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Review of the epigean species of *Paroster* SHARP, 1882, with descriptions of three new species, and phylogeny based on DNA sequence data of two mitochondrial genes (Coleoptera: Dytiscidae: Hydroporinae)

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Abstract

All 11 previously recognized epigean species in the Australian genus *Paroster* SHARP, 1882 (Coleoptera: Dytiscidae: Hydroporinae) are redescribed. Three species, *Paroster acutipenis* sp.n., *P. ellenbrookensis* sp.n. and *P. leai* sp.n., are described as new. A key to species, illustrations of the aedeagi (except for *P. leai*) and colour photographs of all species (except *P. michaelsoni*) are given. Two regions of the mitochondrial genome, an 810 bp region of the CO1 gene, and an 821 bp region spanning part of the 16S ribosomal DNA, the complete tRNA-leu gene and part of the NADH dehydrogenase subunit 1 gene (16S-tRNA-ND1) were sequenced for nine species. The isolated position of *P. gibbi* WATTS, 1978 is confirmed.

Key Words: Coleoptera, Dytiscidae, *Paroster*, Australia, new species, taxonomy, key to species, mtDNA sequences.

Introduction

The genus *Paroster* SHARP was last revised by WATTS (1978), who recognized eight species. Since then two additional species, *Paroster baylyi* HENDRICH & FERY, and *P. ursulae* HENDRICH & FERY, have been described by HENDRICH & FERY (2008), and 33 species were transferred to this genus: *P. thapsinus* (GUIGNOT, 1955) from *Coelambus* THOMSON (see FERY 2004), and 32 stygobitic species from *Nirripirti* WATTS & HUMPHREYS, which has been synonymized with *Paroster* (LEYS & WATTS 2008).

Three new species, unfortunately each represented by only a few specimens, are described in this paper, which deals only with the 14 above ground (epigean) species.

Within the Hydroporini the genus *Paroster* is recognized by the exposed base of the meta-trochanter, evenly punctate metatibia and relatively strong microreticulation (particularly in females). Within the genus the epigean species are morphologically very similar, with, apart from male sexual characters, only colour and size separating many of them.

The number of specimens available to WATTS (1978) was small and many of those were old and poorly labelled. Most species are now known from relatively large series of specimens and can be better characterized. However the situation still remains that the median lobe of the aedeagus and the presence or absence of a modification of the fore claws in the male are the main characters enabling most species to be clearly defined. Size, general shape and colour remain useful secondary characters. This lack of clear taxonomic characters led us to carry out a sequence analysis of mitochondrial DNA to provide a tentative phylogeny of the genus, although we still lack material from the rarer species.

Some of the commonest aquatic habitats in southern Australia are the temporary creeks, swamps, flooded areas and pan-gnammas (which occur on isolated granite outcrops in the south-west of Australia) that form in late winter and early spring but are dry by mid to late summer, a result of a typical Mediterranean climate. Species of *Paroster* appear to have specialized in exploiting these kinds of habitats. Apart from a few individuals of 'year round' species, they are the first water beetles to appear in these habitats after they form. In many places, particularly shallow gutters and pools, they are the dominant species and occur in considerable numbers for a relatively short time in spring and are usually gone well before the water has dried up. Breeding also occurs in these places but frequently adults are abundant yet no larvae are present. It would seem that breeding is highly synchronized and growth rapid, not unexpected in these short-term habitats where larval food can be plentiful and competition from other species is slight. The adaptation by species in the genus to living in temporary water is possibly one of the reasons for the repeatedly successful transition from drying surface water to underground water by *Paroster*-like ancestors, which is hypothesized to have taken place as Australia began drying 10–5 mya (LEYS et al. 2003).

Material and Methods

This paper is based primarily on specimens in the collection of the South Australian Museum, which contains almost all the *Paroster* material in Australian collections. The type material of *P. gibbi* WATTS, *P. insculptilis* (CLARK), *P. michaelsoni* RÉGIMBART, *P. nigroadumbratus* (CLARK), *P. pallescens* (SHARP) and *P. sharpi* WATTS was re-examined but the holotypes of the other species were not, since soundly identified material was available.

Specimens were examined with the aid of a Leitz M8 binocular stereomicroscope. Microscope preparations were made, using a polyvinyl alcohol / acetic acid / phenol mountant (Down's medium), of the pro- and mesotarsi and aedeagi of selected specimens. Illustrations were prepared from electronic images made using an automontage system and manipulated using the program 'Photoshop 8'. Line drawings were based on electronic images, checked by visual reference to the specimens. All specimens are deposited in the South Australian Museum, Adelaide (SAMA) unless otherwise indicated.

ABBREVIATIONS:

ABTC	Australian Biological Tissue Collection, SAMA
AM	Australian Museum, Sydney, Australia
ANIC	Australian National Insect Collection, Canberra, Australia
BMNH	British Museum of Natural History, London, England
CALM	Department of Conservation and Environment, Perth, Australia (formerly: Department of Conservation and Land Management)
CLH	Collection Lars Hendrich, Berlin, Germany, property of NMW
MNHN	Muséum National d'Histoire Naturelle, Paris, France
NMW	Naturhistorisches Museum Wien, Vienna, Austria
SAMA	South Australian Museum, Adelaide, Australia
WAM	Western Australian Museum, Perth, Australia
ZSM	Zoologische Staatssammlung, Munich, Germany

DNA methods and analyses:

To assess species boundaries of the *Paroster* specimens available we used DNA sequencing. DNA extraction, polymerase chain reaction (PCR) amplification and sequencing were performed as described in LEYS et al. (2003). Two regions of the mitochondrial genome, an 810 bp region of the CO1 gene, and an 821 bp region spanning part of the 16S ribosomal DNA, the complete tRNA-leu gene and part of the NADH dehydrogenase subunit 1 gene (16S-tRNA-ND1) were

sequenced. DNA sequences are available on GenBank. For specimens used (see Table 1). DNA vouchers are lodged in the entomological collection of the South Australian Museum, Adelaide (SAMA).

Table 1: Specimens used for DNA sequencing.

ABTC	SAMA reg.#	species/specimen	Locality
78689	25-009238	<i>baylyi</i> a	30 km ENE Perenjori WA VIII/2002
78690		<i>baylyi</i> b	30 km ENE Perenjori WA VIII/2002
78691		<i>baylyi</i> (larva)	30 km ENE Perenjori WA VIII/2002
78784	25-009228	<i>couragei</i> a	Ellen Brook Nature Reserve WA 1/X/2003
78785		<i>couragei</i> b	Ellen Brook Nature Reserve WA 1/X/2003
8944	25-009241	<i>couragei</i> c	6 km S Pinjarra WA X/2004
78652	25-004932	<i>couragei</i> d	Goonaping WA
78653		<i>couragei</i> e	Goonaping WA
78786	25-009211	<i>ellenbrookensis</i>	Ellen Brook Nature Reserve WA 1/X/2003
78588	25-004953	<i>gibbi</i> a	18 km W Casterton Vic 30/X/2001
78589		<i>gibbi</i> b	18 km W Casterton Vic 30/X/2001
78586	25-004946	<i>insculptilis</i> a	12 km N Forreston SA 14/VIII/2001
78587		<i>insculptilis</i> b	12 km N Forreston SA 14/VIII/2001
78965	25-012899	<i>P. michaelsoni</i> a	Remlap Homestead Rock WA 5/VIII/2004
78966	25-012898	<i>P. michaelsoni</i> b	Emu Rock Hyden WA 3/VIII/2004
78782	25-009240	<i>niger</i> a	3 km SW Bushy Swamp WA 5/X/2002
78783		<i>niger</i> b	3 km SW Bushy Swamp WA 5/X/2003
78945	25-009241	<i>niger</i> c	6 km S Pinjarra WA X/2004
78584	25-004947	<i>nigroadumbratus</i> a	12 km N Forreston SA 14/VIII/2001
78585		<i>nigroadumbratus</i> b	12 km N Forreston SA 14/VIII/2001
78942	25-012203	<i>pallescent</i> a	6 km S Pinjarra WA X/2004
78943		<i>pallescent</i> b	6 km S Pinjarra WA X/2004

Phylogenetic analyses of aligned sequence data were performed using PAUP* version 4.0b* (SWOFFORD 2001). Neighbour joining was used to generate a phylogenetic tree. Bootstrapping with 1000 replicates was used to examine the resolution of the branches in the tree. Pairwise sequence divergence based on uncorrected distance was used to examine inter- and intraspecific variation. *Necterosoma regulare* SHARP, 1882 was used as an outgroup.

Checklist of epigeal species of *Paroster*

The genus is endemic for Australia and distributed in the south-west and south-east of the continent (except one doubtful record of *P. thapsinus* from northern Australia; see FERY 2004).

<i>Paroster acutipenis</i> sp.n.	Western Australia (Murchison District), New South Wales
<i>Paroster baylyi</i> HENDRICH & FERY, 2008	SW of Western Australia
<i>Paroster couragei</i> WATTS, 1978	SW of Western Australia
<i>Paroster ellenbrookensis</i> sp.n.	SW of Western Australia
<i>Paroster gibbi</i> WATTS, 1978	South Australia, Victoria
<i>Paroster insculptilis</i> (CLARK, 1862)	South Australia, Victoria
<i>Paroster leai</i> sp.n.	SW of Western Australia
<i>Paroster michaelsoni</i> RÉGIMBART, 1908	SW of Western Australia
<i>Paroster niger</i> WATTS, 1978	SW of Western Australia
<i>Paroster nigroadumbratus</i> (CLARK, 1862)	South Australia
<i>Paroster pallescens</i> SHARP, 1882	SW of Western Australia
<i>Paroster sharpi</i> WATTS, 1978	SW of Western Australia
<i>Paroster thapsinus</i> (GUIGNOT, 1955)	South Australia, New South Wales, SW of Western Australia
<i>Paroster ursulae</i> HENDRICH & FERY, 2008	SW of Western Australia

Paroster acutipenis sp.n.

TYPE MATERIAL: **Holotype** ♂: "Murchinson R WA 27 49 065S 114 46 52 E 18.3.95 S A Halse" (SAMA) Database 25-005192.

ADDITIONAL MATERIAL: 1 ex., "Ballymore L Q 5/89 BV Timms" (NSW: 30°5.946'S 145°2.437'E) (SAMA).

DESCRIPTION: Length 3.0 mm; oval, deep-bodied (Fig. 4).

Head: Light testaceous. Eyes relatively small; microreticulation weak, meshes small, round/oval; sparsely and unevenly covered with small punctures about size of reticulation meshes, moderately indented above antennal bases. Antenna relatively short, stout.

Pronotum: Testaceous, front margin narrowly darker; microreticulate as on head, covered with unevenly distributed small punctures of same size as those on head, some much larger along front margin, slightly weaker on disc.

Elytron: Evenly light testaceous; microreticulation fine, weak, punctures uneven, small, of similar size to those on pronotum, stronger towards apex, serial punctures hard to trace.

Ventral surface: Prosternal process broad, tip pointed, reaching anterior process of metaventricle. Metathorax with wings short, hind margin semicircular. Ventrites sculptured as on elytra. Pro-tarsi moderately expanded, mesotarsi less so.

Male: Little external difference from female. Fore claws weak, equal in size and shape. Median lobe of aedeagus broad at base, evenly narrowing to sharp tip (Fig. 15).

VARIATION: A female specimen from Lake Ballymore in SW Queensland appears to belong to this species despite the large geographic distance from the type locality. It has the dorsal surface more strongly microreticulate as is often the case in species of *Paroster*.

ETYMOLOGY: Latin, *acutus* – acute, sharp, a reference to the long, sharply pointed aedeagus.

