

RESEARCH ARTICLE

Redescription of *Asolene meta* (Caenogastropoda: Ampullariidae) from the São Francisco basin, Brazil

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ABSTRACT. Ampullariids are freshwater snails distributed widely in tropical and subtropical regions of Asia, Africa, and the Americas. *Asolene* d'Orbigny, 1838, *Felipponea* Dall, 1919, *Marisa* Gray, 1824, and *Pomacea* Perry, 1810 constitute the New World genera. Despite their importance and wide distribution, the species limits are still confusing, especially in less studied genera such as *Asolene*. The original description of *Asolene meta* (Ihering, 1915) was based on a single shell, from the municipality of Barra, state of Bahia, northeast Brazil, but provided few characteristics to reliably distinguish it from congeners. We redescribe *A. meta* based on topotypes and additional specimens from other localities of the São Francisco Basin, where this species is endemic. The combined characters of shell morphology (thick shell and wide and deep umbilicus), the respiratory siphon, and egg morphology (oviposition under water and non-calcareous eggs) confirmed *A. meta* as a valid species within *Asolene*. Key anatomical characters include, in males, a penis sheath with two accessory glands on the dorsal surface, one rugose apical and one smooth, a rounded internal basal gland, as well as one gland on the external basal surface; and in females, the pallial oviduct dominating the floor of the mantle cavity, a muscular, oval elongated seminal receptacle, two blind diverticula of the albumen gland and spiral lamellae on the capsule gland, embedded within a mass of parenchymal tissue, peach colored in live specimens. This is the first description of the internal anatomy of *A. meta*, the only species of the genus known to occur in northeast Brazil, extending from west of Bahia to Pernambuco.

KEYWORDS. Apple snail, conchology, morphology, taxonomy.

INTRODUCTION

Asolene d'Orbigny, 1838 belongs to Ampullariidae, freshwater snails distributed widely in tropical and subtropical regions of Asia, Africa, and the Americas. Along with three extant genera, *Felipponea* Dall, 1919, *Marisa* Gray, 1824, and *Pomacea* Perry, 1810, these constitute the New World clade, the more diverse of the two major lineages within the Ampullariidae (Hayes et al. 2009, 2015).

Ampullariids are often major constituents of native freshwater molluscan faunas and play important roles in food webs, as pathogen vectors, and as invasive agricultural pests when introduced (Cowie 2002, Strong et al. 2008, Joshi et al. 2017). However, a deep understanding of the various roles ampullariid species play in freshwater ecosystems is lacking because of persistent taxonomic confusion among the many species (Cazzaniga 2002, Hayes et al. 2012, Thiengo et al. 2017, Barbosa et al. 2022). Such confusion exists primari-

ly because the detailed morphology of most species is poorly known and their classification is still based solely on shell characters, which often exhibit considerable intraspecific variation (Cowie and Thiengo 2003, Thiengo et al. 2011, Cowie and Héros 2012, Cowie et al. 2015, 2017).

While several studies have focused on resolving some of this confusion among the more widespread species in *Pomacea* (Berthold 1991, Cowie and Thiengo 2003, Hayes et al. 2012, Barbosa et al. 2022, Ampuero and Ramirez 2023), less work has been done with the smaller and geographically restricted taxa in *Asolene*. Previous studies of *Asolene* spp. have examined a limited number of species individually and focused on shell characters and geographic distributions (e.g., Hylton-Scott 1958), internal anatomy (e.g., Tillier 1980), reproductive anatomy and egg characteristics (e.g., Bonetto and Ezcurra de Drago 1966, Martin 1984, 1987, 1988, Tiecher et al. 2013) and radulae (e.g., Martin and Negrete 2007). However, none has provided a full description of a single species within the context of a modern systematic framework such as that of Hayes et al. (2012).

Thiengo et al. (2011) reported seven South American species: *Asolene platae* (Maton, 1811), *A. pulchella* (Anton, 1838) and *A. spixii* (d'Orbigny, 1838) in northern Argentina, Uruguay, Paraguay, and southern Brazil; *A. crassa* (Swainson, 1823), *A. granulosa* (Sowerby, 1894) and *A. petiti* (Crosse, 1891) in Guyana, Suriname, French Guiana and northern Brazil and *A. meta* (Ihering, 1915) in northeastern Brazil.

However, the phylogenetic analysis of Hayes et al. (2009) and the preliminary morphological, anatomical, and genetic work of Léon et al. (2018) suggest that *A. platae* and *A. pulchella* may be conspecific. The need for taxonomic clarity is increased by the presence of several ampullariids, including *Asolene* spp., in the aquarium trade, which creates a high potential for inadvertent introduction outside of their native range (Smith 2006). Without a clear understanding of species identities, many introductions may go unnoticed, or remain difficult to control (Hayes et al. 2008).

Here we present an anatomical description of *Asolene meta*, based on topotypes and specimens from other localities throughout the São Francisco River Basin, Brazil, as the original description (Ihering 1915) was based on a single shell and did not include any anatomical information. In addition, we present a preliminary phylogenetic analysis of species of *Asolene*.

MATERIAL AND METHODS

Specimens examined include material deposited in the Coleção de Moluscos do Instituto Oswaldo Cruz (CMIOC; Mollusc Collection of the Institute Oswaldo Cruz, Rio de Janeiro, Brazil) and the Museu Nacional da Universidade Federal do Rio de Janeiro (MNRJ; National Museum of the Federal University of Rio de Janeiro, Rio de Janeiro, Brazil) (Table 1).

Seventy-seven specimens identified a priori by their shell characteristics as *A. meta* were collected in northeast Brazil from November 2006 to October 2012, including from the type locality, Barra, state of Bahia (Fig. 1). The snails were first relaxed in 0.06% Hypnol (Cristália, Brazil), removed from their shells and a piece of foot tissue was taken from each snail and stored in 96% ethanol for subsequent DNA extraction. The soft bodies were preserved in Railliet-Henry's fixative (2% acetic acid, 5% formol, 0.6% NaCl) for analysis of gross anatomy, or Millonig Formalin (Carlson et al. 1973) for histological study of the penial sheath and oviduct. Specimens collected in Juazeiro and Casa Nova were heat-shocked to kill them prior to removal from the shell (Fukuda et al. 2008). All specimens analyzed are deposited in the CMIOC (Table 1).

