

AUTHOR'S VERSION. IF You need the real one, email me.

A multigene phylogenetic analysis results in a redefinition of the genus *Notonomus* Chaudoir (Coleoptera, Carabidae) and descriptions of new species of the subgenus *Leiradira* Castelnau

Kipling Will

Essig Museum of Entomology, University of California, Berkeley, CA, USA. Email: kipwill@berkeley.edu

Abstract. Bayesian analysis of four partial gene sequences (28S rDNA, wg, CAD and COI mtDNA) from exemplars of all genera and 12 of 17 informal groups of the *Notonomus*-series of pterostichine carabids strongly supports a clade requiring redefinition of *Notonomus* Chaudoir, 1862. *Notonomus* is redefined to include all species currently placed in *Notonomus* by Lorenz (2005a) plus two *Sarticus* Motschulsky, 1865 species (*S. blackburni* (Sloane, 1895) and *S. impar* (Sloane, 1893)), all species of *Leiradira* Castelnau, 1867, *Conchitella* Moore, 1962 *Loxodactylus* Chaudoir, 1865 and *Acanthoferonia* Moore, 1965. Analysis of combined data places *Sarticus* sister to *Notonomus* with low support. Individual gene analyses indicated wg is in conflict with other loci and analyses exclusive of wg place *Parhypates* Motschulsky, 1866 sister to *Notonomus* with very high support. *Leiradira* species form a clade within *Notonomus* including *Notonomus dimorphicus* Darlington, 1961 and *N. flos* Darlington, 1961. Six new species of the subgenus *Leiradira* from Queensland are described; *Notonomus (Leiradira) thynnefilium*, *N. (L.) vadosus*, *N. (L.) viridis*, *N. (L.) spectabilis*, *N. (L.) iridescens* and *N. (L.) barrae*. Two additional species of *Notonomus* s.l. are described; *Notonomus hephaestus* from the Lamb Range, Queensland, which is part of a mimicry complex with *Notonomus (Leiradira) aurifer* (Darlington, 1961); and *Notonomus nocturnocappellus*, from New South Wales, which represents a unique combination of characteristics for the genus. Descriptions of all species of *Notonomus (Leiradira)* with a wide gula, a grouping equivalent to Darlington's concept of *Leiradira*, are given. An identification key to species of *Notonomus (Leiradira)*, the two newly described *Notonomus* s.l. species and all recognised subgenera of *Notonomus* is provided.

Received 16 April 2014, accepted 16 November 2014, published online 28 August 2015

Introduction

The bulk of work on the genus *Notonomus* Chaudoir, 1865 was done by Thomas Sloane in a series of ten papers published between 1890 and 1923. Of the 105 species-group taxa that were valid in the genus at the start of my study, Sloane had described 56. Earlier authors (e.g. Castelnau, Macleay, Dejean and Chaudoir), whose works are summarised by Sloane (1902), also published scattered descriptions. No additional species were described in the genus after Sloane's 1923 paper until Darlington (1953, 1961a) described new species from the Queensland tropics and Moore (1960, 1961, 1963) described new species from Victoria. Amazingly it has now been 50 years without any additional description of species, though in the intervening years some important nomenclatural issues and synonymies have been covered in catalogues by Moore (Moore et al. 1987) and Lorenz (2005a, 2005b) and two New Caledonian species attributed to *Notonomus* were moved to *Prosopogmus* Chaudoir, 1865 by Will (2011b).

Sloane's (1895) general treatment of carabids, his treatment of *Sarticus* Motschulsky, 1865 (Sloane 1903) and his two most substantial papers on *Notonomus* (Sloane 1902, 1913), express his significant reservations about the limits of *Notonomus*. At first he attempted to reconcile Australian taxa with the dominant

European generic concepts of the time, e.g. *Pterostichus* Bonelli, 1810 and *Platysma* Bonelli, 1810. He then abandoned those taxa in favour of exclusively Australian genera, but still was plagued by doubts regarding generic limits. Though his overarching approach was practical, he waxed somewhat poetic when discussing the arrangement of *Notonomus* (Sloane 1902: 205): 'I offer a tabulation of the species known to me in which an attempt is made to arrange the species in a fairly natural order, or at least what seems to me a natural order. But, seeing that the species of a large genus in their relationships towards one another resemble the branches of a tree springing from one trunk, rather than a continuous chain, it is impossible to place them in a linear series by aid of a dichotomous table without species being separated sometimes from nearly allied congeners'. Though he explicitly was attempting to find a natural arrangement of *Notonomus* in his subsequent 1913 treatment he maintained that 'the extremely intricate manner in which the characters, on which the groups are founded, are diffused generally throughout the genus, owing, no doubt, to their being derived from numerous ancient stems, probably along many lines of descent, so that the relationships of the present-day species presents a bewildering labyrinth for the taxonomist to puzzle over'. Initially I intended to treat only a

dramatic-looking undescribed species of *Leiradira* (*N.* (*L.*) *barrae*) that I had collected on Mt Lewis, QLD. I then received an abundance of undescribed species from G. Monteith (QM) and realised that Darlington (1961b) had left the status of *Leiradira* Castelnau 1867 and the *Notonomus* series taxa as ‘something to be decided in the future, by the next reviser of the generic classification of Australian Pterostichini’. In the present paper I make my first foray into Sloane’s labyrinth and take the first steps to revise the generic classification of Australian Pterostichini. I now have the excellent works by Sloane, Moore and Darlington to stand on, and DNA sequence data and analysis tools to address the taxonomic puzzle that is *Notonomus*.

Methods

Material examined and identification

Specimens for this study were provided by the following institutions: Australian National Insect Collection (ANIC), CSIRO, Canberra; Carnegie Museum of Natural History (CMNH); Cornell University Insect Collection (CUIC); Essig Museum of Entomology (EMEC), Berkeley; Museum of Comparative Zoology (MCZ) Harvard; Queensland Museum (QM), Brisbane; Zoological Institute (ZISP), St Petersburg.

Material from the QM was central to this study and those specimens are the product of many years of targeted surveys in the mountains of the wet tropics region by the QM staff; particularly Geoff Monteith. Data on specimens from those surveys has been analysed and published on using provisional code names. I list those code names and cite the papers where they published under the distributional information for the species below.

All holotype material is listed with verbatim locality data and unique identifier numbers below. All specimens of previously described species examined are listed in the material examined appendix and each includes a unique identifier number from a collection-specific tag found on each specimen. These numbers tie specimens to database entries that have the expanded, interpreted and often georeferenced data for the specimens. The full data is accessible via the Atlas of Living Australia (<http://www.ala.org.au/>), EssigDB (<http://essigdb.berkeley.edu/>), MCZBase (<http://mczbase.mcz.harvard.edu/>) or from in-house databases maintained by the individual institutions. Summary information is provided for each species below, which are listed alphabetically in *Leiradira* followed by the incertae sedis species.

In addition to specimens listed in the species descriptions below and in the material examined appendix, I curated and studied the pterostichine collection at ANIC, including their holdings of types and additional material in the Sloane and B.P. Moore collections. My work in that collection was instrumental in my assessment of the breadth and depth of sampling for this study. Identification of specimens is based on use of the literature cited herein and comparison with material in the ANIC collection.

Taxon selection for analysis

Given the uncertainty of relationships within Pterostichini s.l., the taxa included in this analysis were selected from a parsimony analysis of a larger unpublished dataset including ~400 Pterostichini representing all North American genera, all but two North American subgenera, most South American genera, all New Zealand genera, all but three Australian genera and a wide sample across the diversity of genera and subgenera from Madagascar, New Caledonia, New Guinea, Africa and Europe. This larger exemplar dataset includes more or less complete sequence data (18S, 28S, CAD) and a partially coded matrix of ~100 morphological characters (K. Will,

unpubl. data). Though clearly preliminary, the genus-level taxa included herein as outgroups always group together with *Notonomus*-series taxa in the preliminary parsimony analyses. Based on that analysis and a general study of morphology, I exclude *Delinius* Westwood, 1864 and *Lesticus* Dejean, 1828 of the *Delinius*-series of Moore (1965), in which he includes *Delinius*, *Lesticus* and *Leiradira*. This informal group was based on similarity of mouthparts and antennae, but male and female genitalia and sequence data do not support a close relationship among these three. *Delinius* is part of a complex of genera related to *Platycaelus* Blanchard, 1843 (K. Will, unpubl. data), while *Lesticus* is part of the ‘trigonotomi’ taxa (Will and Kavanaugh 2012) and more closely related to northern hemisphere pterostichines. Moore included in the *Notonomus*-series *Notonomus*, *Loxodactylus*, *Conchitella* Moore, 1962, *Rhabdotus* Chaudoir, 1865 and *Sarticus*. Though *Rhabdotus* species do share an overall similar form with typical *Notonomus*, they are distinctly different in the features of the female genitalia. *Rhabdotus* females have an elongate gland duct diverticulum not known from any species of the genera included in this analysis (Fig. 5). A diverticulum is known in *Euchroina* (Ortuno 1996; Will 2002) and a variety of other pterostichines (Moore 1965; Liebherr and Will 1998). There are no obvious morphological synapomorphies linking *Rhabdotus* to any genus included in this analysis and sequence data used in the broader unpublished analysis places it very distantly.

Among the *Notonomus*-series genera, *Sarticus* is the most species-rich genus next to *Notonomus*; however, *Sarticus* is very little studied so I have chosen to include a variety of body forms as exemplars from across the range of *Sarticus* (s. str.) (Fig. 1B). Unfortunately, no specimens of *Sarticus* (*Coronacanthus* W.J.Macleay, 1878) species were available. *Parhypates* Motschulsky, 1866 (Fig. 1A) includes a small number of species from Chile (Straneo 1986; Will 2011a) that are strikingly similar to *Notonomus* species (Fig. 1) and were consistently placed together with them in the preliminary analysis.

All species of *Leiradira* were studied and two species from each of the three subgenera in which Darlington (1961b) arrayed species are included in the molecular analysis. Groups within *Notonomus* established by Sloane (1913) and Darlington (1961a, 1961b) were used as guides for sampling within the genus. When possible, the nominal species for the group was included; (Table 1) as was the type species of the genus, *Notonomus* *triplogenioides* (Chaudoir, 1865) (Fig. 1C). Species from five small groups were not available for sequencing: *atrodermis*-group, *cupricolor*-group, *excispennis*-group, *lesueri*-group and *parallelamorphus*-group. In addition, two species described herein, *Notonomus* *nocturnocappellus* and *N.* (*Leiradira*) *barrae*, were included in the molecular analysis as each of these has morphological character state combinations not found in any recognised species group. Though no DNA quality specimens are available for *N.* *hephaestus* and it is not included in the analysis, it is described here to draw attention to its unique combination of characters and apparent involvement in morphological and colour mimicry.

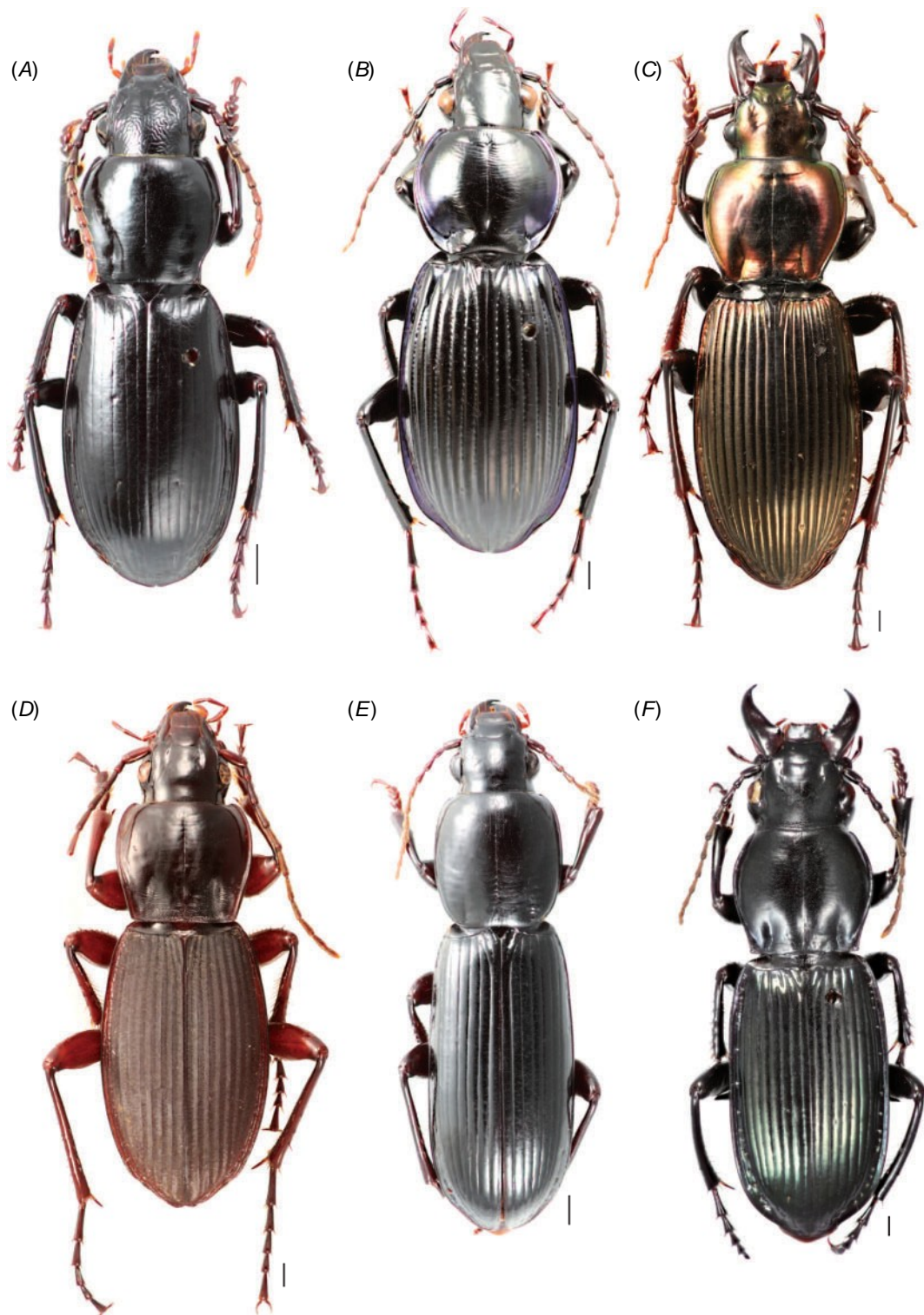


Fig. 1. Dorsal habitus of exemplars of genus-level taxa included in this study, scale bars = 1.0mm. (A) *Parhypates nunni* Straneo, 1987, (B) *Sarticus* (s.str.) *cyaneocinctus* (Chaudoir, 1865), (C) *Notonomus* (s.str.) *triplogenioides*, (D) *Notonomus* (*Loxodactylus*) *carinulatus* (Chaudoir, 1865), (E) *Notonomus* (*Conchitella*) *clivinoides* (Moore, 1962), (F) *Notonomus* (*Acanthoferonia*) *ferox* (Moore, 1965).

Table 1. Taxa included in phylogenetic analysis by group or subgenus

Species	Group or subgenus
<i>N. aequus</i>	aeques-grp
<i>N. angustibasis</i>	angustibasis-grp
<i>N. australis</i>	australis-grp
<i>N. chalybeus</i>	chalybeus-grp
<i>N. dimorphicus</i>	doddi-grp
<i>N. flos</i>	doddi-grp
<i>N. minimus</i>	kingi-grp
<i>N. lateralis</i>	lateralis-grp
<i>N. auricollis</i>	Leiradira
<i>N. puella</i>	Leiradira
<i>N. mediosulcatus</i>	mediosulcatus-grp
<i>N. alternans</i>	Metadira
<i>N. aurifer</i>	Metadira
<i>N. opacicollis</i>	opacicollis-grp
<i>N. triplogenioides</i>	s.str.
<i>N. satrapa</i>	satrapa-grp
<i>N. sphodroides</i>	sphodroides-grp
<i>N. jacobi</i>	Stomimorphus
<i>N. tenuis</i>	Stomimorphus
<i>N. barrae</i>	unplaced
<i>N. noctumocappellus</i>	unplaced
<i>N. violaceus</i>	violaceus-grp

Measurements and methods

Morphological methods

Measurements were made using an eye piece graticule with a Leica MZ12s stereomicroscope. Standard body length (SBL) is representative of the overall length of specimens as viewed dorsally and is the sum of the distance from the base of the labrum to just anterior of the occipital suture + the length of the pronotum along its midline + the length of the left elytron from basal margin where it meets the scutellum to the apex of the elytron. The width of the elytra is the widest point viewed dorsally or as best estimated by summing the width of each elytron if pinning separated the elytra at the suture. The ocular ratio is the greatest apparent width over the eyes when viewed dorsally divided by the width between the eyes at the level of the anterior supra orbital seta.

Male and female genitalia were prepared using the same methods as Will (2002). Head capsules were prepared by first clearing of muscle tissue using warm KOH and then placing them in warm, dilute bleach. They remained in bleach until the membranous region, e.g. the gular sutures, were strongly contrasting white and so highly visible. All images were taken using a modified Microptics XLT digital imaging system and then edited to enhance clarity using standard image editing software. Maps were created using the Cartographer package ver. 1.31 in Mesquite ver. 2.75 (Maddison and Maddison 2011a, 2011b) using the Australia, shaded relief and coloured height base image from NASA (NASA/JPL/NGA 2004), which was modified for colour contrast and cropped to fit.

DNA sequencing

Abbreviations used for loci are: 28S, 28S rDNA (aligned length 1157 bp); COI, cytochrome oxidase I (701 bp + 840 bp);

wg, wingless (462 bp); CAD, carbamoyl phosphate synthetase domain of the rudimentary gene (840 bp). Fragments for these genes were amplified using polymerase chain reaction, exo-sap cleaned and sequenced following the same procedures and primers given by (Will and Gill 2008). The only addition is the COI here includes the JER-PAT primer region and HCO-LCO region, both primer pairs from Simon et al. (1994). The use of these two primer pairs usually leaves a 50–100 bp gap unsequenced in the middle of the otherwise nearly complete COI gene. Assembly of multiple chromatograms for each gene fragment and initial base calls were made with Phred (Green and Ewing 2002) and Phrap (Green 1999) initiated within Mesquite's Chromaseq package ver. 1.0 (Maddison and Maddison 2011c) with subsequent editing by manual inspection within Mesquite. Multiple peaks at a single position were coded using IUPAC ambiguity codes. Sequences have been deposited in GenBank with accession numbers: 28S: KF551597–KF551638; CAD: KF551639–KF551680; COI (HCO-LCO region): KF551681–KF551722; COI (JER-PAT region): KF551765–KF551804; and wg: KF551723–KF551764. The GenBank sequence files include an EMEC##### that links to the complete specimen data in the publically available EMEC database <http://essigdb.berkeley.edu/>. The EMEC record and GenBank files include a KWW### that links the template DNA sample to the voucher specimen deposited in the EMEC.

All sequences are of approximately the lengths given above with a few exceptions. The 28S sequence for *Notonomus* (*Conchitella*) *clivinoides* failed to sequence clearly for the d1 primer and the included sequence starts at aligned position 879 and is derived from the d3i primer. Multiple peaks were seen in the COI from JER-PAT primers for *N. (Conchitella) clivinoides*, *N. (Leiradira) jacobi* and *N. aequus*. These are likely the result of nuclear pseudogenes and no sequences are included for this region of COI. *Notonomus chalybaeus* has an unreadable, multi-peak region at aligned positions 286–401. That region was omitted from the analysis.

