

A NEW SPECIES OF *SPIXIA* FROM ARGENTINA (GASTROPODA, STYLOMMATOPHORA, ODONTOSTOMINAE)

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Abstract A new species of *Spixia* is described in the context of a revision of the genus. *Spixia cuezzae* is distributed in the mountain area of Punilla political department, Córdoba, Argentina. The shell is characterised by its fusiform shape sculptured with tall thin ribs separated by narrow intervals and a sub-oval to sub-circular aperture. A large and muscular penial sheath is observed internally. In *Spixia*, the sculpture of the penis wall is important for differentiation of the species. *Spixia cuezzae* is characterized by a muscle group forming an inverted V-shape in penial area I. Penial area III exhibits zigzag folds which form a transition and are continuous with penial area IV where the folds straighten longitudinally towards the distal part of the penis. This kind of sculpture has not been observed in other species of the genus. *Spixia cuezzae* was compared with its most similar species, *S. costellifer* (Haas 1936) and *S. philippii* (Doering 1874). *Spixia cuezzae* differs from them not only in the shell shape, size and teleoconch sculpture but also in some genital characters such as penial sheath length and thickness as well as sculpture of the penial wall.

Key words *Spixia*, *Odontostominae*, shell ultra structure, genital anatomy, Argentina.

INTRODUCTION

The genus *Spixia* was established by Pilsbry & Vanatta in 1898. It is endemic to South America and occurs across northern and central Argentina, parts of Bolivia, Brazil, Paraguay and Uruguay, but mainly in Argentina. Of the 36 nominal species recognized, 31 occur in Argentina, inhabiting northern and central regions (Salta, Tucumán, Catamarca, Santiago del Estero, Córdoba, La Rioja and San Luis Provinces) with a few species cited also for Corrientes and Entre Rios provinces, which may indicate a disjunct distributional area for the genus.

The species here described, *Spixia cuezzae*, was found in the Punilla valley in the province of Córdoba. This area has quite a diverse malacological fauna, with other species of *Spixia* as well as species of related genera such as *Plagiodontes* (Doering 1876) and *Clessinia* (Doering 1874) found in company with *S. cuezzae*. A review on the taxonomic history of the genus *Spixia* is provided by Salas Oroño (2007).

Existing information on the anatomy of *Odontostominae* is sparse, and the original descriptions for the majority of the genera and species are ambiguous or inaccurate. During a revision of the genus *Spixia*, which is still in progress, it has become clear that most of the species can be readily identified on the basis of shell periostracum morphology plus internal anatomy.

The objective of the present study is to describe a new species, *Spixia cuezzae*, providing a description of shell morphology including ultrastructure of the periostracum, along with relevant anatomical information. This marks a further step towards the systematic revision and cladistic analysis of *Spixia*.

MATERIAL AND METHODS

Field work was carried out in the central and northwestern region of Córdoba province (Argentina) during the summer-autumn seasons from 2005 to 2008. All of the collected material was deposited in the malacological collection of Instituto Miguel Lillo (IML). Type materials of related *Spixia* species deposited in different museums were studied to allow proper comparisons. Relevant materials in the following Museums were reviewed and studied: Instituto Miguel Lillo (IML); Museo de La Plata, Buenos Aires, Argentina (MLP); Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina (MACN); and Senckenberg Museum, Frankfurt am Main, Germany (SMF).

Shell measurements were taken using a minimum of 10 specimens per geographic locality. All measurements taken were expressed in mm. The apertural terminology used follows the methodology of Parodiz (1951) modified by Salas Oroño (2007). Maxima and minima for each measurement is reported with the median value in parenthesis.

Radulae and jaws were prepared for scanning electron microscope imaging (SEM) according to Ploeguer & Breure (1977). SEM micrographs were obtained using a JEOL 35 CF electron microscope at the Laboratory of Microscopy of Northwestern Argentina (LAMENOA) at Tucumán National University, Argentina.

Live specimens were drowned in deoxygenated water with a layer of menthol crystals and fixed in 96% ethanol. Dissections were made using a stereoscopic microscope LEICA MZ6 and anatomical systems were drawn with the help of a *camera lucida*. Colour of the animals was assessed on living specimens and photographs taken before features were drawn. The terminology used for anatomical descriptions follows Tompa (1984) and Salas Oroño (2007). In the genitalia, the penis has been divided into four areas (I–IV) to allow clear comparison of the organ morphology with other species of the genus. All penial areas described are characterised by a specific internal sculpture. Characterisation of the penial areas follows the method of Salas Oroño (2007). Organs close to the ovotestis in its natural position were considered proximal and those located close to the genital pore were considered distal. Drawings were made using these conventions.

Abbreviations used in the text: Ang max – maximum angle; Sp ang – spiral angle; D ap – apertural shell diameter; D maj – major shell diameter; H – shell height; H ap – shell aperture height.

The penial complex is divided up as follows: I) proximal area where there is a constriction then widening; II) proximal middle portion, from the widened area to the middle zone of the penis; III) distal middle portion, from middle zone of the penis to just before where the internal sculpture changes approaching the penial junction with the vagina; IV) distal portion of the penis, from area III to the penial junction with the vagina.

