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FIJI ARTHROPODS I

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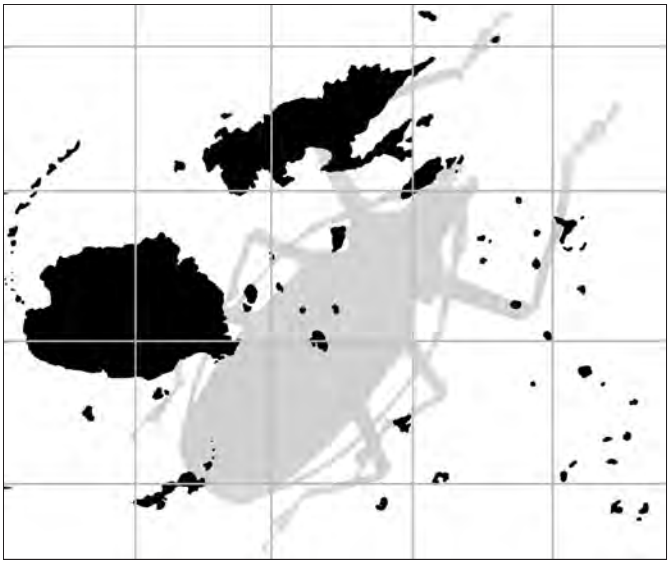
AND
DANIEL J. BICKEL, EDITORS



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The State Museum of Natural and Cultural History
1525 Bernice Street
Honolulu, Hawai'i 96817-2704, USA

FIJI ARTHROPODS

Editors' Preface

We are pleased to present the first issue of *Fiji Arthropods*, a series offering rapid publication and devoted to studies of terrestrial arthropods of the Fiji Group and nearby Pacific archipelagos. Most papers in this series will be the results of collecting and research on the Fijian fauna deriving from the NSF-funded "Terrestrial Arthropods of Fiji" project. Five co-PIs and 18 specialists (see p. 18 of this issue) form the core team of scientists who have agreed to publish new taxa that result from collecting during this survey. However, as space allows, we welcome papers from any scientist who is currently working on arthropod taxonomy in Fiji.

This inaugural issue contains an overview of the project and papers by Neal Evenhuis and Dan Bickel on new taxa of Dolichopodidae. Another paper by Evenhuis on a preliminary checklist of tipuloid flies is also presented. Manuscripts are currently in press or in preparation on Anisopodidae, Saldidae, and Asilidae and will appear in future issues.

All papers in this series are available free of charge as pdf files downloadable from the following url:

http://hbs.bishopmuseum.org/fiji/fiji-arthropods/

We encourage interested authors to contact us before submitting papers.

—Neal L. Evenhuis, Co-editor, neale@bishopmuseum.org
Daniel J. Bickel, Co-editor, danb@austmus.gov.au

Fiji Arthropods I. Edited by Neal L. Evenhuis & Daniel J. Bickel. *Bishop Museum Occasional Papers* 82: 3–25 (2005).

The NSF-Fiji Terrestrial Arthropod Survey: Overview[1,2]

Neal L. Evenhuis
Pacific Biological Survey, Bishop Museum, 1525 Bernice Street, Honolulu, Hawai'i 96817, USA; email: neale@bishopmuseum.org

Daniel J. Bickel
Entomology Section, The Australian Museum, 6 College Street, Sydney, NSW 2010, Australia; email: danb@austmus.gov.au

Abstract: A summary and overview of the NSF-funded project surveying the terrestrial arthropods of Fiji is presented.

BACKGROUND

Despite its central position amid the island groups of the southwest Pacific, the Fijian Archipelago is one of the most faunally unusual areas in the entire Pacific region. For although generally considered to be of Pacific geological origin, the Fiji group harbors New World lizards and African flies, elements that strongly suggest past continental associations for portions of the fauna.

In terms of proximity to other island groups, the Fijian Archipelago lies 1209 km from the Samoan Archipelago, 850 km from Tonga, 369 km from Vanuatu, and 1254 km from New Caledonia. This relatively close juxtaposition to other major Pacific island groups would suggest that the affinities of the Fijian arthropod fauna would be similar to those of the surrounding region. In fact, they are in many cases quite distinct. Critical assessment of this biogeographic anomaly and its origins has been hindered, however, by the absence of comprehensive surveys of the Fijian arthropod biota. Despite successive voyages of exploration and scientific expeditions to Fiji since its first European sighting in 1643 by Abel Tasman, very little has been published specifically in regard to the Fijian arthropod fauna and only a few surveys focusing specifically on arthropods have taken place. The current project will provide a more complete knowledge of the Fijian arthropod fauna, leading to a better understanding of the endemic components in this biota and their phylogenetic and geographic relationships.

Geography and Environment

The Fiji Islands in the eastern Melanesian region of the Central Pacific consist of over 500 named islands and occupy an ocean area of some 650,000 km^2 (Fig. 1) of which the land area is less than 3 percent. There are two large islands: Viti Levu (10,388 km^2) and Vanua Levu (5,535 km^2), two mid-sized islands: Taveuni (434 km^2) and Kadavu (408 km^2), and numerous smaller islands. The highest elevations are 1,323 m (Tomaniivi [= Mt. Victoria])

1. Contribution No. 2005-001 to the NSF-Fiji Arthropod Survey.
2. Contribution No. 2005-003 to the Pacific Biological Survey.

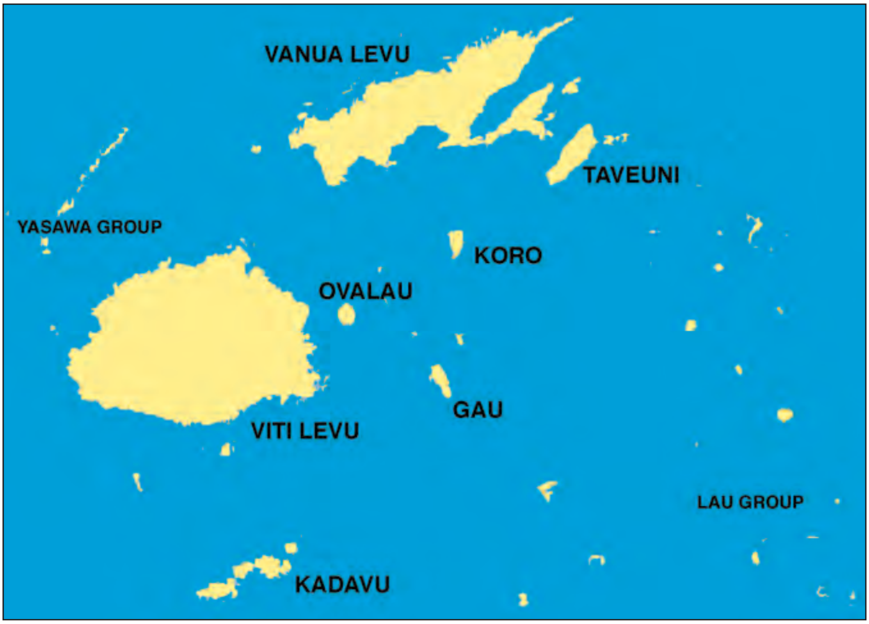

Figure 1. Map of the Fiji Islands showing some of the main islands where collecting stations are located.

on Viti Levu, 1,241 m (Mt. Uluiqala) on Taveuni, and 1,032 m (Mt. Batini) on Vanua Levu. The major islands are rugged, and landforms include volcanic plugs, eroded calderas, deep gorges, and ravines carved by mountain streams, flat-bottomed valleys with extensive flood plains, and mangrove dominated deltas. Although some of the Fijian Islands are true atolls, most of the low islands are composed of bedded limestone overlying volcanics.

Fiji has a warm, humid tropical maritime climate. There are few extremes in temperature, with mean monthly temperatures from 22 °C in July to 26 °C in January. The South East Trades predominate, bringing moisture-laden winds onto the land. On the larger islands, the orographic effect of the mountains is pronounced, with abundant cloud cover and rainfall on wet windward sides, and a marked rainshadow with diminished rainfall on the dry western or leeward sides. Because Fiji is subequatorial, there is weak seasonality, with widespread rainfall between November and April, with greatly diminished precipitation between May and October, especially on the low islands and the leeward sides of the large islands. Strong cyclonic depressions with high winds and rain occur infrequently from November through April. Average annual rainfall in the "dry zone" of the larger islands is between 165–229 cm, while in the lowland wet zone, 305–345 cm. Upland areas often receive 500+ cm, while certain localities in upland Taveuni receive almost 1000 cm of rainfall per year (Ash 1988). Fiji encounters between 10–15 cyclones per decade; 2–4 of these cause severe damage.

Vegetation

Rainfall is the most variable climatic factor in Fiji. It accounts for much of the variation in vegetation and, hence, the biota in general (documented for the Lepidoptera, Robinson 1975). Three generalized forest types occur on Fiji that correlate with rainfall: wet zone, dry zone, and coastal forests. Within these zones, local environmental factors further shape the composition of the forest communities (Mueller-Dombois & Fosberg 1998; Parham 1972; Smith 1979).

Wet Zone Vegetation. Moist tropical forest occurs as lowland rain forest, montane rain forest, and cloud forest. Elevations in Fiji are not high enough to break the continuity of the rainforest, and many species have a range extending from near sea level to the highest elevations. Montane rainforests (Fig. 2) are found in wind-exposed areas above 600 m where annual mean temperatures are 4–6 °C lower than in the lowland forests. Cloud forest occurs on ridges and peaks above 600 m on Fiji's largest islands. The Fijian rainforest has a comparatively large number of species in diverse families but lacks dominant floral indicator species. It supports many lianas, ferns, and epiphytes including orchids.

*Dry Zone Vegetation***.** The dry zones of Fiji, formerly covered with distinctive sclerophyllous forests and scrublands, occur on the leeward coasts and extend upward from sea level to about 450 m. On Viti Levu and to a lesser degree on Vanua Levu, the dry zone vegetation, after years of repeated burning, has been degraded to a flora dominated by grass and fern with many introduced invasive elements. The dry zone upland areas are of unusual interest, being well forested yet separated from the wet zone uplands by intervening tracts of grassland. They have been isolated sufficiently long for floristic endemism to have developed (Thaman 1996). On both Viti Levu and Vanua Levu, much of the area once covered by dry zone forest is now in sugar cane.

*Coastal Vegetation***.** The Fijian littoral and strand vegetation is part of the widely dispersed tropical Pacific coastal flora (Figs. 5, 6). Fiji also has considerable mangrove swamps, with the largest formations found in deltas of the large rivers or where the coastline is protected by barrier reefs. In the drier leeward areas with high seasonal evaporation, hyper-saline mudflats occur, a feature virtually absent in the wetter, windward mangroves.

Geology

In addition to its close proximity to other island groups, the geologic history of Fiji also provides some intriguing hypotheses as to faunal origins. Fiji is located along the tectonically active boundary zone between the Australian and Pacific Plates. The bedrock is a complex of volcanics, pyroclastic sediments, and limestone reef deposits developed since the early Cenozoic, some 40–50 Mya. In addition, uplift and erosion have exposed plutonic and low-grade regional metamorphic rocks of greater age. Limestones, often of great thickness, occur on Viti Levu. Overall, repeated volcanism and tectonic activity, combined with uplift and erosion have resulted in a complicated geology. The oldest exposed land surfaces on Fiji probably date from 5–20 Mya. Most soils are derived from underlying volcanics and uplifted coralline reefs, and alluvial soils are found along the floodplains of large rivers.

Figures 2–4. Selected habitats in Fiji. **2**. Mossy rainforest on the high plateau near Mount Tomanivi on Viti Levu. Photo N. Evenhuis. **3**. Waterfall near Colo-i-Suva on Viti Levu. **4**. Sigatoka sand dunes on leeward Viti Levu. Photos D.A. Polhemus.

Figures 5–6. Selected habitats in Fiji. **5**. Coastal mangrove habitat near Naqara Island along the south shore of Viti Levu with gymnosperm-dominated rainforest on background slopes. **6**. Volcanic rocks and shallow tidal area along shore on leeward Viti Levu. Photos D.A. Polhemus.

Theories on the origin of Fiji are contradictory and have evolved over the last few decades. For many years, Fiji was thought to have originated as a fragment of continental crust near the northeastern edge of the Indo-Australian Plate, where a subduction zone, indicated by the Vitaz Trench, is formed as the Pacific Plate subducts beneath a continental margin (Chase 1971; Green & Cullen 1973). The oldest rocks found in Fiji are from western Viti Levu and date from 34 Mya (Nunn 1998). Earlier authors (e.g., Green & Cullen 1973) hypothesized that Fiji emerged about 50 Mya (Eocene) as part of a volcanic arc, resulting in emplacement of a mixture of ophiolites (oceanic plate mantle) and intermixed with continental plate material. In this scenario, Fiji was part of an island arc system (the Vanuatu-Fiji-Lau-Tonga Ridge) that migrated eastward. Throughout this migration, Vanuatu was thought to be close to Fiji until the mid-Miocene (ca. 20 Mya). By contrast, Yan and Kroenke (1993) provided evidence to suggest that Fiji originated between 48 and 40 Mya on the Pacific Plate at the eastern edge of the outer island arc system, south of the Ontong Java Plateau. This island arc system was far east of the rifted continental sliver containing Norfolk and Lord Howe Islands, thus Fiji and Vanuatu were considered to be oceanic islands. This hypothesis indicates that Fiji and the older islands of Vanuatu emerged only in the last 10 Mya, shifting southward to their present position in relation to the New Hebrides Trench, which separates Vanuatu from New Caledonia.

It is difficult to find explicit statements as to when Fiji became subaerial, although Thornton (1981) believed that the Fiji archipelago was not emergent until the Miocene-Pliocene boundary (ca. 5 Mya). This hypothesis of recent emergence is at odds, however, with the presence of certain anomalous and poorly dispersive elements in the biota. The possibility that Fiji was part of an older migrating island arc system is more compatible with the high levels of endemism in seen in certain arthropod groups, because island arcs are persistent geologic features and their constituent islands are normally large and topographically complex (Polhemus 1996). Indeed, geological evidence suggests that as part of the Melanesian Arc, an ancestral Fiji was positioned much further west some 40 my, close to what is now the Solomon Islands (Hall, 2002)

A further complicating factor in relation to the islands' geologic history and geophysical features is the hypothesis that during the last glacial period [18,000 years B.P.—given an assumed $^{-}$120 m sea level change (Gibbons 1985)]—the islands of Viti Levu and Vanua Levu were in extremely close proximity, and separated by only a few kilometers. This distance could theoretically have permitted the exchange of many taxa between the two islands, and there is limited evidence from various arthropod groups to suggest that these large islands harbor discrete suites of endemic taxa.

In summary, Fiji's uncertain geological history, age, and proximity to other major Pacific island groups, coupled with the geographical complexity of the current islands in the Fijian archipelago, provide an excellent opportunity to utilize biotic data from arthropod groups as an independent means of testing competing geological and palaeogeographic hypotheses.

Biogeography

Fiji's position in the general biogeography of the southwestern Pacific has been reviewed by Keast (1996), Miller (1996), Gressitt (1961), Smith (1979), Mueller-Dombois &

Figure 7. Laboratory facility at the Ministry of Forestry in Colo-i-Suva serving as the center for sorting of arthropods and deposition of voucher collections. Photo D.A. Polhemus.

Fosberg (1998), and various authors in Keast & Miller (1996). The Fijian arthropod fauna shows the following affinities:

1. Papuan/Western Pacific source. This is the overall dominant pattern for the Fijian biota. For example, the Fijian flora shares 90% of its vascular plant genera with New Guinea (Ash 1992). Among the arthropods, macrolepidoptera (Robinson 1975), cicadas (Boer & Duffels 1996), dolichopodid flies (Bickel 1996); and some beetle families (Gressitt 1961) show this pattern as well.

2. Gondwanan source. The breakup of the Gondwanan supercontinent and the resultant drift and isolation of the component landmasses have produced vicariant patterns among the biota. In the SW Pacific, Gondwanan biotas are characteristic of the southern temperate regions. For a Fijian taxon to be Gondwanan, it would need to have direct phylogenetic links to a decidedly Gondwanan taxon from Australia, New Caledonia, or New Zealand—not indirectly via the Melanesian Archipelago. Some taxa, such as the endemic primitive family Degeneriaceae caused earlier speculation that Fiji might be a Gondwanan fragment, or that it arose near Australia (e.g., Raven & Axelrod 1972). However, geological evidence argues strongly against a direct connection, except for the possible accretion of the ‘Eua Ridge, which Kroenke (1996) suggested may have broken away from New Caledonia and drifted toward present-day Tonga, perhaps introducing a depauperate Gondwanan biota into Fiji some 6 Mya. Ash (1992) regards the Degeneriaceae in Fiji as a relict of a wide earlier Malesian distribution and not necessarily Gondwanan.

3. Widespread tramp species and/or accidental introductions. Many species have been accidentally introduced around the World with both prehistoric and recent human traffic.

In addition, there are many species, which are naturally widely dispersed. Such "tramp" species are often adapted to disturbed lowlands where they have an increased chance of both natural dispersal and accidental human transport.

4. *New World source*. The Fijian iguana genera (one extant, *Brachylophus*, and one fossil genus) are phylogenetically nested within the New World iguanas, strongly suggesting long distance dispersal from the Americas, probably by rafting and island hopping (Pregill & Steadman 2004). Some Fijian dipteran taxa may also show similar New World origins (some sciapodine Dolichopodidae; examples found from recent surveys include Mythicomyiidae).

Biogeographical Processes

1. Dispersal. Inter-island dispersal from a western Australasian source (and possibly also the Orient and Neotropics) is considered to be the principal source of derivation for much of the Fijian biota. The transoceanic dispersal capability of arthropods is well established, and many small-sized taxa are easily carried by wind (e.g., records in Holzapfel & Harrell 1968; Peck 1994a) or on oceanic flotsam (e.g., Peck 1994b).

2. Vicariance. In light of Fiji's purported relatively young age, vicariant relationships with distant landmasses seem unlikely. However, the history of the Fiji and the Melanesian arc terrains is not well understood, and the possibility exists that that a component of the current biota has arisen through vicariance, mediated by tectonic rafting of small continental fragments from the Australian Plate. In addition, Pleistocene variations in sea level may have produced more recent vicariance events within the existing archipelago. Craig *et al*. (2001) suggested a combination of dispersal and vicariance to account for the distribution of the black fly subgenus *Inselliellum* (Simuliidae) in the western Pacific but also emphasized the importance of suitable habitat in determining the potential of colonization and subsequent radiation.

Biogeographical Potential

The Fijian biota has great potential to illuminate the biogeographical patterns and processes noted above. Although the terrestrial arthropod fauna is known only in outline, intriguing biogeographical links have been discovered, all of which require further investigation. A central Pacific-New World pattern in the dolichopodid flies is evident in the *Chrysosoma lacteimicans* group, known from the Samoan and Cook Islands, Micronesia, Fiji, and Vanuatu. Some of these species display marked similarities with the Neotropical *Amblypsilopus maculatus* group, but this is not clearly supported by strong synapomorphies, and indeed the generic placement of these two groups is equivocal (Bickel 1994). Further New World-Fijian links are suggested by newly discovered mythicomiid bee flies from the high rainforests of Taveuni, otherwise known from the more arid North and South American cordillera; and simuliid black flies from Taveuni, which are not the expected western Pacific subgenus *Hebridosimulium*, but a South American subgenus (D. Craig, pers. comm.). A link between Fiji and the Afrotropical fauna is suggested by agapophytine therevid snipe flies collected on the Sigatoka Sand Dunes, Viti Levu (Fig. 4) (M. Irwin, pers. comm.) and an undescribed genus of mythicomyiid fly found on Taveuni.