Alignment

Alignment of the protein-coding sequences was straightforward as the only insertions or deletions consist of six contiguous nucleotides, representing two amino acids, in species of *Sarticus* for wg. Multiple sequence alignment of 28S was performed by Opal ver. 2.1 (Wheeler and Kececioglu 2007), using default parameter values within Mesquite.

Phylogenetic analysis

Models of nucleotide evolution were chosen with the aid of mrModelTest ver. 2.3 (Nylander 2004). Using the hierarchical likelihood ratio tests and AIC the chosen models were GTR+I+G for 28S (hLrt, AIC) and COI (hLrt, AIC); and wg (hLrt); GTR+G for CAD (hLrt); HKY+I+G for CAD (AIC) and SYM+I+G for wg (AIC). Analyses were conducted on each gene individually, as well as a matrix of the four genes concatenated together, partitioned by gene. For CAD and wg separate analyses were done for the models chosen by the two criteria. The resulting topologies for CAD and wg did not conflict within a locus, though support and resolution was slightly different. In each

case the model that resulted in the larger support values was used for the combined, partitioned analysis. Those models are GTR+G for CAD and GTR+I+G for wg. Bayesian analyses were conducted using MrBayes ver. 3.2 (Ronquist and Huelsenbeck 2003). Two runs of four chains each were run for 10 million generations, with trees sampled every 1000 generations. Runs all reached an average standard deviation of split frequencies below 0.01 (Huelsenbeck and Ronquist 2005), and likelihood scores and all parameter values reached a stable plateau, based on the tools in Tracer ver. 1.5 (Rambaut and Drummond 2007). For each analysis, the trees in a burn-in period of 50% of the generations were excluded, and the majority-rule consensus tree of remaining trees was calculated to determine Bayesian posterior probabilities (pp) of clades.

Results

Phylogenetic results

Single gene analyses

The independent analyses of CAD and COI result in high and very high support, respectively, for Parhypates as the sister to Notonomus. Neither 28S nor wg provide resolution for the Parhypates, Sarticus and Notonomus node (Table 2; Fig. 2).

In all single gene analyses except for wg, monophyly of Parhypates, Sarticus (without *N. blackburni*) and Notonomus (including *N. blackburni*, *Acanthoferonia*, *Conchitella*, *Loxodactylus* and *Leiradira*) is found with very high support (Table 2). Though monophyly of Sarticus and Parhypates is also very highly supported in the analysis of wg alone, that analysis places those as sister taxa within Notonomus, rendering it paraphyletic. All analyses place *N. blackburni*, *Acanthoferonia*, *Conchitella*, *Loxodactylus* Chaudoir, 1865 and *Leiradira* species among the clade of species currently in *Notonomus*; however, only the relationship between

Loxodactylus and *N. blackburni* is found in multiple analyses (Table 2).

Within the subgenus *Leiradira*, *Notonomus dimorphicus* Darlington, 1961 and *N. flos* Darlington, 1961 are sister taxa with very high support in all analyses and are found to be sister to *N. alternans* + *N. aurifer* Darlington, 1961 in CAD, wg and combined analyses. Species pairs corresponding to *Leiradira* s. str., *Stomimorphus* Straneo, 1953 and *Metadira* Darlington, 1961b are found to have very high support from multiple genes and no contrary support (Table 2; Fig. 2 nodes 5, 7 and 8).

Combined analyses

Combined gene analyses result in very high support of the monophyly of Parhypates, Sarticus (without *N. blackburni*) and Notonomus (including *N. blackburni*, *Acanthoferonia*, *Conchitella*, *Loxodactylus* and *Leiradira*) (Table 2). In the combined analysis including all loci, Sarticus is placed as sister to Notonomus, but with low support (0.61 pp). The analysis excluding wg results in Parhypates + Notonomus with very high support. A monophyletic *Leiradira* (including *N. flos* and *N. dimorphicus*) is found in the combined analyses with high or very high support for all nodes (Table 2; Fig. 2).

Taxonomic results

Genera and subgenera

Based on the results of the phylogenetic analysis, a redefinition of *Notonomus* is required to better align the classification with genealogy. From my general examination of types, non-type specimens and descriptions, there is no obvious challenge to the monophyly of *Notonomus* as conceived here by any described species not included in this analysis. Therefore the genus encompasses all species of *Notonomus* as listed by Lorenz

Table 2. Support for groups found in Bayesian analyses for each gene locus and combined analysis
Node numbers refer to nodes indicated in Fig. 2

	28S	CAD	COI	wg	comb	comb no wg
Parhypates	0.8	1	1	1	1	1
Sarticus (- <i>S. blackburni</i>)	1	1	1	1	1	1
Notonomus+	1	1	1	-0.88	1	1
Leiradira+		0.91			1	0.91
Parhypates+Notonomus		0.72	0.98			0.98
Sarticus+Notonomus			-0.98		0.61	-0.98
nodes # for Leiradira+						
1		0.91			0.88	0.91
2		0.83		-0.58	0.88	0.87
3		0.97		1	1	1
4	0.99	1	1	0.95	1	1
5		1	0.99	1	1	1
6		1	1	-0.61	1	1
7	1			1	1	1
8	0.98	0.61	0.95	1	1	1
very high support, >0.90						
High support, 0.70–0.89						
low support, 0.50–0.69						
contrary support						
blank, no support						

subgenera may call attention to the distinctiveness of the species, but provide little other information. Darlington used three subgenera of *Leiradira* (*Leiradira* s. str., *Stomimorphus* and *Metadira*) and these groups are likely to include close relatives. However, as some or all of the species in Darlington's doddi-group of *Notonomus* (including several undescribed species from Queensland (K. Will, unpubl. Data)) are very likely part of the *Metadira* clade and given species like *N. barrae*, which is morphologically distinct from all other *Leiradira* species, recognition of species groups corresponding to these previously recognised subgenera would be misleading and so they are not employed. *Notonomus* is a large genus and it will benefit from a subgeneric classification once an integrative taxonomic study is done for all the included species.

Notonomus Chaudoir, 1865 subgenus
Leiradira Castelnau, 1867 alternans (Darlington, 1953), comb. nov. *alticola* (Darlington, 1961), comb. nov. *auricollis* (Castelnau, 1867), comb. nov. *aurifer* (Darlington, 1961), comb. nov. *barrae*, sp. nov.
dimorphicus (Darlington, 1961) comb. nov.
flos (Darlington, 1961) comb. nov.
hephaestus, sp. nov.
iridescens, sp. nov.
jacobi (Darlington, 1961), comb. nov.
latreillei (Castelnau, 1867), comb. nov.
opacistriatis Sloane, 1902
puella (Tschitschérine, 1898), comb. nov.
smilodon, nom. nov.
soror (Darlington 1961), comb. nov.
spectabilis, sp. nov.
tenuis (Darlington, 1961), comb. nov.
thynnefiliarum, sp. nov.
vadosus, sp. nov.
viridis, sp. nov.
subgenus *Acanthoferonia* Moore, 1965
ferox (Moore, 1965), comb. nov.
subgenus *Loxodactylus* Chaudoir, 1865
australiensis (Sloane, 1895), comb. nov.
carinulatus (Chaudoir, 1865), comb. nov.
subgenus *Conchitella* Moore, 1962
clivinoides (Moore, 1962), comb. nov.
incertae sedis
blackburni (Sloane, 1895), comb. nov.
impar (Sloane, 1893), comb. nov.
nocturnocappellus, sp. nov.
parallelomorphus Chaudoir, 1878, comb. nov., replacement name for *Notonomus auricollis* (Castelnau, 1867: 211), synonymy by Straneo (1936), preocc. *Leiradira auricollis* Castelnau, 1867.

Species treatments

Notonomus alternans (Darlington), comb. nov.

(Figs 10C, 11E, F)

Leiradira (*Metadira*) *alternans* Darlington, 1953: 90.

Material examined

Sixty-one <<, 27 ,,, one < paratype (QM).

Distribution and type locality

Specimens of this species are known from the type locality Malanda (Darlington 1953) in the north, south to Tully at elevations of 600–1300 m.

Diagnosis

Medium- to large-sized black shiny beetles with prominent elytral striae and uneven interval widths. Superficially similar to *N. opacistriatis*, but easily separated from that species by the apically broadening, dull striae, which are prominent in *N. opacistriatis* but not found in *N. alternans*.

Description

Size. Overall length (SBL) 10.9–15.4 mm. Greatest width over elytra 3.7–5.1 mm.

Colour. Head black. Pronotum black. Elytra black. Body ventral surface piceous. Legs piceous. Mouthparts piceous. Antennae piceous.

Microsculpture. Dorsal and ventral lustre moderately shiny. Head dorsally with microsculpture absent or not visible at 50× magnification. Pronotum dorsally with microsculpture absent or not visible at 50× magnification. Elytra with microsculpture absent or not visible at 50× magnification. Microsculpture of elytral striae slightly opaque, width not significantly widening apically, striae narrower than or, at most, of about equal width of adjacent intervals near elytral apex.

Head. Eyes medium size, slightly produced. Ocular ratio 1.40–1.50. Antennae clearly geniculate, first antennomere longer than 2+3. Frontal impressions deep, divergent, slightly recurved. Labrum with six setae on anterior margin. Labrum anterior margin moderately emarginate. Occlusal margin of right mandible with long, blade-like anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth low, broad, shallowly emarginate. Apical labial palpomere apically expanded, subsecuriform. Lacinia with a row of thick setae medially, mixed with finer setae and additional, more irregular rows of fine setae dorsally and ventrally.

Thorax. Basal pronotal seta in lateral bead near hind angle. Tarsomere 5 ventrally glabrous. Elytral intervals 3, 5 and 7 slightly wider than 2, 4 and 6. Elytral interval 3 with two setigerous punctures or with three setigerous punctures. Elytral striae all more or less impressed throughout their length. Elytral plica not externally visible, internal ridge present.

Abdomen. Ventrites 4–6 with shallow basolateral sulcus. Male aedeagus with long flagellum.

Notonomus alticola (Darlington), comb. nov.

(Figs 12A, 13A, B)

Leiradira (*Metadira*) *alticola* Darlington, 1961b: 6.

Material examined

Sixteen <<, 11 ,,, one damaged, sex undetermined.

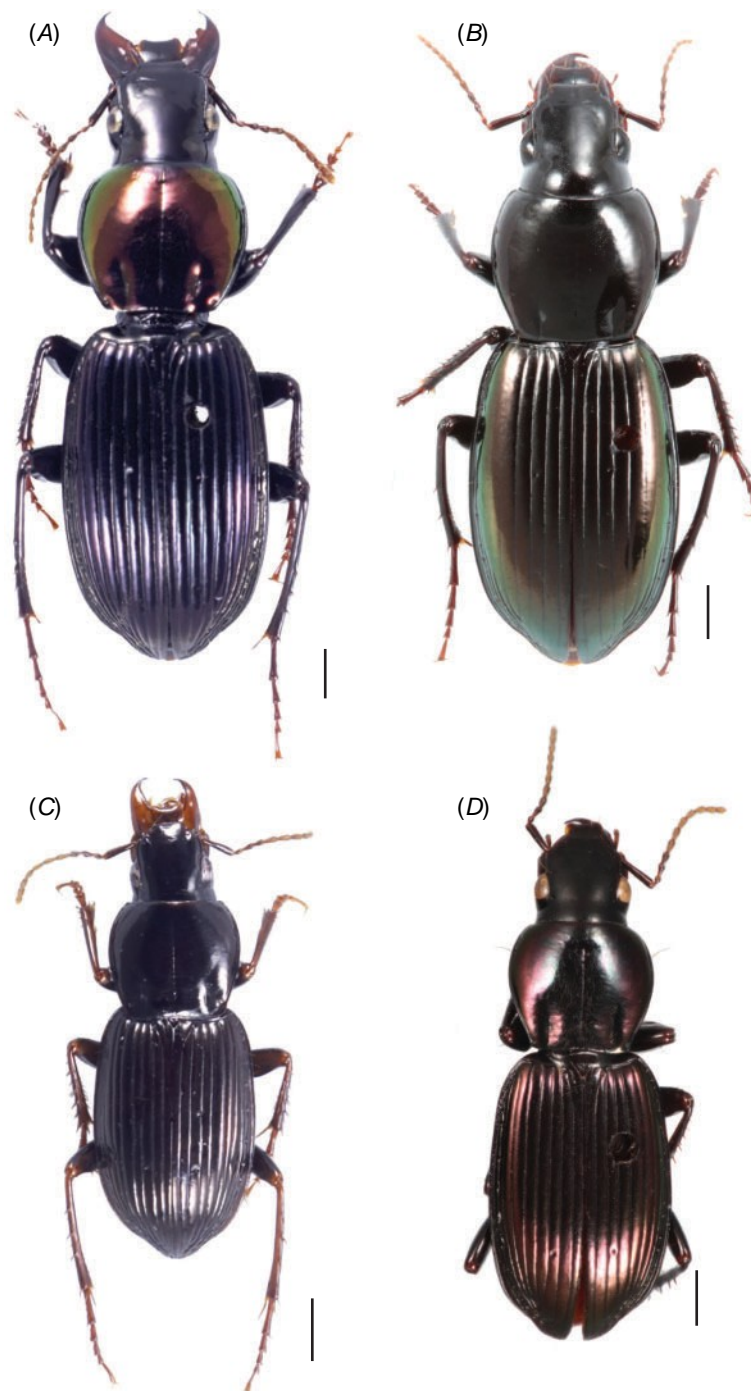


Fig. 3. Dorsal habitus, scale bars = 1.0 mm. (A) *Notonomus auricollis*, (B) *Notonomus latreillei*, (C) *Notonomus puella*, (D) *Notonomus thynnefiliarum*.

Distribution and type locality

Darlington (1961b) established the east side of Mt Bellenden Ker as the type locality and this species is known only from Mt Bellenden and Mt Bartle Frere (Fig. 9) at elevations above 1400 m.

Diagnosis

Large-sized beetles with relatively broader and more ovoid elytra, regularly impressed striae and subtle metallic colour on the head and pronotum that in combination readily distinguishes this species from other *Notonomus* species

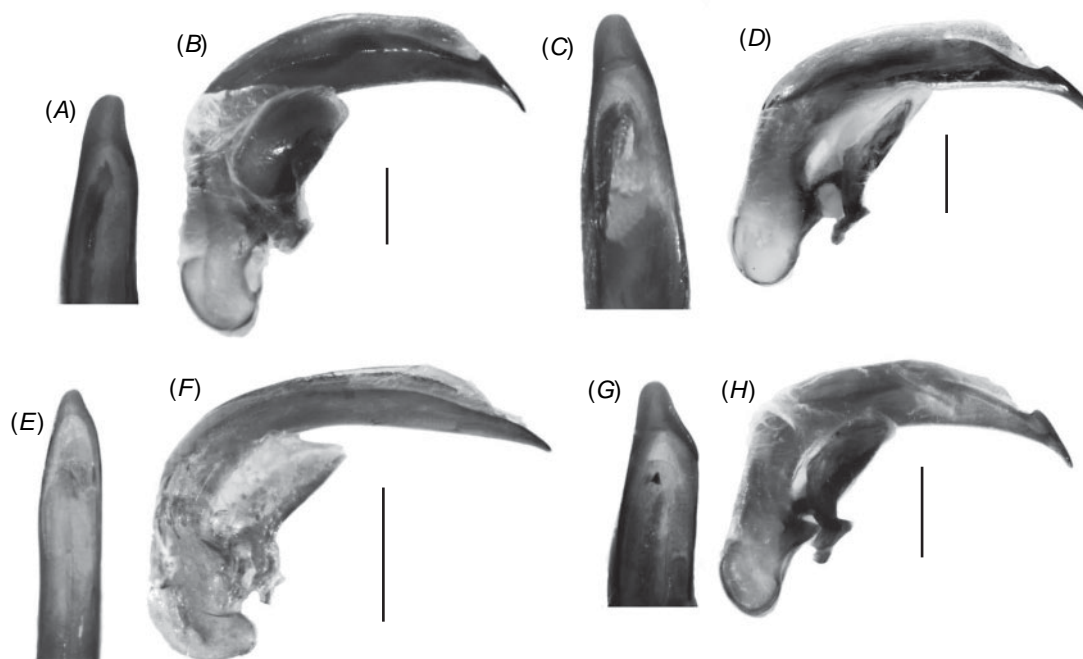


Fig. 4. Male genitalia, scale bar = 0.5 mm. *Notonomus auricollis*, (A) dorsal view blade of median lobe, (B) left lateral view; *Notonomus latreillei*, same C–D; *Notonomus puella*, same E–F; *Notonomus thynnefilium*, same G–H.

including *N. soror*, which is sympatric with it on Mt Bellenden Ker.

Description

Size. Overall length (SBL) 14.0–18.4 mm. Greatest width over elytra 4.8–6.3 mm.

Colour. Head black ground colour with green or metallic purple colour. Pronotum metallic green or purple. Elytra black or metallic purple along lateral margins. Body ventral surface piceous. Legs piceous. Mouthparts piceous. Antennae piceous.

Microsculpture. Dorsal and ventral lustre moderately shiny. Head dorsally with microsculpture absent or not visible at 50× magnification. Pronotum dorsally with microsculpture absent or not visible at 50× magnification. Elytra with microsculpture consisting of isodiametric sculpticells. Microsculpture of elytral striae slightly opaque, width not significantly widening apically, striae narrower than or, at most, of about equal width of adjacent intervals near elytral apex.

Head. Eyes medium size, slightly produced. Ocular ratio 1.35–1.56. Antennae clearly geniculate, first antennomere longer than 2+3. Frontal impressions shallow or not impressed. Labrum with six setae on anterior margin. Labrum anterior margin moderately emarginate. Occlusal margin of right mandible with long, blade-like anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth low, broad, shallowly emarginate. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, mixed with finer setae and additional, more irregular rows of fine setae dorsally and ventrally.

Thorax. Basal pronotal seta in lateral bead near hind angle. Tarsomere 5 ventrally glabrous. Elytral intervals all of approximately equal width. Elytral interval 3 with one setigerous

puncture. Elytral striae all more or less impressed throughout their length. Elytral plica absent.

Abdomen. Ventrites 4–6 with shallow basolateral sulcus or without sulci. Male aedeagus with long flagellum.

Notonomus auricollis (Castelnau), comb. nov.

(Figs 3A, 4A, B, 5)

Leiradira auricollis Castelnau, 1867: 159.

Leiradira cupreicollis Tschitschérine, 1897: 271.

Leiradira purpurascens Tschitschérine, 1897: 270.

Leiradira blandula Tschitschérine, 1898: 45 new synonymy.

Material examined

One hundred <<, 115 , , one , holotype *L. blandula* (ZISP).

Distribution and type locality

The range of this species is from as far north as southern Queensland, near Mistake Mts and Cunningham Gap, south to Dorriggo National Park (Fig. 8). It is a rainforest species usually found at 600–1000 m elevation. Straneo (1941) selected a lectotype for this species but did not restrict the type locality (Moore et al. 1987: 163). The type locality is here restricted to the upper Clarence River, NSW in the vicinity of 28°42'6" S 152°29'21" E.

