A taxonomic study of *Phalacrus uniformis* (Coleoptera: Phalacridae), an Australian beetle now established in New Zealand

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The beetle family Phalacridae is recorded from New Zealand for the first time. Adult and larval stages of *Phalacrus uniformis uniformis* (Blackburn) n.comb. and *P. u. frigoricola* n.subsp. are described. Information on biology and distribution is given. The occurrence of *Phalacrus corruscus* (Panzer) (Europe) in Australia is questioned.

Keywords: Coleoptera; Phalacridae; *Phalacrus uniformis*; taxonomy; biology; distribution; *P. corruscus.*

INTRODUCTION

No Phalacridae have been described from New Zealand, and it is likely that the family is not endemic there (Lea 1932, p. 433). The establishment of an Australian species, *Phalacrus uniformis* (Blackburn) n.comb., in New Zealand is therefore of interest. Also, whereas other *Phalacrus* spp. develop in smutted grains of grasses and sedges (Friederichs 1908, d'Aguilar 1944), *P. uniformis* lives in galls on *Acacia* spp. produced by a rust (*Uromycladium*).

About 10 *Acacia* spp. introduced from Australia are naturalised in New Zealand. By far the commonest is the black or green wattle, *A. mearnsii* De Wildemann (formerly considered in New Zealand to be *A. decurrens* (Wendland) Wildenow). It is heavily infested with galls of *Uromycladium notabile* (Ludwig) McAlpine and *U. acaciae* (Cooke) Sydow, which are persistent and probably contain perennial mycelium, since their surfaces become covered season after season with ochraceous or cinnamon spore masses (Cunningham 1931, p. 205). These galls develop as solid knobs, but various insect larvae ultimately invade them (McAlpine 1906, p. 6). They greatly weaken the trees and considerably shorten their life span (G. Kuschel, pers. comm.).

The species of *Uromycladium* and *Acacia* with which *P. uniformis* is associated in Australia are not recorded, but in New Zealand it has been found in galls on *A. mearnsii* produced by both *U. notabile* and *U. acaciae*. Adults are present on the host all year round. They are very active from August to about March, but are dormant from April to late July, hiding mainly inside old galls. The larvae apparently live concealed in grooves between the

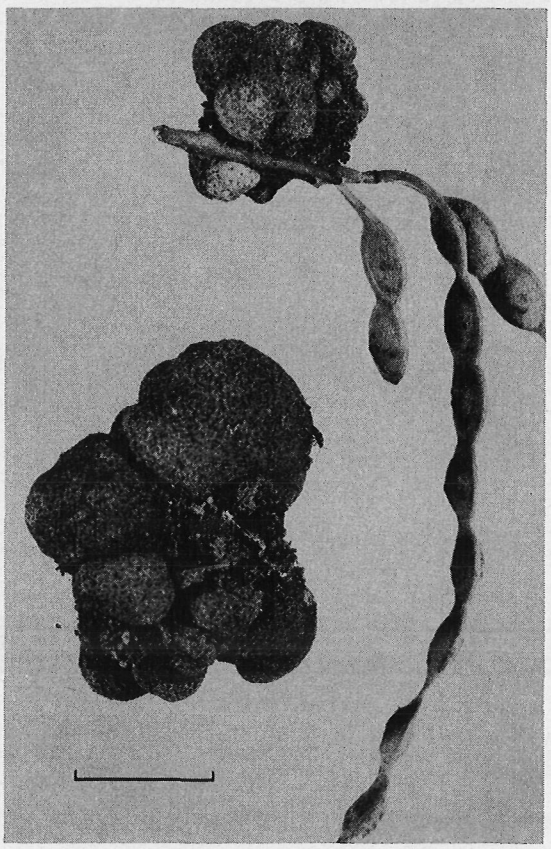

Fig. 1. Galls of *Uromycladium notabile* on *Acacia mearnsii*, Lynfield, Auckland, Dec. 1978. The insect on the larger gall is a bug, not a *Phalacrus* beetle. Scale line = 2 cm. (Entomology Division, DSIR.)

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lobes of the galls (Fig. 1), and have never been seen on the surface, where most spores are produced (G. Kuschel, pers. comm.). Nevertheless, teleutospores of the rust have been found in the gut of both larvae and adults.

Repositories of specimens are abbreviated as follows: ANIC – Australian National Insect Collection, CSIRO Division of Entomology, Canberra; BMNH – British Museum (Natural History), London; BPBM – Bernice P. Bishop Museum, Honolulu; NMVA – National Museum of Victoria, Melbourne; NZAC – New Zealand Arthropod Collection, Entomology Division, DSIR, Auckland; SAMA – South Australian Museum, Adelaide.

TAXONOMY: ADULT

Genus *Phalacrus* Paykull

Paykull, 1800, Fauna Suecica 3: 438.

Phalacrus, with some 90 described species, occurs widely in both the Old and New World. In Australia several species have been detected (R. T. Thompson, unpubl. data), but only two, in addition to *P. uniformis,* have so far been described (*burrundiensis* Blackburn and *insignis* Lea). Most species are unicolorous black (sometimes with brown legs), but a few, including *P. uniformis,* are entirely brown.

Phalacrus uniformis (Blackburn) n.comb. (Fig. 2–19)

Blackburn, 1891: 98 (*Litochrus*?).

Length 1.70–2.66 mm. Dorsum unicolorous red-brown to very dark chestnut brown; underside and legs yellow-brown to red-brown (antennae darker); metanotum and abdominal tergites dark to blackish brown.

Head smooth and evenly convex above, finely and rather densely punctured, the punctures of various sizes and all very ill defined; 3 or 4 (sometimes 5) much larger punctures spaced out around mesal margin of eye, and another near edge of clypeus, above antennal insertion; middle third of clypeal margin truncate or very feebly emarginate; underside smooth, impunctate (except near eye). Mandibles small (for a *Phalacrus*), equal in size but dissimilar: molar surface of left mandible merely rough, but that of right mandible a coarse rasp (Fig. 9, 10); other mouthparts as in Fig. 11–13. Antennae as in Fig. 4, 5.

