Systematics and biogeography of Australian rhopalosomatid wasps (Hymenoptera: Rhopalosomatidae) with a global synopsis of the enigmatic genus *Olixon* Cameron

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Abstract. The wasp family Rhopalosomatidae is represented in Australia only by the genus *Olixon* Cameron. Species of this genus have previously been considered rare based on material in collections and have rarely been observed in the field. All known species of *Olixon* are brachypterous, solitary ectoparasitoids of crickets (Orthoptera: Gryllidae). Prior to our study the world fauna comprised 11 species of which two were endemic to north-eastern Australia. Based on specimens collected during recent intensive surveys in Australia we record 17 species for the continent. Fifteen of these species are described as new, which more than doubles the world fauna of *Olixon*: *O. abrahami*, *O. danggari*, *O. ferrugineum*, *O. guyim*, *O. harveyi*, *O. helgae*, *O. jandakotae*, *O. jawoyn*, *O. jenningsi*, *O. kakadui*, *O. pilbara*, *O. wajuk*, *O. waldockae*, *O. wuthathi* and *O. zonale* spp.n. Females of *Olixon australiae* Perkins and *Olixon flavibase* Townes are redescribed, and the male of *O. flavibase* is described for the first time. A key is provided for all 17 Australian species and their distribution is discussed. Results of a cladistic analysis of the world species of *Olixon* based on 41 morphological characters for 24 ingroup species are presented. The results obtained from equal and implied weighting parsimony analyses indicate that: (i) the Australian species of *Olixon* are not monophyletic, (ii) about three-quarters of the Australian species form a monophyletic group, and (iii) a Central/South American *Olixon* is sister to all other species. The implications of these results for the biogeography of world *Olixon* species are briefly discussed.

Introduction

The small wasp family Rhopalosomatidae consists of four extant genera: *Rhopalosoma* Cresson, *Liosphex* Townes, *Paniscomima* Enderlein, and *Olixon* Cameron (Townes, 1977; Guidotti, 2007). Species of *Olixon* are remarkable in being brachypterous while the other genera are fully winged. Eleven species of *Olixon* have been described from the following regions: the New World (three species), Africa (four species), Madagascar (two species) and Australia (two species) (Townes, 1977; Fernandez & Sarmiento-M, 2002; Lohrmann & Ohl, 2007) (see Fig. 1). *Olixon* is the only rhopalosomatid genus recorded from Australia. Members of this genus are 2.5–10 mm in length and are ant-like in appearance (Fig. 2). Their biology is poorly known, and the only confirmed host record is for the Australian species *O. australiae*, a parasitoid of trigonidiine crickets (Orthoptera: Gryllidae) (Perkins, 1908). Townes (1977) mentions ‘circumstantial evidence’ for wood crickets (*Nemobius* spp.) as hosts of *O. banksii* (Brues) in the Nearctic, and scaly crickets (*Cycloptilum* spp.) as hosts of *O. testaceum* Cameron in the Neotropics.
Specimens of *Olixon* were considered until recently to be extremely rare, as indicated by Townes (1977), who located fewer than 40 specimens in the world’s collections. Some of these specimens had been seen running singly over the ground and were collected by hand. Recently, flight intercept traps (Upton, 1991) and especially pitfall traps have been used more frequently in biological surveys and these have proved to be very effective in collecting *Olixon*. Over the past 15 years these traps have collected hundreds of specimens from various localities in Australia. A close examination of this material has revealed a surprisingly high species diversity. In this study, we record 17 species from Australia, of which 15 are new, thus more than doubling the number of species known world-wide.

We present the results of a cladistic analysis including nearly all (24 of 26) of the known world species of *Olixon* based on morphological characters. This analysis focuses on the relationships among the Australian *Olixon*, and the geographically isolated species from Madagascar, Africa and the New World, to examine the phylogenetic affinities and origins of the Australian fauna. In addition, we discuss the distribution and possible habitat preferences for the Australian species, describe all new taxa, and present a key for their identification.

**Materials and methods**

**Specimens**

Specimens were borrowed from and/or are deposited in the following collections (acronyms used throughout the text): AEI, American Entomological Institute, Gainesville, Florida; AM, Australian Museum, Sydney, Australia; ANIC, Australian National Insect Collection, CSIRO, Canberra,
Australia; BMNH, The Natural History Museum, London, U.K.; CAS, California Academy of Sciences, San Francisco, California; NMV, Museum of Victoria, Melbourne, Australia; NTMA, Museum and Art Gallery of the Northern Territory, Darwin, Australia; QDPI, Queensland Department of Primary Industries and Fisheries Insect Collection, Indooroopilly, Australia; QM, Queensland Museum, Brisbane, Australia; SAM, South Australian Museum, Adelaide, Australia; SMNS, State Museum of Natural History Stuttgart, Germany; WAM, Western Australian Museum, Perth, Australia; WINC, Waite Insect and Nematode Collection, University of Adelaide, Australia.

**Scanning electron microscopy**

Specimens for scanning electron microscopy (SEM) were critical-point-dried and examined in a Philips XL30 FEG-SEM (Philips, Eindhoven, the Netherlands), either uncoated or sputter-coated with gold-platinum.

**Terminology**

Morphological terminology generally follows Goulet & Huber (1993) unless otherwise noted. Pretarsal structures were described according to Frantsevich & Gorb (2002). The term **interocellar distance** is used for the distance between the two posterior ocelli, and **ocellocular distance** is used for the distance between the eye margin and the margin of one of the posterior ocelli (Fig. 6H). The term **pronotal index** is used for the ratio between the length and the width of the pronotum (Fig. 7C), and **propodeal index** is used for the ratio between the length and the width of the propodeum (Fig. 7C). The measurepoints for eye length, malar space and temple length are indicated in Fig. 6A, B. The following abbreviations for frequently used morphological terms are used throughout the text: **F**, flagellomere, for example F1 is the first flagellomere; **IOD**, interocellar distance; **OOD**, ocellocular distance; **S**, metasomal sternite, for example S2 is the second metasomal sternite; **T**, metasomal tergite, for example T3 is the third metasomal tergite.

**Table 1.** List of world species of *Olixon* Cameron and outgroup taxa used for analyses.

<table>
<thead>
<tr>
<th>Olixon species</th>
<th>Included in analyses</th>
<th>Type material checked</th>
<th>Depository of specimens used for analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>O. abrahami</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>WAM</td>
</tr>
<tr>
<td><em>O. atlanticum</em> Fernandez &amp; Sarmiento-M, 2002</td>
<td>No</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><em>O. australiae</em> (Perkins, 1908)</td>
<td>Yes</td>
<td>Yes</td>
<td>BMNH</td>
</tr>
<tr>
<td><em>O. banksii</em> (Brues, 1922)</td>
<td>Yes</td>
<td>No</td>
<td>Coll. M. Oh</td>
</tr>
<tr>
<td><em>O. danggari</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>ANIC, SAM, SMNS, WINC</td>
</tr>
<tr>
<td><em>O. dentatum</em> (Cameron, 1904)</td>
<td>Yes</td>
<td>Yes</td>
<td>BMNH</td>
</tr>
<tr>
<td><em>O. ferrugineum</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>SAM, SMNS, WAM, WINC</td>
</tr>
<tr>
<td><em>O. flavibase</em> Townes, 1977</td>
<td>Yes</td>
<td>Yes</td>
<td>BMNH, QDPIF</td>
</tr>
<tr>
<td><em>O. guyom</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>ANIC</td>
</tr>
<tr>
<td><em>O. harveyi</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>SMNS, WAM, WINC</td>
</tr>
<tr>
<td><em>O. helvega</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>SMNS, WAM, WINC</td>
</tr>
<tr>
<td><em>O. jandakotae</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>ANIC</td>
</tr>
<tr>
<td><em>O. jawoyin</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>SAM</td>
</tr>
<tr>
<td><em>O. jenningsi</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>ANIC</td>
</tr>
<tr>
<td><em>O. kakadui</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>ANIC</td>
</tr>
<tr>
<td><em>O. majus</em> Townes, 1977</td>
<td>No</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><em>O. martini</em> Lohrmann, 2007</td>
<td>Yes</td>
<td>Yes</td>
<td>CAS</td>
</tr>
<tr>
<td><em>O. myrmoxaforme</em> (Arnold, 1935)</td>
<td>Yes</td>
<td>No</td>
<td>BMNH</td>
</tr>
<tr>
<td><em>O. pilbara</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>SMNS, WAM, WINC</td>
</tr>
<tr>
<td><em>O. saltatator</em> (Arnold, 1935)</td>
<td>Yes</td>
<td>No</td>
<td>BMNH</td>
</tr>
<tr>
<td><em>O. testaceum</em> Cameron, 1887</td>
<td>Yes</td>
<td>Yes&lt;sup&gt;b&lt;/sup&gt;</td>
<td>BMNH</td>
</tr>
<tr>
<td><em>O. toliaraensis</em> Lohrmann &amp; Ohl, 2007</td>
<td>Yes</td>
<td>Yes</td>
<td>CAS</td>
</tr>
<tr>
<td><em>O. wajik</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>SMNS, WAM, WINC</td>
</tr>
<tr>
<td><em>O. waldockae</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>SMNS, WAM, WINC</td>
</tr>
<tr>
<td><em>O. wuthathi</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>ANIC, QM, SMNS, WINC</td>
</tr>
<tr>
<td><em>O. zonale</em> sp.n.</td>
<td>Yes</td>
<td>Yes</td>
<td>SMNS, WAM, WINC</td>
</tr>
<tr>
<td>Outgroup taxa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Rhopalosoma alvarengai</em> Townes, 1977</td>
<td>Yes</td>
<td>No</td>
<td>AEI</td>
</tr>
<tr>
<td><em>Paniscomima erlangeriana</em> (Enderlein, 1904)</td>
<td>Yes</td>
<td>No</td>
<td>AEI</td>
</tr>
<tr>
<td><em>Liopsphex varius</em> Townes, 1977</td>
<td>Yes</td>
<td>Yes</td>
<td>AEI</td>
</tr>
</tbody>
</table>

<sup>a</sup>*Olixon* is neutral in gender and the original species epithet *atlanticus* is herein accordingly amended.

<sup>b</sup>The holotype of *Saphobetylus pallidus* Kieffer was checked (synonym of *O. testaceum*).

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Phylogenetic analysis

Twenty-four species of Olixon from throughout the world were included in the analyses, mainly represented by type specimens (Table 1). Three outgroup species were chosen, namely Rhopalosoma alvarengai Townes from South America, Paniscomima erlangeriana Enderlein from Africa and Liosphex varius Townes from South and Central America, representing the other known genera of Rhopalosomatidae, all of which are fully winged. One of these, R. alvarengai, was used to root the tree, as we consider it to be more plesiomorphic for a number of characters including antennal setation and form of the occipital carina. Morphological data for 41 discrete binary or multistate characters were coded into a character matrix (Table 2). The data set was analysed in TNT ver. 1.1 (Goloboff et al., 2003) using uniformly weighted parsimony. Alternative weighting schemes were applied by additional searches under implied weighting, with the aim of resolving character conflict in favour of characters that show lower levels of homoplasy (Goloboff, 1993). The k values ranged from 3, which represents a stronger down-weighting of the homoplasious characters, to 10, which represents a milder down-weighting. Seven multi-state characters (2, 9, 13, 15, 25, 28, 29) were treated as additive, and analyses were run with collapsing rules set to min. length = 0. In order better to explore tree space, analyses were run for each weighting scheme following Vilhelmsen (2007), with 100 replications/5000 trees saved per replication; 500 replications/1000 trees saved per replication; and 1000 replications/500 trees saved per replication. Total Bremer support values (Bremer, 1988, 1994) were calculated by implementing converse constraints with 100 random addition sequences per node. In a second set of analyses, the equal-weighting analysis was repeated by implementing a constraint to force the monophyly of the 17 Australian Olixon species and evaluate how many extra steps were needed for the minimal length trees.

Characters

Head.

1. Frons surface: 0 without deep punctures (Fig. 6B); 1 with deep punctures (Fig. 6D).
2. Malar sulcus: 0 present and complete (Fig. 6B); 1 present but incomplete (indicated near oral margin only) (Fig. 6E); 2 absent (Fig. 6A).
3. Posterior ocelli: 0 present; 1 absent.
4. Anterior ocellus: 0 present; 1 absent.

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5. Ocular sulcus: 0 without pubescence (Fig. 6C); 1 with elongate setae that overlap each other (Fig. 6D).
6. Ratio between interocellar distance (IOD) and ocellular distance (OOD): 0 IOD ≥ IOD; 1 IOD > OOD.
7. Size of lateral ocelli: 0 lateral ocelli enlarged, OOD 0.1–2.0× diameter of lateral ocellus; 1 ocelli not enlarged, OOD more than 2.0× diameter of lateral ocellus.
8. Eye margin: 0 not notched opposite antennal socket; 1 notched opposite antennal socket.
9. Clypeus pubescence: 0 dense and complete; 1 dense, but absent ventromedially (Fig. 5E); 2 sparse, but continuous; 3 clypeus mainly glabrous.

