

mit Herzlichen Grüßen
Jhr. Dr. Schärer

**Sandy Beach Meiofauna of Eastern Australia
(Southern Queensland and New South Wales). I.
Introduction and Macrostomida (Platyhelminthes)**

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Abstract

This is the first of a series describing new turbellarian and nematode species collected during March and April 1992, on eulittoral sandy shores of Southern Queensland and northern New South Wales, Australia. The environment and all sampling sites are described. Four new species of Macrostomida (*Dunwichia arenosa*, gen. et sp. nov., *Bradburia australiensis*, gen. et sp. nov., *Macrostomum australiense*, sp. nov., and *Macrostomum* sp. based only on female sexual maturity) were found in eulittoral habitats of sandy beaches, flats and brackish-water creeks.

Introduction

The marine free-living turbellarian and nematode fauna of Australian beaches is not well known. Early studies were performed by Haswell (1905) on Acoela, and Weiss (1909) on Rhabdoacoela; and the Polycladida received attention from Haswell (1907). The polyclads have been studied also by Hyman (1959) and Prudhoe (1977, 1982a, 1982b). More recently, there have been taxonomic reports of marine triclads by Sluys and Ball (1989) and Sluys (1989), and marine microturbellarians by Winsor (1988, 1990) on Acoela, and Martens and Curini-Galletti (1989) on Proseriata. Only two species are known from Australia and these are both freshwater species: *Macrostomum tuba* v. Graff, 1882, and *Promacrostomum palum* Sluys, 1986. Though very few species are named, the Australian fauna is known to be rich: Dittmann (1991) reported 108 unnamed species in 12 major taxa from the north Queensland intertidal coast.

A first 'census' of free-living marine nematodes of Australia by Johnston (1938) listed 49 species in 33 genera from 20 families. The most recent checklist was produced by Greenslade (1989) who recognised 263 species in 119 genera and 38 families, certainly only a small part of the entire Australian nematode fauna. The checklist of Greenslade (1989) included the recent literature up to 1987. Since that time a number of papers have focussed on nematode ecology, e.g. from north-eastern coasts (mangroves) and the Great Barrier Reef region in the work of Alongi (1987a, 1987b, 1990), Alongi and Christoffersen (1992), Tietjen (1991) and Tietjen and Alongi (1990), and from south-eastern Australia (estuarine, mangroves) in the work of Hodda (1990) and Nicholas *et al.* (1991, 1992). Taxonomic or morphological aspects were dealt with in the publications of Nicholas *et al.* (1988), Nicholas and Stewart (1990) and especially Greenslade and Nicholas (1991), but these specimens were also largely from mangrove or estuarine habitats.

The nematode fauna of Australian sandy (ocean) beaches has been little studied up to now and, according to Gerlach (1980), it would be expected that 'a fairly large percentage of undescribed species' will be encountered in this poorly sampled region of the world.

Investigations on eulittoral associations of Platyhelminthes and Nematoda distributed in sandy beaches and flats of southern Queensland and New South Wales were conducted from March to April 1992, at the field station of the University of Queensland on Stradbroke Island and the Marine Zoological Station of the New England University of Armidale on Arrawarra Headland.

In the present paper we describe the physical environment, the sampling sites, and four new species of Macrostomida. The only macrostomids previously known from Australia are from fresh water (Sluys 1986; Rohde and Watson 1991).

Materials and Methods

For studies on turbellarians, qualitative sediment samples of about 250 cm³ were collected and subsamples of about 10 cm³ taken for decantation of the infauna (Pfannkuche and Thiel 1988). Sexually mature specimens were studied alive and in squash preparations, i.e. flattened under the increasing pressure of the coverslip as the preparation dries. For histological observation, specimens were relaxed in 7% MgCl₂ and fixed in Bouin's fixative (15 mL saturated aqueous picric acid, in tap water), 5mL 36% formaldehyde solution, 1 mL glacial acetic acid). Specimens longer than 1.0 mm were embedded in Paraplast plus (Reichert and Junk), and smaller ones in Technovit 7100 (Haereus-Kulzer, Germany). Before embedding, worms were stained with eosin in 100% alcohol for greater ease in orientation and sectioning. Specimens were cut sagittally and transversely at 2.0–2.5 µm and stained with haematoxylin-eosin according to Gill (Gerrits 1990).

For studies on the nematode and meiofauna community, two replicate samples from each sampling site were taken by pushing a cylindrical perspex corer (2.4 cm internal diameter and 5.0 cm long) into the sand. One of the replicates was used for immediate qualitative collecting of nematodes and live examination of specimens. The other was fixed with 4% formaldehyde (in tap water) immediately on retrieval (bulk fixation, see Riemann 1988) for later quantitative analysis of nematodes and meiofauna. Extraction of nematodes and meiofauna followed the McIntyre method (modified Boisseau method; see Uhlig *et al.* 1973); nematodes were mounted in anhydrous glycerine after dehydration (Blome 1983).

Types are deposited in the Queensland Museum; whole mounts are designated WM, sagittal sections SS and transverse sections TS.

Determination of the abiotic factors, salinity (S), organic matter (OM), and grain size (median =Md), was performed according to Giere *et al.* (1988). The salinity values were measured by refractometric determination (American Optical Corp., Keene, NH, USA) in upper sediment layers during low tide.

Abbreviations in the Figures

ad	adhesive glands	ov	ovary
af	atrium femininum	pg	pharyngeal glands
b	brain	rd	rhabdites
bs	bursa seminalis	rm	rhammites
c	cilia	s	sperm
cg	cement glands	st	stylet
ci	cirrus	t	testes
e	eyes	tr	transverse muscle layer
eg	extravesicular prostatic glands	v	vagina
g	eosinophilous glands	vd	vas deferens
i	intestine	vg	vesicula granulorum
l	longitudinal muscle layer	vs	vesicula seminalis
m	mouth	♂	male gonopore
n	nucleus	♀	female gonopore
o	oocyte		

The Physical Environment

The central east coast of Australia, approximately the border between Queensland and New South Wales, marks the boundary between two biogeographic zones, the North Tropical and the Southern Temperate (Wilson and Allen 1987). The area is thus subtropical with temperatures on the coast ranging from summer highs of 30–32°C to winter lows of

5–7°C; in March–April, day temperatures are in the 25–30°C range. Annual rainfall is 1090–1780 mm, two-thirds falling between November and March, when tropical storms can bring drenching rains to the coast.

The Great Dividing Range curves in to the coast at this boundary, and offshore the warm, south-flowing East Australia Current is countered by the prevailing south-easterly winds. The result is high rainfall on the mountains, which are clothed with subtropical rainforest. From these forest regions short, but substantial, rivers (and numerous smaller streams) flow eastwards carrying silt, yielding heavy terrigenous deposits on the coast (see Stephens 1992). To the north of the boundary, the coastal zone is mainly sandy with some large sandy islands protecting parts of the coast; to the south there are numerous rocky headlands that punctuate the coastline.

The large ocean swells driven by the prevailing winds ensure high-impact sandy beaches in all exposed areas, but wherever headlands, or especially islands, occur, quiet water in the lee leads to the build-up of mud. Consequently, a variety of habitats occurs, from extensive estuarine mangrove forests, through muddy, then sandy, seagrass beds in increasingly cleaner waters, and finally to high-energy, high-dune, beaches and rocky headlands.

Moreton Bay lies close to this boundary. It represents the sunken estuary of the Brisbane River (Stephens 1992) and is protected by Bribie, Moreton, North Stradbroke and South Stradbroke Islands, all high-dune, sand islands. In their lee, mangrove forests and seagrasses occur, but the bay is sufficiently large (1400 km²) that a full range of coastal habitats can be found. Warm water spills into the bay from the north so that tropical species such as corals create fringing reefs in the cleaner waters on islands with attendant, though certainly impoverished, coral reef faunas (Lovell 1989); and temperate species extend their ranges north, especially in the more exposed regions. Thus, the bay serves as a refuge to many species from both biogeographic zones.

