A new genus and two new species of Hydrobiidae (Mollusca: Gastropoda: Caenogastropoda) from south Western Australia

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Manuscript received November 1998; accepted May 1999

Abstract

A new genus of hydrobiid gastropod, *Westrapyrgus* n gen, containing two new species, is described from south Western Australia, these species being the first freshwater members of this family to be described from this state. One species, *W. westralis* n sp, is found in coastal springs in the south-west of Western Australia; the other, *W. slacksmithae* n sp, is from the Avon and Moore Rivers, to the north-east of Perth. The new genus is morphologically most similar to the south-eastern Australian freshwater genus *Austropyrgus* and to the estuarine genus *Tatea.*

Introduction

Freshwater snails of the family Hydrobiidae have recently been shown to be diverse in Australia with large faunas in south-eastern Australia, especially in Tasmania (Ponder *et al*. 1993; Clark, Ponder & Miller unpubl. observ.) and in artesian springs associated with the Great Artesian Basin (Ponder *et al*. 1989, 1995; Ponder & Clark 1990; Ponder 1995). A number of these species are listed as threatened by the International Union for the Conservation of Nature (Baillie & Groombridge 1996; Ponder 1994, 1997, 1998). Many hydrobiids show small morphological differences between populations, even in those from adjacent drainages (*e.g.* Ponder 1982; Ponder *et al*. 1993) and these differences are often indicative of marked genetic differentiation (Colgan & Ponder 1994; Ponder *et al*. 1994, 1995, 1996). To complicate matters further, cryptic species are known to occur in sympatry (Ponder *et al*. 1994).

Apart from Kendrick's (1976) record of *Potamopyrgus* sp from the Avon River, to date the only published valid records of the family Hydrobiidae from Western Australia are for estuarine species in the genera *Ascorhis* (Ponder & Clark 1988) and *Tatea* (Ponder *et al*. 1991). Recently Davis & Christidis (1997) recorded *Potamopyrgus* sp from the Perth area but this record is erroneous, being based on a species of *Coxiella*, a member of the Pomatiopsidae. Nevertheless freshwater hydrobiids associated with coastal springs in the south-west of Western Australia and the River Avon north-east of Perth (Kendrick 1976) have been known for many years (G W Kendrick and S M Slack-Smith, pers. comm.) but have remained undescribed until now.

Material and Methods

Collection

Material for this project was obtained from existing museum collections (see list in Abbreviations), or collected either by hand, by picking from the surface of the substratum, by washing submerged stones, wood and vegetation, or by sweeping vegetation with a hand sieve. Specimens were, in some instances, relaxed using menthol crystals. The samples were then fixed in 10 % formalin neutralised with sodium bicarbonate and, after sorting, stored in 5 % buffered seawater formalin. Where sufficient material was available a sub-sample from each lot was dried.

Morphology

Shells, opercula and radulae were mounted using standard techniques (*e.g.* Ponder *et al.* 1993) and, for the type species, the head-foot was critical-point dried as described by Ponder *et al*. (1993). They were then examined after coating with gold using a Cambridge Instruments S120 scanning electron microscope (SEM). Three radulae were examined for each species.

Using specimens from the type series, shells and opercula were measured using a digitising pad linked to a computer, as described in detail by Ponder *et al.* (1989). The measurements taken are listed below under Abbreviations and all are given in mm. The convexity ratio (CV) is detailed in Ponder *et al.* (1989: Fig 4B). It is calculated using the distance from the outer edge of the middle of the whorl to a line connecting the sutures divided by the distance between the sutures at the end of the penultimate whorl. The number of whorls was counted using the method illustrated in Hershler & Ponder (1998: Fig 17m). Opercular peg length is the vertical height of the longest peg, but not necessarily the same peg in all individuals even within the same species (see Ponder *et al*. 1989: Fig 4E).

Some of the specimens used for measurement were utilised for dissection. Dissection was carried out by one of us (SAC) using an Orient SM1 stereomicroscope and drawing apparatus with the animal in a black, solid watch glass. Fine watchmakers' forceps were used and the specimen being dissected was immersed in tap water containing a few drops of Bouin's fixative to improve contrast. Three specimens of each sex were dissected of

both species. The characters were scored according to a predetermined list of states similar to those employed by Ponder *et al.* (1993). Anatomical measurements were also made and are given in the Appendix. The type species was studied alive by one of us (WFP).

The descriptions were generated using DELTA (Dallwitz *et al.* 1993). The list of characters and their states can be obtained from the first author on request but are similar to those used by Ponder *et al.* (1993).

Statistical analyses were carried out using SYSTAT 5 (Wilkinson 1992). Shell, opercular and anatomical measurements were subjected to ANOVA. Discriminant function analysis was used to test the robustness of the species groups. Sexual dimorphism in shell size (shell length and width) was tested by t-test. A probability > 0.01 was considered to be non-significant.

Abbreviations

Institutions: AMS, Australian Museum, Sydney; SAM, South Australian Museum, Adelaide; WAM, Western Australian Museum, Perth.

Shell measurements and counts: AL, aperture length; AW, aperture width; BW, length of last (body) whorl; CV, convexity ratio; SL, shell length; SW, shell width; TW, number of teleoconch whorls.

Opercular measurements and counts: ML, length of white smear; OL, opercular length; OW, opercular width; PH, maximum peg length; PL, length of area occupied by pegs; PN, number of pegs.

Taxonomy

Family Hydrobiidae

Subfamily Tateinae

Recent studies have enabled a clarification of the generic groupings that have appeared in recent literature and these are briefly outlined below and summarised in Table 1. Ponder (1982) listed as synonyms of *Hemistomia* Crosse, 1872 (type species *H. caledonica* Crosse, 1872) four genus-group names from Australia - *Fluvidona* Iredale, 1937 and *Rivisessor*, *Pupiphrix* and *Angrobia* all of Iredale, 1943, although he did suggest that several groups were present that "may represent subgenera within *Hemistomia* or even separate genera". Ponder (1988) later showed that *Paludina nigra* Quoy and Gaimard, 1835, the type species of *Austropyrgus* Cotton, 1942 (see Cotton, 1942 and Ponder, 1988 for the type species designation) was a species of the group then recognised as *Fluvidona* Iredale, 1943. Recent work on the New Caledonian taxa, including *H. caledonica*, indicates that they can be regarded as distinct from the Australian radiation (Haase & Bouchet 1998). The use of *Fluvidona* for the Australian taxa was followed by Smith (1992) and Ponder *et al.* (1994). However, subsequent work (Miller *et al.* 1999) has shown that *Fluvidona* Iredale, 1937 (type species *Hydrobia petterdi* Smith, 1882), which includes several species in northern New South Wales and southern Queensland, is demonstrably distinct from the large group of species found in south eastern Australia and Tasmania which is now referred to *Austropyrgus*, this latter genus-name including *Rivisessor*, *Pupiphrix* and *Angrobia* as synonyms.

Westrapyrgus n gen

Derivation of name: *Westra* – derived from Western Australia, *pyrgus* Greek, a tower – adopted because of its use in the generic names *Austropyrgus* and *Potamopyrgus*. Gender masculine.

