NEW TEMNOCEPHALANS (PLATYHELMINTHES): ECTOSYMBIONTS OF FRESHWATER CRABS AND SHRIMPS

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Six new species of *Temnocephala* are described from freshwater crabs and shrimps from Queensland, *Temnohaswellia* Pereira & Cuocolo, 1941 is re-erected for two new species with 6 tentacles and *Achenella* n. gen. is proposed for two new species of worms with only one pair of testes. This is the first time temnocephalans have been reported from crabs and shrimps in Australia. □ *Temnocephala, Temnohaswellia, Achenella , ectosymbiont, crab, shrimp.*

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Temnocephalans are small ectosymbiotic flatworms which are known from a variety of freshwater invertebrates from mainly South America and Australia. Their taxonomic status has shown some variation (Williams, 1981), but they are generally considered to be close to the dalyellioid turbellarians. The Australasian region seems the centre of diversity (Cannon, 1991), but here the diversity of hosts recognised has been low, i.e., they have been reported almost exclusively from crayfish of the family Parastacidae. Crabs and shrimps have been reported as hosts in southern Asia and South America; however, this is the first such report from Australia.

Crabs and shrimps were trapped or collected in dip nets from streams and ponds throughout eastern Australia. Hosts were retained for short periods until the hosts could be examined in the field or laboratory with a dissecting microscope and the worms removed into clean water. Worms were fixed when possible in 10% cold buffered formalin, AFA (alcohol, formalin and acetic acid), SUSA or Bouin's fluid: some were obtained from hosts fixed in 70% alcohol or from hosts killed by near boiling water. Whole mounts were stained with Mayer's haemalum or Harris' haematoxylin and mounted in Canada balsam. Serial sections were obtained from worms embedded in 56°C Paraplast and cut at 5-7μm and stained with Mayer's haematoxylin and eosin, though occasionally Mallory's trichrome was used.

Descriptions were prepared with the aid of DELTA (Dallwitz & Paine, 1986). Over 130 characters were designated, though not all were applicable to all descriptions, e.g. egg capsule characters were not included if egg capsules were not found. With limited material of some species and variation in the quality of fixation dependent upon the immediacy of treatment some characters are included as 'inconspicuous', '(absent?)' or simply qualified with '(?)'. All measurements were obtained with the aid of a camera lucida. Material is deposited in the collections of the Queensland Museum (QM) and wholemounts are designated (W) and serial sections (LS, TS or FS -longitudinal, transverse or facial sections: the number of slides in the series given in [ ]).

Abbreviations used in figures: c cirrus, dg disc glands, e eye, es ejaculatory sac, ex excretory ampulla, g gut, ga genital atrium, gc genital capsule, gp gonopore, Hc Haswell's cells, og ootype gland, ov ovary, ph pharynx, plg postero-lateral glands, pr prostate, rg rhabdite glands, ro rosette organ, sg shell glands, sr seminal receptacle, sv seminal vesicle, t testis, v vagina, vit vitellaria, vitd vitelline duct, vr vesicula resorbens.

TERMINOLOGY

Hickman (1967) drew attention to the variety of names used for various parts of the reproductive organs of temnocephalans. I happily accept the term vesicula resorbens (not resorbiens) for this structure described in detail by Haswell (1924). Earlier I have tried to provide a consensus regarding the terminology relating to all turbellarians (Cannon, 1986). Within the male temnocephalan I agree with Haswell (1893) and Baer (1953) that the swollen part of the system storing sperm prior to release is appropriately called the seminal vesicle. The ejaculatory duct leaves the seminal vesicle distally and enters the (usually muscular) base of the intromittent organ. Haswell

(1893) called this muscular base the cirrus bulb, but since this is where the prostate glands join the ejaculatory duct and surround it 'prostate bulb' (or simply 'prostate') is the most appropriate functional term. The prostate is sometimes no wider than the sclerotic base of the male organ, but may be a much enlarged bulb.

As Baer (1953) pointed out, Australian species of temnocephalans also have an additional sac, evidently absent from South American species. This is variably developed: in some it is a discrete sac or vesicle opening, via a narrow duct, into the prostate adjacent to the ejaculatory duct; in others it is merely a proximal extension from the prostate beyond the ejaculatory duct entrance. Haswell (1893) called this the ejaculatory sac, a term I accept. Hickman (1967) called it a prostate vesicle mistakenly attributing this term to Baer (1953) who called such a structure in *Diceratocephala boschmai* a prostate, but said 'elle est sans doute homologue de la vesicle ejaculatrice des autres Temnocephales'. This sac is frequently empty or contains only a few sperm; it does not contain prostatic secretion.

The male intromittent organ in most temnocephalans consists of a hard sclerotic tube the terminal part of which has spines or more often rows of spinelets which are eversible. The terminal part may or may not be enlarged. Haswell (1893) called the organ a cirrus and the terminal part the introvert. Cirrus is the appropriate term for a spiny eversible male organ. The basal rigid section could be considered a stylet, but is here called the shaft, and the term 'cirrus' of Haswell is accepted here, not 'penis' as used by Hickman (1967).

Finally, in many temnocephalans there are distinctly staining cells anterior to or adjacent to the brain. Haswell (1893) first referred to them as 'problematic cells'. They have also been called 'schokoladenbraune Drüsen' (see Cannon, 1991). Hickman (1967) figures and describes these cells which he says may be paranephrocytes, though cautiously, as these latter are wandering cells: the cells in question are constant in position. There are often two pairs and their position near the brain suggests they may be neurosecretory. Until a function can be ascribed I propose to call them Haswell's cells.

Family TEMNOCEPHALIDAE Monticelli, 1899

Temnocephala Blanchard, 1849

Generic diagnosis. Temnocephalidae with five anterior tentacles, a posterior adhesive disc and paired lateral testes.

Temnocephala athertonensis n.sp.
(Figs 1.11a-c)

MATERIAL EXAMINED

HOLOTYPE: ex carapace of *Holthuisana agassizi* (Sundathelphusidae), Rocky Ck, nr Carbeen (17.11.2°S, 145.26.8°E), 26 Sep. 1990, L. Cannon & K. Sewell, Hot water/AFA/Hx GL14562 (W).

PARATYPES: same data as holotype, AFA/Hx GL14563-7 (W); Hot water/Bouin's/H&E GL14569 (LS[2]); Hot water/AFA/H&E GL14570 (LS[2]); Hot-water/Bouin's/Mallory's GL14571 (LS[1]).

OTHER MATERIAL: same data as holotype, AFA/Hx GL14568 (W), Hot water/Bouin's/Mallory's GL14572 (LS[1]); Bouin's/H&E GL14573 (LS[2]); Hot water/AFA/H&E GL14574 (LS[2]); Bouin's/Mallory's GL14575 (LS[1]).

DESCRIPTION

External characteristics. Body about 1.2-2mm (mean=1.7mm) long, and about 0.5-0.9mm (mean=0.7mm) wide; oval or elliptical, dorso-ventrally compressed, but without flanges, or not dorso- ventrally compressed. Pigment creates impression of grey, actually a well defined pattern: dorsally a tracery extends from the base of the tentacles posteriorly and laterally to near the body margins, but becomes less dense towards the posterior. The pigment extends through the body outlining nerve tracts and major structures, and some is seen ventrally especially anterior to the mouth. Posterior adhesive disc pedunculate: disc diameter 280μm at rim, disc peduncle about 145μm in diameter. Epidermis syncitial with scattered nuclei, about 5-6μm high dorsally and ventrally. Cilia entirely absent.

Alimentary system. Mouth mid-ventral in anterior quarter of body. Buccal cavity or prepharynx inconspicuous. Pharynx directed antero-ventrally, as wide as long, about 180μm in diameter; strong, divided into anterior and posterior sphincter blocks by a region containing nucleated cells but few muscle fibres; lacking a non-cellular lip, with a conspicuous non-cellular lining (extending to buccal region), muscles not forming an obvious crenulate buccal rim. Pharynx sphincters slightly stronger posteriorly. Oesophagus inconspicuous. Gut darkly coloured, longer than wide to as wide as long; with ill-defined septa. Gastrodermis about 90μm high. Gut with diatoms.

Excretory system. Excretory pores lateral to mouth. Excretory ampulla a simple vacuole, thick

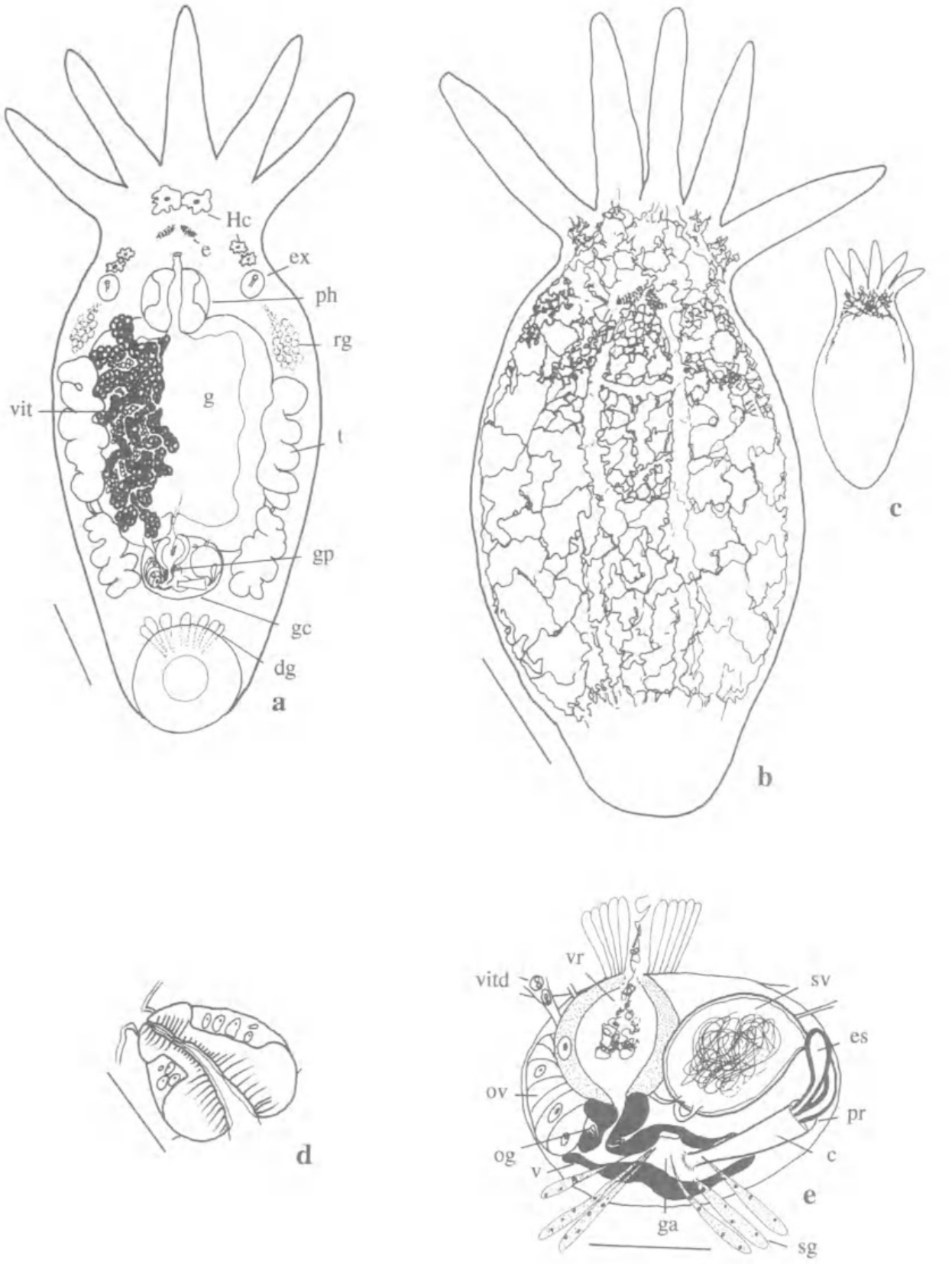


FIG. 1. *Temnocephala athertonensis* n.sp. a, internal anatomy of whole animal; b, dorsal pigment pattern; c, ventral pigment pattern; d, pharynx; e, detail of genital capsule. Scales: a,b, 250μm; c, not to scale; d,e, 100μm.

walled, about 75μm in diameter. Major excretory ducts conspicuous posterior to ampullae.

Nervous and sensory systems. Brain compact, transverse band. Major nerve trunks conspicuous in sections although pigment pattern outlines some. Eyes present, adjacent, with pigment mesh forming a single dark region, each about 40×25μm. Eye pigment granules irregular, mostly small (extremely fine), red-black.

Glands. Rhabdite glands in lateral fields anterior to anterior testes, numerous, 10 or more each side; each about 30μm across, with inconspicuous rhabdite tracts. Rhabdites only accumulate on tentacles. Haswell's cells conspicuous, six, a pair before brain, beside brain and before excretory pores (but median and lateral glands close together), each of the larger anterior pair irregular and about 50μm across, median pairs, smaller, about 30- 40μm across. Oesophageal glands inconspicuous (absent?). Ootype glands present (restricted to a small field). Shell glands present (a small group of eosinophilic glands posterior to gonopore). Posterio-lateral glands present, but difficult to see in whole mounts. Disc glands prominent, a discrete cluster.

Muscles. Longitudinal muscles of body wall of equal size or strength dorsally and ventrally. Circular muscles of body wall similar dorsally and ventrally. Dorso-ventral muscles weak. Attachment muscles of pharynx weak. Attachment muscles of adhesive disc moderately strong. Muscles controlling male organ strong immediately about the cirrus.

Reproductive system ♀. Gonopore mid-ventral, in posterior quarter of body. Genital atrium commodious. Genital complex contained in a connective tissue capsule. Ovary about 70μm in diameter. Vesicula resorbens present, about 80-100μm across, 15μm thick wall, with strong muscular duct or sphincter joining it to vagina, lying free of gut wall (in capsule), can open to gut. Seminal receptacles not present. Vagina strongly muscular, becoming less so proximally. Vitellaria dendritic, dorsal to ventral.

