BASTERIA, 60: 87-138, 1996

Notes on the non-marine molluscs of the island of Borneo 8. The genus Arinia; additions to the genera Diplommatina and Opisthostoma (Gastropoda Prosobranchia: Diplommatinidae)

J.J. VERMEULEN

Rijksherbarium, P.O. Box 9514, 2300 RA Leiden, The Netherlands

The species of the genus *Arinia* (Diplommatinidae) occurring on Borneo are revised. Altogether, 24 species and 5 subspecies are distinguished; all except three are new, and all are endemic to Borneo. The present paper completes the revision of the Bornean Diplommatinidae (see Vermeulen 1991, 1993, 1994, 1996). A few additions and emendations, made necessary by some material collected since the revisions of the genera *Diplommatina* and *Opisthostoma*, have therefore been added. The additions include three new taxa in the genera mentioned.

Key words: Gastropoda, Prosobranchia, Diplommatinidae, *Arinia*, *Diplommatina*, *Niahia*, *Opisthostoma*, taxonomy, Malaysia, Indonesia, Borneo.

This instalment of the series on the terrestrial molluscs of Borneo provides a revision of the diplommatinid genus *Arinia*. It completes the revision of the Bornean Diplommatinidae. Therefore, a framework is presented in which the previous instalments dealing with this family (see Vermeulen 1991, 1993, 1994, 1996), can be fitted. A key to the genera, and new diagnostic descriptions of the genera are provided, as well as some additional information on previously revised genera.

Now, altogether 158 Diplommatinid taxa are known to occur on Borneo, 143 species and 15 subspecies. No fewer than 103 of these taxa have been described as new in the course of this investigation. To attach a meaning to these numbers regarding the relative wealth of the Bornean terrestrial malacofauna, an insight in the state of the malacological exploration of Borneo is necessary, as well as an appreciation of the extraordinarily strict endemism displayed by many species of this family.

In fig. 34 our knowledge of the Bornean malacofauna is given as the amount of collecting done in the various limestone areas. This measure is justified by experience in the field: limestone areas almost invariably harbour the largest concentrations of animals as well as species. On Borneo, the only exceptions to this rule are probably the Crocker Range, consisting of shales and sandstones, and Mt. Kinabalu, a granodiorite pluton. From the high altitude forests on these mountains some 50 species are known, though most occur in small numbers only.

Looking at the limestone areas, Sabah and Sarawak are moderately well explored malacologically: at least one soil sample of about 10 liter is known from most areas indicated on the map. However, a number of rather inaccessible limestone hills still remain untouched by the hand of the collector, for example the Kakus Mts. (2 on fig. 34), and limestone scarps along the upper Baram river (3), both in Sarawak; the Batu Urun/Bukit Sinobang complex (4), and several limestone hills in the upper Segama basin (5; some of these hills are still uncharted, but betray their presence by large slabs of limestone in various tributaries of the Segama river) in Sabah. The situation is quite different in Kalimantan. Here, only the Meratus Mts. have been sampled to a degree:

a row of limestone outcrops surrounding, like a necklace, the higher parts of this mountain range of about 200 km length is represented by 15 soil samples of 20 litre or more each. Our knowledge of a few other limestone ranges in E. and SE. Kalimantan is patchy at best, for instance of the karst areas north of Benualawas (11), of the northern extension of the Meratus Mts. (10), or of the limestone hills in the Kutei National Park (8). Most of the area, however, is malacological *terra incognita*; not a single snail has been collected in the vast limestone areas of the Sankulirang Peninsula (7, G. Sekarat in the South excepted), nor on the limestone ranges between Tanjungredeb and Tanjungselor (6). Other limestone hills are undoubtedly present in the area outlined on the map, but remain so far uncharted. Of particular interest are some limestone hills in the heart of Kalimantan (9), and a few tiny patches of limestone on the geological map close to the Sarawak border (1). Finally, and quite contrary to what one would expect, the coastal areas should also be regarded as unexplored. A fair number of widespread coastal Ellobiidae, Assimineidae and Vertiginidae, already known from neighbouring islands on the Sunda Shelf, have not yet been collected on Borneo.

In fig. 35 the limestone areas are grouped into areas of endemism as far as the Diplommatinidae are concerned. For each area the number of endemic diplommatinids is given, as well as the total number of diplommatinid species occurring there. It shows that the species composition of each area of endemism is fundamentally different from that of other areas. A more detailed map would reveal a number of 'hot spots' of endemism, consisting mainly of limestone hills with a ground surface of 1-25 km^2. Examples are the hill range of which G. Kapor is the southernmost extension (a on fig. 35, with 7 endemics), G. Braang and surrounding hills (b, 6 endemics), and G. Selabor (c, 4 endemics), all in Sarawak; the Sepulot-Simatuoh area (e, 7 endemics), and Gomantong Hill with a few small surrounding hills (f, 5 endemics) in Sabah. Gunung Kinabalu (d), although consisting of granodiorite, should also be mentioned here, with 4 endemics. The Mulu National Park, in Sarawak, and the Meratus Mts., in Kalimantan, are larger areas with numerous small to large limestone outcrops close together. As a whole, both have a high rate of endemism (see fig. 35), but very few species seem to be restricted to a single limestone outcrop, or to a small part within these areas. Though not substantiated here by numbers, a general rule seems to be that, for single limestone hills, the number of species endemic to a given hill increases with its distance to other limestone hills.

Considering these patterns of endemism within the family, more undescribed Diplommatinids will undoubtedly be found in unexplored limestone areas. Even limestone areas that have been explored to an extent, may still yield surprises. The number of species yet to be discovered may be considerable, in spite of the fact that the number of known species has already been tripled during this investigation.

An overview of the collections now available shows that only few other families of terrestrial molluscs on Borneo will show such extreme patterns of endemism, or will include such large numbers of undescribed species once subjected to revision. This means that the total number of species from Borneo now available in collections will be considerably less than 900 species, being 3 times the number of species recorded in literature (excluding the present revisions in Diplommatinidae). About 600 species of terrestrial molluscs seems to be a reasonable estimate.

Out of these 600 species, 300 have come to light during recent collecting activities. These numbers differ widely from those for the surrounding large islands. For instance, about 180 species have been recorded from Java. Recent, medium scale collecting activities have added only some 10 novelties. Apparently the fauna of Java is poorer

in species, and much better known than that of Borneo. Sumatra takes an intermediate position, with slightly less than 200 species recorded in literature. Recent collecting has added tens of new species, but still the number of species now present in collections is lower than twice that figure. Apparently, some work remains to be done there. West Malaysia, finally, counts about 290 recorded species (including revisions of Diplommatinidae), but no information seems available about the number of species added by recent collecting. Incidental soil samples collected by visitors and sorted out by the author usually include one or a few novelties.

For the Diplommatinidae, the numbers are as follows, including the taxa that have been discovered recently: 158 taxa on Borneo, 18 on Java, some 15 on Sumatra, and 63 in Peninsular Malaysia.

The following conclusions may be drawn:

- the Bornean terrestrial malacofauna is richer in species than that of any other island on the Sunda Shelf, although probably closely followed by Peninsular Malaysia;
- Borneo is a centre of speciation as far as the Diplommatinidae are concerned;
- considering the strict endemism displayed by many Diplommatinidae, further collecting on Borneo is absolutely necessary, particularly in the areas that are numbered in fig. 34, in order to complete our picture of the Bornean malacofauna;
- Bornean Diplommatinidae, as well as other small calcicole snails, would benefit most from a conservation policy that aims to leave the most isolated limestone hills untouched, and that tries to concentrate mining, for instance for ore, cement or road-metal, in areas with numerous limestone outcrops close together. In general it would be advisable to avoid destroying entire hills, but always to leave a considerable part untouched.

References to material in the collection of the present author are abbreviated as V, followed by a collection number. The holotype specimens of the species described here will be deposited in the Nationaal Natuurhistorisch Museum (RMNH), unless selected from material from the Florida Museum of Natural History, Gainesville (UF). If available, paratypes from the type locality will be distributed to other institutes. Eventually all other material will be deposited at RMNH.

A few other abbreviations are used in the geographical references in the text, mainly derived from the Indonesian language: Bt. = bukit (hill); G. = Gunung (mountain); K. = Kalimantan (the name of the Indonesian part of Borneo, abbreviation only used in the names of the various provinces); Kpg. = Kampong (village); P. = Pulau (island); R. = River.

After each reference to material seen by the author the number of specimens is given after a slash: /.

The drawings were made by the author, with pencil, using a Wild M8 stereo microscope with camera lucida device.

ACKNOWLEDGEMENTS

Thanks are due to the Nationaal Natuurhistorisch Museum (RMNH), for the use of the library and other facilities put at my disposal. Dr. A.C. van Bruggen has carefully read the manuscript. Again, the Florida Museum of Natural History, Gainesville (UF) sent a large amount of unidentified material on loan. More material was kindly made available by the British Museum (Natural History), London (BMNH), the Field Mu-

seum of Natural History, Chicago (FMNH), and the National Museum of Wales, Cardiff (NMW). Some interesting material was also obtained on loan from the collection of Dr. J.G.M. Raven (R). Dr. P.J.A. Kessler, Mr. E. Meijaard, and Mr. J.L.C.H. van Valkenburg collected some soil samples in areas hitherto malacologically unknown; these samples contained, not surprisingly, some more undescribed taxa.

SYSTEMATIC PART

Family Diplommatinidae

Shell higher than wide (excluding the peristome and the last portion of the spire in case this is inverted), sometimes as high as wide, conical to fusiform to cylindrical. Top whorls often obliquely inserted into the spire, smooth, often finely punctate. All other whorls usually with radial ribs, often crossed by fine spiral striation. About 1/4-2 whorls previous to the aperture a narrowing is present (the *constriction*), without a pore, and without teeth or with one or more longitudinal and/or transversal teeth. The portion of the spire immediately beyond the constriction (in the direction of the aperture, the *tuba*) with or without more longitudinal teeth, or with the continuation of the longitudinal teeth in the constriction. Peristome thickened and reflected, sometimes simple, usually double, the outer often more or less spreading beyond the inner, the inner more or less protruding from the outer. Shell 0.5-11.5 high, 0.5-5.0 wide.

Notes. — 1. Cyclophoridae more or less answering this description, in particular with respect to the presence of a constriction and radial ribs (such as *Alycaeus* Gray, 1850), have a pore, or at least a remnant of a tubular excrescense, at the level of the constriction, close to the suture.

2. Measurements of the shell are taken as follows:
- *Whorl count*: Includes the tuba.
- *Size umbilicus*: Maximum diameter of the space encircled by the last whorl, but excluding the last, deviating portion of the spire (the tuba, or part of it).
- *Shell height*: Includes the peristome.
- *Shell width*: Measured over the widest whorl, but excludes the flaring peristome.
- *Aperture size*: Given is the size over the actual opening. The flaring peristome is excluded.

Key to the genera of Diplommatinidae found on Borneo
(check as large series of specimens as possible)

1 a - Spire dextral, but shell seemingly sinistral because tuba sinistral ..... Genus 1: *Opisthostoma*
b - Spire and tuba both dextral, or both sinistral 2

2 a - Constriction and/or tuba with a columellaris which may or may not be visible in the aperture 3
b - Constriction and tuba both without a columellaris 4

3 a - *Either* umbilicus closed, and radial ribs entirely absent or single-crested, *or* umbilicus open, and shell conical with hardly convex sides or radial ribs with semicircular loops half-way ..... Genus 4: *Diplommatina*

b - *Either* umbilicus closed, and radial ribs double-crested, *or* umbilicus open, and shell conical with distinctly convex sides, (shortly) cylindrical, or shortly fusiform, and with straigth radial ribs ..... Genus 2: *Arinia*

4 a - Whorls 5-7 5/8. Tuba 3/4-7/8 whorl. Shell fusiform ..... Genus 4: *Diplommatina*

b - Whorls 3 1/8-6 1/2; if 5 whorls or more *either* tuba 1/4-1/2 whorl, *or* shell (shortly) cylindrical, *or* both characters present 5

5 a - Aperture not tilted with regard to the coiling axis, or tilted slightly upwards ..... Genus 2: *Arinia*

b - Aperture tilted downwards at an angle of about 45° with regard to the coiling axis ..... Genus 3: *Niahia*

Genus 1: *Opisthostoma* W.T. & H. Blanford, 1860

Shell white, corneous, orange, or dark reddish brown, dextral but seemingly sinistral because of the sinistral tuba. Spire conical to cylindrical, rarely shortly fusiform. Whorls 3-7 1/2 (inverted portion not counted). Top whorls oblique or not. Radial ribs low or high, or with trough-shaped or tubular projections, with a single crest. Constriction without longitudinal teeth, or with 1-3 longitudinal teeth. Tuba 1/4-1/2 whorl, rarely up to 3/4 whorl, inverted, usually without longitudinal teeth, sometimes with 1-2 longitudinal teeth. Umbilicus open or closed. Aperture not tilted, or tilted (obliquely) upwards, rarely downwards, without basal edge, usually without teeth, sometimes with the 1-2 teeth visible; inner peristome usually without a well-demarcated lip. Height 0.5 - 3.5 mm. Operculum with a corneous inner layer and a calcareous outer, multispiral.

Notes. — 1. Peristome usually double (the radial rib or ribs forming the outer peristome hardly to distinctly thicker as, and distinctly wider than the previous ones), sometimes simple (the radial rib closest to the peristome equally thin as, and not or only slightly wider than the previous ones).

2. Revised in Vermeulen (1991, 1994). The following new information can be added:

23 - *Opisthostoma javanicum* Van Benthem Jutting, 1932

Additional material seen. — SARAWAK. 4th Div.: limestone quarry 2 km N. of Kpg. Satap, NW. of Bekenu (leg. Raven R/>10, V 4851/8).

Notes. — The first known locality of this species in Sarawak, in a region from where only *O. brachyacrum* Thompson, 1978, was reported until now. So far, the imperfect morphological segregation between the two species was supported by the strictly allopatric ranges of the two. The above mentioned sample has further complicated the taxonomical problems around these two species.

51 - *Opisthostoma stenotoreton* Vermeulen, 1994

Additional material seen. — SARAWAK. 4th Div.: limestone quarry 2 km N. of Kpg. Satap, NW. of Bekenu (leg. Raven R/>10, V 4852/2).

Genus 2: *Arinia* H. & A. Adams, 1856

Shell white, dextral. Spire conical to cylindrical or shortly fusiform, rarely fusiform. Whorls 3 1/8-6 1/2. Top whorls usually oblique. Radial ribs low, with a single crest or with two parallel crests close together. Constriction usually without longitudinal teeth, rarely with a columellaris and/or a basalis. Tuba 1/4-1/2 whorl, sometimes up to 3/4 whorl, in one species up to 1 1/4 whorl, not inverted, usually without longitudinal teeth, rarely with a columellaris. Umbilicus open or closed. Aperture not tilted, or tilted slightly upwards, without basal edge, without teeth or with a tooth in the angular edge, rarely with a columellaris just visible; inner peristome usually without a well-demarcated lip. Height 1.0-3.2 mm. Operculum with a corneous inner and a calcareous outer layer, multispiral, without a spiral crest on the outer surface.

Distribution. — Philippines, Sulawesi, Lesser Sunda Islands, Borneo. The range of the genus is also difficult to ascertain due to the insufficiently clear delimitation towards the genus *Palaina*.

Ecology. — All Bornean species occur in forest on limestone.

Notes. — 1. Inside, the constriction is usually marked by a transversal thickening all around. This thickening is often more distinct on the palatal side, towards the angular edge. A thin furrow has been observed on its crest in some species. These characters seem to have no diagnostic value and have not been described with each separate species.

2. In seven Bornean taxa of *Arinia* radial ribs occur which have two parallel crests close together. This character is also found in a few Philippine species of the genus, for instance *A. devians* Von Moellendorff, 1887, as well as in the Philippine diplommatinid *Helicomorpha depressa laticosta* Zilch, 1953. The character, however, cannot be used to establish a new section within *Arinia*, because in two Bornean taxa (*A. stenotrochus anisopleuron* and *A. similis*) specimens with only single-crested radial ribs occur next to specimens with a few, or with many double-crested radial ribs.

3. Only four species of Bornean *Arinia* (*A. biplicata*, *A. dioryx*, *A. dentifera*, and *A. streptaxiformis*) have longitudinal teeth, or structures resembling longitudinal teeth, in the constriction and/or the tuba. The small columellaris in *A. dentifera* possibly excepted, their shape and position differs from the teeth found in most *Diplommatina* species; the teeth in both genera are probably not homologous.

4. According to Kobelt (1902), the genera *Arinia* and *Palaina* Semper, 1865, differ in the tuba length: about 1/2 whorl and about 3/4 whorl respectively. Most Bornean species have a tuba of 1/4-1/2 whorl, but in three (*A. stenotrochus*, *A. dentifera*, and *A. streptaxiformis*) it may reach 3/4 whorl, or even 1 1/4 whorl, as in *Palaina*. However, particularly the first and the last species mentioned show a considerable variability in this respect: they may also have a much shorter tuba. The three differ considerably otherwise, so that there is no reason to assume that they are closely related, and they show other characters which indicate that they belong in *Arinia* rather than in *Palaina*.

4. Species like *A. saeperobustior* and *A. turgida* and are similar to the Philippine *A. costata* Von Moellendorff, 1887, the type species of section *Leucarinia* Von Moellendorff, 1893. In fact many Bornean species display one or more diagnostic characters of *Leucarinia*: shell rather small compared to sect. *Arinia*, whitish, peristome double. However, a grouping of the Bornean species according to these characters is impossible without leaving intermediate species; the name *Leucarinia* has therefore not been applied.

6. The operculum of a few species (*A. borneensis*, *A. dentifera*, and *A. streptaxiformis*) could be studied: its outer surface is entirely smooth. In two species from Bali, fitting into

the concept of *Palaina* (*P. gedeana* Von Moellendorff, 1897, and *P. vulcanicola* Vermeulen, 1996) the operculum has a distinct spiral ridge on its outer surface; perhaps this character merits attention as being of value for the distinction between the two genera.

7. The revision of *Arinia* proved to be more complicated than that of the larger genera *Diplommatina* and *Opisthostoma*. This is partly caused by a shortage of characters in *Arinia*; various structures on the radial ribs, as well as the teeth in the constriction and the tuba, which provided such useful diagnostic characters in previously revised genera, are absent in *Arinia*. Next to this, a tendency seems to be present in species of *Arinia* to particularly display a variability in the few remaining characters which can be used to distinguish species. As an example may serve the various structures that can be recognized in the angular edge of the aperture: many species usually showing these structures also include sympatric series in which they are only weakly developed, or even absent. This has resulted in an unusually high number of subspecies in *Arinia*; this rank is reserved for allopatric groups of taxa between which the morphological delimitation is imperfect.

