

TWENTY-SIX NEW DYTISCIDAE (COLEOPTERA) OF THE GENERA *LIMBODESSUS* GUIGNOT AND *NIRRIPIRTI* WATTS & HUMPHREYS, FROM UNDERGROUND WATERS IN AUSTRALIA.

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Summary

Twenty-six new species of stygobitic Dytiscidae from inland Western Australia and Central Australia are described: *Limbodessus atypicalis*, *L. barwidgeensis*, *L. cooperi*, *L. exilis*, *L. leysi*, *L. gumwellensis*, *L. harleyi*, *L. macrohinkleri*, *L. millbilliensis*, *L. micrommatoion*, *L. mirandae*, *L. melitaensis*, *L. narryerensis*, *L. nambiensis*, *L. palmulaoides*, *L. phoebeae*, *L. raeae*, *L. surreptitius*, *L. usitatus*, *L. yandalensis*, *Nirripiriti macrosturtensis*, *N. megamacrocephalus*, *N. mesosturtensis*, *N. microsturtensis*, *N. septum* and *N. tetrameres*. This brings the total of stygobitic Dytiscidae described from Australia to 80 species in four genera. A key to the known species of Australian stygobitic Dytiscidae is given as well as notes on the physico/chemical properties of selected collecting sites. Geographically the study reinforced our working hypothesis that stygal Dytiscidae in Australia are confined to two discrete areas; the Ngalia Basin northwest of Alice Springs in Central Australia and the Yilgarn Craton in Central Western Australia.

As in previous years (see Watts & Humphreys 2004) the stygofauna was found, together with a rich stygobitic fauna largely comprising crustaceans, in those portions of shallow aquifers that ran through areas of calcrete formation.

The following new combinations are proposed: *Limbodessus bialveus* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus cunyuensis* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus hillviewensis* (Watts & Humphreys, 2004), (*Tjirtudessus*); *Limbodessus jundeensis* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus karalundiensis* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus macrotarsus* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus microocular* (Watts & Humphreys, 2004), (*Tjirtudessus*); *Limbodessus occidentalis* (Watts & Humphreys, 2004), (*Boongurrus*); *Limbodessus padburyensis* (Watts & Humphreys, 2004), (*Tjirtudessus*); *Limbodessus silus* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus sweetwatersensis* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus wilunaensis* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus wogarthaensis* (Watts & Humphreys, 2004), (*Tjirtudessus*); and *Limbodessus yuinmeryensis* (Watts & Humphreys, 2003), (*Tjirtudessus*).

This is the seventh paper in our series describing the stygobitic Dytiscidae of Australia (Watts & Humphreys 1999, 2000, 2001, 2003, 2004; Balke *et al.* 2004). In it we describe the new species found during fieldwork in Western Australia in the winters of 2003 and 2004.

Key Words: Dytiscidae, Ngalia Basin, stygobites, stygofauna, underground waters, Yilgarn Craton.

Introduction

Twenty new species in the Bidessine genus *Limbodessus* Guignot, and 6 in the Hydroporine genus *Nirripiriti* Watts & Humphreys, are described from both westerly-draining and easterly-draining palaeodrainage systems in the Yilgarn region of Western Australia and from the Ngalia Basin in central Australia.

Recently Balke & Ribera (2004) have revised the genera *Boongurrus* Larson, *Limbodessus* Guignot, *Tjirtudessus* and the Australian members of *Liodessus* Guignot and synonymised them all under *Limbodessus*. We agree with their decision and place all the new Bidessine species in the genus *Limbodessus* as well as formally transferring a number of species described in our recent papers (Watts & Humphreys 2004) (see later under Taxonomic decisions).

Geographically the new finds extend the known distribution of stygal Dytiscidae some 90 kilometres to the north and 150 kilometres to the east. We also recollected sites in the Northern Territory that yielded stygal Dytiscidae in 2001 and discovered several new species and collected new material of poorly known species that enabled their description. In addition, wells and bores along the Gary Junction Road west of Mt Liebig in Central Australia, and the Canning Stock Route south of Well 36 were sampled without finding stygobitic beetles nor much else stygobitic, albeit with very limited access to the groundwater. Calcretes in the area around Lake Carnegie were also sampled without finding any Dytiscidae and only a sparse stygobitic fauna (Bathynellids,

Copepods, Acarina) at the occasional site. The cautionary principle in making pronouncement on stygofauna was reinforced by the later discovery of stygobitic beetles in Jimmys Well north of Lake Carnegie by another researcher (*Limbodessus harleyi* sp. nov.). Although too early to be sure, the results suggest that the Australian stygobitic dytiscid fauna is restricted to inland Western Australian 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 address questions of phylogeny and evolution (Balke *et al.* 2004; Cooper *et al.* 2002; Leys *et al.* 2003) and the taxonomic composition of the rich fauna associated with the beetles (Taiti & Humphreys 2001; Karanovic & Marmonier 2002; Karanovic 2004).

Materials and Methods

For some older material the collection methods and measurements of physico-chemical parameters in the water largely follow those used previously (Watts & Humphreys 2000), whereas for most of the recent material water quality was determined using a Quanta-G (Hydrolab Corporation, Austin, Texas) water quality monitoring system attached to a 50 m cable which 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, as used by Watts & Humphreys (2004). 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; RN = Prefix for bore numbers in the Northern Territory; MEB = Mineral exploration bore; BF = Borefield
Other prefixes are those for the numbering of bores for particular drilling projects.

Systematics

Taxonomic decisions

Following Balke & Riberia (2004) the following new combinations are proposed. *Limbodessus bialveus* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus cunyuensis* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus hillviewensis* (Watts & Humphreys, 2004), (*Tjirtudessus*); *Limbodessus jundeeensis* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus karalundiensis* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus macrotarsus* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus microocular* (Watts & Humphreys, 2004), (*Tjirtudessus*); *Limbodessus occidentalis* (Watts & Humphreys, 2004), (*Boongurrus*); *Limbodessus padburyensis* (Watts & Humphreys, 2004), (*Tjirtudessus*); *Limbodessus silus* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus sweetwatersensis* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus wilunaensis* (Watts & Humphreys, 2003), (*Tjirtudessus*); *Limbodessus wogarthaensis* (Watts & Humphreys, 2004), (*Tjirtudessus*); and *Limbodessus yuinmeryensis* (Watts & Humphreys, 2003), (*Tjirtudessus*).

KEY TO AUSTRALIAN SPECIES OF STYGOBITIC DYTISCIDAE.

This key is an extension of the one in Watts & Humphreys (2004). (*) Indicates that the character is illustrated in that paper.

- 1 — Scutellum well developed; length 4.5 mm *Copelatus abditus* Balke *et al.*
— Scutellum absent; length 1.0 – 4.9 mm.....2

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- 2 (1) — Paramere one-segmented; metatibia approximately the same width throughout; without pronotal plicae (Hydroporini).....53
 — Paramere two-segmented; metatibia narrow at base then strongly expanding towards apex; usually with pronotal plicae (Bidessini).....3
- 3 (2) — With eyes at least a quarter of normal size with some dark pigment4
 — Without eyes, may have a small chitinized triangular or oval plate or suture lines where eyes normally are6
- 4 (3) — Eyes of normal size; with elytral plicae *Limbodessus occidentalis* sp. nov.
 — Eyes approximately one-third normal size; without elytral plicae5
- 5 (4) — Length 1.8 mm; mesocoxae separated..... *Limbodessus micrommatoion* sp. nov.
 Length 2.6 mm; mesocoxae touching.....
 *Limbodessus microocular* Watts & Humphreys
- 6 (3) — Body length approximately 1.0 mm; legs stout, without swimming-hairs on fore and midlegs..... *Kintingka kurutjutu* Watts & Humphreys
 — Body length variable; legs normal, all with swimming-hairs.....7
- 7 (6) — Mesofemur with spines on hind edge approximately the same strength as those on mesotrochanter; length > 3.0 mm44
 — Mesofemur with spines on hind edge much more robust than those on mesotrochanter; length 1.4 – 4.2 mm8
- 8 (7) — Normal ventrites 1 and 2 lacking or virtually lacking suture between them (i.e. number of visible abdominal segments reduced to four) (*)9
 — Ventrites 1 and 2 with suture between them, at least in inner portion (*).....12
- 9 (8) — Length 0.90 – 0.95 mm..... *Limbodessus atypicalis* sp. nov.
 — Length 1.6 – 3.6 mm.....10
- 10 (9) — Length 1.6 – 2.2 mm; pronotal plicae very weak11
 — Length 3.2 – 3.6 mm; pronotal plicae moderately strong.....
 *Limbodessus sweetwatersensis* (Watts & Humphreys)
- 11 (10) — Eye remnant a small triangular area; mesofemur with 4 spines
 *Limbodessus gumwellensis* sp. nov.
 — Eye remnant a single suture; mesofemur with 5 – 6 spines.....
 *Limbodessus leysi* sp. nov.
- 12 (8) — Pronotal plicae strong, well marked, excavated on inside.....13
 — Pronotal plicae weak, difficult to trace, may be absent, not, or only very weakly, excavated on inside17
- 13 (12) — Mesosternum with posterior portion triangular in midline (*).....14
 — Mesosternum with posterior portion rounded in midline (*).....15

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- 14 (13) — Prosternal process rounded at tip (*); tip of metatrochanter pointed; lobe on apical segment of paramere short.....*Limbodessus morgani* (Watts & Humphreys)
- Tip of prosternal process pointed (*); apex of metatrochanter rounded; lobe on apical portion of paramere long*Limbodessus bialveus* (Watts & Humphreys)
- 15 (13) — Head broad, deflexed, metatrochanter round; spines on hind edge of mesofemur long*Limbodessus silus* (Watts & Humphreys)
- With none of above characters 16
- 16(15) — Combined length of first two segments of metatarsus > rest; eye remnant present as small oval or triangular structure; paramere with long apical lobe
.....*Limbodessus pulpa* (Watts & 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 *Limbodessus cunyuensis* (Watts & Humphreys)
- 17 (12) — Elytron with row of large punctures adjacent to suture36
- Elytron without sutural punctures, other than a few weak ones near base 18
- 18 (17) — Eye remnant present as a small oval or triangular structure32
- Eye remnant reduced to one or several short sutures 19
- 19 (18) — Mesofemur with 5 – 7 spines on hind edge in basal half.....20
- Mesofemur with 2 – 3 pro and mesotarsi not expanded *Limbodessus cooperi* sp. nov.
- Length < 2.8 mm; pro and mesotarsi moderately expanded.....21
- 21 (20) — Protibia thick (*); protarsus moderately expanded, mesotarsus less so; mesotibia slightly angular*Bidessodes gutteridgei* Watts & Humphreys
- Protibia thin (*); protarsus and mesotarsus approximately the same size; mesotibia not angular22
- 22 (21) — Length 2.5 – 2.7 mm; suture between ventrites 1 and 2 complete (*).....
..... *Limbodessus padburyensis* sp. nov.
- Length 1.6 – 2.4 mm; suture between ventrites 1 and 2 obliterated laterally (*)
.....23
- 23 (22) — Metafemur relatively stout (Fig.74); pronotal process weakly bulbous
..... *Limbodessus nambiensis* sp. nov.
- Metafemur relatively thin; pronotal process narrowing towards rounded tip 24

- 24 (23) — Aedeagus broadening towards tip (Fig.50)..... *Limbodessus melitaensis* sp. nov.
 — Aedeagus narrowing towards tip25
- 25 (24) — Paramere with lobe as wide as rest of apical segment, flat on top, expanded slightly at tip*Limbodessus masonensis* (Watts & Humphreys)
 — Paramere with lobe shorter than rest of apical segment, rounded on top, tip pointed *Limbodessus yuinmeryensis* (Watts & Humphreys)
- 26 (19) — 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*Limbodessus cueensis* (Watts & 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 – 2.1 mm27
- 27 (28) — Mesofemur with two strong spines on hind edge near base28
 — Mesofemur with three strong spines on hind edge near base29
- 28 (27)— Aedeagus narrowing abruptly to thin beak; apical lobe of paramere large and long *Limbodessus pinnaclesensis* (Watts & Humphreys)
 — Aedeagus narrowing smoothly to blunt point; apical lobe of parameres very small (Figs 62, 63)..... *Limbodessus millbilliensis* sp. nov.
- 29 (28) — Mesofemur with three spines grouped together near base.....
*Limbodessus fridaywellensis* (Watts & Humphreys)
 — Mesofemur with two spines near base and one more distant30
- 30(29) — Pro and mesotibia club-shaped; antenna with middle segments enlarged a little on inside.....*Limbodessus hinkleri* (Watts & Humphreys)
 — Pro and meso tibia elongate/triangular in shape; middle segments of antenna virtually symmetrical.....*Limbodessus karalundiensis* (Watts & Humphreys)
- 31 (18) — Pronotum not constricted at base; prosternal process reaching or almost reaching mesosternum; 1.4 mm long..... *Limbodessus wilunaensis* (Watts & Humphreys)
 — Pronotum moderately constricted at base; prosternal process not reaching mesosternum; 2.1 – 3.2 mm long.....32
- 32 (31) — Mesofemur with 6 spines close to base on hind edge.....
 *Limbodessus bigbellensis* (Watts & Humphreys)
 — Mesofemur with 3 – 7 spines spread out along basal half of hind edge 33
- 33 (32) — Suture line between ventrites 1 and 2 well marked34
 — Suture lines between ventrites 1 and 2 weak (*), usually obsolete in lateral half 35
- 34(33) — Mesofemur with spines short and stout (Fig. 34); pro and mesotarsi weakly expanded; apical lobe of paramere thin, well separated from rest of segment (Fig. 33)*Limbodessus harleyi* sp. nov.
 — Mesofemur with spines moderately long, weak; pro and mesotarsi strongly expanded; apical lobe of paramere broad overlying rest of segment.....
*Limbodessus challaensis* (Watts & Humphreys)

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- 35 (33) — Ventrite 5 constricted towards apex; aedeagus with medial lobe parallel sided, apex not upturned *Limbodessus jundeeensis* (Watts & Humphreys)
 — Ventrite 5 not constricted towards apex; aedeagus with medial lobe distinctly narrower in middle, apex upturned *Limbodessus narryerensis* sp. nov.
- 36 (17) — Eye remnant small but distinct, elongate triangular or oval 37
 — Eye remnant reduced to single short suture 42
- 37 (32) — Metatrochanter with tip slightly pointed (*); sutural lines between ventrites 1 and 2 complete, distinct *Limbodessus hillviewensis* sp. nov.
 — Metatrochanter with tip rounded; suture between ventrites 1 and 2 obliterated laterally 38
- 38 (37) — Mesofemur with 1 spine *Limbodessus raeae* sp. nov.
 Mesofemur with 2 – 7 spines 39
- 39 (38) — Eye remnant large round (Fig. 24): mesofemur with 2 – 4 spines 41
 — Eye remnant relatively small, triangular; mesofemur with 5 – 7 spines 40
- 40 (39) — Mesofemur with 7 spines; mesosternum parallel sided; pro and mesotarsi moderately expanded *Limbodessus phoebeae* sp. nov.
 — Mesofemur with 4 – 5 spines; mesosternum converging in midline; pro and mesotarsi weakly expanded *Limbodessus windarraensis* (Watts & Humphreys)
- 41 (39) — Length 2.7 – 3.1 mm *Limbodessus mirandae* sp. nov.
 — Length 2.4 – 2.5 mm *Limbodessus exilis* sp. nov.
- 42 (36) — Length > 2.0 mm *Limbodessus usitatus* sp. nov.
 — Length < 2.0 mm 43
- 43 (42) — Mesofemur with 3 spines on hind edge (*); metatrochanter elongate
 *Limbodessus wogarthaensis* (Watts & Humphreys)
 — Mesofemur with 5-6 spines on hind edge; metatrochanter rounded
 *Limbodessus lapostae* (Watts & Humphreys)
- 44 (7) — Mesofemur with spines arranged in two comb-like rows along hind edge from base to apex 45
 — Mesofemur with spines on hind edge spaced out, not dense and comb-like 46
- 45 (44) — Pro and mesotarsi with basal segment not larger than other segments
 *Bidessodes limestoneensis* Watts & Humphreys
 — Pro and mesotarsi with basal segment much larger than others
 *Limbodessus barwidgeensis* sp. nov.
- 46 (45) — Pro and mesotarsus with basal segment much more expanded than other segments 47
 — Pro and mesotarsus with basal segment only moderately expanded compared with other segments 49

- 47 (46) — Antenna with segments 8 – 11 noticeably thinner than others, segment 3 longer than segment 2 *Limbodessus magnificus* (Watts & Humphreys)
- Antenna with segments 8 – 10 not noticeably thinner than others, segment 3 same length as segment 2 48
- 48 (47) — Head as wide as elytra; eye remnant small, triangular
..... *Limbodessus macrotarsus* (Watts & Humphreys)
- Head weak, much narrower than elytra; eye remnant virtually absent.....
..... *Limbodessus macrohinkleri* sp. nov.
- 49 (46) — Ventrite 6 clearly visible, extended behind, vase-like (Fig.121).....
..... *Limbodessus yandalensis* sp. nov.
- Ventrite 6 normal, usually not visible, if so, smoothly rounded behind..... 50
- 50 (49) — Pronotum a little narrower than elytra; length 3.5 – 5.0 mm..... 52
- Pronotum as wide or wider than elytra; length 3.2 – 3.5 mm 51
- 51(50) — Basal portion of apical segment of paramere almost as broad as long.....
..... *Limbodessus eberhardi* (Watts & Humphreys)
- Basal portion of apical segment of paramere very short, about 4x as broad as long (Fig.105) *Limbodessus surreptitius* sp. nov.
- 52(50) — Metatrochanter rounded at tip; aedeagus with median lobe straight, tip pointed; eye remnant small..... *Limbodessus raesidensis* (Watts & Humphreys)
- Metatrochanter pointed at tip; aedeagus with median lobe twisted, tip knobbed; without eye remnant *Limbodessus hahni* (Watts & Humphreys)
- 53 (2) — From the Northern Territory 54
- From Western Australia..... 59
- 54 (53) — Protarsus with segment 3 not bilobed; pronotum not constricted at base.....
..... *Nirripiri pentameres* Watts & Humphreys
- Protarsus with segment 3 bilobed; pronotum weakly to moderately constricted at base 55
- 55 (3) — Head short, very broad, strongly deflexed; pronotum strongly narrowed at base; prosternal process anvil-shaped
..... *Nirripiri macrocephalus* Watts & Humphreys
- Head variably shaped, not deflexed, base of pronotum variable; prosternal process “normally” shaped 56
- 56(55) — Length 2.4 mm; head very large, as wide as elytra
..... *Nirripiri megamacrocephalus* sp. nov.
- Length < 2.0 mm; head moderate size, narrower than elytra 57
- 57 (56) — Length 1.8 mm; body well chitinized
..... *Nirripiri napperbyensis* Watts & Humphreys
- Length 1.2 – 1.6 mm; body weakly chitinized 58

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- 58 (57) — Length 1.2 mm; body only slightly constricted at junction of pronotum and elytra
 *Nirripirti wedgeensis* Watts & Humphreys
 — Length 1.5 mm; body quite strongly constricted at junction of pronotum and elytra
 *Nirripirti newhavenensis* Watts & Humphreys
- 59 (58) — Pronotum (and head) about half width of elytra (*)
 *Nirripirti arachnoides* Watts & Humphreys
 — Pronotum > three quarters width of elytra60
- 60 (59) — Pro and mesotarsi 4-segmented *Nirripirti tetrameres* sp. nov.
 — Pro and mesotarsi 5-segmented61
- 61 (60) — Elytron with visible ventral portion extensive except close to apex (*).....62
 — Elytron with visible ventral portion narrow except in basal quarter (*).....66
- 62 (61) — Length 3.6 – 3.8 mm..... *Nirripirti stegastos* Watts & Humphreys
 — Length 1.5 – 2.5 mm.....63
- 63 (62) — Antenna with segments 6 – 8 greatly expanded, much broader than segments 9 and 10
 (*)..... *Nirripirti bulbosus* Watts & Humphreys
 — Antenna with segments 6 – 10 of approximately equal size.....64
- 64 (63) — Meso and metatibia elongate triangular; body strongly boat-shaped, pronotum much
 narrower in front65
 — Meso and metatibia cylindrical; front and rear of pronotum same width (*).....
 *Nirripirti eurypleuron* Watts & Humphreys
- 65 (64) — Length 2.1 – 2.3 mm; metatrochanter with tip sharply pointed.....
 *Nirripirti skaphites* Watts & Humphreys
 — Length 1.5 – 1.9 mm; metatrochanter with tip rounded
 *Nirripirti killaraensis* Watts & Humphreys
- 66 (65) — Antenna with segment 2 larger and more oval than segment 1; 1.2 – 2.1 mm long75
 — Antenna with segment 2 more or less the same shape as segment 1 or smaller; 2.5 –
 3.9 mm long67
- 67 (66) — Mesofemur with row of about 20 closely placed small spines along hind edge (*)
 *Nirripirti byroensis* Watts & Humphreys
 — Mesofemur with 10 or fewer weak to very strong spines along hind edge68
- 68 (67) — Metasternal plate parallel sided (*); mesofemur with 8 – 10 spines, closely placed,
 very strong; metatrochanter long and thin about 4 x as long as wide.....
 *Nirripirti fortisspina* Watts & Humphreys
 — Metasternal plate narrowing towards rear (*); mesofemur with 4 – 8 spines, weak to
 moderately strong; metatrochanter moderately elongate 2-2.5 x as long as wide 69
- 69 (68) — Metatarsus with segment 1 as long as others combined, with confluent group of 5
 strong spines in middle on outside (*).....
 *Nirripirti copidotibiae* Watts & Humphreys

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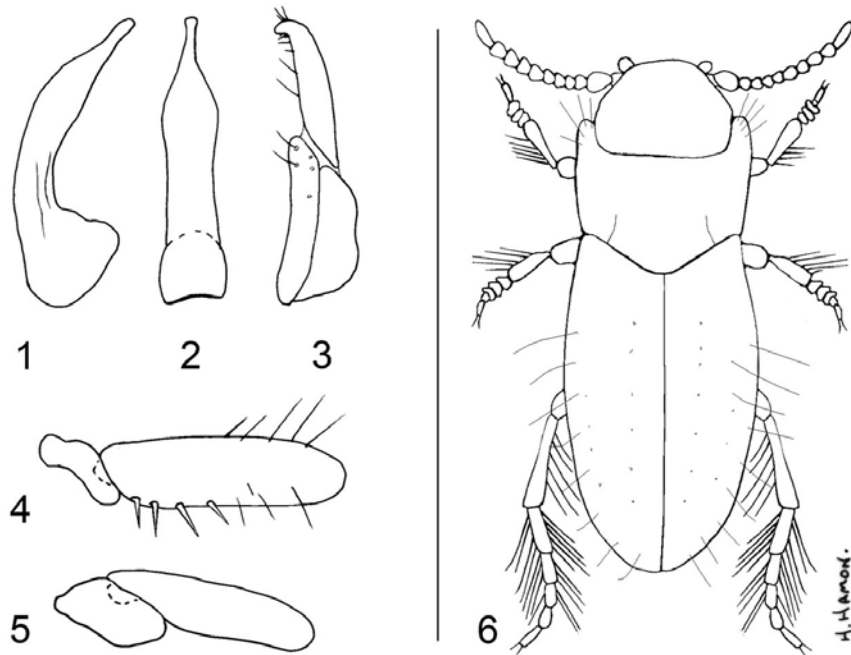
- Metatarsus with segment 1 much shorter than others combined, without confluent group of spines on outside70
- 70 (69) — Metasternal plate without wings (*)...*Nirripiriti plutonicensis* Watts & Humphreys
 — Metasternal wings obvious but short (*)72
- 71 (70) — Mesofemur with 2-4 small lumps on top edge (*).....
 *Nirripiriti verrucosus* Watts & Humphreys
 — Mesofemur with smooth top edge72
- 72 (71) — Mesofemur with moderately strong spines; metacoxal plate nearly reaching mesocoxae73
 — Mesofemur with thin spines; metacoxal plate at least the width of metafemur from mesocoxae.....*Nirripiriti darlotensis* Watts & Humphreys
- 73 (72) — Length 3.6 – 4.1 mm; mesofemur with 7-9 spines on hind margin (Fig. 125).....
 *Nirripiriti macrosturtensis* sp. nov.
 — Length < 3.3 mm; mesofemur with 4-5 spines on hind margin.....74
- 74 (73) — Length 2.8 – 3.0 mm; pronotum with constricted base; antennae not expanded.....
 *Nirripiriti hinzeae* Watts & Humphreys
 — Length 1.8 – 2.4 mm; pronotum with sides sinuate (Fig. 136); antennae in males with greatly expanded middle segments*Nirripiriti mesosturtensis* sp. nov.
- 75 (66) — Elytron with shoulder flared outwards (*) *Nirripiriti hamoni* Watts & Humphreys
 — Elytron with shoulder not flared (*)76
- 76 (75) — Metatrochanter produced into long strong point (*).....
*Nirripiriti innouendyensis* Watts & Humphreys
 — Metatrochanter rounded at most bluntly pointed.....77
- 77 (75) — Protibia distinctly scalloped on inner edge near apex; mesotarsi scalloped on front edge near base..... *Nirripiriti microsturtensis* sp. nov.
 — Protibia and mesotarsi not scalloped78
- 78 (77) — Eye remnant absent; metatrochanter large, squat; hind leg stout; length 1.2 mm ...
 *Nirripiriti milgunensis* Watts & 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 & Humphreys

Descriptions

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

***Limbodessus* Guignot, 1939 (Hydroporinae, Bidessini)**

***Limbodessus atypicalis* sp. nov.**



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

Holotype

♂. 'BES 9936, Newhaven Station, bore RN12787, 22.72519: 131.16636, 24/6/03, col. WF Humphreys & CHS Watts', WAM 38196. Slide mounted.