RESULTS

Genus *Spixia* Pilsbry & Vanatta 1898

Type species: *Spixia striata* (Spix 1827)

Type locality: Sao Paulo, Brazil

Spixia cuezzae sp. nov.
(Figs 1–13)

Holotype IML 15284

Paratypes IML 15285 (n = 7), SMF 333513 (n = 3).

Type locality Argentina, Córdoba Prov., Punilla Dept., road from Capilla del Monte to San Marcos Sierras, 30° 48' 39" S, 64° 37' 14" W; 944 m asl, 17/03/2006. Leg. M. G. Cuezco & E. Salas Oroño.

Material examined Holotype IML 15284 (Fig. 1 A). Paratypes: IML 15285/SMF 333513 (n=10), Argentina, Córdoba, Punilla Dept., road from Capilla del Monte to San Marcos Sierras, 30° 48' 39" S, 64° 37' 14" W, 944 m, 17/03/2006, leg. M. G. Cuezco & E. Salas Oroño; IML 15286, Córdoba, Punilla Dept., road from Capilla del Monte to San Marcos Sierras, 30° 48' 39" S, 64° 37' 14" W, 944 m, leg. M. G. Cuezco & E. Salas Oroño, 17/03/2006; IML 15287, Córdoba, Punilla Dept., Capilla de Monte, near Route 38, 30° 51' 10" S, 64° 31' 53" W, 973 m, leg. E. Salas Oroño, 12/07/2005; IML 15288, Córdoba, Punilla Dept., 1 km to the north of Capilla del Monte, 30° 51' 09" S, 64° 31' 55" W, 900 m. leg. E. Salas Oroño, 16/01/2006; IML 15289, Córdoba, Punilla Dept., San Marcos Sierras, 795 m, 30° 47' 35" S, 64° 37' 45, 8" W, 26 /11/2008, leg. M. G. Cuezco & E. Salas Oroño; IML 2442, Argentina, Córdoba, Punilla Dept., 2 km south of Capilla de Monte on the road to La Cumbre, 950 m, leg. W. Weyrauch, 04/04/1969.

Diagnosis Teleoconch with pronounced, slender ribs, with spacing between ribs narrow and irregular. Penial sheath thick, muscular and large, approximately twice the size found in other species examined. Penial area I: muscular tissue forming a triangular mass above a spongy area comprising an irregular net of lamellae. Inner sculpture of penial area III and IV has a transition area with zigzag festoon lamellae turning straight, longitudinal and continuous towards penial area IV.

Etymology The species is dedicated to Professor Maria Gabriela Cuezco, for her help and permanent support.

Shell (Fig. 1A, 7) Fusiform, comprising 9½ to 10½ slightly convex whorls. Colouration light brown, uniform. Protoconch with thin axial ribs which are parallel, slightly curved on the supe-

