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A REVIEW OF THE *CYPRAEIDAE* GENUS *NOTOCYPRAEA*.

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The genus *Notocypraea* Schilder 1927, which inhabits the seas round southern Australia, has been found an extremely difficult group to classify. The best review so far published is that of Schilder and Schilder (1938); but the amount of material available did not permit these authors to make as thorough a study as they would doubtless have wished.

The reasons for the difficulties of classification so far experienced are three-fold. Firstly, the species are conchologically separated from each other only by small differences. Secondly, there is great variation within species. Thirdly, the preference of the majority of animals for waters below the low tide line has made collection and study of living specimens difficult.

The present review began with a conchological study. The limitations of this method soon became apparent, and the approach was widened to include study of the radula. A considerable number of these was obtained both from fresh and from preserved specimens, and also from the dried remnants of animals salvaged from shells in collections. Evidence based on the appearance and behaviour of living animals and on the morphology of preserved ones has yielded important results, but, owing to scarcity of material, this line of investigation could not be followed very far.

The most useful diagnostic part of the radula was found to be its central tooth. While little subject to variation within each species, considerable differences were found between certain species. One result of the examination of radulae was proof that the three most common and best known forms, *N. angustata*, *N. comptonii* and *N. piperita*, are separate species. This had been doubted by several authors (Pritchard and Gatliff, 1900; Verco, 1918).

A further result was the discovery of several individuals with unique central radula teeth, but which, if judged solely on conchological grounds, would not have been considered to be distinct. These individuals may be freaks, or may later prove to be the first specimens so far found of new species. The specimens have been described and illustrated, but, in order to avoid a possible future swelling of the synonymy of this already over-named family, they have been referred to only by individual letters of the alphabet.

Until more is known about its morphology, classification within the genus is premature. The evidence of the radula, however, shows close relationship within two groups of species:—

(*a*) *N. cuclia*, *N. piperita*, *N. pulicaria* and *N. wilkinsi*.
(*b*) *N. comptonii* and *N. declivis*.

Variation within the species of *Notocypraea* differs considerably from that found in most other *Cypraeidae*. Most species of the latter are easy to determine conchologically, and much of their variation is attributable to the effect of different environmental conditions. Appreciable genetic differences are in some cases shown by the existence of subspecies; the areas inhabited by these subspecies are usually large.

In *Notocypraea* conchological differences within species are both more considerable and more local. Variation is neither clinal nor of conventional subspecific pattern; similar forms are often found in geographically distant areas, sometimes with different forms near-by. This variation was at first considered to be due to ecological factors, but it was later thought to be in excess of that likely to be caused by differing environments.

At this stage the author was informed of some observations made by Mr. C. F. Kurtze at Portland, Victoria. He has seen egg masses of *N. comptonii*, usually on Bryozoa, in all stages of development. The egg masses were roughly conical in shape, about 15 mm. wide at the base, and about 8 mm. high. In each case an adult was on them. In some capsules animals were seen with the oliviform shell already developed. As each young animal reached the appropriate stage of development, the case of its capsule split longitudinally, and the animal emerged and crawled away to the higher fronds of the Bryozoa. The young came out of their individual capsules over a period of several days. About sixteen were seen to come from one egg mass. These observations have been confirmed by Mr. Attorfer, Mr. Drogemuller, and Mr. Kerrison of Port MacDonnell, S.A.

Two egg masses were preserved for inspection. In several respects they differed from those of *C. caputserpentis* L. and *C. moneta L.* described by Vayssiere (1923), and from those of other *Cypraea* species seen by the author. The capsules of *Cypraea* are described by Vayssiere as about 150 to 300 in number, and each a maximum of 1½ by 1 mm. in size. The capsules of *N. comptonii* numbered not more than 50, and were ovoids about 2½ to 3 mm. long and about 1½ mm. wide. They were deep yellow in colour. Both egg masses were in their early stages of development, the capsules containing numerous minute eggs.

A likely hypothesis, supported by both Mr. Kurtze's observations and by the nature of the variation within species, is that *Notocypraea* differs from the rest of *Cypraeidae* in having no veliger larval stage. The intermixture of genes caused by the long distances travelled by free-swimming larvae plays a major part in keeping the species of *Cypraea* uniform. In *Notocypraea* this factor seems to be lacking. Differences in the genotypes of adjacent groups would accordingly be expected.

In the light of this hypothesis it would appear that most *Notocypraea* species are a synthesis of independent or semi-independent groups, many of them with dissimilar genetic constituents, and showing marked conchological differences. A great deal more collecting is needed before the geographical delineation of the species can be made clear; present knowledge is insufficient to permit the nomination of sub-species.

Notocypraea is found in one or more species of sponge in deep water, on the fronds and in holes in the stalks of Bryozoa, between the valves of dead *Pinna* shells, and under stones, rocks and rock ledges. It also lives on rock under seaweed in deep pools, and on piers and submerged wooden stumps. It is not normally found on sand. The preferred habitat is below the low tide line, and only in a few places are specimens found intertidally in considerable numbers.

