BASTERIA, 54: 159-165, 1990

Notes on the non-marine molluscs of the island of Borneo 1. The genus Diaphera (Gastropoda Pulmonata: Streptaxidae)

J.J. VERMEULEN

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

An illustrated account is given of the species of the genus *Diaphera* (Streptaxidae) found on the island of Borneo. Three species, one of which with two subspecies, are known to occur there. Two of these taxa are new: *D. helenae* and *D. wilfordii ectyphus*.

Key words: Gastropoda, Pulmonata, Streptaxidae, *Diaphera*, taxonomy, Indonesia, Borneo.

INTRODUCTION

So far the non-marine molluscs of the island of Borneo have attracted the attention of comparatively few specialists. All surrounding islands, as well as W. Malaysia, are far better explored in this respect.

The present author has spent a year travelling throughout Sabah, Sarawak and Brunei for the purpose of botanical exploration. As a side activity malacological collecting was done whenever possible. Supplementary gatherings were added by several other people. Although large areas remain still unexplored, these collections may give an impression of the Bornean non-marine mollusc fauna.

The author aims to publish the results of these malacological collecting activities in a series of articles of which the present paper is the first.

The amount of time available for the collecting of non-marine molluscs was severely restricted. The collecting was done according to the method outlined by Tweedie (1961: 51). This consists of taking soil samples on spots where shells or fragments of shells are found, or on spots which are suspected to harbour molluscs. Added to these samples were all larger shells which could be picked up by hand.

If the habitats favoured by non-marine molluscs are known, this method enables one to collect large quantities of material in a very short time.

In Borneo, areas with a limestone soil are by far the richest in species, provided the original forest cover is still more or less intact. Soil samples consisting of a mixture of limestone particles, fine earth and leaf litter, taken from rock ledges and crevices, at the foot of steep cliffs or among limestone boulders will yield many species. Generally fewer species are found where the forest floor merely consists of leaf litter, or in deposits at the foot of cliffs consisting of limestone particles and loam only.

Other habitats which deserve closer attention, once traces of non-marine molluscs have been discovered, are:

(1) Along lakes and rivers, where fine organic matter (leaf litter, twigs, soil) is washed ashore.

(2) Along the sea coast, on beaches, above the high water mark. Deposits of floating

organic matter of non-marine origin (small fruits, leaves, twigs) may harbour a specialized fauna of terrestrial molluscs.

(3) Primary forests on volcanic soil. Here collecting in primary forest is often little rewarding. However, where the local people have cleared the forest for shifting cultivation empty V, shells may be scattered among their crops.

(4) Primary forests on ultrabasic soil. Often only larger species occur here. These are easiest to collect where the forest has been cleared for shifting cultivation.

Forests on leached, often poorly drained, sand soils, which are wide-spread in Borneo, are generally poor in molluscs.

Tweedie's collecting method has a major disadvantage: hardly any living animals are obtained in this way. Therefore the systematic studies here presented, will by necessity concentrate on shell characters. Because anatomical characters are ignored, the species described may not correspond to the species as they exist in nature in some cases; they may be considered morphospecies.

Supraspecific delimitation in molluscs tends to lean heavily on anatomical characters. It can therefore be assumed that many genera based on shell characters only will not represent monophyletic entities. They are convenient groupings based on either apomorphic and/or plesiomorphic characters.

In spite of these bleak prospects, it is still useful to try to categorize the terrestrial mollusc fauna of Borneo on account of the meagre set of characters available. A catalogue thus obtained may serve as a base for more profound studies.

If a Bornean species could not be identified with the literature dealing with the Bornean malacofauna, only the literature covering the islands immediately surrounding Borneo has been used, viz. the Philippines, Sulawesi (Celebes), Java, Sumatra, and W. Malaysia. Generally, species not present in this body of literature are considered new. Only incidentally attempts have been made to match Bornean shells with material or literature from beyond this range.

All descriptions refer to material originating from the island of Borneo only; descriptions are intended to differentiate between the Bornean species.

