

# Papéis Avulsos de Zoologia

Museu de Zoologia da Universidade de São Paulo

Volume 48(14):119-127, 2008

www.scielo.br/paz

ISSN impresso: 0031-1047

ISSN on-line: 1807-0205

## REDESCRIPTION OF *HIATELLA MERIDIONALIS* D'ORBIGNY, 1846 (MOLLUSCA, BIVALVIA, HIATELLIDAE) FROM ARGENTINA

LUIZ RICARDO L. SIMONE<sup>1</sup>

PABLO E. PENCHASZADEH<sup>2</sup>

### ABSTRACT

*The redescription of *Hiatella meridionalis* (d'Orbigny, 1846) is provided as first attempt to improve the systematics of the genus in the regions of Atlantic and western Pacific. This reanalysis is based on specimens collected in the vicinity of the type localities and is based on detailed morphology of samples that some researches consider a single, wide ranging species. From the morphological characters, the more interesting are: a high quantity of papillae at incurrent siphon; the retractor muscles of siphon divided in two bundles; the small size of the palps; the muscular ring in the stomach; and the zigzag fashion of the short intestinal loops. These characters distinguish the species from the other hiatellids so far examined. Type material of the species was examined, by first time illustrated, and the lectotype is designated.*

KEYWORDS: *Hiatella meridionalis*, morphology, anatomy, taxonomy, Argentina.

### INTRODUCTION

There is considerable confusion in the taxonomy of the Mediterranean, Atlantic and western Pacific hiatellids. As their shells are highly irregular, it is difficult to find conchological characters for resolving the problem. As related below, a more conservative terminology has been applied by several authors, considering every sample as belonging to a single species. Considerably dissimilar specimens identified under the same epithet: *Hiatella solida* (Sowerby, 1834) or *H. arctica* (Linnaeus, 1767), are commonly found in collections, and even in the literature (e.g., Rios,

1994). The dissimilarity regards not only the shells, but also size, as some populations have specimens growing to more than 40 mm, while others the specimens barely reach 10 mm. It is also regards the bathymetry, there are samples collected intertidal, and others in deep waters. Besides, the geographic range of some species is also extraordinary, occurring from the Arctic to the Antarctic seas, through Mediterranean Sea, almost entire tropical areas, with records in the east and west coasts of the Atlantic, and east coast of the Pacific; normally in disjunct populations. With this data in mind, two conclusions are possible: (1) an astonishing environmental complacency of a small

1. Museu de Zoologia, Universidade de São Paulo, Caixa Postal 42.494, 04218-970, São Paulo, SP, Brasil. E-mails: lrsimone@usp.br; lrsimone@gmail.com

2. Museo Argentino de Ciencias Naturales B. Rivadavia (CONICET) y FCEyN (UBA). Av. A. Gallardo 470, Buenos Aires; Argentina. E-mail: pablop@mail.retina.ar

bivalve, possessing a fantastic power of dispersion, or (2) a misidentification of conchologically similar separated species.

This paper is the first attempt to resolve the systematics of the genus *Hiatella* Gray, 1824 (type species *Mya arctica* Linnaeus, 1767, OD), redescribing one of the species and extending the characters to the anatomy. The set of species that sometimes are considered all synonyms and sometimes with any degree of separation, includes from the European type localities: *Hiatella arctica* (Linnaeus, 1767); *H. rugosa* (Linnaeus, 1767); *H. minuta* (Linnaeus, 1767); and from type localities of the American Pacific coast: *H. byssifera* (Fabricius, 1780); *H. biapertura* (Bosc, 1801); *H. monopena* Bosc, 1801; *H. striata* (Fleuriat, 1802); *H. bicarinata* (Schumacher, 1817); *H. gallicana* (Lamarck, 1818); *H. solida* (Sowerby, 1834); *H. unguana* (Grewinck, 1850); *H. bilirata* (Gabb, 1861); *H. flaccida* (Gould, 1861); *H. orientalis* (Yokoyama, 1920); *H. awana* (Yokoyama, 1924); *H. sakhalinensis* (Take-da, 1953) (Carcelles, 1944; Narchi, 1973; Rosenberg, 2005). Samples from Brazil to north Argentina are normally identified as *H. solida* or *H. arctica* (Narchi, 1973; Rios, 1994; Bremec *et al.*, 2000; Orensanz *et al.*, 2002).

Anatomical information on *Hiatella* is relatively weak, it can be found in Hunter (1949, on *H. gallicana* and *H. arctica*); Purchon (1958); Yonge (1971, on *Hiatella* sp.); Narchi (1973), and Domaneschi & Narchi (1998) (both on Brazilian sample of supposed *H. solida*). These reports are therefore used as a base for the present study.

## MATERIAL AND METHODS

A complete list of examined material is presented after Description. The MZUSP specimens, containing individuals of every sizes, were all dissected. The studied material was collected during scallop fishing, as an epizoic on the shell of live scallop *Zygochlamys patagonica* (King and Broderip, 1832) in grounds 90-130 m depth. The specimens were fixed in 70% ethanol, unrelaxed. They were dissected by standard techniques, with the specimen immerse in fixative under a stereomicroscope. All drawings were made with the aid of a camera lucida. Serial sections of 5 µm of the middle portion of the whole animal were done also using standard histological procedures, stained with Mallory. Voucher material of a previous study (Narchi, 1973), deposited in Museu de Zoologia da USP, was also examined anatomically for basing the comparison and discussion of the presently studied

sample, at least with specimens from Brazilian coast. A complement of the morphological knowledge of the Brazilian and other samples will be published elsewhere; however, the current literature (mainly Narchi, 1973) brings sufficient data for the present discussion and comparison.

In the figures, the following abbreviations are used: **aa**, anterior aorta; **am**, anterior adductor muscle; **an**, anus; **ap**, posterior aorta; **au**, auricle; **bf**, byssal furrow of foot; **bg**, byssal gland; **by**, byssus; **cv**, ctenidial (efferent) vessel; **dd**, ducts to digestive diverticula; **dg**, digestive diverticula; **di**, inner demibranch; **do**, outer demibranch; **es**, esophagus; **fm**, posterior foot retractor muscle; **fr**, anterior foot retractor muscle; **ft**, foot; **gd**, gastric dorsal fold; **gf**, ventral gastric fold; **go**, gonad; **gs**, gastric shield; **gt**, gastric transversal typhlosole; **in**, intestine; **ip**, inner hemipalp; **mb**, mantle border; **ml**, mantle lobe; **mo**, mouth; **mp**, mantle papillae; **op**, outer hemipalp; **pa**, posterior adductor muscle; **pc**, pericardium; **pe**, periostracum cover of siphons; **pl**, pallial line; **po**, pedal orifice in mantle; **pp**, palp; **se**, excurrent siphon; **rm**, transversal rim; **rt**, rectum; **sa**, gastric sorting area; **sc**, suprabranchial chamber; **sh**, shell; **si**, incurrent siphon; **sm**, siphonal retractor muscle; **sp**, gastric sphincter; **st**, stomach; **ty**, typhlosole; **ub**, shell umbo; **um**, fusion between left and right mantle lobes; **ve**, ventricle; **vg**, visceral ganglia; **vm**, visceral mass.

