



<http://dx.doi.org/10.11646/zootaxa.3881.3.3>

<http://zoobank.org/urn:lsid:zoobank.org:pub:4B7B9770-424F-45A5-8244-67781C74728F>

A new Australian genus and five new species of Rogadinae (Hymenoptera: Braconidae), one reared as a gregarious endoparasitoid of an unidentified limacodid (Lepidoptera)

DONALD L. J. QUICKE^{1,5}, MARK R. SHAW², CORNELIS VAN ACHTERBERG³,
KEITH P. BLAND², BUNTIKA A. BUTCHER¹, RICHARD LYSZKOWSKI² & Y. MILES ZHANG⁴

¹Department of Biology, Faculty of Science, Chulalongkorn University, BKK 10330, Thailand. E-mail: d.quicke@email.com

²Department of Natural Sciences, National Museums of Scotland, Edinburgh EH1 1JF, UK

³Afdeling Terrestrische Zoologie, Naturalis Biodiversity Center, Postbus 9517, 2300 RA Leiden, The Netherlands

⁴Department of Entomology, 213C Animal Science Building, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada

⁵Corresponding author. E-mail: d.quicke@email.com

Abstract

Teresirogas Quicke & Shaw **gen. nov.** (type species *T. australicolorus* Quicke & Shaw **sp. nov.**) is described and illustrated, based on a series recently reared gregariously from a cocooned mummy of an unidentified species of Limacodidae collected under loose *Eucalyptus* bark in New South Wales, Australia. Older reared and unreared congeneric specimens represent four additional species, *T. billbrysoni* Quicke & van Achterberg **sp. nov.**, *T. nolandi* Quicke & Butcher **sp. nov.**, *T. prestonae* Quicke & van Achterberg **sp. nov.**, and *T. williamsi* Quicke & van Achterberg **sp. nov.**, which are also described and illustrated. Three of these additional species have also been reared from Limacodidae cocoons on *Eucalyptus*, with one, perhaps erroneous, record suggesting a saturniid host. Molecular analysis confirms the placement of the new type species of *Teresirogas* in the tribe Rogadini, as inferred initially from the claws with pointed basal lobe and host relationships of some of the species, but one species has the claw character poorly developed which had made its affinities uncertain before the more recently reared and sequenceable material became available.

Key words: Hymenoptera, Braconidae, new genus, new species

Introduction

The first and third authors (DQ & CvA) have been aware for some time of an undescribed Australian genus probably belonging to the Rogadinae mostly from old specimens in the Natural History Museum, London, the Australian Museum, Sydney and the Australian National Insect Collection, Canberra. However, its relationships were not easily discerned. Its lack of a prepectal carina, the entirely smooth and undifferentiated mid-basal area on the 2nd metasomal tergite, and the greatly reduced occipital carina (broadly absent dorsally and ventrally) would allow it to key to the Opiinae in several identification works (e.g. van Achterberg 1993, Wharton *et al.* 1997). If it was a member of the Rogadinae, as its general Gestalt suggested, variation in an important morphological character, the presence/absence of a pointed basal lobe on the claws, and also of the sometimes greatly swollen male maxillary palp segments, again made assessment of its affinities difficult. Fortunately, the fourth author (KPB) recently collected a mummified limacodid prepupa in its cocoon under loose *Eucalyptus* bark which, in addition to revealing the host group, both unequivocally showed that the new genus (or at least its type species) was gregarious and provided fresh material for molecular analysis. Mummification of lepidopteran host caterpillars or prepupae is a characteristic of the Rogadinae, some of which are known to be gregarious, whereas opiines are exclusively parasitoids of Diptera and—as far as is known—invariably solitary. Preliminary BLAST searches with the DNA sequence data (28S rDNA and the barcoding region of cytochrome oxidase 1) obtained from *T. australicolorus* **sp. nov.**, confirm that it is indeed a member of the Rogadinae, and molecular analyses presented here show that it belongs to the tribe Rogadini with 100% Bayesian support.

The recognition here of a new and quite widespread Australian genus of rogadine wasp with several brightly coloured species, all undescribed, and recently another new genus from Papua New Guinea (Quicke et al. 2012), serves to highlight the need for more work on the Australian, and more broadly the Australasian braconid wasp fauna. To date members of only six genera of Rogadinae are definitely confirmed from Australia, viz. *Aleiodes*, *Anachyra*, *Batotheca*, *Heterogamus*, *Spinaria*, and *Yelicones* (Quicke 1995, Quicke et al. 1998, van Achterberg 2007, Yu et al. 2014). Of these, the only one for which the Australian fauna has been revised is *Yelicones* (Quicke et al. 1998). Species placed under the name *Rogas* from older literature most probably belong either to *Aleiodes*, or possibly to *Triraphis*. DQ has seen one additional undescribed new genus from Australia based on a specimen in the NHM, but its condition is very poor indeed and description of this genus will need to await the discovery of fresh specimens.

Institutions housing type material are abbreviated as follows: AMS (Australian Museum, Sydney; Australian National Insect Collection, Canberra (ANIC); National Museums of Scotland, Edinburgh (NMS); Natural History Museum, London (BMNH); Naturalis Biodiversity Center, Leiden (RMNH).

Material and methods

Descriptive taxonomy. Wing vein terminology follows Sharkey & Wharton (1997); other terminology follows van Achterberg (1988). Images of *T. australicolor* **sp. nov.** were made using a Leica MZ16 microscope and phototube with an Olympus C-5060 camera, with multiple images stacked using ZereneStacker. Illustrations of *T. nolani* **sp. nov.** were made using an Olympus SXZ16 microscope with automated multiple image capture at preset focal levels using an Olympus DP72 camera, and image combination using the Cell[^]D image processing system.

Since the species recognised here differ very little in characters other than those mentioned in the identification key, and since each is illustrated with a more or less comparable portfolio of photographs, we have adopted a minimalist verbal description style for each.

Molecular methods. Phylogenetic analyses to assess the relationships of the new genus were carried out on cytochrome oxidase 1 and 28S rDNA sequence data for representative cyclostome braconids, and in particular, members of the Rogadinae. Details of taxa included are given in Appendix 1. Taxon selection was based on representing a taxonomically broad set of Rogadinae genera and putatively closely related subfamilies, with individual species selection governed largely by those species for which sequence data were available for both gene fragments. Trees were rooted with *Rhyssalus clavator* Haliday (Rhyssalinae) since this subfamily has emerged from numerous studies as the most basal of the true cyclostome braconids (Quicke 2014).

DNA protocols. Genomic DNA was extracted from legs of mounted specimens using the DNeasy[™] Tissue Kit (Qiagen, Valencia, CA, U.S.A.) following the manufacturer's instructions. Two genes were targeted: 28S rDNA using 28SD1shortF (5'-GUG GUA AAC UCC AUC UAA G-3') and 28SD2shortR (5'-ACA TGT TAG ACT CCT TGG TC-3') (Sharanowski *et al.* 2011); and Cytochrome Oxidase I (COI) using universal primers LCO1490 (5'-GGT CAA CAA ATC ATA AAG ATA TTG G-3') and HCO2198 (5'-TAA ACT TCA GGG TGA CCA AAA AAT CA-3') (Folmer *et al.* 1994). All polymerase chain reactions (PCRs) were performed on a Bio-Rad MyCycler[™] thermal cycler, using approximately 1 µg DNA extract, 1X Standard *Taq* Buffer (10 mM Tris-HCl, 50 mM KCl, 1.5 mM MgCl₂, pH 8.3, New England Biolabs, Ipswich, Massachusetts, U.S.A.), 200 µM dNTP (Invitrogen, Carlsbad, California, U.S.A.), 4 mM MgSO₄, 400 nM of each primer, 1 unit of *Taq* DNA polymerase (New England Biolabs) and purified water to a final volume of 25 µl. Amplicons of 28S rDNA were generated using an initial denaturation of 4 min at 95°C, followed by 35 cycles of 95°C for 30 s, 55°C for 30 s and 72°C for 30 s, and a final elongation for 7 min at 72°C. Amplicons of COI were generated with an initial denaturation of 1 min at 95°C, followed by 35 cycles of 95°C for 15 s, 49°C for 15 s and 72°C for 45 s, and a final elongation period of 4 min at 72°C. Sequencing and product purification was carried out at the University of Kentucky Advanced Genetic Technologies Center (Lexington, Kentucky, USA). Product purification was performed using ExoSAP-IT (Affymetrix, Santa Clara, California, U.S.A.) and sequencing was done on an Applied Biosystems 3730xl DNA Analyzer. Contigs were assembled and edited using Geneious version 5.4.6. (Biomatters, 2011). Sequences were deposited in GenBank and their accession numbers are given in Table 1, and additionally includes 44 newly released sequences.

Alignment. Bases in the length variable 28S rDNA gene fragment were partitioned for analysis as pairing or non-pairing, and regions of ambiguous alignment excluded. Secondary structure interpretation followed the model

of Gillespie *et al.* (2005), though with this more taxonomically restricted subset of taxa it was possible to identify a few additional pairing bases than in other recent studies on larger groupings (e.g. Zaldivar-Riverón *et al.* 2008, 2009, 2013).

Cytochrome oxidase 1 sequences were manually aligned as they were not length variable, with the exception of a three base pair deletion present in all three of the included *Yelicones* species, and its location was ascertained by reference to the amino acid sequence.

Molecular data analyses. Bayesian MCMC analyses of a concatenated dataset of 28S and COI of 101 taxa were performed using Mr.Bayes version 3.2 (Ronquist *et al.* 2012) with two independent searches and four chains. All three datasets were run with and without partitions, with the COI data treated as three separate partitions based on codon positions, while the 28S were divided into two partitions based on secondary structures.

The final concatenated dataset with partitions was run for 30,000,000 generations, using the general time-reversible model, with a parameter for invariant sites and rate heterogeneity modelled under a gamma distribution (GTR+I+G) with a 10% burn-in value (i.e. 3,000,000 generations) discarded.

Results

Bayesian analyses

The Bayesian tree obtained from analysis of the partitioned data set is shown in Figure 1. While most tribes within the subfamily Rogadinae were recovered as monophyletic in the concatenated dataset with 5 partitions, the subfamily itself was not, *Tetratermus* sp. 2 and *Mesocentrus* sp., belonging to subfamilies Lysiterminae and Betylobraconinae respectively, rendering it apparently polyphyletic with this limited taxon sampling. The non-partitioned dataset did not differ greatly either in clade support or topology. A notable difference in the non-partitioned dataset is the monophyly of Yeliconini as the sister group to Aleiodini, while Aleiodini was recovered within Yeliconini in the partitioned dataset.

Despite the subfamily anomaly mentioned above, *Teresirogas* **gen. nov.** is recovered within the tribe Rogadini in all analyses, although the lack of resolution within this clade prevents further insights into the phylogenetic relationships of *Teresirogas* with other members of the tribe.

