

A NEW SPECIES OF *ADELOPOMA* FROM SÃO PAULO URBAN PARK, BRAZIL (CAENOGASTROPODA, DIPLOMMATINIDAE)

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Abstract A new species of diplommatinid land snail, *Adelopoma paulistanum* sp. nov., is described from neotropical S. E. Brazil. The type locality is the urban Park Burle Marx, in São Paulo City, São Paulo State, a highly endangered habitat. The new species is differentiated from the eight known neotropical species, by size, number of ribs on the whorls and sharpness of the apex. An anatomical description is included, showing reno-pericardial structures pallially located, relatively simple pallial gonoducts, aphyally, and a highly concentrated nerve ring. Conservation initiatives are necessary in order to preserve the scarce habitat of this animal.

Key words Diplommatinidae; *Adelopoma*; conchology; anatomy; taxonomy; São Paulo, endangered species.

INTRODUCTION

The megadiversity of the terrestrial Brazilian ecosystems is so extraordinary that new species are often found even in highly modified urban parks. This is also an indication of how poorly known are the local invertebrate faunas. Another case is presented in this paper where a new species of diplommatinid was found in a park inside the largest city of the southern hemisphere, São Paulo.

The family Diplommatinidae Pfeiffer, 1856 was erected on the basis of the genus *Diplommatina* Benson, 1849, which occurs in Asia. The family characteristically contains species of minute size and generally with sinistral shells. Anatomically, they have a single pair of long and filiform tentacles, arising from the posterior region of the head, and the eyes are divided into two lobes at the base of the tentacles (Webster et al, 2012; Simone, 2013). This feature gives rise to the name of the type genus, from Greek *diplós*=double, and *ommatos*=eye.

The family has fifteen genera distributed in Eurasia, Australia, north Africa and Madagascar, plus a single genus in the neotropical region: *Adelopoma* Doering, 1884 (type species *A. tucma* Doering, 1884, OD). This genus has eight known species: *A. occidentale* (Guppy, 1872), from Trinidad; *A. tucma*, from Argentina and Paraguay (Scott, 1948; Quintana, 1982); *A. stolli* (Martens, 1890), from Guatemala and México (Sandoval, 1999); *A. bakeri* Bartsch & Morrison, 1942, from

Venezuela; *A. costaricensis* Bartsch & Morrison, 1942, from Costa Rica; *A. paraguaiana* Parodiz, 1944, from Paraguay, Argentina (Hausdorf & Muñoz, 2004) and Brazil (Haas, 1959 – from Santa Catarina); *A. brasiliense* Morretes, 1954, from São Paulo and Paraná, Brazil (Simone, 2006); and *A. peruvianum* Hausdorf & Muñoz, 2004, from Peru.

Anatomical data on the diplommatinids are scanty and restricted to the reproductive and nervous systems of a few species (Tielecke, 1940). Most descriptions are limited to the shell, operculum and sometimes radula (e.g., Bartsch & Morrison, 1942).

During the research on urban malacofauna in the city of São Paulo, the largest city from the South America, from the Southern Hemisphere and the third largest from the world, samples belonging to an undescribed species were found in the Park Burle Marx, in a small remnant of native Atlantic Rainforest. This paper presents the formal description of the new species, demonstrating that even in remnants of forest in big cities, biodiversity novelties can appear. These urban habitats are continually under threat making the inventory of existing biodiversity a priority. Descriptions of the fauna are needed to support conservation measures under Brazilian laws.

MATERIAL AND METHODS

The samples were collected in forest soil, observed alive and fixed in 70% ethanol. Dissections were performed under a stereomicroscope with the

specimens immersed in fixative. Soft tissues were extracted by crushing the shells and the progressive stages of the dissections were recorded by digital photography. Some shells, opercula and radulae were examined by scanning electron microscopy (SEM) in the Laboratory of Electron Microscopy of the Museu de Zoologia da Universidade de São Paulo (MZSP) using standard mounting and coating techniques.

Anatomical abbreviations **an** anus; **ap** genital aperture; **au** auricle; **bg** buccal ganglia; **bm** buccal mass; **ce** cerebral ganglion; **dd** duct to digestive gland; **dg** digestive gland; **eg** esophageal gland; **es** oesophagus; **ey** eye; **fp** fecal pellet; **ft** foot; **in** intestine; **ki** kidney chamber; **mb** mantle border; **mj** jaw and peribuccal muscles; **mo** mouth; **nr** nerve ring; **op** operculum; **ov** pallial oviduct; **pc** pericardium; **pp** pedal-pleural ganglia; **pt** prostate; **pu** pulmonary (pallial) cavity; **rn** radular nucleus; **rs** radular sac; **rt** rectum; **sa** salivary gland aperture; **sd** salivary gland duct; **sg** salivary gland; **sn** snout; **st** stomach; **te** cephalic tentacle; **tg** integument; **ts** testis; **vd** vas deferens; **ve** ventricle; **vo** visceral oviduct.