However, the geographic source or affinity of insular taxa may not be clear. Many genera or generic groups are widely distributed or cosmopolitan. Taxonomic literature is often fragmentary, and few groups have been analyzed so biogeographic provenance can be associated with unique synapomorphies (if indeed that is always possible). Fiji is likely to have many genera that are pantropical. If insect taxa arrived in Fiji through long distance dispersal from a presumed Papuan source or even the Neotropics, then it is desirable that the ancestral provenance be unequivocally demonstrated. For many insect genera this is impossible. This proposed project undoubtedly will produce many instances where the "dispersed" Fijian taxon becomes better known than that of any potential source area.

Previous Surveys

Early voyagers and explorers paid scant attention to the Fijian Islands and conducted few biological explorations. The Dutch explorer, Abel Tasman in 1643 was the first European to sight the Fijian Islands. He made no landfall, but sailed through the northern Lau group trying to avoid an oncoming hurricane and find safety in deeper waters. William Bligh in 1789, after the famous mutiny on the H.M.S. *Bounty*, passed between Viti Levu and Vanua Levu but, being unarmed, did not land. He returned in 1792 to map the islands.

Zoological exploration in Fiji began almost concurrently with expeditions by the French (*Astrolabe-Zélée* expedition, 1837–1840) and Americans (*U.S. Exploring Expedition*, 1838–1842). These expeditions resulted in only a few new taxa of arthropods being described. Scientific expeditions continued to be made to various of the Fijian islands and new taxa described based primarily on general collecting. In the 1860s, Eduard Graeffe, founder of the Godeffroy Museum in Hamburg, made one of the first biological explorations into the interior of Viti Levu (see Graeffe 1986 for an English translation of his personal travelogue), which resulted in some spectacular collections of walking sticks (*Graeffea* spp.), a huge cerambycid (*Xixuthrus heros*—114 mm long), and some buprestids. However, it was not until the American Museum of Natural History's *Whitney South Seas Expedition* in 1924 that significant and extensive collections of arthropods and associated observations were made (primarily by E.H. Bryan, Jr.), specimens of which are currently deposited in BPBM (as well as Bryan's journals and notes). The *Whitney* expedition visited Viti Levu, but was better known for collecting on almost all of the islands in the Lau Group and for the coining of Kadavu as "a collector's paradise" (Bryan 1924).

Subsequently, a few other scientific expeditions and other smaller visits were made to various of the Fijian islands in search of insects and other arthropods. In 1933, the *Zaca Expedition* (better known as the *Templeton-Crocker Expedition*) stopped in Fiji, with entomologist T.D.A. Cockerell and his wife making a rather cursory collection of arthropods. In 1938, the *Henry G. Lapham Expedition* with Bishop Museum entomologist Elwood C. Zimmerman on board made extensive collections of arthropods on the islands of Viti Levu, Ovalau, and Vanua Levu. Finally, from 1941–1981, Noel H.N. Krauss, Hawaii State exploratory entomologist, made several trips to Fiji in search of insects and other arthropods to be used in biological control of agricultural pests in Hawai'i.

Table 1. Comparison of Diptera Faunas of Selected Pacific Island Groups

Island Group	Size (km^2)	Families	Genera	Species
Fiji	18,376	57	296	493
Hawaiian Islands	16,640	58	342	1545
Samoan Archipelago	2,935	42	210	472

Current State of Knowledge of the Fijian Arthropod Fauna

There is little current comprehensive information published on the arthropod fauna of Fiji. Data available is found in scattered references dating as far back as the middle of the 19th century. Few complete treatments of major arthropod groups have been made and are, for the most part, more than 50 years old and in dire need of revision: Hemiptera (Kirkaldy 1908), orthopteroids *s. lat*. (Bruner 1916), Hymenoptera (Turner 1919), ants (Mann 1921), dragonflies (Tillyard 1924), Diptera Brachycera (Bezzi 1928), long-horned beetles (Dillon & Dillon 1943), Thysanoptera (Moulton 1944), and aculeate wasps (Williams 1947). More recent studies include: Psocoptera (Thornton 1981), cicadas (Duffels 1988), damselflies of the genus *Nesobasis* (Donnelly, 1990), and macrolepidoptera (Robinson 1975).

The arthropod composition of Fiji is only known for a few groups. However, based on recent checklists from Hawaii (Nishida 2002) and the Samoan Islands (Kami & Miller 1998) comparisons can be made for some groups. Table 1 shows the comparative levels of diversity for a few selected orders of insects in Fiji, Hawaii, and the Samoan Islands. To use Diptera as one example, Evenhuis (1989) is the most recent to catalog the entire Pacific Diptera. From this catalog and updated published and unpublished information, there are currently some 493 species of Diptera in 296 genera and subgenera in 57 families known from Fiji. This is in an interesting comparison to the 1545 species in 342 genera in 58 families found in Hawai‘i (Nishida 2002), which has a slightly smaller total land area (16,640 km^2) as compared to Fiji (18,376 km^2) and is roughly comparable to the numbers of species (472), genera (210) and families (42) of Diptera found in the much smaller land area of the Samoan Islands (2,935 km^2) (Kami & Miller 1998). Based on these comparisons, those in the table above, and specimens housed in Bishop Museum, we believe Fiji has many hundreds of undiscovered and undescribed arthropods.

NEEDS AND OPPORTUNITIES

Endemism and Biodiversity

The geographical placement of Fiji adjacent to other island groups of both volcanic and continental origin will allow us to make useful comparisons regarding the degree of endemism observed in the arthropod groups selected for this study with those groups elsewhere in the Pacific. These data can then be used to assess biogeographic hypotheses about origins of the Fijian fauna as well as its relationships to other neighboring faunal elements in the Central and South Pacific. Determining levels of endemism in Fijian arthropods, when placed in conjunction with distributional data, can also assist resource managers in determining potential areas in need of urgent natural resource conservation. Knowing the fauna of Fiji will also enable Fijians to attract more ecotourists. Indeed, the giant Fijian longhorned beetle, regarded as the second largest beetle in the world, has become a flagship for Fijian biodiversity (Yanega *et al*. 2004).

The Fijian government has been implementing a National Biodiversity Strategy and Action Plan for the conservation and sustainable use of the country's biological diversity and this proposed arthropod survey fits into many of the recommended actions (Fiji Department of the Environment 1997, 1999). However, accessible and meaningful knowledge about the Fijian biota is limited. One goal of this survey is to define areas of arthropod endemism and species richness throughout the Fijian archipelago.

Checklists and Literature Databasing

The Hawaii Biological Survey (HBS) was established by the Hawaii State government to inventory the plants and animals of the State of Hawaii and make this information available to the widest user community possible. Since its inception in 1992, the HBS 6-stage methodology (Allison & Miller 2000) has been used as a successful and cost-efficient model for the inventorying of the biota of discrete areas in various parts of the world (e.g., Africa, Indonesia, Papua New Guinea, Bermuda). We trust that by initiating the HBS approach to inventorying the arthropod fauna of Fiji, this project will lead to future Fijian government support of a Fiji Biological Survey that will fully inventory the country's plants and animals and make the information from those surveys available to a wide array of users such as students, scientists, land managers, public information officers, farmers, and others.

URGENCY

Loss of habitat

The population of Fiji (ca. 773,000 as of the most recent [1996] census) is largely confined to the two largest islands: Viti Levu (76%) and Vanua Levu (18%). While the population levels are not alarmingly high for a land area the size of Fiji, an annual 2–3% increase in population (Chandra & Chandra 1998) has resulted in a progressive increase in resource consumption and energy harnessing, resulting in environmental degradation (e.g., building of dams and new houses, logging, clear-cutting for increased agriculture use). Habitat loss (effectively forest loss) remains the most serious threat to the endemic fauna and flora of the Pacific islands. Deforestation in Fiji is moderate but continuing. Virtually all the lowland areas have seen deforestation of some kind and only small pockets of native fauna and flora remain in these protected areas (e.g., Sigatoka dunes). Since the mid 1960s an estimated 90,000–140,000 ha (11–16%) of the nation's forests have been converted to non-forest land use (Watling & Chape 1992), but conservation measures have been initiated in the last few years to reduce the logging of native forests—the number of hectares per year of native forest loss has been decreasing over the past 5 years. As a result, Fiji is one of the best remaining areas in the central Pacific to inventory the native upland fauna before more deforestation takes place making such an inventory an otherwise impossibility. These upland forested areas harbor the greatest diversity of native arthropod species and consequently these areas and their constituent native species are most vulnerable to perturbations and possible resulting reductions in populations and even extinctions. Freshwater drainages have also seen impacts to their native aquatic biota from habitat disturbance (e.g., Haynes 1994) and they have experienced silt and chemical pollution as well as the introduction of exotic plants and animals such as the water hyacinth (*Eichhornia* sp.) and cichlid fishes (e.g., *Oreochromis mossambicus*) (Ryan 2000). Heavy competition for resources by introduced species in aquatic ecosystems for resources inevitably results in a decline of native aquatic invertebrates (Cushing & Allen 2001).

Already, Fiji has witnessed the extinction of a number of its native species. Some of this has undoubtedly come as a result of human disturbance or intervention, but additionally, the introduction of alien invertebrate pests such as ants and vertebrate predators such as the cane toad and mongoose have been directly or indirectly responsible for the demise of many native invertebrates (Ryan 2000) as they have on other Pacific islands (Eldredge 2000; Nishida & Evenhuis 2000).

Biogeographic Link

Previous assessments of Fiji's fauna show an interesting array of affinities to adjacent areas. Preliminary assessments of invertebrate affinities have shown that Fiji is the easternmost Melanesian outpost of some lineages and is a gateway to other lineages occurring further east into French Polynesia. Previous or current arthropod surveys have or are being conducted in Samoa, French Polynesia, New Caledonia, New Guinea, and Australia. It is only logical to fill the gap in these island and nearby continental surveys with an intense arthropod survey of Fiji. By doing so, the results can be added to and integrated with ongoing research into the hypotheses of faunal origins throughout the Melanesian region as well as Fiji's history as a possible source area to further eastern and younger volcanic island faunas.

OBJECTIVES

There are three major objectives:

1. *Diversity Assessment and Faunal Origins*. For each selected terrestrial arthropod group, numbers of native and endemic species will be assessed along with nonindigenous species. New taxa will be described and summaries of taxa will be made concurrent with comparisons of like arthropods on other nearby islands and continental land masses to hypothesize faunal sources of the Fijian taxa.

2. *Capacity-Building of In-Country Taxonomic Expertise*. Working with the Wildlife Conservation Society, the University of the South Pacific, the Fiji Ministry of Fishoeries and Forestry (MAFF), and the Pacific loop of BioNET (PACINET), we will assist in providing training workshops for local people in Fiji participating in the project to learn how to collect, sort, and identify major arthropod groups. Information about our project will be disseminated to villagers via community meetings. Once this project is completed, it is hoped that these participants will continue to monitor the arthropod fauna within Fiji through support from various Pacific partners and funding agencies.

3. ***Checklists and Bibliography***. Checklists of identified taxa of selected focus groups as well as a full list of known (= published) arthropod taxa from Fiji and associated bibliography will be made and posted on the web. We will incorporate environmental data and host-plant data where applicable to give as complete an environmental picture as possible. This information will be made available on the web with the Hawaii Biological Survey website (est. 1.5 million user hits per year) used as a successful model.

PROJECT MANAGEMENT PLAN

Collecting Sites

This project essentially will continue and expand the Fiji Bioinventory of Arthropods (FBA) project, funded by the Schlinger Foundation between September 2002 and May 2004. Over $100,000 has been allocated to fund collectors, parataxonomists, supplies, and project oversight. That project's collecting sites will be continued in this study.

Collecting arthropods in Fiji will follow a two-tiered approach. 1) we propose to assist with the taxonomic portion of the PABITRA project (Pacific-Asia Biodiversity Transect), the collecting of which will be conducted concurrently and in collaboration with with our project. PABITRA has proposed to set up a trapping and collecting transect encompassing a number of different ecosystems in eastern Viti Levu between Mt. Tomaniivi and the Rewa delta on the southeastern coast; 2) we will complement the PABITRA project by using the Schlinger Foundation collecting sites, which are currently in 7 different ecosystems on different islands which provide as complete a coverage of the environment as possible. Various trapping and collecting methods will be employed in and around where the Malaise traps are placed by the NSF team and parataxonomists in Fiji.

Due to logistics constraints, rigorous collecting with Malaise and other trapping devices is currently concentrated primarily on Viti Levu, Taveuni, Vanua Levu, and Kadavu. There are many low islands and atolls, and collecting on the smaller outlying islands is also planned to take place during the project in order to duplicate the collecting of previous explorers and entomologists thereby providing a set of collections that can be used to compare with the older collections for any changes that may have taken place in the intervening years.

Collecting Protocol

In general we will follow the PABITRA collecting protocol (Allison & Englund 2005) which is a modification of the DIPWA methodology (Toda & Kitching 2002). All collecting sites will be located geographically using GPS and will be plotted on GIS and georeferenced to MaNIS standards (http://elib.cs.berkeley.edu/manis/GeorefGuide.html). We will specifically use the following collecting techniques for assessing diversity of arthropods within each collecting site:

1. Malaise traps (Fig. 8).— 2–5 Townes-style Malaise traps will be set up at each site and left for 12 days prior to collection. They will be activated every other week throughout the first year, so that the material collected is not expunged from the site and the quantity obtained does not overwhelm the sorting team. Malaise traps are among the most productive samplers in terms of species richness and number of specimens captured. A Malaise trap intercepts flying insects and takes advantage of their natural propensity to

Figures 8–10. Selected collecting techniques used in the survey. **8.** Malaise trap in mesic forest on Vanua Levu. Photo L. Brorstrom. **9**. Aerial sweep netting riparian arthropods at Wainidruku Creek on Viti Levu. **10**. Sticky trap on tree at Colo-i-Suva.Photos D.A. Polhemus.

climb or fly upward toward light after encountering the trap's central mesh panel. They are funneled into the collecting head of the trap, which is filled with 95% ethanol and are killed by drowning. Traps will be placed along known flight pathways such as small creeks and will intercept insects flying up to a meter above ground level, in or above surface vegetation.

2. Water pan traps.— Shallow plastic pans are placed on the ground or in trees to sample arthropods. The pans are filled with water and a surfactant (soap solution) to allow trapped specimens to sink to the bottom of the pan and drown. Salt will be added to prevent mold from accumulating in humid environments. Yellow, white. or blue colored pans have shown to be most productive in collections of arthropods. They are attractive to flying insects in both open areas and forest canopy. Pan traps will be left for 1 week at each site prior to collection.

3. Pitfall traps.— These consist of small plastic cups placed into the ground with the rim level with the surface. A series of unbaited pitfall traps containing ethylene glycol, and baited pitfall traps will be placed at each site and left for 1 week prior to collection.

4. Aerial nets (Fig. 9).— Aerial sweep nets with a fine mesh to collect smaller Diptera and Hymenoptera will be used to sample arthropods on vegetation, leaf litter, littoral habitats, beaches, and rocky intertidal reefs.

5. Aquatic sampling.— Aside from trapping with Malaise, pan traps, and aerial nets, an aquatic net will be used to specifically sample the stream fauna. In addition, benthic samples will be taken where feasible to collect and identify aquatic larvae, especially those of the selected focus groups.

6. Hand collecting.— Hand collecting, with or without the use of an aspirator, will be used for collecting arthropods on specific species of plants and to collect arthropods that are difficult to collect using other techniques—such as those on craggy rock faces, in small holes and crevices or on muddy substrates.

7. *Sticky traps* (Fig. 10).— Yellow sticky traps will be placed on tree trunks and other suitable vertical surfaces to collect arthropods that orient on vertical surfaces. Collecting in Australia (Bickel & Tasker 2004) has shown a impressive diversity of insects that are collected in this fashion that otherwise are not collected with other trapping methods. Sticky traps will be left for 1 week at each site prior to collection.

8. *Baiting*.— Baits with a mixture of sugar water, yeasted fruits or other vegetable or animal matter will be used to attract flies such as drosophilids, tephritids, platystomatids, tachinids, and beetles, etc. Mammal feces will be used for attracting endemic arthropods associated with this medium. McPhail traps may be used for longer term bait trapping as these can be left in the field for a week. Collecting will then be done either by aerial nets or hand collecting. Baits will be checked periodically after placement and specimens collected immediately following such checks.

9. *Pyrethrin fogging*.— The use of small aerosol room foggers containing pyrethrins has proven successful in the field in collecting cryptic arthropods or those otherwise difficult to access using the techniques described above. Spraying tree trunks, moss, low growing vegetation, etc. with the aerosol and gathering the results of knockdown onto white sheets placed beneath such areas being collected results in collections of arthropods sometimes not collected using other techniques.

Table 2. Target Taxa for Project

Order	Family	#sp.	#new	Specialist
Coleoptera	Buprestidae	43	10–15	C. Bellamy, CDFA
Coleoptera	Chrysomelidae	155	50–75	A. Samuelson, BPBM; C. Reid, AMS
Coleoptera	Cerambycidae	122	10–15	S. Lingafelter, USDA-SEL
Diptera	Dolichopodidae	19	50–60	D. Bickel, AMS; N.L. Evenhuis, BPBM
Diptera	Drosophilidae	20	40–60	D. Grimaldi, AMNH
Diptera	Lauxaniidae	21	40–50	S. Gaimari, CDFA
Diptera	Pipunculidae	1	20–25	J. Skevington, CNC
Diptera	Sphaeroceridae	1	100	S. Marshall, Univ. Guelph
Diptera	Stratiomyidae	21	20–25	N.E. Woodley, USDA-SEL
Diptera	Syrphidae	12	12	F.C. Thompson, USDA-SEL
Heteroptera	aquatic	15	15–20	D.A. Polhemus, SI
Hymenoptera	Ichneumonidae	57	100	A. Bennett, CNC
Hymenoptera	aculeates	40	15–20	F. Parker, retired; J. Pitts, USU
Hymenoptera	Formicidae	70	20–30	E. Sarnat, UC Davis
Spiders	Tetragnathidae	4	15	R. Gillespie, UCB
Spiders	Theridiidae	4	15	R. Gillespie, UCB
Spiders	Araneidae	6	22	R. Gillespie, UCB

10. *Winkler funnel extractions*.— Leaf litter samples will be taken at collection sites mainly for ants and spiders. These samples will be placed in Winkler funnels for extraction of leaf litter invertebrates into alcohol.

11. *Beating sheets*.—Beating sheets (a small canvas in a portable frame) will be used to extract small arthropods from vegetation that otherwise could be missed in other collecting methods such as fogging and aerial sweeping. This method will be used mainly for coleopterans.

Taxonomic Scope and Participants

The focus groups (Table 2) have been selected for comprehensive collecting and systematic description and analysis. These groups are currently known through existing Fijian collections to have a high degree of biodiversity in Fiji and also will act as excellent subjects in testing levels of endemism and in comparisons with other oceanic island groups. In addition, their known faunal constituency in other nearby areas will allow testing of hypotheses concerning origins of the Fijian fauna.

