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### SUMMARY

The family Architectonicidae consists of three subfamilies, Architectonicinae, Heliacinae and Pseudomalaxinae.

In the subfamily Architectonicinae five Recent species are included in the subgenus *Architectonica* (*Architectonica*); two Recent, three fossil (one new but unnamed) in the subgenus *A.* (*Discotectonica*); two Recent species in the subgenus *A.* (*Solatisationax*); one Recent species in the subgenus *Philippia* (*Philippia*); two Recent and one new fossil species (*Philippia* (*Psilaxis*) *mitchellana* Garrard) in the subgenus *Philippia* (*Psilaxis*); one Recent species is included as Architectonicinae sp.

In the subfamily Heliacinae, six Recent species, one of which (*Heliacus* (*Heliacus*) *hedleyi* Garrard) is new, and one new Recent subspecies (*Heliacus* (*Heliacus*) *cerdaleus ponderi* Garrard) are included in the subgenus *Heliacus* (*Heliacus*); 10 Recent species, one of which (*Heliacus* (*Torinista*) *corallinus* Garrard) is new, and one new fossil species (*Heliacus* (*Torinista*) *darraghi* Garrard) are included in the subgenus *H.* (*Torinista*); one Recent and two fossil species, one of which (*Heliacus* (*Awarua*) *otwayanus* Garrard) is described as new, and the other un-named, are included in the subgenus *H.* (*Awarua*); seven Recent species, one of which (*Heliacus* (*Claraxis*) *colmani* Garrard) is new, two unnamed and three fossil species, one of which (*Heliacus* (*Claraxis*) *morningtonensis* Garrard) is new and one unnamed, are included in the subgenus *H.* (*Claraxis*).

In the subfamily Pseudomalaxinae, two Recent species, including one new species (*Pseudomalaxis* (*Pseudomalaxis*) *thetidis* Garrard) and two fossil species are included in the subgenus *P.* (*Pseudomalaxis*); one Recent species is included in the subgenus *P.* (*Spirolaxis*).

### INTRODUCTION

This revision has been compiled for the purpose of placing on record all Recent and Tertiary fossil species now known to occur in Australia. It must be noted that it is based only on shell morphology, together with opercula where possible. No attempt has been made to include anatomical or biological data as this could not have been obtained from the large majority of the species dealt with herein.

The Architectonicidae, commonly known to collectors as "sundial" shells, is the only family of Gastropoda possessing hyperstrophic protoconchs and broad conical teleoconchs, varying from moderately tall to flatly depressed; all species possess an umbilicus which varies from deep and narrow to very wide and perspective.

Kosuge (1966) introduced Heterogastropoda as a suborder of the Mesogastropoda, but it has since been suggested by Climo (1975) that the suborder Heterogastropoda should be raised to ordinal rank, that it covers an ill defined but cohesive group, and may be considered as a primitive order of shelled opisthobranchs. As the ordinal name implies, the Heterogastropoda at present is used to contain certain diverse families which up to the present have presented difficulties in classification. A great deal more work obviously remains to be done in the study of soft parts and endeavouring to trace ancestry through fossil records, and until such time as this work is completed the family Architectonicidae appears to be satisfactorily placed in the above order.

The food of most, if not all species of architectonicids appears to consist, from all the evidence available at date, of various forms of coelenterates. The larger species in the genus *Architectonica* in Australia possibly live chiefly on sand dwelling sea anemones, being mainly trawled from moderately deep water on a sandy-mud bottom. Species in the genus *Philippia* are shown by Robertson, Scheltema and Adams (1970) to live in coarse sand adjoining coral reefs and to feed on the coral polyps at night. Most species in the Heliacinae are found, in tropical and sub-tropical waters in Australia, on or near shallow water reefs, probably also feeding on the coral polyps; some are dredged in coarse gravel and rubble, and some in hard-packed sand in fairly shallow water, and gorgonians and sponges as a source of food are a possibility. Much research remains to be done to confirm these suppositions or otherwise.

*Larval distribution.* The long pelagic existence of the larvae of many species in the family would probably account for the disjunct range shown by a number of species in Australia, depending to a great extent on ocean currents for their dispersal. Robertson (1964:1), writing on the genus *Philippia*, shows probable carriage by ocean currents of larvae of *Philippia krebsii* Morch a total distance of 3,450 km from the West Indies to the Sargasso Sea. Robertson, Scheltema and Adams (1970:55) state "duration of the pelagic larval stage is between several weeks and six months or longer." These remarks most likely apply also to a number of other species in the family as a whole.

A period of postlarval arrested growth occurs in the first teleoconch whorl of many species, and occurs shortly after settling to a benthic existence. At least one break occurs in most species, often two, and following this stage, during the search for a host, Robertson, Scheltema and Adams state (1970:55) that the postlarvae can remain alive without food for a period of several months in the case of *Philippia* species. These breaks in the first teleoconch whorl are very apparent in most species of Heliacinae, but barely visible in most species of Architectonicinae, appearing merely as faint growth lines.

*Protoconchs.* The protoconch is the most important character used to determine the placement or otherwise of any species in the family Architectonicidae, especially in the case of a number of minute species with depressed teleoconchs encountered in other families. The hyperstrophic protoconchs of the architectonicids have the whorls rising above the nucleus, which may be viewed through the umbilicus. The term "anastrophe" was proposed by Dautzenberg and Fischer in 1896 to distinguish the architectonicid protoconch from the hyperstrophic protoconchs of the pyramidellids and mathildids, which are set at far wider angles from the teleoconch axes.

These anastrophic protoconchs show differences in coiling, but generally speaking are remarkably uniform throughout the family, the whorls being mostly "regularly" coiled, some inflated, smooth and shining, the peritreme entire and forming an expanded and reflected varix. The axis of coiling of the protoconchs is set at a very slight angle from the teleoconch, never exceeding about 10°. The diameter of the protoconch obviously cannot be utilised alone for the separation of species, but taken in conjunction with other features can be of assistance in a number of cases.

## MATERIAL AND METHODS

Only specimens from the various State Museum collections have been utilised. Apart from uniform descriptions and technical data, comparisons have been made with other closely related species to enable recognition without difficulty. Some minor taxonomic references have been omitted in various cases, those included being all references to the original authors, those containing references to figures, and also references to Australian authors. The taxonomic characters utilised in descriptions of the various species are all considered to be of equal importance, and every portion of each shell, protoconch, teleoconch, sculpture, aperture, etc., is described in detail in each case.

*Method of protoconch measurement.* The Architectonicidae is one of the few families where measurement of the exposed dorsal portion of the protoconch is rendered comparatively simple owing to its depressed nature. A calibrated optic lens through which to view a micro-millimetre scale at a magnification of 30X was utilised to draw a graph whereby measurements could be made to 1/100th mm of the dry protoconchs of all species dealt with in this revision, measuring from the outer edge of the varix to the far side of first whorl.

SUMMARY OF SUBFAMILIES, GENERA and SUBGENERA  
DEALT WITH IN THIS REVISION

## Subfamily ARCHITECTONICINAE

- Architectonica* (*Architectonica*) Roding, 1798  
     (*Discotectonica*) Marwick, 1931  
     (*Solatisonax*) Iredale, 1931  
*Philippia* (*Philippia*) Gray, 1847  
     (*Psilaxis*) Woodring, 1928

## Subfamily HELIACINAE

- Heliacus* (*Heliacus*) Orbigny, 1842  
     (*Torinista*) Iredale, 1936  
     (*Awarua*) Mestayer, 1930  
     (*Claraxis*) Iredale, 1936

(Refer to explanatory remarks under heading HELIACINAE in Systematic section).

## Subfamily PSEUDOMALAXINAE

- Pseudomalaxis* (*Pseudomalaxis*) Fischer, 1885  
     (*Spirolaxis*) Monterosato, 1913

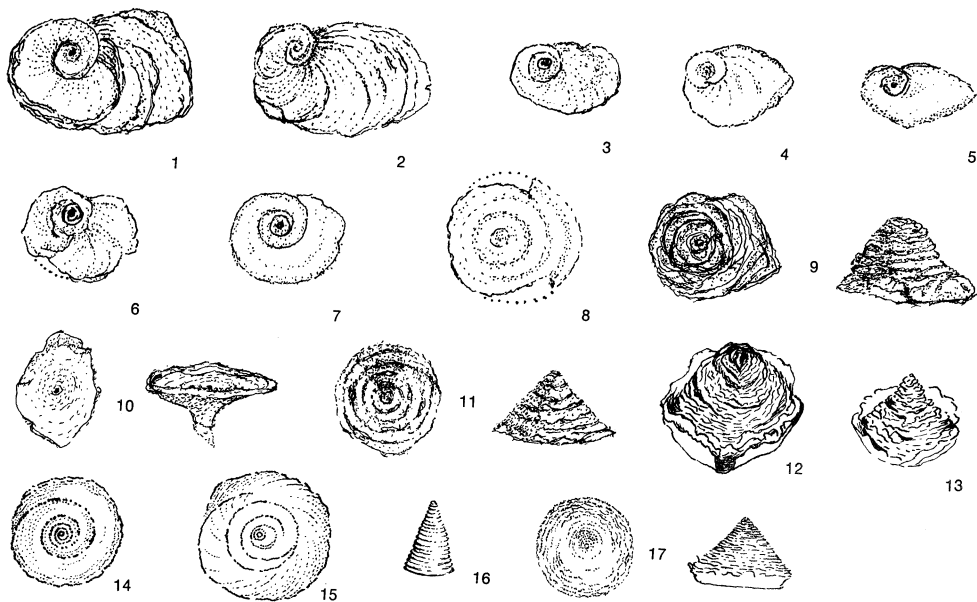
## ORDER OF PRINTING

The type for each genus is printed first if it occurs in Australian waters, otherwise all are in alphabetical order. An index to genera and species is provided at end of the revision.

## ABBREVIATIONS USED

- A.I.M.     Auckland Institute and Museum, Auckland, N.Z.  
 A.M.     Australian Museum, Sydney, N.S.W.

- B.M.N.H. British Museum (Natural History), London, SW7, England.  
 N.M.N.Z. National Museum of New Zealand, Wellington, N.Z.  
 N.M.V. National Museum of Victoria, Melbourne, Victoria.  
 Q.M. Queensland Museum, Brisbane, Queensland.  
 Q.V.M. Queen Victoria Museum, Launceston, Tasmania.  
 S.A.M. South Australian Museum, Adelaide, South Australia.  
 T.M. Tasmanian Museum, Hobart, Tasmania.  
 U.S.N.M. National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.  
 W.A.M. Western Australian Museum, Perth, Western Australia.



Opercula. 1, A. (A). *perspectiva*. X 2.2, A. (A). *maxima* X 2.3, A. (A). *perdix* X 2.7. 4, A. (A). *reevei* X 3.3.5, A. (A). *modesta* X 5.6, A. (D). *acutissima* X 2.5. 7, A. (D). *kuroharai* X 4.8, A. (S). *injussa* X 4.9, H. (H). *stramineus* X 2 (dorsal and side views). 10, P. (P). *novilis meridionalis* X 7 (dorsal and side views). 11, H. (H). *variegatus* X 4 (dorsal and side views). 12, H. (H). *variegatus* X 5. 13, H. (H). *variegatus* X 4. 14, P. (P). *lutea* X 4.5. 15, P. (Ps). *radiata* X 4.5. 16, H. (C). *asperus* X 2.5. 17, H. (T). *dorsuosue* X 6 (dorsal and side view). Fig. 9, 11, 12, 13 and 17 are typical also of H. (H). *hedleyi*, H. (H). *enoshimensis*, H. (H). *madurensis*, H. (T). *fenestratus* and H. (C). *foveolatus*. Figs. 1-11, T. Ireland del. 12-17, J. B. Aitken del.

## SYSTEMATIC SECTION

## Subfamily ARCHITECTONICINAE

DIAGNOSIS: Mainly heavy and solid species, 30-70 mm max. diam., a few as small as 7.5 mm. Single peripheral keel. Sculpture of strong cords and grooves, granose, tessellated or almost smooth. Umbilicus wide and perspective to narrow. Operculum chitinous, thin and flat.

## Genus ARCHITECTONICA Roding, 1798

Subgenus ARCHITECTONICA Roding, 1798. Type species by subsequent designation *Trochus perspectivus* Linnaeus, 1758 (Gray, 1847:151 — mis-spelt *Architectoma*).

REFERENCES: Brookes, 1815:123; H. and A. Adams, 1858:241; Chenu, 1859:232 (*Solarium*); Tryon, 1887:5 (*Solarium*); Suter, 1913:315; Wenz, 1938-44:670; Bayer, 1940:223 (*Solarium*).

SYNONYMS: *Solarium* Lamarck, 1799. Type species by original designation *Trochus perspectivus* Linnaeus, 1758.

DIAGNOSIS: Large to very large, medium to low conical; medium to wide perspective umbilicus; strong peripheral keel separated by a deep groove from both a dorsal and basal cingulum; usually both axially and spirally grooved and beaded, especially in early whorls; flat horny operculum. No species in this subgenus recorded from any Australian locality possesses an anal keel on protoconch.

**Architectonica (Architectonica) perspectiva** (Linnaeus, 1758) Figs. 1 (1-6), 2 (1-3).

*Trochus perspectivus* Linnaeus, 1758:757, no. 503; 1767:1227, no. 581; Gmelin, 1791:3566, no. 3.

*Architectonica perspectiva*. — Roding, 1798:78, no. 1022; Hedley, 1918:101; Oostingh, 1925:29-32; Tomlin, 1928:332; Wilson and Gillett, 1971:34, pl. 13, fig. 11.

*Solarium perspectivum* — Lamarck, 1799: . — Montfort, 1810:163. — Lamarck, 1816: pl. 46, fig. 1. — Wood, 1825:137, pl. 29, fig. 62c. — Sowerby (1820-25) 1831, no. 38, pl. 202. — Reeve, 1864, sp. 11, pl. 2, fig. 11b (not 11a). — Fischer, 1887:715, pl. 9, fig. 15. — King and Ping, 1931:269, fig. 4.

*Solarium incisum* Philippi, 1849:169, no. 45; 1853:27, no. 30, pl. 4, fig. 6.

*Solarium formosum* Hinds, 1844:22. — Bayer, 1940:243.

*Solarium (Architectonica) perspectivum*. — Hanley (Sowerby), 1863:228, pl. 4 (253), figs 36-38.

*Solarium australe* Philippi, 1849:168 (non Morch, 1875). — Bayer, 1940:242.

*Solarium perspectivum* var. *heurni* Bayer, 1940:243, fig. 4.

*Architectonica perspectiva fressa* Iredale, 1936:325, pl. 23, fig. 20.

DESCRIPTION: *Protoconch* regularly coiled, varying .83-1.00 mm diam. *Teleoconch* depressed conic, up to 9½ convex whorls in width of 60 mm, base flatly convex. *Sutures* deeply incised, joined above peripheral keel. *Sculpture* consists of 2 nodular cords, at either margin of whorls, upper cord larger and flattened, with deep narrow sulcus below

it, lower cord higher but narrower; axial sculpture of strong deep oblique grooves across all whorls, resulting in formation of many elongate oblique segments, in addition to fine growth lines; lower nodular cord on body-whorl is divided from peripheral keel by a strong narrow cingulum; this cingulum and the peripheral keel are both covered by suture in earlier whorls; sculpture of base consists of a wide strong rounded cord divided from peripheral keel by one fine narrow cord, and whole base is covered by strong flattened ridges axially with narrow interstices; channels in base covered with light brown periostracum in live specimens. *Umbilicus* widely perspective, 36-40% of shell diameter at maturity; unbilical cord with crowded axially elongate crenulations, centrally ridged and bluntly pointed; outer periumbilical cord with smaller elongate nodules, with a deep sulcus on either side; umbilical canal with convex base, strongly obliquely wrinkled, covered with light brown periostracum. *Aperture* sub-rhomboid, wider towards outer-lip; inner-lip straight with two narrow channels below, extending into aperture for short distance. *Colour* greyish-fawn, chocolate-brown and white (or light brown) spots alternately on lower nodular cord adjoining keel; reddish-brown and white spots alternately on peripheral keel; nodular cord below sutures brown on upper half and white below; a further band of square black-brown spots, or alternatively a continuous black-brown band occurs below the bi-coloured band; heavy cingulum on base adjoining peripheral keel is brown and white spotted; square-cut ends of flattened ridges towards umbilicus are chocolate brown; smaller periumbilical cord whitish with red-brown interstices; main umbilical cord usually medium brown. *Operculum* fawn, widely elliptic, fibrous horny material with thin lamellate growth layers ascending counter-clockwise; nucleus in small spiral depression in top left corner; usual mamillate projection behind nucleus.

TYPE LOCALITY: "Asiae littora" (Linnaeus). Amboyna; Australia (Reeve).

DIMENSIONS: Holotype, 2¼ pollices (Gmelin) = 57.1 mm. Largest specimen examined, max. diam. 61.2 mm, min. diam. 55.1 mm, alt. 35.3 mm, 9½ whorls.

LOCATION OF TYPE: Linnaean Society, London, reg'd number not ascertained.

DISTRIBUTION: From W. of North-West Cape, W. Australia (21° 50' S., 113° 46' E.), northwards round Northern Territory, Gulf of Carpentaria, southwards along Queensland coast to Sydney Harbour, New South Wales. Greatest depth recorded, 54 metres off Tweed Heads, New South Wales. Widespread throughout Indo-Pacific and northwards to Japan, tropical to temperate.

MATERIAL: W. of North-West Cape as above, 2 specimens coll. C.S.I.R.O., Stn. 173, 6/10/1963, W.A.M. No. 58-73. Furthest south on east coast as above, Sydney Harbour, holotype of *A. perspectiva fressa* Iredale, A.M. No. C. 60679. Greatest depth as above, 54 metres Tweed Heads, ex T. A. Garrard coll, A.M. No. C. 87101, which is also largest specimen examined as above. Total specimens examined from all Australian Museums 477 (160 lots). Probably 30% of all specimens brought up by trawl nets in southern Queensland and northern New South Wales are taken alive, but most have the mollusc and operculum removed before sale and an accurate percentage is not possible.

DISCUSSION: The colour pattern in this species varies considerably throughout its range, also the position of the suture to a small extent, being placed occasionally at base of a deep narrow canal; examination of many specimens from Queensland and New South Wales shows a number conforming in colour to the descriptions of the five varieties included in the synonymy. An interesting colour variation is illustrated at fig. 1(1-3) from 37-49 metres off Yamba, New South Wales, the usual second dark band below the suture being replaced by oblique axial stripes. A number have been taken from this area, some also having basal striping. In 2 specimens from Groote Eylandt, Northern

Territory, pure white crenulations on last 2 whorls of umbilical cord replace light brown in primary whorls (A.M. No. C. 69038).

The elongate oblique segments formed by the intersections of axial grooves with the one spiral sulcus, contrast with the granulated appearance of the early whorls in *Architectonica maxima* (Philippi). The whorls are also narrower in *A. perspectiva*, resulting in a shell at maturity with approximately one more whorl than a specimen of *A. maxima* of equal diameter.

**Architectonica (Architectonica) maxima** (Philippi, 1848) Fig. 2 (4-9).

*Solarium maximum* Philippi, 1848:170, no. 47; 1853:6, no. 2, pl. 1, figs 2, 3. — Reeve, 1864, pl. 1, fig. 4. — Marshall (Tryon), 1887:9, pl. 3, fig 31, 32. — Hedley, 1903:349, fig. 73. — Bayer, 1940:227.

*Solarium (Architectonica) maximum*. — Sowerby, 1863:229, pl. 1, figs 5, 6.

*Solarium taylori* Hanley (Sowerby), 1863:230, pl. 3, figs 31, 32; Marshall (Tryon), 1887:10, pl. 3, figs 33, 34.

*Architectonica maxima*. — Hedley, 1917:101; Wilson and Gillett, 1971:34, pl. 13, fig. 12.

*Architectonica grandiosa* Iredale, 1931:228, pl. 25, figs 19, 20.

*Solarium grandiosum*. — Bayer, 1940:226.

DESCRIPTION: *Protoconch* regularly coiled, varying from .83-1.00 mm diam. *Teleoconch* depressed conic, 8½ flatly convex whorls in diam 70 mm, base flatly convex. *Sutures* deeply impressed, joined above peripheral keel *Sculpture* of 4 gemmate cords on each whorl, becoming flat-topped and smoother on penultimate and body-whorl, separated by deep square-cut spiral grooves, the whole crossed by deeply incised axial grooves on all whorls, resulting in a general gemmate appearance; sculpture on base consists of a rounded spiral cord near periphery, separated from larger peripheral keel by a square-cut sulcus; this is followed by a wide space, then 2 further square-cut sulci with narrow crenulated cord between, the whole crossed by fine growth lines; basal sulci usually show signs of light brown periostracum on good specimens. *Umbilicus* widely perspective, averaging 30% of shell diameter at maturity, encircled by heavy white cord with sharp-edged and pointed crenulations; umbilical canal with convex base, strongly wrinkled, covered with folded light brown periostracum. *Aperture* sub-quadrate, external edge and base crenulated by cords, inner-lip straight or slightly arcuate, with deep narrow groove below. *Colour* light greyish-fawn, flattened cingulum below suture with brown and white spots alternately; peripheral keel and cingulum above, also cingulum on base adjoining, are similarly coloured; second smaller periumbilical cord finely spotted brown, and 2 or 3 rows of square brown spots or dashes extend further towards edge of base. *Operculum* light brown, horny, with close-packed fine curved overlapping scales, radiating from nucleus in a coiled circular depression in top left corner counter clockwise, at rear of which is a well raised mamillate nodule.

TYPE LOCALITY: None given. Reeve states "Java; Ceylon."

DIMENSIONS: Holotype, max. diam. 64.3 mm, alt 29.8 mm. Approx. max. size 70 mm, 8½ whorls.

LOCATION OF TYPE: Unknown, unable to trace.

DISTRIBUTION: Shark Bay, Western Australia (25° 30' S., 113° 30' E.), northwards to 32 km N.W. of Anchor Island, off Onslow, Western Australia (21° 31' S., 114° 46' E.),



eastwards along whole northern coastline, and southwards along Queensland and New South Wales coasts to Port Jackson. Greatest depth recorded, 114-124 metres N.E. of Cape Moreton, Queensland (27°02' S., 153°28' E.) Widespread throughout eastern Indian Ocean, western Pacific Ocean and northwards to Philippine Islands and Japan.

**MATERIAL:** Shark Bay as above, 1 specimen coll F. Back 7/1960, W.A.M. No. 149-73. Off Anchor Island as above, 6 specimens, 118 metres, 17/6/60, W.A.M. No. 71-73. Port Jackson as above, 1 specimen "*Triton*" dredge, eastern channel, ex J. Kerslake coll, A.M. No. C. 91666. Greatest depth as above, 1 specimen ex T.A. Garrard coll, A.M. No. C. 91667. Total specimens examined from all Australian Museums 88 (56 lots). The same remarks apply to this species as they do to *Architectonica perspectiva* regarding live specimens, probably 30% or more being taken alive in southern Queensland and northern New South Wales, but exact percentage is a matter of conjecture.

**DISCUSSION:** This species is very variable in colour pattern, the various spots and dashes of brown being distributed indiscriminately in many specimens, and the two species *Solarium taylori* Hanley and *Architectonica grandiosa* Iredale both fall within the range of variation. A brown coloration is also found on the crenulations of the umbilical cord in some instances. One feature which invariably separates this species from *A. (Architectonica) perspectiva* is the presence of at least two, usually three, sharply-cut spiral sulci between the sutures and periphery, compared with one only in all specimens of *A. (A.) perspectiva* examined.

***Architectonica (Architectonica) modesta* (Philippi, 1848) Fig. 1 (7-9)**

*Solarium modestum* Philippi, 1848:171; 1853:15, pl. 3, fig. 1; Reeve, 1864: pl. 2, fig. 12;

Marshall (Tryon), 1887:9, pl. 2, figs 22, 23; Bayer, 1940:228.

*Solarium (Architectonica) modestum*. — Hanley (Sowerby), 1863:229, pl. 1, figs 11, 12; pl. 3, figs 27, 28.

**DESCRIPTION:** *Protoconch* regularly coiled, varying 1.00-1.17 mm diam. *Teleoconch* depressed conic, 6½ whorls in width of 36 mm, becoming increasingly convex, base flatly convex. *Sutures* well impressed, joined above peripheral keel. *Sculpture* — two strongly beaded spiral cords below sutures, becoming smooth on body-whorl at maturity, a sharply-cut sulcus below each, one flatly-beaded cord towards periphery, flatly-ribbed space between; peripheral keel on body-whorl lightly axially grooved, covered by sutures in earlier whorls; fine rounded ridge on base separates peripheral keel from a further high rounded cingulum, central area of base lightly axially grooved. *Umbilicus* perspective, 30% of shell diameter at maturity, umbilical cord with sharply pointed crenulations; a further flat-topped periumbilical cord surrounds the first, grooved on either side; umbilical canal flat-based, crossed by strong irregular growth lines. *Aperture* sub-quadrate, three fine grooves behind peripheral keel and adjoining cingula, two further fine grooves at base of inner-wall, which is vertical. *Colour* — sub-sutural cingulum white, only occasionally spotted with brown, adjoining cingulum continuous dark brown, alternatively light brown with dark brown spots; central space light grey-brown, adjoining cord spotted, peripheral keel white or spotted brown; base light greyish-white, umbilical cord white, very seldom spotted brown; a few scattered brown spots on base of some specimens. *Operculum* thin, concave and chitinous, horn-coloured, widely elliptic, concave nucleus near top inner margin, spiral to commence then expanding rapidly in size counter-clockwise, with strong curved growth lines curved clockwise; reverse side attached to mollusc in shell and not observed.

**TYPE LOCALITY:** Unknown (author). "China; Society Islands" (Reeve).

*DIMENSIONS*: Holotype, diam. 25.37 mm, alt. 11.63 mm, diam. of umbilicus 7.4 mm. Average full grown specimen, max. diam. 36 mm, minor diam. 30 mm, alt. 17 mm, 6½ whorls.

*LOCATION OF TYPE*: Unknown, unable to trace.

*DISTRIBUTION*: W. of Flat Island, near Onslow, Western Australia across north coast and southwards down Queensland coast, noted from Port Douglas, north Queensland (16° 29' S., 145° 28' E.), off Noosa Heads, 106 metres, to N.E. of Cape Moreton, Queensland (27° 02' S., 153° 28' E.), 125 metres. Extends throughout Indonesia, Philippine Islands, Papua New Guinea, Solomon Islands, New Hebrides to Tahiti, also China coast and Japan. Shallow water to 125 metres.

*MATERIAL*: W. of Flat Island as above, two specimens 19/6/60, W.A.M. No. 77-73. Port Douglas as above, one specimen, A.M. No. C. 22076. Off Noosa Heads as above, one specimen pres. Ron Evans, A.M. No. C. 98862. Off Cape Moreton as above, two specimens pres. L. Moore, A.M. No. C. 98750. Total specimens examined from all Australian Museums 24 (11 lots).

*DISCUSSION*: This species bears a strong general resemblance to *A. (Architectonica) perspectiva* (Linnaeus), but can be distinguished by the following four points:

1. The protoconch is larger and more inflated, 1.00-1.17 mm diameter compared with. 83-1.00 mm in *A. (A.) perspectiva*.
2. The cord of white beads below the suture, becoming smooth with age, frequently has a few scattered small brown spots on the body-whorl, but is never completely brown on the upper-half as in *A. (A.) perspectiva*.
3. The dark brown band immediately below the above white cord has a clear-cut sulcus below it, in addition to the sulcus above it found in both species.
4. The crenulated umbilical cord is usually pure white, only rarely brown spotted.

***Architectonica (Architectonica) perdix* (Hinds, 1844) Fig. 1 (13-15)**

*Solarium perdix* Hinds, 1844a:22; 1844b:50, pl. 14, figs 3, 4; Philippi, 1853:8, pl. 1, figs 8, 9; Reeve, 1864: pl. 1, fig. 1; Marshall (Tryon), 1887:9, pl. 2, figs 24, 25; Bayer, 1940:233. *Solarium (Architectonica) perdix*. — Hanley (Sowerby), 1863:233, pl. 2, figs 17, 18.

*Architectonica perdix*. — Hedley, 1916:46; Rippingale and McMichael, 1961:63, pl. 6, fig. 25; Wilson and Gillett, 1971:34, pl. 13, fig. 9.

*DESCRIPTION*: *Protoconch* regularly coiled, vaying .65-.83 mm diameter. *Teleoconch* conic, seven flatly convex whorls in width of 37 mm, body-whorl contracting towards base, base of shell slight convex in centre. *Sutures* finely and deeply incised, joined above peripheral keel. *Sculpture* — two nodular spiral cords commence on first whorl, the uppermost adjoining suture above and finer than that below, which is close to lower suture; both cords expand in size and become flattened with age; wide area between cords strongly incised by numerous growth lines; body-whorl shows peripheral keel divided into two rows of flat square nodules, suture covering lower row in preceding whorls; base of shell slightly convex in centre; a strong spiral cord runs closely inside peripheral keel, whole base crossed by numerous strong growth lines; remains of fawn periostracum in channels when in good condition. *Umbilicus* perspective, average 23% of shell width at maturity, umbilical cord with strong crenulations, axially ridged and serrated; second smaller periumbilical cord of more flattened nodules and having a strongly incised line on either side; umbilical canal with convex base, strongly wrinkled,

covered with fawn periostracum. *Aperture* sub-rhomboid, inner-lip vertical with narrow channel beneath for short distance; outer-lip thin and simple. *Colour* greyish-fawn, nodular cords both above and below sutures spotted with brown; peripheral keel and adjoining cord on base similarly spotted; faint brown markings occasionally on either or both periumbilical cords. *Operculum* fawn, broadly ovate, of fibrous horny material, slightly concave, deeply depressed nucleus towards top left corner, numerous thin lamellate growth layers coiled counter-clockwise; a small protuberance consisting of several minute nodules at rear of nucleus.

TYPE LOCALITY: "Ceylon; N.W. coast of Australia." (Hinds).

DIMENSIONS: Holotype, max. diameter 34.5 mm, min. diameter 28.7 mm, alt. 18 mm. (Hinds drawing). Approximate max. size 37 mm with 7 whorls.

LOCATION OF TYPE: Should be with B.M.N.H. but cannot be traced.

DISTRIBUTION: Western Australia, Cambridge Gulf — Lower Ord River (14° 55' S., 128° 15' E.), eastwards through Darwin, Millingimbi and Crocodile Island, Northern Territory; off Normanton, Gulf of Carpentaria, and southwards along Queensland coast to Bargara, Burnett River mouth, Queensland (24° 49' S., 152° 28' E.), widely distributed north and north-east of Australia, through Indonesia, P.N.G., Solomon Islands, Penang and Malaysia. Sub-tidal.

MATERIAL: Cambridge Gulf as above, 1 specimen coll B. G. Thom June 1971, W.A.M. No. 151-73; Darwin as above, three specimens, A.M. No. C. 12226; Millingimbi as above, two specimens ex J. Kerlake coll, A.M. No. C. 91670; off Normanton as above, two specimens ex T.A. Garrard coll, A.M. No. C. 91671. Total specimens examined from all Australian Museums 322 (54 lots).

DISCUSSION: The closest congener to this species is *A. (Architectonica) reevei* Hanley. The main differences are:

1. The small protoconch in the within species, .65-.83 mm compared with 1.00-1.18 mm diam. in *Architectonica reevei*.
2. The sharply pointed crenulations on umbilical cord compared with the rough crowded crenulations in *A. reevei*.
3. No spiral grooves or ridges on the broad central area of each whorl, compared with several grooves and ridges in *A. reevei*.
4. Position of suture — see "Discussion" under *A. (A.) reevei*.

***Architectonica (Architectonica) reevei* (Hanley, 1862) Fig. 3 (1-9)**

*Solarium reevei* Hanley, 1862:204. — Reeve, 1864: pl. 3, fig. 20; Marshall (Tryon), 1887:12, pl. 4, figs 45, 46; Iredale, 1931:228; Bayer, 1940:251.

*Solarium (Architectonica) reevei*. — Watson, 1886:136; Hanley (Sowerby), 1863:234, pl. 250, figs 9, 10.

*Architectonica reevei*. — Angus, 1867:201. — Hedley, 1917:102; May, 1923:97, pl. 46, fig. 2; Wilson and Gillett, 1971:34, pl. 13, fig. 10.

*Architectonica offlexa* Iredale, 1931:229, pl. 25, figs 15, 16.

*Architectonica relata* Iredale, 1936:326, pl. 23, fig. 19.