**Antenna.**
10. First flagellomere: 0 less than 2× as long as broad; 1 between 2 and 3.7× as long as broad; 2 more than 3.7× as long as broad.
11. Flagellomeres: 0 without conspicuous apical setae; 1 with conspicuous apical setae (Fig. 5A–C).
12. Apical setae: 0 present in both sexes; 1 present in females only.
13. Position of apical setae: 0 present on F1; 1 present on F1–F2; 2 present on F1–F3 (Fig. 5A); 3 present on F1–F4; 4 present on F1–F5; 5 present on more than F1–F5.
14. Number of apical setae per flagellomere: 0 one (Fig. 5B); 1 two (Fig. 5C).

**Thorax.**
15. Shape of forewing: 0 macropterous; 1 brachypterous, but with membrane broadly expanded (Fig. 7G); 2 strap-like, with membrane narrow or not expanded (Figs 2B; 7B, E; 8H); 3 extremely shortened, not or barely longer than tegula (Fig. 8D).
16. Length of forewing: 0 forewing not reaching beyond posterior propodeal margin; 1 forewing reaching beyond posterior propodeal margin.
17. Hindwing: 0 present (Fig. 7C); 1 absent.
18. Penultimate tarsomere: 0 asymmetric (Fig. 10A); 1 symmetric (Fig. 10B).

**Propodeum.**
19. Propodeal setae: 0 medially overlapping (Fig. 8H); 1 not medially overlapping (Fig. 7C).
20. Position of propodeal spiracles: 0 situated closer to posterior than to anterior propodeal margin (Fig. 7F); 1 situated closer to anterior than to posterior propodeal margin.
21. Posteromedian propodeal process: 0 present (Fig. 7C); 1 absent (Fig. 7H).
22. Shape of posteromedian propodeal process: 0 spinose (Fig. 7C); 1 bispinose (Figs 7F, 8H).
23. Posterior propodeal margin: 0 with complete carina; 1 without complete carina.
24. Posterolateral propodeal process: 0 absent; 1 present (Fig. 8F).
25. Metapleural sulcus (separating metapleuron and propodeum): 0 present and complete; 1 incomplete; 2 absent.

**Metasoma.**
26. Length of first tergite in dorsal view: 0 elongate more than 1× as long as wide; 1 short and transverse, less than 1× as long as wide (Fig. 8I).
27. Dorsal surface of first tergite: 0 with transverse carina (Fig. 8G, I); 1 without transverse carina (Fig. 8F).
28. Second tergite: 0 with complete, conspicuous pubescence; 1 conspicuous pubescence incomplete, restricted to anterior half to 2/3 of tergite; 2 without conspicuous pubescence.
29. Lateral carina on T2: 0 ventrally bordered by glabrous area (Fig. 12B); 1 ventrally bordered by area that is anteriorly sparsely setose, posteriorly glabrous; 2 ventrally bordered by completely setose area.
30. Third tergite: 0 densely pilose; 1 with scattered setae or glabrous.
31. Fourth tergite: 0 densely pilose; 1 with scattered setae or glabrous.
32. Fifth tergite: 0 densely pilose; 1 with scattered setae or glabrous.
33. Sixth tergite: 0 densely pilose; 1 with scattered setae or glabrous.
34. Second sternite: 0 densely pilose; 1 with scattered setae or glabrous.
35. Third sternite: 0 densely pilose; 1 with scattered setae or glabrous.
36. Fourth sternite: 0 densely pilose; 1 with scattered setae or glabrous.
37. Fifth sternite: 0 densely pilose; 1 with scattered setae or glabrous.
38. Male seventh sternite: 0 at least posteriorly densely pilose (Fig. 12E); 1 glabrous (Fig. 12F).
39. Male sixth sternite: 0 densely pilose; 1 with scattered setae or glabrous.
40. Female hypopygium: 0 densely setose; 1 glabrous or with inconspicuous pubescence restricted to posterior margin.
41. Male subgenital plate: 0 densely pilose (Fig. 12E, F); 1 at most medially pilose, laterally glabrous.

**Review of relationships of Rhopalosomatidae and Olixon**

The phylogenetic position of Rhopalosomatidae has been the subject of controversy for more than a century. Morley (1910) reviewed the contrasting opinions of various authors that allied Rhopalosoma to Formicidae, Sphecidae, Ichneumonidae or Braconidae. During the last 30 years, a sister-group relationship between Rhopalosomatidae and Pompilidae has been proposed consistently by the majority of authors (e.g. Brothers, 1975, 1999; Königsmann, 1978; Rasnitsyn, 1980, 1988). This relationship is supported only by a single putative synapomorphy, the form of the hind tibial calcar, a modification of the inner hind tibial spur (e.g. Brothers, 1975). However, Day (1988) rejected a close relationship between these families based on the presence of...
a claval lobe in the hindwing of macropterous Rhopalosomatidae but not in Pompilidae, and on differences in the hind basitarsus and hamuli. Day (1988) highlighted rhopalosomatid features as reminiscent of the ‘vespid (s.s.) branch’, for example eye shape, presence of a trochantellus, co-adaptation of the pronotum and mesothorax, form of the mesosoma–metasoma articulation, and articulation of the first and second metasomal segments. The morphological phylogeny of aculeate wasps by Brothers & Carpenter (1993) posits the Rhopalosomatidae as sister to a clade comprising Formicidae + Vespidae + Scoliidae + Bradyponeraeidae. This relationship is supported by the clustering of the basal hamuli, the narrowing and shortening of the prepectus, and the slight constriction at the junction of the first and second metasomal segments. Furthermore, in contrast to previous authors, Brothers & Carpenter (1993) proposed Pompilidae as the sister to Mutillidae + Sapygidae based on a different state of the prepectus: in these families the prepectus is not shortened and is fused with the mesepisternum. A recent comprehensive molecular analysis of aculeate relationships (Pilgrim et al., 2008) strongly supports a Rhopalosomatidae + Vespidae relationship and also supports the Pompilidae + Mutillidae + Sapygidae clade proposed by Brothers & Carpenter (1993), thus refuting the previous general view that Rhopalosomatidae and Pompilidae are sister taxa.

**Olixon**

For more than 120 years, gaining an understanding of the relationships of *Olixon* has been a prolonged and difficult task. Originally, Cameron (1887) considered the genus to belong in the Braconidae, but commented on its similarities with the Bethylidae. Ashmead (1902), Brues (1910, 1922) and Perkins (1912) all placed *Olixon* in the Embolemineae but differed as to whether Embolemineae should be included within the Bethylidae or Dryinidae. Kieffer (1914) thought these unusual wasps to be mesitiine Bethylidae. However, based on morphological similarities between *Olixon* and several wing-reduced taxa of Pompilidae, Reid (1939) concluded that *Olixon* should be included within this family. Reid’s (1939, 1941) notion of the ‘pompiloid’ affinities of *Olixon* and rhopalosomatids in general persisted for the remainder of the 20th century (e.g. Richards & Davies, 1960; Riek, 1970; Brothers, 1975; Königsmann, 1978; Rasnitsyn, 1980, 1988; Naumann, 1991), despite their puzzling biological differences in that pompilids all develop at the expense of spiders whereas rhopalosomatids are known to parasitise only crickets.

Turner & Waterston (1917) related *Olixon* to the small family Rhopalosomatidae based on antennal and male genitalic structures. Brothers (1975) found further morphological evidence for an association between these genera based on the expanded tarsi and swollen foretibiae in the females. Brothers & Carpenter (1993) also confirmed that *Olixon* and the macropterous rhopalosomatid genera form a monophyletic group. Guidotti (1999) listed six morphological characters suggesting affinities of *Olixon* with the Rhopalosomatidae. However, most of these character states are widespread within Vespiformes and are of unclear polarity, although the ‘flat lanceolate bristle on female tarsal claws’ (=claw sensor) may be restricted to Rhopalosomatidae (see below). In his treatment of the world fauna, Townes (1977) listed 13 ‘characteristics’ of Rhopalosomatidae but without providing any explanations for them. All of these characters are absent in *Olixon* or are not unique to Rhopalosomatidae. This applies also to the extended mesotrochantinal lobes (a pair of plates that partially cover the bases of the middle coxae) (Fig. 7A) that are present in all Rhopalosomatidae but occur also in Tiphidae (e.g. Goulet & Huber, 1993).

Most recently, Engel (2008), when describing a new fossil genus, *Eorhopalosoma*, from Myanmar Cretaceous amber, erected the new monogenic subfamily Oxiloxiniae. We argue against using this higher-level taxon, given that: (i) it contains only the single genus *Olixon*, and so makes no useful contribution to the classification of a family containing so few genera; and (ii) it undoubtedly renders paraphyletic the remaining Rhopalosomatidae (i.e. the ‘Rhopalosomatinae’).

**Phylogenetics and Biogeography of Olixon**

For our analyses, the number of trees was unaffected by the different ratios of number of replications/number of trees saved per replication under both equal and implied weighting. All equal-weighting analyses resulted in 10 minimal length trees with 125 steps. The strict consensus tree retrieved *Olixon* as monophyletic, and placed the Central/South American species *O. testaceum* as the sister to all other members of the genus (Fig. 3). The remaining *Olixon* species were part of a polytomy in which the relationships between the North American species *O. banksii*, the Madagascan species *O. martini* Loehrman and *O. toliaraensis* Loehrman & Ohl, the African species *O. saltator* (Arnold) and the Australian species *O. flavibase* Townes remained unresolved. The other Australian *Olixon* species were contained within two clades. Clade A comprised the African species *O. dentatum* (Cameron), and *O. myrmosaeforme* (Arnold) and three Australian species (*O. wallockae, O. wajuk, and O. australiae*), and Clade B comprised the remaining 13 Australian *Olixon* species and was fully resolved.

Forcing the monophyly of the Australian *Olixon* species resulted in 90 minimal length trees that were four steps longer (129) than those found in the unconstrained analyses.

Analysis under implied weights with $k = 3–7$ resulted in a single tree [Goloboff fit: 12.24 (for $k = 3$) to 7.20 (for $k = 7$)] that was very similar to the consensus tree obtained from equal weighting, albeit fully resolved (Fig. 4). Again *O. testaceum* was the sister to all other members of the genus but was followed on the tree by the North American *O. banksii*, then by the two Madagascan species that were sister to each other, and with the Australian *O. flavibase*
Fig. 3. Phylogenetic relationships within the genus *Olixon* (equal weighting analysis). Strict consensus of 10 equally parsimonious trees with a length of 125 steps, produced by maximum parsimony analysis in TNT. Trees were rooted on *Rhopalosoma alvarengai*. Bremer support values are indicated below branches. Clades comprising Australian taxa are marked by dotted lines. Clades A and B are discussed in the text.

Fig. 4. Phylogenetic relationships within the genus *Olixon* (implied weighting analysis). Single tree produced by maximum parsimony analysis in TNT with $k = 3-7$ (Goloboff fit 12.24–7.20). The tree was rooted on *Rhopalosoma alvarengai*. Clades comprising Australian taxa are marked by dotted lines. Clades 1 and 2 are discussed in the text.
being sister to a single group comprising two clades (Fig. 4). Clade 1 comprised a grade of interspersed African (O. saltatator, O. myrmoseaforme, and O. dentatum) and Australian (O. australiae, O. waldoekae, and O. wajuk) species, with the position of O. dentatum being the most divergent in its position compared with the equal-weighting tree. Clade 2 comprised the same 13 Australian species as Clade B in the equal-weighting tree and showed similar relationships among species, in that O. jenningsi and O. harveyi were at the base of the clade and O. jandakotae was sister to the same six terminal taxa. However, relationships among some species were different, particularly along the grade of taxa below O. jandakotae.

Tree topologies under implied weighting with higher k values (k = 8–10) changed only slightly, and confirmed the position of O. testaceum and O. banksii, and the non-monophyly of the Australian Olixon species [Goloboff fit: 6.54 (for k = 8) to 5.52 (for k = 10)].

Discussion

The results of the above analyses must be considered preliminary given the few available external morphological characters. This is at least partly the result of numerous meso- and metathoracic characters being absent because of wing reduction in Olixon, compared with the other fully-winged genera in the family. However, the results do indicate that the Australian Olixon species are not monophyletic. This is supported by the analysis forcing the monophyly of Australian taxa, which resulted in a tree four steps longer than the most parsimonious tree.

Based on this set of relationships among species and the fact that the genus is found in North and South America, Africa, Madagascar and Australia (Figs 1, 13), we postulate tentatively a southern hemisphere distribution for Olixon determined by vicariance resulting from the breakup of Gondwana and a more recent dispersal event into North America. This hypothesis requires that Olixon is more than 80 million years old and that its ancestor was already widespread in Gondwana. Although it may be problematic to consider such a morphologically derived genus to be that old, it would seem less likely to assume multiple independent dispersal events of flightless Olixon species from Africa to Australia, or multiple independent losses of functional wings from a fully-winged dispersing ancestor. Our analyses do not show a sister-group relationship between the North and the Central/South American Olixon species, which contradicts the hypothesis of a dispersal from South to North America. However, given the preliminary nature of our phylogenetic results and the simplified morphology of Olixon it is difficult to test potentially competing biogeographic scenarios effectively. Given these shortcomings, a DNA sequencing approach is likely to be a more profitable avenue of investigation. Interestingly, Guidotti (1999) favours a vicariance explanation for the distribution of rhopalosomatid genera, but there is little support for such a proposal now. Although fossil Rhopalosomatidae are available they make no useful contribution to resolving this question. There are no fossils of Olixon, and the existing fossil taxa are all fully winged, viz. Mesorhopalosoma ceareae Darling (Darling & Sharkey, 1990) from the Lower Cretaceous, Eorhopalosoma gorgyra Engel (2008) from the Mid-Cretaceous, and Propalosoma gutierreziae Dlussky & Rasnitsyn (1999) from the Mid-Eocene.

