

# ANATOMY AND SYSTEMATICS OF *ANODONTITES ELONGATUS* (SWAINSON) FROM AMAZON AND PARANÁ BASINS, BRAZIL (MOLLUSCA, BIVALVIA, UNIONOIDA, MYCETOPODIDAE)

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ABSTRACT. The anatomy of *Anodontites elongatus* (Swainson, 1823), a rare species restricted to the Amazon and Paraná Basins, is described by first time, showing a group of conchological and anatomical characters exclusive of this species that may be analyzed to identify it. Diagnosis of *A. elongatus*: shell long antero-posteriorly, umbones prominent, periostracum opaque and smooth, two posterior radial striae; middle fold of mantle edge very tall; gill long antero-posteriorly and short dorso-ventrally, extending about a half of it total length beyond visceral mass; palps proportionally small, several furrows in its outer surface; stomach without esophageal transversal ridge, dorsal hood and gastric shield poorly developed, major typhlosole entering in  $ddd^2$ , posterior pouch of  $sa^3$  very-long; style sac reduced, without crystalline style; distal region of intestine and rectum with a well developed typhlosole, "T" in section, other intestinal regions without folds; gonad gonochoristic.

KEY WORDS. Unionoïda, *Anodontites elongatus*, anatomy, systematics, Brazil

*Anodontites elongatus* (Swainson, 1823) was described in the genus *Anodon* Oken, 1815, based on a single valve with the dubious provenance "South America". As main characters were given the antero-posterior elongation and the prominent umbones.

Probably due to its singular conchological characters and rarity, *Anodontites elongatus* has few synonyms for a Mycetopodidae, and has been rarely cited in the recent literature.

Several specimens identified as *A. elongatus*, were collected by the author and by the team of biologists and students of Prof. Thomaz Lipparelli of the Universidade para o Desenvolvimento do Estado e Região do Pantanal (UNIDERP), in the Pantanal. The study of these specimens permitted to amplify the knowledge on the species, mainly on anatomy, which is lacking in the literature, and to establish its identity.

This paper is the second of a series began by SIMONE (1994), on *Anodontites trapesialis*, with the objective of describing anatomically each Mycetopodidae species, giving base for future systematic and phylogenetic analyses.

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## MATERIAL AND METHODS

Material Examined. BRAZIL, *Mato Grosso do Sul*: Corumbá (Medalha Bay, near Parque road, Passo do Lontra), MZUSP 28119, 25 specimens, 11/XII/1993; MZUSP 28120, 3 specimens, same local, 4/VI/1995; Miranda River, near Salobra River, MZUSP 28083, 1 specimen, 8/IX/1990, S.V. Leone *leg.*

The specimens were fixed in 70% ethanol, and were deposited in the Museu de Zoologia da Universidade de São Paulo (MZUSP) collection.

The specimens were dissected by standard technique, immersed in 70% ethanol. The inner surface of the stomachs were observed by means of a median-dorsal incision. Intestinal loops were observed in dissection of visceral mass and also by serial sections of 10  $\mu$ m, using the normal histology technique, stained with Mallory.

Anatomical terminology is based on HEBLING (1976) and PURCHON (1958) referent to stomach. Anatomical comparisons with other Mycetopodidae species are based on VEITENHEIMER (1973a,b); MANSUR (1974), HEBLING (1976), VEITENHEIMER-MENDES & MANSUR (1978), MANSUR & SILVA (1990), AVELAR (1993) and SIMONE (1994).

In synonymic list (syn) means synonymy, (R) river. Only the more important localities are indicated.

Abbreviations. (am) anterior adductor muscle, (ap) anal papilla, (au) auricle, (ar) anterior retractor muscle of foot, (baa) anterior pouch of sorting area, (bap) posterior pouch of sorting area, (c) conical protuberance on floor of stomach, (cv) ctenidial vein, (da) anterior gastric fold, (ddd<sup>1</sup>) orifice of left duct of digestive gland, (ddd<sup>2</sup>) orifice of right duct of digestive gland, (dg) digestive gland (diverticula), (dh) dorsal hood, (ec) excurrent canal, (ft) foot, (go) gonad, (gs) gastric shield, (ic) incurrent canal, (id) inner demibranch, (in) intestinal loops, (ki) kidney, (lp) left pouch, (ls) ligament supporting gills, (mb) mantle border, (ne) nephrostome, (od) outer demibranch, (oc) esophagus, (pa) posterior adductor muscle, (pm) protractor muscle of foot, (po) posterior aorta, (pp) palps, (pr) posterior retractor muscle of foot, (r) dorsal ridge of stomach, (rt) rectum, (ry) rectal typhlosolis, (sb) shell border, (ss) style sac, (st) stomach, (tm) transversal muscles, (tr) transversal gastric ridge, (ty) major typhlosolis, (up) union between left and right mantle lobes, (ve) ventricle.

