

Some terrestrial flatworm taxa (Platyhelminthes: Tricladida: Continenticola) of the Subantarctic Islands of New Zealand

Leigh Winsor

School of Marine and Tropical Biology, James Cook University, Townsville, Queensland, Australia
(leigh.winsor@my.jcu.edu.au)

ABSTRACT: Within the context of ongoing taxonomic revisions of terrestrial flatworms from the New Zealand Subantarctic Islands: (1) a new tribe Argaplanini is erected; (2) a new genus *Argaplana* is erected; (3) the species *Argaplana ranuui* is redescribed; and (4) the replacement name *Marionfyfea* is proposed for *Fyfea*, pre-occupied.

KEYWORDS: Land planarians, Continenticola, Geoplanidae, Argaplanini, *Argaplana*, *Marionfyfea*, Subantarctic Islands, New Zealand.

Introduction

Terrestrial flatworm taxa from the Subantarctic and other islands, based on the Museum of New Zealand Te Papa Tongarewa collection of terrestrial flatworms, are presently being studied and revised by the author (Winsor 2006, 2009). This paper concerns the redescription of *Kontikia ranuui* (Fyfe, 1953) and its assignment to a new genus to be accommodated in a new tribe of the Rhynchodermiinae. A replacement name is also proposed for *Fyfea*, pre-occupied.

Materials and methods

The specimen selected for histology was processed to paraffin wax, longitudinally sagittally (LSS) and transversely sectioned (TS) at 8 µm, and stained using the AZAN method (Winsor 1998). Nomenclature of the stripe pattern follows the scheme of Graff (1899: 25). Determination of the cutaneous and parenchymal muscular indices (CMI, PMI) follows Winsor (1983). The classification follows that of Sluys *et al.* (2009). The specimen is held in the collections of the Museum of New Zealand Te Papa Tongarewa, Wellington (MONZ).

Abbreviations used in figures

an	antrum
cg	cyanophil glands
cm	cutaneous musculature
cod	common ovovitelline duct
cs	creeping sole
dp	dorsal plate, parenchymal musculature
ed	ejaculatory duct
ep	eversible penis
fg	female genital canal
gm	glandular margin
gp	gonopore
in	intestine
l	lateral median stripes
m	median dorsal stripe
mo	mouth
nc	nerve cord
oe	oesophagus
ovd	ovovitelline duct
p	pale dots on ventral ground colour
pg	penial glands
ph	pharynx
php	pharyngeal pouch

psv	proximal seminal vesicle
rh	rhammites
sdv	spermiducal vesicle
sg	shell glands
sv	seminal vesicle
te	testis
vd	vas deferens
vi	vitellaria
vp	ventral plate, parenchymal musculature

Systematics

Family Geoplanidae Stimpson, 1857

Argaplana new genus

DIAGNOSIS: Geoplanid with small body, gently tapered at each end, subcylindrical in cross section. Mouth situated in mid-third of body, gonopore closer to mouth than to posterior end. Eyes present in multiple rows around the anterior tip and dorso-anteriorly, extending the length of the body. Sensorial margin passes antero-ventrally around the anterior tip. Sensory papillae, anterior adhesive cup and sucker absent. Creeping sole ciliated, 50% or more of body width. Cutaneous musculature tripartite, with circular, helical and longitudinal muscles; longitudinal muscles in well-defined bundles; dorsal cutaneous musculature thinner than that ventrally, CMI 3.6%. Parenchymal longitudinal muscles present in a dorsal and a ventral plate, PMI 35%, stronger ventrally than dorsally and intersected by a closely woven meshwork of oblique-transverse and dorso-ventral muscle fibres. Testes ventral, extending from behind ovaries to almost the posterior end. Efferent ducts ventral. Penis eversible type without papilla. Ovaries in anterior body third. Ovovitelline ducts unite then enter female genital canal ventro-posteriorly (postflex ventral approach). Female genital canal enters antrum dorso-posteriorly. Resorptive bursa, adenodactyls and viscid gland absent.

TYPE SPECIES: *Argaplana ranuui* (Fyfe, 1953).

ETYMOLOGY: the name *Argaplana* comprises *Argus* (Latin), the mythical hundred-eyed guardian of Io, alluding to the multiple eyes around the anterior tip of the planarian; and *plana* (Latin = flat, planarian). Gender: feminine.

DISTRIBUTION: Campbell Island, New Zealand.

Systematic discussion

The recently proposed higher classification of planarian flatworms (Sluys *et al.* 2009) places all terrestrial flatworms within the Geoplanidae, which comprises three

subfamilies: the Bipaliinae, the Microplaninae, and the Rhynchodeminae (to which all native terrestrial flatworms of New Zealand and its Subantarctic Islands belong). The Rhynchodeminae presently comprises five Tribes: the Rhynchodemini, Caenoplanini, Pelmatoplanini, Anzoplanini and Eudoxiatopoplanini.

