

Recharacterization of *Strophocheilus miersi* Da Costa (Mollusca, Pulmonata, Strophocheilidae) ¹

Meire Silva Pena ^{2,3}, Norma Campos Salgado ² & Arnaldo C.dos Santos Coelho ²

¹ Contribution number 79 of the Malacologia, Departamento de Invertebrados, Museu Nacional, Universidade Federal do Rio de Janeiro.

² Departamento de Invertebrados, Museu Nacional. Quinta da Boa Vista, São Cristóvão, 20940-040 Rio de Janeiro, RJ, Brasil. E-mail: malacomn@mn.ufrj.br, nsalgado@pfe.microlink.com.br

³ Departamento de Ciências Biológicas, Pontifícia Universidade Católica de Minas Gerais. Avenida Dom José Gaspar 500, Coração Eucarístico, 30535-610 Belo Horizonte, Minas Gerais, Brasil. E-mail: mpenapuc@pucminas.br

ABSTRACT. *Strophocheilus miersi* Da Costa, 1904 is recharacterized by the conchology and morphology of the soft parts, the latter for the first time. Palial complex, reproductive and digestive systems provide important characteristics to enrich the knowledge of the genus *Strophocheilus* Spix, 1827. The presence of four arched folds in the posterior region of the pediose mass and the morphology of the suprapediose gland offered more data to identify and diagnose the species.

KEY WORDS. Brazil, conchology, morphology of soft parts, taxonomy.

RESUMO. *Strophocheilus miersi* Da Costa, 1904 é recharacterizado pela conquiologia e pela primeira vez a morfologia das partes moles. Complexo palial, sistemas reprodutor e digestivo forneceram importantes caracteres para enriquecer o conhecimento sobre *Strophocheilus* Spix, 1827. A presença de quatro pregas arqueadas na região posterior da massa cefalopediosa e a morfologia da glândula suprapediosa acrescentaram dados para a diagnose da espécie.

PALAVRAS CHAVE. Brasil, conquiologia, morfologia das partes moles, taxonomia.

Strophocheilus miersi Da Costa, 1904 was presented for the first time at the Ordinary Meeting of Society of London in 1903 by Da Costa, based on the study of shell from Minas Gerais State, Brazil, but the description and illustrations of the shell were only published in 1904.

HAAS (1929) cited *S. miersi* among the Brazilian species of O. Frische Taucha Colln, from Rio Doce region, Espírito Santo State, deposited in Senckenberg Museum, Frankfurt a Main, Germany.

The knowledge about this species was enriched by BEQUAERT (1948) who gave the diagnosis, synonymy and illustration of a shell also collected in Espírito Santo, and correctly identified by F. Lange-de-Morretes in 1937 (MZUSP 3234).

Afterwards, LEME (1973) based on anatomical characteristics of *Strophocheilus debilis* Bequaert, 1948 and the stomach of *S. pudicus* (Müller, 1774), established the diagnosis of *Strophocheilus* Spix, 1827, and considered in this genus four more species: *S. miersi* Da Costa, 1904, *S. contortuplicatus* (Reeve, 1850), *S. calus* Pilsbry, 1901 and *S. roseolabris* Bequaert, 1948.

The capture of living specimens belonging to this genus allowed to give continuity to the study about *Strophocheilus*

whose species have not had their internal morphology well-known until the present moment.

The conchology already done together with the data obtained from studies carried out with palial complex, reproductive and digestive systems, foot tegument and suprapediose gland led us to diagnose *S. miersi*, enrich the knowledge of the *Strophocheilus* and to have important characteristics to provide subsequent comparisons with the soft parts of the other species, in addition to recharacterising them.

MATERIAL AND METHODS

The material studied consists of specimens captured from Reserva Biológica de Santa Lúcia, Santa Teresa Municipality, Espírito Santo State and shells deposited in The Natural History Museum (NHM), London; Museu de Zoologia, Universidade Federal do Espírito Santo (MZ/UFES), Vitória; Museu Nacional, Universidade Federal do Rio de Janeiro (MNRJ), Rio de Janeiro, and Museu de Zoologia, Universidade de São Paulo (MZUSP), São Paulo. This material is listed after the characterization of the species.