DIFFERENTIAL DIAGNOSIS: A relatively distinctive, medium sized, evenly light testaceous species, most easily recognized by the very small sparse punctures over most of the dorsal surface, the unmodified male fore claws and the sharply pointed median lobe of aedeagus.

DISTRIBUTION: Only known from the type locality in Western Australia, and one locality in New South Wales. Most probably a more inland species (Fig. 28).

HABITAT: The type was collected from a shallow, sandy bottomed billabong, with a moderate density of macrophytes, close to the Murchison River.

***Paroster baylyi* HENDRICH & FERY, 2008**

Paroster baylyi HENDRICH & FERY 2008: 33.

TYPE MATERIAL: **Holotype** ♂: “25 km NNW Morawa, Mullewa – Wubin Road, ‘Bilya Rock’, 6.9.2002, 28°59'S 115°52'E Hendrich leg. loc. WA 22/186”; “HOLOTYPE *Paroster baylyi* sp. n. Hendrich & Fery des. 2007” (WAM). **Paratypes** studied: 8 exs. with same data as holotype in SAMA; 1 ex., “31 km E Perenjori, ‘Camel Soak’, 7.9.2002, 29°22'S 116°38'E Hendrich leg. loc. WA 24/188” (SAMA); 6 exs., “Midwest, 10 km E Wubin, Gunjidi – Wubin Road, rock-pools, 7.9.2002, 30°08'S 116°31'E Hendrich leg. loc. WA 26/190” (SAMA).

DESCRIPTION: Length 3.3–3.9 mm. Body oval and vaulted; elytra widest near or shortly behind middle; in dorsal view with discontinuity in outline between pronotum and elytra (Fig. 7).

Aedeagus relatively broad, narrowing slightly towards weakly bilobed tip, which is relatively broad in lateral view (Fig. 22).

For a more extensive description, including habitat details see HENDRICH & FERY (2008).

DIFFERENTIAL DIAGNOSIS: *Paroster baylyi*, *P. ursulae* and *P. michaelsoni* are three externally very similar species. Body shape and size as well as colouration can help to separate *P. baylyi* from the other two species, the knowledge of the collecting site is also useful.

DISTRIBUTION: Inland of south-western Australia. Northwest of a line from Perth to Cue (Fig. 31).

HABITAT: Temporary water-filled rock holes on granite rocks, called gnammas (HENDRICH & FERY 2008).

***Paroster couragei* WATTS, 1978**

Paroster couragei WATTS 1978: 58; WATTS 1985: 24; LAWRENCE et al. 1987: 339; PINDER et al. 2000: 169; NILSSON 2001: 180; WATTS 2002: 45.

TYPE MATERIAL: **Holotype** ♂: "Mullewa, Western Australia, 13.ix.1931, Aust. Harvard Exped, Darlington" (ANIC).

ADDITIONAL MATERIAL: 13 exs., "WA Ellen Brook Nat Res, 14/9/00 C.H.S.Watts"; 3 exs., same except "1/10/03", 5 exs., "WA Goonaping Site A SPM03A Col CALM 3/9/00"; 1 ex., "6 k S Pinjarrah (sic) WA 23/10/96 C. Watts"; 1 ex., same except "4/10/04"; 1 ex., "Pinjarrah (sic) WA, LEA".

DESCRIPTION: Length 2.2–2.7 mm; elongate/oval, deep-bodied (Fig. 5).

Head: Dark-testaceous. Eyes moderately large; microreticulation well marked, meshes small, round/oval; rather sparsely and evenly covered with small punctures a little larger than size of reticulation meshes. Indented areas above antennal bases well marked. Antenna relatively short, stout.

Pronotum: Testaceous, front and rear margins narrowly darker; microreticulate as on head, front and rear margins with numerous strong punctures, rest of pronotum sparsely covered with unevenly distributed small punctures the same size as those on head.

Elytron: Dull yellowish-testaceous, with only vague darker and lighter regions; microreticulation strong, meshes as on pronotum, evenly covered with quite strong punctures a little smaller than the larger ones on pronotum, serial punctures hard to trace, in two shallow grooves particularly at base.

Ventral surface: Prosternal process thin, tip pointed, reaching anterior process of metaventricle. Metathorax with wings short, hind margin squarish; moderately microreticulate, with a few moderately strong punctures. Metacoxal plates large, weakly depressed in midline, quite strongly microreticulate, meshes fine; sparsely covered with quite large punctures, coxal lines widely separated, weakly diverging in front $\frac{1}{2}$, not reaching metathorax. Abdominal ventrites sculptured as for metacoxal plates. Protarsi moderately expanded, mesotarsi less so.

Male: Pro- and mesotarsi a little stouter than in females. Fore claws weak, inner one a little longer and thicker than outer. Median lobe of aedeagus long, thin, tapering to blunt tip (Fig. 16).

VARIATION: The strength of the dorsal reticulation and punctation varies a little.

DIFFERENTIAL DIAGNOSIS: A relatively small Western Australian species, which is most easily confused with *P. niger* and *P. pallescens* which are often found in the same water body. The slightly unequal male fore claws separate it most reliably from these species. Otherwise *P. couragei* is evenly testaceous, including the ventral surface, except for the pronotum being narrowly dark-testaceous on front and rear margins. The elytra are often a dull yellow/grey rather than truly testaceous. *Paroster niger* is much darker – almost black in many – on both dorsal and ventral surfaces, with humeral angles of elytra usually paler. *Paroster pallescens* is a slightly larger species with paler areas on elytra and usually with ventral surface dark-testaceous and pronotum darker than adjacent elytra.

DISTRIBUTION: South-western Australia. A limited area around Perth (Fig. 28).

HABITAT: *Paroster couragei* is an inhabitant of the extensive shallow swamps in south-western Australia. The bulk of these swamps are temporary, drying out in summer. On the coastal plain near Perth *P. ellenbrookensis*, *P. niger* and *P. pallescens* are found in the same localities, often in large numbers, in spring.

***Paroster ellenbrookensis* sp.n.**

TYPE MATERIAL: **Holotype** ♂: "WA Ellen Brook NR 14/9/00 C.H.S.Watts", "SAMA Data base No 25-020708" (SAMA). **Paratypes**: 5 exs. with same data as for holotype, "SAMA Data base No 25-005190" (SAMA); 1 ex., same except "1/10/03", "SAMA Data base no 25- 009211"; 2 exs., "Ellen Brook WA 17/8/92", "SAMA Database No 25-0020703"; 3 exs., "Swan R LEA", "SAMA Data Base No 25-005191" (SAMA).

DESCRIPTION: Length 1.8–1.9 mm; oval, deep-bodied (Fig. 10).

Head: Light testaceous. Eyes relatively small; microreticulation well marked, meshes small, round/oval; rather sparsely and unevenly covered with small punctures about size of reticulation meshes. Antenna relatively short, stout.

Pronotum: Light testaceous, front in central $\frac{1}{3}$ and two small areas either side of midline on rear margin narrowly darker; microreticulate as on head, disc sparsely covered with unevenly distributed small punctures same size as those on head, denser and larger along front and rear margins.

Elytron: Evenly light testaceous; microreticulation strong, meshes as on pronotum, evenly covered with well-marked punctures of similar size to those on rear of pronotum, serial punctures hard to trace.

Ventral surface: Prosternal process narrow with strong central keel, tip pointed, reaching anterior process of metaventricle. Metathorax with wings short, hind margin semicircular, weakly microreticulate, with a few moderately strong punctures. Metacoxal plates large, weakly depressed in midline, rather weakly microreticulate, meshes fine, with a few large shallow punctures, coxal lines moderately separated, weakly diverging in front $\frac{1}{2}$, not reaching metathorax. Ventrites sculptured as for metacoxal plates. Protarsi moderately expanded, mesotarsi less so.

Male: Little external difference between sexes. Male fore claws weak, equal in size and shape. Median lobe of aedeagus relatively thin, weakly constricted near tip, slightly flared at tip (Fig. 19).

VARIATION: The length of the post coxal lines varies a bit between specimens.

ETYMOLOGY: Named after the type locality.

DIFFERENTIAL DIAGNOSIS: Resembling *P. couragei* but smaller, more oval, more brightly testaceous and the males with unmodified fore claws.

DISTRIBUTION: Only known from the type locality, the Ellen Brook Nature Reserve in the Swan River valley, east of Perth (Fig. 31).

HABITAT: All specimens were obtained from a small area of shallow, peaty swamp, which dries out in summer. *Paroster pallescens* and *P. couragei* also occur in the reserve. *Paroster ellenbrookensis* was only found close to the steep-sided, peaty edges of pools of open water.

***Paroster gibbi* WATTS, 1978**

Paroster gibbi WATTS 1978: 58–59; WATTS 1985: 24; LAWRENCE et al. 1987: 339; NILSSON 2001: 180; WATTS 2002: 45.

TYPE MATERIAL: **Holotype** ♂: "Myponga, South Australia, A.H.Elston 2696" (AM). **Paratypes**: 1 ex., "Healesville V 12/68 CW" (SAMA); 5 exs., "Mt Compass SA 8.61 C. Watts" (SAMA).

ADDITIONAL MATERIAL: 1 ex., "Vic. Buangor 9/11/97 C. Watts"; 26 exs. (4 exs. in NMW), "18 Km W Casterton Vic 25.9.98 C. Watts"; 2 exs., "12 Km W Casterton VIC 25/9/98 CHS Watts"; 12 exs., "5 km W Casterton Vic 25/9/98 C Watts"; 1 ex., "Vic 18 W Casterton 29/8/99 C.H.S.Watts"; 3 exs., "4 Km S Glenisla 24/9/98 C. Watts"; 33 exs., "7 km N Glenisla Vic 23/9/98 C. Watts"; 10 exs., same except "28/8/99"; 1 ex., "SA 10 K E Mt Compass 10/9/87 C. Watts"; 1 ex., "Myponga S Australia R.F.Kemp"; 15 exs., "SA 1 km S Nangwarry

5/10/00 CHS Watts"; 5 exs., same except "9/10/97"; 7 exs., same except "19/10/99"; 1 ex., "VIC 5K NW Portland 10/10/97 C. Watts".

DESCRIPTION: Length 1.8–2.2 mm; oval, relatively flat bodied (Fig. 14).

Head: Light testaceous. Microreticulation moderately marked, meshes small, round/oval; sparsely and unevenly covered with small punctures, most a little smaller than reticulation meshes. Antenna relatively short, stout.

Pronotum: Testaceous, front and rear margins in central $\frac{1}{3}$ – $\frac{1}{2}$ narrowly dark-testaceous to black, area between them tending lighter laterally; microreticulate as on head, sparsely covered with unevenly distributed punctures, those on disc same size as those on head, denser and larger along front and rear margins.

Elytron: Evenly dark-testaceous; microreticulation strong, meshes as on pronotum, evenly covered with quite large well-marked punctures larger than those on rear of pronotum, serial punctures hard to trace.

Ventral surface: Prosternal process quite broad, strongly keeled, tip pointed, reaching anterior process of metaventrite. Metathorax with wings short, hind margin semicircular; moderately microreticulate, with a few relatively strong punctures. Metacoxal plates large, weakly depressed in midline, quite strongly microreticulate, meshes fine; rather sparsely covered with large punctures, coxal lines relatively close, weakly diverging in front $\frac{1}{2}$, reaching metathorax. Ventrites microreticulate, punctures smaller than those on metacoxal plate. Protarsi moderately expanded, mesotarsi less so.

Male: Little external difference between sexes. Fore claws weak, equal in size and shape. Median lobe of aedeagus broad, flat, wider towards front, apex truncate (Fig. 20).

VARIATION: There is little variation between specimens.