Institutional abbreviations **MNRJ** Museu Nacional da Universidade Federal do Rio de Janeiro, Brazil; **MZSP** Museu de Zoologia da Universidade de São Paulo, Brazil; **USNM** National Museum of Natural History, Smithsonian Institution, Washington DC, USA.

SYSTEMATICS

Diplommatinidae Pfeiffer, 1856

Adelopoma Doering, 1884

Type species: *Adelopoma tucma* Doering, 1884

Adelopoma paulistanum new species
(Figs 1–35)

Holotype São Paulo city, Park Burle Marx, 23°38'05.61"S 46°43'24.24"W (C.M. Martins col, 29.viii.2009), MZSP 116256.

Paratypes (all from type locality, C.M. Martins col.) MZSP 106109, 14 eroded shells (29.viii.2009), MZSP 106110, 16 shells (Figs 1–4) (09.v.2009), MZSP 106112, 37 shells, MNRJ 26763, 3 shells, USNM, 3 shells (06.vi.2009), MZSP 106114, 18 specimens (Figs 15–17) (06.vi.2009),

MZSP 206115, 1 specimen (20.ix.2009), MZSP 106116, 2 specimens (26.x.2009), MZSP 106117, 16 specimens, 2 radula SEM preparations (Figs 21–24) (29.viii.2009).

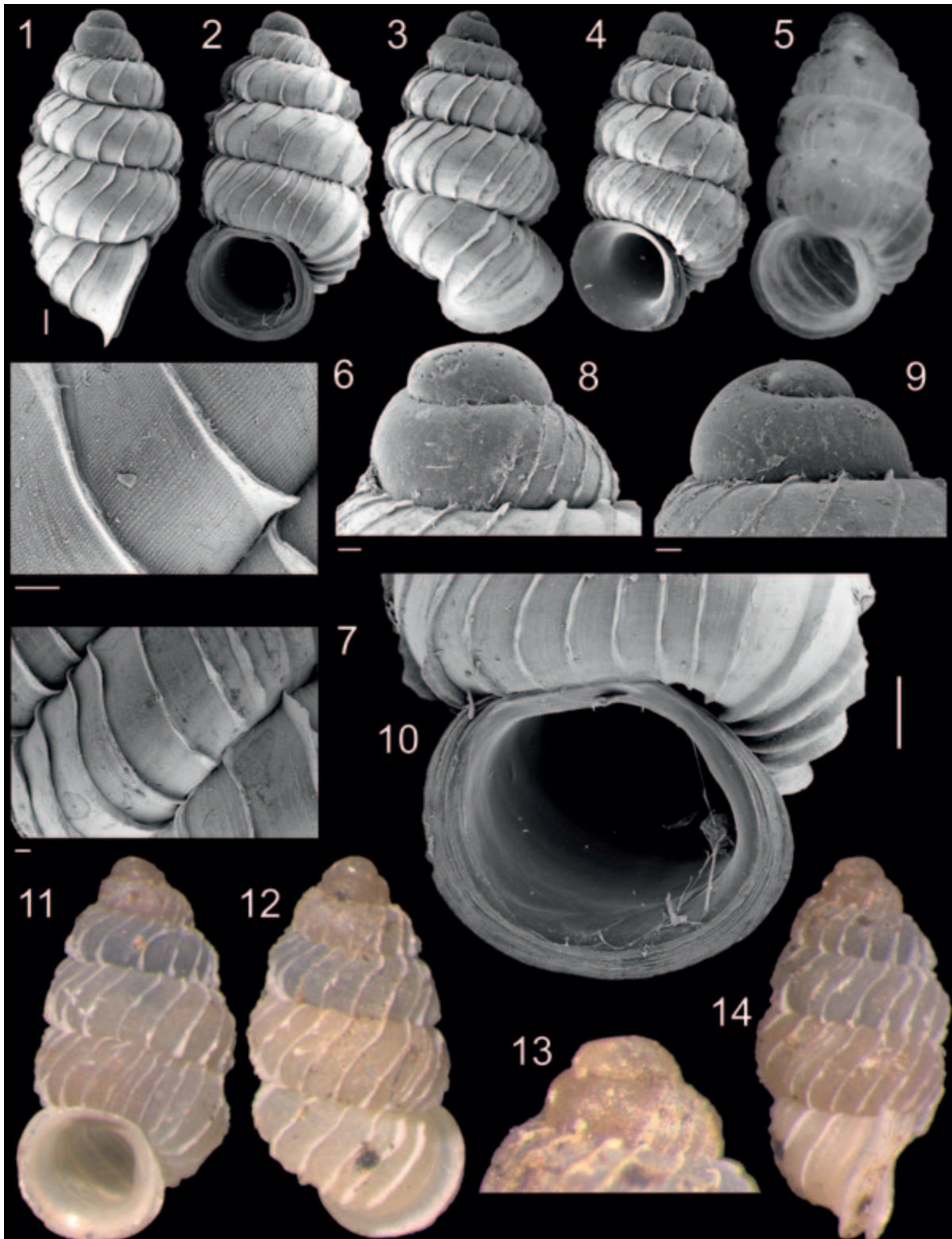
Measurements Holotype, 2.6 by 1.4 mm, 5.5 whorls; Paratypes MZSP 106110#1: 2.9 by 1.5 mm; MZSP 106110#2: 2.7 by 1.4 mm.

