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TELLIMYA TEHUELCHA, NEW SPECIES: FIRST RECORD OF *TELLIMYA* BROWN, 1827, IN SOUTH AMERICA (BIVALVIA: LASAEIDAE), WITH NOTES ON LIFE HISTORY AND REPRODUCTION

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INTRODUCTION

Galeommatoids are small bivalves usually living as epibionts on other invertebrates. Among them, a number of genera, such as *Waldo* Nicol, 1966, *Scioberetia* F. Bernard, 1895, *Montacuta* Turton, 1822, *Tellimya* Brown, 1827, *Brachiomya* Jespersen, Lützen & Nielsen, 2004, and *Montacutella* Jespersen, Lützen & Nielsen, 2004, are associated with sea urchins. Only *Scioberetia* and *Waldo* were reported from the southern tip of South America (F. Bernard, 1895a–c; Zelaya & Ituarte, 2002).

Tellimya was proposed to include *Mya suborbicularis* Montagu, 1803, *Ligula substriata* Montagu, 1808, *Mya ferruginosa* Montagu, 1808, *Tellimya lactea* Brown, 1827, *T. tenuis* Brown, 1827, *T. elliptica* Brown, 1827 (based on *Mya ferruginosa* Montagu, 1808, and an objective synonym thereof), *T. glabrum* Brown, 1827, and *T. ovata* Brown, 1827. Subsequently, Gray (1847) designated *Mya ferruginosa* as its type species. Pérès (1937), Pophan (1940), Deroux (1961) and Oldfied (1961) provided information on the gross anatomy and functional morphology of the type species, and Kamenev (2008) clarified the details of the hinge morphology of the genus. *Tellimya* has sometimes been regarded as a subgenus of *Montacuta* (e.g., Pelseneer, 1925; Ponder, 1968), but currently regarded as a full genus (e.g., Chavan, 1969; Aartsen, 1997; Marshall, 2002; Kamenev, 2008).

In the present paper, a new species of *Tellimya* from the Magellan Region, which constitutes the first record of the genus in South America, is described.

MATERIALS AND METHODS

The specimens described here were obtained at irregular intervals between March 2009 and May 2010 from the intertidal zone at Puerto Deseado, Santa Cruz Province, Argentina (Fig. 1) attached to irregular echinoids of the genus *Abatus*. Echinoids were hand collected during maximum low tides and transported to the laboratory for inspection under stereoscopic microscope. The number of bivalves and their position on the echinoid test were recorded. The maximum diameter of echinoids was measured. Length (L: maximum anteroposterior distance), height (H: maximum dorsoventral distance perpendicular to L) and width (W: maximum distance across valves) of bivalves were measured. Mean values and standard deviation (SD) for the H/L and W/L ratios were calculated. Specimens for anatomy were fixed and decalcified in a 10% formalin solution with 5% acetic acid, and dissected under a stereoscopic microscope. Specimens for histology were fixed in Bouin's solution, dehydrated, embedded in Historesin (Leica®) and sectioned (3.5 µm thick). Sections were stained with haematoxylin and eosin. Shell morphology was studied and illustrated with scanning electron microscopy.

Voucher specimens were deposited in the collections of Invertebrate Zoology at Museo Argentino de Ciencias Naturales (MACN) and Museo de La Plata (MLP).

SYSTEMATICS

Tellimya tehuelcha, n. sp.
Figs. 2–33

Type Locality: 47°45'S, 65°52'W, Puerto Deseado, Santa Cruz Province, Argentina.

Type Material: Holotype (MLP 13396) and 20 paratypes (10 paratypes, MACN-In 39321; 10 paratypes MLP 13397).

Additional Material: Histological sections of seven specimens (MACN-In 39320).

