Austral Entomology

Austral Entomology (2014) **53**, 368–372

Trogidae (Coleoptera: Scarabaeoidea) in forensic entomology: occurrence of known and new species in Queensland, Australia

Werner P Strümpher,[1]* Julianne Farrell[2] and Clarke H Scholtz[1]

[1]*Scarab Research Group*, *Department of Zoology & Entomology*, *University of Pretoria*, *Private Bag X 20, Hatfield 0028, Pretoria, South Africa*.
[2]*School of Biological Sciences*, *The University of Queensland*, *St Lucia, Brisbane, Qld 4072, Australia*.

Werner P Strümpher: http://zoobank.org/urn:lsid:zoobank.org:author:9F2BDEDC-92F8-4F2A-964E-7EC1EE430B37
Julianne Farrell: http://zoobank.org/urn:lsid:zoobank.org:author:C9D42D41-8398-46DE-8898-90313E4C499B
Clarke H Scholtz: http://zoobank.org/urn:lsid:zoobank.org:author:1E7871A5-9951-48EB-AEBB-5D7B3FC142DC
http://zoobank.org/urn:lsid:zoobank.org:pub:1670F4E1-1334-4A25-BA33-47FC30392F9B

Abstract During studies of necrophagous insect succession in pig carcases that were used as surrogates for human corpses, Trogidae were found to be fairly common at the carcases at a study site in south-eastern Queensland. During identification of the species, one of the regular visitors to the carcases was found to be undescribed. While comparing this new species, *Omorgus* (*Omorgus*) *bachorum* sp. nov., with material in the Queensland Museum, another new species, *Omorgus* (*Omorgus*) *undaraensis* sp. nov., was discovered, which we also describe. One new synonym, *Omorgus incognitus* Strümpher & Scholtz, 2011 syn. nov., is also proposed, bringing the total number of Australian species of *Omorgus* Erichson, 1847 to 57.

Key words brachyptery, decomposition, insect succession, keratin feeders, post-mortem intervals.

INTRODUCTION

The use of insects for estimating post-mortem intervals of human corpses has long been implemented in medico-legal investigations of death (Tabor *et al*. 2004). The development rates of forensically important blowflies (Diptera: Calliphoridae) can be used to estimate post-mortem intervals from a couple of days to several months (Goff 2009). Insect colonisation of carrion follows predictable patterns through the decomposition process (Early & Goff 1986; Goff 2009; Villet 2011). Blowflies are among the first arrivals in the early stages of decomposition and are soon followed by various predatory beetles that feed on the huge numbers of larvae that quickly develop. When most of the soft tissue has been consumed, various other insect taxa arrive that feed on the remaining skin, hair, cartilage and bones. The final successional stage is reached with the arrival of the keratin-feeders, mostly beetles of the family Dermestidae (hide- and skin-beetles) and Trogidae (keratin beetles). The latter exhibit a remarkable feeding specialisation; adults and larvae of all known species are considered specialist keratin-feeders and able to digest keratin, unlike dermestids, for example, where in some of the carcase-associated species adults and larvae feed on soft tissue as well as keratin, while in others, only the larvae feed on animal remains, the adults on pollen (Waterhouse 1957).

The Trogidae is a small family of about 300 species worldwide (Scholtz 1982; Smith 2003; Pittino 2006; Zidek 2013). They primarily inhabit in temperate, and arid or savanna regions. Currently, there are three recognised genera in the family: *Trox* Fabricius 1775, *Polynoncus* Burmeister 1876, *Omorgus* Erichson, 1847. All native trogid species in Australia belong to the genus *Omorgus*. Australian Trogidae are fairly well studied and have been revised by Haaf (1954) and Scholtz (1986a; see also Scholtz, 1986b). The number of described species currently stands at 55 (Strümpher & Scholtz 2011), of which two were introduced (Scholtz 1986a). One of the introduced species, *O. suberosus* (Fabricius), a New World native, is now fairly widespread in eastern and south-western Australia. The other exotic species is the virtually cosmopolitan Holarctic species, *Trox scaber* (Linnaeus), which has established in south-eastern mainland Australia (Strümpher & Scholtz 2011).