Paratypes

3; 1, as for holotype, SAMA; 1, 'BES 6681, Newhaven Station NT RN12787 22 43 41S 131 09 59E coll WF Humphreys A. Russ 15/6/01', SAMA; 1, ditto except 'BES 6687 RN15494 22 36 04S 131 14 23E', WAM 38197.

Description (number examined, 4)

Habitus. Length 0.90 – 0.92 mm; relatively flat, weakly constricted at junction of pronotum/elytra; elongate oval; uniformly light testaceous; hindwing seemingly totally lacking.

Head. A little narrower than elytra; smooth, reticulation weak, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant absent or reduced to small suture. Antenna stout, segment 1 broad and barrel-shaped, segment 2 broader, narrower towards base, segment 3 same shape as segment 2 but about one third size, segment 4 a little smaller than segment 3, segments 5 to 10 approximately equal in shape but becoming progressively larger, segment 11 about twice length of segment 10, each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus stout, segment 4 as long as segments 1 to 3 combined.

Pronotum. Relatively long, same width as elytra; anteriolateral angles projecting strongly forward; base broadly constricted, posterolateral angles bluntly pointed, overlying elytra somewhat, hind margin "V"-shaped; smooth, reticulation weak, punctures very weak, sparse, a row of stronger punctures along front margin; basal plicae short very fine.

Elytra. Not fused, lacking inner ridges; elongate, scutellum region well behind humeral angle, 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 weakly differentiated from rest of elytron, that portion of elytron visible ventrally, relatively narrow along most of elytron, becoming broader towards the front.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, sides subparallel, tip rounded, strongly arched in lateral view with highest point (viewed ventrally) between coxae, anterior portion with a number of prominent setae. Mesocoxae in contact at midline. Metathorax triangular in front in midline; wings narrow; "v"-shaped in midline behind. Metacoxal plates large, shiny, virtually nonreticulate, metacoxal lines obsolete; closely adpressed to ventrite 1. Four ventrites (caused by lack of suture line between what would have been ventrites 1 and 2), ventrites 2 to 4 mobile, sparsely covered with small seta-bearing punctures, ventrites 2 and 3 with a long central seta or bunch of long setae.

Legs. Protibia triangular, relatively broad widest near apex where it is about four times its basal width; protarsus weakly expanded, segment 1 about as broad as long, segment 2 narrower than segment 1 and about a half its length, segment 3 similar to segment 1, bifid, segment 4 small, segment 5 narrow, cylindrical, about 1.5x length of segment 3, segments 1 to 3 with a few adhesive setae; claws short and simple. Mesotrochanter elongate/rectangular with a few thin setae on inner edge; mesofemur with 2 to 4 peg-like spines close to base on hind margin (Fig.4); mesotarsus weakly expanded, segments weakly bilobed, segment 4 relatively large. Metatrochanter large, tip rounded, well separated from metafemur (Fig. 23); metafemur broad, lacking spines; metatibia narrow, weakly curved, strongly 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 in apical quarter, tip slightly knobbed; paramere long, thin, apical segment about as long as basal, thin, apex slightly hooked (Figs 1 – 3).

Etymology. Latin. "A- typicalis" – not typical. A reference to the unusual range of morphological characters shown by this species.

Remarks

The smallest stygal beetle yet discovered, *L. atypicalis* is also unusual in its clearly five-segmented pro and mesotarsi, complete absence of a suture line between what are normally ventrites 1 & 2, and parameres which have an apical segment (Fig. 3) unlike that normally found in other species of *Limbodessus*. Without the DNA sequence data placing it in an isolated position but within *Limbodessus* (R. Leys pers. comm.) we would hesitate to include it in the genus.

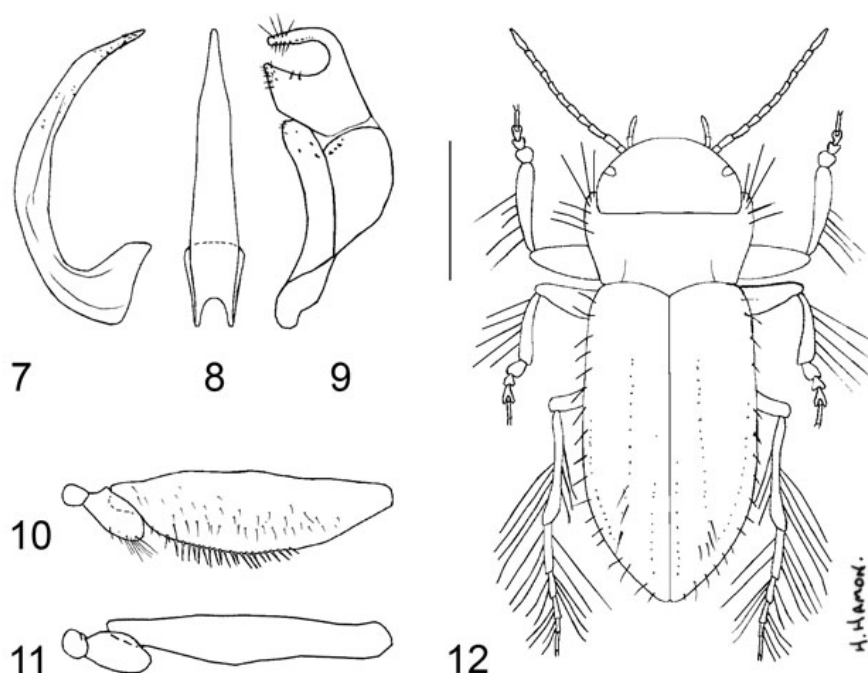
Limbodessus barwidgееnsis sp. nov.

Holotype

♂. 'BES 10379, Barwidgee Station, MEB Site 144, 27.13760; 120.94633, 25/3/04, WFHumphreys & SJB Cooper', WAM 38198. Slide mounted.

Description (number examined, 1)

Habitus. Length 4.4 mm; relatively flat, moderately constricted at junction of pronotum/elytra; elongate; uniformly light testaceous; hindwing reduced, about half length of elytron.



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

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 a confused area of short suture lines. Antenna thin, segments 1 and 2 cylindrical, segment 3 a little longer than segment 2, narrower, narrowing weakly towards base, segments 4 to 10 approximately equal in shape, becoming progressively shorter, segment 11 narrower than and 2x length of segment 10, each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus elongate, segment 3 as long as segment 4.

Pronotum. Relatively short same width as elytra; anteriolateral angles projecting strongly forward; base moderately constricted, posterolateral angles bluntly pointed, overlying elytra somewhat; smooth, reticulation weak, punctures very weak, sparse, a few stronger punctures towards front; basal plicae absent or very weak; 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 quarter, thin along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae (apex broken off in specimen). 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 present indistinct laterally, 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, narrow, widest near apex where it is about 3x its basal width; protarsus expanded, segment 1 broader than long, segment 2 much narrower than segment 1 and about a quarter its length, segment 3 shorter than segment 1 much narrower, 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 number of thin setae on inner edge at apex; mesofemur with 20 – 25 spines in basal two-thirds (Fig. 10); mesotarsus similar in shape but a little longer than protarsus. Metatrochanter oval, relatively small, tip rounded (Fig. 23); metafemur thin, lacking spines; metatibia very 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.

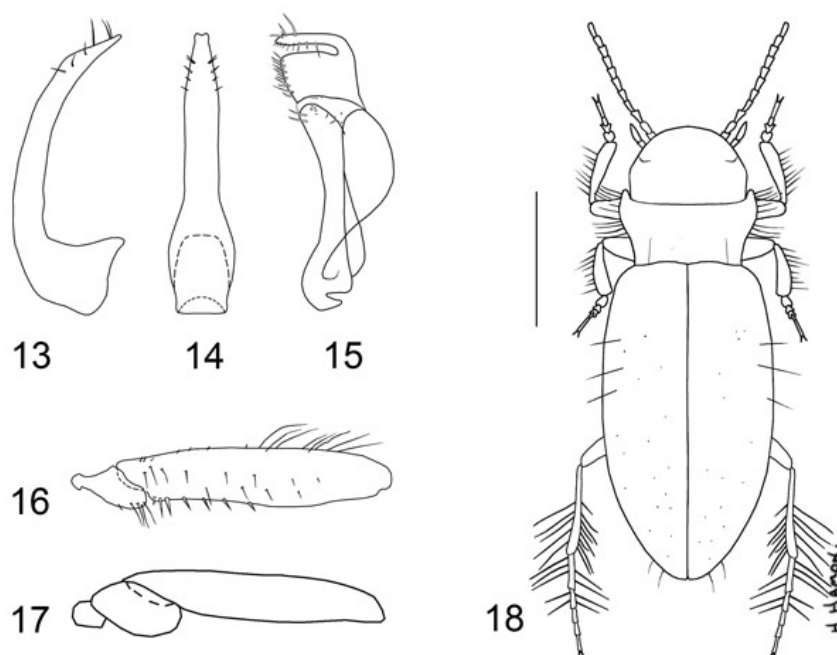
Male. Little external difference between the sexes. Median lobe of aedeagus relatively broad, gradually narrowing towards tip, tip rounded; paramere moderately broad, apical segment with moderately long thin apical lobe well separated from rest of segment. Figs 7 – 9.

Etymology. Named after the pastoral station on which it was found.

Remarks

Known only from a single male specimen this species superficially resembles *Bidessodes limestoneensis* in its large size and in having numerous small spines along the hind edge of the mesofemurs. It differs from this species in the broader head and pronotum, thicker but still relatively thin, pro and mesolegs, the very different shape of the parameres and in DNA sequence (R. Leys *pers com*).

Limbodessus cooperi sp. nov.



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

Holotype

♂. ‘BES 11813 30/9/04 Mt Weld Station Mt Morgan BF PB6 28.73272 122.1543 WF Humphreys & SJB Cooper’. WAM 38199.

Paratypes

12; 2, ‘BES 10581, Mt Weld Station, Mt Morgan BF PB4, 28.73177S 122.1569E, WF Humphreys & SJB Cooper, 30/9/04’, SAMA; 1, ditto, except ‘BES 10584, Mt Morgan BF PB5, 28.73174S 122.15704E’, WAM 38200; 1, ditto except ‘BES 11810, Mt Morgan BF PB7, 28.73159S

122.15884E', SAMA; 7, ditto except 'BES 11813, Mt Morgan BF PB6, 28.73439S 122.14942E', 2 SAMA 4 (+ 1 partial) WAM 38201 – 38205; 1, ditto except 'BES11815 Mt Morgan BF PB1, 28.731338S 122.20403E', SAMA.

Description (number examined, 13)

Habitus. Length 3.2 – 3.6 mm; relatively flat, quite strongly constricted at junction of pronotum/elytra; elongate; uniformly light testaceous; hindwing reduced, half to two-thirds length of elytron.

Head. Relatively small, narrower than elytra; smooth, reticulation weak, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant reduced to short suture line. Antenna thin, segment 1 cylindrical, segment 2 barrel-shaped, segment 3 as long as segment 2, narrower, narrowing towards base, segments 4 to 10 approximately equal in shape, segment 11 a little narrower and 1.6x length of segment 10, each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus, thin, segment 4 about as long as segments 1 to 3 combined.

Pronotum. Narrower than elytra; anteriolateral angles projecting strongly forward; base strongly constricted, posterolateral angles sharply pointed, overlying elytra somewhat; smooth, reticulation weak, punctures very weak, sparse, some stronger punctures towards front margin; basal plicae obsolete, with a row of long setae laterally in anterior half.

Elytra. Not fused, lacking inner ridges; elongate, sides subparallel, smooth, very weakly reticulate, sparsely covered with very small punctures, 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 narrow in anterior quarter, thin along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, sides weakly converging towards rear, tip rounded, moderately 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 obsolete laterally, 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 thin, relatively narrow, widest near apex where it is about three times its basal width; protarsus not expanded, segment 1 about as broad as long, segment 2 as wide as segment 1 and about a third its length, segment 3 a little shorter than segment 1, about as wide, weakly 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 a covering of adhesive setae; claws short and simple.

Mesotrochanter elongate/rectangular with a few thin setae on inner edge; mesofemur with 5 – 7 spines in basal half (Fig. 16); mesotarsus similar to protarsus. Metatrochanter tip rounded (Fig. 17); metafemur 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.

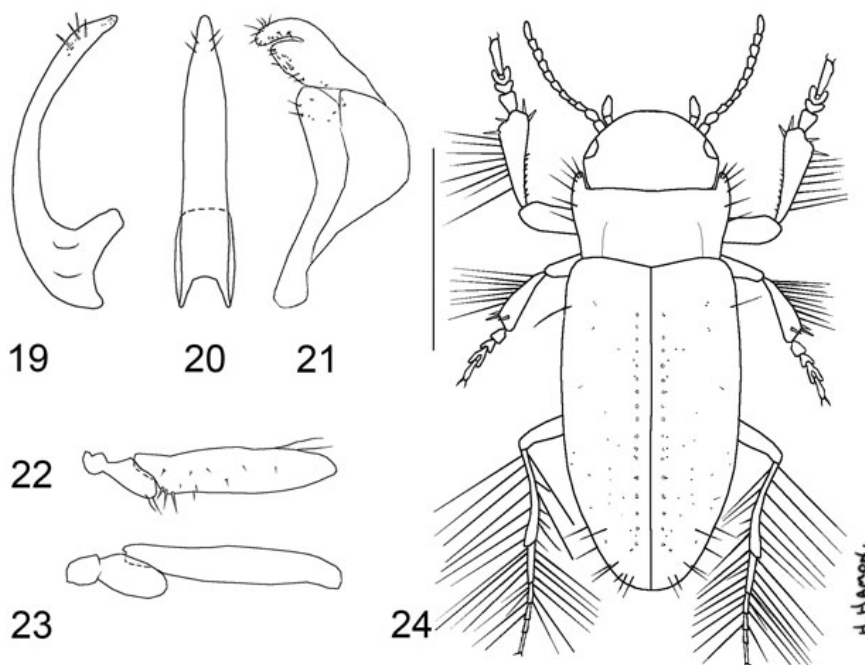
Male. Little external differences between the sexes. Median lobe of aedeagus moderately broad, rapidly narrowing close to tip, tip weakly bilobed; paramere relatively broad, apical segment with long thin apical lobe separated from rest of segment. Figs 13 – 15.

Etymology. Named after Steve Cooper for his support in the field and in the genetics-based studies of Australian stygobitic Dytiscidae.

Remarks

A relatively large species, morphological rather similar to *L. windarraensis*, with smallish head, weak epipleura, thin antennae legs and tarsi, and the tip of the penis weakly bilobed. The hind wings of this species are rather longer than usual but reduced enough not to have folded tips.

Limbodessus exilis sp. nov.



Figs 19-24. *Limbodessus exilis* sp. nov.: 19, lateral view of median lobe of aedeagus; 20, ditto dorsal view; 21, paramere; 22, mesotrochanter and mesofemur; 23, metatrochanter and metafemur; 24, dorsal view. Scale bar represents 1 mm (habitus only).

Holotype

♂: 'BES 10544 Maranalgo Station Site 159, 29.34857 117.80599 WF Humphreys, CHS Watts & C Clay, 5/6/04'. Slide mounted, WAM 38206.

Paratypes

3; 1, as for holotype, SAMA; 1, 'BES 10541 Maranalgo Station Site 160, 29.35431 117.80012 WF Humphreys, CHS Watts & C Clay, 5/6/04' WAM 38207; 1, ditto except, 'BES 10423, 25/5/04', SAMA.

Description (number examined, 4)

Habitus. Length 2.4 – 2.5 mm; relatively flat, moderately constricted at junction of pronotum/elytra; elongate oval; uniformly light testaceous; hindwing reduced, a little shorter than elytron, apex folded.

Head. Narrower than elytra; smooth, reticulation weak, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant large, round, transparent without facets, about a quarter the size of a normal eye. Antenna moderately stout, segments 1 and 2 cylindrical, segment 3 as long as segment 2, narrower, narrowing towards base, segment 4 a bit smaller, segments 5 to 10 approximately equal in shape, inner apical angles slightly expanded, segment 11 elongate, 1.2x 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. Narrower than elytra; anteriolateral angles projecting strongly forward; base moderately constricted, posterolateral angles pointed, overlying elytra somewhat; smooth, reticulation weak, punctures very weak, sparse; basal plicae weak, straight, 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 small punctures, a row of quite widely spaced larger punctures close to inner edges; a few additional larger punctures with long setae, more frequent towards sides. Epipleuron weakly 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 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 in midline behind. Metacoxal plates large, shiny, virtually nonreticulate, metacoxal lines weak, well separated, diverging towards front, reaching nearly to mesosternum; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct only in inner half, 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 weakly expanded, segment 1 about 2x as long as broad, segment 2 as wide as segment 1 and about a half its length, segment 3 about as long as segment 1, about as wide, bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about length of segment 3, segments 1 to 3 with covering of adhesive setae; claws short and simple. Mesotrochanter elongate/rectangular with a few thin setae on inner edge near tip; mesofemur with 2 spines on inner edge near base (Fig. 22); mesotarsus similar to protarsus, a little more elongate. Metatrochanter tip rounded (Fig. 23); metafemur relatively thin, lacking spines; metatibia very 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.

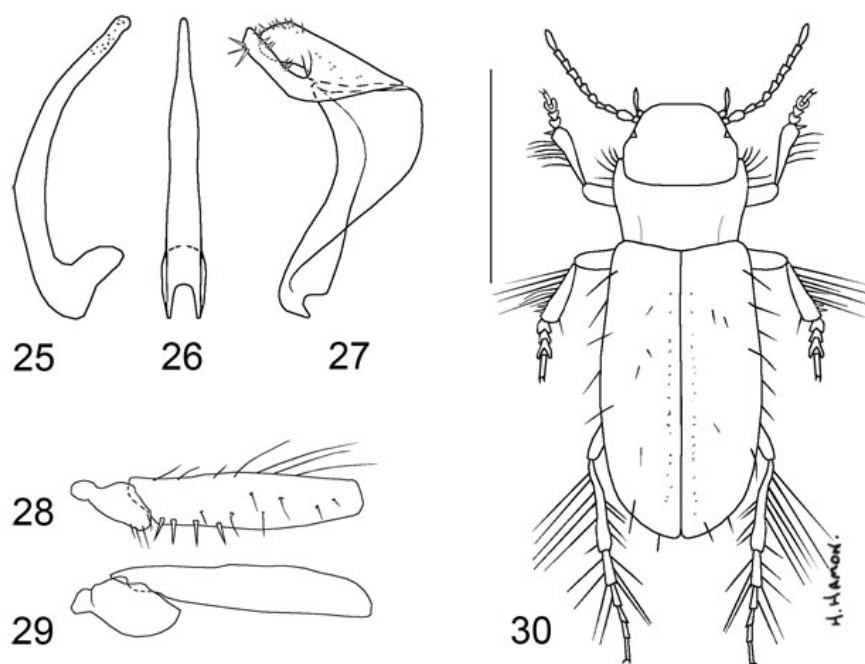
Male. Little external differences between the sexes. Median lobe of aedeagus relatively broad, narrowing near tip, tip rounded, a group of quite strong setae on dorsal surface close to tip; basal segment of paramere broad, apical segment narrow with relatively broad apical lobe separated from rest of segment. Figs 19 – 21.

Etymology. Latin. ‘Exilis’ – thin/weak. A reference to its thin tarsi.

Remarks

The relatively large round eye remnant and wings with some folding at the very tip suggest a species only relatively recently adapted to underground life. Morphologically close to *L. windarraensis* which is larger and has more reduced eyes and wings. DNA sequencing (R Leys *pers com*) suggests that these two species are not phylogenetically close and that *L. exilis* groups with *L. microocular* and *L. micrommatoion* both species with large eye remnants and folded wings.

***Limbodessus gumwellensis* sp. nov.**



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

Holotype

♂. 'BES 10255 17/3/04 Perrinvale Station Gum Well 28.77504 120.41700 WF Humphreys & SJB Cooper'. WAM 38208.

Paratypes

14, as for holotype, 9 SAMA 5 WAM 38209 – 38213.

Description (number examined, 15)

Habitus. Length 1.8 – 2.2 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, segment 1 cylindrical, segment 2 barrel-shaped, segment 3 a little shorter than segment 2, much narrower, narrowing towards base, segments 4 to 10 approximately equal in shape with middle ones a little larger, segment 11 a little narrower and 1.2x as long as 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 quite strongly constricted, posterolateral angles right angles, overlying elytra somewhat; smooth, reticulation weak, punctures very weak, sparse, a row of stronger punctures along front margin; basal plicae moderate, straight, weakly diverging, very 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 edges 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 quarter, thin along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, sides subparallel or bullet-shaped, 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 moderately narrow; rounded in midline behind. Metacoxal plates large, shiny, virtually nonreticulate, metacoxal lines obsolete; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines virtually lacking, faintly traceable towards midline, 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 or slightly club-shaped, 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 half its length, segment 3 about as long as segment 1, about as wide, deeply bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about 1.2x length of segment 3, segments 1 to 3 with very dense covering of adhesive setae; claws short and simple. Mesotrochanter elongate/oblong with a few thin setae on inner edge at tip; mesofemur with 4-5 moderately long spines in basal half (Fig. 28); mesotarsus similar to protarsus. Metatrochanter oval, tip rounded (Fig. 29); metafemur relatively thin, lacking spines; metatibia narrow, moderately curved, widening towards apex; metatarsus moderately 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 thin, gradually narrowing towards tip, tip rounded; paramere relatively thin, apical segment short with a long thin apical lobe overlapping rest of segment. Figs 25 – 27.

Etymology. Named after the pastoral well in which it was found.

Remarks

A rather small, very ‘average’ species with a small triangular eye remnant, thin tarsi, four moderate spines on the hind edge of the mesofemur and the suture line between the first two ventrites much reduced.

***Limbodessus harleyi* sp. nov.**

Holotype

♂. ‘Carnegie Station Jimmys Well 19.4 Km NW Carnegie Homestead 25 39 38S 122 52 09 E 14/4/04 H. Barron’, WAM 38214. Slide mounted.