DESCRIPTION: *Protoconch* elevated and inflated, varying 1.00-1.18 mm diam. *Teleoconch* conical, 6½ flatly convex whorls in diam. of 30 mm, base flatly convex. *Sutures* strongly incised, joined at centre of peripheral keel. *Sculpture* commences with

one small nodular cord at top and two at base of each whorl; from third whorl onwards a second flatly nodular cord develops at top, after which further incised lines appear, resulting in 3-4 flat cords between the double row of nodules on each whorl, but in suppressed form in some specimens; whole sculpture crossed by oblique microscopic growth lines; base of shell with one fine cord adjoining peripheral keel, whole base crossed by numerous fine growth lines. *Umbilicus* perspective, varying widely from 23% to 30% of shell diameter at maturity; umbilical cord with strong axially ridged crenulations, a second smaller periumbilical cord with flat nodules; umbilical canal flat-based, strongly obliquely wrinkled, covered with pale straw coloured periostracum. *Aperture* sub-rhomboid, inner-lip straight and vertical, a fine narrow groove below for short distance into aperture. *Colour* light greyish-fawn, nodular cords both above and below sutures brown spotted, also peripheral keel and cingulum above; cord adjoining peripheral keel on base and two periumbilical cords similarly spotted; wide space between cords often has 2-3 rows of microscopic brown spots. *Operculum* fawn chitinous material, broadly ovate, thin and frail, concave, coiled counter-clockwise, microscopic overlapping growth ridges curved clockwise, nucleus in centre of depressed section in top left corner; small mamillate protuberance behind nucleus.

TYPE LOCALITY: None given. "Sydney" (Reeve).

DIMENSIONS: Holotype, diam. 22 mm, alt. 14 mm. Average fully grown specimen approx. 30 mm x 17 mm, 6½ whorls.

LOCATION OF TYPE: The specimen figured by Hanley in *Thes Conch* (Sowerby), 3:234, pl. 250, figs 9, 10, and also that figured in *Conch Icon* (Reeve) 15, pl. 3, fig. 20, are both held at B.M.N.H. It is uncertain whether either of these two specimens from the Cuming coll. is that from which Hanley made his original description in *Proc Zool Soc Lond*, 1862:204, since he mentioned only one shell and gave no locality.

DISTRIBUTION: On west coast, two records, S.W. of Point Cloates, Western Australia (23° 39' S., 113° 11' E.), and 160 km N.W. of Roebuck Bay (16° 58' S., 120° 47' E.), 194 metres. Range is disjunct until appearance in South Australia, not recorded from Victoria but probably lives on Gippsland coast, and in Tasmania appears only to be recorded from Marion Bay on S.E. coast (42° 48' S., 147° 55' E.) Northwards the species is common in southern New South Wales, becoming scarcer further north, limit of range being southern Queensland in vicinity of Caloundra-Cape Moreton area (27° 02' S., 153° 28' E.) Greatest depth recorded 137 metres off Broken Bay, New South Wales (33° 33' S., 151° 20' E). Mainly sub-tidal. Also occurs in North Island of New Zealand.

MATERIAL: N.W. of Roebuck Bay as above, 1 specimen coll B.M.R. 29/11/67, M.V. "Kos 2" (K67-248), A.M. No. C. 95293. Marion Bay as above, N.M.V. (ex Q.V.M.), 2 specimens, not reg-d. Cape Moreton as above, 5 specimens 114-124 metres, ex T. A. Garrard coll. A.M. No. C. 91675. Greatest depth as above off Broken Bay, 3 specimens ex T. A. Garrard coll, A.M. No. C. 91677. Total specimens examined from all Australian Museums 187 (64 lots).

DISCUSSION: An almost infallible recognition point in this species is the position of the suture, joined directly to the centre of the peripheral keel in lieu of to the base of the groove above it. This fact was pointed out by the author Hanley (1862:205) and also by Bayer (1940:251), who stated that he knew of no other species in the genus where this occurs. This feature is quite clear in the holotypes of *Architectonica offlexa* Iredale, 1931, and also *A. relata* Iredale, 1936, which are both conspecific. This feature is also common to the genus *Philippia*.

Two specimens off Cronulla, New South Wales, 80 metres, coll J. McIntyre 3/2/65, 5 adult whorls, A.M. No. C. 90550. (One specimen, after completion of one main whorl, transferred suture below peripheral keel, on to groove between peripheral keel and adjacent cingulum, giving an imbricating effect to shell, there being no sign of breakage to cause alteration).

Two specimens, Watson's Bay, New South Wales (Port Jackson), coll 1930, A.M. No. C. 73585. (In these two further shells suture is attached to base of peripheral keel in lieu of centre, which does not give any effect of imbrication; however, in last 5 mm of body-whorl one has transferred suture underneath into groove as with one noted above).

Specimen shown under "Distribution" from 160 km N.W. of Roebuck Bay, Western Australia, is only 7.1 mm diam. and is clear and glass-like. However, all features, including position of suture, are clearly those of *A. (A). reevei*, and in view of the other record above from Point Cloates, W. Australia, it is accepted as being this species.

Subgenus *DISCOTECTONICA* Marwick, 1931:101. Type species by original designation *Architectonica balcombensis* Finlay, 1927a:501 (new name for *Solarium acutum* Tenison-Woods, 1879, non Conrad 1860).

References: Wenz, 1938-44:671.

Synonyms: *Acutitectonica* Habe, 1961: Append. 10. Type species by original designation *Solarium acutissimum* Sowerby, 1914. *Russetia* Garrard, 1961:23. Type species by original designation *Russetia dilaniatus* Garrard (= *Discotectonica acutissima* (Sowerby, 1914)).

DIAGNOSIS: Large, acutely depressed conic; large perspective umbilicus; periphery flatly compressed without distinct keel or adjoining cingula as in *Architectonica*; suture follows periphery, which is therefore not embraced by the ovate aperture. (In common with the synonymous subgenus *Acutitectonica* this subgenus does not possess an anal keel on the protoconch).

#### ***Architectonica (Discotectonica) acutissima* (Sowerby, 1914) Fig. 1 (16-18), 2 (19-21)**

*Solarium acutissimum* Sowerby, 1914:36, pl. 2, fig. 9.

*Acutitectonica acutissima*. – Habe, 1961:30, pl. 13, fig. 21; Habe, 1964:46, pl. 13, fig. 21.

*Russetia dilaniatus* Garrard, 1961; 23, pl. 1, fig. 11.

DESCRIPTION: *Protoconch* regularly coiled, .76 mm diam. *Teleoconch* flatly depressed, 6½ whorls in diam. of 38 mm at maturity, slightly concave; base concave near periphery, convex in centre. *Sutures* obscured by peripheral keel of previous whorl and slightly imbricating. *Sculpture* of 8-10 raised spiral cords, tending to bifurcate on body-whorl and penultimate; in early whorls these are bounded by a thicker gemmate cord adjoining the crenulate periphery, which becomes smoother with maturity; whole sculpture decussated by numerous fine growth lines; sculpture of base consists of numerous incised spiral lines, crowded near periphery, with narrow rounded cords between, more widely spaced towards umbilicus with flat areas between, the whole over-ridden by numerous fine growth lines. *Umbilicus* widely perspective, averaging 32% of shell width at maturity; umbilical cord with crowded sharply raised and pointed crenulations, which tend to flatten with maturity; a finely incised sulcus separates umbilical cord from a further sharply crenulated periumbilical cord, then a broad spiral sulcus, followed by a third cord of more flattened nodules; umbilical canal flat-based, strongly obliquely striated. *Aperture* flatly ovate, constricted towards periphery, inner

margin straight but inclined to right at base, a narrow groove below it. *Colour* cream, tending to light grey below sutures with oblique radial fawn streaks, a fawn band in top centre of aperture, edge of umbilicus lightly tinted with same colour. *Operculum* widely ovate with sub-marginal concave nucleus, spiral layers of thin fawn chitinous material, with light brown ring round nucleus and brown rays radiating towards periphery; expands rapidly in area, finely irregularly granulated over whole surface.

TYPE LOCALITY: Kii (Wakayama Pref.), Honshu, Japan.

LOCATION OF TYPE: B.M.N.H. Reg'd. No. 1915/1:6:100.

DIMENSIONS: Holotype, max. diam. 33.5 mm, alt. 11.8 mm. Approx. max. size 38 mm x 15 mm alt., 6½ whorls.

DISTRIBUTION: Off Cape Moreton, southern Queensland (27° 02' S., 153° 28' E.), to Newcastle, New South Wales (32° 58' S., 152° 03' E.) Extends northwards to Philippine Islands and Japan.

MATERIAL: A.M. 1 live specimen 114-124 metres N.E. of Cape Moreton, southern Queensland, coll D. Harris 1967, A.M. No. C.91657. 1 specimen 293 metres off Newcastle, New South Wales, ex "*Challenge*" 1960, A.M. No. C.63345 (Type of *Russetia dilaniatus* Garrard, 1961). Total specimens examined — A.M. 4, including 2 from Japan.

DISCUSSION: This species differs from its nearest congener *A. (Discotectonica) kuroharai* (Kuroda and Habe) by the rough and irregular appearance of the cords in the latter species, which not only vary in width, but the surface of the shell in that species also undulates in an irregular manner; also the totally different colour patterns as shown in descriptions.

The within species does not differ greatly from the Victorian Tertiary fossil species *A. (Discotectonica) balcombensis* Finlay; the spirals in the fossil are more granulated and the whorls do not imbricate to the same degree; basally the sculpture in the fossil has a more tessellated appearance, and the crenulations of the umbilical cords are over-ridden by more prominent spirals. As *A. (D.) acutissima* has been found as far south as Newcastle the possibility that the fossil was ancestral is a distinct possibility.

**Architectonica (Discotectonica) kuroharai** Kuroda and Habe, 1961 (Fig. 1 (10-12))

*Architectonica kuroharai* Kuroda and Habe, 1961: Append 9, pl. 13, fig. 20

DESCRIPTION: *Protoconch* regularly coiled, varying .65-.70 mm diam. *Teleoconch* flatly depressed, 6½ flatly concave whorls in diam. of 28 mm, base convex with depression adjoining periphery. *Sutures* joined below peripheral keel, which imbricates over succeeding whorl. *Sculpture* — a cord of fine elongate nodules forms peripheral keel, commencing immediately following protoconch, nodules increasing in size but coalescing with age, and forming a rough and irregular edge to shell; a further cord of finer nodules commences sub-suturally on first whorl, bifurcating on third whorl, becoming irregular and uneven, and accompanied by 7-8 other irregular flattened cords; whole sculpture is crossed by oblique and uneven growth lines; sculpture of base consists of up to 14 uneven and irregular cords of varying widths crossed by irregular growth lines. *Umbilicus* widely perspective, averaging 39% of shell diameter at maturity; umbilical cord with heavy regular pointed crenulations; two further periumbilical cords of more flattened square nodules, axially elevated; umbilical canal with convex base, strongly and irregularly axially wrinkled. *Aperture* triangularly ovate, base slightly convex, inner-lip inclined inwards basally with fine narrow channel below. *Colour* cream and white ground, brown and white spots alternately on periphery, base white.

*Operculum* of thin fawn chitinous material, concave sub-central nucleus, spiral layers expanding rapidly in size, finely irregularly granulated over whole surface; long tapering peg-like projection behind nucleus with twisted fleshy extremity.

TYPE LOCALITY: Tosa Bay, Shikoku, Japan.

DIMENSIONS: Holotype, max. diam. 26.1 mm, alt 10.5 mm. Max. size approx. 28 mm x 12 mm, 6½ whorls.

LOCATION OF TYPE: National Science Museum, Tokyo, Japan. Reg'd No. not ascertained.

DISTRIBUTION: Only recorded in Australia from Cape Moreton area in southern Queensland (27° 02' S., 153° 28' E). No records are available for any intermediate localities between Australia and Japan.

MATERIAL: 1 specimen N.E. of Cape Moreton, southern Queensland, 114-124 metres, ex T. A. Garrard coll, A.M. No. C.91663. 1 specimen same locality and donor (taken alive), A.M. No. C.68518 (Both specimens trawled by D. Harris, Yeppoon, Q.) 1 specimen off Moreton Bay, southern Queensland (27° 27' S., 153° 39' E.), 77 metres, coll W. F. Ponder 29/3/69, H.M.A.S. "Kimbla", A.M. No. C.77065 (live specimen). A.M. total 3 specimens.

DISCUSSION: Habe mentions that this species has four equidistant grooves on each whorl in addition to a peripheral groove, but this is at variance with the 7-8 grooves on Queensland specimens; also the radial striations are mentioned as fading on the body-whorl, but Queensland specimens show the radial striations becoming coarser and bolder on the body-whorl; a basal peripheral groove is also mentioned but not the number of other grooves on Queensland specimens; also the 18-20 crenulations on umbilical cord contrast with 28 on Queensland specimens. Although it has not been possible to obtain any Japanese specimen for comparison, there is little doubt that the Queensland specimens are conspecific. The differences noted above are probably only ecological variations, and may be due to the possibility that the Australian and Japanese populations have become disjunct over a long period of time, especially as no records of intermediate locality occurrences can be found.

#### FOSSIL SPECIES

**Architectonica (Discotectonica) balcombensis** Finlay, 1927 Fig. 6 (6-8), 10 (7-9).

*Solarium acutum* Tenison-Woods, 1879:236, pl. 21, fig. 11.

*Architectonica balcombensis* Finlay, 1927a:501 (New name for *Solarium acutum* Tenison-Woods, 1879, non Conrad, 1860).

*Architectonica (Discotectonica) balcombensis*. – Marwick, 1931:101.

DESCRIPTION: *Protoconch* regularly coiled, varying .60-.80 mm diam. *Teleoconch* flatly depressed, up to 6½ flatly convex whorls in width of 32 mm, base convex, periphery acute. *Sutures* finely incised, joined to base of peripheral keel. *Sculpture* of up to 9 flatly-rounded narrow spiral cords, flatly gemmate, some with fine threads between, followed by peripheral edge, which is strongly crenulate and often bifid in later stages; base concave next to periphery, balance convex with a number of spiral grooves, and flattened obliquely striated cords of various widths; 2-3 wide flattened cords of axially ridged nodules adjoin umbilicus. *Umbilicus* widely perspective, average 37% of shell diam. at maturity, bounded by strong obliquely crenulated cord, becoming rougher and more irregular with age, spirally striated by 6-7 microscopic grooves and/or threads; umbilical canal with flat base, strongly obliquely striated. *Aperture* narrowly ovate,

contracted to point at outer margin, narrow groove at base of inner-lip, which is sharply inclined to right basally. *Colour* – many specimens retain an overall light brown coloration.

**TYPE LOCALITY:** Lower beds, Muddy Creek, west of Hamilton, Victoria, 6.4 km Muddy Creek Formation: Balcombian: Middle Miocene.

**DIMENSIONS:** Lost holotype, max. diam. 6 mm, alt. 1.5 mm. Largest specimen examined max. diam. 32 mm, min. diam. 28.1 mm, alt. 12 mm, 6½ whorls. Proposed neotype, max. diam. 17.5 mm, min. diam. 16.5 mm, alt. 7.0 mm

**LOCATION OF TYPE:** Holotype should have been lodged with A.M., Sydney with a number of other specimens from the Tenison-Woods coll, but register does not show it as having been received, and it must be presumed lost. The species now described and figured has been accepted by authors for many years as the "*Solarium acutum*" of Tenison-Woods — it agrees well with his description, explanatory notes and figure, and some of the older specimens held by A.M. and N.M.V. and marked as such go back to the year 1888. However, as the original description of *A. (Discotectonica) squamogranosa* Chapple, 1941, takes into account its close relationship with *A. (D). balcombensis* Finlay, it is necessary in order to avoid future confusion and doubt regarding the identity of the two species, to designate a neotype for *A. (D). balcombensis*.

Accordingly in compliance with Article 75 of the I.C.Z.N. I hereby designate a neotype for the species named as *Solarium acutum* Tenison-Woods, 1879 (= *Architectonica balcombensis* Finlay, 1927) and submit the following reasons:

1. No other Australian Tertiary fossil species in the genus *Architectonica* possesses the acute peripheral keel and concave basal area adjoining, with the exception of *Architectonica (Discotectonica) squamogranosa* Chapple, 1941. The author's remarks in English following the Latin description state "each whorl margined with broad granular lines, 2 or 3 in number, the central one where there are 3 being much smaller," fits the proposed neotype and all other specimens examined.

2. The data and description of the species as above are sufficient to ensure recognition of the specimen designated as neotype without difficulty.

3. A thorough search has been made in all fossil and related Recent material in the Australian Museum, Sydney, also in all relevant fossil material at the National Museum of Victoria, Melbourne, but no trace can be found of any specimens which can be connected in any way with material owned by the original author; the holotype and any related material must therefore be presumed lost.

4. It is considered that the neotype is consistent in all respects with the original description, also the author's explanatory notes and the illustration; it also agrees in all respects with other specimens held by the Australian Museum and received as early as 1888, marked as *Solarium acutum* and from the type locality.

5. The neotype is from the same locality and same geological horizon as the holotype, viz., the lower beds of "Clifton Bank," Muddy Creek, 6.4 km west of Hamilton, Victoria. (Muddy Creek Marl: Balcombian: Middle Miocene). Collected by F. A. Cudmore, 1922.

6. The neotype is the property of the National Museum of Victoria, Melbourne, Victoria, Fossil Dept., Reg'd No. P. 34820, where it is housed in a research collection and available for study at all times.



MATERIAL: A.M. Fossil Beach, Mornington Peninsula, Victoria. Grid ref. Cranbourne 072,845. Balcombe Clay: Balcombian: Middle Miocene. 35 specimens (3 lots), A.M. Nos. C. 74895 (28 specs), F. 1932 (6 specs), F. 814 (1 spec.).

Cliff-face S. of Grice's Creek, Mornington Penin., Victoria. Grid Ref. Cranbourne 106,903. Upper Balcombe Clay: Bairnsdalian: Middle Miocene. 2 specimens (1 lot), A.M. No. C. 94482. Muddy Creek, near Hamilton, Victoria. Muddy Creek Formation: Balcombian: Middle Miocene. Topotypes. 4 specimens (2 lots), A.M. No. C. 94483 (3 specs), F 732 (1 spec.).

River Murray Cliffs, near Morgan, S. Australia. Cadell Marl Lens of Morgan Limestone: Batesfordian: Lower Miocene. 5 specimens (1 lot), A.M. No. C. 94484.

N.M.V. Clifton Bank, Muddy Creek, near Hamilton, Victoria. Topotypes. 6 specimens (1 lot), N.M.V. No. P. 31315. 16 topotypes (1 lot) N.M.V. No. P. 31318.

Total specimens examined, A.M. 46 specimens (7 lots), N.M.V. 22 specimens (2 lots), total 68 specimens (9 lots).

DISCUSSION: This species and its two congeners in the subgenus *A. (Discotectonica)* apparently became extinct in the late Miocene, in the form in which they then occurred. Whether the northern *A. (Discotectonica) acutissima* Sowerby is a surviving descendant is open to conjecture, but as shown under "Discussion" following that species there are certain points of resemblance. For differences between *A. (Discotectonica) balcombensis* and *A. (D.) squamogranosa*, see notes following description of the latter.

**Architectonica (Discotectonica) squamogranosa** Chapple, 1941. Fig. 10 (24-25)

*Architectonica (Discotectonica) squamogranosa* Chapple, 1941:123, pl. 14, fig. 1.

DESCRIPTION: *Protoconch* regularly coiled, varying .68-.71 mm diam. *Teleoconch* depressed conoid, 5½ whorls in diam. of 32 mm, convex dorsally, concave section on base adjoining peripheral keel, balance flatly convex. *Sutures* finely incised, joined at base of peripheral keel. *Sculpture* of 5 flattened cords, including peripheral keel, dissected into broad flattened nodules by numerous oblique axial grooves; sculpture on base consists of one narrow raised cingulum, separated from peripheral keel by broad sulcus, in which one or two threads are present; balance of base separated from umbilical cord by a pronounced deep narrow sulcus; numerous axial folds radiate from the sulcus, fading towards periphery. *Umbilicus* wide and perspective, averaging 37% of shell diam. at maturity; umbilical cord wide and strongly crenulate; suture joined away from groove, leaving part of folded area visible through umbilicus; umbilical canal wide, flat-based, with numerous axial growth lines. *Aperture* ovate, contracted at periphery, inner-lip arcuate, outer-lip thin and simple.

TYPE LOCALITY: Lower beds, Muddy Creek, west of Hamilton, Victoria. Muddy Creek Formation: Balcombian: Middle Miocene.

DIMENSIONS: Holotype, max. diam. 19 mm, alt 8 mm. Maximum size 25 mm x 10 mm, 5½ whorls.

LOCATION OF TYPE: N.M.V., Melbourne, Fossil Dept., coll E. H. Chapple, No. F. 14102.

MATERIAL: 2 specimens from Clifton Bank, Muddy Creek, coll F. A. Cudmore 1922, N.M.V. No. P. 31317. 4 specimens from Clifton Bank, Muddy Creek, coll F. S. Colliver, N.M.V. No. P. 31316.

DISCUSSION: This species differs from *A. (Discotectonica) balcombensis* by the deep and sharply cut sulcus surrounding the umbilical cord, and the strong cingulum on base close to the peripheral keel, also lack of any spiral grooves between sulcus and periphery; the broad flattened segmented cords on dorsum contrast with the narrower more numerous and flatly gemmate cords in *A. (D). balcombensis*.

**Architectonica (Discotectonica) sp. Fig. 10 (16-18)**

DESCRIPTION: *Protoconch* 1½ whorls, white, slightly inflated, smooth and shining, .75 mm diam. *Teleoconch* depressed, 3½ flat-topped whorls in diam. of 11.5 mm, base convex, strong crenulated peripheral keel. *Sutures* finely incised, joined immediately below edge of peripheral keel, whorls not imbricating. *Sculpture* of 5 broad flatly crenulated spiral cords, outermost separated from peripheral keel by a fine gemmate thread which commences after first 1½ whorls; whole dorsal surface crossed by rough and irregular growth lines and a number of microscopic spiral threads on top of cords; base with 10 flatly crenulated cords between peripheral keel and a strongly crenulated umbilical cord, the whole crossed by numerous microscopic spiral threads and rough growth lines. *Umbilicus* wide and perspective, 33% of shell diameter at maturity, with microscopic spiral striations on the crenulated umbilical cord, both over-riding and between the crenulations; broad umbilical canal is flat-based, with a central strongly crenulated cord similar to umbilical cord. *Aperture* broadly ovate, peaked towards peripheral keel; inner-lip arcuate, scarcely reflected.

LOCALITY: Just below high-tide mark, east side of North Arm, below Ferndale Parade, Lakes Entrance, Victoria. Grid ref Bairnsdale 913,276. Jemmy's Point Formation: Cheltenhamian: Upper Miocene.

DIMENSIONS: Max. diam. 11.5 mm, min. diam. 10 mm, alt 4.9 mm, 3½ whorls.

LOCATION OF SPECIMEN: N.M.V., Melbourne, Victoria, Fossil Dept. Reg'd No. P. 31319. Pres. Mrs. M. Griffiths, Lakes Entrance, Victoria, 2/1973.

MATERIAL: Single specimen only as above.

DISCUSSION: This third species in the subgenus, unfortunately a unique specimen, has only one feature in common with the type for the subgenus, *A. (Discotectonica) balcombensis* Finlay, apart from the sharp peripheral keel, that is the "broad granular lines" at the margin, the central being the smallest; however, it differs in having flat rhomboid segments composing the main dorsal cords in lieu of fine prickly nodules, it has no concave peripheral area, the base being convexly rounded, and only half the number of basal cords with no fine threads; also the umbilical cord is composed of regular and even roundly-pointed crenulations in place of the broad but narrowly ridged and sharp-ended crenulations in *A. (D). balcombensis*.

Subgenus *SOLATISONAX* Iredale, 1931:229. Type species by original designation *Solatisonax injussa* Iredale, 1931.

References: Wenz, 1938-44:671.

DIAGNOSIS: Medium size, dull, roundly and bluntly medium conical; wide-angled but sharply-edged periphery; deep narrow umbilicus; almost smooth in general appearance; periumbilical nodules tending to disappear at maturity; thin fawn periostracum; no anal keel on protoconch.

**Architectonica (Solatisonax) injussa** (Iredale, 1931). Fig. 4 (13-15).

*Solatisonax injussa* Iredale, 1931:229, pl. 25, figs 7, 8.

*Philippia injussa*. – Bayer, 1942:7.

DESCRIPTION: *Protoconch* regularly coiled, varying .94-1.15 mm diam. *Teleoconch* roundly conical, 6 flatly convex whorls in width of 31 mm, slightly concave dorsally near peripheral keel; base convex. *Sutures* finely incised, joined to base of peripheral keel. *Sculpture* of one central cord of fine elongate nodules, which coalesce on body-whorl; several fine spiral striae on either side of nodules, of varying strengths, the whole crossed by numerous oblique growth lines, which also extend across base. *Umbilicus* perspective but narrow, average 30% of shell diam. at maturity; umbilical cord with small blunt crenulations, tending to fade out with maturity; two barely perceptible flattened periumbilical cords; umbilical canal with convex base, obliquely wrinkled. *Aperture* sub-rhomboid, inner-lip inclined to right at base; outer and basal lip thin and simple. *Colour* dull pale fawn with few oblique darker streaks; light tinge of same colour on umbilical crenulations; thin fawn periostracum. *Operculum* circular, deeply concave, central nucleus, amber in colour, transparent at edges; composed of extremely thin layers of chitinous material; about 20 ragged concentric growth marks on upper surface, 6-7 equal sized layers at periphery; total thickness when dry no more than .5 mm.

TYPE LOCALITY: Between Gabo and Flinders Islands, Bass Strait, 183 metres. Author's original label states "100 fathoms off Gabo Island," which is taken to be approx. 38° S., 150° E.

DIMENSIONS: Holotype, max, diam. 25 mm, alt 14 mm. Max. size 31 mm x 18 mm, 6 whorls.

LOCATION OF TYPE: A.M., Sydney, No. C.57776.

DISTRIBUTION: Off Newcastle, New South Wales (32° 56' S., 151° 56' E.), to eastern Bass Strait, in depths ranging from 137 to 366 metres. There are no known records from outside this area and apparently an endemic species.

MATERIAL: 1 specimen E. of Newcastle as above, 285-292 metres, coll A. A. Racek 2/7/59 ex "Challenge" trawl No. 318, A.M. No. C.63614. 2 specimens off Broken Bay, New South Wales (33° 33' S., 151° 20' E.), 137 metres, ex T. A. Garrard coll ex "Challenge," A.M. No. C. 91662. 1 specimen S. of Gabo Island, Victoria, "Endeavour" 1912, 366 metres, No. E.5590. 1 specimen between Gabo and Flinders Islands, Bass Strait (approx. 39° S., 149° E.), 183 metres, pres. Fisheries Bureau, A.M. No. C.69057.

F.R.V. "Kapala" 7/1975, 366 metres E. of Stanwell Park, New South Wales, Stn. 75-05-01, A.M. No. C. 100604, 12 specimens. 366 metres as above, A.M. No. C.100603, 3 specimens (live). 8/1975, 457 metres E. of Port Kembla, New South Wales, Stn. 75-05-06, A.M. No. C. 100864, 1 specimen. 412 metres E. of Port Kembla, Stn. 75-05-07, A.M. No. C.100865, 24 specimens. 457 metres E. of Port Kembla, Stn. 75-05-09, A.M. No. C.100866, 3 specimens. 16/12/75, 412 metres E. of Kiama, New South Wales, Stn. 75-12-05, A.M. No. C.102734, 17 specimens. (One specimen possesses a strong narrow raised cingulum on base 2 mm in from periphery).

Total specimens A.M. 66 (11 lots).

DISCUSSION: This species cannot be confused with any other in the family, being readily recognisable by the roundly conical formation, dull surface, and small umbilicus almost devoid of ornamentation at maturity. As shown under "Material" this species was very rare until commencement of dredging by F. R. V. "Kapala" in July and August 1975,

when 60 further specimens were acquired, 3 being live with opercula. The specimen from Stn. 75-05-06 is an aberrant one, with dorsum almost flat and umbilicus widely expanded and perspective.

**Architectonica (Solatisonax) atkinsoni** (E. A. Smith, 1891). Fig. 4 (7-9).

*Solarium atkinsoni* E. A. Smith, 1891:441, pl. 35, fig. 19.

*Architectonica atkinsoni*. — Iredale, 1941:228-9.

*Philippia atkinsoni*. — Bayer, 1942:1.

DESCRIPTION: *Protoconch* regularly coiled but inflated and prominent, varying .94-1.17 mm diam. *Teleoconch* depressed conic,  $3\frac{1}{4}$  whorls in diam. of 7.5 mm, flatly convex dorsally and on base, but with narrow concave section adjoining periphery on dorsum. *Sutures* joined below periphery, finely incised, whorls slightly imbricating. *Sculpture* of one fine granulated cord in centre of first whorl, "drifting" towards periphery in second whorl, then becoming flattened and obscure; a peripheral ridge commences simultaneously with above cord, crenulated on first two whorls and becoming flatter and irregular in shape; fine to coarse oblique growth lines cross all whorls; 2 to 9 fine spiral grooves on all whorls, area between grooves flatly rounded, area adjacent to periphery is concave; base with 9-14 fine cords and threads between periphery and umbilicus. *Umbilicus* perspective, average 37% of shell diameter at maturity, bordered by cord with rough and uneven blunt crenulations; umbilical canal with convex base crossed by crowded oblique growth lines. *Aperture* sub-triangular with grooves inside peripheral keel and at base of inner-lip; outer-lip thin, straight and simple; inner-lip below parietal wall curves obliquely to right. *Colour* pale straw with a few indistinct pale fawn maculations. *Operculum* not available.

TYPE LOCALITY: 750 metres off Sydney, New South Wales ("Challenger" Stn. 164B.)

DIMENSIONS: Holotype, max. diam. 7.5 mm, min. diam. 6.5 mm, alt. 4 mm. Largest specimen examined is identical with measurements of holotype with  $3\frac{1}{4}$  whorls.

LOCATION OF TYPE: B.M.N.H. Reg'd. No. 1899:10:12:41.

DISTRIBUTION: From south coast of Western Australia between Eucla and Esperance (31°43' S., to 33°51' S., 121°53' E. to 128°52' E.), 79-147 metres. Eastwards through South Australia, Victoria and northwards to 35 km E. of Narrabeen, New South Wales, north of Port Jackson (33°39' S., 151°17' E.), 146 metres. Least depth recorded, 73 metres off 90 Mile Beach, Victoria; greatest depth apart from holotype, 457 metres 37 km E. of Port Jackson, New South Wales. No known records outside these boundaries and apparently an endemic species.

MATERIAL: Eucla-Esperance as above, 2 specimens coll C.S.I.R.O. 5-9/7/62, H.M.A.S. "Gascoyne" (G2/96-97/62), A.M. No. C. 92966. E. of Narrabeen as above, 4 specimens coll Prof. Haswell, A.M. No. C. 25832. Least depth as above off 90 Mile Beach, 1 specimen N.M.V. No. F. 27942. Greatest depth as above off Port Jackson, 2 specimens coll W. F. Petterd, A.M. No. C. 24480. Total specimens from A.M., N.M.V., S.A.M. and W.A.M. 41 (21 lots).

DISCUSSION: This species bears a resemblance to the much larger *A. (Solatisonax) injussa* Iredale as it would be in its early stages, although no immature specimens of that species have been observed. The within species differs however in having the central granulated cord on the first whorl "drifting" towards the periphery in the second whorl, then becoming flattened and obscure; in *A. (S.) injussa* the central cord remains in the centre of each whorl throughout, and that species grows to 31 mm max. diam. with 6

whorls. An equivalent  $3\frac{1}{4}$  whorls in *A. (S). injussa* would measure 10 mm diam., in comparison with 7.5 mm diam. in the holotype of *A. (S). atkinsoni* also with  $3\frac{1}{4}$  whorls, although the protoconchs of the two species are of equal diameter.

Genus *PHILIPPIA* Gray, 1847

Subgenus *PHILIPPIA* Gray, 1847:146. Type species by original designation *Solarium luteum* Lamarck, 1822.

REFERENCES: Adams, 1858:243; Chenu, 1859:233; Tryon, 1887:5; Wenz, 1938-44:670; Bayer, 1942:1; Suter, 1913:316; Robertson, 1963:12; 1970:66; 1973:37.

DIAGNOSIS: Small, roundly conical, small protoconch, two widely spaced peripheral keels, only one crenulated umbilical cord, other sculpture negligible. (The only species recorded from Australia in this subgenus possesses an anal keel on the protoconch).

***Philippia (Philippia) lutea*** (Lamarck, 1822). Fig. 5 (13-18).

*Solarium luteum* Lamarck, 1822:5. — Deshayes, 1830:159, no. 5; Kiener, 1839:9, pl. 4, fig. 9; Deshayes, 1843:100; Philippi, 1853:31, pl. 1, figs 10, 11; pl. 4, fig. 11; Reeve, 1864, sp. 14; Angas, 1867:201.

*Philippia lutea*. — Adams, 1858:243, pl. 25, fig. 8; Gray, 1847:146; Cotton and Godfrey, 1933:72, pl. 1, fig. 1; Powell, 1937:75; Bayer, 1942:12; Macpherson and Gabriel, 1962:100, fig. 126.

*Solarium (Philippia) luteum*. — Chenu, 1859:233, fig. 1355; Hanley (Sowerby), 1863:237, pl. 4, figs 53, 54; Marshall (Tryon), 1887:16, pl. 5, figs 71, 72.

*Architectonica (Philippia) lutea*. — Suter, 1913:316, pl. 46, fig. 4.