Reproductive system ♂. Testes elliptical: anterior about 170×230μm, lobulate, lateral to gut, posterior about 140×210μm, lobulate, lateral or posterior to gut. Vasa deferentia narrow, entering seminal vesicle separately. Seminal vesicle about 100μm in diameter. Ejaculatory sac present, with narrowed neck. Prostate bulb incorporated, i.e. continuation of cirrus base. Cirrus shaft gently curved. Cirrus hardly tapering, 80μm long, 35μm wide at base. Cirrus introvert not swollen, about 15μm or 1/6 length, only a weak collar of spinelets. Cirrus spinelets minute, few rows, i.e. <20.

ETYMOLOGY

The specific name pertains to the locality.

REMARKS

These worms from small freshwater crabs resemble most closely *T. minor* Haswell, 1888, the only species described with a grey tracery of pigment. The present species is only half the size of *T. minor* and the cirrus completely lacks the swollen introvert of that species. Furthermore, Haswell (1893) makes no mention of a capsule surrounding the genital organs, a characteristic of the present species. The pharynx of the present species is also distinctive. Posterio-lateral glands are present, but barely discernible. The only species described with such glands is *T. chaeropsis* Hett, 1925 from the crayfish '*Chaerops preissi*' (an old name: several species are now recognised from WA) from the region of Mammoth Cave, WA. In that species, however, the glands are conspicuous, adjacent and, furthermore, the worms lack conspicuous pigment except for the eyes (Hett, 1925).

Temnocephala butlerae n.sp.
(Figs 2,11d)

MATERIAL EXAMINED

HOLOTYPE: ex carapace *Holthuisana transversa* (Sundathelphusidae), Bore drain, Augathella (25.48°S, 146.35°E), 20 Apr. 1987, S. Butler, AFA/Haemalum GL14558 (W).

PARATYPES: same data as holotype, AFA/Hx GL14559 (W); Bouin's/H&E GL14560 (LS[3]).

OTHER MATERIAL: same data as holotype, AFA/H&E GL14561 (LS[1]).

DESCRIPTION

External characteristics. Body about 1.5mm long, and about 0.66mm wide; oval or elliptical, dorso-ventrally compressed, but without flanges. Pigment a light tracery over most of dorsal surface, extends to ventral surface (below eyes anterior to mouth). Posterior adhesive disc pedunculate; disc diameter 300μm at rim, disc peduncle 150μm in diameter. Epidermis syncitial, about 4μm high dorsally and ventrally. Cilia entirely absent.

Alimentary system. Mouth mid-ventral in anterior quarter of body. Buccal cavity or prepharynx conspicuous. Pharynx directed antero-ventrally, as wide as long, and about 160μm in diameter;

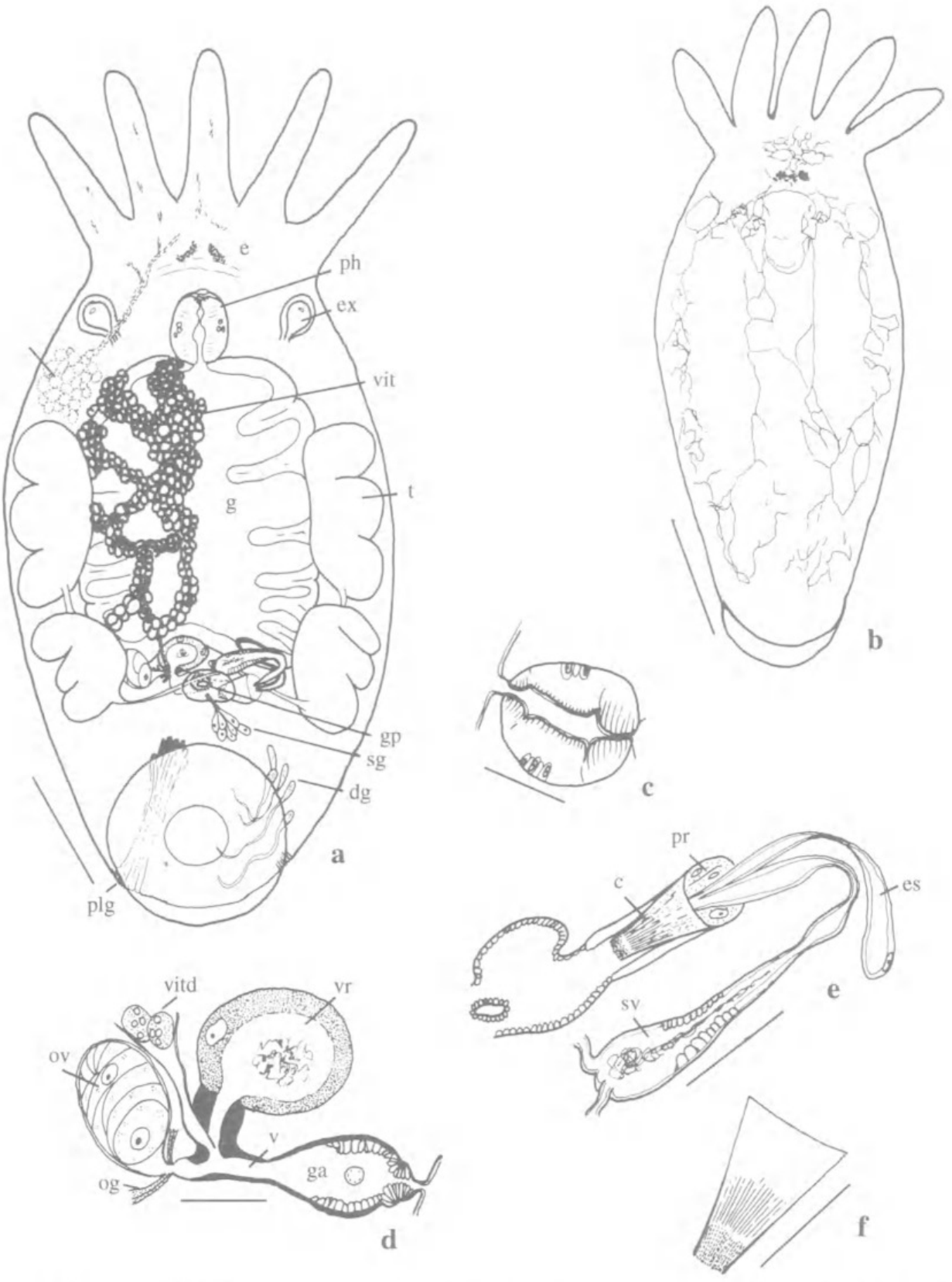


FIG. 2. *Temnocephala butlerae* n.sp. a, internal anatomy of whole animal; b, dorsal pigment pattern; c, pharynx; d, detail female reproductive system; e, detail male reproductive system; f, cirrus. Scales: a,b, 250μm; c-e, 100μm; f, 50μm.

strong, divided into anterior and posterior parts, containing nucleated cells within muscle blocks (concentrated between first and second blocks); lacking a non-cellular lip, with a conspicuous non-cellular lining, muscles forming a crenulate buccal rim. Pharynx sphincters stronger posteriorly. Oesophagus inconspicuous. Gut darkly coloured, longer than wide, weakly septate. Gastrodermis about 20-40μm high (numerous large cells filled with eosinophilic granules lie in gastrodermis).

Excretory system. Excretory pores posterior to mouth. Excretory ampulla a simple vacuole, thick walled (9- 10μm), about 90μm in diameter. Major excretory ducts inconspicuous.

Nervous and sensory systems. Brain compact, transverse band (20μm wide). Major nerve trunks inconspicuous. Eyes present, adjacent, with pigment mesh forming a single dark region, each about 35×25μm. Eye pigment granules irregular, mostly small, red-black.

Glands. Rhabdite glands in lateral fields anterior to anterior testes (well formed, resembling a bunch of grapes), numerous, 10 or more each side; each about 30μm in diameter, with prominent rhabdite tracts to tentacles. Rhabdites evident in ventral epidermis (anteriorly, as well as on tentacles). Two Haswell's cells outlined by pigment. Oesophageal glands prominent. Ootype glands present (not well developed). Shell glands present (eosinophilic, lying posterior to gonopore). Postero-lateral glands present (well developed, but hard to see as they are refractory to haematoxylin and eosin stains). Disc glands present (long tracks spread from peduncle/posterior body to discharge over the disc surface).

Muscles. Longitudinal muscles of body wall of equal size or strength dorsally and ventrally. Circular muscles of body wall similar dorsally and ventrally. Dorso-ventral muscles, attachment muscles of pharynx, of adhesive disc and those controlling male organ all weak.

Reproductive system ♀. Gonopore mid-ventral, in posterior third of body. Genital atrium commodious (sphincter present and muscular festoons about the walls). Genital complex scattered. Ovary about 80×50μm. Vesicula resorbens present, about 100×60μm, with 15μm thick wall, strong muscular duct or sphincter joining it to vagina; lying free of gut wall, not open to gut. Seminal receptacles not present. Vagina short, inner region weakly muscular, opening directly to atrium. Vitellaria dendritic, dorsal to ventral.

Reproductive system ♂. Testes elliptical: anterior about 270×200μm, lobulate, lateral to gut; posterior) about 230×210μm, lobulate, posterior or postero-lateral to gut. Vasa deferentia swollen, entering seminal vesicle separately. Seminal vesicle 95×55μm, with long reflexed ejaculatory duct from it to base of cirrus. Ejaculatory sac present (long), with narrowed neck. Prostate bulb incorporated, i.e. continuation of cirrus base. Cirrus shaft straight. Cirrus strongly tapering, about 70μm long, about 54μm wide at base. Cirrus introvert not swollen, weakly sclerotic, inner surface thrown in to fine ridges becoming a few rows of spinelets.

ETYMOLOGY

The specific name refers to the collector, Dr Shirley Butler.

REMARKS

As with *T. athertonensis* there is a tracery of pigment over the dorsal surface which resembles only one previously described species, *T. minor* Haswell, 1888. The nature of the cirrus and the presence of the postero-lateral glands separates it clearly from *T. minor*. It is close to *T. athertonensis*, but differs in having much finer pigment, a pharynx with a stronger central muscle region, a less muscular vagina, a small, broad cirrus, and most obviously in lacking the conspicuous capsule about the genital organs.

Temnocephala improcera n.sp.
(Figs 3,11e)

MATERIAL EXAMINED

HOLOTYPE: ex *Caridina indistincta* (Atyidae), Murray R., nr Kirrama (18.01°S, 145.53°E), 26 Jul. 1984, L. Winsor, Form./H&E GL14576 (LS[2]).

PARATYPES: same data as holotype, Form./Mallory's GL14577 (LS[1]).

OTHER MATERIAL: same data as holotype, Form./Hx GL14578 (damaged W).

DESCRIPTION

External characteristics. Body about 700μm long, and 350μm wide; oval or elliptical, not dorso-ventrally compressed. Pigment extends through body, prominent on dorsal and ventral surfaces. Posterior adhesive disc pedunculate: disc diameter 230μm at rim, disc peduncle about 100μm across. Epidermis syncitial, 3.5μm high dorsally, 5.5μm high ventrally. Cilia entirely absent.

Alimentary system. Mouth mid-ventral in anterior quarter of body. Buccal cavity or prepharynx

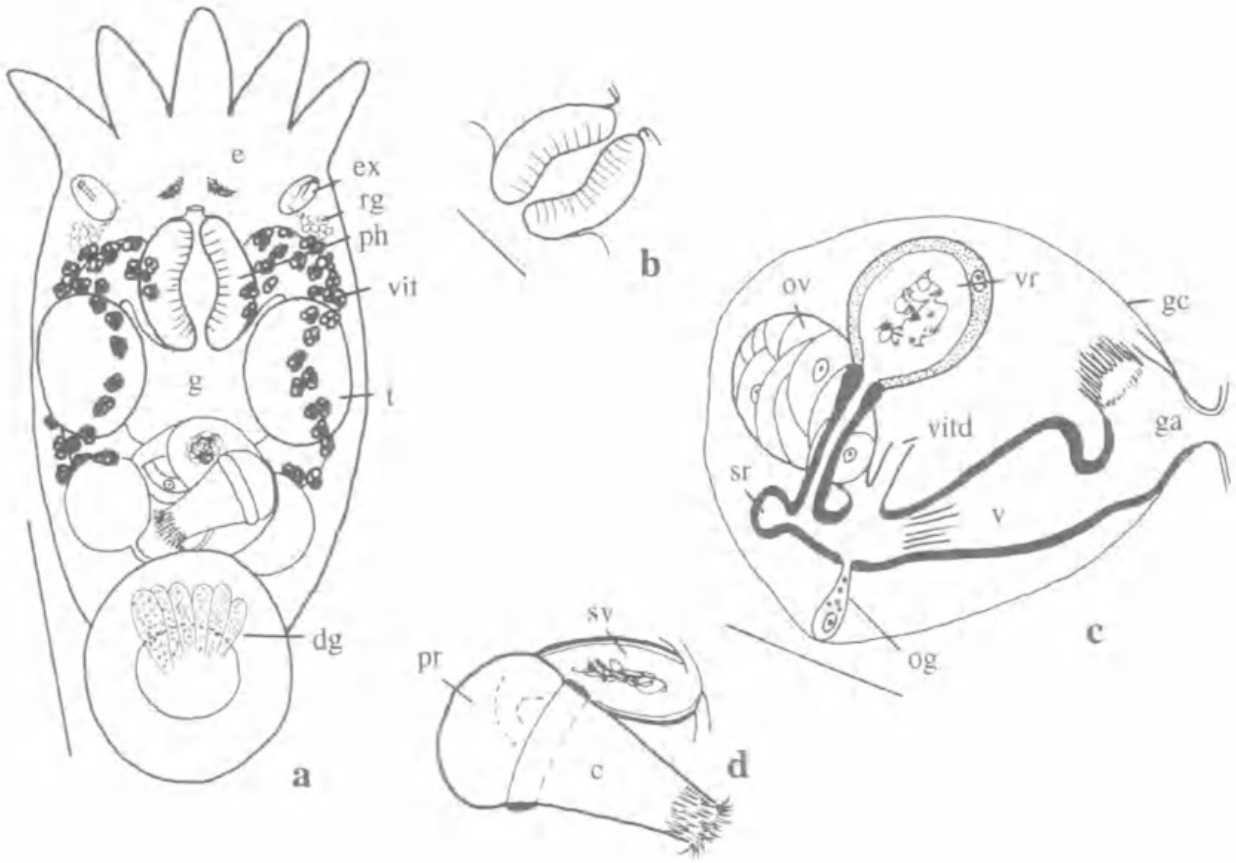


FIG. 3. *Temnocephala improcera* n.sp. a, internal anatomy of whole animal; b, pharynx; c, detail of female reproductive system; d, detail of male reproductive system. Scales: a, 250μm; b,c-d,100μm.

inconspicuous. Pharynx directed antero-ventrally, as wide as long, about 145×130μm; strong, undivided, with a few tiny eosinophilic glands in the muscle block; lacking a non- cellular lip, without a conspicuous non-cellular lining, muscles not forming an obvious crenulate buccal rim. Pharynx sphincters equal. Oesophagus inconspicuous. Gut darkly coloured (filled with brown globular (about 5-10μm) inclusions), longer than wide; with septa. Gastrodermis 60μm high.

