

A Revision of the *Onthophagus pexatus* Species-group, with Description of a New Brachypterous Species (Coleoptera: Scarabaeidae: Scarabaeinae)

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ABSTRACT. The *Onthophagus pexatus* species-group is revised, with the known species—*O. longipes* Paulian, 1937; *O. nammuldi* Matthews, 1972; *O. pexatus* Harold, 1869; *O. squalidus* Lea, 1923—re-described and a new species: *O. bulga* sp. nov., described. This species-group is centred in New South Wales, where both *O. bulga* and *O. nammuldi* are endemic. *Onthophagus bulga* is only the second flightless species of this large genus known from Australia.

Introduction

The dung beetle genus *Onthophagus* Latreille, 1802 is almost cosmopolitan and includes about 2300 described species (Monteith & Storey, 2013; Gunter *et al.*, 2019). The genus is distinctive and is the dominant coprophagous scarabaeine in most parts of the world (Cambefort, 1991). These beetles are generally tunnellers, pushing dung into tunnels under or beside the dung. Recent phylogenetic studies have placed a small number of African species outside *Onthophagus* and these have been removed to genera such as *Digitonthophagus* Balthasar, 1959 and *Hamonthophagus* Roggero, 2016, both of which occur in Australia as single introduced species (Breeschoten *et al.*, 2016; Philips, 2016; Roggero *et al.*, 2017a,b; Gunter *et al.*, 2019a). Phylogenetic studies have also suggested that the native Australopapuan fauna of *Onthophagus* is the result of radiations from one or two Asian ancestors rather than many independent invasions by different ancestors (Breeschoten *et al.*, 2016; Gunter *et al.*, 2019b).

There are 197 species of *Onthophagus* native to Australia (Gunter *et al.*, 2019a). To aid in identification, these species have been placed in 24 informal species-groups (Matthews, 1972) defined by easily discerned external characters, but

which are often restricted to the males. The species-groups were developed when only 164 native described species were known (Matthews, 1972) but are relatively robust to the addition of new taxa. This species-group system has been extended to include the New Guinea fauna, as it is closely related to the Australian fauna (Krikken & Huijbregts, 2012).

In 1993 the Australian Museum was involved in NSW State Government funded surveys of invertebrates of the North-east Forests bioregion, encompassing Barrington Tops to the Queensland border (Ferrier *et al.*, 1999). Almost 2500 unbaited pitfall traps were placed in closed forests for 6 weeks, with ethylene glycol as preservative. Many of these forests had never been surveyed for insects and therefore it was inevitable that new and interesting ground dwelling beetles would be caught. One of those species was a new flightless *Onthophagus*, designated *Onthophagus* NSW4 in an informal system of code numbers devised by Geoff Monteith (Queensland Museum) and Tom Weir (Australian National Insect Collection) for use in databasing museum collections in Australia. The full list of species is given in Monteith & Kenyon (2011). In 2021, the authors, based at the Australian Museum, had the opportunity to revisit some of

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the 1993 sites, using baited pitfalls, and were able to collect several more specimens of this rarely collected species.

Onthophagus NSW4 is a member of the *pexatus* species-group. Three undescribed species are listed in this species-group, *O.* NSW4, described here, *O.* CQ9 and *O.* WA5 (Monteith & Kenyon, 2011). *Onthophagus* CQ9 is only known from two females collected in Passchendaele State Forest near Stanthorpe. They have been described as similar to *O. nammuldi* Matthews, 1972, but with shiny granules on the elytra (G. Monteith, *in litt.* 2021). Given that the species concepts in this group are reliant on males these specimens are set aside in this treatment, but it is possible that they belong to our broad concept of *O. pexatus* Harold, 1869. *Onthophagus* WA5 is based on a single male labelled from the Kimberley region of Western Australia, 1989. It has been described as externally identical to *O. squalidus* Lea, 1923 (G. Monteith, *in litt.* 2021), but the nearest localities for this are in eastern Australia, more than 2500 km away. We consider this beetle to be probably a mislabelled specimen of *O. squalidus*. All other species of the group are redescribed below, based on material in the Australian Museum.

Material and methods

Morphological terminology follows Lawrence & Ślipiński (2013) and the format of the descriptions is based on Matthews (1972) and Monteith & Storey (2013). Labels of the type material are exactly as found, but for all other material examined the data have been slightly edited, to the sequence: named locality plus modifiers, co-ordinates if given, elevation if given, habitat and trapping details, date with months in Roman numerals, collector. The sexes of all specimens examined are noted. Additional records, from a database of specimens in Australian museums examined by Tom Weir and Geoff Monteith and collated by the latter (Monteith, 2015), are supplied as numbers and simplified localities only. These records have already been uploaded to the Atlas of Living Australia website. In the lists of specimens examined an asterisk (*) indicates dissection of genitalia; “/” indicates start of a label. Label data are corrected as follows: latitude and longitude are given as degrees, minutes, and seconds, where those are indicated by use of colons, and dates are standardized. Abbreviations: *AMS*, Australian Museum, Sydney; *ANIC*, Australian National Insect Collection, Canberra; *HS*, homestead, station or property name; *jn*, junction; *Mt*, Mount; *NP*, National Park; *NR*, Nature Reserve; *QDAF*, Queensland Department of Agriculture and Forestry; *QMB*, Queensland Museum, Brisbane; *SF*, State Forest; and *trl*, trail.

Taxonomy

Onthophagus Latreille, 1802

Type species *Scarabaeus taurus* Schreber, 1759 by monotypy.

Onthophagus pexatus species-group (Matthews, 1972)

Diagnosis. The species-group diagnosis provided by Matthews (1972) is valid for inclusion of the new species, but we have modified this diagnosis slightly to accommodate our observations of all species in the group: ground colour grey or black, sometimes with faint green or bronze sheen; upper surface microsculptured, dull, male head without frontoclypeal or frontal carinae and without horns, sometimes with pair of short transverse ridges on vertex; female with low frontal ridge; eyes narrow, with 3–7 facet rows across widest point, separated by 12–23 eye widths; canthus complete; labium with shallow apical excision much less than half length and middle of base neither membranous nor deeply depressed; pronotum entirely setose, setae short; anterior of pronotum without tubercles or ridges; elytral intervals 1–6 with conspicuous setae; male protibiae usually elongated, with apical setal tuft; apicolateral edge metatibia with mix of short stout setae and long slender setae; tarsomere 5 with short lobe between claws, not longer than base of claws, with a prominent pulvillus; pygidium without ocellate punctures; pygidial disc sparsely setose and sparsely shallowly punctured; abdominal ventrites at most only slightly foreshortened along midline, I–V in combination much longer than VI; length 4–8 mm. All species have a small swelling at the sides of the pronotal disc near the margins.

Notes. This is a small fairly well-defined group created for four described species (Matthews, 1972): *O. longipes* Paulian, 1937; *O. nammuldi* Matthews, 1972; *O. pexatus* Harold, 1869; and *O. squalidus* Lea, 1923. Three undescribed species are known in collections (Monteith & Kenyon, 2011), including the species designated *Onthophagus* NSW4, described here. The group is, however, only distinguished from the *O. posticus* species-group by visible setae on the inner elytral intervals (Matthews, 1972; Monteith & Storey, 2013). Both groups include males with unsculptured heads, elongated protibiae with apical setal tufts, and major males with a small median swelling on pronotal anterior. Furthermore, both groups include species with male protibial setal tufts either penicilliform or diffuse, and parameres in lateral view either “crested” or elongated (Monteith & Storey, 2013, fig. 7). The two aedeagal groups seem to correspond to species with densely or sparsely punctured pronota (Matthews, 1972; Monteith & Storey, 2013). However, the *Onthophagus* species groups delineated by Matthews are informal assemblages (Matthews, 1972), based on similarity, that function well for practical purposes. We do not intend to change their definitions here, merely noting that each of the *O. pexatus*- and *O. posticus*-groups is likely to be non-monophyletic and intermixed.

All described species of the *O. pexatus* species-group are found in southeastern Australia, where they occupy the temperate mesic southeastern coastal and montane region defined by Matthews (1972). He noted that there was a sequence of habitat type preferences in the species, from open grasslands (*O. pexatus*), to woodlands (*O. nammuldi*

and *O. squalidus*) to closed forests (*O. longipes*). The new species belongs to the last category. Specimens of the two undescribed species of the *O. pexatus* species-group, both occurring outside New South Wales, *Onthophagus* CQ9 and *Onthophagus* WA5 (Monteith & Kenyon, 2011), have not been examined.

