

SYSTEMATIC STUDIES ON THE NON-MARINE MOLLUSCA OF THE INDO-AUSTRALIAN ARCHIPELAGO

published by

W. S. S. VAN BENTHEM JUTTING

(Zoological Museum, Amsterdam)

V. Critical Revision of the Javanese Freshwater Gastropods

by

W. S. S. VAN BENTHEM JUTTING

(Zoological Museum, Amsterdam)

INTRODUCTION

The following account of the freshwater Gastropods of Java forms the fifth and last part of my revision of the non-marine mollusca of that island¹⁾. It contains members of the Prosobranch families Neritidae, Viviparidae, Ampullariidae, Stenothyridae, Bulimidae, Synceridae, Thiaridae, Potamididae and Buccinidae, and of the Pulmonate families Amphibolidae, Lymnaeidae, Planorbidae and Ancyliidae. The pulmonates all belong to the order Basommatophora. The chief characteristics of both taxonomic groups have already been mentioned in Parts I-III, hence it is not necessary to repeat them here.

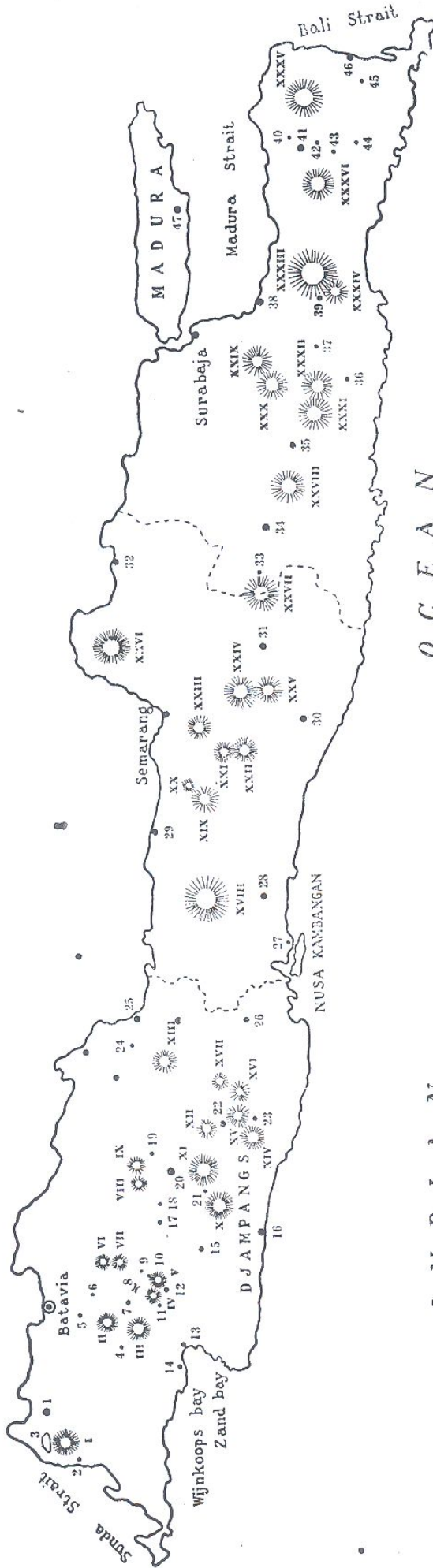
All the species dealt with in this fifth part possess a shell, which can be of a very different shape. There are low, cap-like shells with hardly any whorl, as in the Ancyliidae and part of the Neritidae, flat spirals as in the Planorbidae, low conical or globular shells as in Ampullariidae and Synceridae, and high conical or turreted shells as in Thiaridae. In the family Planorbidae the animals are sinistral, i.e. the internal organs: intestine, respiratory and genital organs open on the left side of the animal instead of on the right as in all other families. In the flat spiral shells of *Gyraulus*, *Polypylis* and *Indoplanorbis* this leiotropism is not directly evident, but in the genus *Amerianna*, belonging to the same family, which has a turbo-spiral shell, the sinistrality is quite clear.

All the species in Part V possess a radula, and most species also a mandibula. Form and texture of both organs are characteristic for the genus. The prosobranchs have a narrow radula with comparatively few

¹⁾ See Treubia, 19 (1948) p. 539-604; 20 (1950) p. 381-505; 21 (1952) p. 291-435; and 22 (1953) p. 19-73.

SKETCH MAP OF THE ISLAND OF JAVA, INDICATING THE LOCALITIES MENTIONED IN THE TEXT. ROMAN FIGURES DENOTE MOUNTAINS, ARABIC FIGURES ALL OTHER LOCATIONS

J A V A S E A



I N D I A N

- | | | | |
|-----------------------|-----------------|-----------------|-------------------|
| I. Karang | XXIX. Welirang | 21. Tjiwidej | 35. Kediri |
| II. Mount Tjibodas | XXX. Ardjuno | 22. Garut | 36. Wlingi |
| III. Salak | XXXI. Kelut | 23. Tjikadjang | 37. Malang |
| IV. Pangrango | XXXII. Kawi | 24. Palimanan | 38. Pasuruan |
| V. Gede | XXXIII. Tengger | 25. Cheribon | 39. Nongkodjadjar |
| VI. Pantjar | XXXIV. Semeru | 26. Bandjar | 40. Wonosari |
| VII. Paniisan | XXXV. Idjen | 27. Tjilatjap | 41. Bondowoso |
| VIII. Burangrang Prah | XXXVI. Jang | 28. Banjumas | 42. Klakak |
| IX. Tangkuban Prah | 1. Serang | 29. Pekalongan | 43. Kalisat |
| X. Patuha | 2. Pasauran | 30. Djokjakarta | 44. Mrawan |
| XI. Malabar | 3. Lake Danau | 31. Surakarta | 45. Rogodjampi |
| XII. Guntur | 4. Leuwiliang | 32. Rembang | 46. Banjuwangi |
| XIII. Tjerimei | 5. Kuripan | 33. Sarangan | 47. Pamekasan |
| XIV. Papandajan | 6. Depok | 34. Madiun | |

teeth per transverse row, the pulmonates have a broad radula with many teeth in each transverse row. Of the prosobranchs the family Neritidae belongs to the Rhipidoglossa, all other prosobranch families to the Taenioglossa. (For explanation see Part I of these Systematic Studies).

The prosobranchs are mostly unisexual, males and females occurring in separate individuals. The pulmonates, however, are hermaphroditic. In the Thiaridae, as far as they have been investigated, the male sex is deficient, only females being present. Propagation is consequently parthenogenetic.

Reproduction takes place by oviposition or by ovovivipary. In many species we know nothing of their mode of reproduction.

Most of the species live in fresh water, either running or stagnant, but some can tolerate a small degree of salinity.

Some species feed on algae and other freshwater plants, others on carrion, and again others on the detritus on the bottom of the water.

The classification used in this part is according to J. THIELE, *Handbuch der systematischen Weichtierkunde* (1929-1935), with some emendations based on more modern investigations.

The author is very much indebted to the authorities of the Museum Zoologicum Bogoriense at Bogor (Buitenzorg), Java, the Rijksmuseum van Natuurlijke Historie at Leiden, the Naturhistorisches Museum at Basle, the Museum d'Histoire Naturelle at Geneva, the Zoologisches Museum at Zürich, the Zoologisches Museum at Berlin, the Senckenberg Museum at Frankfurt-am-Main and the British Museum (Natural History), London, for information, loan of material and the opportunity to study their collections.

Finally I have to thank the Executive Committee of the Zoologisch Insulinde Fonds for financial aid.

Before passing to the Systematic Part a few remarks on the zoogeography of the Javanese freshwater molluscs may be of interest.

Compared with the land fauna the number of freshwater species (gastropods and bivalves combined) is much lower: 171 land against 105 freshwater species¹). This is the more remarkable because firstly, the freshwater division includes a number of bivalves, a class of molluscs which does not occur on land, and secondly, because practically all tropical bodies of water are eutrophic, no oligotrophic waters occurring. This implies that there is ample opportunity for a luxuriant vegetation so that a multifarious animal population is ensured.

¹) The number of land snails would have been much higher if the Ellobiidae, a family of amphibious pulmonates, had been included.

A similar predominance of land snails over freshwater molluscs can be observed in the Netherlands, England, Switzerland, Germany, Belgium and Denmark, as demonstrated in the following table:

Name of country	Surface in 1000 km	Number of species of molluscs			
		Land	Total fr.w.	Freshw. Gastr.	Freshw. Biv.
Java	126	171	105	89	16
Netherlands	34	93	65	39	26
England	151	103	72	44	28
Switzerland	41	169	64	42	22
Germany	472	157	92	63	29
Belgium	30	98	67	43	24
Denmark	43	88	64	36	28

From this table it may be seen that freshwater bivalves in Java are very few in number a fact for which the low amount of Sphaeriidae (*Sphaerium* and *Pisidium*) is chiefly responsible.

In another table I have enumerated the families of freshwater molluscs occurring in Java and in the Netherlands, with the number of species known in each of the two regions:

Family of Mollusca	Java	Netherlands
Gastropoda		
Neritidae	27	1
Viviparidae	2	2
Ampullariidae	3	—
Stenothyridae	3	—
Valvatidae	—	3
Bulimidae	3	2
Hydrobiidae	—	6
Synceridae	7	1
Thiaridae	24	—
Potamididae	9	—
Buccinidae	1	—
Amphibolidae	2	—
Lymnaeidae	1	7
Planorbidae	6	12
Physidae	—	3
Ancylidae	1	2
Lamellibranchia		
Unionidae	6	6
Corbiculidae	7	—
Sphaeriidae	3	18
Dreissenidae	—	2

Not all families occurring in the Netherlands are represented in Java, for the Valvatidae, Hydrobiidae, Physidae and Dreissenidae are missing, whereas there are seven families indigenous to Java which are not found in fresh water in the Netherlands, i.e. Ampullariidae, Stenothyridae, Thiaridae, Potamididae, Buccinidae, Amphibolidae and Corbiculidae.

Also the number of species in the various families is often very different. In the Neritidae and Synceridae Java is favoured, in the Lymnaeidae, Planorbidae and Sphaeriidae the Netherlands are leading.

It is a well-known fact that in the tropics various marine animals (coelenterates, polychaetes, decapod crustaceans, amphipods, isopods, nudibranchs and fishes) occur in absolutely fresh water. The tendency to settle in a fresh water habitat increases from the temperate regions to the tropics. This principle was first propounded by MARTENS (1857, Arch. Naturgesch. 23; 1876, Preuss. Exped. Ost-Asien, 1, p. 314-317) and has been worked out later by MAX WEBER (1894, Erg. Reise Nied. Ost-Indien, 2, p. 528; 1894, Ibid. 3, p. 405; 1895, Hand. 5de Natuur- en Geneesk. Congr. Amsterdam; 1897, Zool. Jahrb. (Syst.) 10, p. 182-199) and THIE-NEMANN (1930, Deutsche Forschung, p. 14).

Among the freshwater molluscs of Java the process of conversion from marine to non-marine conditions is evident in only two families of chiefly marine snails, the Neritidae and the Buccinidae, the former having only a few and the latter no representatives in European freshwaters, but the Indo-Australian freshwater regions abound in a profusion of species, especially Neritidae.

In the opinion of various malacologists the bivalve family Corbiculidae forms a similar instance. It is true that many Malaysian islands are inhabited by a number of *Corbicula*-species. Yet there are no true marine ancestors from which they could be the descendants. Only the genera *Poly-mesoda* and *Batissa*, belonging to the same family, live in brackish water, and in spite of their incorporation in the same family they are not direct relatives of *Corbicula*.

There are, however, no indications that species of *Mytilus*, *Macoma*, *Ostrea*, *Cardium* or *Nassa*, genera which contain several euryhaline species in temperate regions, have penetrated into the fresh water of the tropics.

Another characteristic feature of the non-marine aquatic fauna of the Indo-Australian Archipelago is the great extension of the brackish water fauna. This region, between truly marine and truly freshwater conditions, is manifest along all coasts where the land is not too steeply inclined towards the sea. Generally there occurs a broad, gently sloping

littoral and sublittoral zone consisting of sand- and mudflats covered by brackish water. At low tide the higher parts run dry, at high tide all is inundated. The density of the water depends on tide fluctuations and on seasonal supply of fresh water. As can be expected in an archipelago, the coast line is much longer than in countries which form part of a continent. Consequently, in the brackish water fauna of molluscs and other animals there is much more variety than in regions with only a limited coast line.

Inhabitants of this brackish water region in Java are: part of the Neritidae, Synceridae, Stenothyridae, part of the Thiaridae, Amphibolidae, part of the Corbiculidae, *Terebralia*, *Cerithidea*, *Telescopium*, *Novaculina*, *Pharella*, *Cultellus*, *Psammobia*, *Donax*, *Modiolus* and all Auriculidae.

In a paper on the present state of malacological research in the Malay Archipelago, I have already called attention to a few salient facts about the freshwater fauna of this region (VAN BENTHEM JUTTING, 1948, *Chronica Naturae*, 104, p. 129-138), but it may be useful to repeat them here.

Most islands of the Indo-Australian Archipelago are of continental origin, hence their fauna has been derived from the neighbouring continents, Asia in the West and Australia in the East. The isolation of the various islands from the mainland has lasted long enough to enable the development of endemic species in each of them. This is especially evident among the land snails. In the aquatic molluscs, however, such endemisms are rare, as on the whole the freshwater fauna of the globe is more uniform than the terrestrial one, therefore the evolution of the land fauna must have proceeded differently from that of the freshwater fauna.

The Thiaridae are very abundant, both in number of species and in individuals. This specialization has given rise to many different local forms which renders the family one of the most difficult groups for the taxonomist to deal with. That such a specialization is not of recent origin is demonstrated by the multifarious fossil representatives in palaeontological deposits.

The Najades (Mutelidae and Unionidae) are scarce, in spite of the many large rivers and great lakes. How far this scarcity may be the consequence of the absence or low frequency of certain freshwater fishes on which the young Najades pass their parasitic larval stage, is open to discussion.

Najades occur only in the three Great Sunda Islands, Sumatra, Java and Borneo, and in New Guinea with the adjacent island Misool. The intermediate region is entirely devoid of these bivalves, although the

island of Celebes affords plenty of opportunity for their existence in the great lakes of the central part.

Like the Najades, the Sphaeriidae (*Sphaerium* and *Pisidium*) are scarcely represented. The Corbiculidae, on the contrary, are extremely numerous, especially in the Great Sunda Islands.

The composition of the freshwater fauna of Java is most closely related to that of the mainland of South Eastern Asia. In this respect it resembles two of the other Great Sunda Islands: Sumatra and Borneo. The more one proceeds eastward in the Malaysian region the lesser this resemblance becomes, because one after another various zoological elements disappear. Families such as Ampullariidae, Viviparidae, Ancyliidae, Planorbidae, Unionidae, Cyrenidae, distinctly show this impoverishment. On the other hand, no compensation for the loss by immigration of Australian and Papuan fauna elements has taken place, a compensation which is so evident in the land molluscan fauna (*Papuina*, *Planispira*, *Chloritis*, *Nani-nia*, etc.).

Species of *Physastra* and *Amerianna* and allied genera, which are often considered Australian elements in the fauna of the Oriental region, have, in fact, an almost continuous range of distribution from Africa to Australia. In Java and India, where representatives are absent in the recent fauna, the fossil occurrences have already been recorded (VAN BENTHEM JUTTING, 1937, Zool. Meded. Mus. Leiden, 20, p. 100-101). From Borneo no records are known, but this island has not been sufficiently investigated from a malacological standpoint to allow for a definite opinion.

SYSTEMATIC PART

Systematic Account of the Freshwater Gastropods of Java

[The names between square brackets denote species which have so far been found only on one or more of the outlying islands, close to the coast of Java]

Phylum Mollusca
 Classis Gastropoda
 Subclassis Prosobranchia
 Ordo Archaeogastropoda
 Familia NERITIDAE

Clithon bicolor (RÉCLUZ)

Clithon corona (LINNÉ)

Clithon diadema (RÉCLUZ)

Clithon faba (SOWERBY)

- Clithon flavovirens* (VON DEM BUSCH)
Clithon fuliginosus (VON DEM BUSCH)
Clithon longispina (RÉCLUZ)
Clithon olivaceus (RÉCLUZ)
Clithon oualaniensis (LESSON)
Clithon rarispina (MOUSSON)
Clithon squarrosus (RÉCLUZ)
Neritodryas cornea (LINNÉ)
Neritodryas dubia (GMELIN)
Neritodryas subsulcata (SOWERBY)
Neritina auriculata LAMARCK
Neritina bicanaliculata RÉCLUZ
Neritina violacea (GMELIN)
Neritina turrita (GMELIN)
Neritina waigiensis LESSON
Neritina variegata LESSON
Neritina pulligera (LINNÉ)
Neritina squamipicta (RÉCLUZ)
Neritina zigzag LAMARCK
Neritina labiosa SOWERBY
Septaria borbonica (BORY DE ST VINCENT)
Septaria porcellana (LINNÉ)
Septaria lineata (LAMARCK)

Ordo Mesogastropoda

Familia VIVIPARIDAE

- Bellamyia javanica* (VON DEM BUSCH)
Bellamyia sumatrensis (DUNKER)

Familia AMPULLARIIDAE

- Pila ampullacea* (LINNÉ)
Pila scutata (MOUSSON)
Pila polita (DESHAYES)

Familia STENOTHYRIDAE

- Stenothyra glabrata* (A. ADAMS)
Stenothyra ventricosa (QUOY & GAIMARD)
Stenothyra polita (A. ADAMS)

Familia BULIMIDAE

- Digoniostoma truncatum* (EYDOUX & SOULEYET)
Wattebledia crosseana (WATTEBLED)
Wattebledia insularum n. sp.

Familia SYNCERIDAE

- Syncera bedaliensis* (RENSCH)
 [*Syncera woodmasoniana* (NEVILL)]
Syncera javana (THIELE)
 [*Syncera hidalgoi* (GASSIES)]
Syncera nitida (PEASE)
Syncera carinata (LEA)
Syncera brevicula (PFEIFFER)
 [*Syncera borneensis* (ISSEL)]
 [*Syncera philippinica* (BOETTGER)]
 [*Syncera microsculpta* (NEVILL)]
Paludinella halophila RENSCH
Omphalotropis columellaris QUADRAS & MOELLENDORFF

Familia THIARIDAE

- Brotia testudinaria* (VON DEM BUSCH)
Brotia spadicea (REEVE)
Brotia costula (RAFINESQUE)
Sulcospira sulcospira (MOUSSON)
Faunus ater (LINNÉ)
Balanocochlis glans (VON DEM BUSCH)
Balanocochlis pisum (BROT)
Balanocochlis glandiformis (SCHEPMAN)
Thiara amarula (LINNÉ)
Thiara rudis (LEA)
Thiara winteri (VON DEM BUSCH)
Thiara herklotzi (PETIT)
Thiara scabra (MÜLLER)
Thiara cancellata RÖDING
Thiara setigera (BROT)
Melanoides riqueti (GRATELOUP)
Melanoides granifera (LAMARCK)
Melanoides torulosa (BRUGUIÈRE)
Melanoides tuberculata (MÜLLER)
Melanoides punctata (LAMARCK)
Melanoides plicaria (BORN)
Melanoides maculata (BORN)
Melanoides rustica (MOUSSON)
Melanoides artecava (MOUSSON)

Familia POTAMIDIDAE

- Cerithidea cingulata* (GMELIN)
Cerithidea djadjariensis (MARTIN)
Cerithidea alata (PHILIPPI)
Cerithidea obtusa (LAMARCK)
Cerithidea quadrata SOWERBY
Cerithidea weyersi DAUTZENBERG
Telescopium telescopium (LINNÉ)
 [*Telescopium mauritsi* BUTOT]
Terebralia sulcata (BORN)
Terebralia palustris (LINNÉ)

Familia BUCCINIDAE

- Anentome helena* (VON DEM BUSCH)

Subclassis Pulmonata

Ordo Basommatophora

Familia AMPHIBOLIDAE

- *Salinator fragilis* (LAMARCK)
- Salinator burmana* (BLANFORD)

Familia LYMNAEIDAE

- Lymnaea rubiginosa* MICHELIN

Familia PLANORBIDAE

- Gyraulus convexiusculus* (HUTTON)
Gyraulus terraesacrae RENSCH
Polypylis kennardi (BULLEN)
Helicorbis caenosus (BENSON)
Indoplanorbis exustus (DESHAYES)
Amerianna carinata (H. ADAMS)

Familia ANCYLIDAE

- Ferrissia javana* (MARTENS)

Familia NERITIDAE

Shell generally with small, low spire and large, inflated ultimate whorl. Several species with pretty colours, and patterns of flames, zigzag lines or bands in vertical and spiral direction. Finely sculptured (most freshwater species), or with strong ridges, warts or scales (many marine

species). Various species with a crown of spines. In the interior of the shell the columella and the walls of the old whorls have been resorbed. This interior space is one large cavity.

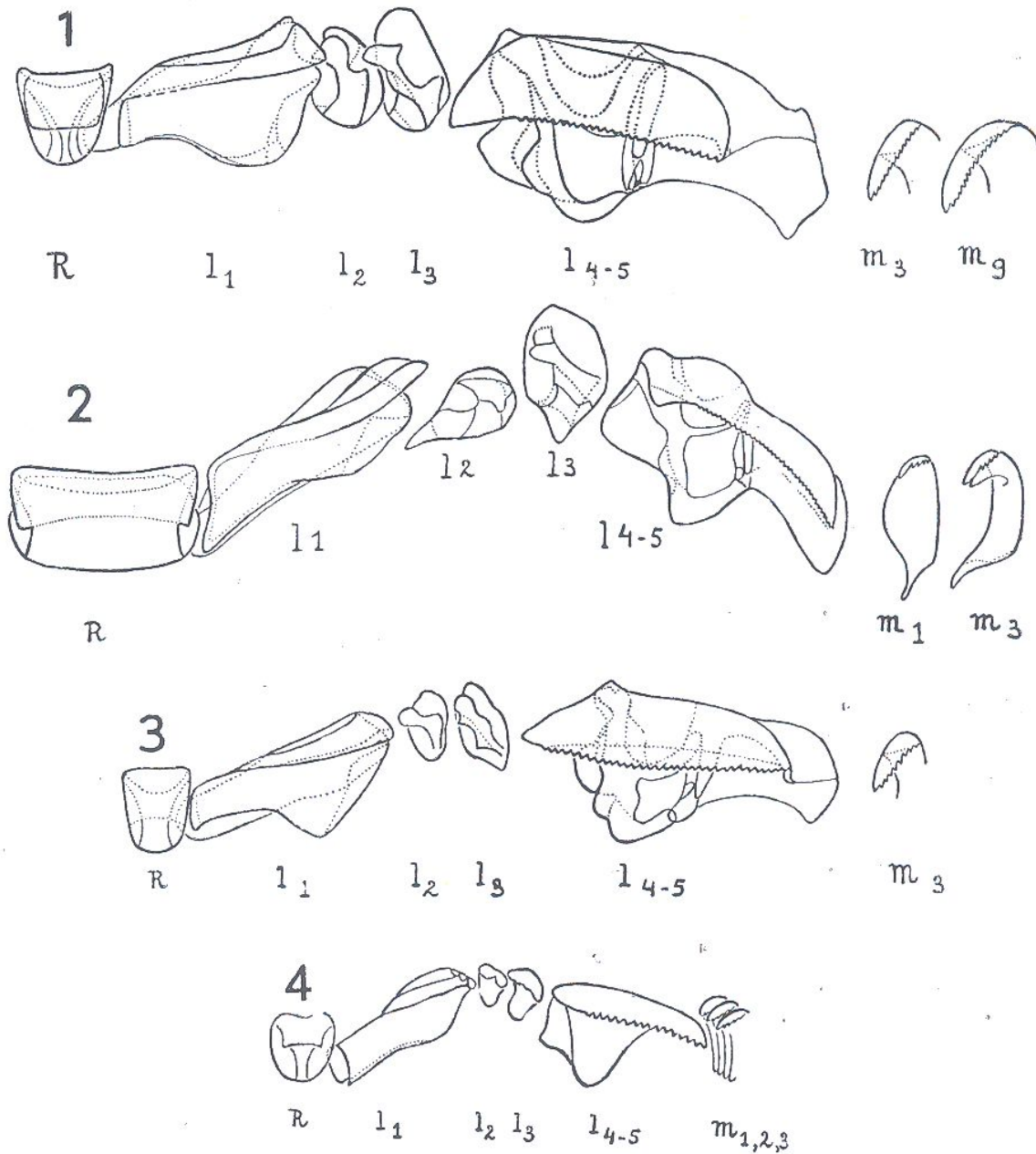


Fig. 1. *Clithon corona* (L.). Radula elements (after H. B. BAKER).
 Fig. 2. *Neritodryas cornea* (L.). Radula elements (after H. B. BAKER).
 Fig. 3. *Neritina variegata* LESS. Radula elements (after H. B. BAKER).
 Fig. 4. *Septaria lineata* (LAM.). Radula elements (after TROSCHERL).

Columellar side broad and generally flattened, with a callous, porcellaneous or puckered surface. Along the aperture the columellar side can be smooth or serrated or denticulated. Exterior margin of aperture sharp, somewhat thickened but never reflected. Umbilicus closed.

Operculum calcareous, of about semi-circular shape, in many fresh-water species with a membranous fringe along the exterior margin. Spirally coiled with few whorls, originating from an excentric nucleus. On the posterior side the operculum is provided with one or two apophyses of various form and strength. In the genus *Septaria* the operculum is of a quite different form. Two pointed lobes are attached in the muscular system of the dorsal side of the foot, the rest of the operculum lies on the dorsal foot-side.

Animal with large anterior part of the body and narrowly tapering foot. Only in *Septaria* the foot is broad and sucker-like, as in *Patella*. Tentacles long; the eyes on short stalks at their exterior bases.

Radulā ∞ .5.1.5. ∞ . The central tooth is quadrate or broadly triangular; the cusp is broad and rounded. Of the five laterals the inner one is large, elongate, lozenge-shaped or trapezoidal, with a transverse elongate cusp. The second and third laterals are much smaller, having a squarish, or irregularly rounded base, and 2-3 cusps. The fourth and fifth laterals are generally fused to one large square or trapezoid, with several processes and a hood-shaped cutting edge, with numerous small denticles. The marginals are very numerous, about 60 or more, with long, narrow stalks and small blades with few denticles (H. B. BAKER, 1923. Notes on the radula of the Neritidae. Proc. Acad. Nat. Sci. Philadelphia, 75, p. 117-178, pl. 9-16).

Respiration takes place by means of gills. The sexes are separate, but there is no exterior sexual dimorphism in the shell or in the animal. Reproduction takes place by oviposition. In the freshwater species the egg capsules are globular or oval, with a leathery wall. They are often deposited on congeners. The larval development of the freshwater species occurs within the egg shell, the young ones hatching after the metamorphosis.

Distribution: marine, brackish water and fresh water of all oceans and all continents. Some species can live partly terrestrial. The food consists of fine algae. Large species are locally eaten by the natives.

Key to the four genera living in Java:

1. Shell symmetrical, cap-like, without whorls, with small apex. Aperture very wide. Operculum squarish, without apophyses, not closing the entire aperture **Septaria**
- Shell asymmetrical, with one or more spiral whorls. Aperture not so wide as in *Septaria*. Operculum semi-circular, with two apophyses at the posterior side. The operculum closes the shell perfectly . . . 2

- 2. Surface of shell smooth and shining, never with spines 3
- Surface of shell more or less coarsely striated by the growth lines. Various species with spines **Clithon**
- 3. Inner marginal teeth of radula with several denticles along the cutting edge. Never with accessory cusp below the blade. Superior apophysis of operculum not grooved longitudinally **Neritina**
- Inner marginal teeth of radula with only few (2-4) denticles along the cutting edge. Below the blade with a strong accessory cusp. Superior apophysis of operculum longitudinally grooved, the ridges ending in finger-like projections at the free end **Neritodryas**

Genus Clithon MONTFORT, 1810

Shell with small spire and large ultimate whorl. Surface moderately or coarsely striated. Several species with spines. With pretty colours, or plain olive-brown. Suture shallow. Umbilicus closed.

Columellar side porcellaneous, the edge along the entrance to the aperture smooth, or with small serrations. Exterior margin of aperture sharp, somewhat thickened, but never reflected.

Operculum calcareous, semi-circular, with membranous fringe along exterior margin. Paucispiral, with excentric nucleus. Surface generally with an oblique, shallow groove starting from the nucleus and ending at the interior margin. In most species the exterior surface of the operculum is minutely puckered with small, distantly placed granules. Back side with two apophyses, connected by a shelly callus.

Central tooth of radula longer than wide. First lateral not so elongate as in the other three genera of this family. Marginals with serrated blades (Fig. 1).

Distribution: all continents, mostly in tropical regions. Most species live in fresh, but a few in brackish water. Living on stones, preferably in running water.

Key to the Javanese species:

- 1. Shell surface beset with numerous small triangular or oval blisters **squarrosus**
- Shell surface striated or wrinkled according to the growth lines, but never with blisters 2
- 2. Shell small, almost pea-shaped. Ornamented with a variety of colour patterns **oualaniensis**

- Shell larger, shaped as a half nut, or a half acorn, often with spiral bands and zigzag markings, but never in such a profusion of colour and pattern as in *oualaniensis* 3
3. Shell with distinctly projecting spire 4
- Shell involute, the spire hidden by the successive whorls. . . **fuliginosus**
4. Shell with a conspicuous red-brown mark along the basal edge of the columellar side **olivaceus**
- Shell without such a spot 5
5. Shell without spines or "shoulder". Spirally banded, the surface scattered with minute triangles on a reddish or yellowish background. **faba**
- Shell generally "shouldered" and with a row of distantly placed spines along this shoulder 6
6. Spines long, pointing more in backward direction (as seen in the moving animal) than towards the apex. Growth striae curiously sinuous at the suture **longispina**
- Spines moderate or short, more pointing to the apex than in backward direction. Growth striae not so peculiarly sinuous at the suture . . . 7
7. Shell generally with moderately developed spines 8
- Shell generally with short spines, or only blunt knobs 9
8. Shell coarsely striated by the growth lines, spire only little projecting **corona**
- Shell finely striated by the growth lines, spire distinctly projecting **diadema**
9. Shell yellowish-green, with an occasional reddish hue. With dark spiral bands and light triangular or arrow-shaped spots. Each of these spots has a dark margin on its front edge **flavovirens**
- Shell darker, olive-green, with black spots of square or oval shape. 10
10. Shell olive-green, with small dark squares. Spire somewhat produced **bicolor**
- Shell dark olive-green, with small oval spots and low spire . . . **rarispinga**

Clithon bicolor (RÉCLUZ, 1843) (fig. 5).

1843. RÉCLUZ, Proc. Zool. Soc. London, p. 172 (*Nerita*).

1843. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1, *Neritina*, p. 26, pl. 1, fig. 4 (*Neritina rugosa*).

1844. RÉCLUZ, Proc. Zool. Soc. London, p. 199 (*Nerita subpunctata*).

1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 269 (*Neritina rugosa*).

1849. MOUSSON, Land & Süßsw. Moll. Java, p. 82, pl. 12, fig. 9 (*Neritina rugosa*).

1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 319 (*Neritina rugosa*).

1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 179, pl. 18, fig. 19, 20, 22-24 (*Neritina subpunctata*), p. 180, pl. 18, fig. 22 (*Neritina subpunctata* var. *glandiformis*), p. 181, pl. 18, fig. 18 and 21 (*Neritina bicolor*).

1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 307 (*Neritina subpunctata*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 265 (*Clithon subpunctata*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Neritina subpunctata*).
1935. PARAVICINI, Arch. Moll. K. 67, p. 175 (*Clithon bicolor*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 267 (*Theodoxus bicolor*).

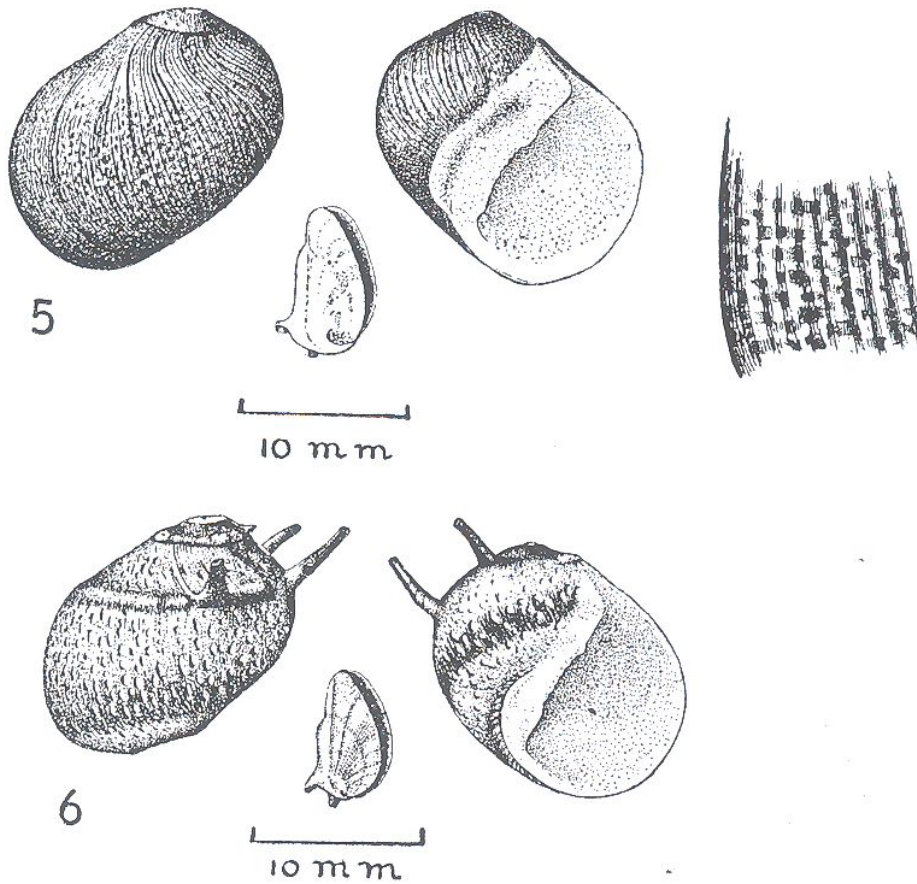


Fig. 5. *Clithon bicolor* (RÉCL.). Shell from back and front, exterior of operculum, and detail of colour pattern, more enlarged. ABDULKADIR del.

Fig. 6. *Clithon corona* (L.). Shell from back and front, and exterior of operculum. ABDULKADIR del.

Shell globular, with small spire and large last whorl. Olive-brown or olive-green with occasional dark spiral bands. Between the moderately coarse growth lines irregular transverse rows of fine black squares are visible. The black spots can be separate or confluent, or anastomosing, or arranged in a fine zigzag pattern. The whole shell is covered by a dark periostracum. Little or not shining, not or hardly transparent.

Whorls about four, rapidly increasing in diameter. Suture shallow. Apex little projecting. Just above the periphery the whorls can be "shouldered". Umbilicus closed.

Aperture oblique, broad semilunar. Columellar side white, or lightly coloured with black or yellow along the penultimate whorl. Columellar side flat, minutely granular, porcellaneous. Along the entrance to the aperture the edge of the columellar side is concave. In the concave part, and just above it, this edge bears minute serrations. Outer margin of peristome sharp, not thickened or reflected.

Operculum white or very light yellowish-pink. Nucleus darker. Exterior margin with a narrow dark-brown zone. The entire outer surface is minutely puckered with distantly placed granules. Obliquely over the exterior surface runs a shallow groove. It corresponds with a low ridge on the interior surface. The two apophyses, the ridge and the peg, are connected by a shelly callus.

Dimensions: height 20-22, width 20-25, height of aperture about 18 mm.

Distribution: Malay Archipelago, the Philippines and Formosa. In fresh, preferably running, water.

Habitat in Java: There are only few records of this species in Java. Probably they do not give a true picture of its distribution in the island.

West Java: Tjisolok, coast of S.W. Java; Mouth of the Tjimandiri, near Wijnkoopsbay; Muara Paranjé in southern Sukabumi; Pameungpeuk in southern Priangan.

East Java: Bomo.

Clithon bicolor has also been recorded from the island of Krakatau in Sunda Strait, and from the island of Madura north of East Java (VAN BENTHEM JUTTING, 1941).

After having classified at first with *Neritina subpunctata* the shells described by VON DEM BUSCH as *Neritina rugosa* (l.c. 1843) MARTENS (1879, p. 186 footnote) changed his opinion and brought them to *Clithon brevispina* (syn. *Cl. corona*). Whether MARTENS also included the reference *Neritina rugosa* BUSCH by MOUSSON (1848, 1849) is an open question. Personally I am inclined to regard both references, the one by VON DEM BUSCH as well as the one by MARTENS, as *Clithon bicolor*.

An olive-blackish shell, covered by a thick black epidermis, with the spire rather protruding and the last whorl narrowed above was introduced by MARTENS (1879, p. 180) as *Neritina subpunctata* var. *glandiformis*. It is hardly acceptable as a distinct variant, and falls entirely in the normal variation of *Clithon bicolor*.

Clithon corona (LINNÉ, 1758) (fig. 1 and 6).

1758. LINNÉ, Syst. Nat. Ed. X, p. 777 (*Nerita*).
1822. LAMARCK, Anim. s. Vert. 6, part 2, p. 185 (*Neritina corona* and *brevispina*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 269 (*Neritina corona australis*).
1849. MOUSSON, Land & Süßw. Moll. Java, p. 83 and 118, pl. 12, fig. 12, pl. 20, fig. 11 and pl. 22, fig. 6 and 7 (*Neritina corona australis*).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 319 (*Neritina corona australis*).
1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 156, pl. 17, fig. 1-4 and 9 (*Neritina brevispina*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 79 and 307 (*Neritina brevispina*) and p. 80 (*Neritina angulosa*).
1905. MARTIN, Samml. Geol. Reichsmus. Leiden (N.F.) 1, p. 273, pl. 40, fig. 657-659 (*Neritina (Clithon) brevispina*).
1907. MARTIN, N. Jahrb. Mineral. 100, II, p. 162 (*Neritina brevispina*).
1908. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, part 3, p. 426 (*Neritina brevispina*).
1911. MARTIN-ICKE, Pithecanthr. Schichten Java, p. 49 (*Neritina (Clithon) brevispina*).
1912. SCHEPMAN, Proc. Malac. Soc. London, 10, p. 238 (*Neritina (Clithon) brevispina*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 264 (*Clithon brevispina*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 101 (*Neritina (Clithon) brevispina*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Neritina brevispina*).
1931. VAN DER VLERK, Leidsche Geol. Meded. 5, Feestbundel Martin, p. 262 (*Neritina brevispina*).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 101 (*Theodoxus corona*).
1937. RIECH, Arch. Naturgesch. (N.F.) 6, p. 82 (*Clithon brevispina*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 267 (*Theodoxus corona* and *Th. angulosus*).
1953. MERMOD, Rev. Suisse Zool. 60, p. 140, fig. 160 (*Neritina brevispina*).

Shell with small spire and inflated last whorl. Dull yellowish or greenish, sometimes with a violet tinge. Many specimens with dark spiral bands of different width, and frequently with small, dark, triangular spots or zigzag lines. Coarsely sculptured by the wrinkled, somewhat undulating growth striae. Thick; not, or hardly transparent.

At a small distance from the suture most specimens are conspicuously "shouldered". This shoulder is even more accentuated by distantly placed spines along it. The spines can be 3-4 mm long, but are often shorter.

Whorls 4-5, rapidly increasing in size. Apex smooth, yellow. Suture not deep, minutely crenulated by the coarse growth striae. Umbilicus closed.

Aperture oblique, broadly semilunar. Columellar side flat, or slightly concave, light yellow or light green, porcellaneous, slightly granular or rugulose. Along the entrance to the aperture the columellar side is somewhat concave. Along this concavity and above it the edge bears several

small denticulations. Exterior margin of peristome sharp, a little thickened, but not reflected.

Operculum semilunar. Exterior surface whitish, with yellow nucleus and dark-brown exterior margin. Scattered over the surface are numerous delicate, distantly placed granules. Obliquely over the exterior surface runs a shallow groove which corresponds with a low ridge on the interior surface. The two apophyses on the interior side of the operculum, the curved ridge and the peg, are connected by a shelly callus. Interior surface of the operculum light brown.

Dimensions: height 30-34, width 28-32, height of aperture about 24 mm.

Distribution: Malay Archipelago, Philippines, various Melanesian islands, New Caledonia.

Habitat in Java: fresh water, in rivers, on stones, small specimens near the surface, older ones in deeper water. Animals living in calcareous water are often incrustated with a lime crust. In other specimens the apex and a few adjoining whorls can be seriously eroded.

West Java: Ujung Kulon; Djakarta; Sukabumi; Palabuan.

Central Java: Tjilatjap.

• East Java: Mangrove near Besuki; river near Puger; Bomo river in Banjuwangi. •

In a fossil state *Clithon corona* has been recorded from Upper Pliocene and Pleistocene layers in East Java (MARTIN, 1905, 1907, 1919; MARTIN-ICKE, 1911; VAN DER VLERK, 1931; VAN BENTHEM JUTTING, 1937).

The species is also found in the island of Nusa Kambangan, south of Central Java and in Madura.

Clithon corona is rather variable in the height of the spire, in coloration, in development of the spines and in the more or less "shouldering" of the last whorl. Specimens with a strong shoulder belong to the forma *angulosa* (RÉCLUZ, 1843), a variant which has often been given the rank of a good species (MARTENS, 1879, p. 158; MARTENS, 1897, p. 80; VAN BENTHEM JUTTING, 1941, p. 267). As a rule this form is very little spinous.

As I have already pointed out under *Clithon bicolor* the shells described by VON DEM BUSCH as *Neritina rugosa* and afterwards quoted by MARTENS (1879) must be regarded as *Clithon bicolor*, in spite of MARTENS' later opinion (1879, p. 186 footnote) that *Neritina rugosa* is related to *Clithon corona*.

A good figure of the radula was published by ADAM & LELOUP (1938, Mém. Mus. Roy. Hist. Nat. Belgique (Hors Série) Vol. 2, Part 19, p. 59, fig. 19).

***Clithon diadema* (RÉCLUZ, 1841) (fig. 9).**

1841. RÉCLUZ, Rev. Zool. (Soc. Cuv.) 4, p. 277 (*Nerita*).
 1879. MARTENS, in MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 154, pl. 15, fig. 22-26 (*Neritina*)
 1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 307 (*Neritina*).
 1908. SCHEPMAN, Siboga Exp. Monogr. 49-1-a, p. 11 (*Neritina (Clithon) diadema*).
 1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 264 (*Clithon*).
 1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Neritina*).
 1937. RIECH, Arch. Naturgesch. (N.F.) 6, p. 81 (*Clithon*).

Shell with small spire and inflated last whorl. Yellowish-brown or olive. Many specimens with dark spiral bands and triangular spots or reticulations. Sculptured by somewhat undulating growth lines, much finer than in *Clithon corona*. Thick; not or hardly transparent. At some distance below the suture the whorls are conspicuously "shouldered". This shoulder is even more accentuated by distantly placed spines along it. The spines can be 4-5 mm long, but are generally longer and more converging in the direction of the apex than in *Cl. corona*.

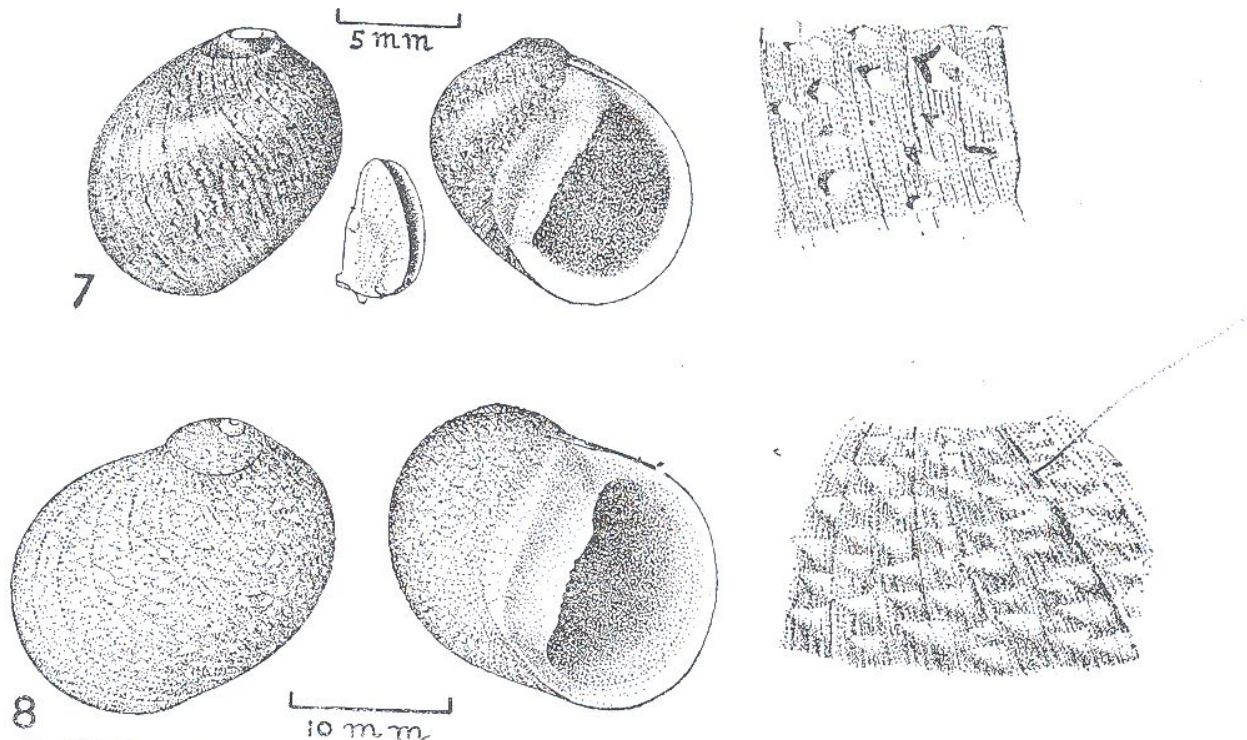


Fig. 7. *Clithon flavovirens* (v.D. BUSCH). Shell from back and front, exterior of operculum, and detail of colour pattern more enlarged. ABDULKADIR del.

Fig. 8. *Clithon squarrosus* (RÉCL.). Shell from back and front, and detail of sculpture more enlarged. ABDULKADIR del.

Whorls 4-5, rapidly increasing in size. The spire is somewhat more elevated than in *Cl. corona*. Apex smooth, yellow. Suture not deep. Umbilicus closed.

Aperture oblique, broadly semilunar. Columellar side flat, or slightly concave, white, granular or rugulose, porcellaneous. Along the entrance to the aperture the columellar side is somewhat concave. Along this concavity and above it the edge bears a number of small denticulations. Exterior margin of peristome sharp, a little thickened, but not reflected.

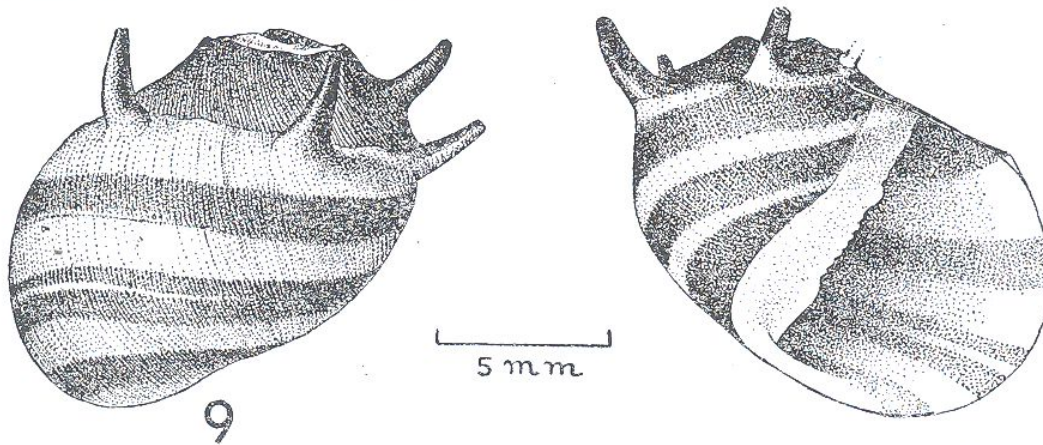


Fig. 9. *Clithon diadema* (RÉCL.). Shell from back and front. ABDULKADIR del.

Operculum semilunar. Exterior surface whitish or greyish, with yellow nucleus and dark-brown or black exterior margin. Scattered over the exterior surface are numerous distantly placed delicate granules. Obliquely over the surface runs a shallow groove which corresponds with a low ridge on the interior surface. The two apophyses, the curved ridge and the peg, are connected by a shelly callus. Interior surface light yellow.

Dimensions: height 15-20, width 15-20, height of aperture 10-12 mm.

Distribution: various islands of the Malay Archipelago, especially in the eastern part. Also in the Philippines and in various Polynesian islands. In fresh water, on stones, in rivers and brooks.

West Java: Palabuan ratu; Muara Tjibuni, south coast of West Java.
East Java: mouth of the Puger River.

Clithon faba (SOWERBY, 1836) (fig. 10).

1836. SOWERBY, Conchol. Illustr. no. 38, fig. 10 (*Neritina*).
1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 176, pl. 18, fig. 14-17 (*Neritina*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 80 and 307, pl. 10, fig. 11 (*Neritina*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 264 (*Clithon*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Neritina*).

Shell with small, low spire and inflated last whorl. Ground colour reddish-violet, or red-orange, with dark spiral bands. The entire surface

is covered with numerous small triangles or arrows and fine undulating lines. Surface irregularly sculptured by the growth striae, some fine and superficial, others coarse and profound. Thick; hardly or not transparent. Below the suture the whorls are slightly concave. Never with spines.

Whorls about four, rapidly increasing in size. Apex smooth, yellow. Suture not deep. Umbilicus closed.

Aperture oblique, broad semilunar. Columellar side flat, or slightly concave, light-yellow or greyish, minutely granular or rugulose, porcellaneous. Along the entrance to the aperture the columellar side is somewhat concave and minutely serrated. Exterior margin of peristome sharp, not reflected.

Operculum semilunar. Exterior surface minutely puckered. Grey, with yellow nucleus and dark-brown exterior margin. Obliquely over the exterior surface runs a shallow groove. Interior surface with curved ridge and rounded peg, connected by a shelly callus. The shallow groove of the exterior surface is visible as a low elevation on the interior surface.

Dimensions: height 15-18, width 12-14, height of aperture about 12 mm.

Distribution: Malaya, Sumatra, Java, Bali, Flores, Celebes. More frequent in the western part than in the eastern part of the Malay Archipelago.

Habitat in Java: in fresh or slightly brackish water.

East Java: Kali Mas near Surabaja.

Clithon flavovirens (VON DEM BUSCH, 1843) (fig. 7).

1843. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1, *Neritina*, p. 26, pl. 1, fig. 6 (*Neritina flavovirens*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 269 (*Neritina flavovirens*).
1857. MOUSSON, Journ. de Conch. 6, p. 163 (*Neritina emergens*).
1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 184 and 283, pl. 19, fig. 1, 2 (*Neritina flavovirens*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 81 and 307, pl. 10, fig. 12, 15 and 16 (*Neritina flavovirens*).
1908. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 3, p. 430 (*Neritina flavovirens* and *N. fl. var. emergens*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 264 (*Clithon flavovirens*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Neritina flavovirens*).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 102 (*Theodoxus flavovirens*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 268 (*Theodoxus flavovirens*).

Shell with small spire and inflated last whorl. Ground colour straw-yellow to olive-green, in exceptional cases somewhat reddish. With occa-

sional dark spiral bands and a pattern of small triangles and fine undulating lines. A little above the periphery the whorls are more or less conspicuously "shouldered". Along the shoulder the shell can produce a few spines. These spines can, however, be entirely absent. Surface finely sculptured by the growth striae. Thick; hardly or not transparent.

Whorls about 4, rapidly increasing in size. Apex smooth, yellow. Suture shallow, umbilicus closed.

Aperture oblique, broad semilunar. Columellar side flat, or slightly concave, greyish, minutely granular or rugulose, with porcellaneous lustre. Along the entrance to the aperture the columellar margin is somewhat concave and minutely serrated. Exterior margin of aperture sharp, not reflected.

Operculum semilunar. Exterior surface smooth, white or pink. With yellow nucleus and dark-brown or black exterior margin. Scattered over the exterior surface are numerous delicate, distantly placed granules. A shallow groove runs obliquely over the outer surface. Interior surface with curved ridge and rounded peg, connected by a shelly callus. Interior white, with dark margin and dark central spot. The groove of the exterior is visible as a low ridge on the interior surface.

Dimensions: height 11-14, width 12-15, height of aperture about 12 mm.

Distribution: *Clithon flavovirens* has been recorded from Java, Madura, Bali, Borneo and Celebes. It is not a common species.

Habitat in Java: almost nothing is known about the habitat of this species.

West Java: Sukabumi; Muara Tjibuni, south coast of West Java; Palabuan, Wijnkoopsbay.

East Java: river near the town of Besuki.

Clithon flavovirens has been recorded as a fossil from Pleistocene layers in East Java (VAN BENTHEM JUTTING, 1937).

***Clithon fuliginosus* (VON DEM BUSCH, 1843) (fig. 11).**

1843. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1, Neritina, p. 26, pl. 1, fig. 5 (*Neritina*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 269 (*Neritina*).
1849. MOUSSON, Land & Süsw. Moll. Java, p. 82, pl. 12, fig. 8 (*Neritina*).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 319 (*Neritina*).
1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 185, pl. 19, fig. 18, 19 (*Neritina*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 307 (*Neritina*).
1908. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 3, p. 430 (*Neritina*).

1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 265 (*Clithon*).

1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Neritina*).

1938. ADAM & LELOUP, Mém. Mus. Roy. Hist. Nat. Belgique (Hors Série) Vol. 2, Part 19, p. 63 (*Neritina*).

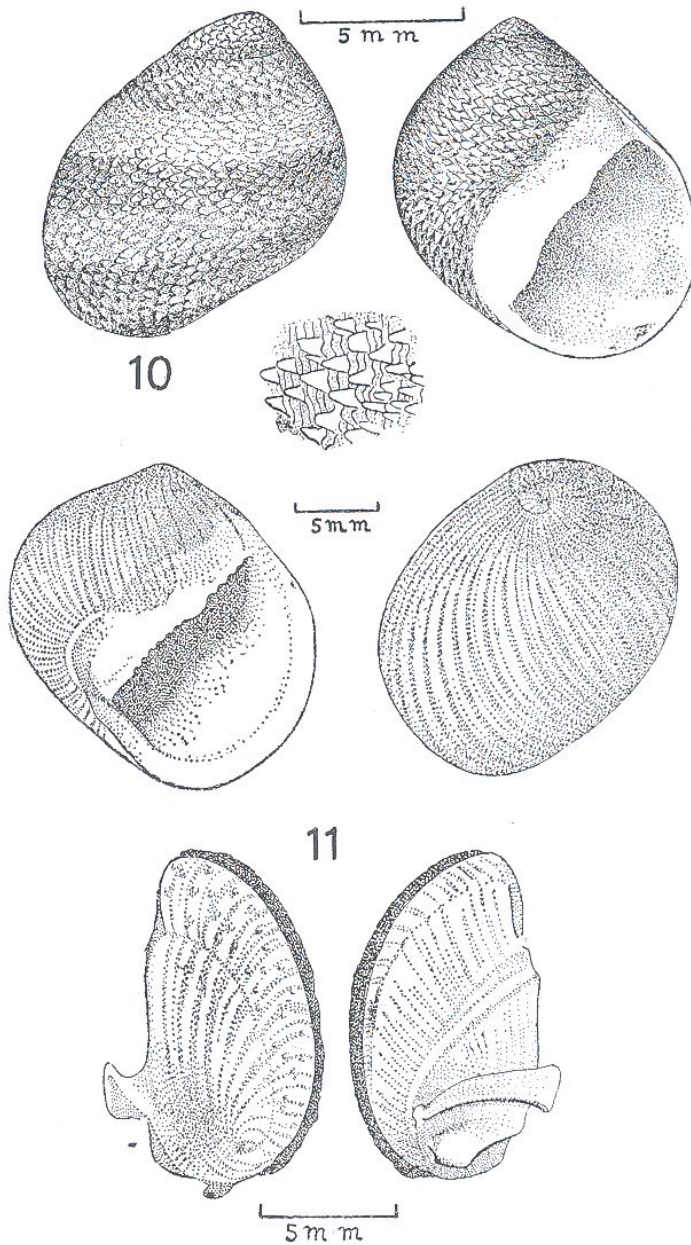


Fig. 10. *Clithon faba* (SOW.). Shell from back and front, detail of colour pattern more enlarged. ABDULKADIR del.

Fig. 11. *Clithon fuliginosus* (V.D. BUSCH). Shell from back and front, operculum from exterior and interior. J. MASTRO del.

Shell globular, spire entirely hidden by the last whorl. Dark olive-green, without spiral bands or other ornamentation, and covered by a

dark, nearly black periostracum. With regular, sometimes coarse, growth striae. Somewhat shining, not transparent. Without spines.

Whorls of the spire and apex not visible exteriorly. The last whorl very large, slightly concave above the periphery, and well rounded below it. Sometimes a little "shouldered". Umbilicus closed.

Aperture oblique, semilunar. Columellar side flat or a little concave, white or grey, porcellaneous, smooth or finely granular. Along the entrance to the aperture the columellar edge is somewhat concave and minutely serrated. Exterior margin of the peristome sharp, not reflected.

Operculum semilunar. Exterior surface light-pink or light-brown. Granular with minute, distantly placed, granules. Nucleus orange. Along the exterior margin bordered by an orange-brown zone. From the nucleus an oblique groove runs over the surface. On the back of the operculum this groove corresponds with a low ridge. Of the two apophyses the upper one is sickle-shaped, somewhat grooved longitudinally and slightly fanning out to the free end. With the lower apophysis, the peg, it is connected by a shelly callus. Interior surface of the operculum smooth, light orange-brown.

Dimensions: height 22-25, width 24-27, height of aperture about 20 mm.

* Distribution: Java. It has not been recorded beyond Java.

Habitat in Java: almost nothing is known about the habitat of this species.

West Java: Djakarta; Palabuan; Karang Hawu (ADAM & LELOUP, 1938); Pameungpeuk, south coast of West Java.

Central Java: Tjilatjap.

***Clithon longispina* (RÉCLUZ, 1841) (fig. 12).**

1841. RÉCLUZ, Rev. Zool. (Soc. Cuv.) 4, p. 312 (*Nerita*).

1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 147, pl. 15, fig. 16, 17, 20 and 21 (*Neritina*).

Shell globular, with small spire and inflated last whorl. Very dark olive or brown, either plain or with black spiral bands of various width and number. Between the spiral bands occasionally some irregular dark wavy lines or network. The entire shell is covered by a strong black, fibrous epidermis which renders it a dull appearance. At a short distance above the periphery the whorls are "shouldered". Along this shoulder the shell bears long, pointed distantly placed spines of 10-15 mm length. The majority point in posterior direction, others in apical direction. Irregularly sculptured by the growth lines. Between the suture and the row

of spines the growth striae are peculiarly sinuous, producing at the suture first a retrogressive, then a progressive sinus.

Whorls 3-4, rapidly increasing in size. Suture distinct. Periphery rounded. Umbilicus closed.

Aperture very oblique, half-moon shaped. Columellar side slightly concave, white, or somewhat rufous in the lower corner, granular, porcelainous. Along the entrance to the aperture the columellar edge is concave in the middle. There are hardly or no denticulations along this edge. Exterior margin of the peristome sharp, not thickened or reflected, with a peculiar rounded protruding lobe.

Operculum semilunar. Exterior surface with cloudy brown and black colour, in some specimens nearly entirely black, with lighter nucleus. Outer margin with a narrow brown zone. Obliquely over the surface runs a shallow groove to the left margin. This groove corresponds with a low ridge (sometimes hardly noticeable) on the back surface. Scattered over the exterior surface are numerous fine, distantly placed, granules. Posterior side with two apophyses; the superior one is grooved and broadened towards the free tip. With the lower one, the peg, it is connected by a shelly callus.

Dimensions: height 20-25, width 24-26, height of aperture 20-22 mm.

Distribution: Mauritius, Bourbon Id., Rodriguez Id., Madagascar, Java.

Habitat in Java: almost nothing is known on the habitat of this species.

West Java: Muara Tjibuni, Sukabumi.

In spite of this rather detailed indication of locality the occurrence of *Clithon longispina* in Java is dubious. The specimens formed part of the collection of the late Major P. A. OUWENS (1850-1922) and it is a well-known fact that he was somewhat careless as to localities and labels.

Clithon olivaceus (RÉCLUZ, 1843) (fig. 13).

1843. RÉCLUZ, Proc. Zool. Soc. London, p. 172 (*Nerita olivacea*).
 1843. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1, Neritina, p. 27, pl. 1, fig. 7 (*Neritina inconspicua*).
 1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 269 (*Neritina inconspicua*).
 1879. MARTENS, in MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 183, pl. 19, fig. 5-7 (*Neritina olivacea*) and p. 186 (footnote) (*N. inconspicua*).
 1914. LESCHKE, Mitt. naturhist. Mus. Hamburg. 31, p. 265 (*Clithon olivaceus*).
 1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Neritina olivacea* and *inconspicua*).

Shell with small spire and inflated last whorl. Greenish or olive-brown, generally without dark spiral bands or other colour pattern, but

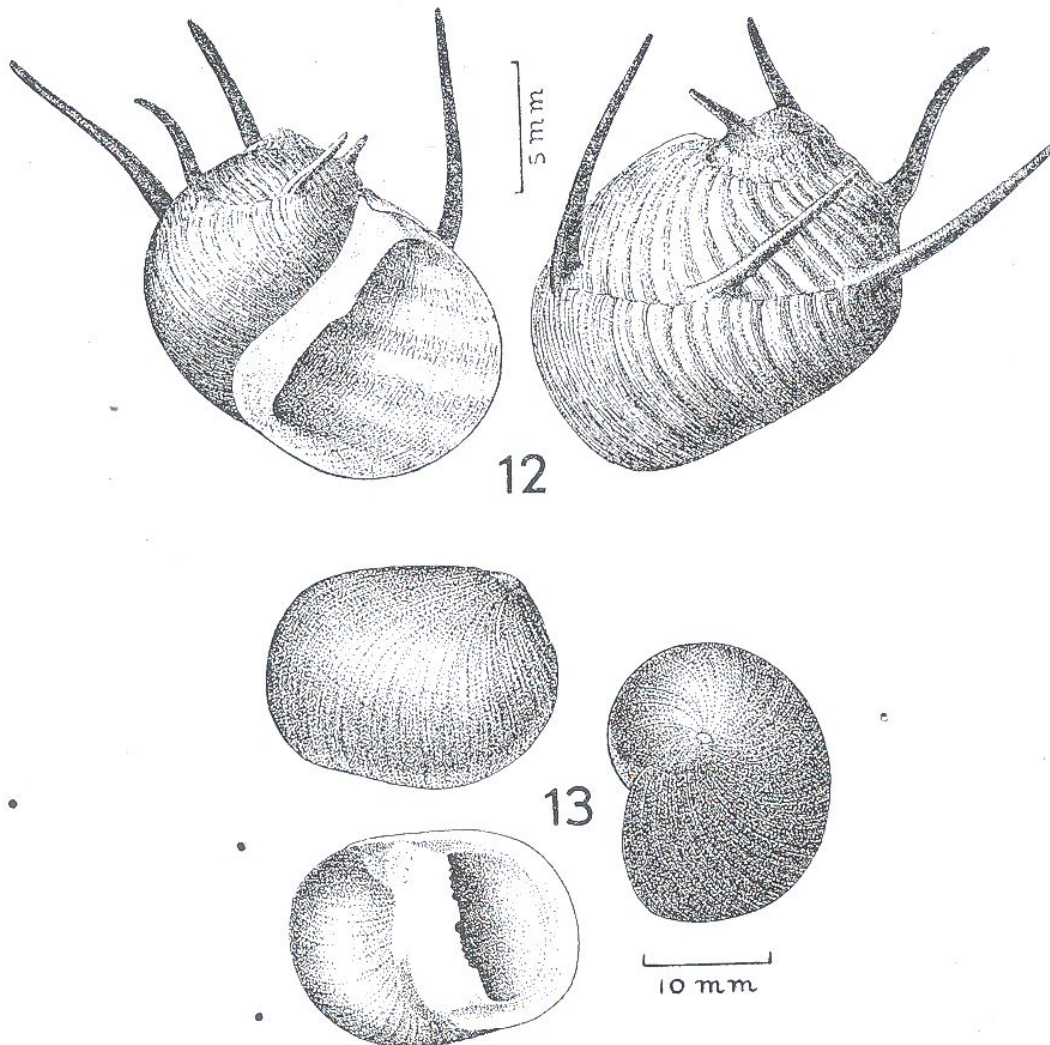


Fig. 12. *Clithon longispina* (RÉCL.). Shell from front and back. ABDULKADIR del.
 Fig. 13. *Clithon olivaceus* (RÉCL.). Shell from back, front and top. ABDULKADIR del.

occasionally with sparse black marks or striae arranged spirally. The entire shell is covered by a dark, almost black periostracum. Sculptured by somewhat undulating growth striae. Without spines.

Whorls 3-4, the apex often eroded. Suture shallow. The last whorl slightly concave between suture and periphery, and well rounded below it. Umbilicus closed.

Aperture oblique, semilunar. Columellar side flat or a little concave, minutely granular, porcellaneous, white, with a red-brown zone along the lower side of the penultimate whorl. Along the entrance to the aperture the columellar edge is somewhat concave and minutely denticulated. These denticles continue as ridges for some distance on the columellar callus.

Exterior margin of peristome sharp, somewhat thickened, but not reflected.

Operculum half-moon shaped. Exterior surface white with brownish cloudy markings and dark-brown zone along the exterior edge. Granular, with minute distantly placed, granules. Nucleus brown. From the nucleus an oblique groove runs over the surface towards the left. On the back of the operculum this groove corresponds with a low ridge. Interior surface of the operculum white, light-yellow or orange-red. The two apophyses, the ridge and the peg, are connected by a shelly callus which is abruptly lowered just under the ridge.

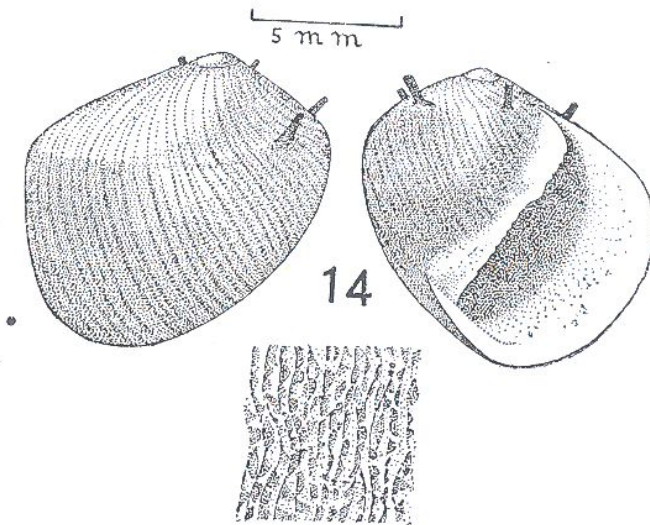


Fig. 14. *Clithon rarispina* (MOUSS.). Shell from back and front, and detail of colour pattern more enlarged. J. MASTRO del.

Dimensions: height 15-18, width 18-20, height of aperture about 12 mm.

Distribution: a rare species, only recorded from the Philippines, Amboina and Java.

Habitat in Java: Almost nothing is known on the habitat of this species in Java.

West Java: near Wijnkoopsbay; Palabuan.

Clithon oualaniensis (LESSON, 1831) (fig. 15).

1831. LESSON, Voy. Coquille, Zool. 2, p. 379 (*Neritina oualaniensis*).

1843. VON DEM BUSCH, in: PHILIPPI, Abb. & Besch. 1, Neritina, p. 30, pl. 1, fig. 13 (*Neritina nubila*).

1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 193, pl. 20, fig. 1-24 (*Neritina oualaniensis*).

1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 82, 218 and 307 (*Neritina ualanensis*).

1905. MARTIN, Samml. Geol. Reichsmus. Leiden (N.F.) 1, p. 323, pl. 45, fig. 748 (*Neritina (Clithon) oualanensis*).
1907. MARTIN, N. Jahrb. Mineral. 100, II, p. 162 (*Neritina oualanensis*).
- 1911-1912. MARTIN, Samml. Geol. Reichsmus. Leiden (N.F.) 9, p. 21 and 47 (*Neritina oualanensis*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 265 (*Clithon ualaniensis*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 101 (*Neritina oualanensis*).
1925. VAN BENTHEM JUTTING, Treubia, 6, p. 144 (*Neritina ualanensis* var. *nigrobifasciata*).
1928. MARTIN, Leidsche Geol. Meded. 3, p. 116 and 128 (*Neritina oualanensis*).
1929. DAMMERMAN, Krakatau, p. 117 (*Neritina ualanensis* var. *nigrobifasciata*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Neritina ualanensis*).
1931. VAN DER VLERK, Leidsche Geol. Meded. 5, Feestbundel Martin, p. 262 (*Neritina oualanensis*).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 102 (*Theodoxus ualanensis*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 268 (*Theodoxus oualaniensis*).
1948. DAMMERMAN, Fauna of Krakatau 1883-1933, p. 520 (*Theodoxus oualaniensis*).

Shell small, globular, with low spire. Very prettily coloured with various patterns of dark triangles, zigzag lines, spiral bands etc. on a yellow, greenish or pink background. Finely sculptured by the growth lines. Shining and a little transparent. Without spines.

Whorls about four, rapidly increasing in size. Suture shallow. Umbilicus closed.

Aperture oblique, semilunar. Columellar side somewhat convex, white, yellow or greyish, porcellaneous, smooth or slightly rugulose. Along the entrance to the aperture the columellar edge is somewhat concave and minutely serrated. Exterior margin of peristome sharp, not reflected.

Operculum semilunar. Exterior surface dark-grey, with lighter nucleus. Finely granular. From the nucleus an oblique groove runs over the surface. On the back of the operculum this groove corresponds with a low ridge. Interior side of operculum with two apophyses, connected by a shelly callus.

Dimensions: height 8-9, width 7-8, height of aperture about 6 mm.

Distribution: very common in the entire East Asian tropical region, from India and Ceylon to Polynesia, and from southern Japan to northern Australia. Also found in the islands of Madura and Verlaten Island, close to the coast of Java.

Habitat in Java: The animals live in brackish water along the coast.

West Java: near Palabuanratu, south coast of West Java, near the shore.

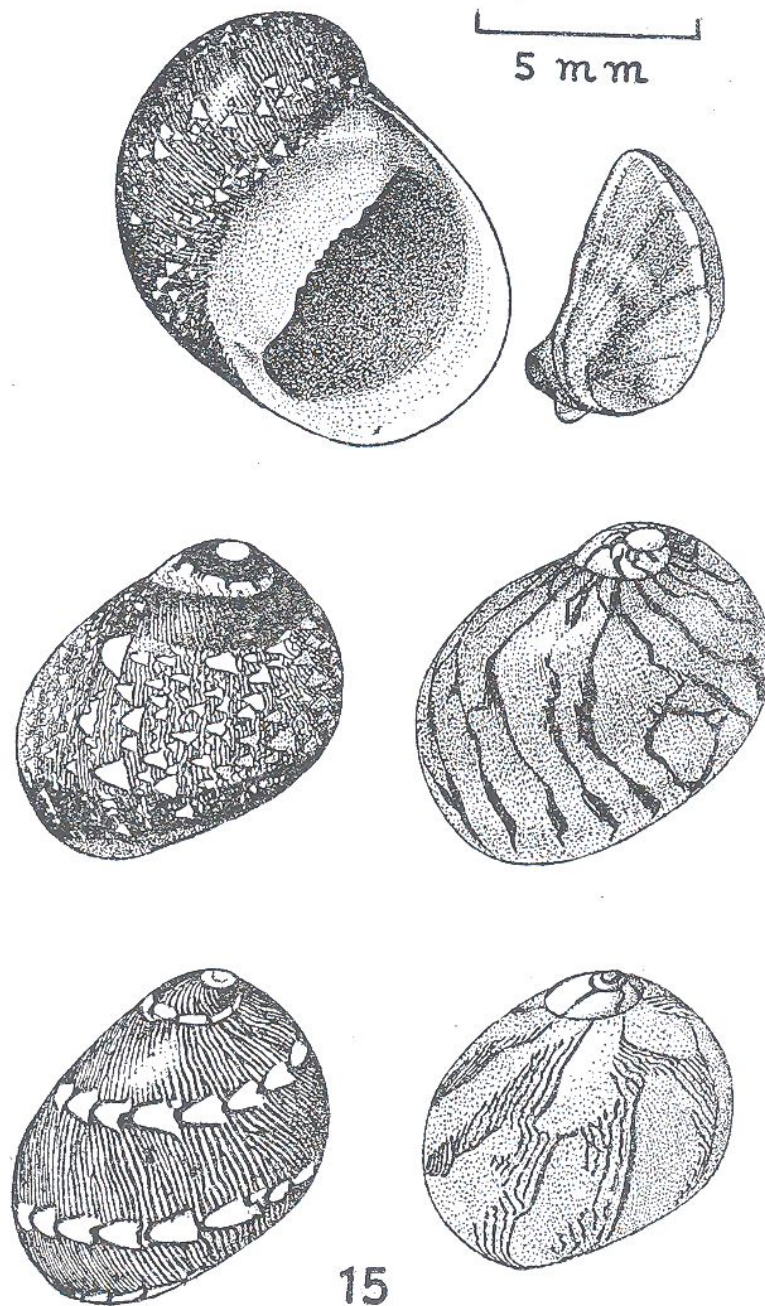


Fig. 15. *Clithon oualaniensis* (LESS.). Shell from front, with operculum. Various colour patterns. ABDULKADIR del.

East Java: Djuwono near Rembang, along the main road.

In a fossil state *Clithon oualaniensis* has been recorded from Pleistocene layers near Djetis in East Java (VAN BENTHEM JUTTING, 1937) and from Miocene layers in West Java (MARTIN, 1905, 1907, 1911-1912, 1919 and 1928; VAN DER VLERK, 1931).

The shells are extremely variable in colour pattern. This induced MARTENS (1879, p. 193) to create six colour forms. One could easily increase the variants with double that number.

Clithon rarispina (MOUSSON, 1848) (fig. 14).

1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 269 (*Neritina rarispina*).
 1849. MOUSSON, Land & Süßw. Moll. Java, p. 83, pl. 12, fig. 5, 6 and pl. 20, fig. 12 (*Neritina rarispina*).
 1885. SCHEPMAN, Notes Leyden Mus. 7, p. 49-50, pl. 4, fig. 3, 3a, 3b (*Neritina* (*Clithon*) *subocellata*)
 1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 307 (*Neritina subocellata*).
 1908. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 3, p. 427 (*Neritina subocellata*).
 1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 265 (*Clithon subocellata*).
 1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Neritina subocellata*).

The following description is chiefly based on SCHEPMAN's original diagnosis of *Neritina subocellata*. Shell nearly globular, delicately striated in the line of growth; with a few striae in the form of old folds near the suture and with microscopic spiral striae. The colour is greyish olive-green, with small blackish spots which are rounded or triangular, sometimes flow together and vary greatly in size and number, they are mostly bordered by a very small rim of a lighter colour. The last whorl is more or less angular above and shows there from one to four spines in some examples. Others are entirely spineless, or still show traces of them on the penultimate whorl. The spines are short, curved upwards and sometimes a little backwards. Spire very small, eroded. In complete specimens there are about two whorls and a half which form a flat cone. Suture not deep, covered by the margin of the next volution. Aperture moderate, obliquely semi-elliptical; upper margin curved, outer and lower margins rounded, interior of the aperture bluish, the callosity near the muscular scar moderately long, low; the columellar plain, callous above, with a narrow layer of enamel which has the appearance of shagreen, becomes thicker towards the free edge and shows here a small sinuosity with 4 to 6 denticles, besides a few secondary ones; the sinuosity is bordered above by a much stronger tooth, and still higher are a few crenulations which form grooves behind.

