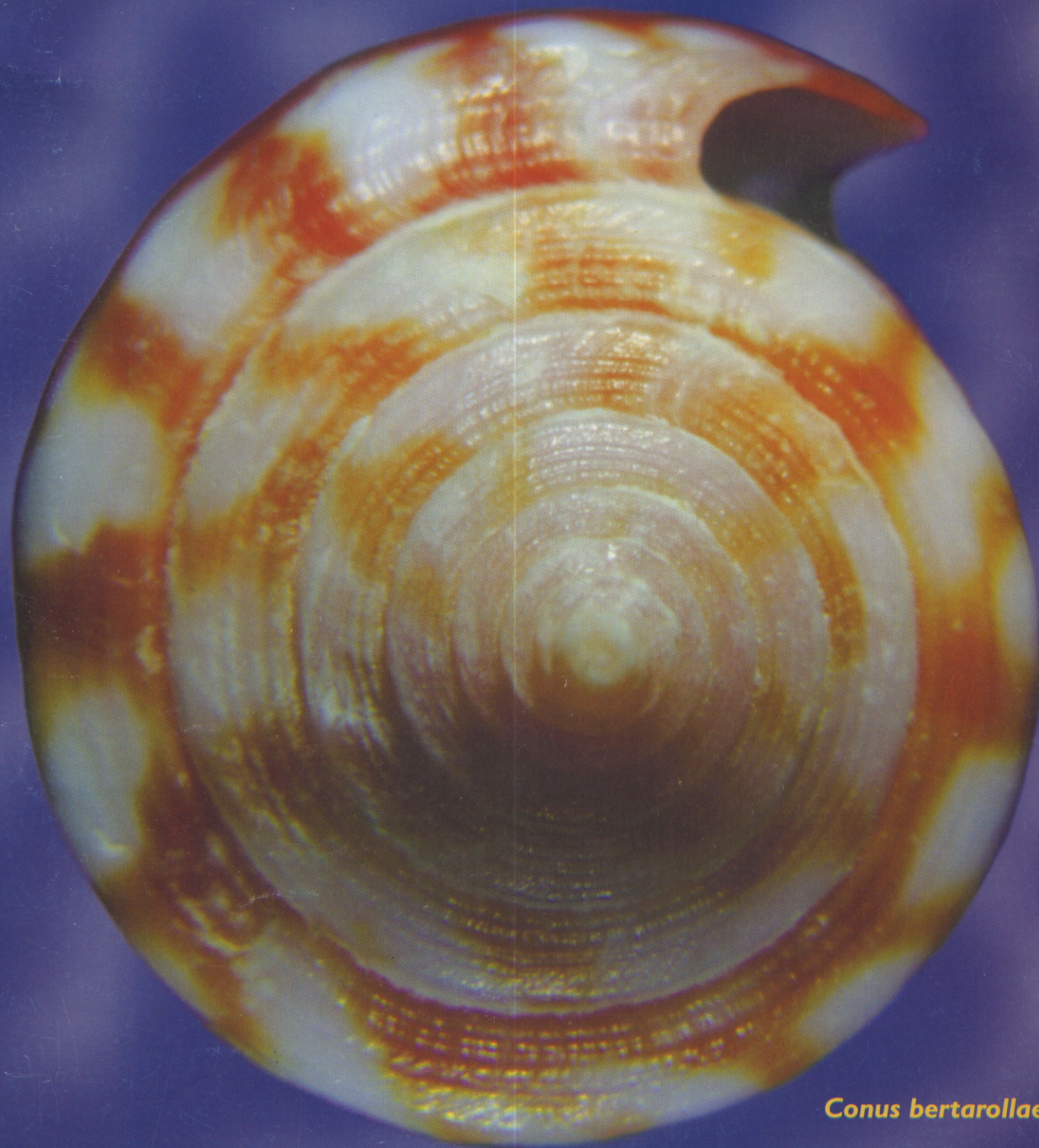




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Conus bertarollae

A New Species of *Conus* Linné (Caenogastropoda, Conoidea) from the Brazilian Coast

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Abstract:

Conus bertarollae, a new species of Conidae is described for shallow waters on reef areas off Bahia Coast, Brazil. The shell is easily distinguishable by the small size, a strong reddish color and by relatively tall spire with almost straight profile. On the inner anatomy the species has papillated mantle border, absence of salivary glands, a well-developed snout gland, a simple penis tip fashion and two flaps crossing from head to mantle anterior to female genital aperture.

Key words: *Conus bertarollae*, new species, anatomy, Mollusca, Conoidea, Brazil.