Type species**:** *Westrapyrgus westralis* n sp

Description

Hydrobiid with an almost smooth, conical shell; protoconch paucispiral with pitted to irregularly wrinkled microsculpture; teleoconch with fine axial growth lines and very fine spiral grooves. Aperture ovate, outer lip slightly to moderately thickened, not reflected. Operculum yellow, paucispiral, flat, with several short, white pegs on inner surface. Head-foot with long, tapering cephalic tentacles, pigmented along entire length or at bases only; pigment on rest of head-foot present or absent; mantle edge simple. Osphradium short, near posterior end of ctenidium; narrow, with pointed ends. Ctenidium well developed, with broad, triangular filaments. Radula similar to related genera (*e.g. Tatea*, *Austropyrgus*, *Fluvidona*) with central teeth each bearing 3-4 pairs of basal cusps. Stomach with posterior chamber markedly smaller than anterior, posterior caecum large, rounded, expanded behind stomach. Male with oval prostate gland with visceral portion slightly longer than pallial section. Pallial vas deferens undulating between prostate and base of penis. Penis on right side of head, with swollen base and longer distal portion. Penial duct undulating through swollen base of

Table 1

Summary of the recent nomenclatural history of the names *Austropyrgus* and *Fluvidona*. Valid genera shown in bold.

Ponder, 1982	Ponder, 1988; Smith, 1992; Ponder *et al.*, 1994	Miller *et al.* 1999 and this work
Hemistomia Crosse, 1872	***Hemistomia*** Crosse, 1872	***Hemistomia*** Crosse, 1872
Fluvidona Iredale, 1937	***Fluvidona*** Iredale, 1937	***Fluvidona*** Iredale, 1937
	Austropyrgus Cotton, 1942	***Austropyrgus*** Cotton, 1942
Rivisessor Iredale, 1943	*Rivisessor* Iredale, 1943	*Rivisessor* Iredale, 1943
Pupiphrix Iredale, 1943	*Pupiphrix* Iredale, 1943	*Pupiphrix* Iredale, 1943
Angrobia Iredale, 1943	*Angrobia* Iredale, 1943	*Angrobia* Iredale, 1943

penis and most of evenly-tapering distal part. Female reproductive system similar to other members of subfamily but with anterior ovary distinctly lobulate. Renal oviduct forms simple U-shaped loop. Seminal receptacle ovoid, distally rounded, with short duct. Bursa copulatrix large, globular, posterior to albumen gland. Albumen gland about equal in length to capsule gland, both glands swollen. Ventral channel (of capsule gland) terminates behind anterior end of capsule gland, pallial genital opening behind anterior end of ventral channel, placed sub-terminally to almost centrally. Renal organ and pericardium extend for about half their length into mantle roof. Circum-oesophageal ganglia typical of family in configuration and unpigmented. Cerebral ganglia well separated (commissure nearly equal to width of ganglion), right pleural-supra-oseophageal connective slightly longer than length of supra-oesophageal ganglion; pedal ganglia short and rounded with short commissure.

Remarks

The two species included in the new genus resemble some species now included in *Austropyrgus* (*i.e.* Ponder *et al*. 1994 as *Fluvidona*) but differ in having pointed (not rounded) ends to the osphradium, the penial duct undulating through most of the length of the long distal part of the penis (not straight or undulating only in basal half or less of distal part) and the female genital opening located well behind the anterior end of the capsule gland (about $^1/_3$ to $^1/_2$ length of the gland from the anterior end, not anterior to the capsule gland, or near terminal). The teleoconch differs in possessing very fine spiral grooves over the whole surface, this character not having been seen in more than 70 species of *Austropyrgus* (Clark, Ponder and Miller unpubl. observ.). In most other characters the two genera are very similar (protoconch, teleoconch shape, general anatomy, operculum). *Westrapyrgus* is most similar to *Tatea* in the characters of the female reproductive system (Ponder *et al.* 1991) but differs from that genus in having a paucispiral protoconch with wrinkled, not spiral microsculpture; a more broadly conical shell covered with minute spiral grooves; in the cephalic tentacles lacking a distal dark band and ciliated ridges on the proximal part of the right tentacle; and in lacking a markedly thickened shell aperture. Again, in the general features of the anatomy, operculum and radular characters, *Tatea* is very similar to *Westrapyrgus* but this is also true for many of these presumably plesiomorphic characters for other members of the subfamily Tateinae (*Fluvidona*, *Potamopyrgus*, *Hemistomia*, *Fluviopupa* etc).

Westrapyrgus westralis n sp

Figs 1A-C; 2A; 3A,B; 4A,B; 5A,B, E, F; 6.

Material Examined

Holotype and Paratypes. 'The Spring', off Skippy Rock Rd, Leeuwin-Naturaliste National Park, WA, 34° 20.98' S 115° 09' E, alt: 20-40 m, 15 Aug 1982, on water cress, coll P H Colman. AMS, C.340714 (Holotype), C.201006 (many paratypes), C.307579 (3 figured paratypes). WAM (S.12386) (5 paratypes).

Additional Material. Cape Leeuwin, adjacent to water reserve swamp, 34° 22' S 115° 7.98' E, coll O Schatz, pres: E V Finckh Coll, 1971, AMS, C.201008 (5); same locality, in water race, on sides of channel, WA, alt: 20-40m, 15 Aug 1982, coll P H Colman, AMS, C.201005 (many); same location, 12 Jan 1982, coll I Loch, AMS, C.201007 (many); same location, coll S Slack-Smith & B R Wilson, 24 Mar 1975, WAM 766-82 (many); Quarry Bay, Cape Leeuwin, WA, 34° 22' S 115° 08' E, from natural spring flowing from hillside, amongst watercress, coll A Brearley, 22 Jan 1978, WAM 765-82 (many).

Ellen Brook Homestead at Ellen Brook, WA, 33° 57' S 115° 01' E, on damp and wet rock surfaces in splash zone of dam spillway, near homestead, coll G W Kendrick, 14 Sep 1980, WAM 752-82 (7); Ellen Brook, Leeuwin-Naturaliste National Park, 9 km NW of Margaret River townsite, waterfall, WA, 33° 54.83' S 115° 0.12' E, 29 Aug 1985, under rocks, on and above falls, coll W F Ponder, AMS, C.201012 (many); same locality, at and above entrance to Meekadarribee Cave, above & below water level, shaded by *Agonis* tree and Arum lilies, coll M Ellis and S Slack-Smith, 13 Oct 1980, WAM 753-82 (many); same locality, edge of spring-fed stream ca 20 m upstream from Meekadarribee waterfall, on moist soil under litter on edge of stream, WAM (many);

"Glenbourne", 33° 54.83' S 115° 0.65' E, spring in tributary on N side, ca 1.5 km W from Caves Road near base of limestone cliffs, 29 Aug 1985, on wood, surface and debris, coll W F Ponder, AMS, C.201010 (many); same locality, coll G W Kendrick, 25 Dec 1976, WAM 811-80 (many); same locality, coll G W Kendrick, 14 Jan 1982, WAM (many); "Glenbourne", 33° 54.97' S 115° 0.05' E, 29 Aug 1985, tributary on N side, ca 1.5 km from main road near junction with main creek, coll W F Ponder, AMS, C.201011 (many).

Yallingup, WA, 33° 39' S 115° 1' E, SAM, TD72 (many); same locality, AM C.202722(3).

Deepdene Cliffs, near Augusta, WA, 34° 16' S 115° 03' E, seepage area at foot of cliffs, coll M Archer, E Jeffreys *et al*., 15 Nov 1969, WAM 758-82 (many); Turner Brook, Deepdene, near Augusta, WA, 34° 16' S 115° 03' E, coll M Archer, E Jeffreys *et al*., 15 Nov 1969, WAM 754-82 (many); same locality, in stream coming from cliffs to rd, coll A Paterson, 12 July 1971, WAM 755-82 (many); south side of Turner Brook, near and below Deepdene Cliff, WA, 34° 16' S 115° 03' E, steep bank, leaf litter below *Agonis flexuosa*, coll S Slack-Smith & M Ellis, 3 Aug 1980, WAM 757-82 (many) and 756-82 (10);

Augusta, WA, 34° 19' S 115° 09'E, caught in the filter of a water meter in the town, coll B J Fleay (Met Water Board), 1973, WAM 759-82 (many); same locality, in filters of town water supply, coll R Curtis (Dept of Health), July 1976, WAM 760-82 (many).