The generic name *Notocypraea* was given by Schilder and Schilder in 1927, and has been accepted by later writers. Kay (1957) has, however, shown that, from the malacological point of view, *Cypraeidae* is not easily separable into genera. Conchologically, moreover, groups of species differ in an intergrading manner rather than in a clear-cut series of distinctions. The special geographic range of *Notocypraea,* as well as its likely difference in method of breeding, is enough to justify generic separation. The name *Notocypraea* is therefore retained.

Beddome (1896, 1898) named and described three varieties, *C. albata, C. mayi* and *C. subcarnea.* The first two appear to be forms of *N. angustata* and *N. comptonii* respectively. Owing to insufficient information, and to the absence of type specimens, *C. subcarnea* is less readily identifiable. In any case none of the three varieties is on present evidence worthy of specific or sub-specific rank. Beddome's names are in common use in South Australia; but the forms to which they are applied are variations of other species, and bear little resemblance to the shells described by Beddome.

The columellar teeth are large, and relatively few in number. The fossula is crossed by regular parallel teeth; often these are formed only at the top and bottom, resulting in a trough which runs along the fossula and joins the columellar sulcus.

Young Shell.—In the early oliviform stage the shell is white or very pale brown, and is crossed by four medium brown interrupted bands. When still below its maximum size the shell darkens into its adult colour, and the bands become concealed.

Animal.—Cephalic tentacles medium brown, rounded at tips. Siphon white, tinged with pale grey, unfringed at the front end, but having instead a series of serrations like the teeth of a saw. Mantle pale brown, appearing whitish-grey against the shell. No mantle papillae are apparent. Foot pale brown. There is some variation in colour, some animals being greyish-brown or even grey.

Radula.—The central tooth differs from other *Notocypraea* species by its large size and by its almost semicircular shape. There are no base cusps, their place being taken by a pair of sharp ridges which extend towards and sometimes across the bottom of the tooth. (Pl. IV., fig. 1).

Variation.—Beach shells from eastern Victoria are occasionally distinctly banded across the dorsum, the interrupted brown bands being of medium width.

Deep water specimens trawled alive off Eden, N.S.W., are of medium size. The shell has a reddish-brown dorsum crossed in the centre by two interrupted or continuous dark brown bands. In this it resembles some forms of *N. comptonii;* the shape of the fossula is here the best diagnostic point. (Pl. I., figs. 2-3).

Habitat: Under rocks and stones; in sponges and Bryozoa.

Distribution: N.S.W., south of Eden, to Gulf St. Vincent, S.A. Eastern and northern Tasmania from Cape Pillar to Cape Grim. A report of dead shells having been found in the Abrolhos Is., W. A., is probably incorrect, and is very likely based on worn specimens of *N. comptonii.*

Nomenclature: *N. angustata* was named by Gmelin in 1791, reference being made to a drawing by Gualtieri in Testarium Conchyliorum Index published in 1742. Iredale (1924) considers the description is not that of an Australian species, his grounds being that Australian shells did not reach Europe before the publication of Gualtieri's work. Since the Dutch were in Tasmania in 1642, an Australian shell could have been that illustrated by Gualtieri; his drawing and description, while not very illuminating, are as good as many referred to for other species by Linnaeus and Gmelin, and not hitherto questioned. There is thus good reason, apart from the need for continuity, for retaining Gmelin's name in place of the proposed alternative *N. verconis* Cotton and Godfrey, 1932.

Most of the specimens examined by the author came from the area between N.S.W. and Spencer Gulf. Little material from Western Australia was available. It is, however, evident that western *Notocypraea* differ in many respects from their eastern relations, and a thorough study of western specimens will very likely disclose the existence of new species and sub-species.

The geographical distributions given below for each species are based on records of shells in public and private collections, and on some localities quoted in literature. Owing to the confusion between species in most scientific papers, many of the latter references are not acceptable.

The list of species is in two parts. The first contains those which on present evidence must be considered valid species. The second describes some forms which further investigation may show to be good species, but on which our present knowledge is insufficient. Tables I.-III. contain details of shell dimensions and other measurable characters.

It only remains to emphasize that this paper is no more than a preliminary review of an extremely complex group. Study of the new material which modern methods of collecting are now providing will inevitably change the picture in many respects. This further research, will only be possible if every collector adopts a new point of view. He will have to realize that information on the animal—its habitat, appearance, structure, radula, behaviour and method of breeding—is even more important than collection of the shell. Until further knowledge of the animal is gained, little progress is likely.

This review would have been impossible without the support and advice of the authorities of the National Museum, Melbourne; to them I am most grateful. My thanks are also due to the Directors and Staffs of the Australian Museum, the South Australian Museum, the Tasmanian Museum and the Western Australian Museum. Much assistance has also been given by private collectors.

LIST OF SPECIES.

Notocypraea angustata (Gmelin, 1791).

(Plate I., figs. 1-8. Plate IV., fig. 1).

Shell.—This is longer than those of most other species of the genus, and broader and taller in proportion to length. Shell size is variable, some shells being longer and considerably more swollen than the average. The dorsum is dark brown or greyish-brown, and rarely shows any trace of dorsal bands.

Notocypraea comptonii (Gray, 1847).
(Plate I., figs. 9-21. Plate IV., fig. 2).

