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Bostryx tortoranus (Doering, 1879) species complex (Gastropoda: Stylommatophora: Bulimulidae), a review of taxonomy and distribution of endemic species from Argentina

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Bostryx tortoranus (Doering, 1879) species complex (Gastropoda: Stylommatophora: Bulimulidae), a review of taxonomy and distribution of endemic species from Argentina

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Morphology of the shell, radula, jaw, anatomy and sculpture of the inner wall of the reproductive system are described and compared for three species belonging to the *Bostryx tortoranus* species complex. On the basis of these characters, the following changes are proposed: *Bostryx martinezi* (Hylton Scott, 1965) is removed from synonymy with *Bostryx tortoranus* (Doering, 1879) and *Bulimulus* (*Scansicochlea*) *cicheroi* Hylton Scott, 1967 is transferred from synonymy with *B. tortoranus* to synonymy with *B. martinezi*. As a result of these changes, the number of species of *Bostryx* known from Argentina has increased to 19 species. *Bostryx tortoranus* and *B. martinezi* are redescribed, also the radula and anatomy of *Bostryx rudisculptus* (Parodiz, 1956) are described for the first time. The main distinctive morphological characters of the three species are: the structure of the shell's protoconch and teleoconch, radular morphology, location of the secondary ureter opening, the length of the free oviduct with respect to the vagina and the epiphallus with respect to the penis and the bursa copulatrix duct's inner wall sculpture. *Bostryx martinezi* and *B. rudisculptus* have restricted distributions and are ecologically endemic, whereas *B. tortoranus* has a wide distribution and is located in different dry ecoregions.

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Keywords: anatomy; inner wall sculpture; synonymy; endemism; ecoregions

Introduction

The genus *Bostryx* was established by Troschel in 1847, with *Bulimulus* (*Bostryx*) *solutus* Troschel, 1847 originally designated as the type species. According to Breure and Romero (2012) based on a molecular analysis, *Bostryx* belongs to the subfamily Bostrycinae, and its members are *B. solutus, Bostryx peruvianus* (Pilsbry), *Bostryx torallyi* (d'Orbigny), *Bostryx* (*Pseudoperonaeus*) *longispira* Weyrauch, *Bostryx* (*Peronaeus*) *agueroi* Weyrauch, *Bostryx* (*Multifasciatus*) *superbus* Weyrauch, and *Bostryx edmundi* Breure and Neubert. Later, Bostrycinae was diagnosed by Breure (2012), based on the following morphological characters: shell with smooth protoconch and genital organs with a relatively long penis sheath. As both characters are not unique to *Bostryx*, new uncertainties were thereby introduced to the taxonomy of this genus.

Bostryx is endemic to South America with a distribution that comprises Argentina, Bolivia, Chile, Peru, Colombia, Ecuador and Paraguay (Breure 1979;

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Cuezzo et al. 2013). Recently Muratov and Gargominy (2011) classified *Bulimulus demerarensis* Pfeiffer a species distributed in French Guiana, Guyana and Surinam, with *Bostryx*. This taxonomic change however is not properly justified and results in a significant re-evaluation of the geographical distribution of the genus. The lack of precise knowledge of the distribution of this genus is due to the confusion in the systematics of the included species. *Bostryx* comprises about 190 species (Quintana 1982; Miquel 1993, 1995; Letelier et al. 2003; Ramírez et al. 2003; Breure and Borrero 2008; Linares and Vera 2012; Cuezzo et al. 2013), 18 of which have been recorded in Argentina (Miquel 1993, 1995; Cuezzo et al. 2013; Miranda and Cuezzo 2014). In Argentina, species of this genus inhabit northern to central portions of the country, including 10 provinces (Catamarca, Cordoba, Jujuy, La Rioja, Mendoza, Salta, San Juan, San Luis, Santiago del Estero and Tucumán) (Miquel 1993, 1995; Cuezzo et al. 2013). *Bostryx* species can be found in different xerophilic environments of ecoregions such as High and Low Monte, Dry Chaco, Espinal, Central Andean Puna and Southern Andean steppe. Although some species occur in a few locations in the Southern Andean Yungas ecoregion, the environment and vegetation of these localities correspond to transitional areas from dry environments to Yungas and atypical Yungas moist rainforest. For this reason, *Bostryx* is considered to be a taxon typical of dry environments.

Most of the genus' species are known only for their shell morphology and radular features and anatomical information on Argentinean species of *Bostryx* is only available for few species (Hylton Scott 1945, 1954, 1967; Parodiz 1956; Breure 1978). Recently, Miranda and Cuezzo (2014) described the sculpture of the reproductive system inner wall for the first time; this is very important for the diagnosis of the genus.

In 1995, Miquel, in his revision of Argentinean species of the genus *Bostryx*, based on conchological characters, maintained that *Bulimulus* (*Bulimulus*) *monticola* Doering, 1879, *Bulimulus jujuyensis* Holmberg, *Bulimulus sporadicus gracilis* Hylton Scott, 1948, *Bulimulus* (*Scansicochlea*) *hyltonscottae* Parodiz, 1956, *Bulimulus* (*Scansicochlea*) *rudisculptus* Parodiz, 1956, *Bulimulus* (*Scansicochlea*) *martinezi* Hylton Scott, 1965, *Bulimulus* (*Scansicochlea*) *cicheroi* Hylton Scott, 1967 and *Bulimulus* (*Scansicochlea*) *gladysae* Hylton Scott, 1967, were variations of *Bostryx tortoranus* (Doering, 1879). He synonymized and combined them in the *Bostryx tortoranus* species complex. However, Cuezzo et al. (2013) considered *B. monticola* a synonym of *Bostryx cordillerae* (Strobel), and raised *B. sporadicus gracilis* subspecies to species, within the genus *Bulimulus* Leach, 1814. In the same work, *B. rudisculptus* was removed from synonymy with *B. tortoranus* and reinstated as a valid species. In agreement with Miquel (1995), the authors proposed that *B. jujuyensis*, *B. martinezi, B. cicheroi, B. hyltonscottae* and *B. gladysae* are synonyms of *B. tortoranus*. In the course of the taxonomic revision of the species of *Bostryx* distributed in Argentina, an important aim was to clarify the status of the species belonging to *Bostryx tortoranus* species complex. For this reason the aims of this study are: (1) to perform a study on the protoconch shell ultrasculpture, a complete description of the shell's morphology, digestive, pallial and reproductive systems and to describe for the first time the reproductive system inner wall sculpture; (2) to identify the taxonomic entities comprising the *Bostryx tortoranus* species complex, based on new shell and anatomical characters provided in this work.

Materials and methods

Specimens were collected from northern (23° S) to central Argentina (32° S) during summer–autumn seasons (November–May) from 1996 to 2012. Extensive materials, including type materials deposited in malacological collections from the following institutions were examined: IBN (Instituto de Biodiversidad Neotropical, Tucumán, Argentina), IFML (Instituto Fundación Miguel Lillo, Tucumán, Argentina), MACN-In (Museo Argentino de Ciencias Naturales 'Bernardino Rivadavia', Buenos Aires, Argentina) and MLP (Museo de La Plata, La Plata, Argentina). Number of paratype specimens is included in parentheses after acronym and collection number. Also the location of the types of species previously synonymized with the valid species name is included. Type locality for each species is given as stated in original publications. Further details were added to clarify the geographic location of each locality.

Living specimens were drowned in deoxygenated water and fixed in 96% ethanol and later transferred and preserved in 80% ethanol. Shell morphology was observed, measured and described under a Leica MZ6 stereoscopic microscope. Seven standard shell measurements were taken using a calliper with shell axis (columella) to Y axis of coordinates and the maximum shell breadth measured accurately in plane view. The selected measurements were: major diameter of the shell (masd); minor diameter (misd); Total shell height (th); body whorl height (bwh); spire height (sh); shell apertural height (ah); shell apertural diameter (mad). Maxima and minima for each measurement are reported and all measurements are expressed in millimetres (mm). The counting of the shell whorls follows Kerney and Cameron's (1979) methodology. Radula and jaw were extracted and prepared according to Ploeger and Breure (1977). Protoconch sculpture, radula and jaw were examined and photographed with a Jeol Scanning Electron Microscope 35CF at the Integral Center of Electron Microscopy (CIME, San Miguel de Tucumán, Tucumán, Argentina). Different anatomical systems were dissected out from alcohol fixed specimens and drawn with the aid of a camera lucida under a microscope. Terminology for the anatomical descriptions follows Tompa (1984). Proximal and distal terms refer to an organ position or part of it in relation to the direction of gamete flow, from ovotestis (proximal) towards genital atrium (distal) (Tompa 1984). The distinction between epiphallus and penis is based on the internal sculpture differences of these organs (Cuezzo 1997, 2006). The anatomical description of *B. rudisculptus* is given in full, since this is the first description of the anatomy of this species, while only the main differential characteristics are presented for the remaining two species.

Maps of the geographical distribution of the species were produced with DivaGis Software (7.3.0.1) (Hijmans et al. 2007), with georeferenced data and political divisions of Argentinean provinces. Ecoregion delimitations are set according to Olson and Dinerstein (1998) and Olson et al. (2001). Total area distribution of each species was then determined on the basis of museum records and recent fieldwork.

Abbreviations used in the text: A: alcohol preserved material; Prov.: province; Dept.: political department division; leg.: collected by; det.: taxonomically identified by.

Taxonomy

Class **GASTROPODA** Cuvier
Subclass **HETEROBRANCHIA** Haszprunar

Order **PULMONATA** Cuvier
Suborder **STYLOMMATOPHORA** Schmidt
Superfamily **ORTHALICOIDEA** Albers
Family **BULIMULIDAE** Tryon
Genus ***Bostryx*** Troschel, 1847

Type species

Bulimulus (*Bostryx*) *solutus* Troschel, 1847 (original designation by monotypy).

Remarks

This genus can be characterized as having a protoconch with axial costules or wrinkles, with numerous fine spiral grooves well marked and densely arranged. Penial retractor muscle inserted in terminal portion of phallic complex. Flagellum inner wall with diagonal folds converging at a central longitudinal fold. Epiphallus divided into proximal thin and wider distal portion. Penis divided by a thin area into proximal swollen portion 1/3 of total penis length and distal cylindrical portion, ¾ of total penis length. Penis proximal portion with inner penis gland and two different sculptures in the inner wall. Penial sheath muscular overlapping more than half portion of penis with retractor muscle inserted in its proximal end. Bursa copulatrix duct divided into proximal thin and wider distal portion.

Bostryx rudisculptus (Parodiz, 1956)
(Figures 1–4)

Bulimulus (*Scansicochlea*) *rudisculptus* Parodiz, 1956: 78; Fernández, 1973: 85; Fernández and Castellanos, 1973: 279; Tablado and Mantinian, 2004: 371.
Bostryx rudisculptus Breure, 1979: 58; Cuezzo et al. 2013: 143.
Bostryx tortoranus Miquel, 1995: 123 [*partim*].

Type material

Holotype (MACN-In 380), Paratypes (MACN-In 380–1 (5)).

Type locality

'Baños de Villavil, provincia de Catamarca'. Villavil is located in Catamarca province, Belén Department.