Key to the Bornean species of *Arinia*
(check as large series of specimens as possible)

1 a - Penultimate whorl with single-crested ribs only (tuba included in the whorl count) 2
b - Penultimate whorl with some or many double-crested ribs (single-crested ribs may also be present) 35

2 a - Inner peristome just above the angular edge with a ridge oblique or perpendicular to the margin, at the right side of which a furrow (see fig. 1a) 3
b - Inner peristome just above the angular edge *either* with a protrusion about parallel to the margin, the palatal side below this protrusion with a transverse furrow (see fig. 1b); *or* with a knob with indeterminate direction compared to the margin of the inner peristome, *or* without knob, protrusion or ridge 16

3 a - Shell conical with almost flat sides 4
b - Shell conical with (moderately) convex sides, (shortly) cylindrical or shortly fusiform 5

4 a - Shell 2.7-3.2 mm high, with 5 7/8-6 1/2 whorls ..... *A. pseudopomatias* (1)
b - Shell 2.0-2.4 mm high, with 4 3/4-5 whorls ..... *A. valkenburgi* (2)

5 a - Last whorl above the aperture without radial ribs (tuba included in whorl count) ..... *A. boreoborneensis* (3)
b - Last whorl above the aperture with 3-12 (inconspicuous) radial ribs/0.5 mm 6

6 a - Peristome on the palatal side distinctly protruding beyond the penultimate whorl. Umbilicus almost closed, or open but less than 0.1 cm wide. Last whorl widest ..... *A. turgida* (11)
b - Peristome on the palatal side *either* not or only slightly protruding beyond the penultimate whorl, *or* moderately protruding, but then either umbilicus 0.15-0.30 mm wide, or last two whorls about equally wide 7

7 a - Umbilicus closed, or open but less than 0.05 mm wide 8
b - Umbilicus open, 0.05-0.30 mm wide 11

8 a - Shell 2.0-2.6 mm high, 1.2-1.5 mm wide (excluding the peristome) ..... *A. saeperobustior* (13)
b - Shell 1.4-1.9 mm high, 0.75-1.05 mm wide 9

9 a - Inner peristome on the palatal and basal side with a rather poorly demarcated lip parallel to the margin, demarcation consisting of a slight furrow close to the margin (see fig. 1c) ..... *A. cylindrica crassilabris* (4.2)
b - Inner peristome on the palatal and basal side without a lip 10

10 a - Tuba slightly more than 3/8 whorl. Outer peristome (slightly widened and then) rather abruptly narrowed on the columellar side and towards the angular edge ..... *A. cylindrica cylindrica* (4.1)
b - Tuba 3/8 whorl or slightly less. Outer peristome gradually narrowed on the columellar side and towards the angular edge ..... *A. clausa* (5)

11 a - Shell 0.7-1.2 mm wide (excluding the peristome) 12
b - Shell 1.2-1.5 mm wide 14

12 a - Constriction inside with two high longitudinal ridges, a parietalis and a basalis, both continuing into the tuba and gradually disappearing towards the aperture, the basal ridge impressed as a furrow outside and just visible in the aperture ..... *A. biplicata* (6)
b - Constriction and tuba inside without longitudinal ridges 13

13 a - Outer peristome abruptly narrowed on the columellar side and towards the angular edge ..... *A. pertusa* (7)
b - Outer peristome (rather) gradually narrowed on the columellar side and towards the angular edge ..... *A. borneensis* (8)

14 a - Tuba 3/8-1/2 whorl. Ridge just above the angular edge of the inner peristome distinct ..... *A. borneensis* (8)
b - Tuba 1/4-3/8 whorl. Ridge just above the angular edge of the inner peristome rather inconspicuous 15

15 a - Outer surface of inner peristome and upper surface of the outer with very fine, inconspicuous lamellae ..... *A. saeperobustior* (13)
b - Outer surface of inner peristome and upper surface of the outer with coarse lamellae ..... *A. ascotrochus* (14)

16 a - Palatal and basal side of the inner peristome with a well-demarcated lip parallel to the margin, demarcation consisting of a distinct furrow close to the margin (see fig. 1c, check carefully, the margin of the inner peristome may be closely appressed to the lamellae immediately below and therefore inconspicuous) 17
b - Palatal and basal side of the inner peristome without a lip parallel to the margin 19

17 a - Umbilicus 0.10-0.25 mm wide ..... *A. dioryx* (9)
b - Umbilicus closed, or open but at most 0.05 mm wide 18

18 a - Shell conical with distinctly convex sides, (shortly) cylindrical or shortly fusiform. Number of whorls 4-4 5/8(-4 3/4) ..... *A. strophostoma strophostoma* (10.1)
b - Shell (narrowly) fusiform. Number of whorls 4 3/4-5 1/4 .....
..... *A. strophostoma fusiformis* (10.2)

19 a - Palatal side of peristome moderately to distinctly protruding beyond the penultimate whorl, *and* umbilicus closed or open but at most 0.1 mm wide 20
b - *Either* palatal side of peristome not or only slightly protruding beyond the penultimate whorl, *or* palatal side of the peristome moderately protruding beyond the penultimate whorl, but then umbilicus more than 0.1 mm wide 22

20 a - Umbilicus closed, or open but shallow: at the level of the penultimate whorl at most 0.05 mm wide ..... *A. turgida* (11)
b - Umbilicus open and deep: at the level of the penultimate whorl about 0.1 mm wide 21

21 a - Radial ribs widely spaced on most of the tuba, but a number of them very close together towards the outer peristome ..... *A. obesa* (16)
b - Radial ribs widely spaced on the entire tuba ..... *A. simplex* (12)

22 a - Shell 1.05 mm wide or wider (peristome not included) 23
b - Shell narrower than 1.05 mm 27

23 a - Shell height 1.85 mm or more 24
b - Shell height less than 1.85 mm 25

24 a - Umbilicus 0.05-0.15 mm wide. Outer surface of the inner peristome and upper surface of the outer peristome with fine, inconspicuous lamellae .....
..... *A. saeperobustior* (13)
b - Umbilicus 0.15-0.30 mm wide. Outer surface of the inner peristome and upper surface of the outer peristome with coarse lamellae ..... *A. ascotrochus* (14)

25 a - Inner peristome just above the angular edge with a distinct protrusion about parallel to the margin, the palatal side below this protrusion with a transverse furrow (see fig. 1b) ..... *A. similis* (21)
b - Inner peristome just above the angular edge with a small, rather inconspicuous knob with indeterminate direction compared to the margin of the inner peristome, or without a knob or protrusion 26

26 a - Penultimate whorl above the aperture with 10-16 radial ribs/0.5 mm; ultimate whorl above the aperture with 6-12 radial ribs/0.5 mm. Tuba about 3/8 whorl. Spiral striation present, fine ..... *A. oviformis* (15)
b - Penultimate whorl above the aperture with 4-6 radial ribs/0.5 mm; ultimate whorl above the aperture with 4-5 radial ribs/0.5 mm. Tuba 1/4 whorl. Spiral striation absent ..... *A. obesa* (16)

27 a - Umbilicus wider than 0.1 mm 28
b - Umbilicus closed, or umbilicus open but at most 0.1 mm wide 31

28 a - Inner peristome just above the angular edge with a distinct protrusion about parallel to the margin, the palatal side below this protrusion with a transverse furrow (see fig. 1b) 29
b - Inner peristome just above the angular edge with a small, rather inconspicuous knob with indeterminate direction compared to the margin of the inner peristome, or without a knob or protrusion 30

29 a - Aperture distinctly oblique: palatal side of the inner peristome immediately below the angular edge obliquely pointing at the coiling axis ..... *A. distorta* (17)
b - Aperture not or hardly oblique: palatal side of the inner peristome immediately below the angular edge pointing more or less downwards ..... *A. similis* (21)

30 a - Outer peristome slightly widened and then abruptly narrowed on the columellar side ..... *A. pertusa* (7)
b - Outer peristome gradually narrowed on the columellar side ..... *A. ferecognita* (18)

31 a - Aperture 0.4-0.5 mm high (measured along the inside). Shell 0.9-1.1 mm wide (excluding the peristome) ..... *A. similis* (21)
b - Aperture 0.20-0.35 mm high. Shell 0.5-0.9 mm wide 32

32 a - [*A. stenotrochus*-complex (19): specimens from Sabah and Sarawak. See the notes under the species mentioned] 33
b - [*A. stenotrochus*-complex (19): specimens from SE. Kalimantan] 34

33 a - Tuba 1/4-1/2 whorl ..... *A. stenotrochus stenotrochus* (19.1)
b - Tuba 5/8-3/4 whorl ..... *A. stenotrochus pachystoma* (19.2)

34 a - Tuba 1/4-3/8 whorl. Last whorl above the aperture without radial ribs ..... *A. stenotrochus anisopleuron* (19.3)
b - Tuba (3/8-)1/2-3/4 whorl. Last whorl above the aperture usually with radial ribs ..... *A. stenotrochus stenotrochus* (19.1)

35 a - Inner peristome just above the angular edge with a ridge oblique or perpendicular to the margin (see fig. 1a) ..... *A. paricostata* (20)
b - Inner peristome just above the angular edge *either* with a protrusion about parallel to the margin, the palatal side below this protrusion with a transverse furrow (see fig. 1b); *or* with a knob with indeterminate direction compared to the margin of the inner peristome, *or* without knob, protrusion or ridge 36

36 a - Umbilicus closed, or open but less than 0.05 mm wide 37
b - Umbilicus open, 0.05-0.65 mm wide 39

37 a - Last whorl above the aperture with (widely but) regularly spaced radial ribs. Shell 0.9-1.1 mm wide (excluding the peristome) ..... *A. similis* (21)
b - Last whorl above the aperture without radial ribs. Shell 0.70-0.85 mm wide .. 38

38 a - Tuba 1/2-5/8 whorl, with a longitudinal columellaris close to, and usually just visible in the aperture ..... *A. dentifera* (22)
b - Tuba 1/4-3/8 whorl, without columellaris ..... *A. stenotrochus anisopleuron* (19.3)

39 a - Umbilicus 0.25-0.65 mm wide. Tuba (1/2-)3/4-1 1/4 whorl, with a rounded, well demarcated ridge outside on the columellar surface, corresponding with a similar furrow inside ..... *A. streptaxiformis* (23)
b - Umbilicus 0.05-0.20 mm wide. Tuba 1/4-1/2 whorl, without a ridge on the columellar side 40

40 a - Penultimate whorl above the aperture with 12-20 radial ribs/0.5 mm ..... *A. similis* (21)
b - Penultimate whorl above the aperture with 5-8 radial ribs/0.5 mm 41

41 a - Radial ribs on the ultimate whorl (tuba included in the whorl count) double-crested, a few ribs close to the peristome excepted..... *A. brevispira brevispira* (24.1)
b - Radial ribs on the ultimate whorl single-crested.. *A. brevispira orientalis* (24.2).

1 - *Arinia pseudopomatias* (Gredler, 1902)
fig. 2

Diplommatina pseudopomatias Gredler, 1902: 60; holotype ("Niah") not seen.
Material seen. — SARAWAK. 4th Div.: G. Subis (Batu Niah) (V 1509/>10).

Shell conical with almost flat sides, last whorl widest. Whorls 5 7/8-6 1/2, (moderately) convex. Tuba 1/4 whorl. Radial ribs single-crested, on the top whorls 8-10 ribs/0.5 mm, on the penultimate whorl 7-9 ribs/0.5 mm, above the aperture 6-9 ribs/0.5 mm. Spiral striation absent. Umbilicus closed, or open but less than 0.1 mm wide. Aperture not turned upwards. Peristome: palatal side distinctly protruding beyond the penultimate whorl, columellar side slightly sinuous or not; outer peristome widely spreading beyond the inner on the palatal and basal side, abruptly narrowed or truncated on the columellar side and towards the angular edge; inner peristome hardly to moderately protruding from the outer, spreading, just above the angular edge with a ridge oblique to the margin, at the right side of which a distinct furrow, palatal and basal side without a lip parallel to the margin, its outer surface and the upper surface of the outer peristome with numerous fine lamellae. Height 2.7-3.2 mm; width 1.35-1.50 mm; index 1.9-2.2. Height aperture 0.45-0.50 mm; width 0.45-0.6 mm.
Distribution. — Borneo: Sarawak, 4th Div., G. Subis only.

2 - **Arinia valkenburgi** spec. nov.
fig. 3

Material seen. — KALIMANTAN. Kalimantan Selatan: limestone escarpments along road Benualawas-Limbungan (V 2845/6). Kalimantan Timur: road Bontang-Sangatta, 6 km N. of junction with road into Kutei National Park (leg. Van Valkenburg & Galzin, V 4513/3, incl. HOLOTYPE RMNH 57207).

Shell conical with almost flat sides, last whorl widest. Whorls 4 3/4-5, convex. Tuba 1/4 whorl. Radial ribs single-crested, on the top whorls 4-6 ribs/0.5 mm, on the penultimate whorl 4-6 ribs/0.5 mm, above the aperture, with 4-8 ribs/0.5 mm. Spiral

striation absent or present, fine. Umbilicus open, 0.1-0.2 mm wide. Aperture not turned upwards. Peristome: palatal side moderately protruding beyond the penultimate whorl, columellar side slightly to deeply sinuous; outer peristome moderately spreading beyond the inner on the palatal and basal side, rather abruptly narrowed on the columellar side and towards the angular edge; inner peristome distinctly protruding from the outer, widely spreading, just above the angular edge with a ridge oblique to the margin, at the right side of which a furrow, palatal and basal side without or with at most a poorly demarcated lip parallel to the margin, its outer surface and the upper surface of the outer peristome with numerous coarse lamellae. Height 2.0-2.4 mm; width 1.1-1.5 mm; index 1.5-1.9. Height and width aperture 0.4-0.5 mm.

Distribution. — Borneo: Kalimantan, K. Selatan, eastern flank of Meratus Mts., and K. Timur, Kutei National Park.

Notes. — Known from two widely distant localities. Specimens from the Meratus Mts. differ slightly from those from the type locality in lacking spiral striation, and in having a deeply sinuous, almost notched peristome on the columellar side. More material may show that two taxa are involved.

3 - **Arinia boreoborneensis** spec. nov.
fig. 4

Material seen. — SABAH. Kudat Zone: limestone hill 5 miles W. of Kudat (leg. Wilford, UF 236665/7); P. Banggi, southernmost point (V 1425/2; V 1449/>10, HOLOTYPE RMNH 57208).

Shell shortly fusiform, (pen-)ultimate whorl widest. Whorls 4 1/4-4 3/4, convex. Tuba slightly less than 3/8 whorl. Radial ribs single-crested, on the top whorls 4-14 ribs/0.5 mm, on the penultimate whorl either absent or 3-5 ribs/0.5 mm, ribs absent above the aperture. Spiral striation absent. Umbilicus open, 0.05-0.10 mm wide. Aperture not turned upwards. Peristome: palatal side at most slightly protruding beyond the penultimate whorl, columellar side not or hardly sinuous; outer peristome at most somewhat spreading beyond the inner on the palatal and basal side, (slightly widened and then) rather gradually narrowed on the columellar side, gradually narrowed towards the angular edge; inner peristome hardly to moderately protruding from the outer (often the two are fused to a single, thick ridge), spreading, just above the angular edge with an inconspicuous to distinct ridge oblique or perpendicular to the margin, at the right side of which a furrow, palatal and basal side without a lip, its outer surface and the upper surface of the outer peristome usually without lamellae. Height 1.45-1.80 mm; width 0.8-0.9 mm; index 1.8-2.1. Height aperture 0.35-0.45 mm; width 0.35-0.40 mm.

Distribution. — Borneo: Sabah, Kudat Zone.

Notes. — The Kudat specimens differ from those from P. Banggi in often having a penultimate whorl partly without ribs, a more inconspicuous ridge near the angular edge of the aperture, and a slightly more protruding inner peristome. More material is needed to decide whether or not it is justified to treat the populations as separate taxa. Unfortunately, the Kudat population is probably extinct, or very near extinction, due to habitat destruction.

4.1 - **Arinia cylindrica cylindrica** spec. nov.
fig. 5

Material seen. — SABAH. Interior Zone: Lian Cave 12 km N. of Keningau (V 1097/>10). Sandakan Zone: Bt. Gomantong, 30 km S. of Sandakan (leg. Wilford, UF 236669/2; V 1586/10, HOLOTYPE RMNH 57209).

Shell cylindrical, last two whorls widest. Whorls 4 1/4-5 1/8, moderately convex. Tuba slightly more than 3/8 whorl. Radial ribs single-crested, on the top whorls 10-22 ribs/0.5 mm, on the penultimate whorl 10-20 ribs/0.5 mm, above the aperture 6-10 ribs/0.5 mm. Spiral striation absent, sometimes present but fine and very inconspicuous. Umbilicus closed but rimate in oblique view. Aperture not turned upwards. Peristome: palatal side not or hardly protruding beyond the penultimate whorl, columellar side not sinuous; outer peristome somewhat spreading beyond the inner or not on the palatal and basal side, (slightly widened and then) rather abruptly narrowed on the columellar side and towards the angular edge; inner peristome slightly to moderately protruding from the outer, spreading, just above the angular edge with a rather inconspicuous to a distinct ridge oblique to the margin, at the right side of which a furrow, palatal and basal side without a lip parallel to the margin, its outer surface and the upper surface of the outer peristome with or without few fine lamellae. Height 1.45-1.80 mm; width 0.75-0.90 mm; index 1.8-2.2. Height and width aperture 0.3-0.4 mm.

Distribution. — Borneo: Sabah, Interior and Sandakan Zone, on two widely distant localities.

Notes. — 1. Next to having a slightly shorter tuba, both *A. clausa* and *A. boreoborneensis* generally have a shorter cylindrical or slightly more fusiform spire, more convex whorls, and less closely placed radial ribs.

2. One population of *A. cylindrica* consists of shells with a slightly shorter tuba, thus obliterating the diagnostic difference between *A. clausa* and *A. cylindrica cylindrica*. It also has the inner peristome with a lip, a character not found elsewhere in the two taxa discussed here. It seems best to regard this population as a separate subspecies:

4.2 - **Arinia cylindrica crassilabris** subspec. nov.
fig. 6

Material seen. — SABAH. Sandakan Zone: limestone hill 7 miles E. of Lamag, 3 miles NNW. of Laab, near road Lahad Datu-Sandakan, near Kinabatangan R. (leg. Wilford, UF 236672/4, incl. HOLOTYPE).

As the nominate subspecies, but shell (shortly) cylindrical. Whorls 4 1/2-4 5/8. Tuba (slightly less than) 3/8 whorl. Inner peristome moderately to distinctly protruding from the outer, palatal and basal side with a rather poorly demarcated lip parallel to the margin. Height 1.60-1.75 mm; width 0.8-0.9 mm; index 1.9-2.0. Height and width aperture 0.3-0.4 mm.

Distribution. — Borneo: Sandakan Zone, Kinabatangan valley, a single locality known.

5 - **Arinia clausa** spec. nov.
fig. 7

Material seen. — SARAWAK. 4th Div.: Bt. Gading, Baram valley, N. of Long Lama (leg. Wilford, UF 210648/4; do. 236642/>10); Bt. Besungai, Baram valley, 4 miles NE. of Long Lama, 0.5 mile SW. of Bt. Gading (leg.

Stevens, UF 236662/1; do. 236664/6); G. Labang Tukeng near Kejin Trib, Baram valley, 4 miles NE. of Long Lama (leg. Stevenson, UF 236657/9); G. Mulu National Park, near National Park entrance (leg. Ball, V 2668/>10, HOLOTYPE RMNH 57210; do. V 2670/1); G. Mulu National Park, Melinau Paku R. headwaters, small hill (leg. Wilford, UF 236644/4); G. Mulu National Park, lower Tutoh valley (leg. Wilford, UF 236646/>10). 5th Div.: Limbang valley, 2 miles NE. of junction Medalan R. and Limbang R. (leg. Wilford, UF 236668/2). SABAH. Interior Zone: Lian Cave 12 km N. of Keningau (V 4564/>10).

Shell more or less shortly cylindrical, or shortly fusiform, last two whorls widest. Whorls 4 1/8-4 5/8, convex. Tuba 3/8 whorl or slightly less. Radial ribs single-crested, on the top whorls 8-18 ribs/0.5 mm, on the penultimate whorl 5-10 ribs/0.5 mm, above the aperture sometimes very inconspicuous but still visible, 5-8 ribs/0.5 mm. Spiral striation absent. Umbilicus closed but rimate in oblique view. Aperture not turned upwards. Peristome: palatal side at most moderately protruding beyond the penultimate whorl, columellar side somewhat sinuous or not; outer peristome hardly to moderately spreading beyond the inner on the palatal and basal side, gradually narrowed on the columellar side and towards the angular edge; inner peristome hardly to moderately protruding from the outer, spreading, just above the angular edge with an inconspicuous to distinct ridge oblique to the margin, at the right side of which a furrow, palatal and basal side without a lip parallel to the margin, its outer surface and the upper surface of the outer peristome with few fine lamellae. Height 1.4-1.9 mm; width 0.85-1.05 mm; index 1.5-2.1. Height and width aperture 0.35-0.45 mm.

Distribution. — Borneo: Sarawak, 4th and 5th Div.; Sabah, Interior Zone, Crocker Range.

Notes. — The sample V 2670, from the G. Mulu area, consists of a single sinistral specimen.

6 - **Arinia biplicata** spec. nov.
fig. 8

Material seen. — SABAH. Sandakan Zone: Bt. Gomantong, 30 km S. of Sandakan (leg. Wilford, UF 236669/5; V 1585/>10, HOLOTYPE RMNH 57211).

Shell shortly cylindrical to shortly fusiform, last whorl or last two whorls widest. Whorls 4-4 1/2, moderately convex. Constriction with two high longitudinal ridges, a parietalis and a basalis, both continuing into the tuba and gradually disappearing towards the aperture. Tuba about 3/8-1/2 whorl, with the basal ridge inside impressed as a furrow. Radial ribs single-crested, on the top whorls and the penultimate whorl 16-22 ribs/0.5 mm, above the aperture with 3-6 ribs/0.5 mm. Spiral striation absent or present, fine and inconspicuous. Umbilicus open, 0.15-0.20 mm wide. Aperture not turned upwards, with the basal ridge just visible inside. Peristome: palatal side not protruding beyond the penultimate whorl, columellar side not sinuous; outer peristome slightly to moderately spreading beyond the inner on the palatal and basal side, rather abruptly narrowed on the columellar side and towards the angular edge; inner peristome slightly to moderately protruding from the outer, spreading, just above the angular edge with a ridge oblique to the margin, at the right side of which an inconspicuous furrow, palatal and basal side without a lip parallel to the margin, its outer surface with few fine lamellae. Height 1.2-1.4 mm; width 0.70-0.85 mm; index 1.5-1.7. Height and width aperture 0.25-0.3 mm.

Distribution. — Borneo: Sabah, Sandakan Zone, Bt. Gomantong only.

Notes. — Well characterized by the furrow inside the tuba, demarcated towards the constriction by two longitudinal ridges.

7 - **Arinia pertusa** spec. nov.
fig. 9

Material seen. — SABAH. Interior Zone: Batu Punggol SE. of Sepulot (leg. Dorman, UF 196617/1; V 1896/>10); 1 km SE. of Simatuoh, 10 km ESE. of Sepulot (leg. Dorman, UF 196557/1; do. 196700/10). Sandakan Zone: limestone hill 7 miles E. of Lamag, 3 miles NNW. of Laab, near road Lahad Datu-Sandakan, near Kinabatangan R. (leg. Wilford, UF 236672/5); Bt. Gomantong, 30 km S. of Sandakan (leg. Wilford, UF 236669/7; V 4563/3). Tawau Zone: G. Madai, 40 km SSW. of Lahad Datu (V 1705/>10; do. 1708/>10, HOLOTYPE RMNH 57212).