Shell: Usually with two continuous brown bands crossing the centre of the brown or reddish-brown dorsum; less frequently there are two additional bands, one towards the front of the shell and a less distinct one near the rear. The bands are narrow, and usually remain separate from each other over the whole width of the shell. In very dark shells these bands are sometimes hard to see. Occasional shells are piperate on the lateral part or even on the top of the dorsum. The fossular teeth are smaller than those of *N. angustata,* and are interrupted or shallowed to form a depression halfway down; the depression is deep in front and shallow where it meets the columellar sulcus. The lateral spots are smaller than those of *N. angustata.* The base of the shell is white, cream, brown or even tinged with purple.

Young Shell: Pale brown in colour, with the dorsum and sides crossed by four narrow medium brown bands composed of discontinuous small patches. (I., 9).

Animal: Pale orange or bright yellow in colour. The cephalic tentacles are rounded at the tips, and darker in colour in front. The siphon bears no fringe of papillae. The mantle has a dozen or so unbranched whitish mamilliform papillae on each side. The mantle edges sometimes meet on top and sometimes on the labial side of the dorsum.

Radula: The central is shaped like a truncated triangle. In the lower corners are two cusps, positioned obliquely with the tips pointing outwards. (Pl. IV., fig. 2).

Variation: The dorsal colour is very variable. In Western Port Bay, Victoria, and Tumby Bay, S.A., shells are very dark brown (I., 10-13), but in other places they are medium or even light brown.

Shells from below the tide level at Portland and Lakes Entrance, Victoria, and intertidally at Port MacDonnell, S.A., are often pale yellow or pale brown in colour, with the dorsal bands sometimes only faintly visible. Some Port MacDonnell shells are completely white. (Pl. I., 18 and 21).

Specimens trawled from southern N.S.W. and eastern Victoria at about 40 fathoms have straw coloured dorsums, and are narrower than shallow water specimens. They have been identified as *N. comptonii* mainly on the evidence of the radula. Later research may show them to be specifically distinct. (Pl. I., figs. 14-16).

Habitat: Intertidally, under stones. In deeper waters on and in Bryozoa and in sponges.

Distribution: Southern N.S.W., about Eden, to Abrolhos Is., W.A. Tasmania.

Notocypraea declivis (Sowerby, 1870).
(Plate II., figs. 22-27. Plate IV., fig. 3).

Shell: Fully adult specimens are recognizable by the dorsal pattern. which consists of a pale milky layer densely covered by many small brown specks. *N. declivis* differs from *N. comptonii* by its general colour being sepia rather than reddish-brown, by the more prominent pairs of terminal patches, and by its greater width and height. The close relationship between the two species is shown by some similarity in the fossular arrangement; but the teeth of *N. declivis* tend to be larger, and are more formed in the centre of the

fossula. The fossular depression is consequently less noticeable. Shells of *N. declivis* from Tasmania are darker and more heavily spotted on the dorsum than shells from western Victoria.

Young Shell: Immature shells from Tasmania (believed to be *N. declivis*) have dorsal bands recalling those of *N. comptonii*.

Radula: Resembles that of *N. comptonii* (Pl. IV., fig. 3).

Distribution: Tasmania, St. Helen's to Stanley; Carnarvon, W.A.; Flinders I., Bass Strait; Lorne, Victoria; Port MacDonnell, S.A.

Nomenclature: Iredale (1935) named a subspecies *N. d.occidentalis* from Western Australia. Of the shells in the Australian Museum labelled with this name, one is *N. pulicaria* and the others, which are piperate on the backs and have no dorsal bands visible, more nearly resemble *N. piperita* than *N. declivis*. Any further specimens put forward as *N. d.occidentalis* can easily be verified by the radula. At present evidence for a western sub-species is insufficient, and the name *occidentalis* must be considered invalid.

Remarks: The only sinistral specimen of *Cypraeidae* known to the author is in the South Australian Museum.

Notocypraea dissecta (Iredale, 1931).

(Plate II., figs. 28-23. Plate IV., fig. 4).

Shell: Subovate or somewhat cylindrical in shape, thin and light in weight, with the right side little calloused. The white or reddish-brown dorsum is crossed by up to four narrow, interrupted, evenly spaced brown bands, the centre two being the most prominent. There is no other dorsal decoration. There are usually two light brown blotches on the front end of the shell, and a stain in the deep and wide spire pit. The spots on the labial side of the shell are small, and average 20 to 30 in number; mature shells have about ten slightly larger spots on the columellar side. The base of fully-grown shells is white. The aperture is broad throughout, slightly constricted in front on the labial side, and sharply bent at the rear. The small teeth extend about halfway across the base on the labial side, but are confined to the aperture on the columellar side. The fossula is wide, deep and long, often with a very prominent lower edge which extends a considerable way out into the aperture in a manner reminiscent of *N. pulicaria*. The columellar sulcus is slight.

Young shell: Similar in colour to the adult. The bands are usually more distinct.

Radula: The central has some points in common with that of *N. piperita*. The base cusps, however, are different in form. (Pl. IV., fig. 4).

Habitat: In sponges. Usually dredged at about 40 fathoms.

Distribution: Sydney to Green Cape, N.S.W.

Remarks: The holotype is in the Australian Museum. It is 19·5 mm. long, 10·9 mm. wide and 9 mm. high, with 28 labial and 21 columellar teeth. The twenty spots on the labial side are

small; the ten on the columellar side are slightly larger. The lower edge of the fossula protudes less far out into the aperture than in most specimens examined. There are traces of the two central dorsal bands.