The measurements of the shells were accomplished with a Kanon Calipter: height (h); width (w), height and width of aperture (ha,wa). The number of whorls was determined according to DIVER (1931) and colors codified by KÜPPERS (1979).

Dissections were done on a distended specimen, after being kept under cold water for 24 hours and preserved in alcohol at 70° GL. The radula and jaw were removed from the bulb, boiled in KOH at 10% cleaned in KOH at 5% and dehydrated in alcohol series to 70°GL; the radula was mounted on a metallic stub, dried in sterilizer and metalized in gold.

Shell and soft parts were studied and drawn using WILD M5 stereoscopic magnifying glass with a camera lucida connected.

Photos of shell were made using a Canon F1 with a Canon macro lens 50 mm; micrographs of radula and details of a roof of the palial cavity with SEM (DSM 950 Zeiss) and Leo 435 VPZ Zeiss, respectively.

RESULTS

Strophocheilus miersi Da Costa, 1904

Figs 1-16

Strophocheilus miersi Da Costa, 1904: 5, pl. 1, fig. 2; Haas, 1929: 8; Bequaert, 1948: 37-39, pl. 26, fig. 1, pl. 7, fig. 1, pl. 31, fig. 3; Lange-de-Morretes, 1949: 140; Leme, 1973: 329; Salgado & Coelho, 2003: 157.

Strophocheilus (Strophocheilus) miersi Da Costa, 1904 Lange-de-Morretes, 1952: 112; Lange-de-Morretes, 1954: 63.

Type. The Natural History Museum (without register number).

Type-locality. Minas Gerais, Brazil (DA COSTA 1904).

Remarks. BEQUAERT (1948) suggest that "the type of the species was collected presumably in the section of Minas Gerais, bordering on Espírito Santo".

Geographical distribution. Brazil, Minas Gerais State (DA COSTA 1904); Brazil, Espírito Santo State (LANGE-DE-MORRETES 1949, 1952), Vale do Rio Doce (HAAS 1929), Linhares, Fundão and Santa Tereza Municipalities.

Diagnosis. Shell oblong-ovate, profile more convex to the left side and extended to the right, flat parietal margin which forms an acuminate angle with the outer lip, columellar callus slightly twisted; stomach with thin walls that become dense at the curvature area, ovarioteste in the inner face of the digestive gland and the presence of four arched folds in the posterior region of the pediose mass.

Characterization. Shell (Figs 1-3). Oblong-ovate, profile more convex to the left side and extended to the right, periostracum slightly attached, dark-brown (Küppers N₈₀A₃₀M₃₀) and yellowish-olivaceous (Küppers N₂₀A₆₀M₃₀); 5¼ whorls. Protoconch smooth in the first 1½ whorls, sculptured by fine axial striae, more pronounced at the inferior region; limits with the teleoconch are well defined by the presence of

a small network corrugation and slight thickness. Suture submarginated. Oval-elongated aperture with flat parietal margin which forms an acuminate angle with the outer lip; white and expanded peristome, columellar callus developed and slightly twisted. Dimensions (mm) (5 shells) – h: 70.6-76.1; w: 29.3-35.4; ha: 34.1-37.4; wa: 16.6 -17.6 mm.