Within the bay, the wave climate is dominated by wind waves rather than swell, these are south-easterly, north-easterly and south-westerly, though north-easterly swells do enter the bay via channels of the North Entrance (Stephens 1992). Mean tidal range increases from 1.38 m in the north to 2 m in the south of the bay. According to Patterson and Witt (1992), a predominant north–south tidal water stream brings clean water down the eastern side of the bay; western tidal currents are weak so that the south-easterly winds ensure a predominantly northerly flow of water along the edges of the bay. This carries the Brisbane River water and so can produce lowered salinities in the western bay, but normally oceanic conditions apply because of the size of the bay and the good exchange of water.

Water exchange between ocean and bay has been estimated at 0.5 /mo (Newell 1971). Water quality is generally good, with higher organic and particle concentrations occurring in the western bay. Dissolved oxygen levels in surface waters exceed 80% for 90% of the time, microbiological levels are low except in the immediate vicinity of the river mouth, and toxicants such as metals, pesticides, petroleum and PCBs are very low (Moss *et al.* 1992).

River sediments are deposited along the western edges of the bay; the long-term rate is estimated at 175 000 tonnes year⁻¹ of mud, i.e. a suspended load concentration of 130 mg L⁻¹ (Stephens 1992). Similarly, Patterson and Patterson (1983) estimate the north-directed littoral drift of sand along the high-energy coast of eastern Australia is 500 000 m³ year⁻¹. Marine tidal delta sand is brought into Moreton Bay by tidal currents from the north and also through the South Passage between Moreton Island and North Stradbroke Island, the latter providing some 200 000 m³ year⁻¹ of sand. There is thus a large tidal delta with intertidal sand banks within the bay.

Sites chosen within this bay were on the mainland at Beachmere and on North Stradbroke Island at Dunwich and Amity Point. On the mainland the site lay adjacent to mangrove and seagrasses, but was sufficiently close to the mouth of the bay to experience relatively clean water. Flood (1980) says of this region 'Subtle variations of the hydraulic regime and differing exposures to waves and tides enable contrasting environments such as sandy beaches and tidal-mud flat to be developed in close proximity'. On Stradbroke Island the Dunwich sites lay around a low rocky headland between mangrove regions; however, the influence of clean ocean water is much stronger to the north, so that the Amity Point sites had considerable oceanic influence from their proximity to the South Passage. These sites are typical of the Moreton Bay habitats.

Farther south, on the more exposed coast of New South Wales, were several sites from Coffs Harbour north to Arrawarra. These ranged from sites with full exposure to the Pacific Ocean, to those sheltered behind headlands and then to those in small tidal estuaries. This is a region where, overall, the sediments can be considered to be a 'very well sorted fine sand' (Hacking 1992). Offshore, the Solitary Islands have impoverished fringing coral reefs (Veron *et al.* 1974).

Sampling Sites

A. Queensland

Moreton Bay, mainland Deception Bay (Fig. 1)

Site B. Beachmere, Caboolture River estuary; eulittoral, semi-exposed sandy beach with fine sand (Md 180–250 μm) and flat with very fine to fine sand (Md 90–250 μm), OM 0.34% (beach) and 0.45–0.85 % (flat), S 28×10^3 .

Moreton Bay, Stradbroke Island (Figs 1, 2)

Site D1. Dunwich, Adam's Beach, eulittoral, semi-exposed beach and flat with fine to medium reddish brown sand (Md 250–500 μm), OM 0.16–0.22% (beach) and 0.34–0.64% (flat), S $12\text{--}22 \times 10^3$ (beach) and $18\text{--}22 \times 10^3$ (flat).

Site D2. Dunwich, beach in front of Ballow Park, eulittoral, semi-exposed beach with medium sand (Md: 250–500 μm) and flat with fine sand (Md 180–250 μm), OM 0.42–0.55%, S $14\text{--}18 \times 10^3$ (beach) and $29\text{--}32 \times 10^3$ (flat).

Site D3. Dunwich, Flinders Avenue (Bradburys Beach), eulittoral, lenitic beach with medium sand (Md 355–500 μm), heavily bioturbated by *Mictyris longicarpus* Latreille, 1806, 'soldier crab', S 12×10^3 (beach).

Site D4. Dunwich, One Mile Beach, eulittoral, lenitic beach with medium sand (Md 355–500 μm), and flat with fine sand (Md 180–250 μm), heavily bioturbated by *Mictyris longicarpus* Latreille, 1806, 'soldier crab', OM 0.31% (beach) and 0.38–0.74% (flat), S $10\text{--}19 \times 10^3$ (beach) and $18\text{--}26 \times 10^3$ (flat).

Site A1. Amity Point, Llewellyn Street, eulittoral, semi-exposed beach and flat with medium to fine sand (Md 180–355 μm), OM 0.26–0.39%, S $3\text{--}20 \times 10^3$ (beach) and $6\text{--}28 \times 10^3$ (flat).

Site A2. Amity point, Toompany Street, eulittoral, exposed beach with medium sand (Md 250–355 μm), OM 0.28–0.30%, S $34\text{--}35 \times 10^3$.

B. New South Wales

Coffs Harbour area (Fig. 3)

Site CH. Coffs Harbour, Jetty Beach, eulittoral, exposed beach and flat with fine sand (Md 180–250 μm), covered with wrack (seaweed debris), OM 0.83–1.78%, S 26×10^3 .

Site CHCK. Coffs Harbour Creek, sheltered brackish water estuary, eulittoral, beach and flat with very fine to fine sand (Md 125–180 μm), OM 0.87%, S 16×10^3 .

Site AR1. Arrawarra Headland, eulittoral, southern high-energy beach, sediment deposits between rocks with fine to medium sand (Md 180–500 μm), open beach with medium to very coarse sand (Md 500–1400 μm ; granule fraction $>4000 \mu\text{m}$ 9.8–14.7%), OM 0.67–0.82%, S $34\text{--}35 \times 10^3$.

Site AR2. Arrawarra Headland, eulittoral, northern exposed beach with very fine to fine sand (Md 125–180 μm) covered with masses of wrack (seaweed debris), S $30\text{--}33 \times 10^3$.

Site WCK. Woolgoolga Creek, sheltered brackish water estuary with sandy flats of high contents of detritus covered with green Cyanophyta and brown algae, flats with very fine to fine sand (Md 125–250 μm), OM 0.80–1.50%, S $16\text{--}26 \times 10^3$.

