THE VELIGER

The Veliger 35(1):64–69 (January 2, 1992)

Simulathena papuensis, a New Planaxid Genus and Species from the Indo-West Pacific

by

RICHARD S. HOUBRICK

Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560, USA

Abstract. ***Simulathena papuensis***, sp. nov., is monotypic, has a plain, thin littorinid-like shell with a large aperture and wide shallow anterior canal, and is sculptured with weak spiral incised lines. The periostracum is moderately thick and the lenticular operculum with terminal nucleus is typical of planaxids. The taenioglossate radula is very similar to those of three planaxid genera and also resembles that of *Fossarus*. A large, extensive subhemocoelic brood pouch of ectodermal origin fills the headfoot, extending anteriorly into the head. A pair of mantle papillae extends from the exhalant siphon. The osphradium is widely separated from the broad, shallow ctenidium. Brooded embryos with large shells hatch from the brood pouch as juvenile snails. ***Simulathena*** is the sister group of the *Hinea, Holcostoma, Supplanaxis* clade, which also includes the Fossarinae.

INTRODUCTION

Study of an unidentified, marine intertidal prosobranch from Yule Island, Papua New Guinea, has revealed a new genus and species of the planaxid group. The family Planaxidae Gray, 1850, a relatively small group of taxa, was reviewed by HOUBRICK (1987) and was thought to comprise six genera and about 20 species throughout the world. HOUBRICK (1990) subsequently allocated *Fossarus* Philippi, 1841, under the subfamily Fossarinae Troschel, 1861, to the Planaxidae, thereby expanding the family. It is therefore surprising to discover yet another genus and species to add to the family. The new taxon, lacking the thick shell characteristic of so many other planaxid taxa, has a generalized littorinid shell shape and a squat, rather smooth and thin shell. Radular, opercular, and anatomical investigations indicate that the new taxon shares a number of features with other planaxid taxa. A description and discussion follow.

MATERIALS AND METHODS

The examined specimens came from the Kanudi Marine Laboratory and were sent by the Papua New Guinea Department of Fisheries to the Australian Museum, Sydney, for identification. Five preserved specimens, which constitute the type lot, were studied and two of these dissected under a Wild M-5 dissecting microscope for anatomical study. One of the specimens was broken and was not used for shell measurements. Although preservation was not optimal, sufficient anatomical features were available for rudimentary character analysis and a description of gross anatomy. However, several important systems, in particular the pallial oviducts, could not be described. Embryonic shells and the radula were studied using an Hitachi S-570 scanning electron microscope.

RESULTS

Simulathena Houbrick, gen. nov.

Diagnosis: Shell thin, squat, having inflated whorls sculptured with weak spirally incised lines, large, fat body whorl, smooth outer lip and very weak, shallow anterior canal. Operculum lenticular with subterminal nucleus. Radula having triangular rachidian tooth with pair of cusps high on basal plate, beneath cutting edge cusps, and lateral tooth with very wide, long lateral extensions of basal plate. Pair of mantle tentacles emerge from exhalant siphon. Large subhemocoelic cephalic brood pouch containing embryos having direct development, emerging as small snails.

Etymology: "like Athena," a Latin combination of *simul,* meaning "like," and Athena, the Greek goddess who sprang forth from the head of Zeus, in reference to direct development in the cephalic brood pouch.

Remarks: This genus appears to be monotypic and differs from other planaxid genera in having a light, thin shell.

The pair of mantle tentacles emerging from the exhalant siphon is distinctive and does not occur in other members of the family. The large embryos and extensive brood pouch extending forward into the head are also unusual.

It is unfortunate that only four specimens were available for study and that their anatomy is only partially known, but it is clear from what has been examined that this species represents an undescribed genus.

Table 1

Shell measurements (mm) and meristics of the holotype (*) and three paratypes of *Simulathena papuensis*.

