

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

published by

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III. Critical Revision of the Javanese Pulmonate Land-snails of the Families *Ellobiidae* to *Limacidae*, with an Appendix on *Helicarionidae*

by

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INTRODUCTION

After having published in 1948 and 1950 two earlier parts of my Critical Revision of the non-marine molluscs of Java, the land-operculates (Treubia, 19) and the pulmonates of the families Helicarionidae, Pleurodontidae, Fruticicolidae and Streptaxidae (Treubia, 20), I now offer the third part containing the remaining land-pulmonates belonging to the families Ellobiidae, Rathousiidae, Vaginulidae, Succineidae, Tornatellinidae, Vertiginidae, Valloniidae, Enidae, Subulinidae, Achatinidae, Endodontidae, Zonitidae, Vitrinidae, Arionidae and Limacidae, with a short appendix to the Helicarionidae.

Only the family Clausiliidae is excluded from this report. Its members will be revised by Mr F. E. LOOSJES, specialist in Clausiliidae, who will publish a monograph of the Javanese species in due time.

The families which now concern us are all members of the subclass Pulmonata. The chief characteristics of this division have already been mentioned in Part II, 1950, p. 381 ff., so that I need not repeat them here.

The family Ellobiidae belongs to the order Basommatophora (in which the eyes are situated at the base of the upper tentacles); all other families of the present report to the order Stylommatophora (with the eyes at the tips of the upper tentacles).

In some families (Rathousiidae, Vaginulidae, Arionidae, Limacidae) the animals are naked, i.e. they either do not possess a shell at all (Rathousiidae, Vaginulidae, Arionidae) or the shell is a small, flat and thin, internal plate, without spiral, below the skin (Limacidae). All other snails have the usual spirally coiled shell, although there is great variation in

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J A V A S E A

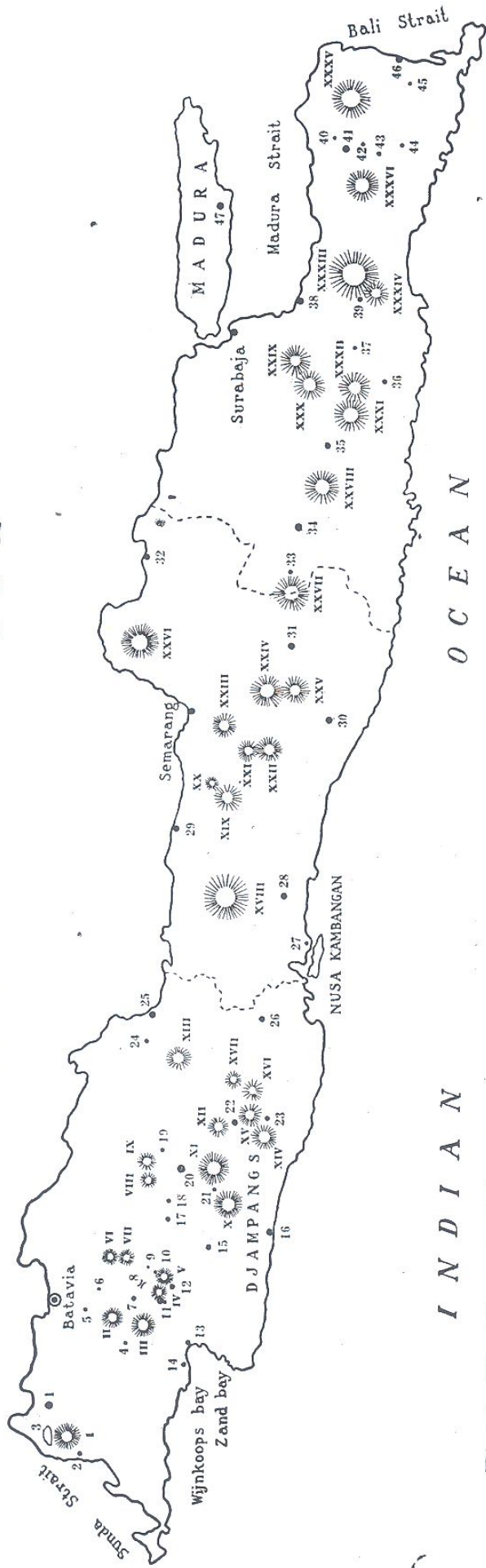


Fig. 1. Sketch map of the Island of Java, indicating the localities mentioned in the text. Roman figures denote mountains, arabic figures all other locations.

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|--------------------|-----------------|-----------------|------------------------|-----------------|-------------------|
| I. Karang | XV. Tjikorai | XXIX. Welirang | 7. Bogor | 21. Tjiwidej | 35. Kediri |
| II. Mount Tjibodas | XVI. Galunggung | XXX. Ardjuno | 8. Puntjak Pass | 22. Garut | 36. Wlingi |
| III. Salak | XVII. Sawal | XXXI. Kelut | 9. Sindanglaja | 23. Tjikadjang | 37. Malang |
| IV. Pangrango | XVIII. Slamet | XXXII. Kawi | 10. Tjibodas | 24. Palimanan | 38. Pasuruan |
| V. Gedé | XIX. Dieng | XXXIII. Tengger | 11. Tjibadak | 25. Cheribon | 39. Nongkodjadjar |
| VI. Pantjar | XX. Prah | XXXIV. Semeru | 12. Sukabumi | 26. Bandjar | 40. Wonosobo |
| VII. Panisan | XXI. Sindoro | XXXV. Jang | 13. Palabuan | 27. Tjilatjap | 41. Bondowoso |
| VIII. Burangrang | XXII. Sumbing | XXXVI. Idjen | 14. Tjisolak | 28. Banjumas | 42. Klakah |
| IX. Tangkuban Prah | XXIII. Ungaran | 1. Serang | 15. Sukanegara | 29. Pekalongar | 43. Kalisat |
| X. Patuha | XXIV. Merbabu | 2. Pasuruan | 16. Sindangbarang laut | 30. Djokjakarta | 44. Wrawan |
| XI. Malabar | XXV. Merapi | 3. Lake Danau | 17. Radjemandala | 31. Surakarta | 45. Rogodjampi |
| XII. Guntur | XXVI. Muriah | 4. Leuwiliang | 18. Padalarang | 32. Rembang | 46. Banjuwangi |
| XIII. Tjerimej | XXVII. Lawu | 5. Kuripan | 19. Tjisarua | 33. Sarangan | 47. Pamekasan |
| XIV. Papandajan | XXVIII. Wilis | 6. Depok | 20. Bandung | 34. Madiun | |

size and shape. All species in these families are dextral; any sinistral specimen is an abnormality.

We have to do with high turreted species (*Achatina fulica* height 130, width 60 mm, *Prosopeas acutissimum* height 27, width 6 mm; *Ena tenuilirata* height 23, width 10 mm) or with very flat ones (*Charopa microdiscus* width 1.6, height 0.7 mm, *Ptychodon celebica* width 1.7, height 0.8 mm, *Trochomorpha planorbis* width 17, height 6 mm); also with multispiral shells (*Trochomorpha planorbis* 7 whorls, *Prosopeas acutissimum* 11 whorls) or with shells consisting of few whorls only (*Vitrinopsis fruhstorferi* 4-5 whorls, *Succinea obesa* 3 whorls). Some species possess a complicated system of folds and teeth in the aperture (*Carychium javanum*, *Gastrocopta* div. spp., *Ptychodon celebica*, *Paraboysidia boettgeri*, *Gyliotrachela fruhstorferi*). Most others, however, have a simple aperture. It is difficult to explain the function of these lamellae for the snails. Obviously the animals do not experience any trouble passing through the constricted gullet. Their soft parts are so flexible that they give way in any direction.

All the species in Part III possess a radula and a mandibula whose form and texture are characteristic for the genus. Of the general organization of the pulmonate radula I have already given an account in Part II, p. 383-384. A figure of radula and jaw of Java's largest land snail, *Achatina fulica*, is reproduced here (fig. 2).

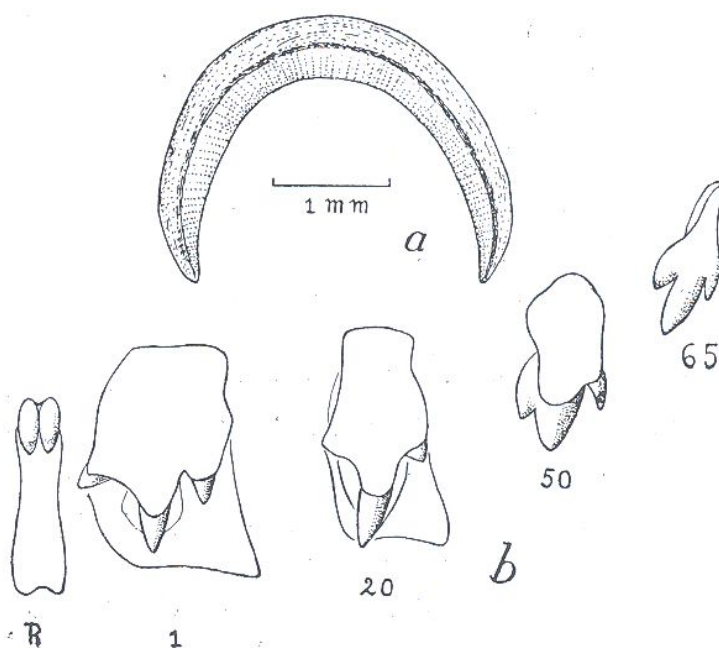


Fig. 2. *Achatina fulica* (FÉR.), Bogor, W. Java.
a, mandibula; b, radula elements.

As far as they have been anatomically investigated the animals treated in the present paper are all hermaphroditic. In most species the sex organs are very simple, without such accessory organs as flagellum, dart-sac and dart, digitiform glands etc. Although self-fertilisation is not impossible, yet the usual mode of reproduction is by means of cross-fertilisation.

Reproduction takes place by oviposition or by ovovivipary. Again I must repeat here the same complaint as expressed in Parts I and II of these Critical Studies: our knowledge of the life history of the Javanese land snails is lamentably deficient. Only in the case of *Achatina fulica*, the Giant African Snail, whose animals were studied chiefly with the purpose of combating them, are we somewhat better informed on the general behaviour, feeding and breeding habits, and physiology.

Most of the species live on the ground, in earth, under stones, among grass and other low vegetation. *Achatina fulica* occasionally climbs trees, walls and hedges, *Meghimatium striatum* is often found in the jungle on trees and shrubs where it feeds on mould and higher fungi; *Gyliotrachela fruhstorferi* lives on limestone mountains grazing the algae from the rocks.

For the classification, the "Handbuch der systematischen Weichtierkunde" by J. THIELE (1929-1935) is followed, with a few slight emendations.

As pointed out on p. 457 of Part II of these Critical Revisions, I was originally inclined to take *Macrochlamys amboinensis* as a species of the family Zonitidae, to be included in Part III. Later investigation, however, has convinced me that it is a Helicarionid after all. Therefore it is inserted here under the name *Tanychlamys amboinensis* in the systematic part, preceding the Rathousiidae.

I am very much indebted to the authorities of the Museum Zoologicum Bogoriense at Bogor (Buitenzorg), Java, of the Rijksmuseum van Natuurlijke Historie at Leiden and of the Naturhistorisches Museum at Basle for the permission to study their collections and to include details in this report. From the malacological section of the Zoological Museum of Berlin, of the British Museum (Natural History) at London, the Institut Royal des sciences naturelles de Belgique and the Zoological Museum of Zürich (MOUSSON Collection), I now and then received specimens on loan in order to clear up some critical details.

As before, the malacological department of the Senckenberg Museum at Francfort on the Main most liberally sent me on loan all their Javanese material of the species under discussion. With the special permission of the curator, Dr A. ZILCH, I include here a few remarks made by him

concerning the confusion of names by BOETTGER and MOELLENDORFF using identical names for different species and different names for identical species (see for instance Part II p. 395: *Liardetia acutiusculu*; p. 405: *Liardetia platyconus*; p. 414: *Lamprocystis infans*; p. 450: *Microcystina gratilla*): "I (ZILCH) should like to remark that from your publication one gets the impression as if O. BOETTGER were responsible for the nomenclatorial mess in several cases. It is, however, so that H. FRUHSTORFER distributed material with Boettgerian names which BOETTGER himself had never seen or identified. At any rate I never saw in other collections such shells with labels in BOETTGER's handwriting. I have referred to this fact in Archiv für Molluskenkunde, vol. 79, 1950, p. 87-88".

DISTRIBUTION AND ECOLOGY

After having thus finished with Part III the account of the land molluscs of Java, I wondered if the sum total of 171 species (inclusive of 9 Clausiliidae) must be considered a high number or a small one, compared with the space they occupy.

In order to answer this question I made a table of Java and various other countries, their area in square kilometres and their snail population, the latter divided in terrestrial Prosobranchs, naked Pulmonates (Lima-*cidae* and Parmarionidae included) and shelled Pulmonates.

TABLE I

Name of country	Surface in 1000 km ² 1)	Mollusca						Total
		Prosobr.	%	Naked Pulm.	%	Shelled Pulm.	%	
Java	126	46	27+	14	8+	111 ²⁾	65—	171
Netherlands	34	1	1+	15	16+	77	83—	93
England	151	2	2—	21	20+	80	78—	103
Switzerland	41	7	4+	18	11—	144	85+	169
Germany	472	5	3+	18	12—	134	85+	157
Belgium	30	3	3+	16	16+	79	81—	98
Denmark	43	2	2+	12	14—	74	84+	88
Puerto Rico	8	21	20+	3	3—	80	77+	104
New Zealand	238	15	6—	10	4—	229	90+	254

In order to ascertain figures which could guarantee comparable values I had to choose countries in which the mollusk fauna is fairly

1) After CH. H. VAN AREN, Aardrijkskundig Woordenboek der geheele Aarde, 1926.

2) Clausiliidae included.

well known through modern handbooks or faunal lists. With the exception of Puerto Rico, no other tropical countries or islands could be compared because no recent summary of the snail fauna was available.

I am fully aware that the comparison of a tropical region with a country in temperate latitudes is hopelessly inadequate, but even this procedure leads to remarkable results, demonstrating that the popular belief:—a tropical country is a paradise for luxuriant snail development—, cannot longer be maintained in all cases.

In the first place we see that the extent of the country is no direct measure for its snail population. A small country like Switzerland, with a total surface of about one-third of that of Java, is not inhabited by one-third of the number of snails or even less, but on the contrary by an almost equal number.

The reverse is not the case either: Germany, with about 4 times the size of Java, is not 4 times as rich in snails as our island.

Which factors can be made responsible for this disproportionate faunal composition? Apart from the degree of temperature and moisture, high and almost constant in Java, temperate and variable in a European country, other agents must be consulted. Passing silently the consequences of civilization by which so much virgin ground has been spoilt for snail life, and which is neither better nor worse in Java than in any European country, the most plausible cause for the almost similar number of species in such divergent regions as Germany or Switzerland and Java, may be imputed to the much greater diversity in environment in those two European countries.

Another detail in the table deserving our attention is the high percentage of operculate landshells in Java (and probably also in other tropical countries) compared with a European country. I have pointed to this feature already in Part I of these Studies (Treubia, 19, 1948, p. 541). An explanation for the fact, however, I am unable to give.

Compared with the other two Greater Sunda Islands: — Sumatra, Borneo, and Celebes as well — the malacology of Java is known best of all. We can safely admit that in the future the composition of its mollusc fauna is not likely to undergo important alterations. The number of species which may eventually be added cannot make a notable increase; for the rest a few species will perhaps be united, or others split up.

The time has not yet come that we must realize a deplorable depletion of the mollusc fauna, either a decline in number or the extermination of certain species, due to the spreading of civilization and cultivation, as is the case with the larger Vertebrates, especially mammals. Yet the

distribution of the land snails has undoubtedly changed, and is still doing so, in consequence of human influences.

The number of Javanese land molluscs now being more or less satisfactorily codified, there remains the still more interesting task to inquire after the causes for the present distribution of each species. Not only the presence of a certain species in an area is worth considering, but its absence also may afford information about the snail's demands and about the properties of its milieu.

Considering what has already been accomplished in this direction on the land molluscs of Java, it must be admitted that the ecological viewpoint has generally been lamentably neglected. Some early attempts were made by MOUSSON (1849, *Die Land und Süßw. Moll. v. Java*) and ZOLLINGER (1860, *Natuurk. Tijdschr. Ned. Ind.* 21, p. 316), the most important contribution, however, being the comprehensive work of MARTENS (1867, *Ostas. Landmoll.*). The latter volume contains not only some chapters on general ecology of Malaysian molluscs, among which Java plays a principal role, but it also offers a wealth of stray notes on habitat and habits scattered in the systematic part.

It must be acknowledged that in the following years several contributions to Javanese malacology were published, but most of them aimed at no more than increasing the number of species. The ecological research has been hardly given any attention at all.

As a consequence of the rapid development of cultivation in Java, a severe destruction menaces the existence of the original fauna. European and native arable land gains ground at the detriment of primeval jungle and undisturbed sites. To give exact figures: in 1917 the cultivated area in Java occupied about 55% of the whole surface of the island (VAN DER VEER, 1919, *Agrarische Regelingen*). In 1939 this area had increased to more than 77% (*Statistisch Jaaroverzicht*, 1939). The native population (in 1939 315 per square km) at present inhabits more and larger villages and clears the woods around the kampongs for providing fuel, leaving the thus abandoned country to be overgrown by grass- and shrub-wildernesses. The growth of cities, the demands of traffic, by rail as well as by road, laid open the land, but at the same time isolated the original fauna in a few small, disconnected refuges, leaving in the cultivated territories such ubiquitous forms for which all circumstances are equally right.

The present paper attempts a tentative contribution to the ecology of the Javanese land molluscs. For that purpose we have to study the distribution of the animals in past and present and to observe their behaviour and their environment. With respect to the occurrence in fossil

strata we have to bear in mind that the present-day arrangement of orographical features of the island is not a fixed one. It is only a temporary picture in a long evolution whose transitions from one phase into another generally proceed very slowly, catastrophes excepted. Correspondingly, the fauna is subject to modifications also, old elements disappearing by extinction or migration, new ones turning up and taking the vacant places.

However, with the exception of two stray species, *Landouria rotatoria* and *Amphidromus palaceus* from the Middle Pleistocene Trinil beds in Central Java (VAN BENTHEM JUTTING, 1937, Zool. Meded. 20), both species still living, the ancestry of our contemporary land snails lies completely in the dark.

When analysing the milieu factors affecting the distribution of the recent fauna, two principal categories can be distinguished: the factors of the climate and those of the facies, the latter embracing soil and vegetation.

The climatic factors include: temperature, air humidity, rain, light, wind, air pressure and monsoon. The facies factors are: grain size, percolation of the soil, salinity, acidity, lime and other mineral content, vegetation and decaying organic matter (humus).

Discussing these factors one by one, and beginning with the temperature, I may remind the reader how, generally speaking, the temperature falls $\pm 5\frac{1}{2}^{\circ}\text{C}$ for every 1000 m of altitude. Places in Java situated at similar altitudes have equal average temperatures. Some local deviations occur because of special configuration of the site: e.g. on sloping ground, where the daily fluctuations are low in comparison with those on an even plain.

The landsnails, being lovers of a uniform high temperature — provided that it is not too dry at the same time — prefer the wooded plains and the hilly country up to a moderate elevation in the mountains.

Strong daylight is generally avoided, perhaps not in the first place on account of the action of the light itself, but because in the tropics more than in temperate regions the exposure to sunshine involves the danger of dessication. Therefore most snails, the shelled as well as the naked ones, hide under grass, stones, dead leaves and low vegetation by daytime, only appearing at night, or in the dimness of the jungle where there is no fear for dessication.

The air pressure is very little subject to fluctuations and does not differ in places at equal altitudes in East or West Java during the successive seasons. Only at increasing altitude, here as elsewhere in the world, the air pressure is inversely proportionate to the hypsometer indi-

cation. For the snail world this means that in hilly and mountainous country more intensive irradiation takes place during the day and more radiation during the night, causing larger extremes of temperatures in the mountains than in the lowlands.

The wind in Java generally presents two types: the monsoon winds, east during the dry season (April-October) and west during the wet season (October-April). Near the coast there is a daily periodicity of land-breeze during the night and early morning, and sea-breeze during the day and afternoon. In the interior of the country the winds blow up and down-valley. The only importance of the winds for the snail population lies in the amount of moisture they can carry.

The relative air humidity is high for most places in Java. It does not differ much in the mountains as compared with the plains. Only during the dry monsoon can it sink so low that it could become almost fatal for the snails unless the animals dig themselves in, either in the ground or in decaying wood.

The density of clouds increases near the mountains. It is a familiar picture in Java, especially in the western part of the island, to see the higher parts of the volcanoes clad in a voluminous cloud mantle during the late hours of the day. The sea side slopes are most frequented, whereas the landward direction, or the slopes facing neighbouring mountains, generally bear fewer clouds. So long as the water-particles remain in cloud form they cooperate to increase the degree of relative air humidity. Beyond a certain maximum they condense to rain.

In contrast with the almost uniform relative air humidity the rainfall increases considerably from the coast to the interior, near the mountains. The often quoted and almost classic example of the annual average for a few places along the line from Tandjong Priok on the coast to Bogor in the interior of West Java illustrates this better than words (from BRAAK, 1919, *Het bergklimaat van Java*, and BRAAK, 1922-1929, *Het klimaat van Nederlandsch-Indië*):

Place	Altitude in m	Average annual rainfall in mm
Tandjong Priok	sea-level	1665
Djakarta	8	1831
Djatinegara	14	1942
Pasar Minggu	20	2282
Depok	90	3255
Bodjonggedeh	140	3514
Bogor	240	4261

Local exceptions from this rule, however, occur and are even not unfrequent. Some of the very high mountain tops show an unexpectedly

low amount of rain. The rain gauge on the summit of Mount Pangrango (alt. 3019 m) for instance, receives a yearly average of 3411 mm, whereas in a similar instrument at Tjibodas (alt. 1425 m) on the slope of Mount Gedé, this figure reaches 3496 mm. On the other hand the showers at such extreme altitudes assume more the character of the rainfall in a temperate climate: a long lasting and moderately heavy drizzle. Hence the humidity on the tops is very high, because the intermittent sunshine periods are short, leaving little time to dry.

The distribution of the majority of the landsnails coincides almost exactly with the areas of heavy rainfall. In West Java, where the climate is more or less equally moist throughout the whole year, such a striking agreement between the isohyetal lines and the districts of comparable snail frequency is not so evident as in the more eastward parts of the island, where the influence of the dry monsoon becomes more perceptible in such a way that only the areas with sufficient rainfall are inhabited by a reasonable number of snails. In order to demonstrate this it is interesting to consult a map of Java on which are marked in the same colour the regions with the same average number of rain-days during the four consecutive driest months of the year (BOEREMA, 1931, Verh. Kon. Magn. Meteor. Observ. Batavia, no. 23).

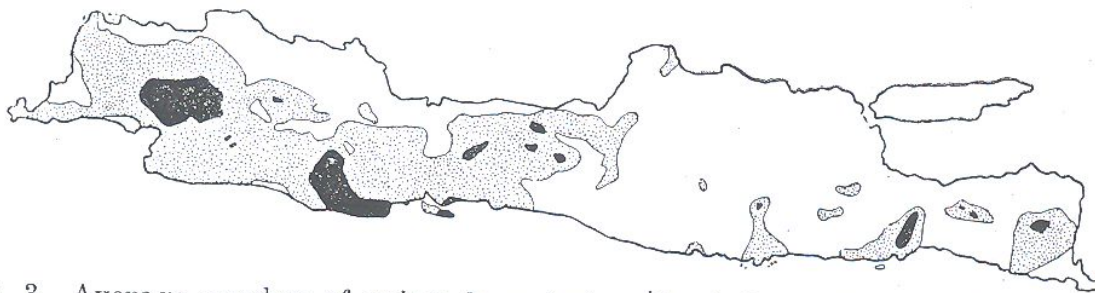


Fig. 3. Average number of rainy days during the 4 driest months of the year in Java. In blank 0-20 days, dotted 20-40 days, black 40-80 days.

[After MOHR, modified by VAN STEENIS]

From this chart (fig. 3) it appears that the wettest areas lie in hilly and mountainous country, in most cases especially on the side where the sea wind is forced up against a mountain flank, the leeward side being distinctly drier. Hence it is not astonishing that those moist localities are exactly the kind of environment preferred by snails. There they find their highest grade of development, both in number of species and of individuals.

At the same time those areas of humidity are also the regions containing the most luxuriant vegetation, and since snails are generally herbivorous it may be assumed that their interest in the rainy quarters

is probably only partly dependent on the amount of rain, but more directly served by the profusion of the vegetation. This focusses our attention on another important aspect of molluscan ecology: the factors of vegetation and soil.

Concerning the soil factors it is not always easy to distinguish between those affecting the molluscs directly and those affecting indirectly. Grain size and percolation of the soil, for instance, will hardly be of any immediate influence on the snails, but they are of far greater importance to the vegetation upon which in their turn the snails depend. The same argument holds good for the majority of the other soil factors, so that finally in the vegetable kingdom are combined all principal facies qualities affecting the composition of the mollusc fauna.

Yet there exist a few physical properties of the soil to which a specific direct action, either positive or negative, cannot be denied. Thus acidity, salinity and the presence of a few other mineral salts in the ground generally keeps mollusc life at a respectable distance. The keen chemical sense of these animals, especially active in their very sensitive skin, prevents them from coming into contact with noxious substances. Only the species of the mangrove belt and the marine beaches (not treated in Parts I-III) are adapted to life in a halobiotic environment.

Quite the reverse behaviour, however, is observed with regard to the presence of carbonate of lime for which the snails show a marked predilection. It is a well known fact in all countries that the lime content of the soil greatly promotes shell life. Such is also the case in Java, where the limestone districts are inhabited by a multitude of species and specimens, sharply contrasting with the areas of igneous rocks and their products poor in, or totally devoid of calcium carbonate. The restricted habitat of some species is most remarkable and many are confined to the small limestone hills, mostly of a precipitous character. If we compare for the moment in West Java such calcareous hills as Mount Tjibodas and Kuripan near Bogor, Mount Pawon and Radjamandala near Padalarang, etc., with the regions of volcanic origin, the differences are more than obvious.

The preceding facts suggest that the geological map of the island would furnish valuable evidence in the search for satisfactory collecting grounds. Further exploration in limestone regions is highly desirable.

West and Central Java are as poor in calcareous deposits as East Java is abundant. From the line Semarang-Djokja eastward a number of West-East hill-ranges, mostly limestone of Tertiary age cross East Java,

fading to isolated knolls and narrow ridges beyond Surabaja in the extreme East of the island. Only in the island of Madura the hill ranges keep up their original development with undiminished intensity. These mountains of medium altitude, rising to 500 m on the average with a surface of several square kilometers, consist of marls of marine origin locally rich in fossils.

Judging from what we have already discussed on carbonate of lime favourably influencing the existence of molluscs, it might be expected that in East Java the vast extent of this most popular facies among snails would exhibit an unrivalled wealth of Gastropods. Unfortunately this expectation is seriously disappointing. The more arid climate and the intensive tilling of the ground for cane fields, teak wood plantations, and native crops render the mollusc population in this part of Java far from abundant. Moreover, the physical qualities of the calcareous soil are also functional. From physico-chemical investigations on the soil of teak woods (BEUMÉE-NIEUWLAND, 1922, Meded. Proefstat. Boschwezen, 8) it has been found that although some of the marls weather away easily, allowing ample circulation of water and air in the ground, in others percolation is either too slow or too rapid, causing a bad texture of the soil.

Locally, the efflata of the volcanoes are relatively rich in carbonate of lime, but they can never compete with the true limestone districts. The snail fauna immediately responds to the favourable opportunities by occurring in a larger number of species and individuals than could be anticipated from the mere location of the site.

The way in which the lime is assimilated by the animals can be two-fold. Either they take it in by drinking or by eating plant tissue containing calcareous combinations. The other way is by rasping it off the rocks with the radula while they search for algae to eat. During this grazing small quantities of the moist and porous surface of the rock are involuntarily swallowed. I often saw snails in captivity supplying their need of lime in this way when other sources of lime containing food were not available.

The relations of vegetation and mollusc life have already been ascertained by various naturalists, and on the whole my own observations are pretty well in accordance with previous reports.

Generally, the quality and quantity of the snail fauna are directly proportional to the degree of preservation of the original flora. The better the latter has been preserved the more we meet the original jungle fauna.

This general statement concerns the vegetation as a whole. Only a few species of landsnails are known which have an exclusive predilection

for a certain host plant. In Java only *Meghimatium striatum* is such a monophagous specialist, feeding on fungi, especially those incrustating moulding logs. Not even such genera as *Parmarion* and the other seminude slugs, though chiefly preferring mould and fungi, are restricted to this diet, but occasionally take other food. A most curious and unusual source of nutrition is recorded of *Parmarion pupillaris* licking latex from fresh tapcuts of *Hevea* trees in rubber plantations (KEUCHENIUS, 1914, Meded. Besoekisch Proefstat. no. 10, p. 7, see also VAN BENTHEM JUTTING, 1950, *Treubia*, 20, p. 438).

A great number of snails can digest decaying organic matter chiefly of vegetable origin. These animals are mainly ground dwellers of various families: *Hemiplecta*, *Elaphroconcha*, *Dyakia*, *Lamprocystis*, *Liardetia*, *Prosopeas*, *Opeas*, *Phaedusa*, *Lagochilus* a.o. Cyclophorids, *Pupina*, *Diplommatina*, etc.

Finally there remains the large number of polyphagous species, arboreal or terrestrial, feeding on fresh leaves, fungi, mosses or algae, soil substance or carrion according to what happens to come in their way.

Whereas a decided preference for a special kind of food is rare among Gastropods, the reverse condition, — disgust for a particular type of vegetation —, is more often observed. Thus ferns of all kinds are rarely or never attacked, and the famous t j e m a r a (*Casuarina*) forests are also remarkably poor in molluscs. Not only the living branches and foliage of these trees are apparently avoided, but in the ground litter snails are equally scarce. The layer of needle-like twigs on the ground is comparatively resistant, only decaying slowly. They compose a thick, compact, dry and impenetrable layer which almost entirely chokes soil life, animal as well as vegetable.

In other districts in Java, where forests of foliage-bearing trees predominate, this organic bottom layer on the contrary offers a most attractive abode for various soil animals. The uniform temperature and degree of moisture, the abundance of food and the appropriate hiding places yield a number of favourable conditions duly appreciated by snails. Therefore these animals play an important role in this biocoenosis, especially in forests at an elevation from 1500 m upwards. Comparing the figures which DAMMERMAN (1925, *Treubia*, 6, p. 134-136) obtained by sieving out samples of surface material from localities at different altitudes in the jungle of Mount Gedé, between 1400 m near Tjibodas and 2400 m near Kandang Badak, a striking increase of the snail population in the latter locality is observed:

Samples near Tjibodas (1400 m alt.)		Samples near Kandang Badak (2400 m alt.)	
no. of species	no. of individuals	no. of species	of individuals
3	8	4	489
1	4	6	819
6	44	6	277
3	5		
1	1		
2	4		
5	22		

In a similar way I found the number of molluscs augmented when ascending other mountains: Papandajan, Salak, Prah, but unfortunately I can not produce quantitative figures in which the high and low regions are compared.

With this evidence in mind it is the more astonishing that a clever and critical naturalist like JUNGHUHN positively denied the presence of mollusc life in the third and fourth girdle of vegetation, viz. the zones between 5000 to 7500 feet (1500-2500 m), and 7500 to 10000 feet (2500 m and more), respectively (1853, Java, Ed. II, 1 p. 464).

This error may be imputed to insufficient observation, but we must admit also that in JUNGHUHN's days next to nothing was known about genera like *Lamprocystis*, *Coneuplecta*, *Liardetia*, *Trochomorpha*, *Landouria*, *Boysidia*, *Gyliotrachela*, *Pupisoma*, *Tornatellina*, *Carychium*, *Lagochilus*, *Alycaeus*, *Palaina*, *Diplommatina*, *Hydrocena*, etc., the majority of which were collected a considerable time afterwards by STRUBELL (1889) and FRUHSTORFER (1891-1893) and described by O. BOETTGER (1891, Ber. Senckenb.) and VON MOELLENDORFF (1897, Nachr. Blatt, 29). KONINGSBERGER (1915, Java, zoologisch en biologisch, p. 597) also mentioned the presence of small snails in the soil fauna of the woods, but his information is too vague to be of further importance here.

The principal environmental factors controlling snail life having now been discussed we can summarize their influence as follows: The total area which a species can occupy is generally determined by climatic conditions; the special sites within that area which in fact it does occupy depend on factors of the facies.

Connected with the preceding paragraphs on historic origin and on milieu factors we have to consider one other aspect of the distribution of the molluscs: — the apparent anomaly that sometimes species are absent from localities which in our opinion would seem to be highly favourable for them. Is it a matter of — still unexplained — physical

conditions, or is the species wanting simply because it has not yet reached the place?

This leads us to inquire into the laws of dispersal which the various species obey. It is a well-known fact that some species penetrate into new areas quickly, while others apparently find much difficulty in adapting a new habitat. What sets bounds to one species may be only a trivial hindrance, easily surmountable, for another.

These arguments may also partly account for the differences in the landsnail fauna of East and West Java. The dissimilarity in the snail population in the extreme parts of the island is a well established phenomenon, the central part being the transition where the two components meet and fuse (VAN BENTHEM JUTTING, 1929, *Treubia*, 11, p. 76-88). Prolonged research, however, has diluted the apparent rigour of the antagonism. Now and then species being reputed to occur in West Java only, turn up from localities in the East and reciprocally. Hence the above mentioned list has been subject to many modifications (table II A) ¹⁾.

Of the total amount of 171 Javanese landsnails 157 are known from West Java, 54 from Central Java and 79 from East Java (3 species only denoted as "Java" are excluded here).

Of the western species 81 are confined to this area, 9 are known from West and Central Java, 28 are known from West and East Java and 41 are known from all three regions.

Of the eastern species 4 are confined to East Java, 4 are known from East and Central Java, 28 from East and West Java and 41 are known from all three districts.

Central Java has no species of its own; the snails occurring here are either identical with western or with eastern species.

This account demonstrates that there is still a difference in the mollusc fauna of West and East Java. Therefore the opinion of PARAVICINI (1921, *De Trop. Natuur*, 10, p. 153) that the "difference in the mollusc fauna between East and West Java seems not to exist as far as we know at present", is not in accord with the facts.

The same author continues in his publication: ".....the composition of the mollusc fauna (changes) with the altitude above sea level, the different zones denoted by JUNGHUHN each contain a special characteristic fauna".

¹⁾ The greater number of species in West Java is not alone a standard for the richness in landsnails of this part of the island. It is also due to the better investigation of West Java, chiefly promoted by the scientific centre of the Kebun Raya Indonesia (Botanic Gardens) at Bogor.

TABLE II

Name of Species	A			B				C				
	Distribution in West Java Central Java and East Java			Distribution according to vegetation zones of JUNGHUHN				Distribution according to vegetation zones of VAN STEENIS				
	West Java	Central Java	East Java	0—650 m	650—1500 m	1500—2500 m	2500—→ m	0—500 m	500—1000 m	1000—1500 m	1500—2400 m	2400—→ m
<i>Hydrocena javana</i>	X		X	X	X	X	X	X	X	X	X	X
„ <i>laeviuscula</i>	X											X
<i>Geophorus oxytropis</i>												X
<i>Sulfurina biconica</i>	X			X				X				
<i>Cyclophorus r. rafflesi</i>	X	X		X	X	X		X	X	X	X	
„ <i>p. perdix</i>	X	X	X	X	X	X		X	X	X	X	
„ <i>kibleri</i>	X			X	X	X					X	
<i>Lagochilus ciliferum</i>	X		X	X	X	X		X	X	X	X	
„ <i>macromphalum</i>	X					X					X	
„ <i>humile</i>												
„ <i>convexum</i>	X			X	X					X		
„ <i>ciliocinctum</i>	X		X	X	X			X	X	X		
„ <i>grandipilum</i>	X	X		X	X			X	X	X		
„ <i>obliquistriatum</i>	X		X	X	X			X	X	X		
<i>Leptopoma altum</i>	X			X	X			X	X			
„ <i>vitreum</i>	X	X	X	X	X			X	X			
<i>Alycaeus jagori</i>	X			X	X			X	X			
„ <i>reticulatus</i>	X			X	X			X	X			
„ <i>crenilabris</i>	X			X	X			X	X			
<i>Chamalycaeus fruhstorferi</i>	X			X	X			X	X	X		
„ <i>longituba</i>	X			X	X			X	X	X		
<i>Pterocyclus sluiteri</i>	X											
<i>Cyclotus discoideus</i>	X		X	X	X	X		X	X	X	X	
„ <i>corniculum</i>	X		X	X	X			X	X	X	X	
<i>Ditropis fruhstorferi</i>	X											
<i>Pupina junghuhni</i>	X		X	X	X			X	X	X		
„ <i>treubi</i>	X			X	X			X	X	X		
„ <i>verbeeki</i>	X			X	X			X	X	X		
„ <i>bipalatalis</i>	X			X	X	X		X	X	X		
„ <i>compacta</i>	X			X	X	X		X	X	X		
<i>Palaina gedeanana</i>	X	X	X		X	X	X			X	X	X
„ <i>nubigena</i>	X				X	X	X			X	X	X
<i>Opisthostoma uranoscopium</i>	X			X	X			X	X		X	X
„ <i>javanicum</i>	X			X	X			X	X		X	X
<i>Diplommatina cyclostoma</i>	X	X			X	X	X				X	X
„ <i>perpusilla</i>	X				X	X					X	X
„ <i>hortulana</i>	X			X	X	X		X	X	X	X	
„ <i>auriculata</i>	X		X	X	X	X		X	X	X	X	
„ <i>ornithorica</i>	X			X	X	X		X	X	X	X	
„ <i>tetragonostoma</i>	X			X	X	X		X	X	X	X	
„ <i>calcarata</i>	X			X	X	X		X	X	X	X	
„ <i>duplicilabra</i>	X		X		X	X		X	X	X	X	
„ <i>javana</i>	X			X	X	X	X		X	X	X	X
„ <i>heteroglypha</i>	X		X		X	X	X		X	X	X	X
„ <i>sulcicollis</i>	X		X		X	X	X		X	X	X	X
„ <i>planicollis</i>	X			X	X	X	X		X	X	X	X

Name of Species	A			B				C				
	Distribution in West Java Central Java and East Java			Distribution according to vegetation zones of JUNGHUHN				Distribution according to vegetation zones of VAN STEENIS				
	West Java	Central Java	East Java	0 — 650 m	650 — 1500 m	1500 — 2500 m	2500 m ↑	0 — 500 m	500 — 1000 m	1000 — 1500 m	1500 — 2400 m	2500 m ↑
<i>Carychium javanum</i>	X		X			X	X				X	X
<i>Atopos ouwensi</i>	X			X		X		X			X	
<i>Laevicaulis alte</i>	X	X		X	X			X	X			
<i>Filicaulis bleekeri</i>	X	X		X	X			X	X	X		
<i>Semperula wallacei</i>	X			X	X			X	X			
„ <i>maculata</i>	X	X	X	X	X			X	X	X		
„ <i>siamensis</i>		X	X	X				X				
„ <i>variegatula</i>			X	X				X	X			
<i>Succinea minuta</i>	X	X	X	X		X		X	X		X	
„ <i>obesa</i>	X	X	X	X	X	X		X	X	X	X	
„ <i>listeri</i>	X			X				X				
„ <i>gracilis</i>												
<i>Elasmias manilense</i>	X			X				X				
„ <i>sundanum</i>	X				X					X		
<i>Pyramidula javana</i>	X		X			X	X				X	X
<i>Costigo moleculina</i>	X			X				X				
<i>Gastrocopta lyonsiana</i>	X			X				X				
„ <i>pediculus ovatula</i>	X			X				X				
<i>Paraboysidia boettgeri</i>	X				X	X			X	X	X	
<i>Gylotrachela fruhstorferi</i>	X			X	X			X	X			
<i>Pupisoma orcula</i>	X			X	X	X		X		X		X
„ <i>perpusillum</i>	X					X	X					X
„ <i>tiluanum</i>	X					X					X	
<i>Ena glandula</i>	X	X	X	X	X	X		X	X			
„ <i>prillwitzi</i>	X				X	X				X	X	
„ <i>tenggerica</i>			X	X		X		X				
„ <i>tenuilirata</i>	X		X	X	X	X			X	X	X	
„ <i>thrausta</i>	X	X	X	X	X			X		X	X	
<i>Phaedusa corticina</i>	X		X		X				X	X		
„ <i>javana</i>	X			X	X	X	X		X	X	X	X
„ <i>salacana</i>	X											
<i>Acrophaedusa cornea</i>	X				X	X				X	X	
„ <i>fruhstorferi</i>	X					X				X	X	
„ <i>junghuhni</i>	X				X	X	X		X	X	X	X
„ <i>nubigena</i>	X				X					X		X
„ <i>orientalis</i>	X					X				X	X	
„ <i>schepmani</i>	X				X	X				X	X	
<i>Glessula sumatrana</i>	X			X	X			X		X		
<i>Subulina octona</i>	X	X	X	X	X			X	X		X	
<i>Opeas clavulinum</i>	X		X	X	X	X		X	X	X	X	
„ <i>gracile</i>	X	X	X	X	X			X	X	X		
<i>Prosopias achatiraceum</i>	X	X	X	X	X	X		X	X	X		
„ <i>acutissimum</i>	X	X	X	X	X	X		X	X	X	X	
<i>Achatina fulica</i>	X	X	X	X	X			X	X			
<i>Charopa microdiscus</i>	X			X				X				
<i>Ptychodon celebica</i>	X				X					X		

Name of Species	A			B				C				
	Distribution in West Java Central Java and East Java			Distribution according to vegetation zones of JUNGHUAN				Distribution according to vegetation zones of VAN STEENIS				
	West Java	Central Java	East Java	0 — 650 m	650 — 1500 m	1500 — 2500 m	2500 — m	0 — 500 m	500 — 1000 m	1000 — 1500 m	1500 — 2400 m	2400 — m
<i>Philalanka micromphala</i>	X						X					X
„ <i>nannophya</i>	X	X		X	X			X				
„ <i>tjibodasensis</i>	X	X	X	X	X			X	X			
„ <i>thienemanni</i>	X	X	X	X	X	X		X	X	X		
<i>Geotrochus conus</i>	X			X	X		X	X	X	X	X	X
„ <i>multicarinatus</i>	X			X	X	X		X	X	X	X	
<i>Trochomorpha planorbis</i>	X	X	X	X	X	X		X	X	X	X	
„ <i>bicolor</i>	X	X	X	X	X	X		X	X	X	X	
„ <i>strubelli</i>	X			X	X	X		X	X	X	X	
„ <i>concolor</i>	X			X	X	X		X	X	X	X	
<i>Vitrinopsis fruhstorferi</i>	X	X	X	X	X	X		X	X	X	X	
<i>Meghimatium striatum</i>	X			X	X	X	X	X	X	X	X	
„ <i>bilineatum</i>	X			X	X	X	X	X	X	X	X	X
<i>Deroceras laeve</i>	X			X	X	X		X	X	X	X	
<i>Coneuplecta bandongensis</i>	X	X	X	X	X	X		X	X	X	X	
„ <i>macrostoma</i>	X			X	X	X		X	X	X	X	
„ <i>sitaliformis</i>	X	X	X	X	X	X		X	X	X	X	
<i>Liardetia acutiuscula</i>	X			X	X	X		X	X	X	X	
„ <i>convexoconica</i>	X	X	X	X	X	X		X	X	X	X	X
„ <i>angigyra</i>	X	X		X	X	X		X	X	X	X	
„ <i>viridula</i>	X			X	X	X	X	X	X	X	X	
„ <i>densetorta</i>	X			X	X	X	X	X	X	X	X	X
„ <i>javana</i>	X			X	X	X		X	X	X	X	X
„ <i>pisum</i>	X			X	X	X		X	X	X	X	
„ <i>reticulata</i>	X			X	X	X		X	X	X	X	
„ <i>platyconus</i>	X			X	X	X		X	X	X	X	
„ <i>dendrophila</i>	X		X	X	X	X	X	X	X	X	X	
„ <i>indifferens</i>	X	X	X	X	X	X		X	X	X	X	X
„ <i>amblia</i>	X			X	X	X	X	X	X	X	X	
„ <i>doliolum</i>	X	X	X	X	X	X		X	X	X	X	X
„ <i>fimbriosa</i>	X			X	X	X		X	X	X	X	
<i>Lamprocystis infans</i>	X	X	X	X	X	X	X	X	X	X	X	
„ <i>gedeana</i>	X			X	X	X	X	X	X	X	X	
<i>Helicarion albellus</i>	X	X	X	X	X	X	X	X	X	X	X	X
„ <i>perfragilis</i>	X			X	X	X		X	X	X	X	
<i>Inozonites imitator</i>	X			X	X	X		X	X	X	X	
<i>Dyakia rumphii</i>	X	X		X	X	X		X	X	X	X	
„ <i>clypeus</i>	X		X	X	X	X		X	X	X	X	X
<i>Elaphroconcha bataviana</i>	X	X	X	X	X	X		X	X	X	X	X
„ <i>javacensis</i>	X	X	X	X	X	X		X	X	X	X	X
„ <i>patens</i>	X		X	X	X	X		X	X	X	X	
<i>Parmarion pupillaris</i>	X	X		X	X	X	X	X	X	X	X	
„ <i>martensi</i>	X		X	X	X	X	X	X	X	X	X	
<i>Microparmarion austeni</i>	X			X	X	X		X	X	X	X	X
„ <i>strubelli</i>	X			X	X	X		X	X	X	X	

Name of Species	A			B				C				
	Distribution in West Java, Central Java and East Java			Distribution according to vegetation zones of JUNGHUHN				Distribution according to vegetation zones of VAN STEENIS				
	West Java	Central Java	East Java	0 — 650 m	650 — 1500 m	1500 — 2500 m	2500 m ↑	0 — 500 m	500 — 1000 m	1000 — 1500 m	1500 — 2400 m	2400 m ↑
<i>Hemiplecta humphreysiana</i>	×	×	×	×	×			×	×	×		
<i>Microcystina exigua</i>	×	×	×	×	×	×		×	×	×	×	
" <i>nana</i>	×	×	×	×	×	×		×	×	×	×	
" <i>gratilla</i>	×		×	×	×	×		×	×	×	×	
" <i>vitreiformis</i>	×					×					×	×
" <i>fruhstorferi</i>	×		×		×			×	×	×		
" <i>subglobosa</i>	×	×	×	×	×	×	×	×		×	×	×
" <i>circumlineata</i>	×			×	×			×	×	×		
<i>Durgella pusilla</i>	×	×	×		×			×	×	×		
" <i>sundana</i>	×			×				×				
<i>Tanychlamys amboinensis</i>	×				×	×	×		×	×	×	×
<i>Ganesella bantamensis</i>	×		×									
<i>Landouria rotatoria</i>	×	×	×	×	×	×	×	×	×	×	×	×
" <i>winteriana</i>	×	×	×	×	×	×	×	×	×	×	×	×
" <i>epiplatid</i>	×			×	×				×	×	×	
" <i>ciliocincta</i>	×	×	×	×	×	×		×	×	×	×	
" <i>smironensis</i>		×	×	×	×	×	×		×	×	×	×
" <i>monticola</i>	×	×	×			×	×				×	×
<i>Chloritis crassula</i>	×		×	×	×	×		×	×	×	×	
" <i>fruhstorferi</i>	×		×	×	×			×		×		
" <i>helicinoides</i>	×			×				×				
" <i>transversalis</i>			×	×				×				
<i>Amphidromus palaceus</i>	×	×		×	×	×		×	×	×		
" <i>heerianus</i>	×	×	×	×	×	×		×	×		×	
" <i>winteri</i>	×	×	×	×	×	×		×	×	×		
" <i>javanicus</i>	×			×	×			×	×			
" <i>perversus</i>	×	×	×	×	×	×		×		×		
" <i>alticola</i>	×			×	×	×				×	×	
" <i>porcellanus</i>	×			×	×			×	×			
" <i>furcillatus</i>	×	×	×	×	×			×	×	×		
" <i>filozonatus</i>		×	×	×				×				
<i>Pseudopartula galericulum</i>	×		×	×	×			×	×	×		
<i>Bradybaena similaris</i>	×		×	×	×	×		×	×	×		
<i>Gulella bicolor</i>	×	×	×	×				×				
Total number of species: 171	157	54	79	111	117	88	28	104	96	98	79	35

Of three species (indicated ~~~~~) no more detailed record than "Java" is available.
 Of seven species (indicated —) no details of altitude are available.

In order to check the correctness of this statement I made a table (table II B) of the vegetation zones of JUNGHUHN and the snails occurring in each separate zone. For the better understanding of the zones I will first give some brief notes on the conditions in each of them.

I. The **Torrid Zone** (from 0-650 m or 0-2000 feet). It comprises mangrove jungle chiefly composed of *Bruguiera*, *Rhizophora*, *Sonneratia*, *Avicennia*, *Nipa*, sandy beaches and dunes with *Spinifex*, *Ipomoea*, *Euphorbia*, *Pandanus*, cultivated grounds with specialized vegetation, either sawahs or cane fields or rubber, coffee, coconut, tobacco, cassava gardens or teak woods. Large areas are also occupied by shrub- and grass-wildernesses with *Lantana*, alang alang (*Saccharum spontaneum*), *Eupatoria*, *Gleichenia* and other ubiquitous forms. Primeval forest in this area is exceedingly rare, only scarce remnants being preserved in isolated patches. There are fig trees of various species, Dilleniaceae, Anonaceae, Myrtaceae, Rubiaceae, Sapindaceae, Leguminosae, Lauraceae, Bignoniaceae with a rich undergrowth of shrubs, lianas and herbs.

