view, b, peripheral view, c, spiral view, 100x
Fig. 2 – *Boldia toeringae* n. sp., holotype, a, umbilical view, b, peripheral view, c, spiral view, 100x
Fig. 3 – *Boldia toeringae* n. sp., paratypoid, extreme spined form, a, umbilical view, b, peripheral view, c, spiral view, 100x
Fig. 4 – *Boldia toeringae* n. sp., paratypoid, a, umbilical view, b, peripheral view, c, spiral view, 75x
Fig. 5 – *Rosalina midwayensis* (Cushman) var. *soldadoensis* (Cushman and Renz), a, umbilical view, b, peripheral view, c, spiral view, 100x

Explanation of Plate IX

Fig. 1 – *Anomalinoides* cf. *A. danica* Brotzen, a, umbilical view, b, peripheral view, c, spiral view, 75x
Fig. 2 – *Anomalinoides midwayensis* (Plummer), a, umbilical view, b, peripheral view, c, spiral view, 100x
Fig. 3 – *Globorotalia centralis* Cushman and Bermudez, a, umbilical view, b, peripheral view, c, spiral view, 100x
Fig. 4 – *Nonion grateloupi* (d'Orbigny), a, c, side views, b, apertural view, 100x

Explanation of Plate X

Fig. 1 – *Nonion kooteni* n. sp., holotype, a, c, side views, b, apertural view, 100x
Fig. 2 – *Nonion kooteni* n. sp., paratypoid, a, c, side views, b, apertural view, 100x
Fig. 3 – *Rotalia* cf. *R. hensoni* Smout, a, umbilical view, b, peripheral view, c, spiral view, 75x
Fig. 4 – *Rotalia* cf. *R. hensoni* Smout, a, umbilical view, b, peripheral view, c, spiral view, 75x
Fig. 5 – *Rotalia* cf. *R. hensoni* Smout, a, umbilical view, b, peripheral view, c, spiral view, 75x

Explanation of Plate XI

Fig. 1 – *Lockhartia* sp., a, b, side views, 75x
Fig. 2 – *Ranikothalia bermudezi* (Palmer), a, c, side views, b, peripheral view, 25x
Fig. 3 – *Smoutina cruysi* Drooger, a, b, side views, 50x

Explanation of Plate XII

Fig. 1 – *Smoutina cruysi* Drooger, a, side view, b, c, peripheral views, 100x
Fig. 2 – *Storssella haastersi* (van den Bold), a, b, side views, c, peripheral view, 75x

HOLOCENE

Explanation of Plate XIII

Fig. 1 – *Quinqueloculina lamarckiana* d'Orbigny, a, apertural view, b, side view, 100x
Fig. 2 – *Quinqueloculina compta* Cushman, a, apertural view, b, side view, 100x
Fig. 3 – *Rosalina floridana* (Cushman), a, umbilical view, b, peripheral view, c, spiral view, 100x
Fig. 4 – *Cibicides (Hanzawaia) concentricus* Cushman, a, umbilical view, b, peripheral view, c, spiral view, 100x
Fig. 5 – *Lagena striata* (d'Orbigny), 100x
Fig. 6 – *Uvigerina proboscidea* Schwager, 100x
Fig. 7 – *Reussella atlantica* Cushman, a, apertural view, b, c, side views, 100x
Fig. 8 – *Globigerina bulloides* d'Orbigny, a, umbilical view, b, spiral view, 100x
Fig. 9 – *Globigerinoides cyclostoma* (Galloway and Wissler), a, umbilical view, b, spiral view, 100x

Explanation of Plate XIV

Fig. 1 – *Nonionella atlantica* Cushman, a, c, side views, b, apertural view, 100x
Fig. 2 – *Eponides repandus* (Fichtel and Moll), a, umbilical view, b, peripheral view, c, spiral view, 100x

Fig. 3 – *Elphidium poeyanum* (d'Orbigny), a, c, side views, b, apertural view, 100x

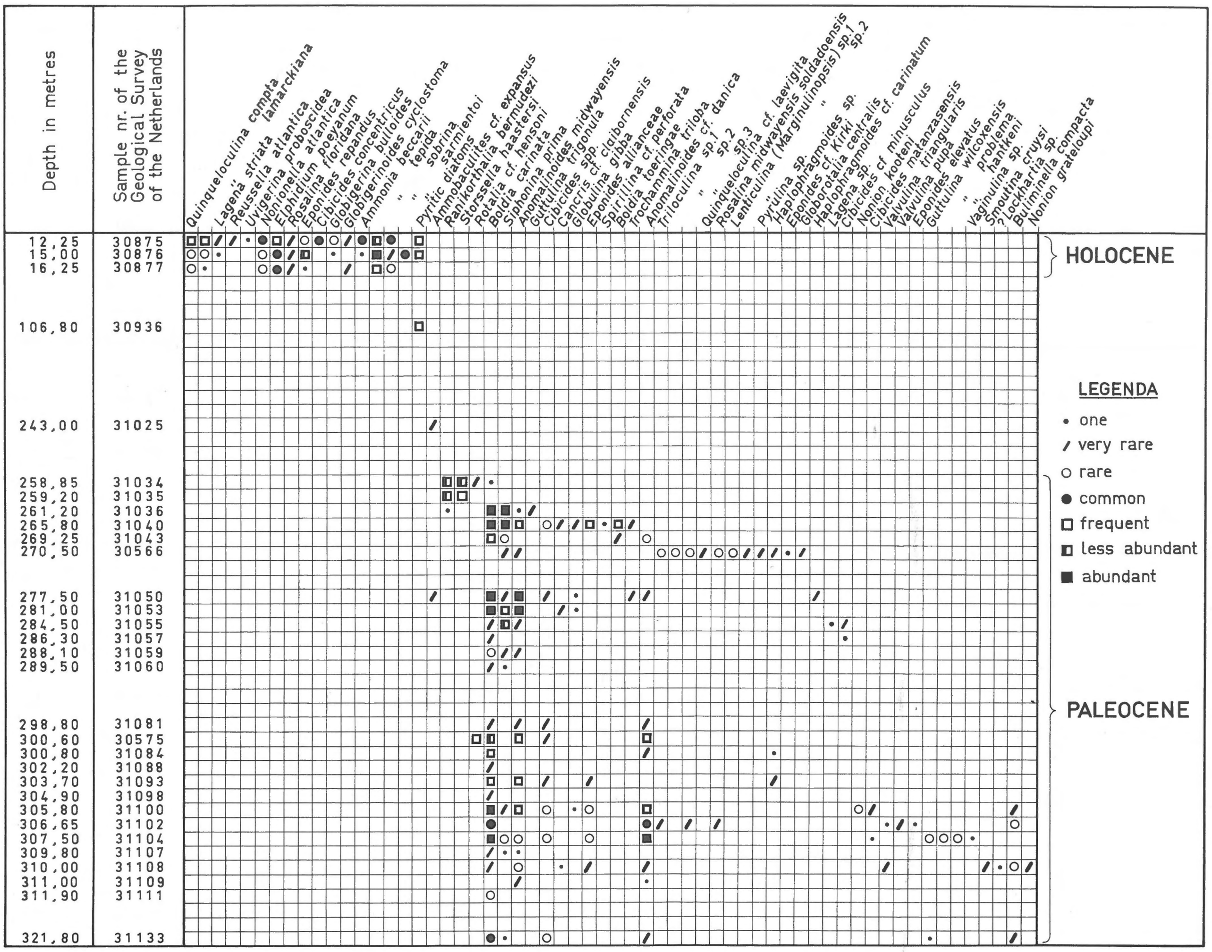
Explanation of Plate XV

Fig. 1 – *Ammonia beccarii* (Linnaeus), a, umbilical view, b, peripheral view, c, spiral view, 100x

Fig. 2 – *Ammonia sarmientoi* (Redmond), a, umbilical view, b, peripheral view, c, spiral view, 100x

Fig. 3 – *Ammonia sobrina* (Shupack), a, umbilical view, b, peripheral view, c, spiral view, 100x

Fig. 4 – *Ammonia tepida* (Cushman), a, umbilical view, b, peripheral view, c, spiral view, 100x