Specimen Processing/Deposition

Specimens collected will be sorted and processed by local parataxonomists in Fiji associated with this project (Fig. 11) and specimens of selected taxonomic focus groups will be sent to specialists for identification and description. A two-week intensive training workshop will be conducted by project specialists to enable parataxonomists to quickly identify selected focus groups being studied in this project. This workshop will include pictorial keys and other identification aids as well as specific techniques needed to collect, process, and curate specimens of each focus group before sending them to Bishop Mu-

Figure 11. Sorting center at Ministry of Forestry laboratory facility, Colo-i-Suva, Fiji. Photo N.L. Evenhuis.

seum where they will be collated by focal taxon and sent to specialists. All specimens will be processed at the Fijian Ministry of Fisheries and Forestry's Forestry Institute in Colo-i-Suva on Viti Levu (MAFF) (Fig. 7). Preservation of specimens will primarily be in alcohol and long-term storage of any remaining trapping residues after sorting focal groups will be at the Bishop Museum. Vouchers of selected specimens will be transferred immediately upon collection to 95% ETOH and frozen for any future molecular studies. Molecular workers will be identified before collection so that shipment to these persons of preserved specimens can be made immediately upon collection. Types of new species will be returned to Fiji once a suitable facility is in place to permanently house type specimens. Identified material will be in the Bishop Museum, Honolulu, with voucher material deposited at MAFF and other museums.

Data Management

All specimens sorted and identified will be databased using Mandala 5.3 (Kampmeier 2002), currently the standard database for processing data and specimens for the NSF-funded therevid PEET project (Mike Irwin, PI). The database team will attend a hands-on week-long training session, conducted by the database coordinator (Kampmeier), the trained collections and database manager, and one other member of the NSF-team. The databasers will enter locality, specimen, and taxon names (identifications only to focal taxon) data. The collections and database manager will ensure consistency and integrity of the data entered into the database. A special feature of this project is that a web interface will be built to allow specialists around the world access to the database. The collaborating specialists can easily enter definitive identifications, sexes of the specimens, data on dissections and molecular analyses of given specimens, and depository information directly into the database via the secure web interface, thus increasing the accuracy of the input data and reducing the time and cost of this input process. This will also allow collaborating specialists direct, immediate access to the entire database. Versions of the Fijian arthropod database also will be accessible to the general public on the World Wide Web during the course of the project.

Checklist and Bibliography

Following the protocol for island biotic surveys standardized by the Hawaii Biological Survey, a database of published records of taxa occurring on Fiji will be compiled from all available literature pertaining to the terrestrial arthropod fauna of Fiji. Most of this literature is currently available in the Bishop Museum, thus this work will be centralized there. This draft information will be made available on the World Wide Web for review and reference for project personnel. From this template of information, project specialists and other scientists will then be able to assess current knowledge of the fauna and make additions and corrections to the current checklist. A final checklist and bibliography will be made available in both hard copy and electronically with the database posted publicly on the World Wide Web following the same procedure as has been done previously for Hawai‘i (Nishida 2002) and Samoa (Kami & Miller 1998).

Publication of Results

New taxa of focal groups found during this survey and via the PABITRA project collecting will be described throughout the project. Publication will be through *Fiji Arthropods*, which is a peer-reviewed journal with quick turn-around time from submission to publication (usually less than one month). Access to these publications will be made available to the general public via pdf file download from the World Wide Web. Non-focal group taxa will be sent to specialists who have indicated interest in working up this material as part of their ongoing revisionary work on those groups.

EXPECTED RESULTS

Database/Bibliographies/Checklists

Specimen Database/Checklist/Bibliography. A complete checklist of the terrestrial arthropods based on the literature and the current project will be made available as hard copy and on the World Wide Web. Concurrently, an associated bibliography of Fijian arthropods will be published and also made available on the World Wide Web.

Refereed Publications. Publications of new taxa resulting from this study will be made throughout the term of the project, primarily being published in the peer-reviewed series *Fiji Arthropods*, published by Bishop Museum Press.

Web-Access to information All information resulting from this project will be made available on the World Wide Web so as to disseminate information to the widest user community possible. This will include descriptions and associated images, checklists, bibliographies, etc.

PROJECT SIGNIFICANCE

Increased Knowledge and Understanding of Areas of Endemism

The Pacific Ocean contains numerous island archipelagoes with a wide range of physical attributes and habitats. Fiji is the largest and most diverse island group in western Polynesia. The rather limited data on the Fijian arthropod fauna suggest that it is both a center of endemicity and a biotic source area for eastern Polynesia and much of Micronesia. Detailed systematic study of the chosen arthropod taxa will facilitate our understanding of Fijian fauna and its role in the biogeography of the central Pacific.

Comparison of Levels of Biodiversity on Islands

We have a good understanding of the arthropod fauna of some Pacific island groups (e.g., Hawai‘i, Samoa, New Zealand). This allows us to make comparisons and predictions using the Fijian fauna, incorporating such parameters such as area, climate, elevation, geological age and proximity to source areas. Knowledge of major components of the Fijian arthropod fauna will thereby provide a basis for further investigation and testing of the theory of island biogeography. We expect that the geocoded locality data we will be obtaining via GPS at each site and associated with taxa can be used as as a potential GIS layer for future analysis.

Native Peoples Embracing Their Natural Heritage

Native Pacific Islanders are an under-represented and under-funded group in the sciences. We see this project as a unique opportunity to allow the growth and development of native Pacific Islanders in a training and educational program that will help them understand better the natural resources surrounding them. The educational/training aspects of this project will be conducted in a fashion that is sensitive to the needs and traditions of the native Fijian peoples. By involving the local people in this project, educating them via training and community meetings while also listening to their stories of the environment, they have the opportunity to be empowered with the potential for decision-making with regard to their natural resources. By doing so we hope that they will embrace their natural heritage and provide for a sustained environment for their future generations.

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Preliminary Checklist of the Tipuloidea (Diptera) of Fiji, with New Combinations[1,2]

Neal L. Evenhuis
Pacific Biological Survey, Bishop Museum, 1525 Bernice Street, Honolulu, Hawaii 96817-2704, USA: email: neale@bishopmuseum.org

Abstract. In keeping with the family classification standards developed by the Biosystematic Database of World Diptera, the known Tipulidae (*s. lat.*) of Fiji are separated into Tipulidae and Limoniidae. The subgenera of *Limonia* recorded from Fiji are raised to generic status resulting in the following 16 new combinations: *Degeneromyia thais* Alexander, **n. comb**. (from *Limonia*), *Doaneomyia fijiensis* Alexander, **n. comb**. (from *Limonia*), *Geranomyia vitiella* Alexander, **n. comb**. (from *Limonia*), *Goniodineura apsellia* Alexander, **n. comb**. (from *Limonia*), *G. kraussiana* Alexander, **n. comb**. (from *Limonia*), *G. lacrimula* Alexander, **n. comb**. (from *Limonia*), *G. veitchi* Alexander, **n. comb**. (from *Limonia*), *Libnotes colossa* Alexander, **n. comb**. (from *Limonia*), *Limnobia vitiana* Alexander, **n. comb**. (from *Limonia*), *Metalibnotes fijiensis* Alexander, **n. comb**. (from *Limonia*), *M. persetosa persetosa* Alexander, **n. comb**. (from *Limonia*), *M. persetosa decemsetosa* Alexander, **n. comb**. (from *Limonia*), *Nealexandriaria anisota* Alexander, **n. comb**. (from *Limonia*), *N. ochricapilla* Alexander, **n. comb**. (from *Limonia*), *Thrypticomyia substaltens* Alexander, **n. comb**. (from *Limonia*). A checklist of the known Tipulidae and Limoniidae of Fiji is presented.

The latest catalog that enumerates the Diptera found in Fiji is Evenhuis (1989). In that work, Tipulidae were considered as one family. Recent phylogenetic evidence (Theowald & Oosterbroek, 1991; Oosterbroek & Courtney, 1995) has shown the Tipulidae *s. lat.* to be represented by four families: Cylindrotomidae, Tipulidae, Pedicidiidae, and Limoniidae. This classification has been adopted by the Biosystematic Database of World Diptera (Thompson, 2004) and is followed here. This change in family classification has been reflected in regional surveys and checklists ongoing in the Pacific (e.g., Hawai‘i: Evenhuis, 2003; Tahiti: Englund, 2004) and the change is formally made here for Fiji.

In Fiji, only two of the tipuloid families have been discovered thus far (Tipulidae, and Limoniidae). Further rigorous surveying in different parts of Fiji may reveal the presence of the Pedicidiidae (thus far, found in the Pacific mainly in New Zealand) and Cylindrotomidae (known in the Pacific from New Guinea and Australia). The listing below follows the treatment of these separate families as well as the concept of genera within these families by recent catalogers. As a result of following the generic concepts of these works as well as those of contemporary European specialists, the subgenera of *Limonia* Meigen are here recognized as separate genera. This results in several new combinations for species formally described in *Limonia* (*s. lat*.).

Tipulidae are represented in Fiji by 5 known species (all endemic to Fiji) in 1 genus; Limoniidae are represented by 58 known species (78% endemic; 45 spp.) in 22 genera. Limoniidae currently is the most speciose family of Diptera known from Fiji.

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1. Contribution No. 2005-002 to the NSF-Fiji Arthropod Survey.
2. Contribution No. 2005-004 to the Pacific Biological Survey.

Table 1. **Checklist of Tipuloidea of Fiji**.

Family Tipulidae

Holorusia Loew, 1863
- *Holorusia degeneri* Alexander, 1978*
- *Holorusia fijiensis* Alexander, 1921*
- *Holorusia lepida* Alexander, 1924*
- *Holorusia vitiana* Alexander, 1978*
- *Holorusia walkeriana* (Alexander, 1924)*

Family Limoniidae

Degeneromyia Alexander, 1956, **n. stat**.
- *Degeneromyia thais* (Alexander, 1956), **n. comb**.*

Dicranomyia Stephens, 1829
- *Dicranomyia fijiana* Alexander, 1924
- *Dicranomyia fullawayi* Alexander, 1915
- *Dicranomyia illingworthi* Alexander, 1914
- *Dicranomyia sordida* Brunetti, 1912

Doaneomyia Alexander, 1921
- *Doaneomyia fijicola* (Alexander, 1953), **n. comb**.*

Geranomyia Haliday, 1833
- *Geranomyia vitiella* (Alexander, 1956), **n. comb**.*

Goniodineura Wulp, 1896
- *Goniodineura apsellia* (Alexander, 1978), **n. comb**.*
- *Goniodineura kraussiana* (Alexander, 1972), **n. comb**.*
- *Goniodineura lacrimula* (Alexander, 1956), **n. comb**.*
- *Goniodineura veitchi* (Alexander, 1924), **n. comb**.*

Helius Lepeletier & Serville, 1828
- *Eurhamphidia* Alexander, 1915
  - *Helius* (*Eurhamphidia*) *perlongatus* Alexander, 1978*
  - *Helius* (*Eurhamphidia*) *perlongatus vitiensis* Alexander, 1956*

Idioglochina Alexander, 1921
- *Idioglochina* sp.*

Libnotes Westwood, 1876
- *Libnotes colossa* (Alexander, 1971), **n. comb**.
- *Libnotes greenwoodi* Alexander, 1924*

Limnobia Meigen, 1818
- *Limnobia perkinsi* Grimshaw, 1901
- *Limnobia strigivena* Walker, 1861
- *Limnobia vitiana* (Alexander, 1956), **n. comb**.*

Limonia Meigen, 1803
- *Limonia bipendula* Alexander, 1978*
- *Limonia dactylolabis* (Alexander, 1921)*
- *Limonia perextensa* Alexander, 1971*
- *Limonia prolixisetosa* Alexander, 1971*
- *Limonia stoneri* Alexander, 1925
- *Limonia viticola* Alexander, 1978

Metalibnotes Alexander, 1972, **n. stat**.
- *Metalibnotes fijiensis* (Alexander, 1914), **n. comb**.*
- *Metalibnotes persetosa persetosa* (Alexander, 1956), **n. comb**.*
- *Metalibnotes persetosa decemsetosa* (Alexander, 1956), **n. comb**.*
- *Metalibnotes veitchiana* (Edwards, 1924), **n. comb**.*

Nealexandriaria Alexander, 1967
- *Nealexandriaria anisota* (Alexander, 1973), **n. comb**.*
- *Nealexandriaria ochricapilla* (Alexander, 1956)*

Table 1 (continued).

Orimarga Osten Sacken, 1869
Orimarga carnosa Alexander, 1956*
Orimarga niveibasis Alexander, 1956*
Orimarga sanguinicolour Alexander, 1956*
Thrypticomyia Skuse, 1890, **n. stat**.
Thrypticomyia subsaltens (Alexander, 1924), **n. comb**.*
Conosia Wulp, 1880
Conosia insularis Alexander, 1942
Conosia irrorata Wiedemann, 1828
Cheilotrichia Rossi, 1848
Empeda Osten Sacken, 1869
Cheilotrichia (*Empeda*) *zimmermani* Alexander, 1971*
Erioptera Meigen, 1803
Erioptera Meigen, 1803
Erioptera (*Erioptera*) *oceanica* Alexander, 1914*
Meterioptera Alexander, 1934
Erioptera (*Meterioptera*) sp.*
Gonomyia Meigen, 1818
Gonomyia Meigen, 1818
Gonomyia (*Gonomyia*) *varipes* Alexander, 1914*
Lipophleps Bergroth, 1915
Gonomyia (*Lipophleps*) *degeneri* Alexander, 1956*
Gonomyia (*Lipophleps*) *digitifera* Alexander, 1924*
Gonomyia (*Lipophleps*) *fijiensis* Alexander, 1914*
Gonomyia (*Lipophleps*) *kraussi* Alexander, 1956*
Gonomyia (*Lipophleps*) *pietatis* Alexander, 1940
Gonomyia (*Lipophleps*) *vanuana* Alexander, 1956*
Gonomyia (*Lipophleps*) *victorina* Alexander, 1956*
Gonomyia (*Lipophleps*) *zimmermani* Alexander, 1956*
Riedelomyia Alexander, 1928
Riedelomyia teucholabina Alexander, 1921*
Styringomyia Loew, 1845
Styringomyia didyma Grimshaw, 1901
Styringomyia fumosa Edwards, 1924*
Toxorhina Loew, 1850
Eutoxorhina Alexander, 1934
Toxorhina (*Eutoxorhina*) *simplex* Alexander, 1934*
Toxorhina Loew, 1850
Toxorhina (*Toxorhina*) *basiseta* Alexander, 1978*
Toxorhina (*Toxorhina*) *noeliana* Alexander, 1956*
Toxorhina (*Toxorhina*) *perproducta* Alexander, 1956*
Trentepohlia Bigot, 1854
Mongoma Westwood, 1881
Trentepohlia (*Mongoma*) *brevicellula* Alexander, 1924
Trentepohlia (*Mongoma*) *monacantha* Alexander, 1978*
Trentepohlia (*Mongoma*) *parvicellula* Alexander, 1973*
Trentepohlia Bigot, 1854
Trentepohlia (*Trentepohlia*) *fijiensis* (Alexander, 1914)*

* species endemic to Fiji.

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New *Cymatopus* (Diptera: Dolichopodidae) from Fiji and Related Areas, With Notes on Described Species[1,2]

Neal L. Evenhuis
Pacific Biological Survey, Bishop Museum, 1525 Bernice Street, Honolulu, Hawai'i 96817-2704, USA; email: neale@bishopmuseum.org

Abstract. Four new species of *Cymatopus*: *C. baravikai*, **n. sp** (Fiji), *C. flavipes*, **n. sp**. (New Caledonia), *C. neocaledonicus*, **n. sp**. (New Caledonia), and *C. othniopteryx*, **n. sp** (East Timor) are described and illustrated. New distributional records are given for *C. leopoldi, C. simplex, C. calcaratoides,* and *C. tibialis*.

INTRODUCTION

Cymatopus Kertész comprises species of moderately sized dolichopodids commonly found along the rocky coastlines of Indo-Pacific countries, with many species possessing a striking array of male secondary sexual characters (MSSC). Grootaert (2003) asserted that as many as 33 primary and secondary sexual characters can be recognized within the genus.

Meuffels & Grootaert (1984) and Grootaert & Meuffels (1993, 2001) give the latest treatments of the genus. Additionally, Evenhuis & Grootaert (2002) provided some new distributional records. In the,1984, 1993, and 2001 articles, keys to species are given, 4 species newly described, and behavioral notes given for a few species. This paper describes and illustrates an additional 4 species, bringing the total number of species worldwide to fourteen.

MATERIALS AND METHODS

Material was examined in, borrowed from, or deposited in the following institutions: Australian Museum, Sydney (AMS); Australian National Insect Collection, CSIRO, Canberra (ANIC), the Natural History Museum, London (BMNH), Bishop Museum, Honolulu (BPBM), California Academy of Sciences, San Francisco (CAS), Canadian National Collection, Ottawa (CNC), Hungarian Natural History Museum, Budapest (HNHM), Illinois Natural History Survey, Champaign (INHS), Ministry of Forestry Entomological Laboratory, Colo-i-Suva (MAFF),Montana State University, Bozeman (MTEC), Museum National d'Histoire Naturelle, Paris (MNHN), New Zealand Arthropod Collection, Auckland (NZAC), Royal Belgian Institute of Natural Sciences, Brussels (RBINS), University of Queensland, St. Lucia (UQIC).

Morphological terminology and abbreviations follow Bickel (1994). Leg measurements are all at the same scale.

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1. Contribution No. 2005-003 to the NSF-Fiji Arthropod Survey.
2. Contribution No. 2005-005 to the Pacific Biological Survey.

SYSTEMATICS

Key to Indo-Pacific Species of *Cymatopus* Kertész based on males[3]

1. Wing modified, with deep sulcus on hind margin (Figs. 2, 3) 2
–. Wing unmodified in shape (cf. Fig. 1) 3

2. Hind region of wing distal to sulcus with field of microtrichiae; border with fringe of long hairs (Fig. 2); fore tarsi modified... (SE Asia) .... **malayensis** Parent
–. Hind region of wing distal to sulcus without field of microtrichia; border without fringe (Fig. 3); fore tarsi without modifications .... (East Timor) .... **othniopteryx**, n. sp.

