

The Zorotypidae of Fiji (Zoraptera)

MICHAEL S. ENGEL

*Division of Entomology, Natural History Museum, and
Department of Ecology & Evolutionary Biology, 1501 Crestline Drive – Suite #140, University of
Kansas, Lawrence, Kansas 66049-2811 USA; email: msengel@ku.edu*

&

*Division of Invertebrate Zoology, American Museum of Natural History,
Central Park West at 79th Street, New York, New York 10024-5192 USA*

Abstract. The zorapteran fauna of Fiji is reviewed based on newly collected material from the “Terrestrial Arthropod Survey of Fiji”. A single, endemic species, *Zorotypus zimmermani* Gurney, is recognized from Fiji, with new records from Vanua Levu and Taveuni. The alate has hitherto not been characterized and a description of the wing venation is accordingly provided for the species.

INTRODUCTION

The insect order Zoraptera is one of the least understood and species poor lineages of the Insecta. Presently there are 34 described living and six fossil species (Rafael & Engel 2006), although new species are already known from Asia and South America and likely from tropical Africa as well (Engel pers. obs.). Nonetheless, the order has remained an enigma since its initial discovery less than a century ago with more controversy surrounding its phylogenetic affinities than any other group of hexapods, perhaps second in this regard only to the Strepsiptera (Engel & Grimaldi 2000, Grimaldi & Engel 2005).

Zorapterans are elusive creatures, living in small aggregations under the bark of rotting logs. Aggregations are known to consist of anywhere up to about 120 individuals and, while not truly social, they are apparently dependent on their gregarious associations, as individuals kept in isolation do not survive for long. Individuals do groom each other and this may serve an “antibiotic” function necessary for survival in their subcortical environment. The degree of relatedness of individuals in such aggregations has never been investigated but is likely to be high, perhaps representing extended families. A similar kind of gregarious behavior is well studied in the webspinners (Embiodea) (*e.g.*, Edgerly 1987, 1988, Ross 2000), close relatives of Zoraptera, and this may provide insights into zorapteran behavior. Species feed on fungal hyphae but apparently will also at times prey upon minute arthropods such as mites.

Species occur in two different forms – a blind, apterous morph and an alate morph, fully winged with well-developed compound eyes and ocelli. These different forms have at times in the past been referred to as “castes” but are not true castes in the sense of social insects as zorapterans are merely gregarious and these are more accurately considered merely different morphs. During the life of an aggregation apterous individuals predominate until such time as resources become limiting or the log deteriorates to a state that it can no longer provide harbor for the zorapterans. At this stage a developmental shift occurs

and females lay eggs that hatch into alates that then disperse to form new aggregations.

Through the courtesy of Dr. Evert I. Schlinger I have recently been able to examine a series of nine zorapterans collected from a variety of localities across Fiji, thereby more fully documenting the range of the species. All of the individuals are of the endemic *Zorotypus zimmermani* Gurney (1939) and most fascinatingly are all alates or dealates, a form that is less commonly encountered for most species. The recovery of alates, however, is not surprising given that all of the specimens were captured in Malaise traps and this is the dispersive morph. Furthermore, all are females, the sex that is most common during episodes of dispersal. *Zorotypus zimmermani* was hitherto known only from the type locality near Colo-i-Suva on Viti Levu (listed under the former spelling Tholo-i-Suva by Gurney) and from seven apterous males, eight apterous females, two dealate females (meaning the wings were hitherto unknown), and 17 nymphs. All of the specimens reported here are deposited in the Bishop Museum, Honolulu, Hawaii and in the Fiji National Insect Collection, Suva, Fiji. Morphological terminology and vein identities follow that of Engel & Grimaldi (2000, 2002) and Rafael & Engel (2006).

SYSTEMATICS

Zorotypus zimmermani Gurney

(Figs. 1–2)

Zorotypus zimmermani Gurney, 1939: 161.

