

A new sibling species of *Notobryon* (Gastropoda, Nudibranchia) from the Caribbean Sea

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A new Scyllaeidae of the genus Notobryon is described from Guadeloupe, in the Lesser Antilles. Notobryon caribbaeus sp. nov. is characterized by having the anterior pair of body lobes remarkably bigger than the posterior pair, a stomach with eight triangular plates, a black and very wide ampulla, a lemon-shaped bursa copulatrix and a complex and well-differentiated sponge-like prostate. The first Caribbean records of Notobryon were provisionally assigned to the Australian species Notobryon cf. wardi and later transferred to Notobryon panamica. However, the structure of the male genital system is one of the main morphological characters to discriminate species in the genus and the presence of a prostate in N. caribbaeus sp. nov. distinguishes it from N. panamica, which remains confined to the eastern Pacific. Of the remaining four species in the world, only Notobryon bijecurum shares this character, but its external anatomy is different: it lacks a bursa copulatrix and the deferent duct is much shorter. Notobryon caribbaeus sp. nov. was captured in the context of an intensive expedition ('Karubenthos') organized by the Muséum National d'Histoire Naturelle, Paris and its description raises the total inventory of sea slugs in Guadeloupe to 150.

Keywords: Mollusca, Opisthobranchia, Nudibranchia, Caribbean, Guadeloupe, 'Karubenthos', *Notobryon*, new species

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INTRODUCTION

The genus *Notobryon* Odhner, 1936 is composed of cryptic, translucent brown-coloured medium-sized sea slugs of the family Scyllaeidae Alder & Hancock, 1855, which bear long rhinophoral sheaths, a keel in the tail and two pairs of dorsal lobes with the gills between them. Shortly after the description of the type of the genus, *Notobryon wardi* Odhner, 1936, another author, Baba (1937), named two additional species, both from Japan: *Notobryon bijecurum* Baba, 1937 and *Notobryon clavigerum* Baba, 1937, which were illustrated in colour by Baba (1949: figures 133, 134), together with *N. wardi* (figures 131, 132). No other species has been introduced posteriorly until the paper of Pola *et al.* (2012), which establish the diagnosis of *Notobryon* and tackled an overview of the Scyllaeidae, as context to a molecular and morphological revision of the genus in which two new species were described: *Notobryon thompsoni* Pola, Camacho & Gosliner, 2012 and *Notobryon panamica* Pola, Camacho & Gosliner, 2012.

The latter authors initially assumed that it was the external and internal anatomical differentiation between the species being so small that has been the cause of the records of *N. wardi* in all the oceans, but concluded that there are indeed remarkable morphological differences across the species, mainly in the genital system.

The first record for a species of *Notobryon* in the Atlantic is owed to Valdés *et al.* (2006), who cite *Notobryon cf. wardi*

from several localities in the Caribbean (Honduras, St Lucia, Virgin Islands and St Vincent & the Grenadines). These authors also remark that the identification is provisional because the species could be undescribed, and they point out that they could have illustrated several species instead of only one.

Pola *et al.* (2012), based on their studies, state that 'eastern Pacific, Indo-Pacific, and temperate biotas consist largely of distinct faunas', but they assign to their newly described Pacific species, *N. panamica*, the specimens known for the genus in the Caribbean (Valdés *et al.*, 2006).

The expedition 'Karubenthos', hosted by the Muséum National d'Histoire Naturelle (MNHN) in Paris, took place in Guadeloupe (Lesser Antilles, Caribbean Sea) in May and December 2012. The objective was the total inventory of the mollusca from the archipelago, for which 92 stations distributed in all the possible habitats were sampled. As a result of this expedition, the inventory of the sea slugs in Guadeloupe was established as 149 species (Ortea *et al.*, 2012, 2013), including one new genus, nine new species and 100 new records for the fauna of the area.

The objective of this paper is the description of a new Caribbean species of the genus *Notobryon*, the sixth known in the world, based on the valid anatomical characters established by Odhner (1936) and Pola *et al.* (2012).