### *Anodontites elongatus* (Swainson, 1823)

*Anodon elongatus* Swainson, 1823 (pl.176) [South America?].

*Margarita (Anodonta) elongata*; Lea, 1836: 53; 1838: 32.

*Anodonta elongata*; Hanley, 1842: 223; 1843: 223. – Adams & Adams, 1857: 503.

*Anodon elongata*; Catlow & Reeve, 1845: 66.

*Anodonta solidula* Deville & Hupé, 1850: 644, pl.16, f.2. – Hupé, 1857: 88, pl.18, f.2 [Amazon]. – Adams & Adams, 1857: 503. – Clessin, 1876: 221, pl.73, f.2. – Paetel, 1890: 185. – Simpson, 1900: 928 (syn). – Haas, 1931: 90 (syn).

*Margaron (Anodonta) solidula*; Lea, 1852b: 53; 1870: 83.

*Anodonta wheatleyi* Lea, 1852a: 287: pl.26, f.49; 1952c: 43, pl.26, f.49. – Adams & Adams, 1857: 503. – Clessin, 1874: 113, pl.36, f.3-4. – Hupé, 1857: 90, [Pará]. – Paetel, 1890: 186. – Simpson, 1900:

928 (syn). – Haas, 1931: 90 (syn).

*Margaron (Anodonta) wheatleyi*; Lea, 1852b: 51; 1870: 82.

*Anodonta schröteriana* Lea, 1852a: 292, pl.29, f.55; 1852c: 48, pl.29, f.55. – Hupé, 1857: 89, pl.18, f.3 [Amazon]. – Adams & Adams, 1857: 503. – Clessin, 1874: 151, pl.47, f.5-6. – Paetel, 1890: 184. – Haas, 1931: 90 (syn).

*Anodonta holtonis* Lea, 1857a: 85; 1857b: 316, pl.32, f.31. – Clessin, 1874: 149, pl.50, f.5-6. – Wright, 1888. – Paetel, 1890: 180. – HAas, 1931: 90 (syn).

*Margaron (Anodonta) schröteriana*; Lea, 1852b: 51; 1870: 82.

*Anodonta (Lamproscapha) wheatleyi*; Adams, 1866: 443 [Ucayali R., Peru].

*Anodon dactylus* Sowerby, 1867 (pl.19, f.75) [hab: ?]. – Simpson, 1900: 929 (syn). – Haas, 1931: 90 (syn).

*Anodon schröteriana*; Sowerby, 1868 (pl.20, f.77) [upper Amazon R.].

*Anodon solidula*; Sowerby, 1869 (pl.23, f.91) [Amazon R.].

*Anodon amethystus* Sowerby, 1869 (pl.24, f.95) [hab: ?]. – Simpson, 1900: 929 (syn). – Haas, 1931: 90 (syn).

*Anodon haltonis*; Sowerby, 1870 (pl.36, f.147) [near Cartago, New Grenada].

*Margaron (Anodonta) holtonis*; Lea, 1870: 79.

*Margaron (Anodonta) dactylus*; Lea, 1870: 80.

*Anodonta amethysta*; Clessin, 1875: 180, pl.60, f.3.

*Anodonta dactylus*; Clessin, 1875: 175, pl.62, f.3. – Paetel, 1890: 178.

*Margaritana schröteriana*; Paetel, 1890: 173.

*Glabaris wheatleyi*; Ihering, 1893: 120 [Amazonas basin].

*Glabaris solidula*; Ihering, 1893: 121 [Amazonas basin].

*Glabaris holtonis*; Simpson, 1900: 921.

*Glabaris elongatus*; Simpson, 1900: 928.

