

# A new species of *Tritonia* (Opisthobranchia: Nudibranchia: Tritoniidae) from the tropical South Atlantic Ocean

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*A new species of the family Tritoniidae is described from the tropical South Atlantic Ocean. The animal was found off north-east Brazil. Tritonia khaleesi sp. nov. is up to 12 mm long, with a slender white body, of which the notum is covered with one broad white band extending from between the eyes and veil to the tail; veil with 4 velar appendages; retractable white rhinophores; rhinophoral sheath with fleshy extension; seven pairs of branchial plumes; the anus is located between the 3rd and 4th gills on the right side, and the genital opening is under the 2nd gill. Internally, T. khaleesi sp. nov. is distinguished from other tritoniids by jaws with 10–14 rows of denticles on the inner lips, absence of stomach plates and the radular formula  $32 \times 2-5.1.1.1.2-5$  teeth. Tritonia khaleesi sp. nov. is the only Tritonia that possesses a unicuspid rachidian tooth as an adult.*

**Keywords:** *Tritonia khaleesi* sp. nov., taxonomy, Nudibranchia, Dendronotina, tropical Atlantic

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## INTRODUCTION

Current understanding of the taxonomy of the family Tritoniidae (Odhner, 1963; Marcus, 1983; Pola & Gosliner, 2010) includes the following valid genera: *Tritonia* Cuvier, 1798, *Tritoniopsis* Eliot, 1905, *Tritoniella* Eliot, 1907, *Marionia* Vayssière, 1877, *Marioniopsis* Odhner, 1934, *Marianina* Pruvot-Fol, 1931, *Paratritonia* Baba, 1949, and *Tochuina* Odhner, 1963. The taxonomy of Tritoniidae is considered problematic despite the revisions of Odhner (1936, 1963), mainly because the descriptions of most species lack information on the internal anatomy, such as the jaws or stomach plates (Smith & Gosliner, 2003), and some animals do not fit appropriately into any of the currently recognized genera (Willan, 1988; Schrödl, 2003).

The species of the family Tritoniidae presently recorded for the western Atlantic are: *Tritonia bayeri* Marcus, 1967, *Tritonia challengeriana* Bergh, 1884, *Tritonia hamnerorum* Gosliner & Ghiselin, 1987, *Tritonia odhneri* Marcus, 1959, *Tritonia plebeia* Johnston, 1828, *Tritonia vorax* (Odhner, 1926), *Tritonia wellsi* Marcus, 1961, *Tritoniella belli* Elliot, 1907, *Tritoniopsis frydis* Marcus, 1970, *Marionia cucullata* (Couthouy, 1852), *Marionia limceana* Silva, Meirelles & Matthews-Cascon, 2013, and *Marionia tedi* Marcus, 1983. Only *T. wellsi*, *T. odhneri*, *M. cucullata* and *M. limceana* have been recorded from Brazil (Silva *et al.*, 2013).

In this paper we describe a new species of nudibranch belonging to the genus *Tritonia* Cuvier, 1798.

## MATERIALS AND METHODS

The animals were collected by hand during a spring tide at the Praia do Pacheco, Caucaia (03°41'S 38°38'W), State of Ceará (Figure 1). The samples were taken to the Laboratory of Marine Invertebrates of the Universidade Federal do Ceará, where they were photographed with a Nikon 4500 digital camera coupled to a stereoscopic microscope, and measured with calipers of 0.1 mm precision. The animals were anaesthetized in a saturated solution of seawater (salinity 35) + fresh water (1:1) + magnesium chloride for 2 h and fixed in 70% ethanol. Some animals were dissected from the right side of the body. The internal organs were observed and photographed under an optical microscope, and compared with the data in the literature. The radula and jaw were extracted and treated with potassium hydroxide (KOH) to remove residual tissue. The radula was examined in a Jeol scanning electron microscope at the Laboratório de Microscopia Eletrônica de Varredura do Departamento de Invertebrados do Museu Nacional. All collected material was incorporated into the 'Professor Henry Ramos Matthews—series B' Malacological Collection of the Universidade Federal do Ceará (CMPHRM-B) and the Museu de Zoologia da Universidade de São Paulo (MZUSP).