Although Trogidae represent a well-established guild of keratin-feeders on virtually any source of keratin, human

*wstrumpher@zoology.up.ac.za.

doi:10.1111/aen.12084

corpses, because of their relatively hairless condition compared with most other animal carcases, do not usually attract the same numbers of these beetles as do bird and other mammal remains. However, during a recent forensic study (J Farrell in prep. 2014) using pig carcases as a surrogate for human corpses, on a peri-urban site at Lilyvale (approximately 140 km west of Brisbane: S27°26′00.61‴, E151°53′18.17″) in south-east Queensland, Trogidae were frequent and abundant visitors to the carcases. Several species were encountered and among them was an unnamed species that we describe here. While the specimens were being identified and compared with specimens in the Queensland Museum collection, one specimen of another undescribed species was found so this, too, is described in this paper. Since Scholtz's (1986a) revision of the Australian trogid fauna, two papers containing descriptions of new Australian species (Kawai 2009; Strümpher & Scholtz 2011) have been published. The recent tracing of Kawai's (2009) obscure paper revealed taxonomic duplication, and as a result, one new synonym was discovered; the synonymy is formalised in this paper.

Fig. 1. Adult habitus of *Omorgus bachorum*.

MATERIALS AND METHODS

Study site

Lilyvale lies on the western slopes of the Great Dividing Range at an altitude of about 520 m above sea level. The area is transformed open eucalypt woodland and open grass country. The region receives most of its rainfall (900–1000 mm/year) in summer. Average temperatures at the study site range between 17 and 31°C in summer, 11 and 26°C in autumn, 2 and 19°C in winter and 11 and 27°C in spring. Winter frosts are common.

Terminology

Morphological terminology follows Scholtz (1986a). Specimens were examined using Zeiss dissecting microscopes. Images of specimens were taken with a Canon EOS 550D and 100 mm macrolens. Focus stacking was performed using the software Helicon Focus version 5.3.

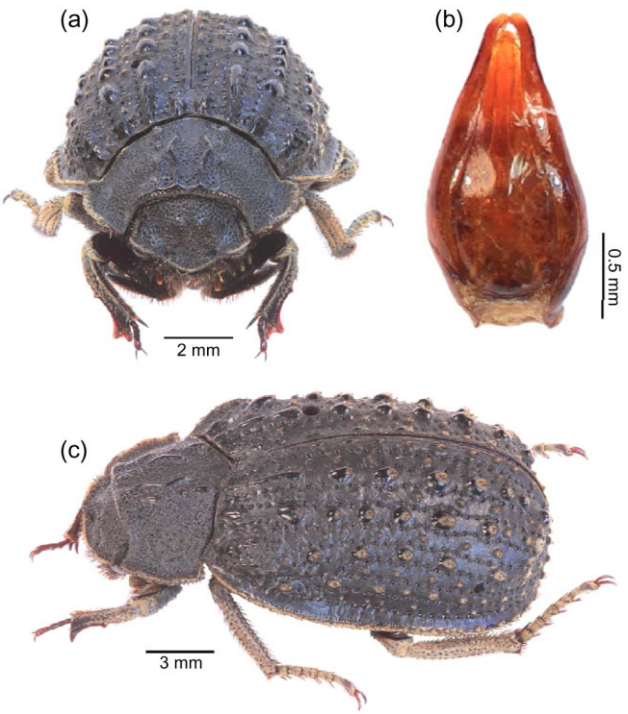

Fig. 2. *Omorgus bachorum* sp. n. (a) pronotum and head of adult habitus, (b) dorsal view of aedeagus, (c) lateral view of adult habitus.

SYSTEMATICS

Institutions to which specimens belong or in which they have been deposited are abbreviated as follows:

QM Queensland Museum, Fortitude Valley, Australia
UPSA Department of Zoology & Entomology, University of Pretoria, South Africa

Genus: *Omorgus* Erichson, 1847.

Type species: *Trox suberosus* Fabricius, 1775 by subsequent designation.

Sub-genus: *Omorgus* (*Omorgus*) Erichson.

Omorgus *(*Omorgus*)* bachorum *sp. nov. (Figs 1,2a–c)* ZooBank registration: http://zoobank.org/urn:lsid:zoobank.org:act:0C515064-9C11-499E-A578-0A90B8B8716B

Type material examined. Holotype (♂ QM: T196162) and 25 Paratypes (14♂, 3♀, QM: T191163-196; 6♂, 2♀, UP)

with the following data: Australia, QLD, 27.434°S-151.888°E, Lilyvale, nr Oakey, 530 m. 05.iv-04.xii.2012. J. Farrell, ex pig carcass. H35383; Paratype (1♀, QM: T196180) with the following data: Australia, QLD, 28°19'S 150°30'E, Bendidee Nat. Pk., 21-22Mar2003. J. Haines, 235 m. dung trap, brigalow, wilga. 51141.