3. Hypopygium exposed; cerci long, narrow 4
–. Hypopygium small, concealed in postabdomen; cerci and other appendages hidden .... (Samoa) .... **spinosus** (Parent)

4. Tibia I without modified hairs or bristles on medial surface; body length usually less than 2.5 mm 5
–. Tibia I with modified hairs or bristles, or otherwise ornamented on medial surface; body length usually more than 2.5 mm 7

5. Tibiae II and III without long hairs; It4 and It5 flattened 6
–. Tibiae II and III with long hairs toward apex; cerci black, with black hairs; It4 and It5 not flattened ... (Christmas I. [Indian Ocean]) .... **longipilus** Parent

6. Coxa I yellow; hypopygium symmetrical; surstylus with conspicuous hook-shaped bristle .... **flavipes**, n. sp.
–. Coxa I black; hypopygium asymmetrical; surstylus without conspicuous hook-shaped bristle (Fig. 15) ... (Australia) .... **simplex** Parent

7. Tibia I with long preapical lobe 8
–. Tibia I with, at most, short or triangular preapical lobe 9

8. Tibia I with black, foliate, modified bristle on anterior distal surface; It5 flattened, length 1.5 x It4 ... (New Guinea, Australia) .... **calcaratoides** Grootaert & Meuffels
—. Tibia I without modified setae or bristles on anterior surface; It5 not flattened, length subequal to It4 ... (Christmas I [Indian Ocean]) .... **calcaratus** Parent

9. Tibia I with modified setae or bristles on medial surface without concavity or swollen area medially.. 10
—. Tibia I without such bristles or setae on medial surface 12

10. Tibia I with bump or swollen area just beyond midpoint on ventral surface (Fig. 11) ... (New Caledonia) .... **neocaledonicus**, n. sp.
—. Tibia I without swollen area 11

11. Tibia I with strong, black, foliate, modified seta on medial surface; with hyaline, pectinate comb apically .... **thaicus** Grootaert & Meuffels
—. Tibia I with three, curved black bristles distomedially; without pectinate comb apically .... **leopoldi** Meuffels & Grootaert

3. I agree with Grootaert & Meuffels (1993) that *setosus* Curran, *cheesmani* (Parent), *bredini* Robinson, and *wirthi* Robinson should be removed from *Cymatopus*. I here treat them as of uncertain generic placement until more research can be conducted to ascertain their generic position.

12. Tibia I with concavity at basal one-third (Fig. 5) bordered basally by protuberance bearing three strong black bristles ... (Fiji) .... **baravikai**, n. sp.
—. Tibia I without such a concavity 13

13. Tibia I with pectinate comb apically; It4 with comb of long, curved setae ...... **tibialis** Kertész
—. Tibia I without pectinate comb apically; It4 without modified setae ....
.... **motuporensis** Grootaert & Meuffels

Cymatopus baravikai Evenhuis**, new species**
(Figs. 4–6)

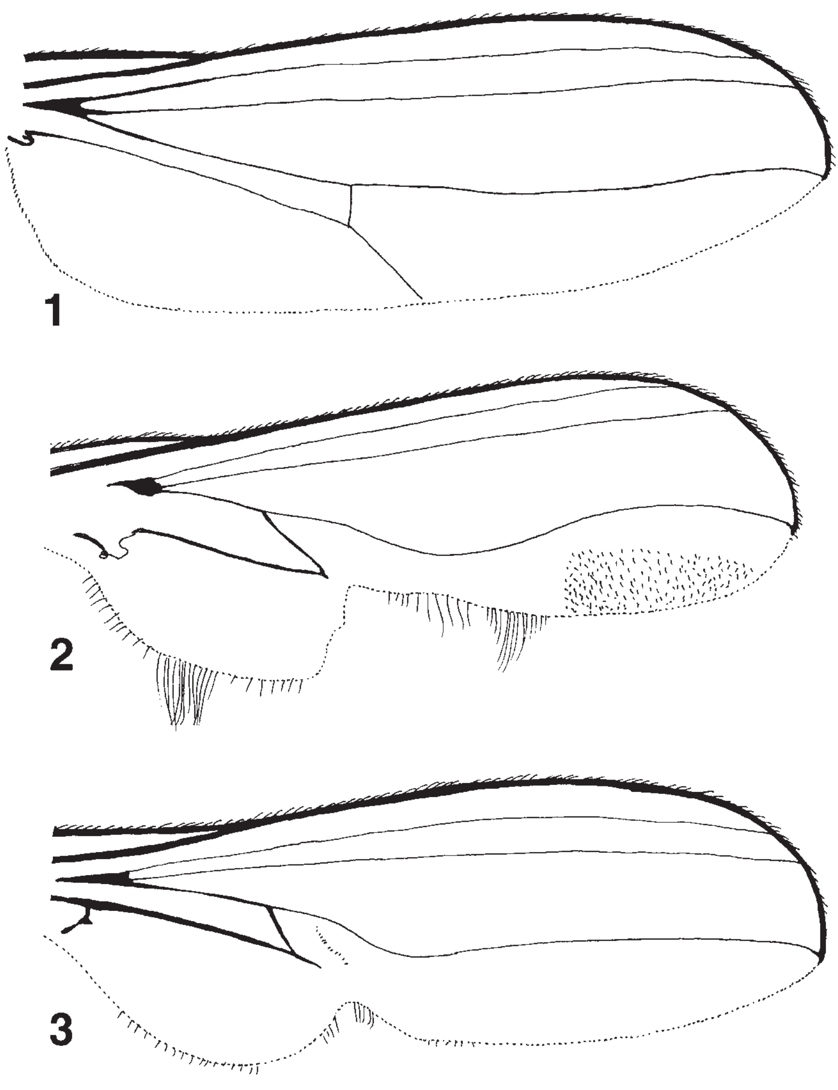
Diagnosis. This species is most similar in appearance to *C. neocaledonicus*, n. sp., from which it can be separated, in males, by the presence of a concavity on the basal third of tibia I (this concavity absent in *neocaledonicus*).

Description. Male. Length: Body: 3.9–5.4 mm; wing 3.7–4.4 mm. *Head*. Frons and face grayish- black, gray pollinose; clypeus slightly protruding. Face width 1.5 times width of first flagellomere. Palpus grayish brown, with 10–12 black hairs, 1 long hair apically, as long as palpus, bristles absent. Mouthparts brown. Occiput black, with long, brownish hairs ventrally; pair of long ocellars and shorter fronto-oribitals just above antennal sockets; pair of minute postocellars; pair of converging postverticals. Upper postoculars uniseriate, black; lower postoculars multiseriate. Antenna (Fig. 4) black; first flagellomere short, conical, slightly higher than long. Arista apical, 3 times length of first three antennal segments.

Thorax. Mesonotum brownish black, gray pollinose; pleura gray, gray pollinose. No acrostichals, 5 dorsocentrals, 1 short humeral, 1 long posthumeral, 3 short propleurals; 1 notopleural, 3 supraalars, 1 long postalar. Scutellum grayish black, with pair of long converging scutellars, minute hair lateral to each scutellar.

Legs. Black except apex of femur I and base of tibia I brownish orange and all of trochanter I yellow. Claws black, pulvilli as long as claws. *Fore leg* (Fig. 5): lengths (femur, tibia, and tarsi): 43: 37: 30: 15: 10: 11: 7. Coxa I with row of about 3–4 strong black bristles basally, patch of shorter finer hairs basomedially, 8–10 long hairs apically. Trochanter I bare. Femur I widest at base, tapering evenly to apex, basal width ca. 1/3 length of coxa I; basoventrally with 4–5 strong thick black spatulate bristles on lateral surface; 2 rows of long black hairs along basal 3/4 of ventromedial surface; anterodorsal surface with short hairs distributed evenly along surface; 1–2 small preapical bristles. Tibia I subequal in length to femur, with concavity on basal 3/5, with 4–5 strong black, slightly curved bristles on basomesal prominence, basalmost bristle clavate, remainder pointed apically; concavity with 1 strong black bristle basomesally, 1 strong black bristle apicomesally; numerous strong short spiky bristles along ventral surface; clear, pectinate comb preapically; short hairs on posterolateral and dorsal surfaces. It1 shorter than tibia, with 2-3 short, strong black hairs at extreme base near juncture with tibia, 2–3 strong, short black bristles at mid-level on anteromesal surface, row of short, straight hairs on anterior surface, finer curved hairs on lateral surface. It2 and It3 unmodified; It4 slightly flared. It5 flared. *Mid leg*. Lengths (femur, tibia, tarsi): 52: 57: 35: 17: 8: 6: 4. Coxa II with two black lateral bristles. Trochanter brown with short black hairs. Femur II without strong bristles, numerous short posteroventral and preapical setae. Tibia II subequal in length to femur, unmodified. Tarsi unmodified. *Hind leg*. Lengths (femur, tibia, tarsi): 65: 60: 40: 22: 13: 8: 8. Coxa and trochanter III bare. Femur III conspicuously bowed mesally, without strong bristles. Tibia III with 3 preapical bristles.

Wing (cf. Fig. 1). Slightly infuscated brownish, veins brown; costa ends just beyond vein M_{1+2}; vein M_{1+2} slightly undulate; R_1 and R_{2+3} slightly converging at wing margin; R_{2+3} and M_{1+2} subparallel. Crossvein m-cu short, oblique, 1/3 length of apical part of M_{3+4}. Anal vein absent. Halter stem darker basally, otherwise halter stem and knob yellowish white. Squama yellowish white with fringe of long white hairs.



Figs. 1–3. Wings of male *Cymatopus*. **1**. *C. neocaledonicus*, n. sp. **2**. *C. malayensis* Parent. **3**. *C. othniopteryx*, n. sp.

Abdomen. Brownish black, gray pollinose laterally on tergites II–V. Tergal hairs and setae very short, black. Sixth sternum with yellowish caudal appendages flared apically (cf. Fig. 9).

Genitalia (Fig. 6). Hypopygium small, sessile, gray. Cercus rod-like, with long hairs on all surfaces, longest apically. Hypandrium (Fig. 6c) brown, strongly bifid apically. Hook-shaped bristle on surstylus subapical; surstylus with long, mesally directed prominence bearing strong apical spine.

Female. As in male except for the following: Face broader, slightly wider than width of first antennal flagellomere. Legs more brownish on segments that are black in male. Femur I with 4–5 long strong black hairs basoventrally, with 3 strong bristles anteroventrally. All other segments unmodified.

Types. Holotype ♂ (BPBM 16,559, FBA 001801) and 3♂, 11♀ paratypes from: FIJI: **Viti Levu**: Suva Province: Suva Point, Laucala Bay, 18°08'S, 178°26'E, 28 Oct 2004, N.L. Evenhuis, D.J. Bickel, M. Tokota'a, intertidal rocks. **Other paratypes**: FIJI: **Viti Levu**: 8♂, 18♀, Naqara Island, 22 Jan 2005, sweeping rocky shore near mangroves, N.L. Evenhuis, D.J. Bickel (BPBM); 17♂, 10♀, 8 km. E. Korotogo, 8 Jun 1988, R. Hurley (MTEC). **Taveuni**: Caukadrove Province: 3♂, 4♀, Taveuni Estates, along marine shoreline at high tide, 16°50'S, 179°59'E, 26 Sep 2002, E.I. Schlinger, M. Tokota'a (FBA 001802–001815) (BPBM). Lau Is: 3♀, **Koroni I**, intertidal rocks, 4 Jul 1977, J.D. Dugdale (NZAC). **Ovalau**: 1♀, Levuka, 0–200 m, Feb 1972, N.L.H. Krauss (BPBM). Holotype in BPBM. Paratypes in BPBM, CAS, CNC, MAFF, MTEC, NZAC, and AMS.

Remarks. Specimens on Viti Levu were collected by sweeping with nets over barnacle-covered intertidal rocks and by hand collecting specimens with plastic vials on the interstices of the vertical rock faces near the shoreline.

Etymology. The specific epithet derives from the Fijian, *baravi* [= shore] + *kai* [= inhabitant], referring to the marine shoreline habitat of this species.

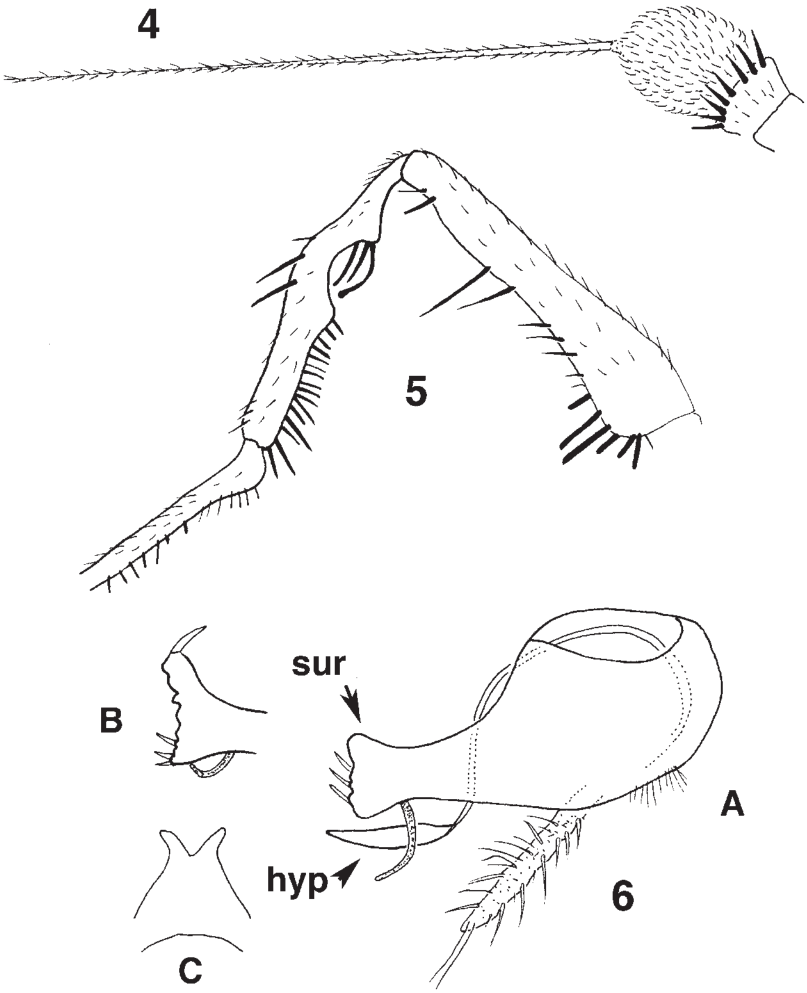
Cymatopus flavipes Evenhuis, **new species**
(Figs. 7–10)

Diagnosis. Similar to *C. simplex* and *C. longipilus* in not having modified bristles or setae on the medial surface of tibia I, but is easily distinguished from those two species by yellow coxa of the foreleg.

Description. Male. Length: Body: 2.6–3.3 mm; wing 2.5–3.0 mm. *Head*. Frons and face grayish brown, gray pollinose; clypeus tan, slightly protruding. Face width 3/4 width of first flagellomere. Palpus gray with 12–14 black hairs evenly spaced, 1 long hair apically, as long as palpus, bristles absent. Mouthparts brown. Occiput black, gay pollinose, with sparse long black hairs ventrally; pair of long ocellars and shorter fronto-oribitals just above antennal sockets; pair of minute postocellars; pair of converging postverticals. Postoculars uniseriate, black. Antenna (Fig. 7) yellow to brownish black; first flagellomere, conical, length 2 x height. Arista apical, 2.5 x length of first three antennal segments.

Thorax. Mesonotum grayish brown, gray pollinose; pleura gray, gray pollinose. No acrostichals, 5 dorsocentrals, 1 short humeral, 1 long posthumeral, 2 short propleurals; 1 notopleural, 3 supraalars, 1 long postalar. Scutellum gray, gray pollinose, with pair of long converging scutellars, minute hair anterolaterad of each scutellar.

Legs. Legs with coxa I and all femora yellow, coxae II and III brownish orange to grayish black, tibiae and tarsi brown. Claws black, pulvilli as long as claws. *Fore leg* (Fig. 8): lengths (femur, tibia, and tarsi): 34: 25: 29: 14: 11: 5: 5. Coxa I with row of about 4 strong black bristles basally, 8–10 finer hairs on apical 1/2, 2–3 apical setae. Trochanter I with 4–5 very small, weak hairs. Femur I widest at base, tapering evenly to apex, basal width ca. 1/3 length of coxa I; ventrally with row strong thick black bristles on lateral surface, 2 rows of long black hairs along apical 3/4 of ventromedial surface; anterodorsal surface with short hairs distributed evenly along surface; 1–2 small preapical bristles. Tibia I shorter than femur, slightly bent basally, strong short spiky bristles on apical 1/2 of ventral surface; clear, pectinate comb preapically; strong black preapical setae not borne on lobe. It1 longer than tibia, with 3–4 very short, strong black hairs at extreme base near juncture of tibia, 2 rows of



Figs. 4–6. *Cymatopus baravikai*, n. sp., male. **4**. Antenna. **5**. Fore femur, tibia, and base of first tarsal segment. **6**. Male genitalia; **a**. hypopygium, lateral view; **b**. detail of surstylus, dorsal view; **c**. apex of hypandrium, ventral view. Abbreviations: hyp = hypandrium; sur = surstylus.

short, straight hairs on anteromesal surface, finer curved hairs on lateral surface. It2, It3, and It4 unmodified. It5 flattened, length ca. 3 x width. *Mid leg*. Lengths (femur, tibia, tarsi): 49: 49: 29: 15: 10: 6: 6. Coxa II with two black lateral bristles. Trochanter yellow with a few short black hairs. Femur II without strong bristles, numerous short, posteroventral setae, 1 preapical seta. Tibia II subequal in length to femur, unmodified, with 1 preapical seta. Tarsi unmodified. *Hind leg*. Lengths (femur, tibia, tarsi): 64: 47: 33: 19: 10: 6: 6. Coxa III with 2 lateral setae. Trochanter III bare. Femur III conspicuously bowed anteriorly, without strong bristles. Tibia III and tarsi unmodified.

Wing (cf. Fig. 1). As in *baravikai*, n. sp. Halter stem yellow basally, otherwise halter stem and knob white. Squama yellowish white with fringe of long brown hairs.

Abdomen. Grayish brown, gray pollinose laterally on tergites II–V. Tergal hairs and setae very short, black. Fourth sternum with lateral spicules. Sixth sternum with yellowish caudal appendages flared apically (Fig. 9).

Genitalia (Fig. 10). Hypopygium small, sessile, gray. Cercus slender, long hairs restricted to lateral surface. Hypandrium (10B,C) shining brown, laterally with spine-like bristle (Fig. 10B); hook shaped bristle of surstylus placed subapically, surstylus curved mesally, with short mesally directed spine at apex.

Female. As in male except for MSSC of legs.

Types. Holotype ♂ and 8♂♀ paratypes from: **NEW CALEDONIA**: Plage de Poé, 5 km W. Bourail, 5 Jul 1995, B.J. Sinclair. **Other Paratypes**: **NEW CALEDONIA**: 5♂♀, Mou, 0 m, on tidal rocks, 3 Dec 1990, D.J. Bickel (AMS); 23♂♀, Tembla, beach area, 22 Nov 1992, E. & M. Schlinger (INHS); 18 ♂♀, 4 km. S. Poindimie, 7 Mar 1978, E.I. Schlinger; 1♀, Poro Beach area, 7 Mar 1978, E.I. Schlinger (INHS). Holotype in MNHN. Paratypes in AMS, INHS, BPBM, and MNHN.

Etymology. The specific epithet derives from the Latin, *flavus* [= yellow] + *pedis* [= leg, foot], referring to the characteristic yellow legs of both males and females of this species.

