BISHOP MUSEUM
OCCASIONAL PAPERS

Fiji Arthropods XIV

Neal L. Evenhuis
and
Daniel J. Bickel, editors
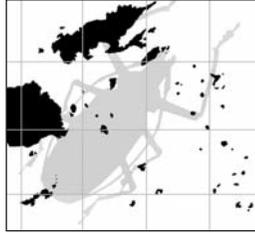
14

Bishop Museum Press
Honolulu

Cover: *Tossinola pamianorum* Bennett, new species (Hymenoptera: Ichneumonidae).

RESEARCH PUBLICATIONS OF BISHOP MUSEUM

FIJI ARTHROPODS XIV

Editors' Preface

We are pleased to present the fourteenth issue of *Fiji Arthropods*, a series offering rapid publication and devoted to studies of terrestrial arthropods of the Fiji Group and near-by Pacific archipelagos. Most papers in this series are the results of collecting and research on the Fijian fauna deriving from the NSF-funded "Terrestrial Arthropods of Fiji" project. Two co-PIs and 15 specialists form the core team of scientists who have agreed to publish new taxa that result from collecting during this survey.

This issue contains a review of the genera of Ichneumonidae of Fiji by Andrew Bennett. Manuscripts are currently in press on Cerambycidae, Mymaridae, and Dictyopharidae and will appear in issue fifteen.

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/

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

The Ichneumonidae (Hymenoptera) of Fiji: Keys to subfamilies and genera with a review of the species of Anomaloninae, Banchinae, Brachycyrtinae and Diplazontinae

Andrew M.R. Bennett

*Canadian National Collection of Insects, Agriculture and Agri-Food Canada,
Ottawa, ON, K1A 0C6, Canada; email: bennetta@agr.gc.ca*

Abstract

The ichneumonids of Fiji are summarized including keys to genera and overviews of the known biology of the recorded subfamilies. Prior to this survey only 28 substantiated species records were documented from Fiji (in 17 genera in 10 subfamilies). This survey collected at least 114 species in 34 genera in 15 subfamilies. In addition, 10 other species previously recorded from Fiji were not collected in this study but are considered credible, therefore the total number of ichneumonid records from Fiji is 124 species in 36 genera in 15 subfamilies. The species of Anomaloninae, Banchinae, Brachycyrtinae, and Diplazontinae are reviewed including descriptions of two new species: *Tossinola pamianorum* **n. sp.** (Banchinae) and *Brachycyrtus wardae* **n. sp.** (Brachycyrtinae). *Lissopimpla veitchi* Turner **n. syn.** (Pimplinae) is considered a junior synonym of *L. nigricans* Fullaway. Brachycyrtinae, Orthocentrinae, Banchinae and Tersilochinae are recorded from Fiji for the first time and Cryptinae is confirmed (known previously only from an incorrect generic identification). Banchinae and Tersilochinae are new records for the south Pacific. Distributions of the morphospecies are tabulated by island and comparisons are made on species richness within the Fijian archipelago as well as in neighboring countries with general suggestions made on future collecting efforts and conservation.

INTRODUCTION

The parasitic wasp family Ichneumonidae is one of the most successful extant lineages of organisms. Yu *et al.* (2005) listed 23,331 described extant species making it the most speciose family worldwide in the Hymenoptera (LaSalle & Gauld 1993). Considering that there are about 1.7 million described species in total (Stork 1997), ichneumonid wasps represent about 1.4 % of all described organisms and about 2.3% of all described insects. Current estimates indicate there may be in excess of 100,000 total species of ichneumonids (Gauld *et al.* 2002a).

Almost all ichneumonids are parasitoids, meaning that their larvae develop on or in one host and their development invariably leads to the death of the host (Waage & Greathead 1985). Within the family there are different types of host-parasitoid interaction including: 1) larval feeding externally (ectoparasitoid) or internally (endoparasitoid); 2) larval feeding commencing immediately after hatching (idiobiosis) or following a delay usually at first instar that allows the host to develop (koinobiosis) (Askew & Shaw 1986);

---

1. Contribution No. 2009-006 to the NSF-Fiji Arthropod Survey.

3) larval feeding in the host (primary parasitism) or in another parasitoid in the primary host (hyperparasitism). Based on knowledge of ichneumonid biology at the subfamily level, it is likely that all of these types of host-parasitoid associations occur in ichneumonids found in Fiji. Details of the biology of the subfamilies found in Fiji are provided in the introduction to each subfamily.

In terms of biogeography, the Ichneumonidae is cosmopolitan. At the subfamily level, some subfamilies are more speciose in the northern hemisphere, for example, those that mainly parasitize sawflies (e.g., Ctenopelmatinae and Tryphoninae) (Gauld *et al.* 1997). There are also several small subfamilies that are predominantly southern, for example, Labeninae (Gauld & Wahl 2000) and Eucerotinae (Gauld & Wahl 2002). In the Oceanic subregion (including New Zealand), 351 species were recorded prior to this study (from 19 of 40 subfamilies) (Yu *et al.* 2005). Previous surveys of the ichneumonids of Fiji have been cursory at best. Turner (1919) recorded eight species from four subfamilies, although two of these "species" are now considered conspecific and another record is certainly incorrect at the species level. Fullaway (1957) recorded 30 species from 9 subfamilies, although only 13 of the species in his list were correctly identified to species based on the current study with an additional 4 records correctly identified to genus (total of 17 correct records from 8 subfamilies). Other records of Fijian ichneumonids include some descriptions of new species from the south Pacific including Fiji (Bridwell 1919, Gauld & Mitchell 1976, Kusigemati 1985) and several that deal exclusively with new species from Fiji (Morley 1915a, Brues 1922, Perkins 1937). Apart from Fullaway (1957), only 11 additional substantiated species records have been added to the Fijian inventory meaning that prior to this study, 28 species were known from 17 genera in 10 subfamilies. See Tables 1 and 2 and well as the text for each subfamily for details of these 28 records. Considering the high species richness of ichneumonids in all other parts of the world, it was expected that more extensive sampling of Fiji would dramatically increase the number of species recorded.

The main purpose of this study was to identify and provide well-illustrated keys to the genera of Ichneumonidae of Fiji. For the subfamilies in Fiji with single species (i.e., those listed in the title), detailed species accounts are provided including nomenclature, diagnoses, and locality information of all specimens. For the remaining subfamilies, species information is not provided in the present paper because careful comparison with type material is required in most groups in order to be sure of species limits and whether some species are previously described or not. Some of these subfamilies will be dealt with at the species level in forthcoming papers. Whenever possible, morphospecies have been included in Table 1; however, when there was uncertainty about species limits, only the genus is listed, together with a conservative estimate of the number of species. These estimates may change with further research.

A secondary goal of the study was to determine the validity of previous records of ichneumonids from Fiji. In some cases, previous records have been verified by collection and/or examination of museum specimens (Table 1) or are considered credible (Table 2). See the Materials and Methods for criteria used to determine credibility of previous records. In other cases, previous species records are believed to be false (Table 3). In a few cases, it was not possible to determine the validity of previous species records. These cases are noted in the text and they have been maintained as valid until such time that more indepth studies are made. Note that the species list of Fijian ichneumonids (combination of Tables 1 and 2) was published previously in Evenhuis (2007). Any differences

in the two publications result from studies undertaken since Evenhuis (2007) and in these cases, the species list of this study (Tables 1 and 2) should be followed. It is ultimately hoped that this survey will provide the foundation to allow ichneumonids to become a model group of organisms for future studies of Fijian and south Pacific biodiversity and ecology which will also permit comparative biodiversity studies with other regions of the world.

MATERIALS AND METHODS

Specimens were obtained by the following methods: 1) collection of specimens for the Fiji Terrestrial Arthropod Survey; 2) examination of specimens in the Canadian National Collection of Insects, Ottawa, ON, Canada (CNC), the American Entomological Institute, Gainesville, FL, USA (AEIC), the Natural History Museum (London) (BMNH) and the Bernice P. Bishop Museum, Honolulu, HI, USA (BPBM); 3) reference to literature. In the case of literature references, the validity of a record was assessed based on such criteria as whether it was deliberately introduced, the number of times the species was recorded, and the reputation of the person(s) making the identification.

Most specimens were collected by Malaise trap, although some material was personally collected by sweeping and in water-filled yellow pan traps. Identification of specimens was by reference to the literature and comparison with identified material. Type material is deposited at the aforementioned institutions. Primary types are on long-term loan to the Bishop Museum but will ultimately be deposited in the Fiji National Insect Collection, Suva (FNIC).

All terms of ichneumonid morphology follow Townes (1969) with the following modifications: hypostomal carina for 'oral carina', supra-antennal area for 'frons', supra-clypeal area for 'face', gena for 'temple', occiput for 'postocciput', malar space for 'cheek', epicnemial carina for 'prepectal carina', laterotergites for 'epipleura', gonofor-ceps for 'claspers', and hypopygium for 'subgenital plate'. The term 'mesosoma' is used for the body region that includes the thorax and first abdominal segment (the propodeum). The term 'metasoma' is used for the apparent abdomen, with MS1, MS2, etc. referring to metasomal segments 1, 2, etc., T1, T2, etc. referring to the tergites of metasomal segments 1, 2, etc. and S1 referring to the sternite of metasomal segment 1. Generalized ichneu-monid morphology is shown in Figs. 1 to 4. Terms of relative position of the body follow Goulet and Huber (1993). Wing venation terms (Fig. 2) follow the Comstock-Needham system as updated by Ross (1936) and incorporate the recommendations of Goulet and Huber (1993) except for naming of the vein that forms the distal edge of fore wing cell 1+2Rs (the 'areolet' of Townes 1969). This vein is of uncertain origin and is here referred to as 'vein 3rs-m' in conformity with Wahl and Gauld (1998). Abscissae of veins are denoted as follows: 1/Cu means the first abscissa of Cu, 2/Cu the second abscissa, etc. The following terms for specialized structures are defined: epomia: a raised ridge (carina) on pronotum (Fig. 1b); glymma: lateral depression sub-basally on T1 (Figs. 1k, 12c); notaulus: longitudinal groove sublaterally on mesoscutum (Fig. 1t); sternaulus: longitudi-nal groove subventrally on mesopleuron (Figs. 1e, 9f); thyridium: scar-like, depression subanteriorly on T2 (Figs. 8e, f).

Regions of the world follow the divisions listed by Yu & Horstmann (1997) and used in the database of Yu *et al.* (2005). Of relevance, the Australian region includes only Australia, New Guinea and the Solomon Islands, whereas all of the other Pacific Islands including Fiji, Hawaii, New Caledonia and New Zealand are considered Oceanic.

Table 1. List of ichneumonids collected in Fiji by island in the present study. Island abbreviations: GA = Gau; KR = Koro; KV = Kadavu; LK = Lakeba; MC = Macuata, ML = Moala group; TA = Taveuni; VL = Viti Levu; VN = Vanua Levu; YS = Yasawa group. * = species recorded in Fiji prior to this study; *G = genus recorded in Fiji by Fullaway (1957); E = species recorded as endemic to Fiji; ‡ = introduced to Fiji for biocontrol.

Taxon	GA	KR	KV	LK	MC	ML	TA	VL	VN	YS
Anomaloninae										
E*Pseudanomalon munin Gauld & Mitchell								X	X	
Banchinae										
E*Tossinola pamianorum n. sp.								X		
Brachycyrtinae										
Brachycyrtus wardae n. sp.			X	X				X	X	
Campopleginae										
*G Campoplex sp. 1		X					X	X		
Campoplex sp. 2								X	X	
E*Casinaria vitilevensis Kusigemati								X	X	
Casinaria sp. 2								X		
Casinaria sp. 3		X						X		
Dusona sp. 1	X	X					X	X		
*Eriborus tutuilensis? Fullaway							X	X		
Eriborus spp. (at least 14 species)	3	2	4				3	10		
Genotropis sp. 1	X	X	X	X	X				X	
Venturia sp. 1	X	X							X	

Table 1. (continued) .

Taxon	Distribution by Island									
	GA	KR	KV	LK	MC	ML	TA	VL	VN	YS
Crematinae										
‡*Eiphosoma dentator (Fabricius)								X		
Pristomerus (at least 3 spp.)	2							2		
Temelucha (at least 3 spp.)	1		3					2	1	
*‡Trathala flavoorbitalis (Cameron)	X	X						X		
Trathala sp. 1										
Cryptinae										
Nipponaetes sp. 1			X					X		
Nipponaetes sp. 2								X		
Nipponaetes sp. 3								X		
Nipponaetes sp. 4										
Paraphylax spp. (at least 10 spp.)	4	1	4				5	7	4	
Diplazontinae										
*Diplazon laetatorius (Fabricius)								X		
Ichneumoninae										
*Ichneumon promissorius Erichson	X		X	X				X	X	

Table 1. (continued).

Taxon	Distribution by Island									
	GA	KR	KV	LK	MC	ML	TA	VL	VN	YS
Mesochorinae										
*G*Mesochorus* sp. 1	X	X	X					X		
Mesochorus sp. 2								X		
Mesochorus sp. 3		X						X		
Mesochorus sp. 4								X		
Mesochorus sp. 5	X									
Mesochorus sp. 6	X	X						X	X	
Mesochorus sp. 7			X				X	X		
Mesochorus sp. 8	X							X		
Mesochorus sp. 9			X							
Mesochorus sp. 10										
Mesochorus sp. 11								X		
Mesochorus sp. 12		X							X	
Mesochorus sp. 13										
Mesochorus sp. 14	X									
Metopiinae										
Exochus sp. 1	X	X						X		
Exochus sp. 2		X								
*G*Metopius* sp. 1	X	X					X	X	X	
Metopius sp. 2	X							X		
Triclistus sp. 1										

Table 1. (continued).

Taxon	Distribution by Island									
	GA	KR	KV	LK	MC	ML	TA	VL	VN	YS
Ophioninae										
*Enicospilus aequalis (Szépligeti)		X					X	X	X	
*Enicospilus dolosus (Tosquinet)				X				X		
*Enicospilus heliothidis Viereck								X	X	
*Enicospilus melanocarpus Cameron		X		X				X	X	
*Enicospilus morleyi Townes							X	X	X	
Enicospilus sp. 1			X					X		
Enicospilus sp. 2		X	X				X	X		
Enicospilus sp. 3			X					X		
Enicospilus sp. 4									X	
Enicospilus sp. 5		X						X		
Enicospilus sp. 6								X		
Leptophion (at least 4 spp.)	1	1	2				3	1	2	

Table 1. (continued).

Taxon	Distribution by Island									
	GA	KR	KV	LK	MC	ML	TA	VL	VN	YS
Orthocentrinae										
Megastylus sp. 1	X	X	X					X		
Megastylus sp. 2	X	X					X	X		
Orthocentrus (at least 1 sp.)	1	1					1	1	1	
Proclitus sp. 1			X				X	X		
Proclitus sp. 2							X	X		
Proclitus sp. 3	X							X		
Pimplinae										
Ephialtini										
Acrodactyla sp. 1		X					X	X	X	
Eriostheus sp. 1	X							X		
Zatypota sp. 1	X						X	X	X	
Pimplini										
*Echthromorpha agrestoria (Swederus)	X	X	X	X	X	X	X	X	X	
E*Echthromorpha tirathabae Fullaway	X		X				X		X	X
Echthromorpha sp. 3									X	
*Lissopimpla nigricans Fullaway	X	X	X					X	X	X

Table 1. (continued).

Taxon	Distribution by Island									
	GA	KR	KV	LK	MC	ML	TA	VL	VN	YS
Tersilochinae (continued)										
Diaparsis sp. 1								X		
Diaparsis sp. 2		X					X	X		
Diaparsis sp. 3								X	X	
Diaparsis sp. 4	X						X			
Diaparsis sp. 5		X						X		
Diaparsis sp. 6										
Tryphoninae										
GNetelia spp. (at least 9 spp.)	1	1		1		1	3	5	2	
Phytodietus (*Weisia*) sp. 1								X		
Total: 114 spp.	33	31	28	8	2	2	32	79	31	1

Table 2. Species previously recorded in literature from Fiji and considered credible records but not collected in this study.

E = previously recorded as endemic to Fiji; ‡ = introduced to Fiji for biocontrol.

Species	Island	Introduced or Native	Reference
Campopleginae			
‡*Casinaria infesta* (Cresson)	Viti Levu?	Introduced	Tothill *et al.* (1930); Fullaway (1957)
‡*Diadegma semiclausum* Hellén	Viti Levu?	Introduced	Waterhouse (1992)
‡*Venturia palmaris* (Wilkinson)	Taveuni and Viti Levu	Introduced	Lever (1945); Fullaway (1957)
Ichneumoninae			
‡*Diadromus collaris* (Gravenhorst)	Viti Levu	Introduced	Waterhouse (1992)
Ophioninae			
Enicospilus insularis (Kirby)	Viti Levu	Native	Gauld & Mitchell (1981)
Enicospilus lineolatus (Roman)	Viti Levu	Native	Gauld & Mitchell (1981)
Enicospilus rufinervis (Szépligeti)	Viti Levu	Native	Gauld & Mitchell (1981)
Enicospilus shinkanus (Uchida)	Vanua Levu	Native	Kusigemati (1985)
Pimplinae			
Lissopimpla excelsa (Costa)	Viti Levu?	Native	Krieger (1907); Fullaway (1957)
Tryphoninae			
E*Netelia fijiensis* (Brues)	Kadavu and Lakeba	Native	Brues (1922)

OVERVIEW OF THE ICHNEUMONIDS OF FIJI

As in all other parts of the world, ichneumonids were most readily collected in Fiji using Malaise traps. Collecting by sweeping was only effective in open habitats such as fields and roadsides and only collected common species. Yellow pan traps were effective for collecting microhymenoptera and some braconids, but relatively few ichneumonids. Additional collecting techniques other than Malaise traps would likely discover more species that do not fly up into Malaise trap heads, although given the relatively low yield of ichneumonids in Malaise traps in Fiji compared to most other parts of the world (e.g. northern temperate regions), the amount of effort required to collect these species may be high.

Table 3. Species incorrectly recorded from Fiji in previous studies

Species	References	Comments
Cryptinae		
Hemigaster sp.	Fullaway (1957)	Misidentification of *Paraphylax* (BPBM specimen examined)
Ophioninae		
Enicospilus castaneus (Ashmead)	Fullaway (1957); Yu *et al.* (2005)	Likely a misidentification of a *Leptophion* sp. (Gauld & Mitchell, 1981)
Enicospilus coarctatus (Brullé)	Fullaway (1957); Yu *et al.* (2005)	Misidentification of *E. lineolatus* (Gauld & Mitchell (1981)
Enicospilus obliquus (Morley)	Fullaway (1957); Yu *et al.* (2005)	Misidentification of *E. aequalis* (Gauld & Mitchell 1981)
Ophion inutilis Smith	Fullaway (1957); Yu *et al.* (2005)	*O. inutilis* belongs to derived species group endemic to New Zealand (Gauld & Mitchell 1981)
Tryphoninae		
Netelia opacula (Thomson)	Turner (1919); Fullaway (1957)	Identifications unreliable
Netelia testacea (Gravenhorst)	Morley (1915); Fullaway (1957)	Identifications unreliable

Table 4: Fijian ichneumonid collecting summary. Samples include only Malaise trap collecting events from the current study that collected at least one ichneumonid, not collecting events from previous surveys or collections by hand or pan trap, all of which produced relatively neglible additional material. Island codes are the same as for Table 1.

	Islands Sampled										
	GA	**KR**	**KV**	**LK**	**MC**	**ML**	**TA**	**VL**	**VN**	**YS**	**ALL**
Species recorded	33	31	28	8	2	2	32	79	31	1	**114**
Samples	38	25	32	17	3	8	70	120	43	6	**362**
Species/ sample	**0.9**	**1.2**	**0.9**	**0.5**	**0.7**	**0.3**	**0.5**	**0.7**	**0.7**	**0.2**	**0.3**
Sites collected	3	3	2	3	1	3	5	14	4	2	**40**
Species/ site	**11**	**10**	**14**	**2.7**	**2.0**	**0.7**	**6.4**	**5.6**	**7.8**	**0.5**	**2.8**

Ichneumonids were collected from ten island groups (Table 1). In total, more than 3700 specimens from 393 collecting events (362 Malaise trap, 15 sweep net, 16 yellow pan trap) at 71 sites were examined, of which over 1600 were dried and mounted. Those that were not mounted were mostly common, easily recognizeable species.

In terms of species, at least 114 were collected in 34 genera in 15 subfamilies. The distribution of these species by island or island group is shown in Table 1 including totals for each island. Ten additional literature records from Fiji were not confirmed by specimens collected in this study but are considered credible (Table 2), therefore the total number of credible ichneumonid records from Fiji is 124 species in 36 genera in 15 subfamilies. Seven previous Fijian species records were considered to be incorrect (Table 3). Of the total 124 credible species records, as few as 25 are described (20.1%) (Tables 1 and 2). This percentage may increase as specimens are compared with previously described type material; however, it is probably more likely that the percentage described will decrease because of the discovery of cryptic morphospecies within the 124 records, not to mention collection and examination of new material which will probably add completely new records of species to Fiji.

In terms of verification of previous species records, 18 of the 28 previous records were verified by specimens collected in this study (marked with an asterisk in Table 1) and the remaining ten are listed with explanation in Table 2. Of the 28 previously recorded species, only 4 are endemic to Fiji (denoted in Tables 1 and 2 with an ^E). Of the 24 non-endemic species, six were deliberately introduced to Fiji for biological control of pests (denoted in Tables 1 and 2 by ‡) (Lever 1937; Hinckley 1963; Clausen *et al.* 1978; Gauld *et al.* 1997).

Below is the key to the 15 subfamilies and 36 genera that are credibly recorded from Fiji (Tables 1 and 2). Additional information on each subfamily is summarized following the key including biology, relative richness of the group in the world and in the south Pacific, relative abundance within Fijian Malaise trap samples and details about specific taxa found in Fiji.

KEY TO THHE GENERA OF ICHNEUMONIDAE OF FIJI

1. T1 with spiracle posterior to middle (Fig. 12e), in dorsal view either petiolate (slender anteriorly and medially but with posterior part strongly widened) (Fig. 13a), or cylindrical (slender and parallel-sided anterior of spiracle and only slightly widened posteriorly) (Fig. 13c) **2**

–. T1 with spiracle at or anterior to middle of tergite (Fig. 1p), in dorsal view gradually widening posteriorly (Fig. 13b) **26**

2(1). Forewing with areolet obliterated (vein Rs touching vein M so that veins 2rs-m and 3rs-m are both indistinguishable) (Fig. 6a) **AND** maxillary palpus long, able to extend posterior to anterior margin of metapleuron. Mandible strongly tapered. Malar space with a thin, deep subocular groove running from eye to base of mandible ... **Orthocentrinae (in part)** .... *Proclitus* Förster

–. Forewing with areolet not obliterated: vein Rs separated at least partially from vein M so that either vein 2rs-m present (Fig. 5c) or vein 3rs-m present (Fig. 6b) or both present (Figs. 5a, b, f), **BUT IF** veins Rs and M close to touching (e.g., Fig. 18a) **THEN** maxillary palpus not able to extend posterior to anterior margin of metapleuron. Mandible moderately to strongly tapered. Malar space with or without a thin, deep subocular groove **3**
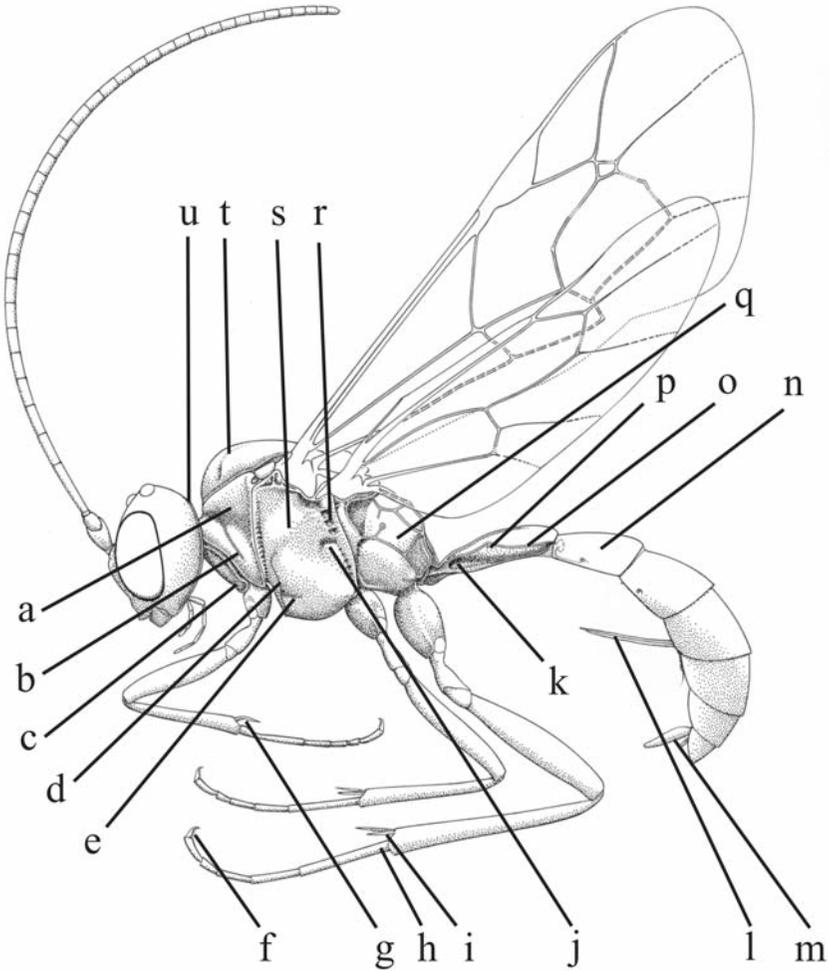
Figure 1. Ichneumonid wasp, lateral view: **a**, pronotum; **b**, epomia; **c**, propleuron; **d**, epicnemial carina; **e**, sternaulus; **f**, hind tarsal claw; **g**, fore tibial spur; **h**, basal segment of hind tarsus; **i**, hind tibial spur; **j**, mesopleural fovea; **k**, glymma; **l**, ovipositor; **m**, ovipositor sheaths; **n**, tergite of metasomal segment two (T2); **o**, dorsolateral carina of tergite one (T1); **p**, spiracle of T1; **q**, propodeum; **r**, mesopleural suture; **s**, mesopleuron; **t**, notaulus of mesoscutum; **u**, occipital carina.