Creek at Marlamup Beach, NW of Windy Harbour, 3 km from Black Head, WA, 34° 44' S 115° 57' E, spring at base of limestone cliffs at junction with ferrugineous rocks and gneiss-bassalt flows, coll B Muir, 5 May 1981, WAM 301-82 (many).

Moses Rock, 15 km NW of Cowaramup, WA, 34° 28' S 116° 15' E, in spring stream below Quininup Lake Cave (CO1), 33° 44' S 115° 02'E, coll V A Ryland, 19 Apr 1976, WAM (many); same locality, in edge of lake below

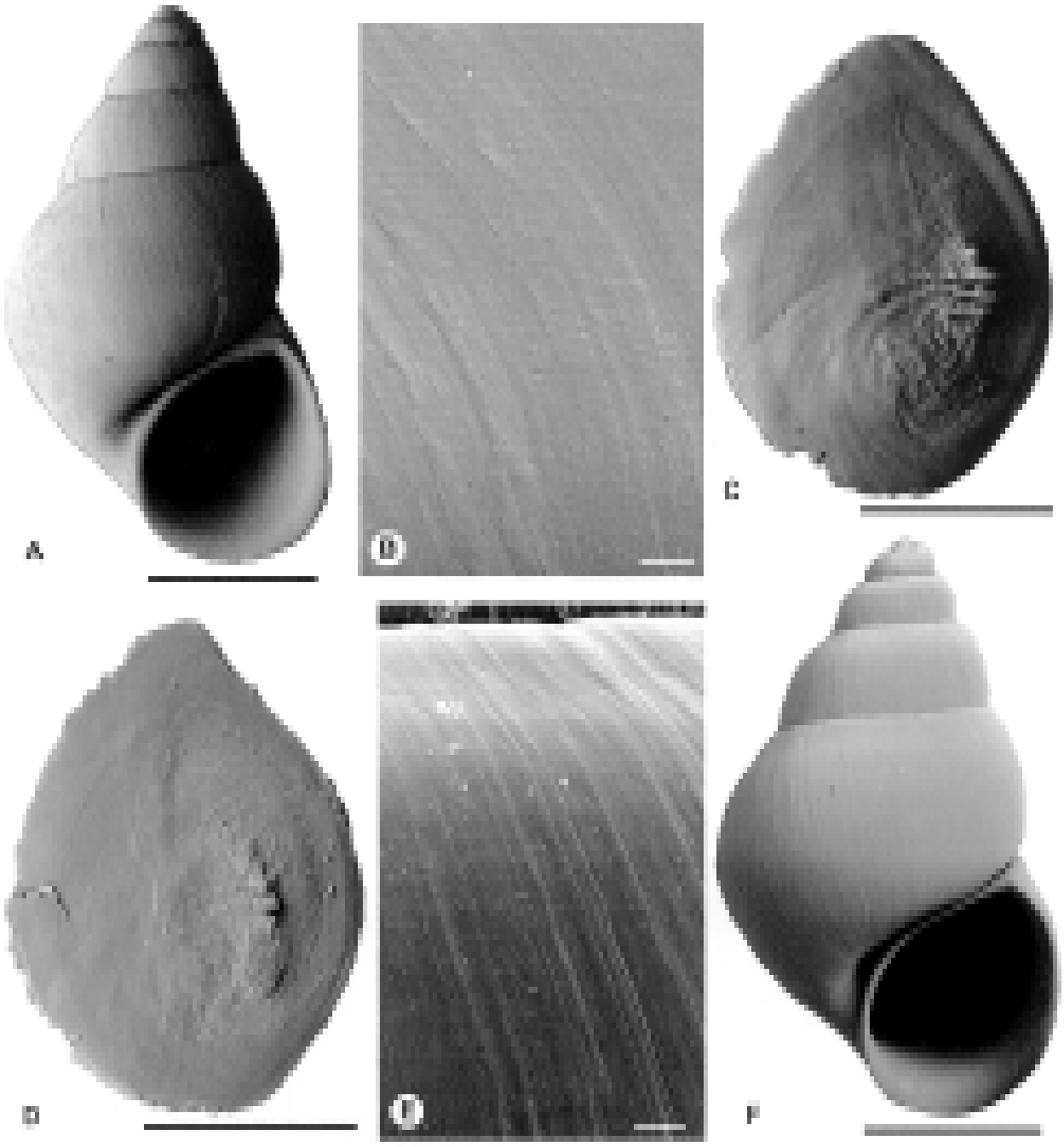

Figure 1. Shells and opercula of *Westrapyrgus* species. **A-C.** *Westrapyrgus westralis* n sp. **A,** shell of holotype. **B,** microsculpture on first quarter of last whorl. **C,** operculum, inner surface (paratype). **D-F.** *Westrapyrgus slacksmithae* n sp. **D,** shell of holotype. **E,** microsculpture on first quarter of last whorl. **F,** operculum of paratype, inner surface. Scales: A, B 1mm; C 200 µm; D 300 µm; E, F 500 µm.

Quininup Lake Cave (CO1), coll V Ryland, 19 Apr 1976, WAM (many).

Creek (Weld River?) flowing into Broke Inlet, WA, 34° 56' S 116° 27' E, coll B G Muir, 26 Oct 1967, WAM (1 juvenile, broader and probably larger than the other material, with marked peripheral angulation).

Diagnosis

Shell conical, whorls weakly convex, periphery subangled; head-foot unpigmented; penis with elbow in middle of distal part when at rest; pallial opening of female genital system placed at about middle of capsule gland and behind anterior end of ventral channel.

Description

Shell (Figs 1A,B; 2A; 3A,B; Table 2). Up to about 4.2 mm in length, spire outline straight. Protoconch (Fig 3A,B) of about 1.3 whorls, with wrinkles forming close, irregular pits (Fig 3B). Teleoconch of up to 4.8 slightly convex whorls, last whorl and base evenly convex to weakly subangled. Surface with fine orthocline growth lines and very fine spiral grooves (Fig 1B). Inner lip of aperture

firmly adhering to parietal wall, outer lip weakly to moderately thickened. Colour yellow-brown, semi-translucent to opaque.

Table 2

Shell dimensions of holotype and paratypes (n = 20; minimum, maximum, mean, standard deviation) of *Westrapyrgus westralis* (in mm).

	SL	SW	AL	AW	BW	CV	TW
Holotype	3.24	1.92	1.32	1.16	2.32	0.14	3.8
Paratypes							
Min	3.02	1.80	1.21	1.03	2.18	0.10	3.8
Max	4.13	2.33	1.60	1.34	2.90	0.16	4.8
Mean	3.46	2.04	1.42	1.19	2.45	0.13	4.2
sd	0.30	0.15	0.11	0.08	0.20	0.02	0.2

Sexual dimorphism. Males (n = 4) are smaller than females (n = 16) in shell length (males 3.14 ± 0.11 mm, females 3.54 ± 0.28 mm) and width (males 1.89 ± 0.06 mm, females 2.08 ± 0.14 mm) and, although these differences are significant (t-test, P< 0.01) the results are inconclusive because of the small number of males measured.

Operculum (Fig 1C). With 2-4 pegs on inner surface, pegs occupying 0.15-0.36 of opercular length (0.24 ± 0.05mm).

Table 3

Opercula dimensions of paratypes (n = 20; minimum, maximum, mean, standard deviation) of *Westrapyrgus westralis* (in mm).