Systematic treatment

Teresirogas Quicke and Shaw **gen. nov.**

Antenna quite long, approximately 1.3 times fore wing length, with 46–60 flagellomeres. Terminal flagellomere strongly acuminate apically. Clypeus rectangularly protruding in lateral view and sculptured. Malar suture present. Eyes glabrous, weakly emarginated opposite antennal sockets. Maxillary palp with 6 segments, that of female with segments 3 and 4 flattened and weakly expanded, that of male with segments 3, 4 and 5 strongly expanded and rather globular. Occipital carina very weak and extending only from approximately the mid-height of the eye and not connecting to hypostomal carina ventrally. Propleuron with postero-dorsal flange. Mesosoma virtually entirely smooth, unsculptured but with widely spaced minute setiferous punctures with long setae. Notauli short and deep, smooth or finely crenulate posteriorly; mesonotum otherwise completely smooth and shining but the somewhat raised scutellum superficially granulate or coriaceous. Middle lobe of mesoscutum more or less protruding anteriorly over pronotum. Scutellar sulcus wide with single strong midlongitudinal carina. Prepectal carina absent. Mesopleuron smooth with mostly widely spaced minute setiferous punctures; precoxal sulcus absent or at most represented by slight dent. Median area of metanotum without midlongitudinal carina. Propodeum largely smooth but with narrow medial longitudinal carina on anterior 0.5 to 0.6; with strong, complete lateral carina. Fore wing second submarginal cell not especially elongate; vein 1-CU1a slightly postfurcal, interstitial or slightly antefurcal (in which case it should be referred to as M+Cub); 1st subdiscal cell distinctly (Figs 4B, 6A) to strongly (Figs 8D, 10A) expanded distally. Hind wing veins M+CU and 1-M approximately equal length; vein m-cu absent. Legs shining, with sparse long setae. Hind tibial comb present. Hind spurs distinctly though weakly curved but not especially long, and largely setose. Claws with or without pointed basal lobe (in the type species this character is present). Metasoma strongly shining without any trace of carinae or rugosity, just the minute, rather evenly and

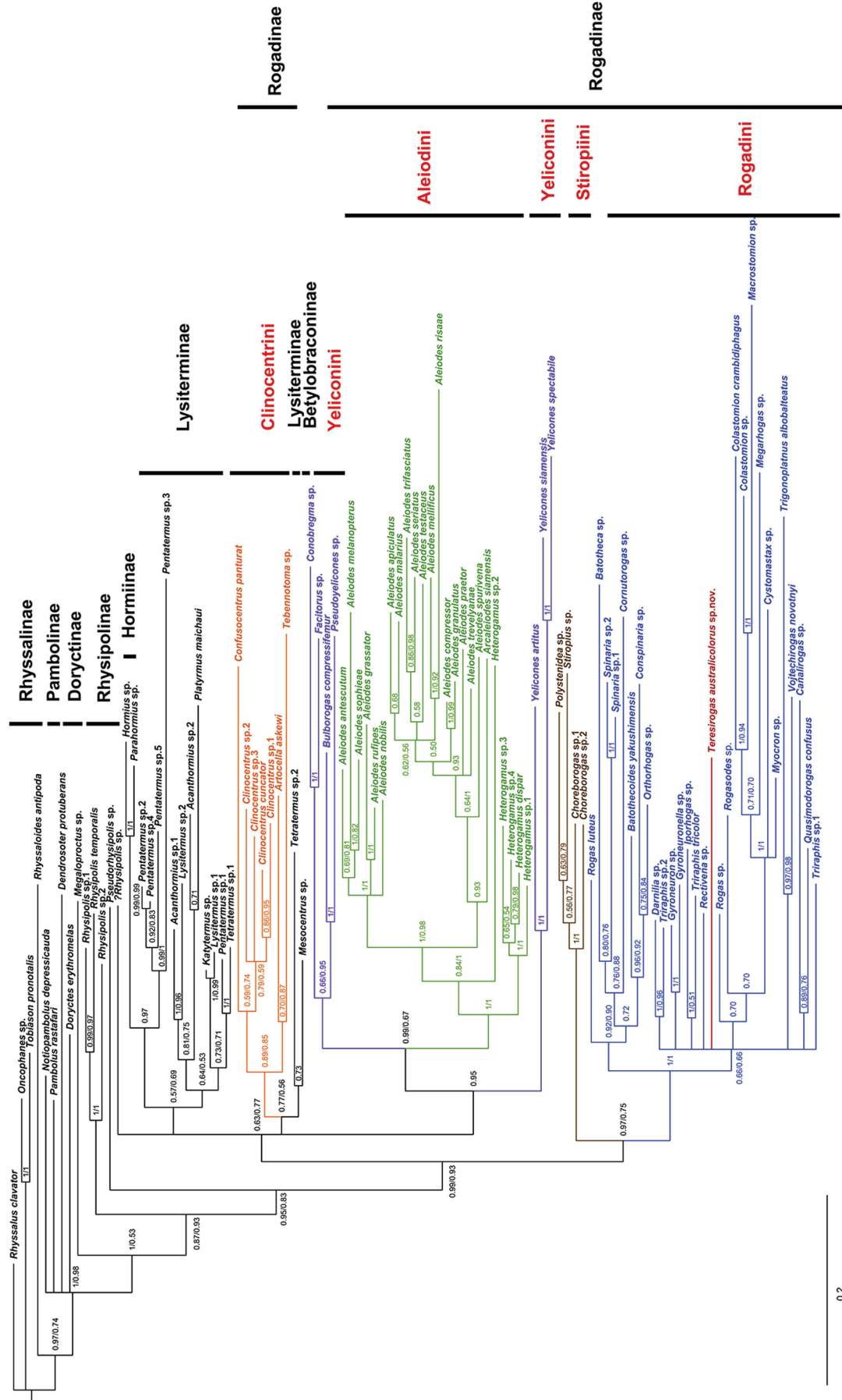


FIGURE 1. Bayesian phylogenetic tree for two genes combined (28S + COI) based on a combined 30 million postburn-in generation using the GTR+I+G model of evolution. The Bayesian posterior probability of clade support is shown as non-partitioned/partitioned. In the cases of discrepancy, only the partitioned probability is shown.

quite widely spaced punctures at bases of setae. All tergites entirely smooth and shining except for rather sparse setiferous puncturation. 1st metasomal tergite not significantly widened in front of sub-basal constriction; with dorsal carinae uniting to form weak midlongitudinal ridge but this not extending the full length of the tergum; with dorsolateral and lateral carinae well-developed and posteriorly running more or less parallel the whole length of segment. 2nd metasomal tergite without midlongitudinal carina, and without basal triangular area; the only sculpture separating it from the first tergite being the carinate posterior margin of the latter. Hypopygium short, apically transverse. Ovipositor normal, hardly to weakly exerted, straight.

Diagnosis. On a global basis the new genus is somewhat difficult to diagnose simply, since some Afrotropical and Neotropical members of *Aleiodes* have completely smooth and shiny metasomas, though they all have a well developed median carina and basal triangular area on the second tergite. However, all specimens of the new genus have the upper part of the clypeus strongly and squarely protruding in profile, and the middle lobe of the mesoscutum more or less protruding over the pronotum. We place it in the Rogadini on the basis at least some members having claws with a pointed basal lobe and interpret the variation as being due to reductions. No members of the Aleiodini have pointed basal lobes though many members of the Rogadini do.

Notes. The new genus will falter at couplet 13 the key to genera of Rogadinae from China by Chen & He (1997) since it has curved hind tibial spurs but these are completely setose. If this curvature is ignored it will founder at couplet 15 because of its lobed claws and smooth rather than longitudinally striate tergites.

Etymology. From Latin ‘*teres*’ meaning smooth, shiny or polished, and the generic name *Rogas*.

Type species. *Teresirogas australicolorus* Quicke & Shaw **sp. nov.**

Additional species. *T. billbrysoni* Quicke & van Achterberg **sp. nov.**, *T. nolani* Quicke & Butcher **sp. nov.**, *T. prestonae* Quicke & van Achterberg **sp. nov.** and *T. williamsi* Quicke & van Achterberg **sp. nov.**

Key to the species of *Teresirogas* gen. nov.

1. Tarsal claws with large pointed and black basal lobe (Figs 4A, 6C, 11B); head usually darker or paler than mesoscutum (Figs 3B, 5A, 6B, 11A) 2
 - Tarsal claws with rounded or only weakly angular basal lobes (Figs 7E,F); head and mesoscutum similarly brownish yellow (Figs 7A, 9A) 4
2. Pterostigma largely yellow and contrasting with dark brown basal fifth (Fig. 12A); hind tarsus brownish yellow (Fig. 11B); ocelli (females) larger, shortest distance between posterior ocellus and eye 0.6–0.7 times transverse diameter of posterior ocellus (Fig. 11E); [head brown or brownish yellow; mesoscutum brownish yellow] *Teresirogas williamsi* **sp. nov.**
 - Pterostigma evenly infuscate or dark brown (Figs 4B, 6A); hind tarsus dark brown or blackish (Figs 4A, 6C); ocelli (females) smaller, shortest distance between posterior ocellus and eye about equal to transverse diameter of posterior ocellus (Figs 3A, 5D); [head usually paler than black mesoscutum (Figs 3B, 5A), but sometimes similarly coloured because of brownish yellow mesoscutum] 3
3. Face generally more extensively finely rugose (Fig. 2C) *Teresirogas australicolorus* **sp. nov.**
 - Face shiny, generally with distinct setiferous punctures (Fig. 5B,C), those near the slightly raised middle part becoming more confluent along a vertical axis *Teresirogas billbrysoni* **sp. nov.**
4. Ocelli (females) very large, shortest distance between posterior ocellus and eye 0.3–0.5 times transverse diameter of posterior ocellus (Fig. 9B); hind tarsus brownish yellow (Fig. 12B); scapus largely dark brown or brown (Fig. 9B) *Teresirogas prestonae* **sp. nov.**
 - Ocelli (females) smaller, shortest distance between posterior ocellus and eye about equal to transverse diameter of posterior ocellus (Figs 7D); hind tarsus dark brown or blackish (Figs 7A); scapus brownish yellow (Figs 7B); [mesoscutum variably produced over pronotum (Figs 7C)] *Teresirogas nolani* **sp. nov.**

Teresirogas australicolorus Quicke & Shaw **sp. nov.**

(Figs 2–4)

Holotype ♀, “AUSTRALIA, N[ew] S[outh] W[ales] Murrumbateman 35°08’S 149°02’E 22.ix.2013 K.P. Bland.”; “Brood of 9 (6 ♀, 2 ♂ sexable) ex indet. limacodid mummy in cocoon coll. under loose Eucalyptus bark, em. end xii.2013” (ANIC).

Paratypes: AUSTRALIA: 4 ♀, 2 ♂, same data as holotype (NMS); 1 ♀, Australia, New South Wales, Tahmoor, nr. Picton, 22.i.1966, M. I. Nikitin (BMNH).

Female. Body length 7.2 mm, fore wing length 6.7 mm.