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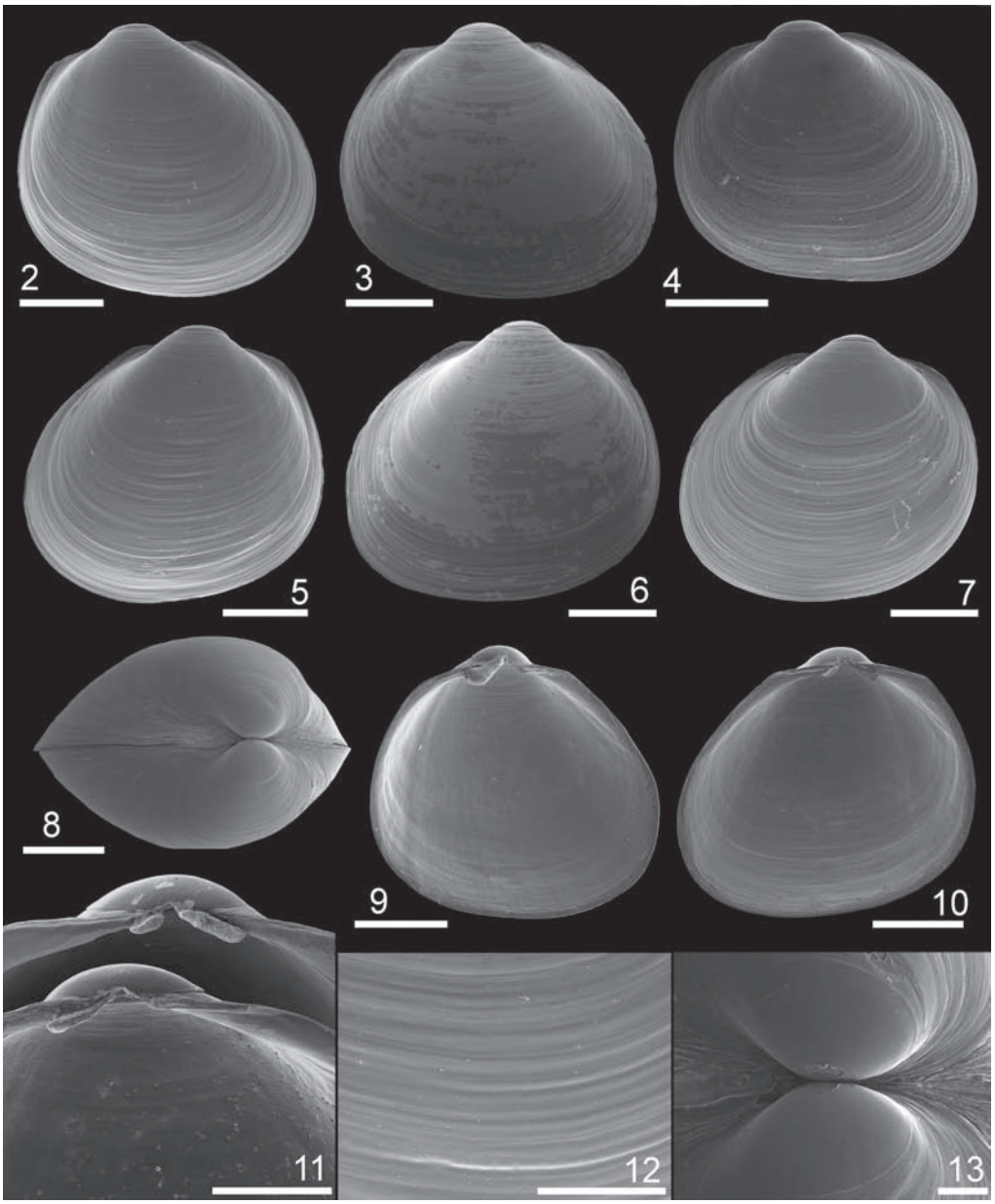
FIG. 1. Locality map: Latitude (°S), longitude (°W).

Distribution: Only known from the type locality (Fig. 1).

Etymology: The species name refers to the Tehuelches, one of the aboriginal people inhabiting vast regions of southeastern Patagonia.

Diagnosis: Shell high, trapezoidal, posteriorly truncate, inflated, sculptured only with well-marked growth lines. Anterior right cardinal tooth short. Protoconch large (about 700 µm diameter). A single demibranch, with up to 50 filaments with extended and anastomosed adfrontal portions, present. Mantle border expanded anteriorly to delimit an inhalant area; inner fold with small papillae exteriorly visible in live specimens.

Description: Shell solid, small (maximum observed L = 5.9 mm), markedly trapezoidal in larger specimens (H / L = 0.86 ± 0.03; n =



FIGS. 2–13. ***Tellimya tehuelcha***, n. sp., shell morphology. FIGS. 2, 5: Holotype (MLP 13396); FIGS. 3, 4, 6–13: Paratypes (MLP 13397); FIGS. 2–8: Outer view. FIGS. 2–4: Right valve. FIGS. 5–7: Left valve. FIG. 8: Dorsal view; FIGS. 9–11: Inner views. FIG. 9: Left valve. FIG. 10: Right valve. FIG. 11: Details of right (upper) and left (lower) hinge plates; FIG. 12: Detail of shell sculpture; FIG. 13: Protoconch. Scale bars: Figs. 2–10 = 1 mm; Figs. 11, 12 = 500 µm; Fig. 13 = 200 µm.