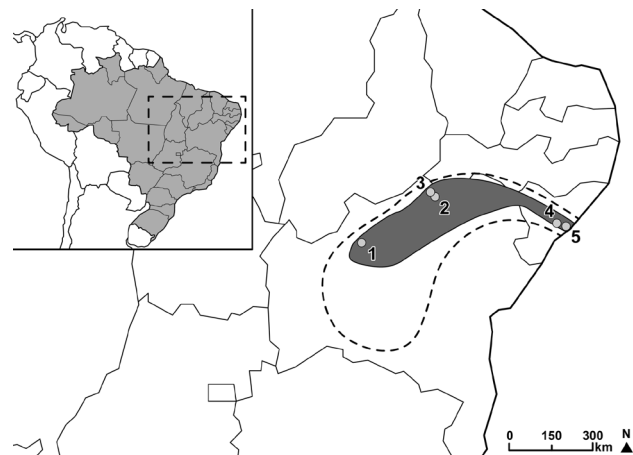


Figure 1. Distribution of *Asolene meta*, with Brazil inset. Shaded area: range determined from sample site data; dashed line: range inferred based on habitat similarities. 1: Barra (Bahia); 2: Juazeiro (Bahia); 3: Casa Nova (Bahia); 4: Propriá (Sergipe); 5: Penedo (Alagoas).

Shells and opercula of 39 adult specimens were measured using a digital caliper (Fig. 2). For gross anatomy, the specimens were examined using a binocular microscope with camera lucida, and structural details were visualized with the aid of aqueous toluidine blue.

For histology of the reproductive structures, the penial sheath of three males and the pallial oviduct of three females were dehydrated in ethanol and embedded in paraplast, sectioned at 5 μ m, and stained with haematoxylin-eosin.

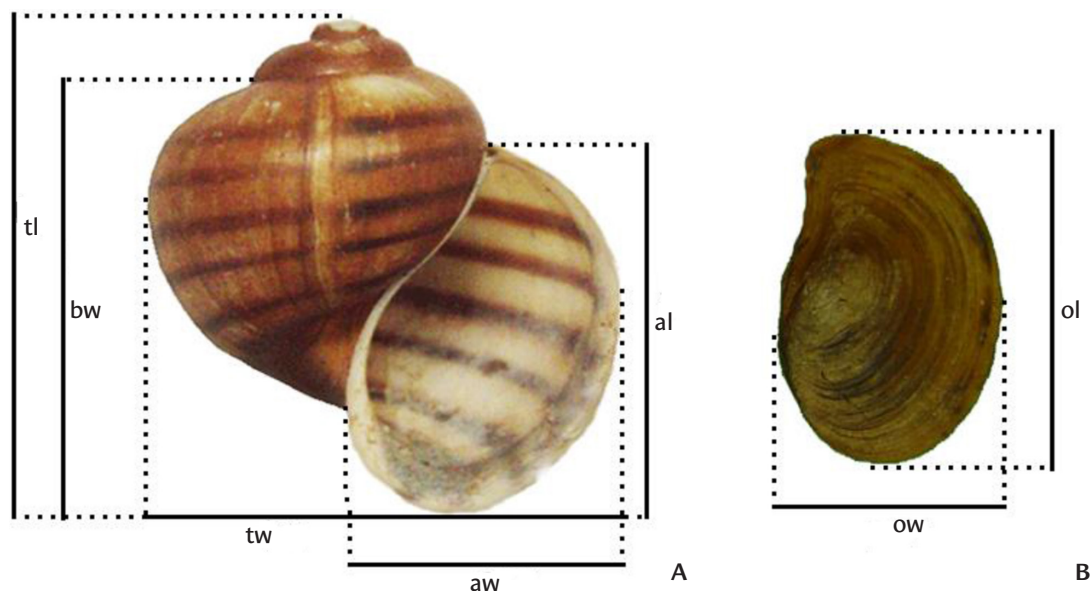


Figure 2. Shell (A) and operculum (B) measurements. (al) Aperture length, (aw) aperture width, (bw) body whorl, (ol) operculum length, (ow) operculum width, (tl) total length, (tw) total width.

Table 1. *Asolene meta* material examined from Brazil.

Site and state	Geographic coordinates	CMIOC catalog number	Number of specimens	GenBank accession number	Traits examined
Barra (Bahia, type locality)	S10°50'50.9" W43°13'49.3"	CMIOC 7742	39	PP110229	S, EA, M, F, K, PE, R
Juazeiro (Bahia)	S09°18'50.2" W40°50'30.6"	CMIOC 7743	10	–	EA, M, F, K,
Casa Nova (Bahia)	S09°10'57.4" W40°58'04.2"	CMIOC 7744	10	–	EA, M, F, K
Propriá (Sergipe)	S10°11'14.7" W36°50'53.1"	CMIOC 5837 MNRJ 15463	5	–	M, K
Penedo (Alagoas)	S10°17'59.7" W36°35'02.2"	CMIOC 5838	13	–	M, K, PE

(S) Shell, (EA) external anatomy, (K) kidney, (M) male reproductive system, (F) female reproductive system, (PE) pericardium, (R) radulae.

For radula analysis, six individuals were dissected, and the radulae were extracted and prepared following Hayes et al. (2012). For ultrastructural analysis the samples were mounted on aluminum stubs, coated with a 20 nm layer of gold, and examined under a scanning electron microscope at 15 kV voltage (Jeol JSM 6390LV) at the Rudolf Barth Electron Microscopy Platform at the Institute Oswaldo Cruz.

Total genomic DNA (gDNA) was extracted from approximately 3 mm³ of foot tissue of four specimens of *A. meta* using the DNeasy Blood and Tissue kit (Qiagen) following Hayes et al. (2008).

A fragment of the mitochondrial cytochrome c oxidase subunit I gene (COI, ~700 bp) was amplified by the universal metazoan primers LCO1490 and HCO2198 (Folmer et al. 1994). Amplifications and the cycling parameters followed Hayes et al. (2009). The amplicons were subject to cycle sequencing in both directions with the BigDye Terminator

v3.1 Cycle Sequencing kit (Applied Biosystems) and analyzed via capillary electrophoresis on the ABI 3730XL (Applied Biosystems) at the sequencing facility of the Fiocruz Technological Platform Network.