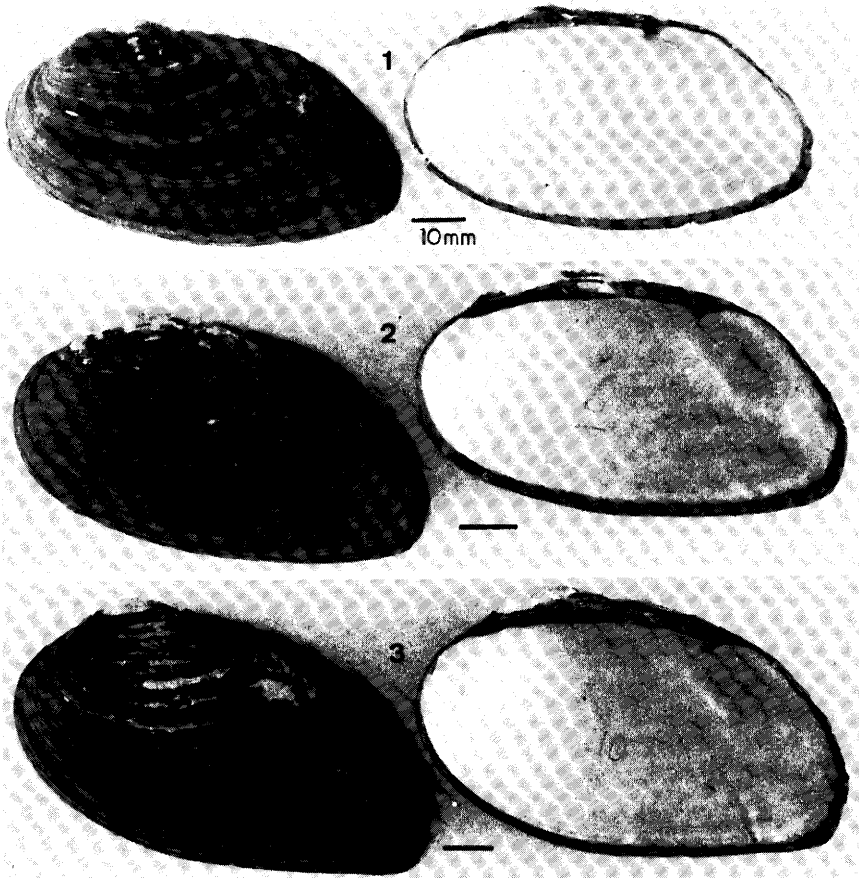
*Glabaris schröterianus* [sic]; Simpson, 1900: 931.

*Anodontites (Anodontites) elongatus*; Haas, 1931: 90 [Tatui R., SP; Mirim R., SP; Goiás; Amazonas; Popayan, Colombia; Magdalena R., Colombia]. – Schade, 1965: 121 [Guaira R., Paraguay].

Diagnosis. Shell long antero-posteriorly, umbones prominent, periostracum opaque and smooth, two posterior radial striae; middle fold of mantle edge very tall; gill long antero-posteriorly and short dorso-ventrally, extending about a half of its total length beyond visceral mass; palps proportionally small, several furrows in its outer surface; stomach without esophageal transversal ridge, dorsal hood and gastric shield poorly developed, major typhlosole entering in  $ddd^2$ , posterior pouch of  $sa^3$  very-long; style sac reduced, without crystalline style; distal region of intestine and rectum with a well developed typhlosole, “T” in section, other intestinal regions without folds; gonad gonochoristic.