MATERIALS AND METHODS

The holotype was found by examination of algae collected by wading in Pointe-Noire, Guadeloupe, during the expedition

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'Karubenthos' organized by the MNHN, from 1–28 May 2012. During this field trip a total of 71 stations were visited, from the shore to 36 m depth, and sampled by direct search, scraping, brushing, underwater vacuuming and dredging, from the shore to 258 m depth (Ortea *et al.*, 2012). All samples were processed onshore; placed in trays for examination and selection of specimens in a temporary laboratory installed by the MNHN in the Marine Biology facility of the Guyana University.

The animal was photographed alive and then preserved in ethanol 96%. An Olympus SZX16 stereomicroscope was used to take data on internal anatomy. The following abbreviations are used: am, ampulla; bb, buccal bulb; bc, bursa copulatrix; cg, cerebroid ganglia; dd, deferent duct; fmg, female gland mass; hd, hermaphroditic duct; n, nephroproct; o, ovotestis; oe, oesophagus; ov, oviduct; p, penis; pb, penial bulb; pr, prostate; r, rectum; s, stomach; sg, salivary glands; sl, stomach lobes; sp, stomach plates; v, vagina.

SYSTEMATICS

Order NUDIBRANCHIA Cuvier, 1817

Family SCYLLAEIDAE Alder & Hancock, 1855

Genus *Notobryon* Odhner, 1936

Notobryon caribbaeus sp. nov.

(Figures 1–4)

Notobryon cf. *wardi*: Valdés, Hamann, Behrens & Dupont, 2006: 232–233.

TYPE MATERIAL

Holotype: adult, 11 mm long preserved, collected in a seagrass meadow of *Halophila stipulacea* inside Anse Caraïbe (type locality), 16°12.37'N 61°47.2'W, Pointe-Noire, Guadeloupe, 'Karubenthos': Station GD16, 11 May 2012. Dissected: jaw and radula mounted for optical microscopy, the remains preserved in 96% ethanol and deposited in the molluscan collections at the MNHN (IM-2000-27252).

DIAGNOSIS

Body translucent orange with reddish-brown and white spots. Reddish-brown pigment concentrated on the crests. Anterior pair of body lobes remarkably bigger than the posterior pair, both separated by a large gap. Jaws amber, elongate and oval. Masticatory border expanded like a flap. Radular formula 14 × 20.0.20. Radular teeth with denticles on both sides of the cusp. Eyes small lacking optic nerve, emerging directly from the cerebroid ganglia. Stomach with eight thick triangular plates. Digestive gland composed of two distinct lobes. Ovotestis composed of two asymmetrical gonads. Ampulla black and very wide. Sponge-like prostate present. Penis unarmed, conical and smooth. Bursa copulatrix big and lemon-shaped.

DESCRIPTION

Body limaciform, translucent orange, bearing scattered small tubercles, with reddish-brown spots, mainly on the sides, and the same coloration concentrated on the crenulated crest that runs from the posterior side of each rhinophoral sheath to the tail, passing through the dorsal lobes (Figure 1A). White dots disperse on surface of the body, but concentrated on the crest, velum, rhinophoral sheaths, rhinophores, tubercles and gills. Sole of the foot translucent with an orange tinge. Velum bilobed and crenulated (Figure 1B). Rhinophoral sheaths long and slender, expanded in the aperture. Rhinophores perfoliate, retractile, visible by transparency (Figure 1C), bearing 10 lamellae and a white apex. Body lobes asymmetrical; the anterior pair remarkably bigger and more quadrangular than the posterior pair. Separated on each side by a gap longer than the first's lobes extended. Gills on the inner side of the lobes, tripinnate, crystalline with some white dots (Figure 1D). Upper margin of the lobes and rhinophoral sheaths crenulated. Internal organs whitish orange seen through the body. Anal opening on the right side, at the posterior base of the anterior lobe. Nephroproct close to the anus. Genital opening below the base of the right rhinophore.