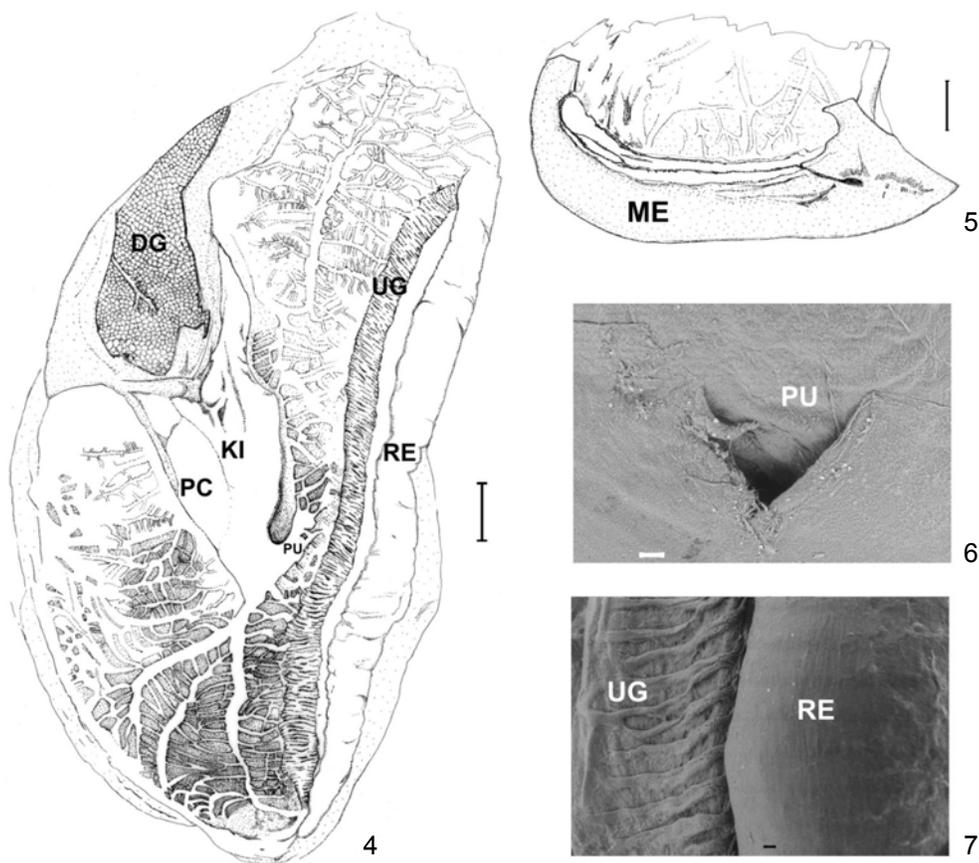
Palial complex (Figs 4-7). The palial cavity is ample with the roof without a pulmonary septum and densely vascularized. The prominent pulmonary vein, receives two transversal veins of the same caliber, coming from the mantle border. The posterior area of the roof is less pigmented with slender veins, except one that runs from the edge of the posterior lobe of the digestive gland to the elongated kidney which has a fronto-lateral extension in the direction of the rudimentary ureter area. Along the rectum there is a transversally folded area forming a drainage canals to urinary gutter. Thick mantle border split in pneumostoma region.

Digestive system (Figs 8-13). Globular bucal mass with evident dorsal and muscular papilla among retractor muscles. Jaw (Fig. 8) with only an arched plate, slightly longitudinal striated and dark-brown pigmented. Radula with central tooth plus 77 teeth per half row (C+77) – the central (Fig. 9) has a rectangular base medianally symmetric. The lateral teeth (Fig. 10) are bigger with inclined cusp to the interior of the radula and the marginals (Fig. 11) with curved cusp and short base. The pharynx is short and narrow and the long esophagus has a developed median region with the salivar glands above it. The stomach (Fig. 13) embedded in the posterior portion of the digestive gland has in general thin walls except at the curvature area where there is a denser muscular wall. In the dorso-median region of the stomach there is a papilla-shaped projection which connects the sides of the structure increasing this area.

