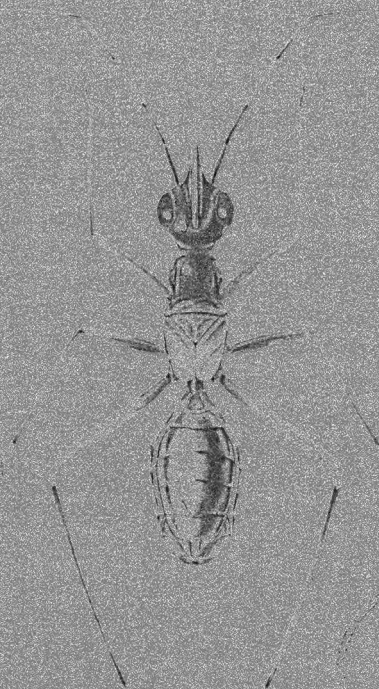


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Cover: This undescribed species of *Mymecoroides* (Heteroptera: Miridae) is about 5 mm in length and occurs along the Great Dividing Range from southeast Queensland to Victoria. It is found on native grasses. The species is sexually dimorphic, with fully-winged males and short-winged females (illustrated here).

All species of *Mymecoroides* are strongly ant-mimetic. This species is being described by Gerry Cassis of the University of New South Wales and Michael Wall of the San Diego Natural History Museum.

Illustration by Hannah Finlay

**THE EARLY STAGES OF *EUPLOEA TULLIOLUS TULLIOLUS*
(FABRICIUS) (LEPIDOPTERA: NYMPHALIDAE: DANAINAE)
FROM BRISBANE, QUEENSLAND**

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Abstract

The early stages of *Euploea tulliolus tulliolus* (Fabricius, 1793) (Lepidoptera: Nymphalidae: Danainae) are fully described and illustrated for the first time from material collected at Taigum, a northern suburb of Brisbane, Queensland. Development time from eggs collected in the field to adults in March in Brisbane was around 17 days. These adult progeny remained active over winter but females did not commence ovipositing until September of that year. An interesting feature of the life history is the distinctive smoky grey-white colour phase of the ultimate larva prior to pre-pupation. Within Brisbane the species occurs sporadically and is generally confined to remnant riparian forest along major creeks that crisscross the suburbs. In these habitats the species can be locally 'common'. The smoky grey-white colour phase recorded here for the ultimate larva of *E. t. tulliolus* could be a diagnostic feature of all *Euploea* Fabricius, 1807 species within the 'tulliolus-complex' and might also be a diagnostic feature of other *Euploea* species groups.

Introduction

Within the Danainae, *Euploea* Fabricius, 1807 (crow butterflies) is the largest genus with at least 54 known species of essentially tropical distribution in the Oriental and Australian regions (Ackery & Vane-Wright 1984, Scheermeyer 1999). The greatest diversity of *Euploea* occurs within the Indo-Australian region (Corbet & Pendlebury 1992, Ackery & Vane-Wright 1984, Parsons 1998), especially on Java, Sumatra and in northern New Guinea (Scheermeyer 1999). On the Australian mainland *Euploea* diversity is relatively meagre with only *E. core corinna* (WS Macleay, 1827) and *E. tulliolus tulliolus* (Fabricius, 1793) extending beyond the tropics. Apart from these two species, all other Australian *Euploea* are restricted to the tropical north: Queensland including Torres Strait, the Northern Territory, and Kununurra in Western Australia (Braby 2000). Despite the popularity of Australian *Euploea* spp. among professional entomologists (e.g. Scheermeyer and Zalucki 1985, Daghlish *et al.* 1986, Scheermeyer 1999, Rahman and Zalucki 1999, Canzano *et al.* 2003, Braby 2009) and butterfly enthusiasts (e.g. Hendry 2010, Moss 2010, M. De Baar *pers. comm.*), the majority of their life histories in Australia are still poorly known, with the exception being *E. c. corinna* (Scheermeyer 1999, Braby 2000). The immature stages of a number of Australian *Euploea* taxa have recently been reported (Meyer 1996, 1997; Lambkin 2001; Braby 2009) but despite this, only the original short description of the early stages of *E. t. tulliolus* exists (Manski 1939), even though it is our second most widely distributed and frequently observed *Euploea* species (Scheermeyer 1999). All subsequent references to the life

stages of *E. t. tulliolus* (Common and Waterhouse 1972, 1981, Braby 2000) are based on this 1939 description.

Euploea tulliolus (Fabricius, 1793) is widespread from Taiwan and southern China, through the Malay Peninsula, the Philippines, Sumatra, Borneo, Java, Sumba, Sumbawa, Flores and New Guinea, eastwards to Vanuatu and Fiji and south to coastal eastern Australia (Ackery and Vane-Wright 1984, Parsons 1998, Braby 2000). It appears to be absent from Timor, Sulawesi, and the eastern Lesser Sunda Islands (Lambkin and Knight 2007). Morishita (1985) provided a comprehensive map indicating the distribution of the 35 named subspecies of *E. tulliolus*. In their sub-division of *Euploea*, Ackery and Vane-Wright (1984) placed *E. tulliolus*, together with *E. hewitsonii* Felder & Felder, 1865 (from Celebes and its vicinity), *E. stephensii* C. Felder & R. Felder, 1865 (from New Guinea, Moluccas and Bismarcks) and *E. darchia* (Macleay, 1827) (from Timor and Tanimbar groups, Kai and northern Australia) (Morishita 1985), into a 'tulliolus-complex' which they tentatively classed as a 'clade' (or more correctly as an 'informal group' as per the International Commission on Zoological Nomenclature, ICZN Code). Ackery and Vane-Wright (1984) admitted that their assemblage of the four taxa into the complex was poorly characterised and the only significant feature of the group that they could determine was perhaps its unique exploitation of *Trophis (Malaisia) scandens* (Lour.) Hook. & Arn. (Moraceae) as a larval host plant (Manski 1939, Meyer 1996, Parsons 1998, Morishita 1985). Furthermore, Ackery and Vane-Wright (1984) indicated that prudence was required even when dealing with the taxonomy of the many races of *E. tulliolus*. They suggested that due to morphological and ecological differences between several races from different regions within the species' range, *E. tulliolus* likely comprised a cryptic species complex.

In Australia, *E. t. tulliolus* has a patchy distribution along the east coast of Queensland and into northern New South Wales (Braby 2000), including several islands of Torres Strait where it is replaced on some islands by the race *E. t. dudgeonis* (Grose-Smith, 1894) (Lambkin and Knight 2007). Lambkin and Knight (2007) presented information on island populations of *E. tulliolus* in Torres Strait and provided some data that in part supported the 'species complex' premise of Ackery and Vane-Wright (1984). Based on this evidence, it may be likely that *E. t. tulliolus* could be a separate taxonomic entity to some of its close congeners to the north of Australia. Because of the need to better define this taxon and the paucity of recorded life history information for *E. t. tulliolus* (Manski 1939), its life history is here described and illustrated from Brisbane, Queensland. In addition, its occurrence, frequency and seasonality within the Brisbane district are described.

Materials and methods

A search was carried out for immature stages of *E. t. tulliolus* in March, 2009 along Cabbage Tree Creek at Taigum, a northern suburb of Brisbane

(27° 20' S, 142° 32' E). Overall the immature stages were difficult to find, but were all located on fresh growing tips of the host plant growing in riparian vegetation. The early stages (three eggs and one larva) were transported to, and reared in Brisbane at ambient conditions in clear plastic round food containers (280ml; 50mm high, bottom radius 42.4mm, top radius 55mm). Larvae were fed daily on fresh host plant stored in the refrigerator. Four adult butterflies were reared from these immature stages.

Results

Host plant

Trophis scandens (Lour.) Hook. & Arn. (Moraceae): as originally reported by Manski (1939) (as *Malaisia scandens*).

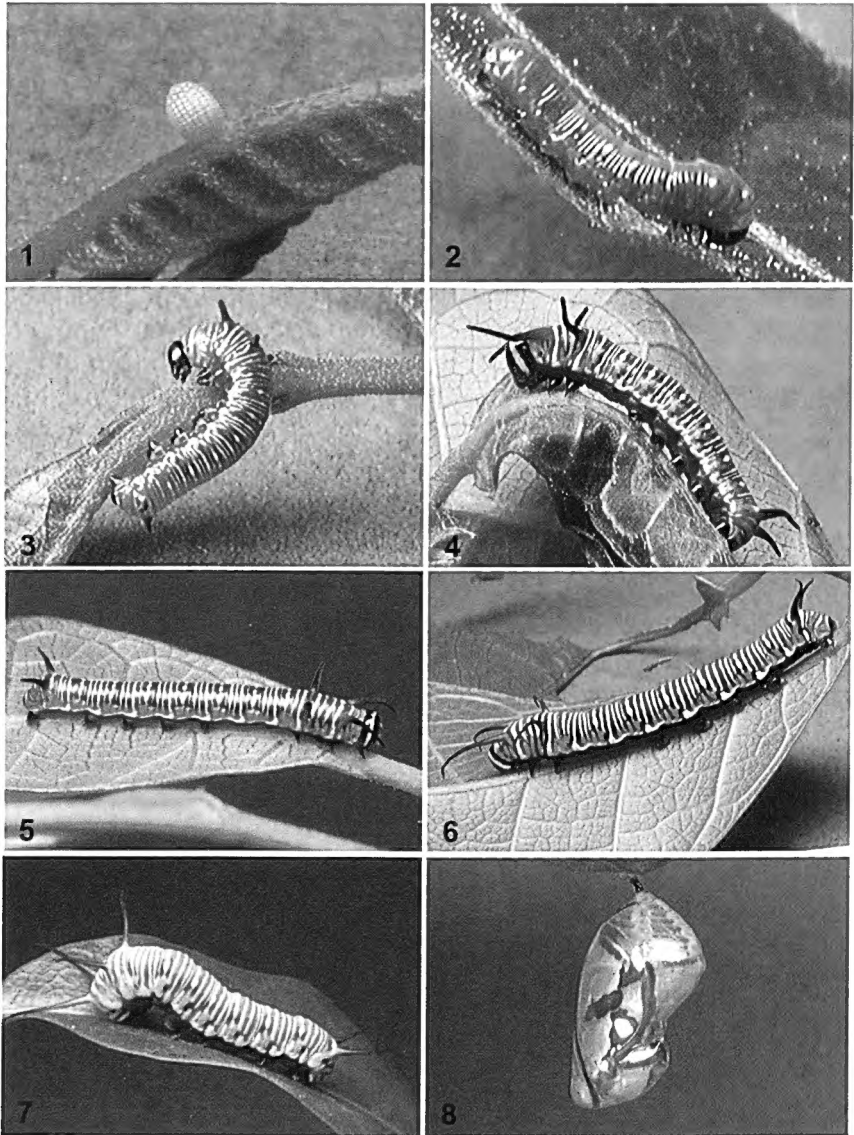
Early stages

Egg: (Fig. 1) (n=4); bullet-shaped; yellow, surface with outlines of circular concave dimples (at least 13 high), each dimple bordered by prominent vertical columns and conspicuous horizontal rows.

First instar larva: (Fig. 2) (n=4); head black; body smooth and cylindrical, semitranslucent, green except for abdominal segments 7 and 8 which are yellow; anal tip black; a pair of slightly raised protuberances same colour as the body on mesothorax, metathorax and abdominal segment 8; bases of legs and prolegs yellow; legs and prolegs black.

Second instar larva: (Fig. 3) (n=4); head black; body smooth and cylindrical, yellow, dorsal and sub-dorsal areas of all segments with suffused black, subcuticular colouration and faint white, transverse bands; anal tip black; a pair of blunt, black filaments on mesothorax, metathorax and abdominal segment 8; all filaments shorter than width of body; bases of legs and prolegs same as body colour; legs and prolegs black.

Third instar larva: (Fig. 4) (n=4); head black with narrow white facial-perimeter band; body smooth, cylindrical; basal, lateral areas including segment 1 of mesothorax and anal segment greenish-yellow, with dorsal and sub-dorsal areas from mesothorax to abdominal segment 8 grey; spiracles small and grey except for pair on mesothorax which are black; mesothorax, metathorax and each abdominal segment with one entire white transverse band, and a series of three, mostly faint, white, predominantly dorsal transverse bands continuing down on the ventral sides about half the width of the body, with a shorter white, predominantly dorsal, intermittently-broken transverse band roughly in the middle of each segment; at the base of the entire transverse, white bands is an unbroken faint, lateral white undulating stripe just below spiracles; anal segment with some faint black and white transverse bands; anal tip black; a pair of blunt, black filaments on mesothorax, metathorax and abdominal segment 8; filaments on mesothorax equal to the width of the body with filaments on metathorax and abdominal



Figs 1-8. Early stages of *Euploea tulliolus tulliolus*: (1) egg (height 1 mm); (2) 1st instar larva (length 4 mm); (3) 2nd instar larva (9 mm); (4) 3rd instar larva (15 mm); (5) 4th instar larva (24 mm); (6) 5th instar larva (31 mm); (7) 5th instar 'smoky grey-white form' larva (30 mm); (8) pupa (height 19 mm).

segment 8 shorter than body width; ventral surface including legs and prolegs grey-black.

Fourth instar larva: (Fig. 5) (n=4); similar to third instar except head black with some white facial markings; body slightly glossy; dorsal white transverse bands and unbroken lateral, white undulating stripe brighter; ventral surface including legs and prolegs black.

Fifth instar larva: (Figs 6, 7) (n=4); similar to fourth instar except white markings on head broader; body matt, yellow, with dorsal and sub-dorsal areas from mesothorax to abdominal segment 8 purplish black; white transverse bands more prominent on all segments; very prominent, undulating, lateral white stripe; spiracles black and prominent; the length of filaments on mesothorax about twice the width of the body; other two pairs of filaments approximately equal to the width of the body; ultimately turning smoky grey-white in colour prior to the formation of the pre-pupa.

Pupa: (Fig. 8) (n=4); entirely amber at first; after two days head and eyes, thorax, wing cases, abdomen and spiracles changing to shining silver; antennae brown, with buff markings on abdomen and wing-cases.