Shell shortly cylindrical to shortly fusiform, last whorl or last two whorls widest. Whorls 4 1/8-5, (moderately) convex. Tuba 3/8-1/2 whorl. Radial ribs single-crested, on the top whorls 4-20 ribs/0.5 mm, on the penultimate whorl 5-18 ribs/0.5 mm, above the aperture 4-12 ribs/0.5 mm. Spiral striation absent, rarely persent on the top whorls, fine. Umbilicus open, 0.15-0.25 mm wide. Aperture not turned upwards. Peristome: palatal side not or hardly protruding beyond the penultimate whorl, columellar side not or hardly sinuous; outer peristome slightly to moderately spreading beyond the inner on the palatal and basal side, slightly widened and then abruptly narrowed on the columellar side and towards the angular edge; inner peristome slightly to moderately protruding from the outer, spreading, just above the angular edge with or without a ridge oblique to the margin, at the right side of which a furrow, palatal and basal side without a lip parallel to the margin, its outer surface and the upper surface of the outer peristome with or without a few rather coarse lamellae. Height 1.30-1.85 mm; width 0.75-1.00 mm; index 1.5-1.9. Height aperture 0.35-0.45 mm; width 0.3-0.4 mm.

Distribution. — Borneo: Sabah, Interior, Sandakan and Tawau Zone, widely scattered localities.

Notes. — 1. Regional forms can be distinguished, differing in a small number of characters, of which the states occur in various combinations. The forms are not sufficiently distinct to be given subspecific status; they are listed below:

Madai form 1 (including the type specimen): Tuba usually 1/2 whorl. Radial ribs densely placed, moderately spaced above the aperture. Angular ridge present.

Madai form 2: Tuba (slightly more than) 3/8 whorl. Radial ribs densely placed. Angular ridge absent. The morphological partition between the two Madai forms is almost perfect, but some specimens are intermediate.

Kinabatangan valley: Tuba 3/8-1/2 whorl. Radial ribs widely spaced (Gomantong) or rather densely placed (Lamag-Laab area). Angular ridge absent. The sympatric *A. simplex* is larger, with the outer peristome spreading wider beyond the inner, and narrowing more gradually on both sides.

Sepulot area: Tuba 3/8 whorl. Radial ribs densely placed, moderately spaced above the aperture. Angular ridge present, sometimes small. The sympatric *A. oviformis* has a very shortly fusiform shell, and lacks the ridge in the angular edge.

2. *Arinia pertusa* is characterized by its usually rather wide umbilicus, and by the outer peristome which is on the columellar side and towards the angular edge more or less truncated after a slight widening.

8 - *Arinia borneensis* E.A. Smith, 1893
fig. 10

Arinia borneensis E.A. Smith, 1893: 350; holotype ("Gomanton, N. Borneo") BMNH 92.7.23.46/1.

Arinia inexpectans Solem, 1964: 16; syntypes ("Gomantong Hill") leg. Haile (holotype FMNH 118952; paratypes FMNH 118951/4).

Material seen. — SABAH. Sandakan Zone: Bt. Gomantong, 30 km S. of Sandakan (BMNH/1, see above; leg. Lee et al., UF 114710/1; leg. Wilford, UF 236669/>10; V 1587/>10); Bt. Kuntos, near m 6 on former road Suanlamba-Gomantong (leg. Wilford, UF 236667/3).

Shell shortly fusiform, last whorl widest. Whorls 4 1/4-4 7/8, convex. Tuba 3/8-1/2 whorl. Radial ribs single-crested, on the top whorls 6-14 ribs/0.5 mm, on the penultimate whorl 6-8 ribs/0.5 mm, above the aperture 4-6 ribs/0.5 mm. Spiral striation absent. Umbilicus open, 0.15-0.20 mm wide. Aperture not turned upwards. Peristome: palatal side slightly to moderately protruding beyond the penultimate whorl, columellar side often somewhat sinuous; outer peristome usually moderately spreading beyond the inner on the palatal and basal side, rather gradually narrowed on the columellar side and towards the angular edge; inner peristome (moderately) protruding from the outer, spreading, just above the angular edge with a ridge oblique to the margin, at the right side of which a distinct furrow, palatal and basal side without a lip parallel to the margin, its outer surface and the upper surface of the outer peristome with few rather fine lamellae. Height 1.60-2.45 mm; width 1.00-1.45 mm; index 1.5-1.8. Height and width aperture 0.4-0.5 mm.

Distribution. — Borneo: Sabah, Sandakan Zone, lower Kinabatangan valley, Bt. Gomantong and a nearby limestone hill only.

Notes. — The type specimens of *A. inexpectans* are larger than any other specimens seen, including the type of *A. borneensis*, but otherwise it is not diferent.

9 - **Arinia dioryx** spec. nov.
fig. 11

Material seen. — KALIMANTAN. Kalimantan Selatan: Beramban, approximately 13 km E. of Rantau (V 3761/>10, HOLOTYPE RMNH 57213); Telaga Langsat, approximately 18 km SSW. of Barabai (V 3433/>10); Bt. Pagat, limestone hill 8 km SE. of Barabai (V 3799/>10); Nateh near Batu Tangga, approximately 18 km E. of Barabai (V 3015/>10); G. Halat, near border Kalimantan Timur along main road Banjarmasin-Balikpapan (V 4848/2); Batu Tungga near Sarungga, W. of road Batulicin-Benualawas (V 3262/>10); limestone escarpments along road Benualawas-Limbungan (V 2846/>10). Kalimantan Timur: Batu Butuk, near Muara Komang along main road Banjarmasin-Balikpapan (V 3527/>10); G. Melihat, foot of S.-facing slope, between river and main road Banjarmasin-Balikpapan (V 2945/>10).

Shell conical with distinctly convex sides, to (shortly) cylindrical or shortly fusiform, last whorl or last two whorls widest. Whorls 4-5 1/4, (moderately) convex. Constriction without teeth, or with a very slight, oblique columellaris. Tuba 1/4-1/2 whorl, with a slight ridge on the columellar side and often one on the basal side (corresponding with furrows inside). Radial ribs single-crested, on the top whorls 8-24 ribs/0.5 mm, on the penultimate whorl 7-18 ribs/0.5 mm, above the aperture 3-6 ribs/0.5 mm, there sometimes almost withour ribs. Spiral striation absent. Umbilicus open, 0.1-0.25 mm wide. Aperture turned slightly upwards or not. Peristome: palatal side not or hardly protruding beyond the penultimate whorl, columellar hardly to deeply sinuous or

furrowed; outer peristome (widely) spreading beyond the inner on the palatal and basal side, or not so, often gradually narrowed, widened and rather abruptly narrowed again on the columellar side, (gradually) narrowed towards the angular edge; inner peristome slightly to distinctly protruding from the outer, widely spreading, just above the angular edge with a (slight) protrusion about parallel to the margin but often at some distance of it, palatal side below this protrusion with a distinct transverse furrow, palatal and basal side with a well-demarcated lip parallel to the margin, its outer surface and the upper surface of the outer peristome with few to numerous fine to coarse lamellae. Height 1.4-2.5 mm; width 0.85-1.3 mm; index 1.4-2.0. Height aperture 0.40-0.55 mm; width 0.35-0.50 mm.

Distribution. — Borneo: Kalimantan, K. Selatan and K. Timur, Meratus Mts., widespread.

Notes. — 1. Variable, particularly in the size of the shells.

2. The margin of the inner peristome is on the palatal and basal side sometimes appressed against the lamellae between the inner and the outer peristome, and therefore not easily recognizable as such. The distinct, well-demarcated lip on the inner peristome may then be wrongly interpreted as the margin of the inner peristome.

10.1 - **Arinia strophostoma strophostoma** spec. nov.
fig. 12

Material seen. — KALIMANTAN. Kalimantan Selatan: Batu Apoh, approximately 35 km NE. of Martapura (leg. Lamb & Mackinnon, V 2457/1; V 3325/>10); Beramban, approximately 13 km E. of Rantau (V 3763/>10); Bt. Pagat, limestone hill 8 km SE. of Barabai (V 4849/4); Nateh near Batu Tangga, approximately 18 km E. of Barabai (V 3014/>10, HOLOTYPE RMNH 57214); G. Buleh, 4 km E. of Muara Uja (V 3715/4); 7 km N. of Kintap (V 3683/>10); limestone escarpments along road Benualawas-Limbungan (V 2848/5).

Shell conical with distinctly convex sides, more or less (shortly) cylindrical, or shortly fusiform; last whorl, or last two whorls widest. Whorls 4-4 5/8(-4 3/4), convex. Tuba 3/8-1/2 whorl. Radial ribs single-crested, on the top whorls 8-28 ribs/0.5 mm, on the penultimate whorl 9-18 ribs/0.5 mm, above the aperture with 6-12 ribs/0.5 mm. Spiral striation absent. Umbilicus closed but sometimes rimate in oblique view, or open but less than 0.05 mm wide. Aperture turned slightly upwards or not. Peristome: palatal side at most slightly protruding beyond the penultimate whorl, columellar side moderately sinuous or not; outer peristome at most slightly spreading beyond the inner on the palatal and basal side, rather gradually narrowed on the columellar side, slightly more abruptly so towards the angular edge; inner peristome moderately to distinctly protruding from the outer, widely spreading, just above the angular edge with a (slight) protrusion about parallel to the margin, palatal side below this protrusion with a distinct transverse furrow, palatal and basal side with a well-demarcated lip parallel to the margin, its outer surface and the upper surface of the outer peristome without with few to numerous fine to coarse lamellae. Height 1.2-2.1 mm; width 0.70-1.15 mm; index 1.6-2.0. Height and width aperture 0.30-0.45 mm.

Distribution. — Borneo: Kalimantan, K. Selatan, Meratus Mts., mainly western flank (a single locality on the eastern flank), rather widespread.

Notes. — 1. The sample V 3014 contains a single sinistral specimen among hundreds of dextral.

2. On average, populations of *A. strophostoma* from the eastern flank of the Meratus Mts. have narrower and more spindle-shaped shells, but a slight overlap in these

characters is found. However, in the single known location where the two forms occur together, the two can be separated without leaving intermediate specimens. Therefore they are regarded as subspecies.

10.2 - **Arinia strophostoma fusiformis** subspec. nov.
fig. 13

Material seen. — KALIMANTAN. Kalimantan Selatan: Batu Tungga near Sarungga, W. of road Batulicin-Benualawas (V 3263/>10); limestone escarpment W. of km 6 road Benualawas-Batulicin (V 3370/4); limestone escarpments along road Benualawas-Limbungan (V 2847/>10, HOLOTYPE RMNH 57215).

As the nominate subspecies, but shell (narrowly) fusiform. Whorls 4 3/4-5 1/4. Umbilicus closed but sometimes rimate in oblique view. Height 1.75-2.05 mm; width 0.80-0.95 mm; index 1.9-2.4. Height and width aperture 0.3-0.4 mm.

Distribution. — Borneo: Kalimantan, K. Selatan, Meratus Mts., E. flank.

11 - **Arinia turgida** spec. nov.
fig. 14

Material seen. — SABAH. Interior Zone: Lian Cave 12 km N. of Keningau (V 1102/8); Batu Urun near Sepulot, from soil deposited at Tenom Agricultural Station (V 1151/>10); Batu Punggol SE. of Sepulot (leg. Dorman, UF 196618/1; V 1897/2); Pun Batu approximately 30 km W. of Sepulot (V 1289/>10). Sandakan Zone: Bt. Kolop, 4 miles WSW. of Latangan (leg. Wilford, UF 236670/5); Batu Putih near road Lahad Datu-Sandakan, near Kinabatangan R. (V 1476/>10); limestone hill 7 miles E. of Lamag, 3 miles NNW. of Laab, near road Lahad Datu-Sandakan, near Kinabatangan R. (leg. Wilford, UF 236671/2); Bt. Gomantong, 30 km S. of Sandakan (V 4561/>10); m 2.5 on former road Suanlamba-Gomantong (leg. Wilford, UF 236666/5); Bt. Kuntos, near m 6 on former road Suanlamba-Gomantong (leg. Wilford, UF 236667/2). Tawau Zone: NW. of road Lahad Datu-Sandakan crossing with Segama R. (V 1669/>10); G. Madai, 40 km SSW. of Lahad Datu (V 1707/>10); G. Baturong, 50 km WSW. of Lahad Datu (leg. Dorman, UF 196823/10; V 1835/>10); Bt. Pababola, Segarong Hills 25 km ESE. of Kunak (V 1759/>10); Batu Tenggar, Segarong Hills 25 km ESE. of Kunak (V 1806/>10, HOLOTYPE RMNH 57216); small limestone outcrop 15 miles NNW. of Kalabakan (leg. Wilford, UF 236673/8).

Shell conical with (moderately) convex sides, or shortly cylindrical, last whorl widest. Whorls 4 1/8-5, convex. Tuba 1/4-3/8 whorl. Radial ribs single-crested, on the top whorls 4-12 ribs/0.5 mm, on the penultimate whorl 6-14 ribs/0.5 mm, above the aperture with 4-8 ribs/0.5 mm. Spiral striation absent or fine, inconspicuous. Umbilicus closed, or open but shallow, less than 0.10 mm wide, at most 0.05 mm wide at the level of the penultimate whorl. Aperture turned slightly upwards or not. Peristome: palatal side distinctly protruding beyond the penultimate whorl, columellar side sinuous or not; outer peristome slightly to moderately spreading beyond the inner on the palatal and basal side, rather gradually narrowed on the columellar side and towards the angular edge; inner peristome moderately to distinctly protruding from the outer, spreading, just above the angular edge with or without a knob, or a ridge oblique or perpendicular to the margin, at the right side of which often an inconspicuous furrow, palatal and basal side without a lip parallel to the margin, its outer surface and the upper surface of the outer peristome with few to numerous fine to coarse lamellae. Height 1.40-2.25 mm; width 0.85-1.40 mm; index 1.5-1.8. Height and width aperture 0.35-0.55 mm.

Distribution. — Borneo: Sabah, Interior, Sandakan and Tawau Zone, widespread.

Notes. — 1. In some populations the variability in size covers the entire size range of the species.

2. Similar to *A. simplex*, see note under that species.

3. *Arinia ascotrochus* and *A. valkenburgi* have a wider umbilicus and a spire with, on average, less convex sides. *Arinia borneensis* has a wider umbilicus, and has the palatal side of the peristome less distinctly flaring.

12 - **Arinia simplex** spec. nov.
fig. 15

Material seen. — SABAH. Sandakan Zone: Bt. Gomantong, 30 km S. of Sandakan (V 4560/3, incl. HOLOTYPE RMNH 57217).

Shell conical with distinctly convex sides, or shortly cylindrical, last whorl widest. Whorls 4 1/4, convex. Tuba 1/4 whorl. Radial ribs single-crested, close to the top 5-6 ribs/0.5 mm, on the penultimate whorl 6-7 ribs/0.5 mm, above the aperture with 4-5 ribs/0.5 mm. Spiral striation present, fine and inconspicuous. Umbilicus open, deep, 0.1 mm wide, at least 0.1 mm wide at the level of the penultimate whorl. Aperture not turned upwards. Peristome: palatal side protruding beyond the penultimate whorl, columellar side not sinuous; outer peristome (moderately) spreading beyond the inner on the palatal and basal side, rather gradually narrowed on the columellar side and towards the angular edge; inner peristome (moderately) protruding from the outer, spreading, just above the angular edge without or with a slight knob, palatal and basal side without a lip parallel to the margin, its outer surface and the upper surface of the outer peristome with few fine lamellae. Height 1.6-1.7 mm; width 0.95-1.10 mm; index 1.4-1.8. Height aperture 0.40-0.45 mm; width 0.4 mm.

Distribution. — Borneo: Sabah, Sandakan Zone, lower Kinabatangan valley, Bt. Gomantong only.

Notes. — 1. The knob, present in the angular edge of the aperture of some specimens, is too weak to ascentain its position compared to the margin of the peristome.

2. Clearly distinct from sympatric *A. turgida* at G. Gomantong, Sabah (see also illustrated specimens). However, populations of *A. turgida* elsewhere are intermediate in some aspects, so that for a diagnostic distinction between the two one has to resort to the depth of the umbilicus: shallow in *A. turgida*, deep in *A. simplex*.

3. *Arinia ferecognita* is smaller and has a less distinctly flaring outer peristome; *A. oviformis* has more closely placed radial ribs.

13 - **Arinia saeperobustior** spec. nov.
fig. 16

Material seen. — SARAWAK. 4th Div.: Bt. Gading, Baram valley, N. of Long Lama (leg. Wilford, UF 236642/2); Bt. Besungai, Baram valley, 4 miles NE. of Long Lama, 0.5 mile SW. of Bt. Gading (leg. Stevens, UF 236661/>10, incl. HOLOTYPE; do. 236663/>10).

Shell conical with distinctly convex sides or shortly fusiform, last whorl widest. Whorls 4 3/4-5 3/8, convex. Tuba 1/4-3/8 whorl. Radial ribs single-crested, on the top whorls 7-15 ribs/0.5 mm, on the penultimate whorl 6-8 ribs/0.5 mm, above the aperture 4-5 ribs/

0.5 mm. Spiral striation absent. Umbilicus open, 0.05-0.15 mm wide. Aperture not turned upwards. Peristome: palatal side not or only slightly protruding beyond the penultimate whorl, columellar side not or hardly sinuous; outer peristome somewhat spreading beyond the inner on the palatal and basal side, (slightly widened and then) gradually narrowed on the columellar side, gradually narrowed towards the angular edge; inner peristome moderately to distinctly protruding from the outer, spreading, just above the angular edge with or without a rather inconspicuous ridge about perpendicular to the margin, at the right side of which an inconspicuous furrow, palatal and basal side without a lip parallel to the margin, its outer surface and the upper surface of the outer peristome with few or numerous inconspicuous lamellae. Height 2.0-2.6 mm; width 1.2-1.5 mm; index 1.6-1.8. Height and width aperture 0.45-0.60 mm.

Distribution. — Borneo: Sarawak, 4th Div., middle Baram valley, limestone outcrops around Long Lama.

14 - **Arinia ascotrochus** spec. nov.
fig. 17

Material seen. — KALIMANTAN. Kalimantan Selatan: G. Siamang near Desah Liu, 30 km E. of Tandjung (V 3094/>10); G. Buleh, 4 km E. of Muara Uja (V 3714/1); Jaro near Muara Uja, limestone escarpment W. of the village (V 3201/>10, HOLOTYPE RMNH 57218); G. Halat, near border Kalimantan Timur along main road Banjarmasin-Balikpapan (V 2799/>10). Kalimantan Timur: Batu Butuk, near Muara Komang along main road Banjarmasin-Balikpapan (V 3528/>10); G. Melihat, foot of S. facing slope, between river and main road Banjarmasin-Balikpapan (V 2946/>10).

Shell conical with moderately convex sides, last whorl widest. Whorls 4 1/2-5, convex. Tuba (slightly more than) 1/4 whorl. Radial ribs single-crested, on the top whorls 6-8 ribs/0.5 mm, on the penultimate whorl 6-12 ribs/0.5 mm, above the aperture 4-6 ribs/0.5 mm. Spiral striation (locally) present, fine. Umbilicus open, deep, 0.15-0.30 mm wide, at least 0.1 mm wide at the level of the penultimate whorl. Aperture turned slightly upwards or not. Peristome: palatal side slightly to moderately protruding beyond the penultimate whorl, columellar side moderately sinuous or not; outer peristome moderately to widely spreading beyond the inner on the palatal and basal side, rather gradually narrowed on the columellar side and towards the angular edge; inner peristome moderately to distinctly protruding from the outer, spreading, just above the angular edge with or without a knob, or an inconspicuous to distinct ridge about parallel to the margin, palatal side below this ridge with a (distinct) transverse furrow, palatal and basal side often with a well-demarcated lip parallel to the margin, its outer surface and the upper surface of the outer peristome with few to numerous coarse lamellae. Height 1.9-2.5 mm; width 1.2-1.5 mm; index 1.5-1.9. Height and width aperture 0.40-0.55 mm.

Distribution. — Borneo: Kalimantan, K. Selatan and K. Timur, northern end of Meratus Mts., limestone areas around G. Serempaka.

Notes. — 1. *Arinia borneensis* has a more fusiform shell, a slightly longer tuba, and lacks spiral striation.

2. The angular edge of the peristome has a ridge essentially parallel, not oblique, to the margin of the peristome. When inconspicuous, its course cannot easily be observed. Next to having a conical spire with almost flat sides, *A. valkenburgi* differs in having an oblique ridge in the angular edge of the peristome.

15 - **Arinia oviformis** spec. nov.
fig. 18

Material seen. — SABAH. Interior Zone: 1 km SE. of Simatuoh, 10 km ESE. of Sepulot (leg. Dorman, UF 196700/2, incl. HOLOTYPE).

