

# A NEW GENUS AND SPECIES OF CAMAENID FROM THE AMAZON RAINFOREST, BRAZIL (PULMONATA, HELICOIDEA)

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*Abstract* *Olympus nimbus*, new genus and species, is described for the Amazon Rainforest, collected at Neblina Peak, Amazonas, Brazil. The taxon is clearly related to the camaenid genus *Solaropsis* because of conchological and anatomical attributes. However, the new taxon differs from its allies mainly in its smaller size (about 15 mm), its tall spire (almost as tall as wide), its narrow umbilicus, in lacking a bursa copulatrix diverticulum and a clear penial epiphallus, and by its complex internal penial organization. This paper also discusses the state of current knowledge of the South American Camaenidae.

*Key words* *Olympus nimbus*, new genus, new species, Camaenidae, rainforest, Brazil

## INTRODUCTION

The Amazon Rainforest is one of the largest biomes of the Planet, filling the Amazon Basin of South America. It encompasses about seven million square kilometers, mostly within Brazilian territory (about 60%), and is widely known for its many thousands of plant and animal species (Lewinsohn & Prado, 2005). In spite of its vast size, it possesses several areas of endemism (Silva *et al.*, 2005). Despite the reputed huge diversity, the terrestrial malacofauna is very poorly known and less than 3% of the species reported from the Brazilian region were collected in that area (Simone, 2006).

Almost every sample of terrestrial molluscs collected in the Amazon Rainforest reveals new species and sometimes higher taxa, as reported here. The region is clearly under-investigated with respect to molluscs, and much work remains to be done. There is an urgency to this considering the current rapid degradation and deforestation (Williams, 2006) with accompanying loss of species, many before they can even be described.

The sample studied here was collected by the arachnologist André do Amaral Nogueira at the base of Brazil's highest mountain, Pico da Neblina (literally fog peak). This is 3,014 m in height, and stands on the border between Brazil, Colombia and Venezuela. Analysis of the sample revealed a new genus and species allied to the genus *Solaropsis* Beck 1837 (= *Psadara* Miller 1878). The taxon was initially considered to belong to the Camaenidae, but, after anatomical structures were examined, was transferred to the Solaropsidae

(Wurtz, 1955; Solem, 1966; Nordsieck 1986, 1989). Phylogenetic analysis based on more substantial material has since seen the transfer of both genera back to the Camaenidae (Tillier, 1989; Cuzzo & Fernández, 2001; Cuzzo, 2002, 2003). A fuller history and systematic discussion of these genera can be found in recent literature (mainly Cuzzo, 2002, 2003) and is not discussed further herein. In addition there has been a controversy related to the validity of *Psadara*, which has variously been considered a junior synonym, an independent genus and a subgenus of *Solaropsis* (Richardson, 1985; Cuzzo, 2002).

## MATERIAL AND METHODS

The sample consisted of a shell and animal preserved in 70% ethanol, deposited in the malacological collection of the Museu de Zoologia da Universidade de São Paulo (MZSP). The specimen was extracted from its shell by means of a window artificially made in the penultimate whorl (Fig. 4). The animal was dissected by standard techniques, under a stereo-microscope, with the specimen immersed in ethanol. Digital photos of most dissection steps were obtained, as well as drawings with the aid of a camera lucida. The radula was examined by scanning electronic microscopy (SEM) in the Laboratório de Microscopia Eletrônica of MZSP.

In the figures, the following abbreviations are used: **aa**, anterior aorta; **ad**, albumen gland duct; **ag**, albumen gland; **an**, anus; **bc**, bursa copulatrix; **bd**, bursa copulatrix duct; **bg**, buccal ganglia; **bm**, buccal mass; **br**, subradular membrane; **cc**, cerebral commissure; **ce**, cerebral ganglion;

**cm**, columellar muscle; **cn**, cerebro-pedal and cerebro-pleural connectives; **co**, connection between penis and vagina; **cp**, gastric central pad; **cv**, pulmonary (efferent) vein; **es**, oesophagus; **da**, digestive gland anterior lobe; **dd**, duct to digestive gland; **df**, dorsal folds of buccal mass; **dg**, digestive gland posterior lobe; **di**, diaphragm; **dw**, dorsal wall of buccal mass; **ef**, oesophageal folds; **es**, oesophagus; **fd**, spermoviduct inner folds; **fl**, penial flagellum; **ft**, foot; **gf**, gastric inner fold; **gl**, optical ganglion; **go**, gonad; **gp**, genital pore; **hd**, hermaphrodite duct; **in**, intestine; **ir**, insertion of m4 in subradular cartilage; **iw**, jaw; **ka**, kidney anterior chamber; **km**, kidney middle flap; **kv**, kidney ventral flap; **m1-m7**, extrinsic and intrinsic odontophore muscles; **mb**, mantle border; **mj**, jaw and peribuccal muscles; **mo**, mouth; **nv**, nerve; **oc**, odontophore cartilage; **od**, odontophore; **of**, odontophore cartilage median fusion with its pair; **pa**, posterior aorta; **pc**, pericardium; **pd**, penis duct; **pe**, penis; **pf**, penis inner folds; **pg**, penial (epiphalic) gland; **pi**, penis inner membrane; **pl**, penial muscle; **pm**, pallial muscle; **pn**, pneumostome; **pp**, pleuro-pedal ganglion; **pr**, pedal nerves; **pt**, prostate; **pu**, pulmonary cavity; **pv**, pneumostome right flap; **ra**, radula; **rm**, radular muscle; **rn**, radular nucleus; **rs**, radular sac; **rt**, rectum; **sa**, salivary gland aperture; **sc**, subradular cartilage; **sd**, salivary gland duct; **sf**, satellite fold of pneumostome; **sg**, salivary gland; **so**, spermoviduct; **sp**, spermoduct; **sr**, seminal receptacle; **st**, stomach; **te**, inverted cephalic tentacle; **tm**, tentacle retractor muscle; **tn**, tentacular nerve; **to**, tissue on radular ribbon preceding radular exposed region in buccal cavity; **ua**, ureter aperture; **un**, union of mantle border with nuchal surface; **ur**, ureter; **ut**, uterus; **va**, furrow originating vas deferens in spermoviduct; **vd**, vas deferens; **vg**, vagina.

## SYSTEMATICS

### Family Camaenidae

#### *Olympus* gen. nov.

*Diagnosis* Shell allied to *Solaropsis*, but about 15 mm in length, almost as tall as broad. Spire relatively well developed. Umbilicus very narrow. Foot lacking medial dorsal furrow. Digestive tubes simple (lacking large typhlosoles). Penis

lacking a clear external epiphallus and with a large, tapered penial flagellum. Bursa copulatrix lacking a diverticulum.

