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PEDIPEDINAE (GASTROPODA: ELLOBIIDAE) FROM HONG KONG

António M. de Frias Martins

Departamento de Biologia, Universidade dos Açores, P-9502 Ponta Delgada,
São Miguel, Açores, Portugal

ABSTRACT

Two species of Pedipedinae are recorded for the first time from Hong Kong and are here provisionally referred to as *Pedipes jouani* Montrouzier, 1862 and *Microtralia alba* (Gassies, 1865), described from New Caledonia. A descriptive study of the reproductive and nervous systems was conducted and confirms previous studies that both genera are consubfamilial. The distribution and dispersal of the species is discussed.

INTRODUCTION

The Indo-Pacific Ellobiidae are particularly well represented by conspicuous, mangrove-dwelling, macroscopic species, relatively few of which have been studied anatomically. Koslowsky (1933) presented a detailed description of *Melampus boholensis* 'H. and A. Adams' Pfeiffer, 1856. Morton (1955) described the anatomy of *Pythia* Röding, 1798, *Ellobium* Röding, 1798 [*E. aurisjudae* (L. 1758)] and of the small pedipedinian *Marinula* King, 1832 [*M. filholi* Hutton, 1878]. Knipper and Meyer (1956) provided good illustrations of the nervous systems of *Ellobium* (*Auriculodes*) *gaziensis* (Preston, 1913), *Cassidula labrella* (Deshayes, 1830) and *Melampus semisulcatus* Mousson, 1869. *Cassidula* Férussac, 1821, *Ellobium* and *Pythia* were discussed by Berry *et al.* (1967) and Sumikawa and Miura (1978) studied in detail the reproductive system of *Ellobium chinense* (Pfeiffer, 1854).

Two species of Pedipedinae were collected from Hoi Ha, Sai Kung Peninsula, during the Fourth International Marine Biological Workshop on the Marine Fauna and Flora of Hong Kong and Southern China, 1989 and constitute first records for Hong Kong. In this paper the anatomy of these species are described, with emphasis on the reproductive and nervous systems.

MATERIALS AND METHODS

The specimens were killed by drowning overnight and then preserved in 70% alcohol.

The dissections were made under a WILD M8 dissecting microscope and the drawings outlined using a camera lucida. No histological preparations were made, but methylene blue was used during the dissection to help in the identification of structures, based specially on the differential coloration of the various glandular material in the presence of that dye.

SYSTEMATICS

Pedipedinae Fisher and Crosse, 1880

Pedipedinae Fisher and Crosse, 1880, 2:5.

Description. Shell generally thick and small, sometimes thin (*Microtralia*), with a large body whorl; aperture with 1–2 columellar teeth and 1–2 parietal teeth: outer lip smooth, with one strong tooth or with an internal, longitudinal, ribbed, callosity (*Pseudomelampus*). Inner whorls resorbed except in *Pedipes*.

Reproductive system characterized by an anterior mucous gland and a prostate gland extending only over the proximal half of the spermoviduct; bursa duct emptying just posterior to female opening.

Central nervous system exhibiting ganglionic concentration; cerebral ganglia well developed; right cerebro-pedal and cerebro-pleural connectives shorter than left ones; visceral nerve ring short, left parieto-visceral connective twice the length of the right one.

Remarks. The subfamily Pedipedinae comprises the world-wide distributed genera *Pedipes* Scopoli, 1777, *Marinula* King, 1832, *Leuconopsis* Hutton, 1884, *Microtralia* Dall, 1894 and the Mediterranean and eastern Atlantic *Pseudomelampus* Pallary, 1900. The eastern Pacific genus *Sarnia* H. and A. Adams, 1855 should be included in the Pedipedinae, on the basis of shell similarities with *Pseudomelampus*; however, anatomical studies are needed to justify this taxonomic decision. The genus *Laemodonta* Philippi, 1846, because of superficial shell similarities, has been erroneously assigned to this subfamily but rightly belongs in the Pythiinae, on the basis of the characteristics of the reproductive and nervous systems (Martins, in press).

The members of this subfamily are usually found under rocks associated with mangroves or marshy areas, living intertidally or supratidally (Hutton 1884; Morton 1955; Martins, personal observations).