New characters of potential phylogenetic importance

During this study we identified two additional putative synapomorphies associated with the antennae and tarsal claws that support the inclusion of Olixon in Rhopalosomatidae. The apical setae on the basal flagellomeres of some Australian Olixon species (Fig. 5A, B) are identical in morphology and position to one of the paired setae found on the flagellomeres of other rhopalosomatid genera. In Rhopalosoma and Paniscomima the paired setae are equal in length, whereas in Liosphex one of these setae is conspicuously shortened (Fig. 5C). Based on this character distribution across genera we postulate that the single long seta in some Olixon species (i.e. O. abrahami, O. dangari, O. ferrugineum, O. helgae, O. jandakotae, O. pilbara, O. wajuk and O. zonale) is homologous to that found on the basal flagellomeres of the other genera: in all remaining Olixon species, including all non-Australian species, both setae have been lost.

The greatly enlarged arorium on the pretarsi of female Olixon (Fig. 11A–C) are also present in the females of winged rhopalosomatid genera. The function of this structure is unknown but it may be host-associated and used by females to adhere to mobile cricket hosts at the time of oviposition. This complex structure comprises an elongate cuticular plate, extended lapel, elongation of the claw sensor, and associated setae. The structure varies only slightly in other rhopalosomatid genera and we can find no reference of any similarly enlarged attachment devices in other families of aculeate Hymenoptera.

In addition to the above two characters, at least some Olixon have a distinct setal pattern on the inner hind tibial surface (revealed under SEM). These setae appear as rod-like (O. harveyi, Fig. 9A, C) or shortened scale-like (O. ferrugineum, Fig. 9B, D). The character state distribution of this feature within Olixon and other aculeates remains unknown, but its phylogenetic utility warrants further study.

Systematics

Family Rhopalosomatidae Ashmead


Diagnosis. Basal flagellomeres with distinct apical setae. Female pretarsus with arorium and cuticular plate greatly
enlarged and claw sensor elongated. Winged forms with cell C almost eliminated in forewing.

**Genus Olixon Cameron**


**Diagnosis.** Head capsule dorsally flattened and extended between toruli, occipital carina present and complete (Fig. 6G).

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**Fig. 5.** Head of Rhopalosomatidae. (A–B) *Olixon ferrugineum* sp.n., antenna (A) and detail (B) of marked area in (A), showing apical seta; (C) *Liosphex varius* detail of antenna. (D–F) *O. ferrugineum* sp.n., frons (D), mouth-parts (E) and maxillary palp (F). aoc, anterior ocellus; as, apical seta; cl, clypeus; F₅, flagellomere; lb, labrum; md, mandible; mp₅, maxillary palpomere; ped, pedicel; poc, posterior ocellus; sc, scape.
Ocelli small (Fig. 5D), sometimes absent. Inner eye margin not notched. Maxillary palp with long apical seta on third palpomere (Fig. 5F). Pronotum elongate with anterior carina (Fig. 7A). Propleuron exposed in lateral view, with distinct lateral carina. Foretibia thickened. Forewing reduced to various degrees; with membrane broadly expanded (Fig. 7G), strap-like, with membrane narrowly or not expanded (Figs 2B; 7B; 8H) or barely longer than tegula (Fig. 5D). Hindwing reduced to short stub (Fig. 7C) or absent. Mesonotum reduced, but with transverse articulation and more or less well-defined mesoscutellum (Fig. 8B–D). Metanotum not traceable (Fig. 8B–D) (compare with fully winged form in Fig. 8A). Propodeum with two posterolateral processes, propodeal spiracles situated closer to posterior than to anterior propodeal margin (Fig. 7F). T1 short and transverse (Fig. 8F, G, I). Female pretarsus with ariolium bilobed, inner surface of lobes (lapel) patterned in lines running perpendicular to the longitudinal axis of pretarsus, outer surface covered with ‘calix-flower’-shaped setae (Fig. 11C). Female uncus without ventral tooth, proximally with conspicuously broadened setae of which one (i.e. the claw sensor) equals length of uncus (Fig. 11B), manubrium (orbiculum) with two equally long setae (Fig. 11A), cuticular plate elongate, lapel extended (Fig. 11C). Male pretarsus with ariolium much shorter than in female, lapel with less distinct lines, outer surface of ariolium with simple setae, uncus with distinct ventral tooth (Fig. 11D).

Biology. As discussed above, the biology of the genus is poorly known with only one confirmed host record, namely that of the Australian species *O. australiae*, which was found to be ectoparasitic on a trigonidide gryllid cricket (Perkins, 1908). However, there is probably little doubt that the family as a whole are cricket ectoparasitoids, given that *Rhpalosoma* has also been found on cricket hosts and forms a ‘cyst’ after the first instar (Gurney, 1953).

A least one Australian species of *Olixon*, *O. harveyi*, has been seen running across open sandy soil. Its movement was rapid and ‘ant-like’ in that it consisted of short bursts of rapid locomotion interspersed with periods of stopping for a few seconds (M. S. Harvey, personal communication). The specimens were found in dry pitfall traps that were being cleared every 24 h in the early morning, so it is not known whether they were nocturnally or diurnally active when they fell into the traps. Krombein (1949) collected males of the North American species *O. banksii* that ‘were running swiftly over the sandy barrens’ but provided no further biological information. It is likely that Krombein’s observations were made during the day, as he later (1978) concluded from his previous (1949) paper that *Olixon* species are diurnal. Townes (1977) stated that *O. banksii* has been found active at day and at night but provided no further details.

Some *Olixon* species were reported to have a small, median stridulatory organ between the second and third metasomal tergites (Brothers, 1975; Tschuch & Brothers, 2000; Lohrmann & Ohl, 2007), but actual stridulation and sound emission have never been observed. We could not detect a similar structure in any Australian species and consider it absent or hidden by the posterior margin of the second metasomal tergite.

Diversity and distribution of Australian species. The Australian fauna, although limited to just the genus *Olixon*, is revealed in this study to be one of the most species-rich faunas in the world for rhopalosomatids, representing more than 30% of known species in the family and more than 65% of known *Olixon* species. *Olixon* occurs across the continent, ranging from the arid interior and coastal mediterranean regions to the wet tropics (Fig. 13A–D). However, the majority of species are found in areas with an annual rainfall of less than 370 mm (15 inches) per year. Given that many remote habitats are yet to be surveyed properly for their insect fauna, more species of *Olixon* surely are to be discovered.

It is clear from the material obtained from comprehensive faunal surveys, such as the Conservation and Land Management (CALM) (Western Australian Government; now Department of Conservation) survey of the Pilbara region from 2003 to 2006, that *Olixon* is collected relatively rarely, and is encountered only in large numbers in long-term, very intensive sampling projects. For example, the CALM survey yielded approximately 400 specimens, belonging to three new species, *O. ferrugineum, O. pilbara* and *O. zonale* (Fig. 13A, C, D). However, this survey utilized 1520 pitfall traps run continuously for 36 months, which amounts to an average capture rate for *Olixon* of fewer than 0.1 specimens/pitfall/12 months. If this is indicative of the population density and/or catchability of most species, it is then not surprising that pitfall traps run for a short period (e.g. 14 days or less) rarely generate specimens of *Olixon* (A. D. Austin, personal observations).

A significant number of species are restricted to the Swan Coastal Plain (around Perth) in Western Australia. These species may prove to be of significant conservation value as they appear to have very restricted distributions, and the remnant habitats in which they are found are under immense pressure from urban development. Four species of *Olixon* (about a quarter of the Australian species) have been found at Bold Park, a small (437 ha) bushland reserve just 7 km west of the Perth Central Business District that is completely surrounded by suburban houses.

**Key to Australian species of Olixon**

1. Antenna 12-segmented (Fig. 5A). Metasoma with 6 visible tergites (Fig. 12A) [females] .................. 2
   Antenna 13-segmented (Fig. 2A, B). Metasoma with 7 visible tergites (Figs 2A, B; 12C, D) [males] ....... 17

2(1). T1 with transverse carina (Fig. 8G, I) ............ 3
   T1 without transverse carina (Fig. 8F) ............... 7

3(2). Malar sulcus incomplete, weakly indicated near oral margin only (Fig. 6E) or entirely absent (Fig. 6A) ......................................................... 4
   Malar sulcus complete, continuous between eye and oral margin (Fig. 6B–D, F) .......................... 5

4(3). Malar sulcus weakly indicated near oral margin (Fig. 6E). Body entirely orange-brown to red-brown.
Forewing at rest not extending beyond posterior margin of propodeum.................*O. harveyi* sp.n.
Malar sulcus completely absent (as in Fig. 6A).
Body predominantly dark brown. Forewing at rest extending beyond posterior margin of propodeum..................*O. flavibase* Townes

5(3). Propodeum with small bispinose posteromedian process (Fig. 8H). Forewing strap-like, at rest reaching mid to two-thirds length of propodeum.................*O. jandakotae* sp.n.
Propodeum without postemriodan process (Figs 7H, 8I). Forewing hardly visible, not or barely longer than tegula, at rest not reaching beyond posterior margin of mesoscutellum (Fig. 8D) .......... 6

6(5). Vertex with distinct piliferous punctures (as in Fig. 6D). Tegulae minute, dorsally separated by more than \(4 \times\) the width of one tegula (Fig. 7H). F1 2.3–2.9 \(\times\) longer than wide...............*O. wajuk* sp.n.
Vertex predominantly smooth (Fig. 6B). Tegulae larger, dorsally separated by less than \(2 \times\) the width of one tegula. F1 3.3–3.5 \(\times\) longer than wide ................*O. wallockae* sp.n.

7(2). Propodeum without posteromedian process (as in Fig. 7H)..........................*O. australiae* (Perkins)
Propodeum with single posteromedian process of various sizes and shapes (Fig. 7A–G) ............... 8

8(7). Body uniformly orange-brown to red-brown in colour ........................................... 9
Body at least partly dark brown to black in colour .................................................. 10

9(8). F1–F3 (sometimes also F4) with distinct apical setae (Fig. 5A). Only T1 with white pubescence, T2 shiny with characteristic punctures from which extremely shortened setae arise, T3–T6 shiny and largely devoid of setae (Fig. 12A). Propodeal spiracle situated on distinct protuberance (Fig. 8E).....................*O. ferrugineum* sp.n.
Flagellomeres without apical setae. At least T1–T3 with dense pubescence (as in Fig. 12C). Propodeal spiracles flattened ...........*O. kakadui* sp.n.

10(8). Antennal flagellomeres without apical setae........ 11
At least F1 with distinct apical seta (Fig. 5B) .... 13

11(10). Head and mesosoma uniformly dark brown to black. Inner distal lobe of penultimate tarsomere distinctly longer than outer lobe (as in Fig. 10A). Hind femur 3.4–3.8 \(\times\) longer than wide.......................*O. wuthathi* sp.n.
Head and mesosoma at least in part orange-brown.
Inner lobe of penultimate tarsomere not distinctly longer than outer lobe (as in Fig. 10B). Hind femur 4.0–4.4 \(\times\) longer than wide ................. 12

12(11). Forewing very long, at rest clearly extending beyond posterior margin of T1. Eyes and posterior ocelli situated closer to occipital carina (Fig. 6H). Posteromedian propodeal process longer, more slender and acute .........................*O. jenningsi* sp.n.

13(10). Forewing strongly reduced, at most strap-like with membrane scarcely wider than longitudinal vein and reaching only to midpoint of propodeum......... 14
Forewing with membrane broadly expanded and two oblique veins indicated by colour streaks, always reaching further than midpoint of propodeum.............................................................. 15

14(13). F1–F3 with distinct apical setae (as in Fig. 5A). Forewing strap-like, membrane scarcely wider than longitudinal vein, reaching to midpoint of propodeum (Fig. 2A, B). T1 and T2 with conspicuous white pubescence ..................*O. dannngari* sp.n.
F1–F5 with distinct apical setae. Forewing not or barely longer than tegula, at rest not reaching beyond posterior margin of mesoscutellum (Figs 7D, 8D). Only T1 with conspicuous white pubescence ........................................*O. zonale* sp.n.

15(13). Only F1 with conspicuous, apical seta. Posteromedian process of propodeum broad and apically blunt, almost bispinose (Figs 7G, 8F). Each posterolateral process of propodeum rather stout (Figs 7G, 8F) .........................*O. helgae* sp.n.
At least F1 and F2 each with conspicuous, apical seta; posteromedian process of propodeum apically acute (Fig. 7C, E); each posterolateral process elongate (Fig. 7C, E) ........................................ 16

16(15). F1 and F2 each with conspicuous, apical seta. All metasomal tergites with dense white pubescence (Fig. 12C). Forewing at rest reaching posterior propodeal margin. .....................*O. pilbara* sp.n.
F1–F3 each with conspicuous, apical seta. Only T1 and anterior half of T2 with dense white pubescence. Forewing shorter, at rest reaching three-quarters length of propodeum (Fig. 7E)..........................*O. abrahami* sp.n.