Material examined

Argentina, Prov. Catamarca, Dept. Belén: MACN-In 380, Baños de Villa Vil, 1933, Gómez M, leg.; MACN-In 380–1, Baños de Villa Vil, 1933, Gómez M, leg.; MLP 10171, Baños de Villa Vil, 1951, Carranza C; Dept. Santa María: IFML 16460, 10 km before La Hoyada, 26° 35′ 20″ S, 66° 21′ 40″ W, 2760 m, 25 November 2003, Cuezzo MG leg.

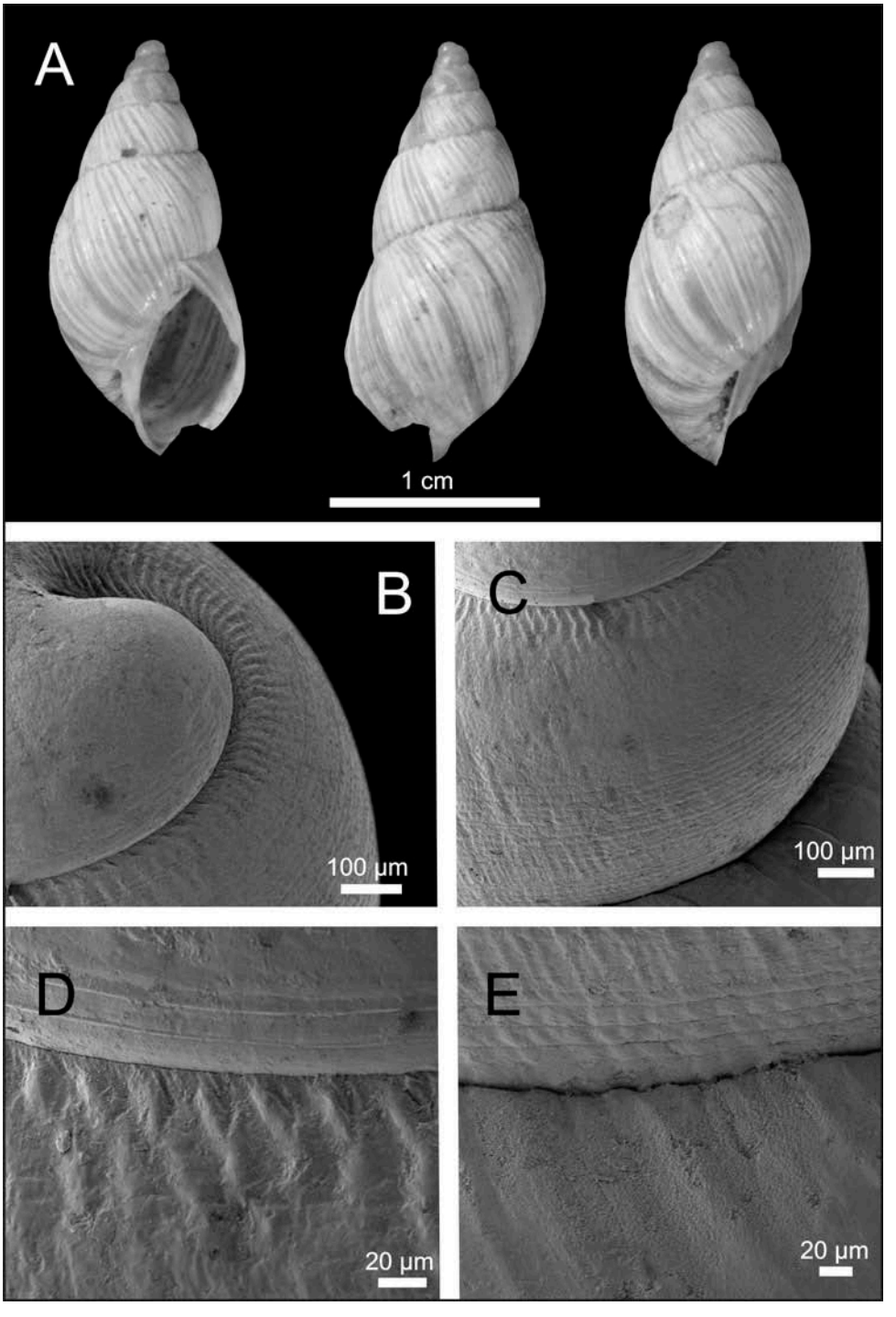

Figure 1. *Bostryx rudisculptus* (Parodiz, 1956) (holotype MACN-In 380). (A) Shell in ventral, dorsal and lateral view; (B) detail of beginning of protoconch; (C) detail of second whorl of protoconch; (D) detail of protoconch's sculpture between the first and second whorl; (E) detail of protoconch's sculpture between the second and third whorl.

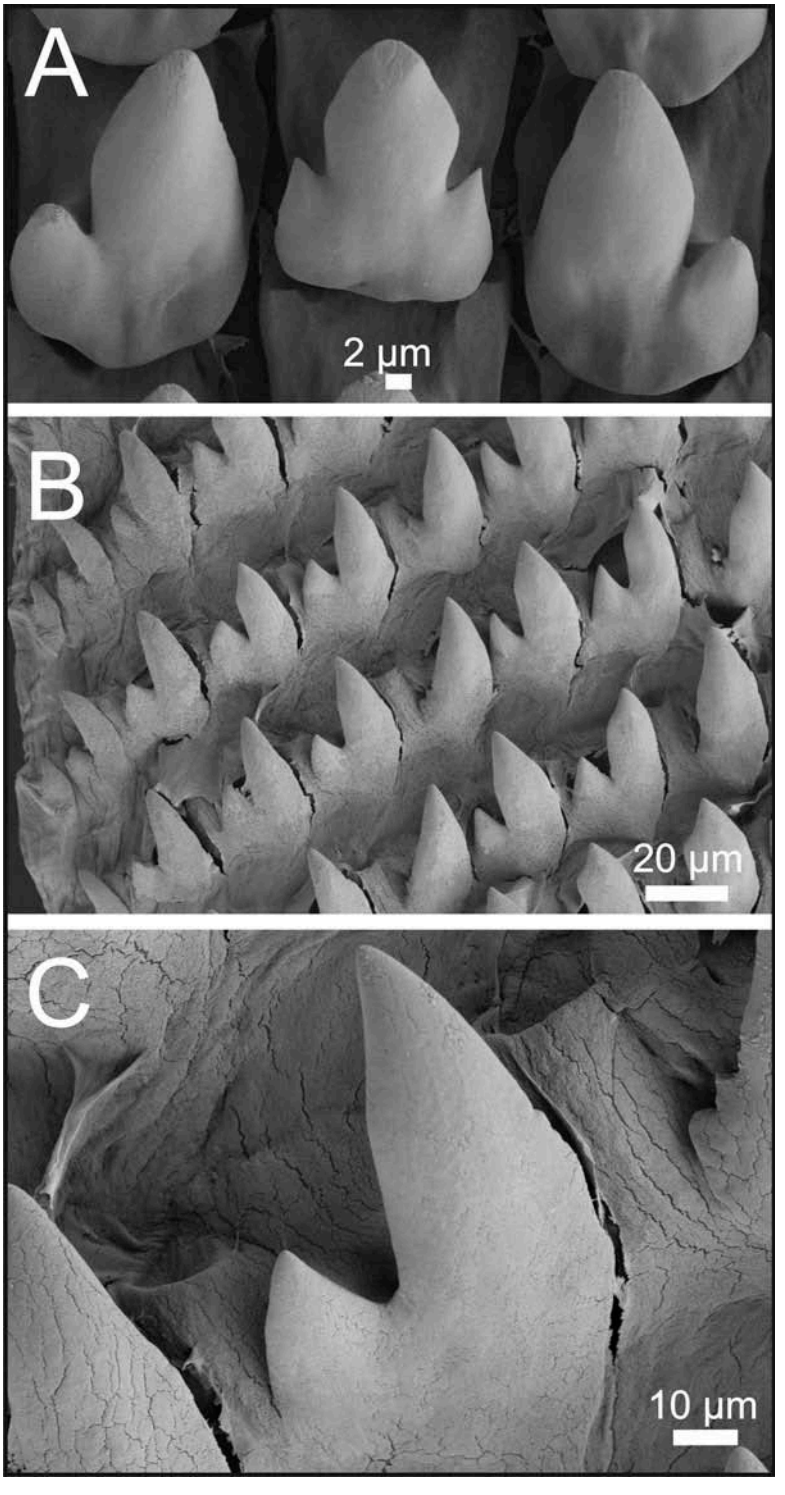

Figure 2. *Bostryx rudisculptus* (Parodiz, 1956). Digestive system. (A) Detail of the central tooth plus the first lateral teeth; (B) marginal teeth; (C) detail of marginal teeth.

Shell. Dextral, fusiform, slender, thin, of 5½ whorls slightly convex (Figure 1A). Shell pale brown, with darker bands (Figure 1A). Protoconch with thick, axial, elevated costules, more marked near suture, parallel to each other (Figure 1B–E). Costules separated by regular narrow spaces. Spiral grooves, parallel, densely arranged, crossing them, thinner than costules (Figure 1B–E). Spire high conic, with whorls increasing regularly in diameter (Figure 1A). Body whorl tall in relation to total height of the shell, 70% of the total length (Figure 1A). Teleoconch with axial oblique ribs (Figure 1A). Suture simple, slightly deep (Figure 1A). Aperture elongated-ovate, tall, half of total shell length (Figure 1A). Parietal space narrow, smooth (Figure 1A). Peristome simple, not expanded (Figure 1A). Umbilicus narrow, partially overlapped by the peristome (Figure 1A).

Measurements. Type material measurements in Table 1.

Range of variability of the species: masd = 5.68–9.46; misd = 5.54–9.46; th = 12.89–20.63; bwh = 9.64–14.60; sh = 4.03–7.97; ah = 7.05–10.02; mad = 4.28–6.30.

External morphology. Lateral groove from genital orifice towards mantle collar, well marked. Foot elongate, basal sole homogeneous, not divided.

Digestive system. Jaw arched with 12 plaques, without sculpture. Central plaque rectangular divided into two minor plaques. Lateral plaques rectangular in shape, regular in size. Radula narrow and long. Central tooth small, triangular, tricuspid (Figure 2A). First lateral tooth bicuspid, similar in size and shape to central tooth (Figure 2A). Marginal teeth bicuspid or tricuspid (Figure 2B, C).

Pallial system (one specimen dissected). Kidney triangular, wider than long, slightly longer than pericardial cavity with inner longitudinal lamellae in contact between them. Pericardial cavity shorter than kidney. Primary ureter bordering kidney along its length. Secondary ureter parallel to rectum, opening at proximal portion of rectum. Distally the secondary ureter splitting into adrectal and abrectal branches. Interramus zone, rectangular, excavated. Rectum opening at mantle collar. Main pulmonary vein, parallel to rectum, with distal portion thinner than proximal portion. Minor veins well marked and thin.