Genus *Pedipes* Scopoli 1777

Pedipes Scopoli, 1777: 392. Type species by subsequent designation of Gray (1847), *Pedipes afra* (Gmelin, 1790) [= *Pedipes pedipes* (Bruguière, 1789)].

Description. Shell up to 6 mm long, globose, solid, white to dark-brown. Spire low,

with up to 5 rapidly expanded convex whorls, usually strongly sculptured spirally. Aperture ovate, widely rounded at base, acute posteriorly; anterior columella flattened and depressed with two strong teeth; parietal tooth strongest, oblique; outer lip sharp, smooth or with tubercle inside. Inner whorls not resorbed.

Animal greyish; tentacles long, pointed; foot equally divided by conspicuous transverse furrow. Visceral mass coiled; ovotestis acinose, embedded in posterior lobe of digestive gland; hermaphroditic duct short, turning into a dilated, straight seminal vesicle; penis unevenly thickened, constricted in the middle. Cerebral commissure long; connectives of visceral ring very short.

Remarks. The similarity of the apertural aspect of *Pedipes* and *Marinula* makes it difficult, on the basis of description alone, to assign the correct generic name to the known nominal species of *Pedipes*. Less than a dozen species of *Pedipes* are known from around the world and this number may decrease eventually when more comparative studies become available. The following species have been described from the Indo-Pacific region: *P. granum* (Morelet, 1872) from Abyssinia; *P. deschampsi* Ancey, 1887 and *P. leoniae* Ancey, 1887 from Aden; *P. jouani* Montrouzier, 1862 from New Caledonia; *P. sandwicensis* Pease, 1680 from Hawaii.

Species of this genus live in mangroves near the sea as well as on open shores, under rocks just above high-tide (Martins 1980; in press).

Pedipes jouani Montrouzier, 1862
(Plate 1A–C; Figs. 1–3)

Pedipes jouani Montrouzier, 1862: 244, pl. 9, fig. 11. [(Île Art) Baie boisée, New Caledonia; syntypes Musée National d'Histoire Naturelle, Paris (ex Musée Bordeaux), (Figs. 1, 2)].

Material. Ninety-five specimens were collected at Flynn Point, Hoi Ha, Sai Kung Peninsula, Hong Kong, 17 April 1989.

Description. Shell (Plate 1A–C; Fig. 1; Table 1): length up to 5.6 mm, oval-conical, solid, yellowish to light-brown with a purplish hue; spire moderately high, whorls up to 4.6, convex, sculptured with 8 spiral cords crossed by longitudinal striae, which gives it a beaded appearance. Body whorl averaging 82% of shell length, with 23 incised spiral grooves; near the outer lip there is a small cord in the groove separating two main cords. Aperture about 70% of length of body whorl, widely ovate, rounded at base; two strong columellar teeth, the posterior one stronger, slightly oblique; parietal tooth strongest, oblique, triangular in appearance; outer lip thickened inside, with a conspicuous, slightly oblique, rounded tubercle in front of posterior columellar tooth, sometimes a small prominence anteriorly, in front of anterior columellar tooth; border of inner lip sharp, crenulated due to the conspicuous grooves/cords that sculpture the shell. First 1.5 whorls of teleoconch raised, bulbous, letting show underneath a portion of the protoconch (Fig. 1A), finely striated transversely, changing then more or less abruptly to the beaded appearance described above. Protoconch surrounded by first whorl of teleoconch, with smooth lip visible from above (Fig. 1B)