17(1). T1 with transverse carina (Fig. 8G, I) ........... 18
T1 without transverse carina (Fig. 8F).............. 22

18(17). Malar sulcus incomplete, weakly indicated near oral margin only (Fig. 6E) or entirely absent (Fig. 6A) .......................................................... 19
Malar sulcus complete, continuous between eye and oral margin (Fig. 6B, D, F) ......................... 20

19(18). Malar sulcus weakly indicated near oral margin only (Fig. 6E). Body entirely orange-brown to reddish-brown. Forewings at rest not extending beyond posterior margin of propodeum ................................................*O. harveyi* sp.n.
Malar sulcus completely absent (as in Fig. 6A).
Body predominantly dark brown. Forewing at rest extending beyond posterior margin of propodeum.................*O. flavibase* Townes

20(18). Propodeum with small bispinose posteromedian process (Fig. 8H). Forewing strap-like, at rest reaching mid to two-thirds length of propodeum (Fig. 8H) .........................*O. jandakotae* sp.n.
Propodeum without posteromedian process (Figs 7 H, 8I). Forewing not or barely longer than tegula, at rest not reaching beyond posterior margin of mesoscutellum (Fig. 8D).  

21(20). Vertex with distinct piliferous punctures (as in Fig. 6D). Tegulae minute, dorsally separated by more than 4× the width of one tegula. F1 2.0–2.5× longer than wide ........................................... 21

22(17). Body uniformly yellowish to red-orange or red-brown; large specimens (4.4–6.2 mm) ................... 23

23(22). Forewing at rest extending beyond posterior margin of propodeum. .......................... 24

25(24). Head and mesosoma dark brown to black. Penultimate tarsomere strongly asymmetrically produced (as in Fig. 10A). Hind femur 3.3–3.9× longer than wide ......................... O. wajuk sp.n.

26(25). Metasoma uniformly dark brown. Head and mesosoma shiny and of various colour (yellowish, light brown or red-brown). Smaller specimens (body length: 2.6–3.3 mm) .... 24

27(24). Mesosoma uniformly black or brown ................. 28

28(27). Only T1 and T2 pilose. Posteromedian propodeal process narrow and acute (Fig. 7E). Forewing with narrowly expanded membrane (Fig. 7E) .................. O. abrahami sp.n.

29(28). Ocular sulcus posteriorly extended at level of dorsal eye margin (Fig. 6C). Forewing strap-like (Fig. 7B). Posteromedian propodeal process elongate and apically rounded (Fig. 7B) ................ O. guyim sp.n.

Propodeal spiracles flattened ........... O. kakadui sp.n.

Only T1 with white pubescence, T2 shiny, anteriorly with characteristic punctures from which extremely shortened setae arise, T3–T7 shiny and glabrous. Propodeal spiracle situated on distinct protuberance (Fig. 8E) .................... O. ferrigineum sp.n.

24(22). Forewing at rest extending beyond posterior margin of propodeum. .......................... 25

25(24). Head and mesosoma dark brown to black. Penultimate tarsomere strongly asymmetrically produced (as in Fig. 10A). Hind femur 3.3–3.9× longer than wide ......................... O. wajuk sp.n.

Head and mesosoma at least in part yellowish to orange. Penultimate tarsomere not or only slightly asymmetrically produced (as in Fig. 10B). Hind femur 4.0–4.4× longer than wide ..................... 26

26(25). Metasoma uniformly dark brown. Head and mesosoma dull orange-brown. Larger specimens (body length: 4.0 mm) ............... O. jenningsi sp.n.

At top tip of metasoma (metasomal segments 4–7) dark brown. Head and mesosoma shiny and of various colour (yellowish, light brown or red-brown). Smaller specimens (body length: 2.6–3.3 mm) .... 24

27(24). Mesosoma uniformly black or brown ................. 28

28(27). Only T1 and T2 pilose. Posteromedian propodeal process narrow and acute (Fig. 7E). Forewing with narrowly expanded membrane (Fig. 7E) .................. O. abrahami sp.n.

At least T1–T3 pilose. Posteromedian propodeal process broader (Fig. 7B, G). Forewing different .................................................. 29

29(28). Ocular sulcus posteriorly extended at level of dorsal eye margin (Fig. 6C). Forewing strap-like (Fig. 7B).
process minute and spinose; setae of dorsal surface predominantly obliquely aligned, bent towards median axis and overlapping medially. Inner distal lobe of penultimate tarsomere much longer than outer lobe. Hind femur 3.8–3.9× longer than wide. Inner hind tibial spur 0.5–0.6× length of basitarsus.

Wings. Forewing with membrane narrowly expanded and tubular longitudinal vein along costal margin and two oblique longitudinal veins indicated by colour streaks. Forewing at rest reaching three-quarters length of propodeum. Hindwing not discernible.

Metasoma. T1 without transverse carina, anterior two-thirds of T2 with dense pubescence, lateral carina on T2 ventrally bordered by glabrous area, remaining tergites and sternites mainly glabrous and shiny.

**Male**

As female except: body length 4.4–4.5 mm; head plus mesosoma 2.0–2.1 mm; flagellomeres without apical setae; hind femur 4.1–4.3× longer than wide.

**Comments**

This species is known only from two remnant bushland areas within the suburbs of Perth (Fig. 13A). It is named in honour of Professor Rudolf Abraham (Elmshorn, Germany), the first author’s former PhD supervisor.

**Olixon australiae** **(Perkins, 1908)**


**Diagnosis**

This species is characterized by the following unique combination of morphological features: forewing barely longer than tegula; propodeum without posteromedian process; T1 without transverse carina.

**Specimens examined.** Holotype, $\exists$, labelled: (1) ‘2332’; (2) ‘Harpagocryptus australiae P. RCL Perkins det.’; (3) ‘Type Harpagocryptus australiae Perkins Townes 1974’; (4) ‘*Olixon australiae* Perkins Tow. 1973’ (BMNH). Type locality given as ‘Queensland’ (Perkins, 1908).

**Female**

**Colour.** Body predominantly dark brown.

**Body length.** 3.3 mm; head plus mesosoma 1.8 mm.

**Head.** Vertex with dense pubescence, surface weakly reticulate without piliferous punctures, surface with reticulate sculpture; interspaces between setal bases weakly reticulate-engraved. OOD 1.3× IOD. Eye 3.2× as long as wide, temple length 0.3× and malar space 0.5× as long as eye width. Malar sulcus present, complete. Clypeus 3.0× wider than high, with dense long pubescence.

**Metasoma.** Pronotal index about 1.5. Scutellar disc concave. Propodeal index about 1.7; each posterolateral process weak, not longitudinally carinate; without posteromedian process; setae of dorsal surface predominantly longitudinally aligned. Inner distal lobe of penultimate tarsomere much longer than outer lobe.

**Wings.** Forewing vestigial, barely as long as tegula. Hindwing vestige discernible.

**Metasoma.** T1 without transverse carina, metasomal tergites and sternites densely pilose. Lateral carina on T2 ventrally bordered by glabrous area.

**Comments**

This species is known only from the single type specimen collected in 1908. No locality information is given other than ‘Queensland’. The type is in poor condition: the antennae and most of the legs are missing; a forefemur, midfemur, midtibia and dissociated tibia with two attached basal tarsomeres are glued to the upper surface of the card; dissociated tarsomeres are glued under the apex of the card. The male is unknown.

**Olixon danggari** sp.n. (Fig. 2A–B)

**Diagnosis**

This species is characterized by the following unique combination of morphological features: mesosoma bicoloured: pronotum and mesonotum orange-brown, mesopleuron and propodeum brown to black; forewing strap-like, reaching to midpoint of propodeum; propodeum with spinose posteromedian process; T1 without transverse carina; only T1 and T2 with dense white pubescence; F1–F3 of female antenna with distinct apical seta.

**Specimens examined.** Holotype, $\exists$, SOUTH AUSTRALIA: 33.53°S, 140.44°E, 32 km N Renmark, 11.x.–9.xi.1995, flight ground intercept trap, Calperum Station/Bookmark Biosphere Reserve Invertebrate Survey (Pullen) (ANIC). Paratypes, SOUTH AUSTRALIA, Calperum Station/Bookmark Biosphere Reserve Invertebrate Survey: 5♀, as holotype (ANIC, WINC); 1♀, as holotype, but: 29.iii.–3.v.1995 (SMNS); 3♀, 7♂, as holotype, but: 9.xi.–12.xii.1995 (ANIC, SMNS); 1♀, 1♂, as holotype, but: 2.–29.iii.1995 (ANIC); 1♀, as holotype, but: 12.xii.1995–25.i.1996 (ANIC); 1♂ as holotype, but: 33.59°S, 140.30°E, 31 km NW Renmark, 23.i.–21.ii.1996 (ANIC); 1♀, same data as before, but: 7.–23.xii.1995, pitfall trap, mallee, A.Lambie & K.R.Pullen (ANIC); 1♀, 3♂, as holotype, but: 34.07°S, 140.37°E, 14 km WNW Renmark, 28.ii.–28.iii.1995 (ANIC, WINC); 10♀, 3♂, same data as before, but: 7.xi.–13.xii.1995 (ANIC); 1♀, 3♂, same data as before,
Olixon ferrugineum sp. n. (Figs 5A, B, D–F; 7A; 8E; 9B, D; 11A–D)

Diagnosis

This species is characterized by the following unique combination of morphological features: body uniformly orange-brown to red-brown; propodeum with spinose postmedian process; propodeal spiracle situated on distinct protuberance; T1 without transverse carina; T2 shiny with characteristic punctures from which extremely shortened setae arise; T3-T6 shiny and largely devoid of setae; at least F1–F3 of female antenna with distinct apical seta.

Specimens examined. Holotype, ♂, WESTERN AUSTRALIA: 24.5 km N of Cowra Line Camp, site RHNW10, ethylene glycol pitfalls, 22.8.4.8’S, 119.1.27.3’E, 27.viii.–21.xi.2003, CALM Pilbara Survey (WAM).

Paratypes, WESTERN AUSTRALIA: 3♀♀, as holotype, but: 23.v.–20.x.2004 (SMNS); 1♂, as holotype, but: 21.xi.2003–23.v.2004 (SMNS); 2♀♀, as holotype, but: 24 km WSW of Mt Marsh, site RHNW02, 22.32.9’S, 118.59.51.3’E, 20.xi.2003–22.v.2004 (SMNS); 1♀, as holotype, but: 33 km W of Rhodes Ridge, site RHNC08, 23.6.11.6’S, 119.2.20.9’E, 25.v.2004–18.x.2004 (SMNS); 1♀, as holotype, but: 21 km WNW of Bonney Downs Homestead, site RHNE11, 22.5.41.S, 119.45.12.5’E, 7.vii.–18.xi.2003 (WINC); 1♀, as holotype, but: 5 km NW of Mt Florance Homestead, site PE08, 21.45.59.3’S, 119.45.12.5’E, 18.viii.–20.xi.2004 (SMNS); 1♀, as holotype, but: 10 km E of Meentheena Outcamp, site NE02, 21.14.46.3’S, 120.32.20.7’E, 16.xi.2003–18.v.2004 (SMNS); 1♀, as holotype, but: 35 km ESE of Meentheena Outcamp, site NE05, 21.20.15.7’S, 120.46.10.9’E, 16.xi.2003–17.v.2004 (WINC); 2♂♂, same data as before, but: 31.vii.–16.xi.2003 (WAM); 1♀, as holotype, but: 1.5 km W of Giles Point, site RHNC04, 23.15.3.4’S, 119.8.40.9’E, 20.xi.2003–25.v.2004 (WAM); 1♀, as holotype, but: 2 km E of Mt Minnie, site WYW01, 22.6.14.9’S, 115.34.4.2’E, 27.xi.2003–30.iv.2004 (WAM); 1♀, as holotype, but: 9.5 km S of Mt Minnie, site WYW04, 22.11.19.1’S, 115.33.13.2’E, 27.xi.2003–29.iv.2004 (SMNS); 1♀, as holotype, but: 8 km NNE of Mt Edith, site WYE05, 22.34.16.9’S, 116.8.53.8’E, 26.xi.2003–2.v.2004 (WINC); 1♀, as holotype, but: 2.5 km N of Mile Camp, site RHNE02, 22.45.57.8’S, 119.37.53.1’E, 19.xi.2003–21.v.2004 (WINC); 1♂, as holotype, but: 1 km
Fig. 6. Head of Olixon. (A) O. banksii ♂, lateral view; (B) O. wallockae sp.n. ♂, lateral view; (C) O. guyim sp.n. ♂, lateral view; (D) O. jandakotae sp.n. ♂, lateral view; (E) O. harveyi sp.n. ♂, ventrolateral view; (F) O. kakadui sp.n. ♂, dorsolateral view; (G) O. jawoyn sp.n. ♂, dorsal view; (H) O. jenningsi sp.n. ♂, dorsal view. occ, occipital carina; el, eye length; eos, extended ocular sulcus; IOD, interocellar distance; ms, malar sulcus; msp, malar space; OOD, ocellocular distance; poc, posterior ocellus; tl, temple length.
119.15.54.3°E, 24.v.–16.x.2004 (SMNS); 2, as holotype, but: 11 km SE of Peedamulla Homestead, site OYW05, 21.54.47°S, 115.43.02°E, 25.ix.2005–15.v.2006 (SMNS); 1, as holotype, but: 53 km NNE of Whim Creek Hotel, site DRE03, 20.25.48.6°S, 118.35.50.3°E, 14.xi.2003–12.v.2004 (SMNS, WAM); 1, as holotype, but: 19.5 km SSW of Mt Amy, site WYE07, 22.25.9.5°S, 115.50.16.1°E, 11.ix.2003–26.xi.2003 (SMNS, WINC); 1, as holotype, but: 20 km WNW of Rhodes Ridge, site RHNC09, 23.3.13.8°S, 119.10.36.8°E, 1.ix.2003–19.xi.2003 (SMNS); 1, same data as before, but: 19.35.2003–25.v.2004 (SMNS); 1, as holotype, but: 3.5 km N of Karratha Station, site DRW05, 20.51.14.1°S, 116.40.7.9°E, 22.ix.–28.xi.2003 (WINC); 1, as holotype, but: 11 km ESE of Marda Pool, site DRW07, 21.3.20.4°S, 116.15.6°E, 24.ix.–27.xi.2003 (WINC); 1, as holotype, but: 12.5 km N of Nullagine, site NW03, 21.46.13.1°S, 120.5.30.7°E, 19.v.–18.x.2004 (SMNS, WINC); 1, as holotype, but: 27.5 km N of Nullagine, site NW06, 21.38.39°S, 120.3.46.7°E, 19.v.–19.x.2004 (SMNS); 1, as holotype, but: 52.5 km N of Nullagine, site NW11, 21.24.27.7°S, 120.4.16.7°E, 3.viii.–17.xi.2003 (WINC); 1, Barlee Range Nature Reserve, Quadrat 3, wet pitfalls, 23.04.46°S, 115.47.27°E, ix.1995 (van Leeuwen, Bromilow) (WAM); 1, same data as before, but: Quadrat 6, 23.23.21°S, 115.53.12E (WAM). SOUTH AUSTRALIA: 1, Innamincka, 0.2km SW Table Hill,

