The anatomy of an *Atopos*-species from Papua New Guinea with a discussion on its systematic position (Mollusca, Gastropoda, Rathouisiidae)*

Johan J.A. De Wilde  
*Koninklijk Belgisch Instituut voor Natuurwetenschappen, Recent Invertebrate Section, Vautierstraat 29, 1040 Brussels, Belgium*

**ABSTRACT:** Thirteen slugs from Kiriwina Island and one slug from Manam Island (Papua New Guinea) are anatomically examined. Drawings of external and internal characters are given. On the basis of these features the specimens are assigned to the genus *Atopos* Simroth, 1891. Their systematic position is discussed. The identification of the examined specimens remains with a certain doubt.

**RÉSUMÉ:** L’anatomie de treize limaces de l’île de Kiriwina et d’une limace de l’île de Manam (Papouasie Nouvelle-Guinée) a été examinée. Les caractères externes et internes sont figurés. Les spécimens sont classés dans le genre *Atopos* Simroth, 1891 sur base de ces caractères. Leur position systématique est discutée. L’identification des spécimens examinés reste douteuse.

1. **INTRODUCTION**

Most species of the family Rathouisiidae Heude, 1885 are described mainly on the basis of their external characters. It is important therefore to get more information about the internal anatomy. Until now little is known about the systematic importance of various internal structures, especially regarding the variability within one species. The study of those carnivorous slugs gains in importance because they are not often found due to their hidden way of life.

2. **MATERIALS AND METHODS**

The material has been collected by Dr. J. Van Goethem during his expeditions in 1976 and 1978 to Papua New Guinea. The specimens were anaesthetized, fixated in a 4% formaldehyde solution and then preserved in 75% alcohol.

Station PNG 76/165(1-12) and PNG 76/166: Thirteen specimens from Kiriwina Island (Trobriand Islands-Milne Bay Province), bush Gusaweta mission of Losua

* Leopold III Biological Station, Laing Island. Contribution No. 33.

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3. OBSERVATIONS

3.1. The Kiriwina — specimens

3.1.1. External characters

3.1.1.1. Measurements. Since the specimens are preserved in 75% alcohol, it is obvious that they are somewhat distorted. The length (L) is taken at the midline of the ventral side of the body after straightening the animal. The breadth (B) is taken at the greatest distance between the two lateral margins of the animal. The height (H) is the longest distance between the keel and the ventral margin. The breadth of the footsole (BF) and the distance between the male and female orifices (MF) are also mentioned.

The length and breadth of the animal labelled under PNG 76/166 were measured by Dr J. Van Goethem while it was crawling. The results in mm are given in Table 1.

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Figure 1. *Atopus (Prima) smithi* (Collinge, 1902) (?), Kiriwina Islands, Trobiand Islands, Papua New Guinea. A. Head region: ventral view, proboscis protruded; B. Head region: right lateral view, proboscis protruded; C. Position of the openings: ventral view; D. Head region: ventral view, proboscis invaginated (for abbreviations, see p. 125).

3.1.1.2. General appearance. Figure 1(A-D). Animal elongate, tapering to both ends; ventral part flattened and dorsum slightly convex in lateral view; body with a prominent dorsal keel starting somewhat behind the rounded margin of the notum (n); anterior end covering the head like a carthulasian cowl; keel becoming narrower towards the posterior end and tapering to a point; ventral side consisting of three parts, a median one and two lateral parts: median one, the footsole (f), shorter than the...
notum and leaving a pyramidal space into which the head can be withdrawn anteriorly; posterior end of the footsole pointed and not extending beyond the mantle border; sole with numerous soleolae. The two remaining lateral parts of the ventrum are continuations of the notum, the so-called 'hynonota' (h).

Footsole and hynonota separated from each other by a small groove with three orifices somewhat behind the head (but still within the first fifth of the body); female genital orifice (f) situated most ventrally; antero-dorsal anal pore (an) and posterodorsal pulmonary orifice (po).

Head entirely covered by the notum and provided with two pairs of tentacles, the upper ones or ommatophores (om) short (PNG 76/166: 5 mm long while crawling), annulated and not invaginable; lower tentacles (lt) smaller, also not-invaginable and bifid, the dorsal part being blunt and rounded and the ventral part being laterally flattened and pointed.

The male genital orifice (cf) situated at the base of the right lower tentacle.