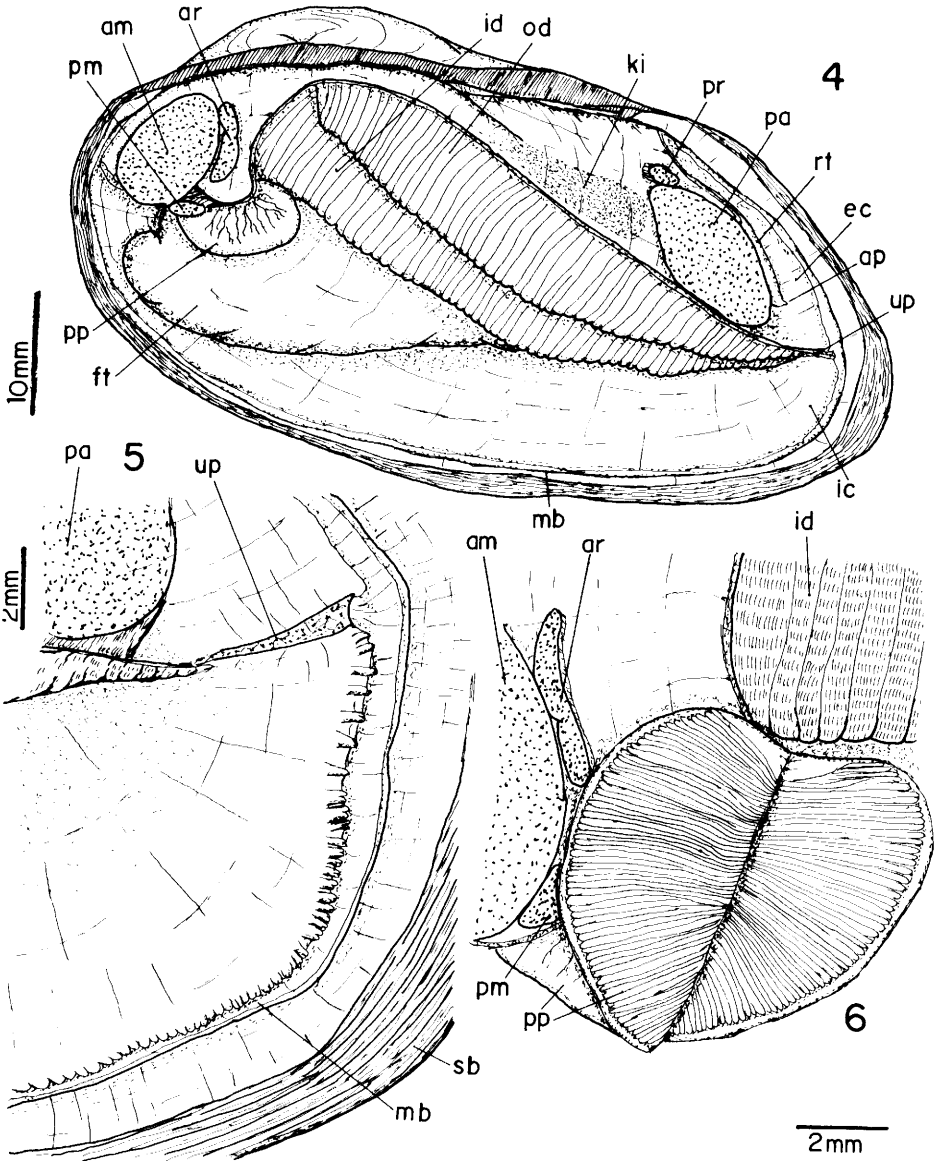
Description. Shell (Figs 1-3). Medium sized (to 60mm), antero-posteriorly long, elliptic outline, thick walled, somewhat rounded in section, dark-brown in color. Umbones somewhat outstanding, rounded, sited in anterior third part of ridge. Periostracum slight thick and opaque, lost near umbones. Sculpture lacking, except for concentric undulations, growth-lines and two conspicuous radial striae between mid and posterior regions of each valve. Hinge edentulous, ligament in all extension of ringe, thick in its mid and posterior regions; in posterior extremity a small triangular enlargement in each valve. Anterior scar elliptic, formed by adductor anterior retractor of foot muscles, protractor muscle of foot scar smaller and sited connected ventral and posterior to anterior adductor scar. Posterior adductor scar

also elliptic, with an upper connected smaller scar of posterior retractor of foot. Dorsal or cardinal muscle scar missing. Pallial line simple. Nacre border somewhat narrow, of homogeneous width.



Figs 1-3. Samples of shell variation of *Anodontites elongatus* (MZUSP 28119). (1) Typical form, i.e., form of most part of specimens, an elliptic outline; (2) specimen with a sharp angle in posterior-ventral region; (3) largest collected specimen, very similar to literature figures of *A. schroeteriana*.