Prothorax twice as wide as head (including eyes); surface of pronotum smooth, less strongly and less densely punctured than head and with a few (about 10) irregularly scattered larger punctures; anterior margin finely bordered throughout, posterior margin without any distinct borderline. Scutellum 0.20–0.24 × as wide as prothorax, smooth and very finely punctured on disc.

Elytra very finely and very weakly microreticulate throughout; each stria marked by a fairly regular row of punctures, each interstria with a similar but sometimes less regular row (Fig. 7); punctures mostly broadly open posteriorly, leaving a crescent-shaped depression with a small, appressed seta inserted in the middle of its wall (ε – punctures of Flach (1888, p. 4)) (Fig. 8); punctures near costal margin larger, denser, confused; basal borderline produced around scutellum to join sutural borderline; sutural stria incomplete anteriorly, but extending posteriorly almost to apex.

Legs similar to those of *P. corruscus* (Panzer), but femora more finely and densely setose, claws relatively larger, and segment 3 of all tarsi in both sexes no larger than in *P. corruscus* ♀ and much

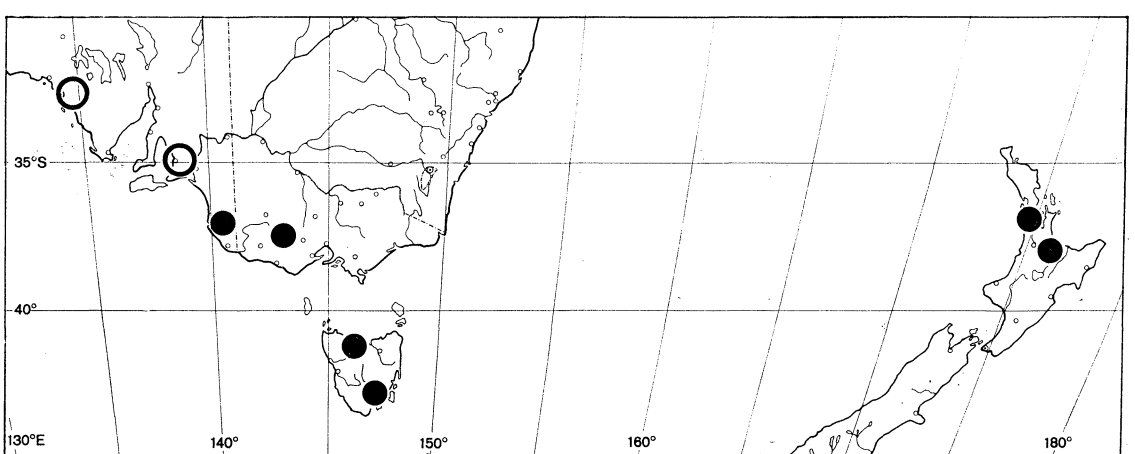
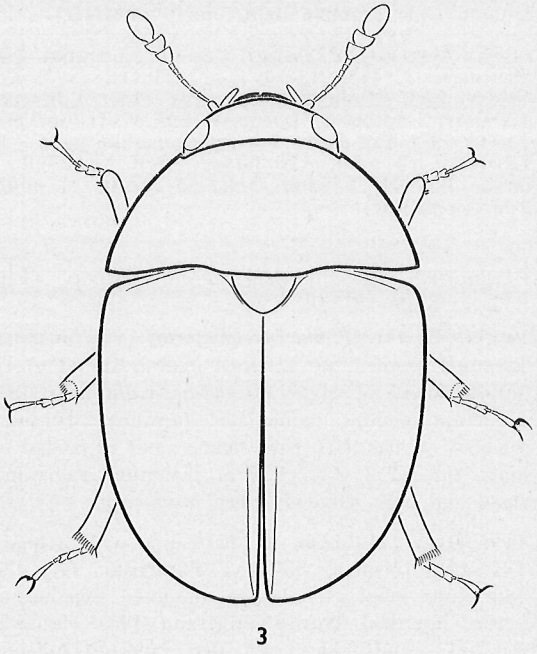


Fig. 2. Specimen localities of *Phalacrus u. uniformis* (○) and *P. u. frigoricola* (●).