*Type species* *Olympus nimbus* Simone 2010.

*Gender* Masculine.

*Etymology* The generic epithet alludes to the type locality, Pico de Neblina, the highest mountain on Brazilian territory. It is analogous to Mount Olympus, the highest mountain in northern Greece and mythical home of the Greek gods.

*Taxonomy* The depressed discoid shell shape, with surface granules (mainly in the spire), the dotted, aligned shell colour, and the simple aperture (lacking teeth) aligns *Olympus* with the South American genus *Solaropsis*. The simplest distinguishing feature is the more inflated, taller spire of *Olympus* so that shell height approaches maximum shell width. Species of *Solaropsis* are 25% or more shorter than their maximum width and even almost planispiral.

Size may be another useful distinguishing feature, as species of *Solaropsis* range from about 30 mm diameter (species previously attributed to *Psadara*) to over 100 mm (*Solaropsis* spp.).

*Olympus* can be easily distinguished anatomically from the *Solaropsis* so far described by the lack of a pedal furrow running along the median-dorsal region, by the lack of a clear external epiphallus, and by the absence of an appendix to the bursa copulatrix.

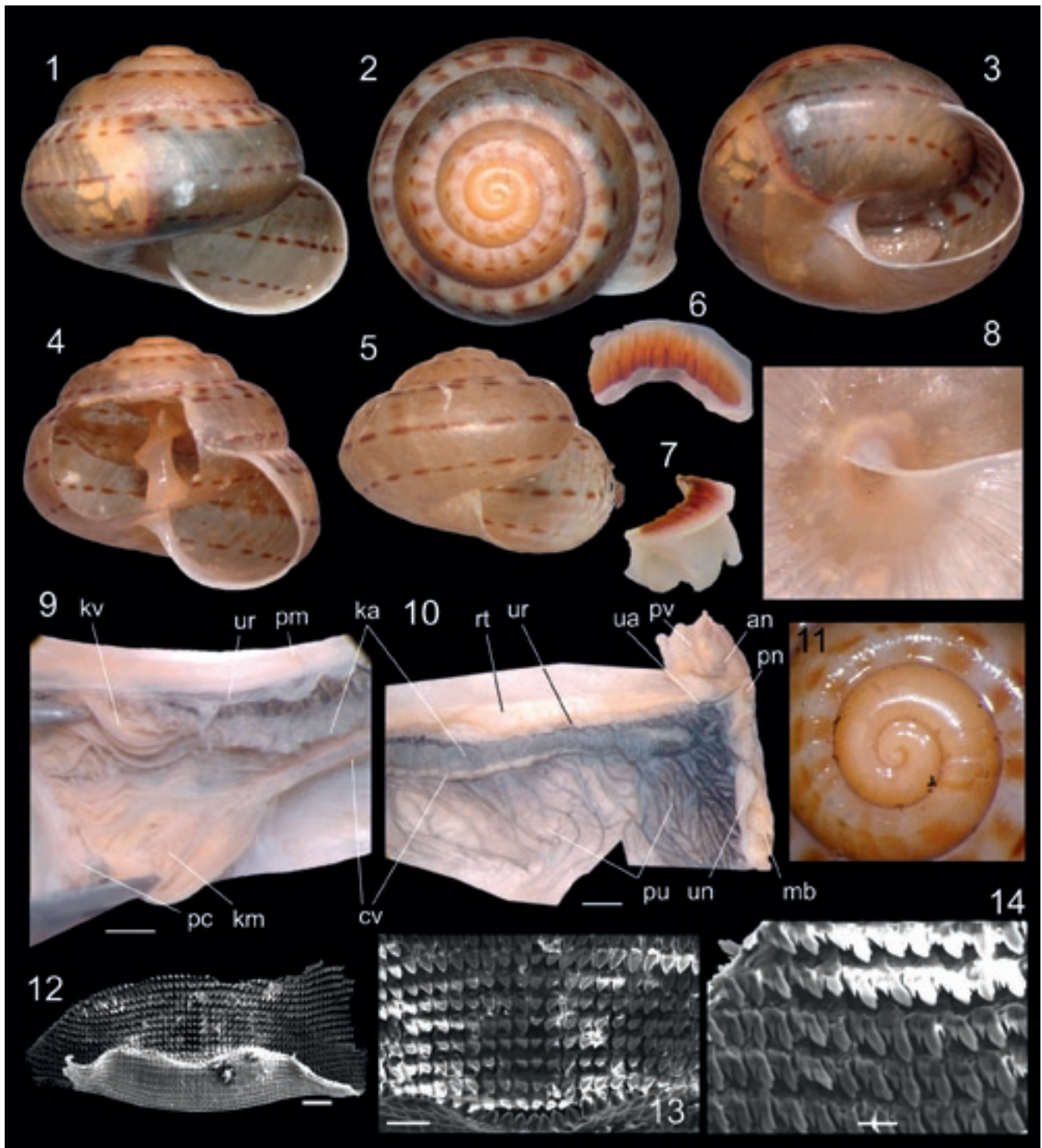
*Olympus nimbus* sp. nov.

(Figs 1–33)

*Types* Holotype MZSP 87151. Paratype 1: MZSP 87149 from type locality.

*Type locality* Brazil, Amazonas, São Gabriel da Cachoeira, Pico da Neblina, Cachoeira do Tucano. Elevation 100 m, 0°39'54.07"N 65°56'09"W (sta. 3; André do Amaral Nogueira col., 24/ix/2007).

*Description* Shell (Figs 1–5, 8, 11) about 15 mm in diameter, turbiform, globose; height about 90% of maximum diameter. Walls thin, fragile, translucent. Spire dome-shaped, occupying about 50% of shell height (Figs 1, 4) and about 78%



**Figures 1–14** *Olympus nimbus* shell and anatomy: 1–4) Holotype, diameter 15.7 mm; 1) frontal (apertural) view with specimens still inside, partially seen by translucence; 2) same, apical view; 3) same, umbilical, slightly apertural view; 4) same, specimen extracted through a window in penultimate whorl artificially done, two whorls of columella visible; 5) paratype MZSP 87149, diameter 14.6, frontal view; 6) jaw, ventral view, right end (left in Fig.) damaged, width = 1.2 mm; 7) same, left view; 8) holotype, detail of umbilicus; 9) kidney and adjacent region of pallial cavity, ventral (inner) view, opened longitudinally, inner flaps deflected outside and gripped by forceps, right flap upside, covering ureter region, left flat downside, covering pericardium, scale = 3 mm; 10) pulmonary cavity, anterior and middle thirds, ventral (inner) view, scale = 3 mm; 11) holotype, detail of protoconch and adjacent region, apical view; 12–14) radula in SEM; 12) whole view of a bended slice, scale = 100  $\mu$ m; 13) detail of central region, scale = 50  $\mu$ m; 14) detail of lateral region, scale = 20  $\mu$ m.