Contigs were assembled, examined for errors and ambiguities, and edited manually in Geneious Prime 2023.0.4 (<http://www.geneious.com>). Consensus sequences from *Asolene meta* and other species of *Asolene*, as well as *Marisa*, *Pomacea*, and *Felipponea* were retrieved from GenBank and aligned using the MUSCLE plugin (Edgar 2004) in Geneious Prime 2023.0.4.

Phylogenetic relationships were reconstructed using Maximum-Likelihood (ML) in PhyML 3.0 (Guindon et al. 2010) and Bayesian Inference (BI) in MrBayes 3.2 (Ronquist et al. 2012). The best-fit nucleotide substitution model for both was selected via the Bayesian Information Criterion (BIC) estimated using Smart Model Selection (SMS, Lefort

et al. 2017) for ML and jModelTest v2.1.10 (Darriba et al. 2012) for BI. Node support was determined by the bootstrap (BS) over 1,000 resamplings for ML and by the posterior Bayesian probabilities (BPP) for BI. For the BI, the trees were sampled after manually removing the first 20% of trees as burn-in and the effective sample size estimates of truly independent samples were determined using the Tracer software, v. 1.7 (Rambaut et al. 2018) and were > 200, as is typical in phylogenetic analyses, indicating robustness of the sampling (Lanfear et al. 2016); and both trees were visualized in FigTree 1.4.4 (Rambaut 2012).

The software Molecular Evolutionary Genetics Analysis version 11 (MEGA, Tamura et al. 2021) was used to calculate Kimura-2-parameter (K2P, Kimura 1980) inter-specific genetic distances, and the application DeSigNate (Hütter et al. 2020) was used to detect the signature molecular characters and their positions diagnostic for each species.

TAXONOMY

Asolene d'Orbigny, 1838

Type species. *Helix platata* Maton, 1811, by subsequent designation of Gray (1847: 148).

Asolene d'Orbigny, 1838 [in 1835–1847]: 364.

Ampulloidea d'Orbigny, 1841 [in 1835–1847]: 379. New name for *Asolene*.

Ampulloides d'Orbigny, 1842 [in 1842–1853]: 1. Incorrect spelling of *Ampulloidea d'Orbigny*, 1841.

Asolena Herrmannsen, 1846: 84. Incorrect spelling of *Asolene d'Orbigny*, 1838.

Ampullaroides Gray, 1847: 148. Incorrect spelling of *Ampulloidea d'Orbigny*, 1841.

Asolene meta (Ihering, 1915)

Figs 3–10

Ampullaria meta Ihering, 1915: 12, figs 6, 7.

Pomacea meta (Ihering, 1915), Cowie and Thiengo 2003: 69.

Pomacea meta (Ihering, 1915), Simone 2006: 55, fig. 2.

Asolene meta (Ihering, 1915), Schilithz et al. 2013: 288.

Holotype: MNRJ 12861 (Fig. 3A).

Type locality: Barra, Bahia State, Brazil (Ihering 1915).

Description. Shell: Shell globose, thick, yellowish to brown with dark brown spiral bands variable in number and thickness, when present (Fig. 3). Ranging in size from 23 to 32 mm in adult shell height and 26 to 35 mm in adult shell width. Periostracum thick and yellowish. Shell comprising three to four rounded whorls, increasing rapidly in size. Spire low, with ratio of spire height to overall shell height ranging from 0.05 to 0.15; apex usually eroded. Body whorl rounded, ranging in height from 22 to 29 mm. Umbilicus deep and wide. Aperture oval, ranging in size from 10 to

23 mm in height and from 12 to 17 mm in width; inside of shell lip usually white.

Operculum: Operculum corneous with concentric nucleus, thick, less flexible than that of *Pomacea canaliculata* (Lamarck, 1822), dark brown, tightly sealing aperture (Fig. 4); ranging in size from 14 to 20 mm in height and from 10 to 13 mm in width.

Radula: Radula taenioglossate, 3 to 6 mm long, 1 to 2 mm wide, with a mean of 32 rows (Fig. 5A–B). Rachidian rectangular with a concave base and lateral edges and apex convex, one prominent, sharply pointed, triangular central cusp, bounded by three to four minors sharply pointed, triangular denticles on each side (Fig. 5C). Lateral teeth with a long base, with four triangulate sharply pointed cusps, one major and three minor (Fig. 5D). Marginal teeth elongated with two sharply pointed cusps, one major and one minor (Fig. 5E).

Reno-pericardial system: Pericardium small, bounding base of mantle cavity at left. Auricle oval anterodorsal to ventricle, with thin walls; two veins, the branchial-pulmonary efferent vein and the efferent renal vein; connected to ventricle through atrioventricular valve. Ventricle quadrangular, larger than the auricle and denser; connected to bulbous aorta, which splits forming the anterior and posterior aortae. Ampulla voluminous, oval elongated, extending along floor of pericardial cavity (Fig. 6B). Siphon approximately half the size compared to *Pomacea* species, formed by two folds, the left end connects to the right end, thus forming an extendable cylindrical tube (Fig. 6B). Osphradium (Fig. 6A, C) anterior to lung and posterior to siphon, elongate oval, stalked, with bipectinate ridges on its anterior portion, following a single central crest with longitudinal ridges. Kidney formed by two interconnected chambers, anterior and posterior (Fig. 6D), communicating via small aperture at anterior left of posterior chamber. Anterior chamber located at mantle roof below ctenidium, dense, wider than long, with rounded borders, smaller than posterior chamber; excretory tissue forming two unequal sets of lamellae occupying entire lumen, regularly arranged transversely on both sides of anterior afferent renal vein; posterior set of lamellae overhanging broad nephropore. Nephridial gland absent. Posterior chamber located superficially on visceral mass, above sets of loops of intestine, elongate, larger and thinner than anterior chamber; internal lamellae spaced irregularly along two branches of two major veins, the renal afferent vein and posterior renal efferent vein; posterior afferent renal vein longer than the anterior afferent renal vein, following the central region of the posterior chamber with numerous branches along its length; efferent renal vein