Type locality BRAZIL. **São Paulo**; São Paulo city, Park Burle Marx, 23°38'05.61"S 46°43'24.24"W (C.M. Martins col, 29.viii.2009).

Diagnosis Shell of ~2.8 mm, ~6 whorls; colour pure white to pale beige. Protoconch of 1.5 whorls. About 16 axial threads in last whorl; possessing spiral micro-sculpture.

DESCRIPTION

Shell (Figs 1–17, 20) Up to 2.8 mm, sinistral, turritiform. Width ~half of length (Figs 1–5, 12). Protoconch bluntly pointed, of 1.5 whorls; profile rounded, surface smooth opaque, suture deep (Figs 8–9, 13, 16–17); occupying ~12% of shell length and ~33% of shell width (~460 µm); transition protoconch to teleoconch clear, prosocline (Figs 10, 13, 21). Teleoconch up to 4.5 whorls, each whorl with rounded profile, suture deep (Figs 1–5). Sculpture well-developed axial threads (Figs 1–5, 16–17), from suture to suture, 20–25 in penultimate whorl; each thread narrow, straight to weakly sigmoid, barely prosocline; interspaces between threads equivalent to 10–15 times threads width; threads normally uniformly distributed, with some sparse regions with weak crowding. Microscopic spiral striae located between and on threads (Figs 6–7, 20), ~50 in penultimate whorl, constituted by minute aligned pits (Fig. 20). Spire occupying ~67% of shell length; first whorls uniformly growing as cone, 2–3 last whorls with approximately same width, cylinder-like; last whorl normally smaller than penultimate whorl (Figs 2, 10). Aperture rounded, peristome complete, cornet-like (Figs 2, 4, 5, 10, 14–15); projected anteriorly and medially, becoming more centrally located than expected if growth was uniform; outer lip more rounded and projected outside than inner lip (Figs 1, 3); callus narrow, barely attached to adjacent region of penultimate whorl (Fig. 10, 11); inferior half of inner lip almost vertical, detached from



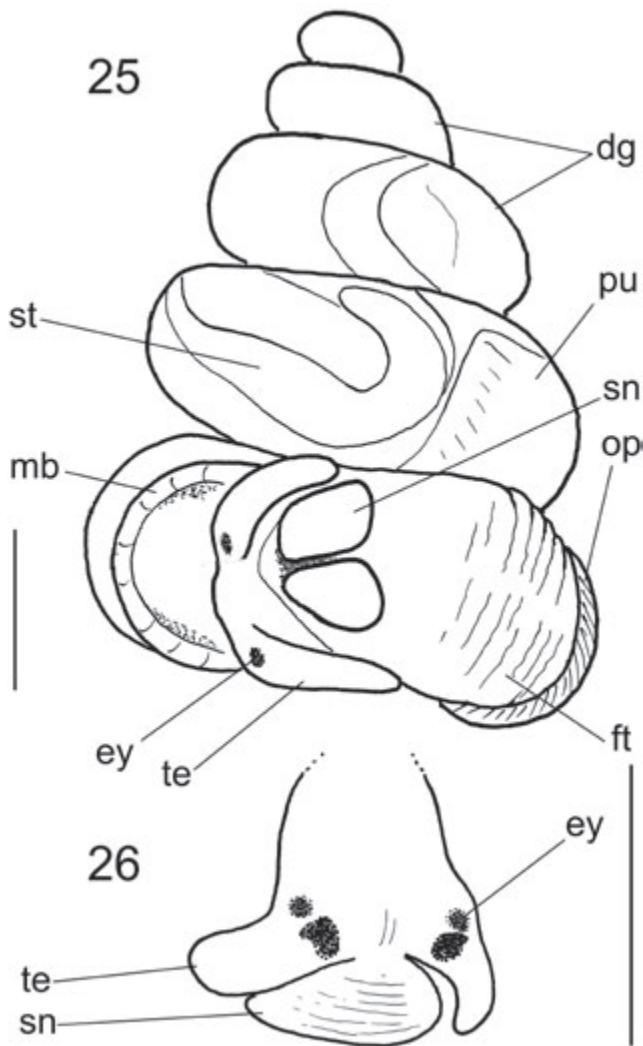
Figures 1–14 *Adelopoma paulistanum* shell: 1) paratype MZSP 106110, left view, scale=0.3 mm; 2) same specimen, apertural view; 3) same lot, other specimen, dorsal view; 4) same lot, other specimen, apertural view; 5) sale lot, other specimen, optical photo, apertural view; 6) MZSP 106110, detail of penultimate whorl, scale=50 μ m; 7) same for other specimen, scale=50 μ m; 8) apex, profile, MZSP 106110 (Fig. 1), scale=50 μ m; 9) same, for other specimen (Fig. 4), scale=50 μ m; 10) detail of aperture, MZSP 106110 (Fig. 2), scale=200 μ m; 11–14) Holotype MZSP 116256 (L 2.6 mm); 11) apertural view; 12) dorsal view; 13) detail of apex in profile; 14) left view (all SEM except for Figs 5, 11–14; Figs 1–5 in same scale.)



