

OBSERVATIONS ON THE MORPHOLOGY OF *POMACEA LINEATA* (SPIX, 1827) (MOLLUSCA, AMPULLARIIDAE)*

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This paper deals with the morphology of Pomacea lineata (Spix, 1827) collected at its type locality.

The shell is globose, moderately heavy, horn-colored with brown spiral bands; apex subelevated; 4 – 5 rounded whorls increasing in diameter rather rapidly, separated by deep suture. Aperture large and ovoid; outer lip sharp; umbilicus narrow and deep; operculum concentric, corneous. Ratios: shell width/shell length = 0.74 – 0.83 (mean 0.78); spire length/shell length = 0.10 – 0.18 (mean 0.13); aperture length/shell length = 0.70 – 0.77 (mean 0.73).

The animal is longisiphonate.

Renal organ brownish with marked invagination at its right edge. Ureter elongated with its long axis transverse to the main axis of the kidney.

The radula is taenioglossate (2.1.1.1.2) and has on average 35 transverse rows of teeth. The form and arrangement of the radula teeth are nearly the same as in other Ampullariidae.

The testis is cream-colored and lies in the first three whorls of the spire. Spermiduct uniformly narrow, running to the base of the spire. Seminal vesicle whitish, slightly pressed dorsoventrally. Prostate cylindrical and thick, similar in color to the testis. Penis whiplike, with a closed circular spermiduct. Penis pouch ovoid completely enveloping the penis. Penis sheath elongated, broad proximally, tapering distally. Its inner surface shows a longitudinal channel along its proximal half and two glands, one on the middle and the other apical. Ovary composed of branched whitish tubules situated on the surface of the digestive gland. Oviduct slender running along the columellar axis toward the base of the spire. Seminal receptacle tubiform, thick-walled and rounded proximally. Albumen gland large, pink, enclosing the receptacle and the spiral capsule gland. Vestigial male copulatory apparatus (penis and its sheath) present in all females examined.

Key words: Mollusca – Ampullariidae – *Pomacea lineata* – morpho¹.

The ampullariids are amphibious freshwater snails distributed throughout the tropical regions. They are represented in Brazil by three genera: *Asolene* Orbigny, 1837, *Marisa* Gray, 1824 and *Pomacea* Perry, 1810.

Anatomical knowledge of this group is still scarce in spite of its abundance and wide distribution. The literature deals mainly with conchological and biological data and the taxonomy, based chiefly upon shell characteristics, has led to an excessive splitting of taxa. The literature records about fifty specific names occurring in Brazil.

Anatomical descriptions of some species of the genus *Pomacea* were presented by Sachwatkin (1920), Lopes (1955, 1956a, b), Scott (1957), Pain & Arias (1958), Andrews (1964, 1965a, b) and Martin (1980, 1984).

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P. lineata is one of the oldest species names in Brazil and its type locality is well defined: "Habitat in aquis Provinciae Bahiensis, e. g. in fluvio Itahype" (Spix, 1827). This river, nowadays called Almada, rises in the Serra dos Vinháticos and flows 110 km before entering the Atlantic at Barra do Itaípe in Ilhéus, state of Bahia.

MATERIAL AND METHODS

On February 4, 1984, I collected 93 specimens from the type locality area, that is, Almada river and neighboring ponds at Campinho, 24 km from Ilhéus.

The living specimens were relaxed in a 0.1% solution of nembutal for 12 hr, drawn from the shell and placed in slightly modified Railliet-Henry's fixative (distilled water 930 ml, sodium chloride 6g, formalin 50 ml, acetic acid 20 ml). Fifty of them were dissected under the stereomicroscope.

The radulae were separated from the buccal mass by digestion, for about 6 hr, in a vial with 10% NaOH immersed in gently boiling water.

Two specimens were embedded in paraffin, sectioned serially, and stained with hematoxylin-eosin for microanatomic observation.

DESCRIPTION

The shell (Fig. 1) is globose, moderately heavy, with greenish or horn-colored periostracum and dark brown spiral bands; apex sub-elevated; 4–5 rounded whorls increasing rather rapidly and separated by deep suture. Aperture large and ovoid; outer lip sharp; umbilicus narrow and deep; operculum concentric, corneous. Ratios: shell width/shell length = 0.74 – 0.83 (mean 0.78); spire length/shell length = 0.10 – 0.18 (mean 0.13); aperture length/shell length 0.70 – 0.77 (mean 0.73).