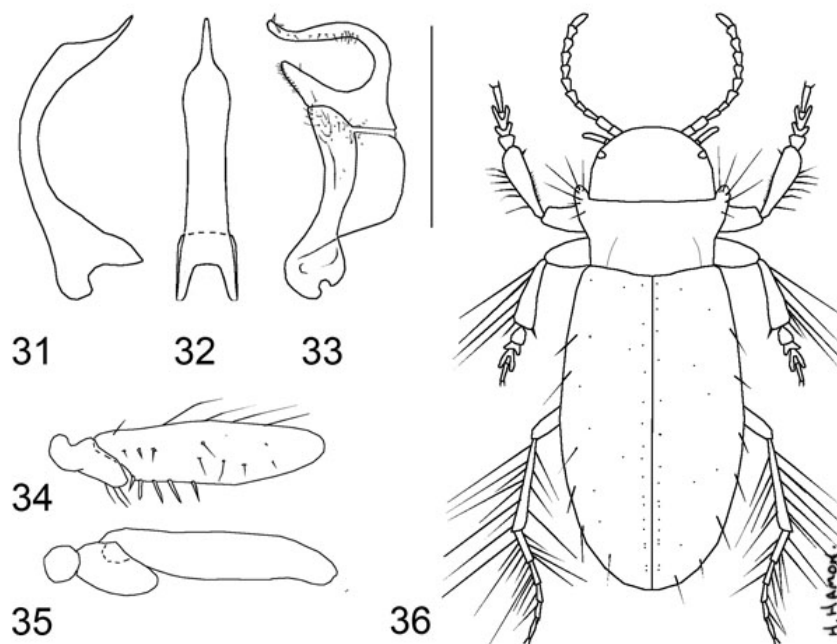
Paratypes

8, as for holotype, 4 SAMA 4 WAM 38215 – 38218.

Description (number examined, 13)

Habitus. Length 2.1 – 2.6 mm; relatively flat, quite strongly 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 moderately strong, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant reduced to small oval area. Antenna moderately stout, segment 1 cylindrical, segment 2 narrowly barrel-shaped, segment 3 as long as segment 2, narrower, narrowing towards base, segments 4 to 10 approximately equal in length, middle segments slightly expanded on inner apical angle, segment 11 parallel-sided, a little longer than segment 10, each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus elongate, segment 4 a little shorter than segments 1 to 3 combined.



Figs 31-36. *Limbodessus harleyi* sp. nov.: 32, lateral view of median lobe of aedeagus; 33, ditto dorsal view; 34, paramere; 35, mesotrochanter and mesofemur; 36, metatrochanter and metafemur; 37, dorsal view. Scale bar represents 1 mm (habitus only).

Pronotum. A little narrower than elytra; anteriolateral angles projecting strongly forward; base quite strongly constricted, posterolateral angles bluntly pointed, overlying elytra somewhat; smooth, reticulation moderately strong, punctures very weak, sparse, a row of stronger punctures along front margin; basal plicae weak, straight, slightly converging, reaching to about a third way along pronotum; with row of long setae laterally in anterior half.

Elytra. Not fused, lacking inner ridges; elongate, widest behind middle, smooth, weakly reticulate, sparsely covered with very small punctures; a few 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 quarter, thin along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, sides weakly tapering towards tip, 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 bow-shaped, moderately broad, widest before apex where it is about four times its basal width; protarsus weakly expanded, segment 1 rather small, as broad as long, segment 2 wider than segment 1 and about two thirds its length, segment 3 longer than segment 1, about as wide, deeply bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about 1.2x 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 – 7 weak spines in basal half (Fig. 34); mesotarsus a little more elongate than protarsus. Metatrochanter tip rounded (Fig. 35); 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.

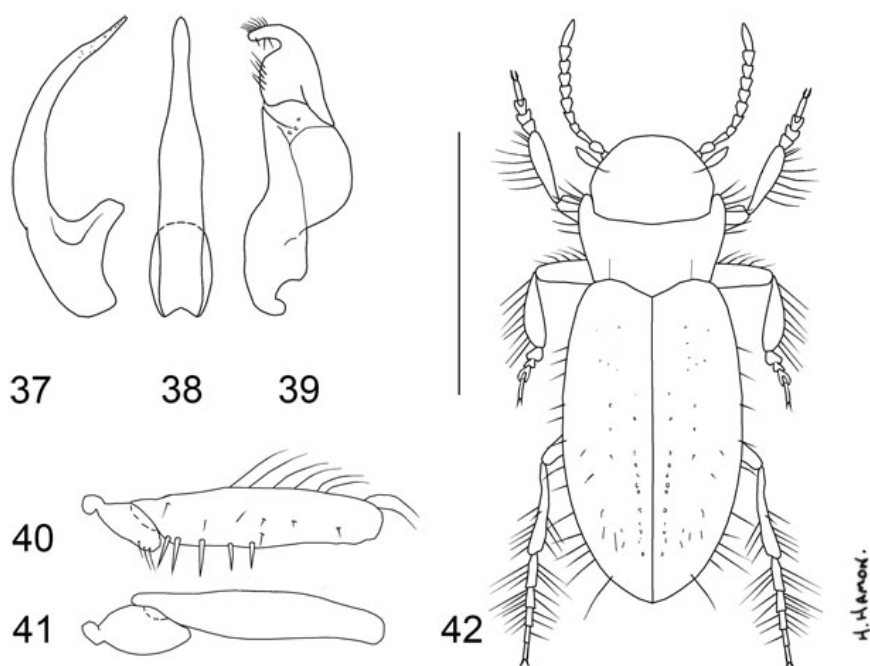
Male. Little external differences between the sexes. Median lobe of aedeagus relatively broad, a little constricted in middle, rapidly narrowing towards tip, tip sharp; paramere broad, apical segment with very long thin apical lobe with upturned tip well separated from rest of segment. Figs 31 – 33.

Etymology. Named after the collector.

Remarks

The most north-eastern species in Western Australia from a calcrete north of Lake Carnegie, *L. harleyi* is a moderately sized species, with short, stout mesofemoral spines and only weakly expanded pro and mesotarsi. Morphologically similar to its nearest geographic species, *L. jundeeensis*, but separated from that species by the complete suture line between the first two ventrites and characters of the aedeagus.

Limbodessus leysi sp. nov.



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

Holotype

♂. 'BES 11813 30/9/04 Mt Weld Station Mt Morgan BF PB6 28.73272S'122.1543E WF Humphreys & SJB Cooper' WAM 38219.

Paratypes

7; 3, as for holotype, SAMA; 4, ditto except, 'BES 11815, Mt Morgan BF PB1, 28.73439S 122.14942E', 1 SAMA 3 WAM 38220 – 38222.

Description (number examined, 8)

Habitus. Length 1.5 – 1.9 mm slides; relatively flat, moderately constricted at junction of pronotum/elytra; elongate oval; uniformly light testaceous; hindwing reduced, about half length of elytron.

Head. Narrower than elytra; smooth, reticulation weak, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant reduced to a single suture line. Antenna stout, segment 1 cylindrical, segment 2 barrel shaped, segment 3 as long as segment 2, narrower, narrowing towards base, segment 4 shorter than segment 3, segments 5-10 stout approximately equal in shape, segment 11 similar width to segment 10 and twice its length, each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus relatively thin, segment 4 as long as segments 1 to 3 combined.

Pronotum. A little narrower than elytra; anteriolateral angles projecting strongly forward; base moderately constricted, posterolateral angles blunt, overlying elytra somewhat; smooth, reticulation weak, punctures very weak, sparse, a band of stronger punctures along front margin; basal plicae weak, straight, reaching to about half way along pronotum; with row of long setae laterally in anterior half.

Elytra. Not fused, lacking inner ridges; elongate, widest about middle, smooth, very weakly reticulate, sparsely covered with very small punctures, a row of larger punctures close to inner edge in apical two-thirds; additional larger punctures with long setae towards sides. Epipleuron not differentiated from rest of elytron, that portion of elytron visible ventrally, moderately broad in anterior quarter, thin along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, sides weakly converging towards rear, tip bluntly pointed, arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact at midline. Metathorax triangular in front in midline; wings very 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 absent or virtually so, 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 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, weakly bifid and nearly as long, segment 3 a little longer than segment 1, about as wide, bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about same length as segment 3, segments 1 to 3 with adhesive setae; claws short and simple. Mesotrochanter elongate/rectangular with a few thin setae on inner edge; mesofemur with 5 – 6 strong spines in basal half (Fig. 40); mesotarsus similar to protarsus. Metatrochanter relatively large, oval, tip rounded (Fig. 41); metafemur moderately wide, 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.

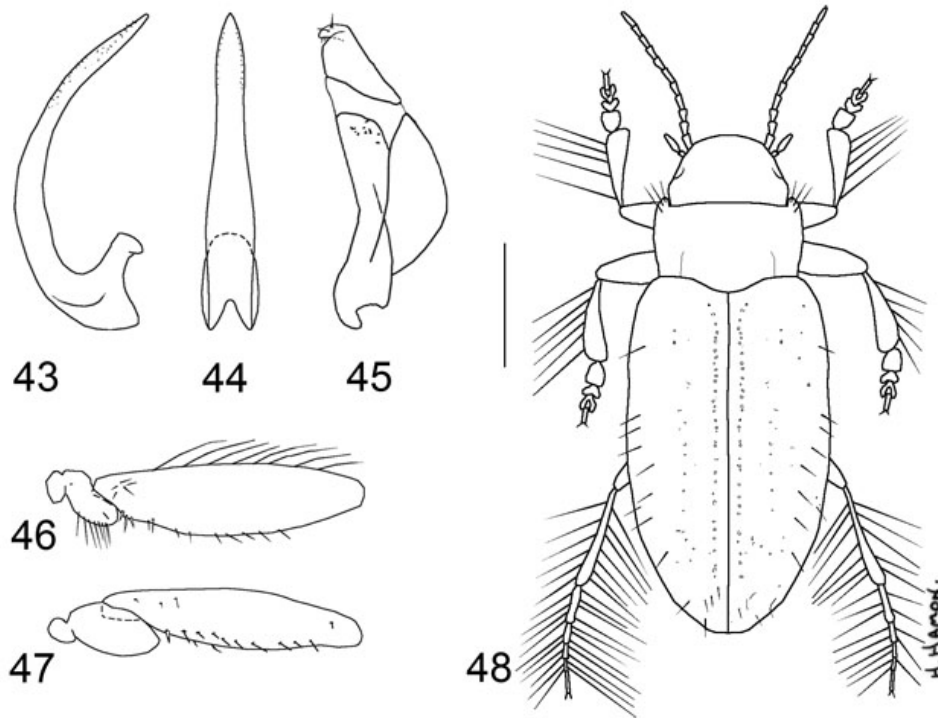
Male. Little external differences between the sexes. Median lobe of aedeagus relatively broad, narrowing rapidly towards tip, then expanded a bit before tip, tip rounded; paramere broad, apical segment with thin apical lobe well separated from rest of segment. Figs 37 – 39.

Etymology. Named after Remko Leys for his support in the field and for carrying out much of the biochemical analysis associated with the study of Australian stygobitic Dytiscidae.

Remarks

A small species with the eye remnant reduced to a small suture, the suture line between the first two ventrites reduced to a small trace near the metacoxae and five to six strong spines on the hind edge of the mesofemur. The tip of the median lobe of the aedeagus is unusual in being slightly expanded.

Limbodessus macrohinkleri sp. nov.



Figs 43-48. *Limbodessus macrohinkleri* sp. nov: 43, lateral view of median lobe of aedeagus; 44, ditto dorsal view; 45, paramere; 46, mesotrochanter and mesofemur; 47, metatrochanter and metafemur; 48, dorsal view. Scale bar represents 1 mm (habitus only).

Holotype

♀. 'BES 10492 3/6/04 Hinkler Stn Dawsons Well 26.88651 120.16203 WF Humphreys CHS Watts & C Clay', WAM 38223. Slide mounted.

Paratypes

6 (all partial); 1, 'BES 6615 Hinkler Well Calcrete Main Road bore North 26 41 04S 120 12 54E coll WF Humphreys CHS Watts S Cooper 12/5/01', SAMA; 1, 'BES 8146 21/8/01 Hinkler Well site 36 road bore North 26.68453 120.21512 WF Humphreys T Karanovic & JM Waldock', SAMA; 4 'BES 7222 site 289 sample 3 Hinkler calcrete east unequipped water bore 26 51 36S 120 18 05E WF Humphreys & HJ Hahn 22/5/99', 2 SAMA 2 WAM 38224 – 38225.

Description (number examined, 1, + 6 partial specimens)

Habitus. Length 3.9 – 4.0 mm; relatively flat, moderately constricted at junction of pronotum/elytra; elongate oval; uniformly light testaceous; hindwing reduced, about quarter length of elytron.

Head. Much narrower than elytra; smooth, reticulation moderate, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant reduced to a feint suture. Antenna relatively thin, segments 1 and 2 cylindrical, segment 3 as long as segment 2, narrower, narrowing towards base, segment 4 a little shorter than segment 3, segments 5 to 10 becoming progressively shorter and broader, segment 11 narrower and 1.6x 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. Much narrower than elytra; anteriolateral angles projecting strongly forward; base moderately constricted, posterolateral angles bluntly pointed, overlying elytra somewhat; smooth, reticulation moderate, punctures weak, sparse, a few stronger punctures along front margin; basal

plicae weak, straight, 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, reticulate, sparsely covered with very small punctures, a row of larger punctures close to inner edge, usually more frequent towards front; a few additional larger punctures with long setae, more frequent towards sides. Epipleuron quite well differentiated from rest of elytron, moderately broad in fifth, thin along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, sides converging towards rear, tip rounded, 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 relatively broad; rounded 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 relatively narrow, widest near apex where it is about four times its basal width; protarsus expanded, segment 1 nearly as broad as long, segment 2 much narrower than segment 1 and about a half its length, segment 3 shorter than segment 1, much narrower, deeply bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about 1.2x length of segment 3, segments 1 to 3 with dense covering of adhesive setae; claws short and simple. Mesotrochanter elongate/rectangular with a few thin setae on inner edge; mesofemur with 5 – 6 small spines on inner edge in basal half (Fig. 46); mesotarsus similar to protarsus. Metatrochanter tip rounded (Fig. 47); metafemur relatively thin, with moderate number of setae/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. Appendages not know. Median lobe of aedeagus relatively thin, expanding lightly before tip, tip rounded; basal segment of paramere broad, apical segment much narrower with short broad apical lobe overlapping rest of segment. Figs 43 – 45.

Etymology. Greek. “Macro” – long. A reference to the fact that it is a large species from the Hinkler well calcrete.

Remarks

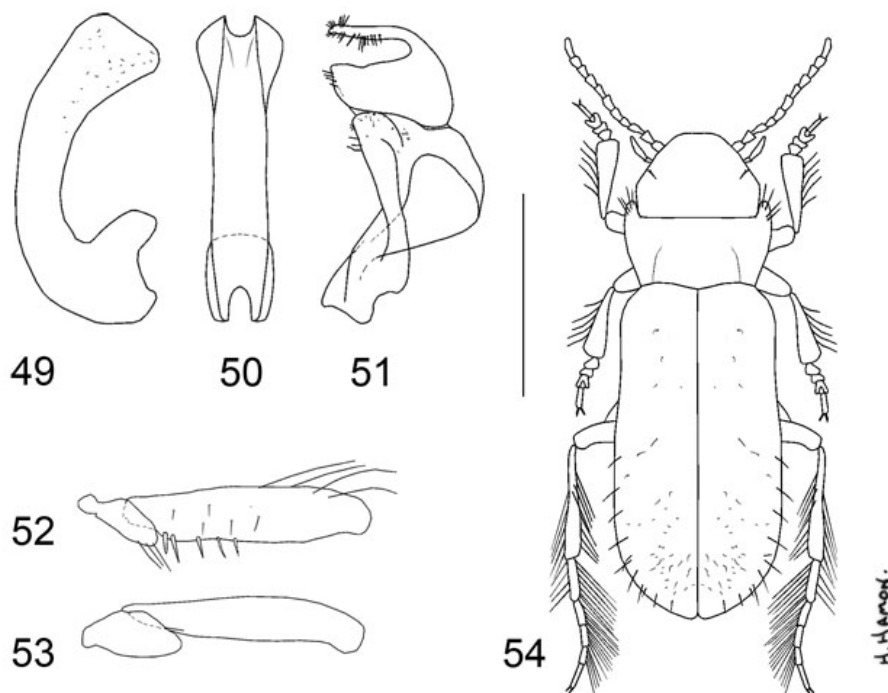
A distinctive, large, broad species, with small head and pronotum, broad metasternal wings, weak spines on the mesofemur, virtually no trace of an eye remnant, and a moderate number of setae/spines on the metafemurs. No other *Limbodessus* is known to have more than the odd small setae on the mesofemur.

This species has been known since the second collecting trip in 1999 from the main road bore locality were, on this and most subsequent visits, numerous body shells of the species have been collected. The one specimen from Dawsons Well is the first specimen collected alive. The cause of the deaths of the specimens in the main road bore is unknown – a nearby bore with a different physio/chemistry has been the source of numerous live specimens of *L. hinkleri*.

Limbodessus melitaensis sp. nov.

Holotype

♂. ‘BES 11832 3/10/04 Melita Station Sons of Gwalia BF site 437 28.93427S 121.3061E WF Humphreys & SJB Cooper’. WAM 38226. Slide mounted.



Figs 49-54. *Limbodessus melitaensis* sp. nov.: 49, lateral view of median lobe of aedeagus; 50, ditto dorsal view; 51, paramere; 52, mesotrochanter and mesofemur; 53, metatrochanter and metafemur; 54, dorsal view. Scale bar represents 1 mm (habitus only).

Paratypes

11, as for holotype, 7 SAMA 4 WAM 38227 – 38230.

Description (number examined, 12)

Habitus. Length 2.2 – 2.5 mm; relatively flat, moderately constricted at junction of pronotum/elytra; elytral sides subparallel; uniformly light testaceous; hindwing reduced, about half length of elytron.

Head. Moderate size, narrower than elytra; smooth, reticulation weak, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant reduced to small narrow area. Antenna moderately stout, segment 1 cylindrical, segment 2 barrel-shaped, segment 3 as long as segment 2, narrower, narrowing towards base, segments 4 to 10 approximately equal in length, middle ones somewhat broader, segment 11 similar in width to segment 10, nearly twice as long; each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus moderately stout, segment 4 as long as segments 1 to 3 combined.

Pronotum. Same width as elytra; anteriolateral angles projecting strongly forward; base moderately constricted, posterolateral angles almost right angles; smooth, reticulation weak, punctures very weak, sparse, some stronger punctures along front margin; basal plicae moderate, straight in basal half, sloping inwards towards front, 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, sides subparallel; smooth, very weakly reticulate, sparsely covered with very small punctures, a few larger punctures with long setae towards sides. Epipleuron not differentiated from rest of elytron, that portion of elytron visible ventrally, narrow in anterior quarter, virtually absent along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, sides subparallel, tip rounded, 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 weak, absent in lateral half, 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 club-shaped, widest near apex where it is about five times its basal width; protarsus moderately expanded, segment 1 as broad as long, segment 2 as wide as segment 1 and about as long, segment 3 as long as segment 1, about as wide, 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 covering of adhesive setae; claws short and simple. Mesotrochanter elongate with a few thin setae on inner edge; mesofemur with 5 – 6 marginal spines in basal half (Fig. 52); mesotarsus similar to protarsus. Metatrochanter tip blunt (Fig. 53); metafemur 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, broadening at apex both laterally and dorsoventrally; paramere broad, apical segment with long thin apical lobe well separated from rest of segment. Figs 49-51.

Etymology. Named after the pastoral station on which it was found.

Remarks

A moderate sized, rather ordinary species, with a small narrow eye remnant, reduced suture line between the first two ventrites and five spines on the hind edge of the mesofemur. It can be distinguished from the morphologically very similar, *L. masonensis* and *L. yuinmeryensis*, by the moderately club-shaped median lobe of the aedeagus rather than the more usual pointed tip found in these two species.

***Limbodessus micrommatoion* sp. nov.**

Holotype

♂. 'BES 8713 4/4/03 Bunnawarra bore site 94, 28.60964 116.57365, W F Humphreys & R Leys', WAM 38231. Slide mounted.

Paratypes

3, as for holotype, 1 SAMA 2 WAM 38232 – 38233.

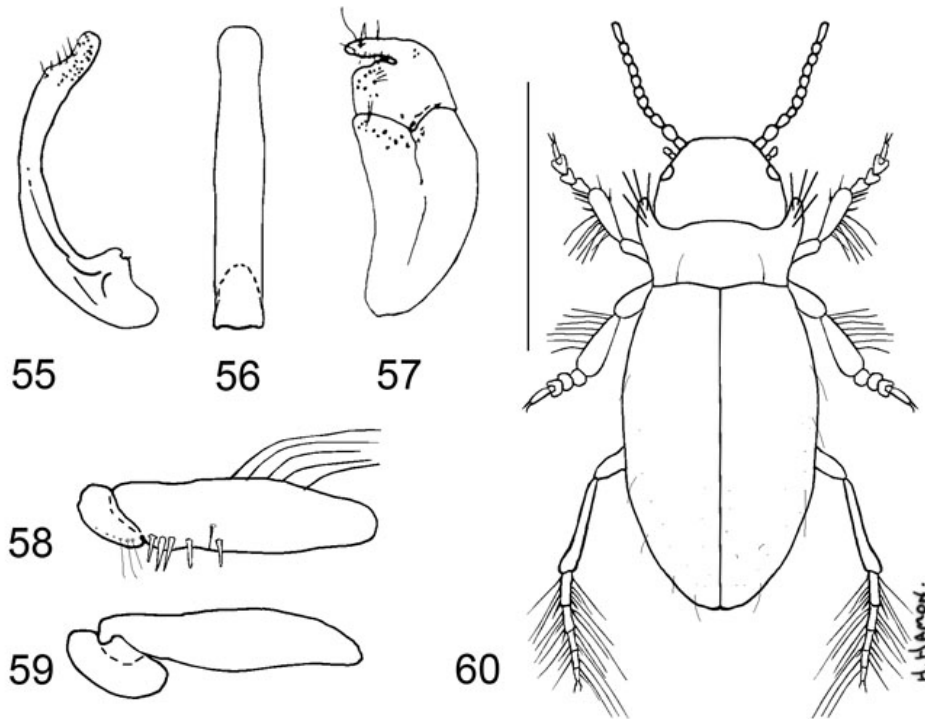
Description (number examined, 4)

Habitus. Length 1.7 – 1.8 mm; relatively flat, strongly constricted at junction of pronotum/elytra; elongate oval; uniformly light testaceous; hindwing reduced, about length of elytron, tip folded.

Head. Narrower than elytra; smooth, reticulation weak, punctures sparse, very small; subparallel in posterior half, widest just behind eye; eye reduced to about one third normal size. Antenna stout, segment 1 cylindrical, segment 2 barrel-shaped, segment 3 shorter than segment 2, narrower, narrowing towards base, segment 4 shorter than segment 3, segments 5 to 10 approximately equal in shape slightly expanded on inner apical angle, segment 11 1.8x as long as segment 10, each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus stout, segment 4 as long as segments 1 to 3 combined.

Pronotum. Same width as elytra; anteriolateral angles projecting strongly forward; base strongly constricted, posterolateral angles bluntly pointed, overlying elytra somewhat; smooth, reticulation weak, punctures very weak, sparse, a row of stronger punctures along front margin; basal plicae

fine, straight, reaching about one third way across pronotum; with row of long setae laterally in anterior half.



Figs 55-60. *Limbodessus micrommatoion* sp. nov.: 55, lateral view of median lobe of aedeagus; 56, ditto dorsal view; 57, paramere; 58, mesotrochanter and mesofemur; 59, metatrochanter and metafemur; 60, dorsal view. Scale bar represents 1 mm (habitus only).