Introduction:

The genus *Conus* Linné, 1758 (type species *C. marmoreus* Linné, 1758), Conidae, is represented in Brazil by 19 species: *C. achetypus* Crosse, 1865; *C. austini* Rehder & Abbott, 1951; *C. brasiliensis*, Clench, 1942; *C. centurio* Born, 1778; *C. clerii* Reeve, 1844; *C. clechi* Martins, 1943; *C. daucus* Hwass, 1792; *C. ermineus*, Born, 1778; *C. jaspideus* Gmelin, 1791; *C. mazei* Deshayes, 1874; *C. mindanus* Hwass, 1792; *C. mus*, Hwass, 1792; *C. regius* Gmelin, 1791; *C. riosi* Petuch, 1986; *C. sanderi* Wils & Moolenbeck, 1979; *C. scopulorum* Van Mol, Tursch & Kempf, 1971; *C. selenae* Van Mol, Tursch & Kempf, 1967; *C. tostesi* Petuch, 1986; *C. villepini* Fischer & Bernardi, 1867 e *C. xanthocinctus*, Petuch, 1986 (Rios, 1994).

The extensive Brazilian coast has several areas where the malacofauna is poorly known or in some cases virtually uninvestigated. It was in one of these areas, that professional divers collected some interesting specimens of *Conus*, that drawn our attention due to the bright red color of the shell and soft parts. As it turned out this species proved to be unknown to science.

The systematics of the Conoidea had been changed in recent years based on inner morphology studies, mainly on the foregut anatomy. This structure possesses the complex and highly modified venom apparatus. Taylor, Kantor & Sysoev

(1993) brought new taxonomic concepts, phylogenetic analysis mainly based on shell, operculum and foregut characters and a standardization of anatomical terminology. A complete anatomical description is also included in present description. Not only as a contribution for recent methodology of classification but also as part of a larger project on morphological comparative study of the Caenogastropoda, in such the presented species is one of the conid representatives, developed by the junior author.

Material and Methods:

The anatomical study is based on dissection using standard techniques, of two males and one female. The specimens were fixed in 70% ethanol. Some parts such as foregut and pallial genital ducts were dehydrated in ethanol series, stained with carmine, cleared and fixed in creosote. All drawings were made using a camera lucida. Radulae and opercula were also examined in SEM in the "Laboratório de Microscopia Eletrônica do Instituto de Biociências da Universidade de São Paulo". Systematics and anatomical terminology follow Taylor et al. (1993) and, on other structures beyond foregut, Marcus & Marcus (1960).

In the figures, the following abbreviations are used: aa, anterior aorta; ac, anterior extremity of ctenidial vein; af, afferent gill vessel; ag, albumen gland; an, anus; ap, anal papilla; as, anterior sphincter of buccal tube; au, auricle; bc, bursa copulatrix; bm, buccal mass; br, bulged basal region of radular sac; bt, buccal tube; ca, capsule gland and bursa apertures; cg, capsule gland; ci, circular muscle fibers; cm, columellar muscle; cv, ctenidial vein; dd, duct to digestive gland; dg, digestive gland; dp, dilated distal end of penis duct; es, esophagus; ey, eye on ommatophore; ff, foot lateral furrow; fs, foot sole; gi, gill; hg, hypobranchial gland; ib, inner wall of buccal tube; ig, ingesting gland; in, intestine; kd, dorsal lobe of kidney; ki, kidney; km, membrane between kidney and pallial cavity; ks, ventral septate lobe of kidney attached to intestine; lf, longitudinal muscle fibers; mb, mantle border; mo, mouth; mp, mantle edge papillae; ne, nephrostome; ng, nephridial gland; nr, nerve ring; nv, nerve; ob, outer wall of buccal tube;

op, operculum; os, osphradium; ov, oviduct; pb, proboscis; pc, pericardium; pd, penis duct; pe, penis; pg, anterior furrow of pedal glands; ps, pallial spermiduct; re, rectum-anal septum; rm, retractor muscle of proboscis; ro, rhynchostome; rr, rostrum; rs, radular sac; rt, rectum; rw, rhynchodeal wall; si, siphon; sn, snout gland; sp, rhynchostomal sphincter; st, stomach; sv, seminal vesicle; te, cephalic tentacles; tg, tegument; tp, terminal pouch or pair of flaps anterior to pallial oviduct; tt, radular tooth; va, vaginal duct; vb, venom bulb; vd, visceral vas deferens; ve, ventricle; vg, venom gland.

Institutions abbreviations: AMNH: American Museum of Natural History; ANSP: Academy of Natural Sciences of Philadelphia; IBUFRJ: Instituto de Biologia da Universidade Federal do Rio de Janeiro; MNHN: Muséum National d'Histoire Naturelle; MNRJ: Museu Nacional da Universidade Federal do Rio de Janeiro; MORG: Museu Oceanográfico da Fundação Universidade de Rio Grande; MZSP: Museu de Zoologia da Universidade de São Paulo; USNM: National Museum of Natural History, Smithsonian Institution.