The radula is taenioglossate (2.1.1.1.2) and has on average 35 rows of teeth. The central tooth is rectangular with a broad base bearing a large central cusp and usually four accessory cusps on each side of it; the central cusp is triangular and sharply pointed; the lateral cusps are pointed, much smaller, and sometimes subdivided into smaller denticles. The lateral tooth is large, elongated and its base is narrower than its tip; the latter has a large pointed central cusp and 2–3 smaller lateral ones on each side. The two marginal teeth are long with acuminate curved tips. The inner marginal has a main cusp and a second smaller one on its inner side. The outer marginal tooth shows a single pointed cusp on the inner side of its tip (Fig. 2).

The two large chitinous jaws are dorsally connected, markedly convex on their outer surface and concave internally. They are thick and brownish anteriorly while posteriorly they decrease gradually in thickness and have a yellowish color (Fig. 3).

The head of the animal is anteriorly prolonged into an extensible snout bearing the mouth and a labial palp on each side. Slender and elongated tentacles are situated behind the palps. The two neck lobes, right and left, are laterally behind the tentacles and are of pallial origin. The right one is a short gutter-shaped structure and serves to direct the exhalant current away from the head of the animal. The left one is a mid-ventrally opened tube which closes by the juxtaposition of its margins. It is capable of great elongation, about four times its rest length, and serves as an inhalant siphon (Fig. 4).

Melanin pigment is especially concentrated on the dorsal surface of the lung, ctenidium, and ureter, obscuring them from view. If this pigmented layer is rubbed off, those organs may be seen by transparency. The pericardium is on the left side of the animal near the mantle edge. The kidney is conspicuous by its brown-

ish color and large size. The greenish digestive gland occupies the greatest part of the visceral hump and partially covers the stomach. The testis and the ovary lie on the digestive gland usually in the three apical whorls.

The presence of a lung and a ctenidium in the mantle cavity is a striking feature of the ampullariids. The ctenidium is monopectinate and is composed of structurally similar triangular leaflets. It begins near the mantle edge and borders the right and posterior walls of the lung before bending to the left toward the pericardium. The lung is formed by a fold of the mantle skirt and is used to store air. Its floor is thicker than its roof and it bears the pulmonary aperture, a slitlike opening closed by apposition of its two lips. During ventilation of the lung, the distal tip of the siphon is projected above the water level whereas its base remains continuous with the pulmonary aperture, thus leading atmospheric air into the lung. Rhythmic movements of the head, which is withdrawn and extended several times in rapid succession, supplement air pumping. The animal can perform pulmonary breath out of as well as under the water (Fig. 17).

The kidney of ampullariids was long considered as consisting of an anterior and a posterior chamber. Embryologic studies by Demian & Yousif (1973) in *Marisa cornuarietis* (L.) showed that only the posterior chamber is a kidney proper. The anterior one is homologous with the ureter of other mesogastropods. The kidney is brownish and its surface area is roughly three times that of the ureter. Its anterior limit is formed by the ureter and the pericardium while laterally and posteriorly it is surrounded by the intestine. Its right wall shows a marked invagination and its floor is very thin. The roof is thick, spongy, and has numerous folds. The renal vessels are very conspicuous and branched. The reno-pericardial canal is at the left angle near the inner renal opening (Fig. 6).

The elongated ureter is transverse to the main axis of the animal. Several transverse lamellae are arranged on either side of the two longitudinal branches of the afferent ureteral vein. The ureteral meatus and the inner renal opening communicate the ureter with the mantle cavity and the kidney, respectively. The meatus is a large ventral aperture at the right side of the ureter, while the renal opening is smaller, slit-like and transverse to the ureter main axis (Figs. 7,8).

The testis is cream-colored and the mantle covering it is dark pigmented. Short and numerous efferent ducts fuse into two main branches that converge into the spermiduct. The latter is very narrow and runs to the base of the spire. Near the pericardium it turns to the right, open-