Institutional abbreviations: **BMNH**, The Natural History Museum, London, England; **MACN**, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina; **MZUSP**, Museu de Zoologia da Universidade de São Paulo, Brazil.

## Systematics

### *Hiatella meridionalis* (d'Orbigny, 1846) (Figs. 1-24)

*Saxicava meridionalis* d'Orbigny, 1846:521 (pl. 81, figs. 21-22; published in 1847).

*Hiatella solida*: Bastida *et al.* 1992:696, Ciocco *et al.* 2005:1272 (non Sowerby, 1834).

*Hiatella arctica*: Pouliot, Bourget & Fréchet 1995:280 (non Linnaeus, 1767).

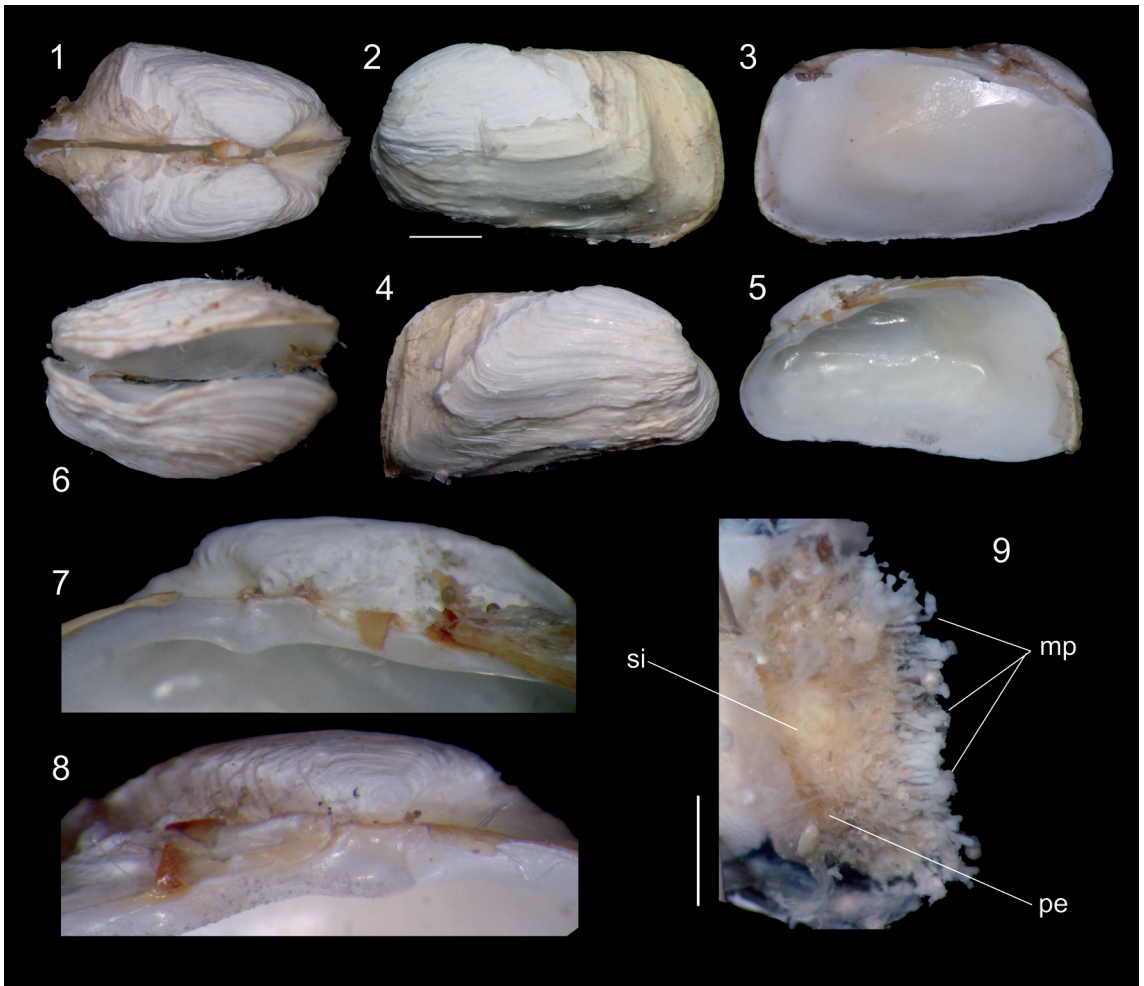
*Types*: BMNH 1854.12.4.672, 6 valves (examined, Fig. 18). Specimen Figs. 18A-B here designed as lectotype, the remaining specimens are the paralectotypes.

*Type locality*: "Malvinas (Falkland) Is. and Patagonia, Argentina".

**Redescription**

*Shell* (Figs. 1-8, 10, 12, 18-24): Outline somewhat rectangular (Figs. 2-5). Outer surface irregular, whitish, with strong growth lines and concentric undulations. Periostacum yellowish, transparent, thick, usually eroded close to umbos, extending beyond calcified shell, along siphons. Umbos weakly protruded, flat, located between middle and anterior thirds; young specimens with umbos slightly more protruded and pointed (Figs. 18E-M). Young specimens sometimes possessing one or two pairs of posterior radial cords, normally interrupted somewhat uniformly, forming successive spines, pointing posteriorly (Figs. 19, 20), or pustules (Figs. 18G, 21, 23), or a mixture of both (Fig. 22); this posterior sculpture disappearing

in larger specimens (Figs. 1-4, 18A-D). Ligament external, located posterior to umbos along about 1/7 of shell length (Figs. 1, 7, 8, 24). Hinge with single short cardinal tooth in each valve, just below umbos, each one with a fold-like platform base (Figs. 6-8, 18B, D, 24); anterior tooth in right valve (Figs. 5, 7). Gap narrow between both valves in posterior (siphonal) region (Fig. 6). Inner surface whitish, glossy (Figs. 3, 5, 24). Scar of anterior adductor muscle elliptical; located close to ventral-anterior corner of valve, at some distance from shell edge; scar area about 1/20 of valve surface. Posterior scars of posterior adductor muscle and anterior retractor muscle also elliptical, located close to dorsal edge of valves, between middle and posterior thirds of dorsal edge; area about double of anterior scar. Pallial line with shallow sinus (Fig. 24).