Notocypraea emblema Iredale, 1931.
(Plate IV., fig. 12).

Shell: The holotype in the Autralian Museum is 27·3 mm. long, 18·1 mm. wide and 15·3 mm. tall. It has 26 teeth on the labial side and 21 on the columellar side. On the labial side there are about 30 medium or large brown spots, with about ten of the same size on the opposite side. The shell is white, with no trace of dorsal bands. The labial side of the aperture is considerably constricted forward. The spire lies in a pit.

Radula: The central of the holotype is very large, and almost square in shape. It has two large base cusps which extend below the bottom edge of the tooth. (Pl. IV., fig. 12).

Remarks: Only one specimen of this species is available. It has many points in common with the holotype of *N. molleri* and with a series of specimens dredged between Green Cape and Gabo Island, and included under the latter name. It was at first proposed to lump the three groups together, but the radula of the holotype of *N. emblema* was later found to differ in shape, size and in form of basal cusps from those of the Green Cape specimens. *N. emblema* is therefore retained as a separate species.

Notocypraea euclia Steadman and Cotton, 1946.
(Plate II., figs. 34-36. Plate IV., fig. 5).

Shell: *N. euclia* differs from *N. pulicaria* by the pale cream dorsum, by the total absence of transverse dorsal bands, by the lower edge of the fossula not protruding to any great extent into the aperture, and by the lesser number of spots on the labial side. While the dorsum is usually plain, occasional specimens are decorated with faint and small light brown spots.

Radula: Resembles that of *N. piperita*. (Pl. IV., fig. 5).

Habitat: All known specimens were dredged by Sir J. Verco at depths of 100 to 116 fathoms.

Distribution: 40 to 90 miles west of Eucla, W. A.

Notocypraea molleri (Iredale, 1931).
(Plate II., figs. 37-44. Plate IV., fig. 8).

Shell: Ovate, with a tall and wide dorsum. The dorsal colour is usually pale flesh, but occasionally white. There are four fairly wide interrupted light brown dorsal bands; the central ones sometimes extend completely across the dorsum, while the end ones reach only to the top. On some shells the bands are only present well down on the left side, or are even absent altogether. There are usually two pale brown anterior terminal blotches, and often an

uneven patch of colour in the spire pit. The labial spots, usually large in size, are generally few in number; the infrequent shells with the columellar sides spotted have still fewer but equally large spots. In mature shells the base is white. The aperture is wide throughout, considerably bent at the rear, and almost unconstricted in front. The teeth are fairly big; on the labial side they extend halfway across the base, though on the columellar side they reach only just beyond the aperture. The fossula is deep, wide and long; it is formed of ridges of teeth on top and bottom, somewhat similar to many specimens of *N. angustata,* but the lower edge goes down more deeply into the shell than the lower edge of the columellar sulcus. The lower adge of the fossula extends slightly out into the aperture.

Radula: The central is almost square in shape; it sometimes has a slight protrusion on the sides. The base cusps are replaced by a pair of ridges similar to those of *N. angustata.* (Pl. IV., fig. 8).

Habitat: In sponges at about 60 fathoms.

Distribution: Off Green Cape, N.S.W., to Lakes Entrance, Victoria. Also off Stanley, North-west Tasmania.

Nomenclature: There are a number of points of similarity in the holotype of *N. molleri* and in the series of shells dredged off Green Cape and Gabo I., by Mr. Buckland. A good case could be made for separating the latter specimens under a new specific name. It is better, however, to consider them for the present as different forms of the one species, and to withhold new nomenclature until more evidence is available.

Iredale proposed the new generic name *Thelxinovum* for the species *molleri* on the grounds that the spire protrudes. While this protrusion is not common, it occurs occasionally in several other species of the genus *Notocypraea,* and is not generically significant. The name *Thelxinovum* must therefore be considered invalid.

Description of the Holotype: The holotype of *N. molleri* (Iredale), which is in the Australian Museum, is 25·5 mm. long, 15·7 mm. wide and 13·3 mm. high. It has 28 labial and 23 columellar teeth. There are about 60 small to medium spots on the labial side, and about 80 on the columellar side. The constriction on the forward end of the labial side of the aperture is slight. The spire protrudes slightly above its pit; its tip is concealed in the callus material deposited on the rear end of the shell. There are no dorsal bands visible. The side and end markings are darker than those of the shells dredged by Buckland, and the lateral spots are more numerous.

Notocypraea piperita (Gray, 1825).

(Plate III., figs. 47-59. Plate IV., fig. 7).

Shell: The dorsum is cream to light brown in colour. On it are four wide interrupted medium-brown bands; on most shells the central two join into one very wide band on top of the shell. The front and rear bands are often less prominent than the central pair. Occasional shells have bands so wide that they coalesce, obscuring most of the cream dorsum. The top and

sides of the shell are sometimes spotted ("piperate") and even occasionally reticulate, the marks being medium or dark brown. The teeth in the region of the fossula are smaller than those of *N. angustata* and more regular than those of *N. comptonii.* They are longitudinally channelled in the centre, the depression extending to form a marked columellar sulcus running the whole length of the shell. The lower part of the fossular teeth sometimes bends out to form a distinct protrusion into the aperture.

