

Mathildidae from New Caledonia and the Loyalty Islands (Gastropoda: Heterobranchia)

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ABSTRACT

Specimens of the genera *Mathilda* and *Tuba* from New Caledonia and the Loyalty Islands are studied, and compared with numerous other nominal mathildid species from the Indo-Pacific and Atlantic Oceans. Diversity is high in this region, with several species showing a much wider distribution in the Indo-Pacific than previously ascertained. *Mathilda* Semper, 1865 is used *sensu lato*, including *Fünbriatella*, *Grammichavilda*, *Mathildona* and *Opimilda*. From the study area thirteen species are diagnosed and compared, and several as yet unnamed forms that need further study are also discussed. Four new species are described, and *Mathilda fusca* (Okutani & Habe, 1981), previously placed in the turritellid genus *Orectospira*, is recognized as the largest extant member of the family Mathildidae. *Tuba* Lea, 1833 is also used *sensu lato*, including *Gegania* and *Tubena*, and is represented by two species (one described as new).

Twelve Indo-Pacific species previously referred to as Mathildidae are removed from the family: *Mathildona cookima* Dell, 1956 (Epitoniidae); *Mathilda elegantula* Angas, 1871 (Pyramidellidae ?); *M. eurytoma* Melvill & Standen, 1896 (Cerithiidae); *M. gracillima* Melvill & Standen, 1901 (Capulidae); *M. oppia* Hedley, 1907 (Rissoidae); *M. opulenta* Hedley, 1907 (Cerithiidae); *M. rosae* Hedley, 1901 (Eulimidae); *Eucharhita pleurorhis* Laseron, 1951, and *Opimilda protolineata* Laseron, 1951 (Triphoridae); *O. porrigata* Laseron, 1951 (Cerithiopsidae ?); *Dunkeria pulchella* A. Adams, 1860, and *D. scabra* A. Adams, 1860 (Epitoniidae).

RÉSUMÉ

Mathildidae de Nouvelle-Calédonie et des îles Loyauté (Gastropoda: Heterobranchia).

Cette étude porte sur les représentants des genres *Mathilda* et *Tuba*, récoltés récemment en Nouvelle-Calédonie et aux îles Loyauté, dont le matériel est comparé à de nombreuses autres espèces nominales de Mathildidae des océans Atlantique et Indo-Pacifique. La région d'étude montre une richesse spécifique élevée, plusieurs espèces présentant une distribution indo-pacifique beaucoup plus vaste qu'il n'avait été démontré jusqu'ici. Le nom *Mathilda* Semper, 1865 est employé *sensu lato*,

BIELER, R., 1995. — Mathildidae from New Caledonia and the Loyalty Islands (Gastropoda: Heterobranchia). In: P. BOUCHET (ed.), Résultats des Campagnes MUSORSTOM, Volume 14. *Mém. Mus. natu. Hist. nat.*, 167 : 595-641. Paris ISBN 2-85653-217-9.

en y incluant *Fimbriatella*, *Granulicharitula*, *Mathildona* et *Opimilda*. Treize espèces sont recensées, décrites et comparées, auxquelles s'ajoutent plusieurs autres formes dont l'identité requiert l'étude de matériel additionnel. Quatre espèces sont décrites comme nouvelles. *Mathilda fusca* (Okutani & Habe, 1981), jusqu'ici classé dans le genre *Orectospira* (Turritellidae), s'avère être la plus grande espèce actuelle de Mathildidae. Le genre *Tuba* Lea, 1833, également employé *sensu lato* et en y incluant *Gegumia* et *Tubenu*, est représenté par deux espèces, dont l'une décrite comme nouvelle.

Deux espèces indo-pacifiques jusqu'ici classées dans les Mathildidae appartiennent en fait à d'autres familles: *Mathildona cookiana* Dell, 1956 (Epitoniidae); *Mathilda eleguntulu* Angas, 1871 (Pyramidellidae ?); *M. eurytima* Melvill & Standen, 1896 (Cerithiidae); *M. gracillima* Melvill & Standen, 1901 (Capulidae); *M. oppia* Hedley, 1907 (Rissoiidae); *M. opulentu* Hedley, 1907 (Cerithiidae); *M. rusne* Hedley, 1901 (Enlimalidae); *Euchurilda pleurorhis* Laceron, 1951, et *Opimilda protolineata* Laceron, 1951 (Triphoridae); *O. porrigata* Laceron, 1951 (Cerithiopsidae ?); *Dunkeria pulchella* A. Adams, 1860, et *D. scabra* A. Adams, 1860 (Epitoniidae).

INTRODUCTION

The marine gastropod family Mathildidae is a deep-water group, with about 130 extant nominal species in the Atlantic and Indo-Pacific Oceans. Most currently recognized members have high-spired shells with a sculpture of intersecting axial and (usually stronger) spiral ribs. The fossil record is extensive and the mathildids *sensu lato* are clearly traceable to the Triassic (e.g., GRÜNDEL, 1976; BATTEN & STOKES, 1986). The group is poorly studied, with most nominal species known from their type series only. The last group-wide attempt to monograph *Mathilda* (*sensu lato*) dates from DE BOURY (1883), and thus predates the introduction of all but four nominal extant species here discussed. Like many other unrevised small-shelled gastropod groups, "Mathildidae" has become a waste basket for taxa difficult to place. With many of the nominal genera (including name-bearing *Mathilda*) based on fossil type material, modern studies involving anatomical data on "mathildids" run the risk of selecting nominal family members that in fact belong to different superfamilies, as will be shown below. This paper presents a first taxonomic "house cleaning" in an attempt to make monophyletic subsets available for subsequent studies.

The group is of phylogenetic interest because most of its current members seem to belong to the 'lower heterobranchs,' an assemblage with unresolved relationships to caenogastropods, opisthobranchs and pulmonates (HASZPRUNAR, 1988; BIELER, 1992). Like the presumably closely related Architectonicidae, most species currently classified as mathildids have heterostrophic shells (i.e., the protoconch axis diverges considerably from that of the teleoconch). Only the protoconch in these forms is hyperstrophic (shell growth ascends the axis of coiling, producing apparent sinistrality although the animal is dextrally organized), while the teleoconch has normal orthostrophic growth. This paper is restricted to species with smooth hyperstrophic protoconchs, excluding such supposed mathildid forms as *Brookesena* Finlay, 1926, which need more study. Generic allocations have been made conservatively, grouping the species into *Mathilda* Sempér, 1865 (*sensu lato*), and *Tuba* Lea, 1833 (*sensu lato*), which here are redefined.

This paper is the first part of an attempt to revise the species-level taxonomy of Indo-Pacific mathildids. The massive collecting efforts off New Caledonia and the Loyalty Islands, including the 19th century type localities of several nominal mathildid species, have provided a unique opportunity for the study of mathildids. The newly collected material, available type material and other museum specimens are compared in a descriptive fashion, based on shell features. Awaiting the results of ongoing studies on additional species (Atlantic Ocean) and other characters (anatomy), no attempt has here been made to reconstruct phylogenetic relationships at the species-level. Special emphasis was placed on the description and illustration of the spiral rib pattern on the shell, which often shows considerable ontogenetic change. The different conditions of growth stages of the same species had led previous authors to describe separate nominal species, which are here synonymized.

Analogous to the situation found in the Architectonicidae (e.g., BIELER, 1993), and based on the very similar larval shell morphology, mathildid species were suspected to have wide geographic distributions. Beginning with PIANI (1981: 3; presenting additions and corrections to an earlier work [1980: 133]), several authors have implied ampho-Atlantic distribution of a single mathildid species, by synonymizing western Atlantic species with one or several eastern Atlantic and Mediterranean forms (e.g., GARCIA-TALAVERA, 1983; OLIVERIO & NOFRONI, 1986, 1988). Accordingly, the New

Caledonia/Loyalty Islands mathildids have been compared to previously described nominal species from Atlantic and Indo-Pacific Oceans, with special attention to the western Pacific.

Thirteen *Mathilda* (*sensu lato*) species are thus diagnosed and compared; of these, four are described as new species. *Tuba* (*sensu lato*) is represented by two species, one of which is described as new.

MATERIALS AND METHODS

The taxonomic data for this work were derived largely from the study of more than 100 specimens newly collected as part of different dredging expeditions in New Caledonia as summarized by RICHER DE FORGES (1990, 1991, 1993) and ROUX *et al.* (1991). In addition, other museum material from the Indo-Pacific and Atlantic Oceans was studied.

Type material: All available type specimens of nominal extant species covered by this monograph were examined. An exception are the eight species-group taxa that were originally described from Japan. They are presently located in private collections or are part of the 'Imperial Household' and were not available on loan for this study. Although some photographs and topotypic specimens have been obtained through the kind cooperation of Japanese colleagues to augment the sometimes insufficient original descriptions, it should be noted that the taxonomic treatment of these particular taxa is not based on direct study of type material.

Scanning electron microscopy (SEM): Previously described type material and other unique specimens received on loan without permission for gold coating were studied and photographed under SEM *without* coating. These specimens were temporarily mounted on stubs with adhesive tabs, commercially available from SEM supply vendors. Excessive 'charging' of these samples was avoided by reducing the accelerating voltage to 2-6 kV. This resulted in an unavoidable loss of resolution, especially in case of larger specimens for which the microscope stage had to be lowered (causing greater working distance). Other specimens were coated with gold. Most specimens were observed and photographed using an AMRAY 1810 scanning electron microscope at Field Museum. Some large specimens were photographed in sections (using a Zeiss Novascan-30 model at the Smithsonian Marine Station, Ft. Pierce, Florida), with the partial images later combined into composite prints. Differences in resolution and contrast among illustrations are a result of this mixture of coated and uncoated material. To allow direct comparison between illustrated specimens, certain aspects were photographed at consistent magnification (teleoconch apex at 25x, protoconch at 72x).

Descriptions and measurements: For the majority of the specimens studied, the following characters were observed and recorded (using calipers and a dissecting microscope with a calibrated eyepiece at 50x magnification; mm accuracy given in parentheses): teleoconch diameter (0.1), shell height (0.1), protoconch diameter (0.02), anal keel length (0.02), number of teleoconch whorls (1/8 of a whorl or better, indicated by trailing "+" or "-"), position of the upper point of whorl attachment (and thus the depth of the suture); spire angle; apical, peripheral, basal, and umbilical sculpture; coloration of proto- and teleoconch (for the latter as ground color plus pattern on the various sculptural elements). In addition, notes were compiled on characters of the periostracum and operculum, and on the shape and degree of heterostrophy of the protoconch. This degree of heterostrophy is given as the angle of deviation between the axes (with 5° accuracy). A completely orthostrophic growth pattern would thus be indicated by 0°, a completely "upside-down" protoconch by 180° heterostrophy.

Teleoconch (= shell) diameter was recorded as the greatest dimension perpendicular to the columellar axis. 'Protoconch diameter' is the maximum protoconch diameter. It should be noted that this is the actual maximum diameter in forms with largely exposed protoconchs (*i.e.*, forms of *Mathilda* [*sensu lato*]), while it represents the maximum exposed diameter in *Tuba*. Shell height is the greatest dimension parallel to the columellar axis, measured from the apex (including protoconch) to

the base of the aperture. Teleoconch whorls were counted from the outer corner of the line demarcating the border between proto- and teleoconch to the farthest extent of the periphery (= the point of the outer lip utilized to measure greatest shell diameter). The number of protoconch whorls was determined by the method of TAYLOR (1975: 10; summarized by JABLONSKI & LUTZ, 1980: 332, fig. 4). Aberrant specimens with obviously distorted or repaired shells were measured but the results were not used in descriptions or statistics.

The ontogenetic development of spiral sculptural elements is shown in graphs (*e.g.*, Figs 8-9, 14, 27), delineating relative position, major differences in strength and, most of all, the sequence of occurrence. The sequence follows the concept and is directly comparable with earlier schemes employed in turritellid and mathildid works, *e.g.* that of GRÜNDEL (1976) who used it for several mathildid species. The labelling of ribs is purely descriptive, identical numbers in different species do not necessarily imply homology.

ABBREVIATIONS AND TEXT CONVENTIONS

Repositories

AIM	: Auckland Institute and Museum
AMS	: Australian Museum, Sydney
ANSP	: Academy of Natural Sciences, Philadelphia
BMNH	: The Natural History Museum, London
DMNH	: Delaware Museum of Natural History, Wilmington
FMNH	: Field Museum of Natural History, Chicago
HUJ	: Zoological Museum, Hebrew University, Jerusalem
MNHN	: Muséum national d'Histoire naturelle, Paris
MUM	: The Manchester [University] Museum
NMNZ	: Museum of New Zealand Te Papa Tongarewa, Wellington
NMP	: Natal Museum, Pietermaritzburg
NMW	: National Museum of Wales, Cardiff
NSMT	: National Science Museum, Tokyo
USNM	: National Museum of Natural History, Washington, DC
ZMA	: Zoölogisch Museum, Amsterdam
ZMB	: Museum für Naturkunde, Humboldt-Universität, Berlin

Other abbreviations

dd	: dead-collected, empty shell (under 'Material examined')
lv	: live-collected specimen (under 'Material examined')
D	: Diameter (mm)
H	: Height (mm)
PD	: Protoconch diameter (μm)
TW	: Teleoconch whorls (number)
OD	: Original designation
SD	: Subsequent designation.

SYSTEMATIC ACCOUNT

HETEROBRANCHIA Gray, 1840

Superfamily ARCHITECTONICOIDEA Gray, 1840

Family MATHILDIDAE Dall, 1889

Genus *MATHILDA* Semper, 1865

Mathilda Semper, 1865a: 330. Type species (SD by DE BOURY, 1883: t12): *Turbo quadricarinatus* Brocchi, 1814; Pliocene. Italy.

DIAGNOSIS for *Mathilda* (*sensu lato*) (shell characters). — *Protoconch*: diameter 440-640 μm ; hyperstrophic, diverging about 100-145° from teleoconch axis; with 1.5 to 2.5 whorls; smooth, glassy, without distinct sculptural elements other than short, curved anal keel and thin callus, the latter covering the protoconch umbilicus (noticeable only in well-preserved specimens); transparent or milk-white with tan pigmentation often on embryonic whorl, suture, anal keel and callus.

Teleoconch: length usually 3-20 mm at 4 1/4 to 14 whorls, but large-shelled forms occasionally up to 40 mm at 19 whorls; slender to broadly cone-shaped, spire angle 17-38°; upper side with concave, straight or slightly bulging whorls; periphery with single or double keel or rounded; aperture round to quadrangular, apertural lip often slightly channeled at columella and under major spiral ribs of body whorl; first teleoconch whorl already with at least a subset of the adult axial and spiral sculpture; exposed primary sculpture on upper side consisting of 3 to 4 spiral ribs (often with interspaced additional ones), 1 or 2 of the main spiral ribs markedly more prominent than the others; spiral ribs crossed (at right angles or following more-or-less sinuous shape of apertural lip) by weaker axial ribs, threads or enhanced growth lines; at rib intersections usually with sculpture of rounded more-or-less coarse nodules; interspaces between spiral ribs cancellate due to axial ribbing; upper point of attachment of the following whorl at a spiral rib less prominent than at least one of the exposed ribs above; this attachment rib and an additional rib next to it forming a distinct double edge at outer shell base; flat, concave or slightly inflated basal area with several more-or-less well-defined spiral threads or ribs, surrounding solid columella, or narrow umbilical chink, or funnel-shaped umbilicus; coloration white, overall tan or marbled brown, with distinct brown blotches, or with spiral pattern of various shades of brown.

REMARKS. — **Type species designation.** In his discussion of the new genus *Mathilda*, SEMPER (1865a: 328-330) focused on the species *Turbo quadricarinatus* Brocchi, implying but not clearly stating that this species was to form the type of his new genus. While some authors (e.g., WRIGLEY, 1940: 10; HARRIS & PALMER, 1947: 234) accepted this as an original designation, others cited various works by COSSMANN (1888, 1912) for subsequent designations (e.g., GRÜNDEL, 1976: 349; WENZ, 1939: 661). The earliest type designation appears to be the one by DE BOURY (1883: 112), who clearly stated: "Type: *Turbo quadricarinatus*, Brocchi" (see also MACNEIL & DOCKERY, 1984: 55).

Spelling of *Mathilda*, *Promathilda* and *Mathildidae*. ANDREAE (1887: 23) introduced the name "*Promathildia*" for what he interpreted as Jurassic precursors of the younger genus *Mathilda* Semper, which he misspelled "*Mathildia*". Since he clearly intended to combine the preposition "pro-" with SEMPER's generic name, "*Promathildia*" is here regarded as merely an incorrect original spelling (ICZN Art. 32c) of *Promathilda*, without separate nomenclatural availability in its original form (ICZN Art.32[c-d]); see also ZITTEL (1900: 457), WENZ (1939: 660) and HAAS (1953: 185). The intentional emendation to *Mathildia* by several authors (COSSMANN, 1888: 309; 1912: 8; KRACH, 1963: 87) is

unjustified (ICZN Art. 33b [iii]). DALL (1889: 266) spelled the generic name as "*Mathilda*", but gave the family name as "Mathildiidae"; the latter is thus interpreted as an incorrect original spelling. DALL appears to be the first of several authors who have proposed this family name (e.g., also SACCO 1892: 27).

Mathilda sensu lato. GRÜNDEL (1973) distinguished three subgroups of *Mathilda*, based on the number of primary spiral ribs (2, 3 or 4 "Primärspiralen", referring to the spiral ribs beginning on the early teleoconch whorls). However, as GRÜNDEL himself pointed out (1973: 949), it remains untested whether the members of these respective groups are indeed monophyletic. *Mathilda s. s.* was defined by GRÜNDEL as always having four primary spiral ribs, the third and fourth of which more strongly developed and often of equal strength. This pattern is referred to as "2+2" in the following descriptions. However, several other rib arrangement patterns were encountered during this study. Pending further anatomical investigations, the present paper addresses the group *Mathilda (sensu lato)*, which is here understood to also include the following nominal genus-group taxa:

Fimbriatella Sacco, 1895: 36. Type species (OD): *Cerithium fimbriatum* Michelotti, 1847, which was erroneously given as "*F. fimbriatella* (Micht.)" and subsequently corrected to "*Fimbriatella fimbriata* (Micht.)" by SACCO (1896: 81).

Granulicharilda Kuroda & Habe in Kuroda, Habe & Oyama, 1971: 416, 260. Type species (OD): *Granulicharilda sagamiensis* Kuroda & Habe in Kuroda, Habe & Oyama, 1971; see below.

Mathildona Iredale, 1929: 186. Type species (OD): *Mathildona euglypta* Iredale, 1929; see below under *Mathilda decorata*. *Opimilda* Iredale, 1929 (: 187, 189) is a subjective synonym of *Mathildona*. Type species (OD): *Mathilda decorata* Hedley, 1903; see below under *M. decorata*.

Mathilda brevicula Bavay, 1922

Figs 1-3, 8

Mathilda brevicula Bavay, 1922: 65, pl. 1, fig. 11.

TYPE MATERIAL. — BAVAY (1922) did not select a holotype nor did he indicate the number of specimens under study. The figured syntype (in the original and here in Fig. 1; H = 3.8, D = 2.2, PD = 480 μ m, TW = 5 1/10; MNHN) is selected as lectotype of *Mathilda brevicula*.

TYPE LOCALITY. — "Loyalty insulas" given in original description. Original specimen label states "Lifou, Nouvelle-Calédonie".

MATERIAL EXAMINED. — **Loyalty Islands.** Lectotype as above, no depth given.

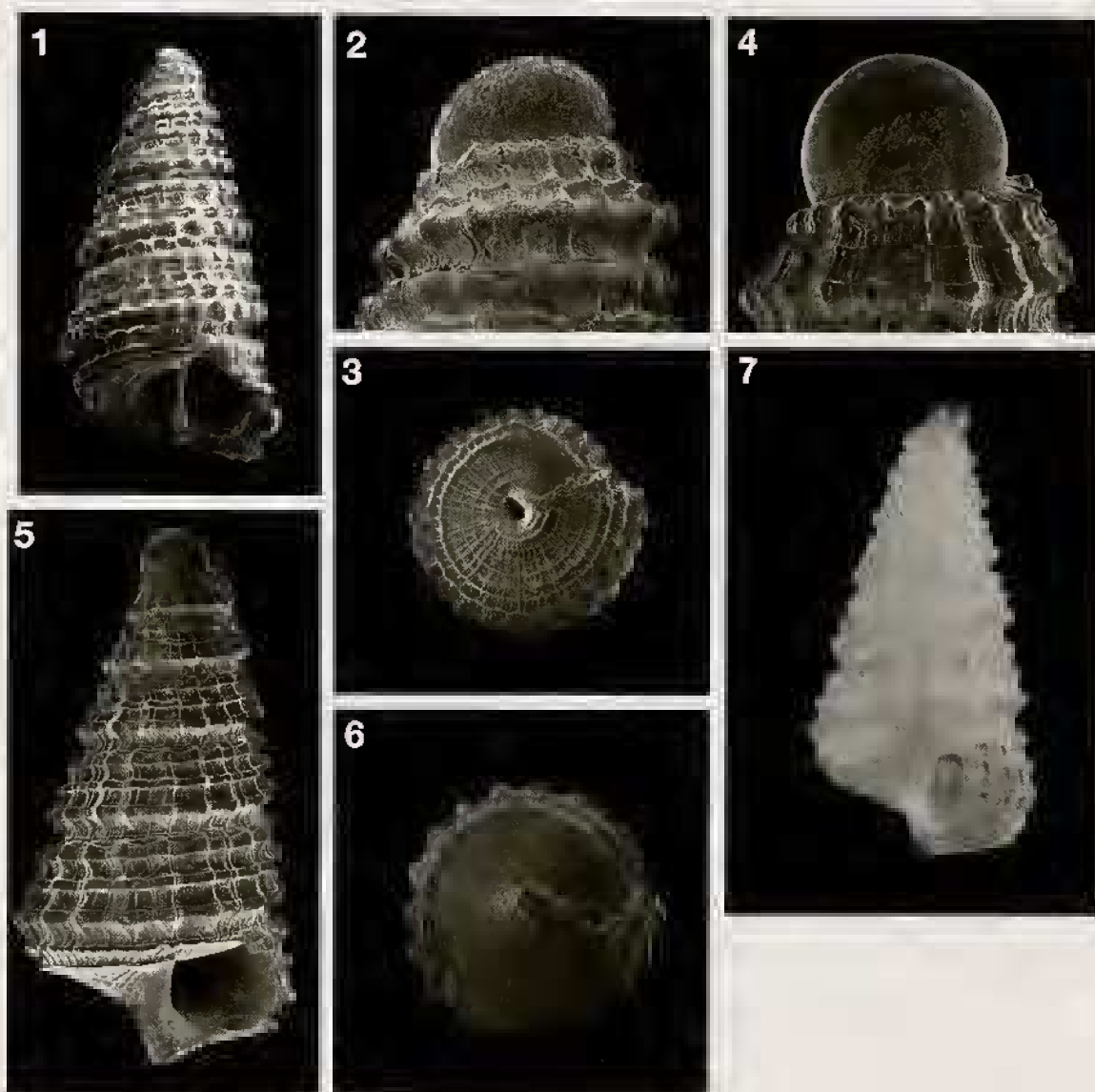
New Caledonia. LAGON: stn 830, 20°49' S, 165°19' E, 105-110 m, 1 dd.

South Coral Sea. Elizabeth Reef, stn 30, 29°57.2' S, 159°01.2' E, 12-17 m, 10.XII.1987, P. Hutchings coll., 1 dd (AMS C155488).

DISTRIBUTION. — Not known from outside this study area; depth 12-110 m; no live material collected.

DESCRIPTION. — *Protoconch* (Fig. 2): smooth, globular, strongly hyperstrophic, at about 135° angle to teleoconch axis; embryonic whorl not exposed, suture hidden or only small part of suture exposed; number of whorls not ascertained; PD 480-520 μ m; with weak peritreme. Protoconch umbilicus completely covered by thin callus, extending between first TW and anal keel. Glassy or milk-white; area before protoconch lip and callus tan.

Teleoconch: slender cone-shaped, base acutely angled; 3.1-3.8 mm at 4 1/2 to 5 1/10 whorls, spire angle 30-34°. Pattern of regular spiral and weaker axial ribs, intersecting at slightly oblique angles to form strong nodules. Spacing of the axials very regular, with ca. 21-24 on fourth whorl. Exposed upper part of earlier whorls with 3 spiral ribs (middle one weakest, lowermost strongest), joined (below the uppermost) by a weak additional rib(s) at about 3 1/2 to 4 1/2 TW (Fig.



FIGS 1-7. — 1-3, *Mathilda brevicula* (SEM, uncoated). — 1, lectotype, Loyalty Islands, 3.8 mm; specimen slightly tilted. — 2, protoconch and first teleoconch whorl, specimen from New Caledonia, LAGON: stn 830, protoconch diameter 520 μ m. — 3, same specimen, shell base with open umbilicus, diameter 2.6 mm. — 4-7, *Mathilda boucheti* sp. nov. — 4-6, paratype 1, New Caledonia, FMNH 224968. — 4, aspect of protoconch and first teleoconch whorl, protoconch diameter 600 μ m. — 5, lateral aspect, 4.6 mm. — 6, shell base, 2.3 mm diameter. — 7, holotype, New Caledonia, 5.0 mm (light photograph).