Key to species of the *Onthophagus pexatus* species-group in New South Wales

- 1 Pronotal disc with sparser punctures, separated by 1–2 diameters, with flat interspaces (Figs 7, 12); sides of pronotum with smooth glabrous margination (Fig. 12); pygidium distinctly convex; male and female often with low ridge or pair of ridges at posterior of vertex (Figs 19–22); major male protibial setal tuft broader, diffuse, and 4th lateral tooth in basal half of tibia (Figs 32–33); metafemoral venter more sparsely and shallowly punctured (Figs 27–28); pygidial setae longer, thinner; aedeagi with elongated but strongly reflexed parameres, downcurved at tip in lateral view (Figs 48, 50–52) 2
- Pronotal disc densely punctured, punctures separated by narrow ridges, or at least interspaces less than puncture diameters in width (Figs 9, 11); sides of pronotum crenulate due to row of punctures with short curved setae (Fig. 11); pygidium flat or almost so; male and female vertex smooth, without ridges (Figs 13–18, 23–24); major male protibial setal tuft narrower, penicilliform, and 4th lateral tooth at half way or in apical half of tibia (Figs 30–31, 34); metafemoral venter more densely and deeply punctured (Figs 25–26, 29); pygidial setae shorter, thicker; aedeagi with short “crested” parameres, beaked at midpoint of inner edge (Figs 46–47, 49) 3
- 2(1) Basal half of head coarsely punctured and microsculptured, dull, but with contrasting shiny ridges (Figs 19–20); elytral setae placed on shiny granules (coastal species) *O. nammuldi*
- Basal half of head shallowly and sparsely punctured, with duller ridges (Figs 21–22); elytral setae set in punctures but anterior edges of some punctures at base of elytra may be shiny and slightly raised (mostly inland species) *O. pexatus*
- 3(1) Fully winged, wings longer than elytra, with apices folded; elytra more quadrate, with prominent humeri and preapical swelling; pronotal punctures denser, partly confluent 4
- Brachypterous, wings scale-like, about half length of elytra (Fig. 35); elytra rounded at sides without prominent humeri or preapical swelling (Figs 1–2); pronotal punctures not confluent (ventral surface of metafemora strongly punctured but smooth and mostly shiny) *O. bulga* sp. nov.
- 4(3) Metafemoral ventral surface rough, some punctures edged by short ridges, distal half dull strongly microreticulate (Fig. 26); elytral intervals without small elevated shiny tubercles and without shiny area at apex of 5th interval; setae longer; pronotum usually longitudinally depressed *O. longipes*
- Metafemoral ventral surface smooth and shiny, with weak microreticulation on posteroapical quarter (Fig. 28); elytral intervals with small elevated shiny tubercles at bases of setae, forming an irregular shiny area at apex of 5th interval; setae shorter; pronotum not longitudinally depressed *O. squalidus*

Onthophagus bulga sp. nov.

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Figs 1–2, 11, 13–16, 25, 30, 35–37, 42, 51–54

Onthophagus NSW4 Monteith & Kenyon, 2011: 57; Reid *et al.*, 2022: 473.

Holotype ♂ / NSW Biriwal Bulga NP 31.5520°S 152.2395°E 676 m 4–5.ii.2021 Reid & Runagall-McNaull AMNEF Site 30 jn Plan Trl/Doyles River Rd burnt dry scler[ophyll forest] macropod dung baited pitfall/ Australian Museum K.397166/HOLOTYP *Onthophagus bulga* Reid & Runagall-McNaull, 2022/ AMS. **Paratypes** (18) all labelled “Paratype *Onthophagus bulga* R & R-M. 2022” : New South Wales: 1♂/ Biriwal Bulga NP 31.5520°S 152.2395°E 676 m 4–5.ii.2021 Reid & Runagall-McNaull AMNEF Site 30/ jn Plan Trl/Doyles River Rd burnt dry scler macropod dung baited pitfall/ K.397167/ (AMS); 1♂/ David Bray property 31.5063°S 152.2498°E 489 m 5–6.ii.2021 Reid & Runagall-McNaull AMNEF Site 35/ end of Gilloglys Rd burnt rainf margin macropod dung baited pitfall/ K.397163/ (AMS); 4♀, identical labels except K.397161, K.397162, K.397164 or K.397165 (AMS); 1♂/ 38CG Fifes Knob Rd, about 4 km from Fifes Fire Trail 30°54'S 152°22'E Carrai SF 163A 740 m (NPWS Survey) 4 Feb–9 Apr 1993 M Gray G Cassis/ K.397243/ (AMS); 1♀/ 38CM Fifes Knob Rd, about 3 km from Fifes Fire Trail 30°54'S 152°22'E Carrai SF 163A 670 m (NPWS Survey) 4 Feb–9 Apr 1993 M Gray G Cassis/ K.397241/ (AMS); 1♀, identical labels except K.397242 (AMS); 1♀/ 38CR Fifes Knob Rd, 2 km from Fifes Fire Trail 30°54'S 152°22'E Carrai SF 163A 800 m (NPWS Survey) 4 Feb–9 Apr 1993 M Gray G Cassis/ K.397244/ (AMS); 1♂/ 57AM Grey Gums Forest Rd 1.1 km from Doyles River Rd 31°33'S 152°14'E Bulga SF 620 m (NPWS Survey) 4 Feb–9 Apr 1993 M Gray G Cassis/ K.397239/ (AMS); 1♀, identical labels except K.397240 (AMS); 1♂*/ 57AG Grey Gums Forest Rd 2.1 km from Doyles River Rd 31°33'S 152°14'E Bulga SF 560 m (NPWS Survey) 4 Feb–9 Apr 1993 M Gray G Cassis/ K.397253/ (AMS); 1♂/ Tirrill Ck FR, Bulga SF, 31.5282°S 152.1399°E 546 m 5–6.ii.2021 Reid & Runagall-McNaull AMNEF Site 31/ Blue Mountain Ck Rd W of Tirrill Ck Xing burnt wet scler. macropod dung baited pitfall/ K.397154/ (AMS); 1♂, 6♀, identical labels except K.397158 (male), K.397153, K.397155, K.397156, K.397157, K.397159, K.397160 minor ♂/ Walcha Survey, Cooplacurripa, grassy forest 31°36'03"S 151°49'59"E [955 m] Transect 18 HSQ OTB January 1993 Ian Oliver/ K.397245/ (AMS).

Description. Mature specimens entirely dull grey-black, usually matted with dirt (squalid) on pronotum, elytra and pygidium; fresh specimens with shiny and feebly microsculptured black head and pronotum, dull and densely microsculptured grey-black elytra, with shiny striae, and dull densely microsculptured grey-black pygidium; freshly emerged specimens usually teneral, with reddish elytral apices, venter, pygidium and legs; antennae yellowish-brown, clubs brown. Length, male 4–6 mm; female 4.5–6 mm.

Male. Head (Figs 13, 15). Surface smooth, shiny, with dense large punctures at base becoming smaller and sparser towards apex, and minute stubble at sides of vertex and on genae. Clypeal apical margin uptilted, arcuately excavate

with sides of excavation slightly produced (worn flat and almost truncate in old specimens), side margins slightly rounded; clypeal suture entirely effaced at frontal portion, genal portions present but not raised; frons flat, without elevations, slightly medially depressed in larger specimens; eyes narrow, 5–6 facet rows in width, separated by 17–20 eye widths, canthus complete, closed by dorsal width of eye; apex of mentum shallowly excavate.

Thorax (Figs 1–2, 11, 25, 30, 35–36). Pronotum. Broad in large males (as wide as elytra), narrower and flatter in small males. Strongly convex, slightly tumid at middle of anterior slope in larger specimens; surface smooth, entirely strongly and closely punctured, intervals shiny in fresh material but microreticulate, mostly less than half diameter of punctures, and covered in dense short semi-erect to strongly recurved setae; anterior angles 80–90°; anterior margined, sides margined and crenulate with curved short setae between crenulations, base without raised edge; pronotal hypomeron dull and densely microsculptured on outer half, strongly punctured, punctures separated by 1–2 diameters, with elevated rims, increasing in diameter towards sides, outermost punctures with long erect seta. Elytra. Almost circular in dorsal view, lacking humeral and preapical swellings, and short, length about equal to length of pronotum along midline. Dull and densely microreticulate, except apical half of suture shiny and striae shiny; intervals flat, with faintly raised lunate tubercles at bases of setae, tubercles more distinct on outermost interval, or all intervals with distinct lunate tubercles (northern specimens); intervals 1–7 with fairly dense erect short scale-like setae, not aligned in rows, outermost interval densely setose; striae punctures slightly broader than striae; metaventricle medially shiny, laterally (lateral to mesocoxae) dull and microreticulate, anterior smoothly convex with scattered long setae, midline of posterior half slightly depressed or grooved; wing narrow, with reduced venation, unfolded in repose and reaching only $\frac{3}{4}$ length of elytron. Legs. Protibiae elongated and narrowed, inner apical angle with compact dense tuft of yellow setae about twice length of apical spur; distal face of apical tooth with loose sparse tuft of yellow setae about as long as apical spur, 4th (smallest) lateral tooth at about midpoint; metafemoral ventral surface smooth and mostly shiny, weakly microreticulate, almost evenly punctured with moderately large punctures separated by 1–2 diameters.