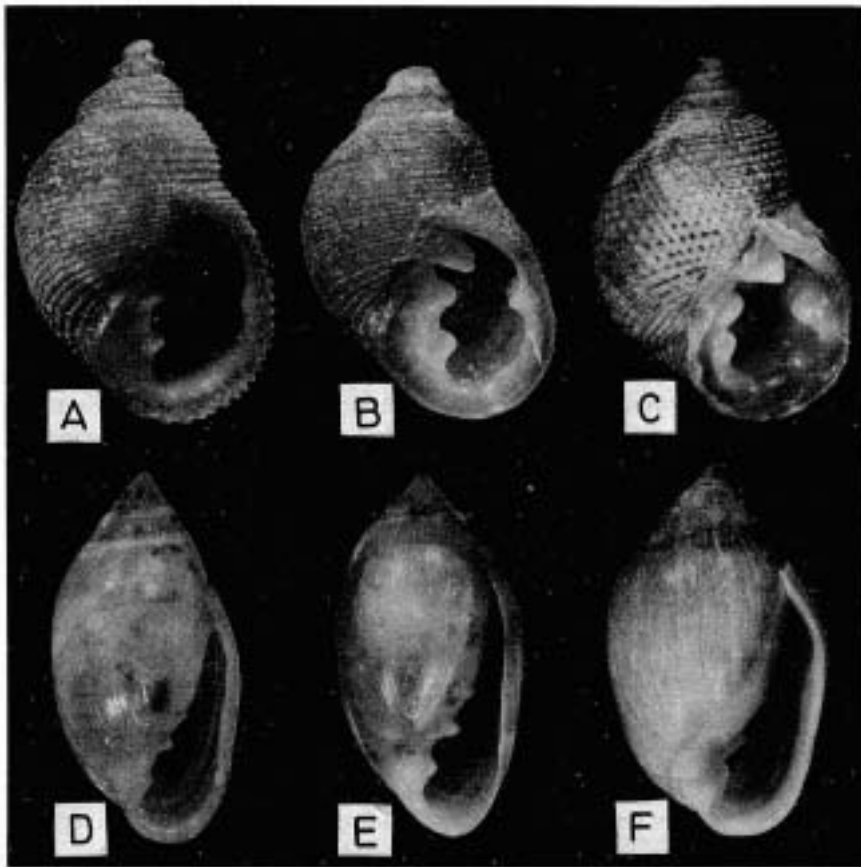


Plate 1. Shells of *Pedipes jouani* and *Microtralia alba*. A–C, *Pedipes jouani*; A, B syntypes, Muséum National d'Histoire Naturelle, Paris, shell length: 5.6 and 4.6 mm; C, Hoi Ha (specimen 2 in Table 1). D–F, *Microtralia alba*; D, syntype, Muséum National d'Histoire Naturelle, Paris, shell length: 6.3 mm; E, syntype, British Museum (Natural History) 1883.11.10.104, shell length: 4.8 mm; F, Hoi Ha, (specimen 2 in Table 2).

Animal: whitish with a light yellow hue, translucent; tentacles long, conical, black at tip, gradually becoming lighter toward base and forming an ashy, translucent band, where visible black eyes are located; dorsum of neck light grey, darker near the head and at the posterior end; a dark-brown fine line running from the female genital opening, near the pneumostome, to the male genital opening, below the right tentacle, marks the position of the closed sperm groove; foot whitish, transversely divided; mantle border whitish, translucent, letting show the purplish colour of the inner side of the outer lip.

Reproductive system (Fig. 2): ovotestis acinose, yellow, embedded in spiral posterior lobe of digestive gland; hermaphroditic duct short, gradually changing into a straight, dilated seminal vesicle tapering toward extremities; albumen gland broadly triangular; posterior mucous gland tightly convoluted; anterior mucous gland and prostate gland covering proximal two-thirds of spermoviduct, which is large and relatively thin; bursa

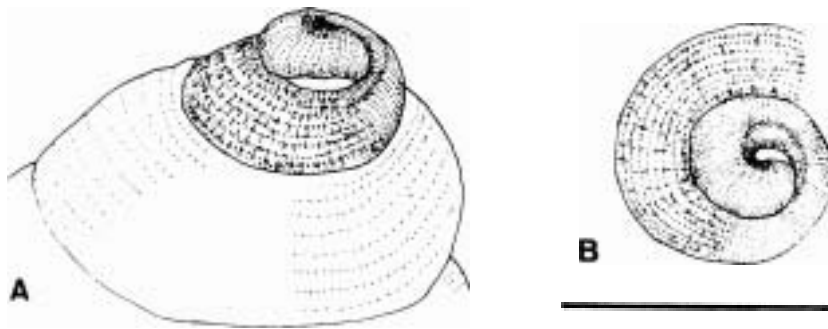


Fig. 1. Protoconch and early whorls of the teleoconch of *Pedipes jouani*. A, side view; B, top view. Scale bar = 0.5 mm.