Excretory system. Excretory pores anterior to mouth. Excretory ampulla a simple vacuole (but elongate), thick walled (12-14μm), about 70×30μm.

Nervous and sensory systems. Brain compact, transverse band. Major nerve trunks inconspicuous. Eyes present, discrete, well separated, about 20×30μm. Eye pigment granules irregular, mostly small, black-brown.

Glands. Rhabdite glands in lateral fields anterior to anterior testes. Rhabdites only accumulate on tentacles (?). Haswell's cells and oesophageal glands inconspicuous (absent?). Ootype glands present. Shell glands and postero-lateral glands absent. Disc glands conspicuous, filling the posterior body.

Muscles. Longitudinal muscles of body wall stronger ventrally. Circular muscles of body wall similar dorsally and ventrally. Dorso-ventral muscles weak. Attachment muscles of pharynx weak. Attachment muscles of adhesive disc strong. Muscles controlling male organ weak.

Reproductive system ♀. Gonopore mid-ventral, in posterior third of body. Genital atrium small. Genital complex contained in a connective tissue capsule. Ovary about 120×60μm. Vesicula resorbens present, about 70×35μm, 7μm thick wall; lying free of gut wall, not open to gut. Seminal receptacle single. Vaginal teeth absent. Vagina long, compartmentalised. Vitellaria scattered laterally, dorsal to ventral.

Reproductive system ♂. Testes rounded: anterior about 150μm in diameter, smooth, lateral to gut, posterior about 100μm in diameter, smooth, lateral or postero-lateral to gut. Vasa deferentia narrow, entering seminal vesicle separately. Seminal vesicle about 35×100μm. Ejaculatory

sac absent (?). Prostate bulb separate, i.e. wider than cirrus base. Cirrus shaft straight. Cirrus hardly tapering, 100μm long, 70μm wide at base, with basal collar. Cirrus introvert not swollen, about 25μm or 1/4 of the cirrus length. Cirrus spinelets moderately sized, filling inside, few rows, i.e. <20.

ETYMOLOGY

From *improcerus* L. = short, referring to the cirrus.

REMARKS

The combination of a pigmented body and the presence of a genital capsule means this species resembles most closely *T. athertonensis* (see above). However, it is much smaller, lacks the postero-lateral glands (though these are poorly developed in *T. athertonensis*), has smooth not lobulate testes, possesses a single seminal receptacle and has a short broad cirrus with a distinctive basal collar: none of these characters are shared with *T. athertonensis*.

Temnocephala minuta n.sp.
(Fig. 4)

MATERIAL EXAMINED

HOLOTYPE: ex *Paratya australiensis* (Atyidae), Sandy Ck tributary of Dawson R. nr Taroom (25.39°S, 149.48°E), 3 Dec. 1986, L. Cannon & J. Jennings, AFA/Haemalum., GL14555 (W).

PARATYPE: same data as holotype, AFA/H&E GL14556 (LS[2]).

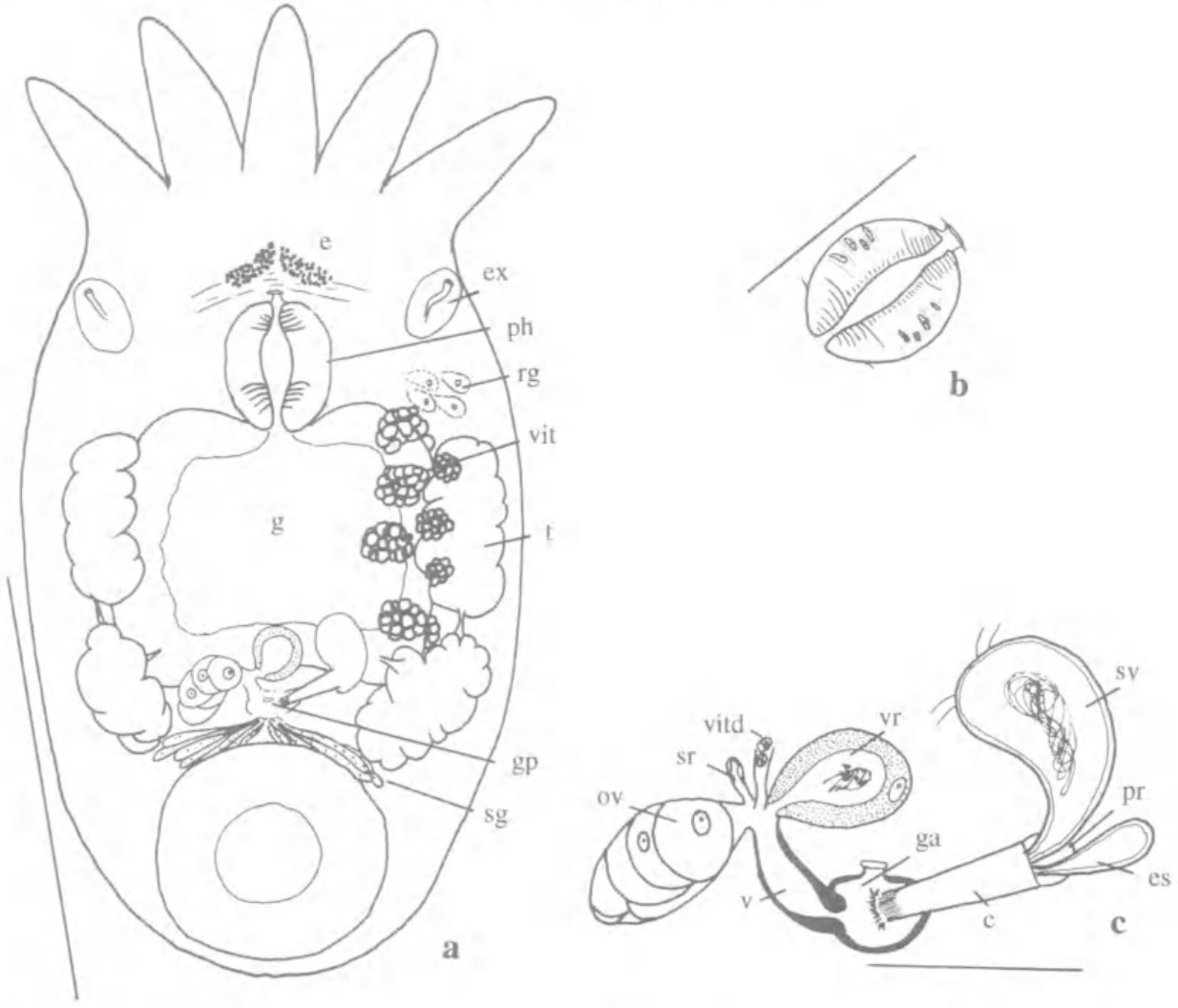


FIG. 4. *Temnocephala minuta* n.sp. a, internal anatomy of whole animal; b, pharynx; c, detail of reproductive systems. Scales: a, 250μm; b, 100μm; c, 50μm.

DESCRIPTION

External characteristics. Body about 550μm long, and 300μm wide; rounded to oval or elliptical, dorso-ventrally compressed, but without flanges. Pigment confined to eyes. Posterior adhesive disc pedunculate: disc diameter 120μm at rim, disc peduncle about 50μm in diameter. Epidermis syncitial, about 2μm high dorsally and ventrally. Cilia entirely absent.

Alimentary system. Mouth mid-ventral in anterior quarter of body. Buccal cavity or prepharynx inconspicuous. Pharynx directed antero-ventrally, as wide as long, about 80μm; strong, undivided, with nucleated cells in muscle blocks; lacking a non-cellular lip, without a conspicuous non-cellular lining, muscles not forming a crenulate buccal rim. Pharynx sphincters stronger posteriorly. Oesophagus inconspicuous. Gut lacking colour, as wide as long; without septa. Gastrodermis about 20-30μm high. Gut contains bacteria.

Excretory system. Excretory pores lateral to mouth. Excretory ampulla a simple vacuole, thick walled, about 30μm in diameter. Major excretory ducts inconspicuous.

Nervous and sensory systems. Brain compact, transverse band. Eyes present, contiguous, 25×15μm. Eye pigment granules irregular, mostly small, red-black.

Glands. Rhabdite glands in lateral fields anterior to anterior testes, few <10 each side; 12-15μm in diameter, with inconspicuous rhabdite tracts. Rhabdites apparently only accumulate on tentacles. Oesophageal glands and ootype glands inconspicuous (absent?). Shell glands present (a small cluster ventral to gonopore). Postero-lateral glands absent. Disc glands present.

Muscles. Longitudinal muscles of body wall stronger ventrally (especially at base of tentacles). Circular muscles of body wall similar dorsally and ventrally. Dorso-ventral muscles strong. Attachment muscles of pharynx weak. Attachment muscles of adhesive disc strong. Muscles controlling male organ weak.

Reproductive system ♀. Genital atrium small (but muscular). Genital complex scattered. Ovary about 30-50μm in diameter. Vesicula resorbens present, about 25-30μm across, 5μm thick wall; lying free of gut wall, not open to gut. Seminal receptacle, single, 7×3μm. Vagina short, simple (but with sphincter at opening to genital atrium). Vitellaria clustered, laterally above and below testes.

Reproductive system ♂. Testes elliptical: anterior about 110×66μm, lobulate, lateral to gut, posterior about 100×63μm, lobulate, posterior to gut. Vasa deferentia narrow. Seminal vesicle about 63×40μm. Ejaculatory sac present, with narrowed neck. Prostate bulb incorporated, i.e. continuation of cirrus base. Cirrus shaft straight. Cirrus hardly tapering, 36μm long, 11μm wide at base. Cirrus introvert not swollen, 7μm or 1/5 of the cirrus length. Cirrus spinelets minute, few rows, i.e. <20.

ETYMOLOGY

From *minutus* L. = small, refers to body size.

REMARKS

This species resembles most closely *T. cita* Hickman, 1967 in lacking pigment except for the eyes and in possession of a cirrus without a median spine. *T. cita* is very much larger, has a cirrus about 5× as big, 4 seminal receptacles (not one), and smooth, unequal testes (not subequal, lobed ones). The only other unpigmented species are *T. dendyi* Haswell, 1893 and *T. engaei* Haswell, 1893. Both these species have a median spine within the cirrus.

Temnocephala neqae n.sp.
(Figs 5,11f)

MATERIAL EXAMINED

HOLOTYPE: ex gills of *Macrobrachium rosenbergii* (Palaemonidae), Mitchell R. at Mt Carbine (16.32°S,145.08°E), Nov. 1981, J. Short, Form./Hx., GL14518 (W).

PARATYPES: same data as holotype, GL14519 (W); ex gills of *M. rosenbergii* (Palaemonidae), Mitchell R., Dec. 1981, B. Power, Form./Mallory's GL14525-6 (LS[2,3]), Form./Gomori's GL14527 (TS[2]).

OTHER MATERIAL: same data as holotype, GL14520-35 (W); Form./H&E GL14537 (LS[3]); GL14538 (egg on gills of host); ex gills of *M. rosenbergii* (Palaemonidae), Mitchell R., Dec. 1981, B. Power, Form./Mallory's GL14536 (W).

DESCRIPTION

External characteristics. Body about 800-1400μm (mean=1040μm) long, and 430–720μm (mean=540μm) wide; oval or elliptical, dorso-ventrally compressed, with flanged edges. Pigment confined to eyes. Posterior adhesive disc pedunculate: disc diameter 220μm at rim, disc peduncle about 125μm across. Epidermis syncitial, 5μm high dorsally, 3μm high ventrally. Cilia entirely absent.