Shell shortly fusiform, almost shortly cylindrical, last whorl widest. Whorls 4 3/8-4 1/2, convex. Tuba about 3/8 whorl. Radial ribs single-crested, on the top whorls 12-14 ribs/0.5 mm, on the penultimate whorl 10-16 ribs/0.5 mm, above the aperture with 6-12 ribs/0.5 mm. Spiral striation present, fine. Umbilicus open, 0.15-0.20 mm wide. Aperture not turned upwards. Peristome: palatal side not protruding beyond the penultimate whorl, columellar side not sinuous; outer peristome somewhat spreading beyond the inner on the palatal and basal side, abruptly narrowed more or less truncated on the columellar side and towards the angular edge; inner peristome moderately distinctly protruding from the outer, spreading, angular edge without protrusion or ridge, palatal and basal side without a lip parallel to the margin, its outer surface and the upper surface of the outer peristome with few to numerous fine lamellae. Height 1.65-1.80 mm; width 1.10-1.15 mm; index 1.4-1.6. Height and width aperture 0.40-0.45 mm.

Distribution. — Borneo: Sabah, Interior Zone, Sepulot area.

16 - **Arinia obesa** spec. nov.
fig. 19

Material seen. — SARAWAK. 4th Div.: G. Subis (Batu Niah) (leg. Wall, UF 236638/>10, do. 236639/1; V 1507/>10, HOLOTYPE RMNH 57219).

Shell conical with convex sides, last whorl widest. Whorls 3 1/2-4, convex. Tuba 1/4 whorl. Radial ribs single-crested, on the penultimate whorl 4-6 ribs/0.5 mm, above the aperture with 4-5 ribs/0.5 mm; close to the outer peristome with numerous more distinct lamellae very close together. Spiral striation absent. Umbilicus open, 0.10-0.20 mm wide. Aperture not turned upwards. Peristome: palatal side at most moderately protruding beyond the penultimate whorl, columellar side not sinuous; outer peristome slightly spreading beyond the inner on the palatal and basal side, rather abruptly narrowed on the columellar side and towards the angular edge; inner peristome (moderately) protruding from the outer, spreading, just above the angular edge with or without an inconspicuous knob, palatal and basal side without a lip parallel to the margin, its outer surface and the upper surface of the outer peristome with few (fine) lamellae. Height 1.5-1.8 mm; width 1.1-1.2 mm; index 1.3-1.5. Height aperture 0.35-0.40 mm; width 0.35-0.45 mm.

Distribution. — Borneo: Sarawak, 4th Div., G. Subis area only.

Notes. — The angular edge of the peristome often has a slight ridge, which probably is oblique to the margin of the peristome. It is, however, so inconspicuous that its course cannot be ascertained.

17 - **Arinia distorta** spec. nov.
fig. 20

Material seen. — SARAWAK. 4th Div.: G. Subis (Batu Niah) (leg. Wall, UF 236640/5, incl. HOLOTYPE).

Shell (shortly) cylindrical, last whorl or last two whorls widest. Whorls 4 1/2-5, (moderately) convex. Tuba 1/2 whorl. Radial ribs single-crested, on the top whorls 35-50 ribs/0.5 mm, on the penultimate whorl 28-40 ribs/0.5 mm, above the aperture 12-16 ribs/0.5 mm. Spiral striation absent. Umbilicus open, 0.2 mm wide. Aperture not turned upwards, but distinctly oblique. Peristome: palatal side not protruding beyond the penultimate whorl, columellar side not sinuous; outer peristome at most slightly spreading beyond the inner on the palatal and basal side, (slightly widened and then) rather abruptly narrowed on the columellar side and towards the angular edge; inner peristome moderately to distinctly protruding from the outer, spreading, just above the angular edge with a protrusion about parallel to the margin, palatal side below this protrusion with a (slight) transverse furrow, palatal and basal side without a lip parallel to the margin, its outer surface and the upper surface of the outer peristome with few fine lamellae. Height 1.4-1.6 mm; width 0.85-0.90 mm; index 1.6-1.8. Height and width aperture 0.35 mm.

Distribution. — Borneo: Sarawak, 4th Div., Subis area only.

Notes. — Characterized by its slanting aperture: the palatal side of the inner peristome, immediately below the angular edge, obliquely points downwards towards at the axis of the shell.

18 - **Arinia ferecognita** spec. nov.
fig. 21

Material seen. — KALIMANTAN. Kalimantan Timur: road Bontang-Sangatta, 6 km N. of junction with road into Kutei National Park (leg. Van Valkenburg & Galzin, V 4512/1, HOLOTYPE RMNH 57220).

Shell shortly cylindrical, last two whorls widest. Whorls 3 1/8, convex. Tuba 3/8 whorl. Radial ribs single-crested, close to the top 20 ribs/0.5 mm, on the penultimate whorl 8 ribs/0.5 mm, above the aperture 6 ribs/0.5 mm. Spiral striation present, fine. Umbilicus open, 0.15 mm wide. Aperture not turned upwards. Peristome: palatal side moderately protruding beyond the penultimate whorl, columellar side not sinuous; outer peristome slightly spreading beyond the inner on the palatal and basal side, gradually narrowed on the columellar side and towards the angular edge; inner peristome moderately protruding from the outer, spreading, angular edge without a ridge, palatal and basal side without a lip parallel to the margin, its outer surface and the upper surface of the outer peristome with few fine lamellae. Height 1.2 mm; width 0.75 mm; index 1.6. Height and width aperture 0.3 mm.

Distribution. — Borneo: Kalimantan: K. Timur, near Kutei National Park.

Notes. — Known from a single specimen only. Differs from sympatric *A. stenotrochus stenotrochus* in having a wider umbilicus.

19.1 - **Arinia stenotrochus stenotrochus** spec. nov.
fig. 22

Material seen. — SARAWAK. 4th Div.: G. Subis (Batu Niah) (leg. Wall, UF 236637/>10; do. 236641/>10; V 4846/>10); near Bt. Kudi, Beluru area SW. of Marudi (leg. Wilford, UF 236653/2; do. 236654/1); Bt. Vrong, Beluru area SW. of Marudi (leg. Wilford, UF 236655/>10, incl. HOLOTYPE; do. 236656/1); G. Mulu National Park, near National Park entrance (leg. Ball, V 4845/7); G. Mulu National Park, Melinau Paku R. headwaters, small hill (leg. Wilford, UF 236644/2; do. 236646/>10; do. 236647/5; do. 236650/>10). SABAH. Sandakan Zone: limestone outcrop W. of Sg. Tabin, lower part, lower Segama valley (leg. Wilford, UF 236675/>10). KALIMANTAN. Kalimantan Selatan: Batu Apoh, approximately 35 km NE. of Martapura (leg. Lamb & Mackinnon, V 2458/4; V 3334/>10); Telaga Langsat, approximately 18 km SSW. of Barabai (V 3434/>10); Bt. Pagat, limestone hill 8 km SE. of Barabai (V 3798/>10); Nateh near Batu Tangga, approximately 18 km E. of Barabai (V 3013/>10); G. Siamang near Desah Liu, 30 km E. of Tandjung (V 4847/3); G. Buleh, 4 km E. of Muara Uja (V 3713/>10); G. Halat, near border Kalimantan Timur along main road Banjarmasin-Balikpapan (V 2797/>10); km 45 road Batulicin-Tanahgrogot, Kobeco logging area compartment F (leg. Kessler, V 4639/1). Kalimantan Timur: Batu Butuk, near Muara Komang along main road Banjarmasin-Balikpapan (V 3529/>10); G. Melihat, foot of S.-facing slope, between river and main road Banjarmasin-Balikpapan (V 2943/>10).

Shell (shortly) cylindrical to shortly fusiform, last whorl widest. Whorls 4 1/8-5, (moderately) convex. Tuba 1/4-1/2(-3/4) whorl. Radial ribs single-crested, on the top whorls 12-32 ribs/0.5 mm, on the penultimate whorl 8-36 ribs/0.5 mm, above the aperture absent, or with up to 20 ribs/0.5 mm. Spiral striation absent, rarely present on part of the last whorl, fine, inconspicuous. Umbilicus closed but rimate in oblique view, or open, up to 0.10 mm wide. Aperture not turned upwards. Peristome: palatal side not or hardly protruding beyond the penultimate whorl, columellar side not sinuous; outer peristome slightly spreading beyond the inner on the palatal and basal side, rather abruptly to rather gradually narrowed on the columellar side and towards the angular edge; inner peristome moderately to distinctly protruding from the outer, spreading, just above the angular edge with or without a protrusion about parallel to the margin, palatal side below this protrusion with or without a transverse furrow, palatal and basal side without a lip parallel to the margin, its outer surface and the upper surface of the outer peristome with few fine lamellae. Height 1.0-1.6 mm; width 0.5-0.9 mm; index 1.6-2.2. Height and width aperture 0.20-0.35 mm.

Distribution. — Borneo: Sarawak, 4th Div. various widely distant limestone areas. Sabah, Sandakan Zone, lower Segama river. Kalimantan, K. Selatan and K. Timur, widespread on the western flank of the Meratus Mts., and further north.

Notes. — 1. *Arinia s. stenotrochus* consists of the forms listed below. Although more or less geographically restricted, the forms are not sufficiently distinct to give any of them a taxonomic rank:

G. Subis area: Shell (shortly) cylindrical, with 4 1/2-5 whorls. Tuba 1/4-1/2 whorl. Ultimate whorl above the aperture without radial ribs, or with 6-8 ribs/0.5 mm. Umbilicus closed, or open, up to 0.10 mm wide. Inner peristome moderately to distinctly protruding from the outer, without a protrusion above the angular edge, or with a weak one.

G. Mulu area: Shell shortly cylindrical to shortly fusiform, with 4 1/8-4 1/2 whorls. Tuba 1/4-1/2 whorl. Ultimate whorl above the aperture usually without radial ribs, sometimes with up to 12 ribs/0.5 mm. Umbilicus closed, or open, up to 0.05 mm wide. Inner peristome moderately protruding from the outer, with or without a protrusion above the angular edge.

Beluru area (including the type specimen): Shell shortly cylindrical, with 4 1/4-4 1/2 whorls. Tuba about 3/8 whorl. Ultimate whorl above the aperture usually without radial ribs, sometimes with up to 4 vague ribs/0.5 mm. Umbilicus closed. Inner peristome moderately protruding from the outer, without a protrusion above the angular edge, or with a weak one.

East Sabah: Shell cylindrical, with 4 1/4-4 3/4 whorls. Tuba 1/2 whorl. Ultimate whorl above the aperture usually with 8-20 radial ribs/0.5 mm, sometimes radial ribs very inconspicuous. Umbilicus closed. Inner peristome moderately protruding from the outer, without a protrusion above the angular edge.

Kalimantan Selatan and Timur: Shell (shortly) cylindrical, with 4 3/8-4 3/4 whorls. Tuba (3/8-)1/2-3/4 whorl. Ultimate whorl above the aperture usually with 4-20 radial ribs/0.5 mm, sometimes without ribs. Umbilicus closed, or open, up to 0.05 mm wide. Inner peristome moderately to distinctly protruding from the outer, with or without a protrusion above the angular edge.

2. The species *Arinia stenotrochus* consists of a large number of local forms, together presenting a Gordian knot. Next to the forms listed in note 1, two taxa can be distinguished which are clearly distinct from *A. s. stenotrochus* in a considerable part of the range of the species (including a number of locations where the forms occur together with *A. s. stenotrochus*), but less clearly elsewhere. The most rigorous solution would be not to recognize any taxon within *A. stenotrochus*; however, the clear and unequivocal differences (established on account of abundant material) between both taxa and sympatrical *A. stenotrochus* in various locations would then not be reflected in a taxonomic rank. It seems appropriate to distinguish the taxa on subspecific level, the rank denoting an imperfect distinction between the taxa involved next to imperfect allopatric occurrence. *Arinia stenotrochus* is in need of further study, perhaps an anatomical survey would yield a more satisfactory division into subspecies, or species.

19.2 - **Arinia stenotrochus pachystoma** subspec. nov.
fig. 23

Material seen. — SARAWAK. 4th Div.: Bt. Sarang, Tatau valley (leg. Bong, UF 236658/3; do. 236659/>10; do. 236660/6); G. Subis (Batu Niah) (V 1508/>10); G. Mulu National Park, near National Park entrance (leg. Ball, V 2672/>10, HOLOTYPE RMNH 57221); G. Mulu National Park, Melinau Paku R. headwaters, small hill (leg. Wilford, UF 236643/>10; do. 236645/>10; do. 236647/9; do. 236652/2). SABAH. Sandakan Zone: limestone escarpment along Sg. Tabin, lower Segama valley (leg. Wilford, UF 236674/6).

As the nominate subspecies, but shell (shortly) cylindrical. Whorls 4 1/8-5 1/4, (moderately) convex. Tuba 5/8-3/4 whorl. Radial ribs single-crested, on the top whorls 18-24 ribs/0.5 mm, on the penultimate whorl 10-32 ribs/0.5 mm, above the aperture absent or with up to 16 ribs/0.5 mm. Spiral striation absent. Umbilicus closed but rimate in oblique view, or open, up to 0.10 mm wide. Aperture slightly turned upwards or not. Outer peristome slightly spreading beyond the inner on the palatal and basal side, inner peristome slightly to distinctly protruding from the outer, its outer surface and the upper surface of the outer peristome with few to numerous fine lamellae. Height 1.20-1.65 mm; width 0.65-0.90 mm; index 1.7-2.3. Height and width aperture 0.25-0.35 mm.

Distribution. — Borneo: Sarawak, 4th Div., various widely distant limestone areas. Sabah, Sandakan Zone, lower Segama river.

Notes. — 1. *A. s. pachystoma* consists of a number of local races, showing comparable

patterns of variability as *A. s. stenotrochus*. They are therefore dealt with similarly:

Bt. Sarang area: Shell cylindrical, with 4 1/8-4 5/8 whorls. Ultimate whorl above the aperture usually without radial ribs, sometimes with up to 8 ribs/0.5 mm. Umbilicus open closed, or open, up to 0.10 mm wide. Inner peristome slightly to moderately protruding from the outer, with a distinct protrusion above the angular edge.

G. Subis area: Shell (narrowly) cylindrical, with 4 3/4-5 1/4 whorls. Ultimate whorl above the aperture usually without radial ribs, sometimes with up to 5 ribs/0.5 mm. Umbilicus closed. Inner peristome moderately protruding from the outer, with a distinct (rarely weak) protrusion above the angular edge. - The shells are often very slender. In some, portions of whorls other than the ultimate have no radial ribs.

G. Mulu area (including the type specimen): Shell cylindrical, with 4 1/2-5 whorls. Ultimate whorl above the aperture with 10-16 radial ribs/0.5 mm, rarely without ribs. Umbilicus closed. Inner peristome distinctly protruding from the outer, without a protrusion above the angular edge, or with a weak one. - A single specimen, otherwise identical with this form of *A. pachystoma* has a tuba of 1/2 whorl, as *A. stenotrochus*. The sample UF 236645 contains a shortly cylindrical specimen with a moderately protruding inner peristome. Considering the variability over the entire range of the species, it has been included in *A. pachystoma*.

East Sabah: Shell (narrowly) cylindrical, with 4 3/4-5 1/8 whorls. Ultimate whorl above the aperture without radial ribs. Umbilicus closed. Inner peristome moderately protruding from the outer, without a protrusion above the angular edge. - In most shells the penultimate whorl is also without ribs, partially or entirely.

2. The G. Mulu and G. Subis populations of *A. stenotrochus s.l.* can be perfectly divided into two taxa, which differ in tuba length: *Arinia s. pachystoma*, with a tuba of 5/8-3/4 whorls, and *A. s. stenotrochus*, with a tuba of 1/4-1/2 whorl. A few other characters less perfectly support this division. Populations of *A. stenotrochus* elsewhere in Sabah and Sarawak can be unequivocally assigned to one of the two taxa on account of the tuba length, although, there, all supporting characters show overlap. Only in SE. Kalimantan the distinction breaks down to an extent: while most *A. stenotrochus s.l.* (but *A. s. anisopleuron* excluded) have a tuba of 3/8-1/2 whorl, some 10% of the shells have a tuba reaching up to 3/4 whorl while otherwise not different from the majority of the specimens with a shorter tuba. All SE. Kalimantan specimens have arbitrarily been included in *A. s. stenotrochus*. The differences between populations of *A. s. pachystoma* and sympatric populations of *A. s. stenotrochus* elsewhere can be worked out by comparing the descriptions of the local races of both subspecies.

19.3 - **Arinia stenotrochus anisopleuron** subspec. nov.
fig. 24

Material seen. — KALIMANTAN. Kalimantan Selatan: Nateh near Batu Tangga, approximately 18 km E. of Barabai (V 4843/>10); G. Siamang near Desah Liu, 30 km E. of Tandjung (V 3095/>10); G. Buleh, 4 km E. of Muara Uja (V 3712/>10); Jaro near Muara Uja, limestone escarpment W. of the village (V 3202/>10); G. Halat, near border Kalimantan Timur along main road Banjarmasin-Balikpapan (V 2798/>10); 7 km N. of Kintap (V 4844/1). Kalimantan Timur: Batu Butuk, near Muara Komang along main road Banjarmasin-Balikpapan (V 3530/>10); G. Melihat, foot of S. facing slope, between river and main road Banjarmasin-Balikpapan (V 2944/>10, HOLOTYPE RMNH 57222); 30 km W. of Balikpapan (leg. Van Balgooij, V 2507/>10).

As the nominate subspecies, but shell cylindrical to somewhat fusiform. Whorls 3 7/8-4 1/2, convex. Tuba 1/4-3/8 whorl. Radial ribs either all single-crested, or some

(e.g. those on the tuba), or many (e.g. those from the penultimate whorl onwards), or almost all (except those close to the top) double-crested with both crests equally high, on the top whorls 12-24 ribs/0.5 mm, on the penultimate whorl 4-14 ribs/0.5 mm, absent above the aperture. a few close to the peristome usually single-crested again. Spiral striation absent. Umbilicus closed but often rimate in oblique view, or open but less than 0.05 mm wide. Aperture not turned upwards. Outer peristome at most moderately spreading beyond the inner on the palatal and basal side; inner peristome hardly to moderately protruding from the outer, its outer surface with few fine lamellae. Height 1.2-1.6 mm; width 0.70-0.85 mm; index 1.6-1.9. Height and width aperture 0.3-0.35 mm.

Distribution. — Borneo: Kalimantan, K. Selatan and K. Timur, Meratus Mts. and its extensions in northwards direction, up to Balikpapan.

Notes. — 1. In the northern part of the range of this subspecies, forms with double-crested ribs on the last two whorls (including the tuba) are predominant, grading into forms with only single-crested ribs towards the south. The two forms cannot be separated without leaving morphological intermediates. The occurrence of a fold in the angular corner of the aperture does not coincide with the character states observed on the ribs. It is therefore not possible to distinguish further taxa within *A. s. anisopleuron* in spite of its extreme variability.

2. Specimens with single-crested radial ribs can be easily distinguished from sympatric *A. s. stenotrochus* by their shorter tuba, a character that is supported by the absence of radial ribs on the ultimate whorl, above the aperture. Such specimens are, however, indistinguishable from series of *A. s. stenotrochus* from Sarawak (for instance, the G. Mulu and G. Subis areas) and Sabah, where a variability occurs in the length of the tuba overlapping on the one side with SE. Kalimantan *A. s. stenotrochus*, and on the other side with *A. s. anisopleuron*. Besides, these specimens may or may not have radial ribs on the last whorl, above the aperture.

20 - **Arinia paricostata** spec. nov.
fig. 25

Material seen. — SABAH. Tawau Zone: NW. of road Lahad Datu-Sandakan crossing with Segama R. (V 1670/>10); G. Madai, 40 km SSW. of Lahad Datu (V 1706/>10); G. Baturong, 50 km WSW. of Lahad Datu (UF 196822/>10; V 1836/>10, HOLOTYPE RMNH 57223); Batu Tenggar, Segarong Hills 25 km ESE. of Kunak (V 4562/1).

Shell conical with (slightly) convex sides, or more or less (shortly) cylindrical, last whorl widest. Whorls 4 1/8-5 1/8, convex, last whorl moderately convex. Tuba 1/4 whorl. Radial ribs double-crested with the distal crest highest (close to the top sometimes a few single-crested), on the top whorls 6-12 ribs/0.5 mm, on the penultimate whorl 3-8 ribs/0.5 mm, towards the last whorl single-crested, above the aperture 4-8 ribs/0.5 mm. Spiral striation fine. Umbilicus almost closed to open, up to 0.2 mm wide. Aperture turned slightly to distinctly upwards. Peristome: palatal side distinctly protruding beyond the penultimate whorl, columellar side sinuous or not; outer peristome moderately to widely spreading beyond the inner on the palatal and basal side, (rather) abruptly narrowed on the columellar side and towards the angular edge; inner peristome hardly to distinctly protruding from the outer, spreading, just above the angular edge with a ridge oblique or perpendicular to the margin, at the right side of which a distinct furrow, palatal and basal side without a lip parallel to the margin, its outer

surface and the upper surface of the outer peristome with few lamellae. Height 1.65-2.50 mm; width 1.2-1.4 mm; index 1.4-2.0. Height aperture 0.4-0.5 mm; width 0.4-0.6 mm.

Distribution. — Borneo: Sabah, Tawau Zone, scattered limestone hills in the lower Segama valley and further South.

Notes. — Shells are often more conical, and have a wider umbilicus than the illustrated ones.

21 - *Arinia similis* E.A. Smith, 1893
fig. 26

Arinia similis E.A. Smith, 1893: 350; syntypes ("Barit Mountain, N.W. Borneo") BMNH 92.7.20.116/1, 92.7.23.11-12/2.