Table 1

Measurements of some of the largest specimens of *Pedipes jouani* collected from Hoi Ha, Sai Kung Peninsula, Hong Kong. H, height of the shell; HA, height of the aperture; HBW, height of the body whorl; N, number of specimen; W, width of shell; #w, number of whorls. Measurements in mm.

N	H	W	HBW	HA	HBW/H	HA/HBW	#w
1	5.2	3.9	4.1	2.9	0.79	0.71	4.6
2	5.1	3.6	4.2	2.9	0.82	0.69	4.5
3	5.1	3.6	4.1	3.0	0.80	0.73	4.6
4	5.0	3.6	4.1	2.6	0.82	0.63	4.5
5	4.8	3.5	3.9	2.7	0.81	0.69	4.5
6	4.6	3.5	3.8	2.6	0.83	0.68	4.5
7	4.5	3.4	3.6	2.6	0.80	0.72	4.2
8	4.1	3.1	3.5	2.5	0.85	0.71	4.0

spherical; bursa duct larger and as long as spermoviduct, emptying near the separation of the vas deferens from spermoviduct. Penis comprises a distal narrow duct gradually enlarging posteriorly, and two equally bulging proximal portions, separated by a tight constriction; anterior vas deferens about one-third of penis length, causing the latter to assume a permanent bent position. Penial retractor muscle shorter than anterior vas deferens.

Nervous system (Fig. 3): cerebral ganglia largest; cerebral commissure long; left cerebro-pleural and cerebro-pedal connectives as long as cerebral commissure, twice the length of their right counterparts; visceral nerve ring short, the left pleuro-parietal connective about three times the length of the right, causing the left parietal ganglion and the visceral ganglia to be displaced to the right.

Remarks. *Pedipes jouani* was described by Montrouzier (1862) on the basis of the shells of one large adult and three smaller individuals and is here, provisionally, for the first time reported outside the type locality (cf. Franc 1954). The individuals collected at Hoi Ha, Hong Kong (Plate 1C), differ somewhat from the type material present at the MNHNP (Plate 1A, B), but look similar to Montrouzier's (1862, pl. IX, fig. 11) illustration. Compared with the Hong Kong material, the New Caledonian specimens show

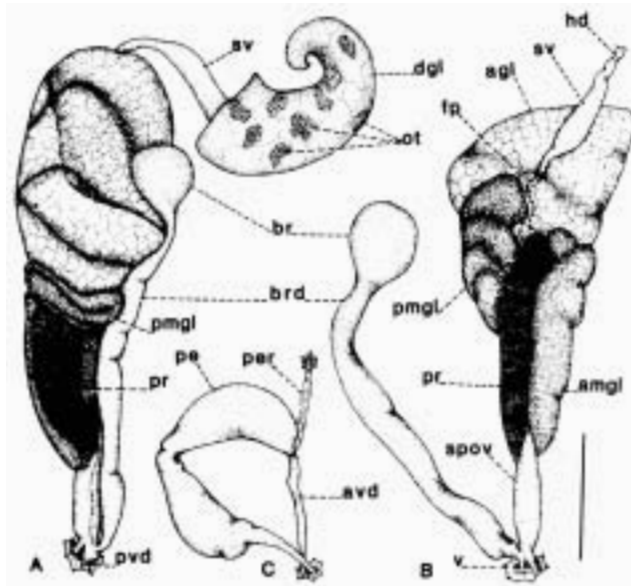


Fig. 2. Reproductive system of *Pedipes jouani*. *agl*, albumen gland; *amgl*, anterior mucous gland; *avd*, anterior vas deferens; *br*, bursa; *brd*, bursa duct; *dgl*, digestive gland; *fp*, fertilization pouch; *hd*, hermaphroditic duct; *ot*, ovotestis; *pe*, penis; *per*, penial retractor muscle; *pmgl*, posterior mucous gland; *pr*, prostate gland; *pvd*, posterior vas deferens; *spov*, spermooviduct; *sv*, seminal vesicle; *v*, vagina. Scale bar = 1 mm.