3(2).   Areolet large and diamond-shaped (rhombic) (Fig. 5a) **4**
–.   Areolet various: open (vein 3rs-m absent) (Figs. 5c, d), pentagonal (Fig. 5b), tri-
            angular (Fig. 5e) or irregularly quadrangular (Fig. 5f) **6**

4(3).   Supraclypeal region without a transverse carina ventral to antennal sockets (Fig.
            7c). Eye strongly notched opposite antenna (Fig. 7c). Fore wing length
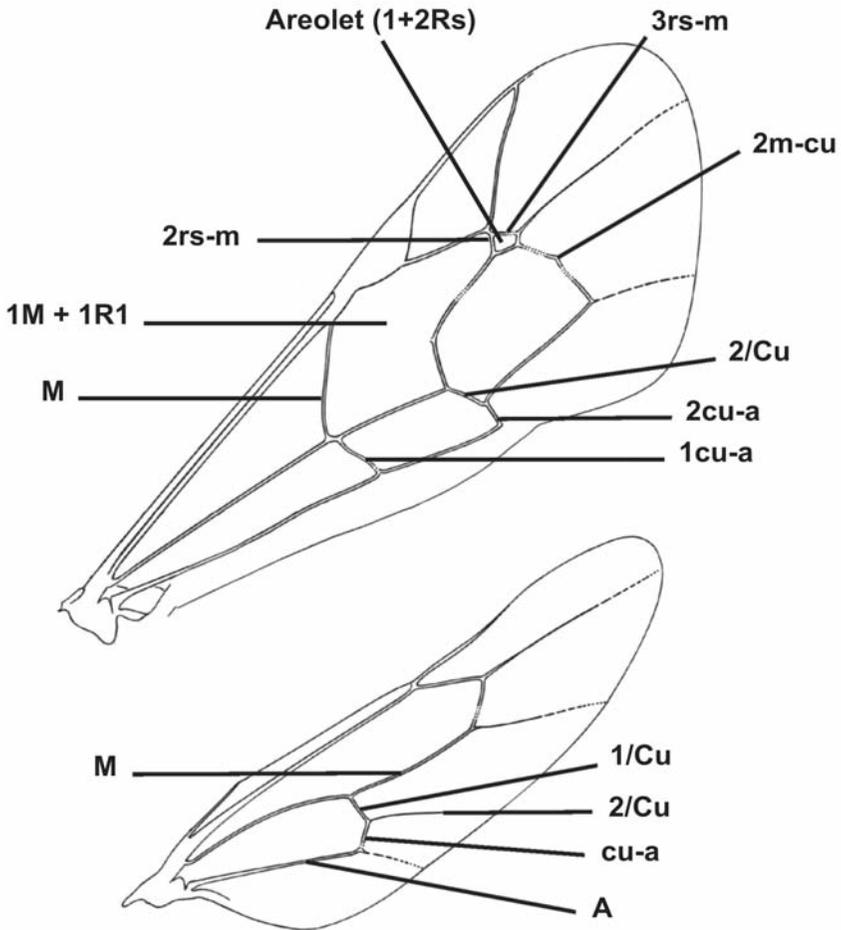
Figure 2. Ichneumonid wasp fore wing (upper) and hind wing (lower). Wing vein abbreviations follow Comstock-Needham system as updated by Ross (1936) and incorporate the recommendations of Goulet & Huber (1993)

greater than 4 mm. *Female*: ovipositor with a dorsal subapical notch (as in Fig. 8b). *Male*: genitalia with gonoforceps wide and rounded apically and bearing hairs (Fig. 12b) ... **Campopleginae** (in part) **5**

–.   Supraclypeal region with a transverse carina ventral to antennal sockets (Fig. 7a). Eye slightly emarginate (not strongly notched) opposite antenna (Fig. 7a). Fore wing length less than 4 mm. *Female*: ovipositor needle-like without a dorsal, subapical notch. *Male*: genitalia with gonoforceps modified into two long, hairless, rod-like stylets apically (Fig. 12a) (not to be confused with female ovipositor sheaths which bear hairs and cover a medial ovipositor) ... **Mesochorinae** .... *Mesochorus* Gravenhorst (in part)

5(4).   Propodeum with spiracle elliptical (Fig. 6f) .... *Dusona* Cameron
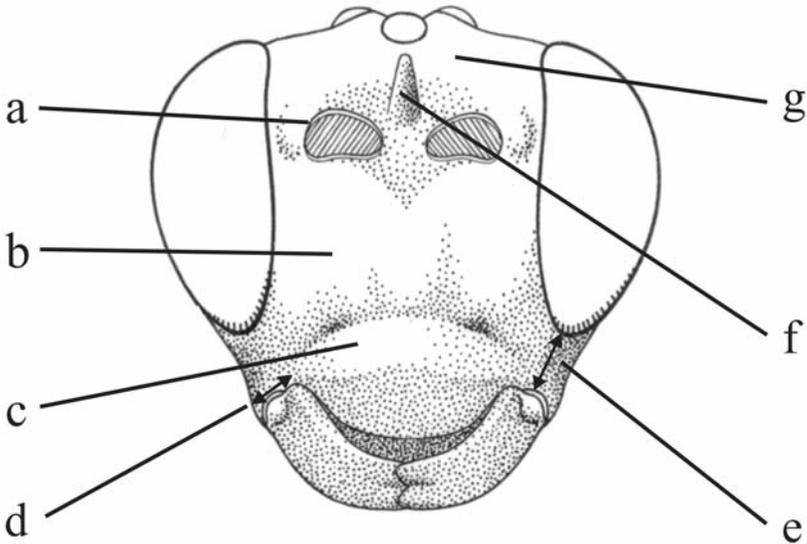
Figure 3. Ichneumonid wasp head, anterior view: **a**, antennal socket (torulus); **b**, supraclypeal area; **c**, clypeus; **d**, arrow indicates basal width of mandible; **e**, arrow indicates malar space; **f**, supra-antennal horn; **g**, supra-antennal area.

–.   Propodeum with spiracle round (as in Fig. 1) .... ***Casinaria*** Holmgren (in part)

6(3).   Fore wing with areolet pentagonal and closed (as in Fig. 5b) **7**
–.   Fore wing with areolet triangular (Fig. 5e), quadrangular (Fig. 5f) or open (Figs. 5c, d) **9**

7(6).   Supraclypeal region without a transverse carina ventral to antennal sockets (as in Fig. 7b). T2 with strong longitudinal striations anterior to thyridium (Fig. 8f). *Female*: ovipositor only slightly extending beyond apex of metasoma. *Male*: genitalia with gonoforceps wide and rounded apically and bearing hairs (as in Fig. 12b) ... **Ichneumoninae** **8**
–.   Supraclypeal region with a transverse carina ventral to antennal sockets (Fig. 7a). T2 without longitudinal striations anterior to thyridium (as in Fig. 8e). *Female*: ovipositor extending greatly beyond apex of metasoma. *Male*: genitalia with gonoforceps modified into two long, hairless, rod-like stylets apically (Fig. 12a) (not to be confused with female ovipositor sheaths which bear hairs and cover a medial ovipositor) ... **Mesochorinae** .... ***Mesochorus*** (in part)

8(7).   Propodeum with spiracle elongate (as in Fig. 6f). Large species (fore wing length 6 to 10 mm). Mesoscutum black, scutellum white to pale yellow .. .. ***Ichneumon promissorius*** (Linnaeus)
–.   Propodeum with spiracle round (as in Fig. 1). Medium sized species (fore wing
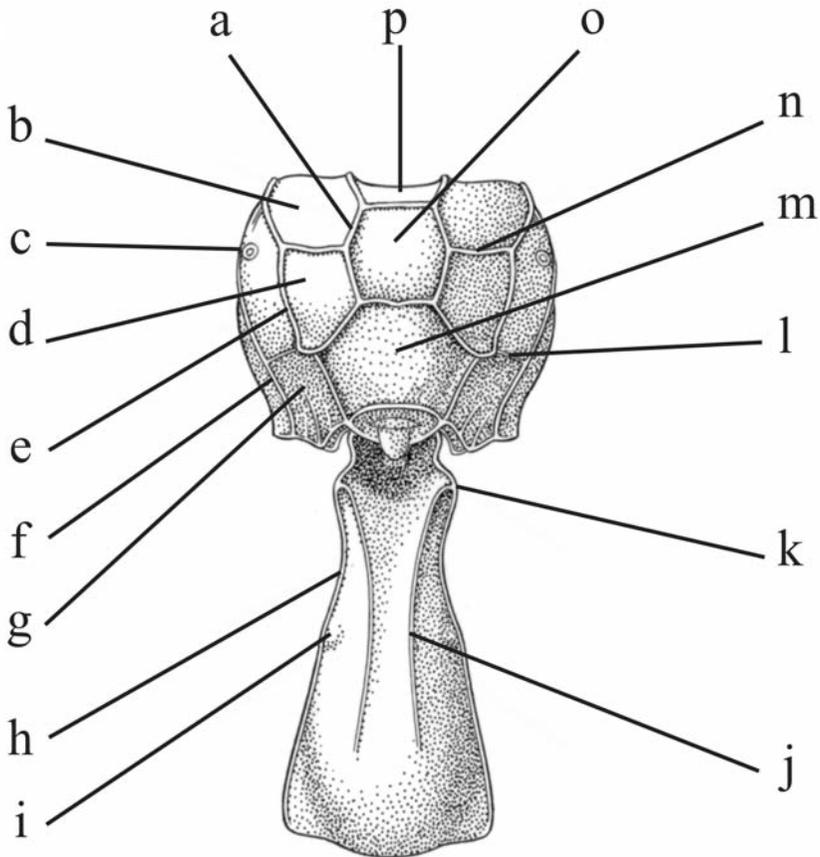
Figure 4. Ichneumonid wasp propodeum (a - g, l - p) and first metasomal segment (h - k), dorsal view: **a**, medial longitudinal carina; **b**, first lateral area; **c**, spiracle; **d**, second lateral area; **e**, lateral longitudinal carina; **f**, pleural carina; **g**, third lateral area; **h**, dorsolateral longitudinal carina; **i**, spiracle; **j**, dorsal longitudinal carina; **k**, anterolateral projection; **l**, posterior transverse carina; **m**, petiolar area; **n**, anterior transverse carina; **o**, areolar area; **p**, basal area.

length less than 4.5 mm). Mesoscutum and scutellum orange to brown ....
.... ***Diadromus collaris*** (Gravenhorst)

9(6).   Areolet open with the remaining intercubital vein joining Cu distal to vein 2m-cu (Fig. 6b). Body colour orange (head and thorax without black markings) .. **10**

–.   Areolet open (as in Fig. 5c) or closed (Fig. 5f), if open, then the intercubital vein basal to vein 2m-cu (Fig. 5c). Body colour various with at least some black markings on the head and/or thorax **12**

10(9).   Clypeus with apical edge truncate (as in Fig. 7f) or uniformly rounded (as in Fig.
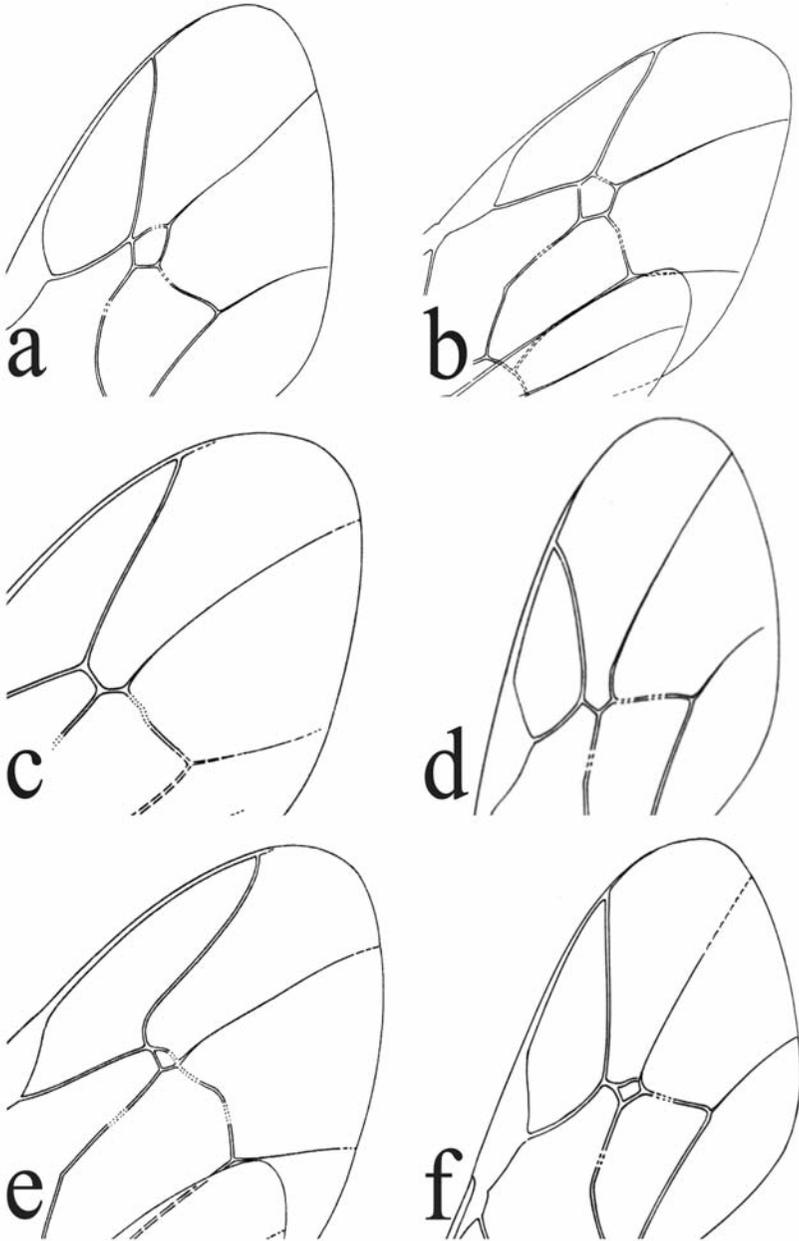
Figure 5. Fore wing, apical half: **a**, *Mesochorus* sp.; **b**, *Ischnus* sp.; **c**, *Eriborus* sp.; **d**, *Paraphylax* sp.; **e**, *Netelia* sp.; **f**, *Casinaria* sp.

7a). Fore wing cell 1M + 1R1 ("horse-head cell") with pigmented sclerites (Fig. 6b) or sclerites absent (as in Fig. 2) ... **Ophioninae** **11**

–.   Clypeus with apical edge pointed medially (Fig. 7b). Fore wing cell 1M + 1R1 without pigmented sclerites (Fig. 15) ...**Anomaloninae** .... ***Pseudanomalon munin*** Gauld and Mitchell

11(10).   Fore wing cell 1M + 1R1 with sclerites (Fig. 6b). Hind wing with five distal hamuli of equal length .... ***Enicospilus*** Stephens

–.   Fore wing cell 1M + 1R1 without sclerites (as in Fig. 15). Hind wing with five distal hamuli with penultimate hamulus much longer than others (most specimens) (Fig. 8d) or with the penultimate hamulus greatly reduced to a much shorter, stub-like remnant (the penultimate hamulus so reduced that it could appear that there are only four hamuli with an enlarged gap between the two most distal hamuli) .... ***Leptophion*** Cameron

12(9).   Mesopleuron with a strong longitudinal groove (sternaulus) extending greater than half the distance from epicnemial carina to posterior edge of meso-pleuron (Fig. 9f). Metasoma dorsoventrally depressed, with T4 and T5 wider than high. Fore wing with areolet open (Fig. 5d). *Female*: ovipositor without a dorsal, subapical notch ... **Cryptinae** **13**

–.   Mesopleuron with sternaulus absent or short, if present, extending no more than half the distance from epicnemial carina to posterior edge of mesopleuron (as in Fig. 1e). Metasoma laterally compressed, with T4 and T5 higher than wide. Fore wing with areolet open (Fig. 5c) or closed (Figs. 5e, f). *Female*: ovipositor with a dorsal subapical notch (most specimens) (as in Fig. 8b) or notch absent **14**

13(12).   Fore wing vein 2m-cu with two unsclerotized regions (bullae) where flexion lines cross the vein (as in (Fig. 2a). Mesopleural fovea consisting of an isolated pit that is not connected to the vertical posterior mesopleural suture (Fig. 10a). T1 smooth (most specimens) or with longitudinal striations. Mandible slightly tapering apically with the teeth subequal (Fig. 11b) .... ***Paraphylax*** Förster

–.   Fore wing vein 2m-cu with a single unsclerotized region (bulla) (as in Fig. 6c). Mesopleural fovea joined to the mesopleural suture by a longitudinal groove (Fig. 11c). T1 with longitudinal striations. Mandible in most spec-imens strongly tapering apically with the dorsal tooth slightly to greatly longer than the ventral tooth (Fig. 11a) or not tapering with teeth subequal .... ***Nipponaetes*** Uchida

14(12).   Mesopleuron with oblique, almost vertical groove medially (Fig. 9e). MS2 with laterotergite not divided from tergite by a crease (Fig. 12f). Clypeus with apical fringe of hairs. Labial palpus with three segments, maxillary palpus with four segments. Small species (fore wing length 2 to 2.5 mm) ... **Tersilochinae** .... ***Diaparsis*** Förster

–.   Mesopleuron without an oblique groove (as in Fig. 1). MS2 with laterotergite divided from tergite by a crease (laterotergites usually folded under tergite) (Fig. 12d). Clypeus without an apical fringe of hairs. Labial palpus with four segments, maxillary palpus with five segments. Small to medium species (fore wing length 2.5 to 6 mm) **15**
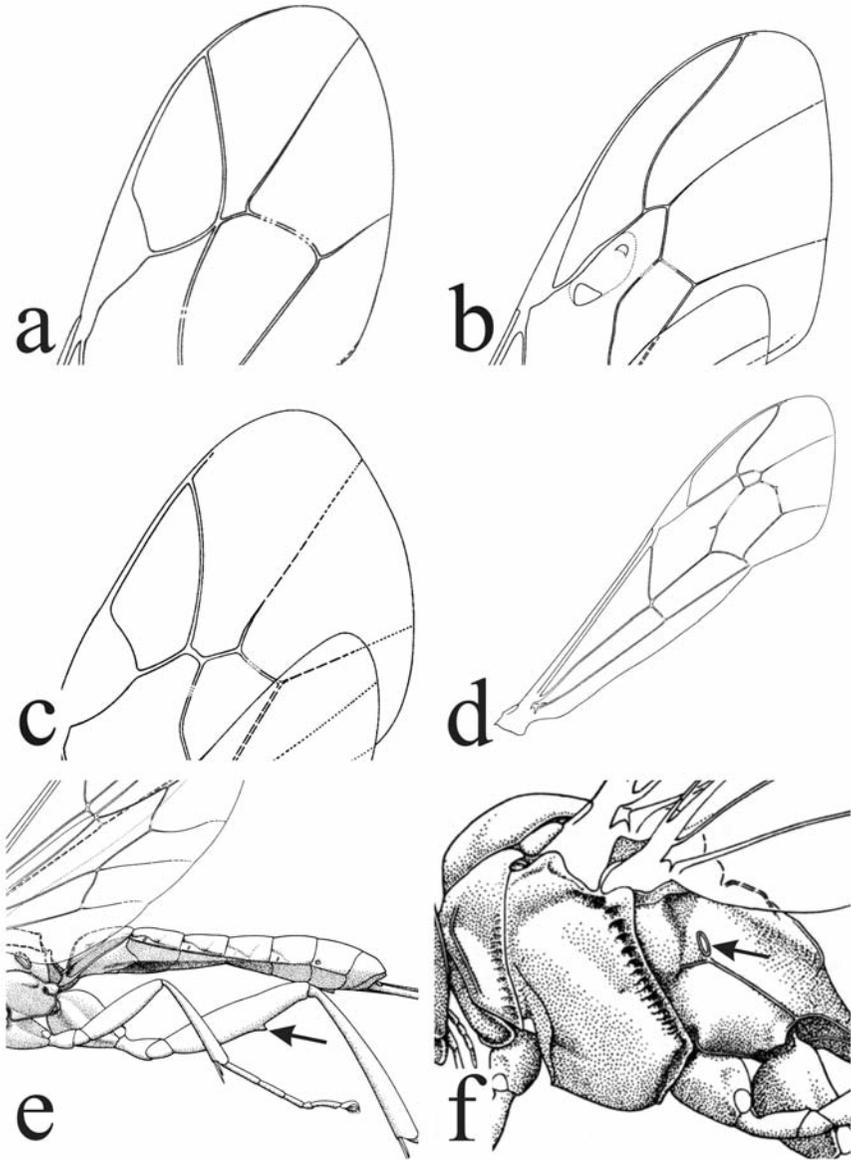
Figure 6. **a–d**, fore wing: **a**, *Proclitus* sp.; **b**, *Enicospilus* sp.; **c**, *Pristomerus* sp.; **d**, *Lissopimpla excelsa*; **e**, metasoma and posterior legs, *Lissopimpla excelsa*. (arrow indicates ventral spine of hind femur); **f**, thorax and propodeum, lateral view, *Dusona* sp. (arrow indicates propodeal spiracle).
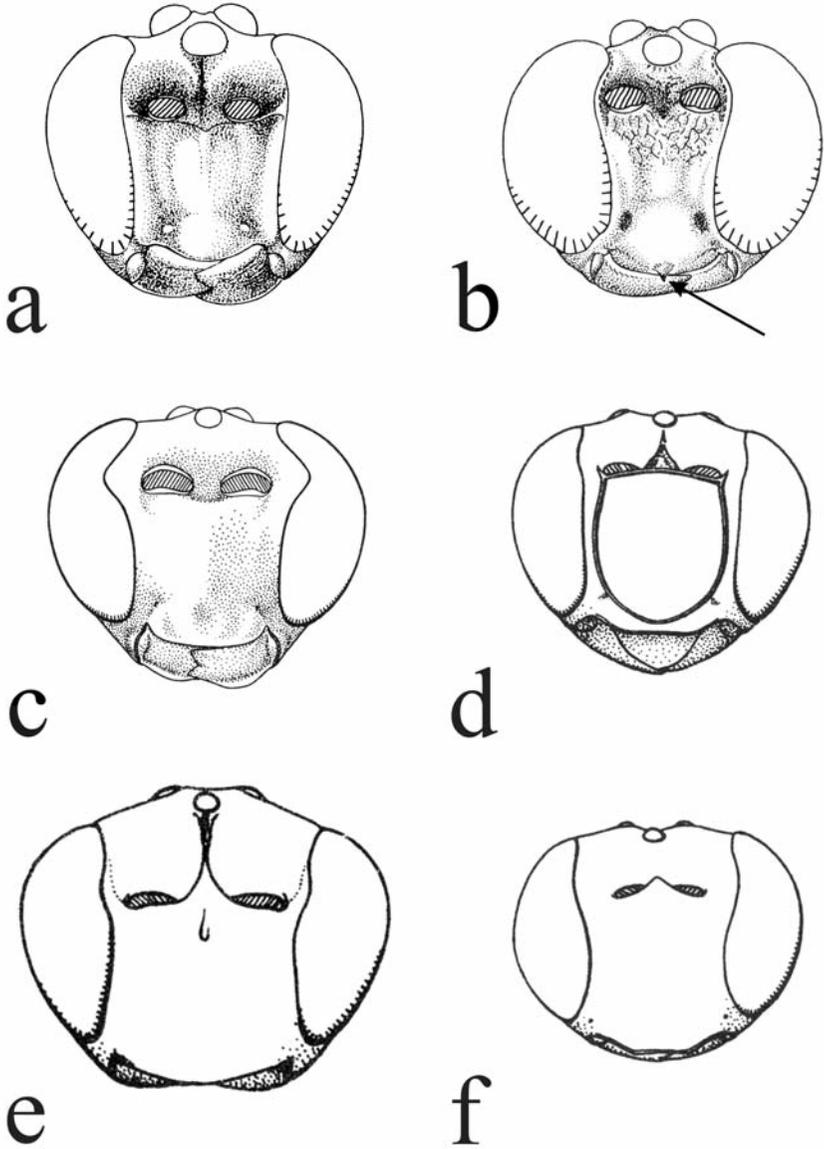
Figure 7. Head, anterior view: **a**, *Mesochorus* sp.; **b**, *Pseudanomalon* sp.; **c**, *Dusona* sp.; **d**, *Metopius* sp.; **e**, *Triclistus* sp.; **f**, *Exochus* sp.
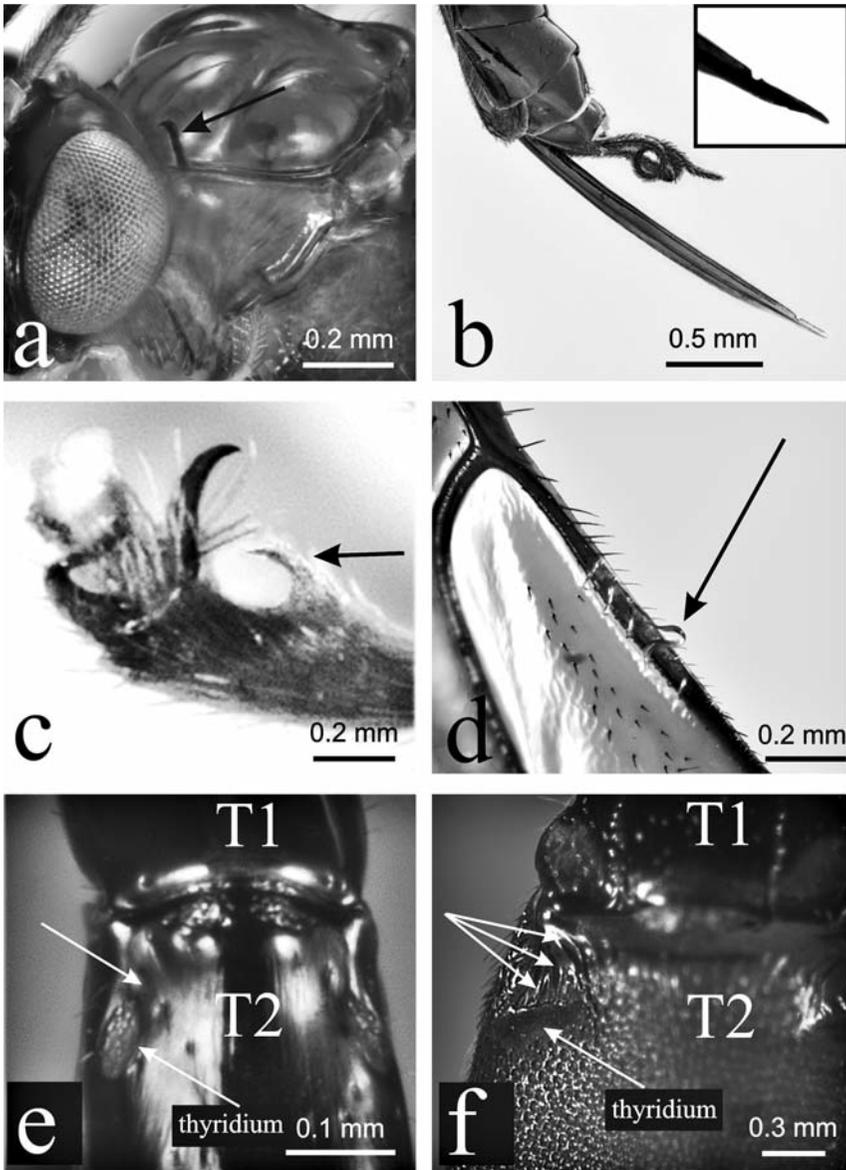
Figure 8. **a**, mesoscutum, lateral view, *Acrodactyla* sp. (arrow indicates vertical carina of mesoscutum); **b**, ovipositor, lateral view, *Tossinola pamianorum* n. sp., holotype; **c**, distal hind tarsomere, *Triclistus* sp. (arrow indicates hooked lobe); **d**, hind wing showing distal hamuli, *Leptophion* sp. (arrow indicates elongate penultimate distal hamulus); e - f, T2 dorsal view: **e**, *Pristomerus* sp. (arrow pointing to anterolateral corner of T2 indicates area that lacks longitudinal striations); **f**, *Ichneumon promissorius* (arrows pointing to anterolateral corner of T2 indicate presence of longitudinal striations).