Diagnosis. *O. bachorum* is a distinct species that can be reliably distinguished from morphologically similar species (e.g. *O. euclensis* (Blackburn), *O. eyrensis* (Blackburn), *O. alternans* (MacLeay) and *O. mentitor* (Blackburn)) by the virtual absence of the laterobasal tubercles and by the evenly rounded discal area of the pronotum. Furthermore, *O. bachorum* has prominent, round glabrous tubercles on the even-numbered costae on the elytra. The other similar species have the tubercles more elongate and acute apically or when round, not as highly raised as the new species.

Description. Description of the new species is limited to characters with known diagnostic value (Scholtz 1986a). The external morphology of males and females is identical. **Size:** Length: 17.3–19.2 mm, width: 7.9–8.7 mm ($n = 27$). **Colour:** Dark grey to black. **Head:** Clypeus triangular, slightly deflexed, apex pointed, margin reflexed; surface of clypeus and frons punctuate, frons with two rounded tubercles; antennal scape pointed with long black setae; pedicel attached subapically; club dark grey to black. **Pronotum:** surface punctuated; sides broad and flat; total pronotal width narrower than the elytra; median discal area slightly raised; ridges and tubercles not prominent and without distinct laterobasal tubercles, median depression shallow; lateral margins attenuated anteriorly, and evenly curved with no distinct incisions, anterior and basal margins with stiff, short setae, basal angle rounded. **Elytra:** humeral calli distinct, scutellum hastate; sides narrow; lateral margins tomentose and with short setae evenly spaced along margin; sutural margin slightly raised and glabrous, with elongated to round tubercles spaced irregularly over the anterior one-third of margin, distal two-thirds of sutural margin with small round tubercles, all tubercles on margin often with posterior tomentosity and short setae. Even numbered costae prominent, and characterised by large round glabrous tubercles irregularly spaced (especially the 2nd and 4th costae), all tubercles have a small posterior tomentose area and often with tuft of short setae; costa 2 with short, broadly rounded and glabrous basal ridge; costa 4 lacks distinct basal ridged, but often with prominent elongate and glabrous basal tubercle; odd numbered costae distinguishable as slightly raised, small round tomentose tubercles, often with one or more short setae; intercostal area with evenly spaced round punctures; one or more irregular nitid patches present laterally; elytral profile convex, attaining maximum height in middle. **Legs:** fore tibia slightly bifid, with setose dorsal keel; lateral tibial margin with one distinct median tooth; tibial spur as long as first three tarsal segments; basal segment of tarsus visible in dorsal view; mesotarsi and metatarsi sparsely setosed. **Male genitalia:** Aedeagus typical trilobite type, simple median lobe, apex pointed, not projecting beyond parameres and lateral lobes symmetrical (Fig. 2b). **Distribution:** Known from only two localities in Queensland, Australia (Fig. 5). **Etymology:** This new species is named after the Bach family in appreciation for their hospitality and technical assistance during Julianne Farrell's field work. All the specimens, except for one, in the type series were collected on their property at Lilyvale, Queensland.

Fig. 3. Adult habitus of *Omorgus undaraensis*.

Omorgus *(*Omorgus*)* undaraensis *sp. nov. (Figs 3,4a,b)* ZooBank registration: http://zoobank.org/urn:lsid:zoobank.org:pub:1670F4E1-1334-4A25-BA33-47FC30392F9B

Type material examined. Holotype (♀ QM: T196181) with the following data: Australia, QLD, 18°14′S–144°38′E, Undara NP, Wind Tunnel, 08Dec2002-08Feb2003, G. Monteith, vine scrub, 11250.