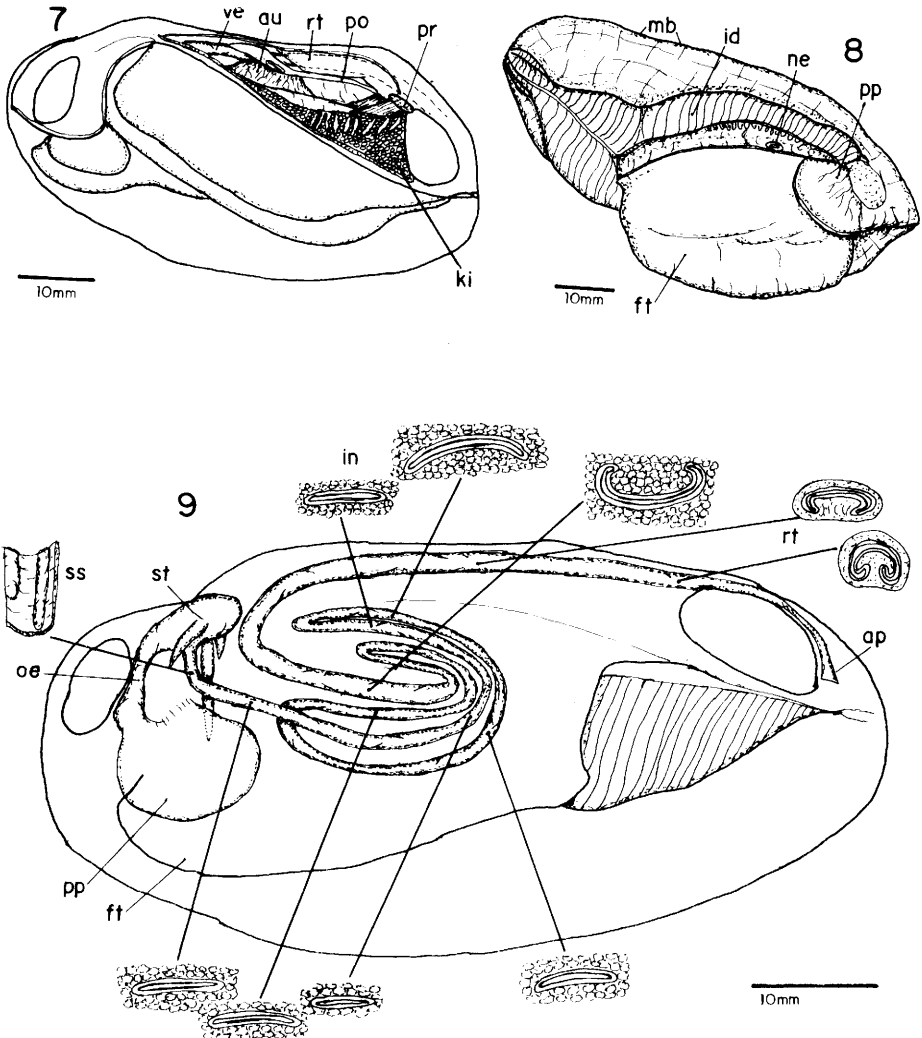
Mantle border. Simple, trifolded, without union except between incurrent and excurrent channels (Figs 4, 5: up). Tentacles small and simple, sometimes bifurcated, from incurrent channel into middle portion of ventral region, where gradually faint (Fig. 5); other regions without tentacles. In mid region of incurrent channel three pairs of tentacles slightly larger (Fig. 5). Color pale-cream with minute dark spots in exposed areas, mainly in posterior region. Middle fold of mantle edge very tall in all examined specimens (Fig. 19).



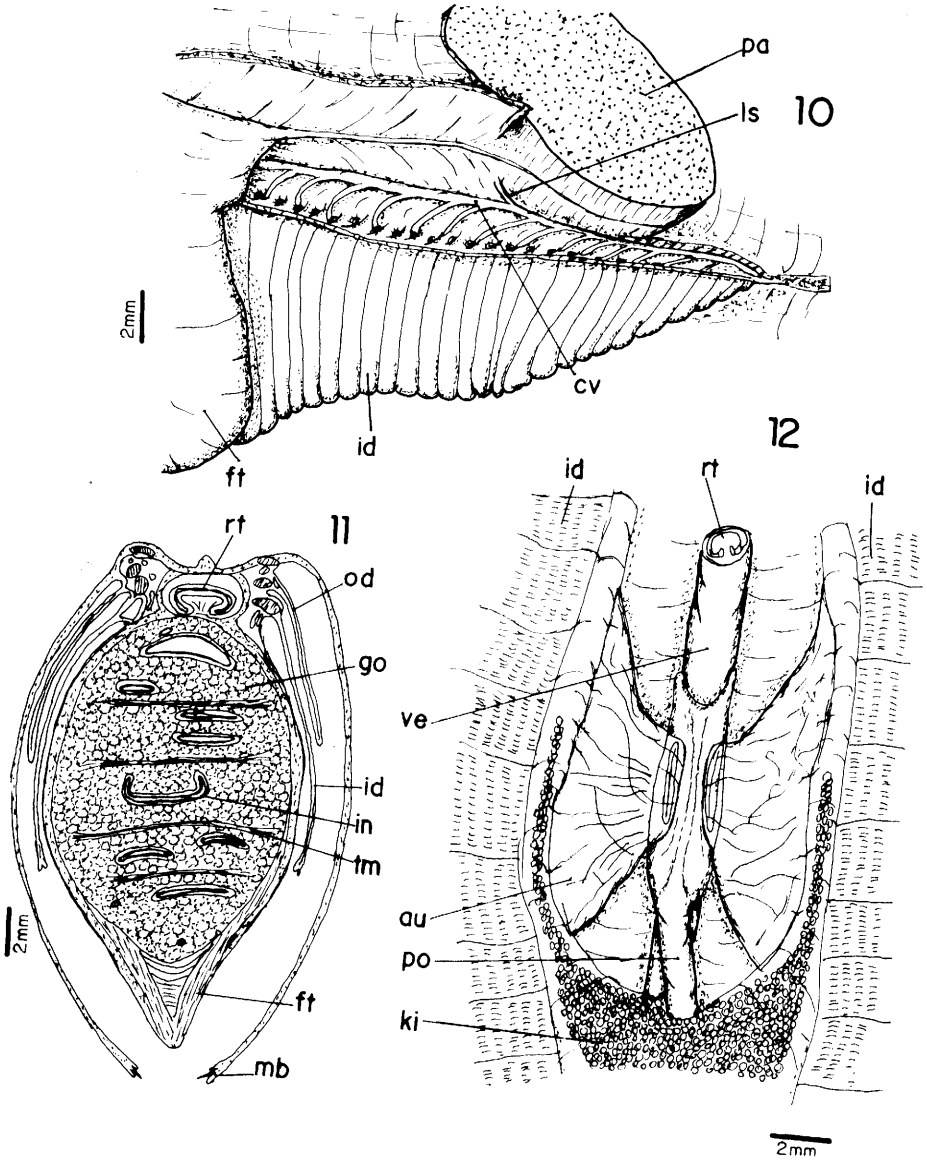
Figs 4-6, *Anodonites elongatus* anatomy. (4) Outer view of left region of pallial cavity, left mantle lobe partially removed; (5) detail of incurrent canal, left mantle lobe removed; (6) detail of left palp, outer hemipalp deflected to show inner folds.

