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## Identification key to adult Odonata of New Caledonia and Wallis and Futuna

Daniel Grand<sup>1,†</sup>, Milen Marinov<sup>2</sup>, Carl Cook<sup>3</sup>, Hervé Jourdan<sup>4</sup>,  
Sophie Rouys<sup>5</sup> & Jörn Theuerkauf<sup>6</sup>

<sup>1</sup> Impasse de la Voute, 69270 Saint-Romain-au-Mont d'Or, France

<sup>2</sup> Plant Health & Environment Laboratory, Investigation and Diagnostic Centres  
and Response, Ministry for Primary Industries, 14 Sir William Pickering Drive,  
Burnside, PO Box 14018, Christchurch, New Zealand

<sup>3</sup> 469 Crail Hope Road, Center, Kentucky 42214-8702, USA

<sup>4</sup> Institut Méditerranéen de Biodiversité et d'Écologie marine et continentale  
(IMBE), Aix-Marseille Université, UMR CNRS – IRD – UAPV,  
Centre IRD Nouméa – BP A5, 98848 Nouméa Cedex, New Caledonia

<sup>5</sup> Conservation Research New Caledonia, BP 2549, 98846 Nouméa Cedex,  
New Caledonia

<sup>6</sup> Museum and Institute of Zoology, Polish Academy of Sciences, Wilcza 64,  
00-679 Warsaw, Poland

† Deceased 24<sup>th</sup> May 2013

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**Abstract.** We present a dichotomous key to identify adults of all presently described Odonata of New Caledonia including the Loyalty Islands (Melanesia) and Wallis and Futuna (Western Polynesia). The key covers a total of 58 species of which approximately 50% are regionally endemic, while others are more widespread species inhabiting neighboring archipelagos such as Vanuatu and Fiji, and even more distant regions.

**Key words.** Dragonfly, Melanesia, Western Polynesia, Loyalty Islands, Pacific islands

### Introduction

There are several publications that provide partial keys to Odonata of New Caledonia focusing on particular genera or families only. CAMPION (1921) was the first who provided a key to three *Isosticta* species known up to date as endemic to New Caledonia. LIEFTINCK (1971) presented a key to five out of the eight presently known *Synthemis* species, all endemic to the country. LIEFTINCK (1975) described six species as new to science from New Cale-

donia and included some of them in keys to Argiolestidae and Isostictidae. KALKMAN & THEISCHINGER (2013) provided an updated key to adults of all Argiolestidae inhabiting New Caledonia. However, none of the previous studies have compiled a key to all species known from this region.

In preparation of the key we followed the previous faunistic list presented by MEURGEY (2004) for Odonata from all French Overseas Territories. Authors' unpublished data is added as well. The new estimate of the regional Odonata fauna considers all up-to-date nomenclature changes, and new faunal additions. The final key presented here is developed to facilitate the identification of 58 described Odonata species known from the study area. It is specialized for the regional fauna and is recommended for identifying the dragonfly species inhabiting the territories of New Caledonia, including the Loyalty Islands, and Wallis and Futuna only.

A large proportion of the species included in the key (almost 50%) is locally (restricted to a certain archipelago) or regionally (occurring within the neighboring islands) endemic. For example, all representatives of the families Argiolestidae, Isostictidae, and Synthemistidae are endemic to the main island of New Caledonia. Unfortunately, those wishing to identify the Odonata of this region will find that information is largely limited to the original species' description in a wide range of journals that frequently is not easily available. Therefore, we consider that a key consolidating this information in a single paper should be a welcome contribution and accomplish a long standing need for an updated identification guide for anyone wanting to research these interesting insects in the laboratory or study their life history in their native habitat.