Material seen. — SARAWAK. 4th Div.: "Barit Mountain", G. Mulu area (BMNH/3, see above); G. Mulu National Park, Melinau Paku R. headwaters, small hill (leg. Wilford, UF 236648/>10; do. 236649/2; do. 236651/1). "Barit Mountain, N.W. Borneo" (BMNH/3, see above). "North Borneo" (NMW/4). "Borneo" (UF 132955/5).

Shell shortly cylindrical, last whorl or last two whorls widest. Whorls 4 1/4-4 5/8, (moderately) convex. Tuba 1/4-1/2 whorl. Radial ribs on the top whorls single-crested, 20-28 ribs/0.5 mm, on the penultimate whorl single- or double-crested, 12-20 ribs/0.5 mm, above the aperture single- or double-crested, 4-9 ribs/0.5 mm; double-crested ribs with both crests equally high. Spiral striation absent or present, fine. Umbilicus usually open, 0.05-0.20 mm wide, sometimes closed. Aperture not turned upwards, not or hardly oblique. Peristome: palatal side not or hardly protruding beyond the penultimate whorl, columellar side not sinuous; outer peristome at most slightly spreading beyond the inner on the palatal and basal side, rather abruptly narrowed on the columellar side and towards the angular edge; inner peristome hardly to moderately protruding from the outer, not spreading, just above the angular edge with a protrusion about parallel to the margin, palatal side below this protrusion with a transverse furrow, palatal and basal side without a lip parallel to the margin, its outer surface and the upper surface of the outer peristome with few fine lamellae. Height 1.5-1.7 mm; width 0.9-1.1 mm; index 1.5-1.8. Height aperture 0.4-0.5 mm; width 0.40-0.45 mm.

Distribution. — Borneo: Sarawak, 4th Div., Mulu area only.

Notes. — 1. Specimens with only single-crested radial ribs occur together with specimens with double-crested ribs on the last 1 1/2 whorls; intermediates (last whorl with double-crested ribs, or only few double-crested ribs on the tuba) are also found.

2. Sympatric *A. s. stenotrochus* and *A. s. pachystoma* have a smaller aperture and are usually smaller. Large specimens of *A. s. stenotrochus* found so far, have more closely placed radial ribs above the aperture and lack a protrusion in the angular corner of the peristome. *Arinia s. pachystoma* has a longer tuba and a narrower shell.

22 - **Arinia dentifera** spec. nov.
fig. 27

Material seen. — SABAH. Tawau Zone: NW. of road Lahad Datu-Sandakan crossing with Segama R. (V 1668/>10, HOLOTYPE RMNH 57224).

Shell more or less cylindrical, last two whorls widest. Whorls 4 1/8-5 1/8, convex.

Tuba 1/2-5/8 whorl, with a short, longitudinal columellaris close to, and usually just visible in the aperture. Radial ribs close to the top single-crested, 10-20 ribs/0.5 mm, on the next whorls double-crested with both crests equally high or with the distal crest highest, on the penultimate whorl 5-7 ribs/0.5 mm, absent above the aperture; ribs on the tuba single-crested again. Spiral striation absent. Umbilicus closed but rimate in oblique view. Aperture not turned upwards. Peristome: palatal side not protruding beyond the penultimate whorl, columellar side not sinuous; outer peristome at most slightly spreading beyond the inner on the palatal and basal side, gradually narrowed on the columellar side, but more abruptly so towards the angular edge; inner peristome at most somewhat protruding from the outer, somewhat spreading, just above the angular edge with a (slight) protrusion about parallel to the margin, palatal side below this protrusion with a transverse furrow, palatal and basal side without a lip parallel to the margin, its outer surface with few fine lamellae. Height 1.25-1.70 mm; width 0.75-0.85 mm; index 1.6-2.0. Height and width aperture 0.30-0.35 mm.

Distribution. — Borneo: Sabah, Tawau Zone, lower Segama valley, so far reported from a single limestone hill.

Notes. — In spite of the presence of a columellaris, as in *Diplommatina*, this species is included in *Arinia* because of a marked overall similarity with other species of this genus, and because of the presence of double-crested radial ribs, a character not present in *Diplommatina*.

23 - **Arinia streptaxiformis** spec. nov.
fig. 28

Material seen. — SABAH. Tawau Zone: Bt. Pababola, Segarong Hills 25 km ESE. of Kunak (V 1760/>10, HOLOTYPE RMNH 57225); Batu Tenggar, Segarong Hills 25 km ESE. of Kunak (V 1805/>10).

Shell more or less cylindrical, last two whorls widest. Whorls (4 3/8-)5-5 5/8, convex, last whorl sometimes moderately convex. Tuba (1/2-)3/4-1 1/4 whorl, with a rounded, well demarcated ridge on the columellar side (corresponding with a similar furrow inside); often with a short, longitudinal tooth in palatal, basal or almost columellar position, close to the constriction. Radial ribs on the top whorls single-crested, 5-11 ribs/0.5 mm, towards the penultimate whorl double-crested usually with the distal crest highest, on the penultimate whorl 3-6 ribs/0.5 mm, above the aperture 4-5 ribs/0.5 mm, ribs close to the peristome often single-crested again. Spiral striation fine. Umbilicus open, 0.25-0.65 mm wide. Aperture not turned upwards, or sometimes slightly so, furrow in the tuba often just visible on the columellar side. Peristome: palatal side usually distinctly protruding beyond the penultimate whorl, columellar side hardly to moderately sinuous; outer peristome hardly to moderately spreading beyond the inner on the palatal and basal side, abruptly narrowed on the columellar side and towards the angular edge; inner peristome somewhat protruding from the outer, moderately spreading, just above the angular edge with a protrusion about parallel to the margin, palatal side below this protrusion with a distinct transverse furrow, palatal and basal side without a lip parallel to the margin, its outer surface with few fine lamellae. Height (1.5-)1.6-2.1 mm; width (0.9-)1-1.4 mm; index 1.3-1.8. Height aperture 0.45-0.50 mm; width 0.4-0.5 mm.

Distribution. — Borneo: Sabah, Tawau Zone, two coastal limestone hills NW. of Semporna.

Notes. — About 5% of the specimens of a sample from Batu Tenggar has the tuba partly detached from the spire.

24.1 - **Arinia brevispira brevispira** spec. nov.
fig. 29

Material seen. — SABAH. Interior Zone: 5.5 km NNE. of Simatuoh, 9 km E. of Sepulot (leg. Dorman, UF 196504/>10, incl. HOLOTYPE).

Shell shortly cylindrical, last two whorls widest. Whorls 4 3/8-4 5/8, convex. Tuba 3/8-1/2 whorl. Radial ribs close to the top single-crested, 11-15 ribs/0.5 mm, others double-crested with both crests equally high, on the penultimate whorl 5-8 ribs/0.5 mm, above the aperture with 3-5 ribs/0.5 mm, a few ribs close to the peristome single-crested again. Spiral striation absent. Umbilicus open, 0.10-0.15 mm wide. Aperture not turned upwards. Peristome: palatal side at most slightly protruding beyond the penultimate whorl, columellar side not hardly moderately sinuous; outer peristome hardly to moderately spreading beyond the inner on the palatal and basal side, abruptly narrowed on the columellar side and towards the angular edge; inner peristome hardly to moderately protruding from the outer, somewhat spreading, just above the angular edge with a (slight) protrusion about parallel to the margin, palatal side below this protrusion with a distinct transverse furrow, palatal and basal side with at most a poorly demarcated lip parallel to the margin, its outer surface with few fine lamellae. Height 1.9-2 mm; width 1.1-1.2 mm; index 1.6-1.8. Height and width aperture 0.45-0.5 mm.

Distribution. — Sabah, Interior Zone, a single limestone hill near Sepulot.

Notes. — 1. *Arinia similis* has the radial ribs on the penultimate whorl more closely placed.

2. Two geographically widely separated populations are known, which are similar in most characters but consistently differ in a few. They are therefore regarded as subspecies.

24.2 - **Arinia brevispira orientalis** subspec. nov.
fig. 30

Material seen. — SABAH. Sandakan Zone: limestone escarpment along Sg. Tabin, lower Segama valley (leg. Wilford, UF 236674/>10); limestone outcrop W. of Sg. Tabin, lower part, lower Segama valley (leg. Wilford, UF 236675/1); Tawau Zone: 'Kirk's Cave', 8 km N. of Lahad Datu (V 1217/>10, HOLOTYPE RMNH 57226).

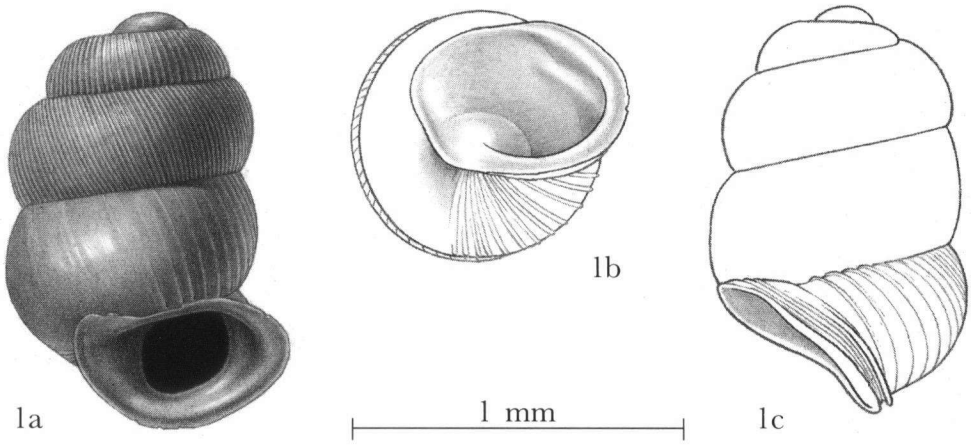
As the nominate subspecies, but last whorl (moderately) convex above the periphery, and somewhat flattened below. Radial ribs double-crested on the penultimate whorl, but towards the ultimate whorl and on the tuba single-crested again. Umbilicus open, 0.15-0.25 mm wide. Height 1.35-2.10 mm; width 0.95-1.20 mm; index 1.4-1.8. Height and width aperture 0.35-0.50 mm.

Distribution. — Sabah, Tawau Zone, lower Segama valley.

Notes. — On average, the Tabin specimens are slightly smaller, have a shorter and wider shell, and have a wider umbilicus, than the specimens found near Lahad Datu.

Genus 3: *Niahia* Vermeulen, 1996

Shell white, dextral. Spire shortly cylindrical. Whorls 4 1/2. Top whorls oblique. Radial ribs low, with a single crest. Constriction without teeth. Tuba 1/4 whorl, not inverted, without teeth. Umbilicus closed. Aperture tilted obliquely downwards at an angle of about 45° with regard to the coiling axis; inner peristome without basal edge,



Text-fig. 1. a, *Niahia oberon* Vermeulen, 1996, holotype specimen, Sarawak: G. Subis (RMNH), front view; b, do., umbilical view; c, do., right lateral view.

without teeth, abruptly widened at the level of the outer peristome, the widening visible inside as a rather distinct though poorly demarcated lip rather close to the margin on the basal side but situated deeper into the aperture on the palatal side. Height 1.25 mm.

Distribution. — Endemic to Sarawak.

Notes. — Further information on this genus, as well as a description of its single species, *N. oberon* Vermeulen, 1996 (see text-fig. 1), is given in Vermeulen (1996).

Genus 4: *Diplommatina* Benson, 1849

Shell white to corneous or orange, dextral or sinistral. Spire usually fusiform, sometimes conical to cylindrical. Whorls 4 1/4-9 1/8. Top whorls usually not oblique. Radial ribs low or high, or with trough-shaped or tubular projections, with a single crest. Constriction usually with 1-5 longitudinal teeth, among which usually a columellaris and/or 1-3 palatales. Tuba 5/8-2 whorls, not inverted, usually with a columellaris, and with a palatalis continuing from the constriction. Umbilicus closed, rarely open. Aperture not tilted, or tilted obliquely downwards at an angle of up to 30° with regard to the coiling axis, rarely up to 45°, often with a (distinct) basal edge, usually with the columellaris visible; inner peristome often with a well-demarcated lip, demarcation consisting of a furrow close to the margin. Height 1.3-11.5 mm. Operculum corneous (sometimes with a calcareous layer?), paucispiral.

Notes. — Revised in Vermeulen, 1993. Because a considerable number of samples containing mainly the sinistral species (species 39-50) became available since this publication, the part of the key dealing with the sinistral species (Vermeulen, 1993: 10-11) is best replaced by the following:

48 a - (1) Shell 1.3-3.1 mm high 49
b - Shell 4.0-11.5 mm high 50

49 a - Shell 1.3-1.5 mm high, about cylindrical ..... *D. whiteheadi* (39)
b - Shell 2.5-3.1 mm high, conical with the last whorl moved inwards ..... *D. busanensis* (40)

50 a - Shell strictly conical, with the last whorl not at all moved inwards ..... *D. isseli* (41)
b - Shell fusiform, or if shell more or less conical, then with the last whorl moved inwards 51

51 a - Peristome simple, either with a lip on the palatal and basal side which is demarcated by a furrow close to the margin of the peristome (make sure to check adult specimens), or without such a lip 52
b - Peristome double. Inner peristome without a lip 54

52 a - Peristome without a lip on the palatal and basal side. Constriction with 1 oblique longitudinal palatalis ..... *D. sulphurea* (48)
b - Peristome with a lip on the palatal and basal side. Constriction with 2-3 longitudinal palatales, the upper approximately parallel to the suture 53

53 a - Shell 4.5-7.5 mm high. Peristome on the parietal side usually reaching the suture of the previous whorl ..... *D. adversa* (42)
b - Shell 10.0-11.5 mm high. Peristome on the parietal side not reaching the suture of the previous whorl ..... *D. goliath* (42a)

54 a - Tuba close to the constriction with a longitudinal palatalis which is situated close to the suture, and which obliquely points downwards towards the constriction 55
b - *Either* tuba close to the constriction with a longitudinal palatalis which is situated close to the suture, and which runs approximately parallel to it, or which slightly points upwards towards the constriction; *or* tuba close to the constriction without a longitudinal palatalis close to the suture 58

55 a - Radial ribs fine, but distinct, present over the entire shell ..... *D. rubra* (49)
b - *Either* radial ribs absent, *or* radial ribs present but inconspicuous, on part of the shell only 56

56 a - Constriction with a strongly oblique to tranversal palatalis in almost basal position, close to its narrowest part ..... *D. subglaber kakusana* (50.2)
b - Constriction without a palatalis in almost basal position close to its narrowest part, or constriction with a very inconspicuous swelling without a clear direction in that position 57

57 a - Shell 4.2-6.0 mm high. Number of whorls 6 1/2-7 1/8 ..... *D. subglaber subisensis* (43)
b - Shell 5.5-7.0 mm long. Number of whorls 7 1/8-7 7/8 ..... *D. subglaber subglaber* (50)

58 a - Radial ribs absent, or radial ribs present but densely placed (5-10 ribs/0.5 mm on the penultimate whorl) 59

b - Radial ribs present, widely spaced (2-4 ribs/0.5 mm on the penultimate whorl) 61

59 a - Shell 4.5-5.4 mm high ..... *D. subglaber subisensis* (43)
b - Shell 5.6-8.0 mm high 60

60 a - All whorls about equally convex. Radial ribs fine, but rather distinct, present over the entire shell ..... *D. electa* (44)
b - Top whorls convex, next whorls almost flat, body whorls slightly convex. Radial ribs absent, or present but inconspicuous, on part of the shell only ..... *D. rubicunda* (45)

61 a - Radial ribs low and wide, not sinuous ..... *D. centralis* (46)
b - Radial ribs high and rather thin, sinuous ..... *D. moluensis* (47)

1a - **Diplommatina meijaardi** spec. nov.
fig. 32

Material seen. — KALIMANTAN. Kalimantan Timur: Sangkulirang area, G. Sekarat (leg. Van Valkenburg & Galzin, V 4503/4, incl. HOLOTYPE RMNH 57227); Sangkulirang area, Muara Karangan (leg. E. Meijaard, V 4606/>10).

Shell dextral, conical with the last whorl moved inwards, last whorl widest; sides flat or slightly concave. Whorls 7 5/8-8 1/2, convex. Suture impressed. Constriction level with the parietal side of the peristome, with 2 parietales, 1-2 longitudinal palatales, 1 transversal palatalis, 1 columellaris. Tuba about 7/8 whorl. Radial ribs continuing up to the peristome, widely spaced, hardly visible but half-way the whorl with an almost tubular projection, in adults often abraded to a semi-circular scar. Spiral striation absent. Umbilicus closed, partly or entirely surrounded by a ridge about half-way the umbilicus and the periphery of the last whorl. Aperture tilted up to 30° with regard to the coiling axis; columellaris distinct, directed downwards. Peristome simple or double, expanding; palatal side hardly to moderately sinuous, without edge; basal side without edge; basal edge not sinuous, rounded; inner peristome, if present, slightly expanding beyond the outer or not, with a palatal lip, free and erect on the columellar side, expanding on the parietal side. Height 5.9-6.4 mm; width 2.9-3 mm; index 2.0-2.2. Height aperture 1.3 mm; width 1.3-1.4 mm.

Distribution. — Borneo: Kalimantan Timur, Sankulirang Peninsula.

Notes. — Similar to *D. bicoronata* Von Martens, 1884, and *Diplommatina spinosa* Godwin Austen, 1889. Differs from both in having a ridge encircling the umbilicus. Moreover, *D. bicoronata* has 2-3 longitudinal palatales.

42a - **Diplommatina goliath** spec. nov.
fig. 33

Material seen. — SARAWAK. 1st Div.: G. Braang, NW. foot, 22 miles S. of Kuching (leg. Wilford, UF 236788/2); G. Gayu 23 miles S. of Kuching (leg. Wilford, UF 236787/9); G. Saak 1 mile W. of Begu, 24 miles S. of Kuching (leg. Wilford, UF 236786/1); limestone hill 1 mile NE. of Pankalan Ampat, 0.5 mile E. of Temerang (leg. Wilford, UF 236785/5, incl. HOLOTYPE).

Shell sinistral, fusiform, last two whorls widest; sides flat or slightly convex. Whorls 6 3/8-6 7/8, slightly convex. Suture impressed. Constriction level with the parietal side of the peristome, with 1 parietalis, 2 longitudinal palatales, 1 transversal palatalis, 1 columellaris. Tuba 3/4 whorl. Radial ribs, often absent on the top whorls, not sinuous, low, thin, moderately spaced (3-7 ribs/0.5 mm on the penultimate whorl). Spiral striation absent. Umbilicus closed. Aperture hardly tilted with regard to the coiling axis; columellaris distinct, directed downwards. Peristome simple, widely expanding, palatal side not sinuous, without edge; basal edge not sinuous, rounded; peristome with a palatal lip, expanding but free and slightly erect on the columellar side, expanding (almost) up to the suture of the previous whorl on the parietal side. Height 10.0-11.5 mm; width 4.3-5.0 mm; index 2.2-2.5. Height aperture 2.9-3.2 mm; width 2.9-3.3 mm.

Distribution. — Borneo: Sarawak, 1st Div., upper Penrissen valley.

Notes. — 1. About half-way the continuation of the columellaris into the tuba has a slight notch in its crest.

2. All other Bornean *Diplommatina* are distinctly smaller: shell 8 mm high at most. *Diplommatina adversa* (H. & A. Adams, 1851) is most similar, but has three longitudinal palatales.

43 - *Diplommatina subglaber subisensis* (Vermeulen, 1993)

Additional material seen. — SARAWAK. 1st Div.: G. Braang, NW. foot, 22 miles S. of Kuching (leg. Wilford, UF 236805/4). 4th Div.: G. Subis (Batu Niah) (leg. Wall, UF 236797/>10; do. 236798/7; do. 236799/2; do. 236800/3);

Notes. — The above mentioned sample of G. Braang is an important extension of the range of this taxon, which was regarded as endemic to the Subis area. The specimens from G. Braang are slightly larger (up to 6 mm high and 3 mm wide), thus partly obliterating the difference in size between this and *D. s. subglaber*. It is possible that new samples will show that the two constitute in fact a single, variable taxon; for the time being, it seems best to keep them separate at subspecific level.

50.2 - **Diplommatina subglaber kakusana** subspec. nov.
fig. 34

Material seen. — SARAWAK. 4th Div.: Kakus Mts., S of Bintulu (leg. Bryant, UF 236804/>10, incl.HOLOTYPE; do. 236810/>10).

As the nominate subspecies (see Vermeulen, 1993: 40) but constriction with 1 parietalis, 1 oblique longitudinal palatalis close to the suture, 1 transversal palatalis, 1 distinctly oblique to tranversal palatalis in almost basal position, 1 columellaris. Radial ribs present only on the last portion of the tuba. Height 5.2-5.9 mm; width 2.5-3.0 mm; index 1.9-2.1. Height aperture 1.35-1.50 mm; width 1.30-1.45 mm.

Distribution. — Borneo: Sarawak, 4th Div., upper Tatau valley, Kakus Mts.

Notes. — Differs from both the nominate subspecies, and from *D. s. subisensis* Vermeulen, 1993, mainly in having a third, distinctly oblique to transversal palatalis. In both other subspecies a slight swelling sometimes occurs in the same position, but this is so short and inconspicuous that its direction cannot be ascertained. The almost entirely glabrous shell surface of *D. s. kakusana* is not diagnostic; similar shells occur among series of the both other subspecies.