Ctenidium. With strong transversal folds as normal mycetopodid (Fig. 4); folds discreetly broad and very numerous. Gill dorso-ventrally short, antero-posteriorly long, inner demibranch broader than outer demibranch (Fig. 4). Other

characters, inclusive microscopic details of gill, as normal of family. Posterior region of gill beyond visceral mass, where left inner demibranch unites with right one, very long (about half of total gill length) (Figs 8, 10). Main vessel of ctenidium in its dorsal region (Fig. 10: cv) which bears several secondary vessels arranged, in both demibranchs, one each two transversal folds (Fig. 10).

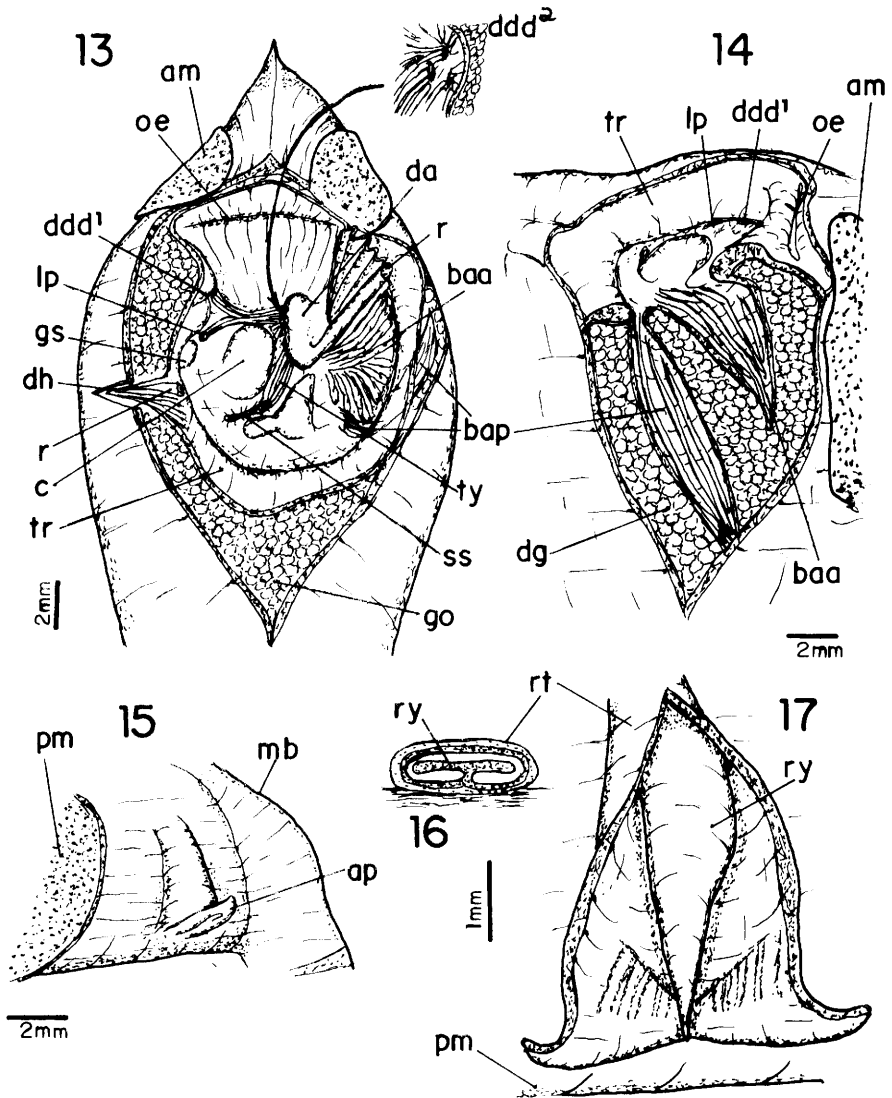


Figs 7-9. *Anodontites elongatus* anatomy. (7) Excretory and circulatory systems, left view, other structures schematically drawn; (8) nephrostome exposed by means of an incision in insertion of right inner demibranch in visceral mass, gill deflected; (9) scheme of digestive system ducts, left view, annexed a detail of style sac (ss) and sections of indicated parts of intestine and rectum.



Figs 10-12. *Anodontites elongatus* anatomy. (10) Posterior region of mantle cavity, left view of right inner demibranch, left pallial organs removed; (11) section in mid region of visceral mass; (12) heart in ventral view, anterior region upper.

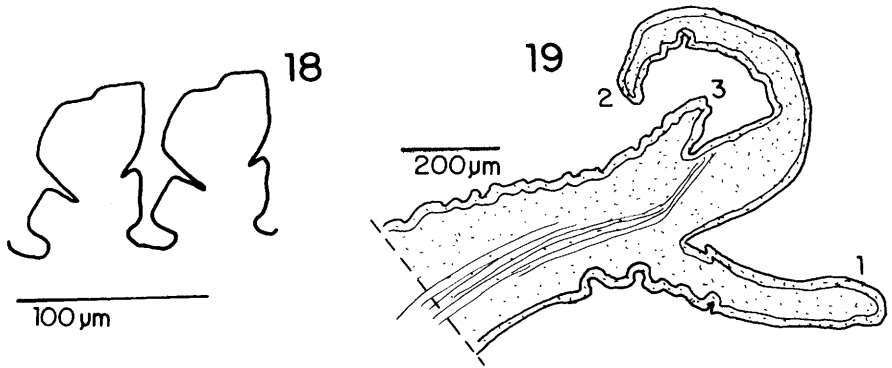
Digestive system. Palps proportionally small, with elliptic outline (Fig. 4); externally several irregular, shallow, radial furrows (Fig. 4); inner folds narrow, mainly visible by means of a microscope, finish near border, an inner smooth margin present (Fig. 6); profile of folds of palps shown in figure 18. Two small zones



Figs 13-17, *Anodontites elongatus* anatomy. (13) Stomach in dorsal view, stomach dorsal wall deflected, dorsal mantle cover removed; (14) detail of stomach in lateral-right view, mantle cover and dorsal stomach wall removed; (15) detail of anal papilla, posterior view, right mantle lobe removed; (16) transversal section of rectum in region when it is exposed; (17) anal papilla opened longitudinally in its mid line.

without folds in anterior and posterior extremities of palps (Fig. 6). Mouth and short esophagus very-broad, about same width of anterior adductor muscle (Fig. 9). Esophagus internally with smooth surface, without transverse rim. Stomach (as normal unionoid) type IV by Purchon's (1958) classification (Figs 9, 13, 14). Minor





Figs 18-19. *Anodontites elongatus* details of serial sections. (18) Scheme of profile of two inner folds of palps, in its middle region; (19) mantle border showing the outer (1), mid (2) and inner (3) folds.