DESCRIPTION: *Protoconch* inflated but small, smooth and shining, varying .82-.94 mm diam., with short anal keel. *Teleoconch* roundly conical, 5 smooth convex whorls in width of 15 mm, base convex. *Sutures* finely incised, joined between two peripheral keels. *Sculpture* consists of only a few vague spiral striations crossed by faint growth lines, and one flatly-rounded keel above sutures, two on periphery of body-whorl; base also has a few vague spiral striations crossed by faint growth lines. *Umbilicus* very small and deep, averaging 15% of shell diam. at maturity, only one periumbilical cord with white closely packed irregular pointed crenulations; umbilical canal with strongly wrinkled convex base. *Aperture* almost circular, with flattened top forming base of penultimate whorl; outer-lip thin and simple. *Colour* deep cream, yellow ochre, light or deep grey, or deep red-brown, with one row of fine purple-brown spots on white band on keel above suture, a further similar row beneath sutures. *Operculum* amber, very thin, chitinous, pauci-spirally coiled counter-clockwise externally, sub-central nucleus, dome-shaped knob on inner surface behind nucleus.

TYPE LOCALITY: "Seas of New Holland" (Lamarck).

DIMENSIONS: Holotype, diam. 12 mm, alt 9 mm. A fully grown specimen measures 15 mm x 10 mm with 5 whorls.

LOCATION OF TYPE: Museum d'Histoire Naturelle, Geneva, reg'd number not ascertained.

DISTRIBUTION: In Western Australia, furthest north Vansittart Bay (14°03' S., 126°17' E.), southwards along W. Australian coast, through S. Australia, Victoria, Tasmania

(Granville Harbour west coast — 41°48' S., 145°00' E.), along north coast and southwards along east coast to Recherche Bay (43°33' S., 146°55' E.); in New South Wales northwards to Woolgoolga (30°07' S., 153°12' E.) Inter-tidal to 82 metres, greatest depth recorded. Also occurs in North Island of New Zealand.

**MATERIAL:** Vansittart Bay as above, 2 specimens coll W. Burrows 12/11/67, A.M. No. C. 45203. Woolgoolga as above, 1 specimen coll J. Kerslake, A.M. No. C. 91661. Greatest depth as above, 1 white specimen in fine condition 82 metres off Port Hacking, New South Wales (34°03' S., 151°11' E.), ex T. A. Garrard coll, A.M. No. C. 91660. Total specimens examined from all Australian Museums 518 (103 lots).

**DISCUSSION:** This species in its early stages, usually up to 2-2½ whorls, possesses even and regularly spaced crenulations round the umbilicus, not crowded and mis-shapen as they usually become towards maturity; in addition a number of heavy and evenly spaced ridges are present, radiating from umbilicus to periphery, which usually disappear entirely or almost so at maturity.

The species appears to be identical or almost so with *Philippia hybrida* (Linnaeus) from the Mediterranean, and possibly spread from there originally. Bayer (1942:13) attempted to explain a few small differences between the two species but his remarks are not convincing. A tremendous variation occurs in *Philippia lutea* in Australia as regards colour pattern, height/width ratio, etc., and the family is noteworthy for its occurrence in widely disjunct areas in identical or closely similar forms. However proving this point is not important so far as this revision is concerned, and the two names may be allowed to remain.

The species varies greatly in Australia, east coast specimens being invariably elevated conic and coloured yellow ochre or light buff, a few specimens light grey; in Victoria light and dark grey specimens predominate, whilst in South Australia a red tinge makes its appearance and the shells become more depressed, the height/width ratio decreasing from 70-80% to 60-70%; in Western Australian specimens the shells become so depressed that the ratio decreases to 45-55%, the bulk of specimens examined being light to deep blackish-red in colour.

Subgenus *PSILAXIS* Woodring, 1928:7, 355. Type species by original designation *Architectonica (Philippia) krebsii* Morch.

**REFERENCES:** Wenz, 1938-44:671; Robertson, 1970-75; Robertson Scheltema and Adams, 1970:55-65.

**DIAGNOSIS:** Larger than *Philippia* s.s. but more flatly rounded, larger protoconchs; one prominent peripheral keel with a smaller cingulum above and below; two crenulated periumbilical cords, inner heavy and irregularly wrinkled, outer smaller with small irregular nodules; generally smooth and polished. (The two Recent species recorded from Australia in this subgenus possess an anal keel on the protoconch, but not the one new fossil species described).

***Philippia (Psilaxis) oxytropis* A. Adams, 1854. Fig. 5 (19-24).**

*Philippia oxytropis* A. Adams, 1854:317. — Bayer, 1942:14.

*Solarium (Philippia) oxytropis*. — Hanley (Sowerby), 1863:236, pl. 4, figs 46, 47; Marshall (Tryon), 1887:15, pl. 5, figs 65, 66.

*Solarium oxytropis*. — Reeve, 1864:pl. 3, fig. 15.

*Philippia manifesta*. — Iredale, 1931:229, pl. 25, figs 9, 10 (not 19, 20).

*Philippia (Psilaxis) oxytropis*. — Robertson, 1970:66-83, text figs.

DESCRIPTION: *Protoconch* smooth and shining, small but inflated, varying 1.33-1.66 mm diam., with long brown anal keel. *Teleoconch* depressed, 4½ flatly convex whorls in diam. of 12.5 mm, convex base. *Sutures* finely incised, joined at centre of peripheral keel. *Sculpture* consists of a prominent smooth peripheral cord with one narrow cingulum above and one below; microscopic growth lines on all whorls; umbilical cord heavy with fine crowded crenulations, surrounding which is a further more finely crenulated cord, separated by a deep fine sulcus from a cord of prominent axially ridged nodules. *Umbilicus* small but perspective, averaging 27% of shell diameter at maturity; umbilical canal flat based and strongly axially striated. *Aperture* roundly triangular, two fine grooves inside peripheral keels, deep groove below inner-lip for short distance; outer-lip thin and simple. *Colour* medium brown with white triangular spots on peripheral keels, also on outer periumbilical cord and occasionally on the main cord. *Operculum* chitinous, mid-brown, concave, thin and frail, central nucleus, showing extremely fine concentric ridging in places; yellow mushroom-shaped knob, constricted basally, at rear of nucleus.

TYPE LOCALITY: New Caledonia.

DIMENSIONS: Holotype, none given. Largest specimen examined measures 19 mm max. diam., 12.5 mm alt., 4½ whorls (Sydney Harbour dredgings).

LOCATION OF TYPE: Should be with B.M.N.H. but unable to be located.

DISTRIBUTION: On west coast, 160 km N.W. of Broome, Roebuck Bay (16°58' S., 120°47' E.), to bay north of Point Cloates (22°37' S., 113°38' E.) and southwards to Shark Bay (25°30' S., 113°30' E.) On east coast, Michaelmas Cay, north Queensland (16°36' S., 145°59' E.), southwards along Queensland and New South Wales coasts to 19 km S. of Montague Island, New South Wales (36°15' S., 150°13' E.) Distribution generally apart from Australia is northern New Zealand, Lord Howe Island, New Caledonia, Cook Islands, Hawaiian Islands and Japan, also one small restricted area at head of Red Sea.

MATERIAL: N.W. of Broome as above, 2 immature specimens, 194 metres (greatest depth recorded), coll. B.M.R. 29/11/67, M.V. "Kos 2" (K67-248), A.M. No. C.94221. Point Cloates as above, 1 specimen "Ningaloo" Exped 30/8/68, W.A.M. No. 125-73. Shark Bay as above, 1 specimen trawled P. Wood 1963, W.A.M. No. 128-73. Michaelmas Cay as above, 1 specimen ex T.A. Garrard coll, A.M. No. C.91668. Montague Island as above, 1 specimen ex L. Woolacott coll, 119 metres, A.M. No. C.91669. Total specimens examined from all Australian Museums 127 (34 lots).

DISCUSSION: This species can be separated from the other Indo-Pacific species *P. (Psilaxis) radiata* (Roeding) to a certain extent by its overall coloration with small white tent shaped markings at the sutures, but more definite differences in the umbilicus and protoconch are described under "Discussion" following the description of *P. (P.) radiata*.

***Philippia (Psilaxis) radiata* (Roding, 1798). Fig. 3 (10-18).**

*Architectonica radiata* Roding, 1798:79, no. 1027.

*Solarium cingulum* Kiener, 1838:6, pl. 3, fig. 6. — Chenu, 1859:232, fig. 1351; Reeve, 1864, pl. 3, fig. 19; Sowerby, 1892:28.

*Solarium (Philippia) cingulum*. — Hanley (Sowerby), 1863:237, pl. 4, figs 55, 56; Marshall (Tryon), 1887:15, pl. 5, figs 63, 64.

*Philippia layardi* A. Adams, 1854:317; Angas, 1871:92; Bayer, 1942:8.

*Architectonica layardi*. — Hedley, 1917:101.

*Philippia stipator* Iredale, 1931:229, pl. 25, figs 17, 18.

*Philippia radiata*. — Kuroda, 1941:86, no. 205; Rippingale and McMichael, 1961:63, pl. 6, fig. 22; Wilson and Gillett, 1971:34, pl. 13, fig. 13; Bayer, 1942:15.

*Philippia (Psilaxis) radiata*. — Robertson, 1970:66-83, text figs.

DESCRIPTION: *Protoconch* smooth and shining, small but inflated, varying 1.15-1.49 mm diam., with short sharp anal keel. *Teleoconch* depressed, 5¼ flatly convex whorls in diam. of 24 mm, base convex. *Sutures* finely incised, joined at centre of peripheral keel. *Sculpture* of 2 narrow ridged cords at base of each whorl, a series of folds at top of first main whorl, all crossed by microscopic growth lines; sculpture on base consists of one flattened ridge adjoining peripheral keel, and irregularly wrinkled growth lines radiating from umbilicus. *Umbilicus* small but perspective, 18% of shell diameter at maturity, bordered by a heavy irregular crenulated cord, and a second narrower periumbilical cord with small irregular nodules; umbilical canal deep, concave base, finely obliquely striated. *Aperture* sub-circular, slight channel behind peripheral keel; inner-lip straight with two small narrow channels at base. *Colour* white with medium to dark brown band round top of whorls; spokes, axial bands or broad but narrowing radiations of colour extend from the sub-sutural band to base of whorls; base white or with narrow or broad band of pale straw colour, often fully coloured with same colour as dorsum; small outer periumbilical cord has faint small yellow-brown spots. *Operculum* chitinous, thin and frail, concave, central depressed nucleus, spiral overlapping growth marks, mushroom shaped projection at rear of nucleus.

TYPE LOCALITY: "La mer des Indies" (Kiener).

DIMENSIONS: Holotype — none given. A fully grown specimen measures 25 mm max. diam., 22 mm min. diam., 15 mm alt., 5¼ whorls.

LOCATION OF TYPE: Unknown, unable to trace.

DISTRIBUTION: Western Australia, Turtle Bay, North-West Cape (21°45' S., 114°10' E.), southwards to Dirk Hartog Island (25°50' S., 113°05' E.), East coast, Murray Island, Torres Strait (9°55' S., 144°05' E.), southwards along Queensland and New South Wales coasts to Port Jackson, New South Wales. Greatest depth 63-73 metres, 3 km N.E. of west side of Gillett Cay, Swain Reefs, Queensland (21°43' S., 152°25' E.) Appears to be mainly sub-tidal. Distribution generally from Red Sea and East Africa through Indian Ocean, northwards to Japan, southwards to Australia and New Zealand, Pacific Ocean generally to Hawaiian Islands.

MATERIAL: Turtle Bay as above, 1 specimen coll L. Figgis, Feb. 1972, A.M. No. C.86126. Dirk Hartog Island as above, 1 specimen coll B. R. Wilson, June 1957, W.A.M. No 4615 (pt). Murray Island as above, 1 specimen coll C. Hedley on beach, A.M. No C.29401. Port Jackson as above, 2 specimens ex "Triton" dredgings off Sow and Pigs Reef, one A.M. No. C.91664 (pt), also holotype of *P. (P.) stipator* Iredale, No. C.93224. Total specimens examined from all Australian Museums 204 (77 lots).

DISCUSSION: A great deal of confusion has existed for many years in Australia regarding the identity of *Philippia radiata*, *P. layardi* and *P. oxytropis*, and separation appears to have been carried out chiefly by colour pattern. Examination of the many specimens from all Museums proves the contention of Robertson (1970) that only two species of *Philippia (Psilaxis)* occur in the Indo-Pacific area, being *P. (P.) radiata* (Roding), extending throughout the Indian Ocean and as far as Tahiti and the Tuamotus in the central Pacific. The other species, *P. (P.) oxytropis* A. Adams on present records is



confined between 113° E. on the Western Australian coast, and about 155° W., including the Hawaiian Islands and Cook Islands in the central Pacific. Disregarding the greatly variable colour patterns of the two species, *P. (P). radiata* can be separated by its very small umbilicus with irregular crenulations, averaging 14% of shell diameter at maturity, compared with 27% in *P. (P). oxytropis*; also a smaller protoconch, varying from 1.15-1.49 mm diam., compared with 1.33-1.66 mm in *P. (P). oxytropis*; the protoconch of *P. (P). radiata* is usually all white but occasionally with patches of brown, and has a short sharp anal keel on protoconch bordered by a thin brown line; the protoconch of *P. (P). oxytropis* is almost invariably coloured brown with a white central patch, it also has a decidedly longer anal keel on the protoconch which is usually all brown, without a darker brown line beside it.

#### FOSSIL SPECIES

##### ***Philippia (Psilaxis) mitchellana* nov. Fig. 10 (10-12).**

**DESCRIPTION:** *Protoconch* 1½ whorls, inflated, smooth and shining, 1.54 mm diam., no anal keel *Teleoconch*. Six flatly convex whorls, dorsum low rounded convex, flatly convex basally. *Sutures* strongly incised, joined at centre of peripheral keel. *Sculpture* — strong peripheral keel, finely squarely beaded for about first two whorls, becoming smooth with age, a flatly rounded cingulum above it; balance of whorls almost smooth, traces of fine flattened spiral ridges in places, incremental growth striae microscopic; base with one strong cingulum divided from peripheral keel by a wide deep groove; irregular folds radiating axially from umbilicus but fading towards periphery. *Umbilicus* perspective, 28% of shell diameter at maturity, one strongly crenulated umbilical cord, divided from folded area by a strong narrow but deep sulcus; umbilical canal wide with slightly convex base, axial growth lines and one fine spiral striation in centre. *Aperture* ovate, contracted at periphery, short groove at base of arcuate outer-lip, no parietal fold present; outer-lip thin and simple.

**TYPE LOCALITY:** Right bank of Mitchell River, "Moondara" farm, Bairnsdale, Victoria, 91 metres north of first gully south of house. Rosehill Marl, Tambo River Formation: Mitchellian: Upper Miocene.

**DIMENSIONS:** Holotype, max. diam. 15 mm, min. diam. 13 mm, alt. 7.5 mm, six whorls, largest specimen examined and appears to be fully grown.

**LOCATION OF TYPE:** N.M.V., Melbourne, Victoria, Fossil Dept., Reg'd No. P.31314.

**MATERIAL:** Holotype as above, coll T. A. Darragh and K. Bell 2/5/1971. 2 specimens, topotypes, coll T. A. Darragh 26/8/1969, N.M.V. No. P.31313. 1 specimen, topotype, coll T. A. Darragh and H. E. Wilkinson 10/12/1966, N.M.V. No. P. 31312.

**DISCUSSION:** The occurrence of a fossil *P. (Psilaxis)* species in the Victorian Tertiary is a discovery of importance. Robertson (1973:37) states: "Fossil *Psilaxis* is known from the Middle Miocene or Pliocene-Pleistocene of Jamaica and from the Upper Pliocene of Japan." (The Japanese species is stated to be *P. (P). radiata* Roeding). This new species, in common with other fossil species, shows one characteristic linking it with *Philippia* s.s., the lack of a second periumbilical cord. The suture is joined at centre of peripheral keel, in common with the two Recent species dealt with in this revision.

Compared with the two Recent species, *P. (P). oxytropis* and *P. (P). radiata* this new species can be separated by the complete lack of an anal keel on the protoconch, also by lack of the usual second periumbilical cord and second sulcus. A fine growth line recording the stage of early post-larval arrested growth occurs at approx. .6 of the

peripheral circumference of the first teleoconch whorl on holotype, adherent marl precludes observation on other specimens.

This new species has also been compared with 2 specimens held by A.M. of the Italian Pliocene species *Philippia (Psilaxis) simplex* (Bronn, 1827), the only differences noted being: *P. (P.) simplex* has 5½ whorls in a diameter of 24 mm, therefore being a decidedly larger species; the dorsal cingulum adjoining the peripheral keel is clear cut and well defined, not fading on the adapical edge which it does in this new species; the exposed dorsal portion of the protoconch in *P. (P.) simplex* measures 1.20 mm and 1.44 mm in the two specimens examined, being smaller than the measurement of 1.54 mm in this smaller new species. Apart from these minor differences the remaining features of the two species are remarkably similar.

#### ARCHITECTONICINAE species

#### “*Fluxina*” *trochiformis* Schepman, 1909, Fig. 9 (19).

“*Fluxina*” *trochiformis* Schepman, 1909:220, pl. 14, fig. 3.

*Notes:* The type for the genus *Fluxina* Dall (1881:52), viz. *Fluxina brunnea* Dall, 1881, has been shown by Merrill (1970:32) to be a species of *Calliostoma*, which therefore removes the genus *Fluxina* from the Architectonicidae. The within species possesses an anastrophic protoconch, and a new genus will therefore be necessary to contain it when a general revision of the Architectonicidae genera is undertaken.

**DESCRIPTION:** *Protoconch* extremely small, regularly coiled, smooth, shining, depressed, varying .30-.33 mm diam. *Teleoconch* smooth, shining, depressed conic, 6 whorls in diam. of 5 mm, flatly convex below suture, slightly excavated dorsally near periphery, peripheral edge thin and sharp, base of whorls also excavated near periphery; no anal keel present on protoconch. *Sutures* joined beneath peripheral edge, not impressed. *Sculpture* of microscopic curved growth lines, both dorsally and on base, a few microscopic spiral threads near periphery on base. *Umbilicus* widely perspective, 30% of shell width at maturity, free of ornamentation except for one very fine smooth cingulum round outer edge; umbilical canal flat-based and smooth. *Aperture* sub-rhomboid, outer-lip thin, smooth and sharp. *Colour* glass-like or translucent white. *Operculum* not available.

**TYPE LOCALITY:** “*Siboga*” Stn. 178, Ceram Sea (2°40' S., 128°37' 30" E.), 835 metres.

**DIMENSIONS:** Holotype, max. diam. 5 mm, alt. 2.5 mm, 6 whorls. Apparently a fully grown specimen.

**LOCATION OF TYPE:** Amsterdam Museum, Netherlands, reg'd No. not ascertained.

**DISTRIBUTION:** 241 km W. of Cape Leveque, Western Australia (16°16' S., 120°45' E.), 330 metres. Gillett Cay, Swain Reefs, Queensland (21°43' S., 152°25' E.), 63-73 metres. Masthead Is., southern Queensland (23°10' S., 151°54' E.), 31-37 metres. Off Cape Martin, South Australia (37°30' S., 140°01' E.), 667 metres. 19 km E. of Cape Mistaken, Maria Is., Tasmania (42°42' S., 148°17' E.), 695 metres. Appears to be widely distributed in tropical to temperate waters, in depths ranging from moderate to very deep water. Extends northwards from Australia at least as far as the Moluccas and Celebes Islands.

**MATERIAL:** Cape Leveque as above, 2 specimens coll B.M.R. 21/11/67, M.V. “*Kos 2*” (K67-227), A.M. No. C.91761. Gillett Cay as above, 3 km N.E. of W. side, 1 specimen coll A.M. party 17-19/10/1962, A.M. No. C.91762. Masthead Is. as above, 1 specimen coll C. Hedley, A.M. No. C.19629 (pt). Cape Martin as above, 16 specimens coll C. Hedley, A.M.

No. C.91763 (pt). Off Maria Is. as above, 1 specimen coll W. F. Ponder 25/3/70, F.R.V. "Penghana", A.M. No. C.97223. A.M. total specimens 21 (5 lots).

DISCUSSION: This very small species is very far removed from the genus *Architectonica*, but can only be placed in the same subfamily. A microscopic examination of the protoconch shows it to be anastrophic but not to a marked degree, the nucleus being visible when viewed through the umbilicus.

Growth lines indicate a wide, deep sub-sutural sinus on upper-lip and a similar sinus on lower-lip commencing close to periphery, but all breakages in the outer-lip dorsally are straight. All the above specimens agree well with Schepman's description and figures of the holotype, except that the cord above suture (peripheral edge) is plain and smooth, with no trace of the fine crenulations mentioned by Schepman, but as the holotype at the time was a unique specimen this small difference is probably an ecological variation or a slightly aberrant specimen. The fine rib or cingulum round the edge of umbilicus mentioned by Schepman as having a fine groove round it, shows no definite groove but only the in-turned edge of the cingulum.

#### Subfamily HELIACINAE

DIAGNOSIS: Light in weight, max. diam. 3-20 mm, with one exception to 30 mm; tall conic to flatly depressed, all strongly sculptured with cords, tessellated or granose; umbilicus narrow to medium width; peripheral area rounded to flatly rounded, or with double or single peripheral keel; operculum chitinous, of many layers built up to rounded cone-shape.

GENERA: On a world wide basis a revision of genera for this subfamily appears necessary, but species represented in Australia may be conveniently placed for the time being in four existing genera as under:

1. *Heliacus (Heliacus)* Orbigny, 1842. Tall to very tall, umbilicus narrow to wide, peripheral area of whorls rounded to flatly rounded.
2. *Heliacus (Torinista)* Iredale, 1936. Moderately to flatly depressed, umbilicus narrow to wide, bicarinate, interspace between keels either medium width or narrow and recessed.
3. *Heliacus (Awarua)* Mestayer, 1930. Moderately depressed, single peripheral keel, wide concave umbilical area with rows of nodules not in form of a cord.
4. *Heliacus (Claraxis)* Iredale, 1936. Depressed to flatly depressed, umbilicus narrow to wide, one sharp peripheral keel.

Authors generally have now accepted the contention of Iredale (1911:301) that the genus *Heliacus* Orbigny, 1842, should take precedence over *Torinia* Gray, which should be considered as dated 1847.

In the whole of the subfamily dealt with herein only one species, *Heliacus (Torinista) corallinus* nov., has an anal keel on the protoconch.

#### Genus HELIACUS Orbigny, 1842

Subgenus HELIACUS Orbigny, 1842:68. Type species by original designation *Solarium heberti* Deshayes, 1830:159.

REFERENCES: Chenu, 1859:232 (*Torinia*); Suter, 1913:317; Cotton and Godfrey, 1933:73; Wenz, 1938-44:666 (*Torinia*).

SYNONYMS: *Teretropoma* Rochebrune, 1882:249. Type species by original designation *Teretropoma perrieri* Rochebrune, 1882. *Torinia* Gray, 1847. Type species by original designation *Trochus cylindracea* Deshayes, 1843.

DIAGNOSIS: Species medium in width, 5-13 mm (with exception of *H. (H). stramineus* (Gmelin) — to 38 mm), tall to very tall, umbilicus narrow to wide, peripheral area of whorls rounded to flatly rounded, axial and spiral sculpture, beaded or tessellated; operculum of many layers of chitinous material, medium to high conical; no anal keel on protoconch in Australian species.

***Heliacus (Heliacus) cerdaleus ponderi* subsp. nov.** Fig. 2 (10-12), 9 (7-9).

*Solarium (Torinia) cerdaleum* Melvill and Standen, 1903:297, pl. 20, fig. 16.

*Torinia cerdalea* — Bayer, 1948:10.

DESCRIPTION: *Protoconch* 2½ whorls, slightly inflated, smooth and shining, varying 1.17-1.52 mm diam. *Teleoconch* rounded elevated, 3½ flatly convex whorls in diam. of 8 mm, base roundly convex. *Sutures* impressed, at base of narrow canal. *Sculpture* — one cord below sutures of axially elongate segments, interstices between segments axially straight, followed by 3 further cords, interstices oblique; a narrow channel, occasionally carrying a very fine cord, then separates the upper segmented peripheral keel; a further similar basal keel below, more contracted, the two being separated by two very fine gemmate cords, giving peripheral area of shell a flatly rounded appearance; a further 5-6 segmented cords follow on base, last two near umbilicus far wider than others. *Umbilicus* narrowly perspective, averaging 28% of shell width at maturity, bordered by a strong obliquely crenulated cord; umbilical canal wide, base of canal strongly convex, axially folded and striated. *Aperture* sub-circular, except for protrusion of base of penultimate whorl, crenulated exteriorly by cords, a fine groove at base of inner-lip. *Colour* fawn to light brown, axial bars and spots of darker brown across top of whorls and round edge to base; deep brown in narrow sulci between spiral cords. *Operculum* composed of multiple layers of horn coloured, ragged-edged chitinous material, low-spined, not usual round cone shape and without central depression; rear attached to mollusc and not examined.

TYPE LOCALITY: Long Reef, Collaroy, near Sydney, New South Wales (33°43' S., 151°18' E.).

DIMENSIONS: Holotype, max. diam. 9.6 mm, min. diam. 8.3 mm, alt. 7.6 mm, 3½ whorls. Maximum size.

LOCATION OF TYPE: A.M., Sydney, Reg'd No. C.94479, and 5 paratypes Reg'd No. C. 94480.

DISTRIBUTION: West coast, 3 km S. of Cape Naturaliste, Western Australia (33°33' S., 115°01' E.), southwards to Bremer Bay (34°23' S., 119°25' E.), and Windy Harbour, Cape D'Entrecasteaux (34°50' S., 116° E.) East Coast, Twofold Bay, New South Wales (37°04' S., 149°54' E.), 10 km E., 91-109 metres, which is greatest depth recorded; northwards to Byron Bay, New South Wales, (28°40' S., 153°38' E.). Appears to be endemic to southern Australia, but the range is disjunct as shown.

MATERIAL: Cape Naturaliste as above, 1 beach specimen coll W. F. Ponder and B.R. Wilson 3/1/72, A.M. No. C.90978; Bremer Bay as above, 1 specimen coll G. W. Kendrick 26/1/72, W.A.M. No. 87-73; Windy Harbour as above, 5 specimens coll R. Dunlop, W.A.M. No. 305-65; Twofold Bay as above, 1 specimen ex N. Buckland coll, A.M. No. C.93604;

Byron Bay as above, 3 specimens coll N. Coleman, May 1975, A.M. No. C.100776. Total specimens examined from all Australian Museums 45 (22 lots).

DISCUSSION: In some respects this new subspecies is as variable as most others in the subfamily. Its origins obviously lie with *Heliacus cerdaleus* (Melvill and Standen, 1903), however, it differs from that species consistently in the following respects:

1. The protoconch of this new subsp. is decidedly larger — 1.17-1.52 mm diam., compared with 1.04 mm in the holotype of *H. cerdaleus*.
2. It possesses 4 cords on the rounded peripheral area of the shell in lieu of only 3 in the holotype of *H. cerdaleus*. The fourth cord commences between the central and lower cords after completion of the first main whorl, as evidenced in the 4 immature specimens available; other cords have a tendency to bifurcate in places and at various growth stages.
3. The holotype of *H. cerdaleus* has a fine intermediate thread between all main cords, and none are visible in any specimen of the new subsp.

Apart from the bifurcation of various cords in some specimens, cords both on dorsum and base tend to vary both in width and number. Colour pattern is variable in depth of colour, and Western Australian specimens tend to have bars of darker colour more pronounced on dorsum. 3 specimens from Woolgoolga, northern New South Wales, all  $2\frac{3}{4}$  whorls and not quite mature, show the deep brown colour in sulci separating spiral cords, as strong narrow bands of colour showing through into aperture, 14-16 in number, which are covered with white or cream overlay when full maturity is reached.

A specimen of this new subsp. from A.M. coll, Reg'd No. C.96135, was compared with holotype of *H. cerdaleus* at B.M.N.H. by Dr. W. F. Ponder, and found to agree except as stated above. The holotype is reg'd No. 1903.12.15.107, type locality Persian Gulf, Fao, on telegraph cable. See "Discussion" under *Heliacus enoshimensis* for differences between that species and *H. cerdaleus ponderi*.

This new subspecies is named for Dr. W. F. Ponder, Curator of Molluscs at A.M., Sydney, who has been of such great assistance in so many ways with the compilation of this revision.

***Heliacus (Heliacus) enoshimensis*** (Melvill, 1891) Fig. 7 (22-25).

*Solarium (Torinia) enoshimensis* Melvill, 1891:411, pl. 2, fig. 12.

*Torinia densegranosa* Pilsbry, 1905:106, pl. 3, figs 15, 16, 17.

*Torinia enoshimensis*.— Melvill, 1913:317 Bayer, 1948:18; Kuroda Habe and Oyama, 1971:423, pl. 61, figs. 10, 11.

*Heliacus enoshimensis* — Habe, 1961:30, pl. 13, fig. 18.

DESCRIPTION: *Protoconch* regularly coiled, varying .94-1.15 mm diam. *Teleoconch* depressed,  $3\frac{1}{2}$  whorls in diam. of 11.5 mm, flatly convex dorsally and basally. *Sutures* deeply impressed, joined at base, or occasionally at centre, of peripheral keel. *Sculpture* of strong, broad, rounded, oblique axial ribs, 60-70 on body-whorl, dissected by 4-5 strong spiral grooves, spiral cords thus formed occasionally have one or two fine threads between; all cords carry several microscopic spiral threads; peripheral keel broad and rounded, basal cord below is narrower and more restricted, a fine thread between the two; 5-6 broad flatly-rounded cords on base, similar to those on dorsum, the last usually the widest and adjoining strongly crenulated umbilical cord. *Umbilicus* deep and

narrowly perspective, averaging 21% of shell diam. at maturity; canal with flatly rounded base, finely vertically striated. *Aperture* circular, outer-lip heavy and crenulated by cords; inner-lip vertical with shallow central groove and strongly reflected. *Colour* — alternate axial markings of fawn and white, or reddish brown and white, on dorsum, periphery and base. *Operculum* typical, roundly cone shaped, built up of thin fawn and white layers of chitinous material, with hollow top.

TYPE LOCALITY: Enoshima, Japan.

DIMENSIONS: Holotype, max. diam. 5 mm, alt. 2.5 mm. Largest specimen examined max. diam 12.1 mm, alt. 6.8 mm, 3½ whorls.

LOCATION OF TYPE: B.M.N.H., Reg'd No. 1884.4.3.10-12 (3 syntypes).

DISTRIBUTION: Woolgoolga, northern New South Wales (30° 07' S., 153° 12' E), and Ballina (28° 50' S., 153° 36' E.), and southwards to Botany Heads, Sydney, New South Wales. Apparently a sub-tidal species. Any records between Australia and the type locality in Japan are unknown.

MATERIAL: Woolgoolga as above, 1 specimen ex T. A. Garrard coll, A.M. No. C.91794, and 1 specimen coll F. H. Plant, Sept. 1966, W. A. M. No. 522-74; Ballina as above, 4 specimens ex T. A. Garrard coll, A.M. No C91793. Botany Heads as above, 3 specimens ex Hargreaves coll, A.M. No. C.96249. Total specimens examined from A.M. and W.A.M. 21 (10 lots). Also occurs at Norfolk Island, Kermadec Islands and Japan.

DISCUSSION: This species bears a resemblance to *Heliacus cerdaleus ponderi* Garrard nov., but the basal keel below the periphery is much more restricted and the shell more depressed in the within species; a very fine thread is occasionally present between the peripheral and basal keel but never as pronounced as the two cords always present in *H. cerdaleus ponderi*. In *Heliacus enoshimensis* the suture is joined to the base of peripheral keel, but in *H. cerdaleus ponderi* it is joined to uppermost of the two fine cords between peripheral and basal keels, resulting in a pronounced canal at the sutures.

#### ***Heliacus (Heliacus) hedleyi* sp. nov. Fig. 9 (22-24).**

DESCRIPTION: *Protoconch* small, smooth and shining, light amber, varying .65-.87 mm diam. *Teleoconch* elevated conic, 4½ flatly convex whorls in diam of 8.8 mm. *Sutures* deeply impressed, joined below dorsal peripheral keel. *Sculpture* of 4 prominently beaded cords, beads rhomboidal in shape, one fine thread between rows occasionally; two strong similar cords on periphery, with two finer cords between, peripheral area flat; base with 4 fine beaded cords and a further cord adjoining umbilical cord, of broad well separated flatly rounded nodules, almost rectangular in shape. *Umbilicus* small and deep, averaging 14% of shell diameter at maturity; umbilical cord with large coarse bluntly pointed crenulations; umbilical canal flat based, rough and uneven. *Aperture* almost circular, inner-lip glazed and strongly reflected, outer-lip sharp edged and crenulate. *Colour* white, occasional nodules on peripheral keels light fawn; aperture white, stained brown near suture, very thin light fawn periostracum. *Operculum* composed of very thin layers of light fawn chitinous material, built up to rounded cone shape with hollow centre.

TYPE LOCALITY: Port Curtis, Queensland (23° 52' S., 151° 21' E.), 13-18 metres.

DIMENSIONS: Holotype, max diam 8.8 mm, min diam 7.7 mm, alt 5.7 mm, 4½ whorls. Fully grown specimen.

LOCATION OF TYPE: A.M., Sydney, New South Wales, Reg'd No. C.18727.

DISTRIBUTION: Type locality only, apparently endemic to eastern Australia.