Reproductive system (one specimen dissected). Ovotestis embedded in digestive gland. Albumen gland bean-shaped (Figure 3A, B). Hermaphroditic duct divided into three parts, central part convoluted seminal vesicle (Figure 3A, B). Proximal and distal hermaphroditic duct portion thin and elongated, and distal portion inserting into half portion of albumen gland (Figure 3A, B). Fertilization pouch–spermathecal complex, long and finger-shaped (Figure 3B). Spermoviduct oviducal portion long, transversely sacculated (Figure 3A). Distally, spermoviduct splitting into free oviduct and vas deferens (Figure 3A). Free oviduct shorter and thinner than vagina (Figure 3A). Bursa copulatrix sac rounded, small, with long duct, reaching distal portion of albumen gland, with broader distal portion (Figure 3A). Bursa copulatrix duct with two different inner wall sculptures, proximal longitudinal straight folds, distal zigzag folds. Vagina cylindrical, 1/3 of penis length (Figure 3A), inner wall with longitudinal parallel thick straight folds. Penial complex formed by penis, epiphallus and flagellum. Penial retractor muscle short, inserted terminally in flagellum (Figure 3C, D). Flagellum thin, short and cylindrical (Figure 3C, D) with inner folds diagonal with

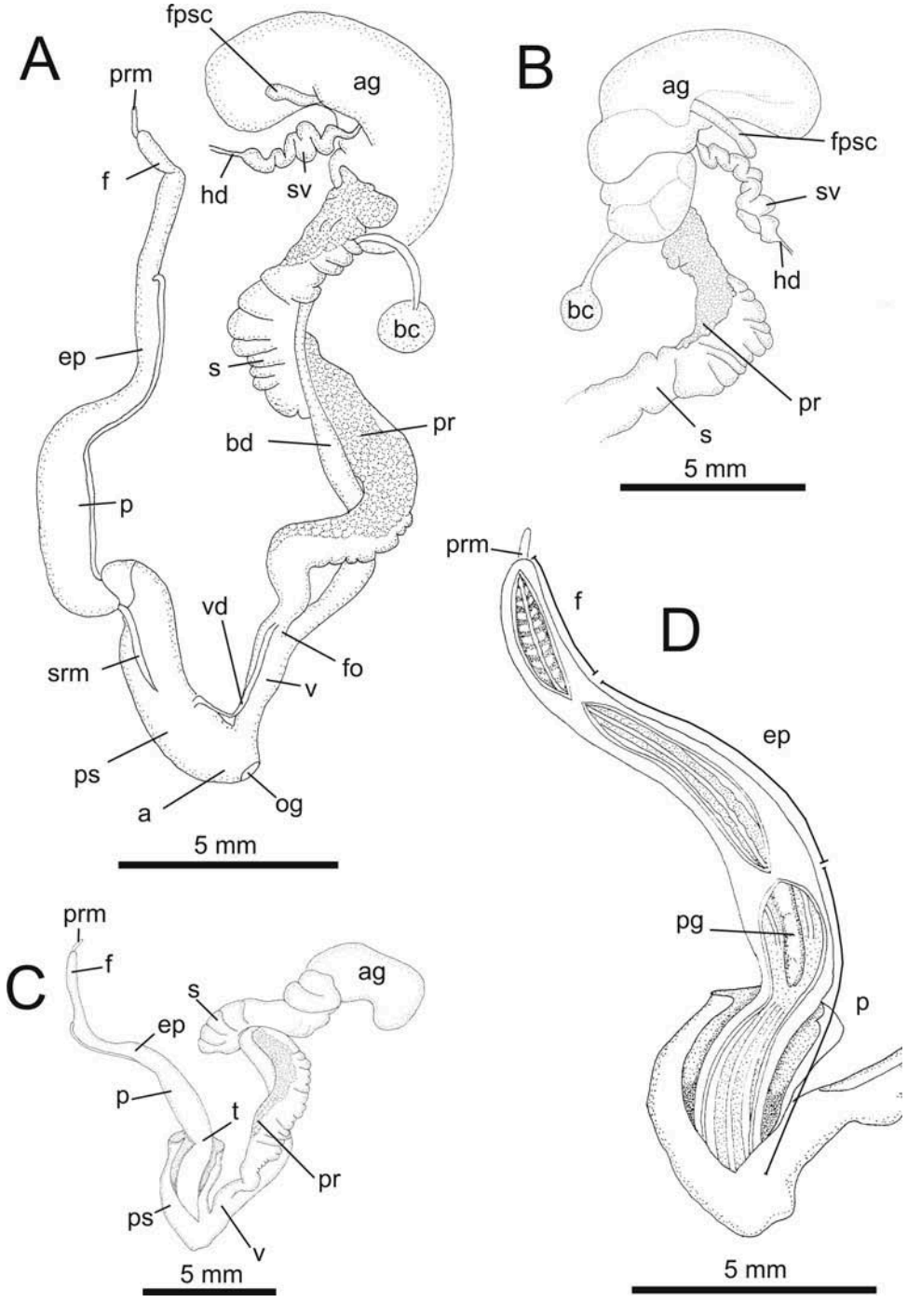

Figure 3. *Bostryx rudisculptus* (Parodiz, 1956). (A) General view of reproductive system dissected out; (B) detail of fertilization pouch–spermathecal complex; (C) detail of the penis without sheath; (D) phallic complex inner wall sculpture. Abbreviations: a, atrium; ag, albumen gland; bc, bursa copulatrix; bd, bursa copulatrix duct; ep, epiphallus; f, flagellum; fo, free oviduct; fpsc, fertilization pouch–spermathecal complex; hd, hermaphroditic duct; og, genital opening; p, penis; pg, penis gland; pr, prostate; prm, penial retractor muscle; ps, penial sheath; s, spermoviduct; srm, sheath retractor muscle; sv, seminal vesicle; t, thinning; v, vagina; vd, vas deferens.

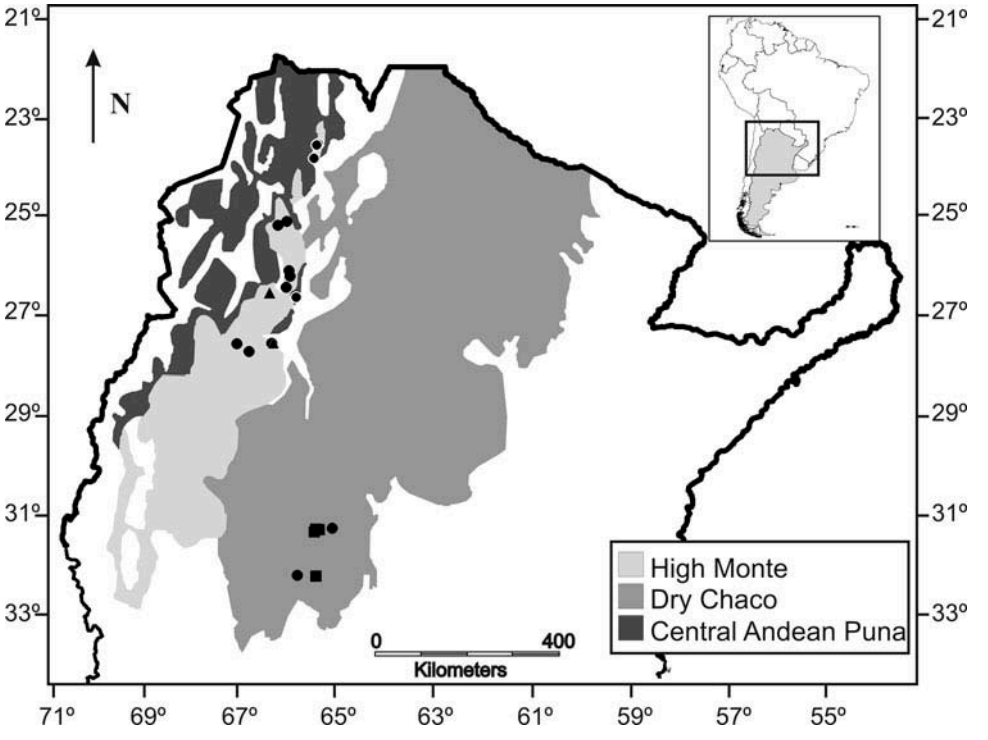

Figure 4. Geographic distribution map of *Bostryx* species from Argentina. Detail showing position of species with respect to ecoregions. References: ■ *B. martinezi* (Hylton Scott, 1965), ▲ *B. rudisculpus* (Parodiz, 1956) and ● *B. tortoranus* (Doering, 1879).

respect to central fold, longitudinal, thin fold extending towards epiphallus (Figure 3D). Epiphallus longer than flagellum, progressively increasing its width towards penis (Figure 3C, D). Inner epiphallus wall with straight, parallel folds in proximal portion, zigzag folds in distal portion (Figure 3D). Penis as long as epiphallus, divided into two regions by a thinner middle section (Figure 3C, D). Proximal penis swollen, internally wall sculpture consisting of thin straight folds followed by smooth area. Distal penis cylindrical with inner straight longitudinal folds area (Figure 3D). Inner penial papilla in proximal penis portion, elongated, triangular with terminal pore (Figure 3D). Penis sheath muscular, folded upon itself in its proximal portion, overlapping the distal portion of penis (Figure 3D). Retractor muscle, not divided, inserting on upper end of penis sheath (Figure 3A). Vas deferens thin, inserting at basal penis sheath (Figure 3A). Atrium short (Figure 3A), inner wall with zigzag folds.

Remarks

Bostryx rudisculptus was originally described in *Bulimulus* (*Scansicochlea*) Pilsbry, by Parodiz (1956), based on shell characters. However, strikingly in 1957 Parodiz did not

Table 1. Morphometric data of the type material examined and compared.

Species	Lot	th	bwh	sh	masd	misd	ah	mad
Bostryx martinezi (Hylton Scott, 1965)	MLP 11448 (H)	19.71	15.52	5.55	8.62	7.95	11.58	6.52
	MACN-In 27208 (P, *n* = 3)	21.21–23.64	14.82–16.74	6.82–7.95	8.37–9.57	7.29–8.45	11.04–12.07	5.63–6.97
	MLP 11011, 11012, 11445, 11446, 11447, (P, *n* = 5)	20.78–22.75	14.46–16.46	7.0–8.09	7.89–9.07	6.98–8.06	9.89–11.40	4.98–5.41
Bulimulus (*Scansicochlea*) *cicheroi* Hylton Scott, 1967	MLP 10996 (H)	22.26	16.82	6.41	10.36	9.10	12.48	6.76
	MLP 10995 (P)	19.66	15.43	5.59	8.76	8.09	11.12	6.45
	MLP 10997 (P, *n* = 2)	18.75–23.51	15.16–17.03	5.44–7.67	8.58–9.40	8.17–8.43	11.19–12.05	5.98–6.25
	MACN-In 27281 (P)	21.36	15.53	6.48	9.63	8.32	10.93	6.24
Bostryx rudisculptus (Parodiz, 1956)	MACN-In 380 (H)	12.89	9.64	4.03	5.68	5.54	7.05	4.28
	MACN-In 380–1 (P)	16.07	11.49	5.39	6.40	5.82	7.66	4.81
Bostryx tortoranus (Doering, 1879)	ZMB 34718 (S)	21.9	—	—	8.93	—	—	—
Bulimulus (*Scansicochlea*) *hyltonscottae* Parodiz, 1956	MACN-In 6516 (H)	26.48	20.33	7.98	11.53	10.49	14.33	8.09
	MACN-In 6516–1 (P, *n* = 3)	25.04–27.65	18.51–20.44	8.0–8.90	11.13–11.83	10.28–10.90	13.34–14.0	7.17–8.19
Bulimulus (*Scansicochlea*) *gladysae* Hylton Scott, 1967	MLP 13345 (H)	23.43	17.78	6.59	11.76	10.07	12.91	7.14
	MLP 11442 (P)	21.97	16.64	6.76	10.74	9.84	11.80	6.87
	MLP 11443 (P)	22.81	17.22	7.23	11.58	10.24	12.38	7.17
	MLP 11149 (P)	20.3	16.41	5.44	11.06	9.78	12.51	7.05
	MLP 11007 (P)	21.84	16.44	6.17	10.21	9.06	11.78	6.63
	MACN-In 27282 (P, *n* = 2)	22.0–23.0	16.73–18.64	6.13–6.90	11.54–11.92	9.85–10.29	12.18–13.45	7.33–7.66

Abbreviations: ah, apertural height; bwh, body whorl height; H, holotype; mad, apertural diameter; masd, major diameter of the shell; misd, Minor diameter; n, number of specimens; P, paratype; S, syntype; sh, spire height; th, total shell height;. *Bostryx tortoranus* (Doering, 1879) measurements according to Breure (2013). Measurements in mm.

list *Bulimulus* (*Scansicochlea*) *rudisculptus* as a species present in Argentina. Later Miquel (1995) relocated *B. rudisculptus* in *Bostryx*, the genus in which it is currently maintained (Cuezzo et al. 2013). The protoconch's sculpture and the reproductive system organization confirm its classification in *Bostryx*.

