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A new genus *Swennenia* for *Gascoignella jabae* Swennen, 2001, a small rare mangrove dwelling sea slug in the Gulf of Thailand, with notes on the species (Gastropoda: Sacoglossa: Plakobranchoidea)

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Abstract. A new genus *Swennenia* is proposed for *Gascoignella jabae*, a small, atypical sacoglossan slug that was described based on a single specimen and provisionally placed in the Platyhedylidae. This species has no rhinophores or oral tentacles, and is unique in having a pair of prominent cerata on its posterior end. Dissections showed the arrangement of the internal organs to be more similar to that of the Limapontiidae. Notes on its live colouration, morphology, anatomy, ecology, and biology are provided.

Key words. Sacoglossa, Limapontiidae, new genus, *Swennenia*, *Gascoignella jabae*

INTRODUCTION

Gascoignella jabae Swennen, 2001, is a small marine sacoglossan slug that was described based on a single specimen found in the mangrove areas of Pattani, Thailand, in 1999. Although its familial and generic placement was already doubted in the original description, Swennen (2001) provisionally assigned this species to *Gascoignella*, supposedly based on similarities in external morphology and micro-habitats to *G. nukuli* Swennen, 2001, described in the same paper. Both species were hidden inside clay with the algae *Boodleopsis* (as cf. *Derbesia marina* in Swennen, 2001) growing on it. Most notably, *Gascoignella jabae* has a single pair of caudal cerata that does not fit with the platyhedylid genus *Gascoignella* Jensen, 1985, or any other genera for that matter (see also discussion in Swennen, 2001).

However, it was not until 2008, and more recently in 2014 and 2015, that several more specimens of *Gascoignella jabae* were collected near the type locality for additional observations and examination. More detailed anatomical examinations reveal that the arrangement of the internal organs is rather more similar to that of the Limapontiidae Gray, 1847, than the Platyhedylidae Salvini-Plawen, 1973. This is further supported by recent phylogenetic analyses that show the species to be a limapontiid and clearly unrelated to *Gascoignella* sensu stricto (see Krug et al., 2015, 2018; Filho et al., 2019). On account of its unique morphological characteristics, we propose a new genus *Swennenia* to accommodate the species described as *Gascoignella jabae* Swennen, 2001, and include details on the live colouration, morphology, anatomy, ecology, and biology of this little-known species.

MATERIAL AND METHODS

Since the discovery of *Gascoignella jabae* Swennen, 2001, ad hoc field trips to obtain additional material for study were made to the mangroves around Ban Bang Tawa and Ban Bana in Pattani province of southern Thailand. Based on the observation that this species was hidden inside clay with filamentous algae *Boodleopsis* cf. *pusilla* growing on the surface (for details see Swennen, 2001), areas overgrown with dense mats of the algae under *Avicennia* and *Rhizophora* trees were targeted (Fig. 1A). Small blocks of clay were cut out from the ground and brought back to the lab. In the lab, the clay blocks were placed on a table, positioned with the algae on top (Fig. 1B), and the undersides of the blocks inspected every day for the presence of slugs, but no slugs were found with this method after a few days. The blocks were then broken into small pieces and each piece carefully inspected for dormant slugs in small cavities, which were picked out with a pair of small forceps.

Two specimens were kept alive for observation, in a small glass container with seawater and a piece of clay with the algae *Boodleopsis* cf. *pusilla*. Specimens intended for dissection were narcotised with $MgCl_2$ then stored in a 5% formaldehyde-seawater solution. Dissection was done under a 4–64× stereomicroscope with fine (diameter 0.15 mm) needles glued onto small bamboo sticks. The slugs were fixed on black wax with thin cactus needles prior to dissection.