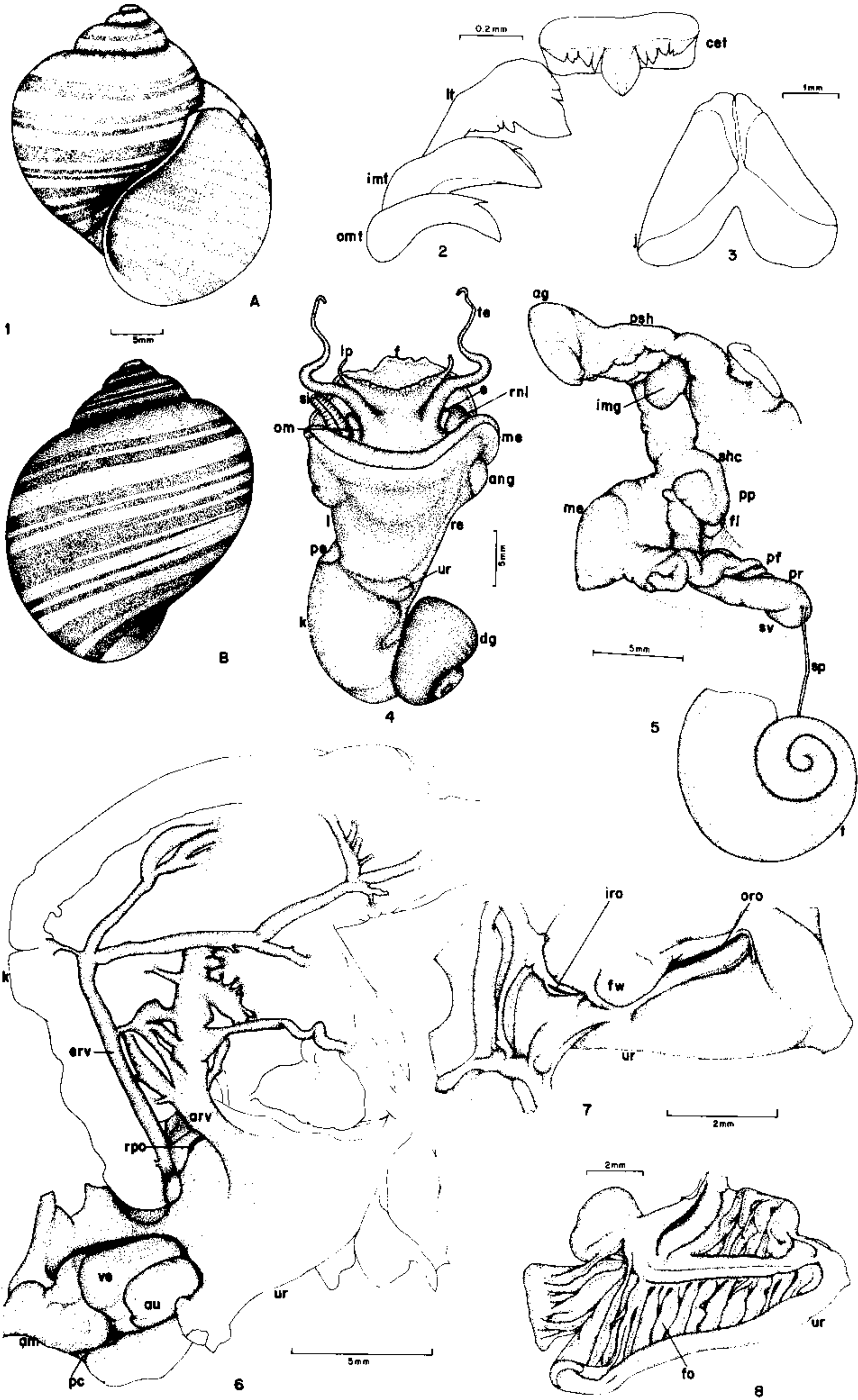


Fig. 1: shell of specimen from Ilhéus (A= ventral view, B= dorsal view). Fig. 2: radula. Fig. 3: jaws, ventral view. Fig. 4: preserved specimen drawn from shell, dorsal view. Fig. 5: male reproductive system. Fig. 6: excretory system. Fig. 7: ureter. Fig. 8: opened ureter. See list of abbreviations.