Operculum semilunar, on the outside with very small granulations, yellowish, grey towards the outer margin and the nucleus, with a reddish rim. Inside similarly coloured. Of the two apophyses the rib is broad at the top, flattened, pale yellow. The lower apophysis is orange-yellow, an intermediate wall of nearly the same height connects it to the rib.

Dimensions: height 14, width 13, height of aperture 10 mm.

SCHEPMAN (1885) continued: "This species has some affinities to *Neritina brevispina* LAM. (i.e. *corona* L.), but it is smaller, more smooth than *brevispina* commonly is, and the colour is quite distinct; none of

the specimens shows any trace of the black band near the suture, which seldom fails in *N. brevispina*. The colouring reminds one of *N. rarispina* MOUSSON (from Java), but that species is smaller and, according to the figures and descriptions, of a much more oblique shape".

In the Zoological Museum of Zürich I compared two original sets of *Neritina rarispina* MOUSSON in the MOUSSON collection. One of these lots (three shells) is spinous, the other (two shells) without spines. All shells are rather smooth, only at the suture the growth lines are combined to bundles which render the sculpture a little more rugose in this region. In addition the surface bears microscopical spiral lines. The colour pattern consists of fine, undulating vertical lines. The columellar callus is bluish-white, the interior of the aperture bluish-grey. In spite of SCHEPMAN's arguments it is my opinion that *Neritina rarispina* MOUSSON and *N. subocellata* SCHEPMAN are identical.

The holotype of *Neritina subocellata* SCHEPMAN from Besuki (East Java), collected by J. SEMMELINK, is in the Leiden Museum.

Habitat in Java: in running water.

East Java: Besuki, river near the town; Puger, river near the town.

Clithon squarrosus (RÉCLUZ, 1843) (fig. 8).

1843. RÉCLUZ, Proc. Zool. Soc. London, p. 174 (*Nerita*).
 1857. MOUSSON, Journ. de Conch. 6, p. 162 (*Neritina ruida*).
 1859. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 18, p. 425 (*Neritina squarrosa* and *ruida*).
 1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 162, pl. 16, fig. 13-18 (*Neritina squarrosa*).
 1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 80 and 307 (*Neritina squarrosa*).
 1908. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, part 3, p. 427 (*Neritina squarrosa*).
 1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 265 (*Clithon squarrosa* and *ruida*).
 1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Neritina squarrosa* and *ruida*).
 1937. RIECH, Arch. Naturgesch. (N.F.) 6, p. 83 (*Clithon squarrosa*).

Shell globular, with small spire and inflated last whorl. At a small distance from the suture most specimens are first concave, then convex and "shouldered". This shoulder can even be more accentuated by distantly placed spines of a few mm length along it. The spines can, however, be altogether absent. Dark olive-brown, with, occasionally, one or two obscure dark spiral bands, and some reddish lines or spots. Sculptured by coarse growth lines. In addition there is a peculiar sculpture of minute

elevated flat blisters, of oval or triangular shape, the triangles pointing with the top angle forward. Not shining or transparent.

Whorls 4-5, rapidly increasing in size. Apex smooth, yellowish, slightly projecting. Suture uneven, in consequence of the coarse endings of the growth lines. Umbilicus closed.

Aperture semilunar, oblique. Columellar side of aperture white or light-yellow, flat or somewhat concave, finely granular, porcellaneous. Along the entrance to the aperture the edge of the columellar side is slightly concave in the middle. This central part is serrated by a few (4-6) denticles. Exterior margin of peristome sharp, not thickened or reflected.

Operculum semilunar. Exterior surface dark-olive to blackish, somewhat lighter round the nucleus. Along the exterior margin a narrow brown zone. The entire surface is minutely puckered with distantly placed granules. Obliquely over the surface runs a shallow groove which corresponds with a low ridge on the posterior surface. Of the two apophyses the ridge projects conspicuously beyond the opercular margin. The peg is normal, with rounded top. The two apophyses are connected by a shelly callus.

Dimensions: height 20-22, width 14-16, height of aperture about 15 mm.

• Distribution: rather local in the Malay Archipelago and the Philippines. It has been recorded from Sumatra, Java, Bali, Sumba, Adonare, Timor, Ambon, Ceram, Buru and the Togian Islands.

Habitat in Java: always in fresh water.

West Java: near Palabuanratu, south coast of West Java.

Central Java: Tjilatjap, south coast.

East Java: Badjulmati and Bomo, in rivers.

• Genus *Neritodryas* MARTENS, 1869

• Shell with small spire and large, rounded last whorl. Surface smooth, or with longitudinal grooves, separating broad, flat ridges. Brownish, with darker flames or network. Never with spines. Suture shallow. Umbilicus closed. Columellar side of aperture porcellaneous, smooth or with minute granules. Along the entrance to the aperture the columellar margin is entire or with small denticulations. Exterior margin of aperture sharp, somewhat thickened, but never reflected.

Operculum calcareous, half-moon shaped. Paucispiral, nucleus excentric. Exterior surface smooth or granular. Posterior side with two apophyses, the upper one long and curved, with several longitudinal ridges, ending in digitiform lobes at the free end. Lower apophysis as a round peg. (fig. 18).

Radula ~5.1.5.~. Central tooth wider than long. First lateral elongate-rectangular. The inner marginals are provided with accessory cusps under their blade. The cutting edge of each marginal has only few (2-4) cusps (fig. 2).

Distribution: tropical regions of Asia, in fresh water. Living on stones or wood, preferably in running water, or on trees along the water, just above the water edge.

The Javanese species can be distinguished as follows:

1. Shell without spiral grooves, columellar side of aperture black, or tinged with red **dubia**
- Shell spirally grooved, columellar side of aperture white, yellow or white with cloudy black spots 2
2. Spiral grooves of shell very superficial, shell with dark spiral colour bands. Columellar side of aperture white or yellow. Operculum with a zone of small elongate, or chevron-shaped ridges along the exterior margin **cornea**
- Spiral grooves deeper, shell not banded. Columellar side of aperture white, clouded with black penetrating from the penultimate whorl. Operculum finely and regularly granular **subsulcata**

The species of *Neritodryas* are very similar, hence it is no wonder that authors have often found difficulties in separating them, and that they have combined several species in later years. Even SOWERBY, after having published in 1836 (Conch. Illustr. fig. 50) his *Neritina subsulcata* changed his mind in 1849 (Thes. Conch. 2) and classified this species under *N. cornea*. This conception has been followed by several later authors, including myself.

On the other hand RIECH (1937, Arch. Naturgesch. (N.F.) 6, p. 76) united *N. cornea* and *N. dubia*. After having examined large series of *Neritodryas* shells, not only from Java, but from other Malaysian islands as well, I now find enough evidence to keep the three species separate.

Neritodryas cornea (LINNÉ, 1758) (fig. 2 and 16).

1758. LINNÉ, Syst. Nat. Ed. X, p. 777 (*Nerita*).
1849. SOWERBY, Thes. Conch. 2, *Neritina*, p. 518, pl. 111, fig. 71 (*Neritina*).
1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 140, pl. 12, fig. 14-18 (*Neritina*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 218 and 307 (*Neritina*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 263 (*Neritina*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 86 (*Neritina*).
1937. RIECH, Arch. Naturgesch. (N.F.) 6, p. 76.
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 268.

Shell semi-globular with small spire and large last whorl. Yellowish-brown, with 3 to 4 dark spiral bands, the intervals crossed by fine anastomosing lines. The whole shell is covered by a brown epidermis. Finely striated by the growth lines. In some shells there is besides a sculpture of shallow spiral grooves (about 17-20 on the last whorl), separating broad, flat ridges. The lower grooves are often obsolete.

Whorls about three, the last one very convex. Suture shallow, descending towards the aperture. Periphery rounded. Umbilicus closed. Aperture very oblique, semilunar. Columellar side of peristome broad, flattened, white or orange, with porcellaneous lustre. Along the entrance of the aperture the columellar side is almost straight, toothless or with a few very fine denticles.

Operculum calcareous, semilunar. Exterior surface black. Finely granular, with a zone of small, elongate or chevron-shaped ridges along the exterior margin. Interior surface orange-brown, with two apophyses: a sickle-shaped, strongly grooved upper one, ending in 6-8 finger-shaped lobes at the free end, and a peg-like lower one. Between the ridge and the lateral edge of the operculum is a deep pit.

Dimensions: height 15-17, width 19-20, height of aperture 13-14 mm.

• Distribution: from the Nicobar Islands to New Caledonia, including the Malay Archipelago and the Philippines. Found in almost any Malaysian island where some exploration has been done. *Neritodryas cornea* is a coastal species, living in the mangrove zone, in brackish water. During low tide outside the water.

Habitat in Java: very little is known of the environment of this species in Java.

West Java: mouth of the Tjimandiri, south coast of West Java.

Neritodryas cornea has also been recorded from Madura island (VAN BENTHEM JUTTING, 1941).

Neritodryas dubia (GMELIN, 1790) (fig. 17).

1790. GMELIN, Syst. Nat. Ed. XIII, p. 3678 (*Nerita*).
1843. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1, Neritina, p. 27, pl. 1, fig. 8 (*Neritina bella*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 269 (*Neritina bella*).
1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 136, pl. 12, fig. 1-7 (*Neritina dubia*).
1890. BOETTGER, Ber. Senckenb. p. 162 (*Neritina dubia*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 218 and 307 (*Neritina* (*Neritodryas*) *dubia*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 263 (*Neritina dubia*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Neritina dubia*).

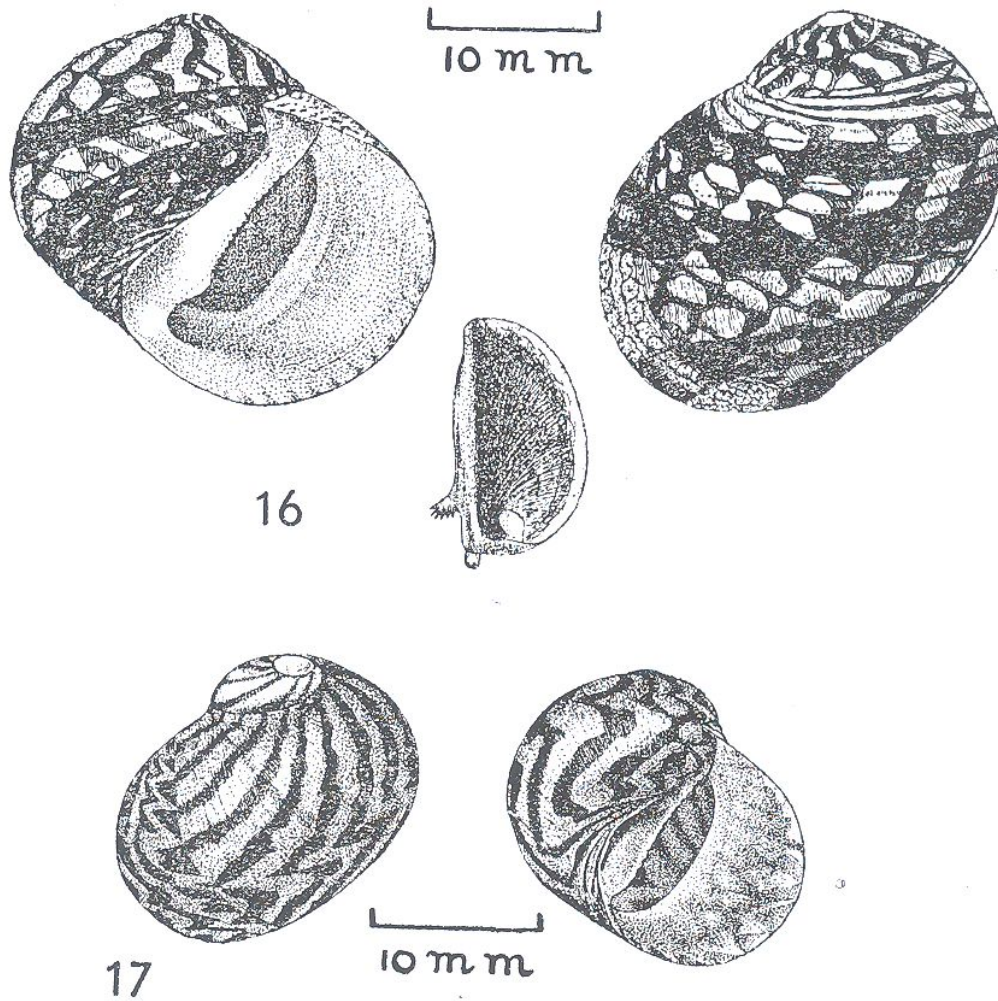


Fig. 16. *Neritodryas cornea* (L.). Shell from front and back, and exterior of operculum. ABDULKADIR del.

Fig. 17. *Neritodryas dubia* (GMEL.). Shell from back and front. ABDULKADIR del.

Shell semiglobular, with small spire and large last whorl. Surface smooth and shining, without spiral grooves. Sculptured by fine, regular growth lines. Ground colour yellowish-brown, with darker zigzag or reticulate pattern. The entire shell is covered by a brown epidermis.

Whorls about three, the last one very convex. Apex protruding. Suture shallow, descending towards the aperture. Periphery rounded. Umbilicus closed.

Aperture very oblique, semilunar. Columellar side of peristome broad, flattened, generally black, or tinged with red, with porcellaneous lustre. Towards the aperture the columella edge is almost straight, with a few very weak serrations or with no serrations at all.

Operculum calcareous, semilunar. Exterior surface brownish, clouded with black. Finely granular, with round or elongate granules. Nucleus

at the basal corner. Back side with two apophyses, a sickle-shaped, strongly grooved upper one, ending in 3-6 finger-shaped lobes at the free end, and a peg-shaped lower one. Between the ridge and the edge of the operculum is a deep pit.

Dimensions: height 17-19, width 18-20, height of aperture 12-14 mm.

Distribution: from Ceylon to the Fiji Islands and Tahiti, including Malaysia and the Philippines. In the Malay Archipelago it is more common in the eastern part than in the four Greater Sunda Islands. *Neritodryas dubia* lives in the coastal region, often in brackish water in the mangrove zone, or on *Sonneratia* and *Pandanus*. During low tide it is exposed in dry places.

Habitat in Java: almost nothing is known of its habitat in Java. West Java: Tandjong Priok (BOETTGER, 1890); Sukabumi.

Neritodryas subsulcata (SOWERBY, 1836) (fig. 18).

1836. SOWERBY, Conch. Ill., no. 50, fig. 50 (*Neritina subsulcata*).

1849. SOWERBY, Thes. Conch. 2, *Neritina*, p. 518, pl. 111, fig. 67 and 70 (*Neritina cornea*).

1859. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 18, p. 425 (*Neritina subsulcata*).

1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 142, pl. 12, fig. 11-12 (*Neritina subsulcata*).

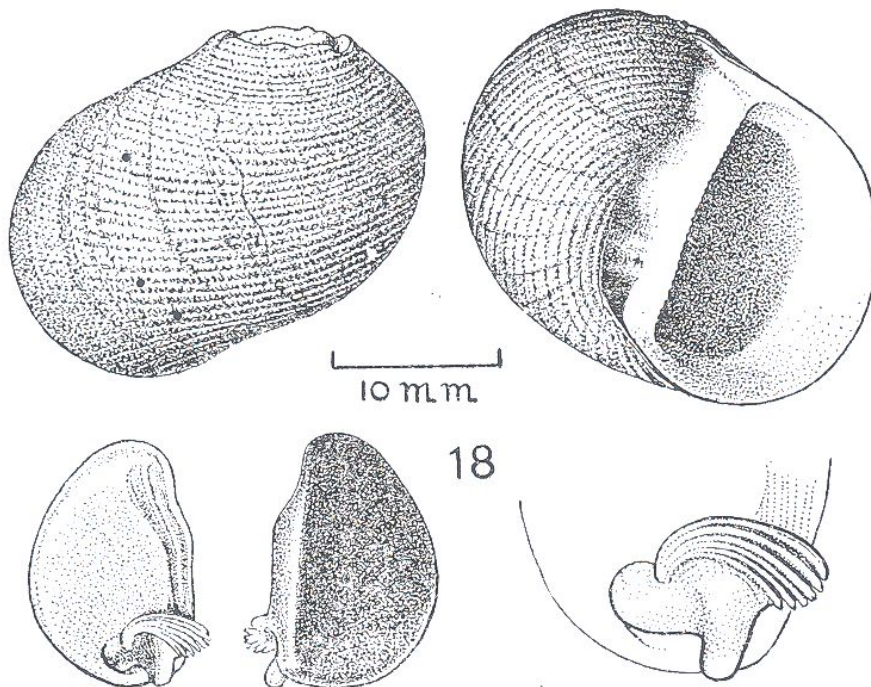


Fig. 18. *Neritodryas subsulcata* (Sow.). Shell from back and front, operculum from interior and exterior, basal part of interior of operculum more enlarged. ABDULKADIR del.

Shell semiglobular, with small spire and large last whorl. Olive to brownish, either plain or with darker network. Covered with greenish-brown periostracum. Finely striated by the growth lines. This sculpture is crossed by conspicuous spiral ribs (about 30 on the last whorl), the grooves being deeper than in *Neritodryas cornea*. Towards the base the spiral sculpture becomes weaker.

Whorls $3\frac{1}{2}$, the last one very convex. Suture shallow. Periphery rounded. Umbilicus closed.

Aperture very oblique, broad semilunar. Columellar side of peristome broad, flattened, porcellaneous, white, with irregular black clouds penetrating from the parietal side. Along the entrance of the aperture the columellar edge is straight or slightly concave, with numerous fine serrations.

Operculum calcareous, semilunar. Exterior surface black, with a white spot round the nucleus. Finely granular. Posterior surface orange-brown, with two apophyses, a sickle-shaped, strongly grooved upper one, ending in 7-8 finger-shaped lobes at the free end, and a peg-like lower one. Between the ridge and the lateral edge of the operculum there is a small, deep pit.

Dimensions: height 26-28, width 28-30, height of aperture about 23 mm.

Distribution: various islands in the Malay Archipelago, the Philippines and the Pacific Ocean. More in the eastern than in the western part of the Malay Archipelago.

Habitat in Java: almost nothing is known of its natural surroundings in Java.

West Java: near Wijnkoopsbay.

Genus *Neritina* LAMARCK, 1816.

Shell generally with short spire and inflated last whorl. In a few species the spire is more elevated. In other species spire and apex are entirely hidden by the large last whorl. Surface smooth, in many species with pretty colours: red, yellow, brown, alternating with a dark zigzag, triangular or reticulate pattern. Never with spines. Suture shallow, umbilicus closed. Columellar side flat or convex, porcellaneous. Along the entrance to the aperture the edge of the columellar side is smooth, or provided with small serrations. Exterior margin of aperture sharp, somewhat thickened, but not reflected.

Operculum calcareous, semicircular, with a membranous fringe along the exterior margin. Paucispiral, nucleus excentric. Posterior side with

two apophyses, the ridge and the peg; the lower one can be transformed into a serrated crest (as in *Neritina labiosa*, fig. 19).

Radula ~.5.1.5.~. Central tooth usually broader than high, or equally long in both directions. First lateral elongate, rectangular. Marginals serrate, with numerous cusps, stretching to the very tip of the cutting edge (fig. 3).

Distribution: Asia, America, Africa, Australia, chiefly in the tropics. Most species in fresh water, a few can tolerate a low degree of salinity. Preferably in running water, or in the shore region of great lakes where the water is sufficiently agitated.

Key to the Javanese species:

1. Shell with distinctly elevated spire 2
 - Spire very small, or quite hidden by the last whorl 4
2. Epidermis with fine, microscopical reticulate structure 3
 - Epidermis without such structure **zigzag**
3. Shell with high spire, whorls distinctly concave below the suture **turrita**
 - Shell with low spire, whorls hardly or not concave below the suture **waigiensis**
4. Shell with two posterior basal "wings" at the peristome 5
 - Shell without such "wings" 6
5. Wings short, more or less triangular, not canaliculate **auriculata**
 - Wings elongate, canaliculate **bicanaliculata**
6. Shell almost symmetrical, with the apex at, or nearly at the posterior end; peristome greatly expanded. **violacea**
 - Shell spirally built, apex at one side; peristome not so extended 7
7. Aperture very large, ear-like. Peristome almost touching the apex 8
 - Aperture moderately large. Peristome not touching the apex 9
8. Shell more or less Patella-shaped. The lower apophysis of the operculum is not peg-shaped, but a serrated ridge **labiosa**
 - Shell not so broad and expanded. The lower apophysis of the operculum is of the usual peg-form. **pulligera**
9. Last whorl large, shell involute, apex and spire are not visible exteriorly. No orange-red spot on the columellar callus. Columellar edge along aperture concave **squamipicta**
 - Last whorl not hiding spire and apex. With orange-red spot on the columellar side. Columellar edge along aperture almost straight **variegata**

***Neritina auriculata* LAMARCK, 1816 (fig. 22).**

1816. LAMARCK, *Encycl. Méth. (Vers.) Explic. Planches*, pl. 455, fig. 6.
1879. MARTENS, in: MART.-CHEMN. *N. Syst. Conch. Cab.* Vol. 2, Part 10, p. 30, pl. 6, fig. 13-15 and fig. 24-27.
1897. MARTENS, in: WEBER, *Erg. Reise Nied. Ost Indien*, 4, p. 76.
1908. HORST & SCHEPMAN, *Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas*, Vol. 13, Part 3, p. 414.
1929. VAN BENTHEM JUTTING, *Treubia*, 11, p. 86.
1953. MERMOD, *Rev. Suisse Zool.* 60, p. 144, fig. 162.

Shell semi-globular or bean-shaped, with flat base. The entire shell consists of only 1-1½ whorls. Top small and flat, aperture wide. Greenish-brown, with darker brown or violet reticulations or flames, either all over the shell or only on the oldest part. Growth striae in semi-circles, with the apex as centre. This sculpture is crossed by finer spiral lines. When the periostracum is still preserved the spirals appear as fine, elevated, fibrous ridges.

Aperture large, half-moon shaped. Surrounded by a broad peristome which ends in two "wings" or "auricles" at the upper and lower columellar sides. Columellar edge of aperture slightly sinuous, with about 20 inconspicuous denticulations. Columellar callus smooth and porcellaneous or minutely granular, greyish-black with an occasional yellow or pink tinge.

Operculum semilunar, columellar side sinuous, nucleus at right hand base. From the nucleus a narrow brown margin runs along the exterior edge of the operculum. The rest of the exterior surface is black. Back side with two apophyses, a conical lower one with a rounded, sometimes bifid, top, and a sharp, sickle-shaped upper one with an acute free top.

Dimensions: (taken in accordance with the natural attitude of the animal): length 18-20, width 13-15, height about 7 mm.

Distribution: from Ceylon to New Ireland and New Caledonia, including most of the Malaysian and Philippine islands. Mostly in running fresh water.

Habitat in Java: almost nothing is known about the habitat of this species in Java.

West Java: Sukabumi; Muara Paranjé, south coast of West Java; Palabuanratu.

There is considerable variation in the development of the "auricles". In some specimens they are blunt and hardly distinguishable, in others they can be large, with pointed tips, sometimes even protruding beyond the posterior margin of the shell. This has given rise to the creation of

a number of varietal names, the principal ones being mentioned by MARTENS, 1879.

Neritina bicanaliculata RÉCLUZ, 1849 (fig. 20).

1849. RÉCLUZ, in: SOWERBY, Thes. Conch. 2, Neritina, p. 509, pl. 113, fig. 135-137.

1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 35, pl. 9, fig. 3-4.

1908. SCHEPMAN, Sib. Exp. Monogr. 49-1-a, p. 9.

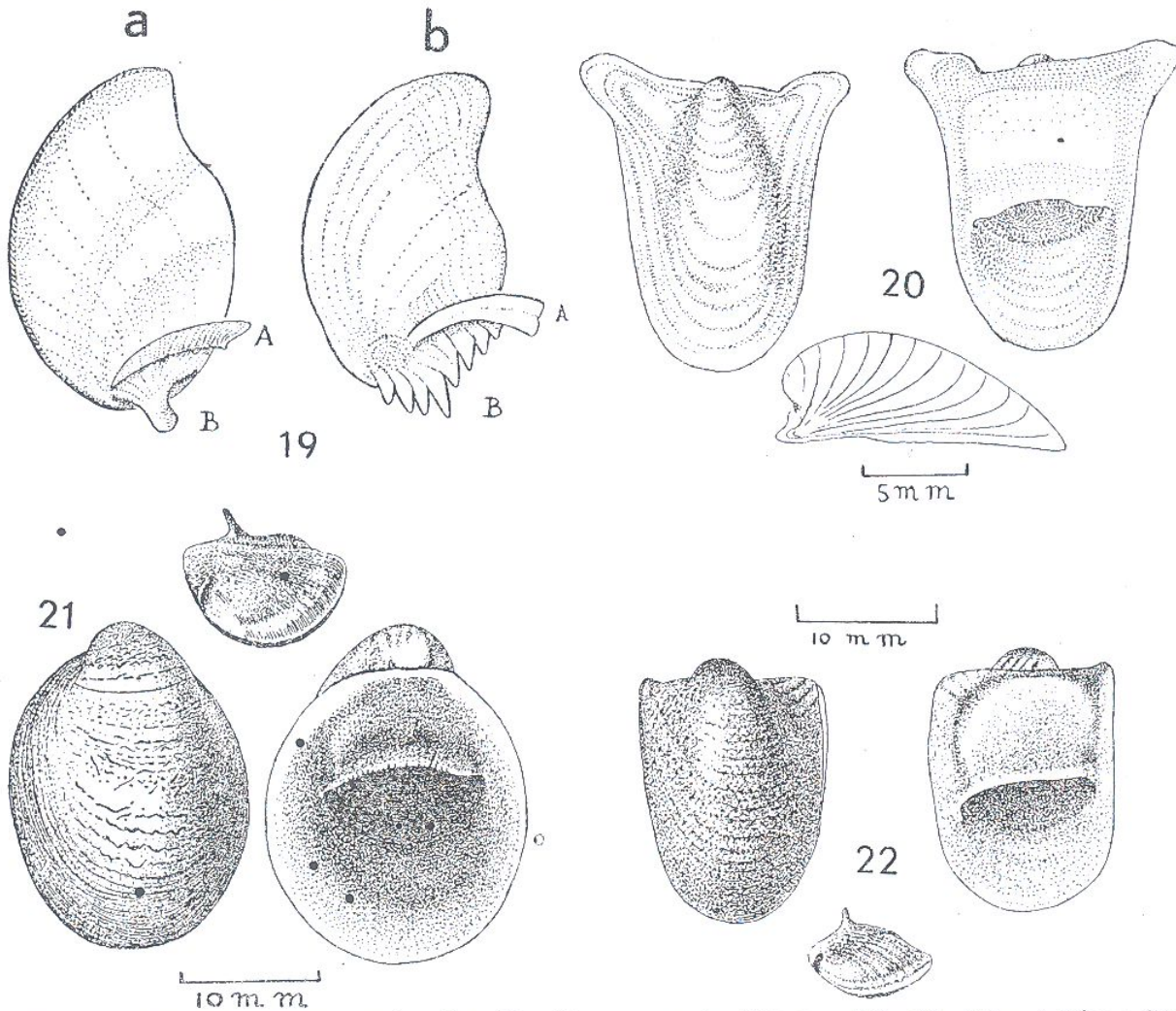


Fig. 19. Interior of opercula of a. *Neritina pennata* BORN and b. *Neritina labiosa* SOW. A. ridge-shaped upper apophysis, B. lower apophysis, peg-shaped in the left figure, serrated in the right figure. Author del.

Fig. 20. *Neritina bicanaliculata* RÉCL. Shell from back, front and side. J. MASTRO del.

Fig. 21. *Neritina violacea* (GMEL.). Shell from back and front, and exterior of operculum. ABDULKADIR del.

Fig. 22. *Neritina auriculata* LAM. Shell from back and front, and exterior of operculum. ABDULKADIR del.

Shell bean-shaped, with flat base and rounded dorsal side. The entire shell consists of 1-1½ whorls only. Apex terminal, small, flat. Aperture wide. The shell is yellowish-brown with darker brown zigzag lines in trans-

verse direction, or with a reticulate pattern. Growth striae in semi-circles, with the apex as the centre. This sculpture is crossed by still finer spiral or longitudinal lines.

Aperture large, broad semi-lunar. Surrounded by a broad peristome which ends in two divergent canaliculate "wings" or "auricles" at the upper and lower columellar sides. These wings are longer and more canaliculate than in *Neritina auriculata*. Columellar edge of aperture slightly sinuous, with about 20-24 delicate denticulations. The columellar callus is smooth and porcellaneous, whitish, greyish or brownish.

Operculum semilunar, columellar side sinuous, nucleus at base. With a membranous fringe along the exterior edge. Back side with two apophyses, the superior one as a sharp, curved ridge, the lower one as a short, pointed peg.

Dimensions: (of the Javanese specimens): longest diam. (without wings) 22, width 17, height 10 mm.

Distribution: recorded from the Id. of Luzon, Philippines, Java and Sumatra.

Habitat in Java: the habitat in Java is unknown. The species has only once been mentioned from Java, without further details.

In the original diagnosis the shell is described as "more patelliform and depressed than *Neritina auriculata*". The three shells from Java, however, have a rather high dorsal side.

Neritina waigiensis (LESSON, 1830) (fig. 26).

1830. LESSON, Voy. Coquille, Zool. 2, p. 379 (*Neritina waigiensis*).
1834. QUOY & GAIMARD, Voy. Astrolabe, Zool. 3, p. 195, pl. 65, fig. 12-14 (*Neritina communis*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 269 (*Neritina communis* and *elegantina*).
- ?1849. MOUSSON, Land & Süßw. Moll. Java, p. 80, pl. 12, fig. 4 (*Neritina communis*).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 319 (*Neritina communis*).
1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 113, pl. 2, fig. 3 and 4, pl. 11, fig. 1-9 (*Neritina communis*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 79 and 307 (*Neritina communis*).
1908. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 3, p. 422 (*Neritina communis*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 264 (*Neritina communis*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 86 (*Neritina communis*).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 103 (*Neritina communis*).

Shell globular, spire somewhat protruding, last whorl large. With pretty colours: straw-yellow, red, white etc. and darker spiral bands of

continuous or interrupted spots or flames. Finely sculptured by the growth striae, somewhat shining. Thick, not transparent. Just as in *Neritina turrita* the epidermis is reticulated by fine, microscopical spiral and vertical striae.

Whorls about four, rapidly increasing in size. Last whorl large and spacious. Apex generally sunken between the later whorls, or, if protruding, appearing as a smooth, yellowish point. Umbilicus closed. Suture descending towards the aperture.

Aperture moderately oblique, broad semilunar. Columellar side broad, porcellaneous, white. Along the entrance to the aperture the columellar edge is slightly concave in the middle. It is finely serrated by 10-15 small denticulations. Exterior margin sharp, sometimes with thickened internal ridge.

Operculum with the exterior surface whitish or light flesh-coloured, with narrow orange zone along the exterior edge. Interior surface somewhat darker, light-brown or pink, with two apophyses. The superior one is a slightly curved ridge, ending in a thick, somewhat bifurcate knob, the inferior one is a round peg on a broad base. Even of highly coloured shells the operculum is not more coloured than in the dull shells.

• Dimensions: height 16-18, width 14-16, height of aperture about 12 mm.

Distribution: especially in the eastern part of the Malay Archipelago. Also in the Philippines.

Habitat in Java: almost nothing is known of the habitat of this species in Java. Of its occurrence in the recent fauna no more details are known than "Java". *Neritina waigiensis* has been recorded as a fossil from Pleistocene layers in East Java (VAN BENTHEM JUTTING, 1937).

Neritina violacea (GMELIN, 1790) (fig. 21).

1790. GMELIN, Syst. Nat. Ed. XIII, p. 3686 (*Nerita violacea*).
1822. LAMARCK, Hist. Nat. Anim. s. Vert. Vol. 6, Part 2, p. 186 (*Neritina crepidularia*).
1836. BENSON, Journ. As. Soc. Bengal, 5, p. 748 (*Neritina cornucopia*).
1837. TROSCHER, Arch. Naturgesch. 3, p. 179 (*Neritina melanostoma*).
1850. RÉCLUZ, Journ. de Conch. 1, p. 65, pl. 3, fig. 3 (*Neritina exaltata*).
1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 37, pl. 7, fig. 1-14 (*Neritina crepidularia*, inclus. vars. *exaltata*, *cornucopia* = *melanostoma*).
1890. BOETTGER, Ber. Senckenb. p. 162 (*Neritina (Dostia) crepidularia*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 218 and 306 (*Neritina crepidularia*).
1908. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Nat. Hist. Pays-Bas, Vol. 13, Part 3, p. 415 (*Neritina crepidularia* and var. *exaltata*).

1914. KONINGSBERGER, Java zoologisch en biologisch, Part 10, p. 447 (*Neritina crepidularia*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 263 (*Neritina crepidularia*).
1923. OOSTINGH, Meded. Landb. Hooges. Vol. 26, Part 2, p. 34 (*Neritina crepidularia*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Neritina crepidularia*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 269 (*Neritina violacea*).
1953. MERMOD, Rev. Suisse Zool. 60, p. 142, fig. 161 (*Neritina crepidularia*).

Shell thick, semiglobular, nearly symmetrical, consisting of about two whorls. Back very convex, base flat. Top small, aperture wide. Yellowish-brown or greenish, with irregular radiating bands or zigzag lines of black or dark-brown, or violet spots. Sometimes the dark pigment dominates so much that the yellowish-brown colour appears like small veins or drops on a dark background. Old shells almost entirely black, due to the dark periostracum and the incrustations with organic or inorganic matter. Growth striae arranged in semi-circles with the apex as the centre.

Whorls 2 to 2½, difficult to count. Aperture large, semilunar, surrounded by a broad peristome, especially widely expanded on the columellar side. This peristome has a porcellaneous lustre and can be whitish, pink, salmon, yellowish or bluish-black. Columellar side almost flat; along the entrance to the aperture slightly sinuous and with 7-10 small denticles.

Operculum semilunar. From the nucleus a chestnut-brown zone runs along the exterior margin. Parallel with it a dark zone runs at a short distance over the surface to the tip. On the back side the operculum has two processes, a conical lower one with rounded top, and a sharp, sickle-shaped upper one with acute free tip.

Dimensions: length 25, width 18, height 12 mm.

Distribution: India, Malaya, the four Greater Sunda Islands, Bali and Timor, the Philippines, southern Japan, New Caledonia. Not in the Moluccas.

Habitat in Java: living in creeks and rivers where the water is under tidal influence: brackish at high tide and fresh at low tide. KONINGSBERGER (1914) reported it from the Rhizophora region.

West Java: Antjol (*violacea* and *viol. f^a exaltata*); near mouth of the Tji Lamaja (*violacea* and *viol. f^a exaltata*); Djakarta; beach east of canal of Pasar Ikan, (*violacea* and *viol. f^a cornucopia*); Tandjong Priok (BOETTGER, 1890); Muara Tjibuni; Palabuanratu, south coast of West Java (*violacea f^a exaltata*).

Central Java: Tjilatjap; beach near Tegal.

East Java: Patjitan (*violacea f^a exaltata*); Surabaya (*violacea* and *viol. f^a exaltata*); Kali Mas near Surabaya (*violacea* and *viol. f^a exaltata*); Sukalelo near Surabaya; tidal woods near Gendjeran, east of Surabaya

(*violacea* f^a *exaltata*); beach near Bandjaraan, east of Surabaja; Banjuwangi; mouth of the river at Puger (*violacea* f^a *cornucopia*).

The species has also been found in the islands of Nusa Kambangan, Madura, Edam and Purmerend (VAN BENTHEM JUTTING, 1941).

In GMELIN's original description the principal colour variants: with a reddish-brown peristome and columellar callus, or with a dark-grey peristome and columellar callus, were already included. Later authors have separated them as species or varieties. The principal forms are:

forma *cornucopia* BENSON, 1836 (syn. *melanostoma* TROSCHEL, 1837) with an almost black or bluish-black lower surface.

forma *exaltata* RÉCLUZ, 1850 with saffron or salmon coloured peristome and columellar callus.

Both colour forms have been found in Java. In the list of localities their occurrence is indicated.

Neritina turrata (GMELIN, 1790) (fig. 23).

1790. GMELIN, Syst. Nat. Ed. XIII, p. 3686 (*Nerita turrata*).
1822. LAMARCK, Hist. Nat. Anim. s. Vert. Vol. 6, Part 2, p. 187 (*Neritina semi-conica* and *strigilata*).
1842. RÉCLUZ, Rev. Zool. (Soc. Cuvier) 5, p. 74 (*Nerita cumingiana*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich. 1, p. 269 (*Neritina semiconica*).
1849. MOUSSON, Land & Süsw. Moll. Java, p. 80, pl. 12, fig. 11 (*Neritina semiconica*).
1830. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 319 (*Neritina semiconica*).
1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 105, pl. 2, fig. 5 and pl. 11, fig. 18-23 (*Neritina turrata*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 307 (*Neritina turrata*).
1908. SCHEPMAN, Sib. Exp. Monogr. 49-1-a, p. 10 (*Neritina turrata* var. *strigillata* and *N. semiconica*).
1908. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 3, p. 421 (*Neritina turrata*) and p. 422 (*N. semiconica*).
1914. PESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 263 (*Neritina turrata* and *N. semiconica*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Neritina turrata*).
1932. MARTIN, Jaarb. Mijnw. Ned. Ind. Vol. 59 (1930), Verh. IIIe Ged. p. 114 (*Neritina turrata*).
1937. RIECH, Arch. Naturgesch. (N.F.) 6, p. 80 (*Vittina turrata*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 269 (*Neritina turrata*).
1953. MERMOD, Rev. Suisse Zool. 60, p. 151, fig. 166 (*Neritina semi-conica*), p. 153, fig. 167 (*Neritina strigilata*).

Shell glandiform, rather high-conical, with elevated spire and large, inflated last whorl. Light-brown or bluish-grey, with oblique, dark, transverse lines or bands. In some shells the dark bands are so broad that the colour pattern is reversed: fine light lines on a dark background. Sculp-

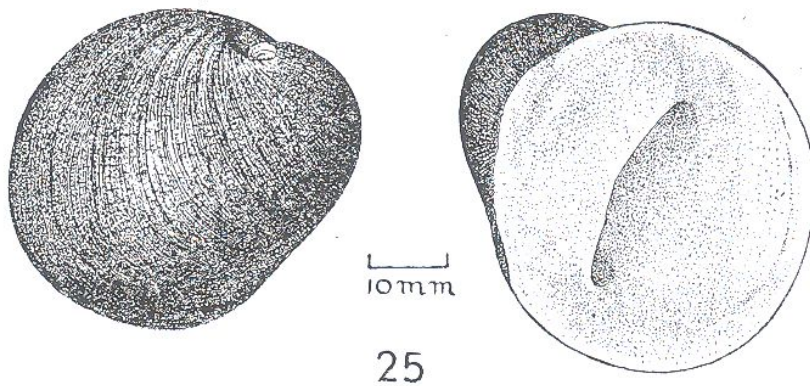
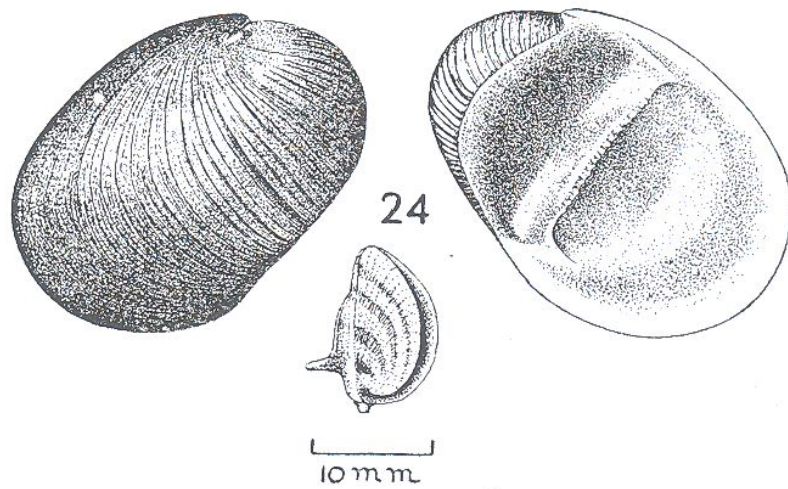
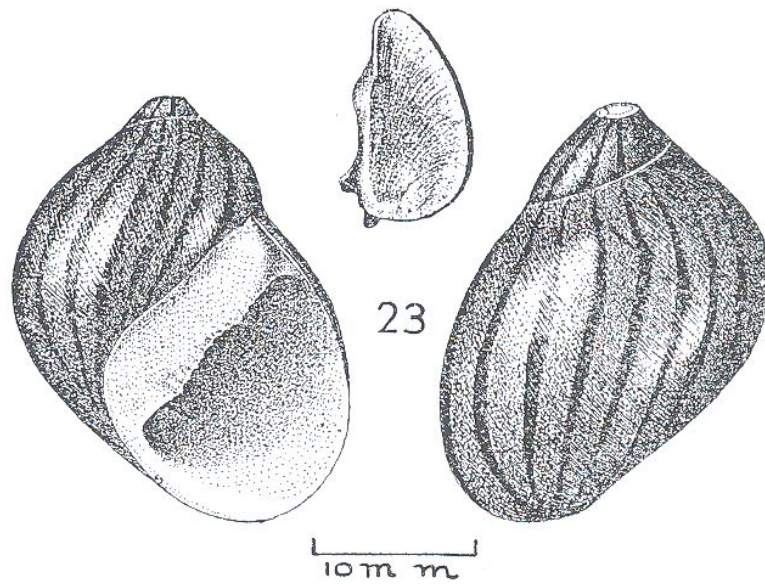


Fig. 23. *Neritina turrita* (GMEL.). Shell from front and back, and exterior of operculum. ABDULKADIR del.

Fig. 24. *Neritina pulligera* (L.). Shell from back and front, and exterior of operculum. ABDULKADIR del.

Fig. 25. *Neritina labiosa* Sow. Shell from back and front. ABDULKADIR del.

tured by fine growth striae. The entire surface is covered by a reticulated epidermis of fine, microscopical and vertical striae. Shell rather thick, not transparent, somewhat shining.

Whorls about 5, rapidly increasing in size. In general convex, but just below the suture slightly concave. Suture shallow. Periphery rounded. Top pointed, but not sharp, base rounded. Umbilicus closed.

Aperture broad, semilunar, rather oblique, bluish-white. Exterior margin of peristome with thick interior rib. Columellar margin callous, porcellaneous, white or yellowish. Along the entrance to the aperture the columellar edge is almost straight, with only a small inflexion in the middle. The margin is serrated with numerous small teeth.

Operculum semilunar, light flesh-coloured or yellowish, with dark-brown zone along the exterior margin. Exterior surface finely granular. From the nucleus a shallow groove curves over the surface, ending at the columellar side, and corresponding with a low ridge on the posterior surface. At the base of the operculum the posterior side bears two apophyses, the upper one as a sickle-shaped ridge with thickened, overhanging crest, the lower one as an oval or round knob on a broad, triangular base. Interior surface of the operculum dark reddish-brown.

Dimensions: height 32-35, width 24-25, height of aperture about 20 mm.

Distribution: from Malaya to Tahiti, including the Malay Archipelago and the Philippines.

Habitat in Java: preferably in running fresh water, but occasionally also in brackish water of estuaries and in the mangrove region.

West Java: Sukabumi (*turrita*); mouth of the Tjimandiri; Palabuan-ratu.

Central Java: Tjilatjap (*turrita* and f^a *semiconica* and f^a *cumingiana*).

East Java: Patjitan, south coast of Madiun (*turrita*).

The species has also been recorded from the islands of Nusa Kambangan (*turrita*, f^a *cumingiana* and f^a *semiconica*) and Madura (VAN BENTHEM JUTTING, 1941).

In a fossil state *Neritina turrita* has been found in tuffaceous layers along the road Djētis-Sidoteko, near Kedungwaru, in East Java (MARTIN, 1932).

Neritina turrita is a very variable species, especially in the colour pattern. The typical form which GMELIN based on a figure in CHEMNITZ, 1786, Conch. Cab. 9, pl. 124, fig. 1085, has broad, oblique dark stripes on a light background. The interstices between the stripes are of about equal width as the stripes themselves. This is the same colour pattern

which LAMARCK (1822) called *Neritina strigilata*. Hence *N. strigilata* LAMARCK is a synonym of *N. turrita* (GMELIN).

In addition to this colour pattern there are two other colour variants of typical *Neritina turrita*: 1. the narrowly striped forma *cumingiana* RÉCLUZ and 2. the forma *semi-conica* LAMARCK with 3 or 4 spiral rows of dark spots on a bright-brown background. All three colour forms have been found in Java. In the list of localities their occurrence is indicated.

Various shells of the *semi-conica* colour pattern start their development with the pattern of the typical broadly striped type, changing to the spiral rows of dark dots or chevrons after two whorls. This fact proves the dubious value of a classification based on colour pattern alone.

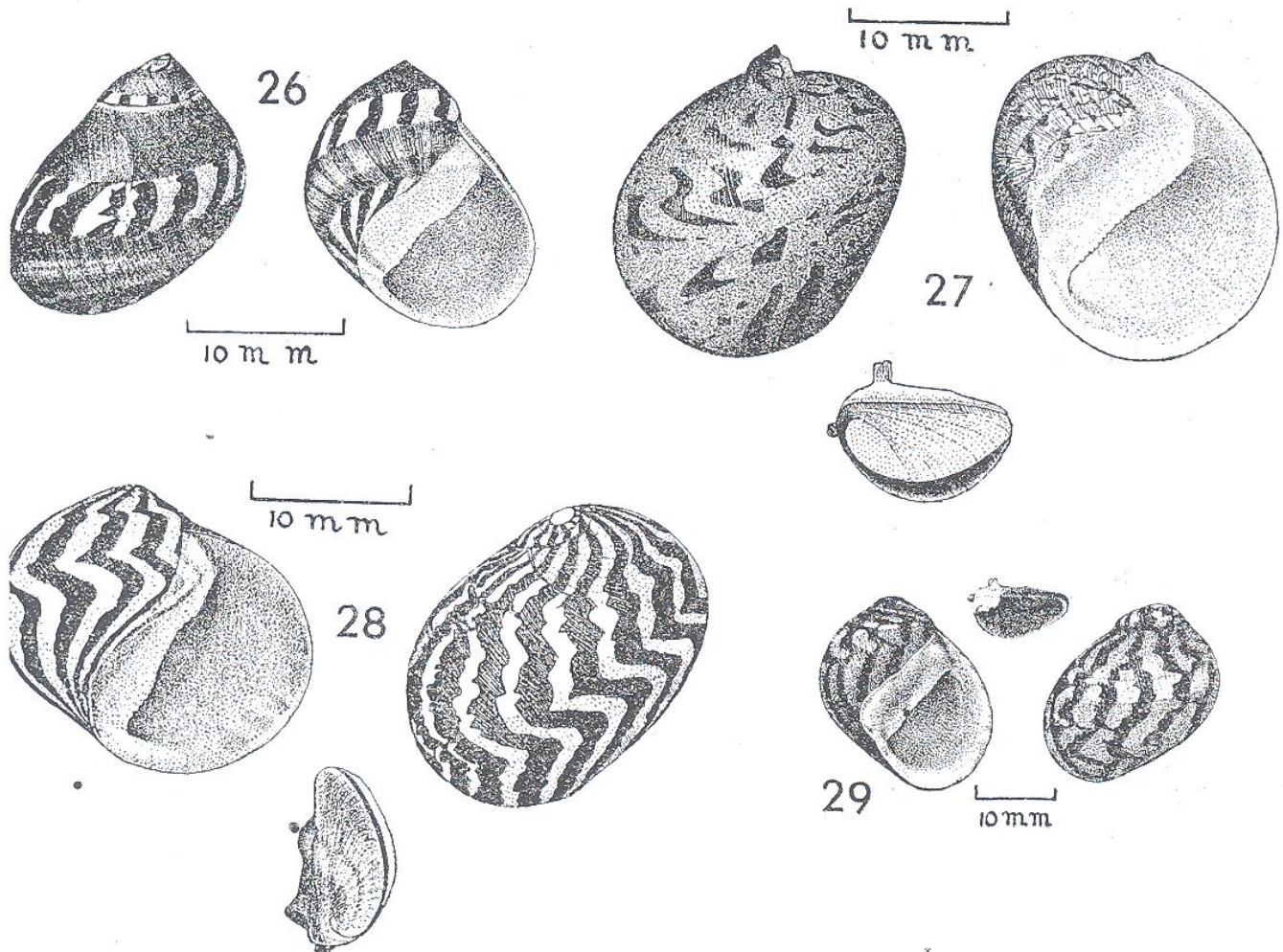
Neritina variegata LESSON, 1831 (fig. 29).

1831. LESSON, Voy. Coquille, Zool. 2, p. 378.
1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 98, pl. 10, fig. 11-17.
1891. BOETTGER, Ber. Senckenb. p. 248.
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 78 and 307, pl. 10, fig. 14.
1908. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 3, p. 420.
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87.
1937. RIECH, Arch. Naturgesch. (N.F.) 6, p. 77 (*Vittina*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 269.

Shell globular, with very small spire and inflated last whorl. Surface smooth, only sculptured by the growth lines. Ground colour yellowish-brown or olive-brown, generally with darker zigzag markings, or with a dark network. In some shells the dark markings dominate, in others the lighter ground colour. There can also occur a tendency to form dark spiral bands. Thick, little or not transparent.

Whorls about three, the first one or two often entirely surrounded by the following ones, so that they are hardly visible exteriorly. Yet there are also shells in which the apex is protruding normally. Suture shallow. Below the suture the whorls are first somewhat concave, but later on convex. Umbilicus closed.

Aperture oblique, semilunar. Columellar side of aperture broad, white or greyish, with darker cloudy spots at the side where the penultimate whorl shines through, and with an orange-red spot in the lower left corner. Occasionally this last spot can be weak or almost invisible. Along the entrance to the aperture the columellar margin is straight, or slightly concave in the middle. In this central region the edge bears 6-10 very



- Fig. 26. *Neritina waigiensis* (LESS.). Shell from back and front. ABDULKADIR del.
 Fig. 27. *Neritina squamipicta* (RÉCL.). Shell from back and front, and exterior of operculum. ABDULKADIR del.
 Fig. 28. *Neritina zigzag* LAM. Shell from front and back, and exterior of operculum. ABDULKADIR del.
 Fig. 29. *Neritina variegata* LESS. Shell from front and back, and exterior of operculum. ABDULKADIR del.

weak serrations. Exterior margin of the aperture sharp, in full grown shells somewhat thickened interiorly.

Operculum: exterior surface black, with a white spot at the base and sometimes a narrow white zone along the exterior margin. A very faint depression curves from the nucleus obliquely over the surface. This groove corresponds with a low ridge on the interior surface. At the back the operculum bears two apophyses. The lower one is short, like a round peg on a broad base, the upper one is long and sickle-shaped, with the free tip excavated like a spoon.

Dimensions: height about 25, width 20-28, height of aperture 18 mm.

Distribution: widely distributed from the Nicobar Islands to Tahiti. Common in the Indo-Australian Archipelago in any island which has been investigated.

Habitat in Java: mostly in fresh water.

West Java: Anjer (MARTENS, 1879); Tandjong Priok (BOETTGER, 1891); near Wijnkoopsbay; mouth of the Tjimandiri, south coast of West Java; Kaliputjang near Pangandaran, along Dirk de Vriesbay.

Central Java: Bagelen; Tjilatjap.

East Java: Puger.

Neritina variegata has also been recorded from the islands of Nusa Kambangan and Madura, close to the coast of Java (VAN BENTHEM JUTTING, 1941).

Neritina pulligera (LINNÉ, 1767) (fig. 24).

1767. LINNÉ, Syst. Nat. Ed. XII, p. 1253 (*Nerita pulligera*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 269 (*Neritina iris*).
1849. MOUSSON, Land & Süßw. Moll. Java, p. 81, pl. 12, fig. 10 (*Neritina iris*).
1849. SOWERBY, Thes. Conch. 2, p. 513, pl. 114, fig. 162 (*Neritina sanguinea*).
1859. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 18, p. 425 (*Neritina petiti* non *N. petiti* RÉCLUZ).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 319 (*Neritina iris*).
1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 49, pl. 1, fig. 4-5 (*Neritina pulligera*) and p. 52, pl. 9, fig. 5 and 6 (*N. iris*).
1890. BOETTGER, Ber. Senckenb. p. 162 (*Neritina pulligera*).
1891. BOETTGER, Ber. Senckenb. p. 248 (*Neritina iris*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 77 and 306 (*Neritina pulligera* and *iris*).
1899. DAUTZENBERG, Ann. Soc. Roy. Malac. Belg. 34, p. 23, pl. 1, fig. 12 (*Neritina pulligera* var. *sumatrana*).
1908. SCHEPMAN, Sib. Exp. Monogr. 49-1-a, p. 9 (*Neritina pulligera* var. *sumatrana*).
1908. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, part 3, p. 416 (*Neritina pulligera* and *iris*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 263 (*Neritina iris* and *pulligera*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Neritina iris* and *pulligera*).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 103 (*Neritina pulligera*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 270 (*Neritina pulligera*).

Shell semi-globular, with round back and flat base. It consists of 1-2 whorls. Top very small, sunken, and surrounded by the last whorl. Aperture very wide. Greenish-brown with darker brown reticulations and zigzag lines, covered by a strong, dark-brown or black epidermis. Sculptured by growth lines and spiral striae, the latter often obsolete.

Aperture large, semilunar, oval or ear-shaped. Surrounded by a broad peristome which is yellow, orange or bluish-black. Along the entrance to

the aperture the columellar edge is slightly sinuous, with about 24 fine denticulations. Columellar callus thick and broad, porcellaneous, with fine granulations, bluish-black with occasional orange tinge.

Operculum semilunar, nucleus at left hand base. From the nucleus irregular light and dark greenish zones radiate over the exterior surface. Posterior surface with two apophyses, a conical peg with rounded top at the base, and a sharp, sickle-shaped ridge above it. The ridge is longitudinally grooved.

Dimensions: height, at the same time height of aperture, 28-30, width about 35-40 mm.

Distribution: Malay Archipelago, Philippines, Northern Australia, various Pacific islands.

Habitat in Java: in rivers, mostly in fresh water.

West Java: Djakarta (BOETTGER, 1890); Kampong Macassar; Tji Salak; Sukabumi; Palabuanratu, Sindangbarang; Pameungpeuk.

Central Java: Bagelen; Tjilatjap.

Neritina pulligera has also been recorded from the islands of Nusa Kambangan and Madura. Besides from the Thousand Islands north of the coast of West Java.

As a fossil the species was found in Pleistocene layers in East Java (VAN BENTHEM JUTTING, 1937).

Neritina pulligera has a very variable shell, both in shape and in colour. This has given rise to the creation of several different "species" which in fact, are not more than local modifications. Unless a more satisfactory insight is obtained on the factors which cause their origin they cannot be classified as geographical or oecological subspecies, but must be regarded as occasional variants. One of the most striking forms is *Neritina pulligera* forma *sumatrana* DAUTZENBERG (1899). It was described from specimens from the River Indrapura, West Sumatra. These shells were distinguished by three characters: 1. the columellar callus is uniformly dark bluish-black, 2. the inside of the exterior lip is only weakly stained with yellowish-orange, 3. the operculum is flesh-coloured, without the greenish rays. This form has also been found in Java.

Specimens with a reddish-brown, instead of bluish-black, columellar callus have been distinguished as *Neritina iris* MOUSSON or *N. sanguinea* SOWERBY. It is possible that *N. petiti* mentioned by ZOLLINGER (1859) is a similar form with red columella. If not, the record is erroneous for Java, *N. petiti* RÉCLUZ being a species from the Philippines and the Moluccas.

MARTENS (1897, p. 306, list) mentioned the occurrence of *Neritina bruguieri* RÉCLUZ from Java. This record was afterwards quoted by LESCHKE (1914, p. 262) and by myself (1929, p. 86). RIECH (1937, p. 73) united *N. bruguieri* as understood by MARTENS (1879, p. 59) with *N. pulligera*, a fact which I can fully confirm. Whether *N. bruguieri* MARTENS (1879 and 1897) is identical with the original conception of RÉCLUZ I cannot prove.

Neritina squamipicta (RÉCLUZ, 1843) (fig. 27).

1843. RÉCLUZ, Proc. Zool. Soc. London, p. 169 (*Nerita*).
- 1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 62, pl. 5, fig. 9-11.
1908. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 3, p. 417.
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87.
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 270.

Shell semi-globular, the spire and the apex entirely concealed by the last whorl, forming a false apex. At this point the aperture-margin can even form a small elevated fold. Last whorl large and spacious. Surface smooth, only sculptured by the growth lines. Thick, little or not transparent. Olive-brown, with fine reticulations and four smoky spiral bands. Shell involute, whorls not visible exteriorly. It is not possible to count the number of whorls. Suture reduced to a point on the apex of the shell. Periphery rounded. Umbilicus closed.

Aperture oblique, broad semilunar. Columellar side of the aperture broad, white, greyish or yellowish. Along the entrance to the aperture the columellar side is slightly sinuous in the middle. In this part it bears about 10-15 minute serrations. Exterior margin of aperture sharp, in fully mature shells somewhat thickened interiorly.

Operculum semilunar, nucleus at left hand base. Light flesh-colour, and with a dark margin along the exterior edge. Posterior surface with two apophyses, a conical peg with rounded top at the base, and a sharp, sickle-shaped ridge above it. The ridge is longitudinally grooved.

Dimensions: height 22-24, width 24-30, height of aperture about 21 mm.

Distribution: MARTENS (1879, p. 63) recorded this species from the Philippines and, with some doubt, from Guam island. It has also been found in New Caledonia (FRANC, 1954, Bull. Mus. Nat. Hist. Nat. Paris (2) 26). In the Malay Archipelago only known from Java and Madura.

Habitat in Java: almost nothing is known of the habitat of this species in Java.

West Java: Sukabumi.

***Neritina zigzag* LAMARCK, 1822 (fig. 28).**

1822. LAMARCK, Hist. Nat. Anim. s. Vert. Vol. 6, Part 2, p. 185.
 1879. MARTENS, in: MART-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 101, pl. 10, fig. 20-24, pl. 2, fig. 6-7 (*ziczac*).
 1908. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 3, p. 420 (*ziczac*).
 1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 264.
 1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*ziczac*).
 1953. MERMOD, Rev. Suisse Zool. 60, p. 135, fig. 157.

Shell globular, with little protruding spire and large aperture. Yellowish-brown, olive, dark-red or violet, with dark transverse zigzag markings. In a certain respect the shell somewhat resembles that of *Neritina turrita* or *N. communis*, but the fine reticulated epidermis of these two species never occurs in *N. zigzag*. Finely striated by the growth striae. Somewhat glossy, thick, not transparent.

Whorls about four, rapidly increasing in diameter, the last one large and spacious. Below the suture the whorls are slightly concave, later on rounded again. Suture shallow. Apex smooth, light-yellow, not sunken.

Aperture very oblique, broad semilunar. Columellar side broad, porcelaneous, greyish or light-pink. Along the entrance to the aperture the columellar edge is slightly concave, and bears about 10 small denticulations. Exterior margin sharp, sometimes with thickened internal ridge.

Operculum: exterior surface white or light flesh-coloured, with a narrow orange zone along the exterior edge. Posterior surface light-brown or orange, with two apophyses. The upper one is a slightly curved ridge, the lower one a rounded peg on a broad base.

Dimensions: height 20-22, width 18-20, height of aperture about 17 mm.

Distribution: from Sumatra to Polynesia, including the Philippines. Recorded from several islands in the Malay Archipelago.

Habitat in Java: Although mostly living in fresh water, it does not avoid brackish water of estuaries.

West Java: Anjer; mouth of the Tji Mandiri, south coast of West Java; Palabuanratu.

***Neritina labiosa* SOWERBY, 1836 (fig. 19 and 25).**

1836. SOWERBY, Conch. Ill., no. 49, fig. 48.

1879. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10, p. 20, pl. 5, fig. 5-8, pl. 1, fig. 8-9.

1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87.

Shell large and wide, rounded above and flat below. It consists of 1½-2 whorls. Spire very small. Greenish-brown, with darker brown reticulations or flames, covered by a thick, black epidermis. Sculptured by growth striae and spiral striae, the latter somewhat undulating, and alternatively strong and weak.

Aperture large, semilunar or ear-shaped. Surrounded by a much expanded peristome which is flesh-coloured or orange. Columellar side of aperture with slightly sinuous edge, without denticulations. Columellar callus broad, smooth, porcellaneous, flesh-coloured or orange.

Operculum (fig. 19) calcareous, thick, semilunar, nucleus at left hand base. From the nucleus a brown margin runs along the exterior of the operculum. Parallel and at a short distance from it an orange zone curves from the nucleus to the tip. On the posterior side the upper apophysis is a strong, rather broad, ridge, with longitudinal grooves. Below it at the basal margin the usual peg-shaped apophysis is replaced by an elevated crest with 7-8 strong teeth.

Dimensions: height, at the same time height of aperture, 45-50, width 48 mm.

Distribution: the species seems to be rare, it has only been recorded from the Philippines, northern Celebes, Amboina and Jáva. The subspecies *melanesica* RIECH (1937, Arch. Naturgesch. (2) 6) from Nova Pommerania.

Habitat in Java: on stones, in rivers, in running water.

West Java: mouth of the Tji Mandiri, south coast of West Java; Sukabumi; Palabuanratu.

East Java: Surabaja.

The very young specimens of *Neritina labiosa* have a greyish-green, instead of an orange-red interior of the aperture.

Doubtful species of Neritinae

ZOLLINGER (1859, Natuurk. Tijdschr. Ned. Ind. 18, p. 425) recorded a *Neritina pulcherrima* MOUSSON from Bomo in East Java. It is not certain what he meant with this name. MOUSSON never described a *Neritina pulcherrima*.

Genus *Septaria* FÉRUSSAC, 1807(syn. *Navicella* LAMARCK, 1809)

Shell symmetrical, cap-shaped, not spirally coiled, without whorls. Apex at the posterior margin. Aperture very large; septum of the columellar side broad and thin, sometimes sinuous, but never with serrations. Smooth, without spines. Olive-brown to yellowish, with darker reticulations, zigzag lines or longitudinal lines. In the interior a left and a right muscle scar denote where the muscles which keep the animal in the shell are attached.

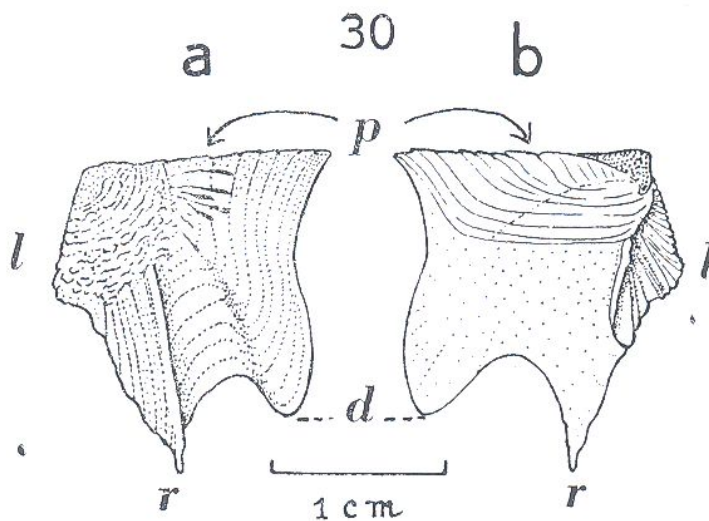


Fig. 30. Operculum of *Septaria*. A. dorsal side, B. ventral side, d. diagonal projection, l. lateral field, p. posterior side, r. rib. Author del.

Columellar side of aperture concave, flattened, shining but not callos. Exterior margin sharp, not thickened or reflected.

Foot large and sucker-like, not retractile into the shell. The animals are unisexual. Radula $\sim 5.1.5. \sim$. The central tooth is a little broader than long. The first lateral is elongate-rectangular. The marginals are serrated with numerous cusps along the cutting edge, up to the tip (fig. 4).

Operculum (fig. 30) much smaller than the aperture, calcareous, as an irregular square plate, with the nucleus at one of the corners. Apophyses of the operculum absent. Exterior surface somewhat shining, interior surface lustreless. Posterior side straight, with dark red-brown margin. The operculum lies in the soft parts in a sac between the foot and the pallial organs. The operculum protrudes from the sack with the dark edge of the posterior side. For the rest it is hidden in the sack and can, therefore, not function as a lid to close the shell.

Distribution: tropical regions of Madagascar, Comoros, Seychelles, Mauritius, Réunion, India, Malay Archipelago, Philippines and many Pacific islands. Always in fresh water, preferably in running water, on stones.

Key to the species living in Java:

1. Apex projecting beyond the posterior margin, and always eroded by usage on the substratum. Shell very broad and thick . . . **borbonica**
— Apex generally not projecting beyond the posterior margin, but if so, it is not eroded by usage on the substrate (although it can be eroded by other causes). Shell never so broad and thick . . . 2
2. Apex slightly curved to the right, somewhat above the posterior margin. Shell broad **porcellana**
— Apex median, at, or just above, the posterior margin. Shell narrow **lineata**

Species of *Septaria* have an extremely variable shell. This is partly due to the form of the substratum on which the animals live. The peristome of the shell follows the irregularities of the stones, branches etc.

Septaria borbonica (BORY DE ST. VINCENT, 1803) (fig. 32).

1803. BORY DE ST. VINCENT, Voy. Iles afric. 1, p. 287 (*Patella borbonica*).
1816. LAMARCK, Encycl. Méth. (Vers) Explic. Planches, pl. 456, fig. 1 (*Navicella elliptica*).
1843. RÉCLUZ, Proc. Zool. Soc. London, p. 157 (*Navicella cumingiana*).
1859. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 18, p. 425 (*Navicella elliptica*).
1881. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10a, p. 10, pl. 1, fig. 4-18 (*Navicella borbonica*) and p. 23, pl. 4, fig. 13-15 (*Navicella junghuhnii*).
1908. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 3, p. 434 (*Septaria junghuhnii*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, pl. 265 (*Septaria junghuhnii*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Septaria junghuhnii*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 271 (*Septaria cumingiana*).
1953. MERMOD, Rev. Suisse Zool. 60, p. 131, fig. 154 (*Navicella elliptica*).

Shell symmetrical, cap-like, without whorls, the apex reaching the posterior margin of the shell and touching the plane of the aperture. The apex is worn off against the substratum. The width of the shell is greater than in *Septaria porcellana* or *S. lineata*. Posterior margin straight, anterior margin a little more pointed-rounded than in *S. porcellana*. Ground colour yellowish-brown or yellowish-green, ornamented with a network of darker threads, making an elegant pattern of triangular, oval, or drop-shaped spots. The entire exterior surface is covered by a thick, dark

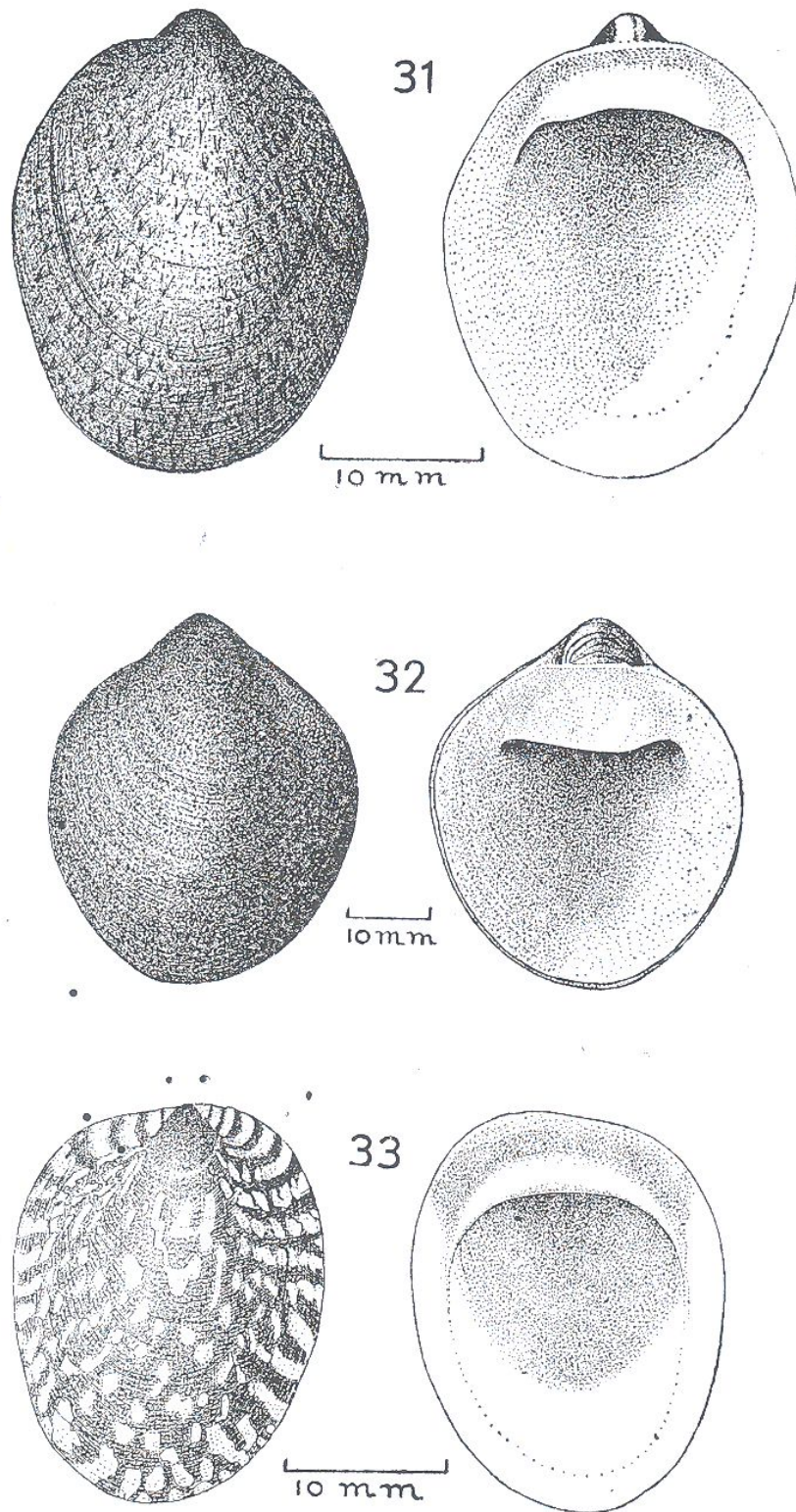


Fig. 31. *Septaria porcellana* (L.). Shell from back and front. ABDULKADIR del.
 Fig. 32. *Septaria borbonica* (BORY). Shell from back and front. ABDULKADIR del.
 Fig. 33. *Septaria lineata* (LAM.). Shell from back and front. ABDULKADIR del.

periostracum, hiding the colour pattern. Parting from the apex the dorsal surface of the shell is concentrically striated with growth rings.

Aperture very large, septum of the columellar side flat, rather narrow, bluish-white, sometimes with an orange-yellow tinge. Along the aperture the columellar margin is straight or somewhat curved, not serrated. Interior of aperture bluish-white. Exterior margin of aperture sharp, not thickened or reflected.

Operculum irregularly squarish, with two straight sides and two sides with pointed lobes. Exterior surface clouded with black and dull reddish-brown. In the angle between the two straight sides the operculum is granular. Interior of about the same colour as the exterior, the dark colour dominating. Along the shorter of the two straight sides there is a broad triangle with radiating ridges. Along the longer of the two straight sides there is a smooth zone, somewhat different in structure from the rest of the interior surface.

Dimensions: length 33-35, height about 14 mm.

Distribution: widely distributed in the oriental tropics: Madagascar, Comores, Seychelles, Réunion, Mauritius, India, Malay Archipelago, Philippines, various Pacific Islands.

Habitat in Java: almost nothing is known of the natural conditions under which this species lives in Java.

West Java: southern Bantam.

East Java: Bomo river.

Septaria borbonica has also been recorded from the island of Madura, off the north coast of East Java (VAN BENTHEM JUTTING, 1941).

Although somewhat variable in shape and colour pattern, the shell of *Septaria borbonica* does not show such great divergence in form and colour as either *S. porcellana* or *S. lineata*.

***Septaria porcellana* (LINNÉ, 1758) (fig. 31).**

1758. LINNÉ, Syst. Nat. Ed. X, p. 781 (*Patella porcellana*).
1825. SOWERBY, Catal. Tankerville Coll. App. p. X, (*Navicella suborbicularis*).
1831. LESSON, Voy. Coq. Zool. 2, p. 386 (*Navicella depressa*).
1881. MARTENS, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 2, Part 10a, p. 31, pl. 6, fig. 5-14 (*Navicella suborbicularis* and var. *furcato-radiata*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 84 (*Septaria suborbicularis* and vars. *furcato-radiata* and *compressa*).
1908. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 3, p. 435 (*Septaria suborbicularis* and vars. *compressa* and *furcato-radiata*).
1912. SCHEPMAN, Proc. Malac. Soc. London, 10, p. 238 (*Septaria suborbicularis* and subvar. *furcato-radiata*).

1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 265 (*Septaria suborbicularis* and subsp. *fuscato-radiata* sic!).
1923. OOSTINGH, Meded. Landb. Hoogesch. Vol. 26, Part 3, p. 38 (*Septaria suborbicularis*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 87 (*Septaria suborbicularis* and var. *furcato-radiata*).
1937. RIECH, Arch. Naturgesch. (N.F.) 6, p. 66 (*Septaria borbonica suborbicularis*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 271 (*Septaria suborbicularis*).

Shell symmetrical, cap-shaped, without whorls, the apex at the posterior side, slightly curved to the right. The apex lies just above the posterior margin. It is often eroded, but not by wear against the supporting surface, as in *Septaria borbonica*. Posterior margin straight, anterior rounded. Ground colour yellowish-brown or yellowish-green, the apical region somewhat violet. Ornamented with a network of dark threads, making an elegant pattern of small triangular, oval or drop-shaped spots. Occasionally specimens with dark, radiating, forked striae occur among the normally coloured ones. The whole exterior surface is covered by a fibrous, olive epidermis. Parting from the apex the dorsal surface is concentrically striated with growth rings.

Aperture very large, septum of the columellar side flat, rather narrow. Bluish-white or yellowish. Along the aperture the columellar margin is straight or slightly concave, not serrated. Interior of aperture bluish-white. Exterior margin of the aperture sharp, not thickened or reflected.

Operculum calcareous, of almost the same shape as in *Septaria borbonica*.

Dimensions: length 30-32, height 10-12 mm.

Distribution: widely distributed in the Indo-Malayan region, from Ceylon to various Pacific islands, including the Philippines and the Malay Archipelago.

Habitat in Java: in fresh water of rivers and lakes, in the lowlands.

West Java: Sukabumi; beach of Wijnkoopsbay near Tjisolak; Palabuhanratu; Pameungpeuk; Tjisalak; Cheribon, Kaliputjang near Pagan-daran, along Dirk de Vriesbay.

East Java: Kali Bomo, south of Banjuwangi (MARTENS, 1881); Besuki.

The species has also been recorded from the islands of Nusa Kambangan, Madura, Amsterdam and Middelburg (VAN BENTHEM JUTTING, 1941).

The shell of *Septaria porcellana* is very variable in shape and colour. The shape largely depends on the nature of the supporting surface. In this way narrow or broad, long or short, high or low shells can be formed.

The colour pattern can also show great variation. The meshes of the network can be wide or narrow, sometimes coalescing, sometimes appearing as zigzag or chevron-shaped markings.

In this way the forma *depressa* LESSON and *compressa* MARTENS are modifications in shape, the forma *furcato-radiata* MARTENS is a colour variant. So long as we are unable to explain the factors which are responsible for these modifications, it does not seem wise to give them sub-specific rank.