of diameter (Fig. 2). Whorls convex, rounded, suture relatively deep. Protoconch with about two whorls, smooth, uniform beige, almost planispiral (weakly convex) (Figs 2, 11). Penultimate whorl about 60% of width of last protoconch whorl. Transition protoconch-teleoconch marked by an orthocline, low, narrow thread (Fig. 11). Teleoconch of three whorls; penultimate whorl about 30% wider than preceding and last whorls (Fig. 2). Surface sculpture a regular mosaic of uniformly spaced nodules, each row intercalated with neighbouring rows, with about 4–5 spiral rows on penultimate whorl (Figs 2, 4, 11). Nodules gradually disappearing before last whorl. Last whorl smooth, with growth lines only present. Umbilicus very narrow, partially covered by base of ventral half of inner lip (Figs 3–5, 8). Peripheral carina very low, blunt. Located nearly in middle of penultimate whorl (Fig. 5), but displaced to an inferior position in last whorl (Figs 1, 4). Colour beige, possessing three spiral, narrow bands split into spots, fairly uniformly and equidistantly distributed, each spot about 4–5 times longer than wide with distance between spots slightly shorter than their length. Central band located slightly above carina (in last whorl), with other bands roughly mid way between this and neighbouring whorls. Inferior band only visible on last (body) whorl (Figs 1, 4, 5). Secondary, paler spots sometimes present, normally axially aligned with spiral spots and mainly located between the superior band and suture (Figs 1–2). Aperture with weakly deflected lips, slightly prosocline (Figs 3, 4). Outline of aperture semicircular, greatly compressed (about 40%) by penultimate whorl (Figs 1, 3–5). Outer lip rounded and ample; inner lip with inferior half concave, as a continuation of outer lip; superior half convex, possessing very thin, transparent callus covering transition of penultimate and last whorls (Figs 3, 8). Columella rounded, concave (Fig. 4).

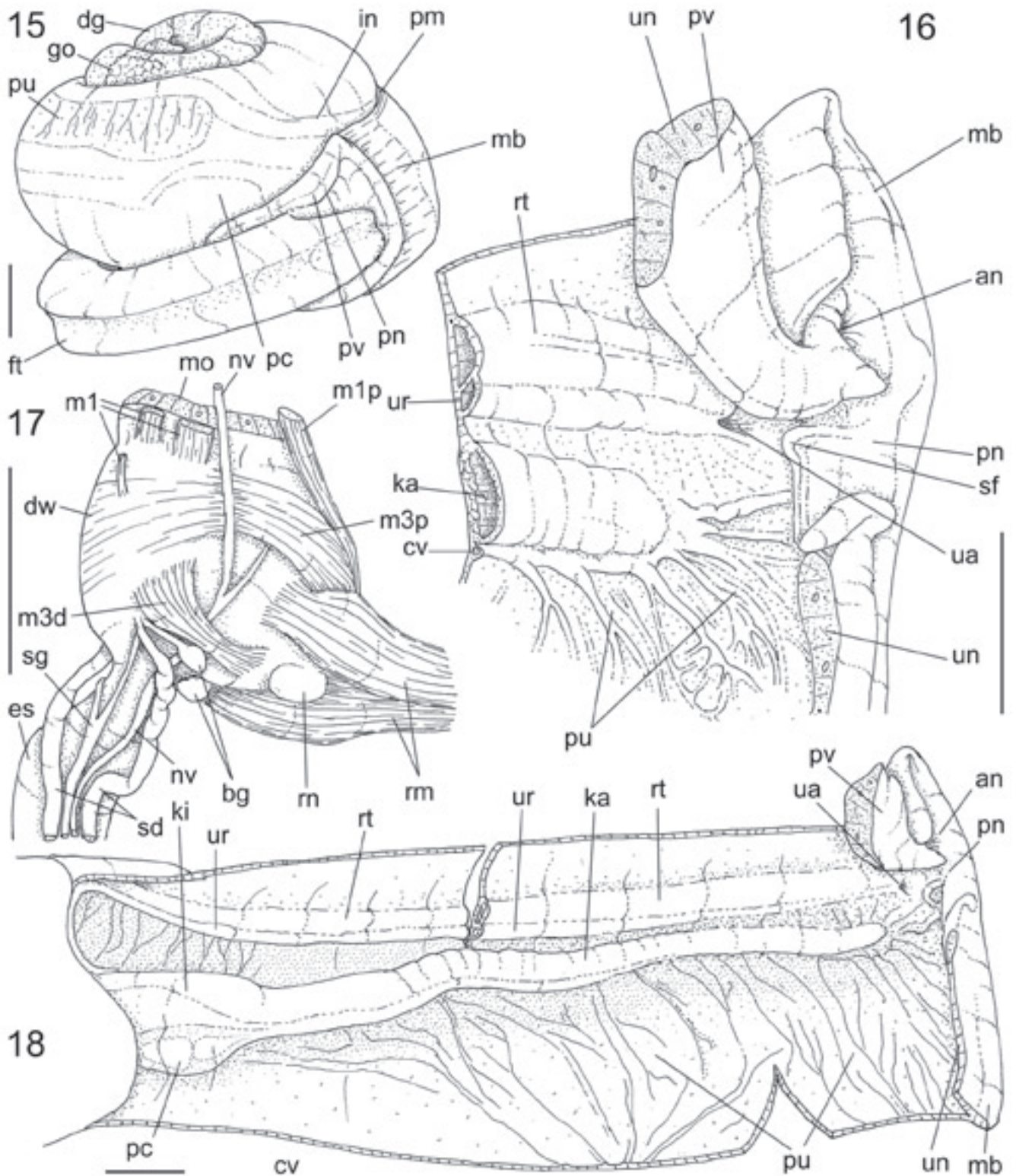
Head-foot (Figs 3, 15, 19) of normal shape. Colour uniform pale brown. Foot dorsal, surface simple, lacking median furrow. Genital orifice circular. Pair of ommatophores and tentacles well-developed, with strong retractor muscles. Eyes dark pigmented. Columellar muscle thick, about half whorl in length.