Diagnosis

Medium-sized beetles with notable metallic colours and regular, well impressed elytral striae. This species is most similar to *N. latreillei*, from which it differs in having more clearly impressed striae, especially laterally, and colour, and *N. thynnefilium*, which it differs from in having the

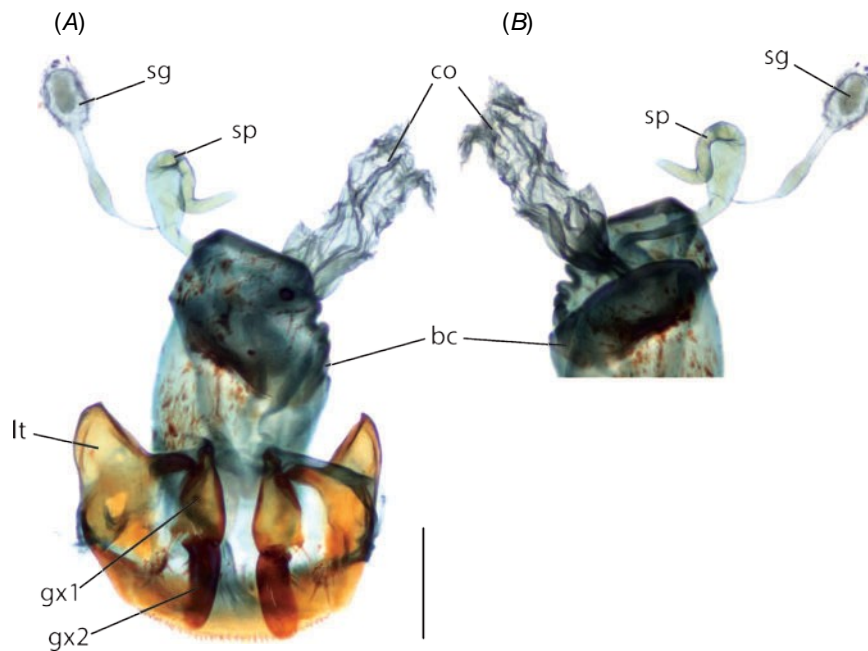


Fig. 5. Female reproductive tract. Scale bar = 1.0 mm. *Notonomus auricollis*, (A) ventral view, (B) dorsal view of apical portion. sg = spermatheca gland, sp = spermatheca, co = common oviduct, bc = bursa copulatrix, lt = laterotergite ix, gx1 = gonocoxite 1, gx2 = gonocoxite 2.

pronotum strongly metallic, contrasting with the head and elytral colours.

Description

Size. Overall length (SBL) 8.9–13.2 mm. Greatest width over elytra 3.0–4.5 mm.

Colour. Head black. Pronotum black ground colour with metallic green colour or clearly metallic green, red or aeneous. Elytra metallic purple. Body ventral surface black or piceous. Legs black or piceous. Mouthparts piceous. Antennae piceous or brown and infuscated.

Microsculpture. Dorsal and ventral lustre very or moderately shiny. Head dorsally with microsculpture absent or not visible at 50 \times magnification. Pronotum dorsally with microsculpture absent or not visible at 50 \times magnification. Elytra with microsculpture consisting of isodiametric sculpticells. Microsculpture of elytral striae slightly opaque, width not significantly widening apically, striae narrower than or, at most, of about equal width of adjacent intervals near elytral apex.

Head. Eyes small, flat. Ocular ratio 1.31–1.43. Antennae clearly geniculate, first antennomere longer than 2+3. Frontal impressions shallow or not impressed. Labrum with four setae on anterior margin, median pair absent. Labrum anterior margin shallowly emarginate or entire. Occlusal margin of right mandible with long, blade-like anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth absent. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, and an irregular row of fine setae dorsally.

Thorax. Basal pronotal seta adjacent to lateral bead and about one pore's width forward of hind angle. Tarsomere 5

ventrally glabrous or setose. Elytral intervals all of approximately equal width. Elytral interval 3 with two setigerous punctures. Elytral striae all more or less impressed throughout their length. Elytral plica externally visible.

Abdomen. Ventrites 4–6 without sulci. Male aedeagus without ligula.

Notes on variation and synonymy

Notonomus auricollis is the only species found to be variable for ventral setation of tarsomere 5. Of 205 specimens examined for setae on tarsomere 5, 110 had no setae and 92 had at least one seta on one tarsomere (three damaged and state unknown). Of the setose individuals the number of setae was usually one, but occasionally two and setae were found on one or several legs. In this sample there was no obvious pattern related to which particular leg was setose, sex bias or specific locality. Setae were finer and shorter than what is found in other species with a pair consistently on all legs, e.g. *N. latreillei*. Though Tschitschérine (1896: 40) noted the difficulty of seeing the ventral setae in this species, he used this as a key identification character to separate *N. auricollis* and *N. blandulus*. Given the large series of individuals available to me and examination of the type of *N. blandulus*, including dissection of the male type's genitalia, it is clear that the type specimen of *N. blandulus* falls well within variation of *N. auricollis*. The type of *N. blandulus* is labelled 'S. Australia. Adelaide.', but this is certainly an erroneous locality. The most south-western record for *N. auricollis* is the vicinity of Glen Innes, NSW more than 1300 km from Adelaide. No specimens of *Leiradira* are known from South Australia.

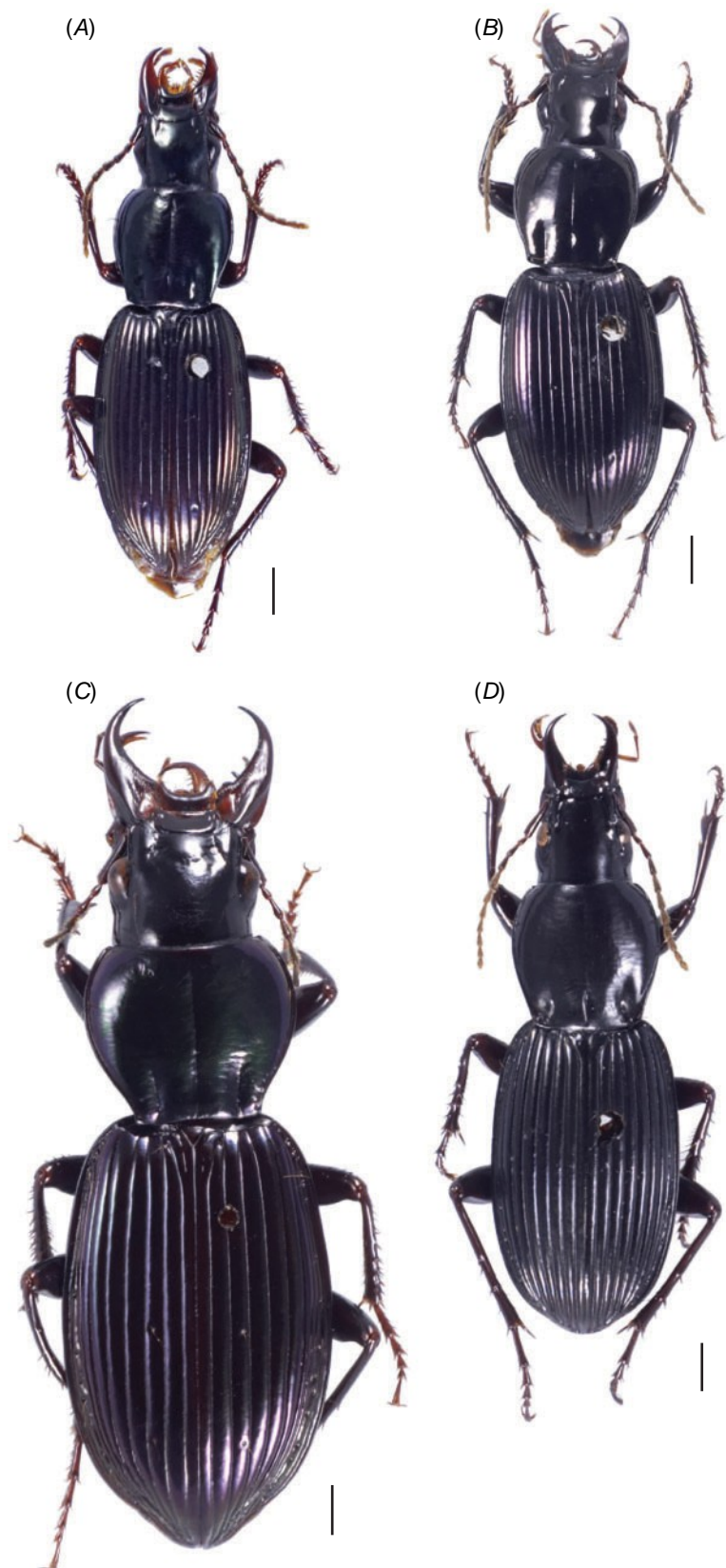


Fig. 6. Dorsal habitus. Scale bars = 1.0 mm. (A) *Notonomus jacobi*, (B) *Notonomus tenuis*, (C) *Notonomus smilodon*, (D) *Notonomus barrae*.

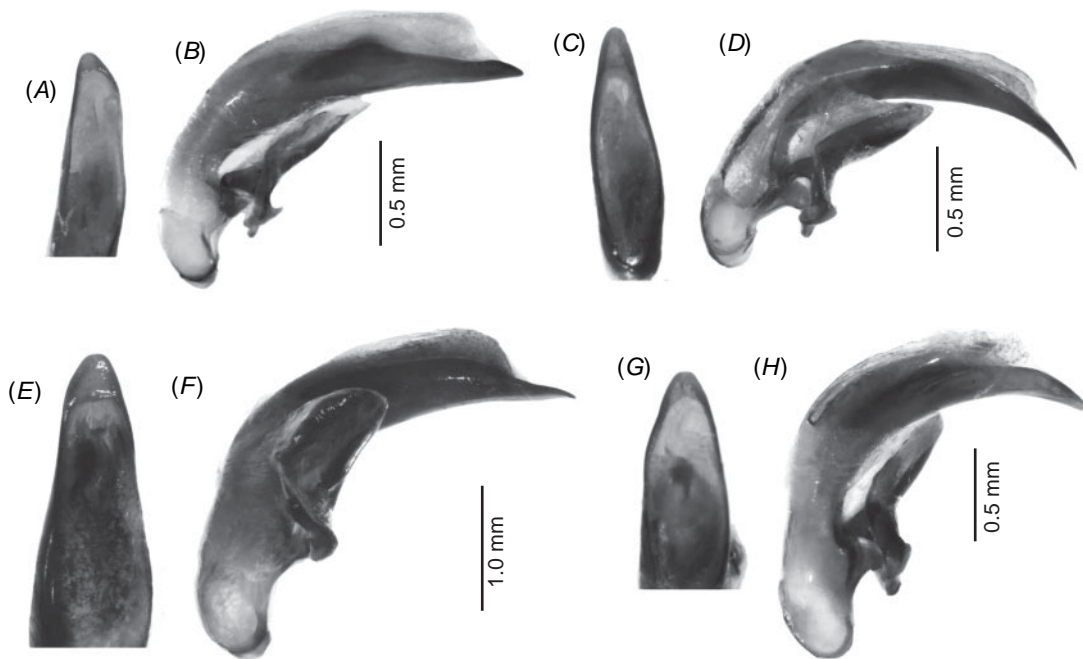


Fig. 7. Male genitalia. *Notonomus jacobii*, (A) dorsal view blade of median lob, (B) left lateral view median lobe with parameres; *Notonomus tenuis*, same C–D; *Notonomus smilodon*, same E–F; *Notonomus barrae*, same G–H.

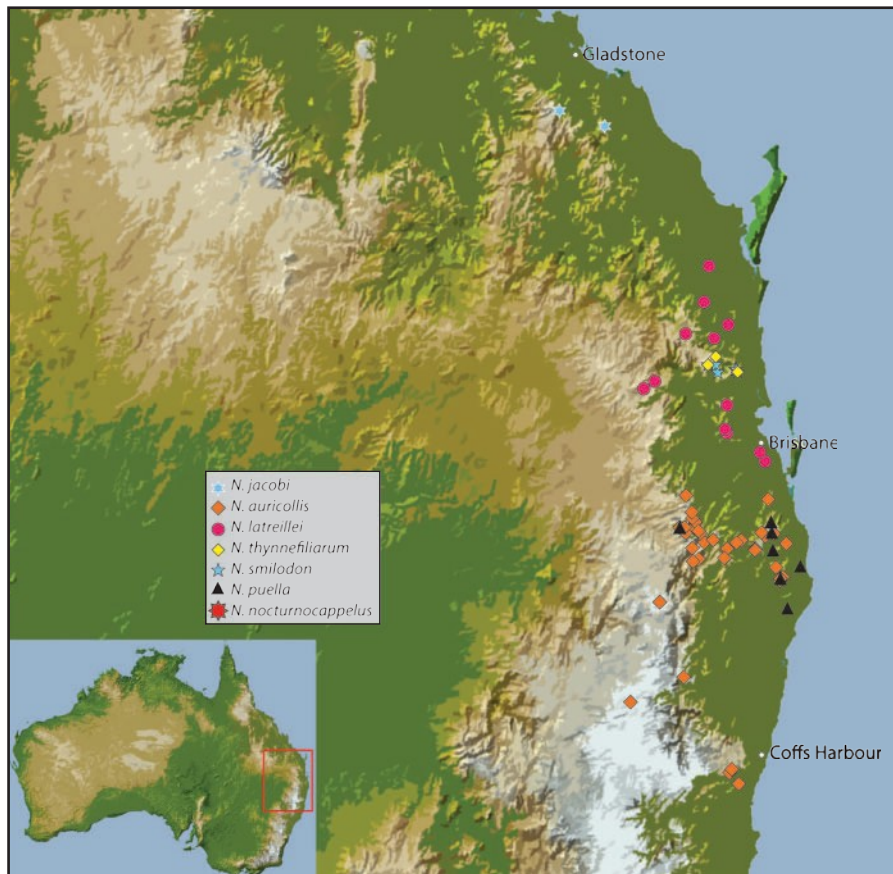


Fig. 8. Map of localities for material examined of *Notonomus* species.



Fig. 9. Map of localities for material examined of *Notonomus* species.

Notonomus aurifer (Darlington)

(Figs 14B, 15C, D, 17A)

Leiradira (*Metadira*) *aurifer* Darlington, 1961b: 4.

Material examined

Thirty-three ♂♂, 18 ♀♀, paratype ♀, (QM).

Distribution and type locality

Darlington (1961b) established the type locality as the ‘mountains north of Kairi’ and this species is known from those mountains at elevations above 900 m as far north as Lambs Head (Fig. 9).

Diagnosis

Strikingly brilliant, shifting metallic red green beetles. Medium-to large-sized *Leiradira* that are very similar to *N. spectabilis*, but immediately separable by the dark metallic purple or blue colour of this species compared to the brilliant red in *N. spectabilis*. *Notonomus aurifer* is nearly identical to *N. hephaestus* in habitus and colour, but *N. aurifer* has the wide gula, rake-like lacinia and differs in patterns of setation generally.

Description

Size. Overall length (SBL) 15.8–19.0 mm. Greatest width over elytra 5.3–6.6 mm.

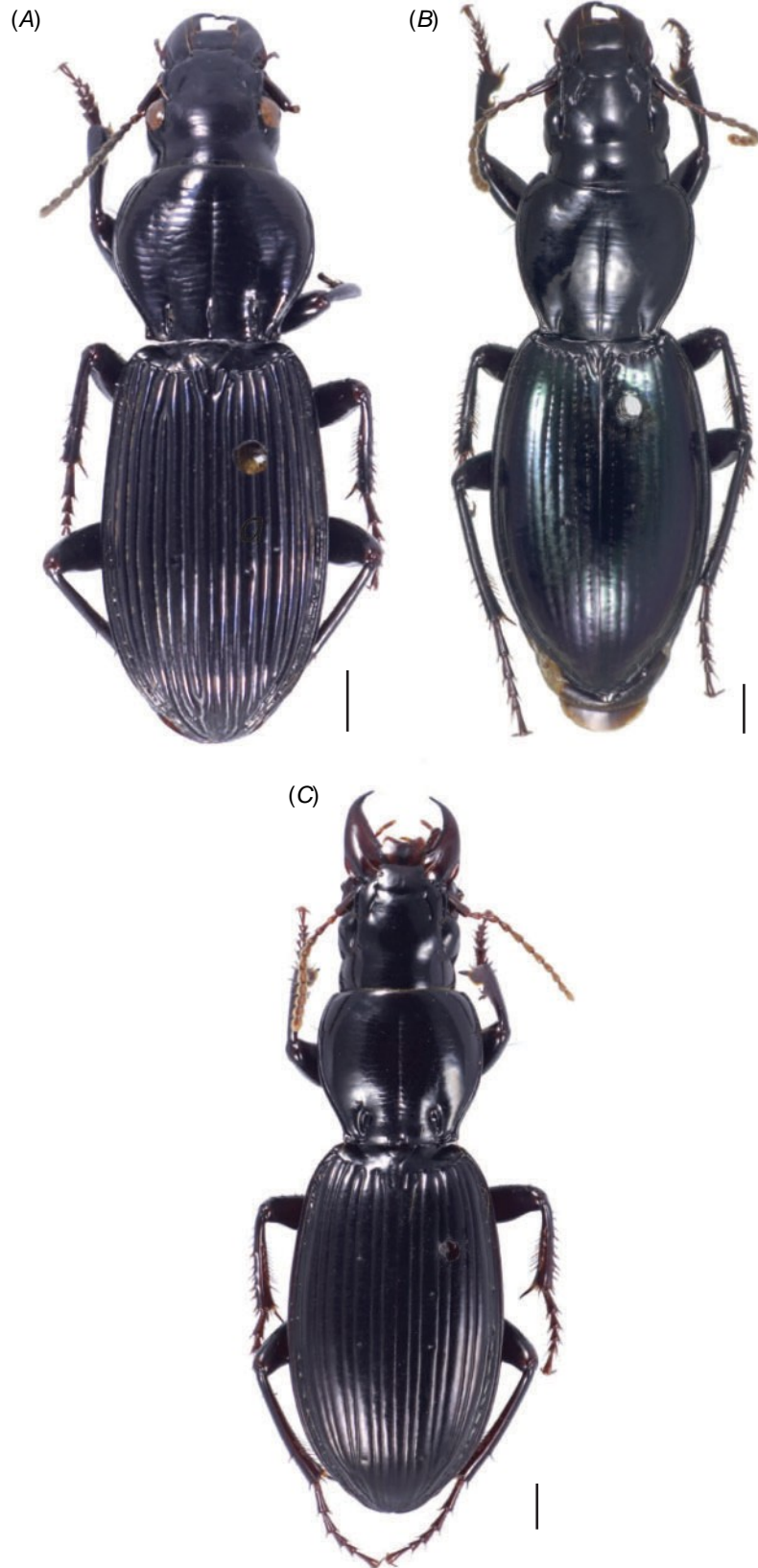


Fig. 10. Dorsal habitus, scale bars = 1.0 mm. (A) *Notonomus iridius*, (B) *Notonomus vadosus*, (C) *Notonomus alternans*.