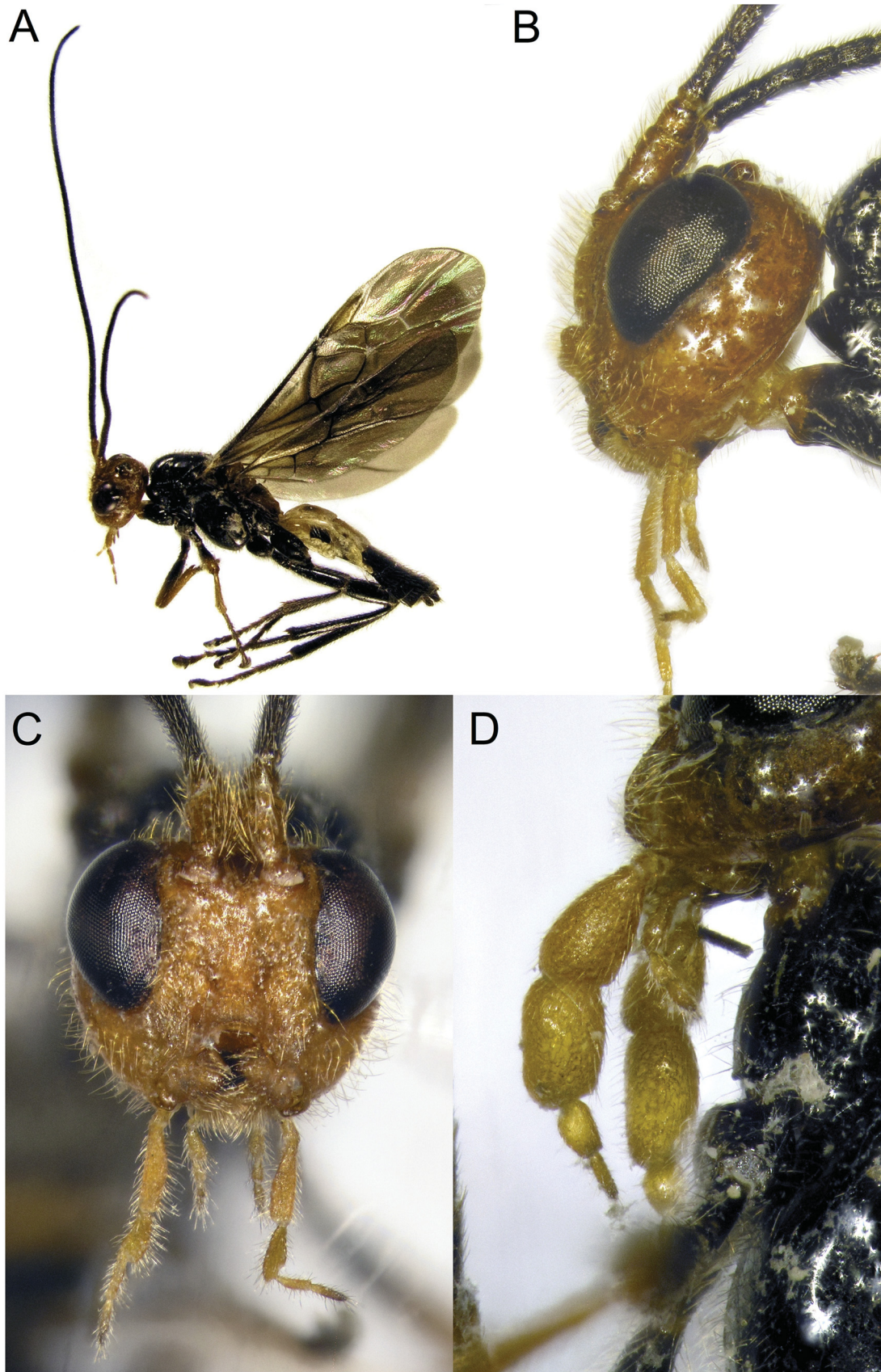


FIGURE 2. *Teresirogas australicolor* **gen. et. sp. nov.** A, habitus, lateral view; B, head (female), lateral view showing protruding clypeus and normal palps; C, head, front view; D, head (male), lateral view showing greatly expanded maxillary palp segments.

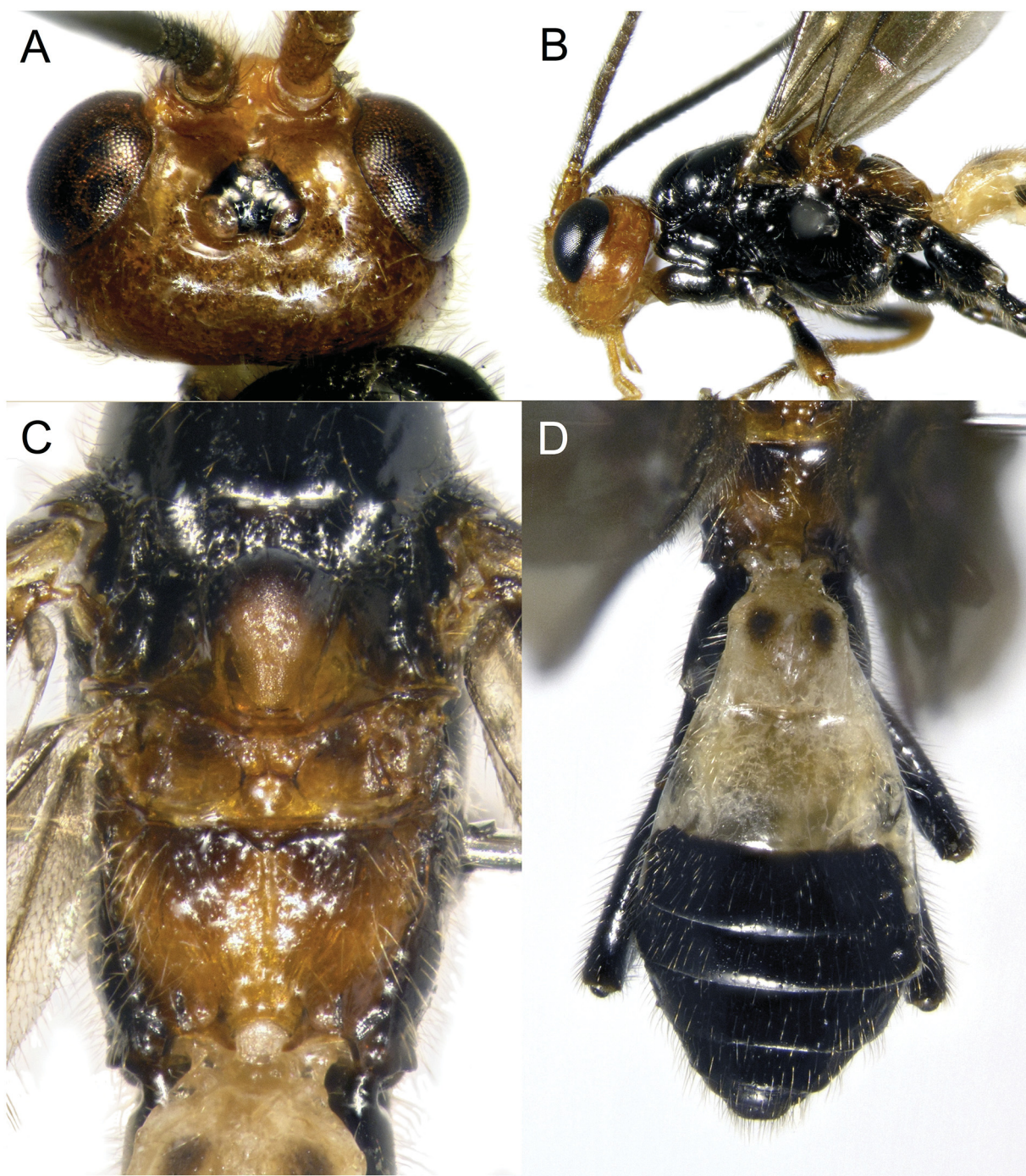


FIGURE 3. *Teresirogas australicolor* gen. et. sp. nov. A, head dorsal view; B, head and mesosoma, lateral view; C, mesosoma, except anterior part, dorsal view; D, metasoma, dorsal view.

Antenna with 57, 58, 58 (♀) and 52 (♂) flagellomeres. Head 2.2–2.4 x wider than face. Face largely coriaceous, with dense, deep setiferous puncturation laterally, the punctures coalescing to form sub-striate-rugulose sculpture rather obscuring malar suture. Mesosoma 1.6 x longer than maximally high. Notauli almost entirely smooth, without punctures or crenulae.

Coloration. Flagellum black; head, scapus and pedicellus orange except stemmaticum black; mesosoma black except scutellum (partly), metanotum and propodeum (largely orange) and legs black except fore tarsus, tibia and apical half of its femur orange; wings brown with dark brown venation but pterostigma largely yellowish; metasomal tergites 1 and 2 mostly white but with a pair of diffuse blackish spots near anterior of 1st tergite in holotype series, tergite 3 onwards black; metasomal sternites membranous with black spots.

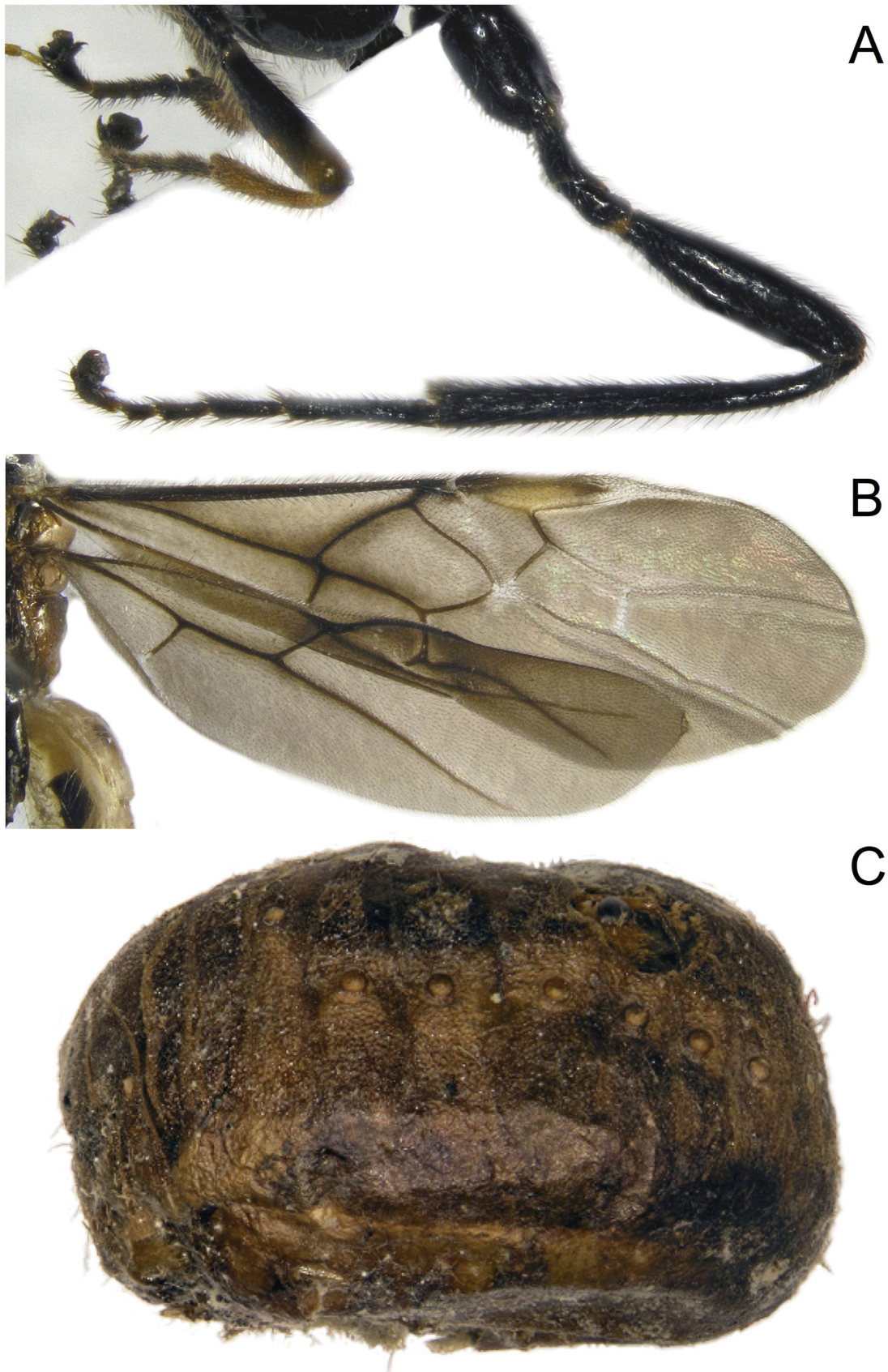


FIGURE 4. *Teresirogas australicolorus* gen. et. sp. nov. A, hind leg and middle and hind claws showing pointed basal lobes; B, wings; C, mummified prepupal host remains, note incompletely emerged wasp, upper right.

