

THIRTEEN NEW DYTISCIDAE (COLEOPTERA) OF THE GENERA *BOONGURRUS* LARSON, *TJIRTUDESSUS* WATTS & HUMPHREYS AND *NIRRIPIRTI* WATTS AND HUMPHREYS, FROM UNDERGROUND WATERS IN AUSTRALIA.

by C. H. S. WATTS* & W. F. HUMPHREYS†

Summary

WATTS, C. H. S. & HUMPHREYS, W. F. 2004. Thirteen new Dytiscidae (Coleoptera) of the genera *Boongurrus* Larson *Tjirtudessus* Watts & Humphreys and *Nirripiriti* Watts & Humphreys, from underground waters in Australia. *Trans. R. Soc. S. Aust.* 128(2), 99-129, 30 November, 2004.

Thirteen new species of stygobitic Dytiscidae from inland Western Australia are described: *Tjirtudessus hillviewensis* sp. nov., *T. microocula* sp. nov., *T. occidentalis* sp. nov., *T. padburyensis* sp. nov., *T. wogarthaensis* sp. nov., *Nirripiriti arachnoides* sp. nov., *N. bulbus* sp. nov., *N. byroensis* sp. nov., *N. copidotibiae* sp. nov., *N. dingbatensis* sp. nov., *N. eurypleuron* sp. nov., *N. innouendyensis* sp. nov., and *N. verrucosus* sp. nov. This brings the total of stygobitic Dytiscidae described from Australia to 55, derived from 33 discrete groundwater calcretes in 8 palaeodrainages. One species, *T. microocula* sp. nov., has partial eyes and wings that are only slightly reduced. *Boongurrus occidentalis* sp. nov. was collected from both surface and underground water and is little modified for an underground existence. Geographically the new species extend the range of stygobitic Dytiscidae in Australia to the Murchison and Moore drainage systems both of which drain to the Indian Ocean. Chemical and physical characters of the groundwater in some of the calcretes in which the new species were found are given.

KEY WORDS: Coleoptera. Dytiscidae. Stygobitic. Descriptions. New species. Water chemistry.

Introduction

This is the sixth paper in our series describing the stygobitic Dytiscidae of Australia (Watts and Humphreys 1999, 2000, 2001, 2003; Balke *et al.* 2004). In it we describe the new species found during fieldwork in Western Australia in winter 2002. Four new species in the Bidessine genus *Tjirtudessus* Watts & Humphreys, and 8 in the Hydroporine genus *Nirripiriti* Watts and Humphreys, are described from the westerly-draining Murchison and Moore paeleodrainage systems. A new species of the genus *Boongurrus* Larson is described from material collected mainly from interstitial sand/gravels in seasonal creeks in the Pilbara but also from three bore holes accessing two different underground calcretes. This new *Boongurrus* species is fully sighted and winged and shows little apparent physical adaptation to a hyporean existence yet was found together with a true stygobitic fauna in deep calcrete.

For the first time in Australia two stygobitic species (only one described here due to lack of a male specimen in one species) were discovered with a true eye remnant, as distinct from the usual small sclerite or short suture line, and wings that, although rather small, still retain veins and folded tips

suggesting that they are at an earlier stage of adaptation to underground life than the other species so far discovered.

Geographically the new finds extend the known distribution of stygal Dytiscidae some 300 kilometres to the west. We also recollected sites in the Northern Territory that yielded stygal Dytiscidae in 2001 without discovering any additional species. In addition, areas of groundwater calcretes near The Granites, Tennant Creek and in the Amadeus basin in the Northern Territory were sampled extensively without finding any Dytiscidae and only a sparse stygobitic fauna (Syncarids, Copepods, Amphipods) at the occasional site. Although too early to be sure the results suggest that the Australian stygobitic dytiscid fauna is restricted to inland Western Australia and the Ngalia basin in central Australia.

The prime aim of this series of papers is to formally describe the dytiscid fauna and to provide a preliminary indication of the ground water characteristics in which they are found. Companion papers by and with co-workers are starting to address questions of phylogeny and evolution (Balke *et al.* 2003, Cooper *et al.* 2002, Leys *et al.* 2003) and the taxonomic composition of the rich fauna associated with the beetles (Taiti and Humphreys 2001, Karanovic and Marmonier 2002, Karanovic 2004).

Materials and Methods

The collection methods and measurements of

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physico-chemical parameters in the water largely follow those used previously (Watts and Humphreys 2000) except that the use of a Quanta-G (Hydrolab Corporation, Austin, Texas) water quality monitoring system attached to a 50 m cable permitted the measurement of various physico-chemical water quality parameters (temperature, specific conductance (or TDS), pH, dissolved oxygen (% saturation or mg L⁻¹), oxidation-reduction potential (redox), and depth, the latter facilitating the determination of any vertical stratification present in the water column in some boreholes. The instrument was calibrated against the standards recommended for the instrument.

Abbreviations used:

- BES Prefix for field numbers, WAM
Biospeleology.
SAMA South Australian Museum, Adelaide.
WAM Western Australian Museum, Perth.
MB Groundwater monitoring bore.

Systematics

Key to Australian species of stygobitic Dytiscidae

- 1 — Scutellum well developed; length 4.5 mm
Copelatus abditus Balke *et al.*
— Scutellum absent; length 1.0 to 4.9 mm..2
- 2 (1) — Paramere one-segmented; metatibia approximately the same width throughout; without pronotal plicae (Hydroporini).....34
— Paramere two-segmented; metatibia narrow at base then strongly expanding towards apex; usually with pronotal plicae (Bidessini)3
- 3 (2) — With eyes4
— Without eyes, may have a small chitinized plate or suture line where eyes normally are5
- 4 (3) — Eyes of normal size; with elytral plicae ..
.....*Boongurrus occidentalis* sp. nov.
— Eyes approximately one-fifth normal size; without elytral plicae.....
.....*Tjirtudessus microocula* sp. nov.
- 5 (4) — Body length approximately 1.0 mm; legs stout, without swimming-hairs on fore and midlegs*Kintingka kurutjutu*
Watts and Humphreys
— Body length > 1.2 mm; legs normal, all with swimming-hairs6
- 6 (5) — Mesofemur with spines on hind edge approximately the same strength as those on mesotrochanter; length > 3.0 mm...29
— Mesofemur with spines on hind edge much more robust than those on mesotrochanter; length 1.4 – 3.6 mm....7
- 7 (6) — Normal ventrites 1 and 2 without suture between them (ie. number of visible abdominal segments reduced to four) (Fig. 82); length 3.2 – 3.6 mm.....
.....*Tjirtudessus sweetwatersensis*
Watts and Humphreys
— Ventrites 1 and 2 with suture between them, at least in inner portion (Figs 83-86); length 1.3 – 3.2 mm8
- 8 (7) — Pronotal plicae strong, well marked, excavated on inside.....9
— Pronotal plicae weak, difficult to trace, may be absent, not excavated on inside .
.....13
- 9 (8) — Mesosternum with posterior portion triangular in midline (Figs 77, 79).....10
— Mesosternum with posterior portion rounded in midline (Fig. 78).....11
- 10 (9) — Prosternal process rounded at tip (Fig. 75); tip of metatrochanter pointed; lobe on apical segment of paramere short.....
.....*Tjirtudessus morgani* (Watts and Humphreys)
— Tip of prosternal process pointed (Fig. 76); apex of metatrochanter rounded; lobe on apical portion of paramere long..
.....*Tjirtudessus bialveus* Watts and Humphreys
- 11 (9) — Head broad, deflexed, metatrochanter round; setae on mesofemur long.....
Tjirtudessus silus Watts and Humphreys
— With none of above characters12
- 12 (11) — Combined length of first two segments of metatarsus > rest; eye remnant present as small oval or triangular structure; paramere with long apical lobe.....
.....*Tjirtudessus pulpa*
(Watts and Humphreys)
— Combined length of first two segments of metatarsus approximately equal to rest; eye remnant reduced to single short suture; paramere with small apical lobe .
.....*Tjirtudessus cunyuensis*
Watts and Humphreys
- 13 (8) — Elytron with row of large punctures adjacent to suture26
— Elytron without sutural punctures, other than a few weak ones near base14
- 14 (13) — Eye remnant present as a small oval or triangular structure23
— Eye remnant reduced to single short suture15
- 15 (14) — Mesofemur with 5 to 7 spines on hind edge in basal half16
— Mesofemur with 2 to 4 spines on hind edge in basal half19

- 16 (15) — Protibia thick (Fig. 73); protarsus moderately expanded, mesotarsus less so; mesotibia slightly angular.....*Bidessodes gutteridgei* Watts and Humphreys
 — Protibia thin (Fig. 74); protarsus and mesotarsus approximately the same size; mesotibia not angular17
- 17 (16) — Length 2.5 – 2.7 mm; suture between ventrites 1 and 2 complete (Fig. 83).....
*Tjirtudessus padburyensis* sp. nov.
 — Length 1.6 – 2.0 mm; suture between ventrites 1 and 2 obliterated laterally (Figs 84-86).....18
- 18 (17) — Paramere with lobe as wide as rest of apical segment, flat on top, expanded slightly at tip*Tjirtudessus masonensis* Watts and Humphreys
 — Paramere with lobe shorter than rest of apical segment, rounded on top, tip pointed.....*Tjirtudessus yuinmeryensis* Watts and Humphreys
- 19 (15) — Mesofemur with four spines near base; antenna with segments 1 and 3 of similar length, segment 11 approximately 1.5x length of segment 10; length 2.1 – 2.4 mm*Tjirtudessus cueensis* (Watts and Humphreys)
 — Mesofemur with two to three strong spines on hind edge near base; antenna with segment 2 large, oval; segment 3 much smaller and thinner, segment 11 approaching 2x length of segment 10; length 1.3 – 1.8 mm.....20
- 20 (19) — Mesofemur with two strong spines on hind edge near base; paramere with apical segment with two finger-like projections*Tjirtudessus pinnaclensis* (Watts and Humphreys)
 — Mesofemur with three strong spines on hind edge near base; paramere with apical segment with one finger-like projection..21
- 21 (20) — Mesofemur with three spines grouped together near base.....*Tjirtudessus fridaywellensis* (Watts and Humphreys)
 — Mesofemur with two spines near base and one more distant.....22
- 22 (21) — Pro and mesotibia club-shaped; antenna with middle segments enlarged a little on inside.....*Tjirtudessus hinkleri* (Watts and Humphreys)
 — Pro and mesotibia elongate/triangular in shape; middle segments of antenna virtually symmetrical.....*Tjirtudessus karalundiensis* Watts and Humphreys
- 23 (14) — Pronotum not constricted at base; prosternal process reaching or almost reaching mesosternum; 1.4 mm long.....
*Tjirtudessus wilumaensis* Watts and Humphreys
 — Pronotum moderately constricted at base; prosternal process not reaching mesosternum; 2.3 – 3.2 mm long24
- 24 (23) — Mesofemur with 6 spines close to base on hind edge*Tjirtudessus bigbellensis* (Watts and Humphreys)
 — Mesofemur with 3 to 6 spines spread out along basal half of hind edge.....25
- 25 (24) — Suture line between ventrites 1 and 2 well marked (Fig. 83); aedeagus with medial lobe parallel sided, apex not upturned.....
*Tjirtudessus challaensis* (Watts and Humphreys)
 — Suture lines between ventrites 1 and 2 weak (Fig. 84), usually obsolete in lateral half; aedeagus with medial lobe distinctly narrower in middle, apex upturned
*Tjirtudessus jundeensis* Watts and Humphreys
- 26 (13) — Distinct oval eye remnant present27
 — Eye remnant reduced to single short suture.....28
- 27 (26) — Metatrochanter with tip slightly pointed (Fig. 11); sutural lines between ventrites 1 and 2 complete, distinct*Tjirtudessus hillviewensis* sp. nov.
 — Metatrochanter with tip rounded; suture between ventrites 1 and 2 obliterated laterally.....*Tjirtudessus windarraensis* (Watts and Humphreys)
- 28 (26) — Mesofemur with 3 spines on hind edge (Fig. 28); suture between ventrites 1 and 2 complete; metatrochanter elongate (Fig. 29).....*Tjirtudessus wogarthaensis* sp. nov.
 — Mesofemur with 5 to 6 spines on hind edge; suture between ventrites 1 and 2 obliterated laterally; metatrochanter rounded*Tjirtudessus lapostaae* (Watts and Humphreys)
- 29 (6) — Mesofemur with spines arranged in two comb-like rows along hind edge from base to apex; mesotibia thin, curved
*Bidessodes limestoneensis* Watts and Humphreys
 — Mesofemur with spines on hind edge spaced out, not dense and comb-like; mesotibia straight30
- 30 (29) — Pro and mesotarsus with basal segment much more expanded than other segments.....31
 — Pro and mesotarsus with basal segment only moderately expanded compared with other segments32
- 31 (30) — Antenna with segments 8 to 11 noticeably

- thinner than others, segment 3 longer than segment 2...*Tjirtudessus magnificus* Watts and Humphreys40
- Antenna with segments 8 to 10 not noticeably thinner than others, segment 3 same length as segment 2.....*Tjirtudessus macrotarsus*. Watts and Humphreys41
- 32 (30) — Pronotum a little narrower than elytra; length 3.5 – 5.0mm.....33
- Pronotum wider than elytra; length 3.2 – 3.5mm.....*Tjirtudessus eberhardi* Watts and Humphreys42
- 33 (32) — Metatrochanter rounded at tip; aedeagus with central lobe straight, tip pointed; eye remnant small ..*Tjirtudessus raesideensis* Watts and Humphreys43
- Metatrochanter pointed at tip; aedeagus with central lobe twisted, tip knobbed; without eye remnant...*Tjirtudessus hahni* Watts and Humphreys44
- 34 (2) — From the Northern Territory35
- From Western Australia39
- 35 (34) — Head short, very broad, strongly deflexed; pronotum strongly narrowed at base; prosternal process anvil-shaped.....*Nirripiriti macrocephalus* Watts and Humphreys45
- Head variably shaped, not deflexed, base of pronotum variably shaped; prosternal process "normally" shaped36
- 36 (35) — Protarsus with segment 3 not bilobed; pronotum not constricted at base; antenna thin, segments 1 and 2 subequal.....*Nirripiriti pentameres* Watts and Humphreys46
- Protarsus with segment 3 bilobed; pronotum weakly to moderately constricted at base; antenna thick, segment 2 much broader than segment 137
- 37 (36) — Length 1.8 mm; body well-chitinized*Nirripiriti napperbyensis* Watts and Humphreys47
- Length 1.2 – 1.6 mm; body weakly chitinized.....38
- 38 (37) — Length 1.2 mm; body only slightly constricted at junction of pronotum and elytra*Nirripiriti wedgeensis* Watts and Humphreys48
- Length 1.5 mm; body quite strongly constricted at junction of pronotum and elytra*Nirripiriti newhavenensis* Watts and Humphreys49
- 39 (34) — Pronotum (and head) about half width of elytra (Fig. 36)*Nirripiriti arachnoides* sp. nov.50
- Pronotum > three quarters width of elytra40
- 40 (39) — Elytron with visible ventral portion extensive except close to apex (eg. Fig. 85).....41
- Elytron with visible ventral portion narrow except in basal quarter (eg. Fig. 86)45
- 41 (40) — Length 3.6 – 3.8 mm.....*Nirripiriti stegastos* Watts and Humphreys42
- Length 1.5 – 2.5 mm.....42
- 42 (41) — Antenna with segments 6 to 8 greatly expanded, much broader than segments 9 and 10 (Fig. 42)*Nirripiriti bulbosus* sp. nov.43
- Antenna with segments 6 to 10 of approximately equal size43
- 43 (42) — Meso and metatibia elongate triangular; body strongly boat-shaped, pronotum much narrower in front44
- Meso and metatibia cylindrical (Figs 61, 62); front and rear of pronotum same width (Fig. 63)*Nirripiriti eurypleuron* sp. nov.45
- 44 (43) — Length 2.1 to 2.3 mm; metatrochanter with tip sharply pointed*Nirripiriti skaphites* Watts and Humphreys sp. nov.46
- Length 1.5 to 1.9 mm; metatrochanter with tip rounded*Nirripiriti killaraensis* Watts and Humphreys47
- 45 (40) — Antenna with segment 2 larger and more oval than segment 1; 1.2 – 2.1 mm long52
- Antenna with segment 2 more or less the same shape as segment 1 or smaller; 2.5 – 3.9 mm long.....46
- 46 (45) — Mesofemur with row of about 20 closely placed small spines along hind edge (Fig. 43)*Nirripiriti byroensis* sp. nov.47
- Mesofemur with 10 or fewer weak to very strong spines along hind edge47
- 47 (46) — Metasternal plate parallel sided (Fig. 80); mesofemur with 8 to 10 spines, closely placed, very strong; metatrochanter long and thin about 4 x as long as wide*Nirripiriti fortisspina* Watts and Humphreys48
- Metasternal plate narrowing towards rear (eg. Fig. 81); mesofemur with 4 to 8 spines, weak to moderately strong; metatrochanter moderately elongate 2 to 2.5 x as long as wide48
- 48 (47) — Metatarsus with segment 1 as long as others combined, with confluent group of 5 strong spines in middle on outside (Fig. 51).....*Nirripiriti copidotibiae* sp. nov.49
- Metatarsus with segment 1 much shorter than others combined, without confluent