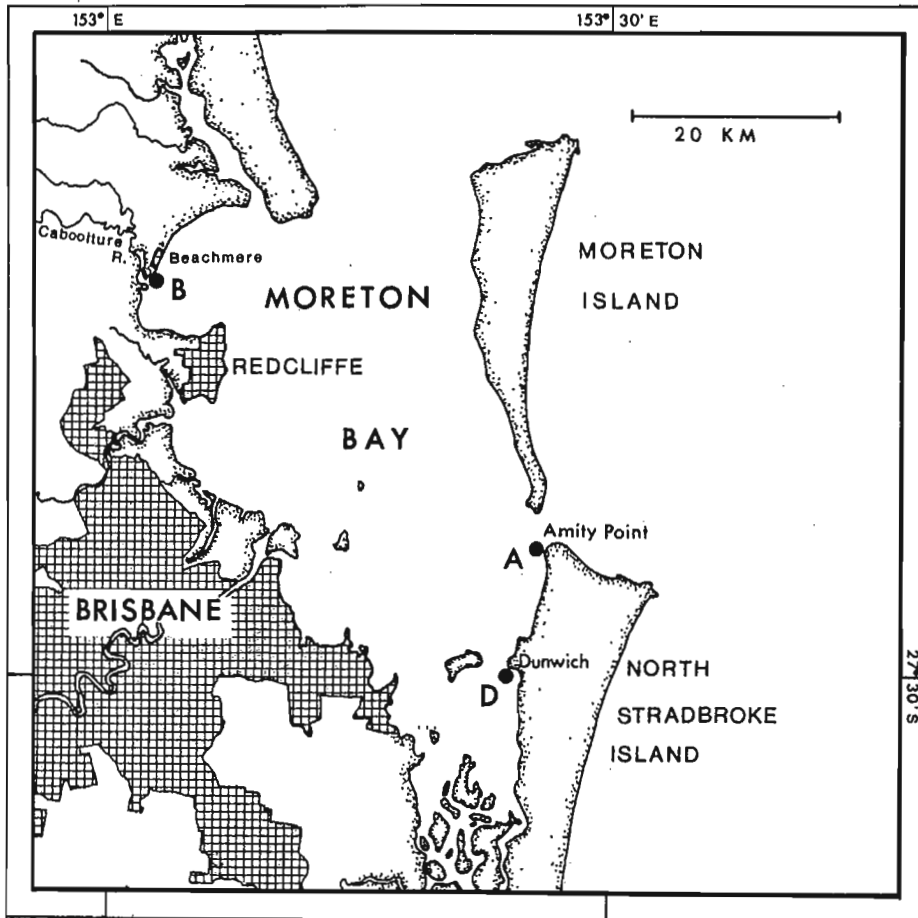


Fig. 1. The sampling locations (A, B, D) in the Moreton Bay area, Queensland, Australia.

Systematic Section

Order MACROSTOMIDA Meixner, 1924
 Family MACROSTOMIDAE Van Beneden, 1870
Dunwichia, gen. nov.

Type of the genus and the only species: *Dunwichia arenosa*, sp. nov.

Diagnosis

Macrostomidae with characteristic outline of the body reduced, i.e. tapers, at spatulate tail. With or without eyes. Rhabdites and rhammites present. Male system of simplex type with cirrus. Discrete prostatic vesicle absent. Ovary and testis single. Seminal bursa present, but atrium feminum and oviduct absent. Gonopores separate.

Remarks

Dunwichia is distinguished from all other macrostomid genera by the unarmed cirrus invaginated in the combined seminal vesicle and by the aberrant seminal bursa of the female system.

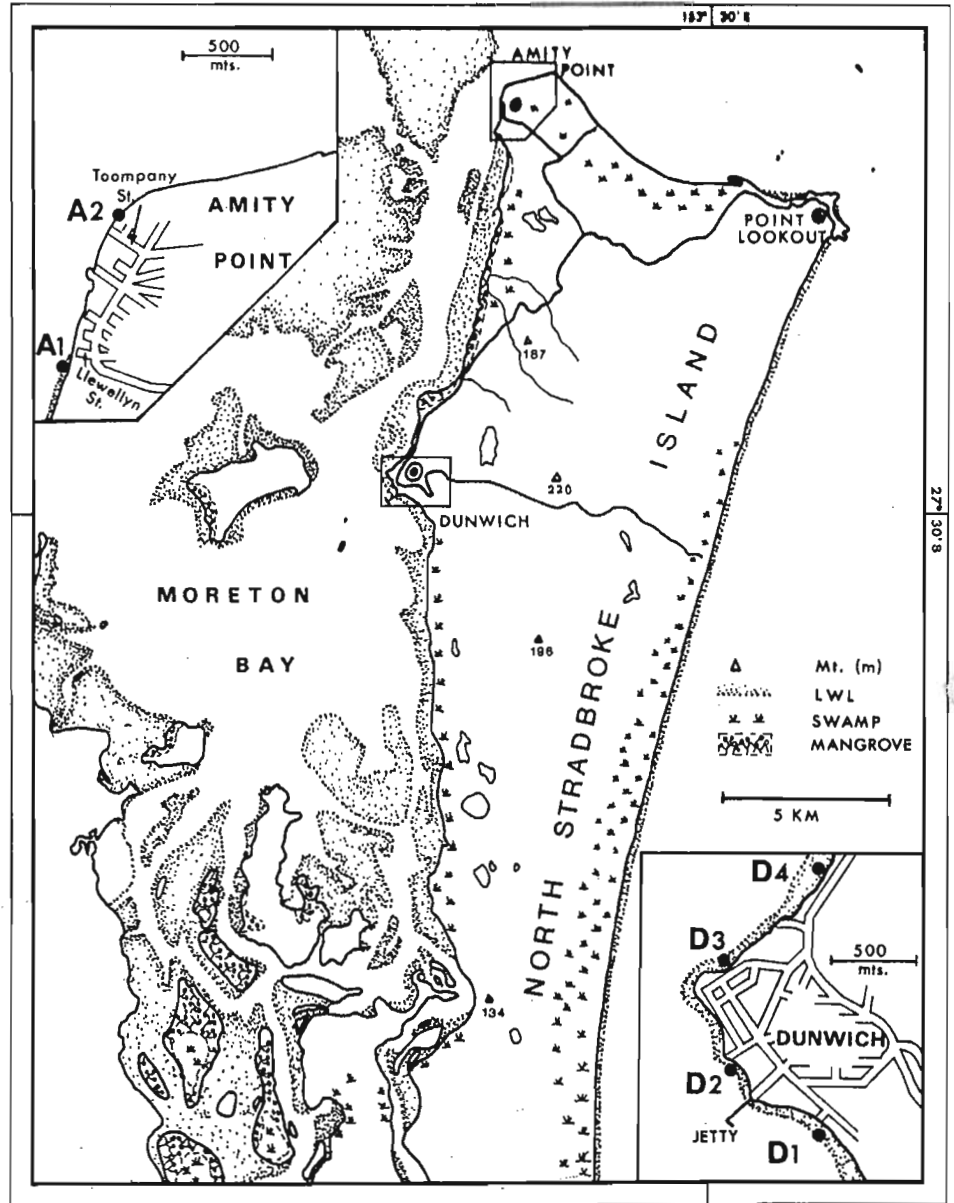


Fig. 2. The sampling locations, Dunwich (D1 to D4) and Amity Point (A1, A2), on North Stradbroke Island, Queensland, Australia. The insets show enlargements of the investigation areas. For abbreviations see text.

Dunwichia arenosa, sp. nov.

(Figs 4–5)

Material Examined

Holotype. Adam's Beach (D1), Mar. 1992, G 211234 (SS), 2.5 μ m sections, mounted on 4 slides.

Paratypes. Same data as holotype, G 211235–6 (SS), 2.5 μ m sections mounted on 5 slides and G 211235–6 (WM) stained with eosin and embedded in Technovit 7100.

Other specimens. Jetty Beach (D2), Mar. 1992; Beachmere (B), Mar. 1992; live and squash observations.