Diagnosis. *O. undaraensis* is a distinct rotund, brachypterous species. It appears to be most similar to *O. ovalis* (Haaf) but can be distinguished from the latter by the appearance of the pronotum and elytra. *O. undaraensis* has the pronotal disc evenly rounded, ridges and tubercles only slightly raised, and pronotal margins evenly curved without indentations, whereas *O. ovalis* has the pronotal disc raised, acutely ridged and pronotal margin distinctly indented; *O. undaraensis* has lateral elytral margin smooth, while *O. ovalis* has lateral elytral margin irregular. *O. undaraensis* also bears superficial resemblance to *O. nigroscobinus* (Scholtz) and *O. mariettae* (Scholtz) but can easily be distinguished from the latter species by differences in pronotal and elytral sculpture.

Description. Description of the new species is limited to the characters with known diagnostic value (Scholtz 1986a). Male specimens are unknown to us. **Size:** Length: 14.1 mm, width: 9.0 mm ($n = 1$). **Colour:** Dark brown. **Head:** Clypeus

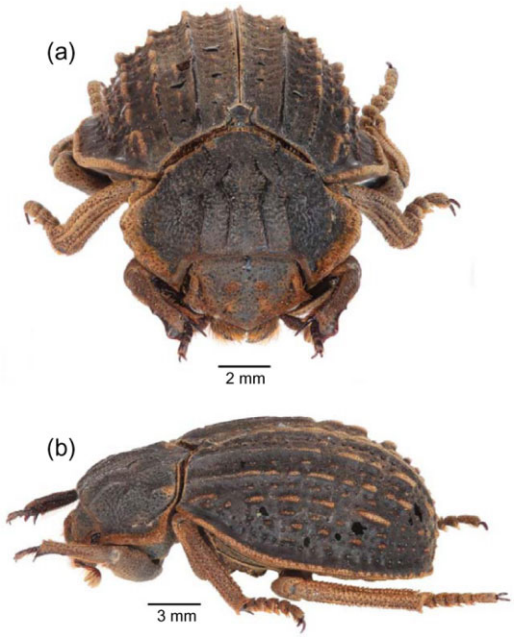

Fig. 4. *Omorgus undaraensis* sp. n. (a) pronotum and head of adult habitus, (b) lateral view of adult habitus.

triangular, only slightly deflexed, apex pointed, margin reflexed; surface of clypeus and frons punctuate with slight tomentosity, each punctures with a short seta; frons bituberculate; antennal scape stout, approximately same length as the rest of the antenna, scape with long fulvous setae; club fulvous. **Pronotum:** surface punctuated; sides broad and tomentose; lateral margins attenuated anteriorly, evenly curved with no distinct incisions, total pronotal width narrower than the elytra; evenly rounded discal area with longitudinal ridges and tubercles, median discal area slightly raised; two distinct laterobasal tubercles present; basal angle rounded. **Elytra:** not fused; humeral angle rounded, calli absent; scutellum hastate, distinctly concave with posterior margins setose; sides very broad; lateral margin smooth with a fine setal fringe; sutural margin slightly raised, anterior one-half indistinctly ridged, second one-half of sutural margin with distinct elongated setose ridges; even numbered costae prominent; second costa fused for one-third elytra length into sharply keeled ridge with glabrous crest, thereafter tuberculate, tubercles ridged and tomentose; rest of even-numbered costae with raised elongated tubercles irregularly spaced; odd-numbered costae distinguishable as slightly raised small round velutinous/setose tubercles and sparsely spaced irregular nitid patches; intercostae with evenly spaced round punctures; elytral profile convex attaining maximum height in the middle. **Legs:** fore tibia not distinctly bifid, with dorsal keel; lateral margin with 1 small median tooth; tibial spur as long as fist 4 tarsal segments; mesotarsi and metatarsi with short setal brushes. **Male genitalia:** Unknown. **Distribution:** Known only from the type locality in northern Queensland, Australia (Fig. 5). **Etymology:** The species is named for the Undara Volcanic National Park in North Queensland where this new species was collected.