	OL	OW	ML	PL	PH	PN
Min	1.03	0.79	0.20	0.15	0.16	2
Max	1.34	0.99	0.45	0.48	0.36	4
Mean	1.18	0.86	0.31	0.29	0.21	3.20
sd	0.09	0.05	0.06	0.07	0.05	0.70

Radula (Fig 4A,B). Central teeth: each with 4-5 lateral cusps, median cusp of medium width, sharply pointed, about 1.5 times longer than adjacent cusps; 3-4 pairs of basal cusps. Basal tongue U-shaped, not protruding past

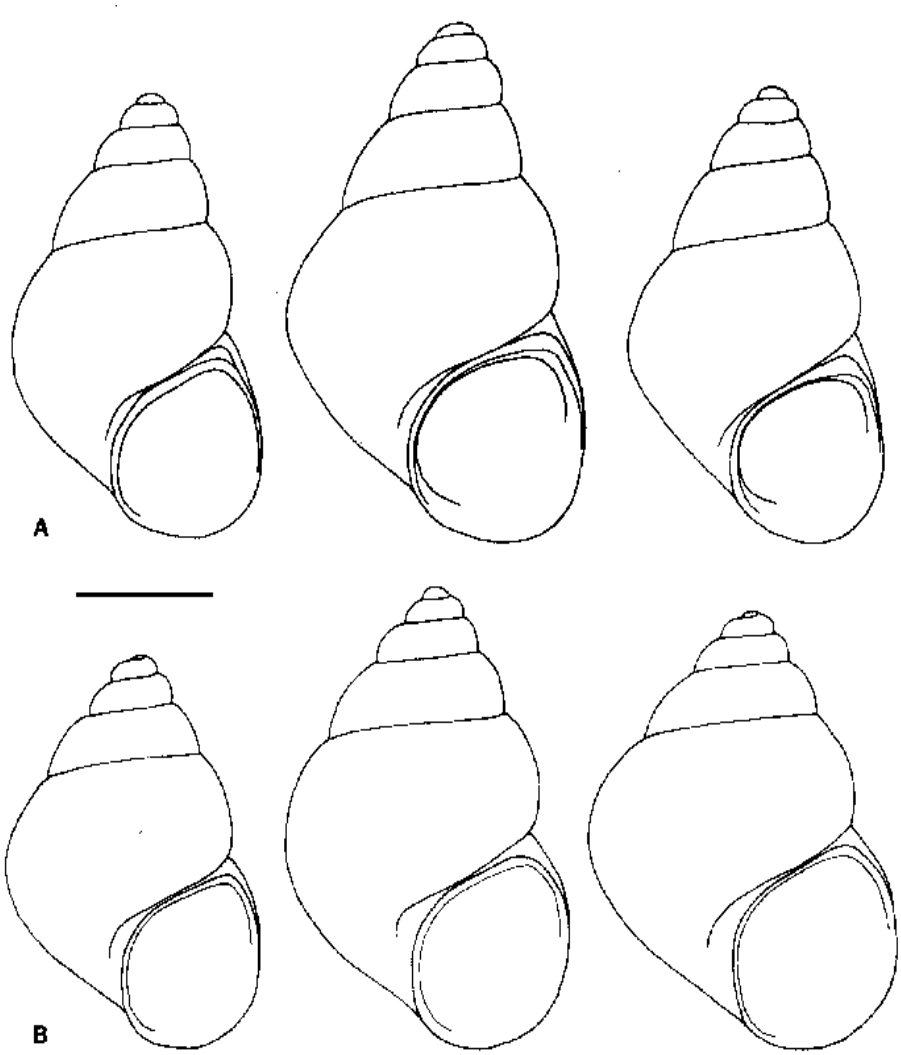

Figure 2. Shells of *Westrapyrgus* species. **A,** *Westrapyrgus westralis* n sp, shells of three paratypes (AMS, C.307579). **B,** *Westrapyrgus slacksmithae* n sp, shells of three paratypes (AMS, C. 340673). Scale 1 mm.

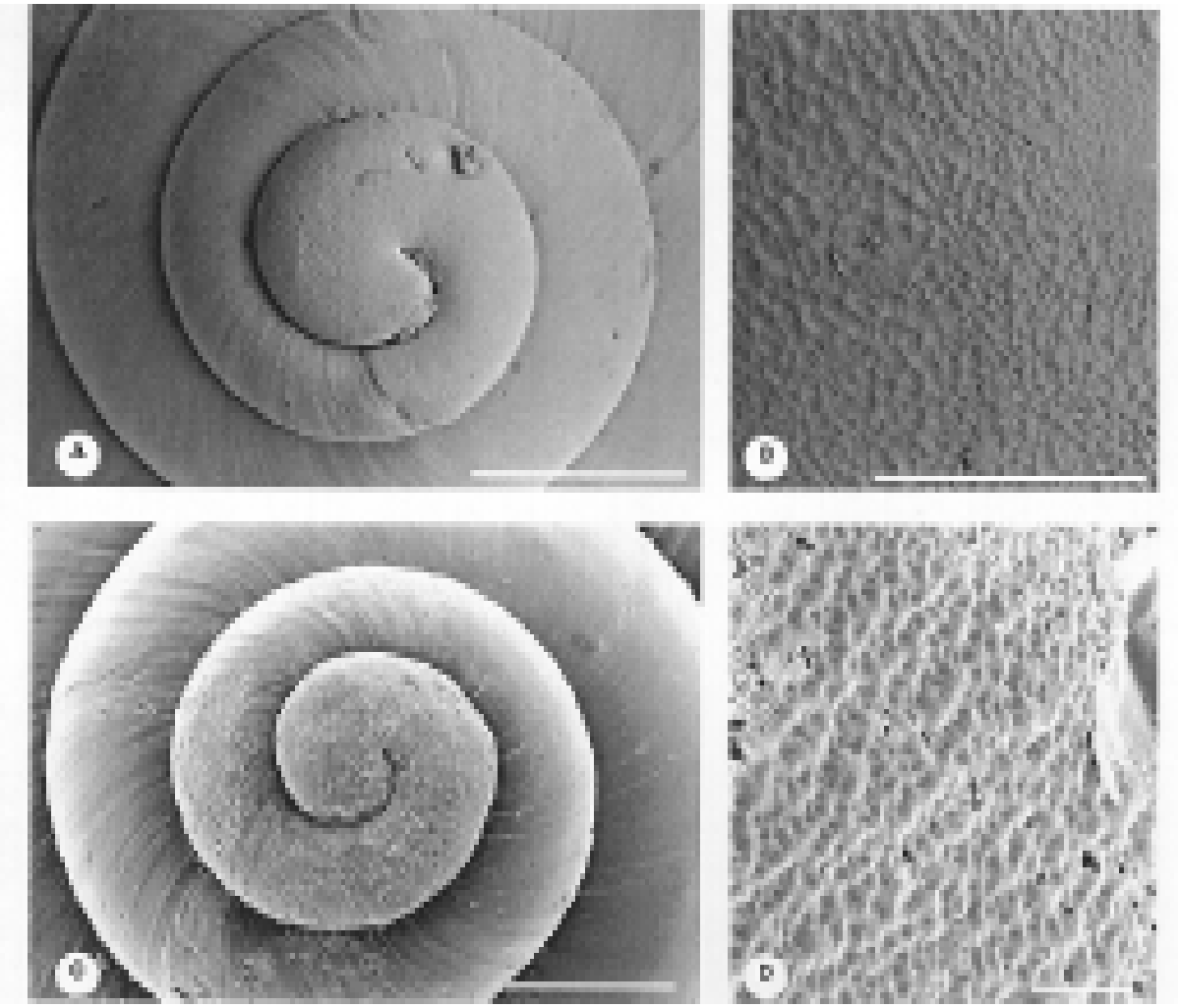

Figure 3. Protoconchs of paratypes of *Westrapyrgus* species. **A, B.** *Westrapyrgus westralis* n sp. **A,** protoconch and upper teleococh whorls. **B,** microsculpture of protoconch. **C, D.** *Westrapyrgus slacksmithae* n sp. **C,** protoconch and upper teleococh whorls. **D,** microsculpture of protoconch. Scales: A, C 200 µm; B, D 50 µm.

lateral edge. Lateral teeth: each with 4 cusps on both sides, median cusp sharply pointed; less than 2 times longer than adjacent cusps. Basal projection of lateral teeth bluntly pointed. Marginal teeth: inner with 20-25 cusps; outer with 30-37 cusps.