## SYSTEMATICS

Infraclass OPISTHOBRANCHIA  
Order NUDIBRANCHIA Cuvier, 1817  
Infraorder DENDRONOTIDA Odhner, 1934  
Family TRITONIIDAE Lamarck, 1804  
Genus *Tritonia* Cuvier, 1797  
*Tritonia khaleesi*, sp. nov.  
(Figures 2–7)

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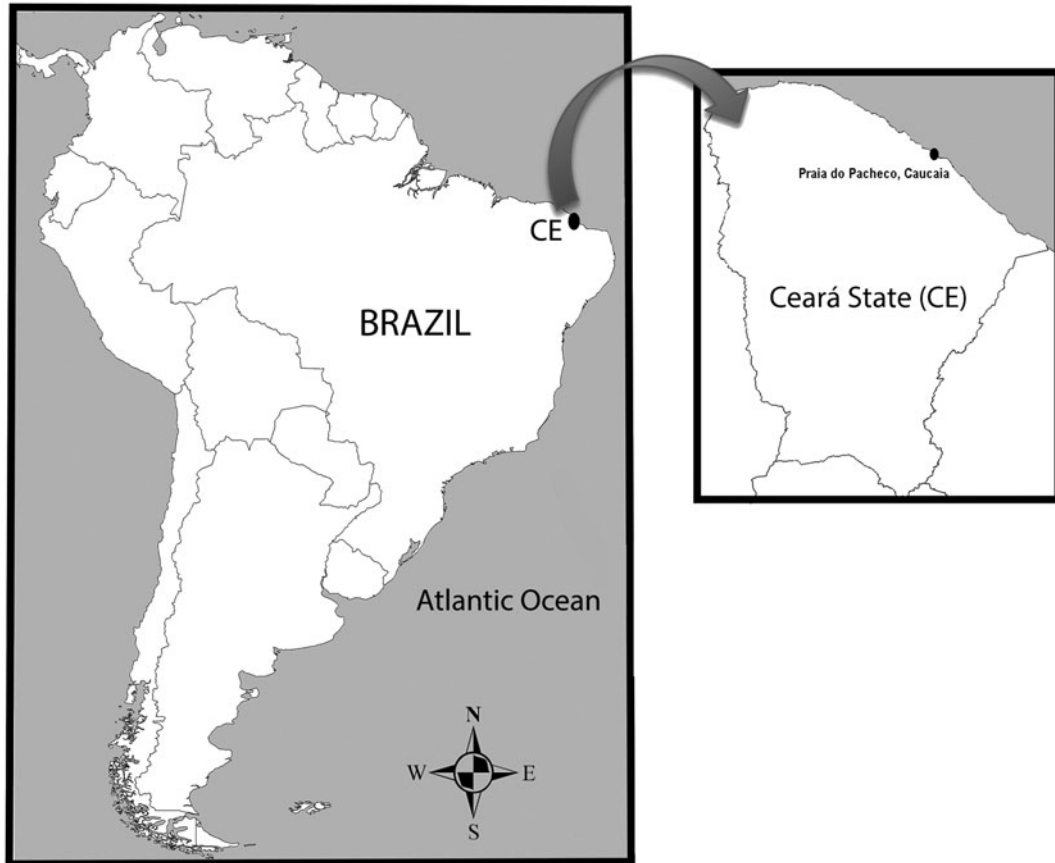


Fig. 1. *Tritonia khaleesi*, sp. nov., distribution map.