MATERIAL: Holotype and 2 paratypes, 13-18 metres, Port Curtis as above, coll C. Hedley. 1 specimen (topotype) coll T. Iredale, A.M. No. C 61483 (pt). One further topotype coll T. Iredale, forwarded overseas for comparison with other species, lost in post.

DISCUSSION: This species is close to the description by Keen (1971:294) of *Heliacus mazatlanicus* Pilsbry and Lowe, 1932, but an anal keel on the protoconch is completely lacking. As the name implies, the above species was described from Mazatlan, Mexico.

Differences between this species and its closest congeners, *Heliacus madurensis* (Schepman) and *H. mighelsi* (Philippi) are described under "Discussion" following the descriptions of those species. This new species is named for the late Charles Hedley, in recognition of his voluminous and accurate work as Curator of Mollusca at the Australian Museum, Sydney.

***Heliacus (Heliacus) madurensis*** (Schepman, 1909). Fig. 4 (10-12).

*Torinia madurensis* Schepman, 1909:222, pl. 14 fig. 4;  
Bayer, 1948:29.

DESCRIPTION: *Protoconch* regularly coiled but elevated, smooth and shining, varying .55-.60 mm diam. *Teleoconch* roundly elevated, 3 roundly convex whorls, base strongly convex. *Sutures* deeply impressed at base of slight canal. *Sculpture* of 4 roundly flattened segmented cords divided by strong spiral grooves and crossed by strong oblique axial lines; 4 strong crenulated cords on periphery; base cut by fine spiral grooves, four flat inter-spaces, one row of axially raised elongate nodules adjoining a strong crenulated umbilical cord. *Umbilicus* narrow and deep but perspective, averaging 21% of shell diameter at maturity; umbilical canal with axially striated flatly convex base. *Aperture* sub-circular, crenulated exteriorly by cords, inner-lip arcuate and strongly reflected. *Colour* white, protoconch clear amber or white. *Operculum* circular, extremely thin amber chitinous base with microscopic black streaks, central portion of smaller diameter built up to rounded top with many successive layers of thin similar material, apex hollow.

TYPE LOCALITY: "Siboga" Stn. 51. Madura Bay, N.E. Java (7° 15' S., 113° 36' E.) 69-91 metres.

DIMENSIONS: Holotype, max diam 6 mm, alt 4.75 mm. (Unique specimen). Largest specimen examined max diam 7 mm, alt 5.5 mm, 3 whorls.

LOCATION OF TYPE: Amsterdam Museum, Netherlands, reg'd no. not ascertained.

DISTRIBUTION: Off Yeppoon, Queensland (23° 08' S., 150° 44' E.), 4 metres; southwards to Bustard Head, Queensland (24° 02' S., 151° 46' E.), 20 metres. Apparently sub-tidal to moderate depths. No records are available of occurrence between Australia and type locality in Java.

MATERIAL: Off Yeppoon as above, 2 specimens ex T. A. Garrard coll, A.M. No. C. 91765 (live). Off Bustard Head as above, 2 specimens ex T. A. Garrard coll, A.M. No. C. 91764 (live). A.M. 4 specimens (2 lots).

DISCUSSION: Protoconch nucleus was mentioned by Schepman as being brown; 2 specimens from off Yeppoon have brown protoconchs but 2 from off Bustard Head are white. This species resembles *Heliacus (Heliacus) hedleyi* Garrard nov., but differs in

having finer sculpture, especially in early whorls, a more elevated protoconch, and sutures joined at base of uppermost of 4 peripheral keels, imparting to the whorls a slightly stepped appearance, whilst the dorsum of *H. (H). hedleyi* is evenly and roundly elevated; the crenulations on umbilical cord of *H. (H). madurensis* are also decidedly finer than those of *H. (H). hedleyi*.

***Heliacus (Heliacus) mighelsi*** (Philippi, 1853). Fig. 7 (7-9).

*Solarium cyclostomum* Mighels, 1845:22 (non *Solarium cyclostomum* Menke).

*Torinia mighelsi* Philippi, 1853:36, sp. 43 (New name for *Solarium cyclostomum* Mighels, non Menke, 1828); Hanley (Sowerby), 1866:240, pl. 5 figs 87, 88; Marshall (Tryon), 1887:19, pl. 6, figs 89, 90.

DESCRIPTION: *Protoconch* smooth and shining, elevated and inflated, varying .83-.98 mm diam. *Teleococonch* elevated, 3½ whorls in diam of 8 mm, convex dorsally and basally, elevated tubular coiling. *Sutures* impressed at base of narrow but deep canal. *Sculpture* of 4 heavy flattened cords, crossed by oblique narrow ridges on top, not in line with ridges on adjoining cords; outermost cord forms peripheral keel, with further basal keel below, interspace equal in width to keels; base with 5 similar narrow cords. *Umbilicus* deep and narrowly perspective, averaging 28% of shell width at maturity, with coarse irregularly crenulated umbilical cord; umbilical canal with slightly convex base crossed by crowded vertical growth lines. *Aperture* circular, sharp-edged, crenulated by cords; shallow groove at base of outer-lip; basal and inner-lip strongly reflected. *Colour* white with thin fawn periostracum. *Operculum* not available.

TYPE LOCALITY: Oahu, Hawaii.

DIMENSIONS: Holotype, max diam 7.6 mm. Largest specimen examined max diam 8 mm, min diam 6mm, alt 6 mm, 3½ whorls.

LOCATION OF TYPE: Unknown, unable to trace.

DISTRIBUTION: Wreck Reef, Coral Sea (22° 08' S., 155° 10' E.); 869 km E. of Gladstone, Queensland, near Kelso Bank (25° 13' S., 159° 44' E), and Lord Howe Island (31° 33' S., 159° 05' E.) From the Hawaiian type locality this species probably occurs across the Pacific to the Australian localities shown, but no other records are available.

MATERIAL: Wreck Reef as above, 1 specimen coll C. Hedley, A.M. No. C. 32402. Kelso Bank as above, 1 specimen 91 metres, coll M.V. "Espirito Santo," B.M.R. Stn. E 68-504, 16/9/68, A.M. No. C 92404. Lord Howe Island as above, 1 specimen coll J. Brazier, A.M. No. C. 92405.

DISCUSSION: The differences noted between this species and *Heliacus (Heliacus) hedleyi* Garrard nov. are:



*H. (H). mighelsi*  
 Protoconch larger and inflated .83-.98 mm diam.  
 4 cords on whorls dorsally, wide space between 3rd and 4th  
 Sutures joined above basal keel, distinct step in coiling  
 Peripheral and basal keels closely set, one small cord between  
 Base with 5 narrow cords, umbilical cord weak with small numerous crenulations, umbilicus wider, 28% of shell diam.

*H. (H). hedleyi*  
 Protoconch smaller, .65-.87 mm diam.  
 4 cords, all equally spaced  
 Sutures joined below peripheral keel  
 Peripheral and basal keels widely set, two smaller cords between  
 Base with 5 variable cords, umbilical cord strongly crenulated, umbilicus narrower, 14% of shell diam.

The differences noted between *H. (H) mighelsi* and *H. (H). madurensis* (Schepman) are:

*H. (H). mighelsi*  
 3 cords dorsally between upper suture and peripheral keel  
 Suture at centre or just above basal keel  
 One small cord between peripheral and basal keels, all close-set  
 Larger and perspective umbilicus, 28% of shell diam.

*H. (H) madurensis*  
 4 cords dorsally  
 Suture at base of uppermost of 4 peripheral cords  
 2 cords between peripheral and basal keels  
 Umbilicus small and barely perspective, 21% of shell diam.

***Heliacus (Heliacus) stramineus***(Gmelin, 1791). Fig. 4 (1-6).

*Trochus stramineus* Gmelin, 1791:3575. — Wood, 1828:137, pl. 29, fig. 63.

*Solarium stramineum*. — Lamarck, 1822:4; Kiener, 1838-39:11, pl. 3, fig. 4; Deshayes, 1843:99.

*Solarium stramineum (Trochus)*. — Philippi, 1853:32, p. 11, pl. 2, fig. 7.

*Solarium (Torinia) stramineum*. — Chenu, 1859:233, fig. 1353; Hanley (Sowerby), 1863:242, pl. 5, figs 95-97.

*Torinia straminea*. — Angas, 1871:92; Marshall (Tryon), 1887:19, pl. 6, figs 93, 94.

*Heliacus stramineus*. — Cotton and Godfrey, 1933:74.

*Grandeliacus mortensenae* Iredale, 1957:124, text fig. 1.

DESCRIPTION: *Protoconch* small, regularly coiled, varying .76-.82 mm diam. *Teleoconch* depressed conic, 5½ convex whorls in diam of 38 mm, base convex. *Sutures* strongly incised at base of deep narrow canal. *Sculpture* of 5 obliquely axially striated spiral cords, with larger gemmate cord above sutural channel; this gemmate cord becomes more deeply axially incised on penultimate and body-whorl, with a vertically striated channel between it and the sutural canal; on body-whorl there are 3 large axially striated cords with a finer one between central and lowest; suture is placed immediately below small central cord; sculpture of base consists of 3 narrow cords, each followed in turn by a broad flattened cord, then 2 more broad cords, and finally the main cord bordering umbilicus; all cords and interstices from protoconch across top of shell and underneath to umbilicus are crossed by numerous fine raised striations. *Umbilicus* broadly perspective and deep, averaging 31% of shell diameter at maturity; umbilical cord with close packed axial crenulations; umbilical canal wide and shallow, convex base, 3 spiral ridges, finely obliquely striated. *Aperture* very large and almost circular, entire lip crenulated by cords; inner-lip arcuate with narrow groove at base. *Colour* creamy-fawn or deeper orange-fawn. *Operculum* of many layers of rough and uneven circular chitinous material, built up to rounded cone shape with central nucleus and typical of the sub-family; a twisted peg-like projection at rear attached to foot of mollusc.

TYPE LOCALITY: Tranquebar, southern India.

DIMENSIONS: Holotype, none given. Largest specimen examined max diam 38.2 mm, min diam 30.5 mm, alt 27mm, 5½ whorls.

LOCATION OF TYPE: Unknown, unable to trace.

DISTRIBUTION: East coast, Buchan's Point near Cairns, north Queensland (16° 44' S., 145° 40' E.), southwards to N.E. of Cape Moreton, southern Queensland (27° 02' S., 153° 28' E.), 114-124 metres (greatest depth recorded). Shallow to moderately deep water. Occurs in eastern tropical Indian Ocean to northern Australian coastline and northwards to Philippine Islands and Japan.

MATERIAL: Buchan's Point as above, 1 specimen ex J. Kerslake coll, A.M. No. C. 92034. N.E. of Cape Moreton as above, 1 specimen ex J. Kerslake coll, A.M. No. C.92033. Total specimens examined from all Australian Museums 13 (11 lots).

DISCUSSION: This large species cannot be confused with any others in the sub-family Heliacinae, reaching 3 times the size and more of any other species, with an equal number of whorls, and is also a rich unicoloured species devoid of other markings.

The species figured by Habe (1961:31, pl. 14, fig. 1) as *H. (H) stramineus* has been omitted from the synonymy, as it is apparently only 23 mm diam in lieu of about 38 mm with the same number of whorls; in addition it has much more resemblance to a large specimen of *H. (Torinista) dorsuosus* (Hinds), and unfortunately a specimen of this species has not been available from Japan.

### ***Heliacus (Heliacus) trochoides* (Deshayes, 1830)**

*Solarium trochoidea* Deshayes, 1830:160.

No records were held by any Australian Museum of the occurrence of this species in Australia up to the time of completion of this manuscript. However since then two

specimens have been sent to the author by a collector in Perth, Western Australia, one from North-West Cape, Western Australia (21° 47' S., 114° 10' E), and the other from Rottnest Island, Western Australia (32° S., 115° 30' E.). It is not possible to give a description or figure of the species at this stage, and this note is made for record purposes.

***Heliacus (Heliacus) variegatus*** (Gmelin, 1791). Fig. 7 (13-18).

*Trochus variegatus* Gmelin, 1791:3575. — Wood, 1828:137, pl. 29, fig. 59.

*Trochus areola* Gmelin, 1791:3575. — Deshayes, 1843:100; Bayer, 1948:20.

*Solarium variegatum*. — Lamarck, 1816, pl. 446, fig. 6; Lamarck, 1822:4; Sowerby (1820-25) 1831, no. 38, pl. 202; Kiener, 1838-39:10, pl. 4, fig. 7; Gray, 1874, Pl. 41, figs 3, 4.

*Torinia variegata*. — Adam, 1858:245, pl. 25, fig. 7. — Fischer, (1885) 1887:714, fig. 484; Marshall (Tryon), 1887:16, pl. 5, fig. 76; Hedley, 1907:483; 1909:360; Wilson and Gillett, 1971:34, pl. 13, fig. 15; Bayer, 1948:23.

*Solarium (Torinia) variegatum*. — Chenu, 1859:233, fig. 1354.

*Heliacus variegatus*. — Finlay, 1927:401; Kira, 1954:12, pl. 12, fig. 4.

*Heliacus variegatus depressiusculus* Bayer, 1948:22.

*Torinista variegata*. — Rippingale and McMichael, 1961:63, pl. 6, fig. 27.

DESCRIPTION: *Protoconch* regularly coiled, varying .82-1.00 mm diam. *Teleoconch* elevated or depressed, 4½ flatly convex whorls, base convex. *Sutures* impressed, at top of narrow canal. *Sculpture* of 4 flatly rounded cords, cut into segments by numerous sharp oblique axial grooves; lowest cord forms a broad rounded peripheral keel, a further narrower basal keel below, followed by 4 flatter cords on base; basal cords are cut by numerous axial grooves which are weaker than those on dorsum. *Umbilicus* small and deep but perspective, averaging 25% of shell diameter at maturity, variable in width, umbilical cord irregularly cut into crowded segments; a strongly folded rough cord bisects the umbilical canal, dividing it into two deep channels. *Aperture* almost circular, outer lip strongly crenulated by cords; two narrow grooves at centre and base of inner-lip, extend a short distance into aperture. *Colour* — cords mottled with brown and white, axial markings most noticeable on peripheral and basal cord; green or brown periostracum. *Operculum* composed of many concentric layers of tough white chitinous material, inter-leaved with layers of extremely thin and fragile horn-coloured material of greater diameter, the whole built into a high rounded cone; usual peg-like projection at rear.

TYPE LOCALITY. "Australian Seas" (Lamarck).

DIMENSION: Holotype, none given. Average adult size, max diam 13 mm, alt 7 mm, 4½ whorls.

LOCATION OF TYPE: Unknown, unable to trace.

DISTRIBUTION: West coast, Rottnest Island, W. Australia (32° 00' S., 115° 30' E), northwards to Cape Dupuy — Cape Malouet, Barrow Island (20° 40-42' S., 115° 26' E). East coast, Murray Island, Torres Strait (9° 55' S., 144° 05' E), southwards along Queensland and New South Wales coasts to Woolgoolga, New South Wales (30° 07' S., 153° 12' E), also N.E. Herald Cay, Coral sea (21° 38' S., 153° 46' E). Inter-tidal and sub-tidal. Specimens also held at A.M. from Lord Howe Island, Indonesia and southern Philipinne Islands.

MATERIAL: Rottneest Island as above, 1 specimen Radar Reef coll S. M. Slack-Smith 16/12/64, W.A.M. No. N. 5228 (two further specimens, same locality, No. N. 5230 and 1 specimen No. N. 5229). 2 specimens Green Island platform, Rottneest Island coll E. P. Hodgkin 13/1/68, W.A.M. No. 96-73. Cape Dupuy — Cape Malouet area as above, 1 specimen coll W.A.M. — U.S.N.M. Barrow Island Exp 13/9/66, W.A.M. No., 728-67 (pt). Murray Is. as above, 1 specimen ex J. Kerslake coll, A.M. No. C. 92037. Woolgoolga as above, 2 specimens ex C. F. Laseron coll, A. M. No. C. 92038. N.E. Herald Cay as above, 1 specimen coll Yaldwin and McMichael Nov. 1964, A.M. No. C. 69064. A.M. 209 specimens (43 lots). N.M.V. 87 specimens (13 lots), W.A.M. 43 specimens (23 lots), S.A.M. 26 specimens (8 lots), Q.M. 8 specimens (4 lots), total 373 specimens (91 lots).

DISCUSSION: Gmelin (1791:3575) described and named the within species as *Trochus variegatus*, and referred to figs 1708 and 1709 in *Conch. Cab.* 5:184, pl. 173. The next species described on the same page was *Trochus areola* and referred to the next two figures Nos. 1710 and 1711. These two sets of figures certainly show a decided difference, but unfortunately this appears to be a further instance of European workers in the past relying on only two or three specimens for unnecessary separation into new species. In the process far too much emphasis has been placed on very minor differences in colour pattern and other variable features, whilst drawings and paintings have been copied in later works and lost definition in the process. A study in the field of large colonies of living *Heliacus variegatus* in Queensland and northern New South Wales will show quantities of specimens conforming to both the above lots of illustrations, with every possible intergrade in colour pattern. In addition the depth of colour varies from light reddish-brown to blackish-brown within the same colony, the width of umbilicus is not constant, sculpture may vary from coarse to fine nodules in many shapes, and the height/width ratio may vary from 58% to as much as 84%.

*Heliacus areola* (Gmelin) and the subsp. *H. depressiuscula* Bayer, 1948, are both synonyms, together with several other varietal names. Many specimens commence with the sub-sutural cord pure white as shown in *Conch. Cab.* figures 1710 and 1711, but in many cases this later becomes spotted or maculated with colour on the body-whorl or earlier.

Some specimens of this species can be confused with *Heliacus (Torinista) dorsuosus* (Hinds), especially any specimens which are more depressed than usual, but can be separated at maturity by the rounded peripheral area compared with the two distinct peripheral and basal keels in the latter species, also by the coarser sculpture, narrower umbilicus, and oblique striped form of coloration, compared with the confused colour pattern of *H. (T.) dorsuosus*, with the alternate white and red-brown groups of nodules on peripheral keel. Discarding of all beach-worn specimens renders separation considerably easier.

I have been advised personally by Mr. George Buick, Librarian, Murdoch University, Western Australia, that he has observed at low tide hundreds of specimens of this species near Ela Beach, Port Moresby, P.N.G., on masses of small blue-green polyps attached to dead staghorn coral. The specimens were in groups of twos and threes, some juvenile and some mature. Many specimens dislodged from the coral were suspended above the water by fine threads up to 75 mm in length, the threads being of such strength that some specimens revolving rapidly in the wind were not dislodged.

Subgenus *Torinista* Iredale, 1936:327. Type species by original designation *Torinista popula* Iredale, 1936 (= *Solarium dorsuosum* Hinds, 1844).

REFERENCES: Wenz, 1938-44:668.

DIAGNOSIS: Small to medium, 3-20 mm diam; moderately to flatly depressed, spirally corded dorsally and basally; umbilicus narrow to wide; a peripheral keel with a definite basal keel below, the interspace between keels being either wide or narrow and recessed; operculum medium to high conical, of many layers. One species only, *Heliacus (Torinista) corallinus* nov., has an anal keel on protoconch.

***Heliacus (Torinista) dorsuosus*** (Hinds, 1844). Fig. 2 (13-15), 9 (1-6).

*Solarium dorsuosum* Hinds, 1844a:23; 1844c:439; Philippi, 1853:37.

*Solarium (Torinia) dorsuosum*. Hanley (Sowerby), 1863:238, pl. 5, figs 73, 74.

*Torinia dorsuosa*. — Marshall (Tryon), 1887:17, pl. 5, figs 80, 81; Hedley, 1909:360; Schepman, 1911:221.

*Torinista popula* Iredale, 1936:327, pl. 24, fig. 15.

DESCRIPTION: *Protoconch* regularly coiled, varying .67-.97 mm diam. *Teleoconch* moderately or flatly depressed, 3½ flatly convex whorls, base roundly convex. *Sutures* finely incised, joined between peripheral and basal keels. *Sculpture* of 4 flat-topped segmented spiral cords, occasionally 3 only, numerous deep narrow oblique axial channels intersected by 2 or 3 sharp incised spiral lines; a larger gemmate peripheral keel is separated from adjoining cord by a row of deep pits, gemmules axially straight; a smaller gemmate basal keel is separated from peripheral keel by a narrow axially striated channel, occasionally a fine spiral thread present; following this are 5 segmented cords on base, of various widths, separated by interstices of small deep pits, the last cord adjoining a crenulated periumbilical cord; all above segments rise to a low oblique axial ridge in centre of each. *Umbilicus* wide and perspective, 27-35% of shell diameter at maturity; umbilical cord with strong axially ridged and pointed crenulations; umbilical canal flat based and divided by a fine central gemmate cord. *Aperture* circular, with narrow groove in centre of inner-lip. *Colour* off-white, fawn or light brown, with fine darker brown spots at intervals on peripheral and basal keels. *Operculum* consists of layers of fawn chitinous material, built up to cone shape with concave top, the usual peg-like projection at rear, and is typical of the genus.

TYPE LOCALITY: Puerto Galero, Mindoro, Philippine Islands, 13 metres.

DIMENSIONS: Holotype, max diam 13.7 mm, alt 8.5 mm, 3½ whorls, fully grown.

LOCATION OF TYPE: Holotype should be with B.M.N.H. but catalogue reveals that it was never received, therefore presumed lost.

DISTRIBUTION: West coast, 3 km W. of Legendre Island, Dampier Archipelago (20° 23' S., 116° 55' E.), 41 metres, southwards along W. Australian coast to Rottneest Island (32° S., 115° 30' E.), east coast, Bateman's Bay, New South Wales (35° 43' S., 150° 11' E.), 137-155 metres, greatest depth recorded; northwards along New South Wales and Queensland coast to North-West island, Capricorn Group (23° 28' S., 152° E.) Intertidal to 155 metres. Extends from Australian localities shown northwards through Indonesia to type locality in Philippine Islands.

MATERIAL: Legendre Island as above, 2 specimens coll B. R. Wilson 9/6/60, W.A.M. no. 103-73. Rottneest Island as above, 1 specimen coll 18/3/69, W.A.M. no. 130-73; 1 live specimen also between Cape Dupuy and Cape Malouet, Barrow Island, Western Australia (20° 40' S., 115° 25' E.), W.A.M. — U.S.N.M. Exped, 13/10/66, Stn. 6, W.A.M. No.

206-73; Bateman's Bay as above, 1 specimen coll C. F. Laseron, A.M. No. C. 94385. North-West island as above, 1 specimen coll T. Iredale and G. P. Whitley May 1929, A.M. No. C 94386. Total specimens examined form all Australian Museums 170 (83 lots).

**DISCUSSION:** This species appears to have been confused for many years in Australia with the new subsp. *Heliacus (Heliacus) cerdaleus ponderi* Garrard, described in this revision, which occurs partly over the same areas on both east and west coasts. Apart from several minor differences, the two species can be separated readily by the double keels on the periphery of *H. (Torinista) dorsuosus*, with the very narrow axially striated channel between; this compares with the rounded or flatly rounded peripheral area in *H. (H.) cerdaleus ponderi*, which has four cords, the two outermost being a little stronger than the two central cords.

Differences between *H. (T.) dorsuosus* and *H. (H.) variegatus* (Gmelin) are described under "Discussion" following description of the latter species.

***Heliacus (Torinista) concavus* (Thiele, 1918). Fig. 4 (16-18).**

*Torinia concava* Thiele, 1918:81 (115, pl. 9 (21), figs 4, 5; Bayer, 1948:10.

**DESCRIPTION:** *Protoconch* regularly coiled, varying .48-.83 mm diam. *Teleoconch* flatly depressed dorsally, approx 4 whorls in diam of 3.5 mm, sharply centrally ridged basally with flat inward-sloping edge. *Sutures* incised, at base of deep narrow canal. *Sculpture* dorsally of one strongly beaded cord on both margins, 3 strong beaded striae between, the whole crossed by numerous close-set oblique axial ribs, nodular at intersections; a beaded peripheral keel, a similar keel below, closely spaced and projecting slightly further than the upper keel; beneath this are 4 similar narrow beaded cords, the last forming the sharply raised edge of a ramp sloping down to umbilicus, and carrying 2 finely beaded spiral striae. *Umbilicus* widely perspective, averaging 34% of shell diam at maturity; umbilical cord with regular sharply pointed crenulations; umbilical canal wide, flat-based and crossed by numerous axial striae. *Aperture* sub-circular internally, square externally, sharp-edged and crenulate. *Colour* pale translucent fawn in live state, some opaque white, one brown spot on top of protoconch, further spot on edge of protoconch aperture; some specimens with few brown spots on peripheral keels. *Operculum* not available.

**TYPE LOCALITY.** Off North-east coast of Zanzibar (5° 55' 8" S., 39° 1' 2" E.), "Valdivia" Stn. 244.

**DIMENSIONS.** *Holotype*, max diam 3.5 mm, alt 1.4 mm. *Largest specimen examined* max diam 2.7 mm, alt .9 mm (2 whorls).

**LOCATION OF TYPE:** Humboldt University Museum, East Berlin, Reg'd No. ZMB. Moll. 101911.

**DISTRIBUTION:** On west coast, W. of Bunbury, Western Australia (33° 03' S., 114° 44' E.), 156 metres, northwards to 225 km N. of Cape Leveque (14° 29' S., 123° 03' E.), 124 metres; along northern coastline and southwards along Queensland coast to Palm Islands, (18° 45' S., 146° 46' E.), 27 metres, to Sugarloaf Point, New South Wales (32° 18' S., 152° 50' E.), 113 metres. Also off Gillett Cay, Swain Reefs, Queensland (21° 43' S., 152° 25' E.) Greatest depth recorded 194 metres, 161 km N.W. of Roebuck Bay, Western Australia (16° 58' S., 120° 47' E.) Widespread throughout Indian Ocean to western Pacific, northwards to P.N.G. (A.M. 2 specimens, Amazon Bay, P.N.G., 13 metres).

MATERIAL: W. of Bunbury as above, 1 specimen coll CSIRO, H.M.A.S. "Gascoyne" 10/8/62, A.M. No. C. 94486; N. of Cape Leveque as above, 3 specimens coll P. H. Colman 12/11/67, M.V. "Kos 2" (B.M.R. Stn. K 67-181), A.M. No. C. 94471. Palm Islands as above, 5 specimens coll C. Hedley, A.M. No. C.10268; Sugarloaf Point as above, 1 specimen Dec. 1967, H.M.A.S. "Warrego," A.M. No. C. 94472; off Gillett Cay as above, 2 specimens, 63-73 metres, coll A.M. Party 17-19 Oct. 1962, A.M. No. C. 94473. Total A.M. 21 specimens (12 lots).

DISCUSSION: The V-shaped base of this species is similar in general formation to that of *H. (Claraxis) foveolatus* (Tate), but the latter species has only one peripheral keel and no basal keel.

***Heliacus (Torinista) corallinus* sp. nov.** Fig. 6 (18-20)

DESCRIPTION: *Protoconch* brown, inflated, 3 whorls, smooth and shining, peritreme entire and forming a greatly reflected broad varix, short anal keel present. *Teleoconch* 3 whorls, flatly convex dorsally and basally, bi-angulated at periphery. *Sutures* strongly impressed at base of deep narrow canal. *Sculpture* of 4 flatly crenulated cords, separated from gemmate peripheral keel by a narrow channel; a similar gemmate basal keel below the peripheral, of equal strength, one narrow gemmate cord in concave space between, crossing numerous fine axial striae; 5-6 crenulated cords on base between basal keel and gemmate umbilical cord. *Umbilicus* wide and perspective, averaging 44% of shell diam at maturity, width variable; umbilical canal with slightly convex base, strongly axially striated, microscopic spiral threads. *Aperture* circular, grooved behind keels and at base of inner-lip, which is not reflected; outer-lip crenulated exteriorly by cords. *Colour* — protoconch brown, adult whorls maculated light brown and white, 2 or 3 brown and white gemmules alternately on both keels. *Operculum* not available.

TYPE LOCALITY: Michaelmas Cay, north Queensland (16° 36' S., 145° 59' E).

DIMENSIONS: Holotype max diam 5.7 mm, min diam 4.8 mm, alt 2.8 mm, 3 whorls. Fully grown.

LOCATION OF TYPE: A.M., Sydney, Reg'd No. C. 94340.

DISTRIBUTION: Michaelmas Cay as above; Burleigh Heads, south Queensland (28° 06' S., 153° 27' E.); Euston Reef, outer Barrier Reef, off Cairns, Queensland (16° 41' S., 146° 15' E.); Lord Howe Island (31° 33' S., 159° 05' E).

MATERIAL: Michaelmas Cay as above, holotype and 6 paratypes, G.B.R. Boring Exped, May-June 1926, coll T. Iredale and G. P. Whitley, A.M. No. C. 94340; Burleigh Heads as above, 2 specimens. Q.M. Reg'd No. M.O. 5715; Euston Reef as above, 5 specimens, 21 metres, coll P. H. Colman 30/11/72, A.M. Reg'd No. C. 105042; Lord Howe Island as above, 2 specimens coll Roy Bell, A.M. No. C 59593 (pt). Total specimens 16 (4 lots). Appears to be endemic to eastern Australian area.

DISCUSSION: This species resembles *H. (Torinista) costatus* (Schepman), *H. (T.) fulvus* (Hinds) and *H. (T.) dorsuosus* (Hinds) but may be separated by the following differences. From *H. (T.) costatus*, the fine spirals in interstices between axial riblets are replaced by strong spiral grooves in this new species, also the broad ribbed space between basal keel and first spiral on base is replaced in this new species by a much narrower groove. The 5 spiral dorsal cords in *H. (T.) fulvus* are replaced by only 4 in this

new species, also the suture is joined at top of basal keel in this new species in lieu of base of top peripheral keel in *H. (T). fulvus*. From *H. (T). dorsuosus* this new species differs in having a deep narrow canal at the sutures, in addition to which the periumbilical cord is finely gemmate and not sharply crenulate. However, the feature which sets this new species apart from all others is the possession of an anal keel on the protoconch. The varix at the protoconch aperture is reflected to a much greater extent than usual, being turned backwards and flattened, forming a broad heavy band of callus. A short sharp anal keel behind the band leaves a narrow and very deep crescent shaped pit between the keel and varix. Only about  $\frac{3}{4}$  of the final whorl of the inflated protoconch is visible dorsally.

The 5 specimens mentioned under "Material" from 21 metres off Euston Reef, Queensland, were taken from the foot of a sandy slope beneath steep coral walls, indicating almost certainly that when alive the species exists in crevices in the vertical coral.

***Heliacus (Torinista) costatus* (Schepman, 1899) Fig. 5 (7-9).**

*Torinia costata* Schepman, 1899:221, pl. 14, fig. 5.

DESCRIPTION: *Protoconch* regularly coiled but slightly inflated, varying .68-.83 mm diam. *Teleoconch* flatly depressed,  $\frac{3}{4}$  flatly convex whorls, deeply canaliculate, base convex. *Sutures* strongly impressed at base of deep narrow canal. *Sculpture* of strong oblique axial ribs on all whorls, with beaded spiral cords on both inner and outer margins, the outer forming a strong peripheral keel; a further beaded basal keel of same strength as that above, space between being concave, vertical striations joining nodules, one central microscopic thread often present; base with strong axial ribs divided by narrow channels, with one finely beaded cord towards outer margin, and 3 or 4 broader crenulated cords between beaded cord and umbilicus. *Umbilicus* widely perspective, averaging 39% of shell diameter at maturity; umbilical cord strong with sharply pointed crenulations; umbilical canal flat-based, obliquely striated, with low ridge towards apical edge. *Aperture* sub-circular, strongly crenulated by external cords, two grooves behind peripheral keels, inner-lip arcuate. *Colour* off-white, marked with light fawn on groups of 2 or 3 peripheral nodules alternately with white, brown spots on protoconch. *Operculum* not available.

TYPE LOCALITY: Rumah-Kuda bay, Roma (Romang) Island, 36 metres. (7° 36' S., 127° 25' E.), north of eastern tip of Timor.

DIMENSIONS: Holotype, max diam 9 mm, alt 3.5 mm. Fully grown.

LOCATION OF TYPE: Amsterdam Museum, Netherlands, reg'd number not ascertained.

DISTRIBUTION: Arafura Sea, 160 km N. of Croker Island, Northern Territory (9° 30' S., 132° 34' E.), Van Diemen's Inlet, Gulf of Carpentaria (16° 59' S., 140° 59' E.), Buchan's Point, north of Cairns, Queensland (16° 44' S., 145° 40' E.), southwards along Queensland and New South Wales coasts to Manly Beach, Sydney, New South Wales. Northwards from Australia at least as far as the type locality north of Timor.

MATERIAL: Arafura Sea as above, 2 specimens, 124 metres, coll P. H. Colman 9/11/69, M.V. "San Pedro Sound," (B.M.R. Stn. P69-1144), A.M. No. C. 92040; Van Diemen's Inlet as above, 1 specimen coll C Hedley, A.M. No. C.15375; Buchan's Point as above, 1 specimen coll J. Kerslake July 1964, A.M.No. C. 92041; Manly Beach as above, 1 specimen ex C. F. Laseron coll, A.M. No. C. 92039. A.M. 12 specimens (6 lots).