Figures 15–24 *Adelopoma paulistanum* hard parts in SEM: 15) paratype MZSP 160114, last whorl, left view, remaining whorls removed to show columella, scale=200 μm; 16) paratype MZSP 160114, spire, apical-slightly left view, scale=200 μm; 17) same, apical view; 18) operculum, outer view, scale=50 μm; 19) same of other specimen; 20) Detail of Fig. 12, penultimate whorl, scale=50 μm; 21) radula (MZSP 106117), whole view, scale=5 μm; 22) same, scale=3 μm; 23) same, detail of lateral region, scale=5 μm; 24) radula of another specimen, scale=5 μm.

penultimate whorl, forming small and narrow umbilicus (Figs 2, 10). Columella as a hollow sinuous tube (Fig. 15)

Head-foot (Figs 25, 26, 28) Length ~half whorl. Colourless. Head as wide as shell aperture; occupying ~1/4 of head-foot volume. Snout (sn)



Figs 25–26: *Adelopoma paulistanum* anatomy: 25) complete specimen extracted from shell, frontal view, topology of some structures also indicated; 26) head, frontal view. Scales=0.5 mm.

simple, stubby, conic, with $\sim 1/2$ of head width and $1/6$ of head-foot length; mouth in snout tip, punctiform (Fig. 28: **mo**). Pair of cephalic tentacles stubby, simple, slender-conic (**te**); located on lateral sides of head. Pair of eyes located at tentacle's base; of two masses each, one mass more superficial, anterior and medial to other mass (Fig. 26: **ey**). Columellar muscle thick, of half whorl. Foot simple and thick; foot sole clearly demarked (Fig. 25); opercular pad subterminal. Haemocoel \sim half of foot width, ~ 4 times longer than wide (Fig. 28).

Operculum (Figs 18–19) Circular, thin, translucent, yellowish, paucispiral. Nucleus central; ~ 2 whorls. Enclosing entire aperture. Scar elliptical,