Depth in metres
Sample nr. of the Geological Survey of the Netherlands
Quinqueloculina compta
" lamarckiana
Lagena striata
Reussella atlantica
Uvigerina proboscidea
Nonionella atlantica
Elphidium poeyanum
Rosalina floridana
Eponides repandus
Cibicides concentricus
Globigerina bulloides
Globigerinoides cyclostoma
Ammonia beccarii
" tepida
" sobrina
" sarmientoi
Pyritic diatoms
Ammobaculites cf. expansus
Ranikorthalia bermudezi
Storssella haastersi
Rotalia cf. hensoni
Boldia carinata
Siphonina prima
Anomalinoides midwayensis
Guttulina trigonula
Cibicides spp.
Cancris cf. claibornensis
Globulina gibba
Eponides allianceae
Spirillina cf. perforata
Boldia toeringae
Trochammina triloba
Anomalinoides cf. danica
Triloculina sp.1
" sp.2
" sp.3
Quinqueloculina cf. laevigata
Rosalina midwayensis soldadoensis
Lenticulina (Marginulinopsis) sp.1
" sp.2
Pyrulina sp.
Haplophragmoides sp.
Eponides cf. kirki
Globorotalia centralis
Haplophragmoides cf. carinatum
Lagena sp.
Cibicides cf. minusculus
Nonion kooteni
Cibicides matanzasensis
Valvulina triangularis
Valvulina pupa
Eponides elevatus
Guttulina wilcoxensis
" problema
" hantkeni
Vaginulina sp.
Smoutina cruysi
?Lockhartia sp.
Buliminella compacta
Nonion grateloupi
12,25 30875
15,00 30876
16,25 30877
106,80 30936
243,00 31025
258,85 31034
259,20 31035
261,20 31036
265,80 31040
269,25 31043
270,50 30566
277,50 31050
281,00 31053
284,50 31055
286,30 31057
288,10 31059
289,50 31060
298,80 31081
300,60 30575
300,80 31084
302,20 31088
303,70 31093
304,90 31098
305,80 31100
306,65 31102
307,50 31104
309,80 31107
310,00 31108
311,00 31109
311,90 31111
321,80 31133
HOLOCENE
PALEOCENE
LEGENDA
• one
/ very rare
○ rare
● common
□ frequent
◧ less abundant
■ abundant