DISCUSSION: The nearest congeners to this species appear to be *H. (Torinista) dorsuosus* (Hinds) and *H. (T.) mazatlanicus* (Pilsbry and Lowe), both easily separated by the possession of strong spiral cords dorsally in lieu of the numerous axial riblets on *H. (T.) costatus*. A further congener is *H. (T.) caelatus* (Hinds), a species growing to 9 mm diam and very similar in appearance, but having decidedly coarser sculpture, with only 50 ribs on body-whorl compared with 90 ribs on *H. (T.) costatus*. Despite the type locality for *H. (T.) caelatus* being the Straits of Macassar and being widely distributed throughout the Western Pacific (Keen, 1971:389), there does not appear to be any record of its occurrence in Australia. Hedley (1909:360) included *H. (T.) caelatus* in his check-list of Queensland species, but the specimens which he collected in that State prove to be *H. (T.) costatus* (Schepman).

The 12 specimens held by A.M. agree precisely in every particular with Schepman's figure and description with the sole exception of the fine spiral striae between the dorsal rib, which is completely lacking. However, all are dead specimens and any microscopic raised striae could easily be eroded, alternatively this could be a variable feature peculiar to more tropical specimens.

***Heliacus (Torinista) delectabilis* (Melvill, 1893) Fig. 5 (1-3).**

*Solarium (Torinia) delectabile* Melvill, 1893:57, pl. 1, fig. 11.

*Torinia delectabilis*. — Bayer, 1948:14.

DESCRIPTION: *Protoconch* smooth and shining, inflated and prominent, raised above first adult whorl, varying 1.00-1.16 mm diam. *Teleoconch* flatly depressed, 3 flat-topped whorls in diam of 6 mm, flatly rounded dorsally, convex base, periphery flat, strongly beaded. *Sutures* deeply incised at base of narrow canal. *Sculpture* dorsally consists of a strong beaded cord on either margin, 3 narrower beaded cords between, crossed by strong oblique axial grooves; outer cord forms peripheral keel, with a further similar but narrower nodular basal keel below; interspace between keels is flat, barely recessed, with one or two fine nodular threads; on base are two fine, two medium and one broad decussated cord, surrounding crenulated umbilical cord. *Umbilicus* small and barely perspective, averaging 22% of shell diam at maturity; umbilical cord with small regular crenulations; umbilical canal flat based, axially and spirally finely striated. *Aperture* sub-circular, inner-lip arcuate with short groove at base; outer-lip crenulated exteriorly by keels. *Colour* off-white or cream, pale chestnut spots widely spaced on peripheral keel, brown spot on top of protoconch and at edge of protoconch aperture. *Operculum* not available.

TYPE LOCALITY: Bombay.

DIMENSIONS: Holotype, max diam 3 mm, alt 2.5 mm. Largest specimen examined, max diam 6 mm, alt 3.3 mm, 3 whorls (Specimen figured, A.M. No. C. 92021).

LOCATION OF TYPE: B.M.N.H. Reg'd No. 1893.2.16.38.

DISTRIBUTION: Off Dongara, Western Australia (29° 15' S., 114° 01' E.), to Rocky Point, southern coast of Western Australia (34° 13' S., 125° 04' E.); 123-125 metres; off Beachport, South Australia, 150 metres (37° 30' S., 140° E.); eastwards to Twofold Bay, New South Wales (37° 06' S., 149° 55' E.), 90 metres. northwards to Crowdy Head, Manning River mouth, New South Wales (31° 50' S., 152° 45' E.), northwards to Moreton Bay, southern Queensland (27° 02' S., 153° 28' E.), 114-124 metres. Eastern Indian Ocean to east coast of Australia.

MATERIAL: Dongara as above, 1 specimen H.M.A.S. "Diamantina" 20/3/72 (DM 1/72), Stn. 55, W.A.M. No. 205/73. Rocky Point as above, 1 specimen 160 km S.E., H.M.A.S.

"Gascoyne," (G2/105/62), A.M. No. C.92019. Beachport as above, 1 specimen S.A.M. not reg'd. Twofold Bay as above, 1 specimen T.A. Garrard coll, A.M. No. C. 92020. Moreton Bay as above, 1 specimen ex T. A. Garrard coll, A.M. No. C. 71469. Total specimens examined from all Australian Museums 24 (18 lots).

DISCUSSION: This species is close to *H. (Torinista) fulvus* (Hinds), but in lieu of the overall blotched and maculated colour of that species it has widely spaced fawn spots on peripheral keel and 2 spots on protoconch in all specimens examined. All specimens also have only 5 cords on dorsum, with interstices bearing strong radial striae, in lieu of the 6 cords on each whorl in *H. (T.) fulvus*. The spire of *H. (T.) delectabilis* is a little higher and the sutures deeper and better defined than in *H. (T.) fulvus*. The two syntypes of *H. (T.) fulvus* have been compared with the holotype of *H. (T.) delectabilis* at B.M.N.H., the above differences quoted, and it is stated that they are definitely not considered to be conspecific.

The very fine sculpture between nodules on the spiral cords described by the author requires at least 30X magnification to be seen clearly, and consists of extremely fine growth lines and granulations, which glitter under the light.

***Heliacus (Torinista) fenestratus* (Hinds, 1844) Fig. 4 (19-21).**

*Solarium fenestratum* Hinds, 1844a:25; 1844b:52, pl. 14, figs 21, 22; 1844c:440. Philipp 1853:23, pl, 3, fig. 13.

*Torinia fenestrata*. – Marshall (Tryon), 1887:20, pl. 6, figs 100, 1.

*Solarium (Torinia) fenestratum*. — Hanley (Sowerby), 1863:241, pl, 5, figs 77, 78 (error for 79, 80).

DESCRIPTION: *Protoconch* regularly coiled, a little inflated, smooth and shining, varying 1.17-1.77 mm diam. *Teleoconch* flatly depressed, 3½ whorls in diam of 7.5 mm, whorls flatly rounded, strongly beaded, base widely umbilicate. *Sutures* incised, at base of wide deep canal. *Sculpture* of 3 strongly beaded cords on first 1½ whorls, 4 on penultimate and body-whorl, with a fifth similar cord forming a strong keel; below this is a further similar basal keel, the two bi-angulating the whorls with a fine thread between; below basal keel are 4 further beaded cords and one or two threads; a similar beaded umbilical cord is separated from others by a narrow canal; entire surface carries strong raised oblique threads crossing all cords and interstices, dividing cords into nodules. *Umbilicus* very wide and perspective, averaging 50% of shell diameter at maturity with deep, narrow canal, which has one or two finely crenulated cords on its base. *Aperture* circular interiorly, crenulated exteriorly by cords, fine grooves internally below cords, peritreme entire or almost so at maturity. *Colour* pale fawn with narrow light brown axial lines crossing periphery and extending partly over dorsum and base. *Operculum* roundly conical with hollow centre, comprised of solid gelatinous material with about 10 layers of very thin ragged-edged chitinous material in form of circular "fins," off-white in colour.

TYPE LOCALITY: New Guinea.

DIMENSIONS: Holotype, max diam 7.4 mm, alt 3.5 mm, 3½ whorls, approx max size.

LOCATION OF TYPE: Should be held by B.M.N.H. but cannot be traced.

DISTRIBUTION: On west coast, south passage Shark Bay, Western Australia (25° 30' S., 113° 30' E.); east coast, Michaelmas Cay off Cairns, Queensland (16° 45' S., 146° 05' E.), and G.B. Reef off Cairns (16° 55' S., 146° 19' E.). Inter-tidal and sub-tidal. Central Indo-Pacific generally extending northwards to Philippine Islands and Japan.

MATERIAL: Shark Bay as above, 1 specimen (live) under coral, coll R. Butler 7/5/66, W.A.M. No. 170-66; Michaelmas Cay as above, 2 specimens coll T. Iredale and G. P. Whitley May-June 1926, G.B.R. Boring Exp, A.M. No. C. 53488 (pt); G.B.R. off Cairns as above, 1 specimen coll D. Pitt, A.M. No. C. 46060. 2 specimens also held by A.M. coll C. Hedley, from Bird Island, Coral Sea (22° 13' S., 155° 40' E.) Total specimens examined A.M. and W.A.M., 10 (5 lots).

DISCUSSION: Compared with its closest congener, *Heliacus (Torinista) infundibuliformis* (Gmelin), the within species grows to only half the size with a corresponding number of whorls, the oblique axial beads on all cords on dorsum are twice as numerous, and the whorls are more rounded on base, which is less sharply ridged in centre than *H. (T.) infundibuliformis*. Differences in colour are also shown in description.

***Heliacus (Torinista) fulvus*** (Hinds, 1844). Fig. 8 (10-15).

*Solarium fulvum* Hinds, 1844a:24; 1844b:51, pl. 14, figs 17, 18; 1844c:439; Philippi, 1853:21, pl. 3, fig. 11.

*Solarium (Torinia) stramineum* var. *fulva* Hanley (Sowerby), 1863:242; Bayer, 1948:35.

TYPE LOCALITY: New Guinea.

DIMENSIONS: Holotype, max diam 7.4 mm, alt 3.2 mm.

LOCATION OF TYPE: B.M.N.H., Reg'd Nos. of 2 syntypes 1844:6:7:34 and 1879:2:26:158.

DISCUSSION: This species is apparently not recorded from Australia, but photographs of the 2 syntypes having been supplied by B.M.N.H. they are shown at fig. 8 (10-15) to assist with recognition. A letter from B.M.N.H. states "The Hinds collection was donated to this Museum in 1842 but Belcher received some of the material, which he donated in 1844 to this Museum. The rest of the Hinds material went to the Lombe Taylor collection... In 1879 the rest of the Lombe Taylor collection was purchased through G. B. Sowerby by this Museum. At this time *Solarium fulvum* (79:2:26:158).....and others.....were acquired." As the two specimens now illustrated were acquired by B.M.N.H. as above from the Hinds collection, it is possible that they represent part of a syntypic series, although the measurements of neither agree with those shown by the author for the holotype.

The colour as shown in the original description is merely "fulva" meaning probably tawny or light brown. The dorsal view of No. 1844:6:7:34 shown at Fig. 8 (1) shows the specimen apparently maculated with this colour and off-white in irregular blotches.

***Heliacus (Torinista) cf. implexus*** (Mighels, 1845). Fig. 9 (16-18).

*Solarium implexum* Mighels, 1845:22. — Hanley (Sowerby), 1863:244.

*Torinia implexa*. — Marshall (Tryon), 1887:23. — Bayer, 1948:37.

DESCRIPTION: *Protoconch* regularly coiled, varying 1.03-1.27 mm diam. *Teleoconch* depressed, 2½-3 whorls, flat dorsally, flatly convex on base, whorls bi-angulated. *Sutures* finely incised, joined between peripheral and basal keels. *Sculpture* of 4 flatly-raised spiral cords bounded by a wider and stronger peripheral keel, the whole decussated by strong flatly-rounded oblique axial striae; microscopic spiral threads visible on all cords, especially peripheral keel; base with 5 similar spiral cords, bounded by basal keel, a little more contracted than peripheral keel above; space between keels deep and narrow with

close-set vertical striae. *Umbilicus* widely perspective, averaging 40% of shell diam at maturity; umbilical cord with regularly spaced and pointed crenulations; umbilical canal wide and shallow, concave base, with close-set vertical striae. *Aperture* sub-circular with deep and narrow grooves behind peripheral keels and at base of inner-lip, which is strongly recurved; outer-lip a little thickened and crenulated by keels. *Colour* translucent white, irregular pale fawn markings on both dorsal and basal spiral cords, occasional pale spots of same colour on peripheral keels. *Operculum* not available.

TYPE LOCALITY: Oahu, Hawaii (author).

In referring to the type locality Johnson (1949:217) quotes a note by W. H. Pease stating "The marine species were from Kauai without doubt." This is the western-most of the main Hawaiian Islands, co-ordinates approx 22° N., 159° 30' W.

DIMENSIONS: Holotype, max diam 6.76 mm. Largest specimen examined, max diam 8 mm, alt 3.3 mm, 3 whorls (N. of Barrow Is., Western Australia, as below).

LOCATION OF TYPE: Unknown, cannot be traced.

DISTRIBUTION: On west coast, N. of Barrow Is. (20° 46' S., 114° 51' E.), 104 metres; 193 km N. of Port Hedland (18° 40' S., 119° 23' E.), 117 metres; 290 km W. of Broome (18° 25' S., 119° 50' E.), 115 metres; 161 km N.W. of Broome (16° 58' S., 120° 47' E.), 194 metres; 225 km N. of Cape Leveque (14° 29' S., 123° 03' E.), 124 metres; eastwards to Murray Is., Torres Strait (9° 55' S., 144° 05' E.), 9-15 metres; Opal Reef, N. of Cairns, Queensland (16° 13' S., 145° 54' E.), 27 metres; N.E. of Yeppoon, 103 km (22° 50' S., 151° 39' E.), 64 metres; off Masthead Is. (23° 10' S., 151° 54' E.), 31-37 metres; E. of Port Jackson, New South Wales, 75-150 metres. Shallow water to 194 metres, greatest depth, N.W. of Broome as above. Apparently widespread throughout Pacific and probably eastern Indian Ocean, but definite records are not available.

MATERIAL: N. of Barrow Is. as above, 1 specimen coll P. H. Colman 10/10/68, M.V. "Espirito Santo," B.M.R. Stn. E68-681, A.M. No. C. 98315; N. of Port Hedland as above, 1 specimen coll P. H. Colman 6/10/68, M.V. "Espirito Santo," B.M.R. Stn. E68-549, A.M. No. C. 98314; W. of Broome as above, 4 specimens coll P. H. Colman 6/10/68, M.V. "Espirito Santo," B.M.R. Stn. E68-547, A.M. No. C. 98313; N.W. of Broome as above, 2 specimens coll P. H. Colman 29/11/67, M.V. "Kos 2", B.M.R. Stn. K67-248, A.M. No. C. 98312; N. of Cape Leveque as above, 1 specimen coll P.H. Colman 12/11/67, M.V. "Kos 2", B.M.R. Stn. K67-181, A.M. No. C. 98311; off Murray Is. as above, 1 specimen coll C. Hedley, A.M. No. C. 98319; Opal Reef as above, 1 specimen coll P. H. Colman 25/11/72, A.M. No. C. 98316; N. E. of Yeppoon as above, 1 specimen coll P. H. Colman 25/9/70, M.V. "San Pedro Strait," B.M.R. Stn. 1261, A.M. No. C. 98317; off Masthead Is. as above, 2 specimens coll C. Hedley, A.M. No. C. 19629; E. of Port Jackson as above, 1 specimen coll CSIRO 18/7/62, H.M.A.S. "Gascoyne," Stn. G2/55-57/62, A.M. No. C. 98318. A.M.15 specimens (10 lots), also 1 specimen Nadi Bay, Viti Levu, Fiji, A.M. No. C. 69063, and 12 specimens Lord Howe Is. coll Roy Bell, A.M. No. C.59593.

W.A.M. 1 specimen coll T. Richert, June-July 1967, 36-73 metres off Waikiki, Oahu, Hawaii, W.A.M. No. 90-73.

DISCUSSION: This species has been regarded by authors in the past as a *nomen dubium* owing to the concise description and lack of an illustration; however the original description coincides in all details with the description now given, and in view of the above W.A.M. specimen being found very close to the type locality it is probable that identification as *H. (Torinista) implexus* (Mighels) is correct.

***Heliacus (Torinista) infundibuliformis*** (Gmelin, 1791). Fig. 7 (19-21).

*Turbo crenellus* Linnaeus, 1767:1236; Gmelin, 1791:3602.

*Trochus infundibuliformis* Gmelin, 1791:3575; Angas, 1877:184.

*Torinia infundibuliformis*. — Adams, 1858:242, pl. 25, fig. 7.

*Solarium chemnitzii* Kiener, 1839:12, pl. 4, fig. 8.

*Solarium infundibuliforme*. — Philippi, 1853:11, pl. 2, figs 8, 9.

*Solarium (Torinia) infundibuliforme*. — Hanley (Sowerby), 1863:243, pl. 5, figs 91-93.

*Torinia infundibuliforme*. — Marshall (Tryon), 1887:19, pl. 8, figs 97, 98.

*Heliacus infundibuliformis*. — Keen, 1971:391.

DESCRIPTION: *Protoconch* deep brown, smooth and shining, regularly coiled, varying .80-.98 mm diam. *Teleoconch* flatly rounded, 4 whorls in width of 15 mm, in form of tightly coiled tube. *Sutures* strongly incised at base of canal. *Sculpture* of 4 strong beaded cords with numerous smaller cords and fine threads between, all crossed by microscopic growth lines; base sculptured in similar manner; edge of whorls has concave section between two strong peripheral cords, with several fine threads and striations; a wide deep canal between whorls with incised suture at base. *Umbilicus* very wide and perspective, averaging 68% of shell diameter at maturity, bordered by strong crenulated cord, beaded in its earlier stages, inside which are smaller beaded cords, with still finer threads and striations between; umbilical canal broad and shallow, flat-based, 3-6 fine spiral striae crossed by microscopic growth lines. *Aperture* circular interiorly, strongly crenulated exteriorly by the numerous cords, two peripheral and one basal cord being prominent; inner-lip reflected. *Colour* medium to dark brown, occasionally with regularly spaced white axial streaks partly across top of whorls and round periphery to base; fawn periostracum. *Operculum* consists of about 12 layers of fawn chitinous material, expanding in size from apex to base, ragged in appearance and roughly formed; not built up to usual rounded cone shape, but flatter with generally untidy appearance.

TYPE LOCALITY: None given.

DIMENSIONS: Holotype, none given. Largest specimen examined max diam 20 mm, min diam 16 mm, alt 7.5 mm, 4½ whorls.

LOCATION OF TYPE: Unknown, unable to trace.

DISTRIBUTION: West coast, between Cape Dupuy and Cape Malouet, Western Australia (20° 40-42' S., 115° 25' E.), only known W. Aust. record; eastwards to Murray Is., Torres Strait (9° 55' S., 144° 05' E.), N.E. Herald Cay, Coral Sea (21° 38' S., 153° 46' E.); West Cay, Diamond Islets, Queensland (17° 25' S., 150° 58' E.), southwards along Queensland coast to Caloundra Beach (26° 48' S., 153° 08' E.) A widespread Indo-Pacific species, extending northwards to Japan.

MATERIAL: Cape Dupuy-Cape Malouet as above, 1 specimen W.A.M. — U.S.N.M. Barrow Is. Exped 13/9/66, W.A.M. No. 727-67; Murray Is. as above, 1 specimen coll C. Hedley, A.M. No. C. 29399; N. E. Herald Cay as above, 2 specimens coll J. C. Yaldwin and D. F. McMichael Nov. 1964, A.M. No. C. 69064; Diamond Islets as above, 1 specimen coll J. C. Yaldwin and D. F. McMichael Oct. 1964, A.M. No. C. 69165; Caloundra Beach as above, 3 specimens ex T. A. Garrard coll, A.M. No. C. 92032. Total specimens examined from all Australian Museums 42 (17 lots).

DISCUSSION: This species has been incorrectly cited by authors for many years as *Heliacus crenellus* (Linnaeus, 1758), a *nomen dubium*. It can be readily separated from all but one other species by its coiled-tube appearance, and the umbilicus consisting of the whole base of shell inside the central sharp basal cord. Differences between this species and its nearest congener, *Heliacus (Torinista) fenestratus* (Hinds), are described under "Discussion" following description of that species.

***Heliacus (Torinista) virgatus*** (Hinds, 1844). Fig. 8 (16-18).

*Solarium virgatum* Hinds, 1844a:25; 1844b:52, pl. 14, figs 18, 19; 1844c:440; Philippi, 1853:21, pl. 3, fig. 10; Hanley (Sowerby), 1863:240, pl. 5, figs 85, 86; Marshall (Tryon), 1887:20, pl. 6, figs 2, 3.

TYPE LOCALITY: New Guinea.

DIMENSIONS: Holotype, max diam 4.2 mm, alt 2.1 mm.

LOCATION OF TYPE: B.M.N.H. Reg'd No. of possible holotype 1874:12: 11:190.

DISCUSSION: This species is apparently not recorded from Australia, but as photographs of the possible holotype have been supplied by B.M.N.H. they are shown at Fig. 8 (16-18) to assist with recognition. This species was isolated from the Hinds material at B.M.N.H. as being closest to the original measurements of the holotype, max diam being about 4.7 mm and alt 2.1 mm.

The colour stated in the original description is "cingulo supremo et ultimo rufis, medianis albis," i.e. reddish on the two cords at either margin and white on the two between, which appears to agree with the dorsal view at Fig. 8 (16).

#### FOSSIL SPECIES

***Heliacus (Torinista) darraghi*** sp. nov. Fig. 10 (4-6).

DESCRIPTION: *Protoconch* very small, 1½ smooth whorls, nucleus submerged, averaging .38-.43 mm diam. *Teleoconch* roundly depressed conic, 5 flat-topped whorls in diam of 13.8 mm, very convex basally. *Sutures* finely incised, joined below peripheral keel, forming slight canal. *Sculpture* of 6 strongly beaded spiral cords of varying strength, outermost forming peripheral keel; a pair of fine oblique threads links each nodule in one cord with corresponding nodule in adjoining cord; peripheral keel is stepped below adjoining cord by wide concave area; a beaded basal keel is more contracted than peripheral keel above, with one to 4 finer cingula and/or threads in space between; base with 5 beaded spiral cords and threads of varying strength, and a wide strongly axially crenulated area crossed by many microscopic spiral threads. *Umbilicus* medium and perspective, averaging 25% of shell diam at maturity; umbilical cord with widely spaced coarse crenulations, joined to surrounding wide crenulated area by numerous fine axial filaments crossing a wide and moderately deep sulcus with an occasional fine thread in centre. *Aperture* sub-circular, crenulated exteriorly by cords, grooved inside peripheral keel and at base of inner-lip, which is arcuate and reflected.

TYPE LOCALITY: Aw. 1. Point Flinders, Cape Otway, Victoria. Grid ref. Aire 367,097. Glen Aire Clay: Aldingan?: Upper Eocene.

DIMENSIONS: Holotype, max diam 13.8 mm, min diam 11.9 mm, alt 8.1 mm. One of the largest specimens studied.

LOCATION OF TYPE: N.M.V., Melbourne, Victoria, Fossil Dept., Reg'd No. P. 31321.

**MATERIAL:** Holotype and 14 paratypes, all type locality, coll F. A. Cudmore. 6 topotypes coll T. A. Darragh and T. Hughes 1/12/72, N.M.V. No. P. 31326. 3 topotypes coll T. A. Darragh and H. E. Wilkinson 5/12/68, N.M.V. No. P. 31323. 1 specimen uppermost bed, washout nearest Brown's Creek, Victoria, Grid ref. Aire 277, 177. Brown's Creek Clay: Aldingan: Upper Eocene, N.M.V. No. 31320 (pt). 1 topotype coll T. A. Darragh and H. E. Wilkinson 13/12/72, N.M.V. No. P. 34817. 1 specimen in cutting Boornong Road, 1.3 miles N. of Cooriemungle Road, Cooriemungle, Victoria, Grid ref. Princetown 982, 485, coll T. A. Darragh and T. Hughes 25/11/72, N.M.V. No. P. 34819. Total specimens N.M.V. 27.

**DISCUSSION:** The fine pairs of threads linking the nodules in each adjoining cord are a good recognition feature in this new species, and have not been observed in any other Victorian Tertiary fossil. The species is named for Thomas A. Darragh, Deputy Director, N.M.V., Melbourne, Victoria, in appreciation of his assistance to the author on many occasions with loan of material and checking of manuscripts.

Subgenus *AWARUA* Mestayer, 1930:144-6. Type species by original designation *Omalaxis amoena* Murdoch and Suter, 1905.

**REFERENCES:** Wenz, 1938-44:667; Bayer, 1948:5.

**DIAGNOSIS:** Original — "Shell very depressed, apex flat. Protoconch minute, smooth, the extreme tip hyaline, visible from below. Whorls keeled, very slightly descending, lightly rounded; sculpture spiral and radial." (Major diam 3 to 15 mm. No anal keel on protoconch).

**NOTE:** The author failed to describe the main distinguishing feature of this subgenus which sets it apart from all others viz., the wide concave area surrounding the umbilicus, with 3 rows of irregularly spaced and uneven nodules at top, centre and base, all crossed by numerous axial threads or filaments, crossing both nodules and interstices. (A simple explanation of this feature is that a great distension has occurred of the sulcus dividing the two periumbilical cords, or in this case the two rows of nodules).

***Heliacus (Awarua) amoenus* (Murdoch and Suter, 1905). Fig. 2 (16-18).**

*Omalaxis amoena* Murdoch and Suter, 1905:293, pl. 24, figs 30, 32; Suter, 1913:318, pl. 15, fig. 21; Finlay, 1926:401.

*Awarua amoena*. — Mestayer, 1930:145; Powell, 1937:75.

*Torinia amoena*. Bayer, 1948:5.

**DESCRIPTION:** *Protoconch* regularly coiled, a little inflated, smooth and shining, varying .61-.76 mm diam. *Teleoconch* 2½ flat-topped whorls, dorsum and base flatly convex, sharp peripheral keel. *Sutures* joined at base of peripheral keel, finely incised and undulating. *Sculpture* of 3-4 fine threads and/or striae on each whorl in varied positions, bounded by a strong gemmate cord on either margin; a wide concave axially ribbed space below outer cord separates it from a finely axially ribbed peripheral keel on a lower plane; these fine riblets or threads cross 3 or 4 fine gemmate cords on the flatly or roundly sloping base, and deep into umbilicus. *Umbilicus* widely perspective, averaging 53% of shell diam at maturity, and bounded by a row of widely spaced strong pointed uneven nodules, not in form of a cord; two further finer periumbilical rows of nodules surround the inner row, also widely spaced; the 3 rows of nodules are widely spaced, central being in a shallow depression between inner and outer rows, and all are over-ridden in an irregular manner by the above numerous fine axial threads or riblets; umbilical canal flat-based and finely axially ribbed. *Aperture* sub-circular, inner-lip

strongly reflected and centrally grooved; outer-lip thin, crenulated exteriorly by cords, grooved behind peripheral keel. *Colour* opaque white. *Operculum* — Mestayer (1930:146) states regarding an operculum in a further specimen other than holotype: "...it is certainly of a conical type. under a 2/3 objective it appears to be spirally wound, with the outer edges free. At the apex is a small pit, from which the first coil arises, passing spirally downwards." (This refers to the barely visible operculum well inside the body-whorl of the paratype.)

**TYPE LOCALITY:** Off Cuvier Island, east of Great Barrier Island, New Zealand (36° 08' S., 175° 55' E.), 219 metres.

**DIMENSIONS:** Holotype, max diam 3 mm, min diam 2.5 mm, alt 1 m, 2½ whorls. Largest specimen examined (A.M.No. C. 94341) max diam 4.1 mm, alt 1.9 mm. 2¾ whorls.

**LOCATION OF TYPE:** N.M.N.Z., Wellington, New Zealand, reg'd No. M 1680.

**DISTRIBUTION:** Apart from type locality, 3 other localities in the Arafura Sea, north of Northern Territory, as follows:

160 km N. of Croker Island, (9° 30' S., 132° 34' E.). 125 metres.

150 km N.W. of Melville Island (9° 53' S., 130° 02' E.), 205 metres.

230 km N. of Goulburn Island (9° 18' S., 133° 38' E.), 135 metres.

**MATERIAL:** Holotype forwarded on loan from N.M.N.Z. 160 km N. of Croker Is. as above, 1 specimen coll P. H. Colman 9/11/69, M.V. "*San Pedro Sound*" B.M.R. Stn. P69-1144, A.M. Reg'd No. C. 94341. 150 km N.W. of Melville Is. as above, 1 specimen coll P.H. Colman 5/12/69, M.V. "*San Pedro Sound*," B.M.R. Stn., P69-1220. A.M. No. C. 105119. (Immature, 1½ whorls). 2.2 x .8 mm. 230 km N. of Goulburn Is. as above, 1 specimen coll P. H. Colman, 1/11/69, M.V. "*San Pedro Sound*," B.M.R. Stn., P69-1073, A.M. No. C. 105120. (Immature, 1¼ whorls). 1.9 x .7 mm.

**DISCUSSION:** A.M. specimen No. C. 94341 has been compared with the holotype, and 2 specimens examined later then compared with the first specimen. It was found that the fine gemmate cords on base between peripheral keel and outer periumbilical cord vary from 3 to 4; that the slope or ramp on which they are placed may vary from flat to slightly convex; the two fine striae and one thread in centre of each whorl dorsally may vary in position, also in one specimen they tend to disappear and then recur. The number of axial threads or riblets may vary on the dorsum of first whorl from 30 to 40, and on the body-whorl up to 60, due to bifurcation of the riblets in various places.

#### FOSSIL SPECIES

##### ***Heliacus (Awarua) otwayanus* sp. nov. Fig. 10 (1-3).**

**DESCRIPTION:** *Protoconch* smooth and shining, 1½ whorls, regularly coiled, averaging .96 mm diam. *Teleoconch* low conic, 5 flat-topped whorls in diam of 13.8 mm, base roundly convex. *Sutures* finely incised, joined at edge of peripheral keel. *Sculpture* dorsally of beaded cord on inner margin, a second cord close to periphery, 3 finer beaded striae between; space between outer cord and peripheral keel smooth and concave, usually a fine spiral thread present; peripheral keel finely beaded on first 3 whorls, smooth on body-whorl and penultimate; base of body-whorl with up to 15 scale-on-scale growth marks, others between are microscopic; one or two fine spiral threads on some specimens. *Umbilicus* wide and perspective, averaging 48% of shell diameter at maturity, with a wide concave area bordered on either margin by a row of sharply pointed crenulations, not in form of cords; scale-on-scale growth marks continued across umbilicus and obliquely across the deep and flat-based umbilical canal. *Aperture*



sub-rhomboid, grooved behind peripheral keel, at lower edge of inner-lip and at base of columella, which is vertical and slightly reflected.

TYPE LOCALITY: Aw. 1. Point Flinders, Cape Otway, Victoria. Grid ref. Aire 367, 097. Glen Aire Clay: Aldingan: upper Eocene.

DIMENSIONS: Holotype max diam 13.8 mm, min diam 12 mm, alt 7.1 mm, 5 whorls. Largest specimen.

LOCATION OF TYPE: N.M.V., Melbourne, Victoria, Fossil Dept., Reg'd no. P. 31325.

MATERIAL: Holotype and one paratype, also from type locality, coll T.A. Darragh and T. Hughes 1/12/72. 6 topotypes coll F. A. Cudmore, N.M.V. No. P. 31322. 2 topotypes coll T. A. Darragh and H. E. Wilkinson 5/12/68, N.M.V. No. P. 31324. Total N.M.V. 10 specimens.

DISCUSSION: The general formation of this species, especially the umbilical area peculiar to the type for the genus places it without doubt as being congeneric, despite the differences in basal sculpture. The further new *Awarua* species described in this revision but not named because of lack of material, serves as a link between *H. (A). otwayanus* and *H. (A). amoenus*, type for the genus, by its intermediate type of basal sculpture.

A Recent unidentified specimen was collected by C. Hedley from 183 metres off Port Macquarie, New South Wales, A.M. No. C. 37723; allowing for usual slight variations this appears to be a Recent specimen of *H. (A). otwayanus*. The specimen is immature, measuring 3.8 mm max diam and 1.7 mm alt, and is slightly eroded.

*H. (Awarua) otwayanus* does not fully agree with the description and illustration, but appears close to *Heliacus aucklandicus* Marshall, from Pakaurangi Point, Kaipara Harbour, New Zealand (T.P.N.Z.I., 1918, vol. 50:263, pl. 18, fig. 2). Finlay, *ibid.*, 1927, Vol. 57, states also that *Heliacus aucklandicus* is very close to *H. marwicki* Allan.

#### ***Heliacus (Awarua)* sp. Fig. 10 (19-21).**

DESCRIPTION: *Protoconch* small, nucleus minute, regularly coiled, .76 mm diam. *Teleoconch* 5¼ flatly concave whorls, dorsum flatly convex, base of body-whorl flat, sloping inwards at 45° to outer edge of umbilicus. *Sutures* finely incised, scalloped, joined under edge of peripheral keel and whorls slightly imbricating. *Sculpture* of 5 gemmate cords and threads on dorsal surface of each whorl, and a flat trifid peripheral keel, whole surface crossed by numerous fine oblique axial striations, nodular at intersections with spirals; base with many fine spiral striations and threads of varying size, crossed by numerous very fine growth lines and a few larger scale-on-scale growth marks. *Umbilicus* commences at peak of shell base as a row of fine nodules not in form of a cord, over-ridden by 4 microscopic spiral threads, and is 66% of shell diameter at maturity; a further row of widely spaced small sharp nodules at base of wide concave umbilical area, and a third still finer row immediately below the first; umbilical canal slightly concave, crossed by numerous oblique microscopic growth lines. *Aperture* rhomboid, upper and outer lips straight, lower edge straight but sloping upwards at inner margin to meet straight but very oblique inner-lip.

LOCALITY: Aw. 1. Point Flinders, Cape Otway, Victoria. Grid ref. Aire 367,097. Glen Aire Clay: Aldingan?: Upper Eocene.

DIMENSIONS: Max diam 15.8 mm, min diam 13.5 mm, alt 5.7 mm, 5¼ whorls.

LOCATION OF SPECIMEN: Fossil Dept., N.M.V., Melbourne, Victoria, Reg'd No. P. 34816. Coll T. A. Darragh and T. Hughes 1/12/73.