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27.34.55°S, 140.52.24°E, pitfalls, 4–9.xi.96, Stony Desert Survey IN004 (SAM); 1

Female

Body length. 4.5–6.6 mm; head plus mesosoma 2.0–2.9 mm.

Colour. Body uniformly orange-brown to red-brown. Few specimens with melanism around coxal articulations.

Head. Vertex with dense short pubescence, surface weakly reticulate, without piliferous punctures. Anterior ocellus often less conspicuous than posterior ocelli. OOD 1.2–1.3× longer than IOD. Eye 2.2–2.6× as long as wide, temple length 0.2–0.3× and malar space 0.4× as long as eye length. Malar sulcus present, complete. Clypeus 3.1–3.2× as broad as high, slightly reticulate and, apart from glabrous ventromedian area, densely setose. F1 3.1–4.5× longer than wide, 2.1–2.9× as long as pedicel and 0.6–0.7× as long as F2. F1–F3 each with distinct apical seta, some specimens with additional seta on F4.

Mesosoma. Pronotal index 1.5. Mesoscutellum flat, tegulae separated by 2.1× the width of one tegula. Propodeal index 1.2–1.4, each posteralateral process strong, posteromedian process present and spine. Propodeal spiracles situated on protuberance. Inner distal lobe of penultimate tarsomere only slightly longer than outer lobe.

Fig. 8. Meso- and metasoma of Rhopalosomatidae. (A–D) mesonotum, dorsal view, Liosphex varius ♀ (A), Olixon banksii ♀ (B), O. wuthathi sp.n. ♀ (forewings removed) (C), O. zonae sp.n. ♀ (D); (E) O. ferrugineum sp.n. ♀, propodeal spiracle, lateral view; (F) O. helgae sp.n. ♀, propodeum and T1, dorsal view; (G) O. banksii ♀, propodeum and T1, dorsolateral view; (H) O. wuthathi sp.n. ♀, propodeum, dorsal view; (I) O. wajuk sp.n. ♀, propodeum and T1, dorsal view. fw, forewing; lps, posterolateral propodeal process; mps, posteromedian propodeal process; no3, metanotum; sc, mesoscutum; scl, mesoscutellum; sp, propodeal spiracle; T1, first metasomal tergite; tg, tegula.

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Hind femur 3.4–4.0× longer than wide, hind tibial spur 0.5× length of basitarsus.

Wings. Size of forewing variable, at rest reaching between half the length of propodeum and T1, wing membrane narrowly to broadly expanded.

Metasoma. T1 without transverse carina. T2 shiny with characteristic punctures from which extremely shortened setae arise; T3–T6 shiny and largely devoid of setae.

Male

As female except: body length 4.6–6.2 mm; head plus mesosoma 2.0–2.7 mm; flagellomeres without apical setae; hind femur 4.5–4.6× longer than wide; T7 with dense pubescence.

Comments

This species has been found in the drier regions of Western Australia and South Australia (Fig. 13A). The species name is from the latin ‘ferrugineum’ (rusty) and refers to the body colouration.

Olixon flavibase Townes, 1977

Diagnosis

This species is characterized by the following unique combination of morphological features: malar sulcus completely absent; forewing extending beyond posterior margin of propodeum; posteromedian propodeal process bispinose; T1 with transverse carina; female flagellomeres without apical setae.

Specimens examined. Holotype, ♂, labelled: (1) ‘Cairns Kur.2.02’; (2) ‘Brit.Mus. 11929-362.’; (3) ‘HOLOTYPE

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Olixon flavibase Townes’; (4) ’Olixon flavibase Tow. 1974’ (BMNH).


Female

**Colour.** Body predominantly dark brown.

**Body length.** 4.1 mm; head plus mesosoma 2.1 mm.

**Head.** Vertex densely setose, some setae arising from conspicuous punctures; interspaces weakly engraved. OOD 1.1× IOD. Eye 2.2× as long as wide, temple length 0.4× and malar space 0.6× as long as eye length. Malar sulcus absent. Clypeus and labrum with dense, white pubescence. F1 about 1.8× longer than wide; 1.6× as long as pedicel and 0.8× as long as F2 (difficult to see because of dirt), flagellomeres without conspicuous apical setae.

**Mesosoma.** Pronotal index about 1.9. Scutellar disc with median carina. Propodeal index about 1.4; each posterolateral process strong, dorsally longitudinally carinate so that process somewhat prow-like; posteromedian propodeal process bispinose, setae of dorsal surface predominantly longitudinally aligned. Inner distal lobe of penultimate tarsomere much longer than outer lobe. Hind femur 4.4× longer than wide. Inner hind tibial spur about 0.5× length of basitarsus.

**Wings.** Forewing with membrane expanded and tubular longitudinal vein along costal margin and two oblique longitudinal veins indicated by colour streaks. Forewing at rest reaching T1. Hindwing vestige discernible.

**Metasoma.** T1 with transverse carina. Metasomal tergites and sternites densely pilose. Lateral carina on T2 ventrally bordered by setose area.

Male

**Body length.** 5.2–5.7 mm; head plus mesosoma 2.4–2.6 mm.

**Head.** Head capsule densely covered with white setae, its surface sculpture finely reticulate; frons additionally with small, widely separated punctures from which short erect setae arise. OOD 1.0–1.1× IOD. Eye 2.2–2.4× as long as wide, temple length 0.4× and malar space 0.4–0.5× as long as eye length. Clypeus 2.6–3.0× as wide as high, labrum completely exposed. F1 1.8–2.5× longer.
than wide, 1.4–1.6× as long as pedicel and 0.5–0.6× as long as F2.

**Mesosoma.** Pronotal index 1.5, propodeal index 1.3–1.4.

Comments

Townes (1977) interpreted label (1) as indicating that the female holotype specimen had been collected at Kuranda near Cairns during February 1902. The males, which are here recorded and described for the first time, were collected relatively near to that locality, also in tropical Queensland (Fig. 13A). The holotype is dirty but mostly intact, but the left antenna is broken beyond F1 with the loss of 6 flagellomeres, and the right antenna lacks F10 and F7.

**Olixon guyim** sp.n. (Figs 6C, 7B)

**Diagnosis**

This species is characterized by the following unique combination of morphological features: ocular sulcus posteriorly extended at level of dorsal eye margin; forewing strap-like; propodeum with elongate spinose posteromedian process; T1 without transverse carina.

**Specimens examined.** Holotype, ♂, QUEENSLAND: 15.16°S, 144.59°E, 14 km WbyN Hope Vale Mission, 8.–10.x.1980, yellow pantrap (Cardale) (ANIC).
Paratype, 1♂, as holotype (ANIC).

**Male**

**Body length.** 2.9–3.4 mm; head plus mesosoma 1.4–1.7 mm.

**Colour.** Median areas (propodeum and T1–T2) dark brown, elsewhere light brown.

**Head.** Vertex densely setose, without conspicuous piliferous punctures; interspaces between setal bases smooth. OOD 1.1–1.3×IOD. Eye 1.8-2.0× as long as wide, temple length 0.4–0.5× and malar space 0.3–0.4× as long as eye length. Ocular sulcus posteriorly extended at level of dorsal eye margin. Malar sulcus present, complete. Clypeus 3.7–3.8× as wide as high. F1 1.2–1.4× longer than wide, 1.0–1.3× as long as pedicel and 0.5× as long as F2. Flagellomeres without conspicuous apical setae.

**Mesosoma.** Pronotal index 1.2–1.4. Tegulae dorsally separated by 2.0× the width of one tegula. Mesoscutellum concave. Propodeal index 1.1; each posterolateral process strong, not longitudinally carinate; posteromedian process elongate and spinose; setae of dorsal propodeal surface predominantly longitudinally aligned. Distal lobes of penultimate tarsomere equally produced. Hind femur 4.4–4.7× longer than wide. Inner hind tibial spur 0.5–0.6× length of basitarsus.

**Wings.** Forewing strap-like, at rest reaching three-quarters length of propodeum. Hindwing absent.

**Metasoma.** T1 short and without transverse carina; T1–T5 with conspicuous pubescence; metasomal sternites mainly glabrous.

**Comments**

The species is known only from the male, from the type locality (Fig. 13B), which is a mosaic of rainforest, eucalypt woodland and grassland that experiences high rainfall. The species name is a contraction of Guugu-Yimidhirr, the name of the aboriginal people on whose traditional lands the type
material was collected. The name is treated as a noun in apposition.

**Olixon harveyi** sp.n. (Figs 6E; 7F; 9A, C)

**Diagnosis**

This species is characterized by the following unique combination of morphological features: malar sulcus indicated near oral margin only; posteromedian propodeal process large and bispinose; T1 with transverse carina; female flagellomeres without apical setae.

**Specimens examined.** Holotype, ♂, WESTERN AUSTRALIA: Bush Bay, 25.07.54.4’S, 11[3].46.05.1’E, BB5, dry pits, WAM/CALM Carnarvon Survey, 27.ix.–2.x.1994 (Harvey et al.) (WAM).

Paratypes, 6♀♂, 7♂♂, as holotype (WAM; WINC; SMNS).

**Female**

**Body length.** 5.7–7.0 mm; head plus mesosoma 2.7–3.3 mm.

**Colour.** Body entirely orange-brown to red-brown.

**Head.** Vertex with dense short pubescence, some setae arising from conspicuous punctures; interspaces weakly reticulate-engraved. OOD 0.9×IOD. Eye 2.2–2.3× as long as wide, temple length 0.3× as long as eye length. Malar sulcus incomplete, weakly indicated near oral margin only. Clypeus 3.1–3.2× as wide as high. F1 2.0–2.1× longer than wide, 1.6–1.7× as long as pedicel and 0.6× as long as F2. Flagellomeres without conspicuous, apical setae.

**Mesosoma.** Pronotal index 1.6–1.9. Tegulae dorsally separated by 1.8× the width of one tegula. Scutellar disc concave, median carina indicated posteriorly. Propodeal index 1.5–1.6; each posterolateral process strong, each process longitudinally carinate and slightly prow-like; posteromedian process bispinose; setae of dorsal propodeal surface predominantly longitudinally aligned. Distal lobes of penultimate tarsomere equally produced. Hind femur 3.9–4.2× longer than wide. Inner hind tibial spur 0.5× length of basitarsus.

**Wings.** Forewing with membrane broadly expanded and tubular longitudinal vein along costal margin and two oblique longitudinal veins indicated by colour streaks. Forewing at rest reaching three-quarters length of propodeum; propodeum with broad postero-median process that is apically blunt, almost bispinose; lateral propodeal process stout; T1 without transverse carina; F1 of female antenna with distinct apical seta.

**Metasoma.** T1 with transverse carina. All metasomal tergites and sternites with dense pubescence, lateral carina on T2 ventrally bordered by setose area.

**Male**

As female except: body length. 5.7–7.1 mm; head plus mesosoma 2.5–3.2 mm; flagellomeres without apical setae; hind femur 4.7–4.9× longer than wide.

**Comments**

This species is known only from Western Australia (Fig. 13B). The type locality site is illustrated in Gibson et al. (2000, Plate 64) and is described as mixed low shrubland over pale calcareous sand with shell fragments on Holocene supra tidal flat of Carnarvon Coastal Plain. It is named in honour of Dr Mark Harvey (Western Australian Museum), who collected all of the known specimens of this species, is one of the very few people to have observed a live *Olixon*, and whose interest in the genus brought the species to our attention.