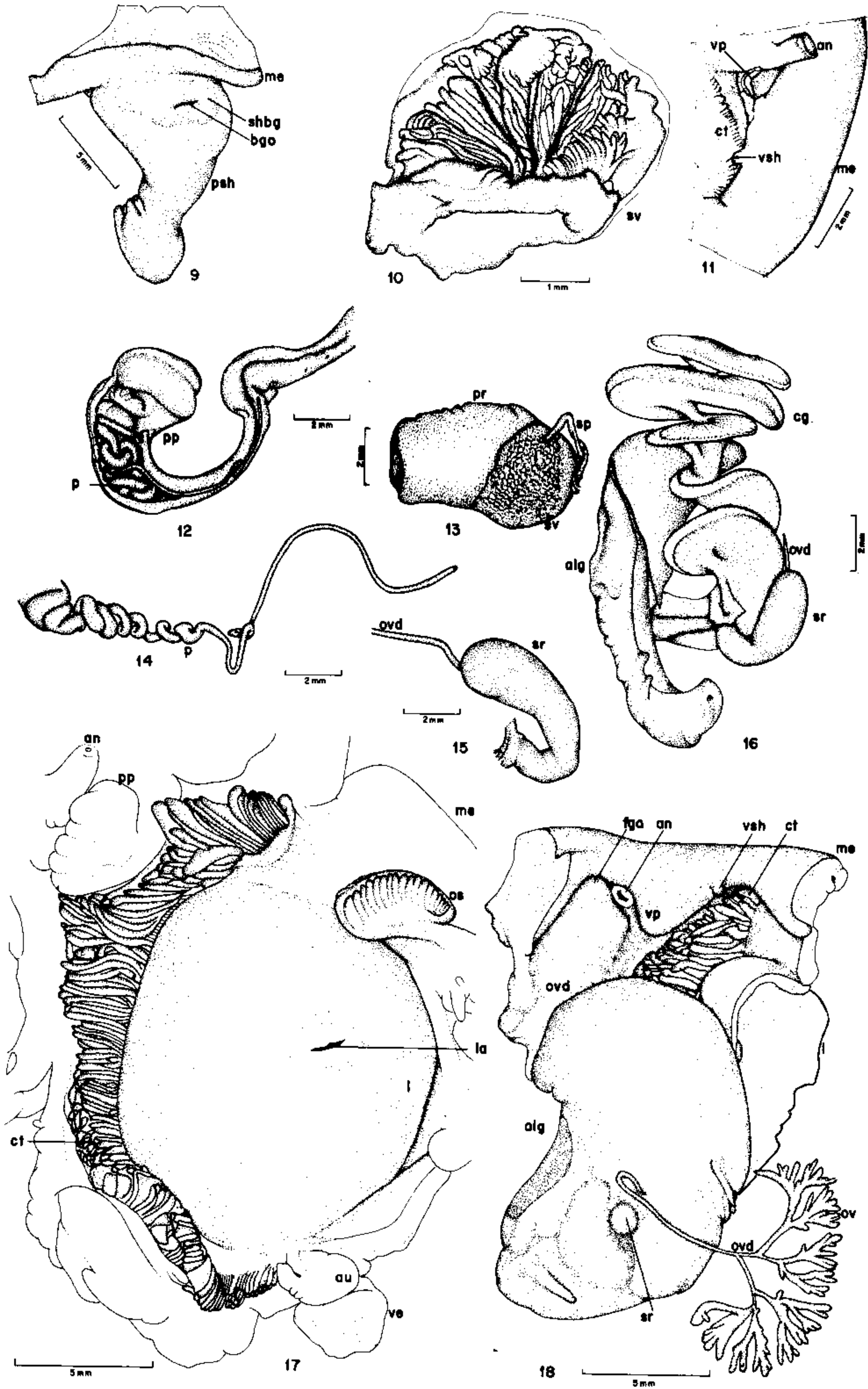


Fig. 9: outer surface of penial sheath. Fig. 10: opened seminal vesicle. Fig. 11: vestigial penis. Fig. 12: penis pouch and penis. Fig. 13: Seminal vesicle and prostate proximal tip. Fig. 14: penis. Fig. 15: seminal receptacle. Fig. 16: capsule gland. Fig. 17: respiratory system. Fig. 18: female reproductive system. See list of abbreviations.

ing into the seminal vesicle, a whitish structure slightly flattened. The prostate follows the seminal vesicle and is noticeable by its creamy color and cylindrical shape. It continues along the left side of the rectum until it reaches the anal papilla where it bends slightly left, opening into the seminal groove below the penis pouch. The prostatic duct is narrow and has a slitlike lumen (Figs. 5, 10, 13).

The penis is whiplike and is roughly 30 mm in length in a 32 mm long specimen. It is housed by a pouch when not in use. This pouch is ovoid and thin-walled, so the coiled penis is seen by transparency. The proximal end of the penis pouch is pink and thick whereas its distal end forms a U-shaped channel which leads the penis during copulation. There is an elongated flange of tissue in the seminal groove that, according to Lopes (1955) and Andrews (1964), aids the transference of seminal fluid from prostate to penis (Figs. 12, 14).