Head-foot (Fig 5E). Snout moderately long, anteriorly bilobed, unpigmented; with cilia in lateral groove behind labia. Foot 1.5 to twice as long as wide, with anterior edge straight to slightly indented and slightly expanded laterally, posteriorly rounded; largely unpigmented, some specimens with little grey pigment anterior to unpigmented opercular lobe. Cephalic tentacles long and tapering, with eyes in weak swellings at base; unpigmented except for grey to black pigment around eye; mid dorsal and mid ventral cilial tracts present and rather weak cilia on lateral edges. Head and neck unpigmented except for posterior continuation of pigment behind eye in some specimens. Cilial tract of right side, especially marked in females and some cilia on anterior parts of foot lateral to snout. Pallial roof and visceral coil unpigmented.

Anatomy (see Appendix for measurements).

Mantle Cavity. Ctenidium with 19-23 (n = 6) filaments, posterior most filament overlaps pericardium. Osphradium elongate, with pointed ends, located between posterior end and middle of ctenidium (posterior end of osphradium at about 3rd to 5th posterior ctenidial filament). Hypobranchial gland well developed; partly covering straight to slightly arched rectum. Renal organ extends forward *ca.* $^1/_2$ its length into pallial cavity; pericardium more than $^1/_2$ within pallial roof.

Stomach (Fig 5B) with large caecum.

Male Reproductive System (Fig 5E, F). Testis of 1.25-1.4 (n = 3) whorls. Seminal vesicle loosely coiled over stomach and conspicuously coiled on both digestive gland and testis behind stomach. About $^1/_3$ of prostate gland within pallial roof, oval in shape, compressed in section. Pallial vas deferens flush with surface; slightly to strongly undulating between prostate and penis, strongly undulating at base of penis. Penis (Fig 5F) unpigmented, with expanded basal portion and distinct elbow about half way along elongate distal portion; proximal part of distal portion with parallel sides, distal part tapering.

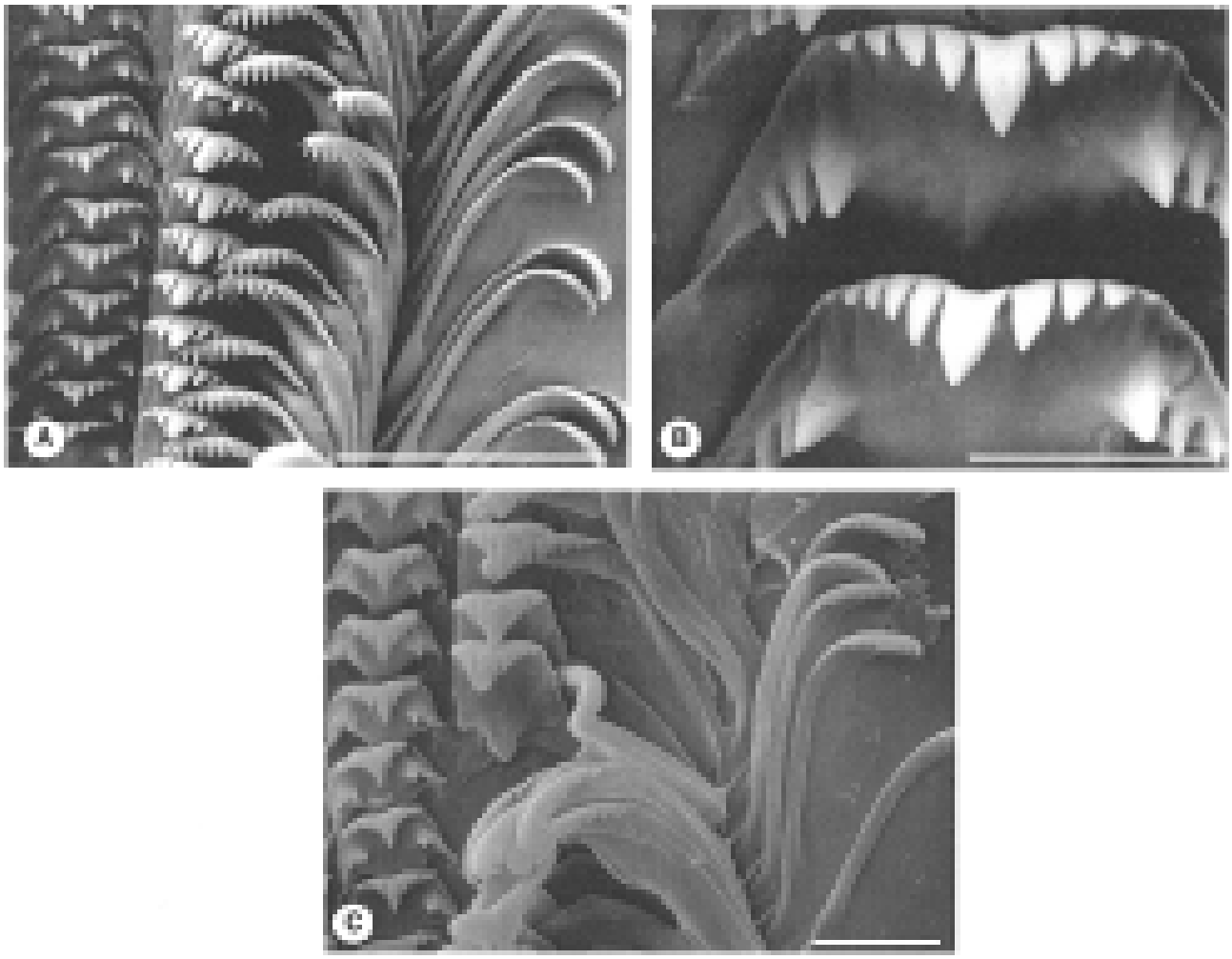

Figure 4. Radulae of paratypes of *Westrapyrgus* species. **A, B.** *Westrapyrgus westralis* n sp. **A,** half rows. **B,** detail of central teeth. **C,** *Westrapyrgus slacksmithae* n sp half rows. Scales: A 50 µm; B 10 µm; C 20 µm.

Penial duct undulating through basal part and about two thirds of distal portion.

Female Reproductive System (Fig 5A). Ovary of about 1.0-1.3 (n = 3) whorls. Coiled oviduct with initial U-shaped loop orientated dorso-ventrally; initial loop medium; proximal part simple with two bends; one bend distal to seminal receptacle. Coiled oviduct and bursal duct join at posterior pallial wall. Bursal duct parallel sided and straight. Oviduct joining bursal duct ventrally or from right side. Seminal receptacle with short duct, ovoid and located at anterior edge of bursa copulatrix. Rectum overlapping albumen and capsule glands. One quarter or less of albumen gland in front of posterior pallial wall. Capsule gland with anterior end tapering or rounded, compressed-oval in section, with distinct glandular zones. Ventral channel indistinct to distinct, with indistinct muscular vestibule; genital opening small; located nearly $^1/_2$ way along capsule gland.