When describing *Patella porcellana*, LINNÉ (1758) referred to RUMPHIUS, Amboinsche Rariteitkamer, 1705, pl. 40, fig. O. In his description, p. 123, RUMPHIUS called these shells "nootedoppen" (= nut shells) and added (translated by me): "One would regard these as a single valve of a lamellibranch, because they have a top on one side as if it were the umbo of a bivalve. Yet this is not so; they stick against the cliffs with the open side. On the back they are painted like small chicken feathers."

Septaria lineata (LAMARCK, 1816) (fig. 4 and 33).

1816. LAMARCK, *Encycl. Méth. (Vers) Explic. Planches*, pl. 456, fig. 2 (*Navicella lineata*) and fig. 3 and 4 (*Navicella tessellaria*).
1822. LAMARCK, *Hist. Nat. Anim. s. Vert. Vol. 6, Part 2*, p. 182 (*Navicella lineata* and *tessellata*).
1842. RÉCLUZ, *Proc. Zool. Soc. London*, p. 157 (*Navicella clypeolum*).
1848. MOUSSON, *Mitth. naturf. Ges. Zürich*, 1, p. 268 (*Navicella maculifera*).
1849. MOUSSON, *Land & Süßw. Moll. Java*, p. 85, pl. 12, fig. 13 (*Navicella maculifera*).
1856. REEVE, *Conch. Icon. Vol. 9*, pl. 5, fig. 20 (*Navicella reticulata*).
1860. ZOLLINGER, *Natuurk. Tijdschr. Ned. Ind.* 21, p. 317 (*Navicella maculifera*).
1881. MARTENS, in: MART.-CHEMN. *N. Syst. Conch. Cab. Vol. 2, Part 10a*, p. 37, pl. 7, fig. 8-17, pl. 8, fig. 1-9 (*Navicella tessellata* and var. *oblonga*).
1897. MARTENS, in: WEBER, *Erg. Reise Nied. Ost Indien.* 4, p. 86 (*Septaria tessellata* var. *clypeolum*).
1908. HORST & SCHEPMAN, *Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 3, Part 3*, p. 435 (*Septaria tessellata* var. *clypeolum*), p. 436 (*S. tess.* vars. *compressa* and *lineata*).
1914. LESCHKE, *Mitt. naturhist. Mus. Hamburg*, 31, p. 266 (*Septaria tessellata* and vars. *clypeolum* and *oblonga*).
1929. VAN BENTHEM JUTTING, *Treubia* 11, p. 87 (*Septaria tessellata* and vars. *clypeolum* and *oblonga*).
1937. RIECH, *Arch. Naturgesch. (N.F.)* 6, p. 68 (*Septaria tessellata* sic!).
1941. VAN BENTHEM JUTTING, *Arch. néerl. Zool.* 5, p. 271 (*Septaria tessellata*).
1953. MERMOD, *Rev. Suisse Zool.* 60, p. 133, fig. 155 (*Navicella lineata*) and p. 134, fig. 156 (*Navicella tessellata*).

Shell symmetrical, cap-like, without whorls, the apex at the posterior side, at, or just above, the posterior margin. The apex can be much eroded, but never by wear against the supporting surface. Posterior margin

straight, anterior rounded, or truncated with rounded corners. Ground colour yellowish-brown or yellowish-green, somewhat reddish-violet towards the apex. Ornamented with longitudinal dark lines or bands, disposed in fan shape. Instead of longitudinal lines, or in addition to them, the shell surface can be covered by a reticulate pattern of flames, drops or zigzag lines. The whole shell exterior is covered by a fibrous, black or olive epidermis. Parting from the apex the dorsal surface is concentrically striated with growth rings.

Aperture very large. Septum of the columellar side flat or a little concave, rather narrow. Bluish-white or yellowish. The columellar margin along the aperture is straight or slightly concave, not serrated. Interior of aperture bluish-white to bluish-black. Exterior margin of aperture sharp, not thickened or reflected.

Operculum similar to that of *Septaria borbonica*.

Dimensions: length 24-25, height 4-6 mm.

Distribution: Malay Archipelago, Philippines, New Guinea, Pacific islands.

Habitat in Java: in fresh water of lakes and rivers, in the lowlands.

West Java: Sukabumi; Palabuan (*lineata* and f^a *clypeolum* and f^a *maculifera*); River Panimbang in Bantam (MOUSSON, 1849).

Septaria lineata has also been recorded from the island of Madura, off the north coast of East Java (VAN BENTHEM JUTTING, 1941).

As in *Septaria porcellana* the shell of *S. lineata* is very variable in shape and colour, dependent on the nature of the substratum. This resulted in modifications in shape (forma *clypeolum* RÉCLUZ and forma *oblonga* MARTENS) and in colour variants (forma *tessellata* LAMARCK, forma *maculifera* MOUSSON, or forma *reticulata* REEVE). Whether these variants are hereditary and locally constant has still to be investigated.

Family VIVIPARIDAE

Shell small to moderately large, pyramidal or low-turreted, with pointed apex and rounded base. Most species are little sculptured, in some species (but not in the Javanese ones) the shells bear strong spiral or vertical ridges. Umbilicus narrow or closed.

Aperture broad-ovate. Peristome continuous or interrupted, rounded or somewhat extended at upper and lower side, or at both.

Operculum corneous, concentrically ringed. Nucleus central or nearly so.

The sexes are separate. Reproduction takes place by eggs which hatch already in the vaginal tract of the female (ovo-vivipary).

Radula 2.1.1.1.2. There is one pair of mandibles.

Distribution: all continents, with the exception of South America, from the tropics to boreal, or even arctic waters. Mostly in fresh water.

The species of Europe, Asia Minor, northern Asia and North America belong to the subfamily Viviparinae, the African, tropical Asiatic and Australian species to the subfamily Bellamyinae. The two subfamilies differ in the male sexual gland which is entirely interwoven with the digestive gland in the Viviparinae, but free from the digestive gland in the Bellamyinae. Besides the embryonic whorls in the Viviparinae are banded, but not banded in the Bellamyinae.

Genus *Bellamyia* JOUSSEAUME, 1886

Shell conoidal, rather inflated, thin, little or not transparent. With one or more obtuse spiral ridges or keels. Top pointed, base rounded, periphery rounded or angular. Embryonic whorls not banded, even in species where the adult shells are spirally banded. Umbilicus narrow, in some species entirely closed.

Aperture broad-oval, without siphonal canal. Operculum of the same form, horny, consisting of concentric rings round a slightly excentric nucleus. The operculum is somewhat depressed in the central region.

Animal light-grey, spotted with yellow and dark-grey specks. Proboscis short, cylindrical. Eyes on small knobs at the exterior bases of the tentacles. The sexes are separate. In the males the right tentacle is different from the left one. It functions as a copulatory organ. The male sexual gland is separate from the mid-gut gland. Eggs hatch already in the vaginal tract of the female (ovo-vivipary). Radula 2.1.1.1.2. Cusps of all teeth weak. The rhachis has no cups in the lateral basal corners (fig. 34).

Distribution: tropical and subtropical regions of Asia, Africa and Australia. In the Malay Archipelago common in the Greater Sunda Islands, rarer (although not absent) in the Lesser Sunda Islands and the Moluccas. In fresh water, running or stagnant.

Locally species of *Bellamyia* are used for food of man and domestic animals, chiefly ducks (ALONTE, 1930, Philipp. Journ. Sci. 19, p. 307), or as bait for fishing.

In Java there are two species:

1. Shell rather slender (but not so slender as in *B. javanica*), colour vivid-green (more bright-green than in *B. javanica*), with distinct spiral colour bands *sumatrensis*
- Shell slenderer than in *B. sumatrensis*, colour more brownish-green, or yellowish-green, spiral colour bands diffuse or missing . . . *javanica*

Bellamyia javanica (VON DEM BUSCH, 1844) (fig. 34 and 35).

1844. VON DEM BUSCH, in PHILIPPI, Abb. & Beschr. 1, Paludina, p. 114, pl. 1, fig. 11-12 (*Paludina*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268 (*Paludina javanica*).
1849. MOUSSON, Land & Süßw. Moll. Java, p. 61, pl. 8, fig. 3-4 (*Paludina javanica* inclus. forma *scalaroidea*, *albomarginata* and *nigromarginata*), p. 62, pl. 8, fig. 5 (*Paludina angularis non angularis* Müller).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 318 and 320 (*Paludina javanica* and *angularis*).
1863. REEVE, Conch. Icon. Vol. 14, pl. 11, fig. 70 (*Paludina virescens*).
1874. TAPPARONE CANEFRI, Mem. Reale Accad. Scienze Torino (2) 28, p. 51 (*Paludina javanica*).
1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 20 (*Paludina chinensis* var. *richthofeni*), p. 23 (*Paludina javanica* and *P. jav.* var. *minor*).
1890. BOETTGER, Ber. Senckenb. p. 154, pl. 6, fig. 5 (*Paludina chinensis* var. *richthofeni*), p. 155 (*Paludina javanica*).
1891. BOETTGER, Ber. Senckenb. p. 249 (*Paludina chinensis* var. *richthofeni* and *P. javanica*).
1894. MARTENS, Jen. Denkschr. 8, p. 83 (*Paludina javanica*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 21 (*Vivipara javanica* and *V. costata* var. *laevior*), p. 22 (*Vivipara javanica* var. *moussoni*).
1898. SARASIN & SARASIN, Süßw. Moll. Celebes, p. 60 (*Vivipara costata* var. *laevior* est *V. javanica*).
1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 314 (*Paludina javanica* and *P. jav.* var. *moussoni*).
1904. BULLEN, Proc. Malac. Soc. London, 6, p. 110, pl. 6, fig. 3 (*Vivipara rouyeri*).
1905. MARTIN, Samml. Geol. Reichsmus. Leiden (N.F.) 1, p. 249-250, pl. 37, fig. 601-604 (*Paludina javanica* var.).
1907. MARTIN, N. Jahrb. Mineral. 100, II, p. 161 (*Paludina javanica*).
1908. MARTIN, Versl. gew. Verg. Kon. Akad. Wet. Amst. (Natuurk.) 17, p. 14 (*Paludina javanica*).
1908. BRANCA, Sitz. Ber. Kgl. Preuss. Akad. Wiss. Berlin, p. 270 (*Paludina javanica*).
1908. KOBELT, in: MART.-CHÉMN. N. Syst. Conch. Cab. Vol. 1, Part 21 (N.F.) p. 251, pl. 5, fig. 7-10, pl. 52, fig. 1-7 (*Vivipara javanica*), p. 255, pl. 52, fig. 8-9, (*Viv. jav. richthofeni*), p. 256, pl. 52, fig. 10-11 (*Viv. jav. moussoni*), p. 257, pl. 53, fig. 1-2 and pl. 55, fig. 8-9 (*Viv. jav. scalaris*), p. 257, pl. 53, fig. 3, 4, 19, 20 (*Viv. jav. borneensis*), p. 258, pl. 53, fig. 5, (*Viv. jav. rouyeri*), p. 259, pl. 54, fig. 16, 19, pl. 53, fig. 23 (*Viv. jav. virescens*), p. 262, pl. 54, fig. 9, 10 (*Viv. hortulana*).
1911. MARTIN-ICKE, Pithecanthr. Schichten Java, p. 50 (*Paludina javanica*).
1911. CARTHAUS, Pithecanthr. Schichten Java, p. 13 (*Paludina javanica*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 220 and 260 (*Vivipara chinensis* var. *richthofeni*, *costata* var. *laevior*, *gratiosa*, *hortulana*, *javanica* incl. var. *moussoni*, *rouyeri*, *scalaris*, *richthofeni*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 98 (*Paludina javanica* var.), p. 139 (*P. javanica*), p. 143 (*P. javanica*).
1923. OOSTINGH, Meded. Landb. Hooges. Vol. 23, No. 3, p. 54 (*Viviparus javanicus* and *Viv. jav. fa moussoni = angularis*).

1924. SCHEIBENER, *Trop. Natuur*, 13, p. 91-93, fig. 1 (*Vivipara javanica*).
1929. VAN BENTHEM JUTTING, *Treubia*, 11, p. 86 (*Vivipara costata* var. *laevior*, *Viv. hortulana*, *Viv. javanica* with vars *moussoni*, *rouyeri* and *scalaris*, *Viv. richt-hofeni*).
1931. VAN ES, Age of Pithecanthropus, on several pages (*Paludina javanica*).
1931. VAN DER VLERK, *Leidsche Geol. Meded.* 5, p. 256 (*Paludina javanica*).
- 1934a. RENSCH, *Zool. Jahrb. (Syst.)* 65, p. 397 (*Vivipara javanica*).
- 1934b. RENSCH, *Trop. Binnengew.* 5, p. 219, pl. 8, fig. 1-12 (*Vivipara javanica*).
1935. OOSTINGH, *Wetensch. Meded. Dienst Mijnb. Ned. Ind.* 26, p. 39 (*Viviparus javanicus*).
1935. PARAVICINI, *Arch. Moll. Kunde*, 67, p. 175 (*Viviparus javanicus*).
1937. VAN BENTHEM JUTTING, *Zool. Meded. Mus. Leiden*, 20, p. 107 (*Viviparus javanicus*).
1939. SANDGROUND, *Geneesk. Tijdschr. Ned. Ind.* 79, p. 1725 (*Viviparus javanicus*).
1941. VAN BENTHEM JUTTING, *Arch. néerl. Zool.* 5, p. 276 (*Viviparus javanicus*).
1941. BONNE, *Natuurwet. Tijdschr. Ned. Ind.* 101, p. 177 (*Viviparus javanicus*).
1947. BONNE, BRAS & LIE KIAN JOE, *Medisch Maandbl.* p. 207-209 (*Viviparus javanicus*).
1948. BONNE, BRAS & LIE KIAN JOE, *Medisch Maandbl.* p. 457, 460 and 462 (*Viviparus javanicus*).
1951. THIENEMANN, *Arch. Hydrobiol. Suppl. Bd.* 19, p. 535 (*Vivipara javanica*), p. 541 (*Vivipara javanica*).
1955. ZILCH, *Arch. Moll. Kunde*, 84, p. 60 (*Bellamyia javanica*), p. 71 (*Bellamyia javanica scalaroidea*).

Shell pyramidal, with elevated spire and rounded base. Brownish-green or yellowish-green under an olive, somewhat fibrous epidermis. Striated with fine undulating transverse lines. In addition there is a spiral sculpture of fine striae and thread-like keels. Of the latter some three to five are more raised than the others. These raised keels, which are for the greater part periostracal, can coincide with narrow spiral colour bands. Periphery angulate or weakly keeled; in fully mature specimens rounded. In fresh shells the surface is moderately glossy.

Whorls 6-7, regularly increasing in size. Suture distinct, but not deep. Top pointed, rather sharp, but often eroded. Base rounded below the peripheral keel. Umbilicus open, but not wide, sometimes bordered by a keel.

Aperture oblique, broad-ovate, somewhat pointed above, rounded or gutter-shaped below. In specimens with a marked peripheral keel (mostly the not fully mature shells) the aperture is angular at that point. Peristome continuous in old shells; in the younger ones there is an interruption on the parietal side where the peristome forms a thin film against the penultimate whorl. Peristome not reflected, sometimes lined with black. The columellar margin is generally thickened in adult shells.

Operculum horny, with a subcentral nucleus. Growth rings concentric. The operculum has the same broad-ovate form as the aperture; it fits at a certain distance up the interior of the aperture.

Dimensions: height 34-40, width 22-26, height of aperture 16-17 mm. A very large shell from Bandung mentioned by BOETTGER (1891) as *Paludina chinensis* var. *richthofeni* had the following dimensions: height 39½, width 31, alt. apert. 20, lat. apert. 16½ mm.

Distribution: all four Great Sunda Islands, and several of the Lesser Sunda Islands, Ambon and the Philippines.

Habitat in Java: very common in lakes, pools, sawahs and rivers.

West Java: mouth of the Tjiringin (MOUSSON, 1849); Udjung Kulon; River Mūrara (TAPPARONE CANEFRI, 1874); River Antjol near Djakarta; beach near Tandjong Priok; beach near canal of Pasar Ikan; environs of Djakarta; kampong Makassar near Djakarta; Bronbeek near Djakarta (SANDGROUND); Djatinegara; sawahs and brook near Depok; sawah near Leuwigadja; sawahs on the estate of Tjiomas, near Bogor; environs of Bogor; Botanical Gardens, Bogor; Tjiliwung near Bogor; Tjiburial, near Bogor; lake near Kuripan; sawahs near Pasauran, Bantam; Lake Danau, Bantam; sawahs near Tjampea; lake Tjisarua near Sindanglaja; sawahs Tjisarua; estate of Tjiliwung, near Puntjak pass; estate of Tjihidung, near Puntjak pass; Tjibodas (PARAVICINI); Djemprak, in brooks, sawahs and ponds; Kemang, in ponds; lake Tjigombong; Tjimatjan, in sawahs, ponds and brooks; Tjibadak near Sukabumi; Sukabumi; Parangkuda near Sukabumi; beach of Pelabuhanratu, near Tjisolak; near waterfall at Tjiandjur, behind the Hospital; Krawang; beach of the Java Sea, near the mouth of the Tjilamaja; Wangun, near Tjisampora, Djampang; Sindangbarang; Telaga Patengan on Mt Patuha; Mt Malabar; sawah near Pengalengan; sawahs near Bandung; brook near Bandung; sawahs near Dago, environs of Bandung; between Lembang and Bandung, in sawahs; Lembang; Mt Tangkuban Prahū; Mt Guntur, near Hack's Radium Hotel; environs of Garut; Kawah Kamodjan, near Garut; Tjipanas near Garut; Tjisurupan, near Garut; Situ Bagendit, near Garut; estate of Bandjarwangi, near Tjikadjang; Mt Tjikorai; Tjiamis; Malangbong; draining ditches on the estate of Pagandaran, near Dirk de Vriesbay; sawahs along road from Sumedang to Bandung; fish ponds near Sumedang; Tjisaaranang, kampong Tjariang, near Sumedang; in sawah near Subang; Palimanan (PARAVICINI, 1935); Cheribon; sawahs near Bungkirit; Kartawinangun, near Madjalengka, in sawah.

Central Java: Tjilatjap; Bagelen; Djeruklegi; Banjumas; along road between Purwokerto and Madjenang, near Karang Putjung; lake in the

southern mountains south of Klaten; water castle at Djokja (MARTENS, 1897); bank of River Solo near Surakarta (MARTENS, 1897); Rawah Pening near Ambarawa; Doro; sawahs near Penawangan; Semarang; in river at Demak; Bloengoen; Rembang; Kali Besèk near Sulang; Tjepu.

East Java: Ngawi; Kali Soko, right tributary river of Kali Solo, near Trinil; lake Ngebel; Kediri; Rawah Galapan, Kediri; waduk of Sumber Kepu, N.N.W. of Kertosono; Rawah Bening, southern Kediri; source of Dander, S of Bodjonegoro; environs of Surabaja; Kali Mas, Surabaja; Sukalelo near Surabaja; Gedangan, S of Surabaja; Lawang; Malang; Singosari near Malang; Kali Brantas near Malang; fish ponds near Punten, Malang (RENSCH, 1934b), Southern Mountains in Pasuruan; Ranu Klindungan (RENSCH, 1934b); Ranu Klakah; Ranu Bedali; Ranu Pakis (RENSCH, 1934b); ponds, sawahs and brooks near Djember; river mouth near Puger; shore of Bali Strait, N. of Banjuwangi (OOSTINGH, 1923).

Bellamya javanica has also been recorded from the islands of Madura, Bawean and Pulu Besar off Rembang (VAN BENTHEM JUTTING, 1941).

Bellamya javanica has been recorded several times in young Pliocene and Pleistocene layers in Central and East Java (MARTIN, 1905, 1907, 1908, 1919; BRANCA, 1908; MARTIN-ICKE, 1911; CARTHAUS, 1911; VAN ES, 1931; VAN DER VLERK, 1931; OOSTINGH, 1935; VAN BENTHEM JUTTING, 1937).

There is a certain amount of variation in the height-width ratio of the shell. With increasing age the height augments more rapidly than the width. Hence old shells are high-turreted and younger ones broad-conical. Besides the degree of development of the spiral keels is variable. All these modifications gave rise to the creation of various forms, varieties and subspecies, most of which head this paragraph.

From a taxonomic point of view such a splitting (which was in most cases based on very few individuals, insufficiently localized) is unnecessary and undesirable. Many of the described variants occur together in the same population and show no signs of oecological or genetical isolation. Unless new and more exact evidence is brought forward to explain this polymorphism there is no reason to consider the different forms as species or subspecies.

In the shells no sex difference is discernible. The narrow part of the right tentacle of the male is much longer (about four times as long) than in the female. One female bears about 15-20 pulli at a time in her uterus. Of these the 4-6 embryos closest to the vaginal opening, which are on the point of hatching, are already well developed; the younger ones, lying closer to the genital gland, are less differentiated, being more or less shapeless to polygonal.

The food of *Bellamya javanica* consists of algae and small pieces of other vegetable matter. Besides, a certain amount of detritus is taken in, and occasionally, dead animal matter.

As has been said before, species of *Bellamya* are locally used as food for ducks. In Java *B. javanica* serves for similar purposes (THIENEMANN, 1951, p. 535), and is also consumed by the population. As *Bellamya javanica* can serve as an intermediate host of a Trematode worm (*Echinostoma*), containing the cercaria stage, any consumption of raw or insufficiently cooked soft parts of the snail must be seriously rejected (SANDGROUND, 1939; BONNE, 1941; BONNE, BRAS & LIE KIAN JOE, 1947 and 1948).

Bellamya sumatrensis (DUNKER, 1852) (fig. 36).

1852. DUNKER, Zeitschr. f. Malak. 9, p. 128 (*Paludina sumatrensis*).
 1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 313 (*Paludina sumatrensis*).
 1908. KOBELT, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 21 (N.F.) p. 276, pl. 56, fig. 9-12 (*Vivipara sumatrensis*), p. 259, pl. 53, fig. 21-22 (*Vivipara javanica subsumatrana*).
 1955. ZILCH, Arch. Moll. Kunde, 84, p. 72 (*Bellamya sumatrensis*).
 not 1929. RAO, Rec. Ind. Mus. 31, p. 281 (*Vivipara sumatrensis* from Endawyne Lake, Birma).

Shell conical to pyramidal, with elevated spire and rounded base. Olive-green to vivid-green under a somewhat fibrous epidermis. Especially the spire is brighter green than in *Bellamya javanica*. Thick, somewhat shining, not transparent. Striated with fine, undulating growth lines. This sculpture is crossed above the periphery by 5-6 aequidistant spiral threads or ridges, each darker green to blackish. Between the dark spirals there is a delicate spiral striation. On the last whorl the dark spirals fade away. The base of the whorls never has dark spirals, but only the microscopical spiral striae. Periphery angular in young and semi-adult shells, but rounded in fully mature ones.

Whorls 6-7, regularly increasing in size. On the whole the shell is somewhat less slender than that of *Bellamya javanica*. Whorls a little convex. Suture distinct, but not deep. Top pointed, rather sharp, but often eroded. Base rounded below the periphery. Umbilicus closed or very narrow.

Aperture oblique, broad-oval, pointed at the upper end, rounded or slightly gutter-shaped below. Peristome continuous in adult shells; in juvenile ones there is an interruption at the parietal side where the

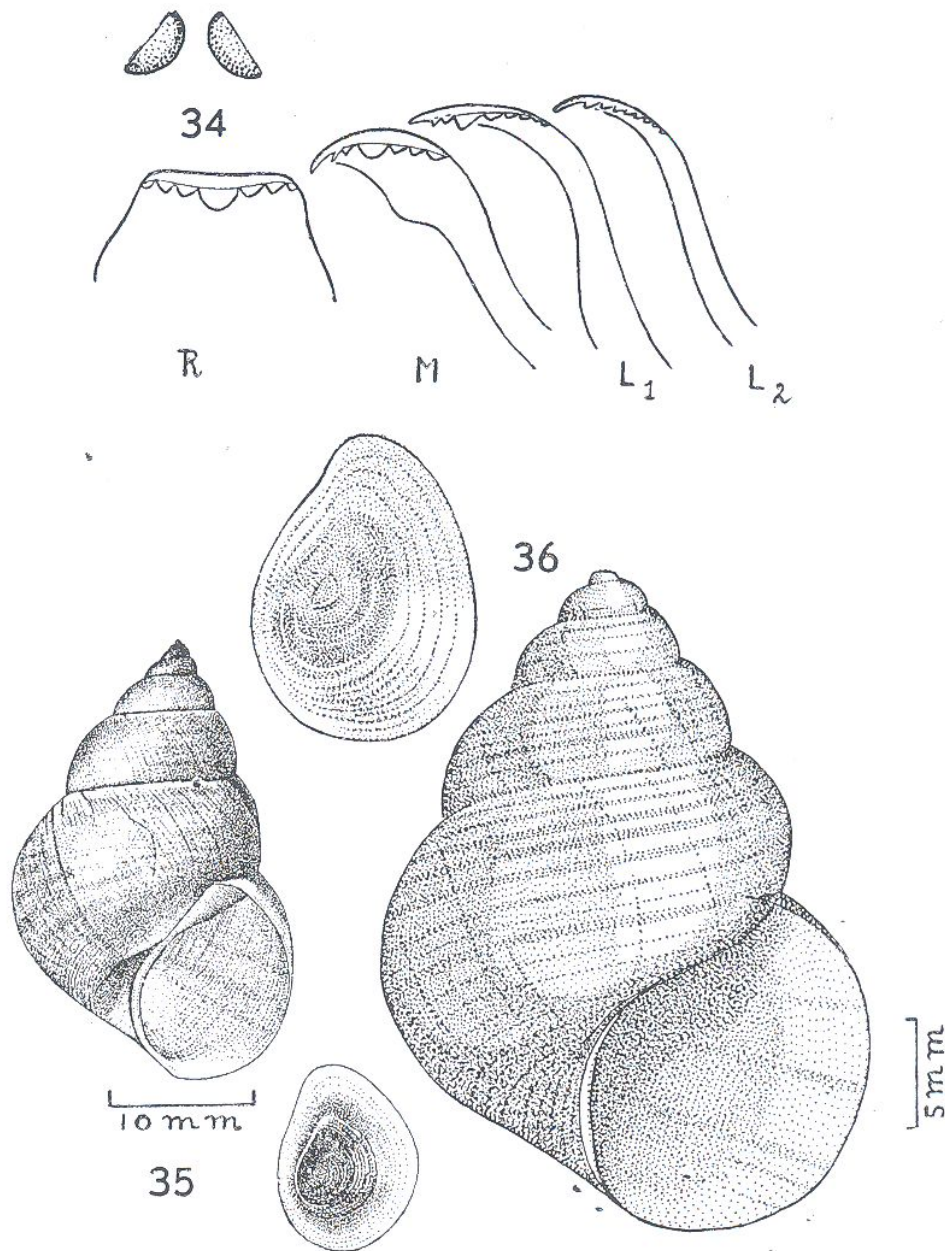


Fig. 34. *Bellamya javanica* (V.D. BUSCH). Mandibulae and radula elements. Author del.
 Fig. 35. *Bellamya javanica* (V.D. BUSCH). Shell and operculum. ABDULKADIR del.
 Fig. 36. *Bellamya sumatrensis* (DKR). Shell and operculum. J. MASTRO del.

peristome forms a thin film against the penultimate whorl. Peristome not expanded or reflected, sometimes lined with black.

Operculum horny, with subcentral nucleus. Growth rings concentric.
 Dimensions: height 25-31, width 18-24, height of aperture 13-15 mm.

Distribution: Sumatra, Java.

Habitat in Java: very rare in Java, no further particulars are known on its habitat.

Central Java: Tjilatjap.

The differences from *Bellamyia javanica* have been mentioned in the key to the species of *Bellamyia*. The ratio of total height: total width in *B. sumatrensis* is about 100: 75, whereas in *B. javanica* it is about 100: 65 or 100: 70.

Various authors do not consider *Bellamyia sumatrensis* a distinct species, but unite it with *B. javanica*. Judging from the abundant material which I have seen, I consider the two as distinct, *B. sumatrensis* being confined chiefly to Sumatra and *B. javanica* to Java.

There are only a few records of *B. sumatrensis* for Java. As far as these lots are localized and as far as I could check their identification, they all come from Tjilatjap where they were collected in the end of the 19th and in the beginning of the 20th century. This fact suggests an incidental importation of the Sumatran species into the southern part of Central Java, probably by human agency, but it is certain that *B. sumatrensis* has not extended its area of distribution in later years.

In my opinion KOBELT's *Vivipara javanica subsumatrana* from "Java" (without further details) also belongs to this Javanese population of *B. sumatrensis*.

Vivipara sumatrensis mentioned by RAO (1929, p. 281) from Endawyne Lake in Burma is a different species.

Doubtful species of *Bellamyia*

Bellamyia costata which has been recorded (PRASHAD, 1928, Mem. Ind. Mus. 8, p. 175; HORST & SCHEPMAN, 1899, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 314) from "Java" (s.n. *Viviparus costatus* or *Paludina costata*) is not a Javanese species, but a native of Celebes. The variety *laevior* MARTENS, described from Java and Celebes (MARTENS, 1897, in: WEBER, Erg. Reise Nied. Ost Indien, 4. p. 21, pl. 2, fig. 5-6) is certainly a form of *Bellamyia javanica*, as P. & F. SARASIN have already pointed out (1898, Süsw. Moll. Celebes, p. 60).

Another dubious species is *Vivipara gratiosa* P. & F. SARASIN (1898, l.c. p. 66) from S. and S. E. Celebes. LESCHKE (1914, Mitt. naturhist. Mus. Hamburg, 31, p. 260) and VAN BENTHEM JUTTING (1929, Treubia, 11, p. 86) mentioned it from Java. Messrs SARASIN suggested the relationship of this species with *Bellamyia javanica*.

VAN HASSELT (1823, Alg. Konst- & Letterbode, 2, p. 244) mentioned a *Paludina intermedia* in lakes and rivers along the southern shores of Java, but it is impossible to classify this species with certainty.

Familia AMPULLARIIDAE

Shell large to moderately large, mostly globular or ovoid, in exceptional cases coiled in a planospiral. Generally dextral, only the genus *Lanistes* (tropical Africa) is sinistral.

Operculum horny in the New World species, but calcareous in the Old World species. In both categories the operculum is composed of concentric rings round an excentric nucleus.

Animal with long, thin tentacles. Eyes at the exterior base of the tentacles on small peduncles. Foot large, tapering backwards. Mantle cavity divided by a vertical longitudinal ridge into a branchial (right) and a pulmonary (left) part, so that the animals can breathe in water as well as in air.

Mandible well developed, consisting of a horny plate on each side of the mouth. Radula 2.1.1.1.2, with one central tooth, symmetrically flanked by one lateral and two marginals.

The sexes are separate. In the male animal an appendix of the mantle margin is transformed into a penis sheath and penis. Most species -at any rate the Oriental ones- are oviparous. Each egg has a calcareous shell; the eggs are deposited together in a batch containing several eggs.

Distribution: tropical regions of Asia, Africa and America, in fresh water, running, or stagnant, where aquatic vegetation is abundant.

Genus *Pila* RÖDING, 1798.

Shell dextral, globular, of different sizes between large (*Pila ampullacea*) and rather small (*P. scutata*). Mostly smooth, or with growth striae, sometimes malleated. Yellowish, brownish or olivaceous, with or without brown spiral bands. Umbilicus open or closed. Aperture large, but not expanded, oval to broad-lunar. Operculum calcareous. Upper extremity pointed, lower one rounded. The columellar side is concave. The interior of the operculum bears a long, almost spindle-shaped mark, surrounded by a groove. This mark denotes the region where the operculum is fastened by muscles to the back of the foot.

The lips are prolonged into labial palps (fig. 37). At the left side of the body the mantle edge is folded into a short, protrusile siphon. By means of this funnel the pulmonary part of the respiratory organ can communicate with the atmosphere, even when the rest of the animal is immersed in the water. The branchial cavity is then completely shut off from respiration. During the aquatic respiration a current of water enters through the left siphon into the pulmonary chamber, then passes to the branchial cavity and leaves through the right siphon.

Radula 2.1.1.1.2, the central tooth with five or more cusps, the laterals with three or more cusps and the marginals with 2-3 cusps. The two mandibles, one on each side, are squarish in outline. They are composed of a thin horny substance which is thicker along the cutting edge (fig. 38).

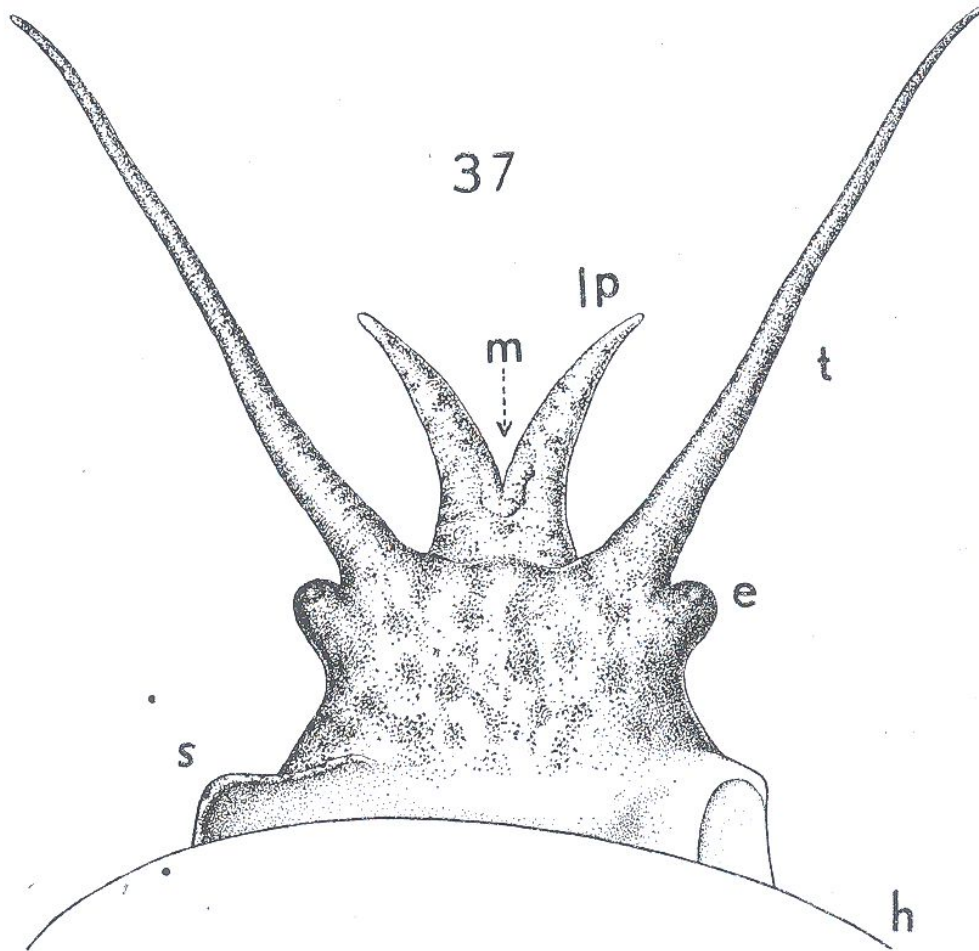


Fig. 37. *Pila sculata* (MOUSS.). Head with tentacles (t), labial palps (l.p.) and eyes (e), shell (h), mouth (m), left siphon (s). ABDULKADIR del.

During dry spells the animals burrow in the mud, close their shells with the operculum and aestivate until the season is favourable to come out again. Breeding takes place at the onset of the rainy season. Male and female meet at the edge of the water, just above or below it. Eggs are laid just above the water edge, on floating plants, reed stems or branches. Some species dig a hollow in the ground to deposit the eggs. As the eggs are very sticky when first laid, they adhere to each other and to the substratum, forming a globular or semi-globular mass. Soon after they are laid the exterior skin of each egg hardens to a calcareous shell. Each egg mass can contain several scores of eggs, in large species even several hundreds.

The animals are herbivorous, but occasionally also take decaying animal remains as food.

PRASHAD (1925, Mem. Ind. Mus. 8, p. 147) recorded that the Indian *Pila globosa* (SWAINSON) "sometimes make long excursions on land in quest of areas with more abundant food or with more water. At such times they crawl very slowly on dry ground and leave a definite track due to the sticky secretion of the sole of the foot". During these vagrancies on land the animals breathe by means of their lung chamber.

Distribution: tropical regions of Africa and Asia. In the Malay Archipelago in the four Greater Sunda Islands and the Philippines. In the Lesser Sunda Islands only in Bali, Lombok and Sumbawa. Not in the other Lesser Sunda Islands, the Moluccas, New Guinea, Australia, Polynesia.

Key to the Javanese species:

1. Shell large and spacious. Suture not deep. Whorls descending gradually, not step-like 2
- Shell smaller. Suture deep. Whorls descending step-like **scutata**
2. Shell rounded-pyriform. Spire low. Umbilicus open, although narrow **ampullacea**
- Shell ovoid. Spire elevated. Umbilicus closed **polita**

Pila ampullacea (LINNÉ, 1758) (fig. 38, 42 and 43) Native name: tottan or keong gondang.

1758. LINNÉ, Syst. Nat. Ed. X, p. 771 (*Helix ampullacea*).
1822. LAMARCK, Hist. Nat. Anim. s. Vert. Vol. 6, Part 2, p. 177 (*Ampullaria fasciata*).
1834. QUOY & GAIMARD, Voy. Astrolabe, Zool. 3, p. 167; pl. 57, fig. 1-4 (*Ampullaria celebensis*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268 (*Ampullaria celebensis*).
1849. MOUSSON, Land & Süßw. Moll. Java, p. 59, pl. 9, fig. 1 (*Ampullaria celebensis*).
1851. PHILIPPI, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 20, p. 59, pl. 19, fig. 1-2 (*Ampullaria sumatrensis*), p. 59, pl. 19, fig. 3-4 (*A. celebensis*), p. 64, pl. 21, fig. 1 (*A. magnifica*).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 318 (*Ampullaria sumatrensis* syn. *celebensis*).
1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 6 (*Ampullaria ampullacea* var. *javanensis* and *A. turbinis* var. *subglobosa*).
1890. BOETTGER, Ber. Senckenb. p. 155 (*Ampullaria ampullacea* var. *magnifica*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 17 (*Ampullaria ampullacea*).
1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 319 (*Ampullaria ampullacea*).
1910. SOWERBY, Proc. Malac. Soc. London, 9, p. 56 (*Ampullaria ampullacea*).

1911. KOBELT, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 20 II, p. 76, pl. 19, fig. 1-4, pl. 21, fig. 1 (*Pachylabra ampullacea*, incl. *celebensis*, *magnifica*, *sumatrensis*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 262 (*Ampullaria ampullacea* incl. var. *magnifica*).
1922. PARAVICINI, Teysmannia, 33, p. 27, fig. 4 (*Ampullaria ampullacea*).
1924. SCHEIBENER, Trop. Natuur, 13, p. 92-95, fig. 2a, 2b, 3 (*Ampullaria ampullacea*).
1925. ALDERSON, Stud. Ampullaria, p. 60, pl. 12, fig. 1-5, pl. 13, fig. 1-2 (*Ampullaria ampullacea*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 86 (*Ampullaria ampullacea* and *A. ampullacea* var. *magnifica*).
1934. RENSCH, Trop. Binnengew. 5, p. 217 (*Pila ampullacea*).
1935. PARAVICINI, Arch. Moll. Kunde, 67, p. 175 (*Ampullaria ampullacea*).
1938. ADAM & LÉLOUP, Mém. Mus. Roy. Hist. Nat. Belg. (Hors Série) Vol. 2, Part 19, p. 74 (*Pila ampullacea*).
1952. MERMOD, Rev. Suisse Zool. 59, p. 86, fig. 148 (*Ampullaria fasciata*).

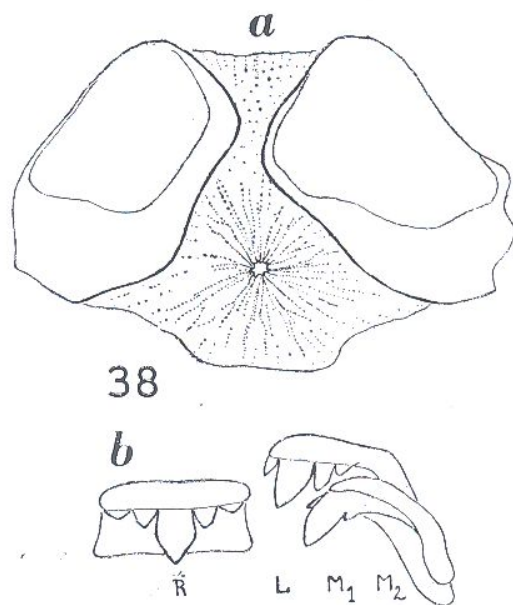


Fig. 38. Mandibulae of *Pila scutata* (MOUSS.), implanted on membrane; in centre of membrane lies the mouth. Radula elements of *Pila ampullacea* (L.). Author del.

Shell large, rounded-pyriform, with inflated last whorl and comparatively low spire. Yellowish-green with a slight tinge of orange. Covered by an olive-green epidermis. Sometimes plain, but mostly with several brown spiral lines and bands of varying width. These colour bands shine through the shell in the interior of the aperture. Occasionally there are also several transverse brown lines, marking previous stages of growth rest. The outer edge of the aperture is also lined with brown. Finely striated according to the growth lines, but without spiral striation. In fresh shells the surface of the periostracum has a soft lustre. Not or little transparent.

Whorls 6-6½, rapidly increasing in diameter, the last one spacious and inflated. Well rounded, but as each following whorl embraces the greater part of its preceding one, only a small, rather flat zone of the latter takes part in forming the spire. Suture distinct, but not deep. The periphery can be indistinctly angular, especially in young shells. It makes the profile somewhat "shouldered". Top little elevated, base rounded, evenly descending to the umbilicus and aperture. Umbilicus open, but not wide, partly hidden by the thickened columellar margin of the aperture.

Aperture oval to elongate-lunar, somewhat oblique. Peristome not continuous (except in large old shells), the parietal side as a thin filmy callus against the penultimate whorl. Columellar and basal margins slightly reflexed. Exterior margin yellow or light-orange, lined with brown and thickened by an internal rib. Somewhat reflexed in the basal region.

Operculum calcareous, oval to elongate-lunar, somewhat concave on its outer surface. Concentrically ringed round a slightly excentric nucleus.

Dimensions: height up to 110 mm, width up to 100 mm, height of aperture 85 mm.

Distribution: common in the four Greater Sunda Islands, but rare or absent in other islands of the Malay Archipelago. Present in the Suia Islands, Saleyar and Batu Islands.

Habitat in Java: fresh water of the lowlands, lakes, ponds, marshes, rice fields, irrigation works, often in great numbers. If in such an overpopulated water basin oxygen becomes deficient, the animals, when still immersed, change from gill respiration to air breathing, bringing their siphon to the surface and taking in atmospheric air.

West Java: ditches near Pardana (MOUSSON, 1849); Lake Danau, Bantam; Djakarta; sawahs at Meester Cornelis; Bogor; Tjilebut near Bogor; Gora, south of Bogor; Bandung; Sindangbarang; Sukabumi.

Central Java: river Tedja near Wonosobo; Kutoardjo; Rawah Pening near Ambarawa.

East Java: Lamungan near Surabaya (PARAVICINI, 1935).

Pila ampullacea has also been recorded from the islands of Madura and Dapur, and from Pulo Pete (ADAM & LELOUP, 1938).

The fossil records of *Pila ampullacea* mentioned in various publications all refer to *Pila scutata* (see under the next species).

Eggs are laid at the water's edge on plants or floating branches, in clusters of 50 or more. Each egg is 10-12 mm in diameter (fig. 42). When laid they are spherical, but in the interior of the egg mass they become angular like honeycomb cells. There is no common calcareous layer en-

veloping the whole batch, as I erroneously related in 1931 (Treubia, 13, p. 11). The diameter of the shell at birth is about 7-8 mm. No details are known about the time necessary for development in the egg shell, nor the rate of growth after birth.

The only exact date for the spawning of *Pila ampullacea* is April 8th, 1924 at Kutoardjo (Kedu), i.e. at the change of the wet monsoon to the dry monsoon. In some regions *Pila ampullacea* is eaten by the native inhabitants. The empty shell is commonly used as a water basin for cage birds.

Pila scutata (MOUSSON, 1848) (fig. 37-40).

1828. GRAY, in: WOOD, Index Test. Suppl. p. 29, pl. 7, fig. 22 (*Ampullaria conica*, non *Ampullaria conica* LAMARCK, 1804, a fossil French shell).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268 (*Ampullaria scutata*).
1849. MOUSSON, Land & Süßw. Moll. Java, p. 60, pl. 8, fig. 2 (*Ampullaria scutata*).
1849. PHILIPPI, Zeitschr. f. Malak. 5, p. 192 (*Ampullaria orientalis*).
1851. PHILIPPI, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 20, p. 9, pl. 1, fig. 4-5 (*Ampullaria scutata*).
1858. REEVE, Icon. 10, pl. 20, fig. 96 (*Ampullaria javanica*).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 318 and 320 (*Ampullaria scutata*).
1890. BOETTGER, Ber. Senckenb. p. 156 (*Ampullaria conica* var. *javanica*).
1894. MARTENS, Jñn. Denkschr. 8, p. 83 (*Ampullaria scutata*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 18 (*Ampullaria scutata*).
1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 319 (*Ampullaria scutata*).
1908. MARTIN, Versl. gew. Verg. Kon. Akad. Wet. Amst. Afd. Natuurk. 17, p. 14 (*Ampullaria ampullacea*).
1908. BRANCA, Sitz. Ber. Kgl. Preuss. Akad. Wiss. Berlin, p. 270 (*Ampullaria ampullacea*).
1910. SOWERBY, Proc. Malac. Soc. London, 9, p. 57 (*Ampullaria conica* and var. *javanica*).
1911. CARTHAUS, Pithecanthr. Schichten Java, p. 13 (*Ampullaria ampullacea*).
1911. MARTIN-ICKE, Pithecanthr. Schichten Java, p. 50 (*Ampullaria scutata*), p. 51 (*A. ampullacea*).
1912. KOBELT, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 20^{II}, p. 83, pl. 35, fig. 6 (*Pachylabra javanica*), p. 90, pl. 38, fig. 6-7 (*P. javanica* var. *fruhstorferi*), p. 93, pl. 1, fig. 4-5, pl. 40, fig. 1-5, 8 and 9 (*P. conica*).
1912. SCHEPMAN, Proc. Malac. Soc. London, 10, p. 236 (*Ampullaria scutata*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 221 (*Ampullaria scutata*), p. 262 (*A. conica*, *javanica* and *scutata*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 98 (*Ampullaria ampullacea* and *A. scutata*).
1922. PARAVICINI, Teysmannia, 33, p. 27, fig. 5 (*Ampullaria scutata*).
1923. OOSTINGH, Meded. Landb. Hooges. Vol. 26, Part 3, p. 56 (*Pachylabra conica*).
1924. VAN DER MEER MOHR, Meded. Inst. Plantenz. no. 63, p. 44, pl. 9 (*Ampullaria* sp.).

1925. ALDERSON, *Studies Ampullaria*, p. 78, pl. 16, fig. 3, 4, 6 and 9 (*Ampullaria conica*).
1929. VAN BENTHEM JUTTING, *Treubia*, 11, p. 86 (*Ampullaria conica*, *javanica* and *jav. var. fruhstorferi*).
1931. VAN BENTHEM JUTTING, *Treubia*, 13, p. 10, fig. 11-13 (*Pila conica*).
1931. VAN ES, *Age of Pithecanthropus*, p. 136 (*Ampullaria scutata* and *A. ampullacea*).
1931. VAN DER VLERK, *Leidsche Geol. Meded.* 5, p. 256 (*Ampullaria ampullacea* and *A. scutata*).
1932. VAN BENTHEM JUTTING, *Treubia*, 14, p. 103 (*Pila conica*).
- 1934a. RENSCH, *Zool. Jahrb. (Syst.)* 65, p. 396 (*Pila conica*).
- 1934b. RENSCH, *Trop. Binnengew.* 5, p. 218 (*Pila conica*).
1935. OOSTINGH, *Wetensch. Meded. Dienst Mijnb. Ned. Ind.* no. 26, p. 41 (*Pila conica*).
1935. PARAVICINI, *Arch. Moll. Kunde*, 67, p. 175 (*Ampullaria scutata*).
1937. VAN BENTHEM JUTTING, *Zool. Meded. Mus. Leiden*, 20, p. 105, pl. 4, fig. 10-11 (*Pila conica*).
1938. ADAM & LELOUP, *Mém. Mus. Roy. Hist. Nat. Belg. (Hors Série)* Vol. 2, Part 19, p. 75 (*Pila conica*).
1939. SANDGROUND, *Geneesk. Tijdschr. Ned. Ind.* 79, p. 1726 ff (*Pila conica*).
1941. VAN BENTHEM JUTTING, *Arch. néerl. Zool.* 5, p. 276 (*Pila conica*).
1947. BONNE, BRAS & LIE KIAN JOE, *Medisch Maandbl.* p. 207-209 (*Pila conica*).
1948. BONNE, BRAS & LIE KIAN JOE, *Medisch Maandbl.* p. 457, 460 and 467 (*Pila conica*).
1951. THIENEMANN, *Arch. Hydrobiol. Suppl. Bd.* 19, p. 535 (*Pila conica*).

Shell rather small for the genus. Well rounded, with large last whorl and elevated spire. Yellowish-green or brownish-green, covered by an olive-green epidermis. Mostly with several irregular brown spiral lines and bands of varying width. These colour bands shine through the shell in the aperture. Occasionally there are also several transverse brown bands, marking previous stages of growth rest. Striated according to the growth lines, but without spiral striation. In fresh shells the surface has a soft lustre. Not or little transparent.

Whorls 6, well rounded, rapidly increasing in size and descending step-like, the last one rather spacious. Suture distinct. Top elevated, base rounded, umbilicus closed.

Aperture oval to broad-lunar, somewhat oblique. Peristome not continuous (except in large old shells), the parietal side as a thin, filmy callus against the penultimate whorl. Basal margin somewhat expanded. Free exterior margin somewhat reflexed in full grown shells.

Operculum calcareous, oval to broad-lunar, broader than either in *Pila ampullacea* or *P. polita*. It is a little concave at the outer surface and concentrically ringed round a slightly excentric nucleus. Along the columellar margin it is only little sinuous.

Dimensions: height up to 47, width up to 41, height of aperture about 33 mm.

Distribution: Birma, Malay Peninsula, Sumatra, Java, Borneo, Celebes and their satellite islands. Of the Lesser Sunda Islands only known in Bali, Lombok and Sumbawa. Further in the Philippines and the Sula Islands. Not in the Moluccas or New Guinea.

Habitat in Java: very common in fresh water basins, mostly in the lowlands, sawahs, ponds and lakes, irrigation works etc.

West Java: Udjong Kulon; Sawahs near Pasauran; Pandeglang; Pardana (MOUSSON, 1849); Lake Danau; river Antjol, near Djakarta; Djakarta; Bronbeek near Djakarta; kampong Makassar near Djakarta; Tandjong Priok; Meester Cornelis; southwest of Depok, in sawah; in Tjiliwung near Depok; Bogor and its environs; Botanical Garden, Bogor; Kuripan near Bogor; Tjiomas near Bogor; Tjiburial near Bogor; Gora, south of Bogor; Lake Tjigombong, near Bogor; Sukabumi; running water in sawah near Tasikmalaja; Sindangbarang; Wanggung, near Tjisampora, Djampang; Parangtritis; draining ditches on estate Pagandaran, along Dirk de Vriesbay; Mt Tangkuban Prah; environs of Garut; Tjipanas near Garut; Tjiamis, beach of the Java Sea near mouth of Tji Lamaja; in sawah near Subang; Tjisaaranang near Tjariang in Sumedang; sawah near Kartawinangun; Palimanan (PARAVICINI, 1935); beach near Cheribon; sawahs near Bungkirit.

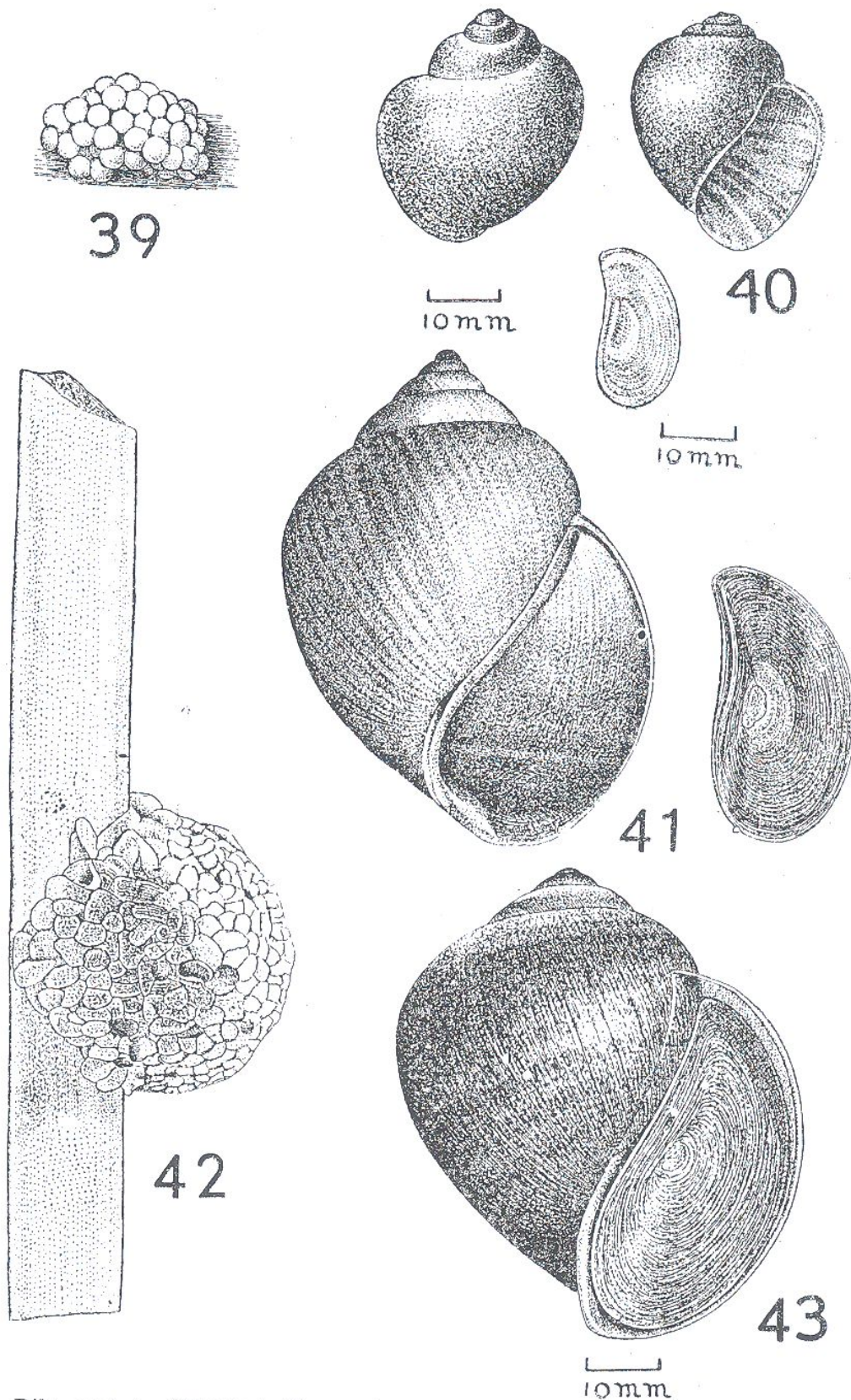
Central Java: Tjilatjap; Rawah Lakbok; Djocja; Blongkeng ravine, on roadside between Djocja and Mt Merapi; Tegal; beach of Pekalongan; Semarang; Tjipiring sugar gardens near Kendal; Karang Putjong; sawahs near Penawangan; Japara; Demak.

East Java: Kali Soko, right tributary river of Kali Solo; Ngawi; Tjepu; Kediri; Rawah Galapan south of Kediri; beach near Bandjaran, east of Surabaja; Tengger Mts; Malang; Lawang; Wlingi; Besuki.

Pila scutata has also been recorded from the islands of Madura, Nusa Kambangan, Bawean, Karimon Djawa and several small islands in the Bay of Djakarta (VAN BENTHEM JUTTING, 1941). Also from Pulo Pete (ADAM & LELOUP, 1938).

As a fossil this species is not rare in Pliocene and Pleistocene layers in Central and East Java (MARTIN, 1908, 1919; BRANCA, 1908; CARTHAUS, 1911; MARTIN-ICKE, 1911; VAN ES, 1931; VAN DER VLERK, 1931; OOSTINGH, 1935; VAN BENTHEM JUTTING, 1937).

Pila scutata is an extremely variable species and it is often difficult to classify the various modifications. This explains why so many names have been given to local forms. In the references at the beginning of this paragraph only the names of the Javanese variants have been mentioned.



- Fig. 39. *Pila scutata* (MOUSS.). Eggs. ABDULKADIR del.
 Fig. 40. *Pila scutata* (MOUSS.). Shell from back and front, and operculum. ABDULKADIR del.
 Fig. 41. *Pila polita* (DESH.). Shell and operculum. ABDULKADIR del.
 Fig. 42. *Pila ampullacea* (L.). Eggs. ABDULKADIR del.
 Fig. 43. *Pila ampullacea* (L.). Shell with operculum. ABDULKADIR del.

Only very few data are available on the spawning time of *Pila scutata*. Egg masses (fig. 39) were found in Lake Tjigombong, near Bogor, in March 1930, and in a pond in the Botanical Gardens at Bogor in August 1926. The first date falls at the end of the wet monsoon, the second in the dry monsoon. Hence there does not seem to be a marked predilection for a certain season.

In 1931 (VAN BENTHEM JUTTING, p. 10) I gave some details about the spawning of *Pila scutata* in Lake Tjigombong. The most important ones are repeated here: "In order to deposit her eggs she (the female) had climbed against an old tree trunk which floated on the water. There, with the front part of her body and shell emerged, the eggs were laid just above the waterline in a cluster of about a hundred. They are round, each being circa 3 mm diameter. At the moment of production the egg shells are gelatinous and sticky, but soon afterwards they become hard and calcareous. . . . The egg mass was removed from Lake Tjigombong to the laboratory at Buitenzorg and here, after a week, the first young snail hatched. During the following days others appeared and in about ten days all had come out. They could be kept and brought up very well in small glass vessels, and were fed on *Elodea* and minute waterweeds from stones. In this way the animals which measured about 1.7 mm high and broad at birth, were 9 mm high and 7 mm broad after two months, and 16 mm high and 13 mm broad after six months."

Pila scutata is occasionally consumed by the Javanese population. As this species can serve as a vector for trematode worms, containing the cercaria stage, any consumption of raw or insufficiently cooked soft parts of the snail must be seriously rejected (SANDGROUND, 1939; BONNE, BRAS & LIE KIAN JOE, 1947, 1948).

Young *Pila scutata* are eaten by the crab-eating frog *Rana cancrivora* and by the Javanese sawah rat, *Rattus rattus brevicaudatus* (VAN DER MEER MOHR, 1924).

Pila polita (DESHAYES, 1830) (fig. 41).

1830. DESHAYES, *Encycl. Méth. (Vers)* Vol. 2, Part 1, p. 31 (*Ampullaria*).
 1838. DESHAYES, *Hist. Nat. Anim. s. Vert. Ed. II, Vol. 8*, p. 544 (*Ampullaria*).
 1851. PHILIPPI, in: MART.-CHEMN. *N. Syst. Conch. Cab. Vol. 1, Part 20*, p. 29, pl. 8, fig. 1 (*Ampullaria*).
 1899. HORST & SCHEPMAN, *Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2*, p. 319 (*Ampullaria*).
 1912. KOBELT, in: MART.-CHEMN. *N. Syst. Conch. Cab. Vol. 1, Part 20^{II}*, p. 82, pl. 8, fig. 1, pl. 38, fig. 1-5 (*Pachylabra*).
 1914. LESCHKE, *Mitt. naturhist. Mus. Hamburg*, 31, p. 262 (*Ampullaria*).

1916. SOWERBY, Proc. Malac. Soc. London, 12, p. 69 (*Ampullaria*).
1923. OOSTINGH, Meded. Landb. Hooges. Vol. 26, Part 3, p. 58 (*Pachylabra*).
1925. ALDERSON, Studies Ampullaria, p. 82, pl. 16, fig. 7-8 (*Ampullaria*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 86 (*Ampullaria*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 277 (*Pila*).

Shell large, with inflated last whorl and elevated, conical spire. Yellowish-green, covered by an olive-green epidermis. External surface polished, sometimes malleated. Spiral colour bands generally lacking. The transverse brown lines, however, marking previous stages of growth rest, are developed at irregular intervals. Finely striated according to the growth lines, but without spiral striation. In fresh shells the surface has a soft lustre. Not or little transparent.

Whorls 6-6½, rapidly increasing in size, the spire more emerging than in *Pila ampullacea*. Last whorl somewhat inflated. Suture distinct. Top elevated, base rounded. Umbilicus closed.

Aperture oval to elongate-lunar, somewhat oblique. Interior light-brown. Peristome not continuous (except in large old shells), the parietal side as a thin, filmy callus against the penultimate whorl. Free margin brown or orange, strengthened by an internal rib.

Operculum calcareous, oval to elongate-lunar, somewhat concave on its exterior surface. It is not so sinuous along the columellar margin as in *Pila ampullacea*. For the rest the opercules of both species are very similar. They are not so broad as in *P. scutata*.

Dimensions: height up to 75 mm, width up to 60 mm, height of aperture up to 50 mm.

Distribution: common in Birma, Tonkin, Cochin China, Cambodia and Siam. In the Malay Archipelago only in Java, and two outlying islands.

Habitat in Java: very little is known on the conditions under which *Pila polita* lives in Java.

West Java: draining ditches on estate Pangandaran, along Dirk de Vriesbay; sawahs near Bungkirit.

Central Java: Tjilatjap; beach near Tegal.

East Java: Armenian Sport Club at Surabaja; environs of Surabaja; Sukalelo near Surabaja; beach near Bandjaran, east of Surabaja.

Pila polita has also been recorded from the adjacent islands of Nusa Kambangan and Madura (VAN BENTHEM JUTTING, 1941).

The development of this species has been described by SEMPER (1862).

Egg masses have never been found in Java.

Doubtful species of *Pila*

NEVILL (1884, Hand List Moll. Ind. Mus. 2, p. 6, also repeated by KOBELT, 1912, l.c. p. 80) mentioned *Ampullaria turbinis* var. *globosa* from Java, with an interrogation mark. According to the description this is certainly not a Javanese species. ALDERSON (1925, p. 65) felt "nearly sure that in his (NEVILL's) green, unbanded, white-lipped shell we have no variety of *turbinis*, but rather the first mention of the Siamese *Ampullaria dalyi*, described much later by BLANFORD".

Familia STENOTHYRIDAE

Shell minute, ovate or conoidal, in most species compressed in dorso-ventral direction. Whorls little convex. Last whorl more or less descending to the aperture. This aperture is generally narrower than the preceding part of the ultimate whorl. Umbilicus narrow or closed. Aperture rounded. Peristome continuous.

Operculum corneous, spirally coiled, narrow in the centre, wider towards the periphery.

Animal with long, slender tentacles. The eyes are implanted at the base of the tentacles. Proboscis long and extensile. The sexes are separate. Radula 2.1.1.1.2.

Distribution: Persia, India, Birma, Malaya, Southern China, Formosa, Philippines, Malay Archipelago, Australia, in fresh and brackish water.

• Genus *Stenothyra* BENSON, 1856.

(syn. *Nematura* BENSON, 1836, non *Nematura* FISCHER, 1813)

Shell minute, ovate, conoidal or subcylindrical, in most species compressed in dorso-ventral direction. Relatively thick. Finely striated, smooth, or with lines of punctures, or with spiral ridges at the base of the last whorl, or with a row of little bristles. Last whorl descending towards the aperture. This aperture is generally narrower than the preceding part of the ultimate whorl, making a triangular area between the upper corner of the aperture and the suture. Umbilicus narrow or closed. Aperture rounded. Peristome continuous, without siphonal canal.

Operculum corneous, spirally coiled, nucleus almost central. The margin is somewhat frayed and irregular. On the interior side there are two transverse ridges (fig. 44).

Radula 2.1.1.1.2 (fig. 45). The rhachis has some additional cusps in the right and left basal corners. The laterals have a conspicuous lateral

prolongation, the "elbow". A pair of small mandibles is present. Sexes are separate. As far as known the females are oviparous.

Distribution: tropical parts of Asia (India, Birma, Malaya, Southern China, Formosa, Philippines, Sunda Islands) and Australia, in fresh or brackish water, living in the mud of estuaries, mangrove flats, in fish ponds, on algae-covered stones.

In Java there are three species:

1. Shell smooth, only growth lines visible 2
- Shell with delicate spiral grooves, bearing deeper punctuations at regular distances *polita*
2. Shell rather large, slightly compressed, suture very shallow
- *glabrata*
- Shell rather small, not compressed, suture deeper *ventricosa*

Stenothyra glabrata (A. ADAMS, 1851) (fig. 46).

1851. A. ADAMS, Proc. Zool. Soc. London, p. 226 (*Nematura*).
 1853. A. ADAMS, Ann. Mag. Nat. Hist. (2) 12, p. 284 (*Nematura*).
 1856. BENSON, Ann. Mag. Nat. Hist. (2) 17, p. 499 (*Stenothyra*).
 1862. FRAUENFELD, Verh. Zool. Bot. Ges. Wien, 12, p. 1159 (*Nematura*).
 1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 44 (*Stenothyra*).

Shell large for the genus, ovate, light straw-colour, or greyish-green, somewhat transparent. Finely striated by the growth lines. Surface smooth and polished. Whorls about 6, rapidly increasing in size. Last whorl descending towards the aperture. The whorls are little convex, hence the profile of the shell is almost straight, with very shallow suture. The shell is somewhat compressed in dorso-ventral direction. This feature is often hardly noticeable and can only be recognised in a slight inflation of the profile of the last whorl. Top pointed, but not sharp. Base rounded. No umbilical opening.

Aperture oblique, round-oval, narrower than the diameter of the last whorl. Peristome continuous, dark-brown or black. Somewhat thickened, but not reflected.

Operculum corneous, spirally coiled round an almost central nucleus. The operculum fits as a lid on the peristome; it does not enter into the aperture.

Dimensions: height 5, width 3, height of aperture $1\frac{1}{2}$ mm.

Distribution: Malaya, Sumatra, Java.

Habitat in Java: only known from brackish fish ponds.

East Java: tambaks (fish ponds) near Sidohardjo.

Stenothyra glabrata has also been found in the island of Kerkhof in the Bay of Djakarta.

Stenothyra ventricosa (QUOY & GAIMARD, 1834) (fig. 44, 45, 47).

1834. QUOY & GAIMARD, Voy. Astrolabe, Zool. 3, p. 173, pl. 58, fig. 6-8 (*Paludina*).

1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268 (*Paludestrina*).

1849. MOUSSON, Land & Süsw. Moll. Java, p. 63, pl. 8; fig. 6 (*Paludestrina*).

1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 317 (*Nematura*).

1862. FRAUENFELD, Verh. Zool. Bot. Ges. Wien, 12, p. 1160 (*Nematura*).

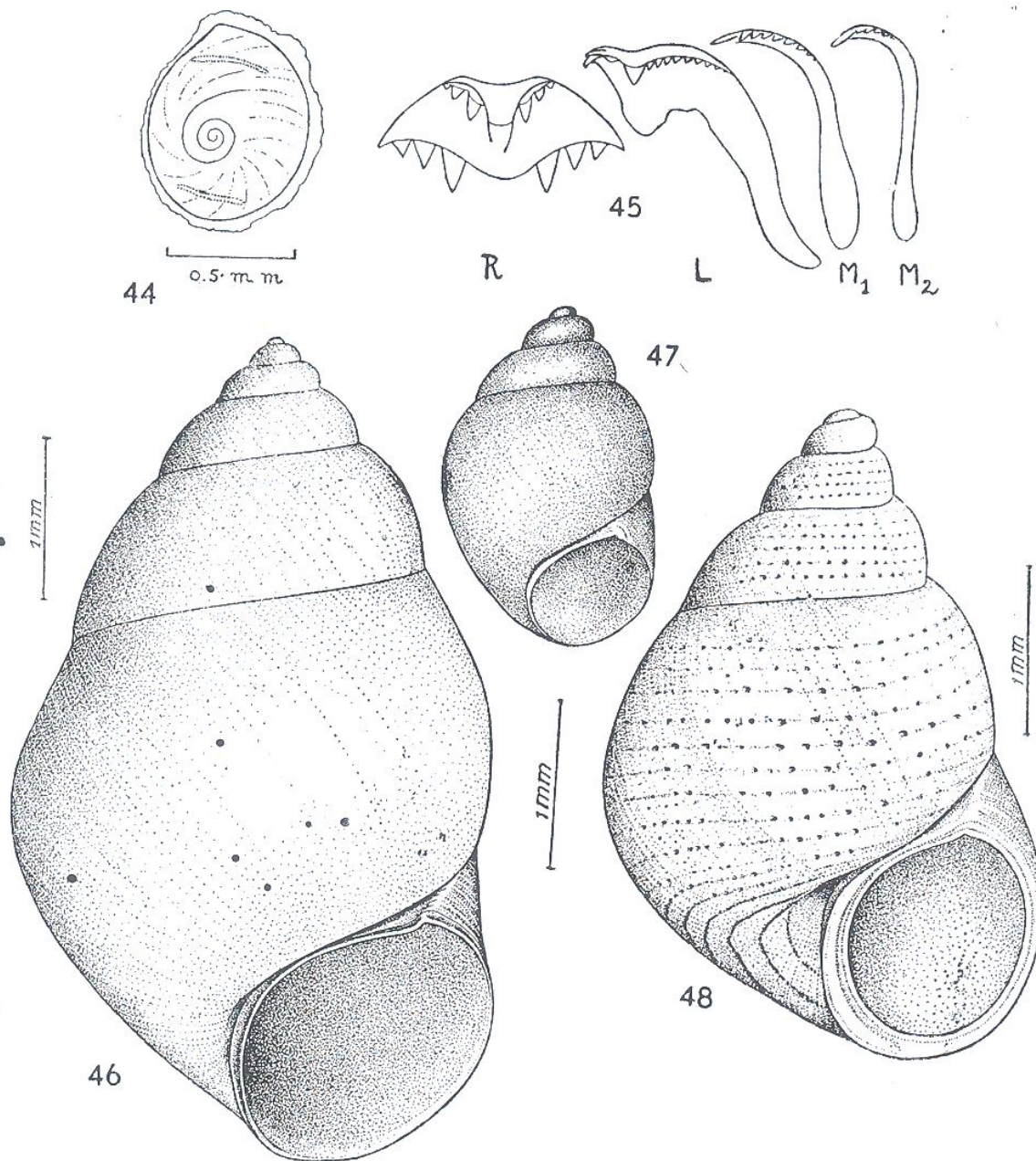


Fig. 44. Operculum of *Stenothyra ventricosa* (QU. & GAIM.). The two ridges on the interior side are shining through. Author del.

Fig. 45. *Stenothyra ventricosa* (QU. & GAIM.). Radula elements. Author del.

Fig. 46. *Stenothyra glabrata* (ADS). Shell. ABDULKADIR del.

Fig. 47. *Stenothyra ventricosa* (QU. & GAIM.). Shell. ABDULKADIR del.

Fig. 48. *Stenothyra polita* (ADS). Shell. ABDULKADIR del.

1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 210, pl. 9, fig. 7 (*Stenothyra moussoni*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 261 (*Stenothyra moussoni* and *ventricosa*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 86 (*Stenothyra moussoni* and *ventricosa*).
1934. RENSCH, Zool. Jahrb. (Syst.) 65, p. 399.
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 104.
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 277.
1948. DAMMERMAN, Fauna of Krakatau, 1883-1933, p. 519.

Shell very small, ovate-turreted, greyish-yellow, somewhat transparent. Finely striated by the growth lines. Surface smooth and polished. Whorls about 5, rapidly increasing in size, not compressed. Last whorl descending towards the aperture. The whorls are slightly convex, hence the suture is deeper than in *Stenothyra glabrata*. Top pointed, but not sharp. Base rounded. There is no umbilical opening, but a distinct groove separates the peristome from the penultimate whorl.

Aperture oblique, round-oval, narrower than the diameter of the last whorl. Peristome continuous, somewhat thickened, but not reflected.

Operculum corneous, spirally coiled round an almost central nucleus. The transverse ridges on the interior side lie close to upper and basal margins. The operculum fits as a lid on the peristome; it does not enter into the aperture.

Dimensions: height 2.5-3.5, width 1.7-2.1, height of aperture 0.9-1.2 mm.

Distribution: India, Java, Celebes, Sumba, Sumbawa, Pulo Panaitan, Verlaten Eiland, Pulo Kambing (Bima Bay), Madura.

Habitat in Java: the species inhabits tidal areas, estuaries, and brackish fish ponds, among Chaetomorpha, in mud and sandy mud.

West Java: in tambaks (fish ponds) near Djakarta, in the stomach of *Chanos chanos* (the bandeng); lagoons of southern Java (MOUSSON, 1849).

Central Java: beach near Pekalongan.

East Java: sandy beach near Tuban, between Grissee and Rembang; Surabaya, mouth of Kediri river (MARTENS, 1897); tambaks near Sido-hardjo; in stagnant brackish water pools south of Malang (MARTENS, 1897).

The species has also been recorded from the islands of Madura, Verlaten Island and Pulo Panaitan.

As a fossil *Stenothyra ventricosa* has been collected at several fossiliferous deposits in the vicinity of Trinil (East Java), in layers which are considered to be of Pleistocene age (VAN BENTHEM JUTTING, 1937).

***Stenothyra polita* (A. ADAMS, 1851) (fig. 48).**

1851. A. ADAMS, Proc. Zool. Soc. London, p. 226 (*Nematura*).
 1853. A. ADAMS, Ann. Mag. Nat. Hist. (2) 12, p. 284 (*Nematura*).
 1856. BENSON, Ann. Mag. Nat. Hist. (2) 17, p. 500 (*Stenothyra*).
 1862. FRAUENFELD, Verh. Zool. Bot. Ges. Wien, 12, p. 1158 (*Nematura*).
 1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 44 (*Stenothyra*).
 1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 211 (*Stenothyra*).

Shell rather large for the genus, broadly triangular with rounded base. Compressed, chestnut-brown, transparent, somewhat polished. Finely striated by the growth lines. Besides there is a sculpture of about 17 shallow spiral grooves. Round the umbilicus the grooves are deeper and bent at an almost right angle. The grooves bear deeper punctuations at regular distances.

Whorls 5-6, rapidly increasing in diameter; little convex, hence the suture is very shallow. Last whorl descending towards the aperture. Top pointed, but not sharp. Base rounded. Umbilicus open, but narrow.

Aperture not oblique, round, its diameter narrower than the preceding part of the last whorl. Peristome not continuous, thickened.

Operculum corneous, spirally coiled round an almost central nucleus. The operculum fits as a lid on the peristome; it does not enter into the aperture.

Dimensions: height 4, width 2.4, height of aperture 1.4 mm.

Distribution: Malaya, Sumatra, Java, Philippines.

Habitat in Java: unknown, but probably similar to that of the other species of *Stenothyra*.

The only reference to the occurrence of this species in Java was by FRAUENFELD (1862, p. 1158) who simply wrote: "Java" without further details.

Familia BULIMIDAE

Shell conoidal or turreted, with moderately convex whorls. Mostly smooth, but in some species with spiral grooves or ridges. Last whorl in many species large and inflated. Umbilicus narrow or closed.

Aperture oval or rounded. Peristome continuous, in a few genera somewhat expanded and gutter-shaped at the base, but never with a siphonal canal.

Operculum calcareous, partly spirally, partly concentrically coiled.

Animal with one pair of long tentacles. Eyes at the exterior bases of the tentacles. Sexes are separate. In the males the penis has a digitiform appendage. As far as known the females lay eggs, single or combined to string-like masses. Radula 2.1.1.1.2 (fig. 49).

Distribution: Europe, North America, Asia, Africa, Australia. Numerous species in tropical countries. In fresh and brackish water.