Abdomen (Fig. 37). Ventrites dull, densely microreticulate and slightly rugose, obscuring puncturation, each with single transverse row of erect pale setae; Pygidium weakly convex, densely and evenly microreticulate except shiny raised margins; punctures distinct but sparse, separated by 2–3 diameters; setae short, scale-like, length about 3× width.

Aedeagus (Fig. 46). In lateral view, parameres “crested”, with a rounded apico-dorsal elevation and prominent but short apico-ventral “beak”.

Female. Head (Figs 14, 16). clypeal suture slightly elevated in frontal portion (faintly in worn specimens), sometimes effaced before reaching genal sutures, straight or slightly convex anteriorly; surface rougher than male, shiny, smooth at base becoming transversely rugose on clypeus, with dense large punctures throughout; pronotum slightly narrower than elytra and relatively flat, like small males; protibiae short and straight, with broad lateral teeth (often rounded due to wear).



Figures 1–4. (1, 2) *Onthophagus bulga* sp. nov., male, dorsal and lateral; (3, 4) *O. longipes* Paulian, male, dorsal and lateral.



Figures 5–8. (5, 6) *Onthophagus nammuldi* Matthews, male, dorsal & lateral; (7, 8) *O. pexatus* Harold, male, dorsal and lateral.



Figures 9, 10. *Onthophagus squalidus* Lea, male dorsal, lateral, and ventral.

Minor male (1 specimen). Clypeal suture as male, clypeal surface as female, protibia as female.

Etymology. The species name, “bulga”, a noun in apposition, means mountain in several eastern Australian languages including Biripi, one of the languages formerly used in the range of this species (Solling, 2014). Most of the material examined has been collected in Bulga State Forest or Biriwal Bulga National Park.

Notes. *Onthophagus bulga* is endemic to the eastern hills and ranges of central northeast New South Wales, in a triangle of localities from Carrai in the north to Barakee and Biriwal-Bulga in the south (Fig. 54). Much of the area of occurrence is relatively remote and poorly surveyed forest; we therefore expect this species to occur at more sites in the region.

This species occurs in wet sclerophyll or dry sclerophyll forest (Figs 51–53), at mid or moderately high elevation (489–955 m). *Onthophagus bulga* is clearly fire tolerant as all three sites in the 2021 survey where this species was trapped had been burnt in the 2019/2020 fires (Reid *et al.*, 2022).

In the 2021 survey, both macropod dung and button mushrooms were used as baits, however *O. bulga* was only collected in traps using the first (Reid *et al.*, 2022). This is not therefore a rarely collected species because of mycophily, such as members of the *erichsoni* species-group (Monteith & Rossini, 2017).

Onthophagus bulga was formerly designated “*Onthophagus NSW4*” (Monteith & Kenyon, 2011; Reid *et al.*, 2022).

Onthophagus longipes Paulian, 1937

Figs 3–4, 17–18, 26, 31, 38, 43

Onthophagus longipes Paulian, 1937: 344; Matthews, 1972: 212; Williams & Williams, 1982: 44; Williams & Williams, 1983: 29; Cassis & Weir, 1992: 140; Monteith & Kenyon, 2011: 57.

Material examined (5♂, 4♀). **Australian Capital Territory:** 1♀/ Lees Ck [vic. 35°34'S 148°86'E, 675 m], pitfall 10.iii.1979 (AMS); **New South Wales:** 1♀/ Cathedral Rock NP, Barokee Swamp, montane sphag. bog/ woodland 1350 m yellow pans 7.xii.1992 D Bickel (AMS); 1♀/ Enfield SF 37BM Daisy Patch Fire Trail, 1.9 km S Enfield Rd 31°20'S 151°54'E 163AS 1130 m (NPWS Survey) 4.ii–9.iv.1993 M Gray G Cassis (AMS); 1♀/ Kunderang Station Ck, NE facing slope above 39BR 30°48'S 152°06'E 410 m (NPWS Survey) 4.ii–9.iv.1993 M Gray G Cassis (AMS); ♂/ Marengo SF 2.1 km along Chimney Rd from jn with Chaelundi Rd 30.105°S 152.412°E human dung trap 13.v.1999 S Lassau & C Lemann (AMS); 1♂/ New England NP 33AM Cliffs Trail (top end) bordering New England NP & Styx River SF, about 3 km S of Point Lookout 30°31'S 152°23'E 1350 m (NPWS Survey) 4.ii–9.iv.1993 M Gray G Cassis (AMS); 1♂*/ Stewarts Brook SF 62AM 0.7 km along unnamed logging track from Omadale Brook Rd, 31°54'S 151°23'E 1250 m (NPWS Survey) 4.ii–9.iv.1993 M Gray G Cassis (AMS); 1♂*/ Stewarts Brook SF 62CM 0.4 km along Barrington Trail from southern Green Gap turnoff, 31°56'S



Figures 11, 12. Lateral margin pronotum. (11) *Onthophagus bulga* sp. nov.; (12) *O. pexatus* Harold.

151°26'E 1430 m (NPWS Survey) 4.ii–9.iv.1993 M Gray G Cassis (AMS); 1♂/ Stewarts Brook SF 62AG Pol Blue Ck, above Tubbrabucca Rd, 31°55'S 151°23'E 1240 m (NPWS Survey) 4.ii–9.iv.1993 M Gray G Cassis (AMS).

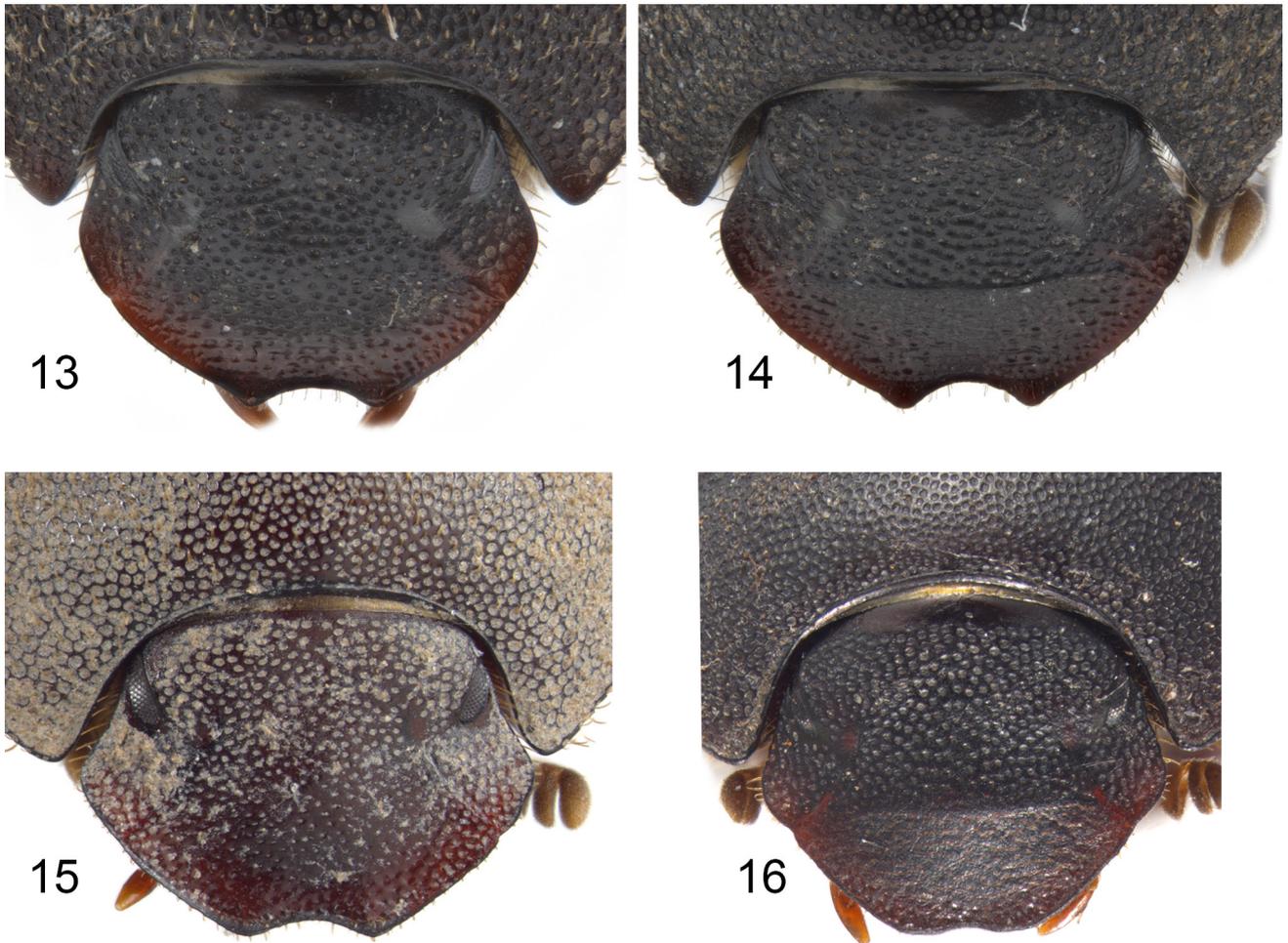
Additional records (not included in Matthews, 1972). **Australian Capital Territory:** 2/ 3k & 6k NE Piccadilly Circus (ANIC); **New South Wales:** 3/ Moppy Lookout (ANIC); 1/ Mt Gibraltar (ANIC); 7/ Robertson (QMB); 2/ Thungutti Campground (ANIC); **Victoria:** 2/ Ghost Point (ANIC); 1/ 2.2k NE Warburton (ANIC); 1/ 6k ESE Tanjil Bren (ANIC); 1/ Tarra-Bulga NP (ANIC); 5/ Wilson Promontory (ANIC, QDAF); 2/ Yanks Folly (ANIC).