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 half; a few additional larger punctures with long setae, more frequent towards sides. Epipleuron moderately differentiated from rest of elytron, relatively broad in anterior quarter, thin along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, sides subparallel, tip bluntly pointed, 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 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 except close to sides, 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 club-shaped, widest near apex where it is about 5x its basal width; protarsus weakly expanded, segment 1 triangular, segment 2 as wide as segment 1 and about a half its length, segment 3 about as long as segment 1, 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 some adhesive setae; claws short and simple. Mesotrochanter elongate/oval with a few thin setae on inner edge; mesofemur with 5 strong spines in basal half (Fig. 58); mesotarsus similar to protarsus. Metatrochanter oval, tip well separated from femur (Fig. 59); metafemur relatively thin, lacking spines; metatibia narrow, curved, strongly widening towards apex; metatarsus stout,

segment 1 longest, segment 5 longer than segment 4, segments 1 and 2 in combination about as long as others; claws weak.

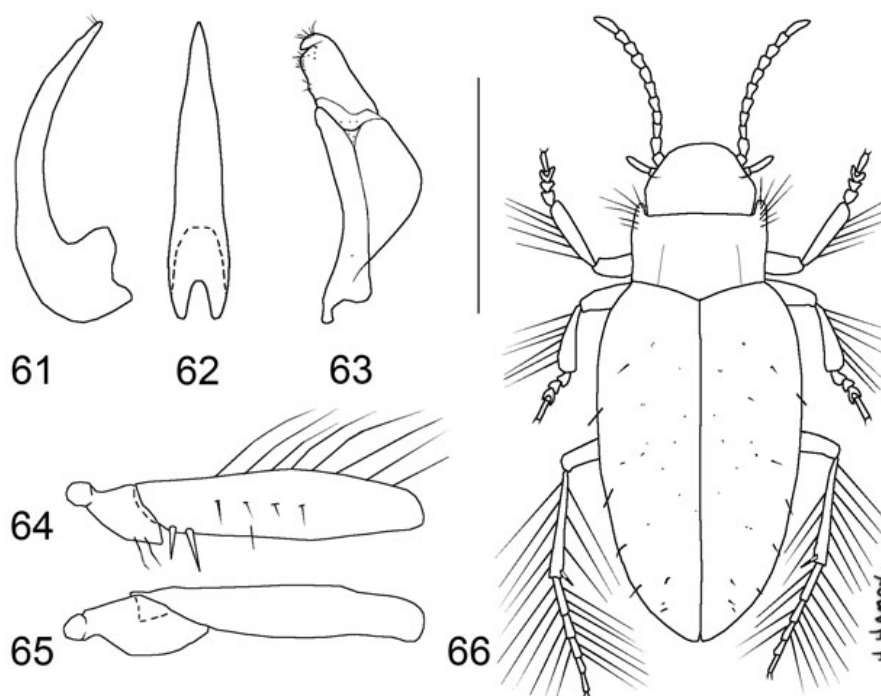
Male. Little external differences between the sexes. Median lobe of aedeagus relatively broad, weakly waisted near tip, tip rounded; paramere broad, apical segment wider than long with short apical lobe. Figs 55 – 57.

Etymology. Greek. “Mikrommatos” – small eyed, “oin” - diminutive. The smaller of the small-eyed *Limbodessus* at Bunnawarra bore.

Remarks

Found in the same calcrete as *L. microocular*, it shares with that species small, non-functional eyes and relatively long, folded wings. It is smaller than *L. microocular* with more oval metatrochanters and longer, thinner apical lobes to the parameres.

***Limbodessus millbilliensis* sp. nov.**



Figs 61-66. *Limbodessus millbilliensis* sp. nov.: 61, lateral view of median lobe of aedeagus; 62, ditto dorsal view; 63, paramere; 64, mesotrochanter and mesofemur; 65, metatrochanter and metafemur; 66, dorsal view. Scale bar represents 1 mm (habitus only).

Holotype

♂. ‘BES 8100, Millbillie Station, Bubble Well site 165 26 33 39S 120 02 27E WF Humphreys, T Karanovic & JM Waldock 22/8/01’. WAM 38234. Slide mounted.

Description (number examined, 1)

Habitus. Length 2.1 mm; relatively flat, weakly constricted at junction of pronotum/elytra; elongate oval; uniformly light testaceous; hindwing reduced, about half length of elytron.

Head. Narrower than elytra; smooth, reticulation weak, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant reduced to a single suture line. Antenna moderately stout, segments 1 and 2 cylindrical, segment 3 shorter than segment 2, much narrower, narrowing towards base, segments 4 to 10 approximately equal in shape, segment 11

elongate 1.4x as long as 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. Narrower than elytra; anteriolateral angles projecting strongly forward; base weakly constricted, posterolateral angles blunt, overlying elytra somewhat; smooth, reticulation weak, punctures weak, sparse; basal plicae moderate, straight, sloping inwards slightly, 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, sides subparallel, smooth, weakly reticulate, moderately covered with very small punctures; a few additional larger punctures with long setae, more frequent towards sides. Epipleuron weakly differentiated from rest of elytron, narrow in anterior quarter, virtually absent along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, sides parallel, 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, weakly reticulate, 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, relatively narrow, widest near apex where it is about four times its basal width; protarsus weakly expanded, segment 1 longer than segment 2 as wide as segment 1 and about a half its length, segment 3 about as long and as wide as segment 1, bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about 1.2x length of segment 3, segments 1 to 3 with a covering of adhesive setae; claws short and simple. Mesotrochanter elongate/rectangular with a few thin setae on inner edge; mesofemur with 2 spines on inner edge near base (Fig. 64); mesotarsus similar to protarsus, a little more elongate. Metatrochanter tip sharply pointed, close to metafemur (Fig. 65); metafemur relatively thin, lacking spines; metatibia narrow, weakly curved, widening towards apex; metatarsus elongate, segment 1 longest, segment 5 only slightly longer than segment 4, segments 1 and 2 in combination about as long as others; claws weak.

Male. Median lobe of aedeagus relatively narrow, gradually narrowing towards tip, tip rounded; basal segment of paramere broad, apical segment narrow with short apical lobe overlapping rest of segment. Figs 61 – 63.

Female. Unknown.

Etymology. Named after the pastoral station on which it was found.

Remarks

A rather small species with sharply pointed metatrochanters and only two spines on the hind edge of the mesofemurs. It shares with *L. bigbellensis* a much-reduced apical lobe to the parameres. The female paratype of *L. wilunaensis* was recorded from the same well, but with some doubt as to the reliability of the record. *Limbodessus wilunaensis* is much smaller (1.4 mm long), with broader head and pronotum and distinctly different aedeagus (Watts & Humphreys 2003).

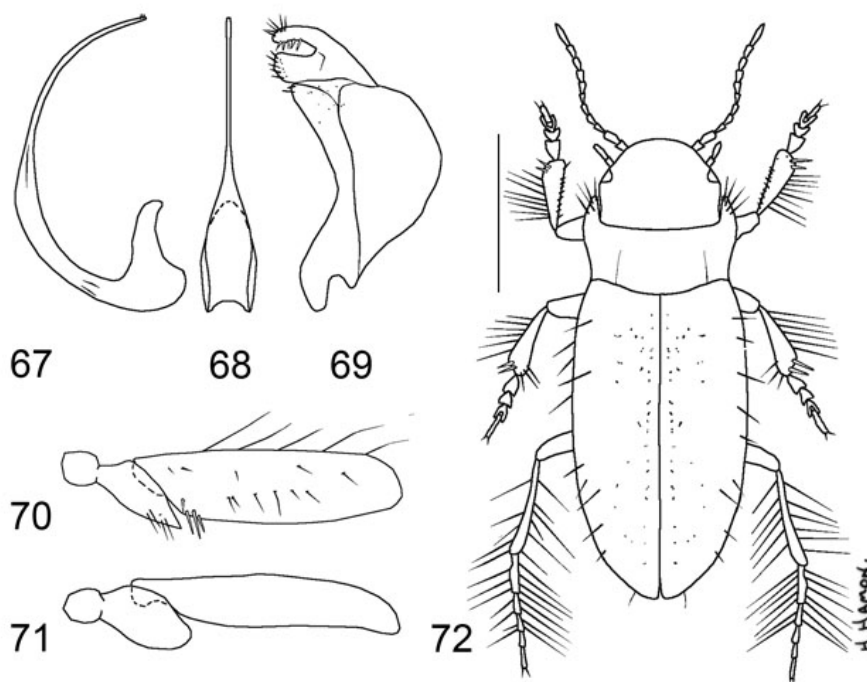
***Limbodessus mirandae* sp. nov.**

Holotype:

♂. 'BES 10487 2/6/04 Yakabindie Station, MEB Site 244 27.74664 120.52381 WF Humphreys CHS Watts', WAM 38235.

Paratypes

6; 1, 'BES 10487 2/6/04 Yakabindie Station (Lake Miranda West), MEB Site 244, 27.74664 120.52381 WF Humphreys, CHS Watts & C Clay', SAMA; 3 (2 partial), ditto except, BES 10479, site 238, 27.74668 120.52759', 1 SAMA 2(p) WAM 38236 - 38237; 1, ditto except, 'BES 10531, MEB site 243, 27.74668 120.52407, 4/6/04', WAM 38238; 1, ditto except, 'BES 10540 (unlabelled in field) prob Yakabindie Station, 2/6/04', WAM 38239.



Figs 67-72. *Limbodessus mirandae* sp. nov.: 67, lateral view of median lobe of aedeagus; 68, ditto dorsal view; 69, paramere; 70, mesotrochanter and mesofemur; 71, metatrochanter and metafemur; 72, dorsal view. Scale bar represents 1 mm (habitus only).

Description (number examined, 7)

Habitus. Length 2.7 – 3.1 mm; relatively flat, moderately constricted at junction of pronotum/elytra; elongate, sides subparallel; uniformly light testaceous; hindwing reduced, about a third length of elytron.

Head. Relatively small much narrower than elytra; smooth, reticulation weak, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant reduced to relatively large semicircular area. Antenna thin stout, segments 1 and 2 cylindrical, segment 3 nearly as long as segment 2, narrower, narrowing towards base, segments 4 to 10 approximately equal in shape, segment 11 a little narrower and 1.4x as long as segment 10, each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus elongate, segment 4 almost as long as segments 1 to 3 combined.

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

Elytra. Not fused, lacking inner ridges; elongate, sides subparallel, smooth, very weakly reticulate, very sparsely covered with very small punctures, a row of larger punctures close to inner edge; a

few additional larger punctures with long setae, more frequent towards sides. Epipleuron moderately differentiated from rest of elytron, relatively broad in anterior third, thin along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, sides converging towards rear, tip bluntly pointed, 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 in midline behind. Metacoxal plates large, shiny, virtually nonreticulate, metacoxal lines weak, well separated, diverging in middle, reaching mesosternum; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct in inner half, 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 moderately broad, widest near apex where it is about 5x its basal width; protarsus weakly expanded, segment 1 longer than broad, segment 2 as wide as segment 1 and about a third its length, segment 3 shorter than segment 1 much narrower, bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about same length of segment 3, segments 1 to 3 with covering of adhesive setae; claws short and simple. Mesotrochanter elongate/rectangular with a few thin setae on inner edge; mesofemur with 2 – 3 spines in basal half (Fig. 70); mesotarsus similar to protarsus except narrowing more sharply immediately before apex. Metatrochanter relatively small, tip rounded (Fig. 71); metafemur thin, lacking spines; metatibia very 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 moderately broad in basal third, extremely thin in apical half to two-thirds; basal segment of paramere broad, apical segment narrow, short, with moderately long apical lobe separated from rest of segment. Figs 67 – 69.

Etymology. Named after Miranda Humphreys.

Remarks

A medium-sized species with a pronounced pronotal/elytral discontinuity in outline, thin antennae, unusually long thin aedeagus and narrow hind legs. Morphologically near *L. exilis* which is of similar size and, like *L. mirandae*, has only two spines on the hind edge of the mesofemur, an unusually low number for species of this size. *Limbodessus exilis* differs in having a smaller eye remnant and is a little smaller. The small number of mesofemoral spines separates it from another rather similar species, *L. phoebeae*, from an adjacent calcrete.

***Limbodessus nambiensis* sp. nov.**

Holotype

♂. 'BES 10314. Nambi Station, MEB Site 106, 28.23974 121.83632, 22/3/04, WF Humphreys & SJB Cooper', WAM 38240. Slide mounted.

Paratype

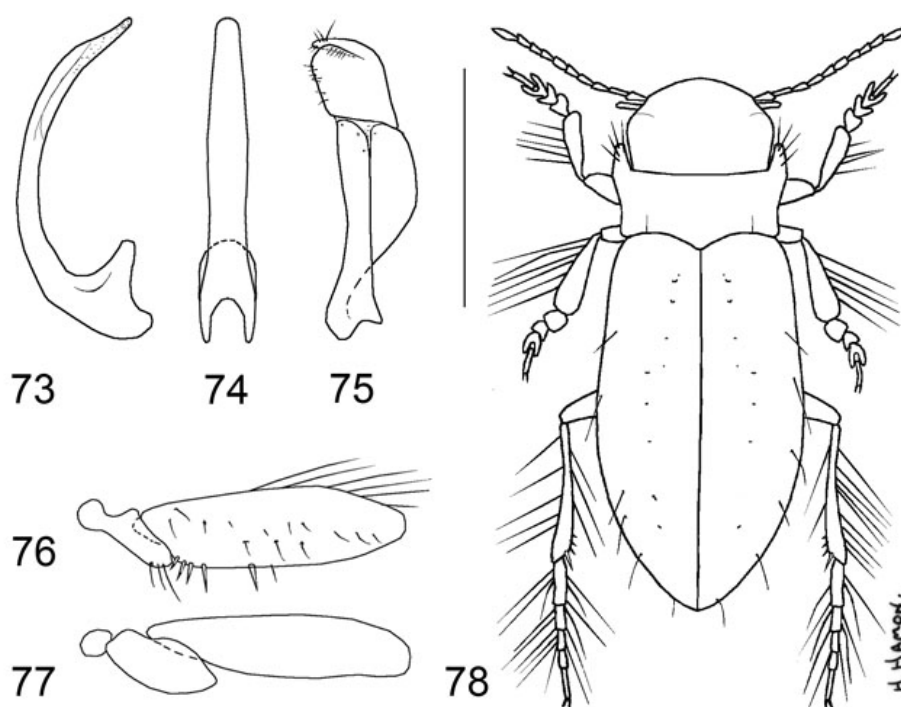
1, as for holotype, except 'BES 10316, MEB Site 105, 28.24039 121.80480', SAMA. Slide mounted.

Description (number examined, 2)

Habitus. Length 2.3 mm; relatively flat, moderately constricted at junction of pronotum/elytra; elongate oval; uniformly light testaceous; hindwing reduced, about two-thirds length of elytron.

Head. Narrower than elytra; smooth, reticulation moderate, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant reduced to a short suture line. Antenna moderately stout, segment 1 cylindrical, segment 2 barrel-shaped, segment 3 shorter than segment 2, much narrower, narrowing towards base, segments 4 to 10 approximately equal in length becoming progressively broader, segment 11 narrower than and 2x as long as 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 as wide as elytra; anteriolateral angles projecting strongly forward; base moderately constricted, posterolateral angles bluntly pointed, overlying elytra somewhat; smooth, reticulation moderate, punctures 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.



Figs 73-78. *Limbodessus nambiensis* sp. nov.: 73, lateral view of median lobe of aedeagus; 74, ditto dorsal view; 75, paramere; 76, mesotrochanter and mesofemur; 77, metatrochanter and metafemur; 78, dorsal view. Scale bar represents 1 mm (habitus only).

Elytra. Not fused, lacking inner ridges; elongate, widest behind middle, smooth, weakly reticulate, sparsely covered with small punctures, a few 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 quarter, 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 bluntly 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 only in inner half, 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 slightly bow-shaped, relatively narrow, widest near apex where it is 5x its basal width; protarsus weakly expanded, segment 1 as broad as long, segment 2 as wide as segment 1 and about a half its length, segment 3 about as long as segment 1 much narrower, about as wide, deeply bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow,

cylindrical, about 1.2x 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 5-7 rather weak spines in basal half (Fig. 76); mesotarsus similar to protarsus. Metatrochanter moderately large, tip bluntly pointed (Fig. 77); metafemur relatively broad, lacking spines; metatibia narrow, moderately curved, widening towards apex; metatarsus moderately elongate, segment 1 longest, segment 5 longer than segment 4, segments 1 and 2 in combination about as long as others; claws weak.

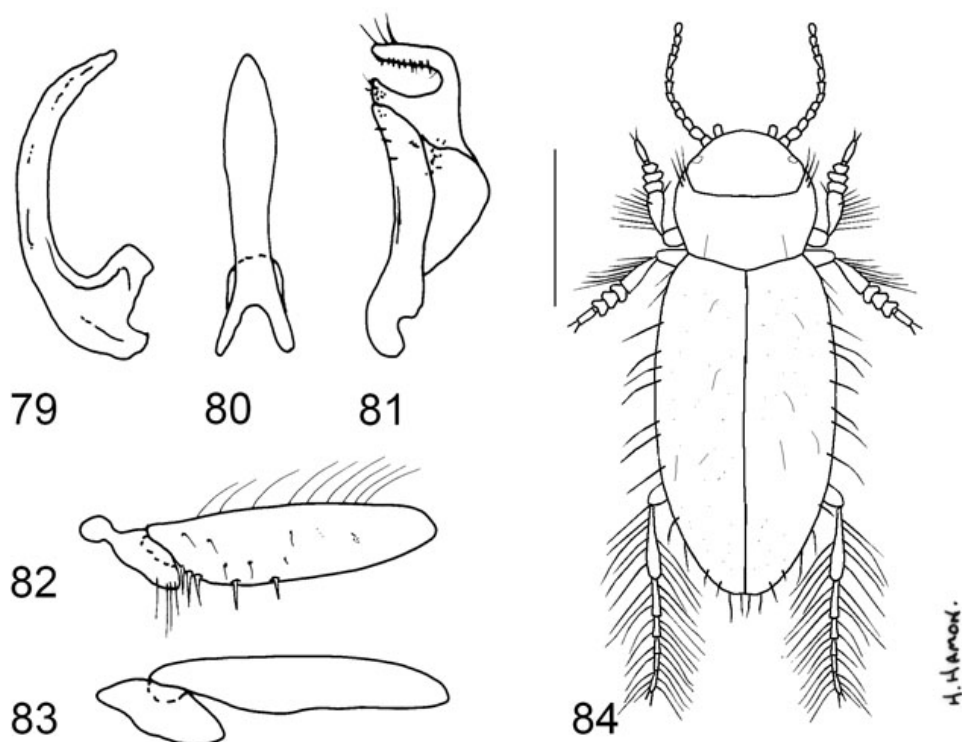
Male. Little external difference between the sexes. Median lobe of aedeagus relatively narrow, gradually narrowing towards tip, tip rounded; paramere moderately broad, apical segment relatively long with long thin apical lobe close to or overlapping rest of segment. Figs 73 - 75.

Etymology. Named after the pastoral station on which it was found.

Remarks

A moderately sized, stout beetle with thick metafemurs, and with the pronotal process broadening into a slightly bulbous apex. The large apical segments of the parameres with their long thin apical lobes are distinctive.

Limbodessus narryerensis sp. nov.



Figs 79-84. *Limbodessus narryerensis* sp. nov.: 79, lateral view of median lobe of aedeagus; 80, ditto dorsal view; 81, paramere; 82, mesotrochanter and mesofemur; 83, metatrochanter and metafemur; 84, dorsal view. Scale bar represents 1 mm (habitus only).

Holotype

♂. 'BES 8742/3 7/4/03 Mt Narryer Station Engine Room Bore, 26.59238 115.92573, WF Humphreys & R Leys', WAM 38241. Slide mounted.

Paratypes

7; 5 as for holotype, 2 SAMA 3 WAM 38242 – 38244; 2, 'BES 8747 7/4/03 Mt Narryer Station Ram Paddock Well 26.59781 115.96988 WF Humphreys R Leys', SAMA.

Description (number examined, 8)

Habitus. Length 2.7 – 3.1mm; relatively flat, moderately constricted at junction of pronotum/elytra; elongate oval; uniformly very light testaceous; hindwing reduced, about half-length of elytron.

Head. Narrower than elytra; smooth, reticulation weak, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant reduced to small narrow rectangular 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 a little narrower and longer than 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. Narrower than elytra; anteriolateral angles projecting strongly forward; base constricted, posterolateral angles sharply pointed, overlying elytra somewhat; smooth, reticulation weak, punctures weak, sparse, a row of stronger punctures along front margin; basal plicae obsolete; with row of long setae laterally in anterior half.

Elytra. Not fused, lacking inner ridges; elongate, widest behind middle, weakly truncated at apex, smooth, very weakly reticulate, moderately covered with small punctures, 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, narrow, sides subparallel, tip 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, short; rounded 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 in inner half absent laterally, 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, ventrite 5 slightly constricted towards apex.

Legs. Protibia triangular, narrow, widest near apex where it is about five times its basal width; protarsus weakly expanded, segment 1 about 2x as broad as long, segment 2 as wide as segment 1 and about a third its length, segment 3 shorter than segment 1 narrower, 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 covering of adhesive setae; claws short and simple. Mesotrochanter elongate/rectangular with a few thin setae on inner edge; mesofemur with 5 spines in basal half (Fig. 82); mesotibia narrowing abruptly before apex; mesotarsus similar to protarsus. Metatrochanter tip rounded (Fig. 83); metafemur relatively thin, lacking spines; metatibia narrow, moderately curved, strongly 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.

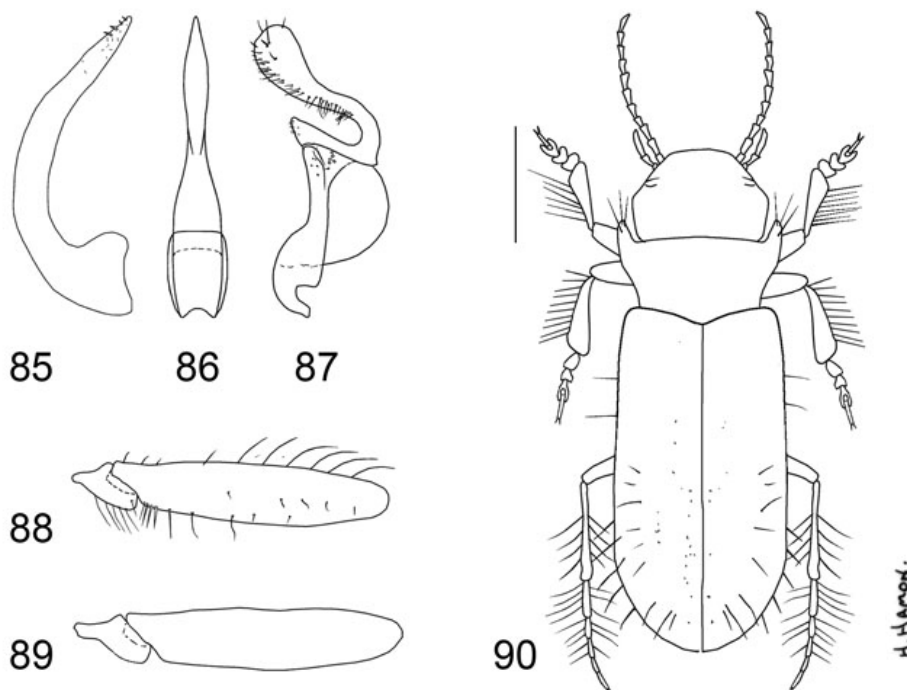
Male. Little external differences between the sexes. Median lobe of aedeagus relatively broad, tip bluntly pointed; paramere broad, apical segment with prominent apical lobe well separated from rest of segment. Figs 79 - 84.