Length	15.8*	14.1	13.8	13.0
Width	9.4*	8.7	9.5	7.7
Aperture length	9.8*	8.6	9.8	8.2
Aperture width	6.2*	5.5	6.2	5.3
Number whorls	5*	5	5	5

Simulathena papuensis Houbrick, sp. nov.
(Figures 1–13)

Description: *Shell* (Figures 1–3, Table 1): The shell is thin, squat, and globose, comprising about five inflated whorls weakly sculptured with incised spiral lines. The protoconch and embryonic whorls (Figures 4–6) are unsculptured, having a smooth gradual transition into the incised spiral lines of the adult shell. The adult whorls, exclusive of the body whorl, each have 4 spiral incised lines and numerous microscopic and weak axial striae. The suture is distinct and slightly sunken into each successive whorl. The body whorl is very large, comprising over 75% of the shell length and is sculptured with about 14 spiral incised lines. The aperture is ovate and large, nearly two-thirds the shell length, and has a concave columella with a weak callus and a smooth edged, rounded outer lip, slightly pointed at the shell base. The anterior canal is merely a slight shallow depression in the basal part of the peristome adjacent to the columella. A well-developed, tan-to-olive colored periostracum covers the shell, and also occurs on embryonic shells. Under the periostracum, the shell is white with 3 broad light-brown spiral bands.

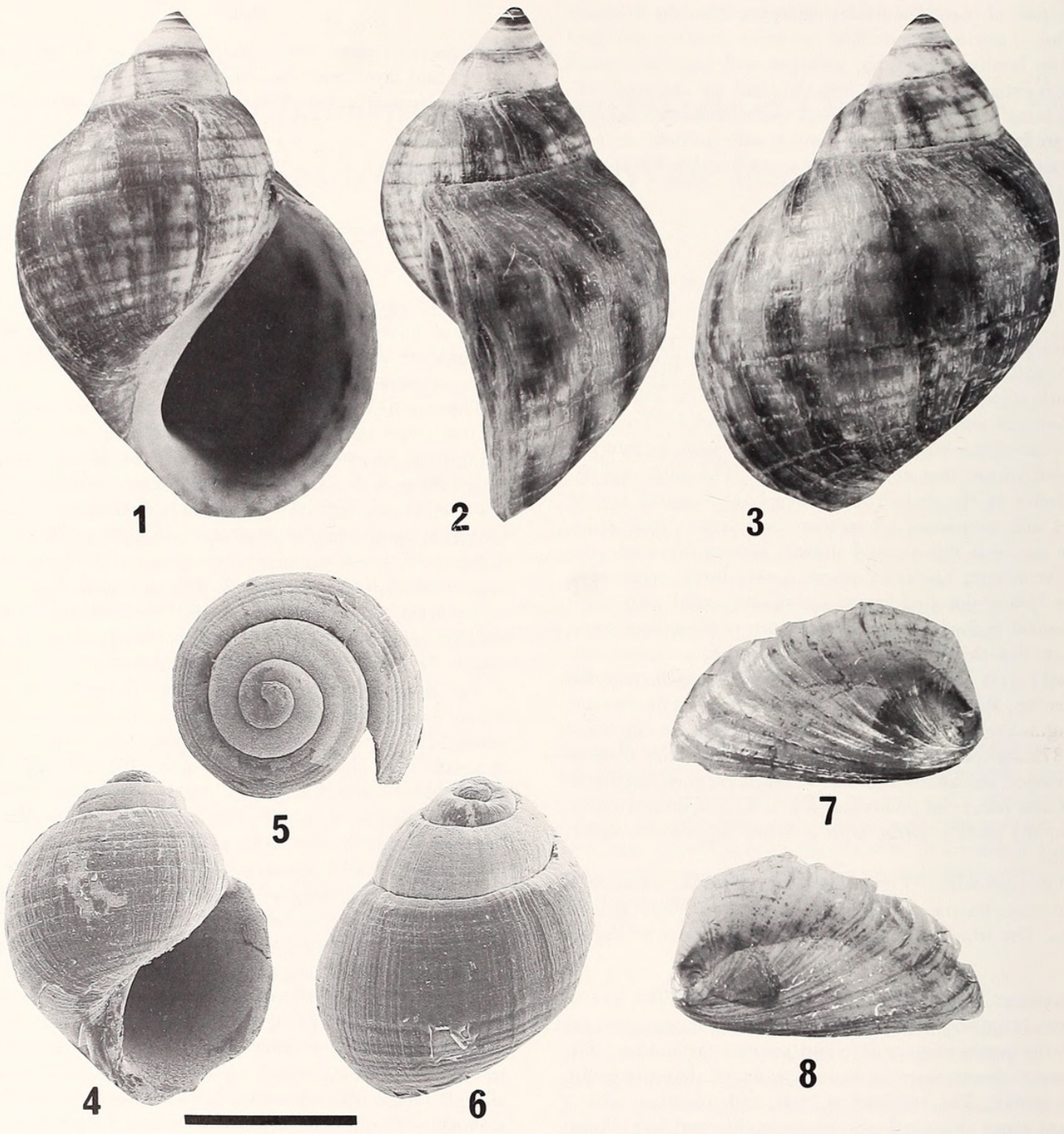
The operculum (Figures 7, 8) is corneous, brown, and lenticular, having a terminal nucleus and many growth lines. The attachment scar is elongate and narrow (Figure 8).