8). Upper point of whorl attachment at a recessed, fourth spiral rib, partly covering it. On body whorl, this rib, and one of almost equal strength immediately below it, forming double keel at outer base. Somewhat concave basal area with

1 or 2 spiral threads and 2 relatively smooth ribs surrounding open, funnel-shaped umbilicus. Coloration: yellowish to dark tan.

Animal: unknown.

REMARKS. — This form can be recognized by its pattern of three nodose spiral ribs on the exposed part of the teleoconch whorls, combined with an open umbilicus. The following species is similar.

Mathilda boucheti sp. nov.

Figs 4-6, 9

TYPE MATERIAL. — Holotype MNHN. Paratypes: 2 MNHN, 1 FMNH 224968, 1 NMP L1144/T1186, 1 USNM 887052.

TYPE LOCALITY. — New Caledonia, CIALCAL 2, stn DW 76, 23°41' S, 167°45' E, 470 m.

MATERIAL EXAMINED. — **New Caledonia.** CIALCAL 2: stn DW 76, 23°41' S, 167°45' E, 470 m, 1 dd (holotype).

BIOCAL: stn DW 38, 23°00' S, 167°15' E, 360 m, 1 dd (paratype MNHN). — Stn DW 44, 22°47' S, 167°14' E, 440-450 m, 2 dd (paratypes: 1 NMP, 1 USNM). — Stn DW 46, 22°53' S, 167°17' E, 570-610 m, 2 dd (paratypes: 1 MNHN, 1 FMNH).

DISTRIBUTION. — Not known from outside this study area; depth 360-610 m; no live material collected.

DESCRIPTION. — *Protoconch* (Fig. 4): smooth, globular, strongly hyperstrophic, at about 130° angle to teleoconch axis; embryonic whorl fully or largely exposed; consisting of about 2 1/2 whorls; PD 540-600 µm; with weak peritreme. Protoconch umbilicus completely covered by callus, extending between first TW and anal keel. Glassy or milk-white; embryonic whorl, protoconch suture and callus tan.

Teleoconch: slender cone-shaped; 4.3-5.7 mm at 5 to 6+ whorls; spire angle 31-32°. Pattern of regular spiral and weaker axial ribs, intersecting at almost right angles to form strong nodules. Spacing of the axials very regular, with ca. 17-21 on fourth whorl. Exposed upper part of whorls with 3

spiral ribs (middle one weakest, lowermost strongest); large specimens with weak additional thread below the middle rib, beginning at about 5 3/4 TW (see Fig. 9). Upper point of whorl attachment at a recessed, fifth spiral rib, partly covering it. On body whorl, this rib, and one of almost equal strength immediately below it, forming double keel at outer base. Basal area with 4-6 indistinct spiral threads. No open umbilicus; callous columella, relatively thick-shelled in larger specimens. Coloration: Early whorls white; after about 3 TW, spiral ribs, especially first and third, with tan color, darkest between nodes.

Animal: unknown.

Measurements:

	H	D	PD	TW	Locality	Collection
Holotype	5.0	2.6	600	5 7/8	[type loc.]	MNHN
Paratype 1	4.6	2.3	600	5 1/2	BIOCAL stn 46	FMNH 224968
Paratype 2	5.7	2.6	600	6 +	BIOCAL stn 46	MNHN
Paratype 3	4.3	2.4	580	5	BIOCAL stn 44	NMP L1144/T1186
Paratype 4	3.4	1.8	600	4 1/3	BIOCAL stn 44	USNM 887052
Paratype 5	2.3	1.3	540	3 1/2	BIOCAL stn 38	MNHN

REMARKS. — This species can be recognized by its pattern of three nodose spiral ribs on the exposed part of the teleoconch whorls, combined with distinct coloration. A similar form in the study area is *Mathilda brevicula* (see above), which differs by its open umbilicus and greater degree of heterostrophy. In the latter, the embryonic protoconch whorl is never exposed on the shell apex. A similarly three-ribbed form is *Mathilda retusa* Brugnone, 1873, described from the Mediterranean Sea (holotype HJ 10.336, *vidi*). In that form, the second and third primary spiral ribs are of equal strength.

ETYMOLOGY. — Named for Dr Philippe BOUCHET, Muséum national d'Histoire naturelle, Paris, who made this material available for study.

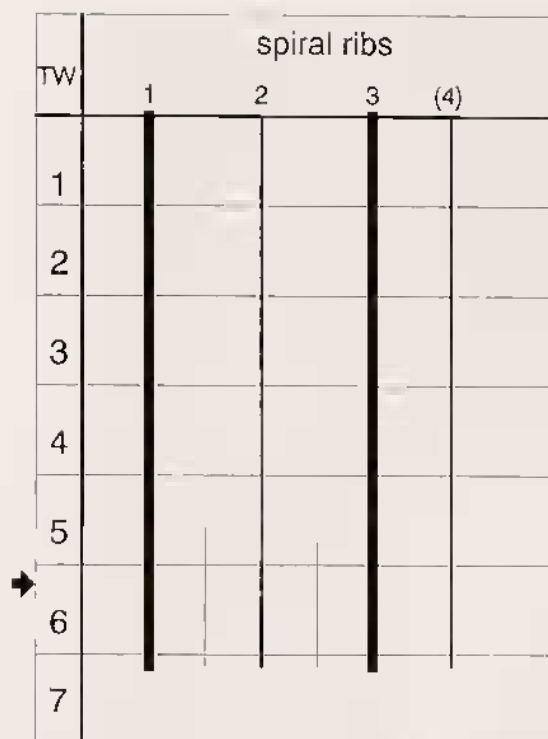


FIG. 8. — *Mathilda brevicuda*. Diagram of spiral sculpture, showing relative position and strength of exposed spiral ribs on the upper side of teleoconch whorls (TW). Rib number in parentheses indicates primary spiral rib serving as attachment of subsequent whorl. Arrow indicating condition of holotype.

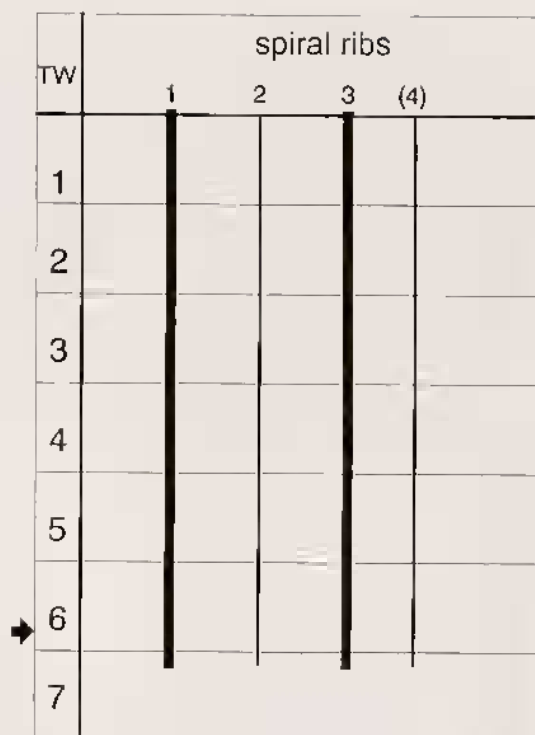


FIG. 9. — *Mathilda bouchei* sp. nov. Diagram of spiral sculpture, as in Fig. 8.

Mathilda cf. *amanda* Thiele, 1925

Figs 11, 14-16

? *Mathilda amanda* Thiele, 1925: 112 (78). pl. 20 (8), figs 26-27.

Synonym:

? *Eucharilda japonica* Kuroda & Habe in Kuroda, Habe & Oyama, 1971: 416 (Japanese), 260 (English), pl. 61, fig. 3 (unclear 19 mm color photograph, apparently of holotype).

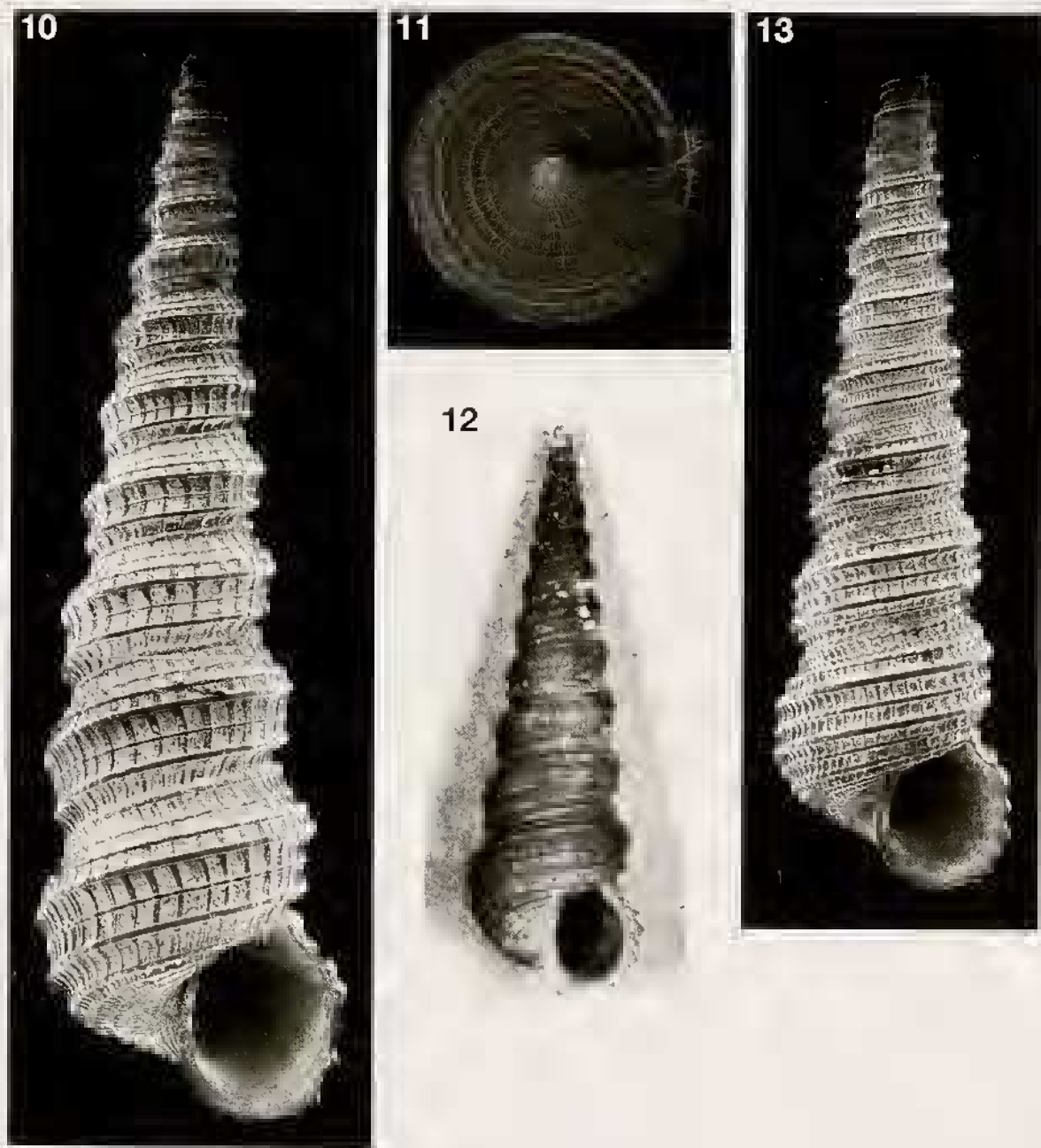
TYPE MATERIAL. — *M. amanda*: lectotype (Fig. 10, here selected; H = 14.3, D = 4.1, protoconch missing; originally figured syntype) and 2 paralectotypes (fragments), ZMB unnumbered. — *E. japonica*: "Height 19.2 mm and breadth 5.8 mm (type specimen)" (KURODA & HABE in KURODA *et al.* 1971: 260); "HT, PT both in H. Majesty's Biol. Lab." (INABA & OYAMA 1977: 54).

TYPE LOCALITY. — *M. amanda*: "Valdivia", stn 244, East Africa, 5°55.8' S, 39°1.2' E, 50 m. — *E. japonica*: "Sagami Bay. Locality: Shuragane-Kakine, 20-35 m, (alive)".

MATERIAL EXAMINED. — Types of *M. amanda* and photograph of holotype of *E. japonica* (courtesy Prof. HABE; here reproduced in Fig. 12).

New Caledonia. LAGON: stn 220, 21°50' S, 165°46' E, 12 m, 1 dd. — Stn 797, 20°58' S, 165°33' E, 92 m, 1 dd. — Stn 836, 20°46' S, 165°16' E, 57 m, 1 dd.

P. Tirard coll., 22°40'-22°50' S, 167°10'-167°30' E, 200-350 m, 10.X.1986, 1 dd.



FIGS 10-13. — 10, *Mathilda amanda*, lectotype ZMB, East Africa, 14.3 mm (SEM, uncoated). — 11, *Mathilda* cf. *amanda*, shell base of specimen from New Caledonia, SMIB 5: stn DW81, diameter 3.1 mm. — 12, holotype of *Eucharilda japonica*, Japan, 19.2 mm (light photograph courtesy Prof. Habe). — 13, lectotype of *Mathilda carystia*, BMNH 1984201, Persian Gulf, 11.2 mm (SEM, uncoated).

SMIB 5: stn DW 81, 22°38' S, 167°35' E, 110 m, 3 dd [incl. SEM specimen]. — Stn DW 82, 22°32' S, 167°32' E, 155 m, 1 dd.

DISTRIBUTION. — Apparently widely ranging from Africa to Japan. New Caledonian depth records ranging from 12 to 350 m. No live-collected records aside from the type locality of nominal species *E. japonica* (20-35 m).

DESCRIPTION. — *Protoconch* (Figs 15-16); smooth; globular; strongly hyperstrophic, embryonic whorl largely exposed, at approximately 125° angle to teleoconch axis; consisting of 1.5 whorls; PD 460-520 μ m; with weak peritreme. Protoconch umbilicus visible between first TW and strong anal keel (no callus observed in available specimens). Translucent orange-tan, with darker suture in some specimens.

Teleoconch: auger-shaped; 10.5 to 19+ mm at 11 to almost 14 whorls; spire angle ca. 17°, later to 21°. Pattern of regular spiral and weaker axial ribs, intersecting at almost right angles. Spacing of the axials very regular, with 23-29 on fourth whorl. Exposed upper part of whorls with 4 spiral ribs, with the 2 lower ones stronger and forming almost-smooth rings; ribs 2 and 3 closest together; third rib prominent and somewhat nodose on early whorls; larger specimens with weak additional threads interspaced (see Fig. 14). Upper point of whorl attachment at a fifth spiral rib, partly covering it. On body whorl, this rib, and one of almost equal strength immediately below it, forming double keel at outer base. Basal area with 4-6 weaker spiral ribs, often interspaced with finer threads; in some specimens with additional rib between primary spirals 3 and 4, reaching equal strength. Umbilicus narrow, almost or completely covered by columellar lip attachment. Coloration: overall horn- to orange-tan.

Animal: unknown.

REMARKS. — This species is tentatively placed as *Mathilda* cf. *amanda* Thiele, 1925. The original specimens of THIELE's species all lack protoconchs; no additional specimens from that part of East Africa were available for comparison. The teleoconch characters, including whorl expansion and spire angle, closely match the *amanda* lectotype (Fig. 10) with material from New Caledonia.

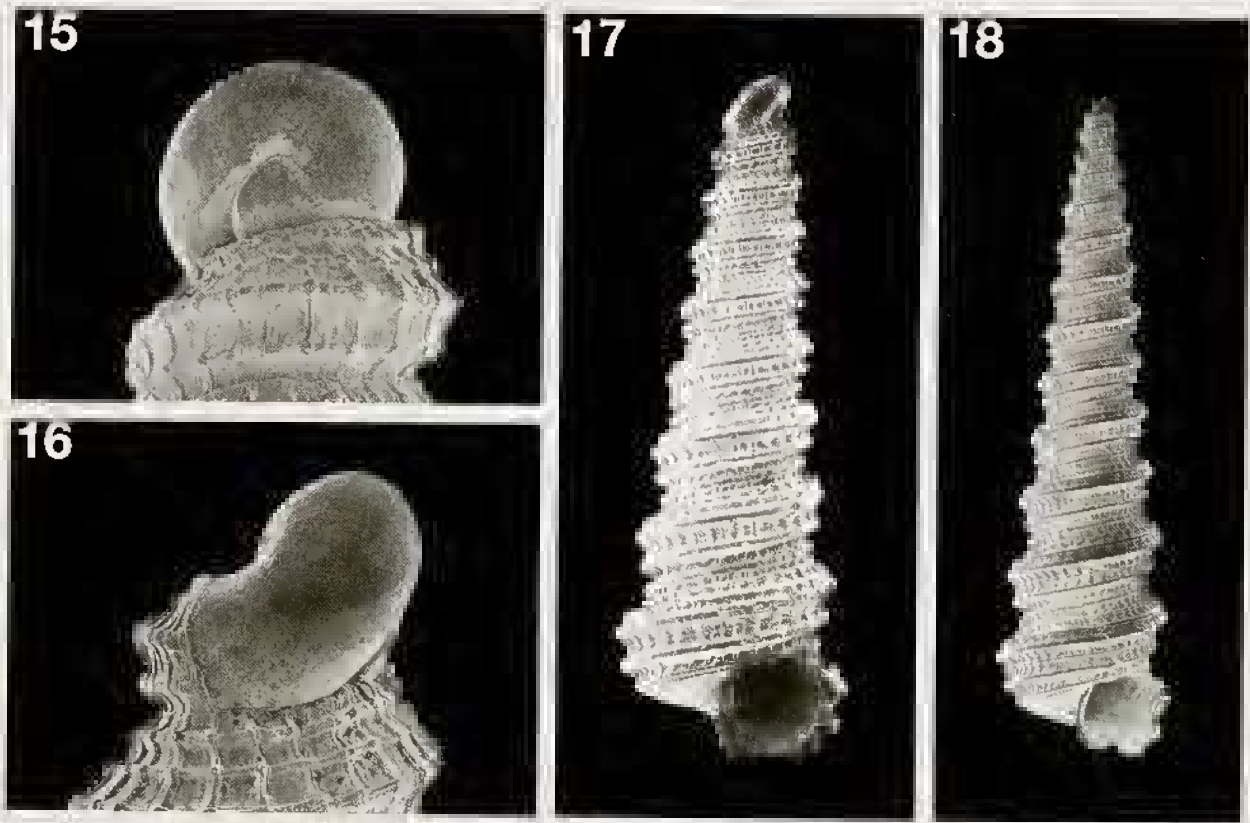
The holotype of *Eucharilda japonica* shows very similar teleoconch sculpture and likewise a spire angle of ca. 20°. Judging from original description and available photograph (Fig. 12), that nominal species may be synonymous.

Based on the present material from New Caledonia, the protoconch size range of "cf. *amanda*" is 460-520 μ m. This appears to be the only character separating this form from *Mathilda carystia* Melvill & Standen, 1903 of the Persian Gulf and Gulf of Oman (Fig. 13). Protoconchs of that nominal species also have only 1.5 whorls, but are considerably smaller (360-400 μ m). The discovery of additional material may show the two morphs to be conspecific.

Taxonomic note on *Mathilda carystia*: *Mathilda carystia* was described by MELVILL & STANDEN (1903: 321-322) from an unstated number of specimens. The given range of color variation ("pale chestnut, dark chestnut, brown, or blackish") indicates numerous syntypes. The origin of the material was given as "Persian Gulf, Koweit, 10 fathoms, mud and sand". The species remained unfigured until the following year, when MELVILL (1904: pl. 8, fig. 7) illustrated a specimen from a different locality in the Gulf of Oman. This specimen (BMNH 1905.6.12.6) was mentioned as "figured syntype" by TREW (1987: 30), but does not qualify as part of the original type series. Of the seven syntypes in BMNH lot 1984201, the largest (H = 11.2, D = 3.2) is closest to the dimensions given in

TW	spiral ribs				
	1	2	3	4	(5)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					

FIG. 14. — *Mathilda* cf. *amanda*. Diagram of spiral sculpture, as in Fig. 8.



FIGS 15-18. — 15-16. *Mathilda* cf. *amanda*, specimen from New Caledonia, (same as in Fig. 11), SMIB 5: stn DW 81, aspects of protoconch and first teleconch whorl, protoconch diameter 460 μ m. — 17-18, *Mathilda sinensis* (SEM, uncoated). — 17, lectotype of *Mathilda sinensis*, MNHN, China Sea, 5.8 mm. — 18, lectotype of *Mathilda telamonia*, BMNH 1912.9.17.26, Persian Gulf, 12.4 mm.

the original description (“long. 12, lat. 3 mm”), and is here selected as lectotype of *Mathilda carystia* (Fig. 13). Two additional paralectotypes are in Cardiff (NMW 1955.158.192, *vidi*).

A species very similar to the *amanda-carystia* complex is *Mathilda sinensis* Fischer, 1867, from the China Sea (1867: 304, pl. 9 [erroneously referred to in text as “XI”], fig. 3). FISCHER did not indicate a holotype in his description and the originally figured syntype is here selected as lectotype (MNHN, Fig. 17). The lectotype (H = 5.8, D = 1.8, TW = 8 1/2+) shows the same general pattern of four major spiral ribs as does *M.* cf. *amanda* from New Caledonia, but differs in having more than 1.5 protoconch whorls as well as a more slender spire angle (16°). *Mathilda telamonia* Melvill, 1912, from the Persian Gulf is here synonymized with *M. sinensis*. MELVILL’s original description (1912: 246, pl. 12, fig. 12) did not indicate the number of specimens in the type series, nor did he designate a holotype. TREW’s (1987: 66) mention of a holotype (BMNH 1912.9.17.26) is here accepted as a lectotype designation in accordance with ICZN Article 74(b). The lectotype (H = 12.4, D = 3.1, PD = 520 μ m; Fig. 18) matches the type dimensions of *M. sinensis* perfectly in having 8 1/2 teleconch whorls at a height of 5.8 mm.

The *Mathilda amanda*-complex shares the pattern of two pairs of primary spiral ribs on the exposed part of the whorls (“2+2” pattern) with several species. These include *Mathilda decorata*, an unnamed *Mathilda* species (discussed below), as well as four Japanese forms described in a separate section below. *Mathilda salve* (also discussed below) shows the “2+2” pattern on its later whorls.

Mathilda decorata Hedley, 1903

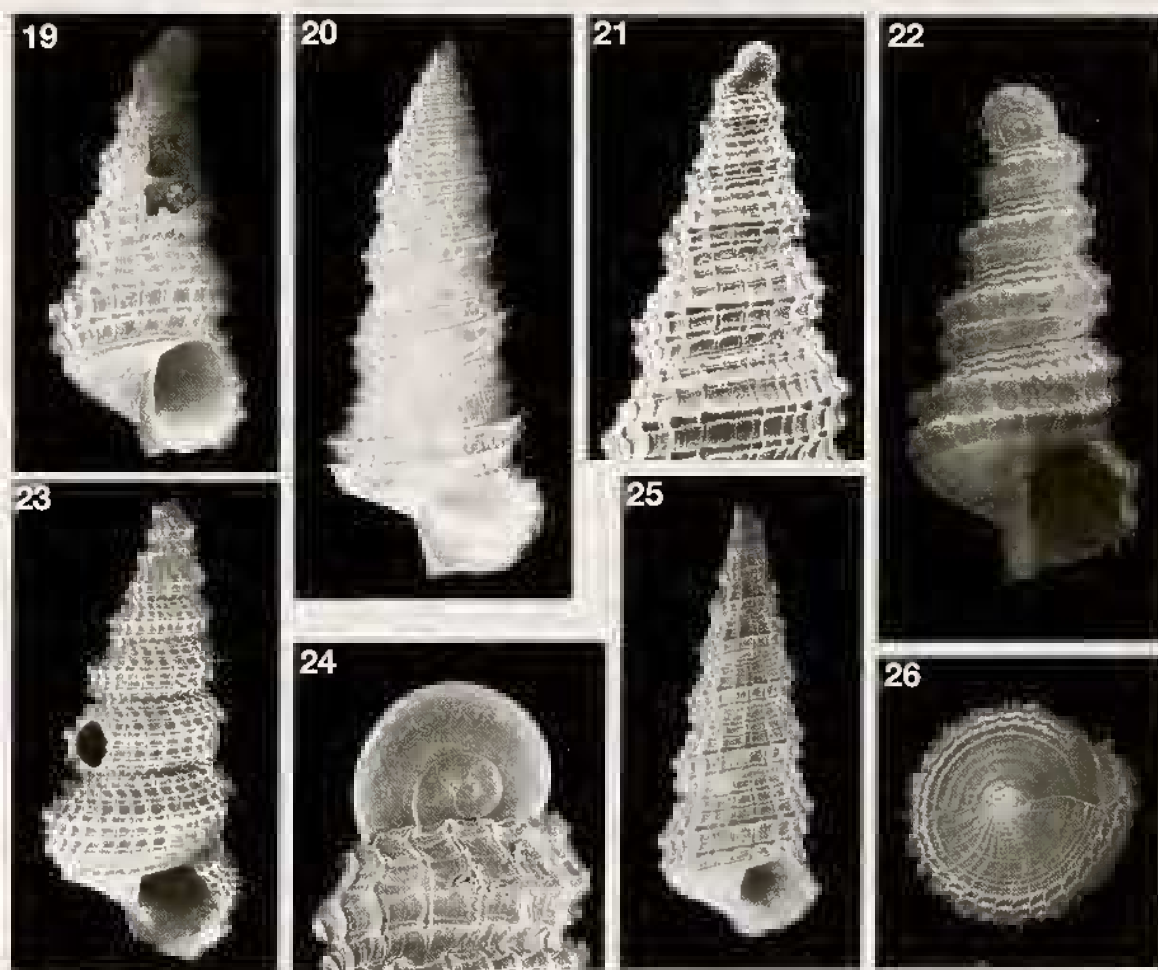
Figs 19-24, 26, 27

Mathilda decorata Hedley, 1903: 352, fig. 75 (holotype).