**Olixon helgae** sp.n. (Figs 7G; 8F; 10A)

**Diagnosis**

This species is characterized by the following unique combination of morphological features: forewing with membrane broadly expanded, reaching three-quarters length of propodeum; propodeum with broad postero-median process that is apically blunt, almost bispinose; lateral propodeal process stout; T1 without transverse carina; F1 of female antenna with distinct apical seta.

**Specimens examined.** Holotype, ♂, VICTORIA: 36.10’S, 145.14’E, Goulburn R., 12 km SSE Nathalia, Remnant Woodland Study site 104R, ex pitfall trap, 17.–22.i.1994 (Milledge, Lilywhite) (NMV).

Paratypes, VICTORIA: 3♂♂, as holotype, but: 10.–17.i.1994 (NMV); 1♀, 2♂♂, 36.09’S, 145.13’E, Rathbones Road, 3 km E Booths Road, site 100A, 17.–22.i.1994 (Milledge, Lilywhite) (NMV, WINC); 1♀, 36.08’S, 145.11’E, Murray Valley Highway, Deep Creek crossing, site 98A, 10.–17.iv.1994 (Milledge) (WINC); 1♀, 36.09’S, 145.13’E, McDonalds Road, 1.8 km S Shepparton, site 79R, 17.–22.i.1994 (SMNS); 1♂, 36.06’S, 145.12’E, Murray Valley Highway, 0.3 km NNW Walshs Bridge Road, site 96R, 10.–17.iv.1994, (SMNS), (Milledge); 2♂♂, 36.04’S, 145.02’E, McDonalds Road, 1.8 km S Shepparton, site 79R, 17.–22.i.1995 (Milledge, Lilywhite) (NMV); 3♂♂, 36.06’S, 145.05’E, Brooms Road, 7.5 km NE of Yambuna, site 85R, 17.–22.i.1995 (Milledge) (NMV); 1♀, 36.05’S, 145.03’E, 5 km ESE of Lower Moira, site 81, 10.–17.iv.1994 (Milledge, Lilywhite) (NMV); 1♀, 36.06’S, 145.07’E, Brooms Road, 9 km SW Nathalia, site 87, 17.–22.i.1995 (Milledge, Lilywhite) (NMV); 3♂♂, 36.07’S, 145.11’E, Murray Valley Highway, Skeleton Creek crossing, site 97A, 10.–17.iv.1994 (Milledge) (NMV). SOUTH AUSTRALIA (all SAM): 2♂♂, Coongie Lakes Study, site 3W, 9.42 km NNE Coongie, 27.05.44’S, 140.09.14’E, pitfall, 6 ii.1987 (Reid); 1♀, same data as before, but: site 13W, 1.77kW Coongie, 27.11.09’S, 140.07.29E; 1♀, Cordillo Downs Station, 0.8 km W Macelann Tank, 26.02.29’S, 140.07.42’E, pitfalls, Stony Desert Survey, YS04, 3.–6.v.1995; 1♀, Innamincka, 7.9 km ENE Patchawara Bore, 27.18.56’S, 140.45.35’E, pitfalls, Stony Desert
Survey, PC004, 10.–14.xi.1996; 1♀, Innamincka, 7.6 km NNE Innamincka, 27.39.35°S, 140.47.05°E, pitfalls, Stony Desert Survey, IN001, 4.–9.xi.1996; 1♂, Innamincka, 4.5 km NNE Table Hill, 27.32.37°S, 140.53.30°E, pitfalls, Stony Desert Survey, IN007, 4.–9.xi.1996; 1♂, Wirraminna, 9.3 km WNW May Hill, 31.14.30°S, 136.33.01°E, pitfalls, Stony Desert Survey, IL008, 4.–9.xi.1996; 1♂, Algebuckina WH, 27.54.3°S, 135.49.6°E, pitfalls, 31.iii.1993 (Forrest), NEW SOUTH WALES: 2♀, 2♂, Yugilbah, 30.12.3°S, 148.46.52°E, DLWC, WALCOL00221, pit trap, ii.2001 (Oliver) (AM); 1♀, same data as before, but: Omeo, 30.1.5°S, 148.7.23°E, WALCOL00257 (AM); 1♂, same data as before, but: Teranna, 30.2.24°S, 148.45.47°E, WALCOL00232 (AM).

**Female**

**Body length.** 4.1–8.5 mm; head plus mesosoma 1.8–3.8 mm.

**Colour.** Body predominantly dark brown to black.

**Head.** Vertex with dense short pubescence, some setae arising from conspicuous punctures, interspaces smooth. OOD 1.1–1.2× IOD. Eye 2.0–2.3× as long as wide, temple length 0.4–0.6× and malar space 0.4–0.5× as long as eye length. Malar sulcus present, complete. Clypeus 3.0–3.1× as wide as high. F1 2.1–2.4× longer than wide, 2.0–2.2× as long as pedicel and 0.5–0.6× as long as F2. F1 with conspicuous apical seta.

**Mesosoma.** Pronotal index 1.6–1.8. Scutellar disc concave. Tegulae dorsally separated by 2.9–3.1× the width of one tegula. Propodeal index 1.6–1.8. Scutellar disc con- 
cave, sometimes with weak median carina. Tegulae dorsally the width of one tegula. Propodeal index 1.2–1.4; each posterolateral short spur 0.4–0.5× length of basitarsus.

**Wings.** Forewing with membrane broadly expanded and tubular longitudinal vein along costal margin and two oblique longitudinal veins indicated by colour streaks. Forewing at rest reaching three-quarters length of propodeum. Hindwing vestige discernible.

**Forewing.** At rest reaching three-quarters length of propodeum; propodeum with minute bispinose postero- median process; T1 transverse carina; F1 and F2 of female antenna with distinct apical seta.

**Mesosoma.** Pronotal index 1.2–1.4. Scutellar disc concave, sometimes with weak median carina. Tegulae dorsally separated by 1.1× the width of one tegula. Propodeal index 1.7–1.8; each posterolateral process strong, not longitudi-

**Body length.** 4.0–5.1 mm; head plus mesosoma 1.9–2.3 mm.

**Colour.** Body predominantly dark brown to black.

**Head.** Vertex sparsely setose, with conspicuous piliferous punctures; interspaces strongly reticulate-engraved. OOD 1.4–1.7× IOD. Eye 2.2–2.5× as long as wide, temple length 0.4× and malar space 0.5× as long as eye length. Malar sulcus present, complete, dorsally with pubescence. Clypeus 2.9–3.1× as wide as high. F1 2.9–3.1× longer than wide, 1.7–1.9× as long as pedicel and 0.6× as long as F2. F1 and F2 each with conspicuous apical seta.

**Comments**

This species has a wide distribution throughout south-
eastern Australia (Fig. 13D). All specimens were collected in pitfall traps. The species has been named in honour of Ms Helga Krogmann (Norderstedt, Germany), the mother of the first author.

**Olixon jandumaktae sp.n. (Figs 6D; 8H; 12D)**

**Diagnosis**

This species is characterized by the following unique combination of morphological features: forewing strap-like, reaching mid to two-thirds length of propodeum; propo-
deum with minute bispinose posteromedian process; T1 with transverse carina; F1 and F2 of female antenna with distinct apical seta.

**Specimens examined.** Holotype, ♀, WESTERN AUSTRALIA: Talbot Road Reserve, site TR1, wet pitfalls, 31.52.05°S, 116.03.04°E, 18.xi.1993–6.i.1994 (Waldock, Goodsell, Webb) (WAM).

Paratypes, WESTERN AUSTRALIA: 1♀, as holotype (WAM); 1♀, as holotype, but: 10.v.–24.vi.1993 (Waldock et al.) (SMNS); 5♀♂, 2♂♂, Warwick Open Space, site WR2, wet pitfalls, 31.50.33°S, 115.49.60°E, 25.ix.–28.xi.1995 (Harvey, Waldock) (WAM, WINC); 1♀, Hepburn Heights, site HH3, wet pitfalls, 31.49.02°S, 115.46.13°E, 28.xi.1995–29.i.1996 (Harvey, Waldock) (WAM); 1♀, Hepburn Heights, site HH2, wet pitfalls, 31.49.07°S, 115.46.11°E, 25.ix.–28.xi.1995 (Harvey, Waldock) (WAM); 1♀, Mt Claremont, site MC2, wet pitfalls, 31.57.39°S, 115.45.56°E, 19.i.–21.iii.1995 (Harvey, Wal-
dock) (WAM); 5♀♂, 13♂♂, Jandakot Airport, site JK2, wet pitfalls, 32.05.0°S, 115.52.5°E, 4.xi.1994–19.i.1995 (Waldock, Harvey) (WAM, WINC); 1♀, same data as before, but: 1.x.4.xi.1994 (Waldock, Longbottom) (WAM); 2♂♂, Perth Airport, site PA8, wet pitfalls, 31.58.36°S, 115.58.28°E, 18.xi.–6.i.1994 (Waldock, Goodsell, Webb) (WAM, WINC); 4♀♂, Landsdale School, site LS1, wet pitfalls, 31.49.14°S, 115.51.01°E, 25.ix.–28.xi.1995 (Harvey, Waldock) (SMNS, WAM).

**Female**

**Body length.** 4.0–5.1 mm; head plus mesosoma 1.9–2.3 mm.

**Colour.** Body predominantly dark brown to black.

**Head.** Vertex sparsely setose, with conspicuous piliferous punctures; interspaces strongly reticulate-engraved. OOD 1.4–1.7× IOD. Eye 2.2–2.5× as long as wide, temple length 0.4× and malar space 0.5× as long as eye length. Malar sulcus present, complete, dorsally with pubescence. Clypeus 2.9–3.1× as wide as high. F1 2.9–3.1× longer than wide, 1.7–1.9× as long as pedicel and 0.6× as long as F2. F1 and F2 each with conspicuous apical seta.

**Mesosoma.** Pronotal index 2.0–2.1. Scutellar disc con- 
cave, sometimes with weak median carina. Tegulae dorsally separated by 1.1× the width of one tegula. Propodeal index 1.7–1.8; each posterolateral process strong, not longitudi-

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bent towards median axis and overlapping medially. Inner distal lobe of penultimate tarsomere much longer than outer lobe. Hind femur 3.8–4.2× longer than wide. Inner hind tibial spur 0.5–0.6× length of basitarsus.

Wings. Forewing strap-like, membrane scarcely wider than longitudinal vein. Forewing at rest reaching mid to two-thirds length of propodeum. Hindwing vestige discernible.

Metasoma. T1 with transverse carina, T2–T3 with dense pubescence, remaining tergites with setae restricted to posterior margin. Lateral carina on T2 ventrally bordered by glabrous area.

Male

As female except: body length 3.6–4.5 mm; head plus mesosoma 1.7–2.0 mm; hind femur 4.2–4.7× longer than wide; subgenital plate densely setose.

Comments

This species is known only from the greater Perth area (Fig. 13B), where it has been found in very small remnant forest patches (mainly Banksia woodlands). The species has been named for the locality from which part of the type series was collected.

**Olixon jawoyn** sp.n. (Fig. 6G)

**Diagnosis**

This species is characterized by the following unique combination of morphological features: eyes and posterior ocelli widely separated from occipital carina; propodeum with broad, spinose posteromedian process that is short and apically blunt; T1 without transverse carina; female flagellomeres without apical setae.

**Specimens examined.** Holotype, ♀, NORTHERN TERRITORY: 20 km W Katherine, 1.vii.1985, flat sandy savannah woodland, (Lowery) (ANIC).

Paratypes, 2♀♀, as holotype (ANIC).

**Female**

**Body length.** 3.3–4.4 mm; head plus mesosoma 1.6–2.2 mm.

**Colour.** Head shiny orange-brown, mesosoma either uniformly orange-brown or with scutellum and propodeum dark brown, metasoma dark brown.

**Head.** Vertex densely setose, without conspicuous piliferous punctures; interspaces between setal bases smooth and shiny. Posterior ocelli situated far away from occipital carina. OOD 1.0–1.1× IOD. Eye 1.8–2.1× as long as wide, temple length 0.4× and malar space 0.4× as long as eye length. Malar sulcus present, complete. Clypeus 2.9–3.3× as wide as high. F1 1.6–1.9× longer than wide, 1.4–1.5× as long as pedicel and 0.6–0.7× as long as F2. Flagellomeres without conspicuous apical setae.

Mesosoma. Pronotal index 1.3. Tegulae dorsally separated by 1.9× the width of one tegula. Scutellar disc concave. Propodeal index 1.4–1.5; each posterolateral process strong, longitudinally carinate so that process slightly prow-like; posteromedian process broad and distinct, apically rounded; setae of dorsal surface predominantly longitudinally aligned. Inner distal lobe of penultimate tarsomere slightly longer than outer lobe. Hind femur 3.9–4.3× longer than wide. Inner hind tibial spur 0.5–0.6× length of basitarsus.

Wings. Forewing with membrane broadly expanded and tubular longitudinal vein along costal margin and two oblique longitudinal veins indicated by colour streaks. Forewing at rest reaching T1. Hindwing vestigial.

Metasoma. T1 without transverse carina. T2–T4 with dense pubescence, lateral carina on T2 ventrally bordered by area that is anteriorly sparsely setose, posteriorly glabrous.

**Comments**

The collector of the type series, the Rev. Lowery, has written on a label associated with the types that this species may be a mimic of the ant *Rhytidoponera borealis* Crawley. The male is unknown. *Olixon jawoyn* sp.n. is known only from the type locality in the Northern Territory (Fig. 13B). It is named for the Jawoyn people, on whose traditional lands the specimens were collected. The species name is a noun in apposition.