Bostryx rudisculptus has a similar range to *Bostryx catamarcanus* (Parodiz 1956), a species which can be clearly differentiated by its shell shape and size. The shell of *B. rudisculptus* is smaller in height and diameter as well as aperture (in height and diameter); the teleoconch has ribs and darker bands. In *B. catamarcanus* in contrast, the teleoconch has costules and uniform coloration.

Bostryx rudisculptus is one of the smaller Argentinean species in the genus *Bostryx*, together with *Bostryx cordillerae* (Strobel), *Bostryx costellatus* (Hylton Scott) and *Bostryx reedi* (Parodiz). *Bostryx rudisculptus* differs from *B. cordillerae* and *B. reedi* by its shell that has ribs and a taller aperture. Moreover it differs from *B. reedi* because of its slender shell, without parietal callus and narrower umbilicus. *Bostryx rudisculptus* differs from *B. costellatus* by its more slender shell, with narrower umbilicus, thinner walls and a teleoconch with densely arranged ribs, whereas in *B. costellatus* there are thicker and higher ribs, and these are more widely spaced.

Distribution and habitat

Bostryx rudisculptus is endemic to Catamarca province (26–27° S, 66–67°W), and known from Belén and Santa María Departments. It inhabits High Monte ecoregion (Figure 4) ranging in altitude between 1630 and 2760 m. It is found under rocks in contact with moist soil.

Bostryx martinezi (Hylton Scott, 1965)
(Figures 4–8)

Bulimulus (*Scansicochlea*) *martinezi* Hylton Scott, 1965: 25; Fernández and Castellanos, 1973: 278; Tablado and Mantinian, 2004: 371.
Bulimulus (*Scansicochlea*) *cicheroi* Hylton Scott, 1967: 7.
Bostryx martinezi Breure, 1978: 100, Breure, 1979: 55.
Bostryx tortoranus Miquel, 1995: 123[*partim*]; Cuezzo et al. 2013: 147. [*partim*]

Type material

Bulimulus (*Scansicochlea*) *martinezi:* Holotype (MLP 11448), Paratypes (MLP 11011 (1), MLP 11012 (1), MLP 11445 (1), MLP 11446 (1), MLP 11447 (1), MACN-In 27208 (3)). *Bulimulus* (*Scansicochlea*) *cicheroi*: Holotype (MLP 10996), Paratypes (MLP 10995 (1), MLP 10997 (1), MACN-In 27281 (1)).

Type locality

'Chancani, Sierra de Pocho, Córdoba'. Chancani is located in western Cordoba province, Pocho Department.

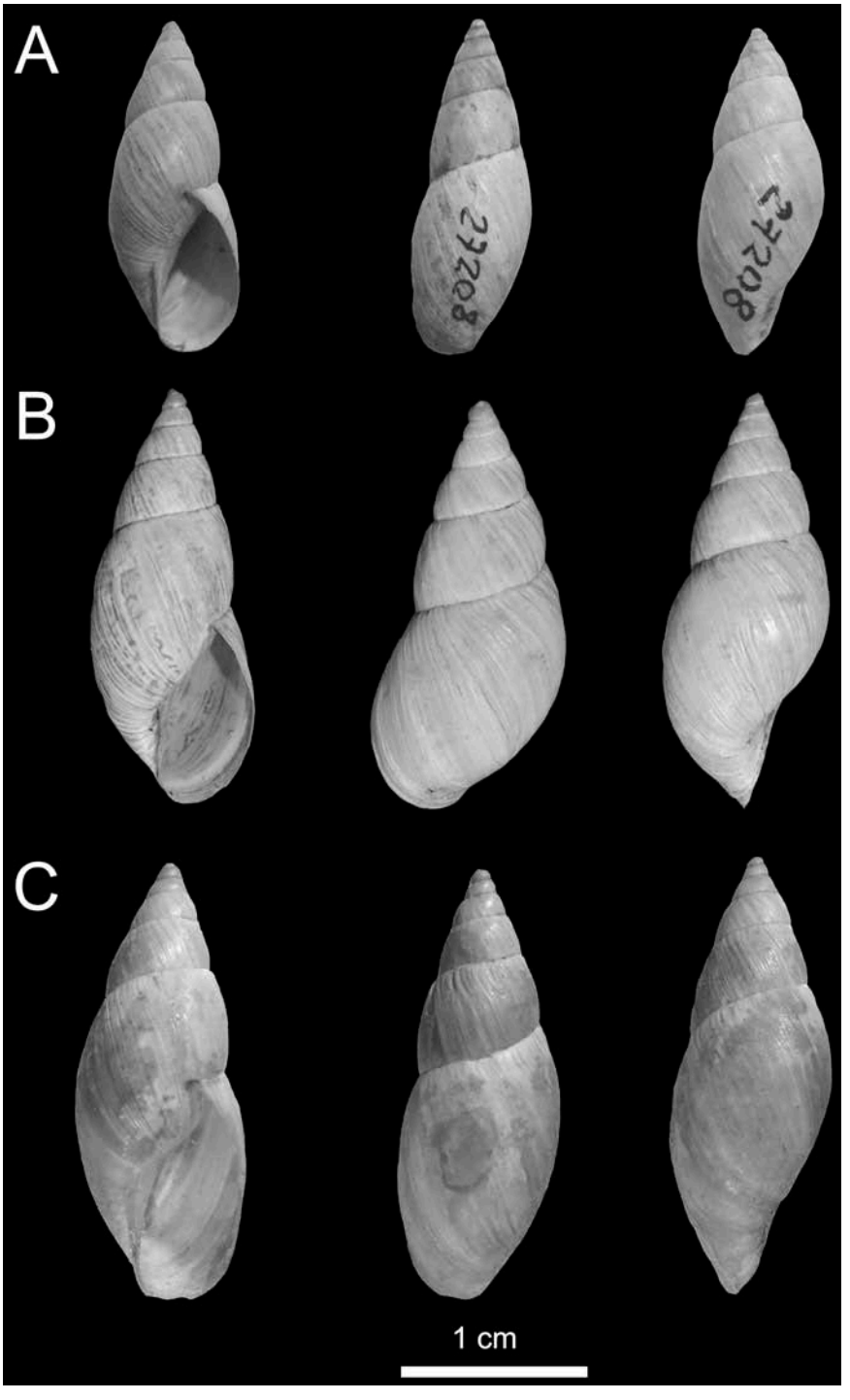

Figure 5. *Bostryx martinezi* (Hylton Scott, 1965). Shell in ventral, dorsal and lateral view. (A) Paratype of *Bostryx martinezi* (Hylton Scott, 1965) (MACN-In 27208); (B) specimen of *B. martinezi* (IFML 15608 (ex CWW 911)); (C) holotype of *Bulimulus* (*Scansicochlea*) *cicheroi* Hylton Scott, 1967 (MLP 10996).

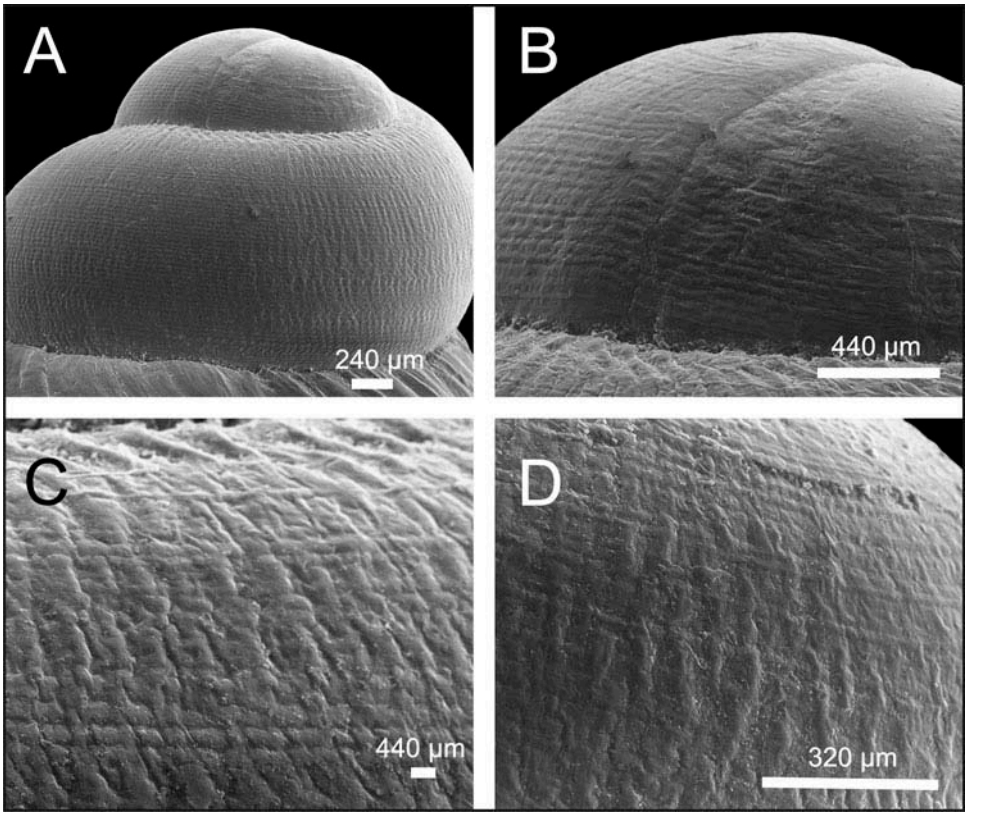

Figure 6. *Bostryx martinezi* (Hylton Scott, 1965). (A) General view of protoconch; (B) detail of microsculpture of the first whorl of the shell; (C–D) detail of microsculpture of the second whorl of the shell.