Young Shell: Not readily distinguishable from that of *N. comptonii.*

Animal: Orange. Mantle papillae elevated above mantle, and sparsely scattered over it.

Radula: The central is somewhat square in shape, and slightly narrower on top. The base cusps are situated near the centre line of the tooth, and point downwards parallel to it. (Pl. IV., fig. 7.)

Variation: Some beach shells from Mallacoota, Victoria, are broader and heavier than shells from other places.

Dorsal reticulation is more frequent in Western Australian shells. There, too, the bands are sometimes hidden.

The identification of the specimens illustrated in pl. III., figs. 57-59 is tentative. Greater knowledge of the Western Australian *Notocypraea* may show this form to be a distinct species.

Habitat: Intertidally, under stones and rocks. In sponges at 40 fathoms off Eden, N.S.W.

Distribution: From Eden, N.S.W., to Freemantle, W.A. Northern shores of Tasmania.

Nomenclature: *Cypraea bicolor* Gaskoin, 1848, is not specifically separable.

Notocypraea pulicaria (Reeve, 1846).

(Plate II., figs. 45-46. Plate IV., fig. 6).

Shell: Somewhat cylindrical in shape, shorter in length than most other *Notocypraea* species, and relatively light in weight. The pale yellow or cream-coloured dorsum is crossed by four narrow transverse bands, medium-brown in colour, consisting of distinct squarish blotches. The lower edge of the fossula usually protrudes a considerable way into the aperture of the shell. The teeth are small and numerous. The base is covered by a thin layer of white callus, occasionally thick enough to hide the coloured bands which cross the columellar side.

Young Shell: Similar in colour and banding to the adult.

Radula: Resembles that of *N. piperita.* (Pl. IV., fig. 6.)

Variation: Occasional shells have slightly wider dorsal bands, while some, perhaps not quite mature, have the lower edge of the fossula less projecting.

Habitat: Intertidally, under stones.

Distribution: Western Australia: Esperance to Freemantle.

Notocypraea wilkinsi (Griffiths, 1959).
(Plate III., figs. 60-63. Plate IV., fig. 9).

Shell: This is easily distinguished from other shallow water species by its dorsal colour, which is pale gold or pale yellow. In this it is similar to some deep-water *Notocypraea,* but it differs by the total absence of dorsal bands, even in the one oliviform shell so far found. Most shells are without lateral spots; when present, as in the holotype, they are very small. The fossular arrangement is somewhat reminiscent of *N. piperita,* to which *N. wilkinsi* is obviously closely related. In proportion to length, shells of *N. wilkinsi* are lighter in weight than the shallow water specimens of the other eastern species.

Animal: Tentacles pale orange, darker at the ends; tapering in shape, with rounded tips. Siphon pale cream, almost translucent, with no papillae at the front edge. Mantle translucent, colourless or very pale orange, almost invisible when extended over the shell; marked on the left with about twenty patches composed of dark dots. Mantle papillae unbranched, mamilliform, with tips rounded; about twenty such papillae occur on each side. Foot very pale cream, also almost translucent, with some raised tubercles on the sides; it extends behind and on both sides of the shell when the animal crawls. The animal of the holotype is the only one so far observed.

Radula: The central has points of similarity with that of *N. piperita.* (Pl. IV., fig. 9).

Habitat: Intertidally, under stones; in deeper water, on Bryozoa.

Distribution: Western Port Bay, Victoria; from Flinders to San Remo. North-west Tasmania (?).

POSSIBLE NEW SPECIES.

Species W.: (Plate III., figs. 64-66; Plate IV., fig. 13). The three specimens which form this group are part of lot 367.57 in the Western Australian Museum. They were collected alive at Bunker Bay, Cape Naturaliste, W.A. The shell dorsum is pale brown, crossed by traces of four interrupted medium-brown bands. The distinctive feature of the group is the radula (Pl. IV., fig. 13); the single one found differs from those of any other species.

Species X.: (Plate III., fig. 67-68.) The specimen illustrated was found in deep water off Portland, Victoria, and is now in the collection of Mr. Kurtze. Two other specimens are known, one number D.985 in the South Australian Museum, and one, from Tasmania, in the author's collection. No radula has been examined. The shells of this group are distinguished by their narrow width (56 per cent. of length) and height (44 per cent. of length), and by their large number of teeth (26 labial and 26 columellar, reduced according to Schilder and Schilder, 1938.) Its dorsum is yellowish.

TABLE II.
SHELL MEASUREMENTS.