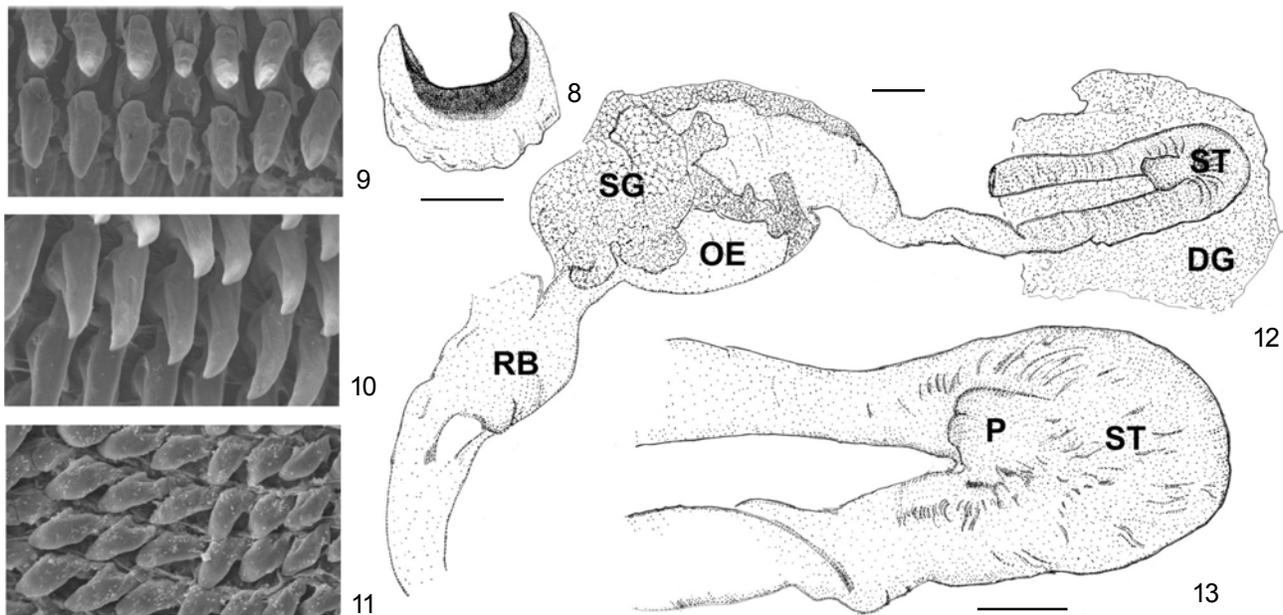
Reproductive system (Fig. 14). Ovariotestis localized on the inner face of the digestive gland, constituted by a group of well-developed follicles, draining through the long and slender conductor duct; long and enovelated hermaphrodite duct with brown pigmentation, dilated at the distal portion; fertilization complex, beside the albumen gland, formed by a blind sac-shaped structure, completely detached, accompanying the junction of the hermaphrodite duct; voluminous, white-translucent albumen gland, not lobulated, sheltered in its concave region with the fertilization complex and the proximal portion of the ovispermoduct, which is muscular and has a short glandular-duct; the prostate is distinct only by its partial wrinkled aspect; extremely long bursa duct with regular diameter bursa duct and a sac-shaped *bursa copulatrix*; long deferent duct with variable diameter, emerging at the end of the prostate, slightly below the bifurcation with the bursa duct. This duct bends to accompany the penis complex and penetrates laterally, just the point of detachment from the penis, forming a small curvature - the epiphallus - at the same level where the wide and split retractor muscle is inserted. The flagellar region lacking.