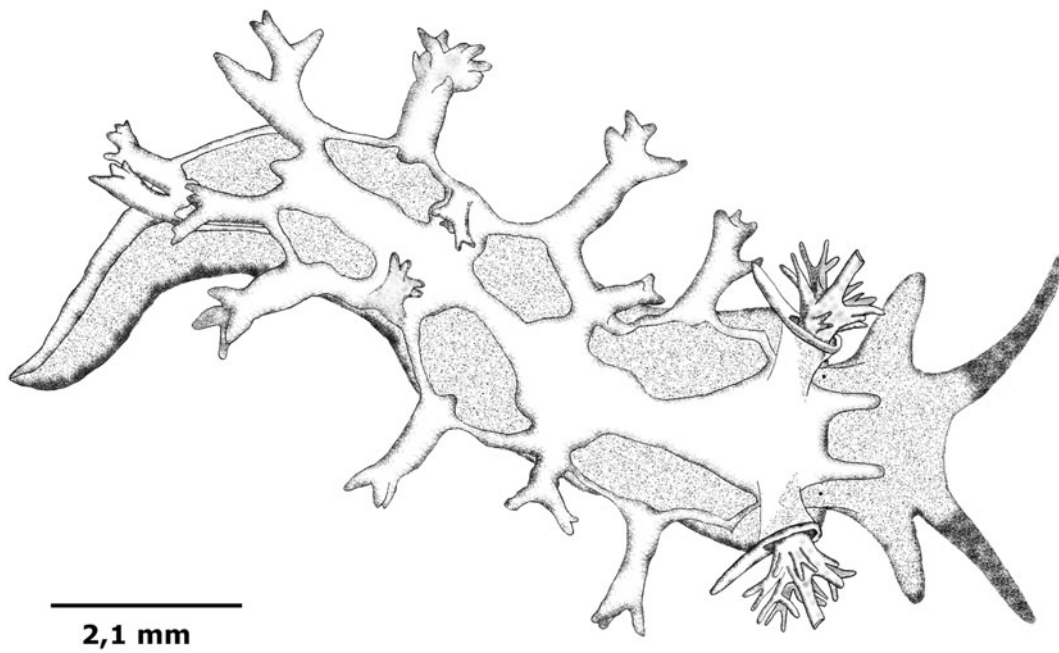
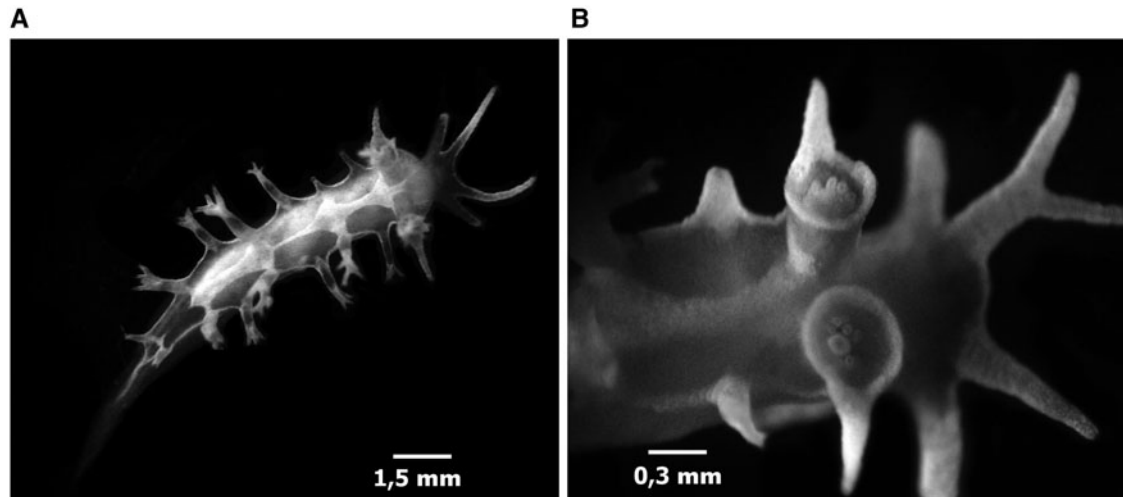


Fig. 2. *Tritonia khaleesi*, sp. nov., holotype CMPHRM 3763B, line drawing. Mature adult.