II. The **Temperate Zone** (from 650-1500 m or from 2000-4500 feet). The greater part is sloping ground, weathered igneous products or limestone covering the surface. Large areas are occupied by European and native cultivations of which tea, cocoa, coffee, cinchona and paddy fields are the most important. The jungle in this zone is rich in *Fagraea*, *Neesia*, Dipterocarpaceae, *Schima*, *Altingia* (only in West Java), *Quercus*, *Castanea*, *Engelhardtia*, *Dysoxylon*, *Cissus*, *Calamus*, etc. The fern trees make their appearance here, but the number of *Ficus*, Anonaceae, Bignoniaceae and Dilleniaceae decreases. The undergrowth is very luxuriant, various Araceae, *Strobilanthes*, *Elatostemma* or *Gleichenia* locally monopolizing parts of the wood. This zone is also well provided with epiphytic ferns and Phanerogams, especially Orchids.

III. The **Cool Zone** (from 1500-2500 m or from 4500-7500 feet). Compared with the preceding regions the total surface of this cool zone is far inferior to either of them. Generally, the third zone forms belts encircling the higher mountains, on sloping, volcanic ground. Therefore these districts are not continuous, but scattered like isolated islands. Only in exceptional cases are they connected by horizontal plains at high altitudes, like the Dieng plateau, the Idjen and Tengger highlands. The mountain flanks in this zone are mostly forest-clad, only locally alternating with European plantations (mostly cinchona). The highlands, however, are intensely cultivated, especially providing vegetables and flowers for the European market. In some parts vast grasslands occupy considerable space. The jungle is a continuation of the preceding zone.

Quercus, *Schima*, *Altingia*, *Castanea* are still present in the lower elevations, but higher one finds *Podocarpus*, Laurineae, *Saurauja*, *Ardisia* and tree ferns. The undergrowth is still abundant: *Dipteris conjugata*, *Polypodium*, *Gleichenia*, *Strobilanthes*, *Elatostemma*, *Rubus*, *Impatiens*, *Begonia*, these being only a few representatives out of a multitude of forms. Lianas are less frequent, but the epiphytic ferns, mosses and orchids are plentiful. The *Casuarina* forests, chiefly occurring in East Java, are more monotonous, their undergrowth being far behind the leafbearing woods in number of species and of specimens.

IV. The Cold Zone (from 2500 m and more or from 7500 feet and more). In this zone the total surface is reduced to very few square km. In many parts the vegetation is absent or nearly so, especially on the slopes of the volcanoes, which are frequently disturbed by violent commotions such as eruptions and stone avalanches. The young volcanic soil in fresh condition is dry and infertile, — in weathered condition fertile. Mountain tops of inactive volcanoes have a weathered soil with a luxuriant vegetation. Those covered with young eruption products are very poor in plants. In this case it is the soil condition which determines the vegetation and not the climate. Such contrasts can be observed, e.g. between M. Pangrango (inactive) and M. Gedé (active), or between M. Merbabu (inactive) and M. Merapi (active).

Rain is not so plentiful, but the atmosphere is damp and foggy. Cultivation in any form is infrequent. Except the barren grounds just mentioned the region is partly occupied by woods, partly by a characteristic low vegetation of dwarfed shrubs and herbs which remind one of the growth of alpine plants. In the wood most species of the third and second zones have disappeared and trees with small, hard, elliptical leaves become more prominent: *Vaccinium*, *Myrica*, *Rhododendron*. Their trunks reach only moderate height and are on the average of a small diameter, crooked and gnarly, covered by heavy cushions of moss and lichens. This special type of forest is usually called moss-forest or cloud-forest.

Outside the wood, in the open undulating savannahs, a gorgeous display of flowering herbs and shrubs shoots up: *Anaphalis* and other Compositae, *Ranunculus*, *Thalictrum*, *Viola*, *Hypericum*, *Gentiana*, *Wahlenbergia*, Rosaceae, *Primula imperialis* (only in West Java), *Polygonum*, *Valeriana*, Ericaceae alternate with grasses, among which *Festuca nubi-gena* plays an important role.

After having thus summarised the principal features of the vegetation zones, we must emphasize at once that the limits of each zone are not fixed sharp lines. JUNGHUHN was the first to acknowledge this, saying:

"As we do not meet in the world, wherever it may be, with gaps or sudden transitions among the created world, no more do such sharply contrasted boundaries occur in the plantgrowth of the island of Java such as I have been obliged to assume here in order to supply a survey of the whole". A few lines farther he remarks: "To a less extent than the plants seem animals to be confined to their residence by sharp limits, as many species of animals—not only those belonging to the feathered inhabitants of the atmosphere, as peacocks, but just as well mammals, e.g. deer, rhinos are found in all zones and seem to enjoy as well life on mountain plains at 9000 feet above sea level, as the grassjungle of the south coast notwithstanding the difference in food at a difference of temperature of 25 to 30° F." Later on we will see how the molluscs respond to the zone division.

Before passing to that chapter we must discuss another complication spoiling the familiar scheme of JUNGHUHN's plant zones. It has been observed that the four belts described above generally undergo a variation in altitude on mountains which rise as isolated tops from the plains but which only reach a moderate altitude. In these cases all four zones are still present, but they become telescoped together, each region being narrower in vertical direction. Hence it may happen that on such tops the cold zone plants already appear at the altitude where the cool zone plants occur on higher mountains (VAN STEENIS, 1935, Bull. Jard. Bot. Buitenzorg (3) 13, p. 298).

Arriving now at the question whether the mollusc fauna follows the zonal division of the vegetation, first of all JUNGHUHN's statements may be quoted: "In the vicinity of fungi, so at moist, shady spots of the soil in the wood where many logs are moulding, we find in this zone (the second one) creeping on the ground or hanging against trunks, branches and leaves a larger number of landsnails than in any other part of this region. They do occur indeed in other parts of these forests also, but not in such crowds as is the case in the so called "tampat tjampur". In the following zone they are already found more rarely and in the fourth, the cold zone apparently no snails are found at all. The principal and most common species, collected by me and identified by Dr J. A. HERKLOTS, will be mentioned here: *Nanina javanica* Feruss., *gemina*, *bataviana* and *Rumphii* v.d. Busch, *Helix conus* Phil., *planorbis* Less., *Winteriana* and *rotatoria* v.d. Busch, *Bulimus perversus* L. and *galericulum* Mousson, *Clausilia javana* Pfeiffer, *orientalis* v.d. Busch and *Junghuhnii* Phil."

We have already seen that the primitive state of faunistical malacology during JUNGHUHN's days led him to incorrect conclusions. Were he

to judge from the investigations of later years, this great pioneer of scientific research in Java would certainly have revised his opinion.

Not only can landsnails—as we have seen—occur in considerable numbers at high altitudes, but equally erroneous is their alleged preponderance in the second zone, the more so if we take into account the percentage which each zone occupies of the total surface of Java ¹).

Still KONINGSBERGER (1915, Java, zoölogisch en biologisch, p. 560-561) adhered to this same statement that the woods of the temperate zone are inhabited by an unusually high amount of landsnails. He mentioned a few genera, but his communications are too brief and too fragmentary to allow definite conclusions.

Since JUNGHUHN's days it has been generally admitted among the botanists studying the Malaysian flora that JUNGHUHN's vegetation zones were not in accordance with the facts observed in nature. Especially the boundaries between the torrid and the temperate zones, and between the temperate and the cool zones could not be maintained at 650 resp. 1500 m altitude, because it was found that somewhere between 650 and 1500 m altitude, a more critical limit for the dispersal of plants occurred, tropical plants being found below that level and temperate ones above it. Various attempts at a more reasonable zonation have been proposed, all of which agreeing that the 1000 m line is a more appropriate demarcation than the 650 m or the 1500 m line. Recently VAN STEENIS (1935, Bull. Jard. Bot. Buitenzorg (3) 13, p. 327 and 329), when summarizing the considerations of himself and his fellow botanists, proposed the following table of orographic zones emending those of JUNGHUHN:

0—1000 m	<i>Tropical zone</i>
500—1000 m	Colline subzone
1000—2400 m	<i>Montane zone</i>
1000—1500 m	Submontane subzone
2400—4000 m	<i>Subalpine zone</i> (upwards to the tree limit)
4000—4500 m	<i>Alpine zone</i> (from the tree limit to the climatic snow line)
4500—upwards	<i>Nival zone</i> (upwards of the climatic snow line).

In order to ascertain whether the landmollusks equally obey to these new principles I grouped the 171 Javanese landsnails according to the new altitudinal zones (table II C) ²).

¹) MOHR (1933, De bodem der tropen in het algemeen, en die van Nederlandsch-Indië in het bijzonder, 1, p. 216-217) gave approximate figures of the percentage of the total surface of the areas in Java lying between sea-level and 1000 m alt. ($\pm 92\%$), between 1000 and 2000 m ($\pm 1\%$) and from 2000 m upwards (0.7%).

²) The two last zones do not occur in Java and are consequently left out in table II C.

Comparing the parts B and C of table II we see that the general difference is not important, the temperate zone of JUNGHUHN approximately being the sum of the 500-1000 and the 1000-1500 m belts of the new system.

A closer analysis demonstrates that in the JUNGHUHN arrangement the dispersal of 52 torrid and temperate species in upward direction, and of 21 cool and cold species in downward direction stopped at the 1500 m limit. Consequently the 1500 m line means an important boundary for 73 out of 171 species of landsnails, i.e. more than a third of the total number.

In the modern classification as proposed by VAN STEENIS the dispersal of 20 species of the tropical zone stops in upward direction at 1000 m, whereas 17 species of the montane and higher zones stop there in downward direction. This amounts to 37 species, or less than one fourth of the total of 171 landmolluscs.

These facts demonstrate that the dispersal of landsnails in Java coincides better with the JUNGHUHN vegetation zones than with the demarcation lines of the modern plantgeographers.

A special matter of interest is formed by the fauna of the high mountains, living in the uppermost zone, the cold zone of JUNGHUHN or the subalpine zone of VAN STEENIS. Most of these organisms have a very restricted, almost insular, distribution, some species are even confined to one mountain. It is generally accepted that these species are stenotopic, but it would be interesting to investigate by experiments whether their acclimatization in lower altitudes were possible if one were going to introduce them there purposely.

It is even the more remarkable that these mountain species do not live in the plains, because rain, rivers and landslides occasionally wash them down. This is the more an argument that the lowlands are no suitable environment for the mountain snails.

With respect to the mountain flora several authors have already pointed to the fact that there are no endemic genera in Java, and only a few endemic species. On the other hand, a number of Javanese oreophytes are closely related to plants of palaeoboreal countries, whereas the affinities with other regions are much less marked (SCHMUCKER, 1926, Beih. Botan. Centralbl. 43, p. 34-68; RANT, 1929, Natuurk. Tijdschr. Ned. Indië, 89, p. 441-468; LAM, 1930, Tijdschr. Kon. Ned. Aafdr. Genootsch. 47, p. 569-573; VAN STEENIS, 1935, Bull. Jard. Bot. Buitenzorg (3) 13, p. 289-417).

For the zoological side of the problem WALLACE (1869, *The Malay Archipelago* Vol. 1, p. 186-188) has asked the attention and these facts have led to the following hypothesis, which, though nearly a century old, has not yet been replaced by a better one.

When during the Great Ice Age of the Pleistocene the unfavourable climatic conditions in North and Central East Asia forced most animals of these regions to migrate southward, the creatures had little difficulty in finding new quarters in the tropics because the accumulation of ice in the polar regions and in high altitudes had withdrawn so much water from the oceans that vast continents, all land that is lying now about 50 m below sea level, emerged, and formed an almost continuous territory between S.E. Asia and Australia. At the same time the temperature was lowered by some degrees.

"It is not necessary to suppose" (says WALLACE, 1876, *The Geographical Distribution of Animals*, 1, p. 335-336) "nor is it probable, that all these great islands [Java, Sumatra, Borneo] were recently united to the continent, and that their separation took place by one general subsidence of the whole. It is more consonant with what we know of such matters, that the elevations and depressions were partial, varying in their point of action and of recurring; sometimes extending one part of an island, sometimes another; now joining an island to the mainland, now bringing two islands into closer proximity. There is reason to believe that sometimes an intervening island has sunk or receded and allowed others which it before separated to effect a partial union independently of it. If we recognise the probability that such varied and often-renewed changes of level have occurred, we shall be better able to understand how certain anomalies of distribution in these islands have been brought about."

Many centuries later, when the climate became more genial, the ice melted and the sea level rose, the palaeoboreal species could not wander back the way they came, because they found their path obstructed by the rising water.

The temperature also rose to its former height again, gently forcing species with a predilection for moderate temperatures to abandon the lower regions and seek refuge in higher altitudes. In Java they found such suitable quarters in the temperate climate of the high mountains. These facts may explain the occurrence of similar (though not identical) species in the mountain regions of Java and in the north temperate latitudes.

As the majority of the volcanoes of Java with a height of over 2500 m do not form a continuous chain, but rise like isolated peaks from the basal plain or from the low hills, just like islands from a sea, this means

that animal life and vegetation on the high summits are separated from mountain to mountain. Hence these organisms cannot wander from one mountain to another without passing the—for these creatures—so unfavourable plains.

It is hardly necessary to remind what an important factor isolation is for the evolution of species, because in this way populations are separated and will never have occasion to interbreed.

WALLACE's hypothesis involves that the animals occurring in the high mountains of Java are chiefly of palaeoboreal origin. Since WALLACE's time, however, our knowledge of the Javanese land snail population has been fundamentally revised, with the result that it is now commonly agreed that not a single species and, hardly two genera (*Carychium* and *Pyramidula*) can be definitely designated as palaeoboreal.

When analyzing the terrestrial snail population of the high mountains (JUNGHUHN's cold zone, table II B of this report) we find that just as in the vegetation there are no endemic genera in Java. In the second place it appears that—although 28 species have been reported from the uppermost zone—only 2 species seem to be confined to these high altitudes.

These figures must not be taken as final because continued research may change them when new data become available.

In the third place it is evident from table II that the genera to which the species of the cold zone belong are by no means palaeoboreal at all. *Hydrocena*, *Palaina*, *Diplommatina*, *Elasmias*, *Pupisoma*, *Phaedusa*, *Acrophaedusa*, *Ptychodon*, *Philalanka*, *Meghimatium*, *Liardetia*, *Lamprocystis*, *Parmarion*, *Microcystina* and *Landouria* are chiefly equatorial and have their centre of distribution in S.E. Asia and outlying islands for the greater part south of the tropic of Cancer. It is true that some scores of years ago many new species described from Java were placed in European genera: *Helix*, *Acanthinula*, *Pupa*, *Hyalinia*, *Bulimus* etc., but modern research, especially the anatomy of the radula and of the generative organs, has completely changed the classification.

The negative result is also remarkable: of the large palaeoboreal and palaeartic family par excellence, the Helicidae, not a single representative is found in Java.

Summarizing, it can be stated that for the origin of the high mountain snails it is not necessary to accept a long migration route from boreal Asia all the way down to Java, but there is more reason to believe that they descended from congeneric species living in lower altitudes in less remote territories.

SYSTEMATIC PART

Systematic Account of the Pulmonate Families *Ellobiidae*, *Rathou-
siidae*, *Vaginulidae*, *Succineidae*, *Tornatellinidae*, *Vertiginidae*,
Valloniidae, *Enidae*, *Clausiliidae*, *Subulinidae*, *Achatinidae*, *Endo-
donidae*, *Zonitidae*, *Vitrinidae*, *Arionidae*, and *Limacidae*, with
an Appendix on *Helicarionidae* (contd from Part II)

[The names between square brackets denote species which are not yet found in the main island of Java, but on one or more of the satellite islands, close to the coast of Java]

Phylum Mollusca
Classis Gastropoda
Subclassis Pulmonata
Ordo Basommatophora

Familia ELLOBIIDAE

Carychium javanum MOELLENDORFF

Ordo Stylommatophora

Familia RATHOUSIIDAE

Atopos ouwensi COLLINGE

Familia VAGINULIDAE

Laevicaulis alte (FÉRUSSAC)

Filicaulis bleekeri (KEFERSTEIN)

Semperula wallacei (ISSEL)

Semperula maculata (TEMPLETON)

Semperula variegatula (SIMROTH)

Semperula siamensis (MARTENS)

Familia SUCCINEIDAE

Succinea obesa MARTENS

Succinea minuta MARTENS

Succinea listeri SMITH

Succinea gracilis LEA

Familia TORNATELLINIDAE

Elasmias manilense (DOHRN)

Elasmias sundanum (MOELLENDORFF)

[*Tornatellina cylindrica* SYKES]

[*Tornatellina subcylindrica* QUADRAS & MOELLENDORFF]

Familia VERTIGINIDAE

- Pyramidula javana* (MOELLENDORFF)
Costigo moleculina VAN BENTHEM JUTTING
Gastrocopta lyonsiana (ANCEY)
Gastrocopta pediculus ovatula (MOELLENDORFF)
 [*Gastrocopta euryomphala* PILSBRY]
Paraboyssidia boettgeri (MOELLENDORFF)
Gyliotrachela fruhstorferi (MOELLENDORFF)
 [*Pupoides coenopictus connectens* RENSCH]

Familia VALLONIIDAE

- Pupisoma orcula* (BENSON)
Pupisoma perpusillum (MOELLENDORFF)
Pupisoma tiluanum (MOELLENDORFF)

Familia ENIDAE

- Ena glandula* (MOUSSON)
Ena thrausta (MOELLENDORFF)
Ena prillwitzi (MOELLENDORFF)
Ena tenuilirata (MOELLENDORFF)
Ena tenggerica (MOELLENDORFF)

Familia CLAUSILIIDAE

- Phaedusa corticina* (VON DEM BUSCH)
Phaedusa javana (PFEIFFER)
Phaedusa salacana (BOETTGER)
Acrophaedusa cornea (PHILIPPI)
Acrophaedusa fruhstorferi (MOELLENDORFF)
Acrophaedusa junghuhni (PHILIPPI)
Acrophaedusa nubigena (MOELLENDORFF)
Acrophaedusa orientalis (VON DEM BUSCH)
Acrophaedusa schepmani (MOELLENDORFF)

The descriptive part of
 this family will be treat-
 ed by Mr F. E. LOOSJES

Familia SUBULINIDAE

- Glessula sumatrana* (MARTENS)
Subulina octona (BRUGUIÈRE)
Opeas gracile (HUTTON)
Opeas clavulinum (POTIEZ & MICHAUD)
Prosopeas achatinaceum (PFEIFFER)
Prosopeas acutissimum (MOUSSON)

Familia ACHATINIDAE

Achatina fulica BOWDICH

Familia ENDODONTIDAE

Charopa microdiscus VAN BENTHEM JUTTING*Ptyehodon celebica* P. & F. SARASIN*Philalanka micromphala* n.sp.*Philalanka nannophya* RENSCH*Philalanka tjibodasensis* (LESCHKE)*Philalanka thienemanni* RENSCH[*Stenopylis coarctata* (MOELLENDORFF)]

Familia ZONITIDAE

Geotrochus conus (PHILIPPI)*Geotrochus multicarinatus* (BOETTGER)*Trochomorpha planorbis* (LESSON)*Trochomorpha bicolor* MARTENS*Trochomorpha strubelli* BOETTGER*Trochomorpha concolor* BOETTGER

Familia VITRINIDAE

Vitrinopsis fruhstorferi (MOELLENDORFF)

Familia ARIONIDAE

Meghimatium striatum HASSELT*Meghimatium bilineatum* (BENSON)

Familia LIMACIDAE

Deroceras laeve (MÜLLER)

Familia HELICARIONIDAE (contd from Part II)

Tanychlamys amboinensis (MARTENS)

Familia ELLOBIIDAE

Shell of various sizes and of various shape and colour. Surface smooth or sculptured. Interior walls resorbed in many species. Peristome generally thickened and armed with lamellae and teeth. Umbilicus closed or open, but never wide.

Animal with short cylindrical tentacles. Eyes at the base of the tentacles. Footsole bipartite or undivided. Central tooth of radula uni-

cuspid or indistinctly 3-cuspid. Marginals with three or more cusps. Hermaphroditic.

Most species live by the sea side, in the tidal or brackishwater zone or just above high water mark, on mud flats and sand banks. Occasional flooding does not seem to do them any harm. Only two genera, *Carychium* and *Zospeum*, are truly terrestrial, living far inland among grass, dead leaves and moss (*Carychium*) or in caves (*Zospeum*).

Distribution: Tropical and temperate zones of the Old and New World.

In Java there are several genera living in the marine belt. They will be treated together with the fresh water fauna in a following number of these Systematic Studies. The only real land genus is:

Genus *Carychium* MÜLLER, 1774

Shell small, elongate-oval to cylindrical, with convex whorls. Finely striated or ribbed in the direction of the growth lines. Umbilicus narrow or closed. Aperture irregularly oval, with one or more denticles. The parietal and the columellar teeth are the lowermost endings of two interior lamellae winding spirally round the columella. The degree of development of these lamellae is correlated with the age of the shell.

Animal whitish, somewhat transparent. Eyes as small dark specks at the base of the tentacles. Hermaphroditic.

Mandibula somewhat arched, composed of a number of small plates. Radula ∞ . 1. ∞ (fig. 4).

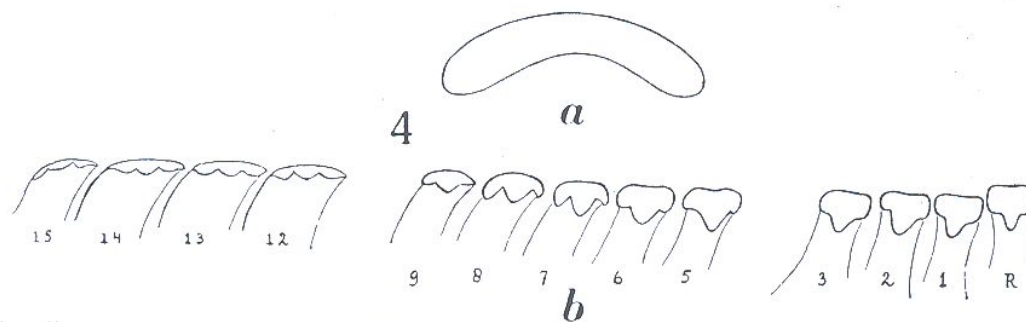


Fig. 4. *Carychium minimum* MÜLL. a. mandibula (after MOQUIN TANDON); b. radula elements. Author del.

Distribution: Europe, N. Africa, Asia, N. America.

In Java only one species:

Carychium javanum MOELLENDORFF, 1897 (fig. 5).

1897 MOELLENDORFF, Nachr. Blatt, 29, p. 90.

1901 KOBELT, Auriculidae in: MARTINI-CHEMNITZ, N. Syst. Conch. Cab. Bd. 1, Abt. 16-II, p. 125 and 285, pl. 31, fig. 16.

1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 240.

Shell elongate-oval to cylindrical. White or cream-coloured, finely striated or ribbed according to the growth lines. These riblets are crossed by a still more delicate spiral striation. Somewhat shining and glossy, transparent.

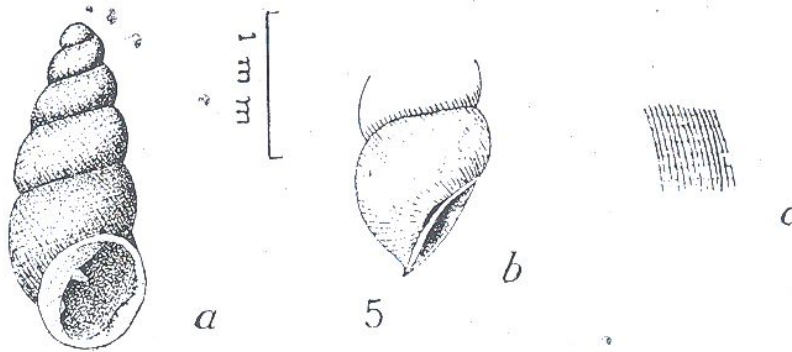


Fig. 5. *Carychium javanum* MLLDFF. a. front view; b. side view; c. detail of sculpture, somewhat more enlarged. ABDULKADIR del.

Whorls 5—6, convex, regularly increasing in size. First two whorls smooth, the following ones finely striated as described above. Suture deep. Top pointed but not sharp. Base rounded, umbilicus hair-fine or closed.

Aperture irregularly rounded-oval, somewhat

oblique. Peristome continuous, in full-grown shells thickened and flatly reflected. Parietal side appressed to previous whorl, provided with a distinct denticle, which is the basal end of a broad interior lamella, winding spirally round the columella. The projection at the columellar side of the aperture is the lower end of a similar, narrower lamella round the shell axis below the broad one. The edge of each lamella is thickened, cord-like. The palatal margin of the peristome is slightly sinuate, with a more or less distinct denticle.

Dimensions: height 1.7 to 2.2 mm, width 0.75 to 1.0 mm, height of aperture 0.6 to 0.8 mm. There is some variation in the degree of slenderness of the shell. The population of Mount Gedeh, near Kandang Badak (of which I could measure about a hundred specimens) is rather broad (height—width ratio on the average 2.1 to 1.0). The only shell from Mount Tjerimei, on the contrary, is an extremely slender one (height 1.7, width 0.65 mm).

The arrangement of the interior lamellae is not unlike the situation in the American species *Carychium exiguum* SAY (vide WINSLOW, 1922, Occ. Pap. Mus. Zool. Univ. Mich. 128, pl. 2, fig. 10-11).

Distribution: Java.

Habitat in Java: among dead leaves, moss, decaying wood in the mountain region, between 1500 and 2800 m alt.

West Java: Mt. Gedeh (E slope, various localities, 1700-2800 m); Mt. Pangrango, 2400 m; Mt. Tjerimei, 1500 m.

East Java: Kawah Idjen-Merapi Game Reserve, 1600-1700 m; Ongop-Ongop, Idjen Highland, 1850 m.

Carychium balianum FULTON from Bali (according to RENSCH: *Carychium indicum balianum*) is a somewhat smaller species (or subspecies), with less distinct riblets, a narrower aperture, but a more developed peristome. The 10 specimens from Baturiti, Bali, (leg. Sunda Expedition RENSCH) in our Museum are high 1.7 to 1.9, wide 0.7 to 0.8 mm, with an aperture of 0.5 to 0.65 mm height.

Familia HELICARIONIDAE (Continued from p. 457, 1950)

For description of the Family see p. 387, 1950.

Genus *Tanychlamys* BENSON, 1834

Shell large or medium-sized, low conical to almost plane above, narrowly umbilicate. Uniformly coloured, polished. Finely striated according to the growth lines. Aperture wide and broad. Peristome not continuous, sharp, not thickened, somewhat reflected in the umbilical region.

Mantle collar with 1 to 4 lobes, extending partly over the shell. Foot narrow, with a large caudal foss, overhung by a "horn". Footsole tripartite.

Central tooth of radula tricuspid, laterals bi- or tricuspid. Marginals bicuspid (fig. 6).

Penis with a coecum, generally spirally coiled. Dart sac and dart present.

Distribution: SE Asia, Sumatra, Java, Celebes, Philippines, Moluccas. In Java only one species:

Tanychlamys amboinensis (MARTENS, 1864) (fig. 6-7).

1864 MARTENS, Monatsber. Akad. Wiss. Berlin, p. 266 (*Hyalina*).

1867 MARTENS, Ostas. Landschn. p. 244, pl. 12, fig. 11 (*Hyalina*).

1886 TRYON, Man. of Conch. (2) 2, p. 170, pl. 52, fig. 6-8 (*Macrochlamys*).

Shell low conical, much broader than high, rounded at the periphery. Brownish-yellow, somewhat whitish at the base in the umbilical region. Hyaline, shining. Very finely striated according to the growth lines. No spiral striation.

Whorls about 6, regularly coiled. Top flat, or nearly so. Profile of the whorls little curved. Suture shallow, with a double margin. Periphery round, umbilicus narrow.

Aperture oblique, broadly lunar. Peristome not continuous, sharp, not thickened or reflected, except for a small distance close to the umbilicus.

Dimensions: height 7—8 mm, width 12—13 mm, height of aperture 4—5 mm.

Distribution: Java, Amboina, Buru, Banda Neira.

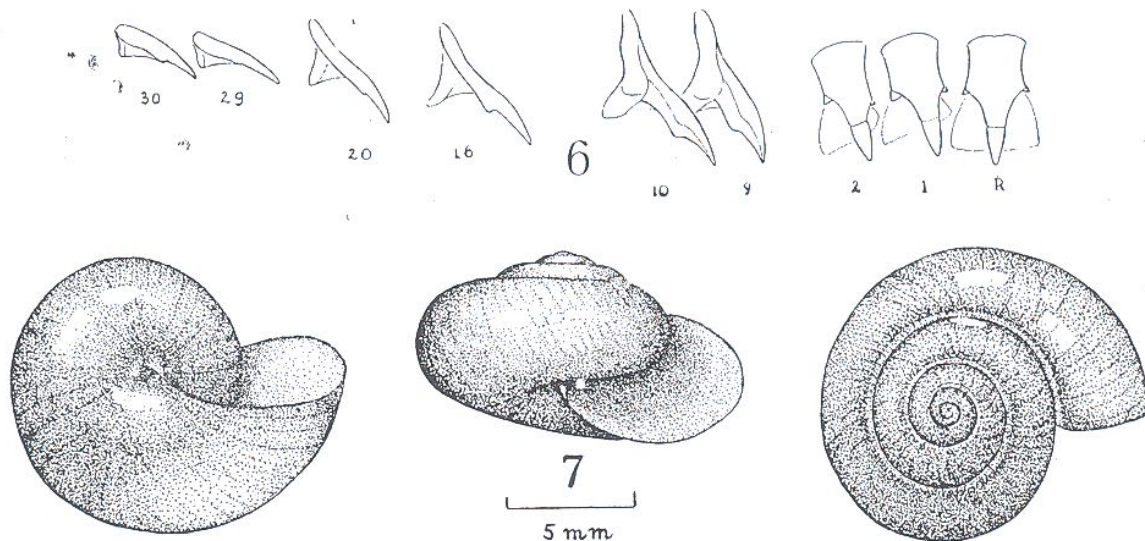


Fig. 6. *Tanychlamys amboinensis* (MARTS). Radula elements. Author del. Fig. 7. Same species. Shell from base, side and top. LENSVELT del.

Habitat in Java: living on the ground, in the woods of the hills and mountains, between 700 and 2958 m.

West Java: Rarahan and Tjibodas, Mt. Gedeh, 1400 m; edge of crater of Mt. Gedeh, 2800 m, and on summit 2958 m; Mt. Salak; Sukabumi, 700 m; Mt. Tangkuban Prah, 700—1400 m; Mt. Malabar, 7000 feet; Mt. Tjikorai, 2500 feet.

When treating the Helicarionidae in Part II of these studies (Treubia, 20, 1950, p. 457) I excluded *Tanychlamys amboinensis* (= *Macrochlamys amboinensis*) because I suspected the species to belong to the Zonitidae. Renewed investigation, however, has proved that the classification of this species in the Helicarionidae must be maintained.

Familia RATHOUSIIDAE

Slugs of moderate to large size, without shell. The mantle covers the entire back (notum) and the lateral parts of the base (hyponotum). Between the left and right hyponotum strips lies the narrow, undivided footsole. There is no discrimination in shield and body. Mid-dorsal line rounded or with a prominent longitudinal keel. Tentacles short, the upper pair bearing the eyes (ommatophores).

The animals are hermaphroditic. Genital organs without such appendages as dart sac and dart, digitiform glands, flagellum, etc. The

penis is only accompanied by the so-called Simroth gland of which the function is still uncertain.

Radula ∞ . 1. ∞ . The teeth are arranged in V form. Central tooth small or absent, latero-marginals each with a long, dagger-shaped or hook-shaped cusp. No mandibula.

Distribution: SE China, Tonkin, Siam, Burma, Malaya, Malay Archipelago, Philippines, New Guinea, Australia.

Genus *Atopos* SIMROTH, 1891.

Slugs of moderate to large size, prismatical in transverse section. Uniformly coloured or elegantly striped and punctated, contrasting with the ground colour. The mantle covers the entire back (notum) and the lateral sides of the base (hyponotum). The sharp edge separating notum and hyponotum is called the perinotum. There is no discrimination in shield and body. Shell entirely absent. Where the left and right walls of the notum join in the middorsal line they form a conspicuous longitudinal keel, enclosing a narrow dorsal sinus. In this sinus large vacuolized cells open. Their secretion produces drops of mucus along the dorsal keel. Notum and hyponotum are granular by numerous small tubercles.

Footsole undivided, rather narrow, transversely wrinkled, separated from the hyponotum by a shallow groove. Of the two pairs of tentacles the uppermost ones bear the eyes (ommatophores). The lower tentacles are shorter and are connected at the base with a small flap of integument. In contracted animals this may suggest that the lower tentacles are bifid.

In the digestive tract stomach and intestine are not distinctly separated, the whole tube being almost equally wide.

Hermaphroditic. Genital organs without such appendages as dart sac and dart, digitiform glands, flagellum, etc. Female genital opening on the right side, close to the anus and to the nephroporus (cloaca), and to the respiratory orifice. All openings lie in the groove between hyponotum and foot. Penis on the right side, large, accompanied by a peculiar gland the Simroth gland, or spin gland. There can even be another Simroth gland on the left side, which has no connection with the male organ. The function of this gland remains uncertain. The male orifice lies on the right side behind the right lower tentacle.

Radula ∞ . 1. ∞ . The teeth are arranged in V form, the angle of the V pointing backward. The central tooth is small or absent, the latero-marginals are larger, each with a long, dagger-shaped or hook-shaped

cusps. All latero-marginals are of the same form, only diminishing in size from the centre to the sides (fig. 8). Mandibula is absent.

The food of *Atopos* is said to consist of vegetable debris and fungi (SIMROTH, 1891, *Zeitschr.wiss. Zool.* 52, p. 593-616). Other authors regard these animals to be predatory (LAIDLAW, 1940, *Bull. Raffles Mus.* 16, p. 130). The dagger-shaped teeth may point in favour of the latter opinion. Feeding experiments are wanted to clear up the question.

Distribution: Cochin-China, Burma, Malaya, Borneo, Sumatra, Simalur, Java, Celebes, Amboina, Buru, Ceram, New Guinea, Australia, Philippines.

In Java there is only one species:

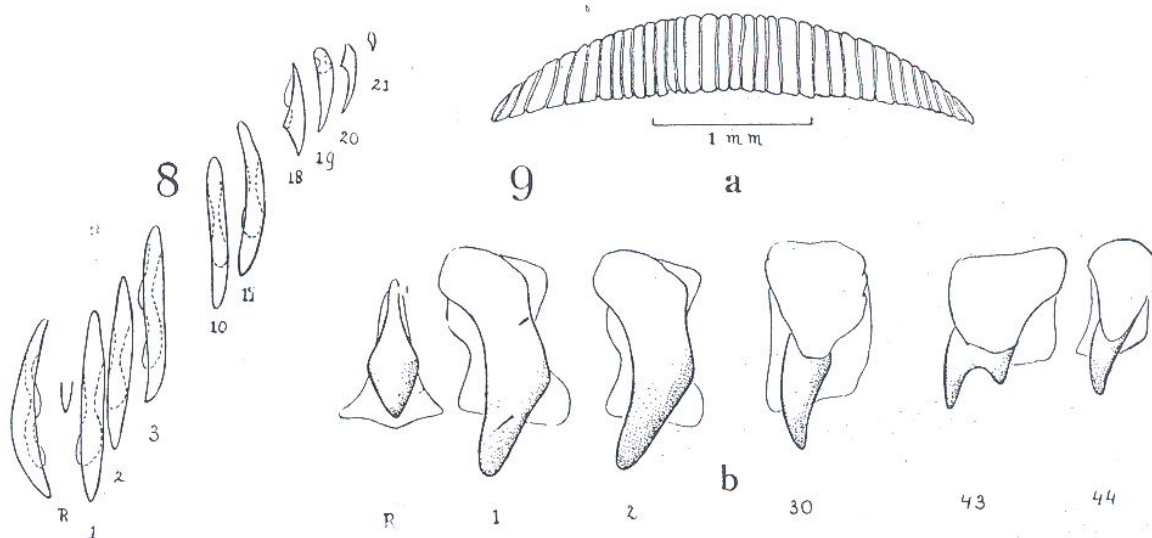


Fig. 8. *Atopos sarasini* COLLINGE. Radula elements (after LAIDLAW). Fig. 9. *Filicaulis bleekeri* (KFST.). a. mandibula; b. radula elements. Author del. The 43th row on the right side of the radula contained teeth which were composed of a fusion of two teeth.

Atopos ouwensi COLLINGE, 1908 (fig. 10).

1908 COLLINGE, *Journ. of Conch.* 12, p. 119.

1914 LESCHKE, *Mitt. naturh. Mus. Hamburg*, 31, p. 223.

1925 HOFFMANN, *Vidensk. Medd. Dansk naturh. Foren.* 81, p. 27 (*A. cristagalli* SAR. et SAR.).

1931 VAN HEURN, *De Trop. Natuur*, 20, p. 18, 1 fig. (*Atopos* sp.).

1931 VAN HEURN, *Journ. of Conch.* 19, p. 150, 1 fig. (*Atopos* sp.).

Slug moderately large. The mantle was described by COLLINGE after a specimen preserved in alcohol as being of a dirty light-brown colour, with a faint tinge of green, and with a few black circular spots laterally. The extreme anterior end was yellow and the prominent dorsal keel light

greenish-yellow. The whole notum had a granular appearance. The head was yellow, the hyponotum greenish-brown, the footsole yellowish-green.

VAN HEURN who described a specimen from Kawah Kamodjang mentioned that it was uniformly black, except the median portion of the base which was greyish. It was likewise granular with very small scattered tubercles. Especially the posterior part of the body was acutely keeled. The margins of the perinotum were sharp and separated from the base by grooves. The posterior end of the mantle reached as far as the foot; the anterior formed a hood-like covering over the head. The foot sole was regularly wrinkled transversely, with 5 to 6 wrinkles in the mm.

Neither of the Javanese specimens has been dissected. I could examine only the exterior features of VAN HEURN's slug (now in the Leiden Museum), and of an immature one collected by Mr W. C. VOÛTE (in the Museum at Amsterdam). In the first mentioned animal the cloaca is situated at the right side, in the groove between hyponotum and footsole, at 14 mm distance from the posterior tip of the notum. The slug of Mr VOÛTE is black to bluish-black on the back. The anterior tip of the notum, the footsole, the hyponotum and a narrow longitudinal zone just above the perinotum are dirty light-brown. We must await more material before further evidence can be given.

Dimensions:

length	38 mm,	width	5 mm,	height	6.5 mm	(COLLINGE)
—	48 —	—	7 —	—	8 —	(VAN HEURN)
—	7 —	—	1.5 —	—	1.5 —	(VOÛTE)

Distribution: West Java.

Habitat in Java: living on the ground under decaying wood in the jungle. Found in altitudes of 250 m (COLLINGE), 1600 m (VAN HEURN), 500 m (VOÛTE).

West Java: Botanical Garden, Bogor, 250 m; "Engelse Vlakte", Kawah Kamodjang, Mt. Guntur, 1600 m; Mt. Masigit, near Padalarang, 500 m.

Mr VAN HEURN made the following remarks on the behaviour of his *Atopos*: "When alive the animal seemed to be very inert and while creeping around during the night it sometimes had two rather short ommatophores protruded; when the slug was dead the tentacles were all retracted."

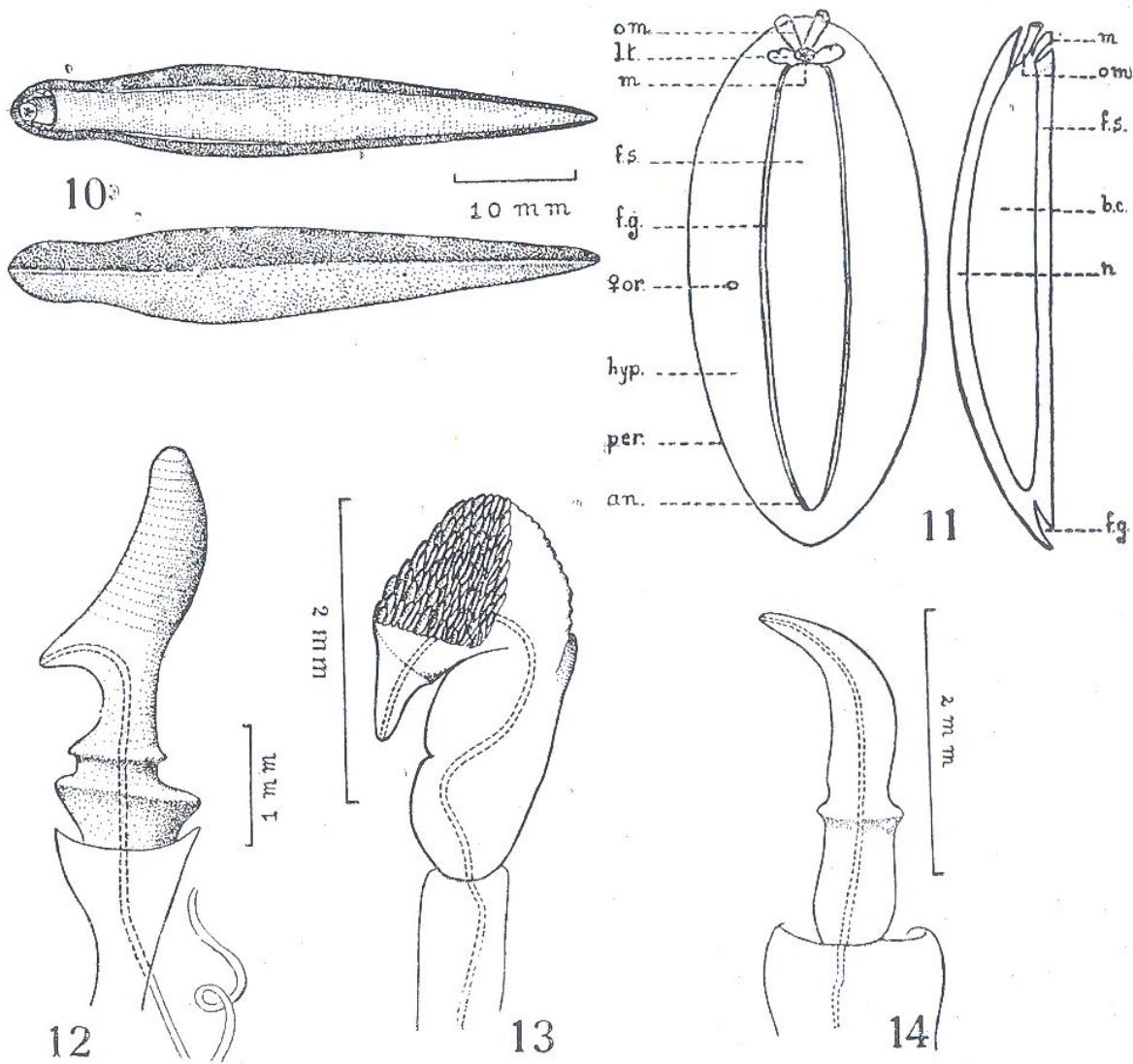


Fig. 10. *Atopos ouwensi* COLLINGE. Animal from back and from base. Author del. Fig. 11. Sketch of organization of vaginulid slug. a. ventral side; b. longitudinal section (after HOFFMANN). an. anus; b.c. body cavity; f.g. footgroove; f.s. footsole; hyp. hyponotum; lt. lower tentacle; m. mouth; n. notum; om. ommatophore; ♀ or. female genital orifice; per. perinotum. Fig. 12. *Semperula variegatula* (SIMR.). Penis. Author del. Fig. 13. *Semperula siamensis* (MARTS). Penis. Author del. Fig. 14. *Filicaulis bleekeri* (KFST.). Penis. Author del.

Familia VAGINULIDAE

Animal oval, slug-like, without interior or exterior shell. Dorsal side covered by the undivided mantle, the notum. Along the lateral sides this notum is separated from the ventral side by a sharp keel, the perinotum. Ventral side divided in three longitudinal zones; the two lateral ones, or hyponota, are the continuation of the dorsal notum. The central zone is the footsole, separated from the hyponota by a groove. Anteriorly of the footsole the head of the slug is visible. In the living animal it protrudes

a little beyond the notum, in contracted ones it lies hidden below the notum. Anus behind the foot sole in the posterior tip of the slug. Here is also the lung opening. The upper tentacles bear the eyes (ommatophores), the lower ones are bifid. Female generative opening about midway in the right hyponotum. Male orifice at the right side in the groove between mouth and foot (fig. 11).

Colour dark-grey on the back, lighter at the ventral side. Some species have a black longitudinal median stripe on a lighter background, others a light stripe on a dark background. Notum and hyponotum can be spotted and veined.

Radula ∞ .l. ∞ , all teeth unicuspid. Rhachis small, latero-marginals well developed. From the centre to the sides these teeth gradually diminish in size. Mandibula arch-shaped, composed of numerous small, parallel plates (polyplacognathous) (fig. 9).

In all vaginulids the morphology of the terminal parts of the male generative organs, the oncheiopodium or penis, forms the most distinct taxonomic feature for separating the species. The preparing of this organ is relatively easy, and, if the microscopical examination in direct light does not provide full details of its interior, the penis can rapidly be made transparent by plunging it into phenolum liquefactum.

Among the Vaginulids of the Indo-Malayan region two types of penis can be distinguished:

- (1) acrocaulous (= opening of sperm-duct at the tip of the slender penis);
- (2) pleurocaulous (= opening of sperm-duct at the side of the compact penis).

In addition to the form of the penis the morphology of the excitatory organ ("Reizpapille") and its appending glands can also be important for the classification of the species. Dart and dart sac are lacking.

Finally the position of the female orifice has certain taxonomic value. According to GRIMPE & HOFFMANN (1925, Zeitschr. wiss. Zool. 124, p. 22) the distance between the ♀ opening and the pedal groove is inversely proportionate to the length of the penis, or in other words: the longer the penis the shorter the distance between ♀ pore and pedal groove. Whether this relation has any biological function is a question not yet solved.

Vaginulids live on a diet of plants and plant-remains. Locally they can do some damage in vegetable gardens and in plantations of tobacco and other crops for the world market.

The animals are found under stones, grass, decaying wood, sometimes in crevices in the ground. By day time they are more or less dormant, but during the night they become more active.

Observations on mating, pairing, spawning and development are scarce. SARASIN & SARASIN (1899, Land Moll. Celebes, p. 72 ff) gave a description of the development of some species of *Vaginula*. Other biological observations are made on species not indigenous in the Malay Archipelago. Therefore these notes can only be used with the greatest reserve for species of the Malaysian region.

Distribution: all tropical countries, with some penetrations into sub-tropical regions. Originally all species had a regional distribution, but through human agency several species have been transported beyond their native countries.

Key to the genera living in Java:

1. Penis acrocaulous 2.
- Penis pleurocaulous **Semperula.**
2. Penis very slender, nearly cylindrical. Collar almost at the base of the penis **Laevicaulis.**
- Penis pointed, but not so slender. Collar about midway of length of the penis **Filicaulis.**

Genus *Laevicaulis* SIMROTH, 1913.

(= *Meisenheimeria* GRIMPE & HOFFMANN, 1924)

As the general morphology is similar to that of the family diagnosis only the distinguishing features will be mentioned here (adapted from the description by GRIMPE & HOFFMANN).

Notum rather dark, female porus close to the foot groove (index 1:5 or somewhat less). Anterior curve of intestine in front of the mid-gut gland. Salivary glands compact, not grape-like. Foot gland reversed, with several coils. Pedal nerves diverging from the very beginning. Receptaculum seminis with long duct. Penis long, cylindrical, radially symmetrical, acrocaulous, with subbasal collar and terminal opening. Without terminal papilla and without glans. Excitatory organ short, conical, with 12—20 long glandular appendages.

Distribution: S. India, Ceylon, Andaman Is., S. China, Formosa, Philippines, Malay Archipelago, Queensland, various Pacific islands, Africa, Madagascar, Mascarene Is.

In Java only one species:

***Laevicaulis alte* (FÉRUSAC, 1823) (fig. 15).**

- 1823 FÉRUSAC, Hist. Nat. génér. et partic., Moll. p. 96 x, pl. 8A, fig. 8, pl. 8B, fig. 6 (*Vaginulus*).
- 1885 SEMPÉR, Reis. Arch. Philipp. Part 2, Vol. III, p. 325 (*Vaginula maculosa* part).
- 1925 HOFFMANN, Jen. Zeitschr. Naturw. 61, p. 120-129 and 226-228, pl. 1, fig. 9 and 11, pl. 2, fig. 12-14, 18 and 21, pl. 3, fig. 26 and 31, pl. 4, fig. 34, 36, 37 and 42, pl. 5, fig. 45b 4, pl. 9, fig. 66, 67 and 68a, pl. 10, fig. 70, pl. 11, fig. 72, 73, 75, 76, 77a and 81 (*Meisenheimeria*).
- 1925 GRIMPE & HOFFMANN, Zeitschr. wiss. Zool. 124, p. 26-31, fig. 1 (*Meisenheimeria*).
- 1928 HOFFMANN, Arch. Moll. Kunde, 60, p. 245.
- 1930 HOFFMANN, Zool. Anz. 88, p. 108.
- 1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 128.

Animal oval, slug-like, without shell. Notum dark-grey to light yellowish-grey, uniformly coloured or spotted with darker spots. Hyponotum lighter than the back. Both notum and hyponotum minutely granular. Female orifice close to the foot groove, at about $\frac{1}{3}$ of the width of the right hyponotum.

Penis long and cylindrical, with subbasal collar. Orifice at the top of the organ (fig. 15).

Dimensions: length 50 to 80 mm, width 24 to 30 mm.