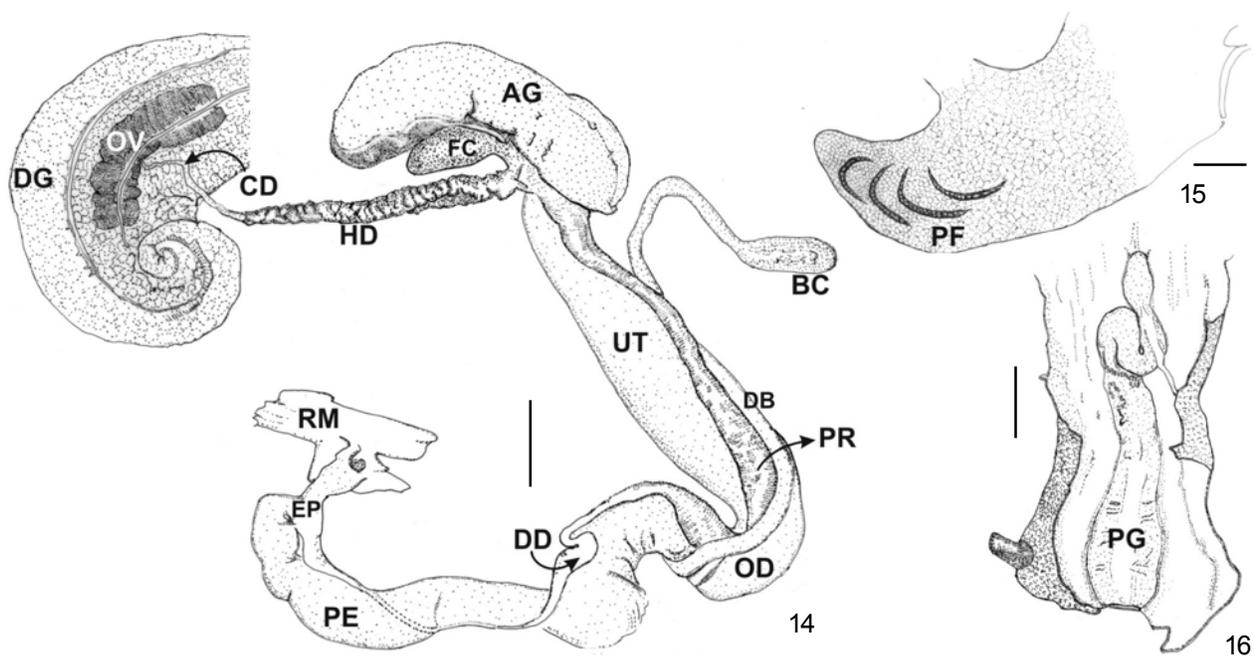
Figures 1-3. *Strophocheilus miersi*, shell and protoconch, MNRJ 9464 (h: 76.1, w: 34.4 mm). Photos by P.M.S. Costa.



Figures 4-7. *Strophocheilus miersi*, MNRJ 9464: (4-5) roof of palial cavity and mantle border, scale bars: 5 mm; (6): primary ureter, Leo 435; (7) urinary gutter, Leo 435. (DG) Digestive gland, (KI) kidney, (ME) mantle border, (PC) pericardial cavity, (PU) primary ureter, (RE) rectum, (UG) urinary gutter.



Figures 8-13. *Strophocheilus miersi*, MNRJ 9464: (8) jaw, scale bars: 1 mm; (9) radula, central tooth, S.E.M.; (10-11) lateral and marginal teeth, S.E.M.; (12) digestive system; (13) detail of the papilla. (DG) digestive gland, (OE) esophagus, (P) papilla, (RB) radular bulb, (SG) salivar gland, (ST) stomach. Scale bars figures 12-13: 3 mm.



Figures 14-16. *Strophocheilus miersi*: (14) reproductive system, MNRJ 9464; (15-16) pediose mass, MNRJ 9464: (15) pediose fold (PF); (16) suprapediose gland (PG). (AG) Albumen gland, (BC) bursa copulatrix, (BD) bursa duct, (CD) collector duct, (DD) deferent duct, (DG) digestive gland, (EP) epiphallus, (FC) fertilization complex, (HD) hermaphroditic duct, (OV) ovariotestis, (OD) oviduct, (PE) penis, (PR) prostate, (RM) retractor muscle, (UT) uterus. Scale bars: 5 mm.