Key to the two genera living in Java:

1. Shell about 10 mm high. Umbilicus surrounded by a small spiral ridge. Peristome without distinct sinuosity in the outer margin **Digoniostoma**
- Shell not higher than 7.5 mm. Umbilicus not surrounded by a spiral ridge. Peristome with a peculiar protruding sinuosity in the outer margin **Wattebledia**

Genus *Digoniostoma* ANNANDALE, 1920

Shell pyramidal or turreted, with rounded base. Whorls convex, finely striated. Last whorl relatively large and inflated. Umbilicus open, but not wide, surrounded by a small ridge at the base of the shell.

Aperture rounded. Peristome continuous, somewhat expanded at the base.

Operculum calcareous, in the centre spirally coiled, towards the periphery concentrically ringed. Nucleus almost central.

Radula 2.1.1.1.2. Central tooth with small cusps in the basal corners. A pair of small mandibles is present. Sexes are separate. As far as known the females are oviparous.

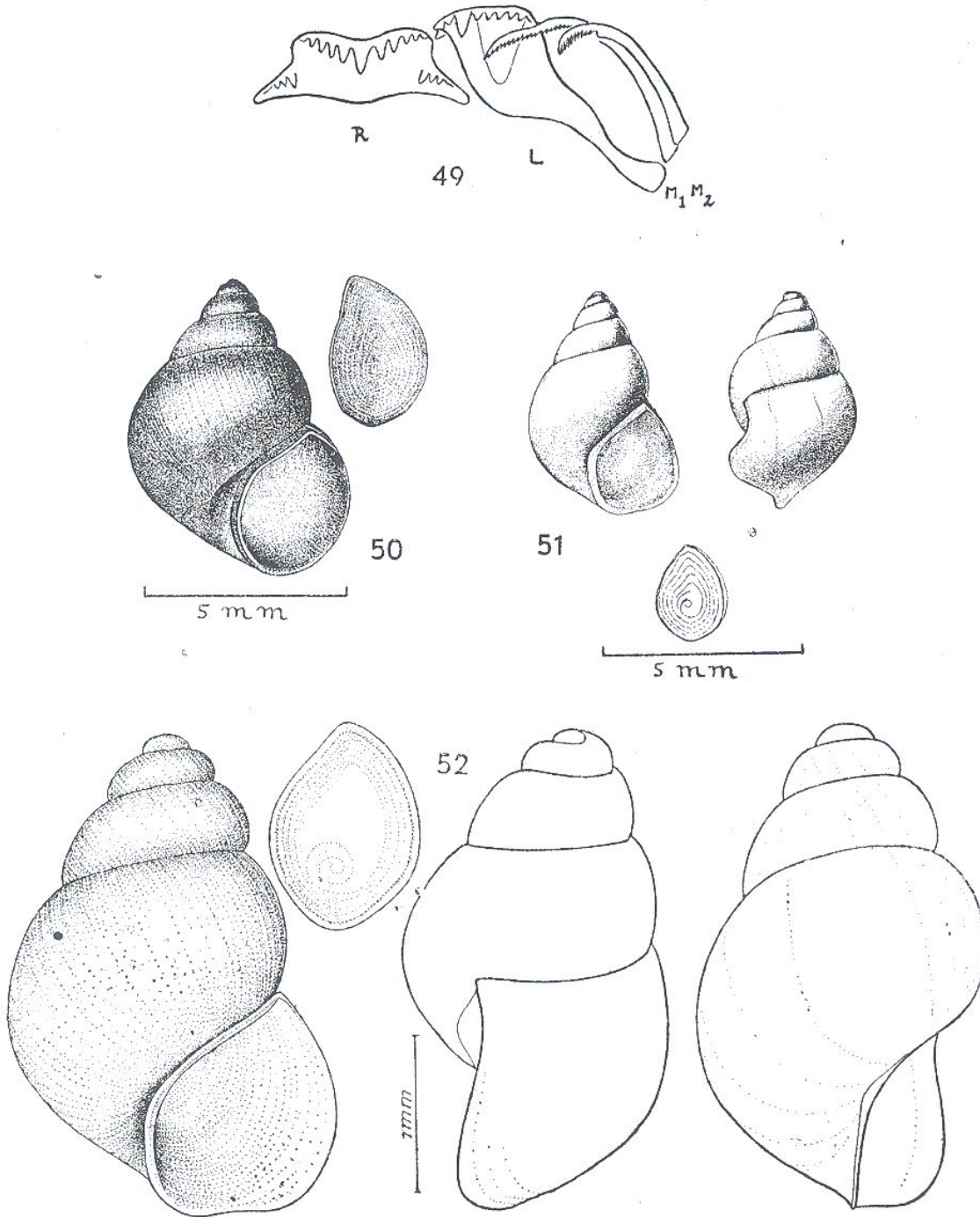
Distribution: Southern China, Siam, India, Malaya, Malay Archipelago, Philippines, New Guinea, in fresh water, either stagnant (lakes and pools), or running (sluggish streams).

In Java only one species:

Digoniostoma truncatum (EYDOUX & SOULEYET, 1852) (fig. 50).

1852. EYDOUX & SOULEYET, Voy. Bonite, Zool. 2, p. 548, pl. 31, fig. 22-24 (*Paludina*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 25, pl. 9, fig. 11-11b (*Bithynia*).
1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 310 (*Bithynia*).
1909. SCHEPMAN, Siboga Exp. Monogr. 49-1-b, p. 196 (*Bithynia*).
1911. MARTIN-ICKE, Pithecanthr. Schichten Java, p. 50 (*Bithynia*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 261 (*Bithynia*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 97 and 143 (*Bithynia*).
1923. OOSTINGH, Meded. Landb. Hoogesch. Vol. 26, No. 3, p. 54 (*Bithynia*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 86 (*Bithynia*).
1931. VAN ES, Age of Pithecanthropus, p. 136 (*Bithynia*).
1931. VAN DER VLIERK, Leidsche Geol. Meded. 5, p. 256 (*Bithynia*).
- 1934a. RENSCH, Zool. Jahrb. (Syst.) 65, p. 398 (*Bithynia*).

- 1934b. RENSCH, Trop. Binnengew. 5, p. 224 (*Bithynia*).
 1935. PARAVICINI, Arch. Moll. Kunde, 67, p. 175 (*Bythinia*).
 1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 104 (*Bithynia*).
 1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 278 (*Bithynia*).



- Fig. 49. *Digoniostoma pulchellum* (BENS.). Radula elements. Author del.
 Fig. 50. *Digoniostoma truncatum* (EYD. & SOUL.). Shell and operculum. ABDULKADIR del.
 Fig. 51. *Wattebledia crosscana* (WATTEBL.). Shell from front and back, and operculum. ABDULKADIR del.
 Fig. 52. *Wattebledia insularum* n. sp. Shell in three different positions, and operculum. ABDULKADIR del.

Shell broad-conical to low-turreted, corneous to light-chestnut. Finely striated by the growth lines, with occasional coarser dark lines, marking previous periods of arrested growth. Under a strong (about 50 times) enlargement a very delicate spiral or crosswise striation is visible. The entire shell has a soft, silky lustre; it is hardly or not transparent.

Whorls 5-6, well rounded. Last whorl large and inflated. Top whorls often lacking (hence the name *truncatum*). Suture moderately impressed. Top pointed, but not sharp. Base evenly rounded, with a distinct ridge round the open umbilicus.

Aperture somewhat oblique, rounded-ovate, a little pointed at the upper angle and expanded at the base. Peristome continuous, slightly thickened, often dark-brown to black.

Operculum calcareous, the centre spirally coiled, the marginal zone with concentric growth rings. Nucleus almost central.

Dimensions: height up till 10, width 6.5-7, height of aperture 4 mm.

Distribution: India, Sumatra, Java, Lombok, Sumbawa, Sumba, Celebes.

Habitat in Java: in drains and ditches, sawahs, lakes, marshes and sluggish rivers, living on the bottom, among mud and aquatic weeds.

West Java: environs of Djakarta; marsh near Djakarta; slokan along Gunungsari Road, Djakarta; Tangerang, ditch along road to Djakarta; sawah near Depok; Lake Tjigombong; Sukabumi; Djampang; sawahs near Bandung; sawahs between Bandung and Lembang; sawahs along road Bandung-Sumedang; sawah near Garut; in sawahs along road Garut-Tasikmalaja; draining ditches on estate Pagandaran, along Dirk de Vriesbay.

Central Java: lake in Southern Mountains near Klaten; Kedungwuni, in sawah near football field; Penawangan; Kali Lusi, near Wirosari; Kali Besèk, near Sulang; Mantingan, in sawah.

East Java: Kali Soko, right tributary river of Kali Solo, near Trinil; Surabaya; Pasuruan; Lake Gratie, near Pasuruan (MARTENS, 1897); Malang (MARTENS, 1897); Rivulet near Djangkar (SCHEPMAN, 1909).

Digoniostoma truncatum has also been recorded from the island of Madura, east of Surabaya.

As a fossil this species was found in Pleistocene deposits at Trinil (MARTIN-ICKE, 1911; MARTIN, 1919; VAN ES, 1931; VAN DER VLERK, 1931; VAN BENTHEM JUTTING, 1937).

Genus *Wattebledia* CROSSE, 1886

Shell conoidal or low-turreted. Whorls flattened or convex, finely striated. Last whorl large and inflated. Umbilicus very narrow, or closed.

Aperture subtriangular. Peristome continuous, the exterior margin flexuous, basal margin almost horizontal, making an angle with the columellar side.

Operculum calcareous, the centre spirally coiled, the marginal zone concentrically ringed.

Distribution: Southern China, Indo China, Java, in fresh water.

In Java two species have been found:

1. Shell till 7.5 mm height. Whorls flattened. Suture shallow. Sinuosity of exterior peristome distinct **crosseana**
- Shell till 3.5 mm height. Whorls convex. Suture deep. Sinuosity of exterior peristome not so distinct **insularum**

Wattebledia crosseana (WATTEBLED, 1884) (fig. 51).

1884. WATTEBLED, Journ. de Conch. 32, p. 127, pl. 6, fig. 4 (*Bythinia*).

1934. RENSCH, Trop. Binnengew. 5, p. 225 (*Bithynia*).

1948. ABBOTT, Bull. Mus. Comp. Zool. 100, p. 281.

1951. THIENEMANN, Arch. Hydrobiol. Suppl. Band, 19, p. 535 (*Bithynia*).

Shell conoidal or low-turreted, straw-colour or greenish-grey. Finely striated with axial growth lines. With soft lustre. A little transparent. Whorls about 5, regularly increasing in size. The last one rather large and inflated. Profile of the whorls little convex, suture little impressed. Top pointed, but not sharp, top angle about 40°. Base evenly rounded towards the aperture. Umbilicus closed.

Aperture little or not oblique. Oval, with rounded base and pointed upper angle. Peristome continuous, thickened, somewhat expanded, often dark brown or black. The exterior margin of the adult shell has a peculiar curve projecting forward. In immature shells this sinuosity is not yet developed.

Operculum calcareous, in the beginning spirally coiled, later with concentric rings round an almost central nucleus.

Dimensions: height up to 7.5, width 4, height of aperture 3 mm.

Distribution: Southern China, Indo China, Java.

Habitat in Java: in fresh water of lakes and marshes.

East Java: Rawah Bening, south of Kediri; Rawah Galapan, south of Kediri; Armenian Sports Ground near Surabaja; Ranu Klindungan, near Pasuruan.

Wattebledia insularum n. sp. (fig. 52).

Shell small, conoidal or broad turreted, straw-yellow or olive. Finely striated with axial growth lines. This sculpture is crossed by a still finer

spiral striation, only visible at a magnification of 50 times or more. The shell is somewhat transparent, and has a soft, silky lustre. Whorls 4-4½, regularly increasing in size. The last one rather large and inflated. Whorls convex, suture distinctly impressed (more than in *Wattebledia crosseana*). Top pointed, but not sharp, often decollate. Top angle about 30° (a little narrower than in *W. crosseana*). Base evenly rounded. Shell narrowly rimate, or the umbilical opening is closed.

Aperture little oblique. Oval, with rounded, somewhat expanded base and pointed upper angle. Peristome continuous, thickened, in many specimens lined with brown. The exterior margin of the adult shell has a peculiar protruding curve, although not so sinuous as in *W. crosseana*. In immature shells the curve is not yet developed.

Operculum calcareous, in the centre spirally coiled. Towards the margin the growth rings are concentric. Nucleus almost central.

Dimensions (in mm):

Rawah Galapan holotype	paratypes									
	Rawah Galapan									
height	3.5	3.1	3.1	2.9	2.8	2.7	2.6	2.6	2.6	2.6
width	2.3	2.1	2.1	1.7	2.1	2.1	1.8	1.8	1.7	1.7
height of aperture . . .	1.5	1.4	1.4	1.2	1.3	1.3	1.3	1.2	1.3	1.3
	paratypes									
	Rawah Bening									
height	3.5	3.4	3.2	3.2	3.2	3.1	3.1	3.1	2.9	2.7
width	2.4	2.3	2.2	2.1	2.1	2.1	2.1	2.0	2.0	1.8
height of aperture . . .	1.5	1.5	1.3	1.3	1.3	1.4	1.3	1.3	1.3	1.2

The new species was collected by Miss ADRIANA G. VORSTMAN on September 19th, 1927 in Rawah Galapan and Rawah Bening, two freshwater marshes south of Tulungagung, in Kediri, at about 150 m altitude.

This is the second member of the genus *Wattebledia* in the Malay Archipelago. It differs from *W. crosseana* (WATTEBLED) in: 1. the smaller size, 2. the smaller top angle, 3. the more convex whorls and deeper suture, and 4. the less developed sinuosity of the outer peristome margin.

Familia SYNCERIDAE

Shell globular to high-conical, smooth, finely striated, or with one or more spiral keels, or -rarely- with a lattice-work of axial and spiral ribs. Whorls flat or rounded. Suture simple or margined. Umbilical opening narrow or entirely closed.

Aperture oval, rounded at the base and pointed at the top. Peristome continuous or interrupted.

Operculum generally corneous; in some rare cases calcareous.

Animals with short, sometimes stunted, tentacles. The sexes are separate. Radula 2.1.1.1.2.

Distribution: all continents. Most species live in mud or sand along brackish coasts, a few in fresh water or on the land.

Key to the genera living in Java:

1. Peristome of shell continuous. 2
- Peristome of shell not continuous, but interrupted at the parietal side **Omphalotropis**
2. Shell usually with subsutural spiral ridge or fine thread. Whorls generally little convex. Umbilicus open or closed **Syncera**
- Shell usually without subsutural spiral ridge or fine thread. Whorls convex. Umbilicus mostly open **Paludinella**

The genera *Syncera* and *Paludinella* are difficult to tell apart. I have classified the brackish water species and one freshwater species (*Syncera bedaliensis*) as *Syncera*, the freshwater species *halophila* as *Paludinella*.

It is a well-known fact that the classification of the Synceridae is a matter of much confusion and controversy. In 1927 THIELE (Zool. Jahrb. (Syst.) 53, p. 113-146, 1 pl.) gave a tentative classification, mostly based on shell and radula characteristics, but his account was not exhaustive, as he studied only a fraction of the many species described in this family, and until modern investigations, based on genital organs, radula and other characters have been carried out in more species, the systematic position of numerous genera and species remains mere guess-work.

Genus *Syncera* GRAY, 1821

(syn. *Assimineae* FLEMING, 1828)

Shell small, low-conical to globular, rather thick and compact. Unicolorous or with dark and light spiral bands. Mostly finely striated, but in some species with a lattice work of vertical and spiral ridges. Whorls moderately convex, last whorl large. Suture margined by a subsutural thread in some species, but simple in others.

Aperture oval or pear-shaped. Peristome continuous; outer margin sharp, not thickened or expanded.

Operculum horny, thin, paucispiral, with excentric nucleus. In some species it is reinforced by a calcareous sheet.

The animal has no skin fold or "cape" overlying the base of the proboscis. A few observations on the animal are quoted from ABBOTT (1948, Bull. Mus. Comp. Zool. Vol. 100, no. 3, p. 281-282): "The animal

does not have true tentacles, but, instead, two short stunted eyestalks in which are embedded the round black eyes (fig. 55). A deep oblique furrow in the flesh on each side of the body divides the head and the body from the lower foot. There are no gills and respiration is by means of a lung which opens to the right side of the mantle. Behind the eye there is often a color streak of white, cream or orange”.

Radula 2.1.1.1.2, the central tooth sometimes with a few additional basal cusps. These denticles can, however, be absent. Distal part of lateral tooth can be solute. Marginals with numerous fine cusps (fig. 53).

Distribution: banks of shallow, brackish coasts of Europe, Asia, Africa, Australia, North America, on mud flats and along tidal creeks, in mangrove zones, immersed during high tide, but above sea level at low tide, rarely in fresh water.

There is some confusion concerning the validity of the name *Syncera*. Some authors regard *Syncera* as a nomen nudum, being not satisfactorily described by GRAY (IREDALE, 1922, Proc. Malac. Soc. London, 15, p. 37; WINCKWORTH, 1934, Journ. of Conch. 20, p. 12; THIELE, 1927, l.c. p. 114; Id. 1929, Handb. d. Syst. Weicht. Kunde, 1, p. 169; WENZ, 1939, Handb. Paläozool. Vol. VI, Gastropoda, Teil 3 (Lief. 4) p. 631). Others, on the contrary, accept the very short diagnosis by GRAY, 1821, as valid (ABBOTT, 1948, Bull. Mus. Comp. Zool. 100, p. 281). Although I regret to give up the familiar name of *Assiminea* I am inclined to follow the latter train of thought, because GRAY's original generic description was not entirely so poor as construed by later authors. It was even defined by a specific name: *S. hepatica* GRAY. The reproach that the diagnosis of *Syncera* did not give any conchological features is an over-estimation of the importance of shell characters, in deference to other qualities of the organism. Moreover, GRAY confirmed (1847, List of Genera; no. 193) the identity of *Syncera* with *Assiminea*, FLEMING, 1828, which had been described in the course of time between his first and his second mentioning of the genus. Although nomenclatorially this is not decisive it strengthens the meaning of his first introduction of the name *Syncera* in science.

Another consequence of the revalidation of *Syncera* GRAY, 1821 is the priority of *S. hepatica* GRAY, 1821 over *Assiminea grayana* FLEMING, 1828.

Key to the species of Java:

1. Operculum thin and corneous 2
- Operculum calcareous **philippinica**
2. Shell with vertical and spiral sculpture, causing a fine lattice work on the shell **microsculpta**
- Shell smooth, or with one or two spiral threads 3

3. Shell rather large for the genus (more than 10 mm high) and with a distinct spiral ridge round the umbilicus **carinata**
 — Shell small to very small (always below 10 mm height), spiral ridge in umbilical region absent or weak 4
4. With high spire 5
 — With low spire 9
5. Shell with five brown spiral bands, of which three are more distinct than the others **bedaliensis**
 — Shell without spiral bands, or -at most- a diffuse differently coloured zone along the suture 6
6. Whorls somewhat convex 7
 — Whorls flat 8
7. Whorls no. 2, 3 and 4 with 3-5 raised spiral lines, later whorls smooth **hidalgoi**
 — All whorls smooth **nitida**
8. With a subsutural spiral thread **woodmasoniana**
 — With a subsutural spiral thread and another one along the periphery **javana**
9. Whorls somewhat convex, without subsutural thread **borneensis**
 — Whorls almost flat, or little convex, with one or two subsutural threads **brevicula**

Syncera bedaliensis (RENSCH, 1934) (fig. 63).

1934. RENSCH, Trop. Binnengew. 5, p. 226, pl. 1, fig. 20 (*Assimineae*).

Shell rather high-conical, ground colour corneous to greenish-yellow, with fine, brown, spiral bands, three of which are generally more distinct than the others. Somewhat shining and transparent. Finely striated with delicate, regular growth lines. This sculpture is crossed by still more delicate spiral lines, only visible under strong magnification (50 times or more).

Whorls about 6, moderately convex, regularly increasing in size. Apex pointed, but not sharp, last whorl evenly rounded towards the aperture. Suture moderately deep. Parallel to the suture, and at a short distance below it, each whorl bears a fine spiral groove. Umbilicus open, but not wide; surrounded by a faint spiral thread at a short distance from the opening.

Aperture oblique, broad-oval, rounded below, pointed above. Peristome continuous, the parietal side pressed against the penultimate whorl. Outer margin somewhat thickened in adult individuals; columellar and basal margins also thickened and, besides, a little expanded. The columellar margin partially hides the umbilical opening.

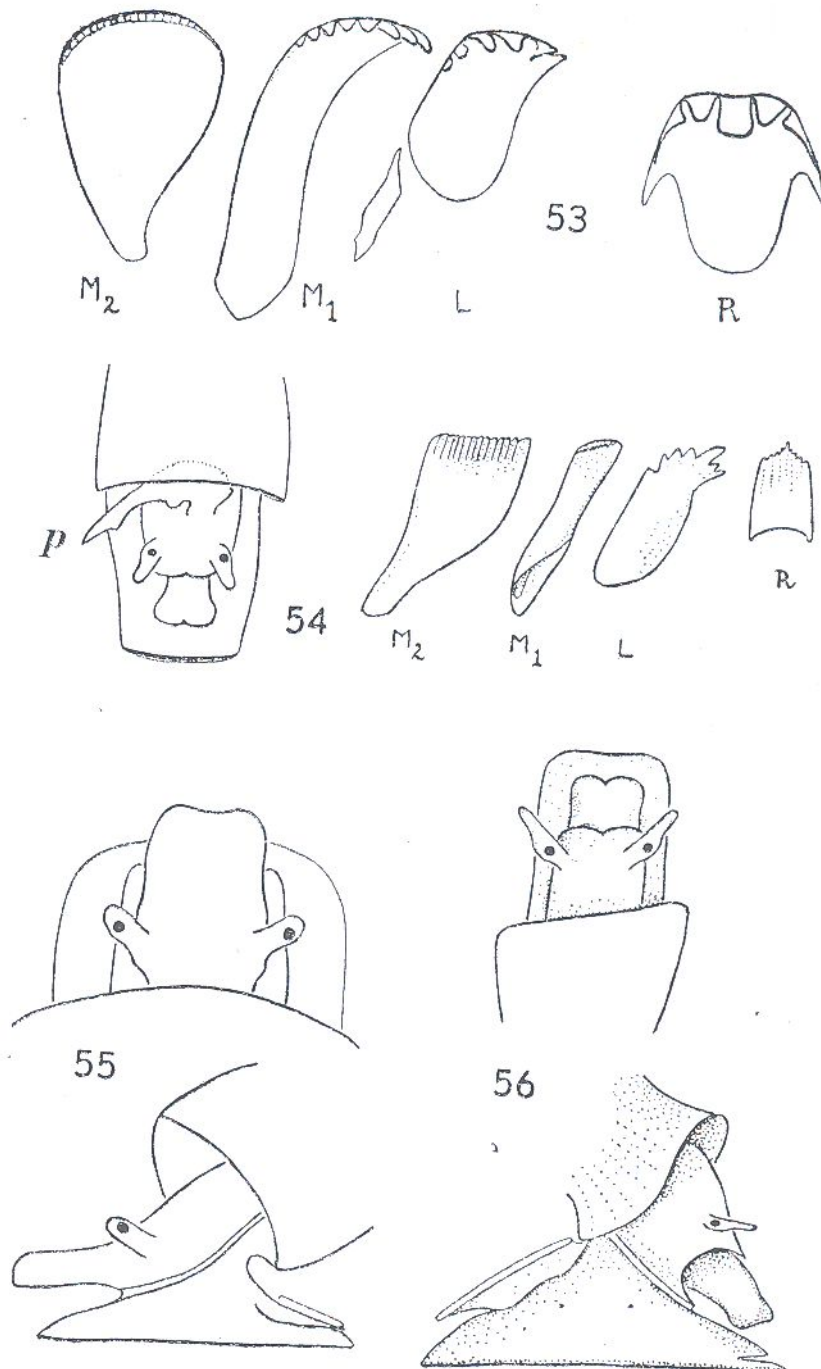


Fig. 53. *Syncera javana* (THIELE). Radula elements. Author del.

Fig. 54. Diagrammatic dorsal view of *Paludinella*. p. penis. Radula elements (after ABBOTT).

Fig. 55. Diagrammatic dorsal view and side view of *Syncera*, showing stubbed tentacles and oblique furrow separating head and foot (after ABBOTT).

Fig. 56. Diagrammatic dorsal view and side view of *Omphalotropis*, showing pointed tentacles, oblique furrow separating head and foot, and the proboscis "cape" (after ABBOTT).

Operculum corneous, paucispiral, nucleus excentric.

Dimensions: height 3.8-4, width 2.7-2.8, height of aperture 1.8 mm.

Distribution: Java.

Habitat in Java: in fresh water, near waterfalls, on stones, sometimes above the water.

West Java: Tjipanas, in small source near the palace of the governor-general; Tjiandjur, near Hospital, along ditch with running water, just above the water.

Central Java: Kali Lusi, near Wirosari.

East Java: Ranu Bedali, on stones near waterfall; Puger, on wet stone.

***Syncera woodmasoniana* (NEVILL, 1880) (fig. 66).**

1880. NEVILL, Journ. As. Soc. Bengal, 49, p. 163 (*Assimineae*).

1881. NEVILL, Journ. As. Soc. Bengal, 50, pl. 7, fig. 1 (*Assimineae*).

1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 69 (*Assimineae*).

1887. BOETTGER, Jahrb. Malak. Ges. 14, p. 211 (*Assimineae*).

Shell high-conical, rather solid. Yellowish-brown to chestnut-brown. Smooth and shining, with oblique growth lines, and much more delicate spiral lines. About halfway between the suture and the periphery the whorls bear a distinct raised spiral thread. A similar thread encircles the umbilical region, but this thread is often obsolete. Each succeeding whorl is appressed collar-like against the preceding whorl. Part of the previous whorl shines through, so that a false margin is formed along the suture.

Whorls $6\frac{1}{2}$ -7, regularly increasing in diameter, forming an ideal cone with flat sides. Suture very shallow. Periphery rounded in full-grown shells, but bluntly angular in immature ones. Top pointed, but not sharp, base rounded. Umbilicus closed or nearly so.

Aperture oblique, oval, with rounded base and pointed top. Peristome continuous, the parietal side pressed against the penultimate whorl. Exterior margin sharp. Columellar side almost vertical, thickened and flattened.

Operculum thin, horny, paucispiral, nucleus excentric.

Dimensions: the two shells from Amsterdam Island have the following dimensions: height 3 width 1.7 height of aperture 1.1 mm
 „ 2.4 „ 1.3 „ „ „ 0.9 „

Distribution: Calcutta, Port Canning, Chandipal, Andaman Islands, Amsterdam Island. So far the species has not been recorded from Java.

Habitat: there are no details about the habitat of this species.

I compared the specimens from Amsterdam Island in Djakarta Bay with — what is considered to be — authentic material from the Andamans in the Senckenberg Museum at Frankfurt-am-Main (leg. HUNGERFORD or BEDDOME via MOELLENDORFF collection). The Djakarta Bay shells agree perfectly with these shells. They are, however, somewhat more slender than the figure of NEVILL, 1881.

Syncera javana (THIELE, 1927) (fig. 53 and 64).

1927. THIELE, Zool. Jahrb. (Syst.) 53, p. 133, pl. 1, fig. 11 (*Paludinella*).

1934. VAN BENTHEM JUTTING, Misc. Zool. Sum. no. 84-85, p. 7-8, fig. 5-7 (*Assimineca sinensis* non *A. sinensis* NEVILL).

1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 279 (*Assimineca sinensis* non *A. sinensis* NEVILL).

Shell rather high-conical. Chestnut-brown or rufous, the two apical whorls somewhat reddish. With soft lustre, hardly or not transparent. Finely striated with delicate growth lines. This sculpture is crossed by still more delicate spiral lines, only visible at a magnification of at least 50 times.

Whorls 7-8, regularly increasing in size. Those of the spire with flat sides and superficial suture. Last whorl obtusely angular at the periphery: below that rounded towards the umbilicus. Each whorl bears two raised spiral ridges or threads, one subsutural (although at greater distance from the suture than is usually the case in *Syncera*) and one peripheral. In shells where the suture coincides with the peripheral ridge the latter is not visible on the whorls of the spire, but only on the last whorl. If, however, the suture runs somewhat below the periphery this ridge is just visible above the suture and parallel to it. Top acute, base rounded. Umbilicus closed. Along the umbilicus a fine, not very conspicuous thread.

Aperture somewhat oblique, broad-oval, rounded below, pointed above. Interior chestnut-brown. Peristome continuous, the parietal side pressed against the penultimate whorl. Outer margin sharp, somewhat thickened, but not expanded. Basal and columellar margins thickened and a little expanded.

Operculum corneous, paucispiral, with excentric nucleus.

Dimensions: height 5-6, width 3-3½, height of aperture 2.3-2.6 mm.

Distribution: Java, Nusa Kambangan, Pulo Panaitan, Island of Nias, Sumatra.

Habitat in Java: in muddy ditches or in sandy mud along the coast in the tidal region.

West Java: Tjipinang; Sukabumi.

In the original diagnosis and in the figure no mention is made of the two spiral threads. Through the courtesy of Dr S. JAECKEL (Berlin) I received on loan four specimens of THIELE's original lot. All four shells show the threads quite distinctly. The measurements of these four shells are:

height	6.2	6.0	5.8	5.5	} mm.
width	3.6	3.6	3.3	3.4	
height of aperture	2.6	2.6	2.4	2.5	

Probably they are all syntypes, as no holotype is indicated and as not one agrees with THIELE's figures: height 6.0, width 3.3 mm.

The presence of the two spiral threads and, in fact, the entire habitus of shell and operculum suggest a classification as *Syncera* rather than as *Paludinella*. Even THIELE's argument that the radula is characteristic of *Paludinella* is not convincing, because he does not mention the pectinate form of the outer marginal tooth, as is so typical in *Paludinella*. Therefore I now classify the species as *Syncera javana* (THIELE).

Another difficulty is caused by the locus typicus: Sukabumi, collected by Major P. A. OUWENS. This sounds rather odd for a *Syncera*, as Sukabumi is an inland town, some 30 miles from the sea. We must, however, remember that Sukabumi can not only stand for the town, but also for the district, a subdivision of Priangan residency, with a long divided coast line along the south coast of West Java facing the Indian Ocean. In my opinion we have to locate the habitat of *Syncera javana* somewhere at this coast, in similar surroundings as other *Syncera* species.

A lamentable error was made by myself when, in 1934 and in 1941, I classified this species as *Assiminea sinensis*. Both samples, from Nias Island and from Nusa Kambangan are identical with *Syncera javana*.

Syncera hidalgoi (GASSIES, 1869) (fig. 67).

1869. GASSIES, Journ. de Conch. 17, p. 78 (*Hydrocena*).
 1882. MORELET, Journ. de Conch. 30, p. 105, pl. 4, fig. 8, p. 198, pl. 10, fig. 15 (*Assiminea granum*).
 1883. MORELET, Journ. de Conch. 31, p. 208 (*Assiminea granum* = *hidalgoi*).
 1887. BOETTGER, Jahrb. Malak. Ges. 14, p. 180 (*Assiminea hidalgoi*).

Shell moderately conical, solid, yellowish-brown to orange-brown, often with a lighter or darker zone below the suture. Somewhat shining and transparent. Finely sculptured by the growth lines. This sculpture is crossed by still more delicate spiral lines (50 times enlargement). Top smooth, the whorls 2, 3 and 4 with 3-5 raised spiral lines. After the fifth whorl these lines fade away. There is no subsutural thread.

Whorls about 6, rapidly increasing in size, somewhat convex. Suture distinct, but not deep. Periphery rounded. Top pointed, and mammillate in well-preserved specimens, base rounded. Umbilicus narrowly open or closed, sometimes encircled by a weak spiral thread.

Aperture oblique, oval, with rounded base and pointed top. Peristome continuous, the parietal side as a thin callus against the previous whorl. Exterior margin somewhat thickened. Columellar margin thick, flattened and expanded.

Operculum thin, corneous, paucispiral with excentric nucleus.

Dimensions: height 2.7-3, width 2-2.3, height of aperture 1.2-1.4 mm.

Distribution: brackish shores of the Indian and Pacific Oceans between Mauritius and New Caledonia.

The species has not yet been found in Java, but on some of the outlying islands in the Bay of Djakarta, north of West Java: Amsterdam, Middelburg, Haarlem and Schiedam.

THIELE (1927, Zool. Jahrb. (Syst.) 53, p. 118) classified *hidalgoi* as a *Paludinella* s. str. In my present paper I have left the species with *Syncera*.

Syncera nitida (PEASE, 1864) (fig. 68).

1864. PEASE, Proc. Zool. Soc. London, p. 674 (*Hydrocena*).

1869. PEASE, Journ. de Conch. 17, p. 165, pl. 7, fig. 11 (*Hydrocena*).

1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 71 (*Assimineae*).

1887. BOETTGER, Jahrb. Malak. Ges. 14, p. 192 (*Assimineae*).

1949. ABBOTT, Occ. Pap. B.P. Bishop Mus. 19, p. 272, fig. 7a-c.

Shell small, broad-conical, with elevated spire and rounded base. Yellowish-brown or greenish-yellow, in some specimens somewhat reddish-brown along the suture. Shining and somewhat transparent. Finely striated with delicate growth lines. This sculpture is crossed by still more delicate spiral striae, only visible under a strong lens (50 times and more enlargement). With a subsutural raised spiral thread along the suture. A similar fine spiral thread along the umbilicus.

Whorls 5-6, regularly increasing in size, somewhat convex. Suture moderately deep. Periphery subangular. Top pointed, but not sharp, base rounded. Umbilicus very narrow, or closed.

Aperture a little oblique, ovate, pointed above, rounded below. Peristome continuous, the parietal side pressed against the penultimate whorl. Outer margin sharp, not reflected. Basal and columellar margins thickened and a little expanded.

Operculum corneous, paucispiral, with excentric nucleus.

Dimensions: height 1.8-2, width 1.2-1.4, height of aperture 0.7-0.8 mm.

Distribution: Mauritius, Ceylon, Hongkong, Philippines, Andaman Islands, Nicobar Islands, various Pacific islands, Java and some islands in the Bay of Djakarta.

Habitat in Java: muddy beach and mangrove zone.

West Java: Sukabumi.

Besides, the species has been found in the islands of Amsterdam, Rotterdam, Middelburg, Hoorn and Leiden in the Bay of Djakarta.

Syncera carinata (LEA, 1856) (fig. 57).

1856. LEA, Proc. Acad. Philadelphia, 8, p. 111 (*Assimineae*).

1860. MARTENS, Proc. Zool. Soc. London, p. 11 (*Omphalotropis maculata*).

1866. MARTENS, Ann. Mag. Nat. Hist. (3) 17, p. 203 (*Assimineae*).

1874. ISSEL, Ann. Mus. Civ. Stor. Nat. Genova, 6, p. 447, pl. 7, fig. 7-9 and textfig. (*Omphalotropis*).

1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 71 (*Assimineae*).

1887. BOETTGER, Jahrb. Malak. Ges. 14, p. 166 (*Assimineae*).

Shell rather large for the genus, broad-conical, with regular, flat-sided spire and somewhat inflated last whorl. Olive-brown to light-chestnut, with occasional darker vertical streaks or flames and 1-3 diffuse spiral bands. Only the two apical whorls are light-brown. Moderately solid, somewhat transparent, with soft, oily lustre. Sculptured with delicate, regular growth striae, crossed by still finer spiral lines which are only visible under a lens of 25 times or more magnification.

Whorls $7\frac{1}{2}$ - $8\frac{1}{2}$, regularly increasing in size, flat, with shallow suture. On each whorl a raised subsutural thread. Round the umbilicus a spiral ridge which causes a minute gutter at the basal margin of the peristome. Periphery rounded. Top acute, base rounded. Umbilicus open.

Aperture vertical, broad-oval, pointed at the top and rounded at the base. Peristome continuous, somewhat thickened. The parietal side is pressed against the penultimate whorl. Outer margin not expanded, basal and columellar margin somewhat expanded.

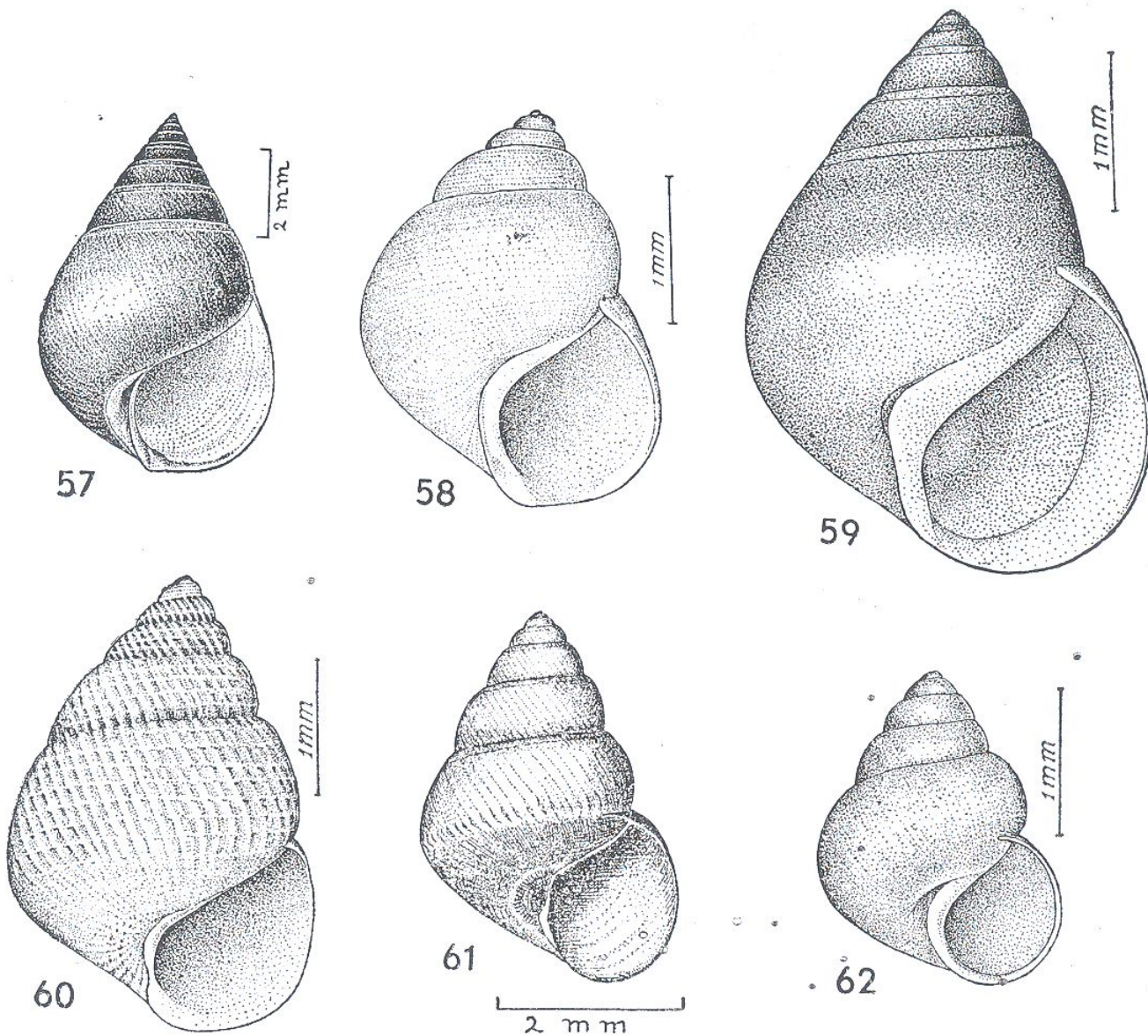
Operculum corneous, paucispiral, nucleus excentric.

Dimensions: height 11-12, width 6-7, height of aperture 5-6 mm.

Distribution: Bangkok, Saigon, Perak, Moulmein, Sarawak, Bangka, Sumatra, Java.

Habitat in Java: nothing is known about the circumstances under which it lives.

Syncera carinata has only been once recorded from "Java" without further details.



- Fig. 57. *Syncera carinata* (LEA). Shell. ABDULKADIR del.
 Fig. 58. *Syncera borneensis* (ISS.). Shell. ABDULKADIR del.
 Fig. 59. *Syncera philippinica* (BTG). Shell. ABDULKADIR del.
 Fig. 60. *Syncera microsculpa* (NEV.). Shell. ABDULKADIR del.
 Fig. 61. *Omphalotropis columellaris* QU. & MLLDFF. Shell. Author del.
 Fig. 62. *Paludinella halophila* RENSCH. Shell. ABDULKADIR del.

ISSEL (1874, p. 85) gave a description of the exterior of the animal.

THIELE (1927, p. 115) classified this species as a *Cyclotropis*, a subgenus of *Paludinella*. In my present report, however, I have left it with *Syncera*.

***Syncera brevicula* (PFEIFFER, 1854) (fig. 65).**

1854. PFEIFFER, Proc. Zool. Soc. London, p. 306 (*Hydrocena*).
 1881. NEVILL, Journ. As. Soc. Bengal, 50, p. 159, pl. 7, fig. 6, 6A (*Assimineae*).
 1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 67 (*Assimineae*).
 1887. BOETTGER, Jahrb. Malak. Ges. 14, p. 163 (*Assimineae*).
 1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 213 (*Assimineae*).
 1929. VAN BENTHEM JUTTING, Treubia, 11, p. 86 (*Assemania*).
 1930. VERWEY, Treubia, 12, p. 175, 177, 178, 188, 190 (*Assimineae*).
 1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 278 (*Assimineae*).

Shell globular or low-conical, with short spire and inflated last whorl. Olive-brown (the brick-red form *miniata* will be described hereafter). Rather solid, not transparent, with soft lustre. Finely striated in vertical and spiral directions. Along the suture with one, occasionally two, sub-sutural spiral grooves. Whorls 5-6, those of the spire narrow and little convex; the body whorl large and inflated. Suture moderately impressed, periphery rounded. Top pointed, but not sharp; base evenly rounded towards the umbilicus. Umbilical opening narrow or closed.

Aperture little oblique, pear-shaped. Interiorly light pink or brown. Peristome continuous, the parietal side pressed against the penultimate whorl. Outer margin sharp, not expanded. Columellar and basal margins thickened and a little expanded. The columellar margin hides the umbilical opening.

Operculum corneous, paucispiral, with excentric nucleus.

Dimensions: height 5-6, width 4-4.5, height of aperture about 3 mm.

Distribution: coasts of India, Ceylon, Burma, Malaya, Siam, southern China, Philippines, Andaman Islands, Sumatra, Java, Borneo.

Habitat in Java: estuaries and mangrove swamps, at the water edge.

West Java: mangrove near Djakarta; mud flats near Laboratory for Fishery Investigations, Djakarta.

Central Java: mangrove near Tjilatjap.

East Java: environs of Surabaya; tidal woods near kampong Gendjeran, east of Surabaya; mangrove near Besuki.

Syncera brevicula has also been recorded from the island of Kerkhof, in the Bay of Djakarta.

There is some variation in the height of the spire. The top whorls are often eroded and repaired.

Like the European *Syncera hepatica* GRAY (= *Assimineae grayana* FLEMING) the Javanese species *S. brevicula* has often been observed to wander about, especially in the morning, in pairs, the large females carrying the small males on the back of their shells (VERWEY, 1930).

***Syncera brevicula* forma *miniata* (MARTENS, 1866).**

1866. MARTENS, Ann. Mag. Nat. Hist. (3) 17, p. 204 (*Assiminea miniata*).

For further records see the references under *Syncera brevicula*.

A very handsome colour-form of *Syncera brevicula* is the bright brick-red f^a *miniata*. Not only the shell is thus coloured, but the animal is also pink, with a red head. It occurs with the main form in the same habitat.

West Java: mangrove near Muara Tangerang; mud flats near Laboratory for Fishery Investigations, Djakarta.

East Java: mangrove near Grissee.

Syncera brevicula f^a *miniata* has also been recorded from the island of Amsterdam in the Bay of Djakarta.

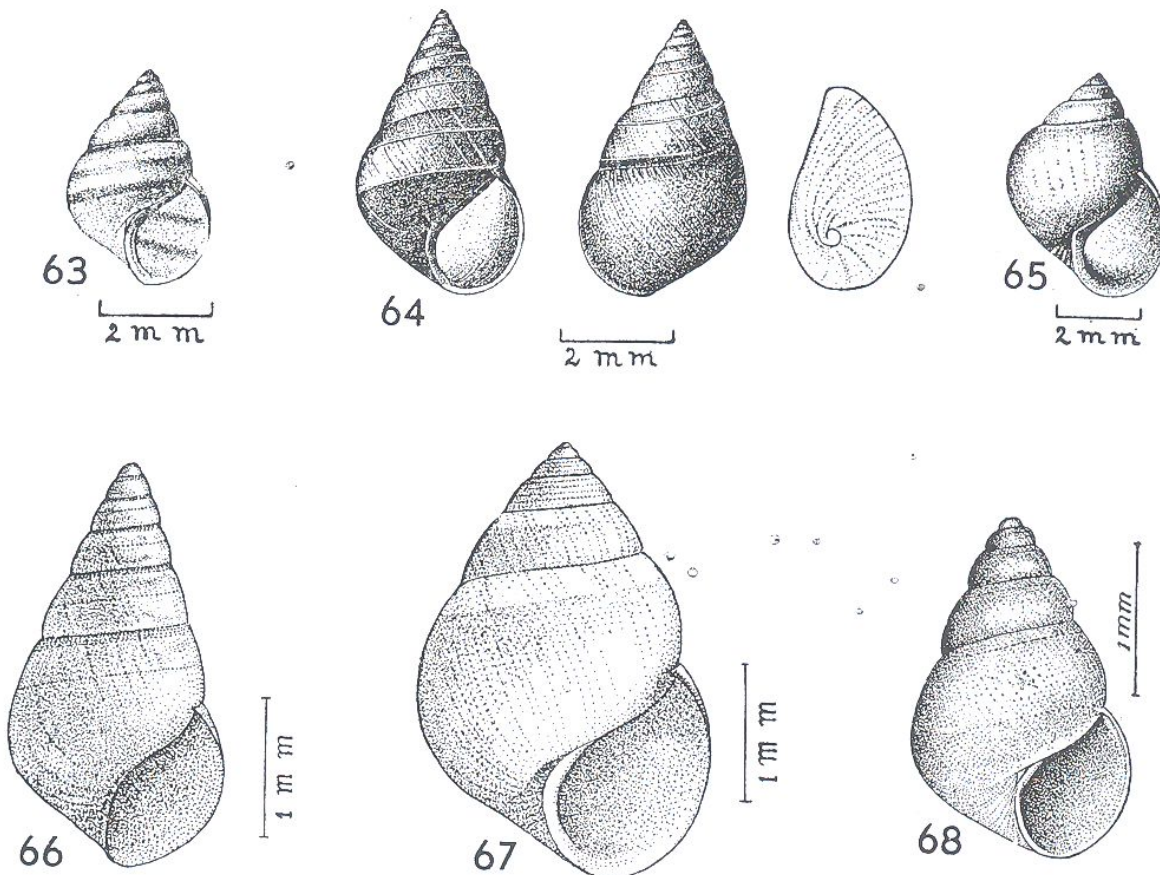


Fig. 63. *Syncera bedaliensis* (RENSCH). Shell. ABDULKADIR del.

Fig. 64. *Syncera javana* (THIELE). Shell from front and back. ABDULKADIR del. Operculum, more enlarged. Author del.

Fig. 65. *Syncera brevicula* (PFR). Shell. ABDULKADIR del.

Fig. 66. *Syncera woodmasoniana* (NEV.). Shell. J. MASTRO del.

Fig. 67. *Syncera hidalgoi* (GASS.). Shell. J. MASTRO del.

Fig. 68. *Syncera nitida* (PSE). Shell. ABDULKADIR del.

***Syncera borneensis* (ISSEL, 1874) (fig. 58).**

1874. ISSEL, Ann. Mus. Civ. Stor. Nat. Genova 6, p. 451, pl. 7, fig. 13-15 (not 16-18) (*Amnicola*).
 1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 66 (*Assimineae*).
 1887. BOETTGER, Jahrb. Malak. Ges. 14, p. 162 (*Assimineae*).
 1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 215 (*Assimineae*).
 1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 278 (*Assimineae*).

Shell low-conical, with short spire and inflated last whorl, cream-coloured, straw-yellow or light-brown, the spire generally darker than the body whorl. Rather thick, little transparent, with soft lustre. Finely, but distinctly spirally sculptured (more distinct than in *Syncera brevicula* or *S. bedaliensis*). No subsutural thread.

Whorls 5-6, those of the spire narrow and moderately convex; the body whorl large and inflated. Suture impressed. Periphery rounded. Top pointed, but not sharp, base evenly rounded to the umbilicus. Umbilical opening pin-point shaped or closed.

Aperture very oblique, pear-shaped. Peristome continuous, the parietal side pressed against the penultimate whorl. Outer margin sharp, not expanded. Columellar and basal margins thickened and a little expanded. The columellar side hides the umbilical opening. Basal margin much receding.

Operculum corneous, paucispiral, nucleus excentric.

Dimensions: height 2.5-3, width 1.9-2.4, height of aperture 1.2-1.5 mm.

Distribution: Ceylon, Andamans, southern China, Philippines, Borneo, some islands in the Bay of Djakarta: Leiden, Haarlem and Schiedam, but not from Java (VAN BENTHEM JUTTING, 1941).

Nothing is known of the circumstances under which this species lives, but they are probably similar to those of the other species of *Syncera*.

***Syncera philippinica* (BOETTGER, 1887) (fig. 59).**

1887. BOETTGER, Jahrb. Malak. Ges. 14, p. 195 (*Assimineae*).
 1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 279 (*Assimineae subeffusa* non *A. subeffusa* BOETTGER).

Shell moderately conical, brown to reddish-brown, with two darker brown diffuse spiral zones. Thick, hardly or not transparent. Finely striated with delicate lines of growth. This sculpture is crossed by still finer spiral striae, only visible at a 50 times magnification.

Whorls 6-7, regularly increasing in size. Rather convex, suture moderately deep. Each whorl bears a fine subsutural spiral thread. Top pointed,

but not sharp, base rounded. Umbilicus closed or narrowly rimate. Along the umbilicus a fine ridge.

Aperture somewhat oblique, broad-oval, rounded below, pointed above. Peristome continuous, the parietal side pressed against the penultimate whorl. Outer margin sharp and not expanded, basal and columellar margins thickened and a little expanded.

Operculum corneous, with calcareous rim and central sheet, paucispiral, nucleus excentric. Parallel to the outer margin is a strong ridge, and further, on the flat part of the operculum, a few (about 8) weak ridges. The operculum lies close to the opening of the aperture, and not so deep as in other *Syncera* species.

Dimensions: height about 5, width 3-3½, height of aperture 2½ mm.

Distribution: Philippines and a few islands near the coast of Java: Pulo Panaitan off the west coast, Island of Amsterdam off the north coast and Nusa Kambangan off the south coast. *Syncera philippinica* has not yet been found in the island of Java.

About the habitat of this species almost nothing is known, but probably it lives under similar conditions as the other species of *Syncera*.

Through a regrettable error I classified some years ago (VAN BENTHEM JUTTING, 1941) shells from the island Nusa Kambangan as *Assimineea subeffusa* BOETTGER. I have now come to the conclusion that they belong to *Syncera philippinica* (BOETTGER).

Syncera microsculpta (NEVILL, 1880) (fig. 60).

1880. NEVILL, Journ. As. Soc. Bengal, 49, p. 165 (*Assimineea*).

1881. NEVILL, Journ. As. Soc. Bengal, 50, p. 158, pl. 7, fig. 5 (*Assimineea*).

1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 70 (*Assimineea*).

1887. BOETTGER, Jahrb. Malak. Ges. 14, p. 190 (*Assimineea*).

Shell broad-conical, yellowish-brown, the apex somewhat darker brown. Rather solid, not transparent, little or not shining. The top whorl smooth, the second whorl finely striated in spiral direction. All other whorls with strong, somewhat flexuous vertical ridges, crossed by somewhat weaker, but still very conspicuous spiral ones, the whole surface thus presenting a fine lattice work. On the last whorl, on the periphery and just below it, the ridges become weaker, but round the umbilicus they appear again, especially the spiral ones.

Whorls 5-6, rather convex. Suture deep. Periphery subangular in immature shells, but rounded in adult ones. Top pointed, but not sharp. Base rounded. Umbilicus very narrow or nearly closed.

Aperture little oblique, broad oval, pointed above, rounded below. Peristome continuous, the parietal side pressed against the penultimate whorl. Outer margin sharp, not expanded. Basal and columellar margins a little thickened and expanded.

Operculum unknown.

Dimensions: height 2.2-3, width 1.5-2, height of aperture 1-1.3 mm.

Distribution: only known from Port Canning near Calcutta, and from the Island Amsterdam in the Bay of Djakarta.

No details are known on the habitat of this species.

Genus *Paludinella* L. PFEIFFER, 1841.

Shell high-conical, rather thin. Unicolourous, smooth or finely striated.

Whorls mostly flat. Suture simple or margined. Umbilicus narrow or closed. Aperture oval or pear-shaped. Peristome continuous, the parietal margin pressed against the penultimate whorl. Operculum horny, paucispiral, with excentric nucleus.

Animal with a fold or "cape" overlying the base of the proboscis (fig. 54). Tentacles short, but not stubbed. The sexes are separate. Radula 2.1.1.1.2. The central tooth without cusps in the basal corners.

Distribution: southern Europe, tropical Asia and various Pacific islands, in, or along, fresh water, rarely in brackish water.

In Java only one species:

Paludinella halophila RENSCH, 1934 (fig. 62).

1934. RENSCH, Trop. Binnengew. 5, p. 228, pl. 1, fig. 23.

Shell conical, with rather high spire on a broad base. Corneous or straw-colour, somewhat shining and transparent. Finely striated with delicate growth lines. This sculpture is crossed by still more delicate spiral lines, only visible under strong magnification (about 50 times).

Whorls 5-6, convex, regularly increasing in size. Apex pointed, but not sharp, last whorl rather inflated. Suture deep. Umbilicus open, but not wide, surrounded by a fine spiral thread at a short distance from the umbilical opening. This spiral thread is often difficult to distinguish.

Aperture oblique, broad oval, rounded below, pointed above. Peristome continuous, the parietal side pressed against the penultimate whorl. Outer margin sharp, not expanded, basal and columellar margins thickened and a little expanded.

Operculum corneous, paucispiral, nucleus excentric.

Dimensions: height 3.5, width 2.5, height of aperture 1.5 mm.

Distribution: West Java.

Habitat in Java: the species lives on moist rocks in the neighbourhood of salt wells near Kuripan.

RENSCH (1934, p. 228) reported that the last whorl is "stumpfkantig" (obtusely angular), but the paratype in the Amsterdam Zoological Museum and the figure in RENSCH's publication do not suggest such angularity. In a sample of *Paludinella halophila* of more than 100 specimens, collected by the present author in the same locality (topotypes!) not one shell, not even the immature ones, displays such a feature. All are evenly rounded at the periphery.

Genus *Omphalotropis* L. PFEIFFER, 1851.

Shell broad-conical to turreted, smooth or sculptured with vertical and spiral striae. Some species with colour bands or colour flames. Umbilicus open, surrounded by a weak or strong spiral ridge. Peristome not continuous, with a minute sinus or incision at the columellar margin.

Operculum corneous, in some species fortified by a calcareous sheet. Paucispiral, nucleus excentric.

Animal with a fold or "cape" overlying the base of the proboscis (fig. 56). Tentacles short, but not stubbed. Radula 2.1.1.1.2. THIELE (1927, Zool. Jahrb. (Syst.) 53, p. 121) described the radula thus: Central tooth generally with 9 cusps, basal cusps absent, lateral tooth long, and more or less narrow, with a cutting edge of different strength which has secondary cusps on both sides. Inner marginal also long and slender, with 7-9 cusps of equal size. Outer marginal broad, carrying about 12-30 secondary cusps. The present author has not seen a radula.

Distribution: tropical parts of S. E. Asia, Malay Archipelago, Philippines, various Pacific islands. Some species live in the coast region, but most lead an entirely terrestrial life in the interior of the country.

In Java only one species:

Omphalotropis (*Stenotropis*) *columellaris* QUADRAS & MOELLENDORFF, 1893 (fig. 61).

1893. QUADRAS & MOELLENDORFF, Nachr. Blatt, 25, p. 183.

1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 279, fig. 1

1953. BUTOT, Trop. Natuur, 33 p. 30.

Shell broad-conical, with rather high spire on an inflated last whorl. Straw-coloured or light-brown. Thin, somewhat transparent, with soft lustre.

Whorls about 6. First $1\frac{1}{2}$ whorls smooth, subsequent ones striated obliquely. This striation is especially distinct (even more or less lamellar) on the peripheral angulation. The vertical striation is crossed by much finer spiral lines. Some of these spirals are stronger than the others. Suture margined by a subsutural thread. All whorls rather convex, suture deep. Periphery angular, but not acute. Top pointed, but not sharp. Base rounded. Umbilicus rather wide, surrounded by a fine, raised thread.

Aperture oblique, oval to broadly lunar. Peristome not continuous. Outer margin sharp and not reflected. Basal and columellar margins slightly thickened and expanded, with an incision, or little sinus, in the umbilical region, sometimes corresponding with a fine funiculus entering the umbilical canal.

Operculum unknown.

Dimensions: height about 4, width about 3, height of aperture $1\frac{1}{2}$ mm.

Distribution: Philippines, Java with its two satellite islands Noordwachter and Klein Kombuis north of West Java.

Habitat in Java: almost nothing is known on the habitat of this species in Java.

West Java: Udjung Kulon; Tjissalak.

Familia THIARIDAE

Shell mostly turreted, with many whorls. In some species smooth, in others sculptured with spiral or axial ribs, knobs, ridges, spines etc. or these systems combined. Aperture oval. Peristome continuous or interrupted at upper and lower corners, but never with a siphonal canal.

Operculum corneous, multispiral with central or subcentral nucleus, or paucispiral with excentric nucleus (fig. 69).

Animal with a short, broad snout. Eyes at the exterior sides of the tentacles, on short stalks near the base of the tentacles. Mantle margin smooth or with short digitiform processes. Foot small. Potentially the sexes are separate, but males are always absent, the females being parthenogenetic. Radula 2.1.1.1.2, the cutting edge of all teeth with cusps, in some species few in number, in others numerous.

Distribution: all continents, in temperate, subtropical and tropical regions. In fresh water, either running or stagnant. Some species can tolerate a small amount of brackish water.

As far as the Thiaridae have been investigated the animals are parthenogenetic; no males occur. The females are ovo-viviparous i.e. the eggs are not directly liberated into the water, but remain in a brood-pouch on the dorsal side of the mother and are hatched there. In the genera *Brotia*,

Thiara and *Balanocochlis* the young snails leave the brood-pouch after 2-3 weeks, and the same is observed in most species of *Melanoides*. Only in the subgenus *Stenomelania* of the last genus the young leave the mother at an earlier stage, as free swimming veliger larvae which metamorphose in the water before settling as young snails.

As a consequence of their parthenogenicity one individual suffices to found a new colony. As no cross breeding takes place such a colony has a very homogeneous genetical composition, developing as a "Reine Linie" (= clone). If the ecological conditions remain practically the same during many generations an isolated colony can develop into a population of uniform individuals with an outspoken local or "insular" character. This procedure may help to explain the almost incredible variability of the members of the family Thiaridae. "The scattering of the limnic species into numerous, comparatively well isolated populations under different ecological conditions favours the evolution of microgeographical races which means an extraordinary high degree of intraspecific variation" (HUBENDICK, 1954, Proc. Malac. Soc. London, 31, p. 9).

The fact that one single individual can start a new colony is a positive advantage over biparental propagation, because in the Thiaridae it is not necessary that the two sexes meet during the mating season in the — what seems to them enormous — under-water territory where they live. Provided the local circumstances are suitable any individual can give rise to a new colony. MORRISON (1954, Proc. Un. States Nat. Mus. 103, p. 374-375) put the problem in this way: "There is required only one individual (any individual) to start a new population or colony if it reaches a new freshwater locality by stream capture or by adventitious transportation. The resultant ability of these snails theoretically to spread more rapidly may partly explain their wider distribution in suitable habitats" and "the present geographic distribution of the Thiaridae argues for their greater ability to spread across oceanic areas on island stepping stones without the necessity for any continuous land bridges".

In 1897 MARTENS (in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 59) tried to explain the wide distribution of *Melanoides tuberculata* from North Africa to the Pacific Islands by assuming that this species, which is a common inhabitant of irrigated rice fields has been passively and unintentionally spread through human agency by inter-local, or even inter-continental transport of young rice plants.

From an economical point of view Thiaridae are important as raw material for burning lime, for which purpose only species occurring in

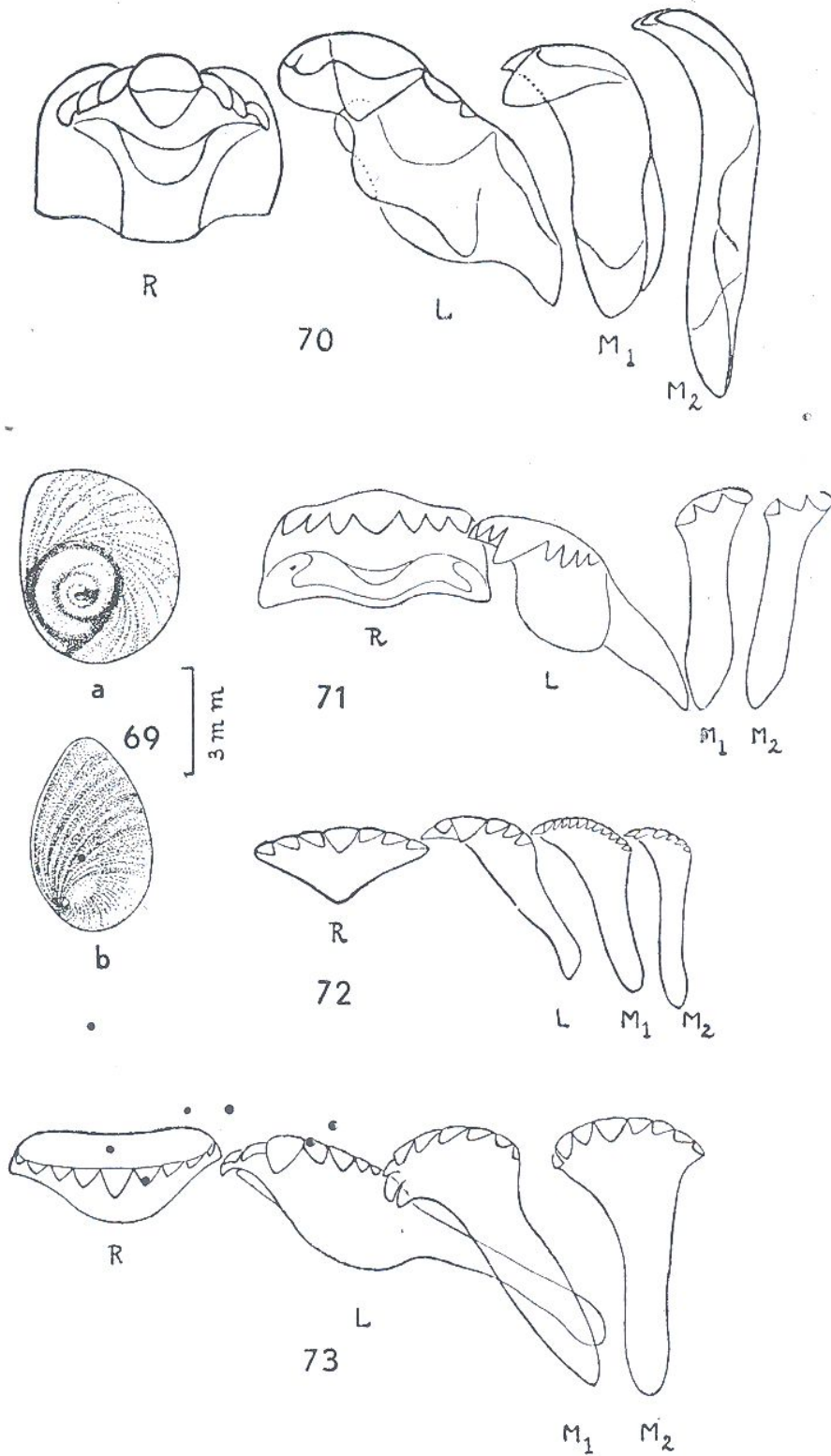


Fig. 69. a. multispiral operculum with subcentral nucleus of *Brotia testudinaria* (v.D. BUSCH), b. paucispiral operculum with excentric nucleus of *Melanoides tuberculata* (MÜLL.). ABDULKADIR del.

Fig. 70. *Brotia testudinaria* (v.D. BUSCH). Radula elements (after ADAM & LELOUP).

Fig. 71. *Faunus ater* (L.). Radula elements (after TROSCHEL).

Fig. 72. *Thiara scabra* (MÜLL.). Radula elements. Author del.

Fig. 73. *Melanoides tuberculata* (MÜLL.). Radula elements. Author del.

great colonies of great assemblages of different species are important. In places where duck farming is practised they are also used for feeding ducks (THIENEMANN, 1951, Arch. Hydrobiol. Suppl. Bd. 19, p. 535).

A number of species in the Oriental region serve as intermediate hosts of trematode parasites (ABBOTT, 1948, Bull. Mus. Comp. Zoöl. 100, p. 285 ff.). Yet BONNE (1940, Natuurk. Tijdschr. Ned. Ind. 100, p. 3) stated that the part played by Thiarids as transmitters of infections of echinostome worms is negligible, because the cercaria avoid these snails.

Key to the genera occurring in Java:

1. Operculum multispiral, nucleus central or subcentral 2
- Operculum with few whorls, nucleus at the basal side 3
2. Shell with short spire and relatively large last whorl (ratio shell height to height of aperture 2 : 1) **Sulcospira**
- Shell with longer spire in relation to the last whorl (ratio shell height to height of aperture 3 : 1) **Brotia**
3. Shell with sinus in upper and lower corner of aperture **Faunus**
- Shell without sinus in upper or lower corner of aperture 4
4. Shell ovoid, without ornamentation. Spire low. Last whorl large. **Balanocochlis**
- Shell more turreted and more sculptured 5
5. Spire of shell descending in steps, pagoda-like. Shell often spinous or sharply nodulous **Thiara**
- Spire of shell evenly descending. Surface with various ornamentation, but never spinous or with sharp nodules **Melanoides**

Genus **Brotia** H. ADAMS, 1866.

Shell imperforate, high-conoid or turreted, with many whorls. Yellowish-brown or dark-brown, with vertical streaks and flames, and spiral bands of darker brown colour. The entire shell is coated with a dark-brown, almost black epidermis. Adult shells not or little transparent and almost lustreless. Sculptured by fine growth lines and, mostly, with spiral grooves, especially on the base of the shell. In addition many species are elaborately sculptured with bold vertical ribs, knobs and spines.

Aperture oval, somewhat flaring at the basal side, but never with a siphonal canal. Peristome not continuous, the parieto-columellar side as a callus against the penultimate whorl. Ratio of shell height to height of aperture about 3 : 1.

Operculum multispiral, nucleus central or nearly so.

Animal with broad, protrusible snout. Tentacles long and slender. Eyes at the exterior side, almost at the base of each tentacle. Foot short

and broad. All animals are parthenogenetic females. Of the Javanese species *Brotia testudinaria* and *B. costula* are viviparous. Of *B. spadicea* the mode of reproduction is unknown. Radula 2.1.1.1.2, all teeth with small cusps (fig. 70).

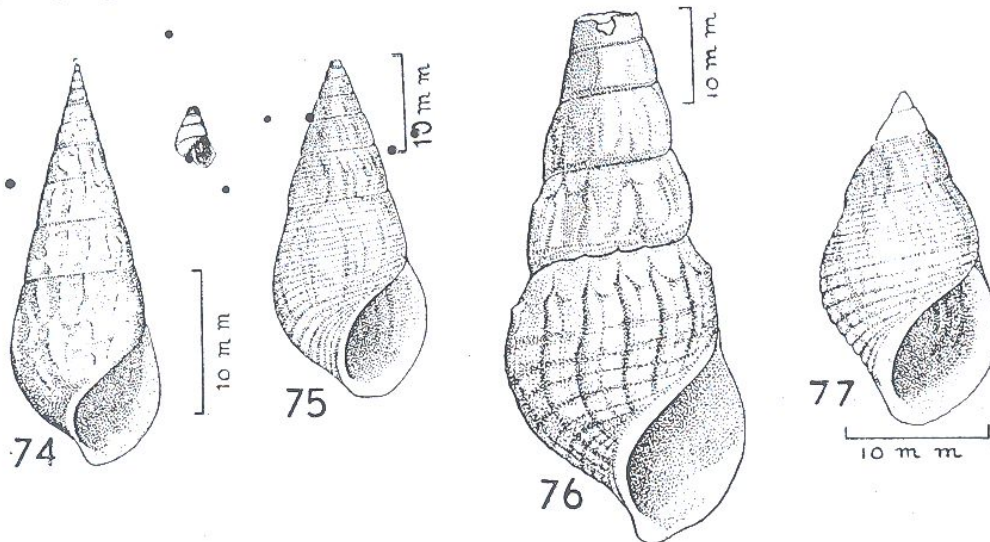
Distribution: India, Indo-China, Malaya, Malay Archipelago, Philippines. In the Malay Archipelago only in the four Great Sunda Islands.

Key to the species living in Java:

1. Shell almost smooth or sculptured with shallow spiral grooves only. . . 2
 - Shell elaborately sculptured with axial ribs and knobs, and spiral grooves : . . . *costula*
2. Shell almost smooth, spiral grooves only at base. Whorls flat or very little convex. *testudinaria*
 - Entire shell with spiral grooves. Whorls more convex *spadicea*

Brotia testudinaria (VON DEM BUSCH, 1842) (fig. 69, 70 and 74).

1842. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1, *Melania*, p. 3, pl. 1, fig. 14 (*Melania testudinaria*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268 (*Melania testudinaria*).
1849. MOUSSON, Land & Süsw. Moll. Java, p. 66, pl. 11, fig. 1-3 (*Melania testudinaria* incl. *lutea*, *scalaroidea*, *striatula*).
1850. LEA, Proc. Zool. Soc. London, p. 180 (*Melania foeda*).
1860. REEVE, Conch. Icon. 12, pl. 21, fig. 154 (*Melania testudinaria*).
1860. REEVE, Conch. Icon. 12, pl. 20, fig. 140 (*Melania agrestis*).
1872. BROU, Matér. Mélaniens, 3, p. 32, pl. 2, fig. 9 (*Melania angulifera*) and p. 33, pl. 3, fig. 4 (*Melania foeda*).



- Fig. 74. *Brotia testudinaria* (v.d. BUSCH). Adult shell, and embryonic whorls more enlarged. J. MASTRO and ABDULKADIR del.
- Fig. 75. *Brotia spadicea* (RVE). Shell. J. MASTRO del.
- Fig. 76. *Brotia costula* (RAF.). Shell. J. MASTRO del.
- Fig. 77. *Sulcospira sulcospira* (MAUSS.). Shell. J. MASTRO del.

1874. BROT, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 49, pl. 6, fig. 3 (*Melania testudinaria*), p. 51, pl. 6, fig. 4 (*Melania foeda*), p. 51, pl. 6, fig. 5 (*Melania angulifera*), p. 101, pl. 13, fig. 10 (*Melania agrestis*).
1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 269 (*Melania testudinaria* and vars *elongata* and *subangulata*).
1888. TENISON WOODS, Proc. Linn. Soc. N. S. Wales (2) 3, p. 1078 (*Melania foeda* and *angulifera*).
1890. BOETTGER, Ber. Senckenb. p. 151 (*Melania testudinaria*).
1891. BOETTGER, Ber. Senckenb. p. 245 (*Melania testudinaria*).
1894. MARTENS, Jen. Denkschr. 8, p. 83 (*Melania testudinaria*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 31 (*Melania testudinaria*), p. 32, pl. 2, fig. 9, 10 (*Melania foeda*), p. 303 (*Melania agrestis*).
1897. STRUBELL, Nachr. Blatt, 29, p. 11 (*Melania strigata*).
1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 248 (*Melania testudinaria*).
1905. MARTIN, Samml. Geol. Reichsmus. Leiden (N. F.) 1, p. 234 and 236, pl. 36, fig. 558, 558a, 559, 561 (*Melania testudinaria*).
1907. MARTIN, N. Jahrb. Mineral. 100, II, p. 160 (*Melania testudinaria*).
1908. BRANCA, Sitz. Ber. Kgl. Preuss. Akad. Wiss. Berlin, p. 270 (*Melania testudinaria* and *M. infracostata*).
1908. MARTIN, Versl. Gew. Verg. Kon. Akad. Wet. Amst. (Natuurk.) 17, p. 14 (*Melania infracostata* and *M. testudinaria*).
1911. CARTHAUS, Pithecanthr. Schichten Java, p. 13 (*Melania testudinaria* and *M. infracostata*).
1911. MARTIN-ICKE, Pithecanthr. Schichten Java, p. 50 (*Melania testudinaria*), p. 51 (*Melania infracostata*).
1912. SCHEPMAN, Proc. Malac. Soc. London, 10, p. 236 (*Melania testudinaria*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 217 (*Melania testudinaria*), p. 251 (*Melania angulifera, foeda* and *testudinaria*), p. 252 (*Melania agrestis*), p. 256 (*Melania strigata*).
1915. SCHEPMAN, Bijdr. t.d. Dierk. 20, p. 23 (*Melania testudinaria*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 96 (*Melania infracostata* and *M. testudinaria*).
1923. OOSTINGH, Meded. Landb. Hooges. Vol. 26, no. 3, p. 42 (*Sulcospira testudinaria*).
1924. SCHEIBENER, Trop. Natuur, 13, p. 94, fig. 1 (*Melania testudinaria*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 84 (*Melania angulifera, foeda, testudinaria, agrestis*), p. 85 (*Melania strigata*).
1931. VAN ES, Age of Pithecanthropus, p. 52 (*Melania testudinaria*), p. 65 (*M. testudinaria*), p. 136 (*Melania infracostata* and *testudinaria*).
1931. VAN DER VLERK, Leidsche Geol. Meded. 5, p. 254 (*Melania infracostata*), p. 255 (*M. testudinaria*).
1932. VAN BENTHEM JUTTING, Treubia, 14, p. 103 (*Melania testudinaria*).
1934. RENSCH, Trop. Binnengew. 5, p. 242 (*Brotia testudinaria*).
1935. OOSTINGH, Wetensch. Meded. Dienst Mijnb. Ned. Ind. 26, p. 29-34 (*Sulcospira testudinaria*, incl. *f. a typica, scalaroidea, striatula, subangulifera, convexa, angulifera*), p. 34 (*Melania foeda*).
1935. PARAVICINI, Arch. Moll. Kunde, 67, p. 175 (*Melania testudinaria*).

1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 110 (*Brotia testudinaria*), p. 112 (*Brotia testudinaria* fa *scalaroidea*).
1938. ADAM & LELOUP, Mém. Mus. Roy. Hist. Nat. Belg. (Hors Série) Vol. 2, Part 19, p. 87, fig. 31 (*Sulcospira testudinaria*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 280 (*Brotia testudinaria*).

Shell turreted, with many whorls. Yellowish-brown to dark-brown, with, occasionally, a dark-brown spiral band at, or just above, the periphery, and numerous irregular, often anastomosing, axial streaks and flames which -if well developed- give the idea of a tortoise-shell pattern for which the species is named. The whorls are almost smooth; only between the periphery and the base some 8-10 spiral ridges generally occur. Last whorl often bluntly angulate at the periphery. Adult shells not or little transparent, and almost lustreless. Epidermis dark-brown, almost black, often incrustated with foreign matter.

Whorls 10-12, regularly increasing in size. Sides almost flat, hence the suture is shallow. Periphery of last whorl rounded or slightly angular. Top whorls often absent. Aperture about one third of entire shell height. Top pointed, base rounded. Umbilicus closed.

Aperture vertical, oval, pointed at the top, rounded below. Basal side somewhat expanded. Peristome not continuous, the two ends connected by a callus against the previous whorl.