**Olixon jenningsi** sp.n. (Fig. 6H)

**Diagnosis**

This species is characterized by the following unique combination of morphological features: head and mesosoma dull orange-brown, metasoma dark brown; forewing with membrane broadly expanded, reaching, but not extending beyond, T1; propodeum with slightly elongate spinose posteromedian process; T1 without transverse carina; female flagellomeres without apical setae.

**Specimens examined.** Holotype, ♀, SOUTH AUSTRALIA: 51.2 km WNW Emu (ruin), 28.31.55’S, 131.41.25’E, 2.–4.iv.2003, pitfalls, tall open shrubland, Sandy Desert Survey, EMU00701 (SAM).

Paratypes, SOUTH AUSTRALIA: 1♀, 1♂, as holotype (SAM); 1♀, 46.5 km WNW Emu (ruin), 8.32.13’S, 131.44.16’E, 2.–4.iv.2003, pitfalls, open mallee, Sandy Desert Survey, EMU00601 (SAM).

**Female**

**Body length.** 4.0–4.6 mm; head plus mesosoma 1.7–2.1 mm.

**Colour.** Head and mesosoma dull orange-brown, metasoma dark brown.

**Head.** Vertex densely setose, with inconspicuous punctures, interspaces reticulate-engraved. OOD 1.2× IOD. Eye 2.1× as long as wide, temple length 0.2–0.3× and malar
space 0.4× as long as eye length. Malar sulcus present, complete. Clypeus 2.7–2.8× as wide as high. F1 1.9–2.2× longer than wide, 1.5–1.7× as long as pedicel and 0.6× as long as F2. Flagellomeres without conspicuous apical setae.

Mesosoma. Pronotal index 1.5–1.6. Mesoscutellum concave, tegulae dorsally separated by 1.3× the width of one tegula. Propodeal index 1.1–1.3; each posterolateral process strong, outer edge carinate; posterolateral process short and broadly based. Setae of dorsal surface predominantly longitudinally aligned. Penultimate tarsomere not asymmetrically produced apically. Hind femur 3.7–4.0× longer than wide. Inner hind tibial spur 0.6× length of basistarsus.

Wings. Forewings with membrane broadly expanded and two oblique veins indicated by colour streaks, forewing at rest reaching T1. Hindwing absent.

Metasoma. T1 without transverse carina, all tergites with dense pubescence, lateral carina on T2 ventrally bordered by pilose area.

Male

As female except: body length 4.0 mm; head plus mesosoma 1.6 mm; hind femur 4.6× as long as wide.

Comments

This species is known only from the type locality in South Australia (Fig. 13B). It is named in honour of Dr John Jennings, our colleague at The University of Adelaide.

Olixon kankadui sp.n. (Fig. 6F)

Diagnosis

This species is characterized by the following unique combination of morphological features: body uniformly orange-brown to red-brown; propodeum with spinose posteromedian process; T1 without transverse carina; at least T1–T3 with dense white pubescence; female flagellomeres without apical setae; male eyes slightly enlarged.


Paratypes, 2♂♀, as holotype, but: 28.iii.85 (Andersen) (ANIC).

Female

Body length. 5.9 mm; head plus mesosoma 2.6 mm.

Body colour. Body uniformly orange to orange-brown.

Head. Vertex densely covered with tiny setae, with inconspicuous punctures, interspaces reticulate-engraved. OOD 1.1× IOD. Eye 2.3× as long as wide, temple length 0.3× and malar space 0.3× as long as eye length. Malar sulcus present, complete. Clypeus 3.3× as wide as high. F1 2.4× longer than wide, 2.2× as long as pedicel and 0.6× as long as F2. Flagellomeres without conspicuous apical setae.

Mesosoma. Pronotal index 1.9. Tegulae dorsally separated by 1.9× the width of one tegula. Mesoscutellum concave. Propodeal index 1.4; posteromedian propodeal process spinose, posterolateral process not carinate; setae of dorsal surface predominantly longitudinally aligned. Penultimate tarsomere asymmetrically produced apically. Hind femur 3.7× longer than wide. Inner hind tibial spur 0.5× length of basistarsus.

Wings. Forewings broken off and missing from specimen, hindwings vestigial but present.

Metasoma. T1 without transverse carina. T2 and T3 with dense pubescence.

Male

As female except: body length 4.4–5.4 mm; head plus mesosoma 1.9–2.3 mm; eye more enlarged, 1.9–2.2× as long as wide, temple length 0.1–0.2× as long as eye length, OOD 0.8× IOD; wings reaching to T1; hind femur 4.8–5.1× as long as wide; all metasomal tergites with dense pubescence.

Comments

This species is known only from the type locality in Northern Territory (Fig. 13C), after which it has been named. It was collected during the wet season.

Olixon pilbara sp.n. (Figs 7C, 12C)

Diagnosis

This species is characterized by the following unique combination of morphological features: forewing with membrane broadly expanded, reaching posterior propodeal margin; propodeum with spinose posteromedian process; T1 without transverse carina; all metasomal tergites with dense white pubescence; F1 and F2 of female antenna with distinct apical setae.


Paratypes, WESTERN AUSTRALIA: 2♂♀, 1♂, as holotype (SMNS, WAM); 1♂, 3♂♀, as holotype, but: 24.5 km N of Cowra Line Camp, site RHNE13, 22.84.8′S, 119.1.27.3′E, 21.xi.2003–23.v.2004 (SMNS, WAM, WINC); 1♂, as holotype, but: 1 km SSE of Cowra Line Camp, site RHNW10, 22.84.8′S, 119.1.27.3′E, 21.xi.2003–23.v.2004 (SMNS, WAM, WINC); 1♀, as holotype, but: 24.5 km E of Mt Minnie, site WYW01, 22.6.14.9′S, 115.34.4.2′E, 27.xi.2003–30.iv.2004 (WINC); 1♀, as holotype, but: 16 km W of Mt De Courcy, site WYE03, 22.44.24.7′S, 116.27.40.1′E, 26.xi.2003–2.v.2004 (WINC); 1♀, as holotype,
but: 10 km E of Meentheena Outcamp, site NE02, 21.14.46.3°S, 120.32.20.7°E, 16.xi.2003–18.v.2004 (SMNS); 5.5°S, as holotype, but: 26 km WNW of Bonney Downs Homestead, site RHNE12, 22.5.7.1°S, 119.42.12.6°E, 18.xi.2003–20.v.2004 (SMNS, WAM, WINC); 1.5°S, as holotype, but: 1.5 km W of Giles Point, site RHNC04, 23.15.3.4°S, 119.8.40.9°E, 20.xi.2003–25.v.2004; 1°S, as holotype, but: 16.3 km SE of Nullagine, site NW01, 21.58.45.8°S, 120.13.26.7°E, 6.viii.–18.xi.2003 (SMNS); 1.5°S, as holotype, but: 1:5 km SW of Mt Florance Homestead, site PE04, 21.47.42°S, 117.51.25.1°E, 24.xi.2003–6.v.2004 (SMNS); 1°S, as holotype, but: 12 km NW of Mt Florance Homestead, site PE09, 21.42.50.7°S, 117.46.31.9°E, 24.xi.2003–5.v.2004 (SMNS); 1.5°S, as holotype, but: 11 km SW of Coolawanyah, site PE03, 21.52.35.2°S, 117.44.28.7°E, 6.v.–13.x.2004 (SMNS); 4.5°S, as holotype, but: 19.8 km WNW of Mt Berry, site WYE10, 22.25.47.9°S, 116.16.47.3°E, 26.xi.2003–2.v.2004 (SMNS); 2.5°S, as holotype, but: 24 km WSW of Mt Marsh, site RHNW02, 22.32.9°S, 118.59.51.3°E, 20.xi.2003–22.v.2004 (SMNS); 1°S, as holotype, but: 20.5 km WNW of Mt Marsh, site RHNW03, 22.27.59.5°S, 119.1.21.3°E, 20.xi.2003–22.v.2004 (SMNS); 1.5°S, as holotype, but: 26 km NE of Mt Mary, site WYW06, 22.15.21.7°S, 115.29.25.9°E, 28.xi.2003–27.xi.2003 (SMNS); 1°S, as holotype, but: 33 km W of Rhodes Ridge, site RHNC08, 23.6.11.6°S, 119.2.20°E, 20.xi.2003–25.v.2004 (SMNS).

**Female**

*Body length.* 2.9–4.3 mm; head plus mesosoma 1.3–1.9 mm.

*Colour.* Head, mesosoma, legs, and metasomal segments 1 and 2 yellow, red-brown or brown, remaining metasomal segments dark brown, metasomal tergite 2 sometimes darkened medially. The head is densely covered with tiny setae, with inconspicuous punctures, interspaces reticulate-engraved. OOD 1.7–2.0× IOD. Eye 2.1–2.3× as long as wide, temple length 0.3× and malar space 0.5× as long as eye length. Malar sulcus present, complete. Clypeus 2.8–2.9× as wide as high. F1 3.0–3.7× longer than wide, 1.8–2.3× as long as pedicel and 0.5–0.6× as long as F2. F1 and F2 with conspicuous apical setae.

*Mesosoma.* Pronotal index 1.3–1.5. Propodeal index 1.2–1.3; posteromedian propodeal process spinose, postero-lateral process slightly carinate; setae of dorsal surface predominantly longitudinally aligned. Pedicel and malar space 0.5× as long as eye length. Malar sulcus present, complete. Clypeus 2.8–3.2× as wide as high. F1 2.6–3.0× longer than wide, 1.7–1.8× as long as pedicel and 0.6× as long as F2. F1 and F2 each with conspicuous apical setae.

*Wings.* Forewing membrane expanded with tubular longitudinal vein along costal margin and two oblique longitudinal veins indicated by colour streaks; forewing reaching posterior margin of propodeum. Hindwing vestigial but present.

*Metasoma.* T1 without transverse carina. All metasomal tergites densely pilose, metasomal sternites and hypopygium only with scattered setae.

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**Male**

As female except: body length 2.6–3.3 mm; head plus mesosoma 1.2–1.9 mm; hind femur 4.1–4.5× as long as wide; body colour varying from yellow, red-brown to brown; head, propodeum and tip of abdomen (metasomal segments 4–7) often darkened.

**Comments**

This species is known only from the Pilbara region in Western Australia (Fig. 13C), after which it has been named. The name is a noun in apposition.

**Olixon wajuk sp. n. (Figs 7H, 8I)**

**Diagnosis**

This species is characterized by the following unique combination of morphological features: vertex with distinct piliferous punctures; tegulae minute; forewing not or barely longer than tegulae; propodeum without postmedian process; T1 with transverse carina; F1 and F2 of female antenna with distinct apical setae.

**Specimens examined.** Holotype, ♀, WESTERN AUSTRALIA: Bold Park, site BP 1, wet pitfalls, 31.57.11°S, 115.46.50°E, 18.xi.1993–6.i.1994 (Waldock) (WAM).

Paratypes, WESTERN AUSTRALIA (all WAM): 2♀♀, 3.5°S, as holotype, but: site BP3, 31.56.30°S, 115.46.27°E (SMNS, WAM, WINC); 2♀♂, as holotype, but: site BP1, 31.56.29°S, 115.46.01°E (Waldock, Goodsell, Webb) (WAM); 1♂, as holotype, but: site BP5, 31.57.14°S, 115.46.15°E, 24.ix.–19.xi.1993 (WAM); 2♀♂, Trigg Dune Bush site TD2 (dune site), wet pitfalls, 31.52.45°S, 115.45.17°E, 25.ix.–28.xi.1995 (Harvey, Waldock) (SMNS, WAM); 2♀♂, Mt Claremont, site MC1, wet pitfalls, 31.57.40°S, 115.46.00°E, 4.xi.1994–9.j.1995 (Waldock, Harvey) (WAM). VICTORIA: 1♀, Wilsons Prom, dry heath pitfalls, 22.i.1984 (Andersen) (NMV).

**Female**

*Body length.* 4.2–5.2 mm; head plus mesosoma 1.9–2.2 mm.

*Colour.* Body predominantly dark brown to black.

*Head.* Vertex sparsely setose, with conspicuous piliferous punctures; interspaces reticulate-engraved. OOD 1.4–1.5× IOD. Eye 2.1–2.3× as long as wide, temple length 0.5× and malar space 0.5× as long as eye length. Malar sulcus present, complete. Clypeus 2.8–3.2× as wide as high. F1 2.6–3.0× longer than wide, 1.7–1.8× as long as pedicel and 0.6× as long as F2. F1 and F2 each with conspicuous apical setae.

*Mesosoma.* Prorotal index 2.0–2.2. Tegulae minute, dorsally separated by 4.2× the width of one tegula. Scutellar disc flat. Propodeal index 1.5–1.6; posteralateral process...
short, not carinate; posteromedian process absent; setae of dorsal propodeal surface predominantly longitudinally aligned. Inner distal lobe of penultimate tarsome much longer than outer lobe. Hind femur 4.1–4.5× longer than wide. Inner hind tibial spur 0.6–0.7× length of basitarsus.

Wings. Forewing not or barely longer than tegula, at rest not reaching beyond posterior margin of mesoscutellum. Hindwing not discernible.

Metasoma. T1 with transverse carina. All metasomal tergites and sternites pilose, lateral carina on T2 ventrally bordered by setose area.