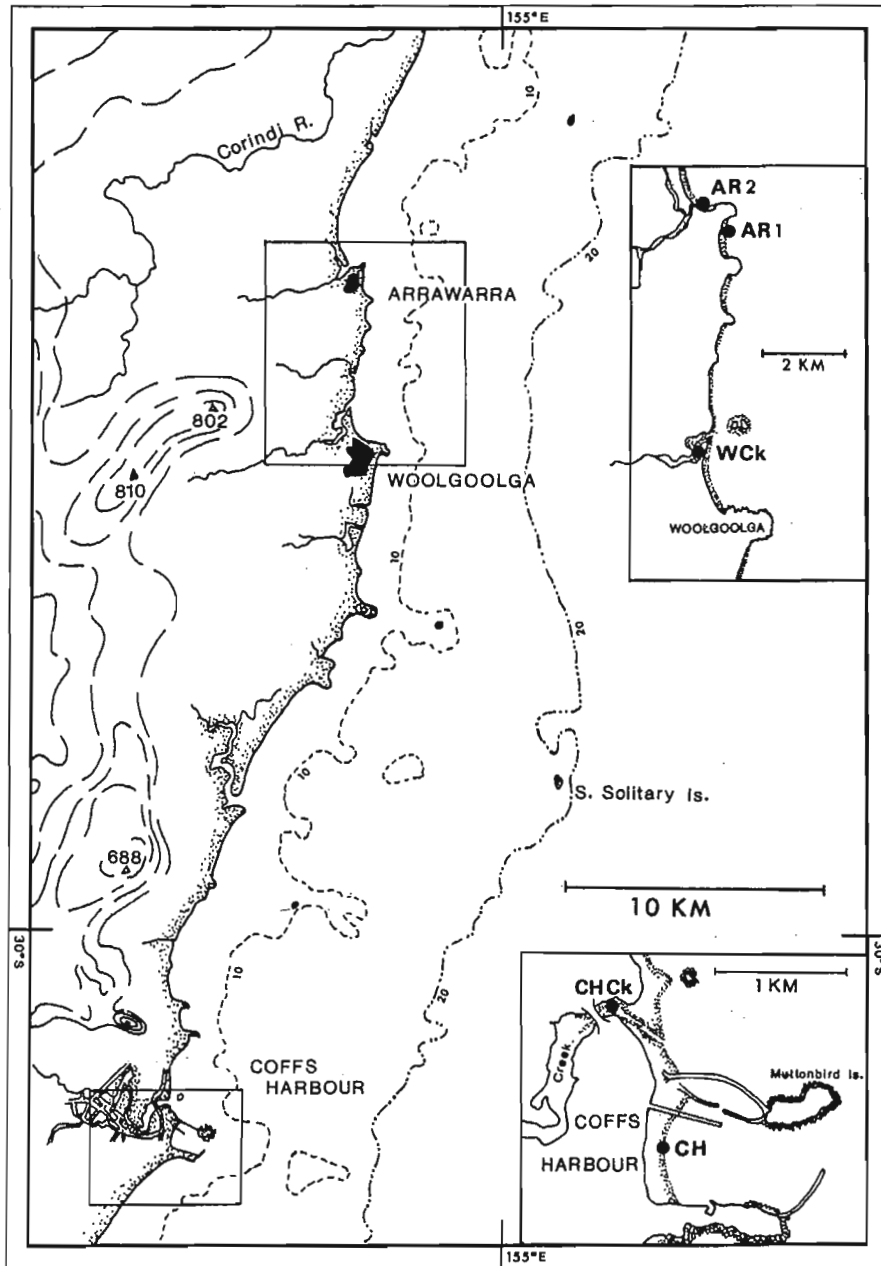


Fig. 3. The sampling locations in the area of Coffs Harbour (CH, CHck), Arrawarra (AR1, AR2), and Woolgoolga (Wck), New South Wales, Australia. The insets show enlargement of the investigation areas. For abbreviations see text.

Morphology (Fig. 4)

Adults 0.9–1.0 mm long and about 0.2 mm wide. The head forms more or less pointed horns laterally, each carrying 2–3 sensory spines. Additionally, sensory hairs and spines, of varying length and stiffness, located laterally on the epidermis. The spatulate rear body end terminates with a 24- μ m-long ciliary tuft. Eyes absent. Colour whitish, but in transmitted light specimens look translucent with contrasting darker intestine. Epidermis (Fig. 5) covered with 9.5- μ m-long cilia, cellular (6.7 μ m thick) with intraepithelial nuclei,

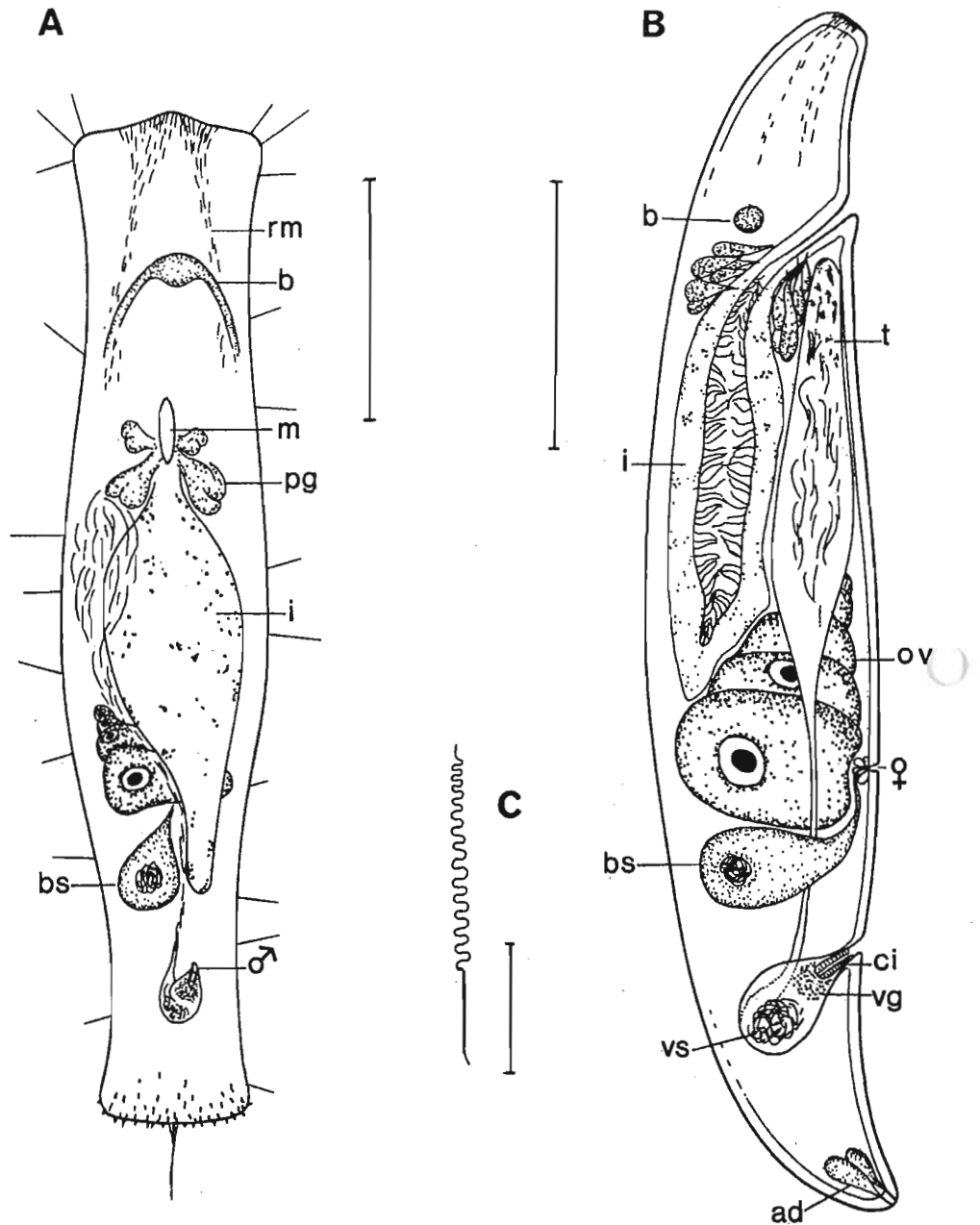


Fig. 4. *Dunwichia arenosa*, gen. et sp. nov.: A, dorsal view in squash preparation; B, diagrammatic sagittal reconstruction; C, sperm. Scale lines A and B, 200 μm ; C, 20 μm .

and invaginated dorsal rhabdite glands containing 2–4 rod-shaped rhabdoids. Rhabdites distributed in longitudinal rows over the dorsal body surface. Between epidermis and body muscle wall, weak outer transverse and strong inner longitudinal muscles present, basal membrane absent. The crescentic brain lies anterior to the mouth. The digestive system composed of mouth, pharynx simplex and intestine extends caudad to the level of the ovary at the transition to the last third of the body. Excretory system absent. Gonopores separate. In the rear body end a glandular adhesive system is developed.