Alimentary system. Mouth mid-ventral in anterior quarter of body. Buccal cavity or prepharynx inconspicuous. Pharynx directed ventrally, wider

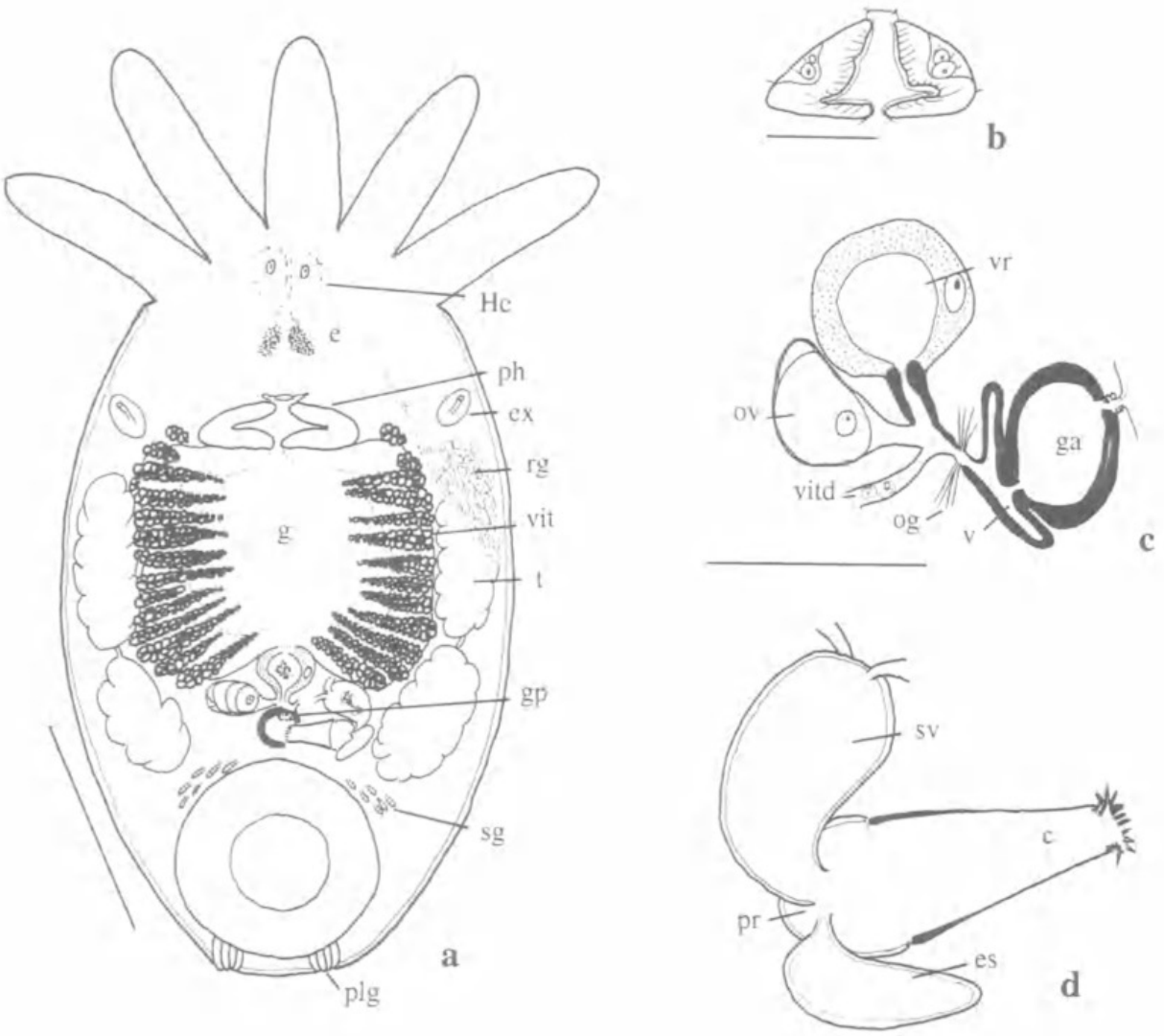


FIG. 5. *Temnocephala neqae* n.sp. a, internal anatomy of whole animal; b, pharynx; c, detail of female reproductive system; d, detail of male reproductive system. Scales: a, 250μm; b, 100μm; c-d, 50μm.

than long, about 95 × 180μm; strong, undivided, with nucleated cells within muscle blocks; lacking a non-cellular lip, with a conspicuous non-cellular lining, muscles forming a crenulate buccal rim. Pharynx sphincters stronger posteriorly. Oesophagus inconspicuous. Gut lacking colour, as wide as long; without septa. Gastrodermis to 16μm high. Gut contains ?rotifers.

Excretory system. Excretory pores posterior to mouth. Excretory ampulla a simple vacuole, thick walled (12μm), about 50 × 36μm. Major excretory ducts conspicuous.

Nervous and sensory systems. Brain compact, transverse band. Major nerve trunks inconspicuous. Eyes present, contiguous, about 40 × 30μm. Eye pigment granules irregular, mostly small, black-brown.

Glands. Rhabdite glands in lateral fields anterior to anterior testes, numerous, 10 or more each side; about 20μm in diameter, with prominent rhabdite tracts to tentacles. Rhabdites only accumulate on tentacles (?). Haswell's cells inconspicuous (only two before brain), each ill defined about 80 × 50μm. Oesophageal glands present. Ootype glands prominent. Shell glands in prominent lateral fields discharging to gonopore. Postero-lateral glands prominent. Disc glands present.

Muscles. Longitudinal muscles of body wall stronger ventrally. Circular muscles of body wall similar dorsally and ventrally. Dorso-ventral muscles and attachment muscles of pharynx weak. Attachment muscles of adhesive disc mod-

erately strong. Muscles controlling male organ strong.

Reproductive system ♀. Gonopore mid-ventral, in posterior third of body. Genital atrium large, muscular. Genital complex scattered. Ovary about 62 × 50μm. Vesicula resorbens present, about 48 × 80μm, 13μm thick wall; embedded in gut wall, opens to gut (in some). Seminal receptacles not present. Vaginal teeth absent. Vagina simple (muscular). Vitellaria dendritic, lateral. Egg capsules ellipsoid, about 300 × 100μm; attached on end on a stalk, on gills.

Reproductive system ♂. Testes elliptical: anterior about 170 × 85μm, lobulate, lateral to gut; posterior about 165 × 95μm, lobulate, lateral to or posterior to gut. Vasa deferentia narrow, entering seminal vesicle separately. Seminal vesicle about 70 × 30μm. Ejaculatory sac present, with narrowed neck. Prostate bulb separate, i.e. wider than cirrus base. Cirrus shaft straight. Cirrus hardly tapering, 52μm long, 30μm wide at base. Cirrus introvert not swollen, only about 12μm or 1/4 of the cirrus length, i.e. about the length of the 2-3 rows of cirral spines. Cirrus spinelets moderately sized, few rows, i.e. <20.

ETYMOLOGY

The specific name refers to northeast Queensland.

REMARKS

The only described species with prominent postero-lateral glands is *Temnocephala chaeropsis* Hett, 1925 from a crayfish '*Chaerops preissi*' from near Mammoth Cave, WA. Unlike the present species, the glands are very close together; among other differences *T. chaeropsis* is much bigger, has four seminal receptacles, evidently lacks an ejaculatory sac and the introvert of the cirrus is more elaborate. Both *T. athertonensis* and *T. butlerae* (see above) also have postero-lateral glands; in neither species are they prominent and easily seen; furthermore, both species are pigmented, unlike the present species.

Temnocephala queenslandensis n.sp.
(Fig. 6)

MATERIAL EXAMINED

HOLOTYPE: ex *Macrobrachium australiense* (Palaemonidae), Hayes Ck off Moggill Ck Brisbane (27.30.4°S, 152.55.8°E), 7 Mar. 1990, L. Cannon & K. Sewell, AFA/Haemalum GL14539 (W).

PARATYPES: same data as holotype, AFA/ H&E GL14540-1 (LS[1,1]).

OTHER MATERIAL: ex *M. australiense* (Palaemonidae), Highvale (27.23°S, 152.48°E), 10 May 1990, L. Cannon & K. Sewell, Bouin's/H&E GL14542 (LS[1]); AFA/Haemalum GL14543 (W); Upper Cedar Ck (27.19.2°S, 152.55.8°E), 10 Apr. 1990, L. Cannon & K. Sewell, Boiling water/AFA/Haemalum GL14544 (W); same data as holotype 14545-9 (W); Ithaca Ck, Brisbane (27.29°S, 152.57°E), 20 Oct. 1988, J. Short, Form./Hx GL14550 (W); Gold Ck, Brisbane (27.25.6°S, 152.50.9°E), 6 Mar. 1990, L. Cannon & K. Sewell, AFA/Haemalum G14551-2 (W); Bouin's/H&E G14553-4 (FS[1,1]); Booloumba Ck (26.39°S, 152.39°E), 23 Mar. 1990, L. Cannon & K. Sewell, AFA/Haemalum G14609-11 (W); AFA/H&E G14612-5 (LS[1,1,1,1,]); Six mile Ck, Cooran (26.20°S, 152.50°E), 23 Mar. 1990, L. Cannon & K. Sewell, SUSA/Haemalum GL14616 (W); SUSA/Haemalum GL14617-8 (LS[1,1]); AFA/Haemalum GL14619-21 (W); Bouin's/H&E GL14622-3 (W); Kin Kin Ck (26.16°S, 152.53°E), 23 Mar. 1990, L. Cannon & K. Sewell, Bouin's/Haemalum GL14624-5 (W); AFA/Haemalum GL14626-28 (W); AFA/H&E GL14629-30 (LS[2,1]); Bouin's/H&E GL14631 (LS[2]); Kroombit Ck, Kroombit Tops (24.23.0°S, 151.00.2°E), 20 Sep. 1990, L. Cannon & K. Sewell, AFA/Hx GL14632 (W); AFA/H&E GL14633 (LS[1]); Tributary of Broken R., Eungella NP (28.10.8°S, 148.32.2°E), 21 Sep. 1990, L. Cannon & K. Sewell, Hot water/AFA/Hx GL14634-5 (W); Bouin's/H&E GL14636-8 (LS[1,1,1]); Stuart Ck, Townsville (19.19.4°S, 146.50.2°E), 23 Sep. 1990, L. Cannon & K. Sewell, AFA/Hx GL14639 (W); Bouin's/H&E GL14640 (LS[1]); upper Pozzle Ck, Hidden Valley, Paluma (18.59°S, 146.01°E), 2 May 1982, L. Winsor, Form./Hx GL14641 (W); Form./H&E GL14642-3 (LS[2,1]); tributary (No. 4) of Blackfellow Ck, Edmonton (17.00.6 E, 145.43.0°E), 28 Sep. 1990, L. Cannon & K. Sewell, AFA/Hx GL14646 (W); Rocky Ck, Carbeen (17.11.2°S, 145.26.8°E), 28 Sep. 1990, L. Cannon & K. Sewell, Bouin's/H&E GL14647-8 (LS[1,1]); Jumrun Ck, Kuranda (16.46.8°S, 145.38.0°E), 28 Sep. 1990, L. Cannon & K. Sewell, Hot water/AFA/Hx GL14649; Bouin's/H&E GL14650,18241 (LS[1,2]); Western R., Cragg Family Bridge, Winton (22.25.0°S, 143.01.9°E), 2 Oct. 1990, L. Cannon & K. Sewell, AFA/Hx GL18242 (W); Bouin's/H&E GL18243 (LS[1]); Longreach Waterhole, Longreach (23.24.7°S, 144.13.8°E), 3 Oct. 1990, L. Cannon & K. Sewell, Bouin's/H&E GL18244-5 (LS[2,1]); Lagoon Ck, Barcaldine (23.33.5°S, 145.16.6°E), 23 Sep. 1990, S. Cook, Alcohol/Haemalum GL18246-48 (W); Dawson R., Taroom (25.39°S, 149.48°E), 3 Dec. 1986, L. Cannon & J. Jennings, AFA/Haemalum GL18249-50 (W); AFA/H&E GL18251 (LS[2]); Carnarvon Ck (25.06.5°S, 148.18.3°E), 18 Sep. 1990, S. Cook, Alcohol/Hx GL18252 (W); ex *M. tolmerum* (Palaemoni-

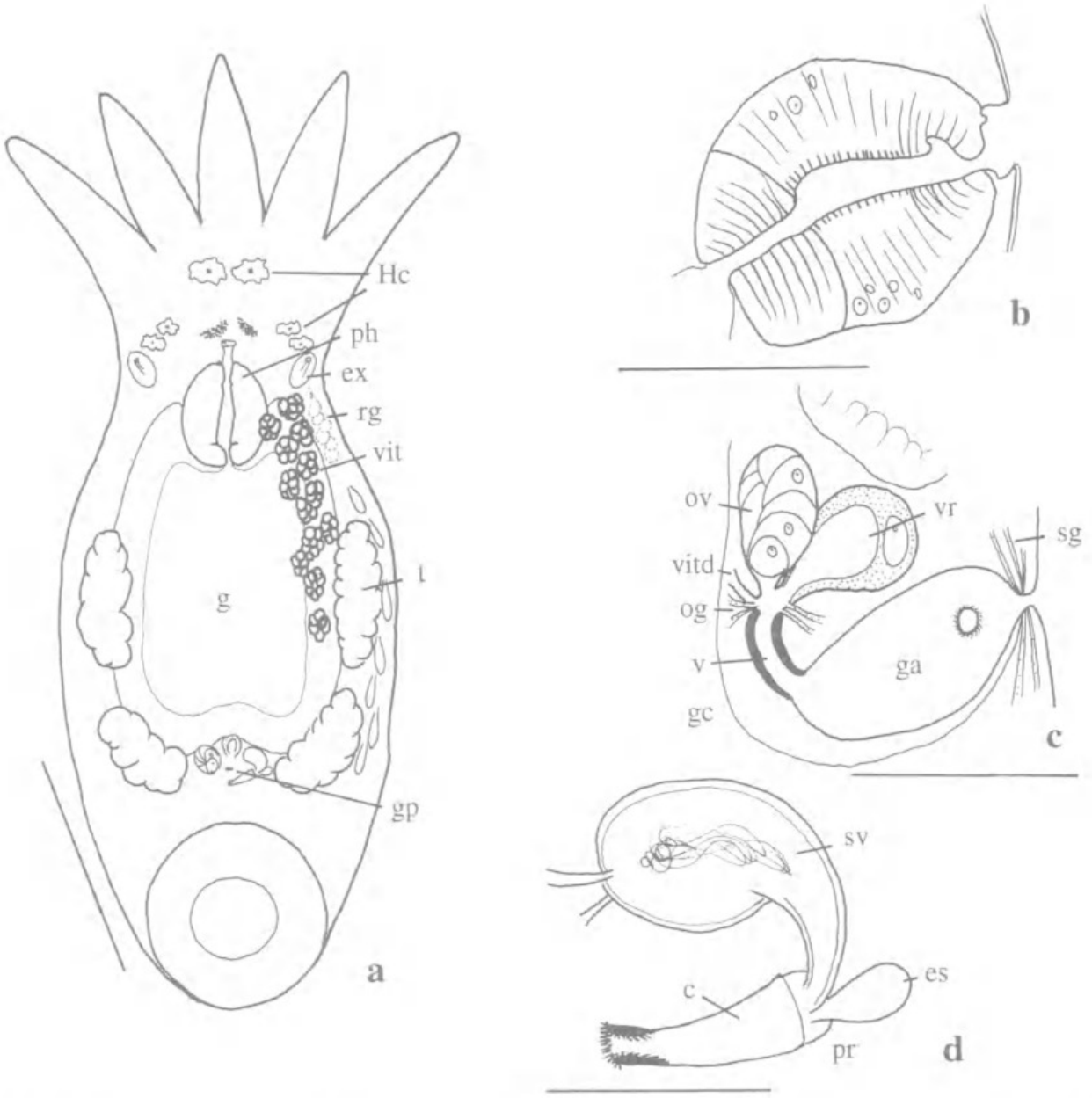


FIG. 6. *Temnocephala queenslandensis* n.sp. a, internal anatomy of whole animal; b, pharynx; c, detail of female reproductive system; d, detail of male reproductive system. Scales: a 250μm; c, 100μm; b, d, 50μm.

dae), Freshwater Ck, Cairns (16.54.1°S, 145.42.4°E), 23 Sep. 1990, L. Cannon & K. Sewell, AFA/Hx GL14644 (W); Bouin's/H&E GL14645 (LS[1]).