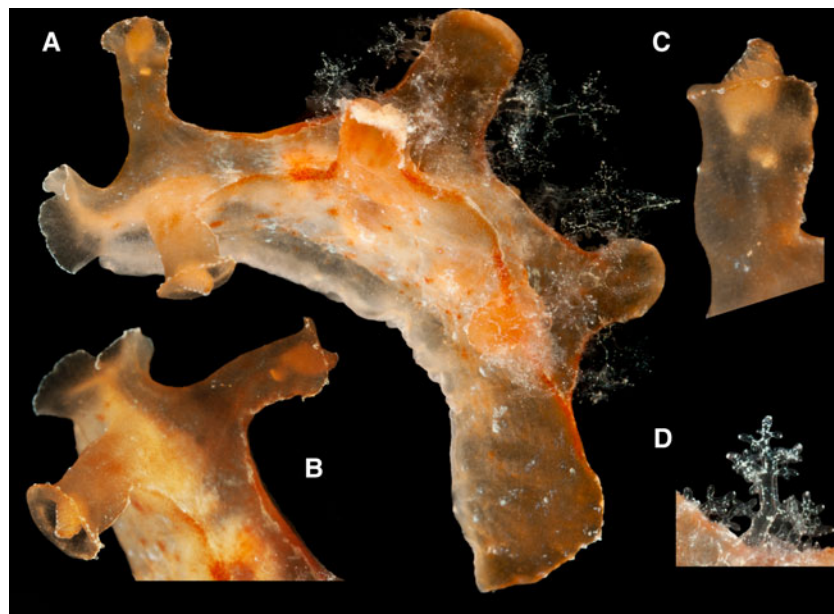


Fig. 1. *Notobryon caribbaeus* sp. nov., holotype: (A) dorso-lateral view of the living animal; (B) dorsal view of the head; (C) lateral view of the rhinophore; (D) gill.

Jaws amber, elongate, oval and 2016 μm long (Figure 2B). Masticatory border expanded like a flap, with hundreds of rounded to polygonal rodlets on its entire surface. Each rodlet conical with a blunt apex which bears several small denticles (Figure 2C).

Radular formula $14 \times 12 - 20.0.12 - 20$. Radula lacking rachidian teeth. Radular teeth with denticles on both sides of the cusp; less but stronger on the outer side (up to 10) than in the inner (up to 18). Innermost lateral teeth small and usually lacking denticles, growing in size and number of denticles to the outer margin (Figure 2D). The last teeth can be slightly smaller.

Buccal bulb prominent and very strong, with an angle in the posterior side where the jaws are visible. Cerebroid ganglia (Figure 2A) forming a ring around the digestive duct at the base of the buccal bulb (Figure 3A), composed of 4 principal lobes on each side, with a refringent sphere between the central ones. Eyes small and very simple, emerging from the most dorsal lobes, lacking optic nerve (Figure 2A). Oesophagus long and narrow, at the beginning. Salivary glands longitudinally attached to the oesophagus, surrounding it. Stomach long and wide, bearing eight thick triangular plates with a wide base and a sharp apex (like the spines of a rose), arranged in a transversal ring, completely coating the inner side of the tube (Figure 3C: only six plates figured for practical reasons). Digestive gland composed of two distinct lobes, the small one connected with the stomach by a long conduct and bearing an accessory gland (Figure 3C).

Ovotestis composed of two gonads; one almost oval and big and the other more rounded and half as big (Figures 3B and 4A). Both united by a very thin duct connected to the hermaphroditic duct. Ampulla very wide, convoluted, black and branched in the deferent duct and the oviduct (Figure 4B). Oviduct straight, long and wide, connected to the apical side of the female gland mass. The deferent duct, at the beginning, goes through a sponge-like, granulose and well-differentiated prostate, composed of hundreds of small rounded glands (Figure 4B). After the prostate the deferent duct is a pearl-white colour, long, thin, convoluted and very strong duct

that narrows abruptly to end in the penial duct. Penial duct pear-shaped, containing the penis. Penis large, unarmed, conical and smooth, with a narrow apex (Figure 4C). Vagina elongate and narrow with a very big lemon-shaped bursa copulatrix.

ETYMOLOGY

This species is named to honour the sea in which it inhabits, the Caribbean, and also to honour the people who lives on its coasts.

HABITAT

Found on seagrass meadow of *Halophila stipulacea*. Very rare, only one specimen captured after an intensive expedition.

DISTRIBUTION

Guadeloupe.