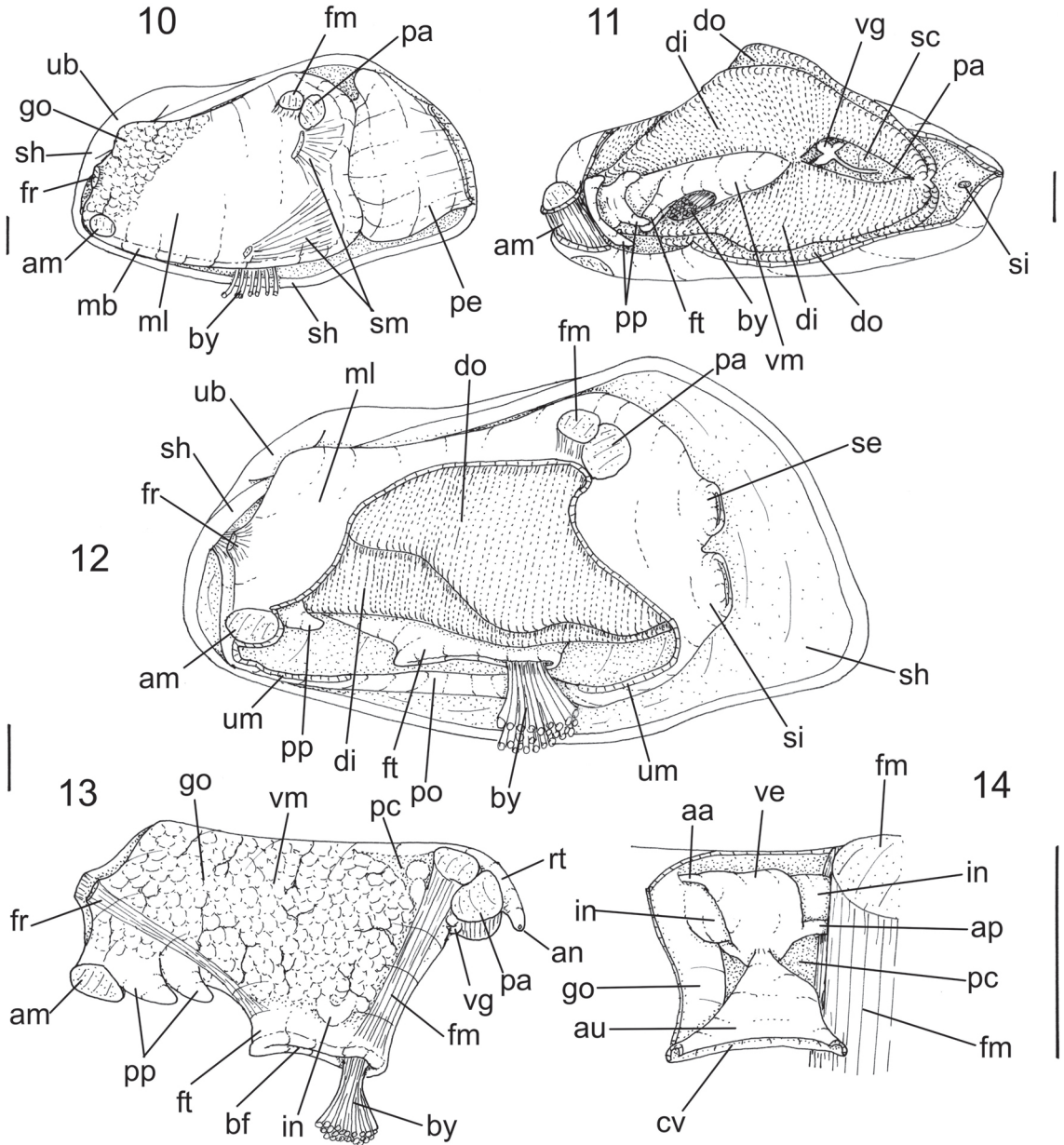


FIGURES 1-9: *Hiatella meridionalis*: 1-5) a specimen MZUSP 61525; 1) dorsal view; 2) left valve, outer view; 3) same, inner view; 4) right valve, outer view; 5) same, inner view; 6) another specimen of same lot, ventral view, main concern to inner view of hinge; scale = 2 mm; 7) detail of hinge, right valve, same specimen of figs 1-5; 8) same, left valve; 9) detail of siphonal area showing siphonal papillae (mp), some papillae and periostracum (pe) are lost and damage because of dissection. Scales = 1 mm.

*Mantle*: Thin, whitish, of uniform thickness (Figs. 10, 12). Edges of mantle lobes mostly fused, a single pedal open (further that of siphonal aperture), situated in middle-anterior region of ventral edge (Fig. 12: po), corresponding to about 1/4 of shell length. Siphon muscular root divided into 2 bands (Fig. 10: sm): 1) ventral band narrower, bordering ventral edge of

mantle along about half of its length and 1/3 of valve height; 2) dorsal band about half shorter than ventral band, with equivalent width of ventral band, attached to shell just ventral to posterior adductor muscle.

*Siphons*: Incurrent siphon about half fused along its length to excurrent siphon in basal region (Fig. 12).



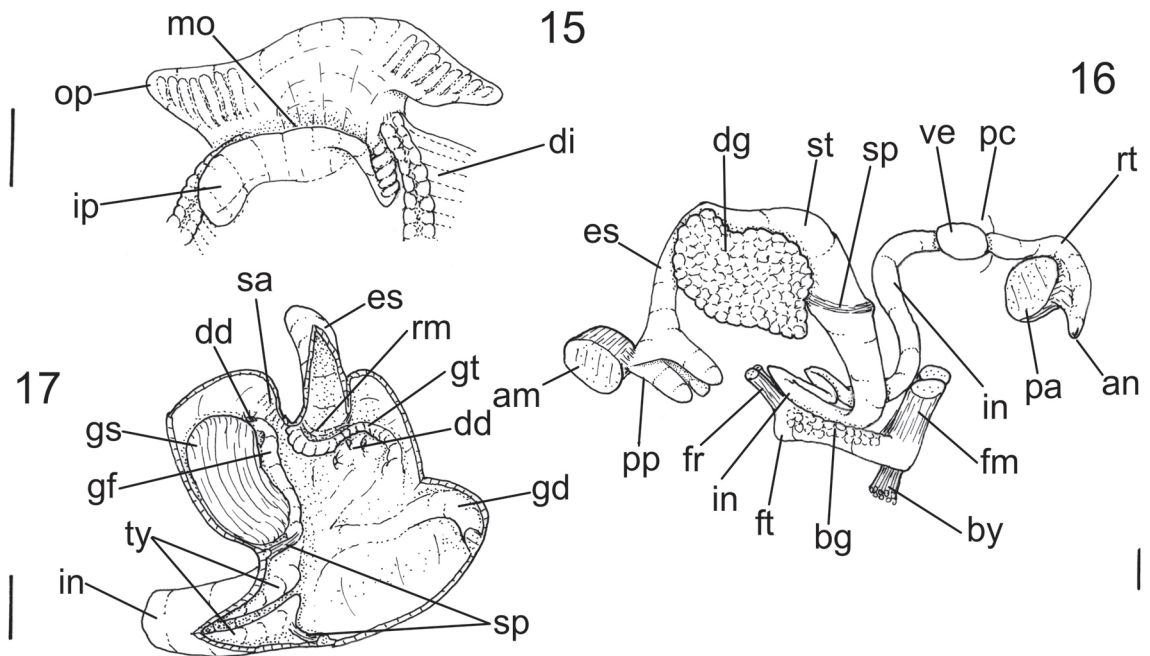
FIGURES 10-14: *Hiatella meridionalis* anatomy: 10) left view of an animal with left valve just removed; 11) whole specimen, ventral view, left mangle lobe partially removed, gills deflected and partially separated from each other in posterior region, showing a portion of suprabranchial chamber, siphons and posterior adductor muscle seen by their ventral base; 12) whole specimen, left view, left valve, periostracum and part of left mantle lobe removed; 13) isolated visceral mass, left view, most structures seen by transparency; 14) detail of pericardium, left view, left pericardial wall removed. Scales = 1 mm.