### Material and methods

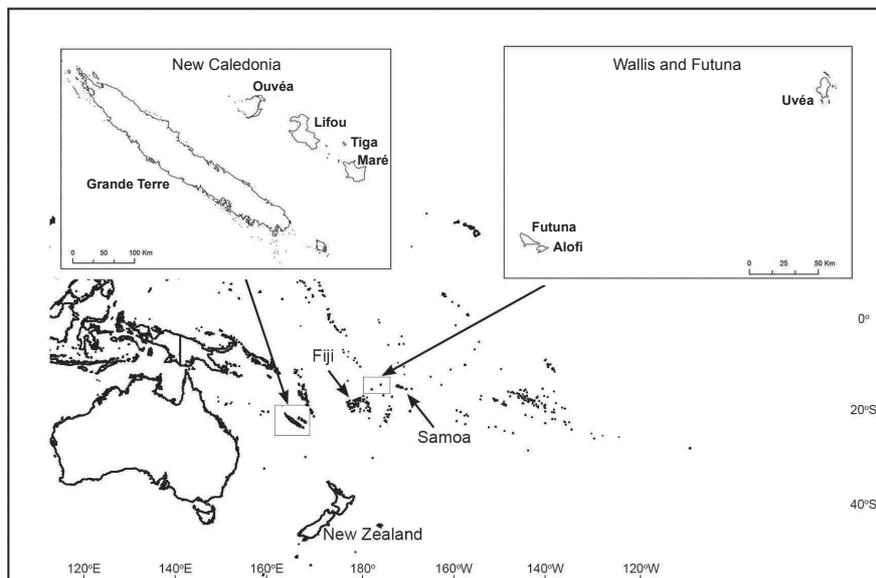
Figure 1 represents the geographical scope of the key presented here. The two Pacific archipelagos of New Caledonia and Wallis and Futuna have usually been investigated for their Odonata fauna separately, but they are combined here as both belong politically to France and have close relationships.

Located just north of the Tropic of Capricorn, New Caledonia is situated about 1,200 km northeast of Australia (19.5–22.5°S, 163.5–168°E). New

Caledonia's total surface area is about 18,000 km<sup>2</sup> and consists of the main island (Grande Terre GT) with small islets and the Loyalty Islands: Ouvéa (OU), Lifou (LI), and Maré (MA) with Tiga. The mainland of New Caledonia is crossed by a long mountain chain with peaks up to 1,620 m a.s.l., separating the island into a wet east coast (over 4,000 mm rainfall per year) and a relatively dry (around 100–2,000 mm) west coast. It has a tropical oceanic climate with a dry warm, a hot humid, and a cool humid season.

Wallis and Futuna is situated between Fiji and Samoa (13–14°S, 176–178°W). Wallis (75 km<sup>2</sup>) is relatively flat (max. elevation 144 m a.s.l) and has only standing water bodies, whereas Futuna (46 km<sup>2</sup>) has elevations of up to 524 m a.s.l. and rivers. Both islands have an annual rainfall of about 3,000 mm with little seasonal differences in temperature.

This identification key builds up on studies previously carried out largely on material from Grande Terre, the New Caledonian main island. It combines the morphological features already covered in these earlier keys referred



**Figure 1.** Situation and detail maps of New Caledonia and Wallis and Futuna in the Pacific Ocean.

to above, together with the diagnostic features of more recently described species in papers by WINSTANLEY & DAVIES (1982), WINSTANLEY (1984), VICK & DAVIES (1988, 1990), and DAVIES (2002). The identification guides to Odonata of Australia by WATSON et al. (1991) and THEISCHINGER & HAWKING (2006) were referred to for the dichotomous characters of higher taxonomic categories, mainly suborder, family and genus. The same guides were followed for the terminology of wing venation.

As the key is mainly intended as a field guide, it provides a number of diagnostic features that we consider sufficient for identification without going too much into details. Every couplet starts with what is considered as the most reliable feature and continues with the characters that may add to identification of closely related taxa. However, even the most reliable feature could vary between the specimens in question, and that is why it is advisable to make a final identification only after weighing all diagnostic characters and always referring to the figures provided with the keys. For *Isosticta* species, we followed the original key proposed by LIEFTINCK (1975) with modifications that were considered important for the observed variations in characteristics. However, even now some females might be difficult to identify based on the key submitted here. The same situation applies for certain *Synthemis* and *Tramea* species, which need further taxonomic studies to provide more reliable morphological features than body/wing coloration to positively establish their correct status.