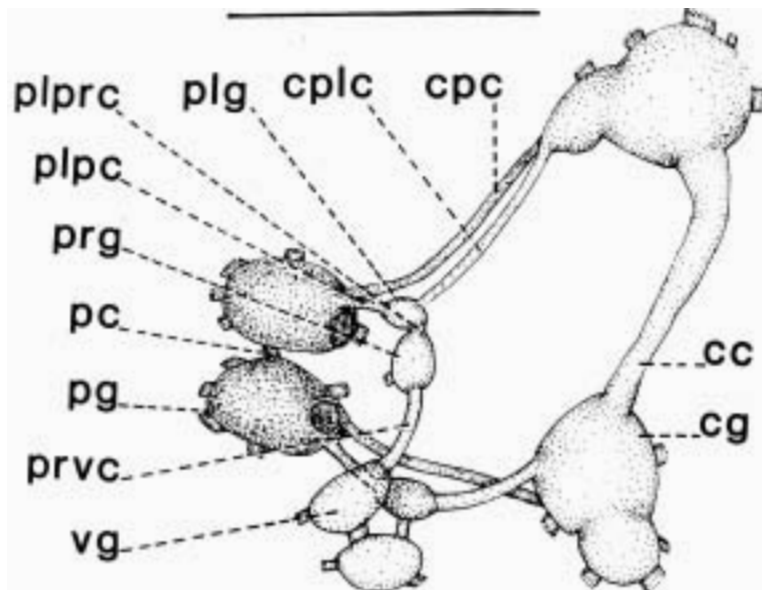


Fig. 3. Central nervous system of *Pedipes jouani*. *cc*, cerebral commissure; *cg*, cerebral ganglia; *cpc*, cerebro-pedal connective; *cplc*, cerebro-pleural connective; *pg*, pedal ganglia; *plg*, pleural ganglia; *plpc*, pleuro-pedal connective; *plprc*, pleuro-parietal connective; *prg*, parietal ganglia; *prvc*, parieto-visceral connective; *vg*, visceral ganglia. Scale bar = 0.5 mm.

a visible keel on the shoulder of the whorls, more visible on the early ones, the beaded appearance is less evident on the body whorl and the columellar teeth are separated further apart. However, the raised, bulbous and finely longitudinally striated first 1 1/2 whorls of the teleoconch, exposing a portion of the smooth protoconch underneath, lead me to conclude that the Hong Kong and New Caledonian specimens are conspecific. A similar situation of shell variability and consistent protoconch appearance was observed in the West Indian *Pedipes mirabilis* (Mühlfeld, 1816) and *Pedipes ovalis* C. B. Adams, 1849, leading to the synonymization of the various nominal species assigned to both of these two (Martins, in press). On the basis of shell characters and pending an analysis of the anatomy of specimens of *P. jouani* from the type locality, the Hong Kong material is, thus, referred to the New Caledonian species.

A comparison of *P. jouani* with other Indo-Pacific species is based mostly on the original descriptions, for only the Hawaiian species material was available. *Pedipes jouani* is distinguishable from *P. granum* and *P. deschampsii*, two closely related species, by the fine decussate appearance of the former and the thinness and fine striation of the latter. It differs from *P. leoniae* and *P. sandwicensis* by the short spires of these species.

The peculiar shape of the protoconch and first whorls of the teleoconch (Fig. 1A, B) clearly separate *P. jouani* from the Atlantic species of *Pedipes* (Martins, in press). The sculpture of the early teleoconch suggests a second larval shell. Nothing is known, however, of the early development of the genus (see Clench 1964). Up to this moment only the Melampinae are considered as having a truly planktonic larva (Morrison 1959; Apley 1970) and Ewald (1963) observed a crawling and, for very short time, occasionally swimming larva of *Ellobium pellucens* (Menke, 1828) [= *E. dominicense* (Férussac 1821)]. Thus, an interpretation of the peculiar sculpture of the early teleoconch of *P. jouani* should await data on the life history of the species.

Habitat notes. *Pedipes jouani* was collected from the high intertidal, among boulders, particularly within crevices where silt had collected or under partially buried rocks, together with *Laemodonta minuta* (Moellendorff, 1885) and *Laemodonta typica* (H. and A. Adams 1854) (Martins and Tristão da Cunha 1992).

Genus *Microtralia* Dall, 1894

Microtralia Dall, 1894, 25:117. Type species by monotypy, *Auricula?* (*Microtralia*) *minuscula* (Dall, 1889) [= *Leuconia occidentalis* Pfeiffer, 1854].