Etymology. Named after the pastoral station on which it was found.

Remarks

A moderate sized, elongate, weakly chitinized species morphologically close to *L. jundeeensis* but larger and with small differences in the aedeagi and eye remnants. The antennae are relatively thin and the metatarsi rather more thin and elongate than usual in the genus.

Limbodessus palmulaoides sp. nov.



Figs 85-90. *Limbodessus palmulaoides* sp. nov.: 85, lateral view of median lobe of aedeagus; 86, ditto dorsal view; 87, paramere; 88, mesotrochanter and mesofemur; 89, metatrochanter and metafemur; 90, dorsal view. Scale bar represents 1 mm (habitus only).

Holotype

♂. 'BES 12075, Windarra Station, South Well, 28.46623S 122.15693E, WF Humphreys & SJB Cooper, 27/9/04', WAM 38245. Slide mounted.

Description (number examined, 1)

Habitus. Length 4.2 mm; relatively flat, quite strongly constricted at junction of pronotum/elytra; elongate sides of elytra subparallel; uniformly light testaceous; hindwing reduced, about a half length of elytron.

Head. A little narrower than elytra; smooth, reticulation weak, punctures sparse, very small; subparallel in posterior half, narrowing strongly in front of eye remnant; eye remnant reduced to confused area of sutures. Antenna thin, segments 1 and 2 elongate cylindrical, segment 3 as long as segment 2, narrower, narrowing towards base expanded a bit on inner apical angle, segments 4 to 10 approximately equal in shape to segment 3, middle ones more expanded on inner apical angle, 11 about 1.5x as long as segment 10 and narrower, each segment except, segment 1, with some very small setae on inside apically. Maxillary palpus thin, elongate, segment 4 as long as segments 1 to 3 combined.

Pronotum. Rather short, about same width as elytra; anteriolateral angles projecting strongly forward; base strongly constricted, posterolateral angles bluntly pointed, overlying elytra somewhat; smooth, reticulation weak, punctures very weak, sparse, some stronger punctures along front margin; basal plicae absent, with 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 row of widely spaced small punctures close to inner edge; 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 quarter, thin along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, sides narrowly bullet-shaped, tip bluntly pointed, weakly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact at midline. Metathorax broadly triangular in front in midline; wings relatively broad; rounded 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 except close to sides, 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, ventrite 6 quite prominent, constricted near apex.

Legs. Protibia club-shaped, relatively narrow, widest beyond middle where it is about four times its basal width; protarsus moderately expanded, segment 1 as broad as long, segment 2 as wide as segment 1 and about a half its length, segment 3 as long as segment 1 a bit narrower, deeply bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about 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 thin with 6 weak spines in basal half (Fig. 88); mesotarsus similar to protarsus. Metatrochanter small broadly oval (Fig. 89); metafemur relatively thin, 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.

Male. Median lobe of aedeagus relatively broad near base, strongly waisted in middle, thin in apical half, gradually narrowing towards tip, tip rounded; paramere relatively broad, apical segment with long paddle-shaped apical lobe well separated from rest of segment. Figs 85 - 87.

Female. Unknown.

Etymology. Latin. "Palmula-oides" – blade-like. A reference to the unusual paddle-shaped apical lobes to the parameres.

Remarks

A large, distinctive species, recognized by the abrupt narrowing of the head in front of the eye remnants, the small rounded metatrochanters and the exposed sixth ventrite. The knucklebone-like tip to the median lobe of the aedeagus and the long paddle-like paramere lobes are also very distinctive.

***Limbodessus phoebeae* sp. nov.**

Holotype

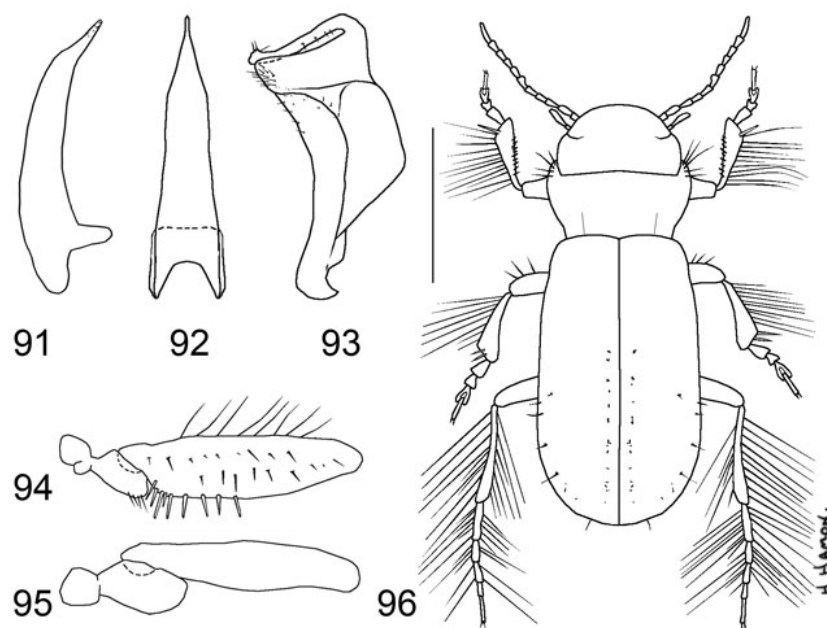
♂. 'BES 10457 1/6/04 Yakabindie Station L Miranda E MEB site 229 27.66407 120.61167 WF Humphreys CHS Watts C Clay', WAM 38246. Slide mounted.

Paratypes

29; 9, as for holotype, SAMA; 10, as for holotype except 'BES 10458', WAM 38247 - 38256; 7; ditto except 'BES10465, Site 227, 27.66403 120.61193' SAMA; 1, ditto except, 'BES10469, Site 229, 27.66403 120.61143' WAM 38257; 1, 'BES 10474 1/6/04 Yakabindie Station MEB site 232 27.66480 120.60773 WF Humphreys CHS Watts C Clay' SAMA.

Description (number examined, 30)

Habitus. Length 2.6 – 2.8 mm; relatively flat, moderately constricted at junction of pronotum/elytra; elongate, sides subparallel; uniformly light testaceous; hindwing reduced, about half length of elytron.



Figs 91-96. *Limbodessus phoebeae* sp. nov.: 91, lateral view of median lobe of aedeagus; 92, ditto dorsal view; 93, paramere; 94, mesotrochanter and mesofemur; 95, metatrochanter and metafemur; 96, dorsal view. Scale bar represents 1 mm (habitus only).

Head. Narrower than elytra; smooth, reticulation weak, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant reduced to a strongly marked (pigmented) suture. Antenna segment 1 cylindrical, segment 2 barrel-shaped, segment 3 as long as segment 2, narrower, narrowing towards base, segments 4 to 10 approximately equal in length, segment 4 narrower than others, segment 11 narrower than and 1.2x length of segment 10, each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus thin, segment 4 as long as segments 1 to 3 combined.

Pronotum. About same width as elytra; anteriolateral angles projecting strongly forward; base moderately constricted, posterolateral 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, reaching to about a third way along pronotum; with row of long setae laterally in anterior half.

Elytra. Not fused, lacking inner ridges; elongate, sides subparallel, not converging until close to apex, smooth, weakly reticulate, very sparsely covered with very small punctures, a few widely spaced larger punctures close to inner edge; 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 weak, well separated, weakly diverging in anterior third, becoming obsolete before reaching mesosternum; 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 5x its basal width; protarsus expanded, segment 1 as broad as long, segment 2 a little narrower than segment 1 and about a third its length, segment 3 shorter than segment 1 narrower, deeply bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about as long as 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 5 – 7 spines in basal half (Fig. 94); mesotarsus similar to protarsus, a little more elongate. Metatrochanter relatively small, tip rounded (Fig. 95); metafemur thin, lacking spines; metatibia very 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, rapidly narrowing towards tip, tip sharply pointed; paramere broad, apical segment with long thin apical lobe strongly reflexed inwards and overlapping rest of segment. Figs 91 - 93.

Etymology. Named after Phoebe Humphreys.

Remarks

A moderate sized species with triangular eye remnants and a strong suture line between the first two ventrites. Morphologically rather similar to *L. mirandae* from an adjacent calcrete but separated from that species by having the mesosternal plate parallel-sided and seven spines along the hind margin of the mesofemur as well as characters of the aedeagus.

***Limbodessus raeae* sp. nov.**

Holotype

♂. 'BES 10491 3/6/04 Hinkler Stn calcrete Dawsons Well 26.88651 120.16203 WF Humphreys CHS Watts & C Clay', WAM 38259. Slide mounted.

Paratypes

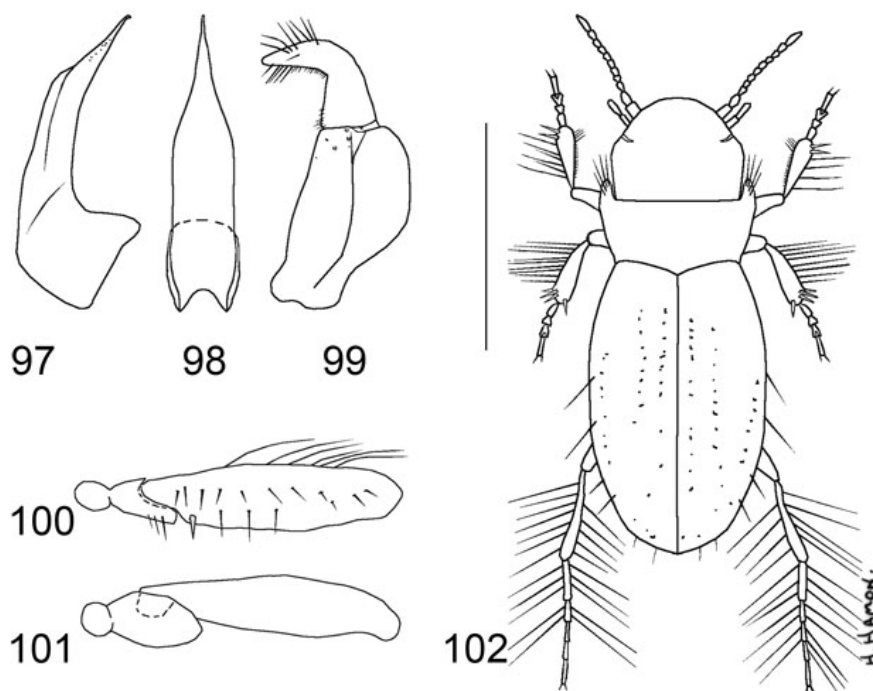
2, as for holotype, SAMA.

Description (number examined, 3)

Habitus. Length 2.0 – 2.1 mm; slightly convex flat, moderately constricted at junction of pronotum/elytra; elongate oval; uniformly light testaceous; hindwing reduced, about a third length of elytron.

Head. Broad, a little narrower than pronotum; smooth, reticulation weak, punctures sparse, small; subparallel in posterior half, bulging slightly just behind eye remnant; eye remnant reduced to small triangular or oval area. Antenna moderately stout, segment 1 cylindrical, segment 2 barrel-shaped, segment 3 shorter than segment 2, narrower, strongly narrowing towards base, segments 4 to 10 approximately equal in shape, segment 11 slightly narrower and 2x length of segment 10, each segment, except segment 1, with some very small setae on inside apically. Maxillary palpus relatively stout, segment 4 as long as segments 1 to 3 combined.

Pronotum. A little narrower than elytra; anteriolateral angles projecting strongly forward; base moderately constricted, posterolateral angles sharply pointed, overlying elytra somewhat; smooth, reticulation weak, punctures weak, sparse; basal plicae absent; with row of long setae laterally in anterior half.



Figs 97-102. *Limbodessus raeae* sp. nov.: 97, lateral view of median lobe of aedeagus; 98, ditto dorsal view; 99, paramere; 100, mesotrochanter and mesofemur; 101, metatrochanter and metafemur; 102, dorsal view. Scale bar represents 1 mm (habitus only).

Elytra. Not fused, lacking inner ridges; elongate, widest behind middle, smooth, very weakly reticulate, moderately covered with very small punctures, a few widely spaced larger punctures close to inner edge; a few additional larger punctures with long setae, more frequent towards sides. Epipleuron weakly differentiated from rest of elytron, relatively narrow in anterior quarter, very narrow along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, relatively broad, sides weakly converging towards rear, tip rounded, moderately arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact at midline. Metathorax triangular in front in midline; wings very narrow; rounded or slightly triangular in midline behind. Metacoxal plates large, shiny, moderately reticulate, metacoxal lines obsolete; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines almost obliterated, 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, relatively narrow, widest near apex where it is about four times its basal width; protarsus narrow, segment 1 about 2x as long as broad, segment 2 as wide as segment 1 and about a half its length, segment 3 shorter than segment 1, about as wide, bifid, segment 4 small, segment 5 narrow, cylindrical, about 1.4x length of segment 3, segments 1 to 3 with a few adhesive setae; claws short and simple. Mesotrochanter elongate/rectangular with a few thin setae on inner edge; mesofemur with 1 spine close to base on inner edge (Fig.100); mesotarsus similar to protarsus, a bit more elongate. Metatrochanter tip blunt (Fig. 101); metafemur relatively broad, 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.

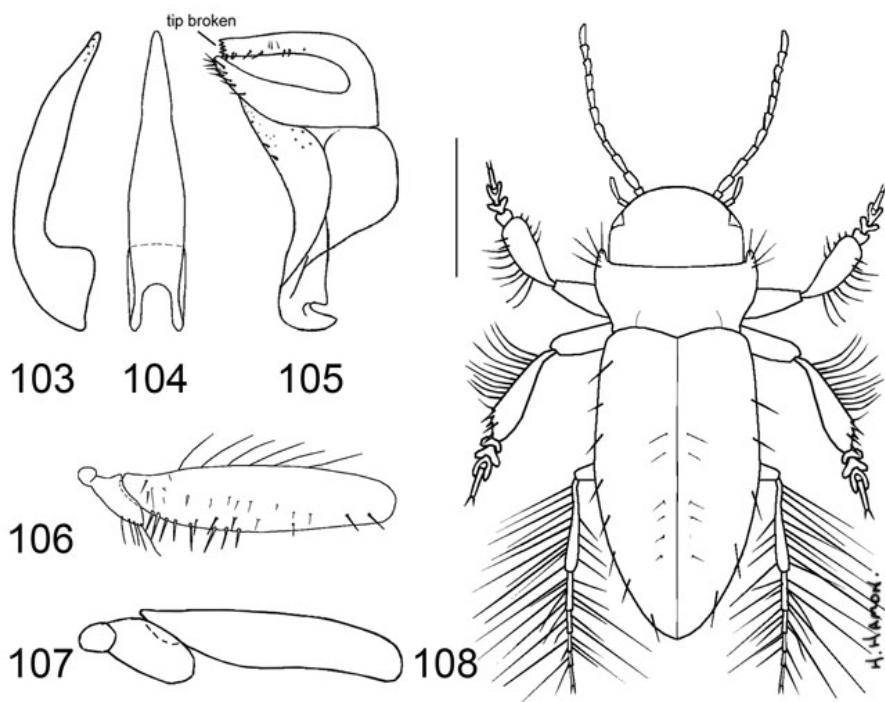
Male. Little external differences between the sexes. Aedeagus small, median lobe relatively broad, rapidly narrowing near tip, tip pointed; basal segment of paramere broad, apical segment narrow, hook-shaped. Figs 97 - 99.

Etymology. Named after Rae Young for her long support of stygobitic studies.

Remarks

A rather small species with thin pro and mesotarsi with only a few adhesive setae, the number of which vary between specimens, and mesofemurs with only one spine on their hind margins. The aedeagus is relatively small and the apical segments of the parameres unusually simple and hook-like. DNA sequencing (R. Leys pers. comm.) places it phylogenetically close to *L. hinkleri* and *L. macrohinkleri* from the same well even though the morphology of these three apparent sister species are very different.

Limbodessus surreptitius sp. nov.



Figs 103-108. *Limbodessus surreptitius* sp. nov.: 103, lateral view of median lobe of aedeagus; 104, ditto dorsal view; 105, paramere; 106, mesotrochanter and mesofemur; 107, metatrochanter and metafemur; 108, dorsal view. Scale bar represents 1 mm (habitus only).

Holotype

♂. 'BES 10389 25/3/04 Challa Station North Main Road Bore 27.99693 118.52344 WF Humphreys & SJB Cooper', WAM 38260. Slide mounted.

Description (number examined, 1)

Habitus. Length 3.2 mm; relatively flat, strongly 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 relatively thin, segments 1 and 2 cylindrical, segment 3 as long as segment 2, narrower, narrowing towards base, segment 4 shorter than segment 3 and more even in width, segments 5 to 10 approximately equal in shape, narrowing towards base, expanded on inner apical angle, segment 11 thinner than and 1.2x 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. Same width as elytra; anteriolateral angles projecting strongly forward; base strongly constricted, posterolateral angles quite sharply 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 in middle, smooth, very weakly reticulate, sparsely covered with very small punctures; a few additional larger punctures with long setae, more frequent towards sides. Epipleuron differentiated from rest of elytron only in posterior half, that portion of elytron visible ventrally, relatively broad in anterior quarter, 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, weakly spined; protarsus moderately expanded, segment 1 as broad as long, segment 2 as wide as segment 1 and about a 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 1.2x 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 – 8 weak spines in basal half (Fig. 106); mesotarsus similar to protarsus. Metatrochanter tip rounded (Fig. 107); metafemur relatively thin, a little sinuate, 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 a little longer than as others; claws weak.

Male. Median lobe of aedeagus relatively broad, gradually narrowing towards tip, tip rounded; paramere broad, apical segment with very long thin apical lobe overlapping rest of segment towards its apex. Figs 103 - 105.

Female. Unknown.

Etymology. Latin. “Surreptitius” – concealed/ clandestine. A reference to its seeming rarity in a well-visited calcrete.

Remarks

A large species resembling *L. eberhardi* in its broad pronotum and elongate shape. The apical segments of the parameres are unusually short with long thin apical lobes (Fig. 105). In the only known specimen the extreme tips of the parameres have been broken off.

***Limbodessus usitatus* sp. nov.**

Holotype

♂. ‘BES 10376 25/3/04 Barwidgee Stn MEB site 143 27.13747 120.94943 WF Humphreys SJB Cooper.’ WAM 38261. Slide mounted.

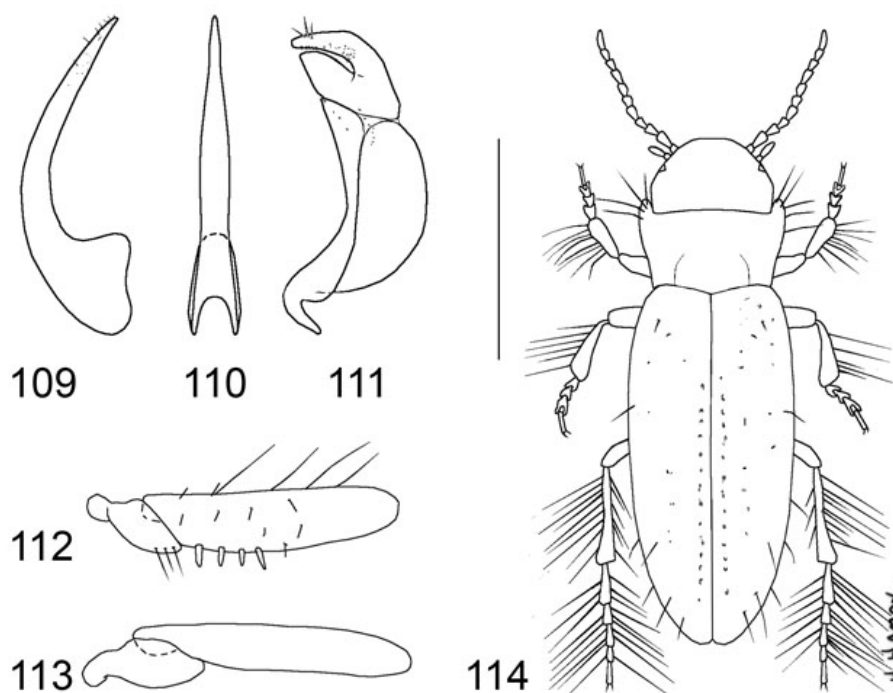
Paratypes

5; 2, as for holotype except, .BES 10380. 1 SAMA 1 WAM 38262; 1, ditto except, ‘BES 10370’ WAM 38263; 2, ‘BES 10367 24/3/04 Barwidgee Station MEB Site 144, 27.13760 120.94633 WF Humphreys & SJB Cooper’, 1 SAMA 1 WAM 38264.

Description (number examined, 6)

Habitus. Length 2.1 – 2.3 mm; relatively flat, moderately constricted at junction of pronotum/elytra; elongate oval; uniformly light testaceous; hindwing reduced, about one third length of elytron.

Head. Narrower than elytra; smooth, reticulation weak, punctures sparse, very small; subparallel in posterior half, widest just behind eye remnant; eye remnant reduced to short suture line. Antenna stout, segment 1 cylindrical, segment 2 barrel-shaped, segment 3 about as long as segment 2, narrower, narrowing towards base, segments 4 to 10 approximately equal in shape middle ones slightly larger, segment 11 sided-sided a bit narrower and 2x as long as 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.



Figs 109_114. *Limbodessus usitatus* sp. nov.: 109, lateral view of median lobe of aedeagus; 110, ditto dorsal view; 111, paramere; 112, mesotrochanter and mesofemur; 113, metatrochanter and metafemur; 114, dorsal view. Scale bar represents 1 mm (habitus only).

Pronotum. Narrower than elytra; anteriolateral angles projecting strongly forward; base moderately constricted, posterolateral angles sharply pointed, overlying elytra somewhat; smooth, reticulation weak, punctures very weak, sparse, a row of stronger punctures along front margin; basal plicae moderate, straight, slightly sloping inwards, 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, parallel-sided, smooth, very weakly reticulate, sparsely covered with very small punctures; a sutural row of large punctures on each elytron a few additional large punctures, more frequent towards sides. Epipleuron not differentiated from rest of elytron, that portion of elytron visible ventrally, thin.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, sides subparallel, tip sharply 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 very weak, well separated, diverging somewhat in

middle, reaching mesosternum; 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 or slightly club-shaped, relatively narrow, widest near apex where it is about 5x its basal width; protarsus weakly expanded, segment 1 a little longer than broad, segment 2 as wide as segment 1 and about a third its length, segment 3 about as long as wide, deeply bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 narrow, cylindrical, about 1.2x 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 at tip; mesofemur with 4 – 5 relatively short spines in basal half (Fig. 112); mesotarsus a little narrower and longer than protarsus. Metatrochanter relatively elongate, tip rounded (Fig. 113); metafemur relatively thin, lacking spines; metatibia narrow, moderately curved, widening towards apex; metatarsus rather stout, segment 1 longest, segment 5 longer than segment 4, segments 1 and 2 in combination about as long as others, spines at apex of segments and metatibia prominent; claws weak.

Male. Little external differences between the sexes. Median lobe of aedeagus relatively broad, gradually narrowing towards tip, tip rounded; paramere relatively narrow, apical segment with long apical lobe narrowly separated from rest of segment which is also narrow. Figs 109-111.

Etymology. Latin. “Usitatus” – familiar. A reference to its now very familiar morphology.

Remarks

A medium sized species with very typical morphology. Separated morphologically from the similar *L. wogarthaensis* and *L. lapostae* by its slightly larger size and details of the aedeagi.

***Limbodessus yandalensis* sp. nov.**

Holotype

♂. ‘BES 10357 23/3/04 Yandal Station MEB site 133 110 mm Fe bore 27.7249 120.95849 WF Humphreys SJB Cooper’. WAM 38265.