The drawings are made by the author. They are based on sketches made with a stereo-microscope with a camera lucida device. The final versions are carried out in pencil.

References to material present in the collection of the author ('collection Vermeulen', and 'collection Vermeulen & Duistermaat') are abbreviated as 'V', followed by a collection number. Holotype specimens of new species will be deposited in the Rijksmuseum van Natuurlijke Historie (Nationaal Natuurhistorisch Museum), Leiden (RMNH), immediately after publication of the species. If possible, paratypes will be distributed to other institutes. Eventually all material will be donated to the RMNH. Until then, material can be made available as a loan through this institution.

ACKNOWLEDGEMENTS

First of all, thanks are due to the staff of the Rijksmuseum van Natuurlijke Historie, Leiden (RMNH), for the use of their extensive library and their generous help in other ways.

The author wishes to thank Mrs. Helena Duistermaat, companion on several collecting trips. Mr. Kan Yaw Chong, reporter of The Sabah Times, also joined me on a number of trips. With a healthy journalistic curiosity and his professionalism he saw

a chance to produce one-page newspaper articles about topics so remote from daily life as terrestrial snail collecting, or the geology of limestone caves. I also wish to thank the Teck Guam Company, and their estate manager Wong Soo Sui. They allowed me to visit Kirk's cave, situated among their plantations. The new subspecies *Diaphera wilfordii ectyphus* was first found here. Mr. A. Lamb and Mrs. K. Mackinnon have been so kind as to send me an extremely rich soil sample from the Meratus Mountains, which e.g. contained numerous specimens of *Diaphera porrecta*, until then only known from the type specimen.

Thanks are finally due to the British Museum (Natural History), London (BMNH), and the National Museum of Wales, Cardiff (NMW), for making type material available to the author.

SYSTEMATIC PART

Genus *Diaphera* Albers, 1850

Shell white or cream-coloured, approximately spindle-shaped, apex rounded. Whorls with 2-3 varices, the last 0.25-0.4 whorl detached. Umbilicus open. Peristome thickened, reflected.

Distribution (see also Van Bruggen, 1972): Philippines (Faustino, 1930: 86; Zilch, 1961: 103), Borneo (Dance, 1970: 155), Talaud Archipelago (Van Benthem Jutting, 1941: 18), Indochina.

Key to the Bornean species of the genus *Diaphera*

1 a — Lower margin of the last 1.25-1.5 whorl more or less smooth. Aperture with a columellar tooth starting close to the peristome ..... *D. porrecta* (2)
b — Lower margin of the last 1.25-1.5 whorl finely but distinctly crenulated. Aperture with a deeply set columellar tooth 2
2 a — Number of whorls 8.5-10. Length of shell, minus detached portion, 5-7.1 mm ..... *D. helenae* (1)
b — Number of whorls 6.25-7. Length of shell, minus detached portion, 3.5-4.5 mm 3
3 a — Shell 2.4-2.5 mm wide (Sabah, S. Tabin) ..... *D. wilfordii wilfordii* (3a)
b — Shell 2.9-3.3 mm wide (Sabah, surroundings Lahad Datu) ..... *D. wilfordii ectyphus* (3b)

1 — **Diaphera helenae** spec. nov.
fig. 1a, 1b

Shell ellipsoid to somewhat obovoid. Apex somewhat oblique. Whorls 8.25-10, convex, top whorls more or less smooth; next whorls with the suture crenulated; crenulations often (not always) continuing as inconspicuous, thin radial riblets over the entire width of the whorl; the last 1.25-1.5 whorl with an approximately sharp, crenulated lower margin; radial riblets very distinct on the last 0.5 whorl. Umbilicus rather wide. Aperture approximately orbicular to obliquely ovate. Peristome somewhat thickened on the palatal side. Teeth three: one distinct, projecting angularis starting on the peristome; one deeply set columellaris; one deeply set palato-basalis.