Male like female, but maxillary palp with segments 3–5 greatly cylindrically swollen (Fig. 2D).

Etymology. The name alludes to the colour pattern being typical of many of the larger Australian braconids belonging to several subfamilies, and indeed to various other insects of Australia and adjacent areas.

Biology. The squat mummy of the holotype series contained nine distinct addressed cells aligned to the host's longitudinal axis. Emergence was, or would have been, towards the anterior end of the host in all but one case (1♀, died partly unclosed, visible in Fig. 4C). In fact only 3♀ and 1♂ had eclosed successfully; a further 2♀ and 1♂ were extracted from the mummy as fully formed dead adults, though in variable condition. Another ♀, a pharate adult (i.e. still in its pupal cuticle, with wings unexpanded) in largely mouldy condition, was sexed from its maxillary palpi, and a further individual was represented by a completely mouldy pupa which could not be sexed; neither of these two is included as paratype.

***Teresirogas billbrysoni* Quicke & van Achterberg sp. nov.**

(Figs 5–6)

Holotype ♀, Australia, “Canberra, ACT, 7 Mar. 1988, L. Barton-Browne, ex *Doratifera* pupa” (ANIC).

Paratypes: AUSTRALIA: 3♀, 4♂, with same label data as holotype (2♀, 3♂, ANIC; 1♀, 1♂ RMNH); 22 ♀, 6 ♂, “Ludlow, WA, 6 Jan. 1987, G. Tribe, ex cocoon under bark of *E[ucalyptus]. rudis*” (16♀, 4♂, ANIC; 6♀, 2♂, RMNH); 1♀, “NE section of Yarratt State Forest, NE. [of] Wingham, 23 Feb. 1982, G. & T. Williams, at U/V light”, “in dry sclerophyll forest” (AMS); 1♀, CSIRO Exp. Fm, Witton, NSW, 4:1:1969, V.J. Robinson” (AMS); 11♀, 3♂, “Canberra, ACT, 16 Feb. 1960, E.F. Riek” (8♀, 2♂, ANIC; 3♀, 1♂, RMNH); 1♀, Como West, NSW, near Sydney, 21 Feb. 1972, L.S. Willan, MV light” (ANIC).

Female. Body length 6.9 mm, fore wing length 6.6 mm.

Antennae with 46–57 flagellomeres (even among females from the same series as the holotype, flagellar segment numbers were broadly spread across this range). Palpi of male vesiculate, of female somewhat widened. Median carina of propodeum distinct. Fore wing vein 1cu-a postfurcal, vein 2-CU1 less curved than in *T. prestonae*. Tarsal claws with large, pointed, black basal lobes.

Etymology. Named after the William Bryson, author of “Down Under” about a trip through Australia as well as many other entertaining works.

Biology. The two series of reared specimens and their data would seem to suggest that they are gregarious parasitoids, though there were no associated host remains with them.

***Teresirogas nolani* Quicke & Butcher sp. nov.**

(Figs 7–8)

Holotype ♀, Australia, “Lakemba, New South Wales, 4:1:1949”, “Ex cocoon *Doratifera velnerans* Lew”, “COM. INST. ENT. COLL. NO. 11346”, “Pres by Com Inst Ent B.M. 1950-58” (BMNH).

Paratypes: AUSTRALIA: 1♀, same data as holotype (BMNH); 7♀, “Berala, 6-2-[19]68, G. Daniels” (5♀ AMS; 2♀ RMNH); 1 ♀, but 11-2-[19]68 (AMS); 1♀, 29-2-[19]68 (AMS); 1♀, “Bred from cup moth [= Limacodidae] pupae, 29 Mch 1934” (AMS); 2♀, “Como West, nr Sydney, NSW, 13.v.1972, L. Willan” (1♀ AMS; 1 ♀ RMNH); 1♀, “Kw.ring.gai Chase Nat. Park, NSW, 27.i.1971, A. & G. Daniels” (AMS); 2♀, Sydney, NSW, Oct. 1966, P. Robertson”, “cup moth parasite” (ANIC); 1 ♀, “New South Wales, 4.1.[19]60. Ex Emperor moth, C.I.E. A 1313” (BMNH), “Pres by Com Inst Ent B.M. 1966-3” (BMNH); 1♀, “Brisbane: H. Hacker 20/11/[19]11” (QM).

Female. Body length 6.9 mm, fore wing length 6.0 mm.

Antennae with 46–60 flagellomeres (the specimen from Kw ring. Gai Chase Nat. Park, NSW having the smallest number, and those from Berala the largest numbers, the holotype has incomplete antennae). Head 2.4 x wider than face. Face largely smooth and shiny except for punctures associated with setae. Mesosoma 1.55 x longer than maximally high. Notauli completely smooth. Fore wing vein 3RSb 2.45 x 3RSa. Vein 3RSa 1.3 x 2RS. Vein 1cu-a interstitial.

Coloration. Flagellum black; head, scapus and pedicellus orange except stemmaticum black; mesosoma

orange; legs dark brown [fore legs missing but coxa orange]; wings brown with darker brown venation; metasomal tergites 1 and 2 largely cream coloured but with small brownish marks at base of 1st tergite and postero-laterally on 2nd, remaining tergites black; metasomal sternites membranous with black spots.

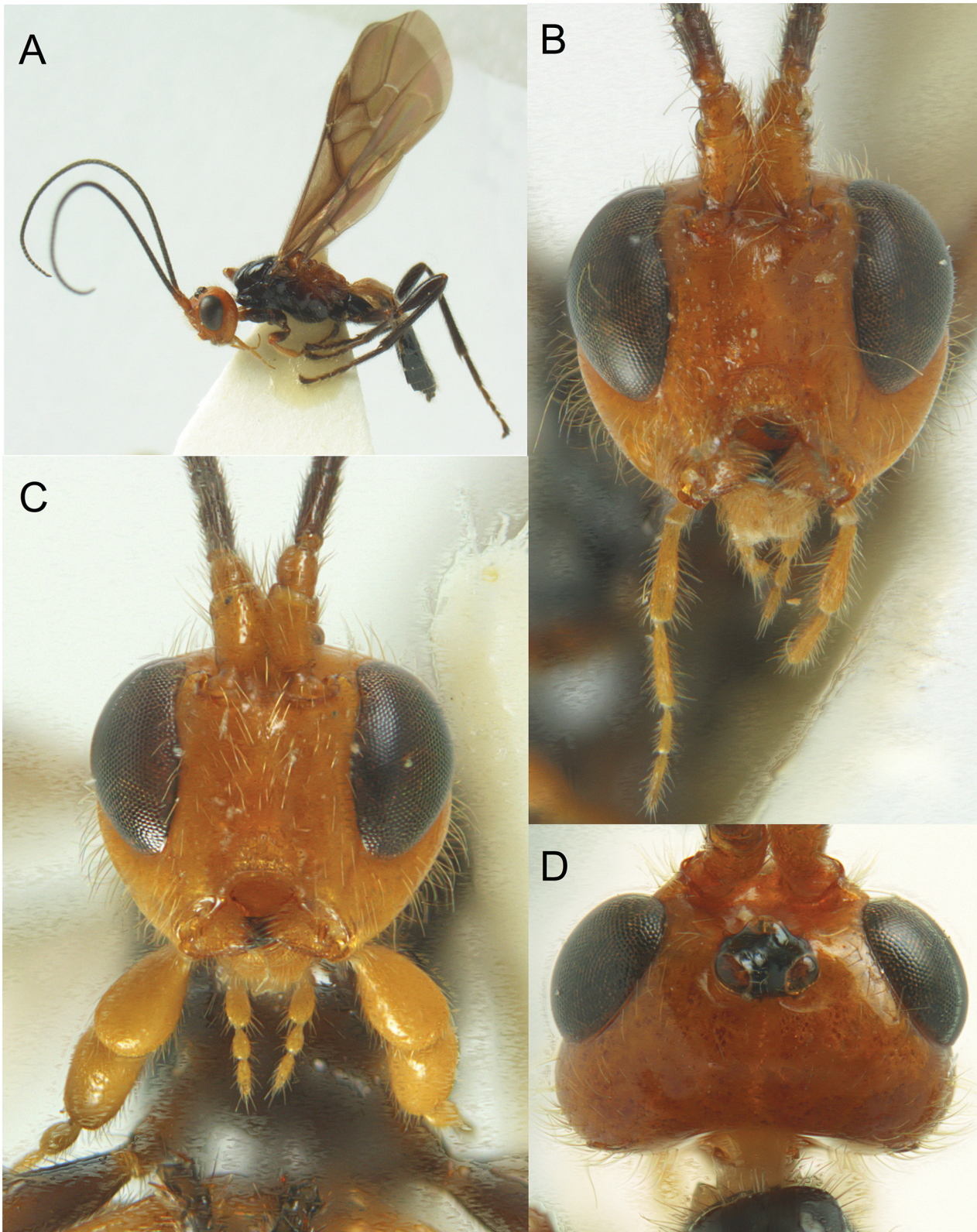


FIGURE 5. *Teresirogas billbrysoni* gen. et. sp. nov. A, habitus; B, head (female), front view; C, head (male), front view; D, head (female), dorsal view.