Mantle organs (Figs 9, 10, 15, 16, 18). Mantle border thick, lacking pigments. Pallial muscle covering columellar surface of pallial cavity

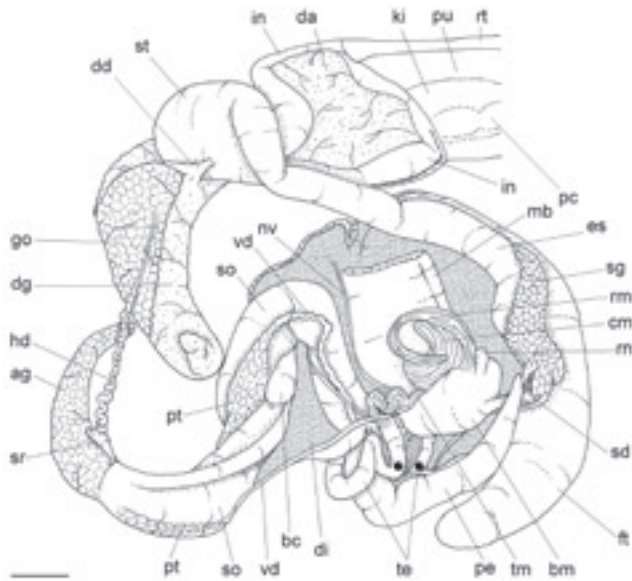
(Figs 9, 15: pm), thin, being thicker along right mantle edge and close to right corner of mantle border. Pneumostome protected by ventral, right flap (pv) and about  $\frac{1}{4}$  of aperture length. Pneumostome about  $\frac{1}{8}$  of aperture length, separated at left from anus (Fig. 16). Wide fold attached dorsally to pneumostome, covering almost its entire dorsal extension and width, except for short furrow edging right border of pneumostome, corresponding to urinary gutter (Fig. 16: sf). Lung of about one whorl length, narrow and elongated. Pulmonary vessels concentrated anteriorly, with edges pigmented dark brown (Fig. 10), gradually becoming more scanty towards posterior and less pigmented, but always present (no wide area lacking vessels). Pulmonary vein running longitudinally between middle and right thirds of pallial cavity. Remaining pulmonary vessels somewhat perpendicularly inserted in pulmonary vein, except for anterior end, with vessels arranged in radial fashion, surrounding anterior end of kidney. Vessels from middle and anterior pulmonary thirds mostly intercalated with vessels inserted in collar vessel, running in anterior pulmonary left edge and along mantle border. Kidney positioned along right edge of pulmonary vein (details below). Between kidney and ureter-rectum mass, distance equivalent to  $\frac{1}{8}$  pallial roof width. This space also possessing similar arrangement of vessels of left pulmonary area, but with proportionally shorter vessels. Between rectum and right edge of lung area equivalent to  $\frac{1}{6}$  pallial roof area, smooth, lacking vessels or folds.

Visceral mass (Figs 15, 19, 20). About two whorls in length. Both digestive gland lobes pale brown in colour. Anterior lobe flattened, occupying about  $\frac{1}{4}$  of visceral volume, located just posterior to pallial cavity. Posterior lobe spiral, tapering towards posterior tip, with about  $\frac{1}{4}$  of visceral volume. Stomach with about  $\frac{1}{5}$  of visceral volume, located between both digestive gland lobes, about half whorl posterior to pallial cavity. Digestive tubes (described below) surrounding anterior lobe of digestive gland. Gonad clearly multi-lobed, pale brown in colour, somewhat conical, encased in middle-right region of posterior lobe of digestive gland, occupying about  $\frac{1}{6}$  of visceral volume.

Circulatory and excretory systems (Figs 9, 18). Pericardium about twice as long as wide, located between middle and left thirds of posterior end



Figures 15–18 *Olympus nimbus* anatomy: 15) specimen extracted from shell, frontal view; 16) region of pneumostome, ventral-inner view, its right flap partially sectioned and deflected upwards; 17) buccal mass, right view; 18) pallial-pulmonary cavity removed from head-foot, ventral-inner view, right flap of pneumostome sectioned and deflected, transverse slice if middle level of right edge (upper in Fig.) artificially done. Scales = 2 mm.



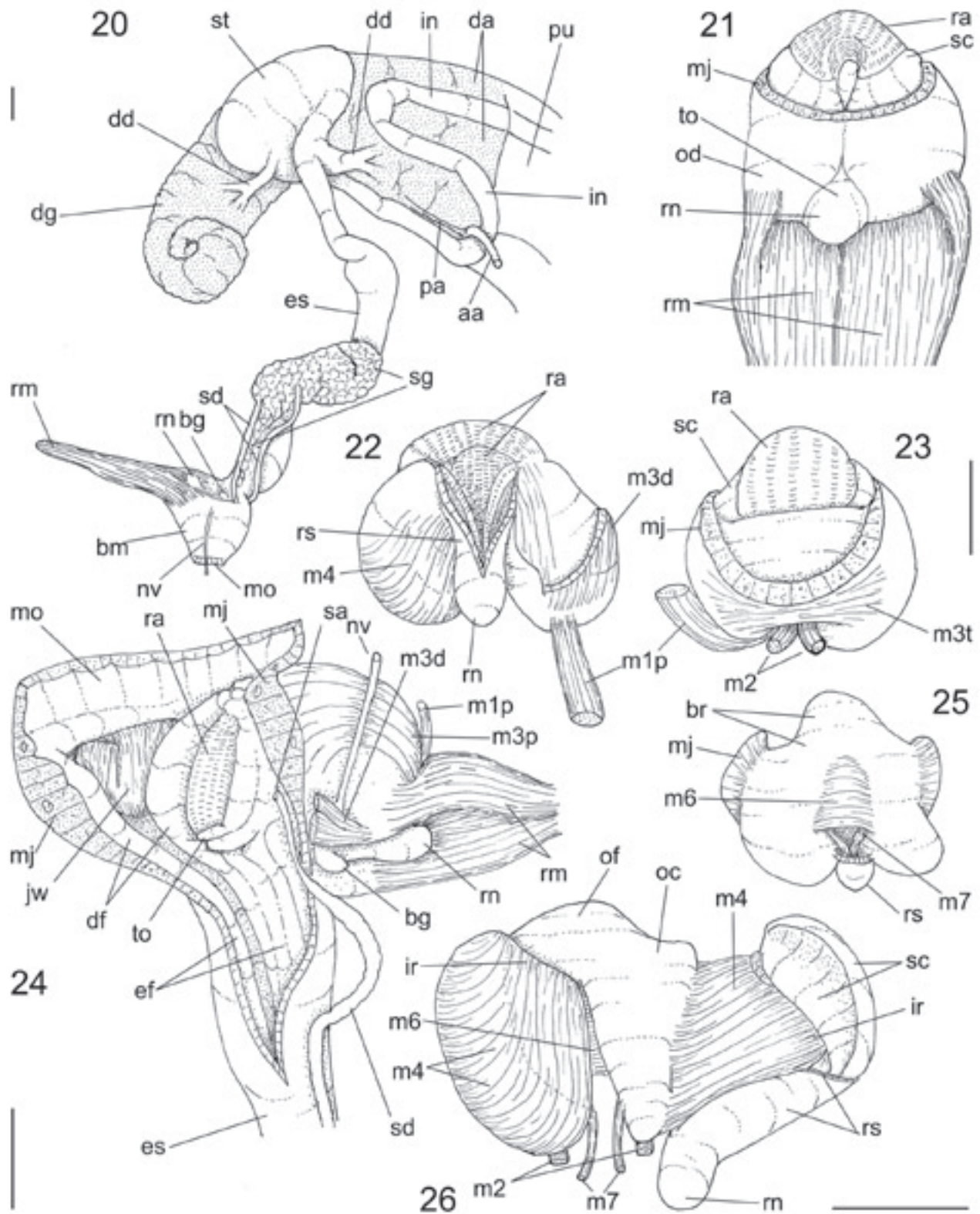
**Figure 19** *Olympus nimbus* anatomy: Whole view of first steps of dissection of specimen, pulmonary cavity and visceral sac totally removed and deflected upwards (pulmonary cavity shown in Fig. 18), head-foot sectioned along left edge of diaphragm and deflected; inner organs separated from each other, but maintained mostly as in situ; digestive tubes and genital structures slightly uncoiled. Scale = 2 mm.