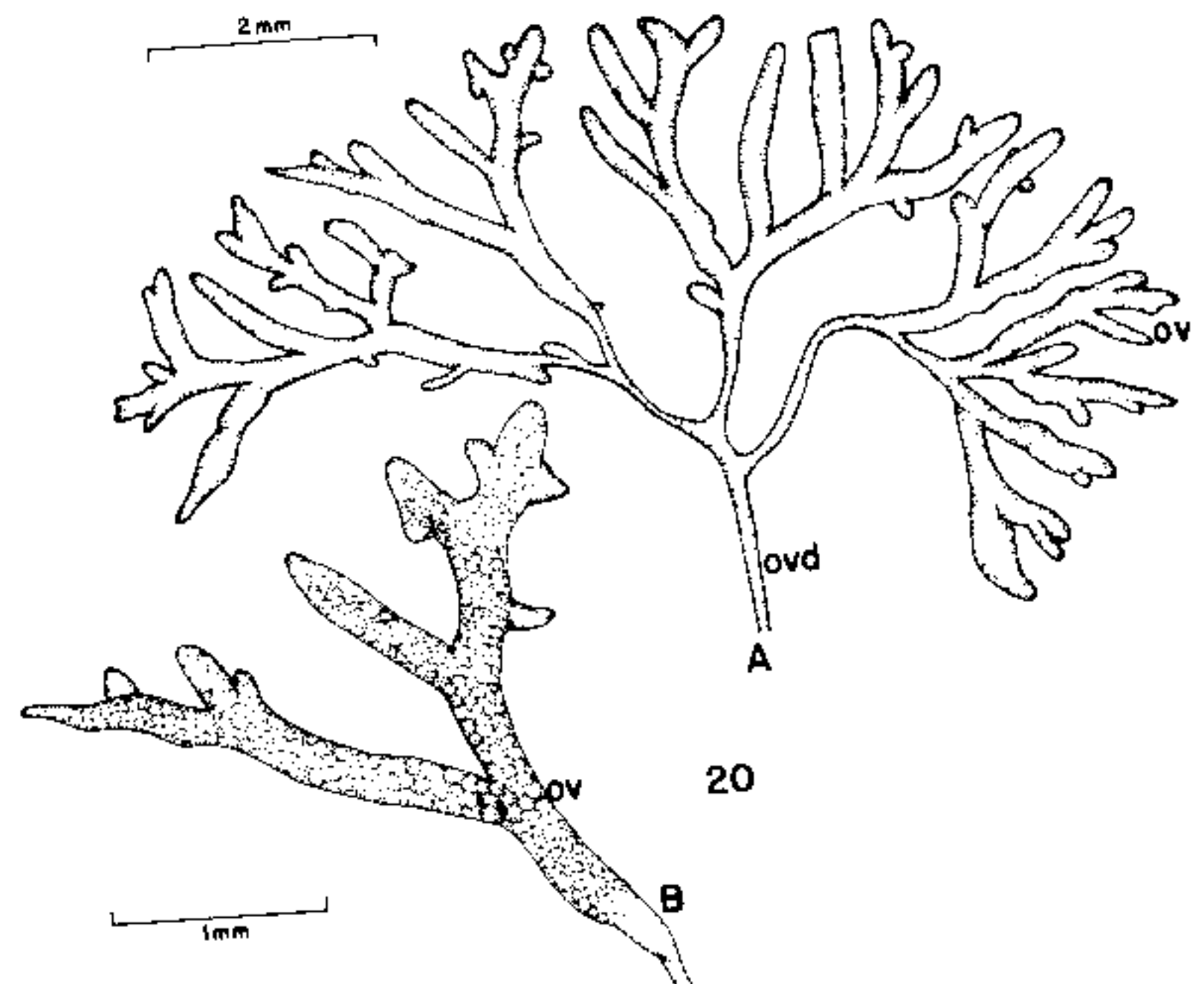
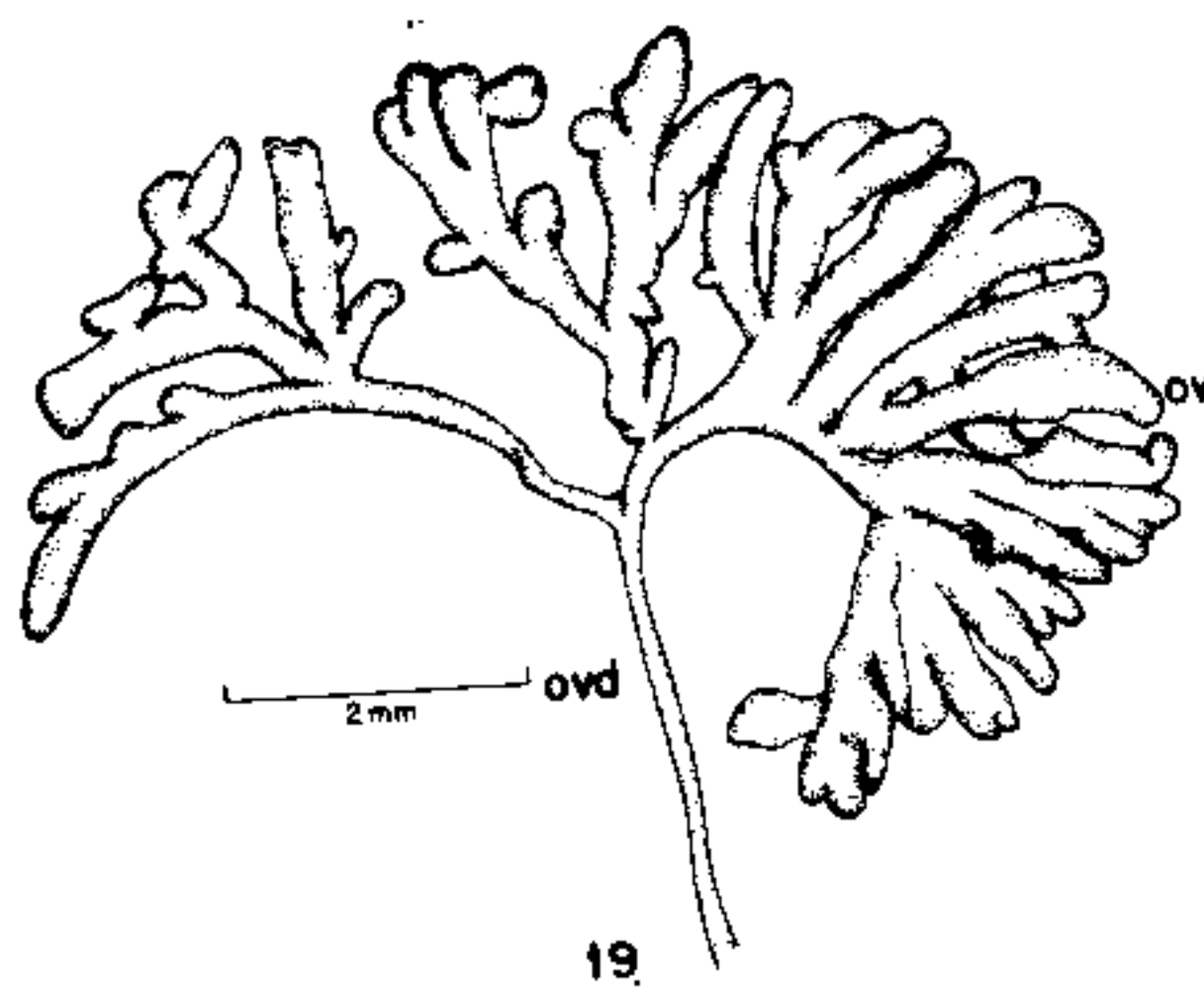
The penial sheath is well-developed and rises to the left of the prostate opening. It is an elongated structure which gradually narrows distalward bearing two margins that juxtapose, thus forming a median longitudinal channel. Its inner surface has a median gland at its right margin and another at its tip. Above the median gland are many swellings formed by subepithelial glands. The outer surface of the sheath shows a glandular pinkish mass embedded in the tissue of the basal portion, and a slitlike opening. The right margin of the sheath forms an inner fold continuous with the channel formed by the penial pouch. During copulation the penis moves along this channel and emerges slightly above the inner median gland. Its proximal part is gripped by the edge of the channel