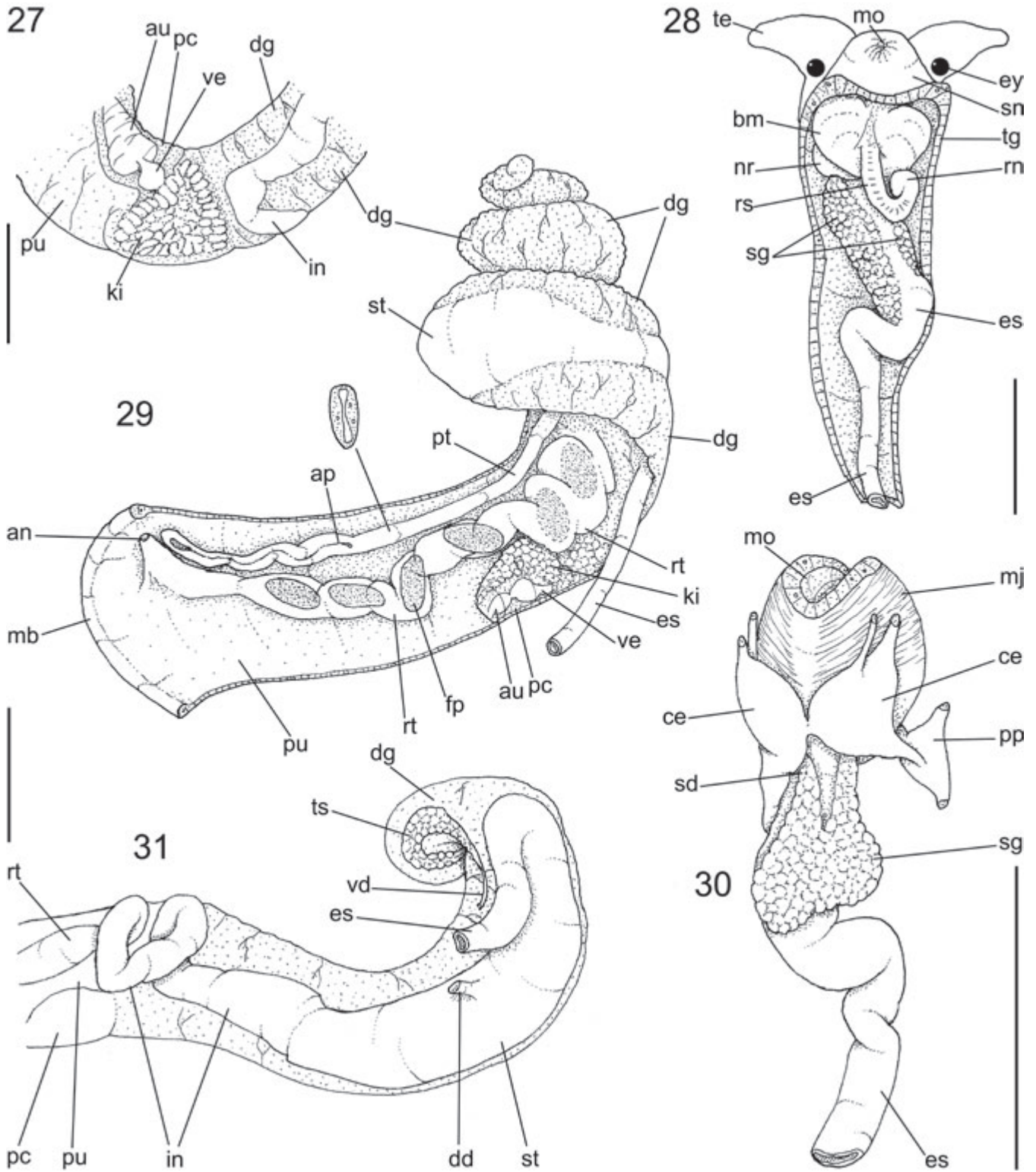
located almost in centre, slightly displaced towards inner margin; occupying $\sim 70\%$ of inner surface.

Pallial cavity (Figs 29, 35) Length ~ 1.5 whorls. Mantle border simple, relatively thick (thicker than more internal regions), narrow. Gill and osphradium absent. Lung venation weak, obscure (Fig. 29: **pu**). Reno-pericardial structures reaching pallial roof (details below). Rectum and gonoducts occupying $\sim 1/3$ of left pallial volume, along its entire length (Fig. 29: **rt**, **pt**). Anus siphoned, located close to left side of mantle border (**an**).