DIFFERENTIAL DIAGNOSIS: A relatively small, flat bodied, south-eastern Australian species, with evenly dark, strongly punctate elytra and with the post coxal lines relatively long and close. The lateral outline of the junction of the pronotum and the elytra is smooth, not slightly sinuate as in other epigeal *Paroster* species.

It is most likely to be confused with *P. insculptilis* which is slightly larger and darker and, although somewhat flattened, not as flat as *P. gibbi*. It can also be separated from *P. insculptilis* by the body outline and postcoxal lines as mention above. From *P. thapsinus* and *P. nigro-adumbratus*, which also occur in south-eastern Australia, it can be distinguished by its much smaller size and the lack of the dark/light dorsal colour pattern.

Although the morphological differences between this species and other *Paroster* species are slight, the biochemical distance is large (Fig. 1); large enough to suggest that *P. gibbi* forms a monospecific clade within the epigeal *Paroster* (LEYS & WATTS 2008).

DISTRIBUTION: South-east of South Australia and south-western Victoria (Fig. 28).

HABITAT: A widespread species inhabiting small, shallow, temporary pools and flooded areas. Although it occurs in the same general area and habitat as *P. insculptilis* the two species have yet to be collected from the same pool.

Paroster insculptilis (CLARK, 1962)

Hydroporus insculptilis CLARK 1862: 411.

Paroster insculptilis (CLARK): SHARP 1882: 392, WATTS 1978: 57–58; WATTS 1985: 24; LAWRENCE et al. 1987: 339; NILSSON 2001: 180; WATTS 2002: 45.

TYPE MATERIAL: **Lectotype** ♂: "Lectotype", "Type H.T.", "67-56", "*H. insculptilis* Clark Australia", "*Hydroporus insculptilis* Clk Det. C. Watts 1979" (NHML). **Paralectotypes**: 1 ex., "Paralectotype", "S.Austr Bakewell 59-24", "*insculptilis* Clark", "*Hydroporus insculptilis* Clk Det. C. Watts 1979"; 4 exs., "Paralectotype", "Co-type", "*Paroster insculptilis* Clk Co-typen", "*Hydroporus insculptilis* Clk Det. C. Watts 1979" (NHML).

ADDITIONAL MATERIAL: 1 ex., "SA 11.2 km E Angaston 19/7/05 Susan Lea"; 2 exs., same except "24/7/04"; 40 exs., "2 Km W Brimpaen Vic 23/9/98 C. Watts"; 5 exs., same except "28/8/99"; 1 ex., "Dodswell Bridge Vic 10/10/98 D. Churches"; 2 exs., "SA 7.2 km N Eden Valley 25/8/05 Susan Lea"; 3 exs., same except "7/9/03"; 1 ex., same except "20/7/03"; 7 exs., same except "20/7/05"; 12 exs. (2 exs. in NMW), same except "24/7/04"; 1 ex., same except "25/8/05"; 2 exs., "10 k N Forreton CHS Watts 14/8/01"; 21 exs., "13 k N Forreton 24/9/99 C Watts"; 2 exs., same except "20/11/99"; 1 ex., "Mt Lofty S.A. J.G.O.Teppe"; 1 ex., "Wellington River Vic 4 km N Licola 30/11/98 CHS Watts"; 5 exs., "Williamstown SA 10.61 C.Watts".

DESCRIPTION: Length 2.1–3.1 mm; elongate/oval, shallow-bodied (Fig. 13).

Head: Dark-testaceous. Eyes moderately large; microreticulation moderately marked, meshes small, round/oval; moderately densely and unevenly covered with small punctures about size of reticulation meshes. Moderately indented above antennal bases. Antenna relatively short, stout.

Pronotum: Dark-testaceous, front angles lighter; microreticulate as on head, sparsely covered with unevenly distributed small punctures, those on disc a little larger than those on head, denser and larger along front and rear margins, a few, much larger ones along front edge.

Elytron: Evenly dark-testaceous; microreticulation strong, meshes as on pronotum; evenly covered with well-marked punctures of similar size to those on rear of pronotum, serial punctures hard to trace.

Ventral surface: Variably light/dark-testaceous. Prosternal process narrowly oval with strong keel, tip pointed, reaching anterior process of metaventricle. Metathorax with wings short, hind margin semicircular; moderately microreticulate, with a few small, sharply impressed punctures. Metacoxal plates large, weakly depressed in midline, moderately strongly microreticulate, meshes fine; rather sparsely covered with small sharp punctures, coxal lines moderately separated, moderately diverging in front $\frac{1}{2}$, not reaching metathorax. Ventrites sculptured as for metacoxal plates. Protarsi moderately expanded, mesotarsi less so.

Male: Little external difference between sexes. Fore claws weak, equal in size and shape. Median lobe of aedeagus relatively narrow, weakly widening towards squarish tip (Fig. 17).

VARIATION: The colour varies somewhat in general lightness or darkness. Specimens from Mt. Lofty Ranges in South Australia tend to be larger than others.

DIFFERENTIAL DIAGNOSIS: A small, dark, slightly flattened species from south-eastern Australia, easily separated from the much larger *P. nigroadumbratus* and *P. thapsinus* by the lack of a colour pattern on the elytra. From the similar coloured but slightly smaller and flatter *P. gibbi*, it can be recognized by its well-separated post-coxal lines and the slightly sinuate outline at the junction of the pronotum and elytra. From the similar sized Western Australian *P. niger* it can be distinguished by the much flatter body, and the elytra never show the lighter lateral colouring present in many *P. niger*.

DISTRIBUTION: South-east of South Australia and south-western Victoria (Fig. 29).

HABITAT: An inhabitant of small, shallow pools. The Forreton population is known from a small (3 x 1 m) shallow pool in a small gutter in an area of open forest. Adults and larvae have been found here in most of the past seven years. *Paroster nigroadumbratus* co-inhabits the pool but is commoner in a nearby small stream. The Brimpaen locality is a moderately extensive roadside swampy area/pool in open forest.

***Paroster leai* sp.n.**

TYPE MATERIAL: **Holotype** ♀: "Swan R Lea", "Data base No 25-020707" (SAMA).

DESCRIPTION: Length 2.0 mm; elongate, dorsal/ventrally flattened; wings reduced to about ½ length of elytra (Fig. 9).

Head: Light testaceous. Eyes small; microreticulation well marked, meshes small, round/oval; sparsely covered with small punctures about size of reticulation meshes. Antenna relatively short, stout.

Pronotum: Light testaceous; microreticulate as on head, sparsely covered with unevenly distributed small punctures same size as those on head, denser and larger along front margin.

Elytron: Light testaceous; microreticulation strong, meshes as on pronotum, evenly covered with moderately large punctures, larger than most of those on pronotum, serial punctures hard to trace.

Ventral surface: Prosternal process broad, tip pointed, not reaching anterior process of metaventrite. Metathorax with wings short, hind margin semicircular, moderately microreticulate, with a few small punctures. Metacoxal plates large, quite strongly microreticulate, meshes fine; sparsely covered with small punctures, coxal lines quite widely separated, weakly diverging in front ½, not reaching metathorax. Ventrites sculptured as for metacoxal plates. Protarsi moderately expanded, mesotarsi less so. Mesofemur with four relatively evenly spaced spines on hind edge.

Male: Unknown.

ETYMOLOGY: Named after the collector, Arthur M. Lea, first curator of Entomology at the South Australian Museum, Adelaide.

NOTES: A small species showing clear stygobitic characters; body flattened, eyes and wings reduced, and prosternal process not reaching anterior process of metaventrite. The punctures and microreticulation are not reduced and the colour, although relatively pale, is similar to that of some other epigeal *Paroster*. In degree of adaptation to a subterranean life it appears to be similar to *Limbodessus rivulus* LARSON which is found in the interstitial areas of small gravelly streams in eastern Australia or even *L. microocula* WATTS & HUMPHREYS which is truly stygobitic from underground water in the Yilgarn region of Western Australia. *Paroster leai* is the first Hydroporini to show such intermediate characteristics.

DISTRIBUTION: Only known from the type locality near Perth, south-western Australia (Fig. 32).

HABITAT: The single specimen was collected in the Swan River region by Arthur Lea sometime around 1920. No detailed information is known about its likely habitat. The South Australian Museum collection includes specimens of *Paroster couragei*, *P. pallescens* and *P. ellenbrookensis* with the same label. In the Swan River valley these three species are restricted to shallow, seasonally dry, peaty swampland. Thus it seems that Lea collected from such habitat and it is possible, although by no means certain, that the specimen of *P. leai* came from a similar habitat.

***Paroster michaelsoni* RÉGIMBART, 1908**

Paroster michaelsoni RÉGIMBART 1908: 312; WATTS 1978: 55; WATTS 1985: 24; LAWRENCE et al. 1987: 340; PINDER et al. 2000: 159; NILSSON 2001: 180; WATTS 2002: 45; HENDRICH & FERY 2008: 36.

TYPE MATERIAL: **Holotype** ♂: “*Paroster* *Michaelseni* Rég. type unic. [sic!]” [hw Régimbart], “Exped. Michaelsen et Hartmeyer” [hw Régimbart], “Boorabbin Regenwassertümpel [rain water ditch] 3.VII”, “Hamb. S.-W.-Austr. Exped. 1905. Stat. 96” [printed, except “96”], “Museum Paris Coll. Maurice Régimbart 1908” [printed], “le seul *Paroster* de la coll. Régimbart” [possibly hw F. Guignot] (MNHN).

MATERIAL STUDIED: 1 ♂, “WA Remlap Homestead Rock, Beacon, 30 02 S 117 38 E, B. Timms 5/8/[20]04”, “DNA Voucher”, “SAMA Database No. 25-012899”; 1 ♂, 1 ♀, “Dingo Rock WA, J.McRae 6/8/[19]98”, “SAMA Database No. 25-004-930”; both specimens mounted on one glue card 1 ♂, “WA Dingo Rock, SPS070, Calm 8/8/[19]98”, “Remnants [sic!] – others used for DNA”, “*Paroster* *michaelseni* Reg, det CHS Watts”, “SAMA Database No. 25-004930”; specimen totally dissected; 2 ♂♂, 3 ♀♀, “WA Yannermoon Rock, 30 40 50 S 118 33 10 E, 11/9/[19]99 CALM”, “SAMA Database No. 25-012896”; one of the males with additional “DNA Voucher 2”, one of the females with “DNA Voucher 1”; 1 ♂, “WA Yannermoon Rock [sic!], SPS126, CALM 11/9/[19]99”, “Tarsi, Gen [= genitalia] on slide”; 1 ♀, “Yellowdine RK [= Rock], large pool, 5.VIII.1964”, on reverse “D.H.D. Edwrd”, “SAMA Database No. 25-005179” 1 ♂, “182 m[iles] E Merrodin [sic! = Merredin], WA 7/[19]64. Edward”, “*Paroster* *michaelseni* Reg, Det. C. Watts 1991”, “SAMA Database No. 25-005181”; 1 ♂, “WA Emu Rock, Heyden 32 28 S 119 25 E, B. Timms 3/8/[20]04”, “DNA Voucher”, “SAMA Database No. 25-012898”; 1 ♂, “WA Disappointment Rock, Norseman 32 08 S 120 56 E, B. Timms 16/7/[20]04”, “DNA Voucher”, “SAMA Database No. 25-012897”; 1 ♀, “WA Disappointment Rock, Norseman 32 08 S 120 56 E, B. Timms 16/7/[20]04”, “SAMA Database No. 25-012897”; 1 ♂, “Buldania Rks. [= Rocks], SWA. 12/[19]59”, “SAMA Database No. 25-005178”.