Head bearing a protrusible proboscis (pro) (PNG 76/166: 8 mm long) with a small triangular mouth; notum and hynonota entirely provided with numerous circular verrucae of various sizes distributed in a way that one wart is surrounded by smaller ones.

3.1.1.3. Colouration. Colour of the notum beige with brown and black spots and speckles arranged in a stellate manner; on either lateral side of the body, somewhat above the midline, two light-brown longitudinal bands; footsole and hynonota beige, the latter ones also provided with black speckles; keel slightly lighter in colour than the rest of the notum and furnished with black spots; ommatophores grey, lower tentacles beige; slime watery and colourless but becoming white after touching.

Description based on the observation of living specimens (J. Van Goethem) completed with my own observations of colour slides.
3.1.2. Internal characters

3.1.2.1. Alimentary system. Figure 2(A-H). The structure of the digestive tract is quite simple. It starts anteriorly with a protrusable proboscis (pro) surrounded by a proboscis sheath (pah). Proboscis a lengthened, muscular tube with a triradiate lumen; no jaw.

Immediately behind the proboscis, almost continuous with it, a cylindrical radular sac (rs) curved downwards posteriorly where a protractor (prt) inserts; radular sac also surrounded by a muscular sheath and containing an excrescence (exc) with a dorsal groove anteriorly; one part of the radula (rad) situated in this groove; the remaining one bent over the anterior margin of the excrescence, thus lying on its ventral and lateral sides anteriorly.

Teeth of the radula arranged in V-shaped rows with the apex directed backwards; each row consisting of about 50 teeth; no central nor marginal teeth; lateral teeth uniform, unicusp and with a cup-like depression in the middle; teeth smallest at the outer margin but gradually increasing towards the middle of the row.

Dorsally of the junction between proboscis and radular sac a thin-walled oesophagus (oes), looping downwards to the right OR to the left of the radular sac, passing through the nervous ring (ventro-dorsally) beneath the latter and then running backwards into the digestive gland (ggl); digestive gland large and conical, filling up the posterior half of the body-cavity and consisting of numerous glandular lobes surrounding a wide lumen (c) in which digestion is taking place.

Close to the outlet of the oesophagus in the digestive gland, a short rectum running antero-dorsally to the right and debouching into the anal pore.

Two salivary glands (sgl) fused OR separated from each other; salivary ducts (sd) passing through the nervous ring and opening ventrally into the proboscis.

3.1.2.2. Glands. Figure 2(A,C); Figure 3(C). Beneath the digestive and nervous system in the anterior area a single, tubular pedal gland (pgl) somewhat flattened dorso-ventrally; it opens at the anterior margin of the footsole; on either side of the pedal gland a left and right Simroth gland (lg-srg); each one consisting of three distinct parts; a distal tubular secretory part (sp), a proximal evaginable part (es), interconnected by a very thin duct; this canal is extremely coiled when the proximal part is not evaginated; free end of the proximal part with a retractor inserting on the interior of the notum somewhat in front of the pericard. Proximal and distal parts of these glands showing much variation in size, even in one specimen. Left Simroth gland opening at the base of the left lower tentacle; right Simroth gland in connection with the penis on the right side.

3.1.2.3. Genital organs. Figure 2(A,C); Figure 3(A-E). Male and female parts largely separated from each other; hermaphrodite gland (gh) and duct (dh) with the female part located in front of the digestive gland, among the other parts of the alimentary system.
Hermaphrodite gland lobulated; hermaphrodite duct short and coiled. Just forward to the opening of this duct into the large and folded oviduct (od), it seems that there is a very small branch to the vas deferens (vd).

Two appendages distally from the oviduct: an irregularly shaped albumen gland (ga) and a lanceolate prostate (gp); prostate with a narrow, almost straight vas deferens running along the oviduct towards the female genital orifice; vas deferens disappearing into the body-wall and continuing its course in it.

Vagina (vg) and pear-shaped receptaculum seminis (bs) proximally from the oviduct.

Vas deferens re-entering the body-cavity at the base of the right lower tentacle, then running backwards dorsally from the penis (p) and opening in it; penis situated at the bottom of the body-cavity and surrounded by a muscular sheath (ps); posterior end of penis bearing a long retractor passing under the vagina and inserted posteriorly on the bottom of the body-cavity; penis opening into an evaginable part by means of a pointed penis papil (pp).