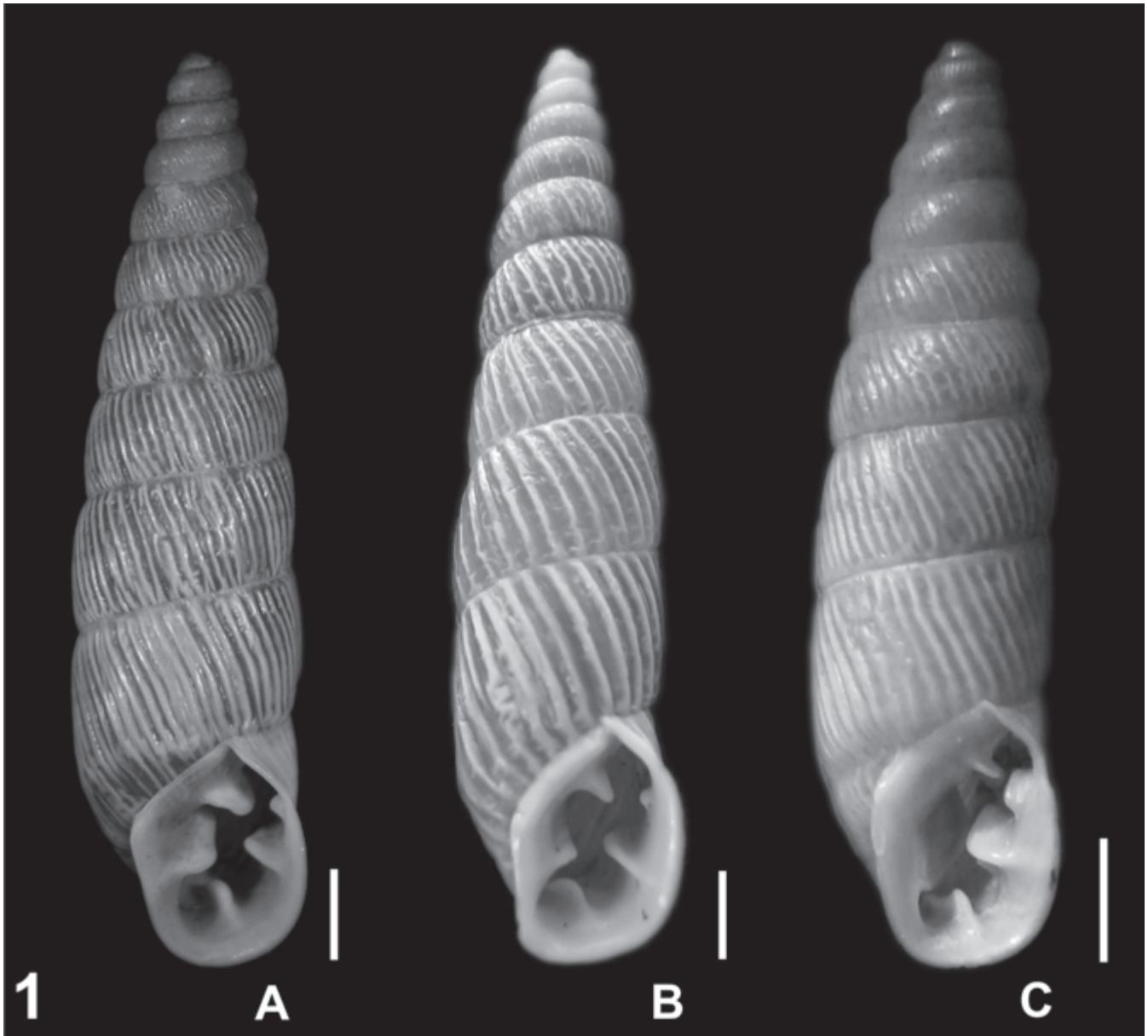
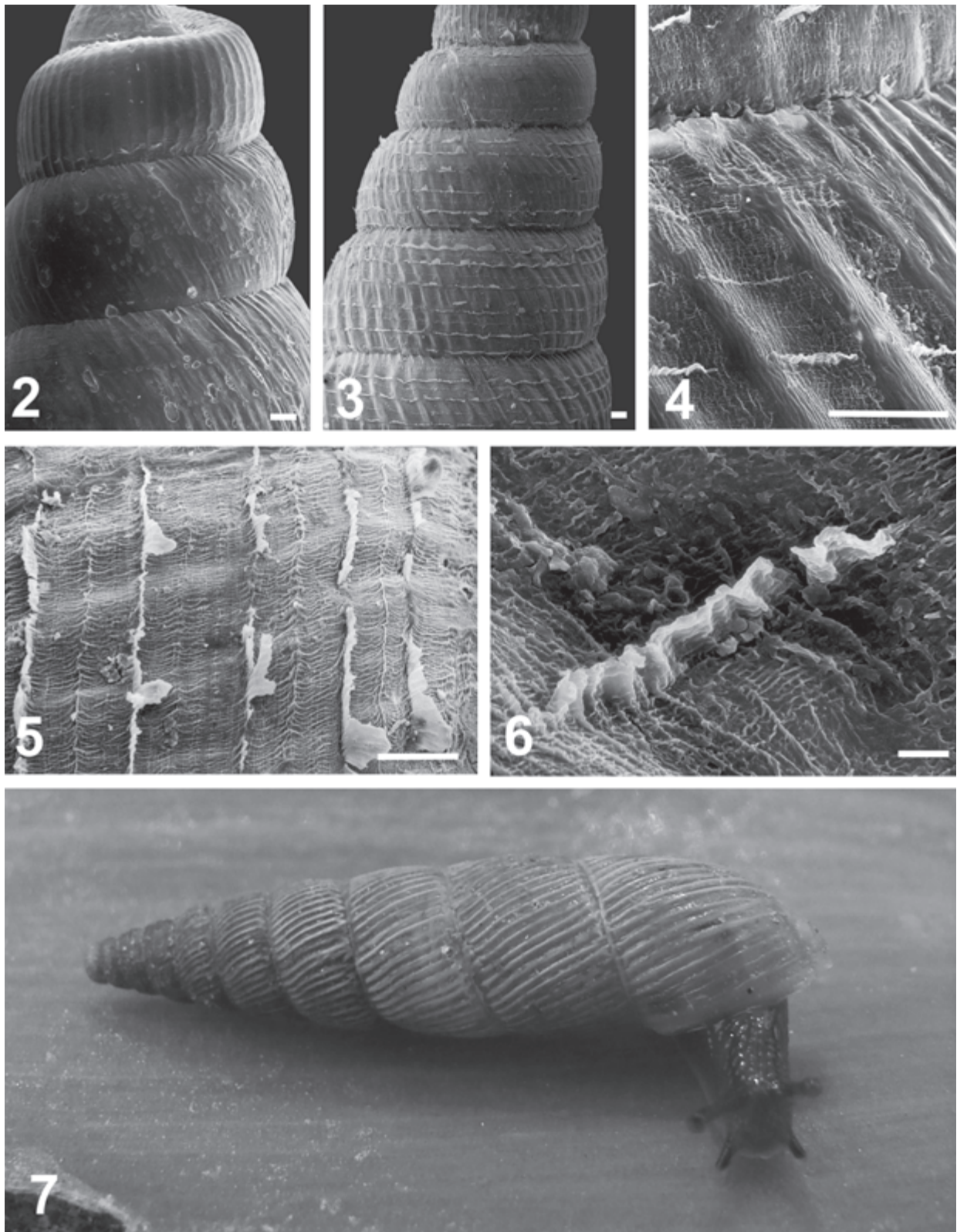