Table 1 presents a list of all species including their distribution within the study area and endemic status.

**Table 1.** Checklist of Odonata species covered by the key with distribution notes and endemic status. Abbreviations for the distribution: GT – Grande Terre; IP – Île des Pins; OU – Ouvéa; LI – Lifou; MA – Maré with Tiga; WA – Wallis; FU – Futuna. Abbreviations for the endemic status: L – local endemic, species restricted to New Caledonia only; R – regional endemic, species inhabiting a neighboring archipelago; N/A – not applicable, species has a wide distribution range

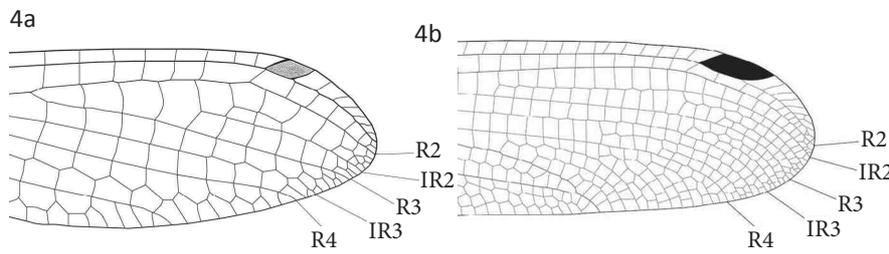
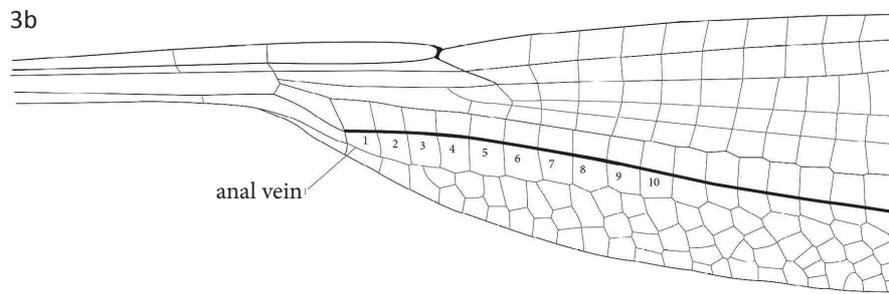
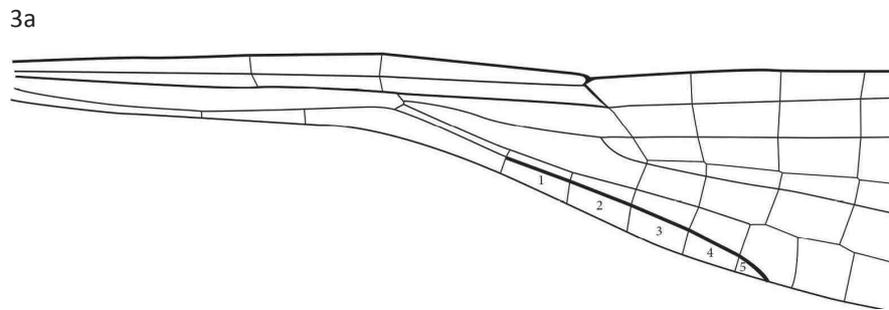
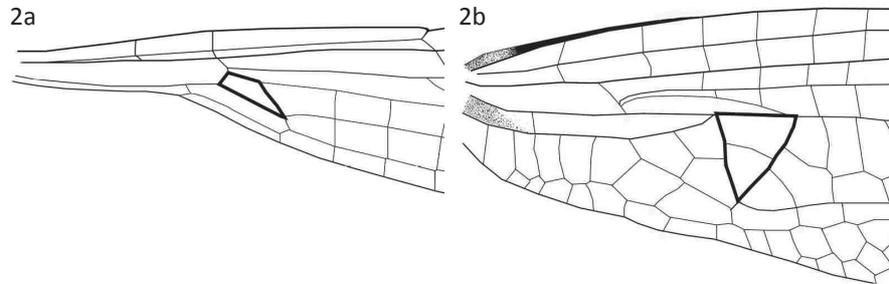
Family	Species	Distribution	Endemic status
Lestidae	<i>Indolestes cheesmanae</i> (Kimmins, 1936)	GT	R
	<i>Lestes concinnus</i> Hagen in Selys, 1862	GT	N/A
Argiolestidae	<i>Eoargiolestes ochraceus</i> (Montrousier, 1864)	GT	L
	<i>Caledargiolestes janiceae</i> Lieftinck, 1975	GT	L
	<i>Caledargiolestes uniseries</i> (Ris, 1915)	GT	L
	<i>Caledopteryx maculata</i> Winstanley & Davies, 1982	GT	L
	<i>Caledopteryx sarasini</i> (Ris, 1915)	GT	L
	<i>Trineuragrion percostale</i> Ris, 1915	GT	L
	Isostictidae	<i>Isosticta gracilior</i> Lieftinck, 1975	GT
<i>Isosticta humilior</i> Lieftinck, 1975		GT	L
<i>Isosticta robustior</i> Ris, 1915		GT, LI	L
<i>Isosticta spinipes</i> Selys, 1885		GT, LI	L
<i>Isosticta tillyardi</i> Campion, 1921		GT, IP	L
Coenagrionidae	<i>Agriocnemis exsudans</i> Selys, 1877	GT, OU, LI, WA, FU	N/A
	<i>Agriocnemis argentea</i> Tillyard, 1906	WA	N/A
	<i>Austroagrion watsoni</i> Lieftinck, 1982	GT	N/A
	<i>Ischnura aurora</i> (Brauer, 1865)	GT, WA, FU	N/A
	<i>Ischnura heterosticta</i> (Burmeister, 1839)	GT, OU	N/A
	<i>Ischnura pamela</i> Vick & Davies, 1988	GT	L
	<i>Xanthagrion erythroneurum</i> Selys, 1876	GT	N/A
Aeshnidae	<i>Aeshna brevistyla</i> Rambur, 1842	GT, IP	L
	<i>Anaciaeschna jaspidea</i> (Burmeister, 1839)	GT, FU	N/A
	<i>Anax gibbosulus</i> Rambur, 1842	GT	N/A
	<i>Anax guttatus</i> (Burmeister, 1839)	GT, WA, FU	N/A
	<i>Anax papuensis</i> (Burmeister, 1839)	GT	N/A
	<i>Austrogynacantha heterogena</i> Tillyard, 1908	GT	N/A