Male reproductive system (Fig. 5)

Testis sac-like, occupying the left lateral area posterior to the pharynx. The vas deferens ends by joining the seminal vesicle. The copulatory organ is of simplex type and consists of a voluminous combined seminal vesicle and a distal unarmed cirrus. The whole complex is invested by a muscular housing. Distally the multi-layered muscle fibres are much stronger than proximally. The combined seminal vesicle contains sperm in its proximal part while its distal section houses the granular secretion that is produced by extraventricular prostatic glands. The invaginated cirrus rests in the distal granulated part of the combined vesicle. The intruded cirrus opens into a short ciliated antrum. The spermatids appear spiralled (Fig. 4C); they are 48 μm long.

Female reproductive system (Fig. 5)

The single ovary extends from the lateral testis backwards, generating caudad a single large oocyte. From a small ventral opening, close behind the oocyte, the syncytial seminal bursa (resembling the female bursa in Acoela) rises dorsocaudad. The transition from the opening to the long bursal duct is constricted by large secretory cells enlarging proximally and being translucent. Sperm is stored in the proximal part of the bursa. Oviduct, female atrium, and ciliated vagina absent.

Remarks

Dunwichia arenosa is the only known species recognised within the genus. Diagnostic distinctions are the male system of simplex type with cirrus and the syncytial seminal bursa.

Ecology

Dunwichia arenosa lives in semi-exposed eu littoral sandy beaches and flats within the high water spring level and the 10-m mark of the anterior flat. In sandy flats it occurs only in oxygenated layers: it is not found deeper than the chemocline. In sandy beaches the species populates the interstitium from the surface to the groundwater table. The specimens move very slowly.

Etymology

The generic name refers to the sampling locality, i.e. Dunwich on Stradbroke Island; the specific epithet refers to the habitat of sandy (*arenosa*) beaches.

Bradburia, gen. nov.

Macrostomum miraculicis Schmidt and Sopott-Ehlers, 1976.

Type species: *Bradburia miraculicis* (Schmidt & Sopott-Ehlers, 1976), comb. nov.

Diagnosis

Macrostomidae with characteristic outline of the body reduced at spatulate tail. With or without eyes. Rhabdites and rhammites present. Male system with accessory stylet connected to tubular stylet proximally. Ovary and testes paired. Female copulatory system as in *Macrostomum* but with interior cuticular lining of the female atrium; cilia absent.

Remarks

The characteristic accessory male stylet fixed proximally to the main one forms the diagnostic feature of the genus. Schmidt and Sopott-Ehlers (1976) described *M. miraculicis* from the Galapagos. The discovery of a further species with this character prompts the erection of the new genus.

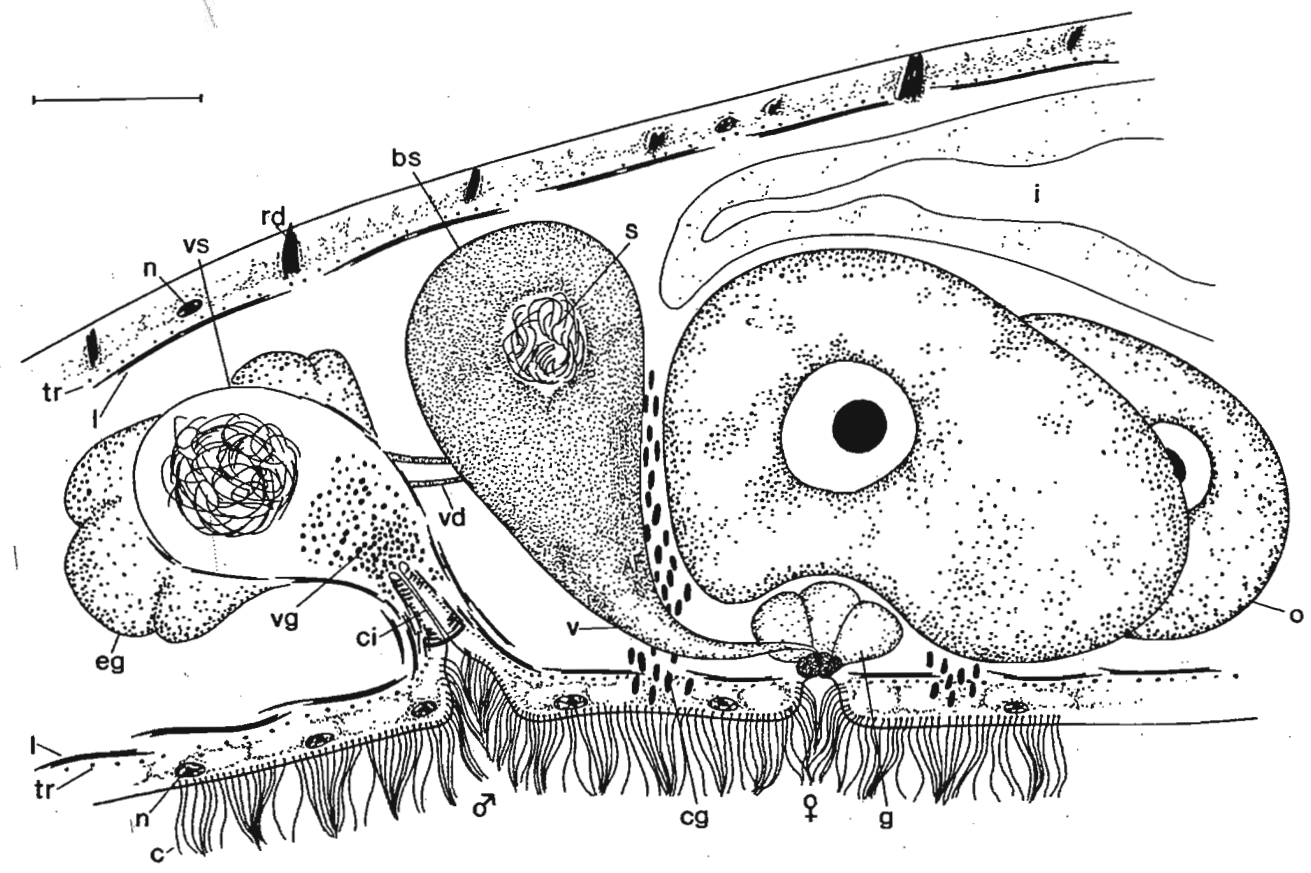


Fig. 5. *Dunwichia arenosa*, gen. et sp. nov.: sagittal reconstruction of the male and female copulatory apparatus. Scale line 30 μ m.

Bradburia australiensis, sp. nov.

(Figs 6-7)

Material Examined

Holotype. Dunwich, Bradbury's Beach (D3), Mar. 1992, G 211237 (SS), 2.5 μm sections mounted on 4 slides.

Paratypes. Same data as holotype, G 211238-9 (SS), 2.5 μm sections mounted on 4 slides and G 211238-9 (WM) stained with eosin and embedded in Technovit 7100.

Other specimens. Dunwich, Jetty Beach (D2), Mar. 1992, live and squash observations.

Morphology (Fig. 6A)

Mature specimens 1.8-2.1 mm long and 0.2-0.25 mm wide. The outline is characteristic of the family Macrostomidae, i.e. proceeding posteriorly it becomes gradually wider before it is abruptly reduced at the short spatulate tail. Body ends rounded. In transmitted light the body looks dirty yellow with darker parts marking the intestine. Anterior and posterior ends with sensory hairs and spines. Epidermis covered with 8-9 μm long cilia, cellular with intraepithelial nuclei and invaginated rhabdite glands containing 2-5 rod-like rhabdoids. Rhabdites scattered over the whole body. In the fore-body rhammite tracks originate caudally of the brain and run to the foremost tip of the body where rod-like rhabdoids are discharged. The brain shows the median constriction that is more common to Dolichomacrostomidae. Eyes absent. The digestive system consists of a mouth located some distance behind the brain, a short oesophagus pierced by extra-pharyngeal glands, and a large intestine covered with 10-12 μm long cilia. The intestine reaches backwards to the last fourth of the body.