Serial.	*angustata.*		*comptonii.*		*declivis.*		*dissecta.*		*euclia.*		*molleri.*		*piperita.*		*pulicaria.*		*wilkinsi.*	
1 L ..	26·3	2·7	23·2	2·1	23·8	2·5	19·6	0·9	19	1·7	24	2·2	21	2·6	17·3	1·9	22·7	4·7
2 W ..	67	2·6	61	3·6	66	2·3	55	2·1	54	1·1	60	2·6	60	4	56	2·2	57	3·7
3 H ..	53	1·9	49	2·7	52	2·4	46	1·5	44	1·4	49	3·2	48	2·8	44	1·6	46	2·5
4 LT ..	25	1·9	24·7	2·2	24·9	1·7	27·5	2·3	28	2·1	26·1	2	25·7	1·5	28·2	1·8	27·2	1·5
5 CT ..	19·9	1·7	21·1	1·7	19·6	1·4	22·7	1·8	25·1	1·2	21·7	1·8	22·1	1·6	27·3	2·5	23·9	1·4
6 PLE ..	2·3	0·6	3·2	0·8	2·5	0·9	5	0·6	3·5	0·7	3·4	0·9	3·8	0·6	6·2	1·4	3·6	0·7
7 Wt ..	1·5	0·3	1·3	0·3	1·7	0·2	0·9	0·1	0·9	0·1	0·8	0·2	1·2	0·3	1	0·1	1	0·3
8 LSN ..	60	(40–80)	50	(40–80)	55	(30–90)	15	(10–20)	25	(0–40)	15	(0–30)	35	(0–100)	35	(10–50)	5	(0–40)
9 CSN ..	45	(30–60)	20	(0–40)	15	(10–20)	10	(0–10)	5	(0–20)	0	(0–10)	15	(0–30)	5	(0–30)	0	(0–10)
10 Ap ..	37	6·3	32	5·3	32	3·1	27	3·6	26	3·3	33	6·5	36	5·4	25	4·5	44	5·8
11 AW ..	9·5	0·9	10·3	1	9·5	0·7	8·4	0·6	7·8	0·4	8·2	1·1	9·1	1·1	9·9	1·2	9·6	0·8

NOTES.—1. Serials 1–7, 10 and 11 give the mean reading followed by the standard deviation.
2. Serials 8 and 9 give the mean reading to the nearest 5 followed by the extremes measured.
3. The number of shells measured varied between 8 (*euclia*) and 62 (*comptonii*).

Species Y.: (Plate III., figs. 69-70; Plate IV., fig. 11). The one immature specimen examined was found to have a distinct radula (Pl. IV., fig. 11). The shell dorsum is deep straw in colour, with faint traces of light-brown bands low down on the columellar side. There are pairs of small light-brown terminal patches in front and to the rear. The spire tip is in a deep pit. The specimen is F20,864 in the National Museum, Melbourne; no locality is given other than Tasmania.

Species Z.: (Plate III., figs. 71-72; Plate IV., fig. 10). Two specimens have been found. One, taken alive off Portland, is pale gold all over; it is in Mr. Kurtze's collection. The second specimen, also taken alive, but from an unknown locality, is in the South Australian Museum; the shell is faded almost to white. The shells are scarcely distinguishable from those of *N. wilkinsi,* but the radula, extracted from the second specimen, is very different in form. (Pl. IV., fig. 10.)

TABLE I.

LIST OF CHARACTERS MEASURED.

Serial.	Abbreviation.	Measurement.
1	L	Length of shell in mm.
2	W	Width of shell as percentage of length.
3	H	Height of shell as percentage of length.
4	LT	Number of labial teeth, reduced to those of a shell 25 mm. long (Schilder and Schilder, 1938). All teeth and ridges were counted.
5	CT	Number of columellar teeth, reduced as in Serial 4. The anterior terminal ridge was the only projection not included in the count.
6	PLE	Protrusion of lower edge of fossula out into aperture. As percentage of length.
7	Wt	Weight of shell in gms. divided by L cubed; Multiplied by 10,000 to facilitate handling of results.
8	LSN	Number of spots on labial side of shell.
9	CSN	Number of spots on columellar side.
10	Ap	Angle between tangents to aperture at front and rear.
11	AW	Width of aperture at rear. As percentage of length.

Table III.

SIGNIFICANCE TESTS.

The statistical significance of differences between certain pairs of species was determined. In the table given below a blank indicates a difference of 0·001 or more, and an entry a difference of less than 0·001. This means that on the average more than a thousand samples would have to be selected from two like populations before a difference of the size actually found could be expected to occur once. Entries in the table thus show that important differences exist between the species. The species named is the one with the larger measurement.

Serial.	*comptonii-declivis.*	*dissecta-molleri.*	*piperita-pulicaria.*	*piperita-wilkinsi.*	*euclia-pulicaria.*
1 L	..	*molleri*	*piperita*	..	..
2 W	*declivis*	*molleri*	*piperita*	..	..
3 H	*declivis*	..	*piperita*	..	..
4 LT	..	..	*pulicaria*	..	..
5 CT	..	..	*pulicaria*	..	..
6 PLE	..	*dissecta*	*pulicaria*	..	*pulicaria*
7 Wt	..	..	..	..	..
10 Ap	..	..	*piperita*	*wilkinsi*	..
11 AW	..	..	..	..	*pulicaria*

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6259/60.—15

CONTENTS OF PLATES.

Plate I.

N. angustata:

1 - 2 Mallacoota, Vict. Beach shell. G.80, 26.
3 - 5 Queenscliff, Vict. G.80, 24.
6 - 7 San Remo, Vict. Beach shell. G.80, 22.
8 Between Eden and Cape Howe, N.S.W. Deep water. Coll. Buckland.