Biological observations

Eggs were found at various heights above the ground (from near ground level to 5m) on juvenile foliage of the host plant, especially on the newly flushed growing buds. Early instar larvae fed exclusively on this juvenile foliage, older larvae preferring soft, fully developed leaves. Early instars severed veins on young leaves in an arc formation prior to eating the isolated distal section of the leaf. Larger larvae severed the leaf midrib before consuming whole soft leaves. This larval vein-cutting behaviour is well known within the Danainae (Clarke and Zalucki 2000). Larvae did not feed on hardened mature leaves, including foliage that had started to harden. Fully grown larvae predominantly rested under mature leaves of the host plant when not feeding. An interesting observation was the distinctive smoky grey-white colour phase that the ultimate motile larva adopted just prior to pre-pupation (Fig. 7). This feature appears to be the very early onset of apolysis, but for all other well noted final instar larvae of Australian *Euploea* species (e.g. *E. c. corinna*; *E. sylvester sylvester* (Fabricius, 1793); *E. alcathoe misenus* Miskin, 1890; *E. a. eichhorni* Staudinger, 1884; *E. algea amycus* Miskin, 1890; unpublished data), apolysis exclusively occurs during the pre-pupal phase, i.e. once larvae are sedentary and preparing to pupate, not while still motile as in the case of *E. t. tulliolus*. In captivity, larvae pupated exclusively on the undersides of mature leaves of the host plant and it is assumed that these locations are likely pupation sites in the field. Larvae developed rapidly in Brisbane during March, with a development time from collected egg to adult of approximately 17 days. Adults that emerged (in March and April) were immediately released into a large flight cage (14 x 6 x 4m) in Brisbane containing potted host plants, and remained active over winter, but females

did not commence ovipositing until September of the same year, coinciding with flushes of growth on the host plants. At Taigum, adult butterflies have been observed throughout summer and autumn. In addition, M. De Baar (*unpublished data*) recently recorded adults of *E. tulliolus* flying in May and June at Oxley Creek in Sherwood, Brisbane; so it is likely that in Brisbane the adult butterflies occur all year round (Braby 2000).

Discussion

Euploea t. tulliolus is largely a coastal Queensland taxon occurring in moist areas often along creeks and rivers where its host plant predominantly grows. Within its range, which extends to Urunga in northern New South Wales (Braby 2000), it has a patchy distribution and tends to occur in localised populations (Scheermeyer 1993, 1999). Scheermeyer (1999) considered *E. t. tulliolus* to be 'rare' in southern Queensland and New South Wales. Within the Brisbane district it occurs sporadically, primarily in remnant riparian forest along some of the major creeks that crisscross the suburbs, and despite it being locally 'common' in this environment, it is not often observed outside this habitat. Populations tend to be sedentary in these environments with butterflies tending to loiter, and therefore populations can generally be found in the same locations year after year. Female butterflies are possibly only fecund during the wetter months which coincide with the seasonal availability of the species' host plant (Scheermeyer 1993, Braby 2000), particularly when the host is actively growing. As part of this reproductive strategy, over dry seasons, particularly in drier environments, large numbers of adults are known to 'dry season aggregate' (Scheermeyer 1993).

Only a small sample size was collected (n=4) but of these, larval colouring and morphology was consistent. All mature larvae developed into a motile non-feeding, smoky grey-white colour phase prior to pre-pupation. Bascombe *et al.* (1999) in Hong Kong reported and illustrated a similar 'purple' colour phase for final instar *E. c. amymone* (Godart, 1819) just prior to pre-pupation (Morishita [1985] described it as 'rose-red' in colour). In addition, Parsons (1998) illustrated two *Euploea* final instar larvae from Papua New Guinea that resembled this distinctive pre-pupation colour phase of *E. t. tulliolus*. One illustration was that of *E. phaenareta callithoe* Boisduval 1832, but the other final instar image was unfortunately referred to twice in his text as *E. t. dudgeonis* and *E. stephensii jamesi* (Butler 1876) (but referred to as *E. tulliolus* in the plate caption). Despite Parsons' (1998) illustration looking very similar to the distinctive colour phase of the final instar larva of *E. t. tulliolus* from Brisbane described here, his illustration might well be that of *E. s. jamesi*, considering that the two species are thought to be closely related (Ackery & Vane-Wright 1984). Confusion with this particular illustration has subsequently misled some authors when making comparisons of *Euploea* larvae (Moss 2010). Scheermeyer and Zalucki (1985) described a purple colour morph for final instar *E. c. corinna* from the drier areas of Queensland

but they indicated that it was a different final instar colour form, rather than a colour phase only developing prior to pre-pupation. A. G. Orr (*unpublished data*) also recorded a similar final instar colour form for *E. camaralzeman scudderii* Butler, 1878 in Borneo.

Finally, the larvae that Parsons (1998) and Bascombe *et al.* (1999) illustrate bear a strong overall resemblance to the smoky grey-white ultimate phase of the larva of *E. t. tulliolus* recorded here and it might be that a characteristic feature of some *Euploea* species groups could be the propensity to develop through this distinctive colour phase, or a very early commencement of apolysis, prior to pre-pupation. Accepting the fact that this phenomenon is unrecorded for *E. c. corinna* in Australia but is recorded for *E. c. amydone* from Hong Kong (Bascombe *et al.* 1999), this might also add some weight to the belief that the predominantly Australian taxon, *E. c. corinna*, might well be specifically different from other *E. core* (Cramer) from south east Asia, as proposed by Morishita (1985) and Braby (2000).

Acknowledgements

I thank R. Kendall of Indooroopilly, Brisbane for allowing the use of his flight cage during the conduct of this work, and M. De Baar and A. G. Orr for their unpublished data.

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**ARRHENOCNEMIS PARVIBULLIS SP. NOV. (ODONATA:
PLATYCNEMIDIDAE), A NEW CALICNEMIINE DAMSELFLY
FROM PAPUA NEW GUINEA, WITH A DESCRIPTION OF THE
FEMALE OF *A. AMPHIDACTYLIS* LIEFTINCK, 1949.**

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Abstract

A new species of damselfly, *Arrhenocnemis parvibullis* (Odonata: Platycnemididae), from the Muller Range of Papua New Guinea is described and its habits and habitat discussed. It represents the third species of this distinctive genus, known from just 16 specimens. The recently discovered female of *A. amphidactylis* is described for the first time.

Introduction

The zygopteran family Platycnemididae is widely distributed in the Old World. Until recently it was not included in the Australian fauna, but according to Carle *et al.* (2008), the protoneurid subfamily Disparoneurinae, which includes many Australasian representatives, may belong in the Platycnemididae, and it is thus treated by Theischinger and Endersby (2010). The subfamily Calicnemiinae however, first recognised by Fraser (1957), has a more enigmatic distribution. The 21 recognised genera range from tropical Africa and Madagascar to Sundaland and the Philippines, New Guinea and the Solomon Islands, but are absent from Sulawesi, the Moluccas and the Lesser Sunda Islands (Gassmann 2005). The New Guinea and Solomon Island fauna is believed to have derived from the Philippines, dispersing along now submerged island arcs from about 25 million years b.p. (van Tol and Gassmann 2005). The close affinity between the Philippine and New Guinean representatives is supported by the fact that in the highly speciose Philippine endemic nominotypic subgenus *Risio cnemis*, and in nine of the ten known New Guinea or Solomon Island endemic genera, the wing tip and distal hind margin of both wings is strongly crenulated, a character unique among the Odonata.

One of the more distinctive New Guinean genera is *Arrhenocnemis* Lieftinck, 1933, until recently known from just 10 specimens representing two species, *A. sinuatipennis* Lieftinck, 1933, and *A. amphidactylis* Lieftinck, 1949. In October–November 2009 one of us (VJK), visited the Muller Range in the Western Province, Papua New Guinea as part of Conservation International's Rapid Assessment Program (RAP). Several Odonata new to science were collected, including a specimen clearly representing a new species of the genus *Arrhenocnemis*, which we describe here, together with notes on its habitat and habits. In July 2006 and October 2008, during fieldwork of the Kelompok Entomologi Papua (KEP) and the Universitas Cenderawasih, Jajapurah (UNCEN) in the Star Mountains in West Papua (Indonesia) VJK

collected three males and the unknown female of *A. amphidactylis* (Kalkman 2008), which is also described here for the first time. Terminology follows Westfall and May (2006), with exception of anal appendages, where we follow Watson *et al.* (1991).

Arrhenocnemis parvibullis sp. nov.

(Figs 1a-h)

Material examined

Holotype ♂: PAPUA NEW GUINEA, Western Province, CI Muller Range expedition, Camp 1 (Gugusu), 05° 43.751S, 142° 15.797E, 515 m asl, 04-11 ix 2009, leg VJ Kalkman; DNA-sample VJK0496, preserved in ethanol, RMNH.

Diagnosis

A small, lightly built damselfly; ground colour dark with bright blue-green markings on the thorax, anterior part of the head and dorsally at the base of most abdominal segments. Legs short with sparse, short, robust spines. Wings with open reticulation; distal margins crenulate. The species can be identified based on the combination of the following three characters: (1) distal margin of wings crenulated, (2) tarsi bearing long spines, one pair per segment, (3) front of synthorax with a pair of small protruberances (i.e. bullae), see Fig. 1g.

Description

Head: Somewhat elongate in profile. Labium pale ochraceous; medium lobe with deep 'U' shaped incision (Fig. 1c), the two lateral projections thus formed tipped with long setae; apex of lateral lobes and maxilla dark brown. Labrum bright apple green thinly bordered with dark brown; basally with small median streak and dark patches at postero-lateral corners. Mandibles exteriorly bright green with large dark brown spot anteriorly. Clypeus shining dark brown; surface of postclypeus and ridge between ante- and postclypeus strongly convex. Genae bright green to just below level of antennal sockets, the green extending diffusely as thin triangular streaks across anterior part of frons, not meeting centrally. Green area on genae almost bisected by squarish dark spot meeting lateral angle of clypeus. Frons matt black, sloping. Remainder of head matt black; vertex distinctly raised and with prominent occipital ridge. Antennae (Fig. 1b) with second segment broad and about same length as first. Eyes moderately small; dark above, apple green beneath.

Thorax: Prothorax: generally lacking strongly defined sculpturing and rather uniform in profile; dark with bright green markings. Anterior lobe distinctly raised in profile with well-defined groove delimiting it from median lobe; dorsally with bright green bar; small rounded anterior processes present at the lateral corners seen in dorsal view. Median lobe only slightly swollen in

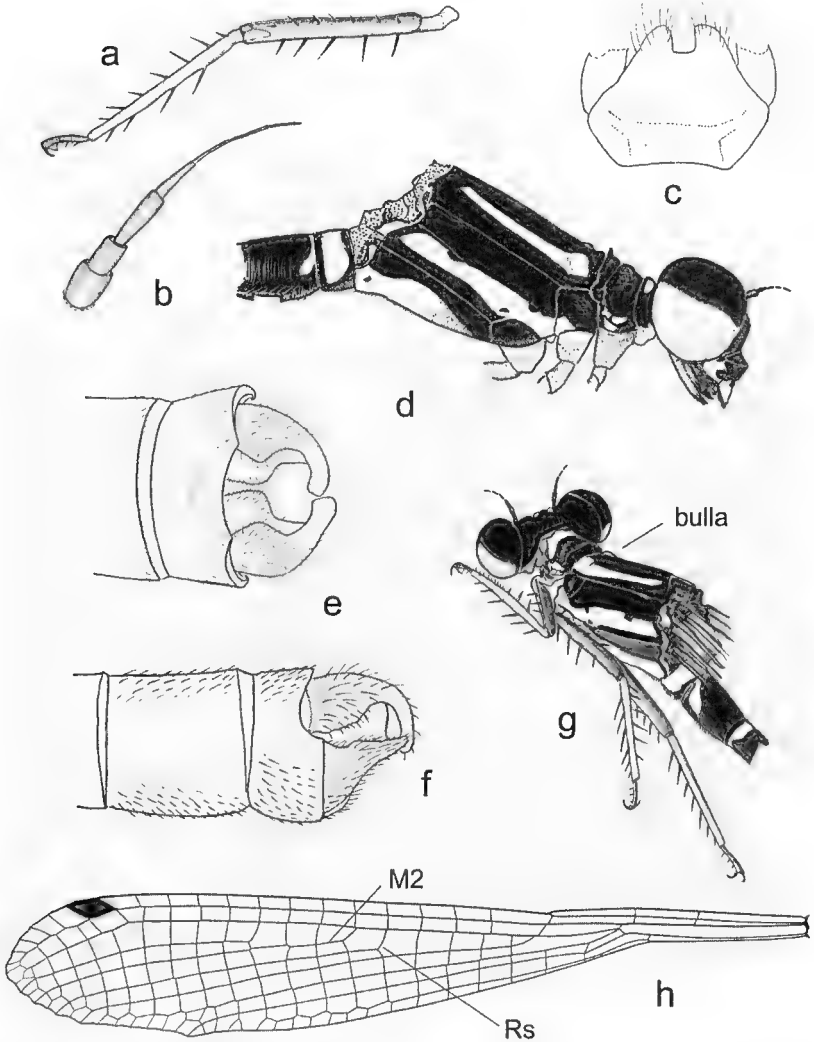


Fig. 1. Holotype male of *Arrhenocnemis parvibullis*: (a) metathoracic leg; (b) antenna; (c) labium detail, ventral view; (d) head and thorax in profile (head drawn forward slightly to reveal anterior lobe of prothorax); (e) anal appendages, dorsal view; (f) anal appendages, in profile; (g) head, thorax and base of abdomen, postero-dorsal view showing bullae on synthorax; (h) left hindwing.

profile, but in dorsal view clearly divided into two slightly bulbous postero-lateral lobes and an anterior depressed, inverted triangular area; laterally with distinct green marking at ventral margin, divided into three sections, extending to coxa (Fig. 1d). Posterior lobe black; only slightly raised at posterior margin; in dorsal view margin with two distinct, subapical, shallow incisions, defining rounded flaps at the lateral extremities of the lobe, only slightly evident in profile. Synthorax: mesepisternum marked with bright blue-green, moderately narrow antehumeral band, its anterior part enclosing a small protruberance (i.e. bulla – Fig. 1g), posteriorly curving gently back to terminate midway between dorsal carina and antehumeral suture, well short of the antearlar triangle. Laterally with diagonal bright blue-green band running from dorso-anterior half of metepisternum, across interpleural suture, to terminate in posteroventral part of mesepimeron, extending into posterior corner of mesoinfraepisternum and most of coxa; anterior margin of band incised at point of crossing suture. Metepisternum anteriorly dark, in posterior half becoming blue green then pale tawny. Venter pale ochreous. Post-sternum with dense fine, short setae. Legs: relatively short and bearing sparse, short, robust spines (Fig. 1a). Coxae pale or marked in green; femora robust; dark brown with posterior ridge; tibiae brown to pale ochreous from pro-meta thorax; pro- and metatibia especially, slightly flattened basally; tarsi dark, very short, each segment bearing strong ventral paired spines; tarsal claws apically bifid. Wings hyaline with black neuration (Fig. 1h); petiolated to just before level of Ax2; Ac nearer Ax2 than Ax1; Arc just beyond level of Ax2; M3 arising just beyond level of nodus; Rs arising at Px4, about midpoint of wing, and one cell before M2 in both wings; quadrilateral in forewing about 4 times as long as wide along posterior margin; postero-distal angle circa 63°; quadrilateral in hindwing about 5.5 times breadth at base; posterolateral angle circa 50°; wing margin in forewing crenulate to level of pterostigma, in hindwing crenulate to level of pterostigma and with strong protrusion at Cu1; pterostigmata in both wings lozenge-shaped and black.

