LATE EOCENE MOLLUSCA AND RELATED COMPOSITE SPECIES FROM SOUTHERN AUSTRALIA

by

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APPENDICES

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BIBLIOGRAPHIC REFERENCES

PLATES

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A P P E N D I X   A

LOCALITIES

All localities mentioned in this study are shown in Figs. 1-5 and in Table XIII.

The main areas dealt with in this study are the Adelaide Plains, the Noarlunga, and the Willunga SubBasins situated on the Eastern side of the St. Vincent Basin. All three of them represent classical localities in the Cainozoic geology and paleontology of Australia.

In particular, the Willunga SubBasin, with the type-section of the Aldingan stage outcropping in Maslin and Aldinga Bays, constitutes the fulcrum around which this thesis develops. The stratigraphic distribution of Tate's species and the comparison of the matrix still attached to their types revealed that Tate's classical locality 'Aldinga', the type of the 'Lower Aldinga Series' (Tate, 1879), is composite. It includes the Middle-Late Eocene deposits of Maslin Bay and of the northern tract of Aldinga Bay, and the Oligocene-Middle Miocene outcrops of the southern Aldinga Bay, from Port Willunga to Sellick Hills.

The Adelaide Plains material is derived entirely from cores; the Willunga material is almost entirely from outcrops, with only a few specimens from the subsurface; the Noarlunga material is represented by few specimens from outcrops, kept in the S.A. Museum Collections.

In order to obtain a better definition of the species and to attempt some interbasin correlation, some samples from two bores in the Murray Basin were also examined initially. To these two bores another four were added during an ongoing project on the Late Eocene Mollusca from the Padthaway Ridge for the S.A. Department of Mines and Energy. This project leads to a revision of the Late Eocene stratigraphic units in the Murray Basin and their relationships, and, therefore, the results will be presented elsewhere. (Buonaiuto, in prep.; M.F. Buonaiuto & W.K. Harris, in prep.)

Finally, part of the material concerning Tertiary composite species with Late Eocene representatives is from younger classical localities

TABLE XIII

BASINS	SUB-BASINS, EMBAY-MENTS	LOCALITIES	KEY	STRATIGRAPHIC UNITS	AGE	PURPOSE OF STUDY	REFERENCES
SAINT VINCENT	ADELAIDE PLAINS SUB.	Adelaide Children's Hospital Bores 5, 1, 2, Hd Yatala, Town Acre 717, corner Kermode St.-Sir Edwin Smith Ave.		Blanche Point Formation	Late Eocene (late P15 middle P16)	Palaeontological	Lindsay, 1969; Buonaiuto, 1975
		Adelaide (Kent Town) Bore, E & WS Bore 5, N.E. Parklands (1881-82)		as above	as above	as above	Tate, 1882; Lindsay, 1969; Ludbrook, 1973.
		Adelaide Metropolitan Subway, Bore CH 3 (DDH), North Bank of Torrens Lake, opposite Kintore Ave.		as above	as above	as above	Buonaiuto, 1975; Lindsay, in prep.
		West End Brewery, western Hindley St., Bore CH 2.		as above	as above	as above	this study; Lindsay, in prep.
		South Parklands, Bore CH 1A		as above	as above	as above	this study; Lindsay, in prep.
		Longyear Bore 50, Hd Noarlunga, Sect. 82		'North Maslin Sands' 'South Maslin Sands' 'Tortachilla Limestone' Blanche Point Formation Chinaman Gully Formation Port Willunga Formation (Aldinga Member)	e-ly M.Eoc. late M.Eoc. e-ly L.Eoc. mid L. Eoc. mid/lL.Eoc. Latest Eoc.	Stratigraphy	this study.
	NOARLUNGA SUB.	Witton Bluff, at Christie Beach; Port Noarlunga Jetty; Onkaparinga River mouth; River Road; Onkaparinga River, at the Fleming Bridge and opposite the Oval; intersection Honeypot Rd-South Road; northern slope of Ochre Point, at Moana Beach.		'North Maslin Sands' 'South Maslin Sands' Tortachilla Limestone Blanche Point Formation Chinaman Gully Formation Aldinga Member and Ruwarung Member* (Port Willunga Formation)	as above *Oligocene	Palaeontology and Stratigraphy	This study; Lindsay, 1970; Stuart, 1969; Glaessner & Wade, 1958; Ludbrook, 1969; Crespin, 1954.
	WILLUNGA SUB.	Maslin Bay (type section)		'North Maslin Sands' 'South Maslin Sands' Tortachilla Limestone Blanche Point Formation	as above	Palaeontology and Stratigraphy	Reynolds, 1953; Crespin, 1954; Glaessner & Wade, 1958; Ludbrook, 1969; Lindsay, 1967; McGowran et al., 1970; Buonaiuto, 1977a; Cooper, 1977a, 1978; Stuart, 1969.
		Aldinga Bay (type section)		Blanche Point Formation Chinaman Gully Formation Aldinga and Ruwarung Members (Port Willunga Formation)			
		Willunga Bore WLG 42, Hd Willunga, sect. 174, on the boundary with sect. 175.		'South Maslin Sands' Tortachilla Limestone Blanche Point Formation	as above	Stratigraphy	Cooper, 1977a, 1978.
		Willunga Bore WLG 40, Sect. 412.		Gull Rock Member (Blanche Point Formation) Aldinga Member (Port Willunga Formation)	as above	Palaeontology	Cooper, 1978; Buonaiuto, in prep.
		Willunga Bore WLG 37, Sect. 477.		Gull Rock Member (Blanche Point Formation)	as above	Palaeontology	Cooper, 1978.
		Chaffeys Road, just South of Coriole and Seaview Wineries, McLaren Vale		Tortachilla Limestone 'Transitional Marl' Member (Blanche Point Formation)	as above	Stratigraphy	Cooper, 1978; this study.
	YORKE PEN.	Stansbury		Port Vincent Limestone	Oligo-Miocene	Palaeontology	Crawford, 1965; Stuart, 1970.
		Point Turton		Point Turton Limestone	Late Oligocene	Palaeontology	Ludbrook, 1967; Crawford, 1965 Lindsay (herein).
MURRAY	PADTHAWAY RIDGE	B.Q. Butler Bore 4, Co Buccleuch, Hd Kirkpatrick, Sect. 8.		Buccleuch Beds	Latest Eocene	Stratigraphy and Palaeontology	Ludbrook, 1969; Buonaiuto, (herein; in prep.)
		Kiki Town Bore, Co Buccleuch, Hd Livingstone, sect. 51		Upper Knight Group Buccleuch Beds	mid L.Eoc. Latest Eoc.	as above	Ludbrook, 1969; Buonaiuto, (herein; in prep.)
		E&WS Coonalpyn Bore 2, Co Buccleuch, Hd Coneybeer, Sect. 56 (type section)		Upper Knight Group Buccleuch Beds	as above	as above	Ludbrook, 1961; Buonaiuto, (herein; in prep.)
		PBD Tintinara Area School Bore 12, Township Allotment, Hd Coombe, Co Cardwell		Buccleuch 'B' Beds	as above	as above	Buonaiuto (herein; in prep.)
		Old S.A. Railways Tintinara Bore, as above		Buccleuch Beds	as above	as above	Clarke, 1896; Tate, 1898; Buonaiuto (in prep.)
	CENTRAL AREA	Waikerie Observation Bore 2, Hd Waikerie, Sect 692		Buccleuch Beds	as above	as above	Lindsay & Bonnett, 1973;
		'River Murray Cliffs', Morgan Hd Cadell, Sect. C (type section)		Cadell Marl Lens (Morgan Limestone)	Middle Miocene	Palaeontology	Tate, 1885; Ludbrook, 1961, 1973.
EUCLA		Wilston Bluff (type section); Weebubbie Cave; Abrakurrie Cave; Toolinna Cove; Haig Cave		Wilson Bluff Limestone	mid M.Eoc.	Palaeontology and Stratigraphy	Lowry, 1970; Ludbrook, 1973; McGowran, 1978a,b,c; Quilty, 1974, 1977.
		Toolinna Cove		Toolinna Limestone	Late Eoc.	Palaeontology	as above
OTWAY	GAMBIER EMB.	Pritchard's Quarry, 12.9 km NNW of Mount Gambier (S.A.)		Gambier Limestone	Late Oligocene	Palaeontology	Ludbrook, 1971; McGowran, et al., 1971; Abele et al., 1976.
	PORT CAMPBELL EMB.	Browns Creek, at Johanna River mouth (Aire District, Vict.) (type section)		Johanna River Sand Browns Creek Formation	Mid.Eoc. Late Eoc.	Stratigraphy Stratigraphy and Palaeontology	Ludbrook, 1973; Abele et al., 1976.
		Castle Cove, Aire District, (type section)		Castle Cove Limestone	Latest Eoc. E-ly Olig.	Stratigraphy	as above
		'Gellibrand River'		Gellibrand Marls	E-ly Mioc.	Palaeontology	as above
		Maude		Lower Maude Limestone	Late Olig.-E-ly Mioc.	Palaeontology	as above; Abele & Page, 1974.
	TINDARRA EMB.	Muddy Creek, near Hamilton (Vict.)		Muddy Creek Marls	Mid. Mioc.	Palaeontology	Abele et al., 1976; Ludbrook, 1973
		Grange Burn, near Hamilton		Grange Burn Coquiña	Latest Mioc. -E. Plioc.	Palaeontology	as above
	TORQUAY EMB.	Bird Rock, 'Spring Creek'		Jan Juc Formation Puebla Formation	Late Olig. E-ly Mioc.	Palaeontology Palaeontology	as above as above
	PORT PHILLIP EMB.	Balcombe Bay		Balcombe Clay (Fyansford Formation)	Middle Miocene	Palaeontology	as above
BASS	TABLE CAPE	'Fossil Bluff', Freestone Cove, Table Cape		Freestone Cove Sandstone	Early Miocene	Palaeontology	Ludbrook, 1967; 1973; Quilty, 1966, 1972, 1974.

distributed along the eastern southern Australian margin. These localities, mentioned in the systematic part, are indicated in Fig. 1 and Table XIII. Stratigraphic units and age of these localities are included in the descriptions of the species. For further information the reader is referred to Ludbrook (1973), who offers an updated and thorough discussion.

The descriptions of the Cainozoic St. Vincent and Murray Basins are purposefully not outlined, and limited to figures because both are well known and overdescribed by previous authors. The intracratonic St. Vincent Basin has been dealt with by Glaessner (1953), Glaessner & Wade (1958), Ludbrook (1969), Stuart (1969, 1970), Wopfner (1972), Daily, Firman, Forbes & Lindsay (1976), etc. The pericratonic Murray Basin has been described by Ludbrook (1957, 1958, 1961, 1969), O'Driscoll (1960), Wopfner (1972), Abele *et al.* (1976).

APPENDIX B

DESCRIPTION OF THE MEASURED DETAILED SECTIONS

Fourteen detailed sections have been measured in total. Nine are located in the Willunga SubBasin (Figs. 3c, 10, 12) at Chaffeys Road, McLaren Vale (Section A); at Maslin Bay (Section B, C, D, V, W, X); at Blanche Point (Section Y); at Chinaman Gully, Aldinga Bay (Section Z). Four are situated in the Noarlunga SubBasin (Figs. 3b, 10); at Witton Bluff, Christies Beach (Section E, F); along the River Road, Onkaparinga River (Section G, H); on the river bank, opposite the Noarlunga oval (Section I). The fourteenth section was measured on the continous core of the Longyear Bore 50, Hd Noarlunga, Adelaide Plains SubBasin (Fig. 3a). Its stratigraphic column and lithological description are shown in Fig. 11.

WILLUNGA SUB-BASIN

SECTION A

Chaffeys Road, McLaren Vale, road cut on the knoll, just south of Coriole and Seaview Wineries. Total thickness 160 cm. Dip sub-horizontal, N-S. From bottom to top.

Tortachilla Limestone :

- Breccia; matrix of mottled yellow and green glauconitic sands; intraformational clasts highly limonitic with moulds of gastropods and bivalves. 30 cm thick.
- Yellowish sands with green glauconitic intercalations. 10 cm thick.
- Yellowish sands with vertical bodies of glauconite (? dissolved karsted horizon). 40 cm thick.The glauconitic bodies (pit filling?) are referable to the overlying,

'Transitional Marls':

- Intraformational breccia: sandy glauconitic matrix; very angular limonitic clasts (Ø~5-10 cm).

SECTION B

'Uncle Tom's Cabin'; total thickness about 3.25 m; dip 4^{o} S 65^{o} W; from bottom to top.

'South Maslin Sands':

- purplish, unconsolidated, well sorted,quarztitic limonitic fine sands; fossil content: limonitized pellets, foraminifera moulds, fragments of shells; in erosional contact with:

Tortachilla Limestone :

- red-brownish, unconsolidated, quartzitic limonitic microconglomerate: poorly clayey sandy matrix prevailing on clasts; clasts of 1-10 mm diameter, spheroidal or well rounded the quarzitic, well rounded often elongated and/or flattened the limonitic; the latter are both from inorganic origin and from moulds of organic origin; fossil content: limonitized pellets, foraminifera molds, sharks' teeth; thickness about 70 cm; passing gradually to:

- microconglomeratic limestone: biomicrudite composed chiefly of Bryozoa with very frequent irregular vertical and horizontal patches of microconglomeratic sands, crossing and following the layering; the lower part is richer in bioclasts; nature of clasts: fragment of shell or limonitic the organic, quartzitic and limonitic the inorganic; fossil content: limonitized pellets worn benthonic foraminifera, Bivalvia and Gastropoda (generally as moulds), echinoids, brachiopods, barnacles, bryozoa, sharks' teeth, worms; thickness about 30-45 cm; unconcormably underlying with erosional contact :
- yellowish brownish unconsolidated microconglomerate with finer intercalations: clasts as the lower; poorly clayey sandy matrix; fossil content: limonitized pellets, worn benthonic foraminifera, bivalves, gastropods, scaphopods, echinoids, brachiopods, barnacles, crabs' claws, sharks' teeth, bryozoa, worms; thickness about 40 cm; passing gradually to:
- greenish unconsolidated coarse microconglomeratic sands, regularly interbedded with thin pinkish bioclastic intercalations, mainly made from bryozoa; clasts finer than the lower ones; fossil content as the lower: thickness about 45 cm; passing gradually to:
- mottled greenish pinkish unconsolidated or spotty cemented microconglomeratic sands with some galls of the same lithology as the 'Transitional Marls'; fossil content, as the lower; thickness about 55 cm; passing gradually to:
- microconglomeratic limestone: biomicrudite, chiefly composed of bryozoa; richer in bioclasts than the lower limestone; hollowed out by deep irregular subvertical pits, filled by the greenish glauconitic sands from the overlying 'Transitional Marls'; fossil content as the lower without crabs' claws; thickness about 65 cm; in erosional karst contact with:

'Transitional Marls' (Blanche Point Formation)

- Greenish unconsolidated glauconitic sands; fossil content as the lower; thickness about 25 cm.

SECTION C.

Reynolds Cave, total thickness about 1.95 m; roughly same lithology, same dip; from bottom to top.

'South Maslin Sands'

- as in Section A, but displaying shrinkage structures in erosional contact with:

Tortachilla Limestone

- microconglomerate as in Section A; thickness about 20-30 cm; passing gradually to:
- microconglomeratic limestone: biomicrudite as the lower in section B with microconglomeratic glauconitic lenses; thickness 65 cm; (?) gradually passing to:
- greenish microconglomeratic glauconitic sands; thickness about 25 cm; gradually passing to:
- pitted limestone as the upper in Section A; thickness about 45 cm in erosional karst contact with:

'Transitional Marls'

- glauconitic sands more clayey than in Section A; thickness 30 cm.

In this section the fossiliferous content appears similar as in Section A, but more scarce.

SECTION D.

15-20 m southward Section B, dip subhorizontal; total thickness measured 1.60 m; from bottom to top:

Tortachilla Limestone

- microconglomerate as the lower in Sections A and B; in contact with:
- barren microconglomeratic sands, interpreted as residue of the Tortachilla Limestone after dissolution of the calcareous content; thickness about 55 cm; passing gradually to:

- same microconglomerate but with very frequent lentils and patches of glauconitic sands; thickness 35 cm; passing gradually to:
- glauconitic clayey sands with relicts of calcareous microconglomerates; fossil content: bivalves, gastropods, brachiopods, bryozoa, worms, crabs, sharks' teeth, barnacles. Passing disconformably to:

'Transitional Marls'

- glauconitic clays and marls.

SECTION V

Southern Cliffs of Maslin Bay, first gully 200 m south of 'Uncle Tom's Cabin'. Dip as in Tortachilla Limestone at'Uncle Tom's Cabin' (from bottom to top).

Tortachilla Limestone

Karsted surface.

'Transitional Marls'

- Green glauconitic, sandy, microconglomeratic limestone, highly fossiliferous, nodular in the upper part. 35 cm thick, unconformably overlain by:
- mottled yellowish greenish, sandy marl with bioclasts and few lithoclasts. fossils observed: *Chlamys flindersi*, *Pycnodonte tatei*, *Spondylus tortachillensis*, *Turritella* sp., gastropods, echinoids, brachiopods. 30 cm thick. Unconformably overlain by:
- Coquiña lens, cemented, with Bryozoa, *C. flindersi*, *C. peroni*, *P. tatei*, brachiopods, echinoids. 10 cm thick, gradually passing to:
- mottled greyish-green, glauconitic soft marls (*Hantkenina* horizon), very rich in glauconitic moulds of mollusca. 55 cm thick. Gradually passing to:
- hard glauconitic limestone with *C. flindersi*, *P. tatei*, *Dimya sigillata*, *Turbo* sp., brachiopods, echinoids, sharks' teeth, *Spirocolpus aldingae*, Bryozoa. 60 cm thick.
- Whitish-yellowish marl with bioclastic thin lenses and *C. flindersi*, *C. peroni*, *S. aldingae*, Brachiopoda, Bryozoa, Echinoidea, *Lentipecten* sp.

D. sigillata, Vermes. 40 cm thick.

- Hard greyish-buff marly limestone, silicified in its top part. 45 cm thick.
- Soft glauconitic mottled green-white marl, with high shell dissolution. 1.45 cm thick.
- Glauconitic marly limestone. 30 cm thick.

'Gull Rock Member'

- Whitish soft marls. 20 cm thick.
- Whitish marly limestone. 18 cm thick.
- Whitish marls with harder nodules (Phygraea tarda horizon). 40 cm thick.
- Grey soft marls. 15 cm thick.
- Hard limestone with some glauconite. 50 cm thick. Unconformably overlain by:

'Hallett Cove Sandstone' (Pliocene)

SECTION W

Maslin Bay, southern cliffs, 100 m about, north of Reynolds Cave.

Gull Rock Member

Top Phygraea tarda horizon.

- alternance of siliceous soft marls, and hard siliceous marls or limestone. 3.10 m thick.
- Observations. In the lowest hard band, were noted a mould of Pleurotomaria s.l., Bryozoa, Spirocolpus, Arca s.ll. sp., a muricid, Bivalvia, Praehyalocylis annulata, Emarginula sp., Chlamys, moulds of siliquariids.

SECTION X

Maslin Bay, detritus conoid, just south of Reynolds Cave.

'Transitional Marls'

- Hard marly limestone, partly silicified.
- Dissolution front.

Gull Rock Member

- Whitish soft marls, with siliceous patches. 80 cm thick.

- Phygraea tarda horizon, whitish soft marls, 70 cm thick, two thin lenses of P. tarda, one at the bottom and one on the top of the unit.
- Soft glauconitic marls, with siliceous patches. 70 cm thick.
- Hard glauconitic marly limestone. 10 cm thick.
- Glauconitic marls with siliceous patches. 2.30 m thick.
- Glauconitic marls. 40 cm thick.
- Glauconitic limestone. 50 cm thick.
- Glauconitic marls. 30 cm thick.
- Glauconitic limestone. 10 cm thick.
- Alternance of glauconitic limestones and marls with Spirocolpus aldingae. 3.10 m thick.

'Soft Marls'

- greyish glauconitic marls. 1.50 m thick.
- detritus.

Hallett Cove Sandstone (Pliocene)

SECTION Y

Blanche Point, 1st and 2nd amphitheatre, southern slope of Blanche Point. Dip about 3^{o}.

'Gull Rock Member'

- Phygraea tarda horizon, whitish marls. 40 cm thick.
- Whitish marls, bioturbed, with patches of glauconitic pellets and Bryozoa. .5 m thick.
- Siliceous limestone or marl. 20 cm thick.
- Whitish marls, with Anellida, Bryozoa, rare Chlamys and Turritella moulds. 40 cm thick.
- Siliceous limestone. 10 cm thick.
- Alternance of grey soft marls and hard siliceous limestone with siliceous nodules. 11.70 cm thick. Spirocolpus assemblages associated with abundant sponge spicules 3.25 m above top P. tarda horizon. Gradually passing to:

'Soft Marls'

- Soft marls very rich in siliceous sponges and Mollusca. 80 cm thick.
- hard horizon of siliceous nodules imbedded in marls similar to the ones above and below (20 cm thick).
- Soft grey to black marls, extremely rich in sponge spicules and Mollusca. 16.50 m thick. Nautilus sp. in patches, 8m above the last hard nodular horizon. Upper part, with shells subjected to intensive dissolution.

SECTION Z

Aldinga Bay, cliff just on the southern side of Chinaman Gully (from bottom to top).

'Soft Marls'

- Lower unit, in erosional contact with:

Chinaman Gully Formation

- Dark grey clay, stained by limonite, 50 cm. thick.
- Very fine alternance of grey fine clayey sands and red clays. 50 cm thick. In erosional contact with:
- Quartz angular sands (2-3 cm) with scarce matrix of finer sand. 15 cm thick.
- Fine whitish clayey quartz sands with thin lenses of red limonitic sands. 25 cm thick.
- Yellow clayey fine sands. 10 cm thick.
- Banded brick-red and grey silty clays. 20 cm thick.
- Grey silty clays. 10 cm thick. In erosional contact with:
- Banded brick-red/grey clays with coarse sand nodules. 10 cm thick. In erosional contact with:
- Grey silty clays with sandy nodules. 5 cm thick. In erosional contact with:
- Brown silty clays with very thin grey horizons. Small scale deformations by compression. 10 cm thick. In erosional contact with:
- Grey coarse clayey sands, stained by limonite. 30 cm thick. In

erosional contact with:

Aldinga Member, Port Willunga Formation

- Quartz microconglomerate with sandy matrix. 15 cm thick.
- Sandstone gradually passing to a crossbedded Bryozoal limestone. 1.10 m thick.

Observations. On the cliffs, just north of Chinaman Gully, the Bryozoal limestone is underlain by a thin horizon of mottled whitish-green glauconitic marls.

NOARLUNGA SUB-BASIN

SECTION E

At Christies Beach, at the middle of the northern side of Witton Bluff; total thickness about 1.75 cm; dip $10^{o}S$ $50^{o}W$; from bottom to top.

South Maslin Sands

- red purplish unconsolidated quartzitic limonitic fine sands intercalated with frequent greenish clayey very fine sands marking cross-bedding; a minor fainter cross-bedding is displayed too; clasts: angular quartz, mica, limonite, organic calcite; fossil content: pellets, limonitic the smaller, calcite the larger, moulds of foraminifera, ?arenaceous foraminifera; fragments of Chlamys sp; in erosional contact with:

Tortachilla Limestone

- red brown unconsolidated very fine sands with very frequent intercalations of greenish veins like as the lower, greenish clayey galls, lentils which in the upper part are graded white greenish at the bottom and limonitic at the top. In the upper part an ondulating limonitic ripple mark-like interbedding; clasts: round quartz, limonitic organic aggregates, organic calcite; fossil content: Bryozoa, limonitized pellets, moulds of badly preserved benthonic foraminifera, traces of intensive bioturbation from burrowing organisms, with borings filled by finer greenish sands; thickness about 90-100; in erosional contact with:

- intraformational conglomerate with angular large galls of sand or of microconglomerate and abundant microconglomeratic lentils; the secondary calcitic cement gradually increases upward from the underlying horizon; clast as the lower; fossil content: limonitic pellets; thickness c. 10-15 cm in erosional contact with:
- green glauconitic fine sands with frequent microconglomeratic and sand galls and microconglomeratic lenses irregularly shaped; clasts: quartz, limonite from organic origin, organic calcite; fossil content: simple or lumped pellets, glauconitic the larger, limonitized the smaller; moulds of foraminifera, calcitic tubules from worms, moulds of molluscs; thickness c. 30 cm; passing gradually to:
- deeply pitted mottled brown greenish microconglomeratic limestone with abundant calcitic cement; clasts as the lower; fossil content: moulds of molluscs and burrowing traces filled of limonitic material; the pits are filled by the overlying glauconitic sands; thickness c. 30 cm.; unconformably underlying to:

'Transitional Marls'

- green glauconitic sands very fossiliferous, nearly a coquiña; fossil content: bivalves, gastropods, echinoids, brachiopods, etc., all generally of very large dimensions; thickness c. 60 cm.

SECTION E

At the foot of Witton Bluff; total thickness estimated 1.50-1.60 m.; the lower contact is not observable; dip as in Section D; from bottom to top.

- Tortachilla Limestone
- Same red-brownish bioturbed sands as the lower in Section D; unconformably underlying to:
- intraformational conglomerate with arenaceous lentils in the lower part and angular sand galls occurring in all the bed but more frequent upward; thickness 30-40 cm; in erosional contact with:
- greenish glauconitic microconglomeratic limestone deeply pitted with sand- and microconglomerate-galls; pits filled by the overlying green sands; fossil content: bivalves, gastropods, echinoids etc. thickness c. 40 cm; unconformably underlying by karst surface to:

Transitional Marls

- green glauconitic sandy coquiña as in Section D; thickness 10-25 cm.

SECTIONS G, H

Along River Road, roadcut on the northern bank of the Onkaparinga River. Total thickness 4.10 m. Dip subhorizontal; crossbedding dipping westward.

?'North Maslin Sands'

- Red yellowish clayey sands, medium size; dispersed quartz pebbles (15 mm) and small clay galls. 60 cm thick.
- Sands with more clayey matrix; regular thin clayey intercalations. 25 cm thick. Brusquely passing laterally to and overlain by,
- Coarser angular purple sands with abundant clay galls. 40 cm thick (max.). Unconformably overlain by:

?'South Maslin Sands'- Tortachilla Limestone undifferentiated.

- Thin ferruginous silty clays, varva-like, gradually passing to alunite westward. 10 cm thick.
- Coarse angular purple sands with dispersed clay galls (ø 2-3 cm); alunite galls on the upper part; large cross-bedded horizons of alunite, gradually passing to sands and clay galls. 90 cm thick.

- Ferruginous clayey sands 30 cm thick.
- Yellow clayey sands with clay galls. 10 cm thick.

'Tortachilla Limestone'

- Yellowish cemented, highly microconglomeratic sands with rare intraformational clasts; cross-bedding in places. 40 cm thick. Unconformably overlain by:
- Red conglomeratic sands, unconformably passing to:

'Transitional Marls'

Green glauconitic sands, very rich in fossil moulds: Turritella, Chlamys, and other Bivalvia, large rounded relicts (Ø 20-30 cm) from the underlain units. Section G, 10 m westward of Section H, is represented by the lowermost unit of Section H and by the above described 'Transitional Marl' unit, containing the relicts from 'Tortachilla Limestone'.

SECTION I

At Noarlunga Oval; total thickness c. 5.85 m; dip 5^{o}S 80^{o}W; from bottom to top:

South Maslin Sands

- sandy clays, brownish in the lower and grey in the upper with 5 cm; brick-red clay at the top; rich in limonite, angular or nearly rounded quartz; and very thin lentils of concretional calcite; fossil content: worm tubules, gastropods, fragments of Chlamys sp; thickness only 70 cm. outcropping; in erosional contact with:
- red-brownish cross-bedded sands with hard limonitic clayey intercalations at the top of each cross-bed; the intercalations often contain veins of concretional calcite; clasts: well rounded quartz, limonite also from organic moulds, mica, organic and concretional calcite; fossil content; limonitic moulds of foraminifera, calcitic and limonitic pellets, calcitic and limonitic moulds of

gastropods, fragments of <u>Chlamys</u> sp, echinoids' radioli; thickness c. 3.60 m gradually passing to:

- cross-bedded microconglomeratic sands with abundant clay-galls and bioturbation traces; clasts as the lower; fossil content: limonitized pellets, poorly preserved benthonic foraminifera in moulds or with their shells; thickness c. 95 cm gradually passing to:
- regularly layered compacted rather coarse sands, of the usual nature; fossil content as the lower; thickness 10-15 cm, unconformably underlying to:
- intraformational conglomerate with angular clay- and sand- and microconglomerate-galls imbedded in abundant sandy matrix poorly consolidated in the lower part; thickness 25-50 cm; unconformably underlying to:
- green unconsolidated glauconitic sands; clasts as the lower; fossil content: limonitic and glauconitic pellets, moulds of gastropods, fragments of molluscs, crinoids, bryozoa, molds and fragments of benthonic foraminifera; thickness c. 15 cm; gradually passing to:
- microconglomeratic limestone (biomicrudite) deeply pitted as usual; fossil content: bryozoa, molluscs, brachiopods, echinoids; thickness c. 65 cm; in erosional karst contact with:

'<u>Transitional Marls</u>'

- green glauconitic fossiliferous sands; thickness c. 20-30 cm.

A P P E N D I X   C

SAMPLE CHECK-LISTS

TORTACHILLA LIMESTONE

(Section B, 'Uncle Tom's Cabin') TL2

	No. spec.	%
GASTROPODA		
Cirsotrema (Cirsotrema) mariae (Tate)	7	1.84
Turritella sp.	several	-
Calyptraea sp.	4	1.05
Siliquaria s.l. sp.	several	-
Emarginula sp,	2	0.52
Trochus sp.	4	1.05
?Patelloida sp.	1	0.26
Gastropoda sp.	1	0.26
Gastropoda sp.	1	0.26
Gastropoda sp.	1	0.26

	LV	RV	BV	vv	no.total spec.	%
BIVALVIA						
Pycnodonte tatei (Suter)	31	8			39	10.24
Limatula margaritata Buonaiuto		1		8	9	2.36
Lima maslinensis Buonaiuto	3				3	0.79
Divarilima cf. polyactina (Tate)				1	1	0.26
Chlamys (Chlamys) aldingensis (Tate)	24	12		26	62	16.27
C. (Chlamys) flindersi (Tate)	18	9	1	17	45	11.81
C. (Chlamys) peroni (Tate)	16	12		12	40	10.50
Dimya sigillata Tate	2	5			7	1.84
Barbatia (Barbatia) cf. *limatella* (Tate)	1	2			3	0.79
Cucullaea (Cucullaea) adelaidensis Tate	10	3			13	3.41
Spondylus (Spondylus) tortachillensis sp.nov.				7	7	1.84
Pteria sp.	3				3	0.79

	LV	RV	BV	vv	no. total spec.	%
Glycymeris (Glycymeris) cf. *kaurna* sp. nov.	3	2			5	1.31
G. (Glycymeris) cf. *lenticularis* (Tate)	1	1			2	0.52
Gari sp.	7	5			12	3.15
Hiatella (Hiatella)?vera (Deshayes)	15	31			46	12.07
Glans sp. A		1			1	0.26
Glans sp. B	3	2			5	1.31
Dosina sp.	8	9	1		18	4.72
Mactra sp.	2	3			5	1.31
Corbula sp.			1		1	0.26
Nemocardium sp.	7	7			14	3.67
Periglypta sp.		1		6	7	1.84
Nuculana sp.	1				1	0.26
Clavagella lirata (Tate)			2		2	0.52
Jouannetia (Pholadopsis) cuneata (Tate)			1		1	0.26
Myadora sp.		1			1	0.26
?Cuna sp.		1			1	0.26
Herella sp.	2	1			3	0.79
Divalucina sp.		1			1	0.26
Katelysia sp.	1				1	0.26

ALIA

Echinoids, Brachiopoda, Cirripedia (two forms), shark teeth, Vermes, Bryozoa.

DIVERSITY INDEXES			Gastropoda		Scaphopoda		Bivalvia		Tot.
			no.	%	no.	%	no.	%	
N=381	N_s=42	Specimens	21	5.51	-	-	360	94.49	381
S_s=42	S_g=39	Species	10	23.81	-	-	32	76.19	42
D_s=.9170	D_g=.9954	Genera	10	25.64	-	-	29	74.36	39

VALVES	LV	RV	BV	VV	Total
Epifaunal	124	83	1	71	279
Infaunal	35	35	5	6	81
uncertain	-	-	-	-	-
Total	159	118	6	77	360
%	(44.17)	(32.78)	(1.67)	(21.39)	

BIVALVIA	%
Epifaunal	77.5
Infaunal	22.5

ARTICULATION RATIOS	spec.	index
Infaunal	76	0.0004
Epifaunal	278	0.0000
aggregate	354	0.0002

DIFFERENTIAL TRANSPORT INDEX	specs.	index	uncertainty ind.
Epifaunal	278	0.0304	0.0150
Infaunal	76	0.0274	0.0052
aggregate	354	0.0252	0.0095

TL3

	no. spec.	%
GASTROPODA		
Siliquaria s.l. sp.	14	1.01
Calyptraea sp.	7	0.51
?*Cellana* sp.	1	0.07
Emarginula sp.	6	0.43
Cirsotrema mariae (Tate)	17	1.23
Natica sp.	9	0.65
?*Vexillum* sp.	6	0.43
Turritella sp.	9	0.65
Marginella sp.	1	0.07
Cypraea sp.	2	0.14
Trochus sp.	19	1.38
Olivella sp.	1	0.07
Scaphander sp.	2	0.14
Gastropoda sp. ind. & juv.	27	1.96
Latirus sp.	1	0.07
SCAPHOPODA		
Dentalium s.l. sp.	11	0.80

	LV	RV	BV	vv	tot.no.spec.	%
BIVALVIA						
Pycnodonte tatei (Suter)	3	4			7	0.51
Pycnodonte tatei juv. morpha A	3	7	1		11	0.80
Pycnodonte tatei juv. morpha B	11	9			20	1.45
Ostrea sp.				2	2	0.14
Ostrea sp. juv.	1				1	0.07
Limatula margaritata Buonaiuto	1			56	57	4.13
Ctenoides sp. nov. aff. *linguliformis* (Tate)		2			2	0.14
Lima maslinensis Buonaiuto	3	2		1	6	0.43
C. (Chlamys) aldingensis (Tate)	8	2		14	24	1.74
C. (Chlamys) peroni (Tate)	29	14		68	111	8.04
C. (Chlamys) flindersi (Tate)	2	3		20	25	1.81
Spondylus tortachillensis sp. nov.	6	1		26	33	2.39
Dimya sigillata Tate	297	368	5	21	691	50.07
Glycymeris cf. *kaurna* sp. nov.	13	5		8	26	1.88
C. (Cucullaea) cf. *adelaidensis* Tate	5	2		1	8	0.58
B. (Barbatia) cf. *limatella* Tate	5	6			11	0.80
Allasinazella gen.nov. cf. *equidens* (Tate)	1	1			2	0.14
Nucula sp.	1	2			3	0.22
H. (Hiatella) ?vera Deshayes	6	28			34	2.46
Limopsis cf. *zitteli* Ihering	1				1	0.07
Propeamussium (Parvamussium) sp.				11	11	0.80
Crenella cf. *globularis* Tate	1	1			2	0.14

	LV	RV	BV	vv	tot.no.spec.	%
Limea (Isolimea) alticosta Tate				14	14	1.01
Gari sp.	13	9		6	28	2.03
Clavagella lirata (Tate)			2		2	0.14
?Pteria sp.		2			2	0.14
Mactra sp.	4	4			8	0.58
Dosina sp.	13	9			22	1.59
Myadora sp.		1			1	0.07
Corbula sp.	1	1			2	0.14
Lucina sp.	3	2			5	0.36
Dosinia sp.	2	3			5	0.36
Herella sp.	3				3	0.22
Bivalve sp. ind.				6	6	0.43
Propeleda sp.	1				1	0.07
Nemocardium sp.	15	16		11	42	3.04
Glans sp. A	1				1	0.07
Glans sp. B	6	7		2	15	1.09
Nuculana sp.	1				1	0.07

ALIA

Brachiopoda, Echinoids, Cirripedia (two forms), Crustacea (crab claws), shark teeth, Vermes, Bryozoa.

DIVERSITY INDEXES

$N = 1380$ $N_s = 51$

$S_s = 51$ $S_g = 46$

$D_s = .7357$ $D_g = .9961$

	Gastropoda no.	Gastropoda %	Scaphopoda no.	Scaphopoda %	Bivalvia no.	Bivalvia %	Tot.
Specimens	122	8.84	11	.80	1247	90.36	1380
Species	14	27.45	1	2.78	36	70.59	51
Genera	14	30.43	1	2.17	31	67.39	46

VALVES	LV	RV	BV	vv	Total
Epifaunal	382	453	6	234	1.075
Infaunal	65	58	2	41	166
Uncertain	-	-	-	6	6
Total	447	511	8	282	1.247
(%)	(35.85)	(40.98)	(0.6)	(22.61)	

BIVALVIA	%
Epifaunal	86.21
Infaunal	13.31
Uncertain	.48

ARTICULATION RATIOS

	specs.	index
Infanual	164	0.0005
Epifaunal	1.069	0.00002
Aggregate	1.241	0.00001

DIFFERENTIAL TRANSPORT INDEXES

	specs.	index	uncertainty index
Infaunal	1.069	0.0781	0.0084
Epifaunal	164	0.0275	0.0074
Aggregate	1.241	0.0584	0.0064

TL4

GASTROPODA	Tot. no. specs.	%
Cirsotrema mariae (Tate) juvs. & ads.	42	2.69
Calyptraea sp.	2	0.13
Cypraea sp.	16	1.02
Olivella sp.	5	0.32
?Terebra sp.	1	0.06
Scaphander sp.	3	0.19
Emarginula sp.	4	0.26
Latirus sp.	3	0.19
Siliquaria s.l. sp.	11	0.70
Natica sp.	1	0.06
Voluta sp.	3	0.19
Turritella sp.	6	0.38
Trochus sp.	7	0.45
Turbonilla sp.	1	0.06
Gastropoda sp.	40	2.56

SCAPHOPODA	tot.no.specs.	%
Dentalium s.l. sp.	10	0.64

BIVALVIA	LV	RV	BV	vv	tot.no.specs.	%
Limea (Isolimea) alticosta (Tate)	44	53		140	237	15.16
Dimya sigillata Tate	276	281	5	119	681	43.57
Limatula margaritata Buonaiuto	5	5		36	46	2.94
Pycnodonte tatei (Suter) juvs.	31	37			68	4.35
Chlamys sp.	6	3		21	30	1.92
C. (Chlamys) aldingensis (Tate)	4			14	18	1.15
C. (Chlamys) flindersi (Tate)	1	1		4	6	0.38
C. (Chlamys) peroni (Tate)	7			49	56	3.58
Spondylus tortachillensis sp. nov.	3	1		5	9	0.60
Propeamussium (Parvamussium) sp.		1		59	60	3.84
Lima maslinensis Buonaiuto				5	5	0.32
Cuspidaria (Rhinoclama) sp.	1	1			2	0.13
Solamen (Exosiperna) cf. *globularis* (Tate)	3				3	0.19
Hiatella (Hiatella) ?vera (Deshayes)	14	9			23	1.47
Tivelina sp.	2	3			5	0.32
Clavagella lirata Tate			1		1	0.06
Cuspidaria (Cuspidaria) sp.	1				1	0.06
Corbula sp.	1				1	0.06
?Lucina sp.		1			1	0.06
Mactra sp.	8				8	0.51
Tellina sp.	11	6		11	28	1.79
Dosina sp.	6	10			16	1.02

	LV	RV	BV	vv	tot. no. specs.	%
Glycymeris sp				11	11	0.70
Nemocardium sp	15	15		4	34	2.18
C. (Cucullaea) cf. *adelaidensis* Tate	2	1			3	0.19
Arca sp.	3	3			6	0.38
Pronucula sp.			1		1	0.06
Bivalve gen. & sp. ind. & juv.	15	15		18	48	3.07

ALIA

Brachiopoda, Cirripedia (two forms), Crustacea (Crabs' claws), Echinoids, Shark teeth and embryonic teeth, Vermes, Bryozoa.

DIVERSITY INDEXES

$N=1.563$ $N_s=43$

$S=43$ $S_g=39$

$D_s=.7778$ $D_g=.9956$

	Gastropoda no.	Gastropoda %	Scaphopoda no.	Scaphopoda %	Bivalvia no.	Bivalvia %	Total
Specimens	145	9.28	10	0.64	1408	90.08	1563
Species	15	34.88	1	2.33	27	62.79	43
Genera	15	38.46	1	2.56	23	58.97	39

VALVES	LV	RV	BV	vv	total
Infaunal	51	30	2	26	109
Epifaunal	399	395	5	452	1.251
Uncertain	15	15	-	18	48
Total	465	440	7	496	1.408
(%)	(33.03)	(31.25)	(0.5)	(35.23)	

BIVALVIA	%
Infaunal	7.74
Epifaunal	88.85
Uncertain	3.41

ARTICULATION RATIOS

	specs.	index
Epifaunal	1.246	0.00001
Infaunal	107	0.0037
Aggregate	1.401	0.0004

DIFFERENTIAL TRANSPORT INDEXES

	specs.	index	uncertainty index
Epifaunal	1.246	0.0509	0.0266
Infaunal	107	0.0360	0.0108
Aggregate	1.401	0.0406	0.0214

TL5

GASTROPODA	no. specs.	%
Cirsotrema mariae (Tate) juvs & ads	18	1.33
Emarginula sp.	9	0.66
Calyptraea sp.	3	0.22
Turbo sp.	28	2.07
Trochus sp.	15	1.11
Latirus sp.	4	0.30
Turritella sp.	13	0.96
Gastropoda ind.	4	0.30
Cypraea sp.	6	0.45
Calliostoma (Fautor) allasinazi sp. nov.	1	0.07
Guildfordia (Pseudostralium) maslinensis sp.nov.	1	0.07
Siliquaria s.l. sp.	13	0.96
SCAPHOPODA		
Dentalium sp.	30	2.22

BIVALVIA	LV	RV	BV	vv	Tot. no. specs.	%
Limatula margaritata Buonaiuto	14	14		24	52	3.76
Limea (Isolimea) alticosta (Tate)	42	48		43	133	9.61
Divarilima polyactina (Tate)	1	2			3	0.22
Dimya sigillata (Tate)	195	162		47	404	29.19
Pycnodonte tatei (Suter)	18	17		4	39	2.82
Pycnodonte sp.				1	1	0.07
Lima maslinensis Buonaiuto	2	2		4	8	0.58
Spondylus tortachillensis sp.nov.		1		1	2	0.14
C. (Chlamys) aldingensis (Tate)	10	3		21	34	2.46
C. (Chlamys) flindersi (Tate)	2	2		3	7	0.51
C. (Chlamys) peroni (Tate)	12	11		19	42	3.03
Chlamys sp.	9			23	32	2.31
Propeamussium (Parvamussium) sp.				14	14	1.01
Nemocardium sp.	61	33		23	117	8.45

	LV	RV	BV	vv	Tot.no.specs.	%
Clavagella lirata (Tate)			28		28	2.02
Mactra sp.	12	9			21	1.52
Corbula sp.	2	2			4	0.29
Gari sp.	11	4		3	18	1.30
H.(Hiatella)?vera (Deshayes)	14	21			35	2.53
Glans sp. B	2	1			3	0.22
Herella sp.	2	2			4	0.29
C.(Cucullaea)adelaidensis (Tate)	18	12		3	33	2.38
Dosina sp.	11	4			15	1.08
Dosinia sp.	5	8			13	0.94
Glycymeris sp.	8	7		2	17	1.23
B.(Barbatia) cf. *limatella* (Tate)	8	8			16	1.16
?Porterius (Ludbrookella) cf. *spinosus* sp. nov.	2	2			4	0.29
Arca sp.		1			1	0.07
Arcopsis cf. *dissimilis* (Tate)		1			1	0.07
Limopsis zitteli Ihering	2				2	0.14
Pronucula sp.	2	2			4	0.29
Bivalvia sp. ind.	37	30	2	36	103	7.44

ALIA

Barachiopoda, Echinoids, Vermes, Cirripedia (two forms), crabs' claws, shark teeth, embryonic teeth, Bryozoa.

DIVERSITY INDEXES			Gastropoda no.	Gastropoda %	Scaphopoda no.	Scaphopoda %	Bivalvia no.	Bivalvia %	Tot.
N = 1384	N= 47	Specimens	119	8.59	30	2.16	1.235	89.23	1.384
S_s= 47	S_g= 43	Species	12	25.53	1	2.12	34	72.39	47
D_s= .8851	D_g=.9963	Genera	12	27.90	1	2.32	30	69.76	43

VALVES	LV	RV	BV	vv	Total
Infaunal	118	72	28	51	269
Epifaunal	347	307	-	207	861
Uncertain	37	30	2	36	105
Total	502	409	30	294	1.235
(%)	(40.65)	(33.12)	(2.43)	(23.81)	

BIVALVIA	%
Infaunal	21.78
Epifaunal	69.72
Uncertain	8.50

ARTICULATION RATIOS	specs.	index
Infaunal	241	0.0131
Epifaunal	861	0.0000
Aggregate	1.205	0.0005

DIFFERENTIAL TRANSPORT INDEXES	specs.	index	uncertainty index
Infaunal	241	0.0552	0.0081
Epifaunal	861	0.0709	0.0089
Aggregate	1.205	0.0326	0.0053

TL6

GASTROPODA	no. specs.	%
Turbo sp.	1	0.85
Natica sp.	2	1.71
Turritella sp.	10	8.55
Gastropoda sp. ind.	4	3.42
SCAPHOPODA		
Dentalium sp.	1	0.85

BIVALVIA	LV	RV	BV	vv	tot.no.specs.	%
Bivalvia sp. ind.	1	4		15	20	17.09
Ostrea sp.				2	2	1.71
Dosina sp.	8	2	1	4	15	12.82
C. (Chlamys) peroni (Tate)				2	2	1.71
Lima maslinensis Buonaiuto				2	2	1.71
Chlamys sp.	1	1		30	32	27.35
Limea(Isolimea)alticosta (Tate)				3	3	2.56
Dimya sigillata Tate				2	2	1.71
C. (Chlamys) flindersi (Tate)				6	6	5.13
Limatula margaritata Buonaiuto	1	1		2	4	3.42

	LV	RV	BV	vv	tot.no.specs.	%
Corbula sp.	1	1			2	1.71
Clavagella lirata (Tate)			1		1	0.85
Gari sp.		1		1	2	1.71
Cardium sp.				1	1	0.85
?Pteria sp.		1			1	0.85
Glycymeris sp.				1	1	0.85
C. (Cucullaea) cf. *adelaidensis* Tate	1	1			2	1.71
Arca sp.	1				1	0.85

ALIA

Brachiopoda, Echinoids, Vermes, Sharks' teeth, Cirripedia (1 form), Bryozoa.

DIVERSITY INDEXES

N = 117 N = 23

S_s = 23 S_g = 21

D_s = .8712 D_g = .9960

	Gastropoda no.		Scaphopoda no.	%	Bivalvia no.	%	Total
Specimens	17	14.52	1	0.85	99	84.61	117
Species	4	17.39	1	4.34	18	78.26	23
Genera	4	19.08	1	4.76	16	76.19	21

VALVES	LV	RV	BV	vv	Total
Epifaunal	4	4	-	50	58
Infaunal	9	4	2	6	21
Uncertain	1	4	-	15	20
Total	14	12	2	71	99
(%)	(14.14)	(12.12)	(2.02)	(71.71)	

BIVALVIA	%
Infaunal	21.21
Epifaunal	58.59
Uncertain	20.20

ARTICULATION RATIOS

	specs.	index
Infaunal	19	0.0000
Epifaunal	58	0.0000
Aggregate	97	0.0000

DIFFERENTIAL TRANSPORT INDEXES

	specs.	index	uncertainty index
Infaunal	19	0.1637	0.0351
Epifaunal	58	0.0000	0.2771
Aggregate	97	0.0318	0.1222

BLANCHE POINT FORMATION

'Transitional Marl Member'

POCKETS

(Section B - 'Uncle Tom's Cabin')

GASTROPODA	no. specs.	%
Turbo sp.	2	2.20
Turritella sp.	18	19.78
Cypraea sp.	1	1.10

BIVALVIA	LV	RV	BV	vv	tot.no.specs.	%
C. (Chlamys) peroni (Tate)	1	2		4	7	7.69
C. (Chlamys) flindersi (Tate)				3	3	3.30
Chlamys sp.	1	1		12	14	15.38
Limea (Isolimea) alticosta (Tate)		1		2	3	3.30
Dosina sp.	1	4		7	12	13.19
Bivalvia sp. ind. & juvs				5	5	5.49
Lima maslinensis Buonaiuto				2	2	2.20
Limatula margaritata Buonaiuto		1		3	4	4.40
Clavagella lirata (Tate)			1		1	1.10
Ostrea sp.				1	1	1.10
Mactra sp.				1	1	1.10
Dimya sigillata Tate		4		3	7	7.69
C. (Cucullaea) cf. *adelaidensis* Tate	2	2			4	4.40
Arca sp				3	3	3.30
Nemocardium sp.	1				1	1.10
Glans sp. B		1			1	1.10
Gari sp.				2	2	2.20
Nucula sp.	2				2	2.20

ALIA

Echinoids, Brachiopods, Cirripedia, Bryozoa.

DIVERSITY INDEXES			Gastropoda n.	%	Scaphopoda no.	%	Bivalvia no.	%	Total
N = 91	N = 21								
S_s= 21	S_s= 19	Specimens	21	23.07	-	-	70	76.92	91
		Species	3	14.28	-	-	18	85.72	21
D_s= .9343	D_s= .9952	Genera	3	15.78	-	-	16	84.21	19

VALVES	LV	RV	BV	vv	Total
Epifaunal	4	11	-	33	48
Infaunal	4	5	1	7	17
Uncertain	-	-	-	5	5
Total	8	16	1	45	70
(%)	(11.43)	(22.85)	(1.43)	(64.29)	

BIVALVIA	%
Epifaunal	68.57
Infaunal	24.29
Uncertain	7.14

ARTICULATION RATIOS	no. specs.	index
Infaunal	16	0.0000
Epifaunal	48	0.0000
Aggregate	69	0.0000

DIFFERENTIAL TRANSPORT INDEXES	no.specs.	index	uncertainty index
Infaunal	16	0.0083	0.1833
Epifaunal	48	0.0009	0.0762
Aggregate	69	0.0000	0.0503

TM1
(Section D-Reynolds Cave)

	no. specs.	%
GASTROPODA		
Trophonopsis hypsellus (Tate)	1	0.22
Cirsotrema mariae (Tate)	1	0.22
Cypraea sp.	1	0.22
Gastropoda sp. *A*.	2	0.45
Gastropoda sp. *B*.	8	1.79
Gastropoda larvae spp. ind.	71	15.85
Calyptraea sp.	1	0.22
Turbo ss. ll. sp.	7	1.56
Calliostoma (Fautor) allasinazi sp. nov.	2	0.45
Guildfordia (Pseudastralium) cf. *maslinensis* sp. nov.	1	0.22
Emarginula sp.	1	0.22
Spirocolpus aldingae (Tate)	210	46.87

SCAPHOPODA	no. specs.	%
Dentalium sp.	2	0.45

BIVALVIA	LV	RV	BV	vv	tot.no.specs.	%
Corbula (Cariocorbula) pyxidiata (Tate)		1			1	0.22
Paraglans latissima (Tate)	1	1			2	0.45
Nuculana (Saccella) chapmani (Finlay)			1		1	0.22
Limopsis (Limopsis) zitteli Ihering		2		1	3	0.67
Pycnodonte tatei (Suter)	1	1		1	3	0.67
Limatula margaritata Buonaiuto				3	3	0.67
Limea (Isolimea) alticosta (Tate)	1			1	2	0.45
Lima maslinensis Buonaiuto	1			4	5	1.12
Vulsella (Vulsella) laevigata Tate	1	3		1	5	1.12
Phygraea tarda (Hutton) juv. (?)	1				1	0.22
Ostrea sp. A juv.	3				3	0.67
Spondylus tortachillensis sp. nov.			3	3	6	1.34
Lentipecten (Lentipecten) sp. aff. *hochstetteri* (Zittel)	1			3	4	0.89
Ostrea sp. B juv.			4		4	0.89
Clavagella lirata (Tate)			4		4	0.89
Dimya sigillata Tate	7		18	7	32	7.14
Modiolus (Modiolus) cf. *adelaidensis* (Tate)	2				2	0.45
Tellina (Tellina) sp. aff. *cainozoica* T. Woods	1				1	0.22
Dosina sp.	4	3		2	9	2.01
Glycymeris sp.				2	2	0.45
Cardium sp.				2	2	0.45
Nemocardium sp.		1		1	2	0.45
Arca (Arca) pseudonavicularis Tate	2				2	0.45
Barbatia (Barbatia) limatella Tate	1				1	0.22
C. (Chlamys) peroni (Tate)		2		12	14	3.12
C. (Chlamys) flindersi (Tate)	2	1		12	15	3.35
Chlamys sp. ind. & juvs.	1		1	9	11	2.46

ALIA

Echinoids, Brachiopoda, Cirripedia, Decapoda (crabs' claws), Bryozoa, Shark teeth, embryonic teeth.

DIVERSITY INDEXES

N = 440	N_s = 40
S_s = 40	S_g = 38
D_s = .9640	D_g = .9940

	Gastropoda no.	Gastropoda %	Scaphopoda no.	Scaphopoda %	Bivalvia no.	Bivalvia %	total
Specimens	306	68.29	2	0.45	140	31.26	448
Species	12	30.00	1	2.50	27	67.50	40
Genera	12	32.43	1	2.70	24	64.86	37

VALVES	LV	RV	BV	vv	total
Epifaunal	24	7	26	56	113
Infaunal	6	8	5	8	27
Uncertain	-	-	-	-	-
Total	30	15	31	64	140
(%)	(21.43)	(10.71)	(22.14)	(45.71)	

BIVALVIA	%
Epifaunal	80.71
Infaunal	19.29
Uncertain	-

ARTICULATION RATIOS

	no.specs.	index
Infaunal	122	0.0969
Epifaunal	87	0.0256

DIFFERENTIAL TRANSPORT INDEXES

	no.specs.	index	uncertainty index
Infaunal	122	0.0260	0.0130
Epifaunal	87	0.0072	0.0545
Aggregate	103	0.0063	0.0394

TM2

GASTROPODA	no. specs.	%
Spirocolpus aldingae (Tate)	102	21.75
Emarginula sp.	2	0.43
Voluta s. l. sp.	2	0.43
Natica s.l. sp.	2	0.43
Calyptraea sp.	1	0.21
Turbo s.l. sp.	24	5.12
Trochus s.l. sp.	2	0.43
Gastropoda spp. ind. & juvs.	8	1.71
?Nototrivia sp.	1	0.21

BIVALVIA	LV	RV	BV	vv	tot.no.specs.	%
Dimya sigillata Tate	39	77			116	24.73
Goniocardium sp.	3	1	1		5	1.07
Vepricardium (Hedecardium) monilectum (Tate)	4				4	0.85
Dosina cf. *multilamellata* (Tate)	17	6	2		25	5.33
Paraglans latissima (Tate)		2			2	0.43
Cucullaea adalaidensis Tate	1				1	0.21
Glycymeris sp.		1			1	0.21
Bivalvia spp. ind.	11	5	1	15	32	6.82
Pycnodonte tatei (Suter)	33	31		4	68	14.50
?Lanternula sp.		1			1	0.21
Lima maslinensis Buonaiuto		1			1	0.21
Spondylus tortachillensis Buonaiuto		1		4	5	1.07
C. (Chlamys) peroni (Tate)	1	2		20	23	4.90
C. (Chlamys) flindersi (Tate)	2	4		25	31	6.61
Chlamys sp.				10	10	2.13

DIVERSITY INDEXES

$N_s = 469$ $N_g = 24$

$S_s = 24$ $S_g = 22$

$D_s = .8543$ $D_g = .9891$

	Gastropoda no.	Gastropoda %	Scaphopoda no	Scaphopoda %	Bivalvia no	Bivalvia %	Total
Specimens	144	30.29	-	-	325	69.71	469
Species	9	37.50	-	-	15	62.50	24
Genera	9	40.91	-	-	13	59.09	22

VALVES	LV	RV	BV	vv	total
Epifaunal	76	116	-	63	265
Infaunal	25	11	3	-	38
Uncertain	11	5	1	15	32
Total	111	132	4	78	325
(%)	(34.15)	(40.62)	(1.23)	(24.00)	

BIVALVIA	%
Epifaunal	78.46
Infaunal	11.69
Uncertain	9.85

ARTICULATION RATIOS	no specs	index
Infaunal	38	0.0014
Epifaunal	255	0.0000
Aggregate	321	0.0002

DIFFERENTIAL TRANSPORT INDEXES	no specs	index	uncertainty index
Infaunal	38	0.2063	0.0000
Epifaunal	255	0.0392	0.6255
Aggregate	321	0.0286	0.0127

Check samples from
Section V, between 'Uncle Tom's Cabin' and Reynolds Cave

S. 1

Chlamys flindersi (Tate), *Dimya sigillata* (Tate), *Gastropoda* sp. ind.

S. 2

Chlamys sp., *Dimya sigillata* (Tate)

S. 3

Chlamys flindersi (Tate), *Chlamys peroni* (Tate), *Dimya sigillata* (Tate), shark teeth. *Hantkenina primitiva* horizon. First appearance of fish bones.

S. 4

Chlamys flindersi (Tate), *Phygraea tarda* (Hutton) *Spirocolpus aldingae* (Tate), *Arca* sp. juv., fish bones.

S. 5

Chlamys flindersi (Tate), *Chlamys peroni* (Tate).

TM^4

SECTION V

(between S.2 and S.3)

GASTROPODA	no. specs.	%
Cirsotrema mariae (Tate)	1	0.33

BIVALVIA	LV	RV	BV	vv	Tot.no. specs	%
C. (Chlamys) flindersi (Tate)	7	22	1	110	140	45.90
C. (Chlamys) peroni (Tate)				8	8	2.62
Pycnodonte tatei (Suter)	91	47	3	6	147	48.20
Dimya sigillata Tate		4			4	1.31
Chlamys sp. ind.				2	2	0.66
Spondylus cf. *tortachillensis* sp. nov.				3	3	0.98

ALIA

Bryozoa.