Systematics:

Conus bertarollae new species
(Figs 1-20)

Type Material: Holotype: MORG 39.007, (22.0 by 11.5 mm). **Paratypes:** MNRJ (23.9 by 12.5 mm); IBUFRJ 8.920 (24.9 by 13.5 mm); USNM (22.8 by 12.0 mm); ANSP (26.0 by 13.4 mm); MNHN (20.4 by 10.5 mm); AMNH (18.0 by 9.4 mm); IBUFRJ 8.919, 3 specimens (15.0 by 7.8 mm; 16.2 by 8.5 mm; 18.7 by 9.7 mm). MZSP 28.778; 3 specimens (22.2mm by 12.2mm; 21.7mm by 11.1mm; 22.5mm by 12.2mm) Coltro Collection; 1 specimen (27.8mm by 11.8mm) Cargile Collection. All from type locality.

Type Locality: Off Alcobaça, Bahia, Brazil

Description:

Shell (figs 1-5) small for genus (length up to 26 mm) with approximately 8 whorls. Color bright orange red with white blotches on spire and shoulder and a spiral band of irregular blotches at mid whorl. Exceptionally, this band may be reduced or missing in some specimens. Spire comprising 1/7 to 1/8 of total shell length, sculptured with thin spiral grooves. Suture deep, inserted just below shoulder, giving to spire a stepped aspect. Protoconch mamillated, white in color, with 0.5 mm in diameter. Teleoconch with a slightly convex profile, sculptured with very thin growth lines crossed by spiral lines (25 on body whorl of holotype) that become stronger anteriorly. Shoulder angular and smooth. Aperture narrow, slightly widening anteriorly. Outer lip smooth with a deep anal canal near suture. Inner lip smooth. Aperture orange-red near its edge turning into a lavender white towards the interior. Head-foot (figs 8, 9, 11, 12). Pigmented by clear pink-orange to

dark pink in exposed areas, inclusive penis; posterior regions cream. Head long, broad, somewhat peduncle like, attached to foot-columellar muscle axis by a broad base. Rostrum of about half of remainder head length, broad, ample distal aperture. Cephalic tentacles long, narrow, with a dark eye near distal region on small ommatophore sited ventrally; tentacle region basal to eye clearly broader than short apical region. Foot broad, somewhat triangular; sole plane; between sole and dorsal foot region a longitudinal, shallow furrow (figs 8, 9; ff); aperture of pedal glands a transversal, deep, broad furrow in anterior or foot margin (fig. 2). Males with penis in right-posterior side of head, described below. Female with a secondary flap near right limit of columellar muscle also described below. Operculum (fig. 6). Corneous, somewhat rectangular, sited in posterior-dorsal region of foot (fig. 8); small sized, occupying small portion of shell aperture.

Mantle organs (figs 10, 13). Mantle border and siphon pigmented with clear pink-orange to dark pink. Mantle border thick, bearing small, uniform, well-spaced papillae, which can occur from its entire width to only its left half. Siphon slightly short, stubby; borders smooth, thick. Osphradium bipectinate, elliptical; each filament scalloped; right filament in approximately equal number than left filaments; right filaments taller and angled; left filaments rounded. Gill long, somewhat narrow, anterior limit slight far from mantle edge, preceded by a short and curved portion of ctenidial vein; each gill filament triangular, turned to right. Between gill and rectum a broad space (about half of pallial cavity width). Hypobranchial gland thin, transparent, uniform surface, most concentrated close rectum. Rectum narrow, in right margin of pallial cavity. Anus situated posterior, about in middle level of pallial cavity; anterior to anus a short septum, distal region of this septum with a papilla. Between rectum and adjacent region of pallial floor run the genital ducts, described below.

Excretory and circulatory systems (fig. 14). Kidney of about 1/3 whorl, situated behind posterior-right limit of pallial cavity. A single and tall lobe attached to rectum strongly pigmented by pink, bearing several transversal not uniform somewhat sinuous folds; around this lobe a somewhat broad hollow space.

Nephridial gland narrow, white, situated in dorsal region of membrane between kidney and pericardium chambers. Nephrostome a transversal slit, in middle region of membrane between kidney and pallial cavity. Heart proportionally large, discretely smaller than kidney, situated just behind posterior-left limit of pallial cavity; auricle with thin transparent walls, ventricle very broad, thick walled; anterior aorta very broader than posterior aorta.

Digestive system (figs 11, 12, 14-17). Rhynchostome in distal aperture of rostrum, preceded by a well-developed sphincter (fig. 5: sp). Rhynchodeal wall with muscular tissue in its anterior half (fig. 12), outer longitudinal fibers (lf), inner circular fibers (ci); gradually muscular tissue faint posteriorly, rhynchodeal walls become a thin, semi-transparent membrane. Rhynchodeal walls outer surface connected with inner surface of tegument by a series of small muscular, short fibers, more concentrated