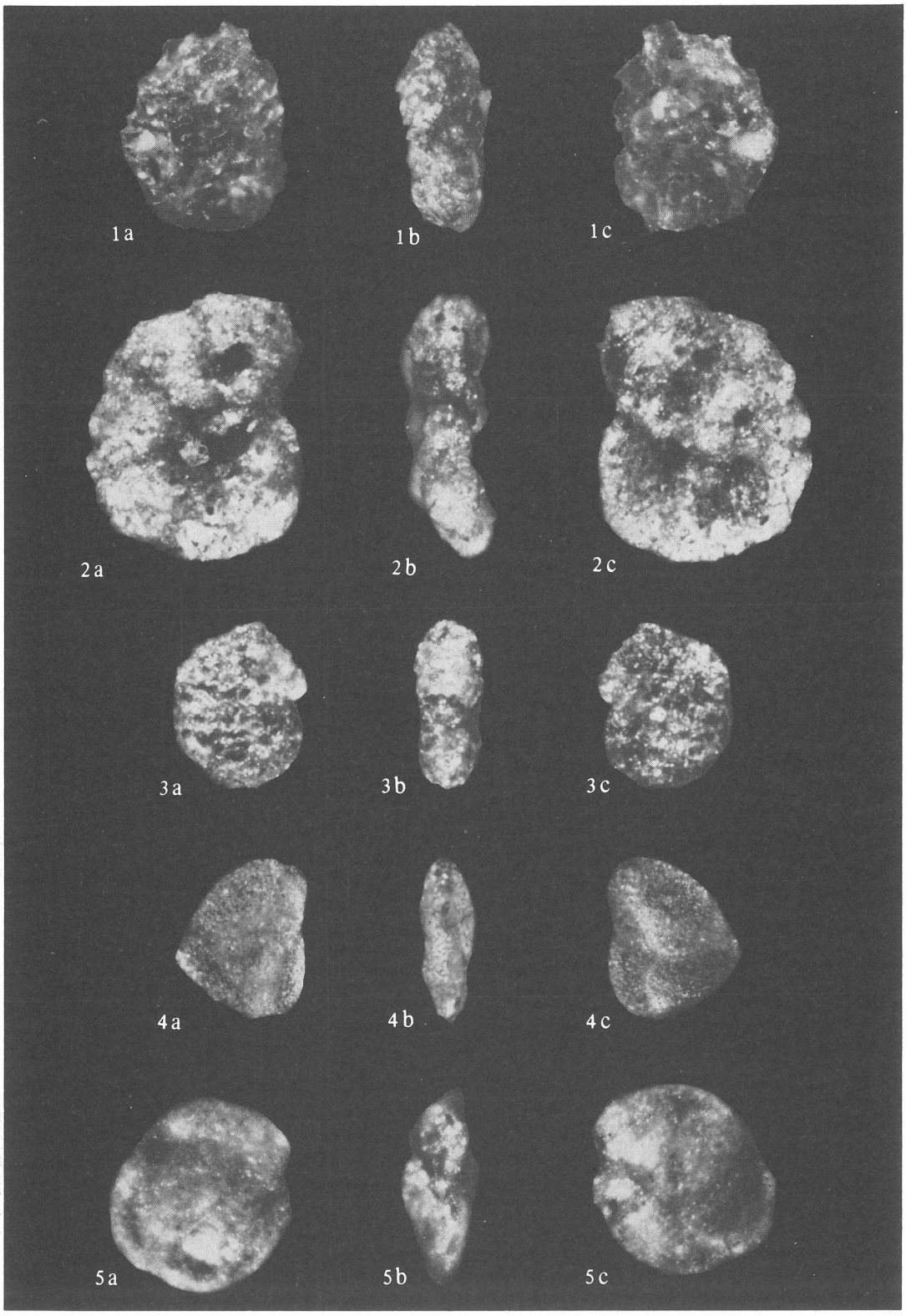


Plate I

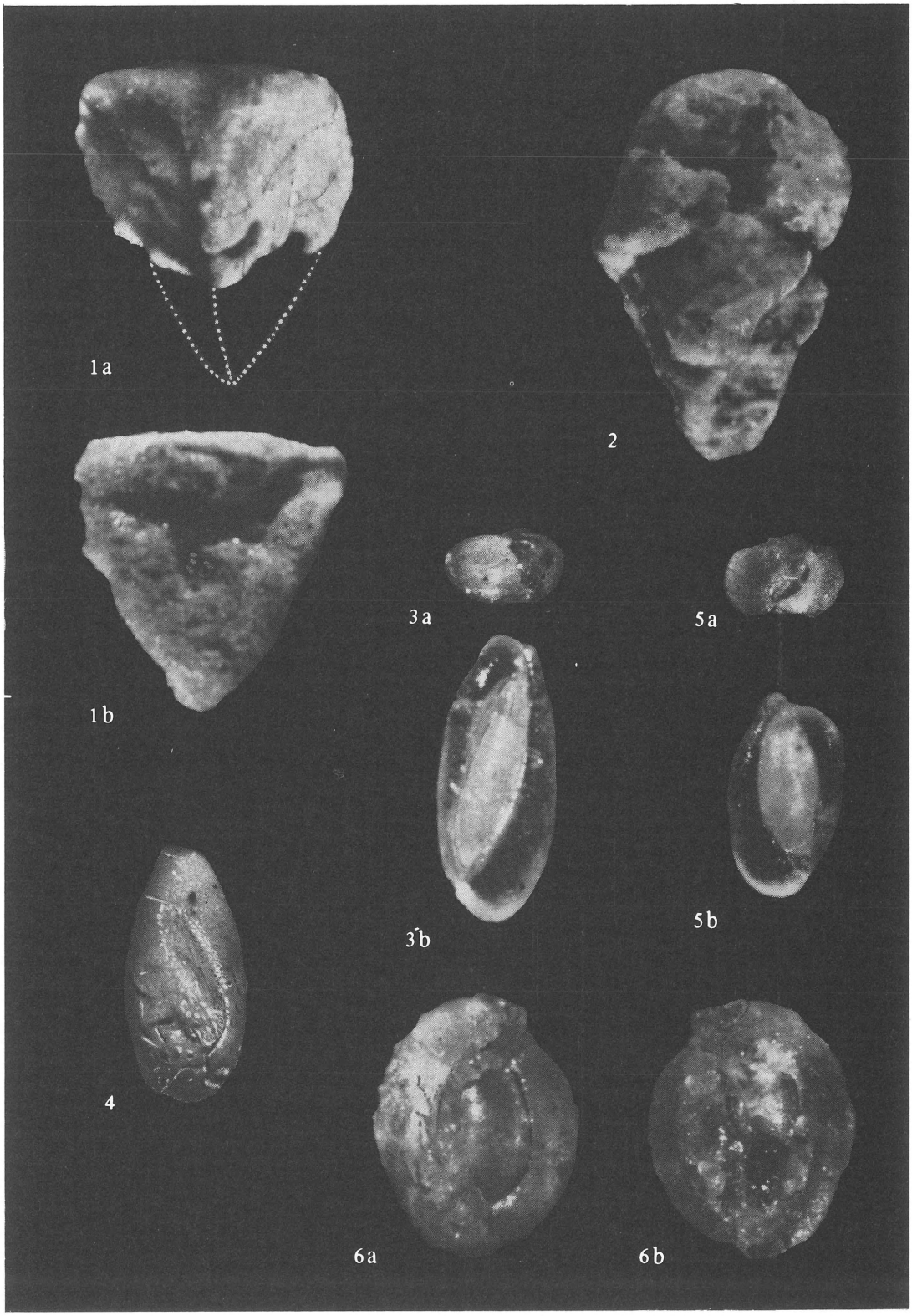


Plate II

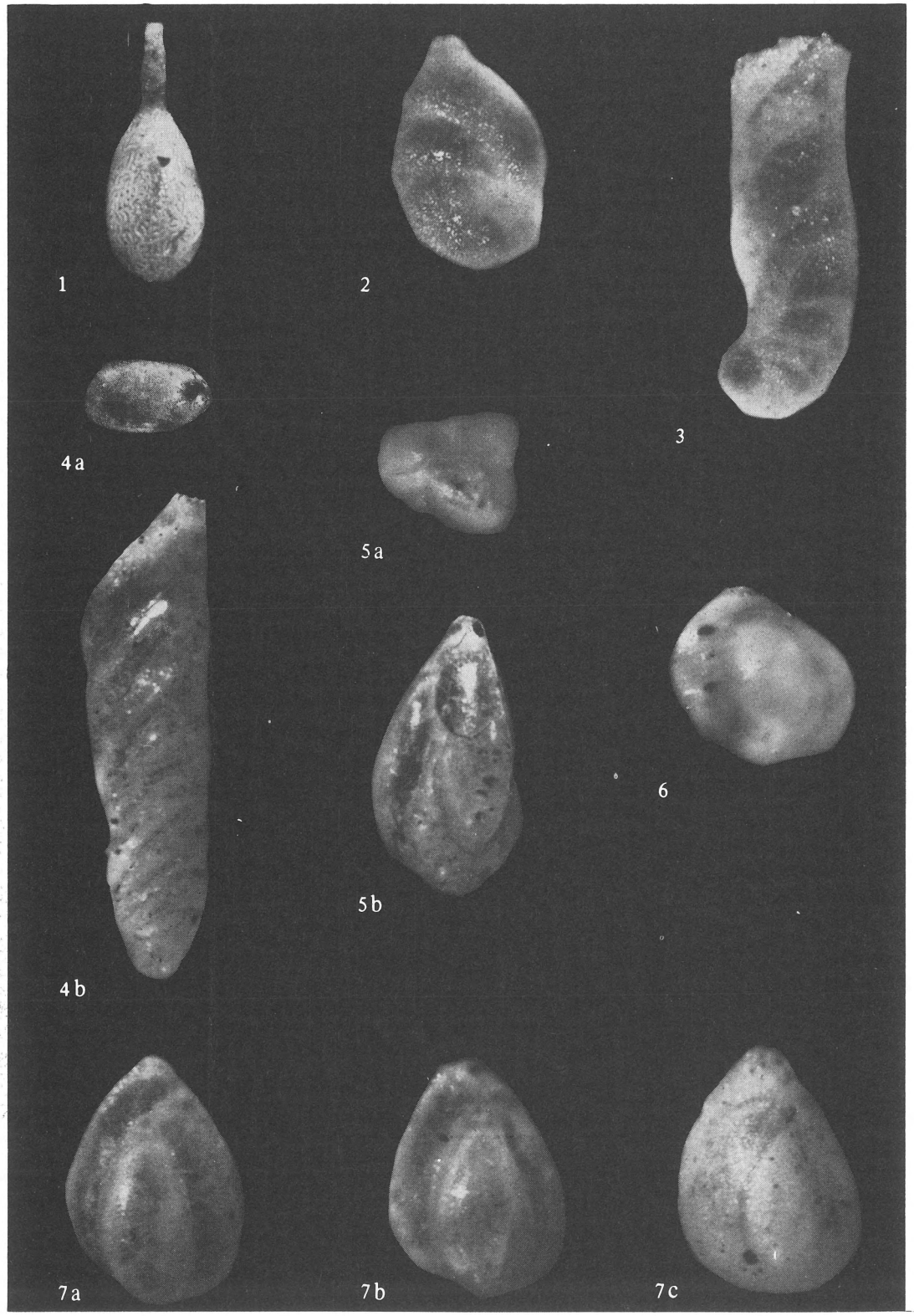


Plate III