DESCRIPTION: Length 3.3–4.0 mm; oval, deep-bodied.

Head: Black, front edge narrowly yellow. Eyes moderately large; microreticulation well marked, meshes small, even, round/oval; moderately densely and evenly covered with small punctures a little larger than size of reticulation meshes, strongly indented above antennal bases. Antenna short, stout.

Pronotum: Dark-testaceous, sides broadly yellow, disc with diffusely yellowish areas; strongly and finely microreticulate as on head, moderately densely and evenly covered with well marked punctures somewhat larger than those on head, a few larger ones along front margin, those on disc often a bit weaker. Sides weakly flanged, more noticeable towards front angles.

Elytron: Dull yellowish-testaceous, with darker and lighter regions; microreticulation strong, meshes as on pronotum, evenly covered with small well-marked punctures, smaller than those on pronotum, serial punctures easy to trace except in strongly reticulate female specimens, sometimes in two shallow grooves particularly at base.

Ventral surface: Prosternal process narrowly oval, without strong keel, tip pointed, reaching anterior process of metaventre. Metathorax with wings short, hind margin semicircular or somewhat squarish; moderately microreticulate, with some small punctures. Metacoxal plates large, weakly depressed in midline, moderately microreticulate, meshes fine; sparsely covered with small sharp punctures, coxal lines widely separated, weakly diverging in front ¼, not reaching metathorax. Ventrites sculptured as for metacoxal plates. Protarsi moderately expanded, mesotarsi less so.

Female: Dorsal surface strongly microreticulate giving a mat surface.

Male: Dorsal surface less strongly reticulate. Pro- and mesotarsi moderately expanded, fore claws elongate, laterally sinuate, inner claw a bit thicker. Median lobe of aedeagus moderately broad, narrowing slightly towards weakly bifid tip (Fig. 21).

VARIATION: Colour varies somewhat between specimens in general lightness or darkness. The strength of the dorsal punctation and microreticulation is variable in both sexes.

DIFFERENTIAL DIAGNOSIS: A relatively large, deep-bodied species, with a dark/light colour pattern on the pronotum and elytra. Male fore claws elongate and asymmetrical. *Paroster baylyi* is very similar morphologically and is also restricted to gnammas but is on average slightly

smaller, more elongate, less deep bodied, with slight but consistent differences in the aedeagal median lobes (see Figs. 21, 22).

The males of *P. sharpi* and *P. thapsinus* also have modified fore claws and are of similar size and colour but *P. michaelsoni* can be readily separated by its much stronger elytral punctation and the lack of a slight flange on the front angles of the pronotum that is unique to *P. michaelsoni*, *P. baylyi* and *P. ursulae*. The smaller *P. pallescens* might also be confused with *P. michaelsoni* but it has the pronotum predominately black (Fig. 3), the dorsal punctures stronger, lacks the flanged pronotum, and the males have unmodified fore claws.

As for characters distinguishing *P. michaelsoni* and *P. ursulae* see below under the latter species.

DISTRIBUTION: Granite outcrops in the wheat belt and Mallee of south-western Australia. East of the Great Northern Highway and south of a line from Wubin to Boorabbin (HENDRICH & FERY 2008) (Fig. 31).

HABITAT: Like its sister species, *Paroster baylyi* and *P. ursulae*, *P. michaelsoni* is seemingly restricted to shallow temporary pools on the exposed surfaces of large granite outcrops in the Mallee of south-west Australia known as 'gnammas' (HENDRICH & FERY 2008). These are shallow, with a thin, sandy substrate if any, dead organic matter, and a sparse amount of vegetation, mostly moss, short grass and herbs. *Paroster niger* also occurs in gnammas (BAYLY 1997) but is not restricted to them. All three species breed in the gnammas.

Paroster niger WATTS, 1978

Paroster niger WATTS 1978: 56–57; WATTS 1985: 24; LAWRENCE et al. 1987: 340; BAYLY 1997: 169; NILSSON 2001: 180; WATTS 2002: 45.

TYPE MATERIAL: **Holotype** ♂: "Rottnest I., Western Australia, 31.x.1932. Aust Harvard Exped. Darlington" (ANIC).

ADDITIONAL MATERIAL: 2 exs., "Australia/ WA/ Stirling Range N.P., Stirling Range Drive - Gum Pass, 450 m, 29.11.1996, L. Hendrich Lok. 41 (CLH); 1 ex., "Armada WA 7/62 DE"; 17 exs., "WA 5k N Bushy Swamp nr Wagin 21/9/00 C.H.S.Watts"; 3 exs., "WA 3km SW Bushy Swamp 33 33 20S 117 16 47E CHS Watts 5/10/03"; 1 ex., "30 k S Dwellingup WA 17. 10. 96 C Watts"; 1 ex., "Perth WA DE"; 4 exs., "6 k S Pinjarrah (sic) WA 23/10/96 C Watts"; 5 exs. (2 exs. in NMW), same except "4/10/04"; 1 ex., "Rottnest Isl 10/ 58 Edward"; 2 exs., "12 k W Serpentine WA 24/10/96 C Watts"; 3 exs., "WA Styles Rock SPS139 CALM 7/9/98".

DESCRIPTION: Length 2.5–2.9 mm; oval, deep-bodied (Fig. 2).

Head: Dark-testaceous to black. Eyes moderately large; microreticulation well marked, meshes small, round/oval; sparsely and unevenly covered with small punctures about size of reticulation meshes. Antenna relatively short, stout.

Pronotum: Dark-testaceous to black, front angles tending lighter in some; microreticulate as on head, moderately covered with unevenly distributed moderate sized punctures, weaker on disc.

Elytron: Dark-testaceous to black, humeral angles and sides tending lighter; microreticulation moderately strong, meshes as on pronotum, moderately densely and evenly covered with well-marked punctures, those on disc of similar size to those on pronotum, both punctures and reticulation stronger and denser towards apex, serial punctures hard to trace, sometimes in two shallow grooves particularly at base.

Ventral surface: Prosternal process relatively narrow towards apex, strongly keeled, tip pointed, reaching anterior process of metaventricle. Metathorax with wings short, hind margin semicircular; moderately microreticulate, with a few moderately strong punctures. Metacoxal plates large, weakly depressed in midline, quite strongly microreticulate, meshes fine; rather sparsely covered with moderately sized sharp punctures, coxal lines relatively close, weakly

diverging in front $\frac{1}{2}$, not reaching metathorax. Ventrites strongly microreticulate, quite densely covered with large punctures. Protarsi quite strongly expanded, mesotarsi a little less so.

Male: Little external difference between sexes. Male fore claws weak, equal in size and shape. Median lobe of aedeagus relatively thin, narrowing rather evenly to rounded tip (Fig. 26).

VARIATION: There is considerable variation in the overall darkness of the species and the extent of the paler areas.

DIFFERENTIAL DIAGNOSIS: A rather small dark species with moderate, evenly sized and spaced punctures on the elytra and quite well marked elytral grooves. Well coloured specimens with nearly all-black head, pronotum and elytral disc, cannot be confused with other species. However some specimens have quite extensive pale areas at the sides and base of elytra that resemble those of *P. pallescens* and, conversely, some *P. pallescens* can be quite dark. *Paroster niger*, in all but the most teneral specimens, has the head dark-testaceous to black except for a very narrow area on the front edge and the pronotum dark except for the front angles lighter in some. In *P. pallescens* the head is lighter coloured with an extensive pale area in front and the pronotum usually has a broad central panel lighter. The head of *P. niger* is slightly narrower and the distance between the eyes less than in *P. pallescens* (see Figs. 2, 3). Ultimately the only reliable character is the thinner median lobe of the aedeagus in *P. niger* (Figs. 26, 27).

DISTRIBUTION: South-western Australia (Fig. 29).

HABITAT: This species has a wider habitat tolerance than most *Paroster*; it occurs in a variety of shallow temporary water bodies, sandy coastal swamps (Rottneest Island), inland flooded areas, small pools in inland creeks (Stirling Range) (Fig. 34) and pools on granite rocks (gnammas).

Paroster nigroadumbratus (CLARK, 1862)

Hydroporus nigroadumbratus CLARK 1862: 411.

Paroster nigroadumbratus (CLARK): WATTS 1978: 53; WATTS 1985: 24; LAWRENCE et al. 1987: 340; NILSSON 2001: 180; WATTS 2002: 45.

TYPE MATERIAL: **Holotype** ♂: "Holotype", "67-56", "*nigro-adumbratus* Clark Australia" (NHML).

ADDITIONAL MATERIAL: 2 exs., "10 K N Forrester SA CHS Watts 14/8/01"; 1 ex., same except "3/9/99"; 1 ex., same except "14/8/01"; 19 exs., "13 k N Forrester 17/9/96 C.Watts"; 19 exs., same except "24/9/99"; 2 exs., "Myponga S. Australia A.H.Elston"; 1 ex., "Williamstown SA Oct 60 C W"; 14 exs., same except "10-61 C Watts".

DESCRIPTION: Length 2.4–3.2 mm; oval, deep-bodied (Fig. 12).

Head: Testaceous. Eyes moderately large; microreticulation well marked, meshes small, round to oval; moderately densely and evenly covered with small punctures about 1.5x size of reticulation meshes. Antenna relatively short, stout.

Pronotum: Testaceous, front and rear margins in central $\frac{1}{3}$ narrowly dark-testaceous to black, area between them tending lighter laterally; microreticulate as on head, sparsely covered with unevenly distributed small punctures same size as those on head, denser and larger along front margin.

Elytron: Dull yellowish-testaceous, with darker and lighter regions; microreticulation strong, meshes as on pronotum, evenly covered with small well-marked punctures of similar size to those on pronotum, serial punctures hard to trace, sometimes in two shallow grooves, particularly at base.

Ventral surface: Prosternal process thin, tip pointed, reaching anterior process of metaventricle. Metathorax with wings short, hind margin semicircular. Metacoxae moderately microreticulate,

with a few moderately strong punctures. Metacoxal plates large, weakly depressed in midline, quite strongly microreticulate, meshes fine; rather sparsely covered with small sharp punctures, coxal lines widely separated, moderately diverging in front $\frac{1}{2}$, not reaching metathorax. Protarsi moderately expanded, mesotarsi less so. Ventrites sculptured as for metacoxal plates.

Male: Little external difference between sexes. Male fore claws weak, equal in size and shape. Median lobe of aedeagus broad, weakly constricted near tip, flared at tip (Fig. 18).

VARIATION: Colour varies somewhat in general lightness or darkness. Strength of the dorsal reticulation is variable with some specimens strongly reticulate giving a mat surface.

DIFFERENTIAL DIAGNOSIS: A moderately sized, deep-bodied species from south-eastern Australia with dark/light areas dorsally and males with unmodified fore claws. Head and pronotum tend to be darker than rest. In the south-east of Australia it can only be confused with *P. thapsinus*, which is larger, more elongate and has modified male fore claws.

In general appearance very similar to the western *P. pallescens*, but a little longer, chunkier and the females are more strongly mat dorsally.

DISTRIBUTION: South Australia: Few spots in Mt. Lofty Ranges and on Fleurieu Peninsula (Fig. 30).

HABITAT: This species is found in small temporary streams and seasonally flooded areas in open forested country. At the Forreton locality it was collected most commonly close to steep banks in relatively shallow pools (to 300 cm) in a small, stony creek but also in shallow gutters in areas often flooded in winter and spring.

Paroster pallescens SHARP, 1882

Paroster pallescens SHARP 1882: 391; WATTS 1978: 56; WATTS 1985: 24; LAWRENCE et al. 1987: 340; NILSSON 2001: 180; WATTS 2002: 45.