Paratypes

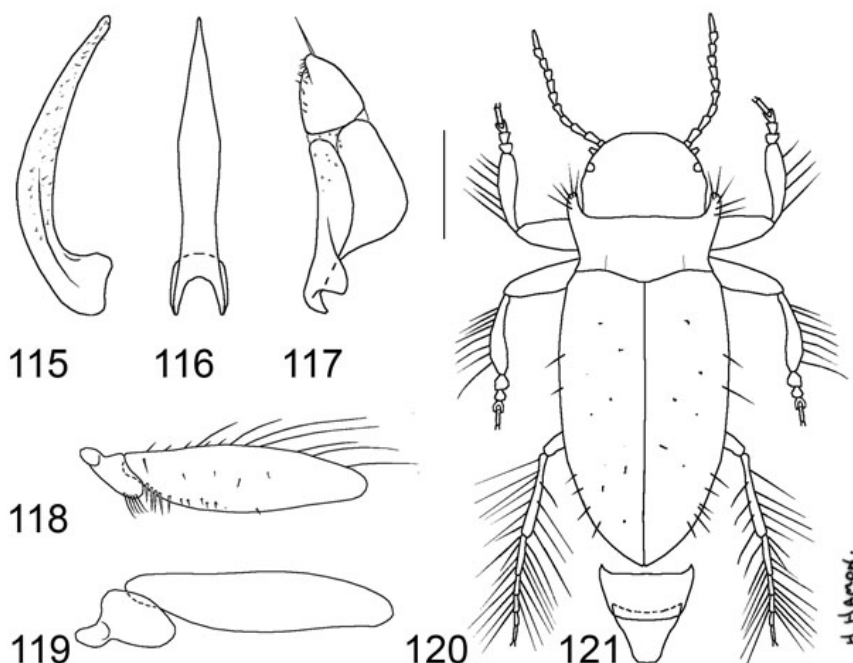
3; 1, as for holotype, WAM 38266; 1(partial), ‘BES 10397 22/3/04 Yandal Stn MEB site 128 27.76413 121.02592 WF Humphreys SJB Cooper’, SAMA; 1, ‘BES 10357 ‘Yandal Station Calowindi Well MEB Site 133, 27.7249: 120.95849, 23/3/04, WF Humphreys & SJB Cooper’, WAM 38267; 1, ‘BES 10354 Yandal Station Calowindi Well (Sink hole) 27.71909 120.96455 WF Humphreys SJB Cooper 23/3/04’, SAMA.

Description (number examined, 4)

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, about same width distally, narrowing towards base, segment 4 similar to segment 3, segments 5 to 10 with slightly bulbous inner apical angle, becoming progressively shorter, segment 11 narrower than 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 2 combined.

Pronotum. Same width as elytra, relatively short; anteriolateral angles projecting strongly forward; base quite strongly constricted, posterolateral angles quite sharply pointed, overlying elytra somewhat; smooth, reticulation weak, punctures very weak, sparse, some stronger punctures along front margin; basal plicae weak, straight, reaching to about a third way along pronotum; with row of long setae laterally in anterior half.

Habitus. Length 3.8 – 4.0 mm; relatively flat, quite strongly constricted at junction of pronotum/elytra; narrowly oval; uniformly light testaceous; hindwing reduced, about half-length of elytron.



Figs 115-121. *Limbodessus yandalensis* sp. nov.: 115, lateral view of median lobe of aedeagus; 116, ditto dorsal view; 117, paramere; 118, mesotrochanter and mesofemur; 119, metatrochanter and metafemur; 120, dorsal view; 121, fifth and sixth ventrites. Scale bar represents 1 mm (habitus only).

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, about same width distally, narrowing towards base, segment 4 similar to segment 3, segments 5 to 10 with slightly bulbous inner apical angle, becoming progressively shorter, segment 11 narrower than 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 2 combined.

Pronotum. Same width as elytra, relatively short; anteriolateral angles projecting strongly forward; base quite strongly constricted, posterolateral angles quite sharply pointed, overlying elytra somewhat; smooth, reticulation weak, punctures very weak, sparse, some stronger punctures along front margin; basal plicae weak, straight, reaching to about a third way along pronotum; with row of long setae laterally in anterior half.

Elytra. Not fused, lacking inner ridges; elongate, almost parallel sided, 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 very weakly differentiated from rest of elytron, that portion of elytron visible ventrally, moderately broad for most of elytron until close to tip.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, diamond-shaped, anterior portion projecting forward a bit, tip 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 in midline behind. Metacoxal plates large, shiny, virtually nonreticulate, metacoxal lines weak, widely spaced, straight, reaching to about a third way to mesothorax; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural

lines distinct, ventrite 5 extended apically (Fig.121), 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 narrow bow-shaped, widest before apex where it is about 5x its basal width; protarsus weakly expanded, segment 1 as broad as long, segment 2 narrower than segment 1 and about a third its length, segment 3 about as long as segment 1, about as wide, bifid, segment 4 very small, hidden within lobes of segment 3, segment 5 stout, cylindrical, about as long as 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 8 – 10 thin spines/setae in basal half (Fig. 118); mesotarsus a little more elongate than protarsus. Metatrochanter relatively small, broadly oval (Fig. 119); metafemur thin, lacking spines; metatibia narrow, moderately curved, widening towards apex; metatarsus, segment 1 longest, segment 5 longer than segment 4, segments 1 and 2 in combination longer than others; claws weak.

Male. Little external differences between the sexes. Median lobe of aedeagus relatively broad, gradually narrowing towards tip, tip rounded; paramere relatively broad, apical segment with very short apical lobe overlapping rest of segment. Figs 115 - 117.

Etymology Named after the pastoral station on which it was found.

Remarks

A large distinctive species with relatively stout antennae, small semicircular eye remnants, very weak mesofemoral spines, broad epipleura and the apex of the sixth ventrite chitinized, constricted and extended backwards, a form otherwise only found in *L. palmulaoides* within the genus.

***Nirripiri* Watts & Humphreys, 2001 (Hydroporinae, Hydroporini)**

***Nirripiri macrosturtensis* sp. nov.**

Holotype

♂. 'BES 10270 18/3/04 Sturt Meadows Station 50 mm PVC Site 63 28.71642 120.88995 WF Humphreys & SJB Cooper', WAM 38268. Slide mounted.

Paratypes

2, as for holotype, except 'BES 10258, MEB Site 20 28.70023 120. 89337', SAMA.

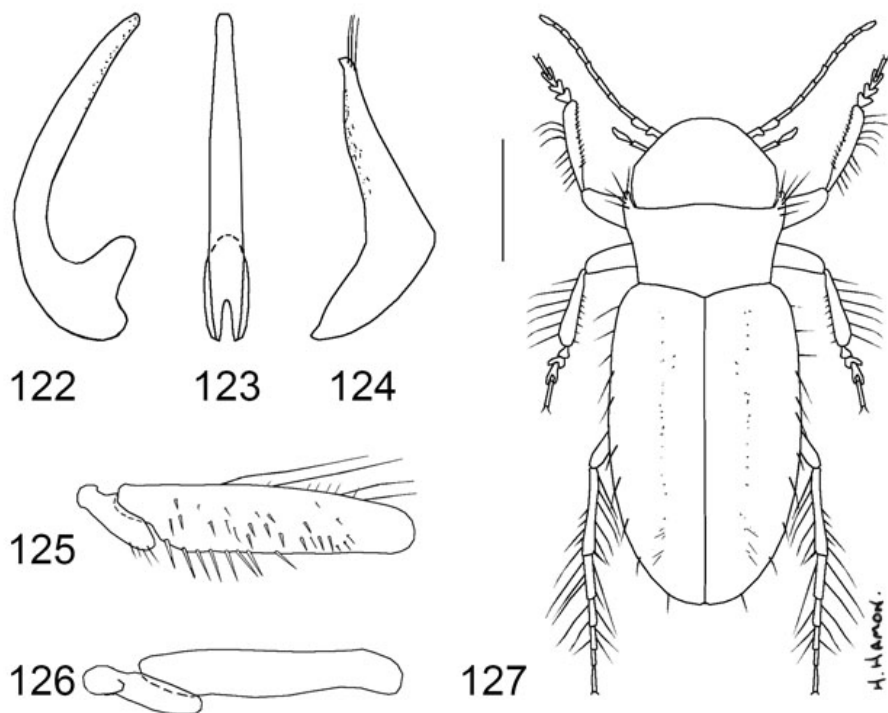
Description (number examined, 3)

Habitus. Length 3.6 – 4.1 mm; elongate, relatively flat, moderately constricted at junction of pronotum/elytra; uniformly light testaceous; hindwing vestigial, reduced to tiny flap.

Head. Relatively large, a little 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 thin, segments 1 and 2 cylindrical, segments 3 to 6 narrower and a bit longer than segment 2, segments 7 to 10 bit shorter than segment 6, segments 3 to 10 with inner apical angles slightly enlarged, segment 11 same length but a little thinner than segment 10, each segment with some very small setae on inside apically. Maxillary palpus elongate, segments 3 to 4 subequal in length, each about as long as segments 2 and 3 combined.

Pronotum. Narrower than elytra; anteriolateral angles projecting forward; sides converging towards the rear, posterolateral 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, parallel-sided; smooth; covered with weak 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.



Figs 122-127. *Nirripiri macrosturtensis* sp. nov.: 122, lateral view of median lobe of aedeagus; 123, ditto dorsal view; 124, paramere; 125, mesotrochanter and mesofemur; 126, metatrochanter and metafemur; 127, dorsal view. Scale bar represents 1 mm (habitus only).

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, apical half oval, thin, sides converging towards rear, apex rounded, weakly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact in midline. Metathorax weakly projecting forward in midline; wings very short; broadly rounded in midline behind. Metacoxal plates large, metacoxal lines weak, relatively close together, strongly diverging in front and rear quarters, reaching beyond half way to mesosternum; sparsely covered with small punctures, moderately reticulate; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct only in inner half, 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 in middle where it is about 3x its basal width; protarsus weakly expanded, segment 1 broadly triangular, segment 2 a little larger, segment 3 longer than segment 1, deeply bifid, segment 4 very small and hidden within lobes of segment 3, segment 5 thin, 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 7 to 8 evenly spaced spines along hind edge in basal half (Fig. 125); mesotarsus a little more elongate than protarsus. Metatrochanter elongate oval with apex rounded (Fig. 126); metafemur thin, lacking spines; metatibia weakly curved, weakly expanded towards apex; metatarsus elongate, segment 1 longest, segment 4 shortest, in combination segments 1 and 2 as long as others, segments 2 to 5 without spines other than at apex, segments 2 to 4 cylindrical; claws weak.

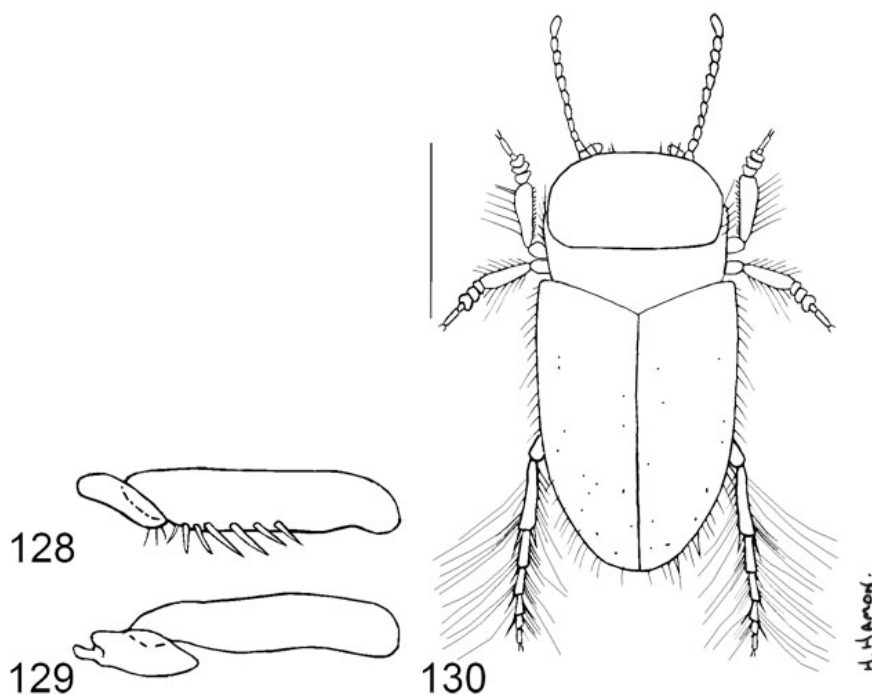
Male. Antenna and protarsi slightly more expanded than in female. Median lobe of aedeagus rather narrow, narrowing towards apex, apex rounded; paramere relatively narrow, tip with two long setae. Figs 122 - 124.

Etymology. Greek. “Macro” – large. A reference to the fact that it is the largest of the three known species from the Sturt Meadows calcrete.

Remarks

A large species with thin antennae, greatly enlarged basal segment on the pro and mesotarsi, seven to nine moderately sized spines on the hind edge of the mesofemur, narrow pronotal process and short metasternal wings. The elytral shoulders are particularly prominent.

Nirripiriti megamacrocephalus sp. nov.



Figs 128-130. *Nirripiriti megamacrocephalus* sp. nov.: 128, mesotrochanter and mesofemur; 129, metatrochanter and metafemur; 130, dorsal view. Scale bar represents 1 mm (habitus only).

Holotype

♀. 'BES 9943 24/6/03 Newhaven Station bore RN 10151 at Camel Well 22.93439 131.23972 WF Humphreys & CHS Watts', WAM 38269. In alcohol.

Description (number examined, 1)

Habitus. Length 2.4 mm; narrowly rectangular, relatively flat, weakly constricted at junction of pronotum/elytra; uniformly light testaceous; hindwing vestigial, reduced to tiny flap.

Head. Very large, as wide as elytra; smooth, rather weak reticulation with small even meshes, a few scattered small punctures; sides diverging to middle; eye remnant reduced to short suture. Antenna relatively thin, segments 1 and 2 cylindrical, segments 3 and 4 half width and two thirds length of segment 2, segment 5 bit longer than segment 4, segments 6 to 10 larger, subequal, segment 11 2.0x length of segment 10, each segment with some very small setae on inside apically. Maxillary palpus elongate, segment 4 about as long as segments 2 and 3 combined.

Pronotum. Short. As wide as elytra in front, narrower than elytra behind; anteriolateral angles long, thin; sides diverging towards the front, posterolateral angles acute (Fig. 130); 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, sides subparallel; smooth; covered with 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, very broad in anterior fifth, then reducing to moderate width until near apex.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, apical half broadly diamond-shaped, strongly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact in midline. Metathorax sharply projecting forward in midline; wings moderate; broadly rounded in midline behind. Metacoxal plates large, metacoxal lines absent, smooth virtually lacking punctures or reticulation; closely adpressed to ventrite 1.

Ventriles 1 and 2 fused, sutural lines distinct, ventrites 3 – 5 mobile, smooth virtually lacking punctures or reticulation 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 1 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 covering of adhesive setae; claws short and simple. Mesotrochanter elongate with a few fine setae at apex; mesofemur with row of 7 to 8 long spines along hind edge in basal half (Fig. 128); mesotarsus thin a lot more elongate than protarsus. Metatrochanter with apex bluntly pointed (Fig. 129); metafemur relatively thin, lacking spines; metatibia weakly curved, weakly expanded towards apex; metatarsus elongate, segment 1 longest, segment 4 shortest, in combination segments 1 and 2 as long as others, segments 2 to 5 without spines other than at apex, segments 2 to 3 weakly hour-glass shaped; claws weak.

Male. Unknown.

Etymology. Greek. “Mega” – large. The large *N. macrocephalus*.

Remarks

Closely resembles the distinctive *N. macrocephalus* with its broad head and thin appendages, but is larger, the suture line between the first two ventrites is complete and it lacks the unique anvil-like pronotal process found in *N. macrocephalus*.

Nirripiriti mesosturtensis sp. nov.

Holotype

♂. ‘BES 10277 18/3/04 Sturt Meadows Station MEB site 33 28.69679 120.90366 WF Humphreys & SJB Cooper’, WAM 38270. Slide mounted.

Paratypes

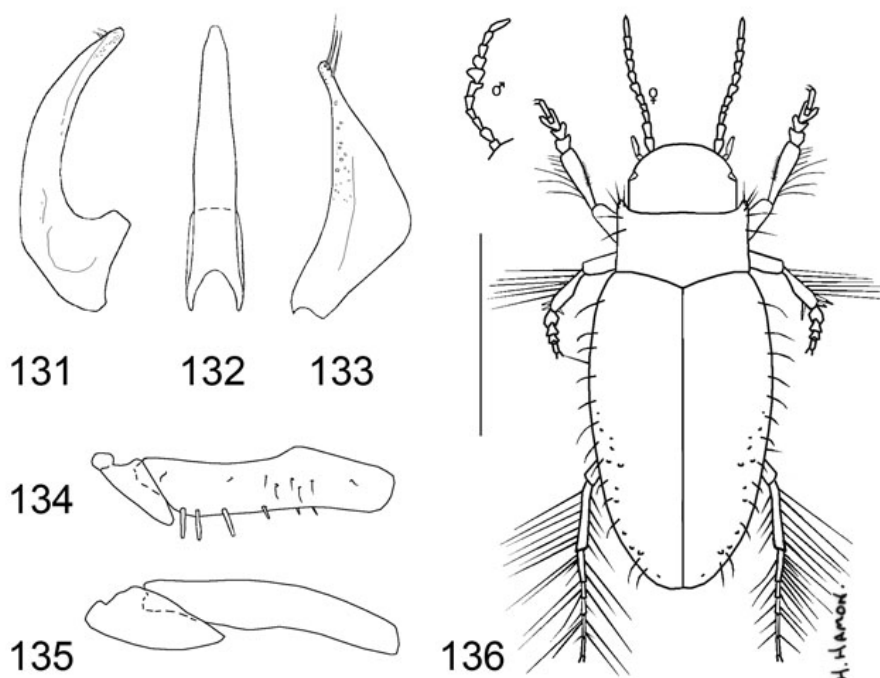
27; 6, as for holotype, 3 SAM 3 WAM 38271 - 38273; 1, ‘BES 10270, Sturt Meadows Station, 50 mm PVC Site 63 28.71642 120.88995 18/3/04 WF Humphreys & SJB Cooper’, WAM 38274; 1, ‘BES 10258 Sturt Meadows Station MEB Site 20 28.70023 120.89337 17/3/04 WF Humphreys & SJB Cooper’, SAMA; 2, as for holotype, except ‘BES 10261 50 mm piezo Site 30 28. 69659 120. 89349 18/3/04’, WAM 38275 - 38276; 4, ditto except ‘BES 10265 MEB Site 24 28.70033 120 89949 (dead)’, 2 SAMA 2 WAM 38277 - 38278; 2, ditto except ‘BES 10269 50 mm PVC Site 63 28.71642 120.88995’, WAM 38279 - 38280; 6, ditto except, ‘BES 10276 MEB Site 33 28.69679 120.90366’, 2 SAMA 4 WAM 38281 - 38284; 5, ditto except, ‘BES 10279 MEB Site 35 28.69837 120 89340 (dead)’, 2 SAMA 3 WAM 38285 - 38287.

Habitus. Length, male 2.05 – 2.3 mm, female 1.9 – 2.05 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, moderately strong reticulation with small even meshes, a few scattered small punctures; sides parallel; eye remnant reduced to short indentation with only a hint of a suture line. (Antennae – see under male and female). Maxillary palpus relatively stout, segment 4 a little longer than segments 2 and 3 combined.

Description (number examined, 28)

Pronotum. Much narrower than elytra; anteriolateral angles projecting forward; sides sinuate, posterolateral angles right angles; a few moderately large punctures along front margin; long setae at sides particularly towards front; reticulation as on head.



Figs 131-136. *Nirripiriti mesosturtensis* sp. nov.: 131, lateral view of median lobe of aedeagus; 132, ditto dorsal view; 133, paramere; 134, mesotrochanter and mesofemur; 135, metatrochanter and metafemur; 136, dorsal view. Scale bar represents 1 mm (habitus only).

Elytra. Not fused, tightly locked, lacking inner ridges; elongate, widest in 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, not reaching mesothorax, apical half almond-shaped, pointed behind, weakly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact in midline. Metathorax moderately strongly projecting forward in midline; wings very short; broadly triangular in midline behind. Metacoxal plates large, metacoxal lines weak, well separated, weakly diverging in front quarter, reaching to about one third way to mesosternum; sparsely covered with small punctures, moderately reticulate; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, inner portions of 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 subrectangular triangular, segment 2 similar, segment 3 a little longer than segment 1, deeply bifid, segment 4 very small and hidden within lobes of segment 3, segment 5, 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 somewhat angular, with row of 4 spines along hind edge in basal half (Fig. 134); mesotarsus a little more elongate than protarsus. Metatrochanter elongate with apex weakly pointed, tip well separated from metafemur (Fig. 135); metafemur thin, strongly sinuate on front edge, lacking spines; metatibia strongly curved, moderately 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 cylindrical; claws weak.

Male. Segment 6 of antenna strongly enlarged apically on inside, segment 7 strongly enlarged on outside at apex, segment 8 moderately enlarged apically; protarsi slightly more expanded than in female. Median lobe of aedeagus relatively narrow, apex rounded; paramere relatively narrow, tip with two long setae. Figs 131 - 133.

Female. Antennae moderately thick, segment 1 cylindrical, segment 2 barrel-shaped, segments 3 and 4 half width and length of segment 2, segments 5 to 10 subequal in length middle ones slightly wider, segment 11 approximately 1.5x length of segment 10, each segment with some very small setae on inside apically.

Etymology. Greek. "Meso" – middle. A reference to the fact that it is the middle sized of the three known species from the Sturt Meadows calcrete.

Remarks

A medium sized species, the males of which are readily recognized by the enlarged middle segments of the antenna which are reminiscent of those of the males in many species of *Sternopriscus*. The middle segments of the antennae of the females are only weakly enlarged. The mesofemurs, particularly in the males, are quite sinuate along the front margin in a similar fashion to those in the sympatric *N. microsturtensis*. The species is also recognizable by its relatively small head and pronotum, parallel or slightly sinuate sides of the pronotum and the elongate, thin hind legs. One of only a few Australian stygo Dytiscidae to show much sexual dimorphism.

Nirripiriti microsturtensis sp. nov.

Holotype

♂. 'BES 10270 Sturt Meadows Station 50 mm bore Site 64 28.71731 120.88889 WF Humphreys & SJB Cooper', WAM 38288. In alcohol.

Paratypes:

6; 2, as for holotype except, 'BES 10261 piezo Site 30 28.69659 120.89349 18/3/04', 1 SAM 1 WAM 38289; 1, ditto except 'BES 10265 MEB Site 24 28.70033 120.89949', SAM; 2, ditto except 'BES 10282 MEB Site 22 28.70034 120.90360', WAM 38290; 1, ditto except 'BES 10284 MEB Site 32 28.69668 120.89656', SAM.