DISCUSSION

The genital system with a granulose prostate, well differentiated and distinct from the deferent duct, relates *Notobryon caribbaeus* sp. nov. with *Notobryon bijecurum* and separates it from all the other described congeners, in which the prostate is only a thickening in the deferent duct (Pola *et al.*, 2012: figure 5).

Notobryon caribbaeus sp. nov., is distinguished from *N. bijecurum* by the much longer and convoluted deferent duct and by the presence of a big, lemon-shaped bursa copulatrix (absent in *N. bijecurum*), a black ampulla and two big gonads in the ovotestis instead of two groups of four and five, among other characters. Regarding the external morphology, the anterior lobes of the dorsum of *N. bijecurum* are much bigger and the posterior ones much smaller, than these in *N. caribbaeus* sp. nov., additionally, the tail in the first species is sharp whilst in the latter is blunt.

Supported by the molecular evidence, Pola *et al.* (2012) infer that there are 'morphological differences amongst closely related species' of *Notobryon*, useful to distinguish them,

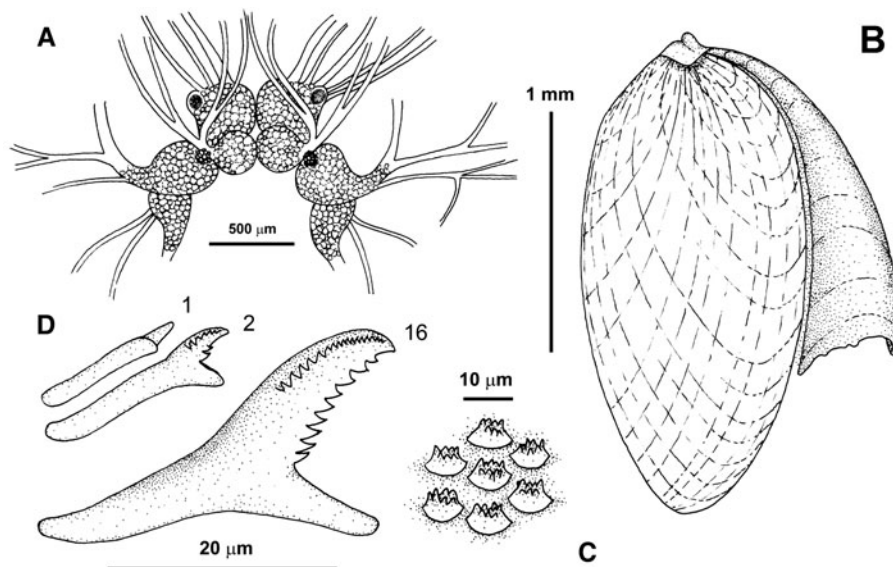


Fig. 2. *Notobryon caribbaeus* sp. nov., holotype: (A) cerebroid ganglia; (B) jaw; (C) jaw rodlets; (D) radular teeth (1, innermost; 2 and 16, outermost).