Anatomy: The animal (Figure 9) is tightly coiled, having a very large body whorl, which comprises the mantle cavity, the pericardial cavity, and part of the kidney. The visceral whorls comprise the large stomach, digestive gland, and gonad. The headfoot is large and muscular with a broad snout (Figure 9, sn), which is enlarged and bilobed at the tip and has short cephalic tentacles, each with a small black eye on the outer side of the tentacular base. A conspicuous birth pore (Figure 9, bp) lies in the right side of the neck in females. The thick columellar muscle (Figure 9, cm) is short but broad, enveloping the ventral side of the body whorl. The large muscular foot is broad and thick, and has a long anterior mucus gland. The mantle skirt is wide and its ventral and dorsal edges are smooth, except for some small papillae (Figure 9, mp) at the inhalant siphon (Figure 9, inh). Emerging from the exhalant siphon are two enlarged, tentaculate papillae (Figure 9, exp) attached to the inner surface of the mantle skirt. The shells of developing embryos (Figure 9, emb) can be seen through the swollen, thinly stretched cephalic epithelium covering the head of brooding females.

The mantle cavity is spacious and extends the depth of the first whorl. A ridegelike osphradium flanked with glandular strips on each side is separated from the ctenidium by a wide area of mantle epithelium. The ctenidium (Figure 9, ct) is long and very wide, and has relatively shallow filaments, each comprising a free, fingerlike leading edge and a very broad, shallow attached base. The fingerlike edge is one-half the base length. The rectum (Figure 9, r) is very wide, a little over one-half the ctenidial width, thin-walled, and filled with long, cylindrical fecal pellets stacked in parallel rows and composed of fine sand.

The snout tip has paired fleshy lobes (Figure 9, l) bordering a slitlike mouth. A pair of chitinous jaws lie on the inside of the opening to the oral cavity. The buccal mass is small. The radular ribbon (Figure 10) is broad and short, about 4 mm in length. The rachidian tooth (Figure 12) is triangular shaped, having a flat basal plate with a basal central projection and a pair of basal denticles, each located under and adjacent to the lateral edges of the cutting edge of the tooth, which has a large blunt central cusp flanked on each side by two or three pointed denticles. The lateral tooth (Figures 11–13) is boomerang-shaped, having a basal plate comprising an inner longitudinal pillar and a very long, flat lateral extension, and a cutting edge with a broad, rounded major cusp flanked with an inner pointed denticle and three or four outer pointed denticles. The marginal teeth (Figure 13) have spatulate shafts and broad, sharply folded tips, each with five rounded denticles. The stomach is a large wide organ occupying over one-half the penultimate whorl, and comprising a short style sac and gastric shield.