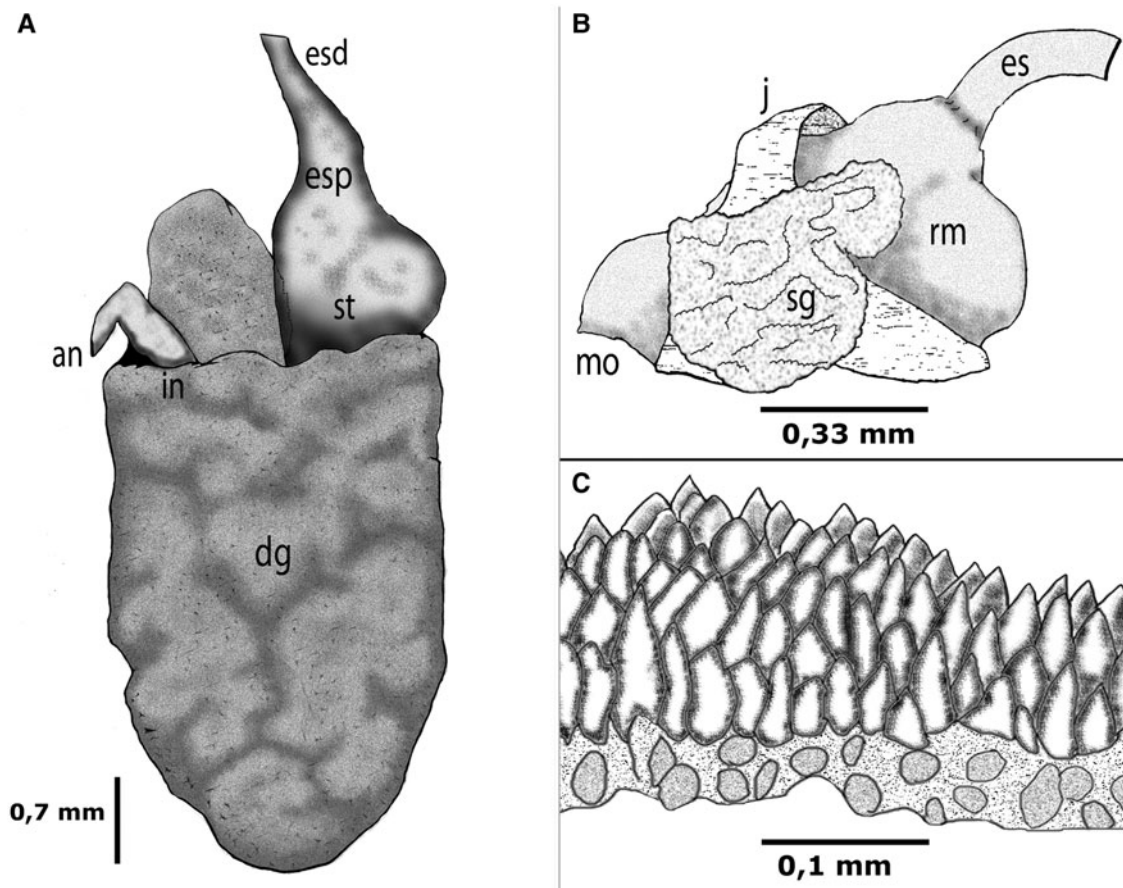


**Fig. 3.** *Tritonia khaleesi*, sp. nov., digital photographs. (A) Holotype CMPHRM 3763B, 12 mm in length; (B) paratype CMPHRM 3759B, rhinophoral sheath possessing a long fleshy extension and retracted rhinophoral club; bifurcated veil appendage.

#### TYPE MATERIAL

Holotype: CMPHRM 3763B, 12 mm long, March 2011, coll. F. Vasconcelos S., 1.0 m depth, dissected. Paratypes: CMPHRM 3757B, 15 mm long, May 2012, coll. F. Vasconcelos S., type locality, 1.0 m depth, dissected. CMPHRM 3758B,

7 mm long, August 2010, coll. F. Vasconcelos S., type locality, 1.2 m depth, dissected. CMPHRM 3759B, 8 mm long, August 2010, coll. F. Vasconcelos S., type locality, 1.2 m depth, dissected. MZUSP 113165, 8 mm long, July 2012, coll. F. Vasconcelos S., type locality, 1.2 m depth, not dissected.



**Fig. 4.** *Tritonia khaleesi*, sp. nov. Drawing from paratype CMPHRM 3757B: (A) digestive system (ventral view): an, anus; dg, anterior digestive; esd, distal oesophagus; esp, proximal oesophagus; in, intestine; st, stomach; (B) head (lateral view): es, oesophagus; j, jaw; sg, salivary glands; rm, radular mass; mo, mouth opening; (C) denticle rows from masticatory border of the jaws.