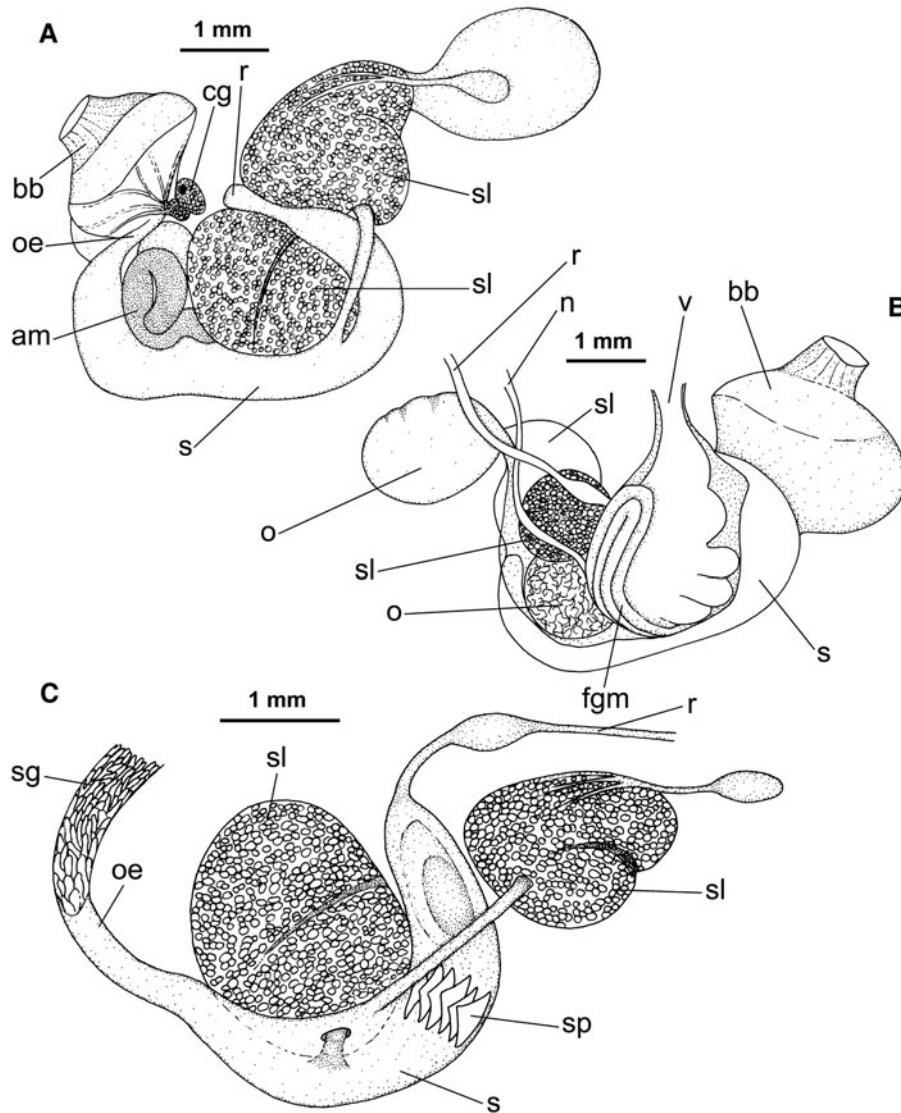


Fig. 3. *Notobryon caribbaeus* sp. nov., holotype: (A) scheme of the internal anatomy, left side of the body; (B) scheme of the internal anatomy, right side of the body; (C) digestive system, left side of the body.

‘especially in the structure of the male genital system’. Based on their conclusions, the presence of a granulose, complex and well-differentiated prostate in *N. bijerecum* and *N. caribbaeus* sp. nov. seems to be an informative synapomorphy. The possibility of developing this complex organ twice independently in the evolution of the genus is apparently less parsimonious. That would suggest that both taxa could share a common ancestor and represent a distinct evolutive lineage in the genus, with a disrupted distribution that we cannot explain. Given that the molecular phylogeny of *Notobryon* conducted by Pola *et al.* (2012) included only three of the five species known for that time, a future phylogenetic and biogeographical approach including all the species of the clade would be desirable.

Notobryon panamica was described in base to samples from Mexico, Costa Rica and Panama. Astonishingly, all the records for *Notobryon* cf. *wardi* in the Caribbean (Valdés *et al.*, 2006: possibly undescribed and/or more than one species), were considered to belong to *N. panamica* by Pola *et al.* (2012), in the absence of samples for molecular or

anatomical studies to support this statement. The external morphology of *N. caribbaeus* sp. nov., but fundamentally the anatomy of the genital system clearly distinguish it from *N. panamica*, which is confined to the eastern Pacific. The presence of two different species, one in the Caribbean and other in the Pacific is consistent with the idea that ‘eastern Pacific, Indo-Pacific, and temperate biotas consist largely of distinct faunas’ (Pola *et al.*, 2012).

Two specimens from St Lucia and St Vincent whose external anatomy is quite similar to that of *N. caribbaeus* sp. nov. have been illustrated by Valdés *et al.* (2006: 232) under the name *Notobryon* cf. *wardi*. These authors include Honduras, St Lucia, Virgin Islands and St Vincent & the Grenadines in the distribution of the latter. However, the illustration from the Virgin Islands possibly corresponds to a different species, as Valdés *et al.* (2006) remark; thus, the distribution of *Notobryon* in the Caribbean is in need of revision.