The tribe Eudoxiatopoplanini and genus *Eudoxiatopoplana* were erected to accommodate taxa with multiple eyes concentrated around the anterior end, dorsally and along the sides; without auricular or tentacular organs or a semilunar headplate; without a creeping sole; and with dorsal testes. The eye pattern in which multiple rows of eyes pass around the anterior tip, with lateral clustering, and eyes extending the length of the body present in *Argaplana*, is similar to that in *Eudoxiatopoplana*. However, in *Argaplana* the testes are located ventrally, unlike *Eudoxiatopoplana*, where the testes are located dorsally. Also, *Argaplana* has a creeping sole, absent in *Eudoxiatopoplana*. *Argaplana* is therefore excluded from the Eudoxiatopoplanini and placed in a new tribe, the Argaplanini.

Argaplanini new tribe

TYPE GENUS: *Argaplana* Winsor, new genus.

DIAGNOSIS: Geoplanidae with eyes of pigment cup-type in multiple rows around the anterior tip, continuing to the posterior end and dorsally. With ventral testes and ventral efferent ducts. With tripartite cutaneous musculature, with cutaneous longitudinal muscles in well-defined bundles, with parenchymal longitudinal muscles present in strong dorsal and ventral plates. Ring zone absent. With a ciliated creeping sole extending over 50% of the body width.

A comparison of key taxonomic characters and states present in *Argaplana* (Argaplanini) and *Eudoxiatopoplana* (Eudoxiatopoplanini) is provided in Table 1.

Argaplana ranuui (Fyfe, 1953) new combination (Figs 1–5)

Geoplana ranuui Fyfe, 1953: 10, text fig. 3, plate II, fig. 2.

Kontikia ranuui (Fyfe) Ogren and Kawakatsu 1991: 83; Ogren *et al.* 1997: 80, 90.

MATERIAL EXAMINED: MONZ 1389. Campbell Island, New Zealand, 52° 30'S 169° 05'E. Collected at 10 m above sea-level under logs by C.M. Clark on 10 August 1962. Sectioned at 8 µm, a series of 44 slides stained with the AZAN method: anterior LSS, and pre-pharyngeal TS and posterior LSS together, sectioned from the left side.

Table 1 A comparison between some key taxonomic characters and states present in the multi-eyed taxa *Argoplana* (tribe Argaplanini) and *Eudoxiatopoplana* (tribe Eudoxiatopoplanini).

Character	<i>Eudoxiatopoplana</i>	<i>Argaplana</i>
Rows of eyes around anterior tip	Multiple	Multiple
Testes	Dorsal	Ventral
Type of creeping sole	Non-ciliated	Ciliated
Cutaneous longitudinal musculature	Weak in bundles	Weak in bundles
Cutaneous muscular index	4.5–6.5%	3.6%
Parenchymal longitudinal musculature	Very strong; present in a ring zone	Very strong, present in a dorsal and a ventral plate; not in a ring zone
Parenchymal muscular index	38.5%	35%
Pharynx	Cylindrical	Cylindrical
Length of pharynx as % of body length	13.3	11.0
Pharyngeal musculature – inner	Mixed circular and longitudinal muscles	Mixed circular and longitudinal muscles
Pharyngeal musculature – outer	Longitudinal muscles, then mixed circular and longitudinal muscles	Circular muscles, then mixed circular and longitudinal muscles
Oesophagus	?Absent	Present
Pharyngeal pouch length as % of body length	8.1	7.7
Mouth position as % of body length	33.8 (anterior body third)	63.2 (mid- to mid-third of body)
Gonopore position as % of body length	49.0 (about mid-body)	76.1 (posterior third of body)
Mouth–gonopore distance as % of body length	15.2	15.5
Copulatory organs – penis type	introverted	eversible without distinct papilla
Copulatory organs – resorptive bursa	present	absent
Copulatory organs – adenodactyls	present	absent

DESCRIPTION:**External features**

A small, cylindroid rhynchodemid, slightly tapered anteriorly to a blunt anterior end (Fig. 1a), the tip of which is rounded. The body broadens, reaching maximum width in the mid-body, after which it tapers gently to a rounded posterior with pronounced caudal tip (Fig. 1b). Body sub-cylindrical in cross section. Mouth ventrally situated in the

second third of the body, with the gonopore in the last body quarter. Creeping sole ciliated, distinct. Dorsal and ventral ground colour cream-white, with the creeping sole a paler colour than the rest of the body. There was no evidence of other markings. With multiple eyes (Fig. 2a–c), crowded around the anterior tip margin, scattered dorsally in a loose median patch and continuing posteriorly in a zigzag pattern to the posterior tip; slightly crowded antero-