Etymology. Named after Western Australia.

Remarks

This species has been found in several coastal springs in south Western Australia (Fig 6) between Cape Naturaliste and the Weld River, and is locally abundant, even to the point where it has been found clogging water filters in Augusta. More extensive survey work in this area will probably increase the number of localities and perhaps extend the geographic range. Confirmation of the eastern-most record (stream flowing into Broke Inlet) is required as this is based on a single juvenile, which has a more strongly angled periphery than the other specimens. The species shows some variation in size within and between populations, one lot in particular (WAM 753-82) being markedly smaller than most others.

The paucity of pigment on the head-foot of this species is unusual, most surface species, like that described below, having a strongly pigmented head-foot.

This species has a similar distribution to that of another caenogastropod, *Austroassiminea letha* Solem *et al.* 1982, a species that is also restricted to coastal springs and seepages (Solem *et al.* 1982), and the two species are

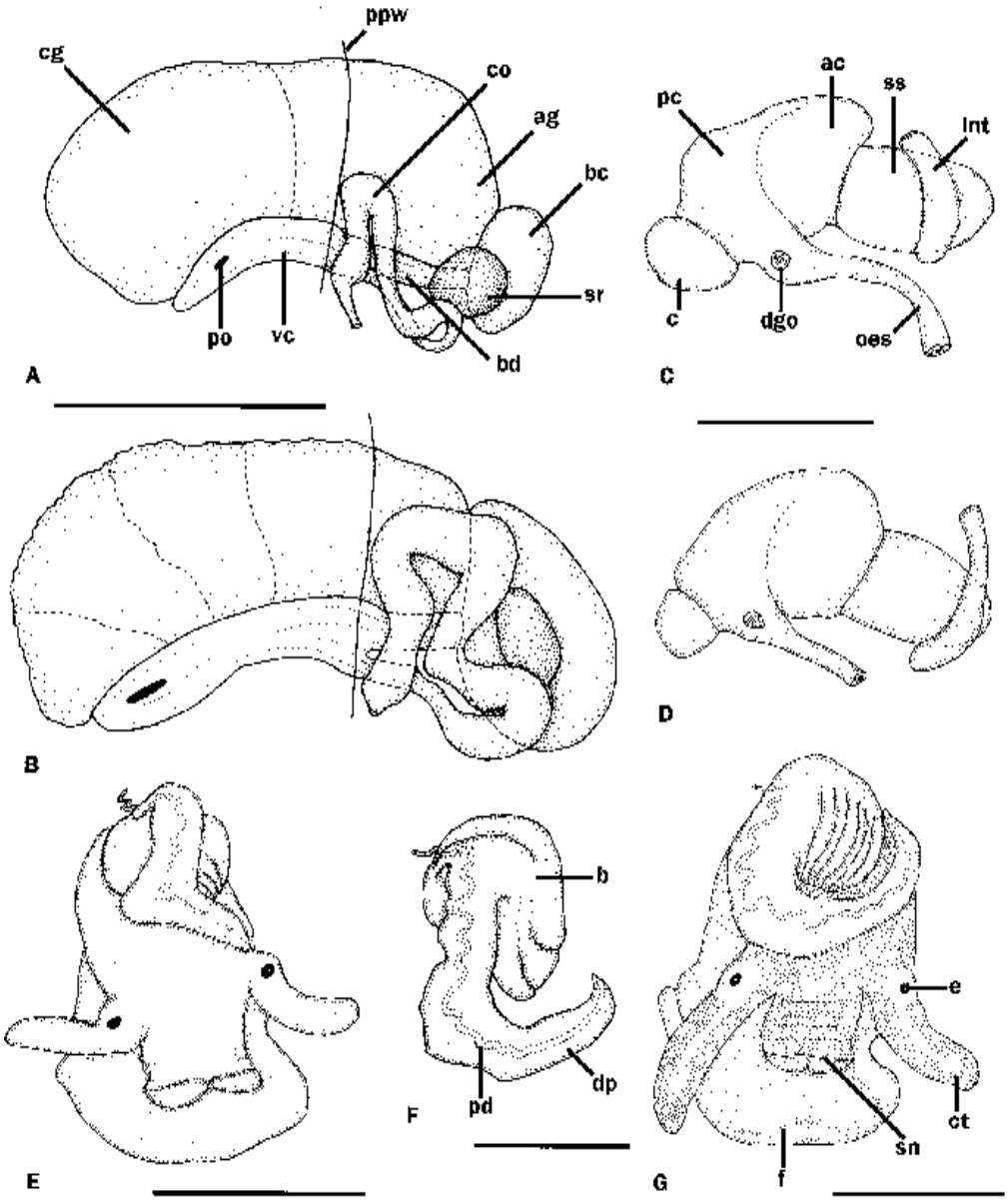

Figure 5. Anatomy of paratypes of *Westrapyrgus* species. **A,B,E,F.** *Westrapyrgus westralis* n sp. **A,** female genital system from left side. **B,** stomach. **E,** head of male showing penis. **F,** detail of penis. **C, D, G.** *Westrapyrgus slacksmithae* n sp. **C,** female genital system from left side. **D,** stomach. **G,** head of male showing penis.
Abbreviations: ac – anterior chamber of stomach; ag – albumen gland; b – base of penis; bc – bursa copulatrix; bd – bursal duct; c – caecum of stomach; cg - capsule gland; co – coiled renal oviduct; ct – cephalic tentacle; dgo – digestive gland opening; dp – distal part of penis; e – eye; f – propodium of foot; int – intestine; oes – oesophagus; pc – posterior chamber of stomach; pd – penial duct; po – opening of pallial oviduct; ppw – position of posterior wall of pallial cavity; sn – snout; sr – seminal receptacle; ss – style sac; vc – ventral channel. Scales: A-E, G 0.5 mm; F 0.2 mm.

found together in two localities (Ellen Brook, Turner Brook near Deepdene Cliffs). Hydrobiids have not been recorded from Cosy Corner, the third locality where living *Austroassiminea* was found.

Westrapyrgus slacksmithae n sp

Figs 1D-F; 2B; 3C,D; 4C; 5C,D,G; 6.

Potamopyrgus **sp**

Kendrick 1976: 101, Fig 4, Table 1.

Material Examined

Holotype and paratypes. Walyunga Pool, Avon R, near junction of Woorooloo Brook and Avon River, at car park,

Walyunga National Park, NE of Perth, WA, 31° 44' S 116° 05' E, 12 Sept 1987, among roots etc, coll W F Ponder & S. M. Slack-Smith, AMS, C.340715 (Holotype), C.340673 (3 figured paratypes), C.201013 (many paratypes), WAM (S.12387) (5 paratypes); Avon R, NE of Perth, 1 km upstream from parking area, Walyunga NP, WA, 31° 44' S 116° 04' E, 12 Sept 1987, in long pool, coll W F Ponder & S M Slack-Smith, AMS, C.201408 (7 paratypes).

Other material examined. Walyunga Pool, Avon R, Walyunga National Park, WA, 31° 44' S, 116° 05' E, coll S Slack-Smith, 5 May 1971, WAM 763-82 (3); same loc, coll S Slack-Smith & A Paterson, 3 May 1971, WAM 762-82 (4); Long Pool near Walyunga Pool, under sides of stones in shallows, coll G W Kendrick, 6 Feb 1969, WAM 764-82 (20); same loc, alive under stones in river bed, coll G W Kendrick, 12 Apr 1970, WAM 862-71 (7).