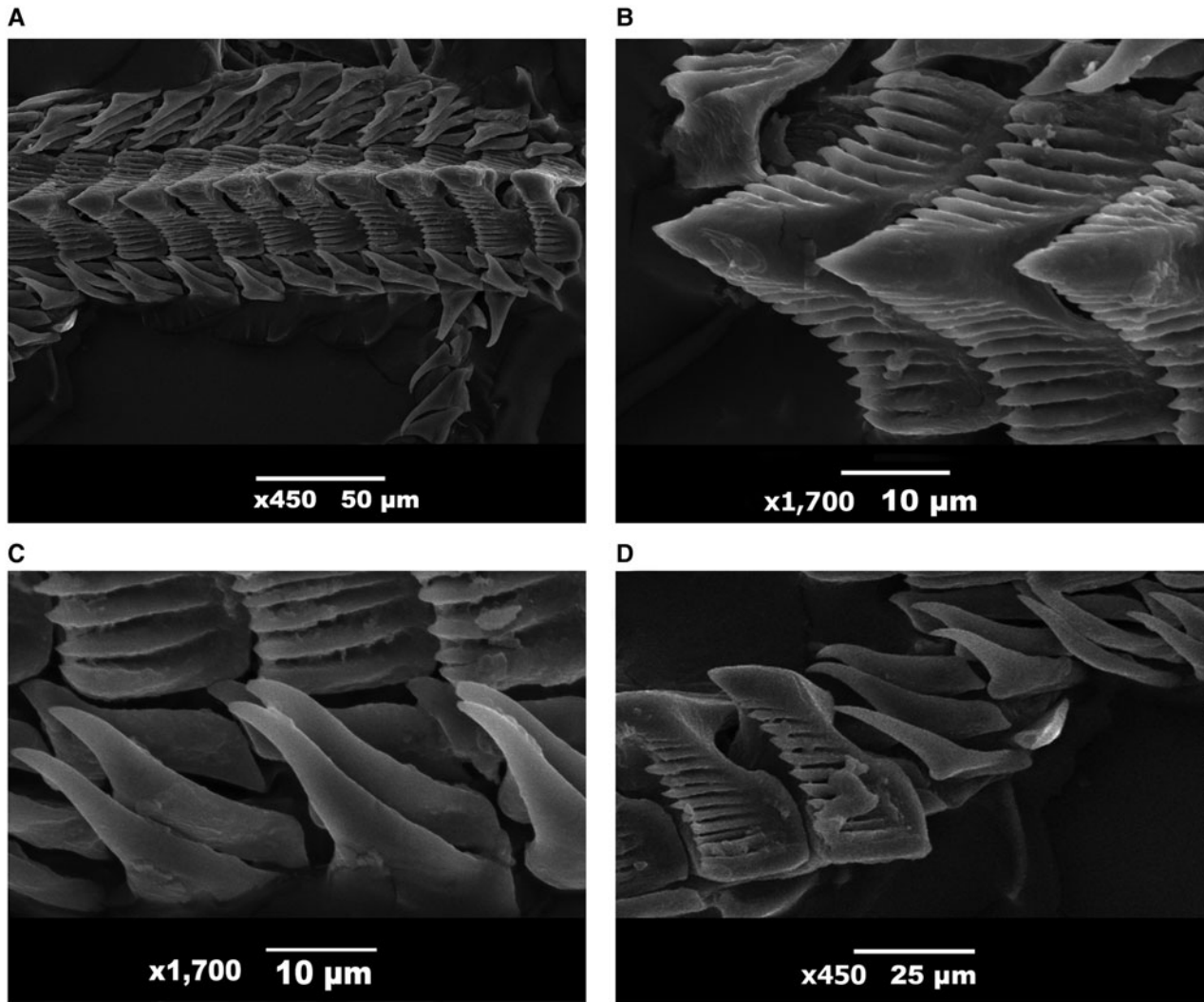


Fig. 5. *Tritonia khaleesi*, sp. nov. scanning electron micrographs of radula of paratype CMPHRM 3757B: (A) overview of radula; (B) rachidian teeth; (C) first lateral and outer laterals; (D) rachidian teeth, lateral view.

#### TYPE LOCALITY

Praia de Pacheco, Caucaia, State of Ceará, north-eastern coast of Brazil (04°02'S 38°11'W).

#### GEOGRAPHICAL AND BATHYMETRIC DISTRIBUTION

*Tritonia khaleesi* is reported only from the north-eastern Brazilian coast, on the Praia do Pacheco, Ceará. So far the species is known only from the intertidal zone.

#### ETYMOLOGY

The name, proposed as a noun in apposition, refers to the title 'Khaleesi', meaning 'Queen', of the main character Daenerys, from the book series *A Song of Ice and Fire* by the American author George R.R. Martin. The character is described as being short and having long white hair, features that resemble the white band on the notum of *Tritonia khaleesi*. The book series was recently adapted for the television series *A Game of Thrones*.

#### DIAGNOSIS

Tritoniidae with four velar appendages; slender white body; notum covered with one white band running from

rhinophores to tail; rhinophoral sheath with fleshy extension; digestive glands fused; absence of stomach plates; seven pairs of gills; jaw with 10–14 rows of denticles on inner lips; unicuspid rachidian tooth.