15(14).   Supraclypeal area entirely black, and either not separated or only weakly separated from clypeus by a groove (Fig. 10b) ...**Campopleginae** (in part) **16**

–.   Supraclypeal area with at least some white, yellow or orange markings, and separated from clypeus by a strong groove (as in Fig. 10c) **22**

16(15).   Areolet closed (Fig. 5a, f) **17**

–.   Areolet open (Fig. 5c) **20**

17(16).   Eye strongly notched opposite antenna (as in Fig. 7c). Propodeum lacking distinct longitudinal carinae medially (Fig. 10e). *Female*: Ovipositor shorter than length of hind tibia .... ***Casinaria*** Holmgren (in part)

–.   Eye slightly emarginate opposite antenna (not strongly notched) (as in Fig. 7b). Propodeum with lateral and medial longitudinal carina medially, thus the second lateral area completely defined by carinae (Fig. 10f). *Female*: Ovipositor shorter or longer than length of hind tibia **18**

18(17).   T1 with glymma present (as in Fig. 12c). *Female*: Ovipositor length 0.4 to 0.6 times length of hind tibia .... ***Diadegma semiclausum*** (Hellén)

–.   T1 with glymma absent (Fig. 12e). *Female*: Ovipositor length greater than length of hind tibia   **19**

19(18).   Fore wing with areolet quadrangular (as in Fig. 5f) and large, the greatest interior distance across the cell greater than four times width of vein 2rs-m. Fore wing membrane slightly darkened. Fore wing length greater than 5 mm. *Female*: antenna with a white band .... ***Venturia*** Schrottky

–.   Fore wing with areolet triangular (as in Fig. 5e) and small, the greatest interior distance across the cell less than three times the width of vein 2rs-m (areolet absent in one wing in some specimens). Fore wing membrane not darkened. Fore wing length less than 4 mm. *Female*: Antenna without a white band .... ***Campoplex*** Gravenhorst (in part)

20(16).   T1 with glymma present as a deep pit (Fig. 12c) **21**

–.   T1 with glymma absent or present only as a shallow, longitudinal groove (Fig. 12e) .... ***Campoplex*** Gravenhorst (in part)

21(20).   Hind coxa black. Tegula black or dark brown. Propodeum with posterior transverse carina strong laterally, but absent medially (Fig. 9c) .... ***Genotropis*** Townes

–.   Hind coxa orange to light yellowish brown. Tegula yellow or white. Propodeum with posterior transverse carina complete medially (Fig. 9d) (most specimens) or weak to absent medially .... ***Eriborus*** Förster

22(15).   Fore wing areolet with vein Rs and vein M very close so that vein 2rs-m is distinguishable only as a slightly pigmented (nebulous) area between the two veins (Fig. 18a). Mandible with dorsal tooth weakly subdivided into two teeth so that mandible appears tridentate (Fig. 18b). Middle and hind legs with tarsus and tibial spurs not separated by sclerotized regions, the tibial apex thus with one large point of insertion (as in Fig. 14a). *Female*: ovipositor without a dorsal, subapical notch ... **Brachycyrtinae** .... ***Brachycyrtus wardae*** **n. sp.**
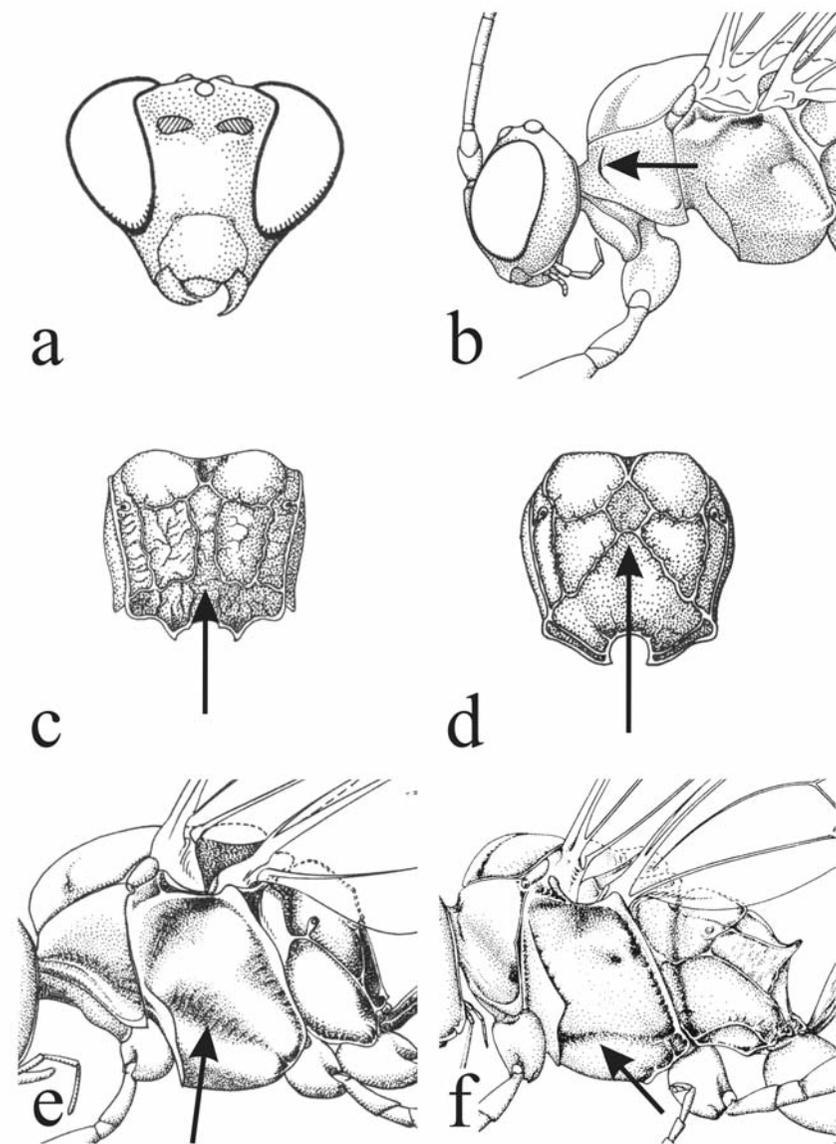
Figure 9. a, head, anterior view, *Echthromorpha agrestoria*; **b**, head and thorax, lateral view, *Zatypota* sp. (arrow points to epomia); c-d, propodeum, dorsoposterior view: **c**, *Genotropis* sp. (arrow indicates lack of posterior transverse carina medially); **d**, *Eriborus* sp. (arrow indicates presence of posterior transverse carina medially); e-f, mesopleuron, lateral view: **e**, *Diaparsis* sp. (arrow indicates oblique groove of mesopleuron); **f**, *Paraphylax* sp. (arrow indicates sternaulus–contrast length with Fig. 1e).
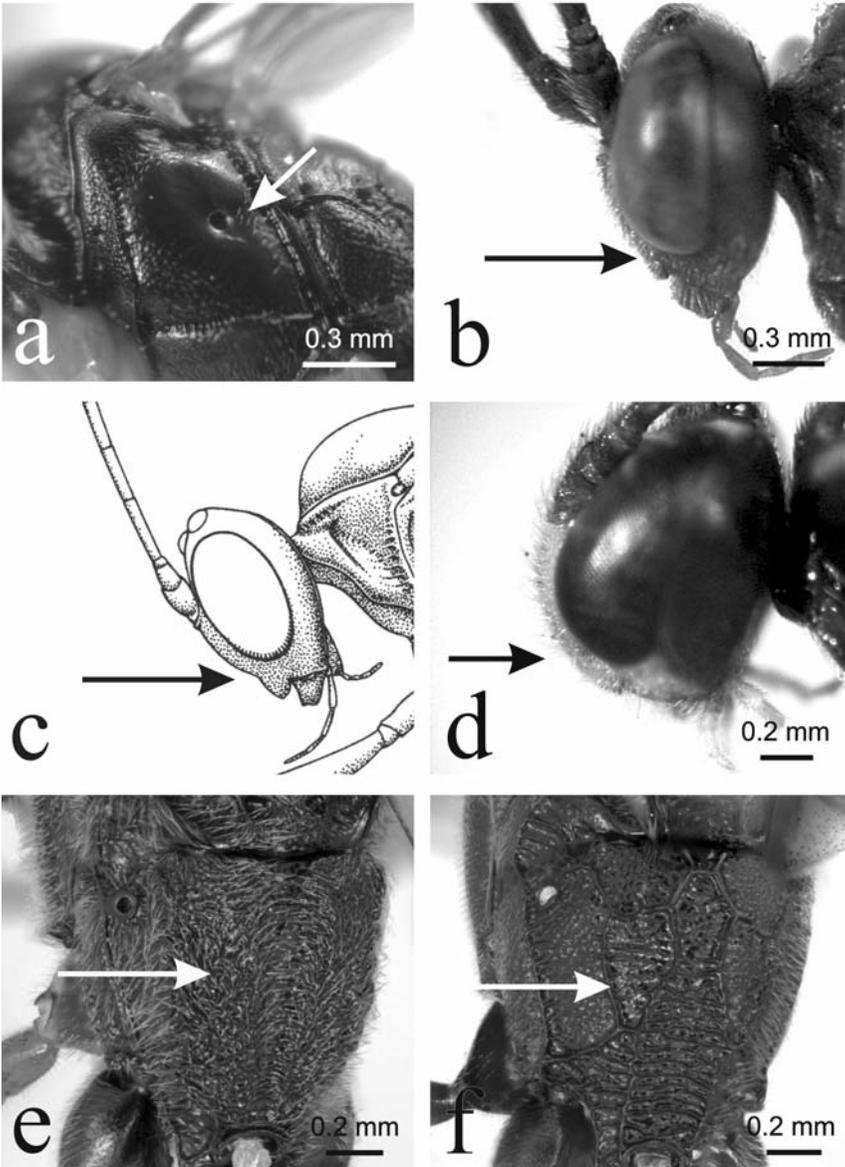
Figure 10. a, mesopleuron, lateral view, *Paraphylax* sp. (arrow indicates lack of longitudinal groove posterior to mesopleural pit); b - d, head, lateral view: **b**, *Dusona* sp. (arrow indicates lack of groove separating clypeus from supraclypeal area); **c**, *Temelucha* sp. (arrow indicates presence of groove separating clypeus from supraclypeal area); **d**, *Exochus* sp. (arrow indicates lack of groove); e-f, propodeum, posterolateral view: **e**, *Casinaria* sp. (arrow indicates lack of longitudinal carinae); **f**, *Venturia* sp. (arrow indicates presence of lateral longitudinal carina).

–.   Fore wing areolet with vein Rs and vein M well separated so that vein 2rs-m is distinct (as in Fig. 5c). Mandible bidentate, the dorsal tooth not subdivided (as in Fig. 3). Middle and hind legs with tibial spurs separated from the base of the tarsus and from each other by sclerotized regions, the tibial apex thus with three separate points of insertion (Fig. 14b). *Female*: ovipositor with a dorsal, subapical notch (as in Fig. 8b) ... **Cremastinae** **23**

23(22).   Hind femur with a ventral, subapical tooth (as in Fig. 6e). Areolet closed (as in Fig. 5f) .... *Eiphosoma* Cresson

–.   Hind femur without a tooth (as in Fig. 1). Areolet open (as in Fig. 5c) **24**

24(23).   T2 with a distinct thyridium (Fig. 8e). Fore wing vein 2rs-m shorter than abscissa of M between 2rs-m and 2m-cu (Fig. 6c) .... *Pristomerus* Förster

–.   T2 without a thyridium. Fore wing vein 2rs-m longer than abscissa of M between 2rs-m and 2m-cu (as in Fig. 5c) **25**

25(24).   MS1 in ventral view with margins of tergite enclosing the sternite so that they are touching or nearly touching along the ventral midline (as in Fig. 13f) .... *Temelucha* Förster

–.   MS1 in ventral view with margins of tergite parallel, not enclosing tergite (as in Fig. 13e) .... *Trathala* Cameron

26(1).   Hind tibia tri-coloured with the following banding pattern from base to apex: brownish orange, white, brown, orange. Mandible with dorsal tooth subdivided so that mandible appears tridentate (as in Fig. 18b) ... **Diplazontinae** .... *Diplazon laetatorius* (Fabricius)

–.   Hind tibia various, but if banded, not with banding pattern above. Mandible bidentate (dorsal tooth not subdivided) (as in Fig. 3) **27**

27(26).   Supraclypeal area with a medial, shield-shaped region bordered by raised carinae (Fig. 7d) ... **Metopiinae** (in part) .... *Metopius* Panzer

–.   Supraclypeal area without raised carinae that delineate a medial, shield-shaped region (as in Fig. 3) **28**

28(27).   Supraclypeal area and clypeus not delineated by a groove in anterior view, the two structures together forming a strongly convex area in profile (Fig. 10d) **29**

–.   Supraclypeal area and clypeus delineated by a groove in anterior view, the two structures not forming one convex area as seen in profile (as in Fig. 10c) **31**

29(28).   Malar space (see Fig. 3e) wide (about 2 times basal width of mandible). Mandibles strongly tapering apically. Supraclypeal area dorsally without a dorsally projecting process between the antennal sockets (as in Fig 7a). Small, delicate specimens: wing length not greater than 2 mm ... **Orthocentrinae** (in part) .... *Orthocentrus* Gravenhorst

–.   Malar space narrow (less than or equal to basal width of mandible) (Fig. 7e). Mandibles only moderately tapering apically. Supraclypeal area dorsally with a dorsally projecting interantennal process (Fig. 7e, f). Medium-sized, robust specimens: wing length 3 to 4 mm ... **Metopiinae** (in part) **30**

30(29).   Interantennal process forming a high, semi-circular flange extending posteriorly between the antennal sockets (Fig. 7e). Areolet closed (as in Fig. 5f) or
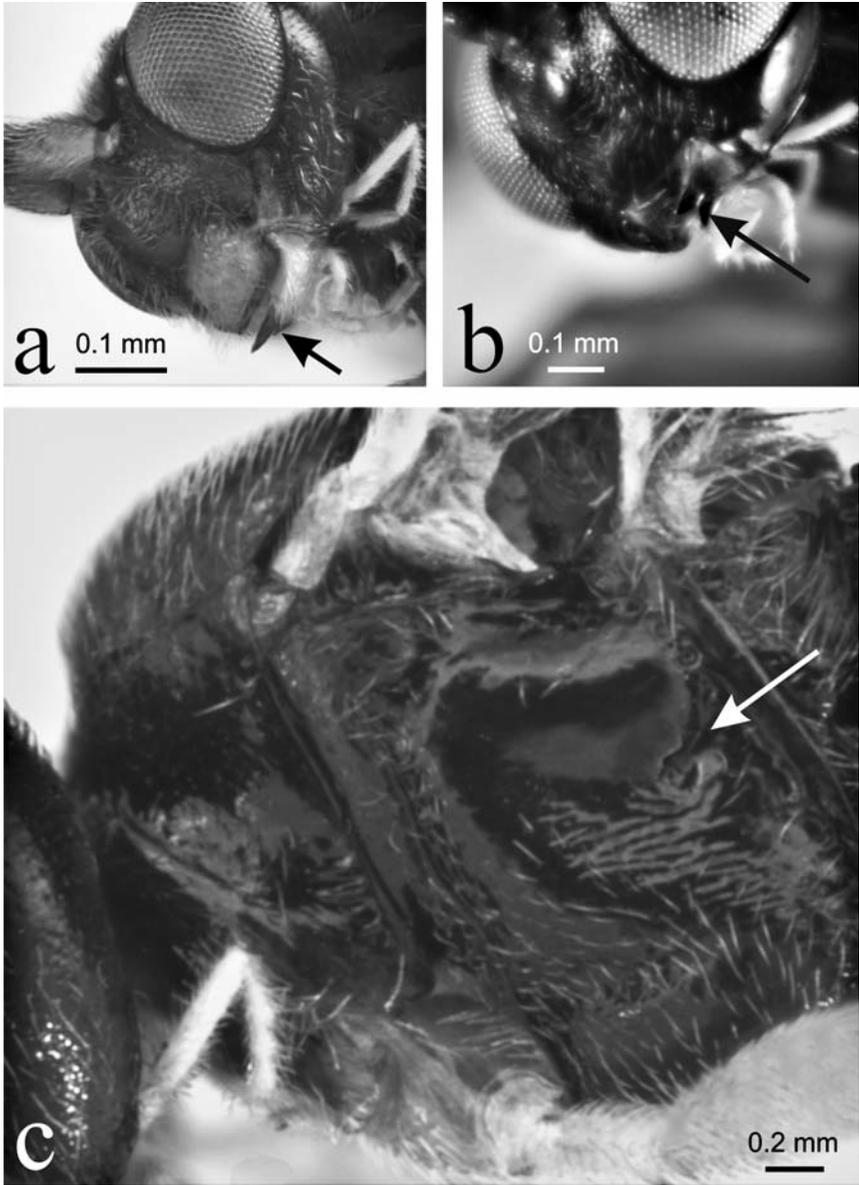
Figure 11. a-b, head, ventroanterior view: **a**, *Nipponaetes* sp. (arrow indicates teeth of mandible); **b**, *Paraphylax* sp. (arrow indicates teeth of mandible); **c**, mesopleuron, lateral view, *Nipponaetes* sp. (arrow indicates presence of groove extending posteriorly from mesopleural fovea).
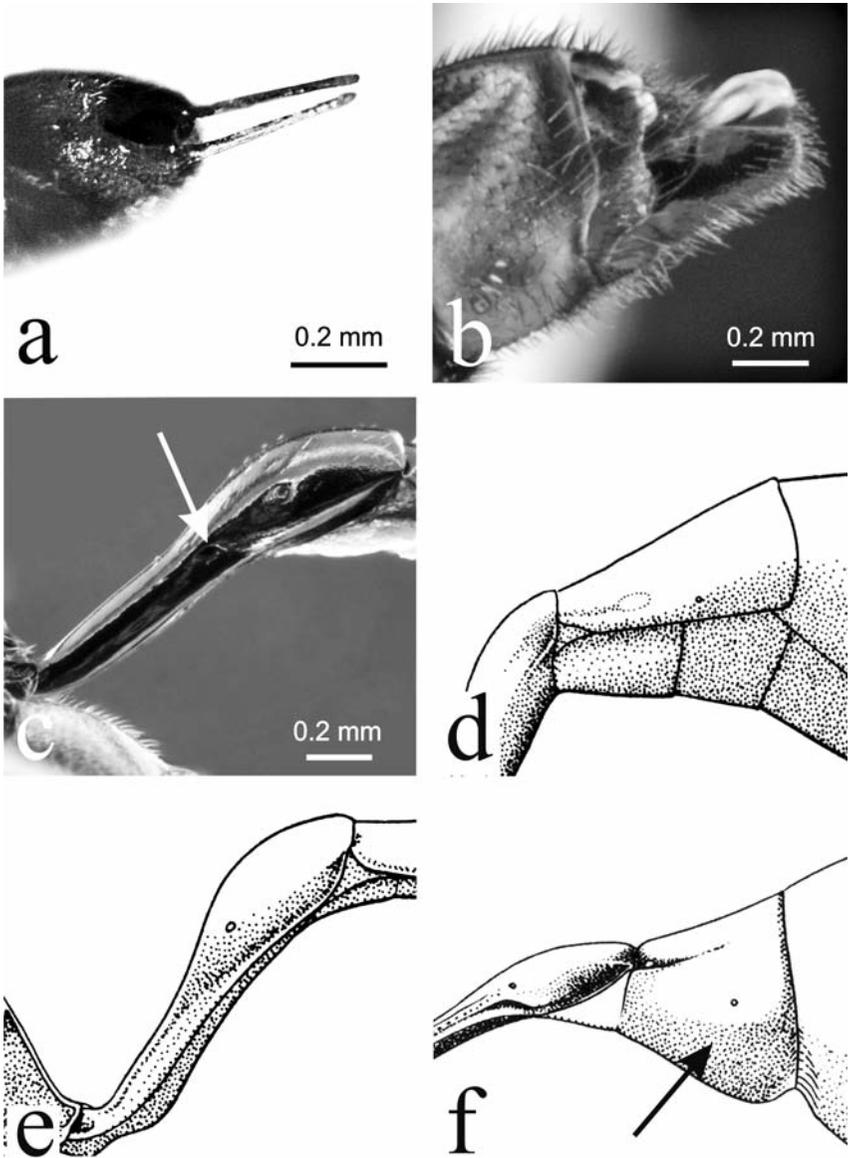
Figure 12. a-b, posterior metasomal segments and gonoforceps (male), ventrolateral view, **a**, *Mesochorus* sp.; **b**, *Casinaria* sp.; **c**, T1, lateral view, *Eriborus* sp.(arrow indicates glymma); **d**, T2, lateral view, *Dusona* sp.; **e**, T1, lateral view, *Campoplex* sp.; **f**, anterior of metasoma, lateral view, *Diaparsis* sp. (arrow indicates laterotergite of MS2).
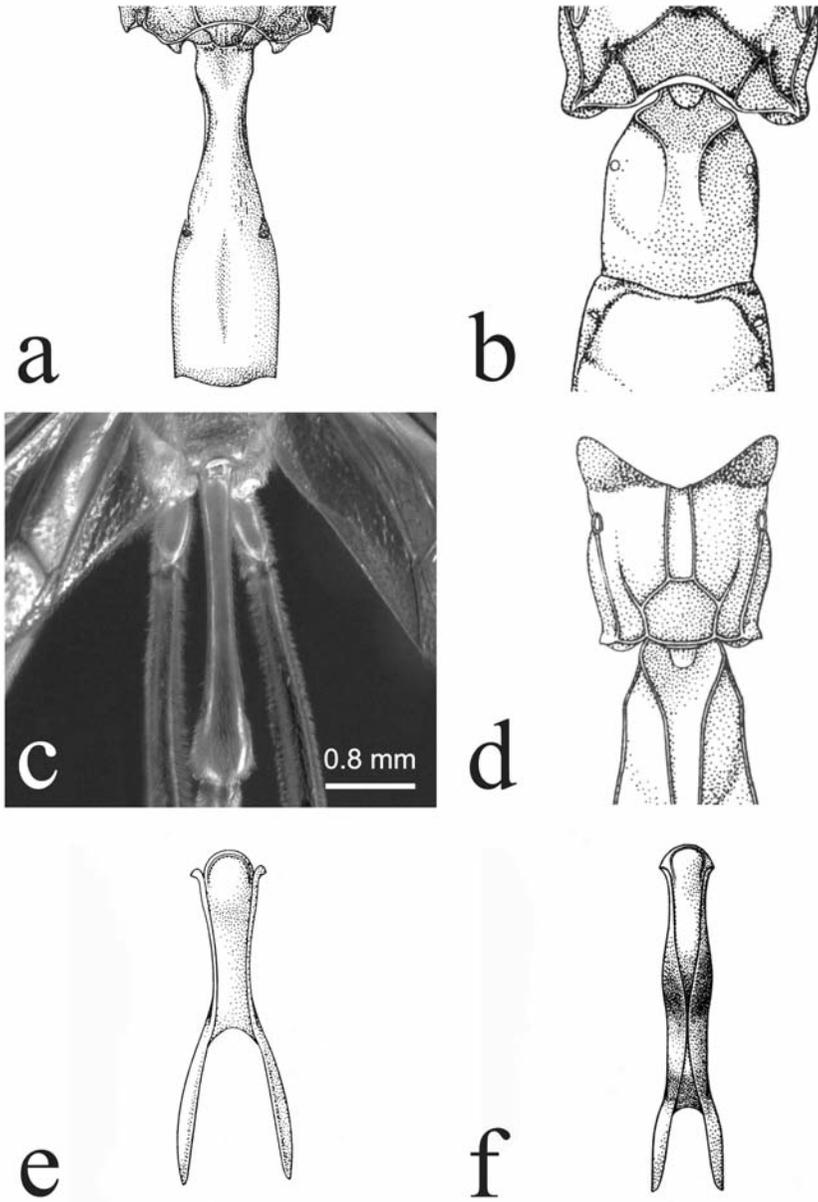
Figure 13. a - c, MS1, dorsal view: **a**, *Mesochorus* sp.; **b**, *Lissopimpla excelsa* sp.; **c**, *Enicospilus* sp.; **d**, propodeum and MS1, dorsal view, *Zatypota* sp.; e - f, MS1, ventral view: **e**, *Pristomerus* sp.; **f**, *Temelucha* sp.
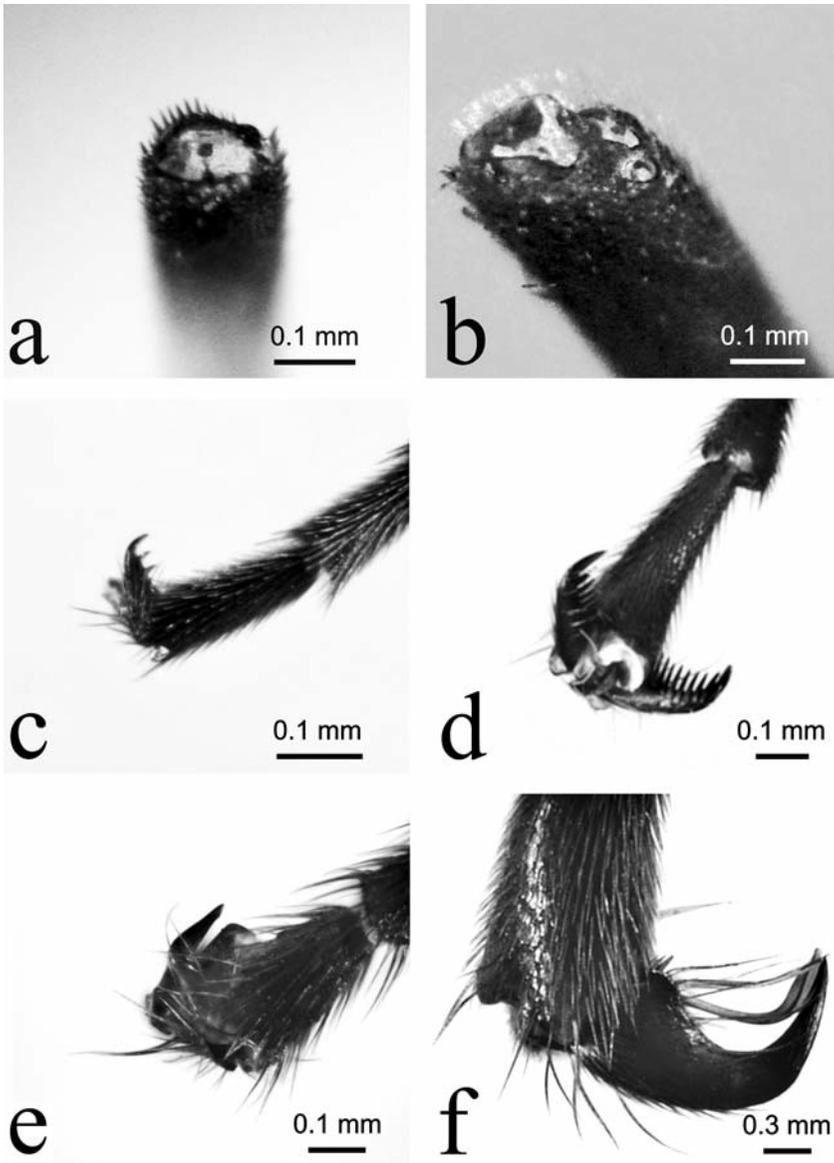
Figure 14. a–b, hind tibia, apical view with spurs and tarsus removed: **a**, *Glypta fumiferanae*, **b**, *Pristomerus* sp.; **c-f** , female hind tarsal claws: **c**, *Tossinola pamianorum* n. sp.; **d**, *Netelia* sp.; **e**, *Eriostethus* sp.; **f**, *Echthromorpha agrestoria*.