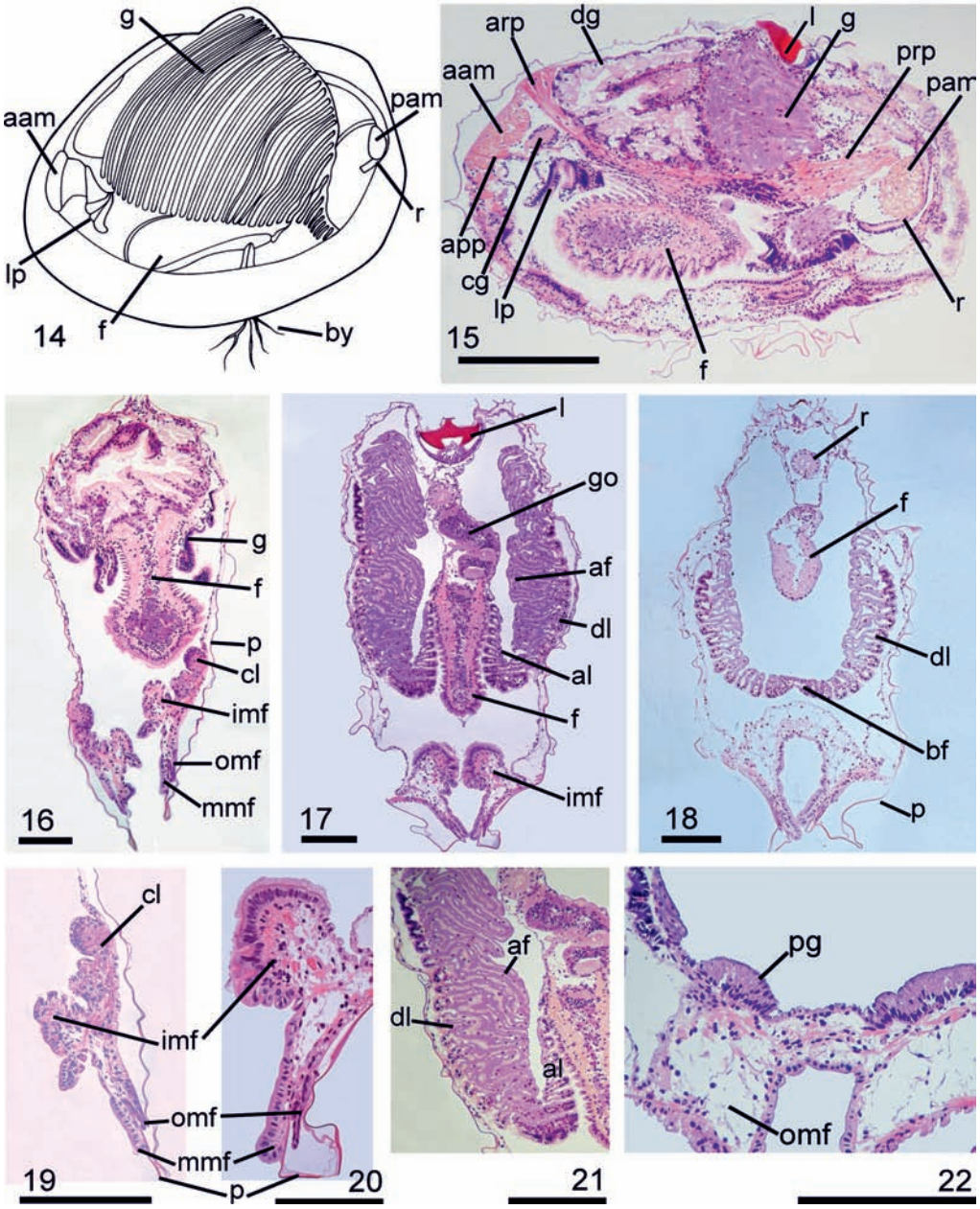
10) (Figs. 2, 3, 5, 6, 9, 10), obliquely ovate in smaller specimens (Figs. 4, 7); inflated (W / L = 0.61 ± 0.03; n = 10) (Fig. 8), equivalve, inequilateral. Anterior end rounded, projecting downward; posterior end truncate (Figs. 2–7). Dorsal margin short, nearly straight, horizontal. Posterior part of dorsal margin slightly sloping, forming a marked angle with posterior shell margin. Dorsal part of anterior margin long, suberect, sloping markedly; ventral part of anterior margin rounded, continuous with ventral margin. Ventral margin widely curved. Posterior margin widely arcuate or nearly straight, almost vertical to slightly oblique (Figs. 2–7). Beaks prominent, inflated, relatively low, posteriorly displaced, orthogyrate. Protoconch ovate, smooth, about 700 µm in diameter, well discernible from teleoconch (Fig. 13).