Male reproductive system (Figs 6-7)

The testes lie postero-lateral to the pharynx (Fig. 7A). The vasa deferentia extend caudad and end by joining the seminal vesicle (Fig. 6A). The seminal vesicle is connected with the prostatic vesicle by a muscular constriction serving as sphincter. The stylet is 95 μm long and its outline is depicted in Figs 6B, 7B and 7C. Proximally, in a slight constriction, a 40- μm -long pointed, tubular, accessory stylet is affixed to the main one.

Female genital system unknown.

Remarks

The only other species of the genus is *B. miraculicis*. Diagnostic distinctions are the outline, the length and the distal hook-like processes of the male stylets.

Ecology

Specimens of *Bradburia australiensis* live in sandy beaches of semi-exposed (site D2) and lenitic (site D3) eulittoral areas. The species populates the upper beaches and is vertically distributed from the surface to the ground-water table. The species feeds on diatoms, forams and nauplii.

Etymology

The generic name refers to the type locality 'Bradburys' Beach on Stradbroke Island; the specific epithet to the place found, i.e. Australia.

Macrostomum australiense, sp. nov.

(Fig. 8)

Material Examined

Woolgoolga Creek (WCK), Coffs Harbour, New South Wales, Apr. 1992, 2 specimens, live and squash observations only.

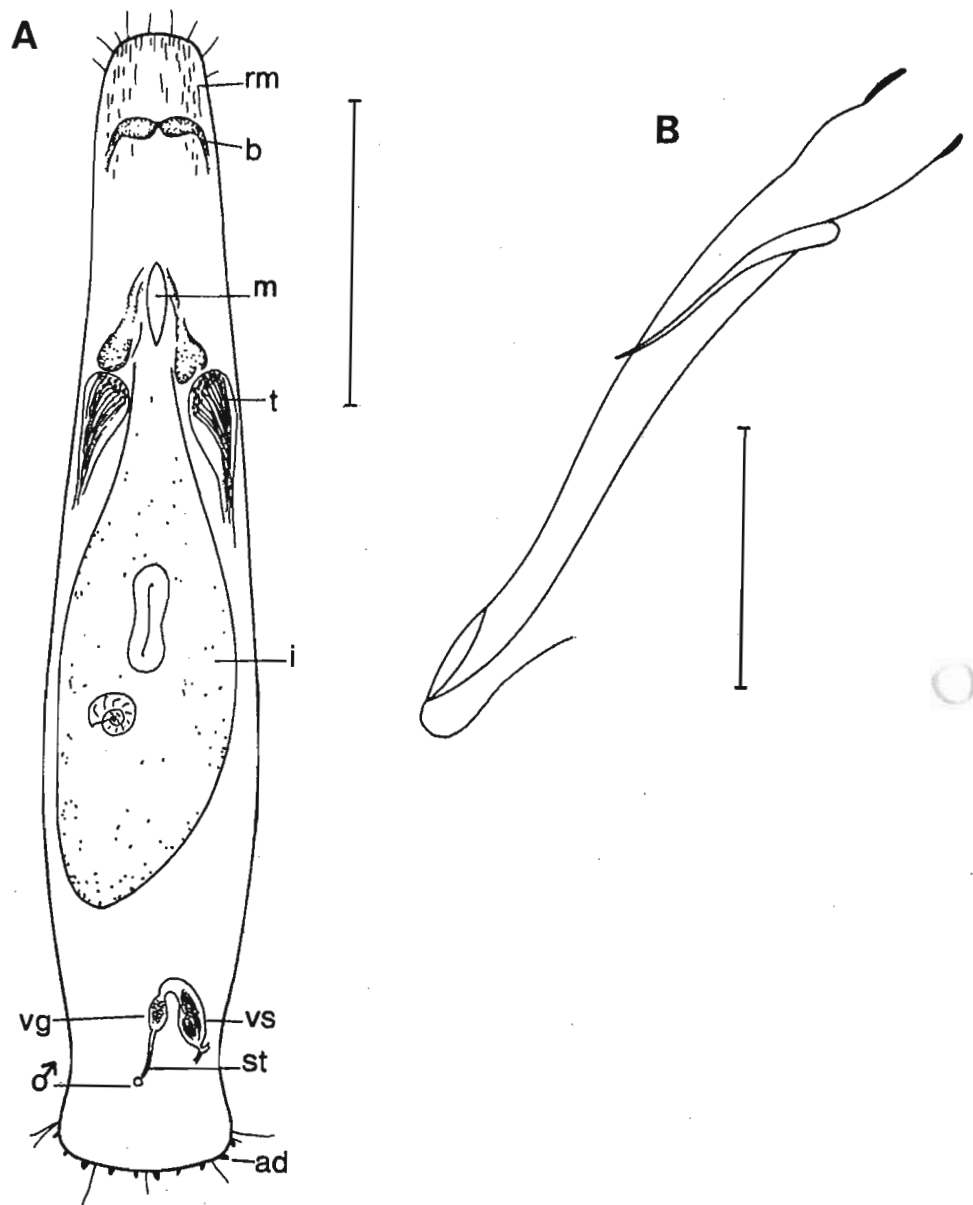


Fig. 6. *Bradburia australiensis*, gen. et sp. nov.: A, dorsal view in squashed preparation; B, stylet. Scale lines A, 500 μ m; B, 40 μ m.

Morphology (Fig. 8A)

Mature specimens are 0.7–0.8 mm long and 0.1–1.2 mm wide. The body is of typical macrostomid outline with a truncate rear end provided with strong rhabdite glands for attaching to sediment grains. Rhabdites of smaller size are distributed in serial rows over the dorsal body surface. Sensory hairs and spines of varying length and stiffness, being somewhat longer than normal ciliation, are found on the epidermis, principally at the body extremities. The species looks yellowish with darker parts representing the intestine. Eyes located behind brain, fronto-lateral to the pharynx. Subtle pharyngeal glands lie lateral to the pharynx and the very short oesophagus. Excretory system absent. Male and female gonopores separate. The species is protandrous.

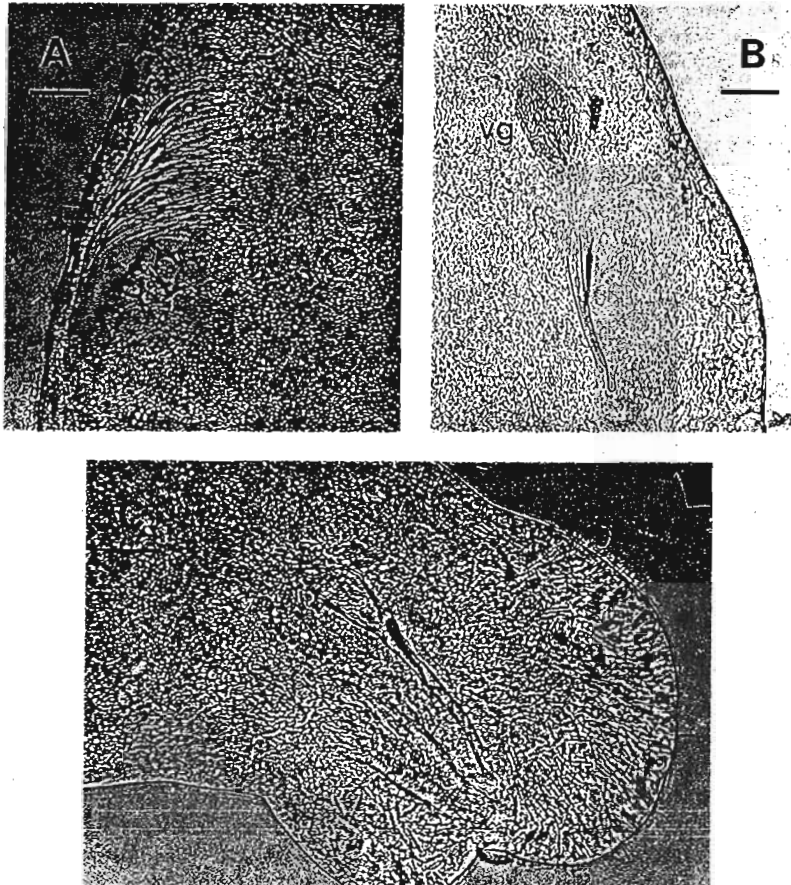


Fig. 7. *Bradburia australiensis*, gen. et sp. nov., photomicrographs of squashed specimens: A, testes; B, distal and C, proximal part of male stylet. Scale lines A, 15 μm ; B and C, 20 μm .