Abdomen: Mainly dark with small green markings, slightly paler beneath; expanded at S1, S2 and from S8-S10, especially evident in dorsal view. S1 dorsally and laterally almost entirely green; S2 with small basal dorsolateral green marks; S3-S7 with dorsal green fleck basally. S8-10 black. Appendages mainly dark; superiors and inferiors subequal in length and slightly longer than S10. Superior in dorsal view (Fig. 1e) strongly incurved, with strong inner, rounded shoulder subbasally; in profile (Fig. 1f) basally thickened with apical process curved sharply downward with a slightly concave, spatulate apex, lying inside apices of inferiors; basally dark with long sparse setae; inferiors dark; in profile roughly triangular, tapering to a point; sparsely clad in setae except on outer and inner basal face; in dorsal view with strong inner shoulder at about their midpoint, thereafter tapering to thin, nearly straight, process.

Measurements: forewing, 23 mm; hindwing, 22.5 mm; abdomen + appendages, 31.5 mm.

Etymology

parvibullis: a noun in the ablative case derived from Latin *parva* + *bulla*, meaning ‘with small knobs’.

Habitat and biology

The new species was found at a small, 2 to 3 m wide, mostly shallow rocky brook in virgin submontane forest at 515 m a.s.l. (Fig. 2). The site was visited on several days but only one male was caught which was found sitting on the vegetation beside the stream.



Fig. 2. Small shallow stony brook in submontane forest in the Muller Range, 515 m a.s.l., type locality for *A. parvibullis* sp. nov.

Arrhenocnemis amphidactylis Lieftinck, 1949

(Figs 3 a-b)

Material examined

1 ♂: INDONESIA, Papua Province, Walmak (Nipsan), 04° 07S, 139° 38E, 1650 m asl, 29 x 2008, leg VJ Kalkman, DNA sample NG071; 1 ♀: INDONESIA, Papua Province, Walmak (Nipsan), 04° 07S, 139° 38E, 1650 m asl, 28 x 2008, leg VJ

Kalkman, DNA sample NG064; 1 ♀ INDONESIA, Papua Province, Star Mountains, Borneo, 04° 23.745S, 140° 26.020E, 1000-1100 m asl, 27 vii 2006, leg VJ Kalkman.

Description of female

Head: Elongate in profile. Labium pale ochraceous; medium lobe with deep 'U' shaped incision, the two flanking lateral projections tipped with long setae; apex of lateral lobes and maxilla brownish. Labrum pale cream. Mandibles exteriorly pale cream with brownish tinge. Clypeus light brown; surface of postclypeus and ridge between ante- and postclypeus strongly convex. Remainder of front of head mainly cream, with pale green tint posteriorly, bisected by obscure pale brown, irregular band at the level of the antennal sockets and about the breadth of the sockets; vertex with distinctly raised and prominent occipital ridge. Antennae with second segment somewhat longer than first, almost equal in length to third segment which is rather short. Posterior part of head very dark brown, with line bisecting the vertex and encircling two lateral ocelli. Eyes moderately small; dark above, pale green to cream beneath.

Thorax: Prothorax saddle-shaped in profile with anterior and posterior lobes both raised in broad rounded lobes; dark above, ventro-laterally pale cream. Synthorax middle brown above with broad, pale green antehumeral bands; anteriorly, at the inner margin of the antehumeral stripes are paired finger-like projections, the outer side of these processes being green, the inner side brown. Laterally mainly pale green blending to cream ventrally with diffuse brown bands, one over mesepimeron, diagonally marking upper half of mesinfraepisternum, and another over metepisternum, enclosing spiracle. Legs relatively short and bearing sparse, robust spines; basally pale, with infuscation deeper in distal segments and at tibio-femoral joint, especially in prothoracic pair. Tarsi very short with strong paired ventral spines. Wings hyaline with black neuration; petiolated to just before level of Ax2; Ac slightly nearer Ax2 than Ax1; Arc just beyond level of Ax2; M3 arising at or just before subnodus; Rs arising at Px4 or Px5 in forewing, at Px3 or Px4 in hindwing; M2 at or near level of Px6 or Px7 in forewing, at or near Px5 or Px6 in hindwing; M1a arising at Px8, Px9 in forewing, at Px7 or Px8 in hindwing. Wing margin in forewing crenulate to level of pterostigma, in hindwing crenulate to level of pterostigma and with strong protrusion at Cu1; pterostigmata in both wings lozenge-shaped; dark reddish brown with very fine amber margin.

Abdomen: Medium build. Dark brown above, laterally and ventrally pale cream, progressively reduced to venter of posterior segments. S1 broadly greenish cream laterally, brown above; S2-S10 dorsally with moderately broad basal pale green fleck; in posterior segments before S10 tending to short streak along dosal carina. Terminal segments slightly clubbed and rounded apically. Valves pale, slender, slightly concave ventrally, with fine subterminal comb of dark setae and longer setae terminally; extending just

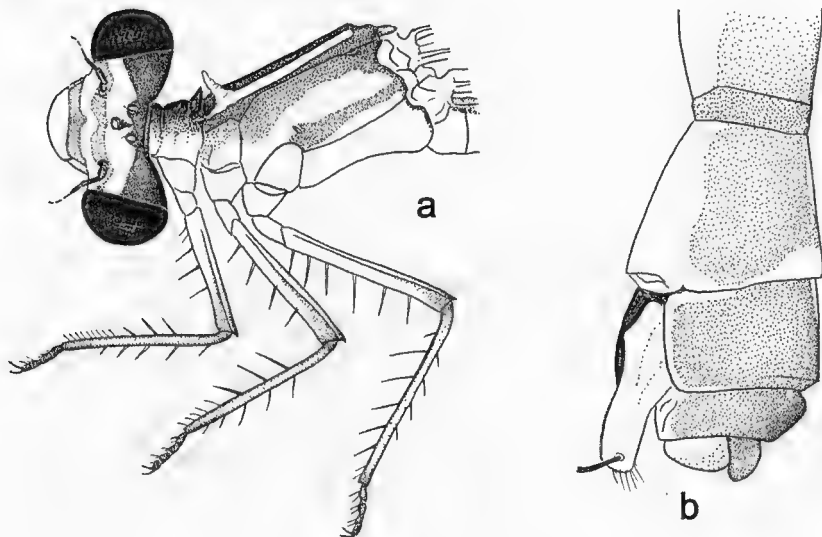


Fig. 3. Female *Arrhenocnemis amphidactylis*: (a) Dorsal view of head and lateral view of thorax showing anterior process on mesepisternum; (b) S8-S10 of abdomen, lateral view.

beyond pale anal tubercle. Anal appendages light brown, short, rounded apically and slightly downturned.

Measurements: forewing, 24-25.5 mm; hindwing, 22.5-24 mm; abdomen + appendages, 28-29 mm.

Comparison of male with type series

The single male examined agrees closely with Liefinck's (1949) descriptions of the holotype male and three paratypes with the following exceptions: green marking on head slightly more developed; left hindwing with Rs arising level with Px3 versus Px4 in types; abdomen with thin dorsal pale green streak along its entire length on S9 and a tiny dot of the same colour at the base of S10, apparently lacking in types. Relative to the type series the wings are slightly longer - hw 23 mm versus 21.5-22.5 mm in type series - and the abdomen plus appendages slightly shorter - 31 mm versus 32-33 mm in type series, hence the abdomen is discernibly slightly shorter relative to the wings.

The antennae (not mentioned by Liefertinck 1949) are of similar proportion to those of female.

Habitat At Borne *A. amphidactylis* was caught at small, shaded and rocky brooks; at Nipsan it was found at small rocky brooks in an area where the vegetation had largely been cleared.

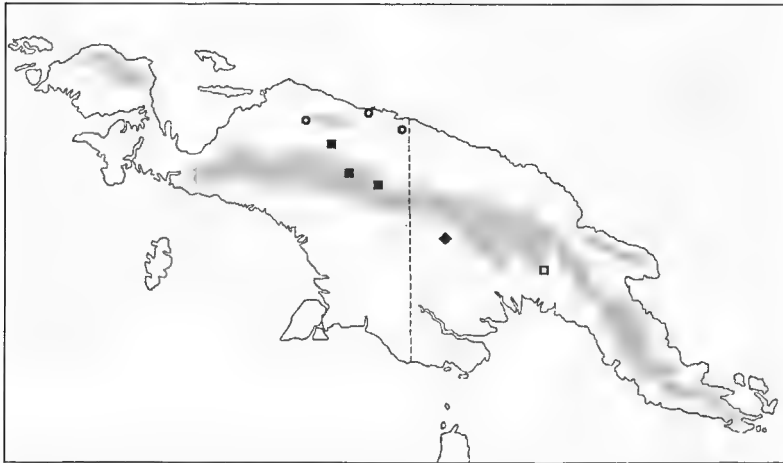


Fig. 4. Map of New Guinea showing locations for known *Arrhenocnemis* collections: open circles, *A. sinuatipennis*; solid squares, *A. amphidactylis*; solid diamond, *A. parvibullis*; open square, *A. sp. incertae sedis*. Grey shading indicates land over 1000m. a.s.l.

Discussion

Although Liefertinck (1933), assigned the genus *Arrhenocnemis* to the Platycneminae (i.e. Platycnemididae *sensu stricto*), he subsequently placed it in the Megapodagrionidae (Liefertinck 1965, 1971), where it appeared in subsequent catalogues (Davies and Tobin 1984; Tsuda 2000). However Gassmann (2005) reinstated it to the Platycnemididae-Calicnemiinae, where it clearly belongs. A unique character is the tarsi which are short and bear long spines, one pair per segment. This, combined with the crenulated margins at the wing tips, makes it easy to distinguish the members of this genus from any other New Guinean Zygoptera.

Other characters supporting the placement of *parvibullis* in *Arrhenocnemis* are: 1. The venation is almost identical to that of *sinuatipennis* and *amphidactylis* and unlike any other New Guinean calicnemiine genus, with

Rs arising well distal to nodus near M2. We are not aware of this condition in any zygopteran other than the Philippine genus *Risio cnemis*.

2. The legs are unusually short with stout, sparse spines.

3. The front of the head is relatively robust and elongated.

4. The labium has a U-shaped distal excavation, as described by Liefinck (1949), which is wider than in any other New Guinean calicnemiine genus.

5. The general body shape and size are very like *sinuatipennis* and *amphidactylis*; coloration and markings distinctive but similar. The bullae on the thorax are reminiscent of the 'fingers' of *amphidactylis*, a structure unique in Zygoptera.

The unusual shortened second antennal segment found in *A. parvibullis* is not clearly evident in either of the other two described species, but Liefinck (1933) notes that the antennae of *A. sinuatipennis* are overall short when compared with the southeast Asian genus *Coelliccia* Kirby, 1890 and other eastern genera of the family. This is true also of *A. amphidactylis*.

Thus far only 16 specimens of *Arrhenocnemis* have ever been collected. These represent a probable four species, from eight localities (Fig. 4). *A. amphidactylis* is distributed in the central mountain range from 700 to 1650m and *A. sinuatipennis* occurs in the hills in the north of West Papua from 165 to 400m. There is a record of an *Arrhenocnemis* sp. from Crater Mountain Biological Research Station published by Oppel (2005, 2006). No details are given and it is not clear if it is a new species, but given its occurrence so far from the known range of other species this seems very likely.

Acknowledgements

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**A NEW CICADA GENUS AND A REDESCRIPTION OF
PAUOPSALTA SUBOLIVACEA ASHTON (HEMIPTERA:
CICADIDAE) FROM EASTERN AUSTRALIA**

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Abstract

We erect a new genus (*Samaecicada* gen. nov.) for *Pauropsalta subolivacea* and provide the first description of the female. The acutely extended, straight to slightly inward facing upper lobes of the pygofer, in combination with undeveloped basal pygofer lobes and lack of pseudoparameres, distinguishes this new monotypic genus from all others in the tribe Cicadettini. Observations indicate that its seasonal emergence is erratic and adults are short-lived. Recent specimens have been captured on medium sized shrubs, notably *Hakea* sp., in open woodland containing *Angophora costata* trees on sandstone ridges.

Introduction

Pauropsalta subolivacea Ashton, 1912 was originally described from a single male specimen from "New South Wales". Recently, additional specimens have been obtained from Northbridge, Maroubra, the Royal National Park and Red Hill, all in the Sydney metropolitan area. The type specimen of *Pauropsalta subolivacea* Ashton, 1912 is housed in the Australian Museum. Despite being in poor condition (with the pronotum and head missing), the most critical morphological features, including the fore and hind wings, opercula and genitalia, are still intact. This specimen, as well as the original description of the species, matches several specimens collected over the past 5 years from sandstone ridges in the Sydney area.

P. subolivacea has acutely extended upper pygofer lobes, which is a typical feature of the genus *Pauropsalta* Goding and Froggatt (Ewart 1989), and easily explains Ashton's (1912) generic designation. However, the type does not possess an infuscation on the margin at the distal end of hind wing cell 2A, which is a characteristic feature of *Pauropsalta* (Ewart 1989). Therefore, the possibility of its inclusion in other genera within the Cicadettini needs consideration. Some features of the male genitalia suggest affinities with *Fijipsalta* Duffels from Fiji and *Nigripsalta* Boer from New Guinea. However, the combination of unique genitalic characters in *P. subolivacea* preclude it from any of the above genera and, on this basis, we erect a new genus for this species.

Terminology follows Moulds (2005), with additional terms for tymbal anatomy sourced from Dugdale (1972) and Bennet-Clark (1997). Several characters highlighted in the cladistic analysis of Moulds (2005) are included in the generic description. The species redescription follows, with the original description of *P. subolivacea* by Ashton (1912) included here for

comparison. Material sourced for this taxonomic work is located in the following collections: AM – Australian Museum, Sydney (holotype male); ANIC – Australian National Insect Collection, CSIRO, Canberra; DE – private collection of D. L. Emery, Sydney; MSM – private collection of M. S. Moulds, Kuranda.