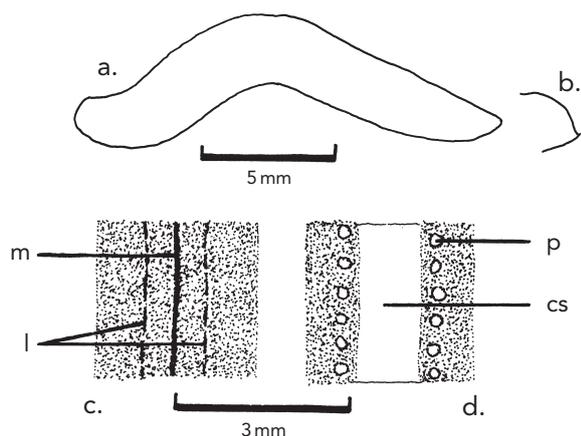


Fig. 1 *Argaplana ranuii* MONZ 1389: (a) whole specimen, latero-dorsal aspect, and (b) caudal tip; (c) dorsal markings and (d) ventral markings redrawn from the original card index belonging to Marion Fyfe and now in the author's possession.

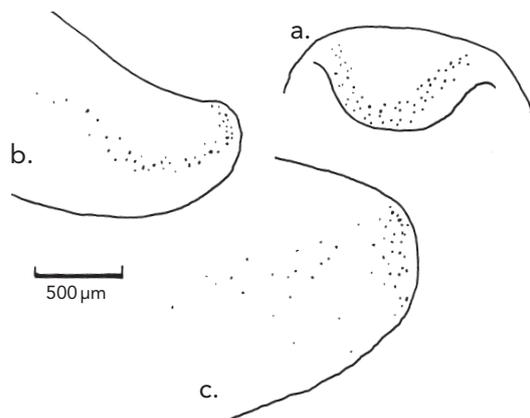


Fig. 2 *Argaplana ranuii* MONZ 1389, anterior tip showing distribution of eyes: (a) frontal aspect; (b) antero-lateral aspect; (c) dorsal aspect.

laterally on either side, then continuing in a staggered submarginal row to the posterior. Dimensions of the single specimen are provided in Table 2.

Internal anatomy

Head: Adhesive suckers with associated musculature absent. Gut extends to within approximately 0.5 mm of tip, overlies ganglion. Eyes pigment cup 23–31 µm diameter; the number of retinal clubs could not be determined. Sensorial zone extends around antero-ventral margin. Ciliated pits some 50 µm apart, simple invaginations, 12.6 µm diameter, 36 µm deep, lined by ciliated anucleate epithelium.

Pre-pharyngeal region: A schematic representation of the transverse pre-pharyngeal region is provided in Fig. 3. Dorsal

Table 2 *Argaplana ranuii* (Fyfe, 1953), dimensions of specimen MONZ 1389. Positions of body apertures are measured from the anterior tip. Dimensions of the specimen given in Fyfe (1953) are provided in parentheses.

Specimen MONZ 1389	
Length (mm)	15.5 (15)
Width (mm)	2.5
Mouth (mm)	9.4 (7.5)
Mouth position as % of body length	63.2 (50.0)
Gonopore (mm)	11.8 (10)
Gonopore position as % of body length	76.1 (66.7)
Distance from mouth to gonopore (mm)	2.4 (2.5)
Mouth–gonopore distance as % of body length	15.5 (16.7)
Width of creeping sole (mm)	1.3
Width of creeping sole as % of body width	52
Body height (mm)	1.3
Pharynx length (mm)	1.7 (protruded)
Length of pharynx as % of body length	11
Pharyngeal pouch length (mm)	1.2
Length of pharyngeal pouch as % of body length	7.7

epithelium 28 µm thick, slightly thicker than the ventral epithelium, which is 27 µm thick, nucleate. Creeping sole comprises a ciliated nucleate columnar epithelium. Broad leaf-like (foliaceous) rhammites 18–27 µm long and 3.6 µm wide, derived from rhabditogen cells underlying cutaneous musculature, extend dorso-laterally to outer margins of creeping sole, abundant laterally. Epitheliosomes secreted from creeping sole. Finely granular erythrophil secretions from parenchymal glands present dorso-laterally over body, abundant laterally to form a marginal adhesive zone. Amorphous xanthophil secretions from parenchymal glands discharged from the ventral surface. Cutaneous cyanophil secretions and pigment absent.