#### DESCRIPTION

External anatomy: the holotype specimen (Figure 2) was 12 mm long when alive. The animal has a slender whitish body. The notum is covered by a broad white band (Figure 3A) extending from between the eyes and veil to the tail. This white band involves the rhinophores, ascending the rhinophore sheaths and branching to involve the 2nd, 4th and 6th gills. The transparent ventral region reveals the orange-colored digestive glands surrounded by the white ovotestis.

The veil is rounded and contains four digitiform appendages in most specimens; one paratype has a bifurcated appendage (Figure 3B). The innermost anterior appendages, i.e. the oral tentacles, are largest, with similar coloration to the white band of the notum. The rhinophoral sheath is chalice-shaped and semitransparent, possessing a long fleshy extension on the outer side. The retractable rhinophoral

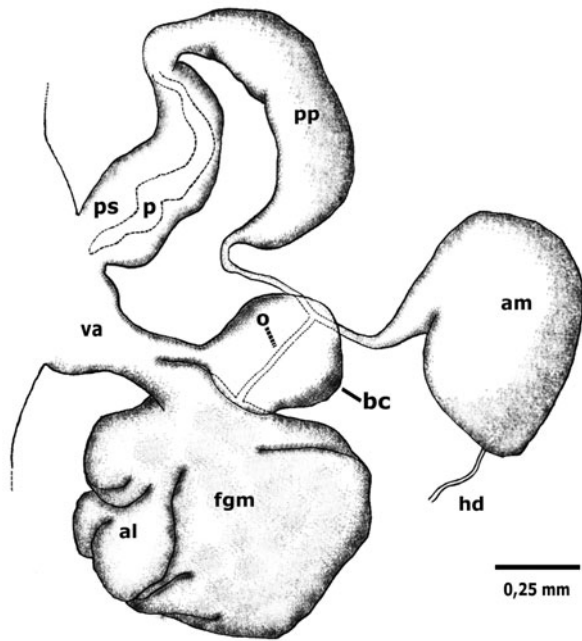


Fig. 6. *Tritonia khaleesi*, sp. nov. Drawing from paratype CMPHRM 3757B. Reproductive system: al, albumin gland; am, ampulla; bc, bursa copulatrix; fgm, female gland mass; hd, hermaphroditic duct; o, oviduct; p, penis; ps, penial sac; pp, prostatic part; va, vaginal atrium. Dorsal view.

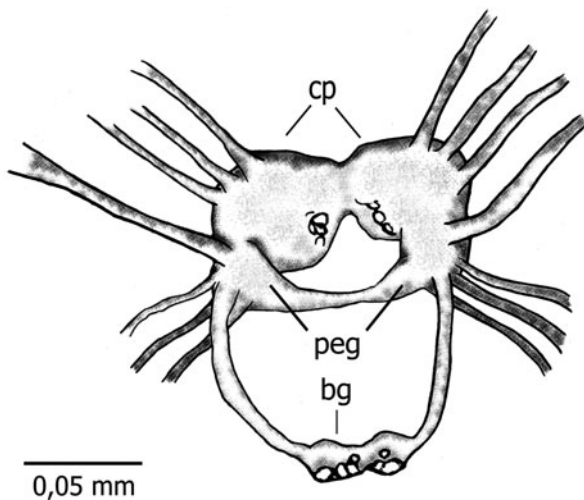


Fig. 7. *Tritonia khaleesi* sp. nov. Drawing from paratype CMPHRM 3757B. Central nervous system: cp, cerebropleural; peg, pedal ganglia; bg, buccal ganglia.

club has five bipinnate plumes. Most specimens have seven gills on either side, but some specimens have eight on one side and seven on the other. The gills are long and have similar coloration to the white band of notum. The gills divide into two main branches. Each main branch divides into two or three smaller branches, although some gills do not branch. The foot is linear, narrow and semi-transparent. The anterior end of the foot has a rounded margin. The anus is located between the 3rd and 4th gills on the right side, while the genital opening is under the 2nd gill. The

mouth is located ventrally and anterior to the foot, between the lips. The renal pore is anterior to the anus.