Redescription. Mature specimens with shiny shallowly microsculptured black head and pronotum, duller and densely microsculptured grey-black elytra, with dull microsculptured striae, and dull densely microsculptured grey-black pygidium; freshly emerged specimens usually teneral, with reddish elytral apices, venter, pygidium and legs; antennae reddish-brown, with brown clubs. Length, male 4.5–6 mm; female 4–5.5 mm.

Male. Head (Fig. 17). Surface smooth, shiny but shallowly microreticulate, with dense large punctures at base becoming smaller and sparser towards apex, minute stubble on genae and longer semi-erect setae on sides of vertex. Clypeal apical margin uptilted, arcuately excavate, each side of excavation

triangularly produced, side margins slightly rounded; clypeal suture entirely effaced at frontal portion, genal portions present and feebly raised; frons flat, without elevations, slightly medially depressed; eyes narrow, 5–7 facet rows in width, separated by 15–20 eye widths, canthus narrowly complete; mentum shallowly excavate at apex.

Thorax (Figs 3–4, 26, 31). Pronotum. Broad in large males (as wide as elytra), narrower and flatter in small males. Moderately convex, slightly tumid at middle of anterior slope in larger specimens; surface smooth, entirely strongly and closely punctured, punctures shallowly ocellate and often slightly elongate, intervals shiny in fresh material but microreticulate, less than half diameter of punctures, and covered in dense short semi-erect to almost recumbent setae; anterior angles 80–90°; anterior margined, sides margined and crenulate with curved short setae between crenulations, base with thin raised edge which may be partly effaced; pronotal hypomeron dull and densely microsculptured, strongly punctured on outer half, punctures separated by 1–2 diameters, with elevated rims, increasing in diameter towards sides, outermost punctures with long semi-erect setae. Elytra. Semi-ovate in dorsal view, with prominent humeri and preapical swelling, longer than pronotum along midline. Duller than pronotum but weakly shiny, striae and suture similar, densely microreticulate; intervals 1–6 flat or slightly uneven in teneral specimens, without obvious



Figures 13–16. *Onthophagus bulga* sp. nov., head, male (left) and female (right). (13, 14) fresh specimens; (15, 16) worn specimens.

small tubercles or elevations, 7th interval may have a few small round shiny tubercles, outer interval with a few lunate punctures; intervals 1–7 with fairly dense erect short scale-like setae, not in distinct rows, outermost interval more densely setose; striae punctures usually distinct, slightly broader and deeper than striae; epipleura with single row of curved setae. Metaventre medially shiny, anteriorly and laterally (lateral to mesocoxae) dull and microreticulate, with scattered semi-recumbent setae, anterior smoothly convex, midline grooved; wing fully developed, folded twice in repose. Legs. Protibiae elongated and narrowed, inner apical angle with compact dense tuft of yellow setae about twice length of apical spur; distal face of apical tooth with loose sparse tuft of yellow setae about as long as apical spur, 4th (smallest) lateral tooth at about midpoint; metafemoral ventral surface rough, with short elongate ridges (elevated edges of punctures), mostly dull and microreticulate, with moderately large but shallow close punctures separated by 0.5–2 diameters.

Abdomen (Fig. 38). Ventrites dull, densely microreticulate, obscuring puncturation, each with single transverse row of semi-recumbent pale setae; pygidium flat or almost so, densely and evenly microreticulate except shiny raised margins; punctures distinct or obscured by microsculpture, sparse, separated by 1–3 diameters; setae short, but thin, length 7–10× width.

Aedeagus (Fig. 43). In lateral view, parameres “crested”, with an angular apico-dorsal elevation and prominent but short apico-ventral “beak”.

Female. Head (Fig. 18). Sides more rounded, surface rougher than male, shiny, smooth at base becoming transversely rugose on clypeus, with dense large punctures throughout; median depression of vertex deeper than male, with sides slightly elevated; clypeal suture slightly elevated in frontal portion, sometimes effaced before reaching genal sutures, straight; pronotum slightly narrower than elytra; protibiae short and straight, with broad lateral teeth.

Notes. Matthews’ redescription was based on 19 males and females, including the male holotype from Victoria, with most specimens in Victoria and the northernmost from the Illawarra, New South Wales. The specimens recorded here extend the distribution of this species north to the Dorrigo Plateau. Our material conforms to Matthews’ description except that the eyes are slightly more variable in size and the striae are usually distinctly punctured.

All sites recorded here are in closed forest, which appears to be its preferred habitat (Matthews (1972; Williams & Williams, 1982), except Barokee Swamp, which is open woodland around a grassy bog at high elevation. The species is rare at its known sites in New South Wales, almost all records being singletons.



17



18



19



20

Figures 17–20. *Onthophagus* species, head, male (left), and female (right), fresh specimens. (17, 18) *O. longipes* Paulian; (19, 20) *O. nammuldi* Matthews.

Onthophagus nammuldi Matthews, 1972

Figs 5–6, 19–20, 27, 32, 39, 44

Onthophagus nammuldi Matthews, 1972: 208; Cassis & Weir, 1992: 143; Monteith & Kenyon, 2011: 57.

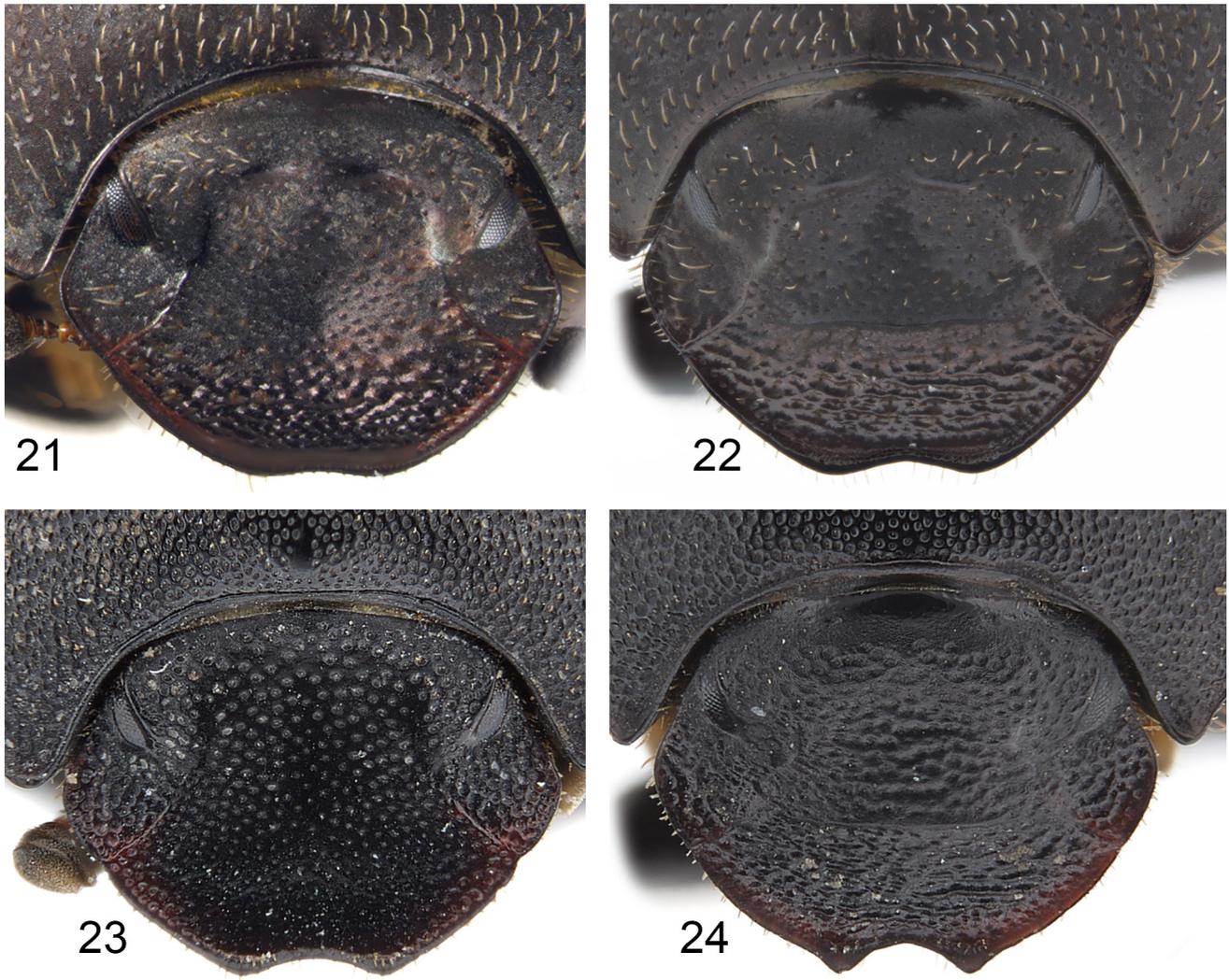
Material examined (3♂, 3♀). **New South Wales:** 1♂*, 2♂, 3♀/ Gerroa 105 km S Sydney 34°46'S 150°48'E [Seven Mile Beach NP] forest, sand, pitfall, excrem. 21–22.iii.2013 C Rojewski (AMS).