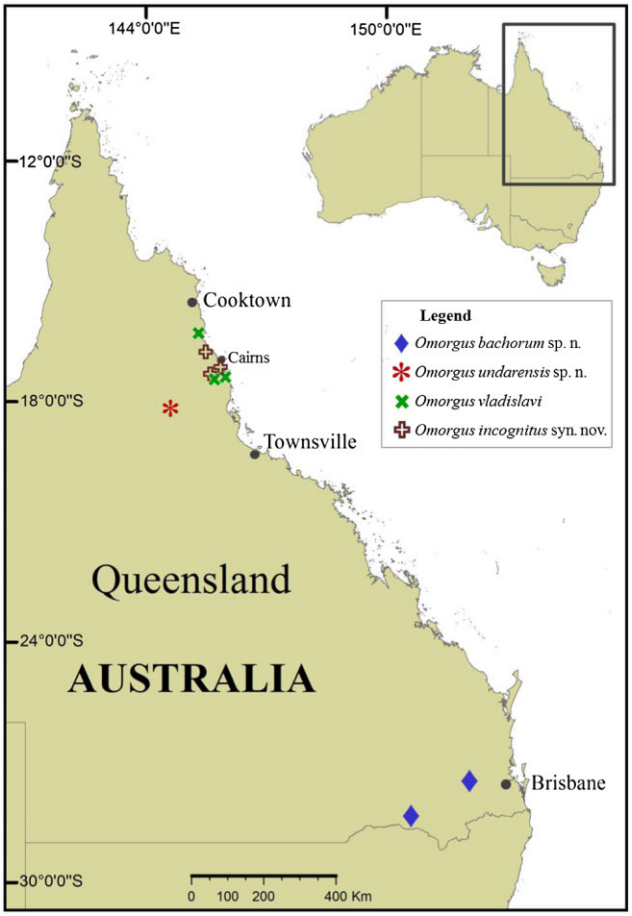

Fig. 5. Distribution map of *Omorgus* spp. in Australia: *O. bachorum* sp. n., *O. undaraensis* sp. n., *O. incognitus* syn. nov. and *O. vladislavi*.

Omorgus (Omorgus) vladislavi *Kawai, 2009*

Type material. Holotype (♂ QM: T169557) with the following data: Innisfail env. (S17°40′270″ E146°02′010″), 43 m in altitude, North Queensland, Australia, 28. XII. 2004, Vladislav Malý leg. Allotype: ♀, Cape Tribulation, N.P., Daintree section (S16°12′127″ E149°04′124″), 85 m in altitude, North Queensland, Australia, 29.XII.2004-7.I.2005, Vladislav Malý leg. Paratypes: 1♂, same locality as the allotype, Štefan Dolák leg.; 1♂, Tully G[e]orge N.P., Queensland, Australia, 7–10. I. 2008, Štefan Dolák leg.

Omorgus (Omorgus) incognitus *Strümpher & Scholtz, 2011, p. 141; syn. nov.*

Type material. Holotype (♂ QM: T196182) with the following data: Australia, Northern Queensland, Mt. Fisher S.F., Milla Milla, 10 November 1979, A. Walford-Huggins. Paratype (1♀ QM: T196183): Australia, Northern Queensland, Upper Mulgrave River, 1–3 December 1965, G. Monteith. Paratypes (2♀ UPSA) with following data: N.E. Australia, Kuranda, 8 October 1987.

Remarks

Strümpher and Scholtz (2011) described *O. incognitus* from four specimens, discovered among unsorted QM material. At the time, neither the authors nor the curators of the beetle collection at the QM were aware of the description of the species, *O. vladislavi*, Kawai, 2009 from Australia published in an obscure journal. The type was only recently returned to the QM. Subsequent comparison of Kawai's (2009) description and accompanying figures of *O. vladislavi* to specimens of *O. incognitus* shows them to be the same species. The important diagnostic features shared by both species include the (1) velutinous tomentosity covering the pronotum and elytra; (2) absence of ridges and tubercles on the odd numbered costa on the elytra; (3) the very distinct morphology of the male genitalia; and (4) similar distribution patterns.

O. incognitus Strümpher & Scholtz, 2011:141 is therefore synonymised with *O. vladislavi* Kawai, 2009: 73.

DISCUSSION

In the forensic carcase decomposition study (J Farrell in prep. 2014) that led to the direct and indirect discovery of these new species, the ones that visited the carcases (*O. bachorum*, *O. suberosus*, *O. subcarinatus* (MacLeay), *O. candidus* (Harold) and *O. euclensis* (Blackburn)) did so during wet and dry seasons, although numbers were highest during the rainy season. This is also similar to the phenology of southern African species in dry savanna (Scholtz & Caveney 1988, 1992) and is probably fairly typical for the group as a whole. Furthermore, most individuals visited the carcases during the late stages of decay. Five stages were described (after Goff 2009): fresh, bloat, decay, post-decay and skeletonised. These are fairly descriptive terms and provide a good idea of the state of the carcase, but the details of each will be presented in J Farrell (in prep. 2014). A total of 243 trogids were collected at the carcases over the 2-year course of the study; of these, a majority (193) was present at carcases in the 'post-decay' and 'skeletonised' stages between about 10 days minimum (after rain) and 120 days post-mortem. Only one individual was collected on 'fresh' carcases and 15 on 'bloated' carcases, providing more, although currently anecdotal, evidence that trogids are mostly found in late to very late stages of carcase decomposition.