Male reproductive system (Fig. 8A, B)

The male system consists of bilateral testes running to either side of the intestine, vasa deferentia, a seminal vesicle, a prostatic vesicle, and a penis stylet which projects into a male antrum. The stylet (Fig. 8B) is a tube-like, slightly curved funnel with a widened proximal base and a distal hook-like bend turned at an angle of about 90° from the main axis. The stylet is 45 μm long. The ventral gonopore opens close to the rear end.

Female genital system (Fig. 8)

The female system was not fully developed, consisting only of a single ovary latero-caudally to the intestine.

Remarks

Macrostromum australiense is distinguished from all other species of *Macrostromum* by the hook at the distal end of the stylet.

Ecology

Macrostromum australiense was found in oxygenated sediments watered by effluent groundwater supplying a pool in the eu littoral area of the Woolgoolga Creek. Sediments

were covered with 2–4 mm thick algal mats of Cyanophyta and green and brown algae. The chemocline was very close to the surface of the sediment (2–4 mm).

Etymology

The specific name refers to the place found, i.e. Australia.

Macrostomum sp.

(Fig. 9)

Material Examined

Specimen 1. Adam's Beach (D1), Mar. 1992, G 211240–1 (SS). 2.5 μm sections mounted on 3 slides.

Specimen 2. Same data as specimen 1, G21140–1 (SS). 2.5 μm sections mounted on 4 slides.

Other specimens. One Mile Beach (D4), live and squash observations, Mar. 1992

Morphology (Fig. 9A)

Mature female specimens 0.78 mm long and 0.15–0.2 mm wide. The outline of the body is characteristic of the genus *Macrostomum*, i.e. the greatest width lies in the middle of the body which is gradually reduced at the spatulate tail. Anterior and posterior body ends rounded. At the anterior tip of the body, bundles of 8–9 rhabdoids of parenchymal rhammite glands open to the exterior. Epidermis supplied with ciliary processes, hairs and spine, and the rear end bears a subtle ciliary tuft. In the spatulate posterior end which is developed as adhesive disk, many adhesive glands are inserted. Over the dorsal body surface rhabdites are grouped into longitudinal rows. The epidermis, 4.5–5.0 μm high, is provided with intraepithelial nuclei and covered with 6.5–7.0- μm -long cilia. Basal membrane absent. Subepidermal rhabdite glands develop 1–2 rhabdoids. In the epidermis the rhabdite gland necks are surrounded by coarse glandular material pouring to the exterior. In the brain, with a characteristic median constriction (Fig. 9A), black eyes are embedded in the dorso-caudal tissue. The pharynx is pierced by the openings of extrapharyngeal glands and opens to the exterior by a ventral mouth. The intestine, densely ciliated with 15–25 μm long cilia, is lined with palisade-like epithelial cells, ventrally twice as high as the dorsal cells. The digestive tract is filled with diatoms and unidentifiable microorganisms.

Female reproductive system (Fig. 9B)

The generative area of the ovary is located at the left side in the middle part of the body, ventro-lateral to the intestine. Caudad a spherical maturing oocyte fills the whole lumen of the body. The posterior part of the ovary passes immediately into the ciliated female atrium from which it is separated by a weak sphincter. An oviduct is lacking. Distad the female atrium narrows and turns to the ciliated vagina before it opens ventrally.

Remarks

Because of the absence of male genital organs, this species has to remain unnamed. Unlike others of the genus, it is characterised by the presence of a single ovary.

Ecology

The species was found in eulittoral sandy flats (D4) and lower parts of beach slopes (D1), only in oxygenated layers. The abundance was very low, about 1 specimen per 100 cm^2 of surface area. The species feeds on diatoms. *Macrostomum* sp. is protogynous.

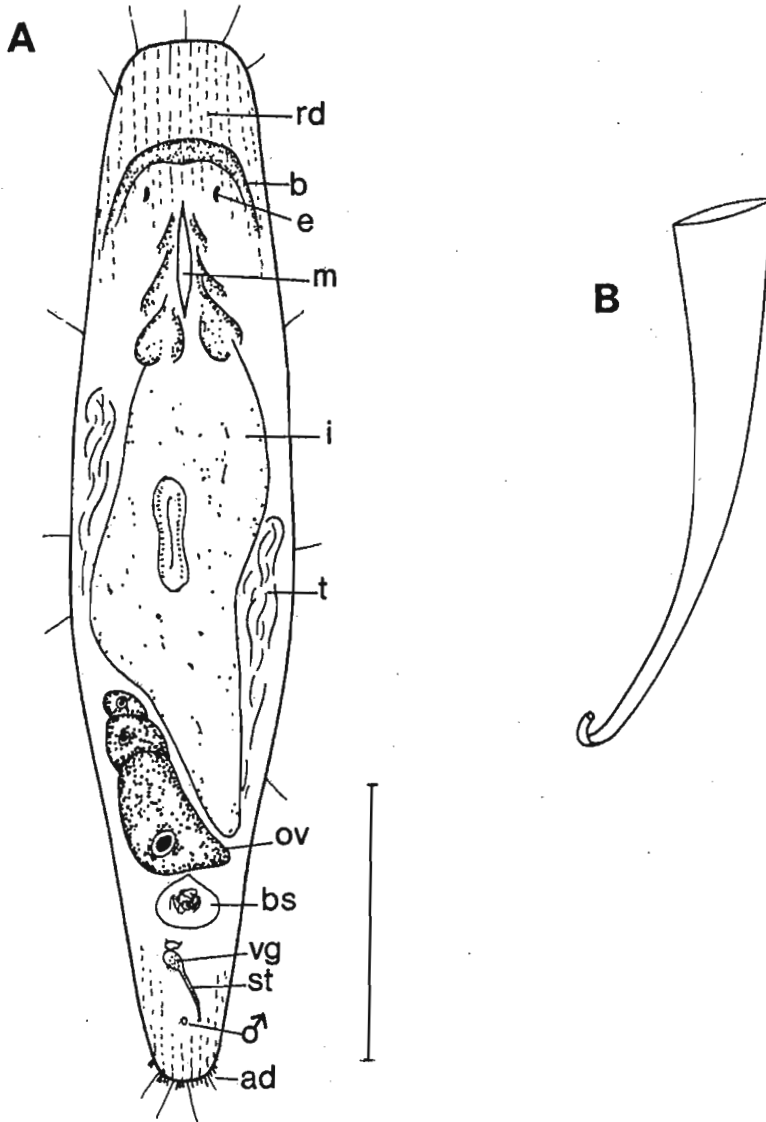


Fig. 8. *Macrostromum australiense*, sp. nov.: A, dorsal view in squash preparation; B, stylet. Scale lines A, 200 μ m; B, 10 μ m.