open (as in Fig. 5c). *Female*: distal hind tarsomere with a hooked lobe on the inner side (Fig. 8c) .... ***Triclistus*** Förster

–.   Interantennal process not extending posteriorly to form a high, semi-circular flange between the antennal sockets (Fig. 7f). Areolet open (as in Fig. 5c). *Female*: distal hind tarsomere simple, without a hooked lobe (as in Fig. 1) .... ***Exochus*** Gravenhorst

31(28). Tarsal claws strongly pectinate (Fig. 14d). Propodeum without any carina except pleural carina (longitudinal carina just ventral to spiracle) present in some specimens. Hind tibia with some sparse, stout spines on lateral surface that are much more stout than hairs covering most of surface ... **Tryphoninae (Phytodietini)** **32**

–.   Tarsal claws simple, sparsely pectinate (Fig. 14c) or with a large, broad basal tooth. Propodeum with or without carinae. Hind tibia covered with uniform thickness of hairs (without stouter spines) **33**

32(31). Forewing with areolet closed (at least in all Fijian specimens). Body predominantly pale orange (little or no black). *Female*: ovipositor about as long as apical depth of metasoma and tapered to a sharp point, without a strong, dorsal, subapical angular swelling (nodus) .... ***Netelia*** Gray

–.   Forewing with areolet open. Body dark orange brown with vertex and mesoscutum predominantly dark brown. *Female*: ovipositor as long as metasoma with a strong, dorsal, subapical angular swelling (nodus) ... ***Phytodietus*** Gravenhorst

33(31). Tarsal claws with several widely spaced teeth (Fig. 14c). Propodeum with the posterior transverse carina strong, and lateral longitudinal and pleural carinae present only as vestiges, other carinae absent (Fig. 16b). *Female*: Ovipositor with a deep, dorsal subapical notch (Fig. 8b) ... **Banchinae** .... ***Tossinola pamianorum*** **n. sp.**

–.   Tarsal claw simple or with a broad, basal tooth. Propodeum not as above. *Female*. Ovipositor with or without a dorsal, subapical notch, if notch present, weak **34**

34(33). Tergite 2 without oblique grooves extending from middle of anterior edge to lateral edges (as in Fig. 1n). Forewing with vein 2rs-m reclivous (end of vein closest to stigma more apical than the end farthest away from stigma (as in Fig. 5d). Fore wing length 2 mm or less. *Female*. Ovipositor length equal or less than apical depth of metasoma ... **Orthocentrinae** (in part) .... ***Megastylus*** Schiødte

–.   Tergite 2 with oblique grooves extending from middle of anterior edge to lateral edges (Fig. 13b). Forewing with vein 2rs-m vertical (Fig. 5c) or slightly inclivous (end of vein closest to stigma more basal than the end farthest away from stigma). Mandible monderately tapered apically, teeth large and clearly bidentate. Fore wing length 1.5 to 8 mm. *Female*. Ovipositor length 1.5 to 3.0 times apical depth of metasoma ... **Pimplinae** **35**

35(34). Clypeus divided into dorsal and ventral sclerites by a transverse suture (Fig. 9a). Tarsal claws simple with a thick, apically widened hair extending from base to tip of claw (Fig. 14f) ... **Pimplini** **36**

–.   Clypeus not divided by a transverse suture. Tarsal claws simple (male) or with a large, broad basal tooth (female) (Fig. 14e) ... **Ephialtini** **37**
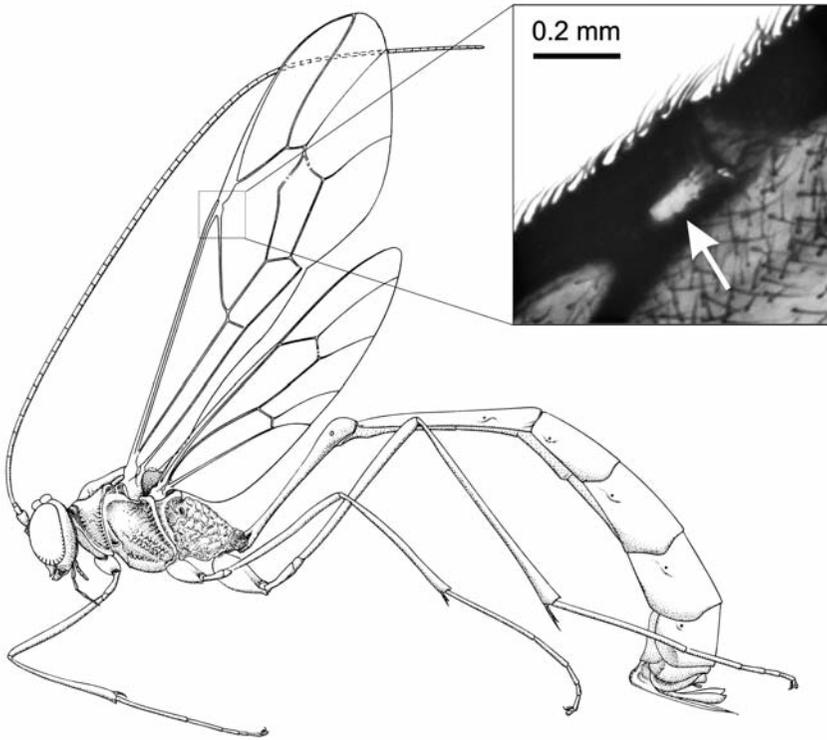
Figure 15. *Pseudanomalon munin* female habitus. Inset is close-up of fore wing with arrow pointing to fenestra at junction of veins Rs + M and Sc + R.

36(35). Hind femur with a ventral, subapical tooth (Fig. 6e). Fore wing vein 1cu-a basal to vein M (Fig. 6d) .... ***Lissopimpla*** Kriechbaumer

–. Hind femur without a ventral, subapical tooth (as in Fig. 1). Fore wing vein 1cu-a opposite or distal to vein M (as in Fig. 2) .... ***Echthromorpha*** Holmgren

37(35). Medial lobe of mesoscutum with a vertical carinae anteriorly on each side just medial to notauli (Fig. 8a). Head black, remainder of body orange to brownish orange .... ***Acrodactyla*** Haliday

–. Mesoscutum without a pair of vertical carinae anteriorly (Fig. 9b). Head yellow or orange, thorax orange and abdomen posterior to T1 dark brown to black ... **38**

38(37). Propodeum with posterior transverse carina (Fig. 13d). Occipital carina complete and strong. Epomia present (Fig. 9b). Head and T1 orange. *Female*: Ovipositor less than or equal to length of hind tibia ...... ***Zatypota*** Förster

–. Propodeum without posterior transverse carina. Occipital carina present ventrally, but absent dorsally. Epomia absent. Head yellow, T1 white. *Female*: Ovipositor greater than length of hind tibia .... ***Eriosthetus*** Morley

Subfamily Anomaloninae

Anomalonines are primary koinobiont endoparasitoids of Lepidoptera or, more rarely, Coleoptera. They lay their eggs in the host larva and emerge from the pupa (Gauld *et al.* 1997). The group is found in all regions with 720 extant described species in 42 genera, although only ten species in six genera are previously recorded from the south Pacific (only known from New Caledonia, Solomon Islands, Vanuatu, Samoa and Fiji) (Yu *et al*. 2005). One species is recorded from Fiji: the endemic *Pseudanomalon munin* Gauld and Mitchell. Nothing is known of its biology, nor of the biology of the entire genus, although the large ocelli, elongate flagella and the lack of black colour of *P. munin* suggests that it is nocturnal based on the known behaviour of unrelated, but similarly structured genera (Gauld & Mitchell 1976). It is a rare species, only known from seven specimens (three from the present study). Consequently, Anomaloninae was the most rarely collected subfamily of ichneumonids in Fiji in the present survey. The only locality previously recorded for *P. munin* was "Fiji" (Gauld & Mitchell 1976).

Pseudanomalon Szépligeti
(Figs. 7b, 15)

Pseudanomalon Szépligeti 1905: 33. Type species: *Pseudanomalon gracile* Szépligeti, by monotypy.

Diagnosis. *Pseudanomalon* can be distinguished from all other Anomaloninae with the exception of a few species of *Aphanistes* Förster by having the lateral ocellus separated from the eye by no more than 0.3 diameter of lateral ocellus (1.0 times diameter or greater in all *Pseudanomalon* spp. and some *Aphanistes* spp.). *Pseudanomalon* can be distinguished from *Aphanistes* spp. with enlarged ocelli in that *Pseudanomalon* does not have the mesoscutum in profile with an angular concavity just anterior to the anterior margin (this region evenly rounded instead).

Species included. Five described species: *P. gracile* Szépligeti from New Guinea, Solomon Islands and Vanuatu; *P. hugin* Gauld & Mitchell from the Democratic Republic of Congo and Sierra Leone; *P. munin* Gauld & Mitchell from Fiji; *P. rectum* (Morley) from Bhutan and Singapore (Morley 1912) and *P. ocellatum* Lee & Kim from Korea (Lee & Kim 1985, 2000). In addition, I have seen two undescribed species: one from Taiwan and one from Uganda (both AEIC). Gauld & Mitchell (1976) revised the four species known to that date and provided a key to species.

Pseudanomalon munin Gauld & Mitchell
(Figs. 7b, 15)

Pseudanomalon munin Gauld & Mitchell, 1976: 121. Holotype (BMNH).

Diagnosis. *Pseudanomalon munin* can be distinguished from all other *Pseudanomalon* spp. by having the supra-antennal area ventral to the median ocellus without rugosity or a vertical, medial carina. The species can be distinguished from all other Fijian ichneumonids by <u>combination</u> of: 1) fore wing with intercubital vein (3rs-m) apical to vein 2m-cu (Fig. 15) and 2) clypeus apically with a strong medial point (Fig. 7b). *Pseudanomalon munin* is a large, reddish brown coloured species (fore wing length 13.0 to 13.3 mm). In

Fiji, it could most easily be mistaken for species in the ophionine genera *Enicospilus* and *Leptophion* and the tryphonine genus *Netelia*. These three genera differ from *Pseudanomalon* by having a truncate or slightly emarginate clypeus (strongly pointed medially in *Pseudanomalon*). In addition, all Fijian *Enicospilus* species have sclerites in the fore wing cell 1M + 1R1 (Fig. 6b), most *Leptophion* spp. have the hind wing with the penultimate distal hamulus much longer than the other distal hamuli (Fig. 8d) and all Fijian species of *Netelia* have fore wing veins 2rs-m and 3rs-m both present (Fig. 5e) (only 3rs-m is present in *Pseudanomalon*).

Material examined. FIJI: 1♀ **Vanua Levu**, Macuata, 0.5 km S. Rokosalase, 16°31'55.2" S 179°1'8.4" E, 97m, Malaise 03, 15.xi-9.xii.2004, I. Sakealevu, FBA 500256 (BPBM); 1♂ **Viti Levu**, Vuda Province, Koroyanitu Park, 1km E Abaca Village, Sauvione Trail, 17°40'01.2" S 177°33'00.0" E, 500m, Malaise 01, 11-19.iii.2003, E. Schlinger, M. Tokota'a, FBA 187953 (CNC); 1♀, Naitisiri Province, 17° 48' 24.1" S 178° 7' 46.2" E, 400m, 28.xi.2002, D. Gruner (BPBM).

Remarks. The type locality of the holotype is simply "Fiji" (Gauld & Mitchell 1976), therefore this is the first precise record of *P. munin* collected from Viti Levu and Vanua Levu.

Subfamily Banchinae

Banchines are primary koinobiont endoparasitoids of Lepidoptera. They lay their eggs in the host larva and emerge from the pre-pupa (Gauld *et al*., 2002a). The subfamily is cosmopolitan with 1705 described species in 61 genera (Yu *et al.* 2005). Prior to this study, the subfamily was not known from Fiji and, in fact, had not been recorded from the south Pacific except for six species of *Lissonota* Gravenhorst from New Zealand (Yu *et al*., 2005).

Tossinola pamianorum **n. sp.** is recorded from Fiji. Nothing is known of its biology, nor of the biology for the genus (Chandra and Gupta, 1977). It is a rare species, known from only seven specimens from one locality (Viti Levu, Colo-i-Suva) which makes Banchinae the third most rarely collected subfamily in Fiji and tied with Diplazontinae for the subfamily with the most restricted range (one locality).

Tossinola Viktorov
(Figs. 8b, 14c, 16)

Tossinola Viktorov, 1958: 1500. Type species: *Tossinola pulchra* Victorov, by original designation.

Diagnosis. *Tossinola* can be distinguished from all other genera of Atrophini by combination of the following: 1) fore wing with areolet open (vein 3rs-m absent); 2) T1–3 densely and strongly punctate; 3) occipital carina joining hypostomal carina well above base of mandible; 4) presence of angular point or lobe around midheight on anterior edge of pronotum. Note that a dorsally interrupted occipital carina is not a generic character for *Tossinola* as mentioned in Townes (1970) because in some species, the carina is complete (albeit weak) medially.

Species included. *T. pulchra* Viktorov from Uzbekistan (Viktorov 1958), *T. breviterebra* Chandra & Gupta and *T. striata* Chandra & Gupta (both from the Philippines) (Chandra & Gupta 1977) and *T. lamellata* (Benoit) from the Democratic Republic of Congo (Benoit 1955). In addition, I have seen the following undescribed species: one from Australia (Queensland), one from China, one from South Africa, one from Kenya, one from Taiwan

(all AEIC) and one from India (CNC). Note that it is likely that the majority of species of *Tossinola* are undescribed. The key below is provided to show which species-specific diagnostic characters have been used previously in *Tossinola*, but it should be used with caution, especially with specimens from areas for which described species are previously unknown. Unfortunately, a complete revision of *Tossinola* was beyond the scope of this paper, but it is hoped that this key will help provide a starting point for future studies.

KEY TO DESCRIBED SPECIES OF *TOSSINOLA*

1.   Fore wing with membrane strongly infumate in apical 0.8 (Fig. 16d). Head (except for apex of clypeus and mouthparts) black (Fig. 16a, c), mesosoma complete-ly yellow (no black markings) (Fig. 16a, b), metasoma completely black (no yellow markings) (Fig. 16a) ... (Fiji) .... ***pamianorum* n. sp.**
—   Fore wing with membrane clear to slightly infumate, not strongly infumate in apical 0.8. Body colour various, but not as above **2**

2(1).   Scutellum completely black **3**
—   Scutellum partly to completely yellow **4**

3(2).   T1 with strong longitudinal striations. Malar space 0.7 to 0.8 times basal width of mandible ... (Philippines) .... ***striata* Chandra & Gupta**
—   T1 without strong longitudinal striations. Malar space as long as basal width of mandible ... (Dem. Rep. Congo) .... ***lamellata* (Benoit)**

4(2).   Mesoscutum predominantly black except for two small yellow anterolateral spots ... (Philippines) .... ***breviterebra* Chandra & Gupta**
—   Mesoscutum predominantly yellow with three longitudinal red spots ... (Uz-bekistan) .... ***pulchra* Victorov**

Tossinola pamianorum Bennett **new species**
(Figs. 8b, 14c, 16)

Diagnosis. *Tossinola pamianorum* can be distinguished from its congenerics by the strongly infumate fore wing (Figs. 16a, d) (all other species have clear to slightly infumate fore wings). It is also the only *Tossinola* species with the following body colour: head completely black (Fig. 16a, c), mesosoma completely yellow/orange, metasoma com-pletely black (Fig. 16a). It can be distinguished from all other Fijian ichneumonids by the unique propodeal carination: posterior transverse carina and remnants of lateral longitu-dinal carinae near posterior transverse carina present, all other carinae (including pleural carina) absent (Fig. 16b). Additionally, the body colour (see above) is unique among Fijian ichneumonids (Fig. 16a).

Description. **Female**. Body length 6.4–7.2 mm. Fore wing length 4.5–5.4 mm.

Head. Clypeus impunctate except for a few fine, widely scattered punctures; supraclypeal and supra-antennal areas coarsely punctate, space between punctures generally less than 0.5 diameter of punctures, interspaces glabrous, supraclypeal area 0.7–0.8 times as wide as high (Fig. 16c); malar space 0.6–0.7 times basal width of mandible; posterior half of vertex and gena glabrous with a few fine, widely-spaced punctures; occipital carina very weak dorsomedially between eyes or absent in this area, joining hypostomal carina dorsal to base of mandible, occipital carina with a sinuation ven-trally; interocellar distance 1.1–1.2 times ocello-ocular distance; flagellum with 26–27 segments, of
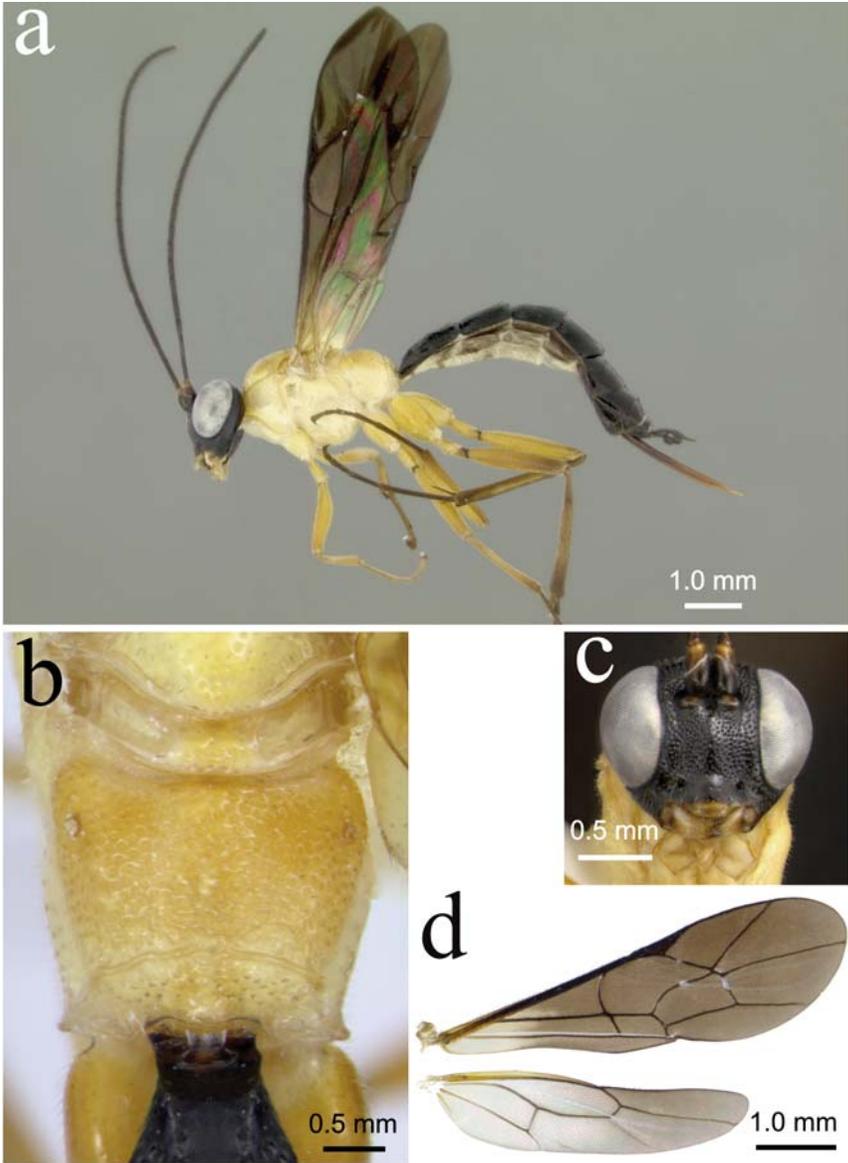
Figure 16. *Tossinola pamianorum* n. sp. female: **a**, habitus, holotype; **b**, propodeum, dorsal view, paratype; **c**, head, anterior view, paratype; **d**, wings, paratype.

roughly uniform diameter from base to near apex, length of first segment 1.7–1.8 times the second. Black, except apical 0.3 of clypeus and palpi yellowish brown; mandibles brown in basal hollow, otherwise white at base gradually darkening to whitish brown, apex brown; scape dark brown, pedicel dark brown basally lightening to yellowish brown apically, flagellum dark brown except base of first flagellomere orange brown.

Mesosoma. Densely, coarsely punctate with interspaces glabrous except as noted; pronotum impunctate ventral to trough, trough without transverse striations, anterior edge with a strong, angulate projection at about midheight, epomia absent; mesoscutum with moderately coarse punctures in anterior half, most of which separated by less than their diameter, posterior half much less densely punctate, notauli absent; scutellum with lateral carinae only at extreme base; mesopleuron with speculum and area ventral to mesopleural fovea almost impunctate with only a few, widely-spaced, coarse punctures; epicnemial carina extending to ventral 0.3 of pronotum, not curving toward pronotum, auxiliary carina short, not reaching epicnemial carina, sternaulus moderately deep but not septate, extending about 0.3 length of mesopleuron; mesosternum with posterior transverse carina of mesosternum absent anterior to middle coxae; metapleuron with submetapleural lobe about as long as apical width of hind tarsus, juxtacoxal carina indistinct; propodeum with posterior transverse carina strong, anterior transverse and medial longitudinal carinae absent; lateral longitudinal carina and pleural carina present only as vestiges just anterior to posterior transverse carina (Fig. 16b); fore wing with vein 1cu-a strongly inclivous, distad of vein M by 0.2–0.3 times length of vein 1cu-a; vein 2rs-m short, basad of vein 2m-cu by about 4 times length of 2rs-m; vein 3rs-m absent; 2m-cu with one wide bulla (0.3 length of 2m-cu) very close to vein M (Fig. 16d); hind wing with vein 2/Cu only pigmented near edge of wing (Fig. 16d), point of intersection with veins 1/Cu and cu-a indicated by a slight angulation just anterior to vein A; hind femur 5.2–5.6 times as long as medial width; hind tibia 8.8–9.4 times as long as apical width; hind basitarsus 2.7–2.9 times as long as longest hind tibial spur; tarsal claws with three stout, widely-spaced teeth (Fig. 14c–note: basal tooth obscured). Dorsal surfaces orange except pale yellow in the following areas: dorsolateral edge of mesoscutum anterior to tegula, longitudinal stripe where notaulus would be if present (Fig. 16a), posterior half of mesoscutum medially, scutellum, metanotum except dorsomedially and propodeum posterior to posterior transverse carina; lateral and ventral surfaces light yellow; legs orange except fore coxa and base of middle and hind coxae light yellow; fore and middle tarsus light brown; middle and hind femur with a ring of brown at extreme base, hind distal trochantellus darkening to brown apically; anterior surface of hind femur darkening to brown in apical 0.2; hind tibia orange brown, except brown subbasally and in apical 0.3; hind tarsus brown; wings with membrane strongly infumate except slightly infumate in basal 0.2 of fore wing and basal 0.5 of hind wing; veins brown (Fig. 16d).