Pediose mass (Fig.15). Homogenous, light-gray, elongated, with sharpened posterior region, covered by rugose epithelium having four arched folds, which are dark-gray with pigmentation. Inside the mass there is a suprapediose gland (Fig. 16) firmly fixed to the floor of the cavity, folding over itself and returning to the anterior portion with opening between the bucal cavity and the foot.

Material examined. BRAZIL, *Minas Gerais*: NHM – Type (without register number), shell (photo) Miers *leg.* [in the 2nd label: Strophocheilidae. A.H.S.Breure,1975]. *Espírito Santo*: MZUSP 3234,1 shell (h:71, w: 35, ha: 35, wa: 15 mm). E.Garbe *leg.*, 1906; Linhares, Cupido,MNRJ 7494, 3 shells (h: 73.4 -75, w: 31.1-35.4, ha: 35-35.5, wa: 17,5 -17.6 mm), J.Evangelista *leg.*, 05.09.1960; Fundão, APA Guapaba-açu, MZ/UFES, 1 shell (h: 70.6, w: 29.3, ha: 34.1, wa: 16.6 mm), S.Tótola *leg.*, 28.III.2002; Santa Tereza, Santa Lúcia, MNRJ 9464, 1 shell (h:76.1, w: 34.4, ha: 37.4, wa: 17.4 mm), radula, jaw, soft parts: 2 roofs of pallial cavity, digestive and reproductive systems, pediose masses and suprapediose glands, M.S. Pena & N.C. Salgado *leg.*, 18.I.2002.

DISCUSSION AND CONCLUSIONS

The analyses of the shells of *S. miersi* from Santa Lúcia locality match with the original description of Da COSTA (1904) and the characterization presented by BEQUAERT (1948).

Shell ovate-oblong, medium size, deep and submarginated suture, Protoconch sculptured with axial striae, expanded peristome and developed columellar callus are the characteristics that confirm the position of *S. miersi* among the species, considered by LEME (1973), in the genus *Strophocheilus* Spix, 1827.

Protoconch sculptured with axial striae, expanded peristome and developed columellar callus are the characteristics that confirm the position of *S. miersi* among the species, considered by LEME (1973), in the genus *Strophocheilus* Spix, 1827.

As far as the soft parts are concerned, *S. debilis* Bequaert, 1948 is the only *Strophocheilus* species thoroughly characterized while *S. pudicus* (Müller, 1774) solely for the stomach. In the former species the ovarioteste is embedded in the digestive gland, there is a short and curve area in the superior region of the penis where defferent duct discharges, called pseudoepiphallus by LEME (1973) and the stomach consists of thick walls with internal folds. The latter one presents the stomach with folded internal surface with thin and transparent portion in the adjacent region of the esophagus. In *S. miersi* the ovarioteste is juxtaposed to the digestive gland, the stomach has thin walls except at the curvature where there is a denser muscular area and the region where the defferent duct discharges is named epiphallus.

Due to the little knowledgwe of the morphology of the soft parts it was made necessary to compare the structures here analysed with those of Strophocheilidae and Megalobulimidae.

The organization of the palial complex corresponds to a pattern described by LEME (1973) for the Strophocheilidae.

BARROS-ARAÚJO (1971), when referring to a more calibrose vase than the others, near the digestive gland in the roof of the palial cavity of *Gonyostomus (Anthymus) turnix* (Gould, 1846), affirmed that it seemed to be the common to the Strophocheilidae. A calibrose vein is also present in *S. miersi* as well the left side of the roof more extensive than the right with more pigmentation and vascularization. The presence of “lamellas obliquely orientated for the anterior and right side”, that conducted the waste products to the urinary gutter, were found and described by HYLTON-SCOTT (1939) in *Strohocheilus lorentzianus* (Döering, 1879), later included in *Megalobulimus* Muller, 1878 by LEME & INDRUSIAK (1990). These stuctures were also observed in *Mirinaba antoninensis* (Lange-de-Morretes, 1952) by LEME *et al.* (1979) and now in *S. miersi*.