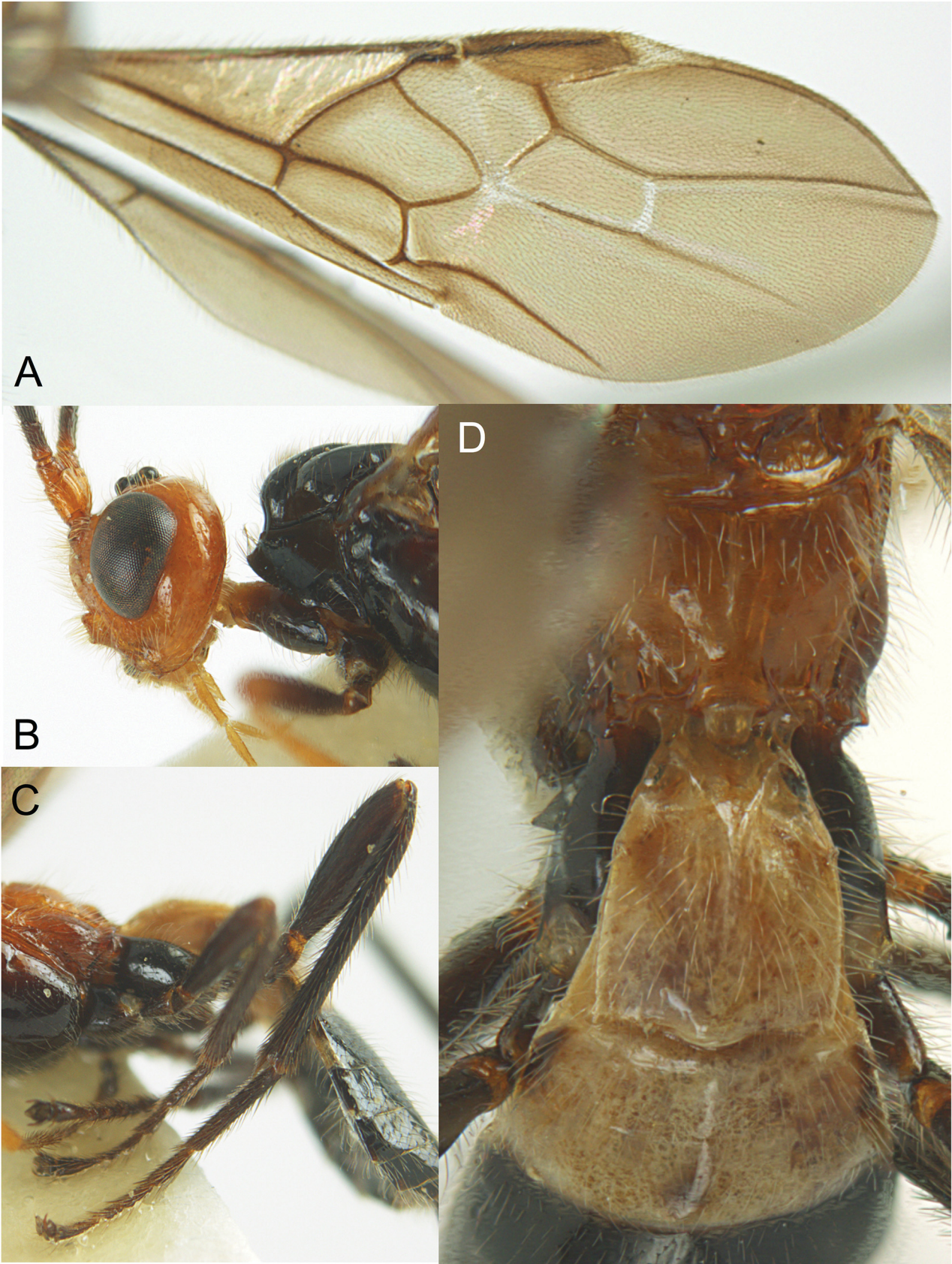


FIGURE 6. *Teresirogas billbrysoni* gen. et. sp. nov. A, fore wing; B, head and anterior of mesosoma, lateral view; C, propodeum, metasoma, mid- and hind legs, lateral view; D, propodeum and metasomal tergites 1 and 2, dorsal view.

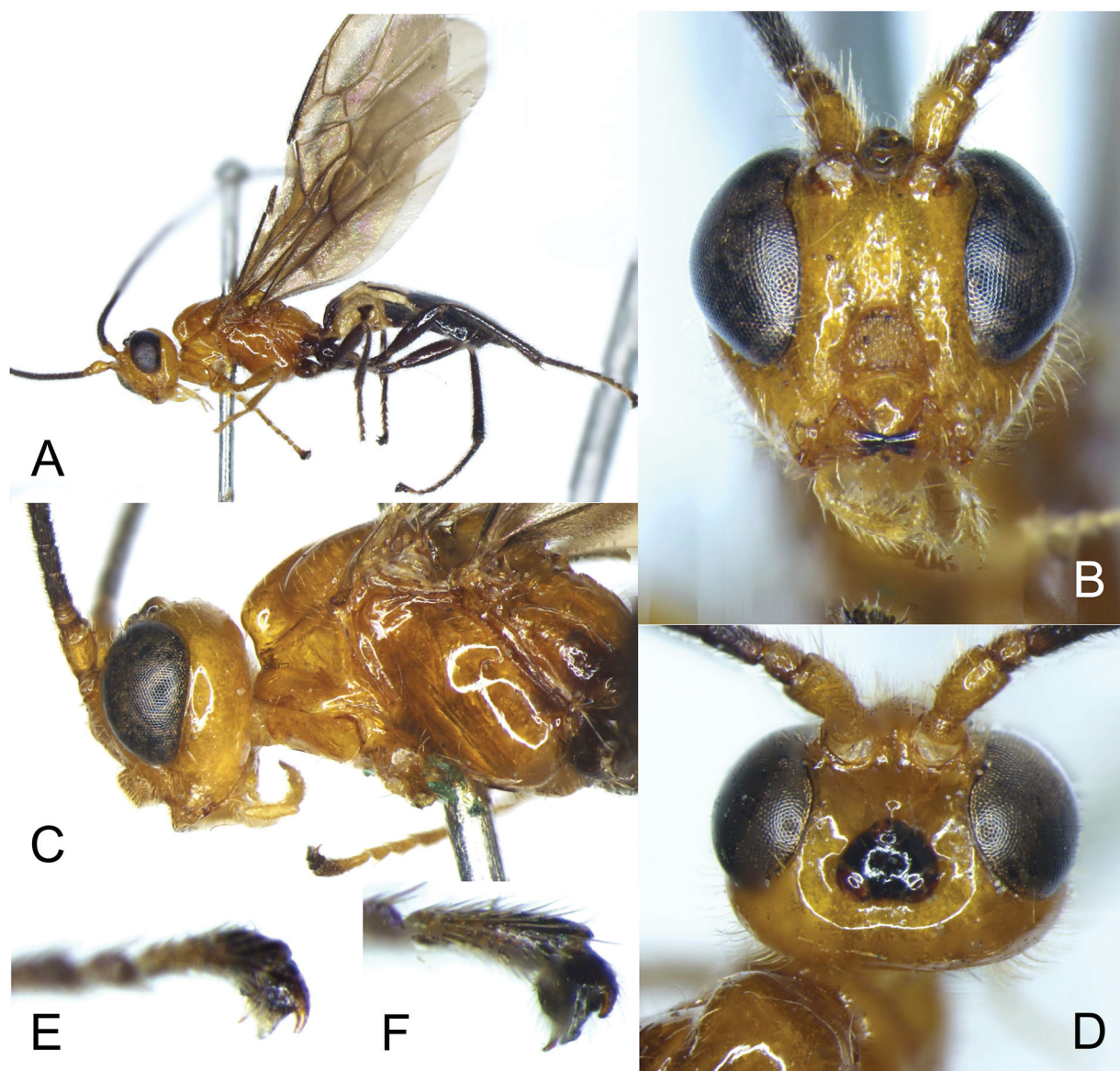


FIGURE 7. *Teresirogas nolani* gen. et. sp. nov. A, habitus; B, head, front view; C, head and mesosoma, lateral view; D, head dorsal view; E, F, views of hind telotarsus and claw showing reduced basal lobe.

Etymology. Named after the famed Australian artist, Sidney Robert Nolan (1917–1972) well known for his Ned Kelly series of paintings.

Biology. The host recorded on the data label of the holotype is a limacodid. Although the mummy is not present the paratype with the same data suggests that the species is gregarious. The host of the other paratype is indicated to be an “emperor moth” which would indicate a member of the Saturniidae, however, all other records are from Limacodidae, especially cup moths of the genus *Doratifera* on *Eucalyptus*, and although there are *Eucalyptus*-feeding saturniids, it may be that the host was misidentified. There is nothing in this case to suggest solitary or gregarious development.

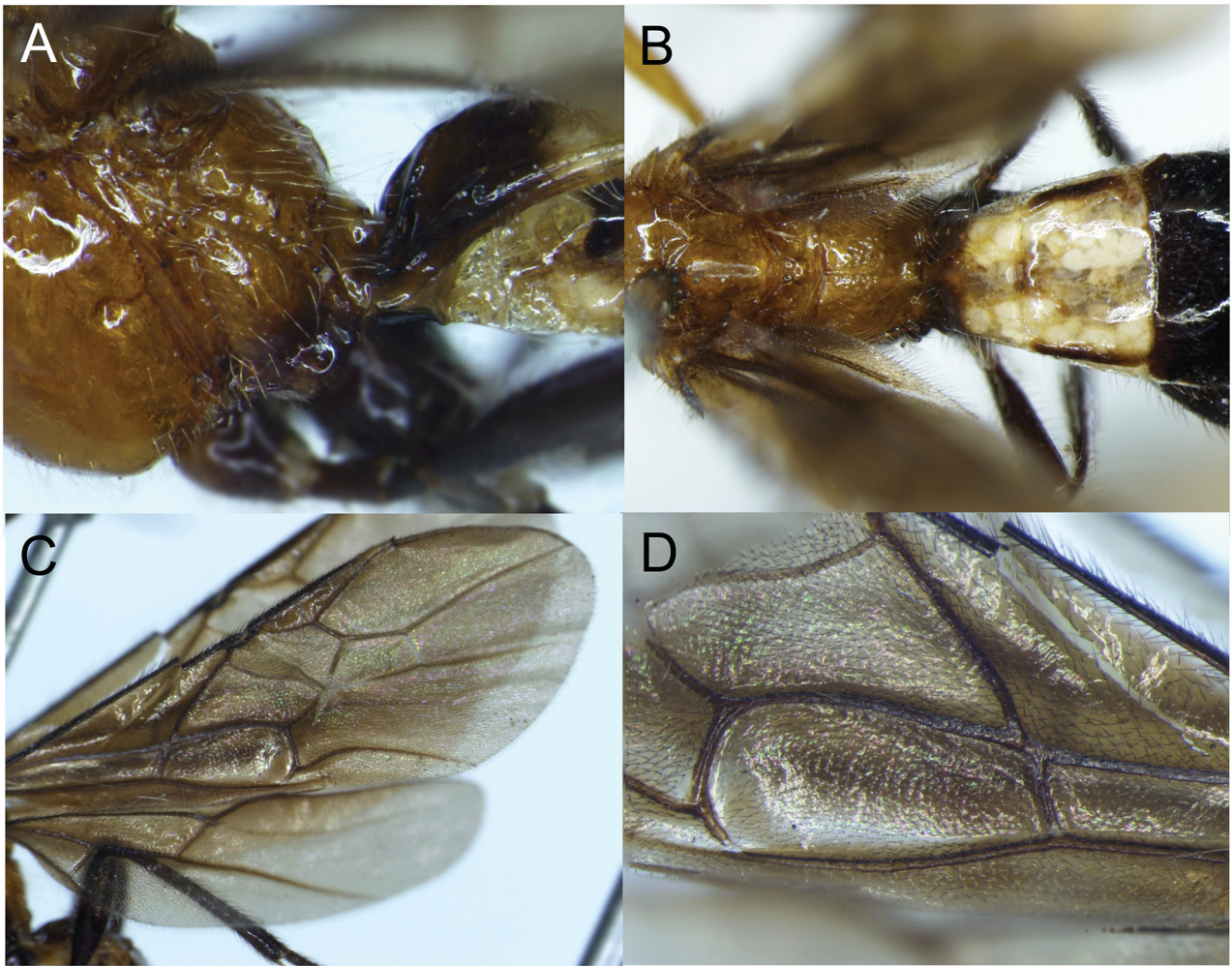


FIGURE 8. *Teresirogas nolani* gen. et. sp. nov. A, posterior of mesosoma and metasomal tergite 1, lateral view; B, scutellum, propodeum, tergite 1, dorsal view; C, wings; D, wings, detail of subdiscal cell.