Metasoma. All tergites glabrous with dense, coarse punctures except as noted; T1 1.4–1.7 times as long as apical width, spiracle at 0.4 length of segment, dorsal longitudinal carinae extending to 0.3, ventrolateral carinae to posterior of segment, dorsolateral carinae absent, deep glymma present at extreme anterior, impunctate dorsally between dorsal carinae and medially to 0.5 length of segment, the remainder of segment laterally and posteriorly with punctures separated by diameter of a puncture except slightly more dense posteriorly, posterior of segment without longitudinal striations: S1 extending to 0.2 of T1 and not attached to T1; T2 1.3–1.5 times as long as length of T1; T2–4 with punctures nearly touching except impunctate in anterior 0.1 and posterior 0.1 of each segment; T5 with dense, moderately shallow punctures from 0.2 to 0.8 except laterally, remainder of segment impunctate; T6–8 impunctate; laterotergites of segments 1–4 separated from tergites by a complete crease, laterotergite 5 separated by a partial crease and laterotergites 6+ pendant; ovipositor slightly upcurved, about equal in length to length of hind tibia, dorsal, subapical notch u-shaped, ventral valve strongly tapering apically with a sub-apical constriction (Fig. 8b). All tergites black, laterotergites light brown to brown, S1 brownish white, S2+ light brown, darkening towards posterior of metasoma (hypopygium dark brown); sternal membranes white; ovipositor sheaths black.

Male. As fremale except occipital carina absent dorsomedially between eyes; interocellar distance 1.3 times ocello-ocular space; flagellum with 30 segments, length of flagellum 1, 1.6 times flagellum 2; fore wing with vein 2rs-m not as short as female, basad of vein 2m-cu by 3 times length of 2rs-m;

T1, 1.8 times as long as apical depth; gonoforceps about as long as apical depth of hind tibia, slightly narrowing toward apex, apical edge truncate. Colour as female except regions of pale yellow are pale brownish orange and regions of orange are slightly darker orange; gonoforceps black.

Specimens examined. Types. Holotype ♀, **FIJI**, **Viti Levu**: Naitasiri Province, 4 km WSW Colo-i-Suva, Mt. Nakobalevu, 18° 3' 21.6" S 178° 25' 19.2" E, 325 m, Malaise 02, 15-24.x.2003, Timoci, FBA 500772 (FNIC). Condition: pinned, intact. Paratypes: 1♀, same data as holotype except 12.x-12.xi.2004, FBA 500787 (BPBM); 1♀, same data as holotype except 12.-24.ix.2004, FBA 500781 (CNC); 1♂, same data as holotype except 18°3'25.2"S 178°25'12.0"E, 300 m, Malaise 01, 24.x-12.xi.2004, FBA 500164 (BPBM); 2♀♀, same data as holotype except 24.ix.-12.x.2004, FBA 500957, 500958 (BPBM), 1♀, same as above except FBA 500959 and DNA voucher # AMRB 10-44A (CNC).

Etymology. This striking species is named in honour of Pam Mitchell and Ian Gauld for their outstanding work on the taxonomy of the Ichneumonidae and in particular, their revision of *Pseudanomalon* (Gauld & Mitchell 1976) and the Indo-Papuan Ophioninae (Gauld & Mitchell 1981).

Remarks. This species has only been collected on Mt. Nakobalevu near Colo-i-Suva, Viti Levu. The fact that this is the only known locality in the south Pacific for the entire subfamily Banchinae despite extensive collection (throughout Fiji at least) demonstrates the high endemicity of Viti Levu. This finding has special importance considering the relative closeness of Colo-i-Suva to Suva and potential future conservation concerns.

Subfamily Brachycyrtinae

The biology of the Brachycyrtinae is poorly known; however, *Brachycyrtus pretiosus* Cushman has been reared as a solitary ectoparasitoid from the pre-pupa of *Nodita pavida* (Hagen) (Neuroptera: Chrysopidae) (Carlson 1979) and *B. nawaii* Ashmead has been reared from pupae of *Chrysopa* (Chrysopidae) (Cushman 1936). It is likely that brachycyrtines only develop on Chrysopidae, although all of the reared species belong to a single, structurally uniform species group (Gauld *et al.* 2000). Whether brachycyrtines are idiobionts or koinobionts is unclear. The subfamily is known from all regions with 20 described species in one genus–*Brachycyrtus* Kriechbaumer. The centre of diversity is the Neotropical region with 12 described species. Other regions have no more than three described species each. In the Pacific islands, two species were previously known: *B. taitensis* (Cheesman) from the Society Isles (Cheesman 1928) and *B. nawaii* (Ashmead) from Hawaii (Higa 1983), the latter species also recorded from Japan, China and the Philippines (Yu *et al.* 2005). In addition, *B. baltazarae* Walkley is known from the Philippines (Walkley 1956) and *B. australis* Roman from Western Australia (Roman 1915).

A new species from Fiji is recorded: *Brachycyrtus wardae* **n. sp.** Nothing is known of its biology. It is a moderately common, widespread species, known from 49 specimens from Kadavu, Lakeba, Viti Levu and Vanua Levu as well as American Samoa. Brachycyrtines were the tenth most common subfamily (of 15) collected in this study.

Brachycyrtus Kriechbaumer
(Figs. 17, 18)

Brachycyrtus Kriechbaumer, 1880: 161. Type species: *Brachycyrtus ornatus* Kriechbaumer, by monotypy.

Proterocryptus Ashmead, 1906: 174. Type species: *Proterocryptus nawaii* Ashmead, by monotypy.

Synonymized by Roman (1915).

Xanthocharops Morley, 1912: 173. Type species: *Xanthocharops primus* Morley, by monotypy. Synonymized by Townes and Townes (1960).

Vakau Cheesman, 1928: 189. Type species: *Vakau taitensis* Cheesman, by original designation. Synonymized by Townes (1945).

Brachycyrtomorpha Kreibohm de la Vega, 1940: 170. Type species: *Brachycyrtomorpha crossi* Blanchard, by monotypy. Synonymized by Townes (1945).

Habryllia Walkley, 1956: 318. Type species: *Habryllia cosmeta* Walkley, by original designation. Synonymized by Wahl (1993c).

Diagnosis. *Brachycyrtus* can be distinguished from all other genera of ichneumonids in Fiji in that the fore wing has vein Rs and vein M very close together so that vein 2rs-m is barely discernible as a poorly pigmented region (Fig. 18a). The only other genus in Fiji with an areolet similar to this is *Proclitus*, but the latter has the areolet completely obliterated (vein Rs and vein M touching) (Fig. 6a). In addition, the mandible is strongly tapered apically in *Proclitus*, whereas the mandible of *Brachycyrtus* has the dorsal tooth subdivided making the mandible appear tridentate (Fig. 18b).

Species included. Twenty species of *Brachycyrtus* have been described from all biogeographic regions. In addition, I have seen at least seven undescribed species from the Neotropical, Ethiopian and Australian regions (AEIC, CNC).

Brachycyrtus wardae Bennett **new species**
(Figs. 17, 18)

Diagnosis. *Brachycyrtus wardae* can be distinguished from all other *Brachycyrtus* by combination of the following: 1) fore wing vein 2rs-m nebulous (not tubular) and short (less than or equal in length to width of vein M near 2rs-m) (Fig. 18a); 2) T2 with thyridium present; 3) propodeum with anterior transverse carina present laterally (Fig. 17b); 4) propodeum with spiracle short oval (not elongate-oval or round); 5) scuto-scutellar groove with longitudinal carinae (not smooth); 6) T1 yellow (not black) from 0.1–0.2 (Fig. 17a); 7) antenna without a medial lighter coloured band (Fig. 17a). In addition, most females of *B. wardae* have a distinctive "heart-shaped" pattern on T2 (Fig. 17c) which is not known in other female *Brachycyrtus* spp.

Description. Female. Body length 3.4 to 5.7 mm. Fore wing length 2.5 to 3.6 mm. Body with a moderately dense covering of short, fine, light-coloured setae, densest on mesoscutum, propodeum and metasomal terga.

Head. Supraclypeal and supra-antennal areas moderately punctate, space between punctures polished and generally less than 0.5 diameter of punctures; malar space 0.4–0.7 times basal width of mandible, mandible with dorsal tooth partially bifid at apex so mandible appears tridentate (Fig. 18b). Eye with strong impression adjacent to antenna (Fig. 18b); vertex, occiput and gena polished with fine, setiferous punctures, occipital carina strong ventrally, joining hypostomal carina above mandible 0.6–0.7 times basal width of mandible; ocello-ocular distance 0.7 to 1.0 times diameter of posterior ocellus, flagellum slightly clavate with 27 segments. Lemon yellow to brownish white, except area directly around and between ocelli black and posterior of vertex between eyes brown except for a pale transverse strip separating dark part of vertex from black ocellar region, ventral surface of antenna brownish yellow darkening to brown apically, apex of mandibles and dorsal surface of antenna brown, palpi white.

Mesosoma. Strongly punctate with punctures nearly touching (space between punctures pol-
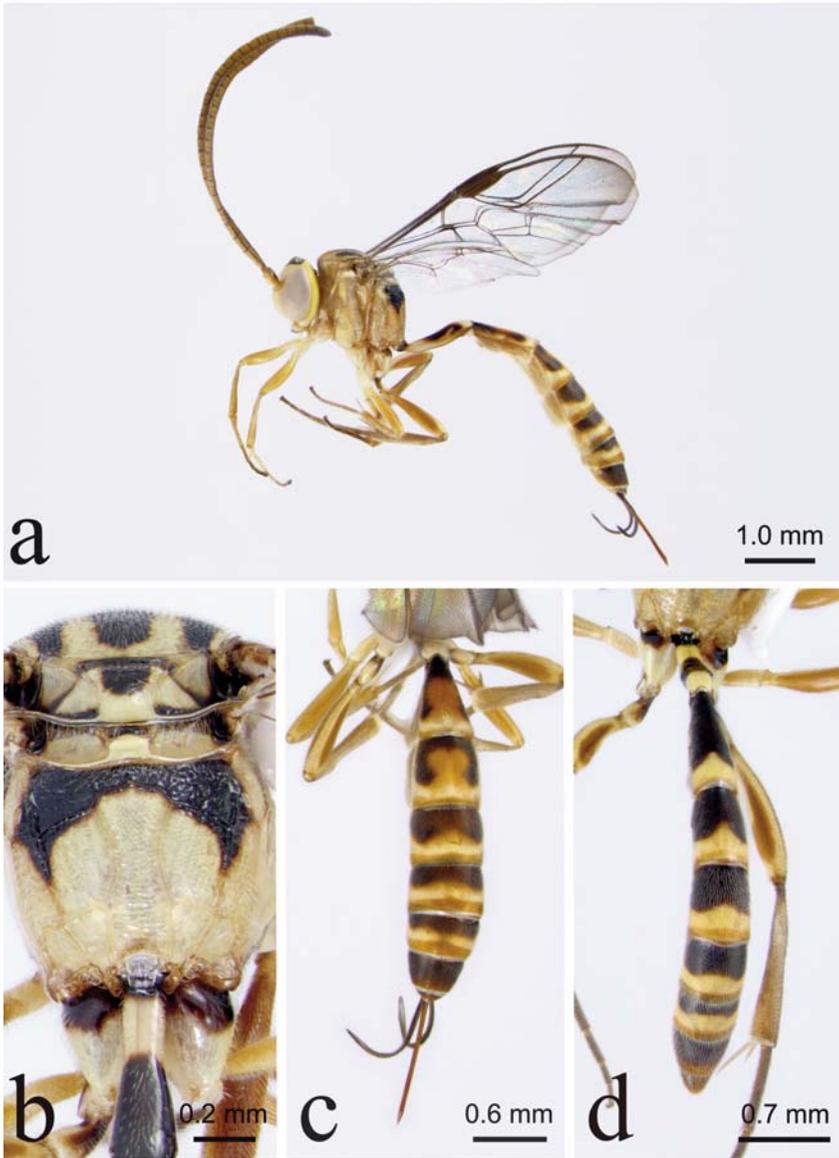
Figure 17. *Brachycyrtus wardae* n. sp.: **a**, habitus, female holotype; **b**, propodeum, dorsoposterior view, male paratype; **c**, T2 and T3, dorsal view, female holotype; **d**, T2 and T3, dorsal view, male paratype.
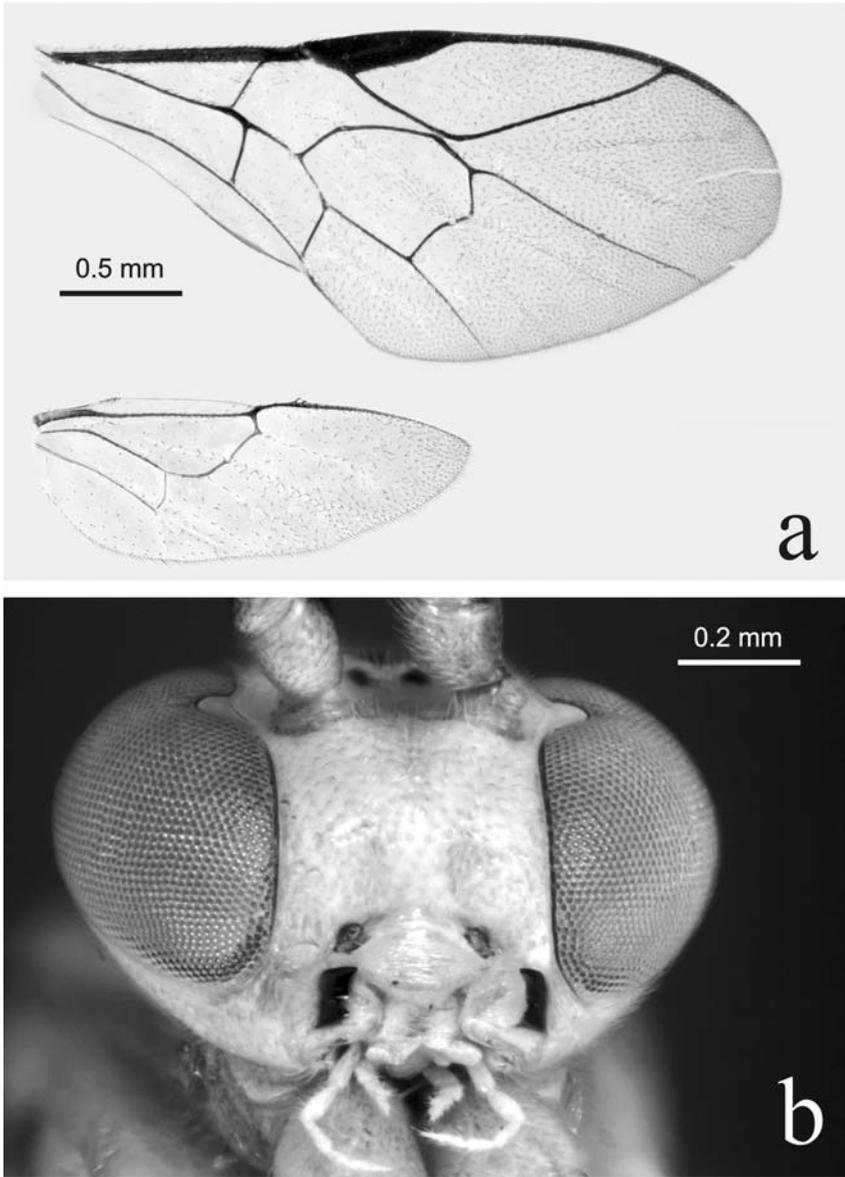
Figure 18. *Brachycyrtus wardae* n. sp.; **a**, wings, female paratype; **b**, head, anterior view, male paratype. Note tridentate mandibles in b.

ished), except the following areas polished with fine, setiforous punctures: pronotum, mesopleuron anterior to epicnemial carina and speculum, posterior of subtegular ridge; epomia straight, flange-like and extending to dorsal edge; mesoscutum with a weak, short anterolateral crest; mesoscutum divided from scuto-scutellar groove by a transverse ridge; scuto-scutellar groove with about nine parallel, longitudinal ridges; scutelleum with lateral carinae flange-like basally and extending to about 0.7 of length; mesosternum longer than greatest diameter of scape in profile; posterior transverse carina of mesosternum present medially; epicnemial carina extending to middle height of pronotum then curving anteriorly toward (but not reaching) pronotum; propodeum strongly punctate to rugoso-punctate; propodeal spiracle moderately to strongly elongate-oval; anterior transverse carina complete with medial section slightly (not strongly) pointed medially (Fig. 17b); posterior transverse carina complete laterally but absent medially, thus areolar and petiolar regions joined, this area entirely crossed by strong, transverse striae; lateral and medial longitudinal carinae complete; pleural carina complete; fore wing vein 1cu-a distal to vein Rs&M by 0.3–0.4 times length of cu-a; fore wing vein 2rs-m nebulous (not tubular) and short (less than or equal in length to width of vein M near 2rs-m) (Fig. 18a). Light brownish white to pale yellow except the following parts dark brown to black: three parallel longitudinal stripes on mesoscutum (one medial and two lateral) from one-third length to near posterior edge, the black occupying less than half total area of mesoscutum; scuto-scutellar groove; medial one-half of dorsal surface of scutellum from base to near apex and also a thin line at extreme ventral edge of scutellum from base to near apex (not joining medially); thin line at extreme dorsal edge of metanotum from base to apex; brown spot on mesopleuron just ventroposterior to posterior end of sternaulus present in some specimens (absent in most); groove separating mesopleuron from propodeum in some specimens; propodeum anterior to anterior transverse carina and medial to spiracles (brown extending slightly posterior to anterior transverse carina in some specimens); coxae and trochanters pale brownish white except hind coxa with brown spot in basal one-quarter of posterior surface (at extreme base only in a few specimens) and hind basal trochantellus completely brown in basal quarter with a brown stripe on anterior (outer) surface extending to near apex and a brown stripe on posterior surface to half; fore femur brownish yellow except whitish yellow at base and extreme apex; middle and hind femora brownish orange on anterior and posterior surfaces from near base to 0.9 of length, dorsal and ventral surfaces whitish yellow, the orange stripes on hind femur darker than middle femur; fore and middle tibiae brownish yellow to brownish white; hind tibia light brown; fore and middle tarsi light to medium brown, hind tarsus brown, all tarsi darkening from base to apex; wing membranes clear, wing veins brown.

Metasoma. Polished with fine setiferous punctures except S1 granulate; T2 length 1.8 to 2.3 times apical width (Figs. 17a, c); thyridium strongly impressed, oblique; ovipositor 1.5–1.6 times as long as length of hind tibia. T1 white, except extreme base including dorsal propodeal-metasomal tendon dark brown and two lateral elongate dark brown markings from 0.3 to 0.8 excluding area around spiracles (Fig. 17a), these markings joined medially from 0.3 to 0.4 in some specimens (including holotype) or joined from 0.3 to 0.7 (American Samoan specimen), dorsal surface orange to brownish orange between dark regions; T2 dark brown in basal 0.3 with brown extending in narrow clavate stripes along dorsolateral edges to 0.8 of segment (Fig. 17c), medial region delineated by brown is orange (yellow in American Samoan specimen), apical 0.1 to 0.2 of segment yellow, lateral edge orange to brownish yellow with a lighter yellow region between thyridium and spiracle, (specimen from Koroyanitu: FBI 203839 has T2 dark brown in basal 0.2, medium brown from 0.2–0.8, slightly darker sublaterally, but clavate stripes not clearly distinguishable); T3 with a roughly u-shaped dark brown pattern extending from anterior edge to 0.8 on lateral edges, area delineated by brown is orange (most specimens) to light brown with the anterior inside edge "heart-shaped" (most specimens) to square (some specimens) (Fig. 17c), 0.8 to 0.9 of segment and lateral edges posterior to spiracle whitish yellow, apical 0.1 dark yellow to orange; T4–6 dark brown from anterior edge to 0.5– 0.7, the medial 0.5 of this area lighter than lateral parts in most specimens, yellowish white from 0.7 to 0.8–0.9, orange from 0.8–0.9 to posterior edge (Fig. 17c); T7–8 brown except fading to orange laterally ventral to spiracles (most specimens), or brown with lateral 0.2 fading to yellow and entire segment fading to orange posteriorly (some specimens); S1 brownish yellow anteri-

orly and brownish orange posteriorly, posterior sternites white; laterotergites and cerci yellowish brown; ovipositor sheath dark brown, ovipositor brownish orange.

Variation in female colour occurs mostly in the dominant background colour which varies from brownish white to tan to lemon yellow. There appear to be no correlating characters with this colour difference and there are specimens with intermediate colour. In addition, yellow specimens were found in the same collecting event with whitish specimens. Accordingly, I believe that there is only one colour variable species present in Fji. Additional colour variation was found in one female from Koroyanitu (FBA 203839) that has T2 and T3 more uniformly brown instead of brown and orange as follows: T2 dark brown in anterior 0.2, light brown from 0.2 to 0.8, brownish yellow from 0.8 to apex (segment is not appreciably darker laterally); T3 with the heart-shaped mark barely distinguishable, the medial region light brown instead of orange and the lateral and posterior parts of segment brownish yellow instead of yellowish white. I do not believe this specimen constitutes a different species because there were no major differences in any structural characters and the overall metasomal colour was similar to other specimens (e.g. the heart-shaped pattern of T3 is present, just less discernible). Finally, the specimen from American Samoa has the sublateral dark markings on T1 joined together medially from 0.3 to 0.7, but otherwise it resembles the Fijian specimens.

Male. Body length 4.7 to 6.1 mm. Fore wing length 2.9 to 4.0 mm.

Head. As female except malar space 0.5–0.7 times basal width of mandible; ocello-ocular distance 0.9 to 1.1 times diameter of posterior ocellus. Dark region of posterior vertex extending laterally to middle of eyes in most specimens, this region narrowly connected to dark interocellar region in some specimens and broadly connected in all specimens to a dark brown to black region on the occiput extending from occipital carina to foramen magnum; supra-antennal region with a dark medial spot in some specimens; antenna dark brown dorsally.

Mesosoma. As female except punctures in areas of strong punctation are sparser and not as deep; wing vein 1cu-a distal to vein Rs&M by 0.3–0.5 times length of cu-a. Brownish white to lemon yellow; black stripes of mesoscutum extending from 0.1 to apex, black occupying about 0.5 total area of mesoscutum; medial three-quarters of scutellum black; mesopleuron with ventroposterior black spot in all specimens, varying from a small round area just ventral to posterior end of sternaulus to a wide crescentic area extending anteriorly to nearly touch epicnemial carina; dark spot dorsal to sternaulus present in most specimens, extending as much as 0.6 length of sternaulus; groove separating mesopleuron from propodeum black in most specimens (yellow in a few); black on propodeum extending posterior to anterior transverse carina along lateral longitudinal carinae in all specimens, extending less than half way to posterior transverse carina (most specimens) or up to three-quarters (some specimens); legs overall slightly darker than female, black on hind coxa more extensive, basal spot extending up to 0.3 of length, black also present in groove near attachment of trochanter in some specimens.

Metasoma. As female except T2 length 2.6–3.0 times apical width (Fig. 17d); gonoforceps narrow, parallel-sided, tapering at apex, extending slightly beyond posterior of metasoma. T1 with sublateral medial black or brown regions joined medially to form a single transverse band (Fig. 17d); T2 black or brown from anterior edge to 0.8, the posterior edge of this dark area invaginated medially, yellow from 0.8 to 0.9, dark yellow to orange from 0.9 to posterior edge (most specimens) (Fig. 17d), middle of dark area may be lighter (i.e., with a brown to orange spot extending from 0.3–0.6 and posterior edge of dark region more invaginated so that the light colour at apex joins medial spot (some specimens); T3 similar to T2, dark to medium brown from anterior edge to 0.7, yellow from 0.7 to posterior edge, slightly darker brownish yellow to orange near posterior edge (most specimens) (Fig. 17d), dark area may be strongly invaginated (u-shaped) with the medial area orange from 0.2 to 0.7 similar to pattern in female although lighter medial region not as wide, occupying no more than one-third the width of segment (some specimens); T4–6 dark to medium brown from anterior edge to 0.6–0.7, yellow from 0.6–0.7 to 0.9, dark yellow to orange from 0.9 to posterior of segments (most specimens), some specimens lighter with anterior brown region only extending to 0.3–0.5; T7 dark brown (most specimens) to brownish orange from anterior edge to 0.5–0.8, brownish orange to brownish yellow from 0.5–0.8 to posterior edge; T8 light brown (most specimens) or brownish yellow; gonoforceps light brown to brownish yellow, darkening towards apex.

Variation in male colouration is similar to the female in that some specimens are predominant-

ly yellow, whereas others are predominantly brownish white. There is also variablity in the amount of dark colouration among males, especially on the supra-antennal area which bears a black spot in some specimens and the mesopleuron which may or may not have a dark mark dorsal to the sternaulus. The ventroposterior dark mark of the mesopleuron also varies greatly in size as does the degree of dark colour on the hind coxa. Finally, the dark marks on T2 and T3 vary, with the majority bearing complete dark bands (Fig. 17d); however, some lighter specimens have orange spots in the middle (dorsally) of the dark bands such that they begin to resemble the female colouration in these segments. There are no correlating characters that suggest that lighter individuals should be separated into a distinct species.

Distribution. Fiji, American Samoa.