REFERENCES

GREDLER, V., 1902. Zur Conchylien-Fauna von Borneo und Celebes. — Nachr.bl. Deutsch. Malakozool. Ges. 34: 53-62.

KOBELT, W., 1902. Cyclophoridae. In: Das Tierreich 16, Mollusca: I-XXXIX, 1-662. — Berlin.

SMITH, E.A., 1893. Descriptions of new species of land-shells from Borneo. — J. Linn. Soc. 24: 341-352.

SOLEM, A., 1964. A collection of non-marine molluscs from Sabah, Malaysia. — Sabah Soc. J. 2: 1-40.

VERMEULEN, J.J., 1991. Notes on the non-marine molluscs of the island of Borneo 2. The genus Opisthostoma (Gastropoda Prosobranchia: Diplommatinidae). — Basteria 55: 139-163.

— —, 1993. Notes on the non-marine molluscs of the island of Borneo 5. The genus Diplommatina (Gastropoda Prosobranchia: Diplommatinidae). — Basteria 57: 3-69.

— —, 1994. Notes on the non-marine molluscs of the island of Borneo 6. The genus Opisthostoma (Gastropoda Prosobranchia: Diplommatinidae), part 2. — Basteria 58: 75-191.

— —, 1996. Notes on the non-marine molluscs of the island of Borneo 7. The genus Niahia (Gastropoda Prosobranchia: Diplommatinidae). — Basteria 60: 67-69.

Plate captions.

Note. — In the illustrations of the *Arinia* species the position of the constriction is indicated by an arrow.

Fig. 1. a, explanatory figure to the key, angular edge of the inner peristome with a ridge perpendicular to its margin (see arrow); b, do., angular edge of the inner peristome with protrusion about parallel to its margin (see arrow); c, inner peristome with a lip parallel to the margin on the palatal and basal side, demarcated with a furrow close to the margin of the inner peristome (see arrow).

Fig. 2. a, *Arinia pseudopomatias* (Gredler, 1902), Sarawak: G. Subis (V), front view; b, do., back view.

Fig. 3. a, *Arinia valkenburgi* spec. nov., holotype specimen, Kalimantan: near Kutei National Park (RMNH), front view; b, do., umbilical view; c, do., right lateral view.

Fig. 4. a, *Arinia boreoborneensis* spec. nov., holotype specimen, Sabah: P. Banggi (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view.

Fig. 5. a, *Arinia cylindrica cylindrica* subspec. nov., holotype specimen, Sabah: Gomantong (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view.

Fig. 6. a, *Arinia cylindrica crassilabris* subspec. nov., holotype specimen, Sabah: hill 7 miles E. of Lamag, 3 miles NNW. of Laab (UF), front view.

Fig. 7. a, *Arinia clausa* spec. nov., holotype specimen, Sarawak: G. Mulu area (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view.

Fig. 8. a, *Arinia biplicata* spec. nov., holotype specimen, Sabah: Gomantong (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view; d, other shell from the same locality, back view with part of the shell wall removed to show the interior of the tuba.

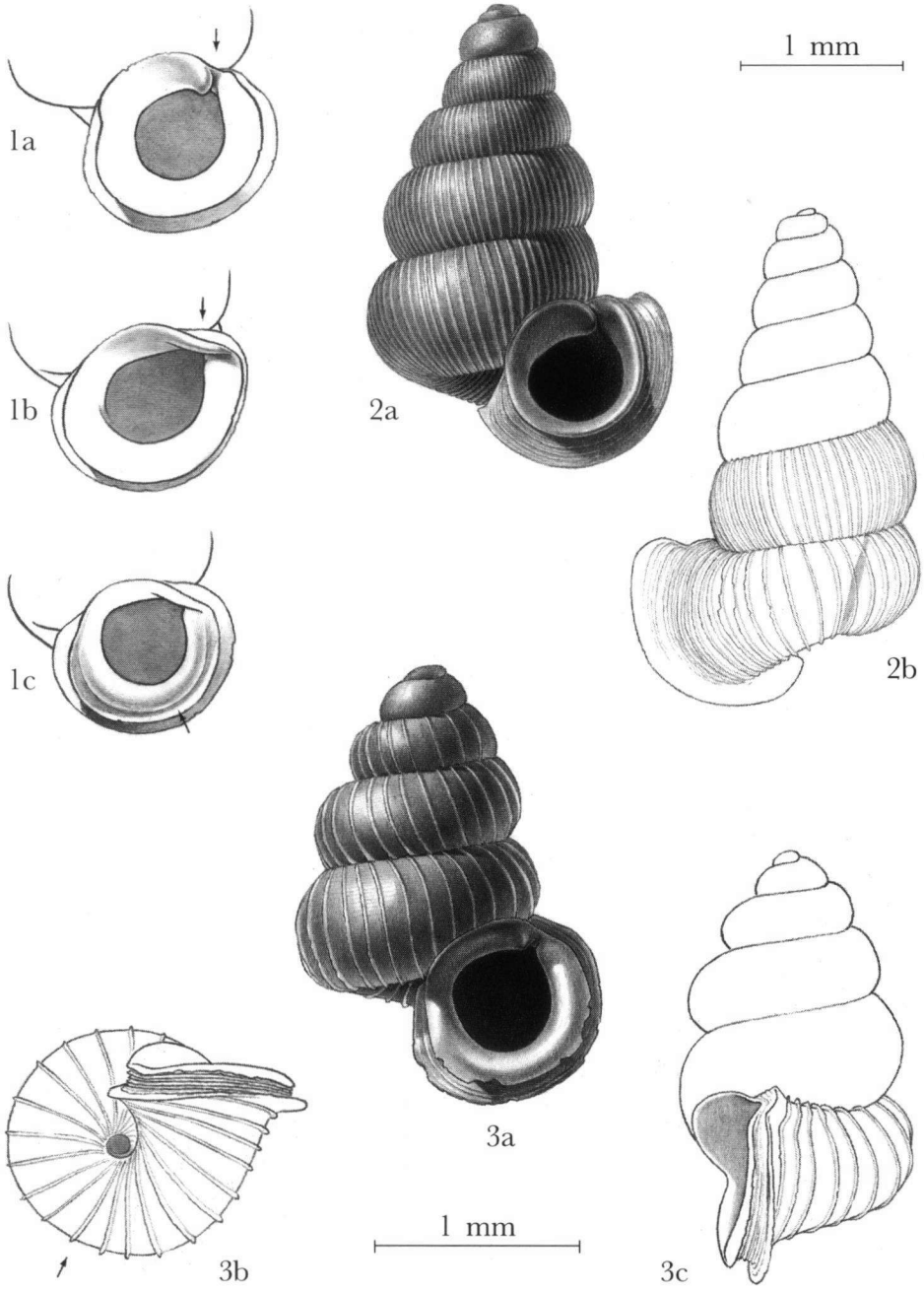
Fig. 9. a, *Arinia pertusa* spec. nov., holotype specimen, Sabah: G. Madai (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view; d, Sabah: Bt. Gomantong (V), front view.

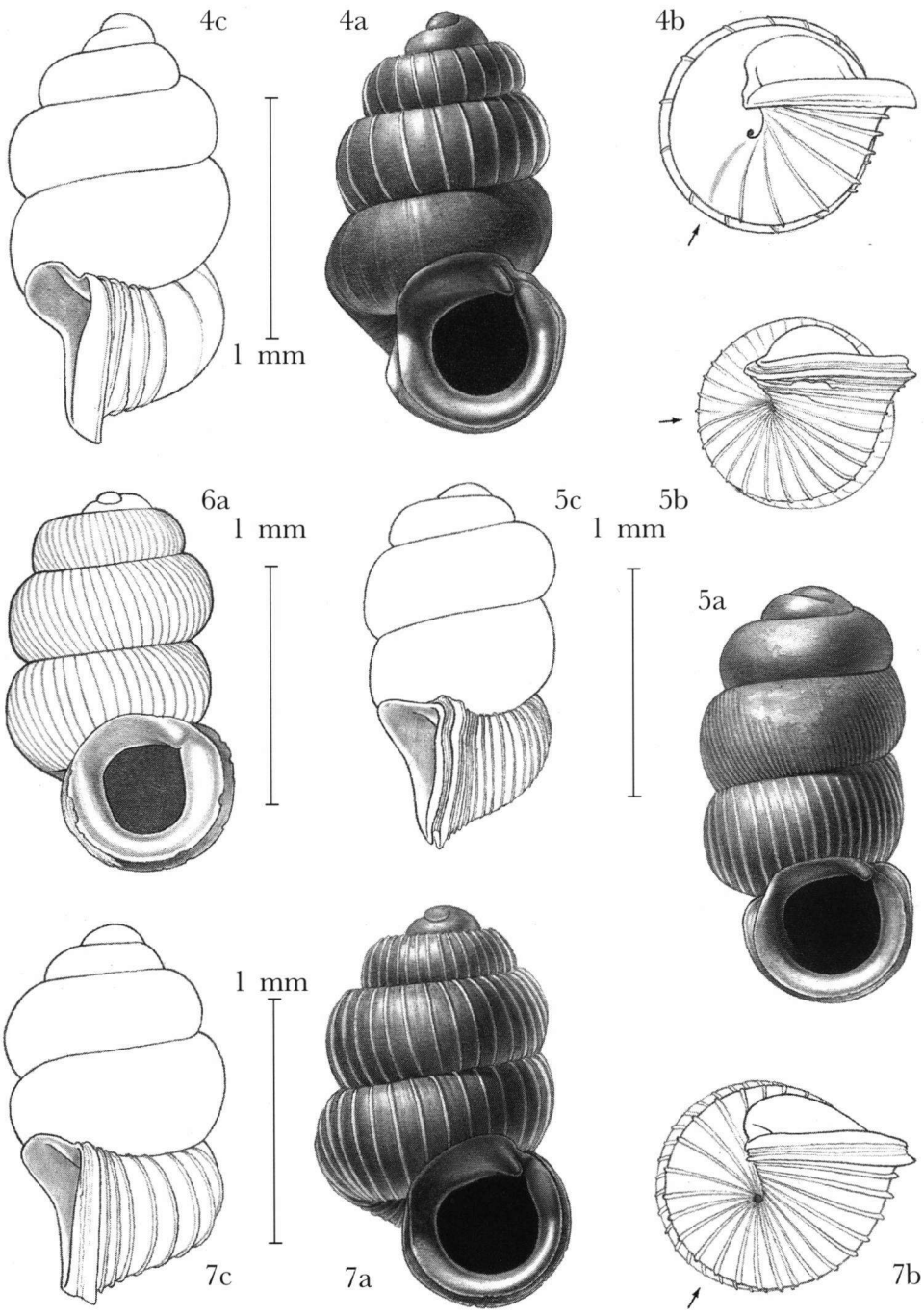
Fig. 10. a, *Arinia borneensis* E.A. Smith, 1893, Sabah: Bt. Gomantong (V), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view; d, other shell from the same locality, operculum.

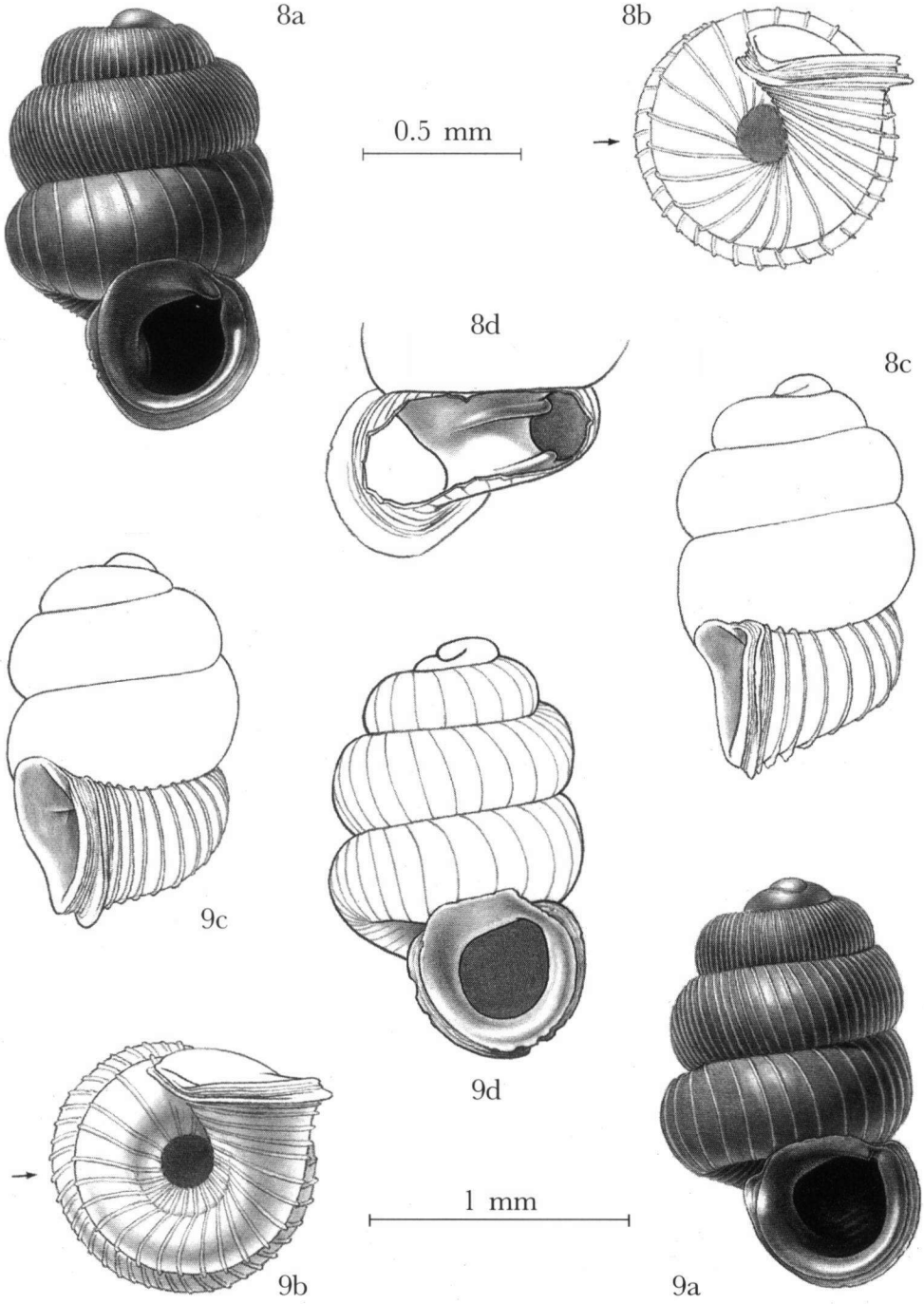
Fig. 11. a, *Arinia dioryx* spec. nov., holotype specimen, Kalimantan: Beramban (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view; d, other shell from the same locality, back view with part of the shell wall removed to show the interior of the tuba; e, Kalimantan: G. Melihat (V), front view; f, do., umbilical view; g, do., right lateral view; h, other shell from the same locality, back view with part of the shell wall removed to show the interior of the tuba.

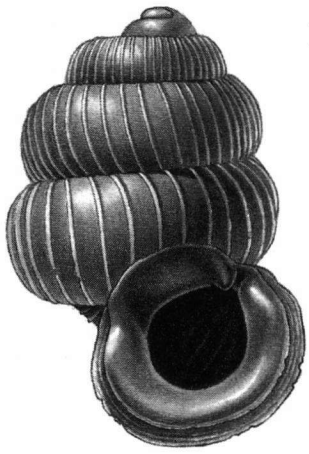
Fig. 12. a, *Arinia strophostoma strophostoma* subspec. nov., holotype specimen, Kalimantan: Nateh near Batu Tangga (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view; d, Kalimantan: Benualawas-Limbungan (V), front view; e, other shell from the same locality, umbilical view; f, other shell from the same locality, right lateral view.

Fig. 13. a, *Arinia strophostoma fusiformis* subspec. nov., holotype specimen, Kalimantan: Benualawas-Limbungan (V), front view; b, other shell from the same locality, umbilical view; c, do., right lateral view.
Fig. 14. a, *Arinia turgida* spec. nov., holotype specimen, Sabah: Batu Tenggar (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view; d, Sabah: Bt. Gomantong (V), front view.
Fig. 15. a, *Arinia simplex* spec. nov., holotype specimen, Sabah: Bt. Gomantong (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view.
Fig. 16. a, *Arinia saeperobustior* spec. nov., holotype specimen, Sarawak: Bt. Gading (UF), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view.
Fig. 17. a, *Arinia ascotrochus* spec. nov., holotype specimen, Kalimantan: Jaro near Muara Uja (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view.
Fig. 18. a, *Arinia oviformis* spec. nov., holotype specimen, Sabah: Simatuoh area (UF), front view; b, other shell from the same locality, umbilical view; c, do., right lateral view.
Fig. 19. a, *Arinia obesa* spec. nov., holotype specimen, Sarawak: G. Subis (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view.
Fig. 20. a, *Arinia distorta* spec. nov., holotype specimen, Sarawak: G. Subis (UF), front view; b, other shell from the same locality, umbilical view; c, do., right lateral view.
Fig. 21. a, *Arinia ferecognita* spec. nov., holotype specimen, Kalimantan: near Kutei National Park (RMNH), front view; b, do., umbilical view; c, do., right lateral view.
Fig. 22. a, *Arinia stenotrochus stenotrochus* subspec. nov., holotype specimen, Sarawak: Bt. Vrong near Beluru (UF), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view; d, Kalimantan: G. Melihat (V), front view; e, do., umbilical view; f, other shell from the same locality, front view; g, do., right lateral view.
Fig. 23. a, *Arinia stenotrochus pachystoma* subspec. nov., holotype specimen, Sarawak: G. Mulu area (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view; d, Sarawak: G. Subis (V), front view; e, Sarawak: Bt. Sarang (UF), front view; f, other shell from the same locality, umbilical view; g, do., right lateral view.
Fig. 24. a, *Arinia stenotrochus anisopleuron* subspec. nov., holotype specimen, Kalimantan: G. Melihat (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view; d, Kalimantan: Jaro near Muara Uja (V), front view.
Fig. 25. a, *Arinia paricostata* spec. nov., holotype specimen, Sabah: G. Baturong (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view.
Fig. 26. a, *Arinia similis* E.A. Smith, 1893, Sarawak: G. Mulu area (UF), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view.
Fig. 27. a, *Arinia dentifera* spec. nov., holotype specimen, Sabah: crossing road Lahad Datu-Sandakan with Segama River (RMNH), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view; d, other shell from the same locality, back view with part of the shell wall removed to show the interior of the tuba.
Fig. 28. a, *Arinia streptaxiformis* spec. nov., holotype specimen, Sabah: Bt. Pababola (RMNH), front view; b, other shell from the same locality, front view; c, d, other shells from the same locality, umbilical view; e, other shell from the same locality, right lateral view; f, other shell from the same locality, back view with part of the shell wall removed to show the interior of the tuba.
Fig. 29. a, *Arinia brevispira brevispira* subspec. nov., holotype specimen, Sabah: near Simatuoh (UF), front view; b, other shell from the same locality, umbilical view; c, other shell from the same locality, right lateral view.
Fig. 30. a, *Arinia brevispira orientalis* subspec. nov., holotype specimen, Sabah: 'Kirk's Cave' near Lahad Datu (RMNH), front view.
Fig. 31. a, *Diplommatina meijaardi* spec. nov., holotype specimen, Kalimantan: Sankulirang area: G. Sekarat (RMNH), front view; b, do. with position of teeth indicated with shading.
Fig. 32. a, *Diplommatina goliath* spec. nov., holotype specimen, Sarawak: Temerang (UF), front view; b, do. with position of teeth indicated with shading.
Fig. 33. a, *Diplommatina subglaber kakusana* subspec. nov., holotype specimen, Sarawak: Kakus Mts. (UF), front view.