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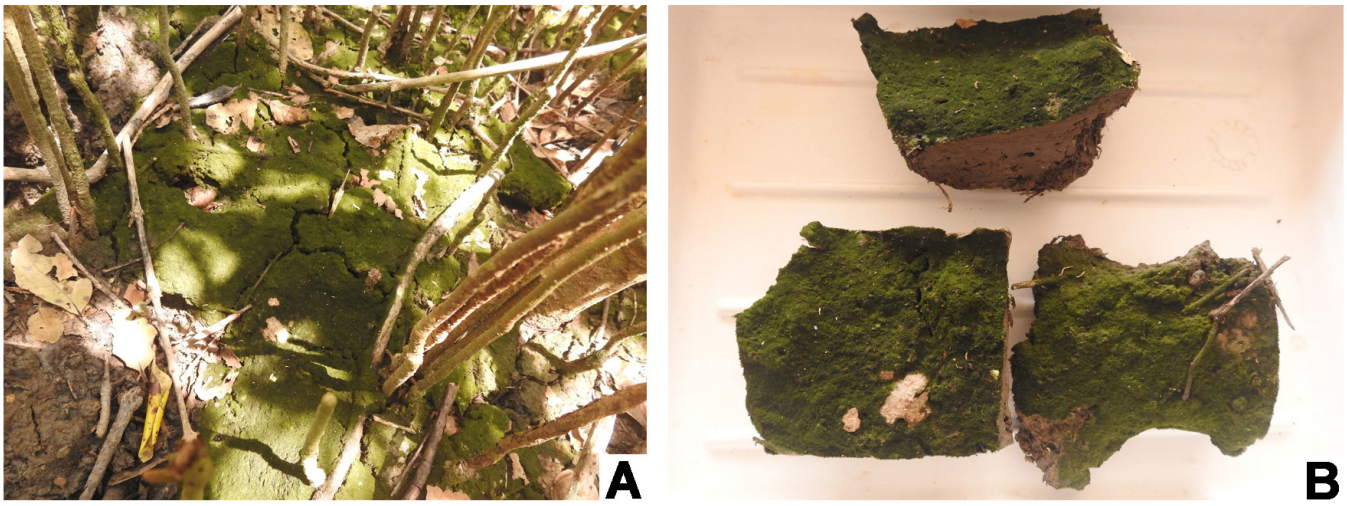

Fig. 1. A, natural habitat in Pattani, Thailand, with mat of the algae *Boodleopsis* cf. *pusilla*, amongst pneumatophores in the mangroves; B, clay blocks cut out of the ground.

TAXONOMY

Family Limapontiidae Gray, 1847

Swennenia, new genus

Type species. *Gascoignella jabae* Swennen, 2001: 78, fig. 2 (type locality: mangrove area near Ban Di, southern Thailand, 06°52′17″N, 101°18′48″E).

Diagnosis. Small, rather flat and elongate slugs without rhinophores or oral tentacles. Dorsum smooth with a pair of prominent rearward-facing cerata at the posterior end of the body. Other details of morphological characteristics are treated as the type species below.

Etymology. The new genus is named in honour of the late Dr Cornelis (Kees) Swennen (1929–2020) who discovered and described the type species. He was a revered collaborator and mentor of the first author. Gender feminine.

Remarks. Thus far monotypic. The animals look superficially similar to *Limapontia* Johnston, 1836, but have a single pair of cerata at the posterior end of the body. Previously placed in Platyhedylidae Salvini-Plawen, 1973, but rightly in the Limapontiidae based on similarities in anatomical characteristics (see Discussion), and molecular analyses that showed it to be sister to a clade comprising the limapontiid genera *Limapontia* Johnston, 1836, *Olea* Agersborg, 1923, and *Calliopaea* d'Orbigny, 1837 (see Krug et al., 2015, 2018; Filho et al., 2019).

Swennenia jabae (Swennen, 2001), new combination
(Figs. 2–6)

Gascoignella jabae Swennen, 2001: 78, fig. 2; Jensen, 2007: 278; Kohnert et al., 2013: 584, 600; Krug et al., 2018: 704, fig. 2.
"*Gascoignella*" *jabae* – Krug et al., 2015: 996, 997, fig. 3; Filho et al., 2019: 543, 544, 553, 564, fig. 3.