Figure 1 *Spixia cuezzae* sp. nov. and similar species: **A** *S. cuezzae*; **B** *S. philippii* (Doering 1874); **C** *S. costellifer* (Haas 1936). Scale bar = 2 mm.

rior edge and with perpendicular micro bands crossing them. Second whorl of protoconch smooth with vestiges of shallow ribs (Fig. 2). Teleoconch tall with narrow axial ribs. Space between ribs narrow and irregular. Surface of third whorl traversed by six elevated, spiral, periostracal rows per whorl. Rows continuous, with irregular lamellae inserted on each (Figs 3–5). One minor spiral row between major spiral rows in some whorls. At ultrastructural level, departing from each major row, growth axial micro folds give the appearance of an irregular net covering all the space between major

rows (Figs 5, 6). Suture slightly crenulate (Fig. 4). Aperture sub-oval to sub-circular, peristome expanded. Parietal callus prominent, with an incision between the parietal callus and palatal side. Aperture with one tooth and four lamellae (Fig. 1A). Suprapalatal tooth bell-shaped, tall, perpendicular with respect to the peristome. Palatal lamellae tall, with rounded border slightly concave on both sides, perpendicular with respect to the peristome. Basal lamellae bell-shaped, diagonal with respect to the peristome, concave on both sides. Columellar lamellae, thick, plateau-shaped. Parietal lamellae tall,



Figures 2–7 *Spixia cuezzae* sp. nov. **2.** View from protoconch to third whorl in profile showing transverse bands between axial costules on protoconch. Scale bar = 100 μ m in SEM. **3.** View from protoconch to fifth whorl showing spiral periostacal ribs with lamellae inserted on them. Scale bar = 100 μ m in SEM. **4.** Microsculpture of teleoconch showing micro folds between ribs beneath periostacum. Scale bar = 100 μ m in SEM. **5.** Microsculpture of teleoconch showing the periostacal lamellae inserted on each row. Scale bar = 100 μ m in SEM. **6.** Detail of spiral rows and micro folds. Scale bar = 10 μ m in SEM. **7.** Living specimen.

plateau-shaped and perpendicular with respect to the peristome. Umbilicus narrow.

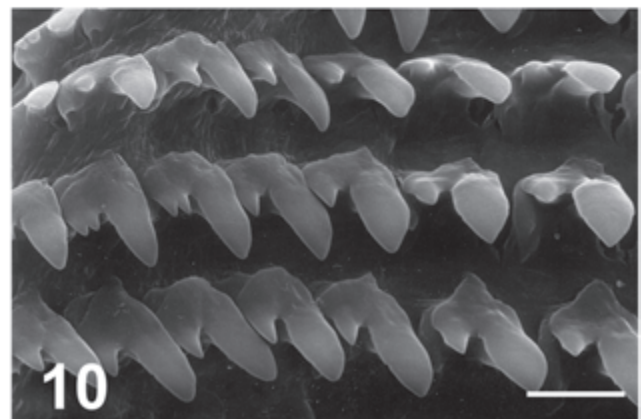
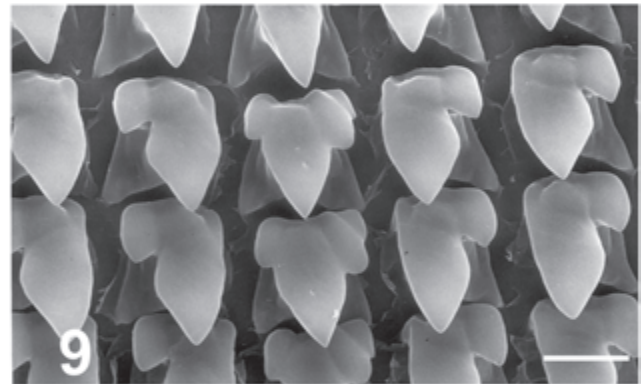
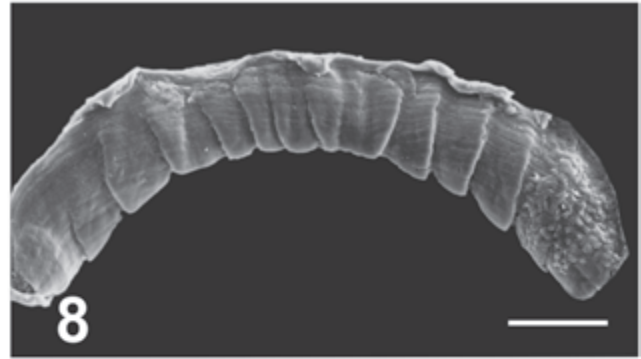
Shell Measurements Holotype IML 15284: H 20.2; D maj 5; H ap 5.3; D ap 3.9; Sp ang 20°; Max ang 140°. Paratypes: IML 15285/SMF 333153 (n = 10), H 18.8–22.2 (median 20.9); D maj 4.7–5.1 (median 4.9), H ap 5.2–6 (median 5.5), D ap 3.6–4 (median 3.8), Sp ang 18°–22° (median 19.5°), Max ang 135°–145° (median 138.2°); IML 15286, (n = 10), H 18.8–22 (median 20.2), D maj 4.8–5 (median 4.9) H ap 5.1–5.7 (median 5.4) D ap 3–4 (median: 3.6); Sp ang 18°–21° (median 19.7°); Max Ang 136°–141° (median 139.3°); IML 15287, (n = 10), H 18–20.5 (median 18.9); D maj 4.3–5 (median 4.9); H ap 4.4–5 (median 4.8), D ap 3.4–4.4 (median: 3.7), Sp ang 20°–24° (median 22°), Max ang 130°–138° (median 133.7°); IML 2442 (n = 2), H 19.5–21 (median 18.9), D maj 4.3–5 (Median: 4.9), H ap 4.4–5 (median 4.8), D ap 3.4–4.4 (median 3.7), Sp ang 20°–22° (median: 21°), Max Ang 133° – 134° (median 133.5°).