- group of spines on outside.....49
- 49 (48) — Metasternal plate without wings (Fig. 81)*Nirripiriti plutonicensis* Watts and Humphreys
- Metasternal wings obvious but short (eg. Fig. 80)50
- 50 (49) — Metafemur with 2 to 4 small lumps on top edge (Fig. 71)*Nirripiriti verrucosus* sp. nov.
- Metafemur with smooth top edge.....51
- 51 (50) — Mesofemur with moderately strong spines; metacoxal plate nearly reaching mesocoxae.....*Nirripiriti hinzeae* Watts and Humphreys
- Mesofemur with thin spines; metacoxal plate at least the width of metafemur from mesocoxae.....*Nirripiriti darlotensis* Watts and Humphreys
- 52 (45) — Elytron with shoulder flared outwards (Fig. 86)*Nirripiriti hamoni* Watts and Humphreys
- Elytron with shoulder not flared (eg. Fig. 85)53
- 53 (52) — Metatrochanter produced into long strong point (Fig. 68)*Nirripiriti innoendyensis* sp. nov.
- Metatrochanter rounded, at most bluntly pointed.....54
- 54 (53) — Eye remnant absent; metatrochanter large, squat; hind leg stout; length 1.2 mm. *Nirripiriti milgunensis* Watts and Humphreys
- Eye remnant represented by a short suture at side of head; metatrochanter elongate; hind leg elongate; length 1.8 - 2.0 mm....
.....*Nirripiriti melroseensis* Watts and Humphreys

Descriptions

The following species descriptions are grouped in alphabetical order under genus which are placed in the order *Boongurrus*, *Tjirtudessus*, *Nirripiriti*.

***Boongurrus* Larson (Hydroporinae, Bidessini)**

***Boongurrus occidentalis* sp. nov.**

FIGS 13-18

Holotype

m: '10 K NW Eerala Stn CHS Watts 23/5/01', WAM 34222. Card mounted.

Paratypes

25; 8, as for holotype, SAMA; 12, 'Wittenoom Gorge Town Pool CHS & GA Watts 26/5/01', 10 SAMA, 2, Lars Hendrich collection (Berlin); 1, 'BES 9277 Killara Station north, unused water bore, 26°

03' 55" S 118° 41' 58" E, 6/6/2002 W. F. Humphreys and R Leys', SAMA; 1, 'BES 9318 Moorarie Stn nr calcrete quarry site 419, 25° 52' 26S 117° 27' 09E, 8/6/02, W. F. Humphreys & R. Leys', SAMA; 2, ditto except 'BES 9320', 1 WAM 34177, 1 SAMA; 1, 'BES 9246 Wagga Wagga Stn, mineral exploration bore 28° 26' 36" S 116° 38' 9" E, 4/6/02, W. F. Humphreys & R. Leys', SAMA.

Description (number examined, 24)

Habitus. Length 1.9 – 2.3 mm; relatively flat, weakly constricted at junction of pronotum/elytra; elongate oval; uniformly light testaceous, elytra uniformly darker; hindwing not reduced; eyes of normal size.

Head. Narrower than elytra; smooth, shiny, weak reticulation towards rear, punctures small, sparse; without cervical stria, subparallel in posterior half, widest just behind eye, antenna stout, segments 1 and 2 cylindrical, segment 3 as long as segment 2, narrower, narrowing slightly towards base, segments 4 to 8 becoming progressively slightly broader, segments 9 and 10 a little narrower than segment 8, segment 11 about twice length of segment 10, each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus elongate, segment 4 as long as segments 1 to 3 combined.

Pronotum. A little narrower than elytra; anteriolateral angles projecting strongly forward; base weakly constricted, posteriolateral angles square, surface slightly rugose, with moderately dense, moderately sized punctures and a row of stronger punctures along front margin; basal plicae strong, excavated somewhat on inside, converging slightly towards front, reaching to about two-thirds way along pronotum.

Elytra. Not fused, with weak inner ridges near apex (ligula), lacking in some; elongate, nearly parallel-sided in middle; rugose, quite densely covered with moderate sized punctures; plicae well impressed, straight, about as long as pronotal plicae. Epipleuron well differentiated from rest of elytra particularly anteriorly, lacking basal carina, relatively broad in anterior quarter then progressively narrowing to near apex.

Ventral surface. Prosternal process strongly narrowed between coxae, reaching mesothorax, apical half elongate triangular, weakly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae separated. Metathorax strongly triangular in front in midline; wings short; broadly rounded in midline behind. Metacoxal plates large, quite strongly punctate, moderately rugose, metacoxal lines distinct, moderately widely spaced, reaching to metasternum, weakly diverging; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct, ventrites 3 to 5 mobile, rugose,

well covered with moderate sized seta-bearing punctures.

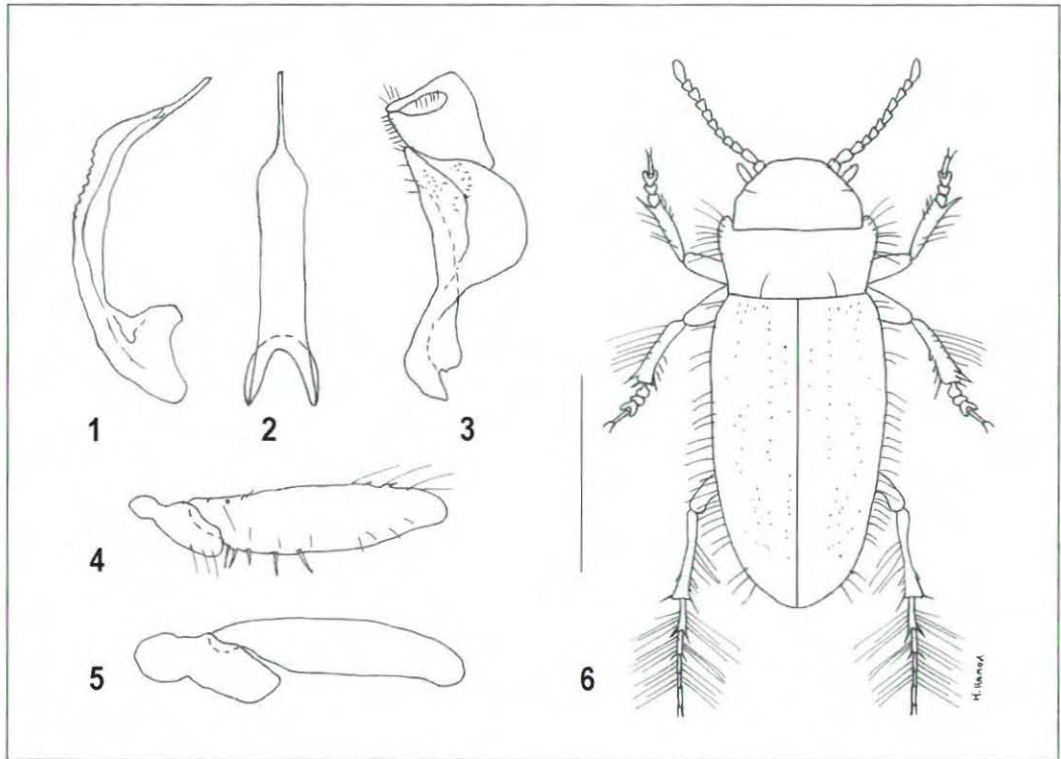
Legs. Protibia triangular, outer edge bow-shaped, widest towards apex where it is about four times its basal width; protarsus weakly expanded, segment 1 as broad as long, segment 2 as wide as segment 1 and about half its length, segment 3 as long as segment 1 and a little narrower, deeply bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about 1.5x length of segment 3, segments 1 to 3 with dense covering of adhesive setae; claws short and simple. Mesotrochanter elongate-oval with a few relatively long, thin setae on inner edge; mesofemur with 4 to 5 moderately strong setae in basal half, only slightly stronger than those on other parts of the femur (Fig. 16), mesotarsus slightly less expanded than protarsus. Metatrochanter tip rounded (Fig. 17); metafemur relatively stout, lacking spines; metatibia narrow, moderately curved, widening towards apex; metatarsi relatively stout, segment 1 longest, segment 5 longer than segment 4, segments 1 and 2 in combination about as long as others; claws weak.

Male

Little external differentiation between the sexes. Median lobe of aedeagus broad in middle narrowing to sharp point; paramere broad, apical segment with relatively stout apical lobe well separated from rest of segment. Figs 13-14.

Remarks

This new species of *Boongurrus* closely resembles *B. rivulus* (Larson) from the Atherton tableland region of north Queensland differing externally only in the larger eyes, slightly less rugose body, slightly weaker tarsi and thinner antennae. The main differentiating characters are the size of the eyes which in the new species are of normal epigeal size in contrast to those of *B. rivulus* which are about three quarters normal size and in the male genitalia. The aedeagus of *B. occidentalis* is broader medially and tapers to a longer and sharper point. The apical segment of the paramere is longer than in *B. rivulus* and the apical lobe smaller but much more distinct (Larson 1994).



Figs 1-6. *Tjirtudessus hillviewensis*: 1, lateral view of central lobe of aedeagus; 2, ditto dorsal view; 3, paramere; 4, mesotrochanter and mesofemur; 5 metatrochanter and metafemur; 6, dorsal view. Scale bar represents 1mm (habitus only).

Most of the specimens have been collected at the edge of pools in sandy riverbeds and interstitially to at least two meters from the water's edge in an upstream direction. It has also been recorded as flying to light (in Australian Insect Collection CSIRO Canberra). A little surprisingly a few specimens were collected during this year's fieldwork from boreholes in two separate calcretes together with a true stygobitic fauna. The Killara North site was an open unused water bore ca 3 m to water and a water depth of ca 9 m in a calcrete area and the associated stygofauna included Bathynellacea, crangonytoid and Ceinidae Amphipoda, Harpacticoida, Cyclopoida. The Moorarie site was a sealed monitoring bore in calcrete within 30 m of a calcrete quarry that penetrated the groundwater; the borehole contained a stygobitic fauna comprising Bathynellacea and Amphipoda. DNA studies (Remko Leys pers. com.) found no differences between *B. occidentalis* specimens collected from epigeal and stygal habitats.

Etymology

Latin. 'Occidental' – western. A reference to its distribution.

Tjirtudessus Watts & Humphreys (Hydroporinae, Bidessini)

Tjirtudessus hillviewensis sp. nov.
FIGS 1-6

Holotype

m. 'BES 9399, Hillview Station, bore at Camel Well, 26° 58' 20S 117° 27' 09" E, 13/6/02, W. F. Humphreys & R. Leys', WAM 34178. Slide mounted.

Paratype

1 (partial), as for holotype except 'BES 9398', SAMA.

Description (number examined, 1 + 1 partial)

Habitus. Length 2.35 mm; relatively flat, weakly constricted at junction of pronotum/elytra; elongate oval; uniformly light testaceous; hindwing reduced, broad, about half length of elytron, tip slightly folded; weakly sclerotized.

Head. A little narrower than elytra; smooth, reticulation weak, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant reduced to small triangular area. Antenna moderately stout, segments 1 and 2 broad, oval, segment 3 as long as segment 2, narrower, narrowing towards base, segments 4 to 10 subequal, segment 11 about twice length of segment 10, each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus,

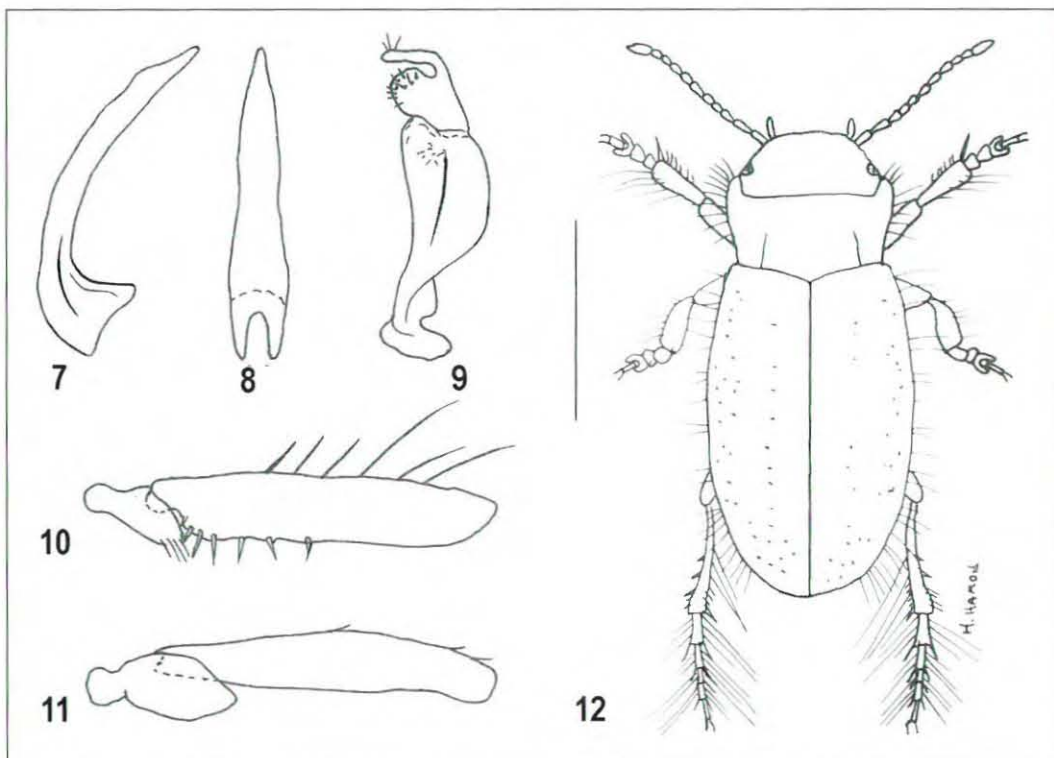
elongate, segment 4 as long as segments 1 to 3 combined.

Pronotum. About same width as elytra; anteriolateral angles projecting strongly forward; base weakly constricted, posteriolateral angles obtuse, overlying elytra somewhat; smooth, with sparse, very weak punctures and a row of stronger punctures along front margin; basal plicae moderately impressed, converging slightly towards front, reaching to about half way along pronotum; numerous long setae laterally in anterior half.

Elytra. Not fused, tightly closed, lacking inner ridges; elongate, almost parallel sided, smooth, very weakly reticulate, sparsely covered with small punctures, a few widely spaced larger punctures close to inner edge; row of long setae near lateral edge, a few additional larger punctures with long setae, more frequent towards sides and apex. Epipleuron moderately differentiated from rest of elytra, moderately broad in anterior quarter, progressively thinner till near apex.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, apical half broad, sides slowly converging to rounded apex, strongly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact at midline. Metathorax broadly triangular in front in midline; wings stout, narrow; narrowly rounded in midline behind. Metacoxal plates large, weakly reticulate, metacoxal lines indistinct, moderately widely spaced, reaching to about halfway to metasternum, quite strongly diverging; a few small setae-bearing punctures towards midline; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct, ventrites 3 to 5 mobile, sparsely covered with small seta-bearing punctures, ventrites 3 and 4 with a long central seta or bunch of long setae.