MATERIAL: Single specimen only as above.

DISCUSSION: This species is very distinct and cannot be confused with any other, nor is it likely to be found to merge with other known species later when more material becomes available. Additional material is naturally necessary before naming it as a distinct species. The basal sculpture of the one Recent and two fossil species described in the genus *Awarua* is quite unique and not encountered elsewhere in the family.

Subgenus *CLARAXIS* Iredale, 1936:327. Type species by original designation *Claraxis illustris* Iredale, 1936 (= *Solarium asperum* Hinds, 1844).

REFERENCES: Wenz, 1938-44:668.

DIAGNOSIS: Small to medium, 3-15 mm diam, moderately to flatly depressed, nodular or gemmate sculpture dorsally and basally, umbilicus narrow to very wide, one sharp peripheral keel, no anal keel on protoconch, Operculum of many layers of chitinous material, medium to tall conical.

***Heliacus (Claraxis) asperus*** (Hinds 1844) Fig. 6 (1-3, 12-14), 7 (1-6).

*Solarium asperum* Hinds, 1844a:23; 1844b:50, pl. 14, figs 9, 10.

*Solarium dilectum* Deshayes, 1863:68, pl. 9 (36), figs 3, 4-6.

*Solarium (Torinia) dilectum*. — Hanley (Sowerby), 1863:241, pl. 4, figs 50, 51.

*Solarium (Torinia) asperum*. — Hanley (Sowerby), 1863:241, pl. 5, figs 77, 78.

*Torinia dilecta*. — Marshall (Tryon), 1887:19, pl. 6, figs 91, 92; Bayer, 1948:15.

*Torinia aspera*. — Marshall (Tryon), 1887:21, pl. 6, figs 7, 8; Thiele, 1925:302, pl. 9, figs 8, 9.

*Solarium (Torinia) admirandum* Melvill and Standen, 1903:322. — Melvill, 1904:84, pl. 8, fig. 6.

*Claraxis illustris* Iredale, 1936:327, pl. 24, fig. 16.

DESCRIPTION: *Protoconch* regularly coiled, smooth and shining, varying .84-.98 mm diam. *Teleoconch* up to 6 flatly convex beaded whorls, convex base. *Sutures* strongly impressed at outer edge of canal between whorls. *Sculpture* of 4 or 5 narrow beaded spiral cords encompassed on outer margin by a similar larger cord; 2 or 3 finer beaded cords lie in an excavation between this outer cord and peripheral keel, which is strongly crenulate; whole sculpture is crossed by numerous fine axial grooves; adjoining peripheral keel on base are 4 or 5 fine beaded cords rising towards top of convex section, followed by 3 larger similar cords, with a fine thread between, and adjoining umbilicus; whole base of shell is crossed axially by crowded fine grooves. *Umbilicus* very widely perspective, averaging 46% of shell diameter at maturity, bordered by strong sharply serrated umbilical cord; umbilical canal strongly obliquely striated on concave base. *Aperture* sub-circular, crenulated exteriorly by cords, and with narrow grooves behind peripheral keel and at base of inner-lip, which is inclined to right basally. *Colour* white, tinged in some specimens with very pale fawn on a few cords in an irregular manner. *Operculum* elongate cone-shaped; solid yellow material covered with clear gelatinous substance formed into 16 sharp-edged separate fins encircling central core; fine spiral peg-shaped attachment at rear.

TYPE LOCALITY: Straits of Macassar, 20 metres.

DIMENSIONS: Holotype, max diam 9.5 mm, alt 3.2 mm. Largest specimen examined, max diam 15.8 mm, min diam 13.5 mm, alt 7.6 mm, 6 whorls. (Rocky Point as below).

LOCATION OF TYPE: B.M.N.H., reg'd No. 79:2:26:159.

DISTRIBUTION: On west coast, 3 localities near Eaglehawk Is., and Delambre Is., Dampier Archipelago (approx. 20° 35' S., 116° 38' E.), 40 metres; south and eastwards on south coast of Western Australia, 121 km E. of Rocky Point (33° 43' S., 125° 04' E.), 77-80 metres; eastwards and north to Port Hacking, New South Wales, south of Port Jackson, 100 metres; north to Narrabeen, north of Port Jackson (33° 39' S., 151° 17' E.), 146 metres (greatest depth recorded); northwards to Cape Moreton, southern Queensland, (27° 02' S., 153° 28' E.), 114-124 metres; northwards round Cape York and west to Arafura Sea, 160 km N. of Croker Is., Northern Territory (9° 30' S., 132° 34' E.), 124 metres. Moderate to deep water and only obtainable by dredging. Distributed round whole Australian coastline and northwards through Indonesia to type locality. Also found in Victorian Tertiary.

MATERIAL: Dampier Archipelago as above, 3 specimens June 1960, W.A.M. Reg'd Nos. 92-93-94/73; off Rocky Point as above, 1 specimen, coll CSIRO 7/7/1962, H.M.A.S. "Gascoyne," (G2/104/62), A.M. No. C. 91977; off Port Hacking as above, 21 specimens in 4 lots, various depths down to 100 metres; E. of Narrabeen as above, 1 specimen coll Prof. Haswell 1907, A.M.No. C. 25833; off Cape Moreton as above, 1 specimen ex T. A. Garrard coll, A.M. No. C. 91976; Arafura Sea as above, 6 specimens coll P. H. Colman 9/11/69, M.V. "San Pedro Sound," (B.M.R. Stn. P69-1144), A.M. No. C. 91978. A.M. and W.A.M. 53 specimens (24 lots). Also 1 specimen Tawitawi Is., Sulu Archip., Philippine Is., 16-23 metres, coll B.R. Wilson 24/2/1964, "Pele" — Sulu Exped., W.A.M. No. 91-73.

FOSSIL SPECIMENS: 5 specimens, cliff-face S. of Grice's Creek, Mornington Penin., Victoria, ex J. Kerslake and T. A. Garrard coll, A.M. No. C. 94474. Grid ref. Cranbourne 106, 903. Upper Balcombe Clay: Bairnsdalian: Middle Miocene. 2 specimens, Fossil Beach, Mornington Penin., Victoria, ex J. Kerslake and T. A. Garrard coll, A.M. No. C. 94475. Grid ref. Cranbourne 072,845. Balcombe Clay: Balcombian: Middle Miocene.

DISCUSSION: Recent specimens show a few slight variations from fossil specimens, however these features are variable and overlap in both Recent and fossil specimens, and are not sufficient and consistent enough to warrant separation.

Specimen mentioned under "Material" W.A.M. No. 94-73 from Dampier Archipelago, W. Australia, is shining white, almost translucent; it has fine fawn spots on cord above peripheral keel, and also on larger inner cord bordering concave section, but absent from the 3 others between them.

***Heliacus (Claraxis) aequatorialis*** (Thiele, 1925). Fig. 9 (13-15).

*Torinia aequatorialis* Thiele, 1925:268 (302), pl. 9 (21), figs 8,9. — Bayer, 1948:4.

DESCRIPTION: *Protoconch* regularly coiled, smooth and shining, very small, .45 mm diam. *Teleoconch* 3 whorls, flatly convex dorsally, base convex, prominent beaded peripheral keel. *Sutures* joined at edge of peripheral keel, at base of narrow canal. *Sculpture* of narrow oblique axial riblets on first whorl, between prominent beaded cords on either margin; after first whorl the axial riblets together with a further cord then develop into 2 cords of obliquely placed square or rectangular nodules; a deep groove, axially striated and pitted, between outer beaded cord and peripheral keel, which is strongly beaded; basally 3 or 4 strong beaded cords, interstices equal in width to cords; followed by 2 stronger squarely noduled periumbilical cords; main umbilical cord broad,

rounded and gross, with large elongate rounded nodules, 7 on last whorl. *Umbilicus* narrow and deep, barely perspective, 21% of shell diameter; umbilical canal flat-based, axially striated by growth lines. *Aperture* circular internally, strongly crenulated exteriorly by cords; inner-lip arcuate, glazed, and partly reflected over umbilicus. *Colour* opaque white. *Operculum* not available.

TYPE LOCALITY: "From Padang (Sumatra) and from East Borneo." (Author).

DIMENSIONS: Holotype, max diam 3.7 mm, alt 1.8 mm, 3 whorls. Apparently average adult size.

LOCATION OF TYPE: Humboldt University Museum, East Berlin, Reg'd No. ZMB Moll. 101908.

DISTRIBUTION: On known records appears to be confined to northern Australia, Indonesia and Borneo (Sabah).

MATERIAL: Unique specimen, 9 metres Van Diemen's Inlet, Gulf of Carpentaria (16° 59' S., 140° 59' E.), coll C. Hedley, A.M. No. C. 15376. (Max diam 3.8 mm, min diam 3.3 mm, alt 1.8 mm).

DISCUSSION: The only specimen held is taken to be *H. (Claraxis) aequatorialis* (Thiele) rather than *H. (C). gemmulata* (Thiele), chiefly on account of the 3 whorls in a diam of 3.7 mm, corresponding with measurements of the holotype, and also on account of the Padang-East Borneo type locality. The only real difference between the within species and *H. (C). gemmulata* (Thiele) from Madagascar, apart from 5 whorls in an equal width, appears to lie in the peripheral keel, and the Australian specimen is closer to *H. (C). gemmulata* in this respect, otherwise it agrees well with the figure and description of *H. (C). aequatorialis*. Owing to the great variations which occur in many species in the sub-family, the two may later prove to be conspecific if and when a quantity of good material becomes available.

#### ***Heliacus (Claraxis) colmani* sp. nov. Fig. 5 (4-6).**

DESCRIPTION: *Protoconch* 1½ whorls, not inflated, regularly coiled, varying .38-.77 mm diam. *Teleoconch* depressed, 2½ flatly convex whorls with strong gemmate peripheral keel. *Sutures* sharply incised, irregular in outline, joined at edge of peripheral keel. *Sculpture* of 4 or 5 beaded spiral cords, those on both margins the strongest; below outer cord a strong beaded peripheral keel, separated from cord above by a wide deep channel; outer sculpture on base consists of 3 or 4 finely beaded cords, inside these a heavier cord, from which the surface is almost flat or steeply ramped, with one further finely beaded cord adjoining the crenulated umbilical cord. *Umbilicus* narrowly or widely perspective, average 29% of shell diam at maturity; umbilical cord sharply and widely crenulated; umbilical canal wide and deep with vertically striated concave base. *Aperture* circular with thin outer-lip strongly crenulated by external cords. *Colour* opaque or translucent white. *Operculum* not available.

TYPE LOCALITY: 370 km W. of Roebuck Bay, Western Australia (18° 30' S., 118° 03' E.), 238 metres.

DIMENSIONS: Holotype, max diam 4.8 mm, alt 1.8 mm, 2½ whorls. Largest specimen examined.

LOCATION OF TYPE: A.M., Sydney, Reg'd. No. C. 97687.

**DISTRIBUTION:** From type locality eastwards to Arafura Sea, 160 km N. of Croker Is., Northern Territory (9° 30' S., 132° 34' E.), 124 metres, eastwards to Murray Island, Torres Strait (9° 58' S., 144° 02' E.), 9-15 metres; southwards to Cape Sidmouth, north Queensland, beach collected (13° 29' S., 143° 37' E.). Shallow water to 238 metres. Appears to be an endemic Australian species.

**MATERIAL:** Type locality as above, holotype coll P.H. Colman 11/10/68, M.V. "Espirito Santo," B.M.R. Stn. E68-576. Arafura Sea as above, 3 specimens coll P. H. Colman 9/11/69, M.V. "San Pedro Sound," B.M.R. Stn. P69-1144, A.M. No. C. 97688; Murray Island as above, 1 specimen coll C. Hedley, A.M. No. C. 97689; Cape Sidmouth as above, 1 specimen coll A. U. Henn, A.M. No. C. 2668 (pt). A.M. 6 specimens (4 lots).

**DISCUSSION:** In some specimens the spiral cords consist of oblique beads following each other in direct lines from one cord to another, but no striations are visible in interstices. In others, oblique axial striations cross over the spiral cords and interstices from the upper suture, round the peripheral keel to the umbilicus. This unique variation in sculpture has not been observed in any other species.

This new species is named for Phillip H. Colman, Dept. of Malacology, Australian Museum, Sydney.

The nearest congener to this new species is *H. (Claraxis) foveolatus* (Tate), and although the two species are very similar basally, *H. (C.) foveolatus* differs in having a smaller protoconch, varying from .37 to .51 mm diam, compared with .38 to .77 mm diam in this new species, and in lieu of the 5-6 cords including peripheral keel on each whorl in the new species, has only 4 cords followed by a wide concave space, then the peripheral keel on a lower plane, which causes a wide canal at the suture. The umbilicus on *H. (C.) colmani* also averages only 29% of shell diameter at maturity, diameter being 4.8 mm, as against an average of 44% in *H. (C.) foveolatus* with a diam of 5 mm.

***Heliacus (Claraxis) foveolatus* (Tate, 1893). Fig. 5 (10-12), 6 (15-17).**

*Torinia foveolata* Tate, 1893:191, pl. 1, fig. 13.

*Heliacus foveolatus*. — Hedley, 1900:93; Cotton and Godfrey, 1933:73, pl. 1, fig. 2.

*Torinista laseronorum* Iredale, 1936:327.

**DESCRIPTION:** *Protoconch* smooth and shining, regularly coiled, varying .37-.51 mm diam. *Teleoconch* 3 whorls, flat-topped, rounded on base, one strong peripheral keel, light fawn periostracum. *Sutures* well impressed at base of narrow canal. *Sculpture* of 3 strong rounded spiral cords on each whorl crossed by equally strong axial ribs, 30-40 on body-whorl, 20-28 on penultimate, nodular at intersections, leaving deep square pits between; one similar cord in centre of ramp above peripheral keel, which is strongly beaded; sculpture on base of 5-6 similar spiral cords of varying strength, and similarly cancellated by axials. *Umbilicus* widely perspective, averaging 44% of shell diam at maturity, bounded by a strong umbilical cord crossed by axial riblets; crenulations on umbilical cord heavy and rounded; umbilical canal wide and shallow, with 2 strong spiral cords crossed by oblique axial riblets, nodular at intersections. *Aperture* circular, crenulated exteriorly by cords and peripheral keel. *Colour* opaque white or clear and glass-like. *Operculum* roundly conical with hollow tip, composed of layers of thin chitinous material with ragged edges, and the usual peg-like projection at rear attached to foot of mollusc.

**TYPE LOCALITY:** Aldinga Bay, South Australia (35°21'S., 138°24'E.)

**DIMENSIONS:** Holotype, max diam 5 mm, min diam 4.25 mm, alt 1.75 mm. Largest specimen examined, max diam 4.7 mm, min diam 4 mm, alt 1.9 mm, 3 whorls, ex C. F. Laseron coll, Pittwater, New South Wales.

**LOCATION OF TYPE:** S.A.M., Adelaide, South Australia, reg'd No. D. 14331.

**DISTRIBUTION:** From Murray Is., Torres Strait (9°55' S., 144°05' E.), southwards along Queensland and New South Wales coasts, then westwards along Victorian coast at least as far as Arno Bay, South Australia (33°54' S., 136°34' E). Intertidal to 20 metres (3 specimens, Port Curtis, Queensland). On present records appears to be an endemic Australian species.

**MATERIAL:** Murray Is. as above, 1 specimen coll C. Hedley, A.M. No. C. 92488. Lady Elliott Is., Queensland (24°07' S., 152°42' E), 1 specimen coll C. Hedley, A.M. No. C. 8837 (pt). Caloundra, Queensland (26°48' S., 153°08' E.), 1 specimen coll C. Hedley, A.M. No. C. 12590. Woolgoolga, New South Wales, (30°07' S., 153°12' E.), coll C. F. Laseron, A.M. No. C. 92028, and 1 specimen coll T. Iredale same locality. Various specimens from Pittwater and Port Jackson, New South Wales, and Arno Bay, South Australia, as above, 7 specimens ex T. A. Garrard coll. A.M. No. C. 92026. Total specimens examined from all Australian Museums 86 (27 lots).

**DISCUSSION:** Basal area in this species from peripheral keel to umbilicus varies from flatly rounded to flat, in the form of a ramp, giving a V-shaped appearance to base of shell. Besides a deeply pitted appearance in the sculpture of this species, other differences between it and its nearest congener, *H. (C). colmani* Garrard nov., are described under "Discussion" following description of that species.

***Heliacus (Claraxis) fragilis* (Hinds, 1844). Fig. 8 (1-9).**

*Solarium fragile* Hinds, 1844a:24; 1844b:51, pl. 14, figs 15, 16; 1844c:439. — Philippi, 1853:20, pl. 3, fig. 9.

**TYPE LOCALITY:** North coast of New Guinea, 13 metres.

**DIMENSIONS:** Holotype, max diam 6.3 mm, alt 2.1 mm.

**LOCATION OF TYPE:** B.M.N.H., Reg'd No. of 3 syntypes 1879:2:26:160-161-162.

**DISCUSSION:** Apparently this species is not recorded from Australia, despite the relatively short distance from the type locality. Photographs of the 3 syntypes have been furnished by B.M.N.H. and are therefore shown at fig. 8 (1-9) to assist with recognition. A letter from B.M.N.H. states regarding *Solarium fragile* that . . . "there is no evidence to suggest that Hinds selected any one as a holotype even though only one was figured. It is likely that Hinds had access to all three specimens when he described the species, hence they probably represent a syntypic series." However, the measurements of none of the 3 syntypes as shown by the mm scale taken with the photographs and now shown on the figure caption agree with the holotype measurements shown by the author.

The original Latin description of the colour pattern in this species indicates that cingula on both inner and outer margins of whorls are painted or ornamented with a dark colour, those between being pearly in appearance.

**Heliacus (Claraxis) sp. Fig. 9 (25-27).**

DESCRIPTION: *Protoconch* 1½ whorls, smooth and shining, inflated, .69 mm diam. *Teleoconch* 2¼ whorls, convex dorsally, very convex basally, unicarinate. *Sutures* deeply impressed, joined at base of peripheral keel and slightly imbricating. *Sculpture* dorsally of 5 spiral cords, separated from peripheral keel by a fine gemmate thread; cords cut into rhomboid segments by numerous oblique axial grooves; axial striae thus formed become bifid or trifid half-way across whorls, and over-ride peripheral keel, extending across base almost to umbilicus, total of 165 on body-whorl; base has 10 cords and threads between peripheral keel and a strongly crenulated umbilical cord, the numerous fine axial threads forming minute nodules at intersections. *Umbilicus* narrow but perspective, 30% of shell width, 3 periumbilical cords visible throughout; umbilical canal convex and irregularly striated by growth lines. *Aperture* sub-circular, grooved behind peripheral keel; outer-lip crenulated by cords, inner-lip arcuate and recurved. *Colour* white, tinged with fawn on peripheral keel. *Operculum* not available.

LOCALITY: 160 km N. of Croker Island, Northern Territory (9°30' S., 132°34' E), 124 metres.

DIMENSIONS OF SPECIMEN: Max diam 5.3 mm, min diam 4.2 mm, alt 2.6 mm, 2¼ whorls.

LOCATION OF SPECIMEN: A.M., Sydney, Reg'd. No. C. 100514.

DISTRIBUTION: Above locality only.

MATERIAL: Specimen is unique.

DISCUSSION: Although only one specimen of this apparently new species is held, it is included owing to its fine condition and unique type of sculpture, the unusually numerous and fine threads extending unbroken across both dorsum and base not being observed on any other species.

**Heliacus (Claraxis) sp. Fig. 9 (20-21).**

DESCRIPTION: *Protoconch* 1½ whorls, clear and glass-like, smooth and shining, not inflated, .27 mm diam. *Teleoconch* 2 whorls, sharply convexly ridged dorsally, sharply convex at lower base, one sharp peripheral keel. *Sutures* joined at upper edge of peripheral keel, forming deep narrow canal at sutures. *Sculpture* of 4 strong spiral cords on dorsum, smooth and rounded, a smooth flat round-edged peripheral keel, four further smooth cords on outer edge below keel, central 2 weaker; below these are 2 stronger similar cords, angulating base of shell; usual crenulated periumbilical cord is replaced in this species by 2 more smooth cords descending into umbilicus; smooth rounded axial ribs, 22 on body-whorl, commence at sutural canal, crossing all spiral dorsal cords, peripheral keel and all basal cords deep into umbilicus; all cords and ribs are nodular at points of intersection. *Umbilicus* wide and perspective, approx 50% of shell diam. *Aperture* circular anteriorly with fine groove behind peripheral keel, strongly crenulated exteriorly by cords. *Colour* translucent white. *Operculum* unknown.

LOCALITY: S.W. end of Garden Island, S. of Perth, Western Australia (32°13' S., 115°41' E.)

DIMENSIONS: Max diam 2.0 mm, min diam 1.7 mm, alt .8 mm.

LOCATION OF SPECIMEN: A.M., Sydney, Reg'd No. C. 105175.

DISTRIBUTION: Above locality only.

MATERIAL: Specimen is unique, coll W. F. & J. M. Ponder and N. Coleman, 31/1/72.

DISCUSSION: Although only one specimen of this minute species is held its appearance and construction are so unique it is considered that it should be placed on record. The strong cancellate form of sculpture leaves deep rectangular pits between ribs and cords, and forms a scalloped peripheral keel, whilst the replacement of the usual crenulated periumbilical cord by 2 further smooth spiral cords is a most unusual feature.

FOSSIL SPECIES

**Heliacus (Claraxis) wannonensis** (Tenison- Woods, 1879). Fig. 6 (9-11).

*Solarium wannonensis* Tenison-Woods, 1879:237, pl. 21, fig. 10.

DESCRIPTION: *Protoconch* regularly coiled, 2 whorls, smooth and shining, .66 mm diam. *Teleoconch* 3½ flatly convex whorls in diam of 6.3 mm, base roundly convex; canaliculate at sutures. *Sutures* finely incised, joined at top of peripheral keel, raised above it and forming a deep canal. *Sculpture* of 4 flattened cords of varying widths, cut into segments by deep oblique axial grooves, inclined to be gemmate; a strong gemmate peripheral keel is then separated from both dorsal and basal cords by deep axially striated grooves; up to 7 gemmate cords on base, with two further strong segmented cords surrounding the wide crenulated umbilical cord. *Umbilicus* widely perspective, averaging 33% of shell diameter at maturity; umbilical canal flat based and obliquely axially striated. *Aperture* sub-circular, grooved at top and base of arcuate inner-lip, and behind peripheral keel.

TYPE LOCALITY: Lower beds, Muddy Creek, near Hamilton, Victoria. Muddy Creek Formation: Balcombian: Middle Miocene.

LOCATION OF TYPE: A.M., Sydney, Reg'd No. F. 1818.

DIMENSIONS: Holotype, max diam 3.5 mm, alt 1 mm, 2¾ whorls. Largest specimen examined, max diam 6.3 mm, min diam 5.4 mm, alt 2.8 mm, 3½ whorls (topotype).

MATERIAL: Holotype, as above, and one topotype as above, A.M. Reg'd. No. F. 572.

DISCUSSION: A further new fossil species described and named in this revision, *Heliacus (Claraxis) morningtonensis* bears a strong general resemblance to *H. (C). wannonensis* and the differences between the two species are therefore set out below:

<i>H. (C). wannonensis</i>	<i>H. (C). morningtonensis</i>
Protoconch .66 mm diam	Protoconch .77-.85 mm diam
4 cords of nodules on dorsum	5 cords of nodules on dorsum
Deep narrow canal at sutures	No canal at sutures
Suture joined at top of peripheral keel and raised to level of previous whorl	Suture joined to edge of peripheral keel and not raised
8-9 cords of gemmules on base of varying widths	4 cords on base enclosing long close-packed axial bars towards umbilicus
2 shallow periumbilical sulci	1 deep narrow periumbilical sulcus
Umbilical cord with 20-22 crenulations on body-whorl	Umbilical cord with 15 heavy widely spaced crenulations on body-whorl



**Heliacus (Claraxis) morningtonensis** sp. nov. Fig. 9 (10-12).

DESCRIPTION: *Protoconch* regularly coiled, 2 whorls, raised slightly above first teleoconch whorl, smooth and shining, varying .77-.85 mm diam. *Teleoconch* flatly convex dorsally, 3¼ slightly convex whorls in diam of 5.8 mm, base roundly convex. *Sutures* strongly impressed at edge of peripheral keel. *Sculpture* of 5 cords on dorsum of oblique axially elongate nodules, including peripheral keel; 4-6 peripherad cords of nodules on base of varying widths, surrounding wide area of axial threads coalescing towards umbilicus to form broad closely packed axial riblets covering half the base of shell; a deep narrow sulcus separates these riblets from the umbilical cord. *Umbilicus* widely perspective, 32% of shell diameter at maturity; umbilical canal with slightly convex base, vertically striated; umbilical cord with 15 strong widely spaced pointed crenulations on body-whorl, and separated from adjoining riblets by a deep narrow sulcus. *Aperture* broadly ovate, narrowing towards peripheral keel and grooved behind it, a further groove at base of arcuate and reflected inner-lip; strongly crenulated by cords externally.

TYPE LOCALITY: Fossil Beach, Mornington Peninsula, Victoria. Grid ref. Cranbourne 072, 845. Balcombe Clay: Balcombian: Middle Miocene.

DIMENSIONS: Holotype, max diam 5.8 mm, min diam 4.5 mm, alt 2.9 mm, 3¼ whorls. Topotype 4.3 x 3.8 x 1.8 mm, 2½ whorls.

LOCATION OF TYPE: A.M., Sydney, New South Wales, Malacology Dept., Reg'd No. C. 94485.

DISTRIBUTION: Type locality only at date.

MATERIAL: Holotype and one topotype as above, ex J. Kerslake — T.A. Garrard coll.

DISCUSSION: Both specimens are in perfect condition and a light overall fawn in colour. Although only the two are held it is considered that describing and naming as a new species is warranted owing to the many differences between this species and its closest congener, *H. (Claraxis) wannonensis* (Tenison-Woods), as described under "Discussion" following description of that species.

This new species also bears a resemblance to the recent *H. (Claraxis) fragilis* (Hinds, 1844), not recorded from Australia, but that species has a flatter base and a second periumbilical cord, whilst the basal riblets do not coalesce in the same manner. It also bears a strong resemblance to the Recent *H. (Torinista) dorsuosus* (Hinds, 1844) so far as the dorsal sculpture is concerned, but that species has a very different form of basal sculpture, with no coalescing riblets.

**Heliacus (Claraxis) sp.** Fig. 10 (13-15).

DESCRIPTION: *Protoconch* 1½ whorls, regularly coiled, smooth and shining, .64 mm diam. *Teleoconch* 5½ whorls in width of 12.2 mm, whorls flat-topped, dorsum convex, base convex, strongly unicarinate. *Sutures* joined at base of peripheral keel, strongly incised, whorls not imbricating. *Sculpture* dorsally of a strong nodular cord adjoining suture, then 2 rows of small nodules, followed by a further strong nodular cord; between latter cord and peripheral keel are 2 strong threads; peripheral keel solid on early whorls, but on body-whorl dividing into 6 compacted threads; whole dorsal surface crossed by strong oblique axial threads, becoming increasingly numerous on body-whorl, crossing peripheral keel and base to umbilicus; 6 strong cords on base; the whole sculpture carries elongate nodules on all cords where crossed by the axial threads.

*Umbilicus* widely perspective, 45% of shell diameter at maturity; umbilical cord strong with large axial nodules; umbilical canal convex, a sharp strongly raised cord near centre, one row of small nodules separating it from outer umbilical cord, whole area crossed by strong oblique axial threads. *Aperture* broadly ovate, narrow grooves behind peripheral keel and in centre of inner-lip, which is a little reflected.

LOCALITY: Probably from "Clifton Bank," near Muddy Creek, 6.4 km West of Hamilton, Victoria.

DIMENSIONS: Specimen max diam 12.2 mm, min diam 10.6 mm, alt 6.6 mm, 5½ whorls.

LOCATION OF SPECIMEN: A.M., Sydney, Reg'd No. C. 100602.

MATERIAL: Above specimen only.

DISCUSSION: This specimen was found with other material from Muddy Creek, Victoria, in the A.M. collection, and although without a separate label is almost certainly from the same locality. It has been placed on record owing to its near perfect condition and complete dissimilarity from all other fossil and Recent species.

#### Sub-family PSEUDOMALAXINAE

DIAGNOSIS: Shells small to extremely small, 1-13 mm major diam, discoidal in shape; whole base of shell forms umbilicus; aperture rounded internally, whorls quadrate externally; very little sculpture; no anal keel on protoconch; operculum chitinous, thin and flat.

#### Genus *PSEUDOMALAXIS* Fischer, 1885

*PSEUDOMALAXIS* Fischer, 1885:174. Type species by monotypy *Bifrontia zanclaea* Philippi, 1844.

REFERENCES: Monterosato, 1913:362; Cossmann, 1915: 122, 141; Thiele, 1931:184; Rehder, 1935:128; Wenz, 1939:668; Pilsbry and McGinty, 1945:9; Eames, 1952:37; Abbott, 1954:138-9; Maxwell, 1966:444; Merrill, 1970:42-7; Glibert, 1973:30; Buoniauto, 1975:28.

SYNONYMS: *Discosolis* Dall, 1892. Type species by original designation *Omalaxis nobilis* Verrill, 1885. *Mangonuia* Mestayer, 1930. Type species by original designation *Mangonuia bollonsi* Mestayer, 1930.

DIAGNOSIS: As for that of sub-family above.

DISCUSSION: Use of the genus *Pseudomalaxis*.

A very comprehensive but unpublished PhD dissertation by A. S. Merrill, 1970, as shown in the "List of References," entitled "The family Architectonicidae in the western and eastern Atlantic," contains the following remarks on p. 43 — "The genus *Pseudomalaxis* is truly a stable one . . . The genus occurs in the deeper waters of the tropics and sub-tropics. The major features are the very flat spire, the squarish shape and tight coiling of the whorls, and the wide open umbilicus."

The disjunct range of similar or closely related species exhibited by a number of species in the family Architectonicidae is also exemplified in the genus *Pseudomalaxis* by the species *Pseudomalaxis nobilis* Verrill of the western Atlantic and West Indies, with the synonymous *P. actoni* Monterosato of the Mediterranean, also the very closely related *P. meridionalis* Hedley in Australia, with its synonyms *P. bollonsi* Mestayer in New Zealand and *P. solaris* Kuroda in Japan.

***Pseudomalaxis (Pseudomalaxis) nobilis meridionalis*** (Hedley, 1903)

Fig. 6(4-5), 7 (10-12)

*Omhalaxis nobilis* Verrill, 1885:423, pl. 44, fig. 12.*Omhalaxis meridionalis* Hedley, 1903:351, text fig. 74.*Discohelix meridionalis*. — Iredale, 1911:256; Mestayer, 1916:125.*Mangonuia bollonsi* Mestayer, 1930:144.*Pseudomalaxis solaris* Kuroda, 1938a:1, text figs 1-3.*Pseudomalaxis (Mangonuia) solaris*. — Kuroda, 1938b:61.*Mangonuia solaris*. — Kuroda and Habe, 1954:81, 83, text fig. 3; Kuroda, Habe and Oyama, 1971:265, pl. 61, fig. 17.*Pseudomalaxis meridionalis*. — Buonaiuto, 1975:28.

DESCRIPTION: *Protoconch* regularly coiled, varying .87-1.04 mm diam. *Teleoconch* discoidal, 4 flatly convex whorls, rising from nucleus to peripheral edge, sides flat but sloping inwards towards base, underside of whorls flatly convex with raised edges. *Sutures* incised, rough and irregular, joined to whole peripheral area but beneath dorsal peripheral keel. *Sculpture* of 2 rough and irregular peripheral rows of axially elongate nodules, forming a bifid keel, a similar raised row of nodules close to inner margin, a number of microscopic spiral threads in flat space between, crossed by strong irregular and oblique growth lines; base of whorls with one strong irregularly crenulated peripheral keel, with flat or flatly convex central space sloping inwards to centre, and a narrow ramp sloping downwards to edge of adjoining whorl, the whole crossed by strong irregular oblique growth lines; outer-edge almost flat, sloping inwards from dorsum to base at 20-25°, 2 fine striae between upper and lower peripheral keels, with a third appearing occasionally only on body-whorl, space between keels crossed by strong vertical growth lines. *Umbilicus* consists of entire base of shell. *Aperture* sub-quadrate, rough and uneven, thickened at outer edge. *Colour* off-white, irregularly maculated with fawn or light brown, fawn spots at intervals on lower peripheral keel; covered with extremely thin fawn periostracum. *Operculum* composed of 5-6 extremely thin fawn layers of chitinous material, very thin overall, slightly concave, attached to foot of mollusc by central peg-shaped projection at rear, minute central perforation in nucleus.

TYPE LOCALITY: Port Stephens, New South Wales.

DIMENSIONS: Holotype, max diam 4.5 mm, min diam 3.6 mm, alt 1.25 mm. Largest specimen examined, max diam 13.3 mm, min diam 11 mm, alt 3.35mm, 4 whorls (Fig. 6 (4-5)).

LOCATION OF TYPE: A.M., Sydney, Reg'd. No. C. 16298.