DIVERSITY INDEXES

$N = 305$ $N_s = 7$

$S_s = 7$ $S_g = 5$

$D_s = .5578$ $D_g = .8571$

	no	%
Gastropoda	1	0.33
Bivalvia	304	99.67

VALVES	LV	RV	BV	vv	total
Epifaunal	98	73	4	129	304
(%)	(32.24)	(24.01)	(1.30)	(42.43)	

BIVALVIA	
Epifaunal	100%

ARTICULATION RATIO : 0.0001

DIFFERENTIAL TRANSPORT INDEX: 0.0918
(uncertainty index: 0.1347)

TM7

GASTROPODA	no specs	%
Cirsotrema mariae (Tate)	1	0.94
Gastropoda spp. ind.	11	10.34

BIVALVIA	LV	RV	BV	vv	tot.no.specs.	%
C. (Chlamys) flindersi (Tate)				21	21	19.81
C. (Chlamys) peroni (Tate)				25	25	23.58
Lentipecten sp.aff. *hochstetteri* (Zittel)				1	1	0.94
Lima maslinensis Buonaiuto				2	2	1.89
Dimya sigillata Tate	12	25			37	34.91
Bivalvia spp. ind.				4	4	3.77
Pycnodonte tatei (Suter)	3	1		4	4	3.77

ALIA

Brachiopoda, Echinoids, Vermes, Bryozoa, Cirripedia (tall form), Fish bones, Sharks' teeth.

OBSERVATIONS. Sample from a highly dissolved interval

DIVERSITY INDEXES

$N = 106$ $N_s = 9$

$S_s = 9$ $S_g = 8$

$D_s = .7765$ $D_g = .9722$

	no.	%
Gastropoda	12	11.32
Bivalvia	94	88.67

VALVES	LV	RV	BV	vv	total
Epifaunal	15	26	-	49	90
Uncertain	-	-	-	4	4
Total	15	26	-	53	94
(%)	(15.96)	(27.66)	-	(56.38)	

BIVALVIA	%
Epifaunal	95.74
Uncertain	4.26

ARTICULATION RATIO: 0.0000

DIFFERENTIAL TRANSPORT INDEX: 0.0158
(Uncertainty index: 0.1183)

TM8

GASTROPODA	tot.no.specs	%
Spirocolpus aldingae (Tate) (260 ads + 1.709 juvs)	1.969	77.61
Pterynotus (Pterochelus) adelaidensis (Tate)	1	0.04
Cylichna angustata (Tate & Cossmann)	6	0.24
Acteon subscalatus (Tate & Cossmann)	38	1.50
Siliquaria altispira sp. nov.	8	0.32
Lunatia aldingensis (Tate)	4	0.16
Cylichna (Cylichnania) callosa (Tate & Cossmann)	7	0.28
Cassoginella palla (Cotton)	1	0.04
Acrocoelum margaritatum sp. nov.	1	0.04
Kosugeia gen.nov. *costatosulcata* sp. nov.	2	0.08
Kaurnaginella gen.nov. *tutgka* sp.nov.	12	0.47
Alaginella submicula (Tate)	1	0.04
Cirsotrema mariae (Tate)	1	0.04
Margarites (Periaulax) rhysus sp.nov. (*ex* Tate)	7	0.28
Basilissa (Basilissa) cossmanni Tate	1	0.04
Calliostoma (Fautor) allasinazi sp. nov.	1	0.04
Pterynotus (Pterochelus) bifrons (Tate)	1	0.04
Argobuccinum (Cymatiella) oligostira (Tate)	3	0.12
Austromitra pumila (Tate)	12	0.47
Vexithara citharelloides (Tate)	1	0.04
Perynotus (Pterochelus) manubriatus (Tate)	1	0.04
Typhis (Talityphis) tetraphyllos sp.nov. (*ex*Tate)	3	0.12
Baryspira (Gracilispira) ligata (Tate)	4	0.16
Waimatea complanata (Tate)	3	0.12
Sigmesalia stylacris (Tate)	3	0.12
Rugobela sp. nov.	2	0.08
Trophon (Enantimene) monotropis (Tate)	11	0.43
Brocchitas altior sp. nov.	4	0.16
Notopeplum protorhysum (Tate)	1	0.04
Emarginula (Emarginula) imbricata sp. nov.	1	0.04

	tot.no.specs	%
Leucorhynchia bifuniculata sp. nov.	3	0.12
Austrofusus sp.	8	0.32
Trophon (Trophonopsis) hypsellus (Tate)	72	2.84
Praehyalocylis annulata (Tate)	4	0.16
?Eumetula (Eumetula) sp. nov. A	3	0.12
?Euseila sp. nov.	2	0.08
?Cerithiella sp. nov. A	4	0.16
?Cerithiella sp. nov. B	1	0.04
?Cerithiella sp. nov. C	1	0.04
?Cerithiopsis (Socienna) sp. nov.	4	0.16
?Notoseila sp. nov.	3	0.12
?Cerithiopsis (Miopila) sp. nov.	2	0.08
?Pilaflexis sp. nov.	3	0.16
?Cerithopsis sp.	3	0.16
?Eumetula (Eumetula) sp. nov. B	3	0.16
?Cerithidea (Cerithidea) sp. nov.	1	0.04
Sirius fenestratus (Tate)	1	0.04
?Cerithioderma sp.	1	0.04
?Cerithiopsis (Cerithiopsilla) sp. nov.	1	0.04
Charonia (Austrosassia) cribrosa (Tate)	1	0.04
Distorsio (personella) maslinensis sp. nov.	3	0.12
Fusinus (Fusinus) sculptilis (Tate)	1	0.04
Comitas (Comitas) sp. nov.	2	0.08
Comitas (Comitas) aldingensis Powell	3	0.12
Tanea falsa sp. nov.	26	1.02
Marginella s.l. sp. nov.	1	0.04
Triphora (Ogivia) trirostrata sp. nov.	2	0.08
Knefastia sp.	18	0.71
Eulima (Balcis) sp. nov. A	4	0.16
Eulima (Balcis) sp. nov. B	1	0.04

	no. specs.	%
Eulima sp. nov. A	7	0.28
Eulima sp. nov. B	3	0.12
Chemnitzia sp. nov. A	1	0.04
Syrnola sp. nov.	1	0.04
Eulima (Balcis) sp. nov. C	1	0.04
Gastropoda spp. ind. & juvs.	56	2.21
SCAPHOPODA		
Gadilina tatei Sharp & Pilsbry	8	0.32
Fissidentalium sp. nov.	6	0.24

BIVALVIA

	LV	RV	BV	vv	tot.no.specs.	%
Pinctada sp. nov.			1		1	0.04
Pinna sp.				1	1	0.04
Dimya sigillata Tate	18	17			35	1.38
Limea (Isolimea) alticosta (Tate)		1			1	0.04
Nuculana (Poroleda) sp. nov.		1			1	0.04
N. (Ledella) leptorhyncha (Tate)	13	5	6		24	0.95
Pronucula tatei (Finlay)	3	2	3	1	9	0.35
Nuculana (Saccella) chapmani (Finlay)	1	1			2	0.08
Allasinazella gen.nov *equidens* (Tate)	2	1	1		4	0.16
Arcopsis dissimilis (Tate)	4	2	3		9	0.35
Barbatia (Barbatia) limatella Tate	1				1	0.04
?Pythina sp.	1				1	0.04
Dosina (Dosina) multilamellata (Tate)		3	2	9	14	0.55
Vulsella cf. *laevigata* Tate	2			1	3	0.12
?Lissarca sp. nov.	7	8	2		17	0.67
Pectunculina cancellata sp.nov.	2	3			5	0.20
Musculus (Musculus) semigranosus (Tate)	1	1	2	2	6	0.24
Septifer (Septifer) sp. nov.	1	2			3	0.12
Paraglans latissima (Tate) juv.		1			1	0.04

	LV	RV	BV	vv	tot.no.specs.	%
Lima maslinensis Buonaiuto				2	2	0.08
C. (Chlamys) peroni (Tate)				1	1	0.04
Chlamys sp.				5	5	0.20
Cuspidaria cf. *adelaidensis* (Tate)	1				1	0.04
Bivalvia spp. ind. & juvs.	2	2	4	7	15	0.59

ALIA

Bryozoa, Sharks' teeth, fish bones, otoliths (first occurrence), siliceous sponges (first occurrence), Echinoids, Crinoidea, Decapoda (crabs' claws), Cirripedia, Anellida, Brachiopoda.

DIVERSITY INDEXES

$N = 2537$ $N_s = 92$

$S_s = 92$ $S_g = 76$

$D_s = .3955$ $D_g .9933$

	Gastropoda no	Gastropoda %	Scaphopoda no	Scaphopoda %	Bivalvia no	Bivalvia %	Total
Specimens	2.361	93.12	14	0.56	162	6.40	2.537
Species	66	71.74	2	2.17	24	26.09	92
Genera	53	69.74	2	2.63	21	27.63	76

VALVES	LV	RV	BV	vv	total
Epifaunal	29	24	7	11	71
Infaunal	28	24	13	11	76
Uncertain	2	2	4	7	15
Total	59	50	24	29	162
(%)	(36.42)	(30.86)	(18.52)	(17.90)	

BIVALVIA	%
Epifaunal	43.83
Infaunal	46.91
Uncertain	9.26

ARTICULATION RATIOS

	specs.	index
Infaunal	63	0.0070
Epifaunal	64	0.0102
Aggregate	138	0.0032

DIFFERENTIAL TRANSPORT INDEXES

	specs.	index	uncertainty index
Infaunal	63	0.0528	0.0060
Epifaunal	64	0.0799	0.0184
Aggregate	138	0.0280	0.0073

GULL ROCK MEMBER

(Section V)

Phygraea tarda horizon

BIVALVIA	LV	RV	BV	vv	total
Phygraea tarda (Hutton)	129	48	2	--	179
(%)	(72.07	(26.82)	(1.12)	--	

ALIA

Brachiopoda, sponge spicules.

DIVERSITY INDEX $D_s = D_g = 0.0$

ARTICULATION RATIO: 0.0001

DIFFERENTIAL TRANSPORT INDEX: 0.5300

EPIFAUNAL BIVALVIA: 100%

(Section Y)

GASTROPODA	no. specs	%
Marginella (Plicaginella) aldingae Tate	8	0.12
Marginella sp. ind	63	0.98
Marginella sp. juvs.	53	0.83
Cottonella gen.nov.*mala* (Cotton)	3	0.05
Siliquaria kaurna sp. nov.	3	0.05
Leucorhynchia bifuniculata sp. nov.	22	0.34
Praehyalocylis annulata (Tate)	20	0.31
Kleinacteon dubius sp. nov.	65	1.01
Kaurnacteon gen.nov.*elevatus* sp.nov.	30	0.47
Acteocina scalarum sp. nov.	4	0.06
Tenuiacteon acicularis sp. nov.	1	0.02
Baryspira (Gracilispira) ligata (Tate)	41	0.64
Jetwoodsia nullarborica (Chapman & Crespin)	3	0.05
Calliostoma (Fautor) cf. *allasinazi* sp. nov.	7	0.11
Basilissa (Basilissa) cossmanni Tate juv.	13	0.20
Pseudomalaxis (Pseudomalaxis) asculpturatus Maxwell	3	0.05
Turbonilla kaurna sp. nov.	2	0.03
Chemnitzia sp. nov . B.	2	0.03
Chemnitzia sp. nov. C.	1	0.02
Syrnola (Pachysyrnola) habei sp. nov.	2	0.03
Tiberia (Cossmannica) maxwelli sp. nov.	8	0.16
Turbonilla rossiae sp. nov.	1	0.02
Turbonilla sp. nov.	1	0.02
Nobolira costata sp. nov.	1	0.02
Merelina kaurna sp. nov.	6	0.09
Retusa (Decorifer) crassa sp. nov.	80	1.25
R. (Decorifer) gracilis sp. nov.	1	0.02
Kosugeia gen. nov. sp. nov.	1	0.02
Inella maxwelli sp. nov.	3	0.05

	no. specs	%
Triphora s.l. *muna* sp. nov.	2	0.03
Triphora (Isotriphora) sp. nov.	1	0.02
Triphora s.l. sp. nov. A	1	0.02
Aclis (Graphis) costata sp. nov.	14	0.22
Aclis (Graphis) laevigata sp. nov.	2	0.03
Notovoluta pagodoides (Tate)	1	0.02
Calyptraea sp.	1	0.02
Sigmesalia stylacris (Tate)	1	0.02
Vexinia callosa sp. nov.	11	0.17
Matilda (Opimilda) sp. nov. A	3	0.05
Cerithiopsis (Socienna) sp. nov. A	1	0.02
Seila s.l. sp. nov. A	11	0.17
Cerithiopsis s.l. gen A sp. A	4	0.06
?Eumetula s.l. sp.	1	0.02
Certhiopsis s.l. gen B sp. A	2	0.03
Cerithiopsis s.l. gen. C sp.	3	0.05
Seila s. str. sp.	6	0.09
Cerithiopsis s.l. gen. D sp.	7	0.11
Cerithiopsis s.l. gen. E sp.	5	0.08
Cerithiopsis s.l. gen. F sp.	12	0.19
Cerithiopsis s.l. gen. G sp.	1	0.02
Cerithiopsis s.l. gen. H sp.	6	0.09
Cerithiopsis s.l. gen. I sp.	2	0.03
Cerithiopsis s.l. gen. K sp.	1	0.02
Cerithiopsis s.l. gen. J. sp.	2	0.03
Cerithiopsis s.l. gen. L sp.	3	0.05
Cerithiopsis s.l. gen. M sp.	5	0.08
Cerithiopsis s.l. gen. N sp.	6	0.09
Cerithiopsis s.l. gen. O sp.	2	0.03
Cerithiopsis s.l. gen. P sp.	1	0.02

Cerithiopsis s.l. gen. Q sp.	3	0.05
Cerithiopsis s.l. gen. R sp.	2	0.03
Cerithiopsis ss.ll. gen. & sp. ind.	36	0.56
?Cerithiopsilla sp. nov.	5	0.08
Cerithiopsis s.l. gen. S sp.	3	0.05
Scala s.l. gen A sp.	1	0.02
Scala s.l. gen. B sp.	4	0.06
Gastropoda opercula gen & sp. ind.	2	0.03
Margarites (Periaulax) rhysus sp. nov. (ex Tate)	8	0.12
Cerithium s.l. sp.	1	0.02
Acteon ss. ll. sp. & gen. ind.	1	0.02
Vexithara citharelloides (Tate)	3	0.05
Austromitra pumila (Tate)	3	0.05
Narona (Inglisella) Turriculata (Tate)	3	0.05
Comitas (Comitas) aldingensis Powell	5	0.08
Charonia (Austrosassia) cribrosa (Tate)	1	0.02
Comitas (Comitas) sp. nov.	5	0.08
Fusinus (Acrocolus) apiciliratus (Tate)	3	0.05
Trophon (Trophonopsis) hypsellus (Tate) juv.	96	1.50
Comitas s.l. sp.	1	0.02
Distorsio (Personella) maslinensis sp. nov.	5	0.08
?Tectifusus sp.	1	0.02
?Columbarium sp. juv.	1	0.02
Zeacolpus sp. (53 ads + 60 juvs.)	113	1.76
Gastropoda sp. ind.	114	1.78
Leiostraca sp. ind.	10	0.16
Eulima s.l. sp. ind.	8	0.12
Eulima s.l. sp. nov.	16	0.25
Odostomia (Auristomia) sulcata sp. nov.	2	0.03
Odostomia s.l. spp. ind.	5	0.08
Balcis sp. nov. A	23	0.36

Balcis sp. nov. B	14	0.22
?Leiostraca sp. nov.	1	0.02
?Chileutomia sp. nov.	10	0.16
Spirocolpus aldingae (Tate) (2.630 juvs + 871 ads)	3.503	54.61
Polinices (Polinices) nothos sp. nov.	20	0.31
Lunatia aldingensis (Tate)	66	1.40
Natica ss.ll. sp.ind.	7	0.15
Tanea falsa sp. nov.	36	0.56
SCAPHOPODA		
Gadilina tatei Sharp & Pilsbry	6	0.09
Siphonodentalium sp. nov.	183	2.85
Cadulus sp. nov.	164	2.56
Fissidentalium sp.	1	0.02

BIVALVIA	LV	RV	BV	vv	tot.no.specs	%
C. (Chlamys) peroni (Tate)				24	24	0.37
C. (Chlamys) flindersi (Tate)				30	30	0.47
Chlamys sp.				4	4	0.06
Lentipecten sp.				1	1	0.02
Poroleda sp.	12	3	13		28	0.44
Dimya asseretoi sp. nov.	276	90	3	1	370	5.77
Corbula (Caryocorbula) pyxidiata (Tate)	1				1	0.02
Hiatella (Hiatella) ?vera (Deshayes)	1				1	0.02
Cuspidaria sp.	1				1	0.02
Cyclopecten s.l. sp. nov.	17	7	1		25	0.39
Propeamussium (Parvamussium) sp. nov.	8	4			12	0.19
Allasinazella gen.nov.*equidens* (Tate)	3				3	0.05
Limopsis zitteli Ihering	10	4		3	17	0.27
Notogrammatodon inexpectatus Maxwell	4	6		2	12	0.19
Arcopsis (Arcopsis) dissimilis (Tate)	17	4		1	22	0.34
Modiolus ss.ll. sp. juv.	1				1	0.02
?Lissarca sp.				25	25	0.39

	LV	RV	BV	vv	tot.no.specs	%
Salaputium aldingensis Finlay	8	7		14	29	0.45
Salaputium lamellatum (Tate)	6	4			10	0.16
Condylocardia radiata (Tate)			5	45	50	0.78
Cardita s.l. sp.	13	23	7	11	54	0.84
Pectunculina cancellata sp. nov.	134	98	8	16	256	3.99
Pronucula (Pronucula) tatei (Finlay)	5	2	4	1	12	0.19
Nuculana (Ledella) leptorhyncha (Tate)			132	193	325	5.07
Dosina (Dosina) multilamellata (Tate)			12	7	19	0.30

ALIA

Bryozoa, shark teeth, fish bones, otoliths, Echinoids, Brachiopoda, ahermatypic corals, Anellida, Decapoda (Crabs' claws), sponge spicules.

DIVERSITY INDEXES

N = 6414	N_s = 127
S_s = 127	S_g = 107
D_s = .6916	D_g =.9964

	Gastropoda		Scaphopoda		Bivalvia		Total
	no.	%	no.	%	no.	%	
Specimens	4.728	73.53	354	5.52	1.332	20.81	6414
Species	98	77.16	4	3.15	25	19.69	127
Genera	82	75.93	4	3.70	22	20.37	108

VALVES	LV	RV	BV	vv	total
Epifaunal	327	111	4	63	505
Infaunal	190	141	181	315	827
Uncertain	-	-	-	-	-
Total	517	252	185	378	1.332
(%)	(38.81)	(18.92)	(13.89)	(28.38)	

BIVALVIA	%
Epifaunal	37.91
Infaunal	62.09
Uncertain	-

ARTICULATION RATIOS

	specs	index
Epifaunal	501	0.00002
Infaunal	646	0.04250
Aggregate	1.147	0.01350

DIFFERENTIAL TRANSPORT INDEXES

	specs	index	uncertainty index
Epifaunal	501	0.3055	0.0057
Infaunal	646	0.0439	0.0965
Aggregate	1.147	0.0721	0.0317

'SOFT MARL' MEMBER

(Section Y)

Nautilus Horizon

GASTROPODA	no specs.	%
Praehyalocylis annulata (Tate)	15	0.59
Styliola sp. nov.	1	0.04
Natica sp. (opercula)	1	0.04
Spirocolpus aldingae (Tate)	122	4.83
Zeacolpus sp.	169	6.69
Lunatia aldingensis (Tate)	11	0.44
Jetwoodsia nullarborica (Chapman & Crespin)	25	0.99
Baryspira (Gracilispira) ligata (Tate)	1	0.04
Tanea falsa sp. nov.	22	0.87
Polinices (Polinices) nothos sp. nov.	38	1.50
Retusa (Decorifer) crassa sp. nov.	31	1.23
Margarites (Periaulax) rhysus sp. nov. (ex Tate)	42	1.66
Paradilhia (Micropyrgos) sp. nov.	3	0.12
Marginella (Plicaginella) aldingae (Tate)	26	1.03
Pterynotus (Pterochelus) manubriatus (Tate)	1	0.04
Limacina sp. nov. A	42	1.66
Aclis (Graphis) costata sp. nov.	2	0.08
Austromitra pumila (Tate)	18	0.71
Ataxocerithium concatenatum (Tate)	1	0.04
Vexithara citharelloides (Tate)	7	0.28
Trophon (Trophonopsis) hypsellus (Tate)	40	1.58
Knefastia sp. nov. B	40	1.58
Kleinacteon dubius	34	1.35
?Miralda s.l. sp. nov.	1	0.04
Acteon ss.ll. sp. ind.	7	0.28
Cylichna (Cylichnania) callosa (Tate)	6	0.24
Kaurnacteon gen.nov. *elevatus* sp. nov.	1	0.04

Acteocina scalarum sp. nov.	1	0.04
Chrysallida sp. nov.	17	0.67
Turbonilla kaurna sp. nov.	3	0.02
Chemnitzia sp. nov. B	1	0.04
Turbonilla rossiae sp. nov.	8	0.32
Tiberia (Cossmannica) maxwelli sp. nov.	2	0.08
Eulima s.l. sp. nov.	23	0.91
Odostomia (Auristomia) sulcata sp. nov.	11	0.44
Leiostraca sp. nov.	8	0.32
?Leiostraca sp.	4	0.16
?Nototrivia sp.	1	0.04
Marginella s.l. spp. ind. juvs	16	0.63
Cassoginella palla (Cotton)	3	0.12
Kaurnaginella gen. nov. *tutugka* sp. nov.	5	0.20
Alaginella submicula sp. nov.	2	0.08
Archierato pyrulata (Tate)	8	0.32
Marginella s.l. spp. ind.	23	0.91
Cottonella cf. *mala* (Cotton)	2	0.08
Leucorhynchia bifuniculata sp. nov.	1	0.04
Turbo ss.ll. sp. ind.	1	0.04
Cirsotrema mariae (Tate)	4	0.16
Columbarium sp.	1	0.04
Matilda (Opimilda) sp. nov. A	4	0.16
Seila s.l. sp. nov.	7	0.28
Murexul prionotus (Tate)	3	0.12
Fusinus (Microcolus) apiciliratus (Tate)	1	0.04
Latirus (Brocchitas) altior sp. nov.	1	0.04
Trophon s.l. sp.	1	0.04
Comitas (Comitas) aldingensis Powell	17	0.67
Comitas s.l. sp. nov. B	12	0.48
Fusinus (Fusinus) sculptilis (Tate)	3	0.12

Inella maxwelli sp. nov.	1	0.04
Triphora s.l. *muna* sp. nov.	2	0.08
Argobuccinum (Cymatiella) oligostira (Tate)	9	0.36
Narona (Inglisella) turriculata (Tate)	2	0.08
Calliostoma (Fautor) allasinazi sp. nov.	2	0.08
Sirius cf. *tabulatus* (Tate)	13	0.51
Trophon (Enantimene) monotropis (Tate)	3	0.12
Fusus s.l. sp. A juv.	10	0.40
Fusus s.l. sp. B juv.	3	0.12
Gastropoda spp. ind. & juvs.	75	2.97
Cerithiopsis s.l. gen. Q sp. nov.	3	0.12
Cerithiopsis s.l. gen. A sp. nov. A	9	0.36
Cerithiopsis s.l. gen. C sp. nov.	1	0.04
Cerithiopsis s.l. gen. H sp. nov.	10	0.40
Cerithiopsis s.l. gen. J sp. nov.	1	0.04
Cerithiopsis s.l. gen. M sp. nov.	14	0.55
Cerithiopsis s.l. gen. D sp. nov.	3	0.12
SCAPHOPODA		
Siphonodentalium sp. nov.	66	2.61
Laevidentalium sp. nov.	22	0.87
Plagioglypta sp. nov.	4	0.16
Gadilina tatei Pilsbry & Sharp	138	5.46

BIVALVIA

	LV	RV	BV	vv	tot.no.specs	%
Notogrammatodon inexpectatus Maxwell	7	1			8	0.32
Bivalvia spp. ind.				6	6	0.24
Divarilima cf. *polyactina* (Tate)	5	1			6	0.24
Corbula sp.				1	1	0.04
Lissarca sp.	3	4			7	0.28
Hiatella (Hiatella) ?vera (Deshayes)	2	1			3	0.12
Arcopsis (Arcopsis) dissimilis (Tate)	7	7	1		15	0.59

Salaputium lamellatum (Tate)	16	27	1	4	48	1.90
Condylocardia radiata (Tate)	20	17	1		38	1.50
Glycymeris lenticularis (Tate)	2	2		5	9	0.36
Dosina (Dosina) multilamellata (Tate)	2	2		13	17	0.67
Propeamussium(Parvamussium) sp. nov.	63	84			147	5.82
Dimya asseretoi sp. nov.	88	55			143	5.66
Salaputium aldingensis Finlay	16	16		2	34	1.35
Pectunculina cancellata sp. nov.	98	80	7	11	196	7.76
Nuculana (Ledella) leptorhyncha (Tate)	116	103	44	5	268	10.61
Pronucula (Pronucula) tatei (Finlay)	5	9		3	17	0.67
*Nuculana (Poroleda)*sp. nov.	2	4	3		9	0.36
*Solamen (Exosiperna)*cf. *globularis* (Tate)				1	1	0.04
Sarepta planiuscula (Tate)	2	1		4	7	0.28
Nuculana (Saccella) chapmani Finlay	15	17	3	11	46	1.82
Limopsis zitteli Ihering juv.	9	4	1	2	16	0.63
Cardium ss. ll. sp.	38	23	1	2	64	2.53
?Eotrigonia sp. ind.juv.		1			1	0.04
Nemocardium sp. ind.	2	7		89	98	3.88

ALIA

Ahermatypic corals (very diversified), shark teeth, otoliths, fish bones and vertebrae. Echinoids, Anellida, sponge spicules, Brachiopoda.

DIVERSITY INDEXES

$N = 2526$ $N_s = 104$

$S_s = 104$ $S_g = 93$

$D_s = .9591$ $D_g = .9976$

	Gastropoda no.	Gastropoda %	Scaphopoda no	Scaphopoda %	Bivalvia no.	Bivalvia %	Total
Specimens	1.901	43.19	230	9.30	1.205	47.71	2.526
Species	75	72.12	4	3.85	25	24.04	104
Genera	67	72.04	4	4.30	22	23.66	93

VALVES	LV	RV	BV	vv	total
Epifaunal	170	148	1	1	320
Infaunal	348	318	61	152	879
Uncertain	-	-	-	6	6
Total	518	466	62	159	1.205
(%)	(42.99)	(38.67)	(5.15)	(13.20)	

BIVALVIA	%
Epifaunal	26.56
Infaunal	72.95
uncertain	.50

ARTICULATION RATIOS

	specs	index
Epifaunal	319	0.0000
Infaunal	818	0.0029
Aggregate	1.143	0.0015

DIFFERENTIAL TRANSPORT INDEXES

	specs	index	uncertainty index
Epifaunal	319	0.1150	0.0000
Infaunal	818	0.0381	0.0124
Aggregate	1.143	0.0284	0.0064

APPENDIX D

1. - Late discovered species of stratigraphic significance

2. - Notes on the Australian Eocene Nautiloidea

D - 1. LATE DISCOVERED SPECIES OF STRATIGRAPHIC SIGNIFICANCE

An ongoing project on the Late Eocene Molluscan faunas from the Buccleuch Beds (Padthaway Ridge, Murray Basin), begun in the first half of 1978 on behalf of the S.A. Department of Mines & Energy, resulted in the discovery of a number of micromolluscan genera which have different representatives in the Blanche Point Formation under the Adelaide City area (St. Vincent Basin) and in the Buccleuch Beds of the Padthaway Ridge. Since this discovery has an obvious and vital significance in the construction of a biostratigraphical framework for the Late Eocene of southern Australia, it was felt that the information derived from these forms ought to be included in this study. However, at that time, writing up of this thesis was already in its final stages. It was therefore considered more appropriate to deal with these meaningful species in an appendix, informally, and to limit their discussion to the morphological differences between the older Blanche Point and the younger Buccleuch forms and to their stratigraphic occurrences.

FAMILY	SCISSURELLIDAE Gray, 1847
GENUS	Scissurella d'Orbigny, 1824
SUBGENUS	Scissurella s. str.

OBSERVATIONS. Scissurella d'Orbigny was recorded in the Blanche Point Formation under the Adelaide City area (Adelaide Plains SubBasin) with Scissurella sp. nov. and in the lower Port Willunga Formation, Aldinga Member, and in the Buccleuch Beds with S. lamellularum sp. nov.

Scissurella sp. nov. is represented by a few juveniles, but differences in protoconch coiling and ornament suggest a different species from S. lamellularum.

DISTRIBUTION.	Scissurella sp. nov.	St. Vincent Basin, Adelaide Plains SubBasin, South Parklands CH-1A, 99-97 m, 85-83 m, 48.3-48 m.
	Scissurella lamellularum	See description of the species.

FAMILY CYCLOSTREMATIDAE Fischer, 1885

SUBFAMILY CYCLOSTREMATINAE Fischer, 1885

GENUS *Circulus* Jeffreys, 1865

OBSERVATIONS. This genus is represented in the Late Eocene of South Australia by three forms: the early-middle P16 *Circulus* sp. nov. *A*, the P17 *Circulus* sp. nov. *B* and the late P17 *Circulus* sp. nov. *C*. *Circulus* sp. nov. *A* and sp. nov. *B* are very close to each other. The former differs from the latter only in smaller protoconch and size (in relation to the whorl number), in rounder abapical-adaxial connection and in even spiral costellae, present also in the abapical margin; whereas, *Circulus* sp. nov. *B* has subangular adaxial-abapical connection, weaker abapical costellae, and two well interspaced and marked costae at the periphery.

Circulus sp. nov. *C*, co-occurring in the upper Buccleuch 'B' Beds with *Circulus* sp. nov. *B* is distinguished by the heavier spiral pattern (abaxial-adapical carina, abaxial spiral costae, weak abapical costellae) and by a rounded abapical-adaxial connection.

Circulus spp.novv. *A* and *B* appear to be related to the Palaeocene Anglo-Paris Basin *Circulus tenuiliratus* (Cossmann)(Glibert, 1973, p.29, pl.4, fig.7) because of their similar ornament pattern. On the other hand, *Circulus* sp. nov. *C*, although closer in umbilical morphology to the other two forms, shows greater affinity with the Palaeocene Anglo-Paris Basin *C. montensis* (Rutot, in Cossmann) (Glibert, *loc.cit.*, fig.4), which however displays a very angular abapical-adaxial connection.

The Pliocene *Partubiola depressispira* Ludbrook displays a congeneric similarity in protoconch and in ornament pattern with *Circulus* sp. nov. *C*, and because of its umbilical morphology, a closer affinity with C. *montensis*. Therefore, it should be referred to *Circulus* Jeffreys. The shell similarity to the above Paleogene species of the extant *Partubiola blancha* Iredale, type of *Partubiola* Iredale, and of the other Pliocene species, *P. varilirata* Ludbrook, strongly suggests a possible congenericity of Partubiola with Circulus.

DISTRIBUTION.

Circulus sp. nov. A: Adelaide Plains SubBasin, South Parkland Bore CH-1A. 48.30-48.00 (15 specimens) (Transitional Marls).

Circulus sp. nov. B: Tintinara Area School Bore 12, 88-86 m (1 spec.), 86-84 m (4 specs.), 84-82.50 (2 specs.), 81.50-80.00 m (4 specs.) depths.

Circulus sp. nov. C: Tintinara Area School Bore 12, 81.50-80.00 m depth (1 spec.)

GENUS Brookula Iredale, 1912

SUBGENUS Brookula s. str.

OBSERVATIONS. Brookula is represented in the Late Eocene by two species: Brookula sp. nov. A from the Blanche Point Formation and Brookula sp. nov. B from the Buccleuch Beds.

Brookula sp. nov. A differs from Brookula sp. nov. B in broader umbilicus, shorter spire, and more interspaced axial costae. These two species represent the oldest occurrence of the genus in Australasia. The oldest forms hitherto known are the New Zealand Early-Middle Miocene B. endodonta Finlay and the late Early Miocene B. pukeuriensis Finlay.

DISTRIBUTION.

Brookula sp. nov. A: St. Vincent Basin, Adelaide Plains SubBasin, South Parkland Bore CH-1 A, 35-35.3 m.

Brookula sp. nov. B: Tintinara Area School Bore, 12, 82.50-84.00 m, 80.00-81.50 m.

FAMILY CAECIDAE Gray, 1847

GENUS Strebloceras Carpenter, 1858

OBSERVATIONS. This genus is represented in the Late Eocene by two forms: Strebloceras sp. nov. from the Blanche Point Formation ('Transitional Marls') (Adelaide Plains SubBasin, St. Vincent Basin), and the already described Strebloceras darraghi sp. nov. from the Buccleuch Beds (Murray Basin) and the Aldinga Member, Port Willunga Formation (St. Vincent Basin).

S. darraghi differs from the older form in higher spire and deeper and narrower umbilicus. These two species represent the oldest record of the genus in Australasia. The only other fossil form known is the New Zealand Early Miocene S. hinemoa Finlay.

DISTRIBUTION.

Strebloceras sp. nov.: St. Vincent Basin, Adelaide Plains SubBasin,
West End Brewery CH-2 50.3-50.00 m (2 specs.),
South Parkland CH-1A, sludges, 44-42 m (12 specs.);
62-60 m, (1 spec.).

Strebloceras darraghi sp. nov.: See description.

FAMILY VITRINELLIDAE

GENUS Vitrinella C.B. Adams, 1850

Vitrinella ss. 11.

OBSERVATIONS. Two Late Eocene forms are referable to Vitrinella ss. 11. the Blanche Point Formation Vitrinella sp. nov. A and the Buccleuch Beds Vitrinella sp. nov. B.

Vitrinella sp. nov. A displays very high lamellose axial costae with narrow interspaces. Vitrinella sp. nov. B has prominent but short axial costae, subdued on the abaxial and, perhaps, larger in size. Both these forms display similar protoconch: one-whorled, heterostrophic-hyperstrophic, separated from the teleoconch by a suture.

The general shell morphology recollects those of: Munditiella Kuroda & Habe (Skeneinae), though the latter has a higher spire; Pondorbis Bartsch (Skeneinae), close also in flexuous costae; and Liotella Iredale (Cyclostrematinae), particularly the extant Liotella annulata (T. Woods) (Cotton, 1959, p.243, fig. 167). The hyperstrophic protoconch, however, is quite similar to those of Orbitestella Iredale and of the ?Elachorbis plicatella group. This would place these two forms in either Vitrinellidae or Orbitestellidae. At present, they are tentatively located in Vitrinella s.ll.

DISTRIBUTION.

Vitrinella s.ll. sp. nov. A: Adelaide Plains SubBasin, South Parklands Bore Bore CH-1A, sludges, 89-87 m and 77-75 m depths.

Vitrinella s.ll. sp. nov. B: Murray Basin, B.Q. Butler Bore 4, Hd Kirkpatrick, Sect.8, 125-122.05 m (1 spec.),125-118.77 m (1 spec.); Kiki Town Bore, Buccleuch Co., 103, 63-116.14 m (6 specs); Coonalpyn E&W Bore 2, Hd Coneybeer, Sect.56, 77.10-76.12 m (1 spec), 72.83-71.52 m (1 spec).Tintinara Area School Bore 12, Co Cardwell, Hd Coombe, 88-86 m (9 spec.),86-84 m (6 spec.) 84-82.50 m (12 specs), 81.50-80 m (3 specs), 80-78 m (1 spec).

FAMILY ARCHITECTONICIDAE

GENUS Pseudomalaxis Fischer, 1885

SUBGENUS Pseudomalaxis s. str.

Pseudomalaxis (Pseudomalaxis) sp. nov. aff. asculpturatus Maxwell.

FIGS. 372-375

MATERIAL. 6 specimens, partly damaged.

OBSERVATIONS. In comparison with the P15/16 P. ludbrookae and with P. asculpturatus Maxwell, this form appears to be closer to the latter. It is similar to P. asculpturatus in plain and very concave abapical region and flat abaxial margin. On the other hand, it differs in more marked and faintly crenulated carinae, in convex adapical margin and presence of a faint abaxial adapical spiral groove. This combination of crenulated carinae, convex adapical margin, and abaxial adapical spiral groove may indicate a development of characters precursory to the Neogene forms of Pseudomalaxis (see Buonaiuto, 1975, p.25, figs. 4a,b).

DISTRIBUTION. Murray Basin, Tintinara Area School Bore 12, 80-81.50 m and 78-80 m depths.

D - 2 NOTES ON THE AUSTRALIAN EOCENE NAUTILOIDEA

Although they are not dealt with in this study, the Australian Eocene Nautiloidea cannot be totally ignored because of their significance as palaeoclimatic indicators. However, since the possibility of post-mortem transport of Nautiloid shells over very long distances by tides and oceanic currents has been proven (Furnish & Glenister, 1964; Teichert, 1964; Stenzel, 1964), the validity of their use in the reconstruction of palaeoclimates in southern Australia rests entirely upon the demonstrability of their autochthony to this region. Yet this problem cannot properly be discussed without considering the known record of the Nautiloidea in the Australian Eocene.

Biostratigraphical observations

Only four genera and species have hitherto been recorded in the Australian Middle and Late Eocene: *Deltoidonautilus prora* (Glenister, Miller & Furnish), *Aturoidea brunnschweilleri* Glennister, Miller & Furnish, *Aturia clarkei* Teichert, and *Cimomia felix* (Chapman). All these four genera have a similar Tethyan-Atlantic-Eastern Pacific-Australian distribution (Sastry & Mathur, 1968; Kummel, Furnish & Glenister, 1964; Ruzhentsev *et al.*, 1962). The Late Jurassic-Oligocene *Cimomia* Conrad seems to have initially appeared in the Australian record in the Late Cretaceous (Glenister, Miller & Furnish, 1956) and disappeared by the end of the Late Eocene (McGowran, 1959; this study). The Late Cretaceous-Oligocene *Deltoidonautilus* Spath and *Aturoidea* Vredenburg initially appeared in the Middle Eocene and Paleocene, respectively, and both disappeared sometime during the Middle/Late Eocene (*loc. cit.*; Teichert, 1943). The Paleocene-Miocene *Aturia* Bronn represents the most recent 'immigrant' of the four, since its record is in the Middle to Late Eocene and its last record is from the Middle Miocene locality of Muddy Creek (Cockbain, 1968a; Glaessner, 1955).

The stratigraphic and geographic distributions of the nautiloid species present in the Australian Eocene are shown in the table below.

BASIN	STRATIGRAPHIC LOCATION	AGE	AUTHORS
	Deltoidonautilus prora		
Carnarvon	lower Giralia Calcaren-ite	Middle to early Late Eocene	Glenister, Miller & Furnish, 1956
	Jubilee Calcarenite	"	"
Norseman-South Coast	Plantagenet Group	early Late Eocene	Glenister & Glover, 1958
	Aturoidea brunnschweilleri		
Carnarvon	lower Giralia Calcaren-ite	Middle to early Late Eocene	" "
	Jubilee Calcarenite	"	" "
	Aturia clarkei		
Carnarvon	lower Giralia Calcaren-ite	Middle to early Late Eocene	as above; Cockbain, 1968a.
	Merlinleigh Sandstone	Middle to Late Eocene (°)	Cockbain, 1968a;(°) Quilty, 1974
Norseman-South Coast	Pallinup Siltstone	early Late Eocene	Cockbain, 1968a
St. Vincent Basin	lower and middle Blanche Point Formation	early-mid. Late Eocene	Glaessner, 1955; Cockbain, 1968a
	Tortachilla Limestone	early Late Eocene	as above
Otway	Browns Creek Formation	early-mid. Late Eocene	O.P. Singleton, 1967
	Clifton Formation (reworked specimen)	Lower Miocene	Glaessner, 1955; Cockbain, 1968a.
	Cimomia felix		
Norseman-South Coast	Plantagenet Group	early Late Eocene	Cockbain, 1968b
St. Vincent (Yorke Penin-sula)	Muloowurtie Formation (?)	Late Eocene	McGowran, 1959
St. Vincent (Eastern part)	Blanche Point Formation	early-mid. Late Eocene	McGowran, 1959; this study
	Tortachilla Limestone	early Late Eocene	as above
Otway	Browns Creek Formation (above, *Phygraea* horizon and below it within *Hantkenina* zone)	middle Late Eocene	McGowran, 1959; this study

A fifth nautiloid genus, the Upper Jurassic-Miocene *Eutrephoceras* Hyatt, is known in the Australian Early Cretaceous-Tertiary (Ludbrook, 1966; McGowran, 1959) but its Tertiary occurrence is restricted to a Paleocene (1 species) and a Late Oligocene-Middle Miocene incursion (3 species) (Teichert, 1943; McGowran, 1959; Darragh, 1970).

In particular, a more detailed nautiloid biostratigraphy can be drawn for the Eastern St. Vincent Basin. Field observations and the examination of the matrix of the specimens which are kept in collections of the S.A. Museum and of the Geology Department, University of Adelaide, revealed that: -

- *Aturia clarkei* and *Cimomia felix* are frequent and co-occur in the Tortachilla Limestone s. str., in the 'Transitional Marl' Member where they show an acme and in the middle and upper Gull Rock Member.
- they are not recorded in the *Phygraea tarda* and Bryozoa horizons (lower Gull Rock Member);
- in the 'Soft Marl' Member *A. clarkei* is not found, but *C. felix* still occurs in patches of individuals clustered together.

Paleoclimatological observations

The paleobiogeographic distribution of the four genera, their biostratigraphical occurrences linked with the Australian palaeoclimatic curves, suggest that: (a) *Aturia* and *Cimomia* were able to live in both tropical and subtropical waters, with *Cimomia* showing a higher eury-thermality; (b) *Deltoidonautilus* and *Aturoidea* restricted to tropical waters, with *Aturoidea* showing the higher stenothermality, since their first occurrences in Australia appears to be linked with the climatic optima of the Paleocene and the Middle Eocene, as suggested by the brief appearance of *Aturoidea* and *Eutrephoceras* in the Paleocene of the Otway Basin (Teichert, 1943) and by the restricted northern distribution of *Aturoidea* in the Middle-Late Eocene.

To support the hypothesis of a climatic control in the occurrences of the Australian Tertiary Nautiloidea, the analysis of the vertical and horizontal distribution of the Eocene species in the western and southern Australian margins revealed the following:

Four distinct nautiloid assemblages can be distinguished in time and place :

- the northern middle to Late Eocene *Deltoidonautilus-Aturoidea-Aturia*, Carnarvon Basin;
- the south-western early Late Eocene *Deltoidonautilus-Aturia-Cimomia* Norseman-South Coast;
- the southern early-middle Late Eocene *Aturia-Cimomia*, St. Vincent, and Otway Basins;
- the southern middle Late Eocene monotypic *Cimomia* assemblage.

These assemblages indicate a decreasing diversity related to time and latitude. This trend appears consistent with the general climatic deterioration from the middle to the Late Eocene and with the present distribution of *Nautilus*, the only extant genus today, which shows similar climate controlled diversity gradient. In fact, four of the five living 'species' are distributed in a NW-SE intertropical belt from the Philippines to the Samoa Archipelago; the fifth species, *Nautilus repertus* Iredale is the only subtropical form and occurs alive off the South Australian Coast (Stenzel, 1964).

Suggested eurythermality and stenothermality of the Australian Tertiary Nautiloidea, as inferred by their paleogeographic and stratigraphic record.

Stenothermality ↑

Eutrephoceras
Aturoidea
Deltoidonautilus
Aturia
Cimomia

Eurythermality ↓

Autochthony of the Australian Eocene Nautiloidea

Reyment (1958), Stenzel (1964), Furnish & Glenister (1964), and Teichert (1964) discuss exhaustively the problems in using the Nautiloidea for palaeoecological and palaeoclimatological interpretations. The main problem in regard to autochthony is the post-mortem drift of nautiloid shell over distances which may extend up to 2.900-7.000 km (Stenzel, 1964; Furnish & Glenister, 1964). The post-mortem drift in nautiloids is controlled by the buoyancy of their shells, which depends in its turn upon several factors: soundness of the shell, wall thickness, size and shape of the body chamber, the presence/absence on the shell of encrusting organisms, the temperature and the salinity of the waters, the hydrodynamic properties of the shell, the rate of shell corrosion in water, etc. (for detailed discussion see Reyment, 1958).

Since all the four genera present in the Eocene have a long, if disjunct, record in the Australian Tertiary, and since all of them are represented by species precinctive to the Australian region, it would be very difficult to deny the possibility of nautiloid populations living at least at drift range from the Australian coasts during that time.

In regard to the possibility of nautiloid populations off the Australian coasts during the Eocene, there are a number of indications pro and against it.

The streamlined shells of Deltoidonautilus and, to a lesser degree, of Aturia favour sinking rather than long distance transport. Stenzel (1935) believed that Aturia in the Texas Eocene was deposited after having drifted, after death, from the deeper parts of the Gulf of Mexico, which does not entail great distances.

The shell shape of Cimomia and Aturoidea is, on the contrary, favourable to buoyancy, and thus to long distance transport. However, the shell drift would more than likely have been restricted to the gyre of the ProtoSouthern Ocean by the South Tasman Rise on the East, as suggested by the late arrival in the western and southern Australian basins of Aturia, which is already present in the Late Paleocene of New Zealand (Fleming, 1945, 1966). A westward shell drift would also be limited by the Eocene analogue of the Western Australian current (Fig. 19). The Western Australian Current analogue may also have allowed a S-N drift along the Western Australian coasts. The resulting distribution might have been similar to that of the living Nautilus repertus Iredale. A N-S drift would have been possible only by shoreline and tidal currents, which would imply a rather short transport prior to the stranding or the sinking of shells. Another possibility, involving long distance floating, would be shell transport by the analogue of the West Wind Drift. This possibility would locate the possible origin of the two nautiloids off the Antarctic or the South American coasts.

However, there is some evidence against the latter hypothesis. Possible cracks in the shell of Cimomia and Aturoidea, due to faulty mantle secretion (Reyment, 1958), may expedite the decay of the shell conchyolin, thus favouring a rapid perforation of the walls. Analogously, the thinness and fragility of the Aturia shells make them predisposed to organic decay and also to damage by impact (Teichert, 1964). Both factors would cause an early sinking of the shells. The absence of encrusting organisms in most of the specimens observed suggests a short span of time between the death of the individual and the final entombment of its shell, which would again infer the possibility of a short transport only.

The frequency of Cimomia and Aturia in the horizons of Blanche Point Formation in which they are known to occur, might find an explanation in Reyment's 1958 hypothesis of a possible predation on nautiloids which would bring about the immediate sinking of the damaged shell. Although no predation marks have been noticed, several of the observed and figured specimens display a missing or damaged body chamber, prior to fossilization. This, however, may also be due to the dragging of the shell against the sea bottom after sinking or to wave action and impacts after being stranded (Reyment, 1958).

Finally, the Middle-Late Eocene N-S diversity gradient observed in the Nautiloids would be against long distance transport as a sole explanation to their presence in the Eocene deposits, because it would rather favour a haphazard accumulation of shells of forms characteristic of different climatic belts. In this case, the co-occurrence of 'sinkers', i.e. Aturia and Deltoidonautilus, together with 'floaters', i.e. Cimomia and Aturoidea, indicates a mixed tanathocoenosis, composed of elements living in deep waters ('floaters') and of elements selective for shallower waters, probably from areas adjacent to their place of entombment.

In conclusion, the hypothesis of autochthony for the Australian Eocene Nautiloidea appears simpler and, therefore, more probable than allochthony.

Finally, taking into account the palaeoenvironmental interpretation of the Eastern St. Vincent Basin, as suggested by the other Molluscan Phyla, the Tortachilla Limestone specimens were probably deposited as a result of shell stranding and those in Blanche Point Formation as a result of shells sinking.

A P P E N D I X   E

J.M. Lindsay

B.J. Cooper

(personal communications)

J.M. Lindsay, S.A. Department of Mines & Energy

Personal communication

'One small, broken half-specimen of *Hantkenina* sp. has been recovered recently from a small amount of fossiliferous limestone matrix in and around a specimen of '*Notostrea lubra*' from the Wilson Bluff Limestone, Eucla Basin. Details of the sample are: S.A.D.M.E. Palaeontology Catalogue No. F186/54, collected by I.R. Campbell, S.A.D.M. 1954, from coastal cliffs 12-15 miles (19-24 km) east of Eucla (i.e. 4-7 miles or 6-11 km east of Wilson Bluff, S.A.) at 83 feet (25.3 m) above sea level. Another sample, F185/54 is described as having the same locality and height above sea level, but lacks *Hantkenina*.

When key parameters are plotted, *Hantkenina* sp. shows morphological affinities both with *H. primitiva* from a thin zone in the Late Eocene of the St. Vincent Basin (Zone P15, top), and with *H. australis*, from basal Wilson Bluff Limestone, Middle Eocene (Zone P12) of the Eucla Basin. However this preliminary examination suggests that the specimen is morphologically closer to *H. australis* because of its relatively low apertural height ratio and its stout tubulospines.

The associated and rather limited foraminiferal faunas in F185/54, F186/54, lack any species restricted to the Middle Eocene part of the Wilson Bluff Limestone, particularly spinose acarininids such as *A. primitiva*; but such negative evidence should be treated with caution. *Globorotalia (Turborotalia) insolita* which is common in both samples might favour a Late Eocene rather than a Middle Eocene age from its presently known range. Other species present such as *Globigerinatheka index*, *Subbotina linaperta*, *Chiloguembelina cubensis*, and the benthonic *Maslinella chapmani*, do not discriminate between Middle and Late Eocene. Neither *Tenuitella aculeata* nor *Truncorotaloides collactea* were found;

which could imply either poor and unsuitable planktonic facies, or a Late Eocene stratigraphic position above the range of Tr. collactea and within the gap in the disjunct range of T. aculeata. Thus, if anything, the foraminiferal fauna associated with Hantkenina sp. favours a Late rather than Middle Eocene age, but the evidence is inconclusive and a Late Eocene age would tend to conflict with the specimen's likeness to H. australis, a species which is typically (but probably not exclusively) Middle Eocene.

Stratigraphically, at 83 feet (25.3 m) above sea level, and with Wilson Bluff Limestone extending below sea level in this area, it is almost certain that Hantkenina sp. is well above the Hantkenina event at the base of Wilson Bluff Limestone (Zone P12). On the other hand the specimen cannot be identified with any certainty with the Hantkenina event at top Zone P15 in the St. Vincent Basin. The individual may represent an intermediate level of Middle to Late Eocene age, with a poorly preserved associated microfauna. Alternatively, Hantkenina sp. could be a peripheral morphotype in a population of H. primitiva of much the same age as in the St. Vincent Basin. Detailed sampling of this section of Wilson Bluff Limestone is needed to resolve the matter.'

J.M. Lindsay
29/3/78

B.J. Cooper, S.A. Department of Mines & Energy
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WILLUNGA EMBAYMENT BOREHOLE WLG 40
(Project QA16)

The succession from 55 m to 74 m in QA16 correlates with the Aldingan unit of the Port Willunga Beds (Lindsay, 1967) and is Late Eocene in age. The topmost beds of the unit (55-56 m) lack Turborotalia aculeata and probably correlate with the Subbotina linaperta Zone of Lindsay (1969) and with the P17 zone of Blow (1969). The remainder of this interval correlates with the T. aculeata Zone of the local zonal scheme and with P16 on the international scale.

B.J. Cooper
8/11/76

APPENDIX F

PUBLISHED PAPERS

1975 - Notes on the genus *Pseudomalaxis* (Mollusca: Gastropoda) and its fossil species in Australia. Trans. R. Soc. S. Aust., 99 (1), pp.21-30.

1977a - Revision of the Australian Tertiary species ascribed to *Limatula* Wood (Mollusca: Bivalvia). Trans. R. Soc. S. Aust., 101 (1), pp. 21-33.

1977b - Revision of the composite species *Lima bassi* Tenison Woods (Mollusca: Bivalvia). Trans. R. Soc. S. Aust., 101 (3), pp. 75-83.

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PLATES

ERRATA - CORRIGE

Explanation of figures

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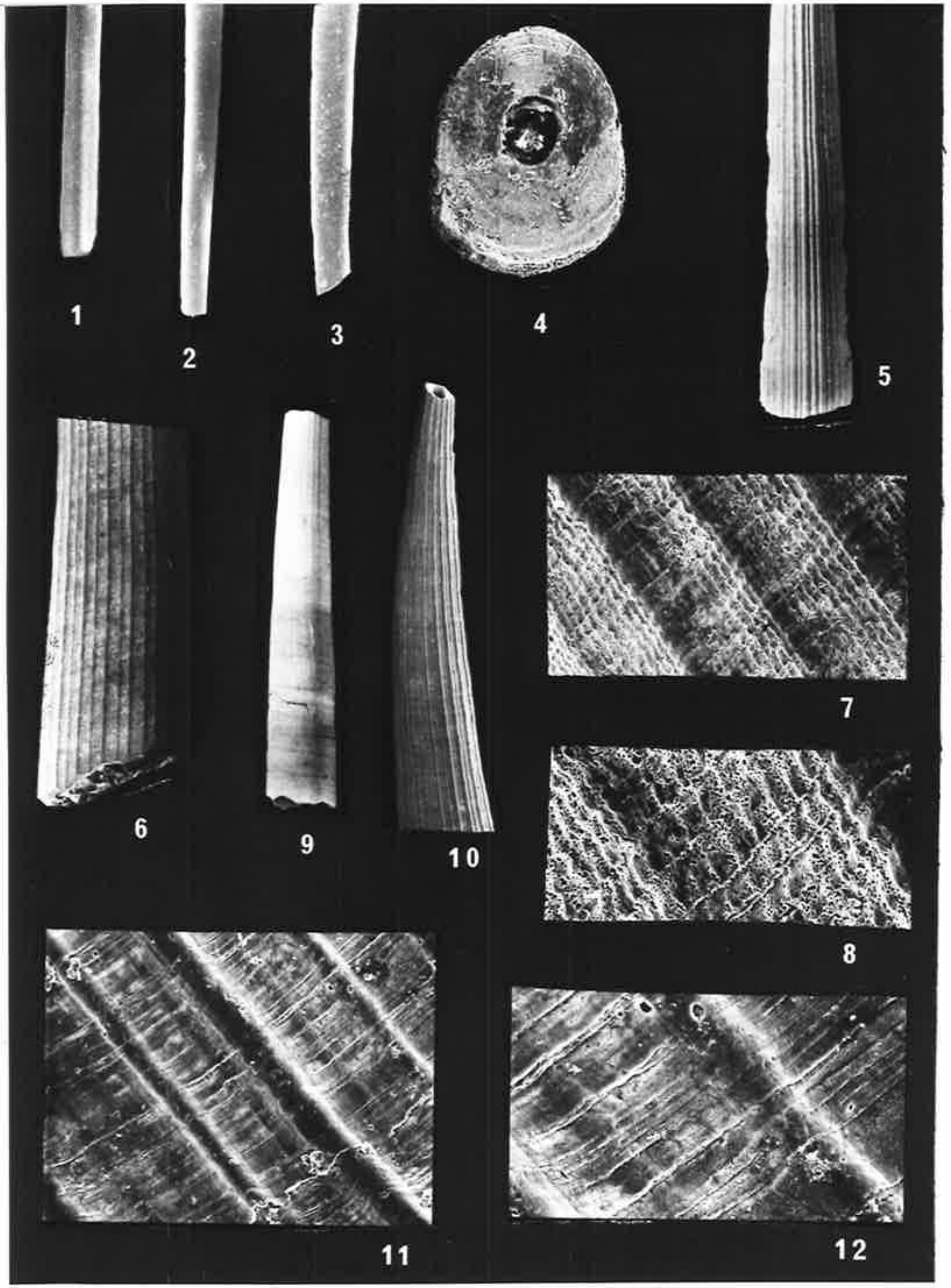
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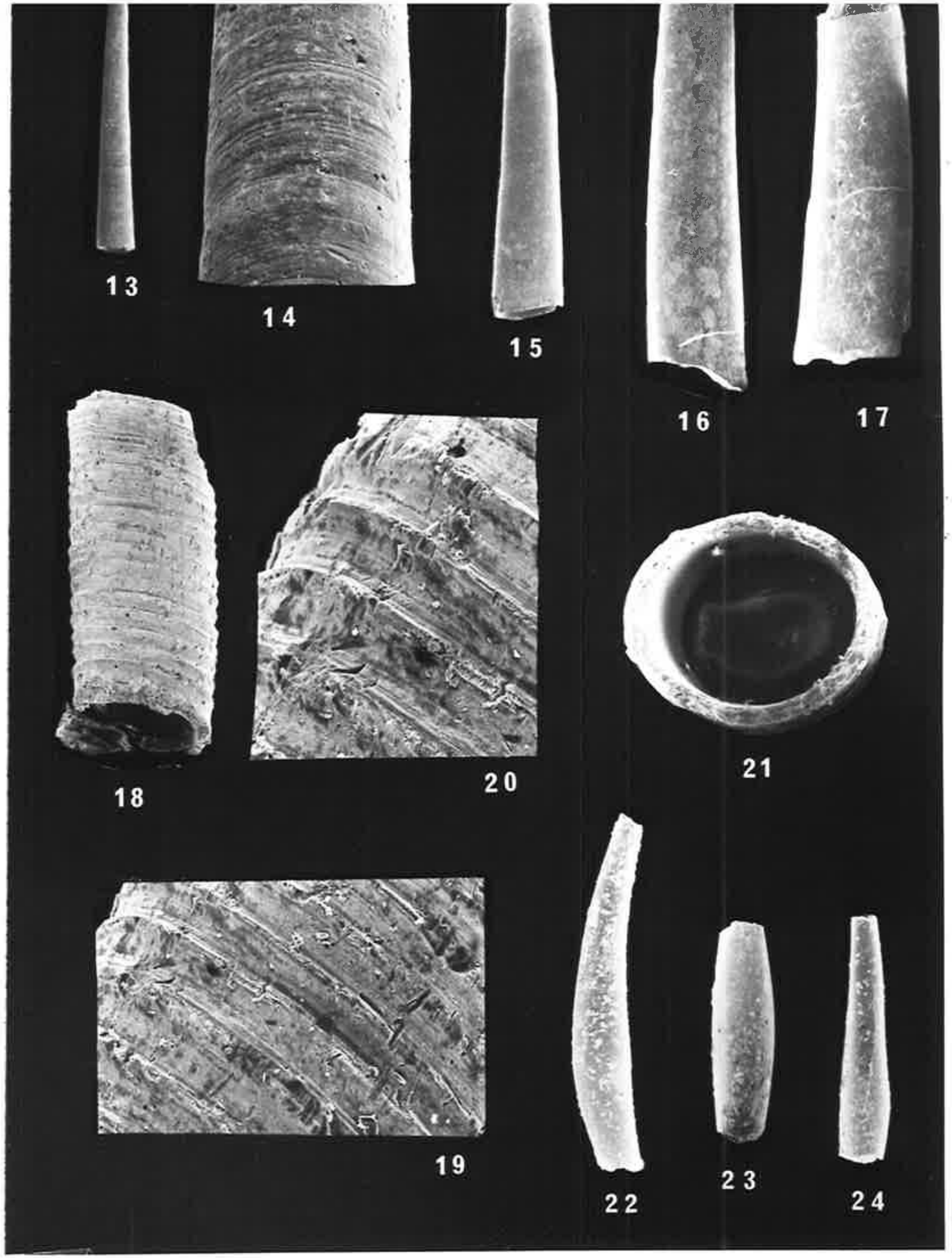
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FIGS. 25-28 Mikadotrochus purkabidni sp. nov. , holotype (SAM P 21267): 25) impression (x 1.3); 26) its latex cast (x 1.1); 27) mould, axial view (x 1.3); 28) same mould, abapical view (x 1.3).