Redescription. Mature specimens dorsally dull grey-black, with or without reddish spot at apex of 6th elytral interval and with reddish spots at sides of apical abdominal tergites, antennae reddish-brown, with blackish-brown to dark grey clubs; densely microreticulate, with shiny less microsculptured anterior third of clypeus, frontal ridges and legs, usually also shiny striae. Length, male 5–6 mm; female 5–6 mm.

Male. Head (Fig. 19). Surface dull and densely microreticulate, except shiny apical third of clypeus and margins, closely and strongly punctured, covered with erect long setae

(may be abraded). Clypeus not produced, margins reflexed, apex arcuately excavate with sides of excavation rounded or feebly angulate, side margins slightly rounded; clypeal suture entirely effaced at frontal portion, genal portions present and raised; frons with pair of shiny transverse ridges which may meet at middle; eyes narrow, 5–6 facet rows in width, separated by 12–14 eye widths, canthus complete, closed by dorsal width of eye; apex of mentum shallowly excavate.

Thorax (Figs 5–6, 27, 32). Pronotum. Moderately convex, slightly narrower than elytra, without anteromedian swelling but midline slightly raised in anterior half and slightly depressed in posterior half; surface smooth, entirely strongly and densely microreticulate except shiny lateral margination, with scattered large shallow punctures separated by 1–2× diameters, each with conspicuous semi-erect seta; anterior angles 80–90°; anterior margined, sides evenly margined without small setose punctures, base without raised edge; pronotal hypomeron dull and densely microsculptured throughout, finely punctured, punctures sparse with long erect setae. Elytra. Semi-ovate in dorsal view, with prominent humeri and preapical swelling, longer than pronotum along midline. Dull and densely microreticulate,



Figures 21–24. *Onthophagus* species, head, male (left), and female (right), fresh specimens. (21, 22) *O. pexatus* Harold; (23, 24) *O. squalidus* Lea.

except apical half of suture shiny and striae usually shinier; intervals flat, except sparse small round shiny tubercles, forming one to two loosely defined rows when viewed longitudinally, tubercles with semi-erect long setae, setose tubercles of outermost interval scattered; striae punctures slightly broader than striae; epipleura with single row of curved setae. Metaventricle medially shiny, laterally (lateral to mesocoxae) dull and microreticulate, shallowly convex with scattered long setae, but midline grooved; wing fully developed, folded twice in repose. Legs. Protibiae slightly elongated and narrowed but with large triangular lateral teeth, inner apical angle with dense but apically spreading tuft of yellow setae about twice length of apical spur; distal face of apical tooth with loose sparse tuft of yellow setae about as long as apical spur, 4th (smallest) lateral tooth in basal half; metafemoral ventral surface smooth and mostly shiny, weakly microreticulate, with scattered large and small punctures, separated by 1–4 diameters.

Abdomen (Fig. 39). Ventrites dull, densely microreticulate, obscuring puncturation, each with single transverse row of erect pale setae; pygidium convex, densely and evenly microreticulate except shiny raised margins, punctures obscured by microreticulation and sparse, separated by >5

diameters, setae long and thin, length >10× width.

Aedeagus (Fig. 44). In lateral view, parameres elongated but strongly deflexed, each with flat oval tip.

Female. Head (Fig. 20). Similar to male except transverse clypeal sutural ridge present, strongly elevated in middle, reaching genal sutures or effaced before them (1 specimen); clypeus and anterior half of genae shiny, frons dull; protibiae short and straight, with large lateral teeth as male.

Notes. Matthews' description was based on 11 males and females from one locality. The material examined here conforms to his description except that the male protibiae are elongated relative to the female and the pronotal punctures sometimes slightly closer.

Onthophagus nammuldi is a rarely collected species, probably because it inhabits rarely sampled coastal forest. The specimens described here were collected in Bangalay Sand Forest, dominated by *Eucalyptus botryoides*, on old sand dune ridges (NSW National Parks & Wildlife Service, 1998). This coastal forest type is listed as an endangered community under the NSW Threatened Species Act (NSW Office of Environment & Heritage, 2022). *Onthophagus nammuldi* was originally described from Durras Lake, which



Figures 25–29. *Onthophagus* species, venter of right metafemur. (25) *O. bulga* sp. nov.; (26) *O. longipes* Paulian; (27) *O. nammuldi* Matthews; (28) *O. pexatus* Harold; (29) *O. squalidus* Lea.

has the same forest type (NSW National Parks & Wildlife Service, 2002). The two other expert identified records (Atlas of Living Australia, 2022) are from similar sites: Gerroa (the north end of Seven Mile National Park) and “8 km ESE of Moruya”. The latter was collected by Murray Upton, who owned a property at Congo, 8 km SE of Moruya, with Bangalay Sand Forest nearby in Eurobodalla National Park (NSW National Parks & Wildlife Service, 2000). There is thus strong evidence that *O. nammuldi* is a coastal forest specialist, strongly associated with the endangered Bangalay Sand Forest.

Onthophagus pexatus Harold, 1869

Figs 7–8, 12, 21–22, 28, 33, 40, 46–50

Onthophagus pexatus Harold, 1869: 86; Blackburn, 1903: 269; Lea, 1923: 355; Boucomont & Gillet, 1927: 214; Matthews, 1972: 209; Cassis & Weir, 1992: 146; Monteith & Kenyon, 2011: 57; Reid *et al.*, 2022.