Systematics

Family CICADIDAE Latreille

Subfamily CICADETTINAE Buckton

Tribe Cicadettini Buckton

Samaecicada gen. nov.

Type species. *Pauropsalta subolivacea* Ashton, 1912

Included species. *S. subolivacea* (Ashton, 1912), comb. nov.

Etymology. Named after Samantha Emery, who collected the first recent material of the type species, which led to its rediscovery.

Diagnosis. A small cicada (type species = 12.1-14.0mm total body length). Width of head (including eyes) equal to, or only slightly greater than, width of pronotum across lateral margins, equal to abdomen width (across auditory capsules); width of pronotum measured from lateral angles similar to width of mesonotum measured between fore wings; pronotal collar with lateral angles confluent with adjoining pronotal sclerites; distance between lateral ocelli slightly greater than distance between each lateral ocellus and adjacent eye. Metanotum partially visible. Abdomen length approximately equal to that of head and thorax combined; rounded in dorsal and lateral profile, with sternites projecting well below level of tergites. Fore wings hyaline; costa well-developed and wider across basal cell and at node, with subcostal vein widening distally along length of basal cell, narrower for remainder to node, with slight curvature exaggerating towards node; fore wing with eight apical cells that have lengths similar to or slightly longer on average than ulnar cells; intersection of veins CuA and M slightly closer to the basal cell than the distal ends of both veins CuA and M; lengths of the four distal vein sections that comprise the inner radial cell margin are of approximately equal length. Hind wings with six apical cells (seven or eight if abnormal). Opercula broadly sickle-shaped, rounded along ventral edge; meracantha broad and marginally overlapping opercula; inner margins of opercula clearly separated. Tymbals with long ribs fused dorsally along basal spur; short ribs present; not extending below wing bases. Pygofer roughly narrowly ovate in dorsal view; upper lobes acutely extended, straight to slightly inward-facing, dominating the pygofer, including dorsal beak; basal lobes not developed; uncus poorly developed, with subtle, posteriorly receding lobe; claspers prominent, curved anteriorly, projected ventrally and curved slightly posteriorly to a subacute termination. Aedeagus simple, without

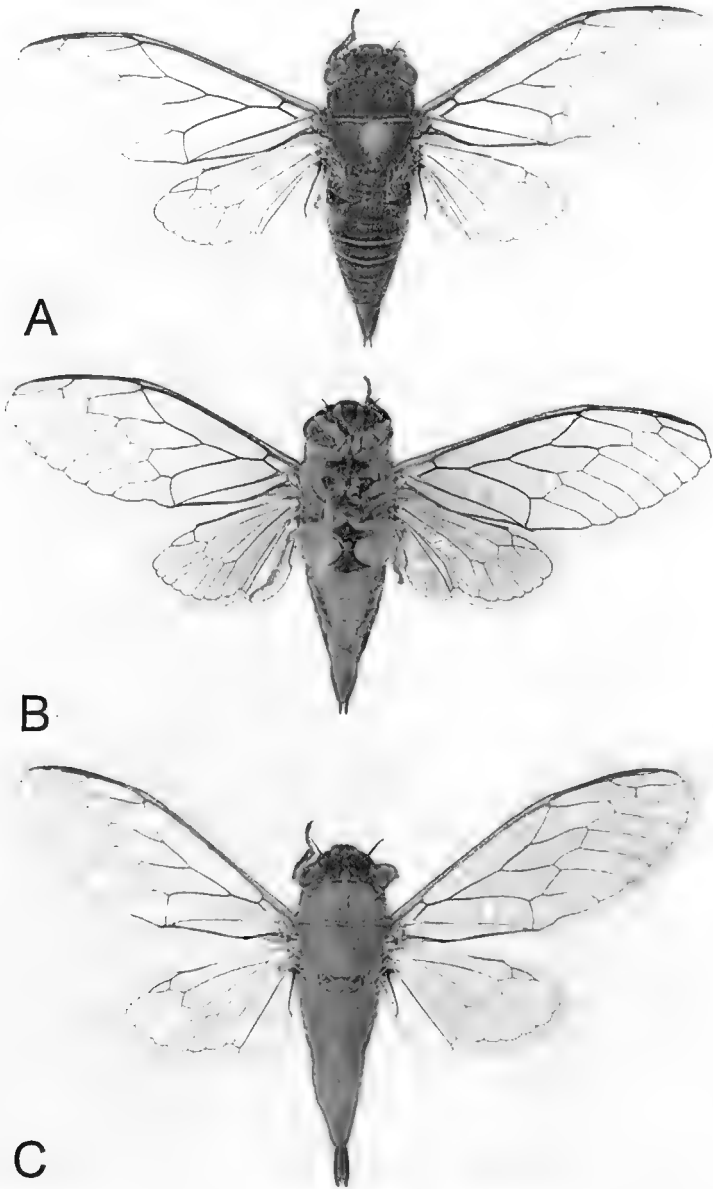


Fig. 1. *Samaecicada subolivacea* comb. nov. from Royal National Park, New South Wales: (A) male, dorsal; (B) male, ventral; (C) female, dorsal. Total body lengths = 12.8mm (male) and 14.0mm (female).

pseudoparameres; theca sclerotized throughout, extending directly from basal plate, without ventral support.

Distinguishing features. The unique characteristics of the male genitalia act as the most useful diagnostic features for this genus. The presence of prominent, acutely extended, straight to slightly inward facing upper lobes of the pygofer, in combination with the absence of basal pygofer lobes, distinguishes this new monotypic genus from all others in the tribe Cicadettini. Other genera that show some affinities with *Samaecicada* are *Nigripsalta*, specifically the type species, *N. carinata* Boer, and *Fijipsalta*. *N. carinata* also has greatly produced upper pygofer lobes and a similarly shaped theca to *Samaecicada*; however, in *Nigripsalta*, the upper pygofer lobes are broad not acute and the claspers are not so prominently developed (Boer 1999). *Fijipsalta* is easily distinguished by having more rudimentary and rounded upper pygofer lobes (Duffels and Ewart 1988). Australian cicadas that could be confused with *Samaecicada* include members of the *Cicadetta forresti* (Distant) group (including *C. capistrata* (Ashton), *C. froggatti* (Distant), *C. juncta* (Walker), *C. sulcata* (Distant) and *C. viridis* (Ashton)), *Graminitigrina* Ewart and *Pauropsalta* Goding and Froggatt. The *C. forresti* group is most easily distinguished by their tymbals with eight long ribs and well-developed basal pygofer lobes. *Graminitigrina* and *Pauropsalta* both have developed basal pygofer lobes and all known *Pauropsalta* species have dorsal pseudoparameres (Ewart and Marques 2008). *Samaecicada* lacks each of these characteristics. As indicated in the introduction, *Samaecicada* also lacks an infuscation on the margin at the distal end of hind wing cell 2A, which is a characteristic feature of *Pauropsalta* (Ewart 1989). The absence of pseudoparameres in *Samaecicada* is significant because these are listed as one of the defining characteristics of Cicadettini as redefined by Moulds (2005). However, this feature is also absent in some species of *Graminitigrina* (Ewart and Marques 2008), so there are other known exceptions.

***Samaecicada subolivacea* (Ashton, 1912) comb. nov.**

(Figs 1-4)

Holotype. ♂, NEW SOUTH WALES, 1912, (AM).

Additional material. NEW SOUTH WALES: 1♂, 34°06'S 151°03'E, Wisers Track, Royal National Park, Sydney, *Hakea* sp 11.i.2005, S. & D. Emery; 1♂, same location, 3.i.2008, S. N. & D. Emery; 1♀, same location, *Hakea* sp 11.i.2005, S. & D. Emery (all DE); 1♂, 33°44'S 151°15'E, Red Hill Swamp, Sydney, 27.xii.2008, R. Perry (spider's web) (MSM); 1♂, N[or]thb[ri]dge, 30.xi.1927 (ANIC); 1♂, Maroubra, 10.x.1935, G.P. Whitley (AM).

Ashton (1912) described the type specimen as follows:

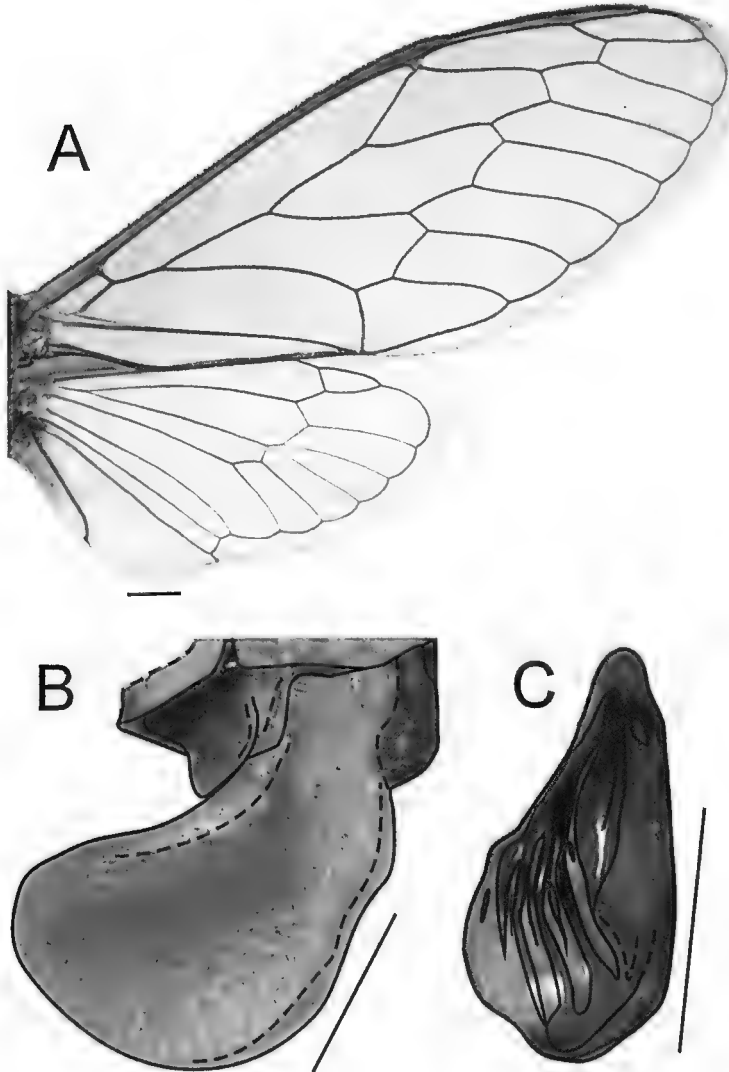


Fig. 2. *Samaecicada subolivacea* comb. nov. (A) right fore and hind wings; (B) left operculum; (C) left tymbal. Photographs taken of specimens from Northbridge, New South Wales (A) and Royal National Park, New South Wales (B and C). Line drawings have been superimposed onto the photographs of the operculum and tymbal (B and C) to assist visualisation of the contained structures. Scale bars 1mm.

“*Pauropsalta subolivacea*, *sp. nov. male*. Head black, pilose, eyes fuscous. Pronotum testaceous, a central black fascia dilated anteriorly and posteriorly (enclosing a pale central stripe). Some spots about the incisures black, posterior margin very narrow, ochraceous. Mesonotum testaceous, two central obconical spots on anterior margin cruciform elevation sordid pale fuscous. Abdomen testaceous, pilose, segments with basal margins black, apex of first and second segment narrowly ochraceous, lateral margins suffused with greenish olive. Body beneath yellow, suffused on legs, opercula and lateral margins of abdomen with greenish olive.

Tegmina and wings hyaline, costa dull ochraceous margined with black, interior venation black, apical paler. Head, excluding eyes, as broad as long, front [frons] much produced, vertical margins continuous. Pronotum as wide as head, and as long. Mesonotum as broad as pronotum, and, from base of cruciform elevation, as long as pronotum and head together. Abdomen long, slender, tapering, as long as head and thorax.

Long.-(excl. teg.), 14 mm.; exp. teg., 38 mm.”

The revised description, with first documentation of the female, is given below.

Male (Figs 1A-B). Head largely black, dorsal surface dull black with red ocelli; postclypeus dull, barred black medially with green lateral and posterior margins, rounded laterally between tops and sides; anteclypeus shiny black; rostrum ochraceous anteriorly, extending into black posteriorly, with length reaching close to posterior edge of mid coxae. Eyes red (live specimens) with greyish coloration at basal posterior margins. Antennae black, supra-antennal plates black.

Thorax with pronotum dull black; midline fascia with variable thin greenish line not reaching pronotal collar; variable and inconspicuous dark brown coloration at bases of paramedian and lateral fissures; pronotal collar shiny black with posterior margin green. Mesonotum black, cruciform elevation black with variable lighter brown ridges; fore wing basal membranes fuscous grey, parapsidal sutures brown in some specimens; metanotum black. Legs with coxae green, each showing a variable brown-black longitudinal lateral fascia, margins black; femora green; tibiae green, with mid tibiae mottled in some specimens, all becoming paler towards base, with spines grading from green at base to black at tips; tarsi green-brown at base, becoming darker brown towards claws.

Wings (Fig. 2A) with fore wing costal veins green, becoming light green posteriorly from the node; basal membranes translucent grey; veins CuA and base of M black, lighter towards base; CuP prominently green to junction with 1A; all other veins black; basal cell transparent; length of fore wings consistently longer than total body length. Hind wing costal vein green; base of vein 1A and 2A light cream, 3A dark brown to black and thickened at

base, all other veins black; plaga pale cream at base, becoming transparent towards apical third; cuc1 approximately 3 times width of cuc2.

Opercula (Fig. 2B) following body axis lateroventrally, broadly sickle-shaped, slightly depressed centrally, rounded and slightly raised at ventral margin; green to pale yellow; clearly separated. Meracanthus small, broad, green to yellow, pointed, minimally overlapping opercula.

Tymbals (Fig. 2C) with four distinct long ribs; long ribs 1-3 brown dorsally, much paler ventrally and becoming identical in colour to surrounding membrane; long rib 4 brown, comparatively shorter; all long ribs fused dorsally along basal spur, with 1-2 and often 3 also joined ventrally; short ribs present to the anterior of long rib 4 (absent in some specimens), between each long rib and posterior to long rib 1; large ridged dome on posterior tymbal plate with ridges; apodeme pit oval-shaped and conspicuous.

Abdomen with tergites shiny black with contrasting green posterior and extreme lateral margins. Sternite I black with greenish coloration laterally under operculum, sternites II-VI yellow green, sternite VII green becoming darker posteriorly; sternite VIII brownish, with black pubescence.