Digestive system (Figure 4): the lips are in a prone position, connecting the tube to the mouth opening. The jaw is concave, narrow, amber-colored, with 10–14 rows of denticles. Two salivary glands are positioned next to the pharynx. Inside the pharynx is the radular mass, where the radula is inserted, connecting to the esophagus in the dorsal region of the buccal mass. The radula (Figure 5) of the paratype measured 1 mm, across the curve. The radular formula is  $32 \times 2-5.1.1.1.2-5$  teeth. The rachidian teeth are unicuspid, each with 11–12 denticles. The first lateral teeth are stout, differing from the remaining lateral teeth which have long sharp cusps. The oesophagus extends from the buccal mass until the connection to the stomach. The stomach is 'U'-shaped, with the digestive gland opening into its middle region. The stomach and intestine do not form a loop around the digestive gland. No stomach plates or girdles were found in the stomach. The typhlosole was found in the intestine and passes through it to the anus. The short intestine exits the stomach and narrows toward the anus. The digestive gland is orange-colored and large, occupying one third of the total length of the animal.

Reproductive system (Figure 6): the reproductive system is androdiaulic. The ovotestis covers most of the surface of the digestive gland, appearing white against the orange-coloured digestive gland. The hermaphroditic duct connects the ovotestis to the ampulla. The ampulla is large and oval; its outlet bifurcates into the oviduct and vas deferens. The slender vas deferens passes into the prostatic part. The prostatic part is long, bulky and thick, becoming the penial sac, where lies the flagelliform penis. The globular spermatheca is smaller than the ampulla and connected to the vagina through a narrow duct. The female gland mass connects to the vagina. The small, nodular and yellow albumen gland is easily discernible inside the female gland mass, together with a folded membrane gland. The penial sac and vagina open to the exterior in a common chamber located below the 2nd gill.

Nervous system (Figure 7): cerebral and pleural ganglia (cerebropleurals) are completely fused and directly connected to the pedal ganglia. The pair of pedal ganglia are connected by the circum-oesophageal nerve ring. A pair of buccal ganglia were found on the ventral oesophagus, completely fused and linked to the pedal ganglia by connectives. The cerebropleurals and the buccal ganglia have easily distinguishable giant nerve cells.

## DISCUSSION

The separation of genera within the Tritoniidae is still problematic 50 yr after the last revision by Odhner (1963). Past species descriptions based mainly on the external anatomy, as well as intense controversy regarding the characters used by different investigators to separate genera are part of the problem. We have combined the available data in an updated table of some species of *Tritonia* and our proposed species (Table 1).

The species described here does not have the digestive gland divided and lacks stomach plates, and therefore the genera *Marionia*, *Marioniopsis*, *Paratritonia* and *Tritoniella* were discarded (Odhner, 1963; Marcus, 1983). The radula of this species does not resemble those of the two remaining

**Table 1.** Comparison of some species of the genus *Tritonia* Cuvier, 1797. Data compiled from Marcus (1961), Gosliner & Ghiselin (1987), Wägele (1995), Smith & Gosliner (2003), Behrens & Hermosillo (2005), Ballesteros & Avila (2006) and Bertsch *et al.* (2009).