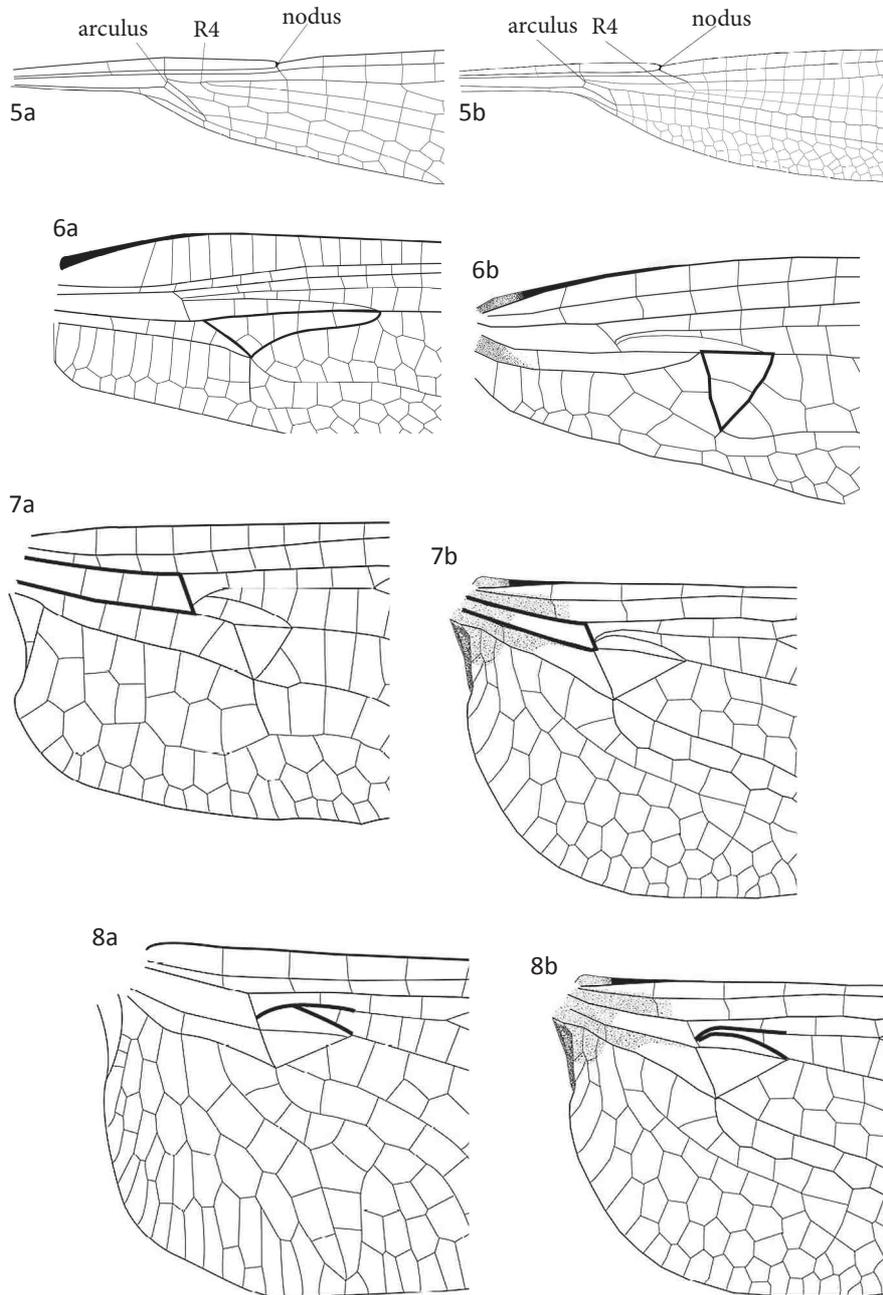
Family	Species	Distribution	Endemic status
Aeshnidae	<i>Gynacantha rosenbergi</i> Kaup in Brauer, 1867	GT	N/A
	<i>Oreaeschna dominatrix</i> Vick & Davies, 1990	GT, LI	L
Corduliidae	<i>Hemicordulia fidelis</i> McLachlan, 1886	GT, OU, LI, IP	R
	<i>Hemicordulia hilaris</i> Lieftinck, 1975	GT, IP	N/A
	<i>Metaphya elongata</i> Campion, 1921	GT	L
Synthemistidae	<i>Synthemis ariadne</i> Lieftinck, 1975	GT	L
	<i>Synthemis campioni</i> Lieftinck, 1971	GT	L
	<i>Synthemis fenella</i> Campion, 1921	GT	L
	<i>Synthemis flexicauda</i> Campion, 1921	GT	L
	<i>Synthemis miranda</i> Selys, 1871	GT	L
	<i>Synthemis montaguei</i> Campion, 1921	GT	L
	<i>Synthemis pamela</i> Davies, 2002	GT	L
	<i>Synthemis serendipita</i> Winstanley, 1984	GT	L
Libellulidae	<i>Agrionoptera insignis</i> (Rambur, 1842)	GT, OU, LI, MA	N/A
	<i>Diplacodes bipunctata</i> (Brauer, 1865)	GT, WA, FU	N/A