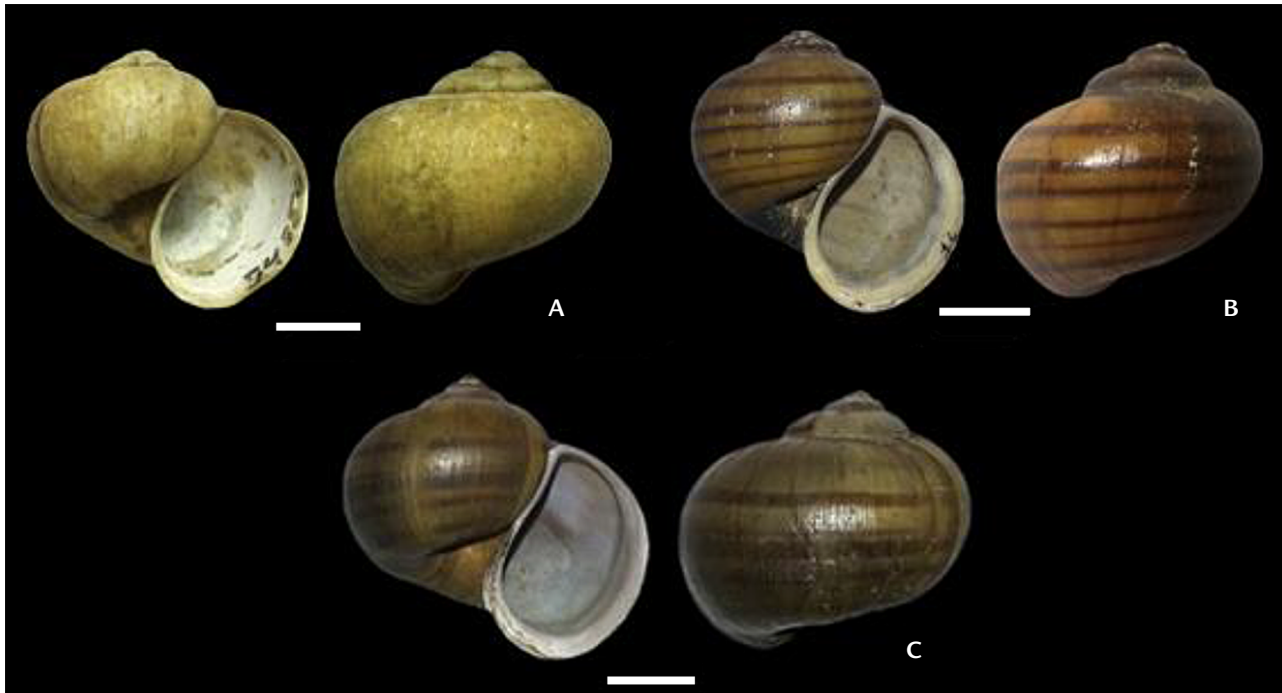


Figure 3. Shells of *Asolene meta*: (A) Holotype (MNRJ 12861), (B) shell from Penedo, Alagoas, Brazil (CMIOC 5838), (C) shell from Barra, Bahia, Brazil (CMIOC 7742). Scale bars: 10 mm.



Figure 4. Operculum of *Asolene meta* from Barra, state of Bahia, Brazil: (A) male, (B) female. Scale bar: 5 mm.