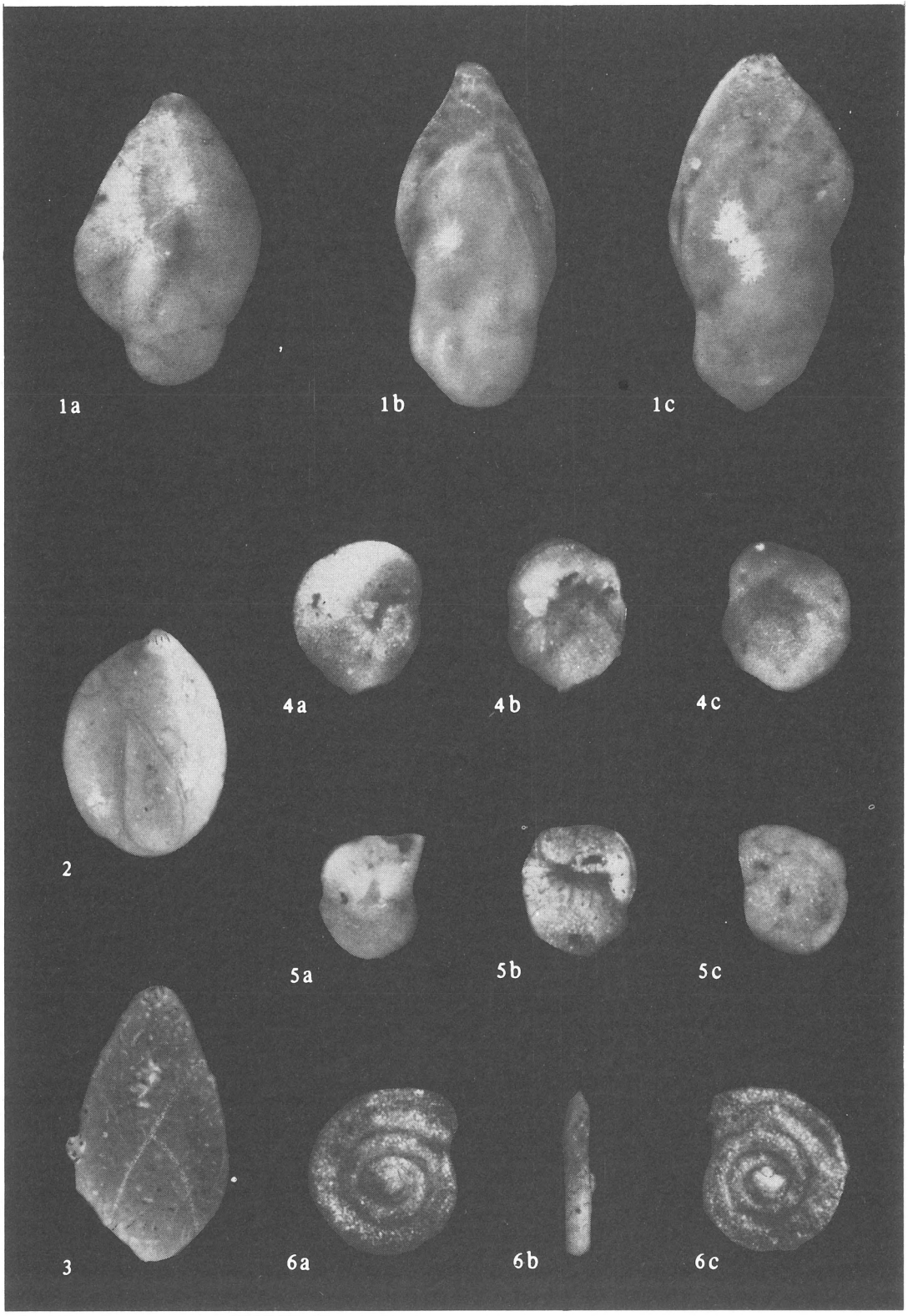


Plate IV

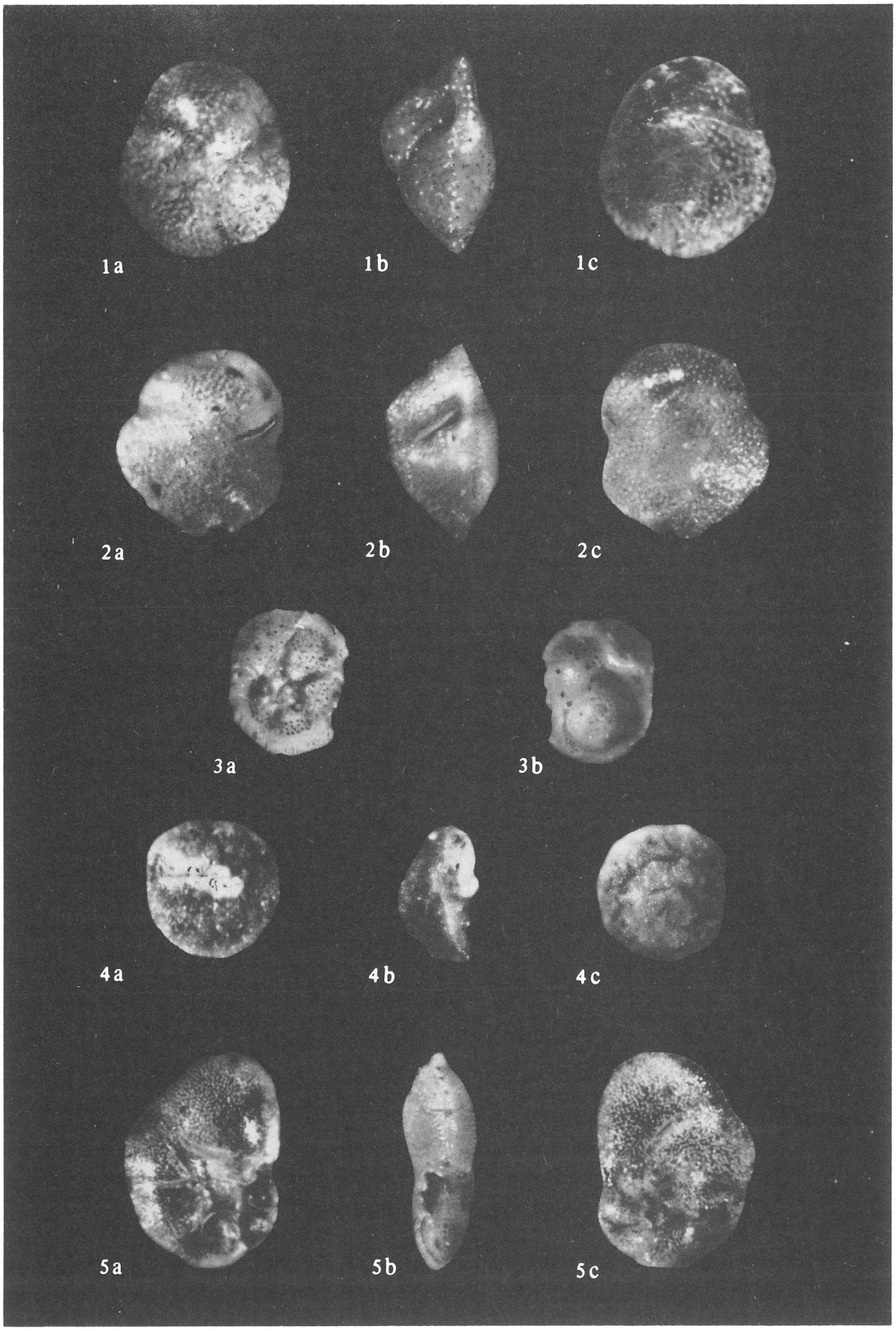


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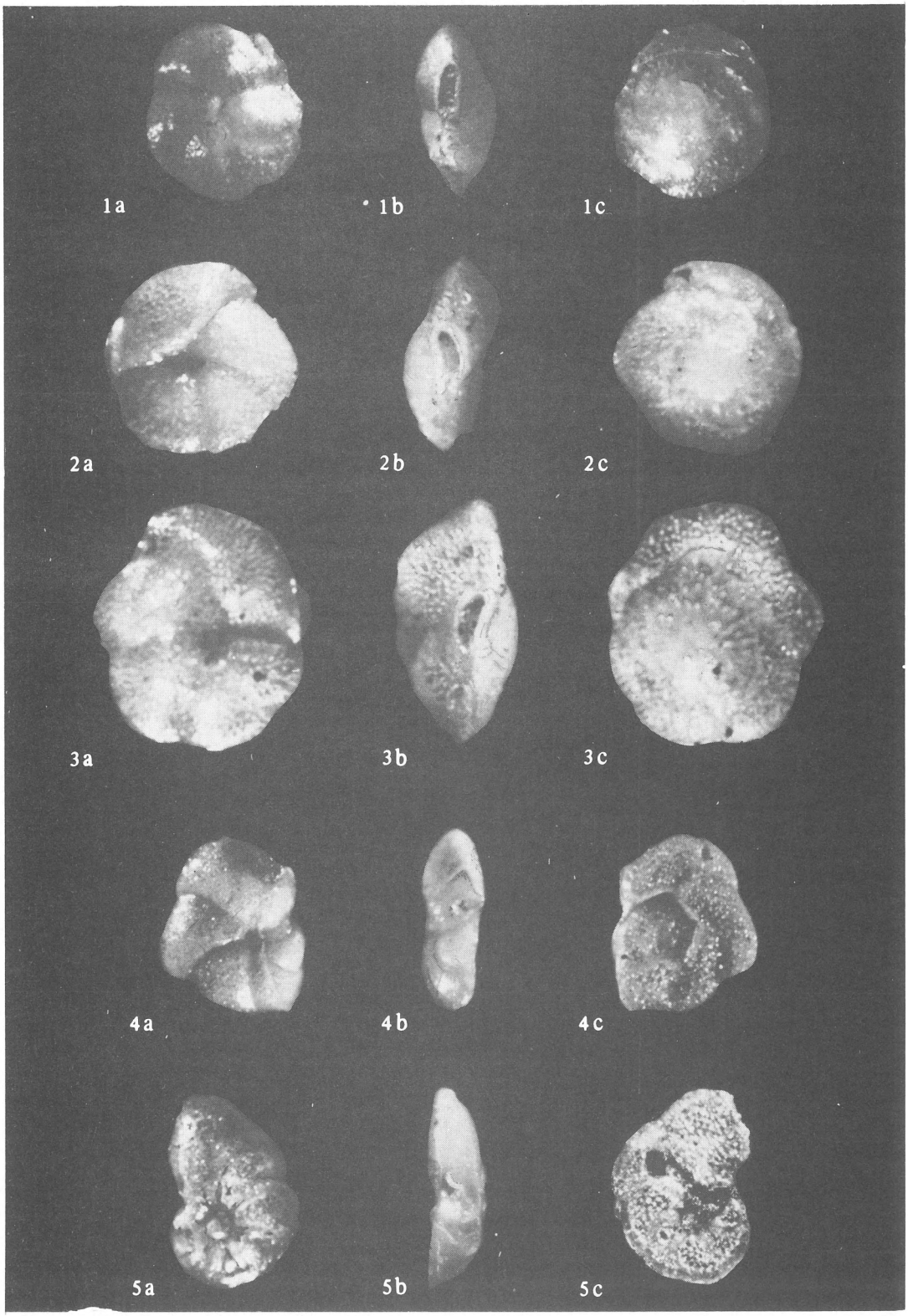