Comparative Discussion

Only four species of the order Macrostromida are known at present from Australian marine areas. These four species are described in this paper and belong to the family Macrostromidae, which is mainly characterised by the simple male and female copulatory systems. The female system is without cuticular elements and consists commonly of a ciliated female atrium turning distally into a vagina. The male apparatus provides most of the taxonomically informative characters: a tube-like simple stylet, or an unarmed cirrus or penis, or neither of them. The genera *Archimacrostromum* Ferguson, 1954, *Bradynectes* Rieger, 1971, *Macrostromum* Schmidt, 1848, *Omalostomum* Van Beneden, 1870, and *Promacrostromum* An Der Lan, 1939, are provided with a stylet. A cirrus is strongly developed in *Siccomacrostromum* Schmidt & Sopott-Ehlers, 1976, and *Psammoma-*

crostomum Ax, 1966. *Antromacrostomum* Faubel, 1974, is provided only with an antrum masculinum. The genus *Myozona* Marcus, 1949, characterised by a circo-muscular constriction of the intestine, contains species with stylet, cirrus, or unarmed penis.

Three genera *inquirenda* (*Protomacrostomum* Steinböck, 1935, *Axia* Ferguson, 1954, and *Inframacrostomum* Ferguson, 1954) have been placed within the Macrostomidae. *Axia* was assigned to *Promacrostomum* by Sluys (1986). *Inframacrostomum*, established by Ferguson (1954) on *Macrostomum rubrocinctum* Ax, 1951, must be re-assigned to *Macrostomum*. The absence of a female atrium is not sufficient as a generic character. Steinböck (1935) established the monotypic genus *Protomacrostomum* based on his inadequate description of *P. groenlandicum*. The anterior opening and position of the pharynx, and the statement of Steinböck that 'die übrige Organisation dürfte in den wesentlichen Zügen mit dem, was wir über die Gattung *Macrostomum* wissen, übereinstimmen', warrant an assignment of *P. groenlandicum* to *Omalostomum*.

Two new genera have been erected for the species described in this paper because the combination of characters is unknown from any existing genus of the Macrostomidae. *Dunwichia arenosa* is characterised by an unarmed cirrus of the simplex type; it resembles most closely *Psammomacrostomum equicaudum* Ax, 1966, and *Siccomacrostomum triviale* Schmidt & Sopott-Ehlers, 1976. The type of the cirrus corresponds to *S. triviale*, but the cirrus of *P. equicaudum* is of the duplex type. The most conspicuous autapomorphies of these three monotypic genera lie in the female reproductive system. In *P. equicaudum* a vagina and female atrium are absent, *S. triviale* has a common genital atrium connected to a female atrium, and a syncytial seminal bursa, typically found in Acoela, occurs in *D. arenosa*.

The nature of the accessory stylet and the cuticular lining in the female atrium of *Macrostomum miraculicis* Schmidt & Sopott-Ehlers, 1976, characterises the new genus *Bradburia*. On the basis of the accessory stylet, the newly described species belongs to this genus although the female system is unknown. The Macrostomidae at present contains 11 valid genera including the two described in this paper.

The female and male reproductive systems of *Bradburia* deviate from those normally found in Macrostomidae. *Bradburia* occupies an intermediate position between the Dolichomacrostomidae (which have a complicated male stylet and cuticular elements in the female bursa) and the Macrostomidae because of two autapomorphies: (i) an accessory male stylet, and (ii) a cuticular lining within the female system. We prefer to defer establishment of a new family because at present only in *Bradburia miraculicis* is the female reproductive system known.

Solely on the basis of its male reproductive system, *Macrostomum australiense* clearly belongs to the genus *Macrostomum*. In the outline of the stylet, with a distal hook, *M. australiense* resembles a group of other species of the genus, namely *M. axi* Papi, 1959, *M. balticum* Luther, 1947, *M. hamatum* Luther, 1947, *M. japonicum* Okugawa, 1930, *M. mystrophorum* Meixner, 1926, and *M. timavi* Graff, 1905. The most conspicuous character of *M. australiense* is that the hook is situated at a right angle to the main axis, and that only a single ovary is developed. These features distinguish *M. australiense* from the other species.

The description of *Macrostomum* sp. is given for completeness, but establishment of a new species is impossible because only the female system, consisting of the typical ciliated female atrium and vagina of the genus *Macrostomum* is known.

Acknowledgments

Financial support was given by the Deutsche Forschungsgemeinschaft to Dr A. Faubel and Dr D. Blome. We thank Dr A. Bartholomai, Director of the Queensland Museum, and staff for facilities and help in Brisbane, and Professor G. Grigg, Zoology Department, University of Queensland, for making the Dunwich Research Station available on Stradbroke Island. Professor K. Rohde assisted with arrangements at the Arrawarra Research Station of the University of New England.

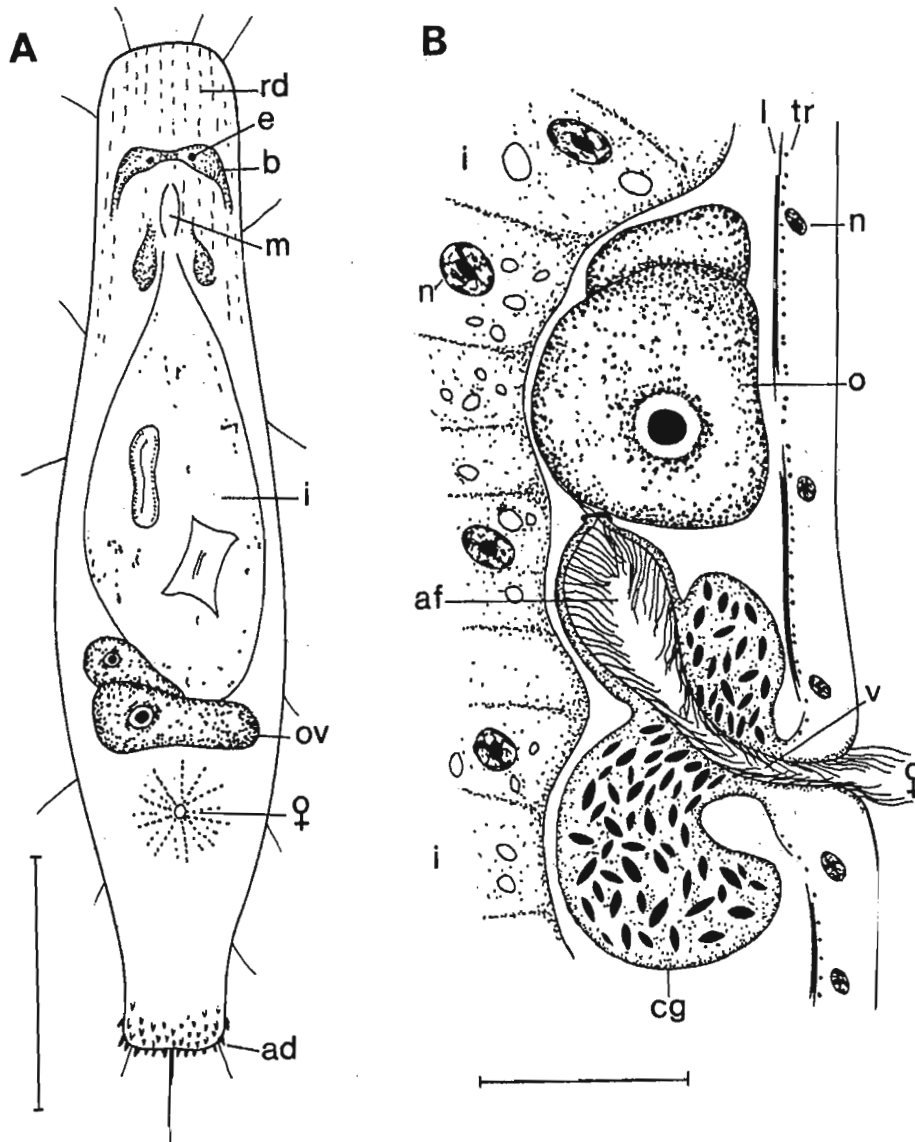


Fig. 9. *Macrostomum* sp.: A, dorsal view in squash preparation; B, sagittal reconstruction of female genital system. Scale lines A, 200 μ m; B, 20 μ m.

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