Specimens examined. Types. Holotype ♀, **FIJI, Kadavu**: 0.25 km SW Solodamu, Moanakaka Bird Sanctury, 19° 4' 40.8" S 178° 7' 15.6" E, 60 m, Malaise 4, 11.iv–2.v.2004, Schlinger and Tokota'a, FBA 164996 (FNIC). Condition: pinned, both antennae broken after 10th flagellomere and glued to point, left apical flagellomere missing. Paratypes: 4♀, same data as holotype, FBA 165779 (CNC); FBA 165929, 165931 (BPBM); FBA 173536 (BMNH); 1♀4♂, Solodamu, 19° 4' S 178° 7' E, 128 m, FJ-41C Malaise in coastal limestone forest, 25.viii.-23.x.2003, Irwin, Schlinger and Tokota'a, FBA 017359, 017354, 017355, 017358, 017360 (BPBM); 1♀ same as above except FBA 017357 (CNC); 1♂, same as above except FBA 017356, left wings on slide CNC ICHW0001 (CNC); 1♀, nr. Namalata Village, 19° 3' 36.0" S 178° 11' 13.2" E, 139 m, 8-10.viii.2004, Malaise 03, H. Reece, FBA 500091 (CNC). **Lakeba**: 1♂, 3.2 km NE Tubou, 18° 13' 44.4" S 178° 52' 1.2" E, 100m, Malaise 3, 25.xi-7.xii.2005, Saubaleinayau, FBA 533170 (BPBM); 1♂, same as above except 7-19.x.2005, FBA 533637 (BPBM); 1♂, same as above except 19.x-1.xi.2005, FBA 533591 (BPBM); 1♂, same as above except 8-20.viii.2005, FBA 533492 (CNC). **Viti Levu**: 1♀, Nandarivatu, Microwave Station, 1100m, Malaise, 16-23.viii.1978, S & J Peck, left wings on slide CNC ICHW0002 (CNC); 2♂, Naitasiri Prov., Eteni, Navai, 17° 37' S 177° 59' E, 700m, FJ-11D Malaise, 24.x.-8.xi.2003, Irwin, Schlinger, Tokota'a, FBA 021311, 021312 (BPBM); 3♂, same as above except 6.vi-15.vii.2003, Schlinger, Irwin, Tokota'a, FBA 013292, 013293, 013294 (BPBM); 2♂, same as above except (CNC); 1♂, same as above except (BMNH); 1♀, Naitasiri Prov., 1.8 km E Navai, Mt. Tomaniivi, 17° 37' 15.6" S 177° 59' 52.8" E, 700m, Malaise 04, 30.viii-23.ix.2004, FBA 500752 (BPBM); 1♀, Naitasiri Prov., 2 km E Navai, old trail to Mt. Tomaniivi, 17° 37' 15.6" S 178° 0' 0" E, 700 m, Malaise 03, 24.xi-9.xii.2003, Schlinger, Tokota'a, FBA 205216 (BPBM); 1♀, Vuda Prov., Koroyanitu Pk, 1 km E. Abaca, 17° 40' 1.2" S 177° 33' 0" E, 800 m, Malaise 1, 26.xi-3xii.2002, Schlinger, Tokota'a, FBA 182021 (BPBM); 3♂, same as above except 22.iv-6.v.2003, FBA 175043, 175045, 175046 (BPBM); 1♂, same as above except 5.vii-6.ix.2004, Tuimereke, FBA 500682 (BPBM); 1♂, same as above except 6.ix-18.x.2004, FBA 500967 and DNA voucher AMRB 9-31A (CNC); 1♂, same as above except FBA 500969 (CNC); 1♀2♂, same as above except 12-19.x.2002, Tokota'a, FBA 203839 (CNC), 209181 (CNC), 209187 (BPBM); 1♀, Vuda Province, Lomalagi Mt., Vaturu Dam, 17° 44' 42" S 177° 39' 54" E, 540 m, Malaise 05, 31.viii-3.ix.2004, Namaqa, FBA 500205 (BPBM); 1♀, Sigatoka Prov., Sigatoka Sand Dunes N.P., 18° 10' 4" S 177° 29' E, 31m, Malaise, 28.xi-3.xii.03, Irwin, Schlinger, Tokota'a FBA 012767 (BPBM); 1♂, same as above except (CNC); 3♀1♂, Suva northern outskirts, xi.1996, Malaise, A. Van Harten (AEIC), 1♂, as above except x.1996 (AEIC); 1♂, as above except ix.1996 (AEIC); 1♂, Naraiyawa 178° 5'E, 17° 56'S 20-23.xi.1986 R.L. Brown (AEIC). **Vanua Levu**: 1♂, 16° 37' 48" S 179° 12' 28.8" E, 630 m, Malaise 1, 7-18.ii.2006, Garau, FBA 532555 (BPBM). **AMERICAN SAMOA, Tutuila**: 1♀, i.1980, Pago Pago-Krauss (CNC).

Etymology. This species is named after Sondra Ward for her many exceptional contributions to ichneumonid taxonomy and specifically for her work with Ian Gauld on the *Brachycyrtus* of Costa Rica (Gauld *et al*. 2000).

Remarks. Previously, members of the Brachycyrtinae that lacked a thyridium on T2 and had the occipital carina extending to the mandible were placed in the genus *Habryllia*, whereas those with a thyridium and occipital carina meeting the hypostomal carina were placed in *Brachycyrtus* (Walkley 1956). Wahl (1993c) synonymized *Habryllia* (= *cosmeta* species group) with *Brachycyrtus* based on the fact that he could find no defining charac-

ter for *Brachycyrtus* that did not also define *Habryllia*. *Brachycyrtus wardae* has a thyridium and therefore does not belong with the ten described species that comprise the *cosmeta* species group. Among the remaining ten described species of *Brachycyrtus*, the greatly shortened fore wing vein 2rs-m of *B. wardae* may indicate affinity to *B. australis*, *B. taitensis*, *B. baltazarae*, *B. primus* (Morley) (endemic to the Seychelles), *B. luteoniger* Seyrig and *B. fianarensis* Seyrig (both endemic to Madagascar), all of which have this vein somewhat shortened, although not to the extent of *B. wardae*.

Subfamily Campopleginae

Campoplegines are primary koinobiont endoparasitoids (Gauld 1984), mostly in Lepidoptera, but less commonly in sawflies, Coleoptera, Raphidioptera and one species has been reared from a terrestrial larva of a species of Trichoptera (Horstmann 2004). They lay their eggs in the host larva (Miller & Renault 1976), although one species of *Hyposoter* Förster is known to oviposit through the host egg into fully developed first instar larvae (van Nouhuys & Ehrnsten 2004). They generally emerge from the larva (Miller & Renault 1976), although some taxa are known to emerge from the pupa, for example *Benjaminia* Viereck (Wahl 1989) and some species of *Hyposoter* (Short 1978). The subfamily is found in all regions with 2133 species in 70 genera. Twenty species were previously known from the south Pacific and Hawaii (Yu *et al.* 2005), but only five from Fiji including three that were introduced for biocontrol against Lepidoptera: *Casinaria infesta* (Cresson) from Hawaii to Viti Levu against the coconut moth *Levuana iridescens* Betheune-Baker (Zygaenidae) (Tothill *et al.* 1930), *Diadegma semiclausum* against *Plutella xylostella* (Linnaeus) (Plutellidae) (Waterhouse, 1992) and *Venturia palmaris* (Wilkinson) to Viti Levu and Taveuni against the coconut spike moth *Tirathaba trichogramma* Meyrick (Pyralidae) (Lever 1945). *Casinaria vitilevensis* Kusigemati is endemic to Fiji and *Eriborus tutuilensis* Fullaway was described from American Samoa and then later reported from Fiji (Fullaway 1957).

This survey found six genera of campoplegines in Fiji: *Campoplex*, *Casinaria*, *Dusona*, *Eriborus*, *Genotropis* and *Venturia*. No specimens of *Diadegma* Förster were collected. In terms of abundance in Malaise traps, campoplegines are the second most common subfamily of ichneumonids in Fiji after Pimplinae. Excluding the speciose genus *Eriborus*, eight species of campoplegines were recorded (Table 1). Based on differences in the carinae of the propodeum, sculpture and ovipositor length, there are at least 14 species of *Eriborus* in Fiji making it one of the most speciose genera of ichneumonids in the country. It is also one of the most abundant genera of ichneumonids in Malaise traps. There is some question as to the monophyly of *Eriborus* and whether the Fijian species should be assigned to it. According to the key of Townes (1970), the main characters that define *Eriborus* are: 1) hind wing lacking vein 2/Cu and 2) hind basitarsus bearing a medial longitudinal ventral row of short, closely spaced hairs. The presence or absence of the hair row is extremely difficult character to determine, even in specimens identified as *Eriborus* by H.K. Townes. If one interprets the Fijian specimens as bearing the hair row, then they should be assigned to *Eriborus*. If one deems that the hair row is absent, then the specimens should be identified as either *Genotropis* (if the areolar region of the propodeum is open) or *Prochas* (if the areolar region is closed). *Genotropis* is a moderate sized genus from the Oriental region with only the type species described: *G. clara*

Townes (Townes 1970b). Examination of the type species of *Genotropis* as well as undescribed species reveals that one species from Fiji fits within Townes's definition of *Genotropis* with the exception that the glymma in the Fijian species is deeper than material examined in the Townes collection. In constrast, *Prochas* is a small sized genus from the Neotropical region (only one species currently described), and whereas some Fijian specimens may key to this genus, they do not bear the striking autapomorphy of the genus: a strongly convex clypeus in profile (Townes 1970b). For this reason, I have tentatively identified all of the Fijian campoplegines that key to "*Eriborus/ Genotropis / Prochas*" as *Eriborus*, with the exception of one common, distinctive species that seems to bear no hair row and has an open areolar region of the propodeum which I place in *Genotropis*. The recognition of *Eriborus* from Fiji is in concurrence with Fullaway who described *E. tuitulensis* from American Samoa (Fullaway 1940) and later stated that this species was present in Fiji (Fullaway 1957). *Genotropis* is the second most common genus of campoplegine in Malaise traps followed by *Dusona*, with the other genera represented by only a few specimens or singletons. With respect to species previously recorded, *Casinaria vitilevensis* was collected and specimens that fit the description of *E. tutuilensis* were also collected, but comparison with type material is required to confirm the latter. No specimens of *C. infesta* or *V. palmaris* were collected.

Subfamily Cremastinae

Cremastines are primary koinobiont endoparasitoids of Lepidoptera or Coleoptera. They lay their eggs in the host larva and emerge from the penultimate or final larval instar (Gauld *et al.* 2000). There are 752 extant described species in 34 genera found in all regions of the world (Yu *et al.* 2005), but only 13 species in 3 genera known from the south Pacific and Hawaii. Only one species has been recorded from Fiji previously: *Trathala flavoorbitalis* (Cameron) that was introduced from Hawaii to Viti Levu in 1928 and 1935 to attempt to control the rice leafroller *Cnaphalocrocis* (= *Susumia*) *exigua* (Butler) (Lepidoptera: Pyralidae) (Hinkley 1963).

   At least nine species of cremastines in four genera are recorded from Fiji in this study: *Eiphosoma*, *Pristomerus*, *Temelucha* and *Trathala* including *T. flavoorbitalis* (Table 1). The subfamily is a small, but widespread component of the Fijian fauna (eighth in abundance with about 70 specimens). Among the four genera, the only unexpected finding was *Eiphosoma* (five specimens) which is a New World genus with its highest diversity in the Neotropics (Gauld *et al.* 2000). The only previous confirmed record of *Eiphosoma* outside the new world is an introduction of *E. dentator* (Fabricius) to the Mauritius against the pigeonpea borer *Ancylostomia stercorea* (Zeller) (Lepidoptera: Pyralidae) (Bennett 1960). There is also a brief mention by Gauld *et al.* (2000) that "*E. dentator* was transported to Fiji , but apparently failed to establish (record in NHM)". Because Fiji is such a huge range extension for the genus, it seems likely that the introduction mentioned by Gauld *et al.* (2000) did establish, albeit in a very localized, small population in southern Viti Levu (Sigatoka Dunes). A search of the Natural History Museum did not reveal voucher specimens of the Fijian biocontrol project nor information on what species *E. dentator* was meant to help control. The Fijian specimens of *Eiphosoma* have a strongly punctate metapleuron which is a synapomorphy of the *dentator* group of Gauld *et al.* (2000). They also have the same colouration and similar

propodeal carination and the distal abscissa of forewing vein M is spectral–the latter char-
acter is unique to *E. dentator* within the genus *Eiphosoma*. Other characters; however, dif-
fer, for example, the Fijian specimens have a complete pleural carina of the propodeum
(absent posteriorly in *E. dentator*) and the malar space is smaller in the Fijian specimens
(0.5 versus 0.6 to 0.8). Because of the extreme range extension for the genus, it is hypoth-
esized that these differences are simply intraspecific variation within a population of
introduced *E. dentator* and not an undescribed, native species of *Eiphosoma*.

 Pristomerus was rarely collected (only six specimens). Based on punctation and
length of ovipositor there are at least three species in Fiji, but it is very difficult to know
if there are more because the males cannot easily be associated with the females.

 About 30 specimens of *Temelucha* were collected and represent at least three species
based on propodeal carinae and the curvature of the ovipositor, but there may be more
depending on whether colour is fixed for each species.

 Some 30 specimens of *Trathala* were also collected and based on comparison of
specimens at AEI and CNC, most of the them appear to be *T. flavoorbitalis*. This species
is colour variable–the dorsal surface of the body ranging from completely light coloured
to mostly dark. There is at least one other species of *Trathala* in Fiji (sp. 1) that has a com-
pletely black mesothorax and there may be additional cryptic species within the speci-
mens tentatively identified as *T. flavoorbitalis*.

Subfamily Cryptinae

The Cryptinae is the most speciose ichneumonid subfamily worldwide with over 4600
described species in 395 genera (Yu *et al.* 2005). Most are idiobiont ectoparasitoids of
holometabolous pupae or pre-pupae (Gauld 1984), but a few are endoparasitoids, for
example, *Phygadeuon trichops* Thomson inside fly puparia (Monteith 1956). A few are
also predators of spider egg sacs (not considered parasitoids because they consume more
than one host egg to develop); for example, some species of *Gelis* Thunberg and
Paraphylax (Austin 1985). Many are also hyperparasitoids. Among the hyperparasitoid
species, some are facultative parasitoids (i.e., they lay their eggs within the herbivorous
host regardless of whether it has been previously parasitized or not, for example *Aptesis
nigrocincta* (Gravenhorst) (Babendreier 2000). Alternatively, some are obligate para-
sitoids that can only develop when a herbivorous host has been previously parasitized.
Among this group, are species that are considered pseduohyperparasitoids that attack the
primary parasitoid after it has emerged from the herbivorous host and built its cocoon, for
example, *Gelis agilis* (Fabricius) (van Nouhuys & Hanski 2000).

 Despite the great numbers of described species of cryptines, only eight species of
Cryptini (from six genera) and eight species of Phygadeuontini (from six genera) were
previously recorded from the south Pacific including Hawaii. No cryptines were previ-
ously recorded from Fiji except for an erroneous record of *Hemigaster* sp. (Fullaway
1957) (see Table 3).

 This study recorded only two genera, both of which were previously recorded from
the south Pacific: *Paraphylax* and *Nipponaetes*. *Paraphylax* is highly speciose in Fiji,
with at least ten distinct morphospecies. It is also one of the most commonly encountered

genera of ichneumonids in Fiji accounting for the fact that cryptines are the third most abundant subfamily of ichneumonids in Malaise trap samples after pimplines and camplopegines. *Paraphylax* can be distinguished from all other Fijian ichneumonids by the mesopleural foveal pit that is closed posteriorly (Fig. 10a) (not opening posteriorly to form a groove). The most common colour pattern of Fijian *Paraphylax* is to have a black head and orange mesosoma (with an orange metasoma in females and black metasoma in males). *Paraphylax sorianoi* Baltazar has been reared from *Thosea sinensis* (Walker) (Lepidoptera: Limacodidae) on coconuts in the Phillipines (Baltazar 1965) and *P. agelenae* (Momoi) from egg sacs of *Allagelena* (= *Agelena*) *opulenta* (Koch) (Araneae: Agelenidae) (Momoi 1966).

   In contrast to *Paraphylax*, *Nipponaetes* was rarely collected in this survey (only 5 specimens representing 3 species); however, BPBM has a series of 47 specimens of a fourth species (*Nipponaetes* sp. 4) that is labeled: "Bred from caterpillar on coconut: Suva, Aug. 28, 1913". Previous host records for *Nipponaetes* spp. have been from *Grapholita* (= *Cydia*) *molesta* (Busck) (Lepidoptera: Tortricidae) in Japan (Uchida 1933), from *Cotesia ruficrus* (Haliday) (Hymenoptera: Braconidae) on rice pests in China (He 1984) and from spider egg sacs in India (Broad *et al.* 2004). The latter authors questioned the record from *C. molesta* and indicated that the tapered, toothless ovipositor of their reared specimens compared well to other cryptines that oviposit into spider egg sacs. It seems unlikely; however, that the BPBM specimens mentioned above were mistakenly "bred" from spider egg sacs rather than caterpillars as the rearing labels indicate. Since host remains do not appear to have been retained for any of the reared specimens of *Nipponaetes*, the precise host range of the genus is unclear, but there does appear to be a relationship with silk-associated hosts. With respect to the generic identity of the four species of *Nipponaetes*, species 1 and 4 fit well within the concept of *Nipponaetes* because their mandibles have a dorsal tooth that is much longer than the ventral tooth (Fig. 11a). The other two species have a less elongate dorsal tooth, therefore their placement in *Nipponaetes* is less certain; however, for the time being, this is where I prefer to place them. Bennett (2006) did note that there were undescribed species at AEIC that seemed to fit within *Nipponaetes*, but had the dorsal tooth of the mandible only slightly longer than the ventral tooth as is present in the Fijian species 1 and 4.

Subfamily Diplazontinae

Diplazontines are koinobiont endoparasitoids of Syrphidae. Oviposition is into the egg or larva with emergence from the puparium (Fitton and Rotheray 1982; Gauld *et al.* 1997). Worldwide there are 339 extant species in 29 genera (Yu *et al.* 2005). In the south Pacific, only two species are recorded: *Syrphoctonus maculifrons* (Cresson) a widespread North America species that has also been recorded in Hawaii (Townes 1947) and the cosmopolitan *Diplazon laetatorius* (Fabricius).

   Diplazon laetatorius was previously recorded from Fiji (Kusigemati 1985) and was also collected in this study (the only species of Diplazontinae). This species was very rarely collected in this survey (only six specimens from one locality) making diplazontines the second most rarely collected subfamily. See the remarks section under *D. laetatorius* (below) for comments on the range of the species.

Diplazon Nees

Bassus of authors, not of genotype.

Diplazon Nees   *Nov. Acta Acad. Nat. Curios.* 1819: 292. Type species: *Ichneumon laetatorius* Fabricius. Subsequent designation by Viereck, 1914.

Diagnosis. *Diplazon* can be distinguished from all other Diplazontinae by combination of the following: 1) notaulus present; 2) spiracle of MS3 on tergite (not laterotergite); 3) apical edge of clypeus medially concave; 4) T1 to T3 with a postmedian, transverse groove.

Species included. Yu *et al.* (2005) listed 55 species. Most species are recorded from the Holarctic; however, a few species are known from the Oriental, Neotropical and Ethiopian regions. Within the Australian region, *Diplazon novoguineensis* Momoi & Nakanishi is known from New Guinea (Momoi & Nakanishi 1968) and as mentioned above, *D. laetatorius* is cosmopolitan.

Diplazon laetatorius (Fabricius)

Ichneumon laetatorius Fabricius, 1781: 424. Holotype, lost.

Diagnosis. *D. laetatorius* is easily distinguished from all other species of *Diplazon* and all other Fijian ichneumonids by the distinctive tri-coloured hind tibia with the following banding pattern: brown, white, brown and orange from base to apex.

Material examined. FIJI: **Viti Levu**, 3♀ 1.1 km SSW Volvoli, Sigatoka Sand Dunes, 18°10'1.2" S 177°29'6.0" E, 25.iii-6.iv.2004, S. Niusoria, Malaise Trap, FBA 500691, 500700, 500703 (BPBM); 2♀, same as above except 13-27.viii.2004, FBA 500744, 500934; 1♀, same as above except 13-25.iii.2004, FBA 500299 (CNC).

Remarks. This species likely has the greatest geographic range of any ichneumonid (and perhaps any hymenopteran) having been recorded from the Canadian Arctic to Argentina, from Norway to South Africa and Japan to New Zealand including many remote oceanic Islands (e.g. Midway) (Yu *et al.* 2005). As with the subfamily, the vast majority of host records of *D. laetatorius* are from Syrphidae (20 genera). Its wide range is likely a result of human agriculture that has spread it along with aphids and aphidophagous syrphids. Because it parasitizes aphidophagous syrphids it can be considered a pest. It is thelytokous throughout most of its range and males are very rare (Gauld *et al.* 1997). The low specimen numbers collected in this survey was likely because our Malaise traps were not located within agricultural fields where *D. laetatorius* would most likely be expected to occur.

Subfamily Ichneumoninae

Ichneumonines are endoparasitoids of Lepidoptera (Gauld 1984). They oviposit in either the larva, pre-pupa or pupa, but always emerge from the pupa (Heinrich 1961). Ichneumoninae is the second largest subfamily with 4288 described species in 438 genera worldwide but despite its species richness, only sixteen species in nine genera have been previously recorded from the south Pacific including Hawaii (Yu *et al.* 2005).

Two species have previously been recorded from Fiji and only one of these was collected in this study: *Ichneumon promissorius* from Gau, Kadavu, Lakeba, Viti Levu and Vanua Levu (Table 1). This species is widespread throughout eastern Australia as well as New Zealand, New Caledonia and Vanuatu (Yu *et al.* 2005). It has been reared from more than a dozen species of Noctuidae including some very important pest species such as *Helicoverpa zea* (Boddie) (Carpenter *et al.* 1994). The other species recorded from Fiji is *Diadromus collaris* which is a Holarctic and Oriental species that was introduced from New Zealand to attempt control of diamondback moth *Plutella xylostella* in 1943 and 1945 (Waterhouse 1992), but apparently did not establish. It was not recovered in this survey, but is considered a valid record for Fiji (Table 2). *Ichneumon promissorius* is a common species in Fiji (more than 100 specimens collected) making ichneumonines the sixth most commonly collected subfamily. It is instantly recognizeable from all other Fijian ichneumonids by the relatively large size (fore wing length 6 to 10 mm) and body colour: black with pale yellow on scutellum, subtegular ridge, apex of T3 and T6 (plus apex of T4 and T5 in male) and orange on all or part of T2.

Subfamily Mesochorinae

Mesochorines are obligate koinobiont endoparasitic hyperparasitoids of ichneumonoids or rarely tachinids (Wahl 1993b). The primary host is usually a lepidopteran or sawfly larva. The female probes the primary host's haemocoel with its slender ovipositor and if a parasite larva is encountered then an egg is laid inside it (Gauld 1984). Emergence is from the pre-pupa (Allen *et al.* 1969). There are 9 genera (Wahl 1993b) and 868 extant species worldwide (Yu *et al.* 2005), the vast majority of which belong to the highly speciose genus *Mesochorus*. Wahl (1993b) demonstrated that *Mesochorus* is paraphyletic with respect to the genera *Stictopisthus* Thomson and *Plectochorus* Uchida which should therefore be considered junior synonyms. Schwenke (1999) recognized all three genera, justifying his classification because it aided species identification. Wahl's classification is followed here, therefore all species are placed in *Mesochorus*. Only two mesochorine species (*Mesochorus*) were known previously from the south Pacific (one from Guam and one from Palau) (Townes 1958).

At least fourteen species of *Mesochorus* were found in this study (Table 1) from about 50 specimens. *Mesochorus* sp. 1 has some variation in the propodeal carina which may indicate that it is actually multiple cryptic species, but the other thirteen species are relatively uniform and readily distinguishable. Species 4 and 6 have an extremely elongate propodeal apex meaning that they belong to the *iwatensis* species group (formerly *Plectochorus*). Species 3,7,8,10,12 and 14 have no medial notch on the transverse ridge ventral to the antennae and thus belong to species groups that were previously placed in *Stictopisthus*. The fact that the Fijian *Mesochorus* belong to several distantly related species groups indicates that there have been multiple colonization events. Despite the relatively high number of species, mesochorines were relatively uncommonly collected in this survey (less than 50 specimens), constituting the ninth most abundant subfamily.

Subfamily Metopiinae

Metopiines are koinobiont endoparasitoids of Lepidoptera that lay their eggs in the host larva and emerge from the pupa (Gauld *et al.* 2002a). Many species parasitize leafrolling caterpillars and these most likely enter the leaf roll to oviposit because they have short ovipositors and short, strong legs that help the female pull herself into recesses. This contrasts to most other subfamilies that parasitize leafrollers, which oviposit through the leafroll and have correspondingly long ovipositors for this purpose (Gauld *et al.* 2002a). There are 816 extant species worldwide classified into 25 genera (Yu *et al.* 2005). Only two species of metopiines were previously recorded from the south Pacific: *Metopius* sp. in Fiji (Fullaway 1957) and the widespread species *Hypsicera femoralis* (Geoffrey) that has been recorded from Hawaii (Timberlake 1918) and New Zealand.

This study confirmed Fullaway's finding of *Metopius* in Fiji (2 species from 10 specimens). In addition, two other genera were collected or found in museum collections: *Exochus* (two species from 17 specimens) and *Triclistus* (1 species from 2 specimens). Metopiines were rarely collected (the twelth most abundant subfamily in this study).

Subfamily Ophioninae

All host records for Ophioninae indicate that they are koinobiont endoparasitoids of Lepidoptera, with the exception of *Ophion nigrovarius* Provancher that has been reared from *Phyllophaga fusca* (Froelich) (Coleoptera: Scarabeidae) (Townes 1971; Carlson 1979; Gauld 1988). They mostly parasitize large, exposed caterpillars, especially Noctuidae, Lasiocampidae, Lymantriidae, Saturniidae, Geometridae, Arctiidae and Sphingidae (Gauld 1988). Generally, the host is killed prior to actual pupation, but after the cocoon or pupation chamber has been constructed. The ophionine larva then spins its cocoon inside the host cocoon or chamber (Gauld 1988). There are 1022 extant described species worldwide in 32 genera (Yu *et al.* 2005). Seventy-five species in six genera have previously been recorded from the south Pacific including Hawaii (Yu *et al.* 2005). Of these 75, 61 belong to the highly speciose genus *Enicospilus* (nearly 700 described species). This is the only genus definitively recorded previously from Fiji with nine species (see Table 1).