	<i>Diplacodes haematodes</i> (Burmeister, 1839)	GT, IP	N/A
	<i>Diplacodes trivialis</i> (Rambur, 1842)	OU	N/A
	<i>Lathrecista asiatica</i> (Fabricius, 1798)	GT, LI, WA, FU	N/A
	<i>Macrodiplax cora</i> (Kaup in Brauer, 1867)	GT, WA	N/A
	<i>Neurothemis stigmatizans</i> (Fabricius, 1775)	GT	N/A
	<i>Orthetrum caledonicum</i> (Brauer, 1865)	GT, LI, IP	N/A
	<i>Orthetrum sabina</i> (Drury, 1770)	GT, WA, FU	N/A
	<i>Orthetrum villosovittatum</i> (Brauer, 1868)	GT	N/A
	<i>Pantala flavescens</i> (Fabricius, 1798)	GT, OU, WA, FU	N/A
	<i>Rhyothemis graphiptera</i> (Rambur, 1842)	GT	N/A
	<i>Rhyothemis phyllis</i> (Sulzer, 1776)	GT, WA	N/A
	<i>Rhyothemis regia</i> (Brauer, 1867)	WA, FU	R
	<i>Tholymis tillarga</i> (Fabricius, 1798)	GT, WA, FU	N/A
	<i>Tamea liberata</i> Lieftinck, 1949	GT	N/A
	<i>Tamea loewii</i> Kaup in Brauer, 1866	GT	N/A
	<i>Tamea transmarina</i> Brauer, 1867	GT, LI, IP, WA, FU	N/A
	<i>Zyxomma petiolatum</i> Rambur, 1842	GT	N/A