of pallial hoof; occupying about 3% of lung area. Auricle located anteriorly, as continuation from pulmonary vein, with about same ventricle size. Anterior aorta about four times wider than posterior aorta (Fig. 20), surrounding left-anterior loop of intestine from dorsal to ventral. Posterior aorta running straight posteriorly. Kidney with about 85% of pallial cavity length; possessing two regions, anterior region (ka) and posterior region (Fig. 18: ki). Anterior renal region with about  $\frac{1}{3}$  of total kidney length, and about 10% pallial roof width, its anterior end a blind sac, rounded, located about 15% of pulmonary length posterior to pneumostome (Fig. 16). Sac internally hollow, with glandular walls, with dorsal wall slightly thicker than ventral wall (Fig. 16: ka). Posterior kidney region conical, lacking clear separation from anterior region and continuous with lumen. Kidney about 1.5 times larger than pericardium, lying along right pericardial side, internally possessing two lateral, glandular flaps (laminae) (Fig. 9). Ventral flap (kv) originating from right-ventral side of posterior kidney region, coiling as spiral towards ventral side and leftwards. Height (if uncoiled) about as great as local renal width, occupying about  $\frac{1}{3}$

posterior region volume. Medial flap (km) originating from dorso-left side of posterior kidney region, about 1.5 times larger than ventral flap, coiling as a spiral towards ventral side and rightwards, surrounding ventral flap. Renal lumen a very narrow space between interstices of these two inter-encased posterior flaps (kv, km), continuous with lumen of hollow anterior renal region. Nephrostome very small, in posterior region of renal right edge, covered by ureter. Primary and secondary ureter complete and closed (tubular), lying along right half of posterior end of lung and along left edge of rectum. Urinary aperture (Fig. 16: ua) simple, turned anteriorly, located at short distance posterior to mantle border and from right edge of pneumostome. Short urinary gutter running from urinary aperture to right side of pneumostome, protected at left by pneumostome dorsal fold (Fig. 16: sf).

Digestive system (Figs 17, 19–27). Buccal mass conical, with about  $\frac{1}{5}$  volume of head-foot and about  $\frac{1}{8}$  whorl in length, located in anterior end of haemocoel. Dorsal wall of buccal mass thick-walled with anterior and lateral folds surrounding jaw, and another pair flanking lateral edges of radula (Fig. 24: df). Jaw with brown anterior surface and white edges of anterior surface and projection running along dorsal wall of buccal mass (Figs 6, 7), protecting it from radula. Anterior surface of jaw possessing about 12 transverse folds and with inner cutting edge somewhat irregular. Pair of radular muscles, or retractors of buccal mass (Figs 17, 20, 21: rm), very thick, originating in columella, in right side of columellar muscle (Fig. 19), and running towards ventral side about 1.5 times buccal mass length, with both connected together as a single mass. Radular muscles inserted into surrounding ventral and lateral regions of odontophore posterior surface. Pair of jaw muscles (Figs 23–25 mj) thick, originating along anterior region of dorsal buccal mass wall, mostly attached to jaw, but surrounding buccal cavity laterally and inserted into dopros-lateral edge of odontophore cartilages. Three pairs of differentiated jugal muscles (Fig. 17: m1) work as protractors of buccal mass, two pairs wider, located more anteriorly, other pair slender and narrow, located more posteriorly. All originate in dorsal region of mouth, running a short distance posteriorly and inserted along antero-dorsal region of dorsal wall of buccal mass, in its anterior third. Another differentiated pair





**Figures 20–26** *Olympus nimbus* anatomy: 20) digestive tubes and gland as in situ, ventral view, topology of some adjacent structures also shown, visceral structures slightly uncoiled; 21) buccal mass, dorsal view; 22) odontophore, dorsal view, radular sac sectioned along median line, left superficial structures removed; 23) same, ventral view; 24) buccal mass, right view, mostly opened longitudinally along right side, dorsal wall (left in Fig.) deflected to show inner surface; 25) odontophore, ventral view, superficial structures and muscles mostly removed; 26) same, dorsal view, radula removed and deflected to right still connected to m4, left muscles as in situ; radula seen in profile. Scale = 1 mm.

of jugal muscles working as ventral protractors of buccal mass (Figs 17, 22, 23: m1p), originate in ventral side of mouth, running straight towards posterior along entire odontophore length and inserted in posterior surface of odontophore. Odontophore with about  $\frac{2}{3}$  of buccal mass volume, placed ventrally, spherical, with about 80% of buccal mass length. Other odontophore muscles: m2, pair of narrow odontophore retractor muscles originating with radular retractors (rm) and running close to median line inside posterior region of odontophore (Figs 23, 26) then inserted in posterior end of odontophore cartilages; m3d, pair of thin muscular layers connecting region anterior to radular nucleus with dorso-lateral surface of buccal mass (Figs 17, 24); m3p, pair of superficial, thin muscle layers connecting region anterior to insertion of radular muscles with lateral surface of dorsal wall of buccal mass and covering ventro-lateral surface of buccal mass (Figs 17, 22, 24); m3t, superficial, transverse, thin layer of muscles located between radular nucleus and pair of radular muscles (Fig. 23); m4, main pair of ventral tensor muscles of radula and very thick, originating in lateral edges of odontophore cartilages and surrounding median surface of cartilages then inserted along ventral surface of radular ribbon, in an area equivalent to odontophore length, in exposed portion of radula and short portion posterior to it (Fig. 26); m6, a thin horizontal muscle connecting both odontophore cartilages along their median-ventral edge, being about  $\frac{1}{3}$  cartilages length (Figs 25, 26); m7, a narrow pair of dorsal tensor muscles of radula originating in median-ventral edge of odontophore cartilages, at some distance from m6 and running a short distance inside radular sac then inserted along posterior region of radular ribbon (Figs 25, 26). Odontophore non-muscular structures: oc, odontophore cartilages, flattened, claviform (Fig. 26), wider anteriorly, tapering gradually posteriorly with anterior region about  $\frac{1}{3}$  of cartilages length and cartilages fused with each other along median-ventral edge at about  $\frac{1}{3}$  their length these being bluntly pointed at posterior end; sc, subradular cartilage, with expanding region in buccal cavity protecting subradular membrane (br), and covered by ventral pair of folds of buccal mass (Figs 24, 26).