Distribution: East Africa, Madagascar, various islands of the Indian Ocean, India, China, Formosa, Andaman Is., Malaya, Java, Celebes, several of the Lesser Sunda Is., Moluccas, Philippines, Queensland, Loyalty Is., New Caledonia.

Habitat in Java: living on the ground, under stones, grass and fallen leaves. Recorded between sea-level and 1000 m alt.

West Java: Djakarta, 15 m; Sukabumi, 700 m; Mt. Malang, 1000 m.

Central Java: Samarang (GRIMPE & HOFFMANN, 1925).

According to HOFFMANN (1925, p. 214) *Vaginula viridi-alba* DESHAYES (1830, Hist. Nat. génér. & part. Moll. 2, p. 96⁷, pl. 8E, fig. 6) (syn. *Onchidium viridi-album* HASSELT, 1823, Alg. Konst- & Letterb. 2, p. 243, nomen nudum) from Kapangdungan, Java, may be an abnormally coloured *Laevicaulis alte*.

The unpublished coloured drawing by G. L. KEULTJES, now in the Leiden Museum, shows a greyish-white animal, with a dark mid-dorsal line and small greenish and brownish transverse spots.

Genus *Filicaulis* SIMROTH, 1913

(= *Vanigula* GRIMPE & HOFFMANN, 1925)

Like in the preceding genus I have limited the description to the typical characteristics only (adapted from the original diagnosis by GRIMPE & HOFFMANN).

Notum brown, generally strongly maculated. Female pore at about $\frac{1}{3}$ of the width of the right hyponotum (index 1: 3 or somewhat more). Anterior curve of intestine in the mid-gut gland. Pedal nerves parallel for a short distance, after that diverging rapidly. Receptaculum seminis with long duct. Penis rather long, conical, radially symmetrical, acrocaulous, with submedial collar and terminal opening. Without terminal papilla and without glans. Excitatory organ conical, with 16-18 short glandular appendices.

Distribution: Bangkok, Sumatra, Java, Borneo, Amboina, Banda, Moluccas.

In Java only one species:

Filicaulis bleekeri (KEFERSTEIN, 1865) (fig. 9 and 14).

- 1865 KEFERSTEIN, Zeitschr. wiss. Zool. 15, p. 118, pl. 9, fig. 1-7 (*Veronicella (Vaginulus) Bleekeri*).
- 1867 MARTENS, Ostas. Landschn. p. 176 (*Vaginulus hasselti* pars), p. 177 (*Vaginulus maculosus* ?), p. 177 (*Vaginulus bleekeri*).
- 1885 SEMPER, Reis. Arch. Philipp. Part 2, Vol. III, p. 325-326 (*Vaginula maculosa* part.).
- 1892 MARTENS, Erg. Reise N.O. Indien, 2, p. 247 (*Vaginulus strubelli*).
- 1893 SIMROTH, Sitz. Ber. naturf. Ges. Leipzig, 17-18 (1891-1892), p. 67 and 85 (*Vaginula strubelli*).
- 1894 MARTENS, Jen. Denkschr. 8, p. 83 (*Vaginulus strubelli*).
- 1897 SIMROTH, Abh. Senck. naturf. Ges. 24, p. 137, pl. 14, fig. 6, 9a, 9b (*Vaginula strubelli*).
- 1912 SCHEPMAN, Proc. Malac. Soc. 10, p. 234 (*Vaginula strubelli*).
- 1914 LESCHKE, Mitt. naturh. Mus. Hamb. 31, p. 240 (*Vaginula bleekeri, maculosus* ?, *marshalli*).
- 1925 HOFFMANN, Jen. Zeitschr. Naturw. 61, p. 135 and 231, pl. 2, fig. 19, pl. 5, fig. 45c4, pl. 7, fig. 46, 47, 51 and 52, pl. 8, fig. 55-57, 59 (*Vanigula bleekeri*).
- 1925 GRIMPE & HOFFMANN, Zeitschr. wiss. Zool. 124, p. 31, fig. 2 (*Vaginula bleekeri*).
- 1925 GRIMPE & HOFFMANN, Nova Caledonia, Vol. III, Part 3, p. 387 (*Meisenheimeria (Vanigula) bleekeri*).
- 1925 HOFFMANN, Vidensk. Medd. Dansk. naturh. Foren. 81, p. 17 (*Vanigula*).
- 1927 HOFFMANN, Ark. f. Zool. 19A, no. 25, p. 24.
- 1950 KALSHOVEN, Plagen Cultuurgew. Indon. 1, p. 47, fig. 13a (*Vaginula bleekeri*).

Animal oval, slug-like, without shell. Notum varying from dark-grey to light yellowish-grey. The lighter specimens are spotted and veined with dark markings, the dark ones are of uniform colour, sometimes with a narrow middorsal line of lighter colour. Hyponotum generally lighter, and the footsole again lighter. Notum and hyponotum are minutely granular. Scattered between these small granules are some larger warts placed wider apart.

Female orifice at about $\frac{1}{3}$ of the distance between the foot groove and the perinotum. Penis conical, with a conspicuous collar at about $\frac{1}{3}$ of the length from the base. Orifice at the top of the penis (fig. 14).

Dimensions: length 50 to 74 mm, width 20 to 30 mm.

Distribution: Sumatra, Borneo, Java, Sebesi, and several Lesser Sunda islands, Moluccas.

Habitat in Java: living on the ground, under stones, fallen leaves, in small crevices. Occurring between sea-level and 1450 m altitude.

West Java: Djakarta, 15 m; Tjiseëng; Bogor, 250 m; Megamendung, near Bogor, 750 m; Telaga Warna, near Puntjak pass, 1450 m; Tjibodas, Mt. Gedeh, 1450 m; Tjihanjavar (?), 1000-4000 feet (MARTENS, 1867); Tjipeueut, near Sukabumi; Mt. Malang, 1000 m; Lake Pendjalu, 725 m;

Central Java: Semarang (SCHEPMAN, 1912).

Occasionally *Filicaulis bleekerii* can do quite a lot of damage in tobacco plantations by eating young plants and the ground weeds which are planted as green manure plants (VAN DER MEER MOHR, 1928, Meded. Deli Proefstat. (2) 52, p. 3; Id. 1931, Ibid. (2) 73, p. 27; Id., 1933, Ibid. (2) 83, p. 31; Id., 1935, Bull. Deli Proefstat. no. 35, p. 8; KUYPER, 1930, Meded. Deli Proefstat. (2) 65, p. 33; KALSHOVEN, 1950, p. 47).

The specimen which I recorded from Sebesi I. as *Vaginula strubelli* SIMR. (VAN BENTHEM JUTTING, 1925, Treubia, 6, p. 143) is a synonym of *Filicaulis bleekerii* (see also VAN BENTHEM JUTTING, 1941, Arch. néerl. Zool. 5, p. 292).

According to HOFFMANN (1925, p. 137) *Vaginula maculosa* DESHAYES (1830, Hist. Nat. génér. & part. Moll. 2, p. 96^s, pl. 8E, fig. 9) (syn. *Onchidium maculatum* HASSELT, 1823, Alg. Konst- & Letterb. 2, p. 243, nomen nudum) from Tjihanjavar, Java, may be *Filicaulis bleekerii* (KEFST.).

The unpublished coloured drawing (s.n. *Onchidium maculatum*) by G. VAN RAALTE, now in the Leiden Museum, shows a dark greyish-brown animal, with irregular black spots and a narrow orange margin along the perinotum. In my opinion there is no doubt that the interpretation *Filicaulis bleekerii* is correct.

Genus *Semperula* GRIMPE & HOFFMANN, 1924

In *Semperula* I have only mentioned those features which separate this genus from the two preceding ones (adapted after the original diagnosis).

Notum brown, finely spotted. Female porus in the middle of the hyponotum (index 1:2 or 1:3). Anterior curve of intestine in the mid-gut

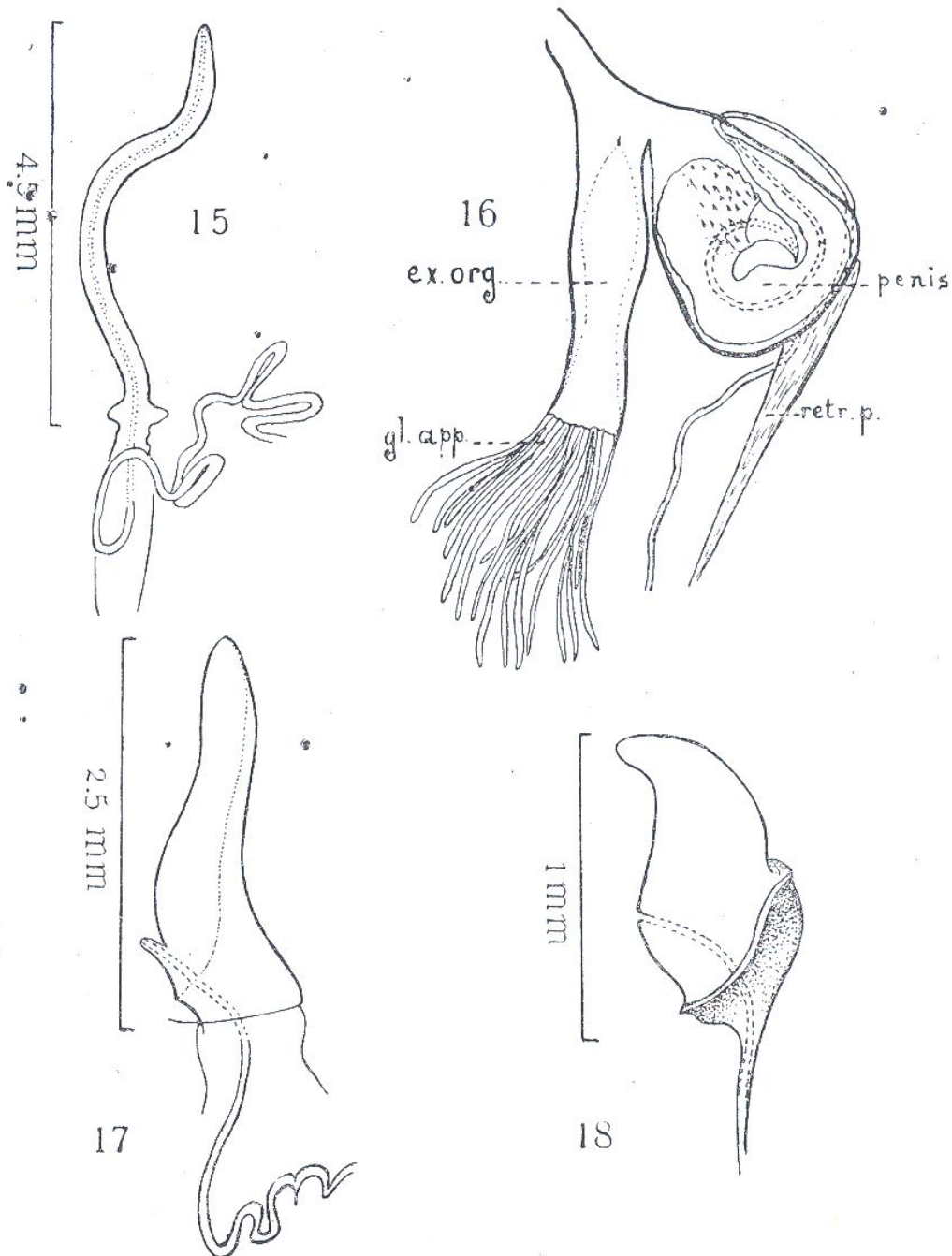


Fig. 15. *Laevicaulis alte* (FÉR.). Penis. Author del. Fig. 16. *Semperula siamensis* (MARTS). Terminal parts of male generative organs. ex. org. excitatory organ; gl. app. glandular appendages; retr. p. musculus retractor penis. Author del. Fig. 17. *Semperula wallacii* (ISSEL). Penis. Author del. Fig. 18. *Semperula maculata* (TEMPL.). Penis. Author del.

gland. Salivary glands like a bunch of grapes. Foot gland straight. Pedal nerves parallel for a short distance, after this diverging rapidly. Receptaculum seminis with a short duct. Penis relatively short, pleurocaulous. Often with a collar at the base and always with a well developed, volum-

inous "glands". In some species this part of the male organ can bear ridges, crests or honey comb cells. Opening of the sperm duct at the side of the penis, in some species on the tip of a small funnel-shaped projection. Excitatory organ conical, with 9 to 30 glandular appendices (fig. 16).

Distribution: India, Ceylon, Burma, Siam, Indo-China, South China, Philippines, Malay Archipelago, Seychelles, Mauritius.

In Java there are 4 species:

1. Glans of penis smooth. 2.
- Glans of penis honey-combed or ringed. 3.
2. Glans of penis long and almost cylindrical. Collar at the base of the penis indistinct or missing *wallacei*
- Glans of penis short, compact. Collar at the base of the penis always well developed *maculata*.
3. Glans of penis curved. Convex side of curve honey-combed in front *siamensis*.
- Glans of penis not curved, delicately ringed. A double collar at the base of the penis. *variëgatula*.

Semperula wallacei (ISSEL, 1874) (fig. 17).

1874 ISSEL, Moll. Born. p. 385, pl. 4, fig. 1-3 (*Vaginula*).

1885 SEMPER, Reis. Arch. Philipp. Part 2, Vol. III, p. 321, pl. 27, fig. 27 (*Vaginula* *Idae*).

1925 HOFFMANN, Jen. Zeitschr. Naturw. 61, p. 186-189 and 255-256, pl. 6, fig. 45k2 (*idae*).

1925 GRIMPE & HOFFMANN, Zeitschr. wiss. Zool. 124, p. 33, fig. 3 and 4 (*idae*).

1928 HOFFMANN, Arch. Moll. Kunde, 60, p. 248 (*birmanica*, non *birmanica* THEOBALD).

1930 HOFFMANN, Zool. Anz. 88, p. 109 (*birmanica*, non *birmanica* THEOBALD).

Animal oval, without shell. Notum light yellowish-brown or grey, marbled with dark spots and veins. In some specimens with a light longitudinal mid-dorsal line. Hyponotum light-yellow, little or not spotted. Both notum and hyponotum are minutely granular. Female porus about midway between perinotum and foot groove. Penis with elongate, smooth glans, without collar. Orifice of vas deference at the side, on a small protuberance (fig. 17).

Dimensions: length 30 to 35 mm, width 10 to 14 mm.

Distribution: S. China, Malaya, Borneo, Sumatra, Java, Celebes.

Habitat in Java: living on the ground, under grass sods, stones, decaying wood. Recorded from 15 and 700 m altitude.

West Java: Djakarta (HOFFMANN, 1928, p. 248); Bandung, 700 m; Garut, 700 m.

By the courtesy of the authorities of the Basle Museum I received on loan the 7 specimens of "*Semperula birmanica*" described from Batavia by HOFFMANN (1928). One specimen of this sample had been opened by HOFFMANN. He gave an elaborate description of the penis which he pretended to agree with the structure of *Semperula birmanica* described by GRIMPE & HOFFMANN (1925).

A renewed inspection brought to light that the curious shape of the true *birmanica* penis is not at all present and that we have to do with *Semperula wallacei*. This made me suspicious against the other six animals of the sample. I opened three of them and found them all to belong to *Semperula wallacei*.

Thus the somewhat artificial zoogeographical explanation by which HOFFMANN accounted for the occurrence of *Semperula birmanica* in Java can be dropped.

During the dissection a curious observation was made, viz. that one of the slugs had a double penis, both on the right side. Both organs are entirely identical, of equal size, each with a vas deferens. The excitatory organ and its glandular appendices in this one slug were lacking.

As far as I know, this is the first record of a supplementary penis in the Vaginulidae. Among others snails, however, various cases have been reported. An account of previous observations has been given by PELSENEER (1920, *Les Variations et leur Hérédité etc. Mém. Acad. Roy. Belg.* (2) 5, p. 229).

Semperula maculata (TEMPLETON, 1858) (fig. 18).

- 1858 TEMPLETON, Ann. Mag. Nat. Hist. (3) 1, p. 49, pl. 2B, fig. 1-5 (*Vaginula*).
- 1867 MARTENS, Oostas. Landschn. p. 176 (*Vaginulus hasselti* pars), p. 177 (*Vaginulus punctatus*).
- 1892 MARTENS, Erg. Reise N.O. Indien, 2, p. 246 (*Vaginulus austeni*).
- 1893 SIMROTH, Sitz. Ber. naturf. Ges. Leipzig, 17-18, p. 68 and p. 85 (*Vaginula newtoni*, *Vaginula platei*), p. 69-70 and p. 85 (*Vaginula cockerelli*).
- 1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 240 (*Vaginula austeni*, *cockerelli*, *newtoni*, *platei*).
- 1925 HOFFMANN, Jen. Zeitschr. Naturw. 61, p. 175 and 210, pl. 1, fig. 3, 4, 6, 8, pl. 3, fig. 32, pl. 4, fig. 35, 38, pl. 6, fig. 45k5.
- 1925 GRIMPE & HOFFMANN, Zeitschr. wiss. Zool. 124, p. 38-44, fig. 7.
- 1927 HOFFMANN, Ark. f. Zool. 19A, no. 25, p. 37.
- 1930 HOFFMANN, Zool. Anz. 88, p. 98 and p. 109.
- 1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 129.
- 1934 HOFFMANN, Trop. Binnengew. 5, p. 255.
- 1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 292.
- 1950 KALSHOVEN, Plagen Cultuurgew. Indon. 1, p. 48.

Animal oval, slug-like, without shell. Notum greyish or greenish-grey, mottled with darker spots and veins, or uniformly dark slate grey with a lighter mid-dorsal line. The hyponotum is usually of a lighter colour. The footsole is still lighter. Both notum and hyponotum are minutely granular. Among these small granules are coarser ones at greater distance.

Female orifice about midway between perinotum and foot groove. Penis thick, with swollen, but smooth "glans" (fig. 18). A conspicuous ridge descends obliquely from about midway of back to the front, forming an incomplete collar. Opening of vas deferens at the side, on a small funnel. In some animals I have found the glans not quite so swollen as in normal specimens, but somewhat more tapering. The fold of the collar, however, was normally developed. Whether this modification is also found in the unpreserved slug, or whether it is a consequence of the preserving, I am unable to decide.

Dimensions: length 25 to 58 mm, width 10 to 25 mm.

Distribution: Madagascar, Rodriguez, Mauritius, Seychelles, India, Ceylon, Tonkin, Cambodja, Hainan, Malaya, Philippines, Sumatra, Pulu Weh, Nias, Borneo, Java, Hoorn, Noordwachte, Celebes, various Lesser Sunda and Moluccan islands.

Habitat in Java: living on the ground, under grass, decaying wood, stones, leaves etc. Recorded between sea level and about 1300 m altitude.

West Java: Anjer (GRIMPE & HOFFMANN, 1925), Djakarta, 15 m; Bogor, 250 m; Mt. Gedeh, 4000 feet; Tjiandjur, 470 m; Tjimahi, 740 m; Bandung, 700 m.

Central Java: near Borobudur (HOFFMANN, 1930).

East Java: Ranu Klakah, 300 m (HOFFMANN, 1934).

According to HOFFMANN (1925, p. 176) *Vaginula punctata* DESHAYES (1830, Hist. Nat. génér. & part. Moll. 2, p. 96^s, pl. 8E, fig. 7) (syn. *Onchidium punctatum* HASSELT, 1823, Alg. Konst- & Letterb. 2, p. 243) from the environs of Buitenzorg, Java, may be *Semperula maculata* (TEMPLET.).

The unpublished coloured drawing by G. L. KEULTJES, now in the Leiden Museum, shows a uniformly chestnut-brown animal.

Further evidence cannot be given. The details of head and tentacles which HOFFMANN (1925, l.c.) brought to "*Vaginula*" *mollis* do not belong to this species, but to "*Vaginula*" *punctata*, as is evident from the original drawing.

HOFFMANN (1925, p. 176) also classified *Vaginula mollis* DESHAYES (1830, Hist. Nat. génér. & part. Moll. 2, p. 96^s, pl. 8E, fig. 8) (syn. *Onchi-*

dium molle HASSELT, 1823, Alg. Konst- & Letterb. 2, p. 243) from Batavia, Java, as *Semperula maculata* (TEMPLET.).

The unpublished coloured drawing by G. VAN RAALTE, now in the Leiden Museum, shows a uniformly brown animal with a light middorsal line. As I remarked already under "*Vaginula*" *punctata* the details of head and tentacles in the centre of pl. 8E belong to this species and not to "*Vaginula*" *mollis*.

Semperula variegatula (SIMROTH, 1918) (fig. 12).

- 1918 SIMROTH, Abh. Senckenb. naturf. Ges. 35, p. 286, pl. 19, fig. 28, 29 (*Vaginula*).
 1925 HOFFMANN, Jen. Zeitschr. Naturw. 61, p. 179 (*maculata* pars).
 1925 GRIMPE & HOFFMANN, Zeitschr. wiss. Zool. 124, p. 43 (*maculata* pars).
 1930 HOFFMANN, Zool. Anz. 88, p. 99, fig. 1-4.
 1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 129.
 1934 HOFFMANN, Trop. Binnengew. 5, p. 256.

Animal oval, without shell. Notum yellowish-brown, mottled with dark spots and veins. With a light mid-dorsal line. About midway between this mid-dorsal line and the perinotum there is on each side a dark longitudinal line. Hyponotum darker than the footsole. Female orifice about midway between perinotum and foot groove. Penis "crochet-hook"-shaped with rather slender, cap-like "glans" and a double ring or collar a short distance above the base. The glans is transversely ribbed or folded with weak folds. Orifice of vas deferens at the side on a short funnel (fig. 12).

Dimensions: length 15 to 49 mm, width 7 to 8 mm.

Distribution: Java, Bali, Lombok.

Habitat in Java: Nothing is known on the conditions under which *Semperula variegatula* lives in Java. We can, however, safely admit that it frequents the same milieu as its congeners.

East Java: Ranu Klakah, 300 m (HOFFMANN, 1934).

I have not seen the species. The above description is compiled after the original diagnosis and the additional notes of HOFFMANN, 1930 and 1934.

Semperula siamensis (MARTENS, 1867) (fig. 16 and fig. 13).

- 1867 MARTENS, Ostas. Landschn. p. 68, pl. 5, fig. 3 (*Vaginulus*).
 1925 HOFFMANN, Jen. Zeitschr. Naturw. 61, p. 179-181 and 256-257, pl. 8, fig. 58, 60, 61, 62, pl. 9, fig. 64, pl. 10, fig. 71, pl. 11, 78-80.
 1925 GRIMPE & HOFFMANN, Zeitschr. wiss. Zool. 124, p. 44, fig. 8.
 1934 HOFFMANN, Trop. Binnengew. 5, p. 257.

Animal oval, without shell. Both notum and hyponotum dark grey, indistinctly marbled with a cloudy, reticulate pattern. Footsole yellowish-grey. Along the perinotum and in the mid-dorsal line there is a narrow

light zone. Notum and hyponotum minutely granular. Female porus about midway between foot groove and perinotum. Penis relatively large, swollen, with thick „glans”. The head of the frontside of this organ is honey combed by long, oval pits or cells. Opening of sperm duct on a funnel-shaped protuberance (fig. 13).

Dimensions: length 28 to 81 mm, width 11 to 31 mm.

Distribution: Siam, Cambodja, Conchin-China, Tonkin, Hongkong, Ceylon, Java.

Habitat in Java: living on the ground, under stones, grass and plant debris. Recorded from 5 to 500 m altitude.

Central Java: Semarang, 5 m.

East Java: Ranu Klakah, 300 m (HOFFMANN, 1934); Kali Sologiri, near Banjuwangi, 500 m.

Familia SUCCINEIDAE

Shell with small spire and large last whorl, amber-coloured or greenish-yellow. Hyaline and glassy. Umbilicus closed.

Animal greyish-yellow to greyish-brown, speckled with black, especially on the mantle. Mandibula elasmognathous, with dorsal quadrangular chitinous plate (elasma). On the concave side of the jaw there is a median projection. Lateral projections of the cutting edge can occur in certain species. Radula $\infty .1. \infty$, the rhachis uni- or tricuspid, laterals with 2 to 4 cusps, marginals multicuspid (fig. 19).

Hermaphroditic. Genital organs without accessory organs. Penis with or without a penis sheath and epiphallus. Dart sac and dart are lacking.

Distribution: All continents, from the tropics up to high latitudes. Most species in moist territory.

In Java there is only one genus:

Genus *Succinea* DRAPARNAUD, 1801

Shell obliquely oval to egg-shaped. Spire small, in some species hardly projecting. Amber-coloured to greenish-yellow. Hyaline, glassy, fragile. Striated according to the growth lines. Whorls few, rapidly increasing in size, the last one very spacious. Suture moderately deep. Umbilicus closed. Aperture oblique, oval. Peristome not continuous, sharp. Not thickened or reflected. Parietal side in many species covered by a thin filmy layer uniting the two ends of the peristome.

Animal greyish-yellow to greyish-brown, spotted with black, especially on the mantle. Body relatively large, although it can entirely be retracted into the shell.

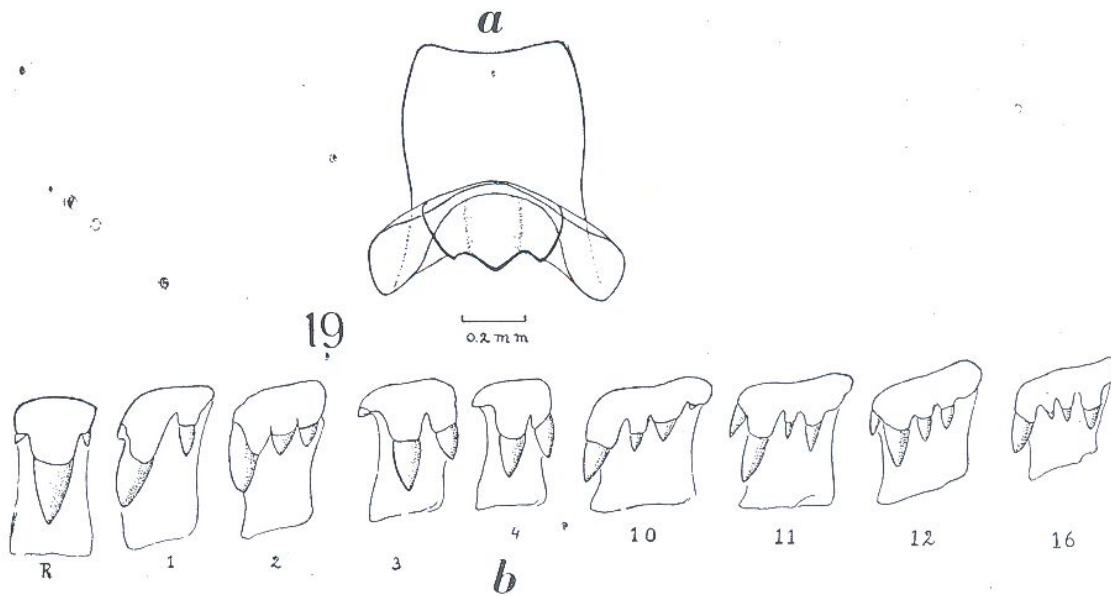


Fig. 19. *Succinea minuta* MARTS. a. mandibula; b. radula elements. Author del.

Radula $\infty .1. \infty$, the rhachis with one to three cusps, laterals with 2 to 4 cusps, marginals multicuspoid.

Footsole provided with a foot fringe. The base of the sole is divided in a broad central and two narrow lateral fields.

Distribution: cosmopolitan, even in arctic and antarctic regions, from the coast up to the mountains. Most species living in humid surroundings.

In Java there are three species. A fourth species lives in two of the satellite islands off the north coast of Java. As it may be expected to appear in Java also some day I have included it in the following key:

- 1. Spire much produced. **gracilis**
- Spire not so produced. 2
- 2. Shell broad, spire small and little produced **obesa**
- Shell more elongate, spire larger and somewhat more produced 3
- 3. Last whorl inflated, aperture placed more to the side of the shell axis. **listeri**
- Last whorl not so inflated, aperture placed more below the spire **minuta**

All over the world there is considerable variation in the species of *Succinea*. Even in one population the individuals can differ to an extraordinary extent. The only way of arriving at a sound classification is by anatomical investigation. Unfortunately this procedure could not be followed in the Javanese species, as I had only dry shells at my disposal. The radula and mandibula preparations were made some twenty years ago in Bogor (Java) when I had living specimens before me.

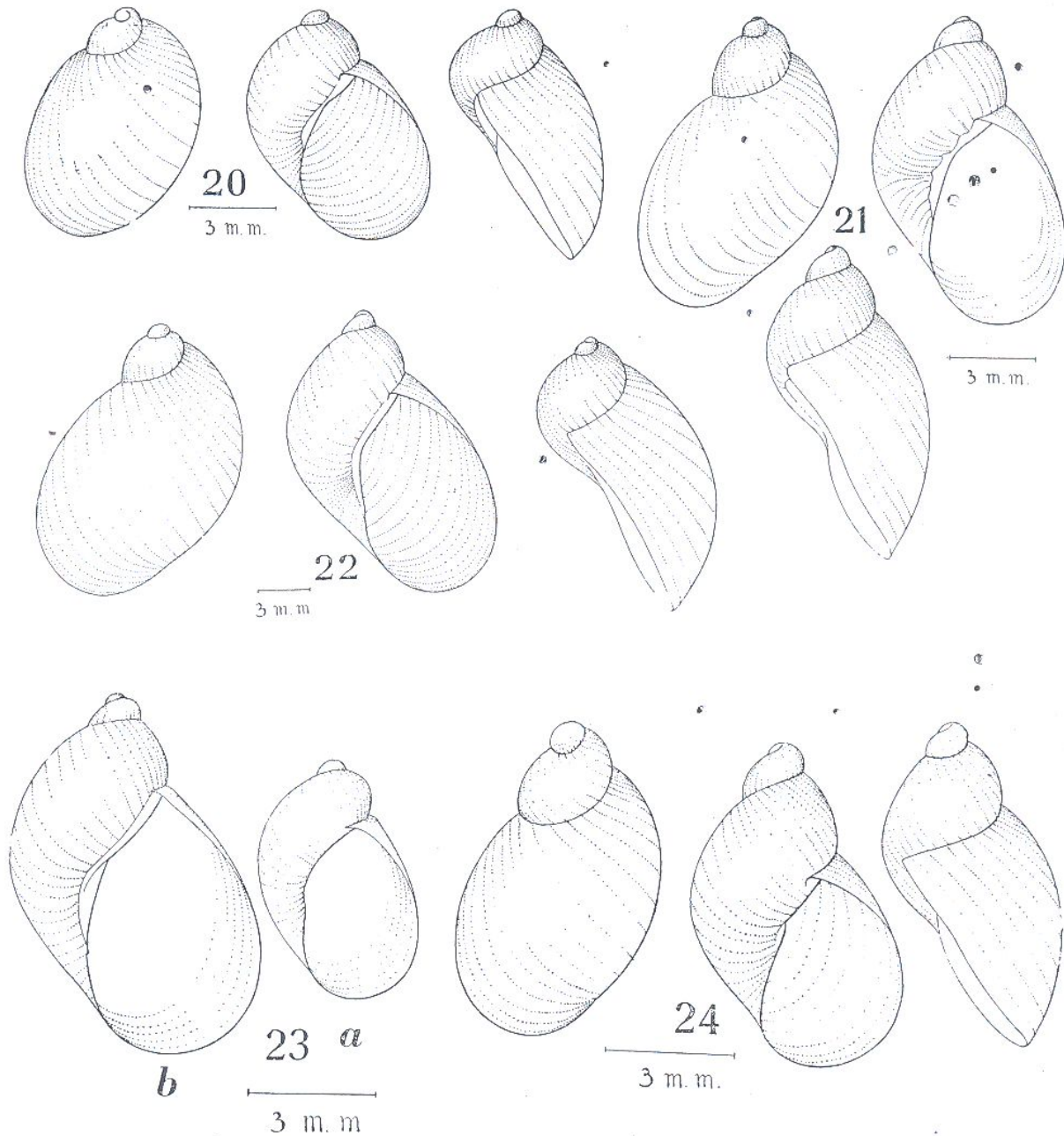


Fig. 20. *Succinea obesa* MARTS. Shell from back, front and side. HEMMINGA del.
 Fig. 21. *Succinea minuta* MARTS. Shell from back, front and side. HEMMINGA del.
 Fig. 22. *Succinea listeri* SMITH. Shell from back, front and side. HEMMINGA del.
 Fig. 23. *Succinea minuta* MARTS. a. lectotype; b. holotype of *Succinea javanica* SCHEPMAN. HEMMINGA del. Fig. 24. *Succinea gracilis* LEA. Shell from back, front and side. HEMMINGA del.

As I remarked already in 1932 (Journ. of Conch. 19, p. 205) it is curious that in the island of Java "apparently very suitable localities, borders of sawahs, ponds and lakes in the lowlands, seldom provide any *Succinea* whereas curiously enough most of the material was collected at a certain elevation above the sea, even to circa 2300 m altitude."

***Succinea obesa* MARTENS, 1867 (fig. 20).**

- 1867 MARTENS, Ostas. Landschn. p. 387, pl. 22, fig. 21.
1888 TENISON WOODS, Proc. Linn. Soc. N. S. Wales (2) 3, p. 1057.
1892 MARTENS, Erg. Reise N. O. Indien, 2, p. 252.
1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 240.
1932 VAN BENTHEM JUTTING, Journ. of Conch. 19, p. 207, pl. 7, fig. 13.
1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 125-127, fig. 55-56.
1934 RENSCH, Trop. Binnengew. 4, p. 757 and 758.
1935 PARAVICINI, Arch. Moll. Kunde, 67, p. 174.

Shell broad-oval, with small spire and large last whorl. Bright amber-coloured when fresh. Somewhat transparent and shining. Finely striated according to the growth lines. This sculpture is obliquely crossed by much more delicate striae, only visible with a powerful lens of about 50 times magnification.

Whorls 3, convex, rapidly increasing in size, the last one large and spacious. Profile of the shell sloping away rapidly. Suture rather deep. Umbilicus closed.

Aperture broad-oval, oblique. Peristome not continuous, sharp, not reflected or thickened. Parietal side with a narrow white margin.

Dimensions: height 9 mm, width 6½ - 7 mm, height of aperture 7 mm.

Distribution: Sumatra, Java, Madura.

Habitat in Java: in grassland, under dead branches and leaves, on stones. Occurring between sea level and about 2000 m.

West Java: Djakarta, under bricks, 16 m; Depok, along Tjiliwong, under branch of palm, 100 m; Kuripan, 200 m; Tjiamis, in dry ditch along the road, 200 m; Mt. Gedeh, 3000 feet; Tjiandjur, under stone in grass along drain, 470 m; between Tjiandjur and Tjugenang, 500 m; Pelabuanratu, sea-level (PARAVICINI, 1935); Bandung, grassland, under stone and wood, 700 m; N of Bandung, near second waterfall of Tjikapundung, on stone, 1000 m.

Central Java: Dieng Plateau, 2000 m (RENSCH, 1932 and 1934); Djuwono, 2 m.

East Java: Lake Gratie, near Pasuruan, 100 m (MARTENS, 1867); Ranu Klindungan (= Lake Gratie), near Pasuruan, 100 m (RENSCH, 1934).

There is some variation in the height—width ratio of the shell. Indeed it would not be a real *Succinea* if it did not present difficulties to the observer. The broad aperture, the small spire, and the oblique microscopical striation are the chief characteristics of this species.

All the shells which I could examine showed a distinct oblique striation sometimes as a criss-cross structure. MARTENS did not mention it

in his diagnosis, but RENSCH (1932) who could examine type and paratypes, and the author herself (1932) found it well perceptible.

RENSCH (1932) dissected a specimen from the Dieng Plateau and gave a figure of the generative organs. According to this author the radula of *S. obesa* is similar to that of *S. javanica* (now *S. minuta*).

***Succinea minuta* MARTENS, 1867 (fig. 19, 21, 23).**

- 1867 MARTENS, Ostas. Landschn. p. 388.
 1912 SCHEPMAN, Proc. Malac. Soc. 10, p. 235, pl. 10, fig. 12, 13 (*javanica*).
 1914 LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 240 (*javanica*).
 1929 MENZEL & TENGWALL, Arch. Rubber, 13, p. 243.
 1932 VAN BENTHEM JUTTING, Journ. of Conch. 19, p. 206 (*minuta*) and p. 206, fig. 10, 11 (*javanica*).
 1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 127-128 and 124-127, fig. 52-54 and 56 (*javanica*).
 1950 KALSHOVEN, Plagen Cultuurgew. Indon. 1, p. 49.

Shell oval, not so broad as *Succinea obesa*. With small spire and large last whorl. Yellowish, greenish or pinkish amber-coloured. Somewhat transparent and shining. Finely striated in the direction of the growth lines, now and then somewhat more folded or ribbed. This sculpture is crossed by two systems of a much more delicate striation, one in spiral direction and one obliquely arranged, only visible under a lens of 50 times magnification.

Whorls 3, rather convex, rapidly increasing in size. The last one large and spacious, although not so broad as in *S. obesa*. Suture rather deep. Umbilicus closed. Profile of the shell descending somewhat more step-like than in *S. obesa*. Aperture oblique, egg-shaped, pointed above, rounded below. Peristome not continuous, sharp, not reflected or thickened. Parietal side with a narrow white margin.

Dimensions: height 5.7 to 11 mm, width 3.6 to 7 mm, height of aperture 4.2 to 8 mm.

I could examine the original lot of *Succinea minuta* (MOUSSON ms) MARTENS, from the island of Bali, central highland near Tjator, 4315 feet, in fissures of tree-bark preserved in the MOUSSON collection at Zürich. Their dimensions are:

height	5.7	4.5	4.0	4.2	4.2	} mm.
width	3.6	3.2	2.5	2.7	2.9	
height of aperture	4.2	3.5	3.0	3.0	3.0	

They proved to be immature specimens of what SCHEPMAN (1912) described as *Succinea javanica* (type specimen in Amsterdam Museum, height 8.6 mm, width 5.6 mm, height of aperture 6.5 mm). This could also

be checked by a growth series from Mt. Ipis, Tegal Primula, Mt. Papan-dajan, 2300 m alt. This samples contained 20 specimens, measuring between 3.6 and 6.5 mm height. It demonstrated the connection between the juvenile form, described as *S. minuta* and the adult form described as *S. javanica*.

Consequently the species ought to be called *Succinea minuta* MARTENS. It is a rather unfortunate coincidence that a juvenile stage, in itself not sufficiently representative of the species, has to serve as the base.

For a better understanding of the species I give not only a figure of the type specimen (a lectotype taken from the original 5 shells) of *Succinea minuta*, (fig. 23a) but also figures of the holotype of *Succinea javanica* SCHEPMAN (fig. 23b) and of the largest specimen of *Succinea minuta* in our collection, collected at Telaga Dringu, Dieng Plateau, 2100 m alt. (height 11 mm, width 7 mm, height of aperture 8 mm) (fig. 21).

Distribution: Java, Krakatau, Bali, Lombok, Sumba.

Habitat in Java: living along lakes and rivers, on vegetation. Recorded between sea-level and 2300 m alt.

West Java: Lake Danau, 250 m; Mt. Ipis, Tegal Primula, Mt. Papan-dajan, on waterplants, 2500 m.

Central Java: Tuntang river, 100 m (type locality of *S. javanica*); Hindu steps, Dieng Plateau, 2000 m; along rivulet in Tegal Panganan, Dieng Plateau, 2200 m; Telaga Dringu, Dieng Plateau, 2100 m.

East Java: tambaks near Sidohardjo, sea-level; coffee plantation in East Java, on branches of coffee trees (MENZEL & TENGWALL).

A mandibula prepared from an animal from Mt. Ipis is long 0.8 mm and wide 0.8 mm. It had a small lateral projection on either side of the central one. Another jaw from the same locality was devoid of lateral projections, only the central one existing.

A radula from this locality is figured in fig. 19b. The rhachis and laterals are tricuspid, marginals with four cusps.

RENSCH (1932, p. 125-126) gave figures of the width—height ratio and of the total height—height of aperture of both *S. javanica* (now *minuta*) and *S. obesa*. They show that in *S. obesa* the width is relatively larger than in *S. javanica* whereas the aperture of *S. obesa* forms a greater part of the total height than in *S. javanica*. RENSCH dissected a specimen from Lombok and gave figures of the sexual organs and the radula.

Whether the specimens recorded by MENZEL & TENGWALL (1929) really belong to *Succinea minuta* is impossible to say for certain as I have not seen the animals. On account of their minute size only one cannot

claim them to belong to *S. minuta*. The two authors mentioned that their *Succinea* occurred on coffee branches which were infested by the Green Coffee Scale. These insects secrete a waxy substance which is an easy prey of sooty mould. MENZEL & TENGWALL supposed that the *Succinea*'s browsed the fungi and algae which grew on the scales' secretions.

Among the unpublished drawings (now in the Leiden Museum) of the mollusks collected in Java in the beginning of the 19th century by KUHLE & VAN HASSELT, there is a figure in colour by an unnamed artist, representing a *Succinea* from Lake Dano. Shell and animal are bluish-green, the apex is somewhat projecting. In my opinion it is identical with *Succinea minuta*.

***Succinea listeri* SMITH, 1888 (fig. 22).**

1888 SMITH, Proc. Zool. Soc. London, p. 537.

1900 SMITH, Monogr. Christmas Id. p. 57, pl. 8, fig. 12-13.

1932 VAN BENTHEM JUTTING, Journ. of Conch. 19, p. 206, pl. 7, fig. 12.

1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 293.

Shell broad-oval, with small spire and large last whorl. Reddish-yellow to yellowish-green, somewhat shining and transparent. Finely striated according to the growth lines. This sculpture is crossed by much more delicate oblique striae, only visible at a magnification of 50 times or more.

Whorls 3, convex, rapidly increasing in size, the last one large and spacious. Suture moderately deep. Umbilicus closed.

The aperture is placed more to the side than in any other of the Javanese Succineids. Aperture oblique, egg-shaped, pointed above, rounded below. Peristome not continuous, sharp, not thickened or reflected. Parietal side with a narrow, white, thin callus.

Dimensions: height 12—17 mm, width 7—11 mm, height of aperture 7—12 mm.

Distribution: Java, Madura, Christmas Island.

Habitat in Java: only recorded once, in sawahs at Kapuk near Djakarta, 10 m above sea-level.

West Java: Kapuk, in sawahs, 10 m.

By the kind permission of the authorities of the British Museum I could study 2 paratypes from Christmas Island, leg. J. G. LISTER (no. 88-8-8. 7-12). Their measurements are: height 12, resp. 11.5 mm, width 8, resp. 7 mm, height of aperture 9, resp. 8.5 mm. For the type specimen SMITH (1900, l.c.) gave the following figures: height 13.5 mm, width 8 mm, height of aperture 10.5 mm.

***Succinea gracilis* LEA, 1841 (fig. 24).**

1841 LEA, Proc. Americ. Philos. Soc. 2, p. 31.

1867 MARTENS, Ostas. Landschn. p. 387-388.

1888 TENISON WOODS, Proc. Linn. Soc. N. S. Wales (2) 3, p. 1058.

1892 MARTENS, Erg. Reise N. O. Indien, 2, p. 252.

1914 LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 240.

1932 VAN BENTHEM JUTTING, Journ. of Conch. 19, p. 206.

1942 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 292-293.

Shell oval, not so broad as *Succinea obesa*. With relatively elevated spire and large last whorl. Yellowish-green, somewhat transparent and shining. Finely striated according to the growth lines and with still more delicate spiral striae, only visible under 50 times magnification.

Whorls 3, convex, rapidly increasing in size. The spire more projecting than in either *Succinea obesa*, *Succinea minuta* or *Succinea listeri*. Last whorl large and spacious, although not so large as in *Succinea obesa*. Suture rather deep. Profile of the shell descending somewhat step-like. Umbilicus closed.

Aperture oval, oblique, more oblique than in either *Succinea obesa* or *S. minuta*. Peristome not continuous, sharp, not reflected or thickened. Parietal side with a narrow white margin.

Dimensions: height 5.5 to 8 mm, width 4 to 5 mm, height of aperture 4 to 5.5 mm.

Distribution: Java?, Noordwachter, Pulu Besar.

Habitat in Java: nothing is known of the circumstances under which this species lives. The occurrence in Java is very problematic, no exact localities having been recorded.

Succinea gracilis was collected in the little island of Noordwachter, north of West Java (VAN BENTHEM JUTTING, 1941). More recently Mr F. WILLEMSE found the species in the small island Pulu Besar, north of Rembang, Central Java.

In *Succinea gracilis* the spire forms a larger part of the total height of the shell than in any of the preceding species. This is the more evident in immature shells where the spire forms a curious knob on the last whorl. Additional measurements of 10 specimens from the Id. of Noordwachter were published by the author in 1941 (l.c. p. 293).

Familia TORNATELLINIDAE

Shell dextral or sinistral, globose-ovate to turreted-conical, generally corneous or brown, some species ornamented with colour-markings. Striated according to the growth lines. In some species with more delicate spiral striation besides.

Top pointed, but not sharp. Base rounded. Umbilicus open or imperforate.

Whorls generally convex, suture mostly well impressed. Aperture oblique, rounded or ovate. In most species with a parietal and a columellar lamella. Immature shells have an interior ridge parallel to the palatal margin. Peristome not continuous. Sharp or thickened. Expanded or not reflected.

Radula without central and lateral teeth, all teeth being of the marginal type. Formula $\infty . 0 . \infty$ (fig. 27).

Hermaphroditic, many species are ovo-viviparous.

Distribution: Islands of the Pacific and Indian Oceans.

In Java only one genus:

Genus *Elasmias* PILSBRY, 1910

Shell globose-conic or ovate-conic, with short spire composed of at most 4 to 5 whorls. Finely striated. Top obtuse, base rounded, not perforate. Aperture large, with a parietal lamella and a twisted, callous columella which is truncate at the basal end.

Peristome not continuous, sharp, not thickened or reflected.

Mode of reproduction: ovo-viviparous.

Distribution: Mauritius, Bourbon, Japan, Philippines, Maldive Is., Natunas, Java, Lombok, New Guinea, Australia, Marianne Is., Caroline Is., New Caledonia, various Polynesian Islands, Hawaiian Is.

The Hawaiian species are known to live on the leaves of trees and shrubs. Of the Javanese species almost nothing is known of their biotopes.

In Java there are two species:

1. Shell globose-conical, with 4 whorls, columella conspicuously truncated. **sundanum**
- Shell ovate-conical, with 5 whorls, columella only slightly truncated
. **manilense**

Elasmias manilense (DOHRN, 1863) (fig. 25).

1863 DOHRN, Malak. Blätt. 10, p. 160 (*Tornatellina*).

1873 SEMPER, Reisen Arch. Philipp. Part 2, Vol. III, p. 133, 140, pl. 16, fig. 13 (*Tornatellina*).

1894 SMITH, Ann. Mag. Nat. Hist. (6) 13, p. 458, pl. 16, fig. 7 (*Tornatellina natunensis*).

1915 PILSBRY & COOKE, Man. of Conch. (2) 23, p. 125, pl. 31, fig. 6, pl. 38, fig. 16.

Shell ovate-conical to ovate-turreted, fragile. Corneous to greyish-green, the first two whorls spirally striated, the subsequent ones more granular and with a somewhat coarser sculpture of oblique growth lines. With soft lustre and somewhat transparent.

Whorls 5, convex, with suture well impressed. Periphery rounded, last whorl not inflated. Top obtuse, base rounded, not perforate.

Aperture oblique, oval. With a conspicuous lamella on the parietal side and another one along the columella indistinctly truncated at the base. Columella spirally twisted. Peristome not continuous, free margin sharp, not thickened or reflected.

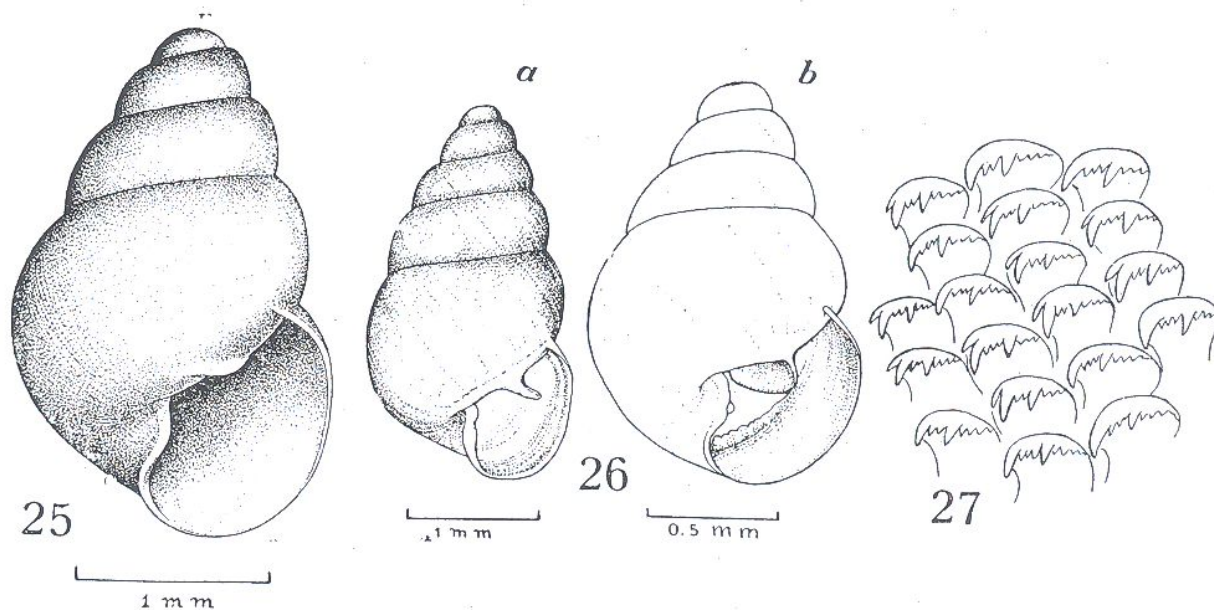


Fig. 25. *Elasmias manilense* (DOHRN). Shell. ABDULKADIR del. Fig. 26. *Tornatellina subcylindrica* QUA. & MLLDFF. a. adult shell; b. juvenile shell, showing internal palatal ridge, and folds on parietal and columellar side. ABDULKADIR del. Fig. 27. *Tornatellina bilamellata* ANTON. Radula elements (after ODHNER).