Legs. Protibia bow-shaped, relatively narrow, widest towards apex where it is about four times its basal width; protarsus weakly expanded, segment 1 as broad as long, segment 2 as wide as segment 1 and about half its length, segment 3 as long as segment 1, narrower, deeply bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about 1.5x length of segment 3, segments 1 to 3 with very dense covering of adhesive setae; claws short and simple. Mesotrochanter elongate/oval with a few thin setae on inner edge; mesofemur with 4 evenly spaced spines in basal half (Fig. 4) mesotarsus a little more elongate than protarsus. Metatrochanter tip angular (Fig. 5); metafemur relatively stout, lacking spines; metatibia narrow, moderately curved, widening towards apex; metatarsus elongate, segment 1 longest, segment 5 a little longer than segment 4, segments 1 and 2 in combination about as long as others; claws weak.



Figs 7-12. *Tjirtudessus microocula*: 7, lateral view of central lobe of aedeagus; 8, ditto dorsal view; 9, paramere; 10, mesotrochanter and mesofemur; 11, metatrochanter and metafemur; 12, dorsal view. Scale bar represents 1mm (habitus only).

Male

Female not known. Median lobe of aedeagus with unusually long thin apical portion, slightly crenulated on top; paramere broad, apical segment with long, narrow, apical lobe separated from rest of segment except at its apex which overlaps rest of segment. Figs 1-2.

Etymology

Named after the pastoral station on which it was found.

Remarks

Most closely resembles *T. windarraensis* in size, presence of an eye remnant, row of large punctures on elytron adjacent to the suture and pointed median lobe of the aedeagus, but differs in the shorter apical segment of the paramere and larger apical lobe, as well as having a more oval eye remnant, and a complete suture between the first and second ventrites which is obliterated laterally in *T. windarraensis*.

Tjirtudessus microocula sp. nov.

FIGS 7-12

Holotype

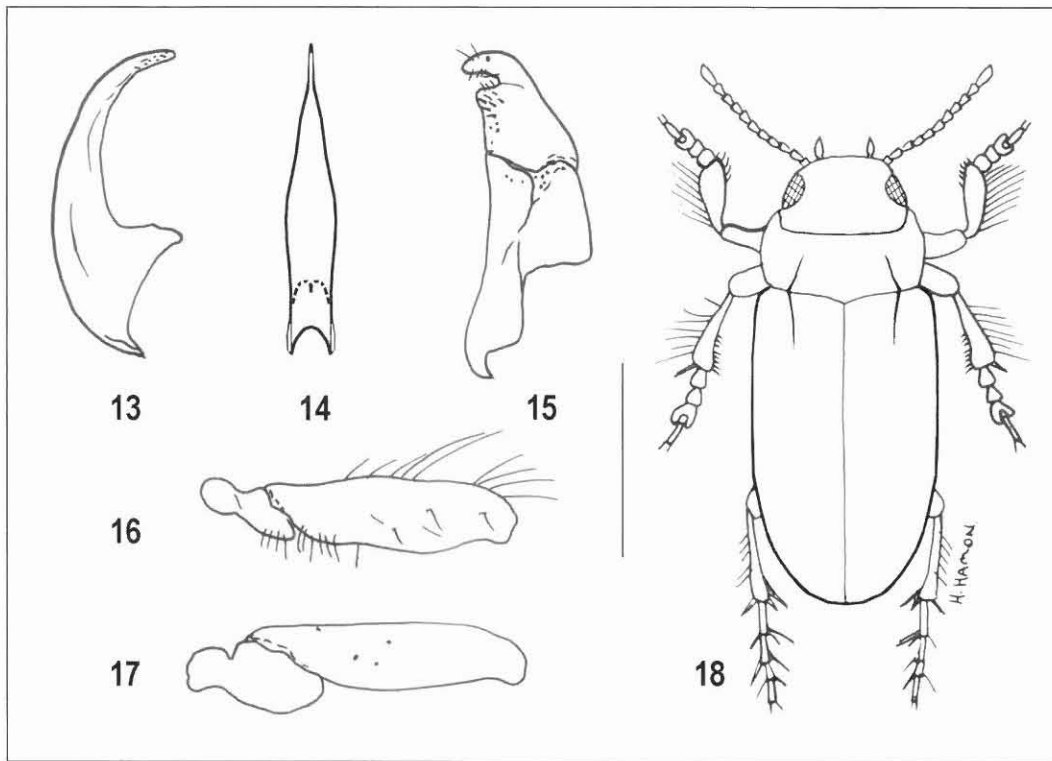
m. 'BES 9223, Bunnawarra Station, bore nr. shearing shed, 28° 36' 35" S 11° 34' 25" E, 3/6/02, W. F. Humphreys & R. Leys', WAM 34179. Slide mounted.

Paratypes

37; 19 + 5 partial specimens, as for holotype. 8 + 5 partial specimens WAM 34180 - 34192, 11 SAMA; 4, as for holotype except 'BES 9224, well near shearers quarters, 28° 36' 36" S 116° 34' 18" E', WAM 34193 - 34196; 4, as for holotype except 'BES 9225', SAMA.

Description (number examined, 38)

Habitus. Length 2.2 - 2.3 mm; relatively flat, weakly constricted at junction of pronotum/elytra; elongate oval; uniformly light testaceous; eyes reduced to about a fifth normal size; hindwing reduced, about length of elytron, tip folded.



Figs 13-18. *Boongurrus occidentalis*: 13, lateral view of central lobe of aedeagus; 14, ditto dorsal view; 15, paramere; 16, mesotrochanter and mesofemur; 17 metatrochanter and metafemur; 18, dorsal view. Scale bar represents 1mm (habitus only).

Head. Narrower than elytra; smooth, reticulation weak, punctures sparse, small; subparallel in posterior half, widest just behind eye; eye reduced to about a fifth normal size, lacking individual facets, darkly pigmented. Antenna relatively thin, segments 1 and 2 cylindrical, segment 3 as long as segment 2, narrower, narrowing towards base, segments 4 to 10 subequal, segment 11 elongate, a little less than twice length of segment 10, each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus, elongate, segment 4 as long as segments 1 to 3 combined.

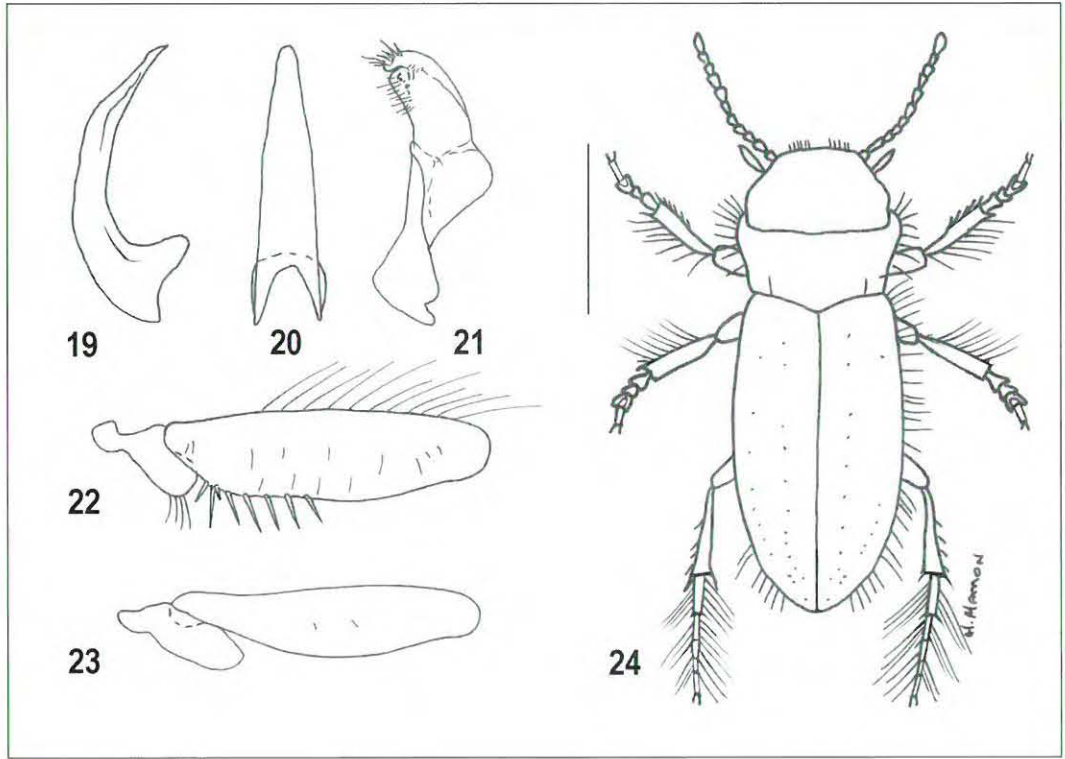
Pronotum. A little narrower than elytra; anteriolateral angles projecting strongly forward; base moderately constricted, posteriolateral angles bluntly pointed, smooth, with sparse, very weak punctures and a few stronger punctures along front margin; basal plicae weak, strongly slanting inwards, reaching to about half way along pronotum; with row of long setae laterally in anterior half.

Elytra. Not fused but tightly closed, lacking inner ridges; widest behind middle, smooth, very weakly reticulate, sparsely covered with very small

punctures, row of long setae near lateral edge, a few additional larger punctures with long setae, more frequent towards sides. Epipleuron well differentiated from rest of elytra, moderately wide in anterior fifth, virtually absent along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, apical half elongate triangular, sides subparallel, rapidly narrowing to small blunt point posteriorly, strongly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact at midline. Metathorax triangular in front in midline; wings narrow; broadly rounded in midline behind. Metacoxal plates large, very weakly reticulate, metacoxal lines obsolete; a few small setae-bearing punctures towards midline; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct except in lateral fifth, ventrites 3 to 5 mobile, sparsely covered with small seta-bearing punctures, ventrites 3 and 4 with a long central seta or bunch of long setae.

Legs. Protibia triangular, relatively narrow, widest



Figs 19-24. *Tjirtudessus padburyensis*: 19, lateral view of central lobe of aedeagus; 20, ditto dorsal view; 21, paramere; 22, mesotrochanter and mesofemur; 23, metatrochanter and metafemur; 24, dorsal view. Scale bar represents Imm (habitus only).

near apex where it is about three times its basal width; protarsus expanded, segment 1 as broad as long, segment 2 as wide as segment 1 and about half its length, segment 3 as long as segment 1 much narrower, deeply bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about 1.5x length of segment 3, segments 1 to 3 with dense covering of adhesive setae; claws moderately long, simple. Mesotrochanter elongate/oval with a few thin setae on inner edge; mesofemur with 5 to 6 spines in basal half, basal two close together (Fig.10); mesotarsus similar to protarsus. Metatrochanter weakly pointed (Fig.11); metafemur relatively thin, lacking spines; metatibia narrow, curved, widening towards apex; metatarsus elongate, segment 1 longest, segment 5 longer than segment 4, segments 1 and 2 in combination about as long as others; claws weak.

Male

Little external difference between sexes. Median lobe of aedeagus variable in width along shaft, tip bluntly pointed; paramere broad, apical segment

with long, narrow, apical lobe well separated from rest of segment. Figs 7-8.

Etymology

Latin. 'Oculus'- eye, 'micro'- small. A reference to the small eyes in this species.

Remarks

Tjirtudessus microocula appears to be in an earlier stage of adaptation to an underground environment than the other stygal Dytiscidae previously recorded in Australia (with the exception of *Boongurrus occidentalis*, which is certainly not an obligate stygobiotic). The eyes are only about a fifth the size of those in epigeal members of the genus and do not seem to be organised into individual ommatidia. It is hard to envisage them as fully functional. As well as the presence of partial eyes *T. microocula* has wings which are still large enough to require folding and still retain veins, the prosternal process is not deflexed and reaches the metathorax hence separating the mesocoxae as in epigeal species.

Two other specimens, both female and because of that not described, of a much smaller species were collected from the same well. This species also has small remnant eyes, moderately developed wings and a prosternal process that reaches the metathorax. Biochemically they are sister species (Remko Leys pers. com.).

Tjirtudessus padburyensis sp. nov.
FIGS 19-24

Holotype

m. 'BES 9329, Mt Padbury Station, Irrigation Well, site 412, 25° 41' 54" S 118° 05' 29" E, 8/6/02, W. F. Humphreys & R. Leys', WAM 34197. Slide mounted.

Paratypes

5; 1, as for holotype, SAMA; 4, as for holotype except 'BES 9330', 2 WAM 34198 - 34199, 2 SAMA.

Description (number examined, 6)

Habitus. Length 2.5 - 2.7 mm; relatively flat, moderately constricted at junction of pronotum/elytra; elongate oval; uniformly light testaceous; hindwing reduced, about length of elytron.

Head. A little narrower than elytra; smooth, reticulation weak, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant reduced to small semicircular area. Antenna moderately stout, segments 1 and 2 cylindrical, segment 3 as long as segment 2, narrower, narrowing towards base, segments 4 to 10 approximately equal in shape, segment 11 similar to segment 10, each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus, elongate, segment 4 as long as segments 1 to 3 combined.

Pronotum. Same width as elytra; anteriolateral angles projecting strongly forward; base strongly constricted, posteriolateral angles bluntly pointed, overlying elytra somewhat; smooth, reticulation weak, punctures very weak, sparse, a row of stronger punctures along front margin; basal plicae moderate, straight, slightly excavated inwards, reaching to about half way along pronotum; with row of long setae laterally in anterior half.

Elytra. Not fused, lacking inner ridges; elongate, widest behind middle, smooth, very weakly reticulate, sparsely covered with very small punctures, a few widely spaced larger punctures close to inner edge in apical third; a few additional larger punctures with long setae, more frequent towards sides. Epipleuron not differentiated from rest of elytron, that portion of elytron visible

ventrally, relatively broad in anterior third, thin along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, sides subparallel, tip bluntly pointed, strongly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact at midline. Metathorax triangular in front in midline; wings narrow; rounded or slightly triangular in midline behind. Metacoxal plates large, shiny, virtually nonreticulate, metacoxal lines obsolete; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct, ventrites 3 to 5 mobile, sparsely covered with small seta-bearing punctures, ventrites 3 and 4 with a long central seta or bunch of long setae.

Legs. Protibia triangular, relatively narrow, widest near apex where it is about four times its basal width; protarsus expanded, segment 1 as broad as long, segment 2 as wide as segment 1 and about a third its length, segment 3 shorter than segment 1 much narrower, about as wide, bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about 1.5x length of segment 3, segments 1 to 3 with very dense covering of adhesive setae; claws short and simple. Mesotrochanter elongate/rectangular with a few thin setae on inner edge; mesofemur with 6 spines in basal half (Fig. 22); mesotarsus similar to protarsus. Metatrochanter tip rounded (Fig. 23); metafemur relatively thin, lacking spines; metatibia narrow, moderately curved, widening towards apex; metatarsus elongate, segment 1 longest, segment 5 longer than segment 4, segments 1 and 2 in combination about as long as others; claws weak.

Male

Little external differences between the sexes. Median lobe of aedeagus relatively broad, gradually narrowing towards tip, tip rounded; paramere broad, apical segment with short apical lobe overlapping rest of segment. Figs 19-21.

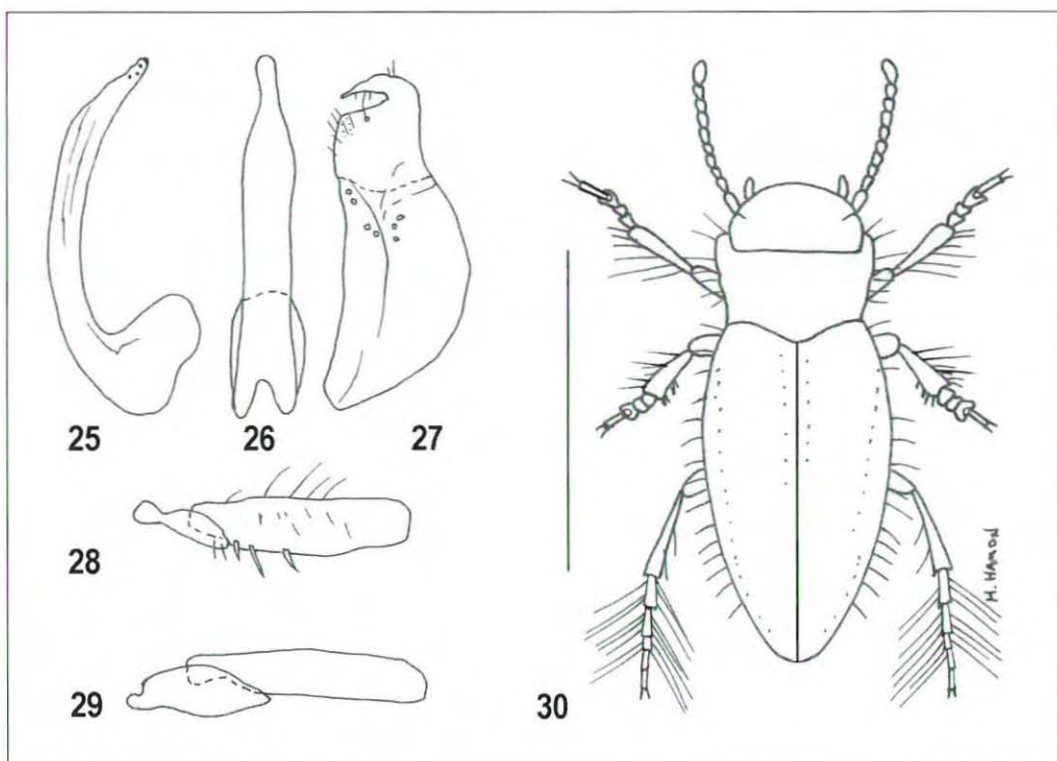
Etymology

Named after the pastoral station on which it was found.