Rangitotoa Powell, 1933, 63:148. Type species by monotypy, *Rangitotoa insularis* Powell, 1933.

Description. Shell: length 5.3 mm, subcylindrical, fragile, translucent-white; spire low, with up to 8.3 whorls; body whorl 80% of shell length; aperture narrow, one small, oblique columellar tooth, two small parietal teeth, the anteriormost largest; outer lip thin, sharp.

Animal whitish to rusty-brown, translucent; foot not divided transversely; eyes absent or concealed under thick skin. Tentacles compressed at tip. Hermaphroditic duct loosely convoluted, pouch-like in the middle; anterior mucous gland and prostate gland covering up half of spermooviduct. Visceral nerve ring short; connectives of left side longer than those of the right.

Remarks. *Microtralia* has been assigned to most subfamilies of the halophilic ellobiids. Dall (1894) tentatively placed it in the Ellobiinae; Thiele (1931), Powell (1933) [as *Rangitotoa*], and Zilch (1959) treated it as a member of the Melampinae; Abbott (1974), followed by Climo (1984) who synonymized *Rangitotoa* with *Microtralia*, considered it a genus of the Cassidulinae; Morton (1955), on the basis of anatomy and habitat preferences, placed *Rangitotoa* within the Pedipedinae. The study of the reproductive and nervous systems of the West Indian *Microtralia occidentalis* (Pfeiffer, 1854) (Martins, in press) and of *Microtralia alba* (Gassies, 1865) in this paper justifies the placement of this genus within the Pedipedinae.

The genus *Microtralia* is represented in the West Indies by one species, *M. occidentalis*. Several species have been described from the Indo-Pacific: *M. ambigua* Turton, 1932 from Port Alfred, South Africa, described from two juveniles; *M. hyalina* (Morelet, 1883) from Mayotte Island, Comores; *M. alba* (Gassies, 1865) from New Caledonia; *M. acteocinoides* Habe, 1961 from Japan; *M. insularis* Powell, 1933 from Rangitoto Island, New Zealand; *M. lucida* (Pease 1869) from Hawaii; *Microtralia* sp. Rehder, 1980 from the Easter Islands.

Species of *Microtralia* live near the high-tide mark, under rocks partially buried in mud (Powell, 1933) or soil, and in mangroves, buried in the soil or under rotting branches (Martins, in press).

Microtralia alba (Gassies, 1865)
(Plate 1D–F; Figs. 4 and 5)

Melampus albus Gassies, 1865: 211 [(Noumea), New Caledonia; syntypes at Musée National d'Histoire Naturelle, Paris (Fig. 4) and British Museum (Natural History), London, 1883.11:10.104–8 (Fig. 5).

Material. Eighty-eight specimens were collected at Flynn Point, Hoi Ha, Sai Kung Peninsula, Hong Kong, 17 April 1989.

Description. Shell (Plate 1D–F; Table 2): length up to 5.3 mm, subcylindrical, fragile, translucent, white; spire low to moderately high; whorls up to 8.3, shiny, slightly convex, apparently smooth, but covered with fine spiral striae; body whorl about 80% of shell length, shiny, covered with fine spiral striae crossed by delicate growth lines. Aperture 87% of body whorl, narrow, with dentition only on anterior half; inner lip with a weak, oblique, columellar tooth and two parietal teeth, perpendicular to the columellar axis, the anterior strongest of the three, the posterior weak, located midway along the length of the aperture; outer lip parallel to body whorl, sharp, thickened inside at midlength, forming a sinus posteriorly.

Animal whitish, translucent; tentacles short, flattened and expanded at tip. Eyes barely apparent under thick skin. Mantle border whitish. Foot entire, white.

Reproductive system (Fig. 4): ovotestis compact, conical, located at posterior tip of visceral mass, covering stomach; hermaphroditic duct loosely convoluted; seminal vesicle pouch-like, continuous with fertilization pouch, which curves posteriorly after entering the roughly quadrangular albumen gland; posterior mucous gland tightly convoluted, large; anterior mucous gland and prostate gland covering only the proximal

Table 2

Measurements of some of the largest specimens of *Microtralia alba* collected from Hoi Ha, Sai Kung Peninsula, Hong Kong. H, height of the shell; HA, height of the aperture; HBW, height of the body whorl; N, number of specimen; W, width of shell; #w, number of whorls. Measurements in mm.