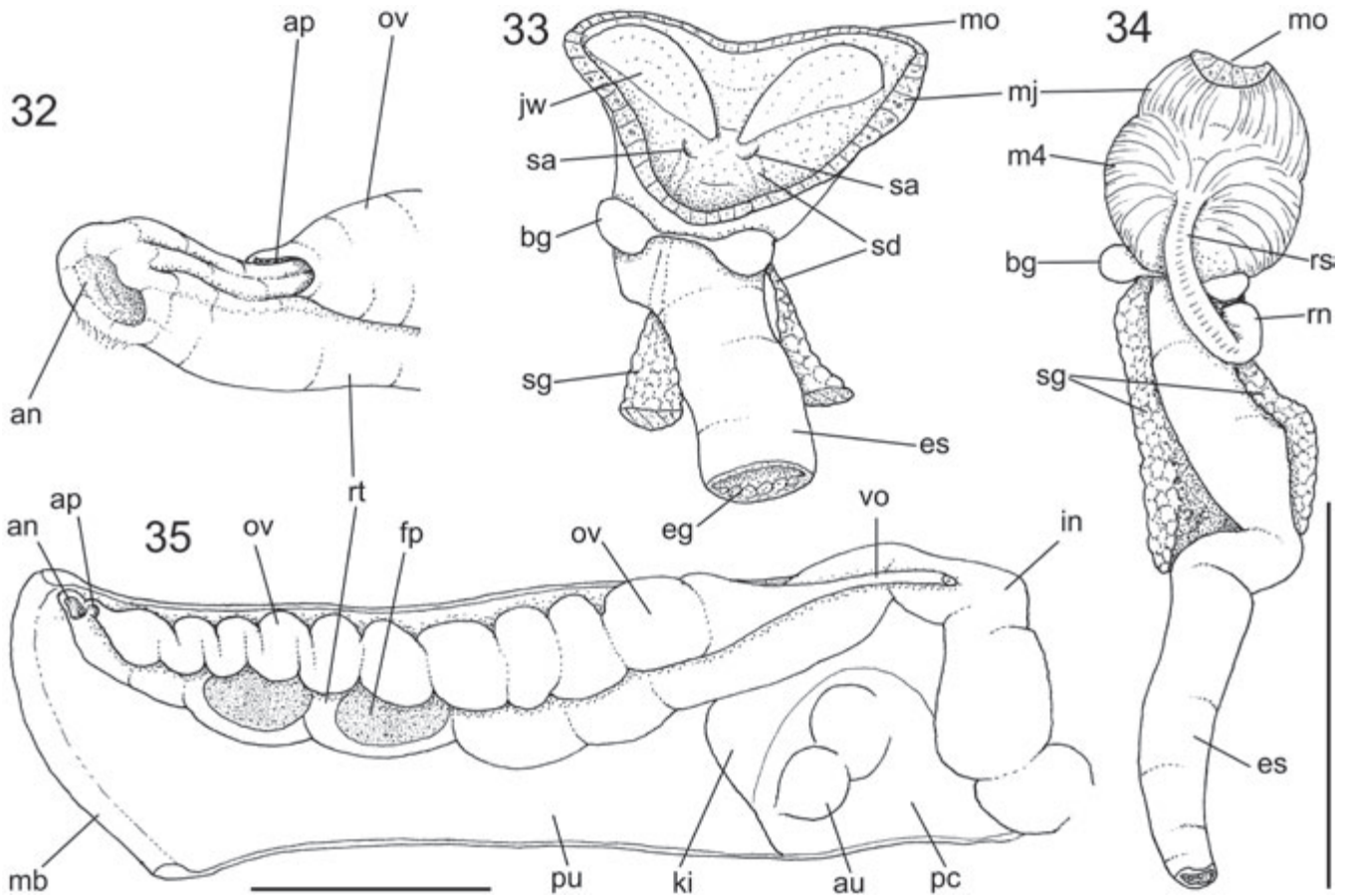
Visceral mass (Figs 25, 29, 31) About 4 whorls in length. Gonad (Fig. 31: **ts**) occupying $\sim 30\%$ of inner visceral volume, granular, cream colour; located in columellar surface. Stomach (**st**) and digestive gland (**dg**) occupying remaining $\sim 70\%$ of visceral volume, more superficially.

Reno-pericardial system (Figs 27, 29) Located in postero-left region of pallial roof (Fig. 29), occupying $\sim 20\%$ of pallial roof area. Kidney solid, white, triangular (**ki**); occupying $\sim 1/3$ of reno-pericardial volume. Pericardium simple (**pc**), as anterior structure, occupying $\sim 30\%$ of reno-pericardial surface. Auricle (**au**) anterior, thin walled. Ventricle (**ve**) as large as auricle, posterior.

Digestive system (Figs 28, 30–31, 34) Mouth punctiform, located in median level of central surface of snout (Fig. 28: **mo**). Oral tube short, thick walled because of jaw muscles (Figs 30, 34: **mj**). Jaw plates thin, wide, antero-posteriorly short (Fig. 33: **jw**). Buccal mass occupying $\sim 1/4$ of haemocoel volume (Fig. 28: **bm**); odontophore ventral and posterior (Fig. 34). Odontophore spherical, occupying \sim half of buccal mass volume. Odontophore muscles (Figs 30, 34): **m1**, several small pairs of jugal muscles connecting structures of haemocoel with adjacent inner surface of haemocoel, more concentrated close to oral tube; **m2**, pair of retractor muscles of buccal mass absent; **m4**, pair of thick dorsal tensor muscles of radula; originating surrounding posterior and lateral edges of posterior cartilages and postero-ventral edge of anterior cartilages, running short distance, becoming narrower, inserting along radular sac, in its region lying posterior half of odontophore; **m5**, auxiliary dorsal tensor



Figures 27–31 *Adelopoma paulistanum* anatomy: 27) middle region of last whorl, transition between pallial cavity and visceral mass, dorsal-outer view; 28) head and haemocoel, ventral view, foot and columellar muscle removed; 29) pallial cavity, ventral-inner view, and visceral mass coiled as in situ, transverse section of indicated level of prostate also shown; 30) foregut, dorsal view, adjacent nerve ring also shown as in situ; 31) last whorls of visceral mass, dorsal-outer view, superficial layer of digestive gland partially removed to show remaining structures. Scales=0.5 mm.