Remarks

A moderately sized very 'average' species with broad tarsi and a complete suture line between ventrites 1 and 2. The unusually small apical lobe to the paramere is shared only with *T. morgani* an otherwise very different species.

Tjirtudessus wogarthaensis sp. nov.
FIGS 25-30



Figs 25-30. *Tjirtudessus wogarthaensis*: 25, lateral view of central lobe of aedeagus; 26, ditto dorsal view; 27, paramere; 28, mesotrochanter and mesofemur; 29 metatrochanter and metafemur; 30, dorsal view. Scale bar represents 1mm (habitus only).

Holotype

m. 'BES 9384, Moorarie Station, Wogartha Well, 25° 57' 58" S 117° 35' 28" E, 12/6/02, W. F. Humphreys & R. Leys', WAM 34200. Slide mounted.

Paratype

1. as for holotype, SAMA.

Description (number examined, 2)

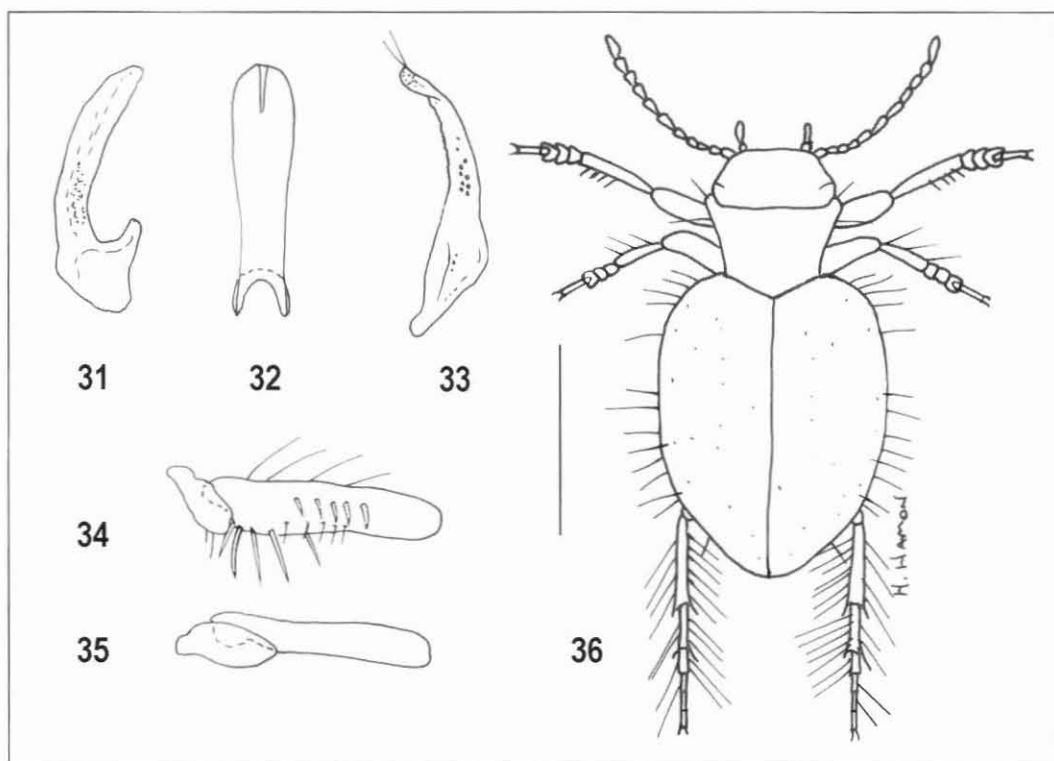
Habitus. Length 1.4 – 1.5 mm; weakly chitinized; relatively flat, moderately constricted at junction of pronotum/elytra; elongate oval; uniformly light testaceous; hindwing vestigial, about one eighth length of elytron.

Head. Considerably narrower than elytra; smooth, reticulation strong, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant reduced to single small suture. Antenna stout, segment 1 cylindrical, segment 2 broader, oval, segment 3 shorter than segment 2, much narrower, narrowing towards base, segments 4 to 8 becoming progressively slightly broader,

segments 9 and 10 a little narrower than segment 8, segment 11 about twice length of segment 10, each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus, elongate, segment 4 as long as segments 1 to 3 combined.

Pronotum. A little narrower than elytra; anteriolateral angles projecting strongly forward; base weakly constricted, posteriolateral angles bluntly pointed, overlying elytra somewhat; smooth, reticulation strong, punctures sparse, very weak, a row of stronger punctures along front margin; basal plicae absent; with row of long setae laterally in anterior half.

Elytra. Not fused, tightly closed, lacking inner ridges; elongate, widest in middle, smooth, strongly reticulate, sparsely covered with very small punctures, row of widely spaced larger punctures close to inner edge; row of long setae near lateral edge, a few additional larger punctures with long setae, more frequent towards sides. Epipleuron indistinctly differentiated from rest of elytra, that portion of elytron visible ventrally relatively narrow, relatively even width until near apex.



Figs 31-36. *Nirridessus arachnoïdes*: 31, lateral view of central lobe of aedeagus; 32, ditto dorsal view; 33, paramere; 34, mesotrochanter and mesofemur; 35 metatrochanter and metafemur; 36, dorsal view. Scale bar represents 1mm (habitus only).

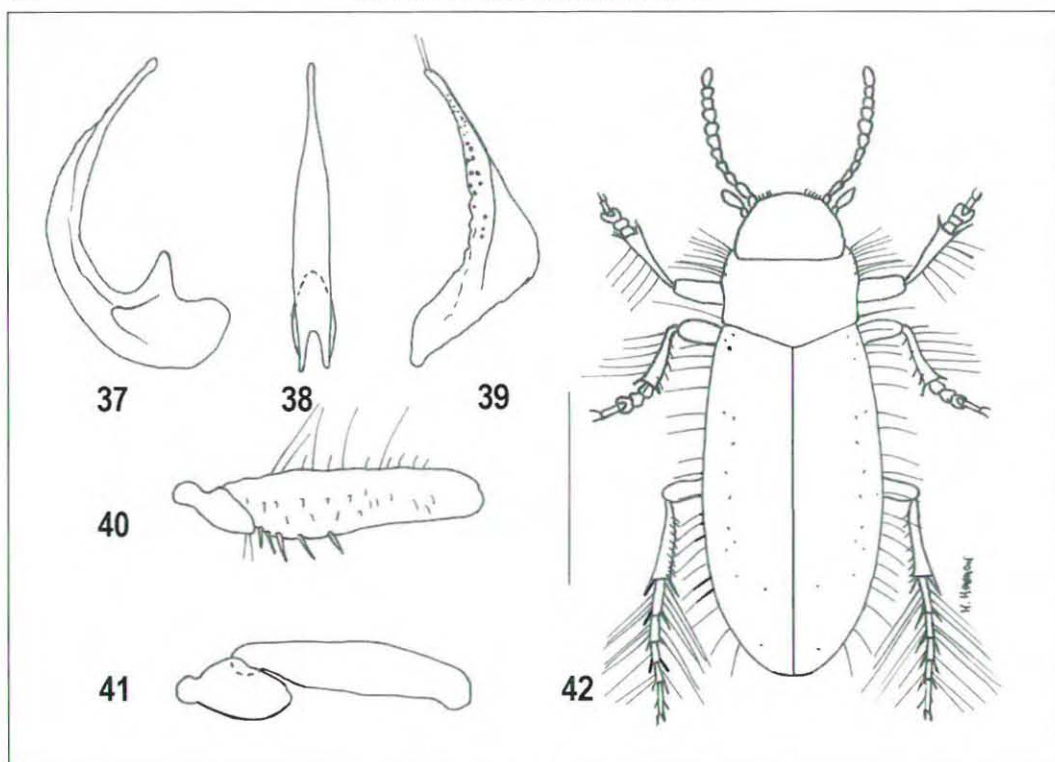
Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, apical half elongate triangular, strongly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact at midline. Metathorax triangular in front in midline; wings narrow; narrowly rounded in midline behind. Metacoxal plates large, strongly reticulate, metacoxal lines indistinct, widely spaced, reaching to about halfway to metasternum, not diverging; a few small seta-bearing punctures towards midline; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct, ventrites 3 to 5 mobile, sparsely covered with small seta-bearing punctures, ventrites 3 and 4 with a long central seta or bunch of long setae.

Legs. Protibia triangular, moderately broad, widest near apex where it is about five times its basal width; protarsus expanded, segment 1 as broad as long, segment 2 as wide as segment 1 and about half its length, segment 3 as long as segment 1, narrower, deeply bifid, segment 4 very small,

hidden within lobes of segment 3, segment 5 narrow, cylindrical, about 1.5x length of segment 3, segments 1 to 3 with dense covering of adhesive setae; claws short and simple. Mesotrochanter elongate/oval with a few thin setae on inner edge; mesofemur with 3 spines in basal half, basal two close together (Fig. 28); mesotarsus more elongate than protarsus, individual segments about half as broad. Metatrochanter tip bluntly pointed (Fig. 29); metafemur relatively stout, lacking spines; metatibia narrow, weakly curved, widening towards apex; metatarsus elongate, segment 1 longest, segment 5 longer than segment 4, segments 1 and 2 in combination about as long as others; claws weak.

Male

Sexes externally similar. Median lobe of aedeagus slightly variable in width along shaft, narrowing to tip which is rounded and slightly twisted; paramere broad, apical segment with relatively short, narrow, apical lobe well separated from rest of segment. Figs 25-27.



Figs 37-42. *Nirripirti bulbus*: 37, lateral view of central lobe of aedeagus; 38, ditto dorsal view; 39, paramere; 40, mesotrochanter and mesofemur; 41 metatrochanter and metafemur; 42, dorsal view. Scale bar represents 1mm (habitus only).

Etymology

Named after the pastoral well in which it was found.

Remarks

A small species recognised by the three spines on the mesofemur, lack of pronotal plicae and with sutural punctures and pointed metatrochanters. The hind wings are the most reduced – to tiny flaps – yet seen in *Tjirtudessus*.

Nirripirti Watts and Humphreys (Hydroporinae: Hydroporini).

Nirripirti arachnoides sp. nov. FIGS 31-36

Holotype

m. 'BES 9367, Byro Station, Yalcallia Well, 25° 54' 39" S 115° 53' 03" E, 10/6/02, W. F. Humphreys & R. Leys', WAM 34201. Slide mounted.

Paratypes

21; 11, as for holotype, 5 WAM 34202 - 34206, 6 SAMA; 10 as for holotype except 'BES 9368', 4 WAM 34207 - 34210, 6 SAMA.

Description (number examined, 22)

Habitus. Length 2.2–2.3 mm; head and pronotum small compared with almost globular elytra, relatively flat, moderately constricted at junction of pronotum/elytra; uniformly light testaceous; hindwing vestigial, reduced to tiny flap.

Head. Small, about a third width of elytra; smooth, moderately strong reticulation with small even meshes, a few scattered small punctures; sides parallel, weakly indented at eye remnant; eye remnant reduced to short suture. Antenna relatively thin, segments 1 and 2 cylindrical, segments 3 to 10 of roughly similar shape but segments 5 to 7 somewhat longer than others, segment 11 thin a little longer than segment 10, each segment with some very small setae on inside apically. Maxillary palpus elongate, segment 4 1.3x as long as segment 3.

Pronotum. Much narrower than elytra;

anteriolateral angles projecting strongly forward; sides sinuate, converging towards rear, posteriolateral angles obtuse; a few scattered minute punctures; long setae laterally, denser towards front; moderately strong reticulation.

Elytra. Not fused, tightly closed, lacking inner ridges; widely oval, widest near shoulders, smooth; covered with fine reticulation; a few scattered small punctures; a few additional larger punctures with long setae, more frequent towards apex, near scutellum and sides. Epipleuron well marked, broad in anterior third, then gradually narrowing to near apex.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, apical half spatulate, strongly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact in midline. Metathorax very sharply triangularly projecting forward in midline; wings short, very narrow; widely rounded in midline behind. Metacoxal plates large, metacoxal lines absent; virtually impunctate; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct in inner two-thirds absent laterally, ventrites 3 to 5 mobile, virtually impunctate except for a few long central setae or bunch of long setae

Legs. Protibia long, narrow, widest past middle where it is about 1.5 x its basal width; protarsus small, weakly expanded, segment 1 broadly triangular, segment 2 about one half length of segment 1, segment 3 longer than segment 1, very deeply bifid, segment 4 very small and hidden within lobes of segment 3, segment 5 cylindrical, about as long as segment 3, segments 1 to 3 with dense covering of adhesive setae; claws short and simple. Mesotrochanter elongate with a few fine setae at apex; mesofemur with row of 5 long spines along hind edge in basal half; mesotibia thin, slightly angular, front edge uneven with long stout setae; mesotarsus more elongate than protarsus (Fig. 34). Metatrochanter roughly oval; metafemur elongate, lacking spines (Fig. 35); metatibia straight, approximately the same width throughout; metatarsus elongate, segment 1 longest, segment 4 shortest; in combination segments 1 and 2 about same length as others, segments 2 to 5 without spines other than at apex; claws weak.

Male

Little external difference between sexes. Central lobe of aedeagus relatively broad, widening slightly towards front. Parameres of average width, tips with two long setae. Figs 31-33.

Etymology

Greek. 'Arachne' – spider. An allusion to its spider-like shape.

Remarks

A very distinctive species readily recognised by its pronounced spider-like shape - small head and pronotum together with large broad body and long thin legs - as well as the five long spines on the mesofemur, angular very spinose mesotibia, unusually thin tarsi, impunctate ventrites, wide epipleura and flanged elytra.

Nirripirti bulbus sp. nov.

FIGS 37-42.

Holotype

m. 'BES 9324, Moorarie Station, bore nr. calcrete quarry, site 419, 25° 52' 26" S 117° 27' 09" E., 8/6/02, W. F. Humphreys & R. Leys', WAM 34211. Slide mounted.

Paratypes

11; 3, as for holotype, SAMA; 8 as for holotype except 'BES 9325', 5 SAMA, 3 WAM 34212 – 34214.