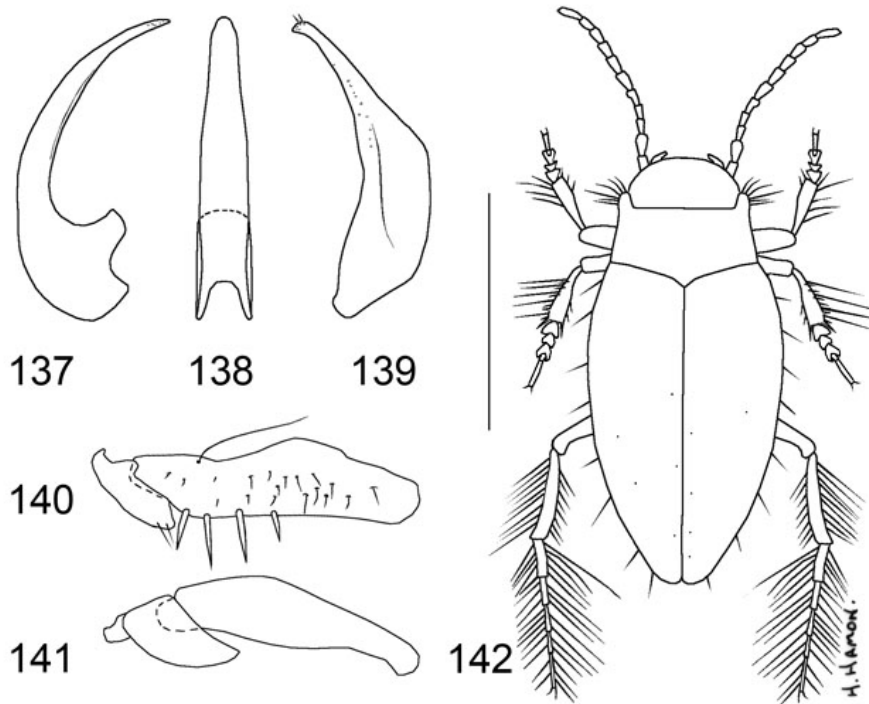
Description (number examined, 7)

Habitus. Length 1.7 – 1.8 mm; elongate, slightly convex, 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 small indentation and faint suture. Antenna relatively thin, segment 1 cylindrical, segment 2 barrel-shaped, segments 3 to 10 subequal in length, middle ones slightly expanded on inner apical angle,

segment 11 1.5x length of segment 10 and a bit narrower, 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. Much narrower than elytra; anteriolateral angles projecting forward; sides weakly diverging towards the rear, posterolateral 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.



Figs 137-142. *Nirripiriti microsturtensis* sp. nov.: 137, lateral view of median lobe of aedeagus; 138, ditto dorsal view; 139, paramere; 140, mesotrochanter and mesofemur; 141, metatrochanter and metafemur; 142, dorsal view. Scale bar represents 1 mm (habitus only).

Elytra. Not fused, tightly locked, lacking inner ridges; elongate, slightly convex, widest before middle, narrowing towards apex; 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 not differentiated, that portion visible ventrally broad in anterior fifth, virtually absent along rest of elytron.

Ventral surface. Prosternal process strongly narrowed between coxae, not reaching mesothorax, apical half oval, strongly pointed behind, strongly arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact in midline. Metathorax weakly projecting forward in midline; wings short, thin; broadly triangular in midline behind. Metacoxal plates large, metacoxal lines weak strongest in front and rear portions, well separated, weakly diverging towards front, reaching 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, quite strongly reticulate with scattered small punctures and a few long central setae or bunch of long setae.

Legs. Profemur with small spatula-like structure at base opposite tip of protrochanter. Protibia narrow, quite strongly excavated on inner edge towards apex; protarsus weakly expanded, segment 1 broadly triangular, segment 2 a little narrower and about half as long, segment 3 narrower than segment 2 and a little longer than 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 angular with row of 4 – 5 spines along hind edge in basal half (Fig. 140); mesotarsus a little more elongate than protarsus. Metatrochanter with apex weakly pointed, tip close to metafemur (Fig. 141); metafemur with distinct ridge along basal half near inner edge, lacking spines; metatibia strongly curved; 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, segments 2 to 4 cylindrical; claws weak.

Male. No external difference between sexes. Median lobe of aedeagus broad, widening towards apex; paramere relatively narrow, tip with two long setae. Figs 137 – 139.

Etymology. Greek. ‘Micro’ – small. In reference to the fact that it is the smallest of the three known species from the Sturt Meadows calcrete.

Remarks

A small, boat-shaped, rather deep-bodied species with the mesofemurs quite strongly sinuate along the front edge and with strong spines. The metafemurs are unusual in having a distinct ridge along the basal half near the inner edge and being strongly scalloped near the apex. The excavation near the apex of the protibia is also distinctive.

Nirripiriti septum sp. nov.

Holotype

♂. ‘BES 8091 Napperby Station NT Gov RN1561 @ Herbert Well 22 54 32S 132 43 45E 18/6/01 WF Humphreys & R Read’, WAM 38291. Slide mounted.

Paratype

♀. ‘BES 9929’ 23/6/03 Napperby Station Herbert Well 22.90891 132.72908 W F Humphreys CHS Watts’, SAMA.

Description (number examined, 2)

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

Head. Relatively large, narrower than elytra; smooth, rather weak reticulation with small even meshes, a few scattered small punctures; sides parallel in posterior half; eye remnant reduced to very short suture. (Antennae – see under male and female). Maxillary palpus very thin, elongate, segment 4 a little longer than segments 2 and 3 combined.

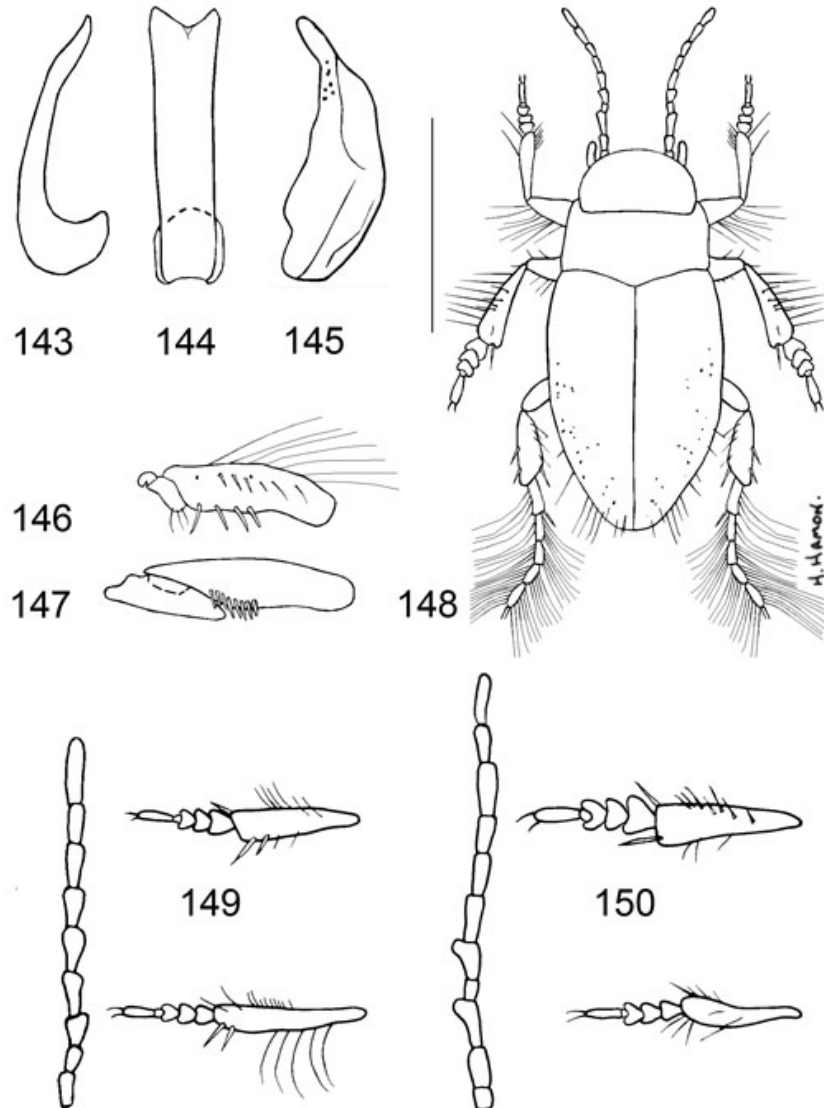
Pronotum. About as wide as elytra; anteriolateral angles projecting forward; sides subparallel, posterolateral angles right angles; a few scattered minute punctures and some larger ones along front margin; long setae at sides particularly towards front; moderately strongly reticulate.

Elytra. Not fused, 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, not reaching mesothorax, apical half elongate-oval, rounded behind, arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact in midline. Metathorax projecting forward in midline; wings moderately long; narrowly rounded in midline behind. Metacoxal plates large, metacoxal lines weak, well separated, weakly diverging in front quarter, reaching nearly mesosternum; sparsely covered with small punctures, moderately reticulate; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct only in inner half, ventrites 3-5 possibly

immobile, 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 3x its basal width; protarsus weakly expanded, 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 adhesive setae; claws short and simple. Mesotrochanter elongate with a few very fine setae at apex;



Figs 143-150. *Nirriparti septum* sp. nov.: 143, lateral view of median lobe of aedeagus; 144, ditto dorsal view; 145, paramere; 146, mesotrochanter and mesofemur; 147, metatrochanter and metafemur; 148, dorsal view; 149, antenna, pro and mesotarsi of female; 150, ditto, male. Scale bar represents 1 mm (habitus only).

mesofemur with row of 4 – 5 long stout spines along hind edge in basal half as well as a number of unusually strong spines on ventral face (Fig. 146); mesotarsus about as long as protarsus, segments 1 and 2 expanded at apical angles, segment 3 with outer apical lobe larger than inner. Metatrochanter thin, elongate, apex weakly pointed, tip close to metafemur (Fig. 147); metafemur relatively stout, with 3 short stout spines on hind margin near base; metatibia stout, weakly curved, weakly expanded towards apex; metatarsus elongate, segments cylindrical, segments 1 and 5 longest, segment 4 shortest, in combination segments 1 and 2 shorter than others, all segments without spines other than at apex; claws weak.

Male. Antenna as for female but with segments 3 and 5 with outer apical angles strongly expanded (Fig. 150). Protarsi with segments 1 and 2 with apical corners enlarged (Fig. 150). Mesotarsi with apical lobes on segments 1 to 3 asymmetrically expanded (Fig. 150). Metafemur with 10 short stout spines on rear edge near base (Fig. 147). Metatibia stouter than in female. Median lobe of aedeagus broad, sides subparallel, apex slightly bifid; paramere short, broad (Figs 143-145).

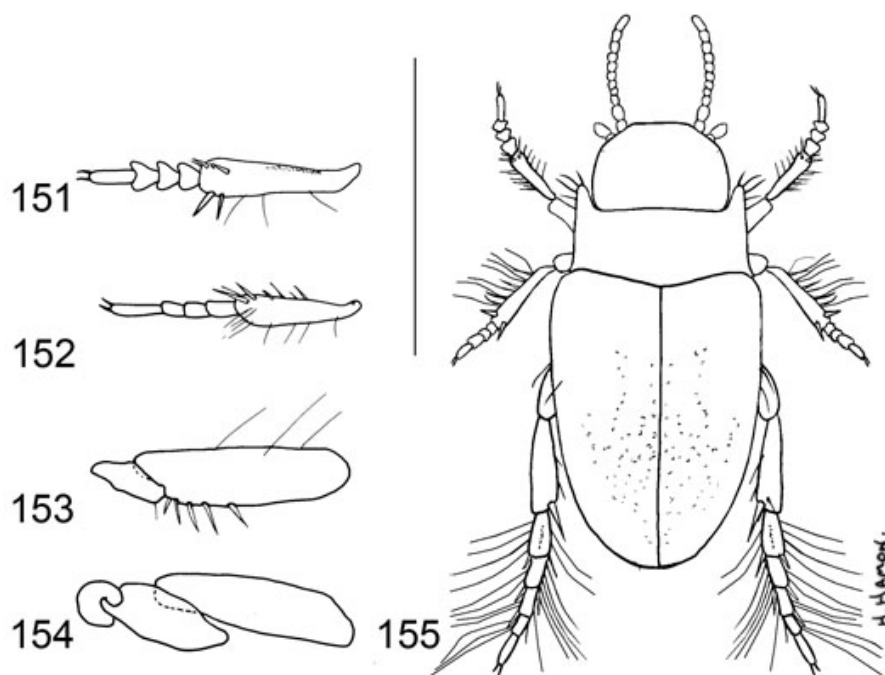
Female. Antenna long, thin, segments 1 and 2 cylindrical, segment 3 as long as segment 2, half width, much narrower in basal half, segment 4 cylindrical, half length of segment 2, segment 5 bit longer than segment 4, narrowing in basal half, bulbous apically, segments 6 to 10 longer, thin, subequal, segment 11 1.5x length of segment 10, each segment with some very small setae on inside apically.

Etymology. Latin. “Septum” – seven. From the working rubric, H (Hydroporini) – 7.

Remarks

A rather small but very distinct species easily recognized by the short stout spines on each mesofemur, long thin metatrochanters (Fig. 147), unusually long segment 5 of the metatarsi and by the asymmetrically expanded antennae and mesotarsal segments, particularly in the male. This is one of the few species of Australian stygo Dytiscidae with strong sexual dimorphism in the legs and antennae. The single female has three stout spines on the metafemur and the single male ten, but this might reflect individual difference rather than a sexual difference. It is possible that ventrites 3 to 5 are fused but we have not been able to confirm this in the limited material available.

Nirripirti tetrameres sp. nov.



Figs 151-155. *Nirripirti tetrameres* sp. nov.: 151, protarsi; 152, mesotarsi; 153, mesotrochanter and mesofemur; 154, metatrochanter and metafemur; 155, dorsal view. Scale bar represents 1 mm (habitus only).

Holotype

♀. 'BES 8847 Mt Augustus Station Isobel Well 24.38609 117.01932 15/4/03 WF Humphreys & R Leys', WAM 38292. Slide mounted.

Paratype

♀. as for holotype, SAMA.

Description (number examined, 2)

Habitus. Length 1.4 – 1.5 mm; stout, relatively flat, not constricted at junction of pronotum/elytra; uniformly light testaceous; hindwing vestigial, reduced to tiny flap.

Head. Narrower than elytra; smooth, rather weak reticulation with small even meshes, a few scattered small punctures; sides parallel in posterior half; eye remnant reduced to short suture. Antenna moderately thick, segments 1 and 2 cylindrical, segment 3 half width and length of segment 2, segment 4 shorter than segment 4, segment 5 to 10 becoming progressively larger, subequal, segment 11 1.2x 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. About as wide as elytra; anteriolateral angles projecting forward; sides subparallel, posterolateral 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, 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, narrowing to about middle, virtually absent along rest of elytron.

Ventral surface. Prosternal process very strongly narrowed between coxae, not reaching mesothorax, apical half round, arched in lateral view with highest point (viewed ventrally) between coxae. Mesocoxae in contact in midline. Metathorax weakly projecting forward in midline; wings very short; V-shaped in midline behind. Metacoxal plates large, metacoxal lines relatively close, weakly diverging in front quarter, reaching nearly to mesosternum; sparsely covered with small punctures, moderately reticulate; closely adpressed to ventrite 1. Ventrites 1 and 2 fused, sutural lines distinct except laterally, ventrites 3-5 mobile, moderately 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 3x its basal width; protarsus four segmented, weakly expanded, segments 1 and 2 subequal, segment 3 as long as segment 1, moderately bifid, segment 4 (apical) stout, cylindrical, longer than segment 3, segments 1 to 3 with only a few adhesive setae; claws short and simple. Mesotrochanter elongate with a few fine setae at apex; mesofemur with row of 5 to 6 strong spines along hind edge in basal half (Fig. 153); mesotarsus a little more elongate than protarsus, four segmented, segments cylindrical, segment 3 not bilobed. Metatrochanter with apex weakly pointed, tip separated from metafemur (Fig. 154); metafemur relatively stout, lacking spines; metatibia short, thick, straight, weakly expanding towards apex; metatarsus stout, segment 1 longest, segment 4 shortest, in combination segments 1 and 2 about as long as others, segments 2 to 5 without spines other than at apex, segments 2 to 4 cylindrical; claws weak.

Male. Unknown.

Etymology. Latin. “Tetra” – four. In reference to its four-segmented pro and mesotarsi.

Remarks

A small, stout, species with thin pro and mesotarsi that, uniquely in Dytiscidae, lack the usual small segment 4 at least in the female. This segment is lacking in males of the Australian Hydroporine genus *Tiporus*, but in this case this is associated with sexual dimorphism of the prolegs. Although the male of *N. tetrameres* is unknown it would be most surprising if the male

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was found to have normal five-segmented tarsi. In contrast to the pro and mesotarsi the metatarsi are unusually stout.

Distribution

Species described herein represent stygal beetles from seven palaeodrainage systems, one of which is in the Northern Territory (Ngalia Basin), the remainder in the Yilgarn of Western Australia (Table 1; Fig. 156). The Lyons palaeodrainage, from which stygal beetles are recorded for the first time, lies to the extreme northwest of their known distribution. This catchment supports higher taxa that are not found in other stygal dytiscid communities, including Melitidae (Amphipoda) and Tainisopidea (Isopoda); the Lyons River may have been captured by the Gascoyne from its previous northward drainage to the Ashburton. Beetles from 21 calcretes are described herein, of which 14 calcretes have stygal beetles recorded for the first time, three from coastal drainages and 11 from inland drainages. Together with earlier papers in the series (Watts & Humphreys 1999, 2000, 2001, 2003; 2004; Balke *et al.* 2004) it brings the number of described stygal Dytiscidae for Australia to 80 species in five genera (*Bidessodes*, *Copelatus*, *Kintingka*, *Limbodessus* and *Nirripirti*). These are derived from 47 discrete groundwater calcrete deposits in nine palaeodrainages representing both coastal and interior drainages. In addition a number of other species are recognised from larvae, and from females that have not been formally described. Overall, calcretes with stygal beetles have from one to four sympatric species (Table 1) and there is no difference in the frequency of occurrence of multiple species of beetles between coastal and inland drainages (Fig. 157: $X^2_2 = 0.019$; $P = 0.991$).

The present paper extends the known distribution of stygal Dytiscidae within Western Australia by about 90 km north, 45 km south, 20 km west and 150 km east. Of the 80 described species of Dytiscidae from Australian groundwaters, *Limbodessus micrommatoion* sp. nov. is the second stygobitic species in which the eyes are not entirely reduced, being about one fifth the size of those in epigeal species and lacking discrete ocelli. *L. microocular*, a sympatric sister species (determined from DNA) 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.

Environment

Groundwater in the arid zone is sometimes markedly stratified in respect of the physico-chemical environment (*inter alia* Watts & Humphreys 2000, 2004) becoming hypersaline with depth and with very low oxygen tensions (eg Fig. 158). However, groundwater characteristics near the water table must be utilised by the stygal beetles, as they probably need to traverse it to reach free air to breathe, and to oviposit and pupate. It is not yet known how the stygal beetles partition their time between different levels of the calcrete system, both within the groundwater profile, and between the phreatic and vadose zone. However, the upper part of the groundwater must be used by the beetles and so the physicochemical attributes of the near surface groundwater, which in these calcretes is normally the least saline and most oxic, must be used by the beetles at some stage.

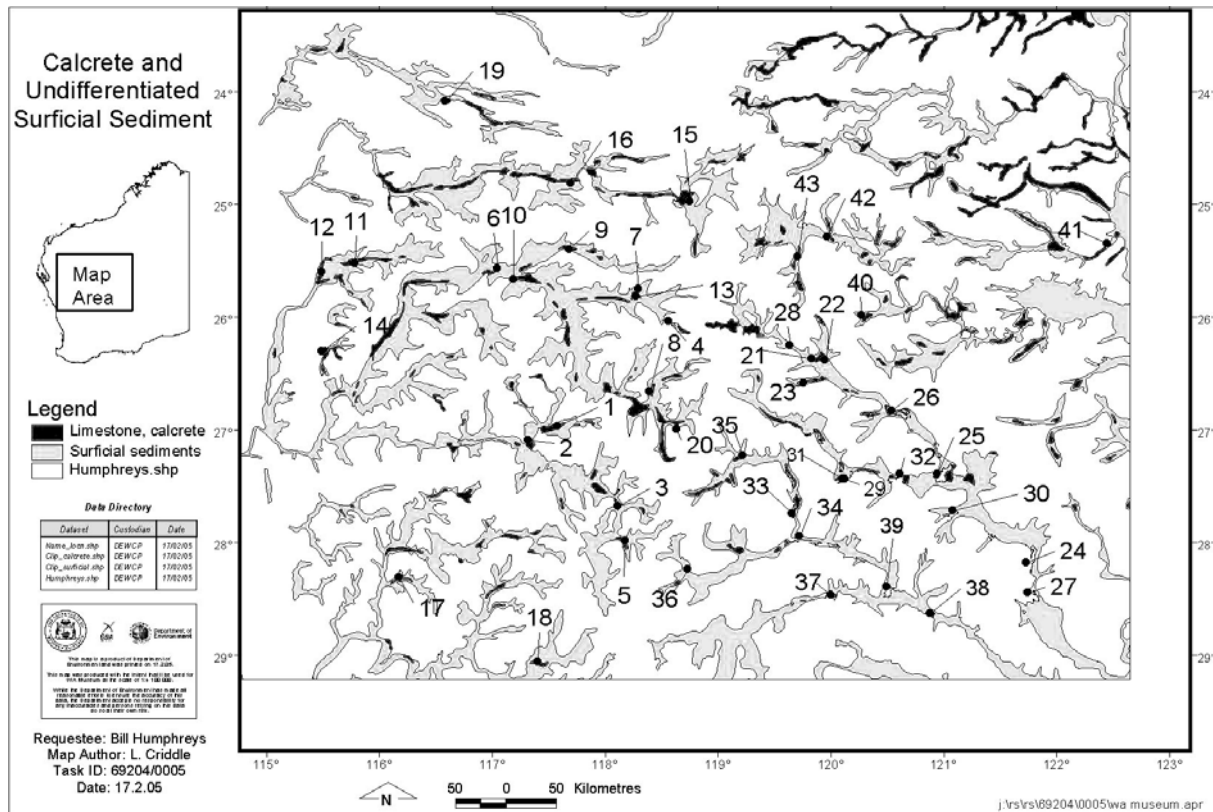


Figure 156. The distribution of the species described in this paper from groundwater calcrete aquifers of the Yilgarn area of Western Australia. The dark shading denotes groundwater calcrete bodies and the lighter shading the surficial sediments associated with the palaeodrainages incised into the Archaean basement. The calcrete bodies are numbered across the map using the numbers from Table 1. The new species referred to in this paper are from the following calcretes — 3, Challa North; 14, Narryer; 17, Bunnawarra; 18, Maranalgo; 19, Mt Augustus; 23, Hinkler Well; 24, Mount Windarra; 26, Barwidgee; 27, Mt Morgan; 28, Bubble; 29, Miranda West; 30, Nambi; 31, Miranda East; 32, Yandal; 37, Perrinvale; 38, Melita; 39, Sturt Meadows; 41, Carnegie; 44. The sites in the Northern Territory are not shown, namely Napperby; 45, Newhaven Homestead; 46, Newhaven Camel Well. Map based on 1: 2,500,000 *Hydrogeological Map of Western Australia* 1989 compiled by D.P. Commander.

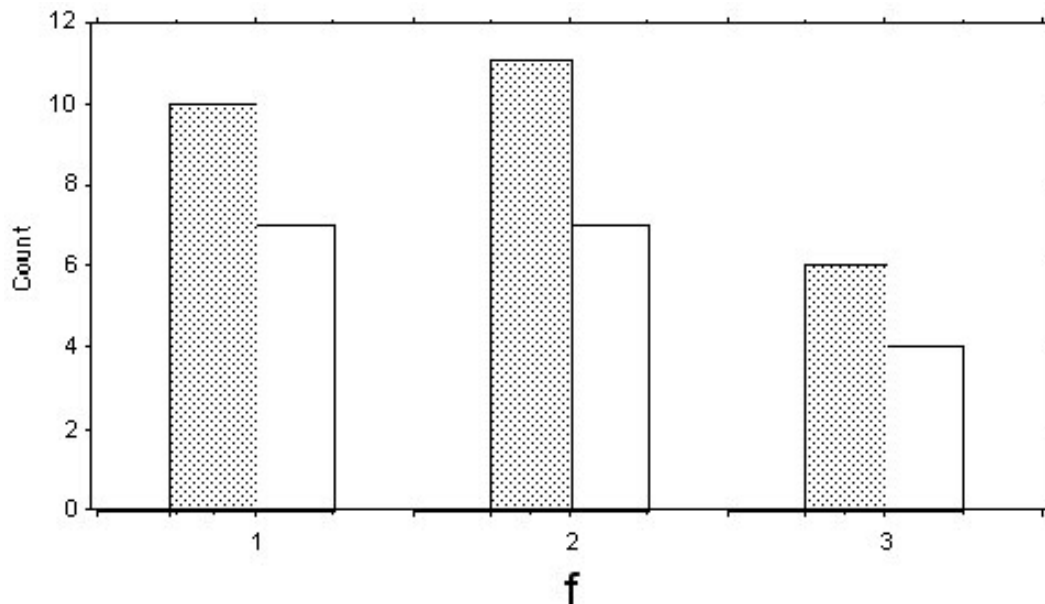


Figure 157. Frequency distribution of sympatric species of stygal dytiscids in calcretes on inland (shaded bars) and coastal drainages (open bars).