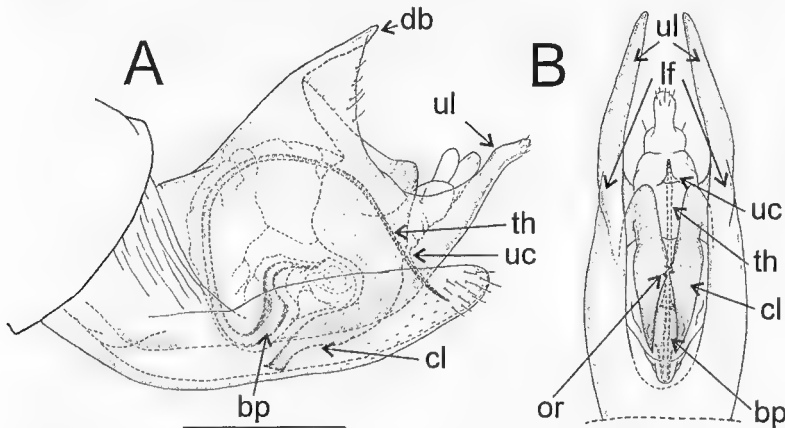


Fig. 3. *Samaecicada subolivacea* comb. nov. Pygofer and male genitalia, viewed (A) laterally from left, and (B) ventrally. Labels refer to following external and internal components: "db" = dorsal beak, "ul" = upper pygofer lobe, "lf" = lateral fold of upper pygofer lobe, "th" = theca, "uc" = uncus, "cl" = clasper, "bp" = aedeagus basal plate, and "or" = tooth-like ornamentation on the inner edge of the claspers (described in the text). Specimen from Royal National Park, New South Wales. Scale bars 1mm.

Genitalia (Fig. 3). Pygofer with upper lobes elongate and acute, extending beyond the posterior end of the abdomen; minor lateral folds evident at ventral base of upper lobes. Uncus subtle, with vestigial posterior projection.

Claspers with undulating curve ventrally, subacute termination; distinct tooth-like ornamentation on inner surface where claspers abut medially. Aedeagus with basal plate acutely downturned at basal end; theca entirely sclerotized, gracile, becoming thinner and gently curved dorsally at apex.

Female (Fig. 1C). Head similar to male apart from a brown spot positioned medially and posterior to ocelli.

Thorax with pronotum mainly green, changing to black anteriorly, with large areas of brown pigmentation either side of midline and a small brown spot on midline immediately anterior to pronotal collar; pronotal collar green with a black spot at each of the lateral margins. Mesonotum brown with inconspicuous cream lines across dorsolateral surface; cruciform elevation arms cream, apex brown, depressions black, grading to cream laterally. Fore wing basal membranes grey. Legs similar to male.

Abdomen with tergites 1-7 green, slightly browner towards midline. Abdominal segment 9 brown dorsally, green laterally, grading to yellow ventrally. Ovipositor brown, noticeably extending 1.5mm beyond termination of abdomen.

Measurements (in mm; range with mean in parentheses: five males, one female). Body length: male 12.1-14.0 (12.8); female 14.0. Fore wing length: male 13.1-14.8 (14.5); female 16.0. Head width: male 3.2-3.7 (3.5); female 4.2. Pronotum width: male 3.4-3.8 (3.73); female 3.6. Abdomen width: male 3.2-3.6 (3.47); female 3.8.

Diagnosis. *S. subolivacea* is distinguished from other species in the tribe Cicadettinae by the combination of acutely elongated, straight to slightly inward-facing upper pygofer lobes and undeveloped basal pygofer lobes. More thorough comparisons are given under the description of *Samaecicada* above.

Distribution, habitat and behaviour

Known only from old locations in Northbridge and Maroubra, and from recent collections in the Royal National Park and Red Hill "Swamp", all in the Sydney metropolitan area. Ashton's specimen (labelled N.S.W.) would also have most likely been collected in the Greater Sydney area. We anticipate that *S. subolivacea* may occur in areas of suitable habitat outside of the Sydney area; however, it could actually be limited to the Hawkesbury Sandstone region. Adults of this species have so far been encountered on *Hakea* sp. shrubs in areas of open woodland containing *Angophora costata*, growing on sandstone ridges adjacent to heathland (Fig. 4). Emergences seem to be irregular and population sizes upon emergence would appear to be small. All specimens have been taken between mid December and mid January, with adults always having been encountered at heights of less than one metre above ground. Apart from the repeated distress calls when a courting pair was captured in 2005, the song of this species has not yet been



Fig. 4. Habitat of *Samaecicada subolivacea* comb. nov. at Royal National Park, New South Wales. The inset at the bottom right shows live specimens of *S. subolivacea* (female pictured left and male pictured right).

heard or recorded. Perhaps the call is mostly ultrasonic and does not transmit far. No specimens have come to light. Specimens in flight travel less than five metres.

Acknowledgments

We thank Max Moulds, Tony Ewart and Dave Marshall for their most helpful comments on the manuscript, Kathy Hill for encouragement and providing advice on generic comparisons, Samantha Emery for valuable assistance in sourcing new material in the field, Dave Britton for taking the photographs of the set specimens and providing access to the type specimen in the Australian Museum, Cate Lehmann (ANIC, CSIRO) for assistance in obtaining images of important morphological features and Anouk Mututantri for producing the line drawings of genitalia. Tony Ewart also provided comparative illustrations for reference during preparation of the manuscript. Material for this study was collected under permit number S11010, issued to DLE by the New South Wales Department of Environment, Climate Change and Water.

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FIRST RECORD OF *APPIAS ALBINA INFUSCATA* FRUHSTORFER, 1910 (LEPIDOPTERA: PIERIDAE) FROM AUSTRALIA

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Abstract

We record the presence of *Appias albina infuscata* on the Australian mainland for the first time. A female black morph of this subspecies, otherwise endemic to Sumbawa, Indonesia, is recorded from near Darwin, Northern Territory. The specimen was recorded during the height of the summer monsoon and probably represents a vagrant that dispersed to north-western Australia facilitated by monsoonal climatic conditions (westerly trade winds) rather than by directional migration.

Observations

On 26th January 2010 a species of *Appias* was observed and photographed at close range in the town of Humpty Doo (12°34'03"S, 131°08'08"E), about 30 km ESE of Darwin, NT. The butterfly, a female, was observed for approximately 10 mins during the early afternoon (1430 h) feeding on flowers of *Micromelum minutum* (G. Forster) Wight & Arn. (Rutaceae) growing in the garden of a rural property adjacent to Edwin Creek, a tributary of the Howard River. During the observation period, the butterfly flew and fed at approximately 2.5m or more above the ground, rendering it difficult to photograph. Despite a careful watch the species was not observed again that day or during subsequent days.

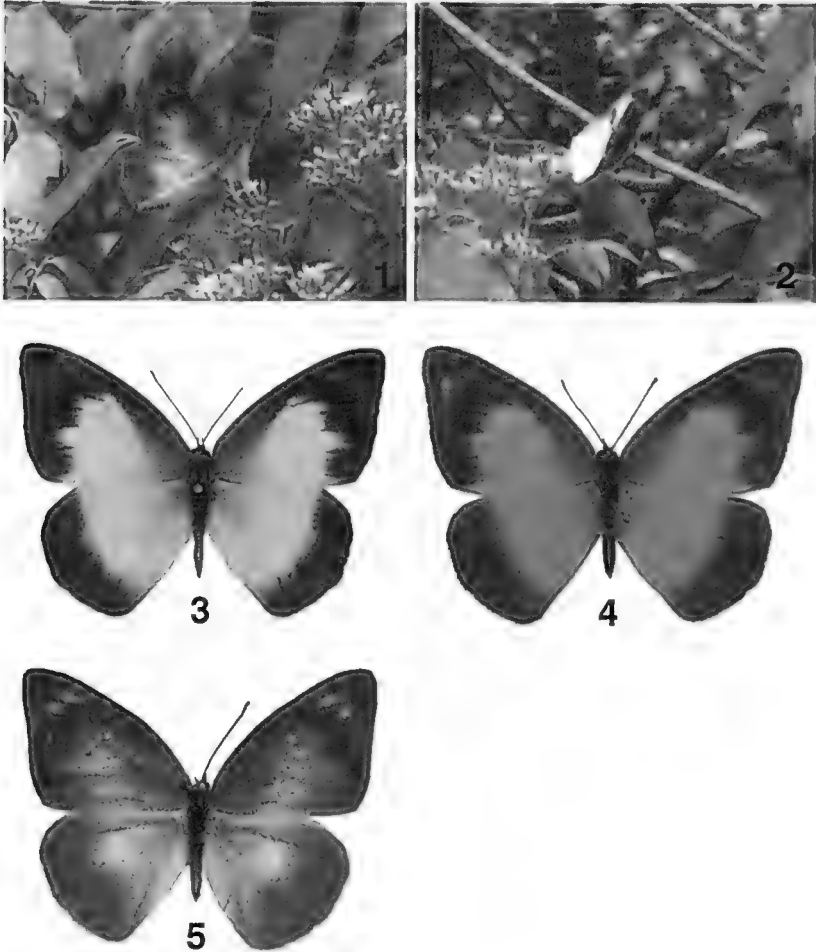
Examination of digital images of the butterfly revealed several distinguishing features. The upperside (Fig. 1) was characterised by a broad black margin, with the termen narrowly edged white and the central areas greyish-white. On the fore wing, the black margin extended broadly along the costa and termen, and more narrowly along the dorsum (from tornus to postmedian area); much of the discal cell was also black, but the central and subbasal areas (from postmedian area distal to cell and median area immediately below cell to dorsum and base) were dark greyish-white. The fore wing had the termen slightly concave, and a series of up to four pale subapical spots that were enclosed by the broad black margin, the two spots between veins R₄₊₅ and M₂ being the largest. On the hind wing, the black margin extended broadly along the termen, with the central and subbasal areas (from median area to base) broadly greyish-white. The underside of the fore wing (Fig. 2) was characterised by a conspicuous yellow patch in the cell, beyond which lay a broad black postmedian band that appeared to extend to the termen. The underside of the subapical area of the fore wing and underside of the hind

wing were both uniformly pale grey (the underside ground colour was noted to be pale grey during the observation period and not white as portrayed in the photo – the white colouration was probably due to reflection of light).

Discussion

We have identified the specimen as *Appias albina infuscata* Fruhstorfer, 1910 based on comparison of types of the genus *Appias* and other material held in the Natural History Museum, London (BMNH). Females of this subspecies are highly variable, but the 'wet-season form' is characterised by having very broad black margins on both wings, which on the fore wing enclose only a few faint subapical spots or sometimes no spots (Yata 1985). They also vary in colour with respect to the central and basal areas on the upperside, which may be either white (Fig. 3), yellow (Fig. 4) or almost black with some greyish-white (Fig. 5). The individual female recorded from near Darwin most closely resembles the holotype of *Appias albina ambigua* form *saweloides* Fruhstorfer, 1910 (Fig. 5), which is an infrasubspecific and unavailable name for *Appias albina infuscata* (Yata *et al.* 2010). This type specimen is almost entirely black and approaches the female black morph of *A. albina albina* from Sulawesi, except that it has some greyish-white scales in the central and basal areas. *Appias albina infuscata* is restricted to the island of Sumbawa, Indonesia, and has not previously been recorded from Australia. The other subspecies of *A. albina* (Boisduval, 1836) that occurs in close proximity to Australia is *A. albina ambigua* Grose-Smith, 1885, previously known under the name *A. albina micromalayana* Fruhstorfer, 1910, which is a junior subjective synonym of *A. albina ambigua* (Yata *et al.* 2010). This subspecies is recorded from eastern Java, Lombok, Sumba, Flores, Timor, Tanimbar and Wetar (type locality), but not the intervening island of Sumbawa (Yata 1985, Yata *et al.* 2010). Although females of *A. albina ambigua* are variable, and the black margins of the 'wet-season form' may be as broad as in *A. albina infuscata*, they are never almost entirely black. Our specimen from north-western Australia (Figs 1, 2) and the holotype of *A. albina ambigua* form *saweloides* (Fig. 5) represent a phenotype that appears to be unique to Sumbawa. This unique phenotype of *A. albina infuscata* and the similar looking black morph of *A. albina albina* from Sulawesi (see Yata *et al.* 2010, Fig. 19P) possibly have a genetic basis.

The specimen photographed near Darwin does not resemble females of *A. albina albina* (Boisduval, 1836) from northern Australia. Although females of *A. albina albina* in Australia are highly variable and are now known to exhibit sex-limited polymorphism, having three distinct colour morphs (white, yellow and intermediate), they do not possess broad black margins with greyish-white central areas on the upperside (Braby *et al.* 2010). In addition, in *A. albina albina* the black terminal band on the hind wing has its proximal edge deeply scalloped between the veins, and occasionally the band is reduced to black spots at the ends of veins, whereas in *A. albina infuscata*



Figs 1-5. Female *Appias albina infuscata*: (1-2) specimen photographed at Humpty Doo, NT, 26 January 2010, showing upperside (1) and underside (2); (3-5) variation in phenotype among 'wet-season forms' from Sumbawa, Indonesia, in the BMNH, showing white morph (3) (syntype, labelled "Sumbawa, Tambora 1897, ex coll. Fruhstorfer", "Fruhstorfer Coll. B.M. 1937-285.", "BMNH(E) #135652", SYNTYPE *Appias albina infuscata* Fruhstorfer, det. J.E. Chainey, 1999"), yellow morph (4) (syntype labelled similarly), and greyish-white morph (5) (holotype of *Appias albina ambigua* form *saweloides* Fruhstorfer, 1910, labelled "Sumbawa, H. Fruhstorfer BMNH(E) #142258, Fruhstorfer purchase BM:1937-285"). Figures 1-2 by A. Worsnop.

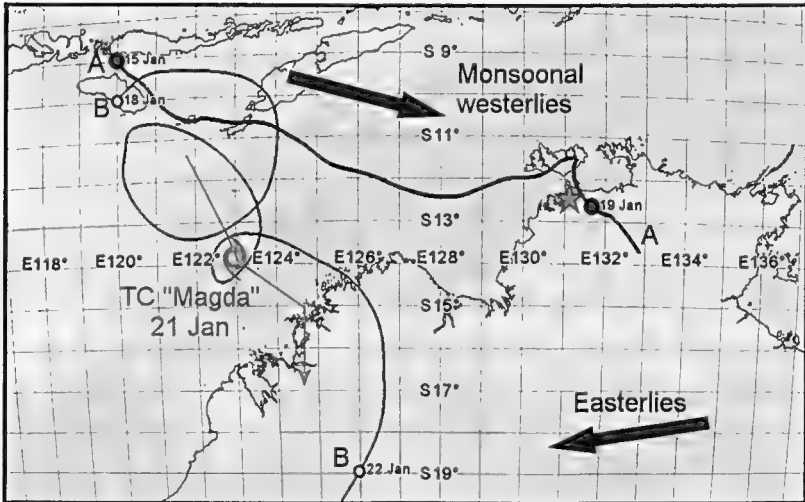


Fig. 6. Map of north-western Australia and the Lesser Sunda Islands, showing two extreme trajectories 'A' and 'B' for January 2010. Star indicates approximate location of specimen of *Appias albina infuscata* near Darwin; broad black arrows indicate prevailing wind directions during January; narrow red arrow indicates approximate path of Tropical Cyclone 'Magda'.