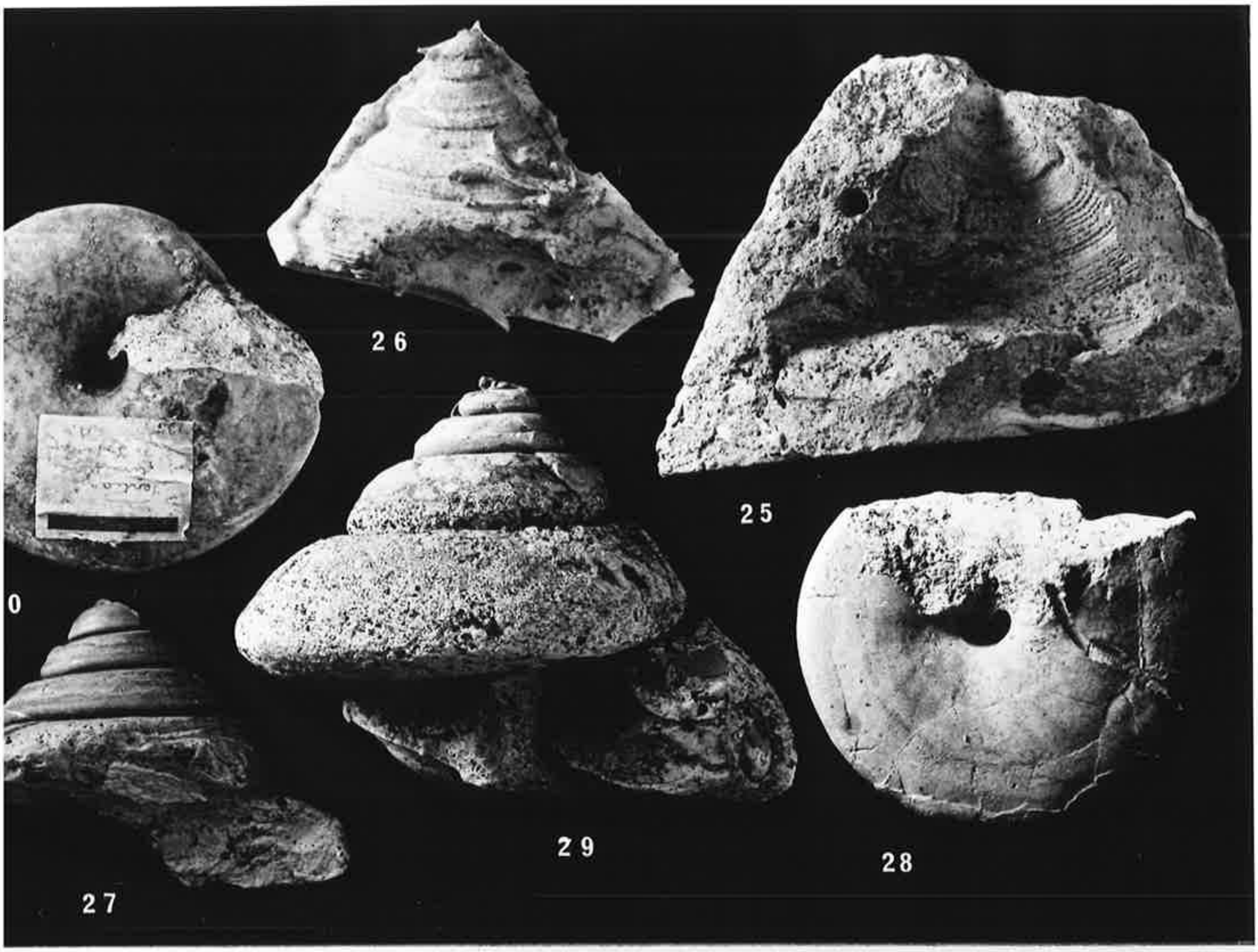
FIG. 29 Mikadotrochus cf. purkabidni sp. nov. (SAM P 21268), mould, axial view (x .80).

FIG. 30 Perotrochus sp. (SAM P 21270), Pt. Vincent Limestone, unknown locality and age, Yorke Peninsula, abapical view (x 70).

FIGS. 31-33 M. purkabidni sp. nov. (SAM P 21267B), paratype, Blanche Point Formation: 31) axial view (x .85); 32) adapical view (x .75); 33) abapical view (x .75).

FIG. 34 M. purkabidni sp. nov. (SAM P 21267C), paratype, axial view (x .85).

FIG. 35 M. cf. purkabidni sp. nov. (SAM P 21268), Tortachilla Limestone, abapical view (x .80).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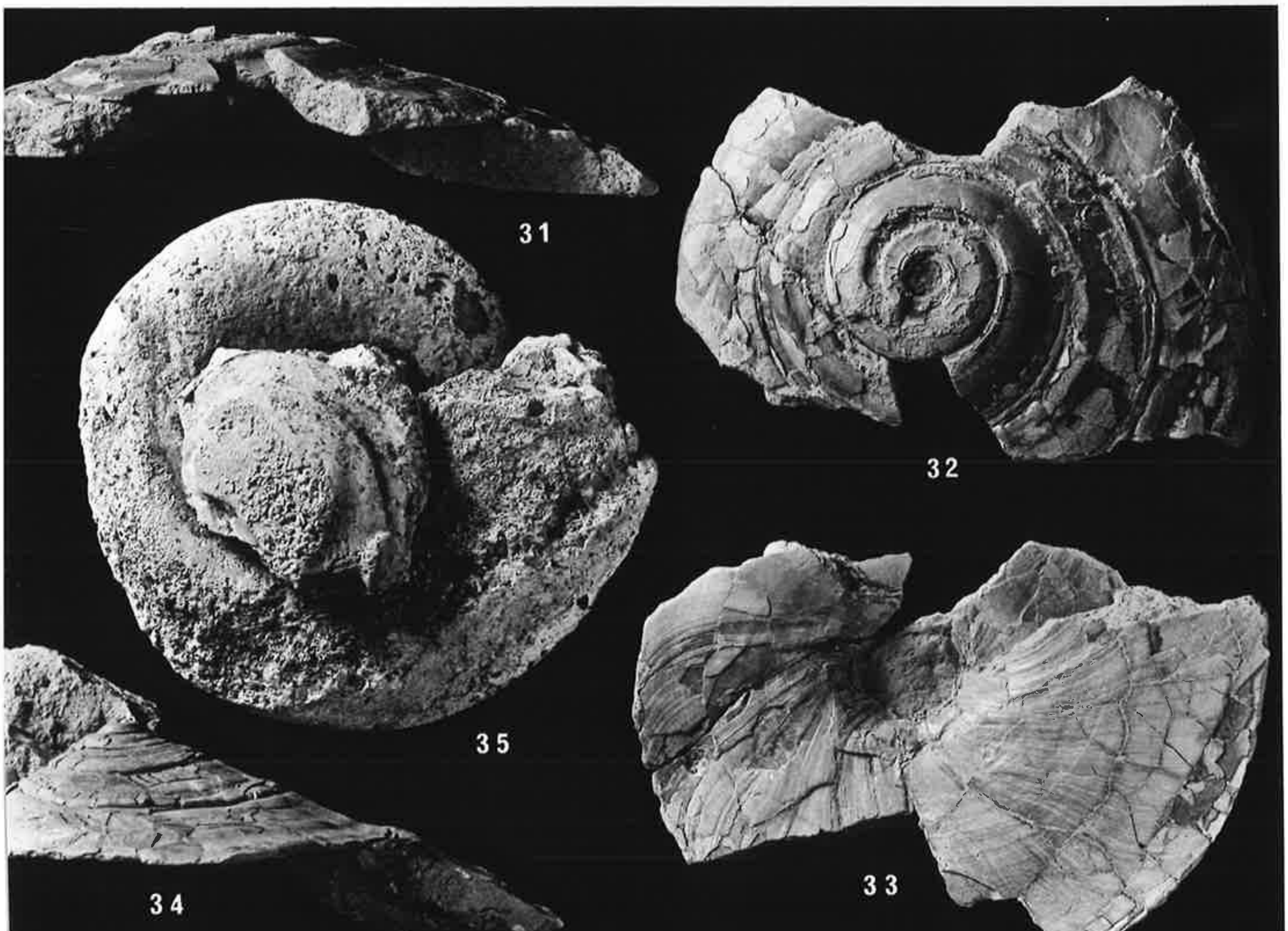
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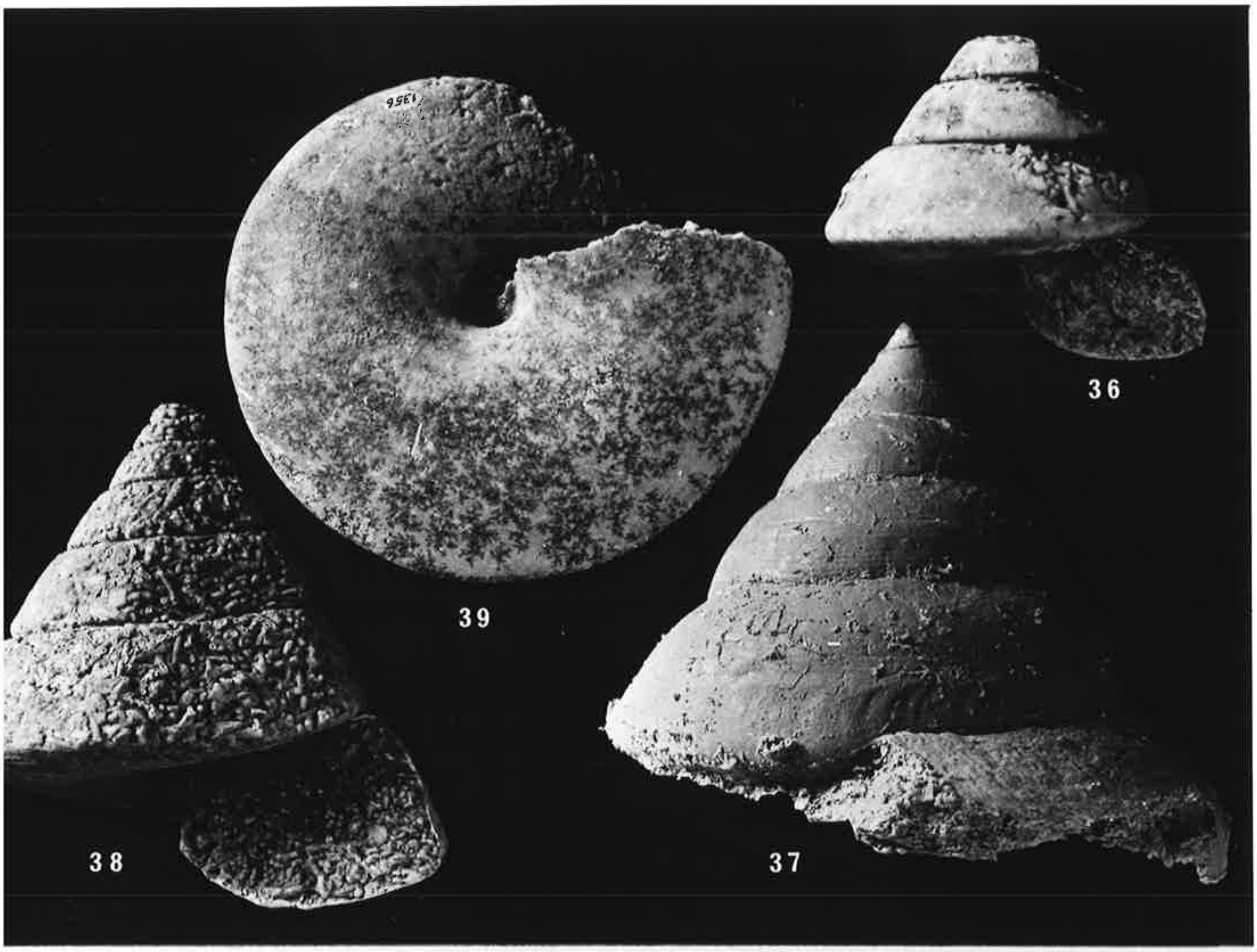
FIG. 36 *Perotrochus* sp. (SAM P 21270), axial view (x .75).

FIG. 37 *Perotrochus* cf. *tertiarius* (McCoy) (SAM P 21269), Gambier Limestone, ?Oligocene, Pritchard's Quarry, axial view (x .77).

FIGS. 38-39 *Mikadotrochus* sp. (AUGD 1356), Pt. Vincent Limestone, age unknown, Stansbury, Yorke Peninsula: 38) axial view (x .77); 39) abapical view (x .77).

FIGS. 40-41 *Perotrochus ?darraghi* sp. nov. SAM P 13113. Views: 40) abapical (x .70); 41) axial (x .75). To note: 41) on the upper right, traces of ornament; 40) traces of umbilical features.

FIGS. 42-44 *Mikadotrochus* sp. nov. NMV P 42704. Views: 42) axial (x 3); 43) adapical (x 4); 44) abapical (x 4).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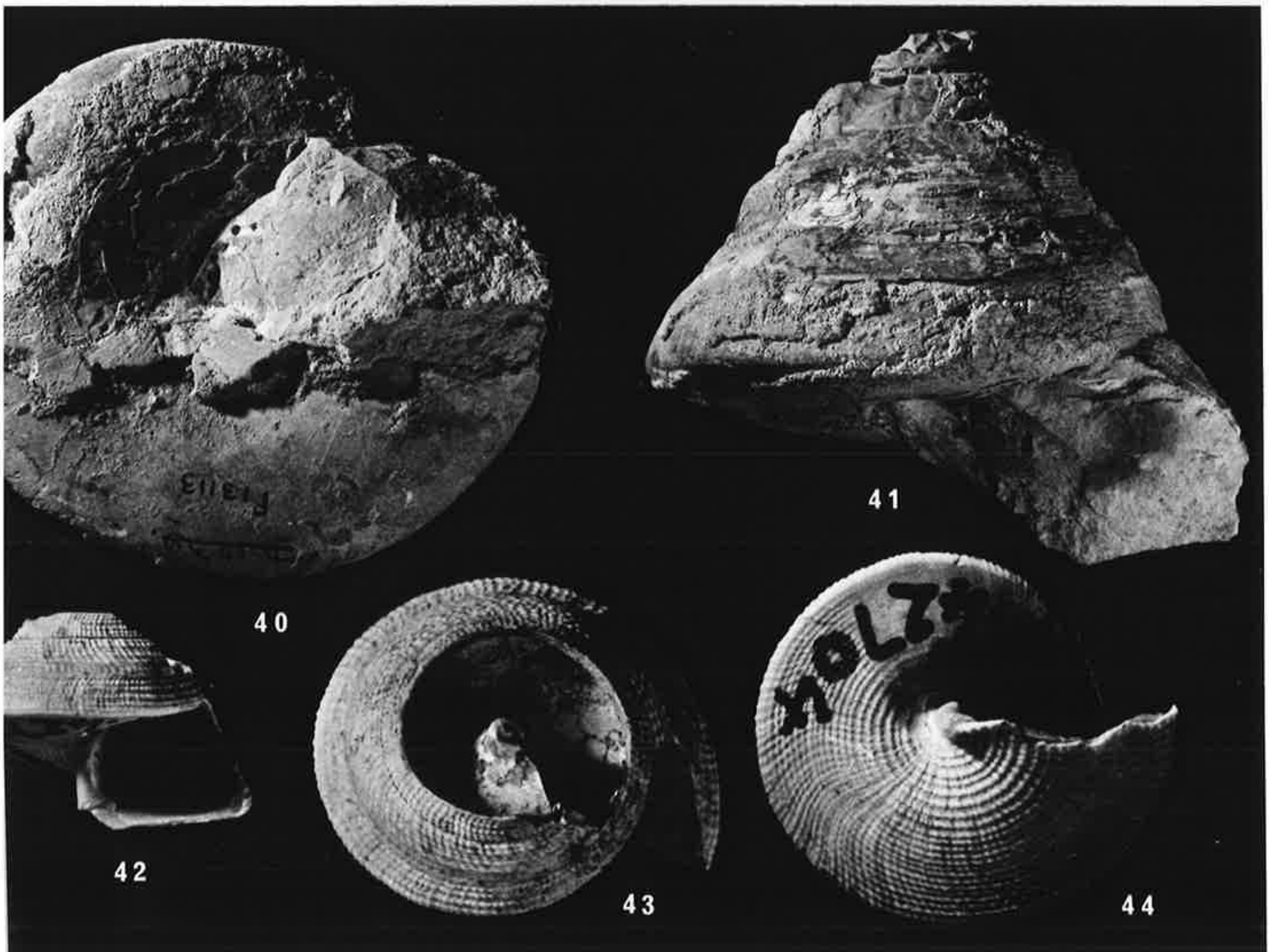
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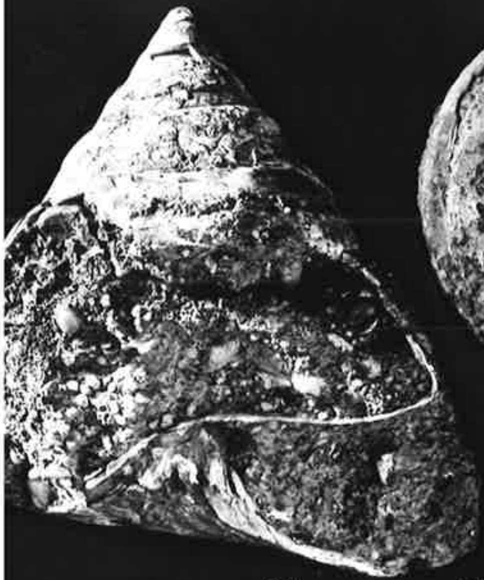
FIGS. 45-47 Perotrochus tertiarus (McCoy), NMV P 42701. Views: 45) axial oral (x .70); 46) abapical (x .75); 47) axial aboral (x .65).

FIGS. 48-49 Mikadotrochus cf. bassi (Pritchard), NMV P 42703. Views: 48) axial (x 2); 49) abapical (x 2).

FIGS. 50-52 Perotrochus darraghi sp. nov., NMV P 42702. Views: 50) axial (x .95); 51) abapical (x 1.1); 52) adapical (x 1.0).

FIGS. 53-54 Perotrochus cf. tertiarius (McCoy) juv., NMV P 42705: 53) axial view (x 7.5); 54) particular ornament and selenizone (x 30).



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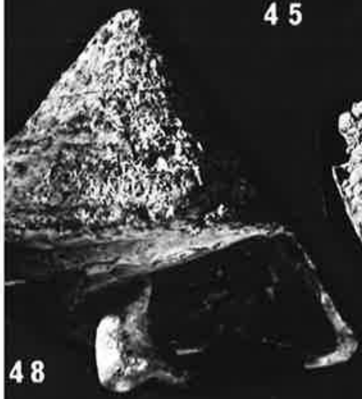

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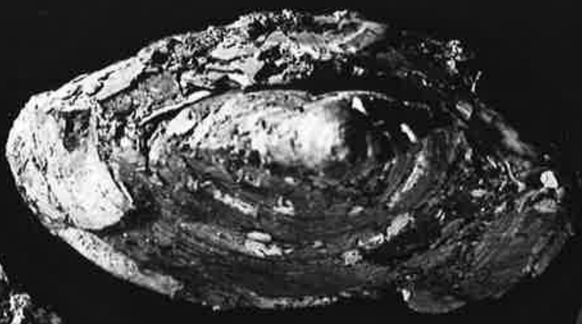

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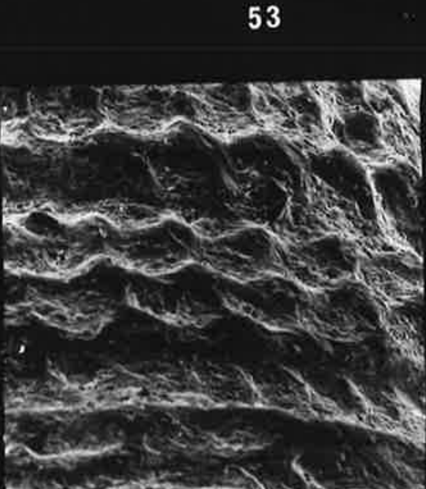

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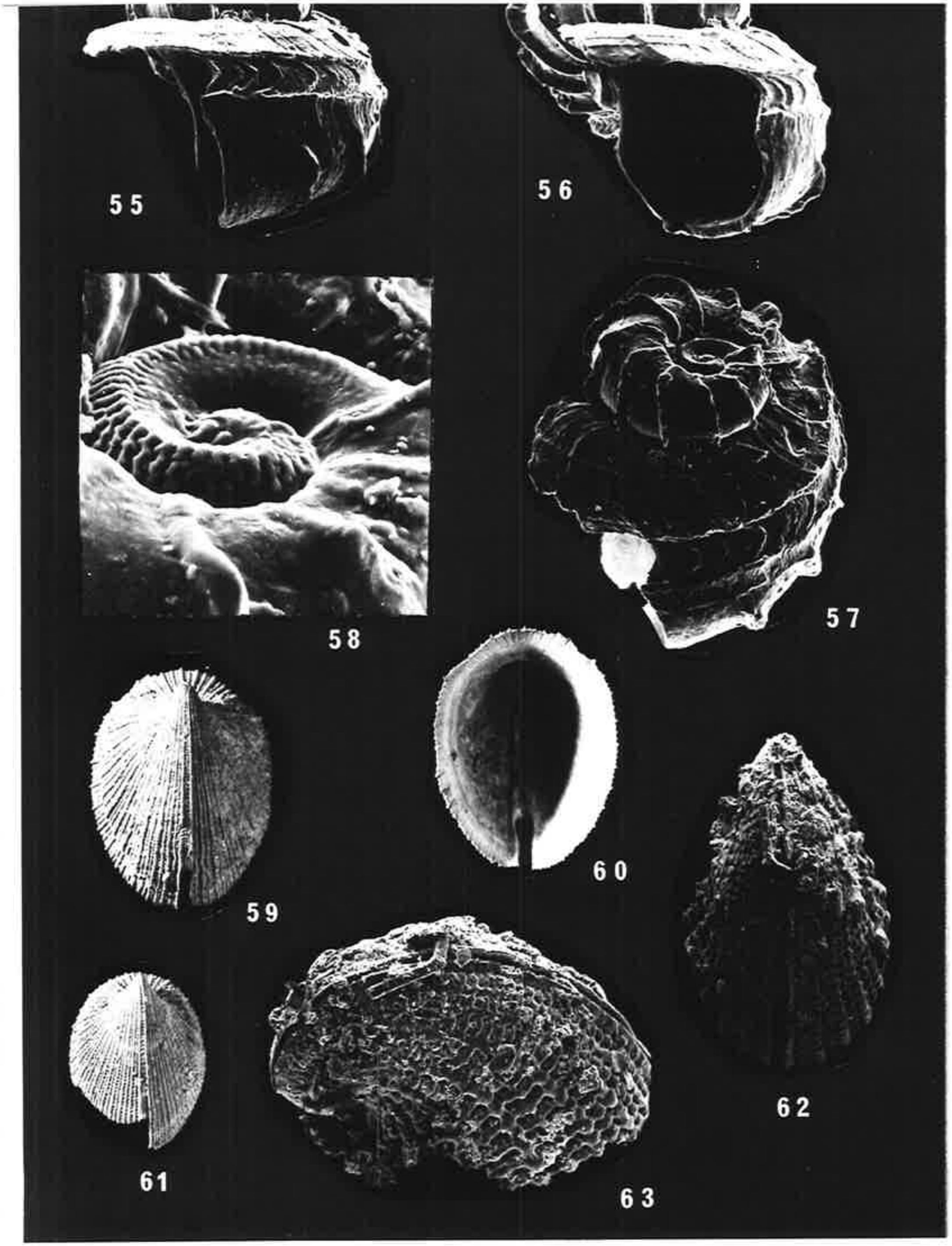
FIGS. 55-58 Scissurella (Scissurella) lamellularum sp. nov., GSSA M 3325. 55) axial, dorso-oral view (x 70); 56) oral view (x 70); 57) adapical view, tilted (x 70); 58) protoconch (x 300).

FIGS. 59-63 Emarginula (Emarginula) imbricata sp. nov. Holotype, SAM P 21271-A: 59) dorsal view (x 2.45); 60) oral view (x 2.45). Paratype, SAM P 21271-B: 61) dorsal view (x 2.45). Paratype, SAM P 21271-C: juvenile: 62) dorsal view (x 32); 63) lateral view (x 40).

FIGS. 64-67 Margarites (Periaulax) rhysus sp. nov. M.margaritatus Holotype. SAM P 21272-A: 64) axial view (x 10); 65) abapical view (x 10). SAM P 21272-B: 66) adapical view (x 10); 67) protoconch (x 60).

FIGS. 68-71 Margarites (Periaulax) rhysus sp. nov., m. laevigatus. SAM P 21273-A: 68) axial view (x 10); 69) abapical view (x 10); SAM P 21273-B: 70) adapical view (x 10); 71) protoconch (x 40).

FIGS. 72-73 Olivia sp. nov. 72) SAM P 21274-A: axial view (x 10); 73) SAM P 21274-B: protoconch and early whorls (x 60).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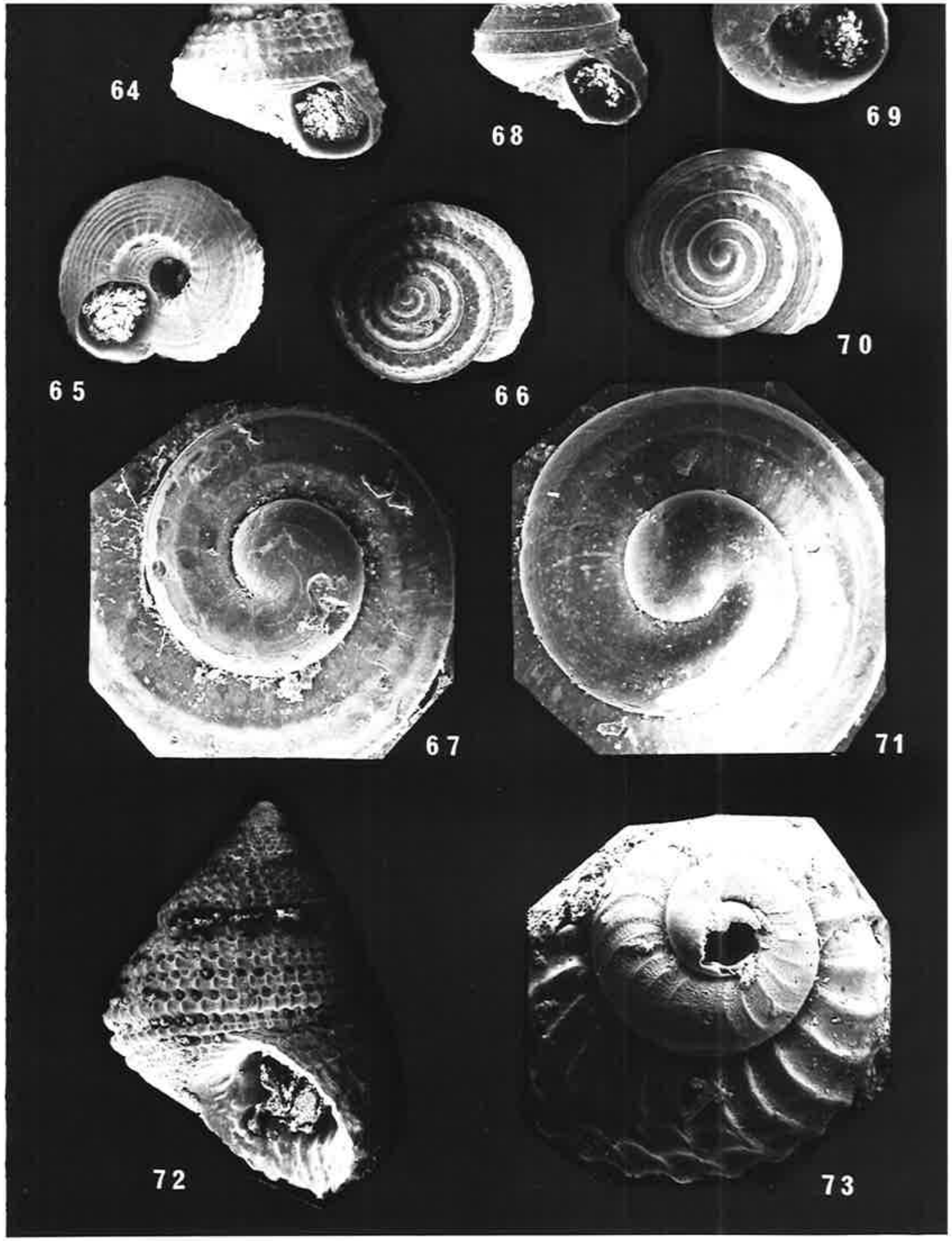
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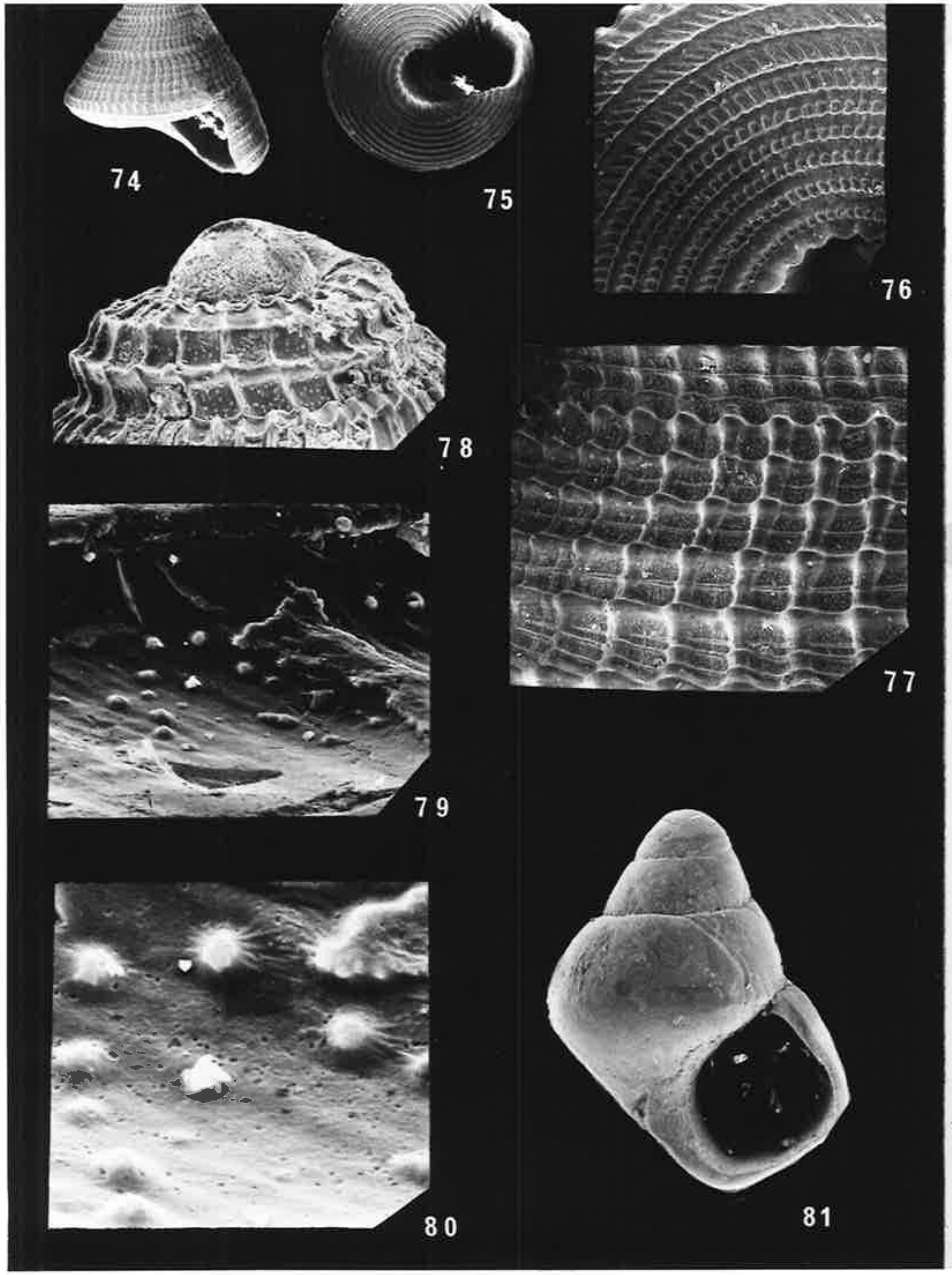
FIGS. 74-80 *Basilissa (Basilissa) cossmanni* Tate, GSSA M 3446. Views: 74) axial (x 10); 75) abapical (x 10); 76) abapical ornament, particular (x 30); 77) last whorl ornament, particular (x 50); 78) protoconch (x 110); 79) pustulate interspaces, particular (x 600); 80) micro-pustulae, particular (x 2000).

FIG. 81 *Gastropoda* gen & sp. ind. GSSA M 3447, axial view (x 10).

FIGS. 82-85 *Calliostoma (Fautor) allasinazi* sp. nov., Paratype, SAM P 18345-C; 82) axial view (x 10); 83) abapical view, tilted (x 10); 84) protoconch (x 100). SAM P 18345-A; holotype, worn surface; 85) axial view (x 2.45).

FIGS. 86-90 *Guildfordia (Pseudastralium) maslinensis* sp. nov. Holotype, SAM P 18346-B: 86) axial view (x 2.25); 87) abapical view (x 2.25); 88) adapical view (x 2.25). Paratype SAM P 18346-C: 89) axial view (x 2.25). Paratype M 3448, juvenile: 90) protoconch (x 140).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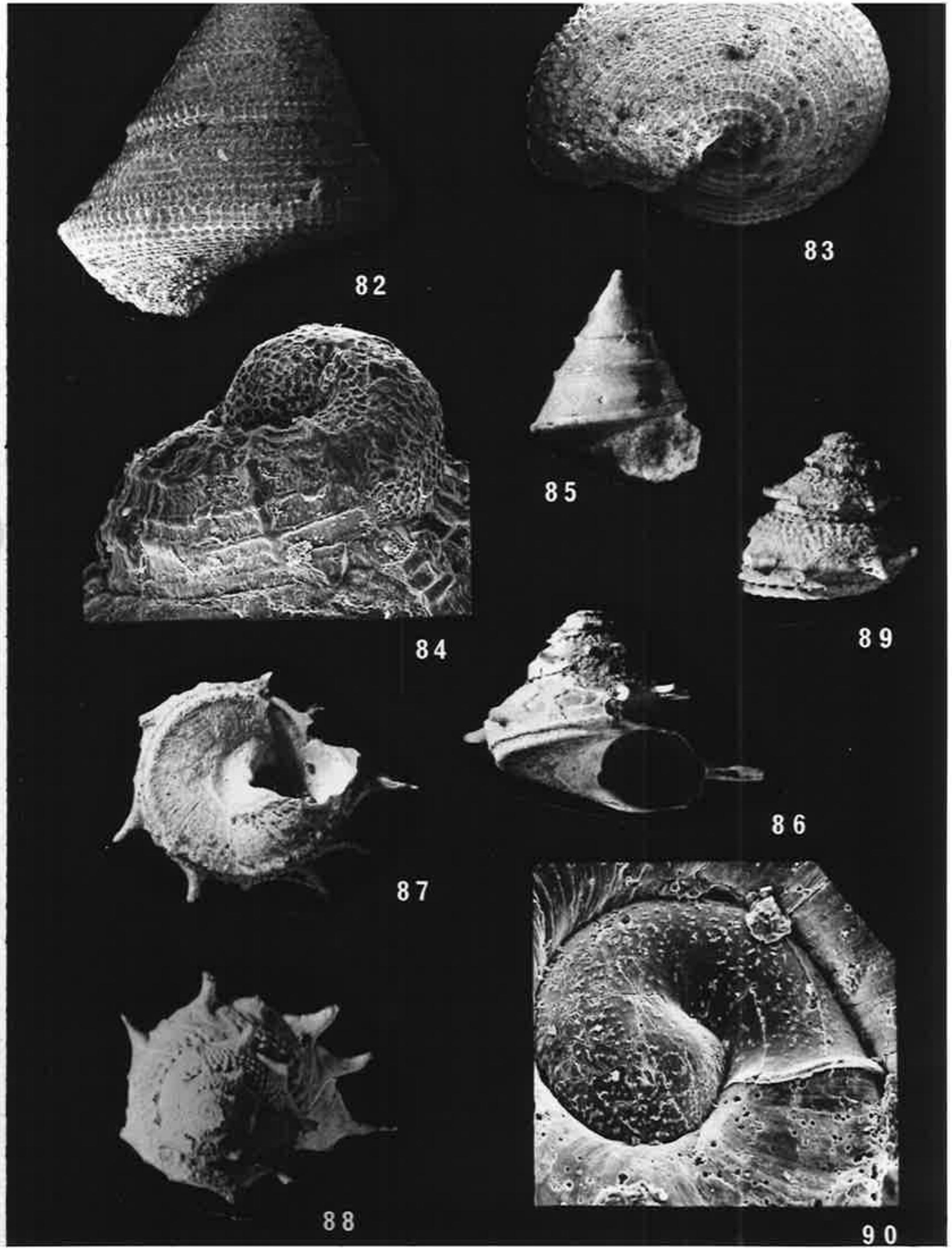
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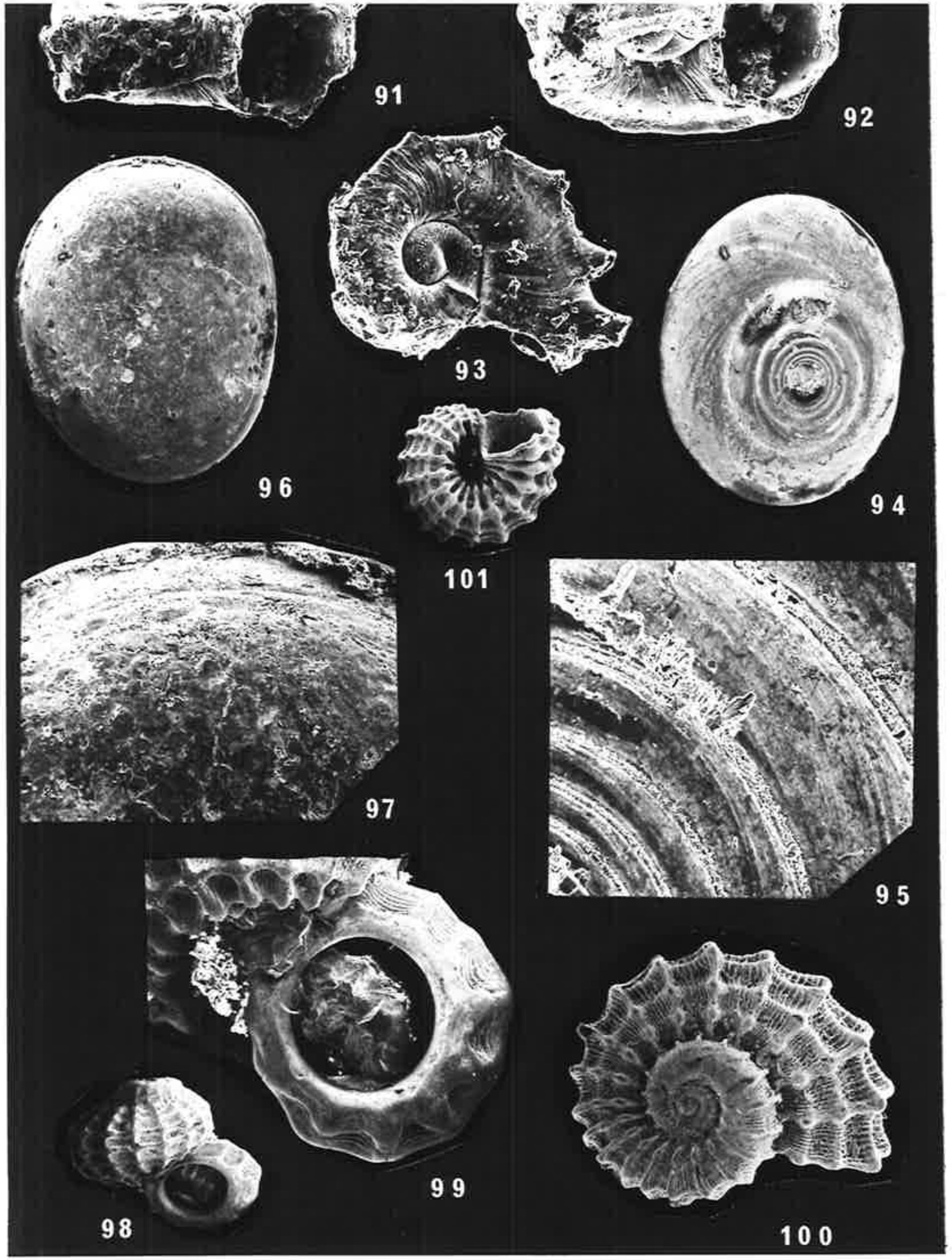
FIGS. 91-97 Guildfordia (Pseudastralium) maslinensis sp. nov. Paratype GSSA M 3448: 91) axial view (x 40); 92) abapical view, tilted (x 40); 93) adapical view (x 40). Opercula. SAM P 18346-Q: 94) outer surface (x 10); 95) particular whorls and suture (x 60) SAM P 18346-R: 96) inner surface (x 10); 97) particular inner surface (x 30).

FIGS. 98-101 Liotina (Austroliotia) intermedia sp. nov. Holotype, GSSA M 3449; 98) axial view (x 10); 99) peristome and umbilicus (x 20). Paratypes: 100) GSSA M 3450, adapical view (x 20); 101) GSSA M 3451, abapical view (x 10).

FIG. 102 Liotina (Austroliotia) intermedia sp. nov. Paratype GSSA M 3450, protoconch (x 50).

FIGS.103-105 Liotina (Austroliotia) ampla sp. nov. Holotype, GSSA M 3454: 103) axial view (x 20); 104) abapical view, tilted (x 20); 105) adapical view, tilted (x 20).

FIGS. 106-110 Liotina (Austroliotia) stricta sp. nov. Holotype, GSSA M 3452: 106) axial view (x8.8); 107) abapical view, tilted (x8.85); 108) particular last whorl ornament (x 30). Paratype GSSA M 3453: 109) adapical view (x 10); 110) protoconch (x 60).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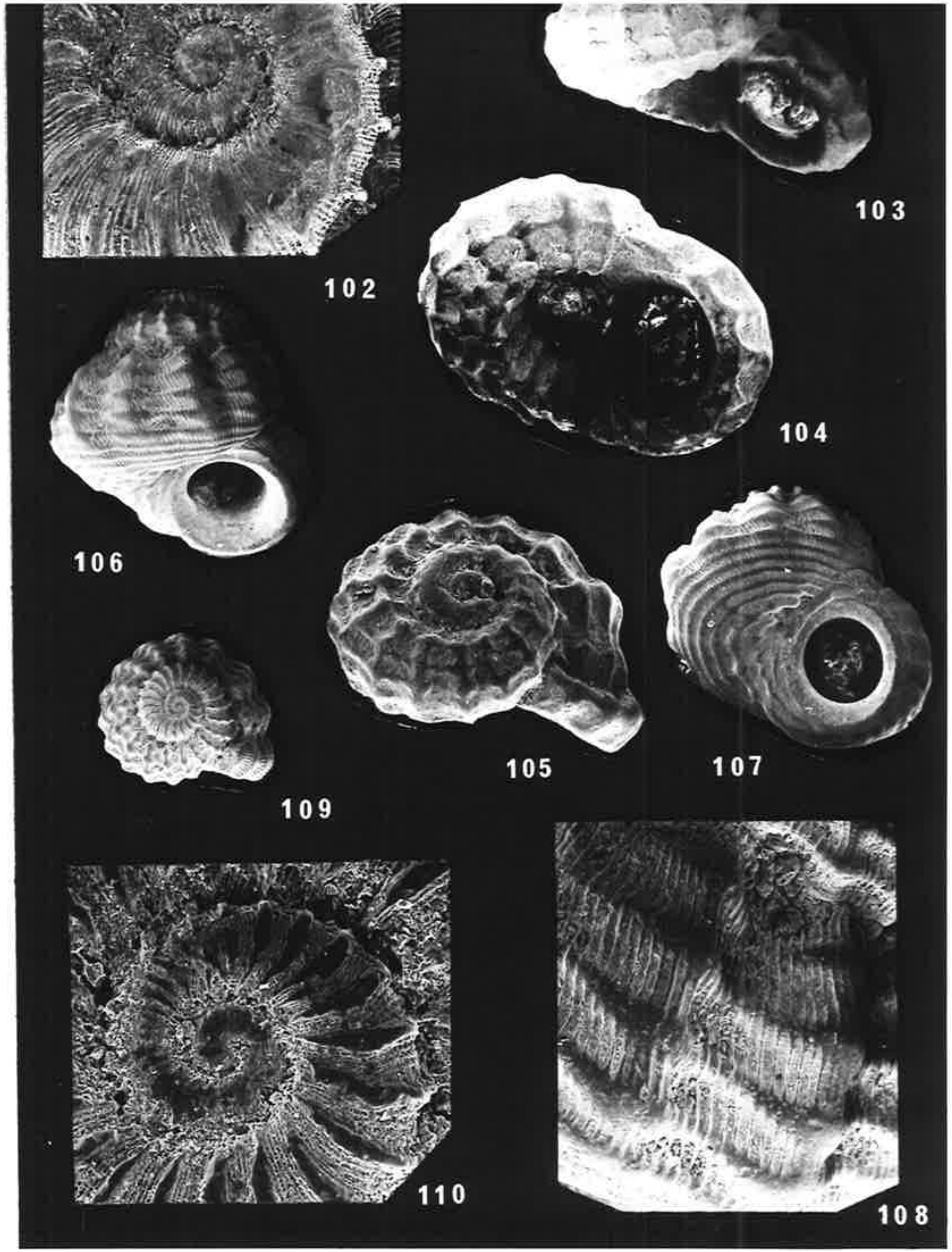
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FIGS. 111-113. Cycloliotia hyotis sp. nov. Holotype, SAM P 21274: 111) axial view (x 10); 112) particular last whorl ornament (x 30). Paratype, SAM P 21275: 113) adapical view (x 10).

FIGS. 114-116 ?Homalopoma (?Caintrainea) ancestralis sp. nov.: 114) holotype, GSSA M 3455, axial view (x 3); 115) paratype, GSSA M 3456, adapical view (x 20); 116) paratype's protoconch (x 80).

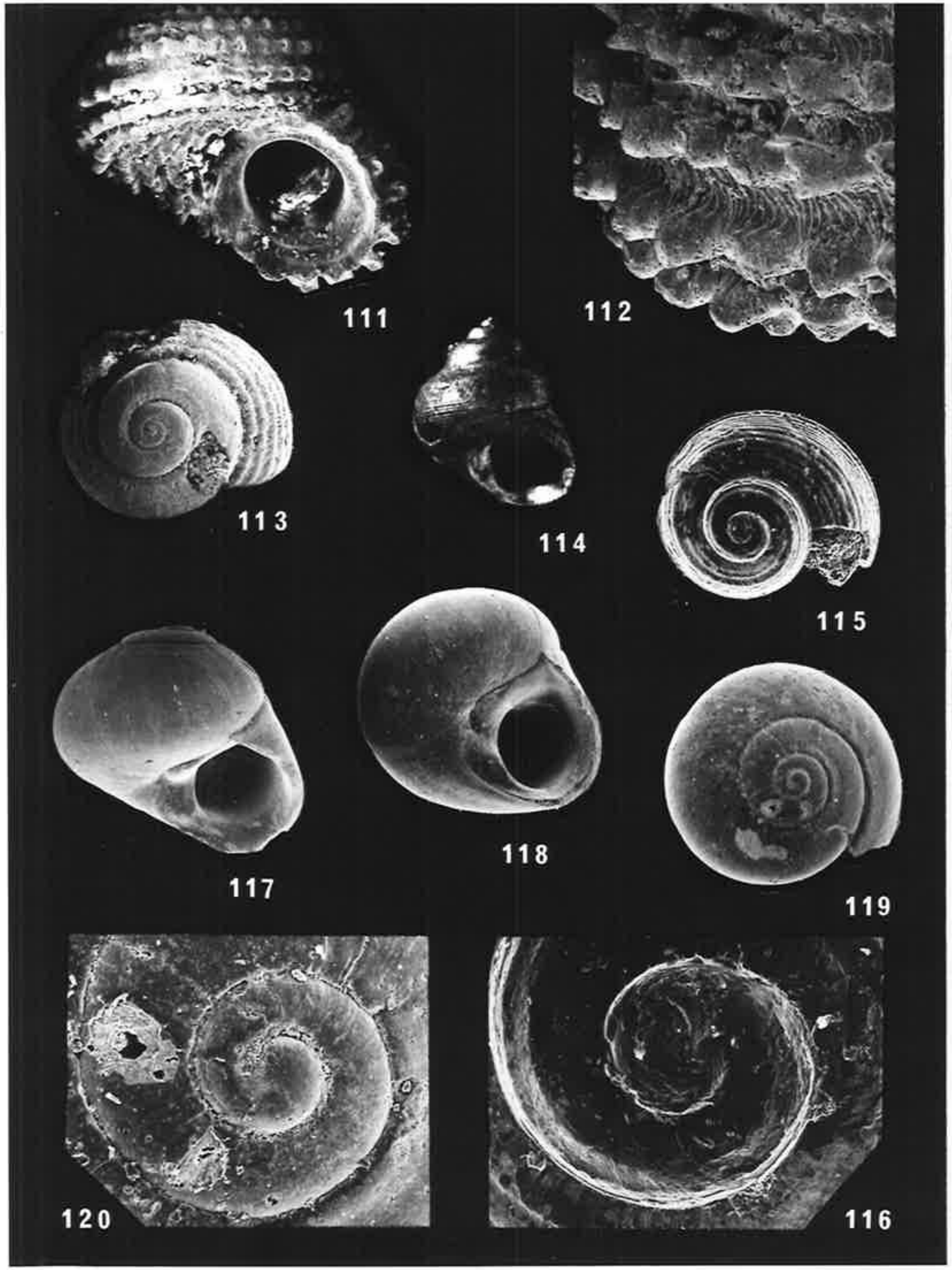
FIGS. 117-120 Vexinia callosa sp. nov. Holotype, GSSA M 3457: 117) axial view (x 20); 118) abapical view, tilted (x 20). Paratype, GSSA M 3458: 119) adapical view (x 20); 120) protoconch (x 70).

FIGS. 121-123 Crossea (Crosseola) antiqua sp. nov. Holotype, SAM T 806-E: 121) axial view (x 20); 122) protoconch (x 90); 123) last whorl punctations, particular (x 500).

FIGS. 124-125 Crossea (Crosseola) semiornata Tate. Paratype, SAM T 810-B: 124) axial view (x 30); 125) protoconch (x 100).

FIG. 126 Crossea (Crosseola) evoluta sp. nov. Holotype, SAM T 806-G, axial view (x 10).

FIG. 127 Crossea (Crosseola) intermedia sp. nov. Holotype, SAM T 806-B, axial view (x 10).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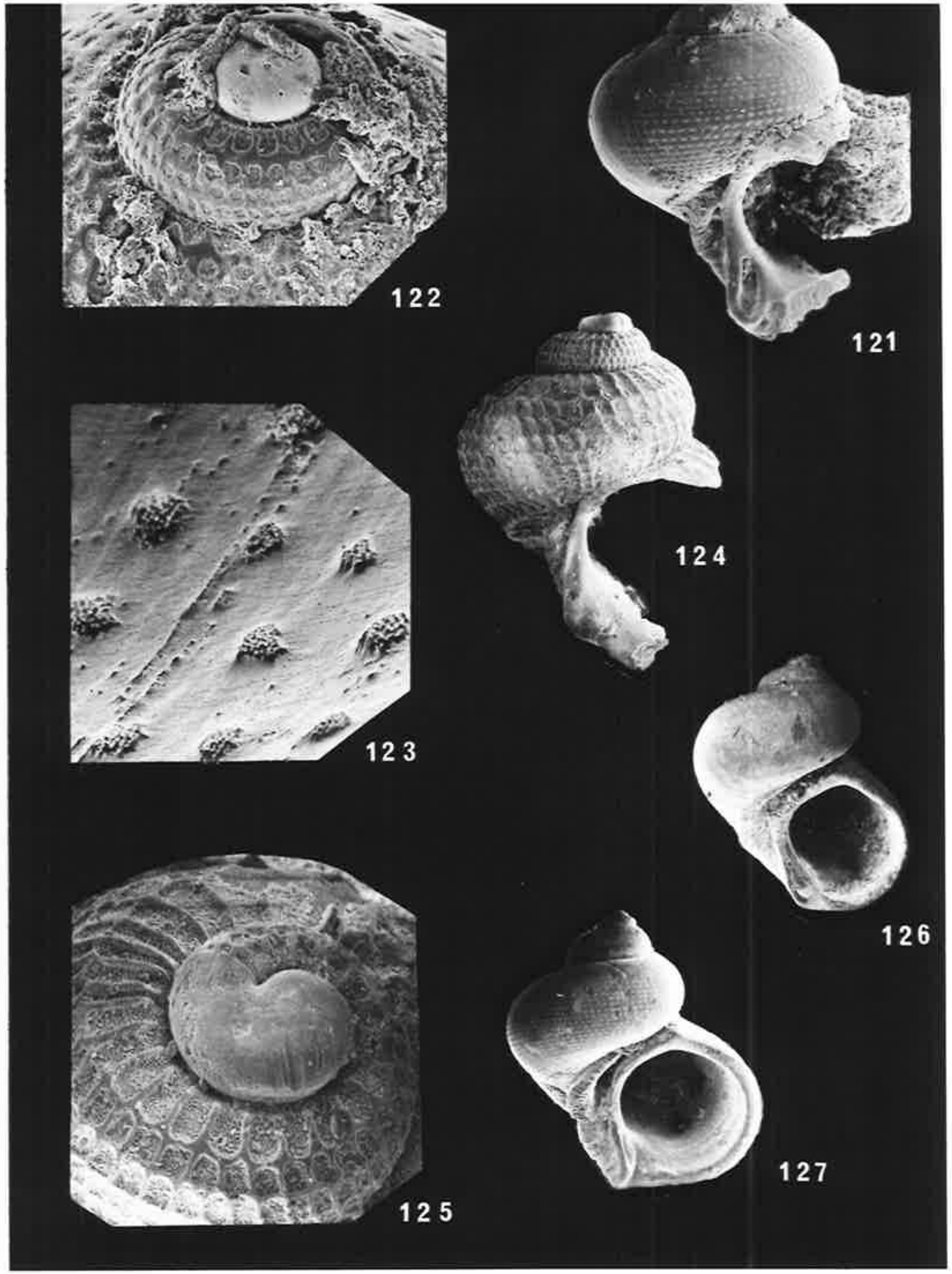
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FIGS. 128-129 Crossea (Crosseola intermedia sp. nov. Holotype: 128) protoconch (x 90);129) last whorl ornament and suture, particular (x 70).

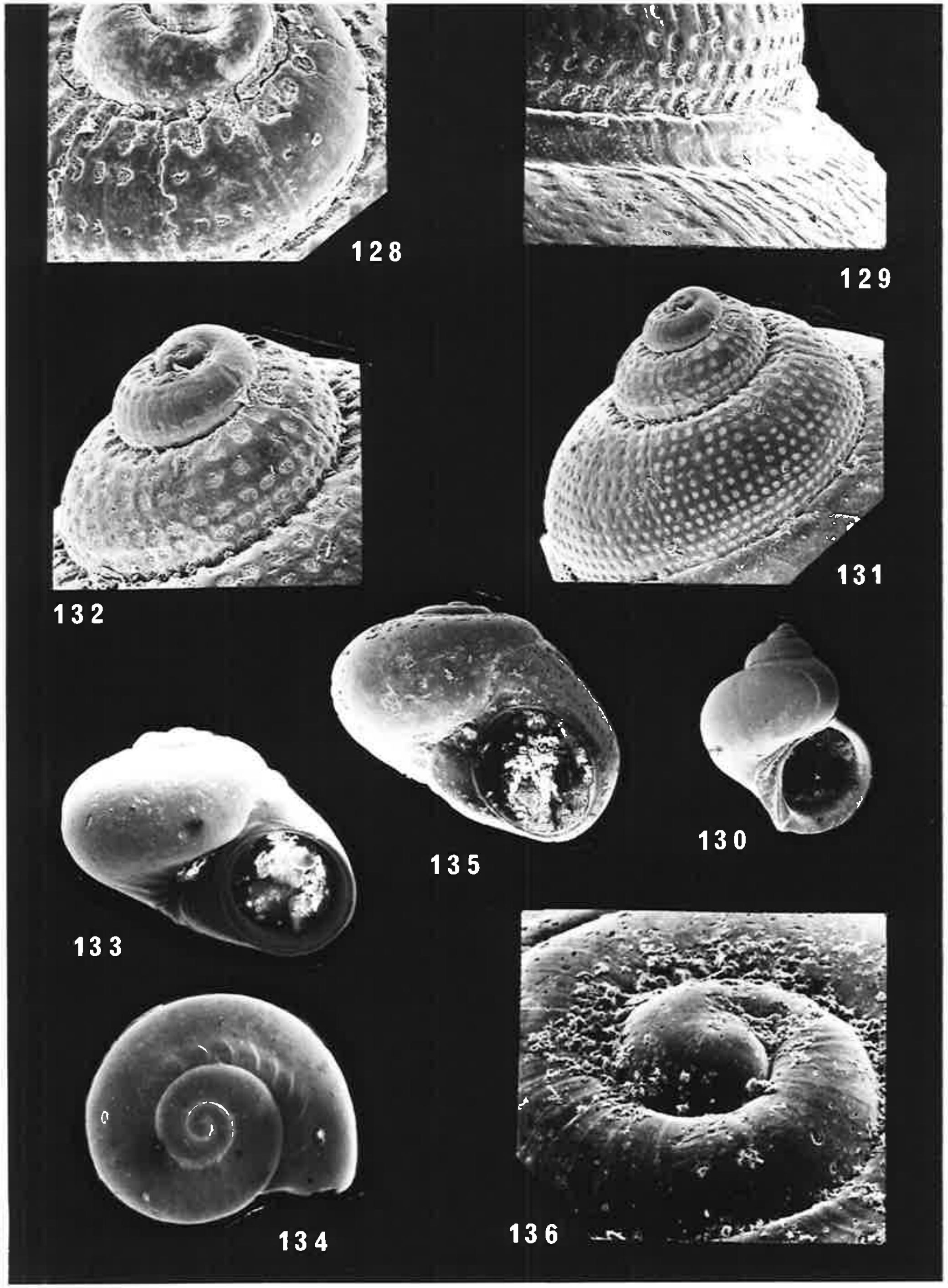
FIGS. 130-132 Crossea (Crosseola) princeps Tate. Syntype, SAM T 806-D: 130) axial view (x 10); 131) early whorls, particular (x 40); 132) protoconch (x 70).