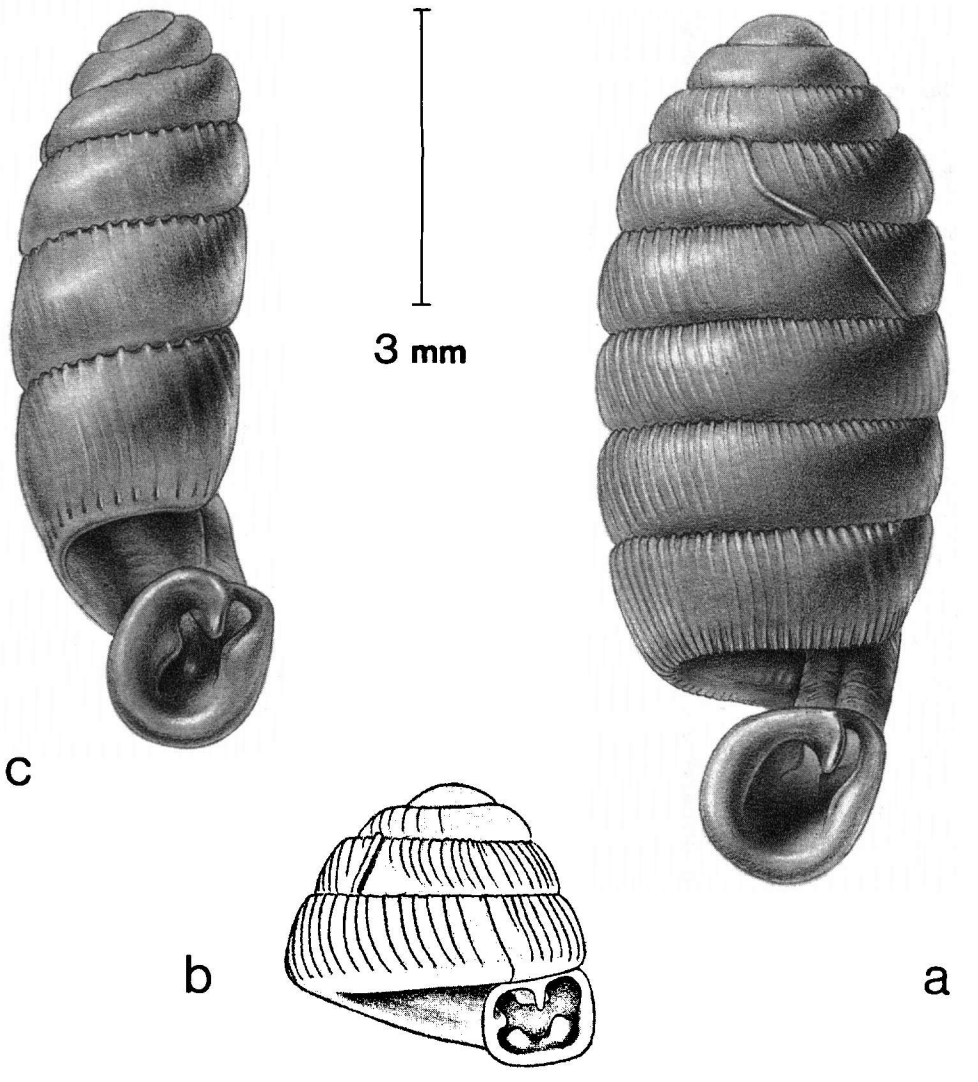

Fig. 1. a, *Diaphera helenae* spec. nov., holotype specimen, Sabah: Gunung Madai (RMNH); b, juvenile from the same locality (RMNH); c, *Diaphera porrecta* (Von Martens), Kalimantan Selatan: Meratus Mts., approx. 35 km NE. of Martapura (RMNH).

Measurements. — Height 6.8-8.3 mm; heigth minus detached portion 5-7.1 mm; width 2.5-3.1 mm; height of aperture 1.4-1.7 mm; width of aperture 1.4-1.6 mm.

Ecology. — Calcicole, on coastal or inland limestone outcrops.

Distribution. — Borneo, endemic.