N	H	W	HBW	HA	HBW/H	HA/HBW	#w
1	5.3	3.1	4.4	3.6	0.83	0.82	8.3
2	5.1	3.0	4.0	3.5	0.78	0.88	8.0
3	5.0	3.1	4.1	3.5	0.82	0.85	8.1
4	4.9	2.9	4.1	3.5	0.84	0.85	8.3
5	4.8	2.9	3.8	3.3	0.82	0.85	8.0
6	4.3	2.6	3.5	3.3	0.81	0.94	7.6
7	4.2	2.6	3.5	3.0	0.83	0.86	8.0

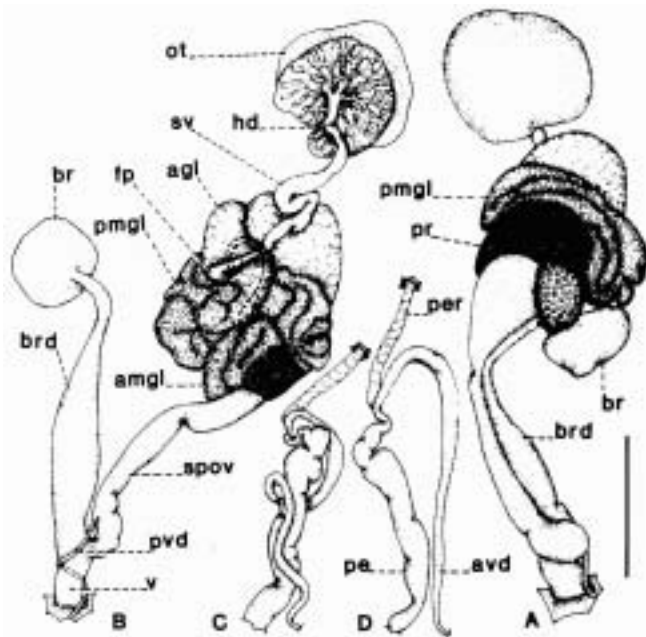


Fig. 4. Reproductive system of *Microtralia alba*. *agl*, albumen gland; *amgl*, anterior mucous gland; *avd*, anterior vas deferens; *br*, bursa; *brd*, bursa duct; *hd*, hermaphroditic duct; *ot*, ovotestis; *pe*, penis; *per*, penial retractor muscle; *pmgl*, posterior mucous gland; *pr*, prostate gland; *pvd*, posterior vas deferens; *spov*, spermoviduct; *sv*, seminal vesicle; *v*, vagina. Scale bar = 1 mm.

fifth of the spermoviduct; proximal third of spermoviduct wide, gradually narrowing anteriorly, ending in a constriction; remaining two-thirds evenly dilated, as wide as anterior end before constriction; bursa round; bursa duct as long as spermoviduct, the anterior third expanded more than twice the width of the anterior spermoviduct, gradually narrowing before entering the bursa; posterior vas deferens exiting spermoviduct before confluence of the latter with bursa duct. Penis two-thirds of spermoviduct, un-