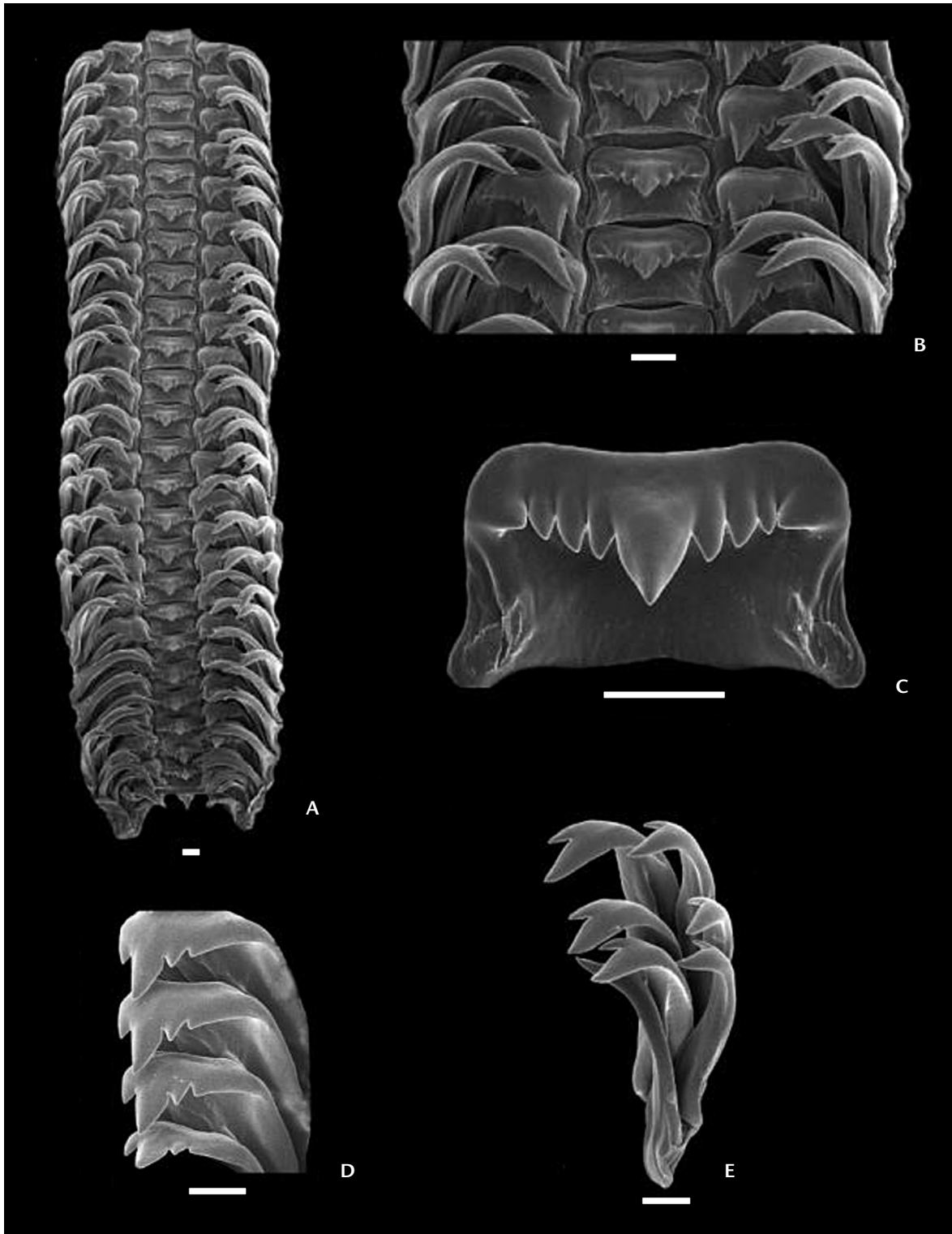


Figure 5. Radular morphology of *Asolene meta*: (A, B) radula, (C) rachidian tooth, (D) lateral teeth, (E) marginal teeth. Scale bars: 100 μ m.

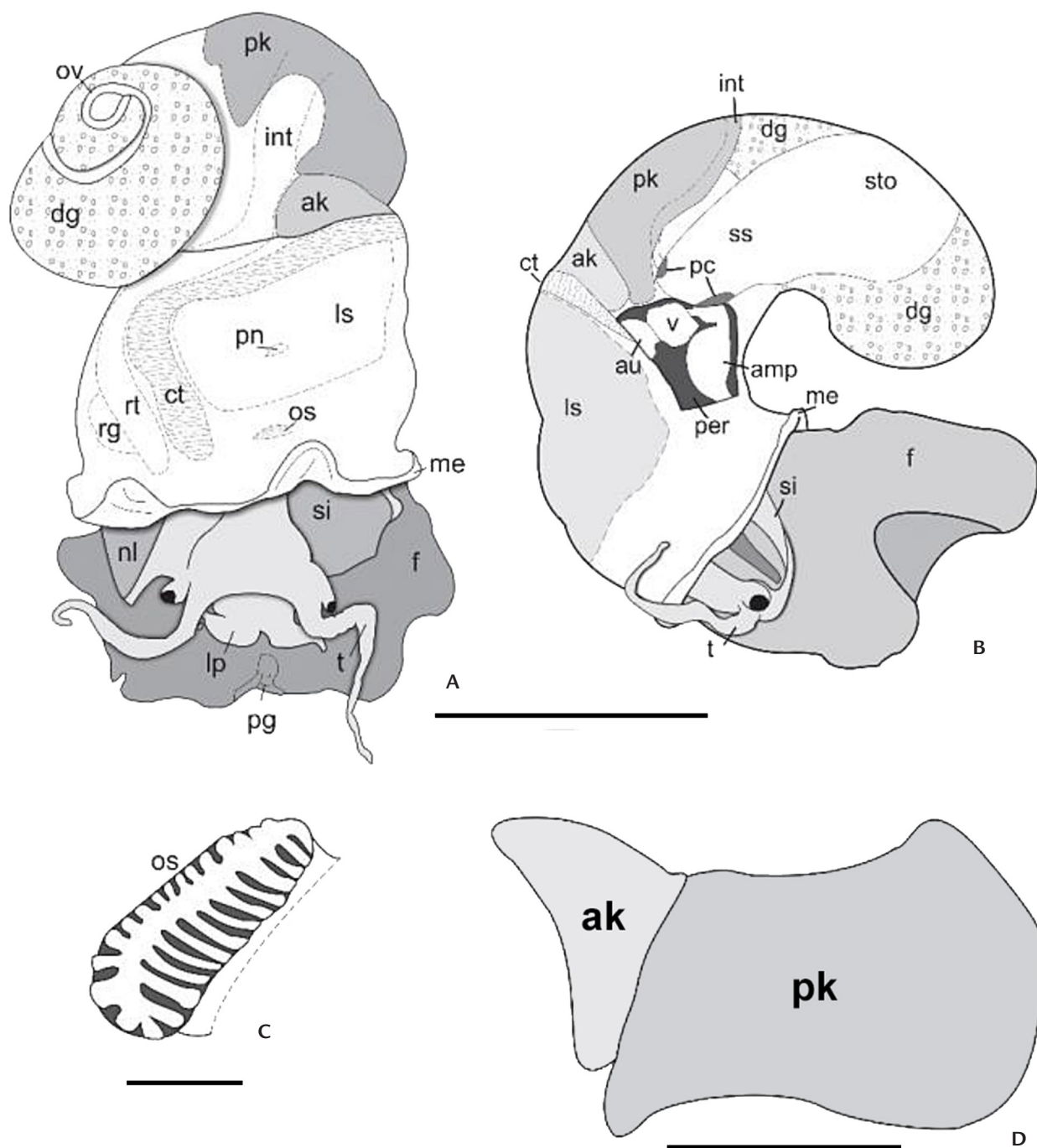


Figure 6. External morphology of *Asolene meta*: (A) dorsal view, (B) left side view, (C) osphradium, (D) kidney. (ak) Anterior kidney, (amp) ampulla, (au) auricle, (cm) columellar muscle, (ct) ctenidium, (dg) digestive gland, (f) foot, (int) intestine, (lp) labial palp, (ls) lung sac, (me) mantle edge, (nl) nuchal lobe, (ov) ovary, (os) osphradium, (pc) pyloric caecae, (per) pericardium, (pg) pedal gland, (pk) posterior kidney, (pn) pneumostome, (rg) rectal gland, (rt) rectum, (si) siphon, (ss) style sac, (sto) stomach, (t) tentacle, (v) ventricle. Scale bars: 10 mm (A, B), 1 mm (C), 5 mm (D).

along left of posterior afferent renal vein, subdivided into numerous branches.