Dimensions: the largest specimen from Java is high 3 and wide 1.6 mm, with an aperture of 1.4 mm height.

Distribution: Philippines, Maldivé Is., Natuna Is., Java.

Habitat in Java: living on the ground, between leaves, grass and earth.

SEMPER (l.c.) dissected the animal, not without difficulty, because of the minute size of the object. His account is as follows (translated by me, v.B.J.): "I had for examination several specimens of *Tornatellina manilensis* DOHRN, preserved in spirit. In consequence of the small size of the object, which could only be dissected with fine needles under the lens, the genital organs could not be laid free and the mandibula could not be found. The penis appeared to be simple. The uterus contained 4 to 6 eggs, the lowest with a fully developed embryo, with a shell of over one whorl. The kidney was band-like, very narrow. The radula could not be isolated entire, the single teeth seemed to be all similar. Whether the central tooth was

missing could not be ascertained. The teeth were provided with a very long, fine and curved principal cusp, and a little denticle on each side."

Finally, SEMPER reported that he found the species between and on leaves and stalks of water plants, occasionally ascending mangrove trees. PILSBRY (1915), however, questioned that statement suggesting that SEMPER mistook his animals for a species of *Assimineae*.

The Javanese specimens were certainly not found in an aquatic biotope, but in the ground litter at the base of limestone cliffs.

West Java: Kuripan, near Bogor, 100 m.

In the classification of this species I have followed the arrangement of PILSBRY & COOKE (1915) who placed it in the genus *Elasmias*. One might wonder whether its maintainance in the original genus *Tornatellina* does not seem more expedient, because the shells are more ovate-conical than broadly ovate, and because the columella is lamellate, but not heavily callous and only slightly truncated below.

***Elasmias sundanum* (MOELLENDORFF, 1897) (fig. 28).**

1897 MOELLENDORFF, Nachr. Blatt, 29, p. 90 (*Tornatellina*).

1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 240 (*Tornatellina*).

1915 PILSBRY & COOKE, Man. of Conch. (2) 23, p. 127.

Shell globose-conical, corneous to olive-green, fragile. First two whorls minutely granular; following ones finely striated according to the growth lines. There is a still finer spiral striation, only visible under strong magnification (25 times and more). Somewhat transparent, and with soft lustre.

Whorls 4, rapidly increasing in size, somewhat convex, the last one globose and inflated. Suture not deep, periphery rounded. Top obtuse, base rounded. Not perforate. Columella twisted spirally.

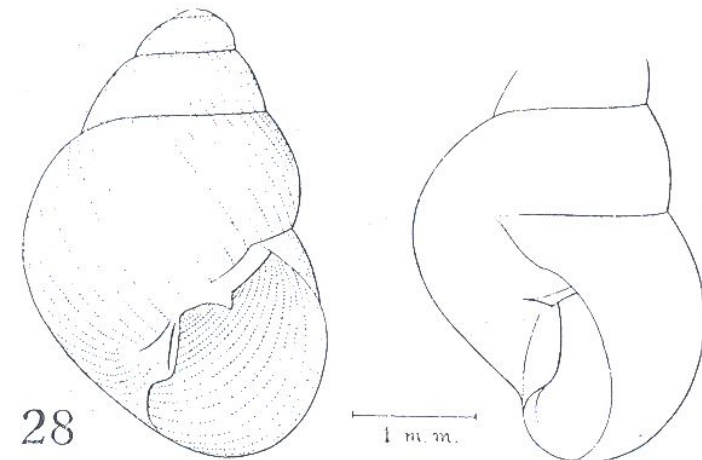


Fig. 28. *Elasmias sundanum* (MLLDFF). Holotype. Shell from front and side. HEMMINGA del.

Aperture oblique, oval. Provided with a lamella on the parietal side, and a crest along the columella. This columellar lamella is distinctly truncated below. Peristome not continuous, not thickened or reflected.

Dimensions: height 2.2 to 3.3 mm, width 1.8 to 2.3 mm, height of aperture 1.3 to 1.5 mm.

Distribution: Java.

Habitat in Java: living in the soil debris in the mountains.

West Java: Mt. Gedeh, 3000—4000 feet.

Elaśmias sundanum looks like the initial stage of a larger shell.

The type specimen, now in the Senckenberg Museum at Francfort on the Main (no. 64033), was collected on Mt. Gedeh, West Java, 3000 feet, by H. FRUHSTORFER in 1892. The shell is high 3.3 mm and wide 2.3 mm, with an aperture of 1.5 mm height.

The following two species *Tornatellina cylindrica* and *T. subcylindrica* have not been found in Java so far, but only on a few satellite islands off the N coast of West Java. This makes it probable that sooner or later they will be recorded from the main island also. Therefore I have included full descriptions of both and a figure of the last species.

***Tornatellina cylindrica* SYKES, 1900.**

1900 SYKES, Fauna, Hawaiiensis, 2, Moll. p. 381, pl. 11, fig. 28.

1915 PILSBRY & COOKE, Man. of Conch. (2) 23, p. 153, pl. 43, fig. 1, 2, 3 and pl. 40, fig. 1, 2.

1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 294.

Shell cylindrical, corneous, fragile. Finely striated in the direction of the growth lines. Transparent, shining.

Whorls 6, little convex, suture shallow, periphery rounded. Last whorl flattened or even somewhat concave in the middle. Top pointed, but not sharp, base rounded, not perforate.

Aperture oblique, elongate-oval. Provided with a large, parietal lamella. Columellar side twisted spirally, not truncate, with 1 to 3 small projecting lamellae which, however, are often absent in the adult stage. In miniature shells the aperture has an internal ridge parallel with the outer margin. Peristome not continuous, sharp, not reflected or thickened.

Dimensions: height 2.2 to 3.2 mm, width 1 to 1.2 mm, height of aperture 1 to 1.1 mm.

Distribution: Hawaiian Islands; islet of Edam, Bay of Djakarta.

Not yet found in Java.

***Tornatellina subcylindrica* QUADRAS & MOELLENDORFF, 1894 (fig. 26).**

1894 QUADRAS & MOELLENDORFF, Nachr. Blatt, 26, p. 16.

1915 PILSBRY & COOKE, Man. of Conch. (2) 23, p. 166, pl. 33, fig. 10-11.

1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 294.

Shell ovate-turreted, yellowish-brown, thin. Finely striated according to the growth lines. Subpellucid, a little shining.

Whorls 6 to 6½, somewhat convex. Suture moderately deep. Periphery rounded, in the last whorl of the adult stage somewhat flattened or even concave in the middle. Top pointed, but not sharp. Base rounded, not perforate.

Aperture oblique, oval, provided in the adult shell with a columellar and parietal lamella. In immature shells there are 2 or even 3 columellar folds. In this stage there is besides an internal palatal ridge, like a serrated barrier, in the aperture, parallel to the outer margin. Peristome not continuous, sharp, not thickened or reflected. Columella dilated above, twisted spirally, but not truncated.

Dimensions: height 3.25 mm, width 1.7 mm, height of aperture 1.25 mm.

Distribution: Guam, Marianne Is., islets of Noordwachter and Zuidwachter, off the N coast of West Java.

The species is not yet found in Java.

Familia VERTIGINIDAE

Shell generally small, low conical or pyramidal or turreted. Thin, finely striated, hyaline, or thick, coarsely striated and not transparent. Aperture either without teeth, or with one to several teeth. For the designation of the mouth armature of the Vertiginidae I copy here the figure and names which PILSBRY proposed (Man. of Conch. (2) 24, 1917, p. VII). This terminology will be used in the following pages. Peristome continuous or interrupted on the parietal side (fig. 29).

Radula ∞ . I . ∞ . Central tooth with 1 to 3 denticles. Laterals bi- or tricuspid. Marginals multicuspid. Mandibula distinctly grooved (aulacognathous) (fig. 30).

Distribution: in all continents and in all climates, from arctic to tropical, and from desert-dry to very moist.

Key to the genera occurring in Java (although *Pupoides* has only been collected in one of the satellite islands of Java, but not in the main island, I included this genus in the key, because it may be found in Java some day):

1. Aperture of shell with teeth 2
- Aperture of shell without teeth **Pyramidula**
2. Aperture and part of last whorl free, trumpet-shaped. **Gyliotrachela**
- Last whorl and aperture entirely adnate 3

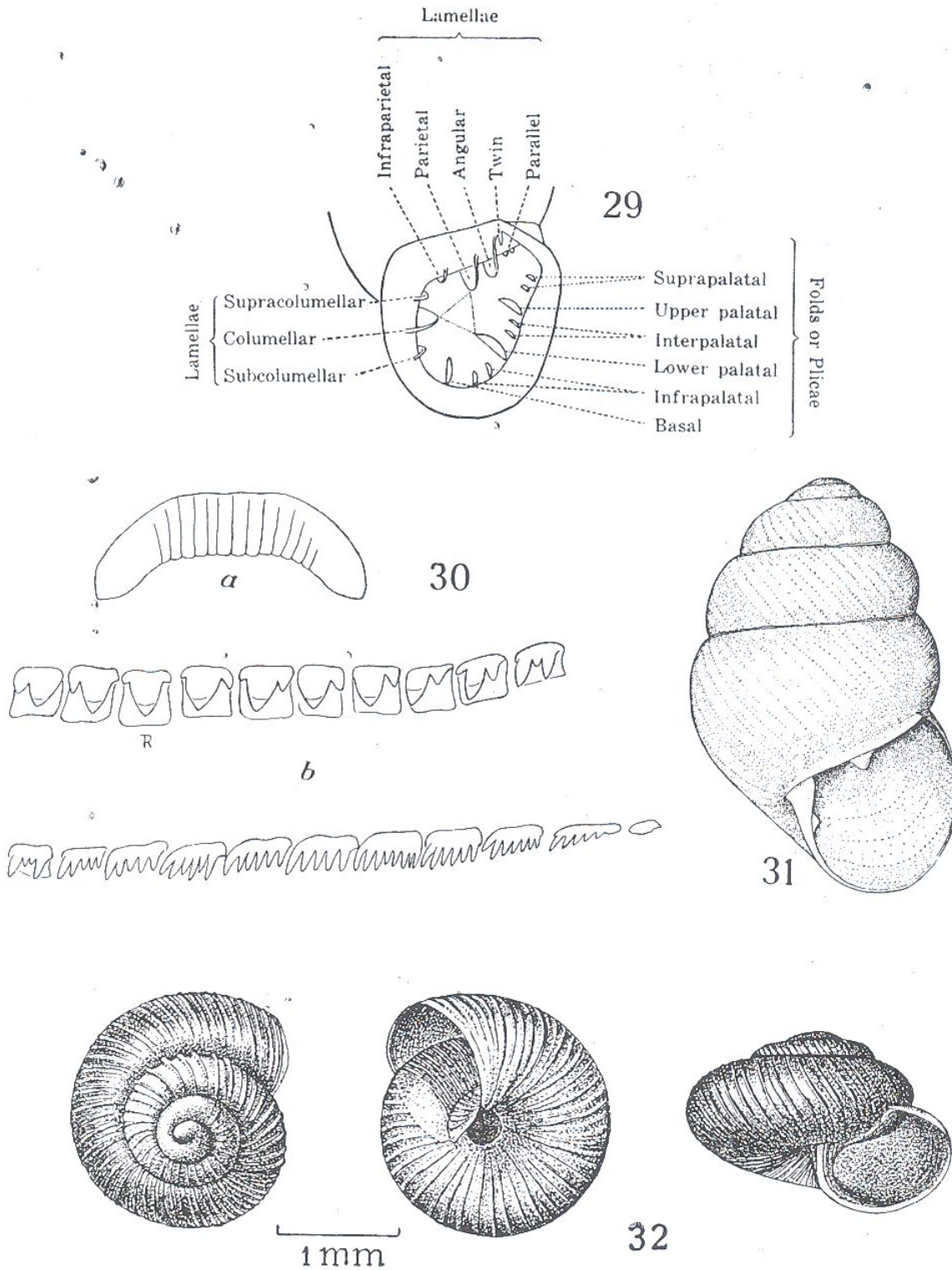


Fig. 29. System of lamellae and plicae in the aperture of a vertiginid shell (after PILSBRY). Fig. 30. *Pyramidula rupestris* (DRAP.). a. mandibula; b. radula elements (after BOWELL). Fig. 31. *Costigo moleculina* v. B. JUTTING. Holotype, about 24 times enlarged (after VAN BENTHEM JUTTING). Fig. 32. *Pyramidula javana* (MLLDF). Shell from top, base and side. ABDULKADIR del.

- | | | |
|----|--|----------------------|
| 3. | Aperture with one tooth (at the parietal side) | Pupoides |
| — | Aperture with more teeth | 4 |
| 4. | Aperture with two teeth (one parietal, one columellar) | Costigo |
| — | Aperture with more teeth | 5 |
| 5. | Angular and parietal teeth separate | Paraboyssidia |
| — | Angular and parietal teeth concrescent | Gastrocopta |

Genus *Pyramidula* FITZINGER, 1833

Shell small, low-conical, brown, striated or ribbed in radial direction. Opaque or somewhat transparent. Some species with indistinct spiral bands or flames.

Whorls convex, in immature animals sometimes carinated at the periphery. Suture distinct. Top obtuse and smooth, base rounded. Umbilicus open.

Aperture oblique, broadly lunar, without teeth. Peristome not continuous, generally sharp.

Genital organs without appendages like flagellum, digitate glands, dart-sac and dart.

Radula ∞ . l. ∞ . Central tooth unicuspid, laterals bicuspid, marginals multicuspid. Mandibula horse-shoe-shaped, striated.

The European *Pyramidula rupestris* is ovo-viviparous; of the Javanese species no details about its mode of reproduction are known.

Distribution: Europe, Asia.

In Java only one species:

Pyramidula javana (MOELLENDORFF, 1897) (fig. 32).

1897 MOELLENDORFF, Nachr. Blatt, 29, p. 65 (*Patula* [*Pyramidula*]).

1914 LESCHKE, Mitt. naturhist. Mus. Hamburg, 31, p. 231.

1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 124, pl. 3, fig. 37 (*Pyr. humilis javana*).

Shell small, low-conical, corneous to olivaceous-brown. Somewhat transparent and glossy. Striated in radial direction, with occasional riblets at more or less regular intervals. The radial sculpture is crossed by very delicate spiral lines. On the first $1\frac{1}{2}$ whorls only this spiral sculpture is present.

Whorls 3 to 4, convex. Suture deep, periphery rounded. Top obtuse, base rounded. Umbilicus rather wide.

Aperture oblique, broadly lunar to subcircular. Peristome not continuous, not expanded, somewhat thickened at columellar and basal margins in fully mature shells.

Dimensions: height 1.6 mm, width 2.2 to 2.4 mm, height of aperture 0.7 mm.

Distribution: Java, Bali, Lombok.

Habitat in Java: living on the ground, in vegetable debris, at altitudes of over 1500 m.

West Java: Mt. Gedeh, 9000 feet; various localities on Mt. Gedeh including craterfield and top under moss, 2400—2900 m; Mt. Pangrango, 2900 m in soil fauna.

East Java: Kawah Idjen-Merapi Game Reserve, 1600—1700 m.

I could examine the type specimen, now preserved in the Senckenberg Museum (no. 42546, type locality: Mt. Gedeh, West Java, 9000 feet, H. FRUHSTORFER). It is high 1.6 mm, wide 2.4 mm and has an aperture of 0.7 mm height.

RENSCH (1932, p. 124) suggested to bring *Pyramidula javana* and "eine relativ grosse Zahl" other *Pyramidula* species of the Oriental region into one "Rassenkreis" of which *P. humilis* BENSON is the main form. His arguments, however, are only tentative, and so long as no further evidence can be presented I consider it wiser to keep *P. javana* as a separate species.

Genus *Costigo* BOETTGER, 1891

Shell pyramidal or turreted, horn colour, striated according to the growth lines, somewhat transparent. Whorls slightly convex, suture distinct. Top rather obtuse, base rounded. Umbilicus closed or hair-like. Aperture oblique, oval or broad pear-shaped. Peristome not continuous, with one tooth on the parietal and one on the columellar side, and sometimes one or two on the palatal side.

Animal unknown.

Distribution: Java, Moluccas, Philippines.

In Java only one species:

Costigo moleculina VAN BENTHEM JUTTING, 1940 (fig. 31).

1940 VAN BENTHEM JUTTING, *Treubia*, 17, p. 331, fig. 1, 2.

Shell oblong-cylindrical, brown, a little more corneous towards the aperture. Shining, translucent, but not diaphanous. Sculptured by oblique growth lines which, on the body-whorl, merge into a peculiar wrinkled, micro-vermicular structure, only visible under strong magnification.

Whorls 5, rounded, although not particularly convex. Suture distinct, but not deeply constricted (not so deep as e.g. in *C. saparuaana* BTTR).

Suture with a narrow, but inconspicuous, thread-like rim. Last whorl not ascending or descending towards the peristome. Top obtuse, base rounded. Umbilicus closed.

Aperture oblique, oval, with an obtuse angle between parietal and columellar wall. There are only two teeth, both white and conspicuous, a parietal one entering the aperture as a very short compressed fold, and a columellar one appearing as a small white knob on the columella, but not continuing interiorly. Peristome simple, a little dilated on its entire outline. Not continuous, the two margins being connected by a thin parietal callus.

Dimensions of the unique specimen (holotype): height 2.2 mm, width 1.4 mm, height of aperture 1 mm.

Distribution: Java.

Habitat in Java: living on the ground, between dead leaves, moss and earth.

West Java: Forest between Tjisolok (Pelabuanratu) and the hot springs (Tjipanas), some miles inland, 300 m.

Genus *Gastrocopta* WOLLASTON, 1878

Shell small, generally dextral, cylindrical or conical-ovate, horn colour or brownish. Finely striated or ribbed according to the growth lines. Somewhat shining and transparent.

Whorls more or less convex. Apex obtuse, base rounded. Umbilicus open or closed.

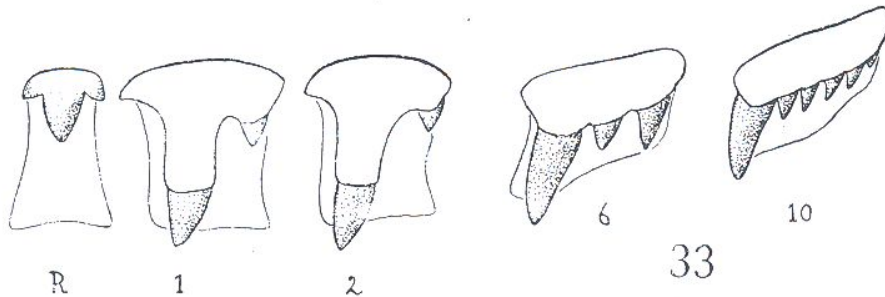


Fig. 33. *Gastrocopta pediculus ovatula* (MLLDFF). Radula elements. Author del.

Aperture oval to heart-shaped, with a lamella on the columellar side, a concrescent parietal and angular lamella on the parietal side, and usually with one or more folds on the palatal side. Peristome expanded, parietal part adnate to the penultimate whorl.

Distribution: tropical and subtropical regions of all continents.

In Java there are two species:

1. Shell cylindrical-ovate, brown *lyonsiana*
 — Shell conical-ovate, cream-colour *pediculus ovatula*

A related species, *Gastrocopta euryomphala* PILSBRY, has been recorded from a few islands off the coast of North Java: Noordwachter, Klein Kombuis and Edam (VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 295, 1941) to which can be added a recent record in the islet of Middelburg. As the species occurs in such close proximity of the main island it can be expected to pop up some day in Java also. Therefore I have given a full description and figure. Its wide umbilicus easily distinguishes the species from the two other *Gastrocopta*.

***Gastrocopta lyonsiana* (ANCEY, 1892) (fig. 34).**

1892 ANCEY, Mém. Soc. Zool. France, 5, p. 713 (*Pupa*).

1917 PILSBRY, Man. of Conch. (2) 24, p. 141-144, pl. 24, fig. 1-4.

1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 295.

Shell cylindrical-ovate, brown, thin, somewhat transparent and glossy. Finely striated in the direction of the growth lines.

Whorls 5½-6, convex. Last whorl somewhat ascending towards the aperture. Suture deep. Top obtuse, base rounded. Umbilicus open, but narrow.

Aperture oblique, rounded heart-shaped. Mouth armature consisting of one columellar lamella, an angular and a parietal one (con crescent at their bases) on the parietal side and 2 or 3 folds on the palatal side. In full-grown shells there is a low vertical swelling behind the outer lip. The palatal teeth are marked on the exterior of the last whorl by short shallow grooves in spiral direction just behind the above mentioned swelling. Peristome continuous or interrupted. In the latter case a very thin membrane against the penultimate whorl unites the two margins. Free margin somewhat thickened and expanded.

Dimensions: height 2.3 to 2.4 mm, width 1.1 to 1.2 mm, height of aperture 0.7 to 0.8 mm.

Distribution: Hawaiian Is., Philippines, Klein Kombuis, Edam, Java.

Habitat in Java: living on the ground, under grass, stones, in the ground litter.

West Java: Djakarta, sea-level; Pameungpeuk, 14 m.

***Gastrocopta pediculus ovatula* (MOELLENDORFF, 1890) (fig. 33 and 35).**

1890 MOELLENDORFF, Ber. Senckenb. p. 253 (*Leucochilus pediculus* var. *ovatula*).

1917 PILSBRY, Man. of Conch. (2) 24, p. 149, pl. 25, fig. 13, 15.

1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 120.

1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 295.

Shell ovate-conical, cream-colour, thin, somewhat glossy and transparent. Finely striated according to the growth lines.

Whorls 4-5, convex; last whorl somewhat ascending towards the aperture. Suture deep. Top obtuse, base rounded. Umbilicus open, but narrow.

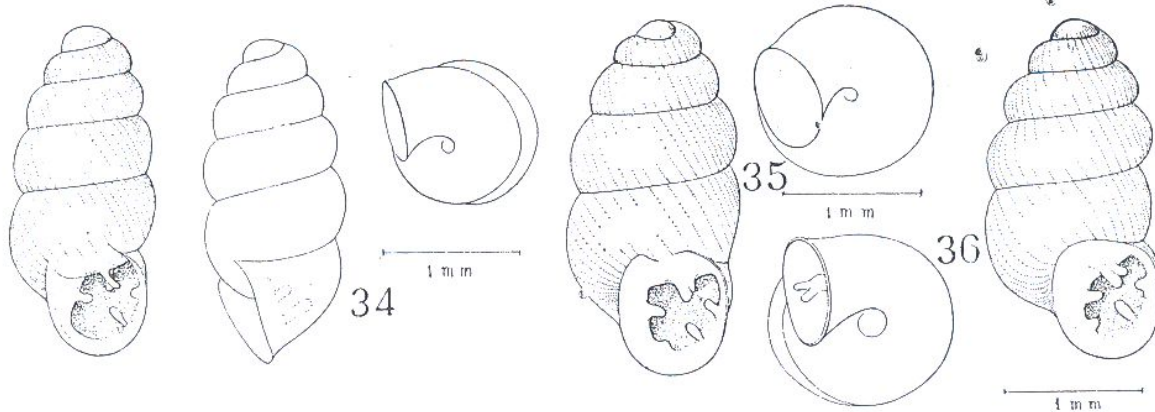


Fig. 34. *Gastrocopta lyonsiana* (ANC.). Shell from front, side and base. HEMMINGA del. Fig. 35. *Gastrocopta pediculus ovatula* (MLLDFF). Shell from front and base. HEMMINGA del. Fig. 36. *Gastrocopta euryomphala* PILS. Shell from front and base. HEMMINGA del.

Aperture oblique, rounded heart-shaped. Provided with several teeth: one columellar lamella on the columella, an angular and a parietal lamella (con crescent at their bases) on the paries and 2 or 3 folds on the labrum. In full-grown shells there is a slight vertical swelling behind the peristome. The palatal teeth are marked on the exterior of the last whorl by short shallow grooves in spiral direction just behind the above mentioned swelling. Peristome continuous, the upper margin shortly adnate to the penultimate whorl. Free margin somewhat thickened and expanded.

Dimensions: height 2.5 to 2.7 mm, width 1.3 to 1.5 mm, height of aperture 0.8 to 0.9 mm.

Distribution: various Pacific Islands, Philippines, SE Australia, Timor, Sumba, Krakatau, Verlaten I., Noordwachter, Zuidwachter, Klein Kombuis, Edam, Java.

Habitat in Java: living on the ground, under stones, moss, in earth. West Java: Pameungpeuk, 14 m, under logs.

***Gastrocopta euryomphala* PILSBRY, 1934 (fig. 36).**

1898 MOELLENDORFF, Abh. naturf. Ges. Görlitz, 22, p. 153 (*Leucochilus euryomphalum*, nomen nudum).

1917 PILSBRY, Man. of Conch. (2) 24, p. 141 (name only).

1934 PILSBRY, Man. of Conch. (2) 28, p. 120, pl. 22, fig. 3-6.

1937 HAAS, Arch. Moll. Kunde, 69, p. 3-4, fig. 3-4.

1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 295.

Shell cylindrical-ovate, cream-colour, thin, somewhat glossy and transparent. Finely, somewhat unevenly striated according to the growth lines.

Whorls 5-5½, very convex, the third and fourth whorls indistinctly angular and bulging, the last whorl a little flattened peripherically. Last whorl slightly ascending to the aperture. Suture very deep. Top obtuse, base rounded. Umbilicus wide and deep.

Aperture oblique, rounded heart-shaped. Mouth armature consisting of one lamella on the columella, an angular and a parietal lamella (con-crescent at their bases) on the parietal side, and one basal and two palatal folds on the basal and palatal sides. In full grown shells there is a slight vertical swelling behind the outer lip. The palatal teeth are marked on the exterior of the last whorl by short shallow grooves in spiral direction just behind the above mentioned swelling. Peristome continuous, the upper margin shortly adnate to the preceding whorl. Free margin somewhat thickened and expanded.

Dimensions: height 2.4 to 2.5 mm, width 1.2 to 1.4 mm, height of aperture 0.7 to 0.8 mm.

Distribution: Philippine Is.; Noordwachter, Klein Kombuis, Edam, Middelburg, in the Bay of Djakarta.

The species has not yet been found in Java.

Genus *Paraboysidia* PILSBRY, 1917

Shell conical to turreted, corneous or dark brown, striated or finely ribbed according to the growth lines. Not or hardly transparent. Surface minutely granular.

Whorls convex or flattened, suture distinct. Periphery rounded in adult, carinated in immature shells. Top obtuse or pointed, but never sharp. Base rounded. Umbilicus closed or minutely perforated.

Aperture oblique, broadly oval, provided with a more or less elaborate system of folds and lamellae of which the angular and parietal lamellae are always separate. Peristome continuous or interrupted, but always adnate. Margins expanded, thickened, with a small contraction in the upper corner (sinulus). In some species a nodule on the inner margin of the palatal wall limits the sinulus.

Radula and mandibula are unknown.

Distribution: India, Tonkin, Malaya, Java.

In Java only one species:

Paraboysidia boettgeri (MOELLENDORFF, 1897) (fig. 37).

1897 MOELLENDORFF, Nachr. Blatt, 29, p. 70 (*Boysidia*).

1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 238 (*Boysidia*).

1917 PILSBRY, Man. of Conch. (2) 24, p. 208, pl. 34, fig. 7-8 (*Boysidia*).

1950 VAN BENTHEM JUTTING, Bull. Raffles Mus. no. 21, p. 38.

Shell trochiform, brown. Striated according to the lines of growth with occasional coarser riblets at regular distances. Little transparent, surface minutely granular. There is no spiral sculpture.

Whorls 5-6, convex, rather solid. Last whorl ascending in front. Suture distinct. Periphery rounded. Top obtuse, base rounded. Umbilicus narrow.

Aperture vertical or a little oblique, broadly oval or heart-shaped. Mouth armature consisting of two parietal and one angular lamella on the parietal wall, a columellar lamella on the columellar side, and two principal palatal folds on the palatal side, sometimes accompanied by a minor one on either side of them.

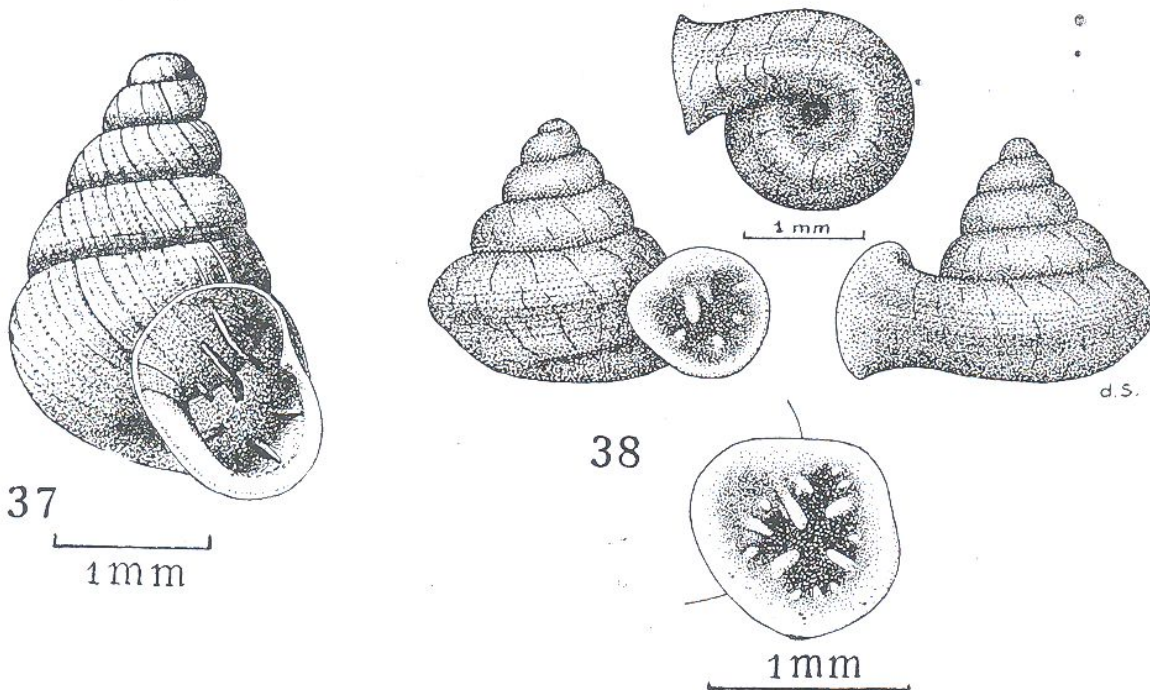


Fig. 37. *Paraboysidia boettgeri* (MLLDFF). Shell. ABDULKADIR del. Fig. 38 *Gylotrachela fruhstorferi* (MLLDFF). Shell from base, front and back. Aperture somewhat more enlarged. DE SMIT del.

Peristome continuous, the parietal side appressed against the penultimate whorl. Margins expanded, thickened, with a small contraction at the upper corner (sinulus). A nodule on the inner margin of the palatal wall limits the sinulus.

Dimensions: height 3.2 to 3.5 mm, width 2.1 to 2.3 mm, height of aperture, 1.3 to 1.4 mm. The type specimen, preserved in the Senckenberg Museum at Francfort on the Main (no. 4616; type locality Mount Gedeh, West Java, 4000 feet, leg. H. FRUHSTORFER, 1892), is high 3.2 mm, wide 2.3 mm, and has an aperture of 1.3 mm height.

Distribution: Java.

Habitat in Java: living on the ground, among moss, dead leaves, decaying wood and low vegetation. Recorded between 700 and 1700 m altitude.

West Java: Pantjoran Mas, near Rarahan, Mt. Gedeh, 1400 m; waterfalls of Tjibeureum, Mt. Gedeh, 1700 m; Mt. Gedeh, 4000 feet; Sukabumi, 700 m.

Genus *Gyliotrachela* TOMLIN, 1930

Shell conical to trochiform, corneous or dark brown, striated or finely ribbed according to the growth lines. Not or hardly transparent. Surface minutely granular. Last part of shell free, trumpet-shaped.

Whorls convex or flattened, suture distinct. Periphery rounded or obtusely carinate. Top obtuse or pointed, but never sharp. Base rounded. Umbilicus generally open.

Aperture oblique or inverted, turning to the sky. Almost round, provided with a more or less elaborate system of folds and lamellae, of which the parietal and angular lamellae are always separate. All plicae and lamellae are minutely spiniferous. Peristome continuous, free from the penultimate whorl. Margins thickened and expanded.

Radula and mandibula are unknown.

Distribution: India, Burma, Indo-China, Malaya, Samui Is., Java, Sumba, Kalao I., Celebes, Tanimbar I., Queensland.

In Java only one species:

Gyliotrachela fruhstorferi (MOELLENDORFF, 1897) (fig. 38).

1897 MOELLENDORFF, Nachr. Blatt. 29, p. 70-71 (*Hypselostoma*).

1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 238 (*Hypselostoma*).

1917 PILSBRY, Man. of Conch. (2) 24, p. 217, pl. 37, fig. 1-3 (*Gyliauchen*).

1932 VAN BENTHEM JUTTING, Journ. of Conch. 19, p. 204, pl. 7, fig. 9a-e.

1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 121.

1950 VAN BENTHEM JUTTING, Bull. Raffles Mus. no. 21, p. 46.

Shell conical, brown to dark brown, somewhat lighter to the aperture. First 1½ whorls smooth, following ones finely striated according to the growth lines, with occasional coarser ribs at irregular intervals. This radial sculpture is crossed by very delicate spiral lines. Not or hardly transparent, rather solid.

Whorls $4\frac{1}{2}$ to 5, convex. Last whorl obtusely angular along the periphery, then flattened below the middle and angular again round the umbilicus. Suture distinct. Umbilicus rather narrow for the genus. Last whorl somewhat ascending towards the aperture and free over a small distance before the peristome.

Aperture slightly oblique, almost round. Mouth armature consisting of (1) on the parietal wall: two parietal lamellae and one angular lamella, (2) on the columellar side: a supracolumellar, a columellar and a sub-columellar lamella, and (3) on the palatal wall: two suprapalatales, one upper palatal, one interpalatal, one lower palatal, two infrapalatal and one basal fold. There is generally some variation in the development of the secondary denticles. All teeth are minutely spiniferous. Peristome continuous, free from the penultimate whorl. Margins thickened and expanded.

Dimensions: height 2.1 to 2.4 mm, width 2.5 to 2.8 mm, height of aperture 0.9 to 1.1 mm.

The type specimen, preserved in the Senckenberg Museum at Francfort on the Main (no. 4580; type locality Mount Djampang, 2000 feet, leg. H. FRUHSTORFER, 1892), is high 2.3 mm, wide 2.8 mm and has an aperture of 1.1 mm height.

Distribution: Java.

Habitat in Java: living on damp limestone rocks, probably feeding on minute algae. The shells are often covered by clumps of agglutinated earth, thus hiding their real shape (VAN BENTHEM JUTTING, 1932).

West Java: Kuripan, 200 m; Gunung Tjibodas, Tjiampea, near Bogor 300 m; Sukabumi, 700 m; Djampang, 2000 feet; limestone hills Mts. Masigit and Pawon, near Padalarang, on wet rock, 500—700 m.

RENSCH (1932, p. 121) suggested to unite all the Indonesian species of *Gyliotrachela* into one "Rassenkreis" of which *G. everetti* (SMITH) is the leading form. Although the idea sounds very attractive I am afraid I cannot follow him in this conception so long as our knowledge of the number of species and their distribution in the Malay Archipelago is so fragmentary.

The following species has not yet been found in Java, but only in one of the little satellite islands off the north coast of Central Java. As it is not impossible that sooner or later it will be found in the main island also, I give a figure and a full description of the species.

Pupoides coenopictus connectens RENSCH, 1932 (fig. 39).

1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 122, pl. 3, fig. 42.

1935 RENSCH, Sitz. Ber. Ges. naturf. Freunde Berlin, p. 318.

1936 FORCART, Verh. naturf. Ges. Basel, 47, p. 139.

Shell oblong-turreted, with broad base and pointed, although not sharp apex. Light brown or glassy-white, somewhat polished and transparent. Striated or finely ribbed in the direction of the growth lines. These riblets become more distinct to the base of the last whorl, especially in the umbilical opening.

Whorls $5\frac{1}{2}$ to 6, well-rounded, suture deep. Top obtuse, base rounded, umbilicus open, although not wide.

Aperture oblique, rounded oval. Provided with only one blunt tooth on the parietal wall near the angle between paries and labrum. Peristome not continuous, white, thickened and flatly expanded. A thin membrane against the penultimate whorl unites the two margins. Outer margin slightly incurved towards the upper angle of the aperture. In some individuals this curve protrudes as an obsolete tubercle.

Dimensions: height 3.6 to 4, width 1.9 to 2.2, height of aperture 1.1 to 1.3 mm.

Distribution: Sumba, Pulu Besar (north of Rembang, Central Java).

Although the shells from Pulu Besar are somewhat more obese and conical than the ones which RENSCH described and figured (1932, pl. 3, fig. 42), I do not consider this a reason for separating them subspecifically.

Familia VALLONIIDAE

Shell small, low-conical to turbinate, smooth or sculptured. Umbilicus open, in many species wide.

Aperture without teeth or with one or more lamellae. Peristome in some species continuous, in others not continuous. In many species thickened and reflected.

Hermaphroditic, in some genera there is a tendency to reduce parts of the male generative organs, e.g. dart sac and dart, or penis. Animal ovo-viviparous, or oviparous.

Mandibula horse-shoe-shaped, grooved (aulacognathous). Radula $\infty.1.\infty$, the rhachis tricuspid. Inner latero-marginals two- to tricuspid, outer ones multicuspid (fig. 42).

Distribution: All continents, often in high latitudes.

In Java only one genus:

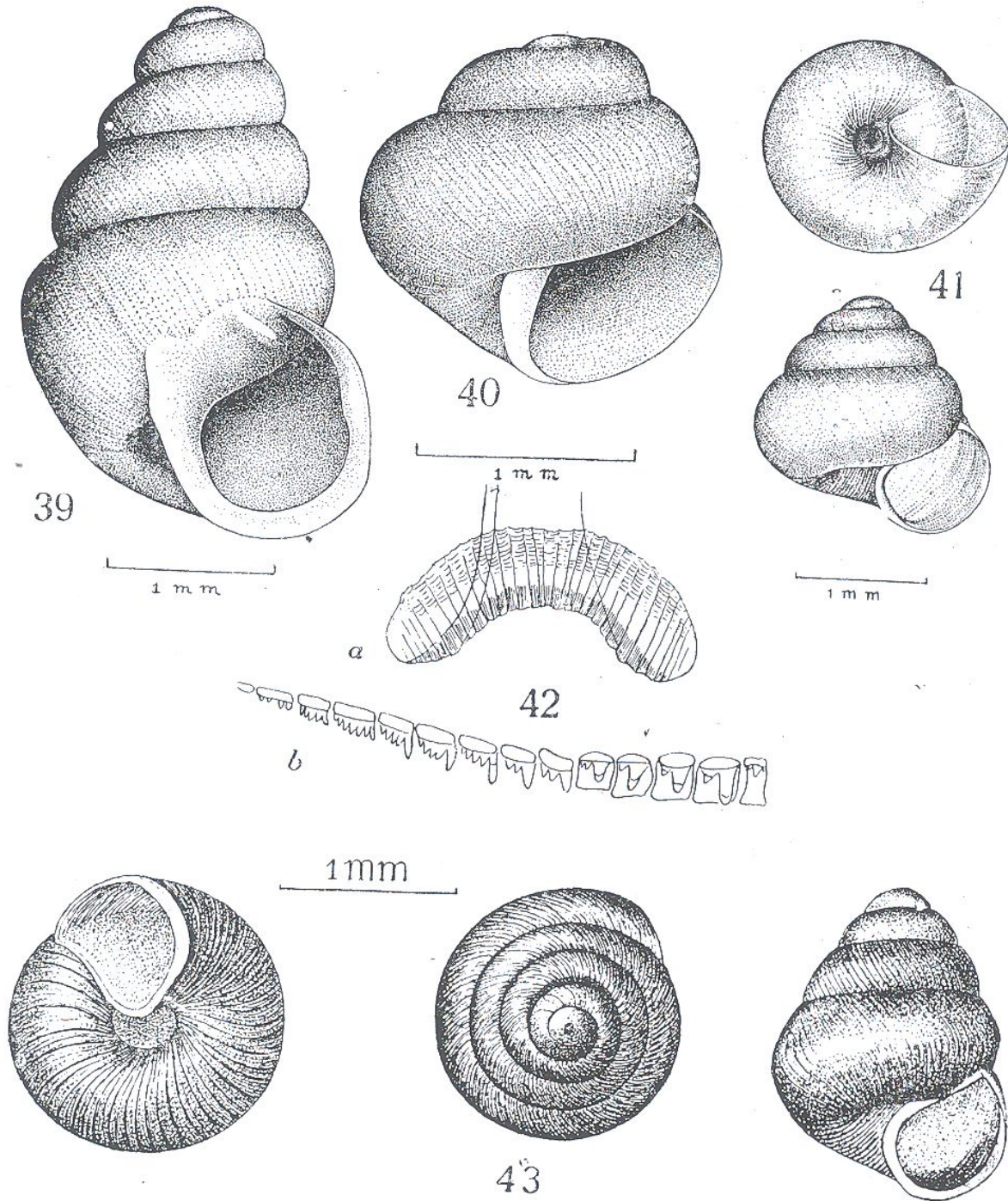


Fig. 39. *Pupoides coenopictus connectens* RENSCH. Shell. ABDULKADIR del. Fig. 40. *Pupisoma orcula* (BENS.). Shell. ABDULKADIR del. Fig. 41. *Pupisoma perpusillum* (MLLDFF). Shell from base and side. ABDULKADIR del. Fig. 42. *Vallonia pulchella* (MÜLL.). a. mandibula (after WATSON); b. radula elements (after STERKI). Fig. 43. *Pupisoma tiluanum* (MLLDFF). Shell from base, top and side. ABDULKADIR del.

Genus *Pupisoma* STOLICZKA, 1873

Shell small, low-conical or globose, with obtuse apex and rounded base. Fragile, transparent, somewhat shining. Finely striated in radial direction, some species even delicately costulate. Between the radial

sculpture some species are minutely pitted, others finely striated spirally. Umbilicus open, narrow or wide.

Aperture broadly lunar or rounded, in most species without mouth-armature. Peristome not continuous, not thickened or reflected.

Animal ovo-viviparous. Mandibula aulacognathous. Radula ∞ . l. ∞ , with tricuspoid rhachis, 2- to 3-cuspoid laterals and 4- to 5-cuspoid marginals.

Distribution: Tropical and subtropical regions of all continents, except Europe. In the forest and in plantations, on tree trunks and leaves.

In Java three species are known:

- 1. Umbilicus distinct 2
- Umbilicus very narrow, partly concealed by reflected columellar margin **orcula**
- 2. Umbilicus moderately wide, shell subconical, somewhat higher than wide **tiluanum**
- Umbilicus very wide, shell globose-conical, almost as high as wide **perpusillum**

The classification of the genus *Pupisoma* is not quite certain. Some authors place it in the family Vertiginidae (PILSBRY, Man. of Conch. (2) 26, 1920), others in the family Valloniidae (THIELE, Handb. Syst. Weicht. kunde, 1, Part 2, 1931).

***Pupisoma orcula* (BENSON, 1850) (fig. 40).**

1850 BENSON, Ann. Mag. Nat. Hist. (2) 6, p. 251 (*Helix*).
 1888 MOELLENDORFF, Nachr. Blatt, 20, p. 108 (*philippinicum*).
 1912 BURNUP, Proc. Malac. Soc. 10, p. 45.
 1920 PILSBRY, Man. of Conch. (2) 26, p. 31, pl. 2, fig. 1-5.
 1929 MENZEL & TENGWALL, Arch. Rubber, 13, p. 241.
 1935 RENSCH, Sitz. Ber. Ges. naturf. Freunde Berlin, p. 319 (*orcula orcula*).

Shell conical-globose, lightbrown, or greenish-brown, or corneous. Very fragile, transparent, glossy.

Whorls 3½, convex, irregularly striated or delicately obliquely ribbed in the direction of the growth lines. This sculpture is crossed by much finer spiral lines, only visible under strong magnification, especially distinct on the base. Suture deep. Apex obtuse, base rounded, periphery rounded. Umbilicus very narrow, partly concealed by a reflection of the columellar side.

Aperture almost entirely round, somewhat oblique. Peristome not continuous, not thickened or reflected. Columellar side concave.

Dimensions: height 1.7 to 2.2 mm, width 1.7 to 2.0 mm, height of aperture 0.6 to 0.9 mm.

Distribution: Old and New World Tropics, South Africa, probably transported by commerce with cultivated plants. Mostly found on leaves and tree trunks. Often difficult to recognise in their natural habitat, because the shells are frequently coated with agglutinated earth.

Habitat in Java: on branches and twigs of rubber trees, and of jungle plants, between 200 and 2500 m altitude.

West Java: Kuripan, near Bogor, 200 m; Gunung Tjibočas, Tjiampea, near Bogor, 300 m; Mt. Gedeh, 8000 feet; Maribaja, near Bandung, SE of hot springs, 1100 m.

MENZEL & TENGWALL (1929), also quoted by KALSHOVEN (1950, *Plagen Cultuur-gew. Indon.* 1, p. 49) recorded the occurrence of *Pupisoma orcula* in Hevea plantations in the Lampong Districts (S Sumatra) where several individuals crowded in spots with extra cork formation at the base of side branches. It is not certain if the snails had caused this callous tissue of the trees.

Whether *Pupisoma pulvisculum* (ISSEL) is synonymous with *P. orcula*, as PILSBRY (l.c.) suggested, I cannot decide. I can only say for certain that three shells from Lombok, preserved under the name *P. pulvisculum* in the Amsterdam Museum (Collection SCHEPMAN) and purchased from SOWERBY & FULTON, are undoubtedly *P. orcula* (BENSON). RENSCH (l.c.) accepted PILSBRY's opinion.

***Pupisoma perpusillum* (MOELLENDORFF, 1897) (fig. 41).**

1897 MOELLENDORFF, *Nachr. Blatt*, 29, p. 66 (*Acanthinula*).

1914 LESCHKE, *Mitt. naturh. Mus. Hamburg*, 31, p. 236 (*Acanthinula*).

1926 PILSBRY, *Man. of Conch.* (2) 27, p. 195 (*Acanthinula*).

1937 HAAS, *Arch. Moll. Kunde*, 69, p. 11, pl. 3, fig. 30-31.

Shell globose-conical, almost as high as broad, corneous-brown or reddish-brown. Very fragile, polished, somewhat transparent.

Whorls 4—4½, convex. First 1½ whorls minutely pitted, subsequent ones finely striated, and locally delicately ribbed in vertical direction, the riblets being especially distinct along the suture and at the entrance of the umbilicus. The much more delicate spiral striation is only visible under a strong lens (magnification of 25 times or more). Suture deep. Apex obtuse, base rounded, periphery rounded. Umbilicus wide, wider than in *P. tiluanum*.

Aperture almost entirely round, somewhat oblique. Peristome not continuous, not reflected. In fully mature shells somewhat thickened.

Dimensions: height 1.6 to 1.8, width 1.5 to 1.7, height of aperture 0.6 to 0.8 mm.

Distribution: Java.

Habitat in Java: living in the ground litter of the jungle, in altitudes of 2400 m and more.

West Java: Mt. Pangrango, 2400 m and 3300 m; Kandang Badak, saddle between Mts. Pangrango and Mt. Gedeh, 2400 m; Mt. Gedeh, 2500 m.

I could examine the type specimen, now preserved in the Senckenberg Museum (no. 4529; type locality: Mt. Pangrango, West Java, 3300 m, H. FRUHSTORFER). It is high 1.7 mm and wide 1.7 mm, with an aperture of 0.7 mm height.

***Pupisoma tiluanum* (MOELLENDORFF, 1897) (fig. 43).**

1897 MOELLENDORFF, Nachr. Blatt, 29, p. 66 (*Acanthinula*).

1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 236 (*Acanthinula*).

1926 PILSBRY, Man. of Conch. (2) 27, p. 195 (*Acanthinula*).

1937 HAAS, Arch. Moll. Kunde, 69, p. 11, pl. 3, fig. 28-29.

Shell subconical, somewhat higher than broad, corneous to brown. Very fragile, transparent, polished.

Whorls 5, moderately convex. First 1½ whorls minutely pitted, subsequent ones finely striated or delicately ribbed in radial direction, especially distinct along the suture and at the entrance of the umbilicus. The much more delicate spiral sculpture is only visible under strong magnification (more than 25 times). Suture moderately deep. Apex obtuse, base rounded, periphery rounded. Umbilicus moderately wide, not so wide as in *P. perpusillum*.

Aperture rounded-oval, somewhat oblique. Peristome not continuous, not reflected. In fully mature shells somewhat thickened.

Dimensions: height 1.6 to 2.0 mm, width 1.4 to 1.6 mm, height of aperture 0.6 to 0.7 mm.

I could examine the type specimen, now preserved in the Senckenberg Museum (no. 4525; type locality: Mt. Tilu, West Java, 2100 m, H. FRUHSTORFER). It is high 2.0 mm and wide 1.6 mm, with an aperture of 0.7 mm height.