Synonyms:

Mathildona euglypta Iredale, 1929: 186, pl. 40, fig. 6 (sketch of holotype).*Opimilda decorata auporia* Dell, 1956: 39-40, fig. 27 (holotype).

Other references:

Mathilda decorata — HEDLEY & PETTERD, 1905: 214. — HEDLEY, 1918: M97. — MAY, 1921: 98; 1923: 93, pl. 44, fig. 8. — THIELE, 1925: 82, fig. 85 (after HEDLEY, 1903). — BIELER, 1988: 215, figs 10-11 (SEM of radula, AMS C14868).*Opimilda decorata* — THIELE, 1931: 737. — COTTON & GODFREY, 1938: 13. — MACPIERSON & GABRIEL, 1962: 99. — LASERON, 1951: 331, fig. 80.*Mathilda (Opimilda) decorata* — WENZ, 1939: 662, fig. 1888 (after HEDLEY, 1903).*Mathildona euglypta* — THIELE, 1931: 737.*Mathilda (Mathildona) euglypta* — WENZ, 1939: 662, fig. 1887 (after IREDALE, 1929).*Glyptozariu euglypta* — LASERON, 1951: 333, fig. 85. — MACPIERSON & GABRIEL, 1962: 99.*Opimilda decorata auporia* — POWELL, 1976: 107; 1979: 250. — MAXWELL, 1966: 446.

FIGS 19-26. — 19-24, *Mathilda decorata*. 19, holotype AMS C16299, New South Wales, 4.25 mm (SEM, uncoated); specimen slightly tilted. — 20, holotype of *Mathildona euglypta*, AMS C57720, New South Wales, 18.5 mm (SEM uncoated). — 21, apex of holotype of *M. euglypta*, enlarged to same scale as Fig. 19 (SEM, uncoated). — 22, holotype of *Opimilda decorata auporia*, NMNZ M8205, New Zealand, 3.4 mm (SEM, uncoated). — 23-24, specimen from New Caledonia, BIOCAL: stn 77, shell length 9.2 mm, protoconch diameter 620 μ m. — 25, *Mathilda zmitaupis*, lectotype BMNH 1901.12.9.144, Gulf of Oman, 10.4 mm (SEM, uncoated). — 26, *Mathilda decorata*, same specimen as in Fig. 24, shell base, diameter 3.7 mm.

TYPE MATERIAL. — *M. decorata*: holotype AMS C16299: H= 4.25, D= 2.0, PD= 580, TW= 4 1/2+; with shell damage in second and third teleoconch whorls. — *M. euglypta*: holotype AMS C57720: H= 18.5, D= 6.6, PD= 560, TW= 9 3/4. — *O. decorata auporia*: holotype NMNZ M8205: H= 3.4, D= 1.6, PD= 0.56, TW= 4 1/4; with large drill hole at beginning of third whorl.

TYPE LOCALITY. — *M. decorata*: "in 63 to 75 fathoms off Port Kembla" (trawled 5-8 miles off Port Kembla, New South Wales [Australia], 113-115 m, mud and pebbles, "Tethis", stn 49, 18.111.1898, E.R. White coll.; *teste* type label). — *M. euglypta*: "Trawled in 50-60 fathoms off Montague Island, New South Wales [Australia]". — *O. decorata auporia*: "Five miles east of North Cape in 75 fathoms ... New Zealand".

MATERIAL EXAMINED. — Types as listed above and additional specimens from New Zealand (NMNZ) and Australia (AMS).

New Caledonia. "Vauban" 1978-79: stn 40, 22°30' S, 166°24' E, 250-350 m, 1 dd.

BIOCAL: stn DW 46, 22°53' S, 167°17' E, 570-610 m, 1 dd. — Stn DW 77, 22°15' S, 167°15' E, 440 m, 1 dd [SEM specimen].

MUSORSTOM 4: stn DW 159, 18°46' S, 163°16' E, 585 m, 1 dd.

MUSORSTOM 5: stn 388, 20°45' S, 160°54' E, 500-510 m, 1 dd.

Loyalty Islands. BIOGEOCAL: stn DW 253, 21°32' S, 166°29' E, 310-315 m, 1 dd. — Stn DW 308, 20°40' S, 166°58' E, 510-590 m, 1 lv.

MUSORSTOM 6: stn DW 406, 20°41' S, 167°07' E, 373 m, 1 dd.

CALSUB: dive 15, 20°37' S, 166°58' E, 538 m, 1 dd.

DISTRIBUTION. — Apparently widely distributed in at least the southwestern Pacific Ocean. Depth records from the New Caledonian region ranging from 250 to 610 m (live record from 510-590 m); published Australian and New Zealand records from 90 m and deeper.

DESCRIPTION. — *Protoconch* (Fig. 24): smooth, globular, hyperstrophic, approximately 100-105° to first teleoconch whorl; embryonic whorl fully exposed; protoconch consisting of 2 1/2 whorls; 560-640 µm in maximum diameter; with weak, hardly elevated peritreme. Weak, curved anal keel bordering deep umbilicus; protoconch umbilicus completely covered by thin, reddish-brown lamella extending between first TW and anal keel. Glassy white to light horn-colored; embryonic whorls, area before peritreme, callus and anal keel brown.

Teleoconch (Fig. 23): slender, tapering (spire angle 25-29°), relatively thin-shelled, with rounded whorls and distinct suture; height 3.4 to 12.1 mm at 4 1/4 to 8 3/4 whorls. Pattern of spiral and axial ribs (with axials often as prominent as spirals), intersecting at approximately right angles to form nodules. Spacing of the axials regular (with 18-25 on fourth whorl), resulting in pattern of almost equal-sided squares on periphery; these "windows" without sculpture except faint growth lines. Spiral sculpture on exposed upper part of earlier whorls consisting of 2 pairs of ribs, with lowermost pair stronger; the second rib initially weakest, the third rib strongest and occasionally somewhat more prominent. After 4 1/2 to 7 1/2 whorls (highly variable) with fine additional spiral threads interspaced (see Fig. 27). Upper point of whorl

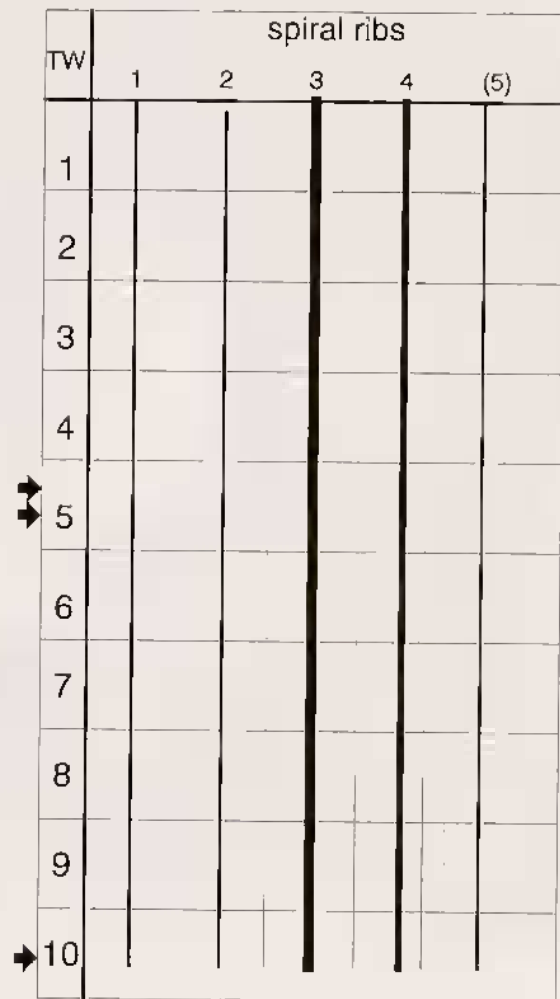


FIG. 27. — *Mathilda decorata*. Diagram of spiral sculpture, as in Fig. 8. Arrows indicating, top to bottom, conditions of holotypes of *Opimilda auporia*, *Mathilda decorata*, and *M. euglypta*, respectively.

attachment at a recessed, fifth spiral rib, fully or partly covering it. On body whorl, this rib, and one of almost equal strength below it, forming relatively smooth double keel at outer base. Straight, or somewhat rounded basal area (Fig. 26) with 4-9 more-or-less faint spiral threads (increasing in strength toward columella) and weak axial threads. Umbilicus a narrow chink or closed by reflected columellar lip. Coloration: translucent white. Periostracum thin, yellowish-white, forming round hollow scales on shell nodules.

Animal: radula lacinioglossate-like with five teeth per row (interpreted as rachidian, one pair of laterals and one pair of marginals; see BIELER 1988: 214, figs 10-11); rachidian and laterals separated by wide space; rachidian with ca. 24 long, filiform cusps of subequal strength, the central ones being longer; marginal teeth longer and with more denticles than the laterals; marginals with feather-like extensions projecting at an oblique angle from shortly below the lip of the "normal" tooth.

REMARKS. — This species is readily recognized by its relatively large protoconch set at about 100° angle, the two unequal pairs of spiral ribs on the whorl surface ("2+2" pattern), and the rounded whorls separated by a distinct suture. The New Caledonian material agrees well with the studied type material from Australia and New Zealand. Other forms with "2+2" morphology are *Mathilda* cf. *amanda* (discussed above), an unnamed species (*Mathilda* sp. A, below), as well as four Japanese forms described in a separate section below.

The difference cited by DELL (1956: 39) between *Mathilda decorata* and his nominal subspecies *auporia* (Fig. 22) was given as "... mainly in the number of axials. In *decorata decorata* there are some 25 axials; in the new form there are 19 on the body whorl". This character varies widely (18-25) in the New Caledonia material, and the two nominal taxa are here synonymized.

Mathildona euglypta (Figs 20-21) is the type species of *Mathildona* Iredale, 1929 (:186). On the following page, IREDALE (1929: 187) introduced another nominal genus: "*Opimilda* is added for *decorata* Hedley, a short, squat, perforate shell, quite dissimilar". WENZ (1939: 662) reproduced the two original illustrations side by side without indicating a scale, and, thus misled described differences between *Mathildona* and *Opimilda* (e.g., referring to relatively small and relatively large protoconchs, respectively). The two nominal type species were based on different growth stages of the same species; the holotype of *M. decorata* is a subadult shell, while the type of *M. euglypta* represents a fully grown specimen (compare Figs 19-21). Accordingly, the nominal genera *Opimilda* and *Mathildona* are also synonymous. LASERON (1951: 332-333) erroneously synonymized *Mathildona* under *Glyptozaria* (a member of Cerithiidae, see below).

Mathilda zmitampis Melvill & Standen, 1901 (: 379, pl. 22, fig. 19; type locality: "Gulf of Oman: lat. 24° 5' N., long. 37° 35' E, 208 fathoms [380 m], sand") is similar. In that species, the third primary spiral rib is initially stronger, the teleoconch whorls are less rounded, the suture not as deep as in *M. decorata*, and the protoconch is smaller (Fig. 25; lectotype, BMNH 1901.12.9.144: H = 10.4, D = 3.7, PD = 0.5, TW = 8 1/4+).

Taxonomic note on *Mathilda zmitampis*: MELVILL & STANDEN's original description (1901: 379) did not indicate the number of specimens in the type series, nor was a holotype indicated. TREW's (1987: 72) mention of a holotype (BMNH 1901.12.9.144) is here accepted as a lectotype designation in accordance with ICZN Article 74(b). This lectotype is the originally figured specimen. The original description mentioned a 208 fathoms station in the Gulf of Oman as the source for the type material. Material labelled "co-types" of *M. zmitampis* can be found in various museum collections (e.g., NMW, ANSP); most such lots are mixtures of various mathildid and non-mathildid species. Since all such material encountered stems from another location (156 fathoms station, cited for *M. zmitampis* only in a subsequent publication by MELVILL & STANDEN [1903: 322]), it does not qualify as type material.

Atlantic *Mathilda barbadensis* Dall, 1889 (: 266, pl. 26, fig. 10; holotype USNM 87328, *vidi*; not figured here) also appears to belong to this complex. The protoconch diameter in that species is much smaller, measuring only 440 µm in the type specimen.

Mathilda maoria (Powell, 1940)

Figs 28-29, 32-33, 38

Opimilda maoria Powell, 1940: 230-231, pl. 29, fig. 7 (sketch of holotype).

Other references:

Opimilda maoria — MAXWELL, 1966: 446. — POWELL, 1976: 107, pl. 27, fig. 7 (sketch of holotype); 1979: 250, pl. 48, fig. 24 (sketch of holotype). HASZPRUNAR, 1985: 201 ff., figs 2, 4, 7-11 (anatomy), 5-6 (shells).

TYPE MATERIAL. — Holotype AIM AK72108: H = 3.1, D = 2.0, PD = 600, TW = 3 9/10 (specimen was larger); paratype AK72311 (from type locality): H = 3.0, D = 1.8 (damaged, specimen was larger), PD = 580, TW = 3 1/4.

TYPE LOCALITY. — "Locality: 140 fathoms off Three Kings Islands, New Zealand" [ca. 34° S, 172° E, depth 256 m].

MATERIAL EXAMINED. — Type material as listed above, and additional specimens from New Zealand (e.g., NMNZ M60793).

New Caledonia. BIOCAL: stn DW 46, 22°53' S, 167°17' E, 570-610 m, 1 dd [SEM specimen]. — Stn DW 51, 23°05' S, 167°45' E, 680-700 m, 2 dd.

CHALCAL 2: stn DW 72, 24°55' S, 168°22' E, 527 m, 1 lv.

DISTRIBUTION. — Here verified from New Zealand and New Caledonia, but presumed widely distributed in the Indo-Pacific (probably conspecific juvenile specimen from Gulf of Oman [NMW] awaiting further study). New Caledonian depth records from 527 to 700 m (live from 527 m); New Zealand records from shallower depths.

DESCRIPTION. — *Protoconch* (Figs 32-33): smooth, globular, strongly hyperstrophic, at about 125° angle to teleoconch axis; with approximately one third of the embryonic whorl exposed; ca. 2 1/2 whorls; PD 580-640 µm; peritreme weak; protoconch umbilicus covered by thin reflected lamella extending between first TW and anal keel. Glassy white, with lamella, area before peritreme, anal keel, and suture reddish-brown.

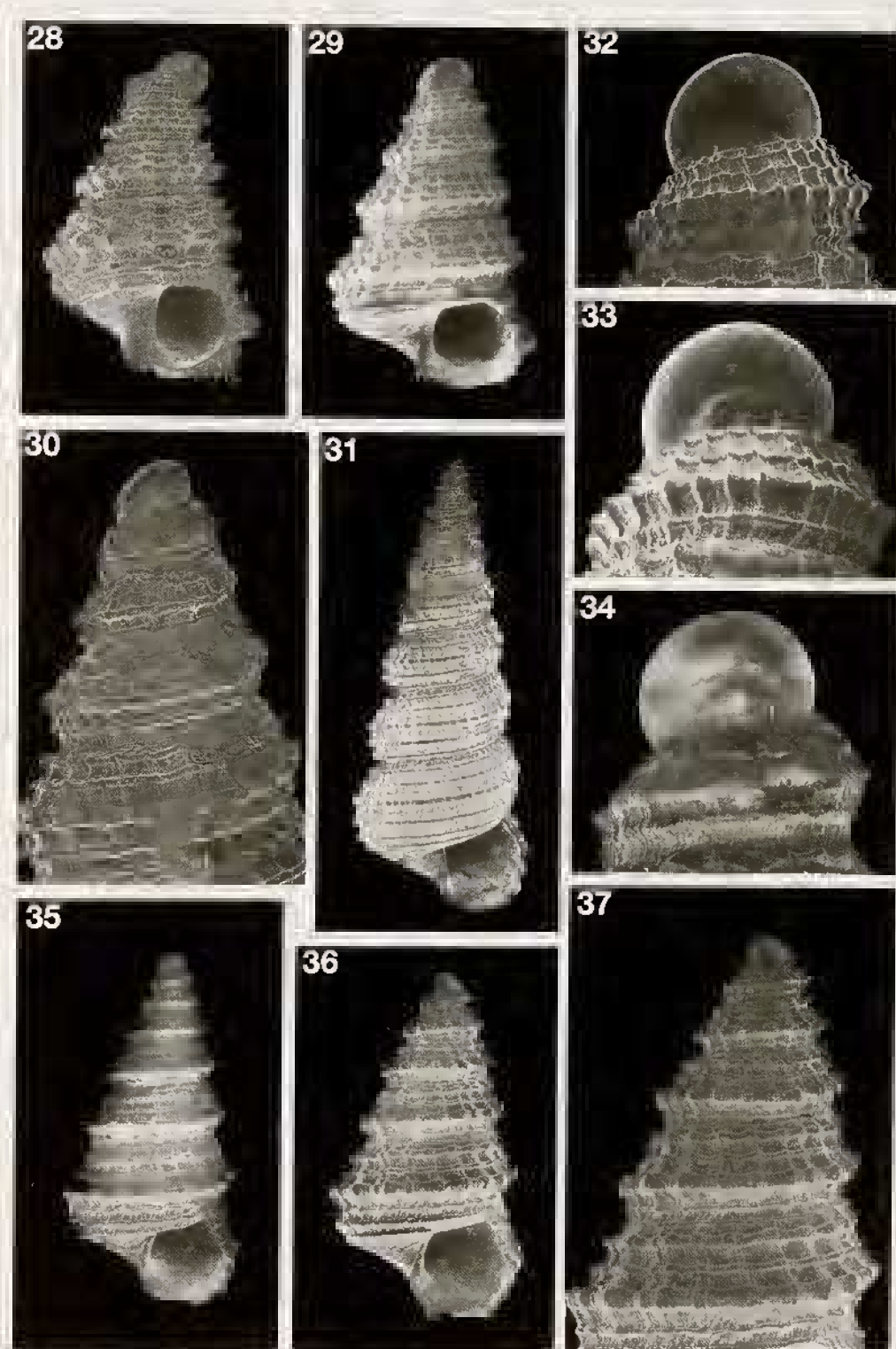
Teleoconch (Figs 28-29): cone-shaped; relatively thin (empty shells translucent in "windows" between strong ribs); larger specimens 6.9 to 13.1 mm at 6 to 8 1/10 whorls; spire angle ca. 38°. Primary pattern on upper side of whorls of 4 spiral and numerous axial ribs, intersecting at approximately right angles to form nodules, spirals stronger; the third

clearly strongest and most prominent. Spacing of axials regular (with 17-25 on fourth whorl). After about 5-6 whorls with additional spiral threads interspersed (Fig. 38). Whorl attachment on a fifth primary spiral rib and one of almost equal strength below (or directly fused with it) demarcating basal perimeter. Basal area with 4-6 weak, more-or-less irregular spiral ribs, intersected by irregular axial growth lines; umbilicus not open. Columellar lip thin, not or only slightly reflected over columella. Coloration: live-collected shell slightly mottled horn-colored with tips of nodules lighter; dead-collected shells overall milk-white. Straw-colored, scaly periostracum covering shell.

Animal: awaiting study; horny operculum flat, concentric and multispiral.

REMARKS. — *Mathilda maoria* was described by POWELL (1940) on the basis of two juvenile specimens with fewer than 4 teleoconch whorls each. Both specimens had been larger; the remnants of subsequent whorls obscure the sculptural features of the base in the types. Several specimens in the New Caledonian region appear conspecific, the only difference being the larger number (up to 25) of axial ribs on the fourth teleoconch whorl, compared to 17 in the holotype.

The pattern of exposed primary spiral ribs in this form is "2+1+1", with the third rib strongest. This pattern is shared with a few other species in New Caledonia (all discussed below): *Mathilda* cf. *hendersoni*, *Mathilda richeri* sp. nov. (with additional ribs), and *Mathilda* sp. aff. *sausibarica* (with ribs fading on later whorls). The relationship of this form with nominal species *Mathilda salve* Barnard, 1963, originally described from South Africa, needs further study. See following discussion.



FIGS. 28-37. — 28, 32, *Mathilda maoria*, holotype of *Opunitaa maoria*, AIM AK72108, New Zealand, shell length 3.1 mm, protoconch diameter 600 μ m (SEM, uncoated). — 29, 33, *Mathilda maoria*, specimen from New Caledonia, BIOCAL: stn DW 46, shell length 4.3 mm, protoconch diameter 620 μ m. — 30, 31, 34, *Mathilda salve*, holotype SAM A9139, South Africa, shell length 15.4 mm, protoconch diameter 560 μ m (SEM, uncoated). — 35, *Mathilda salve*, specimen from New Caledonia, BIOCAL: stn CP 75, 7.8 mm. — 36-37, *Mathilda* cf. *quinquelirata*, specimen from New Caledonia, BIOCAL: stn DW 33, 5.4 mm.

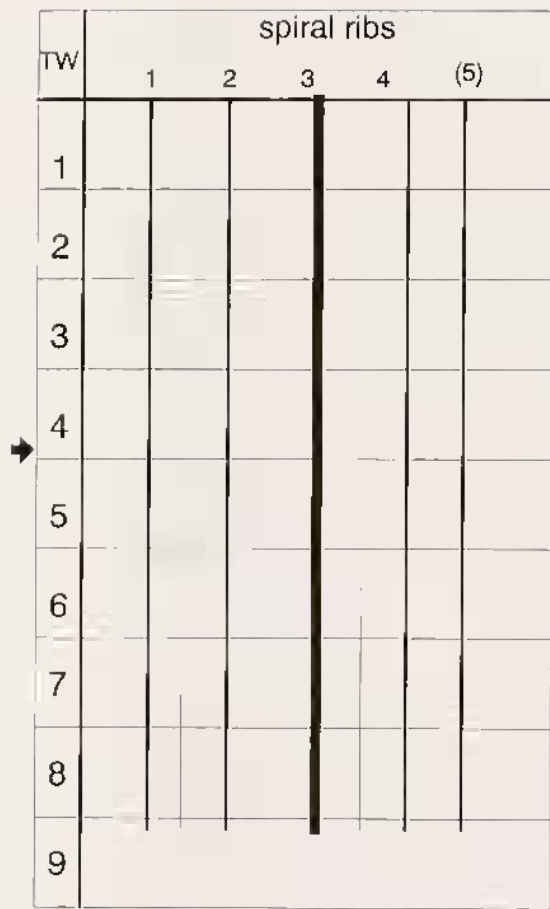


FIG. 38. — *Mathilda maoria*. Diagram of spiral sculpture, as in Fig. 8.

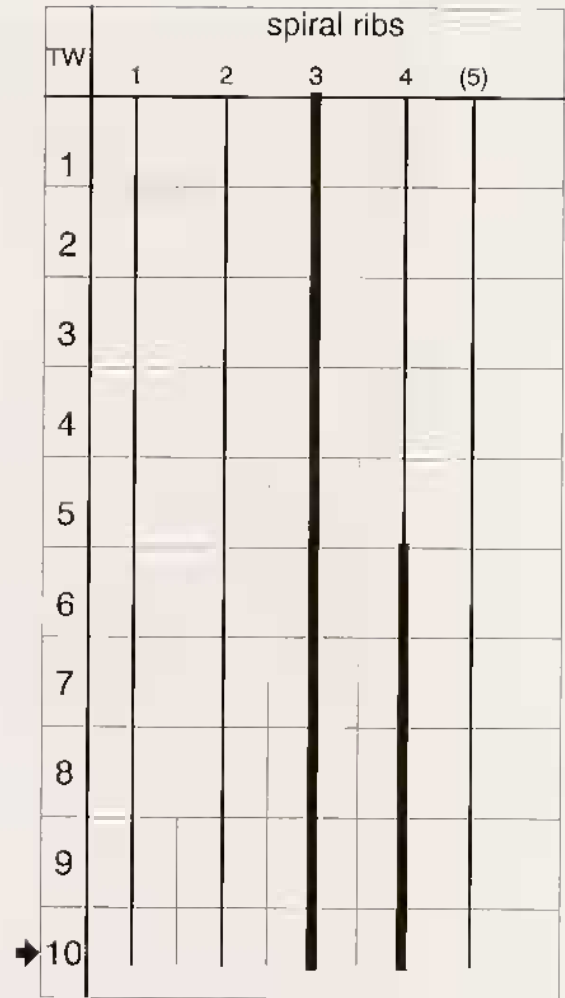


FIG. 39. — *Mathilda salve*. Diagram of spiral sculpture, as in Fig. 8. Fifth rib exposed in holotype.

Mathilda salve Barnard, 1963

Figs 30-31, 34-35, 39

Mathilda salve Barnard, 1963: 176-177, fig. 34.

Other references:

Mathilda salve — KENSLEY, 1973: 74, fig. 239. — BARNARD, 1974: 712.

TYPE MATERIAL. — Holotype SAM A9139: H = 15.4, D = 5.7, PD = 560, TW = 9 1/2; paratype SAM A9141: H = 6.5, D = 2.6 (fragment of 7 whorls, without protoconch). The original description mentions a second paratype ("apex of 4 whorls, no protoconch") which currently cannot be located (SAM A9410; E. HOENSEN, *in litt.* 1993).