Body colour Colour dark gray to brownish

Digestive system (Figs 8–10) Jaw arched, with 11 imbricate plaques and one central plaque. Lateral plaques rectangular, plaques overlapping each other except from most lateral ones. Central plaque subdivided into three portions. Inferior border of jaw with irregular outline due to the projections of plaques (Fig. 8). Jaw finely transversely striated.

Radula Central tooth small, tricuspid with tall mesocone, smooth ectocones sharply pointed. Lateral teeth with tall mesocones and one sharp ectocone on the opposite side of central tooth. Marginal teeth tricuspid with two sharply pointed ectocones (Figs 9–10).

Pallial system (Fig. 11) Kidney triangular, slightly longer than pericardic cavity, pale yellow. Kidney limited proximally by intestine; left border limited by pericardial cavity and right border by primary ureter. Kidney length corresponds to $\frac{1}{4}$ of lung's length. Primary ureter ascending towards top of pulmonary roof, then descending as secondary ureter from top of pulmonary roof to mantle collar, parallel to rectum. Both secondary ureter and rectum covered by connective tissue. Secondary ureter opening



Figures 8–10 *Spixia cuezzae* sp. nov. in SEM. **8.** Jaw. Scale bar = 100 μ m. **9.** Radula, central and lateral teeth. Scale bar = 10 μ m. **10.** Radula, transition from lateral to marginal teeth. Scale bar = 10 μ m.

before rectum opening. Anus located between folds of mantle collar. Pulmonary vein extending from pericardial cavity to mantle collar and parallel to rectum. Presence of a pulmonary fold located parallel to pulmonary vein at third distal portion of pulmonary roof. Proximal portion of fold closed to vein. Pulmonary roof with marked venation in area between pulmonary fold and secondary ureter, becoming more abundant towards distal portion of the pulmonary roof. Pallial gland elongated occupying $\frac{2}{3}$ of