Body 2.5 mm wide. Creeping sole 1.3 mm wide, 52% of body width. Body height 1.3 mm. Body width to height ratio 1.9:1. Cutaneous musculature weak, tripartite, with

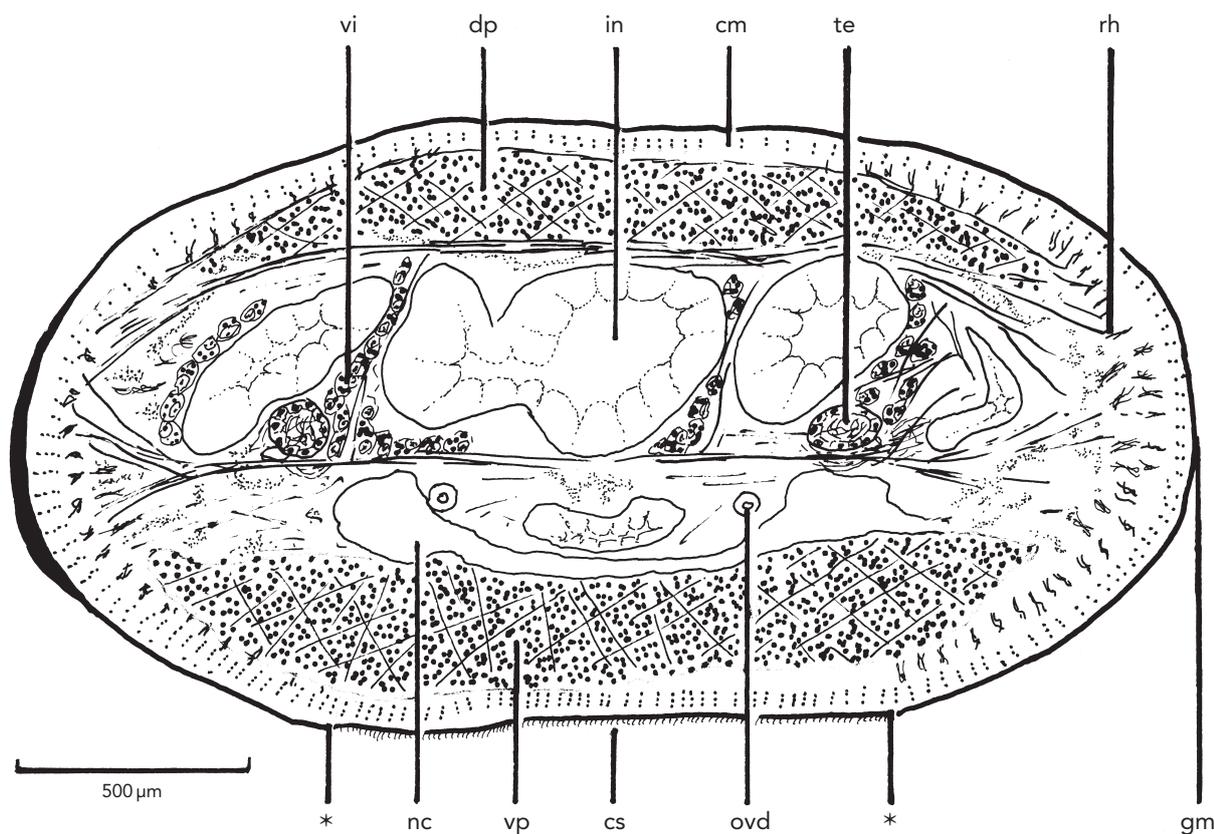


Fig. 3 *Argaplana ranuii* MONZ 1389: pre-pharyngeal region, transverse section. The asterisk (*) indicates the ventral extent of the rhammites. Note that the section is slightly oblique, resulting in an apparent thicker epithelium on the left-hand side of the body.

circular and helical muscles, and with cutaneous longitudinal muscles in distinct bundles, not in-sunk. Dorsal cutaneous musculature thinner ($28\ \mu\text{m}$ thick) than ventral musculature ($33.6\ \mu\text{m}$ thick). CMI 3.6%.

Parenchymal longitudinal muscles in bundles of varying size present in two massive plates tapering laterally to sparse bundles of longitudinal muscles, PMI 35%, stronger ventrally ($284\ \mu\text{m}$ thick) than dorsally ($177\ \mu\text{m}$), intersected by a closely decussate meshwork of oblique-transverse and dorso-ventral muscle fibres in diamond-pattern corseting. Strong suprainestinal transverse muscles, infrainestinal transverse muscles and dorso-ventral muscles present. Nephridial elements present between the ventral plate and cutaneous nerve net.