Material examined

Argentina, Prov. Córdoba, Dept. Pocho: IFML 15608 (ex CWW 911), Sierra de Pocho, between Las Palmas and Chancani, 1050 m, 12 November 1967, Weyrauch W leg. and det.; IFML 15611 (ex CWW 1257), Sierra de Pocho, on the road between Las Palmas and Chancani, 1050–1250 m, 11 December 1969, Weyrauch W leg. and det.; IFML 15610 (ex CWW 2889), Sierra de Pocho, between Las Palmas and Chancani, north-west slope of Sierra de Pocho, 600–900 m, 2 December 1969, Weyrauch W leg. and det.; IFML 15609 (ex SMF 195593), Sierra de Pocho, route between Las Palmas and Chancani, 1050–1250 m, 2 December 1969, Weyrauch W leg. and det.; IFML 15506 A, Chancani, from Las Palmas to El Cadillo, 869 m, 31° 22′ 01″ S, 65° 24′ 74″ W, 18 March 2006, Cuezzo MG and Salas Oroño E leg.; IFML 15507 A, Chancani, from Las Palmas to El Cadillo, before the third tunnel, 921 m, 31° 22′ 17″ S, 65° 24′ 53″ W, 18 March 2006, Cuezzo MG and Salas Oroño E leg.; IFML 15508 A, Chancani, from Las Palmas to El Cadillo, 1440 m, 31° 22′ 60″ S, 65° 23′ 30″ W, 18 March 2006, Cuezzo MG and Salas Oroño E leg.; IBN 826,

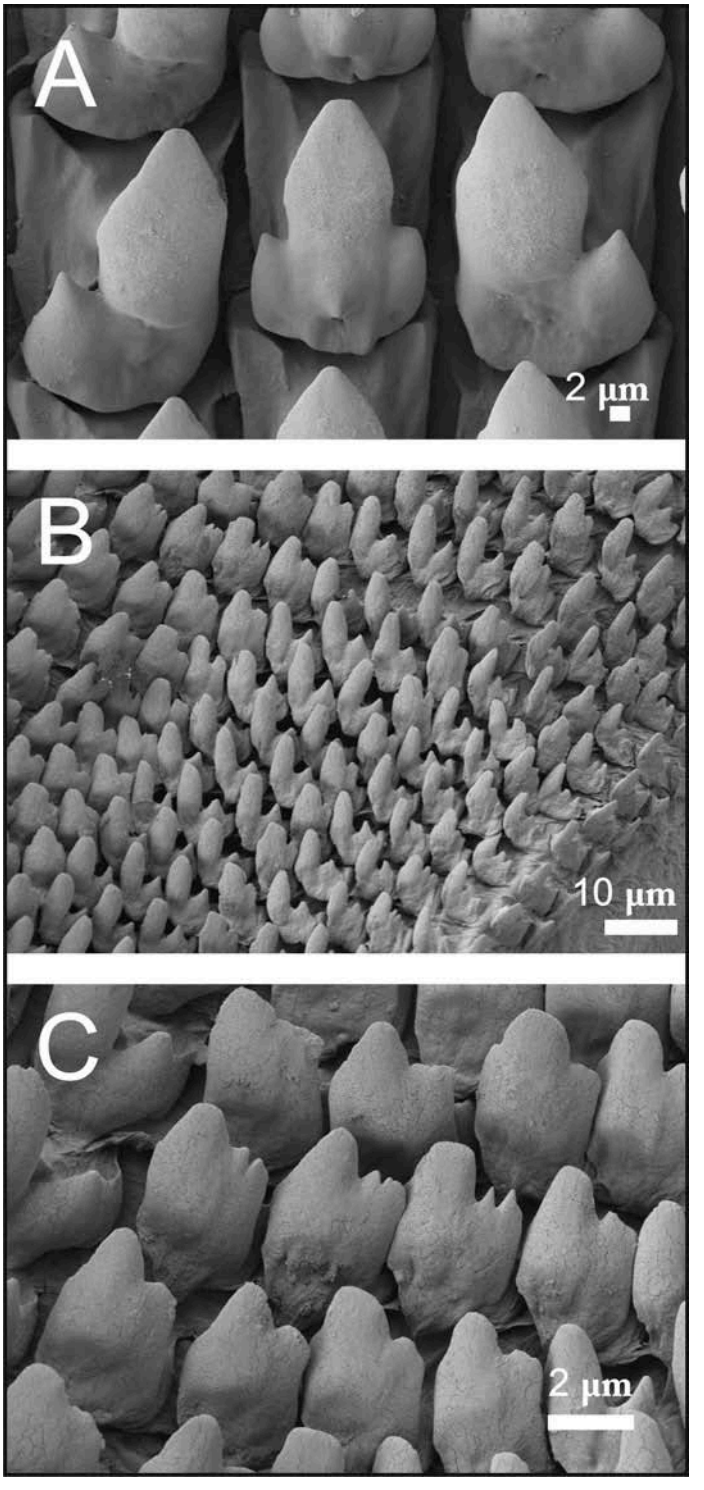

Figure 7. *Bostryx martinezi* (Hylton Scott, 1965). Digestive system. (A) Detail of the central tooth plus the first lateral teeth; (B) marginal teeth; (C) detail of marginal teeth.

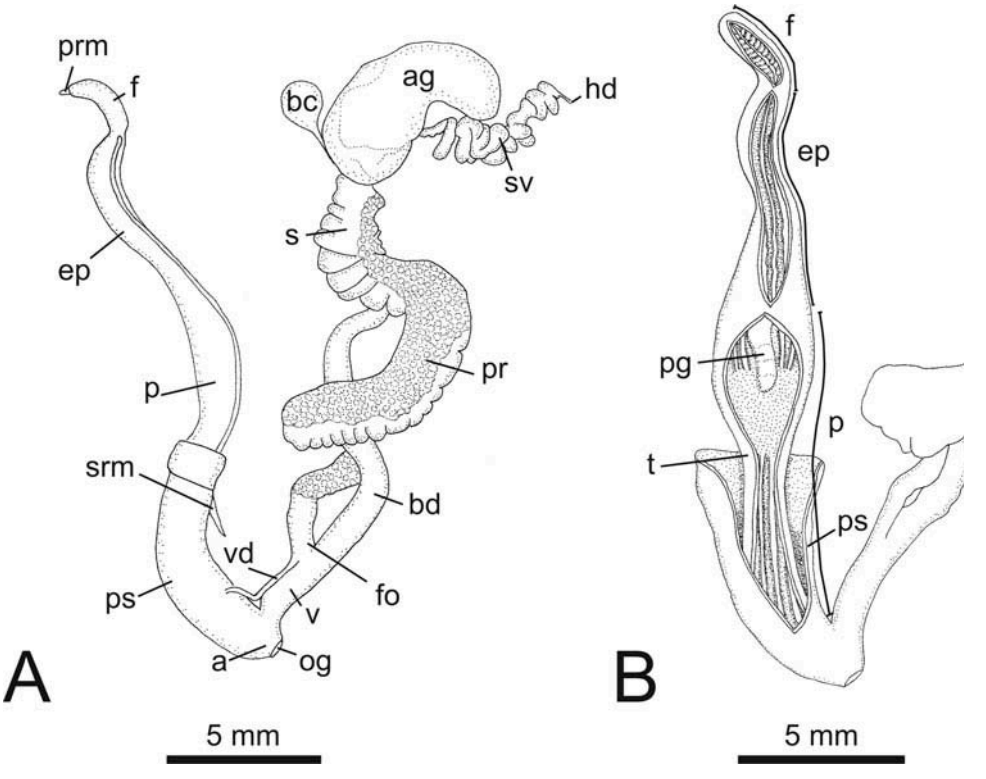

Figure 8. *Bostryx martinezi* (Hylton Scott, 1965). Reproductive system. (A) General view of reproductive system dissected out; (B) morphology and sculpture of phallic complex showing inner wall. Abbreviations: a, atrium; ag, albumen gland; bc, bursa copulatrix; bd, bursa copulatrix duct; ep, epiphallus; f, flagellum; fo, free oviduct; hd, hermaphroditic duct; og, opening genital; p, penis; pg, penis gland; pr, prostate; prm, penial retractor muscle; ps, penial sheath; s, spermoviduct; srm, sheath retractor muscle; sv, seminal vesicle; t, thinning; v, vagina; vd, vas deferens.

Sierra de Pocho, 1021 m, 31° 22.273′ S, 65° 21.080′ W, 3 December 2012, Miranda MJ and Romero F leg.; IBN 829, Sierra de Pocho, Quebrada de La Mermela, 1085 m, 32° 22.485′ S, 65° 23.477′ W, Miranda MJ leg.; MACN-In 25870, Chancani, 1944, Castellanos A. leg.; MACN-In 27208, Sierra de Pocho, between Las Palmas and Chancani, Martínez A leg.; MACN-In 27431 A, Sierra de Pocho, between Las Palmas and Chancani, November 1966, Cichero M leg.; MACN-In 36892 A, Sierra de Pocho, between Las Palmas and Chancani; MLP 11011, Sierra de Pocho, between Las Palmas and Chancani; MLP 11012, Sierra de Pocho, between Las Palmas and Chancani, January 1965, Martínez A leg.; MLP 11446, Sierra de Pocho, between Las Palmas and Chancani, January 1965, Martínez A leg.; MLP 11447, Sierra de Pocho, between Las Palmas and Chancani, January 1965, Martínez A leg.; MLP 11448, Pampa de Pocho, Chancani, January 1965, Martínez A leg. Prov. San Luis, Dept. Junín: MACN-In 27281, Quebrada de Cautana, 3 December

1966, Cichero JA leg.; MLP 10995, Quebrada de Cautana; MLP 10996, Quebrada de Cautana, Cichero JA leg.; MLP 10997, Quebrada de Cautana, Cichero JA leg., MLP 11441, Quebrada de Cautana, 3 December 1966, Cichero JA leg.

Shell. Dextral, fusiform, slender, thin, with 6 to 6¼, flat to slightly convex whorls (Figure 5A–C). Shell uniform yellowish or with darker bands from the third whorl in some specimens. First whorl of the protoconch with thick, axial, elevated costules, parallel to each other and spiral grooves with the same thickness, densely arranged (Figure 6A, B). Second whorl of protoconch with axial, elevated costules, thicker than the spiral grooves and more densely arranged than the first whorl (Figure 6A, C, D). Spire high conic, with whorls increasing regularly in diameter (Figure 5A–C). Body whorl tall in relation to total height of the shell, 80% of the total length (Figure 5A–C). Teleoconch with axial oblique elevated costules, more evident from fourth whorl (Figure 5A–C). Spiral lines crossing them in some specimens. Suture simple, slightly deep (Figure 5A–C). Aperture elongated-ovate, short, 40% of total shell length (Figure 5A–C). Parietal space narrow, smooth (Figure 5A–C). Peristome simple, not expanded (Figure 5A–C). Umbilicus narrow (Figure 5A–C).

Measurements. Type material measurements in Table 1.

Range of variability of the species: masd = 7.89–11.0; misd = 7.27–9.70; th = 18.30–24.60; bwh = 13.80–17.70; sh = 5.40–8.80; ah = 9.70–12.70; mad = 4.98–6.97.

External morphology. Animal body homogeneously pale brown, with lateral groove from genital orifice towards mantle collar, well marked. Foot elongate, basal sole homogeneous, not divided.

Digestive system. Jaw arched with 14 plaques and fine transverse striae. Central plaque triangular divided into two minor triangular plaques. Lateral plaques rectangular in shape, irregular in size. Central tooth triangular, tricuspid, with rounded tip, smaller than the lateral teeth (Figure 7A). First lateral tooth bicuspid, similar in size and shape to central tooth (Figure 7A). Marginal teeth similar to lateral teeth, bicuspid with a sharply pointed ectocone (Figure 7B, C).

Pallial system (six specimens dissected). Kidney triangular, 1/3 of lung roof length. Secondary ureter opening at proximal portion of roof length. Rest of system idem to *B. rudisculptus*.