Distribution: Java.

Habitat in Java: living in the ground litter of the virgin forest, in altitudes of 1700 to 2100 m.

West Java: Near the waterfalls of Tjibeureum, Mt. Gedeh, 1700 m; Mt. Tilu, 2100 m.

Familia ENIDAE

Shell dextral or (rarely) sinistral, oval to turreted. White or coloured. Transparent or opaque. Umbilicus open or closed. Finely striated, or granular, or with oblique ridges.

Aperture with one to several teeth, or toothless. Peristome white, thickened and expanded.

Radula ∞ . 1. ∞ . Central tooth uni- or tricuspid. In laterals and marginals there is much difference in the various genera, uni- and multicuspid teeth occurring.

Distribution: Europa, Asia and Africa, in temperate and tropical regions.

In Java only one genus:

Genus *Ena* TURTON, 1831

Shell dextral or sinistral. Ovate-conical to fusiform-cylindrical. Whittish, corneous or brownish; unicolorous or striped. Surface striated or granular. Top obtuse, base rounded. Umbilicus narrow or closed.

Aperture oval, oblique, in some species (not those in Java) with teeth. Peristome not continuous, white or brownish to violet. Thickened and reflected.

Animal hermaphroditic. Mandibula aulacognathous or elasmognathous. Radula ∞ . 1. ∞ . Central tooth tricuspid, laterals bicuspid, marginals tricuspid or multicuspid (fig. 44).

Distribution: Europe, North Africa, Asia, in temperate and in tropical regions.

In Java there are five species:

- | | | |
|----|--|--------------------|
| 1. | Shell small, under 15 mm height | thrausta |
| — | Shell larger, over 15 mm height | 2 |
| 2. | Whorls convex, suture deep | glandula |
| — | Whorls not so convex, suture not deep | 3 |
| 3. | Shell with oblique, irregular brown streaks or flames | prillwitzi |
| — | Shell plain | 4 |
| 4. | Shell broadly conical, surface regularly striated spirally | tenuilirata |
| — | Shell more cylindrical, surface, although granular, not so regularly striated spirally | tenggerica |

Ena glandula glandula (MOUSSON, 1848) (fig. 45).

1848 MOUSSON, Mitt. naturf. Ges. Zürich, 1, p. 266 (*Bulimus glandula*).

1849 MOUSSON, Land & Süßw. Moll. Java, p. 34-35, pl. 4, fig. 3 (*Bulimus glandula*).

1857 MOUSSON, Journ. de Conch. 6, p. 159 (*Bulimus densespiratus*).

1859 ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 18, p. 424 (*Bulimus densespiratus*).

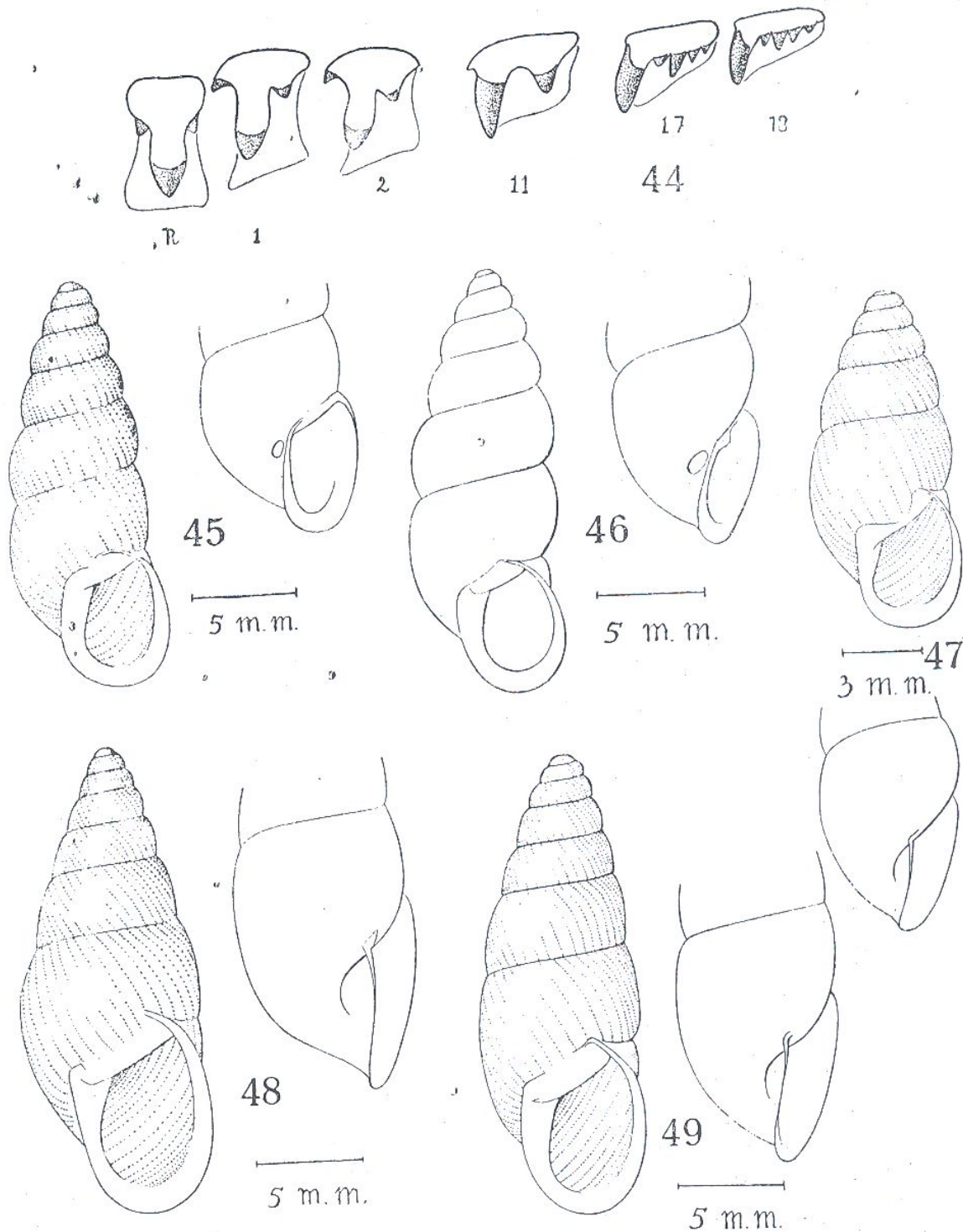


Fig. 44. *Ena obscura* (MÜLL.). Radula elements. Author del. Fig. 45. *Ena glandula glandula* (MOUSS.). Shell from front and detail of last whorl from side. HEMMINGA del. Fig. 46. *Ena glandula camarota* (KOB.). Holotype of subspecies. Shell from front and detail of last whorl from side. HEMMINGA del. Fig. 47. *Ena thrausta* (MLLDFF). Holotype. Shell from front and detail of last whorl from side. HEMMINGA del. Fig. 48. *Ena tenuilirata* (MLLDFF). Holotype. Shell from front and detail of last whorl from side. HEMMINGA del. Fig. 49. *Ena tenggerica* (MLLDFF). Holotype. Shell from front and detail of last whorl from side. HEMMINGA del.

- 1860 ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 318 (*Bulimus glandula*).
- 1867 MARTENS, Oostas. Landschn. p. 370 (*Buliminus glandula*) and p. 374 (*Stenogyra densespirata*).
- 1888 TENISON WOODS, Proc. Linn. Soc. N. S. W. (2) 3, p. 1050 (*Bulimina glandula*) and p. 1052 (*Stenogyra densespirata*).
- 1902 KOBELT, in: MARTINI-CHEMNITZ, N. Syst. Conch. Cab. Vol. 1, Part 13², p. 885-886, pl. 126, fig. 17-18 (*Buliminus (Coccoderma) glandula*).
- 1906 PILSBRY, Man. of Conch. (2) 18, p. 174 (*Opeas densespiratum*).
- 1914 LESCHKE, Mitt. naturh. Mus. Hamburg. 31, p. 236 (*Buliminus (Coccoderma) glandula*) and p. 238 (*Opeas densespiratum*).
- 1923 OOSTINGH, Meded. Landb. Hooges. 26, p. 155 (*E. glandula*).
- 1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 296 (*E. glandula*).

Shell oval to high-conical, corneous-brown. Finely striated according to the growth lines. There is besides a much more delicate granular sculpture, not, or indistinctly spirally arranged. Dull or a little shining, little or not transparent.

Whorls 7 to 8, flattened or convex, suture shallow or well impressed. Last whorl somewhat ascending in front. Periphery rounded in adult shells, obtusely angular in immature ones. Top obtuse, base rounded. Umbilicus narrow.

Aperture oblique, oval, interior corneous. Peristome not continuous, the margins connected by a thin membrane against the penultimate whorl. Free margin white, thickened and reflected. Columellar and palatal sides almost parallel.

Dimensions: height 16 to 20 mm, width 7 to 8 mm, height of aperture 6 to 7 mm.

I could examine the two original specimens which served MOUSSON for his diagnosis of *Bulimus glandula*. They are now in the University Museum of Zürich and labelled "Südliches Java (ZOLLING 45)" which means: South Java, leg. ZOLLINGER, 1845. A holotype had not been marked by the author. Therefore I now designate as lectotype the larger of the two specimens which agrees entirely with the description, the dimensions and the figure in Land & Süssw. Moll. Java, 1849. The smaller shell (high 14.8 mm, wide 6.3 mm, with an aperture of 5 mm height) then becomes the paratype.

Distribution: Java, Madura.

Habitat in Java: Although *Ena glandula glandula* is not rare in Java, very little is known on the circumstances under which it lives. In limestone regions it seems to be frequent, living on the ground, under low vegetation and among earth and plant debris. Recorded between sea-level and 1000 m altitude.

West Java: Kuripan, 200 m; Bogor, 250 m (MOUSSON, 1857); Palabuanratu, sea-level; Tjisolok, near Palabuanratu, not far from the hot springs, 200 m; limestone mountains near Padalarang, 500—700 m; Pasir Babeasan, in small cave, 800 m; Mts. Masigit and Pawon, near Padalarang, 500—800 m.

Central Java: Penawangan (OOSTINGH, 1923); Djurangan.

East Java: Kali Mrawan, Besuki, 1000 m.

As will appear from the paragraph on "Doubtful species of *Opeas*" the shell from Bogor collected by ZOLLINGER in 1857, and preserved in the MOUSSON collection at Zürich under the name *Stenogyra arctispira* MRTNS is not *Opeas arctispira* (MARTS) syn. *Opeas beckianum* (PFR.), but a much larger shell, a not quite full-grown *Ena glandula* (MOUSS.). This very specimen is probably the type specimen of MOUSSON's *Stenogyra densespirata* from Bogor (Journ. de Conch. 6, p. 159, 1857). It agrees at least exactly with the original description and, moreover, there is no other sample labelled *Stenogyra densespirata* in the MOUSSON collection.

***Ena glandula camarota* (KOBELT, 1902) (fig. 46).**

1902 KOBELT, *Buliminus* in: MARTINI-CHEMNITZ, N. Syst. Conch. Cab. Bd. 1, Abt. 13-II, p. 886, pl. 126, fig. 19-20 (*Buliminus (Coccoderma)*).

1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 236 (*Buliminus (Coccoderma)*).

The subspecies differs from the main form in having a larger and more solid shell with more convex whorls, especially the lower ones. The aperture and the peristome are similar as in *Ena glandula glandula* and therefore make the impression of being small and narrow compared with the greater height of *E. gl. camarota*.

In the holotype the peristome is faintly flesh-coloured, in some of the paratypes, however, this feature is so weak as to be almost negligible.

The holotype, now preserved in the Senckenberg Museum (no. 63959, Tengger Mts, 1600 feet, H. FRUHSTORFER, 1891), is high 20 mm and wide 7.8 mm, with an aperture of 7 mm height. In the original diagnosis the dimensions are given as: 20, resp. 9, resp. 7 mm. Paratypes have the following dimensions (in mm):

Tengger Mts, 1600 ft, H. FRUHSTORFER, 1891 Senck. Mus. no. 63960			Southern Mts, 1500 ft, H. FRUHSTORFER, 1891 Senck. Mus. no. 63961			
height	18.7	18.6	19.6	17.3	17.5	19.—
width	7.8	7.8	7.3	7.—	7.3	7.—
height of aperture	6.8	6.8	6.5	6.—	6.—	6.—

Distribution: Java, in similar habitats as the main form.

Central Java: Mantingan, residency of Rembang, 100 m;

East Java: Tengger Mts, 1600 feet; Southern Mts, 1500 feet.

Ena thrausta (MOELLENDORFF, 1897) (fig. 47).

1897 MOELLENDORFF, Nachr. Blatt, 29, p. 70 (*Buliminus* (*Ena*)).

1902 KOBELT, *Buliminus* in: MARTINI-CHEMNITZ, N. Syst. Conch. Cab. Bd. 1, Abt. 13-II, p. 887, pl. 126, fig. 21-22 (*Buliminus* (*Coccoderma*)).

1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 237 (*Buliminus* (*Coccoderma*)).

Shell high-conical, corneous-brown. Fragile, finely striated according to the growth lines. There is besides a much more delicate granular sculpture, more or less distinctly spirally arranged. Dull or a little shining, little or not transparent.

Whorls 6, little convex. Suture moderately well impressed. Periphery rounded in adult shells, somewhat angular in immature ones. Top obtuse, base rounded. Umbilicus very narrow or closed.

Aperture oblique, oval, interior corneous. Peristome not continuous, the margins connected by a thin membrane against the penultimate whorl. Free margin white, thickened and reflected, hiding part of the umbilicus.

Dimensions: height 12 to 13 mm, width 6 to 6½ mm, height of aperture 4½ to 5 mm.

The type from the Tengger Mts, 1220 m, H. FRUHSTORFER 1891, is now preserved in the Senckenberg Museum (no. 63941). It is high 13 and wide 6 mm, with an aperture of 5 mm height.

Distribution: Java.

Habitat in Java: nothing is known of the conditions under which *Ena thrausta* lives.

West Java: Mt. Gedeh, 4000 feet.

Central Java: Kali Soko, tributary of Kali Solo, near Trinil, 75 m.

East Java: Tengger Mts, feet.

Ena prillwitzi (MOELLENDORFF, 1897) (fig. 50).

1897 MOELLENDORFF, Nachr. Blatt, 29, p. 69 (*Buliminus* (*Ena*)).

1902 KOBELT, *Buliminus* in: MARTINI-CHEMNITZ, N. Syst. Conch. Cab. Bd. 1, Abt. 13-II, p. 900, pl. 128, fig. 16-17 (*Buliminus* (*Coccoderma*)).

1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 236 (*Buliminus* (*Coccoderma*)).

Shell ventricose, high-conical, brown, with irregular dark-brown, oblique streaks. Finely striated according to the growth lines. There is besides a much more delicate granular sculpture, not, or only indistinctly, spirally arranged. Dull or a little shining, little or not transparent.

Whorls 7 to 8, little convex or almost flat, suture shallow, often white-margined. Periphery rounded in adult shells, somewhat angular in immature ones. Last whorl only slightly ascending. Top obtuse, base rounded. Umbilicus very narrow or closed.

Aperture oblique, oval. Interior violet. Peristome not continuous, the margins connected by a thin membrane against the penultimate whorl. Free margin white, thickened and reflected, with a narrow brown zone just behind the peristome and parallel with it. Columellar side hiding part of the umbilicus.

Dimensions: height 20 to 23 mm, width 8.5 to 9.5 mm, height of aperture 8 mm.

The type specimen, collected on Mt. Gedeh, West Java, 3000 ft, H. FRUHSTORFER 1892 (Museum Senckenberg no. 63952), is high 23, and wide 9.4 mm, with an aperture of 8 mm height.

Distribution: Java.

Habitat in Java: living in the jungle, in ground litter and at the base of rocks, between 3000 feet and 1800 m altitude.

West Java: Mt. Gedeh, 3000 feet; Tjibodas and environs, Mt. Gedeh, 1400—1800 m; rocks near Rarahan, near Tjibodas, Mt. Gedeh, 1400 m.

***Ena tenuilirata* (MOELLENDORFF, 1897) (fig. 48)**

1897 MOELLENDORFF, *Nachr. Blatt*, 29, p. 69 (*Buliminus* (*Ena*)).

1902 KOBELT, *Buliminus* in: MARTINI-CHEMNITZ, *N. Syst. Conch. Cab.* Bd. 1, Abt. 13-II, p. 539, pl. 85, fig. 6-7 (*Buliminus* (*Napaeus*)).

1914 LESCHKE, *Mitt. naturh. Mus. Hamburg*, 31, p. 237 (*Buliminus* (*Coccoderma*)).

Shell high-conical, brown. Finely striated according to the growth lines. In addition there is a much more delicate granular sculpture, distinctly spirally arranged. Dull or a little shining, little or not transparent.

Whorls 7 to 8, almost flat, suture shallow, often white-margined. Periphery rounded in adult shells, somewhat angular in immature ones. The penultimate whorl (and sometimes the previous whorl also) somewhat sharply ledging over the suture. Top obtuse, base rounded. Umbilicus very narrow or closed.

Aperture oblique, oval, standing more laterally than below the axis of the shell. Interior of aperture violet. Peristome not continuous, the

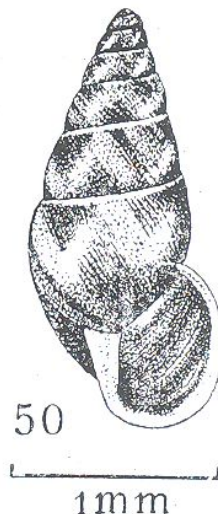


Fig. 50. *Ena prillwitzii* (MLLDF).
Shell. ABDULKADIR del.

margins connected by a thin membrane against the penultimate whorl. Free margin white, thickened and expanded. Columellar side hiding part of the umbilicus.

Dimensions: height 21 to 23 mm, width 9.5 to 10.5 mm, height of aperture 9 to 10 mm.

I could examine the type specimen, collected by H. FRUHSTORFER in the Tengger Mountains, 750 m, (Senckenberg Museum, no. 63947). It is high 22 and wide 9.8 mm, with an aperture of 9 mm height.

Distribution: Java.

Habitat in Java: living in the jungle, on the ground, between plants and plant debris, at altitudes between 1500 feet and 1800 m.

West Java: Mt. Gedeh, 4000 feet; Ardjamanik, N of Bandung.

East Java: Tengger Mts, 750 m; Southern Mts, 1500 feet; Pudjon above Malang, Mt. Kawi, 1200 m; Tjobanrondo, above Pudjon, Mt. Kawi, 1400 m; above Tjobanrondo, Mt. Kawi, between roots of a tree in the mountain forest 1800 m.

Ena tenggerica (MOELLENDORFF, 1897) (fig. 49)

1897 MOELLENDORFF, Nachr. Blatt, 29, p. 69 (*Buliminus* (*Ena*)).

1902 KOBELT, *Buliminus* in: MARTINI-CHEMNITZ, N. Syst. Conch. Cab. Bd. 1, Abt. 13-II, p. 888, pl. 126, fig. 25-26 (*Buliminus* (*Coccoderma*)).

1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 237 (*Buliminus* (*Coccoderma*)).

1934 RENSCH, Trop. Binnengew. 4, p. 757.

Shell high-conical to cylindrical-conical, brown. Finely striated according to the growth lines. There is further a much more delicate granular sculpture, not, or indistinctly spirally arranged. Dull or a little shining; little or not transparent.

Whorls 7 to 8, almost flat or a little convex. Suture shallow, often white-margined. Periphery rounded in adult shells, somewhat angular in immature ones. Last whorl somewhat ascending in front. Top obtuse, base rounded. Umbilicus very narrow or closed.

Aperture oblique, oval. Interior of aperture brown. Peristome not continuous, the margins connected by a thin membrane against the penultimate whorl. Free margin white, thickened and reflected. Columellar side hiding part of the umbilicus. Columellar and palatal margins of the peristome almost parallel, although not quite so as in *E. glandula*.

Dimensions: height 19 to 21.5 mm, width 7.5 to 8 mm, height of aperture 7 to 8 mm.

I could examine the type from the Tengger Mountains, 1200 ft, collected by H. FRUHSTORFER in 1892 (Senckenberg Museum no. 63954). It is high 21.5 and wide 8.4 mm, with an aperture of 8 mm height.

Distribution: Java, Bali.

Habitat in Java: nothing is known of the conditions under which *Ena tenggerica* lives, but probably its biotope is not much different from that of its congeners.

East Java: Tengger Mountains, 1200 feet.

Doubtful species of *Bulimus*

"*Bulimus vestalis* MOUSSON ined.", mentioned by ZOLLINGER, 1859 (Natuurk. Tijdschr. Ned. Indië, 18, p. 424) and by MARTENS, 1867 (Ostas. Landschn. p. 370) from Bogor, West Java, is not in the MOUSSON collection at Zürich and not in the Berlin Museum. Until the shell can be traced somewhere it remains a myth.

Familia SUBULINIDAE

Shell high-conical to turreted, consisting of many whorls. Corneous, greenish or brownish, generally polished and transparent.

Whorls slightly convex, finely striated or costulate. Umbilicus narrow or closed. Aperture oval or pear-shaped. Peristome not continuous. Exterior margin of peristome sharp, not reflected. Columellar margin truncated below, or evenly merging into the basal margin.

Hermaphroditic. Oviparous or ovo-viviparous. In the genital system the accessory organs of the male division like flagellum, digitate glands, dart-sac and dart are missing. Only in *Glessula* an accessory gland of the penis is present.

Radula $\infty .1. \infty$, with a narrow central tooth. Latero-marginals two- to four-cuspid.

Distribution: Tropical and subtropical countries of all continents. The genus *Rumina* in southern Europe.

Genus *Glessula* MARTENS, 1860

Shell ovate-conical to turreted, with several whorls. Dark brown or corneous, polished, somewhat transparent. Whorls slightly convex, finely striated. Top obtuse, base rounded or attenuated. Umbilicus closed.

Aperture oval to egg-shaped, not large. Peristome not continuous. External margin sharp, not reflected. Columellar margin vertical or somewhat excavated; truncated at the base.

PILSBRY (1908, Man. of Conch. (2) 20, p. 50) described the anatomy of *Glessula orophila* (REEVE) from India and Burma and gave the following account of its radula and mandibula: "The jaw is very finely striate, almost smooth. Radula has about 110 teeth in a transverse row. The central

tooth is very small, tricuspid; laterals with three cusps; outer marginal teeth very finely tri- or four-cuspid."

Some species of *Glessula* are viviparous, others oviparous. The male sex organs bear a flagellum, a feature quite exceptional in Subulinidae or Achatinidae. In 1928 H. WATSON (Journ. of Conch. 18, p. 237) on account of an examination of a specimen of *Glessula* from Ceylon, suggested to classify the genus among the subfamily Stenogyrinae of the Achatinidae instead of among the Ferussaciidae as was done by previous authors.

Glessula sumatrana (MARTENS, 1864) (fig. 51).

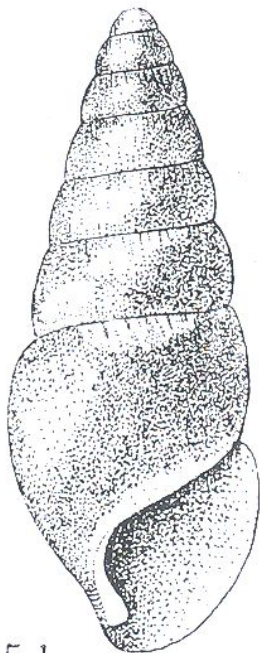
- 1864 MARTENS, Monatsber. Akad. Berlin, p. 527 (*Cionella*).
 1867 MARTENS, Ostas. Landschn. p. 372, pl. 22, fig. 5 (*Cionella*).
 1890 BOETTGER, Ber. Senckenb. p. 148, pl. 5, fig. 9, 9a (*cornea*).
 1891 BOETTGER, Ber. Senckenb. p. 244 (*cornea*).
 1908 BOETTGER, Nachr. Blatt, 40, p. 68 (*javanica*).
 1908 ROLLE, Nachr. Blatt, 40, p. 68.
 1909 PILSBRY, Man. of Conch. (2) 20, p. 50, pl. 14, fig. 3, 4 and 5.
 1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 238 (*cornea*).

Shell spindle-shaped to turreted, chocolate-brown, highly polished, rather solid, little transparent. Vertical striation fine and regular. Spiral striation very weak or absent. The vertical striae are somewhat more costulate at the suture. These minute ribs are generally placed in bundles of 3 to 5. The bundles are separated by deeper grooves.

Whorls 7 to 8, regularly increasing in size, each whorl slightly convex. Suture distinct, not margined. Last whorl about one-third of entire shell-length. Top pointed, but not sharp, finely ribbed in radial direction. Base rounded, somewhat drawn out. Umbilicus closed, even in young shells.

Aperture vertical, oval, pointed above and below. Peristome not continuous. Exterior margin sharp. In fully mature specimens with a narrow interior ridge, sometimes white, sometimes dilute violet. Columellar margin slightly excavated, truncated below. In adult shells a thin white layer against the parietal wall unites the two ends of the peristome.

Dimensions: height 12 to 13 mm, width 4½ to 5 mm, height of aperture 4 mm.



51

5 mm

Fig. 51. *Glessula sumatrana* (MARTS). Shell. Holotype of *Glessula cornea* BTTG. Author del.

The type specimen of *Glessula cornea* BOETTGER from Mount Salak, collected by A. STRUBELL in 1889 (Museum Senckenberg no. 64025) is high 13 and wide 5 mm, with an aperture of 4 mm height.

Distribution: Sumatra, Java.

Habitat in Java: soil fauna of the hills and mountains, between 300 and 1400 m altitude.

West Java: Mt. Salak, Tjianten waterfall, near Leuwiliang, 300 m; Mt. Salak; Mt. Gedeh (BOETTGER, 1891); Pantjoran Mas, near Rarahan, Tjibodas, Mt. Gedeh, 1400 m.

The only difference of some importance between the diagnoses of *G. sumatrana* (MARTENS) and *G. cornea* BOETTGER is the band- or rib-like development of the vertical striae along the suture in *G. cornea*. In the holotype and in 3 paratypes (Museum Senckenberg no. 64025 resp. 64026) of *G. cornea* from Mt. Salak, these striae are clearly visible. Although I could not compare the type of *G. sumatrana*, I am inclined to agree with BOETTGER (1908) and PILSBRY (1909) who united the two forms.

As I had no specimens at my disposal in which the soft parts were preserved, I cannot say anything on the anatomy of *Glessula sumatrana*.

Among the unpublished drawings of the molluscs collected in Java in the beginning of the 19th century by KUHLE & VAN HASSELT (now in the Leiden Museum) there is a figure in colour by G. L. KEULTJES representing "*Bulimus (Acricula) cornea* Nobis, Gedokan, Salak". There is no doubt that shell and animal represent *Glessula sumatrana*, as was already suggested by MARTENS (1867).

Genus *Subulina* BECK, 1837

Shell turreted, with numerous whorls. Corneous to greenish or brownish. Transparent, highly polished. Whorls convex, finely striated in vertical direction. Top obtuse, base rounded. Umbilicus closed.

Aperture small, compared to the high spire. Peristome not continuous, exterior margin sharp, not reflected. Columellar margin excavated, truncated at the base.

Radula with a small tricuspid central tooth. The laterals tricuspid with a large central cusp, in the marginals the central cone is small. Mandibula horse-shoe-shaped, finely striate (fig. 52).

Eggs large, spherical, with a calcareous shell.

Distribution: In all tropical countries. One species, *Subulina octona*, has been introduced in European and U.S. glasshouses (MEEUSE, 1949, *Basteria*, 13, p. 18).

In Java there is only one species:

Subulina octona (BRUGUIÈRE, 1792) (fig. 52 and 53).

- 1792 BRUGUIÈRE, Encycl. Méth. Vers, 1, p. 325 (*Bulinus*).
 1890 BOETTGER, Ber. Senckenb. naturf. Ges. p. 147.
 1891 BOETTGER, Ber. Senckenb. naturf. Ges. p. 274.
 1906 PILSBRY, Man. of Conch. (2) 18, p. 72, pl. 12, fig. 8, 9 and p. 222, pl. 39, fig. 28-37, 39, 40.
 1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 214 and 238.
 1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 106.
 1934 RENSCH, Trop. Binnengew. 4, p. 755.
 1935 PARAVICINI, Arch. Moll. Kunde, 67, p. 174.
 1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 298.
 1950 KALSHOVEN, Plagen Cultuurgew. Indon. 1, p. 49, fig. 15-b.

Shell high-turreted, with numerous whorls. Glassy yellowish-corneous, sometimes a little greenish. Highly polished and transparent. With fine vertical striation; spiral striae very weak.

Whorls 9 to 10, regularly increasing in size. Well rounded, suture distinct, not margined, but somewhat crenulate, especially in the older whorls. Last whorl about two-fifths of the entire shell-length. Top obtuse, base rounded. Imperforate, even in young animals.

Aperture oblique, almost oval, pointed above and below. Peristome not continuous, sharp, not thickened or reflected. The columella is truncated at the lower extremity.

Dimensions: height 19 to 20 mm, width $4\frac{1}{2}$ to 5 mm, height of aperture $3\frac{1}{2}$ to $4\frac{1}{2}$ mm.

Distribution: *Subulina octona* is a tropical cosmopolite. It is difficult to say in which country it originated. In the Malay Archipelago it has been recorded since 1890 (BOETTGER, l.c.) and is now present in almost all islands. Introduction into hothouses in Europe and the U.S. (MEEUSE, 1949) has already been mentioned.

Habitat in Java: under stones, grass, moss and other ground objects, chiefly in the lowlands. Highest record 700 m.

The shells are so transparent that the white, calcareous eggs can be observed through the shell. PILSBRY (1906, p. 74) noted their dimensions as 1.8×1.5 mm.

Anatomical investigations of this species were made by WIEGMANN (1893, Ergebn. Reise N.O. Indien, 3, p. 210, pl. 15, fig. 18-26, pl. 16, fig. 1-7 and Id. 1898, Mitt. Zool. Mus. Berlin, 1, p. 91-92).

West Java: Antjol, near Djakarta, and Tandjong Priok, sea-level; Djakarta, 15 m; Bogor, Botanical Garden, 250 m; Mt. Salak (BOETTGER, 1890); Sukabumi, 700 m; Tjiandjur, 470 m; Bandung, 700 m; Garut, 700 m; Tjisompét, 450 m.

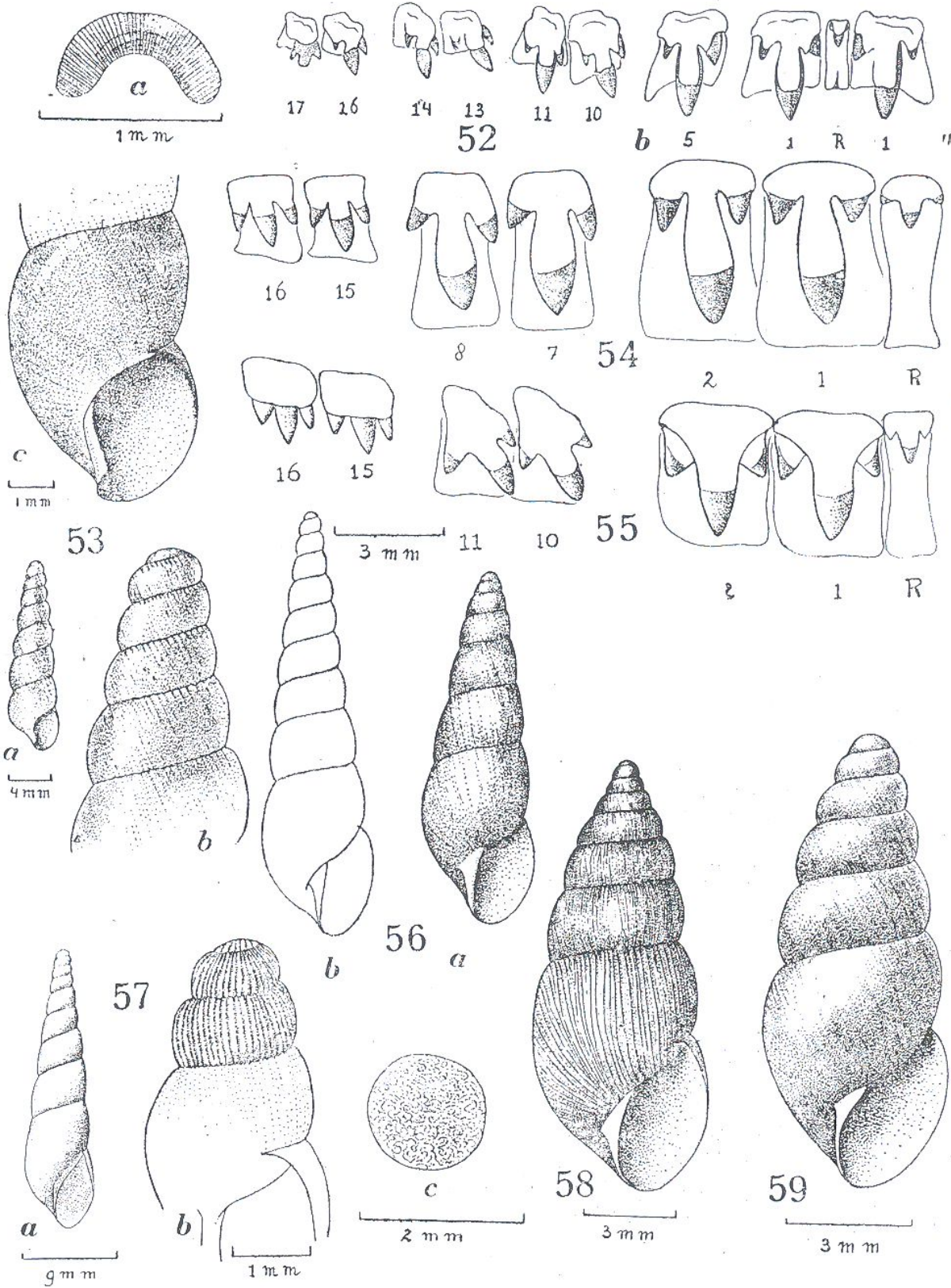


Fig. 52 *Subulina octona* (BRUG.). a. mandibula; b. radula elements. Fig. 53. *Subulina octona* (BRUG.). a. Shell, b. details of spire, c. details of last whorl, enlarged. Fig. 54. *Prosopeas acutissimum* (PFR). Radula elements. Fig. 55. *Opeas gracile* (HUTT.). Radula elements. Fig. 56. a. *Opeas gracile* (HUTT.) and b. *Opeas gracile* fa *panayensis* (PFR). Fig. 57. *Prosopeas acutissimum* (PFR). a. entire shell. ABDULKADIR del.; b. apex with coarse vertical ribs; c. egg. Fig. 58. *Prosopeas achatinaceum* (PFR). Shell. Fig. 59. *Opeas clavulinum* (POT. & MICH.). Shell. All, except fig. 57, author del.

Central Java: Rembang, sea-level.

East Java: Botanical Garden, Surabaya, sea-level; Malang, 500m.

Now and then *Subulina octona* can do some damage in plantations of tobacco, pepper, and other crops for the European market (VAN DER MEER MOHR, 1935, Meded. Deli Proefstat. (2) 91, p. 23; KALSHOVEN, 1950, l.c.). Observations by VAN DER MEER MOHR (1931, Miscell. Zool. Sumatrana, no. 52, fig. 1-2) near Medan (Sumatra) have shown that ants collect living *Subulina octona*, carrying the snails to the ant-nest and using them as food.

Genus *Opeas* ALBERS, 1850

Shell turreted or ovate-conical, with many whorls. Corneous, greenish or brownish. Hyaline, polished. Whorls slightly convex, finely striate or costulate. Top pointed or obtuse, base rounded. Umbilicus narrow or closed.

Aperture rather small compared to the high spire. Peristome not continuous, exterior margin sharp, not reflected. Columellar margin vertical or excavated, not truncated at the base, but evenly merging into the basal margin.

Radula with tricuspid rhachis. Laterals tricuspid, with large central cone. In the marginals the three or four denticles of each tooth are more or less of uniform size (fig. 55).

Eggs large, spherical, with calcareous shell.

Distribution: In all tropical and subtropical countries. Some species have been introduced into European and U.S. glasshouses (MEEUSE, 1949, Basteria, 13, p. 16-18).

In Java there are two species:

1. Spire very slender, apex pointed, vertical sculpture rather coarse **gracile**
- Spire broader, apex obtuse, vertical sculpture fine **clavulinum**

Opeas gracile (HUTTON, 1834) (fig. 55 and 56a).

- 1834 HUTTON, Journ. Asiatic Soc. Bengal, 3, p. 93 and 84-85 (*Bulimus*).
- 1848 MOUSSON, Mitt. naturf. Ges. Zürich, 1, p. 267 (*Bulimus apex*).
- 1849 MOUSSON, Land & Süsww. Moll. Java, p. 35, pl. 4, fig. 5 (*Bulimus apex*).
- 1849 MOUSSON, Zeitschr. Malak. 6, p. 180 (*Bulimus apex*).
- 1860 ZOLLINGER, Natuurk. Tijdschr. Ned. Ind. 21, p. 318 (*Bulimus apex*).
- 1867 MARTENS, Oostas. Landschn. p. 83 and 375, pl. 22, fig. 13, pl. 19, fig. 5 (*Stenogyra*).
- 1888 TENISON WOODS, Proc. Linn. Soc. N. S. W. (2) 3, p. 1051 (*Stenogyra*).
- 1892 MARTENS, Erg. Reise N. O. Indien, 2, p. 243.

- 1897 MOELLENDORFF, Nachr. Blatt, 29, p. 89 (*curvicosta*).
1906 PILSBRY, Man. of Conch. (2) 18, p. 125, pl. 18, fig. 3-6.
1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 238 (*curvicosta, gracile, apex*).
1929 DAMMERMAN, Agric. Zool. Mal. Archip. p. 119.
1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 107.
1935 PARAVICINI, Arch. Moll. Kunde, 67, p. 174.
1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 299.
1950 KALSHOVEN, Plagen Cultuurgew. Indon. 1, p. 49, fig. 13b and 15a.

Shell high-turreted, with numerous whorls. Pale yellowish-white or straw colour. Fragile, hyaline, with a soft silky lustre. Vertical striation distinct, sometimes even delicately ribbed; spiral striae very weak.

Whorls 7 to 8, regularly increasing in size. Well rounded, although less so than in *Opeas clavulinum*. Suture distinct, indistinctly margined. In coarsely striated shells the suture is finely crenulated. Last whorl less than one-third of the entire shell-length. Top pointed, base round. Umbilicus hair-like in immature shells, closed in adult ones.

Aperture vertical, or a little oblique. More or less oval, longer than broad, pointed above and rounded below. Peristome not continuous. Exterior margin not thickened or reflected. Columellar margin slightly reflected.

Dimensions: height 9 to 10 mm, width 3 to 3½ mm, height of aperture 3 mm.

Distribution: *Opeas gracile* is a tropical cosmopolite. The type locality is Mirzapur in India. In the Malay Archipelago it has been recorded since 1848 (MOUSSON, l.c.) and is now present in almost all islands.

Habitat in Java: under stones, moss, grass and other ground objects, chiefly in the lowlands. Recorded between sea-level and 1400 m altitude.

West Java: Pardana (MARTENS); canal between Tandjong Priok and Djakarta, sea-level; Djakarta 15 m; Pasar Minggu, 20 m; Depok, 100 m; Bogor and Kuripan, 200—250 m; Mt. Salak; Tjiseëng; Tjiteureup, 200 m; Mt. Gedeh, 4000 feet; Pantjoran Mas, near Rarahan, Mt. Gedeh, 1400 m; Sukabumi, 700 m; Wijnkoopsbay (PARAVICINI); Tjiandjur, 470 m; Djam-pangs, 2000 feet; limestone mountains near Padalarang, 500 m; Mt. Pawon, near Padalarang, 700 m; Tjitarum R., near Radjamandala, 300 m; Bandung, 700 m; Mt. Tangkuban Prahū, 1000 m; Maribaja, about 100 m SE of hot springs, 1100 m; Purwakarta, 150 m; Garut, 700 m.

Central Java: Gamping and Tandjong Tirto, near Djokja, 100—150 m; Baron, S of Djokja; Sompok, near Samarang, 15 m; Purwodadi, 25 m; Wirosari, 50 m; Mantingan, 100 m; Kali Besèk, near Sulang, 50 m; Kapuran, east of Rembang, 10 m; Kali Soko, tributary of Kali Solo, 75 m.

East Java: Sutji, near Surabaya, 50 m; Tengger Mts.; Durdjo Estate, near Djember, 600 m; Besuki, sea-level.

Opeas gracile is a very variable species, slender and bulky, ribbed and smooth, weakly and strongly sutured shells occurring. This has given rise to a multitude of different names (PILSBRY, l.c.).

Opeas curvicosta MOELLENDORFF is an *O. gracile* in which the vertical ribs are distinctly developed. Moreover it has more "shouldered" whorls than in normal specimens. The type shell, a unique specimen, was collected in the Djampang, West Java, at 2000 feet by H. FRUHSTORFER in 1893 (Museum Senckenberg, no. 63910). When quite young the shell was severely damaged, as can be seen from an oblique crack reaching from the 1½ to the second whorl. This may explain the somewhat irregular further growth. Nevertheless the shell attained a size of 7 mm height, 2½ mm width and an aperture of 2.25 mm height.

Like *Subulina octona*, *Opeas gracile* can do some harm in tobacco plantations and horticulture (DAMMERMAN, l.c.; VAN DER MEER MOHR, Meded. Deli Proefstat. (2) 91, 1935, p. 23; VAN DER LAAN, Ibid. (2) 98, 1938, p. 15; KALSHOVEN, l.c.).

Among the unpublished drawings of the molluscs collected in Java in the beginning of the 19th century by KUHLE & VAN HASSELT (now in the Leiden Museum), there is a figure in colours by G. L. KEULTJES representing "*Bulimus (Acicula) fusiformis* Nobis, Buitenzorg". The animal is light-yellow, the shell brownish-yellow. There is no doubt that they belong to *Opeas gracile*. The opinion of MARTENS (1867) who suggested their affinity to *Stenogyra arctispira* MORTS or to *St. densespirata* MOUSS. cannot longer be maintained if one considers the actual systematic classification of these species (see under Doubtful species of *Opeas*).

***Opeas gracile* forma *panayensis* (PFEIFFER, 1846) (fig. 56b).**

1846 PFEIFFER, Proc. Zool. Soc. London, p. 33 (*Bulimus panayensis*).

1867 MARTENS, Ostas, Landschn. p. 83 and 376, pl. 22, fig. 8 (*Stenogyra panayensis*).

1906 PILSBRY, Man. of Conch. (2) 18, p. 131, pl. 18, fig. 1 and 2.

Intergrading with normal *Opeas gracile* and considered identical by some authors. In its typical form the forma *panayensis* differs in possessing a much more slender shell, with an imperforate axis and a smooth surface. The extreme degree of slenderness can be recognized already in quite young shells, of 3 to 4 whorls, the spire developing as a narrow screw with great pitch, each whorl embracing only a small part of its predecessor.

Dimensions: height 11 to 12 mm, width 3 to 3½ mm, height of aperture 3 to 3½ mm. Number of whorls 9 to 10.

Distribution: in all islands where some serious collecting has been done. Occurs together with the main form.

Habitat in Java: living under similar conditions as *Opeas gracile*.

West Java: Djakarta, 15 m; Pasar Minggu, 20 m; Depok, 100 m; Bogor, 250 m; Gunung Tjibodas, Tjampea, near Bogor, 300 m; limestone mountains near Padalarang, 500 m.

Central Java: Baron and Gamping (100 m) near Djokja; Sompok, near Samarang, 15 m; Purwodadi, 25 m; Kali Besèk, near Sulang, 100 m; Rembang, sea-level.

East Java: Sutji, near Surabaja, 50 m; Durdjo Estate, near Djember, 600 m.

Opeas clavulinum (POTIEZ & MICHAUD, 1838) (fig. 59).

1838 POTIEZ & MICHAUD, Gall. Moll. Mus. Douai, 1, p. 136, pl. 14, fig. 9 and 10 (*Bulimus*).

1906 PILSBRY, Man. of Conch. (2) 18, p. 135, pl. 23, fig. 17, 21, 23.

1929 VAN BENTHEM JUTTING, Treubia, 11, p. 80.

1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 108 (*javanicum*).

Shell moderately to high turreted, with several whorls. Yellowish white or corneous, highly polished and transparent. Vertical striation fine; spiral striae very weak.

Whorls 6 to 8½, regularly increasing in size. Well rounded, hence the suture is distinct. Not margined, but sometimes delicately crenulated by the extremities of the vertical striae. Last whorl about one-third of the entire shell-length. Top obtuse, more obtuse than in *Opeas gracile*. Base rounded. Umbilicus more or less entirely closed by the columellar reflection.

Aperture vertical, or little oblique. Irregularly oval, pointed above, rounded below. Peristome not continuous, sharp, not thickened or reflected along the free margin, slightly so along the columellar margin.

Dimensions: height 10 to 12 mm, width 3½ to 4 mm, height of aperture 3½ to 4 mm.

Distribution: Originally recorded from the Bourbon Islands, but nowadays in Mauritius, Seychelles, Japan, Hawaiian Islands, probably spread by human agency. In the Malay Archipelago established in Sumatra, Borneo, Java, Bali, Celebes and Ambon. Probably also in other islands, but *Opeas clavulinum* is not always recognised as a separate species and often mixed with *O. gracile*.

Habitat in Java: living on the ground, under stones, fallen leaves, grass and among earth. Occurring from 300 to 2000 m altitude.

West Java: Leuwiliang, and Gunung Tjibodas, Tjampea, near Bogor, 300 m; Pantjoran Mas and Tjibodas, 1400 m, Tjibeureum, 1700 m, Mt. Gedeh; Mt. Gedeh, 3000 to 4000 feet; limestone mountains near Padalarang, 700 m; Mt. Tangkuban Prahū, 700 to 1000 m; Tjiwidej, SW of Bandung, 1100 m; Mt. Malabar, 1600 m; Mt. Tjikorai, 4500 feet; Pengalengan, 4000 feet; Negla, near Pengalengan, 1800 m; Tjibitung, distr. of Pengalengan, 2000 m.

East Java: Tengger Mts.; Kali Mrawan, 1000 m; Idjen Plateau, 1100 m; Kendeng, 1400 m and Ongop-Ongop, Idjen Plateau, 1850 m; Kawah Idjen-Merapi game reserve, 1600—1700 m.

Opeas clavulinum differs from *O. gracile* in being not so slender, with more impressed whorls and a more obtuse apex. Due to the close resemblance of the two species, *O. clavulinum* is not always duly recognised. Therefore the records in literature ought to be critically considered.

The samples which RENSCH (l.c. p. 108) identified as *Opeas javanicum* probably belong all to *O. clavulinum*, as goes forth from his own words: "sind relativ breiter," (than *O. gracile*) "besitzen einen stumpferen Apex und weniger Umgänge, die ersten Umgänge sind weniger gewölbt, und die Naht zwischen dem 1. und 2. Umgänge ist nur wenig vertieft. Die stark glänzende Oberfläche zeigt feine, unregelmässige, gebogene Zuwachsstreifen. Die Zahl der Umgänge schwankt bei grossen Stücken zwischen 7½ und 8½".

I could check samples from Bali and Celebes identified by RENSCH as *O. javanicum* and now preserved in the British Museum. These shells belong all to *O. clavulinum*. Probably RENSCH did not examine the original shells of "*Achatina javanica*" REEVE, for then he would have recognised these at once as identical with *Prosopéas achatinaceum* (PFR) (see under that species).

In the MOUSSON Collection at Zürich there are two shells from Sarawak, Borneo, classified as *Stenogyra achatinacea* PFR, collected by DORIA in 1869. In my opinion these shells are *Opeas clavulinum* (POT. & MICH.) and herewith the occurrence of this species in Borneo is definitely ascertained.

At present I cannot enter into the question whether or not the other samples collected by DORIA and described by ISSEL (Moll. Borneensi, 1874, p. 51) as *Stenogyra achatinacea* really belong to this species. For the Fauna of Java the problem is of no further interest.

Doubtful species of *Opeas*.

MARTENS (Ostas. Landschn. 1867, p. 374, pl. 22, fig. 10) described and figured *Stenogyra arctispira*, which he pretended to have collected himself at Anjer, a village in West Java, situated at Strait Sunda. In addition he examined one or more shells collected at Bogor by ZOLLINGER, preserved in the MOUSSON Collection.

At my request the authorities of the Berlin Museum kindly sent me on loan three shells of MARTENS' original lot of six. They have the following dimensions:

height	6.9	6.8	6.3	} mm
width	2.7	2.7	2.7	
height of aperture	1.6	1.6	1.6	
number of whorls	7½	7½	7	

The shells agree exactly with the diagnosis and figure in the above quoted monograph of MARTENS, but they are undoubtedly not a Malaysian species, but the West Indian, Central and South American *Opeas beckianum* (PFEIFFER).

MARTENS himself already noticed the similarity of his new species with *Stenogyra caracasensis* REEVE (a synonym of *Opeas beckianum*), but—probably on account of the entirely different areas of distribution of his species and *St. caracasensis*—he did not arrive at considering them identical.

An explanation for the incompatibility of shell and locality cannot be more than guess work. Although supporting evidence for such a contention can not be given, it is my opinion that some unfortunate mislaying of labels must have taken place, the *beckianum* shells having been allocated the false locality Anjer, which led MARTENS to his inopportune description.

PILSBRY (Man. of Conch. (2) 18, p. 175, pl. 19, fig. 25, 1906) simply translated MARTENS' diagnosis and discussion without further comment. Probably he did not examine the original sample, or else—with his knowledge of American species—he would certainly have recognised them as *Opeas beckianum*.