Alimentary tract: Gut with lateral intestinal branches mostly bifurcate, largely empty. Pharynx (Fig. 4) cylindrical, contracted, ruptured through the dorsal pouch wall, $1.7\ \text{mm}$ long, 11% of body length, with dorsal insertion posterior to ventral insertion. Inner pharyngeal musculature with subepithelial mixed longitudinal-circular muscles; outer

pharyngeal musculature comprises subepithelial circular, then mixed circular-longitudinal muscles. Oesophagus present. Pharyngeal pouch $1.2\ \text{mm}$ long, 7.7% body length. Mouth opens mid-pouch; the pharynx is contracted and the mouth may open more posteriorly towards the end of the pharyngeal pouch. Diverticulum absent.

Reproductive organs: Copulatory organs simple (Fig. 5), situated immediately behind the pharyngeal pouch, with eversible penis. Gonopore $200\ \mu\text{m}$ diameter. Resorptive bursa and adenodactyls absent. Testes mature, ellipsoidal in shape up to $40\text{--}70\ \mu\text{m}$ diameter, follicular, mostly uniserial, ventral, lying just below the gut (Fig. 3) between the intestinal diverticula, extending posteriorly from just behind the ovaries to within $2\ \text{mm}$ of the hind end. Sperm ductules emerge from the lateral lower pole of the testes, pass ventrally around the lateral margin of the nerve cords, and join the vas deferens, which lie approximately in line with the testes immediately below the nerve cords. The vasa deferentia anterior to the pharynx are thin-walled. Just behind the pharyngeal pouch, the efferent ducts form

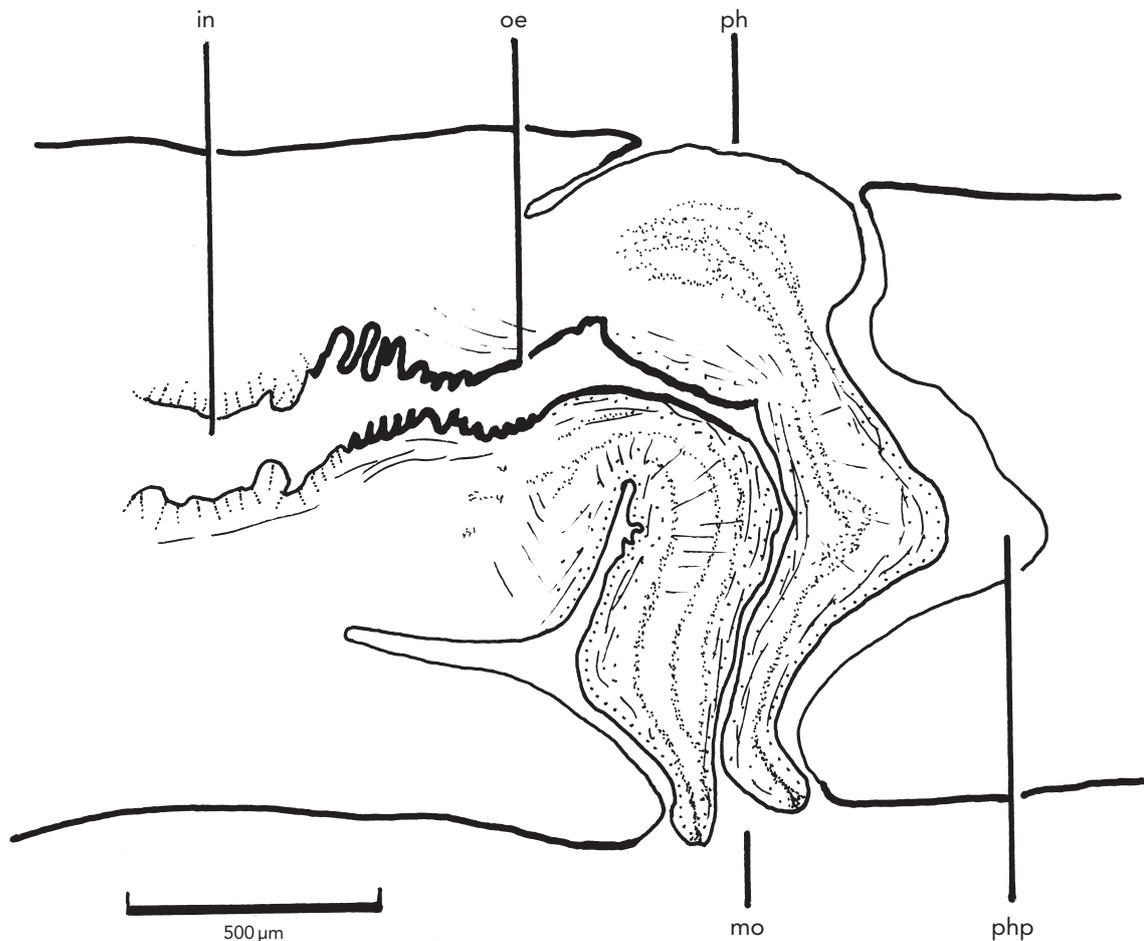


Fig. 4 *Argaplana ranuii* MONZ 1389: pharynx, longitudinal sagittal section.

capacious spermiducal vesicles that rise slightly to open separately into the seminal vesicle.