Male genital orifice conjuncted with the right Simroth gland.

3.1.2.4. Retractors. Figure 2(A,C). Two head-retractors on either side of the pedal gland; the most ventral one anteriorly bifurcated, the two branches surrounding the outlet of the left Simroth gland or the penis; this retractor is running backwards and inserts on the interior side of the foot at a level just in front of the pericard; second retractor situated somewhat more laterally and inserting somewhat more posteriorly at the level of the anal pore; a muscular knot on the bottom of the body-cavity.

3.1.2.5. Nervous system. Figure 2 (A,B,C,E). Nervous system not differing from that described by Odhner (1913) and consisting of a nervous ring (nr) with numerous nerves and situated above the pedal gland; two fused ocophagial ganglia (og) beneath the radular sac.

3.1.2.6. Pallial organs. Figure 2(A). Because only the pericard (pd) with its ventricle (ve) and auricle (au) were clearly visible, it was impossible to observe the other pallial organs. However, a glandular part situated posteriorly of the pericard and somewhat to the right has been considered by Odhner (1913) as an outer part of the lung; the study of the Kiriwina-specimens does not allow any opinion on that matter.

3.2. The Manam-specimen

3.2.1. External characters

3.2.1.1. Measurements (in alcohol). Length: 33 mm; breadth: 5 mm; height: 5 mm; breadth of the footsole: 2 mm; distance between male and female genital pore: 6 mm.

3.2.1.2. General appearance and colouration. Figure 4(A-C). General appearance very similar to that of the Kiriwina-specimens. Colour of the notum beige with brown and
black spots; just above the midline of the lateral side two darker, almost confluent, longitudinal bands; footsole and hyponota beige, the latter ones furnished with brown and black spots. In comparison with the Kiriwina-specimens this animal seems somewhat darker.

Description based on my observations of colour slides only.

3.2.2. Internal characters. Figure 4(D-H). Internal structure not differing from that of the Kiriwina-specimens. Since only one single specimen is available it is impossible to give any idea of the variability within the slugs of this locality.

Oesophagus looping downwards to the right of the radular sac; radula consisting of about 50 teeth, shaped in the same manner as in the Kiriwina-specimens; size of teeth in correspondence with those of a Kiriwina-specimen of the same size; salivary glands fused; other glands, genital organs, retractors and nervous system not differing from those in the Kiriwina-specimens.

4. GEOGRAPHICAL DISTRIBUTION
Geographical distribution of the family Rattussiidae in Papua New Guinea and vicinity:

![Map of Papua New Guinea and vicinity.](image)

**Atopus (Prisma) australis** (Heynemann, 1876): Australia; Gayndah am Burnett-river (circa 25° 40'S) (Queensland); Herberton (Queensland). Irian Jaya: Batavia bivak on the Mamberamo River; Prauwen bivak on the Idenburg River; Doornmanpad; Hollandia; Lorentz River; Upper Digul River (see discussion).

**Atopus (Prisma) prismatica** (Tapparon Canefri, 1883): Papua New Guinea: Island in the Torres Strait; one locality with details unknown. Irian Jaya: Island of Sorong; Lorentz River (see discussion).

**Atopus (Prisma) heynemanni** (Simroth, 1891): Papua New Guinea: Huon Gulf.

**Atopus (Prisma) smithii** (Collinge, 1902): Papua New Guinea: one locality with details unknown; Manam Island; Kiriwina Island (Trobiand Islands).

5. DISCUSSION
The first descriptions of species of the family Rattussiidae Heude, 1885 were merely based on external characters (Heynemann 1876; Semper 1882; Heude 1882, 1883, 1885, 1890 and Tapparon Canefri 1883). The first data on the internal structure were given by Rathousi (1885).

Simroth (1891, 1892) introduced the genus *Atopus*; he gave detailed information on the internal morphology and even on the histological structure. He also proposed the name *Prisma* stating clearly, however, that he was unable to consider it as a separate genus or as a subgenus of *Atopus* or *Vaginula*.

Later on other authors such as Sarasin (1899), Babor (1900), Collinge (1902, 1903), Ghosh (1912, 1913, 1914, 1915), Odhner (1913) and Laidlaw (1940) studied the internal structure of different species in detail. None of them, however, paid attention to the intraspecific variability.