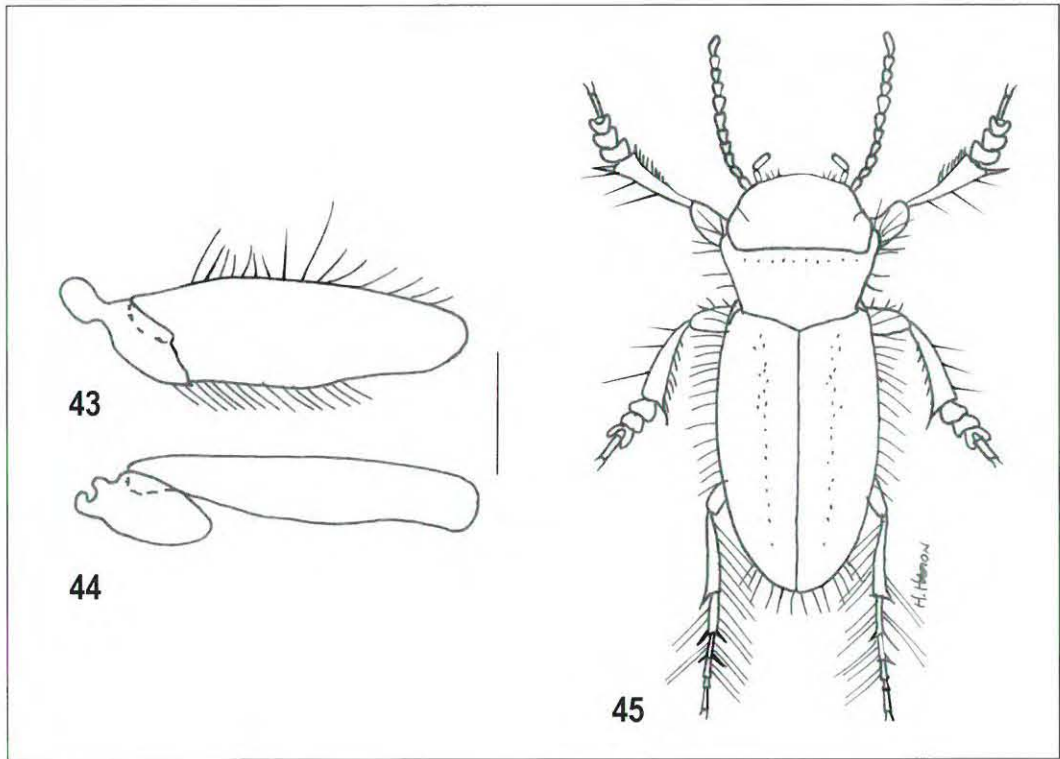
Description (number examined, 12)

Habitus. Length 2.1 – 2.5 mm; narrowly boat-shaped, relatively flat, slightly depressed in sutural region, base of pronotum not constricted; uniformly light testaceous; rather weakly sclerotized; hindwing vestigial, reduced to tiny flap.

Head. Relatively small, much narrower than elytra; smooth, moderately strong reticulation with small even meshes, a few scattered small punctures; sides parallel; eye remnant reduced to short suture line. Antenna relatively thick, segments 1 and 2 cylindrical, about same length, segment 3 about same length but half width of segment 2, segment 4 same shape but a little shorter than segment 3, apex of segment 6 moderately expanded on inside, segments 7 and 8 expanded, almost globular, segments 9 and 10 narrower, segment 11 about 1.3x as long as and thinner than segment 10, each segment with some very small setae on inside apically. Maxillary palpus elongate, segment 4 a little longer than segment 3.

Pronotum. Narrower than elytra; anteriolateral angles projecting forward; sides almost parallel, posteriolateral angles right angles; a few scattered minute punctures and a few larger ones along front edge; moderately strongly reticulate.

Elytra. Not fused, tightly locked, lacking inner ridges; elongate, parallel sided, smooth; covered with relatively strong, regular reticulation; a few scattered small punctures; a few additional larger punctures with long setae, more frequent towards apex and sides. Epipleuron not differentiated, that portion of elytron visible ventrally broad, of even width along most of elytron except close to apex.



Figs 43-45. *Nirripiriti byroensis*: 43, mesotrochanter and mesofemur; 44 metatrochanter and metafemur; 45, dorsal view. Scale bar represents 1mm (habitus only).

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, apical half spatulate, strongly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact in midline. Metathorax weakly projecting forward in midline; wings very narrow; widely triangular behind, apex blunt. Metacoxal plates large; metacoxal lines absent; virtually impunctate, evenly covered with moderately strong reticulation; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct in inner half, absent laterally, ventrites 3 to 5 mobile, virtually impunctate except for a few long central setae or bunch of long setae.

Legs. Protibia narrow, widest past middle where it is about twice its basal width; protarsus weakly expanded, segment 1 broadly triangular, segment 2 about one half length of segment 1, segment 3 as long as segment 1, deeply bifid, segment 4 very small and hidden within lobes of segment 3, segment 5 stout, cylindrical, longer than segment 3, segments 1 to 3 with dense covering of adhesive setae; claws short and simple. Mesotrochanter elongate with a few fine setae at apex; mesofemur with row of 4 to 5

spines along hind edge in basal half, basal two close together, edge slightly indented between spines (Fig. 40); mesotarsus more elongate than protarsus. Metatrochanter relatively large, apex weakly pointed (Fig. 41); metafemur elongate, lacking spines; metatibia curved, approximately the same width throughout; metatarsus elongate, segment 1 longest, segment 4 shortest; in combination segments 1 and 2 shorter than others, segments 2 to 5 without spines other than at apex; claws weak

Male

Antenna with segments 6 to 8 more strongly expanded than the others and the ventral surface of segments 7 and 8 with a transverse groove at their bases. Tarsi similar in males and females. Central lobe of aedeagus narrow, apical quarter thin, tip rounded. Paramere relatively narrow, inner edge crenulated in basal half, tip with one long seta. Figs 37-39.

Etymology

Latin. 'Bulbus' - swollen. A reference to its swollen antennae.

Remarks

A moderate sized, boat-shaped species with wrap-around elytral epipleurae and antennae with distinctive, swollen, mid-segments in both sexes but more pronounced in the males.

Nirripiriti byroensis sp. nov.
FIGS 43-45

Holotype

f. 'BES 9365, Byro Station, Yalcallia Well, 25° 54' 39" S 115° 53' 03" E, 10/6/02, W. F. Humphreys & R. Leys', WAM 34215. In spirit.

Paratype

1; as for holotype except BES 9366, SAMA.

Description (number examined, 2)

Habitus. Length 3.9 – 4.1 mm; elongate, relatively flat, slightly depressed in sutural region, moderately constricted at junction of pronotum/elytra; uniformly light testaceous; hindwing vestigial, reduced to tiny flap.

Head. Large, slightly narrower than elytra; smooth, moderately strong reticulation with small even meshes, moderately covered with scattered small punctures; sides sloping outwards backwards from antennal bases, then inwards to base; eye remnant reduced to short suture. Antenna moderately thin, segments 1 and 2 cylindrical, about same length, segments 3 and 4 half width and shorter than segment 2, segment 5 bit longer than segment 4, segments 6 to 10 larger, subequal, segment 11 a little longer than segment 10, each segment with some very small setae on inside apically. Maxillary palpus elongate, segment 4 a little longer than segment 3.

Pronotum. Slightly narrower than elytra; anteriolateral angles projecting strongly forward; sides weakly sinuate, converging towards rear, posteriolateral angles obtuse; a few scattered minute punctures and some stronger ones along front edge; reticulation relatively weak.

Elytra. Not fused, tightly closed, lacking inner ridges; elongate, sides almost parallel; smooth; covered with weak fine reticulation; sparsely covered with small punctures; a few additional larger punctures with long setae, more frequent towards apex and sides. Epipleuron moderately differentiated, broad in anterior quarter, then rapidly narrowing to middle, virtually absent along rest of elytron.

Ventral surface. Prosternal process very strongly narrowed between coxae, not reaching mesothorax, apical half spatulate, sharply pointed, strongly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact in

midline. Metathorax sharply triangularly projecting forward in midline; wings relatively broad but short; moderately rounded in midline behind. Metacoxal plates relatively narrow; metacoxal lines obsolete, virtually impunctate, moderately reticulate; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct in inner half, indistinct laterally, ventrites 3 to 5 mobile, virtually impunctate except for scattered shallow punctures; each ventrite with a few long central setae or bunch of long setae; hind edge of ventrite 2 slightly sinuate.

Legs. Protibia relatively narrow, relatively even width, about 3x its basal width; protarsus strongly expanded, segment 1 broad, wider than long, lobes slightly asymmetrical, segment 2 about one half length of segment 1, segment 3 as long as segment 1 but narrower, deeply bifid, segment 4 very small and hidden within lobes of segment 3, segment 5 stout, cylindrical, longer than segment 3, segments 1 to 3 with dense covering of adhesive setae; claws short and simple. Mesotrochanter elongate, laterally compressed, with a few fine setae at apex; mesofemur with row of about 20 short spines along hind edge in basal half (Fig. 43); mesotarsus similar shape but smaller than protarsus. Metatrochanter relatively large, elongate/oval, rounded at apex (Fig. 44); metafemur elongate, lacking spines; metatibia weakly curved, slightly expanded towards apex; metatarsus elongate, segment 1 longest, segment 4 shortest; in combination segments 1 and 2 a little longer than others, segments 2 to 5 without spines other than at apex; claws weak.

Male

Unknown.

Etymology

Named after the pastoral station on which it was found.

Remarks

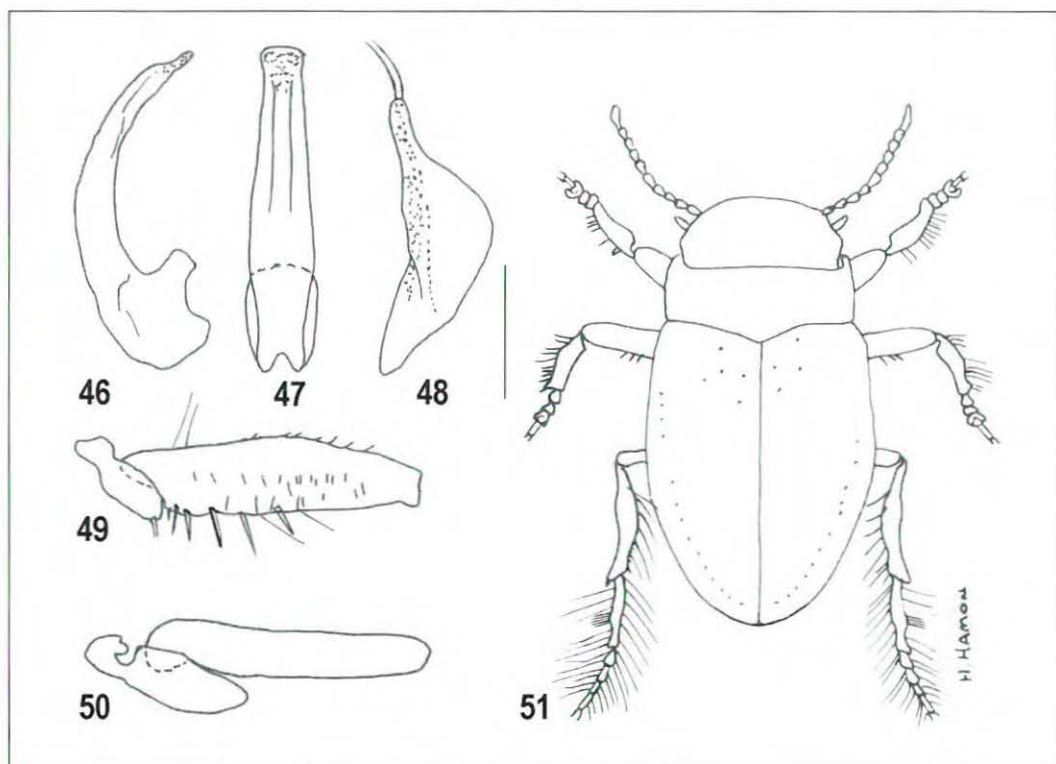
A large, well-chitinized species with thin tibiae but greatly expanded pro and mesotarsi, particularly the basal segments. The expansions are asymmetrical.

Although only two female specimens are known the almost straight, relatively even width of the metatibiae place it in the *Hydroporini*. DNA sequencing places it in a relatively isolated position within *Nirripiriti* (Remko Leys pers com)

Nirripiriti copidotibiae sp. nov.
FIGS 46-51

Holotype

m. 'BES 9335, Innouendy Station, mineral expl. bore, site 431, 25° 49' 19" S 116° 11' 29" E, 9/6/02,



Figs 46-51. *Nirripiri copidotibiae*: 46, lateral view of central lobe of aedeagus; 47, ditto dorsal view; 48, paramere; 49, mesotrochanter and mesofemur; 50, metatrochanter and metafemur; 51, dorsal view. Scale bar represents 1mm (habitus only).

W. F. Humphreys & R. Leys', WAM 34216. Slide mounted.

Paratype

1; m. ditto except BES 8808, 11/4/03, SAMA

Description (number examined, 2)

Habitus. Length 3.2 mm; elongate, relatively flat, slightly depressed in sutural region, not constricted at junction of pronotum/elytra but base of pronotum narrower than elytra; uniformly light testaceous; hindwing vestigial, reduced to tiny flap.

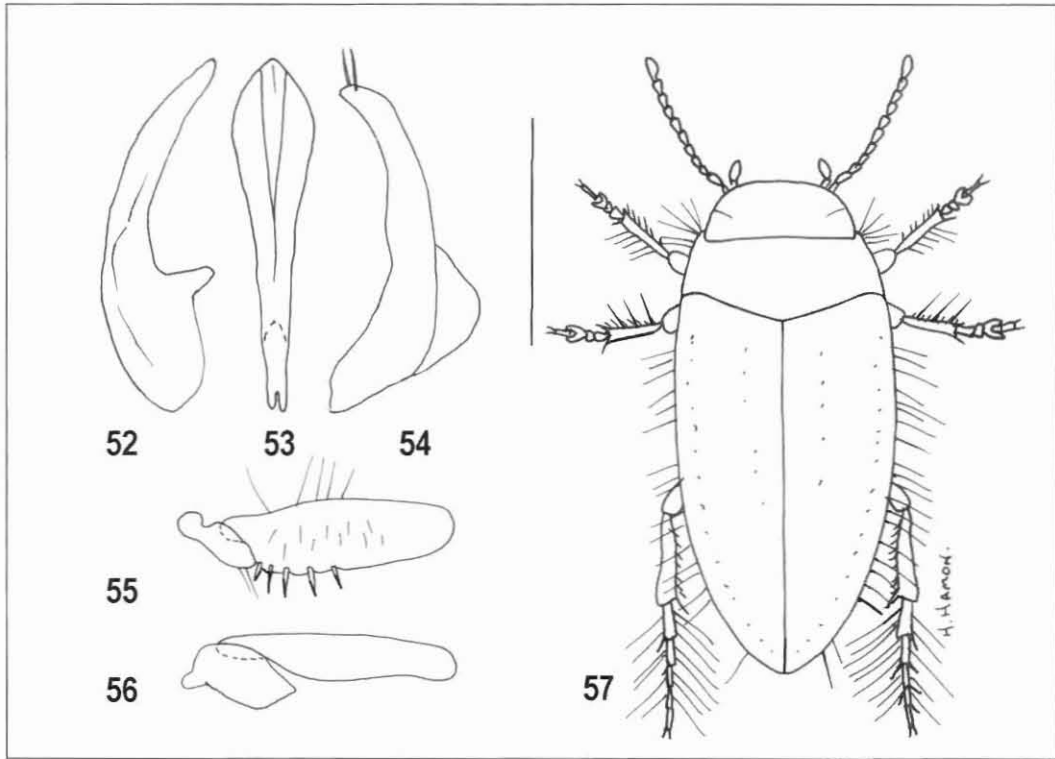
Head. Relatively broad, a little narrower than elytra; smooth, moderately strong reticulation with small even meshes, a few scattered small punctures; sides parallel; eye remnant reduced to short suture. Antenna relatively thin except for expanded segments 6 and 7, segment 1 cylindrical, segment 2 about same length, a little constricted basally, segments 3 and 4 half width and length of segment 2, segments 5 to 7 moderately expanded, segments 8 to 10 thinner, subequal, segment 11 about as long as segment 10, a little narrower, each

segment with some very small setae on inside apically. Maxillary palpus elongate, segment 4 a little longer than segment 5.

Pronotum. Narrower than elytra; anteriolateral angles projecting strongly forward; sides subparallel, posteriolateral angles obtuse; a few scattered minute punctures and some larger ones along front edge; reticulation moderately strong.

Elytra. Properly not fused, lacking inner ridges; elongate, nearly parallel sided, smooth; covered with moderately strong fine reticulation; a few scattered small punctures, a few additional larger punctures with long setae, more frequent towards apex and sides. Epipleuron moderately distinct, broad at base rapidly narrowing in anterior quarter, virtually absent along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, apical half spatulate, apex pointed, very strongly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact in midline. Metathorax projecting forward in midline; wings virtually absent; widely rounded in midline



Figs 52-57. *Nirripiriti dingbatensis*: 52, lateral view of central lobe of aedeagus; 53, ditto dorsal view; 54, paramere; 55, mesotrochanter and mesofemur; 56, metatrochanter and metafemur; 57, dorsal view. Scale bar represents 1mm (habitus only).

behind. Metacoxal plates large, metacoxal lines short, indistinct, area between them and forward onto mesosternum depressed forming a large distinct midline groove; virtually impunctate, moderately reticulate; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct in inner two-thirds, absent laterally, ventrites 3 to 5 mobile, virtually impunctate except for a few long central setae or bunch of long setae.