Plate VI

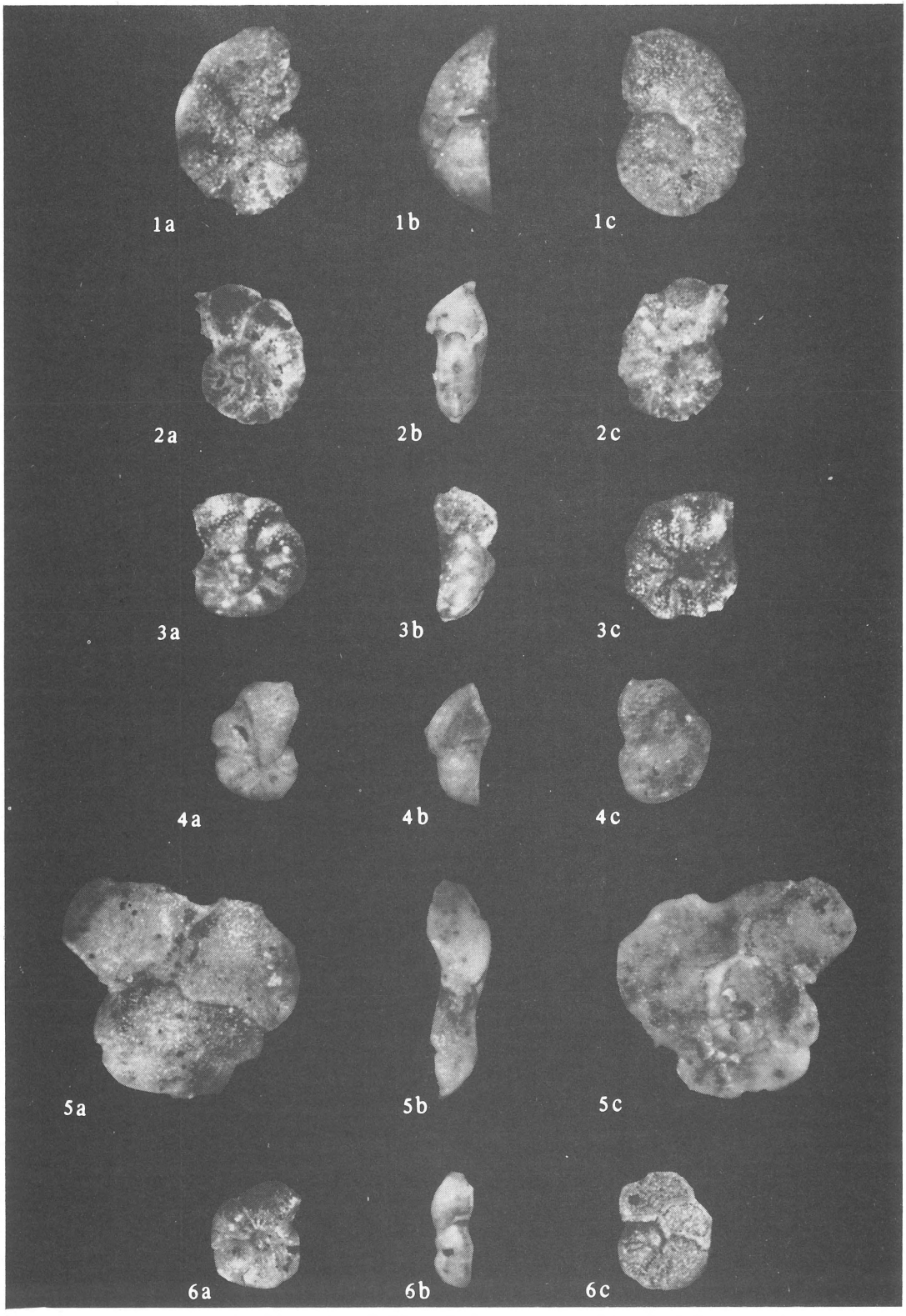


Plate VII

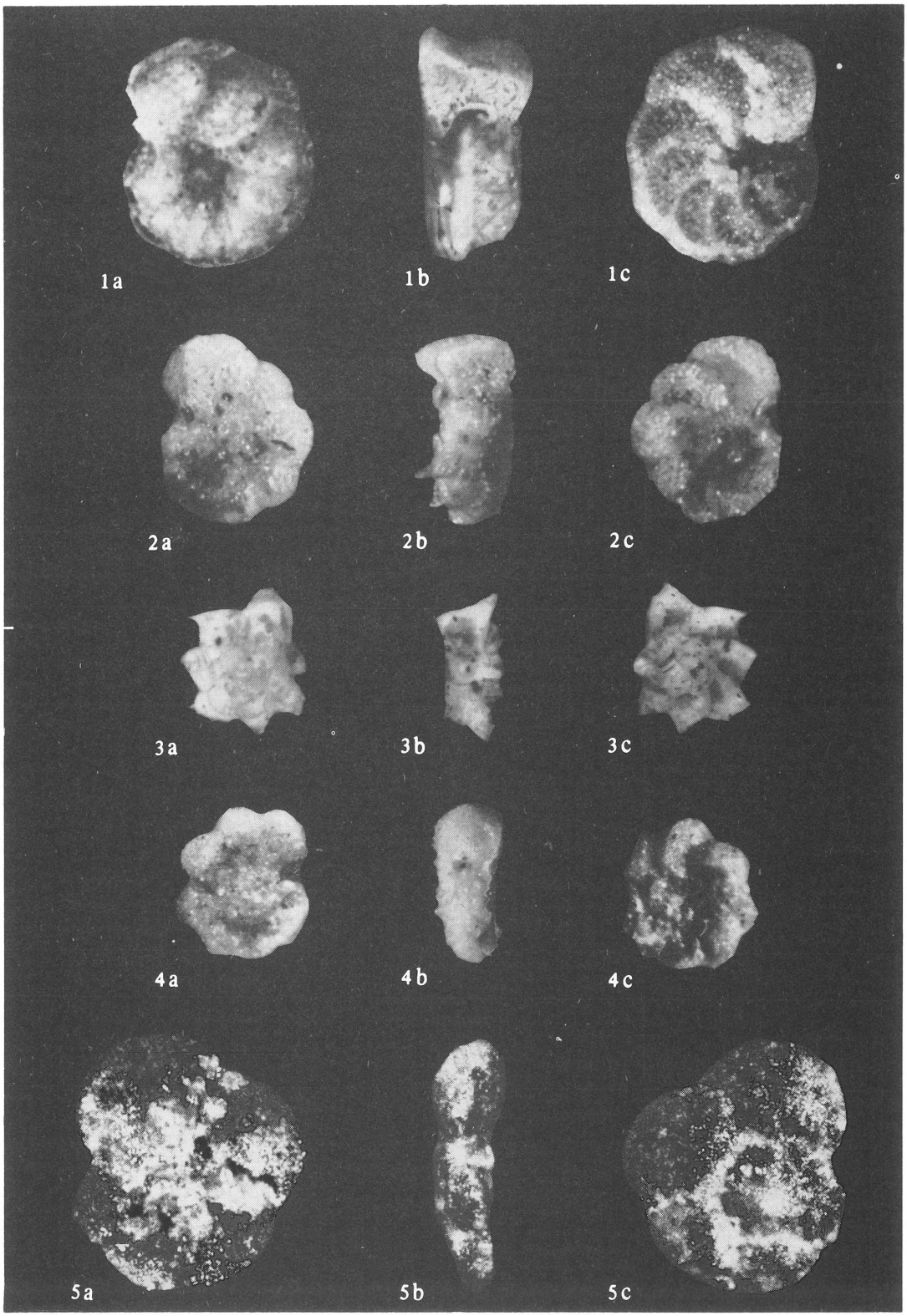


Plate VIII