With the record of *N. caribbaeus* sp. nov. in Guadeloupe, the number of sea slugs in the archipelago raises to 150, 10 of them recently described (Ortea *et al.*, 2012, 2013).

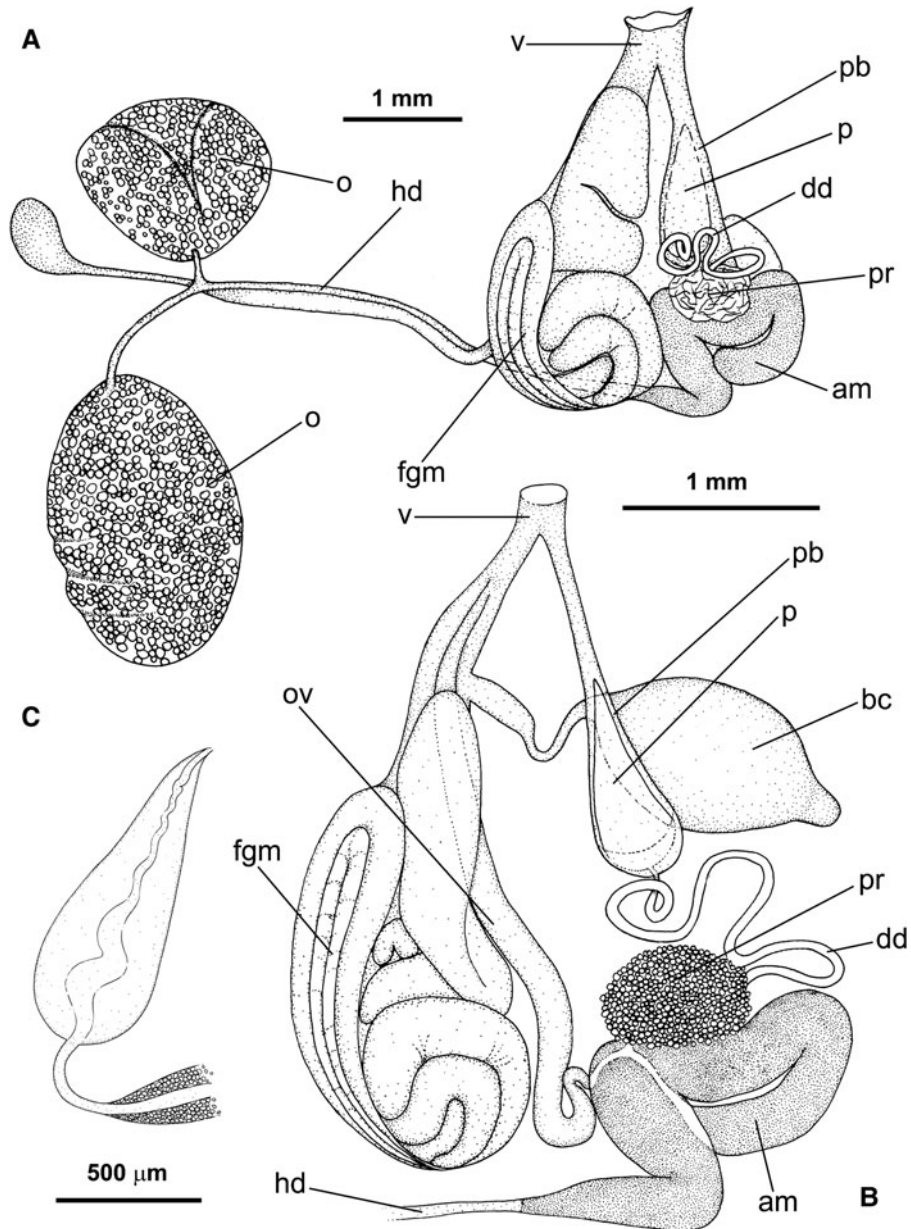


Fig. 4. *Notobryon caribbaeus* sp. nov., holotype: (A) reproductive system with the ovotestis; (B) detail of the reproductive system; (C) penis.

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