Stenogyra arctispira MARTENS was also quoted by TENISON WOODS (1888, Proc. Linn. Soc. N.S.W. (2) 3, p. 1051).

Further confusion was added by the fact that the shell from Bogor, collected by ZOLLINGER in 1857 and lying in the MOUSSON Collection in Zürich under the name *Stenogyra arctispira* MARTENS, is not *Opeas beckia-*

num but *Ena glandula* (MOUSSON) (see there). This specimen is probably a synonym, if not the real type specimen, of MOUSSON's *Stenogyra densespirata* (Journ. de Conch. 6, 1857, p. 159). It agrees at least entirely with the original description.

Another problematic sample is the lot collected at Wonosari, East Java, by ZOLLINGER in 1856, and now preserved in the MOUSSON Collection at Zürich under the name *Bulimus javanica* REEVE. These shells were mentioned by MARTENS (Ostas. Landschn. 1867, p. 377) as *Stenogyra javanica* REEVE, together with samples from Java, Adonare, Ternate and Ambon.

In the paragraph treating *Prosopeas achatinaceum* (PFR), I will explain that the type specimen of "*Achatina*" *javanica* REEVE from Java (now in the British Museum) is an indubitable *Prosopeas achatinaceum*. But does this apply to MARTENS' other references also?

By the courtesy of the authorities of the Zürich Museum I could check the sample from Wonosari, and I found that they belong to quite another species, *Opeas ternatanum* BOETTGER, sometimes called *Curvella ternatana* (BOETTGER).

Moreover the specimen which MARTENS figured on pl. 22, fig. 11 came from Ternate (see Explanation of Plates, p. 447) and—although the figure is not satisfactory—it is certainly more like *Opeas ternatanum* than *Prosopeas achatinaceum*. Of the other localities: Flores, Adonare and Ambon I cannot give an opinion, as I have not seen the samples.

Probably it will for always remain a myth how specimens of the Moluccan species *Opeas ternatanum* ever reached Wonosari in East Java. If any confounding of labels is to be excluded, we can only suppose that these 13 shells were at one time introduced incidentally. After the year 1856 no more material has been discovered. So long as we have no more definite evidence for its occurrence in Java, *Opeas ternatanum* can, in my opinion, better be eliminated from the fauna of Java.

Genus *Prosopeas* MÖRCH, 1876

Shell turreted, with numerous whorls. Corneous to greenish. Finely sculptured with close-set, minutely lamellose, vertical striae, arching forward in the middle of each whorl. Top whorls of some species more coarsely sculptured by distantly placed ribs. Surface not polished, but with soft, silky lustre. Not transparent.

Whorls of the spire little convex, the top whorls somewhat more. Base rounded. Umbilicus narrow or closed.

Aperture small, compared to the high spire. Peristome not continuous, exterior margin sharp, not reflected. Columellar margin vertical or excavated, not truncated at its lower end, but evenly merging into the basal margin.

Radula with small tricuspid central tooth. Laterals tricuspid with a large central cone. In the tricuspid marginals the central denticle is much smaller (fig. 54).

Eggs large, spherical, with calcareous shell.

Distribution: Tropical regions of Asia, from India to the Malay Archipelago and the Philippines.

In Java there are two species:

1. Top whorls with special sculpture of distantly placed ribs. Shell very long and slender **acutissimum**
- Top whorls without special sculpture of distantly placed ribs. Shell not so long and slender **achatinaceum**

Prosopeas achatinaceum (PFEIFFER, 1846) (fig. 58).

1846 PFEIFFER, Symbolae, 3, p. 82 (*Bulimus*).
 1848 MOUSSON, Mitt. naturf. Ges. Zürich, 1, p. 266 (*Bulimus*).
 1849 MOUSSON, Land & Süsw. Moll. Java, p. 35, pl. 4, fig. 4 (*Bulimus*).
 1849 REEVE, Conch. Icon. 5, pl. 17, no. 79 (*Achatina javanica*).
 1860 ZOLLINGER, Natuurk. Tijdschr. Ned. Indië, 21, p. 318 (*Bulimus*).
 1867 MARTENS, Ostas. Landschn. p. 375, pl. 22, fig. 9 (*Stenogyra*) and p. 377 *Stenogyra javanica*) only the sample from Java, REEVE.
 1888 TENISON WOODS, Proc. Linn. Soc. N. S. W. (2) 3, p. 1052 (*Stenogyra*) and p. 1053 (*Glessula javanica*).
 1892 MARTENS, Erg. Reise N. O. Indien, 2, p. 243 (*Stenogyra acutissima* MRTS non PFR and *St. achatinacea*).
 1906 PILSBRY, Man. of Conch. (2) 18, p. 21, pl. 5, fig. 40, 41 (*Prosopeas achatinaceum*) and p. 138, pl. 12, fig. 14, 16, pl. 16, fig. 88, (*Opeas javanicum*) (not pl. 16, fig. 81 and pl. 22, fig. 9).
 1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 214 and 237 (*Prosopeas achatinaceum*) and p. 238 (*Opeas javanicum*-only the first reference).
 1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 113-115.
 1934 RENSCH, Trop. Binnengew. 4, p. 756-757.
 1935 PARAVICINI, Arch. Moll. Kunde, 67, p. 173.
 1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 300.

Shell high-turreted, with numerous whorls, rather solid. Yellowish or greenish, or brownish, with soft silky or waxen lustre; hardly or not transparent. Vertical striation distinct, in fresh specimens as close, thread-like ribs. The top whorls are not sculptured differently, as in *Pr. acutissimum*. Spiral striae very weak.

Whorls 8 to 9, the young ones slowly increasing in size and with well-curved profile, the later ones more rapidly increasing in size and with flatter sides. Last whorl about $\frac{1}{3}$ of the entire shell-length. Suture distinct, not margined. In fresh shells the entire surface is coated with a straw-coloured, fibrous epidermis, rendering the surface a "velvety" appearance. In this epidermis dust and mud are easily accumulating, hiding the shell from the eye. Top pointed, but not sharp. Base rounded. Umbilicus hair-like in immature shells, but closed in adult ones.

Aperture somewhat oblique. Irregularly oval, pointed above, rounded below. Peristome not continuous, the free margin sharp, not thickened or reflected. Columellar margin slightly reflexed and adnate.

Dimensions: height 12 to 14 mm, width 4 mm, height of aperture 4 mm.

Distribution: Sumatra, Pulu Weh, Borneo, Java, Sebesi, Bawean, Nusa Kambangan, Bali, Lombok, Timor, Saleyer, Caroline Is., Hawaiian Is.

Habitat in Java: moss fauna, under dead wood and other vegetable debris, in the plains and in mountainous country. Recorded between sea-level and 1800 m altitude.

West Java: cocoonut gardens near Pasauran, sea-level; Djakarta, 10 m; Kuripan, near Bogor, 200 m; Depok, 100 m; Pardana (MOUS-SON); Tjiseëng; Bogor, various town gardens, 250 m; Mt. Gedeh, 4000 feet; Sukabumi, 700 m; Djampang, 700 m; Mt. Masigit, near Padalarang, 500 m, and surrounding hills, 680—700 m; Bandung, various town-gardens 700—800 m, and Lembang Rd, 900 m; Purwakarta, 250 m; Mt. Ardjuno, 1800 m.

Central Java: Salatiga, 580 m; Kali Besèk, near Sulang, 50 m.

East Java: Ranu Bedali, 100 m, (RENSCH, 1934); Djabung, near Wlingi, 800 m; Malang, 500 m; Tengger Mts; Kalisat-Kalibaru Rd, near Djember, 450 m; Durdjo Estate, near Djember, 600 m.

For many years it has been uncertain what *Opeas javanicum* (REEVE, 1849) is like. The original diagnosis and accompanying figure (Conch. Icon. 5, no. 79) are not very satisfactory. Of the modern authors PILSBRY (Man. of Conch. (2) 18, 1906, p. 138) redescribed the species. Although he does not seem to have examined the type lot — at least he does not explicitly say so — his suggestion that *O. javanicum* has the sculpture of the members of the *Prosopias achatinaceum* group, is certainly right. Of his *javanicum* figures, pl. 12, fig. 14 and 16 as well as pl. 16, fig. 88 represent *Pr. achatinaceum*. The other figures attributed by him to *O. javanicum* (Pl. 16, fig. 81 and pl. 22, fig. 9) resemble more *Opeas clavulinum* (POT. & MICH.).

Several years later RENSCH brought *O. javanicum* into the relationship of *O. gracile* (1932, Zool. Jahrb. (Syst.) 63, p. 108). From his discussion, however, it is evident that he meant *O. clavulinum* (POT. & MIÇH.). This conclusion is confirmed by the samples from Bali and Celebes, identified by RENSCH as *O. javanicum* which were kindly sent to me on loan by the authorities of the British Museum. Both samples were *O. clavulinum*.

By the kind permission of Mr W. J. REES I could also examine the holotype and one paratype of *Achatina javanica* REEVE from Java. There is no doubt that they belong to *Prosopeas achatinaceum* (PFR). The measurements of these two shells are:

	type	paratype	
height	10.95	10.75	} mm
width	3.85	3.65	
height of aperture	3.75	3.50	

As *Prosopeas achatinaceum* has three years priority over *Achatina javanica*, the species ought to bear the first name.

Five other specimens from Hilo (Hawaiian Is.) identified as *Opeas javanicum* (REEVE) and now preserved in the Brussels Museum, are equally *Prosopeas achatinaceum*. Hilo is the type locality of *Opeas henshawi* SYKES, 1904, a synonym of *Opeas javanicum* = *Prosopeas achatinaceum*.

The shells from Wonosari, East Java, collected by ZOLLINGER, 1856, and identified as *Bulimus javanica* RVE and now preserved in the MOUSSON Collection at Zürich (MARTENS, 1867, p. 377), are not this species, but *Opeas ternatanum* BOETTGER (see under Doubtful species of *Opeas*).

***Prosopeas acutissimum* (MOUSSON, 1857) (fig. 54 and 57).**

- 1857 MOUSSON, Journ. de Conch. 6, p. 159 (*Bulimus*).
- 1859 ZOLLINGER, Natuurk. Tijdschr. Ned. Indië, 18, p. 424 (*Bulimus*).
- 1867 ZELEBOR, in: PFEIFFER & ZELEBOR, Verh. Zool. Bot. Ges. Wien, 17, p. 806 (*Bulimus acutissimus* and *B. hochstetteri*).
- 1867 MARTENS, Ostas. Landschn. p. 373 (*Stenogyra laxispira* ?syn. *Bulimus acutissimus*, only the reference, Java, bei Buitenzorg).
- 1888 TENISON WOODS, Proc. Linn. Soc. N. S. W. (2) 3, p. 1052 (*Stenogyra acutissima* and *St. hochstetteri*).
- 1890 BOETTGER, Ber. Senckenb. naturf. Ges. p. 147.
- 1892 MARTENS, Erg. Reise N. O. Indien, 2, p. 243.
- 1897 MOELLENDORFF, Nachr. Blatt, 29, p. 72 (*holosericum* and *hastatum*).
- 1906 PILSBRY, Man. of Conch. (2) 18, p. 22, pl. 3, fig. 85, 86, 87, 88 (*acutissimum*), p. 23, pl. 3, fig. 89-91 (*acut. var. hastatum*), p. 23 (*hochstetteri*) and p. 24, pl. 3, fig. 93, 94 (*holosericum*).
- 1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 237 (*acutissimum*, *acut. var. hastatum*, *hochstetteri* and *holosericum*).

- 1925 VAN BENTHEM JUTTING, Treubia, 6, p. 143 (*Prosopeas turricula*, non *turricula* MARTS).
- 1929 VAN BENTHEM JUTTING, Treubia, 11, p. 80 (*Prosopeas acutissimum*, *acut.* var. *hastatum*, *hochstetteri*, *holosericum*, *turricula* non *turricula* MARTS).
- 1934 RENSCH, Trop. Binnengew. 4, p. 756 (*acutissimum*), and p. 758 (*holosericum*).
- 1935 PARAVICINI, Arch. Moll. Kunde, 67, p. 173.
- 1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 300 (*Prosopeas turricula* non *turricula* MARTS).

Shell very long and slender, with numerous whorls, rather solid. Yellowish or greenish, with soft, silky lustre, hardly or not transparent. Vertical striation distinct, in fresh specimens as fine thread-like ribs. The first half whorl is smooth; on the two following ones the ribs stand wider apart and are somewhat coarser than on the rest of the shell. Spiral striae distinct on the two ribbed top whorls, but weak on the following ones.

Whorls 10 to 11, regularly increasing in size. Sides of the young whorls convex, of the later ones flattened. Suture not deep, not margined. Last whorl about $\frac{1}{4}$ of the entire shell-length. Like *Prosopeas achatinaceum*, fresh shells of *Pr. acutissimum* are coated with a "velvety" periostracum. Between the fibres dust and sand are easily accumulating so that in the wood the snails are successfully camouflaged. Top obtuse, base rounded. Umbilicus hair-like in immature shells, but closed in adult ones, covered by the narrow reflexion of the columellar side.

Aperture somewhat oblique, irregularly oval, pointed towards the top and broader at the base. Peristome not continuous. Exterior margin sharp, not thickened or reflected. Columellar margin slightly reflected.

Dimensions: height 24 to 34 mm, width 5 to 8 mm, height of aperture 6 to 9 mm.

Distribution: Sumatra, Java, Sebesi I.

Habitat in Java: under stones, dead leaves, decaying wood, in hilly and mountainous country, between 250* and 2200 m altitude.

West Java: Mt. Karang, near Tjinjurup, 700 m; waterfall Tjianten, near Leuwiliang, 300 m; Gunung Tjibodas, Tjampea, near Bogor, 300 m; Mt. Salak; Bogor, 250 m; Tjigombong, 500 m (PARAVICINI); forest near Puntjakpass, 1500-1600 m; Mt. Gedeh, 4000 to 7000 feet; Tjibodas and Pantjoran Mas, near Rarahan, Mt. Gedeh, 1400 m; waterfalls Tjibeureum, Mt. Gedeh, 1700 m; limestone hills Mts Masigit and Pawon, near Padalarang, 500-700 m; Pasir Babeasan, in small cave in limestone hill 800 m; limestone hill near Sukanegara, 1000 m; Sukabumi, 700 m; Garut, 700 m; Tjisurupan, near Garut, 3500-5000 feet; Tjibulu near Tjikadjang,

Mt. Papandajan, 1500 m; Tjibitung, near Pengalengan, 2000 m; Mt. Tjikorai; Ardjamanik, N of Bandung; Lembang Rd, near Maribaja, 1000 m; Maribaja, 1100 m.

Central Java: Tegal Pangonan, Dieng Plateau, 2200 m; Dieng (RENSCH, 1934).

East Java: Tengger Mts, 4000 feet; Mt. Ardjuno, 5600 feet.

The species is rather variable; hence it can be understood that specimens of different ages and from different localities have been described as separate species. I could compare the type from Bogor (collected by ZOLLINGER, 1856, Collection MOUSSON, Zürich) and a paratype from "Java" (Mus. Senckenberg, no. 63884) of *Pr. acutissimum*. In addition I examined type and paratypes of *Pr. hastatum* MOELLENDORFF (Mus. Senckenberg, no. 63864 (type) and no. 63865 to 63866 (paratypes)), and of *Pr. holosericum* MOELLENDORFF (Mus. Senckenberg, no. 63868 (type) and 63869 to 63874 (paratypes)). Besides I had before me a large material from various stations, and even some hundreds of specimens from one locality (near waterfalls of Tjibeureum, 1700 m).

Unfortunately I could not compare authentic specimens of *Prosopeas hochstetteri* (ZELEBOR), but judging from the diagnosis it must also be a member of the *acutissimum* group.

This has led me to the conclusion that *hochstetteri*, *hastatum* and *holosericum* are all variants of *Prosopeas acutissimum*. *Pr. hastatum* is probably the fully mature form, the highest specimen attaining 34 mm height and 8 mm width, with an aperture of 9 mm height.

It is a curious fact that PILSBRY (1906) obviously overlooked the descriptions by MOELLENDORFF of *Prosopeas holosericum* and *Pr. hastatum*. Nine years after their first christening PILSBRY described them as new, with the same names, after similar material.

The shells from Sebesi I, which I identified as *Prosopeas turriculum* (Treubia, 6, 1925, p. 143 and Arch. néerl. Zool. 5, p. 300, 1941), on renewed investigation, have proved to belong to *Pr. acutissimum*.

The real *Pr. turriculum* of which I saw six shells from Batu Caves, near Kuala Lumpur, Malaya (VAN BENTHEM JUTTING, Bull. Raffles Mus. no. 19, 1949, p. 63), are very similar to *Pr. achatinaceum*. They only differ in such details as were described by MARTENS (Ostas. Landschn. 1867, p. 83).

In the MOUSSON Collection at Zürich there are three shells from the Batak Mountains, C. N. Sumatra, classified as *Stenogyra laxispira* MARTS, collected by MOESCH in 1859. In my opinion these are also *Pr. acutis-*

sinum, and herewith the occurrence of this species in Sumatra has definitely been established.

The eggs of *Prosopias acutissimum* are enveloped in a white calcareous shell. Their surface is minutely pitted, sometimes confluent into a delicate meandering sculpture. Their diameter is 1½ mm.

Familia ACHATINIDAE

Large, or very large, and solid shells. With a pyramidal spire and inflated last whorl. Ground-colour whitish or brownish, ornated with irregular zig-zag stripes of darker colour. Columella truncated below. Umbilicus closed.

Aperture broadly oval, white, bluish or pink inside.

Sexual system without accessory organs, like flagellum, digitiform glands, dart-sac and dart.

In the radula the rhachis is narrow, with one small cusp. Laterals and marginals bi- or tricuspid. Mandibula horse-shoe-shaped, striate.

Distribution: tropical and subtropical Africa and adjacent islands: Madagascar, Mascarenes, Mauritius, Reunion. One species, *Achatina fulica*, has been introduced in almost all countries of tropical Asia, Malaysian and Pacific islands. Recent occasional introduction into California has been successfully combated (ABBOTT, 1949, Nat. Hist. 58, p. 68).

Genus *Achatina* LAMARCK, 1799

Large to very large and solid shells. With pyramidal spire and capacious last whorl. White or brown, with regular or irregular markings of a contrasting colour. Coarsely striated, sometimes malleated, or with reticulate sculpture. Not or little transparent. Umbilicus closed, columella truncated at the base.

Aperture broadly oval, white, bluish or pink inside. Peristome not continuous, the two ends connected by a thin callus against the parietal wall. Exterior margin sharp, in fully mature specimens somewhat thickened, but never reflected.

Animal hermaphroditic. Genital organs without such appendages as flagellum, digitate glands or dart-sac and dart. Most species are oviparous, but some are ovo-viviparous. Eggs small, numerous, with calcareous shell. They are deposited in loose earth.

Radula ∞ .1. ∞. Central tooth unicuspid (in the youngest stages of some species tricuspid, compare PEILE, Proc. Malac. Soc. 22, 1937, p. 189). Latero-marginals tricuspid. Mandibula horse-shoe-shaped (fig. 2).

Distribution: tropical and subtropical Africa. *Achatina fulica* has been introduced in almost all countries of tropical Asia. In Africa some species are eaten by the natives.

In Java there is only one species:

***Achatina fulica* BOWDICH, 1822 (fig. 2 and 60).**

Popular names: Keong Singapore, Keong Bekitjot, Keong Ratjun (ratjun = poison).

1821 FÉRUSAC, Hist. Nat. génér. & partic. Moll. Tabl. Limaçons, p. 53 (*Helix* (*Cochlitoma*)) nomen nudum.

1822 BOWDICH, Elements of Conch. 1, pl. 13, fig. 3.

1904 PILSBRY, Man. of Conch. (2) 20, p. 55-58, pl. 36 and 37.

1933 LATIF, De Orchidee, 2, p. 117, 123, 147, 151.

1933 LEEFMANS, Landbouw, 9, p. 289-298.

1933 LEEFMANS & VAN DER VECHT, Alg. Landb. Weekbl. Ned. Indië, 17, p. 878-881, 1 fig.

1933 LEEFMANS & VAN DER VECHT, Landbouw, 8, p. 1-10 (sep.).

1933 LEEFMANS & VAN DER VECHT, Bergcultures, 7, p. 579-584.

1934 VAN BENTHEM JUTTING, Journ. of Conch. 20, p. 43.

1934 LEEFMANS, Bergcultures, 8, p. 3-6.

1935 VAN DER MEER MOHR, Natur & Volk, 65, p. 62-67, 8 fig.

1937 HEUBEL, Bergcultures, 11, p. 1667.

1937 LATIF, Alg. Landb. Weekbl. Ned. Indië, 21, p. 701-702.

1948 VAN WEEL, Chronica Naturae, 104, p. 241-243 and 335-336.

1949 HES, Chronica Naturae, 106, p. 226-227, fig. 1.

1949 VAN DER MEER MOHR, Chronica Naturae, 105, p. 290.

1949 VAN DER MEER MOHR, Treubia, 20, p. 1-10.

1950 BEQUAERT, Bull. Mus. Comp. Zool. 105, no. 1, p. 69.

1950 KALSHOVEN, Plagen Cultuurgew. Indon. 1, p. 50-59, fig. 16-18.

1950 VAN DER MEER MOHR, Chronica Naturae, 106, p. 97-98, 3 fig.

1950 REES, Proc. Zool. Soc. London, p. 580.

1951 VAN BENTHEM JUTTING, Treubia, 21, p. 111, fig. 1-3.

1951 GARNADI, Hemera Zoa, 58, p. 279.

Shells large, solid, pyramidal with produced spire and rounded base. Ground colour light yellow or fawn, ornated with irregular brown or mauve vertical bands, streaks or blotches under a greenish-yellow epidermis. With soft lustre, little or not transparent. Coarsely striated in vertical direction. To-

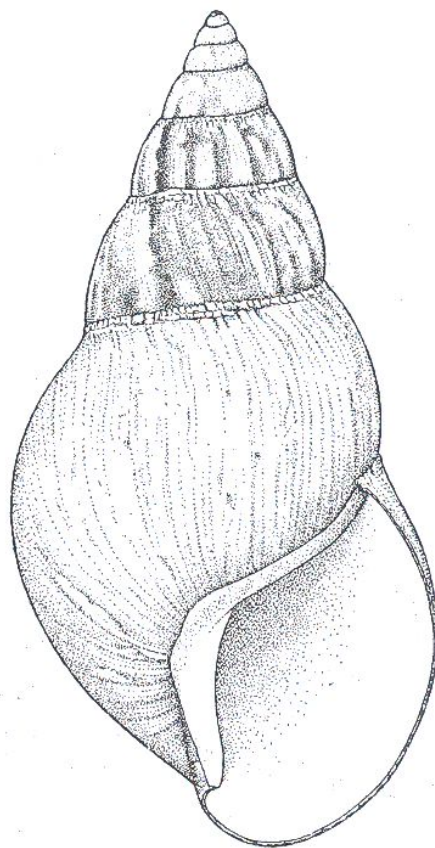


Fig. 60. *Achatina fulica* BOWDICH. Shell. SISWOHAMIDJOJO del.

wards the suture and towards the aperture the striae become almost rib-like. In many specimens there is a finer spiral sculpture also, especially on the whorls of the spire, rendering this part of the shell a decussated appearance. The whole is covered by a yellowish or brownish periostracum which peels off easily.

Whorls 7 to 9, rapidly increasing in size, moderately convex. The last one large and rather inflated. Top whorls smooth. Umbilicus closed, even in young individuals. Suture irregularly crenulated, occasionally lightly margined.

Aperture somewhat oblique, broad-oval, pointed above and below. Height of aperture shorter than the spire. Peristome not continuous, the two ends connected by a thin, white callus against the parietal wall. Outer margin sharp, not thickened or reflected. Interior white or bluish-white. In the interior of young shells the flames of the outside colour pattern are shining through. Columellar margin thickened, slightly tortuous longitudinally and truncated at the lower end.

Dimensions: height 100 to 130 mm, in exceptional cases till 170 mm, width 45 to 60 mm, height of aperture 50 to 55 mm.

Distribution: East Africa, Madagascar, Reunion, Mauritius, India, Ceylon, Malaya, Siam, S. China, S. Japan, Sumatra, Java, Borneo, Celebes, several Lesser Sunda Is., New Guinea, Philippines, Guam, Saipan, Tinian Is., New Britain, New Ireland, Hawaiian Is., Palau Is., Okinawa, S. California (ABBOTT, 1948, *Nautilus*, 62, p. 31 and 1949, *Nat. Hist.* 58, p. 68; BEQUAERT, 1950, l.c.; BOETTGER, 1951, *Abh. Braunschw. Wissensch. Gesellsch.* 3, p. 10).

Habitat in Java: *Achatina fulica* has a predilection for plantations, vegetable gardens, refuse heaps etc. where it feeds on fresh and decaying plants, not even respecting such well-armed plants as *Opuntia* and *Euphorbia*. It is sometimes found eating latex in rubber plantations (FEY, 1940, *Bergcultures*, 14, p. 1112). The animals do not even despise carrion and faeces. Locally some serious damage is done in horticulture and agriculture (LATIF, 1933 and 1937; LEEFMANS & VAN DER VECHT, 1933; HEUBEL, 1937; VAN DER MEER MOHR, 1949; HES, 1949; KALSHOVEN, 1950; GARNADI, 1951).

Generally they live on the ground, but occasionally they climb tree trunks. In the dry season they hide away in the soil, retract in their shells and close it with a thin epiphragm. The snails lead a nocturnal life (REES, 1950).

Achatina fulica inhabits the lower altitudes: lowland plains and hilly country up to about 1000 m altitude, mostly in or near human settlements. It has not been found in truly "wild" conditions, and not in tropical rain forest or in the higher mountains.

VAN WEEL (1948, p. 335) reported that the youngest stages feed on decaying matter, now and then mixed with unicellular algae. Animals with shells between 5 and 30 mm height prefer living plants. In this period they are most dangerous for plantations and gardens. The adult snails, although not quite neglecting living vegetation, turn to the scavenging habit again.

Their own putrifying bodies are a favourite diet of the maggots of certain morbid carrying flies. Therefore it is not imaginary that the snails indirectly cause some additional inconvenience by transmitting diseases from one place to another (SMEDLEY, 1928, *Malayan Natural.* 2, p. 47).

For the production of their substantial shells the Giant African Snail needs a considerable amount of lime. They do not only take it through lime containing food-plants, but also by rasping off free calcareous matter (of rocks, mortar etc.). In regions where the soil is poor in lime the snails lap off the whitewash from the walls of buildings (WITKAMP, 1941, *De Trop. Natuur*, 30, p. 105). This need of lime is turned to account in combating the snails by offering them stones or bags with poisoned lime.

Eggs are spherical to oval (VAN DER MEER MOHR, 1935), with a white or yellow calcareous shell. Their diameter is on the average $5 \times 4\frac{1}{2}$ mm. They are deposited in the ground, in "pockets", under fallen leaves, stones, old ironware etc. in clusters of several scores to 400 or even more of one spawning animal, probably several times a year. The number of eggs depends largely on the age of the animal. The eggs stick together by means of a hyaline mucus.

The eggs generally hatch in about a fortnight, under favourable conditions in a few days, under adverse conditions in 4 to 5 weeks (LEEFMANS, 1934; HEUBEL, 1937; VAN DER MEER MOHR, 1949, VAN WEEL, 1948, p. 336). All eggs of a cluster can hatch simultaneously, or this can take 2 to 3 days (VAN DER MEER MOHR, 1949, p. 5). A large percentage of the eggs is infertile.

On hatching the young *Achatina fulica* has an entirely transparent shell of 2 to $2\frac{1}{2}$ whorls. VAN WEEL (1948, p. 336) observed that the hatching took from 6 to 10 hours.

Young snails grow rapidly after hatching. In six months their shell can attain a length of 10.5 cm (LEEFMANS, 1934) under favourable circumstances.

Adult snails are figured by LEEFMANS & VAN DER VECHT (1933), by VAN DER MEER MOHR (1935) by VAN BENTHEM JUTTING (1951) and by GARNADI (1951). The second publication contains also a figure of a pair in copula.

Although the animals are hermaphroditic, self-fertilization has never been observed (VAN WEEL, 1948). Yet VAN DER MEER MOHR (1949) is inclined to accept this mode of reproduction as possible, and KALSHOVEN (1950) accepts it as pretty sure. A single specimen kept in captivity for 9 years never produced eggs (DOCTERS VAN LEEUWEN, 1932, Hongkong Natural. 3, p. 71). Hence no offspring can be expected in case one single specimen should reach a new territory, unless the animal is gravid. Copulation takes place early in the morning and lasts from one to several (6 to 8, or even 12) hours (VAN WEEL, 1948, p. 336; VAN DER MEER MOHR, 1949; GARNADI, 1951). Eggs are laid 2 to 3 weeks or 1 to 3 months (dependent on the weather conditions) after mating.

The adolescent *Achatina* reaches maturity at an age of 7-8 months (VAN WEEL, 1948, p. 336). According to VAN DER MEER MOHR (1949) no animals under 60 mm height were found mating.

Observations on the total duration of life are somewhat contradictory. The above mentioned animal of DOCTERS VAN LEEUWEN kept in confinement for 9 years must have been several months older as it was already full grown when it was brought from Singapore.

The radula is a long, broad band, about 12 mm long in adult animals. There are some 120 rows of teeth. Each transverse row bears 70-170 teeth (VAN BENTHEM JUTTING, 1951).

The mandibula is horse-shoe-shaped without a median projection (fig. 2).

Anatomical dissections were recently carried out by MEAD (1950, Bull. Mus. Comp. Zool. 105, p. 236, and by VAN BENTHEM JUTTING, 1951). Accessory organs of the genital tract like flagellum, digitiform appendages, dart-sac, dart-gland and dart are entirely missing. VAN WEEL (1948, p. 336) reported that the penis is 3 to 5 mm long.

Some physiological experiments on resorption and production of enzymes in the glandula media intestini of *Achatina fulica* were carried out by VAN WEEL (1948, Chronica Naturae, 104, p. 310-311 and Ibid. 105, 1949, p. 53-55). A chemical analysis of the soft parts was done by VAN WEEL (1948, Chronica Naturae, 104, p. 280). One might even wonder that the Giant African Snail which is so easy to dissect and to keep in captivity has not been employed more for anatomical and physiological studies.

Originally *Achatina fulica* is an inhabitant of Madagascar and a few adjacent islands. Towards the middle of the 19th century (1847) it was introduced by man into India (Calcutta and vicinity). From here it has been transported to Ceylon, Malaya and Sarawak. In 1933 they were recorded in the Rhio Archipelago (LATIF, 1933) and afterwards in Java (LEEFMANS & VAN DER VECHT, 1933; LEEFMANS, 1934; VAN BENTHEM JUTTING, 1934; LATIF, 1937; VAN WEEL, 1948), Sumatra (VAN DER MEER MOHR, 1935, 1940, Trop. Nat. 29, p. 145, 1941, Trop. Nat. 30, p. 173) and Borneo (WITKAMP, 1941, Trop. Natuur, 30).

Of the present distribution in Java the following localities are recorded:

West Java: Serang, 20 m (HEUBEL, 1937); rubber estates in Bantam (HEUBEL, 1937); Tangerang, sea level (HEUBEL, 1937); Tandjong Priok; Djakarta (LEEFMANS, 1933, HEUBEL, 1937); Depok, 100 m; Bogor and environs, 100—250 m; Sukabumi, 700 m; Pelabuanratu, sea-level; Njalingdung, Djampang, 950 m; Sageranten, Djampang, 500 m; Mt. Malang, East Djampang, 1000 m; Tjimahi, 740 m; Bandung and Tandjong, 700—860 m; Purwakarta, 250 m.

Central Java: Cheribon, (HEUBEL, 1937); Kedungwuni, 75 m; Doro, 100 m; Semarang, (KALSHOVEN, 1950); Karangputjung, 150 m; Demak, 100 m.

East Java: Tjaruban, 75 m; Ngandjuk, 60 m; Djombang, 50 m; Kediri, 65 m; Pare, 140 m; Kadongan, near Pare, 180 m; Blitar, 160 m; Wlingi, 250 m; Modjokerto, 25 m; Surabaya, sea-level; Tretes, Mount Welirang, 790 m; Mt. Ardjuno, 900—1000 m; Lawang, 490 m; Singosari, 495 m; Blimbing, near Singosari, 470 m; Malang, 500 m; Winongan, 50 m; Kraksaan, 30 m; Besuki, sea-level.

During the Japanese occupation of the Malay Archipelago (1942-1945) *Achatina fulica* was purposely introduced for food in several internment camps. The once so highly despised snail now became an appreciated source of animal protein for the starving prisoners. In this way it was transported from island to island and has rapidly conquered new areas, acclimatizing perfectly in its new surroundings.

For the benefit of agriculture and horticulture the combating of the Giant African Snail must be continued with undiminished energy. Besides picking with the hand and drowning the snails in boiling water, other means of destruction, chiefly with chemicals, have been recommended (LEEFMANS & VAN DER VECHT, 1933; LEEFMANS, 1934; VAN BENTHEM JUTTING, 1934, HEUBEL, 1937; HES, 1949; REES, 1950; GARNADI, 1951; BEELEY, Journ. Rubber Res. Inst. Malaya, 8, 1937-1938, p. 130).

In nature the snails are eaten by wild pigs, rats and birds (VAN DER MEER MOHR, 1935; KALSHOVEN, 1950). VAN WEEL (1949, *Chronica Naturae*, 105, p. 25) mentioned a fly. An orchid fancier in Malang, East Java, once observed an *Achatina* being attacked by two little caterpillars. The caterpillars were 10 to 12 mm long, somewhat flat, with black and white segments and orange head. GARNADI (1951, p. 292) reported that the frog *Rana tigrina* DAUD. occasionally eats *Achatina* eggs. Other enemies, not from the Malay Archipelago, were mentioned by REES (1950). In plantations in New Britain experiments were made with control of eggs and young of *Achatina fulica* by *Hyalinia cellaria* and some Australian *Rhytida* (J. HOPE MACPHERSON, in litt.).

In Sumatra, not far from Medan, VAN DER MEER MOHR (1950) on various occasions observed *Achatina fulica* congregating in ditches and pools by deliberately entering the water. As soon as the water becomes too deep, the snails automatically rise to the surface. If they fail to reach a firm object to cling to, they finally succumb by drowning. An explanation of this curious behaviour cannot be given. It was not the search for special food, green algae, which forced them to enter the water, because the animals refused algae in feeding experiments.

Various collectors of *Achatina* (*A. fulica* as well as other species) report that malformations and monstrosities of the shells often occur. This may be explained by an observation of VAN WEEL (1948, p. 336) that "snails which have ascended trees, walls, etc. do not climb back the way they have come, but let themselves drop down. Although a well developed shell can withstand an enormous pressure, the sharp knock when reaching the ground often causes it to crack open". This procedure was also observed by GARNADI (1951). The smashed snail is capable to repair its damaged shell, but it is likely that malformations can originate in this way. An example with a carinate, "shouldered" shell was found by HUBERT (1948, *Chronica Naturae*, 104, p. 192).

Familia ENDODONTIDAE

Shell mostly small, flat or slightly conical, cream colour, corneous or brown, in some species with dark-brown flames. Last whorl rounded or carinated. Umbilicus wide, or moderately wide.

Aperture toothless or dentate. Peristome sharp, or a little thickened.

Animal hermaphroditic. Mandibula polyplacognathous or aulacognathous. Radula $\infty . 1 . \infty$, central tooth and laterals tricuspid, marginals tri- or multicuspid (fig. 61).

Distribution: occurring all over the world, in the tropics, the temperate and arctic regions of both hemispheres.

In Java there are three genera. In the following key the genus *Stenopylis*, although it does not occur in Java, is included, because it has been observed in several of the little satellite islands off the northcoast of Java.

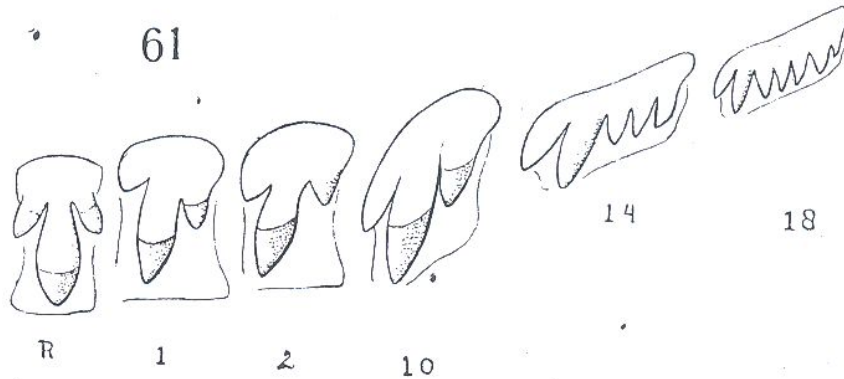


Fig. 61. *Philalanka thienemanni* RENSCH. Radula elements.
Author del.

- | | | |
|----|--|-------------------|
| 1. | Aperture of shell toothless | 2 |
| — | Aperture of shell with teeth | 3 |
| 2. | Shell almost entirely flat | Charopa |
| — | Shell conical | Philalanka |
| 3. | Shell radially ribbed | Ptychodon |
| — | Shell with spiral sculpture | Stenopylis |

Genus *Charopa* ALBERS, 1860

Shell small to very small, spire flat or a little elevated, in some species even concave. Brownish to corneous, sometimes flamed with reddish brown streaks and blotches. Most species ribbed radially.

Whorls flat or convex. Last whorl descending in some species. Periphery rounded or angular. Suture generally deep. Umbilicus wide in most species.

Aperture without teeth. Peristome not continuous, sharp, not reflected.

Animal hermaphroditic. Radula ∞ . 1. ∞ . Rhachis and latero-marginals tricuspid.

Distribution: Java, Celebes, Ambon, New Guinea, Australia, various Polynesian Islands, New Zealand.

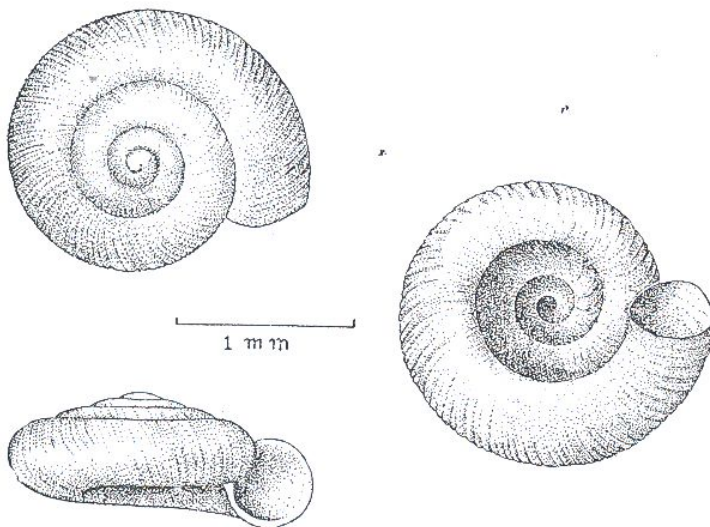
In Java only one species:

Charopa (Discocharopa) microdiscus VAN BENTHEM JUTTING, 1951 (fig. 62).

1951 VAN BENTHEM JUTTING, *Basteria*, 15, p. 28-29, fig. 1.

Shell very small, discoidal, the spire in immature shells not, in adult ones hardly emerging. Cream-colour, transparent. From the very beginning radially ribbed with delicate, closely placed riblets.

Whorls 3 to 3½, convex, regularly increasing in size. Last whorl not descending to the aperture. Periphery rounded. Suture deep. Apex in the horizontal plane, or only little projecting. Base rounded. Umbilicus very wide, showing all previous whorls.



Aperture oblique, broadly lunar to almost round. Without teeth. Peristome not, continuous, sharp, not reflected.

Dimensions: height 0.5 to 0.7 mm, width 1.0 to 1.6 mm, height of aperture 0.4 to 0.5 mm.

Distribution: Java, Celebes.

Habitat in Java:

little is known of the conditions under which this small species lives. It was found dead in the earth at the base of limestone cliffs.

West Java: Kuripan, near Bogor, 200 m.

Genus **Ptychodon** ANCEY, 1888

Shell flat, or very low conical, radially ribbed. Whorls convex, umbilicus large. Cream-colour, corneous or brown, some species with dark-brown markings.

Aperture with one or more teeth on the columellar side and sometimes also on the free margin. Peristome sharp, or a little thickened. Not or only slightly reflected.

Radula ∞. 1. ∞. Central tooth and laterals tricuspid, marginals tri- to multicuspid.

Distribution: Celebes, Misool, Timor, Sumba, Java, Philippines, various Pacific Islands, New Zealand, South Africa.

In Java only one species:

Ptychodon celebica (P. & F. SARASIN, 1899) (fig. 63).

1899 SARASIN & SARASIN, Land Moll. Celebes, p. 175, pl. 25, fig. 257. (*Endodonta*).

1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 101.

1935 RENSCH, Sitz. Ber. Ges. naturf. Freunde, Berlin, p. 322.

Shell small, spire almost flat. Greyish-brown, somewhat shining. The first $1\frac{1}{2}$ whorls striated spirally, the subsequent ones finely ribbed radially.

Whorls $3\frac{1}{2}$, convex, with deep suture. Periphery rounded. Top almost flat, base deeply excavated by the wide umbilicus, showing all previous whorls.

Aperture oblique, broadly lunar, trefoil-shaped by 4 internal teeth: a large one on the paries, and three smaller knobs on basal and palatal sides. Peristome not continuous, slightly thickened, not reflected.

Dimensions: the unique Javanese shell is high 0.8 mm, wide 1.7 mm and has an aperture of 0.6 mm height. Dimensions of a few shells from Celebes are given below.

Distribution: Celebes, Java, Sumba, Timor.

Habitat in Java: little is known of the conditions under which *Ptychodon celebica* lives in Java. Both in Celebes and in Java it was found at an altitude of 700 m and more. The specimens from Sumba and Timor were found in drift material of rivers; hence no indication of the altitude in which they originally occurred is available.

West Java: about 100 m SE of hot springs of Maribaja, near Bandung, 1100 m.

At my request Dr L. FORCART, of the Basle Museum, kindly compared the Javanese shell with the holotype from Celebes in that institute. The principal difference lies in the folds on the free margin of the aperture. There are three such folds—one basal and two palatal—in the Javanese shell, but only one—the basal fold—in the Celebes specimen. As Messrs SARASIN do not speak of a thickened peristome in their shell, and as this feature is not shown either on their plate 25, fig. 257, it seems not improbable that they had to do with an immature specimen, in which the development of the mouth armature is not complete.

This fact became the more probable since I received 8 shells of different ages of what are presumably all *Ptychodon celebica* (SAR. & SAR.), collected in South Celebes on a limestone hill along the main road from Makalé to Kalossi, at 700 to 800 m alt., in September 1948, by Mrs G. A. TAMMES née BOLT. The two youngest shells (max. diam. 1.3 and 1.5 mm)

were provided with the columellar lamella only, the five adult ones (max. diam. 1.8, 1.8, 1.9, 2.0 and 2.0 mm) each had the columellar lamellae and three folds on the free margin of the aperture, whereas the eighth shell, of intermediate age (max. diam. 1.7 mm), possessed the columellar and only one (the basal) tooth on the free edge. This last specimen was in a stage of development similar to that of the SARASIN shell, which is high 0.75 and wide 1.5 mm.

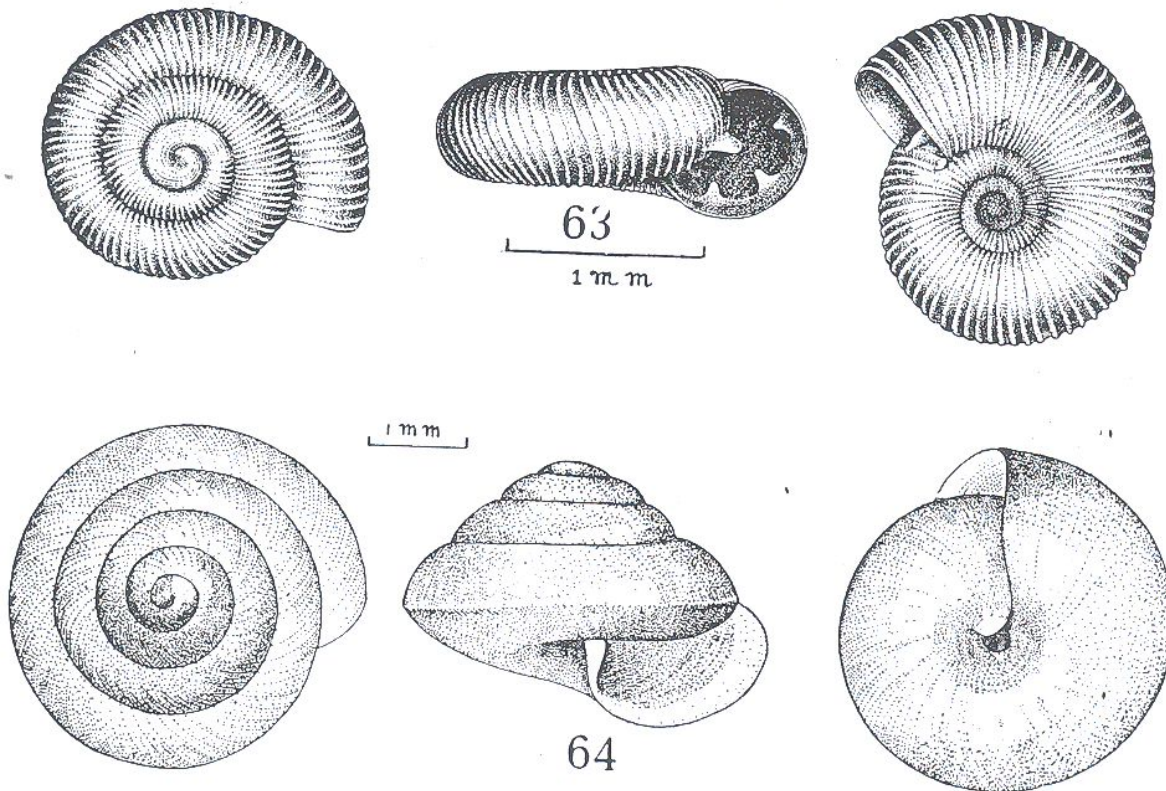


Fig. 63. *Ptychodon celebica* (SAR. & SAR.). Shell from top, side and base. ABDULKADIR del. Fig. 64. *Philalanka micromphala* n. sp. Holotype. Shell from top, side and base. Author del.

Although the Java shell was not collected alive, it has still preserved the distinct spiral lines on the first $1\frac{1}{2}$ whorls, similar to those of the holotype. RENSCH reported of his specimens from Sumba that he could not detect such sculpture, not even at strong magnification under direct light.

Genus *Philalanka* GODWIN AUSTEN, 1898

Shell globular to trochiform, glossy, hyaline, greenish, yellow or brown, many species with one or more spiral ridges. Periphery round or carinated.

Top elevated, base flat, or rounded. Umbilicus open, narrow to wide.

Aperture somewhat oblique, crescent-shaped to quadrangular. Peristome not continuous, sharp.

Animal without dart-sac and dart, or other accessory organs in the genital system. Radula $\infty . 1 . \infty$. Central tooth tricuspid, laterals bi- or tricuspid, marginals multicuspid (fig. 61).

Distribution: South India, Ceylon, Andaman Is., Batu Is., Java, Bali, Sumbá, Flores, Celebes, New Britain.

In Java there are 4 species:

- 1. Shell with two or more distinct spiral ridges 3
- Shell without spiral ridges or only one peripheral keel 2
- 2. Umbilicus narrow, shell low-conical **micromphala**
- Umbilicus wide, shell conical to high-conical **thienemanni**
- 3. Shell with 2 spiral ridges **tjibodasensis**
- Shell with 3 or more spiral ridges **nannophya**

Philalanka micromphala n. sp. (fig. 64).

Shell rather small, low-conical to moderately conical, greenish-yellow. Thin and shining, transparent. Surface with fine radial striae, crossed by still more delicate spiral lines.

Whorls $4\frac{1}{4}$ to $5\frac{1}{4}$ regularly increasing in size. Carinated at the periphery by a thread-like keel. Suture rather deep. Top angle wider than in *Philalanka thienemanni*. Base rounded. Umbilicus narrow for the genus, much narrower than in *Ph. thienemanni*.

Aperture broad sickle-shaped to quadrangular, oblique. Peristome not continuous, sharp, the columellar side hiding part of the umbilicus.

Dimensions: height 2.1 to 2.7 mm, width 3.0 to 3.4 mm, height of aperture 1.1 to 1.2 mm.

Distribution: Java.

Habitat in Java: Only recorded from Mt. Tjikorai, West Java, 2500 m (holotype) and 2800 m (paratypes). No further details are known on the conditions in which this species occurs. Probably it lives under similar circumstances as *Ph. thienemanni*.

The holotype, collected by H. FRUHSTORFER in 1892 on Mt. Tjikorai, is preserved in the Senckenberg Museum (no. 62544), as are also paratypes of this species (no. 62545).

Measurements of holotype and paratypes:

	holotype	paratypes			
height	2.7	2.1	2.3	2.5	} mm
width	3.4	3.1	3.0	3.2	
height of aperture	1.2	1.1	1.1	1.2	
number of whorls	$5\frac{3}{4}$	$4\frac{1}{4}$	$4\frac{1}{4}$	$4\frac{1}{4}$	

From the other species of *Philalanka* in Java the new species differs in having only a peripheral keel and no additional spiral lirae. From *Ph. thienemanni* it is distinguished by the lower spire and the narrow umbilicus.

***Philalanka nannophya* RENSCH, 1932 (fig. 65).**

1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 105, pl. 3, fig. 35.