Outer surface almost entirely covered by periostracum (Figs. 9, 10: pe). Incurrent siphon slightly broader than excurrent siphon; tip bearing several series of small papillae (Fig. 9: mp), each papilla with slender, long, filiform base, and weakly expanded, balloon-like tip. Excurrent siphon tip somewhat similar to incurrent one, except for bearing less numerous papillae, restricted to a single series. Both siphons totally separated from each other by a muscular internal septum, started in posterior end of gills (Fig. 11), attached to gills by cilia.

*Main muscles and foot:* Adductor muscles relatively small. Anterior adductor muscle situated close to ventral-anterior edge of shell (Figs. 10, 12, 13, 24: am), with about 1/25 of valve area. Posterior adductor muscle situated at some distance from postero-dorsal shell edge (Figs. 10, 12, 13, 24: pa); about 1.5 times larger than anterior. Foot relatively small (about 1/6 of visceral volume), byssal furrow running longitudinally along ventral surface, on median line, along about 1/4 of ventral edge of visceral mass (Figs. 12, 13). Byssal gland running in dorsal and lateral regions of this furrow (Fig. 16: bg). Foot anterior region weakly projected; posterior region broader due to byssal gland (Figs. 12, 13). Pair of anterior retractor muscle of foot narrow, slender

(Fig. 13: fr); originating dorsal, at some distance from anterior adductor muscle (Figs. 10, 12, 13), origin with about 1/3 of anterior adductor muscle, and separated from that by a distance about 1/3 of shell height; inserting in anterior region of foot. Pair of posterior retractor foot muscles broad and thick, runs straight towards dorsal (Fig. 13: fm); origin just anterior and dorsal to posterior adductor muscle (Figs. 10, 12, 13) with area approximately 80% of that of posterior adductor muscle; insertion in posterior end of byssal furrow, as continuation from byssus (Fig. 13).

*Pallial cavity:* Occupying about 75% of shell inner volume, covering about 85% of lateral surface of visceral mass. Gills length about 90% of that of shell; gills height about 80% of that of shell. Outer demibranch somewhat triangular, anterior end narrow, increasing gradually, becoming broader in its middle region towards posterior, of same width of inner demibranch (Figs. 11, 12). Inner demibranch somewhat rectangular, width uniform along its length (Figs. 11, 12). Anterior half of inner demibranch connected to visceral mass by cilia, posterior half connected to with inner lamella of other inner demibranch forming an anatomical separation between infra- and supra-bran- chial chambers (Fig. 11) by ciliary connection. Ante-



FIGURES 15-17: *Hiattella meridionalis* anatomy: 15) detail of palps region, ventral view, palps partially deflected; 16) whole digestive system, left view, seen as in situ, some adjacent structures also shown; 17) stomach, dorsal view, dorsal gastric wall partially removed and deflected to right, esophagus and intestine partially opened longitudinally. Scales = 0.5 mm.

rior region of inner demibranch not covered by outer demibranch, introduced between both hemipalps (Fig. 15). Food groove running in outer edge of inner demibranch (Fig. 15).

**Circulatory system:** Heart relatively small (Fig. 13: pc) (about 1/15 of visceral mass), positioned between gonad and pair of posterior retractor muscles of foot. Auricles triangular, each connected to ctenidial (efferent) vessel (Fig. 14) and directly to gill at about 1/4 of gill length, in their middle region. These ctenidial veins narrow in both sides anterior and posterior. Ventricle surrounding intestine, anterior aorta dorsal and posterior aorta ventral (Fig. 14).

**Digestive system:** Palps relatively small (about 1/15 of demibranch area), triangular (Figs. 11-13, 15). Outer hemipalps slightly larger than inner hemipalps (Fig. 15). Inner surface with 8-10 broad, transversal folds; each fold with rounded ventral end, at short distance from palp ventral edge; folds successively smaller towards distal and posterior. Folds

faint in dorsal end at some distance from palp dorsal edge (Fig. 15), forming a smooth inner margin both dorsal and ventral in both hemipalps. Mouth broad and ample, both lips with thick edge; situated somewhat posteriorly to anterior adductor muscle (Figs. 11, 15). Esophagus broad, with about 1/4 of shell length (Fig. 16), inner surface smooth (Fig. 17). Stomach occupying about 1/3 of visceral volume, covered in both sides by pale green digestive diverticles (Fig. 16). Esophageal aperture into stomach protected in ventral side by a narrow rim (Fig. 17: rm), and in dorsal side by tall, long, sigmoid fold, transversally furrowed (Fig. 17: gt). This fold extending in both sides, surrounding anterior sides of aperture to digestive diverticles. Gastric shield with about 1/4 of inner gastric area, located in its left-posterior region. Tall fold surrounding gastric shield ventral edge, extending along gastric dorsal wall in level of intestine origin (Fig. 17). Aperture to digestive diverticles multiple, situated around 2 shallow cavities by side of esophageal aperture; these cavities separated from esophageal aperture by gastric transversal typhlosole, and from each other by space equivalent to