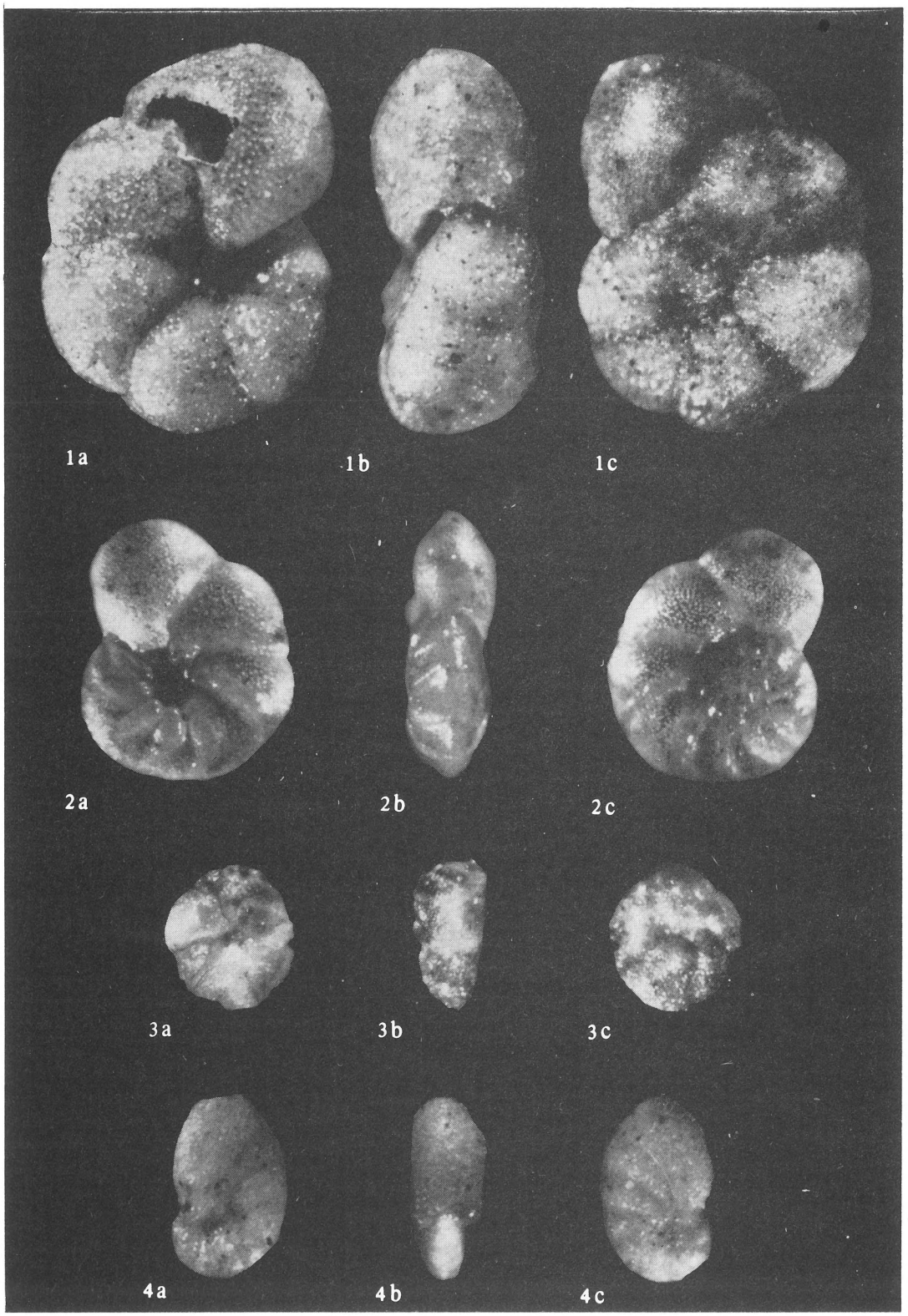


Plate IX

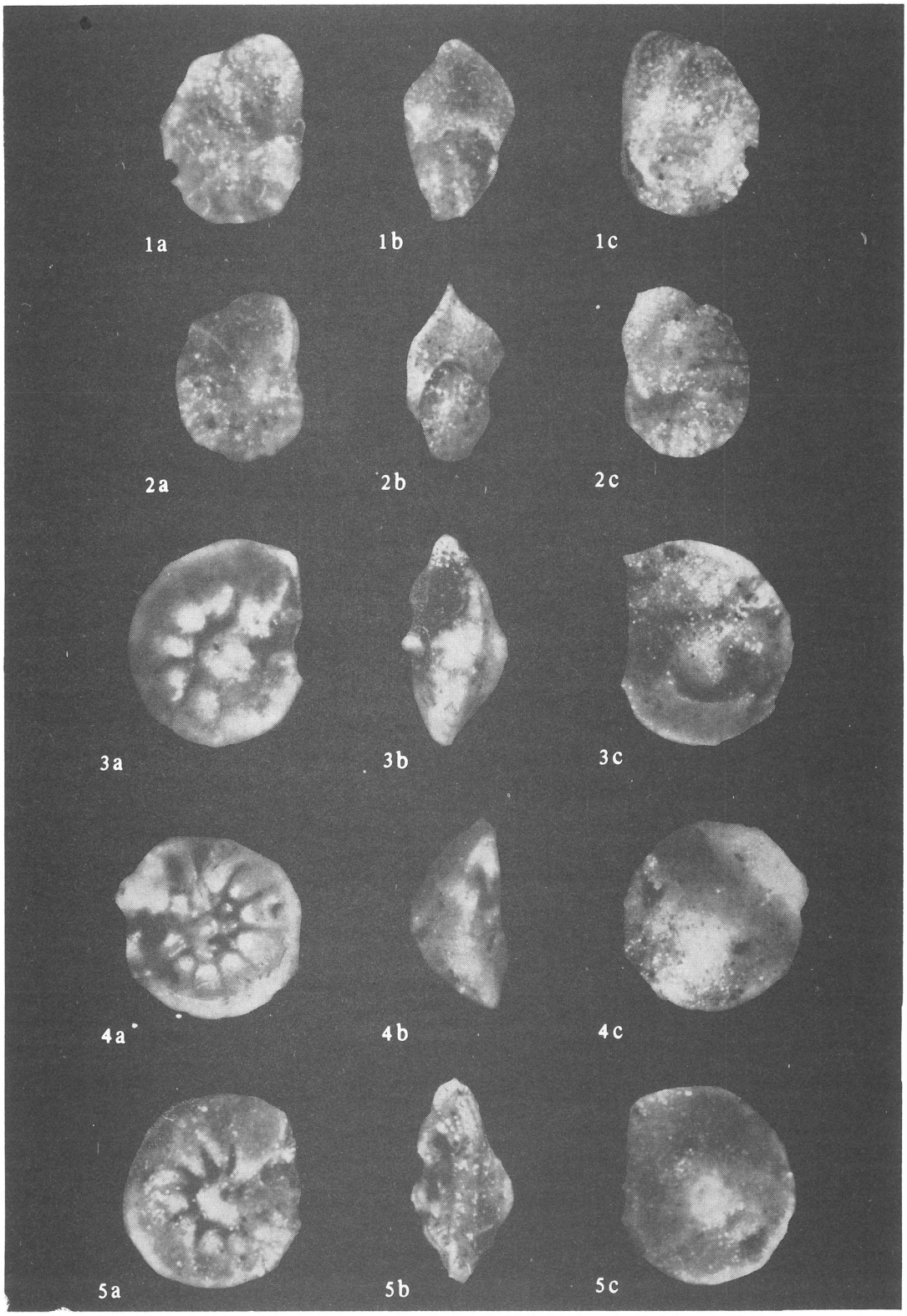


Plate X

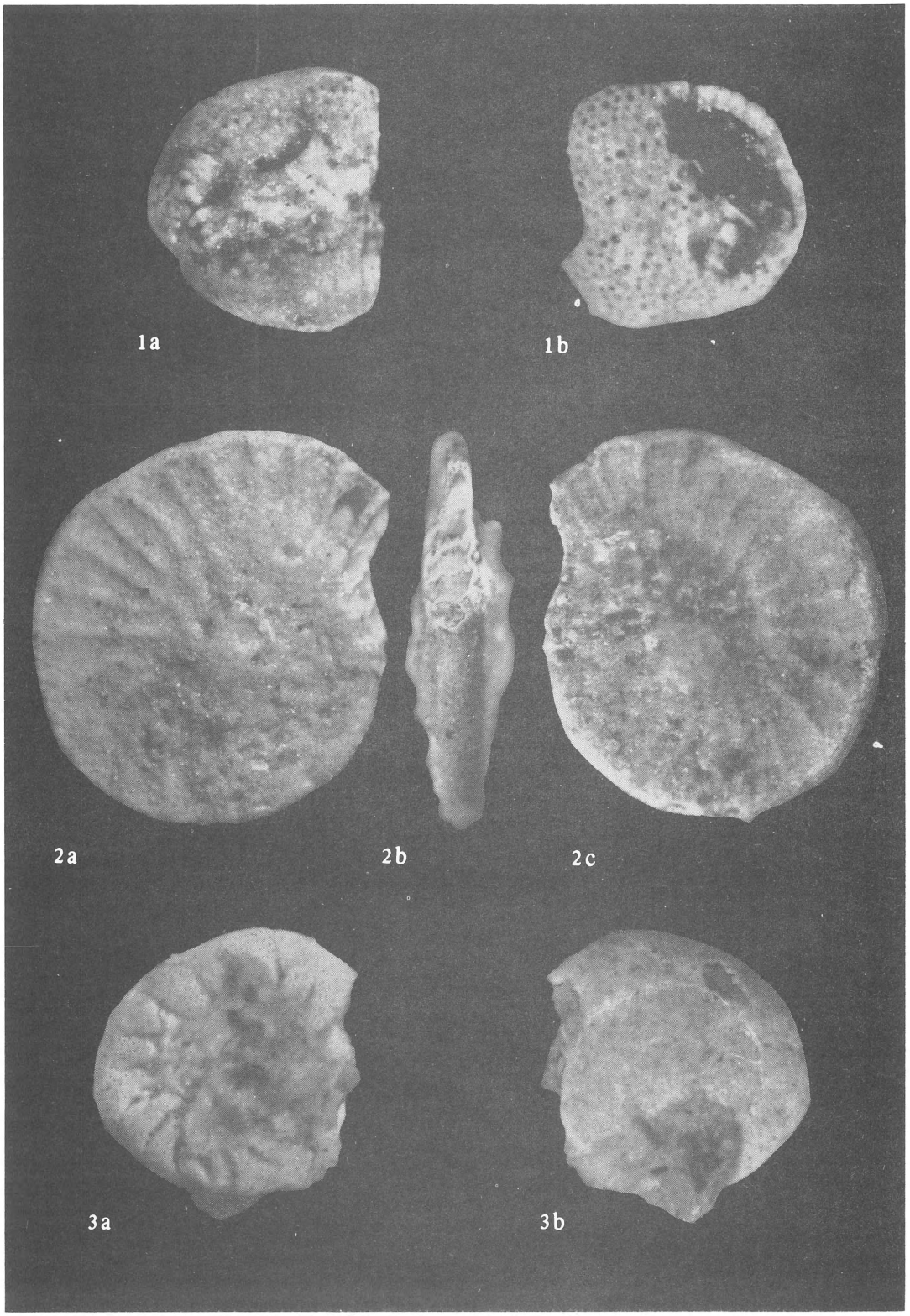