TYPE LOCALITY. — "Cape St. Blaize N. × E. 73 miles. 125 fathoms" [228 m, South Africa]; collected by Cape Government trawler *Pieter Faure* (1897-1907). Paratype SAM A9141 from "off Glendower Beacon (Port Alfred), 100 fathoms" [183 m]; paratype SAM A9140 from "Cape Morgan N. 1/2 W. 77 fathoms" [141 m].

MATERIAL EXAMINED. Holotype and paratype SAM A9141 as listed above, and additional material from South Africa (NMP).

New Caledonia. BIOCAL: stn DW 51, 23°05' S, 167°45' E, 680-700 m, 1 dd. — Stn CP 75, 22°19' S, 167°23' E, 825-860 m, 1 dd [SEM specimen].

CHALCAL 2: stn DW 74, 24°40' S, 168°38' E, 650 m, 1 dd.

DISTRIBUTION. — Apparently widely distributed in at least the southern parts of the Indo-Pacific, previously known only from South Africa. New Caledonian material from 650-860 m. South African records shallower (from 140 m); no live records.

DESCRIPTION. — *Protoconch* (Fig. 34): smooth, globular, strongly hyperstrophic, about 120° to teleoconch axis; with embryonic whorl exposed; with approximately 2 1/2 whorls; PD 560-620 µm; peritreme weak; protoconch umbilicus covered by thin lamella extending between first TW and anal keel. Glassy white, with lamella, area before peritreme, anal keel, and suture reddish-brown.

Teleoconch (Figs 30-31, 35): slender cone-shaped with rounded periphery of later whorls; relatively thin and translucent in "windows" between strong ribs; larger specimens 8-15.4 mm at 6+ to 9 1/2 whorls; spire angle on early whorls about 35°, later changing to ca. 22°. Primary pattern on upper side of whorls of 4 exposed spiral (Fig. 39) and numerous

axial ribs, intersecting at approximately right angles to form nodules (with 18-21 on fourth whorl); the third primary spiral strongest and most prominent, the fourth almost as strong and prominent on later whorls. After 4-6 whorls with additional threads interspersed. Whorl attachment on a fifth primary spiral rib (this rib often partly exposed), demarcating basal perimeter; additional rib of about equal strength next to it, but separated by distinct space. Basal area with about 7-9 irregular spiral ribs and threads, intersected by irregular axial growth lines; umbilicus not open. Coloration: dead-collected shells overall milk-white, occasionally with some tan on spiral ribs.

Animal: unknown.

REMARKS. — The holotype of *Mathilda salve* (Figs 30-31, 34) appears to be a slightly aberrant specimen in that it shows shell repairs in the second and fourth teleoconch whorls. The second repair caused the upper point of shell attachment to be no longer on the fifth primary spiral rib, but below it (thus exposing this rib). The available paratype specimen (SAM A9141) is more slender than the holotype, and its partially preserved whorls show a regular 4-ribbed pattern, with the third rib initially stronger; it may not be conspecific. KENSLEY'S (1973: 74, fig. 239) sketch of this species appears highly stylized and does not accurately depict spiral rib pattern. The protoconchs of New Caledonia material are somewhat larger (580-620 µm) than that of the holotype (560 µm). The holotype also has slightly more axial ribs (21) on the fourth teleoconch whorl than the studied New Caledonian specimens (18-19).

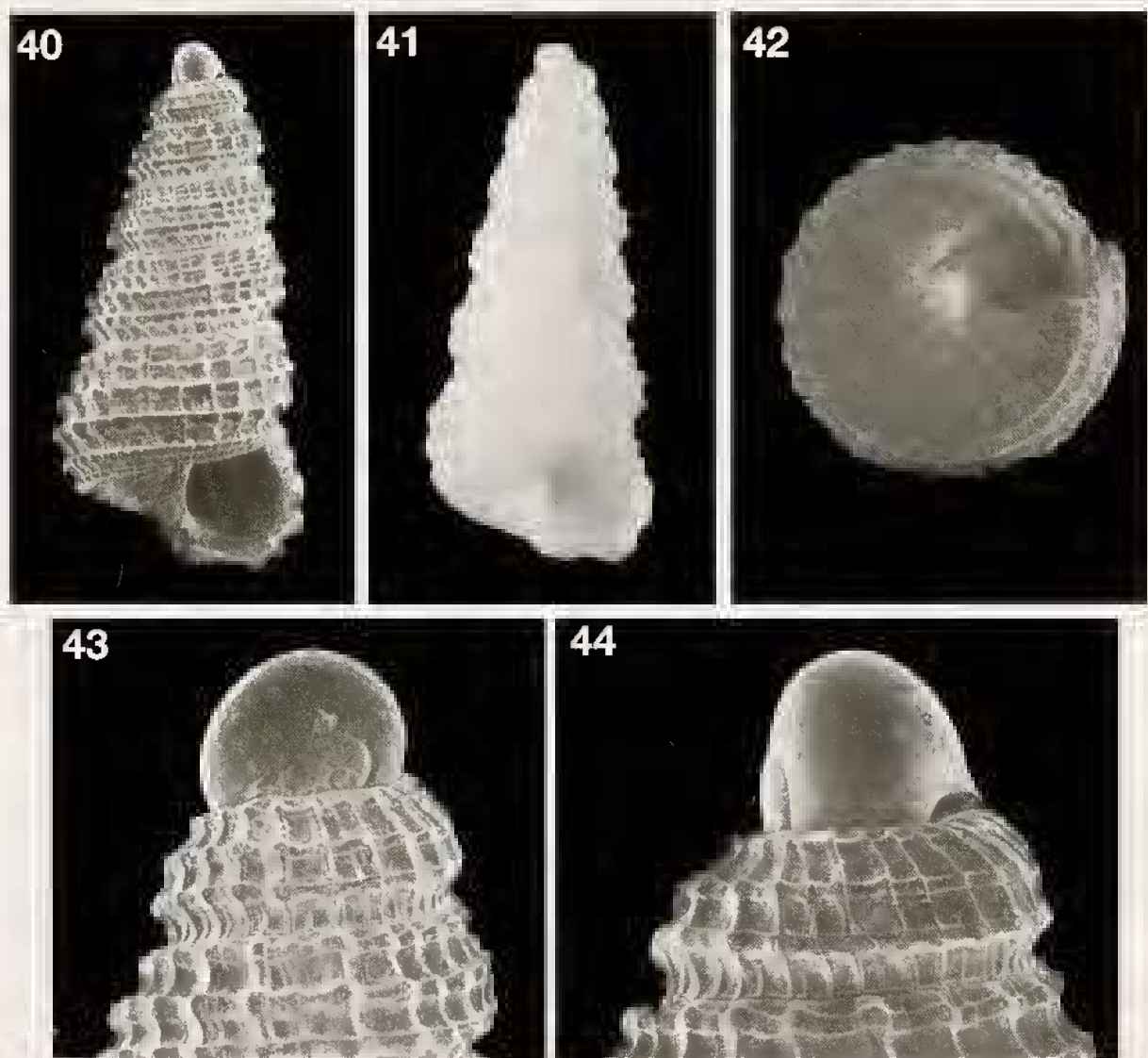
This nominal species is very similar to *Mathilda maoria* (see above) in most characters. Distinguishing features appear to be details of the spiral sculpture (*salve*: third and fourth primary spiral ribs of near-equal strength on later whorls, fifth rib more-or-less exposed; *maoria*: third rib remains strongest, fifth rib largely covered by whorl attachment), the angle of the protoconch (*salve*: embryonic whorl almost completely exposed; *maoria*: about 1/3 of embryonic whorl exposed). Also, the teleoconch spire angles and whorl expansion rates differ slightly. The two forms are micros sympatric at BIOCAL: stn DW 51, 23°05' S, 167°45' E, 680-700 m. Pending anatomical studies and a comparison of additional material from New Zealand and South Africa, they are here treated as separate species. The ontogenetic change from a "2+1+1" pattern of exposed primary sculpture to a "2+2" pattern (Fig. 39) cause larger specimens to resemble the condition in *Mathilda decorata* (discussed above).

Nineteen additional specimens in the New Caledonia material (mostly juveniles between 1.2 and 3 mm in length) could not be reliably assigned to either nominal species (LAGON: stn DW 830; BIOCAL: stn DW 08, DW 38, DW 44; MUSORSTOM 4: stn DW 156; MUSORSTOM 6: stn DW 399, DW 459, DW 484).

Another nominal species very similar to the *maoria/salve* complex is *Mathilda quinquelirata*¹ Kuroda, 1958 (: 25, pl. 21, fig. 12; Figs 36-37), described from Japan. The type material (which was placed in a private Japanese collection after KURODA'S death), consists of a holotype and several

1. This species was also distributed to various collections under the manuscript names "*quinqueplicata*" and "*quinquesculpta*", and has been listed as "*Oponikda quinquelirata*" in the literature (e.g., HIGO, 1973: 227).

paratypes. The holotype was live-collected (the operculum is mentioned in the original description), but no type specimen had a protoconch preserved (KURODA, 1958: 26). Topotypic specimens that appear to represent this species (*e.g.*, ANSP 189901, 248266; DMNH 23518) likewise lack protoconchs. The main difference in teleconch sculpture between this form and the *maoria/salve* complex is that the second primary spiral rib is as weak as the fourth, resulting in a somewhat concave area between the well-developed first and very strong third rib, similar to the condition in *M. sp. aff. sansibarica* (see below). A single specimen in the New Caledonia material (BIOCAL: stn DW 33, 23°10' S, 167°10' E, 675-680 m) shows these characters (H = 5.5, D = 3.0, PD = 580, TW = 5 3/8; Figs 36-37).



FIGS. 40-44. — *Mathilda maculosa* sp. nov. — **40**, paratype FMNH 224969, New Caledonia, 3.7 mm. — **41**, holotype, Loyalty Islands, 4.4 mm (light photograph, showing color pattern of tan blotches). — **42**, shell base of paratype, diameter 1.8 mm. — **43-44**, aspects of protoconch and early teleconch whorls, paratype, protoconch diameter 500 µm.

Mathilda maculosa sp. nov.

Figs 40-45

TYPE MATERIAL. — Holotype MNHN. Paratype FMNH 224969.

TYPE LOCALITY. — Loyalty Islands. MUSORSTOM 6, stn DW 442, 20°54' S, 167°17' E, 200 m.

MATERIAL EXAMINED. — **Loyalty Islands.** MUSORSTOM 6: stn DW 442, 20°54' S, 167°17' E, 200 m, 1 dd (holotype).**New Caledonia.** LAGON: stn 830, 20°49' S, 165°19' E, 105-110 m, 1 dd (paratype).

DISTRIBUTION. — Only known from material listed above, 105-200 m; no live material collected.

DESCRIPTION. — *Protoconch* (Figs 43-44): smooth, globular, hyperstrophic, at about 110° angle to the teleoconch axis; with embryonic whorl exposed; multispiral, consisting of about 2 1/2 whorls; PD 480-500 µm; with weak, hardly elevated peritreme. Weak, curved anal keel (ca. 80 µm) bordering deep umbilicus; protoconch umbilicus completely covered by thin, reddish-brown lamella extending between first TW and anal keel. Glassy white; suture lined with brown.

Teleoconch (Figs 40-41): slender cone-shaped, base acutely angled; 3.7-4.4 mm at 5 1/8 to 6 1/8 whorls, spire angle about 22°. Pattern of regular spiral and axial ribs, intersecting at approximately right angles to form nodules. Spacing of the axials very regular, with ca. 26 on fourth whorl. Exposed upper part of earlier whorls with 3 spiral ribs (lowermost strongest), joined (below the uppermost) by a fourth rib at about 2 1/4 to 3 1/4 TW, so that spiral sculpture consists of 2 pairs of ribs, with lowermost pair stronger (Fig. 45). Upper point of whorl attachment at a recessed, fifth spiral rib, partly covering it. On body whorl, this rib, and one of almost equal strength below it, forming double keel at outer base. Straight, somewhat recessed basal area with 4-6 spiral threads and weak axial threads (Fig. 42). Umbilicus not open. Coloration: milk-white, with tan rectangular blotches extending to full height of exposed whorl; about 5-7 blotches per whorl, each 2-6 nodules wide; pattern not coordinated between neighboring whorls; pigment darkest on spiral ribs.

Animal: unknown.

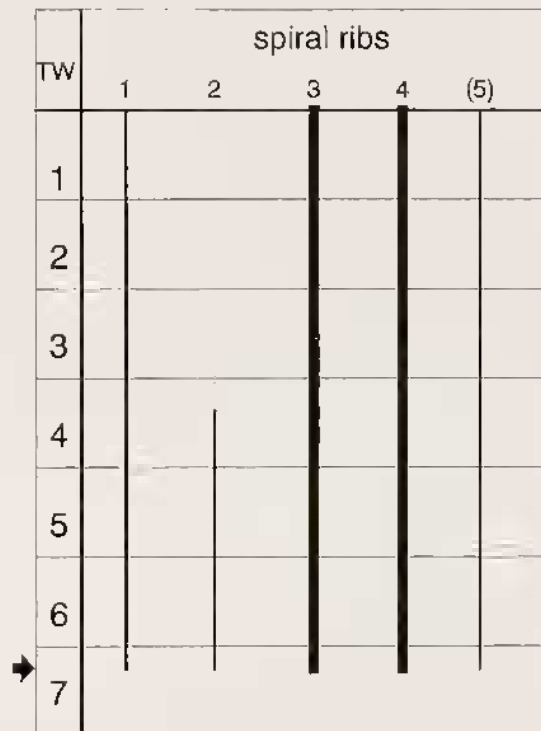


FIG. 45. — *Mathilda maculosa* sp. nov. Diagram of spiral sculpture, as in Fig. 8.

Measurements:

	H	D	PD	TW	Locality	Collection
Holotype	4.4	2.0	480	6 1/8	[type loc.]	MNHN
Paratype	3.7	1.8	500	5 1/8	LAGON stn 830	FMNH 224969

REMARKS. — This form is readily recognized by its slender shell with regular spiral pattern (changing from 3 to 4 well-defined ribs, Fig. 45), its relatively small protoconch and the unusual color pattern. The pattern is relatively faint on the dead-collected type specimens and does not reproduce well in black-and-white light photographs (Fig. 41). It is probably considerably darker in living specimens. The post-first-whorl "2+2" pattern of primary spiral ribs is similar to that of *Mathilda decorata* (discussed above).

ETYMOLOGY. — *Maculosus*, *a*, *um* (Latin adjective): spotted.

Other Indo-Pacific forms with “2+2” rib pattern

The following four nominal species have all been described from Japan. All are tall and slender forms, sharing a basic “2+2” sculptural pattern of four exposed major spiral ribs with the two lower ones strongest, and all have additional spiral threads interspersed at least on later whorls. The type material was not available for direct study and present information does not allow a more critical assessment of these taxa.

(1) *Mathilda cancellata* Kuroda, 1958 (Fig. 46)

Mathilda cancellata Kuroda, 1958: 24-25, pl. 21, fig. 13 (holotype).

Other references:

Mathilda cancellata — AZUMA, 1960: 12; Hanshin Shell Club, 1986: 37.

Opimilda cancellata — KURODA & HABA in KURODA *et al.*, 1971: 414, 259, pl. 61, fig. 5 (21 mm color photograph). — HIGO, 1973: 227. — SPRINGSTEEN & LEOBRERA, 1986: 57, pl. 12, fig. 10 (26 mm color photograph). — HIGO & GOTO, 1993: 351.

TYPE LOCALITY AND MATERIAL (KURODA, 1958: 25): “Off Tosa, Shikoku I., collected by Akibumi Teramachi, and the type specimen belongs to his collection.” Holotype dimensions given as “At. [*sic*] 19.4, diam. 7.5”; the original description mentions about 11 whorls including less than one on the apex for the protoconch. The shell is described as thin, subtransparent, waxen white, narrowly umbilicate.

(2) *Mathilda cerea* Kuroda, 1958 (Fig. 47)

Mathilda cerea Kuroda, 1958: 27, pl. 21, fig. 14 (holotype).

Other references:

Mathilda cerea — AZUMA, 1960: 12. — Hanshin Shell Club, 1986: 37, pl. 14, figs 7-8 (holotype, dimensions given as “25.0 × 7.0 mm”).

Opimilda cerea — HIGO, 1973: 227. — HIGO & GOTO, 1993: 351.

TYPE LOCALITY AND MATERIAL (KURODA, 1958: 27): “Off Tosa, also collected by A. Teramachi”. “[Holotype] whorls 13.5, the apex defective, with the alt. 25.0 and diam. 7.1 mm ... The paratype specimen, with 13 whorls with a heterostrophe protoconch (number of whorls is not certain [*sic*] somewhat by erosion), measuring 23.0x7.8 mm., in Teramachi’s collection.” Described as being similar to *Mathilda quinquelirata* (see discussion under *M. salve*, above), “but much slender, fleshy corneous, spiral ribs are more slender and sharper, with a much less granular appearance”.

(3) *Mathilda gemmulifera* Kuroda, 1958 (Fig. 48)

Mathilda gemmulifera Kuroda, 1958: 27, pl. 21, fig. 11 (holotype).

Other references:

Mathilda gemmulifera — AZUMA, 1960: 12. — Hanshin Shell Club, 1986: 42.

Mathilda cerea [*sic*] *gemmulifera* — Hanshin Shell Club, 1986: pl. 15, figs 1-2 (holotype, dimensions given as “24.0 × 7.0mm”).

Opimilda gemmulifera — HIGO, 1973: 227. — HIGO & GOTO, 1993: 351.

TYPE LOCALITY AND MATERIAL (KURODA, 1958: 27): “Type specimen only, collected by A. Teramachi at off Tosa, and is said to have been obtained from a depth of about 100 fms.” Holotype dimensions given as “Alt. 24.6, diam. 7.3mm.” Described as having “whorls 13, plus a glossy and

46



47



48



49



FIGS. 46-49. — Nominal species from Japan with unresolved taxonomic status. — 46, holotype of *Mathilda cancellata*, "19.4 mm" (light photograph courtesy Prof. HABE). — 47, holotype of *Mathilda cerea*, "25.0 mm" (light photograph taken from publication by Hanshin Shell Club 1986). — 48, holotype of *Mathilda gemmulifera*, "24.0 mm", (light photograph taken from publication by Hanshin Shell Club 1986). — 49, holotype of *Opimilda scalaris* Kuroda & Habe, 1971, "21.5 mm" (light photograph courtesy Prof. HABE).

depressed helicoid, heterostrophe protoconch of 2 whorls with a rounded periphery, its axis being at right angles to that of the later volutions." The original description compares the shell to *Mathilda cerea* (see above), "but differing in that the coloration is slightly paler, more glossy and less sharply angular, with somewhat convex whorls; size of the 3 spiral ribs except the peripheral one nearly similar to one another."

(4) *Mathilda scalaris* (Kuroda & Habe in Kuroda *et al.*, 1971) (Fig. 49)

Opimilda scalaris Kuroda & Habe in Kuroda, Habe & Oyama, 1971: 415, 259-260, pl. 61, fig. 4 (22 mm color photograph of holotype).

Other references:

Opimilda scalaris — HIGO, 1973: 227. — HIGO & GOTO, 1993: 351.

TYPE LOCALITY AND MATERIAL (KURODA & HABE in KURODA *et al.*, 1971: 259-260): "Sagami Bay (alive); Jogashima W 5 km (110-150m) [Japan]". Holotype "Height 21.5 mm and breadth 6.3 mm." The original description reads: "Shell turreted in shape, thin, yellowish white. Whorls consists of 11.5 whorls, two of which sinistrally coiled, smooth, polished protoconch obliquely placed on the teleoconch. Teleoconch whorls somewhat convex with deeply constricted sutures, surrounded by the strong spiral cords, one on the periphery and two between periphery and lower suture, and many weak spiral threads crossed by the lamellate growth lines forming granules at the crossing points as

well as reticulated sculpture at the interspaces. Base of the body whorl rather flat, encircled by two spiral cords and sculptured with 6-7 threads crossed by the growth lines. Outer margin of the aperture thin, roundly curved and columellar margin thickened and gently curved". The type specimen is in the Imperial Household's Biological Laboratory collection (*teste* INABA & OYAMA, 1977: 108) and could not be obtained on loan (MATSUKUMA *in litt.*, HABE *in litt.*).

Mathilda fusca (Okutani & Habe, 1981)

Figs 50-53

Orectospira fusca Okutani & Habe, 1981: 197-199, fig. 1.

Other reference:

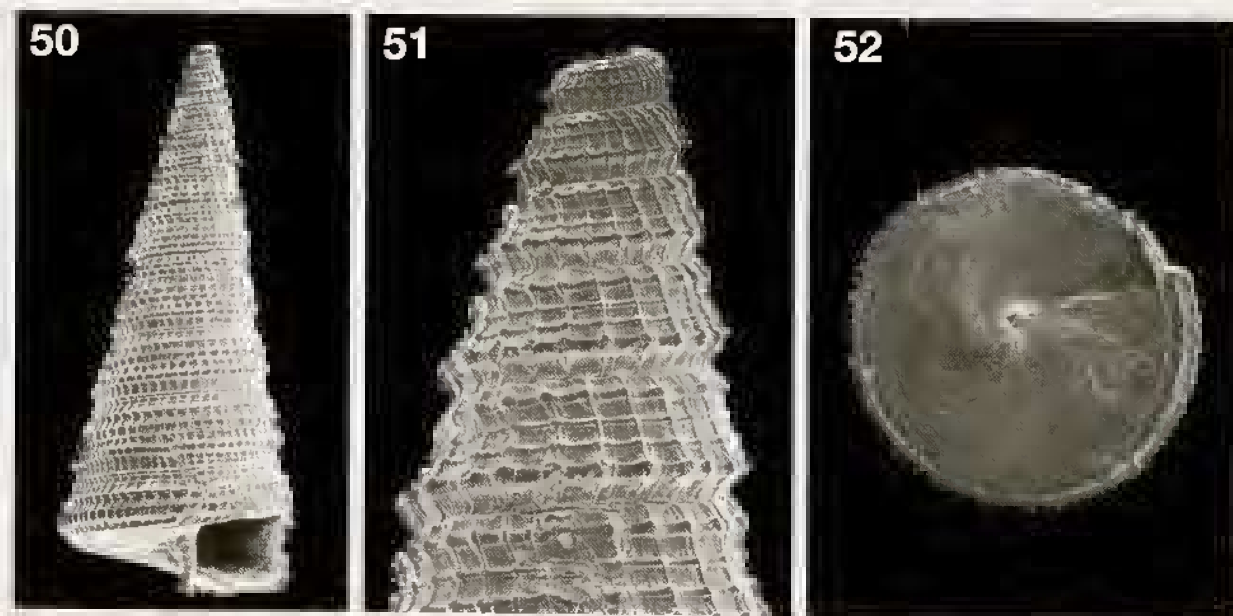
Orectospira fusca — HIGO & GOTO, 1993: 103.

TYPE MATERIAL. — The unique type specimen was described by OKUTANI & HABE (1981: 197-198) as having about 17 teleoconch whorls and a smooth, darkish brown, "mamillar" protoconch with 1.5 whorls. Dimensions were given as "Height 51.7 mm, breadth 21.1 mm, H/B = 2.45, diameter of operculum 7.1 mm". The holotype specimen was in the private collection of S. Hayashi, the original collector. After his death, the collection was bought by a private collector in Tokyo (Mr. Ito; *teste* T. OKUTANI, 7.XII.1990, *in litt.*). The specimen was not available on loan for the present study, but Prof. OKUTANI kindly arranged for a color photograph of the specimen in its current condition ("The protoconch was lost and the apertural lip is a little chipped"; T. OKUTANI, *in litt.*).

TYPE LOCALITY. — "Southwest of Shionomisaki, Kii Peninsula, about 450 m deep", Pacific coast of Japan.

MATERIAL EXAMINED. — **New Caledonia.** BIOCAL: stn DW 36, 23°09' S, 167°11' E, 650-680 m, 1 dd. — Stn DW 51, 23°05' S, 167°45' E, 680-700 m, 3 dd [including SEM specimen], 1 lv [used in ongoing anatomical study].

SMIB 3: stn DW 7, 24°55' S, 168°21' E, 505 m, 1 dd.



FIGS. 50-52. — *Mathilda fusca*, specimen from New Caledonia, BIOCAL: stn DW 51, 14.2 mm. — 50, lateral aspect. — 51, apex (protoconch missing). — 52, shell base, diameter 6.5 mm.

DISTRIBUTION. — Known from Japan (type locality) and current study area, from 450 to 700 m; live-collected from 450 m (Japan) and 680-700 m.

DESCRIPTION. — *Protoconch* (missing on all but one specimen from BIOCAL: stn DW 51; the following interpretation based on this only partly preserved specimen): smooth; globular; strongly hyperstrophic, embryonic whorl not exposed, part of suture exposed; estimated at 135° to teleoconch axis; number of whorls not ascertained, but more than 1 1/2; approximately 500 μ m in maximum diameter; with no distinct peritremic. Glassy white, with protoconch suture tan.