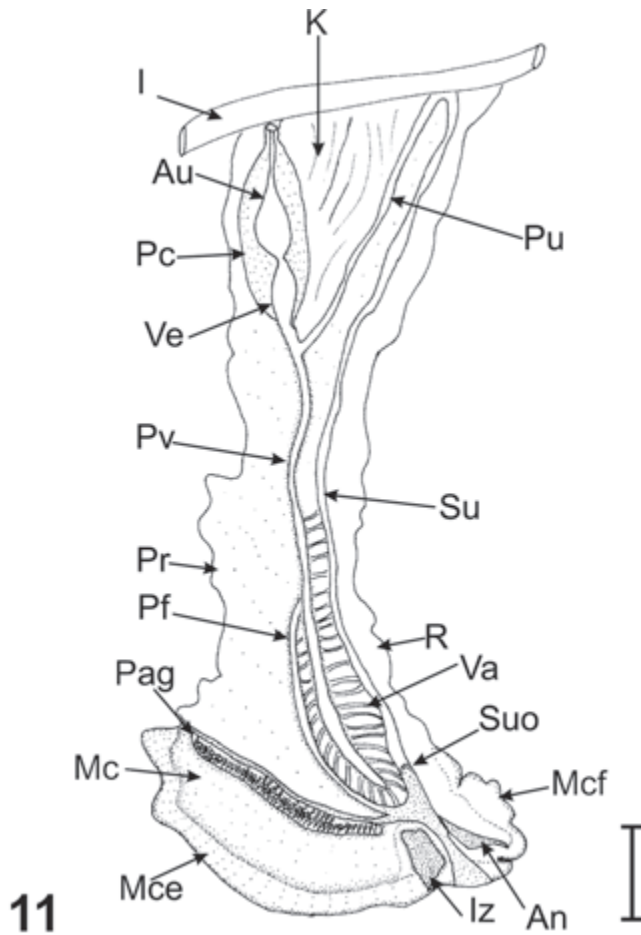


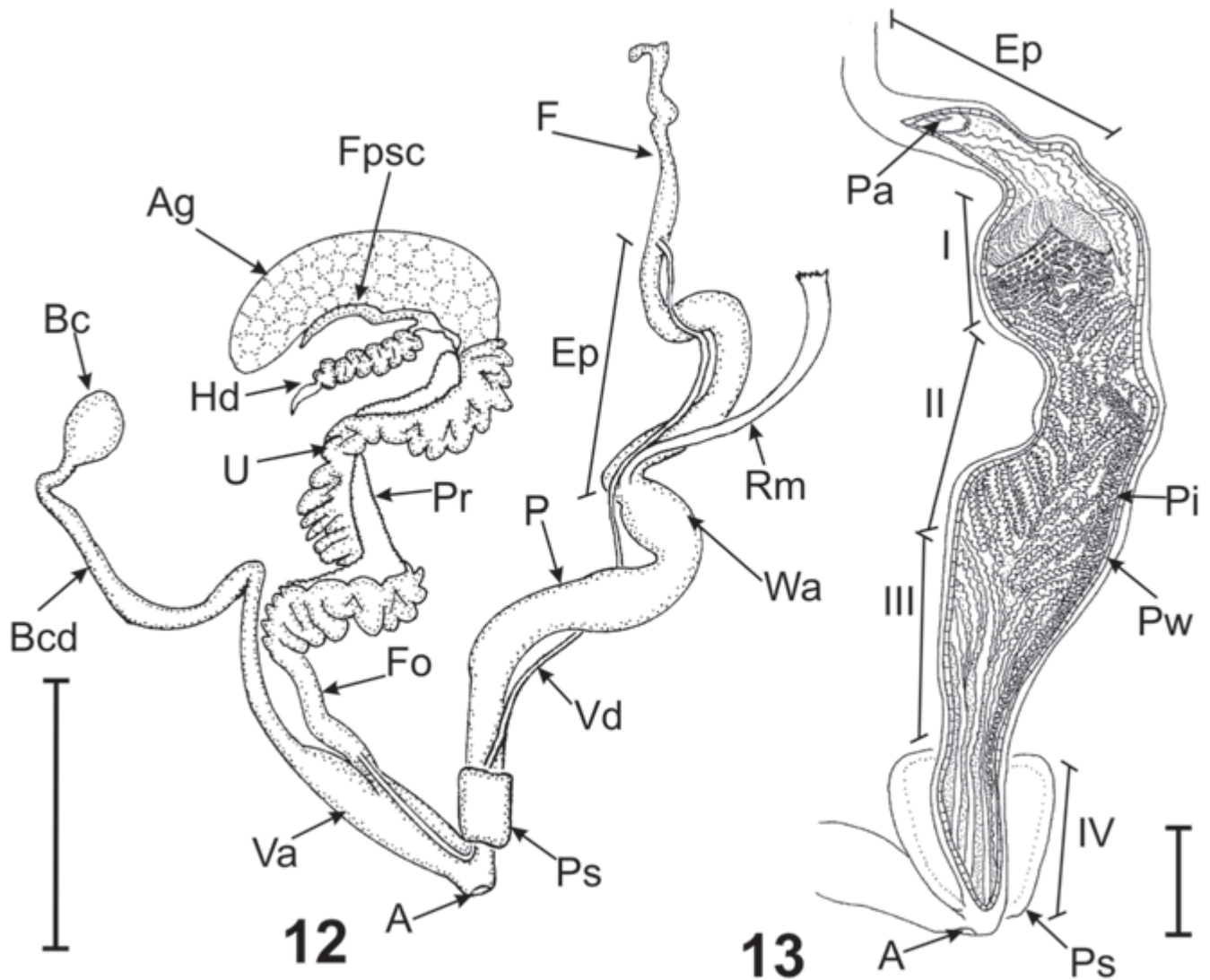
Figure 11 *Spixia cuezzae* sp. nov. Ventral view of pallial system dissected out. Scale bar = 2 mm. Abbreviations: An, Anus; Au, auricle; I, intestine; Iz, interramus zone; K, kidney; Lf, longitudinal folds; Mc, mantle collar; Mce, mantle collar edge; Mcf, mantle collar fold; Pg, pallial gland; Pc, pericardic cavity; Pr, pulmonary roof; Pu, primary ureter; Pv, pulmonary vein; Pf, pulmonary fold; Su, secondary ureter; Suo, secondary ureter opening; V, ventricle.

lung's distal portion, located between pulmonary roof and mantle collar. Interramus zone deeply excavated and rectangular shaped.