Plate XI

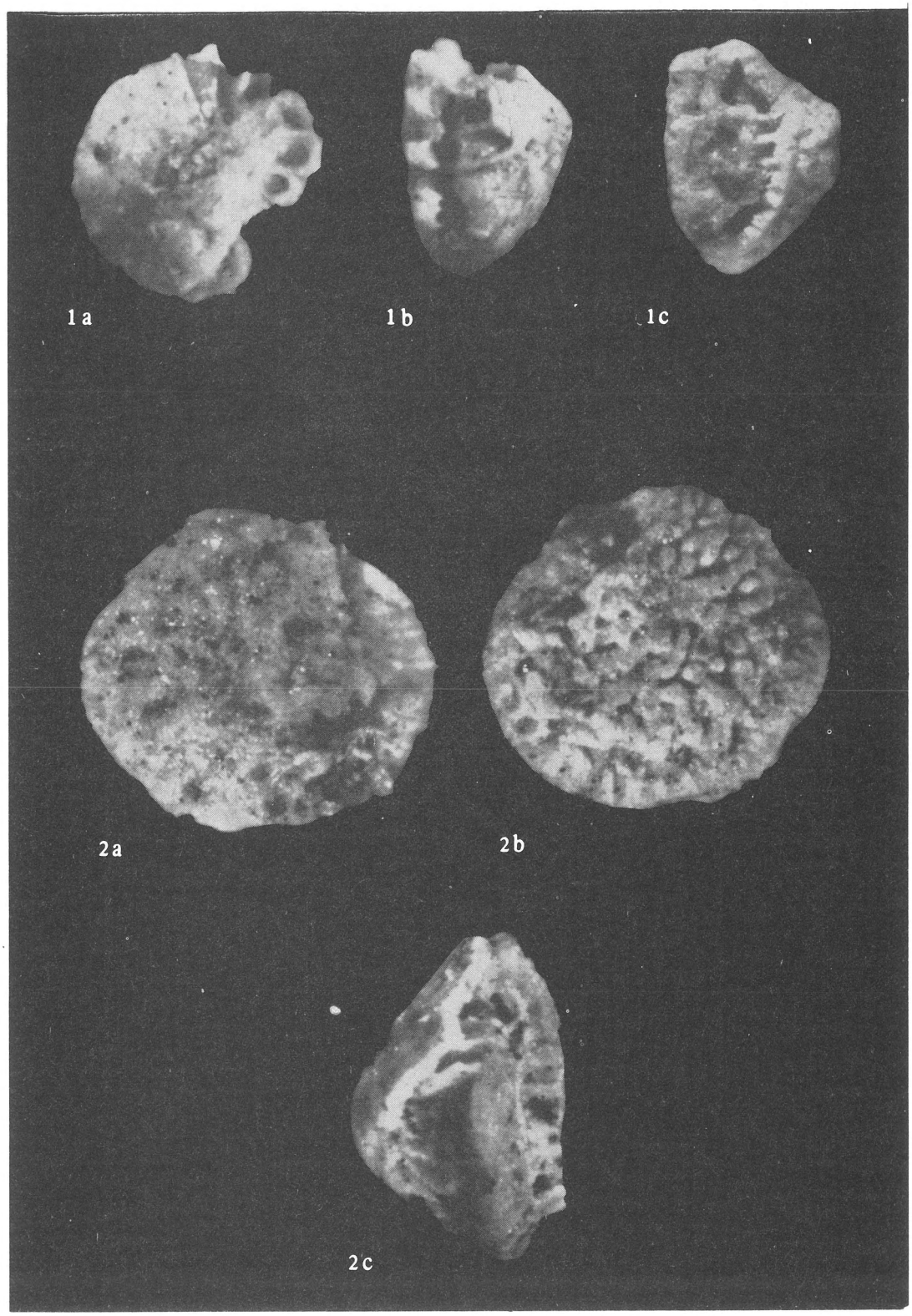


Plate XII

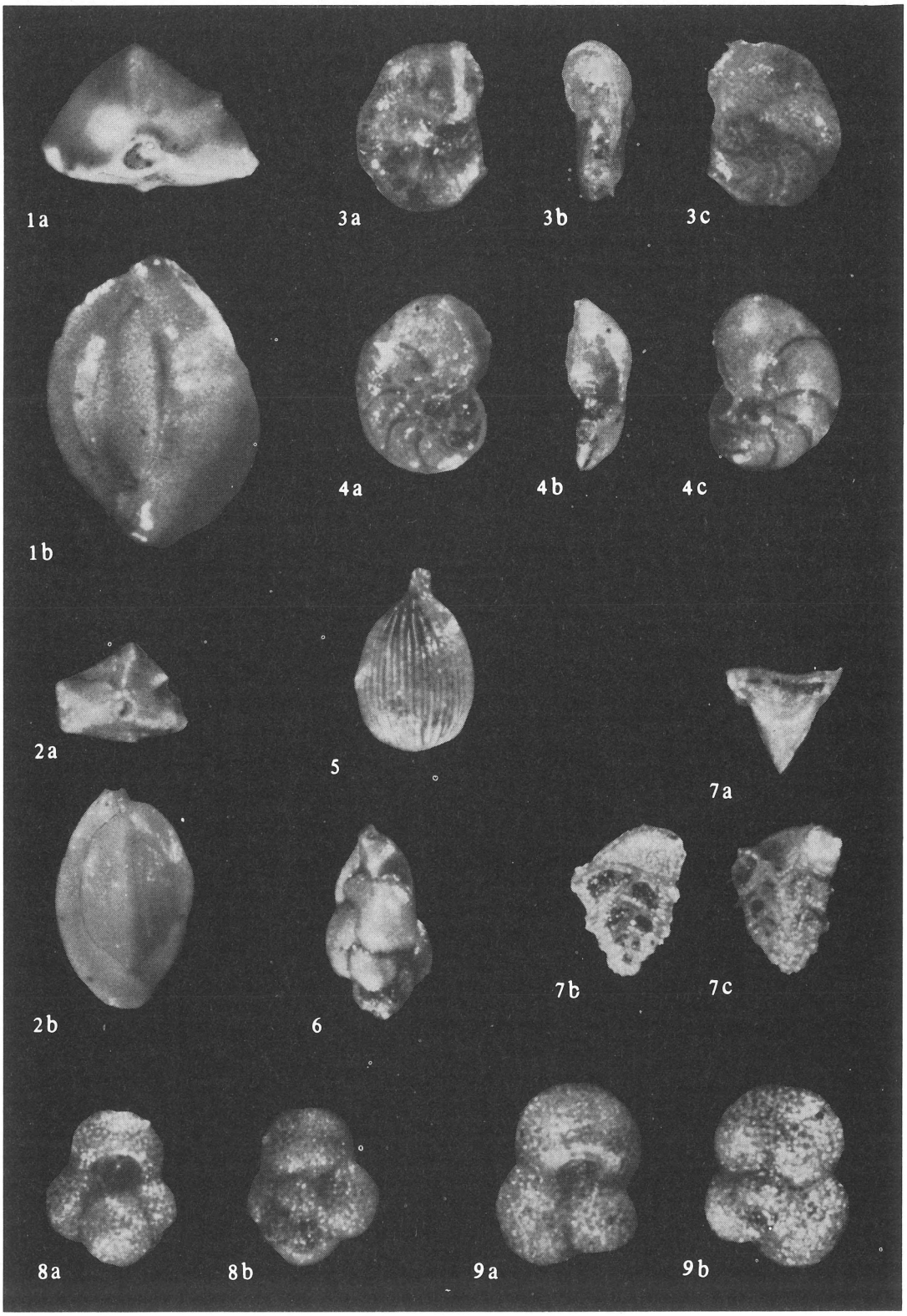