Geographical range	Species	Velar processes	Rhinophore sheath	Branchial plumes (pair)	Radula formula
Western Atlantic	<i>T. bayeri</i> Marcus, 1967	4–6	With a fleshy extension	≤15	20–34 × (9–10.1.1.1.9–10)
Western Atlantic	<i>T. hamnerorum</i> Gosliner & Ghiselin, 1987	4–6	With a fleshy extension	9	26–29 × (9–10.1.1.1.9–10)
Western Atlantic	<i>T. khaleesi</i> sp. nov.	4	With a fleshy extension	7	32 × (2–5.1.1.1.2–5)
Western Atlantic	<i>T. odhneri</i> Marcus, 1959	8–18	Lobed	12–35	60 × (80.1.1.1.80)
Western Atlantic	<i>T. wellsii</i> Marcus, 1961	6	Triangular appendage	10–11	20–21 × (10–11.1.1.1.10–11)
Northeastern Atlantic	<i>T. dantarti</i> Ballesteros & Avila, 2006	12–16	With two protuberances	20–33	35 × (45.1.1.1.45)
Northeastern Atlantic / Northwestern Atlantic	<i>T. plebeia</i> Johnston, 1828	4–8	Smooth	5–6	20–38 × (32–69.1.1.1.32–69)
Eastern Atlantic	<i>T. striata</i> Haefelfinger, 1963	4–6	Smooth	4–6	42 × (26.1.1.1.26)
Eastern Atlantic / Mediterranean	<i>T. manicata</i> Deshayes, 1853	6–8	Smooth	≤6	21–40 × (11–16.1.1.1.11–16)
Eastern Atlantic	<i>T. nilsodhneri</i> Marcus, 1983	6	Smooth	8	25 × (24–30.1.1.1.24–30)
Eastern Pacific	<i>T. pickensi</i> Marcus & Marcus, 1967	3–9	With a fleshy extension	7–13	25–28 × (10–11.1.1.1.10–11)
Eastern Pacific	<i>T. festiva</i> Stearns, 1873	8–12	Smooth	8–12	32–57 × (16–49.1.1.1.16–49)
Eastern Pacific	<i>T. myrakeenae</i> Bertsch & Mozqueira, 1986	4–7	Smooth	≤9	22–25 × (8–10.1.1.1.8–10)
North western Pacific / Eastern Pacific	<i>T. papalotla</i> Bertsch, Valdés & Gosliner, 2009	11–12	With rounded tubercles	-	24 × (0.1.0)
Indo-Pacific	<i>T. bollandi</i> Smith & Gosliner, 2003	12–14	Undulate and flange-like	9–14	66 × (78.1.1.1.78)
South western Pacific	<i>T. incerta</i> Bergh, 1904	7–9	Smooth	13–14	?
Antarctic	<i>T. challengeriana</i> Bergh, 1884	10–18	Smooth	≤30	31–46 × (37–63.1.1.1.37–63)
Subantarctic	<i>T. vorax</i> Odhner, 1926	15–26	Smooth	20–40	54–71 × (79–115.1.1.1.79–115)

possible genera, *Tritonia* and *Tritoniopsis*. Species of *Tritonia* have a tricuspid rachidian tooth and a differentiated first lateral tooth, whereas species of *Tritoniopsis* have a unicuspid rachidian tooth and the first lateral teeth do not differ from the others (Marcus, 1983). Our species has characteristics of both genera: a unicuspid rachidian tooth, and the first lateral teeth are different from the rest, so we cannot assign this taxon to a genus based only on the radula. We decided to assign our species to *Tritonia* based on the number of gills, the fleshy extension on the outer side of the rhinophoral sheath, and the number of veil appendages.

Externally, *T. khaleesi* is very similar to the original illustration of *Tritonia pickensi* Marcus & Marcus, 1967. The two species are slender, whitish, have the notum covered by a broad white band extending from between the eyes to the tail, and the rhinophoral sheath has a fleshy appendage on the outer side. *Tritonia khaleesi* can be distinguished from *T. pickensi* by the number of gills (7–13 in *T. pickensi* and 7 in *T. khaleesi*), the number of velar appendages (3–9 in *T. pickensi* and 4 in *T. khaleesi*), and the rachidian tooth (tricuspid in *T. pickensi* and unicuspid in *T. khaleesi*). Also, *Tritonia pickensi* is reported from the Pacific coast of Mexico, and *T. khaleesi* has been found only in a small area on the Atlantic coast of north-east Brazil.

*Tritonia khaleesi* is easily distinguished from other tritoniids known from the Atlantic by the notum. *Tritonia wellsii* was described with a smooth notum except for a small webbed region between the 10th and 11th gills, but some researchers have reported specimens with opaque white dots (Valdés *et al.*, 2006). *Tritonia bayeri* has a network of white lines on the notum and *T. hamnerorum* has longitudinal white lines on the notum, but only *T. khaleesi* has the

notum covered by a single broad white band extending from between the eyes to the tail. Also, *T. hamnerorum*, *T. bayeri*, *T. wellsii* and *T. khaleesi* are the only tritoniids that are known to possess a fleshy extension on the rhinophoral sheath, together with *T. pickensi* from the Pacific.

The typical rachidian tooth of *Tritonia* is tricuspid, but a few species depart from this standard feature. *Tritonia papalotla* Bertsch, Valdés & Gosliner, 2009 possesses a single pectinate rachidian tooth and a unique diet, feeding on zoanthid anthozoans rather than on gorgonians or soft corals. *Tritonia khaleesi* is the only known member of *Tritonia* that possesses a unicuspid rachidian tooth as an adult. This suggests a unique diet, although it was not possible to observe the species feeding.

## ACKNOWLEDGEMENTS

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