anteriorly. Snout gland well developed (figs 11, 12), in right-posterior region of rhynchodeal wall, bulging within haemocoel; cylindrical, with rounded distal end; inner surface strongly folded, with a white, glandular tissue. Rhynchodeal walls continue with proboscis base. Proboscis conic, slight small, narrow, with about half of rhynchodeal cavity length and width. Proboscis walls with outer layer of circular muscular fibers and inner layer of isolated longitudinal fibers (fig. 16: lf), some of them origin a strong pair of proboscis retractor muscle, inserted in inner lateral surface of haemocoel (fig. 11). Oral tube double walled (figs 16, 17); outer wall thin-transparent (ob), composed almost exclusively by longitudinal muscle fibers, some of them with connections with inner proboscis surface; inner wall (ib) also thin, semi transparent, with inner mucous epithelium. Anterior region of oral tube with a well-developed sphincter just posterior to mouth (fig. 17: as), gripping a tooth. Outer wall of oral tube posterior limit connected with adjacent regions of proboscis and buccal mass by several small muscle fibers (fig. 16). Inner wall of oral tube continuous with buccal mass. Buccal mass somewhat spherical, thick muscular walled (a broad sphincter); inner surface with several uniform low folds, all them beginning and finishing in about same level; two small orifices in right side, that anterior of radular sac, that posterior of venom gland (fig. 16). Radular sac long, curved, with a bulged region in its base (br); brings several radular teeth more concentrated in bulged part. Each radular tooth (fig. 7) cylindrical harpoon-like, measuring about 900 μm long, barbed irregular base, sharp and long tip; tip with a longitudinal, narrow aperture edged in a side by from nine to 12 small, uniform, sharp cusps; in opposite side than aperture a sub-terminal barb. Venom gland extremely long (fig. 12), more than total length of shell when straightened, high convolute, about 90% posterior to nerve ring (always with a loop attached to esophagus in opposed side than remainder gland; fig. 11); without differences in width along its length except a narrow region preceding venom bulb. Venom bulb large, long, somewhat cylindrical, elliptical outline. Salivary glands not found. Esophagus broad, thin walls; inner surface with some longitudinal, low, irregular folds (figs 12, 16). Posterior region of esophagus narrow. Stomach narrow, curved, simple; inner surface with longitudinal, low folds; single duct to digestive gland situated in its right-posterior region (fig. 14). Digestive gland anterior limit with kidney and with pericardium at right and pallial cavity at left (fig. 14), surrounds completely stomach. Intestine narrow, almost straight, runs right margin of anterior region of visceral mass, part through kidney, exits to pallial cavity as above described. Genital system. Male. Testis in peri-columellar region of visceral mass, sperm duct narrow, running on columella. Seminal vesicle situated about half whorl posterior to pallial cavity, strongly convolute (fig. 14), very thick, glandular walls. In ventral region of kidney crosses from left to right side and gradually narrows. Exits to pallial cavity as a broad tube running in right margin of pallial cavity floor (figs 10, 14); posterior region thick walled by prostate gland; anterior region thin walled, suddenly towards left until penis base (fig. 8). Penis somewhat short (fig. 8),

dorso-ventrally flattened; penis duct convolute; penis tip rounded, aperture in its middle region, preceded by a broader cavity of penis duct (fig. 19).

Female (figs 18, 20). Posterior regions similar to those of male. Oviduct narrow in ventral region of kidney, near right-posterior limit of pallial cavity floor inserts in left surface of pallial oviduct and continues as vaginal duct in its left surface. Albumen gland semi-spherical, white, attached to kidney, between both a small ingesting gland, broad, situated compressed in right-posterior region. Capsule gland long, about half of total pallial oviduct, cylindrical, thick walled, yellow, broad but compressed inner duct continuous with vaginal duct; anterior limit of capsule gland suddenly narrows. Bursa copulatrix slight large, broad, situated in dorsal surface of narrow anterior region of capsule gland. A pair of narrow muscular flaps (tp), connected longitudinally with mantle and dorsal surface of head, close right limit of pallial cavity, anterior to anus; capsule gland-vaginal duct and bursa copulatrix apertures open together between both flaps (ca), in its posterior region. Right flap narrower and shorter than left flap (fig. 20).

Discussion:

Conus bertarollae can be easily distinguishable for its characteristic bright orange-red color pattern. *Conus archetypus* also occurs in the Abrolhos archipelago, but it can be differentiated in its length/width proportion that is about 1.74, while in *C. bertarollae* this proportion is about 1.93, the spiral sculpture in *C. archetypus* is weaker and the coloration is paler even in orange specimens.

Conus ceruttii Cargile, 1997, from the Caribbean coast of Honduras and Nicaragua, has a variable color pattern (Cargile, 1997: 50, fig. 5), and the most common variation is extremely similar to the color pattern of *C. bertarollae*. Yet, *C. ceruttii* is larger (length about 40 mm, width about 20 mm) than *C. bertarollae* (length about 26 mm, width about 13 mm); in *C. ceruttii* the spiral sculpture is restricted to the anterior third of the shell, while in *C. bertarollae* the spire and the whole body whorl are spirally sculptured. The soft parts of *C. ceruttii* are cream colored while in *C. bertarollae* they are reddish orange.