FIGS. 133-136 Leucorhynchia bifuniculata sp. nov. Morpha A, paratypes: 133) GSSA M 3460-A, axial view (x 20); 134) GSSA M 3460-B adapical view (x 20). Morpha B, paratype, GSSA M 3460-B: 135) axial view (x 20); 136) protoconch (x 90).

FIGS. 137-138 Leucorhynchia bifuniculata sp. nov. Holotype, GSSA M 3459-A, intermediate between Morphae A and B: 137) axial view (x 20); 138) protoconch (x 90).

FIGS. 139-142 ?Parviturbo dubius sp. nov. Holotype, GSSA M 3461: 139) axial view (x 10); 140) last whorl ornament (x 40); 141) protoconch and pustular early whorls (x 80); 142) particular micropustulae (x 1000).

FIGS. 143-145 Lironoba (Nobolira) costata sp. nov. Holotype, SAM P 21276: 143) axial view (x 20); 144) particular spiral ornament (x 140); 145) protoconch (x 80).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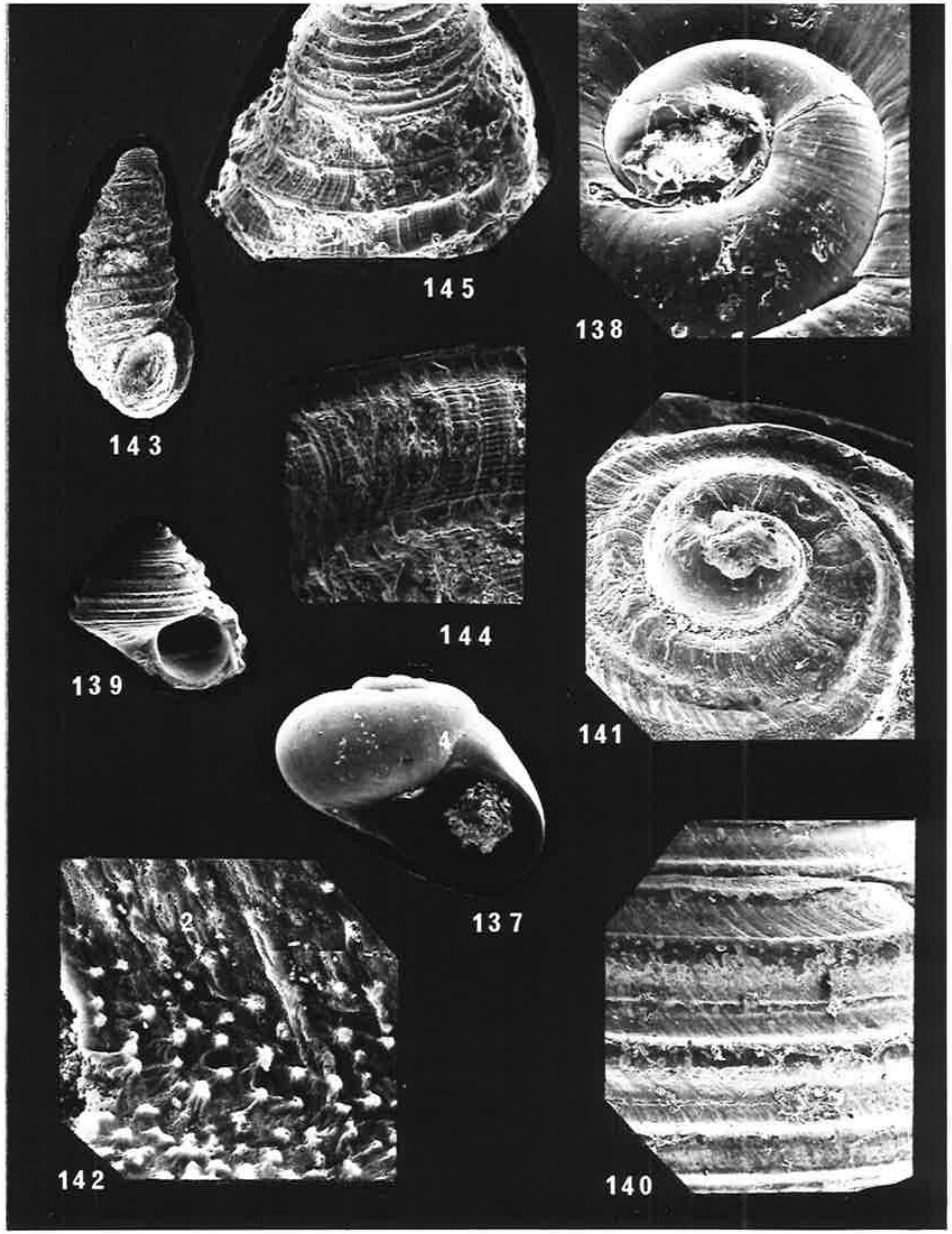
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FIGS. 146-148 Rissoa (Haurakia) costata sp. nov. Holotype, GSSA M 3462: 146) axial view (x 20); 147) protoconch (x 80); 148) protoconch pustulae, at the protoconch/teleoconch suture (x 1200).

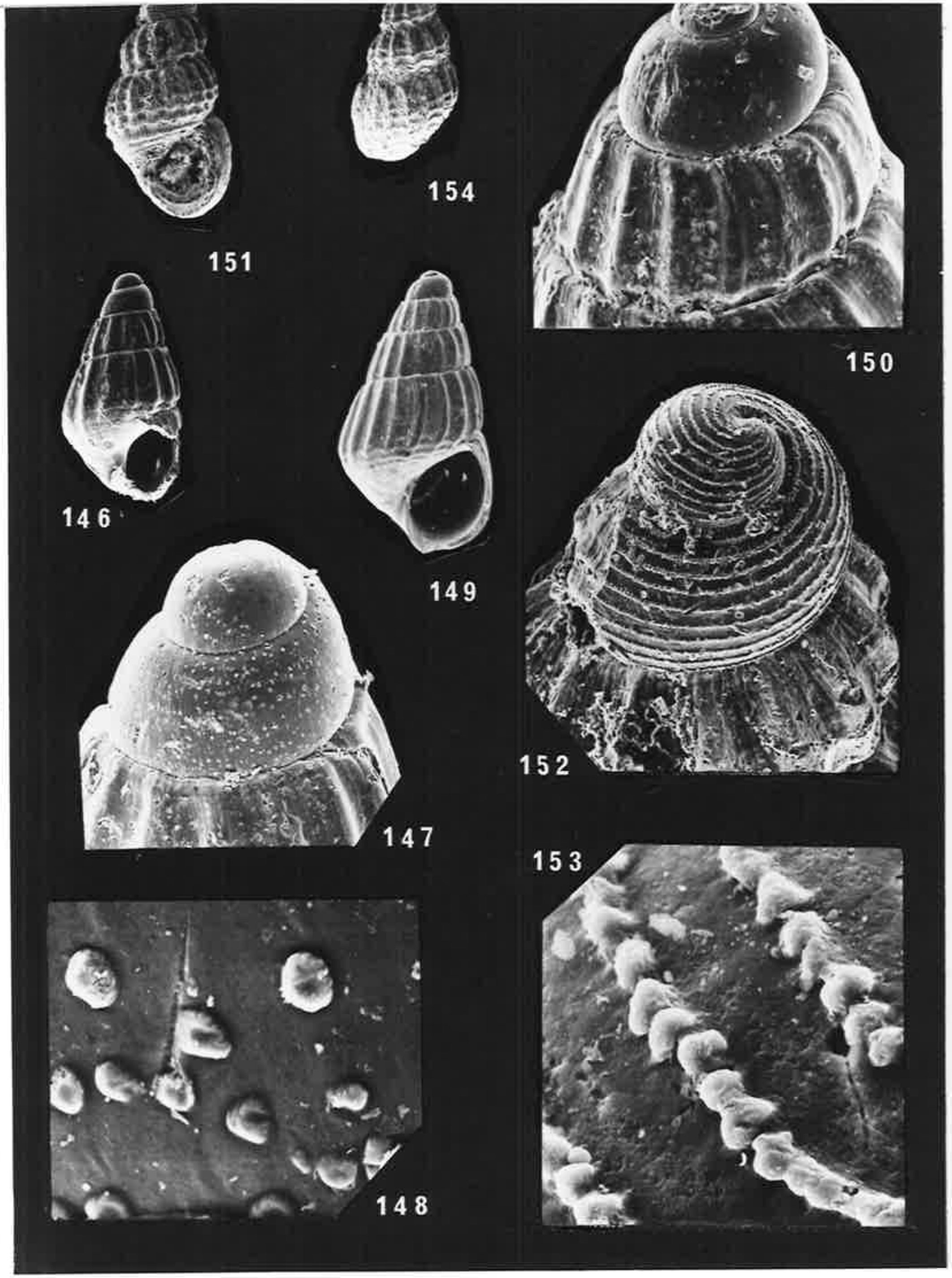
FIGS. 149-150 Turboella (Turboella) flexilis sp. nov. Holotype, GSSA M 3463: 149) axial view (x 20); 150) protoconch (x 80).

FIGS. 151-154 Merelina kaurna sp. nov. Holotype, SAM P 2177-A: 151) axial view (x 20); 152) protoconch (x 80); 153) particular protoconch cords (x 1300). Paratype, SAM P 21277-B: 154) axial view (x 20).

FIGS. 155-157 Strebloceras darraghi sp. nov. Holotype, GSSA M 3322: 155) adapical view (x 50). Paratypes: 156) GSSA M 3322-A, axial view (x 80); 157) GSSA M 3322-B, abapical view (x 80).

FIGS. 158-160 Orbitestella margaritata sp. nov. Holotype, GSSA M 3323-A: 158) adapical view (x 50). Paratypes: 159) GSSA M 3323-B, abapical view (x 90); 160) GSSA M 3323-C axial view (x 90).

FIGS. 161-162 Orbitestella spinosa sp. nov. 161) Holotype, GSSA M 3321-A, adapical view (x 80); 162) Paratype, GSSA M 3321-B, abapical view (x 90).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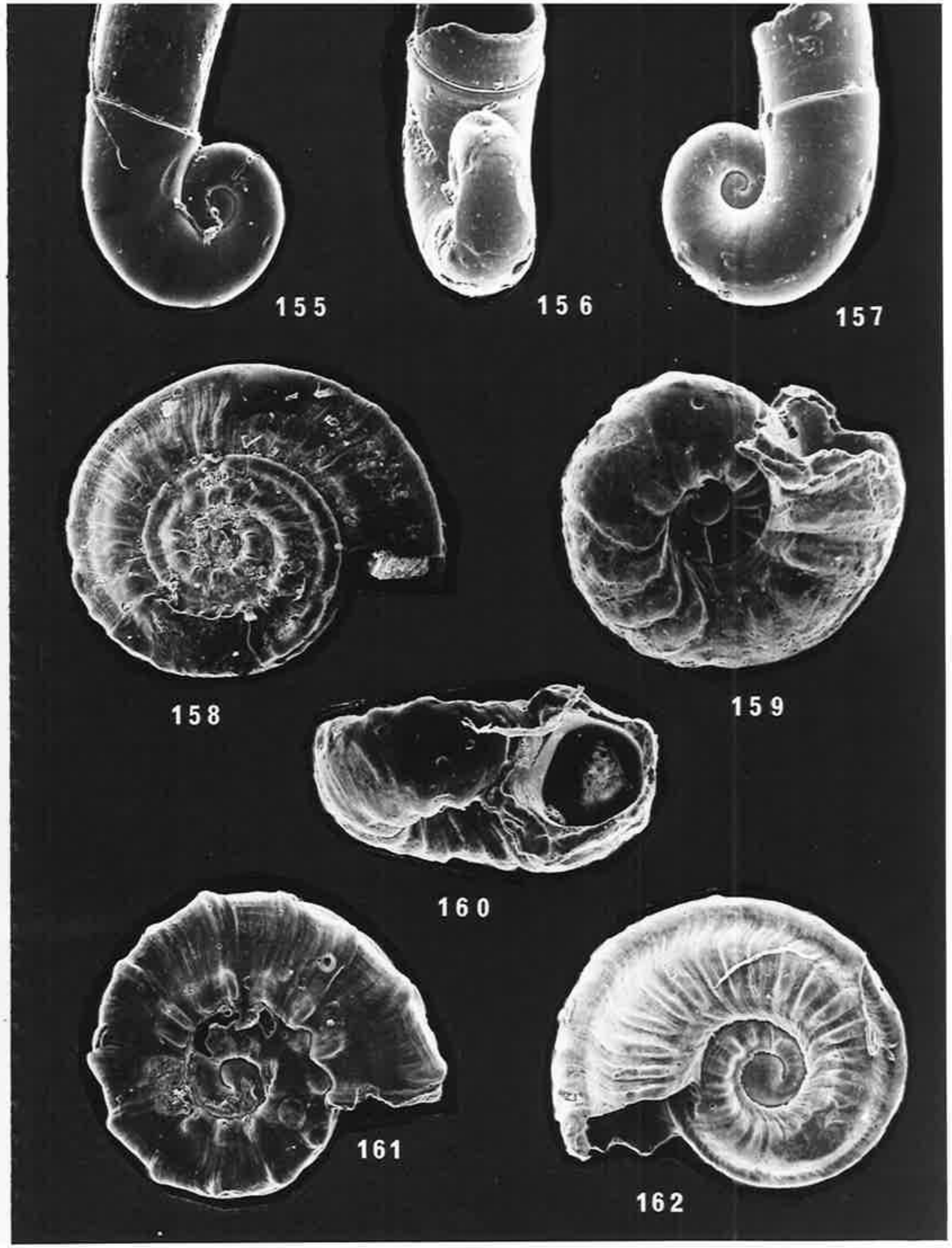
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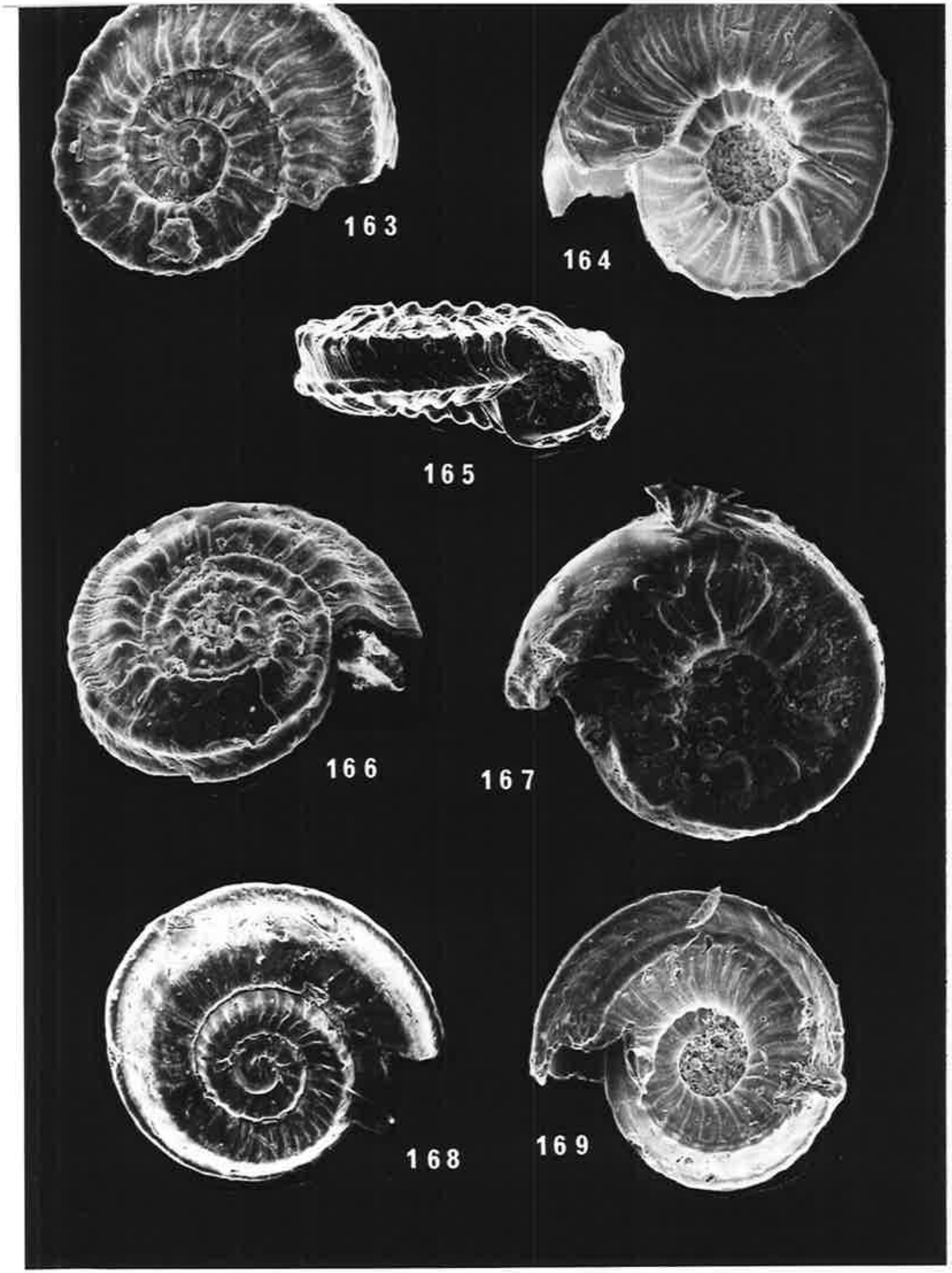
FIGS. 163-165 *Orbitestella rugosa* sp. nov. Paratypes: 163) GSSA M 3319-A, adapical view, slightly tilted (x 60); 164) GSSA M 3319-B, abapical view (x 70). Holotype, GSSA M 3318: 165) axial view (x 50).

FIGS. 166-167 *Orbitestella bastowi* (Gatliff). SAM TD 383: 166) adapical view, slightly tilted (x 50); 167) abapical view (x 70).

FIGS. 168-169 *?Elachorbis pentagonalis* sp. nov. 168) Holotype, GSSA M 3320-A, adapical view (x 50); 169) Paratype, GSSA M 3320-B, abapical view (x 50).

FIGS. 170-175 *Spirocolpus aldingae* (Tate) SAM P 21161-A-F. Morphae: from left to right, suture from flush to grooved. Axial views (all x 2.30).

FIGS. 176-179 *Zeacolpus (Stiracolpus)* sp., SAM P 21162-A-D. All axial views: 176) x 3.5; 177) x 3.35; 178) x 3.5; 179) x 3.4.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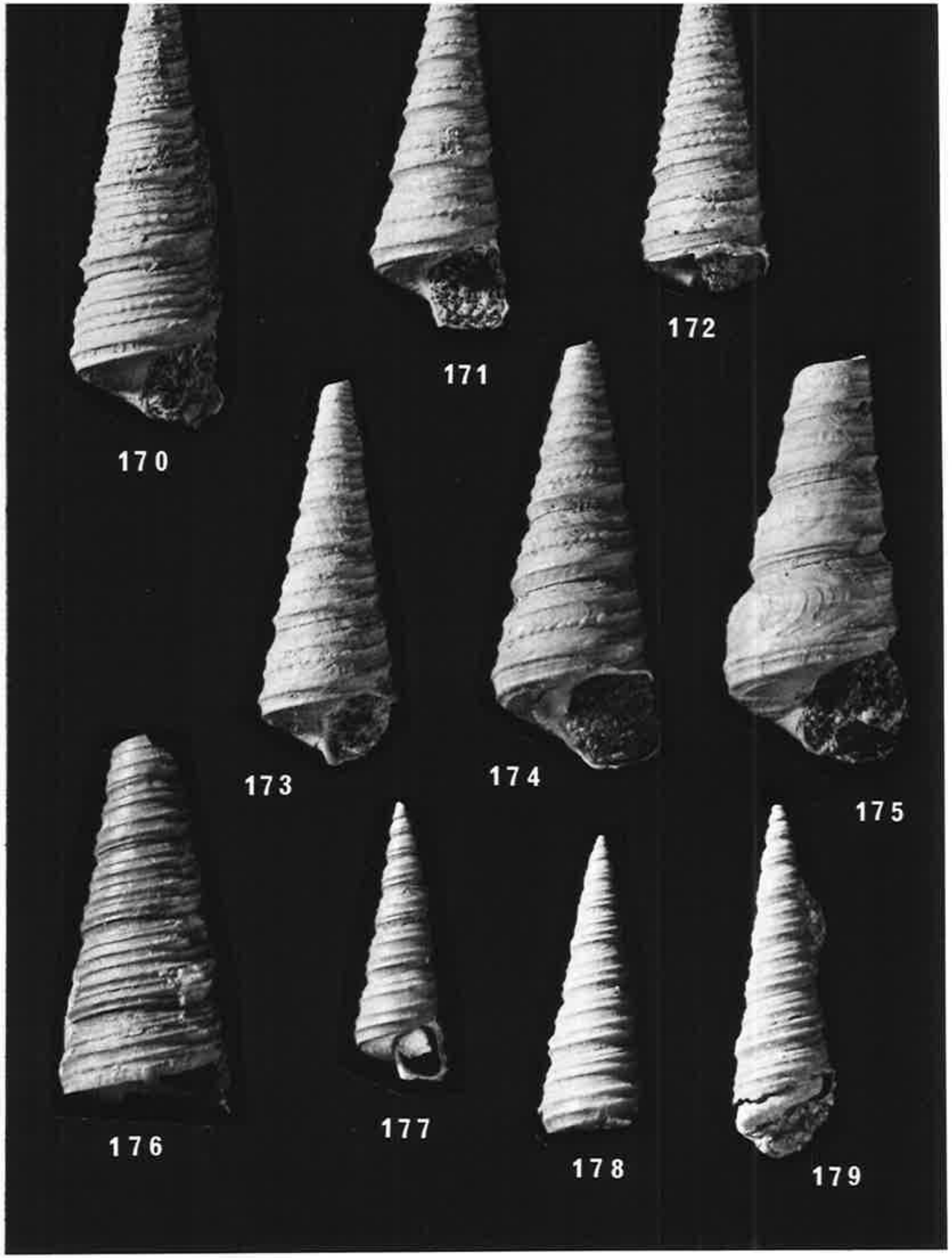
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FIGS. 180a-b Spirocolpus aldingae (Tate), juvenile, SAM P 21163: 180a) axial view (x 20); 180b) protoconch (x 50).

FIGS. 181-182 Zeacolpus (Stiracolpus) sp., juveniles: 181) SAM P 21164-A, axial view (x 30); 182) SAM P 21164-C, protoconch (x 60).

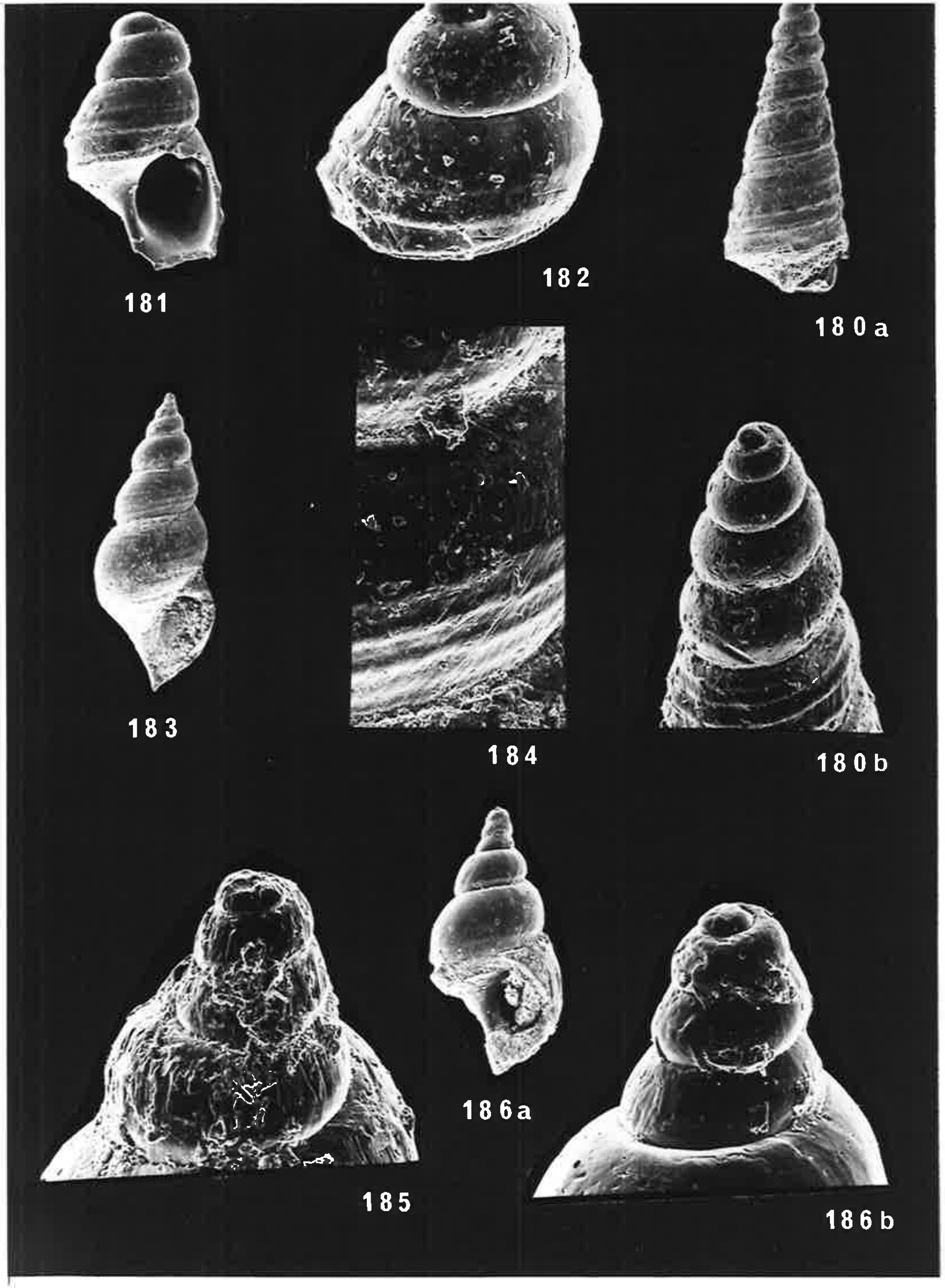
FIGS. 183-186 Sigmesalia stylacris (Tate). Senile, SAM P 21165: 183) axial view (x 10); 184) particular ornament and growth lines (x 50); 185) protoconch (x 80). SAM P 21186, juvenile: 186a) axial view (x 20); 186b) protoconch (x 80).

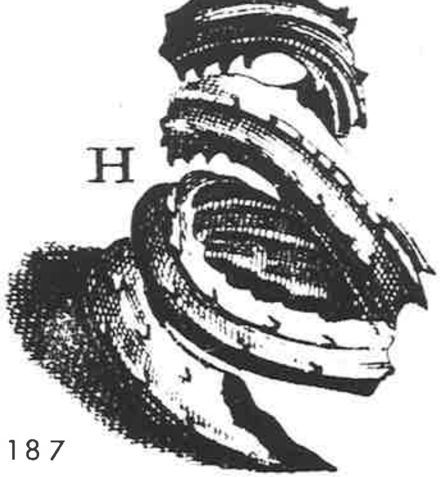
FIG. 187 Serpula anguina Linnaeus s. str. Rumphius's original illustration, pl. 41, fig. H.

FIG. 188 Serpula anguina Linnaeus, var. β. Linnaeus, Lister's original illustration, pl. 548, fig. 2.

FIG. 189 'Siliquarius anguilus' Montfort, Davila's illustration pl. 40, fig. E.

FIGS. 190-191 Tenagodes anguinus (Linnaeus), Guettard's original illustrations, pl. 71, figs. 3-4.





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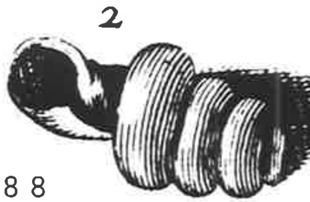

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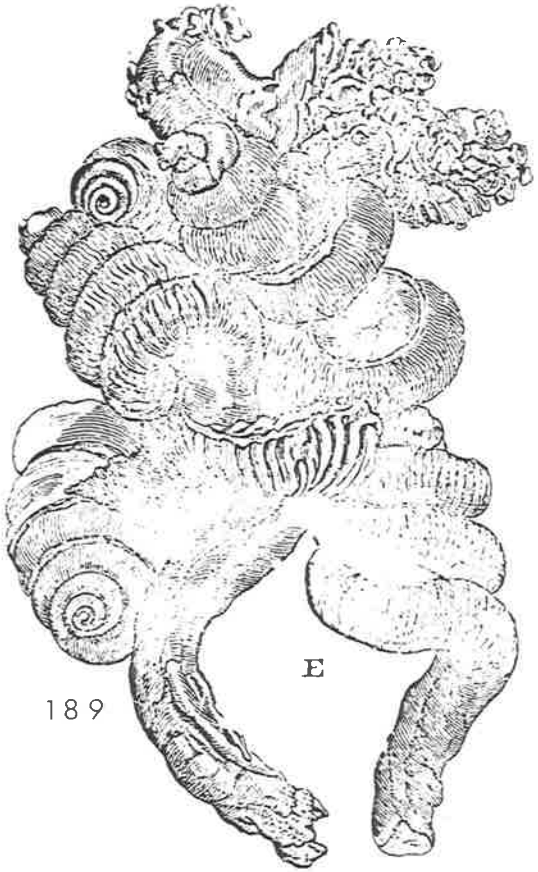

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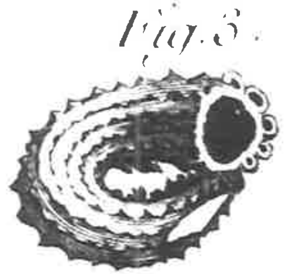

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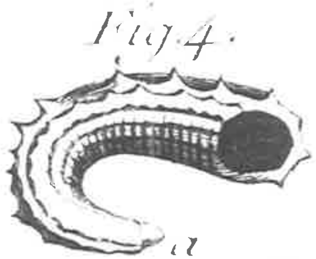

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FIG. 192 Serpula anguina Born, Born's original illustration, pl. 18, fig. 15.

FIG. 193 Serpula muricata Born, Born's original illustration, pl. 18, fig. 16.

FIG. 194 Agathyrsos furcellus Montfort, Montfort's 1808 original illustration, I, p.598.

FIG. 195 'Siliquarius anguilus' Montfort, Montfort's 1810 original illustration, II, p.38.

FIGS. 196-197 Campylothyrsos gen. nov. multistriatus (Defrance), SAM P 21278, Auvers (Late Eocene) (x 2.6).

FIG. 198 Campylothyrsos gen. nov. mitis (Deshayes), SAM P 21279, Auvers (Late Eocene). To note, the slit. (x 2.6).

FIGS. 199-200 Campylothyrsos gen. nov. brevifissuratus (Deshayes), Coll. Buonaiuto, La Ferme de L'Orme, middle Lutetian (by courtesy of J. Le Renard). 199) x 3.05; 200) x 3.15.

FIG. 201 Agathyrsos furcellus Montfort, Coll. Le Renard, La ferme de l'Orme, middle Lutetian (x 3.6).

FIGS. 202-204 Agathyrsos millepeda (Deshayes). Grignon, middle Lutetian (by courtesy of J. Le Renard). 203-4) Coll. Buonaiuto (x 1.9); 204) Coll. Le Renard (x 1.7).

FIGS. 205-206 Agathyrsos lima (Lamarck), Coll. Buonaiuto, Grignon, middle Lutetian (by courtesy of Le Renard) (x 1.7). To note, the slit in Fig. 206.

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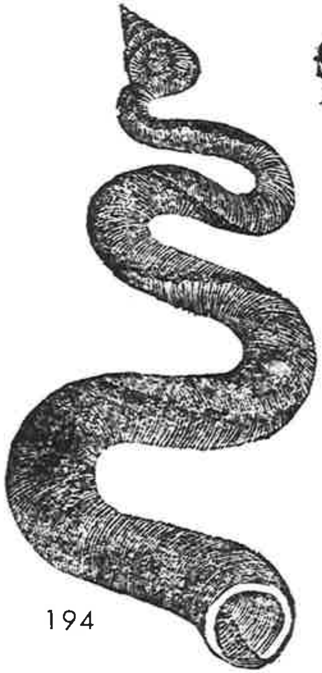

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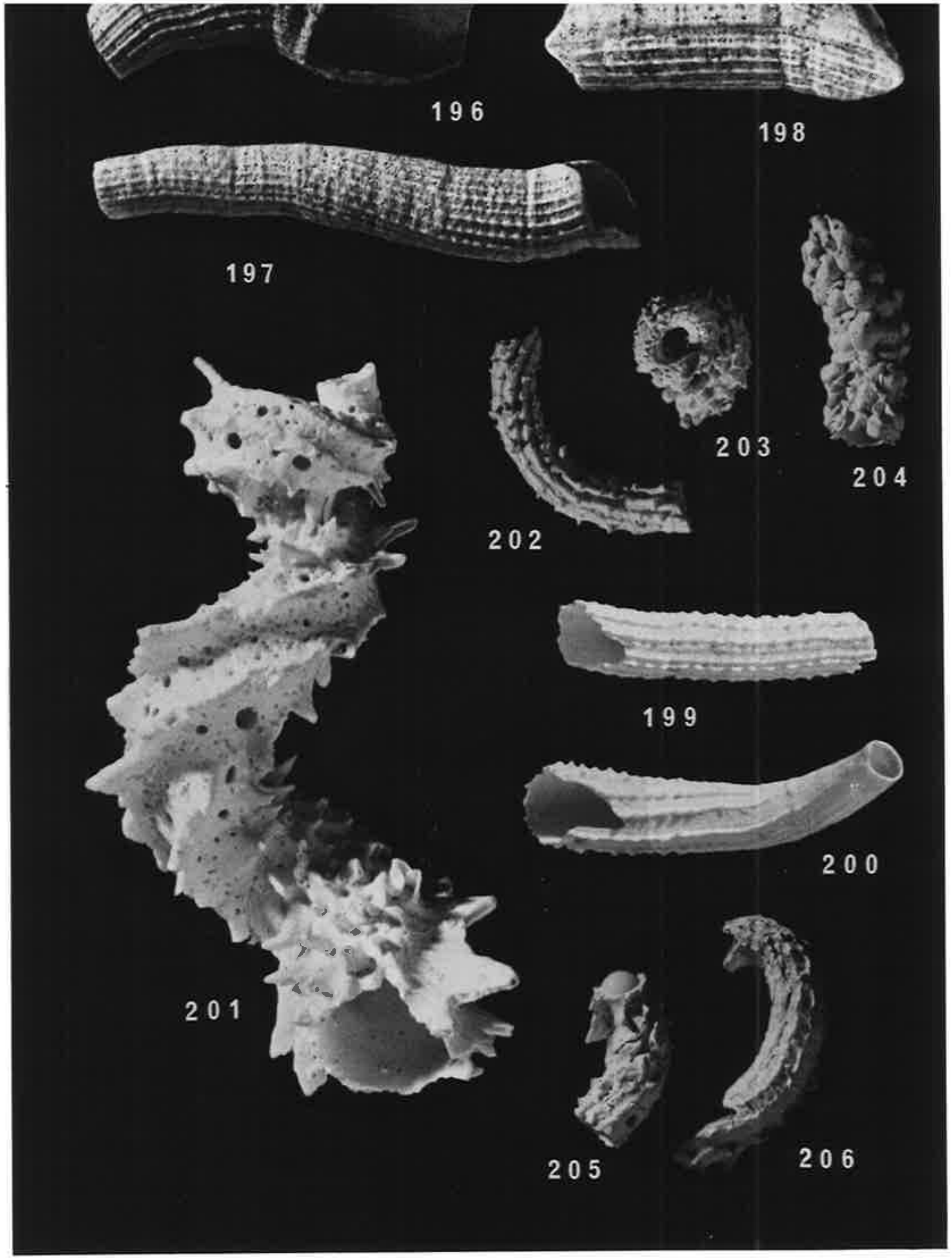
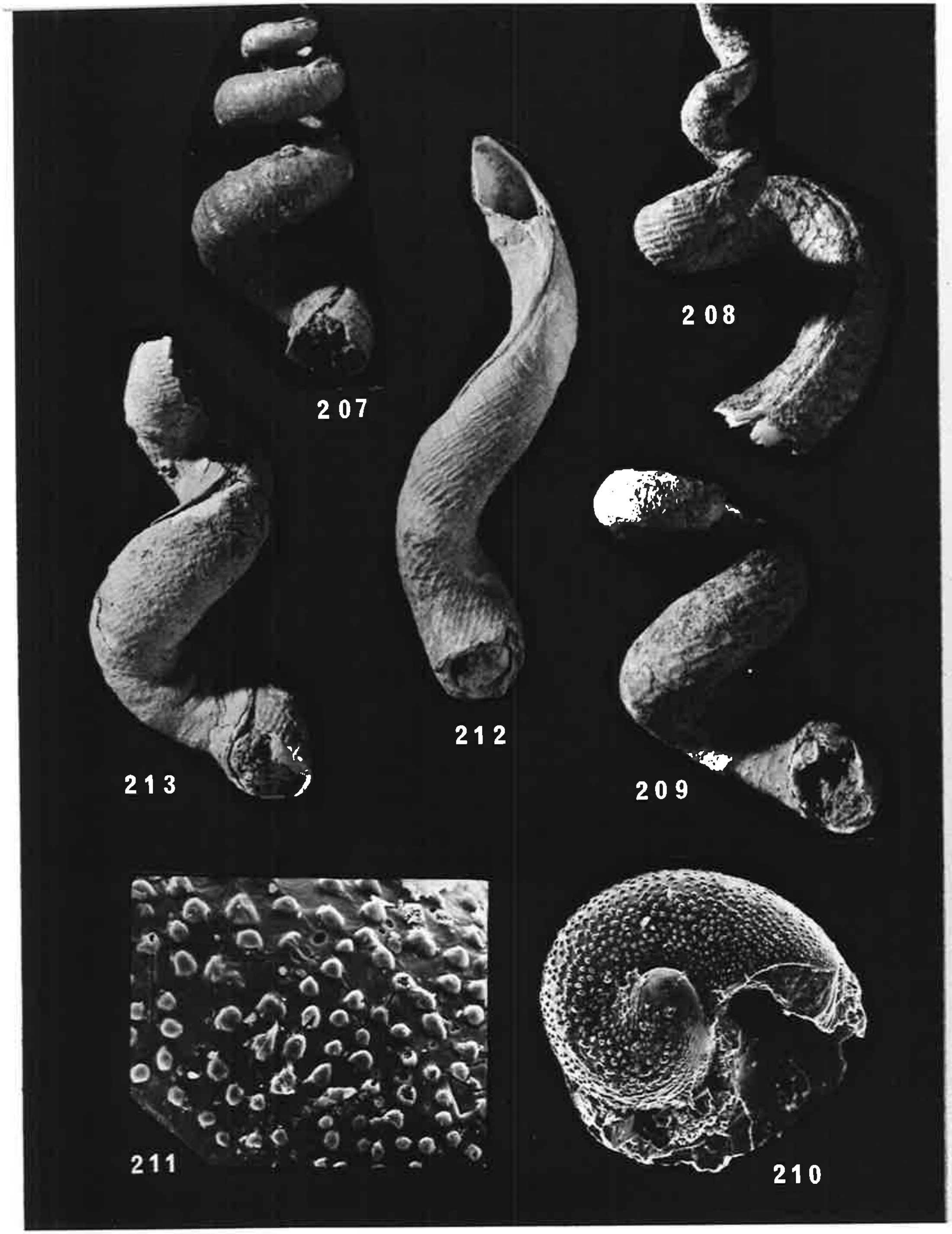


FIGS. 207-211 *Pyxipoma squamigera* sp.nov. Holotype, SAM P 21166: 207) axial view (x 3.30). Paratypes: 208-09) SAM P 21167-A & B, axial view (x 2.75). Paratype GSSA M 3464: 210) protoconch (x 80); 211) particular pustulae (x 400).

FIGS. 212-213 *Siliquaria altispira* sp. nov. Holotype, SAM P 21168: 212) axial view (x 1.85). Paratype, GSSA M 3465: 213) axial view (x 2.30).

FIGS. 214-220 *Siliquaria kaurna* sp. nov. Holotype, SAM P 21169: 214) axial view (x 2.00); 215) adapical view (x 2.00). Paratypes, SAM P 21170A-C, juveniles: 216-218) adapical view (all x 2.00). Paratype SAM P 21171, juvenile: 219) adapical view (x 20); 220) protoconch (x 80).

FIG. 221 *Siliquaria* sp. nov. A. SAM P 21172, axial view (x 2.7)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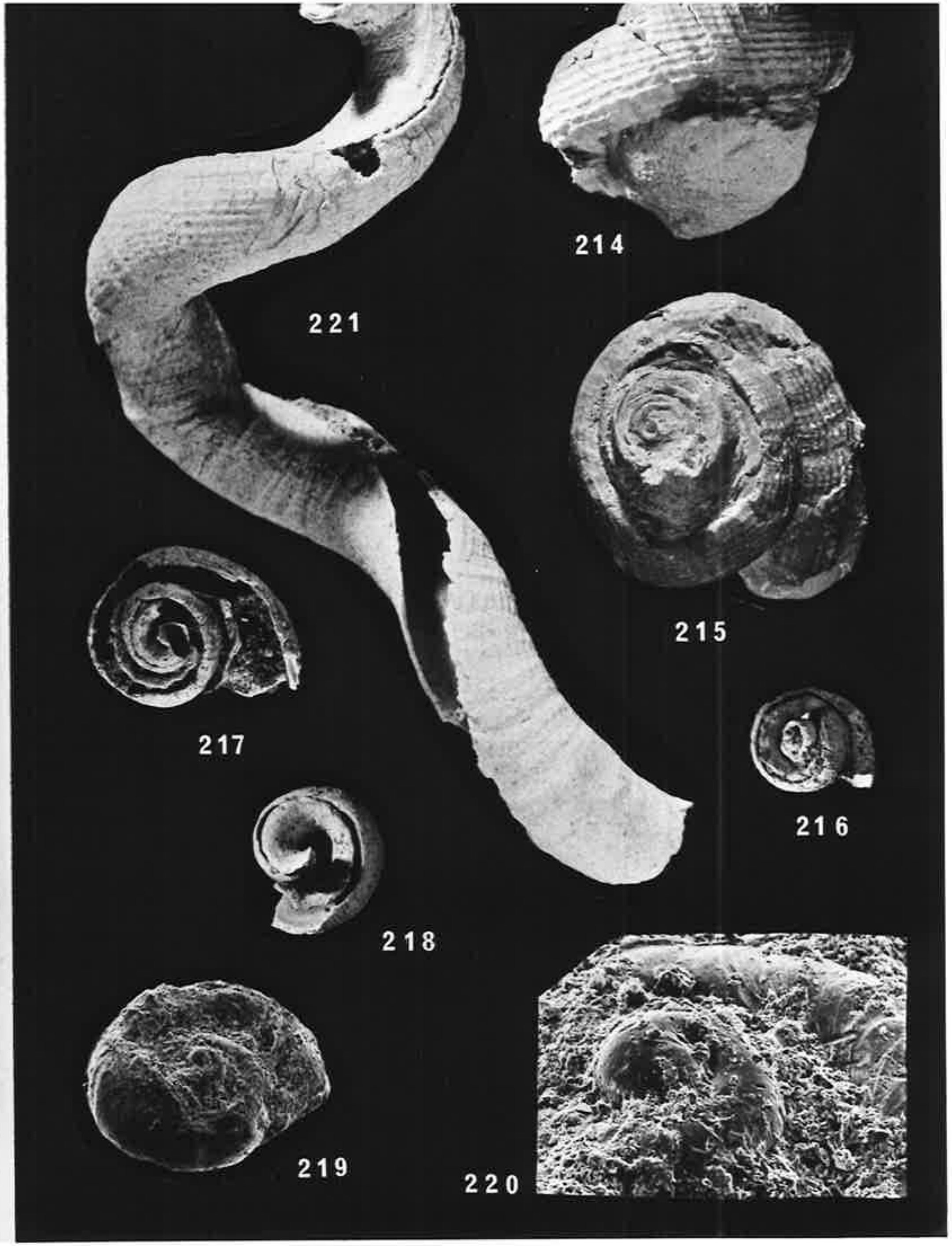
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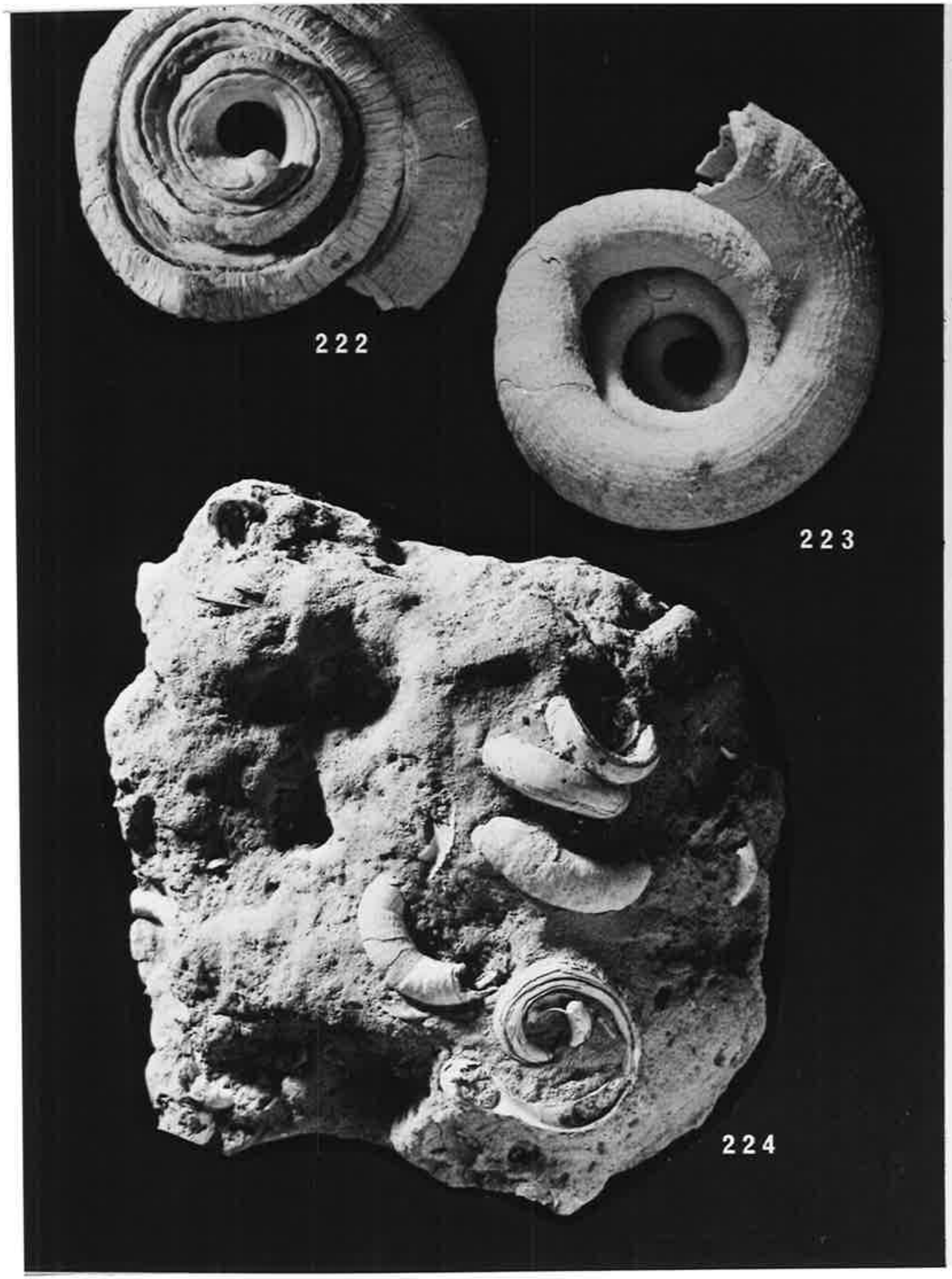
FIGS. 222-224 Siliquaria cadelli sp. nov. Holotype, SAM P 21173: 222) adapical view (x 1.5); 223) abapical view (x 1.5). Paratypes GSSA M 3316 : 224) specimens still imbedded in matrix (x .70).

FIG. 225 Siliquaria cadelli sp. nov. Holotype, axial view (x 1.7).

FIGS. 226-278 Siliquaria occlusa (T. Woods). Neotype, SAM P 21174: 226) axial view (x 2.4); 227) adapical view (x 2.45); 228) abapical view (x 2.7).

FIG. 229 Siliquaria sp. nov. B. SAM P 21176, axial view (x 2.85).

FIG. 230 Siliquaria striata Defrance, SAM P 21280, Ully St. George, Middle Eocene (x 1.25).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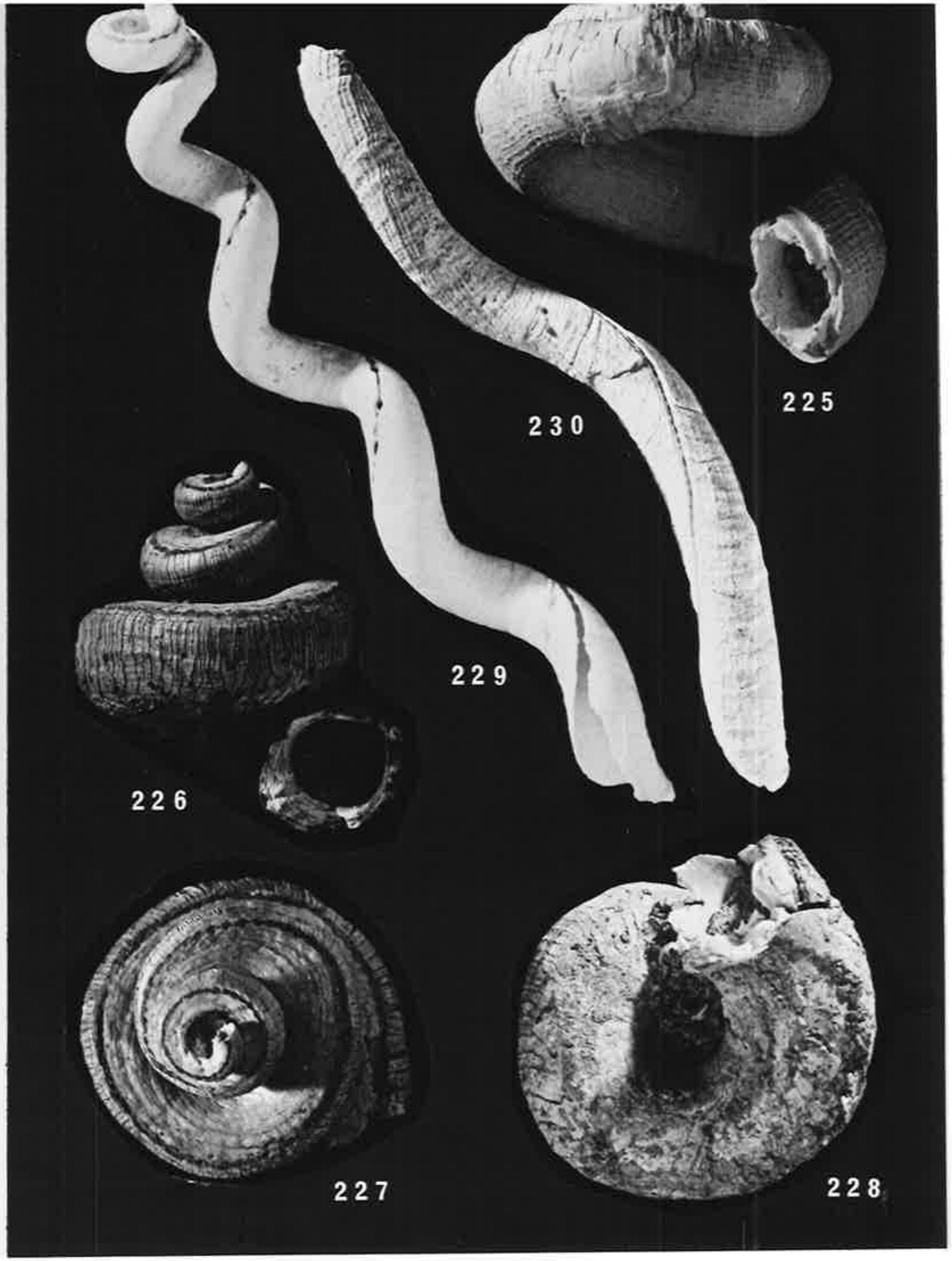
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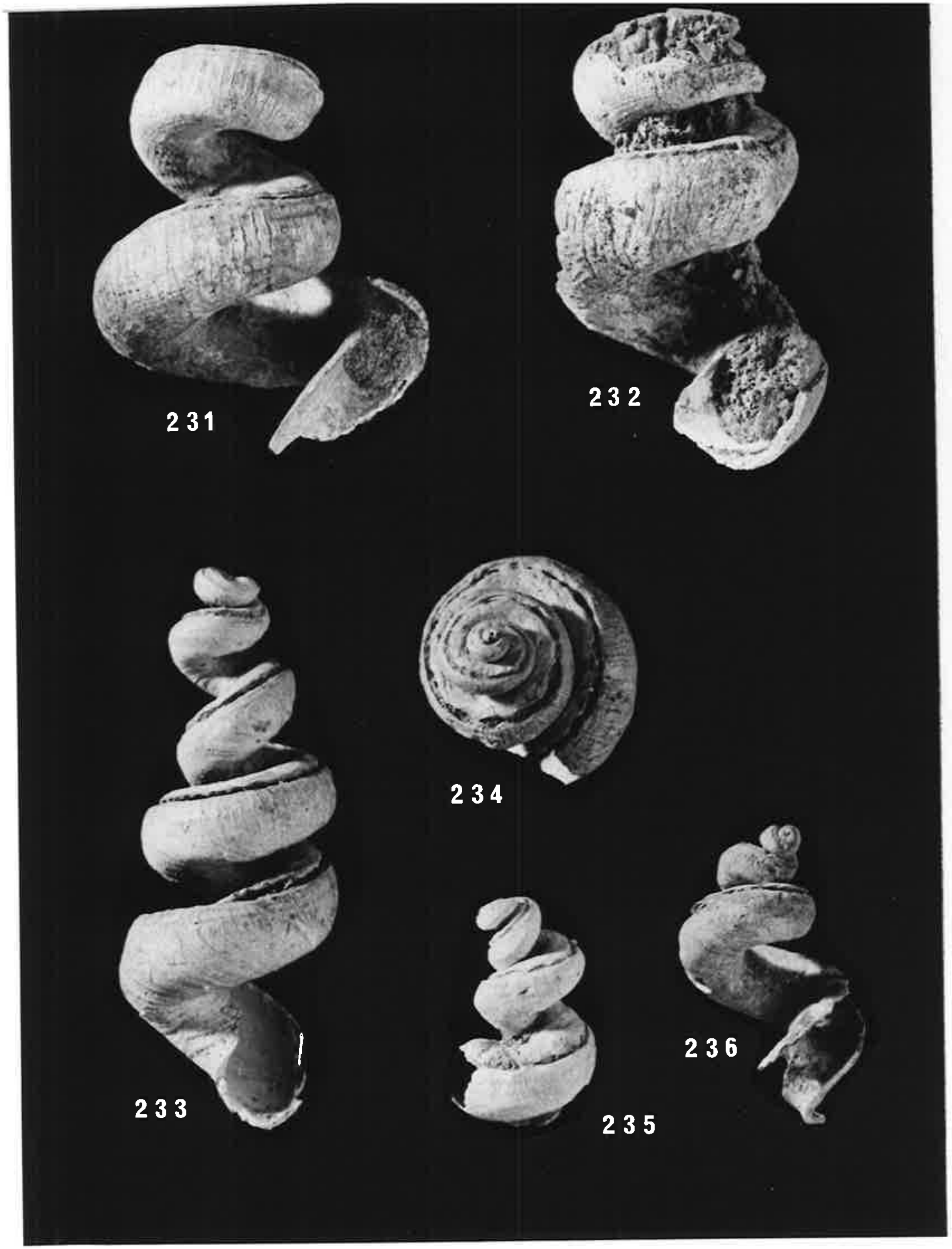
FIGS. 231-232 Siliquaria occlusa (T. Woods). Paraneotypes, SAM P 21175A-B; axial view (x 2.70).

FIGS. 233-236 Siliquaria rugosa sp. nov. Holotype, SAM P 21177: 233) axial view (x 2.5); 234) adapical view (x 2.8). Paratypes, SAM P 21178A-B: 235-36) axial view (x 2.4).

FIGS. 237-241 Niso (Niso) laevigata sp. nov. Holotype, GSSA M 3467-A: 237) axial view (x 4.15). Paratypes: 238) GSSA M 3467-B, axial view (x 4.15); 239) GSSA M 3468, axial view (x 4.15); 240) GSSA M 3469, axial view (x 10); 241) the same, protoconch (x 50).