Moore River crossing, 6 miles E of Guilderton, WA, 31° 20' S 115° 33' E, on bark and sticks at stream edge, coll G W Kendrick, 2 Jan 1970, WAM 761-82 (3).

Diagnosis

Shell ovate-conic, whorls convex, periphery rounded; head-foot black or dark grey; penis with distal portion evenly curved; pallial opening of female genital system in anterior third of capsule gland and close to anterior end of ventral channel.

Description

Shell (Figs 1E,F; 2B; 3C,D). Up to about 3.3 mm in length, spire outline straight to very slightly convex, aperture slightly disjunct. Protoconch (Fig 3C,D) of about 1.3 whorls, with wrinkles forming close, irregular pits (Fig 3D). Teleoconch of up to about 4 weakly convex whorls, last whorl and base evenly convex. Surface with fine orthocline growth lines and very fine spiral grooves (Fig 1E). Inner lip of aperture firmly adhering to parietal wall, outer lip weakly thickened. Colour yellow-brown, semi-translucent to opaque.

Table 4

Shell dimensions of holotype and paratypes (C.201013; n = 15; minimum, maximum, mean and standard deviation) of *Westrapyrgus slacksmithae* (in mm).

	SL	SW	AL	AW	BW	CV	TW
Holotype	2.82	1.80	1.22	0.99	2.09	0.16	3.7
Paratypes							
Min	2.54	1.60	1.15	0.89	1.91	0.120	3.3
Max	3.29	2.01	1.43	1.11	2.44	0.190	4.1
Mean	2.90	1.84	1.28	1.02	2.11	0.154	3.7
sd	0.22	0.12	0.10	0.07	0.15	0.02	0.2

Sexual dimorphism. Males (n = 11) are smaller than females (n = 4) in shell length (males 2.83 ± 0.20 mm, females 3.10 ± 0.05 mm) and width (males 1.80 ± 0.06 mm, females 1.95 ± 0.12 mm) and, although these differences for the shell width are significant (P =< 0.01) the results are inconclusive because of the small number of females measured.

Operculum (Fig 1D). With 1-5 pegs on inner surface, pegs occupying 0.14-0.48 of opercular length (mean 0.31, sd 0.090).

Table 5

Opercula measurements for paratypes (n = 15; minimum, maximum, mean and standard deviation) of *Westrapyrgus slacksmithae* (in mm).

	OL	OW	ML	PL	PH	PN
Min	0.89	0.68	0.17	0.12	0.03	1
Max	1.20	0.85	0.64	0.51	0.27	5
Mean	1.06	0.76	0.48	0.33	0.10	2.4
sd	0.11	0.06	0.12	0.10	0.08	1.45

Radula (Fig 4C). Central teeth: each with 4-5 lateral cusps, median cusp of medium width, sharply pointed, nearly twice as long as adjacent cusps; 3 pairs of basal cusps. Basal tongue U-shaped, just protruding past lateral edge. Lateral teeth: each with 4-5 cusps on both sides. Median cusp sharply pointed; less than 2 times longer than adjacent cusps. Basal projection of lateral teeth pointed. Marginal teeth: inner with 17-21 cusps; outer with 24-28 cusps.

Head-foot (Fig 5G). Cephalic tentacles with black pigment with unpigmented median dorsal stripe; snout, head and neck, foot and opercular lobe all strongly pigmentated with black or dark grey; pallial roof with mottled to uniform black pigment; visceral coil densely pigmented, mostly black or dark grey.

Anatomy (See Appendix for measurements).

Mantle Cavity. Ctenidium with 21-25 (n = 6) filaments. Osphradium elongately oval; located between posterior end and middle of ctenidium. Hypobranchial gland well developed; partly to completely covering straight to slightly arched rectum. Renal organ extends forward *ca.* ½ its length into pallial cavity; pericardium more than ½ within pallial roof.

Stomach (Fig 5D). With large caecum.

Male Reproductive System (Fig 5G). Testis of 1.3-1.5 (n = 3) whorls. Seminal vesicle tightly coiled over stomach and also coiled on both digestive gland and testis behind stomach. Prostate gland about ⅓ within pallial roof, oval in shape, broadly-oval in section. Pallial vas deferens flush with surface; strongly undulating throughout its length. Penis unpigmented, with expanded basal portion and long, evenly-tapering distal portion. Penial duct undulating in base and proximal two thirds of distal portion of penis.

Female Reproductive System (Fig 5C). Ovary of about 1.2-1.5 (n = 3) whorls. Coiled oviduct with initial U-shaped loop orientated obliquely backwards; initial loop high to medium; proximal part with bends and kinks, or twisted; with two bends distal to seminal receptacle. Coiled oviduct and bursal duct join at posterior pallial wall. Bursal duct parallel sided and straight. Oviduct joining bursal duct from right side. Seminal receptacle with short duct, ovoid in shape and located on middle of inner wall of bursa copulatrix. Rectum overlapping albumen and capsule glands. About ½ of albumen gland behind posterior pallial wall. Capsule gland with anterior end rounded, oval in section, with distinct glandular zones. Ventral channel distinct, with indistinct muscular vestibule. Genital opening small, located about ⅓ behind anterior end of capsule gland.

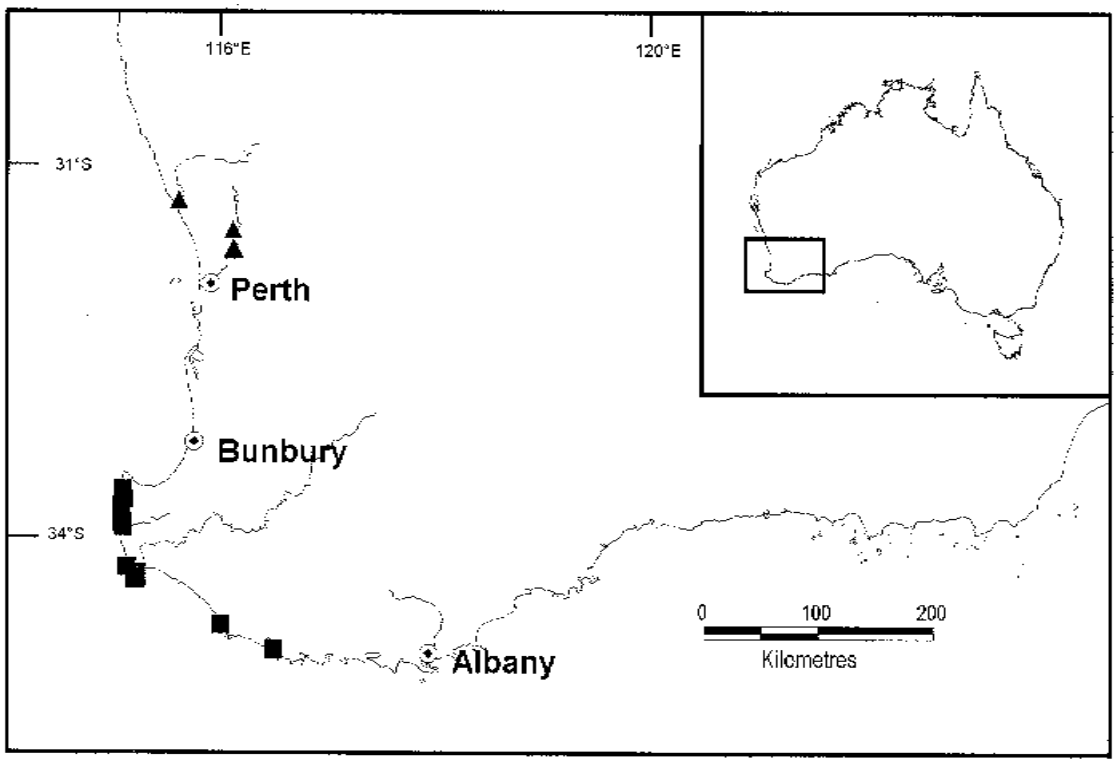

Figure 6. Map of the south west of Western Australia showing the known distribution of the two species of *Westrapyrgus westralis* n sp (n) and *Westrapyrgus slacksmithae* n sp (s).