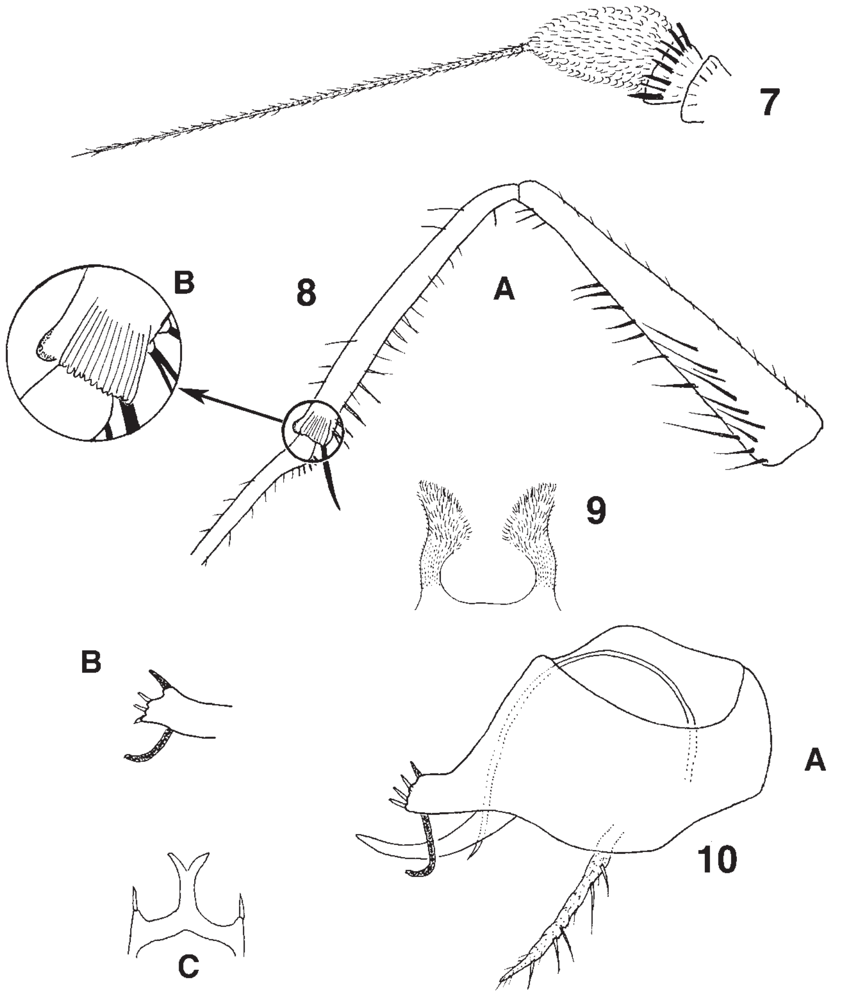
Cymatopus neocaledonicus Evenhuis**, new species**
(Figs. 11–13)

Diagnosis. Most similar to *C. baravikai*, n. sp., but can be easily distinguished by the absence of a concavity on tibia I (present in *C. baravikai*) and the presence of a swollen area at mid point ventrally on tibia I (absent in *C. baravikai*). *Cymatopus neocaledonicus* can be easily separated from the only other species of the genus from New Caledonia, *C. plautinus*, n. sp. by the black legs (these legs yellow in *C. plautinus*).

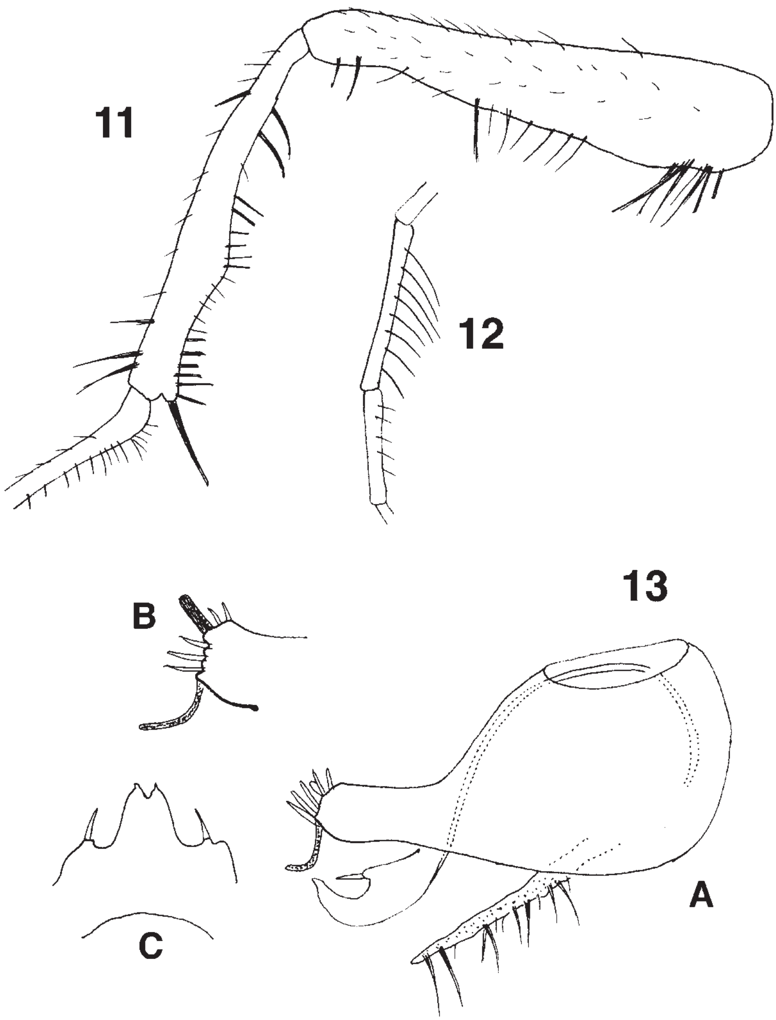
Description. Male. Length: Body: 4.0–4.5 mm; wing 3.4–3.6 mm. *Head*. Frons and face grayish -black, silvery pollinose; clypeus slightly protruding. Face width 1.5 times width of first flagellomere. Palpus grayish brown with 10–12 black hairs, 1–2 long hairs apically, as long as palpus, bristles absent. Mouthparts brown. Occiput black, with long black hairs ventrally; pair of long ocellars and shorter fronto-oribitals just above antennal sockets; pair of minute postocellars; pair of converging postverticals. Upper postoculars uniseriate, black; lower postoculars multiseriate. Antenna (cf. Fig. 4) black; first flagellomere short, conical, length subequal to height. Arista apical, 2.5 x length of first three antennal segments.

Thorax. Mesonotum brownish black, gray pollinose; pleura gray, gray pollinose. No acrostichals, 5 dorsocentrals, 1 short humeral, 1 long posthumeral, 3 short propleurals; 2 notopleurals, 3 supraalars, 1 long postalar. Scutellum grayish -black, with pair of long converging scutellars, short hair 1/3 length of scutellars laterad of each scutellar.

Legs. Black except trochanter I brownish yellow. Claws black, pulvilli as long as claws. *Fore leg* (Fig. 11–12): lengths (femur, tibia, and tarsi): 46: 40: 40: 21: 14: 10: 10. Coxa I with row of about 4–5 strong black hairs on basal 3/4, patch of 8–10 short hairs apically. Trochanter I bare. Femur I (Fig. 11) widest at base, tapering evenly to apex, basal width ca. 1/3 length of coxa I; basoventrally with 4–5 thick black hairs on lateral surface, 2 rows of long black hairs along basal 3/4 of anteroventral surface; short hairs distributed evenly along anterodorsal surface; apical portion of lateral surface



Figs. 7–10. *Cymatopus flavipes*, n. sp., male. **7**. Antenna. **8**. **a**. Fore femur, tibia, and base of first tarsal segment. b. Detail of apex of fore tibia. **9**. Caudal appendages of sixth sternum. **10**. Male genitalia; **a**. hypopygium, lateral view; **b**. detail of surstylus, dorsal view; **c**. apex of hypandrium, ventral view.



Figs. 11–13. *Cymatopus neocaledonicus*, n. sp., male. **11**. Fore femur, tibia, and base of first tarsal segment. **12**. Second and third tarsal segments of foreleg. **13**. Male genitalia; **a**. hypopygium, lateral view; **b**. detail of surstylus, dorsal view; **c**. apex of hypandrium, ventral view.

with 4–6 strong black hairs; 1–2 small preapical bristles. Tibia I (Fig. 11) subequal in length to femur, with swollen area ventrally at mid-level bearing 4–5 strong black hairs, patch of 3–4 strong black bristles on dorsal surface; numerous black hairs along ventral surface; small lobe preapically bearing strong black preapical seta; short hairs on lateral and dorsal surfaces, 2 preapical hairs dorsally. It1 slender, subequal in length to tibia, with 4–5 short, strong black hairs at extreme base near joint , otherwise It1 unmodified. It2 (Fig. 12) with 8–9 long curved bristles on mesal surface. It3 (Fig. 12) with 2–3 short spiky bristles basally. It4 and It5 unmodified. *Mid leg*. Lengths (femur, tibia, tarsi): 71: 62: 45: 20: 10: 8: 8. Coxa II with row of 4–5 black lateral bristles, small patch of longer hairs apically. Trochanter bare. Femur II without strong bristles, numerous short posteroventral and preapical setae. Tibia II subequal in length to femur, unmodified. Tarsi unmodified. *Hind leg*. Lengths (femur, tibia, tarsi): 69: 71: 45: 26: 12: 8: 9. Coxa III with 3 black lateral hairs. Trochanter III bare. Femur III conspicuously bowed mesally, without strong bristles. Tibia III with 3 preapical bristles.

Wing (cf. Fig. 1). Infuscated pale smoky brownish, especially so in cell r1; veins brown; costa ends just beyond vein M_{1+2}; vein M_{1+2} slightly undulate; R_1 and R_{2+3} slightly converging at wing margin; R_{2+3} and M_{1+2} subparallel. Crossvein m-cu short, oblique, 1/3 length of apical part of M_{3+4}. Anal vein absent. Halter stem darker basally, otherwise halter stem and knob yellowish white. Squama yellowish brown with fringe of long brown hairs.

Abdomen. Gray-black, gray pollinose laterally on tergites II–V. Tergal hairs and setae very short, black. Sixth sternum with yellowish white caudal appendages flared apically (cf. Fig. 9).

Genitalia (Fig. 13). Hypopygium small, sessile, gray. Cercus narrow, long hairs restricted to lateral surface, two longest hairs apically. Hypandrium (Fig. 13c) shining brown, broad, rounded apically with tiny bifid apex, spine-like bristle laterally. Surstylus slightly curved mesally, with apical hook-like seta; 3–4 spines and single strong, blunt, black seta subapically.

Female. As in male except for the following: Face broader, slightly wider than width of first antennal flagellomere. Legs more brownish on segments that are black in male. Coxa I with two rows of short black hairs along entire length. Femur I with two rows of hairs: lateral row with short, blunt black hairs; mesal row with long black hairs. Tibia I with strong black setae laterally on basal one-third. All other segments unmodified.

Types. Holotype ♂ and 13♂♀ paratypes from: **NEW CALEDONIA**: 4 km S. Poindimie, 7 Mar 1978, E.I. Schlinger. Holotype in MNHN. Paratypes in INHS, MNHN, and AMS.

Etymology. The specific epithet refers to the country of New Caledonia.

Cymatopus othniopteryx Evenhuis**, new species**
(Figs. 3, 14)

Diagnosis. Similar in appearance to *C. malayensis* on the basis of the conspicuously modified hind margin of the wing in males. This species is easily distinguished from *C. malayensis*, however, by the absence of any patch of microtrichae in the apical portion of the wing field and the absence of a patch of long hairs on the hind margin fringe distal to the sulcus in the wing

Description. Male. Length: Body: 4.6–5.0 mm; wing 4.2–4.7 mm. *Head*. Frons and face grayish black, gray pollinose; clypeus slightly protruding. Face slightly wider than width of first flagellomere. Palpus grayish brown with 10-12 black hairs, 2 long hairs apically, as long as palpus, bristles absent. Mouthparts brown. Occiput black, with long white hairs ventrally; pair of long ocellars and shorter fronto-oribitals just above antennal sockets; pair of minute postocellars; pair of converging postverticals. Upper postoculars uniseriate, black. Antenna brown; first flagellomere short, conical, slightly longer than high. Arista apical, 2 x length of first three antennal segments.

Thorax. Mesonotum dark brownish black, gray pollinose; pleura dark brown, gray pollinose. No acrostichals, 5 dorsocentrals, 1 short humeral, 1 long posthumeral, 4 strong spiky propleurals; 2 notopleurals, 3 supraalars, 1 long postalar. Scutellum grayish black, with pair of long converging scutellars, hair lateral to each scutellar ca. 1/2 length of scutellar.

Legs. Brown, except apices of coxa I, femur I, and base of tibia I yellowish orange; trochanter

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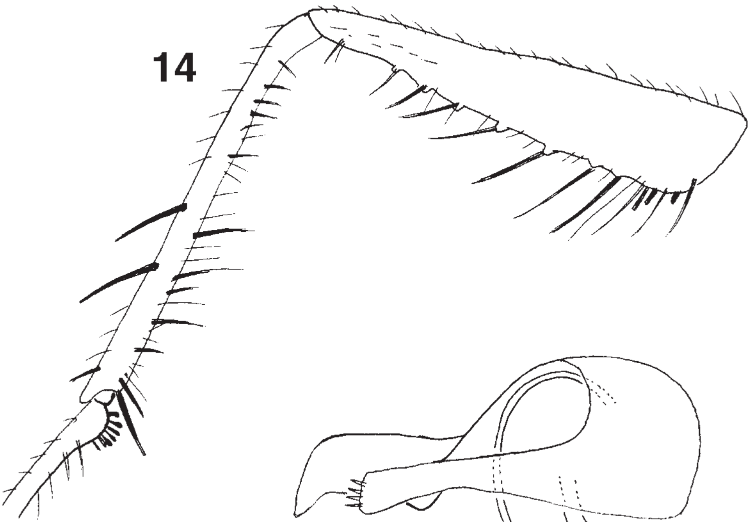

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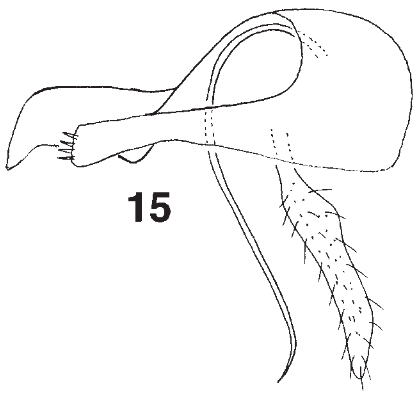

Figs. 14–15. *Cymatopus*, males. **14**. *C. othniopteryx*, fore femur, tibia, and base of first tarsal segment. **15**. *C. simplex*, male hypopygium, lateral view.

I yellow. Claws black, pulvilli as long as claws. *Fore leg* (Fig. 14): lengths (femur, tibia, and tarsi): 40: 38: 28: 15: 11: 5: 5. Coxa I with row of about 4–5 strong black bristles dorsobasally, 8–10 longer, thinner hairs apically. Trochanter I bare. Femur I widest at base, tapering evenly to apex, basal width ca. 1/4 length of coxa I; small patch of black bristles basoventrally on lateral surface, row of 8–10 long, black hairs along basal 3/4 of lateroventral surface, lengths of hairs becoming gradually shorter toward apex; anterodorsal surface with short hairs distributed evenly along surface; 2–3 small preapical hairs. Tibia I subequal in length to femur, with 2 strong black setae on dorsal surface near mid-level, numerous strong, short, spiky bristles along ventral surface; strong, black, preapical seta not borne on lobe; short hairs on lateral and dorsal surfaces. It1 shorter than tibia, with 4–5 short, strong, brownish spatulate hairs at extreme base near juncture with tibia, otherwise It1 unmodified. It2 and It3 unmodified; It4 slightly flared. It5 flared. *Mid leg*. Lengths (femur, tibia, tarsi): 65: 57: 37: 20: 8: 8: 5. Coxa II with 1 black lateral bristle and 2–3 fine apical hairs. Trochanter brown with short black hairs. Femur II without strong bristles, numerous short hairs. Tibia II shorter than femur, with 2 strong preapical setae. Tarsi unmodified. *Hind leg*. Lengths (femur, tibia, tarsi): 65: 62: 40: 22: 12: 10: 8. Coxa III with 2 strong lateral setae. Trochanter III bare. Femur III slightly bowed mesally, without strong bristles. Tibia III and tarsi unmodified.

Wing (Fig. 3). Slightly infuscated, yellowish, veins yellowish brown; hind margin of wing modified by deep concavity at end of M_{3+4}; vein C ends at vein M_{1+2}; vein M_{1+2} strongly undulate; R_1 and R_{2+3} slightly converging at wing margin; Crossvein m-cu short, meeting CuA1 at acute angle, almost opposite end of R_1 in C; apical part of M_{3+4} not reaching wing margin; sparse, short hairs along hind margin, a few longer hairs in concavity; microtrichiae restricted to small row distal to crossvein m-cu. Anal vein absent. Halter stem darker basally, otherwise halter stem and knob yellowish white. Squama yellowish white with fringe of long white hairs.

Abdomen. Black, gray pollinose laterally on tergites II–V. Tergal hairs and setae very short, black. Fourth sternum with small spicules laterally.

Genitalia. Not dissected. Hypopygium small, sessile, black. Cercus relatively broad, with setae apically and laterally.

Female. As in male except for lack of MSSC of legs and wing, and the following: Face broader, slightly wider than width of first antennal flagellomere.

Types. Holotype ♂ and paratype ♀ from: **EAST TIMOR**: Dili District: intertidal rocks at Cape Hatomanulato, W. of Metinaro, 5 Sep 2004, D.A. Polhemus. Holotype and paratype in USNM.

Remarks. This is only the second known species in the genus with modified wings in the males. *Cymatopus malayensis* has modified wings of a similar shape (Fig. 2), but also has conspicuous MSSC in the male legs, which are lacking in *C. othniopteryx*. Further collecting along shores of Indo-Malayan areas may reveal further species in this “modified-wing” group.

Etymology. The specific epithet derives from the Greek, *οτηνειοσ* [= odd, strange] + *πτερψξ* [= wing], referring to the bizarre modification of the wing in males.

NEW RECORDS

Cymatopus calcaratoides Grootaert & Meuffels

Cymatopus calcaratoides Grootaert & Meuffels, 1993: 1577.
This species was originally described from Papua New Guinea, the following record extends the distribution into the Cape York Peninsula, Australia.

Material Examined: AUSTRALIA: 2♂, 2♀, **Queensland**: Portland Roads, 12°36'S, 143°25'E, 14 Dec 1971, D.K. McAlpine, G.A. Holloway, D.P. Sands (AMS).

Remarks. Although this is the first printed published record of this species from Australia, the distribution was previously recorded online (Bickel & Elliott, 2000).

Cymatopus leopoldi Meuffels & Grootaert

Cymatopus leopoldi Meuffels& Grootaert, 1984: 146.
This species was originally described from Laing Island, Papua New Guinea. The following record extends the distribution into the Torres Straits Islands and Cape York Peninsula, Australia.

Material Examined: AUSTRALIA: **Queensland**: 1♂, 1♀, Cape Tribulation, 16°04'S, 145°28'E, G. Daniels, M.A. Schneider (UQIC); 1♂, Dugong Island, Torres Strait, 25 Aug 1949, M.V. Melbidir (ANIC).

Remarks. Although this is the first printed published record of this species from Australia, the distribution was previously recorded online (Bickel & Elliott, 2000).

Cymatopus simplex Parent

Cymatopus simplex Parent, 1941: 195.
This endemic Australian species was originally recorded from southern Queensland. Numerous specimens at hand from various sources extend its distribution to the shores of the following coastal Australian states: New South Wales, South Australia, Tasmania, Victoria, and Western Australia; as well as Lord Howe Island.