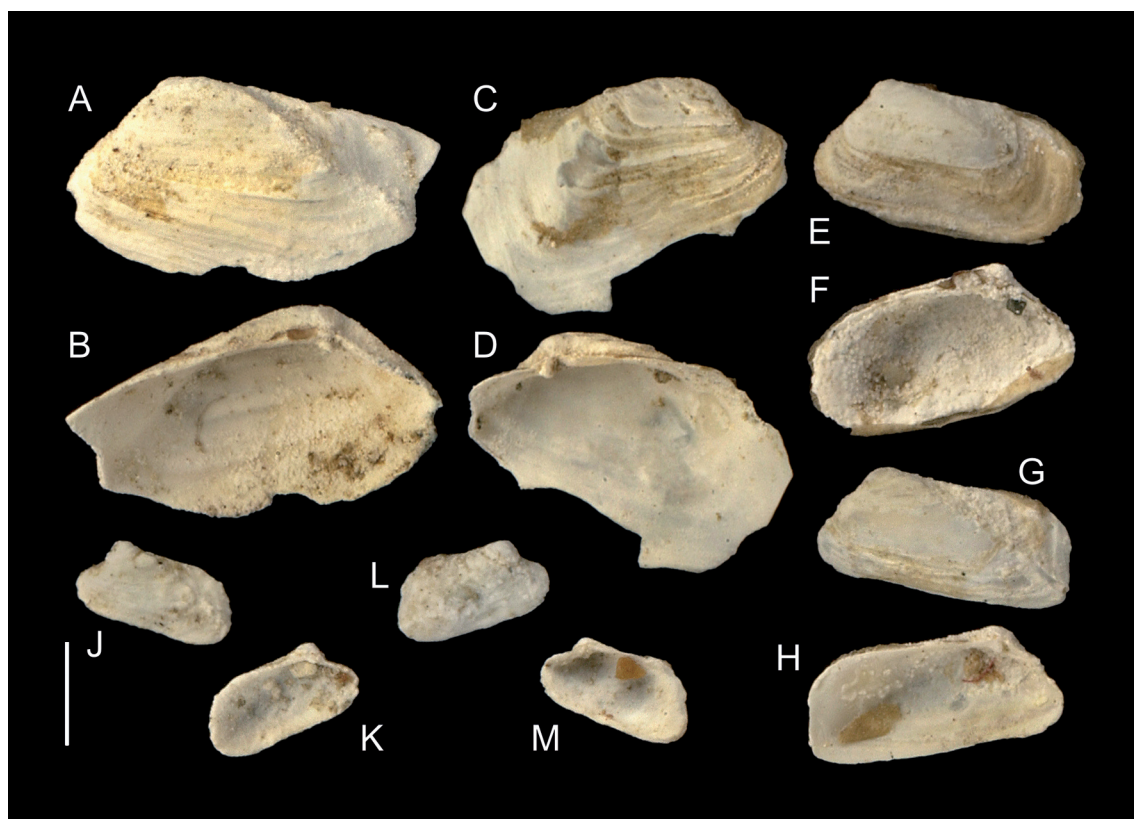
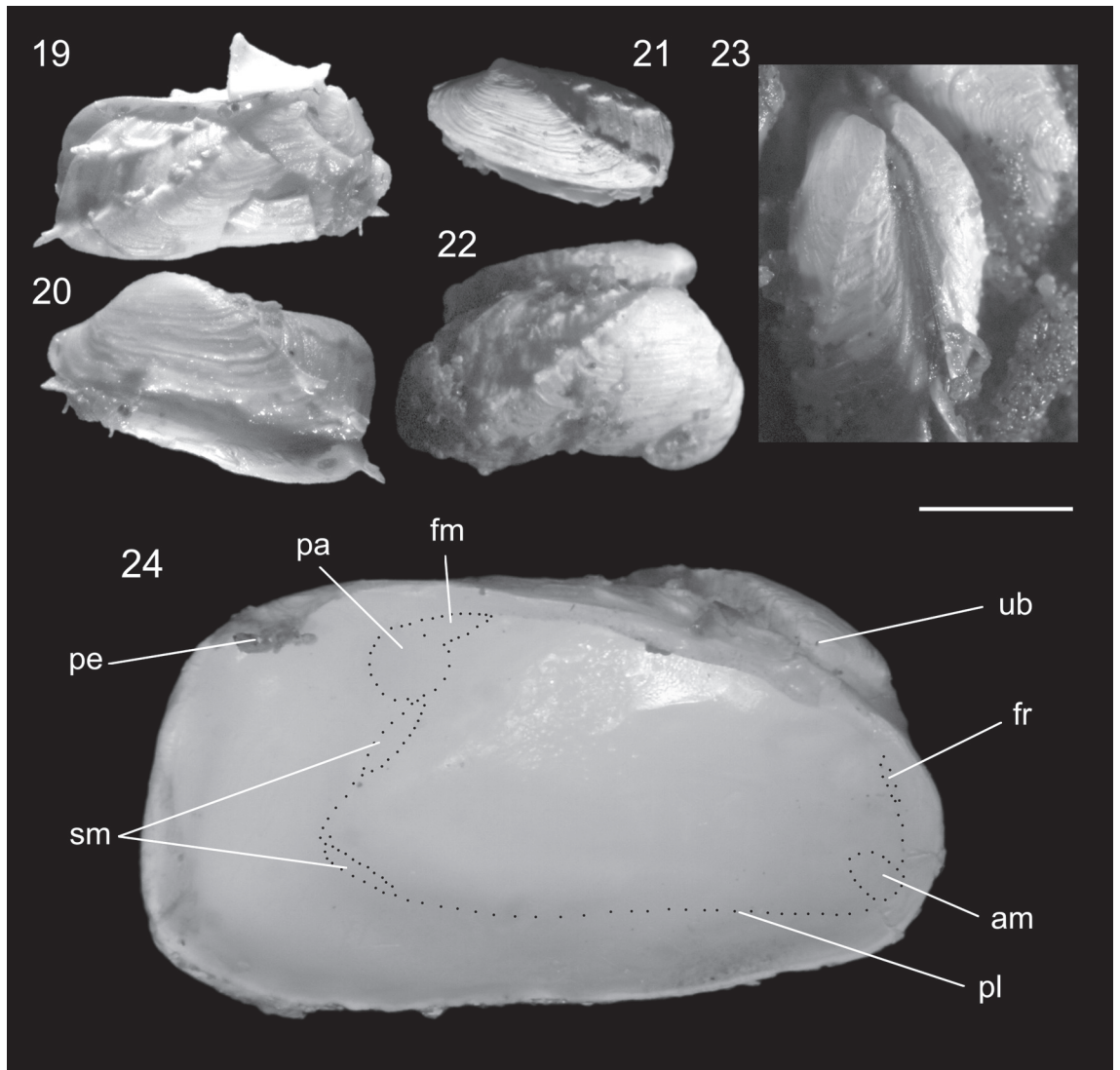


FIGURE 18: *Hiattella meridionalis* type material, 6 valves successively shown in external and internal views; specimen A-B here designated as lectotype; the remaining specimens are the paralectotypes. Courtesy of the Natural History Museum, London. Scale = 1 mm.

about 1/4 of gastric width. Between gastric chamber and intestine a sphincter, marked by a narrow layer of circular muscle immerse in gastric walls (Figs. 16, 17: sp). Intestine and style sac anatomically combined; both separated internally by a pair of tall longitudinal folds; right fold originating in gastric fold surrounding gastric shield; left fold originating abruptly (Fig. 17: ty). Intestine narrowing gradually towards posterior-ventral region of visceral mass; suddenly towards anterior, bordering byssal gland; zigzagging in anterior region of foot, crossing to right side of its first loop, running towards dorsal close to stomach; in this region bearing a curve, running towards pos-

terior, crossing through pericardium, and surrounding dorsal and posterior surface of posterior adductor muscle (Fig. 16). Anus simple, somewhat projected (Figs. 13, 16: an).

*Genital system:* Gonad pale cream in color, located surrounding visceral structures, including digestive diverticula; filling almost entire visceral sac, except ventral region, at some distance from foot (Figs. 10, 13). No gonoducts detectable. Pair of genital orifice located anterior and close to nephropores, separated from them by a distance equivalent to 1/20 of shell length.



FIGURES 19-24: *Hiatella meridionalis* young specimens MACN 36596 showing two pairs of posterior radial cords with spines; 19-20) specimen #1, (broken) right and left valves respectively; 21) specimen #2, left valve; 22) specimen #3, right valve and a portion of left valve; 23) specimen #3 in situ on scallop; 24) left valve, inner view, muscular scars artificially dotted, MZUSP 61525. Scale = 2 mm.