LEME (1973) called “the incipient primary ureter” the rounded vesicle-like expansion situated next to the excretory opening wich was characterized by BARROS-ARAÚJO (1971: 427). This area is also observed in *S. miersi*.

LEME (1974) when describing *Gonyostomus insularis* referred to the jaw as being “smooth with a median projection” which could be understood as being formed only by one plate, as was observed in *S. miersi*. The same author, in 1989, describing *Megalobulimus lopesi*, referred to the radula as being typical to Megalobulimidae, with a barret-shaped central tooth that presented a sharp apex and concave base. In *G. insularis* he noted that the radula has unicusp teeth without specific characteristics. HYLTON-SCOTT (1939) characterized the radula and drew attention to the slight curve to the interior of the lateral teeth as observed in *S. miersi*. This characteristics presented by the radulas showed that it is not typical of the Strophocheilidae as LEME (1973) had affirmed.

The distal region of hermaphrodite duct called “talon” by LEME (1973, 1989) is much convoluted in *S. debilis*, slightly developed in *Megalobulimus lopesi* while it is more developed in *M. lorentzianus apud* HYLTON-SCOTT (1939). Both authors identified the glandular anex-sac as a bag-shaped structure localized at the base of the albumen gland. LEME (1974) named this structure the “fertilization sac” in *G. insularis*. In *S. miersi* this structure is called fertilization complex as SALGADO *et al.* (1995) denominated it for three species of *Thaumastus* Martens in Albers, 1860.

The copulatrix bursa denominated “spermateca” by HYLTON-SCOTT (1939) for *M. lorentzianus* is pear-shaped while in *S. miersi* it is tubular, wider than the duct that preceded it.

The terminology applied to the regions of the penian complex, especially in Strophocheilidae and Megalobulimidae species given origin to different terms:

LEME (1973) named pseudoepiphalus in *S. debilis* the short and curved area in the superior region of the penis where the defferent duct discharges. In the characterization he referred to it as “short”. BARROS-ARAÚJO (1971) illustrated the internal-apical area of this complex denominating it “epiphalus” in *G. turnix*, showing the detachment of the penis lumen; to this

author, the epiphallus is not only an enlargement of the defferent duct. HYLTON-SCOTT (1939) illustrated in *M. lorentzianus* the internal morphology of the posterior portion that receives a defferent duct, which is named epiphallus. In *Mirinaba* Morretes, 1852, LEME (1974) cited this region as epiphallus and pseudoepiphallus which is variable in shape and sometimes absent. In *S. miersi* this region was referred by us, as epiphallus.

Based on the morphologies of the shell and the soft parts, including the presence of four arched folds in the posterior region of the pediose mass and the anatomy of supra-pediose gland, *S. miersi* was diagnosed and recharacterized.

The studies carried out with the jaw, radula, reproductive and digestive systems and pediose mass provide data to compare and allows us to continue the studies in Strophocheilidae and Megalobulimidae families so well represent in Brazil.

ACKNOWLEDGEMENTS

We are grateful to Dr. Henrique Leonel Lenzi, Departamento de Patologia, Instituto Oswaldo Cruz, Rio de Janeiro, for Leo micrographs. Thanks are also due to Paulo Márcio Santos Costa, pos-graduate student of the Zoology Program, Museu Nacional, Universidade Federal do Rio de Janeiro for the shell photos and Dr Luiz Ricardo Simone, Museu de Zoologia, Universidade de São Paulo for the photo type.