'wet-season form' the inner margin of the black band is relatively straight (Figs 1, 3-5). In both *A. albina albina* and *A. albina ambigua* the black terminal band on the fore wing is strongly indented between veins CuA_1 and CuA_2 , whereas in *A. albina infuscata* 'wet-season form' this indentation is absent or poorly developed.

Braby *et al.* (2010) recently reviewed the distribution and habitat preferences of *A. albina albina* in northern Australia, and concluded that breeding populations of this subspecies are resident. In the Northern Territory, the nominate subspecies inhabits coastal semi-deciduous monsoon vine-thicket where its larval food plant *Drypetes deplanchei* (Brongn. & Gris) Merr. (Putranjivaceae) grows on lateritic edges and cliffs. It is considered unlikely that *A. albina infuscata* is also established in coastal areas of northern Australia; otherwise the two subspecies would be sympatric. Although *Appias* butterflies, including *A. albina*, are well-known for their ability to migrate, Darwin lies 1500 km ESE of Sumbawa, which is quite a formidable distance given the vast ocean of the Timor Sea with few 'stepping-stones' between these geographical locations. The only substantial landmasses between north-western Australia and Sumbawa that could facilitate long-distance dispersal by migration are the islands of Sumba, Flores and Timor. Hence, it is possible that the female specimen of *A. albina infuscata* was a vagrant that migrated well beyond its normal distributional range.

However, since the butterfly was recorded during the height of the summer monsoon it is also possible that the specimen was assisted by strong wind currents. The Australian summer monsoon is part of the large-scale Asian-Australian monsoon system and its arrival in northern Australia is accompanied by westerly trade winds from SE Asia (Bowman *et al.* 2010). In order to test this second hypothesis, we used the HYSPLIT trajectory model (Draxler and Hess 1998), accessed through the US 'Ready' site (Draxler and Rolph 2010). The accuracy of trajectory modelling depends to a large extent on the quality of the input meteorological analysis, but such models have been successfully used in the past to trace pollutants such as volcanic ash clouds for periods of several weeks (Tupper *et al.* 2006). The model allows for the dispersing object or gas to be released at any height above the surface. In our simulations, we chose release heights of within 500 m of mean sea level. January 2010 was an active monsoonal month, with the monsoon trough extending well south, and westerly winds across the Timor Sea. In the third week of the month, the flow regime was somewhat complicated by the formation of Tropical Cyclone 'Magda' south of Timor (Bureau of Meteorology 2010). Assuming the possibility of Sumba, Flores or Timor islands being used as stepping stones, we found several trajectories during January 2010 in which the butterfly could have reached and crossed the north-western Australian coast while staying relatively close to the surface. Figure 6 illustrates two divergent models, with trajectory 'A' (15-19 January 2010) bringing the specimen close to the area where it was found in late January in just over four days. Many similar possible trajectories to 'A' were found during the first two weeks of January. Trajectory 'B' is based on analysis from several days later (18th-22nd January 2010) and presents a more chaotic and overall southerly trajectory introduced to the butterfly's potential trajectory by the formation of TC 'Magda', which crossed the Kimberley on 21st January 2010.

It is therefore likely that dispersal of *A. albina infuscata* across the Timor Sea from Sumbawa to north-western Australia was facilitated by monsoonal trade winds, possibly assisted by the islands of Sumba, Flores or Timor as stepping-stones, rather than by migration. Such a dispersal event would have been more possible during the first half of the month (i.e. ≤ 15 January 2010) than in the second half, owing to the favourable wind conditions at that time, implying that the specimen may have been on the mainland for approximately one week before it was discovered on 26th January 2010.

Acknowledgements

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**DEVELOPMENT OF AN INSECTICIDE BAITING SYSTEM
APPLICABLE FOR THE CONTROL OF EXOTIC *VESPULA*
(HYMENOPTERA: VESPIDAE) WASP SPECIES IN TASMANIAN
FORESTRY OPERATION SITES.**

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Abstract

Forestry activities in Tasmania can be severely affected by the presence of nests and large numbers of foraging workers of exotic *Vespula* wasps. A system of insecticidal baiting for nest destruction is described that provides temporary reduction of wasp numbers during forestry activities. There was a reduction in wasp numbers within a 50-metre radius of the baiting sites that was maintained for the remainder of the wasp season.

Introduction

Two exotic species of vespine wasps are well established in Tasmania. One species, *Vespula germanica* (Fabricius, 1793) is common throughout the state and has been of major pest status since 1959 (Bashford 2001). A second species, *Vespula vulgaris* (Linnaeus, 1758), was discovered in 2000 and has spread rapidly throughout the south of the state (Matthews *et al.* 2000).

During the late summer months vespine wasps are active in large numbers throughout Tasmania. The presence and activity of wasps have adversely affected forestry activities with frequent wasp stings reported. Movement of forest workers out of operational areas due to high populations of vespine wasps is costly, both in time lost and productivity (Shimizu *et al.* 1995). The most severe incidents involve nest disturbance caused by machinery, such as bulldozers used to remove dead standing trees, and manual activities such as pruning, thinning, and seed collection in the vicinity of nests. Multiple stings may result in a dangerous anaphylactic reaction (Perez-Pimiento *et al.* 2007). In Tasmania 27% of people stung by vespine wasps suffer anaphylaxis to some degree (Brown 2004). In addition with the advent of tourism ventures within State Forests, especially picnic and barbecue sites, high populations of vespine wasps severely diminish visitor enjoyment.

Large numbers of wasps within a forestry area generally indicate the presence of a number of nests. Use of fipronil, a slow acting insecticide, in a protein bait station system enables foraging workers to transport bait into the nest, eventually killing the colony (Sackmann *et al.* 2001). Wasps were observed to harvest the protein bait over a one to two day period and accumulate enough insecticide within the nest to greatly reduce the wasp field population and cause nest mortality within five days of baiting. Grant *et al.* (1968) first trialled insecticide-laced protein baits, cooked ground horsemeat containing 1% chlordane, in suburban areas of California, and found them highly effective. Chang (1988) tested a number of insecticide/bait combinations for

area-wide control of *Vespula pensylvanica* Saussure, 1857 within sugar cane plantations in Hawaii. Since then there have been a number of trials using fipronil formulations to control *Vespula* species in New Zealand (Spurr 1996), Argentina (Sackmann *et al.* 2001), Tasmania (Warren & Statham 2002) and South Australia (Glenys Wood, pers. comm.).

This study investigated the efficacy of remote feeding stations baited with fipronil in ground meat for reduction of *V. germanica* and *V. vulgaris* populations by colony destruction in forestry situations. Promising results have resulted in incorporation into operational management.

Methods

Evaluation of protein bases (beef mince, wallaby mince, sardines, sardine based cat food, and chicken nuggets) was made prior to this trial. Other workers had previously recorded the attractiveness of these protein sources in field trials (Sackmann 2001, Spurr 1996, Beggs 1998). In this study observations indicated that fresh ground wallaby mince was visited more frequently than other protein sources and, with the addition of water crystals, did not desiccate as quickly as most other protein sources.

Bait stations were constructed of 30 x 12cm lengths of packing case wood as a base and roof held 15cm apart by walls of Gutterguard® plastic mesh. The plastic mesh was stapled to the wood sections with one side unstapled to allow bait placement inside the cage. The mesh size of 1cm² provided easy access to wasps. Traps were suspended 1.5 metres above the ground from a convenient branch using piano wire.

The bait selected consisted of 500g minced wallaby meat marinated overnight in a 500ml 0.1% (w/v) solution of the phenyl pyrazole, Fipronil (Termidor® 100SC) provided by Aventis CropScience Pty Ltd. Marinated mince bait was drained and mixed with water absorbent crystals (Nylex® Water Crystals, active constituent 80% Acrylamide co-polymer) at a rate of 3g crystals per 500g mince. Water crystals reduced the rate of desiccation of the protein bait in the traps, doubling the length of time they were attractive to wasps in the field. The mince mixture was divided into 20g blocks and individually packaged in zip-lock bags. These blocks were stored in the fridge for use within a few days or in the freezer for longer-term storage.

Following the methods of Beggs *et al.* (1998), a bait station was located in the middle of each of two recently logged coupes (WR001B and WR008H) in the Warra LTER site (146° 40'E, 43° 04'S) in southern Tasmania. A third recently logged coupe (WR008B) served as a control site with non-baited Malaise traps set up as in the other coupes. A Malaise trap was placed a few metres away from each bait station and additional Malaise traps set in a transect line at distances of 50 and 100 metres from the bait station. A total of five Malaise traps were used in each transect. At the control coupe Malaise

traps were set up at the same distances apart but without a bait station. Malaise traps were run from October to June in 1999/2000 and 2000/2001. The traps were emptied every month and on a weekly basis for three weeks following each baiting period and the numbers of vespine wasps counted. In late summer when natural protein sources were depleted and wasp populations high, baits would be quickly found and eaten.

Bait stations were run for three days on each of three occasions (4-6th December 1999 when queens were active following overwintering, 24-26th March 2000 and 17-19th March 2001 when workers were very active). After three days the bait blocks were inspected and the traps removed. Wasps located the bait stations within several hours eliminating the need to pre-bait the area. D'Adamo *et al.* (2003) demonstrated that once *V. germanica* located a bait source the visual stimulus of wasp activity guided other workers to that site resulting in rapid removal of the bait.

Results

The initial baiting in December 1999 appeared to have little influence on the numbers of queens captured in Malaise traps as there were similar numbers of queens captured at baited and control sites (Table 1). Queens were observed visiting the baits but very little bait was removed as the blocks appeared relatively intact on the third day. This may indicate that foraging queens are not focussed on protein collection but perhaps spend more time collecting wood pulp for nest construction (Ravaret-Richter 2000).

Table 1. Effect of insecticide baiting on *Vespula germanica* queens following overwintering.

Coupe	Treatment	Number of queens in Malaise trap			
		Week prior to baiting	Week following baiting	Three weeks after baiting	Nine weeks after baiting
WR001B	Baited	2	5	15	9
WR008H	Baited	0	3	11	9
WR008B	Not Baited	3	3	7	9

At the two treatment sites, baiting in March of both years resulted in a marked decrease in the number of wasps collected in Malaise traps within 50 metres of the bait station. Figure 1 illustrates the mean number of wasps collected combined for both baited sites pre- and post-baiting versus the control site. In both cases most of the bait was removed from the bait station during the first day and in all cases no bait remained on day three. The populations of wasps at these sites did not recover appreciably in the three weeks following baiting in either year.

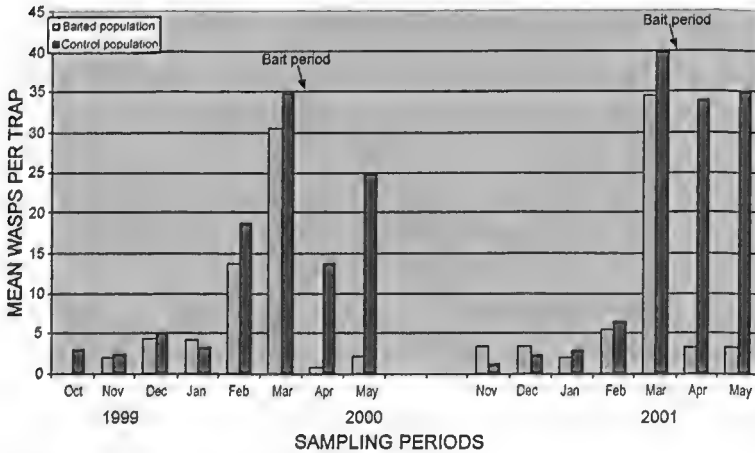


Fig. 1. Impact of baiting on *Vespa* populations.

At the baiting sites (WR001B and WR008H) wasp numbers in Malaise traps in the immediate vicinity of the bait traps declined on average by 98% within one week of baiting. After three weeks the reduction in the Malaise trap catches was still 96-98% of the pre-baiting. In contrast at the control site (WR008B) the wasp numbers in Malaise traps at the centre of the coupe had increased by an average of 23.5% after three weeks across both years.

At 50m from the bait station wasp captures in the baited coupes declined by 90-91% one week after baiting and by 77-90% after three weeks, compared with the control coupe where wasp captures after three weeks were similar to the initial levels.

At 100m from the bait stations wasp captures one week after baiting declined by 56% in one coupe but increased by 5% in the other. The control had increased by 23%. After three weeks one coupe had a reduction of 34% but the other coupe had an increase of 55%. The control had increased in population by 14%. Due to insufficient replication it is difficult to determine any impact at the 100-metre range.

There was a marked reduction in wasp numbers at the baiting site and the 50-metre distance from both baiting sites which persisted for at least three weeks.

Discussion

Since arriving in Tasmania in 1959, the European wasp, *V. germanica*, has spread throughout the state (Bashford 2001). The wasp colonises all open or partly shaded sites where nest construction is possible. The discovery of a second vespidae species, the common wasp, *V. vulgaris*, in Tasmania

Table 2: Impact of insecticide baiting on numbers of *Vespula germanica* workers.

Coupe		Number of wasps captured					
		WR001B		WR008H		WR008B	
Treatment		Baited		Baited		Control-not baited	
Year		2000	2001	2000	2001	2000	2001
Bait station Malaise trap	Pre bait	41	35	31	24	31	50
	One week post baiting	1	0	0	1	15	48
	Three weeks post baiting	0	1	1	1	35	7
50 metres Malaise trap	Pre bait	31	46	19	33	22	37
	One week post baiting	1	7	1	4	19	29
	Three weeks post baiting	3	4	5	7	25	36
100 metres Malaise trap	Pre bait	31	28	42	48	27	56
	One week post baiting	23	39	3	37	32	70
	Three weeks post baiting	31	31	10	49	33	62

(Matthews *et al.* 2000) is of increased concern to forestry workers since it also inhabits closed canopy areas of the forest, thus potentially increasing the distribution of exotic vespine wasps in the state. Currently *V. vulgaris* is restricted to the south and central north of the state where it competes for nest sites with *V. germanica*, and therefore has thus not necessarily resulted in overall increases in *Vespula* populations.