Teleoconch (Figs 50-51): tall cone-shaped, with concave whorl surfaces; very solid and large for family, up to ca. 40 mm at 19 whorls; spire angle 26-27°. Pattern of regular spiral and weaker axial ribs, intersecting at slightly oblique angles to form strong nodules. Spacing of the axials initially very regular, with ca. 26 on fourth whorl, increasing to far over 100 densely-spaced lines on body whorl of large specimens. First whorl bulging, with 3 spiral ribs (middle one weakest, lowermost strongest); beginning with second whorl, regular pattern of 4 major spiral ribs (see Fig. 53; lowermost strongest and most prominent), 2 middle ones (in concave area of whorl) weakest; larger specimens with additional fine threads flanking middle ribs. Upper point of whorl attachment at a recessed, fifth spiral rib, partly covering it. On body whorl, this rib, and one of almost equal strength immediately below it, forming double keel at outer base. Basal area (Fig. 52) with 20-30 relatively regular spiral threads (sometimes alternating in strength). Umbilicus not open. Coloration: light tan, with areas between spiral ribs with reddish tan.

Animal: unknown. Operculum described as "horny, small for the apertural area, multispiral with partially raised spires" (OKUTANI & HABE, 1981: 198).

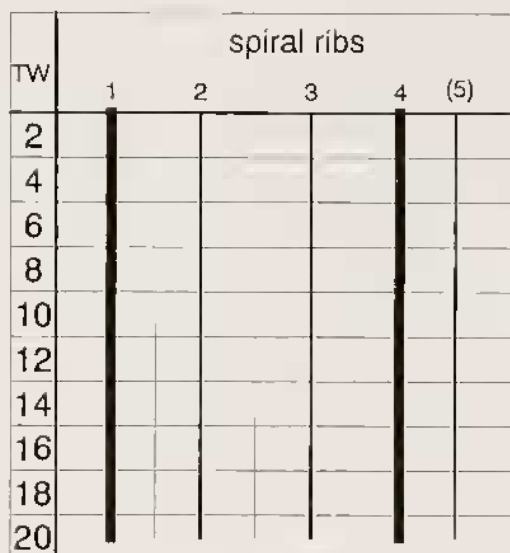


FIG. 53. — *Mathilda fusca*. Diagram of spiral sculpture, as in Fig. 8. Note compressed scale.

REMARKS. — The genus *Orectospira* Dall, 1925 (based on *Basilissa babelica* Dall, 1907, from Honshu, Japan) was originally placed in the Trochidae. HABE (1955) established a subfamily Orectospirinae for this group which he subsequently (1961: 24) raised to family-level. A small number of fossil and Recent species was included by various authors, species that previously had been placed in an array of families ranging from Littorinidae to Cerithiidae (OKUTANI & HABE, 1981). OKUTANI & HABE (1981) recognized only two previously described northwest Pacific species in this deepwater genus, the type species *O. babelica* (Dall, 1907) from "Albatross" stn 4973 and *O. tectiformis* (Watson, 1886) from "Challenger" stn 235. TSUCHIDA (1986) later synonymized *O. babelica* under *O. tectiformis* and showed that *O. shikoensis* (Yokoyama, 1928), originally described as a Pliocene fossil from Taiwan, occurs as an extant, sympatric species off the coast of Japan. OKUTANI & HABE (1981) described a third nominal species in this genus, *Orectospira fusca*. This species was known to date from the single live-collected type specimen from off Kii Peninsula, Japan. The protoconch (no longer with the type specimen, see Type material above) was described as being "mamillar", without mention of heterostrophy.

Among the material dredged during BIOCAL and SMIB 3 campaigns were several specimens here recognized as conspecific with "*Orectospira*" *fusca*. The nominal species is here transferred to *Mathilda* (*sensu lato*), where it represents the largest living species of its family known to date. The distinct pattern of four spiral ribs (with the two weaker middle ones in a concave zone of the whorl; Figs 51, 53) is already well established in early parts of the shells, and even juveniles would be readily recognizable. The size difference to other mathildid species is a result of the much larger number of whorls; measured to the suture after four whorls, for instance, *M. fusca* and *M. brevicula* both average 2.5 mm. The "1+2+1" primary spiral rib pattern on the exposed part of each teleoconch whorl is not known from other extant mathildids.

True *Orectospira* is thus again restricted to forms with whitish shells with little spiral sculpture. It is also noteworthy that the published information (OKUTANI & HABE, 1981) on the operculum of

"*Orectospira*" is based on this mathildid. HOUBRICK (1990) recently placed *Orectospira* in synonymy of *Trochocerithium* COSSMANN & SACCO *in Sacco*, 1896 (Turritellidae).

Mathilda cf. *hendersoni* Dall, 1927

Figs 54-57, 62

? *Mathilda hendersoni* Dall, 1927: 91.

TYPE MATERIAL. — Lectotype (here selected. H = 10.3, D = 4.5, PD = 480 μ m, TW = 8 1/2; USNM 333468).

TYPE LOCALITY. — Here restricted to "Off Fowey Light, Florida coast, in 25 fathoms [46 m]" as given for lectotype lot.

MATERIAL EXAMINED. — Lectotype as above.

New Caledonia. LAGON: stn 830, 20°49' S, 165°19' E, 105-110 m, 2 dd.

Loyalty Islands. MUSORSTOM 6: stn DW 399, 20°42' S, 167°00' E, 282 m, 1 dd.

DISTRIBUTION. — Indo-Pacific records from this study area only, 105-282 m. No live records.

DESCRIPTION. — *Protoconch* (Figs 55-56): smooth, globular, strongly hyperstrophic (approximately 135° to teleoconch axis), embryonic whorl not exposed; multispiral, number of whorls not ascertained: 420-500 μ m in maximum diameter; with weak, hardly elevated peritreme. Curved anal keel bordering deep umbilicus, the latter (in well-preserved specimens) completely covered by thin, reddish-brown lamella extending between first teleoconch whorl and anal keel. Glassy white, suture and outer lip lined with brown.

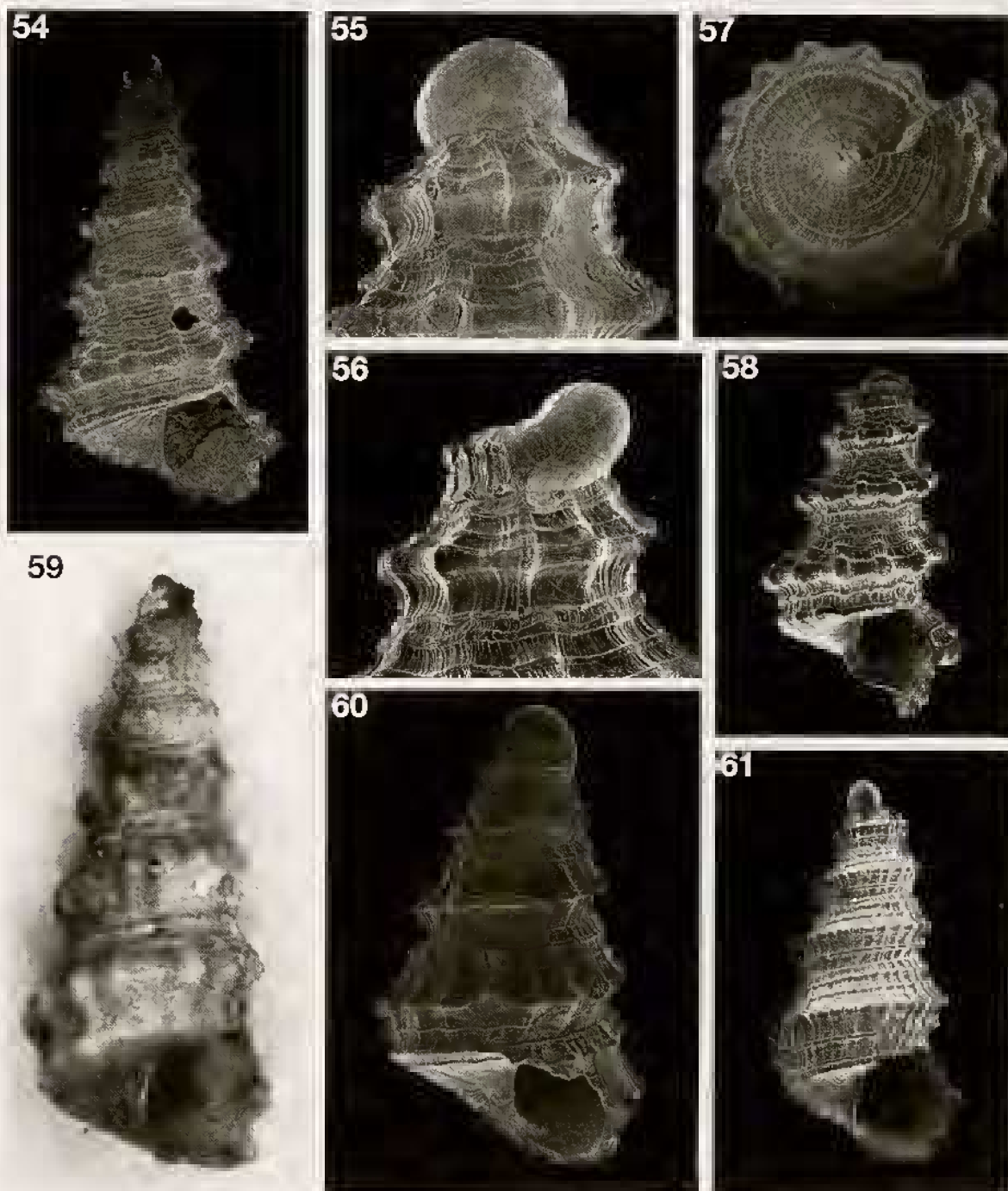
Teleoconch (Fig. 54): slender pagoda-shaped, base acutely angled; 3.1 to 6.2 at 4 1/3 to 6 1/2 whorls. Spire angle 29-30°. Pattern of relatively coarse spiral ribs and axial bulges, intersecting at approximately right angles to form coarse nodules, especially on keel-forming third primary spiral rib; with 12-16 axials on fourth whorl, 16 on body whorl of largest specimen examined. Fine underlying sculpture of axial

riblets. Exposed upper part of first whorl with 5 spiral ribs, with the keel-forming middle one strongest. Upper point of whorl attachment initially below the fifth spiral rib, resulting in rectangular appearance of first whorl. Beginning with second whorl, point of whorl attachment on fifth rib, partly or wholly covering it. Later whorls with additional spiral threads as indicated in Fig. 62 (one specimen with ribs 1, 2, 4 very weak or absent on initial whorls). On body whorl, fifth primary rib and one of almost equal strength below it, forming double keel at outer base. Straight, somewhat recessed basal area (Fig. 57) with 1-4 spiral threads and distinct axial threads, especially in the outer area. Umbilicus open in smaller specimens, partly covered by columellar lip; closed in largest specimen examined. Coloration: off-white to yellowish tan, with nodes on all ribs conspicuously white.

Animal: unknown.

REMARKS. — This form shares a "2 + I + 1" primary rib pattern with *Mathilda maoria* (above). It differs from other New Caledonian species in its very strongly developed third rib, resulting in a fir-tree-like appearance. It is very similar to, and may be conspecific with, a species described from the western Atlantic, *Mathilda hendersoni* Dall, 1927. The Atlantic form was not originally figured. A photographic illustration was provided by RIOS (1985: pl. 52, fig. 725), who also summarized the Atlantic depth records as "from 45 to 100 m" (1985: 154). Further comparative studies of additional specimens will be necessary.

Mathilda hendersoni appears to be similar to nominal species *Granulicharilda sagamiensis* KURODA & HABE *in* KURODA *et al.*, 1971 (: 416-417, 260, pl. 61, fig. 2). That species is only known from the two type specimens described from Japan ("Height 7.7 mm and breadth 3.3 mm" (holotype); "Height 6.9 mm and breadth 3.2 mm" (paratype) (KURODA & HABE *in* KURODA *et al.*, 1971: 260). The types ("in H. Majesty's Biol. Lab." *teste* INABA & OYAMA, 1977: 104) were not available for this study, but a photograph of the holotype (Fig. 59, courtesy Prof. HABE) is here reproduced. The photograph of the holotype shows a relatively small protoconch, which was described by KURODA & HABE (1971: 260) as having two whorls and being "obliquely placed on the teleoconch." Viewed at



FIGS. 54-61. — **54-57.** *Mathilda* cf. *hendersoni*. — **54.** specimen from New Caledonia, LAGON: stn 830, 6.2 mm. — **55-56,** aspects of protoconch and early teleoconch whorls, specimen from Loyalty Islands, MUSORSTOM 6: stn DW 399, FMNH 224966, protoconch diameter 420 μ m. — **57,** shell base, same specimen as in Fig. 54, diameter 3.2 mm. — **58.** *Mathilda* sp. aff. *hendersoni*, New Caledonia, LAGON: stn 830, 2.8 mm. — **59.** *Mathilda sagamiensis*, holotype of *Granulicharilda sagamiensis*, Japan, "7.7 mm" (light photograph courtesy Prof. HABE). — **60.** *Mathilda* sp. aff. *sansibarica*, specimen from New Caledonia, BIOCAL: stn DW 70, 3.8 mm. — **61.** *Mathilda sansibarica*, lectotype ZMB, East Africa, 3.6 mm (SEM, uncoated).

comparable angles, the protoconchs of the New Caledonia material are much larger in relation to the teleoconch. The teleoconch of *G. sagamiensis* appears to have about seven whorls (rather than the originally described six). At a shell height of 7.7 mm, *sagamiensis* seems to have fewer whorls than the "cf. *hendersoni*" specimens, and the number of body whorl nodules is given as "about 20," while it does not exceed 16 in the "cf. *hendersoni*" material. The largest node-bearing ribs appears to be spirally subdivided in the *sagamiensis* type (or two ribs run closely together), a feature not mentioned in the original description.

Mathilda sp. aff. *hendersoni*: a single, small specimen (H = 2.8, D = 1.6, PD = 420, TW = 4; MNHN; Fig. 58) was found with the *M.* cf. *hendersoni* material in New Caledonia. It is similar to *M. hendersoni*, but differs in having a greater degree of heterostrophy (ca. 145°) and by having one strong rib (instead of a double keel) on the outer shell base. The shell is reddish-tan with the nodes on all ribs standing out in white. More, fully grown, specimens are needed for further study.

Likewise currently unassigned (and probably unnamed) are six specimens currently treated as "*Mathilda* sp. aff. *hendersoni*/*maoria*" (BIOCAL: stn DW 46 and DW 66; CHALCAL 2: stn DW 76). The relatively small specimens (H = 3.5 to 5.1) have teleoconch sculptures reminiscent of *M. hendersoni*, but larger protoconchs (560-600 µm) that are much less hyperstrophic.

Mathilda sp. aff. *sansibarica* Thiele, 1925

Figs 60, 63

MATERIAL EXAMINED. — **New Caledonia**. BIOCAL: stn DW 70, 23°25' S, 167°53' E, 965 m, 1 dd.

DESCRIPTION (single specimen). — *Protoconch* (Fig. 60): smooth, globular, strongly hyperstrophic, at about 115° to teleoconch axis; embryonic whorl exposed; about 2 1/2 whorls; 620 µm in maximum diameter; with weak, hardly elevated peritreme. Curved anal keel bordering deep umbilicus, the latter completely covered by thin, reddish-brown lamella extending between first teleoconch whorl and anal keel. Glassy white; suture and outer lip lined with brown; embryonic whorl darker.

Teleoconch (Fig. 60): relatively thin-shelled, translucent; pagoda-shaped, base acutely angled; 3.8 mm at 4 1/10 whorls; spire angle about 38°. Pattern of relatively coarse spiral ribs and axial bulges, intersecting at approximately right angles to form pointed nodules, especially on keel-forming third pri-

mary spiral rib; with 22 axials on fourth whorl. Exposed upper part of first whorl with 3 spiral ribs, with the keel-forming middle one strongest. Upper point of whorl attachment initially at a fourth spiral rib, partially covering it. Beginning with second whorl, point of whorl above this rib, wholly covering it; second primary spiral rib fading to become as weak as spiral thread next to it on later whorls. Later whorls with additional spiral threads as indicated in Fig. 63. On body whorl, fourth primary rib and one of almost equal strength below it, forming double keel at outer base. Basal area with ill-defined spiral threads and growth lines. Umbilicus not open. Coloration: white.

Animal: unknown.

REMARKS. — This single-known specimen differs from other New Caledonian material in having a translucent shell with concave shell areas and relatively weak sculpture (Fig. 63).

The specimen is similar in shell features to *Mathilda sansibarica* Thiele, 1925 (: 112, pl. 20, fig. 25). That nominal species is known from two type specimens from off East Africa (lectotype, originally illustrated syntype, here selected: H = 3.6, D = 1.95, PD = 500, TW = 4 1/10 (Fig. 61); paralectotype: H = 4.1, D = 2.1, PD = 500, TW = 4 1/2+; both ZMB unnumbered; type locality: "Valdivia", stn 245, 5°27.9' S, 39°18.8' E, 463 m; Zanzibar Channel). The *M. sansibarica* type specimens differ mainly in having a well-developed second primary spiral rib, a more prominent fourth primary spiral rib, no additional spiral threads interspaced, and a considerably smaller protoconch size.

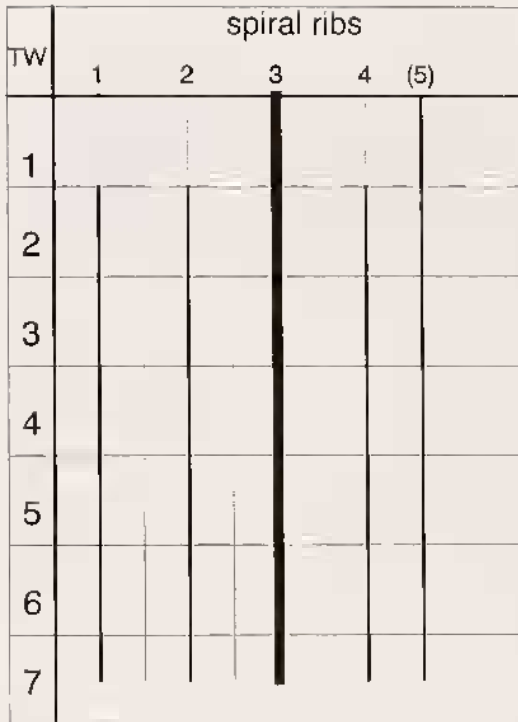


FIG. 62. — *Mathilda* cf. *hendersoni*. Diagram of spiral sculpture, as in Fig. 8. Fifth primary rib exposed on first whorl.

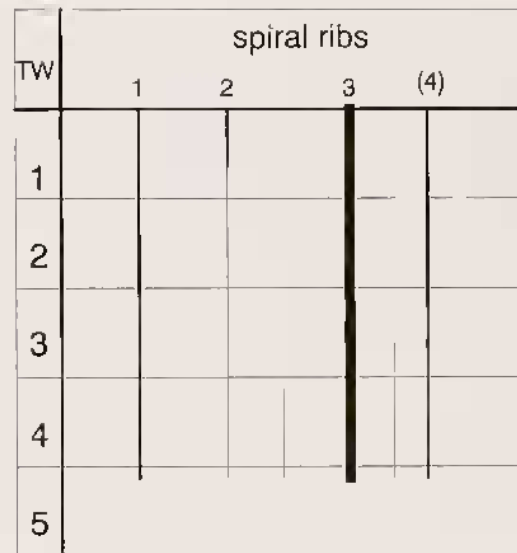


FIG. 63. — *Mathilda* sp. aff. *sansibarica*, diagram of spiral sculpture (based on single specimen), as in Fig. 8.

Mathilda houbricki sp. nov.

Figs 64-68, 73

TYPE MATERIAL. — Holotype MNHN, protoconch damaged.

TYPE LOCALITY. — New Caledonia, BLOAL, stn CP 75, 22°19' S, 167°23' E, 825-860 m.

MATERIAL EXAMINED. — Only known from the type material.

DESCRIPTION (based on holotype). — *Protoconch* (Figs 65-66): smooth, globular, hyperstrophic, at about 115° to teleoconch axis; embryonic whorl exposed; multispiral, consisting of ca. 2 1/2 whorls; 620 µm in maximum diameter; with weak peritreme. Curved anal keel bordering deep open umbilicus; 160 µm long reddish-brown lamella extending from protoconch lip (Fig. 66), partly covering umbilicus. White; embryonic whorl brown.

Teleoconch (Figs 64, 68): cone-shaped with somewhat bulging whorls; 5.9 mm in height at somewhat over 5 whorls; spire angle 35°. Pattern of regular spiral and axial ribs, intersecting at approximately right angles to form nodules; axials about as strong as weakest spirals. Spacing of the axials very regular, with ca. 36 on fourth whorl. Initial part of first postlarval whorl with 2 weaker and 2 stronger

(keel-forming) spiral ribs exposed and upper point of whorl attachment on a fifth rib (partly covering it; Fig. 68). Already on first whorl with 2 additional ribs developing between first, second and third primary spirals, quickly reaching a strength almost identical to that of first and second. After about 3 whorls, this 4+2 pattern supplemented by additional finer spiral threads (between and below the 2 stronger ribs; Fig. 73). On body whorl, the fifth primary spiral rib (seventh in total) and one of almost equal strength below it, forming rounded keel-area on outer base. Basal area (Fig. 67) with about 9 weak, flattened spiral ribs of various width, intersected by weak axial threads fading out as irregular growth lines. Umbilicus not open. Coloration: milk-white.

Animal: unknown.

Measurements: H = 5.9, D = 3.3, PD = 620, TW = 5+.

REMARKS. — This form differs from other mathildid species by its relatively broad shell with an original "2+2" pattern of exposed primary spiral ribs rapidly developing into a "4+2" pattern (Figs 65-66, 73).



FIGS. 64-72. — 64-68, *Mathilda houbricki* sp. nov., holotype, New Caledonia, 5.9 mm. — 64, lateral aspect. — 65-66, aspects of protoconch and first teleoconch whorl, protoconch diameter 620 μ m. — 67, shell base, diameter 3.3 mm. — 68, shell apex. — 69-72, *Mathilda richei* sp. nov., holotype, New Caledonia, 13.7 mm. — 69, lateral aspect. — 70, shell apex. — 71, protoconch and part of first teleoconch whorl (eroded), showing nuclear whorl on the right, protoconch diameter 600 μ m. — 72, shell base, diameter 5.8 mm.

ETYMOLOGY. — Named for the late Dr Richard ("Joe") HOUBRICK, curator at the National Museum of Natural History in Washington, DC.

Mathilda richei sp. nov.

Figs 69-72, 74

TYPE MATERIAL. — Holotype MNHN.

TYPE LOCALITY. — New Caledonia, BIOCAL, stn DW 48, 23°00' S, 167°29' E, 775 m.

MATERIAL EXAMINED. — Only known from the type material.

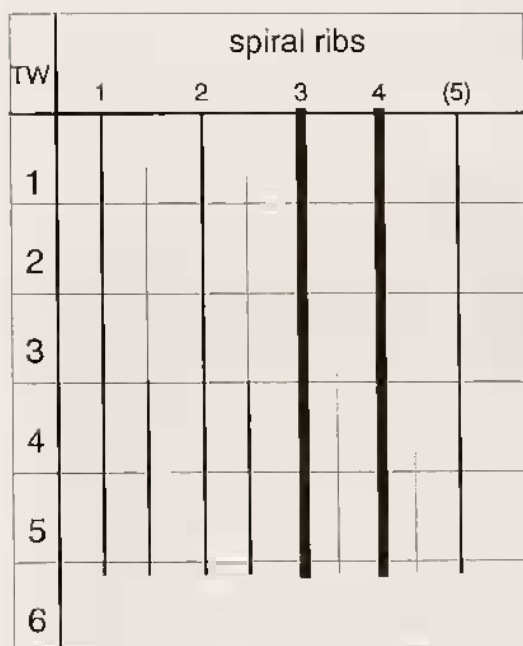


FIG. 73. — *Mathilda houbricki* sp. nov. Diagram of spiral sculpture (holotype), as in Fig. 8.

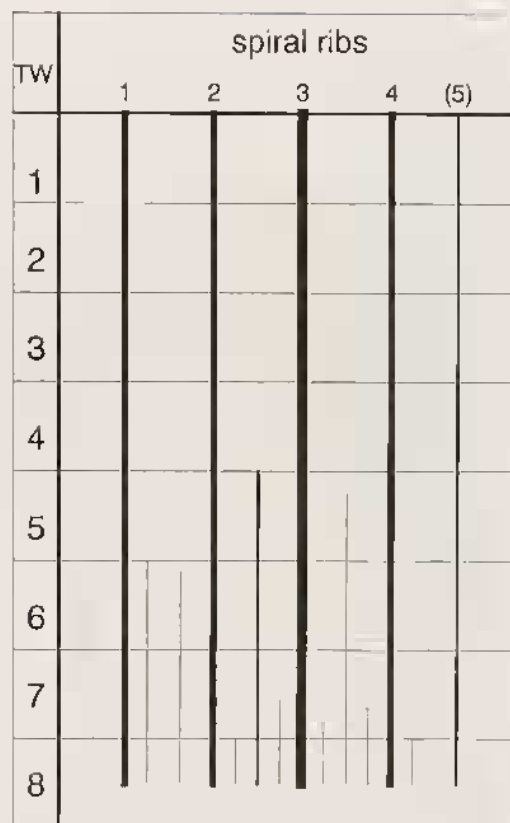


FIG. 74. — *Mathilda richeri* sp. nov. Diagram of spiral sculpture (holotype), as in Fig. 8.