Fig. 2. *Swennenia jabae* (Swennen, 2001), total length including cerata ca. 6 mm, from Pattani Bay photographed in the lab. A, slight dorso-lateral view; B, dorsal view.

Material examined. 5 exx. (2 specimens dissected, not preserved; 1 specimen sent to Dr Patrick J. Krug for DNA studies; 2 specimens kept for biological observations eventually died, not preserved), in mangroves, Ban Bang Ta Wa, Pattani, Thailand, coll. October 2008; 1 ex. (dissected, not preserved), mangroves, Ban Bana, Pattani, Thailand, coll. June 2014; 2 exx. (dissected, not preserved), same locality data as previous, coll. July 2015.

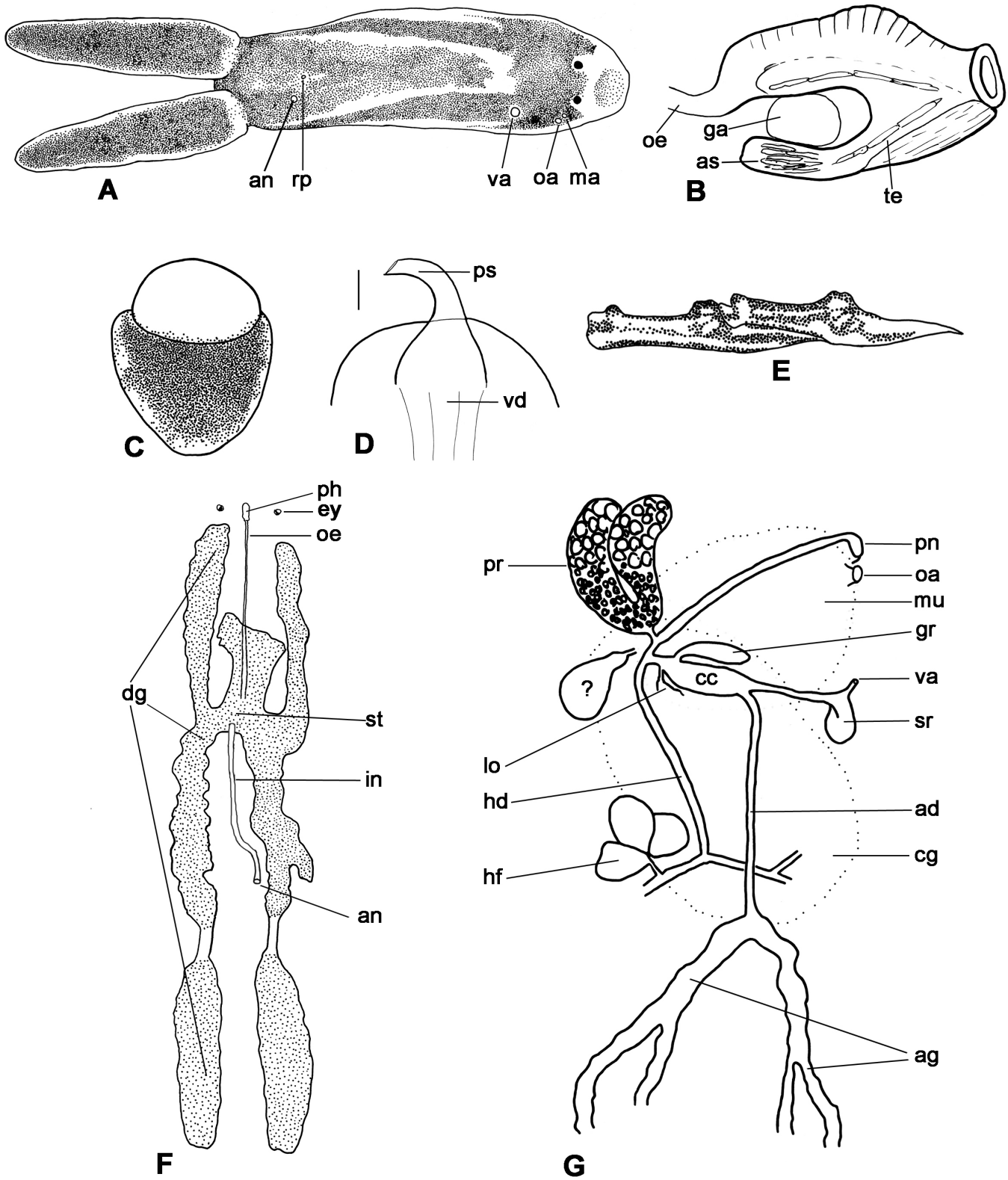

Fig. 3. Drawings of *Swennenia jabae* (Swennen, 2001). A, dorsal view of animal with important parts indicated; B, pharynx; C, eye; D, penis; E, teeth; F, diagram of digestive system; G, diagram of reproductive system. Abbreviations: ad, albumen duct; ag, albumen gland; an, anus; as, ascus; cc, central canal; cg, capsule gland; dg, digestive gland; ey, eye; ga, ganglion; gr, genital receptacle; hd, hermaphrodite duct; hg, hermaphrodite follicles; in, intestine; lo, large oviduct; ma, male aperture; mu, mucus gland; oa, oviducal aperture; oe, oesophagus; ph, pharynx; pr, prostate; ps, penis style; rp, renal pore; sr, seminal receptacle; st, stomach; te, teeth; va, vagina aperture; vd, vas deferens; ?, indeterminate gland.