Thankfully, the ophionines of the Indo-Papuan region (including Fiji) have been relatively recently revised including good keys to the species of *Enicospilus* (Gauld & Mitchell 1981). Five of the nine species of *Enicospilus* previously known from Fiji were collected in this study as well as six additional species (Table 1). The four previously recorded species that were not collected are all considered credible records for Fiji (see Table 2). In addition to the ten islands sampled in this study, Gauld & Mitchell (1981) also recorded the following species from Ovalau which was not part of the present survey: *E. aequalis* (Szépligeti), *E. dolosus* (Tosquinet), *E. melanocarpus* Cameron and *E. morleyi* Townes. In terms of host records for Fiji, *Enicospilus insularis* (Kirby) has been reared from *Spodoptera* sp. (Noctuidae) (Gauld & Mitchell 1981). Species of *Enicospilus* are easily diagnosed from all other Fijian ichneumonids because they have sclerites in the fore wing just posterior to the stigma (Fig. 6b).

Apart from *Enicospilus*, at least four species of *Leptophion* Cameron were also collected (Table 1). This genus is Oriental and Australian with one species known from Vanuata (Cheesman 1936). Comparison with type material is required prior to confirmation of the exact number of *Leptophion* spp. and whether any of them are previously described.

There were several erroneous ophionine records for Fiji listed by Fullaway (1957) according to Gauld & Mitchell (1981): *E. castaneus* (Ashmead) listed as *Ophion nigritulus* Dalla Torre was a misidentification of a *Leptophion* sp.; *E. coarctatus* (Brullé) was a misidentification of *E. lineolatus* (Roman); *E. obliquus* (Morley) was a misidentification of *E. aequalis* (Szépligeti); and *Ophion inutilis* Smith was also considered a misidentification because this species belongs to a derived species group endemic to New Zealand (see Table 3).

The vast majority of ophionine species, including all Fijian species, are nocturnal and possess characteristics found in many groups of nocturnal ichneumonoid parasitoids specifically, a pale orange body with compressed metasoma, large ocelli and long, slender antennae (Gauld & Mitchell 1981). In Fiji, Ophioninae are most likely mistaken for *Netelia* (Tryphoninae) but *Netelia* has a deep glymma on T1 (absent in ophionines) and all Fijian species of *Netelia* have the areolet of the forewing with both 2rs-m and 3rs-m present (Fig. 5e) (only 3rs-m present in ophionines) (Fig. 6b). In addition, *Pseudanomalon* (Anomaloninae) may be mistaken for Ophioninae (see diagnosis of *Pseudanomalon* for distinguishing characters). Ophionines were the fourth most abundant subfamily of ichneumonids in this study with over 300 specimens collected. After *Echthromorpha* spp. (Pimplinae), ophionines are likely the most conspicuous Fijian ichneumonids because of their size, the fact that some species are abundant in disturbed habitats, because they fly to lights at night, and because females will sting if handled carelessly.

Subfamily Orthocentrinae

Orthocentrines are koinobiont endoparasitoids of Bibionomorpha (Diptera) (e.g., Mycetophilidae, Sciaridae, Keroplatidae) (Dasch, 1992; Yu *et al.* 2005), although very little is known of the biology of the vast majority of species. There are 456 extant species in 29 genera worldwide. In the south Pacific, only one species was previously recorded: *Proclitus savaiiensis* (Fullaway) from Samoa (Fullaway 1940).

In terms of morphology, orthocentrines are some of the smallest ichneumonids (fore wing length of the Fijian specimens ranges from 1.5 to 3.5 mm). Members of the *Orthocentrus* group of genera have a strongly convex clypeus and supraclypeal area in lateral view similar to most metopiines. The genera in this group are very homogenous and are likely paraphyletic with respect to each other. The other genera in the Orthocentrinae do not have the convex supraclypeal area but their affinity to the *Orthocentrus* group has been demonstrated cladistically by Wahl & Gauld (1998) based on adult and larval morphology.

This study collected at least five species from three genera: *Megastylus* (at least two species), *Orthocentrus* (at least one species) and *Proclitus* (at least three species) (Table 1). Both *Megastylus* and *Proclitus* do not belong to the *Orthocentrus* group of genera. Of these, *Megastylus* sp. 1 and *Proclitus* sp. 1 and 2 are easily distinguishable species, but *Megastylus* sp. 2 and *Proclitus* sp. 3 are comprised of specimens that range from predominantly orange-bodied to predominantly black-bodied; however intermediates in colour were collected. These two species may each be comprised of two or more species, but no structural differences could be found that correlated with the colour morphs. The specimens of *Orthocentrus* also show some colour variation in the hind coxa which may indicate multiple species, but once again, no correlating structural differences could be found, so for now, it is believed that there is only one species. In terms of abundance,

orthocentrines are usually a relatively uncommon component of Malaise trap samples in Fiji; however, some sites collected many specimens (e.g., Viti Levu, Koroyanitu, 800m) making this subfamily the seventh most commonly collected (around 90 specimens).

Subfamily Pimplinae

The Pimplinae is likely the most biologically diverse subfamily of ichneumonids. Most Ephialtini are idiobiont ectoparasitoids that oviposit on the immature stages of holometabolous insects (Gauld 1991). Some other Ephialtini; however, develop as koinobiont ectoparasitoids on immature or adult spiders (Wahl & Gauld 1998) and the larvae of several genera consume multiple eggs in spider egg sacs to complete development and thus are considered predators rather than parasitoids. Pimplini are endoparasitoids, generally of Lepidoptera (Wahl 1993a). Taxonomically, pimplines may be the most well known major subfamily of ichneumonids (Gauld 1991; Gauld *et al.* 2002b). Many are large, conspicuous species and for some, the biology is relatively well-studied. For example, *Lissopimpla excelsa* (Costa) is a common, easily recognizable species across Australia and New Zealand and the males are well-known as pollinators of the sexually deceptive orchid genus *Cryptostylis* Brown by pseudocopulation with the flower (Coleman & Lea 1928). Worldwide, there are 1526 extant species of pimplines in 73 genera (47 species in 12 genera from the south Pacific) (Yu *et al.* 2005). Previously, only four species were recorded from Fiji (all Pimplini): *Echthromorpha agrestoria* (Swederus) (Ethiopian, Oriental and Australian regions), *E. tirathabae* Perkins (Fijian endemic), *L. excelsa* (Australia, New Zealand and Fiji) (Krieger 1907) and *L. veitchi* Turner (Fijian endemic) (Fullaway 1957).

This study found pimplines to be the most abundant subfamily in Malaise trap samples, although this was largely due to the presence of two very common species: *E. agrestoria* and *L. nigricans* Fullaway (= *vietchi* Turner). In total, seven species in five genera were collected (Table 1). *Echthromorpha agrestoria* is the most common ichneumonid in Fiji and was the only species collected from all ten island groups. It is a colour variable species that previously has been sub-divided into as many as 24 subspecies (Yu *et al.* 2005). Particular colour patterns are found in particular regions or islands; however, intermediates abound which may explain why Gauld (1984) dropped subspecific recognition. I concur with this decision. In Fiji, *E. agrestoria* is a large species (fore wing length 7 to 12 mm) with orange and black mesosoma, T1 and T7+ orange and T2-T6 black. *Echthromorpha tirathabae* was also collected (in much lower numbers) as was a single specimen of a distinctive, third species of *Echthromorpha*.

With respect to *Lissopimpla*, Townes (1958) in his survey of the ichneumonids of Micronesia stated that *L. nigricans* Fullaway is present in Guam and that a "closely related form, apparently only subspecifically distinct, occurs in Fiji and Tonga". Turner (1919) described *L. veitchi* from Fiji; noting that his female specimens had a white band on segments 12-14. Fullaway's original description of *L. nigricans* states that the female antenna is all brown. In Fiji, both male and female *Lissopimpla* specimens exhibit a continuous range of white banding from absent to barely present on one flagellomere to completely banded on up to eight segments. I could find no structural differences to correlate with differences in antennal colour. In addition, Henry Townes examined the type of *L. veitchi* as noted by a homotype label on one of his specimens and this specimen was placed under *L. nigricans* in his collection (AEIC). I concur with Townes (1958) and formally syn-

onymize *L. veitchi* Turner, 1919 **syn.n.** with *L. nigricans* Fullaway, 1913. This species is easily recognizable from all other Fijian ichneumonids by the mostly reddish body and hind femur with a ventral tooth. As for *L. excelsa*, Krieger (1907) recorded it from Fiji stating that one male (from the Fiji islands) had the tooth of the hind femur only suggested, otherwise it fits perfectly with other *L. excelsa*. He did not say how many specimens were collected in Fiji or from which islands. Other papers that record the species from Fiji include: Fullaway (1957) (only a list) and Turner (1919) cited Krieger as "reporting this common Australian species from Fiji", as did Townes *et al.* (1961). Therefore, the only primary record of this species from Fiji is Krieger (1907). Since this was a revision of the genus and *L. excelsa* is a distinctive species, there is little chance for misidentification. I have included *L. excelsa* in Table 2 as a credible record for Fiji despite lack of collection in this extensive survey.

The other three species of pimplines are all Ephialtini from genera that are known to parasitize immature and adult spiders: *Acrodactyla* sp., *Eriostethus* sp. and *Zatypota* sp. Species of *Eriostethus* were previously known from Vanuatu, New Caledonia and the Solomon Islands (Yu *et al.* 2005), but the other two ephialtines are new generic records for the south Pacific.

Subfamily Tersilochinae

Tersilochines are, with very few exceptions, koinobiont endoparasitoids of beetles, most commonly of Curculionidae and Chrysomelidae (Gauld 1984). They generally oviposit into the larva and emerge from the cocoon as found in *Diaparsis jucunda* (Holmgren) on *Lilioceris* spp. (Chrysomelidae) (Haye & Kenis 2004). Like orthocentrines, most tersilochines are relatively small ichneumonids (fore wing length 1.5 to 3.0 mm in Fijian specimens). In Fiji, they are easily distinguished from all other subfamilies by having the second segment of the metasoma with the laterotergites extending ventrally from the tergites (Fig. 12f). All other Fijian ichneumonids have the laterotergites of the second segment creased and folded under the tergites. There are 222 extant species in 20 genera worldwide, although they were unknown from the south Pacific prior to this study.

This study found six species of *Diaparsis* Förster. Tersilochines were rarely collected in Fiji (only the eleventh most abundant subfamily with 35 specimens).

Subfamily Tryphoninae

Tryphonines are koinobiont ectoparasitoids and lay stalked eggs on larval Lepidoptera and sawflies (Hymenoptera) (Kasparyan 1973). Following hatching, the first instar larvae remain inside the shell, attached by caudal appendages, and do not complete development until after host pupation (Gerig 1960). The stalk of the egg is embedded deep in the host, which allows host moulting without sloughing of the egg and associated larva. There are 1199 extant species in 55 genera in eight tribes worldwide (Yu *et al.* 2005). Those tribes of Tryphoninae associated with sawflies are primarily Holarctic; however, the Phytodietini and Oedemopsini that parasitize Lepidoptera are found worldwide. In the south Pacific, 12 species of the highly speciose, widespread genus *Netelia* (Phytodietini) were known prior to this study (Yu *et al.* 2005) including 3 from Fiji: the endemic *Netelia*

fijiensis (Brues) (Brues 1922) as well as two widespread species — *Netelia opacula* (Thomson) (Turner 1919) and *Netelia testacea* (Gravenhorst) (Morley 1915a).

This survey collected at least nine species of *Netelia* and one species of the sister genus to *Netelia*: *Phytodietus*. It is possible that I have collected *N. fijiensis*, but examination of the holotype of *N. fijiensis* is required to confirm this because the description of Brues (1922) is so vague. Until confirmation is made, the distribution of *N. fijiensis* is recorded in Table 2 as Kadavu and Lakeba based on the type series from Vunisea and "Lau". With respect to *N. testacea* and *N. opacula*, the following passage from Townes (1939) is germane: "Until 1924, when Cushman recognized that many species of similar appearance had been passing as a few species, most of our Nearctic species had been determined as *geminata* Say… In other parts of the world there was, and still is, this lack of discrimination. Students have identified specimens from every continent as the European species *testacea*. True *testacea* probably has a normally restricted range. Even in Europe, several species are confused under the name *testacea*." Townes (1939) was the first to use male genitalia for the taxonomy of *Netelia* and found that even Cushman's type series often comprised multiple species. Since the records of *N. testacea* and *N. opacula* in Fiji occurred prior to Townes (1939), the reliability of the records are highly suspect and are hereby considered erroneous records (Table 3). It is possible that one or other of these species are present in Fiji, but this would need to be confirmed. *N. opacula* ranges from Europe to Japan as well as India, whereas *N. testacea* ranges from Europe and North Africa to Japan (Konishi 2005). The nine morphospecies of *Netelia* listed in Table 1 is probably a great underestimate because only about one-third of the specimens are males which are required for most species identifications. The number of morphospecies was arrived at mainly by comparing males, with the exception of two clearly distinct female specimens that represented different species. In addition, dissections of male genitalia were not made which would likely increase the number of morphospecies found. A detailed study of Fijian *Netelia* is well beyond the scope of this study. The body plan of *Netelia* spp. converges on most Ophioninae (pale orange body and large ocelli) because all species are nocturnal. They can be distinguished from Ophioninae by the presence of a very deep glymma at the base of T1 (absent in ophionines). In addition, in Fiji, all *Netelia* spp. have a complete areolet of the fore wing (both 2rs-m and 3rs-m present) (Fig. 5e) whereas the areolet of ophionines lacks the basal intercubital vein (2rs-m) (Fig. 6b).

Phytodietus is a widespread genus that parasitizes leaf-rolling Lepidoptera larvae (Townes 1969). One species is recorded from New Zealand: *P.* (*Euctenopus*) *zealandicus* (Ashmead) (Ashmead 1900) as well as one species from New Caledonia: *P.* (*P.*) *austro-caledonicus* (Montrousier) (Fullaway 1942). The single species of *Phytodietus* collected in this study belongs to *P.* (*Weisia*) Schmiedeknecht. This subgenus has one undescribed species known from Australia (Gauld 1984) and two that occur in the Philippines) (Kaur and Jonathan 1979). *Phytodietus* is a diurnal genus and the single Fijian species (known from one specimen from Nandarivatu) is dark orange and brown. It would most likely be mistaken for the pimpline genera *Lissopimpla* or *Echthromorpha*; however the fore wing of the Fijian species of *Phytodietus* lacks vein 3rs-m (as in Fig. 5c) whereas this vein is present in *Lissopimpla* and *Echthromorpha*. Tryphonines were the fifth most collected subfamily in this study with well over 100 specimens.

ADDITIONAL SUBFAMILIES POSSIBLY PRESENT IN FIJI

Subfamily Eucerotinae

Eucerotines are obligate, internal hyperparasitoids of ichneumonids within lepidopteran and sawfly larvae (Gauld & Wahl 2002). Females lay stalked eggs on leaves and the first instar larva is planidial in form and therefore highly motile (Tripp 1961). The first instar larva seeks out lepidopteran and sawfly larvae and if the host larvae are parasitized they burrow into the primary host and then into the ichneumonid larva. The subfamily has two genera: *Euceros* Gravenhorst and the monotypic *Barronia* Gauld & Wahl and appears to have a southern origin (Gauld & Wahl 2002). Barron (1978) described seven species from Australia, one from New Guinea and one from New Zealand. The group is not known from any south Pacific Islands, but considering the distribution of the group in Australia and adjacent countries, the subfamily's presence in Fiji would not be unexpected. Eucerotines can be distinguished from all other ichneumonids by either: 1) the presence of a bifurcated lobe anteromedially on the pronotum, or 2) flattening and widening of the medial flagellomeres (most evident in males).

Subfamily Labeninae

Similar to eucerotines, labenines are a predominantly southern subfamily with high diversity in Australia (Gauld & Wahl 2000). They have a diverse biology including *Poecilocryptus* Cameron (known from Australia and New Zealand) that appears to be at least partially phytophagous inside galls, and several genera that parasitize wood-boring insects including *Certonotus* Kriechbaumer (Gauld & Holloway 1986). *Certonotus* has 23 species recorded from Australia, eight from the island of New Guinea (Yu *et al.* 2005), *C. hinnuleus* Krieger from New Caledonia (Gauld & Holloway 1986) and *C. mobimbensis* Cheesman from Vanuata (Cheesman 1936). Specimens of *Certonotus* are conspicuous (wing length can be over 1 cm and ovipositor length over 4 cm), therefore it is unlikely that the genus has been overlooked in Fiji given the number of localities sampled. *Certonotus* can be distinguished from all ichneumonids previously recorded from Fiji by the presence of transverse ridges on the mesoscutum (but see Rhyssinae, below).

Subfamily Rhyssinae

Like the labenine genus *Certonotus*, rhyssines are conspicuous ichneumonids that parasitize wood-boring insects. Four genera are native to the Australian region having been recorded from Australia, New Guinea, New Zealand and the Solomon Islands (Kamath & Gupta 1972). In addition, several species have also been introduced to Australia and New Zealand for biocontrol of *Sirex noctilio* Fabricius (Hymenoptera: Siricidae) (Clausen *et al*. 1978). As with labenines, it is unlikely that rhyssines are present in Fiji because they are generally such large, conspicuous insects. Rhyssines can be distinguished from all ichneumonids previously recorded from Fiji by the presence of transverse ridges on the mesoscutum. They can be distinguished from the labenine genus *Certonotus* because *Certonotus* has the attachment of the metasoma high on the propodeum so that the ventral edge of the metasomal foramen does not overlap the dorsal edge of the hind coxal foramina (as seen in posterior view). All rhyssines and almost all other ichneumonids have the metasomal attachment low so that the foramina overlap.

Subfamily Xoridinae

Like labenines and rhyssines, xoridines are conspicuous ichneumonids that parasitize wood-boring insects, especially beetles. Two species of *Xorides* Latreille are known from Australia (Gauld 1984), two from New Guinea (Yu *et al.* 2005) and *X. splendens* (Brues) is known from the Solomon Islands (Brues 1918). Species of *Xorides* can be distinguished from all ichneumonids recorded from Fiji by possession of unidentate, chisel-shaped mandibles (Townes 1969).

DISCUSSION

In the current study, 28 previous literature records were substantiated as valid for Fiji (Tables 1 and 2) and 96 new records were added. This represents a more than 400% increase in the number of species known for Fiji. The 124 species of ichneumonids make the family 8th in species richness of terrestrial arthropods after Curculionidae (244 spp.), Noctuidae (233 spp.), Chrysomelidae (158 spp.), Staphylinidae (155 spp.), Cerambycidae (139 spp.), Formicidae (139 spp.) and Crambidae (133 spp.) (figures based on Evenhuis 2007). This ranking is lower than in northern temperate regions, for example, Ichneumonidae is the most species-rich family in the Nearctic with 4,929 species (Poole and Gentili, 1996). Nevertheless, ichneumonids are still a major constituent of the Fijian arthropod biodiversity comprising about 2.4% of all known terrestrial arthropod species. This figure is based on an update of the total Fijian arthropod species richness (5117 species: Fiji Arthropod Survey website) with the ichneumonid species in the current study.

Compared to other Pacific islands, the number of ichneumonid species recorded in Fiji is high: Hawaii (70 spp.), Solomon Islands (68 spp.), New Caledonia (45 spp.), Vanuatu (35 spp.), Society Islands (15 spp.) and Samoa (14 spp.) (Yu *et al.* 2005). Even compared to much larger countries in the region, Fiji has a substantial number of ichneumonids recorded: Australia (422 spp.), New Zealand (88 spp.). It is not valid at this point to make comparisons on relative species richness because the ichneumonid fauna of most of these other countries/ island groups has not been surveyed to the extent of Fiji. Whether Fiji is relatively more or less diverse than other island groups of its size (e.g. Hawaii, New Caledonia) remains unclear for ichneumonids, but the baseline data in this survey will allow future comparisons to be made. Based on the survey in Fiji, it is probable that the ichneumonid fauna in the south Pacific as a whole is similar to other parts of the world (i.e., a major constituent of the total terrestrial arthropod species richness).

With respect to biogeographical relationships many taxa in Fiji have biogeographical affinities to New Guinea, for example the flora of Fiji shares 90% of its vascular plant genera with New Guinea compared to only 65–75 % with Australia and New Caledonia (Ash 1992) and many insect groups show a similar pattern such as dolichopodid flies (Bickel 1997) and ponerine ants (Wilson 1959). It is hoped that once the species of ichneumonids are better known for Fiji that clearer patterns may emerge, but in terms of genera at least, 32 of the 34 native genera of Fiji are also present in the Oriental region (not including New Guinea) compared to 30 from the Palaearctic, 28 from the Ethiopian and only 25 from both the Nearctic and Australian (including New Guinea) regions. Relatively poor sampling of ichneumonids in New Guinea may affect these data. Half of the genera found in Fiji are widespread throughout the world (17 are recorded from all regions), but

there are a few genera that have a centre of diversity in the southern part of the Eastern hemisphere (*Pseudanomalon*, *Tossinola*, *Genotropis*, *Paraphylax*, *Leptophion*, *Echthromorpha*, *Eriosthethus* and *Lissopimpla*).

There are no endemic genera of ichneumonids known from Fiji. This is perhaps not surprising, since ichneumonids are generally considered strong fliers which permits better active dispersal and therefore decreased chances of the creation of small, isolated populations. Another strong flying group, the spider wasps (Pompilidae), had, until recently, two endemic genera in Fiji, but these are now considered junior synonyms (Pitts *et al.* 2007). Other hymenopteran families do have endemic Fijian genera, for example: ants (Wilson & Hunt 1967) and scelionids (Masner & Johnson 2007), but these families are likely not as strong fliers as most ichneumonids. Endemicity at the generic level is not common for ichneumonids on islands. In Hawaii, the endemic ophionine genera *Abanchogastra* Perkins, *Banchogastra* Ashmead and *Pycnophion* Ashmead were recently synonymized with *Enicospilus* (Bennett 2008). In addition, the other endemic Hawaiian genus *Spolas* Townes is now known to be a more widespread genus that is also present in New Zealand (D. Ward, pers. comm.). In New Caledonia, the monotypic *Ignambia* Cheesman was endemic when it was described (Cheesman 1953), but undescribed species are now known from the Solomon Islands and Java (Townes 1970a).

In terms of species endemicity, it is premature to provide exact figures because levels of endemicity are a reflection of not only biological/geological processes but also sampling effort (on a worldwide scale) and taxonomic knowledge. For the latter two factors, ichneumonid research in the south Pacific has lagged behind many other taxa. Nevertheless, for the described species recorded from Fiji (discounting the five that were deliberately introduced for biological control), 23 % are currently considered endemic to Fiji (5/22) (Tables 1 and 2). Based on my knowledge of the taxa present in Fiji, this number will only increase (probably dramatically) as additional Fijian species are described and ichneumonid taxa are revised. Whereas it is tempting to suggest that levels of ichneumonid species endemicity will be similar to that found for the other highly speciose hymenoptera family in Fiji (Formicidae = 66%) (Ward & Wetterer 2006), a caveat is in order based on the finding that *Brachycyrtus wardae* is present not only on Fiji, but also from one specimen from American Samoa. Only after extensive collecting efforts on surrounding islands will the true level of endemicity in Fiji be known.

With respect to the percentage of undescribed species of ichneumonids in Fiji, it is likely that the majority (perhaps the vast majority) of morphospecies listed in Table 1 are undescribed. This conclusion is reached based on my knowledge of the relatively smaller genera that have species in Fiji: *Pseudanomalon*, *Tossinola*, *Brachycyrtus*, *Genotropis*, *Nipponaetes*, *Leptophion*, *Megastylus*, *Proclitus*, *Acrodactyla*, *Eriostethus*, *Zatypota*, *Echthromorpha*, *Lissopimpla* and *Diaparsis*. All other genera from Fiji have greater than 50 described species (some with several hundred). Most of these do not have up to date species keys which makes it difficult to assess whether the Fijian morphospecies are undescribed. Nevertheless, if the estimate of Gauld *et al.* (2002a) is correct (i.e., less than one-quarter of all ichneumonids are described), it is hard to imagine that less than three-quarters of the morphospecies listed in Table 1 are undescribed, considering that the south Pacific is a relatively poorly sampled region of the world.

Concerning the ichneumonid fauna within the Fijian archipelago, Table 4 provides a summary of Malaise trap collecting events in the present study for each island compared to number of species collected. In terms of collecting effort, by far the highest number of sam-

ples were taken from Viti Levu (120) followed by Taveuni (70) and Vanua Levu (43). As these three islands are the three largest by area, the sampling effort was related to island size, although Vanua Levu was definitely under collected based on its much greater area compared to Taveuni. With respect to sites collected on each island, Viti Levu had by far the most sites examined (14), with Taveuni the second highest (5) followed by Vanua Levu (4).

The number of species found was also much higher on Viti Levu (79) than on any other island, with Gau ranking second (33), closely followed by Taveuni (32) Vanua Levu and Koro (31 species each) and Kadavu (28 species). The remaining four islands/ island groups each had less than 10 species recorded.