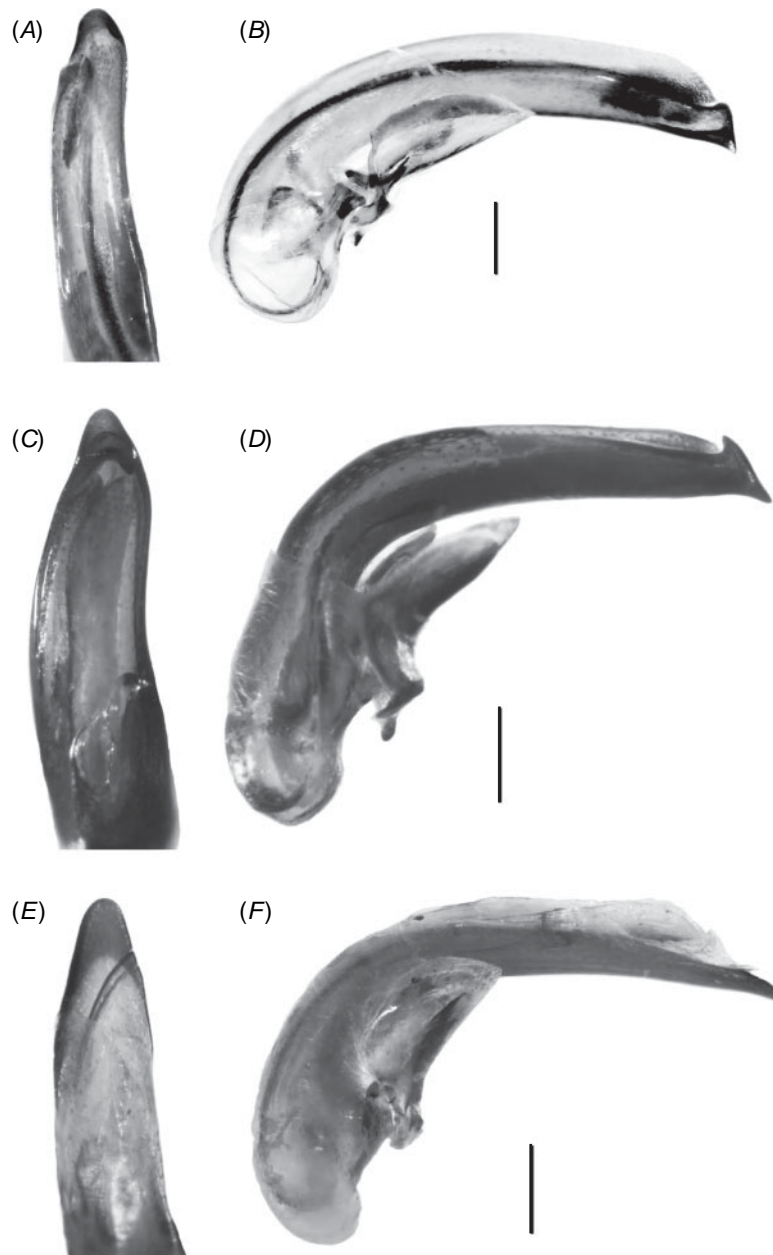


Fig. 11. Male genitalia, scale bar = 0.5 mm. *Notonomus iridius*, (A) dorsal view blade of median lobe, (B) left lateral view median lobe with parameres; *Notonomus vadosus*, same C–D; *Notonomus alternans*, same E–F.

Colour. Head metallic green or metallic red. Pronotum metallic green or metallic red. Elytra metallic green or metallic red. Body ventral surface black. Legs piceous. Mouthparts piceous. Antennae piceous.

Microsculpture. Dorsal and ventral lustre very or moderately shiny. Head dorsally with microsculpture absent or not visible at 50 \times magnification. Pronotum dorsally with microsculpture absent or not visible at 50 \times magnification. Elytra with microsculpture absent or not visible at 50 \times magnification. Microsculpture of elytral striae strongly, obviously opaque mesh, width greatly widening and striae

anastomosing apically, much wider than intervals near elytral apex.

Head. Eyes medium size, slightly produced. Ocular ratio 1.40–1.46. Antennae not geniculate, first antennomere subequal to length of 2+3. Frontal impressions deep, divergent, slightly recurved. Labrum with six setae on anterior margin. Labrum anterior margin moderately emarginate or anterior margin shallowly emarginate. Occlusal margin of right mandible with long, blade-like anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth low, broad, shallowly emarginate. Apical labial palpomere slightly expanded apically. Lacinia

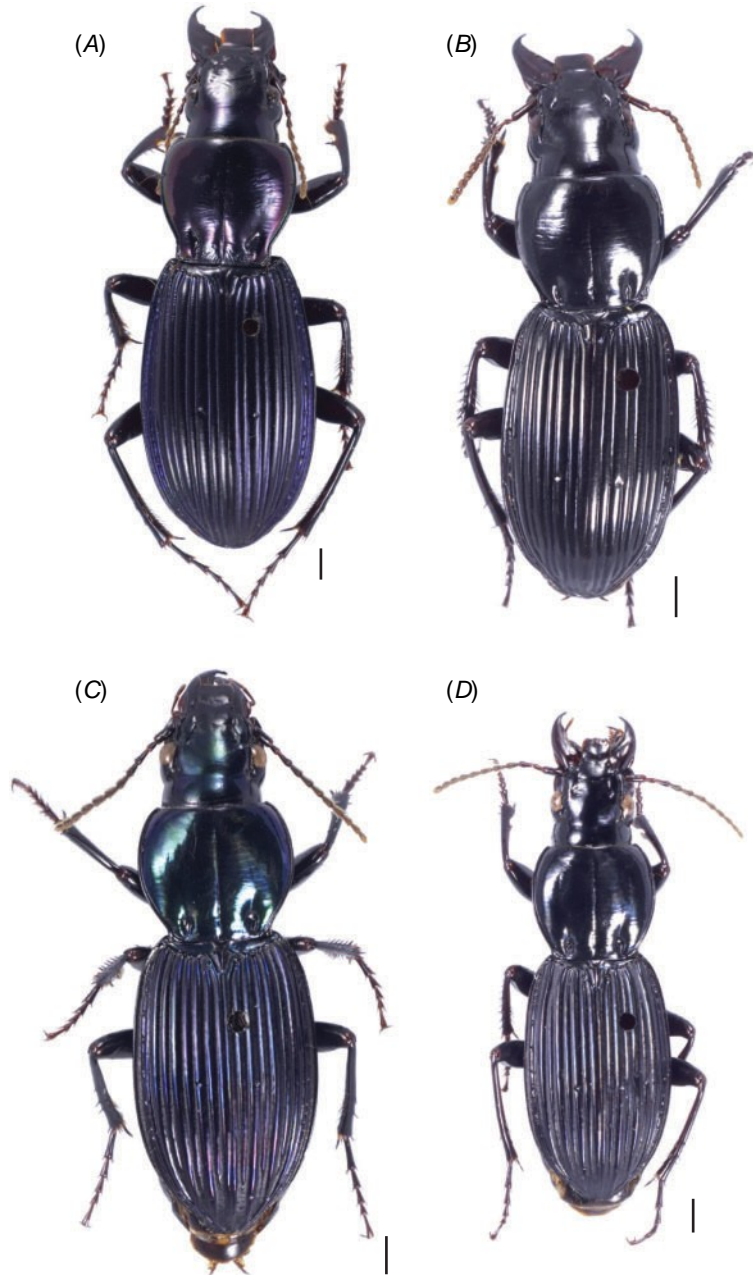


Fig. 12. Dorsal habitus, scale bars = 1.0 mm. (A) *Notonomus alticola*, (B) *Notonomus soror*, (C) *Notonomus viridis*, (D) *Notonomus opacistriatus*.

with a row of thick setae medially, mixed with finer setae and additional, more irregular rows of fine setae dorsally and ventrally.

Thorax. Basal pronotal seta in lateral bead near hind angle. Tarsomere 5 ventrally glabrous. Elytral intervals 3, 5 and 7 much wider than 2, 4 and 6. Elytral interval 3 with two setigerous punctures. Elytral striae all more or less impressed throughout their length. Elytral plica flat, scarcely visible.

Abdomen. Ventrites 4–6 with shallow basolateral sulcus or without sulci. Male aedeagus with long flagellum.

Notonomus barrae, sp. nov.

(Figs 6D, 7G, H)

urn:lsid:zoobank.org:act:E8224794-38B9-47EB-A5F0-461B98C41178

Material examined

Holotype. ♀, '55k0315418/8173573 WGS84, Mount Lewis Road, 1210 m, 23Oct-30Nov2008 K. Staunton, Pitfall CU12A2 c 688°/'QMT189878'. Deposited QM.

Paratypes. Mt Lewis, 27.xii.1972, A. and M. Walford-Huggins (< CMNH), same 7.xii.1975 (, CMNH); 16°32'32.3"S 145°17'03.7"E,

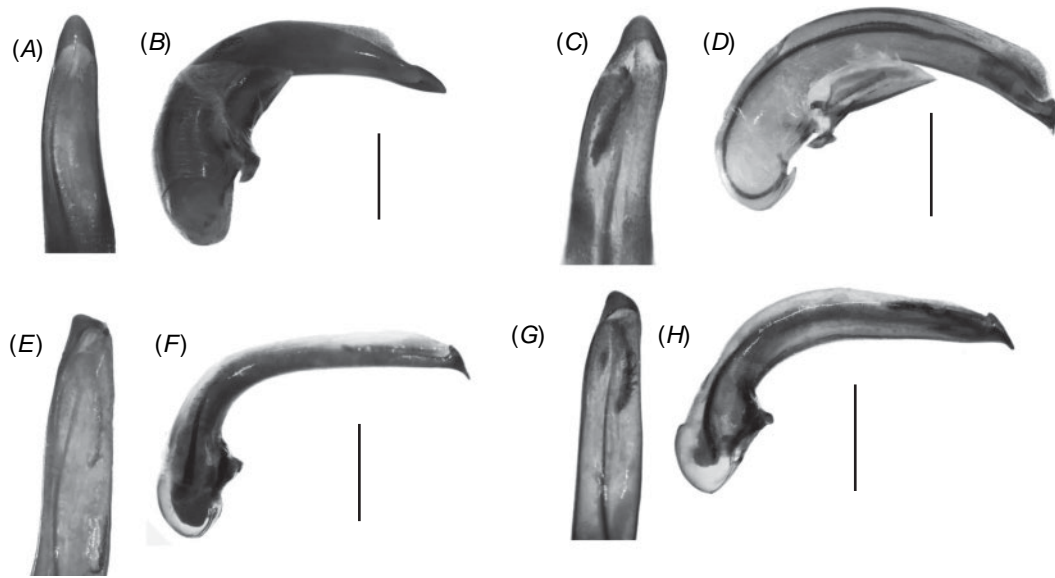


Fig. 13. Male genitalia, scale bars = 1.0 mm. *Notonomus alticola*, (A) dorsal view blade of median lobe, (B) left lateral view median lobe with parameres; *Notonomus soror*, same C–D; *Notonomus viridis*, same E–F; *Notonomus opacistriatus*, same G–H.

974 m, headlamp search, 19.xii.2010, K. Will (AUS2010.xii.19.2) (EMEC208703<, EMEC209820 <, EMEC209819 ,, EMEC); Mount Lewis Road, 1160 m, 23.x–30.xi.2008 K. Staunton, pitfall (T193500, T193501, << QM), same 3Sep–23Oct (T193502 ,QM); Mt Lewis Rd, 29 km from Highway, 14.vii.97, G. Monteith, 1200 m, (T65725 , QM). 16.511°S.145.209°E, Mt Lewis Rd hut, 12 km NW Julatten. 1187 m. 22.xi.2009. Hand. 18632 G.B. Monteith and F. Turco, kww884, EMEC209812 (< EMEC). Devils Thumb area, 10 km NW Mossman, –16.394167°/145.289167°, 1000–1180 m, Monteith, D. Yeates, G. Thompson, 09–10.x.1982 (T20255 , QM); same, 16 23Sx145 16E, 1160 m, 30.vi–1.vii.1997, D.J. Cook (T193503 < QM). 16°23'48"S 145°17'38"E, Devils Thumb, above Fern Patch, Carbine Tableland, 26–27.xi.1990, G. Monteith, H. Janetzki, pitfall trap, 1050 m, (T20266 < QM); (16°24'27"S 145°16'20"E), Devils Thumb–Plane Crash, 27.xi.90, G. Monteith, G. Thompson, D. Cook, R. Sheridan, H. Janetzki, 1300 m (T20267 < QM); (16°26'54"S 145°16'53"E), Mossman Bluff Summit, 10 km W Mossman, 21.xii.89, G. Monteith, G. Thompson, ANZSES, 1300 m (T20264 , QM); (16°27'52"S 145°17'12"E), Mossman Bluff Track, 10 km W Mossman, 17–19.xii.1988, G. Monteith, G. Thompson, pitfall trap, 1000 m (T20261 < QM); (16°28'S 145°18'E), Mossman Bluff Track, 5–10 km W Mossman, 01–17.i.1989, G. Monteith, G. Thompson, ANZSES, pitfall trap, 1260 m (T20263 < QM); (16°29'54"S 145°19'13"E), Mt Demi summit, 16–17.xii.1995, G. Monteith, G. Thompson, 1000 m (T25804 , QM); (16°29'54"S 145°19'13"E), Mt Demi, 7 km SW Mossman, 29.x.1983, D. Yeates, G. Thompson, 1100 m (T20256, T20257, ,, QM); (16°6'44"S 145°24'58"E), Mt Hemmant, 25–27.xi.1993, G. Monteith, D. Cook, H. Janetzki, L. Roberts, 1050 m (T20270 <, T20271 ,, QM); (16°27'17"S 145°12'26"E), Mt Spurgeon, 2 km SE, via Mt Carbine, 20.xii.88, G. Monteith, G. Thompson, 1100 m (T20262, , QM); (16°26'27"S 145°15'8"E), Pauls Luck, Platypus Ck, 13 km W Mossman, 01–16.i.1990, ANZSES, pitfall trap, 1100 m (T20265, , QM); (16°24'19"S 145°13'10"E), Stewart Ck, 4 km NNE Mt Spurgeon (camp 1), 15–20.x.1991, G. Monteith, H. Janetzki, D. Cook, L. Roberts, 1250–1300 m (T20268, T20269, ,, QM); (16°27'52"S 145°17'12"E), The Bluff, 11 km W Mossman, 2.xi.1983, G. Monteith, D. Yeates, G. Thompson, 800–1300 m (T20258 ,, T20259 ,, T20260 <, QM).

Distribution and type locality

The type locality is Mount Lewis, Queensland, S 16°30'45"E 145°16'13"E. The species is known from as far north as Mt Hemmant, just south of Cape Tribulation, through the Daintree and Carbine Tableland to just south of the level of Mossman and Mt Lewis (Fig. 9). It is a rainforest species found at 1000–1300 m elevation. Reported as 'Leiradira NQ2' by Yeates et al. (2002).

Diagnosis

Fairly small, very narrowly-built beetles with notably elongate narrow head and mandibles, no anterior retinacular tooth on the right mandible and a very wide gula.

Description

Size. Overall length (SBL) 9.9–12.2 mm. Greatest width over elytra 3.1–4.2 mm.

Colour. Head black. Pronotum black. Elytra black with spectral iridescence. Body ventral surface black or piceous. Legs piceous. Mouthparts piceous or rufobrunneous, paler than head. Antennae rufobrunneous, paler than head.

Microsculpture. Dorsal and ventral lustre very or moderately shiny. Head dorsally with microsculpture consisting of isodiametric sculpticells. Pronotum dorsally with microsculpture consisting of isodiametric sculpticells. Elytra with microsculpture consisting of isodiametric sculpticells. Microsculpture of elytral striae slightly opaque, width not significantly widening apically, striae narrower than or, at most, of about equal width of adjacent intervals near elytral apex.

Head. Eyes small, flat. Ocular ratio 1.39–1.53. Antennae clearly geniculate, first antennomere longer than 2+3. Frontal impressions deep, divergent, straight. Labrum with six setae on

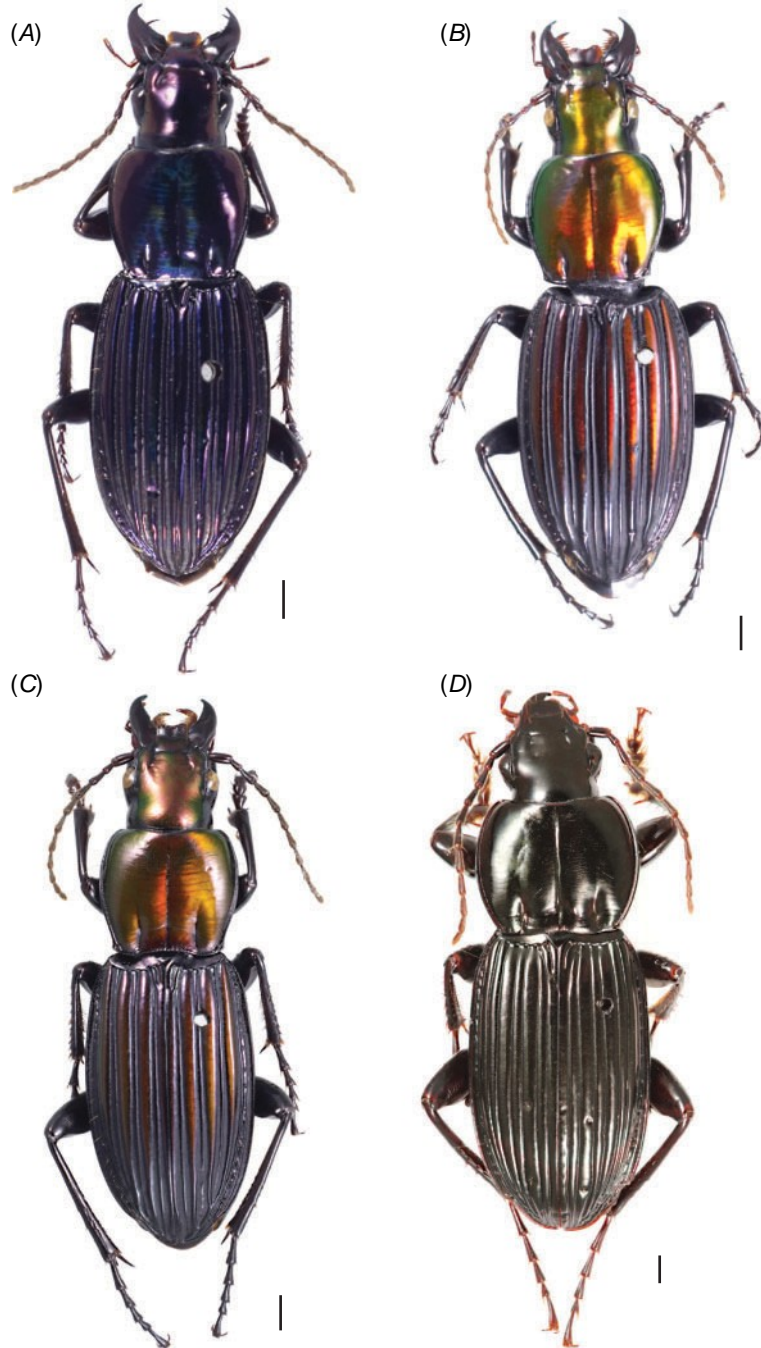


Fig. 14. Dorsal habitus, scale bars = 1.0 mm. (A) *Notonomus spectabilis*, (B) *Notonomus aurifer*, (C) *Notonomus hephaestus*, (D) *Notonomus nocturnocappellus*.

anterior margin. Labrum anterior margin deeply emarginate. Occlusal margin of right mandible without anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth moderately prominent, bilobed. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, mixed with finer setae and additional, more irregular rows of fine setae dorsally and ventrally.