Plate XIII

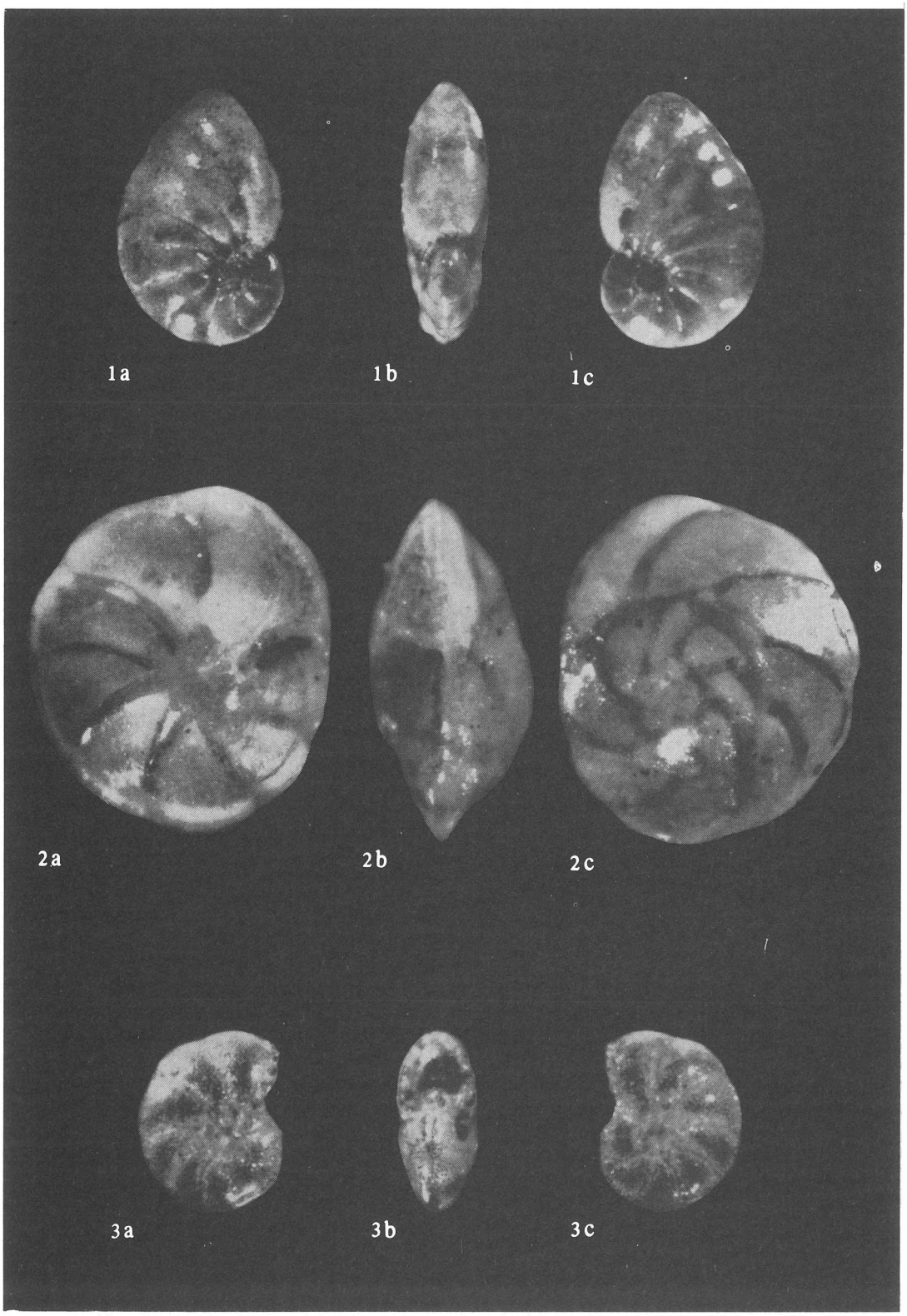


Plate XIV

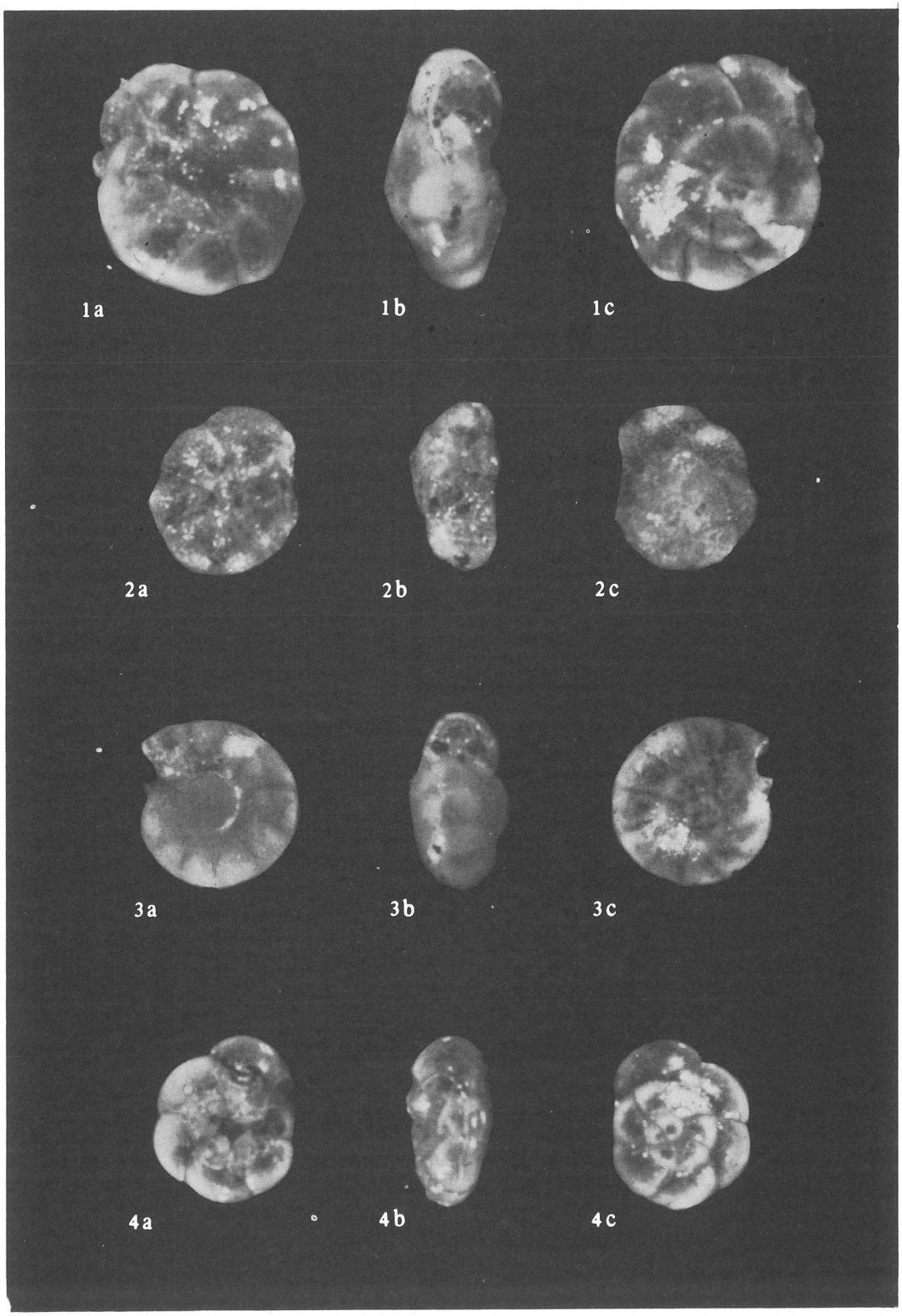


Plate XV