Reproductive system (Figs 12–13) Ototestis consisting of four groups of fan-shaped, digitiform acini, pigmented, homogeneous orange colour. Ototestis embedded in digestive gland. Hermaphroditic duct thin, swollen. Convoluted vesicula seminalis in median portion, ending at albumen gland basal portion. Fertilisation pouch-spermathecal complex inserted at basal portion of albumen gland, with base swollen, long and digit-shaped. Albumen gland

bean-shaped, external surface granular. Spermoviduct consisting of uterus and prostate. Uterus with transverse folds over entire length. Prostate with a granular appearance, light yellow in colour. Free oviduct long, slim, corresponding to $\frac{1}{3}$ of spermoviduct length. Vagina even in diameter corresponding to less than $\frac{1}{3}$ of total penis length. Bursa copulatrix duct long, exceeding approximately $\frac{1}{4}$ of the spermoviduct length, with duct slightly widened in distal area. Phallic complex consisting of flagellum, epiphallus and penis. Flagellum thin, inner wall with zigzag, narrow pilasters. Flagellum corresponding to half the length of the epiphallus. Epiphallus inner wall with flat, longitudinal pilasters. Papilla of epiphallus rounded; external area of epiphallus slightly widened here. Epiphallus divided into two portions by the presence of a papilla: proximal portion ranging from the insertion of vas deferens to the papilla, and distal portion from the papilla to penis where it widens (proximal portion of penis). Epiphallus length corresponds to half total penis length. Penis proximal portion (I) with constriction followed by widened area, penis medial (II, III) and distal portion (IV) cylindrical, even in diameter towards the atrium (Fig. 12). From widened area towards atrium penis inner wall divided into four sections on the basis of its sculpture. Penial area I with muscular tissue of inverted V-shape above an irregular net of lamellae forming spongy tissue. Area II with folded lamellae with festoon borders arranged diagonally to the center. In middle portion of area II, one pilaster of irregular short lamellae overlapped each other, extending towards the distal portion of penial area III. Transition from penial area III to area IV marked by festoon-shaped lamellae, these straightening longitudinally towards distal portion. Area IV with smooth, thin, longitudinal folds towards distal portion (Fig. 13). Penial retractor muscle thin, inserted in distal portion of the epiphallus. Vas deferens adhering to penial retractor muscle and running independently from it, parallel to the epiphallus. Penial sheath muscular and thickly overlapping the distal penis, twice the size found in other species of *Spixia* (Fig. 12).

Habitat *Spixia cuezzae* lives under rocks or at the base of small shrubs, usually close to granitic rocks.



Figures 12, 13 *Spixia cuezzae* sp. nov. **12.** View of reproductive system without ovotestis, dissected out, scale bar = 5 mm. **13.** Penis inner wall, scale bar: 5 mm. Abbreviations: A, atrium; Ag, albumen gland; Bc, bursa copulatrix; Bcd, bursa copulatrix duct; Ca, constriction area; Ep, epiphallus; F, flagellum; Fo, free oviduct; FPSC, fertilization pouch-spermathecal complex; Hd, hermaphroditic duct; P, penis; Pa, papilla of epiphallus; Pi, pilaster; Pw, penis inner wall; Pr, prostate; Ps, penial sheath; Rm, retractor muscle; U, uterus; V, Vagina; Vd, vas deferens. Penial complex: I, constriction and widening area; III, distal medial portion, from medial zone of penis to just before penial junction with vagina; IV, distal portion, from III to penial junction with vagina.

Distribution Found in Punilla political department, Córdoba province, in the Chacoan biogeographic region of Argentina. The biogeographic region has been delimited by Morrone (2006).

Shell measurements of compared specie *Spixia philippii* (Doering 1874) (Fig. 1B): H 20, 8; D maj 4.5; H ap 5.1; D ap 3.5. *Spixia costellifer* (Haas 1936) (Fig. 1C): H 15; D maj 3.9; H ap 4.4; D ap 3.1.

DISCUSSION

The new species is described in the context of an ongoing revision of the genus *Spixia*, the study of type material of other species and a comparison with several closely related taxa. The most important characters differentiating *S. cuezzae* from others of the genus are: comparative width of the ribs present in the teleoconch; length of the penial sheath; penial sculpture. The main differences between *Spixia cuezzae* and *S. costel-*

lifer are: shell size – *Spixia cuezzae* is larger than *S. costellifer*; teleoconch ribs – these are thinner, are irregular and the spaces between ribs are narrower than in *S. costellifer*. The aperture of *Spixia cuezzae* is sub-oval to sub-circular, while in *S. costellifer* it is sub-oval to rectangular. In addition, the columellar lamellae of *S. cuezzae* are short and plateau-shaped, whereas in *S. costellifer* the lamellae are taller, thinner and tongue-shaped, also located deeper within the aperture. The penis of *S. cuezzae* does not form a pouch in the widened area, but this is present in *S. costellifer*, and the internal lamellae of penial area II lie diagonal to the center in *S. cuezzae*, but in *S. costellifer* they form an inverted V-shape. Penial area III also differs from that of *S. costellifer* in the presence of folds which are absent in *S. costellifer*.

A major difference between *S. cuezzae* and *S. philippii* lies in the shell shape of *S. cuezzae* which is fusiform, whereas in *S. philippii* it is turritiform. The ribs present in the teleoconch of *S. cuezzae* are thinner, shallower and the space between each is narrower than in *S. philippii*. The aperture of *S. philippii* is suboval-elongate while in *S. cuezzae* it is sub-oval to sub-circular. Concerning the pallial system, the pulmonary fold in *S. cuezzae* is close to the pulmonary vein, contrary to that of *S. philippii* where the fold runs parallel to the pulmonary vein. In relation to the genital system, the sculpture of the inner penial wall in areas II, III and IV differ between the species with *S. philippii* showing pustules instead of folded lamellae as in *S. cuezzae*.