Figures 32–35 *Adelopoma paulistanum* anatomy: 32) anterior end of pallial oviduct and anus, ventral-slightly right view; 33) foregut, ventral view, odontophore removed, salivary gland only partially shown; 34) foregut, whole ventral view; 35) pallial cavity of female, ventral-inner view, some structures only with topology shown. Scales=0.5 mm (Fig. 32=3-times enlarged as Fig. 35).

muscle of radula, absent or indistinct, as part of m4; m6, horizontal muscle, connecting both anterior odontophore cartilages with each other, along ~2/3 of their ventro-medial. Non-muscular odontophore structures: **oc**, pair of anterior odontophore cartilages, each one ~twice longer than wide, slightly flattened, anterior tip bluntly pointed, posterior edge rounded; **sc**, subradular cartilage, thin, transparent, running along entire ventral surface of radular ribbon (connecting radular teeth), expanding ~twice radular ribbon width in oral cavity, protecting subradular membrane. Radular teeth (Figs 21–24): **rachidian** tooth slightly wider than long, occupying ~1/3 of radular width, cutting edge perpendicularly curved inwards, slightly wider than base, with 5 similar-sized cusps, each cusp with ~1/2 tooth length (Figs 22–23); pair of **lateral** teeth (Figs 22, 24), similar to rachidian, but with ~twice its length and ~half its width, 5 terminal cusps being

3 central cusps ~double larger than median and lateral cusps, and located more distally (Fig 24); pair of **inner marginal** teeth similar to lateral teeth, but weakly narrower and with small basal cusps located in middle level of inner margin (Fig. 24); pair of **outer marginal** teeth with double inner marginal width and with its same length, ~5 terminal cusps, each cusp triangular, distributed along distal half of outer edge, basal cusp wider, blunter and separated from remaining cusps by deep notch (Figs 22–23); remaining cusps sharper pointed, decreasing in size towards medial. Pair of salivary gland flanking as single, flattened, white mass along anterior quarter of oesophagus (Figs 28, 30, 34: **sg**); each gland becoming separated from each other only in anterior end, passing through nerve ring (Fig. 30: **sg**), in level of nerve ring both salivary ducts penetrating in buccal mass dorsal wall (Fig. 33: **sd**), opening in short distance at medial edge of

jaw plates, separated from each other (Fig. 33: **sa**). Oesophagus simple, relatively narrow (Figs 30, 34: **es**), becoming still narrower in posterior half (Fig. 29: **es**); inner surface mostly smooth, with dorsal layer of oesophageal gland (Fig. 33: **eg**); running along ~one whorl up to stomach insertion (Fig. 31: **es**). Stomach elongated, of almost $\frac{3}{4}$ whorl, located in middle region of visceral last whorl (Fig. 25), occupying $\sim\frac{1}{2}$ of volume of visceral last whorl; inner surface simple, lacking special folds or sorting areas; single duct to digestive gland (Fig. 31: **dd**) located in middle level of gastric right surface. No clear border between stomach and intestine (Fig. 31). Intestine formed by gradual narrowing of stomach, performing two loops (Fig. 31: **in**) in region preceding kidney; after these loops running crossing left edge of kidney, reaching pallial cavity as rectum (Figs 29, 35: **rt**). Rectum relatively wide ($\sim\frac{1}{5}$ of pallial cavity width), weakly convolute, running along left side of pallial cavity, bearing relatively large, elliptical fecal pellets (Figs 29, 35: **fp**), aligned along rectum. Anus narrow, siphoned located close to mantle border left side (Figs 29, 35: **an**).

Genital system. Male Testis cream in colour, elongated, located along columellar surface of visceral penultimate whorl (Fig. 31: **ts**). Testis gradually narrowing forming narrow vas deferens (Fig. 31: **vd**) in region preceding pallial cavity. In pallial cavity vas deferens becoming wider, white and glandular, running along left edge of pallial cavity and rectum as prostate gland (Fig. 29: **pt**); prostate 70% tubular (closed), opening in anterior 30%, becoming thick edged furrow (Fig. 29: **ap**). Head-foot aphilic, i.e., lacking penis.