Operculum corneous, dark red-brown, with about 5 spiral whorls and a central nucleus.

Dimensions: height 37-40, width 13-16, height of aperture 12-14 mm.

Distribution: Southern Sumatra, Java and some satellite islands of Java.

Habitat in Java: It is one of the commonest Thiarids in Java. It lives in practically any habitat between sea level and 1500 m altitude, in running or in stagnant, often even in putrified water. Therefore it is easy to understand that local variants are common, and all authors who have seriously studied this species mention its great variability (MOUSSON, 1849; BROU, 1874; MARTENS, 1897; RENSCH, 1934).

West Java: Antjol near Djakarta; Tandjong Priok; River Tanabang in Djakarta; Kali south of Depok; sawah on Tjiomas estate; Bogor and environs; slokans near Herbarium, Bogor; Tjiliwong near Bogor; pond in Botanical Gardens, Bogor; in sawahs near Bogor; Tjiburial near Bogor; Mt Pantjar near Bogor; near waterfall of river Tjianten, Leuwiliang, near Bogor; Mt Tjibodas, estate of Tjampea; Gadok; brook in the jungle of Mt Bunder; Lake of Tjigombong; Tjibadak; Sukabumi and environs; Tjitarik near Sukabumi; Parangkuda near Sukabumi; Palabuan; Wangun

near Tjisampora, Djampang; Tjipanas, quickly running brook behind palace of Governor General; Lake of Tjisarua near Sindanglaja; Tjibodas; Tjimatjan, in sawahs, ponds and rivulets; draining ditch near Kadipaten; Tjiandjur, in ponds, slokans and near waterfall behind the Hospital; between Tjiandjur and Tjugenang, in sawahs; between Tjiandjur and Bandung; Tjiliwung near Radjamandala; kali at Kapek, near Tjimahi; river Tjimahi between Lagador and Kapek; Bandung and environs, in running water; lake and brooks on Mt Patuha, some with sulphureous and hot (32°C) water; Lake Leles between Bandung and Garut; Lake of Bagendit, near Garut; Mt Malabar; Santosa-Patjeh, Mt Papandajan; Mt Guntur, near Hack's Radium Hotel; Malangbong; Tjiamis, in river; Pagandaran on Penandjung peninsula; Purwakarta, in brook; river Tjipelang, near Udjungdjaja, district of Sumedang; Tjisaaranang near kampung Tjariang, district of Sumedang; Palimanan; Cheribon.

Central Java: Sukaredjo; Tegal; near harbour of Pekalongan; near Bodja; Semarang; Penawangan near Semarang; Wirosari near Semarang; Rembang; Kali Besèk; near Sulang; estate of Djumlang, Mt Ungaran; Mantingan; Tuntang river; Magelang; Kali Taman near Salatiga; Djokja; near Mendut temple north of Djokja; Solo.

East Java: Kali Soko, right tributary river of Kali Solo near Trinil; Lake of Ngebel; Berbek; waduk of Sumber Kepu, N.N.W. of Kertosono; Kediri; Modjokerto; Kali Tido, between Tjepu and Bodjonegoro; swimming pool Dander S. of Bodjonegoro; brook near Nglirip, environs of Bodjonegoro; Grisse near Surabaya; Trawas S. of Surabaya; Pasuruan; Banju Biru near Pasuruan; Prigen on Mt Ardjuno; Pudjon on Mt Kawi; river below waterfall at Lawang; Malang and environs; Singosari near Malang; Kali Brantas near Malang; Tengger Mts; Ranu Bedali, waterfall and swimming pool; Ranu Klakah; Ranu Pakis, from 8 m depth and in well along the shore (RENSCH, 1934); Kali Mrawan; Djember; Besuki; Situbondo; sawahs near Pradjekan, S of Situbondo; river Bomo; river Tjarang, Banjuwangi; Rogodjampi (MARTENS, 1897).

Brotia testudinaria has also been collected in the islands of Madura, Bawean, Rotterdam and Nusa Kambangan (VAN BENTHEM JUTTING, 1941).

In a fossil state the species has been recorded from various fossiliferous layers of Pliocene and Pleistocene age in West, Central and East Java (MARTIN, 1905, 1907, 1908, 1919; BRANCA, 1908; CARTHAUS, 1911; MARTIN-ICKE, 1911; VAN ES, 1931; VAN DER VLERK, 1931; OOSTINGH, 1935; VAN BENTHEM JUTTING, 1937).

VAN BENTHEM JUTTING, 1937, p. 111-112, drew attention to the fact that in the fossiliferous layers *Brotia testudinaria* is even more polymorph-

ous than in the recent fauna. The specimens found in prehistoric kitchen middens of Sampung Cave (Central Java) look more like recent than like fossil ones (VAN BENTHEM JUTTING, 1932).

The females are ovo-viviparous. At birth the young shell is about 1½ mm high and has two whorls. The apex is a thick, shapeless, smooth cap of a typical fawn colour, soon changing to light yellowish-brown, with a peripheral and a subsutural dark-brown band, and a brown zone in the umbilical region. The periphery is distinctly angulate, a condition which continues till the shell is semi-adult.

Brotia testudinaria var. *perconica* P. & F. SARASIN, described from the valley of the Kalaëna River in Central Celebes [1898, Süsw. Moll. Celebes, p. 28, pl. 3, fig. 33-34 (shell), pl. 5, fig. 70 (operculum) pl. 6, fig. 94 (radula)] is certainly not a form of *B. testudinaria*. This has already been remarked by RENSCH (1934, p. 244) on account of the structure of the radula and of the absence of a reddish-brown spiral band on the shell. ADAM & LELOUP (1938, p. 88), however, united the Celebes shells again with *B. testudinaria*. When studying type material in the Basle Natural History Museum I found the embryonic whorls quite different. In *B. testudinaria* they are smooth, somewhat inflated, the apical whorl almost shapeless and lying obliquely or transversely to the axis of the shell. In the Celebes form they are radially ribbed by strong, distantly placed ribs on the second to third whorl. I counted 13 ribs on this part of the spire. After the ribbed region the shell is finely sculptured by spiral lines all over the surface.

I studied a paratype (height 40, width 16, height of aperture 14 mm) of *Melania agrèstis* REEVE from the British Museum (Natural History), loc. Borneo, ex Mus. Cuming. This shell is doubtless a *Brotia testudinaria*. It differs somewhat from the (probably badly reproduced) figure of the holotype of *Melania agrèstis* in Conch. Cab. Vol. 12, pl. 20, fig. 140. The locality "Borneo" for a member of the *Brotia testudinaria* tribe seems dubious; it has to be confirmed by new material from unsuspected origin.

Brotia spadicea (REEVE, 1859) (fig. 75).

1859. REEVE, Conch. Icon. 12, pl. 19, fig. 132 (*Melania spadicea*).
 1874. BROU, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 57, pl. 6, fig. 12 (*Melania spadicea*).
 1896. SCHEPMAN, Notes Leyden Mus. 18, p. 135, pl. 2, fig. 1, 1a, 1b (*Melania junghuhni* and vars *fasciata* and *flammulata* non *junghuhni* MARTIN, 1879-1880).
 1898. SCHEPMAN, Notes Leyden Mus. 20, p. 84 (*Melania martini* nom. nov. for *M. junghuhni*).

1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 248 (*Melania junghuhni* and vars *fasciata* and *flammulata*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 251 (*Melania junghuhni*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 84 (*Melania junghuhni*).

Shell high-conoidal to turreted, with many whorls. Yellowish-brown to olive-brown, either plain, or with a dark-brown spiral band (f^a *fasciata*) or with dark-brown vertical flames (f^a *flammulata*). All whorls are spirally grooved, below the periphery stronger than above it. On the penultimate whorl about 16 grooves. Adult shells opaque or slightly transparent, and almost lustreless. Epidermis greenish-brown (not so dark as in *Brotia testudinaria*).

Whorls 8-10, regularly increasing in size. Somewhat convex, suture not deep. Top whorls often eroded. Top pointed, base rounded. Umbilicus closed.

Aperture about 2/5 of the entire shell length. Position of aperture vertical. Form oval, pointed at the top and rounded at the base, somewhat expanded at the basal corner. Interior of aperture bluish-white. Peristome not continuous, the two ends connected by a white callus against the parieto-columellar side.

Operculum horny, dark redbrown, with about 4 whorls and a central nucleus.

Dimensions: height 35-38, width 14-16, height of aperture 13-15 mm.

Distribution: Java.

Since the publication of *Brotia martini* by SCHEPMAN no new material has come to our knowledge. We have, therefore, no information on the habitat and the distribution of the species.

I compared a paratype of *Melania spadicea* REEVE (height 25, width 11, height of aperture 10 mm) from the British Museum (Natural History). It once belonged to the Museum Cuming and is of unknown origin. In the Rijksmuseum van Natuurlijke Historie at Leiden and in the Zoological Museum at Amsterdam I had the original material of SCHEPMAN before me.

MARTENS (1897, p. 33) identified a shell from the WEBER collection as *Melania sulcospira*, adding in the discussion that *Melania spadicea* REEVE, collected in Java by JUNGHUHN and now in the Leiden Museum, might be this species. In the first place MARTENS' identification of the shell from Tjipanas was erroneous. It is not *Sulcospira sulcospira*, but a stunted specimen of *Melanoides tuberculata*. In the second place there were no shells bearing the name *Melania spadicea* in the Leiden Museum. The confusion caused by MARTENS was also quoted by LESCHKE (1914, p. 251).

Brotia costula (RAFINESQUE, 1833) (fig. 76).

1833. RAFINESQUE, Atlantic Journ. no. 5, p. 166 (*Melania costula*).
1835. BENSON, Journ. As. Soc. 5, p. 746 (*Melania variabilis*).
1837. TROSCHER, Wieg. Arch. p. 174 (*Melania varicosa*).
1842. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1, *Melania*, p. 3, pl. 1, fig. 18 (*Melania torquata*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268-269 (*Melania varicosa, torquata* and *infracostata*).
1849. MOUSSON, Land & Süsw. Moll. Java, p. 65, pl. 10, fig. 4 (*Melania varicosa*), p. 65, pl. 10, fig. 3 (*M. infracostata*) and p. 70, pl. 9, fig. 2 and pl. 22, fig. 2 (*M. torquata*).
1859. REEVE, Conch. Icon. 12, pl. 3, fig. 10 (*Melania corrugata non corrugata* LAMARCK), pl. 3, fig. 14 (*M. infracostata*), pl. 31, fig. 204 (*Melania variabilis*).
1860. ZOLLINGER, Natuurk. Tijdschr. Nēd. Indiē, 21, p. 318-319 (*Melania variabilis, infracostata* and *torquata*).
1868. BROU, Matér. Mélaniens, 2, p. 42, pl. 2, fig. 4 (*Melania zollingeri*).
1874. BROU, in: MART-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 85, pl. 10, fig. 1, 1a-d (*Melania variabilis*), p. 98, pl. 12, fig. 3, 3a (*M. infracostata*), p. 110, pl. 14, fig. 5 (*M. torquata*), p. 111, pl. 14, fig. 6 (*M. zollingeri*).
1880. SCHEPMAN, in: VETH, Midden Sumatra, 4, Nat. Hist. Part 3, p. 14 (*Melania subplicata*).
1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 253 (*Melania variabilis* and *infracostata*).
1888. TENISON WOODS, Proc. Linn. N. S. Wales (2) 3, p. 1079 (*Melania variabilis, sumatrensis, infracostata*), p. 1080 (*M. torquata, zollingeri*).
1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 251 (*Melania torquata* and *M. infracostata*).
1905. MARTIN, Samml. Geol. Reichsmus. Leiden (N. F.) 1, p. 234 and 237, pl. 36, fig. 563-564 (*Melania soloensis*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 218 and 252 (*Melania subplicata*), p. 252 (*Melania infracostata, torquata, zollingeri*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 96 (*Melania soloensis*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 84 (*Melania infracostata, torquata, zollingeri, subplicata*).
1931. VAN ES, Age of Pithecanthropus, p. 136 (*Melania soloensis*).
1931. VAN DER VLERK, Leidsche Geol. Meded. 5, p. 255 (*Melania soloensis*).
1934. RENSCH, Trop. Binnengew. 5, p. 239 (*Brotia variabilis*).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 112 (*Brotia variabilis*).
1954. MORRISON, Proc. Un. St. Nat. Mus. 103, p. 382 (*Antimelania costula*).

Shell large and solid, the adult ones not transparent. High-turreted with many whorls. Dark olive-brown, coated by a blackish periostracum. The two or three spiral brown bands of the initial whorls disappear in full-grown shells. There is a great variation in sculpture of the different individuals and of the different parts of the shell in one individual. Generally the sculpture consists of a number of spiral ridges, of which one,

or more, can appear as rows of nodules. If strongly developed the nodules appear as short spines. They can also fuse in axial direction forming more or less pronounced ribs. Finally the costulation can be absent altogether. In some shells the nodules are absent on the upper whorls, only the penultimate and ultimate ones being ribbed (f^a *infracostata* MOUSSON). In others the nodules form axial ribs on the entire shell (f^a *varicosa* TROSCHEL) or undulating folds (f^a *subplicata* SCHEPMAN). The number of forms is endless, and -as their genetic connection is unknown- it is impossible to classify them as ecological or geographical subspecies.

Whorls 12-14, regularly increasing in size; last one large and spacious. Suture moderately deep. Periphery rounded, or somewhat angular by the sculpture. Top generally eroded. In complete shells the first 1-2 apical whorls are a little irregular, nearly shapeless, partly sunken. After this the shell is regularly coiled with slightly convex whorls, finely striated in spiral direction and with 3 brown spiral bands, one at the upper suture, one at the periphery and one below the periphery. Base rounded. Umbilicus closed.

Aperture almost vertical, broad-oval, pointed above, somewhat gutter-shaped or expanded below. Peristome not continuous, the two ends connected by a white callus against the parietal side. Exterior margin slightly sinuous with upper and lower parts receding and central part protruding.

Operculum corneous, dark-brown, multispiral with central nucleus.

Dimensions: height 70, width 22, height of aperture 20 mm.

Distribution: India, Burma, Malay Peninsula, Sumatra, Java.

Habitat in Java: about the Javanese habitat very little is known, but in Sumatra the species lives in fresh water of lakes and rivers.

West Java: Tjiringhin (MOUSSON, 1849); Buitenzorg (LESCHKE, 1914); pond in Botanical Gardens, Buitenzorg (RENSCH, 1934).

Brotia costula has also been recorded from Pliocene and Pleistocene layers in Central and East Java (MARTIN, 1905, 1919; VAN ES, 1931; VAN DER VLERK, 1931; VAN BENTHEM JUTTING, 1937). It is remarkable that *Brotia costula* existed in East and Central Java during the Pliocene and Pleistocene age, because at present the species is no longer found there.

The females are ovo-viviparous, containing several scores of embryos in the brood-pouch.

In the Zoological Museum of Zürich I studied in the MOUSSON Collection the type material of *Melania infracostata* MOUSSON. The two shells are labelled "Java, ZOLLINGER, '44". The locality Tjiringhin, recorded in

MOUSSON's book, is not mentioned, neither on the label, nor in the manuscript Catalogue. The dimensions are (in mm) :

height	54.6	width	20.8	height of aperture	17.5	(6 whorls left)
"	51	"	20.3	"	"	(5 " ")

The largest shell has been figured by MOUSSON and agrees very well with the figure. It is designated here as the holotype, the smaller shell is the paratype.

Both shells have a decollated spire and flat, smooth, upper whorls. The vertical ribs are only preserved in the lower three whorls.

In spite of the arguments of RENSCH (1934, p. 241) who proposed to classify *Melania infracostata* MOUSSON as a separate species it is my opinion that it is one of the numerous modifications of *Brotia costula*.

Melania varicosa TROSCHEL from Java (MOUSSON, 1849, p. 65) is not under this name in the MOUSSON Collection. After the publication of his book (1849) MOUSSON obviously changed his opinion and re-labelled the specimen as "*Melania brookei* RVE? Java (ZOLLINGER '44)". The shell agrees in every detail: number of ribs, number of whorls and yellow edge of basal apertural margin with MOUSSON's plate 10, fig. 4. Under the name *Melania brookei* it is also in MOUSSON's manuscript Catalogue which is of much later date (1889) than the book. In my opinion it is without doubt *Brotia costula*.

It is a remarkable fact that one of the few exact localities for *Brotia costula* (or one of its modifications) in Java was given by MOUSSON, viz. Tjiringhin for *Melania infracostata*, and we have already seen that this name is not on the label, nor in the catalogue.

From the British Museum (Natural History) I studied a shell labelled "*Melania corrugata* LAM. Polillo, P.I. Mus. Cuming". This specimen is so similar to REEVE's figure (1859) that it must have been the model for that plate, proving that *Melania corrugata* REEVE is quite a different thing from *Melania corrugata* LAMARCK, as BROT (1874, p. 85) has already pointed out. *Melania corrugata* REEVE is a synonym of *Brotia costula*.

Two other forms of *Brotia costula* must be dealt with a little more elaborately. These are *Melania zollingeri* BROT and *M. torquata* MOUSSON.

Melania zollingeri was placed by BROT (1874, p. 111) among the species having a circular operculum with a central nucleus. The operculum, however, at that time was not known.

RENSCH (1934, p. 233-234) described a paucispiral operculum with an excentric nucleus as belonging to *M. zollingeri*. As this author took together under *M. zollingeri* several species which certainly are not con-

specific, it is probable that this operculum has no affinities with the true *M. zollingeri*.

In his diagnosis of *Melania curvicosta*, MARTENS (1897, p. 36, pl. 2, fig. 14 and pl. 4, fig. 27) compared his new species with *M. zollingeri* BROU, stating that the axial folds of *curvicosta* are not nodulous and do not reach the upper suture of each whorl.

I have compared the type material of *Melania curvicosta* in the Amsterdam Zoological Museum, and of *Melania zollingeri* in the Natural History Museum of Geneva (BROU Collection) and Zürich (MOUSSON Collection). In my opinion the two species are absolutely synonymous. In spite of MARTENS' statement that the ribs of *M. curvicosta* are not nodulous and that the folds do not reach the upper suture, a paratype of *M. curvicosta* has distinctly nodulous ribs, and these ribs do indeed touch the suture. In the later whorls which occasionally can be somewhat scalarid, the folds can end at a small distance from the suture, but this same feature also occurs in *M. zollingeri* if the spire is more drawn out than usual.

If we thus admit that *M. curvicosta* (which has a circular operculum with a central nucleus) and *M. zollingeri* are synonymous, it follows that *M. zollingeri* also belongs to the genus *Brotia*. Summarizing it is my opinion that *M. curvicosta* and *M. zollingeri* are synonymous and that both belong to *Brotia costula*.

The figures of *Melania torquata* published by MOUSSON (1849, pl. 9, fig. 2 and pl. 22, fig. 2) give the impression that the shells are coarsely plicated. This is, however, not the case as the shells seen in the MOUSSON Collection are almost smooth, bearing darker, undulating colour markings.

MOUSSON remarked (1849, p. 70) that *M. torquata* shows affinities to *M. varicosa* TROSCHEL, and BROU (1874, p. 111) considered it to be a smooth relative of *M. zollingeri*. Both are obvious variants of the extremely variable *Brotia costula* (RAFINESQUE).

The locality Tjiringhin attributed to *M. torquata* by MOUSSON in his book (1849, p. 70) does not appear in his collection or catalogue. The specimen figured on pl. 22, fig. 2 is called f^a *major* in the explanation of the plates (p. 124).

As in the other variants of *Brotia costula* it is remarkable that *M. zollingeri* and *M. torquata* were only collected in Java in the previous century, and that no definite locality was available. It is, therefore, highly desirable that new efforts be made to secure authentic specimens of what seems to be a Sumatran element in the fauna of Java.

In his account of the malacological results of the Limnological Sunda Expedition, RENSCH (1934, p. 233-234) classified a number of small *Mela-*

nians from Java and Sumatra as *Melania (Tiaropsis) zollingeri* BROT (syn. *M. bockii* BROT syn. *M. subcancellata* BOETTGER syn. *M. sykesi* BULLEN). He figured an operculum on p. 234. This figure made me somewhat suspicious as to the identity of these four species, because the operculum is neomelanian, whereas in *M. zollingeri* it is palaeomelanian. At my request the Zoological Museum of Berlin kindly sent me on loan the samples to which RENSCH referred. These are all *Thiara scabra* (MÜLLER) in the high, slender form which BROT described as *Melania bockii*. They are in no way *M. zollingeri*.

A similar error was made by myself (1937, p. 116) when combining *Melania savinieri* with *M. zollingeri*. Since I have seen genuine *M. zollingeri* I am convinced that *M. savinieri* is a quite different species which ought to be classified with *Thiara scabra* (see under this species).

Genus *Sulcospira* TROSCHEL, 1857.

Shell ovoid-conical, not so slender as in *Brotia* or *Thiara*. Yellowish-green or brown. Spirally grooved, especially on the basal region of the whorls. Not or little transparent, lustreless.

Aperture oval, somewhat expanded at the base, but never with a siphonal canal. Peristome not continuous, the parieto-columellar side with a callus against the penultimate whorl. Interior whitish.

Operculum multispiral, nucleus central.

We have almost no information on the soft parts of the animal. Only the radula of *Sulcospira sulcospira* was described by TROSCHEL (1856-1863, Gebiss d. Schnecken, 1, p. 117, pl. 9, fig. 6). It is of the usual Melanoid type.

The same author also recorded that the animal which he dissected contained numerous young ones, each with a shell of two whorls. This proves that the females are ovo-viviparous.

Distribution: India, Java, Celebes, in fresh water.

In Java only one species:

Sulcospira sulcospira (MOUSSON, 1848) (fig. 77).

- 1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 269 (*Melania*).
- 1849. MOUSSON, Land & Süßw. Moll. Java, p. 68, pl. 9, fig. 3 (*Melania*).
- 1857. TROSCHEL, Gebiss d. Schnecken, 1, p. 117, pl. 9, fig. 6 (*Sulcospira typica*).
- 1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Indië, 21, p. 319 (*Melania*).
- 1874. BROT, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 56, pl. 6, fig. 11 (*Melania*).
- 1888. TENISON WOODS, Proc. Linn. Soc. N. S. Wales (2) 3, p. 1078 (*Melania*).
- 1891. BOETTGER, Ber. Senckenb. p. 245 (*Melania*).

1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, pt. 2, p. 248 (*Melania*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 251 (*Melania*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 84 (*Melania*).

Shell ovoid-conical, with several whorls. Yellowish-brown to olive-green under a greenish-brown epidermis. With occasional darker brown, vertical flames, sometimes coalescing to two brown spiral bands. Sculptured with spiral grooves which are stronger on the base of the whorls than above the periphery. Not or little transparent, almost without lustre.

Whorls 6-7, regularly increasing in size, the last one large. Ratio shell length to height of aperture about 2 : 1. Whorls slightly convex, suture not deep, lined by an upper and a lower elevated thread. Periphery rounded, in immature shells it can be somewhat angulate, although this is hardly palpable. Top pointed, often eroded. Base rounded. Umbilicus closed.

Aperture vertical, oval, somewhat produced at the base. Pointed at the junction of ultimate and penultimate whorl, but rounded below. Interior whitish, tinged with brown. Peristome not continuous, the two ends connected by a thick, white callus against the penultimate whorl.

Operculum dark-brown, almost black. Horny, with central nucleus and 3-4 whorls. It does not differ from the opercula of the Javanese species of *Brotia*.

For a description of the radula and of the mode of reproduction see under the genus.

Dimensions: height 21-24, width 11-12, height of aperture 10-12 mm.

Distribution: Java. No details are known of the ecological conditions under which this species lives, and no exact localities are known.

The specimen from Tjipanas recorded by MARTENS (1897, p. 33) as *Melania sulcospira*, is not this species, but a stunted specimen of *Melanoides tuberculata* (see under *Brotia spadicea*). Under these circumstances it remains to be seen whether the two other samples, mentioned by him for *Sulcospira sulcospira* (Batavia and Malangbong) really belong to this species. They have not been included in the list of localities of *Sulcospira sulcospira*.

The shell of *Melania spadicea* REEVE in the Leiden Museum, tentatively classified by MARTENS as *Sulcospira sulcospira* could not be found in that institute.

Melania spadicea REEVE is certainly not conspecific with *Sulcospira sulcospira*, as I could check from original material of *M. spadicea* kindly sent on loan from the British Museum (Natural History).

Genus **Faunus** MONTFORT, 1810.(syn. *Pirena* LAMARCK, 1816).

Shell very slender, with fine, pointed apex, numerous flat whorls and rounded base. Finely striated in longitudinal and spiral directions, some species (but not the Javanese one) with knobs. Dark-brown, or with dark-brown flames on a lighter background. Top acute, base rounded. Periphery often obtusely angular. Imperforate.

Aperture oval, with an incision at the upper and lower corner. Peristome not continuous, outer margin sinuous, protracted in the middle, receding at upper and lower ends. Parietal and columellar sides callous.

Operculum elongate-oval, nucleus excentric, growth ridges spirally coiled, increasing quickly.

Radula 2.1.1.1.2, the central tooth wider than long. TROSCHEL (1857, *Gebiss d. Schnecken*, 1, p. 118, pl. 9, fig. 7) described and figured the radula of *Faunus ater* (fig. 71).

Distribution: Ceylon, Malay Archipelago, Philippines, New Guinea, New Hebrides.

In Java only one species:

• **Faunus ater** (LINNÉ, 1758) (fig. 71 and 78).

1758. LINNÉ, *Syst. Nat.* Ed. X, p. 746 (*Strombus*).
 1822. LAMARCK, *Hist. Nat. Anim. s. Vert.* Vol. 6, Part 2, p. 169 (*Pirena terebralis*).
 1848. MOUSSON, *Mitth. naturf. Ges. Zürich*, 1, p. 268 (*Pirena*).
 1849. MOUSSON, *Land & Süsw. Moll. Java*, p. 63, pl. 10, fig. 1 (*Pirena*).
 1860. ZOLLINGER, *Natuurk. Tijdschr. Ned. Indië*, 21, p. 318 (*Pirena*).
 1874. BROU, in: MART.-CHEMN. *N. Syst. Conch. Cab.* Vol. 1, Part 24, p. 410, pl. 44, fig. 3.
 1888. TENISON WOODS, *Proc. Linn. Soc. N. S. Wales* (2) 3, p. 1087.
 1897. MARTENS, in: WEBER, *Erg. Reise Nied. Ost Indien*, 4, p. 191.
 1899. MORST & SCHEPMAN, *Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas*, Vol. 13, Part 2, p. 267.
 1914. LESCHKE, *Mitt. naturhist. Mus. Hamburg*, 31, p. 258.
 1929. VAN BENTHEM JUTTING, *Treubia*, 11, p. 86.
 1937. VAN BENTHEM JUTTING, *Zool. Meded. Mus. Leiden*, 20, p. 109.
 1952. MERMOD, *Rev. Suisse Zool.* 59, p. 78, fig. 142 (*Pirena terebralis*).

Shell very high-turreted, with long and regular spire. Plain dark-brown, or with longitudinal brown flames on a lighter background. Covered by a dark-brown, almost black, somewhat shining epidermis. Thick and not transparent. Whorls almost flat, suture shallow. Sculptured by fine, undulating growth striae, crossed by a few strong, and numerous fine spiral lines. Below the periphery with more distant spiral ridges which become stronger towards the umbilicus.

Whorls 18-20, regularly increasing in size, forming an almost ideal awl. The 5 or 6 oldest whorls are rather strongly spirally striated; after the 6th whorl the spiral striae become weaker. Top acute, base rounded. Imperforate. Periphery of last whorl sometimes obtusely angular.

Aperture almost vertical, broad-oval, with a sinus at upper and lower end. Peristome not continuous, outer margin with incision at upper corner, then protracted, receding again towards the basal margin. Basal margin curved into a short, open gutter. Parietal margin pressed against the penultimate whorl. All margins somewhat thickened and often with yellow interior callus.

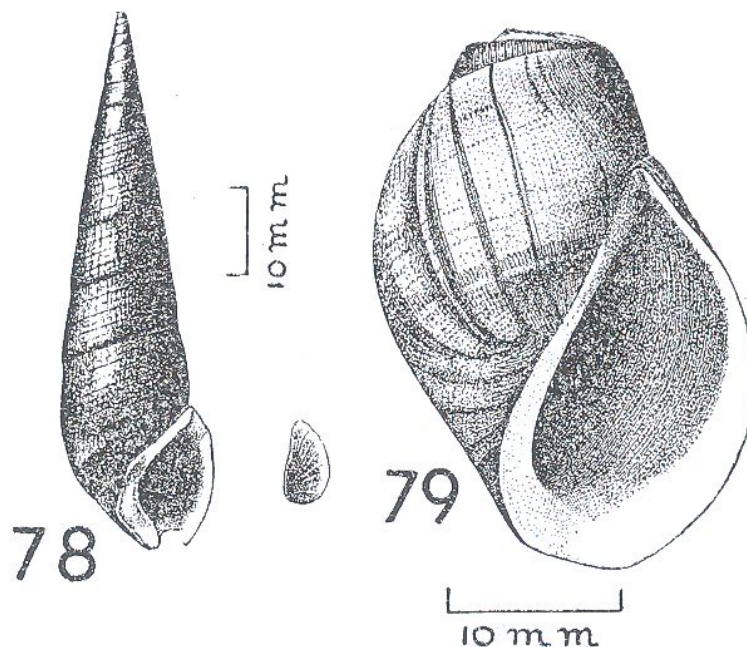


Fig. 78. *Faunus ater* (L.). Shell and operculum. ABDULKADIR del.
Fig. 79. *Balanocochlis glans* (v.d. BUSCH). Shell. ABDULKADIR del.

Operculum horny, ovoid, with the nucleus at the base, and the growth striae in subspiral arrangement.

Dimensions: height 75-85, width 18-22, height of aperture 18-20 mm. The top whorls are generally eroded.

Distribution: in the Malay Archipelago recorded from almost any island where some collecting has been done. Also from Mauritius, Ceylon, the Philippines, New Guinea, New Ireland.

Habitat in Java: fresh and slightly brackish water in the lowlands and in estuaries, on mud flats which run dry during low tide.

West Java: River Tjimarra; Pagelaran near Malimping; Sukabumi; River Tjimandiri near Sukabumi; Palabuanratu at Wijnkoopsbay; Pagandaran, peninsula of Penandjung.

Central Java: Patjitan.

East Java: marshes of Rawah Melema, S of Djatiroto; Wlingi.

Recorded as a fossil from quaternary Putjangan layers in the River Djegrek (East Java).

Genus *Balanocochlis* P. FISCHER, 1885.

Shell globose to ovoid, with short spire and large last whorl. Almost smooth and with few colour markings. Thick, not transparent, lustreless.

Whorls rapidly increasing in diameter. The last one large and spacious. Periphery rounded or indistinctly angular. Suture shallow. Top pointed, base rounded. Umbilicus closed.

Aperture large, oval, pointed above, rounded below. Peristome not continuous, the two ends connected by a white callus against the parieto-columellar wall. Basal region a little expanded, but never with a siphonal canal.

Operculum (as far as known) with the nucleus at the base.

Of the animal very little is known. The radula of *Balanocochlis glans* was described and figured by RENSCH (1934, Zool. Jahrb. (Syst.) 65, p. 416, fig. 6-7). The female of *B. pisum* is ovo-viviparous (BROT, 1868, Matér. Mélaniens, 2, p. 54). The mode of reproduction of the other species is unknown.

Distribution: Sumatra, Java, Sumba, Sumbawa, Flores, Ambon, Obi, Philippines, Waigeu, New Guinea, New Britain, New Ireland, New Hannover.

Key to the species of Java:

1. Shell ovoid to broad spindle-shaped, with a few spiral grooves in the umbilical region and, sometimes, also along the suture 2
- Shell globular, almost without sculpture **pisum**
2. Shell large, last whorl convex, periphery rounded **glans**
- Shell small, last whorl less convex, even somewhat concave below the suture, periphery subangulate **glandiformis**

Balanocochlis glans (VON DEM BUSCH, 1842) (fig. 79).

1831. LESSON, Voy. Coquille, Zool. 2, p. 352 (*Melania inermis* non *M. inermis* SOWERBY 1825, Catal. Shells Tankerville, App. p. IX).
1842. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1 *Melania*, p. 3, pl. 1, fig. 8 and 9 (*Melania glans*).
1843. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1 *Melania*, p. 10, pl. 2, fig. 9 (*Melania siccata*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268 (*Melania glans* and *siccata*).
1849. MOUSSON, Land & Süßw. Moll. Java, p. 67 (*Melania glans*).
1853. PETIT, Journ. de Conch. 4, p. 256, pl. 8, fig. 6 (*Melania glans*).

1859. REEVE, *Conch. Icon.* 12, pl. 34, fig. 232 (*Melania glans*).
1874. BROT, in: MART.-CHEMN. *N. Syst. Conch. Cab.* Vol. 1, Part 24, p. 14, pl. 1, fig. 3 (*Melania glans*) and p. 15 (*M. inermis*).
1884. NEVILL, *Hand List Moll. Ind. Mus.* 2, p. 271 (*Melania glans*).
1897. MARTENS, in: WEBER, *Erg. Reise Nied. Ost Indien*, 4, p. 30 (*Melania glans*).
1899. HORST & SCHEPMAN, *Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas*, Vol. 13, Part 2, p. 247 (*Melania glans*).
1914. LESCHKE, *Mitt. naturhist. Mus. Hamburg*, 31, p. 25 (*Melania glans*).
1929. VAN BENTHEM JUTTING, *Treubia*, 11, p. 84 (*Melania glans*).
1934. RENSCH, *Zool. Jahrb. (Syst.)* 65, p. 415, fig. 6-7 (*Balanocochlis inermis*).

Shell large, thick, ovoid, with short spire and large last whorl. Plain olive-brown, the young stages often maculated with reddish-brown dots along the suture and in interrupted vertical zones.

Finely striated by the growth lines. In the umbilical region and occasionally below the suture there are a few spiral grooves. Not transparent, without lustre. Epidermis dark olive-brown.

Whorls 6-7, those of the spire small, the last one large and spacious. Profile of the whorls slightly convex. Suture distinct, but not deep. In some specimens the suture is margined by 1-3 spiral grooves. Periphery rounded. Top pointed, but not sharp, often eroded. Base rounded. Umbilicus closed.

Aperture somewhat oblique, oval, pointed above, rounded below. Bluish-white in the interior. Peristome not continuous, the two ends connected by a white callus against the penultimate whorl. This callus is especially well developed in the columellar region. Basal side of aperture somewhat expanded. Between columellar and basal part of the peristome is a shallow, hardly palpable furrow.

Operculum long, oval, almost black. Nucleus at the right hand base with the growth ridges fanning out from this point to the top and the left side.

Dimensions: height 30-33, width 18-21, height of aperture 20-22 mm.

Distribution: Sumatra, Java, Sumba, Sumbawa, Flores, Ambon, Obi, Philippines, Waigeu, New Guinea, New Britain, New Ireland, New Hannover.

Habitat in Java: in rivers and rice fields, in fresh water.

West Java: River Pasauran near kampong Pasauran, Bantam; environs of Djakarta; Sukabumi; Tjimandiri near Sukabumi; Palabuanratu at Wijnkoopsbay; Karang Hawu near Wijnkoopsbay; Tjisolok near Wijnkoopsbay; near hot springs of Tjipanas.

East Java: sawahs near Pradjekan, S. of Situbondo.

Young shells as VON DEM BUSCH described under the name *Melania siccata* have a row of brown spots along the suture and vertical rows of small red-brown dots on the body whorl.

The radula has been described and figured by RENSCH (1934).

MORRISON (1954, Proc. Un. States Nat. Mus. Washington, Vol. 103, p. 381) found a large number of eggs in the brood pouch of a *Balanocochlis glans* from the Philippines, but he had no evidence whether these eggs underwent their further development in the female or whether they are released into the water for further development.

***Balanocochlis pisum* (BROT, 1868) (fig. 80).**

1868. BROT, Matér. Mélaniens, 2, p. 54, pl. 2, fig. 5 (*Melania*).

1874. BROT, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 18, pl. 1, fig. 7 (*Melania*).

1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 247 (*Melania*).

1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 251 (*Melania*).

1929. VAN BENTHEM JUTTING, Treubia, 11, p. 84 (*Melania*).

Shell small, thick, ovoid, with small spire and large last whorl. Dark-chestnut under a darker brown epidermis, or olive-brown, with vertical, chestnut streaks. Finely striated by the growth lines. Besides very vague spiral grooves can occur in the umbilical region or along the suture, or in both regions. Not transparent and without lustre.

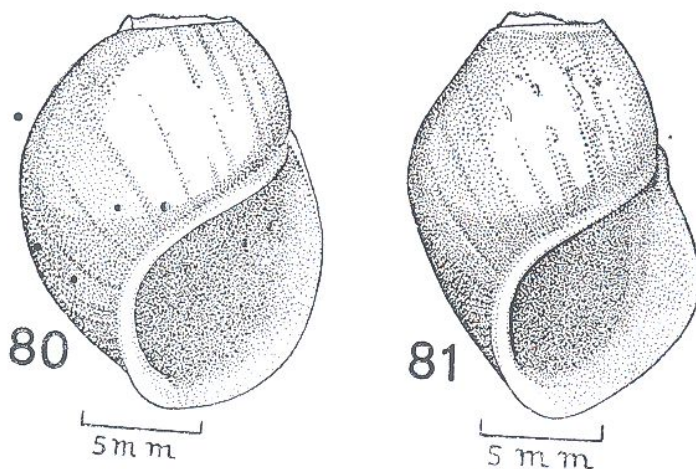


Fig. 80. *Balanocochlis pisum* (BROT). Shell. J. MASTRO del.

Fig. 81. *Balanocochlis glandiformis* (SCHEPM.). Shell. J. MASTRO del.

Whorls about 5, rapidly increasing in size, often difficult to count, as the spire is generally decollated. Profile of the whorls moderately convex, suture distinct. Periphery rounded or subangulate. This subangulate condition is -as BROT, 1868, remarked- demonstrated best at the exterior margin of the peristome. Top pointed. Base rounded. Umbilicus closed.

Aperture oval, pointed above, rounded below. Interior chestnut or violaceous-brown, with the exterior colour pattern shining through. Peristome not continuous, the two ends connected by a thick, white callus against the preceding whorl. Basal side of aperture somewhat expanded and channelled.

Operculum unknown.

Dimensions: height 14-16, width 9-12, height 11-12 mm.

Distribution: Java.

Habitat in Java: nothing is known on the habitat of the species, and no detailed records of the occurrence in Java have been published.

BROT (1868, p. 54) mentioned that one of his specimens contained a number of young shells of about 1 mm diam., with two whorls. This means that the females of *Brotia pisum* are ovo-viviparous. The embryonic shells had a yellowish-olive ground colour with 3 brown spiral bands, a basal, a subsutural and a median one.

***Balanocochlis glandiformis* (SCHEPMAN, 1896) (fig. 81).**

1896. SCHEPMAN, Notes Leyden Mus. 18, p. 136, pl. 2, fig. 2 (*Melania*).

1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 247 (*Melania*).

1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 251 (*Melania*).

1929. VAN BENTHEM JUTTING, Treubia, 11, p. 83 (*Melania*).

Shell rather small, thick, ovoid, with short spire and large last whorl. Plain olive-brown, or occasionally with vertical dark-brown streaks. Epidermis darker brown. Finely striated by the growth lines. In addition a few spiral grooves can occur in the umbilical region, or along the suture, or in both regions. Not transparent, lustreless.

Number of whorls uncertain, as all specimens which I examined were seriously decollated. The two whorls which are left are little convex, even somewhat concave below the suture, then convex again. At the periphery the whorls are bluntly angular. Suture shallow. Top always missing, base rounded. Umbilicus closed.

Aperture somewhat oblique, oval, pointed above, more rounded below. Interior whitish, with the brown colour markings of the exterior shining through. Peristome not continuous, the two ends connected by a thick white callus against the penultimate whorl. Basal side of aperture somewhat expanded.

Operculum unknown.

Dimensions: height 13-16 (last 2 whorls only), width 8-11, height of aperture 9-11 mm.

Distribution: Java, without further details.

Habitat in Java: unknown.

Genus *Thiara* RÖDING, 1798.

Shell moderately to high-turreted, yellowish or brown, often with darker brown speckles or flames. Between the suture and the periphery the whorls are angular. Along this ridge nodules or folds occur at regular distances, some even terminating in sharp spines. This ornamentation renders the shell a pagoda-like appearance.

Top pointed in fresh shells, but mostly eroded in adult specimens. Base rounded, umbilicus closed. There is no siphonal canal.

Aperture more or less vertical. Peristome not continuous. Exterior margin of peristome often sinuous.

Operculum pear-shaped, with excentric nucleus at the narrow, basal end (fig. 69).

The animal (cfr. ABBOTT, 1948, p. 289) "is characterized by its mantle edge which has from 10-14 fleshy papillae, the largest 4 being on the left side. The inside of the mantle is often tinged with a bright hue of blue green or emerald green. The large proboscis swings from side to side in elephant-like fashion as the snail is crawling forward. The colour of the animal is variable—black, gray or brown splotches over which are varying shades of yellow or white. The proboscis is usually transversely striated with strong, and often V-shaped, lines of jet black". Radula 2.1.1.1.2 (fig. 72).

Distribution: tropical regions of East Africa and Asia, some species in Japan and North Australia. The genus is especially abundant in the Malay Archipelago, the Philippines and various Pacific islands. The animals live mostly in fresh water, either stagnant or running. Some species can tolerate a certain degree of salinity.

Key to the species living in Java:

1. The shelly spines end in stiff periostracal bristles 2
- The shelly spines are not prolonged as periostracal bristles 3
2. Zone between suture and row of spines somewhat concave; sculptured by fine spiral striae **cancellata**
- Zone between suture and row of spines not or hardly concave; coarsely ribbed in spiral direction **setigera**
3. Shell surface nodulous through axial ribs and strong spiral ridges, with an additional sculpture of fine undulating spiral lines . . . **rudis**
- Axial ribs strongest, spiral ridges weak, and generally only in the basal part. No fine undulating spiral lines 4

4. Large and thick shells, complete specimens up to 50 mm height . . . 5
 — Smaller and thinner shells, not exceeding 30 mm height 6
5. Shell dark olive-brown or black, almost smooth. Zone between suture and crown of spines little sloping **amarula**
 — Shell greenish-yellow, with a few, coarse, distantly placed spiral grooves. Zone between suture and crown of spines distinctly sloping. **winteri**
6. Whorls descending step-like. Spines on the axial whorls generally sharp. No thick ridge along the suture **scabra**
 — Whorls not descending step-like. Spines on the axial whorls blunt. Along suture of ultimate and penultimate whorls a thick, spiral cord **herklotzi**

Thiara amarula (LINNÉ, 1758) (fig. 82).

1758. LINNÉ, Syst. Nat. Ed. X, p. 774 (*Helix*).
 1847. GOULD, Proc. Boston Soc. Nat. Hist. 2, p. 222 (*Melania cybele*).
 1848. PHILIPPI, Zeitschr. Malak. 5, p. 154 (*Melania villosa*).
 1850. LEA, Proc. Zool. Soc. London, p. 194 (*Melania diadema*).
 1859. REEVE, Conch. Icon. 12, pl. 25, fig. 177 (*Melania amarula*).
 1874. BROT, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 293, pl. 29, fig. 2 (*Melania diadema*), p. 294, pl. 30, fig. 1, 1a-c, 4 (*Melania cybele*), p. 296, pl. 30, fig. 3, 3a-d (*Melania villosa*).
 1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 261 (*Melania amarula*), p. 262 (*M. thiarella, diadema, cybele*).

Shell large, with high spire and spinous last whorl. Dark olive-brown, often coated with black. Sculptured by spiral ridges which become stronger from the suture to the base of each whorl, and which are strongest in the umbilical region. Besides the shell is ribbed in vertical direction, with about 9-12 ribs on the last whorl. Halfway the distance between the suture and the periphery the axial ribs form prominent spines, pointing obliquely upward and outward. Between the suture and the crown of spines each whorl is flattened, causing the spire to descend step-like. Not transparent or glossy.

Whorls about 10, regularly increasing in size. Suture distinct. Periphery rounded below the row of spines. Top pointed in fresh shells, but often eroded. The spire can be so much decollated that only the two last whorls remain. Base rounded. Umbilicus closed.

Aperture almost vertical, oval, pointed above, rounded below. Peristome not continuous, the two ends connected by a thick whitish or orange callus against the previous whorl. Exterior margin slightly sinuous. Basal margin more or less channelled.

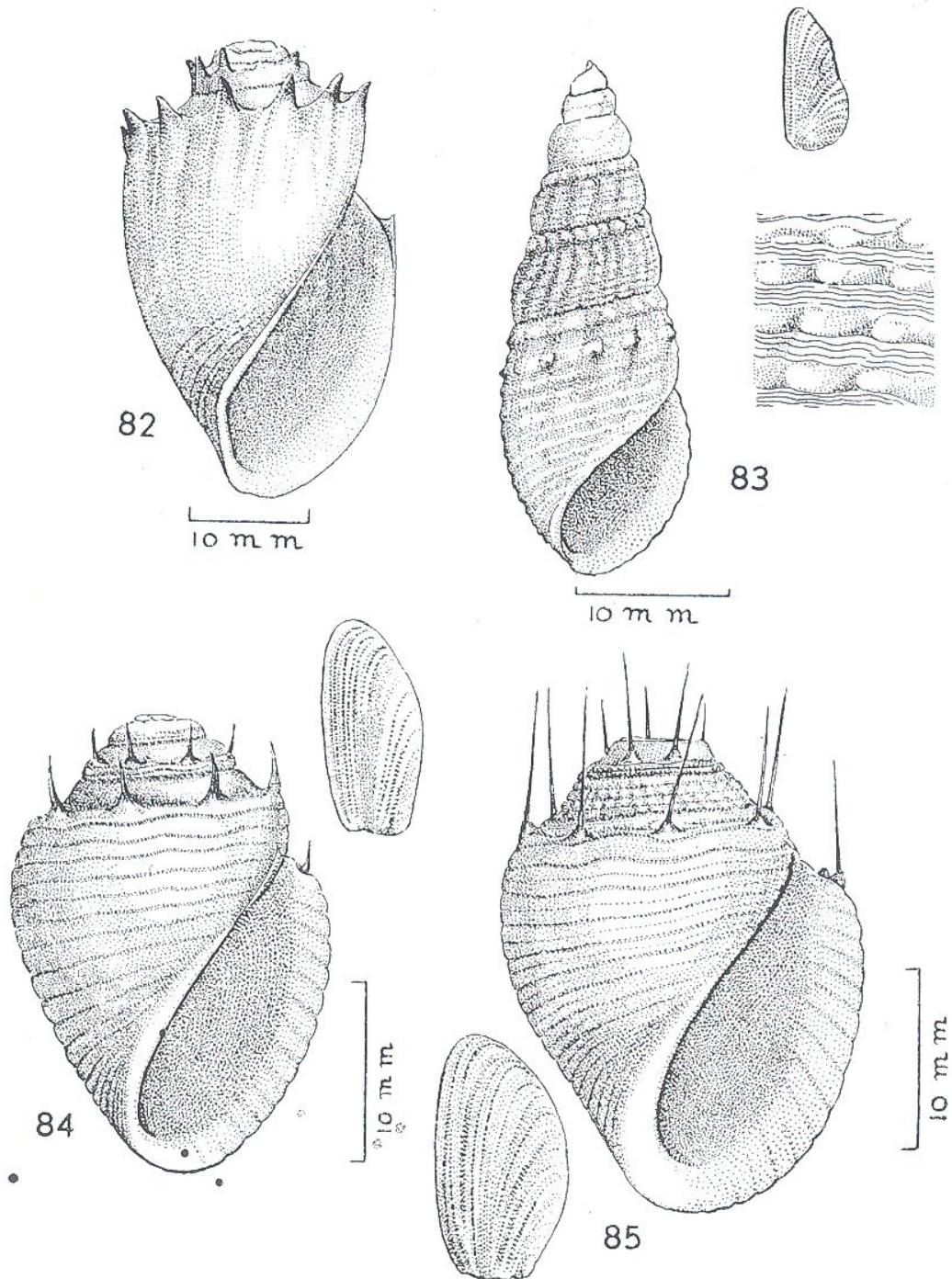


Fig. 82. *Thiara amarula* (L.). Shell. J. MASTRO del.

Fig. 83. *Thiara rufis* (LEA). Shell, operculum and detail of sculpture, more enlarged. J. MASTRO del.

Fig. 84. *Thiara cancellata* RÖD. Shell and operculum. J. MASTRO del.

Fig. 85. *Thiara setigera* (BROT). Shell and operculum. J. MASTRO del.

Operculum horny, oval, almost black. Nucleus excentric, at the left basal corner. From the nucleus the growth lines spread to the top and the right side.

Dimensions: height 46-50, width 23-24, height of aperture 24-25 mm.

Distribution: in fresh water, not common. Recorded from Mauritius, Philippines, Sumatra, Java, Amboina, Fiji, New Caledonia.

Habitat in Java: unknown.

West Java: Sukabumi; Palabuanratu.

East Java: Besuki.

In the very young shells the whorls have two strong spiral ridges and no spines. After the second whorl blunt knobs are developed on the ridges at regular distances, till about the 6th or 7th whorl. After this the knobs extend into sharp spines.

- *Thiara rudis* (LEA, 1850) (fig. 83).

1850. LEA, Proc. Zool. Soc. London, p. 186 (*Melania rudis*), p. 195 (*M. armillata* non *M. armillata* MUENSTER, in: GOLDFUSS, Petref. Germ. 3 (8), 1844, p. 110).
1859. REEVE, Conch. Icon. 12, pl. 24, fig. 172 (*Melania rudis*).
1868. BROT, Matér. Mélan. 2, p. 28, pl. 1, fig. 12 (*Melania armillata*), p. 33, pl. 1, fig. 7 (*M. rudis*).
1874. BROT, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 305, pl. 32, fig. 1, 1a-c (*Melania rudis*), p. 309, pl. 32, fig. 5 (*M. armillata*).
1888. TENISON WOODS, Proc. Linn. Soc. N. S. Wales (2) 3, p. 1085 (*Melania armillata*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 305 (*Melania drilliiformis*).
1904. FULTON, Journ. Malac. 11, p. 51, pl. 4, fig. 3 (*Melania fortitudinis*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 256 (*Melania drilliiformis*), p. 258 (*M. fortitudinis*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 85 (*Melania drilliiformis* and *fortitudinis*).
1934. RENSCH, Zool. Jahrb. (Syst.) 65, p. 408 (*Melania rudis*).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 115 (*Thiara rudis*).

Shell moderately large and strong, subcylindrical, with high spire and rather flat whorls. Yellowish-olive. Sculptured by somewhat undulating axial ribs and strong spiral ridges, causing a pattern of strong, blunt nodules. In the later whorls one spiral ridge of nodules (generally the second one below the suture) can even appear as a row of short thick spines. The row of subsutural nodules immediately below the suture is also strongly developed, resembling a row of beads. Between the subsutural row and the spiniferous row the groove is rather wide. Below the periphery the axial ribs fade away, but the spiral ridges remain and descend till in the umbilical region. Over the whole surface, on the ridges and in the grooves between them, there is a sculpture of very fine undulating spiral lines. Not transparent and without lustre.

Whorls 9-13, little convex. Suture distinct, somewhat wavy by the nodules along it. Periphery rounded. Top pointed, often eroded. Base rounded. Umbilicus closed.

Aperture almost vertical, oval, pointed above, rounded below.

Peristome not continuous, the two ends connected by a white callus against the penultimate whorl. Outer margin sinuous, the middle region projecting, the upper and basal regions receding. Outer margin crenulated by the spiral ridges of the exterior sculpture. Basal margin channelled.

Operculum horny, oval, dark blackish-brown. Nucleus excentric, in the left lower corner. From the nucleus the growth striae spread to the top and to the exterior margin.

Dimensions: height 30-34, width about 10, height of aperture 10-12 mm.

Distribution: India, Ceylon, Burma, Cambodia, Sumatra, Java, Ambon, Batjan, Halmahera, Philippines.

Habitat in Java: very little is known of the habitat of this species in Java.

West Java: Sukabumi; Palabuanratu; Rantjaherang.

Thiara rudis has also been recorded in Pleistocene layers in East Java (VAN BENTHEM JUTTING, 1937, p. 115).

On the first 5 whorls there are two strong spiral ridges which bear nodules at distant intervals. From the sixth whorl onward the number of spiral ridges and of nodules augments till 5 or 6 on the last whorl.

***Thiara winteri* (VON DEM BUSCH, 1842) (fig. 86).**

1842. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1, *Melania*, p. 1, pl. 1, fig. 1-2 (*Melania*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268 (*Melania*).
1849. MOUSSON, Land & Süsww. Moll. Java, p. 77, pl. 12, fig. 1 (*Melania*).
1857. TROSCHEL, Gebiss d. Schnecken, 1, p. 123, pl. 9, fig. 13 (radula) (*Melania*).
1859. REEVE, Conch. Icon. 12, pl. 22, fig. 157 (*Melania*).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 319 (*Melania*).
1874. BROT, in: MARTI-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 301, pl. 31, fig. 5 (*Melania*).
1888. TENISON WOODS, Proc. Linn. Soc. N. S. Wales (2) 3, p. 1085 (*Melania*).
1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 263 (*Melania*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 256 (*Melania*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 85 (*Melania*).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 113 (*Thiara*).

Shell large and solid, with high spire and large last whorl. Greenish-yellow or olive. Sculptured by coarse, distantly placed axial ribs (about 12 on the last whorl) which are spinous in their upper part, forming a spiral crown of broad spines about halfway between the suture and the

periphery of each whorl. These spines may be somewhat darker brown than the shell. Above and below the row of spines the shell bears some flat spiral ridges. In the umbilical region these ridges become more numerous and sharper. The shell is not transparent and hardly shining.

Whorls 6 in decollated shells, but about 8-10 in complete ones. Regularly increasing in size and descending almost step-like. Suture distinct. Periphery rounded below the crown of spines. Top pointed, base rounded. Umbilicus closed.

Aperture almost vertical, oval, pointed above, rounded below. Peristome not continuous, the two ends connected by a thick callus against the parietal side. Exterior margin sinuous, curved forward in the middle, but receding in upper and lower regions.

Operculum horny, dark black-brown. Nucleus excentric, in the left basal corner. From the nucleus the growth ridges are fanning out towards the tip and the side of the operculum.

Dimensions: height about 50, width 20-26, height of aperture 20-26 mm.

Distribution: Sumatra, Java, Philippines.

Habitat in Java: very little is known of the habitat of this species. It is not common in Java, and generally occurs in freshwater basins of considerable size.

West Java: environs of Djakarta; Sukabumi; Palabuanratu.

East Java: Puger.

Thiara winteri was abundant in Pleistocene layers in East Java (VAN BENTHEM JUTTING, 1937).

The radula has been described by TROSCHER (1857, p. 123).

In the young shells the first five whorls bear oblique strong ridges without spines; in the 6th to 7th whorl these ridges become somewhat nodulous, and after the 7th whorl these nodules develop into spines.

Thiara herklotzi (PETIT, 1853) (fig. 87).

1853. PETIT, Journ. de Conch. 4, p. 254, pl. 7, fig. 10 (*Melania herklotzi*).

1854. MENKE, Malak. Blätt. 1, p. 28 (*Melania dimidiata*).

1874. BROU, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 303, pl. 31, fig. 8 (*Melania herklotzi*) and p. 303, pl. 31, fig. 9 (*M. dimidiata*).

1888. TENISON WOODS, Proc. Linn. Soc. N. S. WALES (2) 3, p. 1085 (*Melania herklotzi*).

1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 263 (*Melania herklotzi*).

1904. FULTON, Journ. Malac. 11, p. 51, pl. 4, fig. 1 (*Melania aeruginosa*).

1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 256 (*Melania herklotzi*) and p. 258 (*M. aeruginosa*).

1929. VAN BENTHEM JUTTING, Treubia, 11, p. 85 (*Melania herklotzi* and *M. aeruginosa*).

Shell moderately large and solid, with rapidly tapering spire and large last whorl, rendering the shell a broad spindle-shaped appearance. Brownish-green, often covered by a crust of brown or black foreign matter. Sculptured by coarse, distantly placed axial ribs (about 9-10 on the last whorl) which are spinous in their upper part, forming a crown of broad spines or blunt knobs, about halfway between the suture and the middle of each whorl. In the shells which I have seen a thick spiral ridge runs parallel with the suture on the ultimate and penultimate whorls. No mention is made of this ridge in the original diagnosis or by BROU (1874). Yet in pl. 31, fig. 8, 8a and 8b of BROU's Monograph it has been figured. Only FULTON (1904) mentioned the prominent margin along the

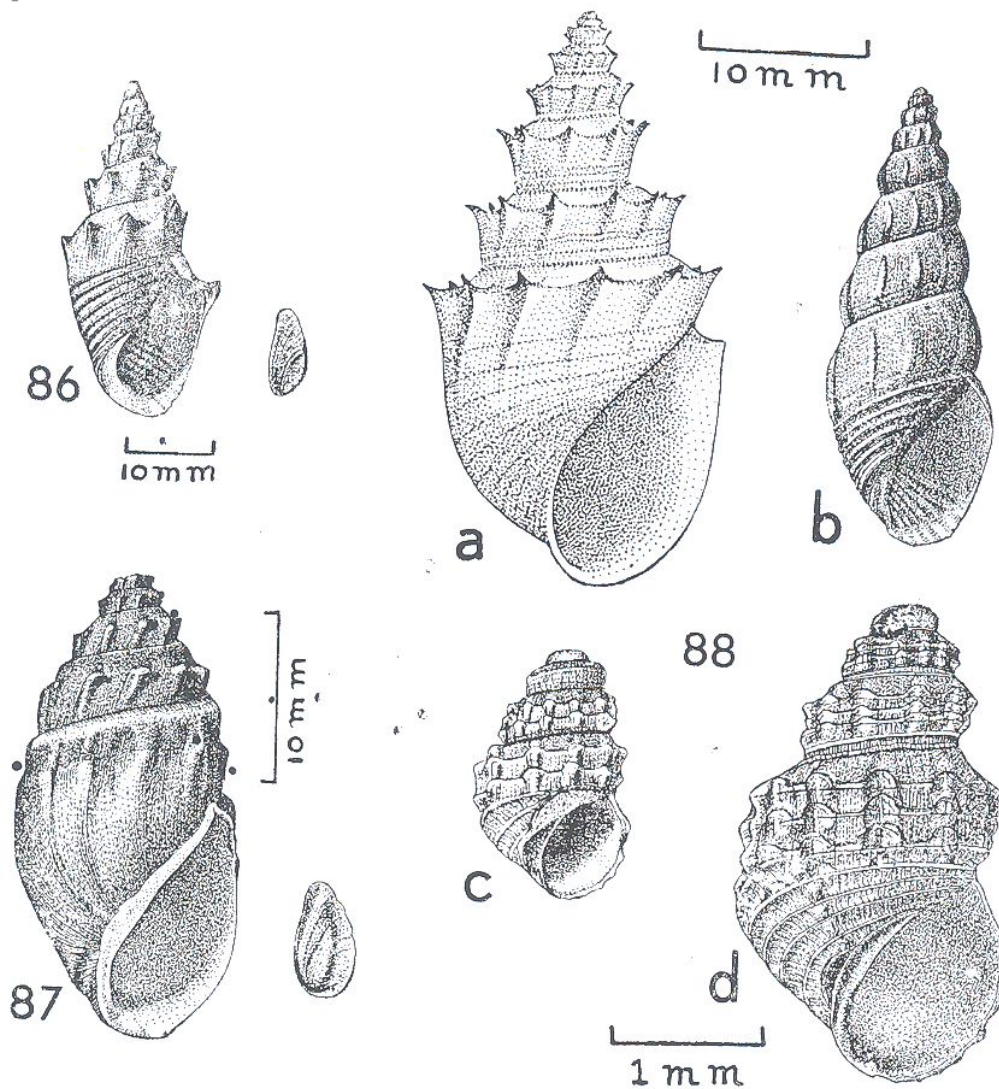


Fig. 86. *Thiara winteri* (v.d. BUSCH). Shell and operculum. ABDULKADIR del.

Fig. 87. *Thiara herklotzi* (PETIT). Shell and operculum. ABDULKADIR del.

Fig. 88. *Thiara scabra* (MÜLL.). a. Shell with well developed ribs and spines, b. shell with obsolete ribs, without spines, c. and d. young stages, more enlarged. J. MASTRO and ABDULKADIR del.

suture in his diagnosis of *Melania aeruginosa*. For the rest the shell is spirally striated. In the umbilical region these striae are more pronounced. The shell is not transparent, nor shining.

Whorls about 10 in complete specimens, but usually less because the spire is often decollated or eroded. Spire about as high as the aperture. Top sharp, base rounded below the row of spines. Suture distinct, umbilicus closed.

Aperture almost vertical, oval, pointed above, rounded below. Peristome not continuous, the two ends connected by a thick callus against the penultimate whorl.

Operculum horny, dark black-brown. Nucleus excentric, in the left basal corner. From this nucleus the growth ridges spread to the tip and the side of the operculum.

Dimensions: height 23-26, width 11-12, height of aperture 11-12 mm.

Distribution: Sumatra, Java.

Habitat in Java: almost nothing is known of the habitat of this species in Java, but it is very likely that it occurs in similar surroundings as the preceding species.

West Java: Sukabumi; Palabuanratu.

Thiara herklotzi is very much related to *Th. winteri*. The latter species is more elegantly pyramidal, with higher spire and more curved whorls. The subsutural ridge contributes to give *Th. herklotzi* its more obese appearance.

***Thiara scabra* (MÜLLER, 1774) (fig. 72 and 88).**

1774. MÜLLER, Hist. Verm. 2, p. 136 (*Buccinum scabrum*).
1822. LAMARCK, Hist. Anim. s. Vert. Vol. 6, Part 2, p. 166 (*Melania spinulosa*).
1842. VON DEM BUSCH, in: PHILIPPI, Abb. & Besch. 1, *Melania*, p. 4, pl. 1, fig. 7 (not 3) (*Melania granum*).
1847. PHILIPPI, Abb. & Besch. 2, *Melania*, p. 172, pl. 4, fig. 13 (*Melania scabrella*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268 (*Melania spinulosa*, *scabrella*, *granum*).
1849. MOUSSON, Land & Süsw. Moll. Java, p. 76, pl. 11, fig. 11-12 (*Melania spinulosa*, incl. f^a *spinulosa* s. str. and f^a *nodose-costata*), p. 77, pl. 12, fig. 2 (*M. scabrella*), p. 77, pl. 12, fig. 3-4 (*M. granum* incl. f^a *granum* s. str. and *buccinoidea*).
1850. LEA, Proc. Zool. Soc. London, p. 194 (*Melania acanthica*).
1859. REEVE, Conch. Icon. 12, pl. 26, fig. 180 (*Melania pugilis*), fig. 182 (*M. pagoda*), fig. 183 (*M. scabra*), pl. 33, fig. 219 (*M. granum*).
1860. BROT, Rev. & Mag. Zool. p. 257, pl. 16, fig. 3 (*Melania myurus*).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 319 (*Melania spinulosa*, *scabrella* and *granum*).
1872. BROT, Matér. Mélaniens, 3, p. 19, pl. 1, fig. 15 (*Melania spinulosa*).

1874. BROT, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 266, pl. 27, fig. 14-15 (*Melania scabra*), p. 270, pl. 27, fig. 12 (*M. granum*), p. 271, pl. 28, fig. 1 (*M. myurus*), p. 278, pl. 28, fig. 10 (*M. acanthica*).
1884. MORLET, Journ. de Conch. 32, p. 330, pl. 7, fig. 2 (*Melania savinieri*).
1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 283 (*Melania scabra*), p. 285 (*M. scabra* var. *myurus* and var. *granum*).
1886. BROT, Rec. Suisse Zool. 4, p. 93, pl. 5, fig. 9, 9a (*Melania savinieri*).
1888. TENISON WOODS, Proc. Linn. Soc. N. S. Wales (2) 3, p. 1083 (*Melania scabra*), p. 1084 (*M. granum* and *myurus*).
1890. BOETTGER, Ber. Senckenb. p. 151, pl. 6, fig. 4, 4a (*Melania subcancellata*), p. 153 (*M. scabra*).
1891. BOETTGER, Ber. Senckenb. p. 246 (*Melania subcancellata*), p. 248 (*M. scabra*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 62, pl. 4, fig. 6-12, pl. 9, fig. 8-9 (*Melania scabra* incl. var. *spinulosa*, *nodosocostata*, *angulifera*, *mutica*), p. 65 (*M. granum*), p. 315 (*M. savinieri*).
1899. HORST & SCHEPMAN, Cat. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 260 (*Melania scabra*, *M. scabra* var. *myura*, *M. granum*, *M. granum* var. *inermis*), p. 261 (*M. savinieri*, *M. pagoda*, *M. acanthica*).
1904. BULLEN, Proc. Malac. Soc. London, 6, p. 110, pl. 6, fig. 1-2 (*Melania varia*).
1905. MARTIN, Samml. Geol. Reichsmus. Leiden (N.F.) 1, p. 234 and 240, pl. 36, fig. 572-573 (*Melania scabra*), p. 321 (*M. granum*).
1907. MARTIN, N. Jahrb. Mineral. 100, II, p. 161 (*Melania scabra* and *M. granum*).
1908. BRANCA, Sitz. Ber. Kgl. Preuss. Akad. Wiss. Berlin, p. 270 (*Melania sarrinieri* (sic!) and *M. scabra*).
1908. MARTIN, Versl. gew. Verg. Kon. Akad. Wet. Amst. (Natuurk.) 17, p. 14 (*Melania savinieri* and *M. granum*).
1911. CARTHAUS, Pithecanthr. Schichten Java, p. 13 (*Melania granum* and *M. sarrinieri* sic!).
1911. MARTIN-ICKE, Pithecanthr. Schichten Java, p. 50 (*Melania granum* and *M. savinieri*).
1912. SCHEPMAN, Proc. Malac. Soc. London, 10, p. 237 (*Melania scabra* var. *mutica*).
1914. FULTON, Proc. Malac. Soc. London, 11, p. 163, fig. 1 (*Melania intrepida*).
1915. SCHEPMAN, Bijdr. t.d. Dierk. 20, p. 26 (*Melania granum* and var. *buccinoidea*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beil. Band, p. 96 (*Melania scabra*, *M. granum*, *M. savinieri*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 84 (*Melania intrepida*), p. 85 (*M. savinieri*, *subcancellata*, *granum* and var. *buccinoidea*, *myurus*, *acanthica*, *scabra* incl. vars. *angulifera*, *mutica*, *nodoso-costata* and *spinulosa*), p. 86 (*Melania varia*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 85 (*Melania simplex* Bttg. nom. nud. non *Mel. simplex* REEVE, 1859, Conch. Icon. 12, pl. 21, fig. 148).
1931. VAN ES, Age of Pithecanthropus, p. 65 (*Melania granum*), p. 136 (*M. granum* and *savinieri*).
1931. VAN DER VLERK, Leidsche Geol. Meded. 5, p. 254 (*Melania granum*), p. 255 (*M. savinieri*, *M. scabra*).
- 1934a. RENSCH, Zool. Jahrb. (Syst.) 65, p. 409 (*Melania scabra*).
- 1934b. RENSCH, Trop. Binnengew. 5, p. 233 (*Melania zollingeri* non *zollingeri* BROT, 1868).

- 1934b. RENSCH, Trop. Binnengew. 5, p. 234 (*Melania scabra*).
1935. OOSTINGH, Wetensch. Meded. Dienst Mijnb. Ned. Ind. 26, p. 10 (*Melania scabra* incl. *fa typica, nodosecostata, mutica, conspicuecostata*).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 116 (*Thiara zollingeri*, non BROU), p. 117 (*Th. zollingeri fennemai*), p. 118 (*Th. scabra*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 280 (*Thiara scabra*).
1951. THIENEMANN, Arch. Hydrobiol. Suppl. Bd. 19, p. 535 (*Melania scabra* and *zollingeri*), p. 541 (*M. scabra*).
1952. MERMOD, Rev. Suisse Zool. 59, p. 74, fig. 136 (*Melania spinulosa*).

Shell moderately to elevated-conical, with high spire and large last whorl. Yellowish-brown or olive-brown, with irregular reddish-brown spots and flames, and 2-3 spiral bands of the same colour, one below the suture, one in the peripheral and one in the umbilical region. The peripheral band is often absent. Surface roughly striated in spiral direction. Below the periphery, especially in the umbilical region the spiral striae form stronger ridges. Besides the shell is characteristically ribbed in vertical direction. At about 1/3 of the distance between the suture and the periphery the axial ribs form prominent spines, pointing obliquely outward. The spines can be of various strength in different shells, varying between blunt knobs and sharp, prickly needles. Fresh shells somewhat transparent and shining. The shell surface is, however, often eroded or coated with brown or black foreign matter.

Whorls 8-12, regularly increasing in size, descending step-like. Suture distinct. Periphery rounded below the row of spines. Top pointed, base rounded. Umbilicus closed.

Aperture almost vertical, oval, pointed above, rounded below. Peristome not continuous. The two ends connected by a white callus against the preceding whorl. Exterior margin somewhat sinuous, projecting forward with rounded curve in the middle, receding in the upper and lower parts. Basal margin somewhat channelled.

Operculum horny, oval, blackish-brown. Nucleus excentric, at the left lower corner. From the nucleus the growth lines are fanning out to the tip and to the side of the operculum.

Dimensions: height 25-30, width 10-13, height of aperture 8-12 mm.

Distribution: Mauritius, Seychelles, India, Burma, Malay Peninsula, Malay Archipelago, Philippines and various Pacific islands. *Thiara scabra* has also been recorded from the islands of Amsterdam, Bawean and Madura, off the coast of Java (VAN BENTHEM JUTTING, 1941).

Habitat in Java: this species prefers freshwater, but is occasionally found in slightly brackish water. It lives in stagnant or running water,

between sea level and 2000 m altitude. It is also found in hot springs at a temperature of about 35°C (RENSCH, 1934b, p. 238).

West Java: Pardana (MOUSSON, 1849); Tjiringhin; Tandjong Priok; river Tanabang, at Djakarta; Tjiliwung at Depok; river near Depok; Bogor; Tjiliwung near Bogor (BOETTGER, 1890); ponds and river Tjiliwung in Botanical Gardens at Bogor (RENSCH, 1934b); Tjiburial, near prise d'eau of Bogor; estate of Tjiomas near Bogor; near Puntjakpass above Bogor; Tjisarua, in rivulets which flow into the lake; Tjipanas; Telaga Gadok, slopes of Mt Salak; Lake of Tjigombong; Sukabumi; in rapidly streaming rivulet near Sukabumi; Sinagar near Sukabumi; Palabuhanratu; river Tjisolok, near Wijnkoopsbay; Tjimandiri, near Wijnkoopsbay; running water of cistern near Tjiandjur; river Tjimahi between Lagador and Kapek; rivulet along road from Tjimindi to Leuwigadja; Bandung, ditch along Merdika road, near cathedral; Lembang near Bandung, in old swimming pool; Sumedang; Tjipelang river near Udjongdjadja, Sumedang; Penandjung Peninsula near Pangandaran; sawah at Kartawinangun, near Madjalengka; Panumbangan, Djampang, from rivulet in cave; fish ponds (temp. 24°C) on Mt Patuha; sawahs near Pengalengan; Pameungpeuk; Garut; Tjipanas near Garut; Tjisurupan near Garut; fish ponds along road of Bandung to Garut; Lake of Bagedit; rivulet near Tjiamis.

Central Java: Pekalongan; Tjomal; Kali Pulman near Bodja; Kali Djumok; (RENSCH, 1934b); Tuntang river; Kali Taman near Salatiga; Kali Lusi near Wirosari; Kali Besèk near Sulang, S of Rembang.

East Java: River Bengawan near Trinil; waterfall above Telaga Wurung near Sarangan (RENSCH, 1934b); Lake of Ngebel; waterfall in Lake of Ngebel; source at Ngledok, near Ngebel (RENSCH, 1934b); Kali Tido in forestry Tjelangap between Tjepu and Bodjonegoro; brook at Nglirip, near Bodjonegoro; Tuban; Kediri; dike at Sumber Kepu, N.N.W. of Kertosono; Kali Mas near Surabaya; Pasuruan; Blauwwater near Pasuruan; Southern mountains, Pasuruan; Tengger mountains; Lawang, in river below cataract; Malang; river Brantas near Malang; rivulet in garden of the "Cultuurschool" at Malang; fish ponds near Punten (RENSCH, 1934b); Ranu Klakah; Ranu Klindungan (RENSCH, 1934b); Ranu Bedali, on stones, near waterfall and near source (RENSCH, 1934b); Ranu Pakis near Mt Lamongan; Djember, ponds, sawahs and stream; river Puger; stalactite formations near Sempol; Kali Mrawan; sawah near Besuki; Lake Tirir (MOUSSON, 1849); river Bomo; Badjulmati.

Thiara scabra has also been recorded (s.n. *Melania scabra*, *granum*, *tjemoroensis* and *savinieri*) from fossiliferous layers of Pliocene and Plei-

stocene age in Central and East Java: CARTHAUS (1911), BRANCA (1908), MARTIN (1905, 1908, 1919), MARTIN-ICKE (1911), VAN ES (1931), VAN DER VLERK (1931), OOSTINGH (1935) and VAN BENTHEM JUTTING (1937). In my paper of 1937 (p. 116) I erroneously combined *Thiara zollingeri* BROT with *Th. savinieri* MORLET. The former is a synonym of *Brotia costula*, the latter of *Thiara scabra*.

In young shells of *Thiara scabra* the first two whorls are smooth. From the third whorl onwards one strong and two weaker spiral carinae appear between the suture and the periphery, and three ridges below the periphery. With the fifth whorl the development of axial ribs starts, causing blunt knobs, afterwards spines, on the intersections with the spiral keel. The embryonic shells and the very young stages are always very similar, even in populations of adult shells which are highly divergent in development of spines.

The females are ovo-viviparous. In a female from Bandung, of 12 mm length, I found 32 embryos, with shells varying from $\frac{1}{2}$ to $2\frac{1}{2}$ mm height.

From the collections of the British Museum (Natural History), London I studied the holotype of *Melania intrepida* FULTON (from Java, collected by FRUHSTORFER). The shell is high 27 and wide 10 mm, with an aperture of 10 mm height. The author compared it with *Melania arctecava* MOUSSON, but that is certainly erroneous. As the spire is much eroded and the embryonic whorls are missing, it is difficult to classify the species. It comes nearest to *Melania simplex* BOETTGER ms, VAN BENTHEM JUTTING, 1929, a nude name, mentioned by me on account of material presented by O. BOETTGER to M. M. SCHEPMAN, and now in the Zoological Museum, Amsterdam. Both forms, *Melania intrepida* FULTON and *M. simplex* VAN BENTHEM JUTTING are -in my opinion- smooth modifications of *Thiara scabra*.

***Thiara cancellata* RÖDING, 1798 (fig. 84).**

- 1798. RÖDING, Mus. Bolten. p. 109 (*Thiara cancellata*).
- 1824. SWAINSON, Qua. Journ. Sci. no. 33, p. 13 (*Melania setosa*).
- 1857. TROSCHEL, Gebiss d. Schnecken, 1, p. 122, pl. 9, fig. 11 (radula) (*Melacanthas setosa*).
- 1859. REEVE, Conch. Icon. 12, pl. 27, fig. 186 (*Melania setosa*).
- 1859. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 18, p. 424 (*Melania setosa*).
- 1874. BROT, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 297, pl. 30, fig. 5, 5a and 6, pl. 31, fig. 1, 1a (*Melania setosa*).
- 1934. RENSCH, Zool. Jahrb. (Syst.) 65, p. 409 (*Melania setosa*).
- 1954. MORRISON, Proc. Un. St. Nat. Mus. 103, p. 379 (*Thiara (Setaeara) cancellata*).