typhlosole (ty) difficult in being individualized, once several folds, of same size, run parallel to it, disappear anteriorly into right aperture of digestive gland ( $ddd^2$ ). Two or three similar folds begin in this aperture and finish part in left aperture of digestive gland ( $ddd^1$ ) and part in aperture of left pouch (Fig. 13). Into each digestive gland aperture, three ducts from digestive glands open. Upper cited folds penetrate into digestive gland ducts. Dorsal hood relatively far from other gastric structures, small, on left and mid side of stomach, internally longitudinal low folds (Fig. 13: dh). Sorting area ( $sa^3$ ) with two pouches, anterior (baa) broader and shorter than posterior pouch (bap), which is very-long, lying ventrally near foot dorsal limit (Figs 13, 14); both sorting area pouches flattened, with several low, narrow, longitudinal folds in inner surface (Fig. 14). Other sorting areas not found. Anterior gastric fold (da) short, in its right-posterior region forms a ridge (r) which passes transversally in dorsal and mid-posterior region of gastric wall; this ridge finishes in right side near dorsal hood anterior limit; produces an anatomic esophageal chamber. Left pouch small, into which open two ducts from digestive gland. Gastric shield (gs) very-small and thin, with slightly homogeneous surface, without projections. On floor of stomach, in left side of intestinal groove (ss) a conspicuous, somewhat rounded mound (c) without annexed ridges. A thick ridge (tr) in almost entire circumference of stomach, except anterior, with a smooth surface; this ridge divides interior of stomach into dorsal and ventral compartments. Style sac very reduced, shown only by two small, short, shallow folds, in initial portion of intestine, afterwards intestine is a flattened tube without inner folds (Fig. 9: ss). Style not found. Other regions of intestine as normal mycetopodid, bearing four ample loops in visceral mass, inner folds lacking (Fig. 9). Terminal region of intestine, before rectum, very broad, with a median, voluminous and broad typhlosole, in its dorsal surface (Fig. 9). In rectum (Fig. 9: rt), base of this typhlosole (now in ventral surface) narrows gradually, becoming "T" in section; in region near posterior adductor muscle extremities of "T" coil. In final region, near anal papilla, typhlosole is dorso-ventrally flattened and broad (Fig. 16), with a very-small base, tapers into