Female (Figs 32, 35) Ovary and visceral structures similar to correspondent structures of male. Visceral oviduct (Fig. 35: **vo**) very narrow, running along columellar surface of visceral mass along 1 whorl, up to right side of posterior pallial cavity end. Pallial oviduct (Fig. 35: **ov**) wide, almost as long as pallial cavity; running along pallial cavity left side, covering rectum ventrally (Fig. 35: **ov**); multi-lobular and with convolute anterior portion. No internal structures detectable. Most composed by elongated capsule gland, thickening oviduct walls. Genital atrium short, located just posterior and ventral to rectum (Fig. 32). Female aperture simple, bearing pair of longitudinal folds in its dorsal side, running anteriorly

along rectum ventral surface, up to ventral edge of anus (Fig. 32: **ap**)

Central nervous system (Fig. 30) Nerve ring located posteriorly to buccal mass (Fig. 28: **nr**). Pair of cerebral ganglia (Fig. 30: **ce**) with each ganglion occupying $\sim 20\%$ of buccal mass volume, relatively spherical; cerebral commissure short, only as narrow region between both ganglia. Pair of pleuro-pedal ganglia (Fig. 30: **pp**) as two masses with $\sim 70\%$ of size of cerebral ganglia.

Habitat In litter and dead leaves on the soil close to tree trunks.

Etymology The specific epithet refers to the way that somebody born in the City of São Paulo is called, i.e., paulistano, distinguishing from somebody born in entire São Paulo State, which is paulista.

DISCUSSION

Adelopoma paulistanum is minute, but is it apparently the largest species of the genus. It reaches 2.8 mm long, while other species rarely reach 2 mm. *A. brasiliense* and *A. brasilianum* are the closest species in this feature, but they barely reach 2.6 mm. The new species normally has 6 whorls (Figs 1–5, 11–12), which is similar to most congeneric species, except for *A. peruvianum*, which possesses ~ 5 whorls. The protoconch of *A. paulistanum* has 1.5 whorls (Figs 8, 9, 13, 16, 17), differentiating it from *A. tucma*, *A. stolli*, *A. paraguayana* and *A. brasiliense*, which have protoconchs of 2 whorls. The new species has 16 threads in the last whorl, which is similar only to *A. stolli*, while *A. occidentale* and *A. bakeri* have 33 threads, *A. costaricense* has 24, *A. paraguayana* has 26, and *A. peruvianum* has 20 threads. The microsculpture found in *A. paulistanum* (Figs 6, 7, 20) is only found in *A. peruvianum* and *A. paraguayana* (Hausdorf & Muñoz, 2004), but this sculpture in the new species is more delicate and uniform. The shell colour of *A. paulistanum* varies from pure white to pale beige; this variation appears to be exclusive, as the other species are always pure white in colour.

The non-shell characters of *Adelopoma paulistanum*, even the operculum and radula, can rarely be compared with the allied species, as they are mostly unknown. The operculum is only

mentioned for *A. tucma* and *A. stollii* (Doering, 1884; Martens, 1890) and appears to be similar to that of *A. paulistanum*. The radula is known for *A. tucma* (Doering, 1884: 458, fig. 1) and *A. occidentale* (Baker, 1923: 47, fig. 21). The radula of *A. paulistanum* differs in having all cusps of the rachidian tooth of a similar size, the longest cusp of the lateral teeth is the third cusp instead of the fourth cusp, and in having 4–5 cusps on the outer marginal teeth, instead of two. It differs from the radula of *A. occidentale* in having sharper pointed cusps, more elongated basal central cusp in the rachidian tooth, and fewer cusps in the outer marginal teeth. The anatomical features of *A. paulistanum* conform to the diplommatinid pattern (Webster et al, 2012; Simone 2013), such as the small size and sinistral coiling; the apparent duplication of the eyes (Fig. 26); the simple mantle border (Figs 25, 29); the short and stubby snout (Figs 25, 28); the total absence of gill and osphradium, having the pallial cavity modified into a lung (Figs 29, 35); the taenioglossate radula (Figs 21–24); and the relatively simple genital structures. The reno-pericardial structures located in the pallial roof instead of inside the visceral mass (Figs 29, 35), the elongation of the stomach (Figs 25, 31), the large size of the nerve ring (Fig. 30), including the buccal ganglia (Figs 33–34: bg), are all features that are uncommon in basal caenogastropods (Simone, 2011), and worthy of further study. The aphally of the diplommatinids, also found in *A. paulistanum*, has confirmed that the exophalic penis found in some other Cyclophoroidea families (Simone, 2004) is a remarkable convergent character with the higher caenogastropods, i.e., the Hypsogastropoda (sensu Simone, 2011).

Doering (1884) stated that the diplommatinids are extremely sensitive to desiccation and exposure to the light, dying quickly. This phenomenon was also observed here, where most specimens died during the simple transportation from the field to the laboratory. This raises the concerns about the conservation of this endangered species, as special care must be taken in managing them.

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