Calculating the average species collected per site for each of the islands revealed that Kadavu had the highest number of species per site (14) followed by Gau (11), Koro (10), Vanua Levu (7.8) Taveuni (6.4) and Viti Levu (5.6). Based on these findings, the following general comments with respect to future collections and/or conservation strategies are made. Note that these conclusions assume that the samples examined in this survey (i.e. ones that contained ichneumonids) are a representative sample of the overall collecting that has occurred for the entire survey. This is believed to be true because Malaise trapping has been by far the most prevalent form of sampling in Fiji and because ichneumonids are generally collected in any Malaise trap set up anywhere in the world. 1) Collecting efforts should continue on Viti Levu because it likely has more undiscovered taxa simply because of the fact that it has more than twice as many species recorded from it than any other island. In addition, it is most likely that new generic records for Fiji will come from Viti Levu as evidenced by the presence of three genera so far found on no other Fijian islands: *Tossinola*, *Triclistus* and *Phytodietus*. 2) Additional collections should be made on Vanua Levu because it has been relatively under-collected. This statement is supported by comparison of the number of collection sites versus island size and also by the fact that a single specimen of *Brachycyrtus wardae* was collected on Vanua Levu compared to multiple specimens from much smaller islands such as Kadavu and Lakeba (i.e. one expects that there should have been more specimens collected on Vanua Levu). In addition, the fact that one of the three specimens of the rarest Fijian subfamily (Anomaloninae) was collected on Vanua Levu demonstrates that the island has the potential for additional discoveries of rare, endemic and undescribed taxa. 3) Additional collections should be made on Kadavu, Gau and Koro. The high number of morphospecies despite the relatively small size of each island and low number of sites collected suggests that additional sampling especially in additional localities, may reveal more undiscovered species. 4) Future collections on Taveuni should be made at new sites. All but one of the 70 collecting events from Taveuni that found ichneumonids were from Mt. Devo (3 sites) or Mt. Koronibuabua (1 site). Whereas the number of species per site for Taveuni was moderately high (6.4 species per site), the species per sample was relatively low (0.5) which may indicate that these sites have been well sampled. 5) The smaller and outer island groups are relatively depauperate and sampling and/or conservation of these islands should be less of a priority, at least with respect to terrestrial biodiversity.

In conclusion, this study respresents the most in depth survey of ichneumonids in the south Pacific islands. There is still a great deal of work to be done describing species, but I believe, even at this point, the data collected support the statement of Evenhuis and Bickel (2005) that "Fiji has many hundreds of undiscovered and undescribed arthropods". Hopefully the findings of this paper will encourage additional work on ichneumonids in

Fiji and the south Pacific and also foster similar studies on other groups that will lead to a greater understanding of Fijian biodiversity and increased levels of conservation within this remarkable country.

LITERATURE CITED

Allen, D.C., Knight, F.B., Foltz, J.L. & Mattson, W.J. 1969. Influence of parasites on two populations of *Choristoneura pinus* (Lepidoptera: Tortricidae), in Michigan. *Annals of the Entomological Society of America* **62**: 1469–1475.

Ash, J. 1992. Vegetation ecology of Fiji: past, present, and future perspectives. *Pacific Science* **46**: 111–127.

Ashmead, W.H. 1900. Notes on some New Zealand and Australian parasitic Hymenoptera with description of new genera and new species. *Proceedings of the Linnean Society of New South Wales* **25**: 327–360.

———. 1906. Descriptions of new Hymenoptera from Japan. *Proceedings of the United States National Museum* **30**: 169–201.

Askew, R.R. & Shaw, M.R. 1986. Parasitoid communities: their size, structure and development. pp. 225–265 *In*: J. Waage & D. Greathead (*eds.*), *Insect parasitoids*. Academic Press, Harcourt Brace Jovanovich, London.

Austin, A.D. 1985. The function of spider egg sacs in relation to parasitoids and predators, with special reference to the Australian fauna. *Journal of Natural History* **19**: 359–376.

Babendreier, D. 2000. Life history of *Aptesis nigrocincta* (Hymenoptera: Ichneumonidae) a cocoon parasitoid of the apple sawfly, Hoplocampa testudina (Hymenoptera: Tenthredinidae). *Bulletin of Entomological Research* **90**: 291–297.

Baltazar, C.R. 1965. A new species of Ichneumon-fly and a Chalcid wasp parasitic on slug caterpillars in Basilan Island. *Philippine Journal of Plant Industry* **30**: 109–113**.**

Barron, J.R. 1978. Systematics of the world Eucerotinae (Hymenoptera, Ichneumonidae) Part 2. Non-Nearctic species. *Naturaliste Canadien* **105**: 327–374.

Bennett, A.M.R. 2006. A new genus of Oedemopsini (Hymenoptera: Ichneumonidae: Tryphoninae) with a key to the genera of the tribe. *The Canadian Entomologist* **138**: 464–472.

Bennett, D.J. 2008. The Ophionine wasps of Hawaii (Hymenoptera: Ichneumonidae). *Journal of Hymenoptera Research* **17**: 1–43.

Bennett, F.D. 1960. Parasites of *Ancylostomia stercorea* (Zell.) (Pyralidae, Lepidoptera), a pod borer attacking pigeon pea in Trinidad. *Bulletin of Entomological Research* **50**: 737–757.

Benoit, P.L.G. 1955. Contributions a l'étude des Ichneumonidae africains (Hymenoptera). I. *Annales du Musée Royal du Congo Belge, Sciences Zoologiques* **38**: 1–55.

Bickel, D. 1997. Restricted and widespread taxa in the Pacific: Biogeographic processes in the fly family Dolichopodidae (Diptera). pp. 331–346. *In*: A. Keast and S. Miller (*eds.*) *The origin and evolution of Pacific Island biotas, New Guinea to eastern Polynesia: patterns and processes*. SPB Academic Publishing, Amsterdam.

Bridwell, J.C. 1919. Miscellaneous notes on Hymenoptera with descriptions of new genera and species. *Proceedings of the Hawaiian Entomological Society* **4**:109–165.

Broad, **G.R., Laurenne, N.M. & Quicke, D.L.J.** 2004. The genus *Nipponaetes* (Hymenoptera: Ichneumonidae: Cryptinae) in Costa Rica, with a reassessment of the generic limits. *European Journal of Entomology* **101**: 651–655.

Brues, C.T. 1918. Parasitic Hymenoptera from the British Solomon Islands collected by Dr.W.M.Mann. *Bulletin of the Museum of Comparative Zoology at Harvard University* **62**: 97–130.

Brues, C.T. 1922. Parasitic Hymenoptera from the Fiji Islands. *Psyche* **29**: 10–22.

Carlson, R.W. 1979. Family Ichneumonidae. pp. 315–740. *In:* K.V. Krombein, P.D. Hurd Jr., D.R. Smith & B.D. Burks (*eds*). *Catalog of Hymenoptera in America north of Mexico*. Smithsonian Institution Press, Washington, D.C.

Carpenter, J.E., Pair, S.D. & Fitt, G.P. 1994 . *Ichneumon promissorius* (Hymenoptera: Ichneumonidae): development on North American hosts. *Journal of Economic Entomology* **87**: 929–932.

Chandra, G. & Gupta, **V.K.** 1977. Ichneumonologia Orientalis Part VII. The tribes Lissonotini and Banchini (Hymenoptera: Ichneumonidae: Banchinae). *Oriental Insects Monograph* **7**: 1–290.

Cheesman, L.E. 1928. A contribution towards the insect fauna of French Oceania. Part 2. *Annals and Magazine of Natural History* **10**: 169–194.

———. 1936. Hymenoptera of the New Hebrides and Banks Islands. *Transactions of the Royal Entomological Society of London* **85**: 169–195.

———. 1953. Parasitic Hymenoptera of New Caledonia and Lifu Island, Loyalty Islands. *Annals and Magazine of Natural History* **6**: 625–636.

Clausen, C.P., Bartlett, B.R., Bay, E.C., DeBach, P., Goeden, R.D., Legner, E.F., McMurtry, J.A., & Oatman, E.R. & Rosen, D. 1978. *Introduced parasites and predators of arthropod pests and weeds: A world review.* Agriculture Handbook 480. Agricultural Research Service, United States Department of Agriculture, Washington. 1977 pp.

Coleman, E. & Lea, A.M. 1928. Pollination of an Australian orchid by the male ichneumonid *Lissopimpla semipunctata* Kirby. *Transactions of the Royal Entomological Society of London* **76**: 533–539.

Cushman, R.A. 1936. The Ichneumon-flies of the genus *Brachycyrtus* Kriechbaumer. *Proceedings of the United States National Museum* **84**: 17–24.

Dasch, C.E. 1992. The Ichneumon-flies of America north of Mexico: Part 12. Subfamilies Microleptinae, Helictinae, Cylloceriinae and Oxytorinae (Hymenoptera: Ichneumonidae). *Memoirs of the American Entomological Institute* **52**: 1–470.

Evenhuis, N.L. 2007. *Checklists of the Terrestrial Arthropods of Fiji*, revised edition. Bishop Museum Technical Report 38.

———. **& Bickel, D.J.** 2005. The NSF-Fiji Terrestrial Arthropod Survey: overview. *Bishop Museum Occasional Papers* **82**: 3–25.

Fabricius, J.C. 1781. *Species insectorum*. Tom. I. Hamburgii et Kilonii. 552 pp.

Fiji Arthropod Survey. Checklist of Species. Available at: http://hbs.bishopmuseum.org/fiji/checklists.html. Accessed 10 December 2008.

Fitton, M.G. & Rotheray, G.E. 1982. A key to the European genera of diplazontine ichneumon-flies with notes on the British fauna. *Systematic Entomology* **7**: 311–320.

Fullaway, D.T. 1940. New species from the Bishop Museum collection of Samoan parasitic Hymenoptera. *Proceedings of the Hawaiian Entomological Society* **10**: 399–410.

———. 1942. A list of parasitic Hymenoptera collected by F.X.Williams in New Caledonia. *Proceedings of the Hawaiian Entomological Society* **11**: 243–247.

———. 1957. A checklist of Hymenoptera of Fiji. *Proceedings of the Hawaiian Entomological Society* **16**: 269–280.

Gauld, I.D. 1984. *An introduction to the Ichneumonidae of Australia*. British Museum (Natural History) Publication 895, 413 pp.

———. 1988. A survey of the Ophioninae (Hymenoptera: Ichneumonidae) of tropical Mesoamerica with special reference to the fauna of Costa Rica. *Bulletin of the British Museum (Natural History), Entomology series* **57**: 1–309.

———.1991. The Ichneumonidae of Costa Rica, 1. Introduction, keys to subfamilies, and keys to the species of the lower Pimpliform subfamilies Rhyssinae, Poemeniinae, Acaenitinae and Cylloceriinae. *Memoirs of the American Entomological Institute* **47**: 1–589.

———. **& Holloway, G.A.** 1986. Australian Ichneumonids of the tribes Labenini and Poecilocryptini. *Bulletin of the British Museum (Natural History), Entomology series* **53**: 107–149.

———. **& Mitchell, P.A.** 1976. The Ichneumonid genus *Pseudanomalon* (Hymenoptera). *Systematic Entomology* **1**: 117–122.

———. **& Mitchell, P.A.** 1981. *The taxonomy, distribution and host preferences of Indo-Papuan parasitic wasps of the subfamiliy Ophioninae*. CAB: Slough. Commonwealth Institute of Entomology, London. 611 pp.

———. ,**Sithole, R., Gómez, J.U., & Godoy, C.** 2002a. The Ichneumonidae of Costa Rica, 4. *Memoirs of the American Entomological Institute* **66:** 1–768.

———. **& Wahl, D.B.** 2000. The Labeninae (Hymenoptera: Ichneumonidae): a study in phylogenetic reconstruction and evolutionary biology. *Zoological Journal of the Linnean Society* **129**: 271–347.

———. **& Wahl, D.B.** 2002. The Eucerotinae: a Gondwanan origin for a cosmopolitan group of Ichneumonidae? *Journal of Natural History* **36**: 2229–2248.

———., **Wahl, D.B, Bradshaw, K., Hanson, P., & Ward, S.** 1997. The Ichneumonidae of Costa Rica, 2. Introduction and keys to species of the smaller subfamilies, Anomaloninae, Ctenopelmatinae, Diplazontinae, Lycorininae, Phrudinae, Tryphoninae (excluding Netelia) and Xoridinae, with an appendix on the Rhyssinae. *Memoirs of the American Entomological Institute* **57**: 1–485.

———., **Wahl, D.B., & Broad, G.R.** 2002b. The suprageneric groups of the Pimplinae (Hymenoptera: Ichneumonidae): a cladistic re-evaluation and evolutionary biological study. *Zoological Journal of the Linnean Society* **136**: 421–485.

———**, Ward, S., & Mallet, V.** 2000. The Ichneumonidae of Costa Rica, 3. Introduction and keys to species of the subfamilies Brachycyrtinae, Cremastinae, Labeninae and Oxytorinae, and with an appendix on the Anomaloninae. *Memoirs of the American Entomological Institute* **63**: 1–453.

Gerig, L. 1960. Zur Morphologie der Larvenstadien einiger parasitischer Hymenopteren des Grauen Lärchenwicklers (*Zeiraphera griseana* Hübner). *Zeitschrift für Angewandte Entomologie* **46**: 121–177.

Goulet, H. & Huber, J.T. 1993. *Hymenoptera of the world: an identification guide to families*. Research Branch of Agriculture Canada, Publication 1894/E. 668 pp.

Haye, T. & Kenis, M. 2004. Biology of *Lilioceris* spp. (Coleoptera: Chrysomelidae) and their parasitoids in Europe. *Biological Control* **29**: 399–408.

He, J.H. 1984. A checklist of Ichneumon-flies parasitic on rice pests from China (Hymenoptera: Ichneumonidae). (In Chinese with English summary). *Acta Agriculturae Universitatis Zhejiangensis* **10**: 77–110. [Not seen, cited from Yu *et al.* 2005].

Heinrich, G.H. 1961. Synopsis of Nearctic Ichneumoninae Stenopneusticae with particular reference to the northeastern region (Hymenoptera), Part I. Introduction, key to Nearctic genera of Ichneumoninae Stenopneusticae, and Synopsis of the Protichneumonini North of Mexico. Supplementum 15. *The Canadian Entomologist* **92**: 1–88.

Higa, S.Y. 1983. *Brachycyrtus nawaii* (Ashmead). *Proceedings of the Hawaiian Entomological Society* **24**: 172.

Hinckley, A.D. 1963. The rice leafroller, *Susumia exigua* (Butler), in Fiji. *Journal of Economic Entomology* **56**: 112–113.

Horstmann, K. 2004. Bemerkungen zur Systematik einiger Gattungen der Campopleginae IV (Hymenoptera, Ichneumonidae). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen* **56**: 13–35.

Kamath, M.K. & Gupta, V.K. 1972. Ichneumonologia Orientalis, Part II. The Tribe Rhyssini (Hymenoptera: Ichneumonidae). *Oriental Insects Monograph* **2**:1–300.

Kasparyan, D.R. 1973. *Fauna of the USSR Hymenoptera*, Vol. III, Number 1. *Ichneumonidae (Subfamily Tryphoninae) Tribe Tryphonini.* Nauka Publishers, Leningrad, USSR. [In Russian]. [Translated from Russian. Amerind Publishing Co. Ltd., New Delhi, 1981. 414 pp.]

Kaur, R. & Jonathan, J.K. 1979. Ichneumonologica Orientalis, Part VIII. The tribe Phytodietini from India (Hymenoptera: Ichneumonidae). *Oriental Insects Monograph* **9**: 1–276.

Konishi, K. 2005. A preliminary revision of the subgenus *Netelia* of the genus *Netelia* from Japan (Hymenoptera, Ichneumonidae, Tryphoninae). *Insecta Matsumurana* **62**: 45–121.

Kreibohm de la Vega. 1940. *Paracharops* and *Brachycyrtomorpha*. n.gen. *Revista Industrial y Agricola de Tucumán* **3**: 170.

Krieger, R. 1907. Über die Ichneumonidengattung Lissopimpla Kriechb. *Zeitschrift für Systematische Hymenopterologie und Dipterologie* **7**: 294–302.

Kriechbaumer, J. 1880. *Brachycyrtus*, novum genus *Cryptidarum*. *Correspondenz-Blatt des Zoologische-Mineralogischen Vereines in Regensburg* **34**: 161–164.

Kusigemati, K. 1985. Records of eight species of Ichneumonidae (Hymenoptera) from Fiji and Solomon Islands, with descriptions of two new species. *Kagoshima University Research Center for the South Pacific. Occasional Papers of the Kagoshima University Research Center for the South Pacific* **5**: 65–73.

LaSalle, J. & Gauld, **I.D.** 1993. Hymenoptera: their diversity, and their impact on the diversity of other organisms. pp. 1–26. *In:* J. LaSalle and I.D. Gauld (*eds.*), *Hymenoptera and biodiversity*. CABI Publishing, Wallingford, U.K.

Lee, J.W. & Kim, C.W. 1985. *Pseudanomalon ocellatum*. *Entomological Research Bulletin* **11**: 39. [not seen; cited in Lee, J.W. and Kim, C.W. 2000].

———. 2000. *Illustrated catalogue of Ichneumonidae in Korea (1. Anomalinae, Eucerotinae, Mesochorinae, Metopiinae, Ophioninae, Paxylommatinae, Tryphoninae)*. Insects of Korea Series 6. Korea Research Institute of Bioscience and Biotechnology & Center for Insect Systematics. Korea. 261 pp.

Lever, R.J.A.W. 1937. A preliminary note on larval parasites of the spike moth in Taveuni Islands. *Agriculture Journal of the Department of Agriculture Fiji* **8**: 34–35.

———. 1945. Recovery of the parasite *Nemeritis* in south Taveuni. *Agricultural Journal of Fiji*, **16**: 46.

Masner, L. & Johnson, N.F. 2007. *Xentor*, a new endemic genus from Fiji (Hymenoptera: Platygastroidea: Scelionidae) and description of three new species. *In*: Evenhuis, N.L. & Bickel, D.J. (eds.), Fiji Arthropods IX. *Bishop Museum Occasional Papers* **94**: 11–20.

Miller, C.A. & Renault, T.R. 1976. Incidence of parasitoids attacking endemic spruce budworm (Lepidoptera: Tortricidae) populations in New Brunswick. *The Canadian Entomologist* **108**: 1045–1052.

Monteith, A.E. 1956. *Phygadeuon trichops* Thoms. (Hymenoptera: Ichneumonidae), an occasional parasite of *Hylemya* spp. (Diptera: Anthomyiidae). *The Canadian Entomologist* **88**: 69–73.

Morley, C. 1912. No. XII. - Hymenoptera, Ichneumonidae. *Transactions of the Linnean Society of London* **15**: 169–179

———. 1915. Notes on a few Ichneumonids from Fiji. *Entomologist* **48**: 139–140.

Momoi, S. 1966. Discovery of *Paraphylax* and *Strepsimallus* in Japan (Hymenoptera: Ichneumonidae). *Mushi* **39**: 51–56.

Momoi, S. & Nakanishi, A. 1968. Discovery of two species of *Diplazon* from New Guinea (Hymenoptera: Ichneumonidae). *Pacific Insects* **10**: 341–343.

Nees von Esenbeck, C.G. 1819. Appendix ad J.L.C. Gravenhorst conspectum generum et familiarum Ichneumonidum, genera et familias Ichneumonidum adscitorum exhibens. *Nova Acta Physico Medica Academiae Ceasareae Leopoldina-Carolinae Erlangen.* **9**: 299–310.

van Nouhuys, S. & Hanski, I. 2000. Apparent competition between parasitoids mediated by a shared hyperparasitoid. *Ecology Letters* **3**: 82–84.

———. **& Ehrnsten, J.** 2004. Wasp behaviour leads to uniform parasitism of a host available only a few hours per year. *Behavioral Ecology* **15**: 661–665.

Perkins, J.F. 1937. On a new species of *Echthromorpha* (Hym. Ichn.) from Fiji. *Bulletin of Entomological Research* **28**: 171–172.

Pitts, J.P., Wilson, J.S. & Parker, F.D. 2007. The spider wasps of Fiji (Hymenoptera: Pompilidae). *Bishop Museum Occasional Papers* **91**: 3–15.

Poole, R.W. & Gentili, P. 1996. *Nomina Insecta Nearctica*, Volume 2: *Hymenoptera, Mecoptera, Megaloptera, Neuroptera, Raphidioptera, Trichoptera.* Entomological Information Services, Rockvillle, MD.

Roman, A. 1915. Results of Dr. E. Mjöbergs Swedish scientific expedition to Australia 1910–1913. I. Schlupfwespen. *Arkiv för Zoologi.* **9**: 1–18.

Ross, H.H. 1936. The ancestry and wing venation of the Hymenoptera. *Annals of the Entomological Society of America* **29**: 99–111.

Schwenke, W. 1999 Revision of the European Mesochorinae (Hymenoptera, Ichneumonoidea, Ichneumonidae). *Spixiana* Supplement **26**: 1–124.

Short, J.R.T. 1978. The final larval instars of the Ichneumonidae. *Memoirs of the American Entomological Institute* **25**, 1–508.

Stork, N.E. 1997. Measuring global biodiversity and its decline. *In:* Reaka–Kudla, M.L., Wilson, D.E. and Wilson, E.O. (*eds*), *Biodiversity II. Understanding and protecting our biological resources.* Joseph Henry Press, Washington, D.C. 41–68 pp.

Szépligeti, G. 1905. Hymenoptera. Ichneumonidae (Gruppe Ophionoidea), subfam. Pharsaliinae-Porizontinae. *Genera Insectorum* **34**: 1–68.

Timberlake, P.H. 1918. Notes on some of the immigrant parasitic Hymenoptera of the Hawaiian islands. *Proceedings of the Hawaiian Entomological Society* **3**: 399–404.

Tothill, J.D., Taylor, T.H.C., & Paine, R.W. 1930. *The Coconut Moth in Fiji: a History of its Control by Means of Parasites.* Imperial Bureau of Entomology, London, 269 pp.

Townes, H.K. 1939. The Nearctic species of *Netelia* (*Paniscus* of authors) and a revision of genera of Neteliini (Hymenoptera, Ichneumonidae). *Lloydia.* **1**: 168–231.

———.1945. A Catalogue and reclassification of the Nearctic Ichneumonidae (Hymenoptera). Part II. The Subfamilies Mesoleiinae, Plectiscinae, Orthocentrinae, Diplazontinae, Metopiinae, Ophioninae, Mesochorinae. *Memoirs of the American Entomological Society* **11**: 478–925.

———. 1947. A *Eumenes* wasp and six adventive Ichneumonidae new to Hawaii (Hymenoptera). *Proceedings of the Hawaiian Entomological Society* **13**: 105–106.

———. 1958. Hymenoptera: Ichneumonidae, Stephanidae and Evaniidae. *Insects of Micronesia* **19**:35–87.

———. 1969. The genera of Ichneumonidae, Part 1. *Memoirs of the American Entomological Institute* **11**: 1–300.

———. 1970a. The genera of Ichneumonidae, Part 2. *Memoirs of the American Entomological Institute* **12**: 1–537.

———. 1970b. The genera of Ichneumonidae, Part 3. *Memoirs of the American Entomological Institute* **13**: 1–307.

———. 1971. The genera of Ichneumonidae, Part 4. *Memoirs of the American Entomological Institute* **14**: 1–372.

———.**& Townes, M.** 1960. Ichneumon-flies of America North of Mexico: 2. Subfamilies Ephialtinae, Xoridinae, Acaenitinae. *United States National Museum Bulletin*, **216**: 1–676.

———.,**Townes, M. & Gupta, V.K.** 1961. A catalogue and reclassification of the Indo-Australian Ichneumonidae. *Memoirs of the American Entomological Institute* **1**: 1–522.

Tripp, H.A. 1961. The biology of a hyperparasite, *Euceros frigidus* Cress. (Ichneumonidae) and description of the planidial stage. *The Canadian Entomologist* **93**: 40–58.

Turner, R.E. 1919. The Hymenoptera of Fiji. *Transactions of the Entomological Society of London* **1918**: 334–346.

Uchida, T. 1933. Über die Schmarotzerhymenopteren von *Grapholitha molesta* Busck. in Japan. *Insecta Matsumurana* **7**: 153–164. [Not seen–cited from Yu *et al.* (2005)].

Viereck, H.L. 1914. Type species of the genera of Ichneumon flies. *United States National Museum Bulletin* **83**: 1–186.

Viktorov, G.A. 1958. [New Ichneumonidae of central Asia.]. *Zoologicheskii Zhurnal* **37**: 1500–1508. [In Russian with English summary.]

Waage, J. & Greathead, D. 1985. *Insect Parasitoids*. Academic Press, Harcourt Brace Jovanovich, London. 389 pp.

Wahl, D.B. 1989. A revision of *Benjaminia* (Hymenoptera: Ichneumonidae, Campopleginae). *Systematic Entomology* **14**: 275–298.

———. 1993a. Superfamily Ichneumonoidea. pp. 395–442. *In*: H. Goulet and J.T. Huber (*eds.*) *Hymenoptera of the world: an identification guide to families*. Research Branch of Agriculture Canada Publication 1894/E.

———. 1993b. Cladistics of the genera of Mesochorinae (Hymenoptera: Ichneumonidae). *Systematic Entomology*, **18**: 371–387.

———. 1993c. Cladistics of the ichneumonid subfamily Labeninae (Hymenoptera: Ichneumonidae). *Entomologia generalis*, **18**: 91–105.

———. **& Gauld, I.D.** 1998. The cladistics and higher classification of the Pimpliformes (Hymenoptera: Ichneumonidae). *Systematic Entomology*, **23**: 265–298.

Walkley, L.M. 1956. A tribal revision of the Brachycyrtinae wasps of the world (Cryptinae - Ichneumonidae). *Proceedings of the United States National Museum* **106**: 315–329.

Ward, D.F. & Wetterer, J.K. 2006. Checklist of the ants of Fiji (Hymenoptera: Formicidae). *Bishop Museum Occasional Papers* **85**: 23–48.

Waterhouse, D.F. 1992. Biological control of diamondback moth in the Pacific, pp. 213–224. *In:* N.S. Talekar (*ed.*) *Proceedings of the 2nd International Diamondback Moth and Other Crucifer Pests Workshop*. Tainan, Taiwan. December 1990, Asian Vegetable Research and Development Center, Shanhua, Taiwan.

Wilson, E.O. 1959. Adaptive shift and dispersal in a tropical ant fauna. *Evolution* **13**: 122–144.

———. **& Hunt, G.L.** 1967. Ant fauna of Futuna and Wallis Islands, stepping stones to Polynesia. *Pacific Insects* **9**: 563–584.

Yu, D., van Achterberg, K. & Horstmann, K. 2005. World Ichneumonoidea 2004. Taxonomy, biology, morphology and distribution. [CD/DVD]. Taxapad®, Vancouver, Canada.

——— **& Horstmann, K.** 1997. Catalogue of world Ichneumonidae. *Memoirs of the American Entomological Institute* **58**: 1–1558.

FIJI ARTHROPODS XIV

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

TABLE OF CONTENTS