DESCRIPTION

External characteristics. Body about 650-950μm (mean=775μm) long, and 290- 350μm (mean=315μm) wide; oval or elliptical, not dorso-ventrally compressed. Pigment confined to eyes. Posterior adhesive disc pedunculate: disc diameter 155μm at rim, disc peduncle about 70μm across. Epidermis syncitial (a strongly staining basement membrane and numerous cell walls seen), 2μm high dorsally and ventrally. Cilia entirely absent.

Alimentary system. Mouth mid-ventral in anterior quarter of body. Buccal cavity or prepharynx conspicuous. Pharynx directed antero-ventrally, as wide as long, about 80μm in diameter; strong, not divided into anterior and posterior parts, without conspicuous nucleate cells within muscle blocks; lacking a non-cellular lip, with a conspicuous non-cellular lining, muscles not forming an obvious crenulate buccal rim. Pharynx sphinc-

ters stronger posteriorly. Oesophagus inconspicuous. Gut lacking colour, as wide as long; without septa. Gastrodermis 50μm high.

Excretory system. Excretory pores lateral to mouth. Excretory ampulla a simple vacuole, thick walled (10μm), about 40×20μm. Major excretory ducts inconspicuous.

Nervous and sensory systems. Brain compact, transverse band. Major nerve trunks inconspicuous. Eyes present, contiguous, about 20×10μm. Eye pigment granules medium, even sized, black-brown.

Glands. Rhabdite glands extending laterally beyond testes, numerous, 10 or more each side; 7-10μm in diameter, with prominent rhabdite tracts to tentacles. Rhabdites only accumulate on tentacles. Haswell's cells present, 2 before eyes and two before each excretory ampulla. Oesophageal glands present. Ootype glands present. Shell glands in prominent lateral fields discharging to gonopore. Postero-lateral glands inconspicuous (absent?). Disc glands present.

Muscles. Longitudinal muscles of body wall of equal size or strength dorsally and ventrally. Circular muscles of body wall similar dorsally and ventrally. Dorso-ventral muscles moderately strong. Attachment muscles of pharynx weak. Attachment muscles of adhesive disc strong (moderately). Muscles controlling male organ weak.

Reproductive system ♀. Gonopore mid-ventral, in posterior third of body. Genital atrium commodious. Genital complex in weak capsule. Ovary about 115×40μm. Vesicula resorbens present, about 40μm in diameter, 8-10μm thick wall; embedded in gut wall, opens to gut (in some). Seminal receptacles absent. Vagina short, simple. Vitellaria in lateral clusters.

Reproductive system ♂. Testes elliptical: anterior about 115×40μm, lobulate, lateral to gut; posterior about 100×50μm, lobulate, posterior to gut. Vasa deferentia swollen, entering seminal vesicle separately. Seminal vesicle about 50×20μm. Ejaculatory sac present, but small with narrowed neck. Prostate bulb incorporated, i.e. continuation of cirrus base (not well defined). Cirrus shaft gently curved (proximally very fine). Cirrus hardly tapering, 45μm long, 17μm wide at base. Cirrus introvert not swollen (slightly thickened and noticeably more thickened than shaft), about 9μm or nearly 1/5 of the cirrus length. Cirrus spinelets moderately sized, few rows, i.e. <20.

ETYMOLOGY

The specific name refers to the locality, Queensland.

REMARKS

Four species completely lack pigment except for the eyes, viz., *T. cita* Hickman, 1967, *T. dendyi* Haswell, 1893 *T. engaei* Haswell, 1893 and *T. minuta* (see above). Only *T. cita* and *T. minuta* have a cirrus without a median spine, but the cirrus is much larger (3-4×) in *T. cita*, and is slightly smaller and straighter in *T. minuta*, than in the present species. *T. cita* also has smooth, oval testes of unequal size and possesses 4 seminal receptacles, whereas *T. minuta* has a single seminal receptacle. These characters distinguish these worms from *T. queenslandensis*.

Temnocephala sp.

MATERIAL EXAMINED

ex shrimp (Atyidae), Sandy Ck nr Taroom (25.39°S, 149.48°E), 3 Dec. 1986, L. Cannon & J. Jennings. Form./Haemalum., GL14517 (W).

DESCRIPTION

External characteristics. Body about 315μm long, and 200μm wide; rounded, dorso-ventrally compressed, but without flanges. Pigment entirely absent, i.e. not even eyes. Posterior adhesive disc pedunculate: disc diameter 100μm at rim, disc peduncle about 60μm across. Epidermis syncitial (?). Cilia entirely absent.

Alimentary system. Mouth mid-ventral in anterior quarter of body. Buccal cavity or prepharynx inconspicuous. Pharynx directed antero-ventrally, wider than long, about 56×42μm; strong, undivided, without prominent nucleate cells in muscle blocks; lacking a non-cellular lip, without a conspicuous non-cellular lining, muscles forming a slightly crenulate buccal rim. Pharynx sphincters stronger posteriorly. Oesophagus inconspicuous. Gut lacking colour, as wide as long; without septa.

Excretory system. Excretory pores dorso-lateral, lateral to mouth. Excretory ampullae about 40×35μm, thick walled (about 5μm). Major excretory ducts inconspicuous.

Nervous and sensory systems. Brain bilobed. Major nerve trunks inconspicuous. Eyes absent.

Glands. Rhabdite glands lateral to testes; with inconspicuous rhabdite tracts.

Muscles. Longitudinal muscles of body wall of equal size or strength dorsally and ventrally.

Reproductive system ♀. Gonopore mid-ven-

tral, in posterior third of body. Genital atrium small (but muscular). Genital complex scattered. Ovary about 18 × 10μm. Vesicula resorbens present, about 31 × 21μm; lying free of gut wall. Seminal receptacles not present (?). Vagina short, simple. Vitellaria dendritic.

Reproductive system ♂. Testes elliptical: anterior about 70 × 35μm, lobulate, lateral to gut, posterior about 35 × 40μm, lobulate, posterior to gut. Vasa deferentia swollen. Seminal vesicle about 35 × 18μm. Ejaculatory sac present. Cirrus shaft gently curved. Cirrus hardly tapering, 36μm long, 14μm wide at base. Cirrus introvert not swollen, about 9μm or 1/4 of the cirrus length. Cirrus spinelets minute, few rows, i.e. <20.

REMARKS

As this is a single immature specimen no type designation is made. The complete lack of eyes, however, strongly suggests this will prove a new species.

Temnohaswellia Pereira & Cuocolo, 1941

Generic diagnosis. Temnocephalidae with 6 anterior tentacles, a posterior adhesive disc, two pairs of testes postero-lateral to gut.

Temnohaswellia pugna n.sp.
(Figs 7,11g)

MATERIAL EXAMINED

HOLOTYPE: ex *Caridina* sp. (?*nilotica*) (Atyidae), Aplin Weir on Ross R., Townsville (19.22°S, 146.44°E), 1976, L. Winsor, Form./Picrocarmine GL14579 (W).

DESCRIPTION

External characteristics. Body about 1700μm long (tentacles about 500μm), and 1000μm wide; rounded, dorso-ventrally compressed, with flanged edges. Pigment confined to eyes and adjacent area (just a scatter between eyes). Posterior adhesive disc pedunculate: disc diameter 350μm at rim, disc peduncle about 180μm across. Disc musculature does not create surface ridges. Epidermis syncitial (?). Cilia entirely absent.

Alimentary system. Mouth mid-ventral in anterior quarter of body. Buccal cavity or prepharynx inconspicuous. Pharynx directed antero-ven-

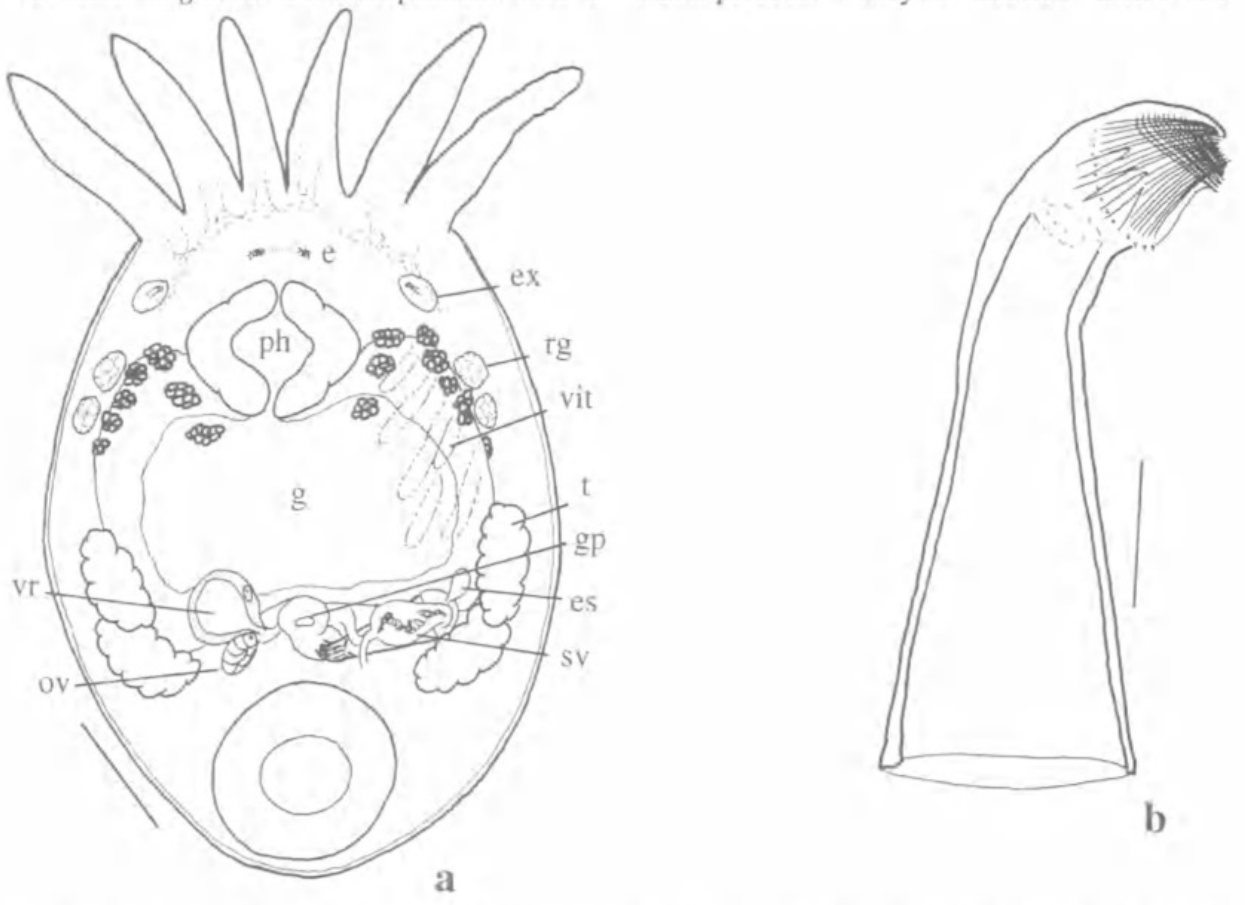


FIG. 7. *Temnohaswellia pugna* n.sp. a, internal anatomy of whole animal; b, cirrus. Scales: a, 250μm; b, 50μm.

trally, wider than long, about 360×270μm; strong, undivided, with nucleate cells within muscle blocks; lacking a non-cellular lip, without a conspicuous non-cellular lining, muscles forming a crenulate buccal rim. Pharynx sphincters subequal, slightly stronger posteriorly. Oesophagus inconspicuous. Gut lacking colour, with 3 ill-defined septa per side. Gastrodermis about 80μm high. Gut contains muscle, crustacea and diatoms.

Excretory system. Excretory pores lateral to mouth. Excretory ampulla strongly coiled, thin walled (10μm), about 90×70μm. Major excretory ducts inconspicuous.

Nervous and sensory systems. Brain compact, transverse band. Major nerve trunks inconspicuous. Eyes present, discrete, well separated (but scattered granules between them), about 20μm across. Eye pigment granules irregular, mostly small, black-brown.

Glands. Rhabdite glands? in lateral fields anterior to anterior testes, in two clumps (the smaller is posterior), with prominent rhabdite tracts to tentacles. Rhabdites evident in dorsal and ventral epidermis. Haswell's cells inconspicuous (absent?). Postero-lateral glands absent.

Reproductive system ♀. Gonopore mid-ventral, in posterior third of body. Genital atrium small. Genital complex scattered. Ovary about 70×5μm. Vesicula resorbens present, about 140μm across, 15μm thick wall; lying free of gut wall, not open to gut. Seminal receptacles absent (?). It is not clear from the specimen if vaginal teeth or muscular ribs are present. Vagina complex, outer region muscular, inner simpler. Vitellaria dendritic, dorsal over gut and lateral (plus some ventral behind pharynx).