Shell surface white, brilliant, sculptured with well-marked, irregularly distributed growth lines (Fig. 12); radial striation absent; periostracum thick, translucent. Hinge plate interrupted behind beaks by a deep triangular pit (Fig. 11). Left valve with only one, anterior cardinal tooth that is slender, elongate, nearly horizontal, straight; right valve: only one anterior cardinal tooth that is short, oblique, moderately solid, cuneiform, slightly bent upward, with sharp cusp (Figs. 9–11). Resilifer short, wide, deeply notched in the cardinal platform, located just in front of posterior part of hinge plate. Resilium large, strong, posterior to beak, butterfly-shaped in transverse section, non-calcified (Figs. 9, 17). Adductor muscle scars and pallial line hardly visible.

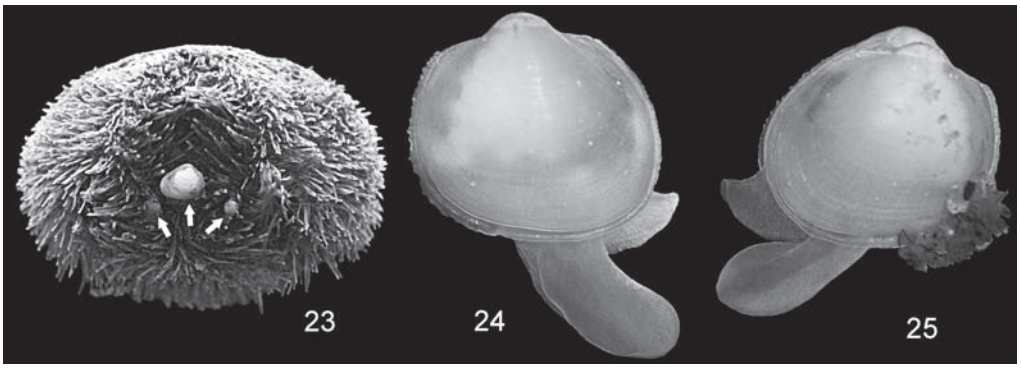
Anatomy: Animal white. Mantle margin relatively wide, not reflected over shell. Anterior half of mantle margin with a ciliated lobe on inside of inner mantle fold (Figs. 16, 19); posterior half of inner fold of mantle border heavily ciliated (Figs. 17, 20). Pallial glands developed on inner surface at posterior part of presiphonal suture (Fig. 22). Pedal opening long, extending for two-thirds of mantle margin length, anteriorly differentiated into a short, frilled-edge, inhalant region that can be extended beyond shell margin (Fig. 24). Short pre-siphonal suture (Fig. 22) and minute exhalant siphon, present. This “siphon” does not extend beyond shell margin in living specimens. Small papillae on middle mantle fold, present (Figs. 24, 25). Transverse section of anterior and posterior adductor muscles small, ovate, the anterior larger (Figs. 14, 15). Labial palps triangular, the outer, the larger with five sorting ridges; inner with 2–3 sorting ridges (Figs. 14, 15). Only inner demibranch present; triangular in outline, with up to 50 filaments with very long adfrontal extensions (Figs. 14, 21); not infrequently, adfrontal extensions of contiguous filaments anastomose. Gill axis almost vertical. Ascending lamellae two-thirds length of descending lamellae (Fig. 17). In lower part of gill, adfrontal extensions of descending and ascending parts of several filaments united, connecting outer and inner lamellae (Fig. 32). Upper end of ascending lamellae fused to visceral mass (Fig. 17); behind visceral mass, posterior ends of left and right ascending lamellae fused, and upper edges of descending lamellae fused to inner mantle epithelium (Fig. 18). Foot ciliated, cylindrical, its base able to form a creeping sole, with slightly marked posterior heel (Figs. 14, 15, 25). Byssal groove running mid-ventrally from heel to just behind anterior tip. Byssus gland large, persistent in adults, opening into a relatively long byssus groove, formed by left and right halves. Byssus composed of a single thread at base, distally split into several very thin treads (Fig. 14). Anterior and posterior retractor pedal muscles large, strong; anterior pedal protractor delicate, crossing anterior adductor muscle (Fig. 15); byssus retractor muscle not well defined.