TYPE MATERIAL: **Holotype** ♂: "Holotype", "W.Australia", "Sharp Coll. 1905-313", "*Paroster pallescens* Type D.S. West Australia" (NHML).

ADDITIONAL MATERIAL: 36 exs. (4 exs. in NMW), "Ellen Brook N R 14/9/00 CHSWatts"; 1 ex., "Geraldton Oct '31 WA Darlington"; 2 exs., "Australia, WA, Perth/Ellenbrook, Mellbrooks Speedway south of Twin Swamp Nature Reserve, 10.-12.9.2002, 31.741230 S 116.019329 E, Hendrich leg. Loc. WA 32/196" (CLH); 4 exs., "Jurien Bay 19/10/88 Halse"; 42 exs., "6K S Pinjarrah [sic] 23/10/96 C.Watts"; 28 exs., "WA 6 Km S Pinjarra CHS Watts 4/10/04"; 6 exs., "12 K W Serpentine WA 24/10 96 C Watts"; 8 exs., "Swan R WA Lea".

DESCRIPTION: Length 2.5–3.1 mm; oval, deep-bodied (Fig. 3).

Head: Dark-testaceous to black, lighter areas towards front. Eyes moderately large; microreticulation well marked, meshes small, round/oval; rather sparsely and unevenly covered with small punctures about size of reticulation meshes. Antenna relatively short, stout.

Pronotum: Dark-testaceous to black, extreme side margins yellowish; microreticulate as on head, rather sparsely covered with unevenly distributed moderately large punctures sparser and weaker on disc.

Elytron: Dull greyish-testaceous, with darker and lighter regions, lighter in basal $\frac{1}{4}$; microreticulation strong, meshes as on pronotum, evenly covered with small well-marked punctures of similar size to those on pronotum, serial punctures hard to trace, sometimes in two shallow grooves particularly at base.

Ventral surface: Prosternal process weakly expanded towards rear, strongly keeled, tip pointed, reaching anterior process of metaventrite. Metathorax with wings short, hind margin semicircular; moderately microreticulate, with a few moderately strong punctures. Metacoxal

plates large, weakly depressed in midline, quite strongly microreticulate, meshes fine; sparsely covered with strong punctures, coxal lines moderately widely separated, weakly diverging in front $\frac{1}{2}$, nearly reaching metathorax. Ventrites sculptured as for metacoxal plates. Protarsi moderately expanded, mesotarsi a little less so.

Male: Pro- and mesotarsi strongly expanded. Fore claws weak, equal in size and shape. Median lobe of aedeagus relatively thin, weakly constricted near slightly bilobed tip (Fig. 27).

VARIATION: The colour varies somewhat in general lightness or darkness. The strength of the dorsal reticulation and punctuation is variable with some specimens, particularly females, strongly reticulate giving a mat surface.

The degree of sexual dimorphism in microreticulation of the elytra varies considerably between populations, for example there is little difference between the sexes in specimens from the Swan Valley whereas specimens from near Pinjarra south of Perth have the females strongly microreticulate.

DIFFERENTIAL DIAGNOSIS: A medium sized Western Australian species with a dark/light dorsal colour pattern. The species can be confused with both *P. couragei* and *P. niger* but most specimens are larger and differently coloured, and can be distinguished by the characters given under those species. Resembles a small *P. sharpi*, *P. baylyi* or *P. michaelsoni* but considerably smaller and the males have unmodified fore claws in contrast to the males of those species.

DISTRIBUTION: South-western Australia, from Perth to Geraldton (Fig. 30).

HABITAT: *Paroster pallescens* occurs in shallow, seasonally flooded areas on the coastal sand plain near Perth, often together with *P. couragei* and *P. niger*. In some localities it can be extremely abundant for a short period in spring. Like all *Paroster* species which are reasonably well known, it disappears well before its habitat dries up in summer.

***Paroster sharpi* WATTS, 1978**

Paroster sharpi WATTS 1978: 53–55; WATTS 1985: 24; LAWRENCE et al. 1987: 340; NILSSON 2001: 180; WATTS 2002: 45.

TYPE MATERIAL: **Holotype** ♂: “Jilakin Lake, WA 16:ix:65 E.Britton” (ANIC). **Paratypes**: All paratypes of *P. sharpi* in fact belong to *P. thapsinus* (see there).

ADDITIONAL MATERIAL: 1 ex., “Jurian Bay WA 19/10/80 A. Storey”; 1 ex., “WA Wannara Claypan CALM SPS 168 8/9/99 J.M.McRae”.

DESCRIPTION: Length 4.0 mm; oval, deep-bodied (Fig. 8).

Head: Light testaceous. Eyes moderately large; microreticulation moderately marked, meshes very small, round/oval; sparsely and evenly covered with very small punctures about size of reticulation meshes; moderately indented above antennal bases. Antenna relatively thin.

Pronotum: Light testaceous; microreticulate as on head, sparsely covered with unevenly distributed moderately sized punctures somewhat larger than those on head, a few larger ones along front margin, those on disc a bit weaker.

Elytron: Evenly light testaceous; microreticulation as on pronotum, evenly covered with relatively small, well-marked punctures of similar size to those on pronotum, stronger towards apex, serial punctures hard to trace, in two shallow grooves towards base.

Ventral surface: Metaventrite and metacoxal plates testaceous, abdominal ventrites lighter. Prosternal process relatively thin, strongly keeled, tip pointed, reaching anterior process of metaventrite. Metathorax with wings short, hind margin squarish; weakly microreticulate, with a

few weak punctures. Metacoxal plates large, weakly depressed in midline, quite strongly microreticulate, meshes fine; moderately covered with strong punctures, coxal lines widely separated, almost parallel, not reaching metathorax. Abdominal ventrites sculptured as for metacoxal plates. Protarsi moderately expanded, mesotarsi less so.

Female: Dorsal surface quite strongly microreticulate giving it a mat surface.

Male: Pro- and mesotarsi moderately expanded, fore claws elongate, slightly sinuate laterally, inner ones slightly longer and thicker. Median lobe of aedeagus relatively thin, weakly constricted near tip, weakly flared at tip (Fig. 24).

VARIATION: The holotype and Jurien Bay specimens have greyish, less testaceous elytral colour than the other specimen, but are more teneral which may account for this variation.

DIFFERENTIAL DIAGNOSIS: A large, evenly testaceous species only likely to be confused with the similar sized *P. thapsinus* from which it can only be reliably separated by the broader and stouter aedeagus. The three known specimens of *P. sharpi* are evenly testaceous on the dorsal surface whereas specimens of *P. thapsinus* usually have a darker head and pronotum as well as more extensive darker areas on the ventral surface. However this colour difference may not hold when more Western Australian specimens of both species become available. The general colour, modified male fore claws and apical ventrite with the apex sharply pointed also tend to ally it with *P. couragei* from which it can be separated by its much larger size, dark areas on the ventral surface and aedeagus.

Paroster michaelsoni, *P. baylyi* and *P. ursulae* are also large with modified male fore claws. These three species are seemingly restricted to pools on rock formations, called gnammas (HENDRICH & FERY 2008). They also have a clear dark/light dorsal colouring in all but the most teneral individuals, very weak elytral punctuation and the front angles of the pronotum are weakly flanged.

DISTRIBUTION: South-western Australia (Fig. 32).

HABITAT: The three known localities suggest that *P. sharpi* inhabits shallow lakes and claypans in the wheat belt area of south-western Australia. These are usually saline to varying degrees and may dry completely but often have pools of less saline water around their perimeters, particularly in winter and spring when all the specimens have been collected. This and the small number of known locations make it hard to identify just how salt tolerant the species is.

Paroster thapsinus (GUIGNOT, 1955)

Hydroporus nigroadumbratus CLARK: SHARP 1882: 391 (misidentification).

Coelambus thapsinus GUIGNOT 1955: 5.

Hygrotus (*Coelambus*) *thapsinus* GUIGNOT: NILSSON 2001: 209.

Paroster thapsinus (GUIGNOT): FERY 2004: 169–171.

TYPE MATERIAL: **Holotype** ♂: “N.Amerika HELMS Upp, Ord R”, “GUIGNOT det 1953, *Coelambus thapsinus* n. sp. Type” (ZSM). **Paratype**: 1 ex., same data as Holotype (ZSM).

ADDITIONAL MATERIAL: 1 ex., “Adelaide Nov 60 CW” (paratype of *P. sharpi*); 4 exs., “Carrathool N.S.W. 25-10-[19]00” (paratypes of *P. sharpi*); 1 ex., “WA Bushy Swamp [near Wagin] 24/9/[19]98 CALM SPS056”; 1 ex., “Morgan Kreisler 20-10-[19]88”; 1 ex., “Mt Lofty S.A. J.G.O.Tepper” (paratype of *P. sharpi*); 1 ex., “Tatiara Creek SA AWQ survey 25/10/[19]95 site 3065”; 4 exs., “Upper Ord R Helms” (paratypes of *P. sharpi*).

DESCRIPTION: Length 3.6–4.2 mm; oval, deep-bodied (Fig. 11).

Head: Dark-testaceous. Eyes moderately large; microreticulation well marked, meshes small, round/oval; moderately densely and evenly covered with small punctures about 1.5x size of reticulation meshes. Antenna relatively short, stout.

Pronotum: Dark-testaceous, sides quite narrowly yellowish; microreticulate as on head, moderately covered with moderately strong punctures, smaller on disc where they are the same size as those on head.

Elytron: Dull yellowish-testaceous, apex and sutural regions tending lighter, often with darker patch in middle towards apex; microreticulation moderately strong, meshes as on pronotum, evenly covered with small well-marked punctures a little smaller than those at rear of pronotum, stronger and denser towards sides and apex, serial punctures hard to trace, sometimes present in two shallow grooves particularly at base.

Ventral surface: Prosternal process with moderately expanded apical portion, strongly keeled, tip pointed, reaching anterior process of metaventrite. Metathorax with wings short, hind margin semicircular; moderately microreticulate, with a few moderately strong punctures. Metacoxal plates large, weakly depressed in midline, quite strongly microreticulate, meshes fine; rather sparsely covered with moderately large, sharply impressed punctures, coxal lines strongly impressed, widely separated, weakly diverging in front $\frac{1}{2}$, almost reaching metathorax. Abdominal ventrites sculptured as for metacoxal plates. Protarsi quite strongly expanded, mesotarsi much less so.

Male: Pro- and mesotarsi a little stronger; fore claws moderately strong, inner one longer and thicker. Median lobe of aedeagus long, thin, weakly constricted near rounded tip (Fig. 25).

VARIATION: The colour varies somewhat in general lightness or darkness. The width of pale area on pronotum is variable, sometimes nearly meeting narrowly in front. The strength of the dorsal reticulation is variable, with some female specimens strongly reticulate giving a mat surface.

DIFFERENTIAL DIAGNOSIS: *Paroster thapsinus* is a large species, the males of which have modified fore claws. Most specimens come from south-eastern Australia where it can only be confused with the smaller *P. nigroadumbratus* from which it can be separated by its larger size and its modified male fore claws and aedeagus. *Paroster thapsinus* is superficially similar to *P. sharpi* and can, on present knowledge, only be separated by the differently shaped median lobe of the aedeagus (Figs 24, 25) and darker colouration of the head and pronotum (Figs. 8, 11).

NOTES: The interesting taxonomic history of this species (and *P. sharpi*) has recently been unravelled by FERY (2004). The species was erroneously described as a North American species. In reality the type specimens are labelled as coming from the Ord River in north-western Australia. But this creates another problem since the, albeit very few, other specimens come from south west and south-eastern Australia and from a very different habitat. As suggested by FERY (2004), the Ord River locality is also likely to be wrong. Compounding the situation is the original description by WATTS (1978) of *P. sharpi* that included (and was primarily based upon) specimens now known to be *P. thapsinus*.