Material examined (60♂, 55♀). **Australian Capital Territory:** 1♀/Tidbinbilla 26.viii.1976 D McAlpine (AMS); **New South Wales:** 2♀/Bogolong [?, label handwritten] (AMS); 1♀/3k NW Carrowbrook on Mt Royal Rd ‘Callicoma Hill’ private land [32.271°S 151.288°E 485 m] open grassy field 5–15.i.2013 JR Gollan, MB Ashcroft, K Turner HVARCLP/A191/1/T1/bait (dung baited pitfall trap) (AMS); 19♂, 1♂*, 8♀/Cathedral Rock NP 30.4422°S 152.2797°E 1349 m site 60 c2k from park entrance, burnt dry scler forest, macropod dung baited pitfall 22–23.ii.2021 Reid & Runagall-McNaull (AMS); 2♂, 4♀/Cathedral Rock NP 30.4416°S 152.2790°E 1347 m site 61 c2k from park entrance, burnt dry scler/open heath, macropod dung baited pitfall 22–23.ii.2021 Reid & Runagall-McNaull (AMS); 1♂/Culoul Range, nr Putty, pollinating *Typhonium brownii*? li.1967 AN Dodd (AMS); 1♀/Goulburn (AMS); 1♂/Hartley Vale, Blue Mtns, open forest at wombat dung, 11.x.2002, B Day & D McAlpine (AMS); 1♀/Jenolan SF 20.iv.1973 DA Doolan (AMS); 2♀/Lake Eucumbene, lake surface, 8.ix.1972 R Farragher (AMS); 1♂, 1♂*, 1♀/‘Dairy Park’ 7.2 km SE Mandurama 33.70083°S 149.13412°E pitfall trap DAPA-LH-2 8–22.xii.2011 G Kay & D Florance (AMS); 1♀/‘Mandurama’ 7.2 km SE Mandurama 33.70318°S 149.13646°E pitfall trap JROW-LH1-3 8–22.xii.2011 G Kay & D Florance (AMS); 2♀/‘Red Hill’ 11.5 km SE Molong 33.16933°S 148.97742°E pitfall trap JTUX-GE-4 8–22.xii.2011 G Kay & D Florance (AMS); 1♀/Mt Coricudgy 29.ix.1983 G Hangay (AMS); 1♂*/Mt Hyland NR 30.1757°S 152.4153°E 1265 m site 55 summit track, burnt closed dry scler forest, macropod dung baited pitfall 20–21.ii.2021 Reid & Runagall-McNaull (AMS); 2♂/Mt Hyland NR 30.1753°S 152.4125°E 1254 m site 56 base of summit track, burnt grassy clearing in dry scler forest, macropod dung baited pitfall 21–22.ii.2021 Reid & Runagall-McNaull (AMS); 1♀/Mt Hyland NR 30.1748°S 152.4119°E 1252 m site 57 base of summit track, burnt grassy clearing in dry scler forest, macropod dung baited pitfall 21–22.ii.2021 Reid & Runagall-McNaull (AMS); 1♂, 4♀/Nullo Mtn SF, c8k SE Cox’s Ck [32.763°S 150.196°E 785 m], undisturbed rainforest gully, 6–16.i.2013 JR Gollan, MB Ashcroft, K Turner HVARCLP/A050/1–3/T1/bait (dung baited pitfall trap) (AMS); 12♂, 1♂*, 4♀/Penrose SF 22.iv.1972 DADoolan (AMS); 1♂, ditto except 6.v.1972 (AMS); 1♂/Putty SF 4–14.i.2013 JR Gollan, MB Ashcroft, K Turner HVARCLP/A008/2/T1/bait (dung baited pitfall trap) (AMS); 1♀/Putty SF 4–14.i.2013 JR Gollan, MB Ashcroft, K Turner HVARCLP/A007/2/T1/bait (dung baited pitfall trap) (AMS); 1♂/Tallong 26.ii.1971 RH Mulder (AMS); 1♂, 1♀/Tamworth, private prop. W side of top of Bald Hill behind radio tower 31°04’33”S 150°57’24”E 15.xi–6.xii.2001 H Doherty & M Elliott NDNW1/060/04 (pit trap) (AMS); 1♀/Tweed River (AMS); 1♂, 1♀/[c2.5k E Wanganui 33.022°S 149.956°E 1050 m] open grassy field grazed by livestock 2k SE end of Vulcan Rd ‘Cubby House’ private land, 6–16.i.2013 JR Gollan, MB Ashcroft, K Turner HVARCLP/A057/1/T1/bait (dung baited pitfall trap) (AMS); 3♀/Warrumbungle Mtns 22.xi.1972 DA Doolan (AMS); 1♂, 3♀/Warrumbungle Mtns 3.x.1979 DA Doolan; 2♂, 1♂*, 4♀/Wollemi NP, scattered trees 700 m from Thompson’s Rd, 2k N of Milbrodale, 5–15.i.2013 JR Gollan, MB Ashcroft, K Turner HVARCLP/A263/1-3/T1/bait (dung baited pitfall trap) (AMS); 1♂*/Wombeyan Caves 9.v.2001 BJ & CJ Day in wombat dung (AMS); 1♂*/[Woolomin] crown res. 0.9k along rd to Woolomin rubbish tip, 100 m E of rd, 31°18’05”S 151°09’20”E, 24.xi–15.xii.2001 L Wilkie, H Doherty, H Smith & M Elliott NDNW1/057/C2 (pittrap) (AMS); 1♀/‘Talong’ 9 km S Wyangala –34.05366°S 148.93733°E pitfall trap SLAV-S-2 8–22.xii.2011 G Kay & D Florance (AMS); **Victoria:** 2♀/Melbourne (AMS); 1♂*/Tallangatta Valley site 41 15.iv.2009 per Belinda Pearce (AMS); 1♂, 1♀/Yallock Vale (AMS).

Additional records (not included in Matthews, 1972). **Australian Capital Territory:** 1/6k W Hall (ANIC); 4k N Pialligo (ANIC); 1/Shepherd’s Lookout (ANIC); **New South Wales:** 1/13k N Bombala (ANIC); 1/Canyon Leigh (ANIC); 15/W end Coolah Tops (QMB); 3/7k WNW Hoskinstown (ANIC); 1/2k NNW Jerangle (ANIC); 1/17k N Molong (ANIC); 1/4k NE Mt Wog Wog (ANIC); 1/Tuglo HS (ANIC); 7/Wyangala Dam (QMB); **Queensland:** 16/5k & 9 km NE Allies Creek (QMB); 1/Bald Mtn (QDAF); 4/Isola Gorge NP (QMB); 3/Moolayember Creek NP (QMB); 3/8.5k SW Mt Hutton (QMB); 2/Mt Norman (QDAF); 7/Oak Wells HS (QMB); 22/Wonga Hills HS (QMB); **Victoria:** 1/36k W Bairnsdale (ANIC).



Figures 30–34. *Onthophagus* species, left protibia. (30) *O. bulga* sp. nov.; (31) *O. longipes* Paulian; (32) *O. nammuldi* Matthews; (33) *O. pexatus* Harold; (34) *O. squalidus* Lea.

Redescription. Mature specimens dorsally dull grey-black, with or without reddish spot at base of 6th elytral interval, antennae reddish-brown, with dark grey to black clubs; teneral specimens with sides and apex of elytra reddish; densely microreticulate, with shiny less microsculptured anterior third of clypeus and legs, usually also shiny striae. Length, male 4.5–6 mm; female 4–7 mm.

Male. Head (Fig. 21). Surface dull and densely microreticulate, except shiny apical third of clypeus and margins, sparsely and finely punctured, covered with slightly curved long setae (abraded in most specimens). Clypeus not produced, margins narrowly reflexed, apex shallowly excavate with sides of excavation rounded, side margins slightly rounded; clypeal suture entirely effaced at frontal portion, genal portions present and raised; frons medially depressed, with or without feebly developed dull transverse ridges; eyes narrow, 5–6 facet rows in width, separated by 14–17 eye widths, canthus complete, closed by dorsal width of eye; apex of mentum shallowly excavate.

Thorax (Figs 7–8, 12, 28, 33). Pronotum. Moderately convex, slightly narrower than elytra, without anteromedian swelling, disc usually evenly convex, but may be feebly depressed along midline in posterior third; surface smooth, entirely strongly and densely microreticulate, with scattered moderately large shallow punctures separated by 1–3× diameters, each with short semi-recumbent seta; anterior angles 80–90°; anterior margined, sides evenly margined without small setose punctures, base with or without raised edge; pronotal hypomeron dull and densely microsculptured throughout, finely punctured on outer half, punctures sparse with long erect setae. Elytra. Semi-ovate in dorsal view, with prominent humeri and preapical swelling, longer than pronotum along midline; dull and densely microreticulate, except striae and apical third of suture usually shinier; intervals flat, except a few specimens with minute shiny tubercles on anterior half of inner intervals; intervals with scattered small punctures and semi-recumbent setae, forming one to two loosely defined rows when viewed longitudinally,

setae of outermost interval longer, scattered, their punctures larger; strial punctures faint, slightly broader than striae; epipleura with single row of curved setae. Metaventrite entirely shallowly microreticulate but medially shinier, shallowly convex with scattered long setae, but midline grooved; wing fully developed, folded twice in repose. Legs. Protibiae slightly elongated and narrowed but with large triangular lateral teeth, inner apical angle with dense but broad tuft of yellow setae about twice length of apical spur; distal face of apical tooth with loose sparse tuft of yellow setae about as long as apical spur, 4th (smallest) lateral tooth in basal half; metafemoral ventral surface smooth and mostly shiny, weakly microreticulate, with scattered large and small punctures, separated by 2–6 diameters.

Abdomen (Fig. 40). Ventrites dull, densely microreticulate, obscuring puncturation, each with single transverse row of erect pale setae; pygidium convex, densely and evenly microreticulate except shiny raised margins, punctures distinct or obscured by microreticulation, sparse, separated by >5 diameters, setae semi-recumbent, long and thin, length >10× width.



Figures 35–36. *Onthophagus bulga* sp. nov., wing and metaventrite.