ACKNOWLEDGEMENT

We thank G. Monteith of the Queensland Museum for the opportunity to examine and study the specimens.

REFERENCES

Burmeister HCC. 1876. Die argentinischen Arten der Gattung *Trox* F. *Stettiner Entomologische Zeitung* **37**, 241–268.

Early M & Goff ML. 1986. Arthropod succession patterns in exposed carrion on the island of O'Ahu, Hawaiian Islands, USA. *Journal of Medical Entomology* **23** (5), 520–531.

Erichson WF. 1847. Conspectus insectorum coleopterorum quae in Republica Peruana observata sunt. *Archiv für Naturgeschichte* **13** (1), 67–185.

Fabricius JC. 1775. *Systema Entomologiae sistens Insectorum Classes, Ordines, Genera, Species adiectis Synonymis, Locis, Descriptionibus, Observationibus*. Officina Libraria Kortii, Flensburgi et Lipsiae, Germany.

Goff ML. 2009. Early post-mortem changes and stages of decomposition in exposed cadavers. *Experimental and Applied Acarology* **49**, 21–36.

Haaf E. 1954. Die australischen Arten der gattung *Trox* (Col. Scarab.) 3, Beitrag zur kenntnis der subfam. Troginae. *Entomologischen Arbeiten aus dem Museum G. Frey* **5**, 691–740, pls.32–33.

Kawai S. 2009. A new species of the genus *Omorgus* Erichson, 1847 (Coleoptera, Trogidae) from Australia. *Kogane* **10**, 73–76.

Pittino R. 2006. Trogidae. In: *Catalogue of Palaearctic Coleoptera, Volume 3. Scarabaeoidea–Scirtoidea–Dasciloidea–Buprestoidea* (eds I Löbl & A Smetana), pp. 26–28, 79–81. Apollo Books, Stenstrup, Denmark.

Scholtz CH. 1982. Catalogue of world Trogidae (Coleoptera: Scarabaeoidea). *Entomology Memoir, Department of Agriculture and Fisheries, Republic of South Africa* **54**, 1–27.

Scholtz CH. 1986a. Revision of *Trox* Fabricius (Coleoptera: Trogidae) of the Australian Region. *Australian Journal of Zoology: Supplementary Series* **125**, 1–99.

Scholtz CH. 1986b. Phylogeny and systematics of the Trogidae (Coleoptera: Scarabaeoidea). *Systematic Entomology* **11**, 355–363.

Scholtz CH & Caveney S. 1988. Adaptations in trogid beetles to extremely arid conditions. *Journal of Arid Environments* **15**, 179–191.

Scholtz CH & Caveney S. 1992. Daily biphasic behaviour in keratin-feeding desert trogid beetles in relation to climate. *Ecological Entomology* **17**, 155–159.

Smith ABT 2003. *Checklist of the Scarabaeoidea of the Nearctic Realm*. Version 3. Electronically published. Lincoln, NE, USA.

Strümpher WP & Scholtz CH. 2011. New species of Trogidae (Coleoptera: Scarabaeoidea) from Australia. *Australian Journal of Entomology* **50**, 139–143.

Tabor KL, Brewster CC & Fell RD. 2004. Analysis of the successional patterns of insects on carrion in Southwest Virginia. *Journal of Medical Entomology* **41** (4), 785–795.

Villet MH. 2011. African carrion ecosystems and their insect communities in relation to forensic entomology. *Pest Technology* **5**, 1–15.

Waterhouse DF. 1957. Digestion in Insects. *Annual Review of Entomology* **2**, 1–18.

Zidek J. 2013. Checklist and bibliography of the Trogidae (Coleoptera: Scarabaeoidea). *Insecta Mundi* **0314**, 1–38.

Accepted for publication 13 February 2014.
Version of record published on 4 April 2014.