Material seen. — SABAH. Tawau Zone: G. Madai (V 1646; HOLOTYPE

RMNH 56444; paratypes distributed to BMNH, NMW); Segarong Hills 25 km ESE. of Kunak, Batu Tengar (V 1815) and Bt. Pababola (V 1782).

Notes. — 1. Most similar to *D. wilfordii*. It differs from that species mainly in the larger number of whorls and the more narrowly ellipsoid, almost cylindrical outline of the shell. The two species are strictly allopatric.

2. At two or three stages during their development the juveniles (fig. 1b) develop a thickened and reflected peristome. The dentition in the aperture differs from that of the adults. The peristome has a knob-like thickening on the palatal side. Four teeth are present: one angularis, one columellaris, two basalis. In general the juveniles are remarkably similar to the juveniles of some W. Malaysian *Sinoennea* sp., e.g. *S. perakensis* (Godwin Austen & Nevill, 1879).

3. Named after Mrs. Helena Duistermaat (Leiden), who collected the first specimens of this species on a trip together with the author.

2 — *Diaphera porrecta* (Von Martens, 1884)
fig. 1c

Ennea porrecta Von Martens, 1884: 198; holotype ("Berge Radjang Klewang, Südost-Borneo") ZMB 36914 (not seen).
Diaphera porrecta: Dance 1970, 155.

Shell narrowly ellipsoid. Apex oblique. Whorls 5.75-6.75, somewhat convex, top whorls smooth; next whorls with the suture crenulated, otherwise approx. glabrous; the last 1.25-1.5 whorl with an approximately sharp, smooth lower margin and a row of small indentations close to it; the last whorl generally with inconspicuous radial riblets which become more distinct on the last 0.5 whorl. Umbilicus rather narrow. Aperture obliquely ovate to elliptic. Peristome with a knob-like thickening on the palatal side. Teeth three: one distinct, projecting angularis starting on the peristome; one columellaris starting close to the peristome; one deeply set palato-basalis.

Measurements. — Height 5.1-6.6 mm; height minus detached portion 3.5-4.5 mm; width 2-2.3 mm; height of aperture 1.4-1.6 mm; width of aperture 1.2-1.4 mm.

Ecology. — Calcicole.

Distribution. — Borneo, endemic.

Material seen. — KALIMANTAN. Kalimantan Selatan: Meratus Mts., approximately 35 km NE. of Martapura (leg. Lamb & Mackinnon, V 2470).

Notes. — The juveniles have the aperture very similar to that of the juveniles of *D. helenae*. The only difference is that the peristome bears a small tooth, rather than a knob on the palatal side.

3a — *Diaphera wilfordii wilfordii* Dance, 1970
fig. 2a

Diaphera wilfordii Dance, 1970: 157; holotype (Sabah, S. Tabin) Wilford leg., 1968, NMW 70.IZ.5; paratype BMNH 1969114.

Shell ellipsoid to slightly ovoid. Apex not or hardly oblique. Whorls c. 7, somewhat convex, top whorls smooth; next whorls with the suture crenulated, otherwise approximately glabrous; the last 1.25-1.5 whorl with a more or less sharp, crenulated lower margin; the last whorl generally with inconspicuous radial riblets which become very