Legs. Protibia relatively broad, widest in middle where it is about 5x its basal width, laterally compressed, almost blade-like; profemur with distinct, thin, dorsal portion near apex covering base of protibia; protarsus moderately expanded, segment 1 broadly rectangular, segment 2 about one half length of segment 1, segment 3 as long as segment 1, deeply bifid, segment 4 very small and hidden within lobes of segment 3, segment 5 stout, laterally compressed, about as long as segment 3, segments 1 to 3 with dense covering of adhesive setae; claws short and simple. Mesotrochanter elongate, laterally compressed with a few fine setae at apex; mesofemur with row of 6 strong

spines along hind edge in basal half (Fig. 49); mesotibia with large blade-like structure on ventral side near apex; basal segment of mesotarsus strongly expanded, other segments a little more elongate than protarsus. Metatrochanter relatively large, basal two thirds narrow, parallel sided, apical portion narrowing to blunt point, deflexed dorsally (Fig. 50); metafemur elongate, lacking spines; metatibia relatively broad, weakly curved, approximately the same width throughout except much narrower near base; metatarsus relatively stout, basal segment very long, nearly as long as length of other segments combined, with distinctive comb of 4 to 5 spines on outside, segments 2 to 5 short, about same length, segments 2 and 3 much wider than others, all segments with very strong spines; claws weak.

Male

Female unknown. Central lobe of aedeagus relatively broad, slightly wider at tip. Paramere relatively broad, tip with two long setae. Figs 46-48.

Etymology

Latin. 'Copsis' – knife. In reference to the sharp raised ridge on the protibia.

Remarks

A medium sized species immediately recognised by the highly modified legs. The pro and mesotibiae are enlarged and angular, particularly the mesotibiae, with blade-like extensions on the inside. The metatarsi have a greatly elongate first segment which has the spines which are usually found evenly spaced along the outside edge grouped tightly together near the middle. Another unique character is the distinct midline groove on the ventral surface of the thorax. Although only one male is known it is unlikely that all of these distinctive characteristics are restricted to males.

Nirripiriti dingbatensis sp. nov.

FIGS 52-57

Holotype

m. 'BES 9347, Innouendy Station, Dingbat Well, 25° 52' 32" S 115° 53' 43" E, 10/6/02, W. F. Humphreys & R. Leys', WAM 34217. Slide mounted.

Paratypes

3; 1, as for holotype, SAMA, 2, as for holotype except 'BES 9346', SAMA.

Description (number examined, 4)

Habitus. Length 2.0–2.2 mm; elongate, relatively flat, not constricted at junction of pronotum/elytra; uniformly light testaceous; hindwing vestigial, reduced to tiny flap.

Head. Relatively small, much narrower than elytra; smooth, rather weak reticulation with small even meshes, a few scattered small punctures; sides parallel; eye remnant reduced to short suture. Antenna moderately thick, segments 1 and 2 cylindrical, segments 3 and 4 half width and length of segment 2, segment 5 bit longer than segment 4, segments 6 to 10 larger, subequal, segment 11 1.5x length of segment 10, each segment with some very small setae on inside apically. Maxillary palpus elongate, segment 4 a little longer than segments 2 and 3 combined.

Pronotum. Narrower than elytra; anteriolateral angles projecting forward; sides diverging towards the rear, posteriolateral angles right angles; a few scattered minute punctures and some larger ones along front margin; long setae at sides particularly towards front; moderately strongly reticulate.

Elytra. Not fused, tightly locked, lacking inner ridges; elongate, widest just behind middle; smooth;

covered with moderately strong fine reticulation; evenly but sparsely covered with small punctures, a few slightly larger punctures with long setae, more frequent towards apex and sides. Epipleuron moderately differentiated, broad in anterior fifth, virtually absent along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, reaching mesothorax, apical half oval, strongly pointed behind, weakly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae not in contact in midline. Metathorax strongly projecting forward in midline; wings very short or absent; broadly rounded in midline behind. Metacoxal plates large, metacoxal lines weak, well separated, weakly diverging in front quarter, reaching to half way to mesosternum; sparsely covered with small punctures, moderately reticulate; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct, ventrites 3-5 mobile, strongly reticulate with scattered small punctures and a few long central setae or bunch of long setae.

Legs. Protibia narrow, widest near apex where it is about twice its basal width; protarsus weakly expanded, segment 1 broadly triangular, segment 2 a little smaller, segment 3 as long as segment 1, deeply bifid, segment 4 very small and hidden within lobes of segment 3, segment 5 stout, cylindrical, longer than segment 3, segments 1 to 3 with dense covering of adhesive setae; claws short and simple. Mesotrochanter elongate with a few fine setae at apex; mesofemur with row of 4 to 5 spines along hind edge in basal half (Fig. 55); mesotarsus a little more elongate than protarsus. Metatrochanter with apex weakly pointed, tip close to metafemur (Fig. 56); metafemur relatively stout, lacking spines; metatibia weakly curved, weakly expanded towards apex; metatarsus elongate, segment 1 longest, segment 4 shortest, in combination segments 1 and 2 shorter than others, segments 2 to 5 without spines other than at apex, segments 2 to 4 weakly hour-glass shaped; claws weak.

Male

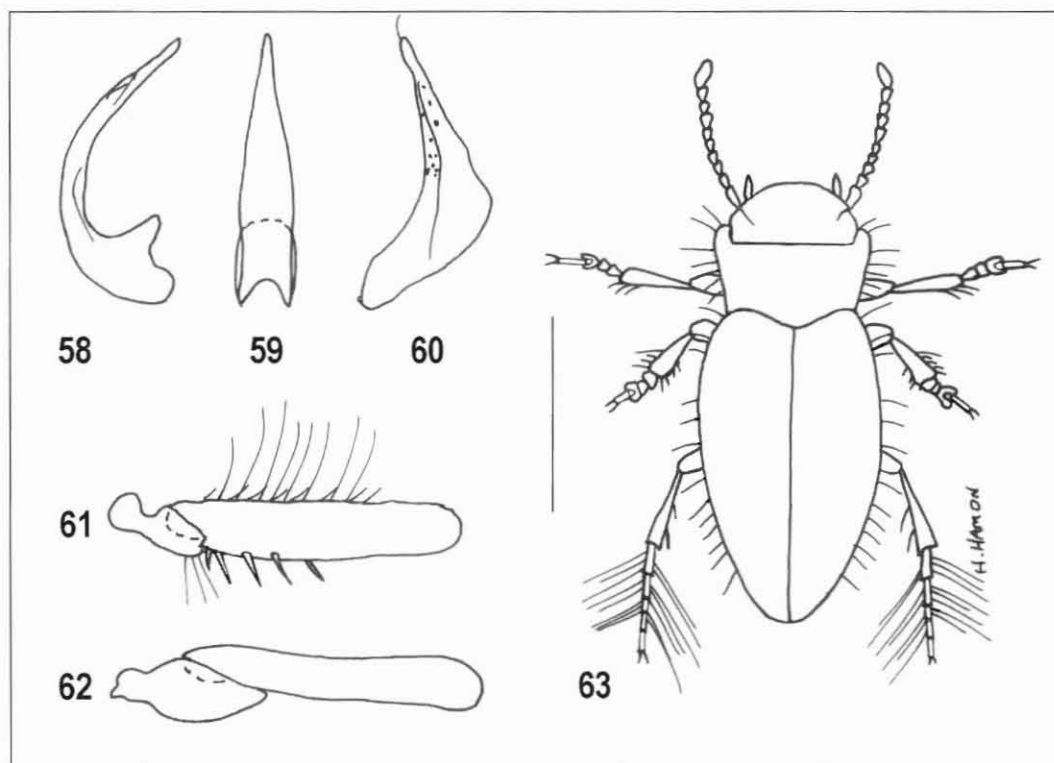
Antenna and protarsi slightly more expanded than in female. Central lobe of aedeagus broad, widening towards apex; paramere relatively narrow, tip with two long setae. Figs 52-54.

Etymology

Named after the well in which it was found.

Remarks

A medium sized species with weakly expanded tarsi and strongly pointed but weakly arched prosternal process. In morphology close to *N.*



Figs 58-63. *Nirripiri eurypleuron*: 58, lateral view of central lobe of aedeagus; 59, ditto dorsal view; 60, paramere; 61, mesotrochanter and mesofemur; 62, metatrochanter and metafemur; 63, dorsal view. Scale bar represents 1mm (habitus only).

innouendyensis and *N. skaphites* but with different prosternal process, different metatrochanters, thinner antennae and broad aedeagus.

Nirripiri eurypleuron sp. nov.
FIGS 58-63

Holotype

m. 'BES 9385, Moorarie Station, Wogartha Well, 25° 57' 58" S 117° 35' 28" E, 12/6/02, W. F. Humphreys & R. Leys', WAM 34218. Slide mounted.

Paratype

m. ditto except BES 8856, 16/4/03, SAMA.

Description (number examined, 2)

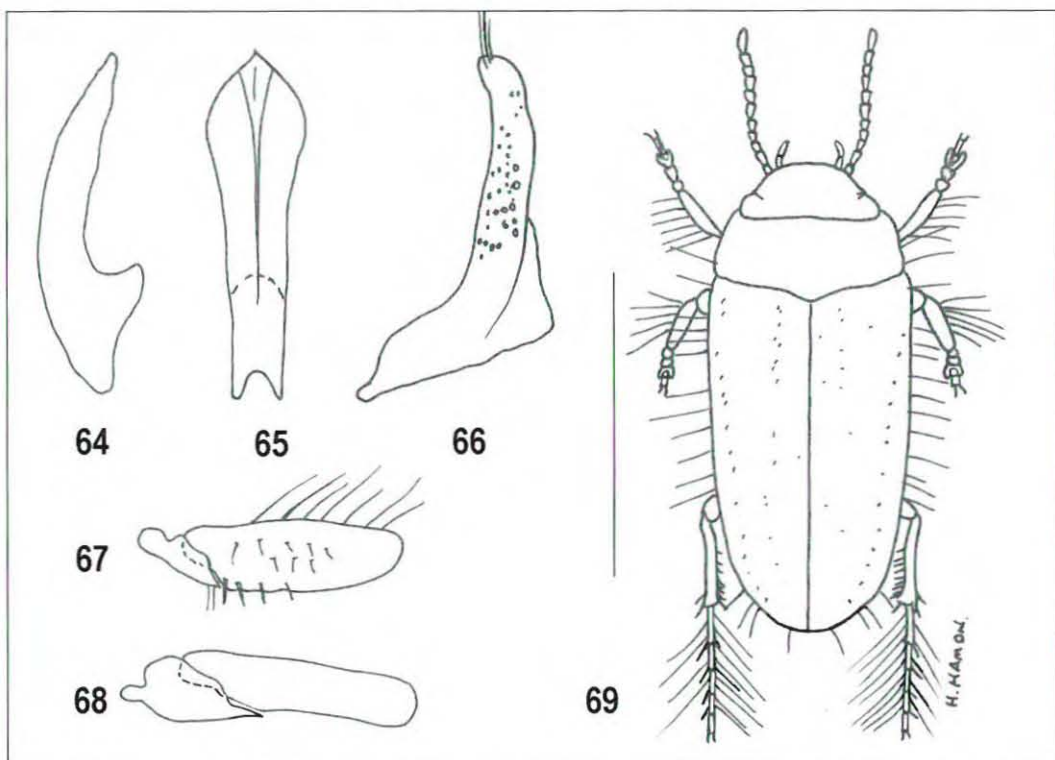
Habitus. Length 2.3 mm; narrowly elongate, relatively flat, slightly depressed in sutural region, pronotum much narrower than elytra, not constricted at base; uniformly light testaceous; hindwing vestigial, reduced to tiny flap.

Head. Relatively small, much narrower than elytra;

smooth, moderately strong reticulation with small even meshes, a few scattered small punctures; sides weakly indented at position of eye remnants; eye remnant reduced to very short suture. Antenna relatively stout, segment 1 cylindrical, segment 2 about same length, more oval, segment 3 half width and shorter than segment 2, segments 4 to 6 subequal in length becoming progressively slightly wider, segments 6 to 10 subequal, segment 11 about twice length of segment 10, each segment with some very small setae on inside apically. Maxillary palpus elongate, segment 4 about twice as long as segment 5.

Pronotum. Narrower than elytra; anteriolateral angles projecting strongly forward; sides parallel, posteriolateral angles square, overlapping base of elytra; a few scattered minute punctures and a few relatively large punctures along front edge; strongly reticulate.

Elytra. Possibly fused, lacking inner ridges; strongly elongate, sides parallel, smooth; covered with strong reticulation; a few scattered small punctures, a few additional larger punctures with long setae, more frequent towards apex and sides.



Figs 64-69. *Nirripiri innouendyensis*: 64, lateral view of central lobe of aedeagus; 65, ditto dorsal view; 66, paramere; 67, mesotrochanter and mesofemur; 68, metatrochanter and metafemur; 69, dorsal view. Scale bar represents 1mm (habitus only).

Epipleuron not differentiated, that portion of elytron visible ventrally very broad, broadest at junction of ventrites 2 and 3.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, apical half parallel sided, apex sharply pointed, strongly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact in midline. Metathorax projecting forward in midline; wings very narrow, short; moderately rounded in midline behind. Metacoxal plates relatively narrow, large, metacoxal lines absent; strongly reticulate, virtually impunctate; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct in inner two-thirds, absent laterally, ventrites 3 to 5 mobile; virtually impunctate except for a few long central setae or bunch of long setae.

Legs. Protibia narrow, widest near apex where it is about twice its basal width; protarsus weakly expanded, segment 2 about one half length of segment 1, segment 3 as long as segment 1, bifid, segment 4 very small and hidden within lobes of segment 3, segment 5 stout, cylindrical about twice

length of segment 3, segments 1 to 3 with dense covering of adhesive setae; claws short and simple. Mesotrochanter elongate with a few fine setae at apex; mesofemur with row of 5 spines along hind edge in basal half (Fig. 61); mesotarsus similar to protarsus. Metatrochanter with curved inner edge, apex bluntly pointed (Fig. 62); metafemur elongate, lacking spines; metatibia straight, approximately the same width throughout; metatarsus elongate, segment 1 longest, segment 4 shortest, in combination segments 1 and 2 about same length as others, segments 2 to 5 without spines other than at apex; claws weak.

Male

(Female unknown). Antenna and legs as above. Central lobe of aedeagus narrowing in apical third, tip bluntly pointed. Paramere rather narrow, tip with single seta. Figs 58-60.

Etymology

Greek. 'Eurypleuron' - wide ribbed. In reference to the broad epipleura in this species.

Remarks

Occurs in the same calcrete as *T. wogarthaensis* which apart from the generic differences is much smaller and has narrow elytral epipleurae. A number of species of *Nirripiriti* are now known to have "wrap-around" elytra: *N. stegastos*, *N. skaphites*, *N. killaraensis* and *N. bulbous*. These can be separated by characters given in the key.

Nirripiriti innouendyensis sp. nov.
FIGS 64-69

Holotype

m. 'BES 9339, Innouendy Station, mineral expl. bore site, 431m., 25° 49' 19" S 116° 11' 29" E, 10/6/02, W. F. Humphreys & R. Leys' WAM 34219. Slide mounted.

Paratypes

5; 1, as for holotype, WAM 34220; 1, as for holotype except, 'BES 9334', SAMA; 1, as for holotype except 'BES 9339', SAMA; 1, as for holotype except 'BES 9343, 10/6/03', SAMA; 1, as for holotype except 'BES 9342, 10/6/02', SAMA.

Description (number examined, 5)

Habitus. Length 1.8 – 2.1 mm; elongate, relatively flat, not constricted at junction of pronotum/elytra; uniformly light testaceous; hindwing vestigial, reduced to tiny flap.

Head Much narrower than elytra; smooth, moderate reticulation with small even meshes, a few scattered small punctures; sides parallel; eye remnant reduced to short suture. Antenna moderately thick, segment 1 cylindrical, segment 2 oval, about same length as segment 1, segments 3 and 4 half width and length of segment 2, segment 5 bit longer than segment 4, segments 6 to 10 larger, subequal, segment 11 2x length of segment 10, each segment with some very small setae on inside apically. Maxillary palpus elongate, segment 4 a little longer than segment 3.