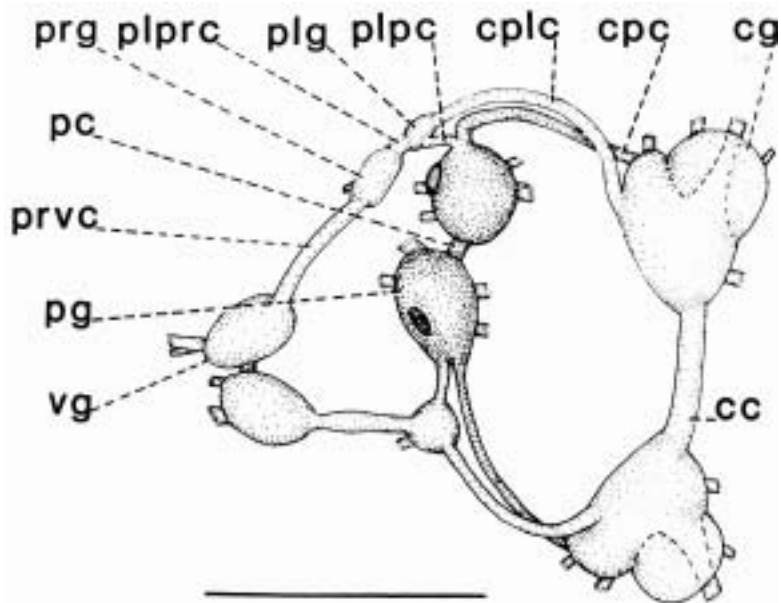


Fig. 5. Central nervous system of *Microtralia alba*. cc, cerebral commissure; cg, cerebral ganglia; cpc, cerebro-pedal connective; cplc, cerebro-pleural connective; pg, pedal ganglia; plg, pleural ganglia; plpc, pleuro-pedal connective; plprc, pleuro-parietal connective; prg, parietal ganglia; prvc, parieto-visceral connective; vg, visceral ganglia. Scale bar = 0.5 mm.

evenly thickened by bulging pouches, narrowing posteriorly to merge with posterior vas deferens; penial retractor attaching to posterior vas deferens near entrance to penis.

Nervous system (Fig. 5): cerebral ganglia largest; cerebral commissure as long as width of cerebral ganglia; left cerebro-pleural and cerebro-pedal connectives slightly longer than right ones; visceral nerve ring short, left parieto-visceral connective longest.

Remarks. *Microtralia alba* exhibits some variability in shell morphology (Table 2; Plate 1D and E of type series) and thickness, mostly apparent on gerontic specimens (Plate 1F), which makes it difficult to compare it, on shell characters alone, with other Indo-Pacific species. Some thinner specimens could well be confused with the West Indian *M. occidentalis*; this fact led Climo (1982) to synonymize the New Zealand *M. insularis* with the West Indian species. However, the anatomy of *M. alba* shows remarkable differences from *M. occidentalis*, mostly in the presence of eyes, shape of the seminal vesicle, width of the bursa duct and elaboration of the penis. On these grounds, a comparison of *M. alba* with other Indo-Pacific species should wait anatomical data on these species.

Habitat notes. *Microtralia alba* was found from a nearly terrestrial environment, just at the upper limit of the boulders where salt water seldom reaches, down to high-tide level. It lives underneath rocks partially buried in soil and in crevices where silt collects, along with *Truncatella* sp., *Hydrobia* sp. and *Pedipes jouani*.

DISCUSSION

Usually ellobiid snails are looked for in mangrove or marshy areas, where most species live. However, the sparse records of the small species of pedipedinian ellobiids and the high number of specimens of both species herein studied collected at one single site are a clear indication of the habitat specificity of the group. Rocky shores, either boulders or cobble beaches, are the preferred environment for some small ellobiid species (Morton 1955; Martins 1980; in press; Martins and Tristão da Cunha 1992). The present record of the New Caledonian *Pedipes jouani* on the shores of Central Asia could well be attributed to such specificity, rather than to a recent introduction.

Microtralia has been collected here and there over the entire Indo-Pacific and its distribution has been linked to human activity. Climo (1982), who considered *M. insularis* to be a junior synonym of the West Indian *M. occidentalis*, explained that nineteenth century shipping and deck cargo, frequently taken from and deposited on supratidal marshy areas, could have been responsible for the dispersal of that species and of the European *Myosotella myosotis* (Draparnaud, 1801). The introduction of *Myosotella myosotis* into eastern North America has been documented (Stimpson 1851; Binney 1859; 1865; Verrill 1880; Dall 1885), and Hanna (1939) and Paulson (1957) also stated that this species has been introduced into California. Although I have accepted accidental transportation by ships as a possible interpretation of the present distribution of *Myosotella myosotis*, a typically Mediterranean species (Martins, in press), I find it questionable when dealing with *Microtralia*. In fact, although the high variability in shell morphology in *Myosotella* precludes a sure specific distinction, no anatomical differences have been found that would justify specific distinction. With *Microtralia*, however, as shown in this work, there are clear anatomical differences to justify specific separation of *Microtralia alba* from *M. occidentalis*, thus questioning Climo's (1982) interpretation of the distribution of this genus.

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