Reproductive system (six specimens dissected). Free oviduct longer and thinner than vagina (Figure 8A). Bursa copulatrix duct long, reaching distal portion of albumen gland (Figure 8A). Bursa copulatrix duct inner wall with longitudinal zigzag folds. Vagina inner wall with longitudinal parallel thinner straight folds. Epiphallus length 2/3 of penis length (Figure 8A, B). Proximal portion of inner wall of penis with straight folds followed by smooth area and distal portion with relaxed zigzag folds or straight longitudinal folds area (Figure 8B). Rest of reproductive system idem to *B. rudisculptus*.

Remarks

Bostryx martinezi was originally described by Hylton Scott (1965) in *Bulimulus* (*Scansicochlea*) Pilsbry, based on the shell morphology, radula and jaw. In 1978, Breure published the first anatomical study of *B. martinezi* and relocated it in the genus *Bostryx* Troschel, 1847. Finally, *B. martinezi* was listed in synonymy with *Bostryx tortoranus* (Doering, 1879) by Miquel (1995) and Cuezzo et al. (2013). Based on the conchological, radular and anatomical observations performed, diagnostic characters discussed later allow the removal of *B. martinezi* from the synonymy with *B. tortoranus.* Additionally, the following change is proposed: *Bulimulus* (*Scansicochlea*) *cicheroi* Hylton Scott, 1967 is transferred from synonymy with *B. tortoranus* to synonymy with *B. martinezi.* This new synonymy is established based on similarities in shell morphology and the fact that shell measurements of *B. cicheroi* fit the range of those of *B. martinezi*. Moreover, the anatomical description of *B. cicheroi* performed by Hylton Scott (1967) is coincident with the anatomy of *B. martinezi*.

Bostryx martinezi differs from *Bostryx peristomatus* (Doering, 1879), a species also found in Sierra de Pocho, because *B. martinezi* is smaller than *B. peristomatus* (in shell height and diameter) with narrower umbilicus without carina, shorter aperture and peristome simple. Moreover, in *B. martinezi* the teleoconch sculpture consists of axial costules whereas *B. peristomatus* has thicker axial ribs and a finely granulate appearance to the last whorls. Regarding morphological characters, *B. martinezi* differs from *B. peristomatus* because of its shorter kidney with respect to pulmonary roof length, the ureter secondary aperture in the proximal portion of the pulmonary roof, and the free oviduct longer than the vagina.

Distribution and habitat

Bostryx martinezi is found from Cordoba to San Luis (31–32° S, 65° W), in the Dry Chaco ecoregions (Figure 4) and within an altitudinal range between 600 and 1440 m (both records from Sierra de Pocho). It is found on rocks on the side of rivers.

Bostryx tortoranus (Doering, 1879)
(Figures 4, 9–12)

Bulimulus (*Bulimulus*) *tortoranus* Doering, 1879: 71.
Bulimulus (*Bostryx-Lissoacme*) *tortoranus* Pilsbry, 1895–1896: 192.
Bulimulus jujuyensis Holmberg; Holmberg, 1912: 149; Hylton Scott, 1945: 207; Parodiz, 1946: 315; Parodiz, 1957: 134; Parodiz, 1962: 434; Breure, 1978: 144; Tablado and Mantinian, 2004: 371; Miquel, 1995: 123.
Peronaeus (*Lissoacme*) *tortoranus* Parodiz, 1946: 315; Parodiz, 1947: 12; Parodiz, 1957: 23; Fernández, 1973: 98.
Bulimulus (*Scansicochlea*) *hyltonscottae* Parodiz, 1956: 59; Miquel, 1995: 123.
Bulimulus (*Scansicochlea*) *gladysae* Hylton Scott, 1967: 8; Miquel, 1995: 123.
Bostryx tortoranus Breure, 1979: 59; Miquel, 1995: 123; Cuezzo et al. 2013: 147.
Bostryx gladysae Breure, 1979: 54.
Bostryx hyltonscottae Breure, 1979: 54.

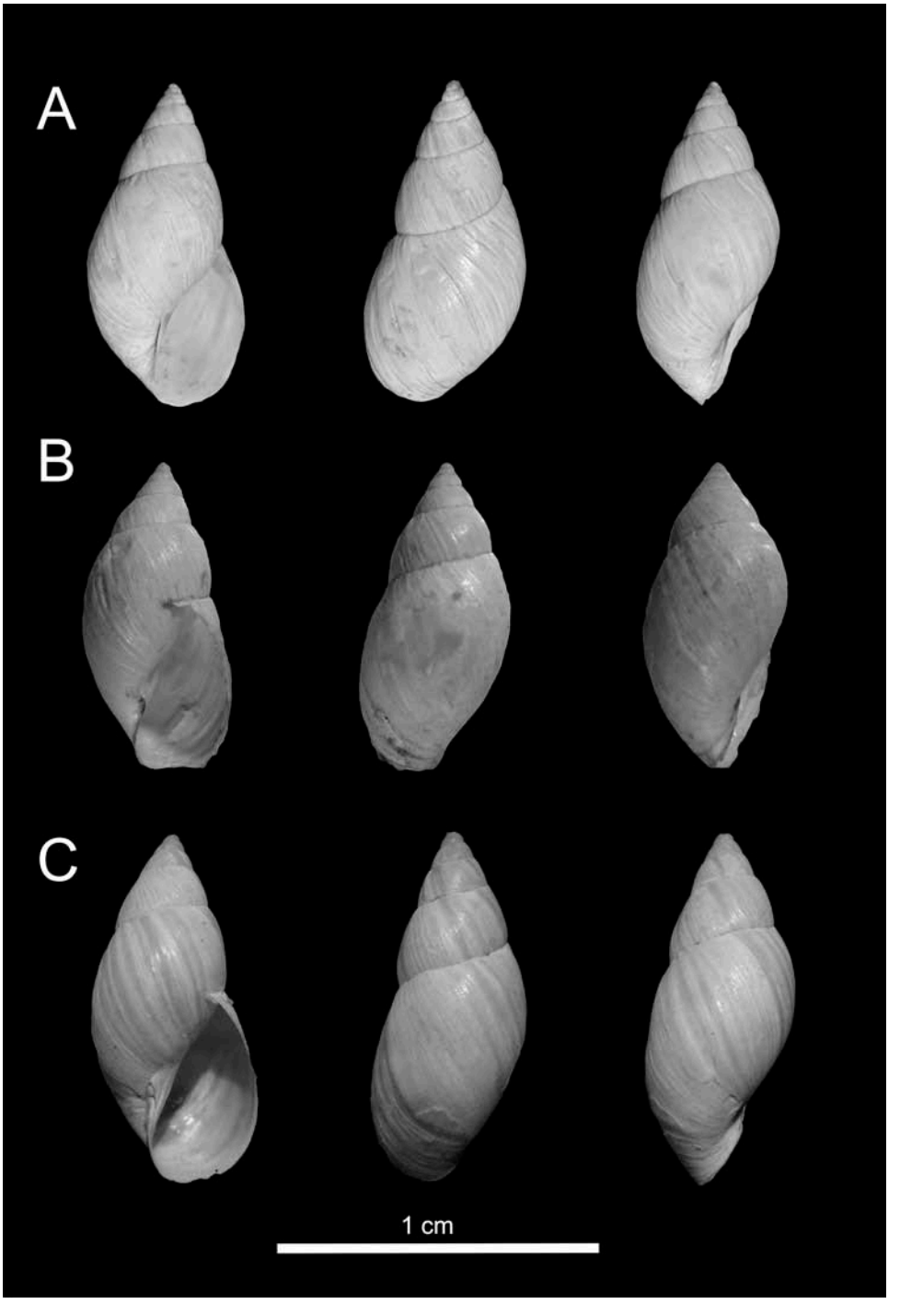

Figure 9. *Bostryx tortoranus* (Doering, 1879). Shell in ventral, dorsal and lateral view. (A) *Bostryx tortoranus* (IFML 15530); (B) *Bulimulus* (*Scansicochlea*) *gladysae* Hylton Scott, 1967 (Holotype, MLP 13345); (C) *Bulimulus* (*Scansicochlea*) *hyltonscottae* Parodiz, 1956 (Holotype, MACN-In 6516).

Type material

Bulimulus (*Bulimulus*) *tortoranus:* Syntypes (ZMB 34718 (3)) ex Doering, according to Breure (2013). *Bulimulus* (*Scansicochlea*) *gladysae:* Holotype (MLP 13345), Paratypes (MLP 11007 (1), MLP 11442 (1), MLP 11006 (1), MLP 11444 (1), MLP 11443 (1), MACN-In 27282 (4)); *Bulimulus* (*Scansicochlea*) *hyltonscottae:* Holotype (MACN-In 6516), Paratypes (MACN-In 6516–1 (4)); *Bulimulus jujuyensis:* Holotype (MACN-In 32686); *Bulimulus* (*Bulimulus*) *monticola:* Syntypes (ZMB 34734 (2)); *Bulimulus sporadicus gracilis:* Hylton Scott, 1948 Holotype (MLP 11015), Paratypes (MLP 11014 (4)).

Type locality

'…quebradas húmedas de la sierra de Pocho (Totoras, Yatan, Cerro Salado)'. The mountain system 'Sierra de Pocho' is located in Cordoba Province, Pocho Department.

Material examined

Argentina, Prov. Catamarca, Dept. Andalgalá: MLP 11006, Foot of Cuesta de la Chilca, 1951; MLP 11007, Foot of Cuesta de la Chilca; MLP 13345, Cuesta de la Chilca, Birabén G leg.; MLP 11442, Cuesta de la Chilca, March 1950; MLP 11443, Foot of Cuesta de la Chilca; MLP 11444, Foot of Cuesta de la Chilca; MLP 11149, Foot of Cuesta de la Chilca; MACN-In 27282, Cuesta de la Chilca, March 1950, Birabén Scott G leg. Prov. Córdoba, Dept. Pocho, IFML 16359, Sierra de Pocho, route to Las Palmas, 31° 20.774″ S, 65° 5.396′ W, 944 m, 4 December 2012, Miranda MJ leg. Prov. Jujuy: MACN-In 19461, Humahuaca river, January 1931, Budín leg. Dept. Ledesma: IFML 158, in route from Tilcara to Garganta del Diablo, 2800 m, 12 September 1962, Willink A leg.; IFML 15607 (ex CWW 2657), in route from Tilcara to Garganta del Diablo, 2800 m, 18 January 1967, Weyrauch W leg.; IFML 14877 A, Cerro Negro, Tilcara, 3000 m, 26 January 2007, Cuezzo MG and Domínguez E leg.; IFML 15530, Cerro Negro, 23° 33′ 57.8″ S, 65° 22′ 14.0″ W, 3143 m, 21 November 2010, Cuezzo MG leg.; IFML 15001 A, Cerro Negro, 23° 34′ 13.8″ S, 65° 22′ 39.7″ W, 2806 m, 21 November 2010, Cuezzo MG leg.; MLP 8071, Fraile Pintado, Birabén M leg. Dept. Tilcara: MACN-In 19590–1, Maimará, March 1931, Budín leg.; MACN-In 30619 A, Cerro Pucará, February 1968, de la Puente R leg.; MACN-In 19506, Tilcara; MACN-In 32686, Tilcara, January 1908, Ambrosetti H leg.; MACN-In 19507, Tilcara, February 1931, Casanova and Gatto leg.; MLP 8075, Tilcara, 1945, Hylton Scott MI leg.; MLP 8070, Tilcara, February 1944, Hylton Scott MI leg. and det.; MLP 1526–1, Tilcara, February 1944, Hylton Scott MI leg. and det. Dept. Tumbaya: MLP 8078, Tumbaya, Weyrauch W leg. Prov. Salta, Dept. Cachi: IFML 15505 A, Route 40, from Cachi to Cafayate, 2160 m, 25° 12′ 37″ S, 66° 11′ 45″ W, Cuezzo MG leg.; IFML 15612, Los Cardones National Park, Pampa TinTin, 3200 m, 25° 08′ 08″ S, 66° 0′ 50″ W, Delhey leg. Dept. Cafayate: IFML 15248, between Cafayate and Colalao del Valle, 26° 08′ 11″ S, 65° 57′ 58″ W, 2156 m, Cuezzo MG leg. Prov. San Luis, Dept. Ayacucho: MACN-In 6516, El Zapallar, 1947, Hylton Scott MI and Birabén M leg.; MACN-In 6516–1, El Zapallar, 1947, Hylton Scott MI and Birabén M. Prov. Tucumán, Dept. Tafí del Valle: IFML 15502