Figures 37–41. *Onthophagus* species, pygidium. (37) *O. bulga* sp. nov.; (38) *O. longipes* Paulian; (39) *O. nammuldi* Matthews; (40) *O. pexatus* Harold; (41) *O. squalidus* Lea.



Figures 42–48. *Onthophagus* species, aedeagus, lateral. (42) *O. bulga* sp. nov.; (43) *O. longipes* Paulian; (44) *O. nammuldi* Matthews; (45) *O. squalidus* Lea; (46) *O. pexatus*, Dairy Park, NSW; (47) *O. pexatus*, Wombeyan Caves, NSW; (48) *O. pexatus*, Woolomin, NSW.

Aedeagus (Figs 46–50). In lateral view, parameres elongated but strongly deflexed, each with flat oval tip.

Female. Head (Fig. 22). Similar to male except transverse clypeal sutural ridge present, elevated in middle, reaching genal sutures or effaced before them; clypeus and anterior half of genae shiny, frons dull, frons usually slightly more strongly and closely punctured; pronotum often slightly narrower relative to elytra; protibiae short and straight, with large lateral teeth as male.

Notes. Matthews' redescription was based on 375 males and females, including the female lectotype (Cassis & Weir, 1992), noting that the species was widespread from Adelaide (type locality) to Melbourne and from there to the Queensland border. More recent collecting, noted above, extends the distribution well into Queensland, but the tropical

Australian records in the Atlas of Living Australia represent mislabelled or erroneously databased old material. Our material conforms to Matthews' description except that the eyes are slightly more variable in size, the head is covered in setae in freshly emerged specimens, setal punctures on the elytra may have raised shiny rims and the 6th elytral interval often has doubled setae on its basal half.

The parameres of this species show some variation in size and shape of the apices, from large and robust, with broad apical flanges (Figs 46, 49) to small and delicate with weakly developed flanges (Figs 47–48, 50). One specimen of the second type is small (4.8 mm long) and worn and its head is more strongly punctured than any other males, but the feeble head ridges and all other characteristics of *O. pexatus* are present. For now we consider it a minor male. Specimens with the larger paramere apices also show some

variation in their shape, also without obvious relationship to external variation, so our conclusion is that this is simply a variable species.

Many sites recorded here are in open grassland, woodland, or clearings in dry sclerophyll forest, habitat regarded as typical of this species (Matthews, 1972). Some occurrences in closed forest may be due to recent fires at the sites, opening up their canopies (Reid *et al.*, 2022). However, it also occurs in closed forest, for example in a rainforest gully, Nullo Mountain. *Onthophagus pexatus* is also known to be attracted to inflorescences of the lily *Typhonium*, a rainforest plant which is pollinated by Coleoptera and Diptera, by mimicking the scent of dung (Sayers *et al.*, 2020).

Onthophagus squalidus Lea, 1923

Figs 9–10, 23–24, 29, 34, 41, 45

Onthophagus squalidus Lea, 1923: 390; Boucomont & Gillet, 1927: 216; Matthews, 1972: 211; Cassis & Weir, 1992: 151; Monteith & Kenyon, 2011: 57; Reid *et al.*, 2022.

Material examined (9♂, 6♀). **New South Wales:** 2♂/ Boonoo Boonoo NP, 28.7998°S 152.1859°E 983 m Site 114 Colongan Rd, burnt tall dry scler., macropod dung baited pitfall 3–4.iv.2021 Reid & Runagall-McNaull (AMS); 1♂*/ Boorook SF, 09AM 1 km E of main rd 28°49'S 152°11'E 900 m (NPWS Survey) 4.ii–9.iv.1993 M Gray G Cassis (AMS); 2♀/ Boyne SF, jn Windywoppa & Lookout Rds, 35°36'28"S 150°12'28"E, CBCR003-048 17.iii.1999 J Tarnawski & S Lessau (AMS); 1♀/ Carrai SF 38AR Fife Fire Trail, 1.6 km NE Fifies Knob Rd 30°55'S 152°23'E 670 m (NPWS Survey) 4.ii–9.iv.1993 M Gray G Cassis (AMS); 1♂/ Cathedral Rock NP 30.4416°S 152.2790°E 1347 m site 61 c2k from park entrance, burnt dry scler/open heath, macropod dung baited pitfall 22–23.ii.2021 Reid & Runagall-McNaull (AMS); 1♂, 1♀/ Donaldson SF 28.3418°S 152.6693°E 524 m Site 113 Summerland Way nr Rabbit Fence trail, burnt wet scler., macropod dung baited pitfall 2–3.iv.2021 Reid & Runagall-McNaull (AMS); 1♀/ East Kunderang Trail 39AR 2.1 km E of West Kunderang Trail 30°49'S 152°03'E 845 m (NPWS Survey) 4.ii–9.iv.1993 M Gray G Cassis (AMS); 1♂/ Richmond Range SF 47A 04AR Goanna Ck Rd, 28°36'S 152°41'E 545 m (NPWS Survey) 4.ii–9.iv.1993 M Gray G Cassis (AMS); 1♀/ Sydney [sic], Francis Greenway HS, leaf litter, cowpasture 10.v.2001, Vacy (AMS); 1♂*/ Upper Hunter River, mature riparian strip, Denman Vineyard at Denman 32°20'36"S 150°44'18"E Denman S1/2P pit trap 23.xi–9.xii.2004 J Gollan (AMS); 1♂, ditto except Denman S1/1 YP yellow pan trap (AMS); **Victoria:** 1♂*/ 4 miles W Melton 3.ii.1974 PJ Gullan (AMS).

Additional records (not included in Matthews, 1972). **Australian National Territory:** 1/ 6k NE Piccadilly Circus (ANIC); **New South Wales:** 1/ Byrill Ck (QMB); 1/ Calosoma HS (ANIC); 3/ W end Coolah Tops (QMB); 1/ 2.5K W Minyon Falls (QMB); 1/ 4k NE Mt Wog Wog (ANIC); 1/ Styx R SF (ANIC); 1/ Unungar SF (ANIC); **Queensland:** 1/ Belmont Hills (QMB); 8/ Buhot Creek (QMB); 1/ Bulimba Creek (QMB); 1/ Burleigh Headland NP (QMB); 2/ 14k & 21k SSW Canungra (QMB); 1/ Levers Plateau (QMB); 1/ Mt Cotton (QMB); 1/ Mt Gannon (QMB); 9/ Mt Huntley (QMB); 1/ Mt Superbus (QDAF); 8/ Passchendaele SF (QMB); 2/ Sankeys Scrub (QMB); 3/ 6k WNW Stanthorpe (QMB); 1/ Tallebudgera Valley (QMB); 7/ Vickerman Reserve (QMB).

Redescription. Mature specimens dull blackish-grey, head and pronotum shiner than duller and densely microsculptured elytra and pygidium; teneral (or recently emerged specimens) with reddish-brown elytral apices, sides of apical ventrites and legs; antennae reddish-brown, with orange to dark brown clubs. Length, male 4.5–7 mm; female 4.5–6.5 mm.

Male. Head (Fig. 23). Surface smooth, shallowly microreticulate, dull to slightly shiny in basal half and shinier in apical half, with close punctures, separated by about 1× diameters at base becoming smaller and sparser towards apex, minute stubble on base of frons and short semi-erect setae on apex of clypeus. Clypeal apical margin uptilted, arcuately excavate, each side of excavation triangularly produced, side margins slightly rounded; clypeal suture entirely effaced at frontal portion, genal suture present (completely effaced on one specimen) but not raised; frons flat, without elevations, slightly medially depressed; eyes narrow, 5–7 facet rows in width, separated by 15–20 eye widths, canthus narrowly complete; mentum shallowly excavate at apex.