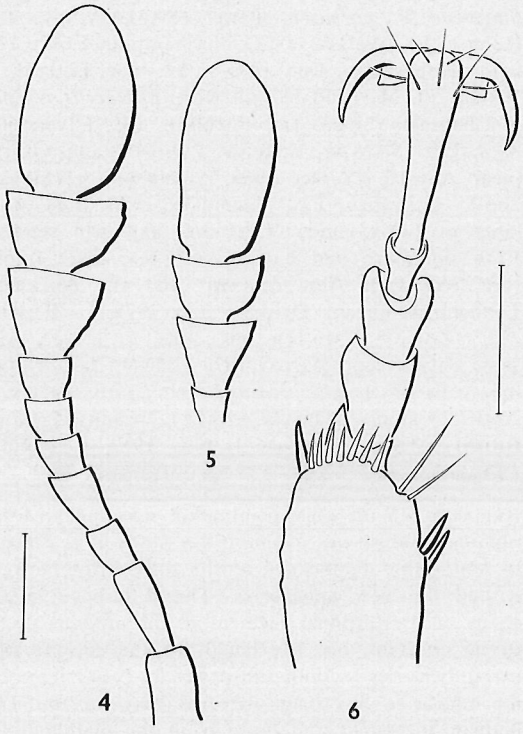
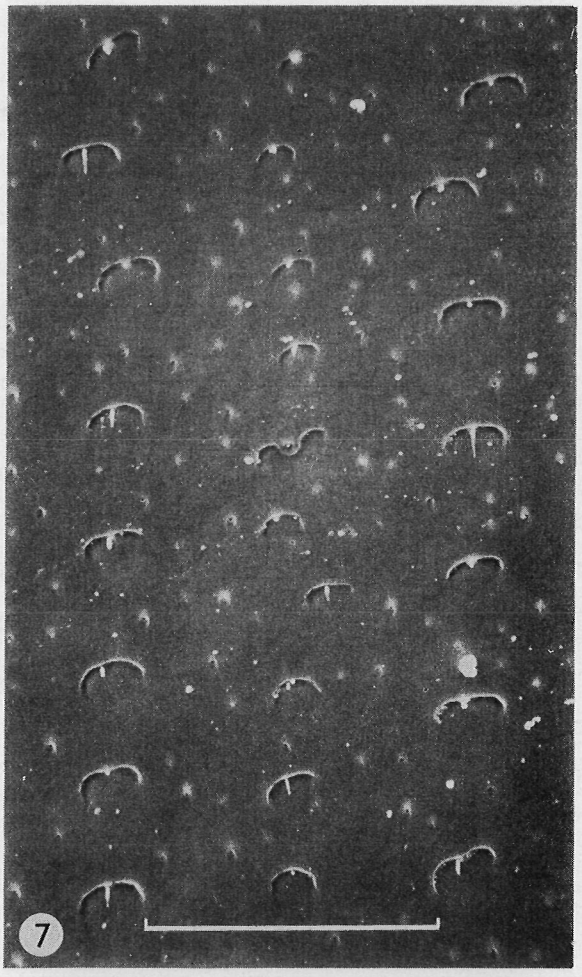


Fig. 3–6. Adult features of (3, 4, 6) *Phalacrus uniformis frigoricola* and (5) *P. u. uniformis*: 3, habitus; 4, left antenna; 5, club of antenna; 6, apex of right foreleg. Clothing setae omitted. Scale lines = 0.1 mm.



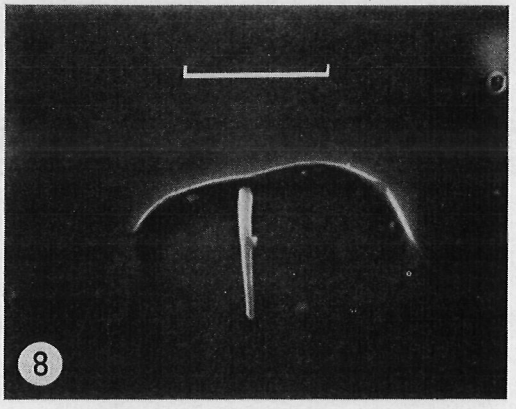


Fig. 7, 8. *Phalacrus u. uniformis*: 7, part of disc of right elytron, showing portions of 2 striae and 1 interstria; 8, one strial puncture. Scale lines = 0.1 mm (7) and 0.01 mm (8).

less strongly bilobed (Fig. 6).

Underside as in *P. corruscus*, but intercoxal process of metasternum more strongly rounded at apex (outline forming a semicircle) and finely pubescent (subtruncate and bare in *P. corruscus*); ventrite 5 (sternite 7) of ♂ with a minute apical notch (clearly visible only when ventrite has been detached).

Genitalia. Median lobe of aedeagus as in Fig. 16, 17; tegmen (Fig. 14, 15) with ridges at sides of apical part which terminate abruptly at two-thirds of the latter's length from apex; sides of apical part also with 1 or 2 pairs of very small setae. Ovipositor compressed; apex of each coxite deeply bifid and curving ventrolaterad (Fig. 18); styli also directed ventrolaterad (Fig. 19).

REMARKS. *P. uniformis* is the first known *Phalacrus* to be found in Australia. It is the only known species which has setae on the tegmen. The apex of the ovipositor differs markedly from that of European species (see Discussion). Whereas many *Phalacrus* spp. show secondary sexual characters, *P. uniformis* has virtually none.

In Australia, *P. uniformis* occurs in Tasmania and in parts of Victoria and South Australia (Fig. 2). Within this range, two allopatric forms can be distinguished. One occurs in South Australia near Adelaide and near Poochera (east of Ceduna), both localities being above the 15°C annual isotherm (Anon. 1974, pl. 10). The other form occurs at Lucindale, South Australia, near Ararat, Victoria, and in Tasmania; all these localities are below the 15°C isotherm. The specimens from New Zealand also belong to this 'cooler' form. The two forms are here described as subspecies.

Phalacrus uniformis uniformis (Blackburn) (Fig. 2, 5, 7, 8, 13–17)

Blackburn, 1891: 98 (*Litochrus*?); 1895: 211, 214 (*Parasemus*). –Champion, 1925: 605 (note) (as *Phalacrus unicolor*, in error). –Hetschko, 1930: 16 (*Litochrus*). –Lea, 1932: 433, 435 (*Parasemus*).

Terminal segment of antennal club slender, sides ± straight in basal two-thirds (Fig. 5). Sutural striae of elytra extending beyond middle to about two-thirds from apex. Terminal segment of maxillary palp somewhat expanded on inner side (Fig. 13). Elytral punctures always large and widely open posteriorly (Fig. 7, 8).

TYPE DATA. **Holotype** ♂: South Australia ['near Adelaide'], with 'T 1343' in red ink on card; BMNH holotype disc; 'Australia/ Blackburn Coll./ B.M. 1910–236.' (printed, with red ink line); '*Parasemus*/ *uniformis*, Blackb.' (Blackburn's hand); 'belongs to *Phalacrus* GCC[hampion]' (Champion's hand). Unique ('the example before me') (BMNH).