***Teresirogas prestonae* Quicke & van Achterberg sp. nov.**

(Figs 9–10)

Holotype ♀ (ANIC) “4 mi. W. of Coolibah HS, N.T., 15.34S 130.54E, 21 June 1968, M. Mendum”.

Paratypes: 1♀, “W.A., Homestead, Beverley Springs, 16.35S 125.29E, 31.v.1993, E.D, Edwards” (ANIC); 1♀, “Qld., 7 km E Laura, 15.35S 144.30E, 27.v.1993, at light, P. Zborowski & A. Roach” (ANIC) 1♀, “18 km NE by E Heathlands, Q., 11.40S 142.43E, 19.iii.1992, E.D. Edwards” (RMNH).

Female. Body length 7.6 mm, fore wing length 6.8 mm.

Median carina of propodeum reduced. Fore wing vein 1cu-a distinctly antefurcal to subinterstitial. Vein 2-CU1 distinctly curved. Basal lobes of claws reduced.

Coloration. Head (except stemmaticum) and mesosoma orange, coloration otherwise rather variable; metasomal tergite 1 entirely pale (ivory), only basal half dark brown, or up to basal two-thirds dark brown; tergite 2 entirely pale or laterally partly darkened.

Etymology. Named after the influential Australian modernist artist, Margaret Preston (1875–1973), well known for her highly colourful paintings.

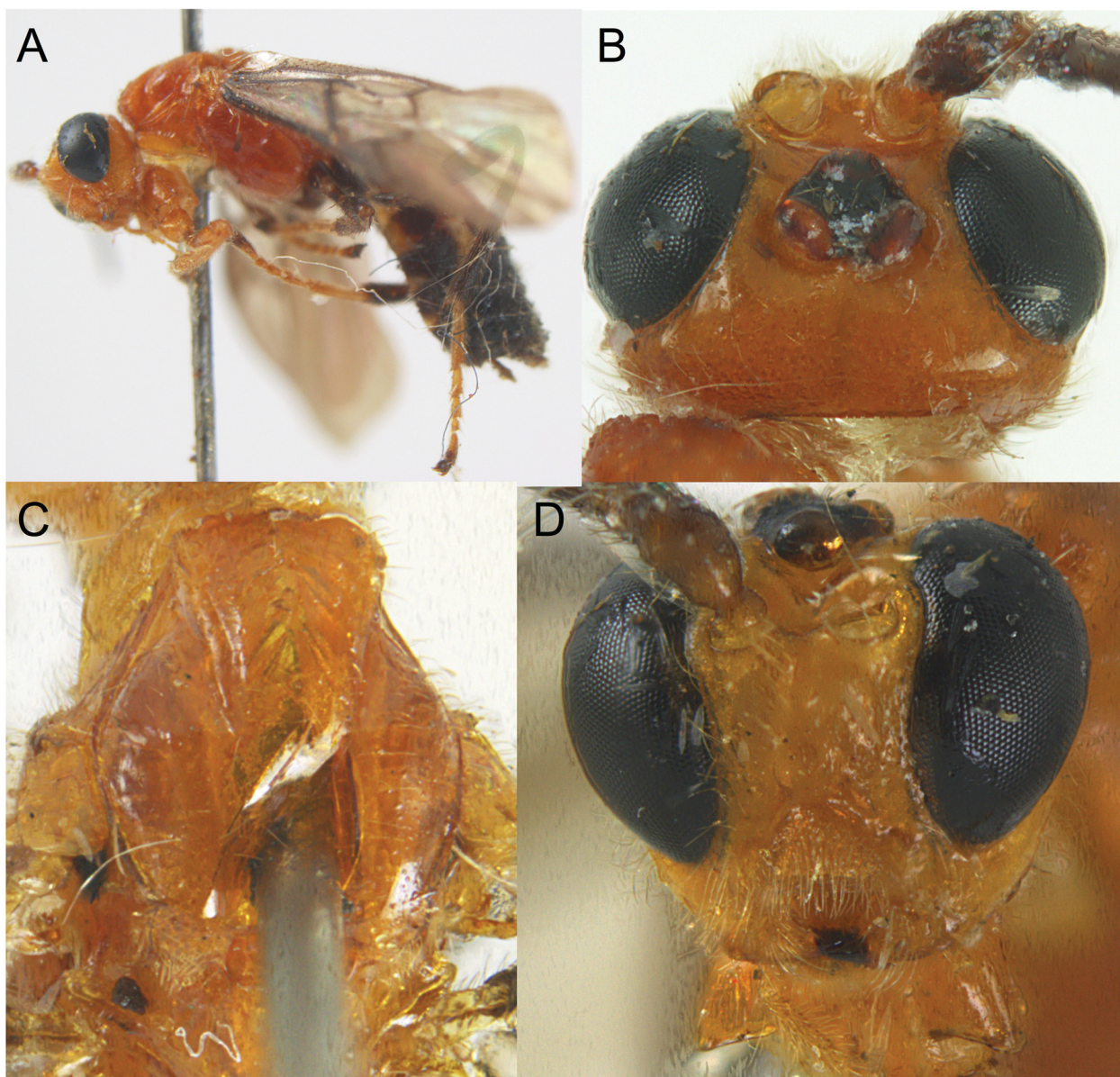


FIGURE 9. *Teresirogas prestonae* gen. et. sp. nov. A, habitus; B, head, dorsal view; C, mesoscutum, dorsal view; D, head, front view.

***Teresirogas williamsi* Quicke & van Achterberg sp. nov.**

(Figs 11–12)

Holotype 1♀, “Solar Village, Humpty Doo, 12.35S 131.07E, N.T., 9 April 1991, M.S. Upton” (ANIC).

Paratype: 1♀, “Near airport, Iron Range, Qld, 20 Dec. 1971, MV light, D.K. McAlpine, G.A. Holloway, D.P. Sand” (AMS).

Female. Body length 7.4 mm, fore wing length 6.0 mm.

Antenna with 51 flagellomeres. Claws with large black pointed lobes (Fig. 11B).

Coloration similar to pale *T. billbrysoni* except pterostigma largely yellow (Fig. 12A) and brownish yellow hind basitarsus.

Etymology. Named after the Australian painter Fred Williams (1927–1982), well known for his evocative paintings of the Australian landscape.

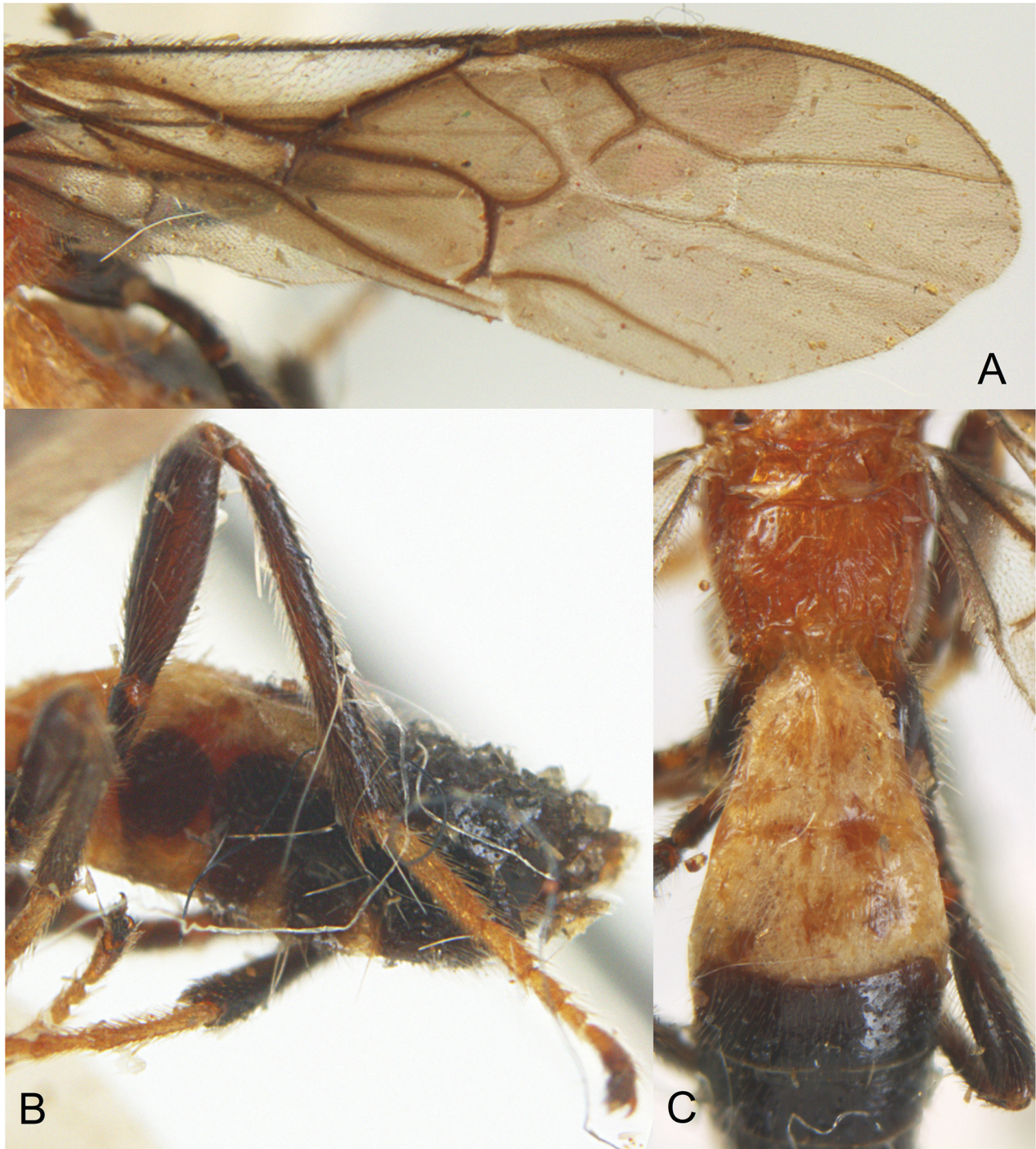


FIGURE 10. *Teresirogas prestonae* **gen. et. sp. nov.** A, fore wing; B, hind leg and mesosoma, lateral view; C, propodeum and metasomal tergites 1–4, dorsal view.

Discussion

It is very surprising that no members of the new genus appear to have been described; perhaps earlier workers assumed that it had, as has happened before for several rather large Australian braconids. Yet neither DQ nor CvA, despite their extensive knowledge of braconid wasps and study of major collections, have ever seen a described species of this taxon. Indeed, the Rogadinae have been a rather taxonomically neglected group until a relatively recent surge in activity (e.g. van Achterberg 1991, Chen & He 1997), especially in the tropics though much work still needs to be done on the temperate fauna also.

The Rogadini (including the Spinariini) are a morphologically heterogeneous group, dominated in terms of number of species by '*Triraphis*' though unpublished molecular analyses strongly suggest that the New World representatives of that genus are not monophyletic with the Old World ones (Quicke *et al.* in prep.). At genus level it is most diverse in the Old World tropics, and two new genera have recently come to light from the S. E. Asian to Indo-Australian region (Quicke & Areekul Butcher 2011, Quicke *et al.* 2012).