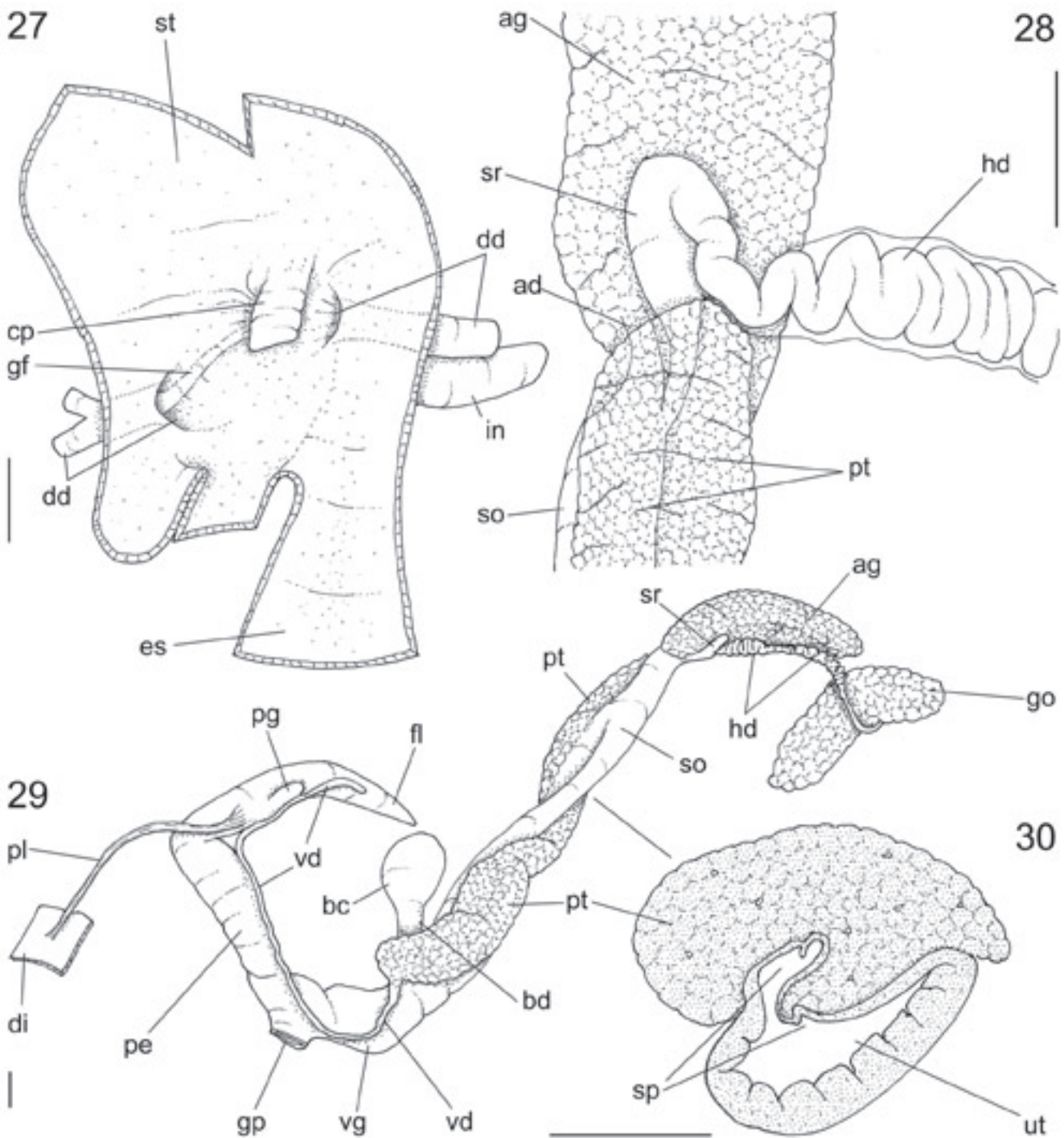
Radula about 1.5 times odontophore length when straightened. Radula (Figs 12–14) with rachidian teeth, 16 pairs of lateral teeth, and about

25 pairs of marginal teeth. Rachidian tooth small, about 1% of radular width and about twice as long as wide, cusp single, projecting almost perpendicularly, then weakly curved inwards, being about 70% of size of base. Cutting edge bluntly pointed and cusp base with central reinforcement (Fig. 13). Lateral teeth similar to rachidian, except in being slightly asymmetrical, turned medially with secondary cusp gradually appearing in more laterally positioned teeth and located at base of outer edge. Marginal teeth similar to lateral teeth, except in being about 30–40% narrower, and with secondary cusp proportionally larger, particularly in laterally positioned teeth (Fig. 14).

Salivary glands covering part of anterior third of oesophagus (Figs 19, 20: sg), and forming a single, white, thin mass. Salivary ducts differentiable from middle level of the glands, with about  $\frac{1}{12}$  oesophageal width. Salivary glands narrowing between both salivary ducts (Figs 17, 20). Salivary ducts opening in middle level of lateral edges of buccal cavity (Fig. 24: sa).

Oesophagus as long as about  $\frac{3}{4}$  whorl, with thin, flaccid walls lacking clear subdivisions and with inner surface of anterior half possessing 4–5 folds as a continuation from buccal cavity folds (Figs 24). Posterior half with a smooth inner surface, walls still thinner. Stomach position and size described above (visceral mass), relatively wide, somewhat conic and gastric walls thin, flaccid. Oesophageal insertion and intestinal origin on left side, close to columella. Duct to anterior lobe of digestive gland close to anterior region of oesophageal insertion. Duct to posterior lobe of digestive gland located a short distance from intestinal origin (Figs 19, 20). Stomach inner surface (Fig. 27) with central pad (cp) rectangular, located in left ventral region, between oesophageal and intestinal portions, occupying about 5% of gastric inner surface. A single gastric fold (gf) runs from posterior edge of central pad to posterior duct to digestive gland. Remaining gastric inner surface smooth. Intestine about 1.5 times longer than oesophagus, sigmoid, with thin walls and smooth inner surface lacking folds (Fig. 20). Intestine initially flanking left side of anterior lobe of digestive gland, then in region of pericardium gradually turning right and posterior, running through digestive gland. Near stomach curving again close to right side of digestive gland lobe then running almost straight forward.