OTHER MATERIAL EXAMINED. South Australia: 2♀, Poochera, 32°44'S, 134°49'E, 22–23 Oct 1977, Lot 77–15, [ex] *Uromycladium* galls, J.F. Lawrence (ANIC); 5 adults, 33 larvae, 38 km W of Poochera, 23 Oct 1977, Lot 77–15, ex *Uromycladium* galls, J.F. Lawrence (2 adults, 20 larvae ANIC; 1 adult, 7 larvae BMNH; 1 adult, 2 larvae NZAC; 1 adult, 2 larvae BPBM).

Phalacrus uniformis frigoricola n.subsp. (Fig. 2–4, 6, 9–12, 18, 19)

Lea, 1932: 441 (*Phalacrus fimetarius* (F.), in part).

Terminal segment of antennal club ovate (Fig. 4). Sutural striae of elytra extending from near apex to about middle (sometimes beyond). Terminal segment of maxillary palp slender, not expanded on inner side (Fig. 12). Elytral punctures sometimes small and only narrowly open posteriorly.

TYPE DATA. **Holotype** ♂: Tasmania, with 'Hobart/ Tas: Lea' (printed) (SAMA). **Paratypes**: 1♂, 1♀, with same label as holotype, mounted together on a card inscribed 'Wattle Galls' and '1923' (latter in red ink) and with Lea's det. label: '*Phalacrus fimetarius* F., *corruscus* Panz.' (SAMA); 1♂, 2♀, Hobart, J.J. Walker, ex G.C. Champion Coll.; 1♀, with 'Hobart [13 Dec 1890 – 13 Mar 1891, J. J. Walker, B. M. 18]91-88', all with '*Phalacrus* n. sp.?' in Champion's hand (all BMNH); 2♀, Ulverstone, A.M. Lea (SAMA). Victoria: 1♀, Mt Langi Ghiran [near Ararat], 17 Dec 1966, A. Neboiss (NMVA). South Australia: 1♂, Lucindale, A.M. Lea, with label in Lea's hand: 'Legs and antennae reddish. Prob. immature' and a det. label: '*fimetarius*. Immature' (SAMA). New Zealand: 102 ex., Auckland, Lynfield, Tropicana Drive, 6 Aug 1978, G. Kuschel (97 NZAC, 5 BMNH); 96 adults, 51 larvae, with same data except 26 Nov 1978 and 'On *Uromycladium* galls of *Acacia mearnsii*' (60 adults, 10 larvae ANIC; 3 adults, 5 larvae SAMA; 3 adults, 5 larvae BPBM); 2 ex., Rotorua, 21 Nov 1973, R. Zondag (SAMA).

REMARKS. With only eight adult specimens of the nominate subspecies available for study it is difficult to assess the significance of the differences between it and the new subspecies. The difference in the shape of the terminal segment of the antenna seems to be constant, but the length of the sutural stria certainly varies in both subspecies. In *P. u. frigoricola* no difference has been detected between the Tasmanian specimens and those from the mainland.

TAXONOMY: LARVA

Descriptions of larval Phalacridae are available only for the genera *Phalacrus* and *Olibrus*;

a key to distinguish these genera was given by Klausnitzer (1978). F. I. van Emden (1928) described the larva of *P. grossus* Erichson, and compared it with that of *P. corruscus* (Panzer) (given as *fimetarius* (F.)), which had previously been described by Friederichs (1908). Subsequently, d'Aguilar (1944) described the larva of *P. caricis* Sturm, and figures of *P. politus* Melsheimer and '*Phalacrus* sp.' appeared in Böving & Craighead (1931). The larva of *P. uniformis* is thus the first phalacrid larva to be described from the Southern Hemisphere.