*Main ganglia of nervous system:* Not seen in details. Pair of visceral ganglia large, close one another, located in ventral surface of posterior adductor muscle, close to adjacent region of posterior foot retractor (Figs. 11, 13: vg).

*Habitat:* Epizoic on the shell of live bivalve *Zygochlamys patagonica*, between 83 and 189 m depth (Bastida *et al.*, 1992).

*Measurements (length, height and width in mm):* MZUSP 61525, #1 (Figs. 1-5): 9.5 by 5.3 by 5.4; #2: 7.9 by 4.5 by 4.2 mm.

*Geographic range:* Argentina coast.

*Material examined:* Lectotype and paralectotypes (see above). ARGENTINA; Buenos Aires; Off Mar del Plata, 39°04'S 55°44'W to 39°29'S 56°04'W, MZUSP 61525, 5 specimens (31/viii/1998), MZUSP 61526, 33 specimens, MACN 36596, 326 specimens (05/ix/2001).

## DISCUSSION

In the original description of *Hiatella meridionalis*, d'Orbigny (1846) figured a specimen with a pair of radial, posterior cords, forming somewhat uniform dots. This pattern is not shown in grown specimen, neither in the type specimens (Fig. 18). Nevertheless, the grown specimens tend to have a slightly uniform carina (Figs. 1, 18A – the here designed lectotype), forming a slope between the posterior and middle thirds of the valves. However, the pattern of two pairs of dotted cords is exhibited by some young specimens (Figs. 19-23). The flat shape of specimen figured by d'Orbigny (1846) and its size (4 mm *sic.*) show that the specimen he examined was young. This is corroborated by the exam of the type material (Fig. 18), in such the larger specimens have about 4 mm (Figs. 18A-D). The finding of young specimens with similar conchological features of d'Orbigny (1846, pl. 81, fig. 21) specimen, allows that they can be considered the same species (Figs. 19-23). The type material figured in this paper (Fig. 18) and the young specimens (Figs. 19-23) show the tendency of the shell to be flatter, with the umbos weakly more protruded and pointed (Figs. 18E-M, 20, 21), features that are gradually modified to an inlaid umbos and a more obese fashion in larger specimens (Figs. 1-5, 18A-D, 22). The two pairs of radial dotted cords can even bear projected spines in some young, 3-4 mm specimens

(Figs. 19-21). These conchological patterns have not been found in specimens collected from other localities so far examined.

The anatomical characters of *Hiatella meridionalis* are similar to those of congener species where the anatomy is known (Hunter, 1949; Yonge, 1971; Narchi, 1973). It, however, differs from Brazilian sample of *H. solida* (*sensu* Narchi, 1973; personal observation), here therefore designed as *H. cf solida*, in having smaller sized palps, a stomach with a less developed dorsal hood, middle region of intestine not coiled (only performing a zigzag), and mainly by the greater quantity of papillae in the incurrent siphon (Fig. 9). It is important to emphasize that all examined specimens of *H. meridionalis* and the Brazilian samples of the *H. cf solida* have an equivalent number of siphonal papillae inside each sample, which demonstrates that such character is not highly variable and a suppose important character for species distinction. As only preserved specimens were available, the study on the inner surface of the stomach is somewhat precluded. Although some differences are detectable among the inner surface of examined specimens with some known hiatellids (Purchon, 1958; Narchi, 1973), e.g., absence of clear sorting areas, a deeper analysis of the differences is not performed here.

*Hiatella meridionalis* occurs much deeper, around 110 m depth, than the Brazilian *H. cf solida*, which is intertidal. *H. meridionalis* differs from *Hiatella* sp. (Yonge, 1971) in having more developed anterior and posterior retractor muscles of the foot, by smaller adductor muscles, by larger pedal aperture in mantle, and by different fashion of siphonal papillae. One interesting character of *H. meridionalis* is the pair of retractor muscles of siphons divided into 2 bundles (Fig. 10). This feature is not usually shown in the siphon-bearing bivalves, but its significance in taxonomy is so far speculative, as it needs to be proved to occur in other hiatellids.

*Hiatella meridionalis* still differs anatomically from species of the genus *Saxicavella* Fischer, 1878 (Scott, 1994) in having longer siphons, in lacking papillae surrounding the siphonal base, foot lacking heel, less developed pallial musculature and longer outer demibranch. A deeper additional analysis on the morphological differences among the hiatellid genera is provided by Yonge (1971).

A revision of the genus *Hiatella* is still in progress, and several morphological differences have been found among geographically distant samples of the genus, indicating that there are actually several species. This paper brings the base for this revision, with a more complete description of one of the species, in



such further studied species will be, gradually, added. Although even the artificial transportation have been advocated for explaining the wide range of this bivalve (e.g., Orensanz *et al.*, 2002), in a single-species scenario, the preliminary results have shown that samples from different regions constitute isolated species. as explained above, in this paper *Hiatella meridionalis* is, then, taxonomically defined. The remaining species will be defined in complementary papers.

## RESUMO

A redescoberta de *Hiatella meridionalis* (d'Orbigny, 1846) é realizada como primeiro passo na melhoria da sistemática do gênero das regiões atlântica e pacífica oeste. Esta re-análise é baseada em espécimes coletados nas vizinhanças da localidade tipo e em morfologia detalhada de amostras que alguns pesquisadores consideram pertencer a uma única espécie de ampla distribuição. Dos caracteres anatômicos, os mais interessantes são: uma grande quantidade de papilas no sifão inalante; o músculo retrator dos sifões dividido em duas porções; o tamanho pequeno dos palpos; um anel muscular transversal no estômago; e um padrão em zigzag no curto intestino. Estes caracteres distinguem a espécie dos demais hiatelídeos até então examinados. Os sintomas da espécie foram também examinados e pela primeira vez ilustrados; o lectótipo é designado.

PALAVRAS-CHAVE: *Hiatella meridionalis*, morfologia, anatomia, taxonomia, Argentina.

## ACKNOWLEDGMENTS

The authors wish to thank John Taylor, BMNH, by photos of the *Hiatella meridionalis* type material; Claudia Bremec and Mario Lasta from INIDEP (Argentina) and Juliana Gimenez (UBA) who kindly provide the biological material herein studied. For Guido Pastorino for earlier discussions on the taxonomic identity of the material. This project is part funding by a governmental project by Fapesp (Fundação de Amparo a Pesquisa do Estado de São Paulo), process 04/02333-8; and part by UBACYT X316, Universidad de Buenos Aires.