Reproductive system (male): Testis voluminous, cream colored, occupying the anterior three whorls of the spire, surrounding digestive gland; thin vas deferens emerging ventrally from testis, continuing along ventral midline of whorl, until entering the rounded seminal vesicle at base of mantle cavity; seminal vesicle separated from the prostate by a small constriction; prostate cylindrical and compact, following along the rectum on the right side of the mantle cavity;

anterior end of prostate crossing over rectum, connecting to rounded, muscular penis bulb; wall of penis bulb thinning anteriorly, forming thin-walled penis pouch at right of penis bulb, containing the coiled, whip-like penis when retracted; penis pouch opening to medial channel on the dorsal surface of penis sheath, allowing passage of penis during copulation (Fig. 7A). Penis long and cylindrical with the diameter gradually decreasing from the base to the apex, formed by a simple epithelium with cubic cells and an extensive layer of muscular fibers; spermatic channel closed (Fig. 7B–D). Penis

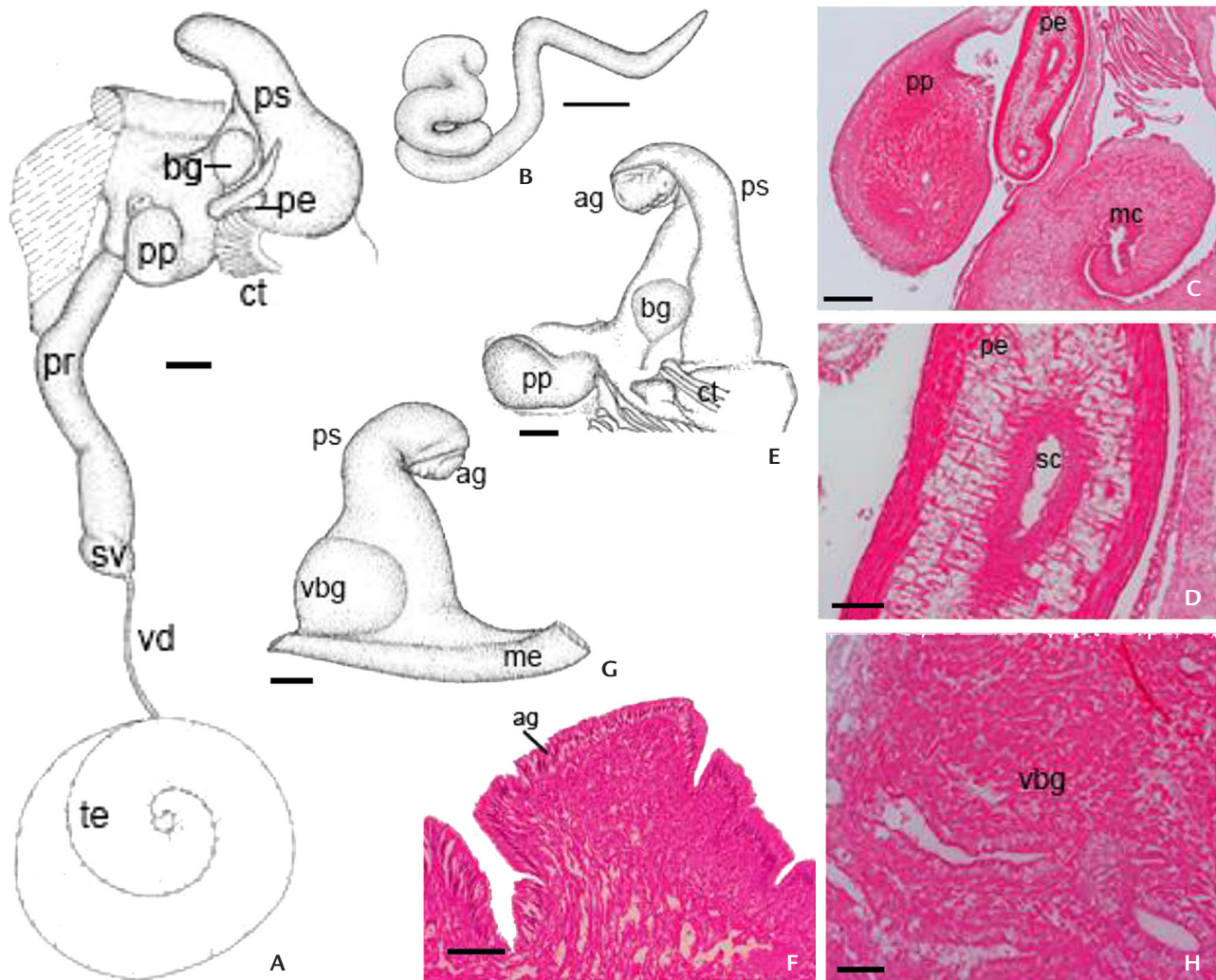


Figure 7. Male reproductive morphology of *Asolene meta*: (A) overall system, (B) penis, (C, D) penis histology, (E) penis sheath ventral view, (F) apical penis sheath gland, (G) penis sheath dorsal view, (H) ventral basal gland. (ag) Apical gland, (bg) basal gland, (ct) ctenidium, (me) mantle edge, (mc) medial channel, (pe) penis, (pp) penis pouch, (pr) prostate, (ps) penis sheath, (sc) spermatic channel, (sv) seminal vesicle, (te) testis, (vd) vas deferens, (vbg) ventral basal gland. Scale bars: 10 mm (A), 1 mm (B), 500 µm (C), 100 µm (D, F, H), 1 mm (E, G).

sheath curved to the right, broad-based with width decreasing gradually from base to apex; medial channel at ventral surface of penis sheath, formed by two folds, the left overlapping the right one, starting at base of penis sheath and extending to almost the apical gland; penis sheath with two accessory glands on ventral surface—one apical and one basal—and one gland on dorsal surface; apical gland with rugose surface formed by tall, prismatic epithelium cells, occupying distal one quarter of penis sheath ventral surface (Fig. 7E, F); internal basal gland, smooth and rounded, at right side of penis sheath near medial channel; basal dorsal gland occupying proximal third of sheath base (Fig. 7G), formed by conjunctive tissue consisting of rounded to oval cells, numerous ducts and a central duct, surrounded by acini, single pore opening externally (Fig. 7H).