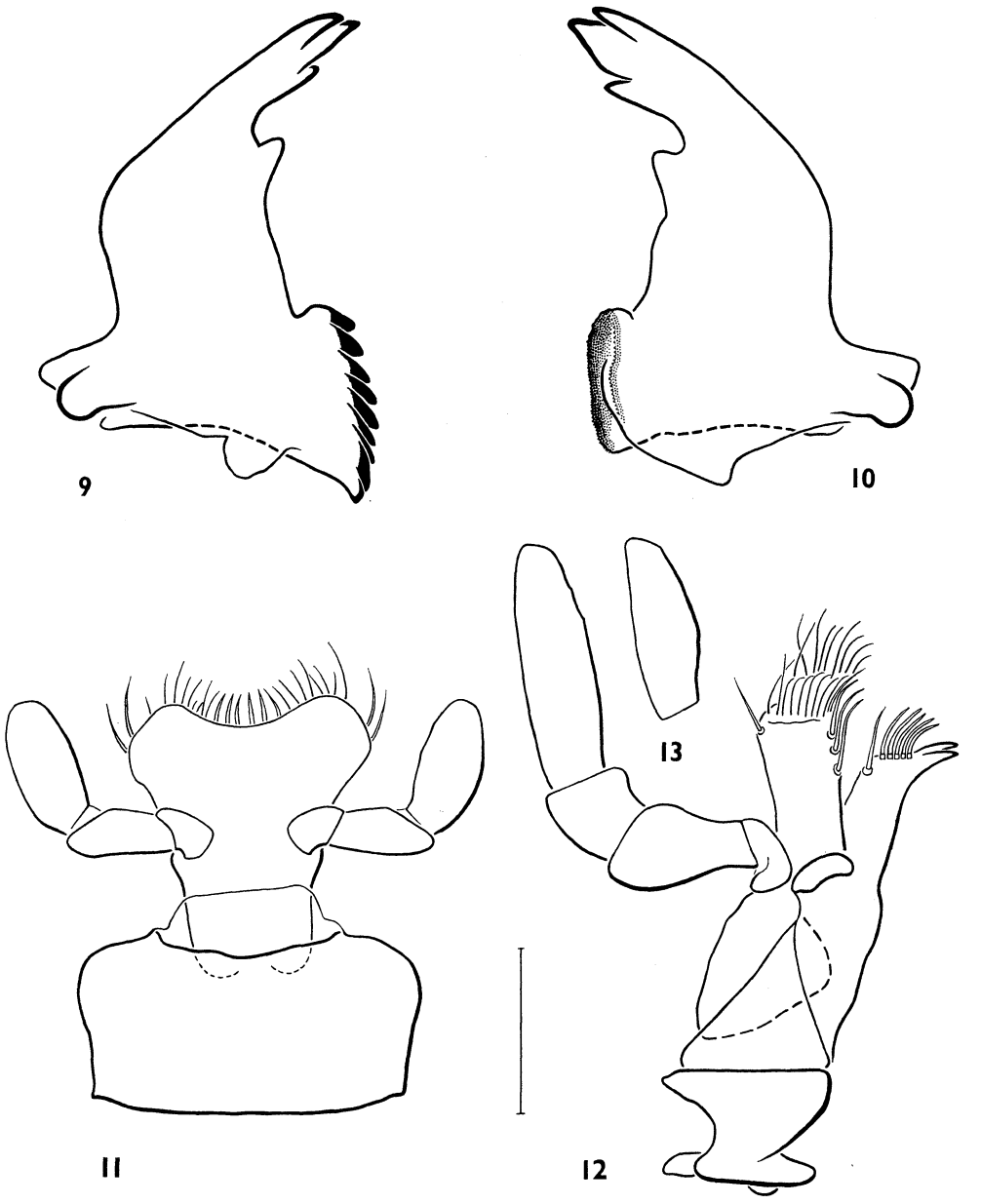


Fig. 9–13. Adult mouthparts (ventral view) of (9–12) *Phalacrus uniformis frigoricola* and (13) *P. u. uniformis*: 9, 10, right and left mandibles; 11, labium; 12, right maxilla; 13, apical segment of maxillary palp. Clothing setae omitted. Scale line = 0.1 mm.

Phalacrus uniformis (Blackburn) (Fig. 20–30)

LARVA (final instar). Length 3.5–4.5 mm (mean 3.95 mm). Form elongate, subcylindrical; body wider than head, tapering slightly posteriorly and terminating in a pair of short urogomphi; sclerotisation weak apart from head, prothoracic tergites, legs, 8th abdominal tergite and sternite, and urogomphi; sclerites ill defined; setae sparse but distinct over entire body; general body colour off-white, with sclerotised regions pale ochreous; spiracles biforous.

Head prognathous, elongate, somewhat depressed, tapering slightly anteriorly in both dorsal and lateral view (Fig. 20, 24); median epicranial suture absent; frontal sutures Ω-shaped, only weakly developed; endocarina absent; clypeus indistinct; ocelli 5 (but 1 or 2 often unpigmented), arranged in an arc just behind and dorsolaterad of antennal base (Fig. 20). Antennae well developed, 3-segmented (Fig. 26); basal segment strongly transverse, with a small, ventrally directed sensory cone on its upper membrane. Labrum somewhat elongate and rounded anteriorly, with setae as shown in Fig. 25. Mandibles (Fig. 29, 30) symmetrical, concave ventrally; apex tapering, tridentate; dorsal molar region well developed, with 1–4 distinct teeth; dorsal external surface with 2 prominent setae. Maxillary palpi 3-segmented; segment 3 elongate, with apical sensilla; galea and lacinia fused to form an obtuse mala bearing both simple and clavate setae (Fig. 28); stipes poorly defined; cardo indistinct or absent; maxillary articulating area reduced. Labium (Fig. 27) with ligula represented by a slight, rounded median swelling bearing 2 setae; labial palpi 2-segmented, short, stout; submentum membranous, with a pair of basal setae. Hypostomal rods dark, diverging posteriorly.

Thorax with segments distinct; paired prothoracic tergites weakly sclerotised, with poorly defined lateral margins, setae as in Fig. 20, 24; meso- and metathorax unsclerotised, setae as in Fig. 20. Legs short, 5-segmented: coxa short, weakly sclerotised; trochanter triangular; femur elongate, trapezoidal; tibia elongate, slightly tapering distally, slightly longer than femur; tarsal claw elongate, pointed, approximately half as long as tibia, with a short unmodified seta halfway along its ventral surface.

Abdomen with 9 distinct segments; segments 1–7 with dorsal setae arranged in 2 irregular, transverse rows on each segment (Fig. 21); ventral setae in 4 groups arranged in a transverse row on each segment, each group arising from a slight protuberance; segment 8 with a well defined trapezoidal tergite, with a spiracle in each posterior corner (Fig. 21, 23) and a brush of elongate setae on either side; ventrally, a sternite may or may not be evident; segment 9 with a pair of short, stout, upwardly