In females, the subhemocoelic brood pouch consists of invaginated, ciliated, ectodermal epithelium that begins at the brood pore (Figure 9, bp) and extends into the neck and head anteriorly to the tentacular lobes and posteriorly and ventrally throughout the headfoot as far back as the posterior mantle cavity. The brood pouch is completely separate from the cephalic hemocoel, but surrounds the nerve ring and mid-esophagus. Internal folding of the inner epithelium of the brood pouch creates many loculae, each accommodating a developing embryo and communicating



Explanation of Figures 1 to 8

Figures 1–8. ***Simulathena papuensis***, sp. nov. Figures 1–3. Holotype AMS C166326, 15.9 × 9.5 mm, Kairuku, Yule Id., Central District, Papua New Guinea. Figures 4–6. Embryonic shells removed from brood pouch showing protoconch, early whorl sculpture, and periostracum (bar = 0.75 mm). Figures 7 and 8. Operculum, 6.7 mm length, showing free (7) and attached (8) sides.

with a common, nearly closed lumen. The brood pouch contains 55–60 embryos, most of which are large and of equal size, but smaller embryos are also randomly distributed throughout the pouch. Before hatching, the embryos have eyes and an operculum and their shells (Figures 4–6) are in an advanced state, attaining 2.25 mm length and having pigment patterns similar to the adult shell and a well-developed periostracum.

Holotype: AMS C166326, length 15.9 mm, width 9.5 mm.

Paratypes: USNM 859456 (two specimens); length 14.7 mm, width 8.7 mm, and length 13.1 mm, width 9.5 mm.

Type locality: Kairuku, Yule Id., Central District, Papua New Guinea (8°50'S, 146°32'E).

Etymology: Named after Papua, where this species was found.

DISCUSSION

The plain, relatively thin shell of ***Simulathena papuensis*** superficially resembles those of some thiarid and viviparid freshwater snails, but the anatomy differs substantially from that of the viviparids. My initial impression was that this species was an undescribed thiarid; however, close examination of the shell, operculum, and radula indicate that ***Simulathena papuensis*** has more in common with members of the Planaxidae than with thiarid species. In addition, several anatomical characters point to the Planaxidae as the proper familial assignment.

Shell: The shell sculpture of incised spiral lines and the wide, very shallow anterior canal are common conchological characters of other species of *Planaxis* Lamarck, 1822, *Supplanaxis* Thiele, 1929, and *Holcostoma* Adams & Adams, 1853, and a lenticular rather than ovate operculum (Figures 7, 8) is typical of all planaxids (see HOUBRICK, 1987). The shell shape of ***Simulathena***, although unique among planaxids, is most like that of *Holcostoma* species. The periostracum, while relatively thick, is not hispid as in many other planaxid species (see HOUBRICK, 1987).

Anatomy: ***Simulathena papuensis*** has a number of characters in common with planaxids. The expanded bilobed snout tip is similar to those seen on planaxid species. The radula is closest to those described for species of *Supplanaxis, Hinea* Gray, 1847, *Holcostoma,* and *Fossarus* (see HOUBRICK, 1987, 1990). The broad, shallow, ctenidial filaments are similar to those described in *Planaxis sulcatus* (HOUBRICK, 1987:36). The pallial gonoducts are open in contrast to the closed systems found in brooding, parthenogenetic thiarids. It was not determined if ***Simulathena*** is gonochoristic, but this condition is assumed until proven otherwise. Although the two specimens of ***Simulathena*** I examined were not preserved well enough to determine the precise pallial oviduct configuration, the large subhemocoelic cephalic brood pouch and the birth pore on the right side of the neck are much like those seen in all other examined planaxid genera (see HOUBRICK, 1987), including *Fossarus,* subfamily Fossariinae (see HOUBRICK, 1990). Similar cephalic brood pouches also occur in many parthenogenetic thiarids (MORRISON, 1954), which are probably a sister group of Planaxidae (see HOUBRICK, 1988).