Reproductive system ♂. Testes elliptical: anterior about 250×100μm, posterior about 220×100μm, lobulate, slightly overlapping. Vasa deferentia swollen. Seminal vesicle sinuous about same length as cirrus. Ejaculatory sac present, with narrowed neck. Prostate bulb incorporated, i.e. continuation of cirrus base. Cirrus shaft straight. Cirrus strongly tapering, 240μm long, 90μm wide at base. Cirrus introvert swollen, slightly thickened and reflexed as with a clenched fist, about 80×45μm or 1/3 of the cirrus length. Cirrus spines apparently at base of introvert. Cirrus spinelets minute to moderately sized, numerous rows, i.e. >20.

ETYMOLOGY

From *pugnus* L. = fist, referring to the shape of the cirrus introvert.

REMARKS

Pereira & Cuocolo (1941) erected the genus *Temnohaswellia* with *T. novaezealandiae* (Haswell, 1888) as the type species. They included in the genus *T. comes* (Haswell, 1893) and placed the poorly described *T. simulator* (Haswell, 1924) in synonymy with it. Baer (1953) rejected the genus believing the possession of 6 tentacles insufficient justification on which to erect a new genus, although he allowed that coupled with the vaginal teeth found in *T. novaezealandiae* there may be justification. This latter character is, however, absent from *T. comes*.

First, Haswell (1924) who was a careful worker clearly distinguished *T. simulator* from *T. comes*: *T. simulator* is here recognised as a valid species. Secondly, Haswell (on the same page) suggests the elaborate vagina of *T. novaezealandiae* may be 'an enormous extension of the thick sphincter of *T. comes* and the metraterm which subtends it.' Thus Haswell clearly saw a link between these species. Further, the relatively posterior position of the testes (overlapping and at the rear of the gut) and the presence of two pairs of clumped glands at the anterior lateral margin of the gut as Fyfe (1942) showed in *T. novaezealandiae* I believe provide characters coupled with the others to indicate these species are related. Fyfe (1942) claimed these paired anterior glands were prostate glands: their position certainly is in more keeping with rhabdite glands. The material available is not adequate to distinguish this character, and regrettably Haswell (1893) did not fully describe *T. comes*. Nevertheless, I believe the genus *Temnohaswellia* Pereira & Cuocolo, 1941 should be recognised as valid. Of the three known species, viz. *T. comes* (Haswell, 1893) which is unpigmented, and T. simulator (Haswell, 1924) and *T. novaezealandiae* (Haswell, 1888) which are pigmented, the present species more closely resembles *T. comes*, but may be distinguished by the cirrus which, though possessing a distinctive introvert, is not curved as in *T. comes*.

Temnohaswellia tetrica n.sp.
(Fig. 8)

MATERIAL EXAMINED

HOLOTYPE: ex *Caridina* sp. (*?nilotica*) (Atyidae), Aplin Weir on Ross R., Townsville (19.22°S, 146.44°E), 1976, L. Winsor, Form./Picrocarmine GL14580 (W).

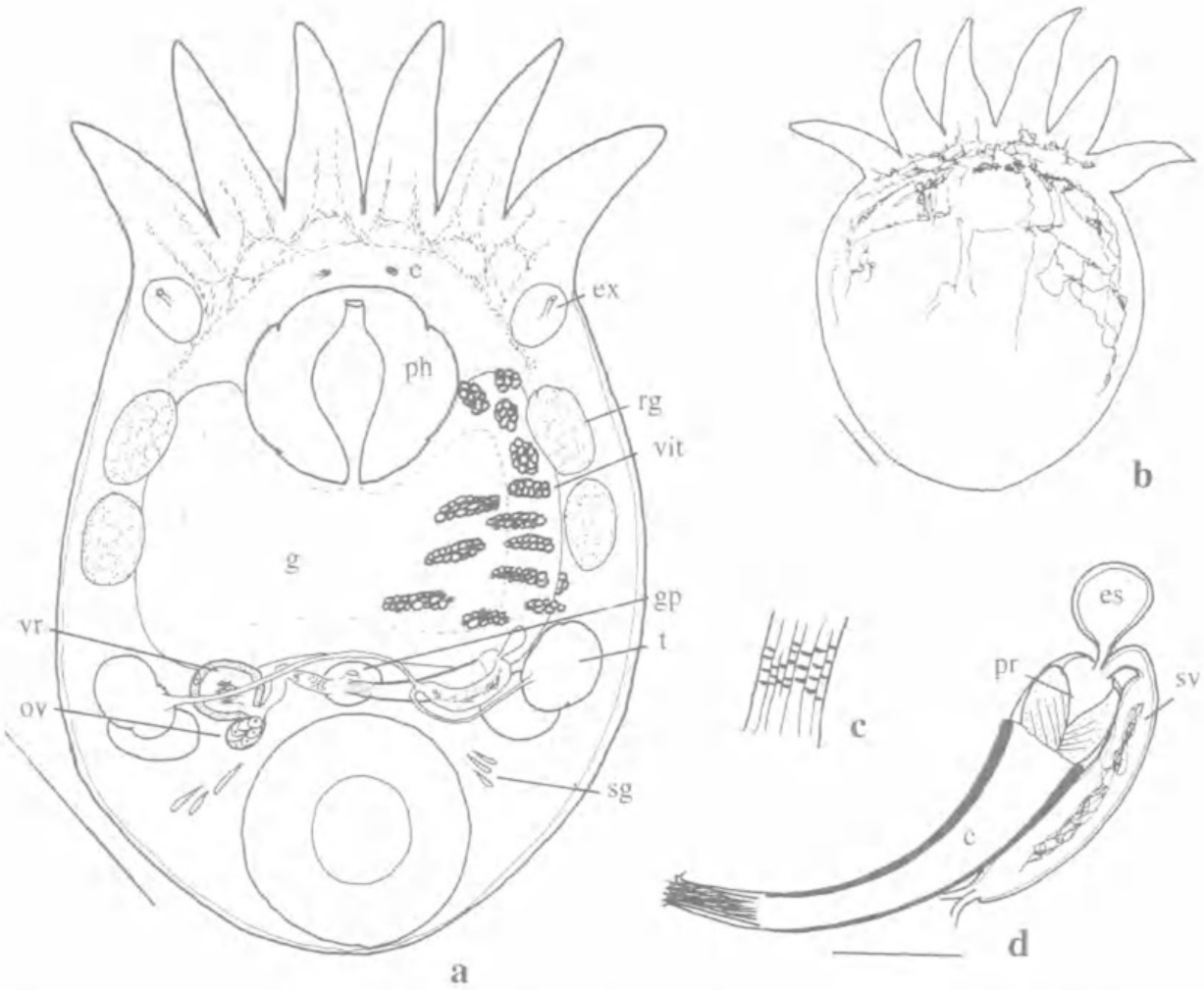


FIG. 8. *Temnohaswellia tetrica* n.sp. a, internal anatomy of whole animal; b, dorsal pigment pattern; c, detail of vaginal teeth; d, detail of male reproductive system. Scales: a,b, 250μm; c, not to scale; d, 100μm.

DESCRIPTION

External characteristics. Body about 2mm long (tentacles about 500μm), and 13mm wide; rounded, dorso-ventrally compressed, with flanged edges. Pigment a tracery over most of anterior dorsal surface. Posterior adhesive disc pedunculate: disc diameter 500μm at rim, disc peduncle about 250μm across. Epidermis syncitial (?). Cilia entirely absent (?).

Alimentary system. Mouth mid-ventral in anterior quarter of body. Buccal cavity or prepharynx conspicuous. Pharynx directed antero-ventrally, as wide as long, about 485μm across; strong, undivided, with nucleate cells within muscle blocks (?); lacking a non-cellular lip, without a conspicuous non-cellular lining, muscles forming a crenulate buccal rim. Pharynx sphincters equal (?). Oesophagus inconspicuous. Gut lacking colour, wider than long; without septa. Gut contains diatoms.

Excretory system. Excretory pores anterior to mouth. Excretory ampulla a simple vacuole, thick walled, about 180μm in diameter. Major excretory ducts inconspicuous.

Nervous and sensory systems. Eyes adjacent, about 30μm across, linked with a pigment mesh forming a single dark region. Eye pigment granules irregular, mostly small, black-brown.

Glands. Rhabdite glands? in lateral fields anterior to anterior testes (in two tandem clumps), individual gland cells within these clumps are not readily distinguishable; clumps 140-170 × 120 μm. With prominent rhabdite tracts to tentacles; rhabdites only accumulate on tentacles (?). Haswell's cells, oesophageal glands and ootype glands inconspicuous (absent?). Shell glands in

prominent lateral fields. Postero-lateral glands absent.

Reproductive system ♀. Gonopore mid-ventral, in posterior third of body. Genital atrium small. Genital complex scattered. Ovary about 80μm in diameter. Vesicula resorbens present, about 120μm across; lying free of gut wall, not open to gut. Seminal receptacles absent (?). Vaginal teeth present, about 5 or 6 rows of fine scale-like teeth in columns. Vagina long, compartmentalised. Vitellaria dendritic, dorsal to ventral.

Reproductive system ♂. Testes rounded, smooth, about 175μm in diameter, both posterior to the gut and slightly overlapping one another (the posterior more dorsal pair vacuolated and apparently invaded by nematodes). Vasa deferentia narrow (?), entering seminal vesicle separately. Seminal vesicle about 35×200μm. Ejaculatory sac present, with narrowed neck. Prostate bulb incorporated, i.e. continuation of cirrus base. Cirrus shaft curved. Cirrus hardly tapering, 350μm long, 70μm wide at base. Cirrus introvert not swollen, about 70μm or 1/5 of the cirrus length. Cirrus spinelets moderately sized, numerous rows, i.e. >20.

ETYMOLOGY

From *tetricus* L. = forbidding, refers to the *vagina dentata*.

REMARKS

The presence of pigment indicates this species resembles *T. simulator* (Haswell, 1924) and *T. novaezealandiae* (Haswell, 1888). *T. novaezealandiae* is said to contain 'a system of formidable chitinous teeth' (Haswell, 1924) and thus, on that account, differs substantially from the present species which has only fine teeth. *T. simulator* also has papillae which 'assume the appearance of teeth', but in the present species there can be little doubt that teeth, not papillae, are present.

The cirrus of the present species is long, slender and curved, so resembles that of *T. novaezealandiae* according to Haswell (1893: pl. XIII, figs 17-18), but not according to Fyfe (1942) who, dealing with *T. novaezealandiae* with prominent vaginal teeth, illustrates and states that the cirrus (penis) is L-shaped. Details of *T. simulator* are sketchy; however, Haswell (1924) stated 'the entire reproductive system closely resembles that of *T. comes*': certainly the cirrus of *T. comes* is much less slender with a more pronounced introvert than occurs in the present species.

The presence of nematodes in the testes of the present species echoes a similar observation made by Haswell (1893) with regard to *T. comes* who said 'many of them had parasitic Nematodes or their eggs or embryos lodged in the testes'.

Achenella n. gen.

Type species. *Achenella sathonota* n.sp.

Generic diagnosis. Temnocephalidae with 5 anterior tentacles, a single pair of testes posterior to the gut, genital organs contained in a connective tissue capsule, vesicular resorbens posterior - not pushing up into or adjacent to the gut, a rosette organ (a cluster of single cells subtending a small disc embedded in the epidermis) anterior to the excretory ampulla, and vitellaria clustered along the lateral margins of the gut.

Species included in Achenella. *A. sathonota* n.sp., *A. cougal* n.sp.

Etymology. From *achen* L. = poor, impoverished; pertaining to having only one pair of testes. Temnocephalidae has several genera with two or more pairs of testes.

Achenella sathonota n.sp.
(Figs 9,12a-d,f-i)

MATERIAL EXAMINED

HOLOTYPE: ex *Caridina indistincta* (Atyidae), Gully nr Capalaba, Brisbane (27.32°S, 153.12°E), 22 Sep. 1988, L. Cannon, Bouin's/Hx GL14589 (W).

PARATYPE: ex *Caridina indistincta* (Atyidae), Waterhole on creek at Henderson Rd, Sheldon, Brisbane (27.36°S, 153.13°E), 18 Mar. 1990, L. Cannon, Bouin's/H&E GL14591 (LS[1]).