Thorax. Basal pronotal seta adjacent to lateral bead and near hind angle. Tarsomere 5 ventrally glabrous. Elytral

intervals all of approximately equal width. Elytral interval 3 without setigerous punctures. Elytral striae all more or less impressed throughout their length. Elytral plica absent.

Abdomen. Ventrites 4–6 without sulci. Male aedeagus without ligula.

Etymology

Honours Cheryl Barr, Museum Scientist/Collection Manager Emeritus, EMEC, whose efforts contributed to this and

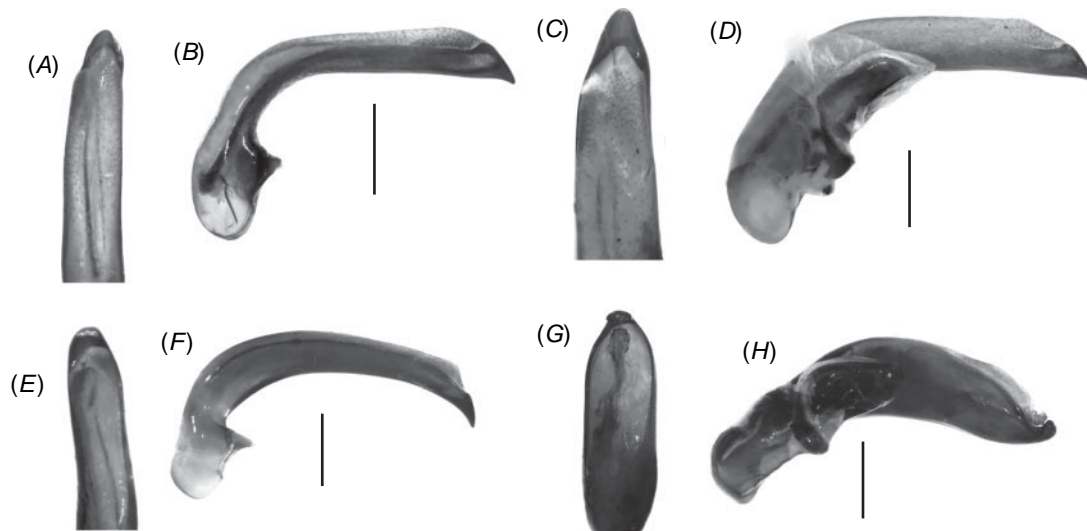


Fig. 15. Male genitalia, scale bars = 1.0 mm. *Notonomus spectabilis*, (A) dorsal view blade of median lobe, (B) left lateral view median lobe with parameres; *Notonomus aurifer*, same C–D; *Notonomus hephaestus*, same E–F; *Notonomus nocturnocappellus*, same G–H.

many other entomological studies during her time at the EMEC.

Notonomus iridescens, sp. nov.

(Figs 10A, 11A, B)

urn:lsid:zoobank.org:act:251A39E8-9450-41A2-8D31-7D95A8E5A8F9

Material examined

Holotype. ♂, 'Upper Boulder Creek, via Tully, 500–600 m 24–27 Oct 1983 Monteith, Yeates & Thompson, QM Reg. No. T20250'. Deposited QM.

Paratypes. Upper Boulder Creek, 11 km NNW Tully, 16–19.xi.1984 D. Cook, G. Monteith, G. Thompson, 850 m, QM reg. No. T20251, (♂, QM); Upper Boulder Creek, 11 km N Tully 05–07.xii.1989, G. Monteith, G. Thompson, H. Janetzki, pitfall trap rainforest, 1000 m, QM Reg. No. T20252, (< QM); 17°36' S 145°45' E, Henrietta Ck, Palmerston NP, 30.xi.1992–15.iv.1993, R. Raven et al. 380 m, rainforest pitfall, 9761 T110058 (< QM).

Distribution and type locality

The type locality is Upper Boulder Creek, Queensland, 17°49'44.00" S 145°54'2.00" E. The specimens in the type series represent the only known localities (Fig. 9).

Diagnosis

Black, somewhat shiny beetles with deeply impressed pronotal basal impressions and dull elytral striae that are very similar to *N. soror*, but with four setae on the margin of the labrum and typically more broadly built.

Description

Size. Overall length (SBL) 10.9–11.7 mm. Greatest width over elytra 3.7–3.8 mm.

Colour. Head black. Pronotum black. Elytra black with spectral iridescence. Body ventral surface piceous. Legs piceous. Mouthparts piceous. Antennae piceous.

Microsculpture. Dorsal and ventral lustre moderately shiny or dull. Head dorsally with microsculpture absent or not visible at 50× magnification. Pronotum dorsally with microsculpture absent or not visible at 50× magnification. Elytra with microsculpture absent or not visible at 50× magnification. Microsculpture of elytral striae strongly, obviously opaque mesh, width slightly widening apically, width less than intervals near elytral apex.

Head. Eyes small, flat. Ocular ratio 1.38–1.45. Antennae clearly geniculate, first antennomere longer than 2+3. Frontal impressions deep, divergent, slightly recurved. Labrum with four setae on anterior margin, median pair absent. Labrum entire. Occlusal margin of right mandible with long, blade-like anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth low, broad, shallowly emarginate. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, and an irregular row of fine setae dorsally.

Thorax. Basal pronotal seta in lateral bead near hind angle. Tarsomere 5 ventrally glabrous. Elytral intervals all of approximately equal width. Elytral interval 3 with one setigerous puncture. Elytral striae all more or less impressed throughout their length. Elytral plica absent.

Abdomen. Ventrites 4–6 with shallow basolateral sulcus. Male aedeagus with long flagellum.

Etymology

The specific epithet draws attention to the spectral iridescence of the beetle.

Notonomus jacobi (Darlington), comb. nov.

(Figs 6A, 7A, B)

Leiradira (*Stomimorphus*) *jacobi* Darlington, 1961b: 9.

Material examined

Six ♂♂, 8 ♀♀.

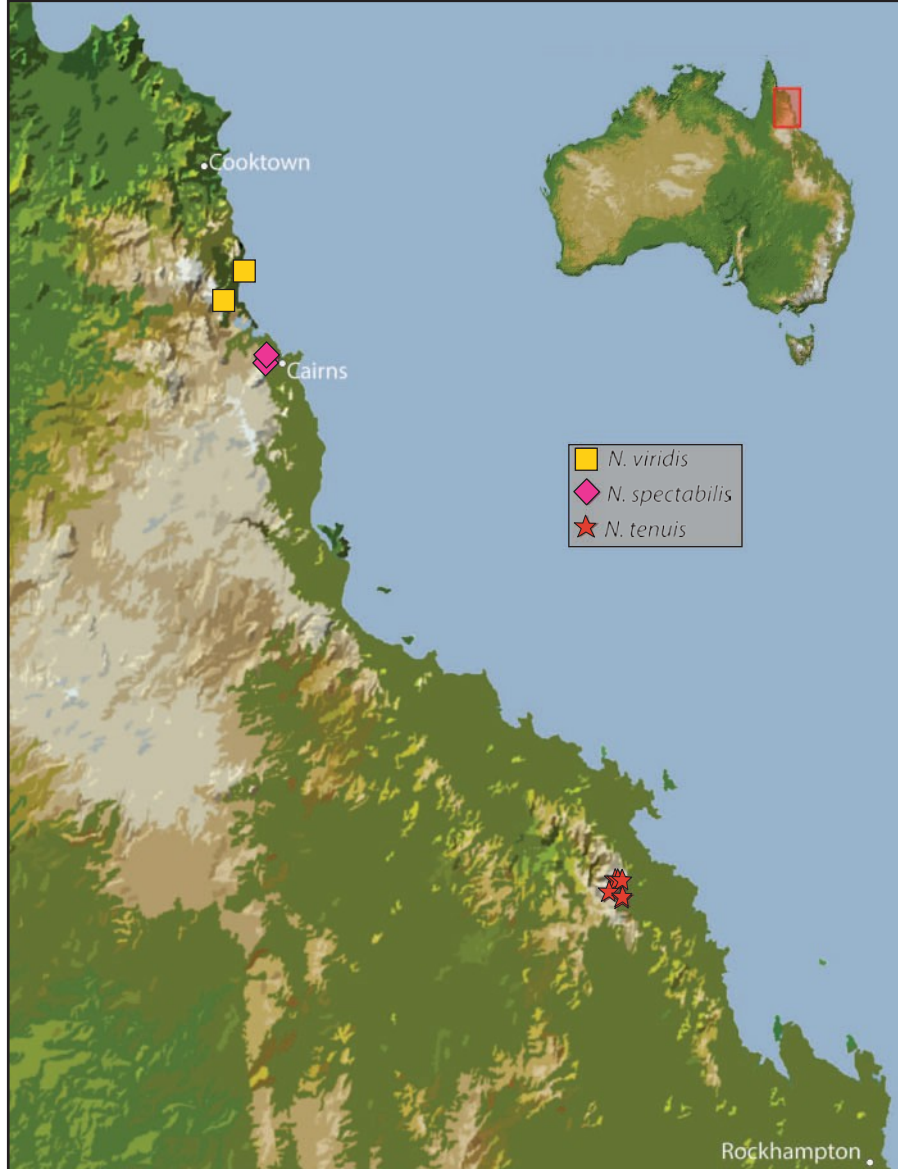


Fig. 16. Map of localities for material examined of Notonomus species.

Distribution and type locality

Darlington (1961b: 10) established the type locality as 'Mt Jacob, c. 45 miles south of Gladstone, South Queensland'. However, Mt Jacob is not an official name that appears on any maps and, as deduced by Monteith (1986), the locality referred to by Darlington corresponds to Bulburin National Park. The type locality can be refined to there, in the vicinity of $24^{\circ}30'58''\text{S}$ $151^{\circ}27'42''\text{E}$. The species is only known from the type locality and the plateau to the west, Kroombit Tops (Monteith 1986) Fig. 8.

Diagnosis

Similar to *N. thynnefiliarum* and *N. auricollis* but with the pronotal margins more sinuate near the base and a subtle green to blue metallic colour on the pronotum.

Description

Size. Overall length (SBL) 9.7–11.0 mm. Greatest width over elytra 3.5–4.1 mm.

Colour. Head black. Pronotum black. Elytra black. Body ventral surface black or piceous. Legs piceous. Mouthparts piceous or rufobrunneous, paler than head. Antennae piceous or rufobrunneous, paler than head.

Microsculpture. Dorsal and ventral lustre moderately shiny or dull. Head dorsally with microsculpture absent or not visible at $50\times$ magnification. Elytra with microsculpture consisting of a mesh of slightly transversely stretched sculpticells. Microsculpture of elytral striae slightly opaque, width not significantly widening apically, striae narrower than or, at most, of about equal width of adjacent intervals near elytral apex.

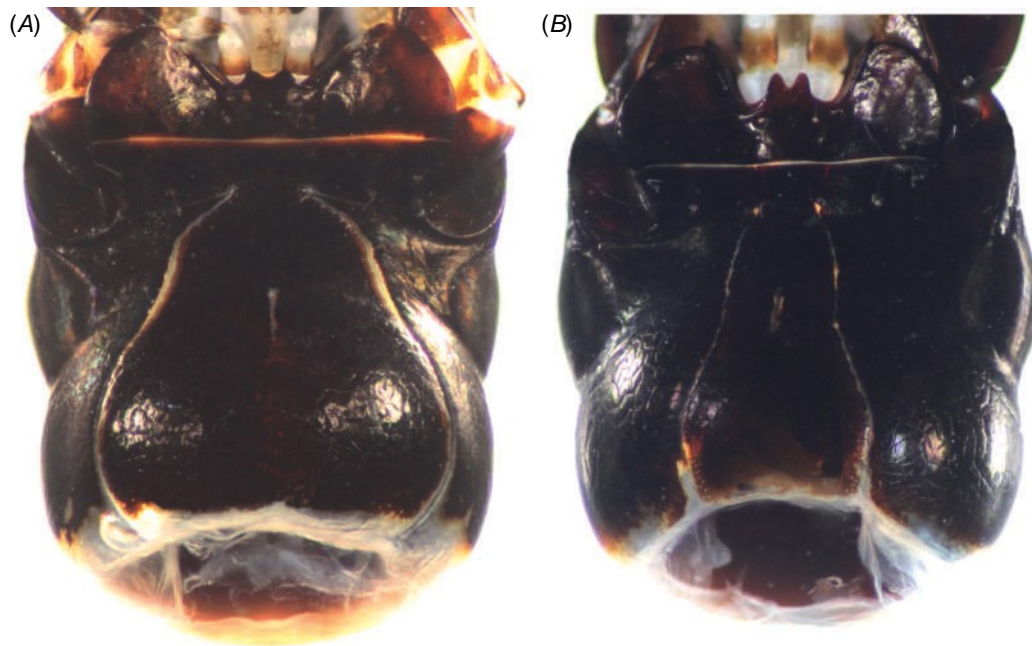


Fig. 17. Ventral view of head capsule. (A) *Notonomus aurifer*, wide gula, (B) *Notonomus hephaestus*, typical narrower gula.

Head. Eyes medium-sized, flat. Ocular ratio 1.36–1.41. Antennae clearly geniculate, first antennomere longer than 2 +3. Frontal impressions short, shallow, recurved. Labrum with six setae on anterior margin. Labrum anterior margin deeply emarginate. Occlusal margin of right mandible with a sharp, narrow anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth low, broad, shallowly emarginate. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, and an irregular row of fine setae dorsally.

Thorax. Basal pronotal seta adjacent to lateral bead and near hind angle. Tarsomere 5 ventrally glabrous. Elytral intervals all of approximately equal width. Elytral interval 3 with two setigerous punctures. Elytral striae all more or less impressed throughout their length. Elytral plica flat, scarcely visible.

Abdomen. Ventrites 4–6 without sulci. Male aedeagus without ligula.

Notonomus latreillei (Castelnau), comb. nov.

(Figs 3B, 4C, D)

Leiradira latreillei latreillei Castelnau, 1867: 158.

Leiradira liopleura Chaudoir, 1868: 163.

Leiradira latreillei chaudiroides Straneo, 1941: 91.

Leiradira latreillei Chaudoir, 1868: 162 [non Castelnau 1867].

Material examined

Fifteen <<, 17 , , .

Distribution

The range of this species is from just south and west of Brisbane, e.g. Pine Mt, to the north as far as Yabba Creek (Fig. 8). It has been

collected in a variety of forest types including rainforest, vine forest and eucalypt forest, at elevations of 50–470 m.

Diagnosis

A medium- to small-sized beetle, somewhat convex in form. Frequently with the outer elytral striae wanting. Most similar to *N. auricollis*, though distinctly differently coloured as discussed under that species.

Description

Size. Overall length (SBL) 9.5–11.5 mm. Greatest width over elytra 3.3–3.9 mm.

Colour. Head black. Pronotum black. Elytra black ground colour with metallic green or bronze reflex. Body ventral surface black or piceous. Legs black or piceous. Mouthparts piceous. Antennae piceous.

Microsculpture. Dorsal and ventral lustre moderately shiny. Head dorsally with microsculpture absent or not visible at 50× magnification. Pronotum dorsally with microsculpture absent or not visible at 50× magnification. Elytra with microsculpture consisting of isodiametric sculpticells. Microsculpture of elytral striae slightly opaque, width not significantly widening apically, striae narrower than or, at most, of about equal width of adjacent intervals near elytral apex.

Head. Eyes medium size, slightly produced. Ocular ratio 1.35–1.42. Antennae clearly geniculate, first antennomere longer than 2+3. Frontal impressions shallow or not impressed. Labrum with four setae on anterior margin, median pair absent. Labrum anterior margin shallowly emarginate. Occlusal margin of right mandible with long, blade-like anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth absent. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, and an irregular row of fine setae dorsally.

Thorax. Basal pronotal seta adjacent to lateral bead, near hind angle or about one pore's width forward of hind angle. Tarsomere 5 setose. Elytral intervals all of approximately equal width. Elytral interval 3 with two setigerous punctures. Elytral striae 5–7 more shallowly impressed in basal third than striae 1–4 or 5–7 very shallow or absent in middle half. Elytral plica externally visible.

Abdomen. Ventrites 4–6 without sulci. Male aedeagus without ligula.

Notes on variation and synonymy

The sample of specimens available for study for this species is small, eight specimens from five localities, and there is significant variation in size and the level of impression of striae 5–7. I am unable to assess Straneo's subspecies.

Notonomus opacistriatis Sloane

(Figs 12D, 13G, H)

Notonomus opacistriatis Sloane 1902: 319.

Material examined

Thirty-one <<, 27 , , , four damaged, sex undetermined.

Distribution and type locality

Specimens are known from as far north as Big Tableland and south to Chujeba Peak (Fig. 9). Darlington (1961b) doubted Cairns was the correct locality as given for the syntypes collected by Froggatt, or provided by Froggatt to Sloane (Sloane 1902). Darlington treated specimens he collected 'near Davies Creek road on the northern Atherton Tableland near Black Mt about 20 miles north of Kuranda' as 'virtual topotypes'. Black Mt is ~20 miles north of Kuranda; however, Davies Creek Road is 20 km (12.5 miles) south-west of Kuranda. In Darlington's list of localities (1960) he correctly places the Davies Creek locality on his map but does not list a Black Mt site. Given the ambiguity of the exact type locality, I select 16°38'55" S 145°29'29" E, Black Mt, 17 km ESE Julatten, the locality data on an extensive series of *N. opacistriatis* specimens in the QM, as the type locality.

Diagnosis

Medium- to large-sized, black shiny beetles with prominent elytral striae. Superficially similar to *N. alternans* but easily separated from that species, which has regularly impressed, narrow striae.

Description

Size. Overall length (SBL) 10.9–13.7 mm. Greatest width over elytra 3.4–4.9 mm.

Colour. Head black. Pronotum black with spectral iridescence. Elytra black with spectral iridescence. Body ventral surface black. Legs piceous. Mouthparts piceous. Antennae piceous.

Microsculpture. Dorsal and ventral lustre very shiny. Head dorsally with microsculpture absent or not visible at 50× magnification. Pronotum dorsally with microsculpture absent or not visible at 50× magnification. Elytra with microsculpture

absent or not visible at 50× magnification. Microsculpture of elytral striae strongly, obviously opaque mesh, width greatly widening and striae anastomosing apically, much wider than intervals near elytral apex.

Head. Eyes medium size, slightly produced. Ocular ratio 1.46–1.52. Antennae not geniculate, first antennomere subequal to length of 2+3. Frontal impressions deep, divergent, slightly recurved. Labrum with six setae on anterior margin. Labrum anterior margin shallowly emarginate. Occlusal margin of right mandible with long, blade-like anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth low, broad, shallowly emarginate. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, mixed with finer setae and additional, more irregular rows of fine setae dorsally and ventrally.