DISTRIBUTION: Off Moreton Bay, southern Queensland (27° 22' S., 150°39' E.), 77 metres, thence southwards to 29 km E.N.E. of Port Stephens, New South Wales (32°42' S., 152°05' E.) 113 metres, near type locality; Narrabeen, near Port Jackson, 146 metres; off Port Hacking, S. of Port Jackson, 82 metres; off Malabar, S. of Port Jackson, 137 metres. Only other known localities are northern New Zealand (*P. bollonsi* Mestayer) and Japan (*P. solaris* Kuroda).

MATERIAL: Off Moreton Bay as above, 1 specimen coll W. F. Ponder 29/3/69, H.M.A.S. "Kimbla," A.M. No. C. 92043; E.N.E. of Port Stephens as above, 1 live specimen, coll P. Sadler, A.M. No. C. 90458; off Narrabeen as above, 2 specimens pres. Prof.

Haswell, A.M. No. C. 25834; off Port Hacking as above, 1 specimen ex T. A. Garrard coll, A.M. No. C. 92044; off Malabar as above, 1 specimen, A.M. No. C. 100777. Total A.M. 7 specimens (6 lots).

DISCUSSION: Holotype of *Mangonua bollonsi* Mestayer has been examined at A.I.M. by Dr. W. F. Ponder, and compared with specimens of *P. (Pseudomalaxis) meridionalis* from New South Wales, proving to be conspecific. The 2 or 3 peripheral threads between keels referred to by Mestayer, also the position of the row of nodules on inner dorsal margin in relation to the periphery, both prove to be variable features; similarly the original comprehensive description and clear photos of *Mangonua solaris* Kuroda leave no room for doubt that that species is also conspecific.

The live specimen of *P. (P.) meridionalis* Hedley from New South Wales, Fig. 6(4-5) has been forwarded to Dr. Harald Rehder at the Smithsonian Institution, Washington, U.S.A., for comparison with the holotype of *P. (P.) nobilis* (Verrill), and other specimens ranging from Chesapeake Bay to Barbados; the only consistent difference appears to be in the basal peripheral cord, which in *P. (P.) meridionalis* is single and stout, whilst in *P. (P.) nobilis* it is either bifid or trifid with the larger cord peripheral and the finer ones towards the umbilicus. The two species are so closely related that they must at least be considered sub-specific.

***Pseudomalaxis (Pseudomalaxis) thetidis* sp. nov.**

Text figs 1a, b.

*Omalaxis* sp. Hedley, 1903:351.

DESCRIPTION: *Protoconch* 2 whorls, smooth, expanding rapidly in size, varying .52-.65 mm diam. *Teleoconch* 1½ whorls, peripheral area straight and vertical, strongly corded dorsally and basally, balance of whorls semi-circular. *Sutures* strongly incised at base of narrow deep canal. *Sculpture* of strong raised keels on both dorsal and basal outer margins, surmounted by widely spaced prominent axially elongate nodules, narrow and pointed; inner margin on both dorsum and base has fine narrow ridge, with or without sharp microscopic nodules; curved microscopic growth marks on all sides of whorls. *Umbilicus* consists of whole base of shell. *Aperture* circular internally except peripheral area, which is straight, conforming to outer-lip, which is thin and simple. *Colour* glass-like or opaque white.

TYPE LOCALITY: Off Cape Three Points, New South Wales (33°18' S., 151° 30' E.), 89-91 metres.

DIMENSIONS: Holotype, max diam 1.4 mm, alt .4mm, 1½ main whorls.

LOCATION OF TYPE: A.M., Sydney, Reg'd. No. C. 16297.

DISTRIBUTION: From 290 km W. of Broome, Roebuck Bay, Western Australia (18°25' S., 119°50' E.), 115 metres, to 160 km N. of Croker Is., Northern Territory (Arafura Sea), (9°30' S., 132°34' E.), 124 metres; 228 km North of Coburg Penin, Northern Territory (Arafura Sea), (9°09' S., 131°51' E.), 220 metres; eastwards and south to Cape Three Points, New South Wales (33°18' S., 151°30' E.), 89-91 metres; E. of Narrabeen, near Port Jackson, New South Wales, 146 metres.

MATERIAL: W. of Broome as above, 1 specimen 6/10/68, M.V. "*Espirito Santo*," B.M.R. Stn. E68-547, A.M. No. C. 97654. N. of Croker Is. as above, 5 specimens, coll P. H. Colman 9/11/69, M.V. "*San Pedro Sound*," B.M.R. Stn. P69-1144, A.M. No. C. 92045. N. of Coburg Penin. as above, 1 specimen, coll P. H. Colman, 13/11/69, M.V. "*San Pedro Sound*," B.M.R. Stn. P69-1167, A.M. No. C. 102588. Off Cape Three Points as above (type

locality) 1 specimen, coll C. Hedley, "Thetis" Exped., 1903. A.M. No. C. 16297. E. of Narrabeen as above, 2 specimens, coll Prof. Haswell, A.M. No. C. 25834 (pt). Total A.M. specimens 9 (5 lots).

DISCUSSION: The specimen referred to by Hedley (1903:351) from 49-50 fms off Cape Three Points, New South Wales, as "perhaps but not certainly the same species" as his *Omalaxis meridionalis* has been used as holotype for the within new species. Apart from its minute size it differs from *Pseudomalaxis meridionalis* in having only one dorsal peripheral cord in lieu of two, no spiral striae on periphery between dorsal and basal cords, and a deeper narrower canal at the sutures. The protoconch and 1½ adult whorls in this new species measure only 1.4 mm diam compared with 4.3 mm in a similar number of whorls in *P. meridionalis*. The protoconch in this new species also measures only .52-.65 diam compared with .87-1.04 mm diam in *P. meridionalis*.

The wide area of distribution as shown has been observed during the past few years in several other minute species in various families, possibly pointing to their existence in quantity in deep water over great distances round the Australian coastline.

#### FOSSIL SPECIES

***Pseudomalaxis (Pseudomalaxis) praemeridionalis*** (Chapman, 1912) Fig. 10 (22-23)

*Homalaxis praemeridionalis* Chapman, 1912:189, pl. 12, figs 4-6; Iredale, 1936:326.

*Pseudomalaxis (Pseudomalaxis) praemeridionalis*. — Buonaiuto, 1975:27.

DESCRIPTION: *Protoconch* regularly coiled, 1¼ whorls, .55 mm diam. *Teleoconch* 2¾ whorls, central dorsal surface concave, rising from protoconch to central gemmate cord on body-whorl, then again concave between this cord and peripheral keel; strongly angulately convex basally, *Sutures* strongly incised, joined at edge of peripheral keel. *Sculpture* consists of strong trifid peripheral cord, from which a narrow sulcus separates a flatly raised narrow cord, which becomes more rounded and prominent towards maturity; in centre of whorls is a prominent nodulose cord separated from peripheral area by a narrow concave section, crossed by rough and irregular growth lines; inner half of whorls flat, almost devoid of sculpture, and sloping down towards inner suture, where edge becomes raised to a slight smooth cingulum; basally the edge of shell slopes inwards at a sharp angle to a raised central cord crossed by numerous strong axially elongate nodules, from which the base continues upwards to the underside of protoconch, leaving base of whorls broadly V-shaped. *Umbilicus* consists of inner area of base inside the central gemmate cord on body-whorl. *Aperture* sub-circular, externally the whorl is contracted towards periphery; inner-lip arcuate and slightly reflected.

TYPE LOCALITY: "Blue Clays" of lower part, Altona Bay coal shaft, Altona Bay, Victoria. Newport Formation: Balcombian: Middle Miocene.

DIMENSIONS: Holotype, max diam 6.25 mm, min diam 5.5 mm, alt 1.75 mm, 1¾ whorls.

LOCATION OF TYPE: Fossil Dept., N.M.V., Melbourne, Victoria, Reg'd No. P. 12360.

MATERIAL: Holotype only specimen examined. One further specimen since found from Fossil Beach, Mornington Penin., Victoria. Grid ref. Cranbourne 072,845. Balcombe Clay: Balcombian: Middle Miocene. Max diam 9.8 mm, alt 3 mm. N.M.V. No. P. 34818. A third specimen held by S.A.M. from "Clifton Bank," Muddy Creek, near Hamilton, Victoria, Muddy Creek Marls: Balcombian: Early Middle Miocene. S.A.M. No. P. 18342.

DISCUSSION: The finding of 2 further specimens of this formerly unique species in widely scattered areas places it in much better perspective, and shows the very small variations in form and sculpture which occurred during its existence.

A comparison with *P. (P). nobilis meridionalis* shows that the latter has a broad plain slightly concave area adjoining the suture, rising to a low flatly-rounded area, which in turn is surrounded on a lower plane by a narrow roughly formed, axially striated area, adjoining the finely noded peripheral keel. In *P. (P). praemeridionalis* the broad plain area is flat, and bounded on the outer margin by a raised sharply crenulated ridge; this ridge is then separated from the finely crenulated peripheral keel by a narrow concave area bearing 2-3 fine spiral threads. The peripheral edge in *P. (P) praemeridionalis* also slopes inwards to the base at a decidedly sharper angle, and the base is not so concave as that of *P. (P). nobilis meridionalis*.

### **Pseudomalaxis (Pseudomalaxis) asculpturatus Maxwell, 1966**

*Pseudomalaxis (Pseudomalaxis) asculpturatus* Maxwell, 1966:444, figs 11-13; Buonaiuto, 1975:25, figs 1-3.

The above small species was described by Maxwell from McCullough's Bridge, New Zealand. Upper Waihao Greensand: Kaitan: Late Eocene.

Further specimens have since been found in the South Australian Adelaide Plains Sub-basin, Adelaide Childrens' Hospital bore No. 5. Blanche Point Marls: Aldingan: Late Eocene. The specimens are preserved in the collection of the Geological Survey of South Australia, Department of Mines, Adelaide, South Australia, Reg'd Nos. G.S.S.A.M. 3298-9, and M. 3300-3. Workers interested in the species are referred to the relevant publication by Buonaiuto.

Subgenus *SPIROLAXIS* Monterosato, 1913:363. Type species by monotypy *Spirolaxis centrifuga* Monterosato, 1890:161.

DIAGNOSIS: Shells minute, protoconch tightly coiled and bearing a varix at aperture, peritreme being entire; adult whorls disjunct, aperture semi-circular, straight or slightly concave on outer edge; peripheral cords dorsally and basally on outer margins of whorls, ornamentation on inner margins minute and spasmodic.

### **Pseudomalaxis (Spirolaxis) rotulacatherinea (Melvill and Standen, 1903)**

Text fig. 2a, b.

*Spirolaxis rotulacatherinea* Melvill and Standen, 1903:299, pl. 21, fig. 3; Iredale, 1911:255 (*catherina* – error); Kuroda, 1938:3 (*catherina* — error).

DESCRIPTION: *Protoconch* smooth and shining, 2 whorls, tightly coiled, nucleus microscopic, .57 mm diam. *Teleoconch* 1½ whorls, detached, perimeter vertical but slightly concave, dorsum lightly ridged in centre, base flat, inner margin of whorls slopes downwards from dorsum and upwards from base towards centre at 45°, leaving narrow vertical central area; protoconch and first half teleoconch whorl raised above level of base of body-whorl. *Sutures* of protoconch strongly incised, no sutures on teleoconch. *Sculpture* — outer dorsal and basal peripheral cords flatly raised, surmounted by strong axially elongate widely-spaced nodules; inner dorsal cord of minute nodules; microscopic growth lines visible. *Aperture* five sided, outer-lip vertical, upper and lower horizontal, inner-lip arcuate, all thin and simple. *Colour* white and shining.

TYPE LOCALITY: Gulf of Oman (24°58' N., 56°54' E.), 285 metres.

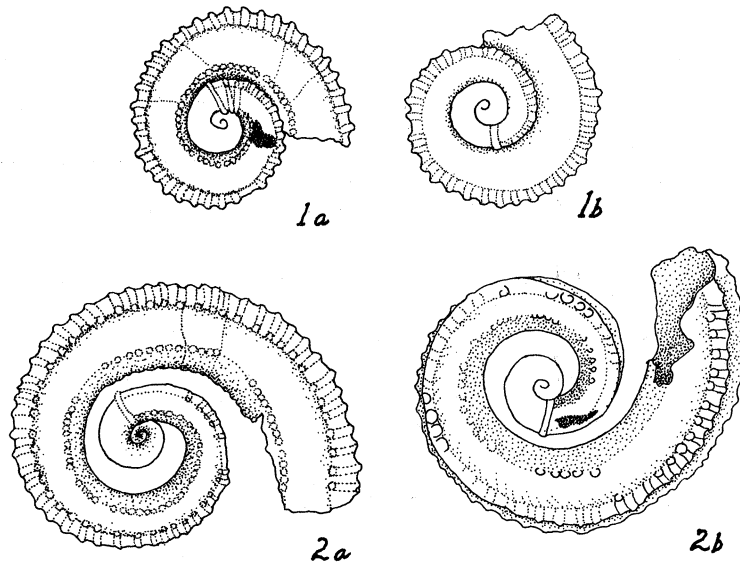
DIMENSIONS: Holotype, max diam 3 mm, alt 1 mm, 2 whorls.

LOCATION OF TYPE: B.M.N.H., Reg'd number not ascertained.

DISTRIBUTION: Only Australian locality on record is approx 238 km N. of Broome, Western Australia (14°50' S., 121°49' E.), 230 metres. Probably widespread throughout Indian Ocean.

MATERIAL: 1 specimen from above locality, coll 18/11/67, M.V. "Kos 2," B.M.R. Stn. K67-205. (2.5 mm x .7 mm).

DISCUSSION: Authors state "Resembles *zanclaea* Philippi but more delicate in every detail." The original illustration shows the axial nodules on peripheral cords more closely spaced than those on the A.M. specimen, but this is most likely a variable feature.



(*Pseudomalaxis*). Fig. 1a, *Pseudomalaxis (Pseudomalaxis) thetidis* sp. nov. Holotype, dorsal view. 89-91 metres off Cape Three Points, New South Wales. X22. Major diam 1.5 mm, alt .4 mm. A.M. No. C. 16297. 1b, *Pseudomalaxis (Pseudomalaxis) thetidis* sp. nov. Paratype, basal view. 228 km N. of Coburg Penin., Northern Territory, 220 metres. X 21. Major diam 1.5 mm, alt .4 mm. A.M. No. C. 102588. 2a, *Pseudomalaxis (Spirolaxis) rotulacatherinea* Melvill and Standen, 1903. Dorsal view. Fig'd spec 238 km N. of Broome, North-west Australia, 230 metres. X 21. Major diam 2.5 mm, alt .7 mm. A.M. No. C. 96365. 2b, *Pseudomalaxis (Spirolaxis) rotulacatherinea* Melvill and Standen, 1903. Basal view of fig. 2a. X 21. Barbara Duckworth del. Aust. Mus., Sydney.

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Valid names are in italics  
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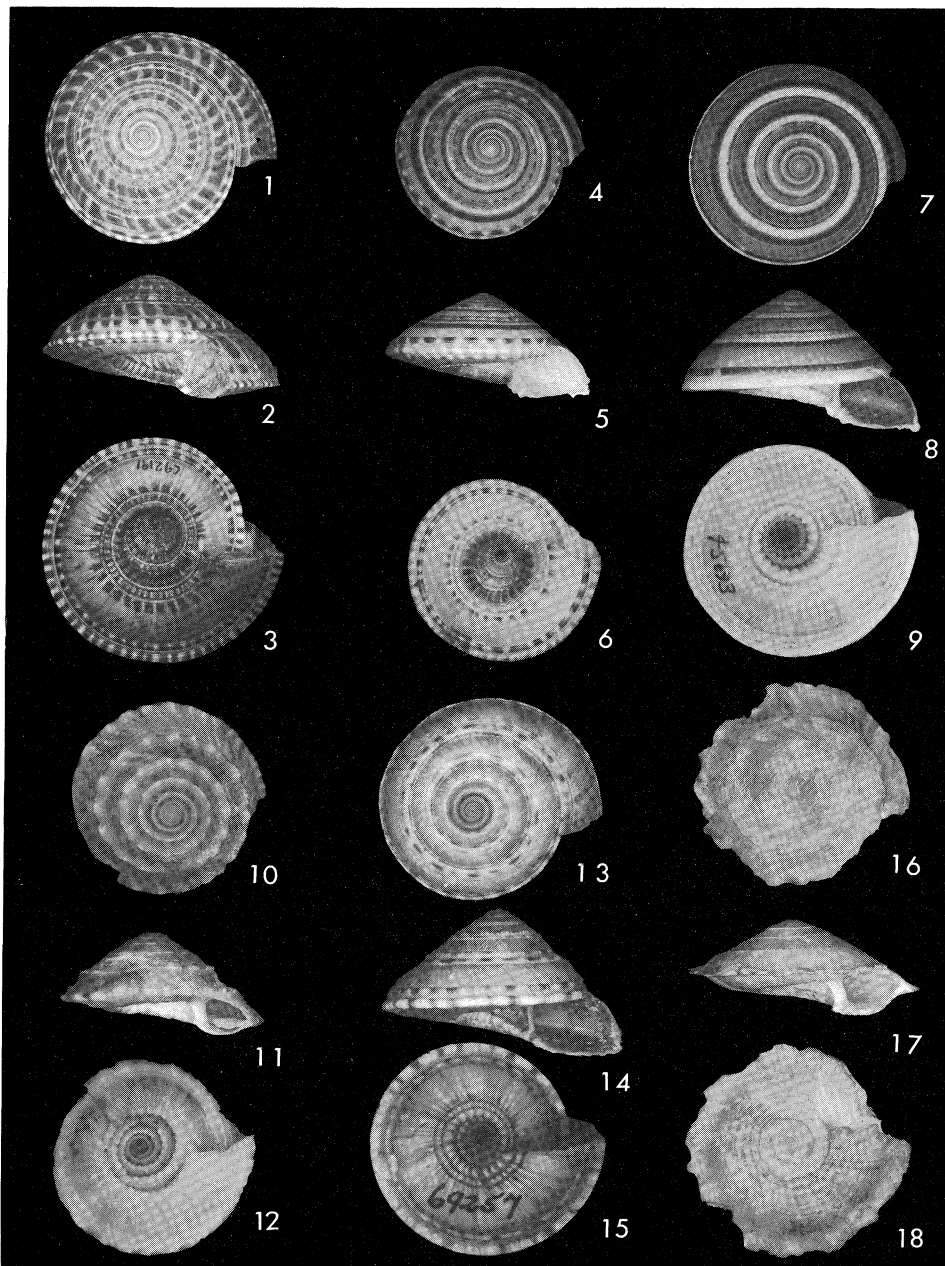


Fig. 1. (1-3) *Architectonica (Architectonica) perspectiva* (Linnaeus, 1758). Fig'd spec off Yamba, N.S.W., 37-49 met. Coll L.Bale (45.8 x 23.2 mm) X .82, A.M. No. C. 92121. (4-6) *Architectonica (Architectonica) perspectiva* (Linnaeus, 1758). Type of *A. (A.) perspectiva fressa* Iredale, 1936. Sydney Harbour, "Triton" dredge. (37.8 x 18.8 mm — amended) X .82, A.M. No. C. 60679. (7-9) *Architectonica (Architectonica) modesta* (Philippi, 1848) Fig'd spec, N. coast of P.N.G., coll W. Burrows (26.6 x 15.2 mm) X 1.35, AM. No. C. 45693. (10-12) *Architectonica (Discotectonica) kuroharai* Kuroda and Habe, 1961. Fig'd spec, N.E. of Cape Moreton, Q'ld, 114-124 met, coll T. A. Garrard (23.2 x 11.3 mm) X 1.33, A.M. No. C. 91663. (13-15) *Architectonica (Architectonica) perdux* (Hinds, 1844) Fig'd spec, Keppel Sands, Q'ld, coll P. H. Colman 14/1/59 (26.4 x 16.3 mm) X 1.4, A.M. No. C. 69257. (16-18) *Architectonica (Discotectonica) acutissima* (Sowerby, 1914) Type of *Russetia dilaniatus* Garrard, 1961. E. of Newcastle, N.S.W., 293 met, coll T.A. Garrard ex "Challenge" (43 x 16 mm) X .84, A.M. No. C. 63345. All photos — Greg Millen, A.M., Sydney.

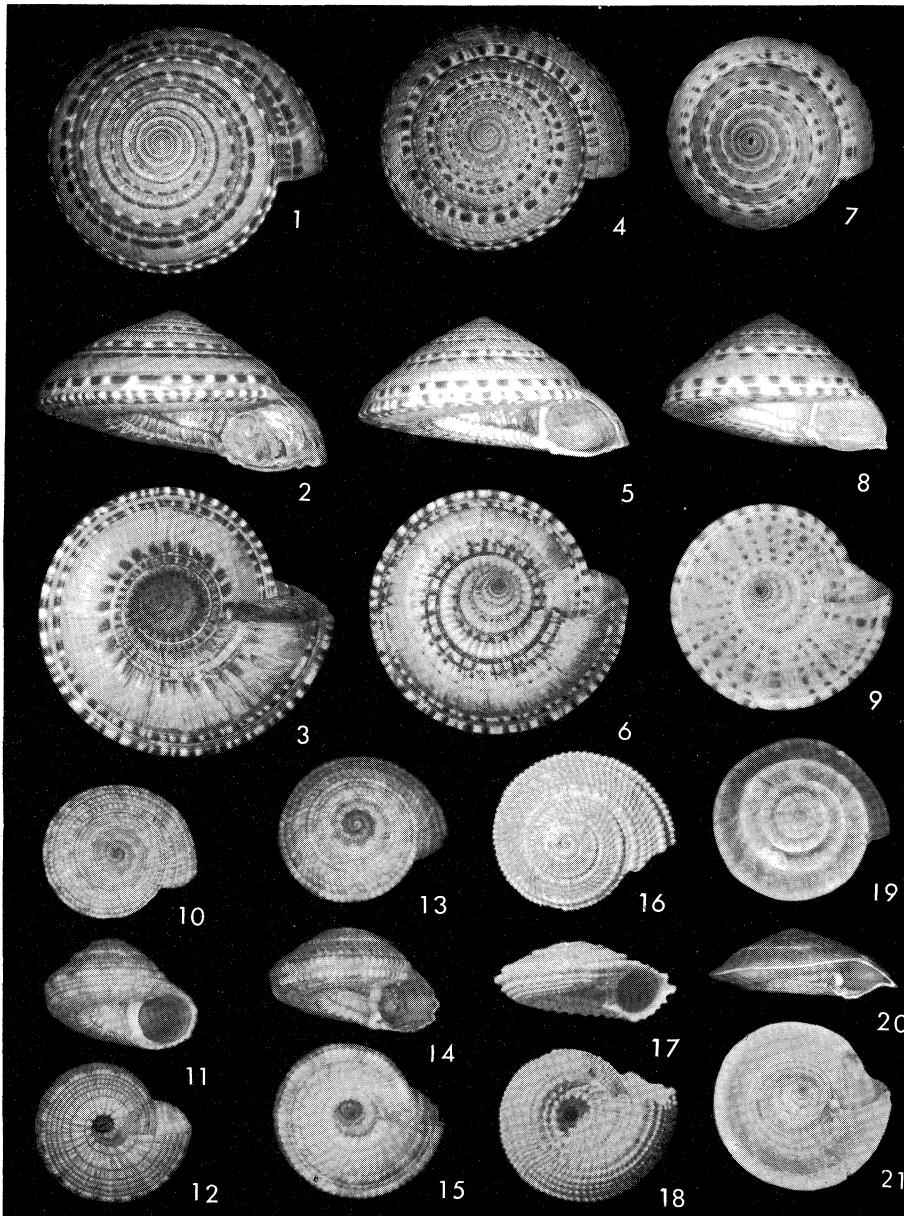


Fig. 2. (1-3) *Architectonica (Architectonica) perspectiva* (Linnaeus, 1758) Fig'd spec, off Trial Bay, N.S.W., ex J. Kerslake coll (56.2 x 29.2 mm) X .83, A.M. No. C. 91673. (4-6) *Architectonica (Architectonica) maxima* (Philippi, 1848) Fig'd spec, off Wide Bay, Q'ld, 54 metres, ex T.A. Garrard coll (51.2 x 26.4 mm) X .82, A.M. No. C. 91665. (7-9) *Architectonica (Architectonica) maxima* (Philippi, 1848) Type of *A. (A.) grandiosa* Iredale, 1931. Sydney Harbour, N.S.W., ex "Triton" dredge (43.2 x 24.3 mm — amended) X .83, A.M. No. C. 57773. (10-12) *Heliacus (Heliacus) cerdaleus ponderi* Garrard nov. Holotype, Long Reef, Collaroy, N.S.W., ex J. Kerslake coll (9.6 x 7.6 mm) X 2.71, A.M. No. C. 94479. (13-15) *Heliacus (Torinista) dorsuosus* (Hinds, 1844) Fig'd spec, North-West Is., Capricorn Group, Q'ld., coll T. Iredale, May 1929 (13.6 x 8.3 mm) X 2.1, A.M. No. C. 94386. (16-18) *Heliacus (Awarua) amoenus* (Murdoch and Suter, 1905) Fig'd spec, Arafura Sea, 160 km N. of Croker Is., Northern Territory, 125 metres, coll P. H. Colman 9/11/69, M.V. "San Pedro Sound" (4.1 x 1.9 mm) X 7.3, A.M. No. C. 94341. (19-21) *Architectonica (Discotectonica) acutissima* (Sowerby, 1914) Fig'd spec, N.E. of Cape Moreton, Q'ld, 114-124 met, coll D. Harris (live) (36.1 x 14.1 mm) X .82, A.M. No. C. 91657. All photos — Greg Millen, A.M., Sydney.



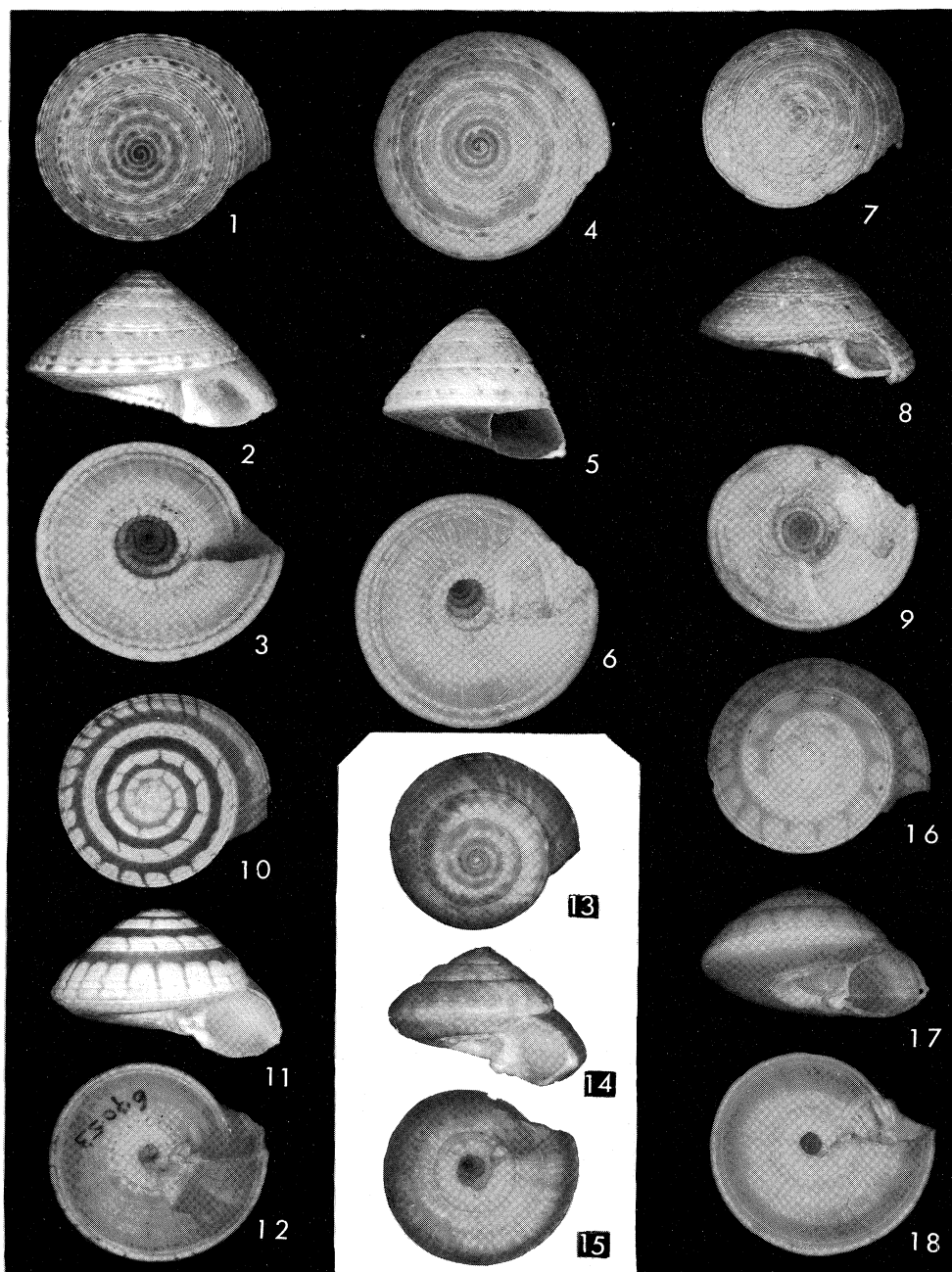


Fig. 3. (1-3) *Architectonica (Architectonica) reevei* (Hanley, 1862) Fig'd spec, off Port Kembla, N.S.W., 82 met, coll T. A. Garrard (27.5 x 17 mm) X 1.38, A.M. No. C. 96236. (4-6) *Architectonica (Architectonica) reevei* (Hanley, 1862) Type of A. (*A. offlexa* Iredale, 1931. Sydney Harbour, N.S.W. (20.2 x 16.2 mm — amended) X 1.88, A.M. No. C. 57774. (7-9) *Architectonica (Architectonica) reevei* (Hanley, 1862) Type of A. (*A. relata* Iredale, 1936. Off Bateman's Bay, N.S.W., 137-155 met (25 x 13.4 mm) X 1.3, A.M. No. C. 60680. (10-12) *Philippia (Psilaxis) radiata* (Roeding, 1798, Fig'd spec, Fairfax Is., Bunker Group, Q'ld. Coll J. Booth, 1968 (25.1 x 15.9 mm) X 1.37, A.M. No. C. 69053. (13-15) *Philippia (Psilaxis) radiata* (Roeding, 1798) Fig'd spec, Madang, P.N.G. (22.1 x 14.9 mm) X 1.35. (Contrasting colour pattern) ex T.A. Garrard coll, A.M. No. C. 96239. (16-18) *Philippia (Psilaxis) radiata* (Roeding, 1798) Type of *Philippia stipator* Iredale, 1931. Sydney Harbour, ex "Triton" dredge (17.1 x 10 mm) X 2.1, A.M. No. C. 93224. All photos — Greg Millen, A.M., Sydney.