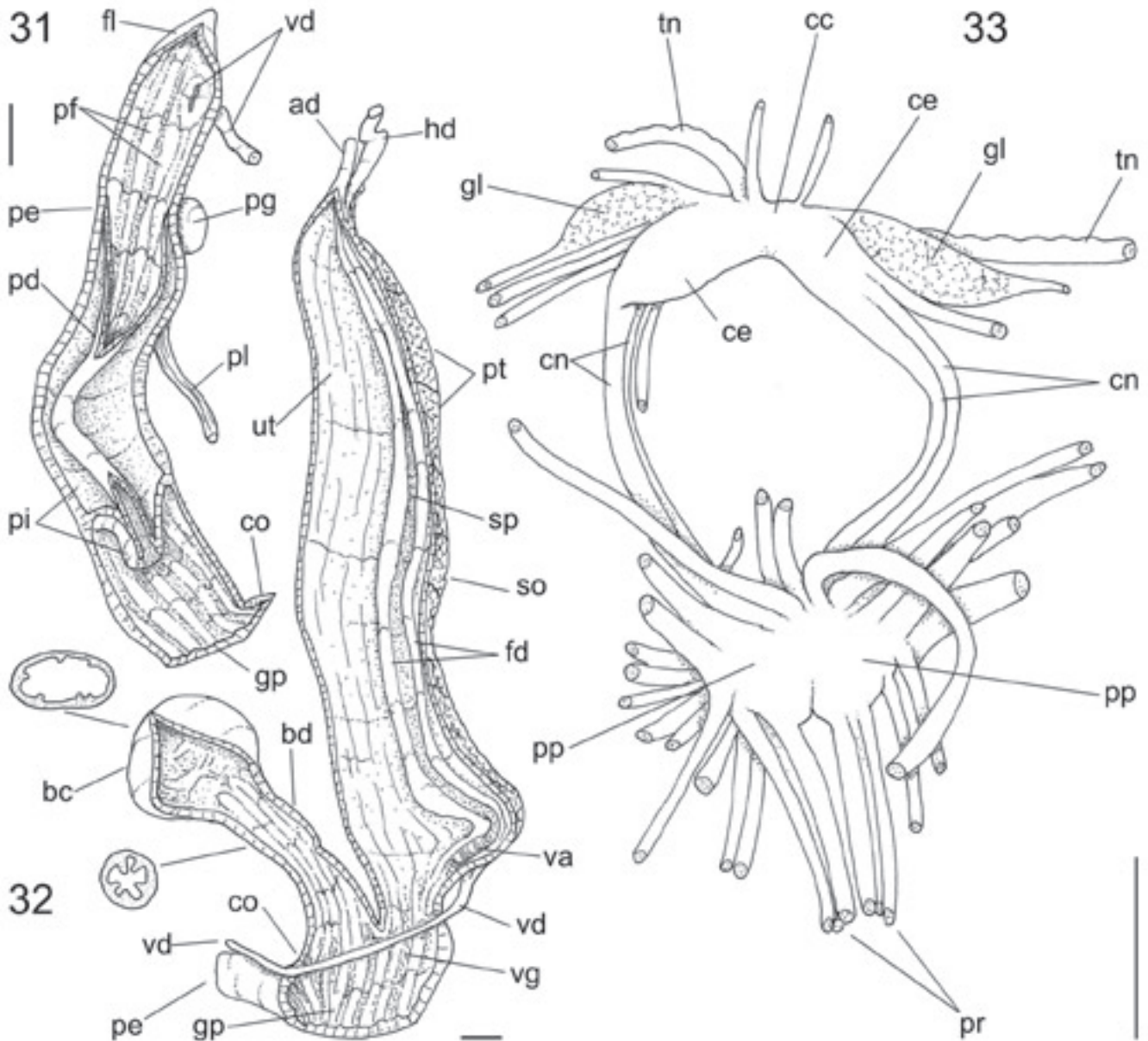


Figures 27–30 *Olympus nimbus* anatomy: 27) stomach, dorsal view, mostly opened longitudinally, including oesophageal insertion, inner surface exposed; 28) genital ducts, ventral view, detail of region between hermaphroditic duct and spermoviduct; 29) genital system, ventral view, mostly uncoiled; 30) spermoviduct, transverse section in indicated level. Scale = 1 mm.

Rectum and anus described above (pallial cavity) (Figs 16, 18).

Genital system (Fig. 29). Gonad described above (visceral mass). Hermaphroditic duct nar-

row and intensely coiled, mainly in anterior region; running for about  $\frac{1}{3}$  whorl close to columella (Fig. 19). Seminal receptacle elliptical, as wide as region between hermaphroditic duct



**Figures 31–33** *Olympus nimbus* anatomy. 31) penis opened longitudinally along anterior surface; 32) spermoviduct and bursa copulatrix opened longitudinally along anterior surface, albumen gland removed except its duct, some transverse sections in indicated levels of bursa also shown; 33) central nervous system (nerve ring), dorsal view. Scales = 1 mm.

insertion and spermoviduct (Fig. 28), possessing about twice hermaphroditic duct width and about three times longer than wide, tapering in area preceding its insertion. Albumen gland solid, pale brown, about as long as gonad (about  $\frac{1}{3}$  whorl); posterior end pointed; width equivalent to about half of foot width. Albumen gland duct subterminal, connected to distal end of spermoviduct (Figs 28, 32). Spermoviduct relatively coiled, of about 1 whorl in length and about as wide as albumen gland. Prostate gland occupying nearly

half of spermoviduct volume (Fig. 30) with inner sperm-grooves running partially immersed in prostate (Fig. 30: sp), but protected along entire trajectory by a pair of folds, dorsal fold larger and wider than ventral fold (Fig. 32: fd), and of about  $\frac{1}{8}$  spermoviduct size. Uterus occupying about  $\frac{1}{3}$  of spermoviduct space, external walls thick-glandular (Fig. 30: ut), containing narrow longitudinal furrows. Vas deferens initiating in anterior end of spermoviduct longitudinal pair of folds (Fig. 32: va), about a half whorl in length