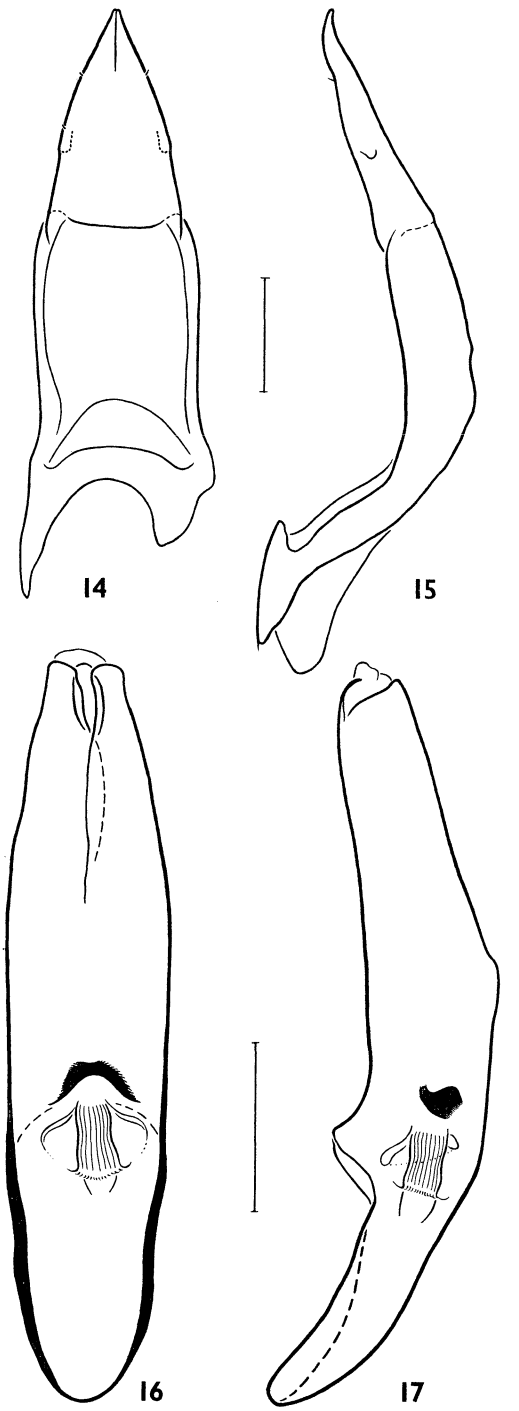


Fig. 14–17. *Phalacrus u. uniformis*, ♂ genitalia: 14, 15, tegmen, ventral and right lateral view; 16, 17, median lobe, dorsal and right lateral view. Scale lines = 0.1 mm.

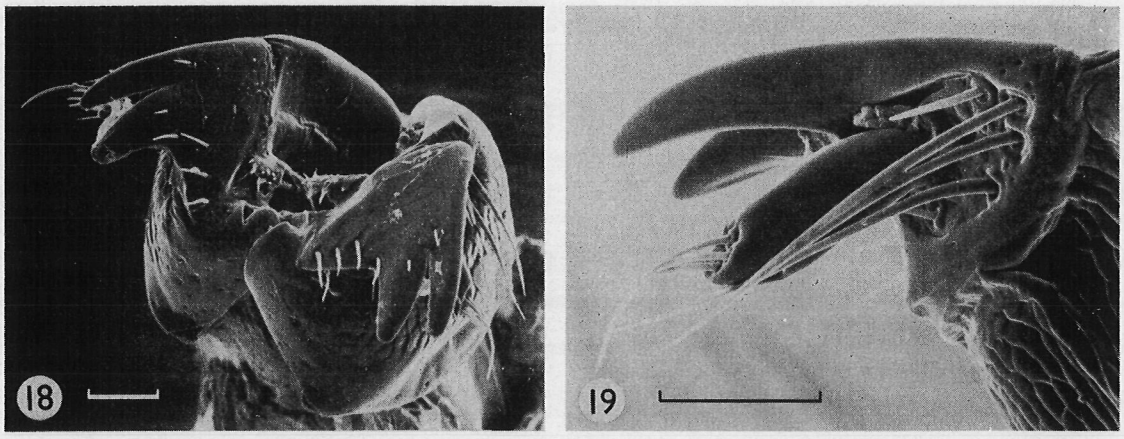


Fig. 18, 19. *Phalacrus uniformis frigoricola,* ♀ genitalia: 18, ovipositor, posterolateral view (coxites reflexed, concealing styli); 19, right coxite, dorsolateral view, showing stylus and associated setae. Scale lines = 0.03 mm.

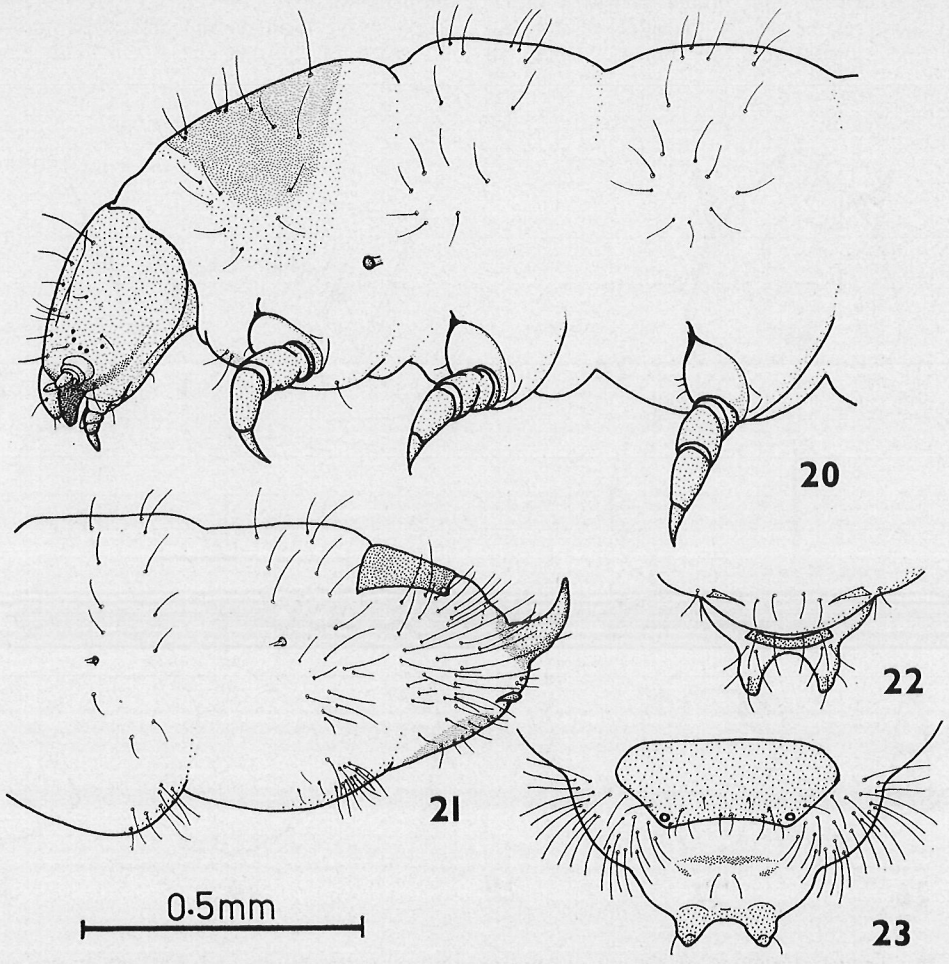


Fig. 20–23. *Phalacrus uniformis frigoricola,* larva: 20, head and thorax, lateral view; 21–23, terminal abdominal segments in lateral, dorsal, and ventral view.

recurved urogomphi (Fig. 21–23) and a narrow, transverse anal sclerite (Fig. 22).