Thorax. Basal pronotal seta in lateral bead near hind angle. Tarsomere 5 ventrally glabrous. Elytral intervals 3, 5 and 7 slightly wider than 2, 4 and 6. Elytral interval 3 with two setigerous punctures. Elytral striae all more or less impressed throughout their length. Elytral plica flat, scarcely visible.

Abdomen. Ventrites 4–6 with shallow basolateral sulcus or without sulci. Male aedeagus with long flagellum.

Notes of variation

Notonomus (*Leiradira*) *opacistriatis* and *N.* (*L.*) *viridis* (see below) are the only species of *Leiradira* in which there is variation in the female protarsomere ventral setation. In all other species females lack the two rows of squamose setae found in males. Of the 21 female specimens of *N. opacistriatis* examined 11 had squamose setae on the ventral surface of tarsomeres 1 and 2, and 10 did not. Females of both states were taken from across the entire range of the species.

Notonomus puella (Tschitschérine), comb. nov.

(Figs 3C, 4E, F)

Leiradira puella Tschitschérine, 1898: 41.

Material examined

Five <<, nine , , , one , holotype and two << (ZISP).

Distribution and type locality

The holotype is labelled with only NSW and no further locality data is provided with the description. The species ranges from Victoria Park, NSW to Numinbah Arch, QLD, west to Springbrook (Fig. 8). It has been repeatedly collected in the Nightcap Ranges National Park and the type locality is here established as the vicinity of the Big Scrub Loop, Nightcap Ranges National Park, 28°38'11" S 153°20'6" E.

Diagnosis

Very small-sized beetles, distinct from all other species though most similar to *N. tenuis*, from which it can be separated by the combination of the black colour with an iridescent shine, pronotum flat and slightly reflexed at the hind angles, basal setae of the pronotum forward of hind angle at least one pore's width or more and complete elytral striae.

Description

Size. Overall length (SBL) 7.3–8.2 mm. Greatest width over elytra 2.5–3.0 mm.

Colour. Head black. Pronotum black. Elytra black. Body ventral surface piceous. Legs piceous. Mouthparts rufobrunneous, paler than head. Antennae brown and infuscated.

Microsculpture. Dorsal and ventral lustre very. Head dorsally with microsculpture absent or not visible at 50× magnification. Pronotum dorsally with microsculpture absent or not visible at 50× magnification or with microsculpture consisting of isodiametric sculpticells just visible. Elytra with microsculpture absent or not visible at 50× magnification or with microsculpture consisting of a mesh of slightly transversely stretched sculpticells. Microsculpture of elytral striae slightly opaque, width not significantly widening apically, striae narrower than or, at most, of about equal width of adjacent intervals near elytral apex.

Head. Eyes small, flat. Ocular ratio 1.38–1.42. Antennae clearly geniculate, first antennomere longer than 2+3. Frontal impressions shallow or not impressed. Labrum with four setae on anterior margin, median pair absent. Labrum anterior margin moderately emarginate. Occlusal margin of right mandible with long, blade-like anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth absent. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, and an irregular row of fine setae dorsally.

Thorax. Basal pronotal seta adjacent to lateral bead and forward of hind angle at least one pore's width or more distance. Tarsomere 5 ventrally glabrous. Elytral intervals all of approximately equal width or 3, 5 and 7 very slightly wider. Elytral interval 3 with two setigerous punctures. Elytral striae all more or less impressed throughout their length. Elytral plica externally visible.

Abdomen. Ventrites 4–6 without sulci. Male aedeagus with long flagellum.

Notonomus smilodon, nom. nov.

(Figs 6C, 7E, F)

Stomimorphus violaceus Straneo, 1953: 2.
preocc. by *Notonomus violaceus* (Castelnau, 1834: 76).

urn:lsid:zoobank.org:act:781B3A50-6AE7-4F32-A4AA-8E83E4D1E898

Material examined

Four <<, four , , .

Distribution and type locality

The original descriptions only state that the unique type was from 'Australia, Queensland'. Type locality is designated here as the Mary Cairncross Park, Queensland, 26°46'47" S 152°52'51" E. The species is only known from the Blackall Range in the vicinity of Maleny, Qld (Darlington 1961b), west to Mt Cabinet and south to the Bellthorpe State Forest in the Conondale Range (Fig. 8).

Diagnosis

Large, easily recognised beetles with distinct falcate mandibles and cordiform pronotum.

Description

Size. Overall length (SBL) 16.4–16.7 mm. Greatest width over elytra 5.4–6.0 mm.

Colour. Head black. Pronotum black ground colour with or without metallic purple or green reflex. Elytra black ground colour with metallic green or purple colour and slight iridescence. Body ventral surface black or piceous. Legs piceous. Mouthparts piceous. Antennae piceous.

Microsculpture. Dorsal and ventral lustre very or moderately shiny. Head dorsally with microsculpture absent or not visible at 50× magnification or with microsculpture consisting of isodiametric sculpticells. Pronotum dorsally with microsculpture absent or not visible at 50× magnification. Elytra with microsculpture absent or not visible at 50× magnification or with microsculpture consisting of transversely stretched sculpticells. Microsculpture of elytral striae slightly opaque, width not significantly widening apically, striae narrower than or, at most, of about equal width of adjacent intervals near elytral apex.

Head. Eyes medium size, slightly produced. Ocular ratio 1.38–1.49. Antennae clearly geniculate, first antennomere longer than 2+3. Frontal impressions short, shallow, recurved or shallow or not impressed. Labrum with six setae on anterior margin. Labrum anterior margin deeply emarginate. Occlusal margin of right mandible with a sharp, narrow anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth low, broad, shallowly emarginate. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, and an irregular row of fine setae dorsally.

Thorax. Basal pronotal seta adjacent to lateral bead and near hind angle. Tarsomere 5 setose. Elytral intervals all of approximately equal width. Elytral interval 3 with two setigerous punctures. Elytral striae all more or less impressed throughout their length. Elytral plica externally visible.

Abdomen. Ventrites 4–6 without sulci. Male aedeagus without ligula.

Notonomus soror (Darlington), comb. nov.

(Figs 12B, 13C, D)

Leiradira (*Metadira*) *soror* Darlington, 1961b: 7.

Material examined

Four <<, five , , .

Distribution and type locality

Darlington (1961b) established the east side of Mt Bellenden Ker as the type locality. Additionally it is known from Boulder Creek, Mt Murray Prior and North Bell Peak (Fig. 9) at 500–100 m elevation.

Diagnosis

Elongate, parallel-sided, medium- to small-sized, black beetles. Nearly identical externally to *N. iridescence* but with six setae on the anterior margin of the labrum.

Description

Size. Overall length (SBL) 10.1–12.5 mm. Greatest width over elytra 3.2–3.9 mm.

Colour. Head black or metallic purple. Pronotum black. Elytra black with spectral iridescence. Body ventral surface piceous. Legs piceous. Mouthparts piceous. Antennae piceous.

Microsculpture. Dorsal and ventral lustre very or moderately shiny. Head dorsally with microsculpture absent or not visible at 50× magnification. Pronotum dorsally with microsculpture absent or not visible at 50× magnification. Elytra with microsculpture absent or not visible at 50× magnification. Microsculpture of elytral striae slightly opaque, width not significantly widening apically, striae narrower than or, at most, of about equal width of adjacent intervals near elytral apex.

Head. Eyes small, flat. Ocular ratio 1.31–1.48. Antennae clearly geniculate, first antennomere longer than 2+3. Frontal impressions deep, divergent, slightly recurved. Labrum with six setae on anterior margin. Labrum anterior margin moderately emarginate. Occlusal margin of right mandible with long, blade-like anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth low, broad, shallowly emarginate. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, and an irregular row of fine setae dorsally.

Thorax. Basal pronotal seta in lateral bead near hind angle. Tarsomere 5 ventrally glabrous. Elytral intervals all of approximately equal width. Elytral interval 3 with one setigerous puncture. Elytral striae all more or less impressed throughout their length. Elytral plica absent.

Abdomen. Ventrites 4–6 with shallow basolateral sulcus. Male aedeagus with long flagellum.

Notonomus spectabilis, sp. nov.

(Figs 14A, 15A, B)

urn:lsid:zoobank.org:act:E1669D0C-5452-44F6-B119-95A409A
AFD78

Material examined

Holotype. ♂, 'NEQ: 16°55'S 145°40'E, Mt Williams, 900–1000 m, 2-3 Dec 1993, Cook, Monteith & Janetzki'/'QM Reg. No. T20305'. Deposited QM.

Paratypes. Mt Williams, (16°54'53" S 145°39'43" E), 02–03.xii.1993, D. Cook, G. Monteith, H. Janetzki, 900–1000 m (T20304, , QM) Mt Williams summit, (16°54'53" S 145°39'43" E), 27–28.xi.1997, G. Monteith, D. Cook, 1000 m (T65732 T128384, T128385, , , QM) Mt Williams, 0.8 km W, (16°54'52" S 145°39'16" E), 27–10.ii.1998, G. Monteith, D. Cook, pitfall trap, rainforest, 820 m (T65727, T65728, T65729, T65730, T65731, << QM); Chujeba Peak summit (16°56'14" S 145°39'19" E), 14–16.xii.1989, G. Monteith, G. Thompson, 1000 m, (T20293 , , T20294 <, T20296 , , T20297, T20298, T20299, T20300, T20301, T20302, T20303, << QM).

Distribution and type locality

Type locality is Mt Williams, Queensland, 16°55'S 145°40'E. This species is only known from the two localities

in the type material (Fig. 16) at elevations from 800 m to 1000 m. Reported as 'Leiradira NQ4' by Yeates et al. (2002).

Diagnosis

Medium- to large-sized *Leiradira* that are very similar to *N. aurifer*, but immediately separable by the dark metallic purple or blue colour of this species compared with the brilliant red in *N. aurifer*.

Description

Size. Overall length (SBL) 15.8 mm. Greatest width over elytra 5.5–6.3 mm.

Colour. Head metallic purple. Pronotum metallic purple or metallic blue. Elytra metallic purple or metallic blue. Body ventral surface black or piceous. Legs piceous. Mouthparts piceous. Antennae piceous.

Microsculpture. Dorsal and ventral lustre very or moderately shiny. Head dorsally with microsculpture absent or not visible at 50× magnification. Pronotum dorsally with microsculpture absent or not visible at 50× magnification. Elytra with microsculpture absent or not visible at 50× magnification. Microsculpture of elytral striae strongly, obviously opaque mesh, width greatly widening and striae anastomosing apically, much wider than intervals near elytral apex.

Head. Eyes medium size, slightly produced. Ocular ratio 1.28–1.44. Antennae not geniculate, first antennomere subequal to length of 2+3. Frontal impressions deep, divergent, slightly recurved. Labrum with six setae on anterior margin. Labrum anterior margin shallowly emarginate. Occlusal margin of right mandible with long, blade-like anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth low, broad, shallowly emarginate. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, mixed with finer setae and additional, more irregular rows of fine setae dorsally and ventrally.

Thorax. Basal pronotal seta in lateral bead near hind angle. Tarsomere 5 ventrally glabrous. Elytral intervals 3, 5 and 7 much wider than 2, 4 and 6. Elytral interval 3 with two setigerous punctures. Elytral striae all more or less impressed throughout their length. Elytral plica flat, scarcely visible.

Abdomen. Ventrites 4–6 with shallow basolateral sulcus or without sulci. Male aedeagus with long flagellum.

Etymology

The specific epithet is the Latin word for outstanding or noteworthy and reflects the notably attractive purple colour of the dorsal surface of this species.

Notonomus tenuis (Darlington), comb. nov.

(Figs 6B, 7C, D)

Leiradira (*Stomimorphus*) *tenuis* Darlington, 1961: 10.

Material examined

Eight <<, two , , .

Distribution and type locality

Only known from the type locality, Eungella Range, Qld (Fig. 16).

Diagnosis

Fairly small, black and non-metallic beetles similar to *N. puella* but distinguished from that species as noted under its diagnosis.

Description

Size. Overall length (SBL) 9.3–9.8 mm. Greatest width over elytra 3.3–3.4 mm.

Colour. Head black. Pronotum black. Elytra black. Body ventral surface black or piceous. Legs piceous. Mouthparts piceous. Antennae piceous.

Microsculpture. Dorsal and ventral lustre moderately shiny or dull. Head dorsally with microsculpture absent or not visible at 50× magnification. Pronotum dorsally with microsculpture absent or not visible at 50× magnification. Elytra with microsculpture consisting of transversely stretched sculpticells. Microsculpture of elytral striae slightly opaque, width not significantly widening apically, striae narrower than or, at most, of about equal width of adjacent intervals near elytral apex.

Head. Eyes medium-sized, flat. Ocular ratio 1.36–1.42. Antennae clearly geniculate, first antennomere longer than 2+3. Frontal impressions short, shallow, recurved. Labrum with six setae on anterior margin. Labrum anterior margin deeply emarginate. Occlusal margin of right mandible with a sharp, narrow anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth low, broad, shallowly emarginate. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, and an irregular row of fine setae dorsally.

Thorax. Basal pronotal seta adjacent to lateral bead and near hind angle. Tarsomere 5 ventrally glabrous. Elytral intervals all of approximately equal width. Elytral interval 3 with two setigerous punctures. Elytral striae all more or less impressed throughout their length. Elytral plica externally visible.

Abdomen. Ventrites 4–6 without sulci. Male aedeagus without ligula.

Notonomus thynnefiliarum, sp. nov.

(Figs 3D, 4G, H)

urn:lsid:zoobank.org:act:150D7569-D051-4C4F-AC56-1CF27054AECD

Material examined

Holotype. ♂, 'Pitfall 1 A/1 ♂, Mary Cairncross Park, via Maleny, S.E. Qld, G.B. & S.R. Monteith'/'QMT189877'. Deposited QM.

Paratypes. Same data as holotype (T196019, QM). T197245, T197246 << QM; T197247, T197248, , QM. Cairncross NP via Maleny, SE Qld, 17.iv.1966. B. Cantrell (T197249, T197250, , QM; T197251 < QM). Rainforest pitfall 1 Mary Cairncross Park, via Maleny, SE Qld, 1974–1975. 488 m. G.B. and S.R. Monteith B3 (T197254, T197255, , QM). Pitfall 13 Bouloumba Ck Conondale, SE Qld. G. Maywald A/3 (T197252 < QM). Pitfall 13 Bouloumba Ck Conondale, SE Qld. G. Maywald A/3 (T197258 < QM). Pitfall 29 Mt Cabinet, via Jimna, Qld. G.B. and S.R. Monteith B/3 (T197253, QM). Site 29, Mt Cabinet, via Jimna, SE Qld. 8.ix.1974 G.B. Monteith Rainforest (T197256, QM). Rainforest pitfall 29B Mt Cabinet, via Conondale, SE Qld. 1974–1975, 792 m G.B. and S.R. Monteith 9T197257, QM).

Distribution and type locality

The type locality is Mary Cairncross Park, Queensland. Estimated coordinates 26°46'47" S 152°52'51" E. Only known from the type locality and the two additional sites in the type series (Fig. 8).

Diagnosis

Fairly small-sized beetles typically with distinct metallic, coppery colour on the pronotum and elytra (see variation below). The elytral striae are completely impressed and the fifth tarsomere is ventrally setose. This combination of features and its distribution separate it from the most similar species, *N. latreillei* and *N. auricollis*.

Description

Size. Overall length (SBL) 9.5–10.0 mm. Greatest width over elytra 3.4–3.5 mm.

Colour. Head black. Pronotum black ground colour with copper colour reflex, especially near margins. Elytra black ground colour with more or less prominent copper colour. Body ventral surface piceous. Legs piceous. Mouthparts rufobrunneous, paler than head. Antennae brown and infuscated.

Microsculpture. Dorsal and ventral lustre moderately shiny or dull. Head dorsally with microsculpture absent or not visible at 50× magnification. Pronotum dorsally with microsculpture absent or not visible at 50× magnification or with microsculpture consisting of isodiametric sculpticells just visible. Elytra with microsculpture absent or not visible at 50× magnification or with microsculpture consisting of a mesh of slightly transversely stretched sculpticells. Microsculpture of elytral striae slightly opaque, width not significantly widening apically, striae narrower than or, at most, of about equal width of adjacent intervals near elytral apex.

Head. Eyes small, flat. Ocular ratio 1.37. Antennae clearly geniculate, first antennomere longer than 2+3. Frontal impressions shallow or not impressed. Labrum with four setae on anterior margin, median pair absent. Labrum anterior margin moderately emarginate. Occlusal margin of right mandible with long, blade-like anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth absent. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, mixed with finer setae and additional, more irregular rows of fine setae dorsally and ventrally.

Thorax. Basal pronotal seta adjacent to lateral bead, near hind angle or about one pore's width forward of hind angle. Tarsomere 5 setose. Elytral intervals all of approximately equal width. Elytral interval 3 with two setigerous punctures. Elytral striae all more or less impressed throughout their length. Elytral plica externally visible.

Abdomen. Ventrites 4–6 without sulci. Male aedeagus without ligula.

Variation

Two specimens from Bouloumba are on the large end of the size range and have a very subdued metallic colour, almost black. It is not clear if this is due to an artefact of preservation or this is a natural colour.

Etymology

The specific epithet honours the three Thynne sisters who donated the land for the Mary Cairncross Reserve, which is the type locality for this species.

Notonomus vadosus, sp. nov.

(Figs 10B, 11C, D)

urn:lsid:zoobank.org:act:555F0F30-9CFD-4E31-A8F2-04C605043A83

Material examined

Holotype. ♂, 'Mt Finnigan summit, via Helenvale, N. Qld. 28-30 Nov 1985, 1100 m, G. Monteith and D. Cook, Pitfall traps, rainforest'/'QM Reg. No. T20253'. Deposited QM.

Paratype. Same as holotype, 3-5 Dec 1990, 1050 m, Monteith, Thomas, Cook, Sheridan and Roberts, QM Reg. No. T20254 (♂, QM).

Distribution and type locality

The type locality is Mount Finnigan, Queensland. Estimated coordinates 15°49'6" S 145°16'45" E. Only known from the type locality (Fig. 9). Reported as 'Leiradira NQ1' by Yeates et al. (2002).

Diagnosis

Unique among *Notonomus* (*Leiradira*) species in having all elytral striae very shallowly impressed or absent.

Description

Size. Overall length (SBL) 12.4–13.7 mm. Greatest width over elytra 4.2–4.5 mm.

Colour. Head black. Pronotum black. Elytra metallic green or copper colour. Body ventral surface piceous. Legs piceous. Mouthparts piceous. Antennae piceous.

Microsculpture. Dorsal and ventral lustre very or moderately shiny. Head dorsally with microsculpture absent or not visible at 50× magnification. Pronotum dorsally with microsculpture absent or not visible at 50× magnification. Elytra with microsculpture absent or not visible at 50× magnification.

Head. Eyes medium size, slightly produced. Ocular ratio 1.44–1.46. Antennae clearly geniculate, first antennomere longer than 2+3. Frontal impressions deep, divergent, slightly recurved. Labrum with six setae on anterior margin. Labrum entire. Occlusal margin of right mandible with long, blade-like anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth low, broad, shallowly emarginate. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, and an irregular row of fine setae dorsally.

Thorax. Basal pronotal seta in lateral bead, adjacent to lateral bead near hind angle. Tarsomere 5 ventrally glabrous. Elytral intervals all of approximately equal width. Elytral interval 3 with one setigerous puncture. Elytral striae scarcely impressed or absent. Elytral plica absent.