As mentioned previously, the pair of mantle tentacles projecting from the exhalant siphon is unusual and not seen among other planaxids. The wide separation between the osphradium and ctenidium is also a unique feature of ***Simulathena.***

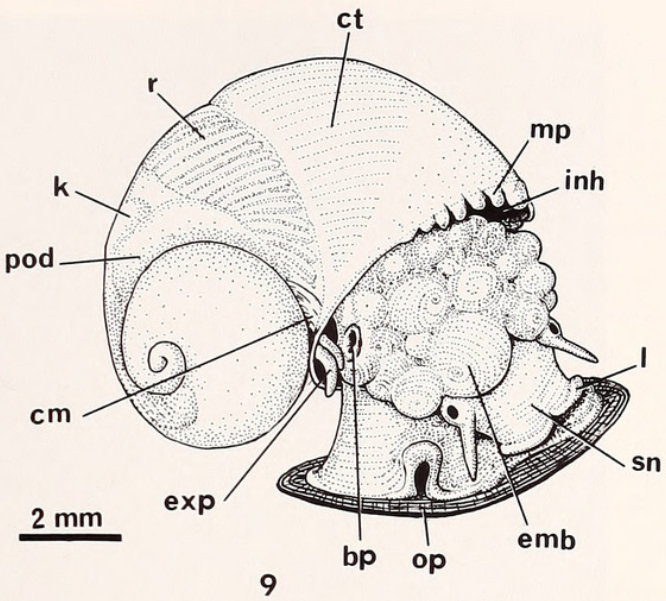
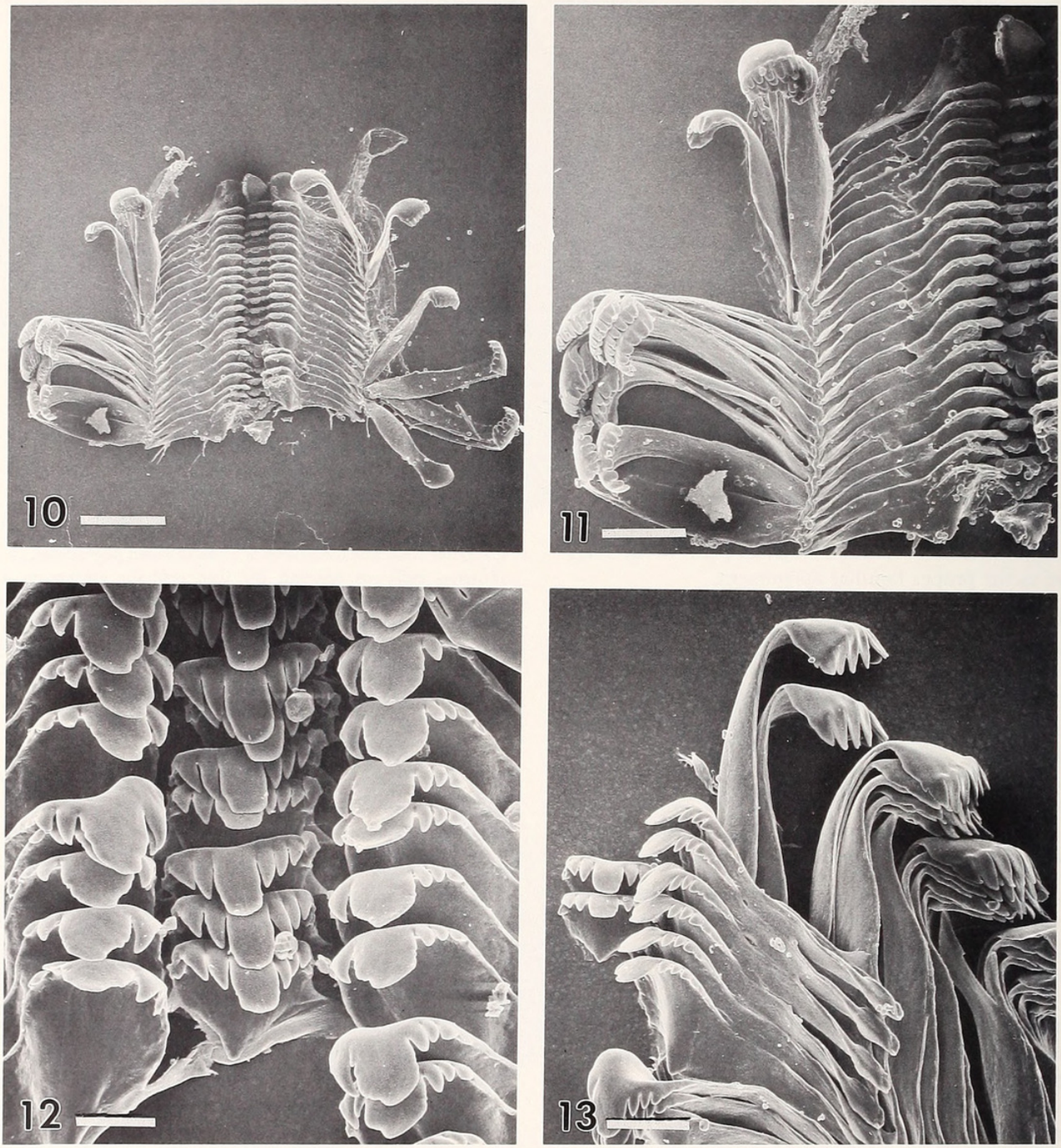