Diagnosis. The species can be recognized by the shallow medioapical emargination of the female subgenital plate, sternum distinctly more heavily sclerotized in emargination; male subgenital plate with apical margin broadly, gently, and weakly concave, nearly straight in some individuals (Gurney describes it as emarginate which is a bit misleading); subgenital plates of both sexes relatively narrow and transverse; terminal terga of male with paramedian pectens of three stout setae; and the male genitalic sclerites as depicted by Gurney (1939). Ventral surface of metafemur with inner marginal spination as follows: apical third with series of 5–6 subequal short spines; three prominent, stout, larger spines, one near midpoint and just before terminal series of short spines, other two large spines in basal third, more distal spine slightly larger; outer marginal spination with series of 5–6 subequal short spines.

Description. Gurney (1939) provided a thorough and accurate characterization of the species and that material is not repeated herein. However, Gurney did not have available to him complete alates and so the wings remain hitherto undocumented. As such, the following description focuses on these missing data. Habitus of the alate female in figure 1. **Wing venation:** Wings of typical paddle-shape, membrane and margins distinctly setose, membrane lightly fuscous; venation nebulous throughout both wings, degree of fuscous pigmentation varies. Forewing with pterostigma present as faint infuscation along anterior, apical wing margin between anterior point of termination of R and apical termination of Rs; R disappearing in pterostigmal base; Rs nearly extending to wing apex, terminating on anterior wing margin at pterostigmal apex; Rs fusing with M shortly after separation from stem of R; rs-m crossvein absent; Rs+M present and slightly longer than basal abscissa of Rs; Rs separating from M nearly opposite from pterostigmal base; M extending to posterior wing margin and terminating before wing apex; CuA₁ present and extending to just before two-thirds wing length before terminating on posterior wing margin; CuA₂ present as a diffuse stub in basal third of wing, terminating on posterior wing margin well proximal to fusion of Rs and M and slightly distal of point



Figure 1. Photomicrograph of alate female of *Zorotypus zimmermani* Gurney from Fiji; dorsal habitus.

of separation of M and Cu from stem of M+Cu (Fig. 2). Hind wing with stem of M exceedingly faint at base of wing, joining slightly more distinct stem of R near wing base; R+M more strongly pigmented, positioned in anterior third of wing and extending to near two-thirds wing length; apical abscissa of R terminating on anterior wing margin well prior to wing apex and slightly more apical than point of termination of M on posterior margin (Fig. 2).

Comments. The wide distribution of *Z. zimmermani* across Fiji and at elevations ranging from near sea level to nearly 1200 m is indicative of the dispersal abilities and broad habitat range of this and other zorapterans. The notion of extreme endemism for most species is likely the result of poor sampling as noted by Engel (2001, 2004) and demonstrated by the already known wide distribution for certain species (*e.g.*, *Z. hubbardi* Caudell throughout the eastern United States), increasingly larger ranges being documented for additional species (*e.g.*, Engel, 2001), and ecological models of zorapteran distribution (Hinojosa-Díaz *et al.* 2006). Certainly more locally endemic species do exist but the concept of zorapterans as being poor flies with almost no ability to disperse or all species being restricted in distribution is assuredly false.

It is interesting to note that there are few records of zorapterans from Oceania. Aside from the Melanesian *Z. zimmermani*, and three species in Indonesia, only two additional species are documented from Australasia (*Z. lawrencei* New on Christmas Island) and Polynesia (*Z. buxtoni* Karny on Samoa) (there is also a species, *Z. swezeyi* Caudell, from Hawaii). None are presently known in Micronesia. Suitable zorapteran habitat occurs widely throughout the region and, given the presence of the aforementioned species, there is great reason to suspect that *Zorotypus* occurs on other oceanic islands. In particular, species should be sought in Papua New Guinea, the Solomon Islands, Vanuatu, New Caledonia, and Tonga. It is a challenge to ascertain the affinities of the few species from