OTHER MATERIAL: Queensland - same data as holotype, H&E GL14597 (LS[1]); same data as paratype, AFA/Haemalum GL14594 (W); Bouin's/Mallory's GL14596 (LS[1]); ex *C. indistincta* (Atyidae), Trib. of Scrubby Ck, Sheldon, Brisbane (27.37°S, 153.05°E), 2 Oct. 1991, I. Olsson, Hot water Form./Hx GL14598 (W); GL14599-14600 (LS[2,2]), ex *C. indistincta* (Atyidae), stream nr Kin Kin (26.16°S, 152.53°E), 23 Mar. 1990, L. Cannon & K. Sewell, AFA/Haemalum GL14583 (W), GL14584-5 (W); AFA/H&E GL14586 (LS[1]), AFA/H&E GL14587-8 (LS[1,1]). ex 'shrimp' (?*C. indistincta*) (Atyidae), Daisy Hill, Brisbane (27.28°S, 153.01°E), 16 Apr. 1989, L. Cannon, Bouin's/Hx GL14590 (W); SUSA/Hx GL14592; AFA/Hx GL14593 (W); ex 'shrimp' (?*C. indistincta*) (Atyidae), Bulimba Ck (27.33°S, 153.07°E), 18 Jul. 1979, A. Arthington, Form./unstained GL14595; NSW - ex *Caridina mccullochi*, tributary of Orara R., NSW (30.16.4°S, 153.03.1°E), 15 Feb. 1992, K. & S. Sewell,

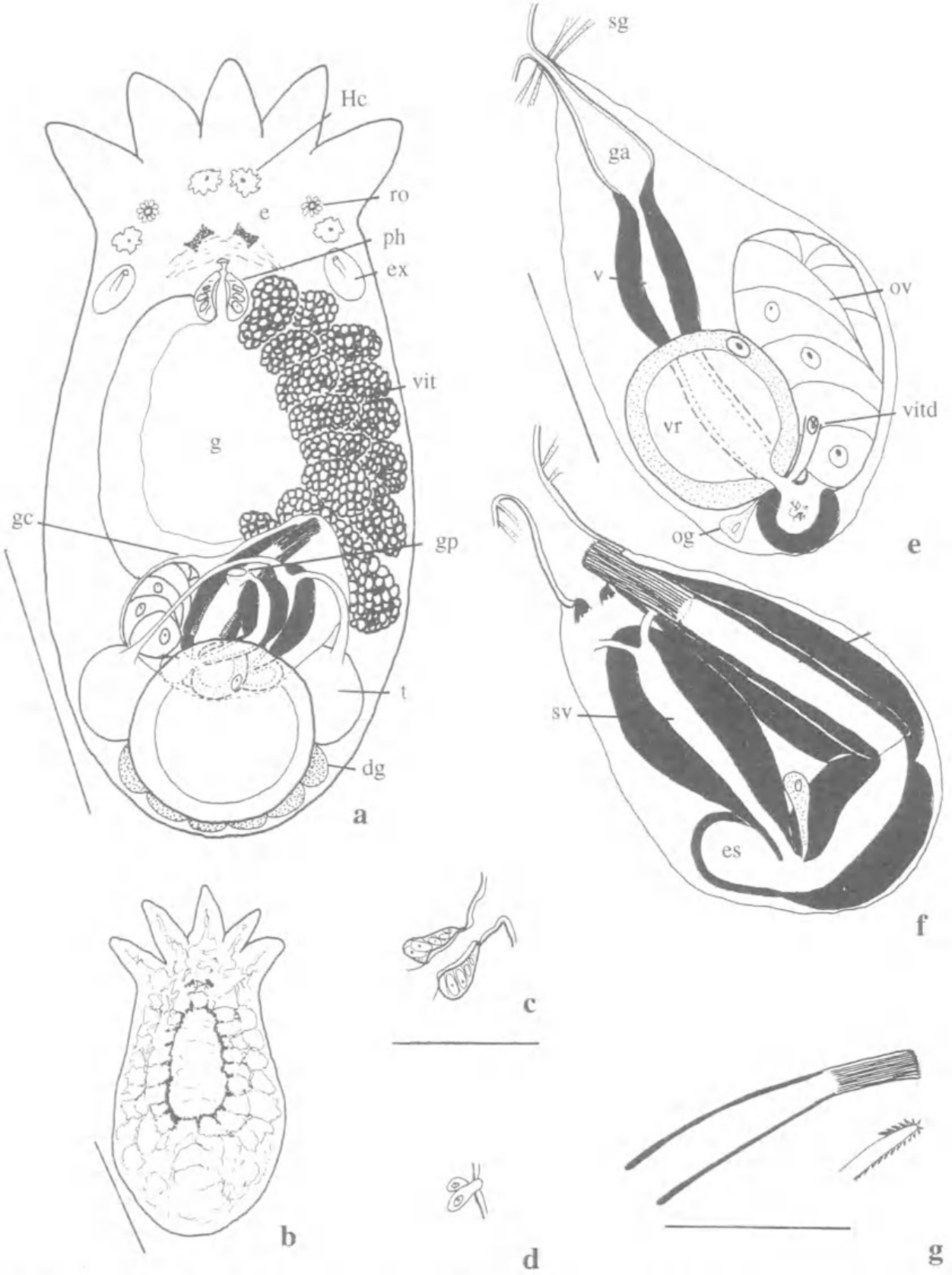


FIG. 9. *Achenella sathonota* n. gen., n.sp. a, internal anatomy of whole animal; b, dorsal pigment pattern; c, pharynx; d, rosette organ; e, detail female reproductive system; f, detail of male reproductive system; g, cirrus, and detail of spinelets. Scales: a,b, 250μm; c-d,e-f,g, 100μm.

Hot water Form./Haemalum GL14601 (W), GL14602 (W); Bouin's/H&E GL14603 (LS[1]),GL14606 (W); Bouin's/Hx GL14605, 14607 (W); Bouin's/H&E GL14608 (LS[1]).

DESCRIPTION

External characteristics. Body about 500-900μm (mean=710μm) long, and 250- 380μm (mean=330μm) wide [specimens from NSW slightly larger, to 1200μm long]; oval or elliptical, not dorso-ventrally compressed. Pigment extends to ventral surface (through parenchyma: especially dense about gut where it outlines the inner limits of the vitellaria). Posterior adhesive disc pedunculate: disc diameter 160μm at rim, disc peduncle 120μm across. Rosette organ about 50μm anterior to excretory ampulla. Epidermis syncitial, 5μm high dorsally, 9μm high ventrally. Cilia entirely absent.

Alimentary system. Mouth mid-ventral in anterior quarter of body. Buccal cavity or prepharynx conspicuous. Pharynx directed antero-ventrally, as wide as long, about 50μm across; very weak, undivided, with prominent cells within muscle blocks (though muscles barely discernible); lacking a non-cellular lip, with a conspicuous non-cellular lining, muscles not forming an obvious crenulate buccal rim. Pharynx sphincters equal but very weak. Oesophagus inconspicuous. Gut lacking colour, wider than long; without septa. Gastrodermis 50μm high. Gut contains eggs (of temnocephalan?), diatoms, cladocerans and nematodes.

Excretory system. Excretory pores lateral to mouth. Excretory ampulla a simple vacuole, thick walled, about 50×30μm in diameter. Major excretory ducts inconspicuous.

Nervous and sensory systems. Brain compact, transverse band. Major nerve trunks conspicuous ventrally. Eyes present, discrete, well separated (but joined by body pigment), about 20μm across. Eye pigment granules medium, even sized (about 1.5μm across), black-brown.

Glands. Rhabdite glands apparently a scatter of ventro-lateral glands about 20μm in diameter, with inconspicuous rhabdite tracts. Rhabdites only accumulate on tentacles (?). Haswell's cells conspicuous, four (a pair before brain, another before excretory pores) about 20μm across. Oesophageal glands inconspicuous (absent?). Ootype glands present. Shell glands in prominent lateral fields discharging to gonopore. Posterio-lateral glands inconspicuous (absent?). Disc glands prominent, a discrete eosinophilic cluster.

Muscles. Longitudinal muscles of body wall of equal size or strength dorsally and ventrally (and quite strong, about 3- 4μm wide). Circular muscles of body wall similar dorsally and ventrally (also 3-4μm wide). Dorso-ventral muscles and attachment muscles of pharynx weak. Attachment muscles of adhesive disc strong. Muscles controlling male organ strong (about stylet and seminal vesicle and also strong as dorso-lateral bands extending antero-lateral and postero-lateral from the region of the gonopore).

Reproductive system ♀. Gonopore mid-ventral, in posterior third of body. Genital atrium commodious. Ovary to about 50×90μm. Vesicula resorbens present, about 50×60μm, 210μm thick wall. Seminal receptacle single, hardly cut off from female canal. Vaginal teeth absent. Vagina long, compartmentalised (proximal region to about 75μm long with muscle walls 4μm thick, distal region to about 150μm long with walls 25μm thick). Vitellaria clumped, lateral (from excretory ampulla to testes - numerous large glands 75μm across).

Reproductive system ♂. Testes rounded, about 80μm in diameter, smooth. Vasa deferentia swollen, entering seminal vesicle separately. Seminal vesicle about 90×60μm, walls 20μm thick. Ejaculatory sac present. Prostate bulb separate, i.e. wider than cirrus base. Cirrus shaft gently curved. Cirrus hardly tapering, 170μm long, 25μm wide at base. Cirrus introvert swollen, but only very little, about 45μm or 1/4 of the cirrus length. Cirrus spines absent. Cirrus spinelets minute on a series of long sclerotic ridges, many rows i.e. >20.

ETYMOLOGY

From *sathon* Gr. = one with a large penis, referring to the relative size of the cirrus to body size.

REMARKS

Only one 5 tentacled species of temnocephalan has been described with one pair of testes, *Temnocephala brenesi* Jennings, 1968, from the shrimps, *Macrobrachium americanum*, in Costa Rica. The correct position of this species must await further study, but it does not appear to conform to *Achenella* n. gen.

In the present species the cirrus is slightly larger for specimens from Kin Kin and considerably larger (280μm long and 55μm wide at base) for those from *C. mccullochi* from NSW. This latter difference in size of the cirrus may reflect just bigger specimens or perhaps indicates these specimens from a different host and a distant

locality belong to a distinct species. Unless other differences become apparent all these specimens should be considered of the same species.

Achenella cougal n.sp.
(Fig. 10)

MATERIAL EXAMINED

HOLOTYPE: ex *Paratya australiensis* (Atyidae), Upper Currumbin Ck, Gold Coast (28.14.6°S, 153.20.8°E), 12 Apr. 1991, L. Cannon & K. Sewell, Hot water Form./H&E GL14581 (LS[2]).

OTHER MATERIAL: same data as holotype, Hx GL14582 (damaged W).

DESCRIPTION

External characteristics. Body about 950μm long, and 400μm wide; oval or elliptical, not dorso-ventrally compressed. Pigment confined to eyes. Posterior adhesive disc broadly pedunculate: disc diameter 180μm at rim. Rosette organ about 100μm anterior to excretory pores. Epidermis syncitial about 5μm high dorsally and ventrally. Cilia entirely absent.

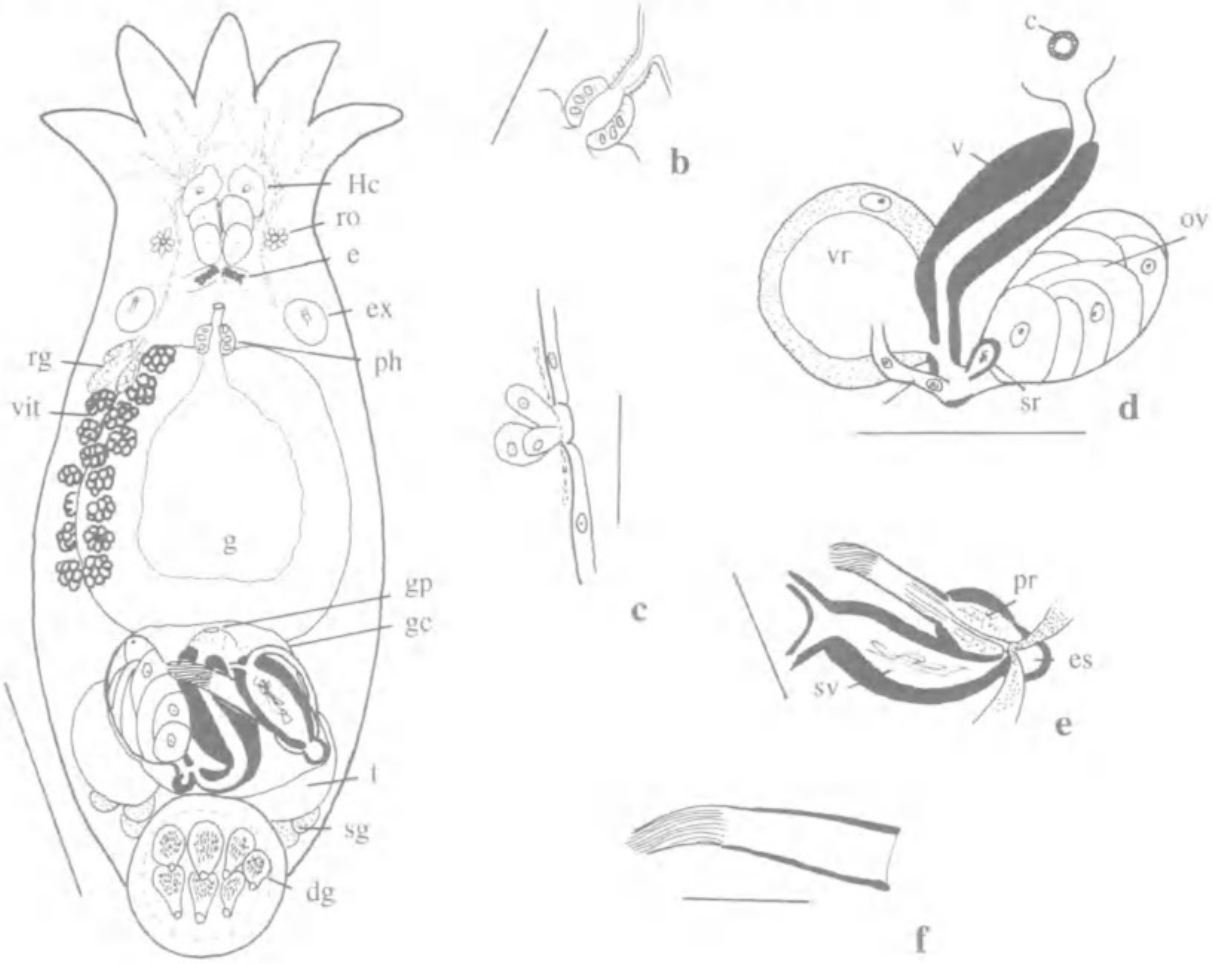
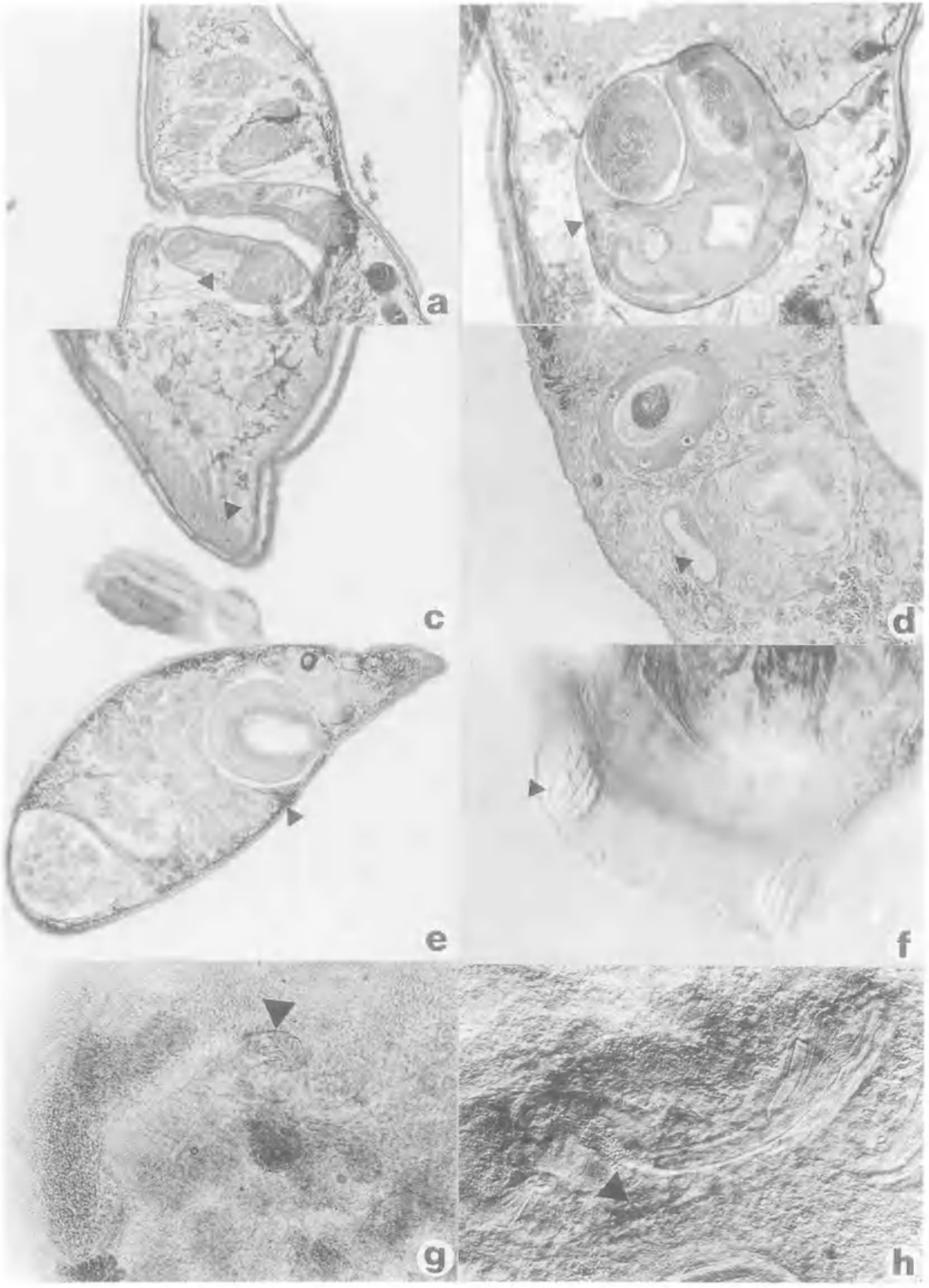