The rostrum, i. e., an extensible tube anterior to rhynchocoel, which cannot be inverted into this, has been found in fish-feeding *Conus* and may be a character of a sub-group of the genus. The snout gland is other character exclusive of some species of *Conus*, Taylor et al. (1993: 129) reported 18 species with this structure, "all but one of which are known to be vermivorous". The remainder foregut characters are of typical conoidean feature, except by the absence of salivary gland. Some other anatomical characters are different from the other conoideans which had been studied by Marcus & Marcus (1960) and by the junior author (some turrids and terebrids). They are: 1) the papillae in the mantle border; 2) the septum anterior to anus (generally the anus of the conoideans have only a papilla); 3) the outstanding, almost peduncled head; 4)

the simple penis, without papilla in the tip; and 5) the pair of muscular flaps of the tegument in anterior region of the pallial oviduct, which may be analogous (or homologous?) to terminal pouch.

Etymology:

This shell is named after late Mrs. Berta Roll, for her help and collaboration finding shells all around the world on the company of her husband Dr. Artur Roll, making his collection one of the most important in Europe.

Acknowledgments:

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Legends

- Fig. 1 – *Conus bertarollae*, 22mm, Holotype, ventral view
 Fig. 2 – *Conus bertarollae*, 22mm, Holotype, dorsal view
 Fig. 3 – *Conus bertarollae*, 22mm, Holotype, spire view
 Fig. 4 – *Conus bertarollae*, 23.9mm, Paratype, ventral view
 Fig. 5 – *Conus bertarollae*, 23.9mm, Paratype, dorsal view
 Fig. 6 – *Conus bertarollae*, operculum
 Fig. 7 – *Conus bertarollae*, tooth radula
 Figs 8-10, *Conus bertarollae* anatomy: 8) head-foot of male, dorsal view, mantle and visceral mass extracted; 9) same, frontal view; 10) pallial cavity, inner-ventral view. Scales = 2 mm.
 Figs 11-14, *Conus bertarollae* anatomy: 11) head and haemocoel, ventral view, foot and columellar muscle extracted, venom bulb discretely deflected; 12) foregut and anterior-mid esophagus, rostrum, rhynchodeal wall and esophagus opened longitudinally with inner surface exposed, head tegument only part shown; 13) pallial cavity roof, transversal section in its middle region; 14) anterior region of visceral mass and posterior limit of pallial cavity, ventral view, kidney chamber and pericardium membrane opened longitudinally, posterior region of vas deferens and esophagus extracted. Scales = 1 mm.
 Figs 15-17, *Conus bertarollae* anatomy: 15) foregut, detail of its posterior region, ventral view, just in region of buccal mass, venom gland only partially shown; 16) proboscis and buccal mass, ventral view, both opened longitudinally, a rectangular hole in outer wall of buccal tube artificially done to show its inner wall, radular sac and venom gland only part shown; 17) proboscis, detail of its apical region, just in mouth, opened longitudinally with inner buccal surface exposed. Scales = 0.5 mm.
 Figs 18-20, *Conus bertarollae* anatomy: 18) pallial oviduct, lateral-right view, terminal pouch flaps (tp) sectioned from head, also a detail of a transversal section of capsule gland, adjacent structures not represented; 19) penis extracted from head, dorsal view; 20) pallial oviduct shown in fig. 11, ventral view. Scales = 1 mm.