Shell rather low-conical, whorls of the spire descending step-like. Olive-green to olive-brown or black, in young shells reddish-brown, sometimes with scattered brown dots. Sculptured by a crown of spines at short distance from the suture. About 12-14 spines on the last whorl. From the shelly base of the spines a stiff bristle of periostracal matter emerges. In exceptional cases there can occur two bristles on one base. Between the row of spines and the preceding suture the whorls are flattened or slightly concave, causing the spire to descend step-like. In this region of the shell there are 5 to 6 fine spiral striae. Below the row of spines the whorls are sculptured by 15-20 flat spiral ridges, separated by narrow grooves and, sometimes, by low, irregular axial ribs. Not transparent and without lustre.

Whorls about 10, rapidly increasing in size, the last one large and spacious. Suture distinct. Periphery rounded below the spines. Top pointed, but often eroded or decollated. Base rounded. Umbilicus closed.

Aperture almost vertical, oval, pointed above, rounded below. Peristome not continuous, the two ends connected by a thick, whitish or light-orange callus against parietal and columellar margins. Exterior and basal margins evenly rounded, somewhat thickened within. The exterior margin is finely crenulated by the spiral ridges of the shell sculpture.

Operculum horny, oval, dark black-brown. Nucleus excentric, at the right basal side. From the nucleus the growth ridges spread to the tip and the side of the operculum.

Dimensions: height 38-44, width 20-28, height of aperture 20-39 mm.

Distribution: Sumatra, Java, Bali, Flores, Celebes, Ambon, Waigeu, Philippines.

Habitat in Java: in estuaries of rivers where the water is somewhat brackish.

West Java: mouth of river Tjibuni.

East Java: mouth of the river near Puger.

The radula has been described by TROSCHER (1857).

In the young shells the whorls descend like the succeeding crowns of a pagoda. The spines are developed from the 5th whorl onward, and from the 6th whorl onward the bristles are also present.

Thiara setigera (BROT, 1870) (fig. 85).

1859. REEVE, Conch. Icon. 12, pl. 27, fig. 185 (*Melania setosa* pars).

1870. BROT, Americ. Journ. Conch. 6, p. 300 (*Melania setigera*).

1874. BROT, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 298, pl. 30, fig. 7 (*Melania setigera*).

1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 67 (*Melania setifera* sic!).

1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 262 (*Melania setigera*).
1905. MARTIN, Samml. Geol. Reichsmus. Leiden (N.F.) 1, p. 234 and 240, pl. 36, fig. 574 (*Melania setigera*).
1907. MARTIN, N. Jahrb. Mineral. 100, II, p. 161 (*Melania setigera*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 256 (*Melania setifera* sic!).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 96 (*Melania setigera*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 85 (*Melania setigera*).
1931. VAN DER VLERK, Leidsche Geol. Meded. 5, p. 255 (*Melania setigera*).

Shell low-conical, almost globular. Whorls of the spire descending evenly, not step-like. Colour olive-green or olive-brown. Sculptured by a crown of spines at a short distance from the suture. About 12-14 spines on the last whorl. The shelly base of these spines is little elevated, but the bristles which they carry are long, till 10 mm length. Between the row of spines and the preceding suture the whorls are slightly concave. This area is somewhat wider than in *Thiara cancellata*, the more so because each whorl in this region is standing up like a collar against the previous whorl. This construction makes the shell-profile more even than in *Th. cancellata*, not step-like. The subsutural part is strongly ribbed spirally by about 4-6 ridges. Each ridge is more or less irregularly divided into obtuse nodules or granules. Below the row of spines the whorls are sculptured by 20-24 flat spiral ridges, separated by narrow grooves. Not transparent, and without lustre.

Whorls 3 in decollated specimens, but certainly more in complete ones. They increase in size rapidly, the last one is large and spacious. Suture often concealed between the spiral ridges. Periphery rounded below the spines. Top unknown. Base rounded. Umbilicus closed.

Aperture a little oblique, broad-oval, pointed above, rounded below. Peristome not continuous, the two ends connected by a thick, whitish or greyish callus. Exterior and basal margins evenly rounded, somewhat thickened within. The exterior margin is finely crenulated by the ribs of the shell sculpture.

Operculum horny, oval, dark black-brown. Nucleus excentric, at the right basal side. From the nucleus the growth ridges of the operculum are fanning out to the tip and to the side.

Dimensions: height 30-38, width 21-30, height of aperture 23-30 mm. The figures for the height deal with decollated shells.

Distribution: Sumatra, Java, Bali, Philippines.

Habitat in Java: unknown, but probably similar to that of the preceding species.

West Java: Sukabumi; Palabuanratu; Pameungpeuk.

1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 262 (*Melania setigera*).
1905. MARTIN, Samml. Geol. Reichsmus. Leiden (N.F.) 1, p. 234 and 240, pl. 36, fig. 574 (*Melania setigera*).
1907. MARTIN, N. Jahrb. Mineral. 100, II, p. 161 (*Melania setigera*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 256 (*Melania setifera* sic!).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 96 (*Melania setigera*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 85 (*Melania setigera*).
1931. VAN DER VLERK, Leidsche Geol. Meded. 5, p. 255 (*Melania setigera*).

Shell low-conical, almost globular. Whorls of the spire descending evenly, not step-like. Colour olive-green or olive-brown. Sculptured by a crown of spines at a short distance from the suture. About 12-14 spines on the last whorl. The shelly base of these spines is little elevated, but the bristles which they carry are long, till 10 mm length. Between the row of spines and the preceding suture the whorls are slightly concave. This area is somewhat wider than in *Thiara cancellata*, the more so because each whorl in this region is standing up like a collar against the previous whorl. This construction makes the shell-profile more even than in *Th. cancellata*, not step-like. The subsutural part is strongly ribbed spirally by about 4-6 ridges. Each ridge is more or less irregularly divided into obtuse nodules or granules. Below the row of spines the whorls are sculptured by 20-24 flat spiral ridges, separated by narrow grooves. Not transparent, and without lustre.

Whorls 3 in decollated specimens, but certainly more in complete ones. They increase in size rapidly, the last one is large and spacious. Suture often concealed between the spiral ridges. Periphery rounded below the spines. Top unknown. Base rounded. Umbilicus closed.

Aperture a little oblique, broad-oval, pointed above, rounded below. Peristome not continuous, the two ends connected by a thick, whitish or greyish callus. Exterior and basal margins evenly rounded, somewhat thickened within. The exterior margin is finely crenulated by the ribs of the shell sculpture.

Operculum horny, oval, dark black-brown. Nucleus excentric, at the right basal side. From the nucleus the growth ridges of the operculum are fanning out to the tip and to the side.

Dimensions: height 30-38, width 21-30, height of aperture 23-30 mm. The figures for the height deal with decollated shells.

Distribution: Sumatra, Java, Bali, Philippines.

Habitat in Java: unknown, but probably similar to that of the preceding species.

West Java: Sukabumi; Palabuanratu; Pameungpeuk.

Thiara setigera has also been recorded from Pliocene layers at Mantjeurih, near Bajah, Central Java (MARTIN, 1905).

The differences between the shells of *Thiara cancellata* and *Th. setigera* are given here in tabular form:

<i>cancellata</i>	<i>setigera</i>
1. whorls descending step-like	1. whorls descending more evenly not step-like
2. spiral ridges in the subsutural area much finer than below the crown of spines	2. spiral ridges about equally strong above and below the spines
3. spiral ridges in the subsutural area continuous	3. spiral ridges in the subsutural area cut into irregular nodules
4. suture simple, not margined	4. along the suture each successive whorl is pressed against the previous one, standing up like a collar
5. shelly part of spines longer than in <i>Th. setigera</i> , but bristles shorter	5. shelly part of spines very short, bristles long

Genus *Melanoides* OLIVIER, 1804.

Shell moderately to high-turreted, with the spire much longer than the last whorl. Smooth, or sculptured with vertical and spiral ridges, but without spines.

Whorls numerous, the apical ones often differing in sculpture from the rest of the whorls. Base rounded. Umbilicus closed.

Aperture pear-shaped, small in comparison with the slender spire. Peristome not continuous, rounded at the base and pointed at the top. There is no siphonal canal.

Operculum horny, dark brown to black. Nucleus excentric, at the narrow basal end.

Radula 2.1.1.1.2 (fig. 73).

Distribution: North and East Africa, Arabia, Persia, India, Ceylon, Burma, Indo China, Southern China, Malaya, Malay Archipelago, Philippines, North Australia, various Pacific islands.

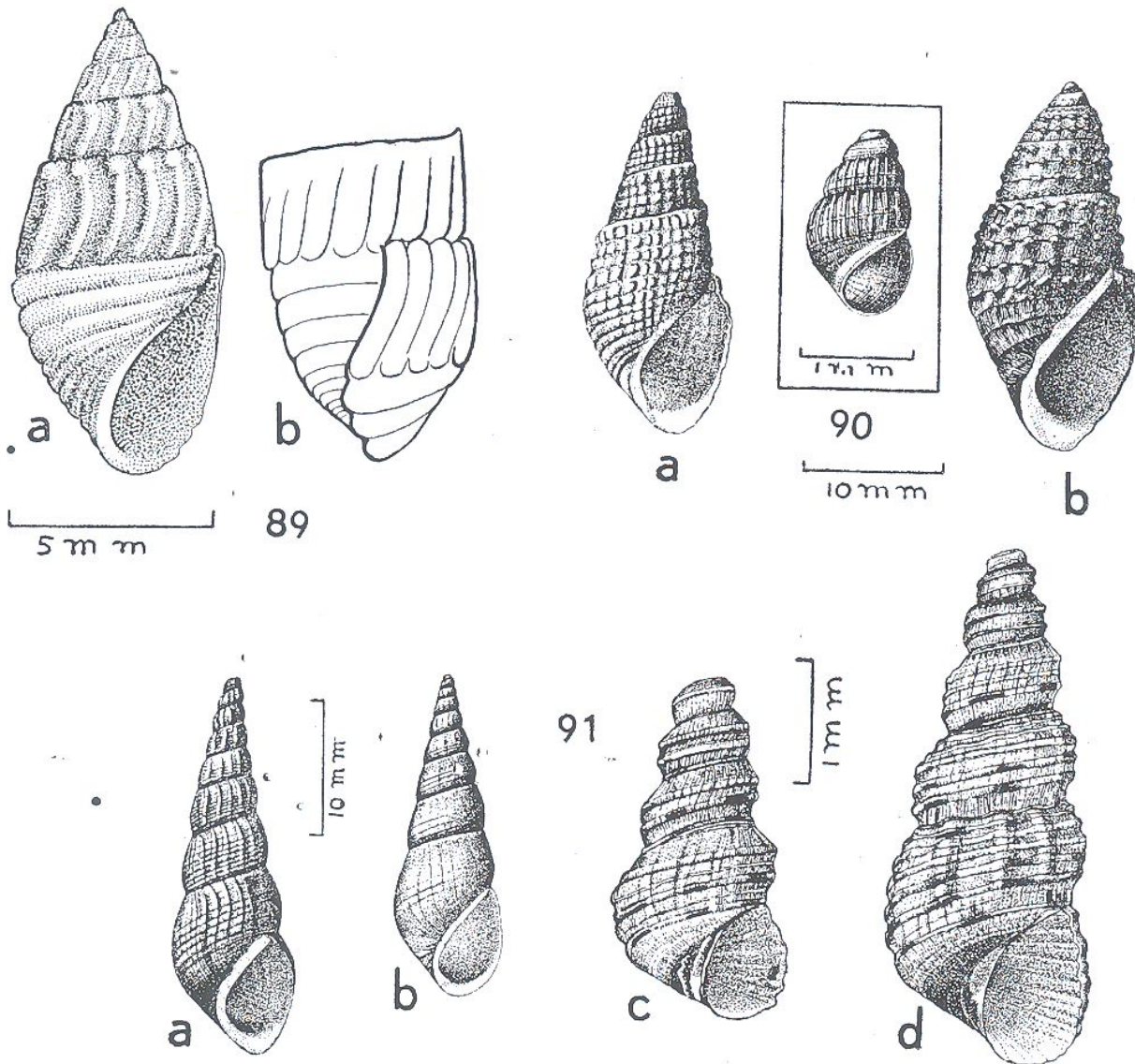
The animals live mostly in fresh water, stagnant or running. Some species can tolerate a small degree of salinity and a high temperature (till 35°C). *Melanoides tuberculata* has been found in wells containing iodine.

Key to the species living in Java:

1. Shell sculptured by vertical and spiral ridges. These ridges are generally crossing, causing a pattern of nodules or granules 2
 - Shell with spiral striae only, or at most some vertical ridges or folds on the apical whorls 4
2. Vertical and spiral ridges crossing 3
 - Vertical ridges above the periphery, spiral ones below it . . . **riqueti**
3. The row of nodules along the suture is stronger than those on the rest of the whorl. Below the periphery the nodules become weaker.
 - Large shells **torulosa**
 - Nodules about equally strong on the entire shell, above and below the periphery. Small to moderately large shells **granifera**
4. Shell with numerous spiral lirae. On the younger whorls with some weaker vertical striae besides. A brown spiral band in the umbilical region and irregular brown dots and flames all over the surface. **tuberculata**
 - The initial whorls mostly with vertical ribs or folds, the younger ones generally spirally striated. No brown spiral band in the umbilical region. Other brown markings present in some, absent in other species. 5
5. Shell very slender, spire attenuate, sharp 6
 - Shell broader, spire not attenuate and not so sharp 7
6. Upper whorls of the spire strongly folded, lower ones smooth or with spiral striae **plicaria**
 - Shell throughout with fine spiral lines, in the lower whorls the central region of each whorl is often smooth, the striae only occurring in the subsutural region and below the periphery **maculata**
7. Shell very large, without colour markings, almost smooth, except a few weak spiral striae below the suture and in the umbilical region. Whorls often concave between suture and periphery **rustica**
 - Shell smaller, with reddish-brown irregular spots. Distinctly sculptured by spiral ridges (on the whole shell) and vertical folds (on the top whorls only) 8
8. Top whorls vertically ribbed, later ones smooth or with weak spiral striae, especially in the umbilical region **punctata**
 - Entire shell spirally ribbed by well-defined, somewhat pinched ridges. On the last whorl they can be divided by vertical grooves into irregular nodules **arctecava**

Melanoides riqueti (GRATELOUP, 1840) (fig. 89).

1840. GRATELOUP, Act. Soc. Linn. Bordeaux, 11, p. 433, pl. 3, fig. 28 (*Melania riquetii*).
 1844. DUNKER, in: PHILIPPI, Abb. & Beschr. 1, Melania, p. 161, pl. 3, fig. 6 (*Melania harpula*).
 1847. PHILIPPI, Abb. & Beschr. 2, Melania, p. 171, pl. 4, fig. 12 (*Melania semicostata*).
 1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268 (*Melania riquetii*).
 1849. MOUSSON, Land & Süssw. Moll. Java, p. 76 (*Melania riquetii*).
 1850. LEA, Proc. Soc. London, p. 185 (*Melania tornatella*).
 1859. REEVE, Conch. Icon. 12, pl. 24, fig. 173 (*Melania tornatella*) and Ibid. 1860, Errata (*Mel. tornatella* syn. *riquetii*).



- Fig. 89. *Melanoides riqueti* (GRAT.). a. front view of shell, b. side view of two last whorls, more enlarged. J. MASTRO del.
 Fig. 90. *Melanoides granifera* (LAM.). a. adult shell, b. forma *lineata* (GRAY). Inset: embryonic shell, more enlarged. ABDULKADIR del.
 Fig. 91. *Melanoides tuberculata* (MÜLL.). a. shell with strong sculpture, b. shell with nearly smooth surface, c. and d. young stages. ABDULKADIR del.

1874. BROU, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 308, pl. 32, fig. 3 (*Melania semicostata*), p. 331, pl. 34, fig. 9 (*M. tornatella*), p. 333, pl. 34, fig. 6 *M. riquetii*).
1879. MARTIN, Tertiärsch. Java, p. 88, pl. 14, fig. 19 (*Melania herklotsi* non *herklotzi* Petit).
1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 273 (*Melania riqueti*).
1888. TENISON WOODS, Proc. Linn. Soc. N. S. Wales (2) 3, p. 1085 (*Melania semicostata*), p. 1086 (*M. riquetii*).
1890. BOETTGER, Ber. Senckenb. p. 154 (*Melania riqueti*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 73 (*Melania semicostata*).
1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 262 (*Melania semicostata*), p. 265 (*M. riqueti*).
1905. MARTIN, Samml. Geol. Reichsmus. Leiden (N.F.) 1, p. 235 and 245, pl. 37, fig. 591, 591a, 592, 593 (*Melania tornatella*).
1907. MARTIN, N. Jahrb. Mineral. 100, II, p. 161 (*Melania tornatella*).
1911. MARTIN-ICKE, Pithecanthr. Schichten Java, p. 47 and 49 (*Melania tornatella*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 258 (*Melania riquetii* and *M. semicostata*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 97 (*Melania tornatella*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 85 (*Melania riqueti* and *M. semicostata*).
1931. VAN ES, Age of Pithecanthropus, p. 52 (*Melania tornatella*).
1931. VAN DER VLIERK, Leidsche Geol. Meded. 5, p. 255 (*Melania tornatella*).
1932. MARTIN, Jaarb. Mijnw. Ned. Ind. 59 (1930) Verh. IIIe Ged. p. 114 (*Melania tornatella*).
1934. RENSCH, Zool. Jahrb. (Syst.) 65, p. 410, fig. 5 (*Melania riquetii* incl. *tornatella*).
1935. OOSTINGH, Wetensch. Meded. Dienst Mijnb. Ned. Ind. 26, p. 26 (*Sermyla tornatella*).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 120-122 (*Thiara tornatella* and *riquetii*).

Shell rather small, moderately turriculate, with pointed spire. Dark corneous, with some scattered darker brown dots, or a vague spiral brown band. Sculptured by spiral ridges and undulating axial ribs. On the 3-4 initial whorls these two systems cross each other and are about equally strong. On the later whorls the two types of sculpture are separated, the vertical ribs being dominant above the periphery, the spiral ridges below it.

On the last whorl there are about 14-17 vertical ribs and 6-7 spiral ones. Fresh shells somewhat transparent and shining.

Whorls about 8, regularly increasing in diameter, little convex. Suture distinct. Periphery rounded. Top pointed, base rounded, umbilicus closed.

Aperture almost vertical, oval, pointed above and rounded below. Peristome not continuous, the two ends connected by a thin white callus against the preceding whorl. Exterior margin sinuous, protruding in the middle, receding in upper and lower regions.

Operculum oval, horny, dark blackish-brown. Nucleus excentric, in the left basal corner. From this nucleus the growth lines spread to the tip and to the outer margin.

Dimensions: height 13-16, width 5-7, height of aperture 6-8 mm.

Distribution: India, Burma, various Malaysian islands, Philippines.

Habitat in Java: fresh and brackish water, in the lowlands.

West Java: between Antjol and Djakarta; fish ponds near Tandjong Priok; mangrove swamp near Tandjong Priok (BOETTGER, 1890); Sukabumi; Tjisaaranang near kampong Tjariang, district of Sumedang; Cheribon.

Central Java: beach N of Pematang; Semarang.

East Java: Tuban; Surabaja (MARTENS, 1897).

Melanoides riqueti has also been found in the islands of Middelburg, Amsterdam, Schiedam, Kerkhof, Hoorn and Edam in the Bay of Djakarta.

In a fossil state the species has been recorded from Upper Pliocene and Pleistocene layers in West, Central and East Java (MARTIN, 1879, 1905, 1907, 1919, 1932), MARTIN-ICKE (1911), VAN DER VLERK (1931), OOSTINGH (1935), VAN BENTHEM JUTTING (1937). VAN ES (1931, p. 52) even suggested a Miocene age for this species.

In the first five whorls there are only two nodulous spiral ribs; in the later ones this number increases and the nodules become confluent, forming vertical or subvertical ribs.

Contrary to my opinion of 1937 (p. 121) I have now come to the conclusion that *Melanoides tornatella* is a synonym of *M. riqueti*.

GOODRICH (1936, The Nautilus, 49, p. 76) reported that *Melanoides riqueti* is viviparous, just as most other Thiaridae. "Thirty-four young were recovered from three shells. The greatest number were of only three whorls. One specimen had five whorls, two of which were smooth if sharply defined growth lines be excepted. The fourth whorl was plicate over the whole surface, with two striations amounting to keels. Both plicae and striae increased in strength on the fifth whorl".

Melanoides granifera (LAMARCK, 1822) (fig. 90).

1822. LAMARCK, Hist. Anim. s. Vert. Vol. 6, Part 2, p. 167 (*Melania granifera*).

1828. GRAY, in: WOOD, Index Test. Suppl. p. 24, fig. 68 (*Helix lineata*).

1834. QUOY & GAIMARD, Voy. Astrolabe, Zool. 3, p. 152, pl. 56, fig. 26-29 (*Melania celebensis*).

1836. BENSON, Journ. As. Soc. Bengal, 5, p. 782 (*Melania lirata*).

1842. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1, Melania, p. 2, pl. 1, fig. 13 (*Melania semigranosa*).

1843. PHILIPPI, Abb. & Beschr. 1, Melania, pl. 60, pl. 2, fig. 4 (*Melania coffea*).

1844. DUNKER, in: PHILIPPI, Abb. & Beschr. 1, *Melania*, p. 164, pl. 3, fig. 15 (*Melania flavida*).
1844. HINDS, Ann. Mag. Nat. Hist. 14, p. 9 (*Melania verrucosa*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268 (*Melania lineata* and *flavida*).
1849. MOUSSON, Land & Süssw. Moll. Java, p. 74, pl. 10, fig. 7 (*Melania semigranosa* incl. *fa exserta* and *fa inserta*), pl. 10, fig. 6 (*Melania lineata* incl. *fa lineata* and *f3 subgranosa*) and p. 75, pl. 10, fig. 5 (*Melania flavida*).
1850. LEA, Proc. Zool. Soc. London, p. 192 (*Melania crenifera*).
1857. MOUSSON, Journ. de Conch. 6, p. 161 (*Melania granospira*).
1857. TROSCHER, Gebiss d. Schnecken, 1, p. 123, pl. 10, fig. 1 (radula) (*Melania semigranosa*).
1859. REEVE, Conch. Icon. 12, pl. 24, fig. 167 (*Melania semigranosa*), fig. 168 (*M. verrucosa*), fig. 169 (*M. crenifera*), fig. 170 (*M. lirata*).
1859. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 18, p. 424 (*Melania granospiralis* sic!).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 319 (*Melania semigranosa*, *M. lirata* = *lineata*), p. 320 (*M. semigranosa* and *M. flavida*).
1868. BROU, Matér. Mélaniens, 2, p. 27, pl. 1, fig. 10 (*Melania granospira*), p. 30, pl. 1, fig. 11 (*M. asperula*).
1872. BROU, Matér. Mélaniens, 3, p. 20, pl. 1, fig. 3 (*Melania granifera*).
1874. BROU, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 317, pl. 32, fig. 15 (*Melania celebensis*), p. 318, pl. 33, fig. 3 (*M. verrucosa*), p. 321, pl. 33, fig. 13 (*M. granifera*), p. 323, pl. 33, fig. 9 (*M. crenifera*), p. 324, pl. 33, fig. 14 (*M. granospira*), p. 326, pl. 33, fig. 10 (*M. coffea*), p. 327, pl. 33, fig. 11 (*M. asperula*), p. 328, pl. 33, fig. 6 (*M. lirata*).
1879. MARTIN, Tertiärsch. Java, p. 89, pl. 14, fig. 20 (*Melania junghuhni*).
1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 277 (*Melania lineata* var. *semigranosa* and *M. lineata* var. *flavida*).
1887. MARTIN, Samml. Geol. Reichsmus. Leiden (1) 3, p. 158 and 324 (*Melania semigranosa*), p. 159 and 338 (*M. granifera*).
1888. TENISON WOODS, Proc. Linn. Soc. N. S. Wales (2) 3, p. 1085 (*Melania crenifera*), p. 1086 (*M. granospira*, *coffea*, *asperula* and *lirata*).
1890. BOETTGER, Ber. Senckenb. p. 153 (*Melania asperula* and *M. coffea*).
1891. BOETTGER, Ber. Senckenb. p. 248 (*Melania coffea* and *M. lirata*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 69 (*Melania celebensis*), p. 71 (*M. granifera* and *M. lineata*), p. 72 (*M. lineata* var. *semigranosa* and *M. flavida*), p. 305 (*M. margaritata* nom. nud.).
1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 263 (*Melania celebensis*), p. 264 (*M. verrucosa*, *granifera*, *lirata* and *M. lirata* var. *asperula*).
1905. MARTIN, Samml. Geol. Reichsmus. Leiden (N.F.) 1, p. 235 (*Melania tjariangensis*, *verrucosa*, *kritjianensis*, *semigranosa*, *junghuhni*), p. 243, pl. 36, fig. 581-583 (*M. tjariangensis*), p. 244, pl. 36, fig. 587-588 (*M. kritjianensis*).
1907. MARTIN, N. Jahrb. Mineral. 100, II, p. 161 (*Melania verrucosa* and *M. semigranosa*).
1908. BRANCA, Sitz. Ber. Kgl. Preuss. Akad. Wiss. Berlin, p. 270 (*Melania verrucosa*).
1908. MARTIN, Versl. gew. Verg. Kon. Akad. Wet. Amsterdam (Natuurk.) 17, p. 14 (*Melania verrucosa*).
1911. CARTHAUS, Pithecanthr. Schichten Java, p. 13 (*Melania verrucosa*).

1911. MARTIN-ICKE, Pithecanthr. Schichten Java, p. 50 (*Melania verrucosa*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 219 and 258 (*Melania tjibodasensis*), p. 257 (*M. asperula, coffea, crenifera, flavida, granifera, lineata* and *lineata* var. *semigranosa*), p. 258 (*M. margaritata*).
1915. SCHEPMAN, Bijdr. t.d. Dierk. 20, p. 27 (*Melania asperula*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 96 (*Melania tjariangensis, verrucosa, kritjianensis*), p. 97 (*M. semigranosa* and *junghuhni*).
1923. OOSTINGH, Meded. Landb. Hooges. Vol. 26, Part 3, p. 49 (*Melanoïdes asperula*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 85 (*Melania asperula, coffea, verrucosa, crenifera, flavida, granifera, lineata, lineata* var. *semigranosa, margaritata, tjibodasensis*).
1931. VAN ES, Age of Pithecanthropus, p. 65 and 136 (*Melania kritjianensis*), p. 136 (*M. verrucosa*).
1931. VAN DER VLERK, Leidsche Geol. Meded. 5, p. 254 (*Melania junghuhni* and *kritjianensis*), p. 255 (*M. semigranosa, tjariangensis* and *verrucosa*).
- 1934a. RENSCH, Zool. Jahrb. (Syst.) 65, p. 404 (*Melania granifera granifera*).
- 1934b. RENSCH, Trop. Binnengew. 5, p. 230 (*Melania granifera lineata*).
1935. OOSTINGH, Wetensch. Meded. Dienst Mijnb. Ned. Ind. 26, p. 19 (*Melanoïdes junghuhni*), p. 22 (*M. tjariangensis*), p. 24 (*M. flavida*) and p. 25 (*M. martini* non *M. martini* Schepman, 1898 = *Brotia spadicea* Reeve, 1859).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 122-126 (*Thiara granifera* and *Th. granifera madiunensis*).
1938. ADAM & LELOUP, Mém. Mus. Roy. Hist. Nat. Belg. (Hors Série) Vol. 3, Part 19, p. 93, fig. 33 (*Melania asperula*).
1941. VAN BENTHEM JUTTING, Arch. Néerl. Zool. 5, p. 281 (*Thiara granifera*).
1951. THIENEMANN, Arch. Hydrobiol. Suppl. Bd. 19, p. 535 and p. 541 (*Melania granifera lineata*).
1952. MERMOD, Rev. Suisse Zool. 59, p. 75, fig. 137 (*Melania granifera*).

Shell obtusely to elongately conical, with elevated spire and large last whorl. Yellowish to olive or brown, the young shells always, and the adult ones often, with 1-3 reddish-brown spiral bands, one just below the suture, one in the peripheral and one in the umbilical region. In general the top whorls are much darker than the later ones, a feature which is still visible in dead and bleached shells. In addition to the spiral colour bands irregular spots and flames of the same reddish-brown colour can occur on the later whorls. The shell is coarsely sculptured by elevated ridges in vertical and spiral direction, causing a pattern of strong, blunt, nodules. On the last whorl the number of spiral ridges varies between 4 and 8. In some specimens the spiral ridges predominate, in others the axial ones. In the umbilical region there are only spiral ribs. The first two whorls are smooth. After the second whorl the crosswise sculpture sets in. Fresh shells are occasionally transparent and shining, but erosion has often worn down the oldest whorls, or the surface is incrustated with foreign matter.

Whorls 12-15, gradually increasing in size, the last one large and spacious. The whorls are little convex, hence the suture is not deep. Periphery of last whorl rounded in adult shells, but often obtusely angulate in immature ones. Top pointed, base rounded. Umbilicus closed.

Aperture almost vertical, oval, pointed above and rounded below. Peristome not continuous, the two ends connected by a thin callus against the penultimate whorl. Outer margin sinuous, protruding in the middle, but receding at the upper and lower extremities. Basal part of peristome somewhat channelled.

Operculum horny, oval, dark red-brown. Nucleus at left lower corner, the growth ridges fanning out from this point.

Dimensions: height 30-40, width 12-16, height of aperture 12-18 mm.

Distribution: India, Malaya, Malay Archipelago, Philippines, Formosa, various Pacific Islands.

Habitat in Java: in fresh water, either running or stagnant. *Melanoides granifera* can tolerate a high amount of turbidity and pollution of the water and is also found in hot water of volcanic lakes and springs of about 30-35°C. Although the species prefers fresh water it can also stand a considerable amount of salinity. It occurs between sea level and about 1200 m altitude (RENSCH, 1934b, p. 232).

West Java: Tji Lampir near kampong Pasauran; Tji Pasauran, upstream of kampong Pasauran; Tji Sungkui near kampong Pasauran; Tji-marra; Pardana (MOUSSON, 1849); between Antjol and Djakarta; Djakarta; river Tanabang, Djakarta; Tandjong Priok; Tjiliwung near Depok; Bogor, in sawah ditches; Botanical Gardens, Bogor, in pond and stream (RENSCH, 1934b); Tjiliwung near Bogor; estate of Tjisarua near Bogor; lake of Tjisarua near Sindanglaja; Tjipanas, on stones in river; Tjibodas, Mt Gedeh; Tjigombong (RENSCH, 1934a); Sukabumi in small, quickly running river; near Wijnkoopsbay; river Tjisolak, near Wijnkoopsbay; Wangun near Tjisampora; Pameungpeuk; Tjiandjur, in shallow cistern; Tjiandjur, in cistern near Hospital; Tjiandjur, in river near waterfall; Tjugenang near Tjiandjur; Tjimatan, in sawahs, ponds and rivulet; Tji Leat near Radjamandala; river Tjimahi, between Lagador and Kapek; sawahs near Bandung; river along Merdika road at Bandung; rivulet along road Tjimindi to Leuwigadja, on stones; fish ponds on slope of Mt Patuha; mountain stream, Mt Patuha, luke-warm water; sawahs near Pengalengan; fish ponds along road Bandung to Garut; Garut; fish ponds along road Kawah Kamodjan to Garut; Tjipanas near Garut; Sadang near Garut, in fish ponds; Leles; sawahs along road Garut to Tasikmalaja; Tjilaut estate near Garut; Situ Bagendit near Garut; small river near

Tjiamis; Tjisaaranang near kampong Tjariang, district of Sumedang; Tjipelang river near Udjungdjaja, district of Sumedang; Kartawinangun, district of Madjalengka, in sawah; irrigation ditches near Kadipaten, district of Cheribon; Pemali river near Cheribon.

Central Java: Tegal; Pekalongan; Tjomal, near Pekalongan; Suka-redjo; river near Bodja, S.W. of Semarang; artificial irrigation stream near Bodja, about 7 km S of Weleri; Semarang (RENSCH, 1934a); lake Mendjer near Wonosobo; Kali Tanam near Salatiga (SCHEPMAN, 1915); Magelang; near waterfall of Sekartangit near Grabak, district of Kedu; Kali Lerang, near Kebumen; south coast near Parangtritis; river Senengkarang near Kedungwuni, on stones; Karang Putjong; Kali Besèk, near Sulang, district of Rembang.

East Java: river Bengawan, near Trinil; Telaga Urung, near Sarangan; lake of Ngebel; Tuban; Djembel, 5 km W. of Tuban; brook near Nglirip, district of Bodjonegoro; Kali Tido in forestry Tjilangkap, between Tjepu and Bodjonegoro; Kediri; Berbek; waduk of Sumber Kepu, N.N.W. of Kertosono; Kali Mas near Surabaja; Sukalelo near Surabaja; Pasuruan; Malang; Kali Brantas near Malang; Malang, garden of Experiment Station; fish ponds at Puntèn near Malang; Singosari near Malang; Pudjon near Malang; stalactite formations near Sempol; Lawang; Tengger Mts; Southern Mountains; Ranu Klakah; Ranu Bedali; Ranu Pakis; Ranu Klindungan; Kali Sampean near Situbondo; travertine deposits near coffee estate Blawan, Idjen plateau; Telaga Wurung; Idjen plateau; outflow of the crater, Idjen plateau; hot fresh water lake of Djeding, Idjen plateau; ponds, sawahs and rivulet near Djember; Kali Tjarang near Banjuwangi; Rogodjampi.

This species has also been collected in the islands of Hoorn, Bawean, Madura and Nusa Kambangan, off the coast of Java.

Melanoides granifera has also been recorded from Upper Pliocene and Pleistocene layers in Central and East Java: MARTIN (1879, 1887, 1905, 1907, 1908, 1919), MARTIN-ICKE (1911), BRANCA (1908), CARTHAUS (1911), VAN ES (1931), VAN DER VLERK (1931), OOSTINGH (1935), VAN BENTHEM JUTTING (1937). As I remarked in my publication of 1937 (p. 124) *Melanoides granifera* is as variable in fossiliferous layers as it is in the present day fauna.

Melanoides granifera is an extremely variable species. Not only the height-width ratio and the ratio total height to height of aperture can vary, but also the number of spiral and axial ridges and, consequently, of the tubercles is variable. This has given rise to the creation of a dozen or more "species" which, on critical examination, cannot be maintained,

but must be classified as synonyms, or, at most, local variants of *M. granifera*. Most of these variants have been described after one single or very few specimens, and have not been found again in later years. Only the forma *lineata* (GRAY, 1828) is readily distinguishable. It possesses fine dark lines coinciding with the spiral ridges. These lines are not only present on the periostracum, but also on the shell itself.

The animal of *Melanoides granifera* has a small, oblong foot. According to ABBOTT (1948, Bull. Mus. Comp. Zoöl. Vol. 100, No. 3, p. 291) "the sides of the foot and body are mottled with black and grey over which are scattered light yellow patches. The tentacles are light grey with numerous encircling black flecks. The underside of the foot is usually colored a chalky grey and in some specimens with an additional pinkish cast. Over this are two or three dozen small, round, yellow dots. The first five papillae on the edge of the mantle are large, with bulbous bases which have yellow dots embedded in the flesh. The "birth pore" on the right side of the body is colored pink. The "brood pouch" contains from 20 to 30 young and numerous eggs. The interior of the mantle is flushed with blue green".

In a later publication ABBOTT (1952, Proc. Un. States Nat. Mus. 102, p. 71-116) dealt at some length with the life history of *Melanoides granifera* and of the trematode worms which adopt this species as an intermediate host for their larvae (cercariae).

Personally I found in a female of 16 mm length from Bandung 17 young of different ages, their shells varying between 1 and 2½ mm height. The first 3-4 whorls bear delicate spiral threads and oblique axial ones. Both systems become stronger with increasing age on the succeeding whorls. In the youngest stage the whorls are little convex, but they become more rounded as growth proceeds.

RENSCH (1934a, p. 406-407) analysed series of *granifera*-shells from Java, Bali, Lombok and Flores, counting the number of spiral ridges on the last whorl in adult or semi-adult shells. He found that in Java the highest percentage (35%) had only 8 ridges, in Bali the highest percentage (22%) had 10 ridges, in Lombok 30% had 11 ridges and in Flores 25% had 13 ridges.

The radula has been described by TROSCHER (1857).

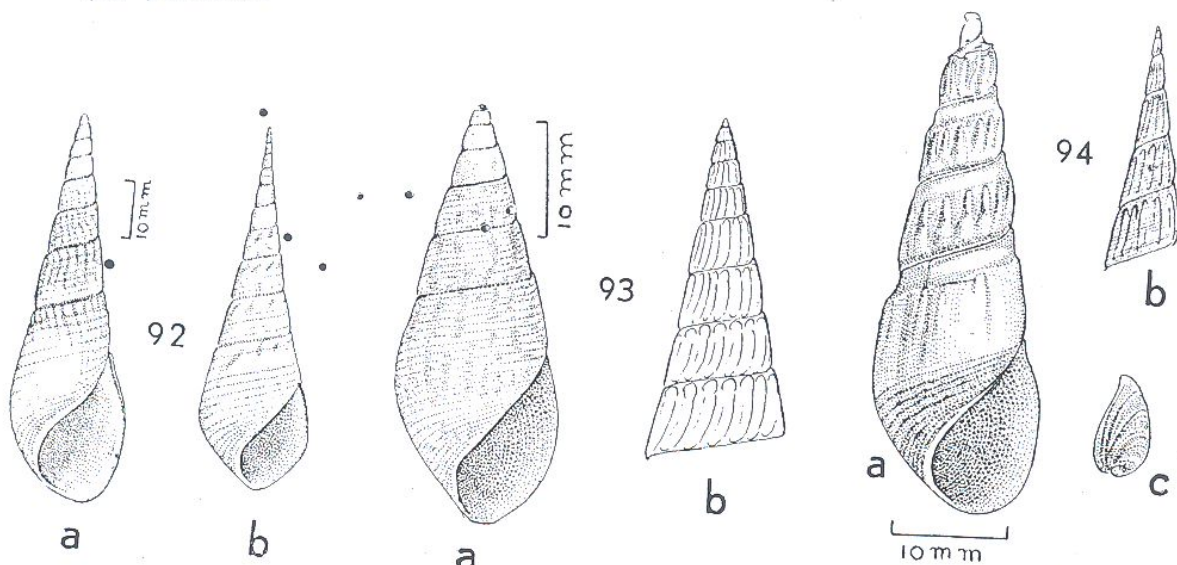
ABBOTT (1952, p. 98-99) found *Melanoides granifera* in: "fast-flowing fresh-water streams" "most abundant in the shallow riffles where the flow of water is fairly rapid and where the bottom consists of a pavement of small stones. Occasionally the snails may be found congregated on firm sandy bottom provided there is a healthy flow of water.

Waters of the stream that are exposed to direct sunlight most of the day appear to attract this species. The upper reaches of the stream that have a very rapid flow of water are not favorable”.

Collecting experience in Java by myself and other naturalists revealed that *Melanoides granifera*, although it is frequently found in running water of rivers and small streams, can also occur in the more quiet water of lakes, ponds and sawahs.

***Melanoides torulosa* (BRUGUIÈRE, 1789) (fig. 92).**

1789. BRUGUIÈRE, Encyl. Méth. Vers, 1, p. 332 (*Bulimus torulosus*).
 1790. GMELIN, Syst. Nat. Ed. XIII, p. 3655 (*Helix crenata* non *H. crenata* Gmelin, Ibid. p. 3623 = *Amphibola crenata*).
 1834. LEA, Trans. Americ. Philos. Soc. Philad. (N.S.) 5, p. 81, pl. 19, fig. 72 (*Melania aculeus*).
 1834. QUOY & GAIMARD, Voy. Astrolabe, Zool. 3, p. 159, pl. 56, fig. 38, 39 (*Melania tirouri*).
 1838. DESHAYES, Hist. Nat. Anim. s. Vert. Ed. II, 8, p. 434 (*Melania crenulata*), p. 435 (*M. tirouri*).
 1844. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1, Melania, p. 159, pl. 3, fig. 2 (*Melania semicancellata*).
 1844. JONAS, Zeitschr. f. Malak. 1, p. 50 (*Melania porcata*).
 1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268 (*Melania semicancellata* and *M. porcata*).
 1849. MOUSSON, Länd & Süssw. Moll. Java, p. 68 (*Melania semicancellata*), p. 69 (*M. porcata*).



- Fig. 92. *Melanoides torulosa* (BRUG.). a. adult shell, b. young shell, somewhat more enlarged. J. MASTRO del.
 Fig. 93. *Melanoides punctata* (LAM.). a. adult shell with decollated spire, b. top whorls, more enlarged. J. MASTRO del.
 Fig. 94. *Melanoides plicaria* (BORN). a. adult shell with decollated spire, b. top whorls, more enlarged, c. operculum. J. MASTRO del.

1859. REEVE, *Conch. Icon.* 12, pl. 5, fig. 26 (*Melania crenulata*), pl. 8, fig. 37 (*M. semicancellata*).
1859. ZOLLINGER, *Natuurk. Tijdschr. Ned. Ind.* 18, p. 424 (*Melania porcata*).
1860. ZOLLINGER, *Natuurk. Tijdschr. Ned. Ind.* 21, p. 318 (*Melania porcata*).
1874. BROU, in: MART.-CHEMN. *N. Syst. Conch. Cab.* Vol. 1, Part 24, p. 114, pl. 14, fig. 9a-f (*Melania crenulata*), p. 118, pl. 15, fig. 1, 1a-b (*M. semicancellata*), p. 121, pl. 15, fig. 8 (*M. obesula*), p. 122, pl. 15, fig. 6 (*M. aculeus*).
1884. NEVILL, *Hand List Moll. Ind. Mus.* 2, p. 226 (*Melania semicancellata*).
1888. TENISON WOODS, *Proc. Linn. Soc. N. S. W.* (2) 3, p. 1080 (*Melania crenulata* var. *porcata*, *M. semicancellata*, *M. obesula*, *M. aculeus*).
1897. MARTENS, in: WEBER, *Erg. Reise Nied. Ost Indien*, 4, p. 45 (*Melania crenulata* incl. var. *porcata*).
1899. HORST & SCHEPMAN, *Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas*, Vol. 13, Part 2, p. 252 (*Melania crenulata* and *M. semicancellata*).
1914. LESCHKE, *Mitt. naturhist. Mus. Hamburg*, 31, p. 253 (*Melania crenulata*, *porcata*, *obesula*), p. 254 (*M. semicancellata*).
1929. VAN BENTHEM JUTTING, *Treubia*, 11, p. 84 (*Melania crenulata*, *obesula*, *semicancellata*).
1934. RENSCH, *Zool. Jahrb. (Syst.)* 65, p. 414 (*Melania crenulata*).
1941. VAN BENTHEM JUTTING, *Arch. néerl. Zool.* 5, p. 281 (*Thiara crenulata* and *Th. obesula*).

Shell large, high-turreted with a great number of flat whorls and a large body whorl. Dark olive or brown, the top whorls generally lighter than the later ones. The top whorls are often spotted with small brown spots or flammules, the later whorls are mostly plain.

Whorls of the spire bear fine decurrent spiral lines, separating flat ridges. Only the very young shells are occasionally axially plicate. In the last 5 whorls the system of flat spiral ridges continues, but they are broader and less numerous. In many specimens, however, the spiral ridges are broken up by transverse lines into 1-4 rows of nodules which may even appear as vertical nodulous ribs. The row of nodules immediately below the suture is generally the strongest and forms an elevated crown. In the largest shells which I have seen the nodules fade away on the body whorl. Below the periphery the nodules are much weaker, but the spiral ridges remain. Shell thick, adult ones not transparent.

Whorls 12-14, little convex. Last whorl somewhat concave below the suture, then convex again. Periphery bluntly angulate in immature shells. Top pointed and sharp in complete specimens, base rounded. Umbilicus closed.

Aperture almost vertical, pyriform, pointed above and rounded below. Peristome not continuous, the two ends connected by a thick, bluish-white callus against the parietal wall. Columellar side somewhat twisted, and so much curved to the left that, on looking from the base, the previous

whorls are visible inside. Basal margin slightly channelled. Outer margin crenulated by the spiral ridges of the sculpture.

Operculum horny, pear-shaped, almost black. Nucleus excentric, situated at the left basal corner. From the nucleus the growth lines of the operculum spread to the top and the margins.

Dimensions: height up to 80, width 20-21, height of aperture 23 mm.

Distribution: India, Burma, many Malaysian islands, Philippines, Solomon Islands.

Habitat in Java: almost nothing is known of the habitat of this species in Java. In other islands it is found in streams.

West Java: Sukabumi; Palabuanratu.

East Java: Surabaya (NEVILL, 1884).

According to SESHAIYA (1940, Current Science, 9, p. 331-332) *Melanoides torulosa* possesses many eggs in the brood pouch during the breeding season. These eggs develop there to veliger larvae. Instead of continuing their metamorphosis in the brood pouch until young shelled snails are found, the larvae are liberated into the water and complete their development there.

In 1937 (VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 128) I united *Melania gendinganensis* MARTIN with *Thiara semicancellata*. The latter species is now listed as a synonym of *Melanoides torulosa*, but I am not sure if *M. gendinganensis* must also be classified as such. Therefore I omitted the reference in the list of synonyms. A renewed examination of *M. gendinganensis* is desirable.

Melanoides tuberculata (MÜLLER, 1774) (fig. 69, 73, 91).

1774. MÜLLER, Hist. Verm. 2, p. 191 (*Nerita tuberculata*).
1822. LAMARCK, Hist. Nat. Anim. s. Vert. Vol. 6, Part 2, p. 167 (*Melania truncatula*).
1834. FÉRUSAC, in: QUOY & GAIMARD, Voy. Astrolabe, Zool. 3, p. 141, pl. 56, fig. 1-4 (*Melania virgulata*).
1842. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1, *Melania*, p. 4, pl. 1, fig. 19 (*Melania ornata*).
1844. HINDS, Ann. Mag. Nat. Hist. 14, p. 9 (*Melania moesta*).
1847. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 2, *Melania*, p. 170, pl. 4, fig. 5 (*Melania inhonesta*).
1847. PHILIPPI, Abb. & Beschr. 2, *Melania*, p. 171, pl. 4, fig. 6 (*Melania rivularis*), p. 174, pl. 4, fig. 20 (*M. coarctata* non *M. coarctata* Lamarck).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268-269 (*Melania ornata*, *coarctata*, *inhonesta*, *tuberculata*, *unifasciata*, *cylindrica* sic!).
1849. MOUSSON, Land & Süßw. Moll. Java, p. 67 (*Melania coarctata*), p. 70, pl. 11, fig. 9 (*M. unifasciata*), p. 71 (*M. inhonesta*), p. 72, pl. 11, fig. 9 (*M. cylindracea*), p. 73, pl. 11, fig. 6, 7 (*M. tuberculata*, incl. fa *virgulata* and fa *plicifera*).

1859. REEVE, Conch. Icon. 12, pl. 5, fig. 22 (*Melania coarctata*), pl. 13, fig. 87, pl. 16, fig. 110 (*M. tuberculata*), pl. 16, fig. 109 (*M. virgulata*), pl. 17, fig. 120 (*M. crepidinata*), pl. 21, fig. 146 (*M. ornata*), pl. 33, fig. 226 (*M. inhonesta*).
1859. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 18, p. 424 (*Melania coarctata*).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 319 (*Melania unifasciata, inhonesta, cylindrica* (sic!), *tuberculata*).
1870. BROU, Americ. Journ. Conch. 6, no. 200 (*Melania javanica*).
1872. BROU, Matér. Mélaniens, 3, p. 22, pl. 1, fig. 13 (*Melania truncatula*).
1874. BROU, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 173, pl. 21, fig. 2 (*Melania ornata*), p. 180, pl. 21, fig. 6 (*M. moesta*), p. 206, pl. 23, fig. 8 (*M. inhonesta*), p. 238, pl. 25, fig. 13 (*M. crepidinata*), p. 246, pl. 26, fig. 7 (*M. javanica*), p. 247, pl. 26, fig. 11 (*M. tuberculata*), p. 252, pl. 26, fig. 10 (*M. cylindracea*), p. 262, pl. 27, fig. 7 (*M. unifasciata*), p. 254, pl. 27, fig. 5 (*M. parreyssi*), p. 253, pl. 26, fig. 5 (*M. malayana*).
1874. ISSEL, Ann. Mus. Civ. St. Nat. Genova, 6, p. 463 (*Melania tuberculata* var. *malayana*).
1874. TAPPARONE CANEFRI, Mem. Reale Accad. Sci. Torino (2) 28, p. 44 (*Melania javanica*).
1884. NEVILL, Hand List Moll. Ind. Mus. 2, p. 232 (*Melania cylindracea*), p. 235 (*M. unifasciata*), p. 241 (*M. tuberculata* var. *plicifera*), p. 247 (*M. rivularis*).
1887. MARTIN, Samml. Geol. Reichsmus. Leiden (1) 3, p. 157 and 324 (*Melania tuberculata*).
1888. TENISON WOODS, Proc. Linn. Soc. N. S. W. (2) 3, p. 1082 (*Melania ornata, inhonesta* and *crepidinata*), p. 1083 (*M. javanica, tuberculata, cylindracea, parreyssi* and *unifasciata*).
1890. BOETTGER, Ber. Senckenb. p. 152 (*Melania tuberculata* incl. var. *parreyssi* and var. *malayana*).
1891. BOETTGER, Ber. Senckenb. p. 246 (*Melania tuberculata* and var. *parreyssi*), p. 247 (*M. malayana* and *M. inhonesta*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 43 (*Melania javanica*), p. 56, pl. 4, fig. 1-4 (*M. crepidinata, M. tuberculata* incl. vars. *plicifera, virgulata, seminuda, angularis, truncatula*), p. 60 (*M. cylindracea*).
1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 256 (*Melania amabilis, M. moesta*), p. 258 (*M. crepidinata*), p. 259 (*M. tuberculata, M. cylindracea, M. pyramis*), p. 257 (*M. societatis*).
1905. MARTIN, Samml. Geol. Reichsmus. Leiden (N.F.) 1, p. 234 and 238 (*Melania tuberculata*), p. 234 and 239, pl. 36, fig. 567-570 (*M. woodwardi*).
1907. MARTIN, N. Jahrb. Mineral. 100, II, p. 160 (*Melania tuberculata*).
1911. MARTIN-ICKE, Pithecanthr. Schichten Java, p. 50 (*Melania tuberculata*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 218 (*Melania tuberculata* var. *plicifera*), p. 253 (*M. javanica, M. coarctata* and *M. ornata*), p. 254 (*M. crepidinata, M. cylindracea, M. inhonesta, M. parreyssi, M. tuberculata* with var. *malayana*), p. 255 (*M. tuberculata* incl. vars. *parreyssi, plicifera, seminuda, truncatula* and *virgulata, M. unifasciata*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 96 (*Melania tuberculata* and *M. woodwardi*).
1921. PARAVICINI, Trop. Natuur, 10, p. 150, fig. 7 and 8 (*Melania tuberculata*).

1923. OOSTINGH, Meded. Landb. Hooges. Vol. 26, Part 3, p. 44 (*Melanoides crepidinata* and *M. tuberculata*).
1925. VAN BENTHEM JUTTING, Treubia, 6, p. 144 (*Melania tuberculata* and var. *seminuda*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 84-85 (*Melania javanica*, *coarctata*, *rivularis*, *ornata*, *crepidinata*, *cylindracea*, *inhonesta*, *parreyssi*, *tuberculata* incl. vars. *malayana*, *plificera*, *seminuda*, *truncatula*, *virgulata*, and *M. unifasciata*).
1931. VAN ES, Age of Pithecanthropus, p. 52 and 136 (*Melania tuberculata*).
1931. VAN DER VLERK, Leidsche Geol. Meded. 5, p. 255 (*Melania tuberculata* and *M. woodwardi*).
1932. VAN BENTHEM JUTTING, Treubia, 14, p. 103 (*Melania tuberculata*).
- 1934a. RENSCH, Zool. Jahrb. (Syst.) 65, p. 400, fig. 2a-e (*Melania tuberculata truncatula*).
- 1934b. RENSCH, Trop. Binnengew. 5, p. 228 (*Melania tuberculata truncatula*).
1935. OOSTINGH, Wetensch. Meded. Dienst Mijnb. Ned. Ind. 26, p. 13 (*Melanoides tuberculata*), p. 17 (*M. woodwardi*).
1935. PARAVICINI, Arch. Moll. Kunde, 67, p. 175 (*Melania tuberculata* and *M. unifasciata*).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 129 (*Thiara tuberculata*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 282 (*Thiara tuberculata*).
1948. DAMMERMAN, Fauna of Krakatau, 1883-1933, p. 519 (*Thiara tuberculata*).
1949. SCHUSTER, Public. Onderafd. Binnenvisserij, 2, p. 198 (*Thiara tuberculata*).
1951. THIENEMANN, Arch. Hydrobiol. Suppl. Bd 19, p. 535 (*Melania tuberculata* and *M. tuberc. truncatula*), p. 541 (*M. tuberc. truncatula*).
1952. MERMOD, Rev. Suisse Zool. 59, p. 76, fig. 139 (*Melania truncatula*).
1953. BUTOT, Trop. Natuur, 33, p. 30 (*Thiara tuberculata truncatula*).

Shell turreted, with high spire and moderately large last whorl. Straw-yellow or olive, or yellowish-brown, with darker red-brown dots and flames, either irregularly distributed over the shell surface, or arranged in longitudinal or vertical rows. A common colour arrangement is a row of brown dots along the suture. Most specimens possess a spiral band of the same colour in the umbilical region. Now and then shells with 3 brown spiral bands (one below the suture, one in the peripheral and one in the umbilical region) occur among the one-banded and mottled shells.

Sculptured by spiral striae, well raised in the upper whorls of the spire, but flatter in the later ones. This sculpture is crossed by vertical striae which can even be developed as coarse, sometimes undulating ribs. Young shells transparent and shining. Adult ones more opaque and with little or no lustre. The whole shell is often coated with black or ferruginous foreign material.

Whorls 10-15, regularly increasing in diameter, the initial whorls convex, the later ones more flattened. Top whorls often eroded or decolated. Suture distinct. At a little distance below the suture the shell can

be somewhat "shouldered". Periphery rounded in adult shells, but a little angular in immature ones. Top sharp, base rounded. Umbilicus closed.

Aperture almost vertical, oval, pointed above, rounded below. Peristome not continuous, the two ends connected by a thin callus against the previous whorl. Exterior margin sinuous, protruding in the middle, receding in top and basal region.

Operculum horny, blackish-brown. Nucleus excentrical, in the left lower corner. The growth striae of the nucleus spread in a short spiral in vertical and lateral directions.

Dimensions: height 30-35, width 10-12, height of aperture 8-10 mm.

Distribution: North Africa, Asia Minor, Iran, India, Burma, Southern China, Malay Peninsula, Malay Archipelago, North Australia, various Pacific islands.

Habitat in Java: generally found in fresh water, but occasionally in brackish water. *Melanoides tuberculata* does not even avoid hot springs (temp. 35°C), or iodine springs. It prefers slowly running water, but can also live in stagnant, even polluted water. In Java the highest station in the mountains where *M. tuberculata* has been found is 1600 m at Mt Malabar.

West Java: Udjong Kulon; Pardana; Tjiringhin (MOUSSON, 1849); Anjer; between Antjol and Djakarta; Djakarta; River Tanabang in Djakarta; River Tjiliwung near Djakarta; fish ponds at Pekulitan, near Djakarta; kali along the road from Djakarta to Tandjong Priok; Meester Cornelis; Krawang; Purwakarta, in pond and stream; Depok, in streamlet; Depok, in sawah; Tjiburial near Bogor, in prise d'eau of Bogor water board; Telaga Gadok, near Bogor; estate of Tjiomas near Bogor; Tjiseëng, sawahs near the sulphur springs; Mt Tjibodas, estate of Tjampea near Bogor; Kuripan (RENSCH, 1934b); River Tjiliwung near Bogor; ponds in the Botanical Gardens at Bogor; estate of Tjisarua near Bogor; near Puntjak pass, S of Bogor; Sindanglaja; Tjipanas; small source near palace at Tjipanas; Lake Tjigombong (RENSCH, 1934b); Sukabumi; sawahs along Wijnkoopsbay, near Tjisolok; Tjitarik; Wangun, near Tjisampora, district of Lengkong; Tjiandjur; shallow cistern near Tjiandjur, running water; between Tjugenang and Tjiandjur; Mt Masigit, near Padalarang; River Tjimahi between Lagador and Kapek; Mt Patuha, mountain-streams and sawahs, in luke warm water; Tjibeureum on Mt Tilu; along the road from Tjimindi to Leuwigadja, in streamlet; rice fields near Bandung; Bandung, on rock near Dago waterfall; sawahs between Bandung and Lembang; from water flowing over rock covered with algae, between Bandung and Lembang; Mt Tangkuban Prah; rice

fields and fish ponds along road of Bandung to Garut; lakes in Engelsche Vlake near Garut; Tjipanas near Garut; Lake of Leles, between Bandung and Garut; Situ Bagendit; Lake of Pendjalu; Mt Malabar; Pengalengan, in sawah; Pameungpeuk; Mt Tjikorai; Tjikungan near Tjikadjang; estate of Bandjarwangi near Tjikadjang; sawahs between the mountains along the road from Garut to Tasikmalaja; under stones on sawah near Tasikmalaja; Tjiamis, on stone in slowly running stream; River Tjipelang, near Udjungdjaja, district of Sumedang; rice fields along road from Sumedang to Bandung; Tjisaaranang near kampong Tjariang, district of Sumedang; Kartawinangun near Madjalengka; Cheribon; irrigation ditch near Kadipaten; irrigation ditches on estate Pangandaran near Dirk de Vriesbay.

Central Java: Tjomal, near spirit factory; Pekalongan; Kedungwuni, in sawah; River Senengkaran, near Kedungwuni; sawahs near Penawangan, district of Semarang; Sron dol, S of Semarang; Lake of Mendjer, near Wonosobo; Magelang; Kali Lerang, near Kebumen; Parangtritis; Karang Putjong; Rembang; Kali Besèk, near Sulang, S of Rembang.

East Java: River Soko, right tributary river of Kali Solo, near Trinil; Lake Pasir, near Sarangan (RENSCH, 1934b); Telaga Urung, near Sarangan; Patjitan; Lake of Ngebel; Tuban; Surabaja; Sukalelo near Surabaja; Kediri; waduk of sumber Kepu, N. N. W. of Kertosono; iodine fields between Surabaja and Pasuruan; Banju Biru near Pasuruan (MARTENS, 1897); Prigen, on Mt Ardjuno; Lawang; Malang; River Brantas near Malang; Puntèn near Malang (RENSCH, 1934b); Mt Batu near Malang, in mountain ponds; Tengger Mts; Ranu Klakah; Ranu Bedali; Ranu Pakis; Ranu Klindungan; Djember, in ponds, sawahs and stream; Kali Mrawan; stalactite formations near Sempol; Sumber Hongko; Kalisat, Idjen plateau; Kalisèngon, Idjen plateau; Djeding, in hot fresh water, Idjen plateau; outflow of the crater, Idjen plateau; Besuki; Badjulmati; Banjuwangi; Rogodjampi.

Melanoides tuberculata has also been found in the islands of Sebesi, Verlaten Island, Amsterdam, Kerkhof, Schiedam, Karimon Djawa, Pulu Besar, Bawean, Madura and Nusa Kambangan off the coast of Java.

Fossil records of this species are extremely scarce, and mostly of Pleistocene or younger date. Interesting is the fossil occurrence in the Balearic Islands and in Sicily where *Melanoides tuberculata* is extinct nowadays.

In Java fossil specimens are recorded from Pliocene and Pleistocene layers in Central and East Java: MARTIN (1887, 1905, 1907, 1919), MARTIN-ICKE (1911), VAN ES (1931), VAN DER VLERK (1931), OOSTINGH (1935),

VAN BENTHEM JUTTING (1937). VAN ES (1931, p. 52) reported even a Miocene age for this species. It is remarkable that *M. tuberculata* is not nearly so numerous in fossil layers as it is in the recent fauna. In a prehistoric cave in Central Java (VAN BENTHEM JUTTING, 1932, p. 103) some shells were excavated from kitchen middens.

Observations in aquaria have demonstrated that *Melanoides tuberculata* shows negative phototaxis. By day time the snails hide away under leaves or bottom detritus, or in the sand. In the evening and at night they come out.

Food consists of green algae and organic waste matter. Carrion, e.g. a dead fish, attracts *M. tuberculata* from all corners of the aquarium. When very hungry they even attack live *Tubifex*.

Propagation is extremely rapid in a tropical aquarium. The offspring from 10 individuals amounted to about 1500 snails in somewhat more than one year.

Females are ovo-viviparous. From an animal of 25 mm height (spire decollated) collected at Gadok, near Bogor, November 1930, I prepared 15 young ones, length between $\frac{1}{2}$ and 4.4 mm. SARASIN & SARASIN (1899, p. 42) reported of 19 embryos (length of mother not stated) in *Melanoides tuberculata* var. *turricula* from Celebes.

The two initial whorls of the apex are smooth, the third and fourth whorls bear 2-4, the fifth and sixth whorls 4-8 spiral keels. After this the number of spiral ridges increases till about 10-15, sometimes more, sometimes less. In the later whorls the ridges are flatter than on the topmost whorls. Sometimes strong and weak ridges alternate.

The spiral ridges are crossed by finer vertical striae, rendering the sculpture a reticulate appearance. As has been already remarked strong axial ribs occasionally occur, either straight or sinuous. A curious fact is that *Melanoides tuberculata* can be vertically ribbed in the middle portion of the shell and be entirely smooth in the lower whorls. The top whorls, usually 6-8 in all, are almost invariably sculptured with spiral keels as described above.

As we have seen *M. tuberculata* is widely distributed from North Africa, through tropical Asia to the Malay Archipelago, Australia and various Pacific islands. Within such an immense territory local forms have developed. The more such populations become isolated the more they acquire distinctive features. As in other species of Melaniids this has led collectors and authors to discriminate a profusion of "species", "subspecies", "varieties", "modifications", etc. which -on critical examination- cannot stand as distinct forms. One of the chief difficulties in determining

the present species is the passing from one pattern of sculpture into another on one and the same shell. In this way a shell can be sculptured as e.g. *malayana* ISSEL in the upper and middle whorls, but look like *semi-nuda* MARTENS in the lower ones. Or, a shell with *truncatula* features in the upper whorls merges into *unifasciata* in the lower ones. Only the first 6-8 top whorls bear the original *tuberculata* sculpture. Consequently these whorls represent the principal characteristics for discrimination, but unfortunately they are often eroded or broken. At any rate there is always a tendency to smooth the sculpture with advancing age.

I cannot quite understand the meaning of the classification into 4 groups which RENSCH (1934a, p. 400) proposed for *Melanoides tuberculata*. Not only a greater number of variants occur in the area of distribution, and more particularly in the island of Java, but, as I pointed out above, more than one pattern of sculpture can occur in one individual. This would lead to the absurdity that the older whorls of the spire belong to one group, but the later ones to another. As this does not seem a sound base for subspecific classification, only a neutral term, as form, race, modification, can be employed for denoting occasional variants which may form more or less pure local populations, but which, genetically, belong to the relationship of *Melanoides tuberculata*.

Melanoides punctata (LAMARCK, 1822) (fig. 93).

1822. LAMARCK, Hist. Nat. Anim. s. Vert. Vol. 6, Part 2, p. 165 (*Melania punctata*, *M. clavus* and *M. laevigata*).
1850. LEA, Proc. Zool. Soc. London, p. 181 (*Melania sobria*).
1857. MOUSSON, Journ. de Conch. 6, p. 162 (*Melania monile*).
1859. REEVE, Conch. Icon. 12, pl. 7, fig. 32 (*Melania sobria*), pl. 7, fig. 34 and Errata (*M. mindoroensis* syn. *litigiosa*), pl. 17, fig. 121 (*M. tristis*).
1860. BROT, Rev. et Mag. Zool. p. 258, pl. 16, fig. 4 (*Melania litigiosa*), p. 259, pl. 16, fig. 5 (*M. semiornata*).
1872. BROT, Matér. Mélaniens, 3, p. 11, pl. 1, fig. 14 (*Melania punctata*), p. 14, pl. 1, fig. 8-9 (*M. laevigata*), p. 15, pl. 1, fig. 17 (*M. clavus*).
1874. BROT, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 159, pl. 19, fig. 10 (*Melania semiornata*), p. 168, pl. 20, fig. 4, 4a (*M. punctata*), p. 170, pl. 20, fig. 5 (*M. litigiosa*), p. 171, pl. 20, fig. 9 (*M. laevigata*), p. 173, pl. 20, fig. 7 (*M. monila*), p. 175, pl. 21, fig. 17 (*M. clavus*), p. 178, pl. 21, fig. 5 (*M. sobria*).
1888. TENISON WOODS, Proc. Linn. Soc. N. S. W. (2) 3, p. 1081 (*Melania semiornata* and *monile*), p. 1082 (*M. tristis*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 44 (*Melania monile*), p. 46, pl. 3, fig. 8 (*M. semiornata*), p. 48 (*M. litigiosa*), p. 49, pl. 3, fig. 14-15 (*M. laevigata*), p. 50, pl. 3, fig. 11 (*M. clavus*).

1899. HORST & SCHERMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 254 (*Melania semiornata*), p. 255 (*M. laevigata* and *M. sobria*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 253 (*Melania monile*), p. 254 (*M. tristis* and *M. semiornata*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 84 (*Melania tristis, semiornata, laevigata* and *monile*).
- 1934a. RENSCH, Zool. Jahrb. (Syst.) 65, p. 411 (*Melania punctata*), p. 415 (*M. clavus*).
- 1934b. RENSCH, Trop. Binnengew. 5, p. 239 (*Melania clavus*).
1941. VAN BENTHEM JUTTING, Arch. néerl.-Zool. 5, p. 282 (*Thiara punctata*).
1952. MERMOD, Rev. Suisse Zool. 59, p. 67, fig. 129 (*Melania punctata*), p. 70, fig. 132 (*M. laevigata*), p. 70, fig. 133 (*M. clavus*).

Shell turreted with high-pointed spire and rather flat whorls. Straw-yellow, greenish-yellow or brownish, generally with darker brown flames and spots, at one time spirally, at another vertically arranged. Initial whorls smooth, following ones (about 9 whorls) also smooth or vertically ribbed with distantly placed ribs which are almost as wide as the intervals between them. The later whorls are smooth again, or very weakly striated. Rather thin, somewhat shining.

Whorls 14-16, regularly increasing in size, and little convex. Hence the suture is not deep. Periphery rounded, or bluntly angulate in immature shells. Top sharp, base rounded, umbilicus closed.

Aperture vertical, pear-shaped, pointed above and rounded below. Peristome not continuous, the two ends connected by a thin callus against the previous whorl. Exterior margin sharp, little or not sinuous. Basal margin somewhat channelled.

Operculum horny, pear-shaped to oval. Nucleus excentric, at the lower left corner. The growth lines of the operculum are arranged fan-like round the nucleus.

Dimensions: height 28-34, width 8-13, height of aperture 8-12 mm.

Distribution: Malay Peninsula, several Malaysian islands, Philippines, New Guinea, New Britain.

Habitat in Java: fresh water, either running or stagnant, streams, sawahs, fish ponds.

West Java: Tji Pasauran in Bantam; Tjikalong; Sukabumi; Tjiantjur (RENSCH, 1934b); fish ponds along the road from Bandung to Garut.

Central Java: Pekalongan; Tjilatjap; Kali Lerang near Kebumen; Parangtritis.

East Java: streamlet near Nglirip, Bodjonegoro; Southern Mountains; Malang; between Bangil and Situbondo; Donomolia, W of P. Sempu, S coast of East Java; Ranu Klindungan; Ranu Klakah; great waterfall near Ranu Bedali (RENSCH, 1934b); Besuki.

Melanoides punctata has also been recorded from the islands of Madura and Nusa Kambangan, close to the coast of Java (VAN BENTHEM JUTTING, 1941).

A somewhat dubious shell is *M. tristis* REEVE of which I studied the holotype (Java, Mus. Cuming) from the British Museum. It is high 39 and wide 12½ mm, with an aperture of 13½ mm height. As REEVE (1859) already pointed out it lacks any striation or plication. Only in the umbilical region three shallow grooves are visible. Through the serious corrugation of the spire no trace of embryonic sculpture is visible. I place it tentatively under *M. punctata*.

Melania trifasciata BOETTGER, mentioned by RENSCH (1934b) is a nomen nudum. As I could check in the Senckenberg Museum, where the type material of *Melania trifasciata* is preserved, this species is a synonym of *M. punctata*. The colour bands are somewhat more clear than is usual in *punctata* shells.

Melanoides plicaria (BORN, 1780) (fig. 94).

1780. BORN, Test. Mus. Caes. Vindob. p. 389, pl. 16, fig. 14 (*Helix plicaria*).
 1822. LAMARCK, Hist. Nat. Anim. s. Vert. Vol. 6, Part 2, p. 165 (*Melania corrugata*).
 1834. QUOY & GAIMARD, Voy. Astrolabe, Zool. 3, p. 155, pl. 56, fig. 34-37 (*Melania costata*).
 1844. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1, *Melania*, p. 160, pl. 3, fig. 3 (*Melania anthracina*).
 1850. LEA, Proc. Zool. Soc. London, p. 189 (*Melania hastula*).
 1858. VON DEM BUSCH, Malak. Blätt. 5, p. 33 (*Melania acutissima*).
 1859. REEVE, Conch. Icon. 12, pl. 4, fig. 17 (*Melania anthracina*), pl. 6, fig. 28, 29 (*M. costata*), pl. 10, fig. 57, 58 (*M. acutissima*).
 1874. BROT, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 127, pl. 15, fig. 9 (*Melania corrugata*), p. 127, pl. 15, fig. 10, 10a (*M. anthracina*), p. 129, pl. 16, fig. 2, 2a (*M. acutissima*), p. 129, pl. 16, fig. 3, 3a-d (*M. hastula*), p. 134, pl. 16, fig. 6, 6a (*M. perplicata*).
 1888. TENISON WOODS, Proc. Linn. Soc. N. S. W. (2) 3, p. 1081 (*Melania anthracina*).
 1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 41 (*Melania plicaria*), p. 42, pl. 3, fig. 1, 2 (*M. acutissima*).
 1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 252 (*Melania anthracina, acutissima*), p. 253 (*M. hastula*), p. 254 (*M. cincta*).
 1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 252 (*Melania acutissima*), p. 253 (*M. plicaria, M. anthracina*).
 1929. VAN BENTHEM JUTTING, Treubia, 11, p. 84 (*Melania plicaria, M. acutissima, M. anthracina*).
 1934. RENSCH, Zool. Jahrb. (Syst.) 65, p. 413 (*Melania plicaria*).
 1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 281 (*Thiara plicaria*).

Shell long and slender, with numerous rather flat whorls, the last one high, but not inflated. Spire sometimes a little concave. Corneous-olive

to olive-brown, rather fragile and transparent, especially in young specimens. Often with brown spots along the suture, or somewhat more elaborately coloured with vertical brown streaks and flames. Initial whorls (about 9) spirally striated with 9-12 elevated lirae. The 3-4 following whorls with strong vertical ribs and fine spiral threads, the later whorls generally smooth, or with a few spiral striae which are more elevated below the periphery than above it.

Whorls 16-18, tapering to a fine, acute apex. Regularly increasing in size. Whorls of the spire little convex. With increasing age the convexity of the whorls augments as an effect of loose-coiling, causing the profile of each whorl to be a little concave below the suture, then convex again. Suture not deep. Periphery rounded. Top acute, base rounded. Umbilicus closed.

Aperture vertical, broad-pyriform, pointed above, rounded below. Peristome not continuous, with a thin callus against the parietal wall. Exterior margin slightly sinuous, protruding in the middle, receding in upper and lower regions. Columellar side twisted and much curved, showing the interior columella from the base.

Operculum unknown, but probably similar to that of other *Melanoides* species.

Dimensions: height 90-100, width 18-19, height of aperture about 23 mm.

Distribution: Malay Archipelago, Philippines, New Guinea, New Britain, Fiji Is.

Habitat in Java: almost nothing is known of the habitat of this species in Java.

West Java: Sukabumi; Palabuanratu; Tjimandiri.

Central Java: Patjitan.

***Melanoides maculata* (BORN, 1780) (fig. 95).**

1780. BORN, Test. Mus. Caes. Vindob. p. 390, pl. 16, fig. 5 (*Helix maculata*).
1842. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 1, Melania, p. 1, pl. 1, fig. 3-4 (*Melania flammulata*), p. 4, pl. 1, fig. 17 (*M. terebra* nec Benson, nec Lesson).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268 (*Melania terebra*, *M. aspirans*).
1849. MOUSSON, Land & Süsw. Moll. Java, p. 68, pl. 11, fig. 5 (*Melania aspirans* non *M. aspirans* Hinds).
1859. REEVE, Conch. Icon. 12, pl. 9, fig. 45 (*Melania flammulata*), pl. 9, fig. 46 (*M. terebra* nec Benson, nec Lesson).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 319 (*Melania aspirans* Mousson non Hinds).
1862. BROT, Matér. Mélaniens, 1, p. 51 (*Melania terebriformis*).
1874. BROT, in: MART-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 135, pl. 16, fig. 7 (*Melania maculata*), p. 144, pl. 18, fig. 1 (*M. terebriformis*).

1888. TENISON WOODS, Proc. Linn. Soc. N. S. W. (2) 3, p. 1081 (*Melania terebriformis*).
 1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 253 (*Melania terebriformis*, *M. subulata*).
 1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 254 (*Melania terebriformis*).
 1929. VAN BENTHEM JUTTING, Treubia, 11, p. 84 (*Melania terebriformis*).

Shell high-turreted, extremely attenuate, with numerous whorls. Light- to dark-brown, somewhat olivaceous, with irregular red-brown spots or vertical zig-zag lines. Finely striated by the growth lines. This sculpture is crossed by numerous regular spiral lines. Some shells are malleated. Suture margined by a somewhat stronger spiral ridge. In some shells the spiral ridges occur just above and below the suture whereas the central region of the whorls is smooth. Rather thick, little or not transparent, with soft lustre.

Whorls about 18-20 in complete shells, but the top whorls are mostly eroded or broken. Regularly increasing in size, with nearly flat sides and little incised suture. Periphery of last whorl slightly angular in immature shells, but rounded in full grown ones. Top pointed and sharp, base rounded. Umbilicus closed.

Aperture nearly vertical, pyriform, pointed above, rounded below. Peristome not continuous, the two ends connected by a white callus against the parietal side.

Operculum corneous, with excentric nucleus in the left basal corner. From this nucleus the growth lines of the operculum spread to the top and the exterior margin.

Dimensions: height 65-70, width 15-18, height of aperture 16-19 mm.

Distribution: Java and several Moluccan islands.

Habitat in Java: no details on the habitat are available.

West Java: Tjiringhin (MOUSSON, 1849); Tjitjurug; Tjitarik.

Melanoides maculata can be confounded with *M. plicaria* and *M. torulosa*. From the former it differs in the absence of vertical folds on the spire and by the weaker sculpture. From *M. torulosa* it differs in having a more slender spire, with more acute apex, and in missing the granular sculpture which — in *M. torulosa* — is most conspicuous just below the suture.

BROT (1874, p. 141) was the first to suggest that *Melania aspirans* MOUSSON (MOUSSON, 1849, p. 68) was not the same species as *M. aspirans* HINDS, but a synonym of *M. maculata* (= *M. flammulata*). In the MOUSSON collection there is no sample of *M. aspirans*, *maculata* or *flammulata* from Tjiringhin.

Melanoides rustica (MOUSSON, 1857) (fig. 96).

1857. MOUSSON, Journ. de Conch. 6, p. 160 (*Melania rustica* incl. var. *obscure-fusca* and *M. digitalis*).
1859. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 18, p. 424 (*Melania rustica*), p. 425 (*M. digitalis*).
1868. BROU, Matér. Mélaniens, 2, p. 16, pl. 2, fig. 11 (*Melania rustica*).
1874. BROU, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 138, pl. 17, fig. 2, 2a-b (*Melania rustica*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 44, pl. 4, fig. 22-23 (*Melania rustica*).
1899. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 255 (*Melania digitalis*).
1905. MARTIN, Samml. Geol. Reichsmus. Leiden (N.F.) 1, p. 234 and 235, pl. 36, fig. 556, 557 (*Melania sondeiana*).
1907. MARTIN, N. Jahrb. Mineral. 100, II, p. 160 (*Melania sondeiana*).
1911. MARTIN-ICKE, Pithecanthr. Schichten Java, p. 47 (*Melania sondeiana*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 253 (*Melania rustica*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 96 (*Melania sondeiana*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 84 (*Melania rustica*).
1931. VAN DER VLERK, Leidsche Geol. Meded. 5, p. 255 (*Melania sondeiana*).
1934. RENSCH, Zool. Jahrb. (Syst.) 65, p. 414 (*Melania rustica*).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 126 (*Thiara rustica*).