FIG. 242 Eulima (Margineulima) striata sp. nov. Holotype, GSSA M 3470, axial view (x 3.8).

FIGS. 243-247 Aclis (Graphis) costata sp. nov. Holotype, SAM P 21179A: 243) axial view (x 20); 244) spiral and axial ornament (x 100); 245) particular spiral ornament (x 800). Paratypes, axial view (both x 20): 246) SAM P 21179B; 247) SAM P 21179C.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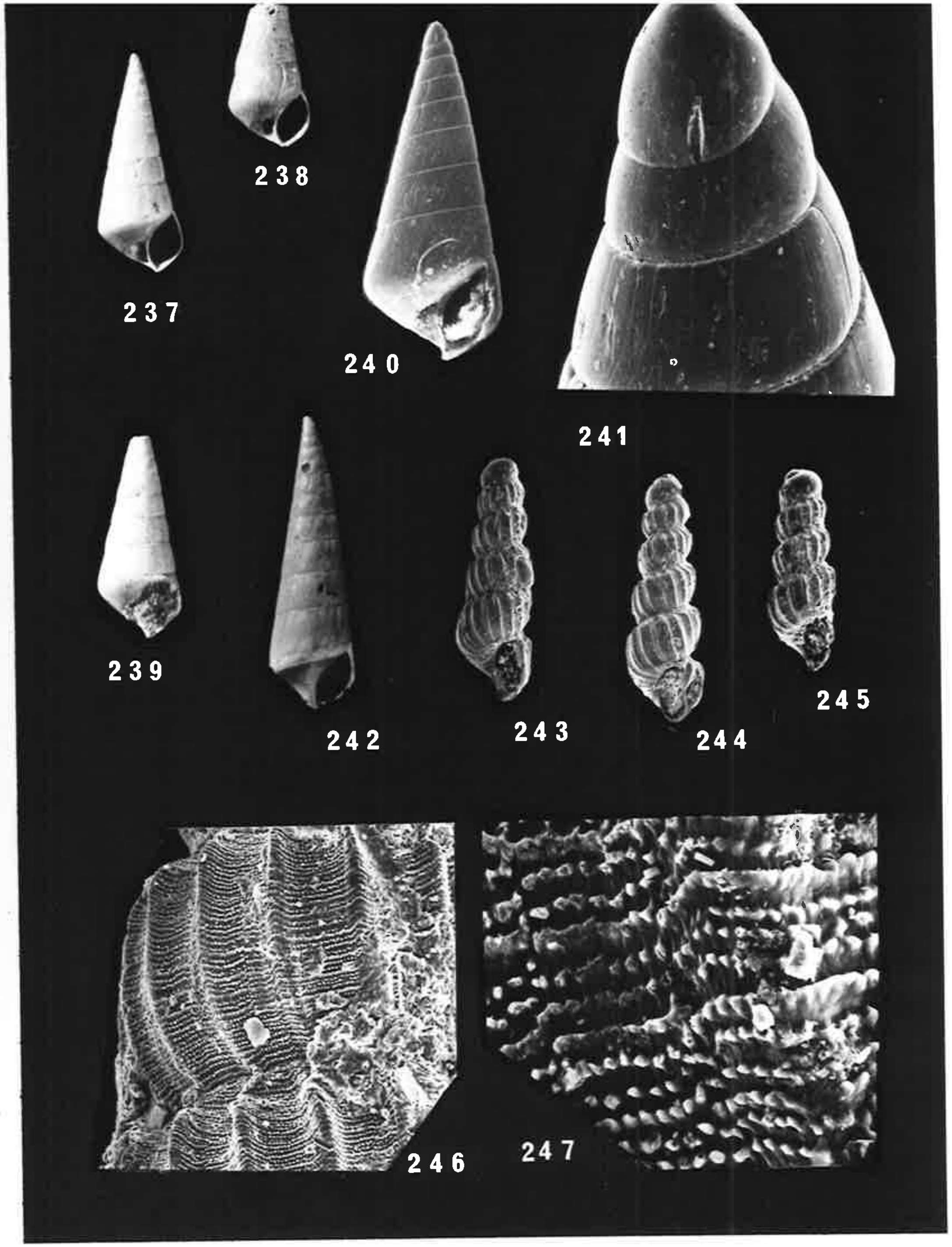
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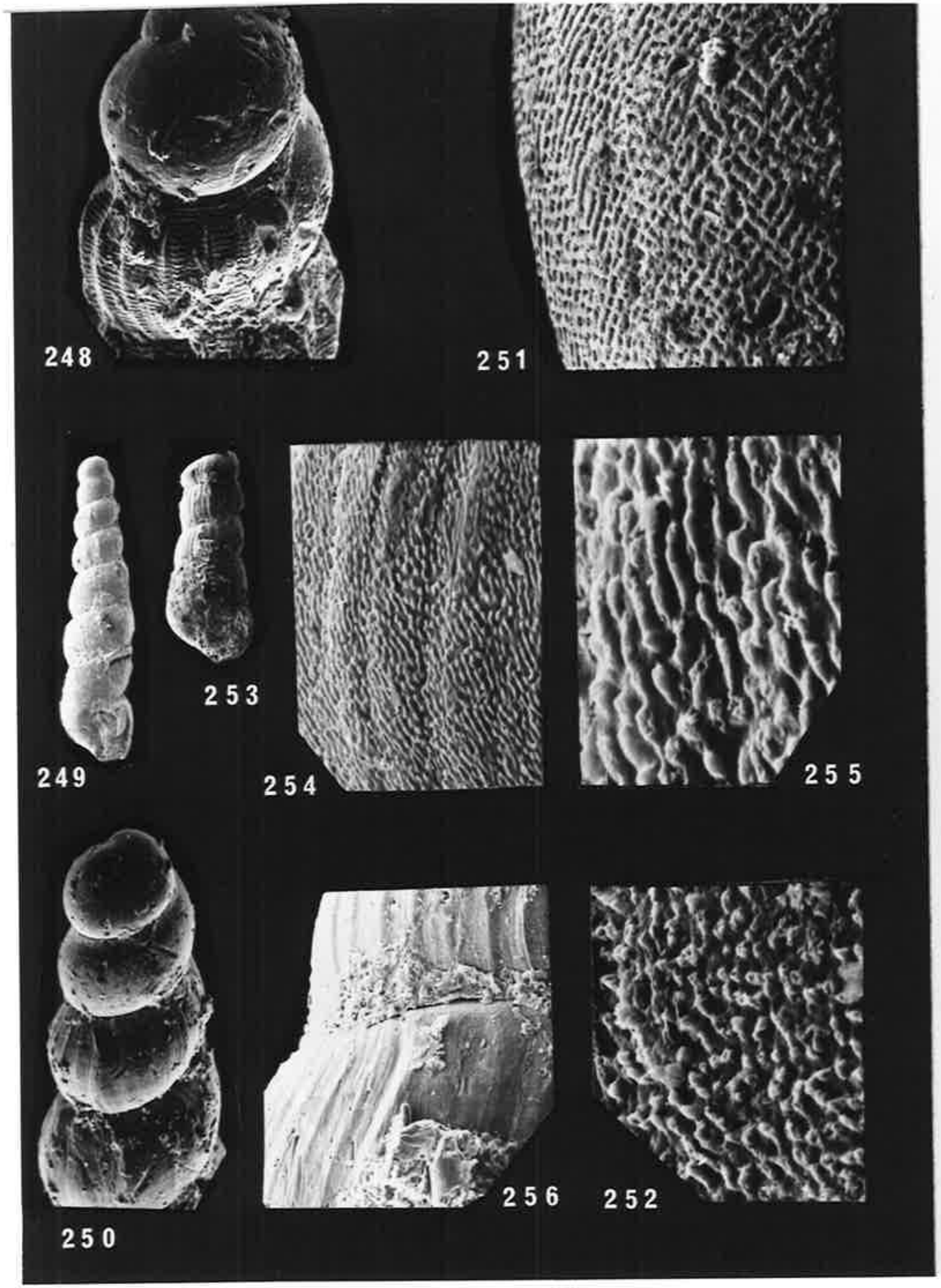
FIG. 248 *Aclis (Graphis) costata* sp. nov. Holotype, protoconch (x 120).

FIGS. 249-256 *Aclis (Graphis) laevigata* sp. nov. Holotype, SAM P 21180A: 249) axial view (x 20); 250) protoconch (x 70); 251) protoconch ornament, particular (x 700); 252) penultimate whorl, particular pustulae (x 2000). Paratype, SAM P 21180B: 253) axial view (x 20); 254) young adult stage, vermiculations (x 200); 255) vermiculations, particular (x 2000); 256) penultimate/last whorl sutural region, particular (x 120).

FIGS. 257-260 *Lunatia aldingensis* (Tate). Holotype, SAM T 1505B: 257) axial view (x 2.0); 258) axial aboral view (x 2.0); 259) adapical view (x 2.0). Paratype, SAM T 1505A: 260) axial view (x 2.0).

FIGS. 261-262, 266 *Polinices nothos* sp. nov. Holotype, SAM T 1505J: 261) axial view (x 2.35); 262) protoconch (x 38). Paratype, SAM T 1505K: 266a) axial view (x 3.5); 266b) adapical view (x 3.3).

FIGS. 263-265 *Tanea falsa* sp. nov. Holotype, SAM T 1505M: 263) axial view (x 10); 264) protoconch (x 40). Paratype, SAM P 21181: 265) abapical view, tilted (x 9.5).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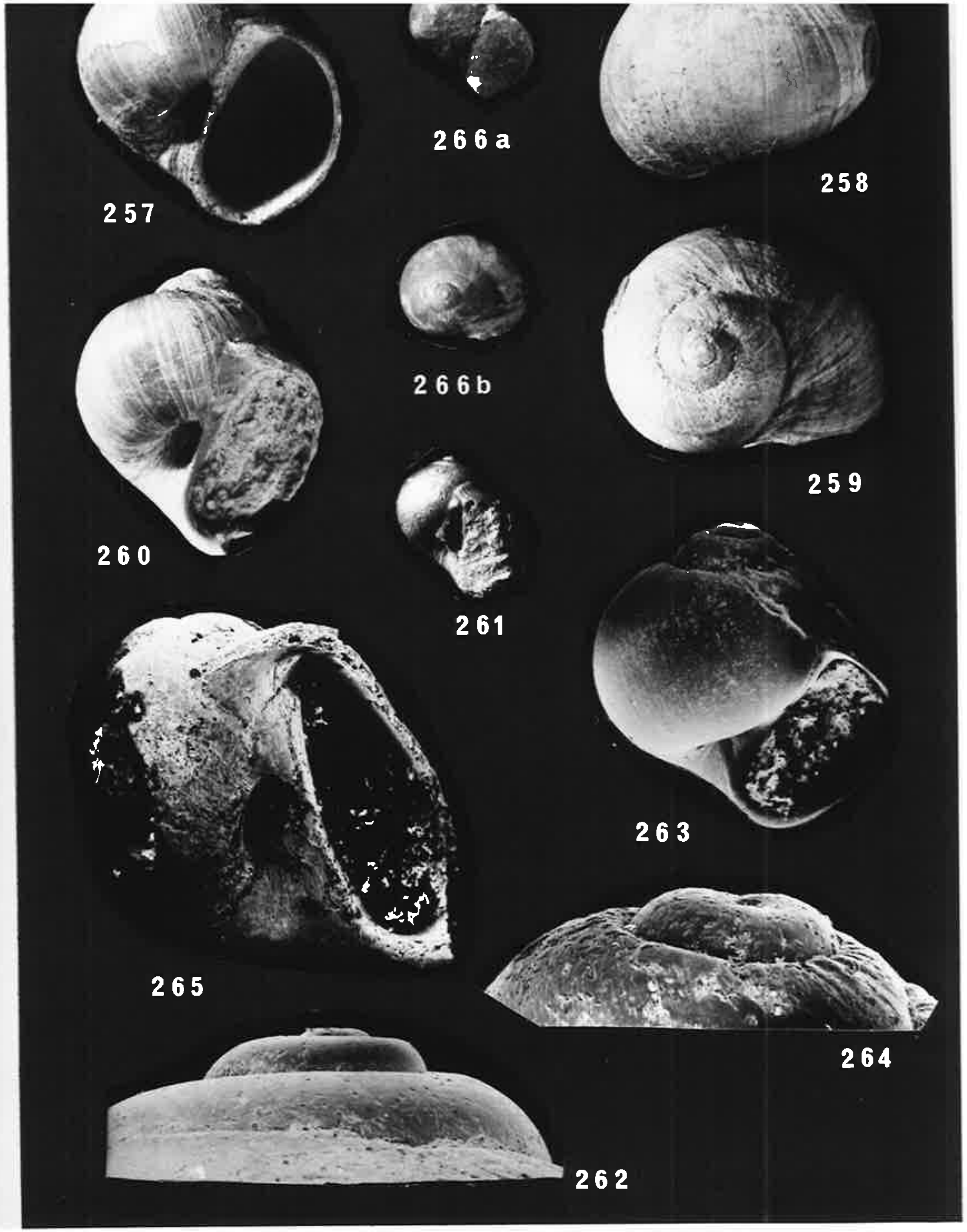
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FIGS. 267-268 Charonia (Austrosassia) cribrosa (Tate). 267) SAM T 503B, holotype (x 1.9); 268) SAM T 503C, paratype (x 2.8).

FIGS. 269-273 Argobuccinum (Cymatiella) oligostirum (Tate). 269) SAM T 495C, holotype (x 2.55); 270) SAM T 495B, paratype (x 3 .15); 271) SAM P 21187, axial view (x 2.65). GSSA M 3392: 272) axial view (x 8.67); 273) protoconch (x 50).

FIGS. 274-277 Distorsio (Personella) maslinensis sp. nov. 274) SAM P 21188, holotype (x 3.5); 275) GSSA M 3393, paratype (x 3.5). GSSA M 3394, paratype: 276) axial view (x 10); 277) protoconch (x 40).

FIGS. 278-279 Pterynotus (Pterochelus) manubriatus (Tate): 278) holotype, SAM T 435 B (x 2.85); 279) SAM P 21189, deformed silicified specimen (x 3.6).

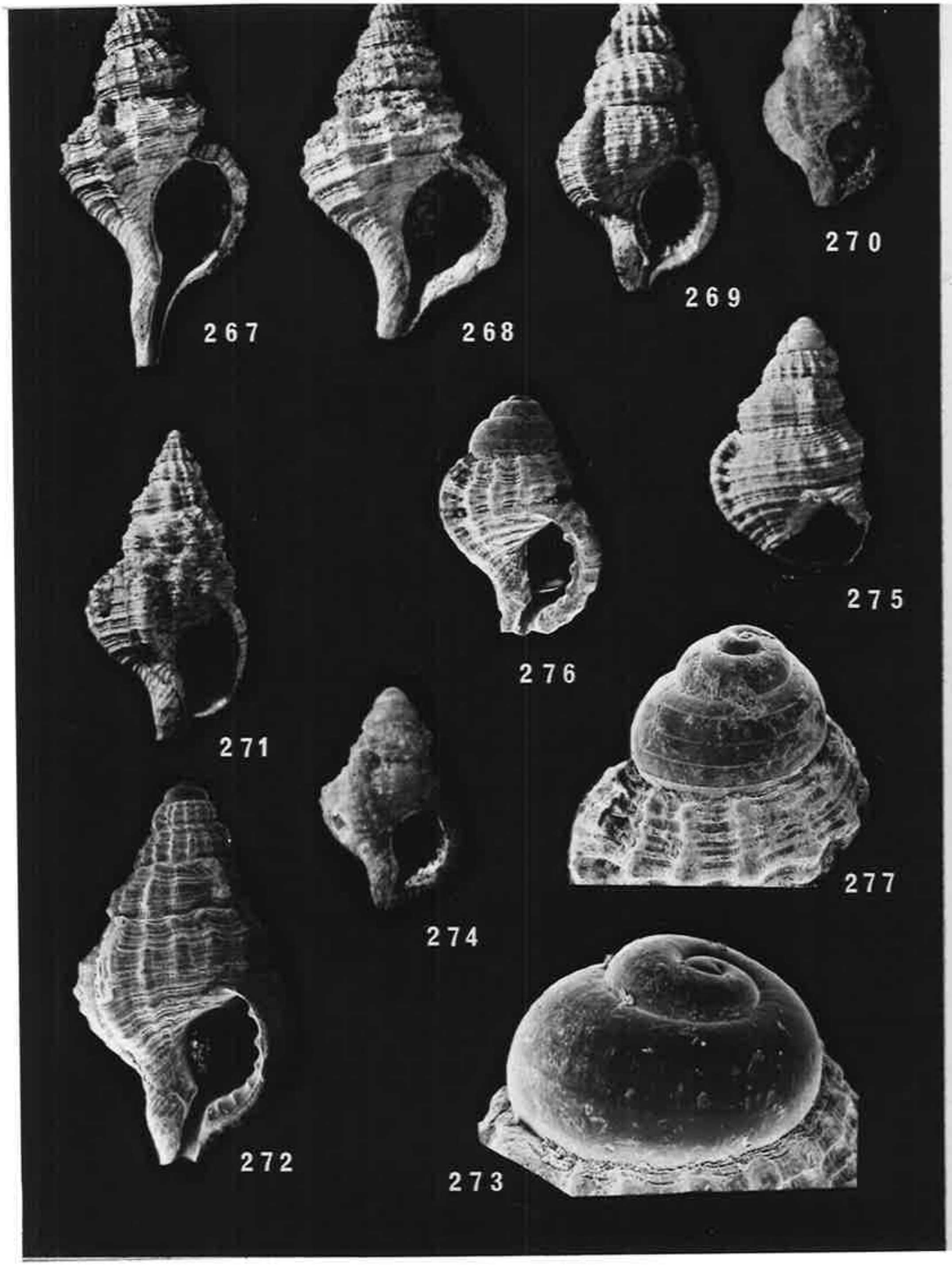
FIGS. 280 Pterynotus (Pterynotus) bifrons (Tate), holotype, SAM P 439A (x 3.0).

FIGS. 281-282 Pterynotus (Pterochelus) adelaidensis sp.nov., SAM P 21185: 281) adoral axial view (x 3.45); 282) aboral axial view (x 3.45).

FIGS. 283-285 Typhis (Talityphis) tetraphyllos sp. nov. Holotype, SAM P 21183: 283) adoral axial view (x 3.70); 284) aboral axial view (x 3.70); 285) paratype SAM T 459, aboral axial view (x 2.6).

FIGS. 286-288 Typhis (Talityphis) waikeriensis sp. nov. Holotype, GSSA M 3395: 286) adoral axial view (x 3.25); 287) aboral axial view (x 3.25); 288) adapical view (x 3.35).

FIGS. 289-290 Laevityphis (Laevithypis) ludbrookae Keen & Campbell. 289) holotype, SAM T 453A (x 3.1); 290) paratype SAM T 453B (x 3.1).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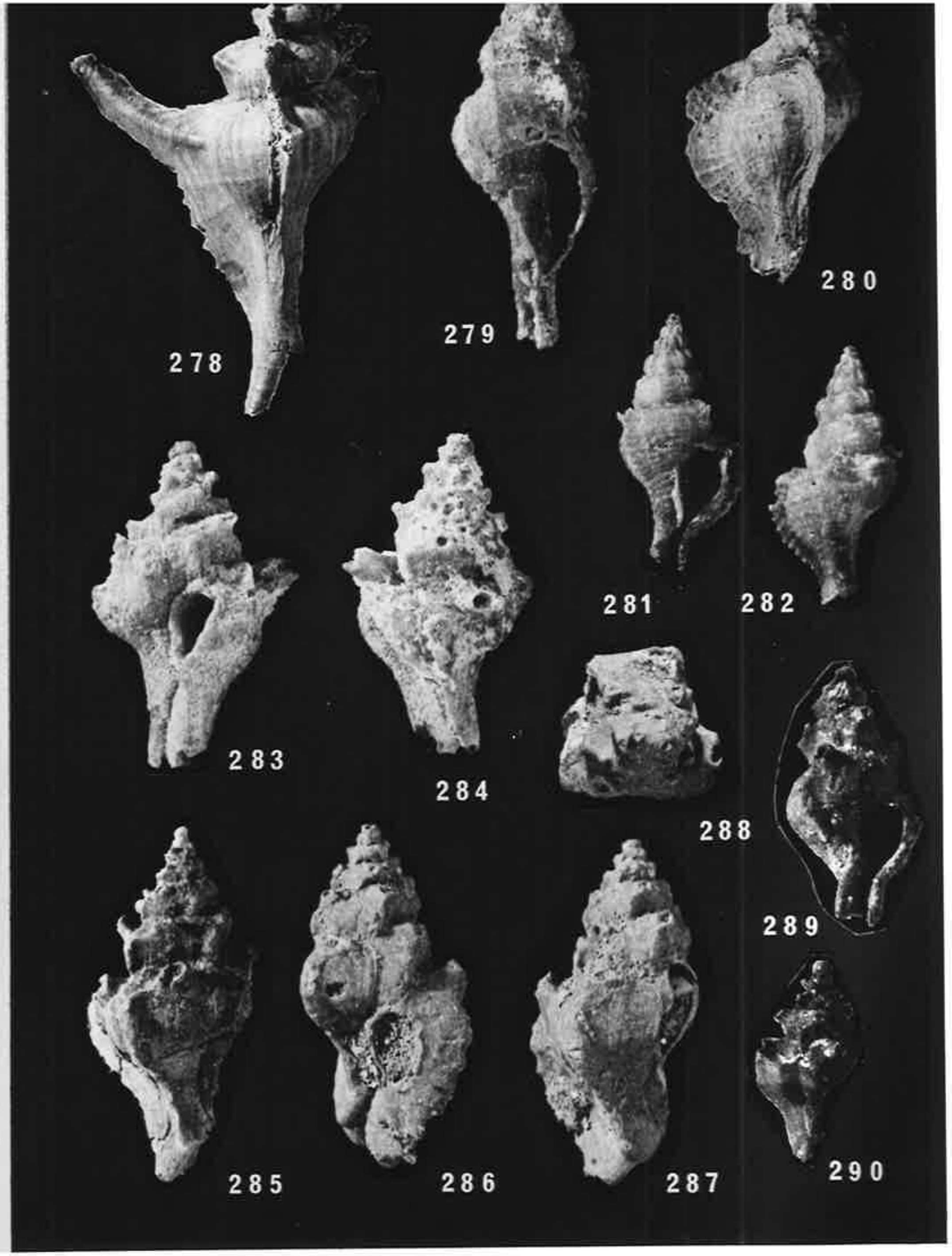
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FIGS. 291-292 Trophonopsis (Trophonopsis) hypsellus (Tate). GSSA M 3396: 291) axial view (x 10); 292) protoconch (x 50).

FIGS. 293-294 Trophon (Enantimene) monotropis Tate, SAM P 21190: 293) axial view (x 10); 294) protoconch (x 40).

FIG. 295 Latirus (Brocchitas) aldingensis (Tate). Holotype, SAM T 570B, axial view (x 3.1).

FIG. 296 Latirus (Brocchitas) altior sp. nov. Holotype, SAM P 21191, axial view (x 3).

FIGS. 297-299 Latirus (Brocchitas) altior m. intermedia m. nov. 297) Holotype, GSSA M 3397 (x 3.0); 298) paratype GSSA M 3398 (x 3.3); 299) paratype, SAM T 570C (x 3.35).

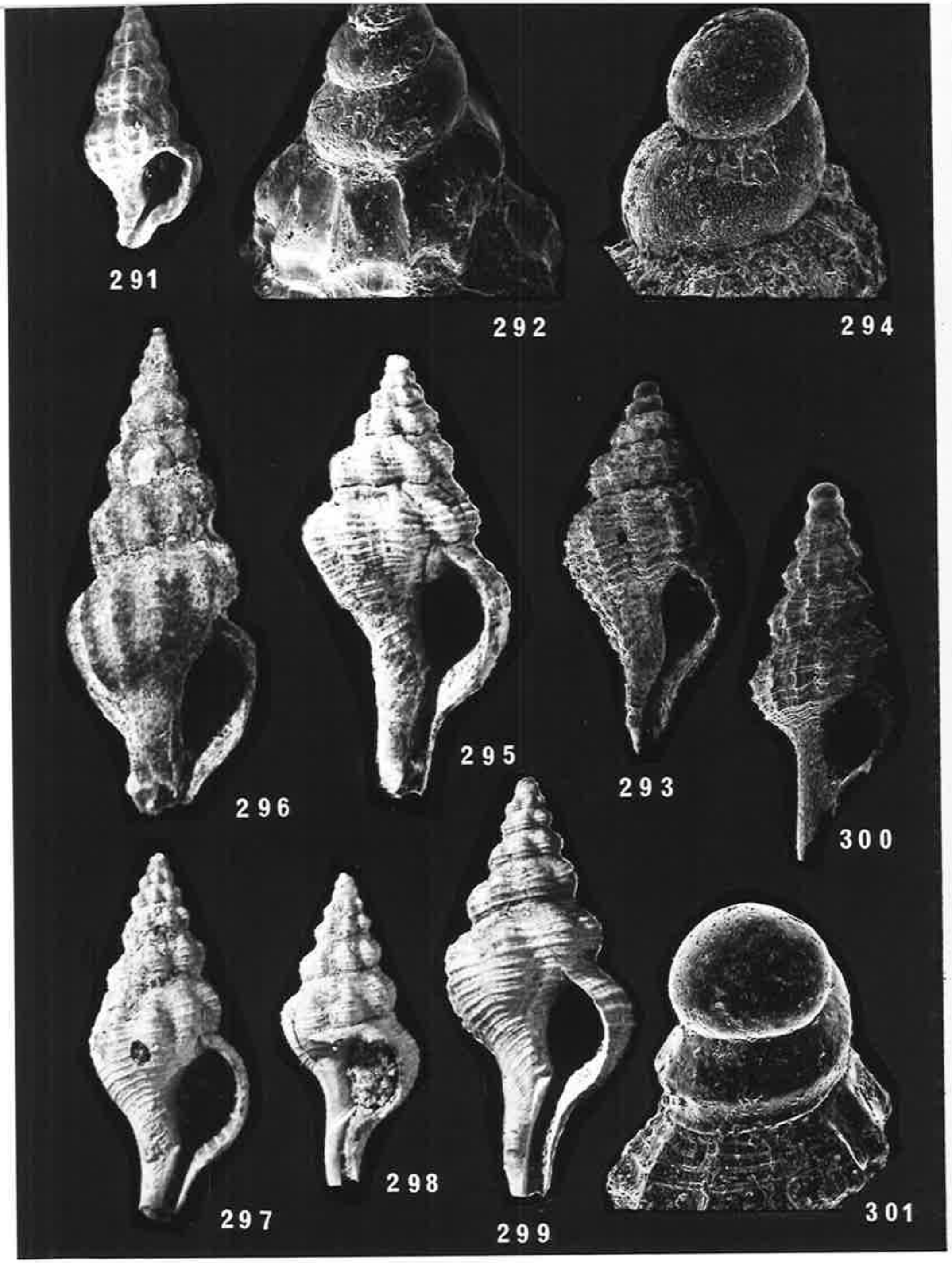
FIGS. 300-301 Fusinus (Fusinus) sculptilis (Tate). Paratype, SAM T 478H: 300) axial view (x 10); 301) protoconch (x 40).

FIGS. 302-306 Baryspira (Gracilispira) ligata (Tate). 302) SAM P 21191, axial view, silicified slightly deformed specimen (x 3.5); 303) GSSA M 2858, axial view (x 10); 304) GSSA M 2855 A, juvenile (x 20). GSSA M 2855 B, juvenile: 305) axial view (x 20); 306) protoconch (x 40).

FIGS. 307-308 Austromitra pumila (Tate) SAM P 21192: 307) axial view (x 20); 308) protoconch (x 80).

FIG. 309 Notopeplum protorhysum (Tate). GSSA M 2978, axial view (x 3.3).

FIGS. 310-311 Waimatea subcrenularis (Tate). 310) GSSA M 3400A, axial view (x 3.45); 311) GSSA M 3400 B, axial view (x 3.45).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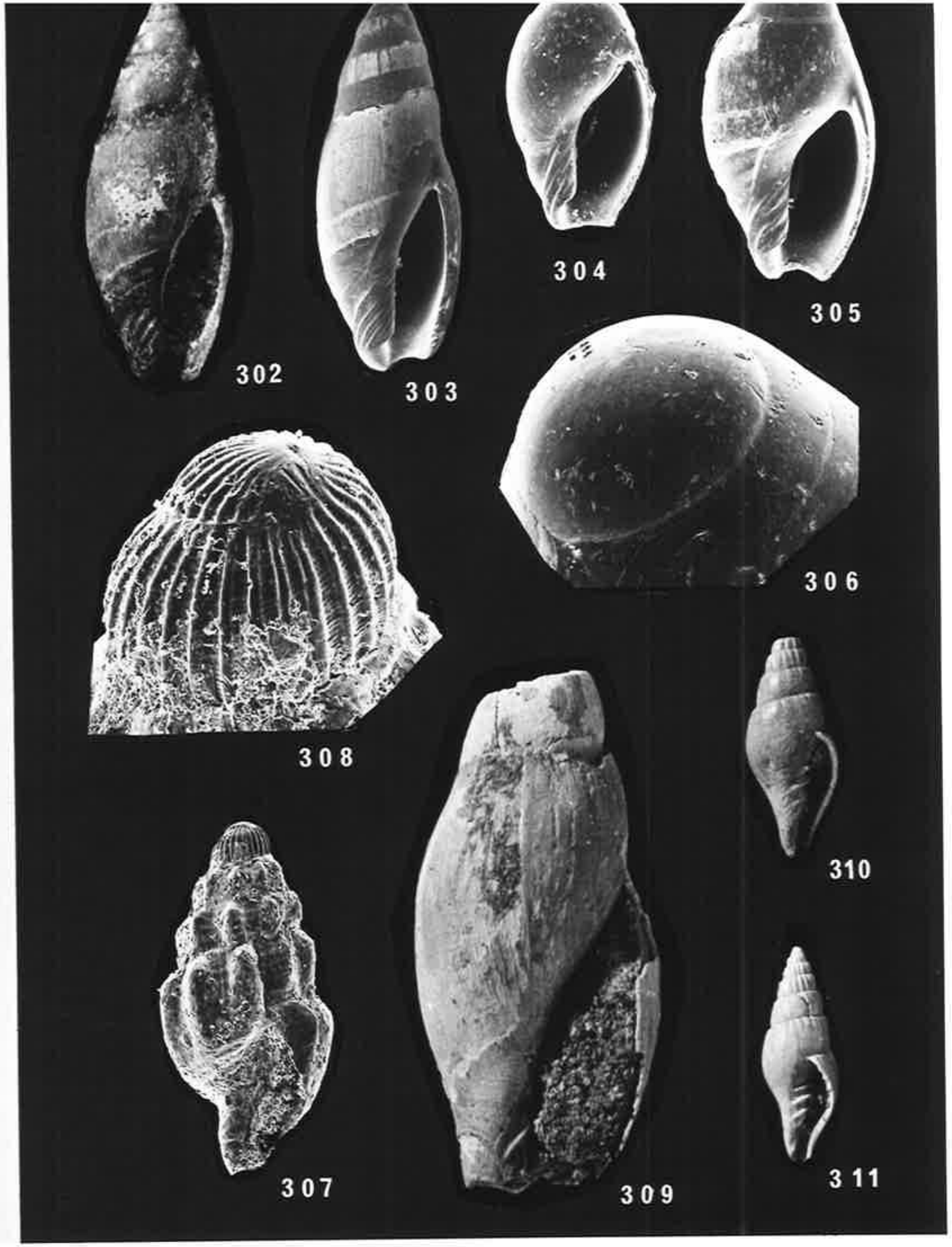
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FIGS. 312-313 Waimatea subcrenularis (Tate). GSSA M 3399: 312) axial view (x 10); 313) protoconch (x 50).

FIGS. 314-315 Waimatea complanata (Tate). GSSA M 3401: 314) axial view (x 10); 315) protoconch (x 50).

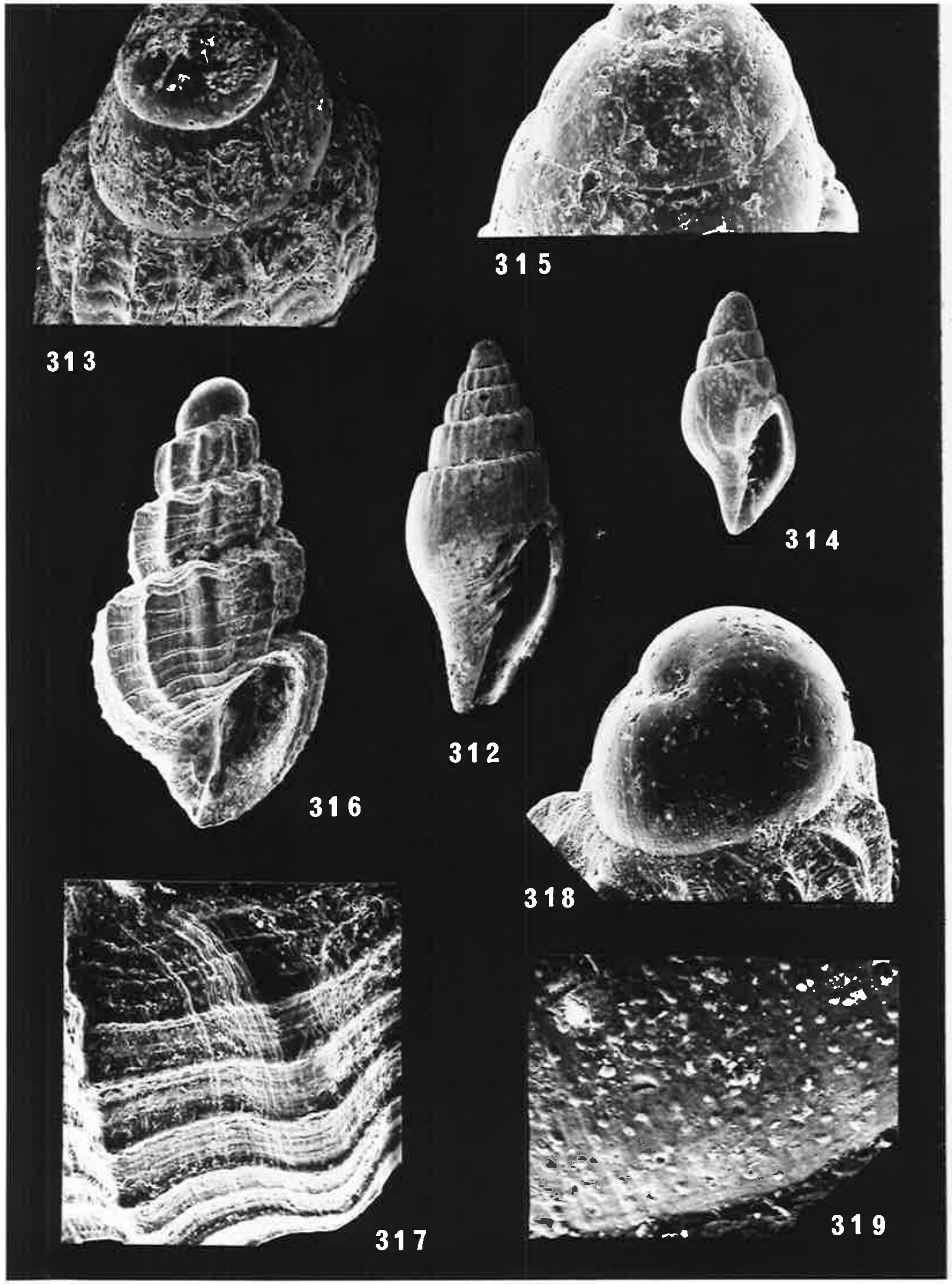
FIGS. 316-319 Narona (Iglisella) turriculata (Tate). SAM P 21193: 316) axial view (x 24.35); 317) particular, ornament last whorl (x 60); 318) Protoconch (x 60); 319) particular, protoconch pustulae(x 400).

FIGS. 320-322 Cottonella mala (Cotton), SAM P 21207A-C, axial view, all x 3.7.

FIG. 323 Conuginella muna sp. nov., holotype, GSSA M 3417, axial view (x 3.55).

FIGS. 324-327 Marginella sp. nov. A, GSSA M 3402: 324) axial view (x 10); 325) abaxial lip denticulations (x 30, tilted); 326) protoconch (x 70); 327) abapical vermiculations (x 80).

FIGS. 328-330 Kaurnaginella tutugka sp. & gen. nov. GSSA M 3403 A-C, axial view (all x 20).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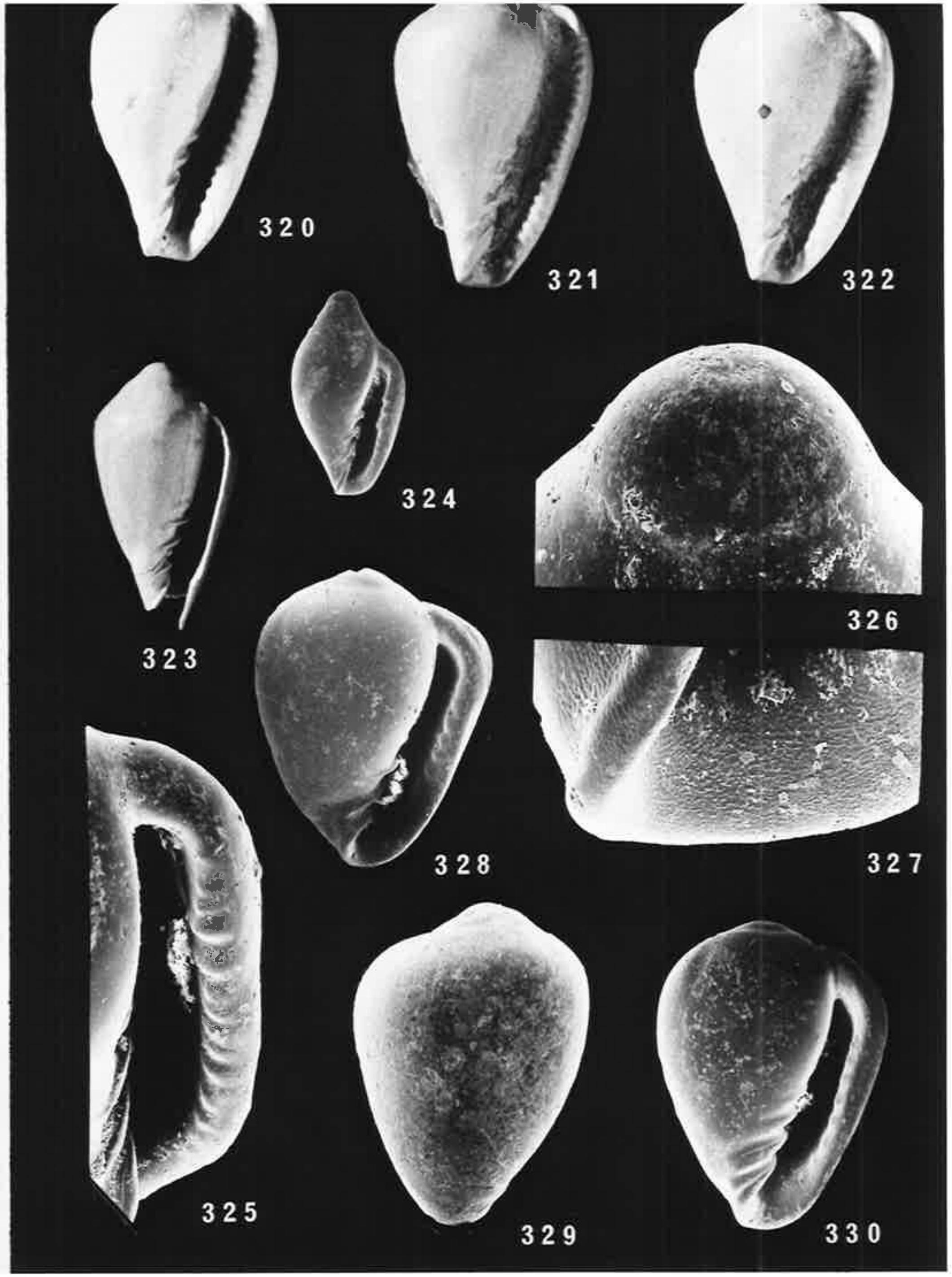
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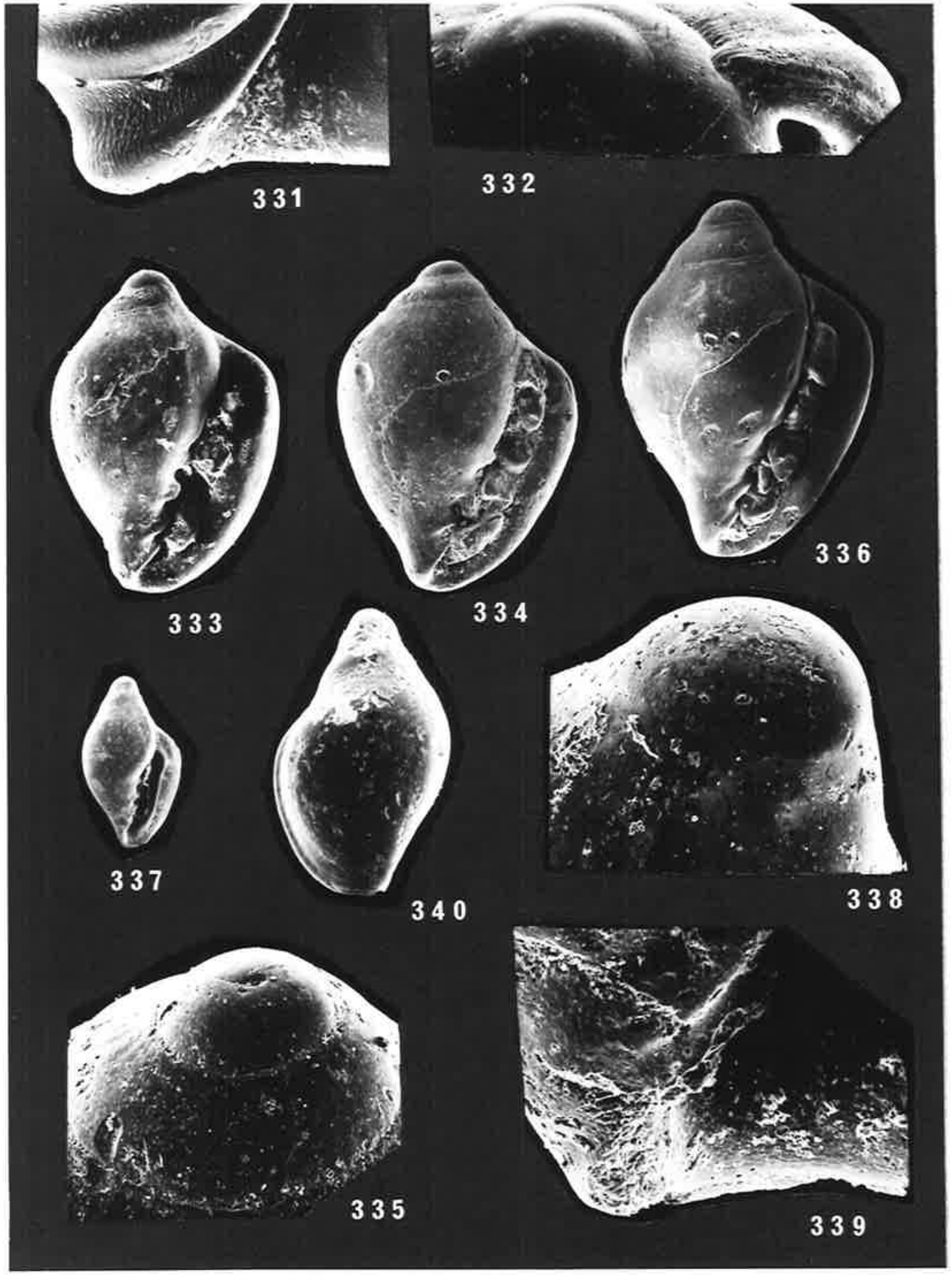
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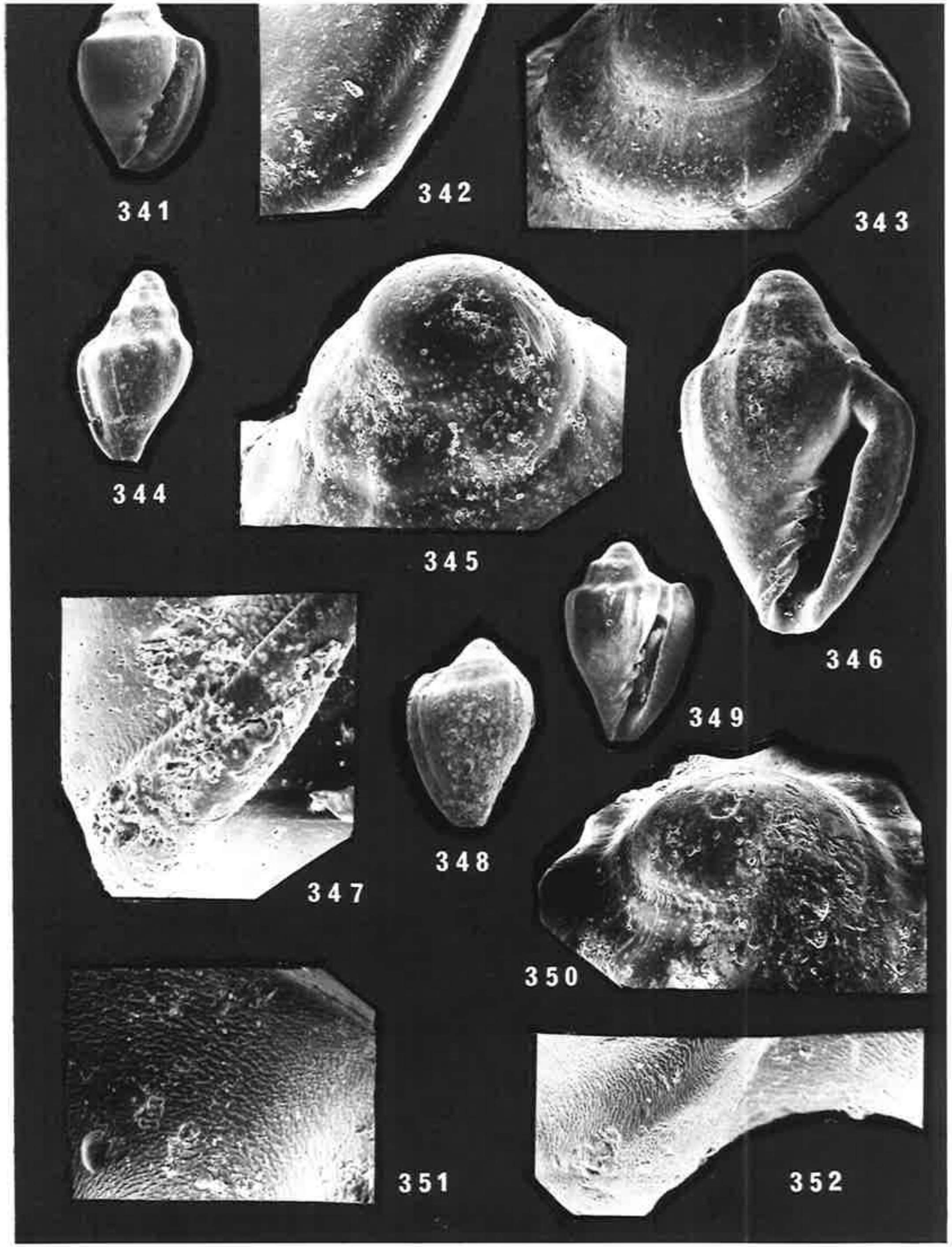
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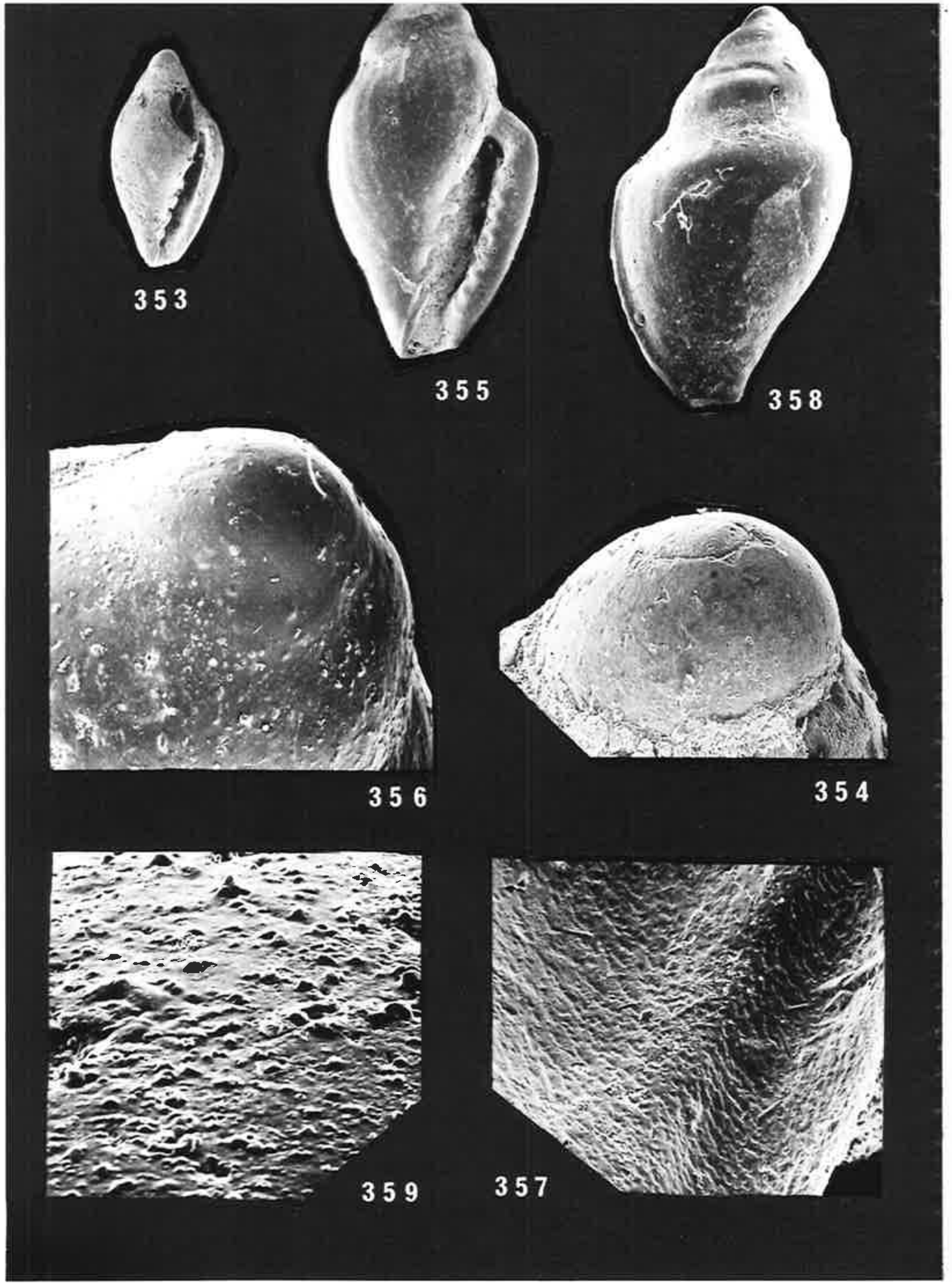
FIGS. 353-359 Marginella (Mioginella) regula (Cotton). SAM P 21194: 353) juvenile, axial view (x 10); 354) protoconch (x 60). SAM T 656A: 355) axial view (x 10); 356) protoconch (x 50); 357) abapical vermiculations (x 140). SAM T 656B: 358) axial aboral view (x 10); 359) protoconch pustulations.

FIGS. 360-363 Vexithara citharelloides (Tate). SAM P 21208: 360) axial view, juvenile (x 10); 361) protoconch (x 80). SAM T 631B, holotype: 362) axial view (x 3.25). SAM P 21182: 363) axial view (x 3.45).

FIGS. 364-365 Comitas (Comitas) aldingensis (Powell). SAM P 21195: 364) axial view (x 10); 365) protoconch (x 50).

FIGS. 366-369 Comitas sp. nov. GSSA M 3411: 366) axial view (x 10); 367) ornament, particular (x 40); 368) protoconch (x 50); 369) protoconch pustulae (x 300).

FIGS. 370-371 Rugobela sp. nov. GSSA M 3412: 370) axial view (x 10); 371) protoconch (x 50).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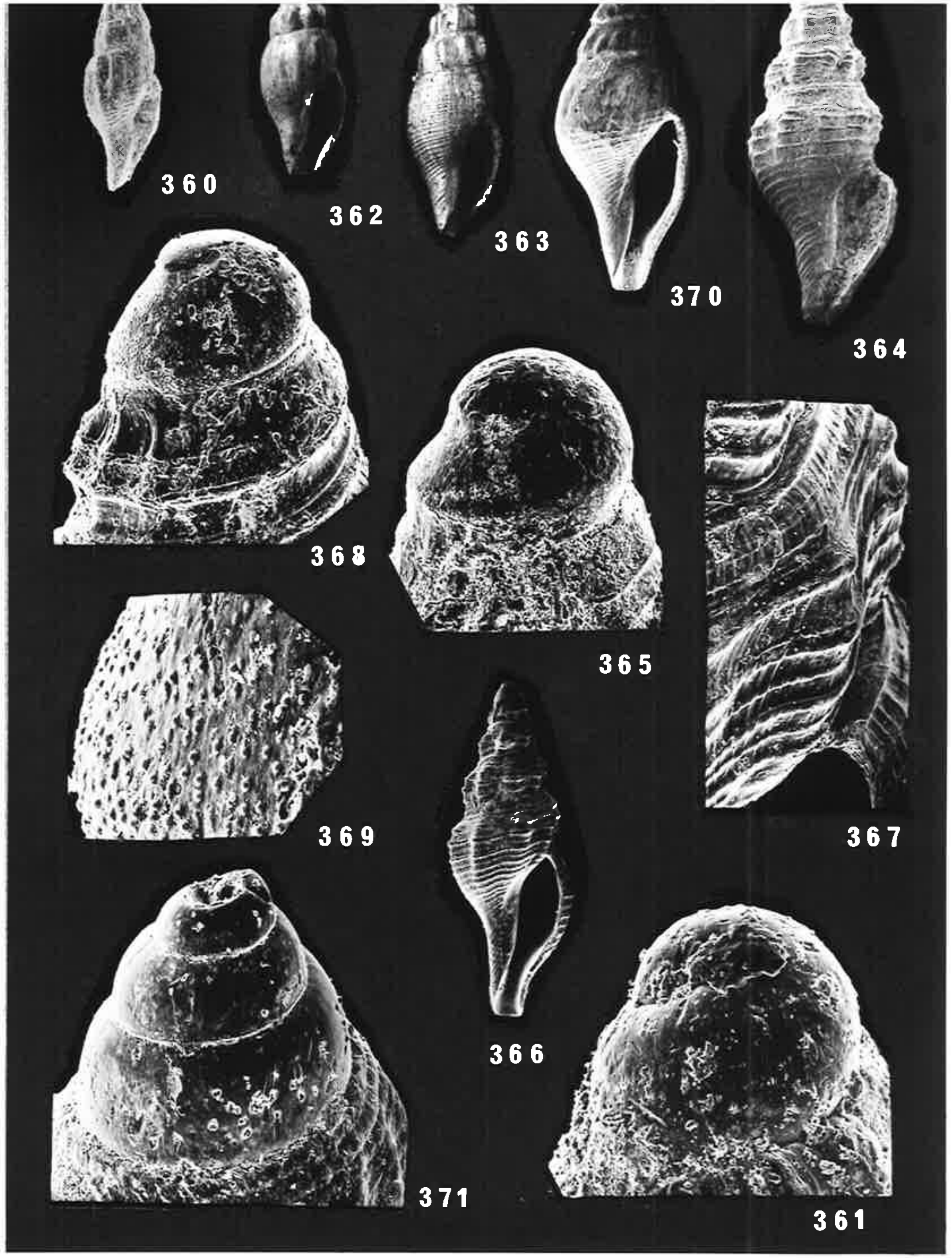
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FIGS. 372-375 *Pseudomalaxis (Pseudomalaxis)* sp. nov. aff. *asculpturatus* Maxwell. GSSA M 3415A-C: 372) GSSA M 3415-A, adapical view (x 30); 373) GSSA M 3415-B, abapical view (x 30); 374) GSSA M 3415-C, axial view (x 30); 375) the same, tilted adapical view (x 100).