while the distal part enters the pallial oviduct. When the sheath is not in use its distal part is usually folded back into the mantle cavity (Figs. 5, 9, 21).

Microanatomic studies show that the penis has a closed circular spermiduct surrounded by a layer of circular fibers around which there is loose connective tissue. In this tissue there are two large and some smaller blood sinuses. A layer of longitudinal fibers is present between the connective tissue and the epithelial coat (Fig. 22).

The ovary occupies a similar position to the testis and is composed of multibranched whitish tubules lying superficially on the digestive gland. It is arborescent and usually has 3-4 main branches that fuse to form the oviduct. The latter is narrow and runs along the columellar axis to the spire base. At the level of pericardium it turns to the right and merges into the albumen gland before opening into the receptacle. The latter is tubulat and thick-walled. Its proximal end is rounded and tapers distally. The receptacle is almost completely enclosed by the albumen gland, except for part of its proximal end (Figs. 15, 18, 19, 20).

The albumen gland is the most conspicuous organ of the reproductive system because of its large size and pink color. During breeding season its size enlarges considerably occupying the greatest part of the visceral hump, while in resting periods it is very reduced. Its proximal half lies against the ureter and the lateral wall of the kidney, while the distal end enters the pallial cavity. It encloses an inner spiral channel (capsule gland) beginning at the receptacle and extending until it emerges from the proximal end. The diameter of this channel is about 3 mm and



Figs. 19 and 20: ovary.