DISTRIBUTION: South-eastern Australia and a single record from south-western Australia (Fig. 32).

HABITAT: Only three modern specimens of *P. thapsinus* are known. The two south-eastern specimens were collected from small temporary stony creeks in open forested country. The Adelaide locality, actually Dry Creek near Modbury, is semipermanent and in most years there are a few small, spring-fed pools remaining over summer. The Tatiara locality dries out

completely in late spring. The south-western specimen is from Bushy Swamp (near Wagin), a large, shallow, sparsely vegetated, permanent lake in open forest country.

***Paroster ursulae* HENDRICH & FERY, 2008**

Paroster ursulae HENDRICH & FERY 2008: 35.

TYPE MATERIAL: **Holotype** ♂: "AUSTRALIA / WA Great Eastern Hwy, 80 km WSW Coolgardie 'Scenic Lookout', sandstone hill, Mallee, 12.I.2000, in gnammas, Lars Hendrich leg. (loc.16/162)", "HOLOTYPE *Paroster ursulae* sp. n. Hendrich & Fery des. 2007" (WAM). **Paratypes** studied: 8 exs. with the same locality data as the holotype (SAMA).

DESCRIPTION: Length 3.7–4.2 mm.

Habitus as in Fig. 6; more stout and compact; distinctly larger than *P. baylyi*.

Species appearing much darker than *P. baylyi*, because yellowish areas on surface much less extended and brownish areas distinctly darker. Also underside somewhat darker; antennomeres almost entirely dark brownish beginning with fifth or sixth. Pronotum in dorsal view, behind anterior angles not diverging posteriorly, but sides more or less straight and parallel or slightly rounded and converging; thus, point of maximum width not at base, but often distinctly before base, and discontinuity in outline between pronotum and elytra rather prominent.

Reticulation and punctation on upper surface similar to that of *P. baylyi*, but generally more distinct. Setae longer and at least on sides and anterior margin of pronotum more distinct.

Male: Most characters as in *P. baylyi* but median lobe of aedeagus larger, in ventral view rather narrow and more or less evenly tapering to truncate apex (Fig. 23).

Female: On average smaller than males (compare with measurements in HENDRICH & FERY 2008). Reticulation of upper surface strongly impressed, in particular on elytra; thus, latter appearing very matt.

VARIATION: As in *P. baylyi* mainly concerning extent of dark areas; on elytra in several specimens reaching until base, yellowish markings on pronotum often reduced to rather narrow stripes on sides and a band parallel to anterior margin before centre of disc; even this band often darkened medially. As in *P. baylyi* often elytra with dark areas weakly lightened centrally.

DIFFERENTIAL DIAGNOSIS: The separation of *P. ursulae* from *P. michaelseni* is difficult; the shape of the sides of the pronotum and the larger size as well as the more vaulted form of the elytra of *P. ursulae* can only be used for a preliminary identification. According to HENDRICH & FERY (2008), a safe determination – at least of the males – is impossible without dissection. The shape of the median lobe of the aedeagus in ventral view provides a good distinguishing character.

DISTRIBUTION: Only known from the type locality near Boorabbin, south-western Australia (Fig. 31).

HABITAT: As in *P. baylyi* and *P. michaelseni* (Fig. 33).

Key to epigeal species of the genus *Paroster*

- 1 Metacoxal lines relatively close, length approximately 3 x the width between them; sides of pronotum curved producing a smooth outline with elytra (Fig. 14)..... *gibbi*
- Metacoxal lines well separated, length approximately 2 x the width between them; sides of pronotum relatively straight in posterior $\frac{2}{3}$ producing a sinuate outline together with elytra (Fig. 13)..... 2

2(1)	Dorsal surface evenly testaceous (anterior and posterior margins of pronotum may be a bit darker), abdominal ventrites testaceous.....	3
–	Dorsal surface testaceous to dark-testaceous, often with obvious darker and lighter areas, abdominal ventrites often dark	7
3(2)	2.2–4.0 mm long.....	5
–	Less than 2.0 mm long.....	4
4(3)	Elongate, body flattened, eyes very small, dorsal distance between eyes 10 x dorsal width of eye (Fig. 9).....	<i>leai</i>
–	Oval, deep bodied, dorsal distance between eyes 5 x dorsal width of eye (Fig. 10). ...	<i>ellenbrookensis</i>
5(3)	Punctures on discs of pronotum and elytra similar to those on head; male fore claws of equal size.....	<i>acutipennis</i>
–	Punctures on discs of pronotum and elytra larger than those on head; male fore claws uneven in size.....	6
6(5)	2.2–2.7 mm long.....	<i>couragei</i>
–	4.0 mm long.....	<i>sharpi</i>
7(2)	Male fore claws equal in size and shape; 2.1–3.2 mm long	8
–	Male fore claws unequal in size and shape; 3.2–4.2 mm long	11
8(7)	South-western Australia.....	9
–	South-eastern Australia.....	10
9(8)	Head (except sometimes extreme front edge), pronotum and usually most of the elytra black (Fig. 2); aedeagus with tip narrow (Fig. 26).....	<i>niger</i>
–	At least front of head and sides of pronotum light testaceous/yellowish, elytra with extensive light testaceous/yellowish areas (Fig. 3); aedeagus moderately broad (Fig. 27).....	<i>pallescent</i>
10(8)	2.1–3.1 mm long; elytra evenly testaceous to dark-testaceous.....	<i>insculptilis</i>
–	2.7–3.2 mm long; elytra with light and dark areas	<i>nigroadumbratus</i>
11(7)	Elytral punctures relatively strong, towards apex as large as serial punctures which are hard to trace; sides of pronotum not flanged (south-western and south-eastern Australia)	<i>thapsinus</i>
–	Elytral punctures weak, towards apex smaller than serial punctures which are easy to trace, sides of pronotum slightly flanged (south-western Australia).....	12
12(11)	Median lobe of aedeagus larger, in ventral view rather narrow and more or less evenly tapering to truncate apex (Fig. 23); larger (3.4–4.2 mm), in mature specimens dorsal colour usually rather dark (Fig. 6)	<i>ursulae</i>
–	Median lobe of aedeagus broader (Figs. 21–22); smaller (3.3–3.9 mm), dorsal colour lighter (Fig. 7).....	13
13(12)	Median lobe of aedeagus as in Fig. 21.....	<i>michaelseni</i>
–	Median lobe of aedeagus as in Fig. 22.....	<i>baylyi</i>

Phylogenetic analyses

A neighbour joining tree using sequence data of CO1 and 16S-tRNA^{leu}-ND1 is presented in Fig. 1. The isolated position of *P. gibbi*, first reported by LEYS et al. (2003), is confirmed.

Three clades are apparent from the tree, of which two representing sister species are supported by bootstrap values of 100. The third clade, which includes *P. insculptilis*, *P. niger* and *P. ellenbrookensis* has a much lower bootstrap support mainly due to the unresolved position of *P. insculptilis*. Uncorrected pairwise sequence divergence among specimens of *P. niger* and *P.*

ellenbrookensis is 5.3–6.2 %. The pairwise sequence divergence between *P. couragei* and *P. nigroadumbratus* is 3.0–4.7 %, while between *P. pallescens*, *P. baylyi* and *P. michaelsoni* the sequence divergences are in the range of 1.7–3.3 %. These latter values are low, considering that values in such a range are often found intraspecifically (WIEMER & FIEDLER 2007). The neighbour joining tree (Fig. 1) suggests that *P. pallescens* may represent a different lineage to the other two species in the clade. This is supported by the morphological and ecological differences sufficient to no doubt the specific validity of *P. pallescens*. The sequence data provide no support for the hypothesis that *P. baylyi* and *P. michaelsoni* are separate taxa. Morphologically, they and *P. ursulae*, for which no sequence data are available, can only be separated by differences in the aedeagi (HENDRICH & FERY 2008). These three species appear to form a genetically closely related group of sibling species living in ephemeral rock pools (pangnammias). This species complex requires further study, including more extensive genetic analysis, before it is properly understood.

According to DNA sequence data, *Paroster couragei* and (*P. baylyi* + *P. michaelsoni*) are not monophyletic despite being the only species in the matrix with modified male fore claws, suggesting that this character evolved independently in the two lineages.

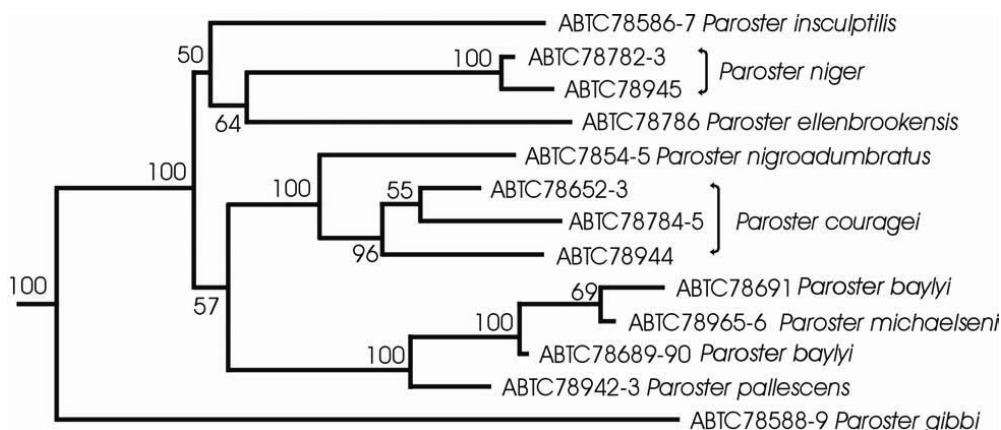
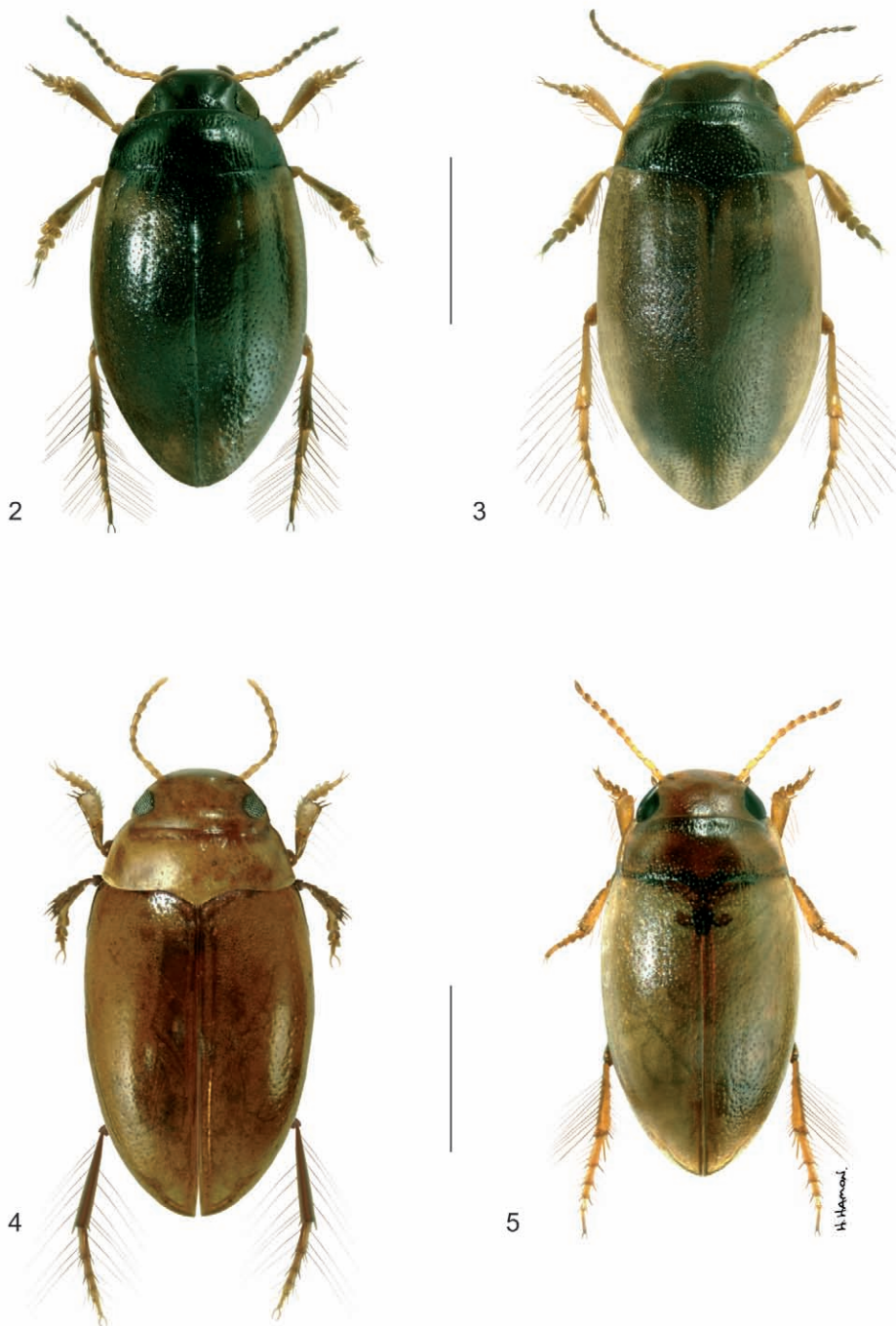