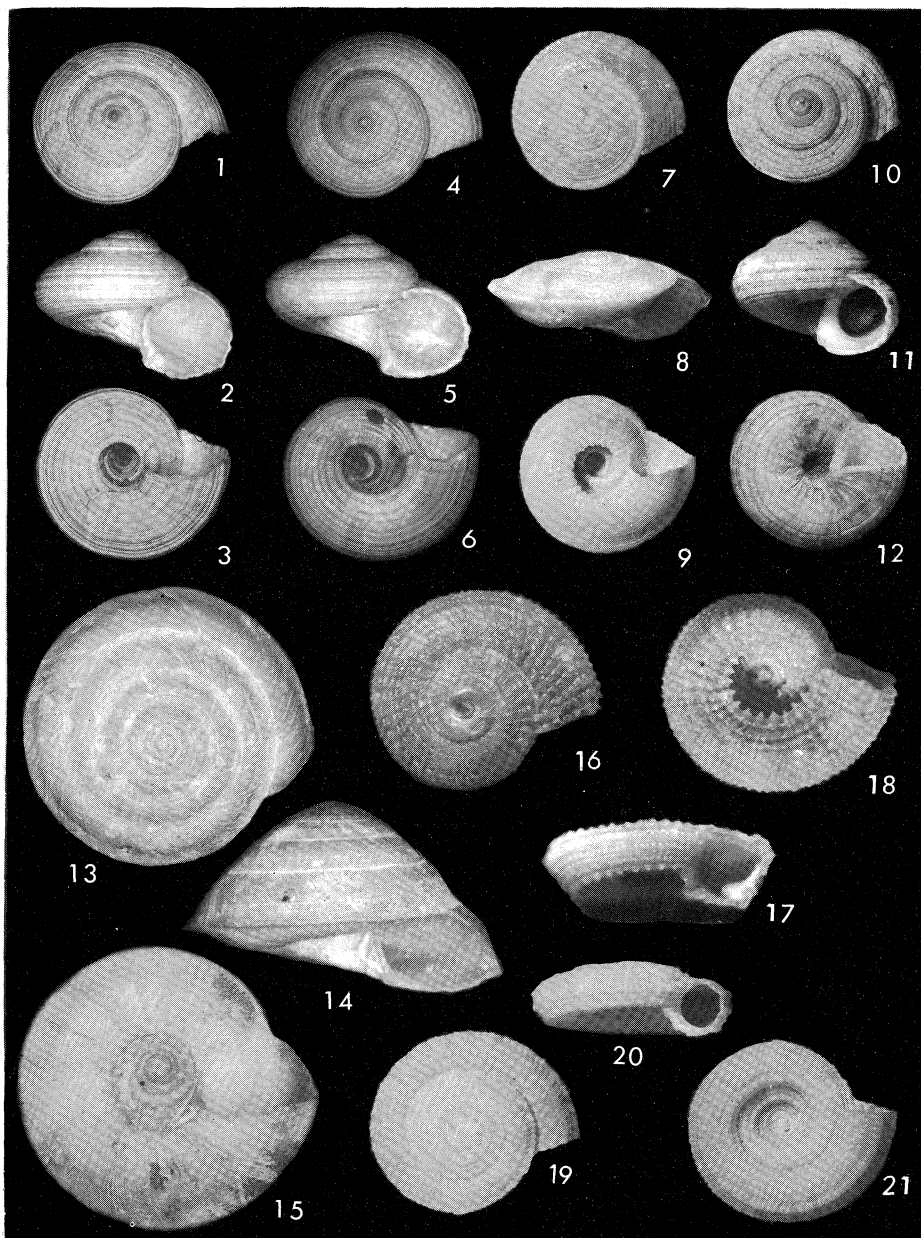


Fig. 4. (1-3) *Heliacus (Heliacus) stramineus* (Gmelin, 1791). Fig'd spec, off Island Head, 80 km N. of Yeppoon, Q'ld, 49 met, ex T.A. Garrard coll (38.4 x 26.9 mm) X .83, A.M. No. C. 92036. (4-6) *Heliacus (Heliacus) stramineus* (Gmelin, 1791) Type of *Grandeliacus mortensenseae* Iredale, 1957. Hummock Hill Is., near Port Curtis, Q'ld. Coll Mrs. C. Mortensen, 1956 (38.4 x 26.8 mm) X .83, A.M. No. C. 96241. (7-9) *Architectonica (Solatisonax) atkinsoni* (E. A. Smith, 1891) Fig'd spec, S.E. of Lakes Entrance, Vic., 155 met, ex T. A. Garrard coll (6.3 x 2.8 mm) X 4.6, A.M. No. C. 96242. (10-12) *Heliacus (Heliacus) madurensis* (Schepman, 1909) Fig'd spec, S.E. of Bustard Head, Q'ld, 20 met, ex T. A. Garrard coll (6.9 x 5.5 mm) X 4.1, A.M. No. C. 91764. (13-15) *Architectonica (Solatisonax) injussa* (Iredale, 1931) Holotype, off Gabo Is., Vic., 183 metres, coll T. Iredale (25.4 x 15.4 mm) — amended, X 1.9, A.M. No. C. 57776. (16-18) *Heliacus (Torinista) concavus* (Thiele, 1918) Fig'd spec, off Bunbury, W. Aust., 156 met, coll CSIRO 10/8/62, H.M.A.S. "Gascoyne," Stn, G3/175/62 (2.5 x 1 mm), X 15.2, A.M. No. C. 94486. (19-21) *Heliacus (Torinista) fenestratus* (Hinds, 1844), Fig'd spec, Bird Is., Coral Sea, coll C. Hedley (9.3 x 3.8 mm) X 3.6, A.M. No. C. 8477. All photos — Greg Millen, A.M., Sydney.

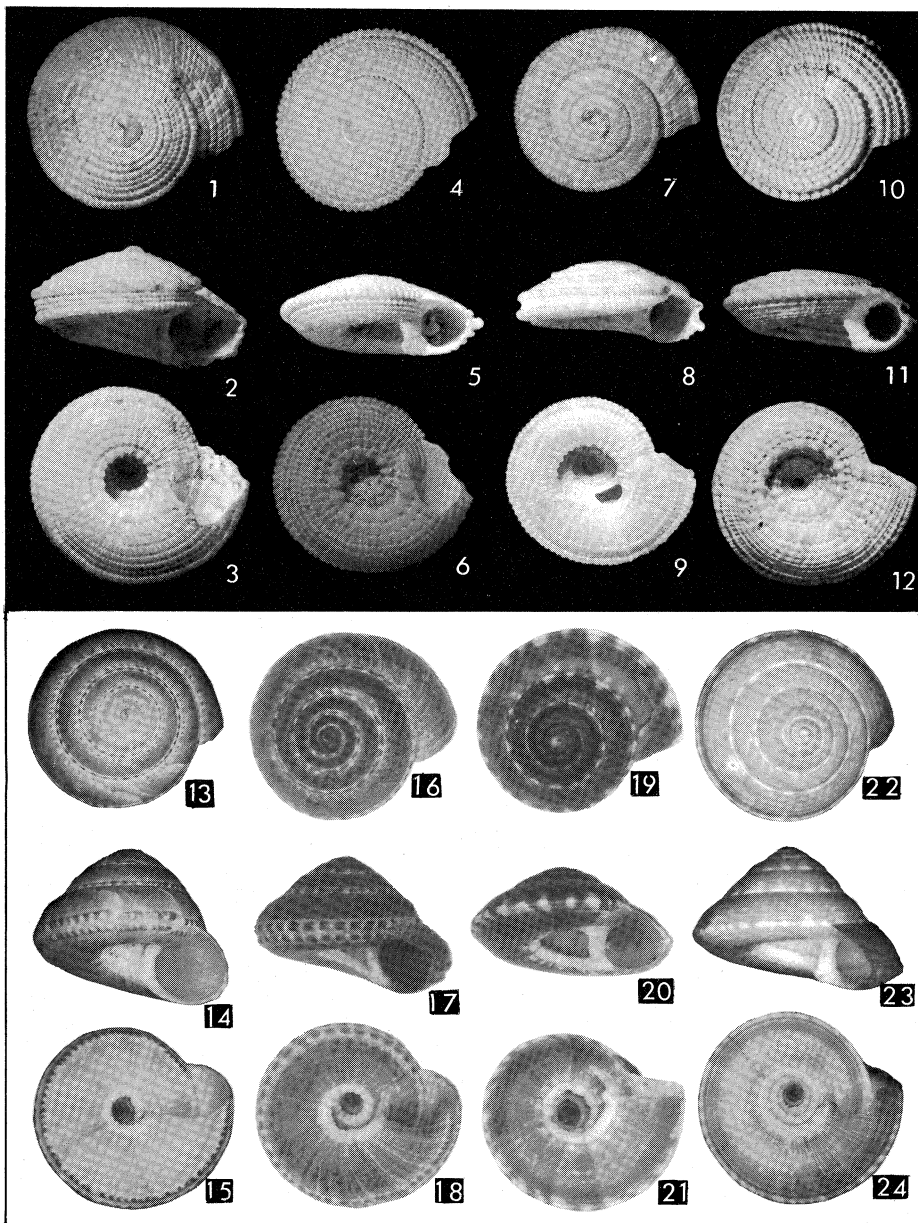


Fig. 5. (1-3) *Heliculus (Torinista) delectabilis* (Melvill, 1893) Fig'd spec, Twofold Bay, N.S.W., coll Roy Bell (6 x 3.3 mm) X 6, A.M. No. C. 92021. (4-6) *Heliculus (Claraxis) colmani* Garrard, nov. Holotype. 370 km W. of Roebuck Bay, W. Aust., 238 met, coll P. H. Colman 11/10/68, M.V. "Espirito Santo," B.M.R. Stn. E68/576 (4.8 x 1.8 mm) X 6.9, A.M. No. C. 96364. (7-9) *Heliculus (Torinista) costatus* (Schepman, 1899) Fig'd spec, Manly Beach, N.S.W., ex C. F. Laseron coll (5.2 x 2.4 mm) X 6, A.M. No. C. 92039. (10-12) *Heliculus (Claraxis) foveolatus* (Tate, 1893) Fig'd spec dredged Pittwater, N.S.W., ex C. F. Laseron coll (4.7 x 1.9 mm) X 7, A.M. No. C. 96258. (13-15) *Philippia (Philippia) lutea* (Lamarck, 1822) Fig'd spec, Huskisson, Jervis Bay, N.S.W., ex T. A. Garrard coll (15.7 x 12.5 mm) X 2.1, A.M. No. C. 96237. (16-18) *Philippia (Philippia) lutea* (Lamarck, 1822) Fig'd spec, Portland, Vic, ex T. A. Garrard coll (14.7 x 10 mm) X 2.3, A.M. No. C. 96238 (Dark grey form). (19-21) *Philippia (Psilaxis) oxytropis* (A. Adams, 1854) Fig'd spec, Woolgoolga, N.S.W., ex J. Kerlake coll (14.3 x 8.3 mm) X 2.4, A.M. No. C. 96240. (22-24) *Philippia (Psilaxis) oxytropis* (A. Adams, 1854) Holotype of *Philippia manifesta* Iredale, 1931. Sydney Harbour, N.S.W. (18.2 x 12.5 mm) — amended, X 1.8, A.M. No. C. 57775. All photos Greg Millen, A.M., Sydney.

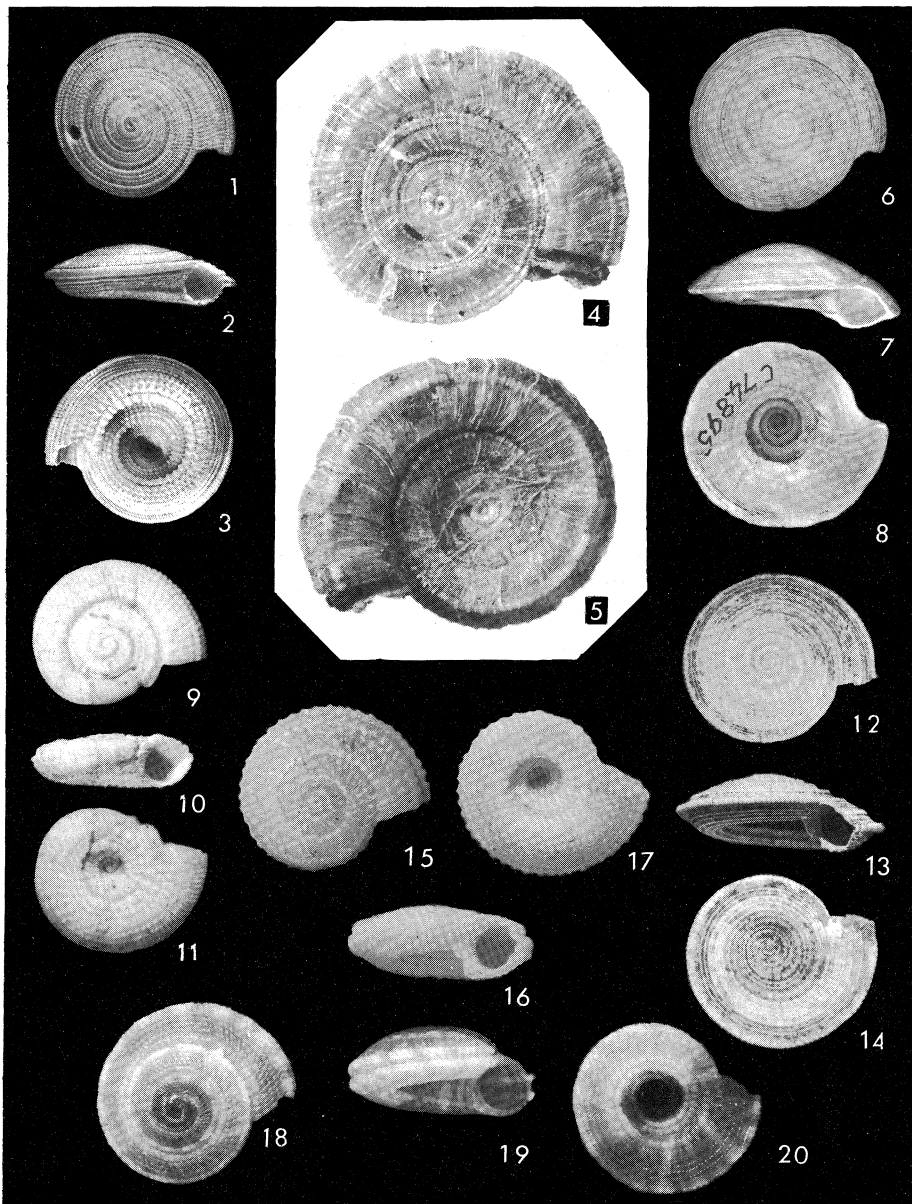


Fig. 6. (1-3) *Heliacus (Claraxis) asperus* (Hinds, 1844) Holotype, Straits of Macassar, 20 met (approx 9.5 x 3.2 mm) X 3.1, B.M.N.H. Reg'd No. 1879:2:26:159. (4-5) *Pseudomalaxis nobilis meridionalis* (Hedley, 1903) Fig'd spec, 29 km E.N.E. of Port Stephens, N.S.W., 113 met, coll P. Sadler (13.3 x 3.35 mm) X 4.1, A.M. No. C. 90458 (live). (6-8) *Architectonica (Discotectonica) balcombensis* (Finlay, 1927) Fig'd spec, Fossil Beach, Mornington Penin., Vic. Grid ref Cranbourne 072,845. J. Kerslake and T. A. Garrard coll (24.7 x 9.9 mm) X 1.4, A.M. No. C. 74895. (9-11) *Heliacus (Claraxis) wannonensis* (Tenison-Woods, 1879) Holotype. Lower beds, Muddy Creek, W. of Hamilton, Vic. Pres J. E. Tenison-Woods, 1892 (3.5 x 1 mm) X 11.1, A.M. No. F. 1818. (Holotype is worn). (12-14) *Heliacus (Claraxis) asperus* (Hinds, 1844) Fig'd spec, Cliffs S. of Manyung Rocks, Mornington Penin., Vic. Grid ref, Cranbourne 106, 903. J. Kerslake and T. A. Garrard coll (12.2 x 4.7 mm), A.M. No. C. 94474. (15-17) *Heliacus (Claraxis) foveolatus* (Tate, 1893) Holotype of *Torinista laseronorum* Iredale, 1936. Port Jackson, N.S.W., 26 metres (4.5 x 1.8 mm) X 7.3, A.M. No. C. 60693. (18-20) *Heliacus (Torinista) corallinus* Garrard nov. Holotype. Michaelmas Cay, Q'ld. Coll T. Iredale and G. P. Whitley, G.B.R. Boring Exp, May-June 1926 (5.7 x 2.8 mm) X 5.9, A.M. No. C. 94340. Photos — 1-3, B.M.N.H. 4-5, Chas Turner, A.M., Sydney. 6-17 Greg Millen, A.M., Sydney. 18-20, author.

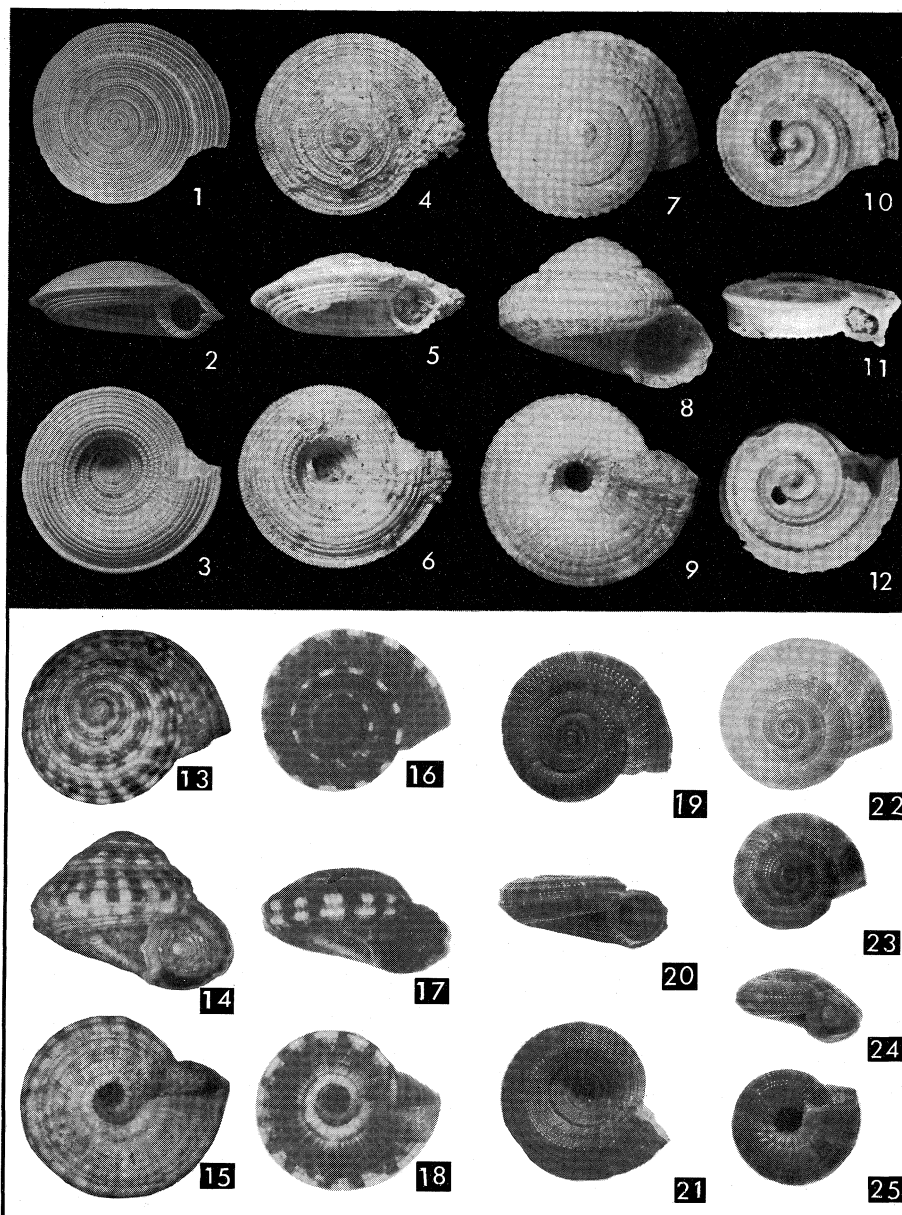


Fig. 7. (1-3) *Heliacus (Claraxis) asperus* (Hinds, 1844) Fig'd spec, off Port Hacking, N.S.W., 100 met, ex T. A. Garrard coll (13.2 x 5.7 mm) X 2.5, A.M. No. C. 96257. (4-6) *Heliacus (Claraxis) asperus* (Hinds, 1844) Holotype of *Claraxis illustris* Iredale, 1936, off Crowdy Head, N.S.W., 82 met, coll T. Iredale (7.5 x 3.3 mm — amended) X 4.4, A.M. No. C. 60694. (7-9) *Heliacus (Heliacus) mighelsi* (Philippi, 1853) Fig'd spec Lord Howe Is., coll J. Brazier (8.3 x 6.1 mm) X 4.3, A.M. No. C. 92405. (10-12) *Pseudomalaxis nobilis meridionalis* (Hedley, 1903) Holotype, Port Stephens, N.S.W., coll C. Hedley (4.5 x 1.25 mm) X 6.7, A.M. No. C. 16298. (13-15) *Heliacus (Heliacus) variegatus* (Gmelin, 1791) Fig'd spec, live — low tide, Wooli, N.S.W., ex T. A. Garrard coll (16.4 x 13 mm) X 2.1, A.M. No. C. 96250. (16-18) *Heliacus (Heliacus) variegatus* (Gmelin, 1791) Fig'd spec, Shelly Beach, Angourie, N.S.W., ex N. Jackson coll (13.2 x 8.8 mm) X 2.3, A.M. No. C. 96251 (depressed specimen, colour variation). (19-21) *Heliacus (Torinista) infundibuliformis* (Gmelin, 1791) Fig'd spec, Caloundra Beach, Q'ld, ex T. A. Garrard coll (12.7 x 5.9 mm) X 2.3, A.M. No. C. 92032. (22-25) *Heliacus (Heliacus) enoshimensis* (Melvill, 1891) Fig'd spec, East Ballina Beach, N.S.W., ex T. A. Garrard coll (8.3 x 4.5 mm) X 3.5 and 2.6, A.M. No. C. 91793. All photos — Greg Millen, A.M., Sydney.

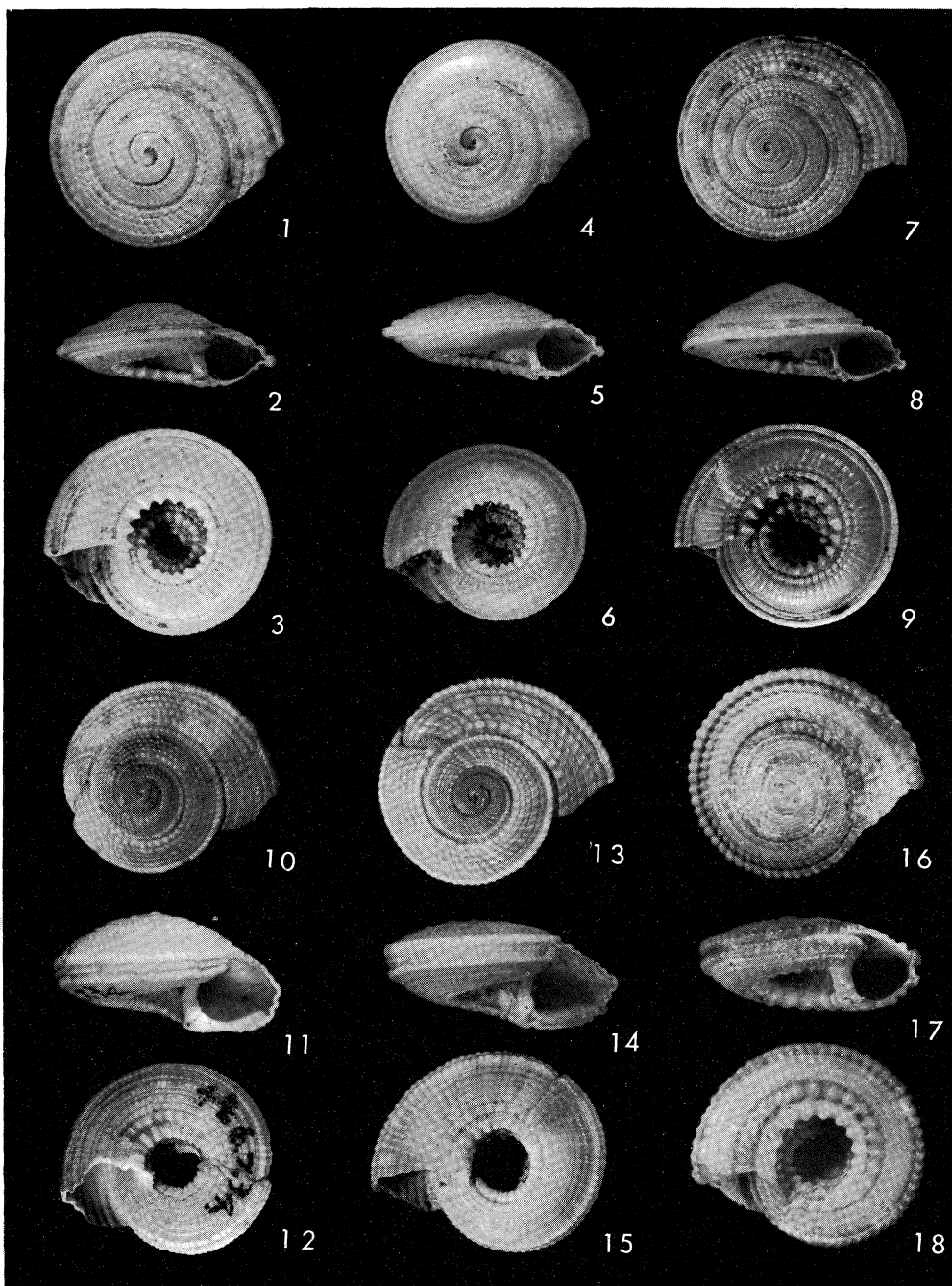


Fig. 8. (1-9) *Heliacus (Claraxis) fragilis* (Hinds, 1844), 3 syntypes B.M.N.H., Reg'd Nos. 1879: 2:26:160-162. North coast of New Guinea, 13 metres. Figs 1-3 approx 6.9 mm diam, 3.1 mm alt. 4-6 approx 5.9 mm diam, 2.5 mm alt. 7-9 approx 12.3 mm diam, 5.5 mm alt. (10-15) *Heliacus (Torinista) fulvus* (Hinds, 1844), 2 syntypes B.M.N.H. Reg'd Nos. 1844: 6:7:34. New Guinea. Figs. 10-12 approx 11.4 mm diam, 6 mm alt. Reg'd No. 1879: 2:26:158. Figs. 13-15 approx 8.4 mm diam, 4.1 mm alt. (16-18) *Heliacus (Torinista) virgatus* (Hinds, 1844), possible holotype B.M.N.H. Reg'd No. 1874: 12:11:190, approx 4.7 mm diam, 2.1 mm alt. (Author's measurements of holotype, 4.2 mm diam, 2.1 mm alt.) New Guinea. All photos — B.M.N.H.

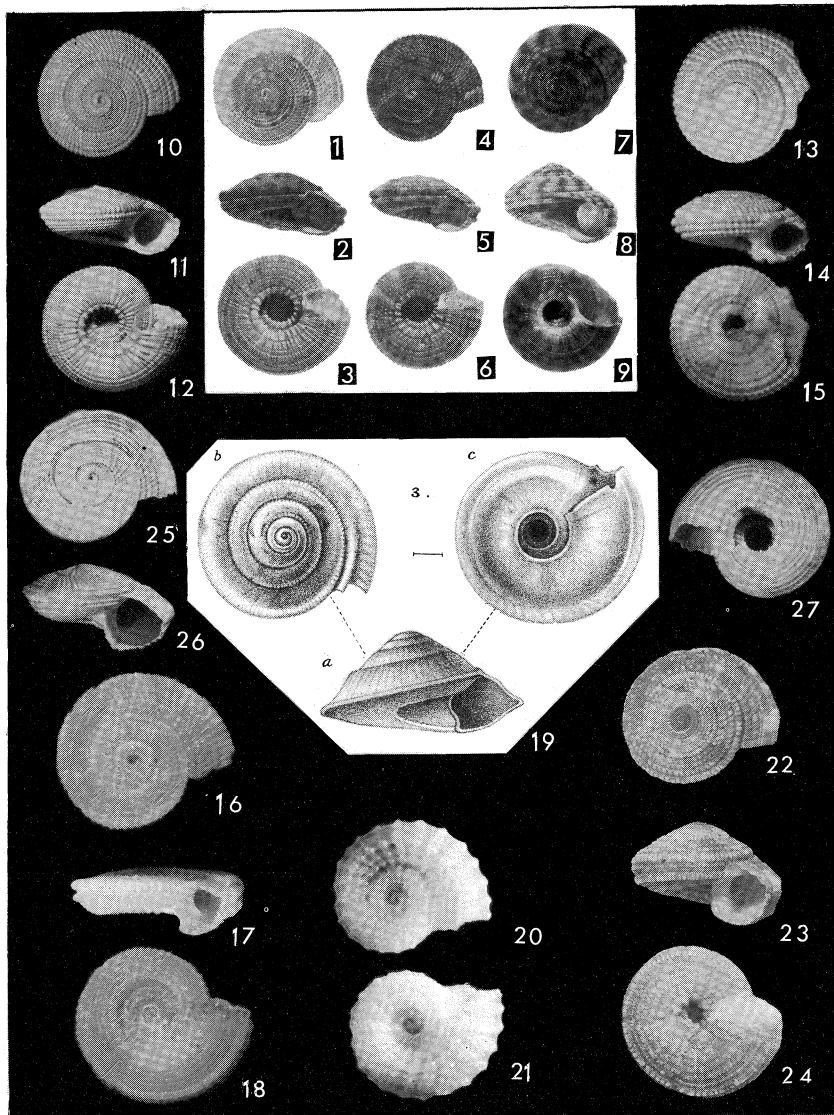


Fig. 9. (1-3) *Heliacus (Torinista) dorsuosus* (Hinds, 1844) Holotype of *Torinista popula* Iredale, 1936. Sydney Harbour, N.S.W., ex "Triton" dredge (9.2 x 4.6 mm — amended) X 2.6, A.M. No. C. 60692. (4-6) *Heliacus (Torinista) dorsuosus* (Hinds, 1844) Fig'd spec off Moreton Bay, Q'ld., 75-80 met, coll W. F. Ponder 29/3/69, H.M.A.S. "Kimbla" (8.2 x 3.9 mm) X 2.6, A.M. No. C. 96264. (7-9) *Heliacus (Heliacus) cerdaleus ponderi* subsp. nov. Fig'd spec, 3 km S. of Cape Naturaliste, W. Aust., coll W. F. Ponder and B. R. Wilson 3/1/72 (8.3 x 5.8 mm) X 2.6, A.M. No. C. 90978. (10-12) *Heliacus (Claraxis) morningtonensis* Garrard, nov. Holotype, Fossil Beach, Mornington Penin., Victoria, ex J. Kerlake, T. A. Garrard coll (5.8 x 4.5 mm) X 4.6, A.M. No. C. 94485. (13-15) *Heliacus (Claraxis) aequatorialis* (Thiele, 1925) Fig'd spec, 9 met. Van Diemen's Inlet, Gulf of Carpentaria, coll C. Hedley (3.8 x 1.8 mm) X 6.8, A.M. No. C. 15376. (16-18) *Heliacus (Torinista) cf. implexus* (Mighels, 1845) Fig'd spec, 31-37 met off Masthead Is., Q'ld., coll C. Hedley (4.5 x 1.5 mm) X 7.3, A.M. No. C. 19629. (19) *Architectonicinae* sp. — *trochiformis* (Schepman, 1909) Fig'd from author's orig. drawing — "Siboga Exped." 835 met, Ceram Sea (5 x 2.5 mm) X 6.6, (Vol 2:220, pl. 14, fig. 3). (20-21) *Heliacus (Claraxis)* sp. S.W. end of Garden Island, S. of Perth, Western Australia. Coll W. F. & J. M. Ponder, N. Coleman. (2 x .8 mm) X 14. A.M. C. 105175. (22-24) *Heliacus (Heliacus) hedleyi* Garrard nov. Holotype, Port Curtis, Q'ld., 13-18 met, coll C. Hedley (8.8 x 5.7 mm) X 3.3, A.M. No. C. 18727. (25-27) *Heliacus (Claraxis)* sp. Fig'd spec, 124 met, 160 km N. of Croker Is., Northern Territory (9°30'S., 132°34'E), coll P. H. Colman 9/11/69, M.V. "San Pedro Sound" (5.3 x 2.6 mm) X 5.5, A.M. No. C. 100514. All photos — Greg Millen, A.M., Sydney.



Fig. 10. (1-3) *Heliacus (Awarua) otwayanus* nov. Holotype. Aw. 1, Point Flinders, Cape Otway, Victoria. Grid ref. Aire 367, 097. Coll T. A. Darragh and T. Hughes 1/12/72 (13.8 x 7.1 mm) X 2.4, N.M.V. No. P. 31325. (4-6) *Heliacus (Torinista) darraghi* nov. Holotype. Aw. 1, Point Flinders, Cape Otway, Vict. Grid ref. Aire, 367, 097. Coll F. A. Cudmore (13.8 x 8.1 mm) X 2.4, N.M.V. No. P. 31321. (7-9) *Architectonica (Discotectonica) balcombensis* (Finlay, 1927) Neotype. Lower beds, "Clifton Bank," Muddy Creek, near Hamilton, Vic. Coll F. A. Cudmore 1922. (Major 17.5, Minor 16.5, Alt. 7 mm) X 1.6 N.M.V. No. P. 34820. (10-12) *Philippia (Psilaxis) mitchellana* nov. Holotype. Right bank of Mitchell River, "Moonlara" farm Bairnsdale, Vic. 91 met N. of first gully south of house. Coll T. A. Darragh and K. Bell 3/5/71. (15 x 7.5 mm) X 2.4, N.M.V. No. P. 31314. (13-15) *Heliacus (Claraxis)* sp. Fig'd spec probably from Muddy creek, 6.4 km W. of Hamilton, Vic., locality doubtful. (12.2 x 6.6 mm) X 2.5, A.M. No. C. 100602. (16-18) *Architectonica (Discotectonica)* sp. Fig'd spec, just below high-tide mark, E. side of North Arm, below Ferndale Parade, Lakes Entrance, Vic. Grid ref. Bairnsdale 913, 276. Pres Mrs. M. Griffiths, Lakes Entrance, Vic. (11.5 x 4.9 mm) X 2.4, N.M.V. No. P. 31319. (19-21) *Heliacus (Awarua)* sp. Fig'd spec, Aw. 1, Point Flinders, Cape Otway, Vic. Grid ref. Aire 367, 097. Coll T. A. Darragh and T. Hughes 1/12/73 (15.8 x 5.7 mm) X 1.7, N.M.V. No. P. 34816. (22-23) *Pseudomalaxis (Pseudomalaxis) praemeridionalis* (Chapman, 1912) Holotype. Altona Bay Coal Shaft, Altona, Bay, Victoria. (6.25 x 1.75 mm) X 6.7, N.M.V. No. P. 12360. (24-25) *Architectonica (Architectonica) squamogranosa* (Chapple, 1941) Holotype. Lower beds, Muddy Creek, W. of Hamilton, Victoria. Coll E. H. Chapple (19 x 8 mm) X 2.2, N.M.V. No. P. 14102.