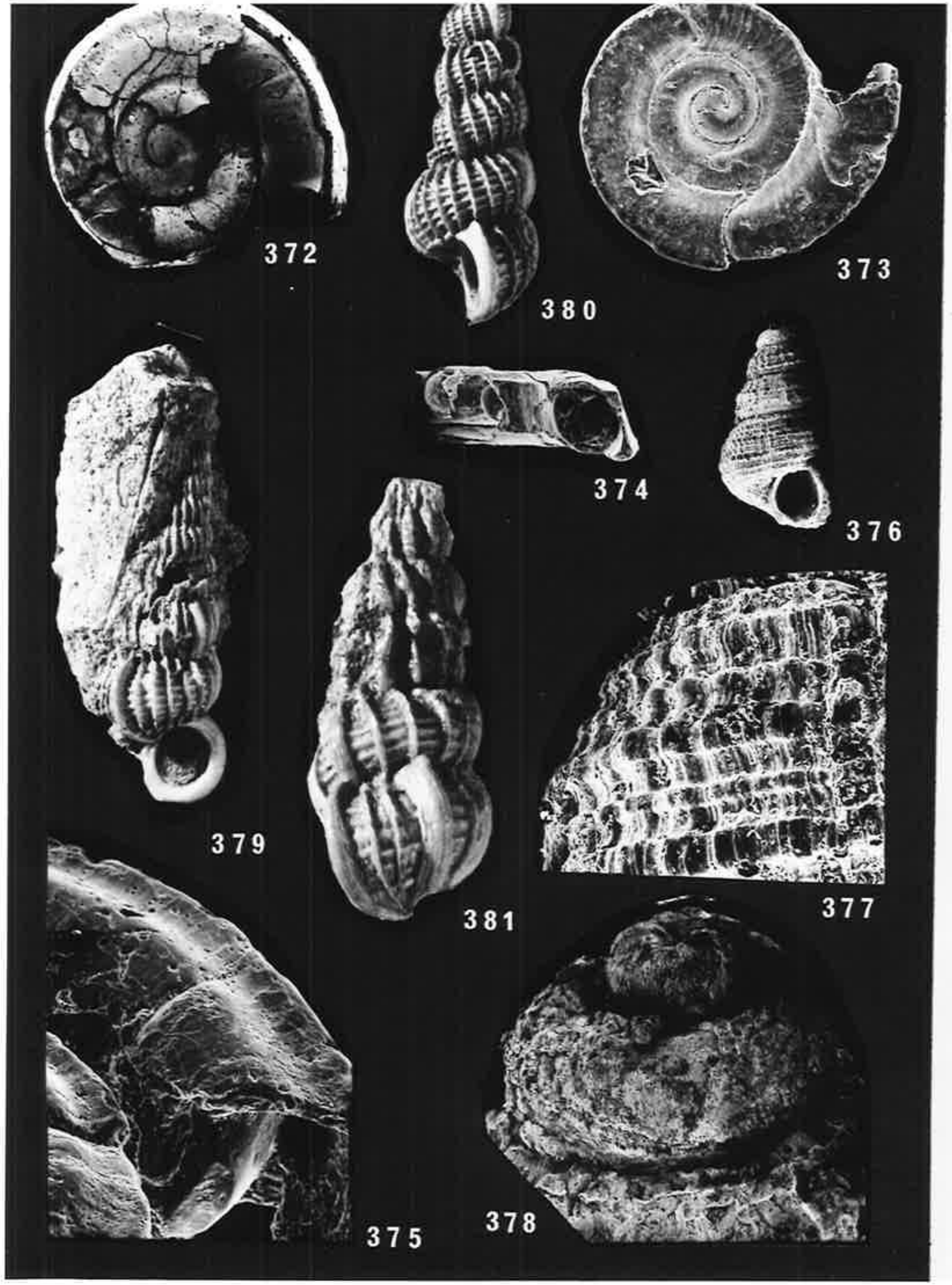
FIGS. 376-378 *Acrocoelum margaritatum* sp. nov. SAM P 21196, holotype: 376) axial view (x 10); 377) ornament, particular (x 50); 378) protoconch (x 50).

FIGS. 379-381 *Cirsotrema (Cirsotrema) mariae* (Tate). 379) SAM T 778A, holotype, axial view (x 1.5); 380) SAM T 778E, paratype (x 1.8); 381) SAM T 778H, paratype (x 1.8).

FIGS. 382-384 *Chemnitzia* sp. nov. *A*. SAM P 21197: 382) axial view (x 30); 383) protoconch, abapical view (x 80); 384) protoconch, adapical-axial view (x 80).

FIGS. 385-387 *Chemnitzia* sp. nov. *B*, SAM P 21198: 385) axial view (x 30); 386) protoconch, axial-abapical view (x 80); 387) protoconch, adapical view (x 80).

FIGS. 388-390 *Turbonilla rossiae* sp. nov. SAM P 21199, holotype: 388) axial view (x 30); 389) protoconch, abapical view (x 80); 390) protoconch, axial-adapical view (x 80).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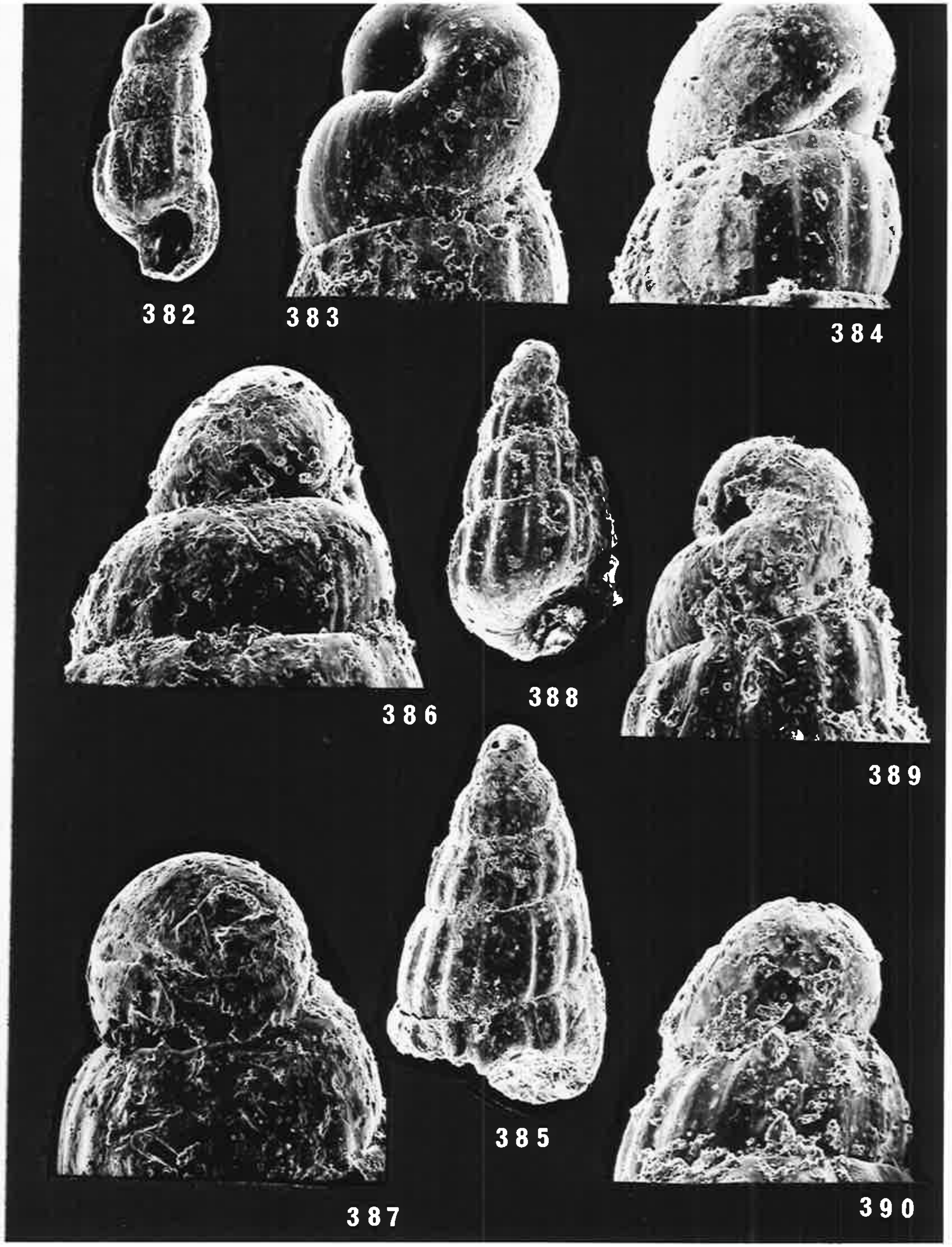
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FIG. 391 Turbonilla kaurna sp. nov. SAM P 21200, holotype, axial view (x 30).

FIG. 392 Turbonilla sp. nov., SAM P 21201, axial view (x 20).

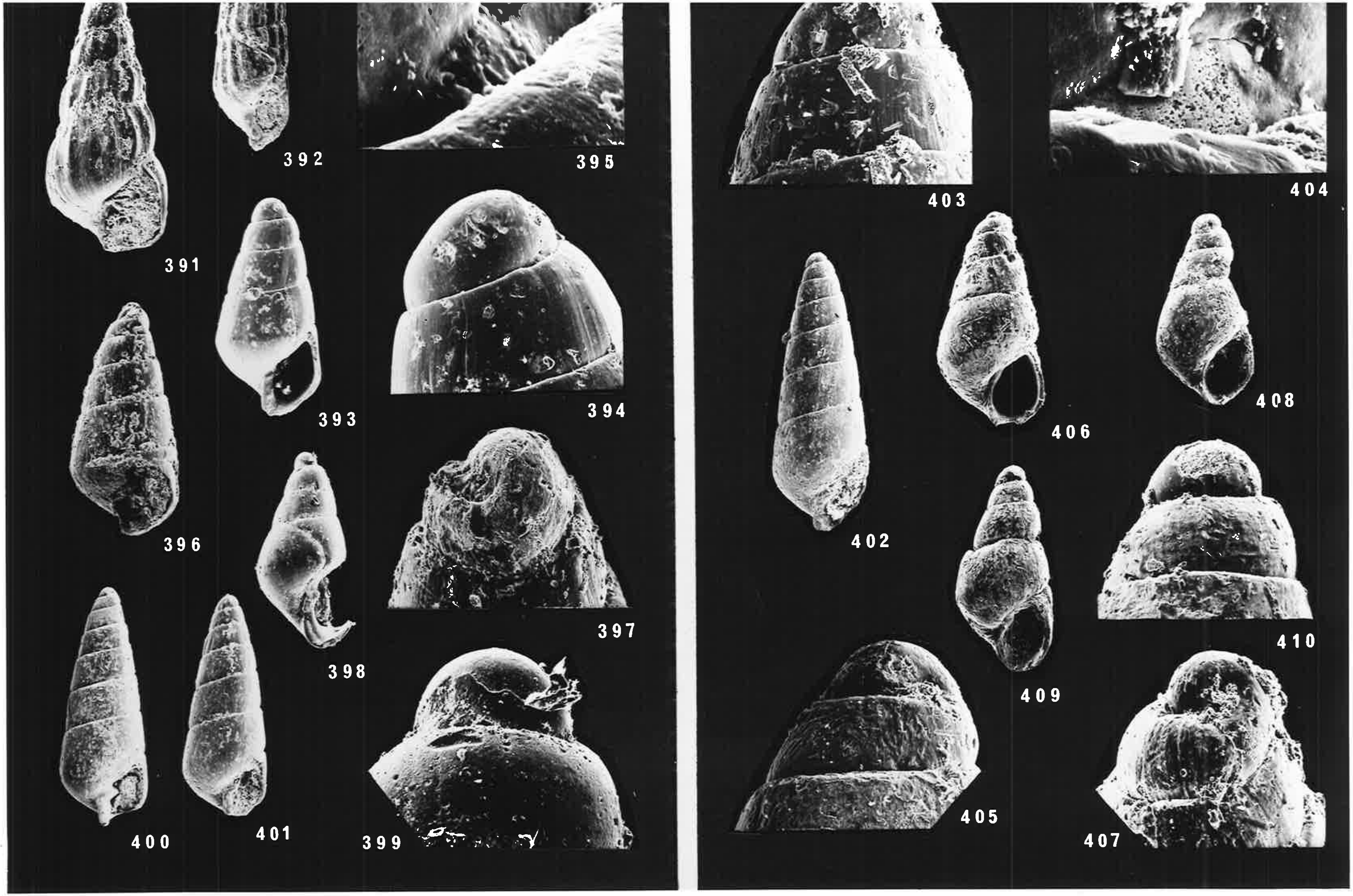
FIGS. 393-397 Syrnola (Pachysyrnola) habei sp. nov., GSSA M 3413, holotype: 393) axial view (x 30); 394) protoconch, axial-adapical view (x 100); 395) protoconch, particular nucleus (x 1000). SAM P 21202B, paratype: 396) axial view (x 30); 397) corroded protoconch, abapical view (x 100).

FIGS. 398-399 Syrnola s.l. sp., GSSA M 3414: 398) axial view (x 30); 399) protoconch (x 160).

FIGS. 400-401 Tiberia (Cossmannica) maxwelli sp. nov. 400) SAM P 21203-A, holotype, axial view (x 20); 401) SAM P 21203-B, paratype, axial view (x 20).

FIGS. 402-405 Tiberia (Cossmannica) maxwelli sp. nov.: 402) SAM P 21204-C, paratype, axial view (x 20); 403) SAM P 21204-B, protoconch, axial-adapical view (x 110); 404) the same, particular nucleus (x 1000); 405) SAM P 21204-A, protoconch, abapical view (x 110).

FIGS. 406-410 Odostomia (Auristomia) sulcata sp. nov.: SAM P 21205-A, holotype: 406) axial view (x 30); 407) protoconch, abapical view (x 110); Paratypes: 408) SAM P 21205-B, axial view (x 30). To note on the right margin, predation drilling; 409) SAM P 21205-C, axial view (x 30); 410) the same, protoconch, adapical view (x 110).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FIGS. 411-414 Kosugeia costatosulcata sp. nov. Paratype GSSA M 3418, 411) shell (x 24); 412) last whorl (x 42); 413) protoconch (x 60, tilt 45°). Holotype, Maslin Bay, SAM P 21209: 414) shell (x 20).

FIGS. 415-420 Inella maxwelli sp. nov. Holotype SAM P 21210: 415) shell (x 34); 416) last whorl (x 52); 417) protoconch (x 54, tilt 45°). Paratype SAM P 21210-A: 418 shell (x 20). Paratype SAM P 21210B: 419) shell (x 20); 420) last whorl (x 38).

FIGS. 421-422 Viriola sp. nov. GSSA M 3419: 421) shell (x 10); 422) last whorl (x 30).

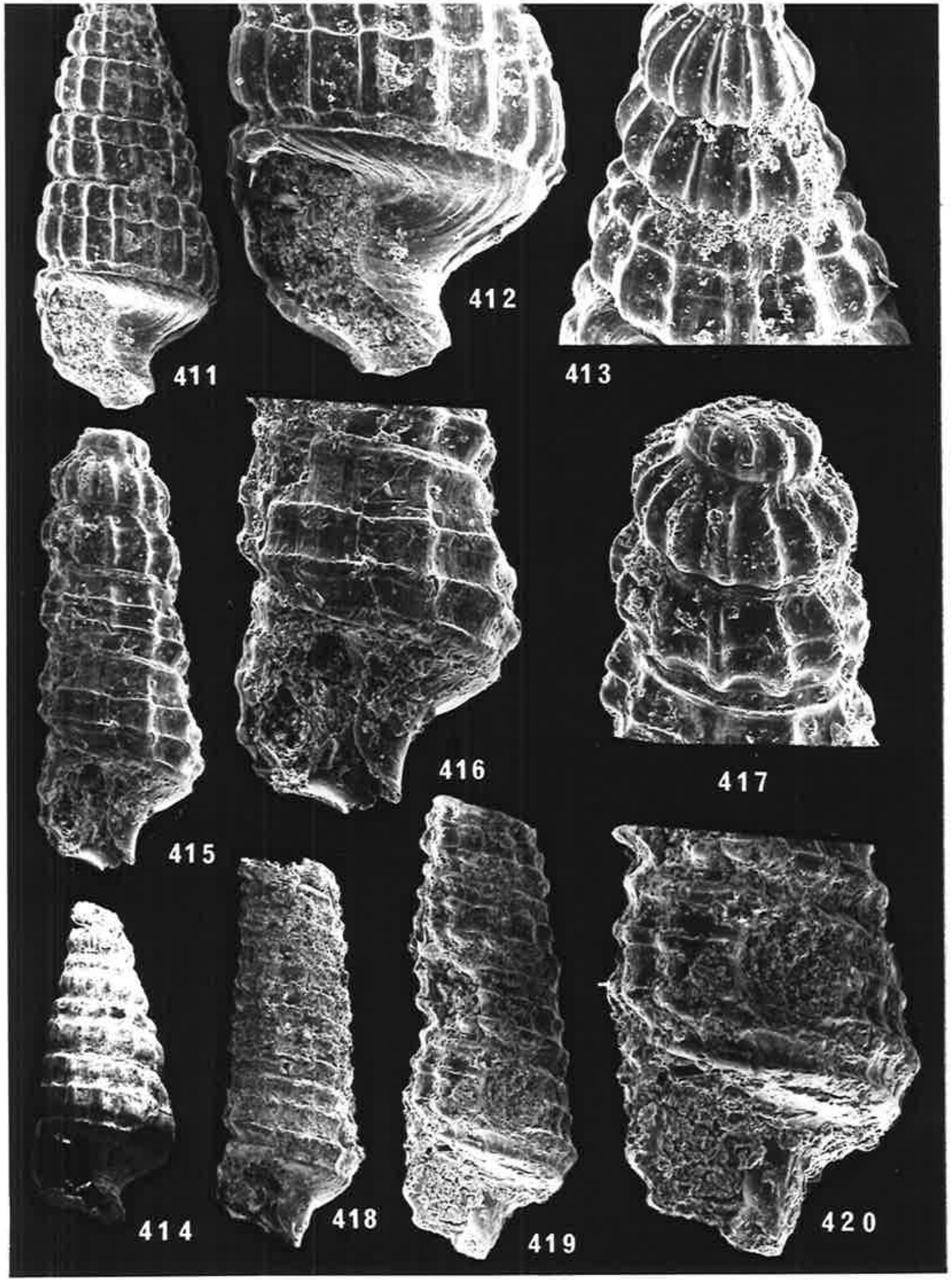
FIG. 423 Isotriphora sp. nov. SAM P 21211, shell (x 20).

FIGS. 424-427 Triphora (Ogivia) trirostrata sp. nov. Holotype GSSA M 3420: 424) shell (x 10); 425) protoconch (x 50, tilt 45°); 426) last whorl (x 30). Paratype GSSA M 3421: 427) shell (x 20).

FIG. 428 Triphora s.l. sp. nov. A. SAM P 21212, protoconch (x 40).

FIGS. 429-430 Triphora s.l. muna sp. nov. Paratype SAM P 21213A: 429) deformed last whorl (x 20); 430) shell (x 10).

FIG. 431 Triphora s.l. ?sp. nov. B, GSSA M 3423, worn shell (x 10).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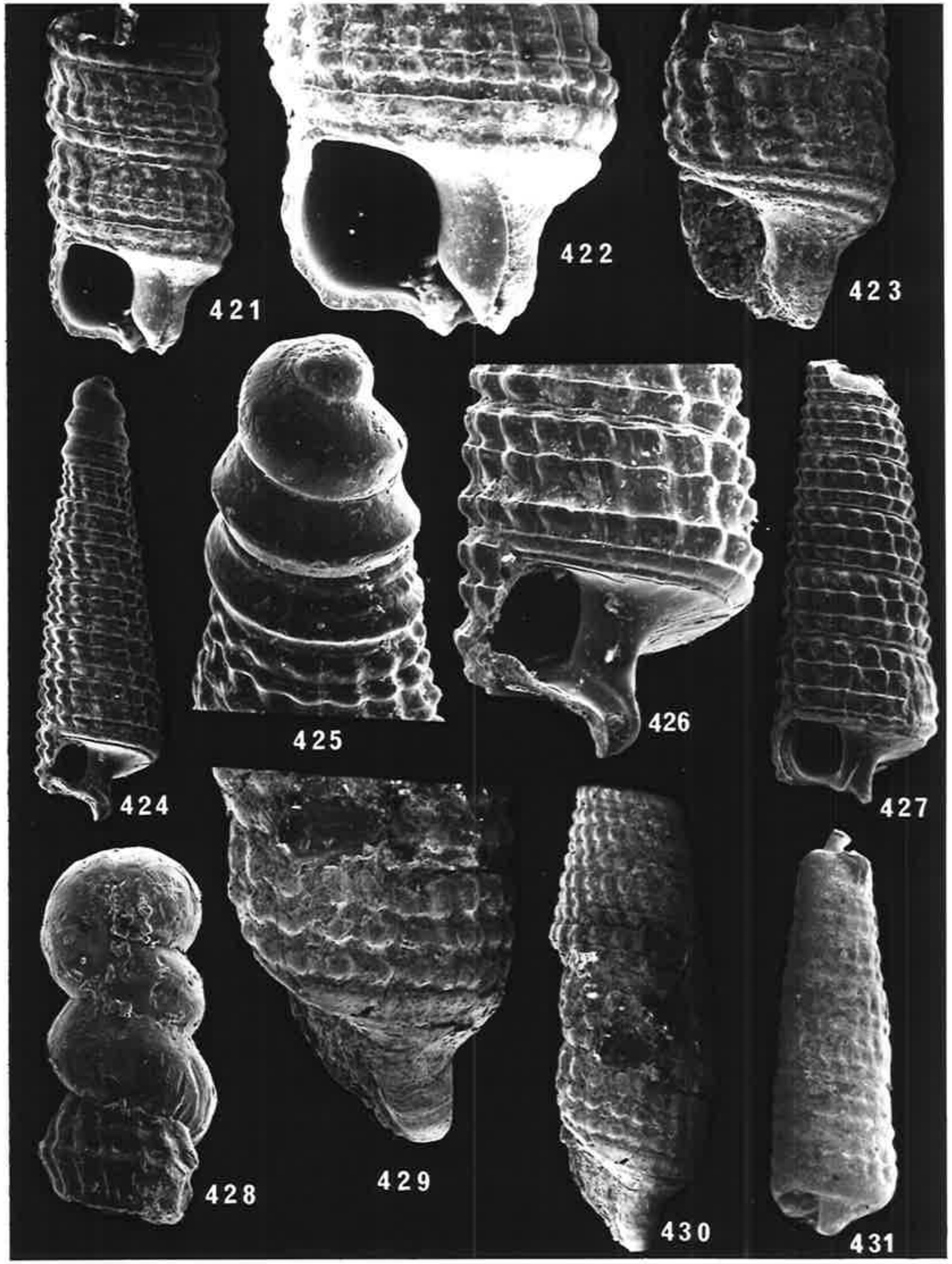
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FIGS. 432-435 Triphora s.l. muna, sp. nov. Holotype, SAM P 21213: 432) axial view (x 20); 433) last whorl (x 40); 434) protoconch (x 80). Paratype, GSSA M 3422; 435) axial view (x 40).

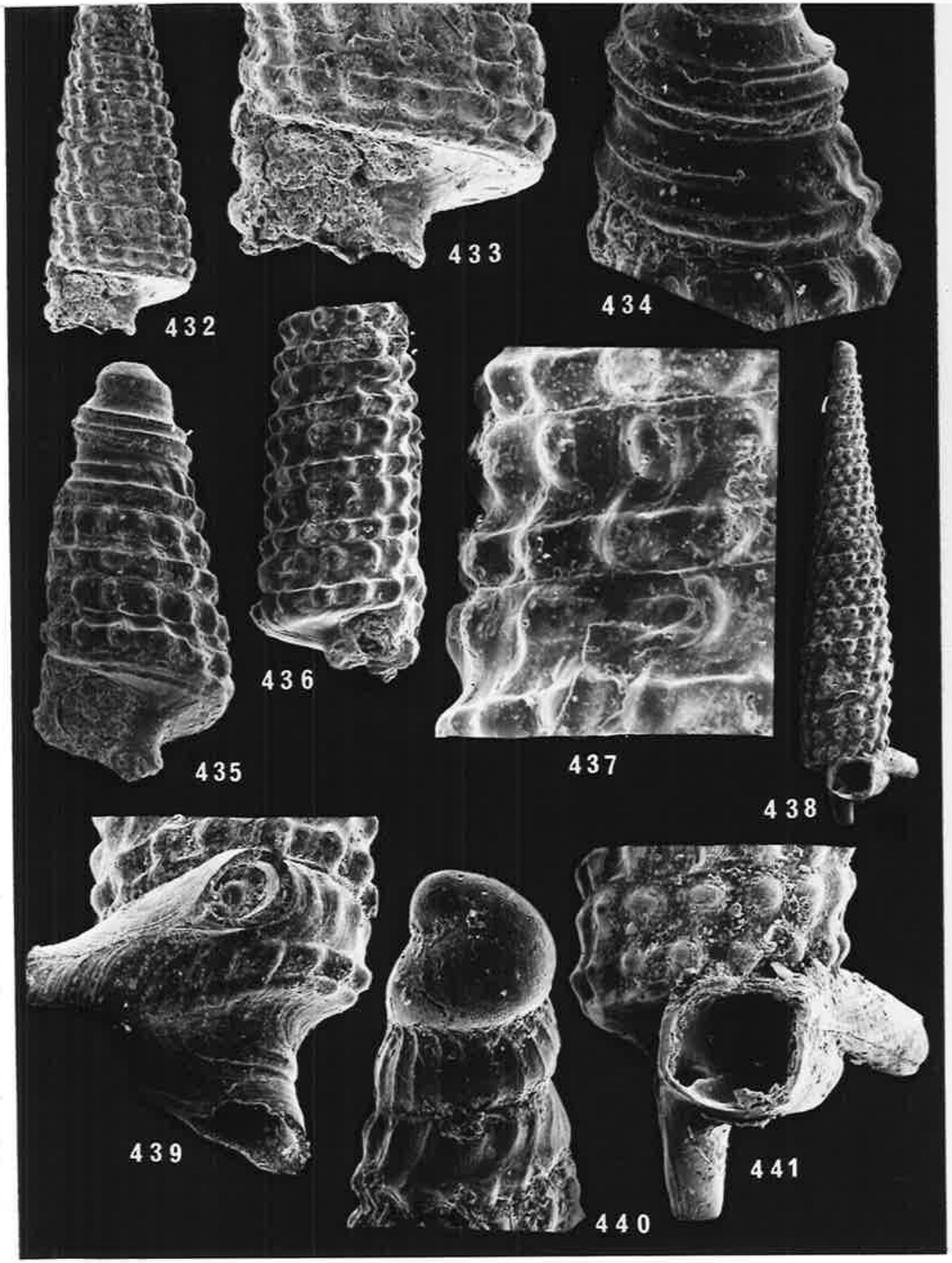
FIGS. 436-437 Triforis (Granulotriforis) sp. nov. GSSA M 3424: 436) shell (x 20); 437) particular ornament and whorl (x 70).

FIGS. 438-441 Triforis (Granulotriforis) epallaxa (Verco) SAM P 21214, Great Australian Bight, 50-120 fms (Holocene): 438) shell (x 10); 440) protoconch (x 60, tilt 45^{o}); 441) last whorl (x 30). Topotype SAM P 21215, Cape Jaffa, 300 fms. 439) last whorl, particular adapical channel (x 30).

FIGS. 442-444 Acteon subscalatus Cossmann. SAM P 21216: 442) axial view (x 20). SAM P 21217: 443) axial view (x 30); 444) protoconch (x 60, tilt 45^{o}).

FIGS. 445-447 Kaurnacteon elevatus gen. & sp. nov. (all x 30): 445) paratype SAM P 21218B; 446) paratype SAM P 21218E; 447) paratype SAM P 21218A.

FIGS. 448-451 ?Kleinacteon dubius sp. nov.: 418) paratype GSSA M 3425, axial view (x 30). Holotype, SAM P21219: 449) axial view (x 40); 450) ornament (x 100); 451) protoconch (x 80, tilt 45^{o}).



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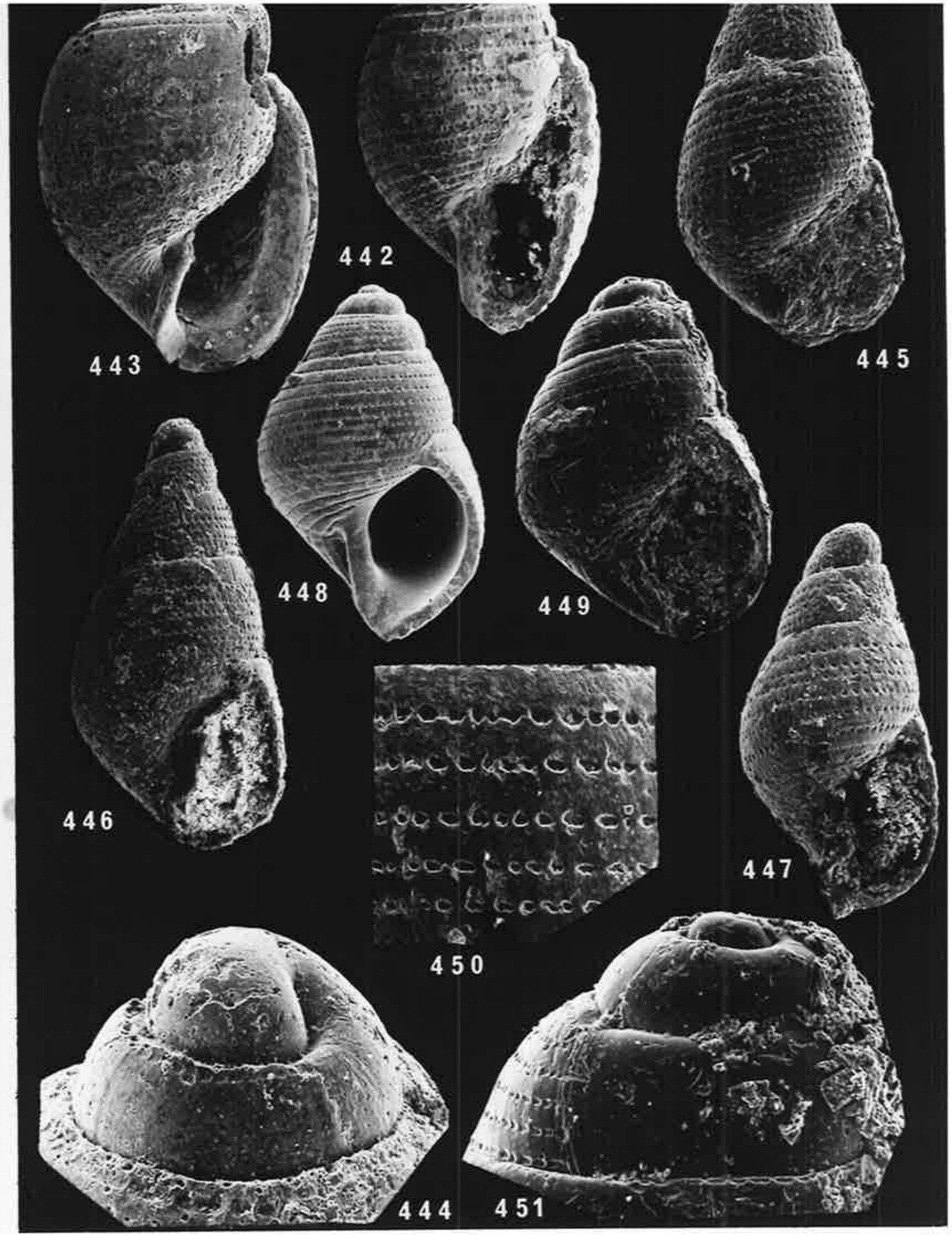

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FIGS. 452-454 Kaurnacteon elevatus gen. & sp. nov. Holotype SAM P 21220: 452) shell (x 30); 453) ornament (x 100); 456) protoconch (x 120, tilt 45°).

FIGS. 455-458 Tornatellaea (Tornatellaea) minutissima sp.nov. Paratype GSSA M 3426: 455) axial view (x 30); 456) protoconch (x 80, tilt 45°). Holotype GSSA M 3427: 457) shell (x 30); 458) ornament (x 100).

FIGS. 459-461 Tornatellaea (Triploca) ligata (Tate). Paralectotype SAM 1758 B: 459) axial view (x 10); 460) ornament (x 120). Lectotype SAM T 1758 A; 467) axial view (x 4.7).

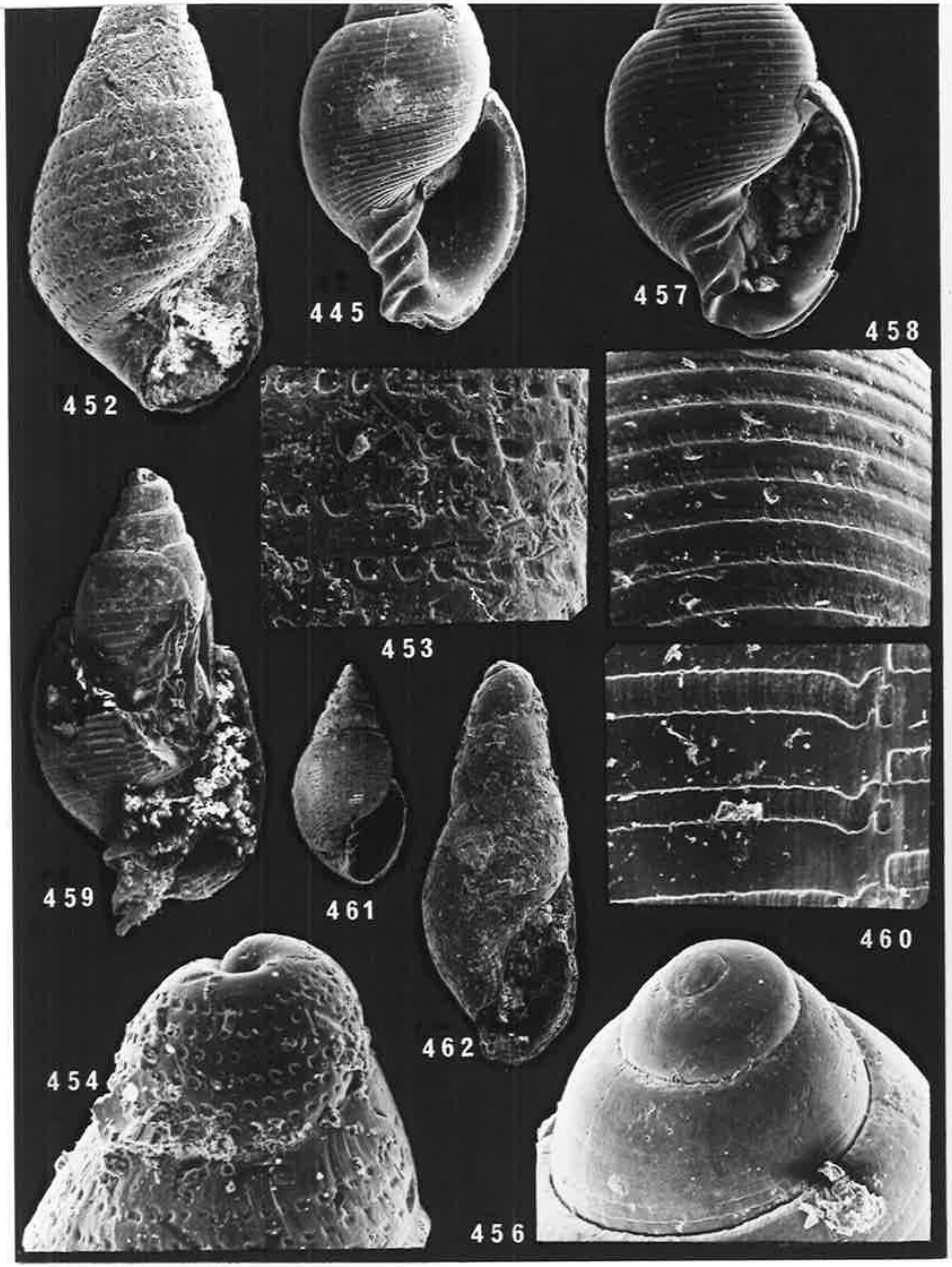
FIG. 462 Tenuiacteon acicularis sp. nov. Holotype SAM P 21221: 462) (x 30).

FIGS. 463-464 Tenuiacteon acicularis sp. nov. Holotype:463) ornament (x 100); 464) protoconch (x 80, tilt 45°).

FIGS. 465-469 Acteocina scalarum sp. nov. Paratype SAM P 21222A: 465) apical view (x 40); 466) ornament (x 130). Holotype SAM P 21222: 467-468) shell two views (x 30); 469) protoconch (x 70, tilt 45°).

FIGS. 470-472 Cylichna (Cylichnania) callosa (Tate & Cossmann). SAM P 21223: 470) axial view (x 10); 471) peristome (x 20). SAM P 21224; 472) adapical view (x 50, tilt 45°).

FIGS. 473-474 Cylichna (Cylichna) cf. angustata (Tate & Cossmann). 473) SAM P 21225, adapical view (x 50, tilt 45°); 474) SAM P 21226, axial view (x 20).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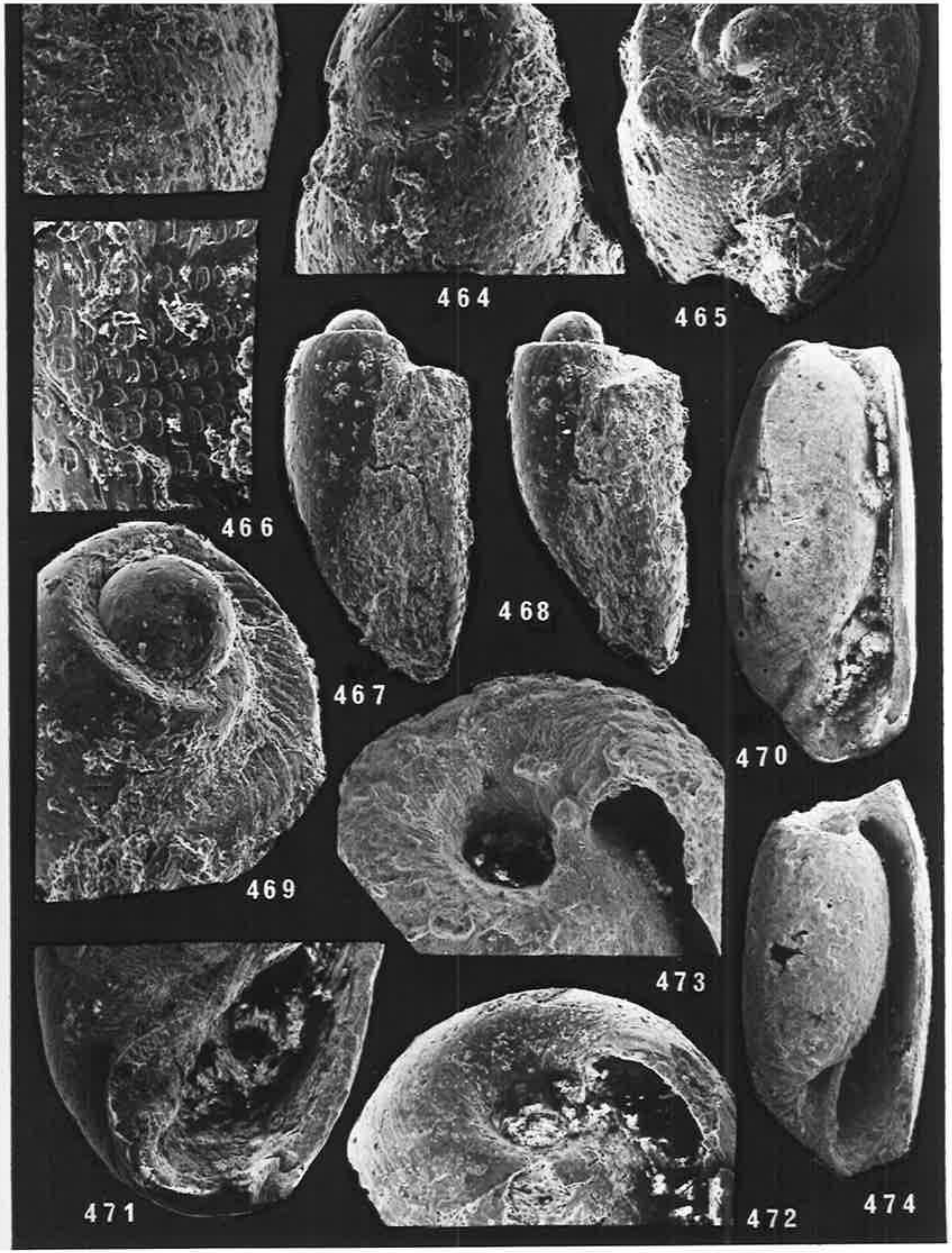
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FIGS. 475-477 Retusa (Decorifer) crassa sp. nov. 475) Holotype SAM P 21227 (x 30); 476) paratype SAM P 21227A, dorsal view (x 20); 477) Paratype SAM P 21227B, adapical view (x 70, tilt 45°).

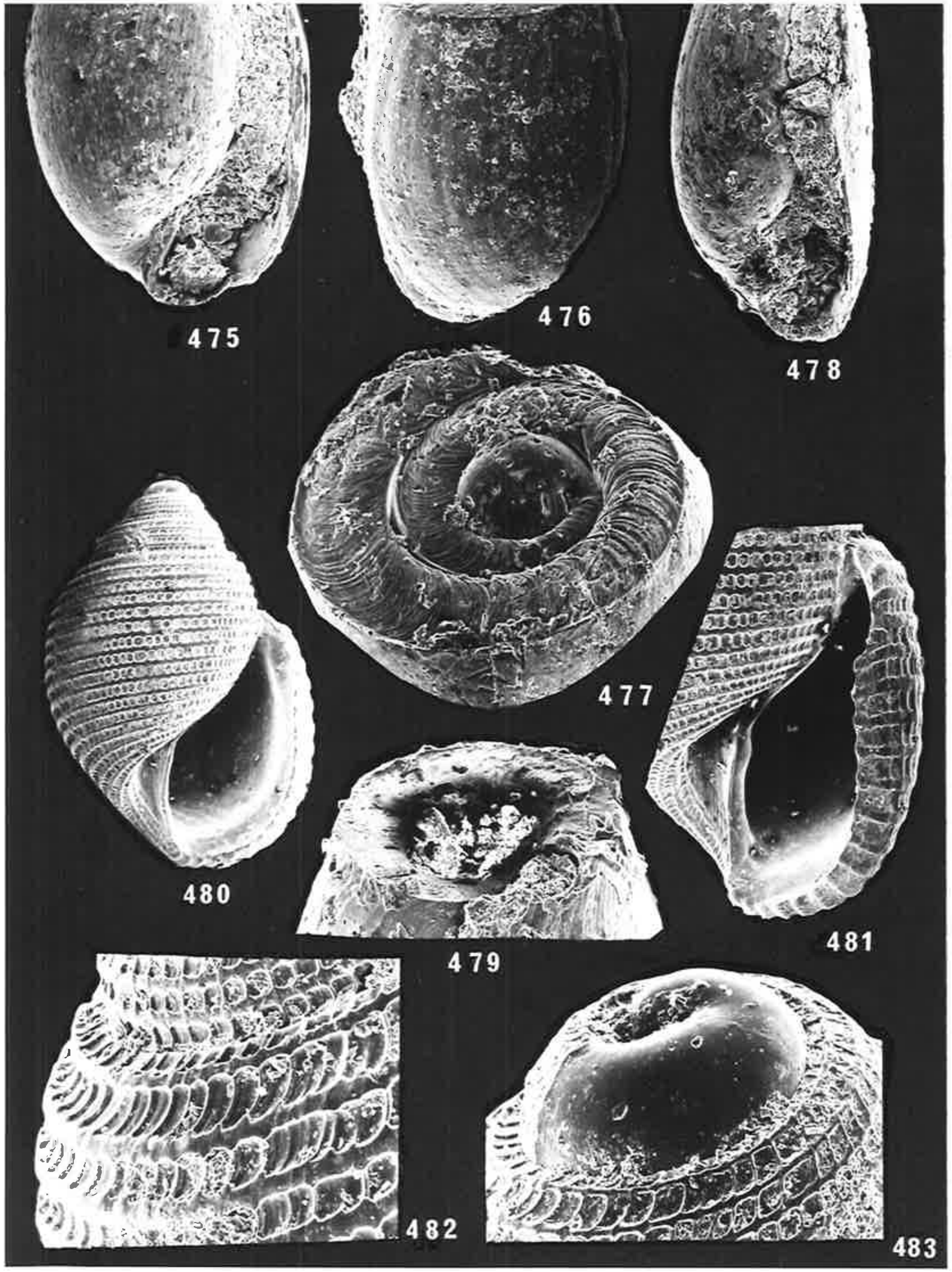
FIGS. 478-479 Retusa (Decorifer) gracilis sp. nov. Holotype SAM P 21228, 478) axial view (x 20); 479) adapical view (x 70, tilt 45°).

FIGS. 480-483 Obrussena alveolata (Tate). Holotype SAM T 713: 480) shell (x 10); 481) peristome and umbilicus (x 20, tilt 30°); 482) particular ornament (x 80, tilt 45°); 483) protoconch (x 70, tilt 45°).

FIGS. 484-487 Bovicornu robbai sp. nov. Holotype SAM P 21229: 484) peristome (x 70); 485) the holotype into the matrix of Ectosinum sp. nov. (x 10); 486) protoconch (x 200); 487) shell (x 30);

FIGS. 485,488 Sinum (Ectosinum) sp. nov. Adelaide Bore, SAM P 21229: 485) axial view (x 10); 488) protoconch (x 50, tilt 45°).

FIGS. 489-496 Praehyalocylis annulata (Tate). 489) SAM P 21230A, squashed shell (x 10); 490) SAM P 21230B, squashed shell (x 10); 491) SAM P 21230C, compressed shell (x 10, tilt 45°); 492) SAM P 21230D, particular protoconch (x 100); 494) the same, juvenile (x 50); 495) SAM P21230A, particular ornament (x 30); 496) SAM P 21230E, shell (x 10). SAM T 214: 497) axial view (x 10).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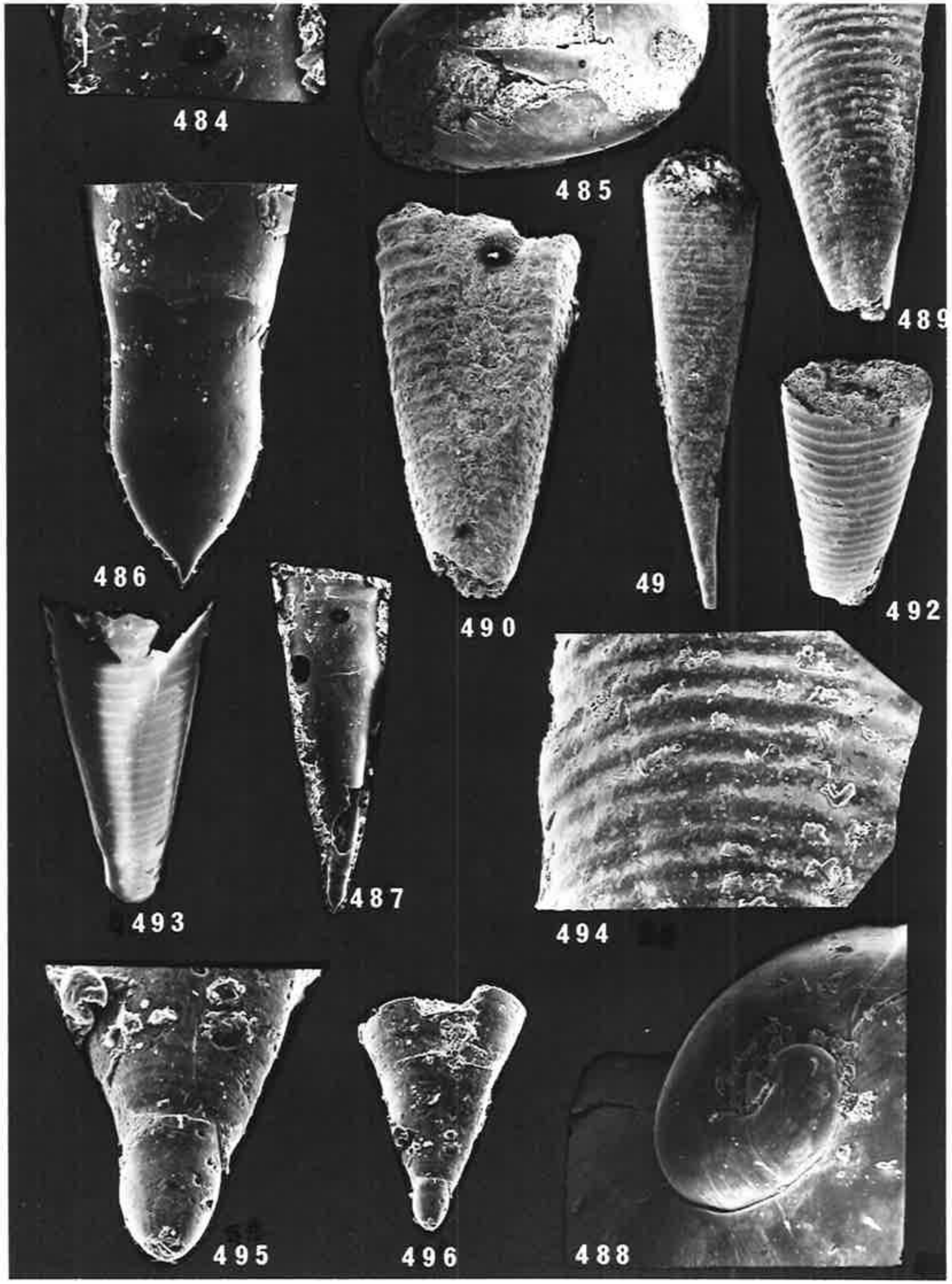
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FIGS. 497-500 Praehyalocylis annulata (Tate). SAM T 214: 497) shell fragment, inner ornament (30); 498) the same, particular, cone-in-cone structure (x 3000); 499) grouped tubules (x 800); 500) solitary tubule (x 5000).

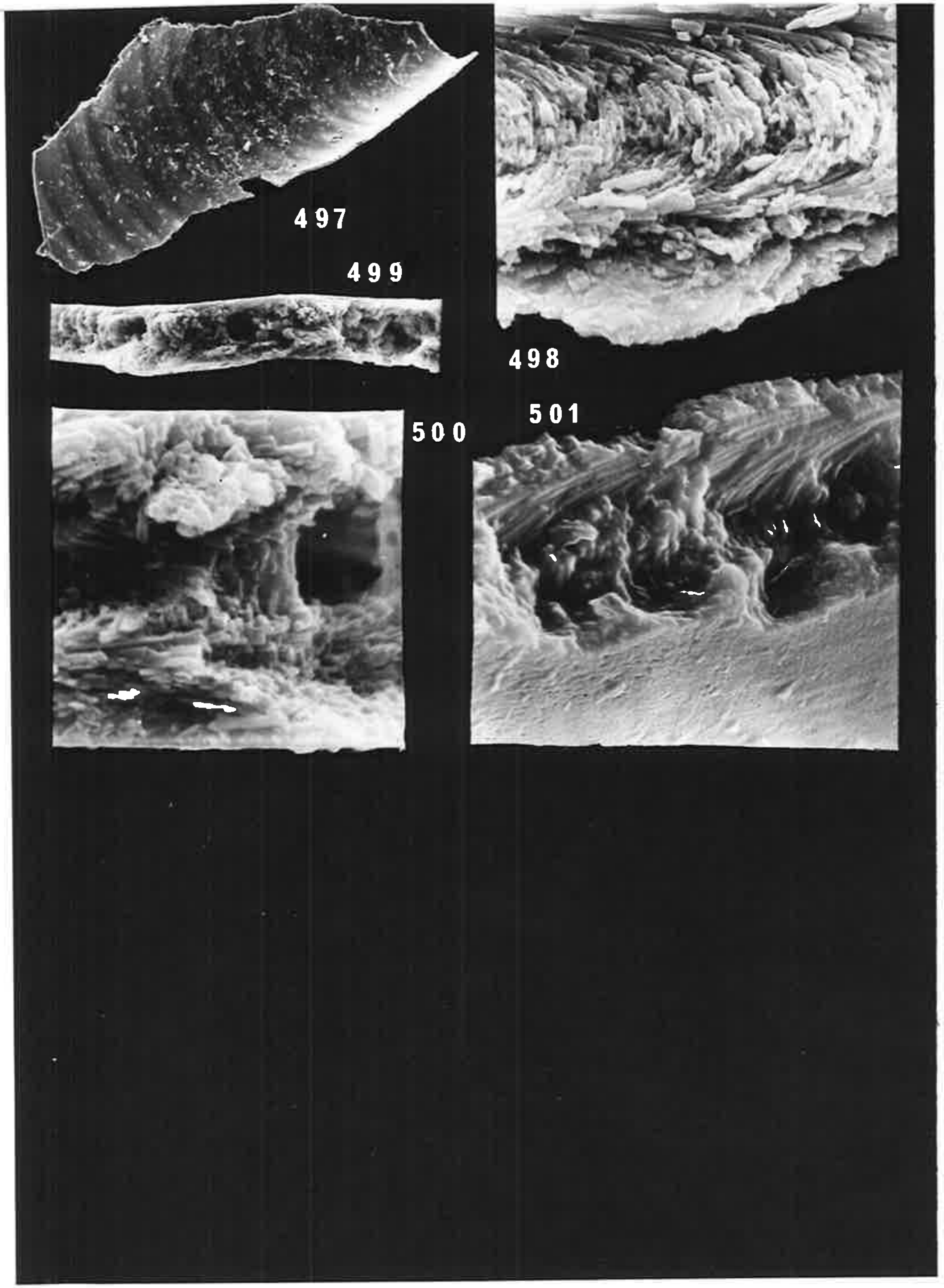
FIG. 501 Bovicornu robbai sp. nov. SAM P 21229, particular shell structure (x 4000).

FIG. 502 Pronucula (Pronucula) tatei (Finlay), SAM P 21251, specimen with abraded surface (x 20).

FIGS. 503-508 Nuculana (Saccella) chapmani (Finlay). SAM P 21231-A: 503) RV, outer (x 10); 504) particular anterior ornament (x 100); 505) particular, ventral ornament (x 100). SAM P 21231-B: 506) RV, inner (x 10); 407) particular, umbonal cardinal region; 508) particular, posterior teeth (x 90).

FIGS. 509-513 Nuculana (Ledella) leptorhyncha (Tate). SAM P 21232-A: 509) LV, outer (x 10); 510) particular ornament (x 130). SAM P 21232-B: 511) LV, inner (x 10); 512) umbonal cardinal region (x 60); 513) particular, posterior teeth (x 100).

FIG. 514 Nuculana (Poroleda) sp. nov. SAM P 21230, LV, bivalved specimen (x 10).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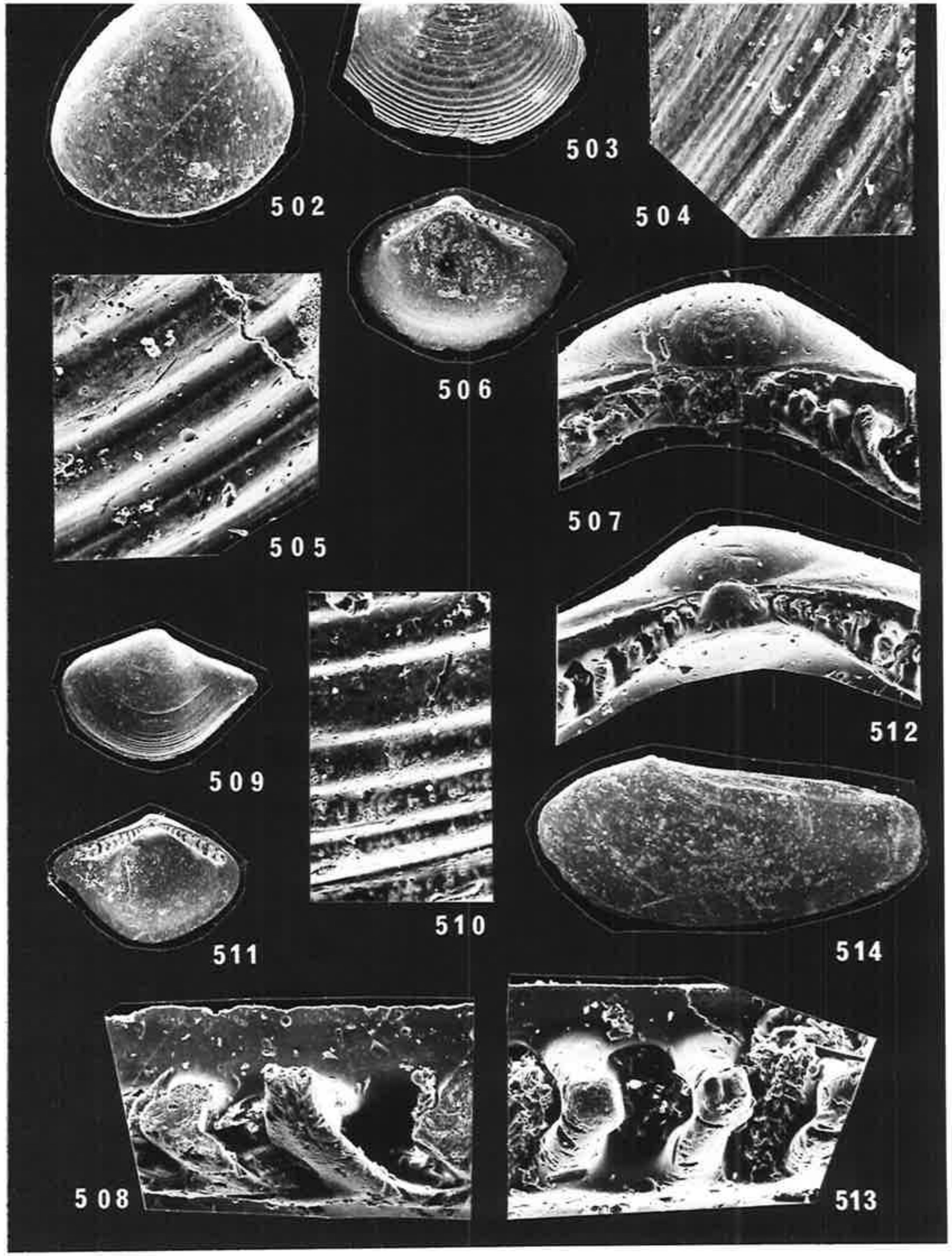
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FIGS. 515-516 Glycymeris (Glycymeris) lenticularis (Tate): 515) SAM T 1011-A, holotype, LV, outer (x 1.7); 516) SAM T 1011-D, paratype, RV, inner (x 2 .65)

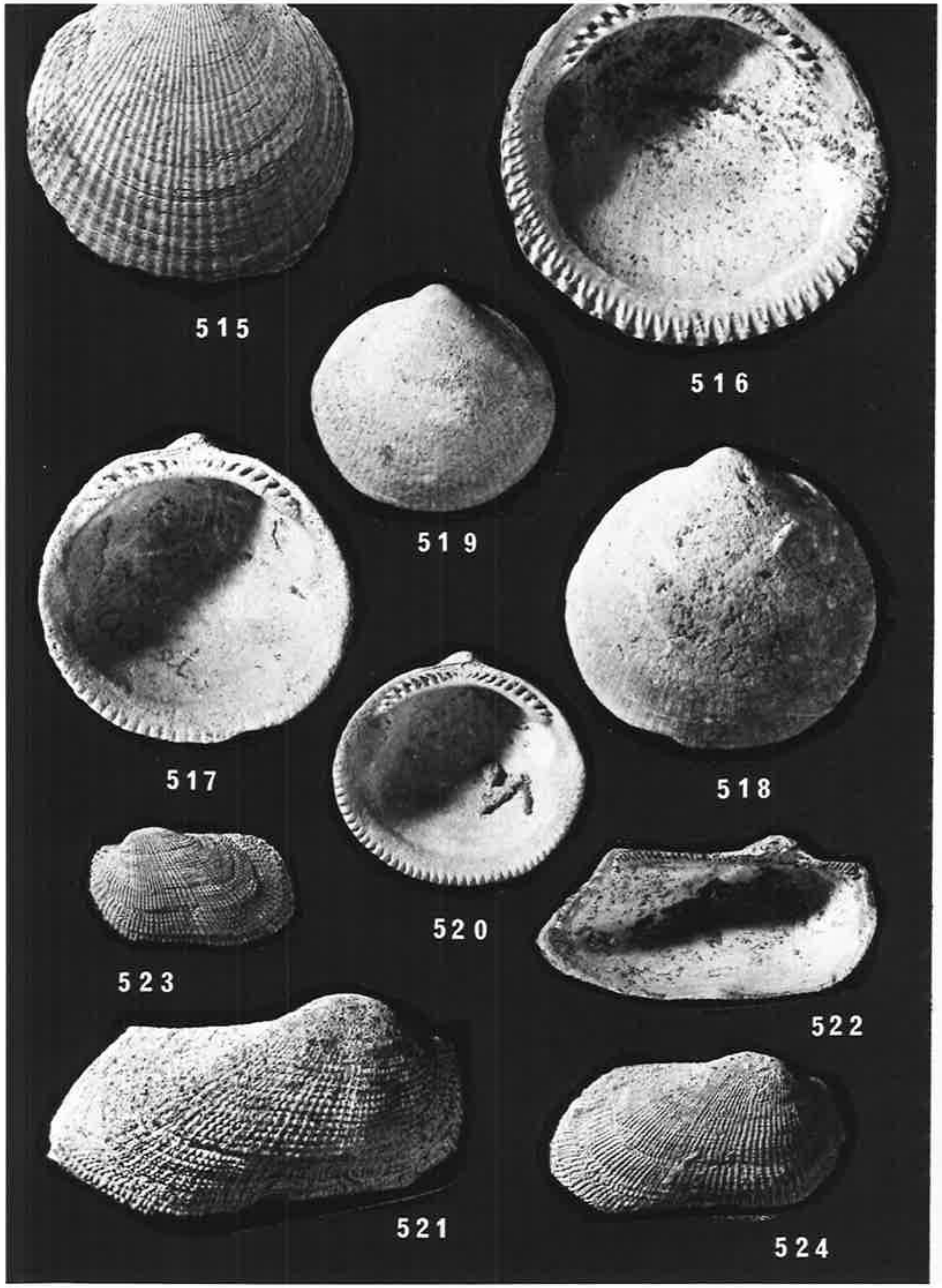
FIGS. 517-520 Glycymeris (Glycymeris) kaurna sp. nov. SAM T 1055-U, holotype, LV: 517) inner (x 2); 518) outer (x 2). SAM T 1055-W, paratype, LV: 519) outer (x 2); 520) inner (x 2).