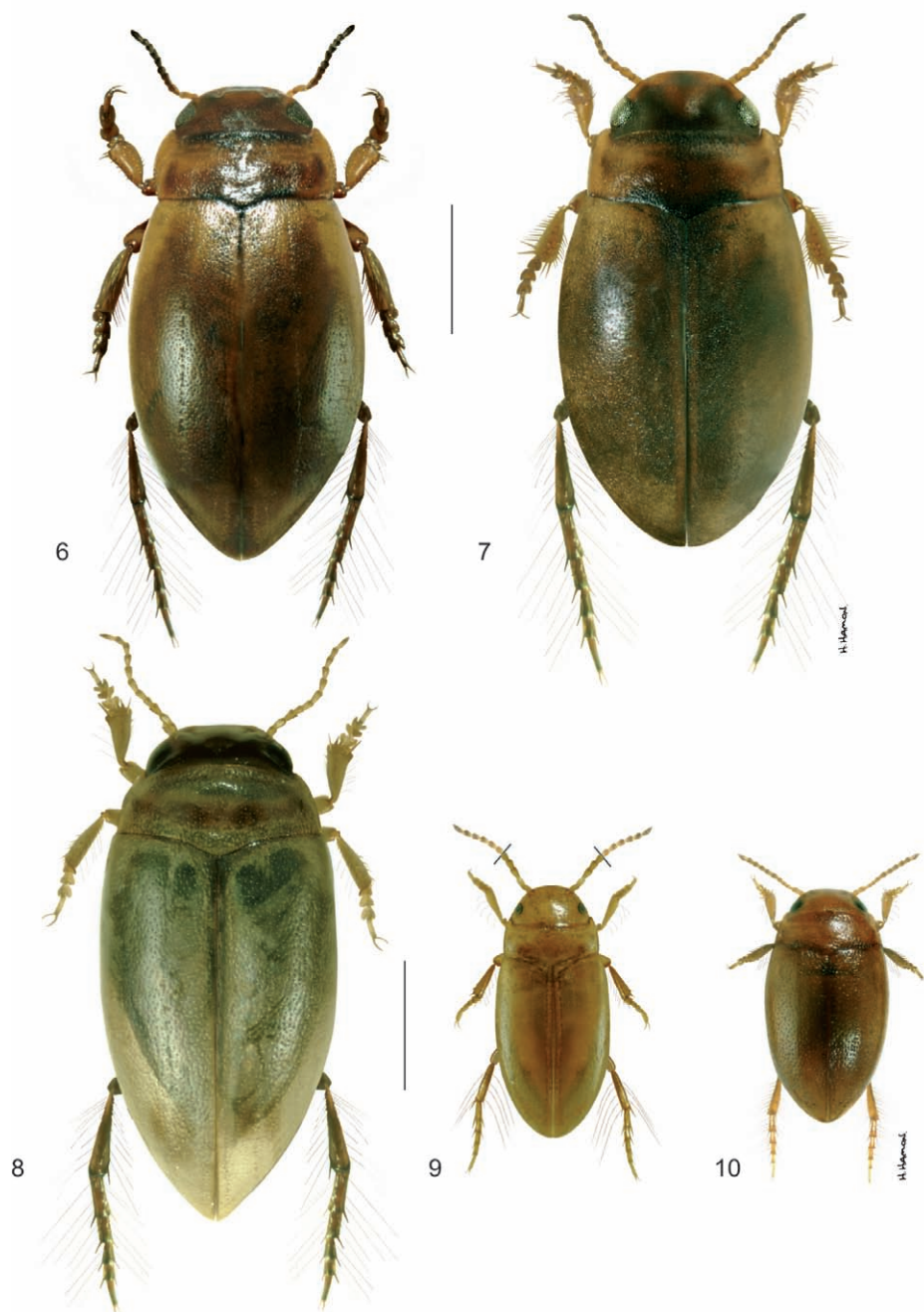
Fig. 1: Neighbour joining tree for 22 specimens in nine species of the genus *Paroster*. The bar indicates the number of nucleotide changes in the branches; the number in italics above the branch shows the bootstrap proportion.

Acknowledgements

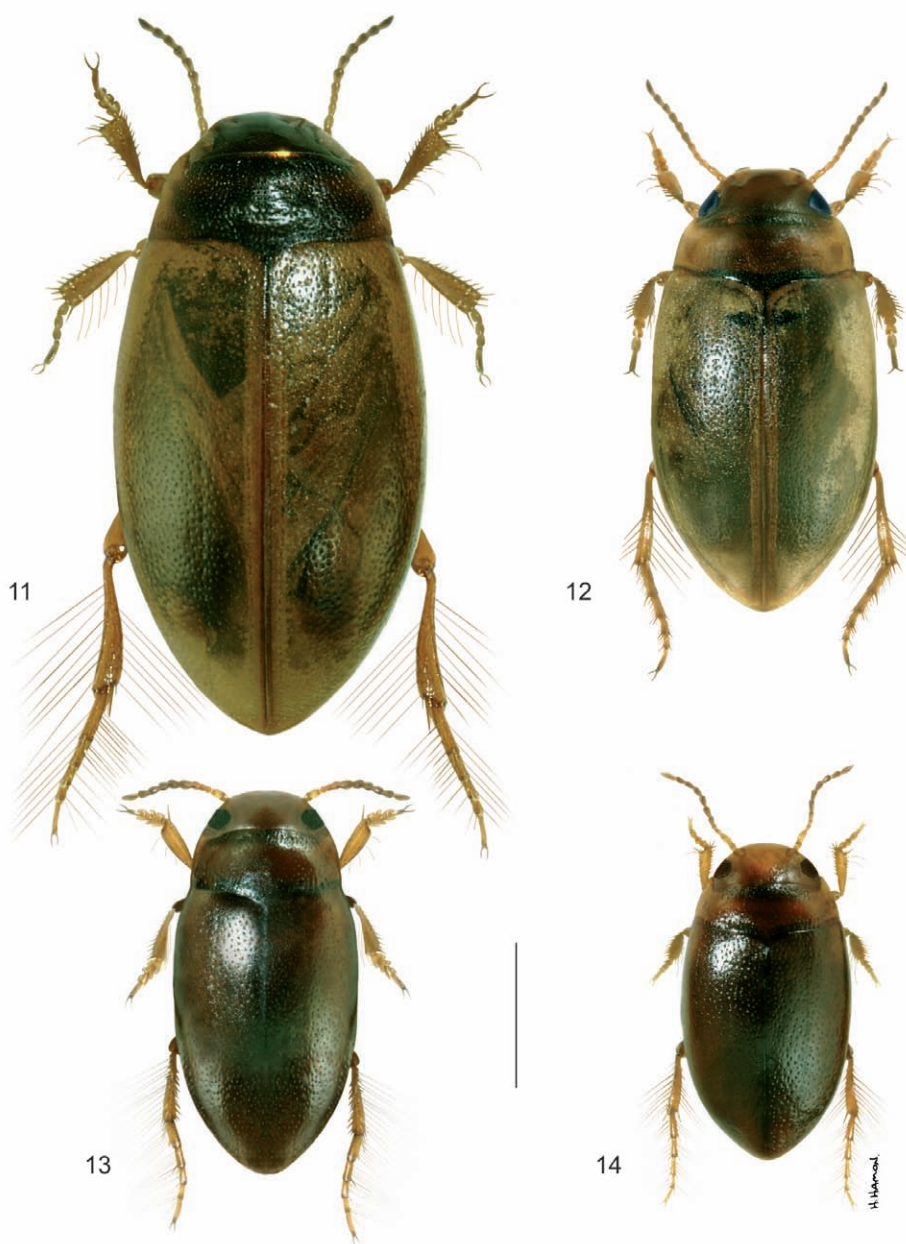
We are extremely grateful for the help and encouragement given by Jane McRae of the Western Australian Department of Environment and Conservation, who provided specimens from departmental faunal surveys. Andy Austin of the University of Adelaide is thanked for allowing access to the University's automontage facility. The work of Howard Hamon who skillfully drew the illustrations, enhanced the colour illustrations and prepared the plates is greatly appreciated. Lars Hendrich (ZSM) ran his discerning eye over the manuscript. He also kindly provided us with specimens and a manuscript version of the descriptions of *P. baylyi* and *P. ursulae*, and provided valuable label data of different type material from Paris and London. The habitat photographs were also taken by Lars Hendrich.