Seminal vesicle musculature comprises inner circulo-oblique muscles that merge ectally with the longitudinal muscles of the penis bulb. Glands supplying the seminal vesicle are located in the parenchyma outside the penis bulb. The seminal vesicle comprises two parts: a proximal section, spheroid in shape, some 70 μm diameter, with fimbriate vacuolate nucleate non-ciliated columnar cyanophil epithelium, through which necks of glands situated external to the penis bulb discharge fine-grained erythrophil and amorphous cyanophil secretions into the lumen; and a distal section, 57 μm long with a columnar epithelium that merges into that of the ejaculatory duct.

Ejaculatory duct short, 114 μm long, lined by rugose nucleate non-ciliated cuboidal epithelium that grades into the tall, glandular antral epithelium, underlain by strong circulo-oblique muscles. Fine erythrophil and xanthophil

secretions derived from glands external to the penis bulb pass through penial musculature into lumen of ejaculatory duct. Penis bulb with fairly loose, mixed musculature enclosing the spermiducal vesicles, with strong circular and longitudinal muscles where the ejaculatory duct opens into the antrum. Penis eversible type without a papilla.

Ovaries situated approximately one-third of the distance between the brain and the root of the pharynx; ellipsoid, with left ovary slightly larger (140 μm dorso-ventral axis \times 170 μm antero-posterior axis) than the right (106 μm \times 84 μm), both with 200 μm diameter laterally, embedded in lateral nerve cords. Ovitelline ducts arise from mid-posterior walls of ovaries. Proximal end of each duct slightly expanded, without sphincter muscle at point of contact with ovary. Resorptive cells absent.

Ovitelline ducts lined by nucleate ciliated low-columnar epithelium, and with inner longitudinal and ectal circular musculature, filled with sperm, pass ventrally and