Reproductive system (female): Ovary arborescent occupying similar position to the testis in males, formed by numerous diverticula embedded in the digestive gland; diverticula connected to one another, forming three to four branches that merge into the thin visceral oviduct, extending through the floor of mantle cavity, connecting to seminal receptacle. Pallial oviduct dominating floor of mantle cavity, comprising muscular, oval elongated seminal receptacle, two blind diverticula of albumen gland and spiral lamellae of capsule gland, embedded within a mass of parenchymal tissue, peach colored in live specimens (Fig. 8A–D); copulatory bursa lacking; seminal receptacle lies transversely to pallial oviduct, exposed at the surface of parenchymal mass, with highly convoluted lumen bearing orientated sperm (Fig. 8D); posterior end of seminal receptacle abruptly turning to left into a thin channel; albumen gland flattened forming two concave diverticula extending around periphery, one diverticulum anterodorsally at left and the other posteriorly at right, forming a U-shaped curve to connect to capsule gland; capsule gland completing three revolutions coiling counter-clockwise, doubling back and completing four clockwise revolutions, with three of these emerging from parenchymal tissue, to connect with elongate, voluminous vagina; vagina narrowing anteriorly, communicating to mantle cavity via small opening adjacent to rectum (Fig. 8A).

Eggs: Eggs non calcareous, rounded, unpigmented, becoming more translucent before hatching, allowing visualization of juveniles inside eggs; laid under water, on submerged vegetation embedded in gelatinous mass (Fig. 9); one clutch of 72 eggs was recovered in the laboratory; eggs 3.5 to 4.0 mm in diameter; 44 juveniles hatched approximately nine days after clutch was laid.

Biogeography: *Asolene meta* is native to northeast Brazil, in the Rio São Francisco Basin, from west of Bahia

to Pernambuco. We expect that its range may extend southwest of Bahia (Fig. 1).

Phylogenetic analysis: The topologies of the ML and BI trees are almost identical. We choose to show the ML tree, on which the BPP values are included for those clades recovered in both phylogenies (Fig. 10). The COI gene was sequenced from four individuals from the type locality of *A. meta*, which were identical and for this reason, we chose to use one of them for this study. The complete matrix included 18 sequences from eight species and lengths from 573 to 657 bp including missing data. Both phylogenetic trees recovered *A. meta* in a well-resolved and strongly supported clade of other *Asolene* species (Fig. 10). However, in the BI phylogeny a single specific sister species to *A. meta* was not recovered, while in the ML tree a clade of *A. platae* and *A. pulchella* with low support was recovered as sister to *A. meta*, with low node support for the three-species clade. The complete alignment contained 120 parsimoniously informative sites, including 51 between *A. meta* and *A. platae-pulchella*, 31 between *A. meta* and *A. spixii*, and 39 between *A. spixii* and *A. platae-pulchella*. This entire *Asolene* clade was sister to *Felipponea iheringi* (Pilsbry, 1933). The mean K2P interspecific distance between *A. meta* and *A. spixii* was $5.38 \pm 0.29\%$ (5.18–5.88%) and $7.02 \pm 0.51\%$ (6.12–7.93%) between *A. meta* and *A. platae-pulchella*. We detected through the DeSigNate analysis 15 binary and 1 asymmetric molecular character between *A. meta* and *A. platae-pulchella/A. spixii* (Table 2).

Table 2. The 15 binary and 1* asymmetric molecular diagnostic characters for *Asolene meta* and *Asolene pulchella-platae/Asolene spixii* determined by DeSigNate.

Sequence position	<i>Asolene meta</i>	<i>Asolene pulchella-platae/Asolene spixii</i>
30	G	A
33	A	G
49	T	C
66	G	A
87	G	A
171	G	A
189	G	A
252	A	G
293	G	C
297	C	T
300	C	T
426	C	T
462	C	T
474	C	T
519	G	A
363*	C	A/G



Figure 8. Female reproductive morphology of *Asolene meta*: (A) overall system, (B) pallial oviduct dorsal view, (C) pallial oviduct ventral view, (D) histology of seminal receptacle. (agl) Albumen gland, (cgl) capsule gland, (ct) ctenidium, (ls) lung sac, (me) mantle edge, (pa) parenchymal tissue, (po) pallial oviduct, (sr) seminal receptacle, (ova) ovary, (va) vagina, (vo) visceral oviduct. Scale bars: 1 mm (A), 5 mm (B, C), 20 µm (D).

DISCUSSION

Asolene meta was first described by Ihering (1915) in *Ampullaria* Lamarck, 1799, often used at that time in the literature to refer to species now placed in *Pomacea*, although *Ampullaria* is in fact a junior objective synonym of *Pila* Röding, 1798 (Cowie 1997, ICZN 1999, Cowie and Thiengo

2003), an Old World genus of Ampullariidae. Our analysis showed that *A. meta* formed a monophyletic group with the other *Asolene* species, as a distinct species. In addition, there were clear molecular diagnostic characters and the genetic K2P distances were high, reaching values similar to that between the sister species *Pomacea sordida* (Swainson, 1823) and *Pomacea intermedia* (Férussac in Quoy & Gaimard,

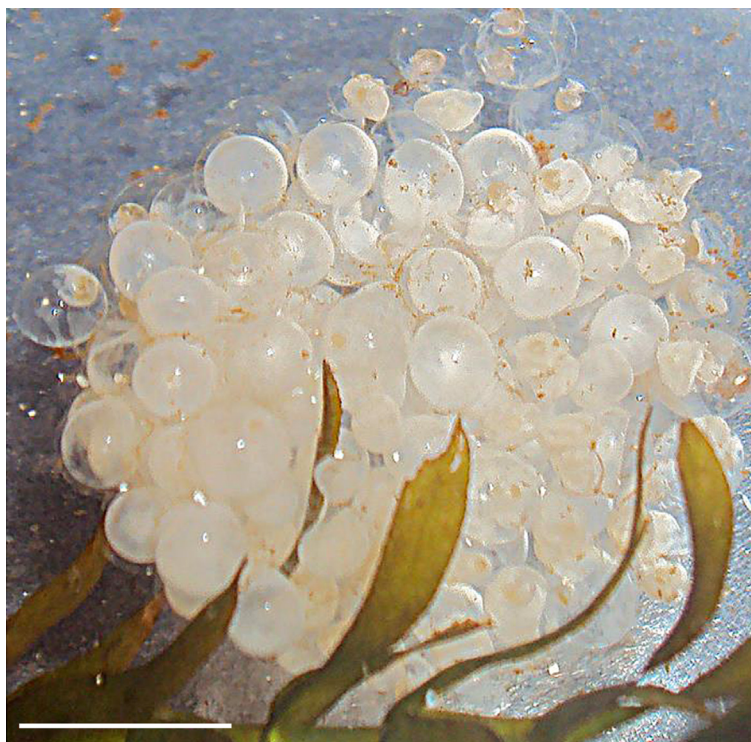


Figure 9. Egg mass of *Asolene meta* laid in the laboratory by an adult snail from Barra, state of Bahia, Brazil. Scale bar: 10 mm.