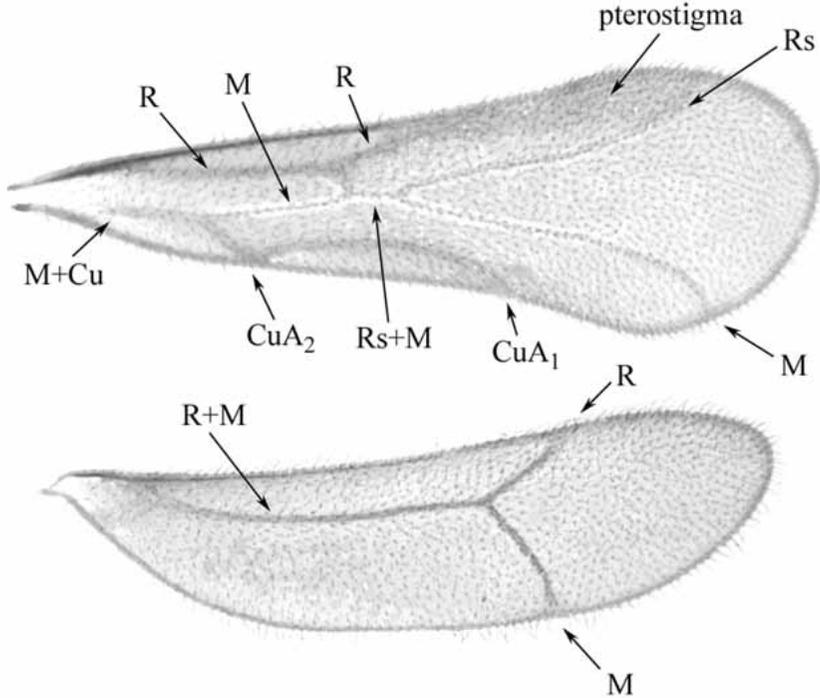


Figure 2. Wing venation of *Zorotypus zimmermani* Gurney from Fiji; forewing above, hind wing below.

Oceania given the paucity of available material and that only *Z. zimmermani* and *Z. lawrencei* have been adequately characterized and figured in the literature. It is tempting to hypothesize a relationship between *Z. zimmermani* in Fiji with *Z. buxtoni* from Upolu, Samoa (holotype and only known specimen captured at 2000 m near Malololelei), but too little information is available on the latter species to permit a positive association. Karny (1932) provided a brief account of the species but the sole specimen available to him was a badly damaged, apterous individual. So poor was the specimen that he could not ascertain whether it was an adult or a nymph. From the scant information on the species, the structure of the cercus suggests more of an affinity with *Z. javanicus* Silvestri rather than *Z. zimmermani*. In *Z. buxtoni* and *Z. javanicus* the cercus is strongly conical, with an elongate, stout, terminal seta or spine, while in the Fijian species the cercus is more oval, with scattered, elongate, more flexible setae both apically, subapically, and laterally. Extensive new collections need to be made in Samoa before anything more about the identity and affinities of *Z. buxtoni* can be ascertained.

New records. FIJI: Viti Levu: 4 alate ♀♀, 1 dealate ♂, Naitasiri Province, 3.3 km N Veisari Settlement, log road to Waivudawa, 300 m, 14.ii–8.iii.03 [14 February–8 March 2003], Malaise 4, E.I. Schlinger & M. Tokota'a, 18.069°S 178.367°E [FBA 134766–

134770]. 1 alate ♀, Naitasiri Province, 4 km WSW Colo-i-Suva Village, Mt. Nakobalevu, 372 m, 24–28.x.2003 [24–28 October 2003], Malaise 3, E.I. Schlinger & M. Tokota'a, 18.055°S 178.424°E [FBA 134760]. **Vanua Levu:** 1 dealate ♀, Bua Province, Batiqere Range, 6 km NW Kilaka Village, 61 m, 3–10.vi.2004 [3–10 June 2004], Malaise 4, E.I. Schlinger & M. Tokota'a, 16.811°S 178.988°E [FBA 134763]. **Taveuni:** 1 dealate ♀, Cakaudrove Province, 5.6 km SE Tavuki Village, Devo Peak, 1187 m, 3–10 Jan 2003 [3–10 January 2003], Malaise 1, E.I. Schlinger & M. Tokota'a, 16.843°S 179.966°E [FBA 134761]. 1 alate ♀, Cakaudrove Province, 3.2 km NW Lavena Village, Mt. Koronibuabua, 217 m, 1–24.ii.2004 [1–24 February 2004], Malaise 3, E.I. Schlinger & M. Tokota'a, 16.855°S 179.89°E [FBA 134765].