Rogadines are normally quite extensively sculptured, but in common with many groups of normally sculptured Ichneumonoidea from Australia, the new taxon has evolved a very smooth cuticle. Only one other genus of Rogadinae lacks a prepectal (=epicnemial) carina, and that is *Orthorhogas* which is currently only known from Madagascar. However, the latter genus is almost certainly not closely related to *Teresirogas* since it is strongly sculptured, has an elongate metasoma, large and ventrally curved hypopygium and strongly curved and exerted ovipositor. Further, in the Bayesian molecular analysis (Fig. 1) *Orthorhogas* is nested with quite strong support within a clade largely comprising genera of Spinariina.

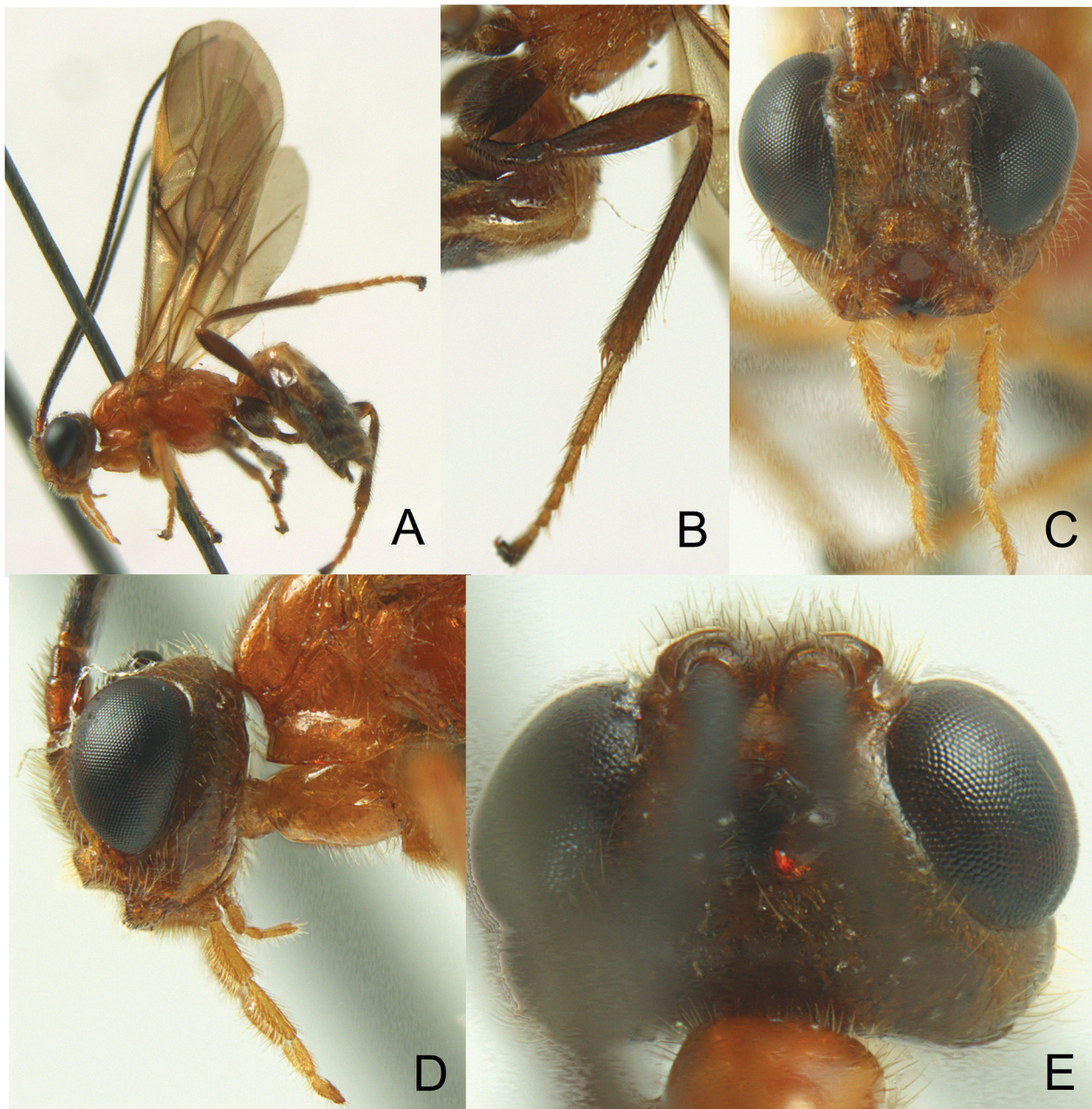


FIGURE 11. *Teresirogas williamsi* gen. et. sp. nov. A, habitus; B, hind leg; C, head, front view; D, head, lateral view; E, head, dorsal view.



FIGURE 12. *Teresirogas williamsi* **gen. et. sp. nov.** A, fore wing; B, posterior of mesosoma and anterior of metasoma, dorsal view; C, metasomal tergites 2 and following, dorsal view.

Within *Teresirogas* **gen. nov.** two groups of species are apparent. *T. australicolorus* **sp. nov.**, *T. williamsi* **sp. nov.** and *T. billbrysoni* **sp. nov.** having the least expanded 1st subdiscal cell of the fore wing and the tarsal claws with a large acute basal lobe. The other species have the 1st subdiscal cell of the fore wing more expanded and the tarsal claws lack an acute basal lobe. The modification of the 1st subdiscal cell is in keeping with that in that oval cells (either the 1st subdiscal or apical part of the subbasal cell) is largely restricted to nocturnal taxa, though its function is yet to be determined (Quicke & Shaw 2005, Quicke in press). The basic colour pattern of the body of all

species is typically tricoloured: head and more or less mesosoma orange or brownish yellow, basal half of metasoma ivory or white and its apical half black. The colour of the mesosoma is variable, even within species (e.g. *T. billbrysoni* **sp. nov.**).

Acknowledgements

We are grateful to Barbara Sharanowski for help in arranging sequencing analysis, and to the Animal Systematic Research Unit and the Integrated Ecology Lab, Department of Biology, Faculty of Science, Chulalongkorn University for allowing us to use their Cell[^]D imaging facility. We would like to thank Chulalongkorn University Centenary Academic Development Project for support.

References

- Biomatters (2011) Geneious Version 5.4.6. Available from: <http://www.geneious.com/> (accessed 21 October 2014)
- Chen, X. & He, J. (1997) Revision of the subfamily Rogadinae (Hymenoptera: Braconidae) from China. *Zoologische Verhandelingen, Leiden*, 308, 1–187.
- Folmer, O., Black, M., Hoeh, W., Lutz, R. & Vrijenhoek, R. (1994) DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. *Molecular Marine Biology and Biotechnology*, 3, 294–299.
- Gillespie, J.J., Yoder, M.J. & Wharton, R.A. (2005) Predicted secondary structure for 28S and 18S rRNA from Ichneumonoidea (Insecta: Hymenoptera: Apocrita): impact on sequence alignment and phylogeny estimation. *Journal of Molecular Evolution*, 61, 114–137.
<http://dx.doi.org/10.1007/s00239-004-0246-x>
- Quicke, D.L.J. (1995) *Batotheca* (Hymenoptera: Braconidae) new to Australia. *Australian Entomologist*, 22, 17–18.
- Quicke, D.L.J. (2014) *Biology, Systematics, Evolution and Ecology of Braconid and Ichneumonid Parasitoid Wasps*, 688 pp. [Wiley Blackwell, Chichester, UK]
- Quicke, D.L.J. & Areekul Butcher, B. (2011) Two new genera of Rogadinae (Insecta: Hymenoptera: Braconidae) from Thailand. *Journal of Hymenoptera Research*, 23, 23–34.
<http://dx.doi.org/10.3897/jhr.23.1659>
- Quicke, D.L.J. & Shaw, M.R. (2005) First host record for the rogadoine genus *Pholichora* van Achterberg (Hymenoptera: Braconidae) with description of a new species and notes on convergent wing venation features. *Journal of Natural History*, 39, 531–537.
<http://dx.doi.org/10.1080/00222930410001708678>
- Quicke, D.L.J., Austin, A.D. & Chishti, M.J.K. (1998) Revision of the Australasian species of *Yelicones* (Hymenoptera: Braconidae: Rogadinae). *Invertebrate Taxonomy*, 12, 897–928.
<http://dx.doi.org/10.1071/it97030>
- Quicke, D.L.J., Smith, M.A., van Achterberg, C., Miller, S.E. & Hrcek, J. (2012) A new genus and three new species of parasitoid wasp from Papua New Guinea and redescription of *Trigonophatnus* Cameron (Hymenoptera, Braconidae, Rogadinae). *Journal of Natural History*, 46, 1369–1385.
<http://dx.doi.org/10.1080/00222933.2012.658585>
- Ronquist, F., Teslenko, M., van der Mark, P., Ayres, D.L., Darling, A., Höhna, S., Larget, B., Liu, L., Suchard, M.A. & Huelsenbeck, J.P. (2012) MrBayes 3.2: efficient Bayesian phylogenetic inference and model choice across a large model space. *Systematic Biology*, 61, 539–542.
<http://dx.doi.org/10.1093/sysbio/sys029>
- Sharanowski, B.J., Dowling, A.P.G. & Sharkey, M.J. (2011) Molecular phylogenetics of Braconidae (Hymenoptera: Ichneumonoidea), based on multiple nuclear genes, and implications for classification. *Systematic Entomology*, 36, 549–572.
<http://dx.doi.org/10.1111/j.1365-3113.2011.00580.x>
- Sharkey, M.J. & Wharton, R.A. (1997) Morphology & terminology. In: Wharton, R.A., Marsh, P.M. & Sharkey, M.J. (Eds.), *Identification Manual to the New World Genera of Braconidae*. Vol. 1. Special Publication of the International Society of Hymenopterists, pp. 19–37.
- van Achterberg, C. (1988) Revision of the subfamily Blacinae Foerster (Hymenoptera: Braconidae). *Zoologische Verhandelingen, Leiden*, 249, 1–324.
- van Achterberg, C. (1991) Revision of the genera of the Afrotropical and W. Palaearctical Rogadinae Foerster (Hymenoptera: Braconidae). *Zoologische Verhandelingen, Leiden*, 273, 1–102.
- van Achterberg, C. (1993) Illustrated key to the subfamilies of the Braconidae (Hymenoptera: Ichneumonoidea). *Zoologisches Verhandelingen, Leiden*, 283, 1–189.
- van Achterberg, C. (2007) Revision of the genus *Spinaria* Brullé (Hymenoptera: Braconidae: Rogadinae), with keys to genera

and species of the subtribe Spinariina van Achterberg. *Zoologische Mededelingen, Leiden*, 81, 11–83.