However *V. vulgaris* is able to form nests and forage in closed canopy forests adjacent to open sites. This has resulted in an increase in the land area occupied by introduced vespine species and in wetter forest types utilised by the forest industries.

Both visual and olfactory cues are important to wasps seeking prey. Gaul (1952) reported upwind flights to carrion as an important location technique.

December baiting was investigated following the work of Grant (1963) who suggested that baits applied early in the wasp season would serve to reduce populations of queens that had overwintered and thereby reduce nest establishment. This trial suggests that this is probably not the case, as very few queens were attracted to the baits in December.

Spurr (1997) using a sardine based cat food containing sulfluramid, found that wasp numbers were reduced by up to 90% within 10 days, while Sackmann (2001) reported 87% reduction in wasp numbers, using a bait consisting of 0.1% fibronil-laced minced beef, results comparable to those reported here. In pre-testing of protein bases the current study found that in warm weather both sardines and sardine based cat food developed hard crusts within hours of exposure, rendering them unattractive to wasps, while chicken nuggets were rarely visited. Initially, there was little difference between fresh minced beef and minced kangaroo meat in their attractiveness to wasps. However the kangaroo mince maintained its 'attractiveness' for several days longer than minced beef when both were mixed with water crystals. In areas of low nest density the addition of water crystals ensured the baits stayed attractive over a longer period enabling foraging workers to find and remove the baits.

The data obtained from the current study showed that bait stations reduced high population densities by at least 77% over a radius of 50 metres. However the results need to be verified by a more substantial trial incorporating sufficient replication to provide a robust analysis of the data.

Forestry operations such as harvesting and road building provide numerous opportunities for vespine wasps to establish nests. Subsequent operational activities at these sites result in disturbance of foraging wasps and nest sites. Forestry workers have been stung and high population numbers have resulted in cessation of work activities. For forestry operations involving manual labour such as pruning or thinning, it is recommended that bait stations be established at 100m spacing along transects within coupes at least one week prior to work commencement. Prior to thinning and pruning operations surveys should be conducted to determine tree selection and areas and observations of wasp activity made during these surveys to enable a decision on the need for wasp treatment. Following baiting there would be at least a three-week period when operations could be conducted without being affected by foraging wasps.

The baiting system detailed in this paper has been adopted by forestry planning managers in Tasmania and is used in both hardwood and softwood coupes prior to thinning and pruning operations where high wasp populations have been reported.

Acknowledgements

My thanks to members of the National European Wasp Workshop who assisted with the initial field testing of baits at the Warra LTER site. Phil Morrow (Bayer International) recommended and provided the Termidor^R insecticide for the trials.

This research was conducted under permit number PER7341 (for experimental use of Fipronil in eucalypt plantations for the control of

European and Common wasps) obtained from Australian Pesticides and Veterinary Medicines Authority. I appreciate comments from Dr Tim Wardlaw (Forestry Tasmania) on an earlier draft of this paper. Two referees added greatly to the comprehension and layout of this paper.

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**A SUMMARY OF RECENT TAXONOMIC CHANGES IN THE
GENUS *CHRYSOLARENTIA* BUTLER, 1882 (LEPIDOPTERA:
GEOMETRIDAE)**

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Recently a checklist of species of the genus *Chrysolarentia* Butler, 1882 was published in the *Victorian Entomologist* (Edwards and Marriott 2010). Several taxonomic decisions were made which affect the standard checklist of Australian Lepidoptera (Nielsen *et al.* 1996). Justifications for decisions are provided in the original paper. A summary of the changes made is as follows:

1. *C. insulsata* (Guenée, [1858]) and *C. correlata* (Walker, 1862), treated as synonyms by McQuillan and Edwards (1996) are reinstated as separate species.
2. *C. argodesma* (Meyrick, 1891) is placed in *Chrysolarentia*.
3. *C. pentodonta* (Lower, 1915) is transferred to *Chrysolarentia* and treated as a junior synonym of *C. gypsomela* (Lower, 1892).
4. *C. trygodes* (Meyrick, 1891), *C. crocota* (Turner, 1904) and *C. phaulophanes* (Turner, 1936) were listed as separate species in Nielsen *et al.* (1996). The latter two are considered junior synonyms of *C. trygodes*.
5. *C. tristis* (Butler, 1882) and *C. caesia* (Turner, 1904) represent the two sexes of the same species with the former taking priority.

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TWO NEW SPECIES OF THE ENDEMIC AUSTRALIAN GOBLIN SPIDER GENUS *CAVISTERNUM* (ARANEAE: OONOPIDAE) FROM QUEENSLAND

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Abstract

Two new species, *Cavisternum federicae* sp. nov. and *Cavisternum monteithi* sp. nov. are described, taking the number of species in this endemic Australian genus to 21 (Baehr *et al.* 2010). *C. federicae* sp. nov. is the first species collected in rainforest.

Introduction

The Oonopidae is a megadiverse spider family with over 600 described species in 76 genera (Platnick 2010) and about 2500 expected species worldwide. These small spiders (0.5-4.0 mm), commonly known as goblin spiders, possess only 6 eyes and generally have an armour of abdominal scutae. They are quite common in most terrestrial habitats, in litter, under bark and even in forest canopy (Platnick and Dupérré 2009a, b). The goblin spider fauna is most diverse in the tropical and subtropical regions (Platnick and Dupérré 2010) but they also occur in high altitudes of the Himalayan Mountains (Baehr and Ubick in press).

Species of *Cavisternum* are united by the peculiar morphology of the male mouthparts and sternum. In particular, the sternum has a concave depression covered with clavate setae and the fangs are broadened at the tip (Baehr *et al.* 2010). The genus is found in tropical northern Australia and shows high endemicity, with most species recorded from only a single location (Baehr *et al.* 2010). This paper is part of the world-wide revision of the family Oonopidae, conducted by the "Goblin Spider PBI" project (see <http://research.amnh.org/oonopidae/>). Spiders of this recently described genus have been found in pitfall trap samples, litter extractions and on bark. They occur over the northern part of Australia. The majority of locations from which these spiders were collected are generally low rainfall sites, with open woodland vegetation.

Material and Methods

Specimens were examined using a LEICA MZ16A microscope. Photomicrographic images were produced using a Leica DFC 500 and the software program AutoMontage Pro Version 5.02. The description was generated with the aid of the PBI descriptive goblin spider database

mentioning only the differences to the genus description. Drawings are done from left palp. All measurements are in millimetres. Scales of drawings are 0.5 mm for habitus lateral and 0.1 mm for palps. Abbreviations are used in the text as follows: ALE, anterior lateral eyes; PLE, posterior lateral eyes; PME, posterior median eyes.

Systematics

Family Oonopidae Simon, 1890

Cavisternum Baehr, Harvey and Smith, 2010.

Type Species: *Cavisternum clavatum* Baehr, Harvey and Smith, 2010:
6-13; figs. 1, 4, 7, 26-83; map1.

Diagnosis: Males of this genus can easily be recognized and separated from all other oonopid genera by the concave sternum covered with clavate setae (Figs 2, 5) and the fangs with broadened tips.

Cavisternum federicae sp. nov.

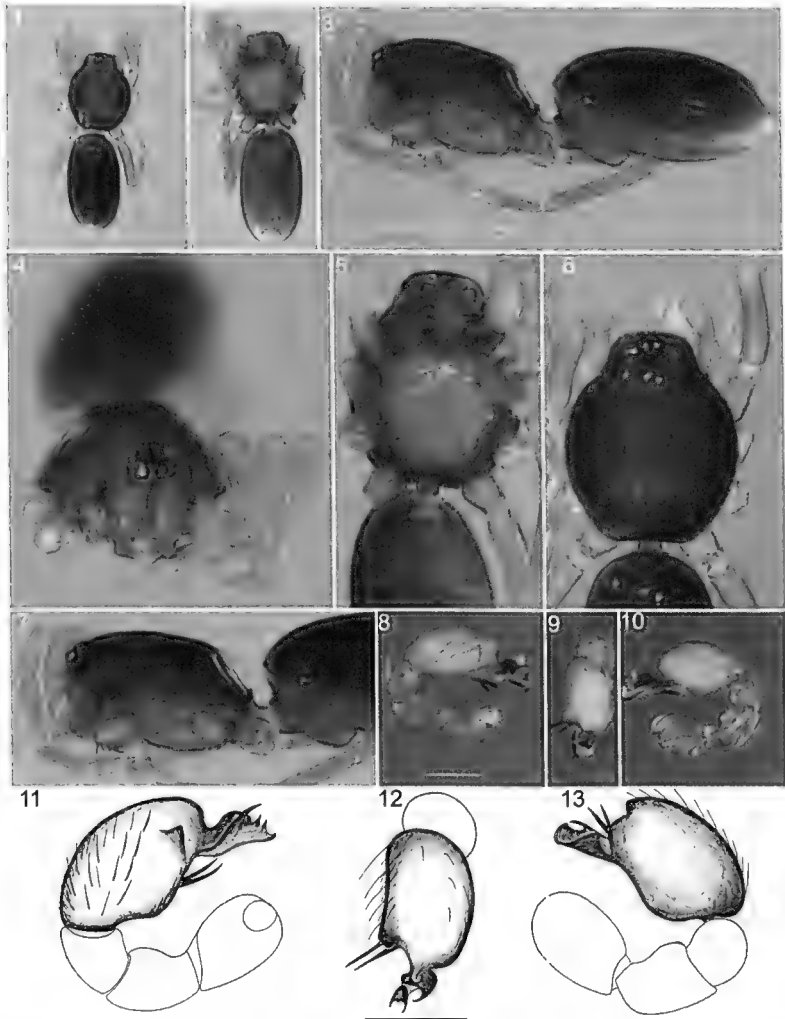
Figures 1-13, 27

Holotype: AUSTRALIA: Queensland, Capricorn Caves, campground, 100m rainforest, 23°26'S, 150°49'E, barkspray (15 April 2010, G. Monteith, F. Turco) (PBI_OON 00023431), deposited in QM (S88300).

Etymology: The species name is an eponymous noun in the genitive case in honour of Dr Federica Turco, an extraordinary beetle expert who collected the holotype.

Diagnosis: Males resemble those of *C. rochesteriae* with median concavity occupying about 2/3 of sternal length, 2/3 of sternal width and epigastric scutum protruding but can be easily separated by the complex bulbal tip with a conductor consisting of two equally long prolateral projections and a complex folded embolus (Figs 8-13).

Male: Total length 1.20. Carapace, mouthparts and abdominal scutae red-brown, without any pattern (Figs 1-3), pars cephalica slightly elevated in lateral view (Fig. 7), carapace lateral margin with blunt denticles (Fig. 6). Clypeus margin slightly rebordered (Fig. 4), vertical in lateral view. Eyes ALE:0.045; PME:0.051; PLE:0.044, ALE circular, PME oval, PLE circular; posterior eye row straight from both above and front; ALE separated by their radius to diameter, ALE-PLE touching, PME touching for less than half their length, PLE-PME touching. Sternum, pale orange, uniform, not fused to carapace, median concavity occupying about 2/3 of sternal length, 2/3 of sternal width covered with field of clavate setae (Fig. 5). Chelicerae straight, anterior face unmodified; fang tip distally widened. Labium and endites much more heavily sclerotized than sternum. Endites anteromedian part strongly excavated with medially directed tooth-like projection. Abdomen cylindrical, rounded posteriorly. Epigastric scutum not extending far dorsal of pedicel.



Figs 1-13. *Cavisternum federicae* sp. nov., male (PBI_OON_23431): (1) Habitus, dorsal view; (2) Same, ventral view; (3) Same, lateral view; (4) Prosoma, frontal view; (5) Same, ventral view; (6) Same, dorsal view; (7) Same, lateral view; (8) Palp prolateral view; (9) Same, dorsal view; (10) Same, retrolateral view; (11) Palp (drawing) prolateral view; (12) Same, dorsal view; (13) Same, retrolateral view.

Scutae weakly sclerotized, covering full length of abdomen, no soft tissue visible from above, not fused to epigastric scutum, surface smooth. Postepigastric scutum covering nearly full of abdominal length. Legs yellow,

without colour pattern; patella plus tibia I shorter than carapace. Epigastric region with small sperm pore, strongly protruding extension between sperm pore and anterior spiracles. Palp proximal segments yellow; embolus dark, femur attaching to patella basally (Figs 8, 10, 11, 13); patella about as long as femur; cymbium square in dorsal view (Figs 9, 12), cymbium-bulb complex square with big additional cymbial prodistal tooth, bulbal tip with a conductor consisting of 2 spine-like prolateral projections, with a complex, folded embolus (Figs 11, 13).

Female: Unknown.

Distribution: Known only from the type locality in south east Queensland.

Cavisternum monteithi, new species

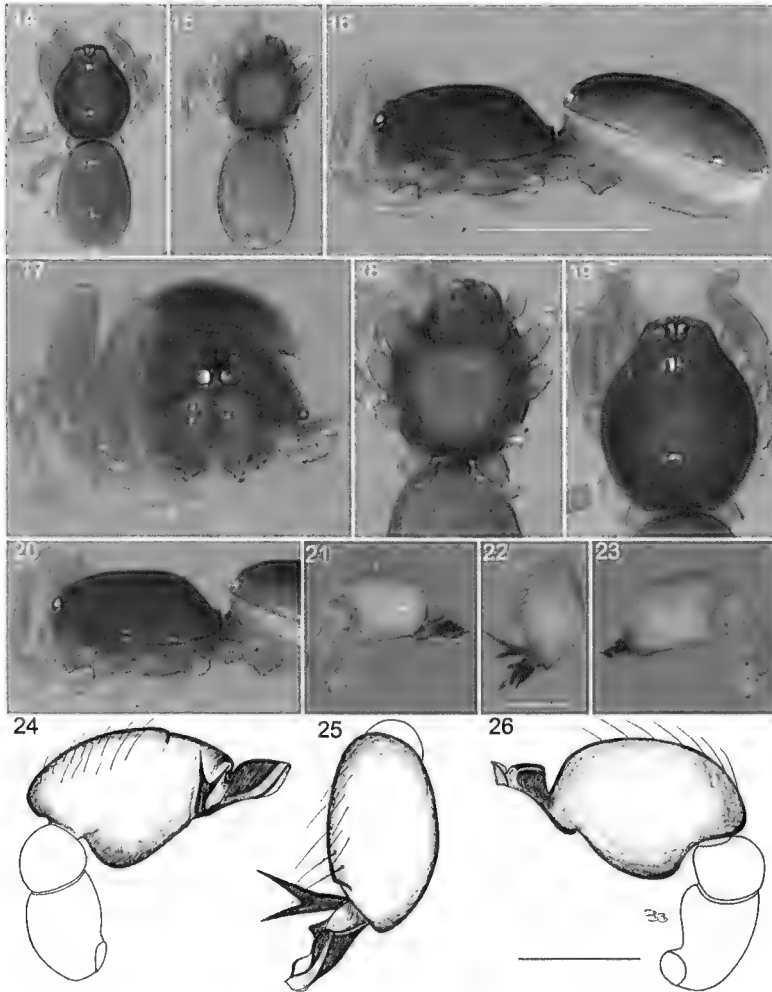
Figures 14-27

Holotype: AUSTRALIA: Queensland, Barakula SF. Stockyard Rd., 26°32'S, 150°44'E, barkspray (10 Feb. 2010, G. Monteith, F. Turco) (PBI_OON 00023434), deposited in QM (S88459).