## REFERENCES

- BASTIDA, R.; ROUX, D. & MARTINEZ, D.E. 1992. Benthic communities of the Argentine continental Shelf. *Oceanologia Acta*, 15(6):687-698.
- BREMEC, C.; BREY, T.; LASTA, M.; VALERO, J. & LUCIFORA, L. 2000. *Zygochlamys patagonica* beds on the Argentinean shelf. Part I: Energy flow through the scallop bed community. *Archive of Fishery and Marine Research*, 48(3):295-303.
- CARCELLES, A. 1944. Catalogo de los moluscos marinos de Puerto Quequén. *Revista del Museo de La Plata, Zoología*, 3:233-309.
- CIOCCO, N.F.; LASTA, M.L.; NARVARTE, M.; BREMEC, C.; BOGAZZI, E.; VALERO, J. & ORENSANZ, J.M. 2005. Scallops: fisheries in Argentina. In: Shumway, S. & Parsons, G. (Eds), *Developments in Aquaculture and fisheries sciences*. Elsevier, p.1251-1292.
- D'ORBIGNY, A.D. 1835-1847. Mollusques. In: *Voyage dans l'Amérique Meridionale (le Bresil...)* execute pendant les annes 1829-1833. P. Bertrand, Paris, v. 5, pt. 3, 758p + 85 pls.
- DOMANESCHI, O. & NARCHI, W. 1998. Adaptive convergences in two nestling bivalves (Myoida: Myidae, Hiattellidae) of the Brazilian littoral. *Iheringia, Serie Zoologia*, 85:89-96.
- HUNTER, W.R. 1949. The structure and behavior of *Hiatella gallicana* (Lamarck) and *H. actica* (L.), with special reference to the boring habit. *Proceedings of the Royal Society of Edinburgh*, 63:271-289.
- MIKKELSEN, P. 2006. *Western Atlantic Bivalves*. Available at: <<http://peet.amnh.org>>. Access in: 12/ May/2006.
- NARCHI, W. 1973. On the functional morphology of *Hiatella solida* (Hiattellidae: Bivalvia). *Marine Biology*, 19:332-337.
- ORENSANZ, L.J.M.; SCHWINDT, E.; PASTORINO, G.; BORTOLUS, A.; CASAS, G.; DARRIGRAN, G.; ELÍAS, R.; LÓPEZ GAPPA, J.J.; OBENAT, S.; PASCUAL, M.; PENCHASZADEH, P.; PIRIZ, M.L.; SCARABINO, F.; SPIVAK, E.D. & VALLARINO, E.A. 2002. No longer the pristine confines of the world ocean: a survey of exotic marine species in the southwestern Atlantic. *Biological Invasions*, 4:115-143.
- POULIOT, F.; BOURGET, E. & FRÉCHETTE, M. 1995. Optimizing the design of giant scallop (*Placopecten magellanicus*) spat collectors: field experiments. *Marine Biology*, 123(2):277-284.
- PURCHON, R.D. 1958. The stomach in the Eulamellibranchia; stomach type IV. *Proceedings of the Zoological Society of London*, 131:487-525.
- RIOS, E.C. 1975. *Brazilian marine mollusks iconography*. Fundação Cidade do Rio Grande, Rio Grande, 331p. + 91 pls.
- RIOS, E.C. 1994. *Seashells of Brazil*. 2<sup>nd</sup> edition. Fundação Universidade do Rio Grande, Rio Grande, 368p. + 113 pls.
- ROSENBERG, G. 2005. *Malacolog 4.0.1*: Western Atlantic Mollusk Database. Available at: <<http://data.acnatsci.org/wasp/search.php>>. Access in: 10/Apr./06.
- SCOTT, P.H. 1994. A new species of *Saxicavella* (Bivalvia: Hiattellidae) from California with unique brood protection. *Veliger*, 37(1):62-68.
- YONGE, C.M. 1971. On the functional morphology and adaptive radiation in the bivalve superfamily Saxicavacea (*Hiatella* (= *Saxicava*), *Saxicavella*, *Panomya*, *Panope*, *Cyrtodaria*). *Malacologia*, 11(1):1-44.

Recebido em: 07.12.2007

Aceito em: 06.06.2008

Impresso em: 30.06.2008

## EDITORIAL COMMITTEE

**Publisher:** Museu de Zoologia da Universidade de São Paulo. Avenida Nazaré, 481, Ipiranga, CEP 04263-000, São Paulo, SP, Brasil.

**Editor-in-Chief:** Hussam Zaher, Serviço de Vertebrados, Museu de Zoologia, Universidade de São Paulo, Post Office Box 42.494, CEP 04218-970, São Paulo, SP, Brasil. E-mail: [editormz@usp.br](mailto:editormz@usp.br).

**Managing Editor:** Carlos José Einicker Lamas (Museu de Zoologia, Universidade de São Paulo, Brasil).

**Associate Editors:** Mário César Cardoso de Pinna (Museu de Zoologia, Universidade de São Paulo, Brasil); Marcos Domingos Siqueira Tavares (Museu de Zoologia, Universidade de São Paulo, Brasil); Sérgio Antonio Vanin (Museu de Zoologia, Universidade de São Paulo, Brasil).

**Editorial Board:** Aziz Nacib Ab'Saber (Universidade de São Paulo, Brasil); Rüdiger Bieler (Field Museum of Natural History, U.S.A.); Walter Antonio Pereira Boeger (Universidade Federal do Paraná, Brasil); Carlos Roberto Ferreira Brandão (Universidade de São Paulo, Brasil); James M. Carpenter (American Museum of Natural History, U.S.A.);

Ricardo Macedo Corrêa e Castro (Universidade de São Paulo, Brasil); Mario de Vivo (Universidade de São Paulo, Brasil); Marcos André Raposo Ferreira (Museu Nacional, Rio de Janeiro, Brasil); Darrel R. Frost (American Museum of Natural History, U.S.A.); William R. Heyer (National Museum of Natural History, U.S.A.); Ralph W. Holzenthal (University of Minnesota, U.S.A.); Adriano Brilhante Kury (Museu Nacional, Rio de Janeiro, Brasil); Gerardo Lamas (Museo de Historia Natural "Javier Prado", Lima, Peru); John G. Maisey (American Museum of Natural History, U.S.A.); Antonio Carlos Marques (Universidade de São Paulo, Brasil); Naércio Aquino Menezes (Universidade de São Paulo, Brasil); Christian de Muizon (Muséum National d'Histoire Naturelle, Paris, France); Nelson Papavero (Universidade de São Paulo, Brasil); James L. Patton (University of California, Berkeley, U.S.A.); Richard O. Prum (University of Kansas, U.S.A.); Olivier Rieppel (Field Museum of Natural History, U.S.A.); Miguel Trefaut Urbano Rodrigues (Universidade de São Paulo, Brasil); Randall T. Schuh (American Museum of Natural History, U.S.A.); Luís Fábio Silveira (Universidade de São Paulo, Brasil); Ubirajara Ribeiro Martins de Souza (Universidade de São Paulo, Brasil); Paulo Emílio Vanzolini (Universidade de São Paulo, Brasil); Richard P. Vari (National Museum of Natural History, U.S.A.).

## INSTRUCTIONS TO AUTHORS

(April 2007)

**General Information:** *Papéis Avulsos de Zoologia (PAZ)* and *Arquivos de Zoologia (AZ)* cover primarily the fields of Zoology, publishing original contributions in systematics, paleontology, evolutionary biology, ontogeny, faunistic studies, and biogeography. *Papéis Avulsos de Zoologia* and *Arquivos de Zoologia* also encourage submission of theoretical and empirical studies that explore principles and methods of systematics.