N. comptonii:

9 Flinders, Vict. G.77, 12.
10-12 Flinders, Vict. G.77, 14.
13 Tumby Bay, S.A. G.77, 59.
14-16 Between Eden and Green Cape, N.S.W. Deep water. G.77, 40.
17 Portland, Vict. Coll. Kurtze.
18 Port MacDonnell, S.A. S.A. Museum.
19-20 San Remo, Vict. Beach shell. G.77, 27.
21 Port MacDonnell, S.A. S.A. Museum.

Plate II.

N. declivis:

22-24 Seven Mile Beach, Stanley, N.W. Tasmania. Beach shell. G.78, 4.
25-27 Portland, Vict. G.78, 7.

N. dissecta:

28-29 G.D.1
30 Coll. Buckland
31 Coll. Buckland
32-33 G.D.2

All between Eden and Green Cape, N.S.W. Deep water.

N. euclia:

34-36 80 miles west of Eucla, W.A. Deep water. G.F.1.

N. molleri:

37-39 Off Gabo I., Vict. Deep water. G.E.8, 1.
40-41 Off Gabo I. Deep water. G.E.8, 2.
42-44 Between Eden and Green Cape, N.S.W. Deep water. G.E.3.

N. pulicaria:

45-46 W. Aust. G.75, 2.

Plate III.

N. piperita:

47 San Remo, Vict. Beach shell. G.76, 14.
48-50 Glenelg, S.A. G.76, 2
51 Western Port Bay, Vict. G.76, 16.
52-54 Tumby Bay, S.A. G.76, 17.
55-56 Eden, N.S.W. Deep water. Coll. Buckland.
57-59 Bunker Bay, Cape Naturaliste, W.A. W.A. Mus., 367-57.

N. wilkinsi:

60-61 Western Port Bay, Vict. Paratype No. 3. G.C.6.
62-63 Flinders, Vict. Beach shell. Paratype No. 2. G.C.3.

Species W.:

64-66 Bunker Bay, Cape Naturaliste, W.A. W.A. Mus., 367-57.

Species X.:

67-68 S.A. Museum D.985.

Species Y.:

69-70 National Museum, Melbourne F.

Species Z.:

71-72 Portland, Vict. Coll. Kurtze.

PLATE IV.

Central Teeth of Radulae.

1. *N. angustata* (Gmelin).
2. *N. comptonii* (Gray).
3. *N. declivis* (Sowerby).
4. *N. dissecta* Iredale.
5. *N. euclia* Steadman and Cotton.
6. *N. pulicaria* (Reeve).
7. *N. piperita* (Gray).
8. *N. molleri* (Iredale).
9. *N. wilkinsi* (Griffiths).
10. Species Z.
11. Species Y.
12. *N. emblema* Iredale.
13. Species W.

Notes.—1. The teeth shown in 1, 2, 4, 5, 6, 7 and 8 are the average forms taken from a number of radulae. 3 is based on a sketch by Vayssiere. 9 and 12 are drawn from the holotypes; no other radulae of these species has so far been found. The radulae on which 10, 11 and 13 are based are also unique.

2. 2 and 8 show alternative forms of centrals.

3. The chain dotted lines in 13 show the position of cusps which appear to be on the back of the tooth.

4. Magnification is x 150.


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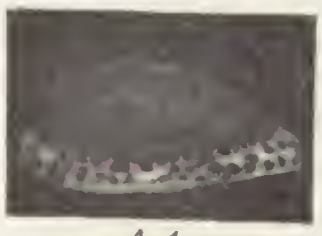
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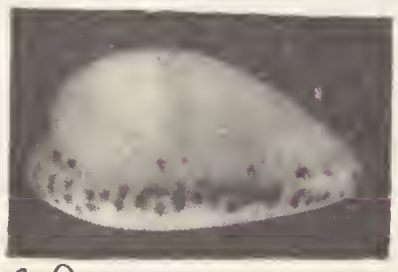
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PLATE I.


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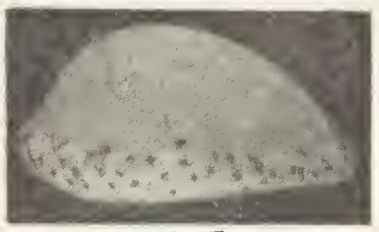
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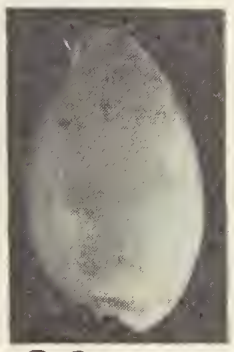
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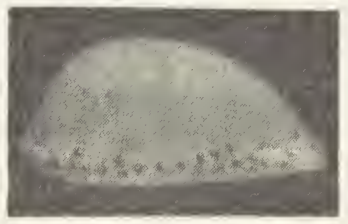
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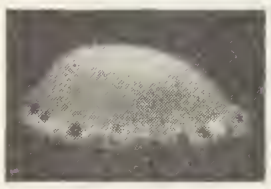
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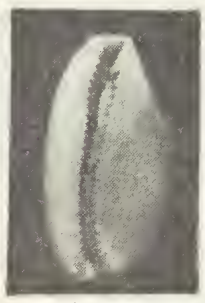
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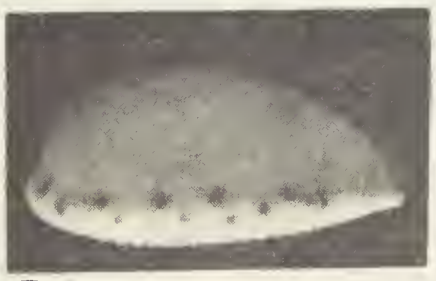
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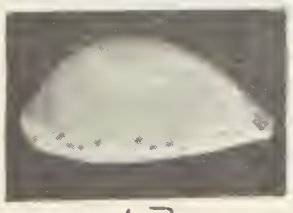
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PLATE II.