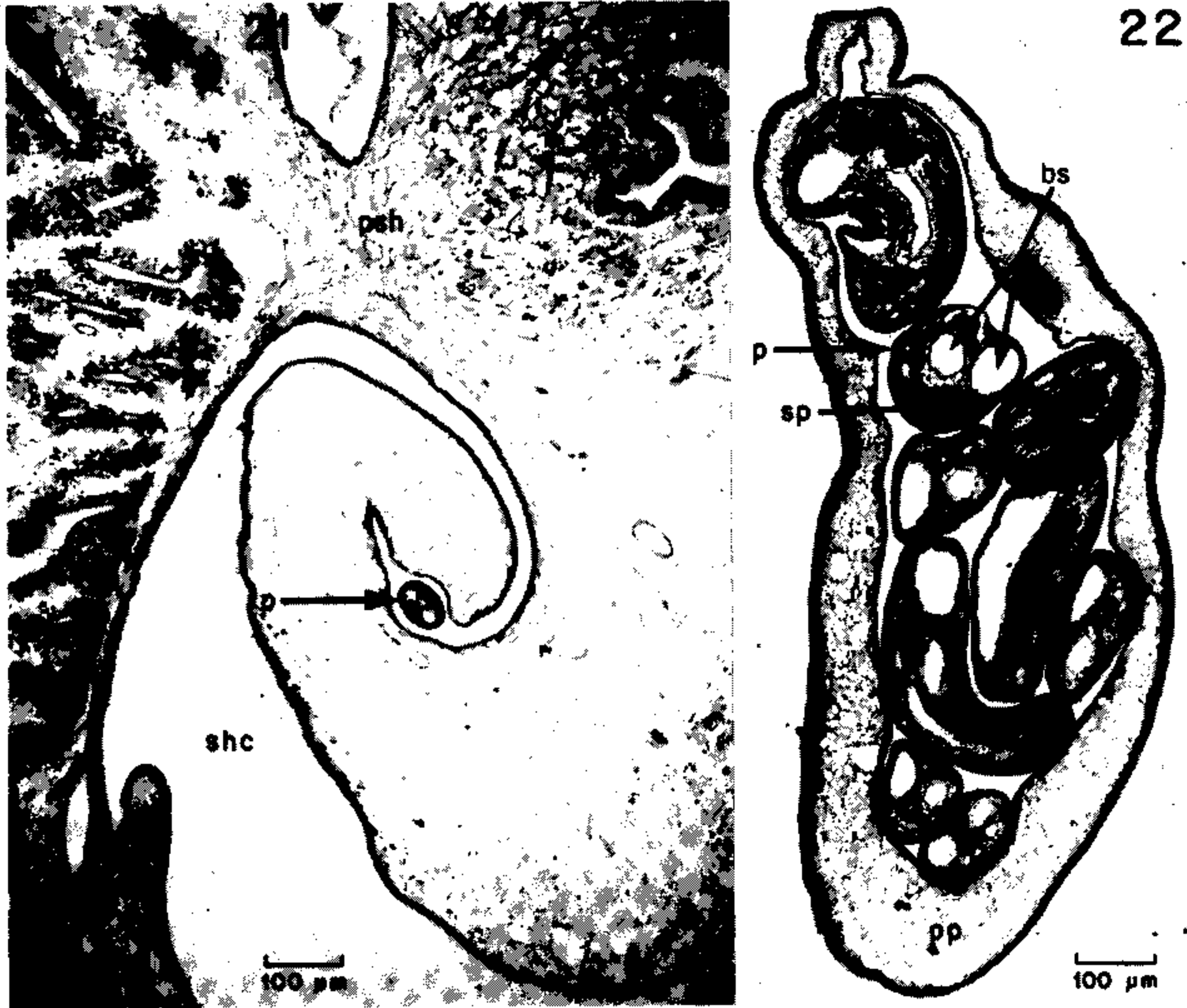


Fig. 21: section through basal portion of penial sheath. Fig. 22: section through the middle portion of the penis pouch. See list of abbreviations.

its lumen is very narrow. The main duct of the albumen gland is in the adjacent glandular mass. Its lumen is also very narrow and has many slitlike openings for albumen exit. The walls of this duct and of the capsule gland are rather iridescent (Fig. 16).

The pallial oviduct runs along the rectum until it reaches the female genital aperture beside the anus. Its inner surface has deep furrows and folds.

The male vestigial copulatory apparatus penis during copulation. There is an elongated examined (Figs. 11, 18).

The pink spheric calcareous-shelled eggs are roughly 3 mm in width. They are laid in clusters (100 eggs on average) on aquarium walls just above the water level. Near hatching the eggs become whitish-pink and it is easy to put them apart. At a room temperature of 25°C hatching takes place about 15 days after oviposition.

DISCUSSION

Variation in shell and aperture as well as in ornamental bands was observed, giving no reliable characteristics for species discrimination.

Michelson (1961) pointed out that intraspecific variation reduces the diagnostic value of the radula below family level. Pain (1972) reported the uniformity of the radula in the whole family. The radula of *P. lineata* is similar to that of other known congeneric species.

The respiratory system has the same appearance as in *Pomacea canaliculata* (Lamarck, 1822) as described by Andrews (1965a).

The kidney of *P. lineata* is similar to that of *P. canaliculata* studied by Andrews (1965a). It differs from that of *Pomacea paludosa* (Say) described by Michelson (1961) in the rectangular shape and the protuberance anteriorly situated at its left margin.