and about  $\frac{1}{10}$  of spermoviduct width, weakly coiled. Vagina with about  $\frac{1}{6}$  spermoviduct length and same width, inner surface simple, with 4–5 longitudinal, low folds (Fig. 32: vg). Bursa copulatrix rounded, wide, slightly narrower than spermoviduct width; walls thin, inner surface simple. Bursa duct with about  $\frac{1}{3}$  width of bursa, and about twice its length with inner surface containing 5–6 longitudinal, narrow folds close to each other, continuing into genital atrium (Fig. 32: bd). Penis of about half spermoviduct length, and about  $\frac{2}{3}$  its width, with penis muscle connected to middle level of penis wall. Penial (epiphalic) gland of about  $\frac{1}{5}$  penis width and  $\frac{1}{12}$  penis length (Figs 29, 31: pg), with distal end rounded, internally solid, no duct detectable. No epiphallus in external view; however, epiphallic region present in inner view (Fig. 31) marked by change of in internal wall sculpture between penis and portion bearing complementary tube. Flagellum (fl) of about  $\frac{1}{10}$  penis length, tapering towards distal end. Internally, penis possessing secondary duct (Fig. 31: pd), of about half penis length and  $\frac{1}{5}$  penis width, its middle portion running free inside penial chamber, broadening posteriorly with 4–5 longitudinal, wide folds and papilla of vas deferens insertion (Fig. 31: vd). Anterior end protruding into chamber at penis base directed towards genital pore, with 4–5 longitudinal folds on inner surface. Penis inner membrane protecting penis secondary duct (Fig. 31: pi). Genital pore rounded, simple.

Central nervous system (Fig. 33) located at base of buccal mass. Paired cerebral ganglia elliptical, about twice as long as wide, weakly flattened with cerebral commissure short, and of about half width of each ganglion. Each cerebral ganglion of about  $\frac{1}{4}$  width of local oral tube. Pair of optical ganglia (gl) slightly smaller than cerebral ganglia, and located close to these, connected to antero-median side. Tentacular nerves (tn) connected more internally than connection of optical ganglia. Pair of pedal ganglia, pleural and visceral ganglia (pp) forming single mass located opposite cerebral ganglia, and of about same size. No differentiable ganglion detectable. Several pairs of nerves originate from these ganglia. Pair of cerebro-pedal and cerebro-pleural connectives (cn) similar-sized, about three times longer than cerebral ganglia. Pair of buccal ganglia located in region between buccal mass and oesophageal origin with each ganglion spherical,

of about  $\frac{1}{3}$  cerebral ganglion size (Figs 17, 24: bg).

*Measurements (in mm)* Holotype: 15.7 by 13.1; Paratype MZSP 87149: 14.6 by 10.9.

*Distribution* Known only from the Brazilian face of Neblina Peak, the type locality.

*Habitat* Amongst vegetation, close to soil.

*Material examined* Types.

*Etymology* The specific epithet refers to the collecting locale in which “Neblina” (Portuguese for fog) is present. From the Latin *nimbus*, meaning cloud, mist.

## DISCUSSION

As referred to above, *Olympus* belongs to the South American Family Camaenidae, and has affinity with *Solaropsis*. This affinity is based on the possession of nodules on the shell surface, as *Olympus* only has nodules on the spire. Surface spotting is also characteristic and both genera have an interesting mosaic of aligned brown spots or streaks, which has been described as “skin of snake” [as in *Solaropsis pellisserpentis* (Chemnitz 1795)]. Absence of teeth in the aperture is also characteristic and distinguishes them from related South American camaenid genera such as *Labyrinthus* Beck 1837, *Isomeria* Albers 1850 and *Polydontes* Montfort 1810. The only camaenid genera previously recorded from the Brazilian Amazon are *Solaropsis*, *Psadara* and *Labyrinthus* (Simone, 2006: 238–246). However, *Solaropsis* and *Psadara* are here considered synonyms, following specific literature (Cuezzo, 2003).

*Olympus* uniquely possesses a significantly raised spire. Other South American camaenids are discoid, with a low spire and sometimes approaching planispiral. In addition, *Olympus* appears to be smaller than other camaenids, as the remaining taxa attain 50–100 mm in diameter.

The anatomy is informative and introduces new elements to the systematics and phylogeny of the South American Camaenidae (Cuezzo, 2002, 2003). However, this is partly because so few species have been studied anatomically.



Anatomically, one of the outstanding characters that distinguishes *Olympus* from *Solaropsis* is the lack of a diverticulum in the bursa copulatrix. *Solaropsis* is the only camaenid genus that possesses this typical helicoidean character (Cuezzo, 2002, 2003). Furthermore, the duct of bursa in *Solaropsis* is generally bifurcated, which is not the case in *Olympus*. Another distinct character of *Olympus* is the lack of well-developed typhlosoles in the digestive tubes, which are present in *Solaropsis* and *Isomeria* (Cuezzo, 2003). In the penis, *Olympus* lacks a clear epiphallus in external view, which is apparent in all *Solaropsis*. The penis of *Olympus*, though, has a complex inner structure like a secondary tube that may possibly work as an epiphallus. Moreover, there is a clear change in the internal wall sculpture between the penis and the portion bearing a complementary tubule. The change in the internal sculpture in most Stylommatophora is a way to differentiate penis from epiphallus when there are no external differences and when a verge is absent. For this reason, *O. nimbus* appears to possess an epiphallus despite its unclear external appearance.

The jaw plate of *Olympus nimbus* appears to be thicker than that known from other South American camaenids (Cuezzo & Fernández, 2001: 320).

The length of the kidney is remarkable, reaching about 90% of the lung length. An anterior, hollow chamber forms the longest part (Figs 9, 10, 16, 18: ka). This feature is shared with other camaenid genera, such as *Solaropsis*, *Labyrinthus*, *Isomeria* and *Polydotes* (Solem, 1966; Cuezzo, 2003), and the *Olympus* form is particularly close to that of *Solaropsis chicomendesi* Cuezzo & Fernández 2001 (fig. 2), and *S. angulifera* Haas 1955 (Cuezzo, 2002: fig. 1).

The concentration of ganglia surrounding the pair of pedal ganglia, found in *Olympus nimbus* is another noteworthy feature amongst the stylommatophorans. It is very difficult to distinguish individual ganglia in this ventral mass, but in some *Solaropsis*, despite being of similar complexity, individual ganglia can be distinguished (Cuezzo & Fernández, 2001; Cuezzo, 2002).

Applying the classification of the Camaenidae devised by Cuezzo (2003), it is possible to consider *Olympus* in the subfamily Caracolinae, which also includes *Solaropsis*. However, it appears that

an older name for this taxon, Pleurodontidae (or Pleurodontinae) has precedence (Bouchet & Rocroi, 2005).

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