REFERENCES

- BARROS ARAUJO, J.L. 1971. Contribuição ao conhecimento de *Gonyostomus (Anthinus) turnix* (Gould, 1846) (Mollusca, Pulmonata, Strophocheilidae) **Revista Brasileira de Biologia**, Rio de Janeiro, **31** (4): 425-430.
- BEQUAERT, J.C. 1948. Monography of the Strophocheilidae, a Neotropical family of terrestrial mollusks. **Bulletin of Museum of Comparative Zoology**, Cambridge, **100** (1): 1-210.
- DA COSTA, S.I. 1904. Descriptions of new species of land-shells from Central and South America. **Proceedings of the Malacological Society of London** **5**: 5-6.
- DIVER, C. 1931. A method of determining the number of the whorls of the shell and its application to *Cepaea hortensis* Mull. **Proceedings of the Malacological Society of London** **19**: 234-239.
- HAAS, F. 1929. Beiträge zur Kenntnis der Südamerikanischen Binnenmollusken. **Senckenbergiana**, Frankfurt, **11** (1/2): 8-13.
- HYLTON SCOTT, M.I. 1939. Estudio Anatómico del *Borus "Strophocheilus lorentzianus"* (Doer.) (Mol. Pul.) **Revista del Museo de la Plata Nueva Serie, Zoologia**, Buenos Aires, **1**: 217-278.
- KÜPPERS, H. 1979. **Atlas de los colores**. Barcelona, Blume Editorial, 161p.
- LANG-DE-MORRETES, F. 1949. Ensaio de Catálogo dos Moluscos do Brasil. **Arquivos do Museu Paranaense**, Curitiba, **7** (1): 5-216.
- . 1952. Novas espécies Brasileiras da família Strophocheilidae. **Arquivos de Zoologia**, São Paulo, **3** (4):109-126.
- . 1954. Adenda e Corrigena ao Catálogo dos Moluscos (sic) do Brasil. **Arquivos do Museu Paranaense**, Curitiba, **10** (2): 37-76.
- LEME, J.L.M. 1973. Anatomy and systematics of the Neotropical Strophocheiloidea (Gastropoda, Pulmonata) with the description of a new family. **Arquivos de Zoologia**, São Paulo, **23** (5): 295-337.
- . 1974. *Gonyostomus insularis* uma nova espécie de Strophocheilidae (Pulmonata) da ilha dos Búzios, São Paulo, Brazil. **Papéis Avulsos de Zoologia**, São Paulo, **28**:1-9.
- . 1989. *Megalobulimus lopesi* sp.n., uma nova espécie de Pulmonata terrestre da mata atlântica Brasileira (Mollusca, Gastropoda, Megalobulimidae). **Memórias do Instituto Oswaldo Cruz**, Rio de Janeiro, **84** (Supl. 4): 313-318.
- LEME, J.L.M. & L.F. INDRUSIAK. 1990. *Megalobulimus parafragilior* sp. n., uma nova espécie de Pulmonata terrestre da Serra do Mar (Gastropoda, Megalobulimidae). **Papéis Avulsos de Zoologia**, São Paulo, **37** (5): 97-105.
- LEME, J.L.M.; R.L. CASTRO & L.F. INDRUSIAK. 1979. Contribuição anatômica e histológica para o conhecimento de *Mirinaba antoninensis* (Morretes, 1952) (Gastropoda, Strophocheilidae). **Papéis Avulsos de Zoologia**, São Paulo, **32** (14): 183-191.
- SALGADO, N.C.; A.C.S. COELHO, & H.M. BARROS. 1995. Macroanatomia, microanatomia e histologia do sistema reprodutor de *Thaumastus (Thaumastus) taunaisii* (Férussac, 1922), *T. (T) magnificus* (Grateloup,1839) e *T. (T) achilles* (Pfeiffer,1852) (Mollusca, Gastropoda, Bulimidae). **Boletim do Museu Nacional, N. S., Zoologia**, Rio de Janeiro, (358): 1-46.
- SALGADO, N.C. & A.C.S. COELHO. 2003. Moluscos terrestres do Brasil (Gastrópodes operculados ou não, exclusive Veronicellidae, Milacidae e Limacidae), p. 149-189. In: Z. BARRIENTOS & J. MONGE-NÁJERA (Eds). **Malacologia Latinoamericana. Revista de Biología Tropical**, San José, **51** (Supl. 3): XVII+1-536.

Received in 15.VII.2003; accepted in 19.I.2004.