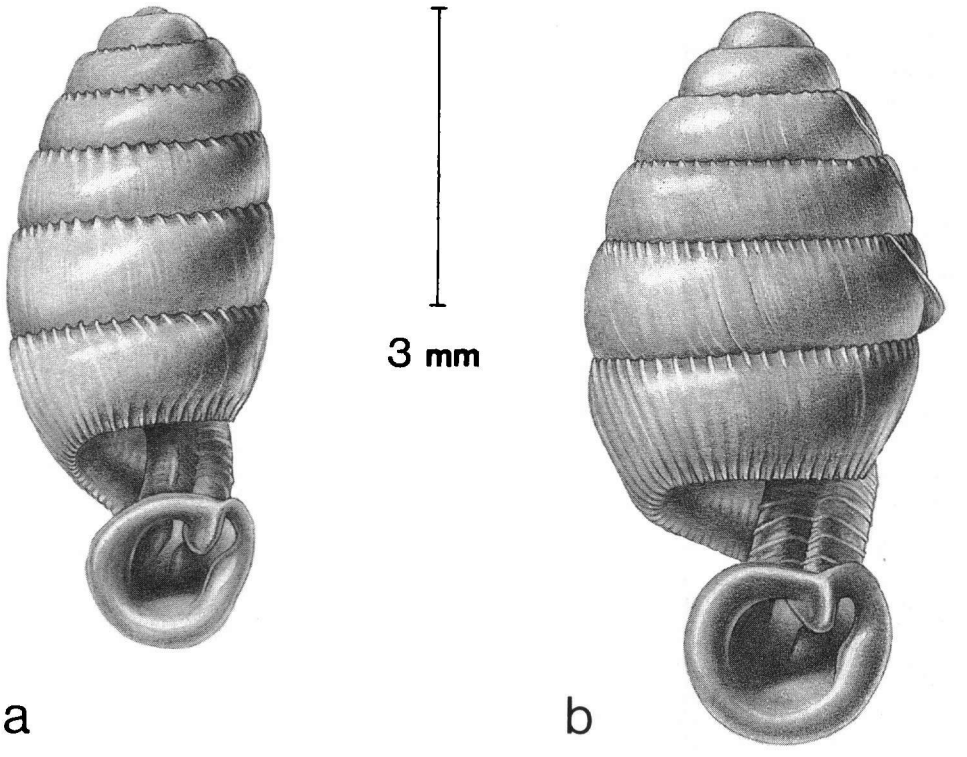

Fig. 2. a, *Diaphera wilfordii wilfordii* Dance, holotype specimen, Sabah: Sungei Tabin (NMW); b, *Diaphera wilfordii ectyphus* subspec. nov., holotype specimen, Sabah: Kirk's Cave near Lahad Datu (RMNH).

distinct on the last 0.5 whorl.. Umbilicus rather narrow. Aperture obliquely ovate. Peristome somewhat thickened on the palatal side. Teeth three: one distinct, projecting angularis starting on the peristome; one deeply set columellaris; one deeply set palato-basalis.

Measurements. — Height 5.3-5.9 mm; height minus detached portion 3.5-3.8 mm; width 2.4-2.5 mm; height of aperture 1.4-1.5 mm; width of aperture c. 1.5 mm.

Ecology. — Calcicole.

Distribution. — Borneo, endemic.

Material seen. — SABAH. Tawau Zone: S. Tabin (leg. Wilford, see above).

3b — *Diaphera wilfordii ectyphus* subspec. nov.
fig. 2b

Shell ellipsoid to ovoid. Apex not or hardly oblique. Whorls 6.25-7, somewhat convex, top whorls smooth; next whorls with the suture crenulated, otherwise approx-

imately glabrous; the last 1.25-1.5 whorl with a more or less sharp, crenulated lower margin; the last whorl generally with inconspicuous radial riblets which become very distinct on the last 0.5 whorl. Umbilicus rather narrow. Aperture approximately orbicular to obliquely ovate. Peristome somewhat thickened on the palatal side. Teeth three: one distinct, projecting angularis starting on the peristome; one deeply set columellaris; one deeply set palato-basalis.

Measurements. — Height 5.2-7.1 mm; height minus detached portion 3.5-4.5 mm; width 2.9-3.3 mm; height of aperture 1.5-1.9 mm; width of aperture 1.5-1.9 mm.

Ecology. — Calcicole.

Distribution. — Borneo, endemic.

Material seen. — SABAH. Tawau Zone near Lahad Datu: 'Kirk's Cave' (V 1245; HOLOTYPE RMNH 56446; paratypes distributed to BMNH, NMW); S. Segama (V 1665).

Notes. — 1. Differs from *D. w. wilfordii* only in having a distinctly wider shell. The two taxa inhabit areas which are separated by a wide geographical gap, therefore they are considered subspecies here.

2. The juveniles have the aperture more or less identical to that of the juveniles of *D. helenae.*

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