A, between Amaicha and El Infiernillo, after Ampimpa, 26° 38′ 06″ S, 65° 50′ 05″ W, 21 December 2001; IFML 15503 A, Route 307, between Amaicha and El Infiernillo, 26° 40′ 14″ S, 65° 49′ 13″ W, 2756 m, 21 December 2001, Ituarte C leg.; IFML 15504 A, Ruinas de Quilmes, 3 January 2004, Domínguez E leg.; IFML 15282, 5 km after Colalao del Valle, on the side of route, 26° 15′ 07″ S, 65° 56′ 42″ W, Cuezzo MG leg.; IFML 15281, Route 307 between Amaicha and El Infiernillo, 26° 40′ 49″ S, 65° 48′ 46″ W, 2850 m, 26 November 2002, Cuezzo MG leg.; IFML 15510 A, Route 307, between Tafí del Valle and Amaicha, 26° 38′ 18″ S, 65° 49′ 30″ W, 2650 m, 26 November 2002, Cuezzo MG leg.

Shell. Dextral, elongated-ovate, of 5½ to 6½ whorls slightly convex (Figure 9A–C). Shell whitish to yellowish brown. Protoconch with thick, axial, elevated costules slightly wavy, discontinuous, and parallel to each other (Figure 10A–C). Costules separated by regular narrow spaces (Figure 10A–C). Spiral grooves thinner than costules, parallel, more densely arranged, crossing them (Figure 10A–C). Spire high conic, with whorls increasing regularly in diameter (Figure 9A–C). Body whorl tall in relation to the total height of the shell, 75% of the total length (Figure 9A–C). Teleoconch with axial, elevated oblique ribs (Figure 9A–C), irregularly arranged. Suture simple, deep (Figure 9A–C). Aperture elongated-ovate, tall, half the total shell length (Figure 9A–C). Parietal space narrow, smooth (Figure 9A–C). Peristome simple not expanded (Figure 9A–C). Umbilicus rimate (Figure 9A–C).

Measurements. Type material measurements in Table 1.

Range of variability of the species: masd = 8.93–11.98; misd = 8.70–11.0; th = 18.80–29.87; bwh = 14.70–22.11; sh = 5.60–8.90; ah = 10.0–15.35; mad = 6.10–8.90.

External morphology. Animal body homogeneously pale yellowish, with lateral groove from genital orifice towards mantle collar, well marked. Foot elongate, basal sole homogeneous, not divided.

Digestive system. Jaw arched with nine to 11 plaques, without sculpture. Central plaque triangular not divided. Lateral plaques rectangular in shape, the two next to central plaque similar in size, following lateral plaques smaller than the central plaque. Central tooth small, triangular, tricuspid, with rounded tip (Figure 11A, B). First lateral tooth tricuspid, similar in size and shape to central tooth (Figure 11A). Following lateral teeth bicuspid, ectocones developed (Figure 11C). Tooth lateral from 23 teeth of the tooth central bicuspid with serrate ectocone (splitting into two little cones) (Figure 11C). Marginal teeth bicuspid with a rounded ectocone (Figure 11D).

Pallial system (10 specimens dissected). Secondary ureter opening at half rectum length. Rest of system idem to *B. rudisculptus*.

Reproductive system (10 specimens dissected). Free oviduct longer and thinner than vagina (Figure 12A). Bursa copulatrix duct long reaching middle portion of albumen gland (Figure 12A). Bursa copulatrix duct with inner zigzag longitudinal folds. Vagina cylindrical, 1/3 of penis length (Figure 12A), inner wall with straight longitudinal parallel folds. Epiphallus the same length as the penis (Figure 12A, B). Proximal penis swollen, with inner zigzag folds followed by smooth area, distal

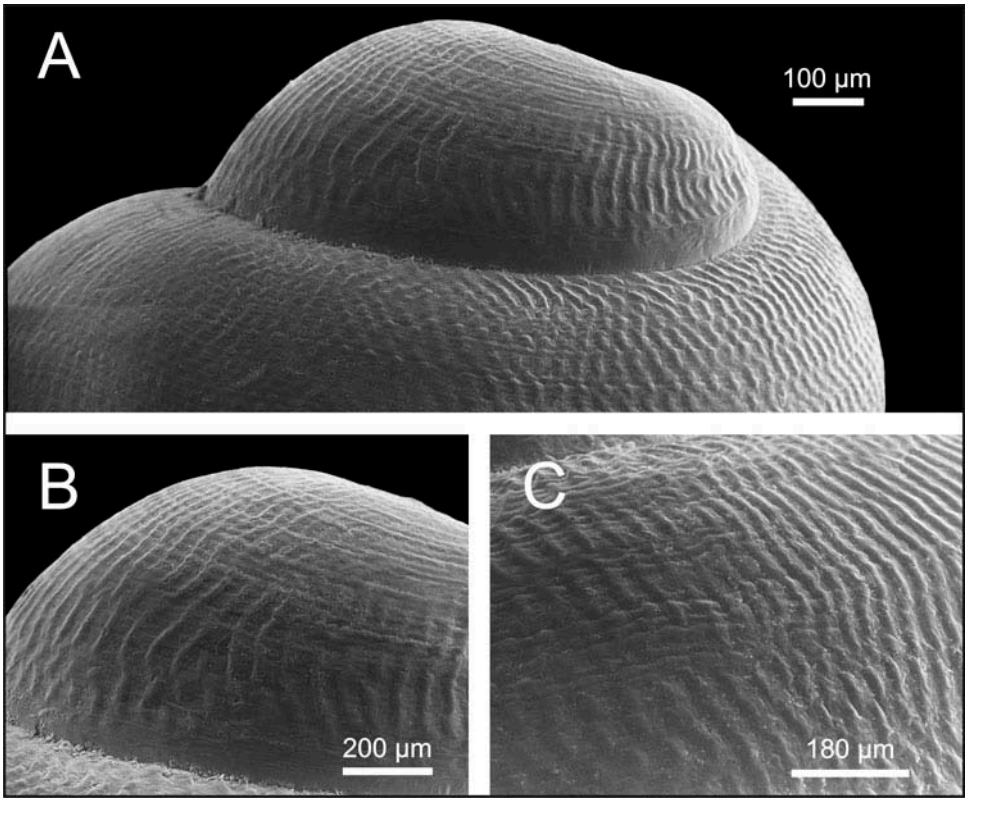

Figure 10. *Bostryx tortoranus* (Doering, 1879). (A) General view of protoconch; (B) detail of microsculpture of the first whorl of the shell; (C) detail of microsculpture of the second whorl of the shell.

portion cylindrical with inner zigzag folds (Figure 12B). Rest of reproductive system idem to *B. rudisculptus*.

Remarks

Bostryx tortoranus was originally described by Doering (1879) in *Bulimulus* (*Bulimulus*) Leach, 1815, based on shell and jaw characters. Subsequently Pilsbry (1895–1896) classified it in *Bulimulus* (*Bostryx-Lissoacme*) Pilsbry, 1896 due to the absence of sculpture on the protoconch. Later, Parodiz (1946) confirmed that the protoconch of this species had a spiral striation and classified it as *B. tortoranus* in *Peronaeus* Albers, 1850. Finally, Breure (1979) relocated *B. tortoranus* to *Bostryx*, a placement currently maintained (Miquel 1995; Cuezzo et al. 2013).

The examination of the type material and numerous other specimens in the Argentinean museums indicates that this species shows high shell variability in form, size and coloration. In agreement with Miquel (1995) and Cuezzo et al. (2013), *Bulimulus jujuyensis*, *Bulimulus hyltonscottae* and *Bulimulus gladysae* are also considered here as synonyms of *B. tortoranus*.

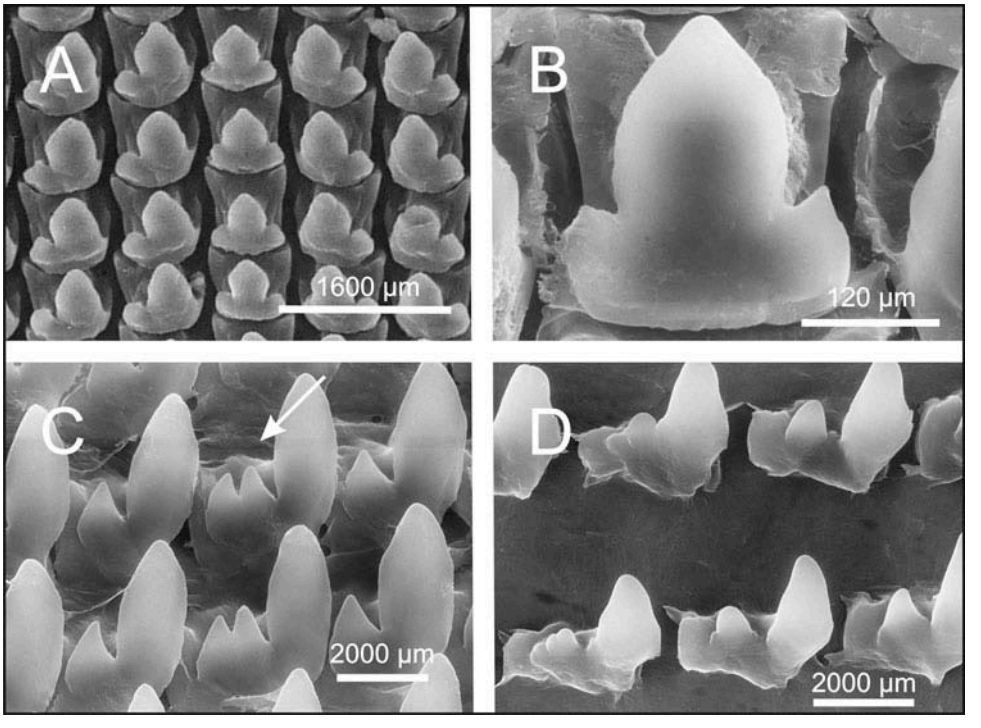

Figure 11. *Bostryx tortoranus* (Doering, 1879). Digestive system. (A) Detail of the central tooth; (B) central and lateral teeth; (C) detail of the lateral teeth and modification of the twenty fourth tooth from the central tooth; (D) detail of the marginal teeth.