- Wharton, R.A., Marsh, P.M. & Sharkey, M.J. (Eds.), (1997) *Manual of the New World genera of the family Braconidae (Hymenoptera). Vol. 1*. Special Publication of the International Society of Hymenopterists, 439 pp.
- Yu, D.S., van Achterberg, C. & Horstmann, K. (2014) Taxapad 2014, Ichneumonoidea 2011, Ottawa, Canada. Database on flash-drive. Available from: www.taxapad.com (Accessed 16 October 2014)
- Zaldivar-Riverón, A., Belokobylskij, S.A., León-Regagnon, V., Briceno, R. & Quicke, D.L.J. (2008) Molecular phylogeny and historical biogeography of the cosmopolitan parasitic wasp subfamily Doryctinae (Hymenoptera: Braconidae). *Invertebrate Systematics*, 22, 345–363.
<http://dx.doi.org/10.1071/is07028>
- Zaldivar-Riverón, A., Shaw, M.R., Saez, A.G., Mori, M., Belokobylskij, S.A., Shaw, S.R. & Quicke, D.L.J. (2009) Evolution of the parasitic wasp subfamily Rogadinae (Braconidae): phylogeny and evolution of lepidopteran host ranges and mummy characteristics. *BMC Evolutionary Biology*, 8, 329–329.
<http://dx.doi.org/10.1186/1471-2148-8-329>
- Zaldivar-Riverón, A., Rodríguez-Jiménez, A., Sarmiento, C.E., Pedraza-Lara, C. & López-Estrada, E.K. (2013) Phylogenetic relationships and description of *Bolivar*, a new genus of Neotropical doryctine wasps (Hymenoptera: Braconidae). *Invertebrate Systematics*, 27, 673–688.

APPENDIX 1. Material included in molecular analyses. Genbank accession numbers starting with KM are newly generated for this study.

| Subfamily/tribe | Species | Provenance | Genbank accession number | |
|------------------|------------------------------------|------------|--------------------------|------------|
| | | | 28S | COI |
| Betylobraconinae | <i>Mesocentrus</i> sp. | Australia | KM067175 | JF963534 |
| Doryctinae | <i>Dendrosoter protuberans</i> | | EF645736 | EF645775 |
| | <i>Doryctes erythromelas</i> | USA | GQ374709 | GQ374627 |
| | <i>Megaloproctus</i> sp. | Colombia | AY935466 | AY935393 |
| Hormiinae | <i>Hormius</i> sp. | Madagascar | AY935455 | AY935385 |
| | <i>Parahormius</i> sp. | Cameroon | AY935456 | AY935386 |
| Lysiterminae | <i>Acanthormius</i> sp. 1 | Madagascar | AJ302883 | AY935381 |
| | <i>Acanthormius</i> sp. 2 | Thailand | - | KM067236 |
| | <i>Katytermus</i> sp. | Japan | EU854406 | EU979624 |
| | <i>Lysitermus</i> sp. 1 | Uganda | EU854405 | KM067238 |
| | <i>Lysitermus</i> sp. 2 | Nigeria | KM067177 | JF963503 |
| | <i>Pentatermus</i> sp. 1 | Madagascar | KM067178 | FN662435 |
| | <i>Pentatermus</i> sp. 2 | Madagascar | KM078032 | JF963713 |
| | <i>Pentatermus</i> sp. 3 | Thailand | KM067179 | KM067254 |
| | <i>Pentatermus</i> sp. 4 | Nigeria | KM067212 | JF963501 |
| | <i>Pentatermus</i> sp. 5 | Benin | AY935453 | AY935383 |
| | <i>Platyrmus maichau</i> | | EU854407 | - |
| | <i>Tetratermus</i> sp. 1 | Uganda | AY935452 | AY935382 |
| | <i>Tetratermus</i> sp. 2 | Nigeria | KM067180 | ? JF963501 |
| Pambolinae | <i>Notiopambolus depressicauda</i> | Australia | AY935459 | AY935389 |
| | <i>Pambolus rastafari</i> | | - | JQ268750 |
| Rhysipolinae | <i>Pseudorhysipolis</i> sp. | Costa Rica | AY935450 | AY935377 |
| | <i>Rhysipolis temporalis</i> | Russia | AY935449 | AY935376 |
| | <i>Rhysipolis</i> sp. 1 | - | GQ374708 | GQ374626 |
| | <i>Rhysipolis</i> sp. 2 | Thailand | - | KM067237 |
| | ? <i>Rhysipolis</i> | Chile | KM078031 | KM078033 |
| Rhyssalinae | <i>Oncophanes</i> sp. | UK | AY935481 | AY935407 |

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APPENDIX 1. (Continued)

| Subfamily/tribe | Species | Provenance | Genbank accession number | |
|--------------------------|------------------------------------|------------------|--------------------------|----------|
| | | | 28S | COI |
| | <i>Rhyssaloides antipoda</i> | | JN710479 | JN710487 |
| | <i>Rhyssalus clavator</i> | Poland | AY935482 | AY935409 |
| | <i>Tobiason pronotalis</i> | Vietnam | AY935480 | AY935408 |
| Rogadinae: Aleiodini | | | | |
| | <i>Aleiodes antescutum</i> | Thailand | KM067183 | JF962536 |
| | <i>Aleiodes apiculatus*</i> | UK | EF115440 | EF115455 |
| | <i>Aleiodes compressor</i> | UK | EU854328 | EF115458 |
| | <i>Aleiodes melanopterus</i> | Brazil | KM067213 | KM067239 |
| | <i>Aleiodes granulatus</i> | Canada | KM067214 | JF962657 |
| | <i>Aleiodes grassator</i> | Hungary | EU854332 | EU979584 |
| | <i>Aleiodes malarius</i> | Thailand | KM078029 | JQ388336 |
| | <i>Aleiodes mellificus</i> | Thailand | KM078030 | JF962707 |
| | <i>Aleiodes nobilis</i> | UK | KM067184 | JF962562 |
| | <i>Aleiodes praetor</i> | UK | EU854334 | KM067256 |
| | <i>Aleiodes risaae</i> | Thailand | KM067215 | JQ388401 |
| | <i>Aleiodes rufipes</i> | Sweden | KM067186 | KM067257 |
| | <i>Aleiodes seriatus</i> | UK | KM067216 | KM067240 |
| | <i>Aleiodes sophieae</i> | Thailand | KM067217 | JQ388368 |
| | <i>Aleiodes spurivena</i> | Vietnam | - | JF903066 |
| | <i>Aleiodes testaceus</i> | UK | EF115493 | EF115454 |
| | <i>Aleiodes trevelyanae</i> | Uganda | EF115433 | EF115448 |
| | <i>Aleiodes trifasciatus</i> | Malawi | EU854354 | EU979604 |
| | <i>Arcaleiodes siamensis</i> | Thailand | KM067187 | JQ388379 |
| | <i>Heterogamus dispar</i> | UK | KM067190 | JF963404 |
| | <i>Heterogamus</i> sp. 1 | Colombia | KM067218 | KM067241 |
| | <i>Heterogamus</i> sp. 2 | Costa Rica | KM067219 | JF963395 |
| | <i>Heterogamus</i> sp. 3 | Papua New Guinea | KM067221 | KM067242 |
| | <i>Heterogamus</i> sp. 4 | Thailand | KM067220 | JF962667 |
| Rogadinae: Clinocentrini | | | | |
| | <i>Artocella askewi</i> | Spain | AY93335451 | AY935379 |
| | <i>Clinocentrus cuncator</i> | UK | AJ784962 | AY935378 |
| | <i>Clinocentrus</i> sp. 1 | Madagascar | KM067194 | KM078033 |
| | <i>Clinocentrus</i> sp. 2 | Papua New Guinea | KM067233 | KM067251 |
| | <i>Clinocentrus</i> sp. 3 | Papua New Guinea | KM067234 | KM067252 |
| | <i>Confusocentrus panturat</i> | Thailand | - | KM067258 |
| | <i>Tebennotoma</i> sp. | Madagascar | KM067235 | JF963885 |
| Rogadinae: Rogadini | | | | |
| | <i>Batotheca</i> sp. | Papua New Guinea | KM067226 | JF415904 |
| | <i>Batothecoides yakushimensis</i> | Taiwan | JF962970 | EU854360 |
| | <i>Canalirogas</i> sp. | Thailand | KM067198 | JF963044 |
| | <i>Colastomion crambidiphagus</i> | Papua New Guinea | KM067228 | JF963127 |

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APPENDIX 1. (Continued)

| Subfamily/tribe | Species | Provenance | Genbank accession number | |
|-----------------------|--|------------------|--------------------------|----------|
| | | | 28S | COI |
| | <i>Colastomion</i> sp. | Papua New Guinea | KM067229 | KM067247 |
| | <i>Conspinarina</i> sp. | Taiwan | AJ509014 | EU480586 |
| | <i>Cornutorogas</i> sp. | Thailand | KM067201 | KM067262 |
| | <i>Cystomastax</i> sp. | Venezuela | AY935445 | AY935369 |
| | <i>Darnilia</i> sp. | Thailand | KM067199 | KM067263 |
| | <i>Gyroneuron</i> sp. | Thailand | KM067202 | JF963364 |
| | <i>Gyroneuron testaceator</i> | China | EU854372 | EU979614 |
| | <i>Iporhogas</i> sp. | Thailand | KM067222 | KM067243 |
| | <i>Macrostromion</i> sp. | Thailand | KM067230 | HM435179 |
| | <i>Megarhogas ?maculipennis</i> | Thailand | EU854379 | JF963804 |
| | <i>Myocron</i> sp. | Tanzania | EU854380 | EU979616 |
| | <i>Orthorhogas</i> sp. | Madagascar | - | JN278324 |
| | <i>Quasimodorogas confusus</i> | Thailand | - | KM067250 |
| | <i>Rectivena</i> sp. | Benin | EU854384 | EU979618 |
| | <i>Rogas luteus</i> | France | KM067204 | KM067264 |
| | <i>Rogas</i> sp. | Tanzania | AJ784931 | AY935364 |
| | <i>Rogasodes</i> sp. | Thailand | KM067224 | KM067245 |
| | <i>Spinaria</i> sp. 1 | Papua New Guinea | KM067227 | JF271524 |
| | <i>Spinaria</i> sp. 2 | Thailand | KM067205 | FN662444 |
| | <i>Teresirogas australicolorus</i> gen. et sp. nov. | Australia | KM067223 | KM067244 |
| | <i>Trigonoplatnus albobalteatus</i> | Papua New Guinea | KM067225 | JF415905 |
| | <i>Triraphis</i> sp. 1 | Belize | KM067232 | KM067249 |
| | <i>Triraphis</i> sp. 2 | Papua New Guinea | KM067231 | KM067248 |
| | <i>Triraphis tricolor</i> | Netherlands | KM067206 | KM067265 |
| | <i>Troporhogas</i> sp. | Sri Lanka | KM067246 | KM067246 |
| | <i>Vojtechirogas novotnyi</i> | Papua New Guinea | - | JF271566 |
| Rogadinae: Stiropiini | | | | |
| | <i>Choreborogas</i> sp. 1 | Costa Rica | KM067207 | JF963107 |
| | <i>Choreborogas</i> sp. 2 | Colombia | KM067208 | AY935374 |
| | <i>Polystenidea</i> sp. | USA | - | JF963791 |
| | <i>Stiropius</i> sp. | Costa Rica | AJ784961 | AY935373 |
| Rogadinae: Yeliconini | | | | |
| | <i>Bulborogas compressifemur</i> | Belize | KM067209 | KM067266 |
| | <i>Facitorus</i> sp. | Vietnam | EU450765 | EU450766 |
| | <i>Pseudoyelicones</i> sp. | Costa Rica | KM067210 | KM067267 |
| | <i>Yelicones artitus</i> | Costa Rica | KM067211 | JF963958 |
| | <i>Yelicones siamensis</i> * | Thailand | AJ784323 | JN278234 |
| | <i>Yelicones spectabile</i> | Madagascar | AJ784319 | AJ784319 |

* sequences combined from two different individuals.