Etymology

Named after Mrs Shirley Slack-Smith of the West Australian Museum, who assisted in the collection of the type material.

Remarks

Kendrick (1976) in a paper detailing the degradation of the Avon River, recorded this species from that river and noted that he had first collected it in 1969. He noted that "Records are from streams in south-western Australia between the Moore and Frankland Rivers, it being found on submerged sticks, bark, stones, *etc*". This distribution conforms to the total distribution of the two taxa recorded herein. Kendrick (1976) further noted that in the Avon River "*Potamopyrgus* sp" was "known only from pools in the Walyunga National Park…. situated in the Darling Range immediately below the confluence with the comparatively fresh Wooroloo Brook". He suggested that this species might have previously occurred more widely along the Avon. Currently this species appears to be restricted to a few localities in the Avon and Moore Rivers (Kendrick 1976 and herein) and consequently its conservation status requires assessment. While it is possibly also living in other nearby drainages, with the considerable amount of collecting of macroinvertebrates in the streams along the south western seaboard it is unlikely that this reasonably conspicuous species would have been overlooked.

This species differs from *Westrapyrgus westralis* in having a more ovate shell (compare Fig 2A and B), in lacking a distinct "elbow" in the distal part of the penis, in the head-foot being heavily pigmented (almost entirely unpigmented in *W. westralis*) and in the more anterior placement of the female genital opening.

When the measured populations of the two species are compared using ANOVA, all shell measurements are significantly (P - 0.001) different. The opercular measurements are also significantly different at this level, with the exception of the length of the area occupied by the pegs and the number of pegs. Consequently the two species separate well using shell and opercular measurements with all specimens being correctly assigned in a discriminant function analysis. The two species are also readily discriminated on the basis of their radulae, particularly concerning the inner and outer marginal cusp counts. Comparisons (using t-tests) of anatomical measurements (see Appendix) show that only the length of the gastric caecum, the length of the bursa copulatrix, the width of the duct of the bursa copulatrix and the length of the capsule gland differ at the P - 0.001 level. The number of ctenidial filaments, the lengths of the renal gland and seminal receptacle and the width of the bursa copulatrix differ at the P - 0.05 level.

Discussion

Whilst some efforts have been made to sample small molluscs in fresh water systems in southern Western Australia, much remains to be done and, possibly, additional taxa will eventually be discovered. The two species described above appear to show a well-marked geographical separation. It is unclear, however, as to what extent suitable habitats (for hydrobiids) within this gap have been sampled.

The two taxa exhibit many differences in the details of the shell size and shape, as well as in details of the radula, operculum and anatomy. The recognition of a distinct genus of Hydrobiidae in southern Western Australia is not surprising given the high degree of endemism in plants and animals in that area. However, unlike many other elements of the fauna and flora in this area, *Westrapyrgus* has few distinct apomorphies separating it from its eastern relatives. It has only been possible to assign generic rank to these species after completing a detailed study of hydrobiids in other parts of Australia. This has enabled seemingly insignificant characters (such as the minute spiral grooves on the shell of both species of *Westrapyrgus*) to be used with some confidence. While it is possible to obtain useful morphological characters to separate species and genera, the very nature of these characters in this "morphostatic" radiation results in high levels of homoplasy and necessitates the use of molecular data to resolve phylogenies. The phylogenetic relationships of this group will be discussed elsewhere using such data.

Acknowledgements: We are grateful to Mr P H Colman and Mrs S M Slack-Smith for collecting material used in this study and Mr G W Kendrick for initially drawing our attention to the Avon River species. A Murray drew the shell outlines and L Elkan rendered two of the anatomical illustrations. We also thank two anonymous reviewers and Dr P Middelfart for their constructive suggestions on an earlier version of the manuscript. This work was funded by a grant from the Australian Biological Resources Study.

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Appendix

Table of anatomical measurements of *Westrapyrgus westralis* and *W. slacksmithae*. Explanation of abbreviations used in table (in order of appearance). CTENFIL – number of ctenidial (gill) filaments; OSL – length of osphradium; CTWID – width of ctenidium; KL – length of renal gland; KW – width of renal gland; SS – length of style sac; STOML – length of stomach proper; CAEC – length of gastric caecum; PRL – length of prostate; PRW – width of prostate; PENEYE – distance between right eye and base of penis; SRL – length of seminal receptacle; SRW – width of seminal receptacle; BCL – length of bursa copulatrix; BCW – width of bursa copulatrix; BCDTW – width of bursal duct; BCDTL – length of bursal duct; AGL – length of albumen gland; AGW – width of albumen gland; CGL – length of capsule gland; CGW – width of capsule gland. Measurements in mm.

Westrapyrgus westralis n sp

	CTENFIL	OSL	CTWID	KL	KW	SS	STOML	CAEC	PRL	PRW	PENEYE	SRL	SRW	BCL	BCW	BCDTW	BCDTL	AGL	AGW	CGL	CGW
n	6	6	6	6	6	6	6	6	3	3	3	3	3	3	3	3	3	3	3	3	3
Min	19.00	0.23	0.17	0.38	0.15	0.40	0.43	0.17	0.47	0.22	0.49	0.09	0.07	0.17	0.13	0.03	0.12	0.27	0.22	0.33	0.24
Max	23.00	0.34	0.30	0.52	0.22	0.51	0.60	0.25	0.66	0.35	0.76	0.12	0.11	0.24	0.17	0.05	0.23	0.33	0.27	0.43	0.33
Mean	21.17	0.29	0.25	0.43	0.18	0.46	0.54	0.21	0.59	0.29	0.65	0.10	0.09	0.21	0.14	0.05	0.17	0.29	0.25	0.38	0.29
sd	1.47	0.04	0.05	0.06	0.02	0.04	0.06	0.03	0.10	0.07	0.14	0.02	0.02	0.03	0.03	0.01	0.05	0.03	0.03	0.05	0.05

Westrapyrgus slacksmithae n sp

	CTENFIL	OSL	CTWID	KL	KW	SS	STOML	CAEC	PRL	PRW	PENEYE	SRL	SRW	BCL	BCW	BCDTW	BCDTL	AGL	AGW	CGL	CGW
n	6	6	6	6	6	6	6	6	3	3	3	3	3	3	3	3	3	3	3	3	3
Min	21.00	0.26	0.20	0.46	0.16	0.36	0.40	0.09	0.52	0.27	0.54	0.14	0.11	0.41	0.24	0.09	0.17	0.33	0.27	0.50	0.27
Max	25.00	0.39	0.28	0.60	0.24	0.49	0.61	0.17	0.76	0.36	0.65	0.17	0.13	0.46	0.30	0.14	0.22	0.46	0.33	0.52	0.38
Mean	23.33	0.35	0.22	0.53	0.19	0.42	0.51	0.13	0.65	0.30	0.60	0.16	0.12	0.44	0.27	0.11	0.19	0.39	0.30	0.51	0.32
sd	1.51	0.05	0.04	0.06	0.03	0.05	0.07	0.03	0.12	0.05	0.05	0.02	0.01	0.03	0.03	0.03	0.02	0.07	0.03	0.01	0.06