ACKNOWLEDGEMENTS

I am grateful to Dr. Evert I. Schlinger, Leah Brorstrom, and Dr. Neal L. Evenhuis for collecting and making available the material discussed herein, and to Dr. Courtenay Smithers, Dr. José A. Rafael, and Dr. Daniel J. Bickel for comments on the manuscript. Partial support for this work was provided by a Guggenheim Fellowship from the John Simon Guggenheim Memorial Foundation (to M.S.E.), while NSF DEB-0425790 ("Terrestrial Arthropod Survey of Fiji") and the Schlinger Foundation supported fieldwork in Fiji. The Government of Fiji (Ministries of Environment and Forestry) is gratefully acknowledged for permitting my colleagues to undertake their surveys in Fiji thereby making possible the discovery of the zorapterans reported herein. This is contribution No. 3466 of the Division of Entomology, University of Kansas Natural History Museum.

LITERATURE CITED

- Edgerly, J.S.** 1987. Maternal behaviour of a webspinner (order Embiidina). *Ecological Entomology* **12**(1): 1–11.
- . 1988. Maternal behaviour of a webspinner (order Embiidina): Mother-nymph associations. *Ecological Entomology* **13**(3): 263–272.
- Engel, M.S.** 2001. New neotropical records for three *Zorotypus* species (Zoraptera: Zorotypidae). *Entomological News* **112**(4): 278–280.
- . 2004. Zoraptera, pp. 637–640. In J.L. Bousquets, J.J. Morrone, O. Yáñez-Ordóñez & I. Vargas-Fernández (eds.), *Biodiversidad, Taxonomía y Biogeografía de Artrópodos de México: Hacia una Síntesis de su Conocimiento* [Volumen IV]. Universidad Nacional Autónoma de México, México D.F., viii + [ii] + 790 + [4] pp.
- . & **D.A. Grimaldi.** 2000. A winged *Zorotypus* in Miocene amber from the Dominican Republic (Zoraptera: Zorotypidae), with discussion on relationships of and within the order. *Acta Geológica Hispánica* **35**(1): 149–164.
- . & **D.A. Grimaldi.** 2002. The first Mesozoic Zoraptera (Insecta). *American Museum Novitates* **3362**: 1–20.
- Grimaldi, D. & M.S. Engel.** 2005. *Evolution of the Insects*. Cambridge University Press, Cambridge, xv + 755 pp.
- Gurney, A.B.** 1939. A new species of Zoraptera from Fiji. *Occasional Papers of Bernice P. Bishop Museum* **15**(14): 161–165.
- Hinojosa-Díaz, I.A., E. Bonaccorso & M.S. Engel.** 2006. The potential distribution of *Zorotypus hubbardi* Caudell (Zoraptera: Zorotypidae) in North America, as predict-

- ed by ecological niche modeling. *Proceedings of the Entomological Society of Washington* **108**(4): 860–867.
- Karny, H.H.** 1932. Psocoptera. *Insects of Samoa* **7**(4): 117–129.
- Rafael, J.A. & M.S. Engel.** 2006. A new species of *Zorotypus* from Central Amazonia, Brazil (Zoraptera: Zorotypidae). *American Museum Novitates* **3528**: 1–11.
- Ross, E.S.** 2000. EMBIA: Contributions to the biosystematics of the insect order Embiidina. Part 2: A review of the biology of Embiidina. *Occasional Papers of the California Academy of Sciences* **149**: 1–36.