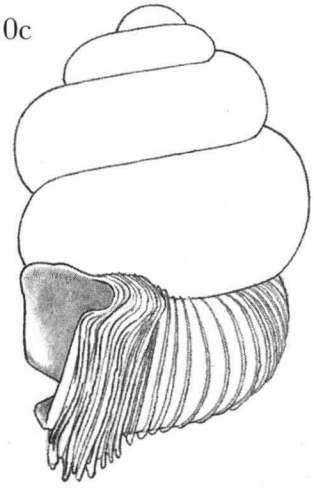

1a
1b
1c
2a
1 mm
2b
3a
1 mm
3b
3c


4c
4a
4b
1 mm
6a
1 mm
5c
5b
1 mm
5a
1 mm
7c
7a
7b


8a
8b
0.5 mm
8d
8c
9c
9d
1 mm
9b
9a



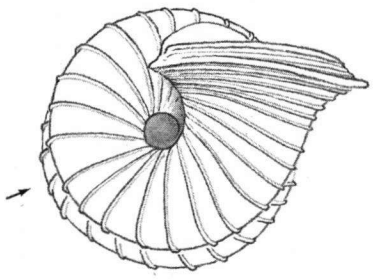
10a

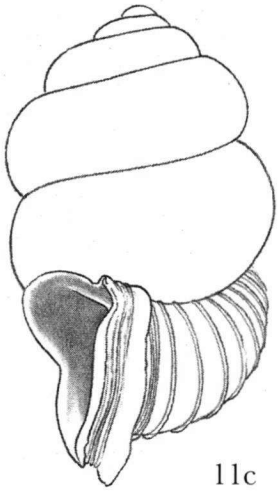


10c

1 mm

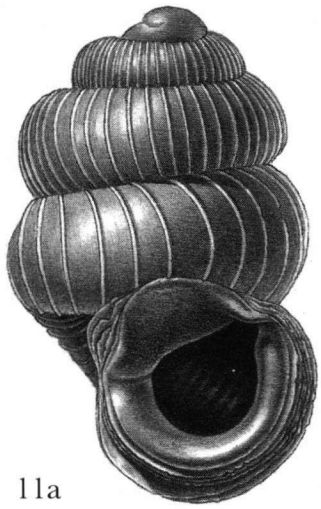
10b



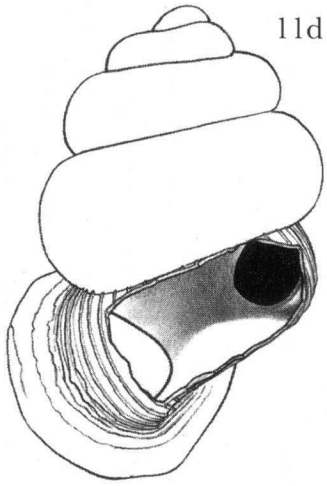


11c

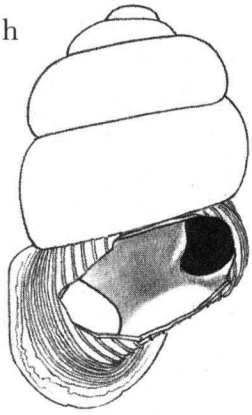
1 mm



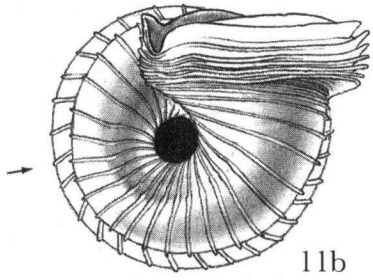
11a



11d

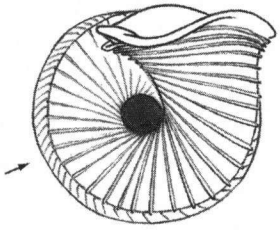


11h

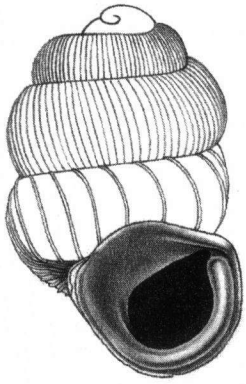


11b

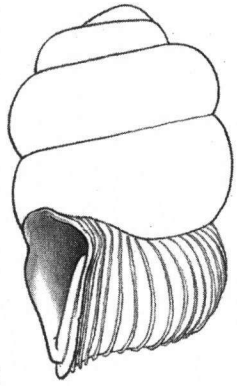
1 mm



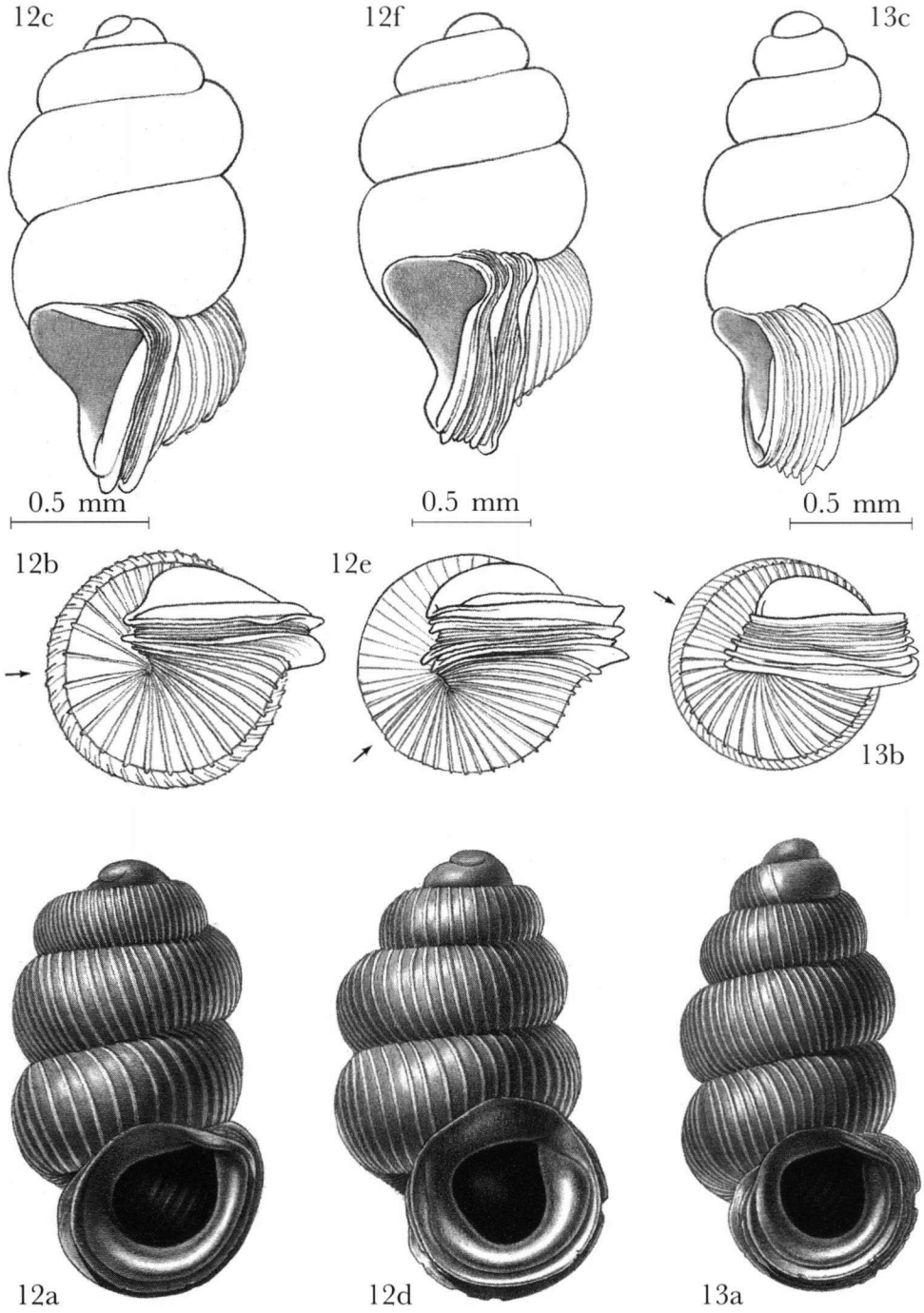
11f

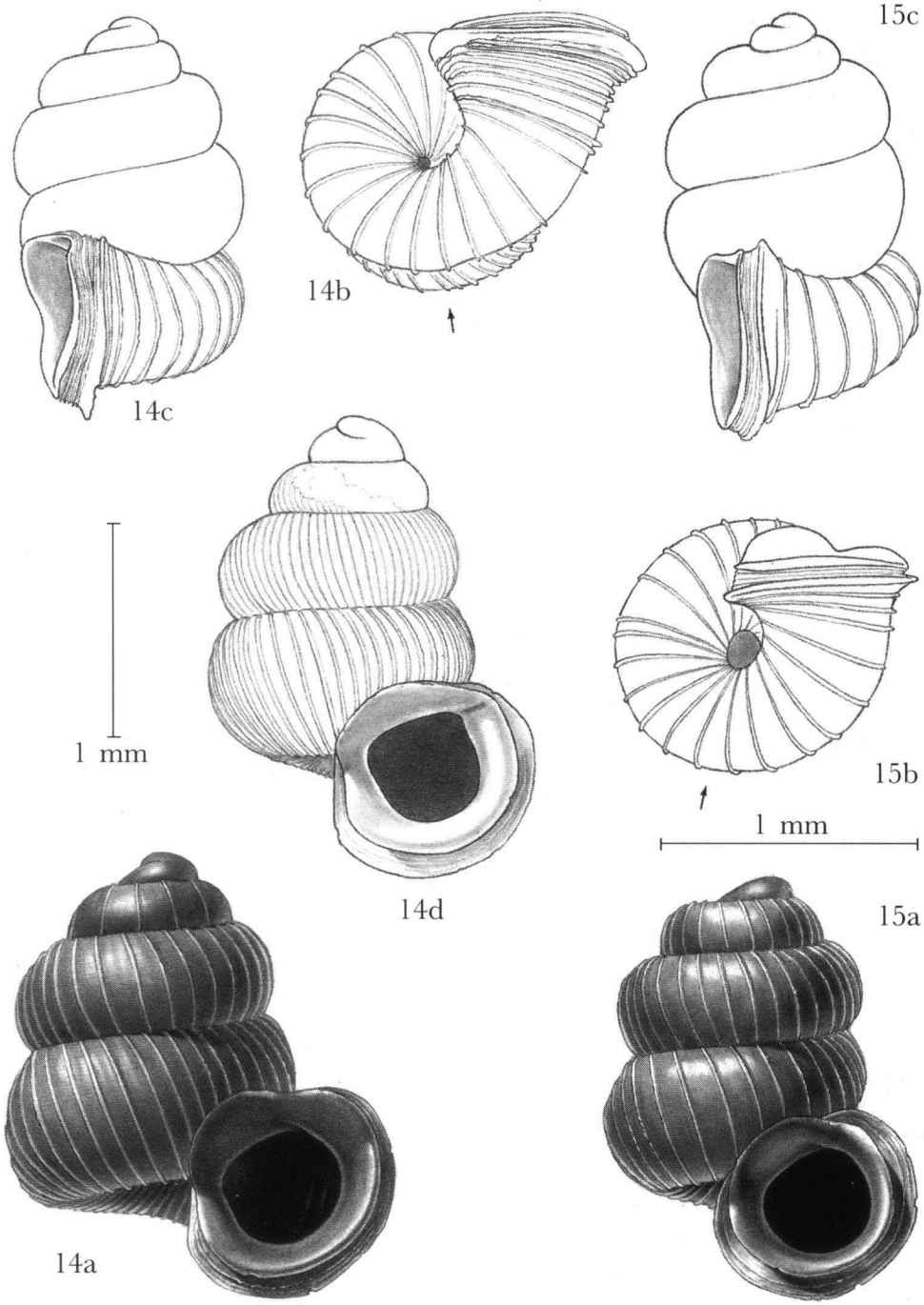


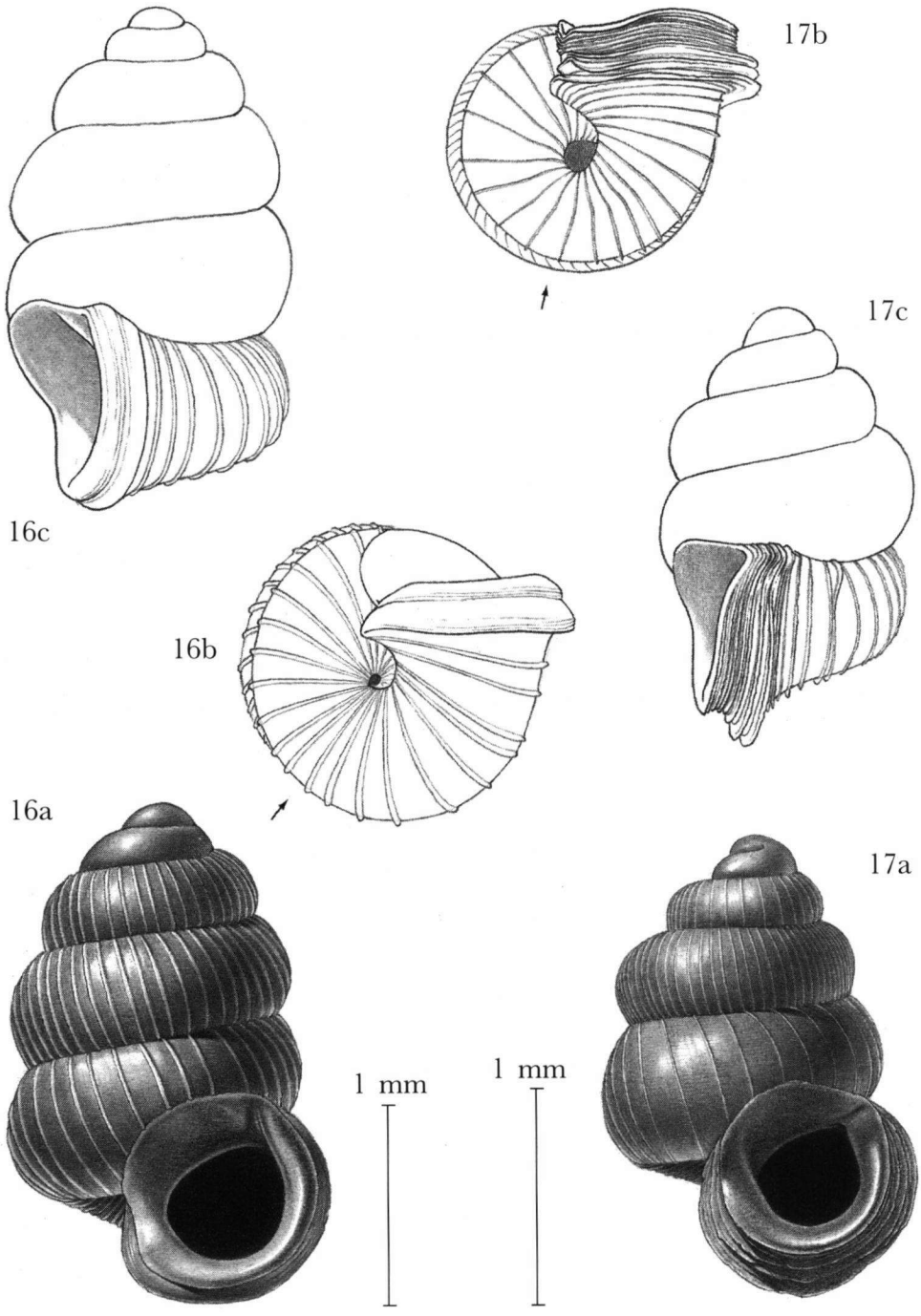
11e

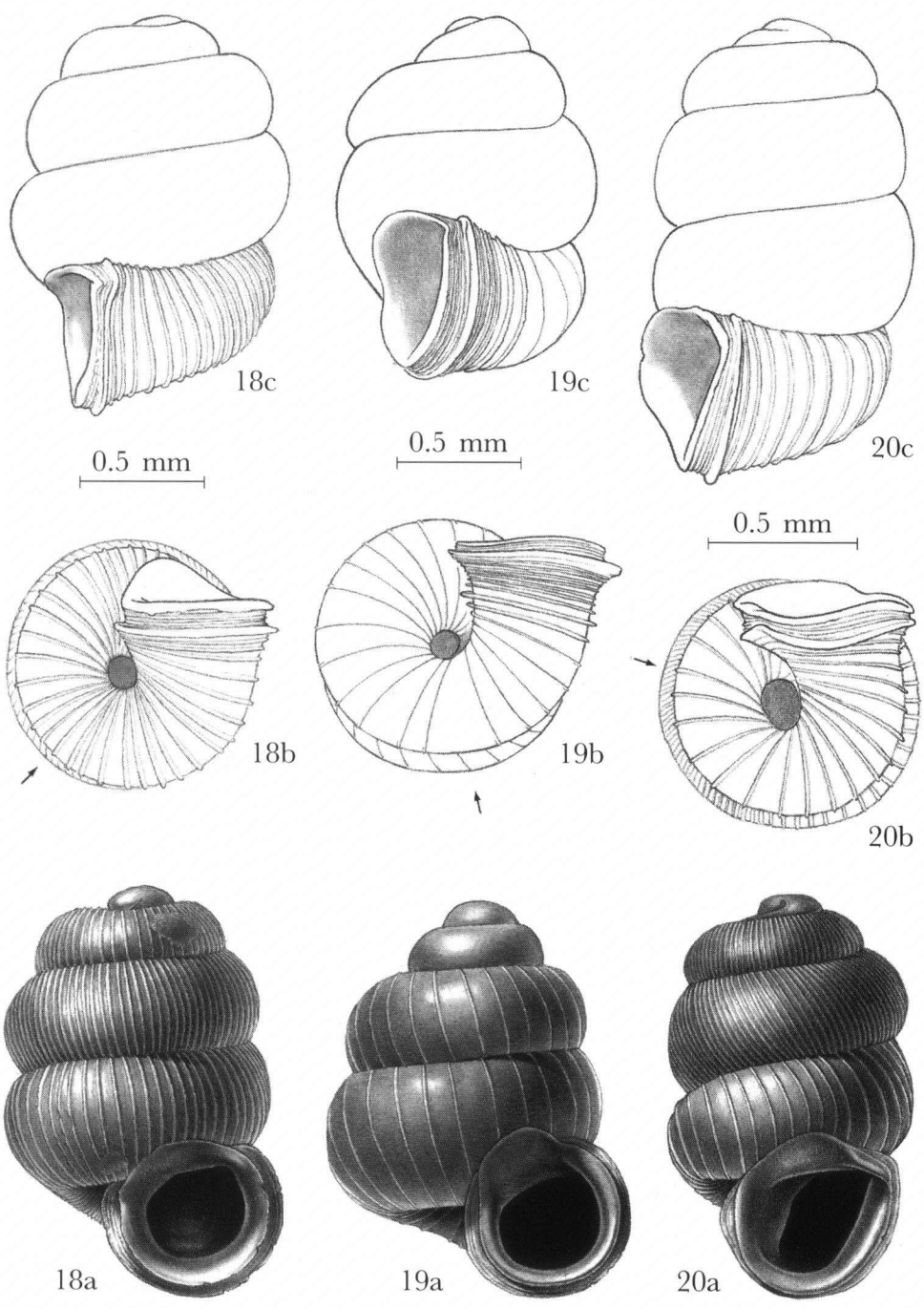


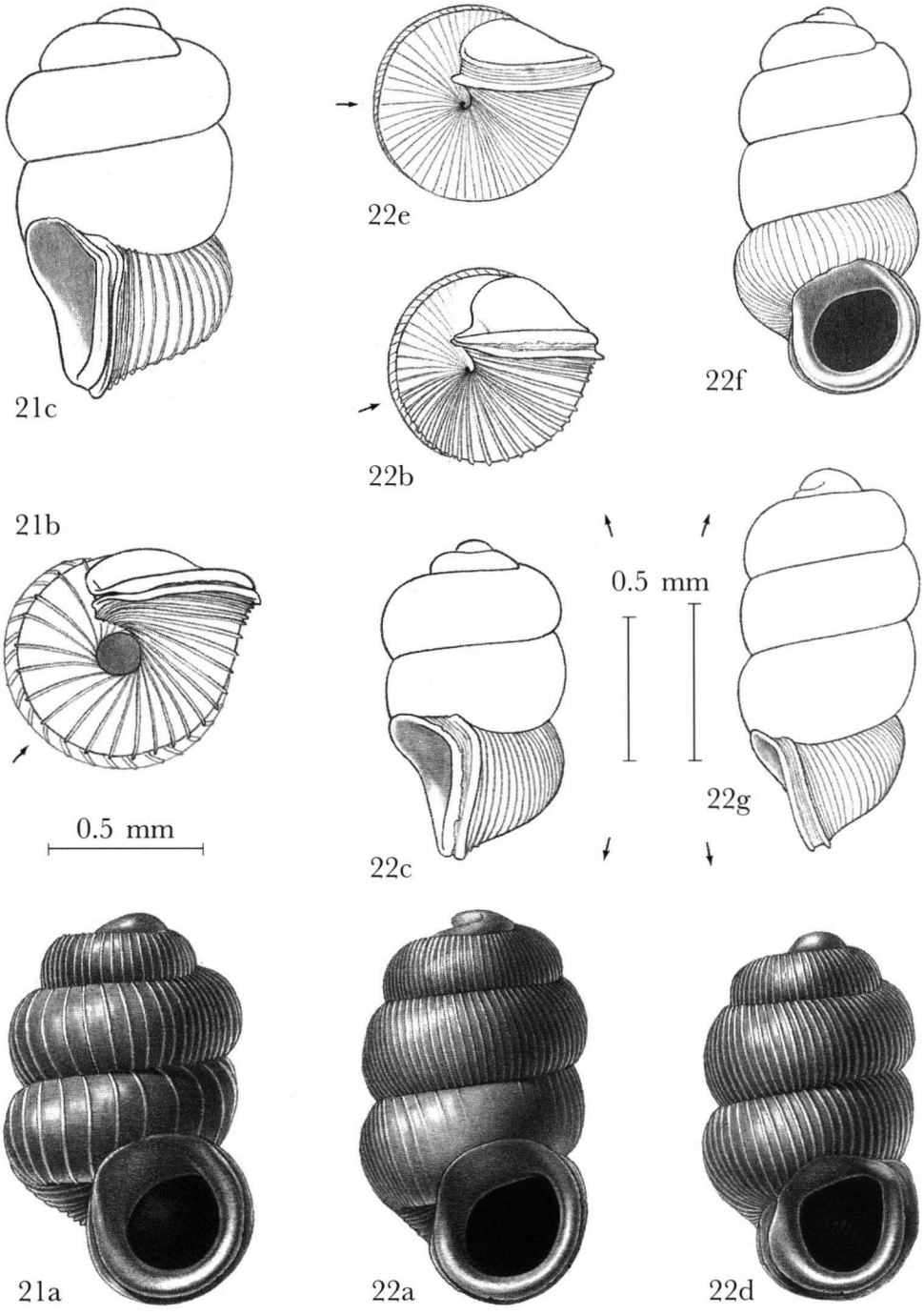
11g

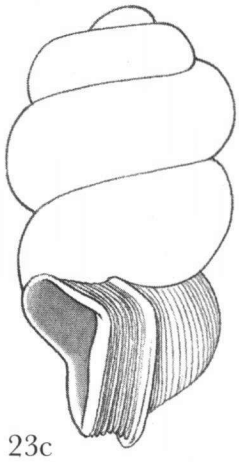

12c
12f
13c
0.5 mm
0.5 mm
0.5 mm
12b
12e
13b
12a
12d
13a


15c
14b
14c
1 mm
15b
1 mm
14d
15a
14a

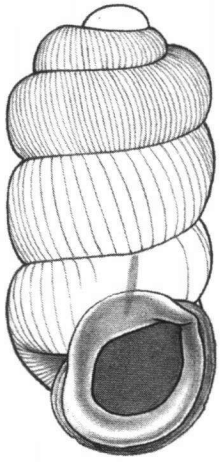

17b
17c
16c
16b
16a
17a
1 mm
1 mm


18c
0.5 mm
19c
0.5 mm
20c
0.5 mm
18b
19b
20b
18a
19a
20a

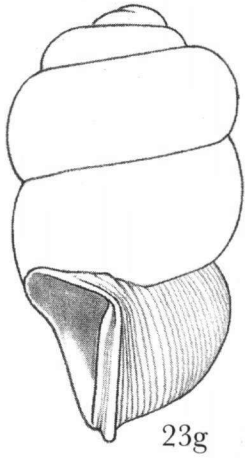

21c
22e
22f
22b
21b
0.5 mm
0.5 mm
22g
22c
21a
22a
22d



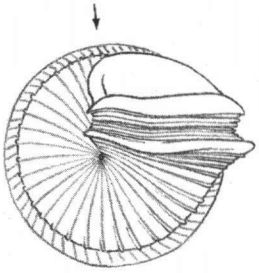
23c



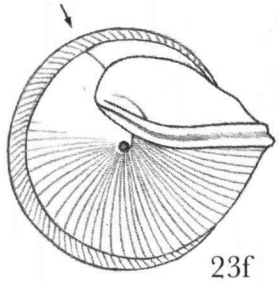
23d



23g

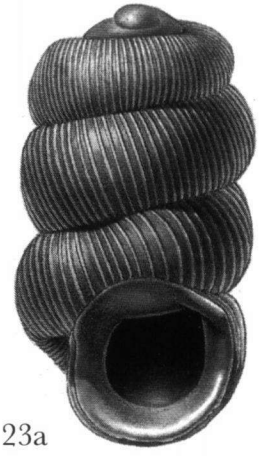


23b

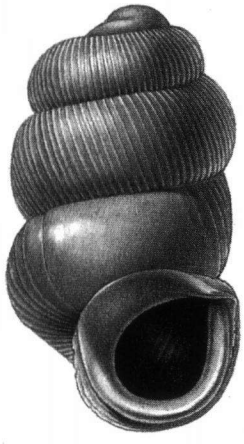


23f

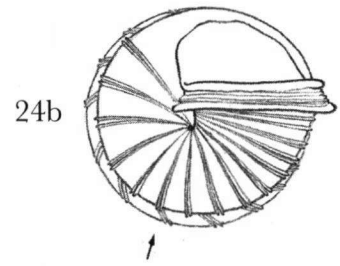
1 mm



23a

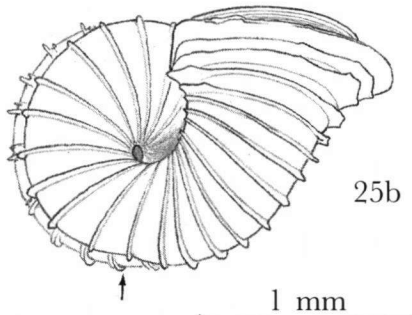


23e



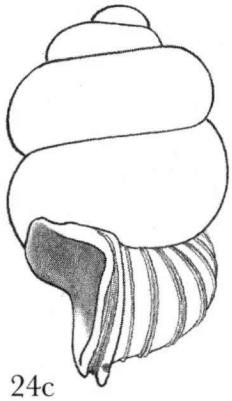
24b