DESCRIPTION (based on holotype). — *Protoconch* (Fig. 70): smooth; globular; hyperstrophie, embryonic whorl partly exposed, approximately 120° to teleoconch axis; multispiral, consisting of ca. 2 1/2 whorls; 600 μm in maximum diameter; peritreme weak; umbilicus open (some remnants of callus and/or anal keel visible). White, embryonic whorl darker.

Teleoconch (Fig. 69): cone-shaped with somewhat bulging whorls; 13.7 mm in height at somewhat over 7 1/2 whorls; spire angle ca. 35°. Primary pattern of 4 spiral and numerous axial ribs, intersecting at approximately right angles to form nodules; third spiral somewhat stronger and most prominent,

fourth spiral initially weakest. Spacing of axials regular, with ca. 26 on fourth whorl. After first 3 teleoconch whorls with additional ribs developing between primary spirals, some of which are later flanked by additional threads after 6 whorls (see Fig. 74). Whorl attachment on a fifth primary spiral; this rib and one of almost equal strength below it demarcating basal perimeter. Basal area with about 9 weak, flattened spiral ribs and threads of various width, intersected by irregular axial growth lines. Umbilicus not open. Coloration: milk-white.

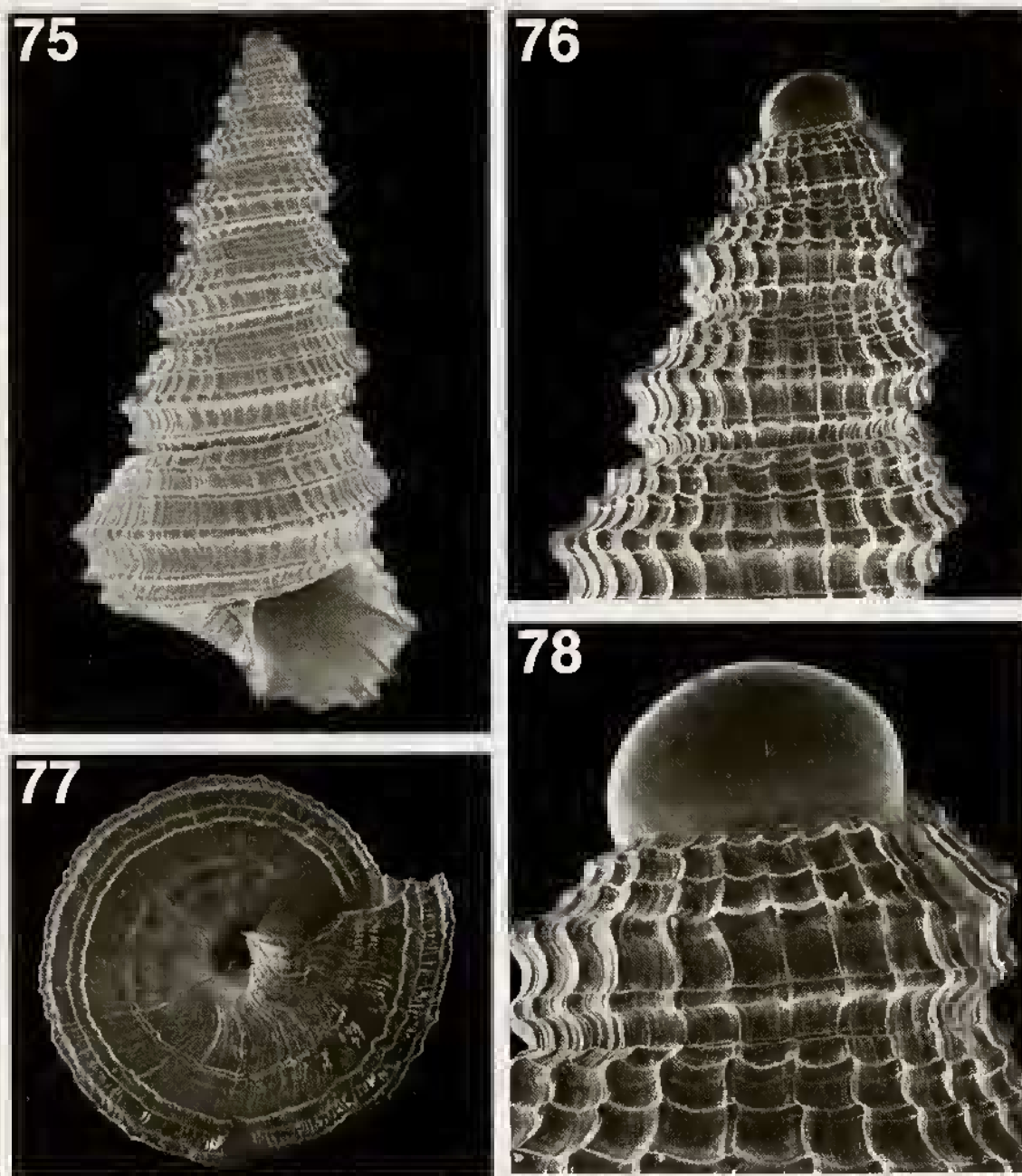
Animal: unknown.

Measurements: H = 13.7, D = 5.8 (shell originally wider; body whorl broken back, exposing part of columella), PD = 600. TW = 7 1/2.

REMARKS. — This form is readily recognized by its relatively broad shell, prominent third spiral rib, and numerous interspaced spiral threads on later whorls. The initial "2 + 1 + 1" pattern of exposed primary spiral ribs (Figs 70, 74) is reminiscent of the *Mathilda maoria* complex (discussed above). *Mathilda houbricki* sp. nov. (above) is somewhat similar in overall shell shape.

A similar shell from the same station differs in having the interspacing threads beginning earlier (already on the second whorl) and by having the upper point of whorl attachment on the fourth, not fifth, primary spiral. The specimen shows two major shell repairs on the second whorl and the sculptural patterns may thus not be species-specific. The specimen (MNHN) was not included in above description.

ETYMOLOGY. — Named for Dr Bertrand RICHER DE FORGES, who participated on the BIOCAL campaign and was one of the collectors of the new species. His "Programme LAGON," conducted for ORSTOM between 1984 and 1989 in the coral reef lagoons of New Caledonia, provided many of the mathildid specimens used in the present study.



FIGS 75-78. — *Mathilda* sp. A, New Caledonia, CHALCAL 2: str DW 72, 10.4 mm. — 75, lateral aspect. — 76, shell apex. — 77, shell base showing open umbilicus, diameter 4.8 mm. — 78, aspect of protoconch and first teleoconch whorl, protoconch diameter 540 μ m.

Mathilda sp. A

Figs 75-79

MATERIAL EXAMINED. — New Caledonia, CHALCAL 2, stn DW 72, 24°55' S, 168°22' E, 527 m. 1 Iv.

DESCRIPTION (based on single specimen). — *Protoconch* (Fig. 78): smooth, globular, strongly hyperstrophic, estimated at ca. 135° to teleoconch axis; only small part of suture exposed; number of whorls not ascertained; 540 µm in maximum diameter; peritreme weak; protoconch umbilicus completely covered by thin lamella extending between first TW and anal keel. Transparent-white, with lamella, area before peritreme, anal keel, and suture reddish-brown.

Teleoconch (Figs 75-76): cone-shaped; 10.4 mm in height at 7 3/8 whorls; spire angle ca. 32°. Primary pattern of 4 spiral (see Fig. 79) and numerous axial ribs, intersecting at approximately right angles to form nodules; the third and fourth spirals initially stronger and similarly prominent, beginning with the fourth whorl, the third clearly strongest and most prominent. Spacing of axials initially regular (with 30 on fourth whorl), beginning with sixth whorl, axials becoming weaker and their spacing becoming increasingly crowded, eventually representing little more than axial growth marks. Whorl attachment on a fifth primary spiral under formation of a distinct suture; this rib and one of almost equal strength below it demarcating basal perimeter. Basal area (Fig. 77) with about 5 weak, very irregular spiral ribs and threads (intersected by irregular axial growth lines), surrounding narrow (ca. 0.5 mm) but well-developed, open umbilicus. Columellar lip thin, not reflected over umbilicus. Coloration: overall milk-white; early whorls with tan hue. Tan, sealy periostracum covering shell.

Animal: single known specimen has dried-in animal with flat horny operculum visible in aperture (pending further study).

Measurements: H = 10.4, D = 4.8, PD = 540, TW = 7 3/8.

REMARKS. — This form differs from the others by its combination of a strongly hyperstrophic protoconch, an open umbilicus, distinct "2+2" primary spiral rib pattern, strong spiral sculpture on the base, and fading axials on the final whorls. The specimen was apparently live-collected, its light shell color not due to fading. Additional material is needed for a more detailed taxonomic assessment.

TW	spiral ribs				
	1	2	3	4	(5)
1					
2					
3					
4					
5					
6					
7					
8					

FIG. 79. — *Mathilda* sp. A. Diagram of spiral sculpture, as in Fig. 8.

Genus *TUBA* Lea, 1833

Tuba Lea, 1833; 127. Type species (SD by COSSMANN, 1912: 13): *Tuba alternata* Lea, 1833; Eocene.

The concept of *Tuba* (*sensu lato*) here also includes *Gegania* Jeffreys, 1884 (: 365) with type species by monotypy *Gegania pinguis* Jeffreys, 1884 (Recent, off Portugal), and *Tubena* Marwick, 1943 (: 188), with type species (OD) *Gegania (Tubena) viola* Marwick, 1943 (Miocene, New Zealand).

DIAGNOSIS for *Tuba* (*sensu lato*) (shell characters). — *Protoconch*: diameter 580-820 µm, strongly hyperstrophic ("upside-down"), diverging over 140° from teleoconch axis; with about 2.5 whorls; smooth, glassy, without distinct sculptural elements other than short, curved anal keel and thin callus, the latter covering the protoconch umbilicus (noticeable only in well-preserved

specimens); transparent or milk-white with tan pigmentation often on embryonic whorl, suture, anal keel and callus.

Teleoconch: length usually 4.1 to 10 mm at 3 3/4 to 4 3/4 whorls, but up to 26.5 mm at 7 whorls; broadly cone-shaped with bulging whorls; periphery and base rounded (juveniles with double keel), aperture round, apertural lip slightly channeled at columella and beneath major spiral ribs; teleoconch with primary sculpture of 4-5 spiral ribs (often with interspaced additional ones after first whorl), 1 or 2 of the main spiral ribs markedly more prominent than the others; spiral ribs crossed (at right angle or following the sometimes strongly sinuous shape of apertural lip) by weaker axial ribs, threads or enhanced growth lines; at rib intersections, usually with sculpture of rounded more-or-less coarse nodules, spiral rib interspaces cancellate due to axial ribbing; upper point of attachment of the following whorl at a spiral rib less prominent than at least one of the exposed ribs above; this attachment rib, with an additional rib next to it, forming a distinct double edge at outer shell base; flat, concave or slightly inflated basal area with several more-or-less well-defined spiral threads or ribs, surrounding solid columella, narrow umbilical chink, or funnel-shaped umbilicus; white, sometimes with brown spiral ribs.

REMARKS. — *Tuba sensu lato*. *Tuba* Lea, 1833, was introduced for three species from the Tertiary of Alabama. Most authors later accepted synonymy of this nominal taxon with JEFFREYS' (1884) *Gegania*, but the older name *Tuba* was often thought preoccupied and thus unavailable. However, *Tuba* Lea, 1833, and its type species *Tuba alternata* were placed on the official ICZN lists as being available, all earlier introductions of the same generic name deemed *nomina nuda* or occurring in works rejected for nomenclatural purposes (ICZN Opinion 436, 1957). JEFFREYS (1884: 365) based *Gegania* on *G. pinguis*, described as differing from *Mathilda* "in having a short spire and an intorted but not a heterostrophe nucleus." He erroneously interpreted the highly hyperstrophic protoconch (of which only the base is exposed on the shell apex) as homeostrophic. *Tubena* Marwick, 1943, was introduced as a subgenus of *Gegania*. MARWICK (1943: 188) saw *Tubena* to differ from *Gegania pinguis* in being umbilicate and in having better developed axial sculpture. However, as is demonstrated by the *Tuba* material from New Caledonia, these features appear to be variable.

Tuba valkyrie (Powell, 1971)

Figs 80-86

Gegania valkyrie Powell, 1971: 210, fig. 1.

Other references:

Gegania valkyrie — CLIMO, 1975: 275 ff., figs 1 (shell), 2-3, 5d (anatomy and radula), 4i-k (eggs). — POWELL, 1976: 107; 1979: 250. — HASZPRUNAR, 1985: 201 ff., figs 1, 3, 12-14 (anatomy). — BIELER, 1988: 213 ff., fig. 4 (sketch of radula after CLIMO, 1975), fig. 14 (SEM of protoconch).

TYPE MATERIAL. — Holotype AIM AK71328; H = 14.3, D = 8.8, PD = 780, TW = 5 1/4 (outer lip broken, large hole in fourth whorl).

TYPE LOCALITY. — "E.S.E. of the Poor Knights Islands, 329 m" [New Zealand].

MATERIAL EXAMINED. — **New Zealand**. Holotype as above.

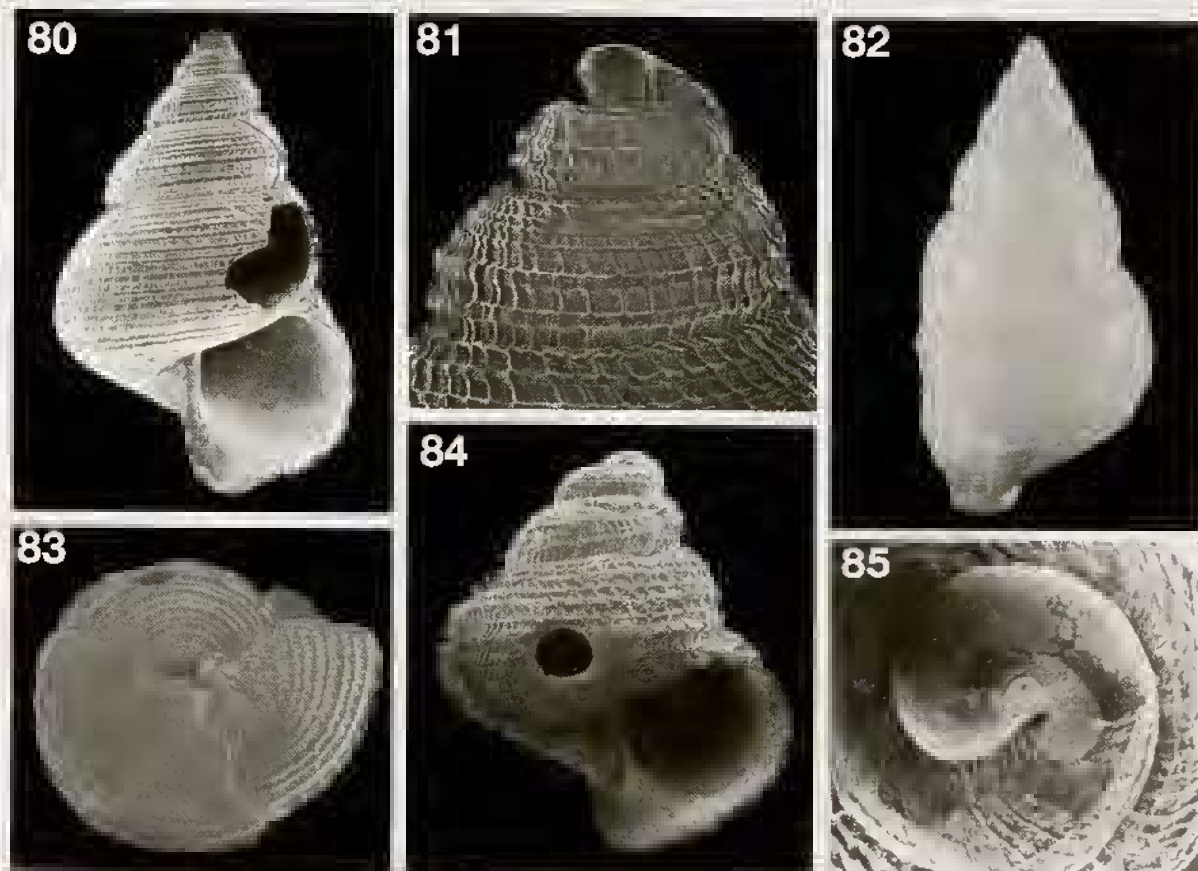
North Cape, National Museum Northland Expedition, R.V. "Acheron". Biological Station BS 402, 170 m, 20.11.1974 (material also studied by CLIMO [1975] and HASZPRUNAR [1985]: 2 dd, 2 lv (NMNZ M36712).

New Caledonia. BIOCAL: stn DW 66, 24°55' S, 168°22' E, 505-515 m, 2 lv.

MUSORSTOM 4: stn DW 212, 22°47' S, 167°10' E, 375-380 m, 1 lv.

Loyalty Islands. MUSORSTOM 6: stn DW 394, 20°49' S, 167°09' E, 570 m, 1 dd. — Stn DW 468, 21°06' S, 167°33' E, 600 m, 1 dd (SEM specimen, FMNH 224967).

Réunion. MD32: stn DC 112, 20°53' S, 55°09' E, 740-780 m, 8 dd.



FIGS. 80-85. — *Tuba valkyrie*. — 80-81, holotype AIM AK 71328, New Zealand, shell length 14.3 mm (SEM, uncoated). — 82, light photograph of large specimen from Loyalty Islands, MUSORSTOM 6: stn DW 394, shell length 26.5 mm. — 83-84, specimen from Réunion, FMNH 224967, MUSORSTOM 6: stn DW 468; shell base diameter 3.0 mm, shell length 3.2. — 85, aspect of protoconch and first teleoconch whorl, specimen from New Zealand, NMNZ M36712, protoconch diameter 640 μ m.

DISTRIBUTION. — The new record from Réunion indicates that this species is widely distributed in (at least the southern parts of) the Indo-Pacific. Known depth range is 170-780 m, with live records from 170-515 m.

DESCRIPTION. — *Protoconch*: smooth, globular, strongly hypertrophic, almost completely upside-down (over 145° to teleoconch axis; consisting of ca. $2\frac{1}{2}$ whorls [counted on specimen from Réunion], all but final half whorl hidden; 600-780 μ m in maximum exposed diameter; with weak, hardly elevated peritreme. Weak, curved anal keel (ca. 80 μ m) bordering deep umbilicus; protoconch umbilicus completely covered by thin, reddish-brown lamella extending between first TW and anal keel. Glassy or milk-white; anal keel lined with brown; on some specimens with brown hue, especially near peritreme.

Teleoconch: with initially somewhat angular, later regularly bulging whorls; average size 5-10 mm at $3\frac{3}{4}$ to $4\frac{3}{4}$ whorls, but large specimens to 26.5 mm at 7 whorls; spire angle initially up to 68° , on later whorls more slender (to 53°); lower apertural lip drawn into open, shallow channel. Shell thin, shiny, especially in cancellate "windows" translucent. Distinct 'arrested growth' mark at ca. $1/6$ TW. Fine pattern of spiral ribs intersected by weaker axials; axials following growth lines in a sigmoidal curve arching backward (opisthocyrt), about equal in strength to weakest spiral rib.

Exposed upper part of earlier whorls with two groups of 3 spiral ribs; first group of about equal strength, sometimes joined by a weaker fourth (subsutural) rib; second group, forming angular side of whorl above the attachment of the subsequent whorl, with upper and lower ribs strongest. Fourth main rib of the angular region serving as upper point of whorl attachment, occasionally fully exposed on later whorls. On later whorls with additional ribs as shown in Fig. 86 and difference in rib strength fading, resulting in regularly cancellate pattern, with the spiral ribbing strongest. Often with fine additional threads interspersed on later whorls. Base with about 12-15 spiral ribs, somewhat differing in strength, strongest toward periphery. Initially with narrow, open umbilicus, on later whorls closed by reflected columellar lip. Spacing of the axials on the upper side usually regular (35 on second TW, 42 on third, ca. 40 on fourth [New Zealand specimens]), but often extremely crowded from stages of slow growth and on base due to converging axial riblets, especially close to umbilicus. Coloration: white.

Animal: described by CLIMO (1975) and HASZPRUNAR (1985).

REMARKS. — *Tuba valkyrie* was originally described from a single, somewhat worn specimen collected off the Poor Knights Islands, New Zealand (POWELL, 1971) (Figs 80-81). Based on six additional specimens, collected alive off North Cape (New Zealand), CLIMO (1975) described anatomical aspects and reported on radula, egg mass and the presumed food organism, antipatharian coral *Parantipathes tenuispira* Silberfeld. More detailed anatomical information was added by HASZPRUNAR (1985: 201 ff.). CLIMO (1975) also provided SEM photographs of the shell. His illustrations of a protoconch of the North Cape material (CLIMO, 1975: fig. 1) led HASZPRUNAR (1985: 207) to the conclusion that *T. valkyrie* shows "only traces" of a hyperstrophic condition. BIELER (1988: 219, fig. 14) reexamined North Cape specimens by SEM and verified the presence of a strongly hyperstrophic condition in this species (Fig. 85).

The strongly opisthocyrt riblets facilitate recognition of this form. A smaller, somewhat worn Loyalty Island specimen shows several shell repairs (at 1 and 2 1/3 and 2 2/3 TW), the outer lip is somewhat broken back in its central part (Fig. 84). The animal apparently died from the attack of a predatory snail, as indicated by a complete bore hole in the body whorl. A larger specimen (Fig. 82) is the largest shell of an extant *Tuba* species recorded to date. The two largest specimens studied (including the holotype) also have unusually large protoconchs (700 and 780 µm, as opposed to 600-680 µm for all others studied).

TW	spiral ribs						
	1	2	3	4	5	6	(7)
1							
2							
3							
4							
5							
6							
7							

FIG. 86. — *Tuba valkyrie*. Diagram of spiral sculpture, as in Fig. 8.

Tuba fuscocincta sp. nov.

Figs 87-91

TYPE MATERIAL. — Holotype NMP C8591/T1185. Paratype MNHN.

TYPE LOCALITY. — Transkei, off Nthionyan River, 32°17.4' S, 29°05.6' E, 340-450 m, RV "Meiring Naude", stn D12, 5.VII.1985, Kilburn coll. Paratype from New Caledonia, BIOCAL, stn DW 77, 22°15' S, 167°15' E, 440 m.

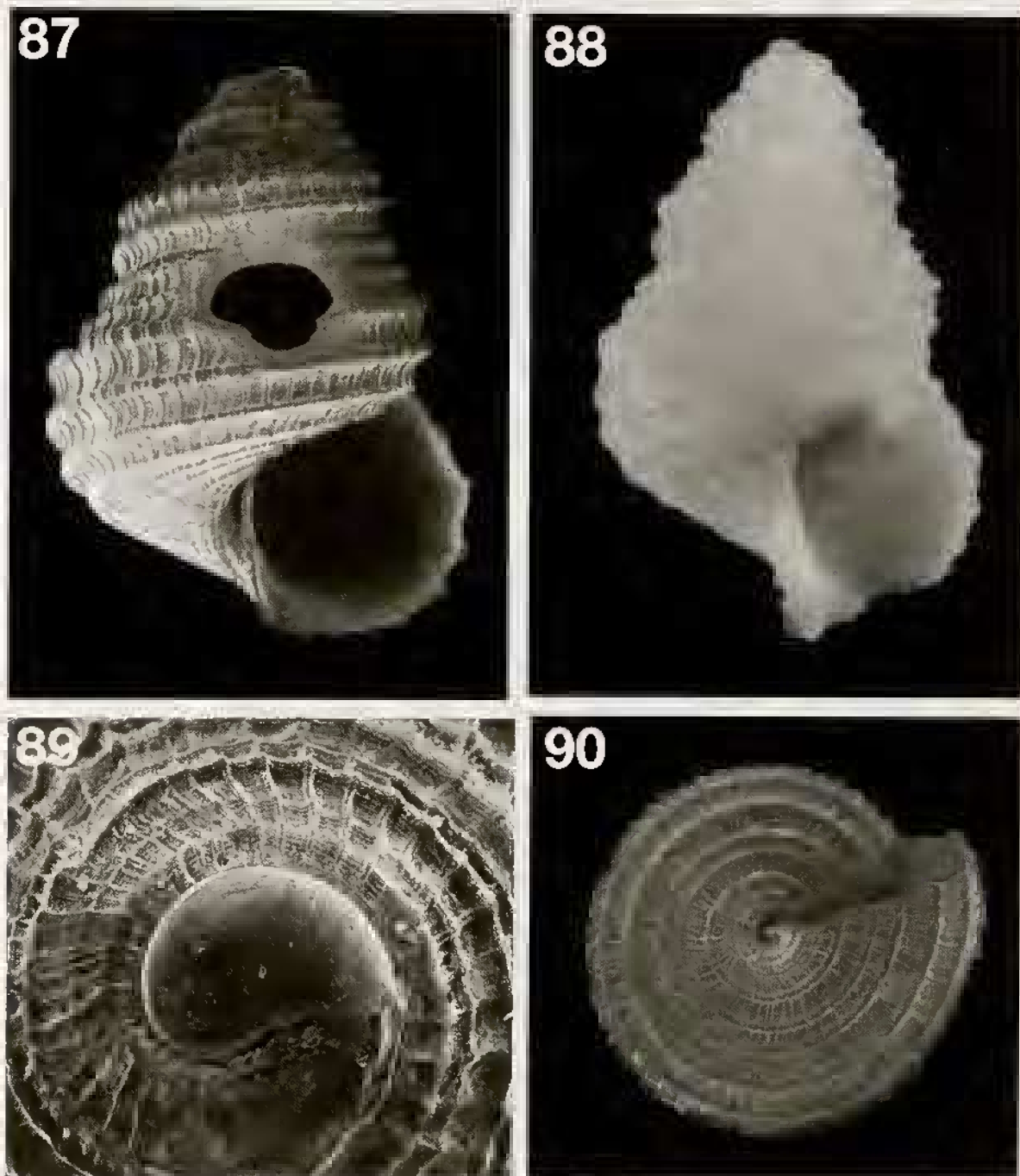
MATERIAL EXAMINED. — Holotype. New Caledonia, BIOCAL: stn DW 77, 22°15' S, 167°15' E, 440 m, 1 dd (paratype).