Male

As female except: body length 3.8–4.7 mm; head plus mesosoma 1.7–2.0 mm; hind femur 5.1–5.3× longer than wide.

Comments

This species has been collected mainly in the Perth area, Western Australia (Fig. 13C). From Victoria it is known only from a single specimen from Wilsons Promontory National Park (Fig. 13C). It is named for the Wajuk people, on whose traditional lands the type material was collected. The name is a noun in apposition.

Olixon wallockae sp.n. (Fig. 6B)

Diagnosis

This species is characterized by the following unique combination of morphological features: vertex without distinct piliferous punctures; forewing not or barely longer than tegulae; propodeum without posteromedian process; T1 with transverse carina; female flagellomeres without apical setae.


Paratypes, WESTERN AUSTRALIA: 2♀, 31.57.14’S, 115.46.16’E, Bold Park, wet pitfall, site BP 5, 6.i.–18.iii.1994 (Harvey, Wallock) (WAM, ANIC); 3♂, 31.57.40’S, 115.46.00’E, Mt Claremont, site MC1, wet pitfall, 4.xi.1994–19.i.1995 (Harvey, Wallock) (SMNS, WAM, WINC); 1♀, Hepburn Heights, site HH3, wet pitfall, 31.49.02’S, 115.46.13’E, 28.xi.1995–29.i.1996 (Harvey, Wallock).

Female

Body length. 3.6 mm; head plus mesosoma 1.6 mm.

Colour. Body predominantly brown to dark brown.

Head. Vertex densely setose, without conspicuous piliferous punctures; interspaces between setal bases weakly reticulate-engraved. OOD 1.4× IOD. Eye 2.0× as long as wide, temple length 0.3× and malar space 0.4× as long as eye length. Malar sulcus present, complete. Clypeus 2.5× as wide as high. F1 3.4× longer than wide, 2.2× as long as pedicel and 0.6× as long as F2. Flagellomeres without conspicuous apical seta.

Mesosoma. Pronotal index 1.9. Tegulae dorsally separated by 1.7× the width of one tegula. Scutellar disc flat. Propodeal index 1.7; each posterolateral process elongate, not longitudinally carinate; posteromedian process absent; setae of dorsal propodeal surface predominantly longitudinally aligned. Inner distal lobe of penultimate tarsome much longer than outer lobe. Hind femur 4.5× longer than wide. Inner hind tibial spur 0.7× length of basitarsus.

Wings. Forewing not or barely longer than tegula, at rest not reaching beyond posterior margin of mesoscutellum. Hindwing not discernible.

Metasoma. T1 with transverse carina. Metasomal tergites and sternites pilose, lateral carina on T2 ventrally bordered by anteriorly pilose area.

Male

As female except: body length 3.7–4.3 mm; head plus mesosoma 1.7–2.0 mm; hind femur 4.4–4.7× longer than wide.

Comments

This species is known only from the greater perth area, where it has been found in small remnant woodland patches. It is named in honour of Ms Julianne Waldock, whose efforts have provided many of the Western Australian Olixon for this study.

Olixon wuthathi sp.n. (Figs 8C, 12B)

Diagnosis

This species is characterized by the following unique combination of morphological features: body uniformly brown to dark brown; head with piliferous punctures; forewing with membrane broadly expanded, reaching T1; propodeum with spinose posteromedian process; T1 without transverse carina; female flagellomeres without apical setae.


Paratypes, QUEENSLAND: 4♀, 2♂, as holotype (ANIC, WINC), 1✈, 2♂, as holotype; but: 21.x.–12.xi.1993 (Zborowski, Horak) (ANIC); 3♂, as holotype, but: 12.viii.–9.ix.1993 (Zborowski, Shattuck) (ANIC); 3♂, as holotype; but: 13.vii.–12.viii.1993 (Zborowski, Baldwinson) (ANIC, WINC); 2♀, 3♂, 12.40’S, 142.39’E, 3 km W Batavia Downs, flight intercept trap, 24.x.–23.xi.1992 (Zborowski, Calder) (ANIC, SMNS); 3♂, 12.39’S, 142.42’E, 4 km NE Batavia Downs, 22.vi.–23.viii.1992 (Zborowski, Cardale) (ANIC); 1♀, 1♂, 12.39’S, 142.42’E,
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All specimens except the Mt Gamet female were collected using flight intercept traps. Collections were made in six woodland associations: (i) woodland dominated by Eucalyptus tetrodonta, E. nesophila and E. hylandii; (ii) open woodland dominated by E. leptolepha, E. papuana and E. clarksoniana; (iii) low open woodland on grey, low-lying soils and dominated by Melaleuca viridiflora with some E. clarksoniana; (iv) tall woodland dominated by E. tetrodonta, E. nesophila and Erithropleum chlorostachys; (v) very open woodland on sandy soil with Triodia; and (vi) notophyll vine forest on a sandstone plateau. Adults have been collected during the drier and cooler months from April to October. The species has been named for the Wuthathi people of Cape York Peninsula, whose traditional lands lie near the type locality. The species name is a noun in apposition.

Olixon zonale sp. (Figs 7D; 8D; 10B)

Diagnosis

This species is characterized by the following unique combination of morphological features: forewing not or barely longer than tegulae; propodeum with minute spinose posteromedian process; metasoma with belt-like colour pattern; T1 without transverse carina; T2–T6 mainly glabrous and shiny; F1–F5 of female antenna with distinct apical setae.


Paratypes, WESTERN AUSTRALIA: 1♀, 1♂, as holotype (WINC); 2♂♂, 3♀♀ as holotype, but: 9 km NE of Cowra Line Camp, site RHNW11, 22.17.38.8’S, 119.3.40.9’E, 27.viii.2003–21.xi.2003 (WAM, WINC); 1♂, as holotype, but: 24.5 km N of Cowra Line Camp, site RHNW10, 22.8.48.8’S, 119.1.27.3’E, 21.xi.–23.v.2004 (SMNS); 1♀, as holotype, but: 45 km N of Nullagine, site NW08, 21.28.47.8’S, 120.5.29.6’E, 3.viii.–17.xi.2003 (SMNS); 1♀, as holotype, but: 3.5 km S of Karratha, site DRC01, 20.46.4.7’S, 116.50.31.3’E, 1.vii.–12.xi.2003 (WAM); 1♂, as holotype, but: 9 km SW of Giles Point, site RHNC02, 23.19.0.2’E, 119.6.5.7’E, 20.xi.2003–25.v.2004 (WINC); 1♀, as holotype, but: 24 km WSW of Mt Marsh, site RHNW02, 22.32.9’E, 118.59.51.3’E, 20.xi.2003–22.v.2004 (SMNS); 1♀, as holotype, but: 8 km NNE of Mt Edith, site WYE05, 22.34.16.9’S, 116.8.53.8’E, 2.v.–7.x.2004 (WINC); 1♂, as holotype, but: 8 km SW of Roeburne, site DRC09, 20.48.28.7’S, 117.4.21’E, 5.vii.–12.xi.2003 (WINC); 1♀, as holotype, but: 12.5 km N of Nullagine, site NW03, 21.46.13.1’S, 120.5.30.7’E, 19.v.–18.x.2004 (WINC); 2♂♂, 1♀, as holotype, but: 16.3 km SE of Nullagine, site NW01, 21.58.45.8’S, 120.13.26.7’E, 6.viii.–18.xi.2003 (SMNS); 1♀, as holotype, but: 2.5 km N of Fortescue River crossing on Dampier Paraburdoo Railway, site PE11, 21.50.0.8’S, 117.36.39.2’E, 25.xi.2003–6.v.2004 (WINC); 1♀, as holotype, but: 2 km E of Mt Minnie, site

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4 km NE Batavia Downs, 18.xi.–22.vii.1992 (Zborowski, Nielsen) (ANIC); 2♂♂, 12.40’S, 143.00’E, 13 km E by S Weipa, 12.ix.–24.x.1993 (Zborowski) (ANIC); 1♂, 19 miles [ = 31 km] W Mt Gamet, 5.iv.1973 (Allwood, Angeles) (NTMA); 1♀, Emerald, flight intercept trap, 31.xii.1986 (H.Howden, A.Howden) (QM); 1♂, 22.02’S, 148.03’E, Moranbah, 5 km S, 240m, 20.xii.1997–26.iv.1998, flight intercept trap, Bendee Scrub, 5799 (Monteith) (QM); 1♂, 22.03’S, 148.04’E, Moranbah, 6 km S, 220m, 20.xii.1997–26.iv.1998, flight intercept trap, BoxFlat, 5803 (Monteith) (QM); 1♂, 25.25’S, 149.58’E, ‘Mt Rose’ via Taroom, vine scrub, remnant, pitfall, 5052, 260m, 23.xiii.–15.xii.1997 (Cook) (QM).

Female

Body length. 4.0–5.8 mm; head plus mesosoma 1.8–2.4 mm.

Colour. Predominantly brown to dark brown.

Head. Vertex with dense short pubescence, surface with both conspicuous piliferous punctures and inconspicuous piliferous punctures; interspaces between punctures weakly reticulate-engraved. OOD 1.3–1.7 × ID. Eye 1.9–2.2 × as long as wide, temple length 0.3–0.4 × and malar space 0.4–0.5 × eye length. Malar sulcus present, complete. F1 1.7–1.9 × longer than wide, 1.2–1.4 × the length of pecidel and 0.5–0.6 × the length of F2. Flagellomeres without conspicuous apical setae.

Mesosoma. Pronotal index: 1.4–1.6. Tegulae dorsally separated by 2.0 × the width of one tegula. Scutellar disc concave. Propodeal index 1.3–1.5; each posterolateral process strong, not longitudinally carinate; posteromedian process; metasoma with belt-like colour pattern; T1 without transverse carina; T2–T6 mainly glabrous and shiny; F1–F5 of female antenna with distinct apical setae.

Metasoma. T1 without transverse carina. Exposed surfaces of T1–T4 densely covered with fine setae, T5–T6 anteriorly glabrous, posteriorly with scattered setae. Lateral carina on T2 ventrally bordered by glabrous area.

Male

As female except: body length 2.8–4.7 mm; head plus mesosoma 1.5–2.2 mm; F1 1.6–2.0 × longer than wide; hind femur 4.3–4.7 × longer than wide.

Comments

The species occurs in woodland habitats throughout the north-east and in the wetter, remnant scrub (notophyll vine forest) patches of northern Cape York Peninsula (Fig. 13D).
Female

Body length. 2.9–4.1 mm; head plus mesosoma 1.4–1.7 mm.  
Colour. Head, prothorax, mesopleuron and legs orange-brown, propodeum dark brown to black, mesonotum orange-brown or black. Metasoma bicoloured, with belt-like pattern: at least posterior half of second tergite orange-brown, often also third and anterior half of fourth tergite with same colour, rest of metasoma dark brown to black.  
Head. Vertex with sparse pubescence, without conspicuous piliferous punctures; interspaces between setal bases smooth. OOD 1.2–1.4×IOD. Eye 2.1–2.4×as long as wide, temple length 0.3–0.4×malar space 0.4–0.5×as long as eye length. Malar sulcus present, complete. Clypeus 3.2–3.5×as wide as high. F1 2.8–3.2×longer than wide, 1.7–1.9×as long as pedicel and 0.5–0.6×as long as F2. F1–F5 each with conspicuous apical setae.  
Mesosoma. Pronotal index: 1.6–1.7. Tegulae narrow, dorso-laterally separated by 2.4×the width of one tegula. Propodeal index 1.3–1.5; each posterolateral process strong, not longitudinally carinate; posteromedian process minute and spinose; setae of dorsal surface predominantly longitudinally aligned. Inner distal lobe of penultimate tarsomere only slightly longer than outer lobe. Hind femur 4.1–4.2×longer than wide, inner hind tibial spur 0.4–0.5×length of basitarsus.  
Wings. Forewing not or barely longer than tegulae. Hindwing absent.

Metasoma. T1 without transverse carina. T2–T6 mainly glabrous and shiny.

Male

As female except: body length 2.6–3.7 mm; head plus mesosoma 2.0–2.1 mm; flagellomeres without apical setae; hind femur 4.3–4.5×longer than wide.

Comments

This species is known only from the Pilbara region in Western Australia (Fig. 13D). The species epithet zonale (from Ancient Greek: ωπαί) refers to the belt-like colour pattern on the metasoma.

Acknowledgements

We thank Dave Britton (AM), Gavin Broad (BMNH), Chris Burwell (QM), Jan Forrest (SAM), Mark Harvey (WAM), Terry Houston (WAM), John LaSalle (ANIC), Volker Lohrmann (ZMHB), Michael Ohl (ZMHB), Julianne Waldock (WAM), Ken Walker (NMV), Shaun Winterton (QDP) and Robert Zuparko (CAS) for loan of material; the Humboldt Foundation (Feodor Lynen program), the Australian Biological Resources Study, and The University of Adelaide for financial support towards this research; CSIRO Entomology for permission to use a line drawing from *Insects of Australia* that formed the basis for Fig. 2; Nadine Guthrie for assistance in providing us with the Pilbara Survey material; John Jennings for his comments on a draft of the paper; and Mark Harvey for his encyclopaedic knowledge of all nomenclatorial. An earlier draft of this paper was improved greatly by reviews by Lars Vilhelmsen, Volker Lohrmann, and two anonymous reviewers.

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