The reproductive system of *P. lineata* is similar to that of different species as described by other authors: *P. canaliculata* (Lopes, 1956b; Scott, 1957; Andrews, 1964); *P. falconensis* (Pain & Arias, 1958); *P. gigas* (Sachwatkin, 1920); and *P. haustum* (Lopes, 1955). It differs from *P. lineata* studied by Lopes (1956a) mainly in the penial sheath, which according to this author is shorter and broader, and has a single large gland at its outer base.

The closed penial spermiduct of *P. lineata* agrees with Michelson's (1961) observations. He

stated that an external spermiduct characterizes Oriental species while an internal duct is characteristic of American ones.

In *P. lineata* the penis is completely enclosed by its pouch. Martin (1980) pointed out that this enclosure is different in *Pomacea* and *Mari-sa*. In the former the pouch is well-developed, and in the latter it is smaller, enclosing only 1/4 of the penis. She also noticed that in *Pomacea scalaris* (Orbigny, 1837) the pouch is less developed than in other species. As pointed out by Andrews (1964) there is no pouch in *Pila Röding*, 1798, so it is probable that besides being a differential generic character, the pouch may also be used for species discrimination.

RESUMO

Observações sobre a morfologia de *Pomacea lineata* (Spix, 1827) (Mollusca, Ampullaridae) – Neste trabalho é estudada a morfologia de *Pomacea lineata* (Spix, 1827) baseada em material coletado na localidade-tipo.

Concha com espessura moderada, globosa, castanha, com faixas espirais castanhas-escuras; ápice pouco elevado, 4–5 giros arredondados crescendo rapidamente em diâmetro, separados por suturas profundas. Abertura grande oval; lábio externo simples; umbigo pequeno e profundo; opérculo concêntrico, córneo. Razões: largura da concha/comprimento da concha = 0.74 – 0.83 (média 0.78); comprimento da espira/comprimento da concha = 0.10 – 0.18 (média 0.13); comprimento da abertura/comprimento da concha = 0.70 – 0.77 (média 0.73).

Animal com sifão bem desenvolvido.

A rádula é tenioglossa (2.1.1.1.2) e tem em média 35 fileiras transversais de dentes. A forma e a disposição dos dentes radulares são semelhantes ao padrão dos ampularídeos.

Rim de cor castanha apresentando uma invaginação acentuada na parede direita. Ureter alongado e transversal ao eixo principal do rim.

Testículo constituído por uma massa de cor creme, ocupando as três primeiras voltas da espira. Espermiduto estreito e uniforme, correndo para a base da espira. Vesícula seminal esbranquiçada levemente achatada dorso-ventralmente. Próstata cilíndrica e compacta com coloração semelhante à do testículo. Pênis em forma de chicote com canal espermático fechado e de contorno circular. Bolsa do pênis ovalada, envolvendo-o completamente. Bainha do pênis alongada tendo sua largura diminuída gradualmente da base para a extremidade; sua superfície interna apresenta um canal mediano em sua metade proximal e duas glândulas, uma media-

na e outra apical. Ovário constituído por túbulos ramificados branco-amarelados situados superficialmente sobre a glândula digestiva. Oviduto estreito correndo pelo eixo columelar até a base da espira. Receptáculo seminal tubular com parede espessa e extremidade proximal alargada. Glândula de albume volumosa e rosada envolvendo o receptáculo seminal e a glândula da casca em espiral. Vestígio do aparelho copulador masculino (pênis e sua bainha) presente em todas as fêmeas examinadas.

Palavras-chave: Mollusca – Ampullaridae – *Pomacea lineata* – morfologia

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ABBREVIATIONS USED IN THE FIGURES

ag: apical gland – alg: albumen gland – am: ampulla – an: anus – arv: afferent renal vein – au: auricula – bgo: sheath basal gland opening – bs: blood sinuses – cet: central tooth – cg: capsule gland – fga: female genital aperture – fl: flange – fo: lamella – fw: folded back wall – img: inner median gland – imi: inner marginal tooth – iro: inner renal opening – j: jaws – k: kidney – l: lung – la: lung aperture – lp: labial palps – lt: lateral tooth – me: mantle edge – om: ommatophore – omt: outer marginal tooth – oro: outer renal opening – os: osphradium – ov: ovary – ovd: oviduct – p: penis – pc: pericardial cavity – pd: prostatic duct – pe: pericardium – pf: pallial fold – pp: penis pouch – pr: prostate – psh: penial sheath – re: rectum – rnl: right neck lobe – rpo: reno-pericardial opening – shbg: sheath basal outer gland – shc: sheath channel – si: siphon – sp: spermiduct – sr: seminal receptacle – sv: seminal vesicle – t: testis – te: tentacle – ur: ureter – ve: ventricle – vp: vestigial penis – vsh: vestigial sheath.

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