Biological Observations: ***Tellimya tehuelcha*** lives as an epibiont on the heart urchin *Abatus cavernosus* (Philippi, 1845), particularly in muddy sand, where it was found attached by its byssus exclusively at the urchin’s anal region (Fig. 23). Echinoids of 20.9 to 39.1 mm length were found to host these bivalves (examined range: 4.95–39.1 mm). The bivalve did not show a differential axis of orientation with respect to the echinoid oral-aboral axis. Specimens of ***Tellimya tehuelcha*** were found all year round on echinoids. These observations, and the fact that no free living specimens were found when sieving the sediments where echinoids were present, support the assumption that ***Tellimya tehuelcha*** develops its entire life history on *Abatus cavernosus*. The number of bivalves per echinoid varied between 1 and 10 (Fig. 26); when more than one specimen was present on a single host, only one large specimen (over 2 mm length) was present; the remaining specimens usually were juveniles.

A total of 32 specimens (1.25–3.4 mm length) were studied histologically. ***Tellimya***



FIGS. 14–22. ***Tellimya tehuelcha***, n. sp., anatomy. FIG. 14: Gross anatomy (left side); FIG. 15: Sagittal section; FIGS. 16–22: Transverse sections showing details of demibranch, demibranch fusion, and mantle border. FIG. 16: Anterior section; FIG. 17: Median section; FIG. 18: Posterior section showing fusion of demibranchs and posterior mantle border; FIG. 19: Detail of the anterior portion of the mantle border; FIG. 20: Detail of the median portion of the mantle border; FIG. 21: Detail of demibranch showing the adfrontal extension of filaments and the fusion of ascending lamella to the visceral mass; FIG. 22: Detail of posterior fusion of the mantle border at the level of presiphonal suture and pallial glands. Scale bars: Fig. 15 = 500 µm; Figs. 16–18 = 200 µm; Figs. 19, 21, 22 = 300 µm; Fig. 20 = 150 µm. Abbreviations - aam: anterior adductor muscle; af: adfrontal extensions of branchial filaments; al: ascending lamella; app: anterior protractor pedis; arp: anterior retractor pedis; bf: branchial fusion; by: byssus; cg: cerebral ganglion; cl: ciliated lobe; dg: digestive gland; dl: descending lamella; g: gill; go: gonad; f: foot; imf: inner mantle fold; l: ligament; lp: labial palp; mmf: middle mantle fold; omf: outer mantle fold; p: periostracum; pam: posterior adductor muscle; pg: pallial glands; prp: posterior retractor pedis; r: rectum.



FIGS. 23–25. ***Tellimya tehuelcha***, n. sp., living specimens. FIG. 23: Bivalves on the echinoid (arrows indicate the exact position of the bivalves); FIG. 24: Right side; FIG. 25: Left side.

tehuelcha is a peculiar simultaneous hermaphrodite, with an initial stage of gonadal development when, despite their reduced extension in the visceral mass, male tissues are preponderant, and a subsequent stage when female tissues are dominant (Fig. 27). Specimens at sizes below 1.8–2 mm in length, showed acini containing only early male germ cells: spermatogonia and spermatocytes I, the latter with clear figures corresponding to the first meiotic prophase (Fig. 28). In these specimens, male tissues are localized mainly at the posterodorsal region of the visceral mass.

In specimens larger than 2 mm length, female germ cells progressively become evident (Figs. 27, 29). As vitellogenesis proceeds, a reduced number spermatocytes remain as small groups of germ cells blocked throughout vitellogenesis at the stage of spermatocyte I. Seminal receptacles were not observed. Vitellogenesis starts early, when oocytes reach about 80 µm diameter (Fig. 30). The diameter of ripe oocytes is about 350–400 µm (Fig. 31). Gonads in late vitellogenic stage showed male germ cells still at the spermatocyte I stage; specimens