Abdomen. Ventrites 4–6 with shallow basolateral sulcus. Male aedeagus with long flagellum.

Etymology

From the Latin for shallow, drawing attention to the shallowly impressed elytral striae.

Notonomus viridis, sp. nov.

(Figs 12C, 13E, F)

urn:lsid:zoobank.org:act:68A2B2D3-02B1-45FF-8ED2-DFC93E9AD813

Material examined

Holotype. ♂, 'Mossman Bluff Track, 5–10 km W. Mossman, N. QLD, 20 Dec 1989 – 15 Jan 1990, Monteith, Thompson & ANZSES, site 6A, 810 m, Pitfall'/'QM Reg. No. T20286'. Deposited QM.

Paratypes. Same as holotype, 16–30.xii.1988, G. Monteith, G. Thompson, ANZSES, pitfall trap, 480 m (T20272, ♂, QM), 600 m (T20274, ♀, ~ QM), 860 m (T20275, < QM), 1000 m (T20276, < QM); 01–17.i.1989, 1000 m (T20277, < QM); 20–15.i.1990 480 m (T20278, ♀, QM), 760 m (T20279, T20280, T20281, << QM), 810 m (T20285, ♀, ~ QM), 860 m (T20282 <, T20283 ♀, ~, T20284 <, QM), 930 m (T20289 <, T20290 ♀, ~, T20291 <, T20292 ♀, ~, QM), 1000 m (T20287, T20288, << QM).

Distribution and type locality

The type locality is Mossman Bluff Track, Queensland. Estimated coordinates 16°28'30" S 145°18'30" E. Only known from the vicinity of the type locality (Fig. 16). Reported as 'Leiradira NQ3' by Yeates et al. (2002).

Diagnosis

Distinctive medium-sized *Leiradira* with vividly metallic green pronotum and purple to blue-black elytra.

Description

Size. Overall length (SBL) 12.3–14.8 mm. Greatest width over elytra 4.3–5.1 mm.

Colour. Head black ground colour with very slight metallic green colour in some. Pronotum metallic green. Elytra black with spectral iridescence. Body ventral surface black. Legs piceous. Mouthparts piceous. Antennae piceous.

Microsculpture. Dorsal and ventral lustre moderately shiny. Head dorsally with microsculpture absent or not visible at 50× magnification. Pronotum dorsally with microsculpture absent or not visible at 50× magnification. Elytra with microsculpture absent or not visible at 50× magnification. Microsculpture of elytral striae strongly, obviously opaque mesh, width greatly widening and striae anastomosing apically, much wider than intervals near elytral apex.

Head. Eyes medium size, slightly produced. Ocular ratio 1.39–1.54. Antennae not geniculate, first antennomere subequal to length of 2+3. Frontal impressions deep, divergent, slightly recurved. Labrum with six setae on anterior margin. Labrum anterior margin shallowly emarginate. Occlusal margin of right mandible with long, blade-like anterior retinacular tooth. Gula very wide, nearly width of head. Mentum tooth low, broad, shallowly emarginate. Apical labial palpomere slightly expanded apically. Lacinia with a row of thick setae medially, mixed with finer setae and additional, more irregular rows of fine setae dorsally and ventrally.

Thorax. Basal pronotal seta in lateral bead near hind angle. Tarsomere 5 ventrally glabrous. Elytral intervals 3, 5 and 7 slightly wider than 2, 4 and 6. Elytral interval 3 with one setigerous puncture. Elytral striae all more or less impressed throughout their length. Elytral plica flat, scarcely visible.

Abdomen. Ventrites 4–6 with shallow basolateral sulcus or without sulci. Male aedeagus with long flagellum.

Variation

Of the seven females in the series of paratypes, five have protarosomere 1 with a ventral vestiture of expanded, squamous setae as in males, while two have typical unadorned female tarsomeres. Those with the additional setae are designated in the type material list above with a tilde sign next to the . The only other species to show variation of the female tarsal vestiture is *N. (L.) opacistriatis* (see above).

Etymology

The specific epithet draws attention to the green metallic head and pronotum in this beetle.

Notonomus hephaestus, sp. nov.

(Figs 14C, 15E, F, 17B)

urn:lsid:zoobank.org:act:D07C8B21-F7E8-4000-9B8E-57C3BF250186

Material examined

Holotype. ♂, 'Lambs head, 10 km W. Edmonton N. Qld. 10-12 Dec 1989, 1200 m, Monteith, Thomson, Janetski'//QM Reg. No. 20088'. Deposited QM.

Paratypes. Same as holotype QM Reg. Nos T20083, ♂, T20084, ♂, T20089, ♀, (QM). East Lambs Head (east end), 17°1'46"S 145°39'20"E, 29. xi.93, G. Monteith, H. Janetski, D. Cook, 1180 m (T20102, < QM).

Distribution and type locality

The type locality is Lambs Head, Queensland. Estimated coordinates 17°123'S 145°38'33"E. Only known from the type locality (Fig. 9).

Diagnosis

Strikingly brilliant, shifting red to green metallicbeetles. *Notonomus hephaestus* is nearly identical to *N. aurifer* in habitus and colour, but *N. hephaestus* has the typical, narrow gula, brush-like lacinia and differs in patterns of setation as described below.

Description

Size. Overall length (SBL) 20.0–22.6 mm. Greatest width over elytra 6.8–7.8 mm.

Colour. Head metallic green or metallic red. Pronotum metallic green or metallic red. Elytra metallic green or metallic red. Body ventral surface black. Legs piceous. Mouthparts piceous. Antennae piceous.

Microsculpture. Dorsal and ventral lustre very or moderately shiny. Head dorsally with microsculpture absent or not visible at 50× magnification. Pronotum dorsally with microsculpture absent or not visible at 50× magnification. Elytra with microsculpture absent or not visible at 50×

magnification. Microsculpture of elytral striae strongly, obviously opaque mesh, width greatly widening and striae anastomosing apically, much wider than intervals near elytral apex.

Head. Eyes medium size, slightly produced. Ocular ratio 1.32–1.38. Antennae not geniculate, first antennomere subequal to length of 2+3. Frontal impressions short, shallow, recurved. Labrum with six setae on anterior margin. Labrum anterior margin shallowly emarginate. Occlusal margin of right mandible with moderately long, thick anterior retinacular tooth. Gula narrow, much narrower than width across mentum. Mentum tooth prominent, bilobed. Apical labial palpomere slightly expanded apically. Lacinia multiple rows of moderately heavy and fine setae forming a brush.

Thorax. Basal pronotal seta in lateral bead near hind angle. Tarsomere 5 ventrally glabrous. Elytral intervals 3, 5 and 7 much wider than 2, 4 and 6. Elytral interval 3 without setigerous punctures. Elytral striae all more or less impressed throughout their length. Elytral plica externally visible.

Abdomen. Ventrites 4–6 with shallow basolateral sulcus or without sulci. Male aedeagus with long flagellum.

Etymology

Named for the Greek god of fire and metallurgy. This is an allusion to the fiery red metallic colours of this beetle.

Notonomus nocturnocappellus, sp. nov.

(Figs 14D, 15G, H)

urn:lsid:zoobank.org:act:E3477C81-BAF5-420F-A221-37563F7E2C70

Material examined

Holotype. ♂, '28°36'39.0"S 153°21'46.8"E, AUSTRALIA: New South Wales, Whian Whian Conservation Area, 379 m, 2.i.2011, K. Will, vine/palm scrub, pitfall/B.mori extract [AUS2011.i.2.4]//U.C Berkeley EMEC 2008, 469'. Deposited ANIC.

Paratypes. '28°35'31.3"S 153°22'50.7"E, AUSTRALIA: New South Wales Nightcap Ranges National Park, Eucalyptus 2nd growth, 396 m. 2.i.2011 K. Will [AUS2011.i.2.5]', (EMEC 208467 ♀, ANIC); same data (EMEC 208466 < EMEC, EMEC 208468 < QM), same data with DNA voucher number kww870 (EMEC208657 < EMEC).

Distribution and type locality

The type locality is Whian Conservation Area, New South Wales, 28°36'39"S 153°21'47"E. Only known from the type locality (Fig. 8).

Diagnosis

The large size and relatively wide, depressed body form in combination with wider elytral intervals 3, 5 and 7 and the placement of the hind setae of the pronotum in the marginal bead separates this species from all other *Notonomus*.

Description

Size. Overall length (SBL) 19.0–21.3 mm. Greatest width over elytra 6.5–7.4 mm.

Colour. Head black. Pronotum black. Elytra black. Body ventral surface black. Legs piceous. Mouthparts piceous. Antennae piceous.

Microsculpture. Dorsal and ventral lustre dull. Head dorsally with microsculpture consisting of isodiametric sculpticells. Pronotum dorsally with microsculpture absent or not visible at 50× magnification. Elytra with microsculpture consisting of isodiametric sculpticells. Microsculpture of elytral striae slightly opaque, width not significantly widening apically, striae narrower than or, at most, of about equal width of adjacent intervals near elytral apex.

Head. Eyes prominent. Ocular ratio 1.32–1.59. Antennae not geniculate, first antennomere subequal to length of 2+3. Frontal impressions short, straight. Labrum with four setae on anterior margin, median pair absent. Labrum anterior margin shallowly emarginate. Occlusal margin of right mandible with moderately long, thick anterior retinacular tooth. Gula narrow, much narrower than width across mentum. Mentum tooth prominent, bilobed. Apical labial palpomere apically expanded, subsecuriform. Lacinia multiple rows of moderately heavy and fine setae forming a brush.

Thorax. Basal pronotal seta adjacent to lateral bead near hind angle. Tarsomere 5 ventrally glabrous. Elytral intervals 3, 5 and 7 slightly wider than 2, 4 and 6. Elytral interval 3 with two setigerous punctures. Elytral striae all more or less impressed throughout their length. Elytral plica externally visible.

Abdomen. Ventrites 4–6 without sulci. Male aedeagus without ligula.

Etymology

The specific epithet is a Latin form of the type locality, Nightcap Range.

Notonomus impar (Sloane), comb. nov.

Sarticus impar Sloane, 1903: 614.

Sloane noted in his treatment of this species that, like *N. blackburni*, it deviated from the typical characteristics of *Sarticus* species (Sloane 1903: 610). The holotype is now highly damaged and is missing both the prothorax and head. Fortunately, features noted by Sloane such as the uneven widths of the intervals and ventral punctation allow for confident identification of intact, associated specimens in the ANIC collection that appear to have been studied and identified as this species by Sloane. Based on this series of specimens, it is clear that Sloane's initial hesitation to place this species in *Sarticus* was justified. Though the pronotum is rounded at the hind angles the lateral margins are not explanate as is typical of *Sarticus*. Ventral punctation is common among *Sarticus*, but this varies between species (Lutshnik 1916) and the pronotal form falls well within variation found in *Notonomus*.

Key to subgenera and species

1. Gula very wide (Fig. 17A), reaching or surpassing the buccal fissure laterally, sutures often very lightly marked
.....*Leiradira sensu* Darlington 2
- Gula narrow (Fig. 17B), not as wide or up to just a little wider than the apices of the mental epilobes, sutures usually clearly evident*Other Notonomus* spp. 19
2. Mentum tooth absent 3
Mentum tooth present, usually broad and little produced 7
3. Tarsomere 5 setose ventrally on all legs, with two or rarely three pairs of prominent setae. Questionable specimens of *N. auricollis* covered by both couplets 4
Tarsomere 5 glabrous ventrally or, at most, some (one to two) legs with one fine seta on the tarsus, or with a pair of fine setae 6
4. Abdominal ventrites with minute punctulae laterally 5
Abdominal ventrites without minute punctulae laterally *Notonomus thynnefiliarum*
5. Pronotum black or with a very slight tint of metallic colour near the margins. Elytral striae 5–7 more shallowly impressed in the basal third than 1–4. Often 5–7 are very shallow or absent in the middle half. When impressed basally 5–7 are frequently interrupted or crenulated *Notonomus latreillei*
Pronotum prominently a metallic cupreous or green colour. All elytral striae more or less equally impressed along their length ... *Notonomus auricollis* (in part)
6. Dorsal surface black with spectral iridescence. SBL < 9.0 mm
.....*Leiradira puella*
Pronotum with distinct green or cupreous metallic sheen, elytra black with a slight violaceous colour. SBL > 9.0 mm *Notonomus auricollis* (in part)
7. Right mandible with sharp, prominent anterior retinacular tooth (Fig. 18A) or no retinacular teeth 8
Right mandible with a large, broad blade-like tooth (Fig. 18B) 11
8. Right mandible with sharp, prominent anterior retinacular tooth (Fig. 18A). Elytral plica present 9
Right mandible without retinacular teeth. Elytral plica absent
..... *Notonomus barrae*
9. Tarsomere 5 glabrous ventrally 10
Tarsomere 5 setose ventrally *Notonomus smilodon*
10. Head and pronotum with slight green metallic sheen and obvious, irregular mesh of microsculpture. Elytra with noticeable purpurescent or bronze colour *Notonomus jacobi*
Head and pronotum without microsculpture. Colour black, with slight iridescence throughout *Notonomus tenuis*
11. Anterior margin of the labrum with six setae 12
Anterior margin of the labrum with four setae *Notonomus iridescens*
12. Striae deeply impressed throughout their length 13
Striae scarcely impressed or absent *Notonomus vadosus*
13. Elytral striae without or with slightly opaque microsculpture, not significantly widening apically, narrower or, at most, of about equal width of the intervals near the apex 14
Elytral striae with strongly opaque microsculpture, greatly widening and anastomosing apically, wider than the intervals near the apex 16
14. Elytral intervals nearly of equal width. Elytral interval 3 with one setigerous puncture 15
Elytral intervals 3, 5 and 7 much wider than 2, 4 and 6. Elytral interval 3 with two setigerous punctures *Notonomus alternans*
15. Elytra broad, elongate ovoid. Slight metallic sheen throughout. Head and pronotum, particularly the pronotum near the base, cupreous. Elytra purpurescent with distinct blue to purple margins. Mesh microsculpture evident on elytra *Notonomus alticola*
Body form narrow, elytra parallel-sided. Black and more or less iridescent throughout. Transversely stretched microsculpture scarcely visible on elytra *Notonomus soror*
16. Elytral intervals 3, 5 and 7 about twice as wide as adjacent intervals 1, 2, 4 and 6 in the basal third of the elytra 17
Elytral intervals 3, 5 and 7 at least five times as wide as adjacent intervals 2, 4 and 6 in the basal third of the elytra 18
17. Pronotum clearly cordiform, as broad as, or wider than width of elytra, vividly metallic green. Head with more or less green metallic colour. Elytra iridescent with slight purple colour *Notonomus viridis*

- Pronotum with shallowly arcuate margins, somewhat constricted at the base, slightly narrower than elytral width. Dorsally black iridescent throughout*Notonomus opacistriatis*
18. Dorsally vivid red-green metallic*Notonomus aurifer*
Dorsally deep blue-purple metallic*Notonomus spectabilis*
19. Eyes and postocular region at most slightly prominent. Metatrochanters short and moderately pointed or blunt 20
Eyes and postocular region greatly enlarged and very prominent. Metatrochanters very long and pointed*Notonomus (Acanthoferonia) ferox*
20. Elytra intervals convex or flat, not narrowly costate. Lustre of elytra somewhat dull to shiny 21
Elytral interval narrowly costate. Elytral lustre very dull*Notonomus (Loxodactylus) spp.*
21. Body form exceptionally elongate cylindrical (Fig. 1E). Elytra with internal ridge and no external plica
..... *Notonomus (Conchitella) clivinoides*
Body form various, but not elongate cylindrical. Elytral plica usually present 22
22. Tropical species. See Darlington's key to the doddi-group that includes *N. flos* and *N. dimorphicus*. In that key *Notonomus hephaestus* will key to couplet 7 where the following can be inserted:
[7x] Elytral intervals of approximately equal width. Colour not vivid red-green metallic 8
Odd numbered elytral intervals much wider than even intervals. Dorsally vivid red-green metallic *Notonomus hephaestus*
Species from outside the tropics. No key includes all of the other currently described *Notonomus* species. For informal groups and species use Sloane's (1913) key. *Notonomus nocturnocappellus* will key to couplet 20(24) there, but fail to fit character combinations of the remaining groups. Refer to the diagnosis provided herein. For species published after 1913 consult works by Sloane (1913, 1916, 1923) and Moore (1960, 1961, 1963).

Discussion

Morphology and implied relationships

The genus *Notonomus* has over 120 described species and a diversity of morphological character states. Based on material I have collected and studied, at least 40 species, probably more, remain to be described and many of the currently recognised species need a thorough study to test their status. Morphology needs to be comprehensively studied among *Notonomus* species and near relatives to summarise the full diversity in the group and discover morphological diagnostic and synapomorphic features. Here I focus on *Leiradira* species (sensu Darlington) and limit discussion to prominent character systems and similarities across taxa that may prove to be synapomorphies once comparatively analysed.