The reproductive system of *S. cuezzae* is in general similar to the rest of the species of the genus with slight variations in relative length of the organs, but the most relevant differences relate to the size of the penial sheath, which is twice as large as those of other species. In *S. cuezzae* the penial sheath is thicker and more muscular in comparison to other species where the penial sheath tends to be thin and translucent.

Spixia cuezzae was found only in the Punilla Department, Córdoba Province in central Argentina. The type locality of *Spixia philippii* is located in Totoral department, Córdoba, and this species has not been found in Punilla. Parodiz (1942) in his revision of Argentinean Odontostominae, mentioned that *S. philippii* was collected in Capilla del Monte, (Punilla Department), but after reviewing the

material collected at this locality, I conclude that this author failed to characterise *S. philippii* adequately and may have confused his material with what we here designate *S. cuezzae*. On the other hand, *S. philippii* is found in Totoral, Cruz del Eje and Ischilín departments that are to the north of Punilla in Córdoba. The distribution of *S. costellifer* is not well defined because the type locality “Minas de Hierazuela, Córdoba” is difficult to localise. However living material of *S. costellifer* was recently collected in Cruz del Eje Political Department in the north of Punilla Dept.

Spixia cuezzae, *S. philippii* and *S. costellifer* differ from other species of *Spixia* in shell sculpture with the exception of *Spixia parodizi* (Hylton Scott 1951). Like these, *S. parodizi* is sculptured with ribs, but the shell shape is much more turritiform and narrower than *S. philippii* in particular. Also the ribs of *S. parodizi* are more widely spaced and pronounced than in *S. philippii*.

ACKNOWLEDGEMENTS

I thank Maria Gabriela Cuezco, for comments and inputs during the preparation of this paper and for her help during field work. Thanks are also extended to Ing. Roberto Andrada for help in obtaining SEM micrographs at the Electron Microscope Laboratory of the National University of Tucumán (LAMENOA). Thanks to G. Sanchez for assistance in editing of plates. Thanks also to Ronald Janssen (SMF), Michael Schrödl, and Enrico Schwabe (ZSM), Mathias Glaubrecht and Thomas von Rintelen, (ZMB) for permission to work in the collections of the relevant Museums, and to Frank Köhler for assisting me in ZMB. Also thanks to the Honorary Editor and anonymous referees for corrections and comments. This research was supported by PIP 6048 from CONICET awarded to M. G. Cuezco and PICT 2006–00528 awarded to E. Dominguez. The author is a fellow of the Argentine National Council of Scientific Research (CONICET).

REFERENCES

- DOERING A 1874 Apuntes Sobre la Fauna de Moluscos de La Republica Argentina. *Boletín de La Academia Nacional de Ciencias Exactas, Córdoba* 1: 452–457.

- DOERING A 1875a Estudios Sistemáticos y Anatómicos Sobre Moluscos Pulmoníferos de Los Países del Plata. *Periódico Zoológico* **1**: 138–252.
- DOERING A 1875b Apuntes Sobre la Fauna de Moluscos de La Republica Argentina. *Boletín de La Academia Nacional de Ciencias Exactas, Córdoba* **2**: 323–331.
- DOERING A 1876 Apuntes Sobre la Fauna de Moluscos de La Republica Argentina. *Boletín de La Academia Nacional de Ciencias Exactas, Córdoba* **2**: 300–400.
- HAAS F 1936 Über einige neue oder wenig bekannte Bulimuliden des Natur-Museums "Senckenberg". *Senckenbergiana*, **18** (3/4): 148–154.
- HYLTON SCOTT MI 1951 Nuevos Moluscos terrestres del Norte Argentino. *Acta Zoológica Lilloana* **10**: 5–29.
- MORRONE JJ 2006 Biogeographic areas and transitions zones of Latin America and the Caribbean islands based on panbiogeographic and cladistic analyses of the entomofauna. *Annual Review of Entomology* **51**: 467–494.
- PARODIZ JJ 1942a Los Odontostóminos de la Argentina (Primera parte). *Physis* **19**: 191–218.
- PARODIZ JJ 1942b Los Odontostóminos de la Argentina (Segunda parte). *Physis* **19**: 321–343.
- PARODIZ JJ 1951 Métodos de Conquiliometría. *Physis* **20**: 241–248.
- PILSBRY HA 1898 Notes on the genus *Odontostomus*. *The Nautilus* **12**: 57–58.
- PLOEGER S & BREURE ASH 1977 A rapid procedure for preparation of radulae by routine search with the scanning Electron Microscope. *Basteria* **41**: 47–52.
- SALAS OROÑO E 2007 Taxonomic Review of the *Spixia pyriformis* species complex (Gastropoda: Pulmonata: Odontostominae). *Zootaxa* **1498**: 1–25.
- TOMPA AS 1984 Land Snails (Stylommatophora). In TOMPA AS, VERDONK HH & VAN DEN BIGELAAR JS (eds) *The Mollusca*, VII: 47–140. Academic Press, New York.