Figure 9

External anatomical features of ***Simulathena papuensis***, sp. nov., showing embryos beneath the thin cephalic epithelum of the anterior brood pouch. Legend: bp, brood pore; cm, columellar muscle; ct, ctenidium; emb, embryo inside brood pouch; exp, exhalant papillae; inh, inhalant siphon; k, kidney; l, lobe forming lip of mouth; mp, mantle papillae; op, operculum; pod, pallial oviduct; r, rectum containing fecal pellets; sn, snout.

Reproductive biology: The most striking external anatomical feature of ***Simulathena papuensis*** is the enlarged brood pouch extending forward into the head (Figure 9). The brood pouch has a ciliated epithelium and is formed by an ectodermal invagination, as described in other planaxids (see HOUBRICK, 1987). It engulfs much of the cephalic hemocoel, and comprises numerous, thin-walled loculae, all of which communicate with the lumen of the pouch and with each other. Each locula contains or enfolds a single uncapsulated embryo. Embryos presumably enter the brood pouch as fertilized, uncapsulated eggs, and are probably fed on nutritive liquids secreted by the brood pouch walls. They grow to be quite large (up to 2.25 mm in length), presumably emerging through the brood pore as small snails. Most embryos are very large and it is difficult to imagine how they can maneuver through the interstices of the brood pouch and emerge from the small brood pore. It is possible, but unlikely, that they rupture through the thin epithelium of the head and dorsal surface of the neck when they are ready to hatch, although it is unclear what this would do to other, less-developed embryos. Most embryos are roughly the same size, but a number of smaller shelled embryos are present, suggesting that different cohorts are being brooded or that some em-



Explanation of Figures 10 to 13

Figures 10–13. Scanning electron micrographs of various aspects of the radula of ***Simulathena papuensis***, sp. nov. Figure 10, bar = 175 μm; Figure 11, bar = 65 μm; Figure 12, bar = 25 μm; Figure 13, bar = 43 μm.

bryos do not receive the same nourishment from the brood pouch as do others. It is unlikely that the smaller embryos serve as a food source for larger embryos, because they have well-developed shells. The only other planaxid known to brood very large embryos that hatch out as young snails is the Persian Gulf population of *Planaxis sulcatus* (see Thorson, 1940; Barkati & Ahmed, 1982; Houbrick, 1987), in which nurse eggs have been documented.

The large size of the enclosed embryonic snails in ***Simulathena papuensis*** is unusual among most planaxids, but very large embryos are not uncommon among parthenogenetic thiarids (Houbrick, personal observations).