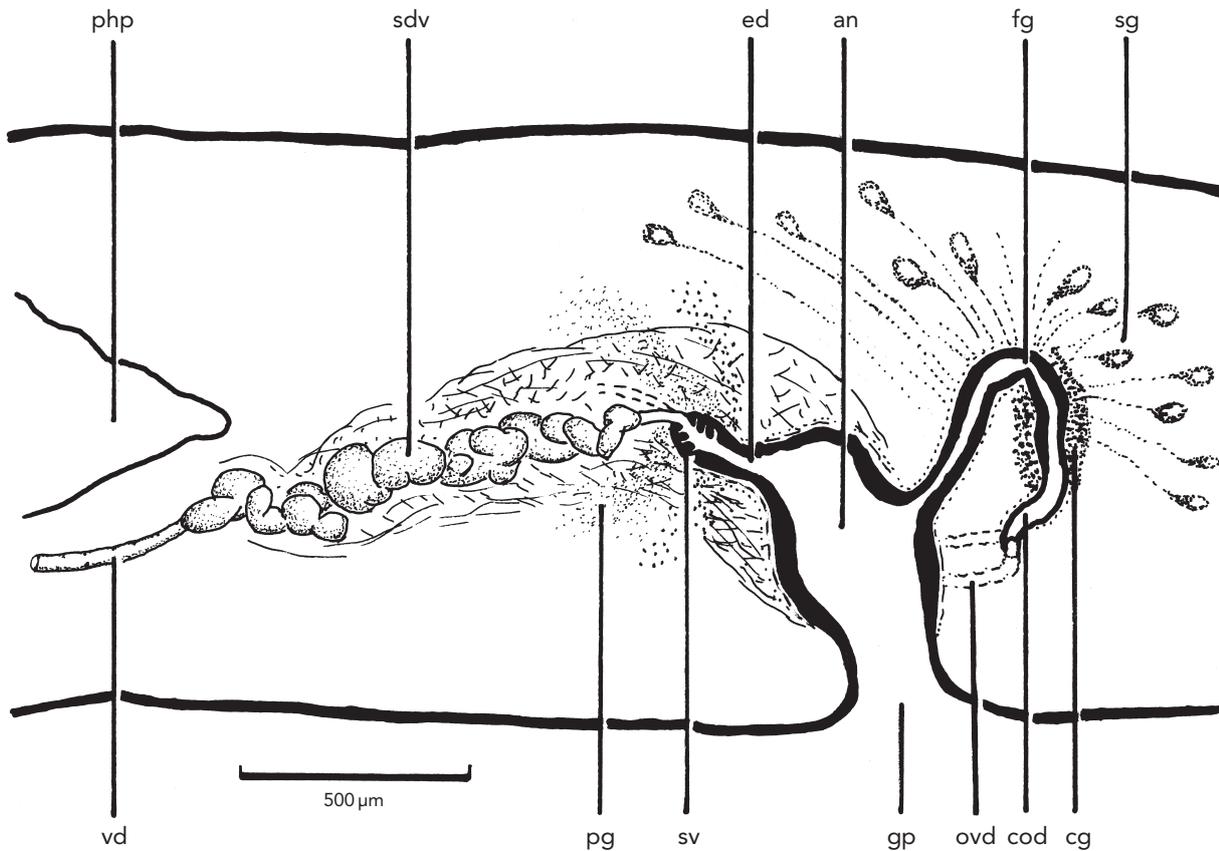


Fig. 5 *Argaplana ranuii* MONZ 1389: copulatory organs, composite longitudinal sagittal section.

continue posteriorly along nerve cords, and just behind the copulatory organ bulb bend medially, then unite to form a short, common ovovitelline duct. Common oviduct 200 μm long, with epithelium and musculature same as ovovitelline duct, communicates directly with the female genital canal (proflax ventral approach). Genitointestinal duct absent. Female genital canal curves slightly and rises vertically, bends anteriorly to enter the mid-dorsal rear wall of female antrum. Genital canal lined by columnar epithelium with cyanophil cytoplasm, receives coarse xanthophil ('shell gland' secretion), and fine granular cyanophil granules secreted into lumen as strands; both secretions derived from glands in surrounding parenchyma; with inner longitudinal and outer circular musculature. A thick lamellar xanthophil length of secretion (putative cocoon wall) was present in the distal genital canal. Antrum lined by pseudostratified epithelium comprising strand cells, the tips of which are heavily charged with coarse xanthophil granules together with cyanophil gland cells. The cyanophil gland cells appear to be secreted in a holocrine manner into the

antral lumen. The antral lumen contains a mixture of xanthophil and cyanophil secretions. Antrum with subepithelial longitudinal muscularis is surrounded by circular muscles merging into a loosely interwoven, mixed muscularis.

Vitellaria well developed, situated between gut diverticula, empty into the ovovitelline ducts via short, narrow vitelline funnels.

PATHOLOGY: Gregarines present in intestinal mucosa.

ETYMOLOGY: Fyfe (1953) did not specify the origin or gender of the specific epithet. During the Second World War, one of the relief ships that supplied the coastwatchers on the Subantarctic Islands was the *Ranui* (Fraser 1986), after which Ranui Cove in Port Ross, Auckland Island, is named. Fyfe based her description on some eight specimens (RAF4) collected by J.H. Sorensen on Campbell Island. Contrary to Ogren & Kawakatsu (1991: 83) and Ogren *et al.* (1997: 80), the species has not been found on the Auckland Islands. As there are no landmarks named 'Ranui' on Campbell Island, in all likelihood Fyfe named the species

as *ranuii* after the relief ship or Ranui Cove. Ranui is also a community in urban Waitakere City, West Auckland, New Zealand. The ending of the specific epithet *ranuii* suggests that the name is masculine and therefore is in apposition to the feminine generic name.

Systematic discussion

With respect to the eyes in *Argaplana ranuii*, Fyfe (1953) stated that ‘The numerous eyes are arranged in a ring round the anterior end, which is turned up, and the eyes continue in a zig-zag along the sides’; the eye pattern was not illustrated (although six taxa were considered by Fyfe (1953), only plate IV, figure 1 illustrates an eye pattern of the hooded end of *Coleocephalus fuscus*). In the absence of a specific comment, it must be assumed that Fyfe did not consider the eye pattern present in *A. ranuii* to be noteworthy.