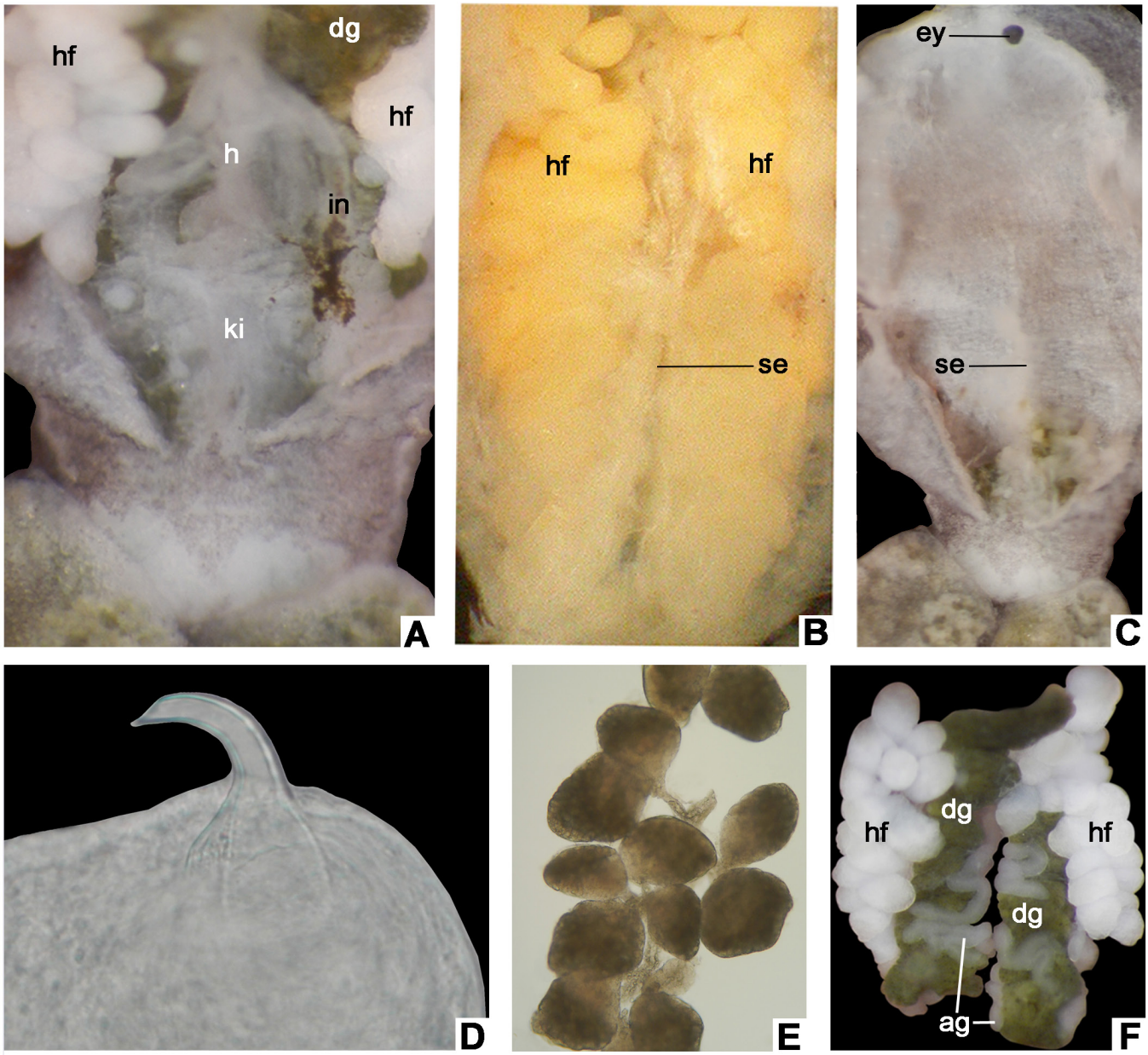

Fig. 4. Internal organs of *Swennenia jabae*. A, pericardium; B, dorsal view of the body with the skin removed to show the hermaphrodite follicles and septum; C, dorsal view with the skin and internal organs removed to show the septum; D, penial style; E, hermaphrodite follicles; F, position of digestive gland, hermaphrodite follicles, and albumen gland. Abbreviations: ag, albumen gland; dg, digestive gland; ey, eye; h, heart; hf, hermaphrodite follicles; in, intestine; ki, kidney; se, septum.

Live colouration. Slug translucent yellow with a small fine patch of light brown pigment on the frontal part of the head, and a large dark brown to black transverse patch over the head, with frontal open areas for the eyes, that extend longitudinally along the lateral sides of the notum. There is a similarly coloured longitudinal band over the central part of the notum up to the posterior end where it merges with the lateral bands. The cerata also bear a dark band on the dorsal side. Dark green digestive gland discernible under the skin of the body, along the body to the tips of the cerata (Fig. 2).