The physico-chemical characteristics of the superficial part of the groundwater at the sites of 21 of the 26 species described herein are given in Table 2. In contrast to the coastal drainages, for which Watts & Humphreys (2004) reported relatively low salinity -with one exception (900-2600 mg L⁻¹ TDS) - and little stratification in groundwaters, the waters reported here are saline with a mean of 5800 (range 1000-18300) mg L⁻¹ TDS. The upper part of the groundwater may range from fresh to sea water level salinity (our unpublished data) in different calcretes, and even at the same site may exhibit a marked change in salinity in response to aquifer recharge resulting from the episodic rainfall that is characteristic of this arid region (Humphreys 2001).

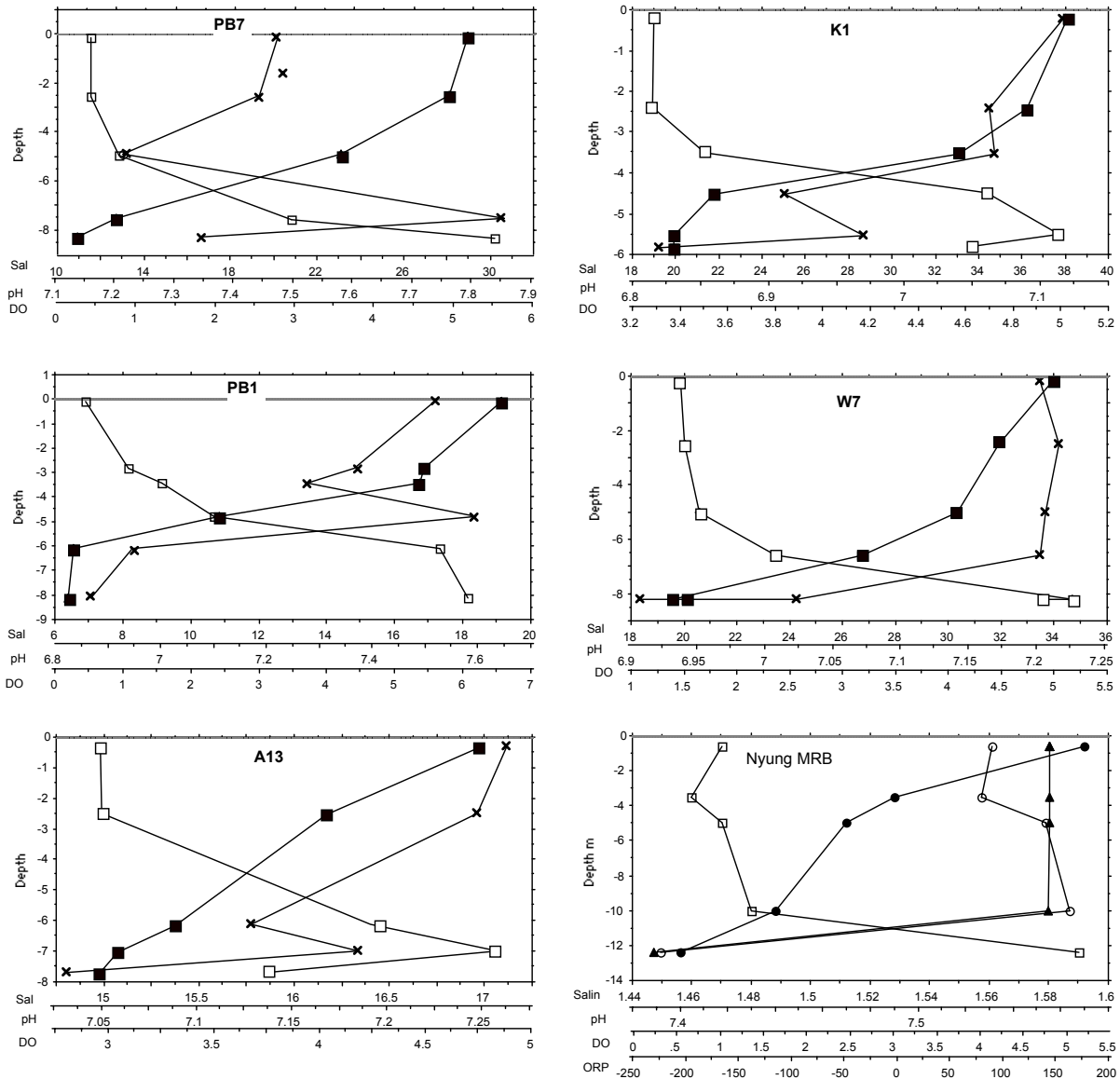


Figure 158. Vertical profiles through the water column of salinity (TDS mg L⁻¹; open squares), pH (filled square) and DO (mg L⁻¹; crosses) in groundwaters from which stygal dytiscids, described herein, were collected. The bores are in the same aquifer (Mt Morgan) and the data are summarised in Table 3. The bores are from upper left and across, PB7, K1, PB1, W7, A13, and, from a different calcrete (Challa north) the MRB near Nyung Well to give an example of stratification associated with strongly negative ORP values.

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Table 1. The distribution of stygal species of dytiscids amongst discrete calcrete bodies in Australia. The separate palaeodrainage systems (Fig. 156) 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. (47 calcretes, 9 palaeodrainages)

	Calcrete	Palaeovalley	1 Species	2 Species	3 Species	4 Species
WESTERN DRAINAGES						
1	Cue	Murchison	<i>Limbodessus magnificus</i>	<u><i>Limbodessus cueensis</i></u>		
2	Austin Downs	Murchison	<u><i>Limbodessus cueensis</i></u>	<i>Limbodessus bigbellensis</i>	<i>Limbodessus</i> sp. 3	<i>Limbodessus</i>
3	Challa North	Murchison	<i>Limbodessus challaensis</i>	<i>Limbodessus surreptitius</i> sp. nov.		
4	Killara	Murchison	<i>Nirripiriti killaraensis</i>			
5	Windimurra	Murchison	<i>Limbodessus</i> sp. 1			
6	Moorarie Bin Bin	Murchison	<u><i>Limbodessus occidentalis</i></u>	<i>Nirripiriti bulbosus</i>		
7	Killara North	Murchison	<u><i>Limbodessus occidentalis</i></u>			
8	Hillview	Murchison	<i>Limbodessus hillviewensis</i>			
9	Mt Padbury	Murchison	<i>Limbodessus padburyensis</i>	<i>Limbodessus</i> sp.		
10	Moorarie	Murchison	<i>Limbodessus wogarthaensis</i>	<i>Nirripiriti eurypleuron</i>	<i>Nirripiriti verrucosus</i>	
11	Innouendy	Murchison	<i>Nirripiriti copidotibiae</i>	<i>Nirripiriti innouendyensis</i>		
12	Byro West	Murchison	<i>Nirripiriti arachnoides</i>	<i>Nirripiriti byroensis</i>	<i>Nirripiriti dingbatensis</i>	
13	Karalundi	Murchison	<i>Limbodessus karalundiensis</i>	<i>Nirripiriti skaphites</i>	<i>Nirripiriti stegastos</i>	
14	Narryer	Murchison	<i>Limbodessus narryerensis</i> sp. nov.			
15	Three Rivers Station	Gascoyne	<i>Bidessodes gutteridgei</i>	<i>Bidessodes limestoneensis</i>	<i>Nirripiriti plutonicensis</i>	
16	Milgun Station	Gascoyne	<i>Nirripiriti hamoni</i>	<i>Nirripiriti milgunensis</i>		
17	Bunnawarra	Moore	<i>Limbodessus microocular</i>	<i>Limbodessus micrommatoion</i> sp. nov.		
18	Maranalgo	Moore	<i>Limbodessus exilis</i> sp. nov.			
19	Mt Augustus	Lyons	<i>Nirripiriti tetrameres</i> sp. nov.			
INLAND DRAINAGES						
20	Paroo	Carey	<i>Limbodessus eberhardi</i>	<i>Limbodessus pulpa</i>	<i>Kintingka kurutjutu</i>	
21	Lake Violet	Carey	<i>Limbodessus wilunaensis</i>			
22	Uramurdah Lake	Carey	<i>Limbodessus hahni</i>	<i>Limbodessus morgani</i>		

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23	Hinkler Well	Carey	<i>Limbodessus hinkleri</i>	<i>Limbodessus macrohinkleri</i> sp. nov.	<i>Limbodessus raeae</i> sp. nov.	
24	Mount Windarra	Carey	<i>Limbodessus windarraensis</i>	<i>Limbodessus lapostaae</i>	<i>Limbodessus palmulaoides</i> sp. nov.	
25	Melrose Station (Lake Darlot)	Carey	<i>Nirripiriti darlotensis</i>	<i>Nirripiriti melroseensis</i>		
26	Barwidgee	Carey	<i>Limbodessus barwidgeeensis</i> sp. nov.	<i>Limbodessus usitatus</i> sp. nov.		
27	Mt Morgan	Carey	<i>Limbodessus cooperi</i> sp. nov.	<i>Limbodessus leysi</i> sp. nov.		
28	Bubble	Carey	<i>Limbodessus millbilliensis</i> sp. nov.			
29	Miranda West	Carey	<i>Limbodessus mirandae</i> sp. nov.			
30	Nambi	Carey	<i>Limbodessus nambiensis</i> sp. nov.			
31	Miranda East	Carey	<i>Limbodessus phoebeae</i> sp. nov.			
32	Yandal	Carey	<i>Limbodessus yandalensis</i> sp. nov.			
33	Depot Springs	Raeside	<i>Limbodessus fridaywellensis</i>	<i>Nirripiriti hinzeae</i>		
34	Pinnacles Stn	Raeside	<i>Limbodessus pinnaclesensis</i>	<i>Nirripiriti fortisspina</i>	<i>Nirripiriti</i> sp. 8	? <i>Nirripiriti</i> larvae
35	Lake Mason	Raeside	<i>Limbodessus raesidensis</i>	<i>Limbodessus masonensis</i>		
36	Yuinmery	Raeside	<i>Limbodessus yuinmeryensis</i>			
37	Perrinvale	Raeside	<i>Limbodessus gumwellensis</i> sp. nov.			
38	Melita	Raeside	<i>Limbodessus melitaensis</i> sp. nov.			
39	Sturt Meadows	Raeside	<i>Nirripiriti macrosturtensis</i> sp. nov.	<i>Nirripiriti mesosturtensis</i> sp. nov.	<i>Nirripiriti microsturtensis</i> sp. nov.	
40	Jundee	Carnegie	<i>Limbodessus jundeeensis</i>			
41	Carnegie	Carnegie	<i>Limbodessus harleyi</i> sp. nov.			
42	Cunyu: Sweetwaters	Nabberu	<i>Limbodessus cunyuensis</i>	<i>Limbodessus silus.</i>	<i>Limbodessus sweetwatersensis</i>	
43	Cunyu: SBF	Nabberu	<i>Limbodessus bialveus</i>	<i>Limbodessus macrotarsus</i>		
44	Napperby	Ngalia Basin: N.T.	<i>Nirripiriti macrocephalus</i>	<i>Nirripiriti napperbyensis</i>	<i>Nirripiriti septum</i> sp. nov.	
45	Newhaven Homestead	Ngalia Basin: N.T.	<i>Nirripiriti newhavenensis</i>	<i>Limbodessus atypicalis</i> sp. nov.		
46	Newhaven Camel Well	Ngalia Basin: N.T.	<i>Nirripiriti pentameres</i>	<i>Copelatus (Papuadytes) abditus</i>	<i>Nirripiriti megamacrocephalus</i> sp. nov.	<i>Nirripiriti</i> sp NT 9
47	Central Mount Wedge	Ngalia Basin: N.T.	<i>Nirripiriti wedgeensis</i>	<i>Limbodessus</i> sp.		

Table 2. Water quality values for the surface water at sites inhabited by stygal beetles described in this paper. (Some examples of the change in water quality through the water column are given in Fig. 158.)

	Temp	pH	TDS	DO	ORP	Depth to water/ depth of water
	°C		mg L ⁻¹	mg L ⁻¹	mV	(m)
<i>Limbodessus atypicalis</i>	17.5	7.6	1.1	1	246	-1.8
<i>L. barwidgeeensis</i>	26.2	7.3	6.1	5	144	4/10
<i>L. cooperi</i>	20.5-24.1	7.1-7.5	6.9-11.6	1.5-6.6	78-166	64/30
<i>L. exilis</i>	22.6	8.3	3.2	8	104	3/. 05
<i>L. leysi</i>	20.5	7.1	8.5	1.5	124	64/30
<i>L. gumwellensis</i>	23.7	7.3	4.8	3.7	158	3.5/1
<i>L. harleyi</i>						
<i>L. macrohinkleri</i>	16.4	7.9	2.6	3.5	127	4.5/0.5
<i>L. melitaensis</i>	-	-	-	-	-	-
<i>L.+ micrommatoion</i>	25.6	7	3.9	5.3	383	3/2.5
<i>L. millbilliensis</i>	18.7	7.3	1.7	-	-	-
<i>L. mirandaae</i>	24.1-25.0	7.4-7.7	3.6-19.6	3.1-6.8	-129	-
<i>L. nambiensis</i>	-	-	-	-	-	-
<i>L. narryerensis</i>	26.0-27.6	7.0-7.4	2.1-4.1	0.7-2.9	318-354	-
<i>L. palmulaoides</i>	-	-	-	-	-	2.5/0.5
<i>L. phoebeae</i>	24.1	7.3	18.3	5.2	140	3.5/1
<i>L. raeae</i>	16.4	7.9	2.6	3.5	127	4.5/0.5
<i>L. surreptitius</i>	26.7	7.4	1.5	2.3	128	1.8/12
<i>L. usitatus</i>	26.2	7.3	6.1	5	144	3.6/9.5
<i>L. yandalensis</i>	26.9	7.3	1.6	6.8	143	1.5/0.5
<i>Nirripiriti macrosturtensis</i>	-	-	-	-	-	-/0.5
<i>N. megamacrocephalus</i>	27.9	7.1	3.4	0.7	227	-/3.3
<i>N. mesosturtensis</i>	27.3	7.1	14.3	4.6	164	-/8
<i>N. microsturtensis</i>	26.1	7	14.3	3.8	171	1.5/6
<i>N. septum</i>	24.6	7.3	3.4	4.3	398	2/1.5
<i>N. tetrameres</i>	29.5	7.9	1	7.5	280	4/1.5
Mean	23.8	7.4	5.8	4.1	177	11.1/5.8
Minimum	16.4	7.0	1.0	0.7	-129	1.5/0.1
Maximum	29.5	8.3	18.3	8.0	398	64/30
Range	13.1	1.3	17.3	7.3	527	63/30

The variability in the sampling conditions can be gained from the depth to and of the groundwater. The water table varied between 1.5 and 64 m below the ground surface, and the depth of water sampled varied from 0.1 to 30 m below the groundwater surface. The temperature of groundwater is, like cave temperatures, generally close to the mean annual temperature of the region but is seen here to vary widely (Table 2). This is largely owing to the inclusion of pastoral wells, which vary in temperature as cold winter air can drain into the wide opening (typically ~2 m diameter). The mean pH (Table 2) is typical of carbonate aquifers. The surface DO levels are generally moderate (mean 4.1 mg L⁻¹) but may decline markedly away from the surface (Fig.158).

Several sampling sites contained sufficiently deep water for profiling. Examples are shown in Fig.158 for profiles in different bores in the Mt Morgan calcrete and a summary of the results shown in Table 3. It can be seen from this table that the vertical physicochemical profile in a single aquifer can be quite varied with values varying up to three fold between locations at a given depth, at the surface (TDS), or by an order of magnitude at 6 m depth (DO). This small data set does not suggest that the environment is more regionally consistent at depth as the range of values encountered may increase (TDS) or decrease (pH, DO) at depth.

Table 3. Minimum, maximum and range of TDS mg L⁻¹, DO mg L⁻¹ and pH at 0, 6, and 8 m water depth in different bores in the Mt Morgan calcrete aquifer (N = 5 except for 8 m when N = 4). This aquifer contains *Limbodessus cooperi* and *L. leysi* as well as Bathynellacea; *Haloniscus* (Oniscidea: Isopoda) and Copepoda.

	TDS @ 0 m	TDS @ 6 m	TDS @ 8 m	pH @ 0 m	pH @ 6 m	pH @ 8 m	DO @ 0 m	DO @ 6 m	DO @ 8 m
min	7	14	15.9	7.12	6.82	6.81	2.8	0.12	0.5
max	20	34	34	7.8	7.39	7.14	5.5	3.7	2.7
range	13	20	18.1	0.68	0.57	0.33	2.7	3.58	2.2

The marked salinity gradients (Fig. 158) may be 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 bacteria, providing a source of energy for the ecosystem (Humphreys 2001) and there is an indication from the negative ORP values that such could be the case in some of the aquifers examined here, eg Lake Miranda (Fig. 158; Table 2).

ASSOCIATED FAUNA

The fauna associated with the stygal beetles is shown in Table 4 largely at a high taxonomic level as, being new to science, this material is mostly still being described. The frequency with which these higher taxa of stygobites are associated with the dytiscid species reported here is given in Fig. 159. While this suggests that certain taxa more commonly occur in association with the dytiscids, it may reflect differential sampling efficiencies in boreholes for the different taxa. To date most

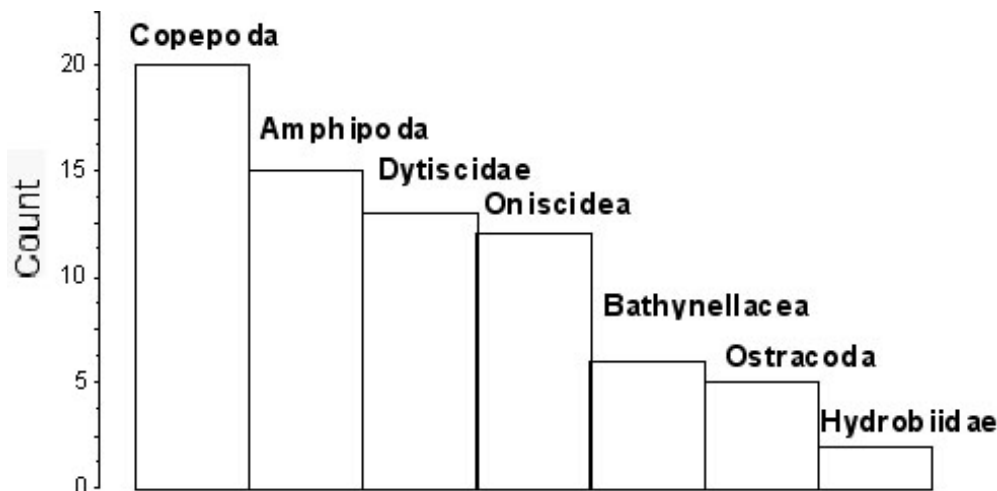


Figure 159. Frequency with which major taxa of stygobites occur sympatrically with 23 species of stygal Dytiscidae.

TWENTY SIX NEW DYSTICIDAE (COLEOPTERA) FROM UNDERGROUND WATERS IN AUSTRALIA

aquifers have been sparsely sampled, and the veracity of these data will be tested with detailed sampling currently underway in selected aquifers where there is good access to the groundwater. These higher taxa 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. Morphological (Karanovic & Marmonier 2002; Taiti & Humphreys 2001) and molecular work (R. Leijs, *pers. comm.*) consistently indicates that many of the higher taxa are represented by sympatric species within a given calcrete and that many are restricted in their distribution to a single calcrete, as found for the beetles (Cooper *et al.* 2002; Leys *et al.* 2003).

Table 4. Stygofauna sampled at the same locations as the stygal diving beetles.

Species	Associated stygofauna
<i>Limbodessus atypicalis</i>	<i>N. newhavenensis</i> ; Bathynellacea; Calanoida; Hydrobiidae aff <i>Trochidrobia</i> ; <i>Haloniscus</i> (Oniscidea)
<i>L. barwidgeeensis</i>	<i>Limbodessus usitatus</i> ; Amphipoda: Ceinidae; Cyclopoida; Ostracoda
<i>L. cooperi</i>	<i>L. leysi</i> ; Bathynellacea; <i>Haloniscus</i> sp.; Copepoda
<i>L. exilis</i>	Ceinidae; Cyclopoida; Harpacticoida; Ostracoda
<i>L. leysi</i>	<i>L. cooperi</i> ; Bathynellacea; <i>Haloniscus</i> sp.; Copepoda
<i>L. gumwellensis</i>	Amphipoda; Copepoda: Cyclopoidea; <i>Haloniscus</i> sp. (Oniscidea)
<i>L. harleyi</i>	
<i>L. macrohinkleri</i>	<i>L. raeae</i> ; <i>L. hinkleri</i> ; <i>Metacyclops laurentisae</i> Karanovic, 2004 (Cyclopoida); Amphipoda Ceinidae;
<i>L. melitaensis</i>	Amphipoda; Oniscidea
<i>L. micrommatoion</i>	-
<i>L. millbilliensis</i>	<i>L. wilunaensis</i> ; Oniscidea: <i>Haloniscus</i> sp.; Amphipoda: Crangonyctoidea; <i>Haifameira pori</i> Karanovic, 2004 (Hapacticoida: Ameiridae); <i>Goniocyclops uniarticulatus</i> Karanovic, 2004 (Cyclopoida); Bathynellidae; <i>Candonopsis dani</i> Karanovic & Marmonier 2002 (Ostracoda)
<i>L. mirandaae</i>	<i>L. phoebeae</i> ; Cyclopoida; Harpacticoida; Oniscidea; Amphipoda: Ceinidae
<i>L. nambiensis</i>	Cyclopoida; Isopoda: Oniscidea; Amphipoda: Ceinidae
<i>L. narryerensis</i>	Amphipoda; Cyclopoida; Ostracoda
<i>L. palmulaoides</i>	Amphipoda; Cyclopoida
<i>L. phoebeae</i>	<i>L. mirandaae</i> ; Cyclopoida; Harpacticoida; Oniscidea; Amphipoda: Ceinidae
<i>L. raeae</i>	<i>L. macrohinkleri</i> ; <i>Metacyclops laurentisae</i> Karanovic, 2004 (Cyclopoida); Amphipoda: Ceinidae
<i>L. surreptitius</i>	Amphipoda; Cyclopoida
<i>L. usitatus</i>	<i>L. barwidgeeensis</i> ; Amphipoda: Ceinidae
<i>L. yandalensis</i>	Amphipoda: Ceinidae, Crangonyctoidea; Ostracoda; Cyclopoida
<i>Nirripiriti</i>	
<i>macrosturtensis</i>	<i>N. mesosturtensis</i> ; <i>N. microsturtensis</i> ; Hapacticoida; Amphipoda: Crangonyctoidea; Isopoda: Oniscidea
<i>N. megamacrocephalus</i>	Cyclopoida; Bathynellacea; Mollusca: Hydrobiidae
<i>N. mesosturtensis</i>	<i>N. macrosturtensis</i> ; <i>N. microsturtensis</i> ; Hapacticoida;
<i>N. microsturtensis</i>	Isopoda: Oniscidea
<i>N. septum</i>	<i>N. macrocephalus</i> ; <i>N. napperbyensis</i> ; <i>N. septum</i> ; Bathynellacea, Cyclopoida; <i>Haloniscus</i> sp. (Oniscidea)
<i>N. tetrameres</i>	-

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