FIG. 10. *Achenella cougal* n.sp. a, internal anatomy of whole animal; b, pharynx; c, rosette organ; d, detail female reproductive system; e, detail of male reproductive system; f, cirrus. Scales: a, 250μm; b, 100μm; c, 50μm; d-e, 100μm; f, 50μm.

FIG. 11. Photomicrographs of new temnocephalans from crabs and shrimps. a-c, *Temnocephala athertonensis* n.sp.: a, pharynx showing prominent cells between sphincter blocks; b, genital capsule; c, weak postero-lateral glands; d, *Temnocephala butlerae* n.sp. genital region showing prominent ejaculatory sac; e, *Temnocephala improcera* n.sp. showing simple muscular pharynx: note pigment below body wall; f, *Temnocephala neqae* n.sp. posterior end showing prominent postero-lateral glands; g, *Temnohaswellia pugna* n.sp. cirrus; h, *Temnohaswellia tetrica* n.sp. showing shaft of cirrus and vaginal teeth, overlaying the introvert. Scales: 1cm = 100μm (a,b,e,g,h); 1cm = 50μm (c,d,f). Nomarski f,g,h.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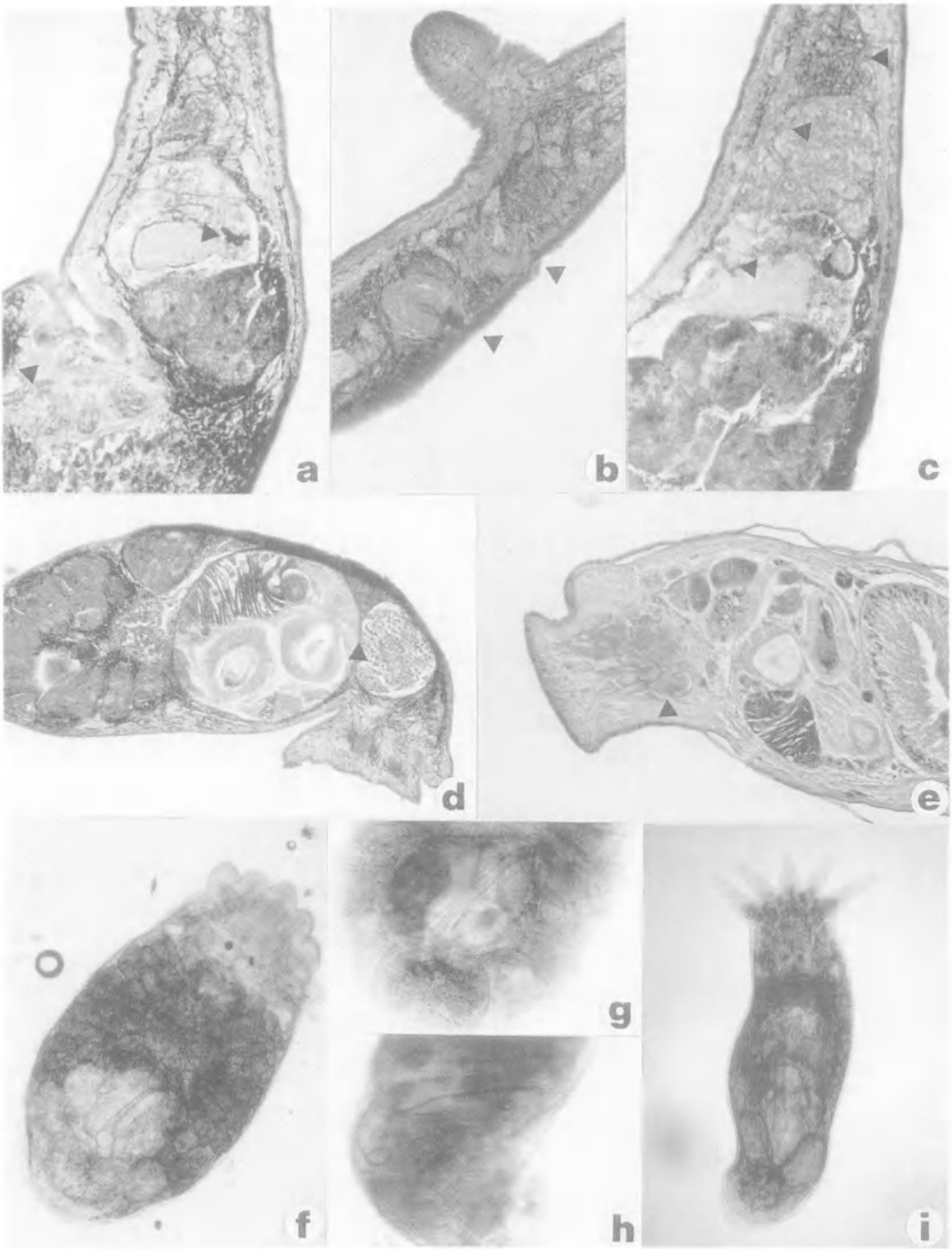
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Alimentary system. Mouth mid-ventral in anterior quarter of body. Buccal cavity or prepharynx conspicuous (muscular, about 50μm deep). Pharynx directed antero-ventrally, as wide as long, about 72μm in diameter; weak, undivided, with prominent cells within muscle blocks; lacking a non-cellular lip, with a conspicuous non-cellular lining, muscles not forming an obvious crenulate buccal rim. Pharynx sphincters equal (very little musculature). Oesophagus inconspicuous. Gut lacking colour, as wide as long; without septa. Gastrodermis about 70μm high.

Excretory system. Excretory pores lateral to mouth. Excretory ampulla a simple vacuole, thick walled (12- 15μm), about 50μm in diameter. Major excretory ducts inconspicuous.

Nervous and sensory systems. Brain bilobed (with large bilobed ?forebrain). Eyes present, discrete, well separated, about 30-40μm across. Eye pigment granules medium, even sized, about 2μm, black-brown to red-black.

Glands. Rhabdite glands in lateral fields anterior to anterior testes (and anterior and lateral to pharynx), few, less than 10 each side; 15-25μm in diameter, with rhabdite tracts to base of tentacles. Rhabdites only accumulate on tentacles. Haswell's cells conspicuous, two together before ?forebrain, about 70×30μm. Oesophageal glands and ootype glands inconspicuous (absent?). Shell glands present postero-lateral to testes open to gonopore. Postero-lateral glands absent. Disc glands prominent, scattered around testes with a cluster of deeply eosinophilic club shaped cisternae opening on to disc.

Muscles. Longitudinal muscles of body wall stronger ventrally. Dorso-ventral muscles and attachment muscles of pharynx weak. Attachment muscles of adhesive disc and muscles controlling male organ strong.

Reproductive system ♀. Gonopore mid-ventral, in posterior third of body. Genital atrium large. Ovary about 130×80μm. Vesicula resorbens present, about 90μm across, 15μm thick wall. Seminal receptacle single, about 20μm across. Vaginal teeth absent. Vagina long, compartmentalised, distally muscular 145μm long walls 25μm thick, proximally 40μm long walls 7-8μm thick. Vitellaria discrete (scattered), lateral about 20μm across.

Reproductive system ♂. Testes a single pair, rounded, about 140μm in diameter, smooth, posterior to gut. Vasa deferentia swollen (to about 20μm), entering seminal vesicle separately. Seminal vesicle about 100×70μm with thick (10μm) walls. Ejaculatory sac present about 50μm in diameter, with wide neck (joins directly to back of prostate bulb). In holotype a very large prostate gland (110-125μm across) lies anterior to testes. Prostate bulb incorporated, i.e. continuation of cirrus base. Cirrus shaft straight. Cirrus hardly tapering, 100μm long, 20μm wide at base. Cirrus introvert not swollen, about 40μm long tapering to 10μm wide; 1/3 of the cirrus length. Cirrus spines present, on about 20 strong ribs spiralling out.

ETYMOLOGY

The specific name refers to the name of the locality. Currumbin Ck rises in Cougal National Park.

REMARKS

The lack of pigment in the body and the much smaller, more gracile cirrus serve to clearly distinguish this species from the only other member of the genus *A. sathonota*.

Achenella sp.

MATERIAL EXAMINED

ex Austratya striolata (Austratyidae), Yuccabine Ck, Kirrama (18.13°S, 145.45°E), 10 Jul. 1985, R. Smith, Bouin's/H&E GL14557 (TS[3]).

DESCRIPTION

External characteristics. Body about 500μm long, and 400μm wide; oval or elliptical, not dorso-ventrally compressed. Pigment confined to eyes. Posterior adhesive disc pedunculate: disc diameter 140μm at rim, disc peduncle about 90μm across. Epidermis about 7μm high dorsally and ventrally. Cilia entirely absent (?).

Alimentary system. Mouth mid-ventral in anterior quarter of body. Buccal cavity or prepharynx inconspicuous. Pharynx directed antero-ventrally (?), as wide as long, about 70μm in diameter; weak, with nucleate cells within muscle blocks (?); without a conspicuous non-cellular lining.

FIG. 12. Photomicrographs of new temnocephalans from crabs and shrimps. a-d,f-i, *Achenella sathonota* n. gen., n.sp. a, weak pharynx, brain and eye; b, excretory pore and anterior to it the rosette organ; c, brain, ?forebrain and Haswell's cell; d, genital capsule and posterior testis; e, *Achenella cougal* n.sp. genital capsule and prominent cisternae of disc glands with a weakly pedunculate adhesive disc; f, specimen from Capalaba; g, posterior showing cirrus, specimen from Stretton; h, posterior (lateral) showing cirrus, specimen from Kin Kin; i, specimen from Orara R., NSW. Scales: 1cm = 50μm (a-c); 1cm = 100μm (d,e,g,f); 1cm = 250μm (f,i).

Pharynx sphincters equal (?). Gut lacking colour, as wide as long (?). Gastrodermis about 40μm high.

Excretory system. Excretory pores lateral to mouth. Excretory ampulla a simple vacuole, thick walled (20μm), about 35-40μm across. Major excretory ducts inconspicuous.

Nervous and sensory systems. Brain compact, transverse band. Major nerve trunks inconspicuous. Eyes present, discrete, well separated, about 25 × 20μm. Eye pigment granules medium, even sized, red-black.

Glands. Rhabdite glands in lateral fields anterior to anterior testes (?); about 15μm across. Shell glands present. Disc glands prominent, a discrete cluster.

Muscles. Longitudinal muscles of body wall of equal size or strength dorsally and ventrally. Circular muscles of body wall similar dorsally and ventrally. Dorso-ventral muscles weak; attachment muscles of pharynx and of adhesive disc weak. Muscles controlling male organ strong, about 25μm thick.

Reproductive system ♀. Gonopore mid-ventral, in posterior quarter of body. Genital atrium commodious. Ovary about 50 × 70μm. Vesicula resorbens present, about 75μm in diameter, about 20μm thick wall. Vagina chambered and strongly muscular. Egg capsules ovoid or pyriform, about 225μm in diameter, attached on side without stalk, on cephalothorax (inside branchial chamber).

Reproductive system ♂. Testes rounded. Seminal vesicle about 50μm across. Ejaculatory sac present, with narrowed neck? Cirrus shaft straight. Cirrus hardly tapering, 100μm long, 32μm wide at base. Cirrus introvert not swollen, about 10μm long or 1/9 of cirrus. Cirrus spinelets minute, few rows, i.e. <20.

REMARKS

This one sectioned specimen is tentatively placed in *Achenella* as there appears but one pair of testes, the genital organs are in a capsule and disc glands are prominent. Until better material is available it is not appropriate to provide a specific name.

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