Pronotum. Same width as elytra; anteriolateral angles projecting strongly forward; sides diverging slightly towards rear, posteriolateral angles right angles; a few scattered minute punctures and some larger ones alone front edge; moderately reticulate.

Elytra. Not fused, but tightly closed, lacking inner ridges; broad, sides subparallel, smooth; covered with moderately fine reticulation; evenly but sparsely covered with small punctures; a few additional larger punctures with long setae, more frequent towards apex and sides. Epipleuron weakly differentiated, that portion of elytron visible ventrally broad in anterior fifth, virtually absent along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, reaching mesothorax, apical half suboval, tip sharply pointed, in same plane as rest of body. Mesocoxae not in contact in midline. Metathorax strongly projecting forward in midline; wings very short; moderately rounded in midline behind. Metacoxal plates large, metacoxal lines weak, relatively wide, diverging slightly in anterior quarter, reaching to about half way to mesosternum; sparsely covered with scattered very small punctures; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct, ventrites 3 to 5 mobile, with scattered sparse small punctures and a few long central setae or bunch of long setae.

Legs. Protibia narrow, widest near apex where it is about three times its basal width; protarsus weakly expanded, segment 1 broadly triangular, segment 2 about one half length of segment 1, segment 3 as long as segment 1 deeply bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 stout, cylindrical, longer than segment 3, segments 1 to 3 with dense covering of adhesive setae; claws short and simple. Mesotrochanter elongate with a few fine setae at apex; mesofemur with row of 4 evenly spaced spines along hind edge in basal half (Fig. 67); mesotarsus a little more elongate than protarsus. Metatrochanter with basal half broad, apical half elongate produced into long thin point (Fig. 68); metafemur elongate, lacking spines; metatibia curved, approximately same width throughout; metatarsus elongate, segment 1 longest, segment 4 shortest, in combination segments 1 and 2 about same length as others, segments 2 to 5 without spines other than at apex; claws weak.

Male

Little external difference between the sexes. Central lobe of aedeagus broad, widening towards apex. Paramere moderately broad, tip with two long setae. Figs 64-66.

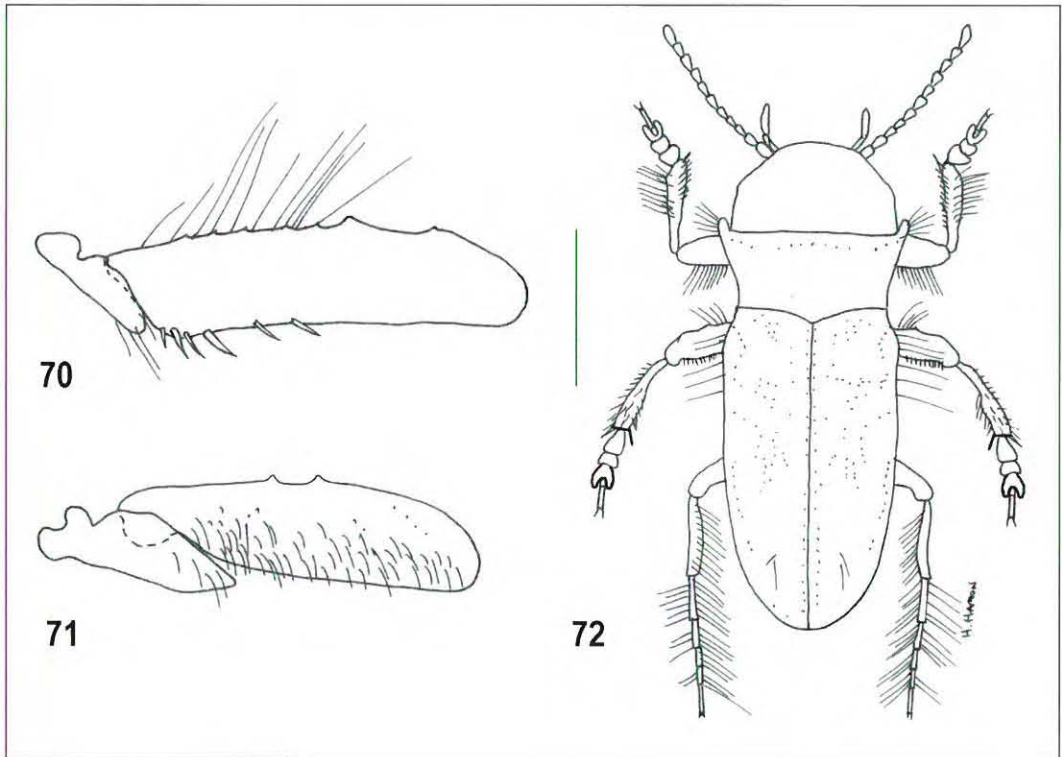
Etymology

Named after the pastoral station on which it was found.

Remarks

A small, parallel sided, species readily recognised by the long, sharply pointed metatrochanters. One of the small number of *Nirripiriti* with the prosternal process not arched in ventral view and with the tip reaching the metathorax.

Nirripiriti verrucosus sp. nov.
FIGS 70-72



Figs 70-72. *Nirripiriti verrucosus*: 70, mesotrochanter and mesofemur; 71 metatrochanter and metafemur; 72, dorsal view. Scale bar represents 1mm (habitus only).

Holotype

f. 'BES 9386, Moorarie Station, Wogartha Well, 25° 57' 58" S 117° 35' 28" E, 12/6/02, W. F. Humphreys & R. Leys', WAM 34221. Slide mounted.

Description (number examined, 1)

Habitus. Length 3.2 mm; elongate, relatively flat, slightly depressed in sutural region, weakly constricted at junction of pronotum/elytra; uniformly light testaceous; hindwing vestigial, reduced to tiny flap.

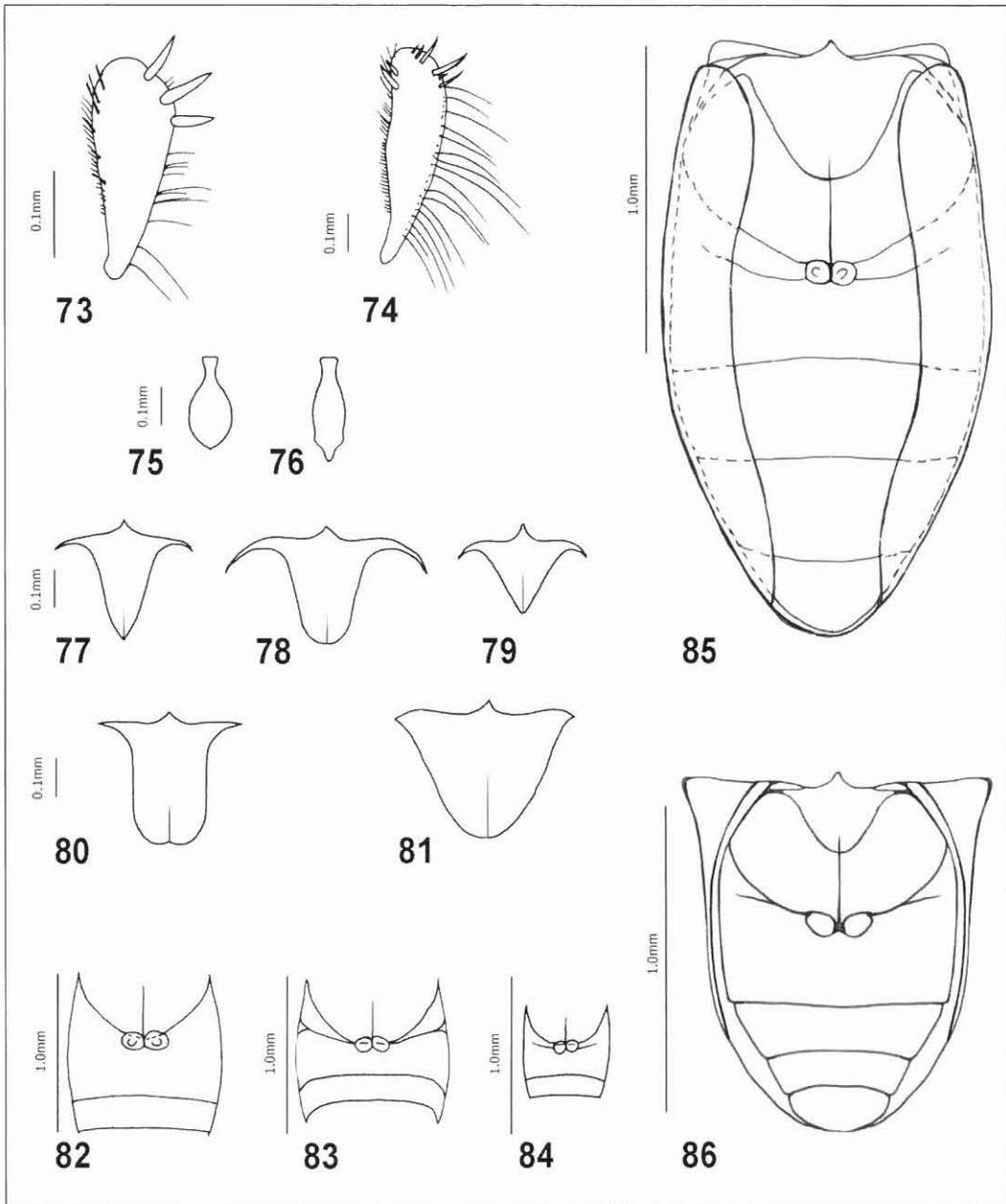
Head. Relatively large, a little narrower than elytra; smooth, moderate reticulation with very small even meshes, a few scattered small punctures; sides weakly concave behind eye remnant; eye remnant reduced to small suture. Antenna with segment 1 cylindrical, segment 2 more oval and about same length as segment 1, segment 3 same width but much narrower than segment 2, segments 4 to 8 progressively wider, segments 9 and 10 a little narrower than segment 8, segment 11 about 1.3x length of segment 10. Maxillary palpus elongate,

segment 4 longer than segment 5.

Pronotum. Slightly narrower than elytra, anteriolateral angles projecting strongly forward, sides narrowing towards rear, base weakly constricted, posteriolateral angles obtuse; a few scattered minute punctures and a few larger punctures near front edge; moderately reticulate with small meshes.

Elytra. Not fused, lacking inner ridges; elongate, almost parallel sided, smooth; covered with rather weak fine reticulation; a moderate number of scattered small shallow punctures, a few additional larger punctures with long setae, more frequent towards apex and sides. Epipleuron weakly differentiated, that portion visible ventrally broad in anterior quarter, then gradually narrowing to middle, virtually absent along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between mesocoxae, not reaching mesothorax, apical half unusually elongate, apex bluntly pointed, strongly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact in midline. Metathorax



Figs 73-86. Illustrations of characters used in the key to species. 73, protibia of *Bidessodes gutteridgei*. 74, ditto *Tjirtudessus padburyensis*. 75-76, Pronotal processes of *T. morgani*; 76 *T. bialveus*. 77-81, Mesosternal plates of; 77, *T. morgani*; 78, *T. pulpa*; 79, *T. bialveus*; 80, *Nirridessus fortisspina*; 81, *N. plutonicensis*. 82-84, ventrites 1-2 or 1-3 of; 82, *T. sweetwatersensis*; 83, *T. challaensis*; 84, *T. masonensis*. 85, Ventral view of abdomen showing wide "wrap-around" epipleura of *N. stegastos*. 86, ditto, *N. hamoni* showing flared shoulders and narrow epipleura.

TABLE 1: *The distribution of stygal species of dytiscids amongst discrete calcrete bodies in Australia.* The separate palaeodrainage systems (Fig. 87) and the Indian Ocean and interior drainages are indicated. Species shown in bold are those treated in this paper. Species underlined occur in more than one calcrete.

Calcrete	Palaeovalley	Species present		
WESTERN DRAINAGES				
1. Cue	Murchison	<i>Tjirtudessus magnificus</i>	<u><i>Tjirtudessus cueensis</i></u>	
2. Austin Downs	Murchison	<u><i>Tjirtudessus cueensis</i></u>	<i>Tjirtudessus bigbellensis</i>	<i>Tjirtudessus</i> sp. 3
3. Challa North	Murchison	<i>Tjirtudessus challaensis</i>	<i>Tjirtudessus</i> sp. 2	
4. Killara	Murchison	<i>Nirripiri killaraensis</i>		
5. Windimurra	Murchison	<i>Tjirtudessus</i> sp 1		
6. Moorarie Bin Bin	Murchison	<u><i>Boongurrus occidentalis</i></u> sp. nov.	<i>Nirripiri bulbus</i> sp. nov.	
7. Killara North	Murchison	<u><i>Boongurrus occidentalis</i></u> sp. nov.		
8. Hillview	Murchison	<i>Tjirtudessus hillviewensis</i> sp. nov.		
9. Mt Padbury	Murchison	<i>Tjirtudessus padburyensis</i> sp. nov.		
10. Moorarie	Murchison	<i>Tjirtudessus wogarthaensis</i> sp. nov.	<i>Nirripiri eurypleuron</i> sp. nov.	<i>Nirripiri verrucosus</i> sp. nov.
11. Innouendy	Murchison	<i>Nirripiri copidotibiae</i> sp. nov.	<i>Nirripiri innouendyensis</i> sp. nov.	
12. Byro West	Murchison	<i>Nirripiri arachnoides</i> sp. nov.	<i>Nirripiri byroensis</i> sp. nov.	<i>Nirripiri dingbatensis</i> sp. nov.
13. Karalundi	Murchison	<i>Tjirtudessus karalundiensis</i>	<i>Nirripiri skaphites</i>	<i>Nirripiri stegastos</i>
14. Three Rivers Station	Gascoyne	<i>Bidessodes gutteridgei</i>	<i>Bidessodes limestoneensis</i>	<i>Nirripiri plutonicensis</i>
15. Milgun Station	Gascoyne	<i>Nirripiri hamoni</i>	<i>Nirripiri milgunensis</i>	
16. Landor Station	Gascoyne			
17. Bunnawarra	Moore	<i>Tjirtudessus microocula</i> sp. nov.	<i>Tjirtudessus</i> sp	
INLAND DRAINAGES				
18. Paroo	Carey	<i>Tjirtudessus eberhardi</i>	<i>Tjirtudessus pulpa</i>	<i>Kintingka kurufutu</i>
19. Lake Violet	Carey	<i>Tjirtudessus wilumaensis</i>		
20. Uramurdah Lake	Carey	<i>Tjirtudessus hahni</i>	<i>Tjirtudessus morgani</i>	
21. Hinkler Well	Carey	<i>Tjirtudessus hinkleri</i>	<i>Tjirtudessus</i> sp.	
22. Mount Windarra	Carey	<i>Tjirtudessus windarraensis</i>	<i>Tjirtudessus lapostae</i>	
23. Melrose Station (Lake Darlot)	Carey	<i>Nirripiri darlotensis</i>	<i>Nirripiri melroseensis</i>	
24. Depot Springs	Raeside	<i>Tjirtudessus fridaywellensis</i>	<i>Nirripiri hinzeae</i>	
25. Pinnacles Stn	Raeside	<i>Tjirtudessus pinnaclesensis</i>	<i>Nirripiri fortisspina</i>	<i>Nirripiri</i> sp 8 ? <i>Nirripiri</i> larvae
26. Lake Mason	Raeside	<i>Tjirtudessus raesideensis</i>	<i>Tjirtudessus masonensis</i>	
27. Yuinmery	Raeside	<i>Tjirtudessus yuimmeryensis</i>		
28. Jundee	Carnegie	<i>Tjirtudessus jundeeensis</i>		
29. Cunyu: Sweetwaters	Nabberu	<i>Tjirtudessus cunyuensis</i>	<i>Tjirtudessus silus</i>	<i>Tjirtudessus sweetwatersensis</i>
30. Cunyu: SBF	Nabberu	<i>Tjirtudessus bialveus</i>	<i>Tjirtudessus macrotarsus</i>	
31. Napperby	Ngalia Basin: N.T.	<i>Nirripiri macrocephalus</i>	<i>Nirripiri napperbyensis</i>	<i>Nirripiri</i> sp NT 7
32. Newhaven	Ngalia Basin: N.T.	<i>Nirripiri newhavenensis</i>	<i>Nirripiri pentameris</i>	<i>Copelatus abditus</i> <i>Nirripiri</i> sp NT 9 and <i>Tjirtudessus</i> sp
33. Central Mount Wedge	Ngalia Basin: N.T.	<i>Nirripiri wedgeensis</i>	<i>Tjirtudessus</i> sp	

33 calcretes 8 palaeodrainages

projecting forward in midline; wings very narrow; moderately rounded in midline behind. Metacoxal plates large, metacoxal lines absent; virtually impunctate; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct in inner two-thirds, absent laterally, ventrites 3 to 5 mobile, virtually impunctate except for a few long central setae or bunch of long setae.