Material Examined: AUSTRALIA: **Lord Howe Island**: [no further data], E,T. Kingston (AMS). **New South Wales**: Ashton Park, Mosman, Sydney, 33°50'S, 151°15'E, 16 Sep 1980, D.J. Bickel (AMS); Ashton Park, Mosman, Sydney, 33°50'S,151°15'E, 21 Nov 1993, B.J. Sinclair (CNC); Bass Point, N of Kiama, 7 Jan 1978, E.I. Schlinger (CAS); Batemans Bay, 35°43'S, 150°11'E, 17 Sep 1949, Paramonov (ANIC); Broulee Beach, 35°51'S, 150°11'E, 9 Oct 1971 (ANIC); Brunswick Heads, 28°32'S, 153°33'E, Jan 1961, K.R. Norris (ANIC); Bundeena, 10 Dec 1966, D.K. McAlpine (AMS); Byron Bay, Jan 1961, K.R. Norris (ANIC); Kurnell, 34°00'S, 151°13'E, 7 Sep 1979, D.K. McAlpine (AMS); La Perouse, 26 May 1956, D.K. McAlpine (AMS); Narrabeen Head, 16 Jan 2005, tidal rocks, N.L. Evenhuis (BPBM); Newport, 33°39'S, 151°19'E, 15 Aug 1987, T. Robinson (AMS); Royal NP, Burning Palms trail, 34°11'S, 151°02'E, 25 Jun 1995, B.J. Sinclair (CNC); Royal NP, Burning Palms, 34°11'S, 151°02'E, 25 Jun 1995, B.J. Sinclair (CNC); Royal NP, Burning Palms trail, 34°11'S, 151°02'E, 13 Mar 1994, B.J. Sinclair (CNC); Sydney Harbour, Shark Island, 27 Nov 1987, B.J. Day (AMS); Valcluse, Bottle & Glass Rocks, 15 Apr 1981, McAlpine, Day, & Kent (AMS); Valla Beach, nr Nambucca, 11 Aug 1984, K.C. Khoo (AMS). **South Australia**: Seal Bay, Kangaroo Island, 36°00'S, 137°20'E, 6 Dec 1977, D.K. McAlpine & M.A. Schneider (AMS). **Tasmania**: Freycinet NP, 23 Feb 1994, B.J. Sinclair (CNC); Rocky Cape NP, nr sisters Beach, 29 Jan 1989, D.J. Bickel (AMS). **Victoria**: Walkerville, nr Waratah Bay, 6 Apr 1986, D.K. McAlpine (AMS). **Western Australia**: Bunker Bay, Cape Naturaliste, 33°32'S, 115°02'E, 11 Nov 1991,D.J. Bickel (AMS). [All localities are represented by male vouchers confirming the identification.]

Remarks. This species is not a member of *Cymatopus s. str.* (cf. hypopygia in Figs. 6, 10, and 13 vs. Fig. 15) and may be better placed in another genus, such as the New Zealand genus *Abatetia* Miller. It is here provisionally left in *Cymatopus* until further research can ascertain its generic status. Although this is the first printed published record of this species from states of Australia other than Queensland, the distribution was previously recorded online (Bickel & Elliott, 2000).

Cymatopus tibialis Kertész

Cymatopus tibialis Kertész, 1901: 409.

Cymatopus tibialis was originally described from New Guinea. Grootaert & Meuffels (1984) added new records from Papua New Guinea but the range remained restricted to the island of New Guinea. Material examined in this study extends its distribution into the Solomon Islands.

Material Examined. SOLOMON ISLANDS. SANTA CRUZ GROUP: **Reef I**: 1♂, Mohawk Bay, near beach, 26 Jul 1926, E. Troughton & A. Livingston (AMS).

CHECKLIST OF SPECIES OF *CYMATOPUS* KERTÉSZ

[excluding the 4 Neotropical species (*setosus* Curran, *cheesmani* (Parent), *bredini* Robinson, and *wirthi* Robinson), which may belong in a different genus]

1. *Cymatopus baravikai* Evenhuis, n. sp. **Type-locality:** Suva, Viti Levu, Fiji. **Types**: Holotype ♂ in BPBM.

Distribution: Fiji (Viti Levu, Taveuni, Lau Group [Koroni I])

2. *Cymatopus calcaratoides* Grootaert & Meuffels, 1993: 1577. **Type-locality:** Laing Island, Papua New Guinea. **Types**: Holotype ♂ in RBINS

Distribution: Papua New Guinea.

3. *Cymatopus calcaratus* Parent, 1935: 59. **Type-locality:** Christmas Island [Indian Ocean]. **Types**: Holotype in BMNH.

Distribution: Christmas Island [Indian Ocean].

4. *Cymatopus flavipes* Evenhuis, n. sp. **Type-locality:** Plage de Poé, New Caledonia. **Types**: Holotype ♂ in MNHN.

Distribution: New Caledonia.

5. *Cymatopus leopoldi* Meuffels & Grootaert, 1984: 146. **Type-locality:** Laing Island,

Papua New Guinea. **Types**: Holotype ♂ in RBINS.

Distribution: Australia (Queensland), Papua New Guinea.

6. *Cymatopus longipilus* Parent, 1935b: 61. **Type-locality:** Christmas Island [Indian Ocean]. **Types**: Holotype in BMNH.

Distribution: Christmas Island [Indian Ocean], Thailand.

7. *Cymatopus malayensis* Parent, 1935a: 208. **Type-locality:** Pulau Aur, Malaysia. **Types**: Lectotype in BMNH.

Distribution: Malaysia (Johore, Pulau Aur), Singapore, Thailand.

8. *Cymatopus motuporensis* Grootaert & Meuffels, 1993: 1580. **Type-locality:** Motupore Island, Papua New Guinea. **Types**: Holotype ♂ in RBINS

Distribution: Papua New Guinea.

9. *Cymatopus neocaledonicus* Evenhuis, n. sp. **Type-locality:** 4 km S. of Poindimie, New Caledonia. **Types**: Holotype ♂ in MNHN.

Distribution: New Caledonia.

10. *Cymatopus othniopteryx* Evenhuis, n. sp. **Type-locality:** Cape Hatomanulato, East Timor. **Types**: Holotype ♂ in USNM.

Distribution: East Timor.

11. *Cymatopus simplex* Parent, 1941: 195. **Type-locality:** Burpengary, Queensland, Australia. **Types**: Holotype ♂ in BMNH.

Distribution: Australia (Lord Howe Island, New South Wales, South Australia, Queensland, Tasmania, Victoria, Western Australia).

12. *Cymatopus spinosus* Parent, 1934: 297 [1935b: 64]. **Type-locality:** Samoa. **Types**: Syntypes in BMNH.

Distribution: Samoa.

13. *Cymatopus thaicus* Grootaert & Meuffels, 2001: 351. **Type-locality:** Khao Lak, Phang-Nga, Thailand. **Types**: Holotype ♂ in RBINS.

Distribution: Malaysia, Thailand

14. *Cymatopus tibialis* Kertész, 1901: 409. **Type locality**: Seleo Island & Berlinhafen [= Aitape], Papua New Guinea. **Types**: Syntypes in HNHM (destroyed in 1956).

Distribution: Papua New Guinea, Solomon Islands (Reef I).

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The *Plagiozopelma flavipodex* Species Group (Diptera: Dolichopodidae: Sciapodinae) from Fiji, Vanuatu, and the Solomon Islands[1]

Daniel J. Bickel
Australian Museum, 6 College Street, Sydney NSW 2010, Australia; email: danb@austmus.gov.au

Abstract. Nine new species of *Plagiozopelma* Enderlein (Diptera: Dolichopodidae: Sciapodinae) are described, keyed and figured: *P. spinicaudum*, **n. sp**., *P. tokotaai,* **n. sp**., *P. devoense,* **n. sp**., and *P. vitiense,* **n. sp**. (all from Fiji), *P. laffooni,* **n. sp**., *P. efatense,* **n. sp**., *P. santense,* **n. sp**., and *P. bellicum,* **n. sp**. (all from Vanuatu), and *P. sukapisu,* **n. sp.** (from the Solomon Islands). These new species all belong in the *flavipodex* species Group. The island of Taveuni in the Fiji Group is the easternmost limit of this genus in the Pacific. The Fijian species *Plagiozopelma tokotaai, P. devoense,* and *P. spinicaudum* share an unusual setation on the female thorax, with 2 strong posterior setae and 2–3 weak anterior hairs, normally a secondary sexual character state found only in males.

INTRODUCTION

Plagiozopelma is a widespread Old World tropical genus of Sciapodinae (Dolichopodidae) found primarily in moist forest habitats. Most species have a delicate appearance with long pale yellow legs and often a very long male arista. The genus was redefined and summarized in Bickel (1994).

This paper was initiated to describe four species of Fijian *Plagiozopelma* collected by the Terrestrial Arthropod Survey of Fiji, but expanded to include undescribed species from nearby island groups, four from Vanuatu, and one from the Solomon Islands. The Fijian fauna, which is at the eastern Old World limit of *Plagiozopelma,* can thus be seen in a wider context of congeners.

MATERIALS AND METHODS

This study is based on material from the following collections: Natural History Museum, London (BMNH), Bishop Museum, Honolulu, (BPBM), and the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM).

The left lateral view of the hypopygium or male genital capsule is illustrated for all species. In describing the hypopygium, 'dorsal' and 'ventral' refer to morphological position prior to genitalic rotation and flexion. Thus, in figures showing a lateral view of the hypopygium, the top of the page is morphologically ventral, while the bottom is dorsal. Morphological terminology follows Bickel (1994). The CuAx ratio is the length of the m-cu crossvein/ distal section CuA. The position of features on elongate structures such as leg segments is given as a fraction of the total length, starting from the base. The relative lengths of the podomeres should be regarded as representative ratios and not measurements. The ratios for each leg are given in the following formula and punctuation: trochanter + femur; tibia; tarsomere 1/ 2/ 3/ 4/ 5. The following abbreviations and terms are used: FSSC, Female secondary sexual character(s), non-genitalic characters found only on the female body; MSSC, Male secondary sexual character(s), non-genitalic characters found only on the male body; I, II, III: pro- , meso-, metathoracic legs; C, coxa; T, tibia; F, femur; ac, acrostichal setae; ad, anterodorsal; av, anteroventral; dc, dorsocentral setae;

1. Contribution No. 2005-004 to the NSF-Fiji Arthropod Survey.

dv, dorsoventral; pd, posterodorsal; pv, posteroventral; t, tarsus; t1-5, tarsomeres 1 to 5. On the figures, arrows indicate diagnostic features.

SYSTEMATICS

Genus *Plagiozopelma* Enderlein

Diagnosis. *Head:* frons usually shining, highly polished; vertical seta present in females, but absent or present as weak hair in males; face usually bulging in males (MSSC), but conforming with curvature of eyes in females; male clypeus usually narrowed and separated from margins of eyes; male scape often swollen and vase-like; pedicel with only weak setae; male first flagellomere conical with dorsoapical to apical arista; female first flagellomere subrectangular with dorsoapical to dorsal arista.

Legs: coxa I usually with 3–7 strong lateral spine-like setae, more strongly developed in females than males, although CI sometimes with 3 strong black distolateral setae; tibiae and femora in both sexes with few major setae.

Wing: crossvein m-cu slightly sinuous to straight.

Abdomen: terga with only short setae; hypopygial peduncle (segment 7) with tergum and sternum both well-developed; aedeagus with dorsal angle; cercus usually deeply forked, with subequal dorsal and ventral arms.

Remarks. *Plagiozopelma* occurs across the Oriental, Afrotropical, and Australasian tropics but is especially diverse on the Indian subcontinent. It is discussed in detail in Bickel (1994).

KEY TO *PLAGIOZOPELMA* SPECIES GROUPS FROM AUSTRALIA AND THE WESTERN PACIFIC, AND TO MALES OF SPECIES IN OF THE *FLAVIPODEX* GROUP FROM FIJI, VANUATU AND THE SOLOMON ISLANDS

1. Vertex and frons usually with pruinosity; male frons often with hairs on lateral slope; male scape rarely swollen and vase-like; pedicel often with long ventral and dorsal setae; CI without lateral spine-like setae; FI and TI usually with long setae (Old World tropics) .... **Chrysosoma** Guérin-Méneville

–. Frons highly polished metallic blue-green; male frons bare or with single weak vertical seta only; male scape often swollen and vase-like; pedicel with only weak setae; CI with 3–7 strong lateral spine-like setae (stronger in females than males); FI and TI in both sexes usually without major setae (Old World tropics) .... **Plagiozopelma** Enderlein .. 2

2. Five strong dc present in both sexes; head circular in anterior view; face and clypeus elongate; pleura with silvery pruinosity; CI with 3–5 strong black distolateral spine-like setae; IIIt3–5 each slightly flattened (MSSC); m-cu straight; epandrium with flat dorsal surface; cercus lobate (Australia, New Guinea, Solomons) .... **angustifacies** Group

–. Male usually with 2 strong posterior dc and 3–4 weak hair-like dc anteriad; head wider than high; vertex and frons polished metallic green-blue; other features various .. 3

3. Male scape not strongly swollen; arista distinctly shorter than body and simple; male IIIt3–5 dorsoventrally flattened, padlike; male It_1 with four long posterior crocheted hairs distally; epandrium elongate subtriangular; cercus with elongate blade-like arm subtended basally by shorter inner arm (Australia, New Guinea) .... **terminiferum** Group

–. Male scape swollen and vase-like; male arista as long as or longer than body, and often with apical flag; male IIIt3–5 unmodified; male It_1 rarely with long posterior hairs; epandrium not as prolonged; cercus as two subequal arms, outer dorsal arm and inner ventral arm (Orient, Australasia to Fiji) .... **flavipodex** Group .. 4

4. Apex of male arista with flattening or flag 5
–. Apex of male arista simple, unmodified 8

5. Apical aristal flag rounded and orbiculate, black with white base (Figs 1b, 1f) 6
–. Apical aristal flag obovate (Figs 1d, 1h) 7

6. Basitarsus I longer than tibia I; large, wing length > 4.0 mm; aristal flag (Fig. 1b); hypopygium (Fig.1a); surstylus curved and somewhat flattened; dorsal cercal arm clavate (widespread: Asia, Australia, New Guinea, Northern Marianas Is) .... **P**. **flavipodex** Becker
–. Basitarsus I shorter than tibia I; smaller, wing length < 3.5 mm; aristal flag (Fig. 1f); hypopygium (Fig.1e); surstylus somewhat expanded apically; dorsal cercal arm elongate, with setae as figured (Vanuatu) .... **P**. **santense**, n. sp.

7. Apical aristal flag narrow obovate and black (Fig. 1d); hypopygium (Fig. 1c); dorsal cercal arm elongate and straight ventral cercal arm straight (Vanuatu) .... **P**. **laffooni**, n. sp.
–. Apical aristal flag obovate and white (Fig. 1h); hypopygium (Fig. 1g); dorsal cercal arm narrow and slightly curved, with long apical seta; ventral cercal arm with distinct subapical bend (Vanuatu) .... **P**. **efatense**, n. sp.

8. Pleural cuticle at least one third yellow, in distinct contrast to metallic blue-green color elsewhere on thorax 9
–. Pleura mostly metallic blue-green or dark brown, with at most yellow cuticle above coxae or on metapleuron 10

9. Entire pleura and anterior slope of mesonotum yellow; basitarsus I with fine whitish ventral pile along its length; basitarsus III distinctly white, and distal tarsomeres infuscated; hypopygium (Fig. 2d); dorsal cercal arm curved with long dorsoapical seta; ventral cercal arm split along distal third ... (Fiji) .... **P**. **devoense**, n. sp.
–. Pleura metallic green dorsad of imaginary line extending from coxa I base to just below halter base, and pleura ventrad of this “line” yellow to coxal bases; basitarsus I with 3–4 short ventral setae at very base; basitarsus III yellow; hypopygium (Fig. 2a); dorsal cercal arm slightly clavate; ventral cercal arm with distinct expansion just beyond mid-length ... (Fiji) .... **P**. **vitiense**, n. sp.

10. Tibia I with 5–6 fine pale curved posterior setae along distal fifth; basitarsus I with pv row of some 20 weak curved decumbent setae along length; tibia II more than 1 1/2 length of femur II; hypopygium (Fig.2f); dorsal cercal arm with 3 long apical setae; ventral cercal arm with 2 long dorsal subapical setae ... (Solomon Islands) .... **P**. **sukapisu**, n. sp.
–. Tibia I bare of curved posterior setae; basitarsus I with at most short ventral setae near base; tibia II less than 1 1/2 length of femur II; cercus not as above 11

11. Hypopygium (Fig. 2c); surstylus distally expanded and subtriangular; dorsal cercal arm with lateral row of long setae; ventral cercal arm with 4–5 strong ventral setae on distal third .. (Fiji) .... **P**. **spinicaudum**, n. sp.
–. Surstylus not distally expanded and subtriangular, but with dorsoapical digitiform projection (Figs. 2b, 2e) 12

12. Basitarsus I with short ventral setae along length; hypopygium (Fig. 2e); dorsal cercal arm without long dorsoapical seta; ventral cercal arm with group of pale distal subapical hairs, with two short curved subapical setae. ... (Vanuatu) .... **P**. **bellicum**, n. sp.
–. Basitarsus I unmodified; hypopygium (Fig. 2b); dorsal cercal arm with long dorsoapical seta; ventral cercal arm bare with short curved subapical setae ... (Fiji) .... **P**. **tokotaai**, n. sp.

THE *PLAGIOZOPELMA FLAVIPODEX* SPECIES GROUP

Diagnosis. *Head*: vertex, frons, and face highly polished metallic blue-green or bronze green; vertical seta in male reduced to weak hair on frons, but strong and well-developed in female; male face slightly bulging (Fig. 1d), with some grey pruinosity ventrally and laterally; female face wider than that of male, and with frontoclypeal suture not strongly marked; male scape swollen and vase-like (MSSC) (group autapomorphy); male first flagellomere almost conical with apical to dorsoapical arista; female first flagellomere shorter with dorsoapical arista; male arista often with apical flag (MSSC), and male arista usually longer than body (MSSC); female arista always unmodified, and about half body length.

Thorax: mesonotum and scutellum usually shining metallic blue-green; setae black; 2 pairs strong ac present; males with dc comprising 2 strong posterior setae and 2–3 weak anterior hairs (MSSC), while females have 4 strong dc setae (although in three Fijian species, females also have 2 strong posterior setae and 2 -3 weak anterior hairs); 1 postalar, 2 postsutural supra-alar, 2 presutural intra-alar, 2 notopleural, 1 presutural supra-alar, and 1 weak postpronotal setae present; median scutellar setae strong, lateral scutellars reduced to tiny hair or absent.

Legs: CI with 5–7 strong lateral spine-like setae, more strongly developed in females than males (FSSC) (group autapomorphy), and female CI sometimes with additional anteromedian setal fields (FSSC); female TII usually with offset ad-pd setal pair in basal quarter; $IIIt_1$ with ventral seta at very base.

Wing: hyaline; crossvein m-cu straight.