Etymology: The species name is an eponymous noun in the genitive case in honour of Dr. Geoff Monteith, former Senior Curator of the Queensland Museum and a tremendous collector of invertebrates who collected the holotype.

Diagnosis: Males resemble those of *C. rochesteriae* in having a cymbial prodistal tooth but can be separated by the median concavity occupying about 3/4 of sternal length, 1/2 of sternal width, the strongly protruding epigastric scutum (Figs 15, 18) the complex bulbal tip with bifurcal conductor and curled embolus (Figs 21-26).

Male: Total length 1.17. Carapace and scutae brown, lateral margin without denticles; ALE:0.046; PME:0.048; PLE:0.041, ALE circular (Fig. 17), PME squared, PLE circular; posterior eye row straight from above (Fig. 19); ALE separated by less than their radius, ALE-PLE touching, PME touching throughout most of their length, PLE-PME touching. Sternum pale orange, with oval median concavity covering 3/4 of sternum length and 1/2 of sternum width (Fig. 18). Chelicerae, endites and labium yellow-brown. Endites distally excavated, anteromedian part deeply indented with tooth like projection medially. Abdomen ovoid (Fig. 14). Epigastric scutum strongly protruding (Figs 16, 20). Postepigastric scutum covering nearly full length of abdominal length (Fig. 15). Legs yellow, patella plus tibia I shorter than carapace (Fig. 20). Epigastric region with small, oval sperm pore; midway between sperm pore and anterior spiracles a strongly protruding extension (Fig. 18). Palpal femur attaching to patella subbasally (Fig. 21); patella about as long as femur; cymbium with prodistal knob (Fig. 25), bulb pear-shaped, bulbal tip with bifurcate conductor and curled embolus (Figs 24-26).



Figs 14-26. *Cavisternum monteithi* sp. nov., male (PBI_OON_23434): (14) Habitus, dorsal view; (15) Same, ventral view; (16) Same, lateral view; (17) Prosoma, frontal view; (18) Same, ventral view; (19) Same, dorsal view; (20) Same, lateral view; (21) Palp prolateral view; (22) Same, dorsal view; (23) Same, retrolateral view; (24) Palp (drawing) prolateral view; (25) Same, dorsal view; (26) Same, retrolateral view.

Female: Unknown.

Distribution: Known only from the type locality in south east Queensland.



Fig. 27. Distribution of *Cavisternum federicae* sp. nov. (circle) and *Cavisternum monteithi* sp. nov. (square) in Australia.

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BOOK REVIEW

A Guide to the Beetles of Australia by George Hangay and Paul Zborowski. CSIRO Publishing, Melbourne, 2010, 248 pp., \$44.95.

This attractive book is the latest addition to the soft-covered, semi-popular, handbook series on Australian insects from CSIRO Publishing which, since 2004, has covered butterflies (2004), dragonflies (2006), moths (2007) phasmids (2009) and katydids (2010). The size of the particular group covered governs the sort of treatment received. Thus the butterflies, dragonflies and phasmids are treated to species level and enjoy the title "*The Complete Field Guide to...*" whereas the more numerous moths and katydids are given an overview treatment and are called simply "*A Guide to...*". Having more than 30,000 Australian species the megadiverse beetles fall very much into the latter camp, and thus we have another "*Guide...*" before us.

The authors have made an heroic attempt to get across this enormous group of animals in a small guide book and they have both succeeded and failed. The photographic coverage is very good and almost 90 families are shown in more than 400 colour photographs, many of them for the first time in an Australian publication. However the good coverage has come at the price of rather too many being apparently dead specimens, probably taken at light and posed on out-of-context green leaf backgrounds, examples being the crumpled specimens of *Talyra* on p.168 and *Titaena* on p.179. The geographic coverage of photographed species is very much slanted to north Queensland where Paul Zborowski resides; fine by us Queenslanders but probably disappointing for readers elsewhere. The accuracy of identification of the images is reasonable given the fraught task involved in putting names to Australian beetles. There's a smattering of errors but the most outstanding is that of the exciting picture by Owen Kelly of a living specimen of the extremely rare *Omma stanleyi* (Ommatidae) which is attributed to a species in another family (Cupedidae).

The body text has a long illustrated introduction dealing with many general aspects of beetles including life histories, food, behaviour and anatomy. The anatomy section has a rather strange depiction of the dorsal sclerites of the head which needs revision. One important omission from morphology is an explanation of the basic strial pattern on beetle elytra which is critical to the classification of many groups. In the description of antennal types the term "plumose" is incorrectly used for ptilodactylid antennae and should be "flabellate".

At the core of the book are the family treatments. These use up-to-date definitions of the families which is one of the positives of the book. A lot of unfamiliar overseas common names are used for families and these are probably a lost cause in Australia. For example I fear it is too late to try to bring in the name "shining leaf chafers" for the Rutelinae which we have known familiarly as "Christmas beetles" for more than a century.

However, notwithstanding these several obvious flaws, the book is a long way ahead of any alternative in Australia for popular treatment of our enormous beetle fauna and should be bought, read and used. It needs a lot of minor corrections and I'm sure that these will be brought to the attention of the authors, and we can look forward to an improved second edition in due course.

Geoff Monteith, Queensland Museum

THE IDENTITY OF *SELIDOSEMA ZYGOPHORA* LOWER, 1893 (LEPIDOPTERA: GEOMETRIDAE: ENNOMINAE)

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Abstract

The Australian *Selidosema zygophora* Lower is shown to be a junior subjective synonym of *Pseudocoremia suavis* (Butler) from New Zealand. *P. suavis* is a very common insect in New Zealand and a significant pest of *Pinus radiata* plantations. In view of the fact that the two specimens mentioned by Lower are the only ones known from Australia it is conjectured that they are mislabelled specimens from New Zealand and it is recommended that the name should be omitted from the Australian list.

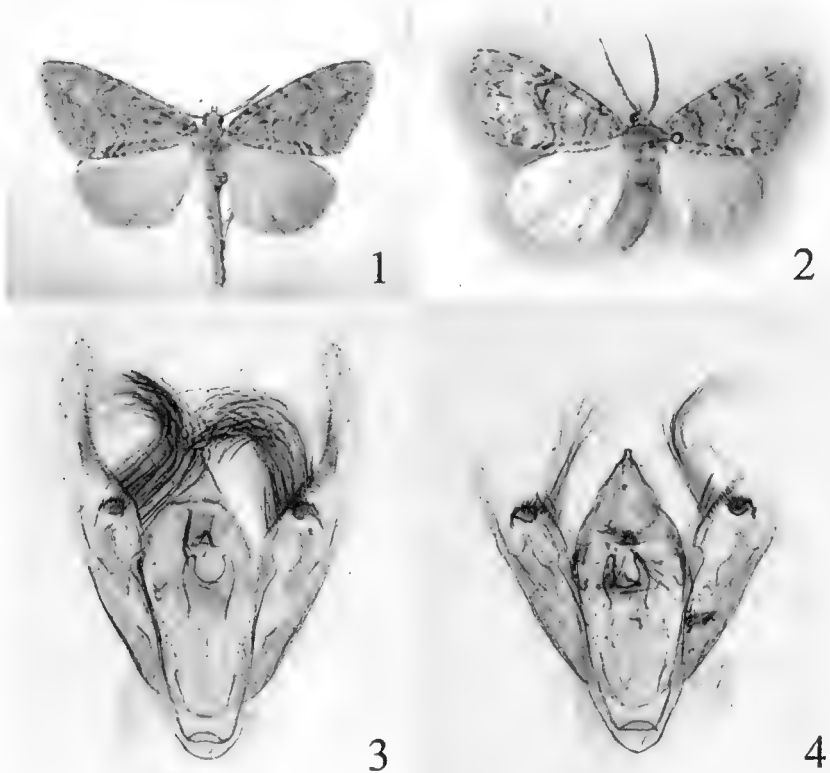
Introduction

Selidosema zygophora Lower, 1893 was described from two specimens collected by Mr W.H.F. Hill at Croydon, Victoria. One of these specimens was given to Oswald Lower by Hill. The Lower collection in the SAMA contains a single specimen labelled as *Selidosema zygophora*. In the preparation of the *Checklist of the Lepidoptera of Australia* (McQuillan & Edwards 1996) this species posed a problem. There were no conspecific specimens in the ANIC nor were specimens subsequently found in the MV (Marriott and Hewish pers. comm.) or other collections examined. The syntype in the SAMA was the only known extant specimen and the specimen retained by Hill appeared to be lost. The species clearly did not belong in the genus *Selidosema* (a European and North African genus with type species *Geometra plumaria* [Denis & Schiffermüller, 1775]) (Scoble 1999) and was equally clearly not closely related to any other known Australian taxon. In the absence of further information it was placed in an unknown genus at the beginning of the Ennominae, Boarmiini.

Interest in the species revived in the early stages of preparation of the Geometridae section of *Moths of Victoria* where clearly the species had to be accounted for. By coincidence a chance examination of Hudson (1928), in which pl. XVI fig. 18 depicted a moth very similar to a photograph of the syntype of *S. zygophora*, led to the hypothesis that *S. zygophora* was in fact a New Zealand moth. This illustration was identified by Hudson as *Selidosema suavis* Butler, 1879. The genus *Pseudocoremia* Butler, 1877 (type species *Selidosema fragosata* Felder & Rogenhofer, 1875, a junior subjective synonym of *Larentia productata* Walker, 1862) was adopted in New Zealand for *P. suavis* and its relatives about 1975 (Dugdale 1975).

This tentative identification was subsequently checked by dissection of the syntype and comparison with identified modern New Zealand specimens.

The following abbreviations are used for the Australian National Insect Collection (ANIC), the Museum of Victoria (MV), the New Zealand Arthropod Collection (NZAC) and the South Australian Museum (SAMA)



Figs 1-4: (1) Adult male, *Pseudocoremia suavis*, Mahinapua, NZ (NZAC) (Wingspan 31mm); (2) Lectotype *Selidosema zygophora* (SAMA) (Wingspan 32mm); (3) Male genitalia (aedeagus omitted), *P. suavis*, Laingholm, NZ (NZAC); (4) Male genitalia (valvae broken and aedeagus omitted), Lectotype, *S. zygophora* (SAMA).

Identification

The genus *Pseudocoremia* contains a suite of at least 27 New Zealand species (Dugdale 1988, Stephens & Gibbs 2003, Stephens *et al.* 2007), one from Norfolk Island and one from the Chatham Islands. Characters which permit the identification of *P. suavis* include the markedly outward bend in the median lines of the forewing when approaching the dorsum, these lines are darker near the dorsum, the male genitalia (the form of the valva, the processes on the valva and the juxta) and the form of the fovea (Dugdale pers. comm.; Stephens 2001). The syntype of *S. zygophora* and the modern

New Zealand specimens of *P. suavis* (Figs 1-4) agree very closely in these features except that the syntype has had the tips of the valvae damaged at some time in the past. These specimens also agree closely with the illustrations of *P. suavis* male genitalia given by Stephens (2001). The agreement of these characters leaves no doubt that *P. zygophora* and *P. suavis* are conspecific. Fortunately the name *P. suavis* has 14 years priority over the name *P. zygophora*.

Type

In order to fix the identity of *S. zygophora* Lower the syntype labelled "Sel: zygophora Lower 2497" "Type" "2497 Caulfield" "Specimen photog for Checklist Aust. Lep. Film 28/11" "SAMA Database Number 31-001789" in the SAMA, Adelaide, is here designated as LECTOTYPE.

Discussion

Lower's unpublished collection registers, both the superseded one and the final one, contain the entry "zygophora" without further information and without a Lower species number. However the labels on the SAMA specimen do have a Lower species number, namely 2497. It is noteworthy that the locality label of Caulfield on the specimen also bears Lower's number so it is not an original locality label received from Hill. In his original description Lower did not give "Caulfield" which is on the label but gave "Croydon, Victoria". This discrepancy adds credence to the hypothesis that the specimen may be a mislabelled New Zealand specimen. However Reed (2002) mentions no place in New Zealand of the name of Caulfield although there is a Croydon beside the Hokonui Hills and there is a nearby forest remnant, Croydon Bush, in Southland. Hill lived at Windsor, Victoria, which is near Caulfield and both are southeast of the City of Melbourne, but Croydon is some distance away to the east of the City, although Hill did collect widely on what was then the eastern outskirts of Melbourne and near Ballarat.

P. suavis is a common widespread species found throughout New Zealand except the Subantarctic Islands (Hudson 1928, Dugdale 1958). Its biology has been recorded by Hudson 1928, Dugdale 1958 and Berndt *et al.* 2004, and it is known to feed on a wide range of trees and shrubs including *Kunzea*, *Leptospermum*, *Metrosideros*, *Nothofagus*, *Phyllocladus*, *Podocarpus* and the introduced *Cupressus*, *Eucalyptus*, *Pinus* and *Pseudotsuga* among many others (Dugdale 1958). In New Zealand it is a significant defoliator of plantations of *Pinus radiata* with periodic outbreaks causing severe damage (Zondag 1968, White 1974, Kay 1983). It is not confined to forests and is also common in suburbia.

Conclusion

S. zygophora is a junior subjective synonym of *P. suavis*. In view of its ubiquity and pest status in New Zealand it is very unlikely that a cryptic population has persisted in Melbourne for 117 years without rediscovery. It is

therefore concluded that the species is no longer present, if it ever was, in Australia and that the specimens supposedly from Australia are, in all probability, mislabelled New Zealand specimens. The species can be omitted from the Australian list.

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