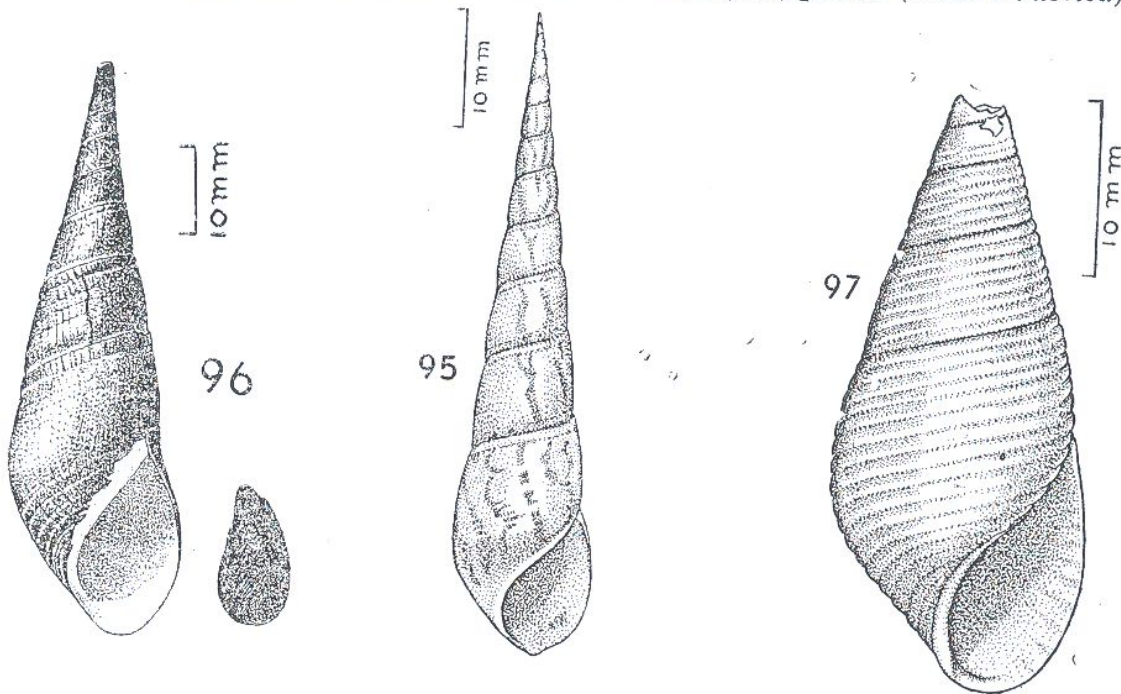


Fig. 95. *Melanoides maculata* (BORN). Shell. J. MASTRO del.

Fig. 96. *Melanoides rustica* (MOUSS.). Shell and operculum. ABDULKADIR del.

Fig. 97. *Melanoides artecara* (MOUSS.). Shell. J. MASTRO del.

Shell solid, turreted, with high spire and broad last whorl. Dark-olive or dark-brown, covered by a black epidermis. With irregular spiral

lines which can be evenly distributed over the whole whorl, but which are sometimes only visible in the upper and lower regions of the whorl leaving the central part smooth. In the umbilical region the spirals are always stronger, appearing as distinct ribs. The 7-8 top whorls can be provided with narrowly placed axial ribs. These oldest whorls have also a lighter ground colour with dark-brown spots, flames or zig-zag stripes. Not transparent and with little lustre.

Whorls 10-15, regularly increasing in size, little convex. In large-sized shells the lowest whorls can be concave below the suture, then convex again, causing a more or less conspicuous angle in the transition zone. Another, still weaker, spiral angle can occur lower down on the whorl. Periphery rounded. Suture little oblique, rather superficial, margined. Top mostly eroded, base rounded. Umbilicus closed.

Aperture subvertical, oval, with round basal side and pointed top. Peristome not continuous, the two ends connected by a white callus which can be very thick in old individuals. Exterior margin evenly rounded, or with an obtuse angle at the spot where the concave part of the whorl changes into the convex part. Columellar margin deeply excavated.

Operculum corneous, black. With excentric nucleus at the lower left corner. From this nucleus the growth lines of the operculum spread over the surface to the tip and to the exterior margin.

Dimensions: height 70-80, in exceptional cases as high as 92 mm, width 22-26, height of aperture 24-28 mm.

Distribution: Sumatra, Java, Bali, Sumbawa, Sumba, Flores.

Habitat in Java: almost nothing is known of the habitat of this species in Java.

West Java: Sukabumi; Tjimandiri.

Central Java: Tjilatjap.

East Java: Besuki (MARTENS, 1897); Banjuwangi; Rogodjampi (MARTENS, 1897).

In a fossil state *Melanoides rustica* has been recorded from Upper Pliocene layers at Sonde and vicinity (East Java) (MARTIN, 1905, 1907, 1919; MARTIN-ICKE, 1911; VAN DER VLERK, 1931; VAN BENTHEM JUTTING, 1937).

Melanoides rustica is a species of somewhat uncertain position among the Javanese Melaniids because it has few constant and reliable characteristics. Especially the embryonic whorls are imperfectly known. Without these, and without more material of various ages and from more localities, it is not possible to obtain a clear picture of this problematic species.

Very large and thick shells were named by MOUSSON *Melania rustica* var. *obscure-fusca*. They have distinct spiral lirae in the basal region, a thickened columellar margin and a concavely retracted basal margin.

In consequence of its highly turreted spire and its infrasutural concave region of the lower whorls, *Melanoides rustica* can be confounded with *M. funiculus* QUOY & GAIMARD. In the latter species, however, the aperture is differently shaped, especially the columellar region which is more excavated in *M. funiculus*, with a peculiar ridge separating the black base of the whorl and the white, callous columella.

Another species which has some superficial likeness with some forms of *Melanoides rustica*, is *M. punctata*. In this species, however, the oldest whorls have better developed vertical ribs. Besides, the whorls are generally more convex, with deeper, more oblique suture than in *M. rustica*.

***Melanoides artecava* (MOUSSON, 1857) (fig. 97).**

1857. MOUSSON, Journ. de Conch. 6, p. 161 (*Melania arcte-cava*).
 1859. REEVE, Conch. Icon. 12, pl. 12, fig. 71 (*Melania arcticava*).
 1859. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 18, p. 425 (*Melania contecava* sic!).
 1874. BROT, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 24, p. 165, pl. 20, fig. 1, 1a, b (*Melania arctè-cava*).
 1888. TENISON WOODS, Proc. Linn. Soc. N. S. W. (2) 3, p. 1081 (*Melania arcte-cava*).
 1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 253 (*Melania artecava*).
 1929. VAN BENTHEM JUTTING, Treubia, 11, p. 84 (*Melania artecava*).

Shell solid, turreted, with high spire and broad last whorl. Dark-olive or dark-brown, covered by a black epidermis. Ornated with reddish-brown spots on the spiral ribs. These spots are arranged in vertical series. Not transparent and with hardly any lustre. Spirally ribbed, with well-defined, somewhat pinched, ridges. They are especially distinct on the last three whorls; the previous ones are almost smooth, with thread-like spiral grooves. On the last whorl there are about 8-9 ridges above the periphery, and some 15 below it. In the umbilical region the spirals are more closely set and finer. This sculpture can be crossed above the periphery only by strong axial ribs or folds. The crossing of the two systems renders the shell a nodulous appearance, reminding of *Melanoides granifera*. In very old shells the entire sculpture can become evanescent, remains being only preserved at suture and base.

Whorls 5-6 (top eroded!), little convex, hence the suture is not deep. Periphery rounded. Umbilicus closed. Top generally eroded, base rounded.

Aperture almost vertical, oval, with rounded base and pointed top. Interior bluish-grey. Peristome not continuous, the two ends connected by a grey-white callus against the penultimate whorl. Exterior margin

crenulated by the spiral ridges. Columellar side almost straight, not sinuous.

Operculum corneous, black, oval, with rounded base and pointed top. Nucleus excentric near the base.

Dimensions: height 26-43 (eroded shells!), width 10-17, height of aperture 10-21 mm. MOUSSON (1857, p. 161) mentioned a height of 58 mm for a complete specimen.

Distribution: Java.

Habitat in Java: seems to live in running fresh water, the only record in which a habitat is mentioned being a river near Bomo.

West Java: Palabuanratu.

East Java: Badjulmati; river near Bomo.

Just as the preceding species, *Melanoides arctecava* takes a somewhat uncertain position in the family Thiaridae. Unless more material becomes available, especially shells with well preserved embryonic whorls, *M. arctecava* remains a problematic species.

The species is generally badly understood by most authors. In collections I saw various shells under this name which belonged, in fact, to other species. Hence is it recommendable to be extremely careful with the records in literature, as it is not certain that these quotations really refer to *Melanoides arctecava*. The references quoted at the head of this paragraph have all been checked by me.

M. arctecava can be easily confounded with *M. punctata* (LAM.), *M. granifera* (LAM.) and *M. torulosa* (BRUG.). From the former it differs in having a coarser sculpture with the spiral ridges more pinched. From *M. granifera* it differs in having flatter whorls and often missing the vertical ridges, from *M. torulosa* in lacking the strengthened nodulous ridge along the suture and in having a less excavated columellar side of the peristome.

Dubious species of *Melania* from Java

VAN HASSELT (1823, Alg. Konst- en Letterbode, 2, p. 246) mentioned two indeterminable species: *Melania mutabilis* and *M. granulata* from Java.

In 1849 MOUSSON (p. 116, pl. 22, fig. 5) described and figured *Melania perfecta* from brooks near Maros, Southern Celebes. In later years this species has now and then been mentioned from Java: REEVE, 1859, Conch. Icon. 12, pl. 13, fig. 84; HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 2, p. 250. These records are either based

on erroneous identifications, or on incorrect locality labels, because *M. perfecta* is not indigenous in Java.

ZOLLINGER (1859, *Natuurk. Tijdschr. Ned. Ind.* 18, p. 424) mentioned "*Melania* (?) *impura* Mouss." from Java. It is impossible to ascertain which species he can have meant, MOUSSON never described a *Melania impura*. There is a *Melania impura* LEA, but this species has been found in the Philippines.

In 1896 SCHEPMAN (*Notes Leyden Museum*, 18, p. 138, pl. 2, fig. 5 and 6) described *Melania mülleri* and *M. subpunctata* from Java. The systematic position of both is uncertain. As the embryonic whorls are missing in all specimens it is impossible to classify these two species.

Moreover the locality "Java" seems doubtful. Whether the localities Borneo (both species) and Moluccas (*M. mülleri*) are more reliable I am unable to say. No new material of either species has been collected in recent years. Therefore we have to await further evidence before a definite opinion can be given.

Familia POTAMIDIDAE.

Shell high-conical to turreted, with many whorls. Thick, most species coarsely sculptured by ribs and nodules. Some genera possess spiral ridges along the columella in the interior of the shell. Compared with the spire the aperture is small. Lower margin of aperture sinuous, forming a short siphonal canal.

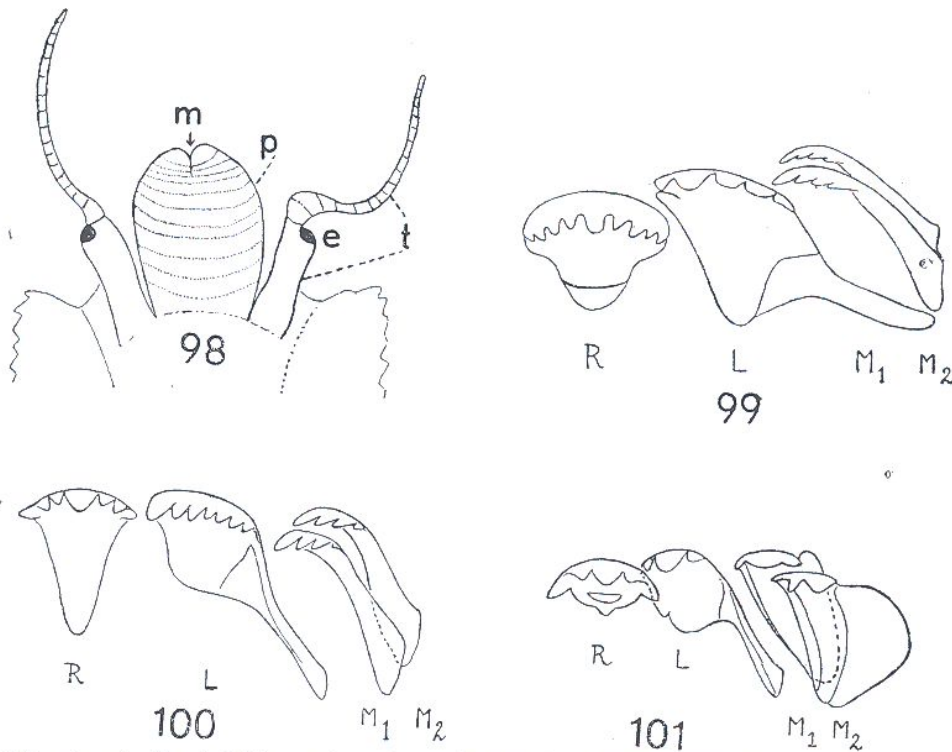
Operculum corneous, circular with central nucleus and many narrow whorls.

Animal with one pair of tentacles. The base of the tentacles is thick, the distal end abruptly narrowing (fig. 98). Radula 2.1.1.1.2 (fig. 99). The sexes are separate.

Distribution: subtropical and tropical regions of all continents, living in the tidal region, in brackish estuaries, fish ponds etc.

Key to the genera living in Java:

1. Spiral ridge (or ridges) along columella present (in *Terebralia* not visible from the exterior!) 2
- Spiral ridges along columella absent **Cerithidea**
2. Spire with many narrow whorls; only spiral sculpture present. **Telescopium**
- Spire with broader whorls; axial sculpture dominant, spiral sculpture finer **Terebralia**



- Fig. 98. Head of *Cerithidea cingulata* (GMEL.), showing proboscis (p), mouth (m), tentacle (t) consisting of a broad base and a flagellum-shaped distal part, eye (e). Author del.
- Fig. 99. *Cerithidea cingulata* (GMEL.). Radula elements. Author del.
- Fig. 100. *Telescopium telescopium* (L.). Radula elements. Author del.
- Fig. 101. *Terebralia sulcata* (BORN). Radula elements (after TROSCHERL).

Many species of this family, especially the large ones, were eaten by the native inhabitants of the Malay Archipelago in prehistoric times. Traces of this diet are found nowadays in kitchen middens, often far inland (HENGEVELD, 1920, Meded. Rapp. Dept. B.O.W., Verschill. onderwerpen no. 1; VAN BENTHEM JUTTING, 1939, Treubia, 17, p. 2; Id. 1940, Nova Guinea (N.S.) 4, p. 14, 20).

Genus *Cerithidea* SWAINSON, 1840.

Shell high-conical, with many whorls. Thick, sculptured by axial and spiral ridges. In some species the two systems are of about equal strength, forming regular nodules, in other species the vertical ribs dominate. Last whorl usually with a thick varix. Base with spiral ridges only. There are no internal ridges along the columella.

Aperture relatively small, rounded or broad oval, at the base ending in a short siphonal canal. Peristome not continuous. Outer margin thickened, often sinuous and expanded.

Operculum circular, horny, with many concentric whorls round a central nucleus.

Distribution: brackish coasts along Indian and Pacific Oceans in muddy creeks, mangrove belts and in brackish fish ponds.

In Java there are 6 species:

- | | |
|--|----------------------|
| 1. Whorls with spiral ridges | 2 |
| — Whorls without spiral ridges | weyersi |
| 2. Penultimate whorl with three spiral ridges | 4 |
| — Penultimate whorl with 6-7 spiral ridges | 3 |
| 3. Penultimate whorl with 4-5 vertical ribs, periphery of last whorl rounded | obtusa |
| — Penultimate whorl with 9-10 vertical ribs, periphery of last whorl angular | quadrata |
| 4. Last part of last whorl adnate | 5 |
| — Last part of last whorl free | alata |
| 5. Profile of shell straight; groove between superior and middle spiral row deeper than that between middle and inferior row; varix strong | cingulata |
| — Profile of shell somewhat convex; grooves between the three spiral ridges of equal depth; varix weak | djadjariensis |

Cerithidea cingulata (GMELIN, 1790) (fig. 98, 99 and 102).

1790. GMELIN, Syst. Nat. Ed. XIII, p. 3561 (*Murex cingulatus*).
1838. POTIEZ & MICHAUD, Gal. Moll. Douai, 1, p. 363, pl. 31, fig. 19, 20 (*Cerithium fluviatile*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 183 (*Potamides cingulatus*).
1902. MARTENS, Rumphius Ged. boek, p. 120 (*Potamides cingulatus*).
1909. SCHEPMAN, Siboga Exp. Monogr. 49-1-b, p. 168 (*Potamides fluviatilis*).
1914. KONINGSBERGER, Java zoologisch en biologisch, Part 10, p. 446 (*Potamides cingulatus*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 259 (*Potamides cingulatus*).
1923. OOSTINGH, Meded. Landb. Hooges. Vol. 26, Part 3, p. 73 (*Potamides cingulatus*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 86 (*Potamides cingulatus*).
1938. ADAM & LELOUP, Mém. Mus. Roy. Hist. Nat. Belg. (Hors série), Vol. 2, Fasc. 19, p. 98 (*Cerithidea cingulata*).
1940. VAN REGTEREN ALTENA, Zool. Meded. Mus. Leiden, 22, p. 212, pl. 20, fig. 1-11 (*Cerithidea cingulata*).
1941. VAN REGTEREN ALTENA, Leidsche Geol. Meded. 12, p. 7 (*Cerithidea cingulata*).
1945. VAN REGTEREN ALTENA, Zool. Meded. Mus. Leiden, 25, p. 144 (*Cerithidea cingulata*).
1949. SCHUSTER, Public. no. 2, Onderafd. Binnenvisserij, p. 197-198 (*Cerithidea cingulata*).

Shell high-conical, with many whorls, yellowish-brown to dark-brown, occasionally greyish or dull-violet. The whorls of the spire bear three

strong spiral ridges, crossed by axial ribs of about the same strength, thus forming rows of regular granular nodules. On the last whorl the vertical folds fade away, but the spiral ridges continue on its base. The groove between the first and second spiral rows is deeper than that between the numbers two and three. Of the three spiral ridges on each whorl the lowermost is generally yellowish-brown, the two upper ones dark-brown. The grooves between the rows are always dark-brown. On the last whorl, opposite the lip, the shell bears a strong varix. Last whorl adnate to penultimate one.

Whorls about 15, regularly increasing in size, flat. Suture distinct, but not deep. The profile of the entire shell is straight. Periphery of last whorl angular in immature shells, but almost rounded in full grown ones. Top acute, base rounded, umbilicus closed.

Aperture narrow, oval, with pointed narrow ends. At the basal side with a short siphonal canal. Peristome not continuous. Columellar side thickened. Outer lip thickened and a little expanded. Basal margin with a tong-shaped curve along the siphonal canal.

Dimensions: height 30-35, width 10-14, height of aperture about 10 mm.

Distribution: India and Ceylon, Malaya, Southern China, Japan, Philippines, Malay Archipelago, New Guinea.

Habitat in Java: mangrove zone, Rhizophora region (KONINGSBERGER, 1914), very common in brackish and supersalted fishponds (salinity 15-45 ‰).

West Java: River Antjol near Djakarta; Pasar Ikan, Djakarta; empang near Tjilintjing, Djakarta; fishponds W and E of canal, Pasar Ikan; fishpond at Tandjong Priok; fishponds Pekulitan near Djakarta; mouth of the Tjilamaja; Cheribon; between Bungkirit and Tjuningan, Cheribon.

Central Java: coast near Tegal; little island off Karang Anjer, W of Semarang; Semarang (ADAM & LELOUP, 1938); shore near kampong Kedung, E of Semarang; Patjitan.

East Java: Surabaya; Indro near Surabaya (VAN REGTEREN ALTENA, 1945); mangrove near Grisse; Sukalelo, E of Surabaya; Pasuruan; reef of Batjulmati; Banjuwangi (MARTENS, 1897).

Cerithidea cingulata has also been found in the island of Madura, along the coast near Kamal, Djumiang and Sepulu.

In a fossil state the species has been recorded from various deposits of miocene and younger age in India, China, Japan and Malaysia, including Java (VAN REGTEREN ALTENA, 1941).

Cerithidea cingulata is a very common inhabitant of the brackish and saltwater fishponds along the northern coast of Java, so common, that it becomes a serious pest (SCHUSTER, 1949). Locally, numbers of 200 to 500 snails per square meter can occur. They live in the upper bottom layer which is constantly in motion and which consists of almost liquid mud. In this milieu the animals feed on the organic debris of the upper bottom layer. When, however, the bottom of the pond is quiet and motionless a gelatinous surface layer of fungi, bacteria and cyanophyceae develops which the snails do not like, and which is especially unfavourable for the young stages. The adult animals can exist, but their progeny is impeded.

***Cerithidea djadjariensis* (K. MARTIN, 1899) (fig. 103).**

1899. MARTIN, Samml. Geol. Reichsmus. Leiden (N.S.) 1, p. 216, pl. 33, fig. 502, 502a (*Potamides djadjariensis*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Bd, p. 94 (*Potamides djadjariensis*).
1931. VAN ES, Age of Pithecanthropus, p. 45 (*Potamides djadjariensis*).
1931. VAN DER VLERK, Leidsche Geol. Meded. 5, p. 250 (*Potamides djadjariensis*).
1940. VAN REGTEREN ALTENA, Zool. Meded. Mus. Leiden, 22, p. 215, pl. 20, fig. 12-19 (*Cerithidea djadjariensis*).
1941. VAN REGTEREN ALTENA, Leidsche Geol. Meded. 12, p. 9 (*Cerithidea djadjariensis*).
1945. VAN REGTEREN ALTENA, Zool. Meded. Mus. Leiden, 25, p. 144 (*Cerithidea djadjariensis*).

Shell high-conical, with many whorls. Yellowish-brown to dark-brown. The whorls of the spire bear three strong spiral ridges, crossed by axial ribs of about the same strength. The points of intersection of the two systems are developed as elevated nodules. On the last whorl the vertical folds fade away, but the spiral ridges continue on the base of the whorl. The spiral groove between the superior and middle spiral ridges is of equal depth as that between the middle and inferior ones. Of the three spiral rows the inferior one is generally yellowish-brown, the two upper ones dark-brown. The grooves between the spiral ridges are all dark-brown. On the last whorl, opposite the lip, the shell bears a weak, often obsolete, varix. Last whorl adnate to the previous one.

Whorls about 17, regularly increasing in size, somewhat convex. Suture distinct, but not deep. The profile of the entire shell is also convex. Periphery of last whorl angular in immature shells, but less angular or rounded in full-grown ones. Top acute, base rounded, umbilicus closed.

Aperture rather narrow, oval, with pointed narrow ends. The basal side forms a short siphonal canal. Peristome not continuous. Columellar

side thickened. Outer lip thickened and a little expanded. Basal margin tongue-shaped along the siphonal canal.

Dimensions: height 40-43, width 18-20, height of aperture 9-10 mm.

Distribution: Madagascar, Mauritius, Mergui Archipelago, Malay Archipelago, Southern China, Japan.

Habitat in Java: coast region, especially in river mouths and in the mangrove zone, in water of varying salinity, at low tide more or less dry.

West Java: coast near Antjol; river Antjol, near Djakarta; Tandjong Priok; empang near Djakarta; Muara Tangerang, W of Djakarta; fishponds at Tjilintjing near Djakarta; fishpond at Tandjong Priok; pond near Laboratory for Inland Fisheries, Bogor; Cheribon.

Central Java: little island off Karang Anjer, W of Semarang; Japara; Patjitan.

East Java: Ujung, Surabaja; Grisee, N of Surabaja; between Bangil and Situbondo; Besuki.

Cerithidea djadjariensis has also been found in the island of Amsterdam in the Bay of Djakarta, and in Madura island along the coast near Kamal and Sepulu.

As a fossil the species has been recorded from Pliocene and younger deposits in Central and East Java (MARTIN, 1899, 1919; VAN ES, 1931; VAN DER VLERK, 1931; VAN REGTEREN ALTENA, 1941).

The spawning of *Cerithidea djadjariensis* has been observed in Japan by HABA (1955, Venus, 18, p. 204-205, fig. 6). The snail deposits its eggs in July and August, in the evening, at low tide. When laid on the mud the egg mass takes the shape of a curved cord measuring 50 to 90 mm length and 3-3.5 mm in diameter. It bears numerous transverse striae caused by the arrangement of rows of small sand grains on the exterior surface. On the inner curve of the cord these sand grain rows are absent. The striae of sand vanish with time and the egg mass becomes flat. At an early stage of development the eggs shine through the transparent gelatinous capsule as yellow or bluish-green spots of 0.2 mm diameter.

Cerithidea alata (PHILIPPI, 1849) (fig. 104).

1849. PHILIPPI, Abb. & Besch. 3, Cerithium, p. 17, pl. 1, fig. 11 (*Cerithium alatum*).
 1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 185 (*Potamides alatus*).
 1930. VERWEY, Treubia, 12, p. 175, 176, 180, 185, 190, 192 (*Cerithidea alata*).
 1940. VAN REGTEREN ALTENA, Zool. Meded. Mus. Leiden, 22, p. 218, pl. 20, fig. 20-22 (*Cerithidea alata*).
 1945. VAN REGTEREN ALTENA, Zool. Meded. Mus. Leiden, 25, p. 144 (*Cerithidea* cf. *alata*).

Shell high-conical, with many whorls. Yellowish-brown to dark-brown. The whorls of the spire bear three strong spiral ridges, crossed by axial ribs of about the same strength. The points of intersection of these two systems are developed as elevated nodules. On the last whorl the vertical folds fade away, but the spiral ridges continue on the base of the whorl. The groove between the first and second spiral rows is generally deeper than that between the second and third ones. Of the three spiral ridges on each whorl the lowermost is generally yellowish-brown, the two upper ones dark-brown. The grooves between the rows are always dark-brown. This colour pattern is also visible in the interior of the aperture. On the last whorl, opposite the lip, the shell bears a varix of moderate strength (stronger than in *C. djadjariensis*, but weaker than in *C. cingulata*). Last whorl free towards the aperture.

Whorls 16-18, regularly increasing in size, slightly convex. Suture distinct, but not deep. The profile of the entire shell is also somewhat convex. Periphery of last whorl angular in immature shells, but less angular or rounded in full-grown ones. Top acute, base rounded, umbilicus closed.

Aperture rather narrow, obliquely oval, with pointed narrow ends. The base terminates in a small canal. Peristome not continuous. Columellar side thickened. Outer lip thickened and expanded wing-like. Basal margin with a tongue-shaped curve along the siphonal canal.

Dimensions: height 34-40, width 9-11 (peristome included), height of aperture about 10 mm.

Distribution: Mergui Islands, Malaya, Malay Archipelago, Philippines.

Habitat in Java: like the preceding species in the mangrove zone and in brackish fishponds.

West Java: coast near Antjol; river Antjol near Djakarta; empang at Tjilintjing near Djakarta; Muara Tangerang W of Djakarta; muddy soil near Laboratory for Fisheries Investigations, Djakarta; fishpond near Djakarta; fishpond near Tandjong Priok.

East Java: Surabaja; Sukalelo, E of Surabaja; Besuki.

Cerithidea alata has also been found at Djumiang in the island of Madura.

Cerithidea obtusa (LAMARCK, 1822) (fig. 106).

1822. LAMARCK, Hist. Nat. Anim. s. Vert. 7, p. 71 (*Cerithium obtusum*).

1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 186, pl. 9, fig. 22 (*Potamides obtusus*).

1923. OOSTINGH, Meded. Landb. Hooges. Vol. 26, Part 3, p. 76 (*Potamides obtusus*).
 1930. PFLUGFELDER, Zool. Anz. 89, p. 276-283, fig. 1-7 (*Potamides obtusus*).
 1930. VERWEY, Treubia, 12, p. 175, 180, 184 (*Cerithidea obtusa*).
 1941. VAN REGTEREN ALTENA, Leidsche Geol. Meded. 12, p. 11 (*Cerithidea obtusa*).
 1945. VAN REGTEREN ALTENA, Zool. Meded. Mus. Leiden, 25, p. 145 (*Cerithidea obtusa*).

Shell high-conical, with many whorls. Thick, sculptured with spiral and axial ribs. There are 6-7 spirals on the upper part of each whorl, and about 4 to 5 axial ribs to the cm on the penultimate whorl (occasionally a few more). Although the axial ribs dominate in strength, the spirals are distinct too, especially on the body whorl where the axial ribs fade away. The crossings of the two systems form more or less sharp nodules. A varix can occur on the last whorl, but is never very distinct.

Colour brown, or dull purplish-brown, with a lighter zone just below the suture. The spiral ridges are generally somewhat darker than the grooves between them, a feature which is especially distinct when holding the last part of the last whorl against the light. The base of the whorls is either plain brown, or yellowish with a darker brown zone.

Whorls 7-8, the top is always broken off. All whorls moderately convex, suture rather deep. Periphery rounded in full-grown shells, but obtusely angular in immature ones. Base rounded, with numerous (12-15) fine spiral ridges. Last whorl not, or only slightly, ascending towards the aperture.

Aperture wide, circular or quadrangular with rounded angles. Almost vertical, ending in a short siphonal canal at the base. Peristome not continuous, the columellar margin slightly twisted, the outer lip thickened and expanded. At the base the peristome is produced tongue-shaped along the right side of the siphonal canal.

Operculum corneous, circular, multispiral, with central nucleus and concentric growth lines.

Dimensions: height about 50 (decollated spire!), width 27, height of aperture (without peristome) 12 mm.

Distribution: India, Malay Peninsula, Siam, Indo-China, Malay Archipelago.

Habitat in Java: living in the tidal zone, on mud banks which are partly dry at low tide, concentrating in the wettest spots. VAN DER MEER MOHR (Trop. Natuur, 30, 1941, p. 53, fig. 7 and 8) figured assemblages of *Cerithidea obtusa* surrounding small pools dug by *Periophthalmus*, the mud skipper. PFLUGFELDER (1930) often found the snails on *Acanthus ilicifolius* at the edge of the mangrove zone. IJZERMAN reported of animals hanging with the top of the shell downward and with closed operculum

from branches of *Rhizophora* and *Avicennia*, about one meter above the ground.

West Java: Antjol, tidal forest; mangrove W of canal from the harbour of Djakarta to the sea; fishpond near Djakarta; Tandjong Priok; mouth of the Tjilamaja; Cheribon; Madjalengka.

East Java: Surabaya; Kali Mas, Surabaya; Indro near Surabaya (VAN REGTEREN ALTENA, 1945); mangrove between fishponds at Gendjeran, near Surabaya; Sukalelo E of Surabaya; Pasuruan.

Cerithidea obtusa has also been found in the island of Hoorn, in the Bay of Djakarta, and in Madura Island, at Djumiang and Sepulu.

As a fossil the species has been recorded from Pliocene layers in Central and East Java (VAN REGTEREN ALTENA, 1941).

The mantle edge of *Cerithidea obtusa* is provided with an eye. When the animal moves about the eye is visible at the right side in a small depression of the mantle edge. When the animal has withdrawn into its shell the eye just fits in the siphonal canal of the shell, enabling the snail to observe movements and shades in its environment (PFLUGFELDER, 1930).

***Cerithidea quadrata* SOWERBY, 1866 (fig. 107).**

1866. SOWERBY, in: REEVE, *Conch. Icon.* Vol. 15, pl. 1, fig. 5 (*Cerithidea quadrata*).
 1897. MARTENS, in: WEBER, *Erg. Reise Nied. Ost Indien*, 4, p. 187, pl. 9, fig. 23 (*Potamides quadratus*).
 1899. HORST & SCHEPMAN, *Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas*, Vol. 13, Part 2, p. 235 (*Potamides quadratus*).
 1930. VERWEY, *Treubia*, 12, p. 175, 180, 184, 185 (*Cerithidea quadrata*).
 1945. VAN REGTEREN ALTENA, *Zool. Meded. Mus. Leiden*, 25, p. 145 (*Cerithidea quadrata*).

Shell high-conical (more slender than *Cerithidea obtusa*), with many whorls. Thick, sculptured by spiral and axial ridges. There are 6-7 spirals on the upper part of each whorl, and 9-10 axial ribs to the cm on the penultimate whorl. On the last whorl the number of axials is smaller and their development is less strong. Axial and spiral ridges are of about equal strength, causing a pattern of regular squares, the crossings of the two systems being nodulous. A varix is generally well developed at the beginning of the last half whorl. Colour dull-brown, with a lighter zone just below the suture. The spiral ridges are generally somewhat darker brown than the grooves between them, a feature which is especially distinct when holding the terminal part of the last whorl against the light. The dark zones even continue on the outer lip of the aperture.

Whorls about 9 (top always broken off), moderately convex, suture rather deep. Periphery always angular, even in full-grown shells. Base

rounded, with numerous (12-15) fine spiral ridges. Last whorl not, or only slightly, ascending towards the aperture.

Aperture rather wide, quadrangular with rounded angles. Almost vertical, ending in a short siphonal canal at the base. Peristome not continuous, the columellar margin slightly twisted, the outer lip thickened and expanded. At the basal side the peristome is produced tongue-shaped along the right side of the siphonal canal.

Operculum corneous, circular, multispiral, with central nucleus and concentric growth ridges.

Dimensions: height about 48 (decollated spire!), width 20, height of aperture (without peristome) 10 mm.

Distribution: Malay Peninsula, Siam, Indo-China, Malay Archipelago, Philippines.

Habitat in Java: living in the mangrove zone and brackish fishponds. IJZERMAN found *Cerithidea quadrata* hanging from branches of mangrove trees in a similar way as *C. obtusa*.

West Java: Antjol; mangrove W of harbour canal, Djakarta; Tandjong Priok.

Central Java: Tjilatjap.

- East Java: Surabaya; Sukalelo E of Surabaya.

Cerithidea quadrata has also been found in the island of Purmerend, Bay of Djakarta, and at Djumiang, in the island of Madura.

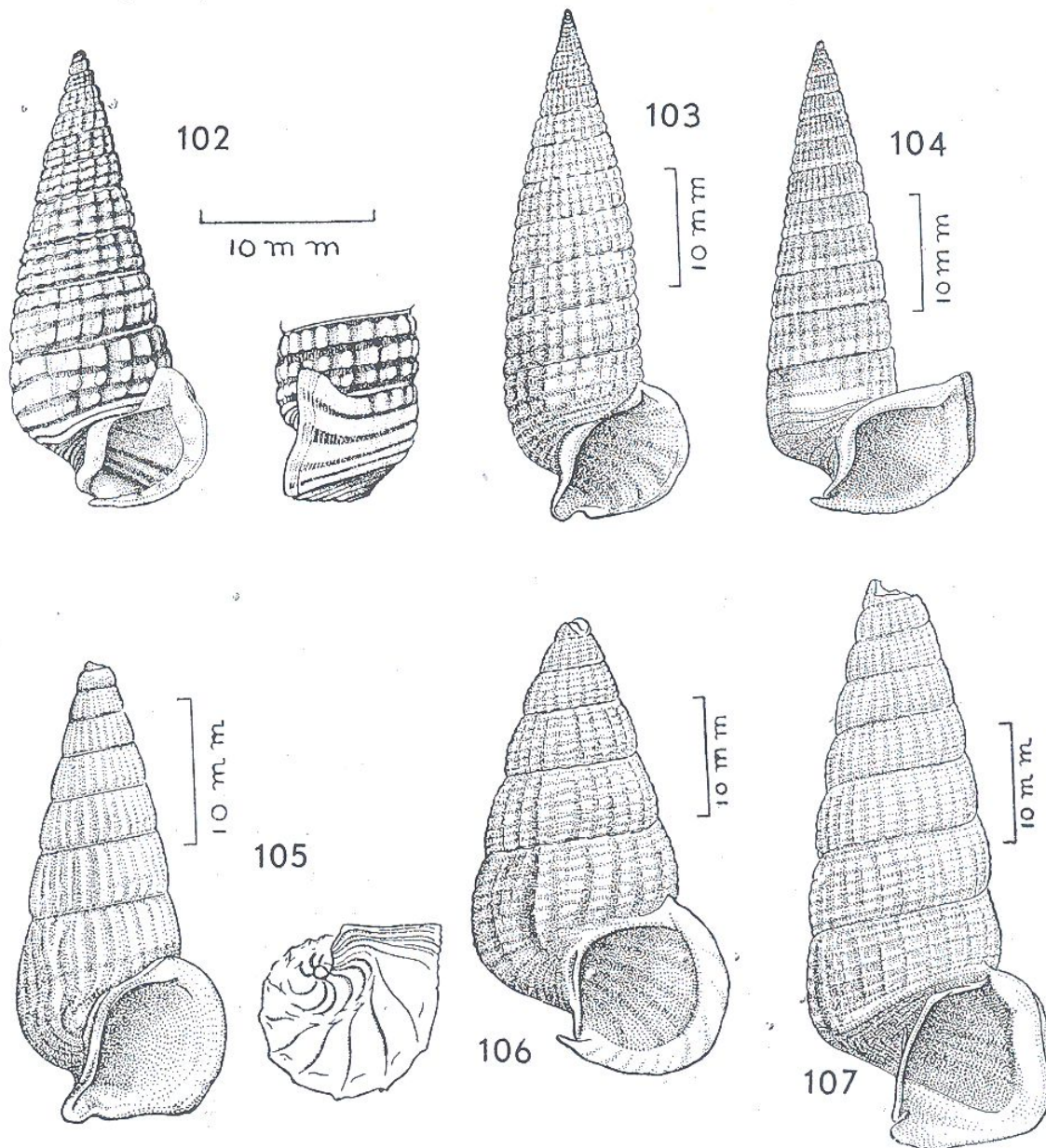
Cerithidea quadrata is very similar to *C. rhizophorarum* A. ADAMS, 1854. If the two species should prove to be identical the name *C. rhizophorarum*, having 12 years priority, must replace *C. quadrata*.

C. rhizophorarum was mentioned from Kamal and Sepulu in Madura Island, but never from Java proper (VAN REGTEREN ALTENA, 1945, Zool. Meded. Mus. Leiden, 25, p. 145). Although the specimens are in rather bad condition they agree sufficiently with shells of *Cerithidea quadrata* from various localities in the Amsterdam Zoological Museum.

Cerithidea weyersi DAUTZENBERG, 1899 (fig. 105).

1899. DAUTZENBERG, Ann. Soc. Roy. Malac. Belg. 34, p. 8, pl. 2, fig. 1, 1a, 1b (*Cerithidea weyersi*).
1890. BOETTGER, Ber. Senckenb. p. 167 (*Cerithidea ornata non ornata* A. ADAMS, 1855).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 189 (*Potamides ornatus non ornata* A. ADAMS, 1855).
1914. KONINGSBERGER, Java zoologisch en biologisch, Part 10, p. 446 (*Potamides ornatus non ornata* A. ADAMS, 1855).

1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 259 (*Potamides ornatus* non *ornata* A. ADAMS, 1855).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 86 (*Potamides ornatus* non *ornata* A. ADAMS, 1855).



- Fig. 102. *Cerithidea cingulata* (GMEL.). Entire shell, and two last whorls from side. ABDULKKADIR del.
- Fig. 103. *Cerithidea djadjariensis* (MARTIN). Shell. J. MASTRO del.
- Fig. 104. *Cerithidea alata* (PHIL.). Shell. J. MASTRO del.
- Fig. 105. *Cerithidea weyersi* DAUTZ. Shell, and base of shell. J. MASTRO del.
- Fig. 106. *Cerithidea obtusa* (LAM.). Shell. J. MASTRO del.
- Fig. 107. *Cerithidea quadrata* SOW. Shell. J. MASTRO del.

Shell high-conical, with many whorls. Thick, sculptured with axial ribs only. These ribs stand rather close together. They even continue on

the base of the last whorl and are peculiarly sinuous there. The penultimate whorl is provided with about 20-26 ribs. The entire surface is finely striated in spiral direction. Colour yellowish-brown, with one or two vague, darker brown bands.

Whorls about 10 (top generally broken off), little convex. Suture distinct, but not deep, margined by a thin thread. Periphery obtusely angular in young shells, but rounded in adult ones. Base rounded, with numerous spiral ridges. Last whorl not ascending towards the aperture.

Aperture rather wide, rounded. Almost vertical, ending in a very short and shallow siphonal canal at the base. The columellar side of the aperture is obliquely twisted towards the exterior. Peristome not continuous, free margin thickened and a little expanded. At the basal side the peristome forms a tongue-shaped curve along the right margin of the siphonal canal.

Dimensions: height 33 (apex broken), width 13, height of aperture 9 mm.

Distribution: Sumatra, Java, Moluccas.

Habitat in Java: estuaries of rivers, brackish water at high tide, fresh at low tide.

West Java: mouth of River Tjimandiri; Tandjong Priok (BOETTGER, 1890).

From the Senckenberg Museum I received on loan the shell which BOETTGER (1890) recorded as *Cerithidea ornata* from Tandjong Priok, Java (SMF no. 153447). It is high 27, and wide 12.5 mm, and has an aperture of 8 mm height. In his publication BOETTGER spoke of "Einige Schalen" (= some shells), but the Frankfurt Museum possesses only one specimen. This shell is a distinct *Cerithidea weyersi*.

Most Javanese specimens are a little higher than the shells which DAUTZENBERG described from Sumatra. The other characteristics, viz. the twisted columella, the thin thread along the suture, the rounded periphery of the last whorl and the continuation of the axial ribs on the base of the last whorl appear on the Javanese shells in a similar way as on the paratypes from Indrapura (Sumatra) which I studied in the Zoological Museum, Amsterdam and in the Rijksmuseum van Natuurlijke Historie at Leiden.

Genus *Telescopium* MONTFORT, 1810.

Shell large, high-conical on a broad, nearly flat base. With many narrow flat whorls. Thick, sculptured by spiral ridges. Last whorl obtusely angular at the periphery in adult shells. In immature shells sharply an-

gular. There are no varices, but the last whorl of adult shells can bear thin, leaf-like ridges, standing away from the shell and marking previous growth interruptions. A thick spiral fold winds spirally along the columella; another one runs along the base of the whorls. Columella twisted.

Aperture obliquely quadrangular, at the base ending in a siphonal canal. Peristome not continuous. Outer lip somewhat thickened and sinuous towards the base.

Operculum circular, corneous, with central nucleus and many concentric whorls.

Radula 2.1.1.1.2. The rhachis has a strong central cusp and 3-5 smaller lateral cusps at each side. The lateral teeth are composed of a trapezoidal "body" and a narrow "shaft". The marginals have 3-4 cusps along the cutting edge (fig. 100).

There are two species in Java:

1. Whorls slightly convex. Periphery of last whorl rounded. Columellar side of aperture long and oblique, with weak spiral rib. Apical angle about 38-40°. Operculum with 5-6 whorls. The edges of these whorls are fringed **mauritsi**
- Whorls flat. Periphery of last whorl angular. Columellar side of aperture short, twisted and with strong spiral rib. Apical angle about 30-35°. Operculum with about 17 whorls. The edges of these whorls are hardly or not fringed **telescopium**

Telescopium telescopium (LINNÉ, 1758) (fig. 100, 108).

1758. LINNÉ, Syst. Nat. Ed. X, p. 760 (*Trochus telescopium*).
1828. SCHUMACHER, Essai Vers test. p. 233 (*Telescopium fuscum*).
1874. TAPPARONE CANEFRI, Mem. Reale Accad. Sci. Torino (2) 28, p. 42 (*Telescopium fuscum*).
1884. MARTIN, Samml. Geol. Reichsmus. Leiden (1) 3, p. 145, 328, 348 (*Potamides telescopium*).
1890. BOETTGER, Ber. Senckenb. p. 167 (*Telescopium fuscum*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 180 (*Potamides telescopium*).
1899. MARTIN, Samml. Geol. Reichsmus. Leiden (N.S.) 1, p. 220, pl. 33, fig. 509, 509a (*Telescopium telescopium*).
1914. KONINGSBERGER, Java zoölogisch en biologisch, Part 10, p. 446 (*Potamides telescopium*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 259 (*Potamides telescopium*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beil. Bd, p. 94, 128, 137 (*Telescopium telescopium*).
1923. OOSTINGH, Meded. Landb. Hooges. Vol. 26, Part 3, p. 75 (*Potamides telescopium*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 86 (*Potamides telescopium*).

1930. VERWEY, Treubia, 12, p. 175, 176, 180, 190, 192 (*Telescopium telescopium*).
1931. VAN DER VLERK, Leidsche Geol. Meded. 5, p. 252 (*Telescopium telescopium*).
1934. VAN BENTHEM JUTTING, Indisch Dierenleven, p. 4, fig. 2 (*Telescopium telescopium*).
1938. ADAM & LELOUP, Mém. Mus. Roy. Hist. Nat. Belg. (Hors Série), Vol. 2, Fasc. 19, p. 99 (*Telescopium telescopium*).
1941. VAN REGTEREN ALTENA, Leidsche Geol. Meded. 12, p. 13 (*Telescopium telescopium*).
1945. VAN REGTEREN ALTENA, Zool. Meded. Mus. Leiden, 25, p. 145 (*Telescopium telescopium*).
1949. SCHUSTER, Public. no. 2, Onderafd. Binnenvisserij, p. 198 (*Telescopium telescopium*).
1954. BUTOT, Basteria, 18, p. 1-13, pl. 1, fig. 1 and 2, pl. 2, fig. 1 and 3 lower row (*Telescopium telescopium*).

Shell large, high-conical on a broad, nearly flat base. With many narrow flat whorls. Thick, sculptured by spiral ridges. Reddish-brown, purplish-brown or blackish-brown, with an occasional lighter zone below the suture.

Whorls 13, top whorls mostly eroded. The whorls increase in diameter slowly. Last whorl obtusely angular at the periphery in adult shells, in juvenile shells sharply angular and in very old shells almost rounded. Profile of the whorls flat, suture very superficial. Top pointed, but not sharp. Base almost flat, umbilicus closed. A thick, grooved, spiral fold winds along the columella, another one runs at the interior base of the whorls.

Aperture obliquely quadrangular, ending in a siphonal canal at the base. Peristome not continuous. Outer lip somewhat thickened, sinuous towards the base.

Operculum circular, corneous with central nucleus and about 17 concentric whorls. The edges of the whorls are only little fringed and never foliaceous.

Dimensions: height 110, width 45, height of aperture 25 mm.

Distribution: Madagascar, Reunion, coast of India and Ceylon, Burma, Malay Peninsula, Malay Archipelago, Philippines, coast of North Australia.

Habitat in Java: mud flats in the mangrove region, between tide marks where the water is salt or highly brackish. The animals live partly buried in the mud, only the top of the spire projecting. The species occurs also in the brackish water fishponds along the north coast of Java (SCHUSTER, 1949).

West Java: fishponds between Banten and Tjilegon; Antjol; Tandjong Priok; Tjilintjing; mud flats along the harbour near Laboratory for

Marine Investigations, Djakarta; near mouth of the Tjiliwung; Wijnkoopsbay.

Central Java: Kramat, E of Tegal (VAN REGTEREN ALTENA, 1945).

East Java: Perol, near Kediri; between Surabaya and Grisee (ADAM & LELOUP, 1938); Surabaya; Gendjeran near Surabaya; mud flats W of mouth of Kali Mas, near Surabaya; Grisee, N of Surabaya; Sidohardjo, in fishponds; Sukalelo, E of Surabaya; between Bangil and Situbondo; Banjuwangi.

Telescopium telescopium has also been found in several islands off the coast of Java: Pulo Panaitan, Leiden, Edam, Middelburg, Amsterdam and Madura. In the latter island it was found near Djumiang, Sepulu and Kamal (VAN REGTEREN ALTENA, 1945).

In a fossil state the species has been recorded from Miocene and younger layers in West, Central and East Java (VAN REGTEREN ALTENA, 1941, p. 13).

In the Philippines *Telescopium telescopium* is sold in the markets for food (TALAVERA & FAUSTINO, 1933, Philipp. Journ. Sci. 50, p. 35, pl. 15, fig. 1).

***Telescopium mauritsi* BUTOT, 1954 (fig. 109).**

1954. BUTOT, Basteria, 18, p. 7, pl. 1, fig. 3 and 4, pl. 2, fig. 2, 3 upper row, text-fig. 1 (*Telescopium mauritsi*).

Shell large, high-conical on a broad, nearly flat base. With many narrow, slightly convex whorls. Thick, sculptured by spiral ridges which are, however, often obsolete. Purplish-brown to blackish-brown.

Whorls about 9, top whorls eroded, slowly and regularly increasing in size. Last whorl much enlarged and widened, bulging out beyond the regular flat profile of the shells, and with rounded periphery. Suture somewhat deeper than in *Telescopium telescopium*. In adult shells the last whorl bears thin, sinuous ridges, standing away from the shell and marking previous growth interruptions. Top pointed, but not sharp. Apical angle 38-40°. Base almost flat. Umbilicus closed. A thick, grooved spiral fold winds along the columella, another one lies at the base of the whorls. The columellar fold is nearly entirely hidden by a violet-brown, porcellanous sheet covering columella and parietal side.

Aperture obliquely triangular, ending in a short siphonal canal at the base. Peristome not continuous. Outer lip thickened, sinuous at the base.

Operculum circular, corneous, with a central nucleus and about 5-6 whorls. The edges of these whorls can be partly free, forming a fibrous or foliaceous fringe.

Dimensions: height up to 126, width up to 63, height of aperture about 33 mm.

Distribution: Sumatra, Pulo Panaitan, New Guinea.

Habitat: BUTOT (1954, p. 8) observed that *Telescopium mauritsi* prefers a different habitat from that of *T. telescopium*, the former living inland in the *Rhizophora mucronata* belt, the latter among *Lumnitzera* and *Sonneratia* vegetation by the sea side.

T. mauritsi has not yet been recorded from the main island, but only from Pulo Panaitan, in Sunda Strait.

Genus *Terebralia* SWAINSON, 1840.

Shell high-conical to turreted, with many whorls. Thick, sculptured by axial and spiral ridges. In some species the two systems are of about equal strength, forming regular nodules, in others the vertical ribs dominate. Last whorl (and sometimes previous ones too) with a thick varix. Base of the whorls with spiral ridges only. A thick spiral fold winds along the middle of the columella and another one lies at the base of the last whorl, or in the corner between columella and last whorl.

Aperture oval or rounded, at the base ending in a siphonal canal. Peristome not continuous. Outer margin thickened, often sinuous and expanded.

Operculum circular, horny, multispiral with central nucleus.

Radula 2.1.1.1.2. Rhachis wider than high, with three cusps. Laterals with a quadrangular, tricuspid blade and a long, narrow stalk. The marginals are also tricuspid. The outer marginal bears a large semicircular membrane at the exterior side (fig. 101).

Distribution: brackish coasts along Indian and Pacific Oceans, on mud flats and in the mangrove region.

There are two species in Java:

1. Shell large and turreted, whorls almost flat *palustris*
- Shell high-conical and smaller, whorls convex *sulcata*

Terebralia sulcata (BORN, 1778) (fig. 101, 110).

1778. BORN, Index Mus. Caesar. Vindob. p. 324 (*Murex sulcatus*).
1874. TAPPARONE CANEFRI, Mem. Reale Accad. Sci. Torino (2) 28, p. 41 (*Pyrazus sulcatus*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 178, pl. 9, fig. 27 (*Potamides sulcatus*).
1899. MARTIN, Samml. Geol. Reichsmus. Leiden (N.S.) 1, p. 211 (*Potamides sulcatus*).
1911. MARTIN, Samml. Geol. Reichsmus. Leiden (1) 9, p. 21 (*Potamides sulcatus*).

1914. KONINGSBERGER, Java zoölogisch en biologisch, Part 10, p. 446 (*Potamides sulcatus*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 259 (*Potamides sulcatus*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Bd, p. 93 (*Potamides sulcatus*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 86 (*Potamides sulcatus*).
1930. VERWEY, Treubia, 12, p. 175, 190 (*Terebralia sulcata*).
1931. VAN ES, Age of Pithecanthropus, p. 51 (*Potamides palustris*), p. 95 (*P. palustris* and *P. sulcatus*), p. 115 (*P. sulcatus*).
1931. VAN DER VLIERK, Leidsche Geol. Meded. 5, p. 251 (*Potamides sulcatus*).
1935. OOSTINGH, Wetensch. Meded. Dienst v.d. Mijnb. Ned. Indië, 26, p. 51 (*Terebralia sulcata*).
1941. VAN REGTEREN ALTENA, Leidsche Geol. Meded. 12, p. 17 (*Terebralia sulcata*).
1948. DAMMERMAN, Fauna of Krakatau, p. 190 and 519 (*Terebralia sulcata*).

Shell high-conical, thick. Light to dark-brown, with occasional lighter spiral zones. Coarsely sculptured by thick vertical ribs or folds, and narrow but deep spiral grooves. These two systems form a pattern of squares or nodules which is strongest below the suture. On the last whorl the axial folds fade away below the periphery, the basal part bearing only spiral ribs. Old periods of arrested growth are marked by a thick varix. Epidermis dark-brown.

Whorls about 12, regularly increasing in size with somewhat curved sides. Suture narrow, but deep. Top pointed, but not acute, often eroded. Base rounded in adult shells, but angular in immature ones. Umbilicus closed.

Aperture oval, pointed at top and basal ends. Vertical or a little oblique, somewhat ascending towards the peristome.

Peristome not continuous, with short siphonal canal at basal side. Columellar side twisted. In the interior of the aperture there are two spiral ridges, one winding along the middle of the columella and one at the transition of the columella and the base of the whorls. This last fold can be obsolete. In full grown animals the folds are invisible from the outside. Exterior lip thickened and expanded, sometimes closing with a curve over the siphonal canal, leaving a round opening free.

Operculum (as in the genus description).

Dimensions: height 40-50, width 20-27, height of aperture 18-22 mm.

Distribution: Hongkong, Tonkin, Singapore, Malay Archipelago, Philippines.

Habitat in Java: living on mud flats in the mangrove region, often attached to branches or roots of *Sonneratia* and *Rhizophora*, or on stones.

West Java: Anjer (MARTENS, 1897); Tji Sadane W of Djakarta; Djakarta (TAPPARONE CANEFRI, 1874); mangrove near Djakarta (VERWEY, 1930); Wijnkoopsbay.

East Java: Tuban, mangrove near G. Lurus, in Besuki.

Terebralia sulcata has also been found in Pulo Panaitan; Verlaten Island, northern pool (DAMMERMAN, 1948); Noord Wachter; Middelburg; Amsterdam; Edam; Boompjes Island, N of Cheribon; mangrove near Kali Lèlè, in Karimon Djawa Islands; Djumiang and Sepulu in the island of Madura.

As a fossil the species has been recorded from Miocene and younger layers in West Central and East Java (MARTIN, 1899, 1911, 1919; OOSTINGH, 1935; VAN ES, 1931; VAN DER VLERK, 1931; VAN REGTEREN ALTENA, 1941).

In the Philippines *Terebralia sulcata* is used as food (TALAVERA & FAUSTINO, 1933, Philipp. Journ. Sci. 50, p. 35-36).

Terebralia palustris (LINNÉ, 1767) (fig. 111).

1767. LINNÉ, Syst. Nat. Ed. XII, p. 1213 (*Strombus palustris*).
1874. TAPPARONE CANEFRI, Mem. Reale Accad. Sci. Torino (2) 28, p. 41 (*Pyrazus palustris*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 176, pl. 9, fig. 24, 25 (*Potamides palustris*).
1899. MARTIN, Samml. Geol. Reichsmus. Leiden (N.S.) 1, p. 210, pl. 32, fig. 478 (*Potamides palustris*).
1902. MARTENS, Rumphius Gedenkb. p. 120 (*Potamides palustris*).
1914. KONINGSBERGER, Java zoologisch en biologisch, Part 10, p. 446 (*Potamides palustris*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 259 (*Potamides palustris*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Bd, p. 93, 130, 132 (*Potamides palustris*).
1925. OOSTINGH, Meded. Landb. Hooges. Vol. 29, Part 1, p. 46 (*Potamides palustris*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 86 (*Potamides palustris*).
1931. VAN ES, Age of Pithecanthropus, p. 45 (*Potamides palustris*).
1931. OOSTINGH, Arch. Moll. Kunde, 63, p. 194 (*Terebralia palustris*).
1931. VAN DER VLERK, Leidsche Geol. Meded. 5, p. 251 (*Potamides palustris*).
1941. VAN REGTEREN ALTENA, Leidsche Geol. Meded. 12, p. 15 (*Terebralia palustris*).

Shell high-turreted, thick, brownish-black, with irregular, indistinct lighter spiral bands or vertical flames. Coarsely sculptured by thick, vertical ribs or folds, and narrow, but deep spiral grooves. The two systems form a pattern of squares or nodules which is especially well developed just below the suture. On the last whorl the vertical folds fade away below the periphery, the basal part being only sculptured spirally. Old periods of arrested growth are marked by a thick varix. Epidermis blackish-brown.

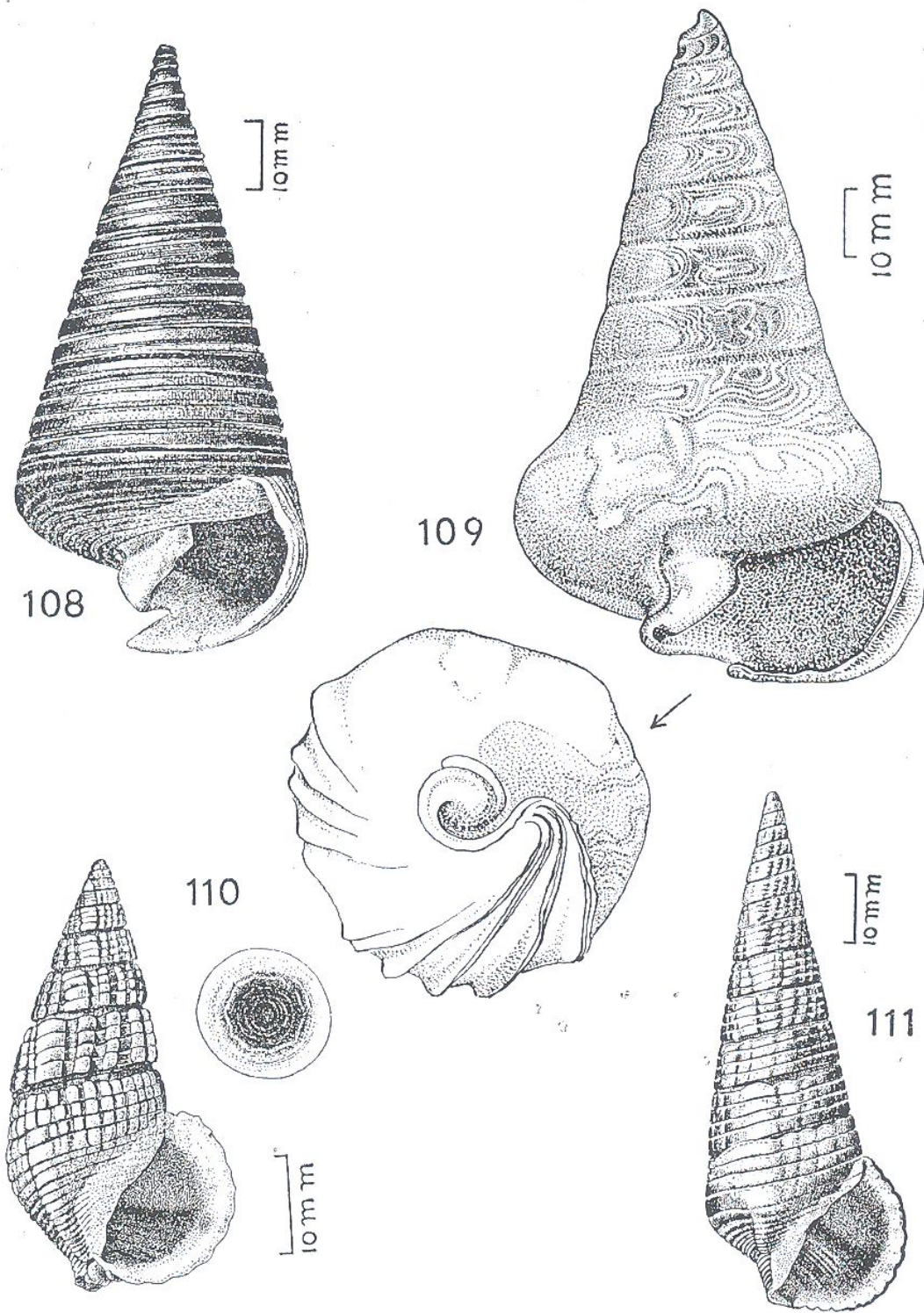


Fig. 109. *Telescopium mauritsi* BUTOT. Shell, frontal and basal view. J. MASTRO del.

Fig. 108. *Telescopium telescopium* (L.) Shell. ABDULKADIR del.

Fig. 110. *Terebralia sulcata* (BORN), Shell, and operculum, more enlarged. ABDULKADIR del.

Fig. 111. *Terebralia palustris* (L.). Shell. ABDULKADIR del.

Whorls 18-20, regularly increasing in size, with flat sides. Suture narrow, but deep. Top pointed, but not acute, often eroded. Base rounded in adult shells but angular in immature ones. Umbilicus closed.

Aperture oval, with pointed narrow ends. Almost vertical, somewhat ascending. Peristome not continuous, with short siphonal canal at the basal side. Columellar side twisted. In the interior of the aperture there are two spiral ridges, one winding along the middle of the columella and one at the transition of the columella and the base of the whorls. This last fold can be obsolete. In full grown shells the folds are not visible from the exterior. Parietal side somewhat porcellanous in adult specimens. Exterior lip thickened and sinuously expanded.

Operculum (as in genus description).

Dimensions: height up to 160, width up to 50, height of aperture about 40 mm.

Distribution: coastal regions of the Indian Ocean from East Africa and India to the Malay Archipelago, where it has been recorded from almost any island. Also in the Philippines and North Australia.

Habitat in Java: living on and partly in mud flats, in the tidal zone, in the mangrove bushes. Some notes on growth and behaviour of *Terebralia palustris* in the Nicobar Islands were given by SEWELL (1924, Rec. Ind. Mus. 26, p. 542) and in the Andaman Islands by RAO (1938, Rec. Ind. Mus. 40, p. 193-206, pl. 3).

West Java: Bantam; Muara Tangerang (TAPPARONE CANEFRI, 1874); fishponds near Djakarta; Antjol; Tandjong Priok; Palabuan (MARTENS, 1897); Wijnkoopsbay.

East Java: between Bangil and Situbondo.

Terebralia palustris has also been found in several islands off the coast of Java: Pulo Panaitan; Sebesi (OOSTINGH, 1931); Amsterdam; Rotterdam; Haarlem; Middelburg; Edam; Pulo Pajung; Pulo Babi and at Djumiang and Sepulu in the island of Madura.

The species has been recorded as a fossil from Miocene and younger layers in West, Central and East Java (MARTIN, 1899, 1919; VAN ES, 1931; VAN DER VLERK, 1931; VAN REGTEREN ALTENA, 1941).

Familia BUCCINIDAE.

Shell oval, fusiform or turreted, with high spire. Last whorl produced into a siphonal canal at its base. Whorls generally convex, but in some species almost flat. In many species the shells are sculptured with axial ribs and spiral striae. Columella without spiral folds.

Operculum horny, with subcentral or excentral nucleus.

Animal with long, slender proboscis and siphon. The sexes are separate. Propagation mostly by eggs which are deposited in horny capsules, single or in strings. Eyes at the base of the tentacles.

Radula 1.1.1. Central tooth generally large, with several cusps. Laterals with only few cusps.

Distribution: chiefly marine species, living in all oceans, from littoral waters to great depths. Only a few species inhabit fresh water.

Genus *Anentome* COSSMANN, 1901.

Shell fusiform to turreted, greenish or brownish, thick, not transparent. Spire pointed, base produced into a short siphonal canal. Whorls moderately convex. Suture shallow or distinctly impressed. Whorls with strong vertical ribs and weaker spiral sculpture. Periphery rounded or angular. Aperture elongate-oval. Siphonal canal short and wide. Peristome not continuous, somewhat thickened, little or not expanded. Operculum pear-shaped, with the nucleus at the narrow end.

Radula 1.1.1, the central tooth with 4-7 cusps, the lateral teeth with 2-4 cusps (fig. 112). The sexes are separate. The animals possess a long, tubular siphon which they carry upwards during locomotion.

Distribution: Siam, Cambodia, Malaya, Sumatra, Borneo, Java, always in fresh water. Not in Celebes or the Lesser Sunda Islands, with the exception of Timor where MARTENS (1897, p. 75) found a dead specimen in fresh water near Kupang.

In Java only one species:

Anentome helena (VON DEM BUSCH, 1847) (fig. 112, 113).

1847. VON DEM BUSCH, in: PHILIPPI, Abb. & Beschr. 2, Melania, p. 170, pl. 4, fig. 4 (*Melania helena*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 268 (*Melanopsis helena*).
1849. MOUSSON, Land & Süßw. Moll. Java, p. 64, pl. 10, fig. 2 (*Melanopsis helena*).
1853. PETIT, Journ. de Conch. 4, p. 255, pl. 7, fig. 11 (*Melania theminckiana*).
1860. REEVE, Conch. Icon. 12, pl. 6, fig. 24 (*Hemisinus helena*).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 318 (*Melanopsis helena*).
1874. TAPPARONE CANEFRI, Mem. Reale Accad. Science Torino (2) 28, p. 47 (*Hemisinus helena*).
1876. BROU, Journ. de Conch. 24, p. 346 (*Canidia helena*) and p. 347, pl. 12, fig. 1 and 3 (*C. theminckiana*).
1885. SCHEPMAN, Tijdschr. Ned. Dierk. Ver. (2) 1, p. 6-7 (*Canidia helena*).
1890. BOETTGER, Ber. Senckenb. p. 165 (*Canidia helena*).
1891. SCHEPMAN, Notes Leyden Mus. 13, p. 156 (*Canidia helena* var. *rotundicosta* and f. *angustior*).
1894. HORST & SCHEPMAN, Catal. Syst. Moll. Mus. Hist. Nat. Pays-Bas, Vol. 13, Part 1, p. 124 (*Canidia theminckiana*, *C. helena* var. *rotundicosta*).

1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 75 (*Canidia helena*), p. 306 (*C. helena* and *C. temminkiana*).
1912. SCHEPMAN, Proc. Malac. Soc. London, 10, p. 236 (*Canidia helena*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 220 and p. 259 (*Canidia helena*), p. 260 (*C. temminkiana*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 86 (*Canidia helena* and *C. temminkiana*).
1934. RENSCH, Trop. Binnengew. 5, p. 244, fig. 14 (*Canidia helena*).
1935. PARAVICINI, Arch. Moll. Kunde, 67, p. 175 (*Clea (Anentome) helena*).
1951. THIENEMANN, Arch. Hydrobiol. Suppl. Bd 19, p. 535 (*Canidia helena*).
1954. VAN NIEL, Penggemar Alam, 34, p. 107 (*Anentome helena*).
1954. BUTOT, Penggemar Alam, 34, p. 108-115, fig. 1-2 (*Anentome helena*).

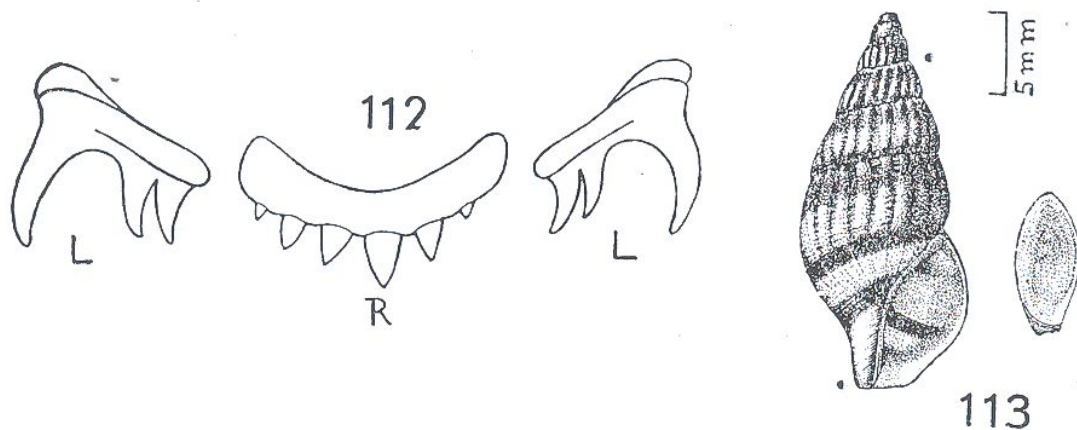


Fig. 112. *Anentome helena* (v. D. BUSCH). Radula elements. Author del.

Fig. 113. *Anentome helena* (v. D. BUSCH). Shell and operculum. ABDULKADIR del.

Shell turreted, olive-brown under a brown epidermis. With three brown spiral bands, one on, or just above, the middle of each whorl, one just below the periphery and one in the umbilical region. Thick, not transparent. Ribbed with rounded or sharp, somewhat undulating axial ribs, varying in number between 12 and 27 on the last whorl. Between the ribs a weaker spiral striation is visible. This spiral sculpture is more distinct below the periphery where the longitudinal ribs fade away.

Whorls 7-8, rather convex. First $1\frac{1}{2}$ whorls smooth, the following two more or less angular above the periphery, later whorls rounded in adult shells. In immature shells the periphery is angular. Top pointed, but not sharp, often eroded. Base produced into a short canal or siphon. Imperforate.

Aperture almost vertical, oval or pear-shaped. Siphonal canal short and wide. Peristome thickened, but not expanded. Exterior margin with a shallow notch between the periphery and the siphonal canal.

Operculum pear-shaped, with the nucleus at the narrow end. Growth ridges in wide curves. At the interior side, behind the nucleus, there is an elevated ridge or knob.

Dimensions: height 18-22, width 8-10, height of aperture 9-10 mm.

Distribution: Java, Sumatra, Borneo, Timor. Whether the reference New Hannover (MARTENS, 1897) really concerns this species remains to be seen.

Habitat in Java: in lakes and rivers, fish ponds and lakes, always in fresh water.

West Java: Lake Danau in Bantam; between Antjol and Djakarta; Djakarta; River Tjiliwung near Djakarta; Bogor; ponds near the palace at Bogor (BUTOT, 1954); Tjiliwung near Bogor (BOETTGER, 1890); Tjiburial near Bogor; lake near Kuripan; Sukabumi; River Tjikaso, near Tandjong Sari, district of Sukabumi (BUTOT, 1954); Palabuan near Wijnkoopsbay; Malangbong (MARTENS, 1897); Tjipanas near Garut; Lake Pendjalu; fish ponds along Lake Pendjalu; Situ Bagendit; Lake Leles, between Bandung and Garut.

Central Java: Kedungwuni, on stones in Kali Senengkaran, near railway bridge; River Tuntang; Kali Lerang, near Kebumen; Baung waterfall near Purwodadi; Kali Besèk, near Sulang, S of Rembang.

East Java: Rawah Gelapan and Rawah Bening, S of Kediri; Modjokerto; Prapat; Surabaya (MARTENS, 1897); Malang; Ranu Klindungan (RENSCH, 1934); Ranu Klakah.

Anentome helena has also been recorded from the island of Madura, off the Northcoast of East Java.

There is a certain amount of variation in the number of axial ribs on the whorls and in the strength of their development. As stated before, the number varies between 12 and 27 (RENSCH, 1934, p. 244 mentioned 14-22 ribs) and the strength between sharply pinched ridges and low, smooth undulations. SCHEPMAN (1891) described a variety *rotundicosta* in which the ribs are broadly rounded with rather narrow intermediate spaces. A very slender variant of this variety was distinguished by him as forma *angustior*. Both the variety and the forma are browner than the main species.

Although somewhat more slender and more closely ribbed than typical *Anentome helena*, the shells described as *Melania theminckiana* by PETIT (1853) are not sufficiently distinct to be maintained as a separate species (a fact which PETIT acknowledged in 1856, Journ. de Conch. 5, p. 41).

In the radula the central tooth is broader than long, with anterior and posterior margins curved, the cutting edge with 4, 5, 6 or 7 pointed cusps, often irregular in shape. The lateral teeth are large and strong, with 2-4 cusps, all somewhat hook-shaped, especially the exterior one.

BROT (1876) mentioned 7 cusps, SCHEPMAN (1885) 4 and 5 cusps, RENSCH (1934) 7 cusps in the central tooth. My own preparations revealed rhachidial teeth with 6 cusps (Fig. 112) and BUTOT (1954) found 5 cusps in a Sumatran specimen. This last snail showed an abnormality in the lateral teeth, the left longitudinal row bearing laterals with 4 cusps, the right row with 3 cusps.

From other investigations (LEBOUR, 1906, Journ. of Conch. 11, p. 282-286) it appears that most Buccinidae are exceedingly irregular as to their radula. Sometimes it is even impossible to say which is the normal form.

Mr J. P. VAN NIEL (1954) made some observations on the feeding habits of *Anentome helena* in Sumatra. He kept some snails in his home aquarium and observed that one of them consumed a live *Indoplanorbis exustus* by halfway entering the last whorl. All three *A. helena* attacked a live earthworm thrown into the aquarium, and after this a dead "ikan kepala tima" (*Panchax panchax*). Of this fish the intestine, the throat and the eyes were devoured, but the rest of the body was left untouched. An examination of the earthworm proved that the skin was pierced by many minute holes, and that the interior organs were digested for the greater part. Finally some young *Bellamya javanica* were attacked by destroying the top whorls and getting access to the soft parts along this way. After their meal the snails retired into the sand on the bottom, burrowing so deep that only part of the shell projected above the sand.

These observations show that *Anentome helena* is a highly predatory mollusc. They never touched the algae in the aquarium.

Familia AMPHIBOLIDAE.

Shell low conical, naticoid, with large last whorl. Coarsely sculptured in *Amphibola*, but much finer in *Salinator*. Most species with open umbilicus, but some are imperforate.

Aperture large, about semicircular. In *Amphibola* the outer lip has a distinct sinus in the upper corner, in *Salinator* there is no such extension.

As far as they have been investigated all species bear a thin, horny, paucispiral operculum.

Animals almost without tentacles, with a broad and low head, and a broad foot. Radula ∞ .2.1.2. ∞ (fig. 114). Breathing takes place by a "waterlung", i.e. there is no gill, but the mantle cavity has vacuolized walls and is filled with water. The animals are hermaphroditic; the male and female ducts can be combined (monaulic system, *Amphibola*), or separated, diaulic system, *Salinator*). Reproduction is unknown.

Distribution: southern and eastern Asia, Australia, New Zealand, Fiji islands. The species generally live between tide marks in salt or brackish water, in mud or sand in sheltered bays, estuaries or mangrove swamps (HUBENDICK, 1945, Proc. Malac. Soc. London, 26, p. 106).

Genus *Salinator* HEDLEY, 1900.

Shell rather small, naticoid, with large last whorl. Finely sculptured by the growth striae. Most species with open umbilicus, but some are imperforate. Aperture large, semicircular. Peristome without sinus in the upper corner.

Operculum paucispiral, thin, horny.

Animal with one pair of short tentacles. Foot broad, head broad and flat. Radula ~.2.1.2.~, the central tooth broad with 5 cusps. Somewhat above and behind the rhachis lies a small, unicuspid, lateral tooth, then follow a large, tricuspid lateral tooth and a number of long, hook- or dagger-shaped marginals (SCHACKO, 1878, Jahrb. Deutsch. Malak. Ges. 5, p. 1-9, pl. 1).

Breathing takes place by a lung which is filled with water. There is no gill. The animal of *Salinator fragilis*, the only one investigated, is hermaphroditic. Male and female ducts are separated (diaulic condition).