FIGS. 521-522 Arca (Arca) pseudonavicularis Tate: 521) holotype, SAM T 1057, RV, outer (x 2.25); 522) paratype, SAM T 1057-B, LV, inner (x 2.25).

FIGS. 523-524 Barbatia (Barbatia) limatella Tate: 523) paratype SAM T 1048-K, LV, outer (x 2.1); 524) paratype, SAM T 1048-J, RV, outer (x 2.1)

FIGS. 525-527 Barbatia (Barbatia) limatella Tate. 525) SAM T 1048-E, paratype, RV, outer (x 2); 526) SAM T 1048-D, paratype, RV, inner (x 1.75); 527) SAM T 1048-C, paratype, RV, outer (x 1.95).

FIGS. 528-535 Porterius (Notogrammatodon) inexpectatus Maxwell 528) SAM T 1056-R, LV, inner (x 2.7); 529) the same, posterior hinge, particular crenulated teeth (x 100); 530) SAM T 1056-U, RV, inner (x 3.2); 531) SAM T 1056-S, LV, inner, (x 2.7); 532) GSSA M 3437, LV, inner (x 10); 533) NZGS 9481, topotype, outer, bivalved specimen RV view (x 9); 534) SAM T 1056-T, RV, outer (x 3.2); 535) the same, particular ornament (x 40).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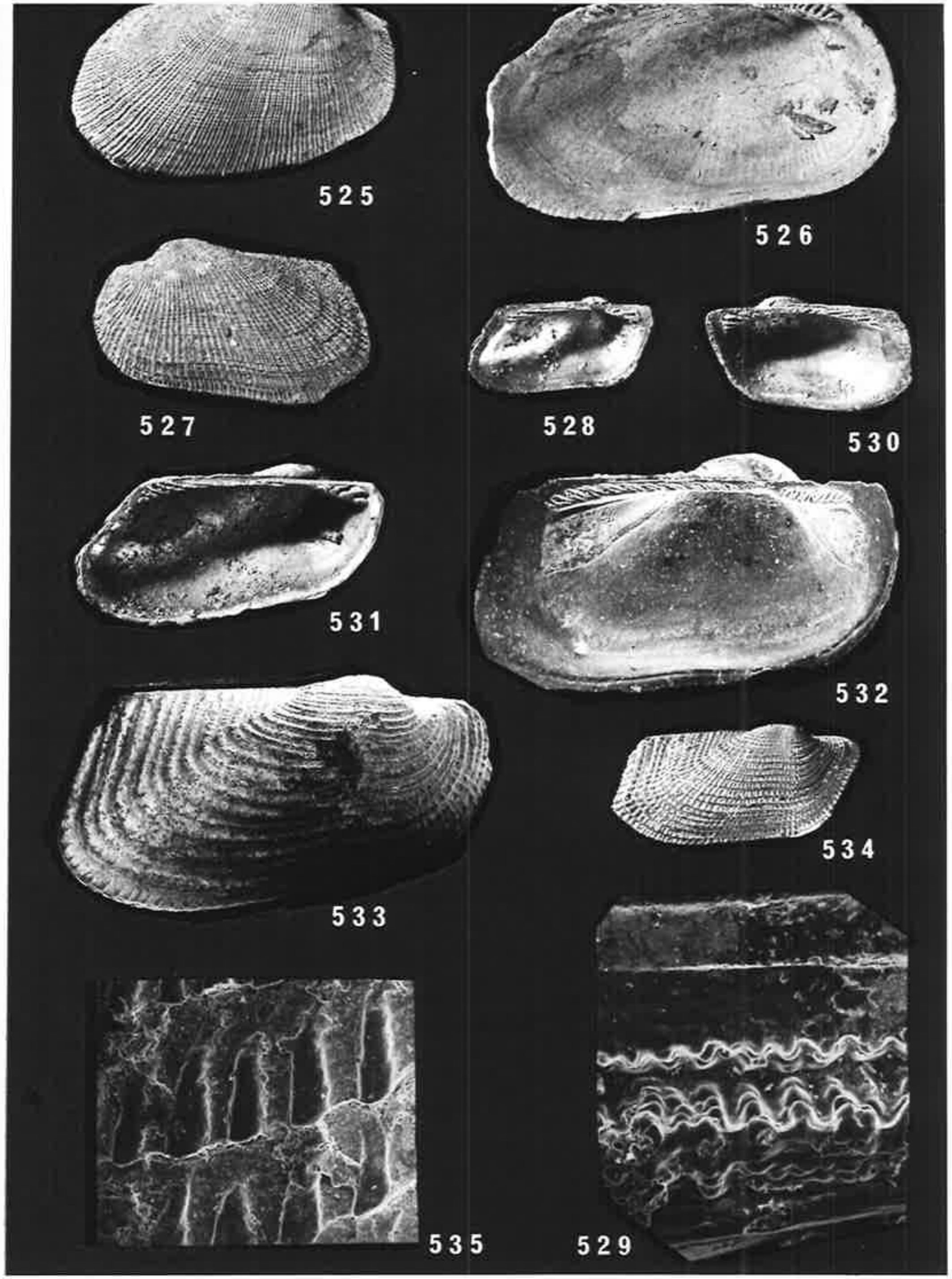
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FIGS. 536-543 *Porterius (Ludbrookella) spinosa* subgen. & sp. nov.: 536) GSSA M 3433, paratype, RV fragment (x 2.75). GSSA M 2820-A, holotype, LV; 537) outer (x 3.85); 538) inner (x 3.85). GSSA M 2820-B, RV, paratype: 539) outer (x 3.85); 540) inner (x 3.85). Paratypes: 541) GSSA M 3427-A, LV, outer (x 3.85); 542) GSSA M 3427-B, LV, outer (x 3.85); 543) GSSA M 3427-D, particular RV posterior hinge (x 100).

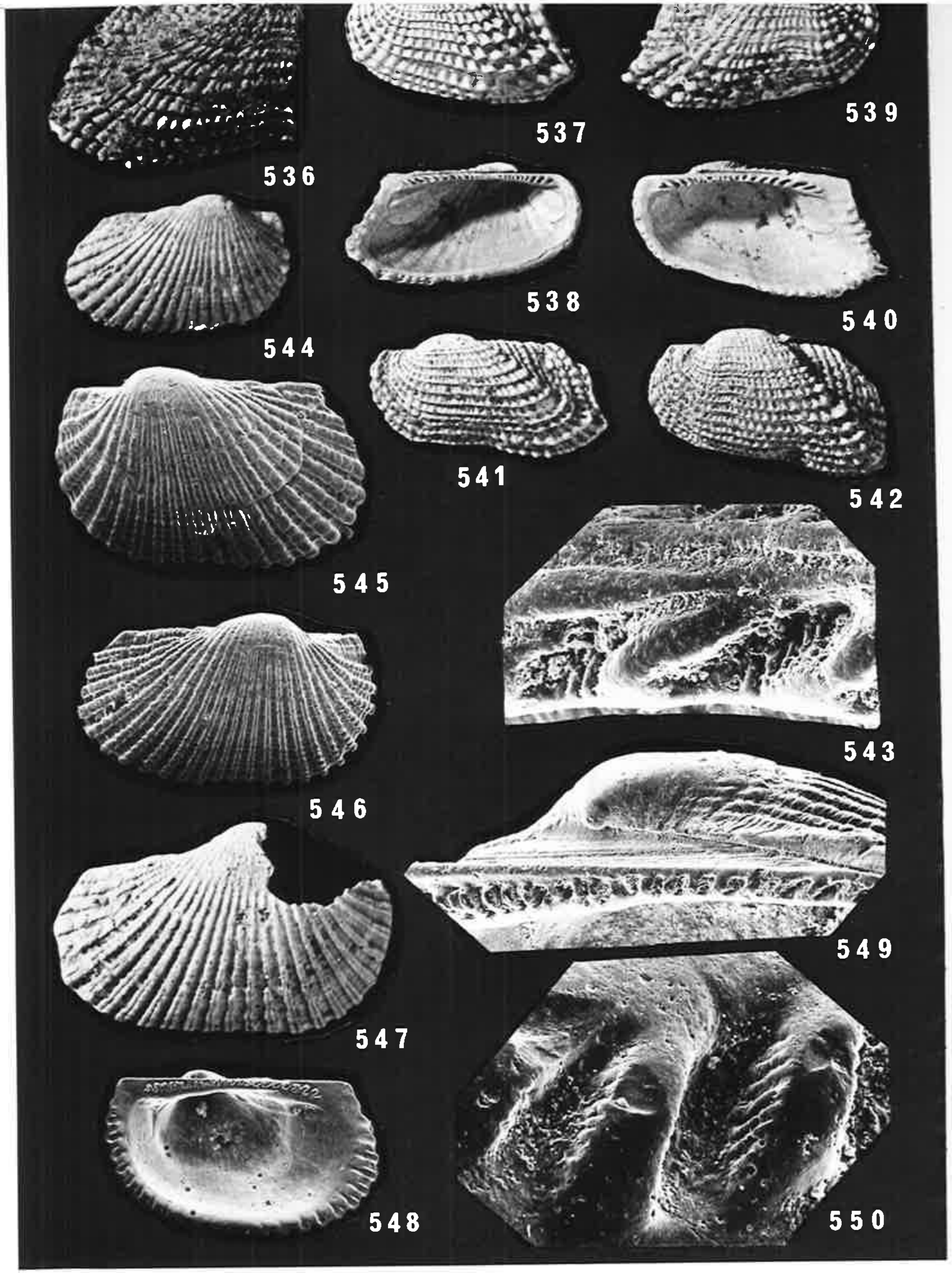
FIGS. 544-550 *Grammatodon* s.l. *margaritatum* sp. nov.: 544) Holotype, GSSA M 3432-A, RV, outer (x 3.8). Paratypes: 545) GSSA M 3416-C, LV, outer (x 10); 546) GSSA M 3416-D, RV, outer (x 10); 547) GSSA M 3432-B, RV, senile, outer (x 3.8). Paratype GSSA M 3416-B, RV; 548) inner (x 10); 549) cardinal area (x 30); 550) posterior hinge, particular, tooth striations (x 200).

FIGS. 551-554 *Cucullaea (Cucullaea) adelaidensis* Tate. 551) SAM T 1047-A, holotype, LV, outer (x 1.8); 552) SAM T 1047-D, paratype, RV, inner (x 1.65); 553) SAM T 1047-F, paratype, RV, outer (x 2.45); 554) SAM T 1047-E, paratype, LV, inner (x 1.5).

FIG. 555 *Arca (Barbatia) centenaria* Glenn (*non* Say), figured by Newell (1969) as *Arca centenaria* Say.

FIG. 556 *Arca centenaria* Say, Conrad's 1832 illustration.

FIG. 557 *Striarca centenaria* (Say), Bird's 1965 illustration.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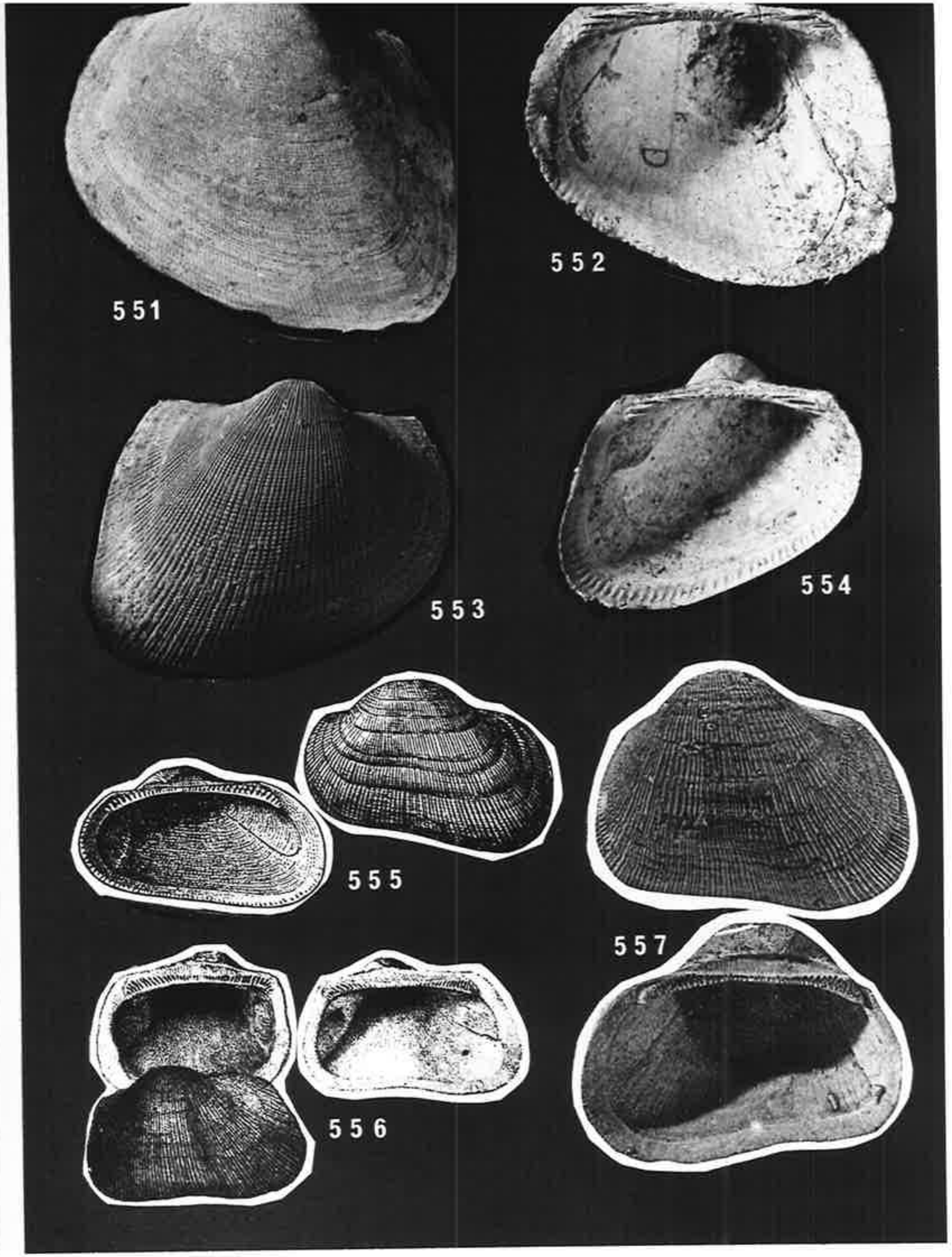
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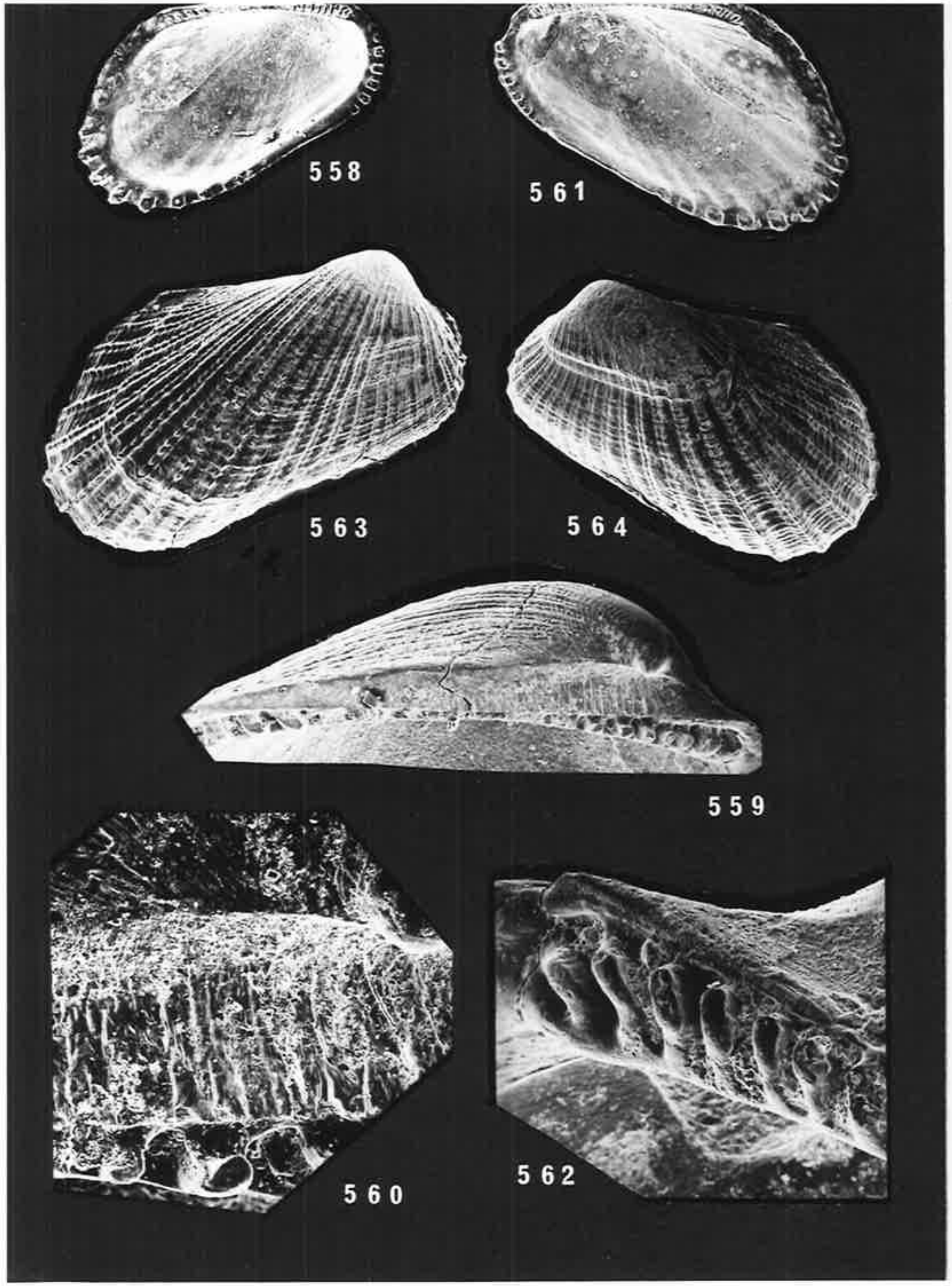
FIGS. 558-564 Scapularca scapulina (Lamarck). SAM P 21252-D: LV, inner (x 9.2); 559) cardinal area (x 32.3); 560) particular resilifer (x 89.3). SAM P 21252-B: 561) RV, inner (x 8.2); 562) particular anterior hinge, striations on the last tooth (x 80). SAM P 21252-C: 563) RV, outer (x 10). SAM P 21252-A: 564) LV, outer (x 10).

FIGS. 565-567 Arca lactea Linnaeus. Pheziers, France, Pliocene. SAM P 21253: 565) LV, inner (x 9.5); 566) cardinal area (x 14.2); 567) posterior hinge and tooth striations (x 37).

FIGS. 568-571 Arca quadrilatera Lamarck. Paris Basin, Middle Eocene, SAM P 21254-A: 568) LV, inner (x 10) SAM P 21254-B: 569) RV, inner (x 10); 570) particular, resilifer and hinge gap (x 50); 571) posterior hinge and tooth striations (x 44).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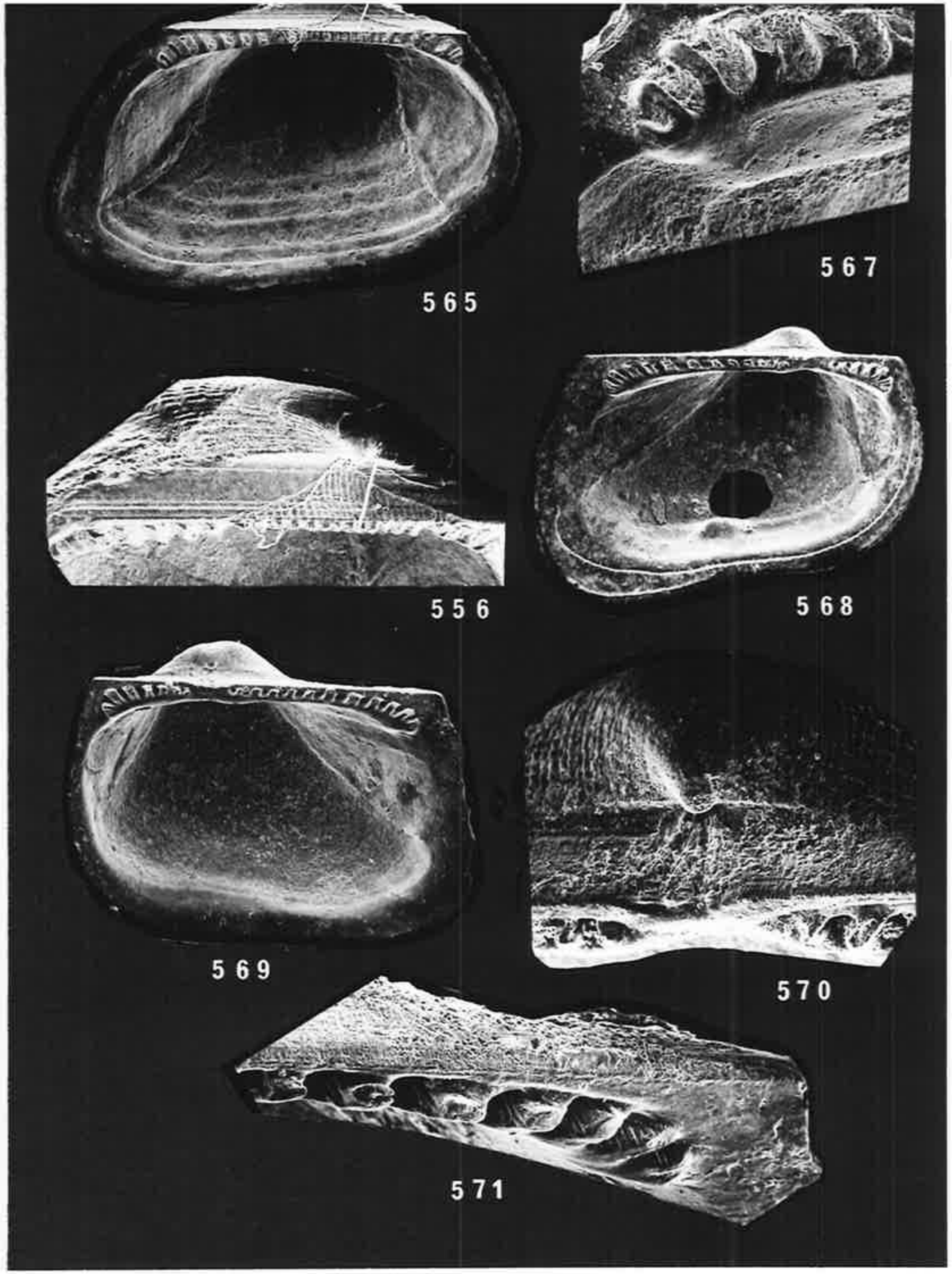
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FIGS. 572-579 Allasinazella gen. nov. equidens (Tate). 572) SAM T 1058-M, paratype, RV, outer (x 10); 573) GSSA M 3438-B, LV, outer (x 10). GSSA M 3438-A: 574) LV, inner (x 10); 575) cardinal area (x 15); 576) particular resilifer (x 60). SAM T 1058-T, paratype: 577) RV, inner (x 10); 578) anterior hinge (x 32); 579) posterior hinge, particular tooth crenulations (x 150).

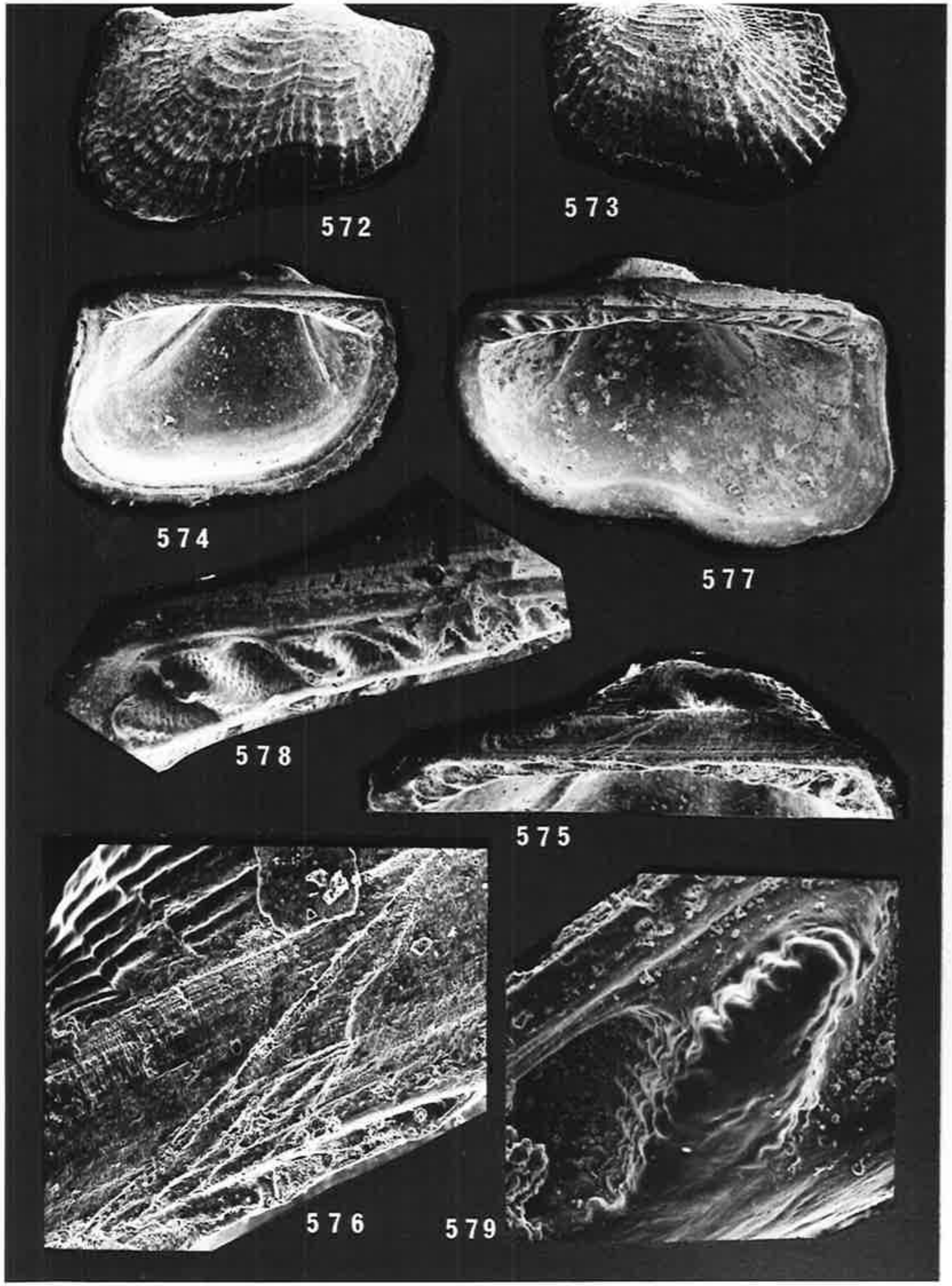
FIGS. 580-582 Arcopsis dissimilis (Tate). 580) GSSA M 3439, LV, outer (x 9.5); 581) GSSA M 3440, LV, inner (x 10); 582) the same, particular resilifer and tooth striations (x 40).

FIGS. 583-585 Arcopsis januaria (Marwick), NZGS 9481: 583) bivalved specimen, LV, view (x 2.6); 584) umbonal view (x 2.6); 585) anterior view (x 2.6).

FIGS. 586-587 Limopsis (Limopsis) aurita (Brocchi), Siena, Italia, Pliocene. 586) SAM P 21251-A, LV, outer (x 3.5); 587) SAM P 21251-B, RV, inner (x 4).

FIGS. 588 L. (Limopsis) insolita (Sowerby) BMNH 12530-1, bivalved specimen, LV View (x 2.35).

FIGS. 589-590 L. (Limopsis) multiradiata Tate. GSSA M 2804: 289) RV, outer (x 3.3); 590) inner (x 4.2).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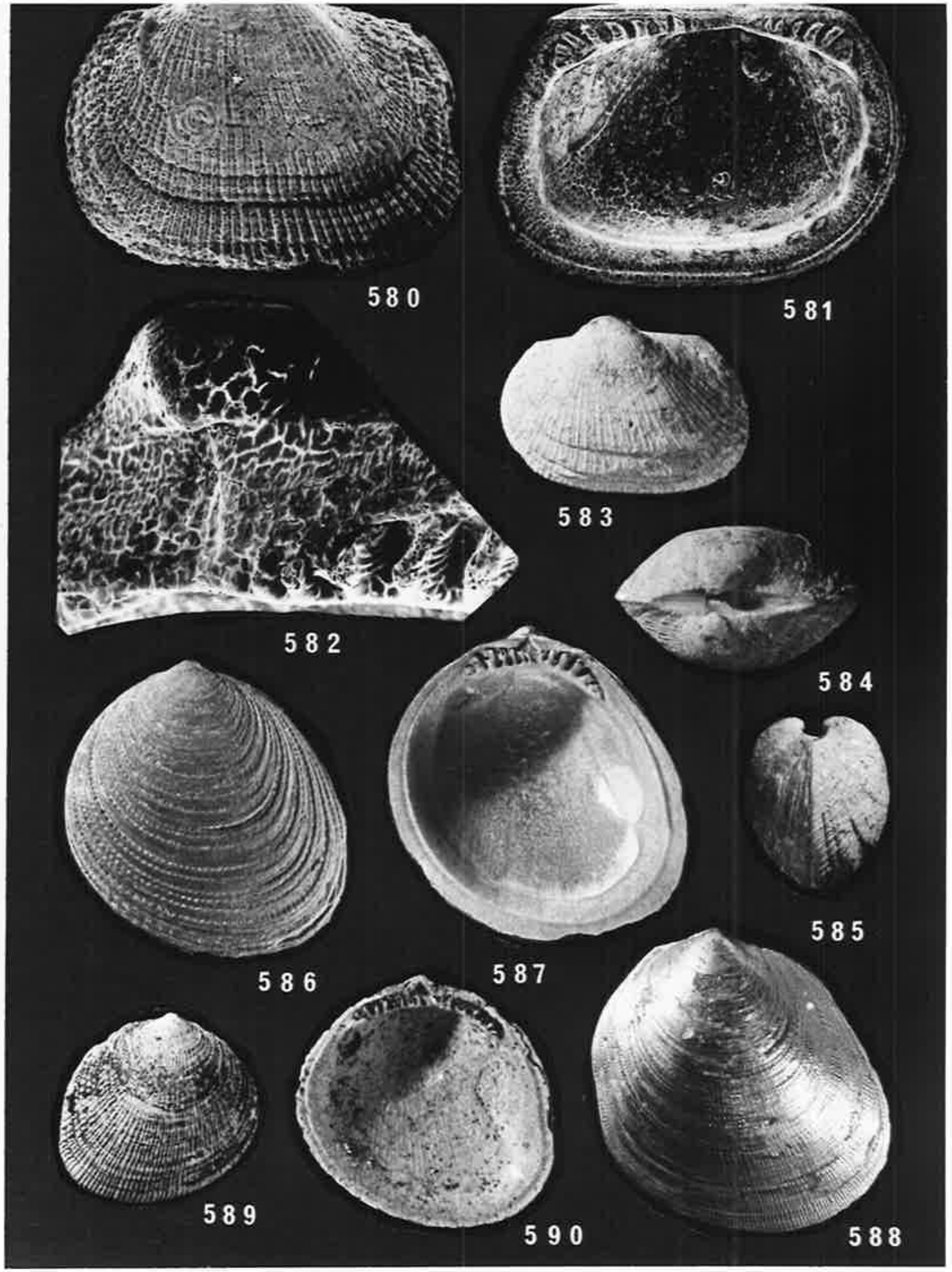
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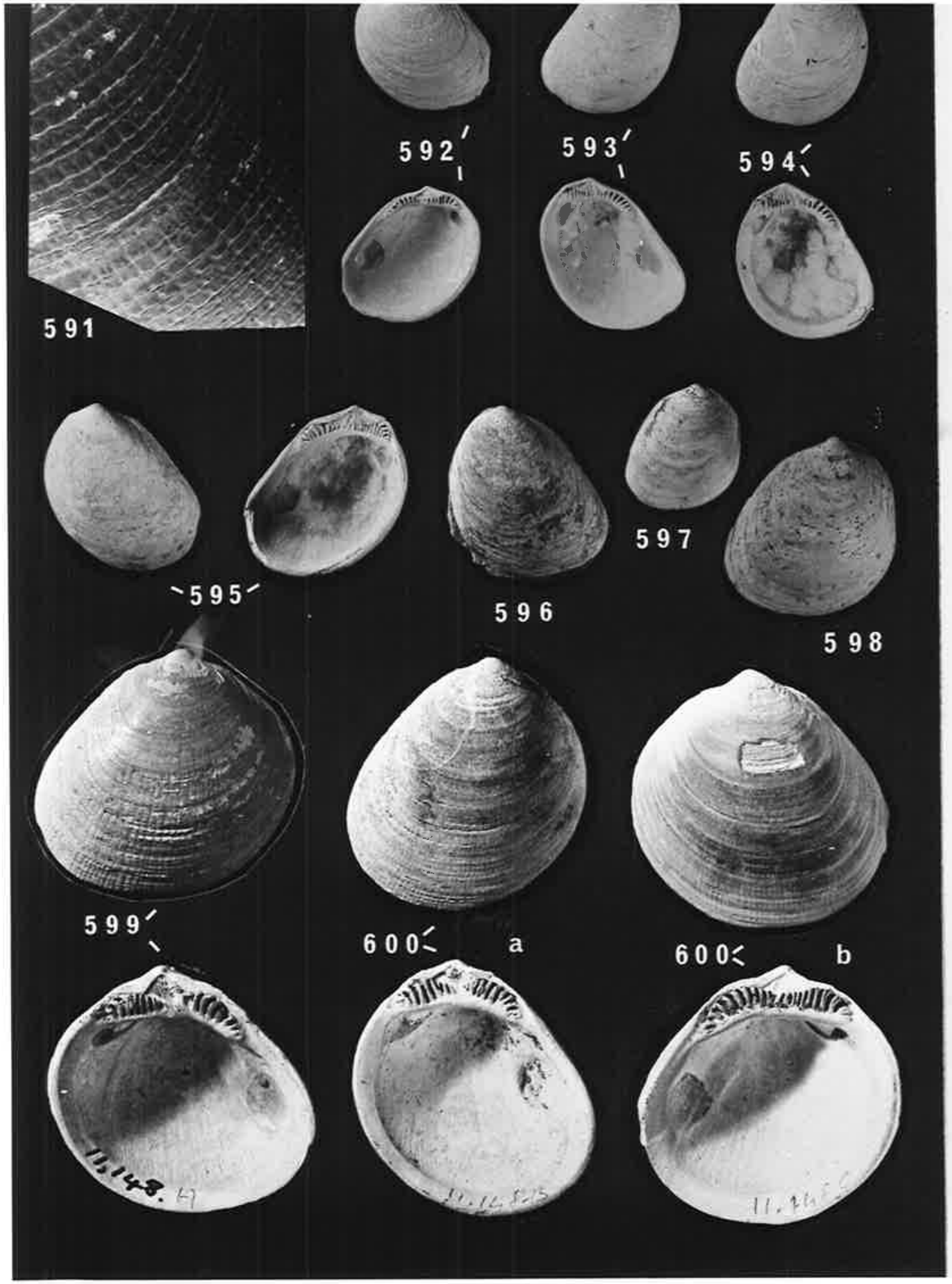
FIGS. 591-598 L. (Limopsis) insolita (Sowerby). 591) BMNH 12530-1, particular ornament (x 98); 592) BMNH 12530-2, LV, outer and inner views (x 1); 593-4) BMNH 12530-7/8, RVs, outer and inner views (x 1); 595) BMNH 12530-6, LV, inner and outer views (x 1); 596-8) BMNH 12530-3/-4/-5, bivalved specimens, LV, RV, and RV views, respectively (x 1). To note the variability in outline and inner morphology.

FIGS. 599-600 L. (Limopsis) campa Allan. Topotypes; inner and outer views (all x 1.9): 599) NZGS 11 148-A; 600a) NZGS 11 148-B; 600b) NZGS 11 148-C).

FIGS. 601-604 L. (Limopsis) zitteli Ihering. GSSA M 2082: 601) outer, LV (x 3.6); 602) particular, microriblets in juvenile stages (x 60); 603) particular, microriblets in adult stages (x 60); 604) particular, ventral margin, riblets of 'morningtonensis' type (x 40).

FIGS. 605-607 L.(Limopsis) multiradiata Tate, juveniles: 605) GSSA M 3429, LV, inner (x 10); 606) GSSA M 3430), RV, outer (x 10); 607) the same, particular ornament (x 30).

FIGS. 608-610 L. (Limopsis) zitteli Ihering. Juveniles. Topotypes of 'Limopsis waihaoensis Allan', NZGS 9508-A/-C, outer and inner views; LV, LV, and RV, respectively (all x 2.45).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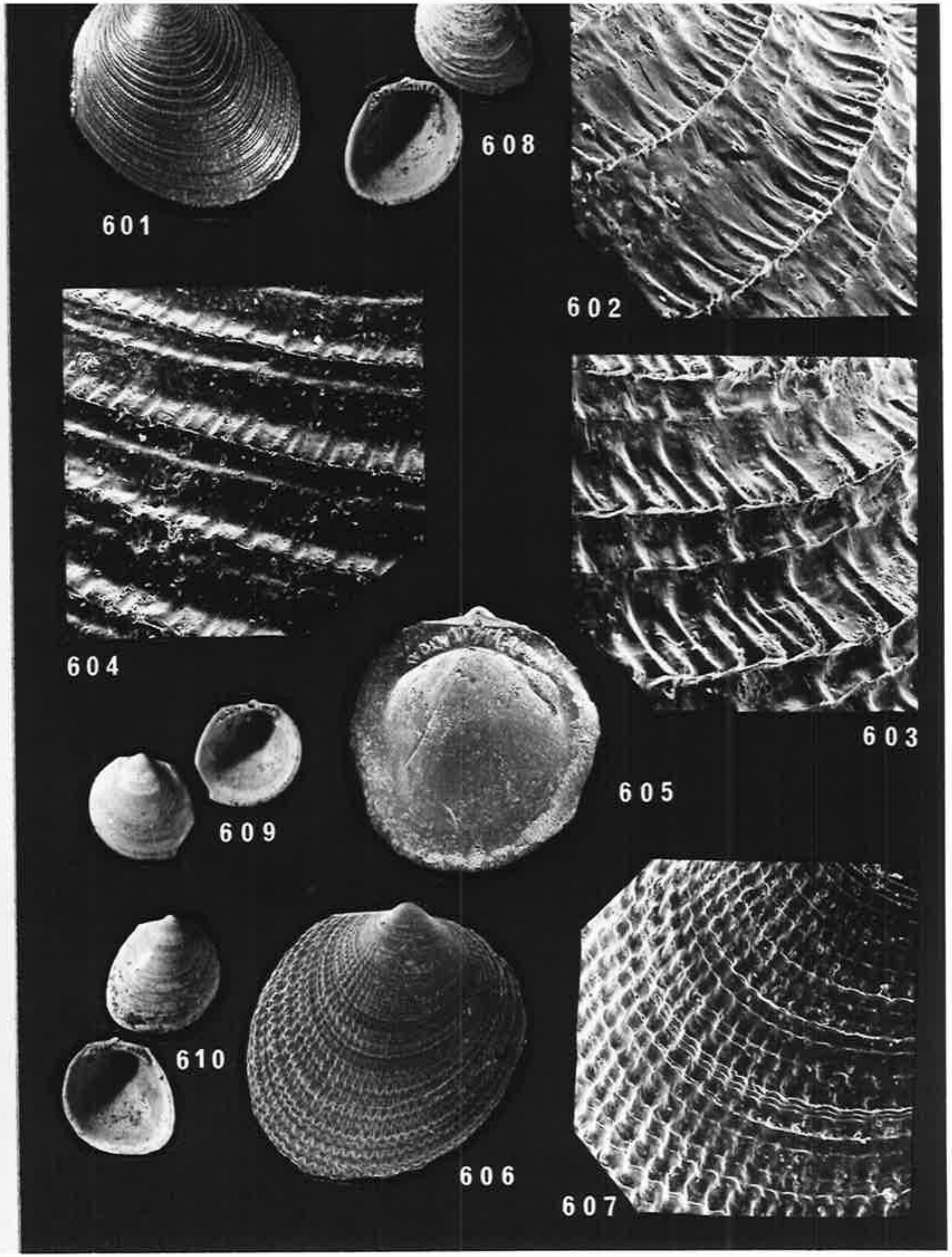
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FIG. 611 L. (Limopsis) zitteli Ihering. GSSA M 2816, outer shells. Lot showing the variability range in outline (all x 1).

FIG. 612-614 L. (Limopsis) zealandica Hutton, Topotypes, NZGS 9520-A/-C, outer shells; RV, RV, and LV respectively (all x 1.9)

FIG. 615 L. (Limopsis) zitteli Ihering. The same as in Fig. 611, inner views showing the variability of the cardinal area and of the hinge (all x 1).

FIGS. 616-618 L. (Limopsis) zealandica Hutton. The same as in Figs. 612-4, inner views (all x 1.9).

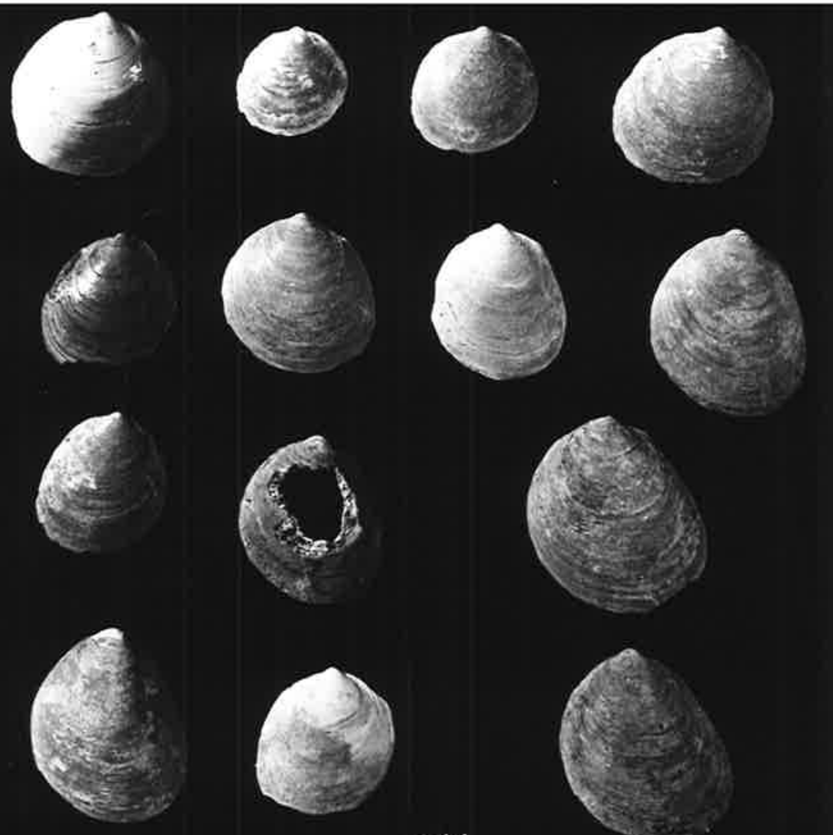

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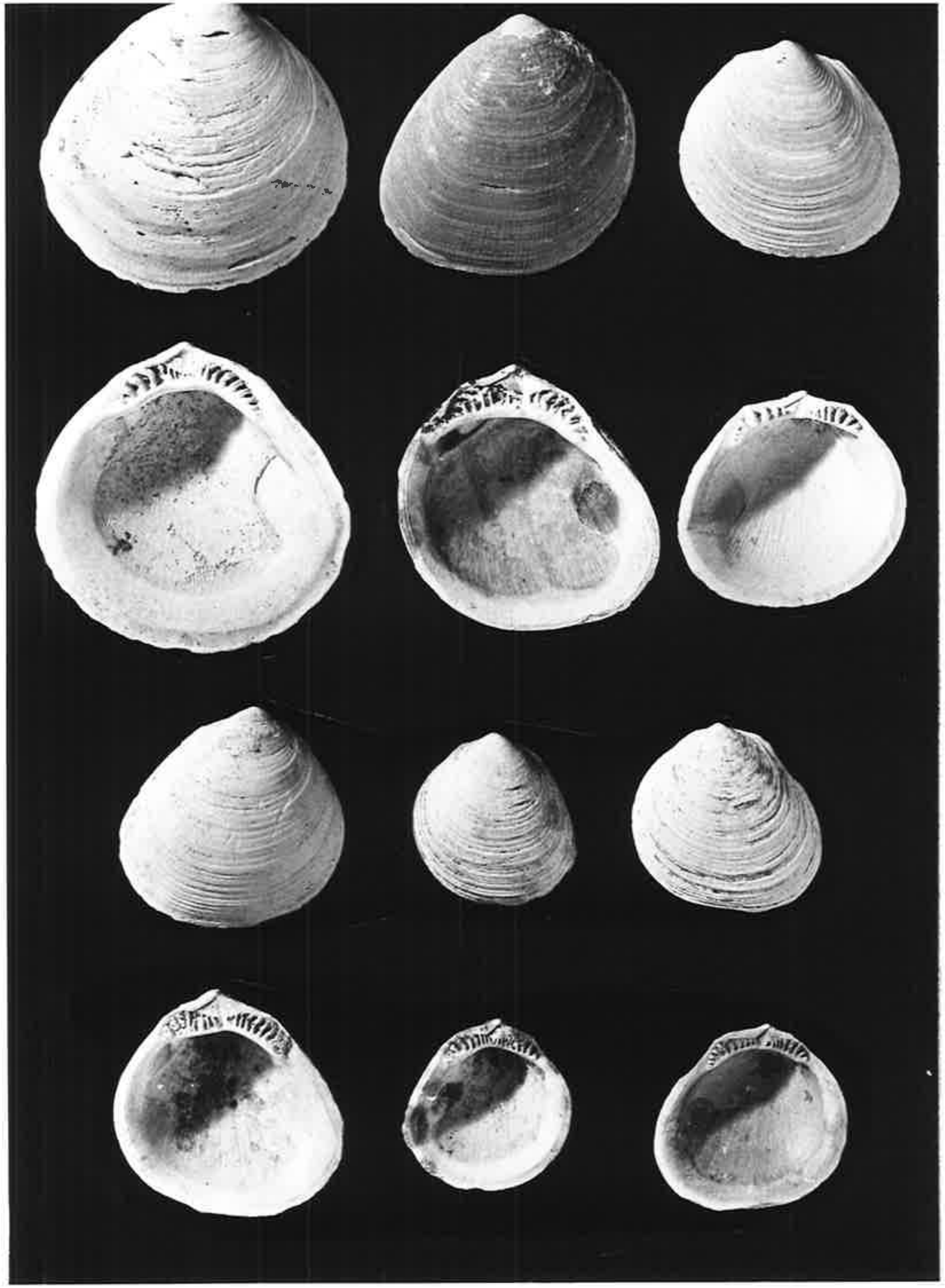
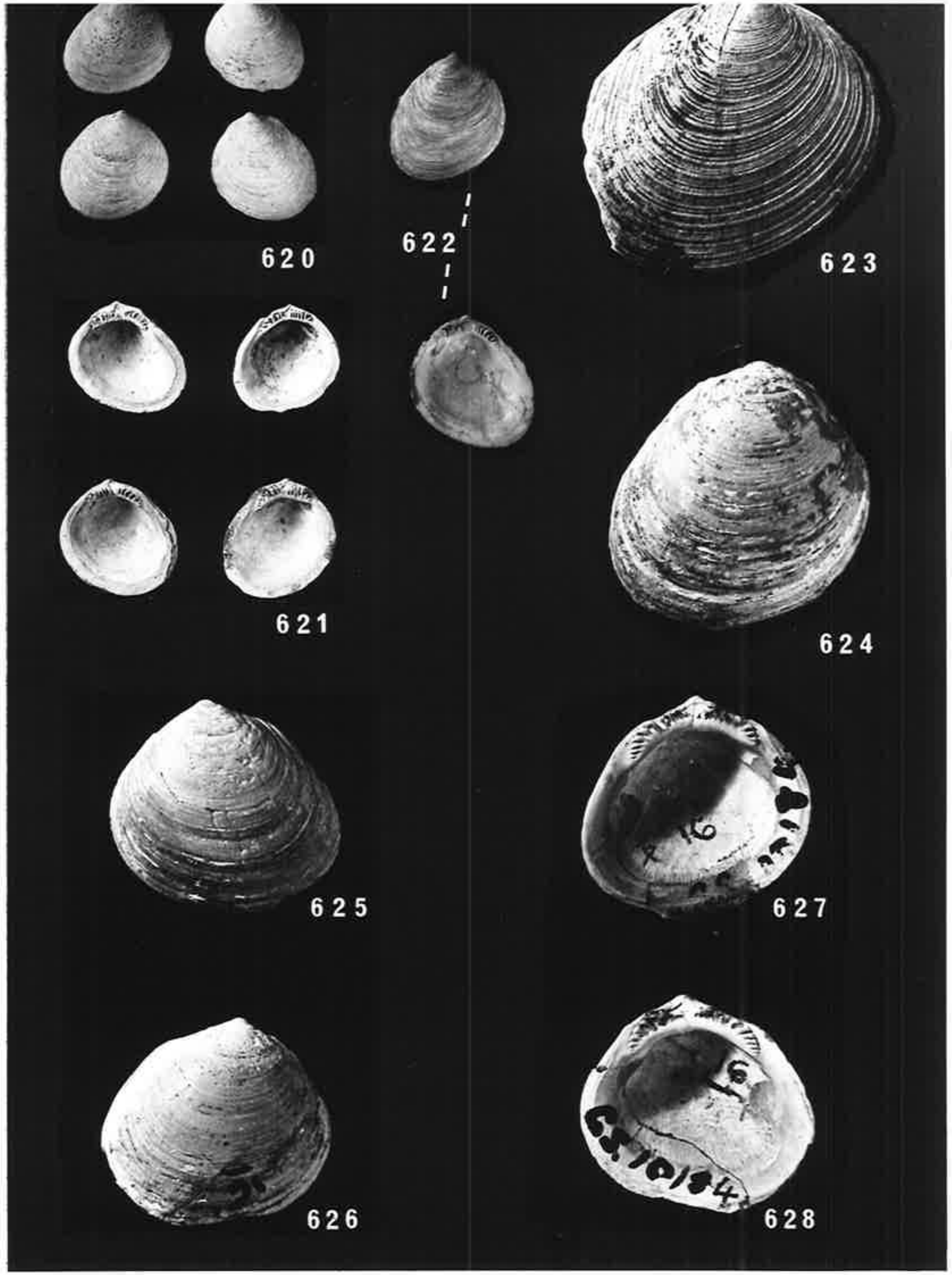
FIG. 619 L. (Limopsis) zitteli Ihering. GSSA M 3436, lot from Sutherlands, South Canterbury, New Zealand (Awamoan, Early Miocene): outer and inner views (all x 3).

FIGS. 620-622 L. (Limopsis) valida Singleton. NMV P 31297: 620) outer views (x 1); 621) inner views (x 1); 622) SAM P 21252, cast of the holotype, RV, inner and outer views (x .9).

FIG. 623 L. (Limopsis) morningtonensis Pritchard. SAM T 1020-A, RV, outer (x 2.8).

FIGS. 624-628 L. (Limopsis) lawsi King. Topotypes: 624) NZGS 10 184-A, bivalved specimen, RV view (x 1.8); 625) NZGS 10 184-B, LV, outer (x 1.75); 626) the same, inner (x 1.75); 627) NZGS 10 184, RV, outer (x 1.75); 628) the same, inner (x 1.75).

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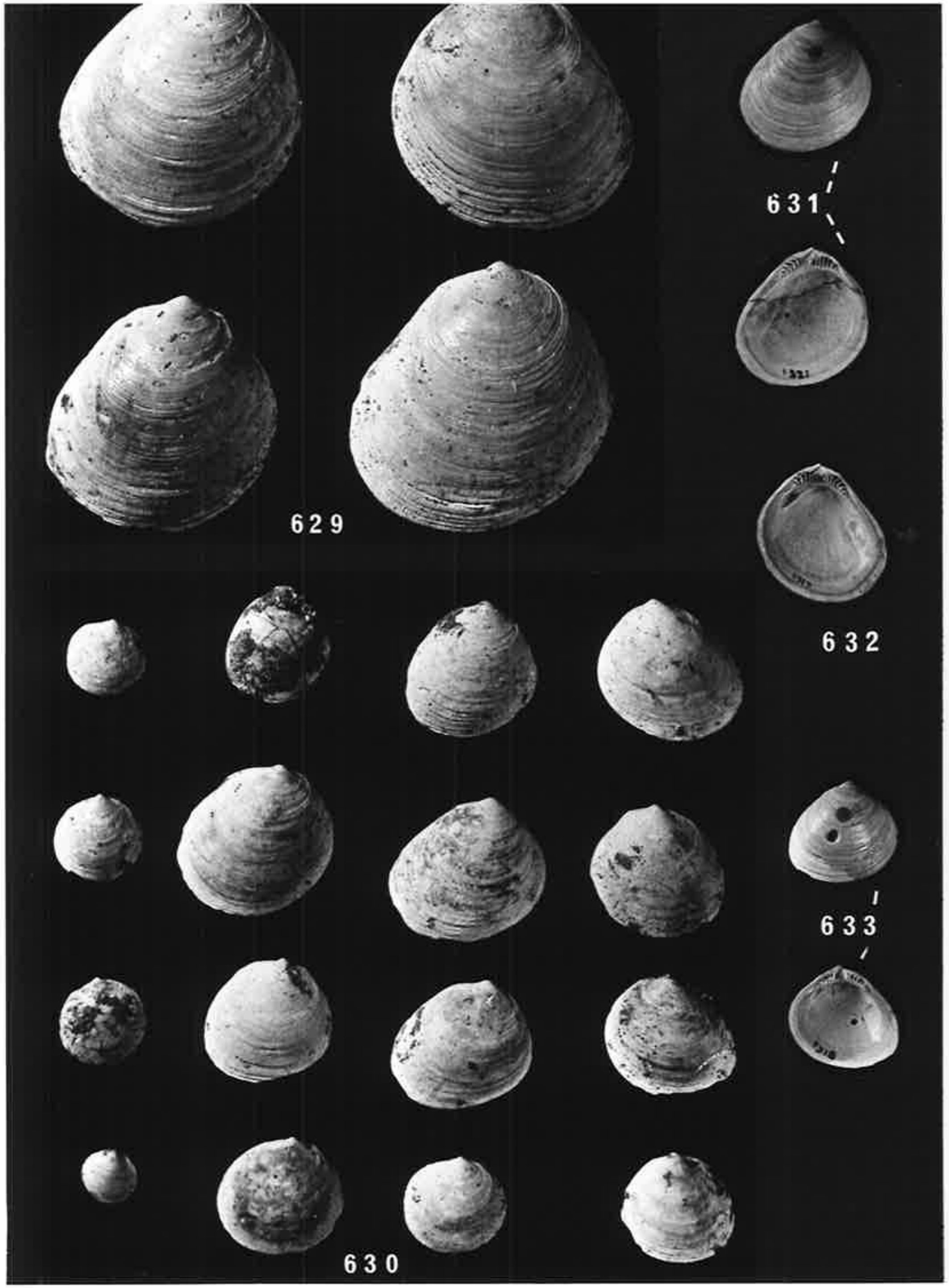
FIGS. 629-630 *L. (Limopsis) zitteli* Ihering. Topotypes of '*L. parma* Marwick', Shell Gully, Chatton, New Zealand (Duntroonian, Middle Oligocene), ZNGS 9806: 629) seniles, outer (x 1.72); 630) lot showing the variability range in outline, outer views (all x 1).