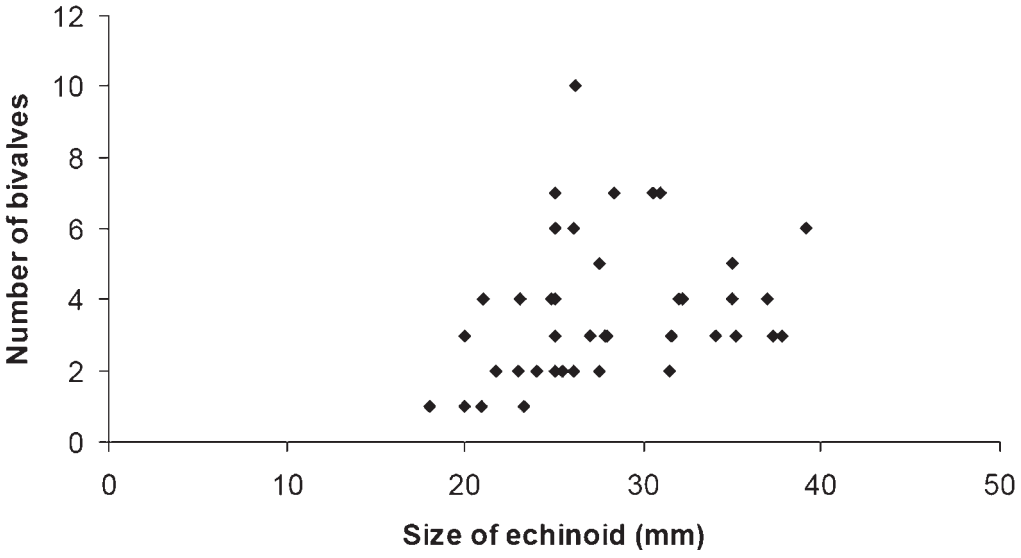
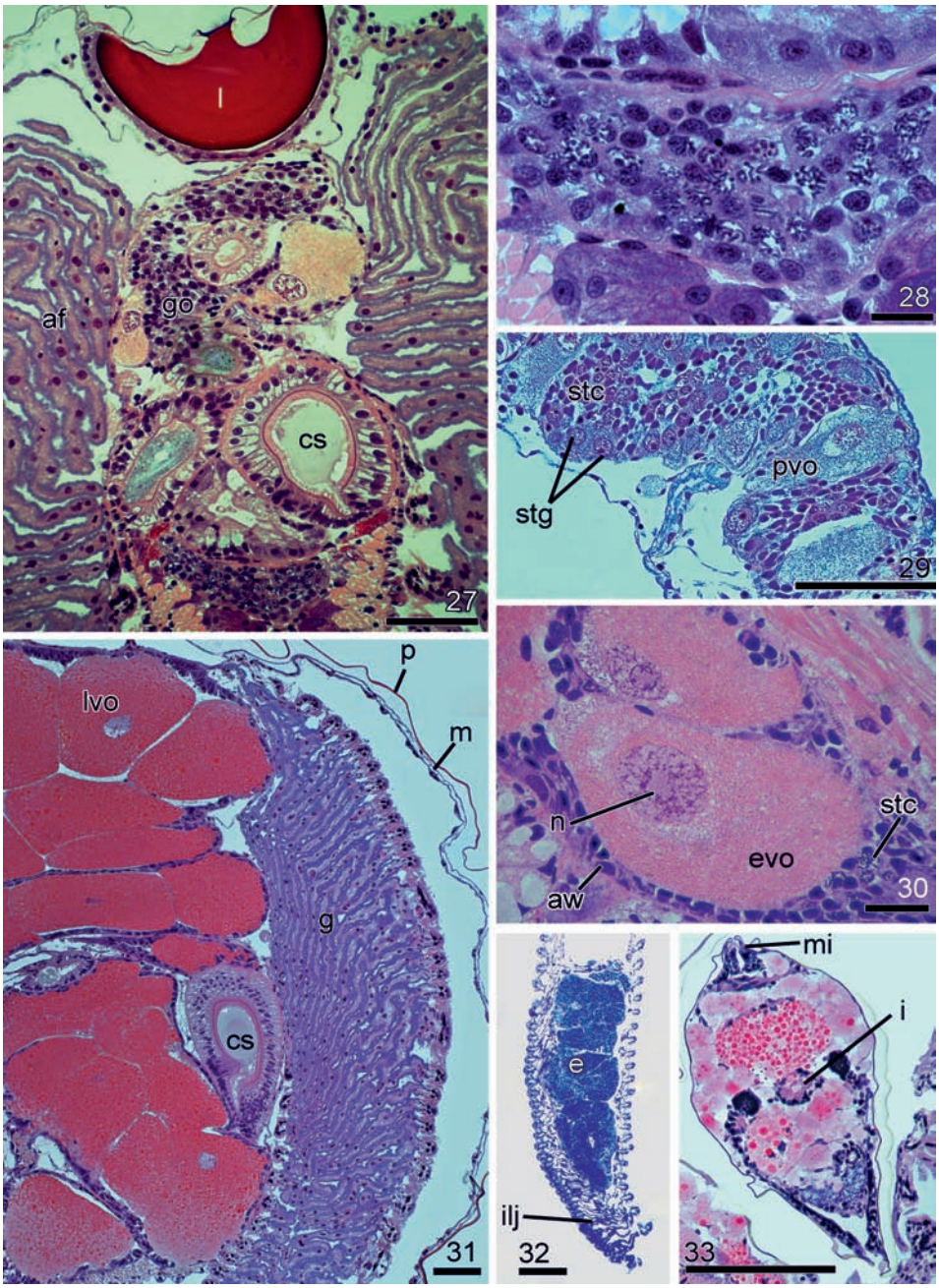


FIG. 26. Relationship between echinoid size and number of bivalves.