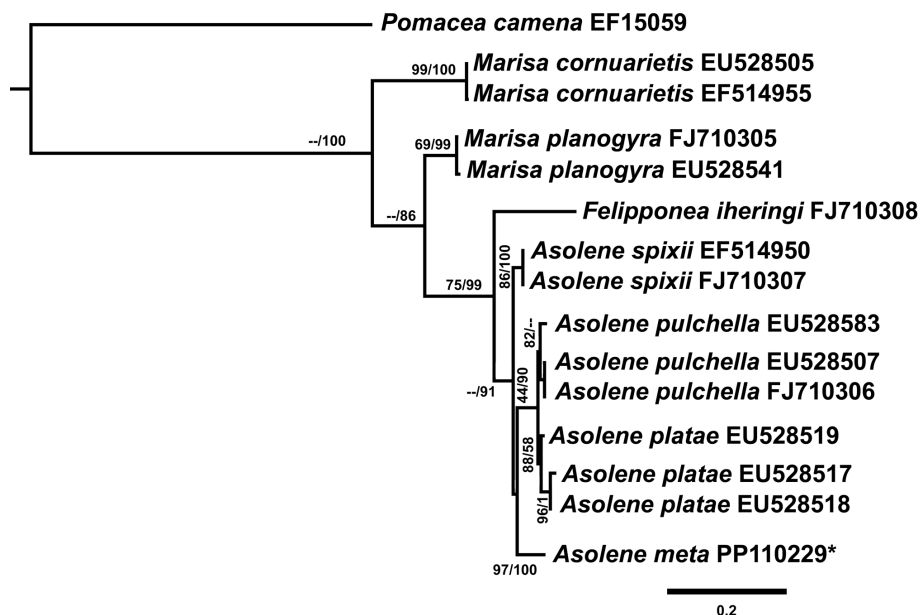


Figure 10. Phylogenetic tree obtained from Maximum likelihood topology for New World genera of Ampullariidae using the MT-COI gene demonstrating the position of *Asolene meta* among *Asolene* species. Sequences from *Asolene meta* were obtained in this study and all the other sequences were retrieved from GenBank. Node values are bootstrap (BS) from the Maximum likelihood analysis and Bayesian Posterior Probability (BPP) from the Bayesian inference analysis. *MT-COI sequence generated from the sample from this study.

1825) (Barbosa et al. 2022), as well as only slightly less than that between the clearly distinct species *Pomacea maculata* Perry, 1810 and *P. canaliculata* (Hayes et al. 2012). Based on shell morphology (thick shell and wide and deep umbilicus), the lack of sexual dimorphism in shell shape, the shape of the kidney, the ampulla, only slightly extensible respiratory siphon and egg morphology (oviposition under water and non-calcareous eggs), all previously described as characteristics of *Asolene* (Thiele 1929, Hylton-Scott 1958, Tillier 1980, Thiengo 1995), we confirm the generic placement of *A. meta* in *Asolene* previously reported by Schilithz et al. (2013).

Radula morphology of *A. meta* exhibited no intraspecific variation. Comparatively, it seems similar to that of *A. platae*, studied by Martin and Negrete (2007), who proposed that radula characters can be used to differentiate species of *Pomacea* and to distinguish them from species of the other genera studied, *Asolene* and *Felipponea*. Hayes et al. (2012) suggested that the base of the rachidian tooth differed between *P. maculata* and *P. canaliculata*. However, the apparent similarity between *A. meta* and *A. platae* suggests a lack of interspecific radula variation within *Asolene*. Additional comparative studies are needed to investigate these possible patterns.

The shape of the penis sheath and position of the associated glands of *A. meta* are very similar to those of *A. platae* (Martin 1984), *A. granulosa*, and *A. crassa* (Tillier 1980), although the shape of the glands on the dorsal surface appears to differ among these species. Further comparative studies are needed to verify the variation in penis sheaths among *Asolene* species and its taxonomic value both within *Asolene* and between *Asolene* and other ampullariid genera.

As for the female morphology, *A. meta* lacked the copulatory bursa seen in *P. maculata* and *P. canaliculata* (Hayes et al. 2012). A similar condition in *A. meta* has been observed in *A. spixii* and *A. platae* (K.A. Hayes personal communication), suggesting that this condition may be shared among *Asolene* species.

The eggs of *A. meta* are rounded, non-calcareous, unpigmented, and deposited under water in a gelatinous mass. They are similar to those of *A. platae*, which differ only in being yellowish rather than unpigmented (Tiecher et al. 2013, *A. platae* misidentified as *A. pulchella*). However, this information for *A. pulchella* may refer to *A. platae*, as *A. platae* and *A. pulchella* may be conspecific, based on the analyses of Hayes et al. (2009), and on the preliminary work of Léon et al. (2018). However, the taxonomic differentiation of *A. platae* and *A. pulchella* and the identification of a single sister species for *A. meta* are beyond of the scope of the present study.

Asolene meta is restricted to the São Francisco basin and is the only species of *Asolene* known to occur in north-east Brazil. The São Francisco basin occupies an area of 639 km², divided into four regions: Upper, Middle, Submiddle and Lower São Francisco, distinct ecologically and biogeographically (cbhsaofrancisco.org.br). We found *A. meta* in the Submiddle and Lower São Francisco, but based on the geographic similarities, we expect it to occur in the Middle São Francisco, southwest of Bahia.

This is the first anatomical description of *Asolene meta* and additional comparative studies with congeneric species are needed in order to expand taxonomic knowledge of the genus and of Neotropical ampullariids in general.

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