Many species of *Leiradira* are recognised at a glance by gross features of the head, including somewhat elongate mandibles and more or less geniculate antennae, though both of these vary enough to include states also found in most *Notonomus* species. At a finer scale the details of the mouthparts are also sometimes, but not in all cases, distinctive in species traditionally included in *Leiradira*. Among those characters are the presence of a very transverse mentum (Moore 1965) and the lacinia having a medial row of thick, almost tooth-like setae (Darlington 1961b). These features led to some authors grouping *Leiradira* species with *Delinius* (e.g. Tschitschérine 190; Moore 1965) or place them near *Lesticus* in a broadly defined 'Trigonotomides' (Chaudoir 1868). Darlington (1961b), however, preferred a closer relationship of *Leiradira* and *Notonomus* based on variation he saw, but

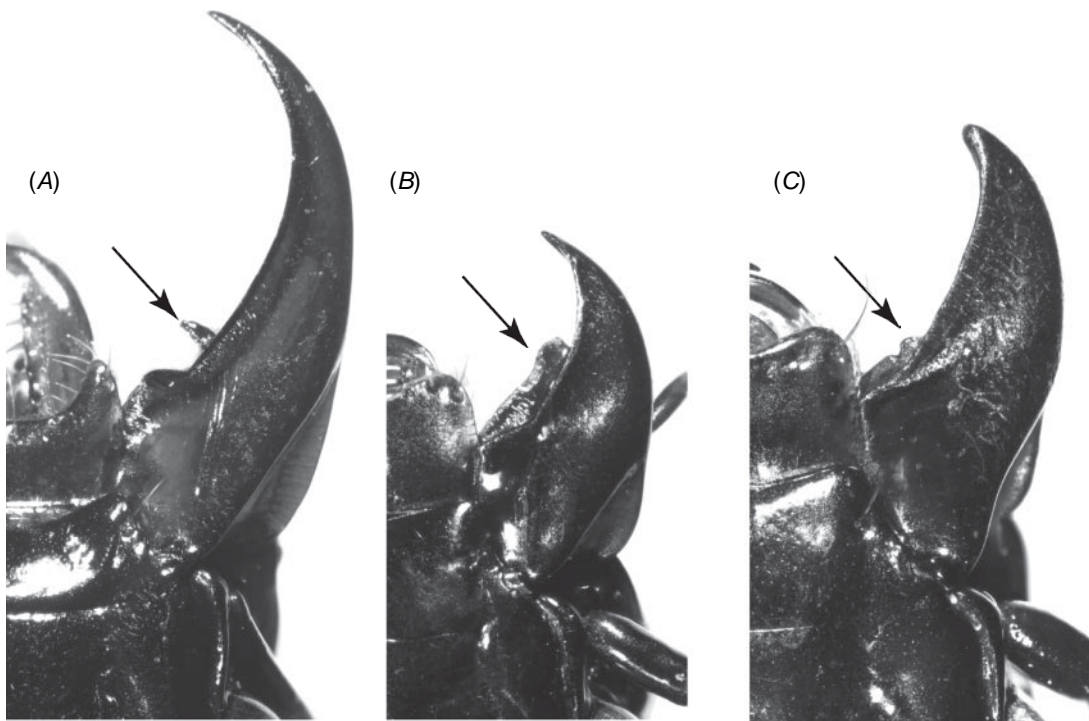


Fig. 18. Right mandible, dorsal view. Arrow indicates retinacular tooth. (A) *Notonomus smilodon*, (B) *Notonomus viridis*, (C) *Notonomus hephaestus*.

postulated a recent common ancestor of *Leiradira*, *Delinius* and *Notonomus*. Darlington's assessment of variation was at least partly on track and he correctly noted that his *Metadira* species and species in the doddi-group were most similar and that the widened and opaque striae of the elytra are most likely synapomorphies. The position of the pronotal setae and mouthpart characters he used are more problematic. All mouthparts features vary between species traditionally placed in *Leiradira* such that no character state is found exclusively and uniformly in all *Leiradira* that is not also found in some *Notonomus* species. The only possible exceptions are the extremely wide gula (Fig. 17A) and tooth-like lacinial setae. The vestiture of the lacinia varies in *Leiradira* from having almost no other setae in addition to the prominent medial row of heavy tooth-like setae, to having a larger and heavier row medially but also having numerous additional ventral and dorsal setae. The difference between this latter state and the typical *Notonomus* lacinial brush is a matter of the density of the setae and not obviously significant. The exceptionally wide gula is quite distinct from the much narrower form found in other *Notonomus*. The difference between *N. aurifer* and *N. hephaestus* (Fig. 17), for example, is clear and remarkable. The suite of character states – transverse mentum, low or absent mentum tooth, rake-like lacinia and very wide gula – is found in *Delinius*, some *Lesticus* species, *Paraloma*, some *Platycaelus* species (K. Will, unpubl. data) and *Leiradira*. The suite of features appears to co-vary. This is likely a syndrome related to a feeding adaptation that has evolved in these various groups independently. Forsythe (1982, 1983) noted the relationship of gular width and musculature and feeding in carabids. In species with large mandibular adductors, gular width decreases to accommodate these large muscles that drive mastication with the mandibles. Gular width is expanded for larger stipital retractor muscles that drive the maxillae, which includes the lacinia. Heavily built, rake-like laciniae are associated with a wide gula and a lack of extra-oral digestion. In the few species included in Forsythe's study no specific diet type was identified for beetles with mouthparts of this type. Both fragmentary and 'mush' contents were seen in the crop. The inclusion of *N. dimorphicus*, *N. hephaestus*, *N. flos*, and probably other doddi-group species, in *Leiradira* suggests that evolution of this mouthpart syndrome and its reversal has occurred within *Notonomus*.

The typical species of *Notonomus* have the occlusal margin of the right mandible with a moderately long to short, thick triangular anterior retinacular tooth (Fig. 18C). Within *Leiradira* species four different forms of the right mandible are known. *Notonomus flos*, *N. dimorphicus* and *N. hephaestus* all have the typical *Notonomus* triangular tooth (Fig. 18C). *Notonomus barrae* has no tooth. *Notonomus Jacobi*, *N. tenuis* and *N. smilodon* (i.e. *Stomimorphus* sensu Darlington) have a very narrow, elongate tooth (Fig. 18A). All other species of *Leiradira* have a broad, thin blade-like tooth (Fig. 18B). These very distinctive mandibular types suggest that there may be feeding specialisations in *Leiradira* and that these may prove to be synapomorphies for clades within the genus *Notonomus*.

The female reproductive tract is frequently an important source of phylogenetic characters in carabids (Liebherr and

Will 1998). Many species of *Notonomus* have not yet been examined; however, for all taxa I have studied this system is surprisingly uniform and unadorned (Fig. 5) across species of *Notonomus*, *Parhypates* and *Sarticus*. The male aedeagus median lobe and paramere form is also not exceptional or notably varied. However, the structures of the endophallus does show promise for phylogenetic characters. Some species have an elongate flagellum (e.g. Fig. 13D), which is linear and the length of the median lobe as in many *Leiradira* species, or it is much longer than the median lobe and coiled as in some *Parhypates* species. Possibly homologous to one or both of these are short, broader ligula found in many species of *Notonomus* and some *Sarticus*. A flagellum that is linear and the length of the median lobe is found in all species of Darlington's *Metadira*, *N. puella*, *N. dimorphicus*, *N. flos* and *N. hephaestus*. This feature is consistent with the placement of *N. dimorphicus* and *N. flos* in *Leiradira*, and may prove to be synapomorphic for the clade.

Possible local mimicry

In terms of size, colour, general body form and modifications of the elytral striae *N. aurifer* and *N. hephaestus* are nearly identical (Fig. 14B, C). However, close examination of the pattern of setation, genitalia and especially head and mouthparts (Fig. 17) reveals significant differences that have typically been considered generic-level distinctions. The phylogenetic relationships of *N. hephaestus* are not known, but if similarity of colour and elytral modifications were to prove synapomorphic and place this species sister to *N. aurifer*, then this would represent a case of very divergent and likely very rapid mouthpart evolution. If *N. hephaestus* is more closely related to other *Notonomus* with unmodified mouthparts, e.g. *N. dimorphicus* and *N. flos* (Fig. 2), then this is a case of morphological structure and colour mimicry.

The ranges of *N. aurifer* and *N. hephaestus* are sympatric on Lambs Head in Queensland. In addition to these two metallic red species, an undescribed red-bronze *Trichosternus* species and the red-bronze form of *Notonomus montorum* Darlington are also sympatric there. To the north of Lambs Head there is an apparent distributional break coincident with the lowlands along the Clohesy River. North-east of the river in the highlands on and near Mt Williams and Chujebu Peak, the red-coloured species are not found, but rather there occurs a suite of black, metallic blue or purple species, including *N. spectabilis*, and a blue colour form of *N. montorum*, which are both restricted to the area, and the widespread *N. opacistriatis*. Outside the Lamb Range, black, blue, green and iridescent-coloured *Notonomus* and *Trichosternus* predominate. The coincident distribution of red beetles at Lambs Head seems unlikely to be a random pattern and it implies predation pressure by a visual predator. However, there is no obvious candidate predator of these large, flightless and largely nocturnally active beetles currently known to be restricted to the Lamb Range. Resemblance of form, colour and in some cases behaviour that can be attributed to mimicry is well documented in carabids. This includes mimicry with cockroaches (Schmied et al. 2013), mutillid wasps (Mawdsley et al. 2012), chrysomelid

beetles (Lindroth 1971) and within complexes of associated carabid beetles (Bonacci et al. 2011). As all the species involved have pygidial glands, and so are presumably chemically defended, this may be a case of Müllerian mimicry, but more information on the distribution, phylogeny and behaviour is needed to fully understand the underlying cause of this pattern.

Acknowledgements

I thank Geoff Monteith (QM emeritus) for extensive help, information and invaluable specimens that made this work possible and suggestions that improved the early draft of this paper; the current and former CSIRO gang, including Ainsley Seago, Cate Lemman, Adam Slipinski, Hermes Escalona, Stephen Cameron and Nicole Gunter for their help and collaboration during my sabbatical in Australia; Cezary Rojewski, Roger de Keyser and Allen Sundholm, Sydney, for providing valuable specimens; Pete Hudson (SAMA) for hosting me in South Australia; the folks at Minnowarra Station, SA, for allowing me access to their property; and Nicholas Grady-Grot and Erika So, undergraduates at University of California, Berkeley who worked on various aspects of the project.

References

Bonacci, T., Brandmayr, P., and Zetto Brandmayr, T. (2011). Predator feeding choice on conspicuous and non-conspicuous carabid beetles: first results. *ZooKeys* 100, 171–179.

Darlington, P. J. (1953). Australian Carabid Beetles II. Some New Pterostichini. *Psyche* 60, 90–101. doi:10.1155/1953/25184

Darlington, P. J. (1960). Australian Carabid Beetles IV. List of Localities, 1956–1958. *Psyche* 67, 111–126. doi:10.1155/1960/81583

Darlington, P. J. (1961a). Australian Carabid Beetles IX. The Tropical Notonomus. *Breviora* 148, 1–14.

Darlington, P. J. (1961b). Australian Carabid beetles VIII. Leiradira, especially the tropical species. *Breviora* 147, 1–11.

Castelnau, F. L. L. (1867). Notes on Australian Coleoptera. *Transactions and Proceedings of the Royal Society of Victoria* 8, 31–38.

Chaudoir, M. (1868). Révision des Trigonotomides. *Annales De La Société Entomologique De Belgique* 11, 151–164.

Forsythe, T. G. (1982). Feeding Mechanisms of certain ground Beetles (Coleoptera: Carabidae). *The Coleopterists Society* 36, 26–73.

Forsythe, T. G. (1983). Mouthparts and feeding of certain ground beetles (Coleoptera: Carabidae). *Zoological Journal of the Linnean Society* 79, 319–376. doi:10.1111/j.1096-3642.1983.tb01170.x

Green, P. (1999). PHRAP. Version 0.990329. Available at URL: <http://phrap.org>

Green, P., and Ewing, B. (2002). Phred. Ver. 0.020425c. Available via <http://phrap.org>

Huelsenbeck, J., and Ronquist, F. (2005). Bayesian analysis of molecular evolution using MrBayes. In 'Statistical Methods in Molecular Evolution'. (Ed. R. Nielsen.) pp. 183–226. (Springer: New York.)

Liebherr, J. K., and Will, K. W. (1998). Inferring phylogenetic relationships within Carabidae (Insecta, Coleoptera) from characters of the female reproductive tract. pp 107–170. In 'Phylogeny and Classification of Caraboidea Coleoptera: Adephegata'. (Eds G. E. Ball, A. Casale, and A. V. Taglianti.) pp. 107–170. (XX International Congress of Entomology. Atti Museo Regionale di Scienze Naturali di Torino. Italy.)

Lindroth, C. H. (1971). Disappearance as a protective factor: a supposed case of Batesian mimicry among beetles (Coleoptera: Carabidae and Chrysomelidae). *Entomologica Scandinavica* 2, 41–48. doi:10.1163/187631271X00031

Lorenz, W. (2005a). 'A Systematic List of Extant Ground Beetles of the World (Coleoptera 'Geadephaga': Trachypachidae and Carabidae, incl. Paussinae, Cicindelinae, Rhysodinae).' 2nd edn. (Wolfgang Lorenz: Tutzing, Germany.)

Lorenz, W. (2005b). 'Nomina Carabidarum – a Directory of the Scientific Names of Ground Beetles (Coleoptera 'Geadephaga': Trachypachidae and Carabidae, incl. Paussinae, Cicindelinae, Rhysodinae).' 2nd edn. (Wolfgang Lorenz: Tutzing, Germany.)

Lutshnik, V. (1916). Notes on species of the genus *Platysma* (Coleoptera) from Australia. *Proceedings of the Zoological Society of London* 86, 535–536. doi:10.1111/j.1096-3642.1916.tb02034.x

Maddison, D. R., and Maddison, W. P. (2011a). Cartographer: a Mesquite package for plotting geographic data. Available at <http://mesquiteproject.org/packages/cartographer>

Maddison, W. P., and Maddison, D. R. (2011b). Mesquite: a modular system for evolutionary analysis. Available at <http://mesquiteproject.org>

Maddison, D. R., and Maddison, W. P. (2011c). Chromaseq: a Mesquite package for analyzing sequence chromatograms. Version 1.0. Available at <http://mesquiteproject.org/packages/chromaseq>

Mawdsley, J. R., Erwin, T. L., Sithole, H., and Mawdsley, A. S. (2012). A synopsis of the genus *Cypholoba* Chaudoir (Coleoptera, Carabidae, Anthiini) known to occur in the Republic of South Africa. *ZooKeys* 43, 23–43.

Monteith, G. (1986). Insects from Kroombit Tops, Queensland with some results of a site survey of Coleoptera. *The Queensland Naturalist* 27, 27–34.

Moore, B. P. (1960). Studies on Australian Carabidae (Coleoptera) 1. New species of the tribes Agonicini, Trechini and Pterostichini. *Proceedings of The Royal Entomological Society of London* 29, 165–169.

Moore, B. P. (1961). Notes on Australian Carabidae (Col.). II *Notonomus atridermis* Sloane. *Entomologist's Monthly Magazine* 96, 134–136.

Moore, B. P. (1963). New or little known Australian Carabidae in the Frey Museum (Col.). *Entomologischen Arbeiten Aus Dem Museum Georg Frey* 14, 435–444.

Moore, B. P. (1965). Studies on Australian Carabidae (Coleoptera) 4. – The Pterostichinae. *Transactions of the Royal entomological Society of London* 117, 1–32.

Moore, B. P., Weir, T. A., and Pyke, J. E. (1987). Carabidae. In 'Zoological Catalogue of Australia. Volume 4. Coleoptera: Archostemata, Myxophaga and Adephegata'. (Eds J. F. Lawrence, B. P. Moore, J. E. Pyke and T. A. Weir.) pp. 23–320. (Australian Government Publishing Service: Canberra.)

NASA/JPL/NGA (2004). Australia, shaded relief and colored height. Available at <http://photojournal.jpl.nasa.gov/catalog/PIA06665> [Verified 11 September 2013].

Nylander, J. A. A. (2004). MrModeltest v2. Evolutionary Biology Centre, Uppsala University.

Ortuno, V. M. (1996). The female genitalia of the Poecilini from the Iberian Peninsula I The genus *Orthomus* Chaudoir, 1838. *Nouvelle Revue D'Entomologie* 13, 261–274.

Rambaut, A., and Drummond, A. J. (2007). Tracer V.1.5. Available at <http://evolve.zoo.ox.ac.uk/>

Ronquist, F., and Huelsenbeck, J. P. (2003). MrBayes 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics* 19, 1572–1574. doi:10.1093/bioinformatics/btg180

Schmied, H., Lambert, M., and Geissler, P. (2013). New case of true mimicry in cockroaches (Blattodea). *Entomological Science* 16, 119–121. doi:10.1111/j.1479-8298.2012.00529.x

Simon, C., Frati, F., Beckenbach, A., Crespi, B., Liu, H., and Flook, P. (1994). Evolution, weighting, and phylogenetic utility of mitochondrial gene-sequences and a compilation of conserved polymerase chain-reaction primers. *Annals of the Entomological Society of America* 87, 651–701. doi:10.1093/aesa/87.6.651

Sloane, T. G. (1895). Studies in Australian entomology. No. VII. New genera and species of Carabidae (including some notes on previously described species, and synoptic lists of genera and species). *Proceedings of the Linnean Society of New South Wales* 9, 393–455.

Sloane, T. G. (1902). A revision of the genus *Notonomus* (family Carabidae; Subfamily Feronini). *Proceedings of the Linnean Society of New South Wales* 27, 252–325.

- Sloane, T. G. (1903). Studies in Australian Entomology No. XII. New Carabidae (Panagaeini, Bembidiini, Pogonini, Platysmatini, Platynini, Lebiini, with revisional lists of genera and species, some notes on synonymy, &c.). Proceedings of the Linnean Society of New South Wales 28, 566–642.
- Sloane, T. G. (1913). Revisional notes on Australian Carabidae. Part iv. The genus *Notonomus*. Proceedings of the Linnean Society of New South Wales 38, 404–449.
- Sloane, T. G. (1915). Studies in Australian entomology. No. xvii. New genera and species of Carabidae (Pamborini, Migadopini, Broscini, Cuneipectini, Nomiini, Pterostichini, Platynini, Oodini, Harpalini, and Leblini). Proceedings of the Linnean Society of New South Wales 40, 438–473.
- Sloane, T. G. (1916). Carabidae from the Upper Williams River, N.S.W. Proceedings of the Linnean Society of New South Wales 41, 196–208. [Coleoptera]
- Sloane, T. G. (1923). Studies in Australian Entomology. XVIII. New genera and species of Carabidae. Proceedings of the Linnean Society of New South Wales 48, 17–39.
- Straneo, S. L. (1941). Sui tipi dei Pterostichini (Coleopt. Carabid.) Australiani della collezione Castelnau nel Museo Civico di Genova Nota III. Annali del Museo Civico di Storia Naturale Giacomo Doria 61, 83–94.
- Straneo, S. L. (1953). Nuovi Pterostichini VII. Doriania, Supplemento. Museo Civico di Storia Naturale “Giacomo Doria”, Genova 1, 1–12.
- Straneo, S. L. (1986). Sui gen. *Parhypates* Motschulsky (Coleoptera, Carabidae). Atti della Società italiana di scienze naturali e del Museo civico di storia naturale di Milano 183, 221–236.
- Tschitschérine, T. (1897). Matériaux pour servir à l'étude des Féroniens III. Horae Societatis Entomologicae Rossicae 30, 250–351.
- Tschitschérine, T. (1898). Matériaux pour servir à l'étude des Féroniens IV. Horae Societatis Entomologicae Rossicae 32, 1–224.
- Tschitschérine, T. (1902). Notes sur les Platysmatini de l'Australie. Horae Societatis Entomologicae Rossicae 35, 502–534.
- Wheeler, T. J., and Kececioglu, J. D. (2007). OPAL Package version 2.1. Multiple alignments by aligning alignments. Bioinformatics 23, i559–i568. doi:10.1093/bioinformatics/btm226
- Will, K. W. (2002). Revision of the New World Abariform Genera *Neotalus* N. Gen. and *Abaris* Dejean (Coleoptera: Carabidae: Pterostichini (Auctorum)). Annals of the Carnegie Museum 71, 143–213.
- Will, K. W. (2011a). *Chaetauchenium* Tschitschérine, 1900 (Carabidae : Pterostichini) a new species and new status for a lineage from the Valdivian temperate rainforest. Gayana Zoologica 75, 192–197.
- Will, K. W. (2011b). Taxonomic review of the Pterostichini and *Loxandriini* fauna of New Caledonia (Coleoptera, Carabidae). ZooKeys 147, 337–397.
- Will, K. W., and Gill, A. S. (2008). Phylogeny and classification of *Hypherpes* auctorum (Coleoptera: Carabidae: Pterostichini: Pterostichus). Annals of Carnegie Museum 77, 93–127. doi:10.2992/0097-4463-77.1.93
- Will, K. W., and Kavanaugh, D. H. (2012). A new species of *Lesticus* Dejean, 1828 (Coleoptera, Carabidae) from the Finisterre Range, Papua New Guinea and a key to the genera of pterostichine-like Harpalinae of New Guinea. ZooKeys 246, 27–37. doi:10.3897/zookeys.246.4112
- Yeates, D. K., Bouchard, P., and Monteith, G. (2002). Patterns and levels of endemism in the Australian Wet Tropics rainforest: evidence from flightless insects. Invertebrate Systematics 16, 605–619. doi:10.1071/IT01032