FIGS. 27–33. ***Tellimya tehuelcha***, n. sp., histological sections of the visceral mass and embryos. FIG. 27: Hermaphrodite gonad of a 2.4 mm length specimen; FIG. 28: Detail of spermatocytes showing characteristic figures of first meiotic prophase; FIG. 29: Detail of spermatocytes I and pre-vitellogenic oocytes; FIG. 30: Detail of early vitellogenic oocytes; FIG. 31: Oocytes in late vitellogenic stage; FIG. 32: Early developping embryos within the inner demibranch; FIG. 33: Late developping embryo. Scale bars: Figs. 27, 31 = 100 µm; Fig. 28 = 20 µm; Fig. 29 = 50 µm; Fig. 30 = 30 µm; Figs. 32, 33 = 200 µm. Abbreviations - af: adfrontal extension of branchial filaments; cs: crystaline stylet; e: embryos; evo: early pre-vitellogenic oocyte; aw: acinus wall; g: gill; go: gonad; i: intestine; ilj: interlamellar junction; l: ligament; lvo: late vitellogenic oocytes; m: mantle; mi: mantle isthmus; n: nucleus; p: periostracum; pvo: pre-vitellogenic oocyte; stg: spermatogonia; stc: spermatocytes.

ready to spawn showed few mature sperms intermingled among female acini.

Released ova are retained in both inner demibranchs (Fig. 32), where embryos develop. Up to 33 embryos per demibranch were found in a specimen of 3.3 mm in length. Brooding embryos remain free within the branchial space of the maternal individuals until complete their development and being released as miniature juveniles (about 700 µm length) (Fig. 33).

DISCUSSION

Tellimya tehuelcha resembles in general shell shape and gross anatomy *Tellimya ferruginosa*, the type species of the genus; both species have only one (the inner) demibranch, with anastomosing gill filaments; mantle margin, with papillae, not covering the outer shell surface; foot with anterior and posterior retractor muscles and pedal protractor, but lacking of byssus retractor muscle; absence of seminal receptacles; shell with posteriorly displaced beaks; hinge plate interrupted below beaks, with only one, anterior, obliquely directed cardinal tooth in the right valve, and the left valve with only a long, slender tooth parallel to the dorsal margin, anterior to the beak. These characters support the cogeneric status of the two species.

Tellimya tehuelcha differs from *T. ferruginosa* in having a less projecting anterior end and more markedly truncate posterior margin, resulting, in adult specimens, in a markedly trapezoidal (instead ovate) shell outline. The protoconch is larger in ***T. tehuelcha*** (about 700 µm) than in *T. ferruginosa* (410 µm). *Tellimya ferruginosa* has, in addition to papillae on the mantle margin, two "tentacles", dorsal and ventral to the exhalant siphon, which are absent in ***T. tehuelcha***. Deroux (1961) reported for *T. ferruginosa* an external part of the ligament, which is not present in ***T. tehuelcha***, where the ligament is completely internal. According to Deroux (1961), *T. ferruginosa* has the ascending lamella of inner demibranch nearly as long as the descending lamella, a condition quite different from that observed in ***T. tehuelcha***.

Tellimya tenella (Lovén, 1846) has a flat, oval shell, with convex dorsal margin, faint microscopic radial striae, and very narrow hinge plate. This species, as *T. ferruginosa*, has a smaller protoconch than ***T. tehuelcha*** (about 420 µm in diameter) and two large siphonal tentacles, one above and the other below the exhalant siphon.

Tellimya semirubra (Gaglini, 1992) differs from ***T. tehuelcha*** in having a triangular shell outline, and *Tellimya vitrea vitrea* (Hedley, 1907), *Tellimya benthicola* (Dell, 1956), *Tellimya reinga* (Crozier, 1966), and *Tellimya vitrea aupouria* Ponder, 1968, differ from ***T. tehuelcha*** in having elongate oval shell outlines, sculptured with radial riblets. *Tellimya vitrea aupouria* has in addition a protoconch smaller than that in ***T. tehuelcha*** (about 300 µm in diameter) and the ascending lamella of inner demibranch are nearly as long as descending lamella.