FIGS. 631-633 *L. (Limopsis) zitteli* Ihering. Types of '*L. chapmani* Singleton': 631) holotype, MUGD 1317, RV, outer and inner views (x .95); 632) paratype, MUGD 1321, LV, inner (x .95); 633) paratype, MUGD 1318, RV, inner and outer views (x .95).

FIGS. 634-635 *L. (Limopsis) zitteli* Ihering. The same as in Fig. 628, inner view (x 1.46); 635) the same as in Fig. 629, inner views showing the variability in cardinal area and in hinge (all x 1).

FIG. 636 *L. (Limopsis) maccoyi* Chapman. GSSA 3431, topotype, RV: 636) outer view and inner view (x 1.9).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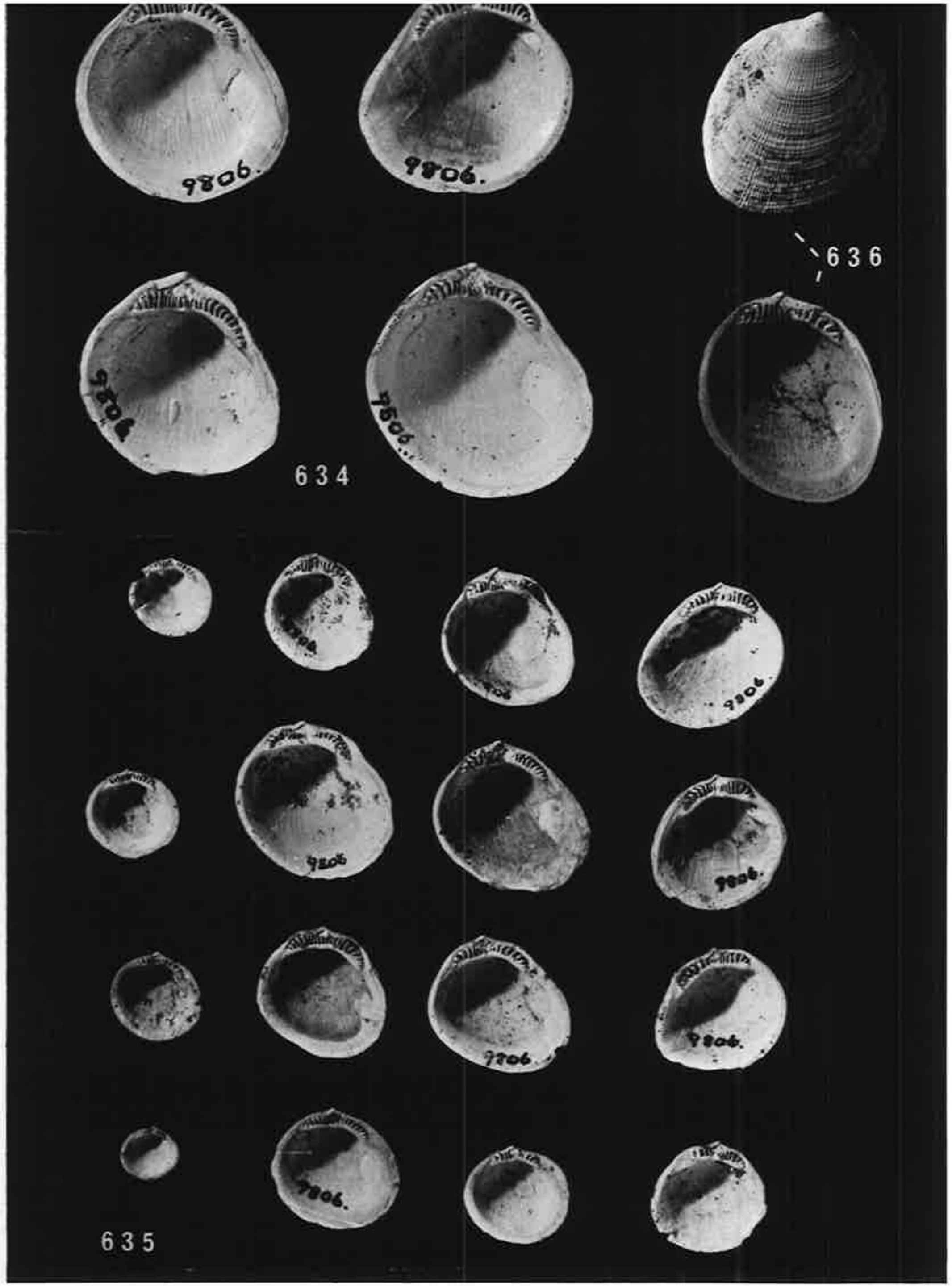
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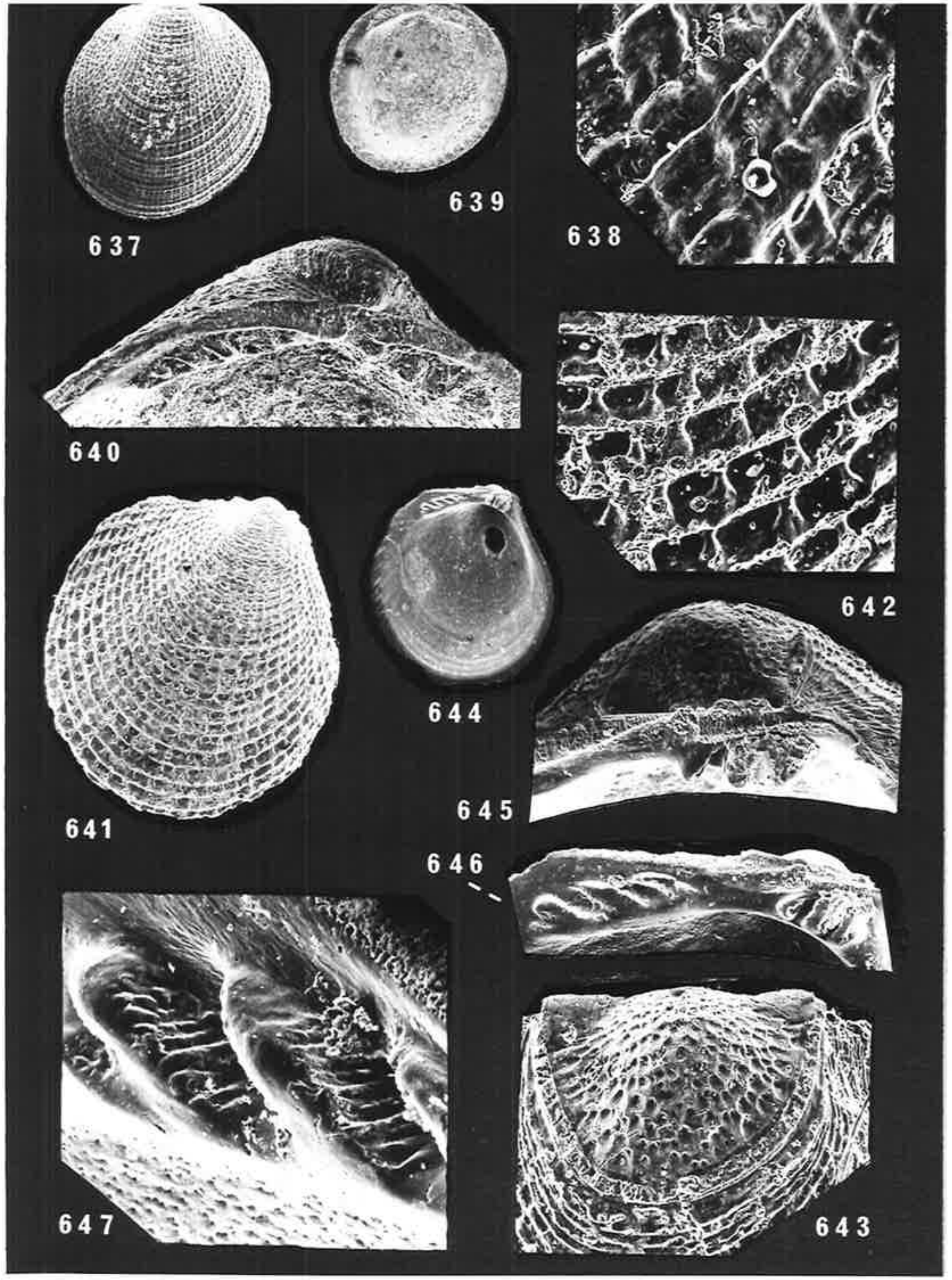
FIGS. 637-640 Limopsis (Pectunculina) cancellata sp. nov. SAM P 21205-A holotype, RV: 637) outer view (x 10); 638) particular, ornament (x 80). Paratype, SAM P 21205-B, LV: 639) inner view (x 10); 640) cardinal area and hinge (x 30).

FIGS. 641-647 Limarca angustifrons Tate. GSSA M 2871-A, RV: 641) outer (x 20); 642) particular, ornament (x 70); 643) prodissoconch (x 70). GSSA M 2871-B, LV: 644) inner view (x 10); 645) cardinal area, resilifer, and prodissoconch (x 50); 646) hinge (x 30); 647) particular, striations, posterior teeth (x 130).

FIGS. 648-650 Septifer (Septifer) sp. nov. 648) GSSA M 3441-A, LV, outer (x 10); 649) GSSA M 3441-B, RV, inner (x 9.5); 650) the same, particular hinge (x 40).

FIG. 651 Pinna sp., SAM P 21255 (x 9.5).

FIGS. 652-655 Vulsella laevigata Tate: 652) SAM T 975-A, holotype, LV, inner (x 1.9); 653) SAM T 975-B, paratype, LV, outer (x 1.9); 654) SAM P 21237-A, RV, inner (x 1.7); 655) SAM P 21237-B, RV, outer (x 2.7) and inner (x 2.8), respectively.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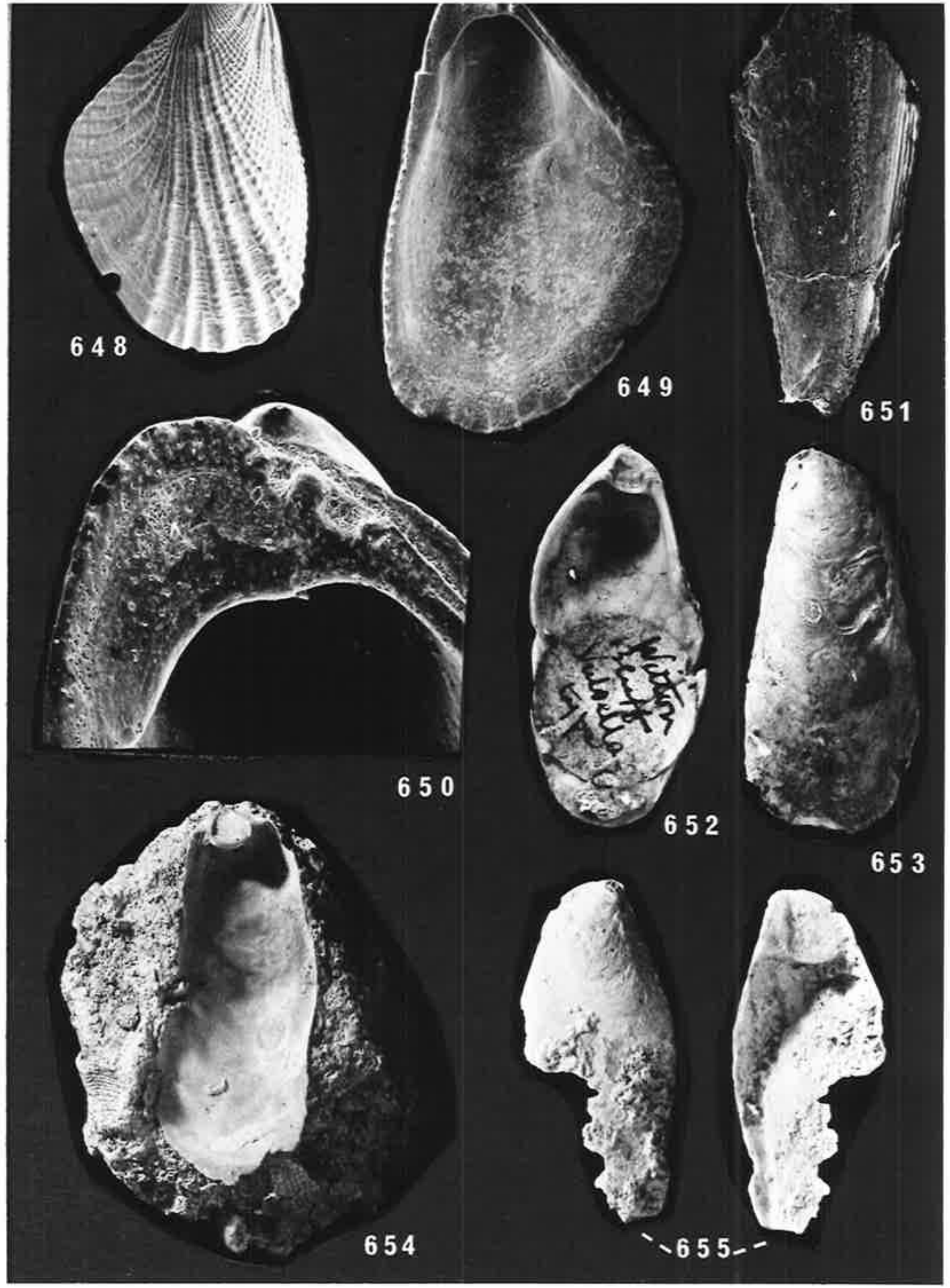
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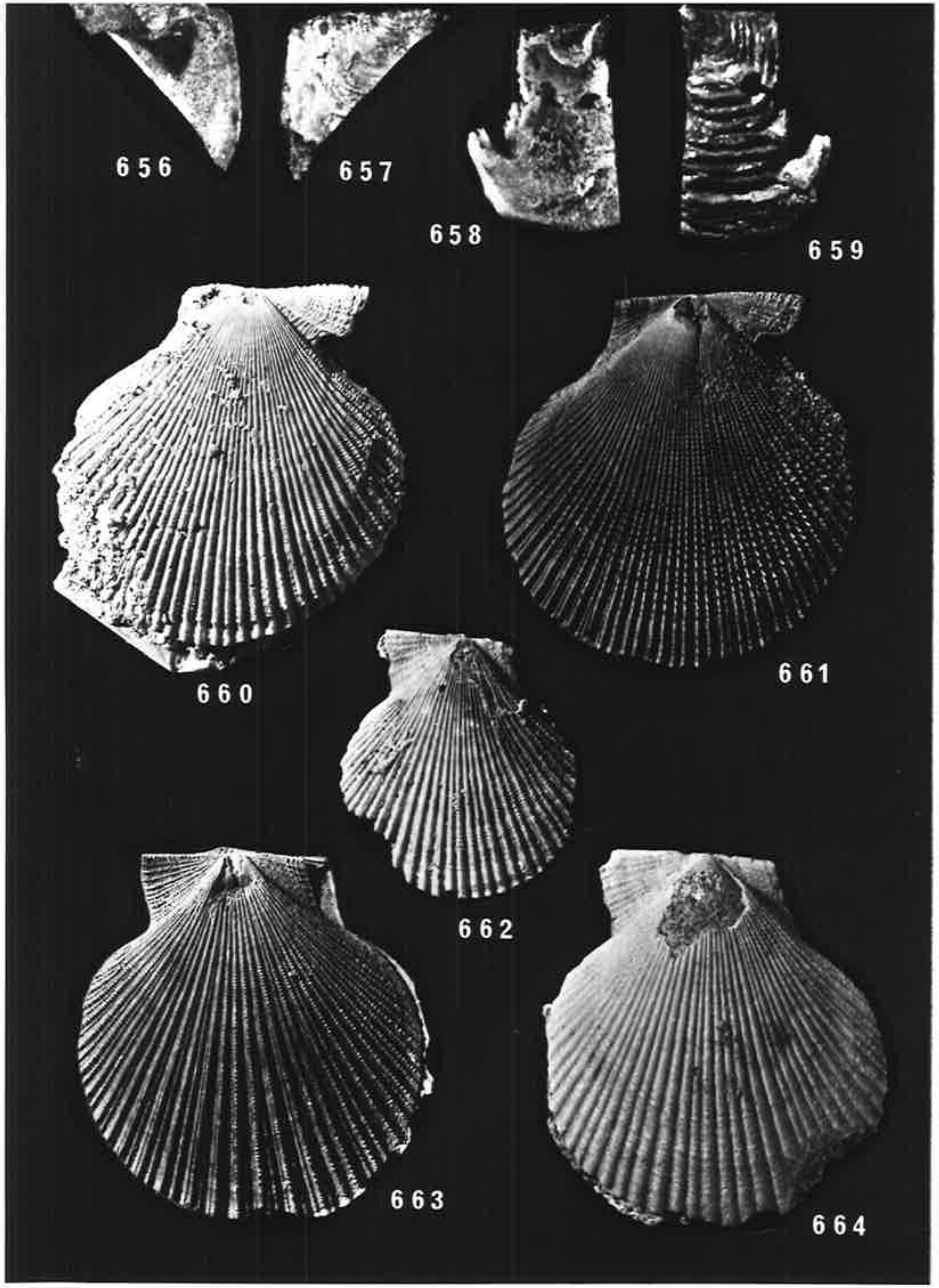
FIGS. 656-659 Pinctada (Pinctada) sp. nov. 656-57) SAM P 21256-A, fragment of RV: inner (x 4), and outer (x 4); 658-59) SAM P 21256-B, fragment of LV: inner (x 4) and outer (x 4).

FIGS. 660-663 Chlamys (Chlamys) peroni (Tate). 660) SAM P 21241, RV, outer (x 1.9); 661) SAM T 930-C, holotype, RV, outer (x 1.5); 662) SAM P 21240, LV, outer (x 1.9); 663) SAM T 930-E, paratype, bivalved specimen, LV outer view (x 1.3).

FIG. 664 C.(Chlamys) flindersi (Tate), SAM P 21239-A, LV, outer (x 1.3).

FIGS. 665-667 C. (Chlamys) flindersi(Tate). 665) SAM T 931-B, paratype, RV, outer, (x 1.3); 666) SAM T 931-D, paratype, LV, outer (x 1.55); 667) SAM P 21239-B, RV, outer (x 1.3).

FIGS. 668-670 C. (Chlamys) aldingensis (Tate). 668) SAM P 21242-A, RV, outer (x 1.65); 669) SAM P 21242-B, LV, outer (x 1.65); 670) SAM P 21242-C, LV, outer (x 1.7).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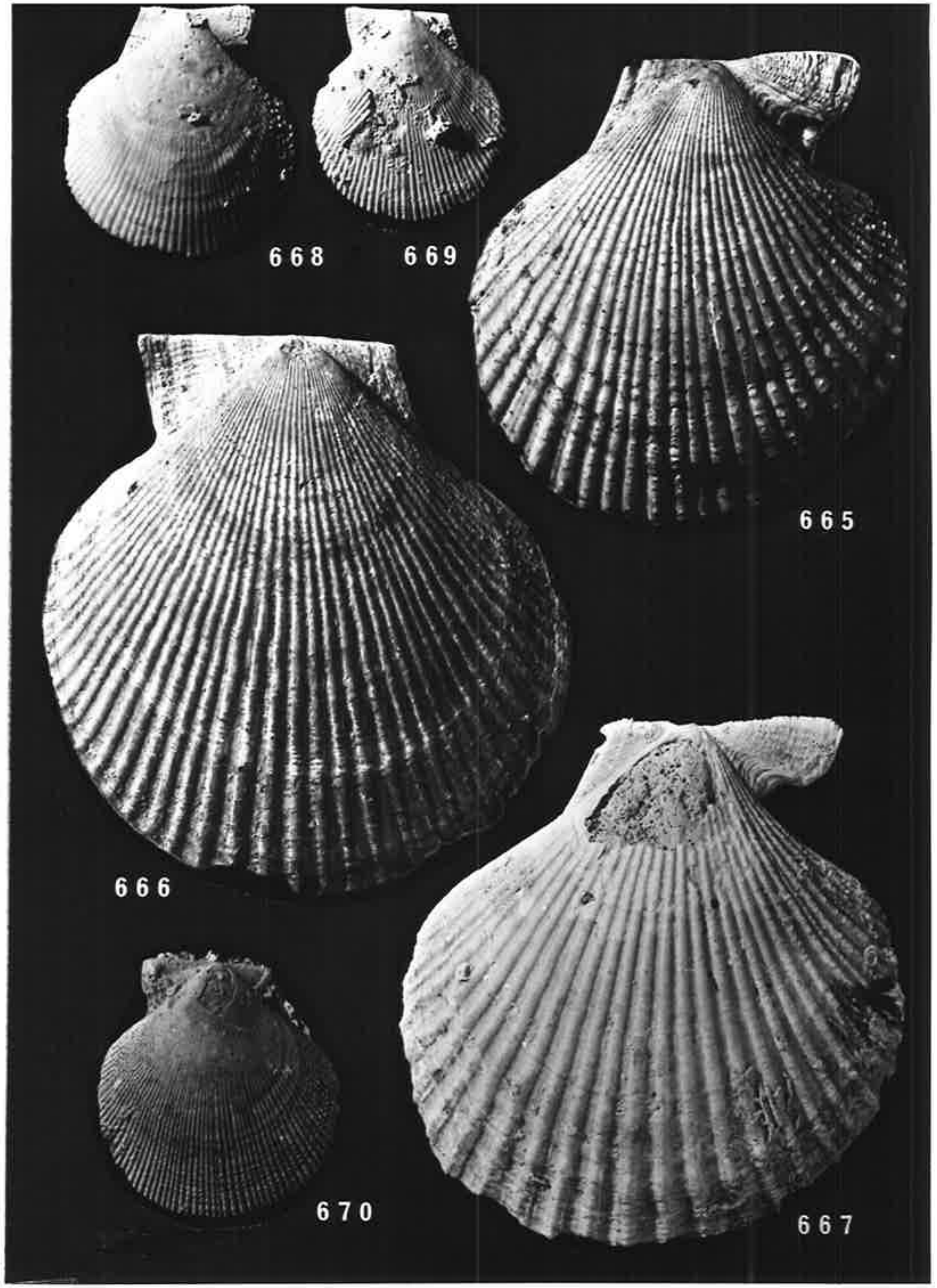
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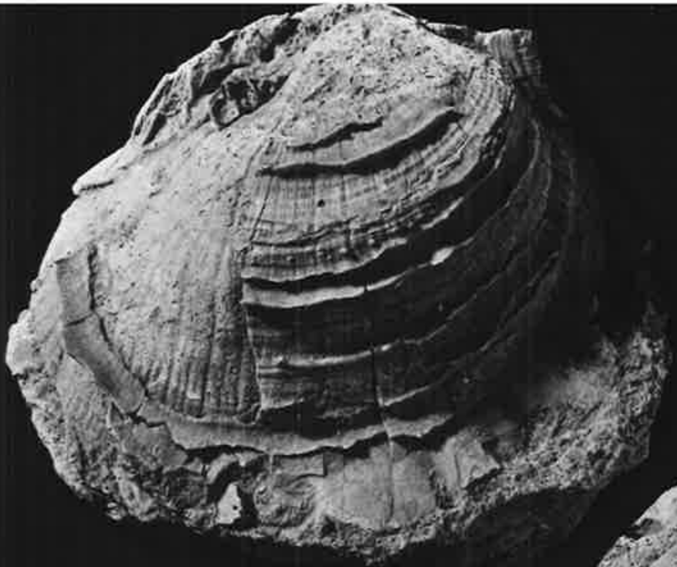
FIGS. 671-675 Spondylus (Spondylus) tortachillensis sp. nov. 671) SAM T 987-A, holotype, LV view (x 1.4); 672) the same, RV view (x 1.4); 673) SAM P 21238, 1 paratype, LV, outer (x 1.6).

FIGS. 674-681 Dimya sigillata Tate. 674) SAM P 21233-A, RV, outer (x 4.4); 675) SAM P 21233-B, LV, inner (x 4.4); 676) SAM P 21234-C, RV, inner (x 10.9); 677) SAM P 21233-E, RV, inner, attached to a Bryozoa (x8.16); 678) the same, particular hinge (x 20); 679) SAM P 21234-B, LV, inner, (x 8.5); 680) SAM P 21233-D, LV, outer, laterally tilted (x 6.15); 681) SAM P 21234-A, RV, outer, attachment area broken (x 7.47).



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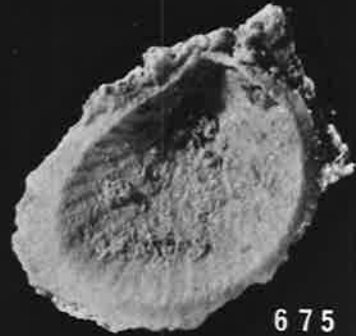

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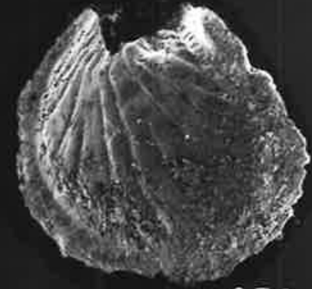

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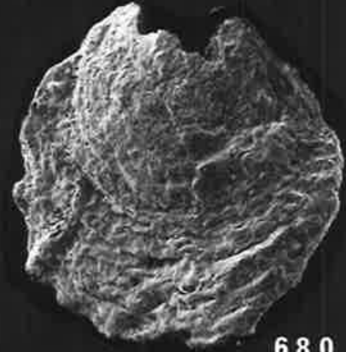

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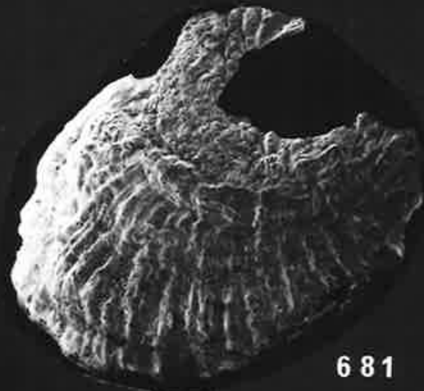

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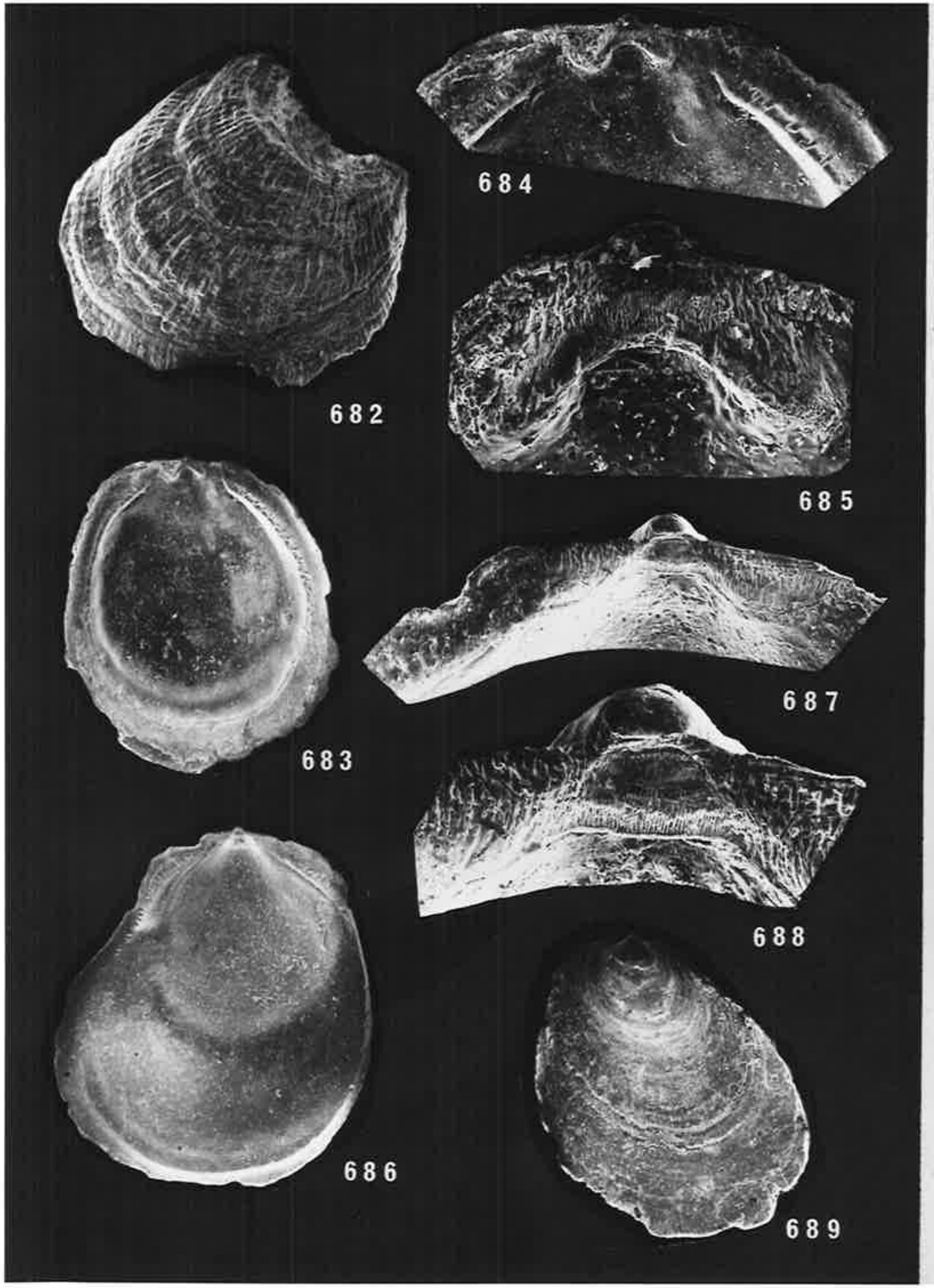
FIGS. 682-689 Dimya asseretoi sp. nov. SAM P 21206-A, holotype, RV: 682) outer (x8.75); SAM P 21206-B, paratype, RV; 683) inner (x 10); 684) hinge (x 20); 685) particular tooth and tooth striations (x 70). SAM P 21206-C, paratype, LV; 686) inner (x8.78); 687) hinge (x 30); 688) particular fossette and ligamental striations (x 70). SAM P 21206-D, LV; 689) outer (x 8.6)

FIG. 690 Ctenoides sp. nov. aff. linguliformis (Tate), SAM P 21244, ?RV, outer (x 2.8).

FIG. 691 Divarilima cf. polyactina (Tate) SAM P 21249, RV, outer (x 3.9).

FIGS. 692-696 Limea (Isolimea) alticosta (Tate). 692) SAM P 21257, RV, inner (x 9); 693) the same, hinge (x 21.85); 694) SAM P 21236-A, RV, outer (x 10); 695) P 21236-B, RV, outer (x 10); 696) SAM P 21236-C, LV, particular abraded ornament (x 40).

FIGS. 697-698 Paraglans latissima (Tate). SAM T 1130-B, paratype, LV: 697) outer (x 1.5); 698) inner (x 1.7)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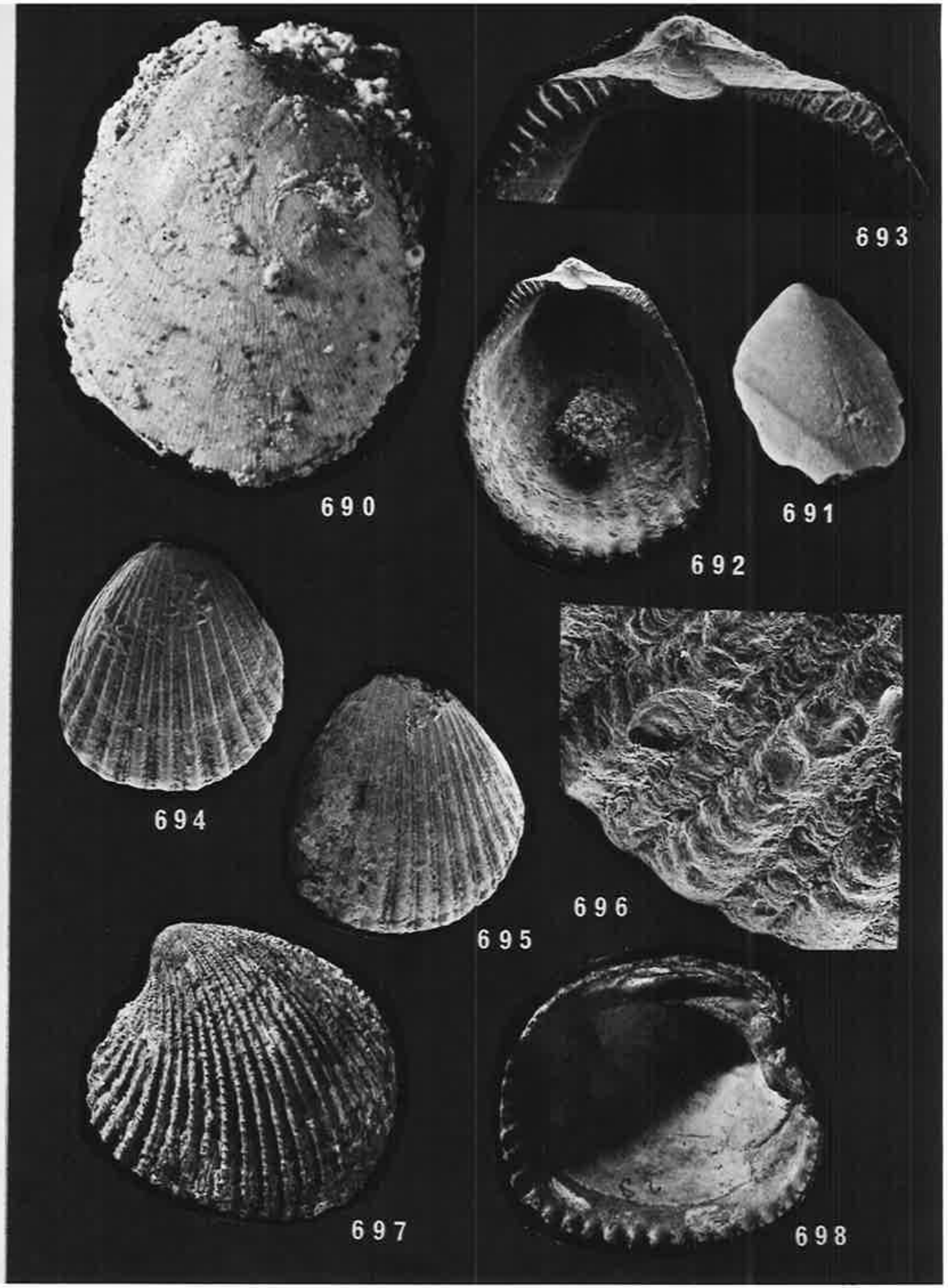
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FIGS. 699-701 *Corbula (Caryocorbula) pyxidata* Tate. 699) SAM P 21235, RV, inner (x 8.92); 700-701) SAM P 21250, LV, inner and outer (x 3.8).

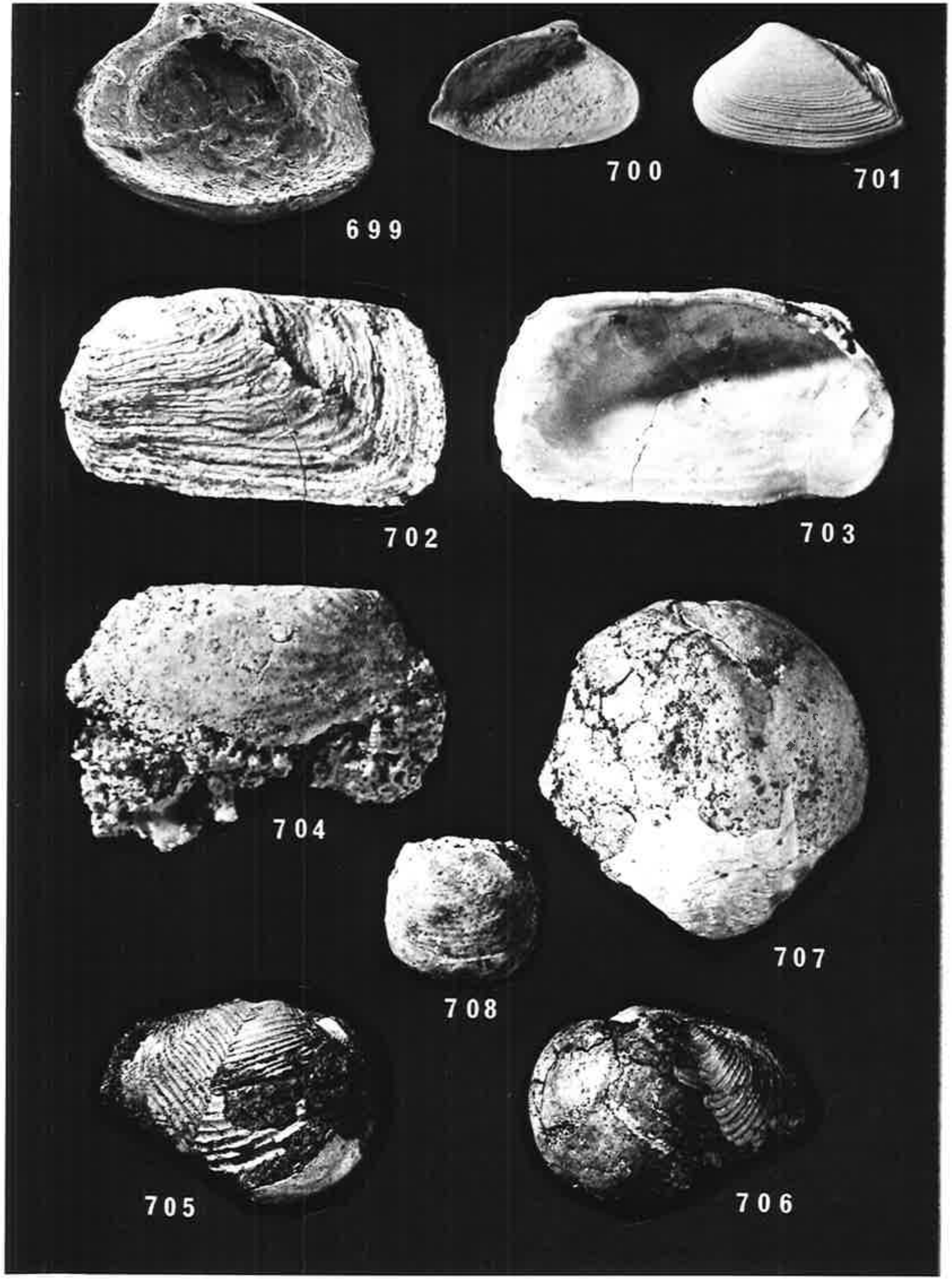
FIGS. 702-704 *Hiatella (Hiatella) ?vera* (Deshayes) . 702-03) SAM T 853-B, outer and inner LV (x 3.9); 704) SAM P 21248, mould, RV (x 3.9).

FIGS. 705-708 *Jouannetia (Pholadopsis) cuneata* Tate. SAM T 350-A, holotype: 705) RV view (x 1.8); 706) LV view (x 1.8); 707) anterior view (x 2.7). SAM P 21243: 708) LV view (x 1.75).

FIG. 709 *Clavagella (Clavagella) ? lirata* (Tate), SAM T 322-D (x 1.9).

FIGS. 710-712 *C. (Clavagella) lirata* Tate. 710) SAM T 323, holotype (x 2.9); 711-12) SAM T 322-C,-E, moulds (x 1.7 and x 1.85, respectively).

FIG. 713 *Pycnodonte (Pycnodonte)* sp. cf. *tatei* (Suter). SAM P 21245, LV, inner (x 1.3).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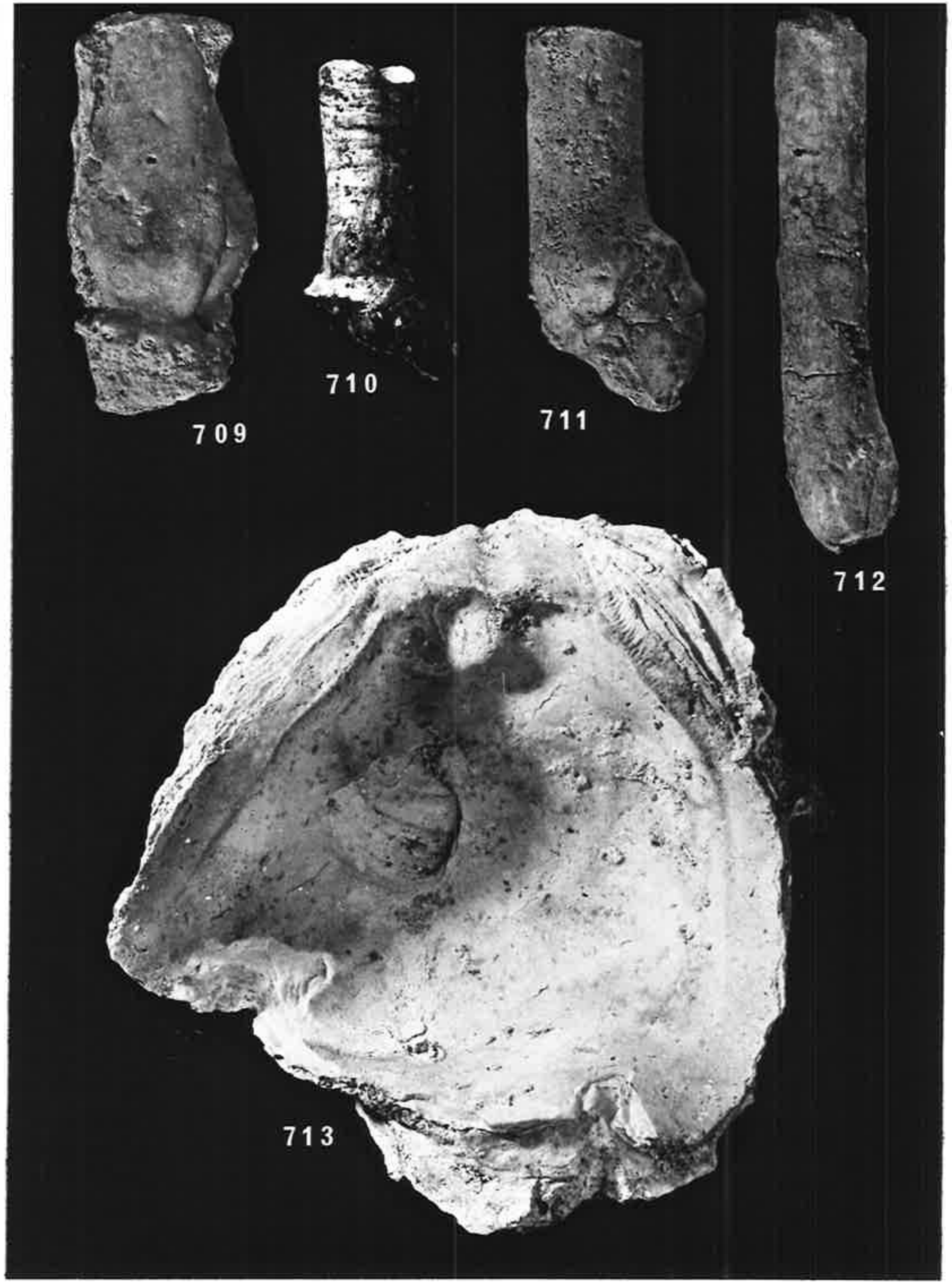
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FIG. 714-716 *Pycnodonte tatei* (Suter). 714) SAM P 21247-B, RV, inner (x 1.7); 715) SAM P 21247-C, RV, outer (x 1.75); 716) SAM P 21247-A, bivalved, LV view (x 1.3).

FIGS. 717-718 *P. (Pycnodonte) tatei* (Suter), SAM P 21247-D, LV, outer and inner (x 1.7).

FIGS. 719-720 *Notostrea subdentata* (Hutton). SAM P 21258, topotype, Trelissick Basin, New Zealand (Duntroonian, Middle Oligocene). LV, outer (x 1.76) and inner (x 1.76). Posterior vermiculations obscured by matrix.

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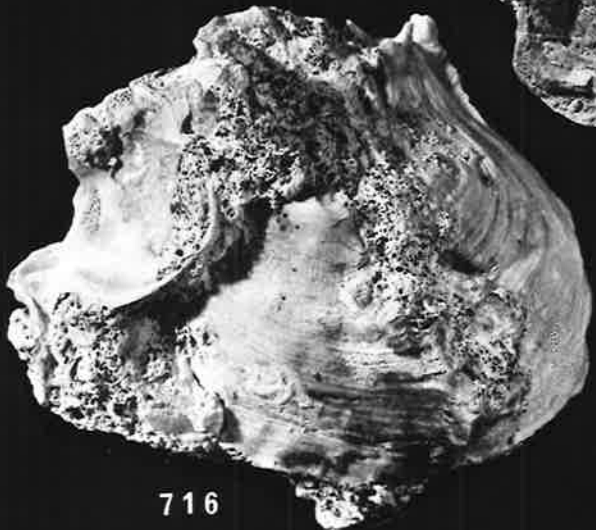

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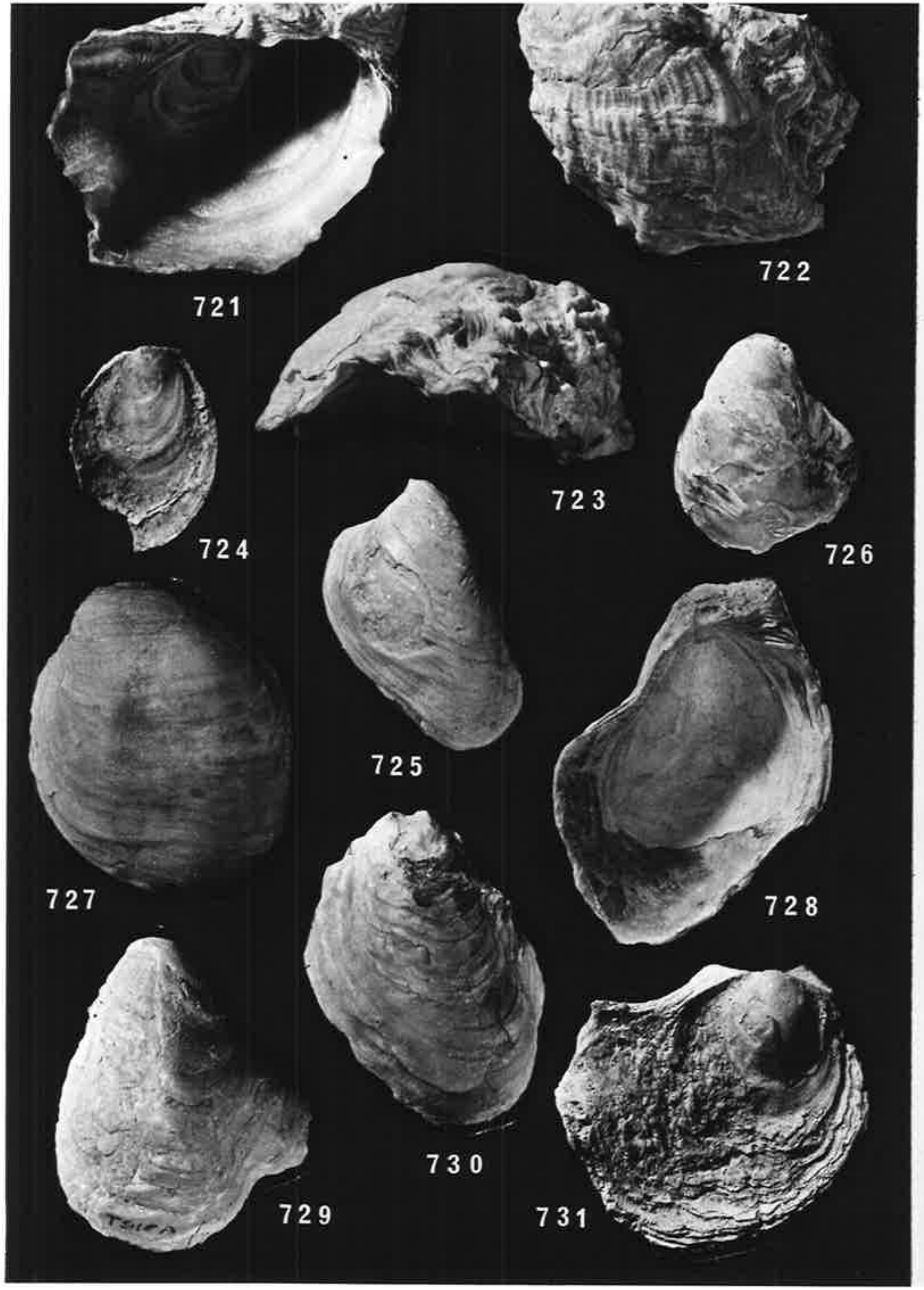
FIGS. 721-723 *Pycnodonte (Phygraea) andreai* sp. nov. SAM P 21259, holotype, LV: 721) inner (x 1.9); 722) outer (x 1.85); 723) lateral posterior view (x 2.15).

FIGS. 724-731 *Pycnodonte (Phygraea) tarda* (Hutton). 724) SAM T 916-G, RV, outer, (x 1.7); 725) SAM T 916-D, LV, outer (x 1.65); 726) SAM T 912-E, LV, outer (x .96); 727) SAM T 912-C, LV, outer (x 1.15); 728) SAM T 912-B, LV, inner (x 1.4); 729) SAM T 916-A, LV, outer (x 1.0); 730) SAM T 912-D, LV, outer (x 1.65); 731) SAM T 916-E, RV, outer (x 1.4).

FIGS. 732-739 *P. (Phygraea) tarda* (Hutton). Topotypes, Tioriori, Chathams Islands (Waipawan, Middle Paleocene). NZGS 1177-D, RV: 732) inner (x 2.42); 733) hinge (x 3.13); 734) outer (x 2.54). NZGS 1177-A, LV: 735) inner (x 1.35); 736) outer (x 1.31). NZGS 1177-C, LV: 737) inner (x 1.35); 738) outer (x 1.35). NZGS 1177-B, LV: 739) outer (x 1.08).

FIGS. 740-742 *P. (Phygraea) tarda* (Hutton). 740) SAM T 916-C, LV, outer (x 1.41); 741) SAM T 912-A, LV, outer (x .9); 742) SAM T 916-B, LV, outer (x 1.45).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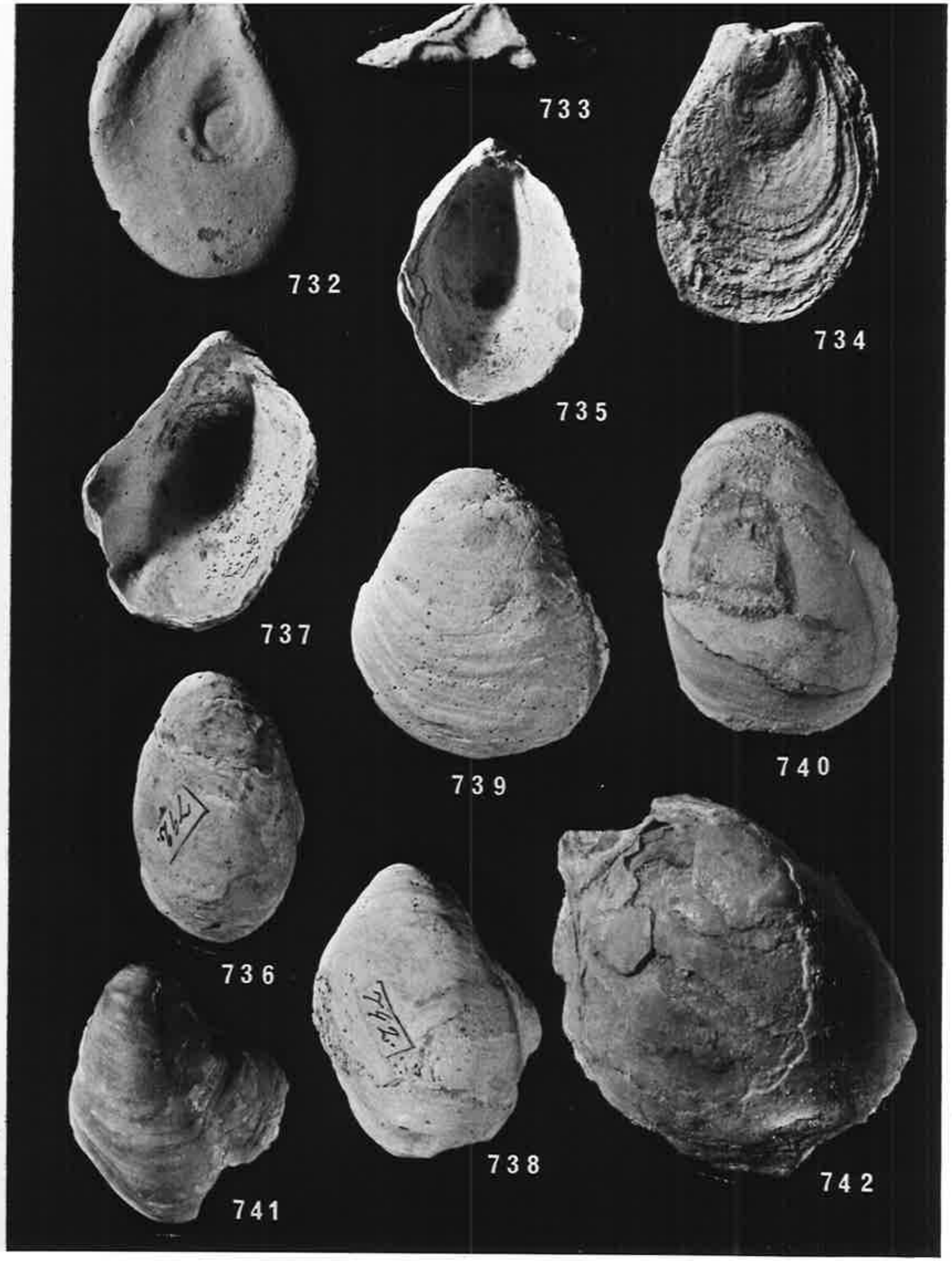
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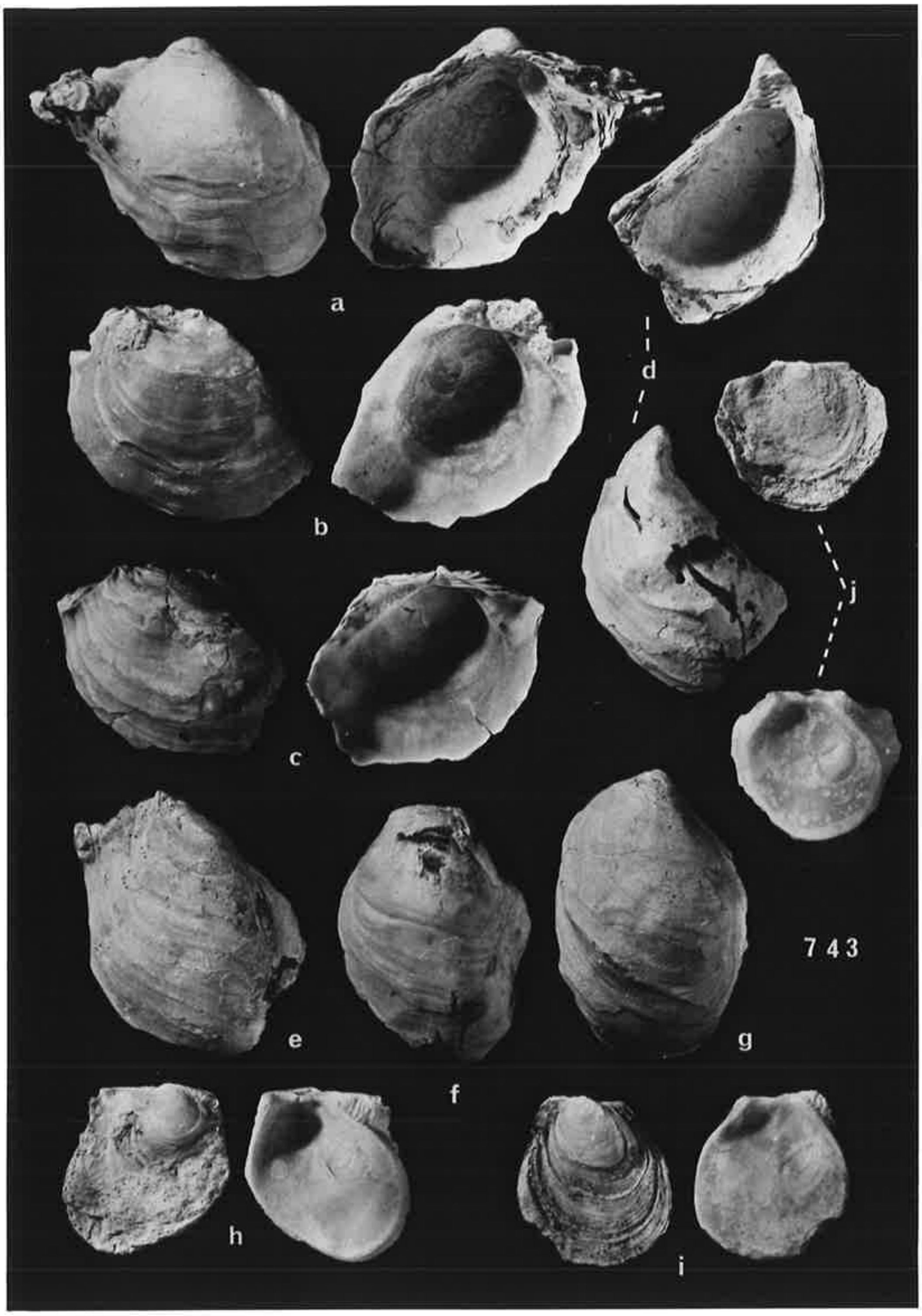
FIG. 743 <u>P. (Phygraea) tarda</u> (Hutton). SAM P 21260, morphae, lot showing the variability LV and RV outlines and morphology. LV: a) outer (x 1.23) and inner (x 1.11); b-c) outer and inner (all x 1.17); d) outer and inner (x 1.19); e) outer (x 1.17); f) outer (x 1.19); g) outer (x 1.2). RV: h-j) inner and outer (all x 1.32).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NOTES ON THE GENUS *PSEUDOMALAXIS* FISCHER (MOLLUSCA: GASTROPODA) AND ITS FOSSIL SPECIES IN AUSTRALIA

By M. F. BUONAIUTO

ADELAIDE
February, 1975

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REVISION OF THE AUSTRALIAN TERTIARY SPECIES ASCRIBED TO *LIMATULA* WOOD (MOLLUSCA, BIVALVIA)

By M. F. BUONAIUTO

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