REMARKS. The larval material consists of a series of 33 larvae of *P. u. unifomis* from Poochera, South Australia, and a series of 51 larvae of *P. u. frigoricola* from Auckland, New Zealand. This material shows that the two subspecies differ in two characters. In subsp. *frigoricola* three distinct teeth are consistently present on the mandibular mola, and in some specimens a small additional basal tooth is present (Fig. 29). In subsp. *uniformis*, however, only the upper tooth is distinct (Fig. 30), and since this difference is constant in all the specimens examined the reduced number of teeth is unlikely to have been caused by mechanical wear. Also, even correcting for overall size, the width between the urogomphi is slightly greater in subsp. *frigoricola*. In addition, the sternite of abdominal segment 8 is evident only in the Poochera series; this may, however, be due to the effect of different fixation and preservation techniques, since all sclerotised regions are more clearly defined in this series than in the Auckland specimens. Before any firm conclusions can be reached regarding the taxonomic significance of these differences material from other localities will have to be examined.

In general appearance, the basic form of the mouthparts, antennae, ocelli, legs, and tergites, and the form of the urogomphi, the larva of *P. uniformis* accords well with the described Palearctic and Nearctic species of *Phalacrus*. There is, however, a striking difference in the overall shape of the head, which is elongate and depressed in *P. uniformis*; in the other described *Phalacrus* species (and in *Olibrus*) the head is distinctly shorter and deeper, with well rounded sides. Also notable is the absence of an endocarina in *P. uniformis*, which may be correlated with this difference in head shape. The following minor differences between *P. uniformis* and the three other described species have also been noted:

(i) fewer teeth on the mandibular mola than in *P. caricis* (*P. grossus* and *P. corruscus* have minute

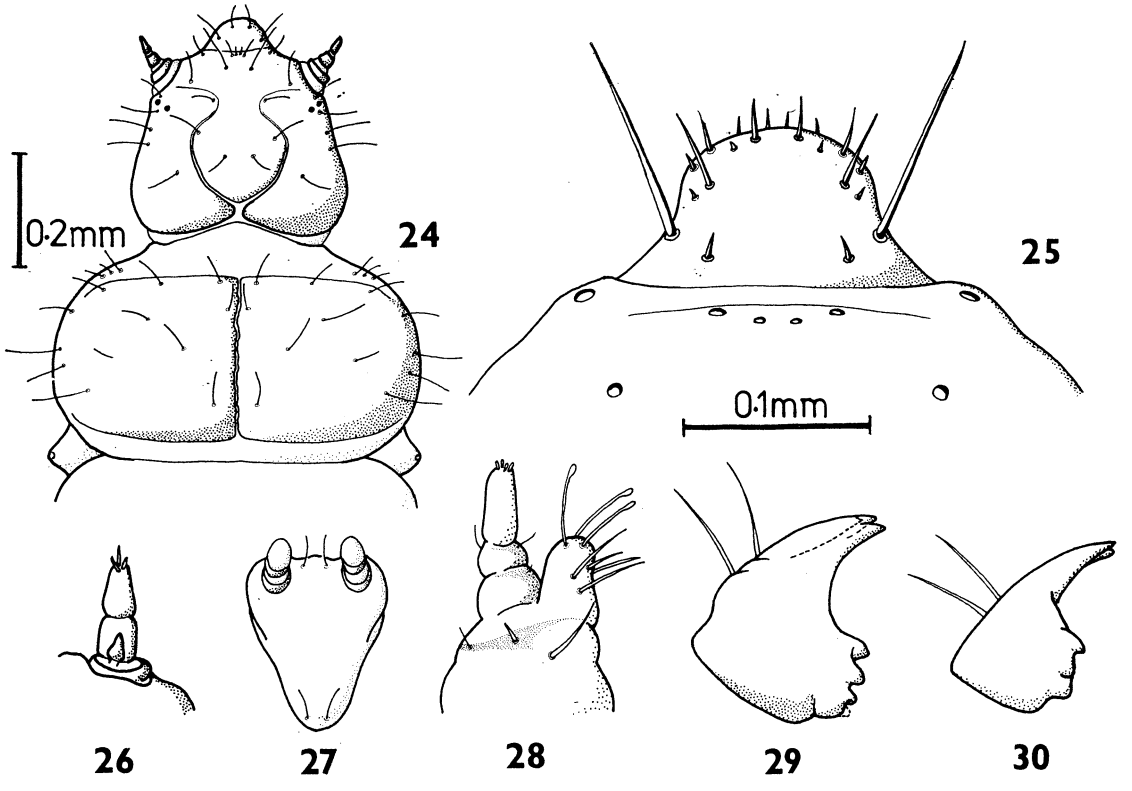


Fig. 24–30. Larval structures of (24–29) *Phalacrus uniformis frigoricola* and (30) *P. u. uniformis*: 24, head and prothorax, dorsal view; 25, labrum, dorsal view; 26, antenna, ventral view; 27, labium, ventral view; 28, maxilla, ventral view; 29, 30, left mandible, dorsal view.

denticles only);

(ii) fewer anterior setae on labrum;

(iii) urogomphi shorter than in *P. corruscus* and closer together than in *P. grossus* (but similar to those of *P. caricis*);

(iv) longer setae on 8th abdominal segment;

(v) evidence of an 8th abdominal sternite (in some specimens only—see above).