Abdomen: elongate; sparsely haired with only 2 pairs strong marginal setae on each tergum; male postabdomen (Fig. 1c): hypopygial peduncle (segment 7) with well developed tergum and sternum; hypopygium usually subtriangular; hypandrial arm elongate, usually reaching at least to apex of aedeagus; surstylus fused to epandrium without external evidence of suture; epandrium with 2 short setae along ventral margin; cercus bifid, with two elongate subequal arms, an external dorsal arm and internal ventral arm.

Remarks. The *flavipodex* Group comprises about 70 described species, found throughout most of the Oriental and Australasian tropics, as well as Melanesia (see review in Bickel, 1994). Species extend as far east as Fiji and the Northern Marianas. Most species are associated with rainforest and are frequently collected in yellow pans or Malaise traps near creeks.

This group is based around *Plagiozopelma flavipodex,* a widespread Oriental-Australasian species. Most group members have a delicate appearance with long pale yellow legs and often a very long male arista. Males of most species have an arista that is longer than the body, and sometimes an apical flattening or aristal flags (MSSC).

Nine species in the *flavipodex* Group are newly described here, from Fiji (4 spp.), Vanuatu (4 spp.), and the Solomon Islands (1sp.).

Plagiozopelma flavipodex (Becker)
(Fig 1a, b)

Diagnosis. **Male**: length 4.2–5.0 mm; wing: 4.0–4.7 × 1.5 mm.

Head: clypeus tapering and covered with grey pruinosity; palp and proboscis yellow; antenna yellow; first flagellomere elongate, conical; arista with apical flag (Fig. 1b) orbiculate, black with white base (MSSC); ventral postcranium with pale setae.

Thorax: shining metallic green with bronze reflections; scutellum blue; pleura with some grey pruinosity.

Legs: all coxae and remainder of legs entirely yellow; I: 4.3; 4.8; 5.5/ 1.8/ 1.2/ 0.6/ 0.4; CI with 6–7 pale lateral setae; TI bare; It_1 distinctly longer than TI, It_1 with some short ventral setulae in basal quarter; II: 5,3; 8.2; 6.9/ 2.2/ 1.6/ 0.4/ 0.3; TII with ad setae at 1/6, pd at 1/4 and pv at 4/5, although position of setae may be somewhat variable among specimens; III: 7.3; 11.4; 4.2/ 2.3/ 1.3/ 0.7/ 0.3; TIII with row of short dorsal setae.

Wing: hyaline; crossvein m-cu straight; CuAx ratio: 1.2; lower calypter pale with dark brown rim and pale setae; halter yellow with infuscated club.

Abdomen: metallic bronze-green with some silvery pruinosity; hypopygium (Fig.1a); epandrium yellow with brown cercus, surstylus and hypandrium; epandrial lobe elongate but decumbent, along epandrial margin, and with two strong setae; surstylus curved and somewhat flattened, with ventral subapical setae; dorsal cercal arm almost clavate, with dark brown setose "club'; ventral cercal arm bare except for pale subapical hairs, as figured.

Female: similar to male except lacking MSSC and as noted: arista simple, CI with additional anteromedian setae as well as lateral setae; TII with offset ad-pd setal pair in basal quarter; TIII with strong ad at 1/4 and 4–5 dorsals.

Material Examined. See Bickel (1994, 1995).

Remarks. *Plagiozopelma flavipodex* is widespread throughout the Indo-Pacific region, from lowland Nepal to New Guinea and northeastern Australia, and extending to the Philippines, Guam, Northern Marianas, Sundaland, and Christmas Island (Bickel, 1994). It is often abundant at lowland sites. Its wide distribution may be the result of both natural dispersal and accidental human introduction.

Plagiozopelma laffooni Bickel, **new species**
(Figs. 1c, d)

Description. **Male**: length 3.7–3.8 mm; wing: 3.0 × 1.0 mm.

Head: (Fig. 1d); clypeus tapering and covered with grey pruinosity; palp and proboscis yellow; antenna yellowish; arista with apical flag, narrow obovate and black (MSSC).

Thorax: mesonotum and pleura metallic green with bronze reflections, but pleural cuticle yellow immediately dorsad of CII; metapleuron yellow ventrally and brown dorsally; pleura with grey pruinosity.

Legs: all coxae and remainder of legs entirely yellow, with only distalmost tarsomeres infuscated; CI with 6 pale yellow lateral spine-like setae; I: 3.6; 3.7; 2.8/ 1.2/ 0.8/ 0.6/ 0.4; TI bare; It1distinctly shorter than TI, and with some short ventral setae at very base; II: 3.8; 5.7; 4.0/ 1.5/ 1.0/ 0.5/ 0.4; TII with ad seta at 1/5, and with short subapical ad seta; III: 5.7; 8.0; 2.8/ 1.5/ 1.0/ 0.5/ 0.4; TIII with some short dorsal setae.

Wing: CuAx ratio: 1.1; lower calypter pale with dark brown rim and pale setae; halter yellow with infuscated club.

Abdomen: elongate; metallic bronze-green with some grey pruinosity; postabdomen (Fig. 1c); epandrium yellow with brown cercus, surstylus and hypandrium; epandrial lobe with long and short setae; surstylus with dorsoapical digitiform projection; dorsal cercal arm elongate, narrow with setae as figured; ventral cercal arm elongate and bare except for group of long pale subapical hairs, as figured.

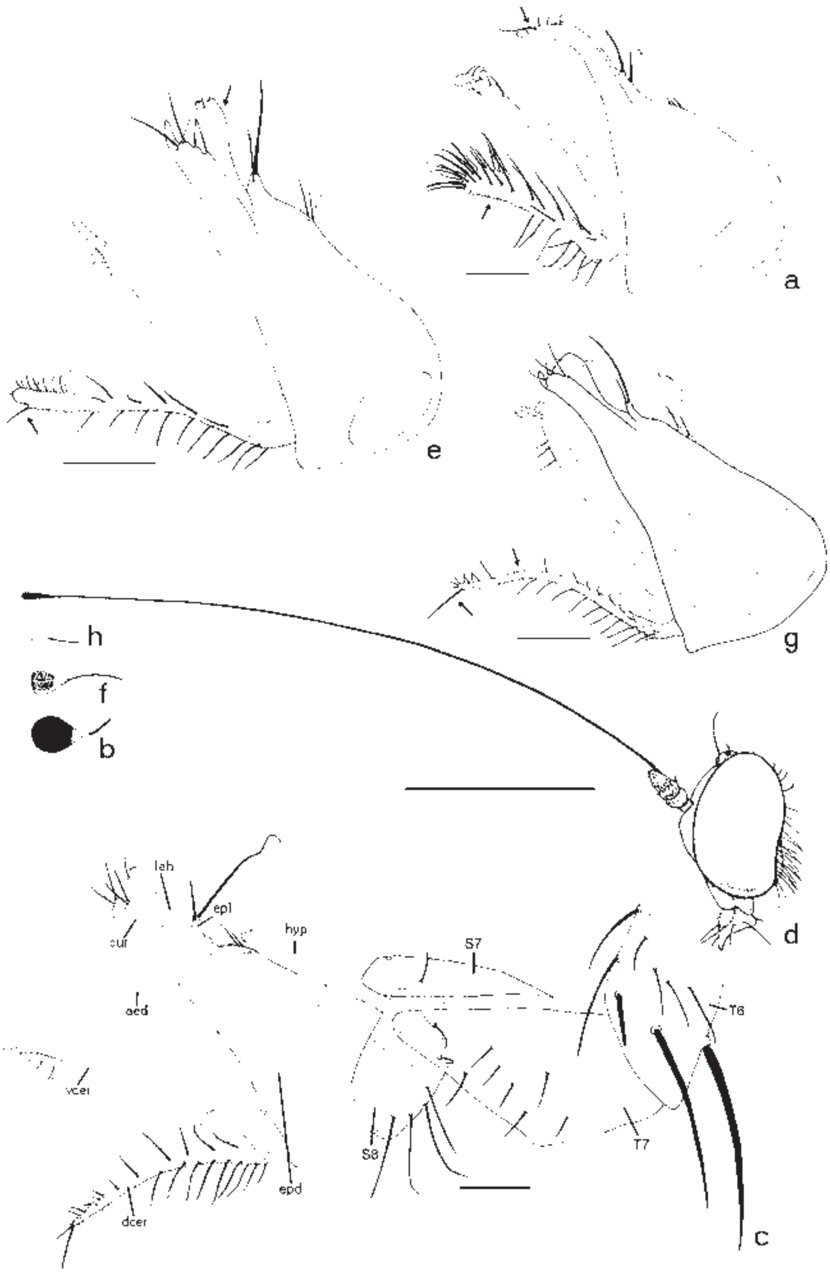
Female: similar to male except lacking MSSC and as noted: arista simple, TI and TII with similar setation; TIII with ad seta at 1/5, and also with dorsal setae.

Types. Holotype ♂, 12♂, 18♀ paratypes, VANUATU: **Espiritu Santo**: Segond Channel, x.1944, J. Laffoon (USNM). Paratype ♂, same but ix.1944 (USNM).

Other material: VANUATU: **Espiritu Santo**: 4♂, 8♀, no locale, ix.1944, K.L. Knight (USNM); ♂, no locale, viii ix.1929, L.E. Cheesman (BMNH). **Malekula**: ♂, Ounua, iii–iv.1929, L.E. Cheesman (BMNH). **Epi**: ♂, 12.vi.1925, P.A. Buxton (BMNH). **Lamen**: 11♂, 8♀, 0–100 m, i–ii.1976, N.L.H. Krauss. **Ambrym**: ♂, 0–100 m, xii.1984, N.L.H. Krauss (BPBM).

Remarks. *Plagiozopelma laffooni* is known from the adjacent islands of Espiritu Santo, Malekula and Ambrym in the Vanuatu archipelago. Males can be readily recognized by the black obovate aristal flag (Fig. 1d).

Etymology. The species is named in honor of Jean Laffoon, long time Professor of Entomology at Iowa State University, who collected in Vanuatu (then the New Hebrides) during World War II.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Plagiozopelma santense Bickel, **new species**
(Fig. 1e, f)

Description. **Male**: length 3.2–3.3 mm; wing: 3.0 × 0.9 mm.

Head: clypeus tapering and covered with grey pruinosity; palp and proboscis yellow; antenna yellow but slightly infuscated; arista longer than body, and with apical flag (Fig. 1f) orbiculate, black with white base (MSSC).

Thorax: mesonotum and pleura metallic green with bronze reflections, but mesopleura yellow just dorsad of CII; metepimeron yellow ventrally and brown dorsally.

Legs: all coxae and remainder of legs entirely yellow, with only distalmost tarsomeres infuscated; CI with 6 pale yellow lateral spine-like setae; I: 3.0; 3.2; 2.5/ 1.0/ 0.6/ 0.4/ 0.3; TI bare; It1distinctly shorter than TI; II: 3.5; 4.8; 3.8/ 1.0/ 0.8/ 0.4/ 0.3; TII with ad seta at 1/5, and with short subapical ad seta; III: 4.7; 7.0; 2.4/ 1.4/ 0.8/ 0.5/ 0.3; TIII with some short dorsal setae.

Wing: CuAx ratio: 1.2; lower calypter pale with dark brown rim and pale setae; halter yellow with infuscated club.

Abdomen: elongate; metallic bronze-green with some grey pruinosity; hypopygium (Fig. 1e); epandrium yellow with brown cercus, surstylus and hypandrium; epandrial lobe stout with one strong and one slightly weaker seta; surstylus somewhat expanded apically, with dorsoapical digitiform projection, and with setae as figured; dorsal cercal arm elongate, with distal setae as figured and with short dorsoapical seta; ventral cercal arm curved and bare except for group of pale subapical hairs, as figured.

Female: similar to male except lacking MSSC and as noted: arista simple, TI and TII with similar setation; TIII with ad seta at 1/5, and also with dorsal setae.

Types. Holotype ♂ (BPBM 16,566), paratype ♂, VANUATU: **Espiritu Santo**, 1.5 km NE of Luganville, 11.iii.1964, R. Straatman (BPBM).

Other material: VANUATU: 2♀, **Espiritu Santo**, 1.5 km NE of Luganville, 12.iv.1964, R. Straatman. ♂, **Anatom** (= Aneytioum), Anelgaohat, 0–200 m, xi.1978, N.L.H. Krauss (BPBM).

Remarks. *Plagiozopelma santense* is known from the rather distantly separated islands of Espiritu Santo and Anatom, Vanuatu. Males can be readily recognized by the large spatulate aristal flag which is black with a white base, similar to that found on the widespread *P. flavipodex.* However the two species are readily separated by the relative lengths of the male fore tibia and basitarsus, and genitalic differences, as noted in the key.

Etymology. The species is named for the island of Espiritu Santo, shortened in everyday speech to "Santo."

Plagiozopelma efatense Bickel, **new species**
(Figs. 1g, h)

Description. **Male**: length: 3.2 mm; wing 3.0 × 1.0 mm.

Head: clypeus tapering, with yellow cuticle near distal margin; palp and proboscis yellow; antenna yellow; arista longer than body; arista with small apical flag (Fig. 1h), obovate and white (MSSC).

Thorax: mesonotum and pleura metallic green with bronze reflections, but with yellow cuticle just dorsad of CII; metepimeron yellow ventrally and dark brown dorsally.

Legs: all coxae and remainder of legs entirely yellow with distal tarsomeres infuscated; CI with 6 lateral pale spine-like setae; I: 3.6; 3.7; 2.9/ 1.1/ 0.8/ 0.6/ 0.4; TI bare; It1shorter than TI; II: 4.0; 6.2;

Fig. 1. *Plagiozopelma flavipodex*: **a**. hypopygium, left lateral view; **b**. male arista, apex. *P. laffooni*: **c**. male postabdomen, left lateral view; **d**. male head, left lateral view. *P. santense*: **e**. hypopygium, left lateral view; **f**. male arista, apex. *P. efatense*: **g**. hypopygium, left lateral view; **h**. male arista, apex. Legend: aed, aedeagus; dcer, dorsal arm of cercus; epd, epandrium; epl, epandrial lobe; hyp, hypandrium; lah, lateral arm of hypandrium; S7, S8, sternum 7, 8; sur, surstylus; T6, T7, tergum 6, 7; vcer, ventral arm of cercus.

←

Fig. 2. *Plagiozopelma* male hypopygia, left lateral view. **a**. *vitiense*; **b**. *tokotaai*; **c**. *spinicaudum*; **d**. *devoense*; **e**. *bellicum*; **f**. *sukapisu*.

4.2/ 1.3/ 1.0/ 0.5/ 0.3; TII bare; III: 5.8; 8.5; 4.0/ 1.6/ 1.2/ 0.6/ 0.3; TIII with some short dorsal setae.

Wing: CuAx ratio: 1.0; lower calypter pale with dark brown rim and pale setae; halter yellow with infuscated club.

Abdomen: metallic blue-green with some grey pruinosity; vestiture sparse, with only 2 pairs of dorsal setae on each tergum; sternum 8 with short weak setae; hypopygium (Fig. 1g); epandrium yellow with brown cercus, surstylus and hypandrium; surstylus slightly expanded distally, with dorsoapical digitiform projection; epandrial lobe with 1 strong seta and 1 weak seta; dorsal cercal arm narrow and slightly curved, with long apical seta; ventral cercal arm with distinct subapical bend, with setae as figured.

Female: unknown.

Types. Holotype ♂ (BPBM 16,565) VANUATU: **Efate**, Port Vila, 0–100 m, i.1972, N.L.H. Krauss (BPBM).

Remarks. *Plagiozopelma efatense* can be separated from all related Vanuatu members of the genus by its entirely white obovate aristal flag (Fig. 1h). Also, the male basitarsus I is shorter than tibia I.

Etymology. The species is named for the island of Efate in Vanuatu.

Plagiozopelma bellicum Bickel, new species
(Fig. 2e)

Description. **Male**: length 3.2 mm; wing: 2.7 × 1.9 mm.

Head: clypeus tapering and covered with grey pruinosity; palp and proboscis yellow; antenna yellowish; arista simple, about two-thirds body length.

Thorax: mesonotum and pleura metallic green with bronze reflections, except for yellow area on meron, just dorsad of CII.

Legs: all coxae and remainder of legs entirely yellow; CI with 6 strong spine-like setae; I: 3.0; 3.3; 2.7/ 1.0/ 0.8/ 0.6/ 0.3; TI bare; It1with short ventral setae along length; II: 4.7; 5.5; 4.0/ 1.4/ 0.8/ 0.5/ 0.3; TII with anterior seta at 1/5, and with anteroapical seta; III: 4.5; 7.2; 2.5/ 1.5/ 1.0/ 0.7/ 0.3; TIII with only a few short dorsal setae.

Wing: CuAx ratio: 1.1; lower calypter pale with dark brown rim and pale setae; halter with yellow stalk and brown club.

Abdomen: elongate; metallic bronze-green with matt areas over tergal overlap; sparsely haired with only 2 pairs of marginal setae on each tergum; hypopygium (Fig. 2e); epandrium yellow with brown cercus, surstylus and hypandrium; epandrial lobe stout, with longer and rather short setae; surstylus with prolonged dorsoapical digitiform projection; dorsal cercal arm with setae as figured; ventral cercal arm bare except for group of pale distal subapical hairs, with two short curved subapical setae.

Female: unknown.

Types. Holotype ♂, VANUATU: **Espiritu Santo**, Segond Channel, viii.1944, J. Laffoon (USNM).

Remarks. *Plagiozopelma bellicum* is a small-sized species known only from Espiritu Santo, Vanuatu. It is the only Vanuatu species without an apical aristal flag. The hypopygium of *P. bellicum* is closest to that of the Fijian *P. tokotaai.*

Etymology. The species epithet "*bellicum"* is from the Latin, meaning "of war", referring to that fact this species was collected on Espiritu Santo during World War II.

Plagiozopelma vitiense Bickel, new species
(Fig. 2a)

Description. **Male**: length 3.2 mm; wing: 2.8 × 1.0 mm.

Head: clypeus tapering, yellow at very apex; palp and proboscis yellow; scape and pedicel brownish; first flagellomere yellow; arista elongate, simple and slightly shorter than body length.

Thorax: metallic blue-green on mesonotum and extending onto pleura, so that the metallic color is restricted dorsad of imaginary line extending from base of CI to just below halter base, while pleura yellow between this "line" and coxal bases.

Legs: all coxae and remainder of legs entirely yellow, except distal tarsomeres infuscated; CI with 6 strong spine-like setae; I: 3.2; 3.3; 2.4/ 1.0/ 0.6/ 0.4/ 0.3; TI bare; It1distinctly shorter than TI, and with 3–4 short ventral setae at very base, distinct from adjacent vestiture; II: 3.8; 4.8; 3.7/ 1.2/ 0.8/ 0.4/ 0.3; TII with ad at 1/5; III: 5.5; 7.2; 2.6/ 1.6/ 1.0/ 0.7/ 0.3; TIII with short dorsal setae.

Wing: CuAx ratio: 1.1; lower calypter pale with dark brown rim and pale setae; halter with yellow stalk and brown club.

Abdomen: elongate; metallic bronze-green with some silvery pruinosity; sparsely haired with only 2 strong dorsals on each tergum; hypopygium (Fig. 2a); epandrium yellow with brown cercus, surstylus and hypandrium; epandrial lobe very short, with elongate and short seta; surstylus with dorsal digitiform projection; dorsal cercal arm slightly clavate, with brown setose "club"; ventral cercal arm bare except for distinct expansion just beyond mid-length, and with some subapical hair-like setae as figured.