ventral and middle limit of anal papilla (Fig. 17). Anal papilla bordered by thick walls (Fig. 15).

Visceral mass. Serial sections show digestive gland (diverticules) mainly distributed in anterior region near stomach, and gonochoristic gonad in mid and posterior regions (Fig. 11).

Excretory-circulatory systems. Both as normal Unionoida, and shown in figures 7 and 12. Kidney well-developed, dark colored, with a series of small, clear, outer glandular folds arranged transversally. Nephrostome in anterior region of dorsal border of inner demibranch (Fig. 8: ne). Heart proportionally short, sited in middle region of dorsal line (Fig. 7), auricle walls thin and transparent (Figs 7, 12). Ventricle valves slit-like, bordered by thick elevated walls (Fig. 12).

Range. Amazon and Paraná Basins, from Colombia to Uruguay.

Habitat. Little is known on the life-habits of this animal, the author only collect it twice, in a single day each, and in the literature no information about habitat is found. The specimens were found in shallow water (about 0.5m deep), near surface of the sediment, which is a muddy sand, in a lake with slow current. It is interesting to note that generally the most common naiad in the South American collect sites are specimens of the genus *Diplodon* (Hyriidae), but no *Diplodon* was found in the local where occurs *A. elongatus*, which has a similar outline and size of the most *Diplodon* species. In the same local of *A. elongatus* were found *A. trapesialis* (Lamarck, 1819), *Mycetopoda siliquosa* (Spix, 1827) and *Castalia* sp. (several specimens of each), two specimens of *Monocondylaea* sp. and only one *A. patagonicus* (Lamarck, 1819).

Discussion. By antero-posterior elongation, *Anodontites elongatus* has some similarity with *Anodontites obtusus* (Spix, 1827) and *A. trigonus* (Spix, 1827), differs conchologically from both in having larger size, thick walls, umbones more outstanding and periostracum smooth (without reticulation). *A. elongatus* has some affinity also with species of the *A. patagonicus* group, differs by antero-posterior elongation.

The characters listed in the diagnosis differ *A. elongatus* from the other species of Mycetopodidae with known anatomy (see references cited in material and methods section). The main distinctive characters of the soft parts are stomach with poorly developed dorsal hood and gastric shield, posterior pouch of the sorting area  $sa^3$  very-long, style sac reduced with style missing and the "T" in section typhlosole of the rectum.

*A. elongatus* differs from *Anodontites trapesialis* (*sensu* SIMONE 1994) in having shell smaller, with thick walls and an elliptic outline; also in having gill and palps proportionally smaller; palps externally with several furrows, internally folds difficult to be seen, smooth inner area of the palps smaller; mantle without fourth fold, but with tentacles in incurrent canal; style sac reduced without style and inner structures; "T" shaped typhlosole in the rectum; anal papilla with thick walls; gonad gonochoristic and separated from the digestive gland.

The stomach of *A. elongatus* differs from the stomach of *A. trapesialis* (HEBLING 1976) in having: esophagus without transversal ridge; anterior fold shorter; transversal ridge in mid-dorsal gastric wall; dorsal hood poorly developed and far from the other gastric structures; posterior pouch of the sorting area ( $sa^3$ )

very-longer; no other sorting area well developed; gastric shield poorly developed; protuberance of the floor rounded, without projections; major typhlosole small and with several similar folds in its sides, major typhlosole finishing in  $ddd^2$  (and not in  $ddd^1$ ); separated folds from  $ddd^2$  into  $ddd^1$  and left pouch; absence of a fold around the aperture of the style sac.

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