Shell rounded-conical, light brown, shining, somewhat transparent. Whorls 4, finely striated according to the growth lines and further ornated with 5 spiral ridges, the lowermost at the periphery, the other four on the upper part of the whorl only. Below the periphery the base of the shell has a few fine spiral lines. Top obtuse, base rounded. Umbilicus narrow. Suture deep.

Aperture somewhat oblique, oval to sickle-shaped. Peristome not continuous, not thickened or reflected.

Dimensions: height 1.2 to 1.4 mm, width 1.4 to 1.6 mm, height of aperture 0.4 to 0.6 mm.

Distribution: Sumba, Java.

Habitat in Java: nothing is known of the circumstances under which *Ph. nannophya* lives. Its vertical distribution lies between 50 m and 700 m.

West Java: Kuripan, near Bogor, 200 m; Mt. Pawon near Padalarang, 700 m.

Central Java: Sulang, near Kali Besèk, 50 m.

***Philalanka tjibodasensis* (LESCHKE, 1914) (fig. 66).**

1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 207-208 and 229 (*Sitala*).

1929 VAN BENTHEM JUTTING, Treubia, 11, p. 78 (*Sitala bicarinata* BTG. ms).

1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 103.

1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 104, pl. 3, fig. 39 (*diminuta*).

1940 VAN BENTHEM JUTTING, Treubia, 17, p. 332 (*diminuta*).

Shell conical, greenish-yellow, almost glassy-hyaline. First whorl smooth, the subsequent ones ornated with two strong spiral ridges, one along the periphery and one somewhat above it. They make the whorls descend almost step-like. Between the strong ridges there are numerous fine spiral striae. In fresh shells the strong spirals bear a chitinous fringe, continuous or divided into numerous short stiff hairs. The fine spiral lines are only somewhat scaly or fibrous.

Whorls 5 to 6, regularly increasing in size. Top obtuse, base rounded. Umbilicus open, not wide. Suture deep.

Aperture oblique, broad sickle-shaped. Peristome not continuous, not thickened or reflected. The columellar side hides part of the umbilicus.

Dimensions: height 3.4 to 4.0 mm, width 3.6 to 4.1 mm, height of aperture 1.0 to 1.3 mm.

Distribution: Java, Bali, Celebes, Ambon.

Habitat in Java: living in the ground litter among fallen leaves, earth, low vegetation, from the plains up to the mountain forests, between 50 and 1500 m altitude.

There is a great deal of variation in this little species, high or flat shells, with hair-fine or with more open umbilicus occurring even in one

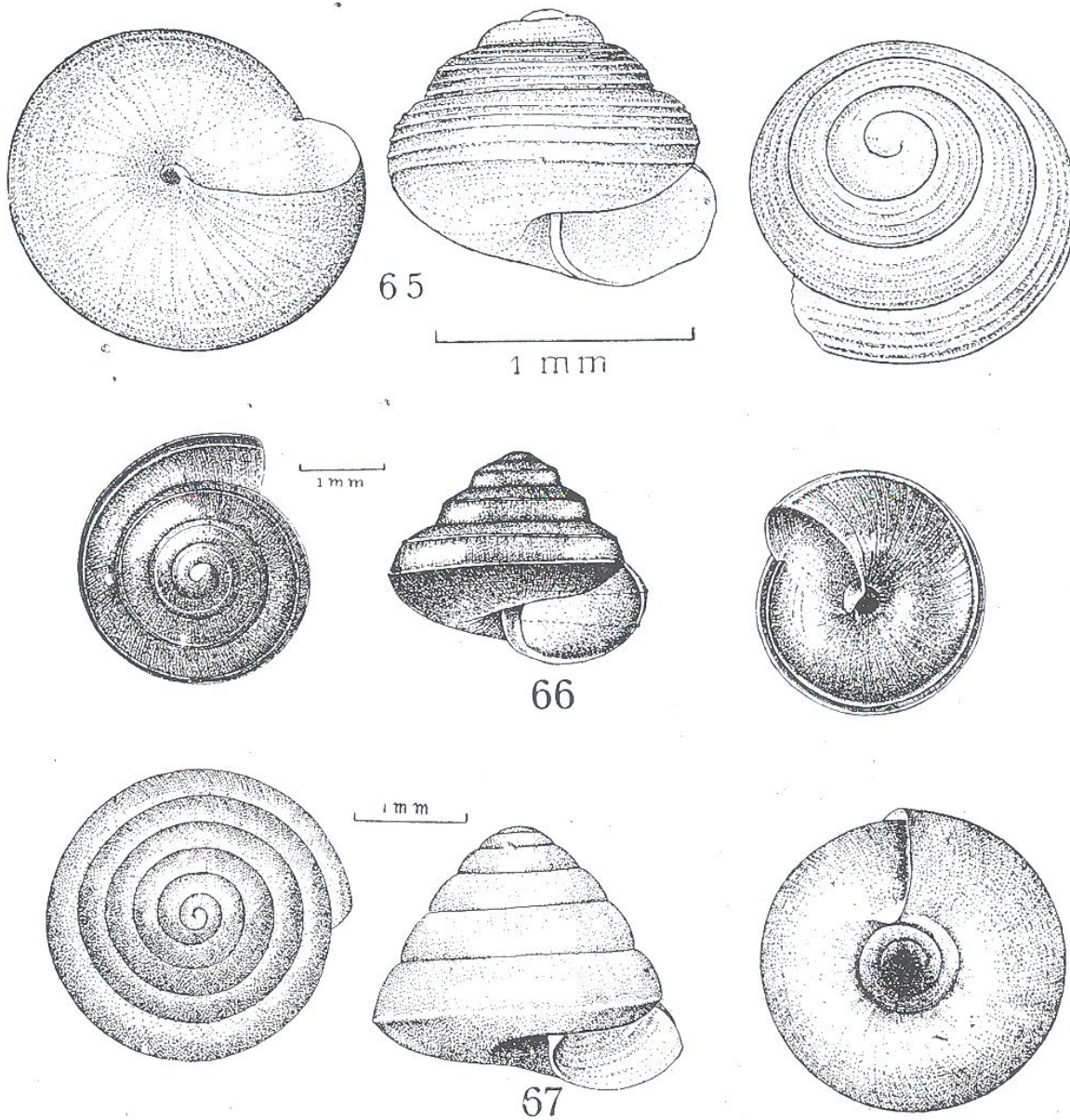


Fig. 65. *Philalanka nannophyc* RENSCH. Shell from base, side and top. ABDULKADIR del.
 Fig. 66. *Philalanka tjibodasensis* (LESCHKE). Shell from top, side and base. ABDULKADIR del.
 Fig. 67. *Philalanka thienemanni* RENSCH. Shell from top, side and base, Author del.

population. Among series from Celebes and from Ambon, I found shells with 3 spiral keels on the last whorl (2 on each preceding whorl). As there are no other differences I do not see a reason to separate them.

The species which RENSCH described as *Ph. diminuta* (of which I could compare 8 paratypes from Baturiti, Bali) in my opinion is synonymous with *Ph. tjibodasensis*.

West Java: Tjianten, near Leuwiliang, 300 m; Gunung Tjibodas, Tjampea, near Bogor, 300 m; Kuripan, near Bogor, 200 m; Depok, 100 m; Bogor, 250 m; Mt. Paniisan, near Bogor, 600 m; Warangloa, near Bogor, Mt. Salak, 500 m; estate of Tjisarua-Z., slope of Mt. Pangrango, on leaf of *Strobilanthes*, 800 m; forest near Puntjak pass, 1500 m; Tjibodas, Mt. Gedeh, 1500 m; Sukabumi, 700 m; forest between Tjisolok and Tjipanas, near Pelabuhanratu, 100 m; limestone hill near Sukanegara, 1000 m; Maribaja, near Bandung, 1100 m; Mt. Tjikorai.

Central Java: Sulang, near Kali Besèk, 50 m.

East Java: Tengger Mts; Nongkodjadar, 1200 m; Glen Falloch Estate, virgin forest, 1200 feet.

***Philalanka thienemanni* RENSCH, 1932 (fig. 61 and 67).**

1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 105-106, pl. 3, fig. 33.

1934 RENSCH, Trop. Binnengew. Vol. 4, p. 755 and 758.

Shell small, conical to high-conical, greenish-yellow or brown, thin and shining, transparent. With fine radial striae, crossed by still more delicate spiral lines. Whorls $4\frac{1}{2}$ to 6, regularly increasing in size, carinated along the periphery. Suture rather deep. Top angle narrower than in *Philalanka micromphala*. Base rounded in young shells, flatter in adult ones. Umbilicus wide, showing all previous whorls.

Aperture broad sickle-shaped to quadrangular, oblique. Peristome not continuous, sharp.

Dimensions: height 1.6 to 2.3 mm, width 2.3 to 3.0 mm, height of aperture 0.6 to 0.8 mm.

Distribution: Java.

Habitat in Java: living on the ground, in the woods among earth, fallen leaves, grass, moss and other low vegetation. Occurring between 1000 and 2565 m altitude. Only the locality Surabaya (leg. H. FRUHSTORFER, 1890, Mus. Senckenberg, no. 62542) lies at about sea-level.

West Java: Mt. Gedeh, 4000-6000 feet; Tjibodas, 1400 m and forest of Mt. Gedeh up to saddle between Mts. Gedeh and Pangrango, 2400 m, in soil fauna; limestone hill near Sukanegara, 1000 m; Mts. Tilu, and Wajang, 6300-6500 feet.

Central Java: Mt. Prahū, Dieng plateau, 2565 m; Dieng plateau, 2000 m (RENSCH); Tjemorosewu, near Sarangan, Mt. Lawu, 1875 m (RENSCH).

East Java: Surabaya, sea-level; Nongkodjadjar, and environs, 1200-1400 m; Kendeng III, 1400 m and Ongop-Ongop, Idjen plateau, 1850 m; Kawah Idjen-Merapi Game reserve, 1600—1700 m; virgin forest of Jang plateau, 2000 m.

Young shells are somewhat differently shaped. They are much wider than high, with a less open umbilicus and a more rounded base. With advancing age the height increases, the umbilicus becomes wider and the base flatter.

***Stenopylis coarctata* (MOELLENDORFF, 1894) (fig. 68).**

1894 MOELLENDORFF, Nachr. Blatt, 26, p. 113 (*Plectopylis*).

1914 FULTON, Ann. Mag. Nat. Hist. (8) 14, p. 163.

1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 103.

1935 RENSCH, Sitz. Ber. Ges. naturf. Freunde, Berlin, p. 322.

1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 300, fig. 2, 3.

Shell depressed, almost flat above, somewhat concave below. Creamy white, hyaline, polished. First whorl smooth or punctate, the following ones finely striated spirally.

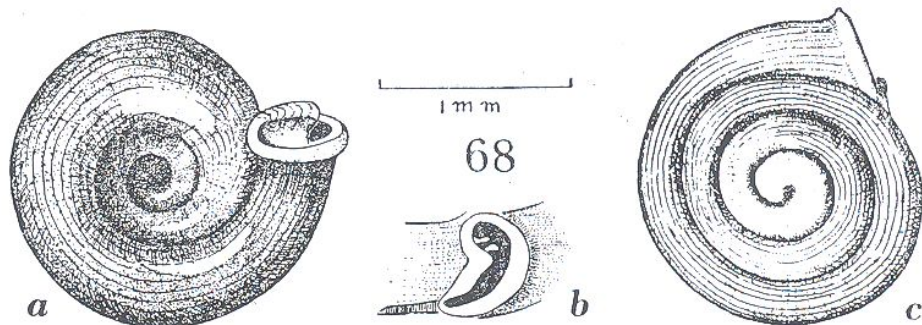


Fig. 68. *Stenopylis coarctata* (MLDFF). Shell from base (a) and top (c). Detail of aperture (b). After VAN BENTHEM JUTTING.

Whorls $3\frac{1}{2}$, slowly increasing in diameter, well rounded, separated by a deep suture. Periphery rounded or weakly angular just above the middle. Umbilicus very wide, showing all the whorls.

Aperture oblique, ear-shaped, with two teeth on the interior wall, a long upper tooth, reaching to the peristome, and a short lower one more internally. Peristome continuous, white, thickened and reflected. The parieto-columellar side projecting.

Dimensions: height 0.6 to 0.7 mm, width 1.6 to 1.7 mm, height of aperture 0.5 to 0.6 mm.

Distribution: Philippines, New Guinea, Central Australia, Sumba and various islands in the Bay of Djakarta: Noordwachter, Zuidwachter, Klein Kqmbuis, Enkhuizen (VAN BENTHEM JUTTING, 1941), to which can be added a recent record in the island of Edam.

So far *Stenopylis coarctata* has not been found in Java. As the species occurs within so little distance from the main island, and as it can be expected to appear there also some day, I have given a full description and a figure.

Familia ZONITIDAE

Shell low or high conical, generally wider than high. Thin, often transparent. Perforate or imperforate.

Aperture toothless or with teeth. Peristome usually sharp and not reflected.

Mandibula smooth, curved, with a central projection at the concave side. Radula $\infty. 1. \infty$, rhachis uni- to tricuspid, laterals uni- to tricuspid, marginals uni- to bicuspid.

Footsole undivided or tripartite. Posterior tip with or without a "horn" overhanging the posterior mucus gland.

Hermaphroditic, in the genital system such accessory organs as dart-sac and dart, flagellum and digitiform appendages are lacking.

Two genera occur in Java:

- | | | |
|----|--|---------------------|
| 1. | Shell imperforate, more or less trochiform | Geotrochus |
| — | Shell perforate, more or less lenticular | Trochomorpha |

Genus *Geotrochus* VAN HASSELT, 1823

Shell broadly conical, angular or keeled at the periphery. Whorls flat or a little convex. Suture shallow. Umbilicus closed.

Aperture oblique. Peristome not continuous, not or hardly thickened and not reflected.

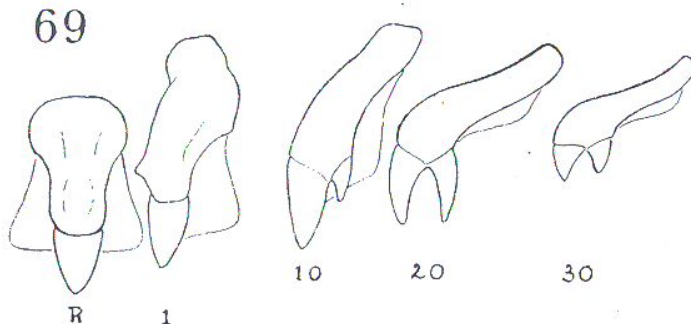


Fig. 69. * *Geotrochus conus* (PHIL.). Radula elements. Author del.

Animal, at least in the Javanese species, without a "horn" at the posterior tip of the foot. Footsole undivided.

Radula with a unicuspid, or indistinctly tricuspid, central tooth, laterals uni- or bicuspid, marginals bicuspid (fig. 69).

Distribution: Malay Peninsula, Java, Borneo.

In Java there are two species:

1. Shell with flat whorls of chestnut-brown colour, with a creamy white zone along the shallow suture **conus**
- Shell plain greyish-brown, whorls somewhat rounded, suture deeper **multicarinatus**

There is some uncertainty as to whether *Geotrochus* (syn. *Chiroktisma* GUDE, 1913) and *Eurybasis* GUDE, 1913 ought to be classified in the family Helicarionidae or in the Zonitidae. GODWIN AUSTEN's anatomical description of *Helix conicoides* (now *Eurybasis conicoides*) (Proc. Malac. Soc. London, 1, 1895, p. 286) sounds partly like subfamily Sesarinae of Helicarionidae, partly like subfamily Trochomorphinae of Zonitidae. Of *Eurybasis* I have not examined the soft parts, but for the two Javanese species of *Geotrochus* I am inclined to classify them in the Zonitidae, subfamily Trochomorphinae (compare also H. B. BAKER, 1941, Bull. no. 166 B. P. Bishop Mus.). On account of the anatomical dissections by LAIDLAW (1932, Proc. Malac. Soc. London, 20, p. 93-94), *Eurybasis lychnia* (BENSON) from Malaya resembles *Trochomorpha*.

Geotrochus conus (PHILIPPI, 1841) (fig. 69 and 70).

- 1823 VAN HASSELT, Algem. Konst- & Letterb. 2, p. 233 (*Geotrochus zonatus* nom. nud.).
 1841 PHILIPPI, in: PFEIFFER, Symbolae, 1, p. 39 (*Helix*).
 1842 PHILIPPI, Icones, Vol. 1, pl. 1, fig. 6 (*Helix*).
 1848 MOUSSON, Mitt. naturf. Ges. Zürich, 1, p. 266 (*Helix*).
 1849 MOUSSON, Land & Süßw. Moll. Java, p. 20, pl. 2, fig. 2 (*Helix*).
 1860 ZOLLINGER, Natuurk. Tijdschr. Ned. Indië, 21, p. 317 and 319 (*Helix*).
 1867 MARTENS, Ostas. Landschn. p. 253 (*Trochomorpha*).
 1887 TRYON, Man. of Conch. (2) 3, p. 72, pl. 14, fig. 87-88 (*Helix*).
 1888 TENISON WOODS, Proc. Linn. Soc. N. S. W. (2) 3, p. 1027 (*Trochomorpha*).
 1890 BOETTGER, Ber. Senckenb. p. 140 (*Trochonanina*).
 1913 GUDE, Proc. Malac. Soc. London, 10, p. 390 (*Chiroktisma*).
 1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 228 (*Trochonanina*).
 1929 VAN BENTHEM JUTTING, Treubia, 11, p. 77 (*Chiroktisma conus* and *Ch. conus* var. *livata*).
 1932 VAN BENTHEM JUTTING, Journ. of Conch. 19, p. 208-209, pl. 7, fig. 14 and 16 (*Chiroktisma*).
 1935 PILSBRY, Nautilus, 49, p. 67.
 1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 303 (*Eurybasis* (*Chiroktisma*)).

Shell trochiform, an almost ideal cone with straight lines and flat base, sharply keeled along the periphery. Chestnut-brown, not transparent, with a narrow white or creamy zone, varying in width, just above and below the periphery. In occasional specimens the width of this white zone

can become so large that the shell makes the impression of being white with a narrow brown, spiral band.

First two whorls almost smooth, the following ones finely striated according to the growth lines. In many specimens this striation is crossed on the upper side of the whorls by fine spiral lirae, sometimes delicate and not elevated, but in others appearing as raised ridges. The shells in which these spiral lirae are very conspicuous can be distinguished as *Geotrochus conus* forma *lirata* (VAN BENTHEM JUTTING, 1932) (see below). The base of the shell is always smooth and shining, even in the lirate specimens. Apex blunt.

Whorls 8 to 8½, descending regularly, almost flat in profile, hence the suture is extremely shallow. Last whorl not descending towards the aperture. Umbilicus closed.

Aperture oblique, rhombiform, with rounded basal angle. Peristome not continuous, sharp along the free margin, but somewhat thickened in the umbilical region.

Dimensions: height 11 to 13 mm, width 15 to 18 mm, height of aperture 4 mm.

Geotrochus conus forma *lirata* (VAN BENTHEM JUTTING, 1932) differs from the main form in having a varying number of raised spiral ridges, diminishing in size from the carina upward on the whole shell and from the suture upward on each whorl (fig. 70 c). Although the presence of this spiral sculpture reminds the condition in *G. multicarinatus*, it is beyond doubt that the forma *lirata* belongs to the *conus* relationship.

Distribution: Java, Nusa Barung, Madura. As I have pointed out in my paper of 1932 (p. 209), the occurrence of *Geotrochus conus* in Madura needs confirmation.

Habitat in Java: living in the woods of the hills and mountains, on the ground and on low foliage. Recorded between sea-level and 1400 m altitude.

West Java: wood near Tjinjurup, Mt. Karang, 700 m; crater-forest of Mt. Karang, 1000 m; Mt. Salak, 1000 m; Warangloa, 500 m; Mt. Panisan, 600 m; Mt. Pantjar, 800 m; Tjisarua-Z. 800 m; Megamendung, 800 m, near Bogor; Tjiliwong estate, Puntjak pass, 1200 m; Mt. Gedeh, 4000 feet; Mt. Pangrango; wood near Situgunung, S slope of Mt. Gedeh, 1000 m; Sukabumi, 700 m; Palabuanratu, sea-level; Tjibeber, 450 m; limestone hill near Sukanegara, 1000 m; Djampang, 2000 feet; Mt. Malang, 1000 m; Bungbulan, 1500 feet; Mt. Tjakrabuana, near Tjiawi, 1000 m.

MARTENS (1867, p. 253) found out that *Geotrochus zonatus*, described by VAN HASSELT (1823), is the species which we now know as *Geotrochus*

conus (PHIL.). He did not, however, take the consequence of bringing "*Helix*" *conus* into the genus *Geotrochus*, but classified it as *Trochomorpha*. MARTENS recorded the species with an interrogation mark from Agam (Padang district, Sumatra), but he suggested that there could be a confusion with *Trochomorpha bicolor*. Later DEGNER (*Treubia*, 10, 1928, p. 359) repeated this state of affairs and actually we know the species with certainty only from West Java and Nusa Barung.

PILSBRY (1891, *Man. of Conch.* (2) 7, p. 3) already alluded to the fact that *Geotrochus* is a valid generic name, but nevertheless GUDE (1913) created the new genus *Chiroktisma* for the two Javanese species. It was not before 1935 that PILSBRY brought the status of *Geotrochus* again in the foreground.

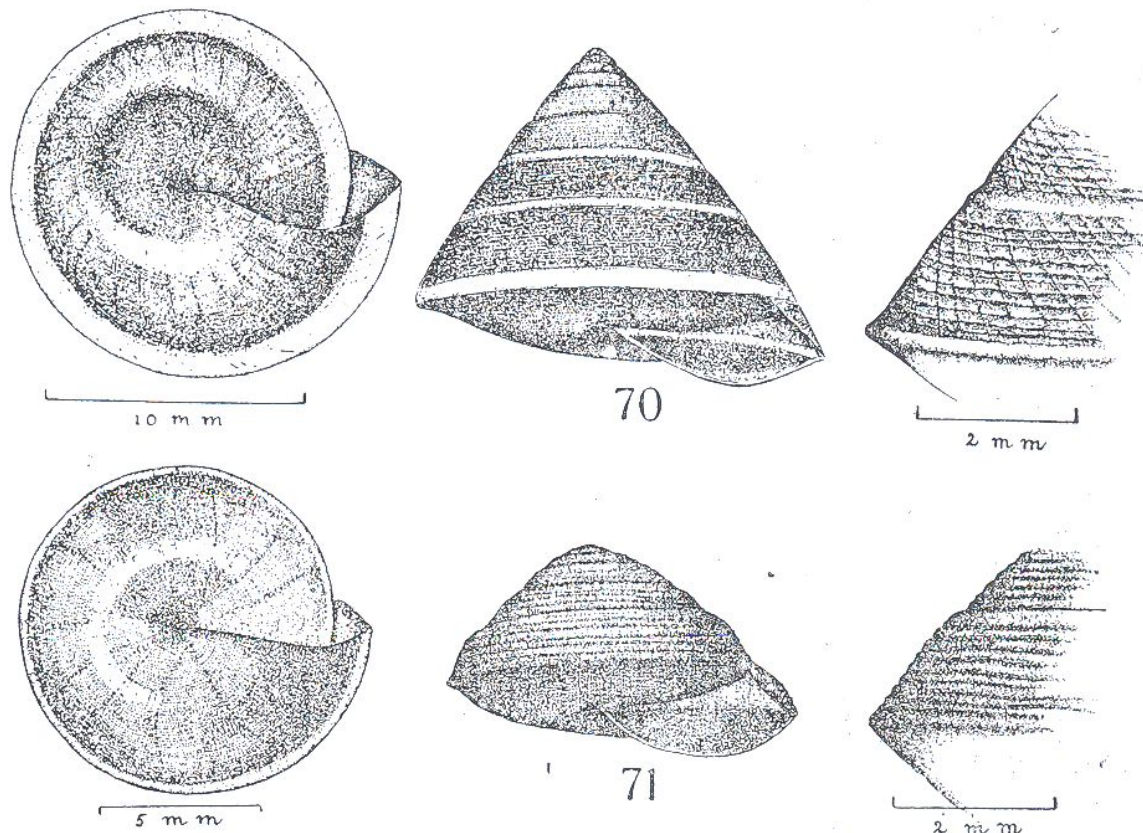


Fig. 70. *Geotrochus conus* (PHIL.). Shell from base and side. Detail of sculpture of *G. conus* *fa* *lirata* (v. B. JUTTING), somewhat more enlarged, LENSVELT del. Fig. 71. *Geotrochus multicarinatus* (BTTGR). Shell from base and side. Detail of sculpture, somewhat more enlarged, LENSVELT del.

***Geotrochus multicarinatus* (BOETTGER, 1890) (fig. 71).**

1890 BOETTGER, *Ber. Senckenb.* p. 141, pl. 5, fig. 2, 2a-c (*Trochonantina*).

1913 GUDE, *Proc. Malac. Soc. London*, 10, p. 390 (*Chiroktisma*).

1914 LESCHKE, *Mitt. naturh. Mus. Hamburg*, 31, p. 207 and 228 (*Trochonantina*).

1929 VAN BENTHEM JUTTING, Treubia, 11, p. 77 (*Chiroktisma*).

1932 VAN BENTHEM JUTTING, Journ. of Conch. 19, p. 208-210, pl. 7, fig. 15 (*Chiroktisma*).

1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 304 (*Eurybasis (Chiroktisma)*).

Shell low conical to trochiform, not so sharply cone-shaped as the preceding species. Sharply carinated along the periphery. Greyish-brown, not, or very little, transparent. First two whorls almost smooth, the others ornamented on the upper side with two to eight raised spiral lirae. These ridges are crossed by delicate growth lines. The base of the shell is always smooth and shining.

Whorls 6 to 7, with blunt apex. The whorls descend more or less step-like and are somewhat rounded, so that the suture is more clearly impressed than in *Geotrochus conus*. Last whorl not descending towards the aperture. Umbilicus closed.

Aperture oblique, rhombiform, with rounded basal angle. Peristome not continuous, not reflected, sharp along the free margin, but somewhat thickened in the umbilical region.

Dimensions: height 8 to 9 mm, width 12 to 13 mm, height of aperture 3 mm.

Distribution: Java and, doubtfully, Madura. As I have pointed out in 1932, the occurrence of *Geotrochus multicarinatus* in Madura needs confirmation.

Habitat in Java: living in the wood, on the ground and on low foliage. Recorded between 250 and 2000 m altitude.

West Java: Bogor, 250 m; Tjibodas, Mt. Gedeh, 1400 m; limestone hill near Sukanegara, 1000 m; Mt. Tangkuban Prah, 1000 m; Tjisurupan, Mt. Papandajan, 3500 feet; Tjibitung, near Pengalengan, 2000 m; Mt. Tjakrabuana, near Tjiawi, 1000 m.

Genus *Trochomorpha* ALBERS, 1850

Shell low conical to lens-shaped, with acute carina along the periphery. Umbilicus open, in many species even wide. Unicolorous or spirally banded, hyaline or opaque.

Mandibula horse-shoe-shaped, oxygnathous, in some species with cross ribs, in others without such ribs. Radula ∞ . 1. ∞ . Central tooth with one cusp or tricuspid. Latero-marginals uni-, bi- or tricuspid (fig. 73).

Distribution: South and East Asia, Malay Archipelago, various Pacific Islands.

In Java there are 4 species:

1. Shell very flat, umbilicus very wide **planorbis**
— Shell not so flat, umbilicus narrower **2**
2. Shell unicolorous **concolor**
— Shell ornated with brown spiral bands **3**
3. Shell rather flat, brown spiral bands generally not well marked,
merging imperceptibly into the yellow ground colour . . . **bicolor**
— Shell somewhat more elevated, brown spiral bands well marked . .
. **strubelli**

Trōchomorpha planorbis (LESSON, 1831) (fig. 72 and 73).

- 1831 LESSON, Voy. Coquille, Zool. 2, p. 312, pl. 13, fig. 4 (*Helix*).
- 1848 MOUSSON, Mitt. naturf. Ges. Zürich, 1, p. 266 (*Helix*).
- 1849 MOUSSON, Land & Süsw. Moll. Java, p. 24-25, pl. 2, fig. 9 (*Helix planorbis* var. *javanica*).
- 1860 ZOLLINGER, Natuurk. Tijdschr. Ned. Indië, 21, p. 317 (*Helix zollingeri*).
- 1864 MARTENS, Monatsber. Akad. Berlin, p. 267 (*appropinquata*).
- 1867 MARTENS, Oostas. Landschn. p. 249, pl. 13, fig. 4, 7 and 8 (with varieties *appropinquata*, *lessoni* = *approximata* and *javanica*).
- 1887 TRYON, Man. of Conch. (2) 3, p. 82, pl. 16, fig. 78-82 (*Helix*).
- 1888 TENISON WOODS, Proc. Linn. Soc. N. S. W. (2) 3, p. 1029 (*Tr. zollingeri* and *planorbis*).
- 1890 BOETTGER, Ber. Senckenb. p. 142-143 (*Tr. planorbis* var. *javanica*).
- 1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 210 and 230 (inclus. var. *javanica*).
- 1929 VAN BENTHEM JUTTING, Treubia, 11, p. 78 (inclus. var. *javanica*).
- 1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 78-79.
- 1935 PAVICINI, Arch. Moll. Kunde, 67, p. 172.
- 1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 303.

Shell very low conical, shaped like a flat lens. Buff or light brown, sometimes milky white, occasionally with a narrow, vague, spiral band of darker brown just above and below the periphery. First $1\frac{1}{2}$ whorls smooth, the subsequent ones finely and regularly striated in the direction of the growth lines. In some shells there is an additional spiral striation, either on one side (upper or lower) or on both sides. Thin and somewhat shining, especially on the base. Somewhat transparent so that the dark blotches of the mantle shine through.

Whorls $5\frac{1}{2}$ to 6, regularly increasing in size. The spire very little elevated, lying almost in one plane. Sharply keeled at the periphery by a pinched carina which is somewhat lighter than the rest of the shell. Apex blunt. Above the carina the profile of the shell is almost flat, hence the suture is not, or only slightly impressed. Last whorl not descending towards the aperture. Base rather flat, rounded, or somewhat angular round the very wide umbilicus.

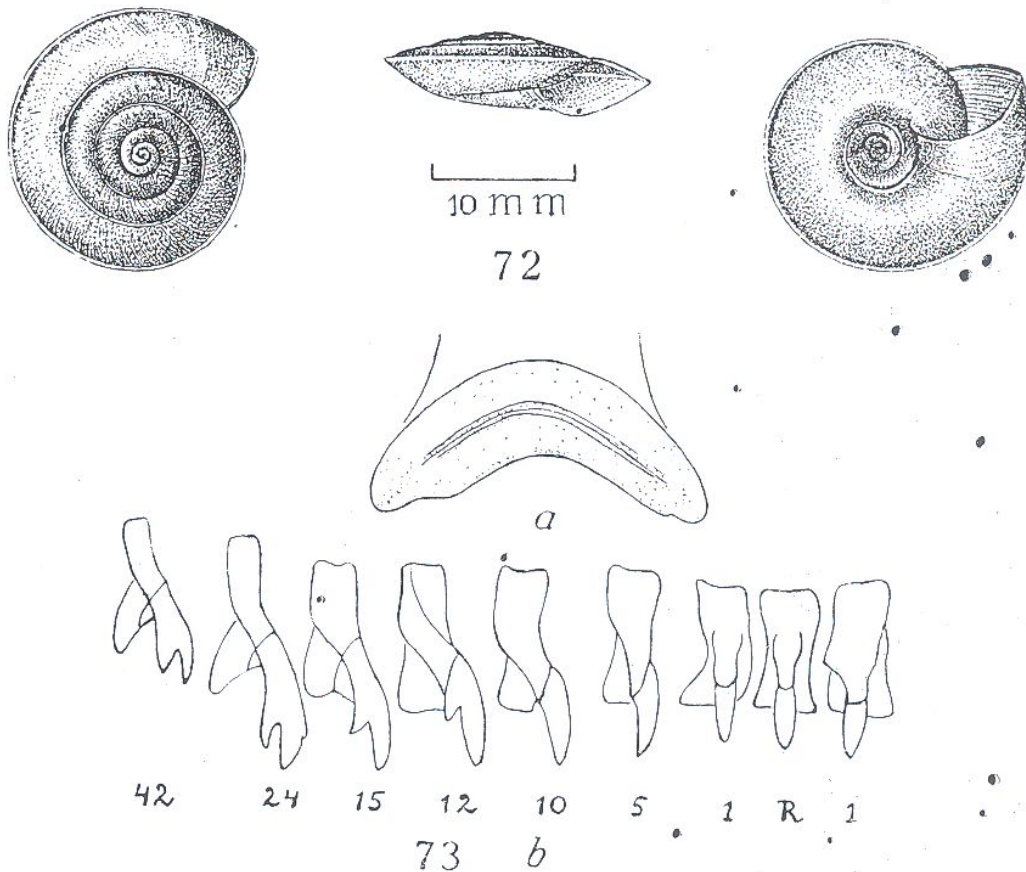


Fig. 72. *Trochomorpha planorbis* (LESS.). Shell from top, side and base. ABDULKADIR del. Fig. 73. Same species, a. mandibula; b. radula elements (after WIEGMANN).

Aperture oblique, rhombiform, with a rounded basal angle. Peristome not continuous, not, or only slightly thickened, sharp, not reflected.

Dimensions: height 5 to 6 mm, width 15 to 17 mm, height of aperture 4 to 4½ mm.

The species is varying in flatness. Sometimes the spire is a little elevated, in other shells it is lying in one plane. The spiral striation is also little constant, in some specimens it is present on both the upper and lower sides, in others only on one side, or not at all. This diversity has given rise to the naming of several varieties, e.g. *appropinquata* MARTENS, *lessoni* MARTENS, *javanica* MOUSSON, *nummus* ISSEL, which, however, have little systematic value.

Distribution: Java, Sumatra, Borneo, Celebes, various Lesser Sunda islands, various Moluccan islands, Philippines, New Guinea, Aru Is., New Britain.

Habitat in Java: living in the wood, on the ground, among dead leaves, low vegetation etc., moving only in moist weather. Recorded between sea-level and 1400 m.

West Java: wood near Tjinjurup, Mt. Karang, 700 m; Tjiringin (MARTENS, 1867); Tjiminju (MARTENS, 1867); Gunung Tjibodas, Tjampea, 300 m; Tjiapus, Mt. Salak (PARÁVICINI, 1935); Mt. Pantjar, near Bogor, 400 m; Tjibodas, Mt. Gedeh, 1400 m (LESCHKE, 1914); Sukabumi, 700 m; Palabuanratu and Tjisolok, road to hot springs, 100 m; Wangun, near Tjisampora, Lengkong distr., Bungbulan, 1500 feet; Pameungpeuk, S of Garut, 350 m; Tjilaut Estate, near Garut; Kaliputjang, near Pangan-daran, 200 m.

Central Java: Residency of Banjumas (MARTENS, 1867).

East Java: Kali Mrawan, 1000 m.

Animal, according to Messrs SARASIN (1899, Landmoll. Celebes, p. 172), with a black foot. The ground colour of the mantle is also black, with white flecks arranged in transverse rows. This black and white pattern is visible through the shell.

Radula 47.1.47. The central tooth and the adjoining laterals unicuspid, the outer latero-marginals bicuspid. Mandibula without transverse ribs.

The specimens preserved as *Trochomorpha zollingeri* PFEIFFER, 1851 from Java in the MOUSSON Collection at Zürich (5 shells collected by ZOLLINGER in 1847 and one shell collected by GEALE in 1875), in my opinion are certainly *Tr. planorbis* LESSON, and not — as MARTENS, 1867, p. 251, suggested — *Tr. lardea* MARTENS, 1867 (see also under *Tr. lardea*). They have the very flat shape and the very wide umbilicus of *Tr. planorbis* and they lack the solid edge along the peristome of *Tr. lardea*. Whether they are synonymous with the original *Tr. zollingeri* (PFEIFFER, 1851) described from "Java?" I must leave undecided. MARTENS considered the true *Tr. zollingeri* PFEIFFER related to, although not identical with, *Tr. tricolor* MARTENS. Only the examination of the original lot can clear up this uncertainty.

Among the unpublished drawings of the molluscs collected in Java in the beginning of the 19th century by KUHLE & VAN HASSELT (now in the Leiden Museum), there is a figure in colour by A. MAUREVERT of shell and animal of an unnamed snail from "Tjimignac" (i.e. Tjiminju). They belong to *Trochomorpha planorbis*, as was already suggested by MARTENS (1867).

***Trochomorpha bicolor* MARTENS, 1864 (fig. 74).**

1864 MARTENS, Monatsber. Akad. Berlin, p. 267.

1867 MARTENS, Ostas. Landschn. p. 252, pl. 13, fig. 2.

1887 TRYON, Man. of Conch. (2) 3, p. 82, pl. 16, fig. 83-85 (*Helix*).

1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 230.

1923 OOSTINGH, Meded. Landb. Hooges. 26, no. 3, p. 151.

1929 VAN BENTHEM JUTTING, Treubia, 11, p. 78.

1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 77-78.

1934 RENSCH, Trop. Binnengew. 4, p. 753.

1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 303.

Shell low conical, almost lens-shaped, yellow or light brown with a spiral zone of chestnut above and below the periphery, at a little distance from the peripheral keel. In some shells this band is only narrow, exhibiting a large part of the yellow ground colour; in others the band is broad leaving only narrow strips of yellow on either side. The contours of the dark zone are generally vague, although there are also individuals in which they are well marked.

First $1\frac{1}{2}$ whorls smooth, subsequent ones finely and regularly striated in the direction of the lines of growth. This structure is generally crossed by still finer spiral striae. Somewhat shining, little or not transparent, more solid than *Trochomorpha planorbis* or *Tr. concolor*.

Whorls $5\frac{1}{2}$ — $6\frac{1}{2}$, regularly increasing in width, sharply keeled at the periphery by a somewhat pinched carina. Apex blunt. Above the keel the profile of the whorls is almost flat, hence the suture is not, or only slightly, impressed. Last whorl not descending towards the aperture. Base rather flat, evenly rounded towards the moderately wide umbilicus.

Aperture oblique, rhombiform, with a rounded basal angle. Peristome not continuous, sharp, not thickened or reflected.

Dimensions: height 5 to 6 mm, width 13 to 14 mm, height of aperture 4 to $4\frac{1}{2}$ mm.

As has been pointed out in the above description, there is some variation in the extension of the brown spiral band. In some samples the brown band appears late, at about the region of the fourth or fourth and one-half whorl. The preceding whorls are unicolorous. The elevation of the spire may also vary in different individuals.

Distribution: Malaya, Sumatra, Mentawai, Dwars in den Weg (P. Sangiang), Java, Borneo, Bali, Lombok, Flores, Ceram, Obi.

Habitat in Java: Living in the wood, on the ground, among dead leaves, low shrubs etc., moving only in wet weather. RENSCH (1932) mentioned that the species occurred in the mountain forests between 400 and 1300 m altitude. In the stomach he found fungus hyphens and tissue remains of phanerogamous leaves. From my data it appears that *Trochomorpha bicolor* is recorded between 50 and 1200 m alt.

West Java: waterfall Tjianten, Leuwiliang, 300 m, and Gunung Tjibodas, Tjampea, near Bogor, 300 m; limestone hills near Padalarang, in

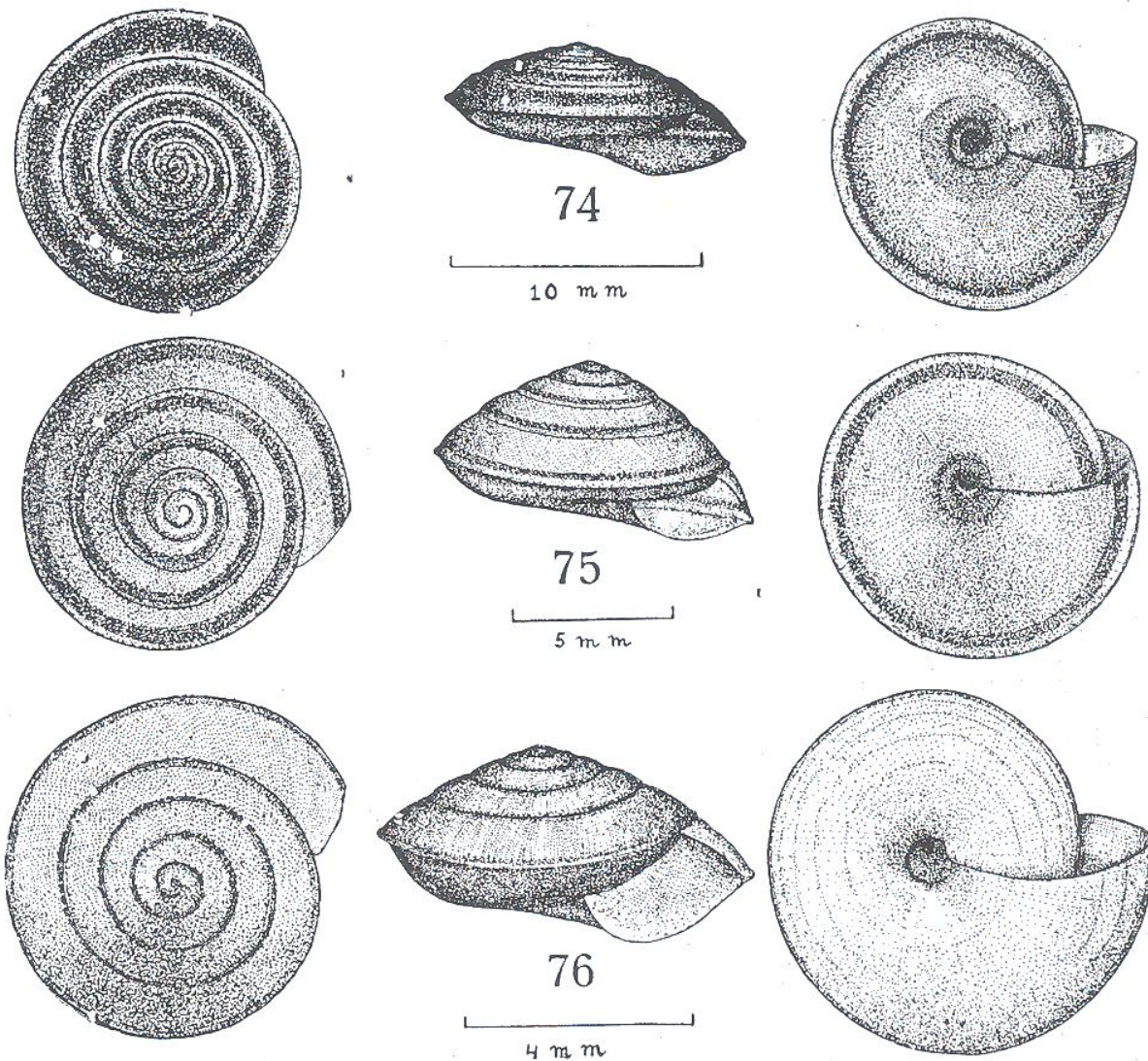


Fig. 74. *Trochomorpha bicolor* MARTS. Shell from top, side and base. Fig. 75. *Trochomorpha strubelli* BTTGR. Shell from top, side and base. Fig. 76. *Trochomorpha concolor* BTTGR. Shell from top, side and base. All LENSVELT del.

earth at the base of the rocks, 700 m; Mt. Masigit, 700 m, and Radjaman-dala, 200 m, near Padalarang; environs of Bandung, 800 m, and those of Maribaja, 1000—1100 m.

Central Java: Penawangan (OOSTINGH); Lake Ngebel, Mt. Wilis (RENSCH, 1934); Mantingan, near Rembang, 100 m; Kali Besèk, near Sulang, 50 m.

East Java: Southern Mts, near Pasuruan, 1200 to 1500 feet; Tengger Mts, 1200 m; Malang, 500 m; Wonosari (MARTENS, 1867); Djabung, near Wlingi, 800 m; Kali Mrawan, E of Djember, 1000 m; Glen Falloch, 1200 feet; Glen Nevjs, 1250 feet; Blawan, Idjen plateau, 950 m.

***Trochomorpha strubelli* BOETTGER, 1890 (fig. 75).**

1890 BOETTGER, Ber. Senckenb. p. 143, pl. 5, fig. 5a-c.

1892 MARTENS, Erg. Reise N. O. Indien, 2, p. 233.

1892 PILSBRY, Man. of Conch. (2) 8, p. 126, pl. 30, fig. 9-11.

1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 210 and 231.

1929 VAN BENTHEM JUTTING, Treubia, 11, p. 78.

1935 PARAVICINI, Arch. Moll. Kunde, 67, p. 173.

Shell low conical, ground colour yellowish, ornated with two narrow spiral zones of chestnut, one above and one below the periphery, at some distance from the peripheral keel. These brown bands are always well marked.

First $1\frac{1}{2}$ whorls smooth, following ones finely and regularly striated in the direction of the lines of growth. This sculpture is crossed in some specimens by a still more delicate spiral striation. Somewhat shining, a little transparent, more solid than *Trochomorpha planorbis* and *Tr. concolor*.

Whorls 6 to $6\frac{1}{2}$, regularly increasing in diameter, sharply keeled at the periphery by a somewhat pinched carina. Apex blunt. Above the keel the whorls are slightly curved, hence the suture is only shallow. Base rather flat, evenly rounded towards the moderately wide umbilicus.

Aperture oblique, rhombiform, with a rounded basal angle. Peristome not continuous, sharp, not thickened or reflected.

Dimensions: height 6 to $6\frac{1}{2}$ mm, width 11 to 12 mm, height of aperture 4 mm.

There is some variation in the elevation of the spire, but generally this species is well distinguished by the raised spire and the well defined brown spiral bands.

Distribution: Java, Sumatra.

Habitat in Java: there is no information on the ecological conditions under which *Trochomorpha strubelli* lives. One can, however, presume that these circumstances are similar to those of *Trochomorpha planorbis* and *Tr. bicolor*. The original diagnosis was made after a single shell from Mt. Salak, West Java. This specimen is not in the Senckenberg Museum, where the bulk of the BOETTGER Collection is preserved.

West Java: waterfall Tjianten, near Leuwiliang, 300 m; Warangloa, Mt. Salak, 500 m; Mt. Salak (BOETTGER); Tjampea (LESCHKE); saddle between Mts Pantjar and Paniisan, near Bogor, 500 m; Tjigombong, 500 m (PARAVICINI); Megamendung (MARTENS); Mt. Gedeh, 2000 feet; Pasir Pabeasan, and Mts Pawon and Masigit, near Padalarang, 500—800 m; Palabuanratu; Djampang, 3600 feet; Sukanegara, (PARAVICINI); Tjilaut estate, S of Garut, 500 m; Bandjarwangi, near Tjikadjang, 1500 m; Mt. Tangkuban Prah, 1000 m.

Among the unpublished drawings of the molluscs collected in Java in the beginning of the 19th century by KUHLE & VAN HASSELT (now in the Leiden Museum), there is a figure in colour by G. L. KEULTJES representing "*Geotrochus zonatus* Nöbis, Maggamendoen". There is no doubt that this is *Trochomorpha strubelli* as was already suggested by MARTENS (1892).

***Trochomorpha concolor* BOETTGER, 1890 (fig. 76).**

1890 BOETTGER, Ber. Senckenb. p. 143-144, pl. 5, fig. 6, 6a-c.

1892 PILSBRY, Man. of Conch. (2) 8, p. 126-127, pl. 30, fig. 12-14.

1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 230.

1929 VAN BENTHEM JUTTING, Treubia, 11, p. 78.

Shell low conical, uniformly glassy-brown or olivaceous. First $1\frac{1}{2}$ whorls smooth, the subsequent ones finely and regularly striated according to the lines of growth. On the base there is an additional spiral striation. Thin, glossy and transparent, the dark-blotched mantle of the animal shining through.

Whorls 5 to $5\frac{1}{2}$, regularly increasing in diameter, sharply keeled at the periphery by a somewhat pinched carina. Apex blunt. Above the keel the whorls are slightly curved, hence the suture is only shallow. Base evenly rounded towards the moderately narrow umbilicus.

Aperture oblique, somewhat rhombiform, with a rounded basal angle. Peristome not continuous, sharp, not thickened or reflected.

Dimensions: height 4 mm, width $7\frac{1}{2}$ mm, height of aperture 2 mm.

Distribution: Java.

Habitat in Java: we have no information on the ecological conditions under which *Trochomorpha concolor* lives. They may be similar to those mentioned under *Tr. planorbis* and *Tr. bicolor*.

Trochomorpha concolor seems to be rare in Java. Perhaps the inconspicuousness of the species is the reason why it is not often collected.

The original diagnosis was made after a series of three shells from Mt. Gedeh, West Java, 3000 feet alt., collected by AD. STRUBELL in 1890. These shells — together with three others from the same locality — once forming part of the BOETTGER collection, are now in the Senckenberg Museum at Frankfurt (no. 63767). No type specimen was indicated. Therefore I chose as lectotype the largest shell of the lot. This specimen is high 4 mm, wide $7\frac{1}{2}$ mm and has an aperture of 2 mm height.

West Java: Mt. Gedeh, 3000 feet; rocks near Rarahan, near Tjibodas, Mt. Gedeh, 1400 m; Palabuanratu; limestone hill near Sukanegara, 1000 m; Mt. Tilu, 6300 feet; Mt. Tangkuban Prahū, 1000 m; Tjibituring, near Pengalengan, 2000 m.

Doubtful species of *Trochomorpha*.

MARTENS (1867, p. 248) mentioned, not without doubt, two other *Trochomorpha* from Java, viz. *Tr. hartmanni* PFEIFFER (Proc. Zool. Soc. London, 1845, p. 125) and *Tr. timorensis* MARTENS (1867, p. 248, pl. 13, fig. 6). Both species were quoted by LESCHKE (1914, p. 230 and 231) and by myself (1929, p. 78) in our check lists of the mollusca of Java.