1 mm



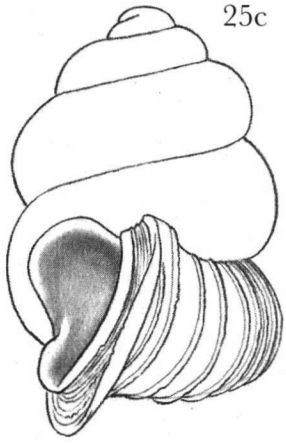
25b

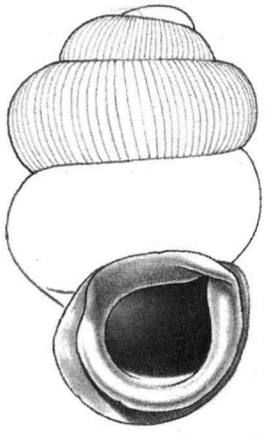
1 mm



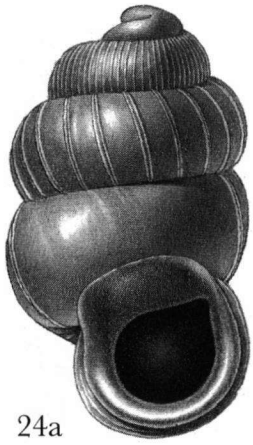
24c

25c



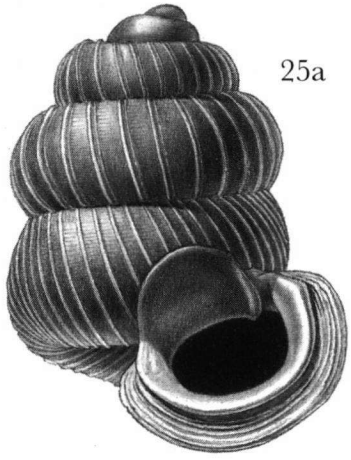


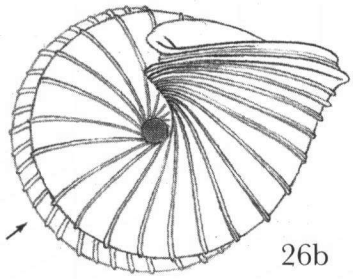
24d



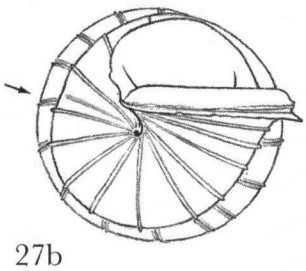
24a

25a

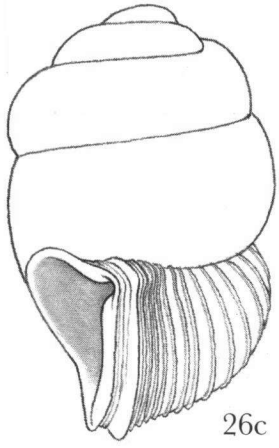




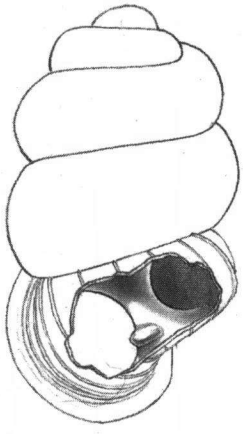
26b



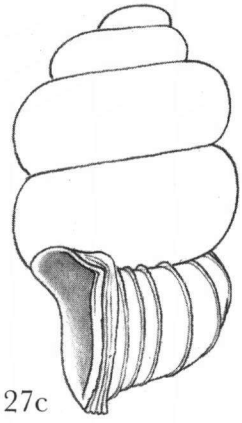
27b



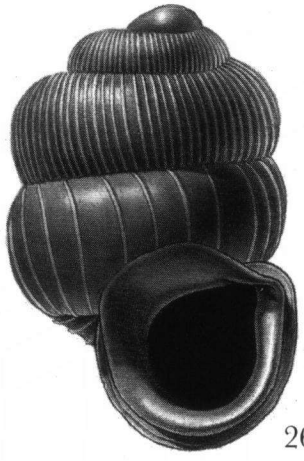
26c



27d



27c

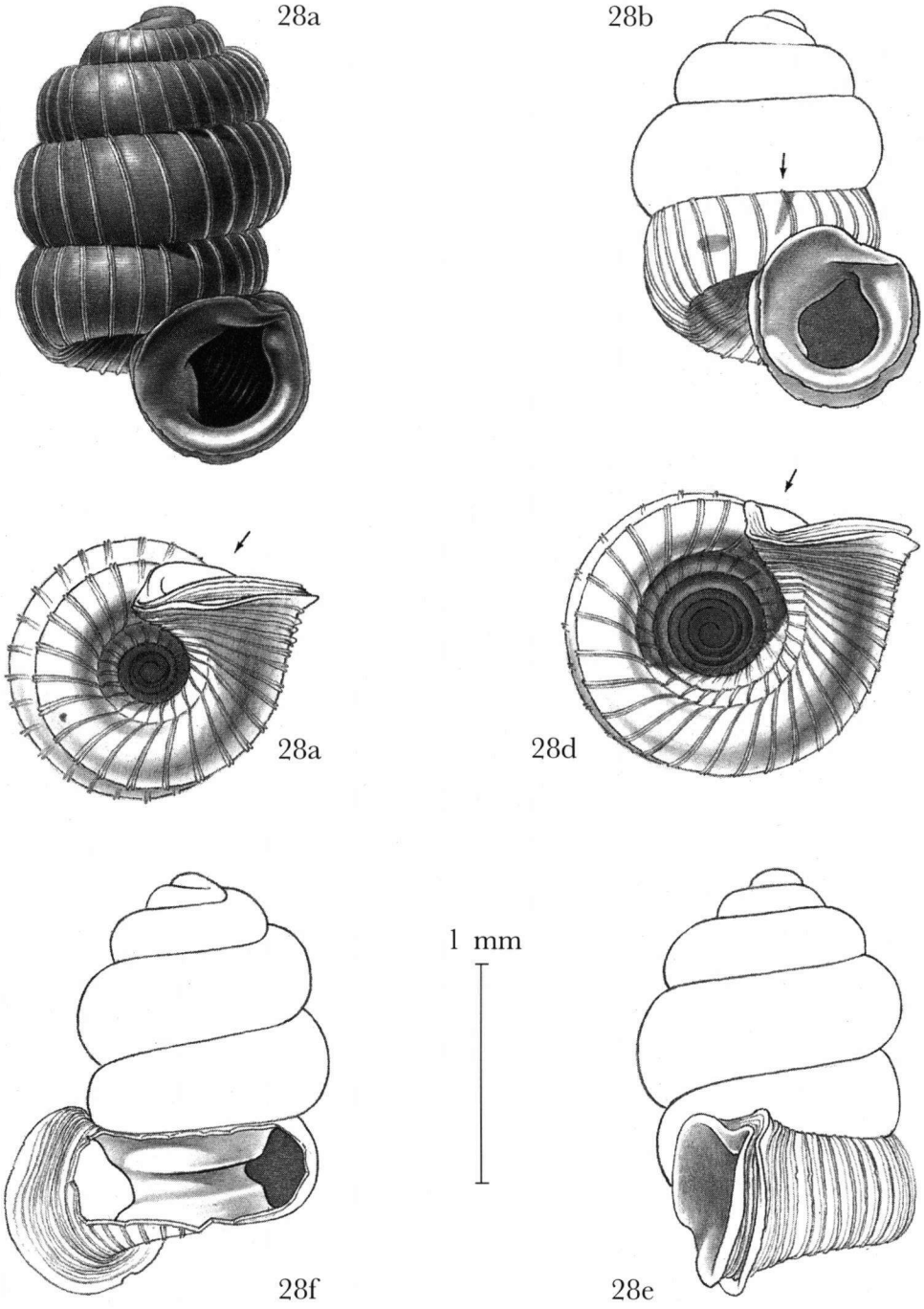


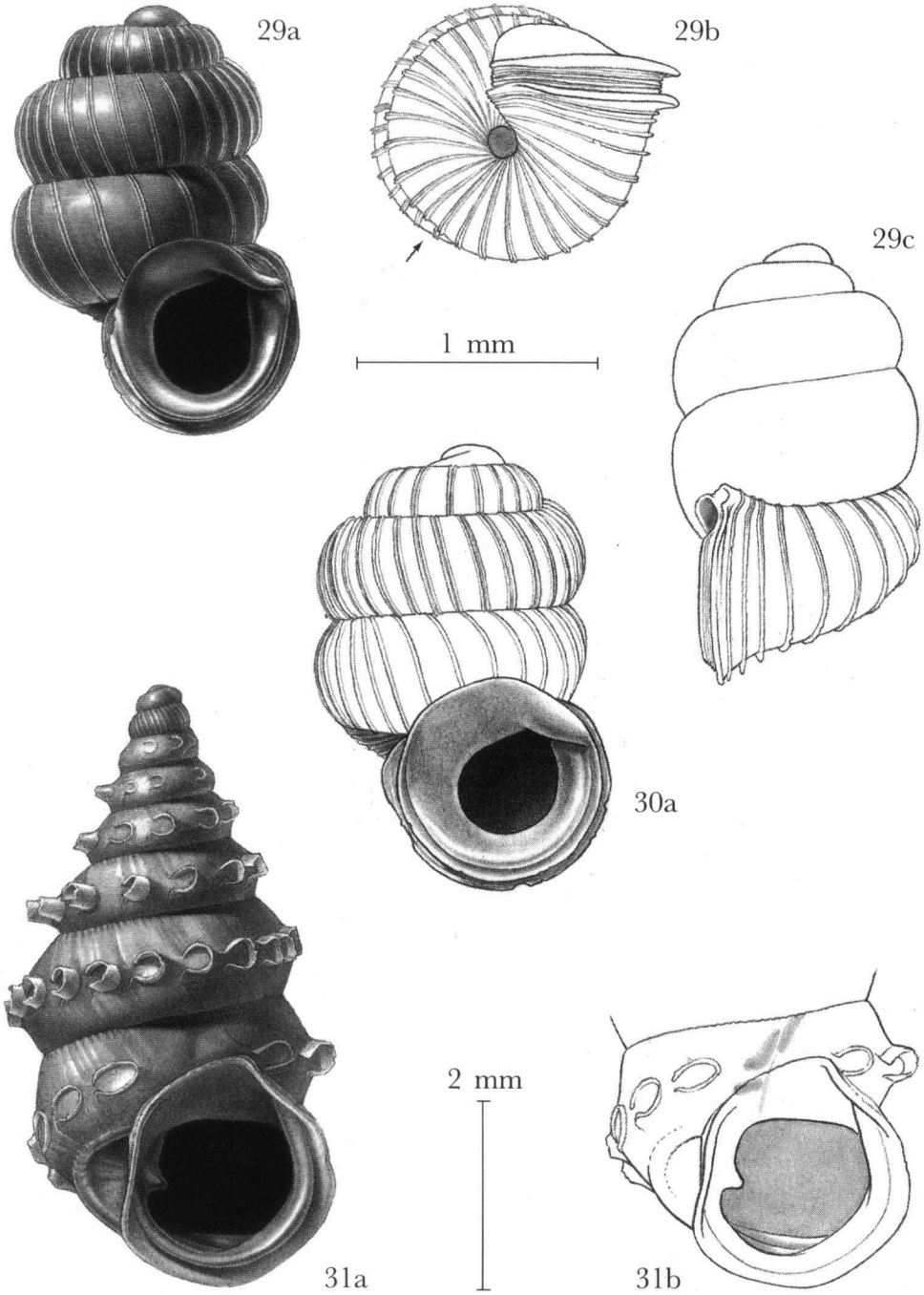
26a

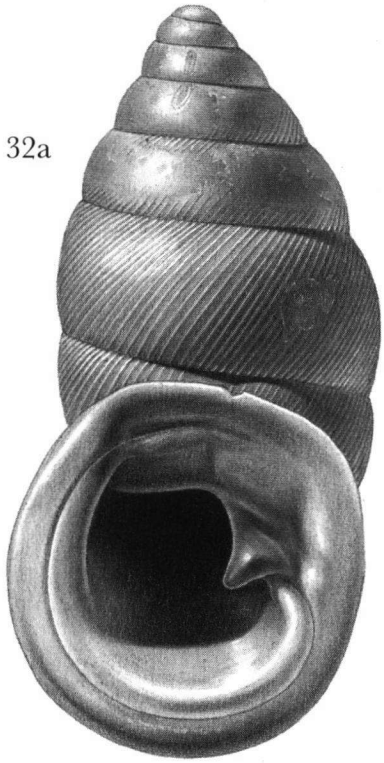
1 mm

1 mm

27a

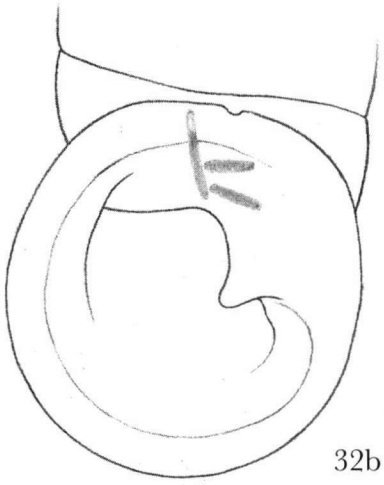

28a
28b
28a
28d
1 mm
28f
28e


29a
29b
29c
1 mm
30a
31a
2 mm
31b



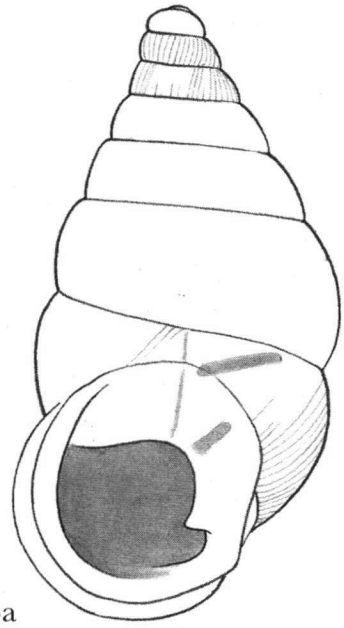
32a

2 mm



32b

2 mm



33a

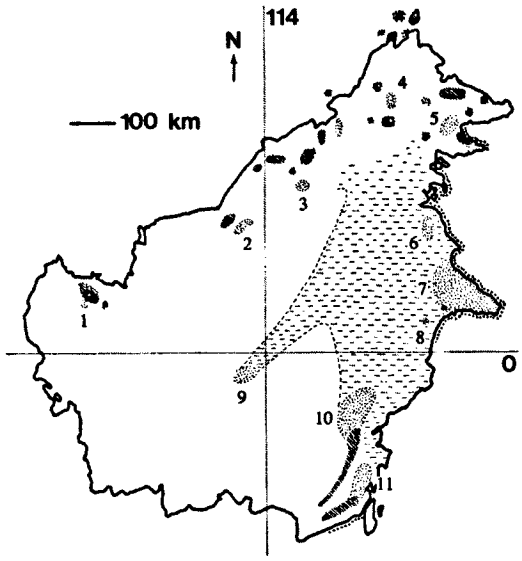


Fig. 34. Borneo, areas with one or more limestone outcrops: areas explored malacologically (oblique hatching), areas so far not explored (dots), areas in which more, so far uncharted, limestone hills are likely to occur (open horizontal hatching), and calcareous deposits in coastal areas (uplifted coral reefs, dotted lines). The numbers refer to unexplored, but possibly particularly interesting limestone areas, see the text.

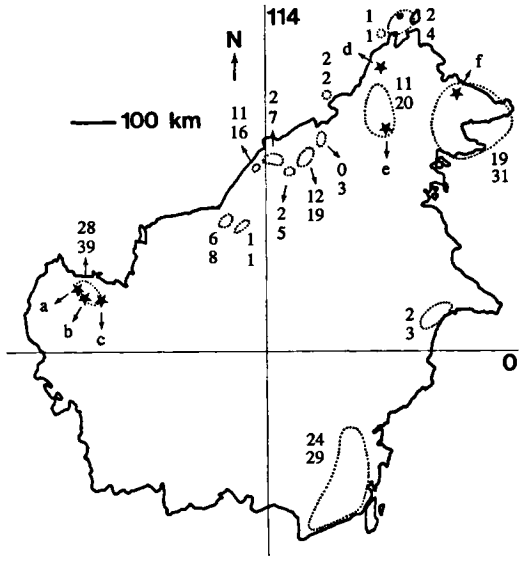


Fig. 35. Borneo, areas of endemism in Diplommatinidae. For each area two numbers are given; the upper refers to the number of endemics to that particular area, the lower to the total number of species found in that area.