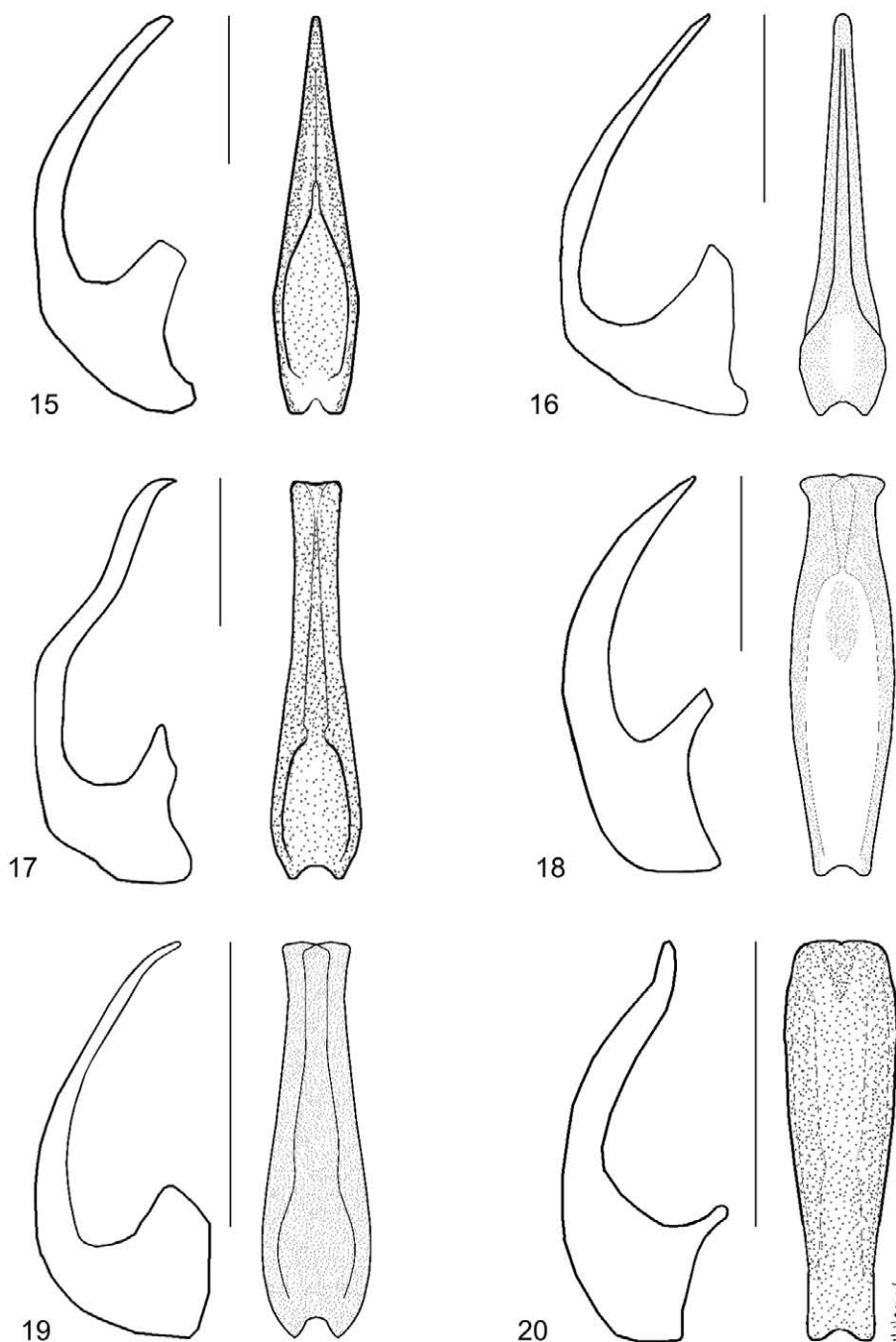
Figs. 2–5: Habitus photographs of 2) *Paroster niger*; 3) *P. pallescens*; 4) *P. acutipenis*; 5) *P. couragei*.
Line = 1 mm.



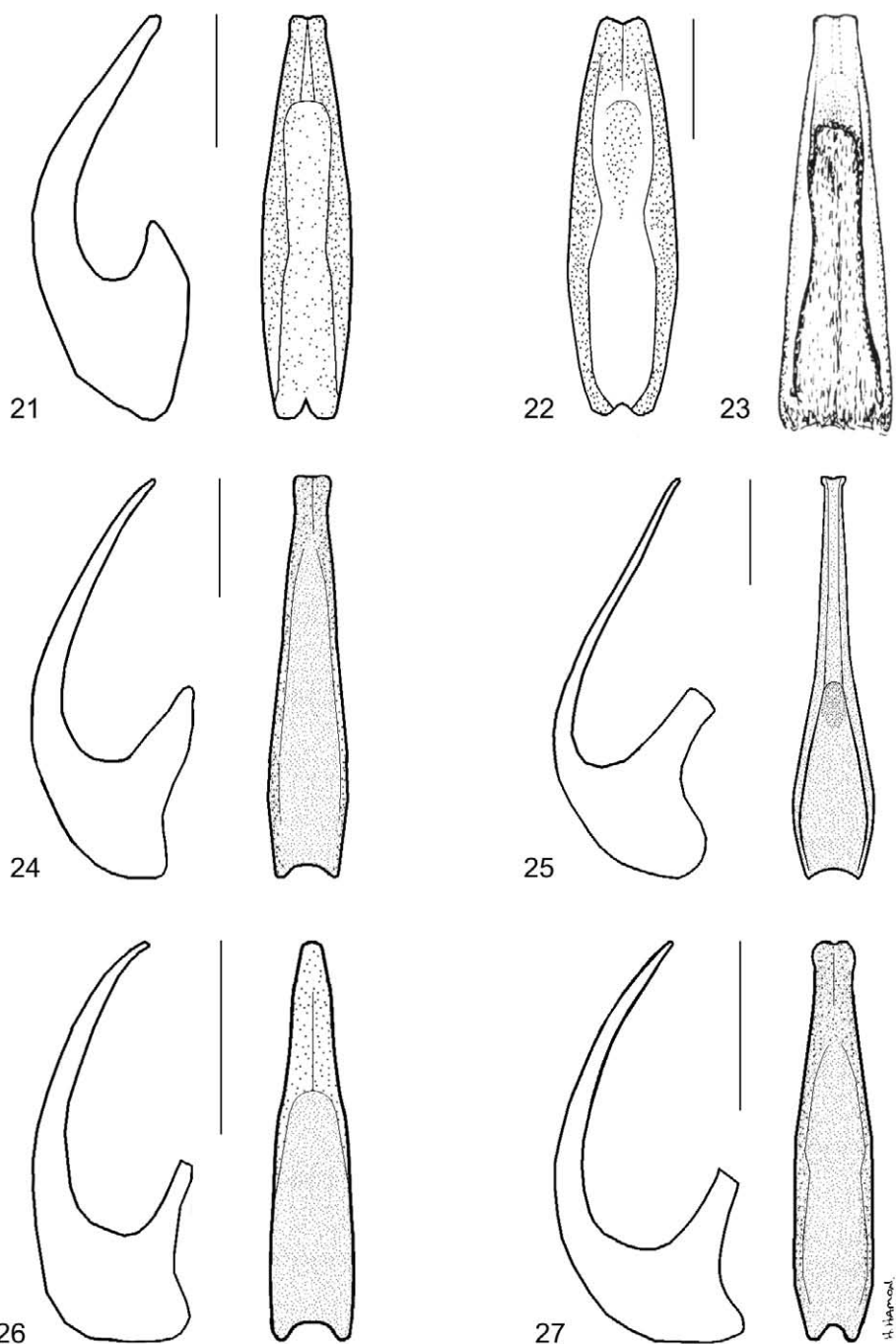
Figs. 6–10: Habitus photographs of 6) *Paroster ursulae*; 7) *P. baylyi*; 8) *P. sharpi*; 9) *P. leai*; 10) *P. ellenbrookensis*. Line = 1 mm.



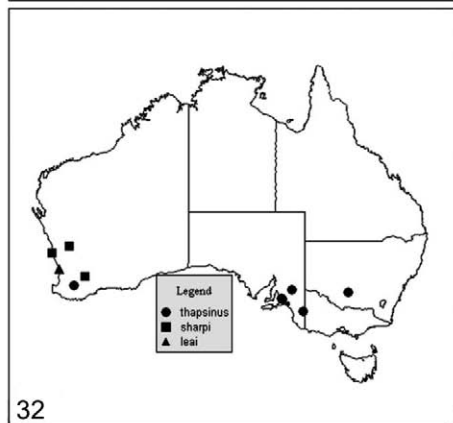
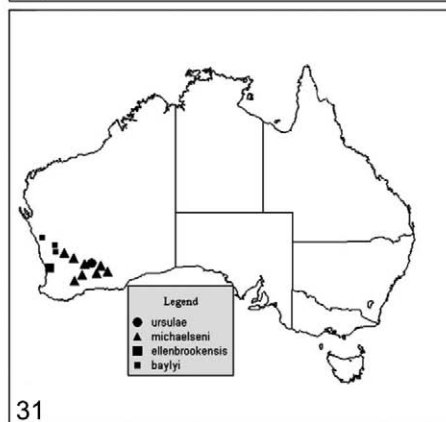
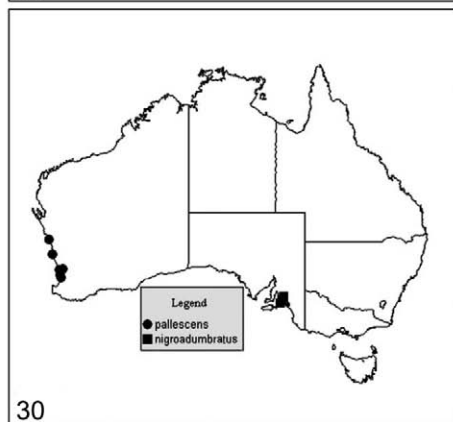
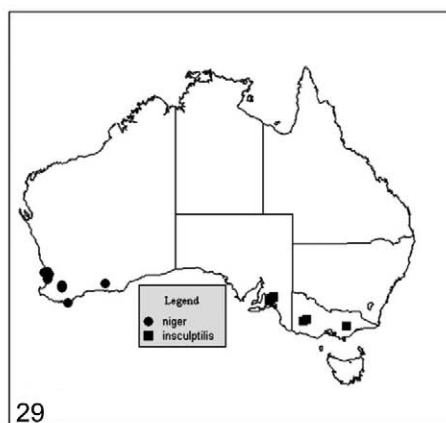
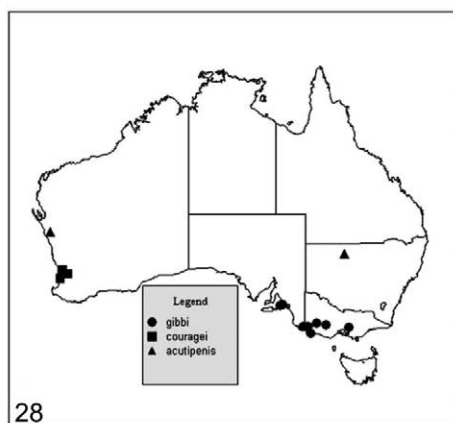
Figs. 11–14: Habitus photographs of 11) *Paroster thapsinus*; 12) *P. nigroadumbratus*; 13) *P. insculptilis*; 14) *P. gibbi*. Line = 1 mm.



Figs. 15–20: Line drawings of aedeagi. Left hand drawing, lateral view; right hand drawing, ventral view. 15) *Paroster acutipenis*; 16) *P. couragei*; 17) *P. insculptilis*; 18) *P. nigroadumbratus*; 19) *P. ellenbrookensis*; 20) *P. gibbi*. Lines = 0.25 mm.



Figs. 21–27: Line drawings of aedeagi. 21) *Paroster michaelsoni*, left hand drawing lateral view, right hand drawing ventral view (lateral view similar for *P. baylyi* and *P. ursulae*); 22) *P. baylyi*, ventral view; 23) *P. ursulae*, ventral view; 24–27: left hand drawing lateral view; right hand drawing ventral view; 24) *P. sharpi*; 25) *P. thapsinus*; 26) *P. niger*; 27) *P. pallescens*; Lines = 0.25 mm.



Figs. 28–32: Distribution of *Paroster* species in Australia. 28) *P. gibbi*, *P. couragei*, *P. acutipenis*; 29) *P. niger*, *P. insculptilis*; 30) *P. pallescens*, *P. nigroadumbratus*; 31) *P. ursulae*, *P. michaelsoni*, *P. ellenbrookensis*, *P. baylyi*; 32) *P. thapsinus*, *P. sharpi*, *P. leai*.



Figs. 33–34: Habitats of *Paroster*. 33) Type locality of *P. ursulae*, pan-gnammas on granite outcrop 80 km WSW Coolgardie, Western Australia; 34) isolated pools of an intermittent creek in the Stirling Ranges, Western Australia, habitat of *P. niger*. Both photographs by L. Hendrich.

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