The former, however, is a species from Morotai I., whereas *Tr. timorensis* inhabits Timor and a few other Lesser Sunda islands. Both bear some superficial resemblance to *Tr. planorbis*, hence the confusion can result either from an erroneous identification, or from a dubious location.

Under *Trochomorpha planorbis* I have already discussed that the specimens of *Tr. zollingeri* PFEIFFER from Java in the MOUSSON Collection at Zürich and which MARTENS (1867, p. 251) classified under his *Tr. lardea*, in my opinion are not *lardea*, but true *planorbis*.

There is another point which adds to the confusion. Both samples of *Tr. zollingeri* PFR. in the MOUSSON Collection were labelled only "Java". One sample contains 5 shells and was collected by ZOLLINGER in 1847, the other one contains 1 shell and was collected by GEALE in 1875. There is no question of the locality "Buitenzorg" appended to one of these samples, as MARTENS related.

On the other hand there is a sample of two *Tr. lardea* MARTS from Buitenzorg (= Bogor), Java, collected by TEYSMANN in 1862, in the MOUSSON Collection. These are true *lardea*. They are higher conical, with a narrow umbilicus and with a thickened peristome along the upper and lower margin. Their dimensions are: height 5 resp. 5 mm, width 14 resp. 13½ mm, height of aperture 3½ resp. 3 mm.

It may be that MOUSSON, on receiving these shells from TEYSMANN in 1862 (when *Tr. lardea* MARTENS was not yet created), named these shells *Tr. zollingeri* PFR, and that afterwards MARTENS when inspecting the MOUSSON Collection between 1864 and 1867 renamed these shells *lardea* MARTS, a name copied later on by MOUSSON on the label. This explanation, however, is pure guess work.

A figure of one of the Bogor shells of *Tr. lardea* is reproduced here (fig. 77).

One may wonder how a species, which is a native of the Ambon group of islands in the Moluccas (Ceram, Ambon and Buru), found its way to Bogor in West Java. If any mislaying of labels or specimens is to be excluded, the shells might have been transported with plants from the Moluccas for the Botanical Garden to Bogor. TEYSMANN himself travelled

much and far, visiting the Moluccas and sending living plants to Bogor. Hence there is plenty of opportunity for involuntary introduction. In later years *Tr. lardea* has never been found in Java again.

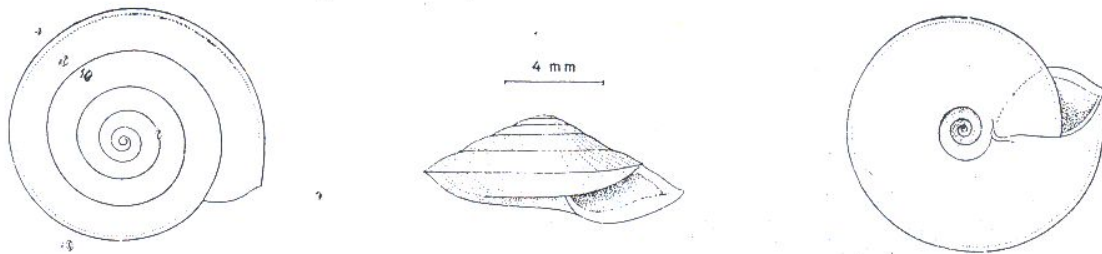


Fig. 77. *Trochomorpha lardea* MARTS. Shell from top, side and base. HEMMINGA del.

Doubtful species of *Zonitidae*.

For many years there has been some uncertainty about the status of MOUSSON'S species *Zonites micula* (Journ. de Conch. 6, p. 158, 1857) from Bali, collected by ZOLLINGER in 1856. In 1950 I could clear up this problem (Basteria, 14, p. 63) from which publication the following lines are quoted.

In 1867 MARTENS (Ostas. Landschn. p. 258) mentioned the species, verbally citing MOUSSON'S diagnosis, and recording shells from Bogor, Java, collected by TEYSMANN (see also ZOLLINGER, in: Natuurk. Tijdschr. Ned. Indië, 18, 1859, p. 424 and TENISON WOODS, in: Proc. Linn. Soc. N. S. W. (2) 3, p. 1028, 1888, s.n. *Trochomorpha micula*).

In 1914 LESCHKE (Mitt. naturh. Mus. Hamburg, 31, p. 229) placed it in the genus *Sitala* and I followed him in this respect (VAN BENTHEM JUTTING, 1929, Treubia, 11, p. 78).

A few years later (1931, Zool. Jahrb. (Syst.) 61, p. 70) RENSCH, when describing an immature *Durgellina* from Bali and Flores added: "Ich möchte annehmen, dass es sich hier um eine "*Zonites micula*" MOUSSON handelt Allerdings stimmt dazu die Angabe "apertura rotundato semilunaris" nicht". (I am inclined to suppose that we have to do here with "*Zonites micula*" MOUSSON, although the indication "apertura rotundato semilunaris" does not agree).

The only way of forming a definite opinion was to study MOUSSON'S original lot. The Museum of Zürich kindly sent to me on loan MOUSSON'S specimens from Bali. They proved to be the same species which MOELLEN-DORFF in 1897 described from Java under the name *Kaliella ambli* (Nachr. Blatt, 29, p. 60) which I quoted as *Liardetia ambli* (1950, VAN BENTHEM JUTTING, Treubia, 20, p. 409).

If the specimens from Bogor, mentioned by MARTENS, are identical with MOUSSON'S shells—a fact which I cannot check because I have not

seen MARTENS' material, nor do I know where it is housed (not in the Berlin Museum or in the Leiden Museum), then the Bogor shells collected by TEYSMANN equally belong to *Liardetia ambli*.

At any rate *Zonites micula* is not identical with the shells which RENSCH associated with it and which he figured on pl. 3, fig. 39.

Summarizing, it can be stated that *Zonites micula* MOUSSON, 1857 and *Kaliella ambli* MOELLENDORFF, 1897 are synonymous and that for the sake of priority the species ought to bear the first specific name. On account of modern research it must be placed in the genus *Liardetia*, the full name now being *Liardetia micula* (MOUSSON, 1857).

Familia VITRINIDAE

Shell low conical, very thin and fragile. Transparent and polished. With only few whorls which rapidly increase in size. Generally not perforate. Aperture very wide and oblique.

In several species the animal cannot retract entirely in its shell. Foot slender, footsole tripartite. Mantle with two neck- and two shell lobes, partly hiding the shell when the animal is moving.

Mandibula with an obtuse prominence at the concave side. Radula with tricuspid rhachis and laterals. Marginals bi- or tricuspid.

Receptaculum seminis with short canal. Amatorial gland of the vagina present (most *Vitrina* species) or absent (genus *Vitrinopsis* and a few *Vitrina* species).

Distribution: Palaearctic region, tropical Asia, E. Africa and N. America.

In Java only one genus:

Genus *Vitrinopsis* SEMPER, 1873

Shell low conical, wide, fragile, glassy-transparent, highly polished. Finely striate according to the growth lines. With few whorls, rapidly increasing in size, the last one very large. Suture almost impalpable. Apex obtuse, base rounded. Umbilicus closed.

Aperture oblique, broadly lunar. Peristome not continuous, sharp, thin, not reflected.

Animal with two large mantle lobes covering part of the shell when the snail is moving. Foot tripartite, tapering to a narrow point, without tail-horn (fig. 78). Mandibula horse-shoe-shaped, with an obtuse prominence at the concave side. Radula ∞ .1. ∞ . Rhachis and latero-marginals tricuspid (fig. 79).

Distribution: Philippines, Java, Bali, Lombok, Sumbawa, Flores, Timor.

In Java only one species:



Fig. 78. *Vitrinopsis fruhstorferi* (MLLDFF). Preserved animal from right and left side, showing mantle lobes and pointed foot. Author del. Fig. 79. *Vitrinopsis fruhstorferi* (MLLDFF). Radula elements (after RENSCH).

***Vitrinopsis fruhstorferi* (MOELLENDORFF, 1897) (fig. 78, 79 and 80).**

- 1897 MOELLENDORFF, Nachr. Blatt, 29, p. 58 (*Helicarion*).
- 1912 SCHEPMAN, Proc. Malac. Soc. London, 10, p. 229, pl. 10, fig. 1, 2 (*collingei*).
- 1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 223 (*Helicarion fruhstorferi* and *Vitrinopsis collingei*).
- 1925 VAN BENTHEM JUTTING, Treubia, 6, p. 143 (*Helicarion lineolatus* v. B. J. non MARTENS).

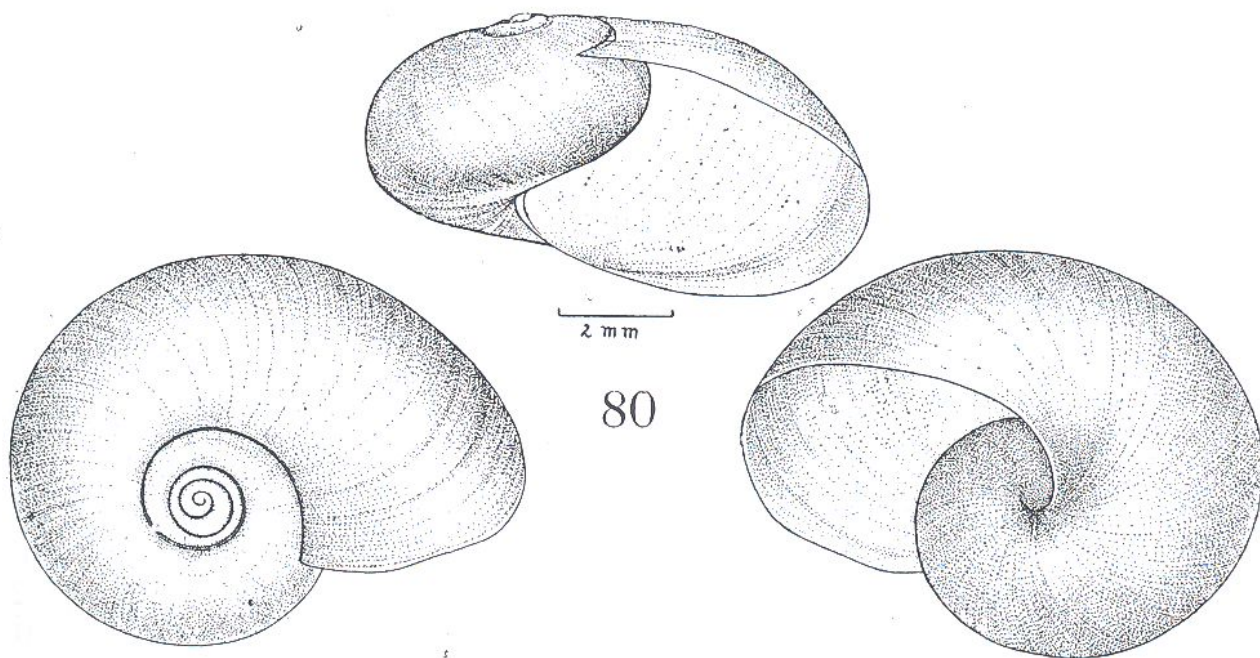


Fig. 80. *Vitrinopsis fruhstorferi* (MLLDFF). Shell from side, top and base. ABDUL-KADIR del.

- 1929 VAN BENTHEM JUTTING, Treubia, 11, p. 76 (*Helicarion fruhstorferi* and *Vitrinopsis collingei*).
- 1932 RENSCH, Zool. Jahrb. (Syst.) 63, p. 79.
- 1934 RENSCH, Trop. Binnengew. 4, p. 754.
- 1941 VAN BENTHEM JUTTING, Arch. néerl. Zool. 5, p. 309 (*Helicarion lineolatus* v. B. J. non MARTENS).
- 1950 VAN BENTHEM JUTTING, Treubia, 20, p. 419.

Shell with very low spire and rapidly increasing whorls, the last one very large and spacious. Yellowish-brown in live animals, but more greenish in empty shells. Finely striated radially and with still more delicate spiral striae. With high glassy lustre, transparent. Suture shallow, margined.

Whorls $4\frac{1}{2}$ to 5, little convex, irregularly coiled, so that after $1\frac{1}{2}$ to 2 whorls the third whorl is narrower than the preceding ones. After this the whorls become wider again. Top obtuse, base rounded. Umbilicus closed.

Aperture oblique, broadly lunar. Peristome not continuous, sharp, thin, not reflected.

Dimensions: height 8 to 9 mm, width 11 to $11\frac{1}{2}$ mm, height of aperture 7 to $7\frac{1}{2}$ mm.

Distribution: Java, Sebesi, Bali, Lombok, Sumbawa, Flores.

Habitat in Java: living on the ground, on low vegetation or on decaying wood, in the mountain forest between 100 and 1300 m altitude.

West Java: Tjibodas, Mt. Gedeh, 1400 m; Ujung Genteng, near Sandbay, 100 m; Pasir Pabeasan, in limestone hills near Padalarang, 800 m.

Central Java: Gamping, near Djokja, 100 m.

East Java: Southern Mts, near Pasuruan, 1500 feet; Tengger Mts (LESCHKE); Nongkodjadar, Tengger Mts, 1200 m; Djabung, near Wlingi, 800 m; Kali Mrawan, 1000 m.

On account of a few differences in the shell and in the soft parts of the present species, compared with the two *Vitrinopsis* of the Philippine Islands on which SEMPER's generic diagnosis was founded, RENSCH (1932) suggested to bring *Vitrinopsis fruhstorferi* into a new subgenus: *Sundavitrina*. A critical comparative study of all the species would seem to be necessary to confirm this opinion.

Radula ∞ .1. ∞ . Rhachis tricuspid with two small ectocones, latero-marginals tricuspid, the two outermost teeth being only small and shapeless.

The animal was described after a preserved specimen by SCHEPMAN (1912, s.n. *Vitrinopsis collingei*) as follows: "Of a light flesh coloured tint

which on its upper surface is only clearly visible beneath the shell and the foot-fringe, the neck of a rather dark slate colour, as well as the upper tentacles, the sides of the anterior part mottled with faint spots of black pigment, the dorsal face of the caudal part nearly quite blackish, mantle blackish, with two lobes; right mantle lobe large, strongly black-spotted, leaving only an arborescent figure of whitish colour; left lobe narrower, of the same colour, but of simpler pattern, with only a few light-coloured branches; caudal part sharp, pointed behind, without mucous pore, with a median dorsal groove of lighter colour, and oblique furrows; running from the median groove towards the posterior end; foot-fringe bordered above by a double, impressed line. Foot-sole divided in a narrow median and two lateral planes, flesh-coloured, darker behind".

RENSCH (1932, p. 80) made some observations on living animals: "The foot of the living animal is dark-grey to black-gray with brownish-white wedge-shaped dorsal stripes and a few equally coloured little spots merging into the ground colour on the body flanks. The central area of the footsole is light brownish, the lateral zones gray black, or occasionally light brownish. The mantle lobes are brownish-white with grey-black spots, distributed in the form of a dark leaf with light veins. Length of a preserved animal about 45 mm from the snout to the tip of the tail. In the living animal the mantle lobes cover a large part of the shell when the animal is moving undisturbed. The snail cannot entirely withdraw into its shell; the mantle lobes can only be partly retracted. The animal is very active; when touched it moves the body convulsively to right and left".

In Part II, p. 419 of these Critical Studies (Treubia, 20, 1950) I have already pointed out the confusion concerning *Helicarion fruhstorferi*, *Vitrinopsis collingei* and *Vitrinopsis dohrni*. It is perhaps of interest to repeat that paragraph here:

"The species (*Vitrinopsis fruhstorferi*) is synonymous with *Vitrinopsis collingei* SCHEPMAN, 1912, from Nongkodjadjar (Proc. Malac. Soc. London, 10, p. 229) and also with the (unpublished) *Vitrinopsis dohrni* BOETTGER (museum label name in Senckenberg Museum, no. 62538) from the Southern Mountains, residency of Pasuruan, 1500 feet, collected by H. FRUHSTORFER in 1891.

The type specimen of *Vitrinopsis fruhstorferi* (MOELLENDORFF) was collected in the same locality (Museum Senckenberg, no. 62491) and not in West Java as RENSCH (1932) pretended.

On the other hand the shell of *Vitrinopsis dohrni* BOETTGER, ms, collected at Mount Tjikoraj, West Java, by H. FRUHSTORFER and preserved

in the SCHEPMAN Collection of the Amsterdam Zoological Museum, is not a *Vitrinopsis* or a *Helicarion*, but a *Microparmarion* sp."

The animals from Sebesi Island which I brought to *Helicarion lineolatus* in 1925 (VAN BENTHEM JUTTING, Treubia, 6, p. 143, see also VAN BENTHEM JUTTING, 1941, Arch. néerl. Zool. 5, p. 309) have, on renewed investigation, proved to be *Vitrinopsis fruhstorferi* (MLLDFE).

What *Vitrinopsis* sp. (BOETTGER, 1891, Ber. Senckenb. p. 242), collected in the estate Arga Sarie, Mt. Malabar, 5000 feet, is like, I am unable to decide.

Familia PHILOMYCIDAE

Slugs of moderate to large size. The mantle covers the whole back, there is no discrimination between shield and body. Respiratory orifice on the right side in the slit near the anterior edge of the mantle. In this slit the kidney and the anus open also. Footsole undivided. No caudal gland.

Hermaphroditic, the male organs with or without a dart-sac. No epiphallus. A vesicula seminalis may be absent or present (present in both Javanese species of *Meghimatium*). Genital opening on the right side, somewhat behind the right ommatophore.

Radula ∞ . 1. ∞ . Rhachis uni- or tricuspid. Laterals uni- or bicuspid. Marginals bi- or multicuspid (fig. 81).

Mandibula horse-shoe-shaped or crescent-shaped, aulacognathous, with a short projection at the concave side.

Distribution: Japan, China, Tonkin, India, Borneo, Sumatra, Java, Celebes, temperate and tropical America, south to Colombia. Introduced in the Hawaiian Islands.

In Java only one genus:

Genus *Meghimatium* VAN HASSELT, 1823

Slugs of moderate to large size. Usually with 5 longitudinal dark-brown to black bands on a lighter background. In some species the bands are straight and well marked, in others diffuse, cloudy or split up in rows of dark dots or anastomosing to a reticulate pattern. Footsole undivided, unicolorous, yellowish or buff.

Animals hermaphroditic, the male organs without an amatorial organ. Fertilisation takes place by means of a spermatophore.

Radula and mandibula as described for the family.

Distribution: Japan, China, Tonkin, India, Borneo, Sumatra, Java, Celebes. Introduced in the Hawaiian Islands.

In Java there are two species:

1. Ground colour light yellow to light orange, with 5 dark well defined longitudinal lines **striatum**
- Ground colour yellowish-white, with 5 dark longitudinal bands which are often dissolved in rows of dark cloudy spots, or in a mesh-work of anastomosing veins **bilineatum**

Meghimatium striatum VAN HASSELT, 1823 (fig. 81, 82 and 83).

- 1823 VAN HASSELT, Alg. Konst- & Letterb. 2, p. 232.
 1824 VAN HASSELT, Bull. Sci. Natur. et de Géol. 3, p. 82.
 1832 FÉRUSAC, Hist. Nat. génér. part. Moll. pl. 8E, fig. 1 (*strigatum* sic!) (text p. 96^b by DESHAYES published between 1839 and 1851).
 1866 KEFERSTEIN, Malak. Blätt. 13, p. 67, pl. 1, fig. 1-4.
 1867 MARTENS, Ostas. Landschn. p. 178 (*Philomycus*).
 1870 BERGH, Verh. Zool. Bot. Ges. Wien, 20, p. 855 (*Philomycus*).
 1885 HEYNEMANN, Jahrb. d. malak. Ges. 12, p. 302 (*Philomycus*).
 1885 TRYON, Man. of Conch. (2) 1, p. 229, pl. 56, fig. 5 (*Tebennophorus*).
 1890 COCKERELL, Ann. Mag. Nat. Hist. (6) 6, p. 387 (*Limacella*).
 1892 MARTENS, Erg. Reise N. O. Indien, 2, p. 233 (*Philomycus*).
 1903 SIMROTH, Sitz. Ber. naturf. Ges. Leipzig, 1901-1902 (1903) p. 41 (*Philomycus*).
 1914 LESCHKE, Mitt. naturh. Mus. Hamburg, 31, p. 225 (*Philomycus*).
 1924 HOFFMANN, Jen. Zeitschr. Naturw. 60, p. 374 and 383 (*Philomycus*).
 1929 VAN BENTHEM JUTTING, Treubia, 11, p. 76 (*Philomycus*).

Slug of moderate size, ground colour of the mantle orange-yellow to pink, with 5 dark, almost black, longitudinal bands, one median, and two lateral ones on either side. The two lowermost bands can be very thin and thread-like or they may be absent altogether. In occasional specimens there can occur fine, irregular, black veins from one band to another. Other animals have a light central zone in the black bands.

Respiratory orifice in the slit on the right side. In this slit the rectum opens also. Genital aperture behind the right ommatophore, below the mantle and somewhat anteriorly of the mantle-slit.

Footsole undivided, unicolorous, somewhat lighter than the ground colour of the mantle.

In the genital organs prepared from a slug collected at Mount Tangkuban Prahū the receptaculum seminis was large, with the blind division broadly cylindrical, with weak longitudinal folds. In the atrium genitale a thick internal fold (ligula) was projecting from the wall between the opening of penis and oviduct.

Mandibula horse-shoe-shaped, ribbed, with a short protuberance at the concave side. There is a considerable amount of variation in the sculpture of the jaw, from almost smooth to coarsely ribbed.

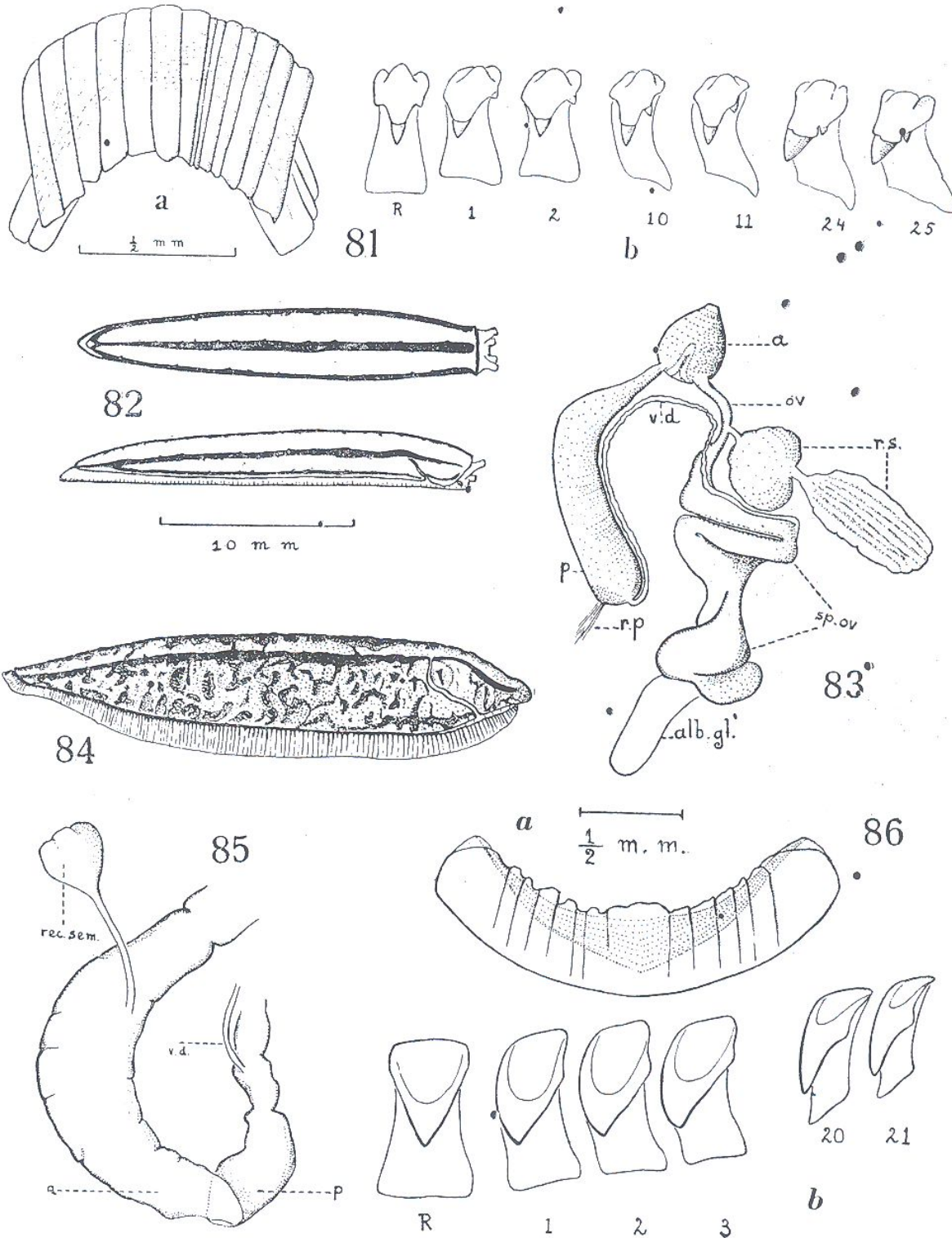


Fig. 81. *Meghimatium striatum* v. HASS. a. mandibula; b. radula elements. Fig. 82. Same species. Animal from back and side. Fig. 83. Same species. Sexual organs. a. atrium genitale; alb. gl. albumen gland; ov. oviduct; p. penis; r.p. retractor penis; r.s. receptaculum seminis; sp. ov. spermoviduct; v.d. vas deferens. Fig. 84. *Meghimatium bilineatum* (BENS.). Preserved animal from right side. Length 40 mm, height 11 mm, width 8 mm. Fig. 85. Same species. Distal part of sexual organs. a. atrium genitale; p. penis; rec. sem. receptaculum seminis; v.d. vas deferens. Fig. 86. Same species. a. mandibula; b. radula elements. The marginal teeth were so weakly developed that they could not be drawn with certainty. All figures author del.

Radula 40.1.40. Rhachis with a large central cusp and two inconspicuous lateral denticles. Lateral teeth bicuspid, with a very small ectocone. Marginal teeth multicuspid, small. KEFERSTEIN (1866, fig. 4) figured the lateral teeth of the radula with 1 cusp only. In my specimens they were distinctly bicuspid.

Dimensions: length about 40 mm, width 9 mm, height 9 mm. These measurements were taken from preserved specimens.

Distribution: Java, Sumatra, a somewhat different form in South Celebes. The record for Sumatra is new; this animal was found by Jonkheer F. C. VAN HEURN at Situng Galing, Karo Highlands. The central and upper lateral bands of this slug were normal, but instead of the lower lateral bands it had 7 small specks on the left side and 4 on the right. Length of the slug (in alcohol) 19 mm.

The record for Honolulu (COLLINGE, 1897, Proc. Malac. Soc. London, 2, p. 295) was erroneous for *Meghimatium australe* (BERGH) (COLLINGE, 1899, Journ. Malac. 7, p. 80 footnote), syn. *Megh. bilineatum* (BENSON). It is not certain whether the earlier record of COLLINGE (1896, Proc. Malac. Soc. London, 2, p. 50) from Mt. Tantalus, near Honolulu, has to undergo this same change of name. The genital organs of this animal which COLLINGE figured at p. 48, fig. VI do not agree with the organisation of *Meghimatium striatum*, because the duct of the receptaculum seminis opens into the vaginal atrium separately from the oviduct.

Habitat in Java: *Meghimatium striatum* lives on pieces of bark, stumps and dead logs, generally hiding away during the day. Only during very wet weather it may be found creeping about at daytime, but they generally come out only at night. The food consists of various fungi. Recorded between 350 and 2800 m altitude, in the rain forest.

West Java: wood near Mt. Karang, 1000 m; Mt. Salak, near Tjigombong, 700 m; Tjisarua-Z., 800 m; Megamendung, 800 m; wood near Telaga Warna, near Puntjak pass, 1450 m; Tapos, slope of Mt. Pangrango, 1000 m; Tjibodas, 1400 m and various localities up to 2800 m on E slope of Mts Gedeh and Pangrango, often on fungi; Situ Gunung, S slope of Mt. Gedeh, 1100 m; Radjamandala, 350 m; wood near Leuwimanggu, 800 m; Mt. Malang, 1000 m; Mt. Patuha, feeding on *Polyporus* 1550 m; Mt. Malabar, 1600 m; Mt. Burangrang, 1900 m; Mt. Tangkuban Prah, 1000-1500 m.

By the courtesy of the authorities of the Leiden Museum I could examine the original lot of three specimens (long 21, 21 and 10 mm), collected by KUHLE & VAN HASSELT in Java (catal. no. 70, no further details of locality) and described by VAN HASSELT (1823). DESHAYES (in FÉRUSAC,

l.c.) added the more precise locality Mt. Gedokan, which is obviously copied from an unpublished drawing by G. L. KEULTJES in the same Institute, bearing the reference: "Tongo in Monte Gedokan". According to MARTENS (1892), this Gedokan represents part of Mt. Salak, West Java.

The Leiden animals (in liquor) do not show the slightest trace of the usual colour-pattern: the dark longitudinal bands on a light orange background. All three slugs are uniformly sooty brown. Whether the animals never possessed the typical colour-pattern, or — what seems more likely — whether the decoloration is due to unsatisfactory preservation, I am unable to decide. The original drawing does indeed figure a striped animal. The two oldest *Meghimatium striatum* in the Amsterdam Museum, collected by MAX WEBER at Tjibodas in 1888 (MARTENS, 1892), and which have now been in alcohol for over 60 years, still show the characteristic colour-pattern quite clearly.

***Meghimatium striatum* forma *reticulata* FÉRUSAC, 1832 (fig. 87).**

- 1832 FÉRUSAC, Hist. Nat. génér. partic. Moll. pl. 8E, fig. 2-3 (text p. 96⁵ by DES-HAYES published between 1839 and 1851) (*Megh. reticulatum*).
 1862-1866 KEFERSTEIN, in BRONN, Klass. & Ordn. Tierr. Weichtiere, Bd. 3; Abt. 2, pl. 101, fig. 7 (*Megh. reticulatum*).
 1870 BERGH, Verh. Zool. Bot. Ges. Wien, 20, p. 855 (*Philomycus*).
 1885 HEYNEMANN, Jahrb. d. Malak. Ges. 12, p. 302 (*Philomycus reticulatus*).
 1885 TRYON, Man. of Conch. (2) 1, p. 167 (*Parmarion reticulatus*), p. 229, pl. 56, fig. 10 (*Tebennophorus reticulatus*).
 1890 COCKERELL, Ann. Mag. Nat. Hist. (6) 6, p. 387 (*Limacella reticulata*).
 1924 HOFFMANN, Jen. Zeitschr. Naturw. 60, p. 383 and 387 (*Philomycus reticulatus*).

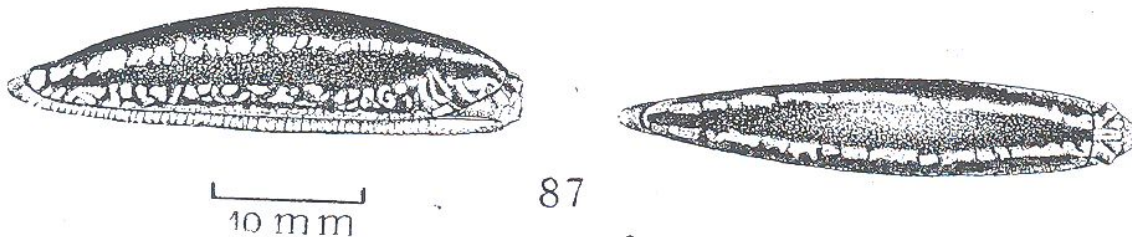


Fig. 87. *Meghimatium striatum* f. *reticulata* FÉR. Animal from side and back. ABDUL-KADIR del.

The animal differs from the main form in the reticulate pattern of the dark markings on the mantle. The ground colour of the mantle is more reddish brown instead of yellowish brown or pink.

Dimensions: in the original description the length is given as 38 mm and the width as 7 mm. The specimens which I could examine (all preserved) are long between 41 and 8 mm.

Distribution: Java.

Habitat in Java: occurs in the same surroundings as the main form.

West Java: wood near Mt. Karang, 1000 m; Mt. Gedokan (= part of Mt. Tangkuban Prahau massif) (FÉRUSSAC); Tegal Primula, Mt. Papan-dajan, 2200 m; E slope of Mt. Telagabodas, 1200 m.

In the Leiden Museum there is a sample of 7 slugs preserved under the name *Philomycus reticulatus* VAN HASSELT (length 41, 40, 38, 30, 25, 21, 18 mm) from Java (catal. no. 69, label without further details) collected by KUHLE & VAN HASSELT. Whether they form the original lot on which the figure and description in FÉRUSSAC (1832) were based¹), I am unable to say. At any rate the slugs do not show the slightest trace of the reticulate pattern. Like the sample of *Meghimatium striatum* from the same origin, mentioned in the preceding paragraph, the animals are of a uniform dull dark-grey to dark-green hue.

HOFFMANN (1924) tentatively classified *Meghimatium reticulatum* under *Megh. pictum*, but it has more affinities to *Megh. striatum*.

Whether *Meghimatium tarmes* (SARASIN & SARASIN) should be considered to be a dark *Megh. striatum* forma *reticulata*, I am unable to decide. The marbled pattern on the back of the notum and the more punctated lateral parts of the animal point in that direction. The bluish hue of the dark parts—as Messrs SARASIN remarked—is caused by a fine mucous layer hiding the black colour. The radula of *Meghimatium tarmes* is reported to bear a rhachis with a bifid central cusp, which is quite unusual in *Meghimatium* (SARASIN, 1899, pl. 30, fig. 301). Messrs SARASIN remarked already that this bifurcation may be incidental and may “vermutlich auch fehlen” (probably be also absent). So long as no better evidence is available I must leave this form out of account.

***Meghimatium striatum* forma *celebica* (SARASIN & SARASIN, 1899)**
1899 SARASIN & SARASIN, Landmoll. Celebes, p. 207, pl. 9, fig. 100 (*Philomycus*).

This variety differs from the main form in having the dark longitudinal bands on the mantle much broader than their interstices, so that the slug makes the impression of a dark, almost black, animal with 4 very narrow light stripes.

It remains to be seen whether this is a constant colour form. (Only one animal collected.) As I pointed out in the description of the main form,

¹) VAN HASSELT never described *Meghimatium reticulatum*. Therefore FÉRUSSAC on account of Plate 8E fig. 2-3 must be considered to be the author. FÉRUSSAC remarked that the figure was prepared after a drawing by VAN HASSELT. MARTENS, however, who inspected VAN HASSELT's original figures in the Leiden Museum, reported that such a figure is not in that institute (1892, Erg. Reise N.O.I., 2, p. 234).

the dark bands are liable to variation, and in some cases it is difficult to decide if the bands are still limited enough to classify the slug as *Meghimatium striatum*, or if they have just reached the required width to designate it as *Meghimatium striatum* forma *celebica*.

Meghimatium striatum forma *celebica* has not yet been found in Java.

Meghimatium bilineatum (BENSON, 1842) (fig. 84, 85 and 86).

- 1842 BENSON, Ann. Mag. Nat. Hist. 9, p. 486 (*Incilaria*).
 1870 BERGH, Verh. Zool. Bot. Ges. Wien, 20, p. 855 (*Philomycus*).
 1885 TRYON, Man. of Conch. (2) 1, p. 229, pl. 56, fig. 5 (*Tebennophorus*).
 1890 COCKERELL, Ann. Mag. Nat. Hist. (6) 6, p. 386 (*Limacella*).
 1903 COLLINGE, Journ. Malac. 10, p. 79-82 ("probably a variety of *Philomycus bilineatus*").
 1908 COLLINGE, Journ. of Conch. 12, p. 118 (*Philomycus*).
 1924 HOFFMANN, Jen. Zeitschr. Naturw. 60, p. 364 (*Philomycus*).

Slugs of moderate to large size, with 3 to 5 longitudinal brown or black bands on a yellowish-white background. The central band can be dissolved in rows of dark cloudy spots or in a reticulate pattern. The upper lateral bands are distinctly limited along their medial edge, but more diffuse along their ventral edge. The lower lateral bands are only vaguely marked along the front part of the mantle edge. Between the bands the notum is irregularly flecked with brown spots. Upper tentacles dark, of about the same colour as the longitudinal bands. Footsole yellowish or whitish, unicolorous, not divided in longitudinal zones.

Animals hermaphroditic, male organs without a dart-sac. The atrium of the second largest animal from Java which I could investigate is not so bottle-shaped as in HOFFMANN's figure (1924, pl. 22, fig. 12 and p. 370, fig. 6) and the spermatheca duct is much narrower. The latter feature — according to HOFFMANN — is an indication that the animal is not yet sexually mature (1924, p. 371, fig. 7) (fig. 85).

• Radula $\infty . 1 . \infty$, central tooth with a large central cusp. Lateral teeth indistinctly bicuspid, marginal ones bi- to multicuspid, small (fig. 86).

Mandibula horse-shoe-shaped to crescent-shaped, striate or ribbed with a short projection at the concave side. Left and right of the median line the ribs are not equally broad and equally numerous. The mandibula of the Javanese slug is somewhat wider in transverse direction than the one HOFFMANN figured (1924, pl. 22, fig. 6). The lesser width of HOFFMANN's figure may be caused by the fact that this author presented the jaw in the natural curved position whereas in my figure it is drawn after a jaw prepared in flat condition.

Dimensions: the four specimens collected in Java have the following dimensions:

length	40	25	22	19	} mm
width	8	7	5	5	
height	11	8	6	5	

SIMROTH (Sitz. Ber. naturf. Ges. Leipzig 1897-1898 (1899) p. 31) mentioned specimens of *Meghimatium bilineatum*, in preserved condition, of 85 mm length.

Distribution: Chusan I., China, Japan, Liu Kiu Is., Formosa, Tonkin, India, Borneo (?), Java, Sandwich Is.

Habitat in Java: living on the ground, under stones, in decaying grass.

West Java: Pengalengan, under stone, in decaying grass, 1700 m, Febr. 12, 1948.

The specimens from Pengalengan are the first modern record of this species, 40 years after COLLINGE (1908) mentioned it from "Java". I have not seen the latter slug, an immature animal, collected by Major P. A. OUWENS. Whether the species has lived in Java for all these years or whether the old colony became extinct and the 1948 record is a new introduction, I am unable to decide. In this connection it may be reminded that the Japanese, during their occupation of the island of Java from 1942 to 1945, may have imported involuntarily *Meghimatium bilineatum*, which is a common species in their country.

Concerning the biology of *Meghimatium bilineatum* living in Japan, several details have been published on their sexual cycle and life history. In solitary individuals self-fertilization can occur resulting in an equally fertile and abundant progeny as in cross-breeding slugs. Whether these facts are similar in the Javanese representatives is totally unknown. In order not to create mistaken notions for the Javanese slugs of *Meghimatium bilineatum*, I have left out all evidence relating to observations in nature and in the laboratory made in their original countries: China and Japan. Malacologists who are interested in such processes are referred to IKEDA, 1929, Annot. Zool. Japon. 12, p. 295-321, and 1937, Journ. of Sci. Hiroshima Univ. (B) 5, p. 67-123). It is recommended to future investigators to compare this information with the observations carried out on Javanese specimens.

By their colour-pattern the slugs are difficult to detect in their natural surroundings. Yet it seems going a little too far when SIMROTH (1899, Sitz. Ber. naturf. Ges. Leipzig, 1897-1898, p. 30-34) interpreted

this protective coloration as a case of advantageous mimicry, the slug thus imitating a poisonous viper and consequently being avoided by supposed predators.

Familia LIMACIDAE

Animals naked exteriorly, but with a small interior shell. Front part of the slugs covered by a "shield" which is a modified part of the mantle. Texture and colour of the shield are generally different from the rest of the body. Footsole tripartite.

Respiratory orifice on the right side of the body, close to the slit in the shield. Genital organs open behind the right ommatophore.

Mandible oxygnathous, horse-shoe-shaped or crescent-shaped, with a median projection at the cutting edge.

Radula $\infty . 1 . \infty$. Rhachis and adjoining latero-marginals tricuspid. Outer marginals dagger-shaped, unicuspid, or with a minute second denticle.

Distribution: Holarctic region. Several species have been introduced through commerce in other continents.

In Java only one genus:

Genus *Deroceras* RAFINESQUE, 1820

Animals with a small interior shell, and a long slender body. The shell is lying in the "shield", a rudimentary part of the mantle on the anterior end of the body. On the right side, behind the middle of the shield, is a small slit in the shield. Close to this slit lies the respiratory orifice. The opening of the generative organs lies behind the right upper tentacle. There is no caudal mucous pore.

Mandible oxygnathous, crescent-shaped or horse-shoe-shaped, with a median projection at the concave side.

Radula $\infty . 1 . \infty$, the central tooth and the laterals tricuspid. Marginals pointed, dagger-shaped and a little curved (fig. 88).

Distribution: Europe, Asia Minor, N. Africa, N. America. Several species have a world-wide distribution, and are probably introduced.

In Java there is only one species:

Deroceras laeve (MÜLLER, 1774) (fig. 88 and 89).

1774 MÜLLER, Verm. Hist. 2, p. 1, no. 199 (*Limax*).

1941 HOFFMANN, Zool. Anz. 136, p. 243, fig. 1 (*Agriolimax*).

Shell small, thin, calcareous, white, nearly flat. It is placed under the skin in the posterior part of the dorsal shield. Size of the shell about $2\frac{1}{2} \times 1\frac{1}{2}$ mm. From the posterior nucleus of the shell concentric growth lines spread in semi-circles in forward direction.

Animal (in alcohol) yellowish grey to brownish grey, with darker pigmentation as speckles and veins on the shield and on the back of the body, especially in the grooves between the skin tubercles. Towards the footsole the pigmentation disappears gradually. Round the pneumostome there is a lighter zone.

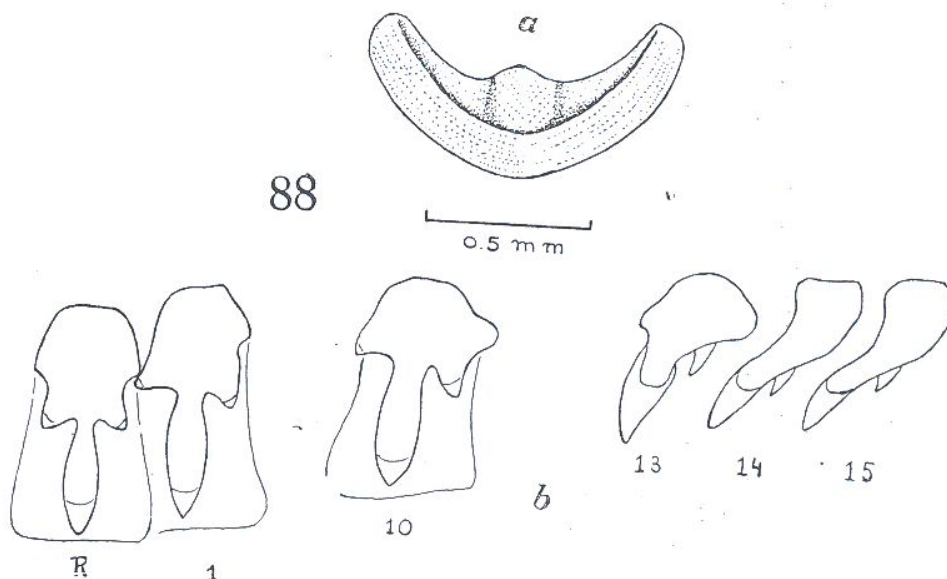


Fig. 88. *Deroceras laeve* (MÜLL.). a. mandibula; b. radula elements. Author del.

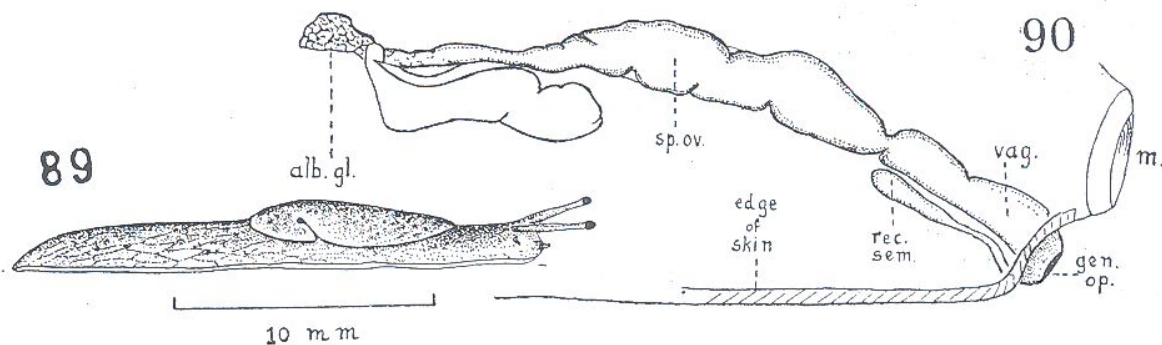


Fig. 89. *Deroceras laeve* (MÜLL.). Animal from right side. Author del. Fig. 90. Same species. Sexual organs. alb. gl. albumen gland; gen. op. genital opening; m. mouth; rec. sem. receptaculum seminis; sp. ov. spermooviduct; vag. vagina. Author del.

Shield about one-third of the total length of the animal. It is minutely granular, the granules indistinctly arranged in concentric ovals. Neck long, hence the shield of live specimens lies more median than in other limacid slugs. Head dark, tentacles almost black. Tail-end indistinctly keeled.

Footsole yellowish grey, in the preserved specimens from Java unicolorous, divided in three longitudinal zones. Mucus colourless, hyaline.

The reproductive organs of specimens from Mount Tangkuban Prahū were described by HOFFMANN (1941) to be aphyllid, no male organs being developed. The animals were obviously in the female phase, such as described by BABOR (1894, Verh. deutsch. Zoolog. Ges. 4 (München) p. 55-61, see also TAYLOR, 1894, Monogr. Land & Freshw. Moll. Brit. Isles, 1, p. 124, fig. 137).

Of another sample, collected at Pengalengan by Mr L. J. M. BUTOT in January 1948, I dissected the largest animal (about 20 mm length in alcohol) and found it equally to be in the female stage (fig. 90).

In both samples the generative organs were not pigmented, with the exception of the hermaphroditic gland which was bluish-grey.

Mandible crescent-shaped, with rounded ends and a median projection at the concave side.

Radula with tricuspid rhachis and laterals. The marginals are dagger-shaped and a little curved, in the medial ones with a small ectocone.

Distribution: Europe, N. Asia, N. and C. America. Introduced in N. Africa, S. Africa, Canary Is., West Indies, S. America, Australia, Polynesia, Java, Ceylon, Madagascar.

West Java: Mt. Tangkuban Prahū, 1000—1600 m; Pengalengan, on decaying paper and plantain leaf, in vegetable garden, 1700 m.

Of the Javanese specimens nothing is known of their habits and food. European *Deroceras laeve* prefer damp, even wet places in woods. From the various records of introduced representatives, however, it is evident that the immigrants have adapted a mode of life somewhat different from their behaviour in European countries. They are no longer the hydrophilous species of marshy sites, but live in gardens and plantations. It is true that in a tropical climate such ecological conditions warrant a satisfactory supply of moist.

European *Deroceras laeve* keep chiefly to a vegetable diet, but occasionally they do not despise animal food. The slugs are active and speedy, and can also form slime-threads by which they may hang down from leaf tips.

In European specimens the reproductive cycle starts with the female phase, no male organs like penis and its appendages being as yet developed. Later, the male organs begin to appear, till the animals are perfectly hermaphroditic. After this the female organs atrophy and the animals

end in a purely male phase (BABOR, 1894). This alternation of sex concerns especially the emissary vessels and their appendages, but not the reproductive glands, because in the ovotestis there have been stated sperm cells in the female stage as well as egg cells in the male phase.

Whether the sexual cycle can be repeated in a single individual's life, is unknown. It is equally uncertain how long the animals live and how much time it takes before the various stages are completed.

One fact, however, is remarkable, viz. that in the regions where *Deroceras laeve* is not indigenous but lives as an immigrant, almost all animals which have been checked anatomically are in the aphyllid stage, male organs being not, or only rarely and incompletely, developed. Such has been reported by various authors: SIMROTH (1884, Sitz. Ber. naturf. Ges. Leipzig, 10, p. 74 and 1887, Zeitschr. wiss. Zool. 45, p. 646), GRIMPE & HOFFMANN (1925, Nova Caledonia, Zool. 3, p. 407), BOETTGER (1931, Arch. Zool. Ital. 16, p. 255), HOFFMANN (1941, l.c.), PILSBRY (1948, Land Moll. North America, 2, Part 2), VAN REGTEREN ALTENA (1950, Zool. Verh. Rijksmus. Nat. Hist. Leiden, 11, p. 19).

Although no exact experiments have been carried out, one must admit that animals in this female condition can propagate quite well, probably through internal self-fertilization, because *Deroceras laeve* is by no means rare in its new surroundings.

This aphyllid variety, race, mutation, or modification has been named *Deroceras laeve sandwichense* (EYDOUX & SOULEYET) by BOETTGER (1931).

It is curious that the phenomenon has originated independently in several countries where *Deroceras laeve* has been introduced. BOETTGER (1931) considered it an adaptation to tropical life, but he does not explain how this procedure works.

The reverse migration: introduction from tropical countries into hothouses in Europe has also taken place. In the cases where such animals have been dissected the slugs were again in the female phase (MEEUSE & HUBERT, 1949, Basteria, 13, p. 24).

There is no evidence of the supposed date at which *Deroceras laeve* came to Java for the first time. The introduction most likely took place with cultivated plants for vegetable or flower gardens, or for plantations.