External characteristics. Slender, rather flat, smooth slug. Total length, including cerata, up to 10 mm (adult specimens 6–10 mm). Body length about 3–4 times its width. Head with a small velum, without rhinophores or oral tentacles. Posterior end blunt, with two cerata maintained in the rearward-facing position as extensions of the body. The cerata, typically with a length that is around or more than half of the body, are rather stiff, slightly contractible and have blunt tips (Figs. 2, 3A, 5).

Anus on the dorsum, right of the pericardium. Renal pore on the left side of the pericardium. Genital apertures triaulic, with penal just behind and positioned much lower than the right eye, oviducal shortly posterior of the penal, and vaginal aperture more posterior and more dorsal in position than oviducal (Fig. 3A).

Internal characteristics. Eyes nearly spherical, with clear lens (Fig. 3C). In a large specimen (total length of body with cerata 9.8 mm) eye height 100 µm, width 95 µm; in a small specimen (total length 6.5 mm) eye height 63 µm,

width 60 µm. Oral tube below the eyes. Pharynx situated just posterior of the eyes, slender, length 242 µm, height 133 µm (Fig. 3B). Radula with 6 teeth in ascending and 5 teeth in descending row, about 20 partly broken teeth in ascus (Fig. 3B). Teeth length 75–86 µm, basal parts 34–49 µm with large articulation knobs (Fig. 3E).