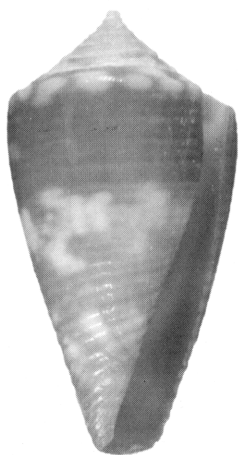


Fig. 1

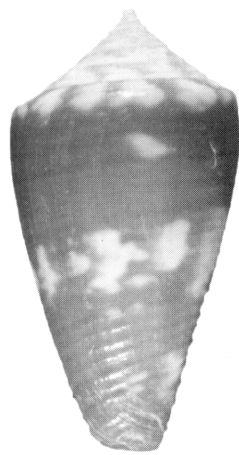


Fig. 2

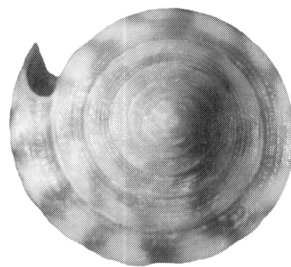


Fig. 3

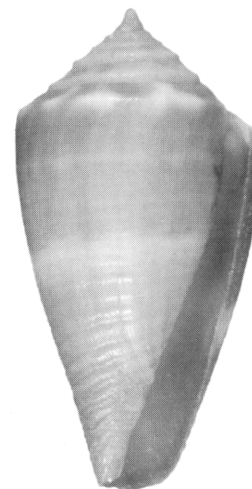


Fig. 4

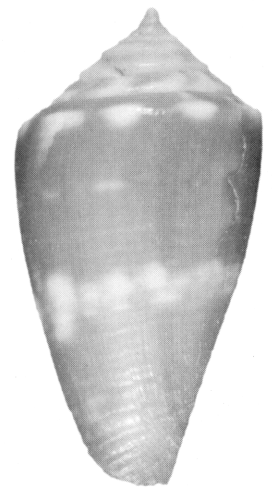


Fig. 5

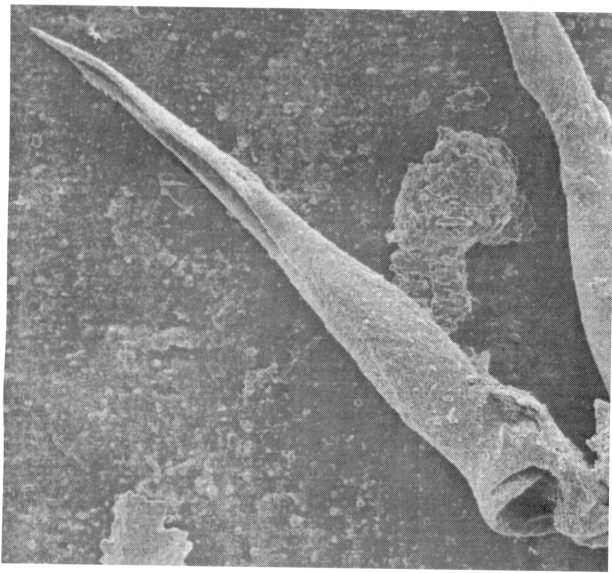