All contributions must follow the International Code of Zoological Nomenclature. Relevant specimens should be properly curated and deposited in a recognized public or private, non-profit institution. Tissue samples should be referred to their voucher specimens and all nucleotide sequence data (aligned as well as unaligned) should be submitted to GenBank ([www.ncbi.nlm.nih.gov/Genbank](http://www.ncbi.nlm.nih.gov/Genbank)) or EMBL ([www.ebi.ac.uk](http://www.ebi.ac.uk)).

**Peer Review:** All submissions to *Papéis Avulsos de Zoologia* and *Arquivos de Zoologia* are subject to review by at least two referees and the Editor-in-Chief. All authors will be notified of submission date. Authors may suggest potential reviewers. Communications regarding acceptance or rejection of manuscripts are made through electronic correspondence with the first or corresponding author only. Once a manuscript is accepted providing changes suggested by the referees, the author is requested to return a revised version incorporating those changes (or a detailed explanation of why reviewer's suggestions were not followed) within fifteen days upon receiving the communication by the editor.

**Proofs:** Page-proofs with the revised version will be sent to e-mail the first or corresponding author. Page-proofs must be returned to the editor, preferentially within 48 hours. Failure to return the proof promptly may be interpreted as approval with no changes and/or may delay publication. Only necessary corrections in proof will be permitted. Once page proof is sent to the author, further alterations and/or significant additions of text are permitted only at the author's expense or in the form of a brief appendix (note added in proof).

**Submission of Manuscripts:** Manuscripts should be sent to the e-mail of the Editor-in-Chief [editormz@usp.br](mailto:editormz@usp.br), along with a submission letter explaining the importance and originality of the study. Address and e-mail of the corresponding author must be always updated since it will be used to send the 50 reprints in titled by the authors. Figures, tables and graphics should not be inserted in the text. Figures and graphics should be sent in separate files with the following formats: ".jpg" and ".tif" for figures, and ".xls" and ".cdr" for graphics, with 300 dpi of minimum resolution. Tables should be placed at the end of the manuscript.

Manuscripts are considered on the understanding that they have not been published or will not appear elsewhere in substantially the same or abbreviated form. The criteria for acceptance of articles are: quality and relevance of research, clarity of text, and compliance with the guidelines for manuscript preparation.

Manuscripts should be written preferentially in English, but texts in Portuguese or Spanish will also be considered. Studies with a broad coverage are encouraged to be submitted in English. All manuscripts should include an abstract and keywords in English and a second abstract and keywords in Portuguese or Spanish.

Authors are requested to pay attention to the instructions concerning the preparation of the manuscripts. Close adherence to the guidelines will expedite processing of the manuscript.

**Manuscript Form:** Manuscripts should not exceed 150 pages of double-spaced, justified text, with size 12 and source Times New Roman (except for symbols). Page format should be A4 (21 by 29.7 cm), with 3 cm of margins. The pages of the manuscript should be numbered consecutively.

The text should be arranged in the following order: Title Page, Abstracts with Keywords, Body of Text, Literature Cited, Tables, Appendices, and Figure Captions. Each of these sections should begin on a new page.

(1) **Title Page:** This should include the title, short title, author(s) name(s) and institutions. The title should be concise and, where appropriate, should include mention of families and/or higher taxa. Names of new taxa should not be included in titles.

(2) **Abstract:** All papers should have an abstract in English and another in Portuguese or Spanish. The abstract is of great importance as it may be reproduced elsewhere. It should be in a form intelligible if published alone and should summarize the main facts, ideas, and conclusions of the article. Telegraphic abstracts are strongly discouraged. Include all new taxonomic names for referencing purposes. Abbreviations should be avoided. It should not include references. Abstracts and keywords should not exceed 350 and 5 words, respectively.

(3) **Body of Text:** The main body of the text should include the following sections: Introduction, Material and Methods, Results, Discussion, Conclusion, Acknowledgments, and References at end. Primary headings in the text should be in capital letters, in bold and centered. Secondary headings should be in capital and lower case letters, in bold and centered. Tertiary headings should be in capital and lower case letters, in bold and indented at left. In all the cases the text should begin in the following line.

(4) **Literature Cited:** Citations in the text should be given as: Silva (1998) or Silva (1998:14-20) or Silva (1998: figs. 1, 2) or Silva (1998a, b) or Silva & Oliveira (1998) or (Silva, 1998) or (Rangel, 1890; Silva & Oliveira, 1998a, b; Adams, 2000) or (Silva, pers. com.) or (Silva et al., 1998), the latter when the paper has three or more authors. The reference need not be cited when authors and date are given only as authority for a taxonomic name.

(5) **References:** The literature cited should be arranged strictly alphabetically and given in the following format:

- **Journal Article** – Author(s). Year. Article title. *Journal name*, volume: initial page-final page. Names of journals must be spelled out in full.
- **Books** – Author(s). Year. *Book title*. Publisher, Place.
- **Chapters of Books** – Author(s). Year. Chapter title. In: Author(s) or Editor(s), *Book title*. Publisher, Place, volume, initial page-final page.
- **Dissertations and Theses** – Author(s). Year. *Dissertation title*. (Ph.D. Dissertation). University, Place.
- **Electronic Publications** – Author(s). Year. *Title*. Available at: <electronic address>. Access in: date.

**Tables:** All tables must be numbered in the same sequence in which they appear in text. Authors are encouraged to indicate where the tables should be placed in the text. They should be comprehensible without reference to the text. Tables should be formatted with vertical (portrait), not horizontal (landscape), rules. In the text, tables should be referred as Table 1, Tables 2 and 3, Tables 2-6. Use "TABLE" in the table heading.

**Illustrations:** Figures should be numbered consecutively, in the same sequence that they appear in the text. Each illustration of a composite figure should be identified by capital letters and referred in the text as: Fig. 1A, Fig. 1B, for example. When possible, letters should be placed in the left lower corner of each illustration of a composite figure. Hand-written lettering on illustrations is unacceptable. Figures should be mounted in order to minimize blank areas between each illustration. Black and white or color photographs should be digitized in high resolution (300 dpi at least). Use "Fig(s)." for referring to figures in the text, but "FIGURE(S)" in the figure captions and "fig(s)." when referring to figures in another page.

**Responsibility:** Scientific content and opinions expressed in this publication are sole responsibility of the respective authors.

**Copyrights:** A concession letter of copyrights and assent should be sent to the Editor, signed by all the authors, prior to publication of the manuscript. A model is available in the home page of the Museu de Zoologia da Universidade de São Paulo.

For other details of manuscript preparation of format, consult the CBE Style Manual, available from the Council of Science Editors ([www.councilscienceeditors.org/publications/style.cfm](http://www.councilscienceeditors.org/publications/style.cfm)).

*Papéis Avulsos de Zoologia* and *Arquivos de Zoologia* are publications of the Museu de Zoologia da Universidade de São Paulo ([www.mz.usp.br](http://www.mz.usp.br)).

Always consult the Instructions to Authors printed in the last issue or in the electronic home pages: [www.scielo.br/paz](http://www.scielo.br/paz) or [www.mz.usp.br/publicacoes](http://www.mz.usp.br/publicacoes).