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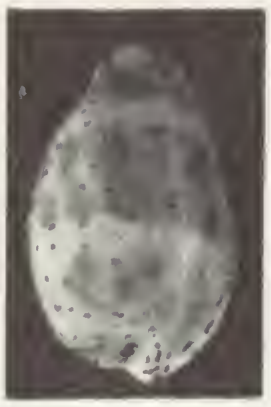
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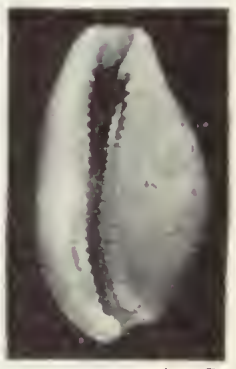
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PLATE III.

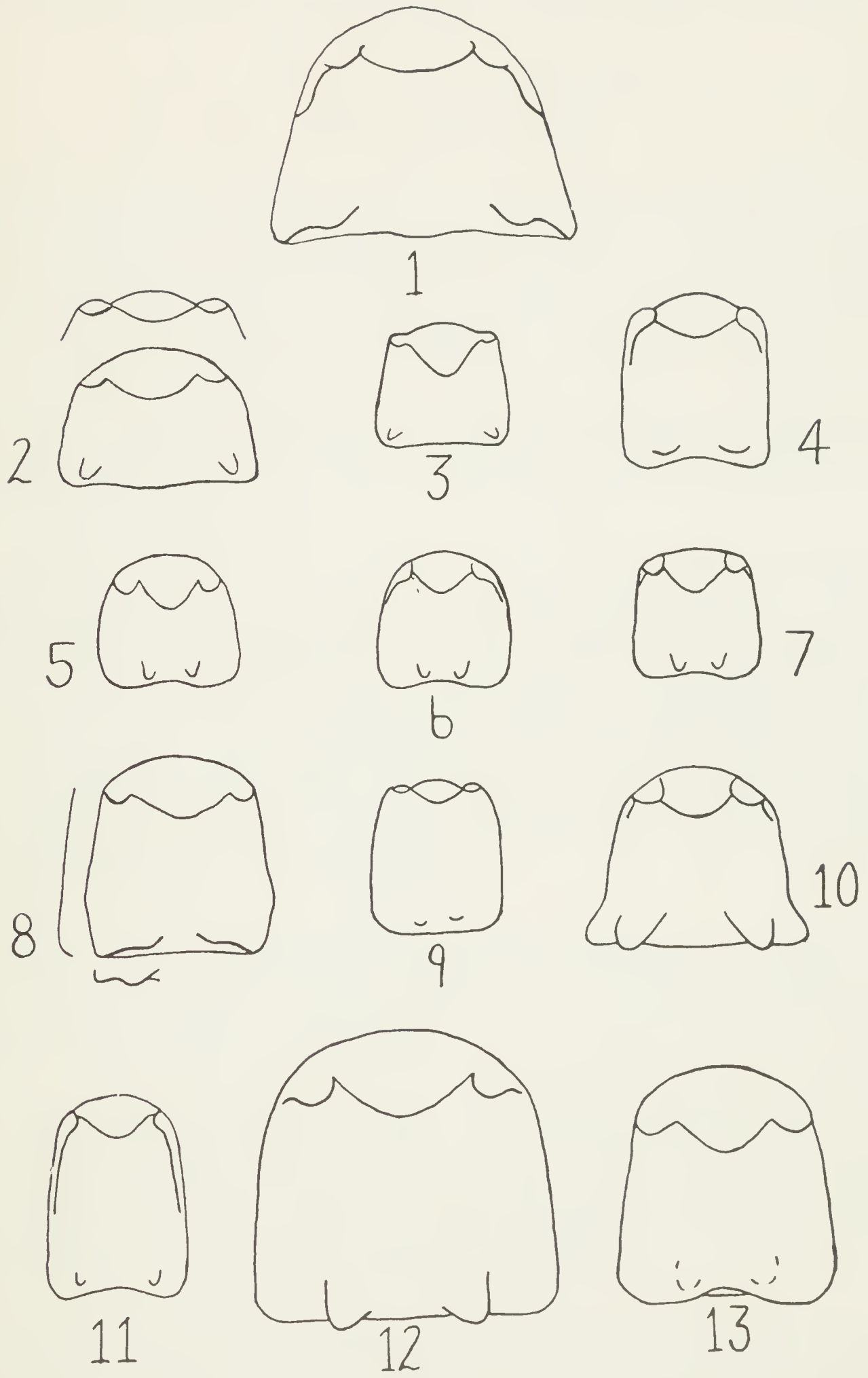

PLATE IV.

CENTRAL TEETH OF RADULAE.