As it has been reported by Oldfield (1961) for *Tellimya ferruginosa* and Jespersen et al. (2007) for *Epilepton clarkiae* (Clark, 1852), the byssus gland of ***Tellimya tehuelcha*** is divided in two parts by a central lamella, and differs from that described for *Montacuta substriata*, in which the glandular duct open to a radial structure formed by numerous lamellae (Oldfield, 1961).

Mode of Life

The species of *Tellimya* for which their habitat is known are frequently associated to irregular echinoids. In this regard, the mode of life of ***Tellimya tehuelcha*** is similar to that reported for the small specimens of *T. ferruginosa*, which live attached to the ventral or subanal spines of the echinoids *Echinocardium cordatum* (Pennant, 1777), *E. flavescens* (Müller, 1776), *E. pennatifidum* Norman, 1868, and *Spatangus purpureus* (Müller, 1776) (Pophan, 1940; Oldfield, 1961; Gage, 1966a). However, larger specimens of *T. ferruginosa* occur free in the burrow produced by the echinoid. This fact is related to the absence of byssus gland in larger specimens of *T. ferruginosa* (Pérès, 1937; Gage, 1966a). On the contrary, in ***T. tehuelcha*** the byssus gland is persistent in adults, and adult specimens also appear attached to the host. Pérès (1937) reported that usually two or three specimens of *T. ferruginosa* are found per echinoid, with a maximum of five or six. Marshall (1891) reported up to 18 bivalves per echinoid, but being only one of them "mature". These characteristics on the mode of life are similar to those observed in ***T. tehuelcha***, in which up to ten attached bivalves per echinoid were found, with only one of them full sized.

Tellimya vitrea aupouria was reported as living on the interambulacrum five of the irregular echinoid *Brissus gigas* Fell, 1947 (Ponder, 1968), and *Tellimya tenella* as living free, in fine sediments (Ockelman, 1965) or "on *Brissopsis lyrifera* (Forbes) (?)" (Lovén, 1848).

Reproductive Biology

According to Oldfield (1961), *Tellimya ferruginosa* is a protogynous, consecutive hermaphrodite, with the gonad developing first entirely as female, undergone a short transition period after the ova are shed, and then become entirely male. Jespersen et al. (2004) stated that the montacutid *Brachiomya stigmatica* Jespersen, Lützen & Nielsen, 2004 might be considered either as a protogynic or alternate hermaphrodite. Our findings for ***Tellimya tehuelcha*** indicate that the species should be considered a protandric hermaphrodite.

The development of ***Tellimya tehuelcha*** is entirely lecitotrophic and occurs within the branchial space of the parental specimens; consequently, the free-living larval stage is suppressed. According to Pophan (1940) and Gage (1966b), *Tellimya ferruginosa* retains early larvae (up to a size of about 140 µm diameter) in the demibranch, which are later released, following a planktonic life period until they metamorphose and settle, when reaching about 410 µm diameter. This is consistent with that described for *Tellimya tenella*, in which shelled embryos (of 127–137 µm in diameter) were found in the demibranch of parental specimens, and free veligers of up to 420 µm in diameter were found in the plankton (Ockelman, 1965). The study of the reproductive biology of ***Tellimya tehuelcha*** is currently in progress.

Geographic Distribution

At the present state of knowledge of the genus, the distribution of *Tellimya* shows as a patchy global pattern. Species of the genus were reported from the Northern Hemisphere in the northeast Atlantic (*Tellimya ferruginosa, Tellimya tenella*, *T. voeringi*) and Mediterranean Sea (*Tellimya ferruginosa, Tellimya semirubra*); other reports also come from the Southern Hemisphere in Australia (*Tellimya vitrea vitrea*), and New Zealand (*Tellimya vitrea aupouria, Tellimya benthicola*, *Tellimya reinga*).

The original illustration of *M. cylindracea* Smith, 1885, a species described from the "North Atlantic deep waters", shows a hinge plate similar to that of *Tellimya*. According to Serge Gofas (personal communication), *M. cylindracea* may be a synonym of *T. ferruginosa*.

Four species from the sub-Antarctic and Antarctic waters have been described under *Tellimya* (i.e., *T. antarctica* Smith, 1907, *T. minima* Thiele, 1912, *T. ovalis* Thiele, 1912, and *T. flavida* Preston, 1916), but all were subsequently reallocated by Dell (1964) into *Mysella* Angas, 1877, and *Rochefortia* Velain, 1877. Thus, the new species described here provides new evidence on the occurrence of this genus in the Southern Hemisphere, and represents the first record not only for the Magellan Region but also for South America.

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