Legs. Protibia distinctly club-shaped, widest towards apex where it is about four times its basal width; protarsus strongly expanded, segment 1 almost square, segment 2 about one half length of segment 1, segment 3 longer than segment 1, deeply bifid, segment 4 very small and hidden within lobes of segment 3, segment 5 stout, cylindrical, about as long as segment 3, segments 1 to 3 with dense covering of adhesive setae; claws short and simple. Mesotrochanter elongate with a few fine setae at apex; mesofemur with row of 5 short spines along hind edge in basal half (Fig. 70), the basal ones closer together, anterior edge uneven with a number of small protuberances, metatibia somewhat club-shaped; mesotarsus considerably more elongate than protarsus. Metatrochanter moderately large, basal half parallel sided apical half triangular, apex blunt, well separated from femur (Fig. 71); metafemur elongate, anterior edge uneven, lacking spines, ventral surface with short setae; metatibia relatively thick, curved, approximately the same width throughout; metatarsus elongate, segment 1 longest, segment 4 shortest; in combination segments 1 and 2 the same length as the others, segments 2 to 5 without spines other than at apex; claws weak.

Male

Unknown.

Etymology

Latin. 'Verrucosus' – full of warts. In reference to the warty edges of the mesofemurs.

Remarks

A large species recognised by the long thin club-shaped pro and mesotibia and the noticeable bumps on the front edge of the mesofemur. In general morphology resembles *N. hinzeae* and *N. darlotensis* but as well as the club-shaped tibiae and warty mesofemurs it has more elongate metatarsi, the prosternal process is much less deflexed and, uniquely among the Australian stygal Dytiscidae, the surface of the metafemurs have a moderate covering of setae (Fig. 71).

Although known only from a single female specimen the relatively straight, even-width, metatibiae place it in the Hydroporini. Mitochondrial DNA places it in an isolated place within *Nirripiriti* (Remko Leys pers. com.).

Discussion

Distribution

Species described herein represent stygal beetles from two palaeodrainage systems, the Murchison and the Moore, both of which drain to the Indian Ocean (Fig. 87); in earlier papers in the series (Watts and Humphreys 1999, 2000, 2001, 2003; Balke et al 2004) we also recorded beetles from palaeodrainage systems which drained to the inland. It brings the number of described stygal Dytiscidae for Australia to 55 species in five genera (*Bidessodes*, *Copelatus*, *Kintingka*, *Nirripiriti* and *Tjirtudessus*). These are derived from 33 discrete groundwater calcrete deposits in eight palaeodrainages representing both coastal and interior drainages. In addition a number of other species that have not been formally described are recognised from larvae and females.

Of the 55 described stygobitic species of Dytiscidae from Australia (*ibid.*), *T. microocula* is the first in which the eyes are not entirely

TABLE 2. *Water quality data for several of the stygal water beetles.* Values are presented for the upper layer of water only through which the beetles need to pass to breathe. The vertical stratification for some deeper bores is shown in Figs 88-90.

Species	Temp. (°C)	pH	Specific conductance (mS cm ⁻¹)	Salinity (TDS mg L ⁻¹)	DO%	DO (mg L ⁻¹)	ORP (mV)	Depth (m)
<i>T. padburyensis</i>	19.81	7.94	2.49	1.28	53.5	4.82	448	0.1
<i>T. hillviewensis</i>	21.07	7.87	1.8	0.91	88.1	7.72	295	0.2
<i>N. dingbatensis</i>	21.54	7.9	15	8.68	57.3	4.77	351	0.3
<i>N. copidotibiae</i>	27.12	7.39	2.54	1.31	82.4	6.5	371	0.3
<i>N. innouendyensis</i>	27.12	7.39	2.54	1.31	82.4	6.53	71	0.3
<i>N. bulbus</i>	25.17	8.53	2.6	1.34	93.8	7.64	346	0.3
<i>N. arachnoides</i>	19.87	8.1	4.88	2.6	72.9	6.51	228	0.1
<i>N. byroensis</i>	19.87	8.1	4.88	2.6	72.9	6.51	228	0.1
<i>B. occidentalis</i>	26.47	7.68	2.47	1.27	54.9	4.36	313	0.1

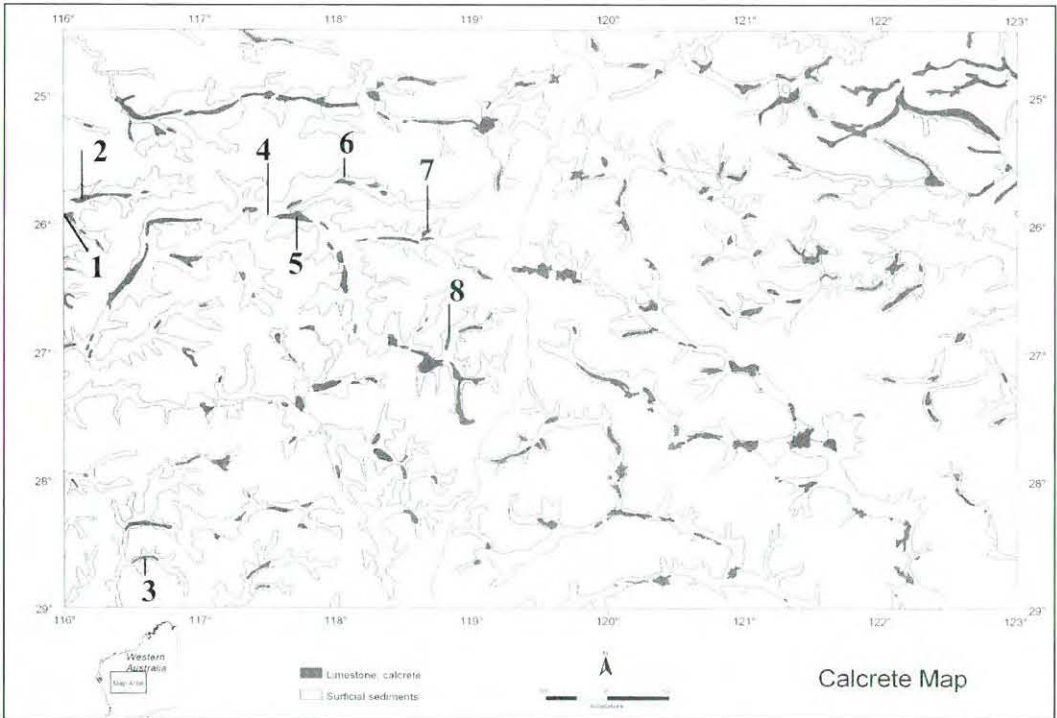


Fig. 87. The distribution of the species discussed in this paper in the groundwater calcrete aquifers of the Yilgarn area of Western Australia. The dark shading denotes groundwater calcrete bodies and the lighter shading the surficial sediments associated with the palaeodrainages incised into the Archaean basement. The calcrete bodies are referred to as 1: Byro; 2, Innouendy; 3, Bunnawarra; 4, Mt. Gould (the Wittenoom population of *B. occidentalis* sp. nov. is 400 km north of this site); 5, Moorarie; 6, Mt. Padbury; 7 Killara North; 8, Hillview. All sites are in the Murchison catchment except Bunnawarra which is in the Moore palaeodrainage. Map based on 1: 2,500,000 *Hydrogeological Map of Western Australia 1989* compiled by D.P. Commander.

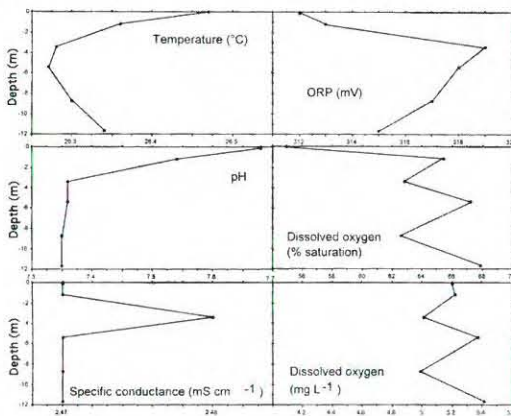


Fig. 88. Depth profiles of several physico-chemical parameters in the bore inhabited by *Boongurrus occidentalis* sp. nov. in an uncapped, never-used water bore in the Killara North calcrete.

reduced, being about one-fifth the size of those in epigeal species and seemingly lacking discrete ommatidia. Most interestingly, an undescribed sister species (determined from DNA) from the same calcrete also retains eye remnants to a similar degree suggesting that this lineage is of more recent evolution to subterranean life than the other stygal members of the genus.

Boongurrus occidentalis sp. nov. is the first clearly epigeal species to be found in deep groundwater in Australia. However, other epigeal species have been recorded from underground habitats: *Copelatus australis* (Clark) from hyporheic systems within river gravels in the Flinders Range, South Australia (Remko Leys, pers. com.) and *C. irregularis* Macleay from small pools of water in the furthest reaches of deep vertical caves in arid Cape Range, northwestern Australia (W.F.H. personal observation).

TABLE 3. Stygofauna recorded from the same calcrete bodies from which the Dytiscidae reported here were collected.

Calcrete	Associated stygal taxa
Bunnawarra	Amphipoda, Ostracoda, Harpacticoida, Cyclopaedia, Annelida
Badja	Oniscidea (Isopoda), crangonytoid and Ceinidae Amphipoda, Cyclopoida, Ostracoda
Killara north	Bathynellacea, crangonytoid and Ceinidae Amphipoda, Harpacticoida, Cyclopoida
Mt Padbury	Bathynellacea, crangonytoid and Ceinidae Amphipoda, Cyclopoida, Ostracoda
Mt Gould	Bathynellacea, Amphipoda
Innouendy	Microturbellara, crangonytoid Amphipoda, Cyclopoida, Ostracoda
Byro	Ostracoda
Moorarie	Amphipoda, Ostracoda, Cyclopoida
Belele	Ostracoda

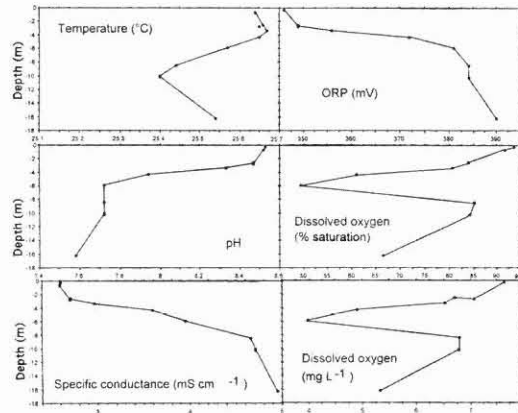


Fig. 89. Depth profiles of several physico-chemical parameters in a capped bore inhabited by *Nirripirti bulbus* sp. nov. and *Boongurrus occidentalis* sp. nov.

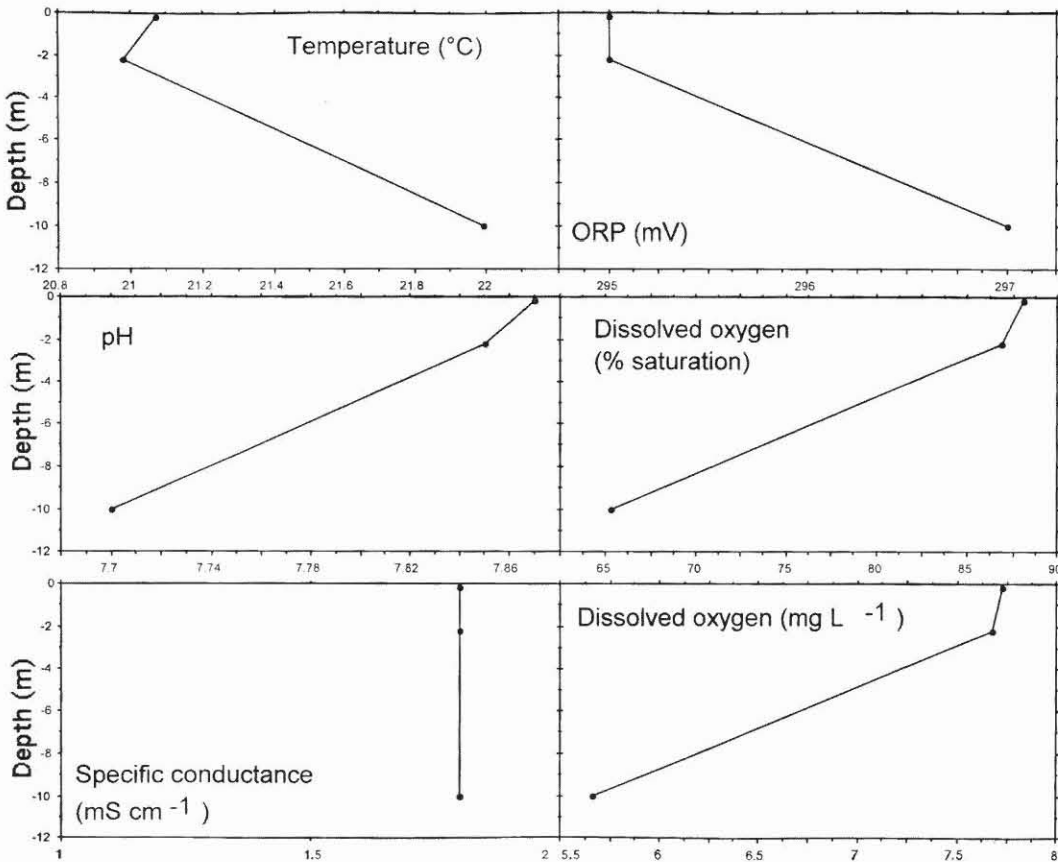


Fig. 90. Depth profiles of several physico-chemical parameters in Camel Well inhabited by *Tjirtudessus hillviewensis* sp. nov. in the Hillview calcrete.

Environment

Groundwater in the arid zone is sometimes markedly stratified in respect of salinity *inter alia* (Watts and Humphreys 2000). However, groundwater characteristics near the water table must be utilised by at least the larger species of stygal beetles, as they need to traverse it to reach free air to breathe. The physico-chemical characteristics of the superficial part of the groundwater at the sites of 9 of the 13 species described herein are given in Table 2. These waters are generally of rather low salinity for the Yilgarn (900-2600 mg L⁻¹ TDS) with the exception of the site for *N. dingbatensis* sp. nov. (Table 2). The latter site, while being part of the Murchison palaeovalley, which now contains the large episodic Murchison drainage, now lies in the separate small drainage of the Wooramel River and showed a much greater salinity (8680 mg L⁻¹ TDS).

Several sampling sites contained sufficiently deep water for profiling. Generally these showed little stratification and the values over which the variables ranged was small (Figs 88 and 90). Only the site occupied by *N. bulbus* sp. nov. exhibited a marked salinity gradient (Fig. 89) and this was accompanied by large changes in pH, redox and oxygen level. In other stratified systems a pronounced nadir in oxygen levels associated with the halocline and the reduction in pH have been associated with a cascade of nitrogen species and sulphur bacteria (Humphreys 1999). The typically high nitrate and sulphate contents of the Yilgarn aquifers potentially could similarly support chemoautotrophic sulphur bacteria, providing a source of energy for the ecosystem

(Humphreys 2001), however, there is no indication from the ORP values that such is the case here and the changes in oxygen level may result from groundwater flow.

Associated fauna

The fauna associated with the stygal beetles is shown in Table 3 at a high taxonomic level. These are likely to represent substantial diversity and many short-range endemics, as has been found in some other taxa in calcretes containing stygal dytiscids where studies have been completed. For example, 31 species of copepods, including five new genera and 23 new species have been described for other calcretes in the Yilgarn (Karanovic 2003). Five new species of *Candonopsis* (Candoninae: Ostracoda) have been described from similar areas, all but one species restricted to a single calcrete area (Karanovic and Marmonier 2002). Finally, four new species of stygal Oniscidea (families Scyphacidae and Philosciidae) have been described from calcretes, three of the species from a single saline calcrete (Taiti and Humphreys 2001).

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