Distribution: Australia, Fiji, Philippines, Southern China, Japan, India, Burma, Malaya, Sumatra, Java.

In Java there are two species:

1. Shell with rather coarse growth striae. Whorls well-rounded, not or hardly descending towards the aperture. Suture deep. Umbilicus wide **fragilis**
- Shell with fine growth striae. Whorls flatter, distinctly descending towards the aperture. Suture shallower. Umbilicus narrower. . . **burmana**

Salinator fragilis (LAMARCK, 1822) (fig. 114, 115).

1822. LAMARCK, Hist. Nat. Anim. s. Vert. Vol. 6, Part 2, p. 179 (*Ampullaria*).

1945. HUBENDICK, Proc. Malac. Soc. London, 26, p. 107.

1952. MERMOD, Rev. Suisse Zool. 59, p. 95, fig. 153 (*Ampullaria*).

Shell turbinate, naticoid. Spire moderately elevated, last whorl large and inflated. Horn colour or greyish-yellow, with occasional brown spiral lines. These lines can coalesce to one or two broad spiral bands. The brown coloration now and then appears as vertical, wavy streaks. Epidermis rusty-brown. Lines of growth rather coarse and uneven in adult shells. Surface not or hardly polished, shell little transparent.

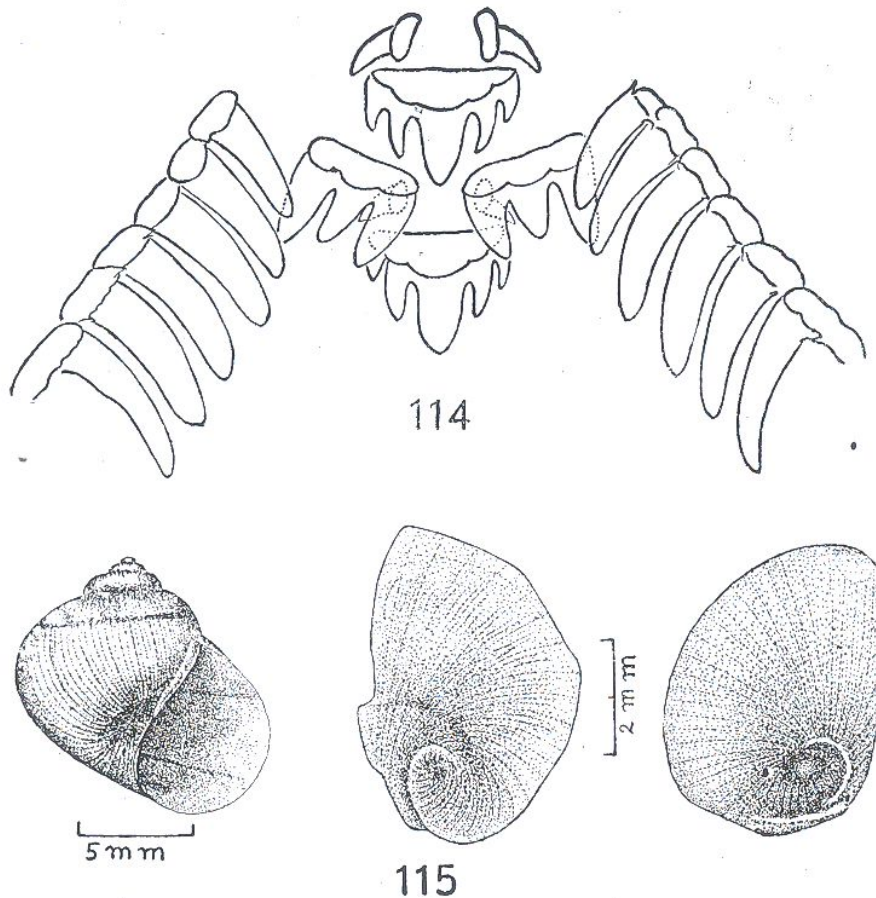


Fig. 114. *Salinator fragilis* (LAM.). Radula elements (after SCHACKO).

Fig. 115. *Salinator fragilis* (LAM.). Shell, and operculum from out- and inside, more enlarged. ABDULKADIR del.

Whorls about 5, rapidly increasing in size, well rounded. Not or hardly descending towards the aperture, in some shells even a little ascending. Periphery rounded, occasionally with an obsolete "shoulder" above the periphery. Suture deep, in adult shells even somewhat canaliculate. Top pointed, base rounded. Umbilicus open, wide.

Aperture semicircular, wide, little oblique. Peristome with almost straight columellar side and evenly rounded free margin. In adult shells the peristome is continuous.

Operculum horny, thin, surface sometimes fibrous. Spirally coiled with few whorls. Nucleus in the left lower corner.

Dimensions: height 12-16, width 11-15, height of aperture 8-10 mm.

Distribution: Southern Australia from King George's Sound (Western Australia) to Port Jackson (New South Wales); Tasmania; Java.

Habitat in Java: brackish water, in fish ponds and along the coast.

West Java: Cheribon.

East Java: Surabaya; Tambak Sarijoso near Surabaya, in brackish water.

A somewhat more conical form with a more produced spire, coarser shell sculpture and darker colour pattern has been distinguished as *Salinator fragilis* f. *quoyana* (POTIEZ & MICHAUD, 1838). In Java it was found only once, among a large series of the typical form, at Cheribon.

Salinator burmana (BLANFORD, 1867) (fig. 116).

1867. BLANFORD, Journ. As. Soc. Bengal, 36, Part II, p. 66, pl. 13, fig. 7-10 (*Amphibola*).

1930. VERWEY, Treubia, 12, p. 175, 176, 180, 190.

1945. HUBENDICK, Proc. Malac. Soc. London, 26, p. 108.

Shell turbinate, naticoid. Spire moderately elevated, last whorl large and inflated. Light straw-colour, with occasional brown spiral lines. In some shells these lines coalesce to broad spiral bands. Epidermis light horn-colour in young shells, but rusty-brown in adult ones. Lines of growth fine, slightly sinuous. Young shells polished and transparent, adult ones no longer so.

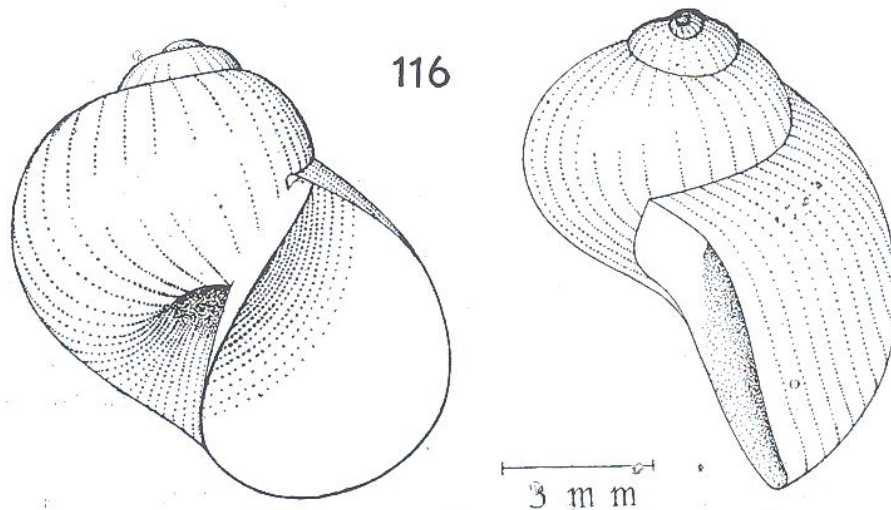


Fig. 116. *Salinator burmana* (BLF.). Shell. D. HEMMINGA del.

Whorls $4\frac{1}{2}$ -5, rapidly increasing in size, more flatly rounded than in the preceding species, distinctly descending towards the aperture. Occasionally the whorls can be slightly "shouldered" above the periphery. Suture shallower than in *Salinator fragilis*. Periphery rounded. Top pointed, base rounded. Umbilicus open and rather wide, although not so wide as in *S. fragilis*.

Aperture wide, semicircular, little oblique. Peristome with almost straight columellar side. The free margin is evenly rounded, although somewhat more flattened in the upper part than in *S. fragilis*. Peristome not continuous, the interruption in the upper left corner is short.

Operculum horny, very thin. With one or two spiral whorls round an excentric nucleus at the left basal side.

Dimensions: height 8-12, width 8-11, height of aperture 5-8 mm.

Distribution: India, Burma, Java.

Habitat in Java: in mangrove swamps, fish ponds, in brackish water in the mud.

West Java: Muara Tangerang, W of Djakarta; mangrove near Djakarta; fish ponds along the coast near Djakarta; Cheribon.

East Java: environs of Surabaya; mangrove swamps near Kampong Gendjeran, E. of Surabaya.

Salinator burmana has also been found in the island of Amsterdam, Bay of Djakarta.

Familia LYMNAEIDAE.

Shell turreted to broad-oval, with large, produced spire, or with hardly any elevation of the spire at all. Last whorl generally wide. Most species have thin yellowish-brown or yellowish-green shells with rounded whorls. Suture distinct. Umbilicus open or closed.

Aperture wide, with sharp, fragile peristome. Columellar side twisted longitudinally.

Animal with a broad foot and flat, triangular tentacles. Eyes lying at the base of the tentacles.

Respiration takes place by means of a "lung". The animals are hermaphroditic. Reproduction by means of eggs which are laid in a gelatinous mass.

Radula ∞ .1. ∞ , the rhachis unicuspid or indistinctly tricuspid.

Distribution: all continents, with the exception of N.E. Canada and N.E. Siberia, northern South America, Central North Africa, S.W. Australia and various Pacific islands (HUBENDICK, 1951, Kgl. Svenska Vetensk. Akad. Handl. (4) 3, no. 1, map p. 177).

In Java only one genus:

Lymnaea LAMARCK, 1799.

Shell turreted to broad-oval. Spire high, moderate, or very low, hardly projecting above the whorls. Last whorl generally very wide. Most species with thin, yellowish-brown or yellowish-green shells. Whorls well rounded; suture distinct. Rimate or with closed umbilicus.

Aperture wide, with sharp, fragile peristome. In some species with an internal rib strengthening the exterior margin. Peristome not conti-

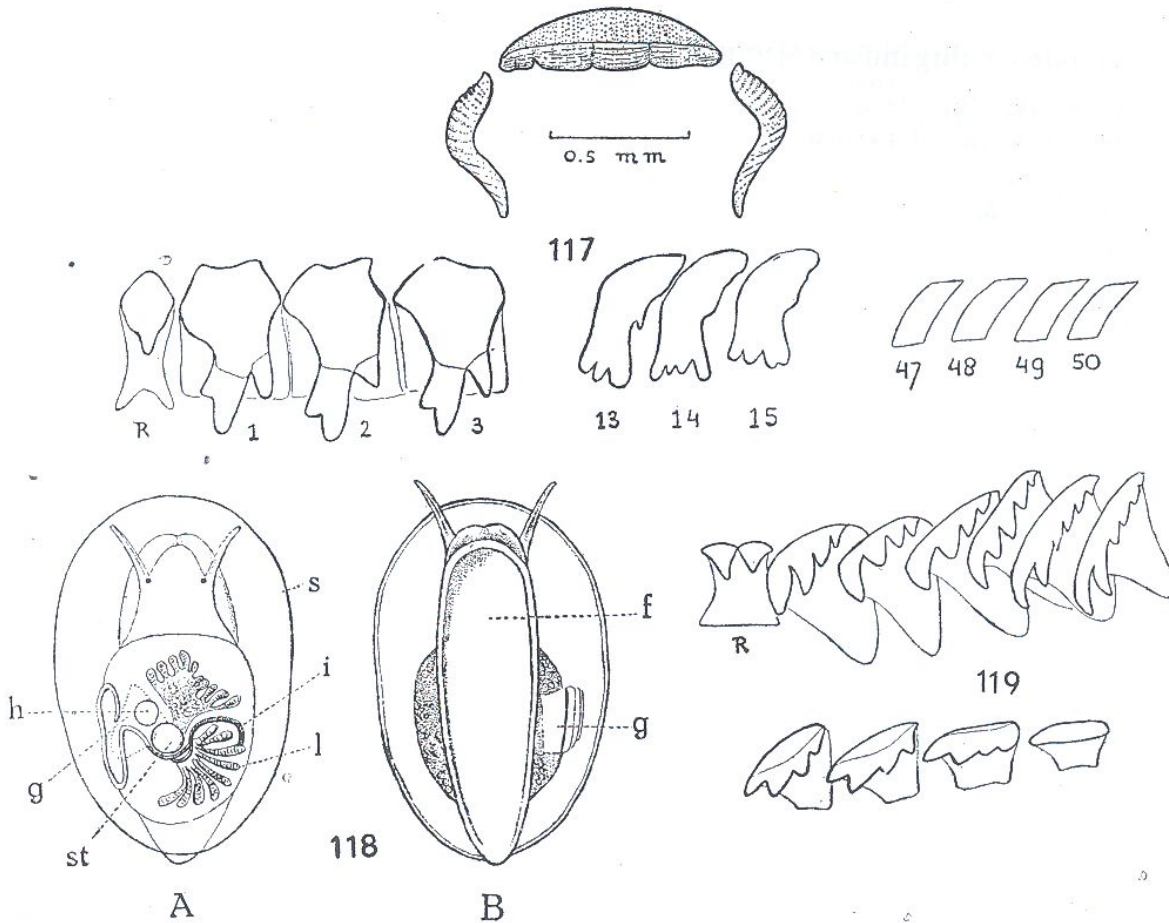


Fig. 117. *Lymnaea rubiginosa* MICH. Mandibula and radula elements. Author del.
 Fig. 118. *Ferrissia javana* (MRTS). Animal from A. top, and B. base, f. foot, g. gill, h. heart, i. intestine, l. mid-gut gland, s. shell, st. stomach. ABDULKADIR del.
 Fig. 119. *Ferrissia javana* (MRTS). Radula elements. Author del.

nuous. Columellar side more or less conspicuously twisted longitudinally. Operculum absent.

Animal with broad foot and flat, triangular tentacles. Eyes at the base of the tentacles (fig. 120). Hermaphroditic. Although cross fertilization is the normal mode of reproduction, self fertilization can occur in isolated individuals. Eggs are deposited in gelatinous strings on water plants, stones, branches, etc.

Radula $\infty.1.\infty$. The central tooth is small, and asymmetrical, as only the right lateral cusp is well developed. The adjoining laterals are strong, tricuspid. Mandibula slightly curved, with a chitinous appendage on each side (fig. 117).

Distribution: almost cosmopolitan (see under distribution of the family Lymnaeidae). Mostly in fresh water, stagnant or slowly running. Some species can tolerate a low amount of salt water.

In Java only one species:

***Lymnaea rubiginosa* (MICHELIN, 1831) (fig. 117, 120 and 121).**

1831. MICHELIN, Mag. de Zool. 1, part 1, Moll. no. 22, pl. 22 (*Lymnaeus rubiginosus*).
1834. DESHAYES, in: BELANGER, Voy. Ind. Orient. p. 418, pl. 2, fig. 13, 14 (*Limnaea succinea*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 267 (*Limnaeus succineus* and *L. longulus*).
1849. MOUSSON, Land & Süsww. Moll. Java, p. 42, pl. 5, fig. 1 (*Limnaeus succineus* var. *javanica*), p. 43, pl. 5, fig. 2 and 3 (*L. longulus* and vars *gracilis* and *brevis*).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Indië, 21, p. 318 (*Limnaeus succineus* and *L. longulus*).
1862. KÜSTER, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 17b, p. 29, pl. 5, fig. 18, 19 (*Limnaeus succineus*), p. 30, pl. 5, fig. 20, 21, 22 (*L. auricula*), p. 30, pl. 5, fig. 23, 24 (*L. rubiginosus*), p. 34, pl. 6, fig. 13 (*L. megaspida*), p. 35, pl. 6, fig. 17 (*L. singaporinus*).
1867. MARTENS, Malak. Blätt. 14, p. 222-225 (*Limnaeus javanicus* and vars *obesus*, *intumescens*, *moussoni*, *rubiginosus*, *longulus*, *gibberulus*, *spirulatus*).
1878. NEVILL, Hand List Moll. Ind. Mus. 1, p. 232 (*Limnaeus javanicus*).
1881. MARTENS, Conch. Mitt. 1, p. 87-91, pl. 16, fig. 1-10 (*Limnaea javanica* and vars *obesa*, *intumescens*, *ventrosa*, *subteres*, *angustior*).
1886. CLESSIN, in: MART.-CHEMN. N. Syst. Conch. Cab. Vol. 1, Part 17, p. 392, pl. 55, fig. 12 (*Limnaeus javanicus*).
1890. BOETTGER, Ber. Senckenb. p. 150, pl. 6, fig. 3 (*Limnaeus javanicus* var. *intumescens* and var. *longula*).
1891. BOETTGER, Ber. Senckenb. p. 244 (*Limnaeus javanicus* var. *subteres* and var. *longula*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 3, pl. 1, fig. 3-7, pl. 12, fig. 2 and 4 (*Limnaea javanica* incl. vars *costulata*, *intumescens*, *ventrosa*, *turgidula*, *subteres*, *angustior*, *porrecta*).
1908. BRANCA, Sitz. Ber. Kgl. Preuss. Akad. Wiss. Berlin, p. 272 (*Limnäus javanicus*).
1911. MARTIN-ICKE, Pithecanthr. Schichten Java, p. 50 (*Limnaeus rubiginosus*).
1912. SCHEPMAN, Proc. Malac. Soc. London, 10, p. 235 (*Limnaea javanica*).
1913. SCHEPMAN, Siboga Exp. Livr. 49-1-f, p. 459 (*Limnaea javanica*).
1914. LÖSCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 216 (*Limnaea javanica* var. *intumescens*), p. 249 (*Lymnaea javanica*, incl. vars. *angustior*, *costulata*, *gibberula*, *intumescens*, *longula*, *obesa*, *porrecta*, *spirulata*, *subteres*, *ventrosa*).
1915. SCHEPMAN, Bijdr. t.d. Dierk. 20, p. 23 (*Limnaea javanica*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 69 (*Limnaea rubiginosa*).
1923. OOSTINGH, Meded. Landb. Hooges. Vol. 26, Part 3, p. 156 (*Lymnaea javanica* fa. *obesa*).
1924. SCHEIBENER, Trop. Natuur, 13, p. 93, fig. 1 (*Lymnaea javanica*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 83 (*Limnaea javanica* and vars *angustior*, *costulata*, *gibberula*, *intumescens*, *longula*, *obesa*, *porrecta*, *spirulata*, *subteres*, *ventrosa*).
1931. VAN ES, Age of Pithecanthropus, p. 136 (*Limnaeus rubiginosa*).
1931. VAN DER VLERK, Leidsche Geol. Meded. 5, p. 208 (*Limnaea rubiginosa*).

- 1934a. RENSCH, Zool. Jahrb. (Syst.) 65, p. 390 (*Limnaea succinea*).
- 1934b. RENSCH, Trop. Binnengew. 5, p. 204 (*Limnaea succinea*).
1935. OOSTINGH, Wetensch. Meded. Dienst Mijnb. Ned. Ind. 26, p. 117 (*Lymnaea javanica*).
1935. PARAVICINI, Arch. Moll. Kunde, 67, p. 175 (*Limnaea javanica*).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 97, pl. 4, fig. 1-5 (*Lymnaea javanica*).
1939. SANDGROUND, Geneesk. Tijdschr. Ned. Ind. 79, p. 1726 and following ones (*Lymnaea rubiginosa brevis*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 291 (*Lymnaea javanica*).
1947. BONNE, BRAS & LIE KIAN JOE, Medisch Maandbl. p. 207-209 (*Lymnaea rubiginosa*).
1948. BONNE, BRAS & LIE KIAN JOE, Medisch Maandbl. p. 457, 460 and 462 (*Lymnaea rubiginosa*).
1951. HUBENDICK, Kgl. Svenska Vetensk. Akad. Handl. (4) 3, Part 1, p. 50 and 191 (*Lymnaea javanica*), p. 50 and 205 (*L. succinea*), p. 52 (*L. labiosa*), p. 52 and 181 (*L. auricula*), p. 56 and 194 (*L. megaspida*), p. 56 and 193 (*L. longula*), p. 180 (*L. angustior*), p. 182 (*L. brevis*), p. 185 (*L. costulata*), p. 188 (*L. gibberulus*), p. 189 (*L. gracilis*), p. 190 (*L. intumescens*), p. 197 (*L. obesus*), p. 56 and 201 (*L. rubiginosa*), p. 204 (*L. spirulatus*), p. 207 (*L. ventrosa*).
1951. THIENEMANN, Arch. Hydrobiol. Suppl. Bd 19, p. 535 and 541 (*Limnaea succinea*).
1953. BUTOT, Trop. Natuur, 33, p. 30 (*Lymnaea auricularia* race *rubiginosa*).
1954. BUTOT, Basteria, 18, p. 65 (*Lymnaea javanica*).

Shell thin, of about oval shape with moderate to rather high pointed spire and large, inflated last whorl. Unicolorous straw-yellow or light amber or olive. Occasionally a longitudinal coloration of stripes occurs. The whole shell is somewhat shining and transparent. Surface with fine growth striae, sometimes of equal strength and evenly distributed, sometimes arranged in bundles, separated by intervals, forming quasi vertical ribs. Other shells can be "hammered". A very delicate spiral structure can also occur. The entire surface is covered by "a thin periostracum which is often incrustated with foreign matter."

Whorls about 6, rapidly increasing in size. The whorls of the spire rather flat, the ultimate and penultimate ones moderately rounded. Suture well impressed. Periphery rounded, or, in some modifications, with high "shoulder". Apex reddish-brown, shining, sharp. Base rounded. Umbilicus closed or as a narrow slit.

Aperture slightly oblique, elongate-oval to broad-oval, pointed at the upper corner, rounded, but not widened at the base. Peristome not continuous, sharp, fragile, not reflected. The two ends are connected by a thin, filmy callus against the parietal wall. The parieto-columellar side is slightly twisted longitudinally.

Dimensions: height 30-34, width 18-20, height of aperture 20-24 mm.

Distribution: Southern Siam, Malay Peninsula, Greater and Lesser Sunda Islands, Buru, New Guinea, Philippines. The species has been introduced with tropical waterplants in the hothouses of the Zoo at Blijdorp (Rotterdam) (MEEUSE & HUBERT, 1949, *Basteria*, 13, p. 9, pl. 1, fig. 1a, b, fig. 2 s.n. *Radix javanica longula*).

Habitat in Java: in stagnant and slowly running fresh water, very common between sea level and about 2000 m alt. Occasionally in hot springs (c. 34°C).

West Java: Tjiringhin (MOUSSON, 1849); Udjong Kulon; sawahs near Pasauran; Lake Danau; sawahs near Pasirangin, slope of Mt Karang; Djakarta; ditch on Gunung Sari Road, Djakarta; near mouth of Tji Lamaja, Djakarta; Bronbeek near Djakarta (SANDGROUND, 1939); sawahs near Kuripan; sawah near Depok; sawahs near Mt Tjibodas, Tjampea; Tjikoya (MARTENS, 1867); environs of Bogor, Tjiliwung near Bogor (BOETTGER, 1891); ponds in the Botanical Gardens, Bogor; Dramaga, near Bogor; Tjiomas near Bogor; Gadok (MARTENS, 1867); Tjiseëng, sawahs near the sulphur wells; Tjitajam (LESCHKE, 1914); Tjisarua, in sawahs; Telaga Warna near Puntjak pass; fish pond S of Puntjak pass (RENSCH, 1934b); Sindanglaja; Tjipanas, small spring and marsh near swimming pool; Tjibodas, G. Gedeh, in small ponds near the Laboratory; brook near Tjibeureum, G. Gedeh; Situ Gunung, S slope of Mt Gedeh; Lake Tjigombong near Bogor; Sukabumi, small, quickly running river; Palabuan; between Tjugenang and Tjiandjur, in sawahs; fish ponds at the foot of Mt Patuha; Telaga Patengan, Mt Patuha; Tjibeureum, Mt Tilu; Pengalengan; sawahs near Bandung; on rock in Dago waterfall, near Bandung; rivulets and waterfall near Bandung; between Bandung and Lembang, in sawahs and on wet rocks; Lembang, in swimming pool; Lembang, pond in hotel grounds; Mt Tangkuban Prahur; brook near Hack's Radium Hotel, Mt Guntur; Lake Leles; Situ Bagendit, near Garut; Tjipanas near Garut, in hot springs; lakes in the English Plains, near Garut; Tjisurupan, near Garut (MARTENS, 1867, 1881); Estate of Bandjarwangi, near Tjikadjang; brook between Garut and Tasikmalaja; Lake of Pendjalu; draining ditches on Estate Pangandaran, near Dirk de Vriesbay; steep valley along road to Subang near Tjiater, in ponds; Tenger Agung near Subang; sawahs along road of Bandung to Sumedang; Tjisaaranang near kampong Tjariang, district of Sumedang.

Central Java: Kedungwuni, sawah near footballfield; Seraju river near Dieng Plateau (RENSCH, 1934b); Tegal Pangonan, Telaga Balekambang, Telaga Sewiwi, Kali Putih, and marsh near Kali Dolog, all on Dieng Plateau; Tuntang river; Rawah Pening, near Ambarawa; along road

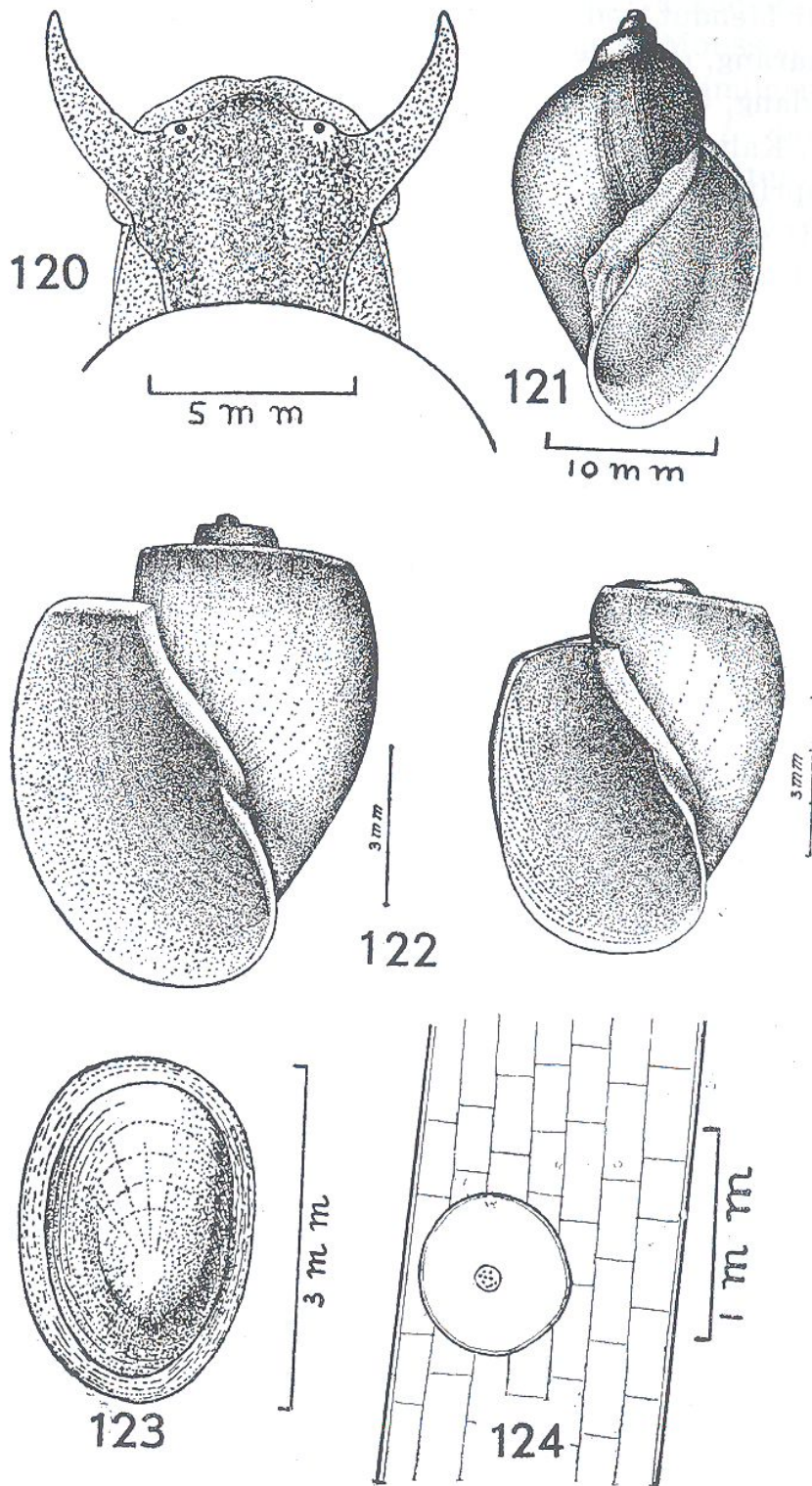


Fig. 120. *Lymnaea rubiginosa* MICH. Head of animal, with eyes and tentacles. ABDULKADIR del.

Fig. 121. *Lymnaea rubiginosa* MICH. Shell. ABDULKADIR del.

Fig. 122. *Amerianna carinata* (ADS). Shell (after BUTOT).

Fig. 123. *Ferrissia javana* (MRTS). Shell. Author del.

Fig. 124. *Ferrissia javana* (MRTS). Egg. Author del.

between Tjandi Mendut and Djokja; Kali Lerang, near Kebumen; Koppeng near Semarang, outflow of swimming pool; Demak; Rembang; Kali Besèk, near Sulang, S. of Rembang; in sawah near Mantingan.

East Java: Kali Soko, right tributary river of Kali Solo, near Trinil; Lake Ngebel; spring at N bank of Lake Ngebel and spring on Mt Nukoro, near Ngebel (RENSCH, 1934b); River Tedja, near Kediri; Rawah Bening, near Kediri; Surabaya; Armenian Sport Club, Surabaya; Pasuruan (MARTENS, 1867, 1881); Ranu Klindungan; Mt Ardjuno; Prigen, on Mt Ardjuno; Lawang, pond below cataract; fish ponds at Punten, near Malang; in outflow of hot springs near Malang (MARTENS, 1867, 1881); mountain ponds on Mt Batu; Djemprak, in brooks, sawahs, ponds; Nongkodjadar, in stream; Tengger Mts; Ranu Lamongan; Ranu Bedali (RENSCH, 1934b); Ranu Pakis; Djangkar, N coast of E Java; Djember, in ponds, sawahs, and brook; Estate of Kali Mrawan, near the house; Blawan lor, Idjen plateau; travertine deposits near coffee estate Blawan, Idjen plateau; hot water lake near Djeding, Idjen plateau; Kalisat, Idjen plateau; Banjuwangi; Rogodjampi (MARTENS, 1867).

Lymnaea rubiginosa has also been collected at Sumenap, island of Madura (MARTENS, 1867, 1881; VAN BENTHEM JUTTING, 1941).

This species has been recorded from Pliocene layers at Bumiaju and Kali Tjemoro (Central Java) (OOSTINGH, 1935) and from Pleistocene layers at Trinil and other excavations in the Kendeng Mountains (East Java) (BRANCA, 1908; MARTIN-ICKE, 1911; MARTIN, 1919; VAN ES, 1931; VAN DER VLERK, 1931; VAN BENTHEM JUTTING, 1937).

As so many other species of *Lymnaea* the Javanese species is extremely variable in shape. The height of the spire, the width of the aperture, the convexity of the whorls, the sculpture of the exterior surface, and other characters vary to a great extent. These variations do not seem to be bound to certain geographical regions. Yet there is some evidence that ecological factors influence the morphology of the shell (extreme low or extreme high temperatures, shortage of food, difference in water movement etc.) (see RENSCH, 1934a, p. 391-392; and 1934b, p. 205).

Lymnaea rubiginosa belongs to a large assemblage of related "species", "races" or "forms" distributed in continental Southern and South-eastern Asia, Malaysia and Philippines.

In 1951 HUBENDICK classified all these forms in three principal races with a great number of local modifications under the super-species *Lymnaea auricularia* (L.), mostly on account of the morphology of the genital organs (long and slender spermathecal duct, round or pear-shaped spermatheca, long penis, prostate with one internal fold). One of these races,

Lymnaea rubiginosa, inhabits Southern Siam, Malaya and the Sunda Islands. It includes the wellknown *Lymnaea javanica* (MOUSSON).

As it has not been definitely established that the similarity in organization of the race *L. rubiginosa* to the super-species *L. auricularia* is based on genetic relationship, and as there are other factors, especially the form of the shell, even in the very young stages, which point to a separation of the Malaysian form and the European species, I prefer to classify the common *Lymnaea* of Malaya and the Sunda Islands as *Lymnaea rubiginosa* (MICHELIN).

In the original diagnosis MICHELIN mentioned "les Indes orientales" as provenance. MARTENS (1867, p. 224) stated: "MICHELIN's Exemplare kommen auch von Batavia" (MICHELIN's specimens also come from Batavia).

It is very unfortunate that we know so very little of the general behaviour, respiration, food, and propagation of this common Javanese water snail.

Familia PLANORBIDAE.

Shell sinistral, either disc-shaped with the apex not projecting above the discoidal plane (*Indoplanorbis*, *Gyraulus*, *Polypylis*, *Helicorbis*), or turbinate with elevated spire (*Amerianna*). In the genus *Polypylis* the shell has internal septa.

Although the true nature of the shell (and of the body of the animal!) is sinistral, it is the general custom to treat the discoidal species (genera *Indoplanorbis*, *Gyraulus*, *Polypylis* and *Helicorbis*) as if they were dextral. This custom will be practised in the present work also.

Animal with two slender tentacles (fig. 129). In most species the blood is red. Although the animals chiefly breathe by means of a lung, some species possess an accessory gill. Correlated with the planorboid form is the elongate arrangement of the internal organs which are lying behind each other (not by the side of each other).

Radula $\sim 1 \sim$, the central tooth generally with 2 cusps, the latero-marginals with one large and a few smaller cusps, or all of uniform shape. The mandibula consists of a central transverse part and two vertical lateral appendages (fig. 128). In some species the lateral pieces can be broken up into numerous small plates.

The animals are hermaphroditic. Reproduction takes place by eggs which are deposited in considerable numbers in a gelatinous mass attached to water plants.

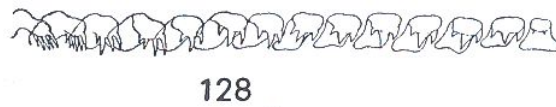
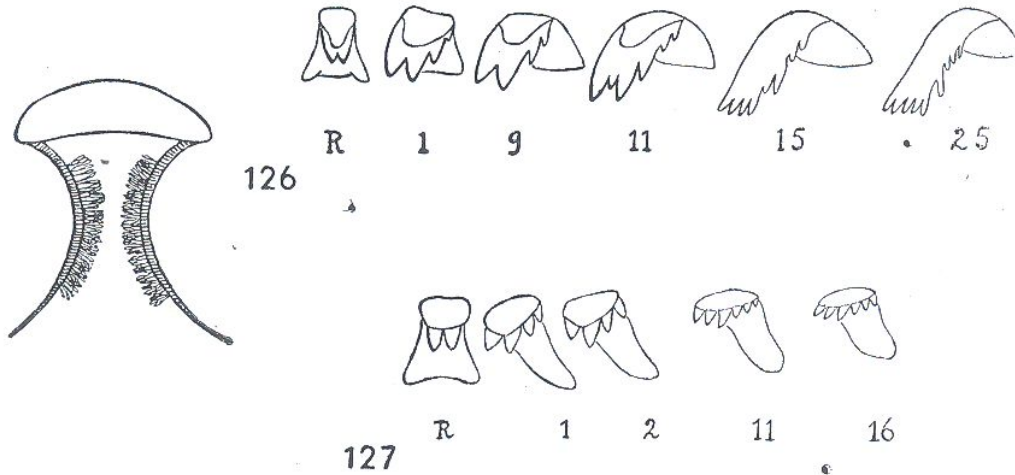
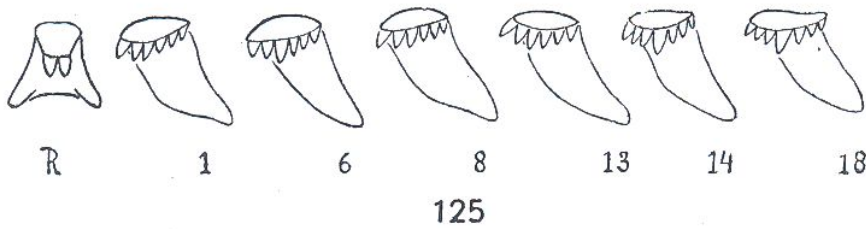


Fig. 125. *Polypylis kennardi* (BULL.). Radula elements. Author del.
 Fig. 126. *Indoplanorbis exustus* (DESH.). Mandibula (after RAO) and radula elements (after F. C. BAKER).
 Fig. 127. *Gyraulus convexiusculus* (HOTT.). Radula elements. Author del.
 Fig. 128. *Amerianna carinata* (ADS). Mandibula and radula elements (after BUTOT).

Distribution: all continents; even in arctic regions. Always in fresh water, either stagnant or slowly running. A few species can tolerate a low degree of salinity.

In Java there are five genera:

- 1. Shell discoidal, apex and whorls in one plane 2
- Shell turbinate, with elevated spire **Amerianna**
- 2. Shell large, whorls rounded at periphery **Indoplanorbis**
- Shell small, whorls rounded or carinate at periphery 3
- 3. Shell without internal septa 4
- Shell with internal septa **Polypylis**

4. Shell with rounded periphery (or, if carinated, the keel lies in the middle of the whorl). Whorls in wide spiral **Gyraulus**
 — Shell with blunt angle at the base of the whorl. Whorls in narrow spiral **Helicorbis**

Genus **Gyraulus** CHARPENTIER, 1887.

Shell mostly small. Whorls coiled in a flat spiral, round or carinate along the periphery. Upper and lower sides little convex, sometimes the top side a little more convex than the base. Apex in the same plane as the upper side of the whorls, or a little sunken. Suture distinct.

Animal with long, cylindrical tentacles, the eyes lying at their inner bases. Foot narrow. Accessory gill absent or as a small lobe, with a free, undivided margin. All internal organs elongate, lying behind each other. Blood red or colourless.

Radula \sim .1. \sim . The rhachis with two cusps. Inner laterals with one large and a few smaller cusps. Marginals with several small cusps (fig. 127).

Hermaphroditic. Penis with a stylet at its tip. Vergic sac and verge short. Reproduction takes place by eggs which are laid in small quantities in gelatinous strings.

Distribution: All continents, in fresh, mostly stagnant water or in sluggish streams.

In Java two species:

1. Shell very small (max. diam. 2.3 mm) and flat. All whorls visible on both sides. Top side little convex, apex not sunken : . . . **terraesacrae**
 — Shell larger (max. diam. about 8 mm) and not so compressed. Top side concave, apex deeply sunken **convexiusculus**

Gyraulus convexiusculus (HUTTON, 1849) (fig. 127, 129 and 130).

1834. HUTTON, Journ. As. Soc. Bengal, 3, p. 91 and 93 (*Planorbis compressus* non *Pl. compressus* MICHAUD 1831 = *Pl. vortex*).
1848. MOUSSON, Mitth. naturf. Ges. Zürich, 1, p. 267 (*Planorbis tondanensis* non *Pl. tondanensis* QUOY & GAIMARD, 1834).
1849. HUTTON, Journ. As. Soc. Bengal, 18, II, p. 657 (*Planorbis convexiusculus*).
1849. MOUSSON, Land & Süßsw. Moll. Java, p. 44, pl. 5, fig. 4 (*Planorbis tondanensis* non *Pl. tondanensis* QUOY & GAIMARD, 1834).
1859. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 18, p. 424 (*Planorbis propinquus*).
1860. ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 318 and 320 (*Planorbis tondanensis*).
1867. MARTENS, Malak. Blätt. 15, p. 213 (*Planorbis infralineatus* and *Pl. compressus*) and p. 214 (*Planorbis tondanensis*).

1878. NEVILI, Hand List Moll. Ind. Mus. 1, p. 244 (*Planorbis javanicus* nom. nud., and *Pl. tonganensis* sic!).
1891. BOETTGER, Ber. Senckenb. p. 245 (*Planorbis compressus* and *Pl. infralineatus*).
1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 12, pl. 1, fig. 14-16 (*Planorbis proclivis* pars), p. 13, pl. 1, fig. 17-22, pl. 12, fig. 7, 10 (*Pl. compressus*).
1911. MARTIN-ICKE, Pithecanthr. Schichten Java, p. 50 (*Planorbis tondanensis*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 216 and 250 (*Planorbis compressus* and *Pl. infralineatus*).
1919. MARTIN, Samml. Geol. Reichsmus. Leiden, Beilage Band, p. 69 (*Planorbis tondanensis*).
1921. GERMAIN, Rec. Ind. Mus. 21, p. 118 (*Planorbis convexiusculus*), p. 119 (*Pl. saigonensis*), p. 140 (*Pl. infralineatus*).
1931. VAN BENTHEM JUTTING, Treubia, 13, p. 5-8, fig. 1-4 (*Planorbis convexiusculus*).
1931. VAN ES, Age of Pithecanthropus, p. 136 (*Planorbis tondanensis*).
1931. VAN DER VLIERK, Leidsche Geol. Meded. 5, p. 208 (*Planorbis tondanensis*).
- 1934a. RENSCH, Zool. Jahrb. (Syst.) 65, p. 394 (*Gyraulus convexiusculus*).
- 1934b. RENSCH, Trop. Binnengew. 5, p. 209 (*Gyraulus convexiusculus*).
1935. OOSTINGH, Wetensch. Meded. Dienst Mijnb. Ned. Ind. 26, p. 117 (*Gyraulus convexiusculus*).
1935. PARAVICINI, Arch. Moll. Kunde, 67, p. 175 (*Anisus compressus*).
1937. VAN BENTHEM JUTTING, Zool. Meded. Mus. Leiden, 20, p. 96 (*Gyraulus convexiusculus*).
1939. SANDGROUND, Geneesk. Tijdschr. Ned. Indië, 79, p. 1725 ff (*Anisus convexiusculus*).
1940. BONNE, Natuurk. Tijdschr. Ned. Indië, 100, p. 3 (*Anisus convexiusculus*).
1941. VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 291 (*Anisus convexiusculus*).
1947. BONNE, BRAS & LIE KIAN JOE, Medisch Maandbl. p. 207-209 (*Anisus convexiusculus*).
1948. ABBOTT, Bull. Mus. Comp. Zool. 100, no. 3, p. 304, fig. 14 (*Gyraulus convexiusculus*).
1948. BONNE, BRAS & LIE KIAN JOE, Medisch Maandbl. p. 457, 460 and 462 (*Anisus convexiusculus*).
1951. THIENEMANN, Arch. Hydrobiol. Suppl. Bd 19, p. 535 and 541 (*Gyraulus convexiusculus*).
1953. BUTOT, Trop. Natuur, 33, p. 30 (*Planorbis convexiusculus*).

Shell disc-shaped, somewhat flatter below than on the top side. Yellowish olive or horn-colour, fragile, somewhat shining and transparent. Finely striated by the growth lines. Fine spiral striae can also occur, but are often obsolete.

Whorls 4-5, arranged in a flat spiral, increasing in diameter regularly, each whorl embracing a great part of its preceding one. All whorls are visible on top and basal side. Apex sunken. Whorls well rounded, suture deep. Periphery rounded, or angular or carinate, sometimes with a membranous fringe along the carina.

Aperture oblique, broad-oval, the upper margin projecting. Peristome sharp, not continuous, or with the two ends connected by a white callus against the penultimate whorl.

Dimensions: max. diam. 8, height 3 mm.

Distribution: Lower Mesopotamia, Eastern Persia, Seistan, India, Ceylon, Burma, Indo-China, China, Japan, Siam, Malaya, Malay Archipelago, New Guinea, Philippines.

Habitat in Java: fresh water of lakes, ponds, ditches, rice fields, and slowly running streams. Between sea level and about 2000 m alt.

West Java: Udjong Kulon; Djakarta (MARTENS, 1867); Tjiliwung, near Depok; lake near Kuripan; sawahs on the estate of Tjampea; Tjijam (LESCHKE, 1914); Bogor and environs; Tjiliwung near Bogor (BOETTGER, 1891); ponds in the Botanical Gardens, Bogor; Lake of Tjigombong; Sukabumi; Palabuan; pond and brook near lake of Sindangloja (RENSCH, 1934b); pond at Tjibodas, G. Gedeh, Telaga Paternan, on Mt Patuha; Bandung; between Lembang and Tjiater; between Bandung and Garut; Situ Bagendit; Kawah Kamodjan, near Garut; lakes in the English Plains near Garut; Palimanan; draining ditches on estate of Pangandaran, near Dirk de Vriesbay.

Central Java: spring of Seraju river near Patakbanteng, Dieng plateau (RENSCH, 1934b); Telaga Sewiwi, 2000 m, Dieng plateau; Semarang; Koppeng near Semarang; Borobudur (RENSCH, 1934b); lake near Rembang; Kali Besèk, near Sulang, S of Rembang.

East Java: Nasturtium marsh above Telaga Wurung near Sarangan (RENSCH, 1934b); Lake Ngebel; Rawah Bening near Kediri; Djemprak, brooks, sawahs, ponds; Ranu Klindungan, E of Pasuruan (RENSCH, 1934b); Ranu Bedali; Ranu Lamongan; Ranu Pakis; Djeding, hot water lake, Idjen plateau; Blawan lor, Idjen plateau; Kalisat, Idjen plateau.

The species has also been recorded from the Karimon Djawa islands, Madura and Pulu Besar, off the N coast of Java (VAN BENTHEM JUTTING, 1941).

Fossil records are from Pliocene layers at Bumiaju (Central Java) (OOSTINGH, 1935) and from Pleistocene layers at Trinil (East Java) (MARTIN-ICKE, 1911; MARTIN, 1919; VAN ES, 1931; VAN DER VLERK, 1931; VAN BENTHEM JUTTING 1937).

In my paper on freshwater molluscs from the Malay Archipelago (1931, p. 6) I discussed the reason for uniting *Planorbis convexiusculus* and *Pl. infralineatus*.

In the Zoological Museum of Zürich I studied the shells which MOUSSON (1848, 1849) recorded from Java (about 50 specimens) under the

name *Planorbis tondanensis*. These shells are all *Gyraulus convexiusculus* and are different from the true *Planorbis tondanensis* QUOY & GAIMARD from Celebes.

Another sample, collected by ZOLLINGER in 1856 at Buitenzorg (8 specimens) and preserved in the MOUSSON Collection, under the name *Planorbis tondanensis*, are equally *Gyraulus convexiusculus*.

Among the shells described by MARTENS (1897, p. 12-13) from Ajer Tabit and Tabeh di Aripa (Sumatra) as *Planorbis proclivis* there are 2 specimens (one from each locality) which are certainly not this species, but *Gyraulus convexiusculus*. One of them, the shell from Ajer Tabit, was figured by MARTENS on pl. 1, fig. 14, 15, 16. In the discussion on p. 13 MARTENS drew already attention to the difference in this Ajer Tabit shell, without, however, separating it.

The remaining material, i.e. the true *Planorbis proclivis*, is so similar to *Pl. sumatranus* described in the same publication that it seems adequate, as RENSCH (1934b, p. 212) proposed, to unite the two species, *Pl. sumatranus* having priority.

Gyraulus convexiusculus is known as an intermediate host for human echinostome infection (BONNE, 1940).

• *Gyraulus terraesacrae* RENSCH, 1934 (fig. 131).

1934. RENSCH, Trop. Binnengew. 5, p. 211, fig. 3.

Shell disc-shaped, almost equally flat above and below. Light straw-colour, fragile, somewhat shining, little transparent. Finely striated by the growth striae. On the initial whorl some extremely delicate spiral striae are visible.

Whorls $2\frac{1}{2}$ - $3\frac{1}{4}$, arranged in a flat spiral, regularly increasing in diameter. The whorls do not embrace each other so much as in *Gyraulus convexiusculus*. Periphery well rounded, suture deep. All whorls are visible on top and basal side. Apex not or scarcely sunken.

Aperture somewhat oblique, broad-oval or nearly round, the upper margin a little projecting. Peristome sharp, not continuous.

Dimensions: max. diam. 1.75-2.3, height 0.55-0.7 mm.

Distribution: Java.

Habitat in Java: only found once in a marsh, at 2000 m alt.

Central Java: marsh Toksewiwi, Dieng plateau.

Compared with shells of *G. convexiusculus* the present species is much smaller. In immature *G. convexiusculus* of the same diameter as the largest *G. terraesacrae* there are fewer whorls and each whorl of *G. convexiusculus* is higher and broader, with the apex more sunken. Moreover

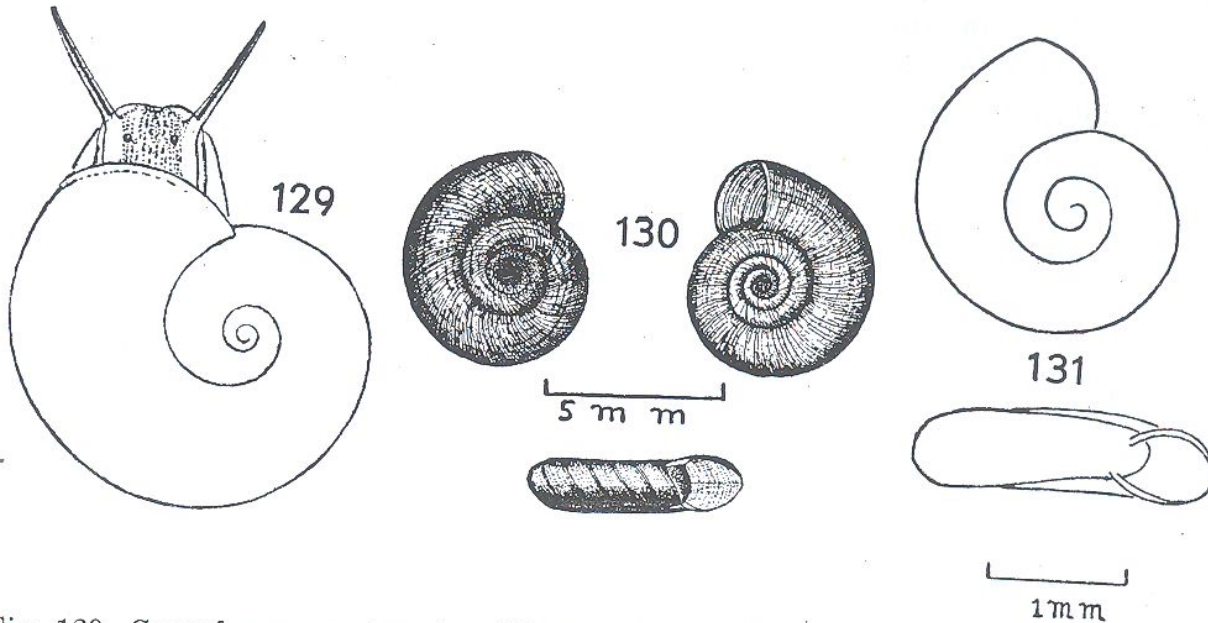


Fig. 129. *Gyraulus convexiusculus* (HUTT.). Shell with animal. ABDULKADIR del.

Fig. 130. *Gyraulus convexiusculus* (HUTT.). Shell from top, base and side. ABDULKADIR del.

Fig. 131. *Gyraulus terraesacrae* RENSCH. Shell from top and side. Author del.

G. convexiusculus is more narrowly coiled, each whorl embracing a great part of the preceding one, whereas in *G. terraesacrae* the whorls are more extending in width, leaving a greater part of the preceding one free. The top side of *G. terraesacrae* is less concave than in *G. convexiusculus*.

Genus *Polypyliis* PILSBRY, 1906.

Shell small, disc-shaped, with few, rapidly increasing whorls, each of which embraces the greater part of its preceding one. Consequently each previous whorl projects far into the lumen of the following one.

Top side concave, base almost flat. Umbilicus open or closed. Periphery angular. Interior of the shell with distantly placed groups of three low, transverse ridges which shine through the shell.

Animal with long, cylindrical tentacles (fig. 132). There is no accessory gill. Foot narrow and short. All internal organs elongate, placed behind each other.

Radula \sim .1. \sim . Central tooth with two cusps; the latero-marginal teeth almost of uniform shape, with several denticles (fig. 125).

Hermaphroditic. Penis without a stylet, and without penial gland in the praeputium. Reproduction takes place by eggs which are laid in small numbers in gelatinous capsules.

Distribution: tropical and oriental Asia. In fresh, stagnant water of lakes and ditches, among algae and higher vegetation, or on the bottom.

In shell form and in anatomy of the soft parts *Polypylis* is very close to the European *Segmentina* FLEMING, 1818. From this genus the oriental *Polypylis* differs in having a less flattened shell, and a (as a rule) less carinated periphery. The Javanese species, however, has a rather acutely keeled periphery. The chief difference in the anatomy is the absence of a penial gland in *Polypylis* (present in *Segmentina*).

In Java only one species:

***Polypylis kennardi* (BULLEN, 1906) (fig. 125, 132 and 133).**

1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 15 (*Segmentina calathus* non *calathus* BENSON, 1850).
 1906. BULLEN, Proc. Malac. Soc. London, 7, p. 130 (*Segmentina kennardi*).
 1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 250 (*Segmentina calathus*).
 1929. VAN BENTHEM JUTTING, Treubia, 11, p. 83 (*Segmentina calathus*).
 1931. VAN BENTHEM JUTTING, Treubia, 13, p. 8, fig. 5 and 6 (*Segmentina calathus*).
 1934. RENSCH, Trop. Binnengew. 5, p. 215 (*Segmentina kennardi*).
 1951. THIENEMANN, Arch. Hydrobiol. Suppl. Bd 19, p. 535 (*Segmentina kennardi*).
 1952. BUTOT, Trop. Natuur, 32, p. 18 (*Segmentina calathus*).
 1953. BUTOT, Trop. Natuur, 33, p. 30 (*Segmentina calathus*).

Shell rather high-discoidal, with diverging sides so that the profile is trapezoidal. Flattened above and below. Apex sunken. Yellowish-white or corneous-brown, often incrustated with brown foreign matter. Fresh specimens are transparent and shining. Surface with fine, undulating growth lines, crossed by still more delicate spiral ones, only visible under a strong lens (25 times or more).

Whorls about four, only visible on the top side. Suture rather deep. Last whorl very large, embracing the greater part of the shell. Sharply angular at the base along the periphery. Base on the whole flattened, but slightly convex in the middle of the last whorl and concave towards the umbilicus. Umbilicus minute, occluded.

In the interior of the shell there are 1-3 transverse systems of low, white septa. Each system consists of 2-3 ridges, one against the upper palatal wall, one against the basal wall and (occasionally) one against the parietal wall.

Aperture very oblique, broad semilunar, with angular exterior margin. Columellar side deeply split by the angle of the preceding whorl. Peristome not continuous. Upper margin arcuate, protruding; lower one almost straight, receding.

Dimensions: max. diam. 2.3-3.0, height 1.0-1.3 mm.

Distribution: Sumatra, Java, Sumba.

Habitat in Java: among algae in freshwater lakes and ditches.

West Java: Udjong Kulon; Kuripan near Bogor, in a lake; Bogor; Lake of Pendjalu; draining ditches on estate Pangandaran, near Dirk de Vriesbay.

East Java: Lake of Ngebel; Rawah Bening and Rawah Galapan, S of Kediri; Ranu Klindungan (RENSCH, 1934; THIENEMANN, 1951).

The species has been once found floating on the Bay of Djakarta (BUTOT, 1952).

I fully agree with RENSCH (1934, p. 215) when he proposes to unite *Segmentina taia* ANNANDALE & PRASHAD from India (1925, Rec. Ind. Mus. 27, p. 110, fig. 2) with *S. kennardi* BULLEN.

There is a lamentable confusion round this species, chiefly caused by VON MARTENS. This author (1897, p. 15) identified a shell from Bogor (= Buitenzorg) West Java, as *Segmentina calathus*, not realizing that the specimen he had before him was, in fact, entirely different from this Indian species. The Javanese form is smaller and higher, with a hair-fine or closed umbilical opening. It was described nine years later by BULLEN as *S. kennardi* from Mount Singgalang, Sumatra.

Another error was made by PRASHAD who identified as *Segmentina calathus* specimens from Medan, Sumatra (1921, Rec. Ind. Mus. 22, p. 474). These shells, however, do not possess internal septa at all. Hence they must be classified as *Helicorbis caenosus* (see next species).

As far as I know, the true *Polypylis calathus* (BENSON) has never been found in Sumatra, or in any other island of the Malay Archipelago.

Genus *Helicorbis* BENSON, 1855.

Shell small, discoidal, lens-shaped, with flat upper and lower sides and a distinctly angular or carinate periphery. Whorls narrowly coiled, each whorl clasping a great part of the preceding whorl. There are no internal septa. Umbilicus open, not wide. Light-brown, or vitreous horn-colour. Transparent and polished.

Animal with a small pseudobranch which is somewhat lobulate along its periphery.

Radula $\sim 1 \sim$, in shape and arrangement of teeth very much like *Polypylis*.

Hermaphroditic. Penis without a stylet.

Distribution: India, Burma, eastern and central China, Philippines, Java, Sumatra. In fresh and stagnant water, among vegetation.

In shell form *Helicorbis* resembles the European *Hippeutis*. From this genus the oriental *Helicorbis* differs in having a less carinate peri-

phery of the shell. Moreover this angularity does not occur along the middle of the whorl (as in *Hippeutus complanatus*), but close to, or entirely at the base.

In Java only one species:

***Helicorbis caenosus* (BENSON, 1850) (fig. 134).**

1850. BENSON, Ann. Mag. Nat. Hist. (2) 5, p. 349 (*Planorbis caenosus*).

1953. BUTOT, Trop. Natuur, 33, p. 30 (*Planorbis thienemanni*).

Shell discoidal, flattened above and below. Apex sunken. Finely striated by the growth lines, in fresh specimens transparent and glossy. Reddish-brown to light-brown, often incrustated with dark organic matter.

Whorls about 4. On the top all whorls are visible, at the base the last two whorls are visible in the umbilicus. Suture rather deep. Last whorl large, embracing the greater part of the previous one. Peripheral angle not quite at the base, as in *Polypylis kennardi*, and not so sharp as in this species. Umbilicus distinct, much wider than in *P. kennardi*. Interior septa absent.

Aperture very oblique, broad semi-lunar, exterior side angular at the periphery. Columellar side > shaped by the angle of the preceding whorl. Peristome not continuous. Upper margin arcuate, protruding. Lower margin almost straight, receding.

Dimensions: max. diam. 2.6-3.3, height 1.1-1.4 mm.

Distribution: India, Burma, Sumatra, Java.

Habitat in Java: fresh water of lakes and ditches, among vegetation.

West Java: Udjong Kulon; lakes in the English Plains near Garut.

ANNANDALE (1922, Rec. Ind. Mus. 24, p. 362) mentioned that in the shell of *Helicorbis caenosus* internal ridges can now and then be detected.

In an earlier publication ANNANDALE & PRASHAD (1921, Rec. Ind. Mus. 22, p. 595) assigned *H. caenosus* to *Hippeutis*, i.e. the ridge-less genus of which the oriental species are now separated in *Helicorbis*, and such was the same opinion of PRASHAD (1922, Rec. Ind. Mus. 24, p. 15).

At a later occasion ANNANDALE & RAO (1925, Rec. Ind. Mus. 27, p. 109-110) again referred to the fact that internal ridges are weakly developed in *H. caenosus*.

In the original description BENSON explicitly denied the presence of internal septa.

The shells recorded by PRASHAD (1921, Rec. Ind. Mus. 22, p. 474) as *Segmentina calathus* from near Medan, Sumatra, were not this species, but *Helicorbis caenosus*.

Genus *Indoplanorbis* ANNANDALE & PRASHAD, 1920.

As the genus is monotypical, i.e. containing only one species, the description of the species following hereafter applies just as well to the genus.

The chief characteristics of the genus are: 1. the lobulated or folded free margin of the pseudobranch, 2. the presence of a very long and narrow verge, contained in a vergic sac and ending distally in a wider, muscular praeputium (penis sheath), 3. the absence of glands or flagellum in the penial complex, 4. the short duct of the receptaculum seminis (spermatheca).

In Java only one species:

Indoplanorbis exustus (DESHAYES, 1834) (fig. 126, 135).

1834. DESHAYES, in: BÉLANGER, Voy. Indes-orientales, p. 417, pl. 1, fig. 11-13 (*Planorbis exustus*).
1836. BENSON, Journ. As. Soc. Bengal, 5, p. 743 (*Planorbis indicus*).
1921. GERMAIN, Rec. Ind. Mus. 21, p. 26, pl. 1, fig. 4-9, pl. 4, fig. 11, 17, 18, textfig. 1-11 and 13-16 (*Planorbis exustus*).
1945. BAKER, Moll. Fam. Planorbidae, p. 196-201, pl. 21 and pl. 66, fig. 1, pl. 22, fig. 5-9, pl. 79, fig. 33-35 (*Indoplanorbis exustus*).
1946. VAN BENTHEM JUTTING, Journ. of Conch. 22, p. 221 (*Planorbis exustus*).
- 1954a. BUTOT, Trop. Natuur, 34, p. 21, fig. 1 (*Planorbis exustus*).
- 1954b. BUTOT, Basteria, 18, p. 65 (*Planorbis exustus*).

Shell moderately large, disc-shaped, the base showing all previous whorls. Upper side concave, base much less concave or almost flat. Periphery rounded. Corneous or olive, sometimes darker along the periphery, but lighter above and below it. Often with reddish-brown vertical streaks at irregular intervals. Somewhat shining and transparent. Narrowly and irregularly striated by the growth lines. Last whorl occasionally of irregular shape, with inflations and constrictions. In fresh specimens a very delicate spiral striation is visible.

Whorls 4-5, rapidly increasing in diameter. The last whorl very large and dilated towards the aperture, often bell-shaped and slightly ascending. Suture deep. Peristome rounded, without angle.

Aperture broad sickle-shaped, little oblique, interior with porcellanous lustre. Peristome sharp, not continuous, with a thin, filmy callus against the penultimate whorl and sometimes with a thickened interior ridge along the free margin.

Dimensions: max. diam. 17-24, height 5-12 mm.

Distribution: Lower Mesopotamia, India, Ceylon, Burma, Malaya, Indo China, Siam, Sumatra, Java, Celebes.

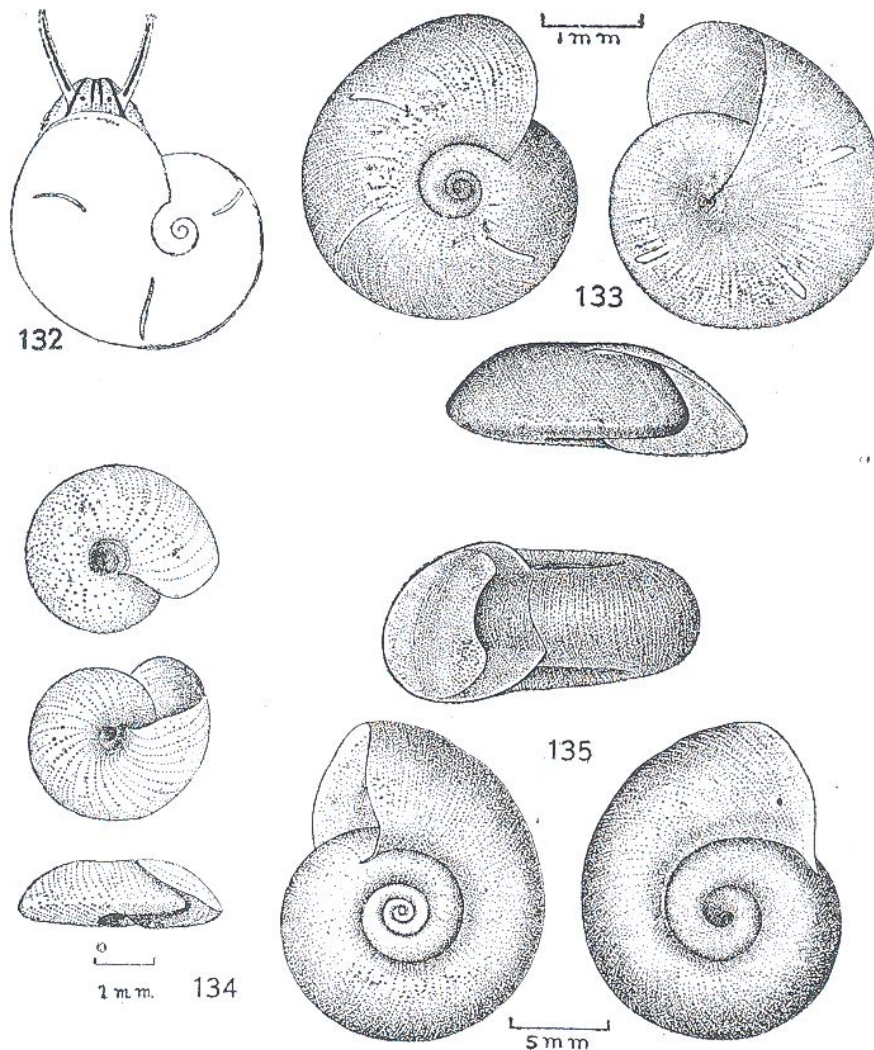


Fig. 132. *Polypylis kennardi* (BULL.). Shell with animal. ABDULKADIR del.
 Fig. 133. *Polypylis kennardi* (BULL.). Shell from top, base and side. ABDULKADIR del.
 Fig. 134. *Helicorbis caenosus* (BENS.). Shell from top, side and base. Author del.
 Fig. 135. *Indoplanorbis exustus* (DESH.). Shell from side, base and top. ABDULKADIR del.

In the Malay Archipelago the species was known for many years in Sumatra, especially in the northern and north-eastern part: Atjeh, Serdang, Deli. No records were available from the western and southern districts of Sumatra.

Since 1942 *Indoplanorbis exustus* is reported from Java (VAN BENTHEM JUTTING, 1946, p. 221). In this paper the recent introduction in this island is discussed.

A few years later Mrs G. A. TAMMES-née BOLT collected *Indoplanorbis exustus* in the southern peninsula of Celebes at Sunggu Minassa, in ditches along rice fields and at Makassar in a concrete tank with water plants in her garden. In Celebes too the species is a recent immigrant.

Habitat in Java: fresh water, among water plants.

West Java: sawahs near Djakarta; Bronbeek near Djakarta; Passar Minggu; Botanical Gardens at Bogor, in ponds; Bandung (BUTOT, 1954a and 1954b).

In general appearance *Indoplanorbis exustus* resembles the European *Planorbis corneus* (L.). As in this species the shell is variable in size, shape of the aperture, colour, sculpture and mode of coiling. The morphology of the genital organs, however, is quite different.

The animal was first described by BENSON (1836, p. 744) as black-olive, occasionally dark maroon-red. An account of the anatomy was published by RAO (1923, Rec. Ind. Mus. 25, p. 199-219), BAKER (1933, Journ. Morphol. 55, p. 1-9), LARAMBERGUE (1939, Bull. Soc. Zool. France, 64, p. 286-295) and BAKER (1945, Moll. Fam. Planorbidae, p. 197-201).

The animal has one pair of long cylindrical tentacles. Eyes at the inner bases of the tentacles. Breathing takes place by a lung. Besides, the species possesses an accessory gill (pseudobranch) with a lobulated free margin.

Radula \sim .1. \sim . Central tooth with two cusps. The adjoining laterals with 4 cusps, the marginals with several cusps.

Although being hermaphroditic cross fertilization is the usual mode of propagation. Penis without a stylet. The vergic sac is long and slender, containing an equally long and narrow verge, ending distally in a muscular praeputium. For copulation the entire praeputium is everted and the copulatory portion of the penis protrudes and seeks the female opening of the partner. In the female division of the genital organs the spermatheca is small with a very short duct. Reproduction takes place by laying eggs in gelatinous strings.

According to SEWELL (1924, Rec. Ind. Mus. 26, p. 535) *Indoplanorbis exustus* can reach an age of about two years. Very young shells are much higher than wide, with a slightly produced spire, much resembling a *Physa* shell (ANNANDALE, 1918, Rec. Ind. Mus. 14, p. 111-112, pl. 11, fig. 1, 1a; GERMAIN, 1921, p. 40-41, fig. 13-16).

Genus *Amerianna* STRAND, 1928.

(syn. *Ameria* H. ADAMS, 1861 non *Ameria* WALKER, 1854 = Lepidoptera).

Shell sinistral, with small, elevated spire and large last whorl. All whorls "shouldered", or even carinated in their upper part. Finely striated by the growth lines. Not shining, scarcely transparent. Umbilicus very narrow or closed. Aperture large and wide. Peristome angular in the upper corner, rounded below.

Animal with a small accessory gill (pseudobranch). Radula $\sim 1 \sim$ (fig. 128). Central tooth with two denticles, laterals with three denticles, marginals with more denticles. Hermaphroditic.

Distribution: Australia, New Guinea, Kei Islands, Obi, Buru, Java, in fresh water.

In Java only one species:

Amerianna carinata (H. ADAMS, 1861) (fig. 122, 128).

1861. H. ADAMS, Proc. Zool. Soc. London, p. 143 (*Physa*).
 1883. TAPPARONE CANEFRI, Ann. Mus. Civ. St. Nat. Genova, 19, p. 247 (*Physa*).
 1931. THIELE, Handb. Syst. Weicht. Kunde, 1, Part 2, p. 478, fig. 573 (*Isidora*).
 1954a. BUTOT, Trop. Natuur, 34, p. 22, fig. 2.
 1954b. BUTOT, Basteria, 18, p. 66-70, fig. 2-3.

Shell sinistral, with small, elevated spire and large, somewhat inflated last whorl. Straw-colour to olive, very fragile, somewhat transparent, but not glossy. Sculptured by numerous, fine lines of growth of unequal strength. This structure is crossed by still more delicate spiral lines.

Whorls $3\frac{1}{2}$ -4, rapidly increasing in size. Sharply "shouldered" in the upper region of each whorl, hence the whorls descend step-like. Apex small, mamillar, projecting. Base rounded. Umbilicus closed or as a mere chink.

Aperture large, long-oval, oblique. Interior of aperture shining, sometimes with a purplish streak parallel to the outer margin. Peristome not continuous, the two ends connected by a thin, filmy layer against the penultimate whorl. Columellar side slightly twisted, with an oblique fold. Exterior margin sharp, fragile, angular at the "shoulder" of the whorl. Basal margin somewhat expanded.

Dimensions: height 10-14, width 6-7, height of aperture 8-9 mm.

Distribution: Australia (Queensland and northern New South Wales), Kei Islands, Java.

Habitat in Java: in fresh water of a pond in the Botanical Gardens at Bogor, and in the tanks of a Chinese fish dealer in the same town (BUTOT, 1954a and 1954b).

West Java: Bogor.

Amerianna carinata was imported in Java about 1951.

While *Amerianna carinata* is a recent immigrant in Java, and no other recent species of this genus occurred in the island prior to this introduction, a fossil representative *A. duboisi* was recorded from Pleistocene deposits near Trinil (East Java) (VAN BENTHEM JUTTING, 1937, Zool. Meded. Mus. Leiden, 20, p. 98, fig. 1, pl. 4, fig. 6-9). An unidentified

species was mentioned by OOSTINGH (1935, Wetensch. Meded. Dienst Mijnb. Ned. Indië, 26, p. 118) from Upper Pliocene layers at Bumiaju (Central Java).

Familia ANCYLIDAE.

Shell generally small. In the adult state not spirally coiled, but cap- or shield-like, somewhat conoidal in the middle, with more or less elevated apex. Symmetrical or slightly asymmetrical, with the apex turned to the left or to the right of the sagittal axis. Shell thin and transparent, concentrically striated. In some species also with radial striae from the apex to the basal margin.

Animal dextral or sinistral. Patelliform, with large sucker-foot. The head lies in front of the foot. It is provided with two short, or moderately long tentacles. The eyes are situated on the back of the head, at the base of the tentacles. With a gill lamella at the side of the body (fig. 118).

Mandibula horse-shoe shaped, composed of numerous minute chitinous plates on a thin basal membrane. Radula \sim .1. \sim . Central tooth with an even or an uneven number of cusps. Inner laterals with 2-7 cusps (fig. 119).

The snails are hermaphroditic. Reproduction takes place by eggs. They are laid in gelatinous capsules, either singly or in a small number in one capsule.

Distribution: freshwater of all continents, in the tropics and in temperate regions.

In Java only one genus:

Genus *Ferrissia* WALKER, 1903.

Shell small and thin: depressed, shield-like, elongate-oval. Apex low and obtuse, behind the middle of the shell-length, subcentral, somewhat inclined to the right side. The shell is sculptured with fine, concentric lines of growth. In some species with additional radial lines from the apex to the basal margin. Light horn-colour.

Animal sinistral, with large sucker-foot. Tentacles short or medium-sized. Eyes at the base of the tentacles. Respiration takes place by a gill at the left side of the animal. Genital opening and anus also at the left side.

The snails are hermaphroditic. Reproduction takes place by eggs, laid on water plants, stones etc.

Radula ~.1., the central tooth with two cusps, the laterals with 2-5 cusps. The lateral teeth are placed very obliquely to the transverse axis.

Distribution: North America, Africa, tropical Asia, including the Malay Archipelago, Australia. In fresh water, either stagnant or slowly running.

In Java only one species:

Ferrissia javana (MARTENS, 1897) (fig. 118, 119, 123, 124).

1897. MARTENS, in: WEBER, Erg. Reise Nied. Ost Indien, 4, p. 15, pl. 1, fig. 35-37 (*Ancylus javanus*), p. 16, pl. 1, fig. 38-39, pl. 12, fig. 8 (*A. celebensis*).
1914. LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 251 (*Ancylus javanus*).
1929. VAN BENTHEM JUTTING, Treubia, 11, p. 83 (*Ancylus javanus*).
1931. VAN BENTHEM JUTTING, Treubia, 13, p. 8, fig. 7-10 (*Protancylus javanus*).
1934. RENSCH, Trop. Binnengew. 5, p. 215, fig. 7 (*Ferrissia javana*).
1950. BONDESEN, Natura Jutlandica, 3, p. 65 and 68 (*Protancylus javanus*).

Shell elongate-oval, like a narrow, low shield or cap. It is slightly wider anteriorly than at the hind end. The apex is generally obtuse and lies behind the middle of the long axis, somewhat turned to the right. Shell very thin and transparent. Exterior surface yellowish-brown to greenish-brown. Interior surface with a glassy-white glaze. Concentrically striated, with the apex as the centre. The striae become stronger towards the basal margin. Besides there are very fine radial lines from apex to basal margin.

Animal sinistral, patelliform, with large sucker-foot. Tentacles slender. Eyes dorsal, at the base of the tentacles. Respiration takes place by a gill at the left side of the animal.

The snails are hermaphroditic, reproduction takes place by eggs laid singly on water plants. They are circular or subovate, and covered by a hyaline chitinous capsule of about 0.6 mm diameter (fig. 124).

In the radula the rhachis bears two cusps, the neighbouring laterals four and the marginals 5-7 cusps.

Dimensions: length up to 3.2, width 2.4, height up to 0.9 mm.

Distribution: Sumatra, Java, Celebes.

Habitat in Java: in stagnant or slowly running water, on leaves of water plants, e.g. *Hydrilla*, on stones, branches, etc. entirely submerged. Up to about 1400 m altitude.

West Java: ponds and brook in the Botanical Gardens at Bogor; tributary river of the Tjiliwung, near Bogor (RENSCH, 1934); lake of Tjigombong; Telaga Warna, near Puntjak Pass, 1400 m; fish ponds S of Puntjak Pass (RENSCH, 1934); lakes in the English Plains near Garut.

East Java: brook flowing into Ranu Lamongan (RENSCH, 1934); Kali Mrawan.

There is some variation in the length-width ratio and in the length-height ratio of the shell.

I fully agree with RENSCH (1934, p. 216) who proposed to unite *Ancylus celebensis* MARTENS with *A. javanus* MARTENS, the latter having priority.