Ecology: Nothing has been recorded about the microhabitat of this species except that it lives in the intertidal zone.

Geographic distribution: ***Simulathena papuensis*** is known only from the type locality, but probably occurs in other suitable habitats in New Guinea.

Phylogeny: The original phylogeny of the Planaxidae presented by HOUBRICK (1987:fig. 27) is outdated. *Angiola* Dall, 1926, is now regarded as a synonym of *Hinea,* because *Hinea* has been found to exhibit bioluminescence (PONDER, 1988), which was the only character separating the two genera.

A preliminary updated phylogenetic analysis of the Planaxidae (18 characters, 9 taxa, consistency index = 74) was run, using many of the same characters originally employed by HOUBRICK (1987:48–50) and some modified, revised ones. The revised analysis was done with the Hennig86 algorithm and included new taxa, the Fossarinae, and used *Thiara* Röding, 1798, as the outgroup. The results suggest that ***Simulathena*** is the sister group of the clade comprising *Hinea, Holcostoma, Supplanaxis,* and *Fossarus.* This is readily seen by the similarity among the radulae of these taxa. However, final resolution of planaxid phylogeny awaits a more formal cladistic analysis involving many other cerithioidean taxa and a more complete reappraisal of the characters.

ACKNOWLEDGMENTS

I thank Mr. Phil Coleman, of the Australian Museum, Sydney, for sending me the specimens for examination. I am grateful to the staff of the Smithsonian Scanning Electron Microscope facility for assisting me and for providing photomicrographs. I also thank Mr. Victor Krantz, of the Smithsonian's Photographic Services for photography. Dr. Robert Hershler provided critical comments about the manuscript.

LITERATURE CITED

BARKATI, S. & M. AHMED. 1982. Studies on the reproductive biology of some prosobranchs from the coast of Karachi (Pakistan) bordering the northern Arabian Sea, 1: Observations on *Planaxis sulcatus* (Born, 1780). The Veliger 24(4): 355–358.

DALL, W. H. 1926. New shells from Japan and the Loochoo Islands. Proceedings of the Biological Society of Washington 39:63–66.

GRAY, J. E. 1850. Systematic arrangement of the figures. System of Mollusca. Richard & John E. Taylor: London. Pp. 63–124.

HOUBRICK, R. S. 1987. Anatomy, reproductive biology, and phylogeny of the Planaxidae (Cerithiacea: Prosobranchia). Smithsonian Contributions to Zoology No. 445:iii + 57 pp., 27 figs.

HOUBRICK, R. S. 1988. Cerithioidean phylogeny. *In:* W. F. Ponder (ed.), Prosobranch Phylogeny. Malacological Review, Supplement 4:88–128.

HOUBRICK, R. S. 1990. Anatomy, reproductive biology and systematic position of *Fossarus ambiguus* (Linné) (Fossarinae: Planaxidae; Prosobranchia) Açoreana, 1990, Supplement: 59–73.

MORRISON, J. P. E. 1954. The relationships of old and new world melanians. Proceedings of the United States National Museum. 103(3325):357–394, 2 pls.

PHILIPPI, R. A. 1841. Zoologische Bemerkungen. *Fossarus,* ein neues Genus der Kammkiemigen Mollusken. Archiv für Naturgeschischte 7(1):42–49, pl. 5.

PONDER, W. F. 1988. Bioluminescence in *Hinea braziliana* (Lamarck) (Gastropoda: Planaxidae). Journal of Molluscan Studies 54:361.

RÖDING, P. F. 1798. Museum Boltenianum. II. Conchylia. Trappii: Hamburg. 199 pp.

THORSON, G. 1940. Studies on the egg masses and larval development of Gastropoda from the Iranian Gulf. Danish Scientific Investigations in Iran, Part 2, Copenhagen. 238 pp.

TROSCHEL, F. H. 1856–1863. Das Gebiss der Schnecken zur Begründung einer Natürlichen Classification, Volume 1: 661. Berlin.