DISTRIBUTION. — Apparently widely distributed, with known specimens from South Africa and New Caledonia.

DESCRIPTION. — Protoconch [only outer base available for non-destructive study]: smooth; globular, strongly hyperstrophic, almost completely upside-down (over 145° to first teleoconch whorl); 580 µm in maximum exposed diameter; with weak, hardly elevated perireme. Weak, slightly curved

anal keel (ca. 80 µm) bordering deep protoconch umbilicus; umbilicus partly covered by thin, brittle, reddish-brown callus extending between first TW and anal keel. Glassy white, with outermost anal keel region brown.

Teleoconch: thin, shiny, especially in cancellate "windows"



FIGS 87-90. — *Tuba fuscocincta* sp. nov. — 87, paratype, New Caledonia, lateral aspect, 4.1 mm. — 88, holotype NMP C8591/T1185, Transkei, South Africa, 7.2 mm (light photograph, showing color pattern on spiral ribs). — 89, aspect of protoconch and first teleoconch whorl, paratype, protoconch diameter 580 μ m. — 90, shell base, paratype, diameter 3.1 mm.

translucent; 4.1 to 7.2 mm at $3 \frac{1}{4}$ to $4 \frac{3}{8}$ whorls. Spire angle initially about 50° , later decreasing to approximately 47° on body whorl. Distinct arrested growth mark at about $1/6$ of first whorl. Upper part of each teleoconch whorl with "2+2" pattern of exposed primary spiral ribs. The less prominent upper pair is closely spaced, with the upper (first) rib stronger; the following pair, together with a fifth spiral rib (the latter on early whorls partly covered by the attaching following whorl) forming angular peripheral region. On body whorl, these 3 peripheral ribs equally spaced, with slight decrease in rib strength from top to bottom. Umbilicus narrow, open. Base with 6-8 well-defined more-or-less equally spaced spiral ribs, the outermost of which strongest. Larger specimen with additional threads between primary ribs (Fig. 91). Spiral ribs and interspaces crossed, mostly at right angles, by axial riblets, always finer than the weakest spiral rib. Spacing of the axials on the upper side regular (32-34 on second TW, 41-46 on third), but crowded on base due to converging axial riblets, especially close to umbilicus. Surface, notably the uppermost (first) spiral rib, with microscopic spiral striae. Coloration: white; beginning on first TW, the fourth primary spiral rib becoming gradually darker, reaching a solid orange-brown after 2 TW; the rib below it (= upper point of attachment of subsequent whorl) also brownish (on smaller specimen only), but much lighter; a third brown rib surrounding the 2 tightly-spaced ribs at the umbilicus; remainder of shell off-white.

Animal: unknown.

Measurements:

	H	D	PD	TW	Locality	Collection
Holotype	7.2	4.7	580	$4 \frac{3}{8}$ [was $4 \frac{1}{2}$]	[type loc.]	NMP C8591/T1185
Paratype	4.1	3.1	580	$3 \frac{1}{4}$ [was $3 \frac{1}{2}$]	New Caledonia	MNHN

REMARKS. — Although known from only two specimens, the distinctive coloration in conjunction with a strongly hyperstrophic protoconch and well-defined teleoconch sculpture separate this form from other known mathildids and justify description as a new species. The paratype is a fresher specimen, with the shell coloration better preserved. The species is placed in *Tuba* rather than *Mathilda* (*sensu lato*), mainly because of its broadly rounded shell and strongly hyperstrophic protoconch.

ETYMOLOGY. — *Fuscocinctus*, -a, -um, compound adjective from Latin *fuscus*, -a, -um (brown) and *cinctus*, -a, -um (having a girdle); referring to its distinctive brown spiral bands.

Nominal mathildid species removed from the family

Mathildona cookiana Dell, 1956 (: 39, fig. 30); " $40^\circ 52.6' S$, $174^\circ 49.5' E$, Cook Strait, in 75 fathoms" [137 m; New Zealand]. DELL noted in the original description that the apex was damaged in all available specimens and that the "generic position cannot be certain" (1956: 39). POWELL (1979: 250) retained the species tentatively in nominal genus *Mathildona*, while MAXWELL (1966: 447) noted that DELL's species "is almost certainly not congeneric with the genotype *M. euglypta* Iredale, differing in having strong axial folds, an arcuate columella, and a continuous peristome". The holotype (NMNZ M8842, H = 9.8, D = 3.7; Fig. 92) lacks mathildid-typical

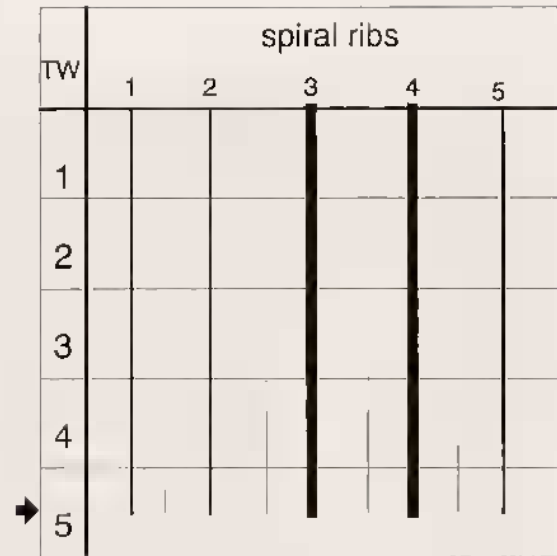


FIG. 91. — *Tuba fuscocincta* sp. nov. Diagram of spiral sculpture, as in Fig. 8.

sculptural elements. Additional specimens studied (NMNZ) have complete protoconchs and identify this species as a member of the Epitoniidae.

Mathilda elegantula Angas, 1871 (: 15, pl. 1, fig. 8); "Lane Cove Creek, Port Jackson", New South Wales, Australia. *M. elegantula* was made the type species, by OD, of *Eucharilda* Iredale, 1929 (: 187, no family placement indicated). The holotype (BMNH 1871.7.5.9, H = 11.3, D = 2.9; Fig. 93) appears to be a member of the Pyramidellidae. THIELE (1931: 269) suggested synonymy with the pyramidellid genus *Cingulina*.

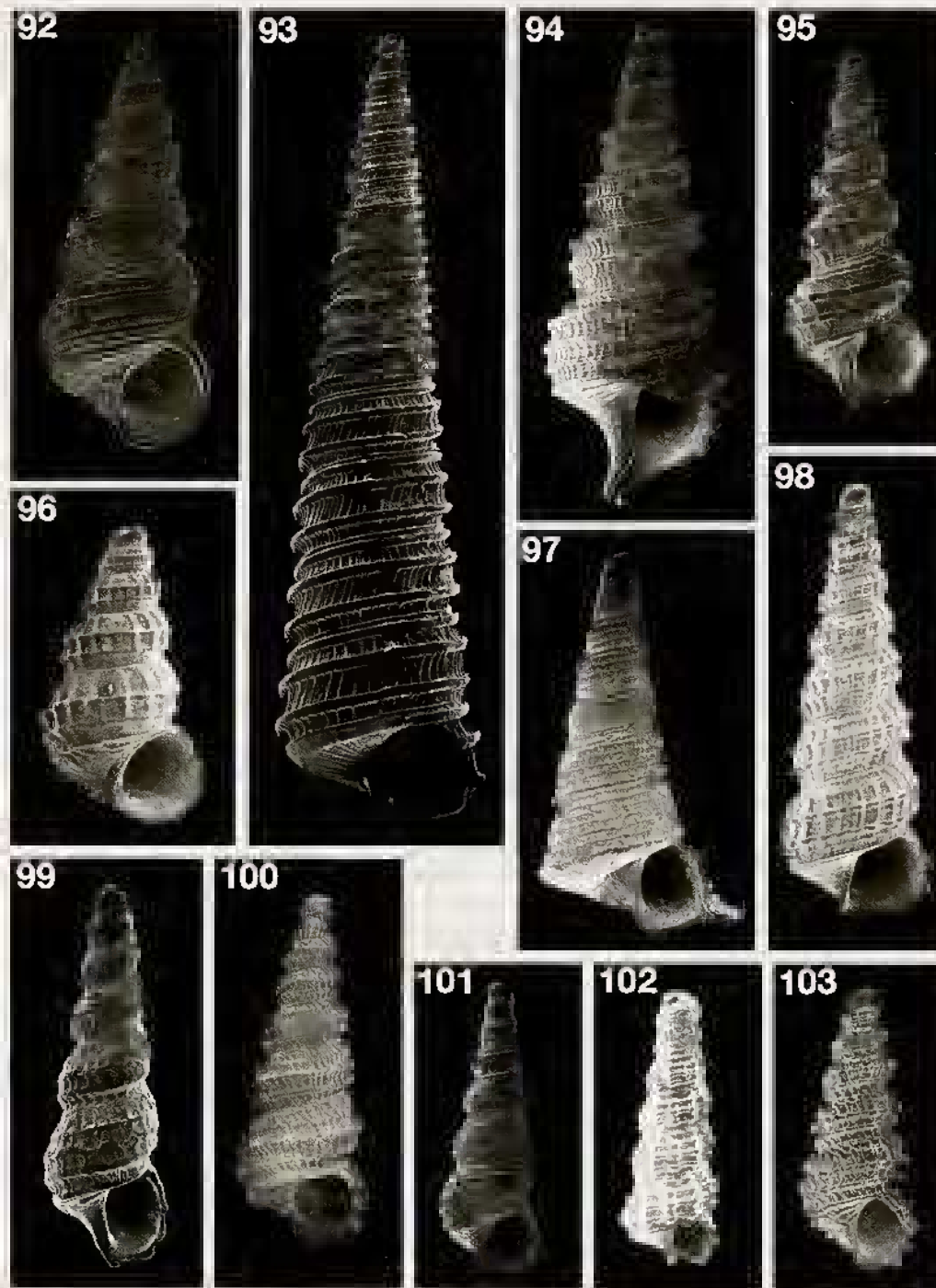
Mathilda eurytima Melvill & Standen, 1896 (: 310-311, pl. 11 [1897], fig. 73), from the Loyalty Islands. This species was based on two specimens. The originally illustrated syntype (MUM EE 3730; H = 6.4, D = 2.6) is here shown in Fig. 94. The second specimen (NMW 1955.158.203; H = 6.4, D = 2.6; *vidi*) is mentioned in the original description as having been called "*Mathilda sineusis*" in an earlier work (MELVILL & STANDEN, 1895: 117; there with reference to non-existing illustration). *Mathilda eurytima* is now known to be based on immature specimens of *Cerithium nodulosum* Bruguière, 1792 (see HOUBRICK, 1992: 126 ff.; TOMLIN, 1936: 150). HOUBRICK gave an illustration of the second specimen (1992: fig. 89E; as *Matilda* [*sic*], erroneously citing the collection number as "NMW 1955158207"). HOUBRICK's (1992: 127) reference to the two type specimens as "syntype" and "paralectotype" does not fulfill ICZN Article 74(b) for a lectotype designation 'by inference of holotype'. The originally illustrated syntype (MUM) is here selected as lectotype.

Mathilda gracillima Melvill & Standen, 1901 (: 378-379, pl. 22, fig. 18); "Gulf of Oman: lat. 24° 55' N, long. 57° 59' E, 37 fathoms [68 m], sand and mud bottom." The original authors did not indicate a single type specimen; TREW's (1987: 43) reference to "Holotype: BM(NH) 1901.12.9.145" qualifies as lectotype designation in accordance with ICZN Article 74(b). This specimen (H = 11.0, D = 4.1; Fig. 95), which agrees with the original illustration and given dimensions ("Long. 11, lat. 4 mm"; MELVILL & STANDEN, 1901: 379), has a homeostrophic protoconch and lacks *Mathilda*-typical outer basal sculpture. It is considered a member of Capulidae (Trichotropidae) by WARÉN (*in litt.*, Dec. 1993).

Mathilda oppia Hedley, 1907 (1907b: 500, pl. 16, fig. 9); Masthead Reef, Capricorn Group, Queensland, Australia, 23°32' S, 151°45' E, 31-37 m. This nominal species was originally described from a "few specimens", without indication of a holotype. The originally figured syntype (AMS C21782; H = 3.35, D = 1.8; Fig. 96) is here selected as lectotype. In contrast to the original description, the specimen does not have a heterostrophic protoconch. It appears to be a member of the Rissoidae, probably belonging to the genus *Alvania* Risso, 1826 (B. MARSHALL *in litt.*, March 1994).

Turritella opulenta Hedley, 1907 (1907a: 292, pl. 54, fig. 9); 5-6 miles off Cape Three Points, NE of Broken Bay, New South Wales, Australia, 74-91 m. *T. opulenta* became type species (OD) of *Glyptozaria* Iredale, 1924 (: 248), a genus that LASERON (1951) erroneously synonymized with *Mathildona* Iredale, 1929 (see discussion under *Mathilda decorata*, above). *Glyptozaria opulenta* was recognized as a member of family Cerithiidae (see HOUBRICK, 1981: 838 ff.). The specimen here illustrated (AMS C16764; Fig. 98) was received as the holotype lot. However, the specimen is smaller (H = 4.2, D = 1.7) and has fewer whorls (TW = 6 1/4) than the specimen of the original description.

Eucharilda pleurorbis Laseron, 1951 (: 331, fig. 84); Manly Beach, Sydney, New South Wales. The smaller of two specimens in the type lot (AMS C103226) has a complete homeostrophic apex and is closest to the original description. It is here selected as lectotype (H = 3.2, D = 1.1; Fig. 101). This nominal species is a synonym of the triphorid *Seilarex turritelliformis* (Angas) (*teste* MARSHALL *in litt.*, March 1994).



FIGS 92-103. — Nominal "mathildids" removed from the family (SEM, uncoated). — **92**, holotype of *Mathildona cookiana*, NMNZ M8842, New Zealand, 9.8 mm. — **93**, holotype of *Mathilda elegantula*, BMNH 1871.7.5.9, New South Wales, 11.3 mm. — **94**, lectotype of *Mathilda eurytima*, MUM EE 3730, Loyalty Islands, 6.4 mm. — **95**, lectotype of *Mathilda gracillima*, BMNH 1901.12.9.145, Gulf of Oman, 11.0 mm. — **96**, lectotype of *Mathilda oppia*, AMS C21782, Queensland, 3.35 mm. — **97**, lectotype of *Mathilda rosae*, AMS C8976, New South Wales, 5.0 mm. — **98**, specimen (type material?) of *Turritella opulenta*, AMS C16764, New South Wales, 4.2 mm. — **99**, lectotype of *Opimilda porrigata*, AMS C103222, New South Wales, 4.1 mm. — **100**, syntype of *Dunkeria pulchella*, 1860, BMNH 1878.1.28.329, Japan, 3.3 mm. — **101**, lectotype of *Fucharilda pleurorbis*, AMS C103226, New South Wales, 3.2 mm. — **102**, holotype of *Opimilda protolineata*, AMS C03225, New South Wales, 2.0 mm. — **103**, syntype of *Dunkeria scabra*, BMNH 1878.1.28.334, Japan, 2.9 mm.

Opimilda porrigata Laseron, 1951 (: 332, fig. 82); Point Halliday, near Taree, New South Wales, Australia. The larger of two syntypes (AMS C103222) is in slightly better condition and is here selected as lectotype (H = 4.1, D = 1.4; Fig. 99). MARSHALL (*in litt.*, March 1993) suggested possible placement in the Cerithiopsidae.

Opimilda protolineata Laseron, 1951 (: 331, fig. 81); Manly Beach, Sydney, New South Wales, Australia (holotype AMS C103225, H = 2.0, D = 0.8; Fig. 102). The species was placed in the Triphoridae, genus *Metaxia* Monterosato, 1884, by MARSHALL (1983: 16).

Dunkeria pulchella A. Adams, 1860 (1860a: 120); from "off Mino-Sima [Mino-Shima]; 63 fathoms", Japan. This species was subsequently referred to as *Mathilda pulchella* (A. Adams) by HABE (1977: 158, fig. 6), and by HIGO & GOTO (1993: 351). Based on sketches taken by MAKIYAMA during his stay in London in 1929, HABE (1977: 158) placed this nominal species in the Mathildidae, arguing that the "figured specimen has the large and globular protoconch and the latticed sculpture on the surface of the shell". The originally figured syntype (BMNH 1878.1.28.329; H = 3.3, D = 1.2; Fig. 100), has a homeostrophic protoconch. It is considered a member of Epitoniidae (WARÉN *in litt.*, Dec. 1993).

Mathilda rosae Hedley, 1901 (: 721, pl. 48, figs 13-14); "Balmoral Beach, Middle Harbor, near Sydney", New South Wales, Australia. The figured syntype (AMS C8976) is here selected as lectotype (H = 5.0, D = 2.8; Fig. 97). This is the type species, (OD), of genus *Charilda* Iredale, 1929 (: 187, no family placement indicated). WARÉN (*in litt.*, March 1994) recognized it as a member of family Eulimidae.

Dunkeria scabra A. Adams, 1860 (1860b: 421); "Tsu-Sima [Tsu-Shima]; 16 fathoms [29 m]", Japan. Based on sketches taken by MAKIYAMA during his stay in London in 1929, HABE (1977: 158-159, fig. 5) placed this nominal species in the Mathildidae, stating that this "is also a member of the genus *Eucharilda* in the family Mathildidae, resembling the young *Eucharilda sineusis* (Fischer)". More recently, HIGO & GOTO (1993: 351) placed the species in *Mathilda sensu stricto*. The syntype in London (BMNH 1878.1.28.334; H = 2.9, D = 1.2; Fig. 103) has a homeostrophic protoconch and a sculpture much unlike *Mathilda sineusis*. WARÉN (*in litt.*, Dec. 1993) recognized it as a member of family Epitoniidae.

Nominal species removed from the *Mathilda* (*sensu lato*) group

Opimilda fastigia Laseron, 1951 (: 332, fig. 83); "Port Stephens", New South Wales, Australia (holotype AMS C103223, *vidi*). The protoconch of the type specimen is not heterostrophic, the species may be related to the following.

Mathilda neozelanica Suter, 1908 (: 40, pl. 3, fig. 53); "Hauraki Gulf", New Zealand. This taxon was made type species of *Brookesena* Finlay, 1926; a group with homeostrophic protoconchs.

Nomiua nuda for Indo-Pacific Mathildidae appearing in the literature

DE BOURY (1911) discussed "*Mathildia*" [*sic*] specimens in the DE FOLIN collection (MNHN). By quoting apparently unpublished label information by DE FOLIN, DE BOURY (1911: 68-69) introduced the following *nomiua nuda* for Indo-Pacific forms:

"*Mathildia complexa*" from "Maurice (?)".

"*M. crenata*" from "iles Andaman (?)".

"*M. effusa*" from "Panama"; recognized by DE BOURY (1911) as the apex of a *Rissoina*.

"*M. incisa*" from "îles aux Perles, Panama (?)".

"*M. ovula*" from "îles aux Perles (?)".

"*M. procera*" from "îles Andaman (?)".

These names, as well as DALL's (1927: 88) *nouveau nudum* "*Mathilda diomedae*", have no nomenclatural standing.

DISCUSSION

Species diversity. The discovery of 15 mathildid species and several additional "forms" in the New Caledonian region further demonstrates the high biotic diversity in this region. Previous reports usually described only a few mathildid species in any given area (e.g., SPRINGSTEEN & LEOBRERA [1986: 57] mention only "1 or 2" species presently reported from the Philippines). A similarly large number of mathildids in the Recent fauna was reported by LASERON (1951) for New South Wales. His *Mathilda*-group comprised nine species. However, as was shown above, six of these belong to other families, two are synonymous and one appears to belong to *Brookesena* (a possible mathildid group without heterostrophy), leaving only one species here considered a member of the *Mathilda*-group.

Morphological diversity. *Rib pattern:* in the past, *Mathilda* (*sensu lato*) has been defined as displaying a pattern of two pairs of primary spiral ribs, with the lower pair usually stronger (GRÜNDEL, 1973: 949; 1976: 342). Several of the New Caledonian taxa show this "2+2" pattern at least on their early teleoconch whorls (*Mathilda* cf. *amauda*, *M. decorata*, *M. houbricki*, *M. sp. A*). Others (*M. maoria*, *M. hendersoni*, *M. richeri*, *M. salve*, *M. sp. aff. sansibarica*) differ slightly by having the third rib more strongly developed, thus displaying a pattern of "2+1+1". There is only a gradual difference between these variant patterns, as exemplified by *M. salve* whose larger shells show an ontogenetic change from "2+1+1" to "2+2". However, other species differ in more profound ways. *M. boucheti* and *M. brevicula* only show 3 ribs, with the central one weakest ("1+1+1"). *Mathilda maculosa* starts the first teleoconch whorl with only three ribs in a "1+2" pattern and then changes ontogenetically to "2+2". *Mathilda fusca* displays a unique "1+2+1" pattern with the outer ribs strongest. *Tuba* species usually show more than four exposed primary ribs. Whether these patterns indeed qualify to describe monophyletic groupings is unclear at this point and will depend on future corroboration by other characters.

Umbilicus: the presence or absence of an umbilicus has been a traditional character to distinguish between mathildid (sub)genera. However, the New Caledonian taxa show a wide range of umbilical features: *Mathilda brevicula* (in contrast to otherwise similar *M. boucheti*) and *Mathilda sp. A* (in contrast to otherwise similar *M. decorata*) have open, funnel-shaped umbilici. Other New Caledonian *Mathilda* species have either solid columellae or narrow umbilical chinks that are more-or-less covered by columellar lip attachments. In *Tuba*, the umbilicus is either open and narrow, or closed by the reflected columellar lip.

Generic subdivision. *Tuba* (or *Gegania*) differs from other investigated mathildids in several characters of the internal anatomy, especially the buccal apparatus (HASZPRUNAR, 1985). However, the wide range of shell features encountered in this study blurs the traditional line of distinction between *Mathilda* and *Tuba* based on shell characters alone. *Mathilda* (*sensu lato*) was usually considered to comprise high-spined shells with few dominant spiral ribs and a protoconch that was distinctly hyperstrophic, but not "upside-down". In contrast, *Tuba* shells were seen as less tall, rounded, with numerous, finer spiral ribs and a strongly hyperstrophic protoconch that was placed almost "upside-down" on the first teleoconch whorl. The specimen recognized as *Mathilda* cf. *hendersoni* has a very slender shell combined with a very strongly hyperstrophic protoconch, while the specimens of *Tuba fuscocincta* start out with a *Mathilda*-like "2+2" teleoconch rib pattern.

Long distance dispersal. Like the species in its supposed sister taxon, Architectonicidae, many mathildid taxa are here found to have wide geographic distribution. Long-range (teleplanic) larval dispersal has been demonstrated for architectonicids (ROBERTSON, 1964; SCHELTEMA, 1968), and the larval shells are very similar in the two families (living mathildid larvae have not yet been described). Further range extensions are likely to be found with increasing knowledge of the group. Again parallel to the situation found in the Architectonicidae (BIELER, 1993), most of the widely distributed Indo-Pacific mathildid species do not appear to extend into the Atlantic Ocean. One possible exception is *Mathilda* cf. *hendersoni*.

Future work. This work is the first step of a revision of worldwide Mathildidae. Further taxonomic changes in this group must be expected. Generic allocations will stabilize as anatomical material becomes available. New synonymies will result from comparisons with Neogene fossils and, possibly, with nominal species not originally described from the Indo-Pacific. Future taxonomic descriptions should not be based solely on juvenile specimens or on shells lacking the protoconch. Descriptions of mathildids must include detailed data on the protoconch (statements such as "bulbous," "globose," or "rather heterostrophic" are insufficient), and they must include illustrations of the teleconch (*i.e.*, by careful drawings or SEM photomicrographs, with sculptural details enlarged). "New" species should be discussed within the context of previously named forms in at least the same ocean system, and should be based on type material that is available to the scientific community (*i.e.*, deposited in accessible, professionally maintained facilities).

ACKNOWLEDGMENTS

Special thanks are due to Philippe Bouchet (MNHN), Bertrand Richer de Forges (ORSTOM) and their colleagues, who collected this material, accomplished the enormous task of presorting the specimens, and who made the material available for study.