Female: similar to male except lacking MSSC and as noted: pleura also with division, dorsally blue- green, and ventrally yellow; TI with row of 3 short dorsal setae near 1/4; It1also with 3–4 short ventral setae at very base; TII with strong ad at 1/5, and short pd at 2/3.

Types. Holotype ♂ (BPBM 16,564), paratype 2♂, 4♀, FIJI: **Viti Levu**, Nausori Highlands, 500–700m, xi.1976, N.L.H. Krauss (BPBM, Acc. No. 1977.29).

Other material: FIJI: 1♂, 3♀, **Ovalau**, Levuka, 0–200 m, xii.1978, N.L.H. Krauss (BPBM). **Viti Levu**: 2♂, Vuda Prov., Savuione Trail, Koroyanitu Village, 17°40'S 177°33'E, 450 m, disturbed mid-elevation moist forest, Malaise trap, 12–19.x.2002, M. Irwin, M. Tokotaai & E. Schlinger; Naitasiri Prov., old trail to Mt. Tomaniivi, from Navai Village 17°37'S 177°59'E, 700m, gymnosperm dominated rainforest: ♂, 23.ix.2004; ♂, 18.x.2004; ♀, 30.vii.2004, M. Tokotaai & E. Schlinger; ♂, 2♀, Tilivaleva, 305–366 m, 25.iii.1970, N.L.H. Krauss; 1♂, 1♀, Korotongo, 0–100 m, iii.1981, N.L.H. Krauss (BPBM).

Remarks. *Plagiozopelma vitiense* is known from several localities on Viti Levu as well as Ovalau. This species is distinctly smaller than its congeners in Fiji, and can be recognized in both sexes by the distinctive pleural color, dorsally blue-green, and ventrally yellow. As well, both sexes have 3–4 short ventral setae at the very base of basitarsus I.

Etymology. The specific epithet is based on "Viti", the indigenous Fijian name for the Fiji islands.

Plagiozopelma tokotaai Bickel, **new species**
(Fig. 2b)

Description. **Male**: length 3.8–3.9 mm; wing: 3.2 × 1.3 mm.

Head: palp and proboscis yellow; antenna brown but yellowish along ventral surface; first flagellomere conical; arista black, simple and very long, at least one and a half times body length (MSSC); ventral postcranium with abundant pale setae.

Thorax: mesonotum and all pleura metallic blue-green, with some grey pruinosity; dc with 2 strong posterior setae and 3–4 weak anterior hairs; metepimeron dorsally metallic blue-green, ventrally yellow.

Legs: all coxae and remainder of legs yellow, except CII with brown vertical stripe, and distal tarsomeres infuscated; CI with 6 strong pale spine-like setae; I: 5.0; 5.2; 4.5/ 1.8/ 1.2/ 0.7/ 0.4; TI with very short ad at 1/5; It_1unmodified; II: 5.2; 8.2; 6.0/ 1.6/ 1.2/ 0.6/ 0.4; TII with ad seta at 1/6, pd seta at 1/8 and 3/10; III: 7.0; 10.7; 4.5/ 2.0/ 1.2/ 0.6/ 0.4; TIII with some scattered longer setae.

Wing: CuAx ratio: 1.3; lower calypter pale with dark brown rim and pale setae; halter stalk yellow at base, with brownish club.

Abdomen: elongate; metallic bronze-green with some grey pruinosity; hypopygium (Fig. 2b); epandrium yellow with dorsal cercal arm, surstylus and hypandrium; epandrial lobe rather short, with strong and weak seta; surstylus curved and somewhat flattened, with dorsoapical digitiform projection; dorsal cercal arm with setae as figured and with long dorsoapical seta; ventral cercal arm bare except for some pale subapical hairs, as figured.

Female: similar to male except lacking MSSC and as noted: dc also with 2 strong posterior setae and 3–4 weak anterior hairs; TIII with ad seta at 1/5 and subapically, and pd at 1/2.

Types. Holotype ♂ (BPBM 16,562), paratypes, 3♂ FIJI: **Viti Levu**: Naitasiri Prov., Navai Village, Veilaselase Track, 17°37'S 177°59'E, 700 m, gymnosperm dominated rainforest, Malaise trap, 28.xii.2004, M. Tokotaai & E. Schlinger (FJVL11-M02); paratypes, 1♂, 2♀, same, but 23.ix.2004 (FJVL-11-M02); paratypes 5♂, 1♀ same but 6.xi.2004 (FJVL11-M01); paratype ♂, same but 23.xii.2004 (FJVL11-M02) (BPBM).

Other material: FIJI: **1**♂, 3♀, **Ovalau**, Lovoni Valley, 50–200 m, 27.xii.1969, N.L.H. Krauss (BPBM). **Viti Levu**: 3♀, Naitasiri Prov, old trail to Mt. Tomaniivi from Navai Village, 17°37'S 177°59'E, 700 m, gymnosperm dominated rainforest, Malaise trap, 30.viii.2004, M. Tokotaai & E. Schlinger (FJVL11-M03, BPBM); ♂, ♀, 8 miles up Sigatoka Valley, 6.viii.1972, D.E. Hardy; ♂, Lami, 0–200 m, xii.1978, N.L.H. Krauss; ♂, Kalekana to Mt Korobaba (nr Lami), 250 m, 14–16.x.1979, G.A. Samuelson (BPBM).

Remarks. *Plagiozopelma tokotaai* is known from several sites on Viti Levu, at least from mid-elevations near 700 m and the nearby island Ovalau.
The three species *Plagiozopelma tokotaai, P. spinicaudum* and *P. devoense* are unusual in having the female thorax with 2 strong posterior setae and 2–3 weak anterior hairs, normally a secondary sexual character state found only in males (see discussion above).

Etymology. This species is named in honor of Moala Tokota'a, who has coordinated the field trapping program of the Fiji Arthropod Survey.

Plagiozopelma spinicaudum Bickel, **new species**
(Fig. 2c)

Description. **Male**: length 2.7–3.0 mm; wing: 2.6 × 0.8–3.0 × 1.2 mm.

Head: palp, proboscis and associated setae yellow; antenna brown, but yellowish ventrally; arista simple, and about as long as body.

Thorax: mesonotum, scutellum and most of pleura metallic green, although metapleuron dorsally metallic blue-green and ventrally yellow; dc with 2 strong posterior setae and 3–4 weak anterior hairs.

Legs: all coxae and remainder of legs yellow, except tarsomeres distad of basitarsi infuscated; CI with 6 strong spine-like setae; I: 4.2; 4.5; 3.7/ 1.5/ 0.8/ 0.6/ 0.3; TI bare; II: 5.0; 6.7; 5.0/ 1.4/ 1.0/ 0.6/ 0.3; TII with short ad at 1/6 and subapically, and short pd at 1/5; III: 6.0; 8.5; 3.8/ 1.7/ 1.0/ 0.6/ 0.3; TIII with some short dorsal setae.

Wing: CuAx ratio: 1.2; lower calypter pale with dark brown rim and pale setae; halter yellow with brown club.

Abdomen: elongate; metallic bronze-green with some silvery pruinosity; sparsely haired with only 2 strong dorsals on each tergum; segment 7 brown; sternum 8 yellow; hypopygium (Fig. 2c); epandrium yellow with hypandrium, dorsal cercal arm and apex of ventral cercal arm brown; epandrial lobe short pedunculate with 2 strong setae; surstylus distally expanded and subtriangular, and with setae as figured; dorsal cercal arm with lateral row of long setae; ventral cercal arm with 4–5 strong ventral setae on distal third.

Female: similar to male except lacking MSSC and as noted: dc also with 2 strong posterior setae and 3–4 weak anterior hairs; TII with ad at 1/5 and subapically and pd near 1/3.

Types. Holotype ♂ (BPBM 16,561) (FBA 001794) 5♀ paratypes (FBA 001790, 001792, 001796–001798) FIJI: **Viti Levu**: Naitisiri Prov., Colo-i-Suva Forest Park, Waisila Ck, 18°03'S, 178°26'E, 150 m, 26–27.x.2004, yellow water traps, D.J. Bickel (BPBM).

Other material: FIJI: **Ovalau:** 4♂, 3♀, Levuka, 0–200 m, xii.1978, N.L.H. Krauss (BPBM). **Viti Levu**: ♂, Naitisiri Prov., headwaters of Veisari River, W. of Suva, upper Waivudawa Ck, 290 m., 18°04'21.9"S. 178°21'48.2"E, 23.i.2005, D.J. Bickel & M. Tokota'a (AMS); 2 ♂, 4 ♀, Naitisiri Prov., Navai Village, Eteni, 700 m., 17°37'S. 177°59'E, Malaise FJ-11A, 6.vi–15.vii.2003, M. Irwin, et al. (BPBM). 4♂, 9♀, Lami, 0–200 m, iii.1972, xii.1978, N.L.H. Krauss; ♂, Navai, 800–900 m, 8.x.1971, N.L.H. Krauss; ♂, Nukura Forest, 60–130 m, 15.x.1979, N.L.H. Krauss; ♂, ♀, Tacirua, 16.xii.1978, N.L.H. Krauss (BPBM).

Remarks. *Plagiozopelma spinicaudum* is known from Viti Levu and the nearby island of Ovalau. It can be readily recognized the apically expanded surstylus, the row of lateral setae on the dorsal cercal arm, and the subapical group of strong setae on the ventral cercal arm. *P. spinicaudum* has female thorax setation similar to that of *P. tokotaai*, q.v.

Etymology. The epithet "*spinicaudum"* is from the Latin, *spina* (spine) and *cauda* (tail), referring to subapical group of spinelike setae on the ventral arm of the cercus.

Plagiozopelma devoense Bickel, **new species**
(Fig. 2d)

Description. **Male**: length 3.9 mm; wing: 3.7 × 1.3 mm.

Head: vertical seta as weak black hair on frons; face slightly bulging, with some grey pruinosity ventrally and laterally; clypeus tapering and with grey pruinosity; palp and proboscis yellow; scape and pedicel brownish; first flagellomere yellow, conical; arista simple, about as long as body length.

Thorax: dorsum mostly metallic green with bronze reflections; entire pleura and anterior slope of mesonotum yellow; setae black; 2 pairs strong ac present with tiny seta anteriad; dc with 2 strong posterior setae and 3–4 weak anterior hairs (MSSC); lateral scutellar setae absent.

Legs: all coxae and remainder of legs yellow, except CII with brown lateral stripe, basitarsus III distinctly white, and distal tarsomeres infuscated; CI with 6 pale spine-like setae; CII with pale anterior seta; CIII with pale lateral seta; I: 5.0; 5.2; 5.0/ 2.0/ 1.5/ 1.0/ 0.4; TI bare; TI and It_1 subequal; It_1 not flattened, but with fine whitish ventral pile along its length; II: 5.6; 8.3; 6.3/ 2.0/ 1.3/ 0.7/ 0.5; TII with short ad-pd setal pair at 1/8, and with pd seta at 1/3; III: 7.8; 11.0; 4.7/ 2.3/ 1.5/ 0.8/ 0.6; TIII with 3–4 larger setae along dorsal row, and with some short av setae; IIIt1distinctly white, contrasting with yellow TIII and brown distal tarsomeres, and with some short ventral setulae.

Wings: CuAx ratio: 0.8; lower calypter pale with dark brown rim and pale setae; halter stalk yellow at very base, but with distal stalk and club brownish.

Abdomen: elongate; metallic bronze-green with some silvery pruinosity; sparsely haired with only 2 strong dorsals on each tergum; segment 7 and sternum 8 brownish; sternum 8 with only short weak hairs; hypopygium (Fig. 2d); epandrium yellow, with brown dorsal cercal arm and hypandrium; epandrial lobe short with strong and weaker seta; surstylus slightly expanded distally; dorsal cercal arm curved with some setae and long dorsoapical seta; ventral cercal arm split along distal third, and with setae as figured.

Female: similar to male except lacking MSSC and as noted: similar thoracic color with yellow pleura; dc also with 2 strong posterior setae and 3–4 weak anterior hairs.

Types. Holotype ♂ (BPBM 16,563) FIJI: **Taveuni**: Cakaudrove Prov.: Devo Peak Tower, 179° 58'E 16°51'S, 1200 m, cloud forest, Malaise trap, FJ-8, 31.x–21.xi.2002, M. Irwin, E. Schlinger, & M. Tokoka'a (FBA001623); paratypes: ♂, ♀, Devo Peak Forest Reserve, 179°59'E 16°50'S, 800 m, Malaise trap, 10–16.i.2003, & ♀, same but 3–10.i.2003 (FBA 041108, 038948, 042704) (BPBM).

Remarks. *Plagiozopelma devoense* is known from 800–1200 m on Taveuni Island, Fiji. However, the species can be identified by the yellow pleura and the long apical seta on the dorsal arm of the cercus. This species is possibly endemic to Taveuni.

Etymology. This species is named for its type locality, Devo Peak.

Plagiozopelma sukapisu Bickel, **new species**
(Fig. 2f)

Description. **Male**: length 3.7 mm; wing: 2.7 × 0.9 mm.

Head: palp yellow with dark brown setae; proboscis yellow; antenna brown; first flagellomere conical; arista long, only slightly shorter than body length, and simple.

Thorax: mesonotum and pleura, including metepimeron metallic green with bronze reflections, and with some grey pruinosity.

Legs: coxae yellow, but CII with some infuscation laterally; remainder of legs entirely yellow; CI with 6 pale spine-like setae; I: 4.3; 4.8; 3.4/ 1.3/ 1.0/ 0.6; TI with 5–6 fine pale curved posterior setae along distal fifth (MSSC); It1 with pv row of some 20 pale weak curved decumbent setae along length (MSSC); II: 4.5; 7.5; 6.0/ 1.8/ 1.2/ 0.6/ 0.4; TII very long, almost twice length FII; TII with short ad seta at 1/5; III: 6.0; 10.8; 4.8/ 2.0/ 1.3/ 0.8/ 0.4; TIII with row of short dorsal setae.

Wing: CuAx ratio: 1.7; cross vein dm-cu slightly curved; lower calypter pale with dark brown rim and pale setae; halter yellow with slightly infuscated club.

Abdomen: elongate; metallic bronze-green with some silvery pruinosity; sparsely haired with only 2 strong dorsals on each tergum; hypopygium (Fig. 2f); epandrium mostly dark brown; dorsal cercal arm yellow, ventral arm brown; epandrial lobe with 2 strong setae; surstylus lobate with long apical seta; cercal arms broadly joined at base; dorsal cercal arm with 3 long apical setae; ventral cercal arm with 2 long dorsal subapical setae and group of ventral subapical setae, as figured.

Female: unknown.

Types. Holotype ♂ (BPBM 16,567), SOLOMON ISLANDS: **Santa Ysabel**, Sukapisu, 900 m, light trap, 19.vi.1960, C.W. O'Brien (BPBM).

Remarks. *Plagiozopelma sukapisu* is known from the type locality at 900 m on Santa Ysabel, Solomon Islands.

Etymology. The specific epithet "*sukapisu*" is an indigenous place name and is treated here as a noun in apposition.

PHYLOGENETIC RELATIONSHIPS OF THE MELANESIAN *PLAGIOZOPELMA*

Two species groups of *Plagiogzoplema* extend into Melanesia. The *angustifacies* group includes the Solomon Islands *P. arctifacies* (Parent), three described species from New Guinea and Australia, as well as undescribed species (Bickel, 1994). This group will not be considered any further here.

The *flavipodex* species group includes the nine central Pacific species treated here. What are the phylogenetic relationships among these nine species? Do they display synapomorphies that suggest phylogenetic and biogeographical relationships?

All species have distinctive character states that allow identification using male secondary sexual characters (MSSC) and/or genitalic structure, as is the case in most Sciapodinae (Bickel, 1994). Most of these characters comprise minor variations in the color, form and setation of the male cercus and legs, and few are strong enough to provide unequivocal synapomorphies among species. Rather, they reflect variable expression of a suite of potential characters/ character states possibly used in species recognition. Two characters warrant further discussion:

1. Male apical arista flag (MSSC). Males of most *flavipodex* Group species have an apical flattening or flag (Figs 1b, d, f, h) at the end of a long arista, and this MSSC might be a synapomorphy for the entire Group. However it is absent in all four Fijian species, one of the four Vanuatu species, and the single Solomon Island species. The secondary loss of the aristal flag (to an *apparent* unmodified plesiomorphic state) in these species may represent single or multiple homoplastic changes. I suggest at least two cases of secondary loss of the aristal flag, once in the Solomon Island *P. sukapisu* (which has genitalic

structures distinct from the Fiji and Vanuatu species) and at least once for a clade that might comprise the single Vanuatu species, *P. bellicum* and all the Fijian species.

Here it should be noted that at least two of the Vanuatu species, *P. laffooni* (Fig. 1d) and *P. efatense* (Fig. 1h), show highly reduced aristal flags, which may reflect an evolutionary trend away from prominent flags (as displayed in widespread *P. flavipodex*, Fig. 1b, and Vanuatu endemic *P. santense*, Fig. 1f), possibly towards losing the flags altogether.

2. Modified female thoracic chaetotaxy. Three Fijian species, *Plagiozopelma tokotaai, P. devoense,* and *P. spinicaudum* have the female dorsocentral setation with 2 strong posterior setae and 2–3 weak anterior hairs, a strong synapomorphy which makes them sister taxa. Normally, this is a male secondary sexual character state found in many genera of Sciapodinae. In most *Plagiozopelma* and other sciapodine genera, females display the unmodified condition, where all 4–5 dorsocentral setae are more or less equally strong. Here is another case of a male secondary sexual character becoming incorporated into the female phenotype. A similar expression of "male" thoracic chaetotaxy in the female phenotype occurs in some Australian *Amblypsilopus* species (discussion in Bickel, 1994). The fourth Fijian species, *P. vitiense,* has normal unmodified female chaetotaxy.

BIODIVERSITY AND BIOGEOGRAPHY

The Melanesia faunal composition noted here, from Fiji (4 spp.), Vanuatu (4 spp.) and the Solomon Islands (1 sp.) suggests that even from initial surveys, the *flavipodex* Group is well developed in the western Pacific. Of these, the Solomon Islands fauna is most under-represented in collections. Only a single male was found in the BPBM collection, described here as *P. sukapisu*, collected from 900 m on Santa Ysabel. This leads me to suspect that with its elevation and geographic complexity, the Solomon Islands has a rich but uncollected endemic fauna.

Both Vanuatu and Fiji probably have a few additional undescribed species. The three Viti Levu species seem reasonably widespread and broadly sympatric, and all also occur on the nearby offshore island of Ovalau. The single Taveuni species is known only from upland sites. I have not seen material from Vanua Levu.

Biogeographically, the Melanesian *flavipodex* Group fauna is probably derived via island stepping-stone dispersal from a Sundaland-Papuan source (Bickel, 1997). The group displays both widespread inter-island dispersal ability (for example, the distribution of *P. flavipodex* itself) and local endemism. The genus does not occur on New Caledonia (Bickel, 2002) or in temperate Australia/ New Zealand and it has no Gondwanan connections. There is no evidence of *Plagiozoplema* occurring east of the Fiji Group.

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FIJI ARTHROPODS I

(edited by N.L. Evenhuis & D.J. Bickel)

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