Distribution and habitat

Bostryx tortoranus is found latitudinally from Jujuy to San Luis provinces (23–32° S) and longitudinally from Jujuy to Catamarca (65–67° W). A distributional break between 27° and 31°S in the distribution of *B. tortoranus* has been registered. This species inhabits a variety of xerophilic environments of High Monte, Dry Chaco and Central Andean Puna ecoregions (Figure 4). It is common at altitudes from 944 to 3200 m, with the lowest locality corresponding to Pocho Department in Cordoba Province (Dry Chaco) and the highest locality including Cachi Department in Salta Province (High Monte). It is usually found inside crevices between rocks or on the vegetation.

Discussion

This work provides anatomical descriptions of the three *Bostryx* species endemic to Argentina. On the basis of shell microsculpture and new anatomical information, *Bostryx tortoranus* and *Bostryx martinezi* are redescribed and the radula, shell microsculpture and anatomy of *Bostryx rudisculptus* are described for the first time. This study found new morphological and anatomical evidence to differentiate *B. martinezi* and *B. rudisculptus* from *B. tortoranus*. The shell of *B. tortoranus* is elongated-ovate,

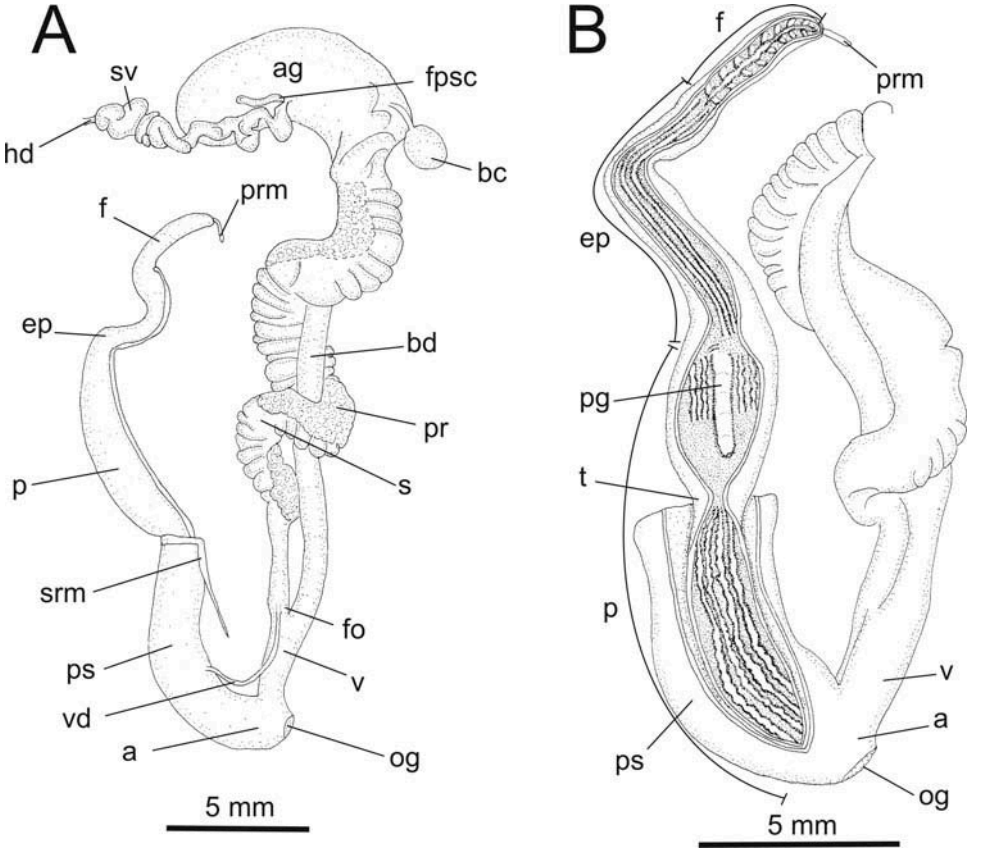

Figure 12. *Bostryx tortoranus* (Doering, 1879). (A) General view of reproductive system dissected out; (B) morphology and sculpture of phallic complex showing inner wall. Abbreviations: a, atrium; ag, albumen gland; bc, bursa copulatrix; bd, bursa copulatrix duct; ep, epiphallus; f, flagellum; fo, free oviduct; fpsc, fertilization pouch–spermathecal complex; hd, hermaphroditic duct; og, opening genital; p, penis; pg, penis gland; pr, prostate; prm, penial retractor muscle; ps, penial sheath; s, spermoviduct; srm, sheath retractor muscle; sv, seminal vesicle; t, thinning; v, vagina; vd, vas deferens.

whereas that of *B. martinezi* is fusiform with a smaller shell aperture (in height and diameter). *Bostryx rudisculptus* is evidently smaller than the other species in all parameters studied. The teleoconch sculpture is clearly different among the three species, the pronounced sculpture of *B. rudisculptus*, consisting of thick and elevated ribs contrasting with the shallower, thinner and more widely spaced axial ribs in *B. tortoranus* and the axial costules cut by spiral lines in *B. martinezi*. In regard to the shell's protoconch sculpture, differences between the species are noted. While in *B. tortoranus* and *B. rudisculptus* it is not possible to recognize two different sculptures between the first and second whorls of the protoconch, in *B. martinezi* the sculpture clearly differs between these whorls. In the digestive system, the jaw has sculpture only in *B. martinezi*, while in *B. tortoranus* and *B. rudisculptus* it is smooth. In *B.*

martinezi and *B. rudisculptus* the lateral teeth are similar; in contrast, in *B. tortoranus* only one lateral tooth is bicuspid with a serrate ectocone. *Bostryx martinezi* and *B. rudisculptus* have bicuspid (or tricuspid in *B. rudisculptus*) marginal teeth with pointed-end ectocones, whereas those of *B. tortoranus* are bicuspid with rounded pointed ectocones. The radula of *B. rudisculptus* has fewest teeth, whereas the radula of *B. tortoranus* has the most teeth. The organization of the pallial system was similar in the three species analysed, and is in agreement with previous descriptions provided by Hylton Scott (1945, 1967), Breure (1978) and Miranda and Cuezzo (2014) for other *Bostryx* species from Argentina. The only difference that could be found between the species was the location of the secondary ureter opening. In regard to the reproductive system, the organization is in general similar in the three species and similar to other *Bostryx* species described (Hylton Scott 1945, 1967; Parodiz 1956; Breure 1978; Miranda and Cuezzo 2014). Only some variations in the relative length and organ's inner wall sculpture were detected. In the case of *B. rudisculptus*, the free oviduct is shorter than the vagina, whereas in the other two species it is longer. Another difference was found in epiphallus length with respect to penis length, being the same in *B. rudisculptus* and *B. tortoranus*, and with the epiphallus shorter than the penis in *B. martinezi.* There is only one kind of sculpture in the inner wall of the bursa copulatrix duct in *B. tortoranus* and *B. martinezi*, whereas in *B. rudisculptus* the inner wall morphology of the bursa copulatrix duct has two sectors differing in their sculpture. In summary, the main distinguishing morphological features of *B. tortoranus, B. martinezi* and *B. rudisculptus* are the shell teleoconch and protoconch sculpture, radular morphology, location of secondary ureter opening, free oviduct length compared to the vagina, the epiphallus compared to the penis and the bursa copulatrix duct's inner wall sculpture. All these morphological characters justify that *B. tortoranus, B. martinezi* and *B. rudisculptus* are considered as different species. As a result of this study the number of species of *Bostryx* known from Argentina has increased to 19 species.

The area of distribution of a species is a complex expression of a combination of factors such as historical causes, ecology, regional and local processes, ecological interactions, and planned or accidental introductions (Castilla and Guiñez 2000; Soberón and Peterson 2005). In the cases of land snails, the temperature, precipitation and available humidity are the most critical environmental factors that can have significant effects on distribution (Craze and Lace 2002; Pfenninger 2004; Pfenninger et al. 2007; Mensink and Henry 2011). Some snails inhabit arid zones by mitigating against dehydration. One of these adaptations is the use of efficient microhabitats that maintain relatively stable conditions despite larger changes in the surrounding environment and where the risk of dehydration is lower (Moreno Rueda et al. 2009; Mensink and Henry 2011). The microhabitats frequently selected by *Bostryx* species are under rocks, inside crevices between rocks or on rock walls usually exposed to direct sunlight, on vegetation, and shadowy places between small thorny shrubberies or cacti (Doering 1879; Hylton Scott 1948; Miranda and Cuezzo 2014). *Bostryx rudisculptus* had the smallest distributional range of the three species. Apart from material from Santa María Department (Catamarca Province), no new distributional records have been published since its description by Parodiz in 1956. Even though *B. martinezi* and *B. tortoranus* have close type localities, *B. martinezi* is common at lower altitudes and is an ecological endemic species (inhabits a unique ecoregion). According to Hylton Scott (1965), Chancani is a place with special physiographic

and climatic conditions, with some species of land snails strictly adapted to their environment, among them *Spixia chancanina* (Doering), *Spixia aconjigastana* (Doering), *Plagiodontes weyenberghi* (Doering) and *Bostryx peristomatus* (Doering, 1879). *Bostryx tortoranus* had the largest range of distribution both latitudinal and longitudinally. The land snail resistance to drought and sensitivity to cold apparently limits their distribution (Pfenninger 2004). Because *B. tortoranus* exists over a larger geographical range, it is likely more tolerant to a wider range of habitats and climatic variation than the other species.

According to Miquel (1995), *B. tortoranus* extends from Jujuy to San Luis central area provinces, including Salta, Catamarca, Tucumán, Santiago del Estero, La Rioja and Cordoba provinces. However, in his distributional map Miquel included the distribution of *B. martinezi, B. rudisculptus, B. monticola* and *B. sporadicus gracilis*, which are now considered different species. Based on museum records and recent field work, *B. tortoranus* inhabits two areas with different ecological conditions separated from each other geographically. The north area occurs in the High Monte ecoregion, with a few occurrence records in Central Andean Puna ecoregion. This area has high altitude (more than 2000 m) and is characterized by a warm and dry climate with big daily and seasonal variation of temperature and rainfall restricted to summer (Pol et al. 2006). There are two characteristics communities, shrubbery of *Larrea divaricata* Cav. and *Larrea cuneifolia* Cav. 1800 and forest of *Prosopis flexuosa* D.C. and *Prosopis chilensis* (Mol.) Stuntz (Pol et al. 2006). The south area comprises the Dry Chaco ecoregion and low areas (under 1000 m). This area is surrounded by mountains which give it particular characteristics as they act as a barrier and restrict precipitation. Furthermore, evapotranspiration exceeds water supply, resulting in strong evaporation causing salinization of soils (Torrella and Adámoli 2006). Characteristic trees of this ecoregion are *Schinopsis quebracho-colorado* (Schltdl.) F. A. Barkley and T. Mey., *Aspidosperma quebracho-blanco* Schltdl. and *Bulnesia sarmientoi* Lorentz ex Griseb. (Torrella and Adámoli 2006). However, there are no morphological or anatomical differences between specimens of the two mentioned areas. According to Ringuelet (1956), almost every disjunct distribution in Argentinean territory is an indicator of physiographic or climate changes in the past. The vertical distribution of *B. tortoranus* is the widest of the species considered. Although Miquel (1995), following Doering (1879), mentioned that it extended to approximately 4000 m, that height corresponds to *B. monticola* and *B. tortoranus* does not exceed 3200 m.

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