Fig. 7 – *Conus bertarollae*, tooth radula

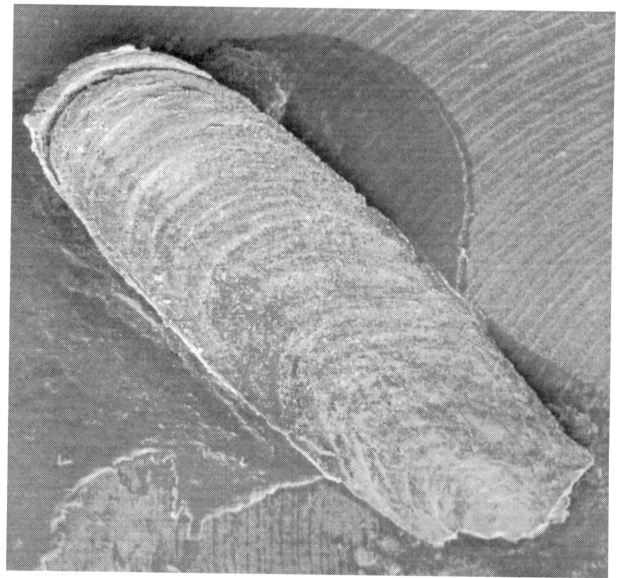


Fig. 6 – *Conus bertarollae*, operculum

Fig. 8

Fig. 9

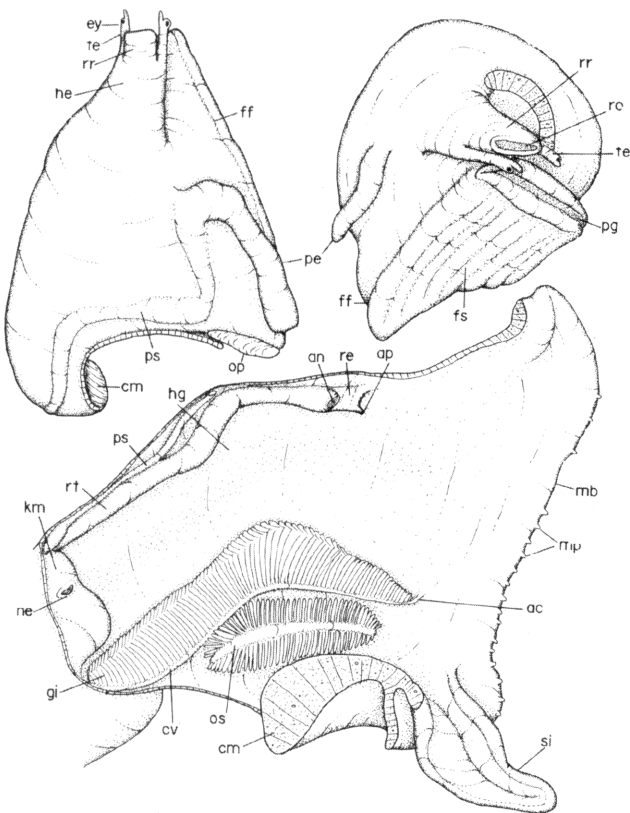


Fig. 10

Fig. 11

Fig. 12

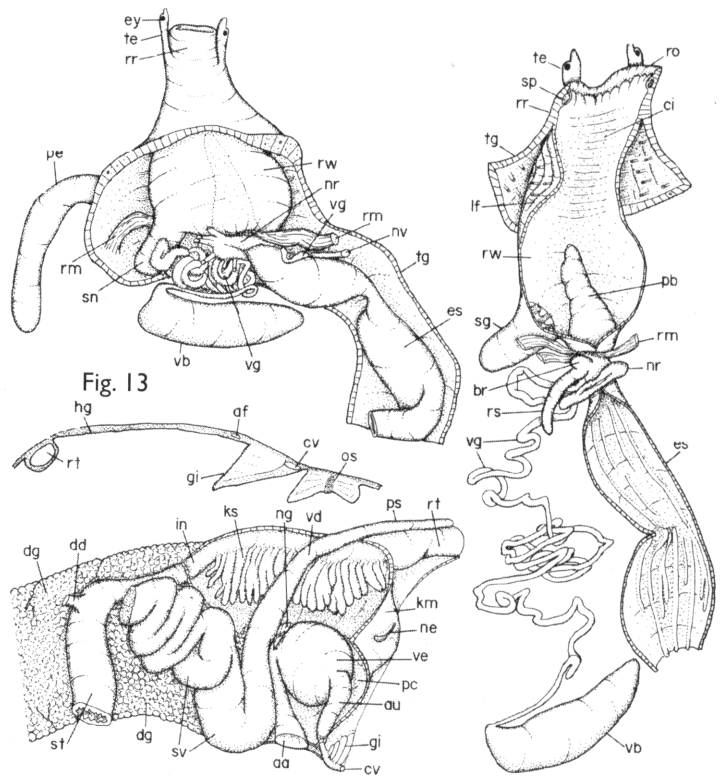


Fig. 13

Fig. 14

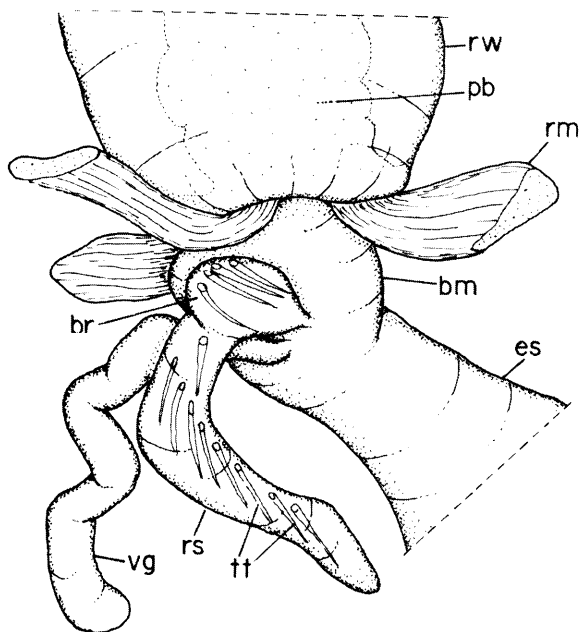


Fig. 15