The presence of an endocarina, used by van Emden (1942, p. 254) to distinguish Phalacridae from Cucujidae (and mentioned by Klausnitzer (1978) in his family description), can no longer be used as a diagnostic family character. Phalacrid larvae may now be distinguished by the following combination of characters: ocelli five; mala obtuse; cardo indistinct; maxillary articulating area reduced; labial palpi two-segmented; hypostomal rods divergent posteriorly; tergites present only on prothorax and eighth abdominal segment.

DISCUSSION

This account of *P. uniformis* confirms Champion's assignment of this species to *Phalacrus*. Also, although Lea placed *P. uniformis* in *Parasemus* in his catalogue of Australian Phalacridae (1932, p. 435), he nevertheless determined specimens in his possession as *Phalacrus corruscus* (Panzer), attributing their brown colour to immaturity. Blackburn's original description (1891, p. 98) is based on a single imperfect specimen. He refers the species, and another described with it (*alpicola*, now in *Parasemus*), to "*Litochrus*(?)" because both lack the prominent tibial spines which are characteristic of that genus. He then adds that they agree with *Litochrus* in having the hind tarsi "evidently longer than the intermediate". While this is true of *alpicola* it certainly does not apply to *P. uniformis*, and this mistaken observation may account for Blackburn's failure to recognise this small, brown species as a *Phalacrus*. In spite of its atypical appearance, the tegmen of the male closely resembles that of European species (cf. Thompson 1958, fig. 18–22), whereas the ovipositor is of the *Phalacrus* type (cf. Thompson 1958, fig. 13–17). The larva also conforms in most respects to the other known *Phalacrus* larvae.

Some of the differences observed between the present species and its European relatives may be related to their respective habitats. In particular, the structure of the ovipositor apex may reflect the very different substrates on which the eggs are laid. In the smut-inhabiting European species the entire ovipositor is strongly flattened, and the eggs are inserted into the narrow crevices between the scales of the grass floret or between the scale and the grain (Friederichs 1908, pp. 40–41). In *P. uniformis*, however, the ovipositor is stout and has strong apical teeth (Fig. 18, 19). The eggs are laid on a woody gall, the surface of which is strongly folded and bears fissures of various sizes, often filled with frass and plant debris. Although nothing is known of the oviposition habits of this species, its ovipositor would clearly be able to force its way into a mass of loose particles in order to deposit the eggs in a secure and sheltered situation. Similarly, the narrower head of the larva would enable it to move more freely in the fissures of a woody gall.

The two forms of *P. uniformis* are unusual in that, in spite of the morphological differences (in both adult and larval stages) noted above, the adults appear to have identical genitalia. This is the reverse of the situation normally found in Phalacridae (and many other Coleoptera), species of which can scarcely be distinguished externally yet often have quite different genitalia (cf. *Phalacrus grossus* Erichson and *P. dieckmanni* Vogt (Vogt 1967, p. 161)). In view of this, we follow the advice of Mayr (1969, p. 197) and regard them provisionally as subspecies.

It is unlikely that *P. uniformis* is of economic importance, either in controlling the *Uromycladium* or assisting in its dispersal. Although the larvae must consume large quantities of rust spores, thus probably rendering them non-viable (cf. smut spores eaten by *P. corruscus* (Friederichs 1908, p. 45)), this reduction in the number of spores is probably not significant. Further, the larvae appear not to damage the gall itself. As regards dispersal, the rust appears to have become well established in New Zealand long before the beetle was found there (at least by 1890 (Cunningham 1931, p. 206–7)), so other agents must have been responsible for its initial spread.

AUSTRALIAN RECORDS OF *PHALACRUS CORRUSCUS*

During this study a number of Australian *Phalacrus* specimens determined as the European species *P. corruscus* have been seen. Since none of these specimens in fact belong to *P. corruscus*, the validity of the other Australian records of this species is called into question.

P. corruscus was first recorded from Australia by Blackburn (1891, p. 100): "A *Phalacrus* occurring commonly in South Australia, and which I have met with in Victoria also, appears to me incapable of separation from this European species". Seven specimens from Adelaide (in SAMA), determined as *P. corruscus* by Blackburn, have been examined. Six belong to a species which resembles *P. corruscus* superficially and is undescribed; the seventh, a smaller specimen, belongs to another undescribed

species. Later, Lea (1932, p. 441) gave records of *P. corruscus* (as *fimetarius* (F.)) from all the states of Australia. The specimens on which a number of these records are based have been examined, and all were found to belong to other species, thus: Hobart and Ulverstone, Tasmania, and Lucindale, South Australia (*P. uniformis frigoricola* (see above)); Mt Lofty, South Australia (undescribed species, near *uniformis* but with very different tegmen) (in SAMA); Ringwood, Victoria, and Largs Bay, South Australia (undescribed species) (in NMVA). In addition, there are specimens of undescribed species in BMNH from King George's Sound (Albany), Western Australia, and from Tasmania, wrongly determined as *P. corruscus* by Lea and Champion respectively. (Champion's record of *P. corruscus* from Kumaon, northern India (1924, p. 237) is also incorrect, though the species concerned is very closely related to *corruscus*.)

The only indication that *P. corruscus* may occur in Australia is afforded by an unlabelled specimen found among undetermined material in NMVA. This could, however, have come from an old British or European collection (A. A. Calder, pers. comm.). It seems possible, perhaps even likely, therefore, that *P. corruscus* does not occur outside its natural range in the Palearctic Region.

P. corruscus may be distinguished externally from all Australian *Phalacrus* so far examined by its indistinct elytral puncture-rows and the presence of a fine but distinct borderline at the base of the pronotum, in front of the scutellum.

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