Oesophagus goes straight to the stomach, from which the green digestive gland branches on both lateral sides, both further branching in the anterior and posterior directions, the latter to the posteriormost end of the body where they go via a constriction that is not green, into a ceras where the branch widens and is green again (Fig. 3F). The intestine runs from the dorsal side of the stomach to the anus (Fig. 3F). Heart and kidney in posterior half of body, anterior of anus (Fig. 4A).

Reproductive system. The hermaphrodite follicles are in the posterior part of the body on both sides with an open area in between (Fig. 4B, F). It may locally have a partial septum (Fig. 4B, C). The specimen examined has 52 follicles (Fig. 4E, F) with a mean length of 225.9 ± 16.4 µm (194–245 µm) and mean width of 160.1 ± 27.0 µm (111–199 µm). Hermaphrodite ductules unite into a main duct, a widening or ampulla is not noted. The duct splits into a short oviduct and vas deferens. The vas deferens receive the prostate duct shortly after the split. The duct is connected with two large prostate glands each consisting of two parts, the part connected with the duct has small, pale globules and the distal part has large, white globules (Fig. 3G). The penis has a small, curved spine with a width at the tip of about 3 µm (Figs. 3D, 4D). Short oviduct goes to the central canal that receives the albumen duct which is connected with the branches of the albumen gland (Fig. 4F), which closely join the distal branches of the digestive gland that extends from the stomach into both cerata.

The vagina opens via a narrow tube, enters a seminal receptacle and goes into the central canal (Fig. 3G). In this area an indeterminate gland was found, but for which the connection could not be established. A genital receptacle originates from the central canal. The other female glands (capsule and mucus glands) could not be separated. They envelop the central reproductive organs and connect with the oviducal aperture.

Ecology and biology. Based on collections thus far, this small slug seems to be restricted to areas in the mangroves that are only occasionally inundated during the highest tides at certain times of the year. Hence, they appear to be capable of long periods of dormancy, hiding most of the time inside stiff clayey mud. Their apparent association with the algae *Boodleopsis* cf. *pusilla*, suggest that it is possibly their primary food source. In the field no specimens were seen in the open during low tide. It is not known if the animals only appear when the ground is submersed or wet during high tides.

The two specimens kept for observations did not hide and were seen seemingly sucking on the algal threads. Black

Fig. 5. Dorsal view of animal. A, faeces being expelled in thin strings from the anus (total length including cerata ca. 5.5 mm); B, animal with new ceras being regenerated (total length including cerata ca. 3 mm).

faecal matter was expelled in thin strings from the anus (Fig. 5A). In one individual that had lost a ceras during initial handling, the regeneration of the lost ceras is apparent after two days (Fig. 5B). Egg strings were produced overnight; the narrow strings found in a knot on the algae. Egg capsules were packed in single row, arranged spirally in the string (Fig. 6A, B). Fresh ova yellow, with one ovum per capsule, un-cleaved spherical ova with a mean diameter of 54 µm, SD ± 3 (N=8). Capsule size 120 ± 9 mm × 98 ± 8 mm (N=10). Veligers hatched after 4 days in a mean temperature of 28°C (Fig. 6C).