In this way, several species were described on the basis of internal characters that nowadays seem to be without any diagnostic importance. For instance, the course of the oesophagus looping down to the right or to the left of the radular sac seems to be variable since both forms occur among the Kiriwina-specimens. Still another example are the Simroth glands. As already mentioned, these glands and even their constituting parts seem to be highly variable. Finally, the shape of the tubular pedal gland varies considerably within the Kiriwina slugs. With regard to the genital apparatus, an important characteristic, never seen by previous authors, can be added, namely a very small connection between the hermaphrodite duct and the vas deferens.

Considering the points mentioned above, a complete revision of this family seems necessary, especially in relation to the internal morphology. Hoffmann (1926) already attempted a revision but unfortunately his study was based on external characters only. He also stated that the name *Prisma* Simroth, 1891 was insufficiently defined and assigned all species to the genus *Atopus* with the exception of three *Ratghousta* species.

Collinge (1902b) described a new species, *Prisma smithii*, on the basis of a single specimen from Papua New Guinea (details of locality unknown). This species shows close resemblance to the slugs from Kiriwina Island and Manam Island as far as the
external characters are concerned, but it lacks the banding pattern. However, the description was based on an animal which had been kept in a preserving solution for a long time. It is very well possible therefore that the specimen no longer had its original colour or pattern.

Since it was impossible for us to examine true Atopos species, the systematical position of Prisma remains ambiguous. It seems appropriate, however, to consider Prisma tentatively as a subgenus of the genus Atopos until further research will allow better definition of the two taxa.

For all these reasons, the Kiriwina-specimens and the Manam-specimen are provisionally assigned to Atopos (Prisma) smithi (Collinge, 1902). Two other related species, Prisma primatica (Tapparoni Cancri, 1883) and Prisma heyemanni (Simroth, 1881), were also mentioned in Collinge’s paper (1902b). Odhner (1913) examined a single slug from Herberton (Australia), labelled it Atopos (Prisma) australis (Heyemanni, 1876) and obviously considered Prisma as a subgenus with the broad hyponotum being the chief character.

Hoffmann (1926) in his revision synonymized P.smithi, P.heyemanni and P.primatica with A.australis ( Heyemanni, 1876) stating that the colour and pattern of slugs are extremely variable, and therefore cannot be used as distinctive characters.

Van Bentheim Jutting (1933) examined several snails from northern Irian Jaya. In naming the various specimens she followed the revision published by Hoffmann (1926), so all specimens were labelled Atopos australis. Further on page 89 she stated that ‘For this combination of doubtful Atopos species the name of the oldest member, A.heyemanni, has to be employed’. However, if the revision of Hoffmann is followed, A.australis should be used for it is the oldest name. Finally, some snails from Mamberamo River and Idenburg River (northern Irian Jaya) and from Lorentz River (southern Irian Jaya), studied by Van Bentheim Jutting (1933), resemble our specimens from Kiriwina Island and Manam Island.

Awaiting a revision of the family based on more specimens from different localities (if possible type-localities from previously described species), I prefer to label the examined slugs Atopos (Prisma) smithi (Collinge, 1902). Since it is well possible that A.(P.) smithi is a synonym of a previously described species, I consider my identification with a certain doubt.

ACKNOWLEDGEMENTS

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ABBREVIATIONS

an: anal pore
au: auricle
bs: receptaculum seminis (bursa seminalis)
c: cavity within the digestive gland
dg: digestive gland
dh: hermaphrodite duct (ductus hermaphroditicus)
es: eversible portion of Simroth gland
exc: excrescence within the radular sac
f: foot sole
fg: albumen gland (glandula albuminalis)
gh: hermaphrodite gland (glandula hermaphroditica)
gp: prostate (glandula prostatica)
h: hypostomum
ll: left Simroth gland
lt: lower tentacle
mk: muscular knot
n: notum
nr: nervous ring
od: ovicist
oes: oesophagus
or: oesophageal ganglia
om: ommatophore
p: penis
pd: pericard
pg: pedal gland
ph: pulmonary orifice
pp: penile papill
pt: protractor
ps: penial sheath
pro: protractor
psb: protractor sheath
r: retractor
rad: radula
rect: rectum
rs: radular sac
t: testis	ag: right Simroth gland
sd: salivary duct
sgl: salivary gland
sp: secretory part of Simroth gland
vd: vas deferens
ve: ventricle
vrg: vagina
v: female genital orifice
€: male genital orifice

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