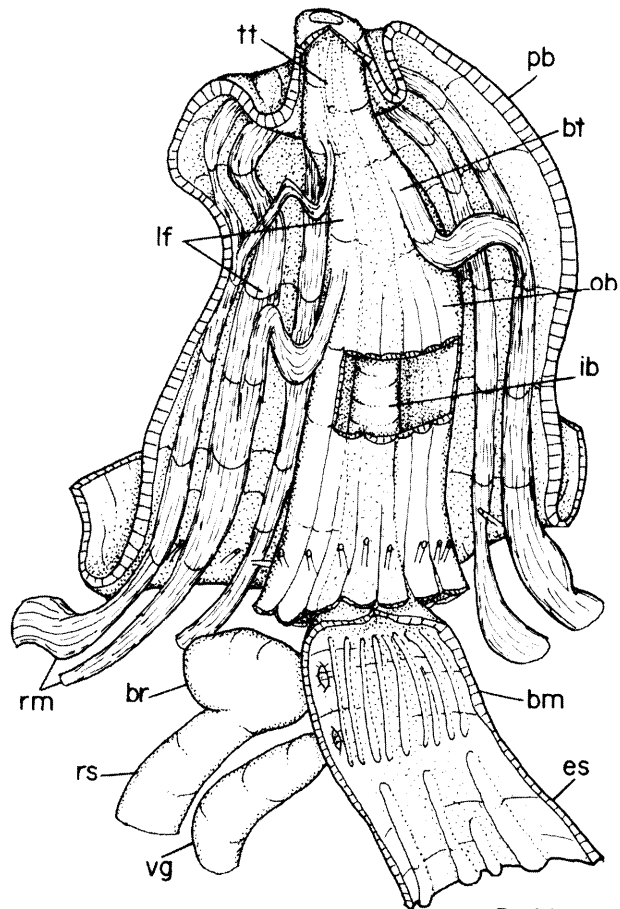


Fig. 16

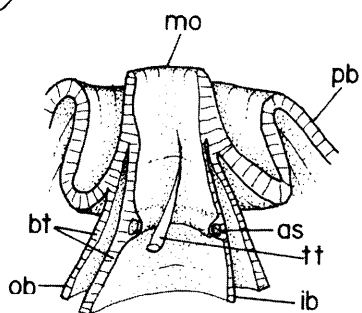


Fig. 17

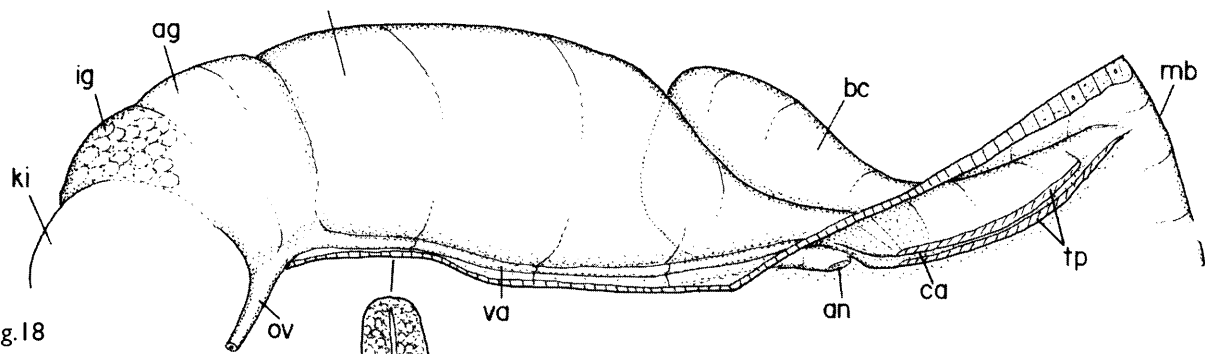


Fig. 18

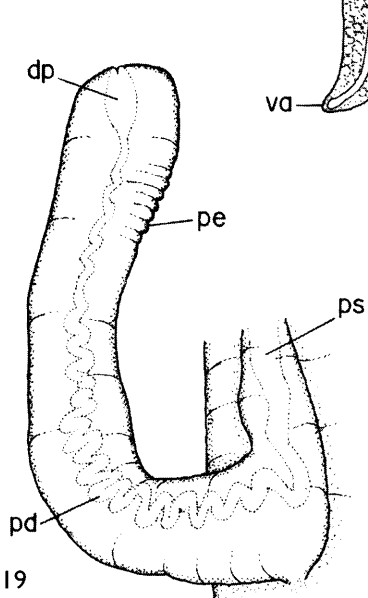


Fig. 19

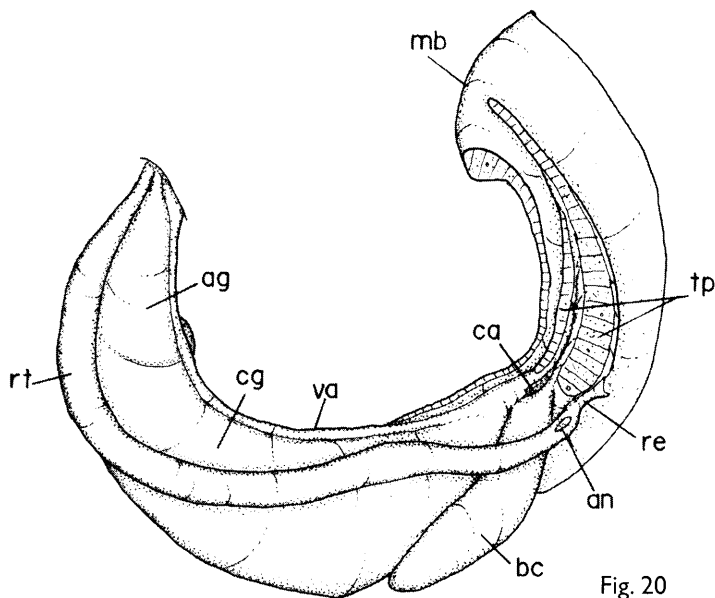
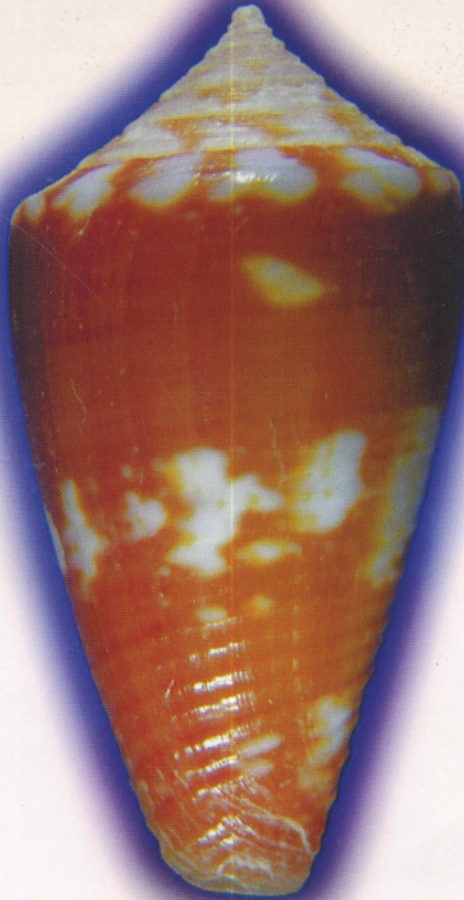


Fig. 20



Conus bertarollae