For specimen loans, photographs, and assistance with literature or other information, I thank Kenneth J. Boss (Museum of Comparative Zoology, Harvard University, Cambridge, U.S.A.); Wilfrida Decraemer (Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium); Elena Ferrero (Universita degli Studi di Torino, Italy); Mary A. Garback and Gary Rosenberg (ANSP); Tadashige Habe (Natural History Museum, Tokai University, Japan); Elizabeth Hoenson (SAM); the late Richard S. Houbrock (USNM); M.G. Harasewych and Alan Kabat (USNM); Norio Kikuchi (Hanshin Shell Club, Japan); Richard N. Kilburn (NMP); Ian Loch and Winston F. Ponder (AMS); Bruce A. Marshall (NMNZ); Akihiko Matsukuma (National Science Museum, Tokyo, Japan); Henk K. Mienis (HUU); Takashi Okutani (Tokyo University of Fisheries, Japan); P. Graham Oliver and Alison Trew (NMW); Charles Pettitt (MUM); Kathie Way (BMNH); Anders Warén (Naturhistoriska Riksmuseet, Stockholm, Sweden); and the curatorial staff of the Auckland Institute and Museum.

I am grateful to Paula Mikkelsen (Delaware Museum of Natural History), who reviewed an earlier draft of the manuscript, and to Bruce A. Marshall and Anders Warén who shared their notes on some of the species here removed from the family. I thank Philippe Bouchet and an anonymous reviewer who provided very helpful critical comments.

Initial research on mathildid taxonomy was done during a Smithsonian Postdoctoral Fellowship in the Division of Mollusks (USNM). Comparative data on Atlantic species were collected during my stays at the Smithsonian Marine Station at Link Port in Fort Pierce, Florida. I thank Mary E. Rice and her staff for their kind and efficient support. Julianne Piraino provided expert assistance with some of the composite SEM photographs. The final phase of manuscript preparation was supported by the U.S. National Science Foundation under Grant DEB-9318231. This is Smithsonian Marine Station Contribution no. 354.

REFERENCES

- AIBAS, H.L., 1962. — The English Cretaceous Turritellidae and Mathildidae (Gastropoda). *Bulletin of the British Museum (Natural History), Geology*, **7** (6): 173-196, pls 28-32.
- ADAMS, A., 1860a. — Mollusca Japonica: New species of *Aclis*, *Ebala*, *Dmkeria*, &c. *Annals and Magazine of Natural History*, ser. 3, **6**: 118-121.
- ADAMS, A., 1860b. — On a new genus and some new species of Mollusca from Japan. *Annals and Magazine of Natural History*, ser. 3, **6**: 414-422.
- ANDREAE, A., 1887. — Die Glossophoren des Terrain à chailles der Pfirt. *Abhandlungen zur Geologischen Specialkarte von Elsass-Lothringen*, **4** (3): 1-45, pl. 1. R. Schultz & Cie, Strassburg.
- ANGAS, G.F., 1871. — Description of thirty-four new species of shells from Australia. *Proceedings of the Zoological Society of London*, (1871): 13-21, pl. 1.
- AZUMA, M., 1960. — *A catalogue of the shell-bearing Mollusca of Okinoshima, Kashivajima and the adjacent arco (Tosa Province), Shikoku, Japan*. Privately published. Map, 102 pp., pls 1-5, index 17 pp.
- BARNARD, K.H., 1963. — Contributions to the knowledge of South African marine Mollusca. Part III. Gastropoda: Prosobranchiata: Taenioglossa. *Annals of the South African Museum*, **47** (1): 1-199, 37 figs.
- BARNARD, K.H., 1974. — Contributions to the knowledge of South African marine Mollusca. Part VII. Revised fauna list. *Annals of the South African Museum*, **47** (5): 663-781.
- BATTEN, R.L. & STOKES, W.L., 1986. — Early Triassic gastropods from the Sinbad member of the Moenkopi Formation, San Rafael Swell, Utah. *American Museum Novitates*, **2864**: 1-33.
- BAVAY, A., 1922. — Coquilles des sables littoraux marins. *Journal de Conchyliologie*, **67**: 57-66, pl. 1.
- BIELER, R., 1988. — Phylogenetic relationships in the gastropod family Architectonicidae, with notes on the family Mathildidae (Allogastropoda). In: PONDER, W.F. (ed.), Prosobranch phylogeny: Proceedings of a Symposium held at the 9th International Malacological Congress, Edinburgh, 1986. *Malacological Review, Suppl.* **4**: 205-240.
- BIELER, R., 1992. — Gastropod phylogeny and systematics. *Annual Review of Ecology and Systematics*, **23**: 311-338.
- BIELER, R., 1993. — Architectonicidae of the Indo-Pacific (Mollusca: Gastropoda). *Abhandlungen des naturwissenschaftlichen Vereins in Hamburg, (NF)* **30**: 1-376, 286 figs.
- BOURY, E. DE, 1883. — Description d'espèces nouvelles de *Mathilda* du Bassin de Paris et révision du genre. *Journal de Conchyliologie*, **23** (2): 110-153, pl. 5.
- BOURY, E. DE, 1911. — Observations sur les *Mathildia*, de la collection de Folin. *Bulletin du Muséum d'histoire naturelle, Paris*, **17**: 68-69.
- BROCCHI, G., 1814. — *Conchiologia fossile subappennina con osservazioni geologiche sugli Apennini e sul suolo adiacente*. Stamperia Reale, Milan. Vol. 1: lxxx + 240 pp.; Vol. 2: 241-712, 16 pls.
- BRUGNONE, J., 1873. — *Miscellanea malacologica*. Pars prima. Michaelis Amenta, Panormi. 15 pp.
- CLIMO, F.M., 1975. — The anatomy of *Gegania valkyrie* Powell (Mollusca: Heterogastropoda [sic]: Mathildidae) with notes on other Heterogastropods. *Journal of the Royal Society of New Zealand*, **5** (3): 275-288.
- COSSMANN, M., 1888. — Catalogue illustré des coquilles fossiles de l'Éocène des environs de Paris. Troisième fascicule. *Annales de la Société Royale Malacologique de Belgique*, **23**: 3-324, pls 1-12.
- COSSMANN, M., 1912. — *Essais de paléonchologie comparée*, vol. 9. Privately published, Paris. 216 pp., 10 pls.
- COTTON, B.C. & GODFREY, F.K., 1938. — A systematic list of the Gastropoda. The marine, freshwater, and land univalve Mollusca of South and Central Australia. *Malacological Society of South Australia Publication*, **1**, 44 pp.
- DALL, W.H., 1889. — Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico (1877-78) and in the Caribbean Sea (1879-80), by the U.S. Coast Survey Steamer "Blake," Lieut.-Commander C.D. Sigsbee, U.S.N., and Commander J.R. Bartlett, U.S.N., commanding. XXIX. Report on the Mollusca. Part II. Gastropoda and Scaphopoda. *Bulletin of the Museum of Comparative Zoology, Harvard College*, **18**: 1-492, pls 10-40.
- DALL, W.H., 1927. — Small shells from dredgings off the southeast coast of the United States by the United States Fisheries Steamer "Albatross" in 1885 and 1886. *Proceedings of the U.S. National Museum*, **70**: 1-134.
- DELL, R.K., 1956. — Some new off-shore Mollusca from New Zealand. *Records of the Dominion Museum*, **3** (1): 27-59.
- FINLAY, H.J., 1926. — A further commentary on New Zealand molluscan systematics. *Transactions and Proceedings of the New Zealand Institute*, **57**: 320-485, pls 18-23 (volume "issued 10th March, 1927"; article "issued separately, December 23rd 1926").
- FISCHER, P., 1867. — Description d'une espèce nouvelle des îles Chusan. *Journal de Conchyliologie*, **15**: 304-305, pl. 9.
- GARCIA-TALAVERA CASAÑAS, F., [1983]. — *Los moluscos gastropodos antitlánticos (Estudio paleo y biogeográfico de las especies bentónicas litorales)*. Secretariado de Publicaciones de la Universidad de la Laguna, Colección Monografías, **10**, 352 pp., 7 pls.
- GRÜNDEL, J., 1973. — Zur Gastropodenfauna aus dem Dogger. I. Die Gattungen *Mathilda* und *Encycloidea*. *Zeitschrift für geologische Wissenschaften*, **1** (8): 947-965, 1 pl.

- GRÜNDEL, J., 1976. — Zur Phylogenie und Umgrenzung der Gattungen *Mathilda* und *Prounithilia* (Gastropoda). *Jahrbuch für Geologie*, 7-8: 337-351, 1 pl.
- HAAS, O., 1953. — Mesozoic invertebrate faunas of Peru, Part 2. Late Triassic gastropods from central Peru. *Bulletin of the American Museum of Natural History*, 101: 7-328, pls 1-18, 1 chart.
- HABE, T., 1955. — Notes on the systematic position of the genus *Orectospira* Dall 1925. *Dobutsugaku Zasshi (The Zoological Magazine)*, 64 (8): 259-260 [Japanese with English abstract; a modified English version also published in *Minutes of the Conchological Society of Southern California*, 147: 4; 1955].
- HABE, T., 1961. — *Coloured illustrations of the shells of Japan*, vol. 2. Hoikusha, Osaka. xii + 183 pp., 66 pls.
- HABE, T., 1977. — Six species of Japanese shells described by A. Adams. *Venus, Japanese Journal of Malacology*, 36 (3): 157-159.
- HANSHIN SHELL CLUB, 1986. — *Bibliography of Dr. Tokubei Kuroda (for commemoration of his 99th birthday)*. Nishinomiya. 103 pp., 33 pls.
- HARRIS, G.D. & PALMER, K. VAN WINKLE, 1947. — The Mollusca of the Jackson Eocene of the Mississippi embayment (Sabine River to the Alabama River). Second Section including Part II, Univalves and Index. *Bulletin of American Paleontology*, 30 (117): 207-563, pls 26-65.
- HASZPRUNAR, G., 1985. — On the anatomy and systematic position of the Mathildidae (Mollusca, Allogastropoda). *Zoologica Scripta*, 14 (3): 201-213.
- HASZPRUNAR, G., 1988. — On the origin and evolution of major gastropod groups, with special reference to the Streptoneura. *Journal of Molluscan Studies*, 54: 367-441.
- HEDLEY, C., 1901. — Studies on Australian Mollusca, Part III. *Proceedings of the Linnæan Society of New South Wales*, (1900 [4]): 721-732, pl. 48.
- HEDLEY, C., 1903. — Scientific results of the trawling expedition of H.M.C.S. "Thetis" off the coast of New South Wales, in February and March 1898. Mollusca, Part II. Scaphopoda and Gastropoda. *Memoirs of the Australian Museum*, 4 (6): 325-402, pls 36-38.
- HEDLEY, C., 1907a. — The results of deep-sea investigation in the Tasman Sea. 3. — Mollusca from eighty fathoms off Narrabeen. *Records of the Australian Museum*, 6 (4): 273-304, pls 54-56.
- HEDLEY, C., 1907b. — The Mollusca of Mast Head Reef, Capricorn Group, Queensland. Part II. *Proceedings of the Linnæan Society of New South Wales*, 32 (3): 476-513, pls 16-21.
- HEDLEY, C., 1918. — A check-list of the marine fauna of New South Wales. Part I. — Mollusca. *Journal of the Royal Society of New South Wales*, 51, Suppl.: M1-M120.
- HEDLEY, C. & PETERD, W.F., 1905. — Mollusca from three hundred fathoms, off Sydney. *Records of the Australian Museum*, 6 (3): 211-225, pls 37-38.
- HIGO, S., 1973. — *A Catalogue of molluscan fauna of the Japanese Islands and the adjacent area*. 397 pp., 61 pp., index.
- HIGO, S. & GOTO, Y., 1993. — *A systematic list of molluscan shells from the Japanese Is. and the adjacent area*. 23 + 693 + 13 + 149 pp.
- HOUBRICK, R.S., 1981. — Systematic position of the genus *Glyptozaria* Iredale (Prosobranchia: Gastropoda). *Proceedings of the Biological Society of Washington*, 94 (3): 838-847.
- HOUBRICK, R.S., 1990. — Aspects of the anatomy of *Plesiotrochus* (Plesiotrochidae, fam. n.) and its systematic position in Cerithioidea (Prosobranchia, Caenogastropoda). In: WELLS, F.E., WALKER, D.I., KIRKMAN, H., & LETHBRIDGE, R. (eds.), *Proceedings of the Third International Marine Biological Workshop: The Marine Flora and Fauna of Albany, Western Australia*. Vol. 1: 237-249. Western Australian Museum, Perth.
- HOUBRICK, R.S., 1992. — Monograph of the genus *Cerithium* Bruguière in the Indo-Pacific (Cerithiidae: Prosobranchia). *Smithsonian Contributions to Zoology*, 510: i-iv, 1-211.
- INABA, T. & OYAMA, K., 1977. — *Catalogue of molluscan taxa described by Tadashige Habe during 1939-1975, with illustrations of hitherto unfigured species (for commemoration of his sixtieth birthday)*. Tokyo. 185 pp., 7 pls.
- IREDALE, T., 1924. — Results from Roy Bell's molluscan collections. *Proceedings of the Linnæan Society of New South Wales*, 49 (3): 179-278, pls 33-36.
- IREDALE, T., 1929. — Mollusca from the continental shelf of eastern Australia. No. 2. *Records of the Australian Museum*, 17 (4): 157-189, pls 38-41.
- JABLONSKI, D. & LUTZ, R.A., 1980. — Molluscan larval shell morphology. Ecological and paleontological implications. In: RHOADS, D.C. & LUTZ, R.A. (eds.), *Skeletal growth of aquatic organisms*. Topics in geobiology, Vol. 1: 323-377. Plenum Press, New York and London.
- JEFFREYS, J.G., 1884. — On the Mollusca procured during the 'Lightning' and 'Porcupine' Expeditions, 1868-70. (Part VIII.). *Proceedings of the Zoological Society of London*. (1884): 341-372, pls 26-28.
- KENSLEY, B., 1973. — *Sea-shells of southern Africa: Gastropods*. Maskew Miller Ltd. and South African Museum, Cape Town. 225 (+ 11) pp.
- KRACH, W., 1963. — Mollusca of the Babičá clays (Paleocene) of the Middle Carpathians, pt.1: Gastropoda. *Studia geologica polonica*, 14: 1-152, pls 1-27.
- KURODA, T., 1958. — Descriptions of five new species of Japanese marine gastropods. *Venus, Japanese Journal of Malacology*, 20 (2-3): 22-30, pl. 21.

- KURODA, T., HABE, T., & OYAMA, K., 1971. — *The sea shells of Sagami Bay*. Maruzen Co., Tokyo. 741 pp. (Japanese), 121 pls. 489 pp. (English), 51 pp. index, map.
- LASERON, C.F., 1951. — The New South Wales Pyramidellidae and the genus *Mathilda*. *Records of the Australian Museum*, **22** (4): 298-334.
- LEA, I., 1833. — *Contributions to Geology*. Carey, Lea & Blanchard. Philadelphia. 227 pp., 6 pls.
- MACNEIL, F.S. & DOCKERY III, D.T., 1984. — Lower Oligocene Gastropoda, Scaphopoda, and Cephalopoda of the Vicksburg Group in Mississippi. *Mississippi Department of Natural Resources, Bureau of Geology, Bulletin*, **124**: 1-415, incl. 72 pls.
- MACPIERSON, J.H. & GABRIEL, C.J., 1962. — *Marine Mollusca of Victoria*. Melbourne University Press & The National Museum of Victoria. xv + 475 pp.
- MARSHALL, B.A., 1983. — A revision of the Recent Triphoridae of Southern Australia. *Records of the Australian Museum, Suppl.* **2**: 1-119.
- MARWICK, J., 1943. — Some Tertiary Mollusca from North Otago. *Transactions of the Royal Society of New Zealand*, **73** (3): 181-192. pls 25-27.
- MAXWELL, P.A., 1966. — Some upper Eocene Mollusca from New Zealand. *New Zealand Journal of Geology and Geophysics*, **9** (4): 439-457.
- MAY, W.L., 1921. — *A check-list of the Mollusca of Tasmania*. John Vail, Government Printer, Tasmania. 114 pp.
- MAY, W.L., 1923. — *An illustrated index of Tasmanian shells*. John Vail, Government Printer, Tasmania. 100 pp., incl. 47 pls.
- MELVILL, J.C., 1904. — Descriptions of twelve new species and one variety of marine Gastropoda from the Persian Gulf, Gulf of Oman, and Arabian Sea, collected by Mr. F.W. Townsend, 1902-1904. *Journal of Malacology*, **11** (4): 79-85, pl. 8.
- MELVILL, J.C., 1912. — Descriptions of thirty-three new species of Gastropoda from the Persian Gulf, Gulf of Oman, and North Arabian Sea. *Proceedings of the Malacological Society of London*, **10** (3): 240-254, pls 11-12.
- MELVILL, J.C. & STANDEN, R., 1895. — Notes on a collection of shells from Lifu and Uvea, Loyalty Islands, formed by the Rev. James and Mrs. Hadfield, with list of species. Part II. *Journal of Conchology*, **8** (9): 84-130. pls 2-3 [addenda and errata on pp. 131-132 issued January 1896].
- MELVILL, J.C. & STANDEN, R., 1896. — Notes on a collection of shells from Lifu and Uvea, Loyalty Islands, formed by the Rev. James and Mrs. Hadfield, with list of species. Part II. *Journal of Conchology*, **8** (9): 273-315, pls 9-11 [plates issued April 1897].
- MELVILL, J.C. & STANDEN, R., 1901. — The Mollusca of the Persian Gulf, Gulf of Oman, and Arabian Sea, as evidenced mainly through the collections of Mr. F.W. Townsend, 1893-1900; with descriptions of new species. *Proceedings of the Zoological Society of London*, (1901 [2]): 327-460, pls 21-24.
- MELVILL, J.C. & STANDEN, R., 1903. — Descriptions of sixty-eight new Gastropoda from the Persian Gulf, Gulf of Oman, and North Arabian Sea, dredged by Mr. F.W. Townsend, of the Indo-European Telegraph Service, 1901-1903. *Annals and Magazine of Natural History*, ser. 7, **12**: 289-324, pls 20-23 [reprinted in *Journal of the Bombay Natural History Society*, **16**: 86-98, 217-234, pls A-D].
- MICHELOTTI, A.J., 1847. — Description des fossiles des terrains miocènes de l'Italie septentrionale. *Naturkundige Verhandlungen van de Batavaasche Hollandsche Maatschappij der Wetenschappen te Haarlem*, ser. 2, **3** (2): i-vi + 1-408, 17 pls.
- OKUTANI, T. & HABE, T., 1981. — A new species of the genus *Orectaspira* from the Pacific coast of Japan (Gastropoda: Prosobranchia). *Venus, Japanese Journal of Malacology*, **39** (4): 197-199.
- OLIVERIO, M. & NOFRONI, I., 1986. — Sistematica e zoogeografia della "quinta" *Mathilda* del Mediterraneo: *Mathilda gemmlata* Scmper, 1865 (Allogastropoda). *Notiziario C.I.S.M.A.* [Centro Italiano Studi Malacologici], **8-9**: 21-26.
- OLIVERIO, M. & NOFRONI, I., 1988. — Su *Mathilda gemmlata* Scmper 1865 = *M. barbadosis* sensu Warmke & Abbott, non Dall. (Mathildidae: Allogastropoda). *Notiziario C.I.S.M.A.*, **11**: 33-35.
- PIANI, P., 1980. — Catalogo dei molluschi conchiferi viventi nel Mediterraneo. *Bollettino Malacologico*, **16** (5-6): 113-224.
- PIANI, P., 1981. — Errata corrigé ed emendatio n.° 1. *Bollettino Malacologico*, **17** (1-2), Supplement, 12 pp.
- PILSBRY, H.A., 1895. — *Catalogue of the marine mollusks of Japan with descriptions of new species and notes on others collected by Frederick Stearns*. F. Stearns, Detroit. viii + 196 pp., pls 1-11.
- POWELL, A.W.B., 1940. — The marine Mollusca of the Auporian Province, New Zealand. *Transactions of the Royal Society of New Zealand*, **70** (3): 205-248, pls 28-33.
- POWELL, A.W.B., 1971. — New Zealand molluscan systematics with descriptions of new species: Part 7. *Records of the Auckland Institute and Museum*, **8**: 209-228.
- POWELL, A.W.B., 1976. — *Shells of New Zealand. An illustrated handbook*. Fifth revised edition. Whitcoulls Publishers, Christchurch, Sydney, London. 154 pp., 45 pls.
- POWELL, A.W.B., 1979. — *New Zealand Mollusca: marine, land and freshwater shells*. Collins, Auckland, Sydney, London. xiv + 500 pp., 82 pls.
- RICHER DE FORGES, B., 1990. — Les campagnes d'exploration de la faune bathyale dans la zone économique de la Nouvelle-Calédonie. In: CROSNIER, A. (ed.), Résultats des Campagnes MUSORSTOM, vol. 6. *Mémoires du Muséum national d'Histoire naturelle*. Paris, (A) **145**: 9-54, figs 1-13.
- RICHER DE FORGES, B., 1991. — Les fonds meubles des lagons de Nouvelle-Calédonie: généralités et échantillonnages par dragages. In: Le benthos des fonds meubles des lagons de Nouvelle-Calédonie, vol. 1: 7-148. Collection Etudes et Thèses. ORSTOM. Paris. 312 pp.

- RICHER DE FORGES, B., 1993. — Campagnes d'exploration de la faune bathyale faites depuis mai 1989 dans la zone économique de la Nouvelle-Calédonie. Liste des stations. In: CROSNIER, A. (ed.), Résultats des Campagnes MUSORSTOM, vol. 10. *Mémoires du Muséum national d'Histoire naturelle, Paris*, **156**: 27-32.
- RIOS, E.C., 1985. — *Seashells of Brazil*. Fundação Cidade do Rio Grande (etc.), Rio Grande. 329 pp., 102 pls.
- ROBERTSON, R., 1964. — Dispersal and wastage of larval *Philippia krebsii* (Gastropoda: Architectonicidae) in the North Atlantic. *Proceedings of the Academy of Natural Sciences of Philadelphia*, **116** (1): 1-27.
- ROUX, M., et al., 1991. — L'étagement du benthos bathyal observé à l'aide de la soucoupe "Cyana". *Documents et Travaux de l'IGAL*, **15**: 151-165.
- SACCO, F., 1892. — *I molluschi dei terreni terziarii del Piemonte e della Liguria*, Parte XI (Eulimidæ e Pyramidellidæ). Carlo Clausen, Torino. 100 pp., 320 figs.
- SACCO, F., 1895. — *I molluschi dei terreni terziarii del Piemonte e della Liguria*, Parte XIX (Turritellidæ e Mathildidæ). Carlo Clausen, Torino. 46 pp., 3 pls.
- SACCO, F., 1896. — *I molluschi dei terreni terziarii del Piemonte e della Liguria*, Parte XIX (Turritellidæ e Mathildidæ) (1). *Bollettino dei Musei di Zoologia ed Anatomia comparata della R. Università di Torino*, **11** (267): 79-81.
- SCHELTEMA, R.S., 1968. — Dispersal of larvae by equatorial ocean currents and its importance to the zoogeography of shoal-water tropical species. *Nature*, **217** (5134): 1159-1162.
- SEMPER, O., 1865a. — Du genre *Mathilda*. *Journal de Conchyliologie*, **13**: 328-341, pl. 8.
- SEMPER, O., 1865b. — Addition à la monographie du genre *Mathilda*. *Journal de Conchyliologie*, **13**: 341-345, pl. 8.
- SPRINGSTEEN, F.J. & LEOBRERA, F.M., 1986. — *Shells of the Philippines*. Carvel Seashell Museum, Manila. 377 pp. incl. 100 pls.
- SUTER, H., 1908. — Additions to the marine molluscan fauna of New Zealand, with descriptions of new species. *Proceedings of the Malacological Society of London*, **8**: 22-42, pls 2-3.
- TAYLOR, J.B., 1975. — *Planktonic prosobranch veligers of Kaneohe Bay*. Unpublished Ph.D. thesis, University of Hawaii. xiii + 593 pp., illus. [University Microfilms International, Inc., Ann Arbor, Michigan; No. 75-25. 168].
- THIELE, J., 1925. — Mollusca = Weichtiere. In: KÜKENTHAL, W. & KRUMBACH, T. (eds.), *Handbuch der Zoologie. Eine Naturgeschichte der Stämme des Tierreiches*, **5** (1): 15-96, text-figs 9-109. Walter de Gruyter & Co., Berlin, Leipzig.
- THIELE, J., 1931. — *Handbuch der systematischen Weichtierkunde*, **1** (2): 377-778, 313 figs (1931). G. Fischer, Jena.
- TOMLIN, J.R. LE B., 1936. — Shells from the Loyalty Islands. *Proceedings of the Malacological Society of London*, **22**: 145-152.
- TREW, A., 1987. — *James Cosmo Melvill's new molluscan nautes*. National Museum of Wales, Cardiff. 84 pp.
- TSUCHIDA, E., 1986. — Taxonomic revision on two species of the genus *Orectospira* (Gastropoda: Prosobranchia). *Venus, Japanese Journal of Malacology*, **45** (2): 75-86, 3 text-figs, 2 pls.
- WENZ, W., 1939 [in 1938-1944]. — Gastropoda, Teil 1: Allgemeiner Teil und Prosobranchia. In: SCHINDEWOLF, O.H. (ed.), *Handbuch der Paläozoologie*, **6** (3): 481-720, figs 1236-2083.
- WRIGLEY, A., 1940. — Some Eocene Mollusca, with descriptions of new species. *Proceedings of the Malacological Society of London*, **24** (1): 6-17, 21 text-figs.
- ZITTEL, K.A. VON, 1900. — *Text-book of palaeontology*, translated and edited by C.R. Eastman. Vol.1, pt.1. Macmillan & Co, London and New York. viii + 706 pp.