DISCUSSION

Swennenia jabae, new combination, looks somewhat similar to a *Limapontia*, but it can be easily distinguished by the

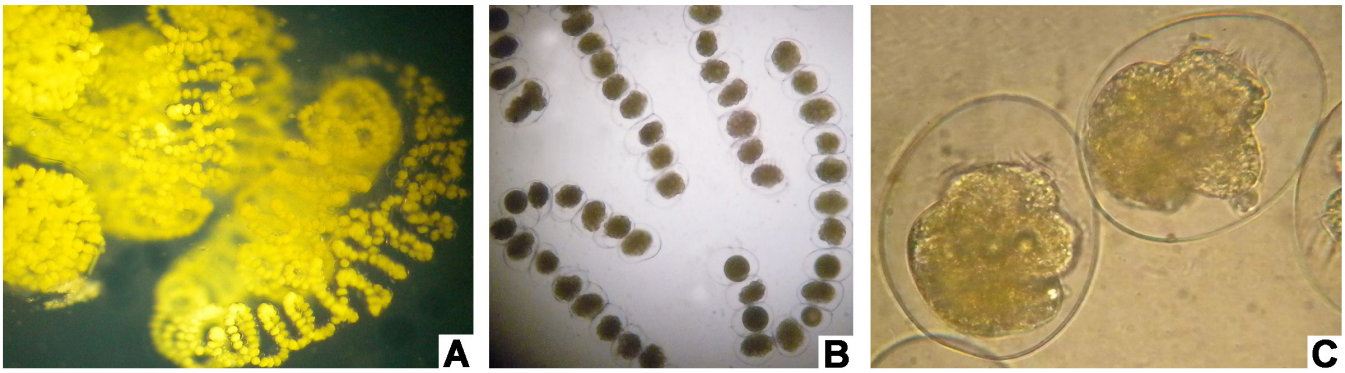

Fig. 6. Egg mass and embryos of *Swennenia jabae*. A, egg string; B, closer view of egg string showing individual capsules; C, veligers about to hatch on 4th day.

presence of a pair of caudal cerata while *Limapontia* has none. During our dissections it was found that there was no split visceral sack, and that it is a pair of real cerata. No tubular swellings on the oesophagus were found and it has a different shape of the pharynx with a clear protruding ascus, which is lacking in *Gascoignella* (see Jensen, 1985; Kohnert et al., 2013). Only in the posterior part was there an indication of a septum between the left and right branches of the posterior part of the digestive gland and the hermaphrodite follicles. These characters together with the reproductive organs and sabot-shaped teeth show similarities with the limapontiid genera *Alderia* Allman, 1845, *Ercolania* Trinchese, 1872, and *Limapontia* Johnston, 1836. The position of the anus, the vagina, and the digestive and reproductive systems are also similar to the aforementioned limapontiids (see e.g., Jensen, 1985, 1991, 1996). The seminal receptacle has a very short vaginal duct to the vaginal opening, and the penial style of *Swennenia jabae* does not seem to be of the penetrating type, but may come within the vaginal opening for sperm delivery.

Possibly because of its small size, cryptic habits and apparent rarity, *Swennenia jabae* has not been found or reported outside the Pattani area in Thailand. The species is rare even in the three sites in Pattani where they have been collected, and several collecting trips did not yield specimens. All specimens were found by taking clay with algae to the lab, and found by breaking the clay into small pieces to look for dormant slugs in sticky mucus. Cutting the small blocks of clay, to a depth of 2–8 cm, out of the ground under mangrove trees is easiest when the mud is rather dry. It has been noticed that the absence of algal threads under the surface means there is only Cyanophyta and no slugs, but mud overgrown with Cyanophyta does not appear to hinder the presence of slugs and algae. Occurrence of *Boodleopsis* is therefore always first checked by breaking a piece of clay for the presence of tiny algal threads in the cracks. Further surveys following our method of collection may eventually prove *Swennenia jabae* to be more widespread in and beyond the adjacent areas of the Gulf of Thailand.

ACKNOWLEDGEMENTS

The proposal of a new genus was originally mooted by the late Cornelis Swennen, and his contribution to this paper cannot be overstated. Besides the concept, some of his unpublished notes are included herein and he was the one who sent the specimen to Patrick J. Krug (California State University, Los Angeles) for molecular analysis, which further clarified the phylogenetic position of the species. We thank the reviewers for the comments and suggestions that improved the manuscript.

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