At present, only two austral flatworm genera are known to have multiple rows of eyes that contour around the anterior tip – *Argaplana* and *Eudoxiatopoplana* – the key taxonomic characters and states of which are compared in Table 1. The two genera are chiefly differentiated on the basis of the positions of the testes (dorsal in *Eudoxiatopoplana* and ventral in *Argaplana*), penis type and creeping sole (present in *Argaplana* and absent in *Eudoxiatopoplana*). The pointed caudal tip noted in the specimen of *Argaplana ranuii* is similar to that present in an as yet undescribed eyeless Australian terrestrial flatworm and may be a fixation artefact. The specimen examined and described in this paper (MONZ 1389) exhibited no markings, possibly resulting from the process of preservation. Only the ventral markings showing the ‘row of pale dots on the brown bands’ of *A. ranuii* have previously been illustrated (Fyfe 1953: text fig. 3). However, the dorsal and ventral markings of the species are illustrated in colour in the original card index belonging to Marion Fyfe, now in the author’s possession. In the material examined and described by Fyfe (1953), the species had a dark brown dorsal ground colour with a single median dark brown dorsal stripe. In an immature specimen 12 mm long, Fyfe (1953: 11) noted that the dorsum had a red-brown ground colour with two narrow black stripes dividing it into three more or less equal zones. The markings of the dorsal surface illustrated by Fyfe in her card index and redrawn here (Fig. 1c) appear to be a composite of these two forms.

Fyfe (1953) compared *Geoplana ranuii* to *Geoplana quadrangulata* (Dendy, 1890; 1891; now *Reomkago quadrangulata*) with respect to similarities in the external features of the two species, in particular the size, antero-ventral halo

markings (circles in Fig. 1d), and lack of clear demarcation between dorsal and ventral surfaces. *Reomkago* is characterised by a single row of eyes around the anterior tip without antero-lateral crowding (multiple rows of eyes in *Argaplana*); creeping sole <50% body width (>50% in *Argaplana*); and strong dorso-ventral musculature (absent in *Argaplana ranuii*) that is responsible for the quadrangulate cross-sectional shape of *R. quadrangulata*. A distinct penis papilla is present in *Reomkago quadrangulata* and absent in *Argaplana ranuii*, which has an eversible penis lacking a papilla.

Fyfe (1953) also noted that the cylindrical pharynx in *Argaplana ranuii* was also present in *Reomkago quadrangulata* and another species, *Artioposthia ventropunctata* (Dendy, 1892). A cylindrical pharynx is present in numerous land planarian taxa. Of greater significance than the type of pharynx is the pharyngeal musculature. In this case, *Argaplana ranuii*, *Artioposthia ventropunctata* and *R. quadrangulata* all have a Dendrocoelid-type derived pharyngeal musculature with mixed inner musculature, but differ in that *Argaplana ranuii* has an outer circular-mixed musculature whereas *R. quadrangulata* and *Artioposthia ventropunctata* have an outer pharyngeal musculature of longitudinal-circular-longitudinal muscles (Winsor 2003).

Curiously and without explanation, Ogren & Kawakatsu (1991) transferred Fyfe’s *Geoplana ranuii* to the genus *Kontikia*, although data on the musculature of *G. ranuii* was unavailable and Fyfe’s figure showed that the species clearly lacked a penis papilla characteristic of *Kontikia*. The description of the seminal vesicle and ejaculatory duct provided by Fyfe (1953) generally accords with that of the specimen examined here. The only difference noted is the relative lengths of the seminal vesicle (127 µm) and ejaculatory duct (114 µm); in Fyfe’s figure (plate II, fig. 2), the distal seminal vesicle appears longer than in the specimen considered here. Fyfe’s description of the distal epithelium with long gland cells of the seminal vesicle accords more with that of the distal ejaculatory duct.

Comments

Both *Argaplana* and *Eudoxiatopoplana* exhibit unusual combinations of taxonomic features that underline the constraints of morphologically based taxonomy of terrestrial flatworms and reinforce the need to reassess the characters and states that define terricolan genera and higher ranks. The relative importance of some characters, including the dorso-ventral extent of the testes, and the presence or absence of

a creeping sole and adenodactyls, needs to be reassessed. Are terrestrial planarians with multiple eyes around the anterior tip, with dorso-ventral testes, with or without a creeping sole, and with or without adenodactyls in their copulatory apparatus awaiting discovery?

Replacement name for *Fyfea* Tribe Anzoplanini

Marionfyfea nomen novum

Fyfea Winsor 2006: 88. Junior homonym of *Fyfea* Finlay & Marwick, 1937.

Artioposthia (in part); Fyfe, 1953: 9; Ogren & Kawakatsu 1991: 37.

TYPE SPECIES: *Artioposthia carnleyi* Fyfe, 1953.

The terrestrial flatworm genus *Fyfea* was erected to accommodate those Anzoplanini with a post-oral ovary, inverted penis and adenodactyl (Winsor 2006). Subsequently, I found that the name had previously been used for a Palaeocene gastropod honouring a Mr H.E. Fyfe, who discovered an important Wangaloan fossil assemblage at Boulder Hill, near Dunedin (Finlay & Marwick 1937). The name *Marionfyfea* is now proposed to replace *Fyfea* Winsor, 2006, preoccupied. The new name is after Marion Fyfe, the author of the type species. Gender feminine.

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