Thorax (Figs 9–10, 29, 34). Pronotum. Broad in large males (as wide as elytra), narrower and flatter in small males. Moderately convex, slightly tumid at middle of anterior slope in larger specimens; surface smooth, midline not obviously elevated or depressed, entirely strongly and closely punctured, punctures not ocellate, slightly elongate at middle, becoming rounder and larger towards sides, intervals shiny and not microreticulate, less than half diameter of punctures, and covered in dense short curved and thickened setae (lengths less than diameter of punctures); anterior angles 80–90°; anterior margined, sides margined and crenulate with curved short setae between crenulations, base with or without



Figures 49, 50. *Onthophagus pexatus* Harold, apices of parameres. (49) Dairy Park, NSW; (50), Woolomin, NSW.

thin raised edge at middle; pronotal hypomeron dull and densely microsculptured, strongly punctured on outer half, punctures separated by 1–2 diameters, with elevated rims, increasing in diameter towards sides, outermost punctures with long semi-erect setae. Elytra. Semi-ovate in dorsal view, with prominent humeri and preapical swelling, longer than pronotum along midline. Surface including striae densely microreticulate and duller than pronotum, except numerous shiny tubercles on intervals and shiny apical half of sutural margins; all intervals flat except for distinct shiny tubercles, apex of 5th interval with irregular shiny area formed by coalesced tubercles, similar but much smaller patches may be present at apices of 3rd and 4th intervals; tubercles in 2–3 irregular rows in intervals 2–7, denser on outermost interval; each tubercle with minute short curved scale-like seta, not in distinct rows, outermost interval more densely setose; striae punctures weak, slightly broader and deeper than striae; epipleura with single row of curved setae. Metaventrite medially shiny, anteriorly and laterally (lateral to mesocoxae) dull and microreticulate, with scattered semi-recumbent setae on anterior half, anterior smoothly convex, midline grooved; wing fully developed, folded twice in repose. Legs. Protibiae elongated and narrowed, inner apical angle with compact dense tuft of yellow setae about twice length of apical spur; distal face of apical tooth with loose sparse tuft of yellow setae about as long as apical spur, 4th (smallest) lateral tooth at about midpoint; metafemoral ventral surface smooth and mostly shiny, distinctly microreticulate on apical third, almost evenly punctured with moderately large punctures separated by 1–3 diameters.

Abdomen (Fig. 41). Ventrites dull, densely microreticulate, obscuring puncturation, each with single transverse row of short semi-recumbent pale setae, set on shiny tubercles on ventrites 5–6; pygidium flat or almost so, densely and evenly microreticulate except shallowly microreticulate and shinier raised margins; punctures distinct or obscured by microsculpture, sparse, separated by 1–3 diameters; setae short and thick, length 5–8× width.

Aedeagus (Fig. 45). In lateral view, parameres “crested”, with an angular apico-dorsal elevation and prominent but short apico-ventral “beak”.

Female. Head (Fig. 24). Sides more rounded, surface rougher than male, mostly shiny, smooth at base becoming transversely rugose on clypeus, with dense large punctures throughout; median depression of vertex not deeper than male; clypeal suture slightly elevated in frontal portion, effaced before reaching genal sutures, straight, genal sutures often slightly raised; pronotum slightly narrower than elytra; protibiae short and straight, with broad lateral teeth.

Minor male (one specimen). As major male but genal sutures slightly elevated and protibiae short, without setal tufts.

Notes. Matthews’ redescription was based on 172 males and females, including 141 from a single locality (Canberra), and the female holotype from south Queensland. He recorded it along the coast and Dividing Range from Victoria to south Queensland. The material examined here fits within this range and conforms to Matthews’ description, except that he

noted a slightly different size range (5–8 mm long), the eyes are slightly more variable in size and the striae are distinctly but feebly punctured.

Onthophagus squalidus appears to be tolerant of a wider range of habitats (Reid *et al.*, 2022) than indicated by Matthews, who regarded it as a woodland species. The sites recorded here vary from closed forest to open grassland. The species appears to be rare where it occurs in New South Wales, most records being singletons.

Discussion

Australia has a large number of flightless scarabaeine species, most of which are confined to closed wet forest (Monteith & Kenyon, 2011). The restriction of a flightless scarabaeine species to what is particularly undistinguished eucalypt forest, much of which was extensively burnt in the 2019–2020 wildfires, is remarkable. Even more unusual is that it is a species of *Onthophagus*, a huge genus in which brachyptery is rare.

There are 11 flightless species of *Onthophagus* worldwide, mostly Central American, with just two in Australia, *O. bulga* and *O. apterus* Matthews, 1972 (Kohlmann *et al.*, 2019). *Onthophagus apterus* is a large species (18 mm long) in the *declivis* species-group. At time of its description nothing was known of the biology but it is now known to occur in scattered vine thicket (dry rainforest) sites in the otherwise semi-arid Brigalow Belt of the western dividing range of Queensland (Monteith, 1999). The habitat of this flightless species is therefore distinctly refugial within the landscape, although the “refuges” may be due to concentrations of sheltering nocturnal mammals in densely vegetated patches rather than due to edaphic factors operating on the beetles (Monteith, 1999). The Central American brachypterous *Onthophagus* species are in montane rainforests, also refugial, described as “stable environments associated with deeply incised valleys” (Kohlmann *et al.*, 2019: 23). In contrast, there is nothing obviously different or refugial about the habitats where *O. bulga* has been collected. All of the sites in our recent survey had been burnt in the extensive fires of 2019–2020 (Figs 51–53), and all of the known sites for this species are of mid to moderately high elevation, on ridges or the slopes of higher massifs. The distribution of *O. bulga* remains unexplained.

The habitat of the *pexatus*-group species is an interesting issue. Matthews (1972) hypothesized a succession of the species with increasing canopy closure, from *O. pexatus* in open areas, *O. nammuldi* and *O. squalidus* in woodlands, to *O. longipes* in closed forests. This is undermined by the greater ranges of habitat recorded here for all except *O. nammuldi*, which does genuinely seem to be restricted to a certain forest type or at least to the restricted combination of calcareous sand and closed canopy. Two or three species of the group may occur together. More significantly, as noted in the introduction, this species-group is unlikely to be monophyletic and therefore the idea of species and habitat successions can only realistically be discussed once a comprehensive phylogeny of Australian *Onthophagus* is available.



Figures 51–53. *Onthophagus bulga* sp. nov. collecting localities in February 2021: (51) junction Plan Trail and Doyles River Road, Biriwal Bulga NP (Site 30); (52) Tirrill Flora Reserve, above Tirrill Creek Crossing, on Blue Mountain Creek Road, Bulga State Forest (Site 31); (53) Bray Property, Gillogly's Road, at edge of Biriwal Bulga NP (Site 35). Photos by Chris Reid.

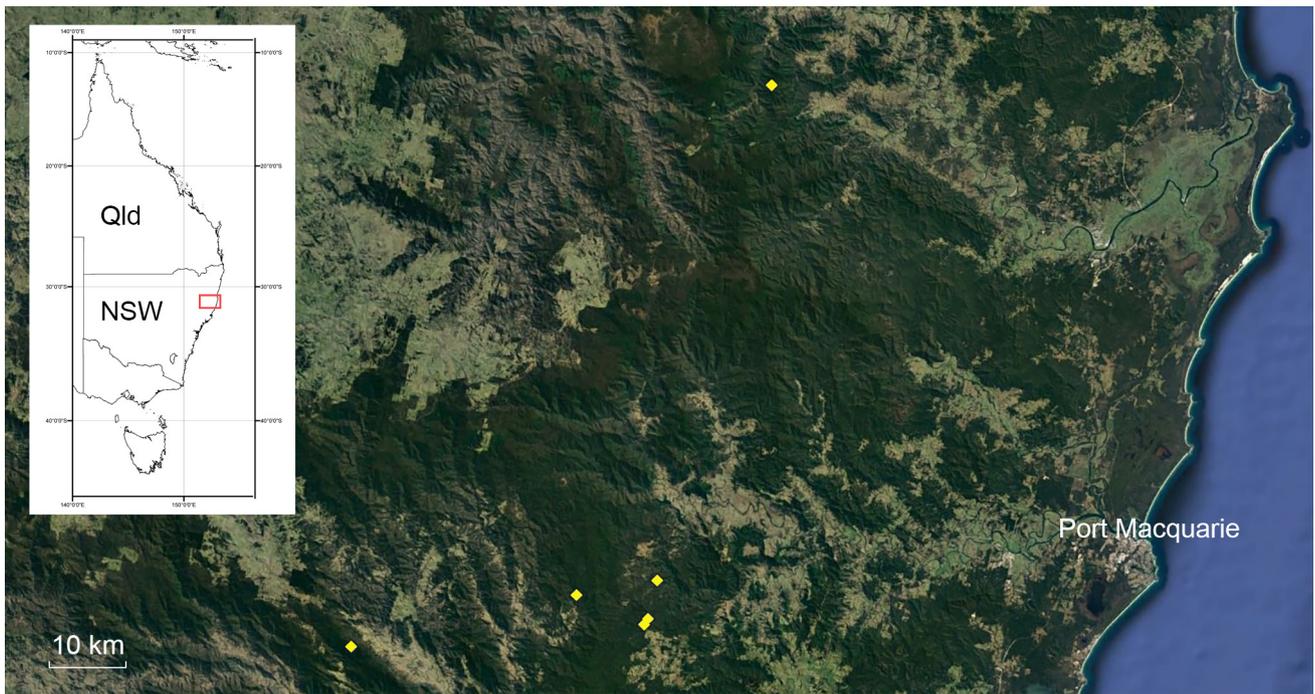


Figure 54. Distribution of *Onthophagus bulga* sp. nov. in central eastern New South Wales.

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