### Key to suborders and families

Abbreviations used in the key: GT – Grande Terre, the main island of New Caledonia, IP – Île des Pins, OU – Ouvéa, LI – Lifou, MA – Maré with Tiga, WA – Wallis, FU – Futuna.

- 1a – Discoidal cell a simple quadrilateral (Fig. 2a); eyes not touching on the dorsum of the head ..... Suborder *Zygoptera* (2)
- 1b – Discoidal cell a simple triangle (Fig. 2b); eyes touching on the dorsum of the head ..... Suborder *Anisoptera* (5)
- 2a – Anal vein absent; CuP short, extending only about 5 to 7 cells (Fig. 3a) ..... **Isostictidae** (genus *Isosticta*) (III)
- 2b – Anal vein present; CuP longer than 7 cells (Fig. 3b) ..... (3)
- 3a – No supplementary longitudinal veins between branches of Rs (R2, IR2, R3, IR3 and R4) in distal portion of wings (Fig. 4a) ..... **Coenagrionidae** (IV)
- 3b – At least one supplementary, intercalated vein several cells long between branches of Rs in distal portion of wings (Fig. 4b) ..... (4)
- 4a – R4 starting closer to arculus than to nodus (Fig. 5a) ..... **Lestidae** (I)
- 4b – R4 starting closer to nodus than to arculus (Fig. 5b) . **Argiolestidae** (II)
- 5a – Triangle of fore wing elongate along wing axis (Fig. 6a) . **Aeshnidae** (V)
- 5b – Triangle of fore wing not elongate along wing axis, often elongate across it (Fig. 6b) ..... (6)
- 6a – Cross-veins present in median space (Fig. 7a) ..... **Synthemistidae** (genus *Synthemis*) (VI)
- 6b – No cross-veins in median space (Fig. 7b) ..... (7)
- 7a – Sectors of arculus fused at their origins and forming a short stalk (except in the fore wing of some *Rhyothemis*) (Fig. 8a); wing coloration variable, often with dark general, nodal or distal coloration ..... **Libellulidae** (VIII)
- 7b – Sectors of arculus diverging from their origins (at least in hind wing) (Fig. 8b); wings hyaline or partly suffused yellow or pale orange, with or without yellow to reddish brown marks at their bases ..... **Corduliidae** (VII)



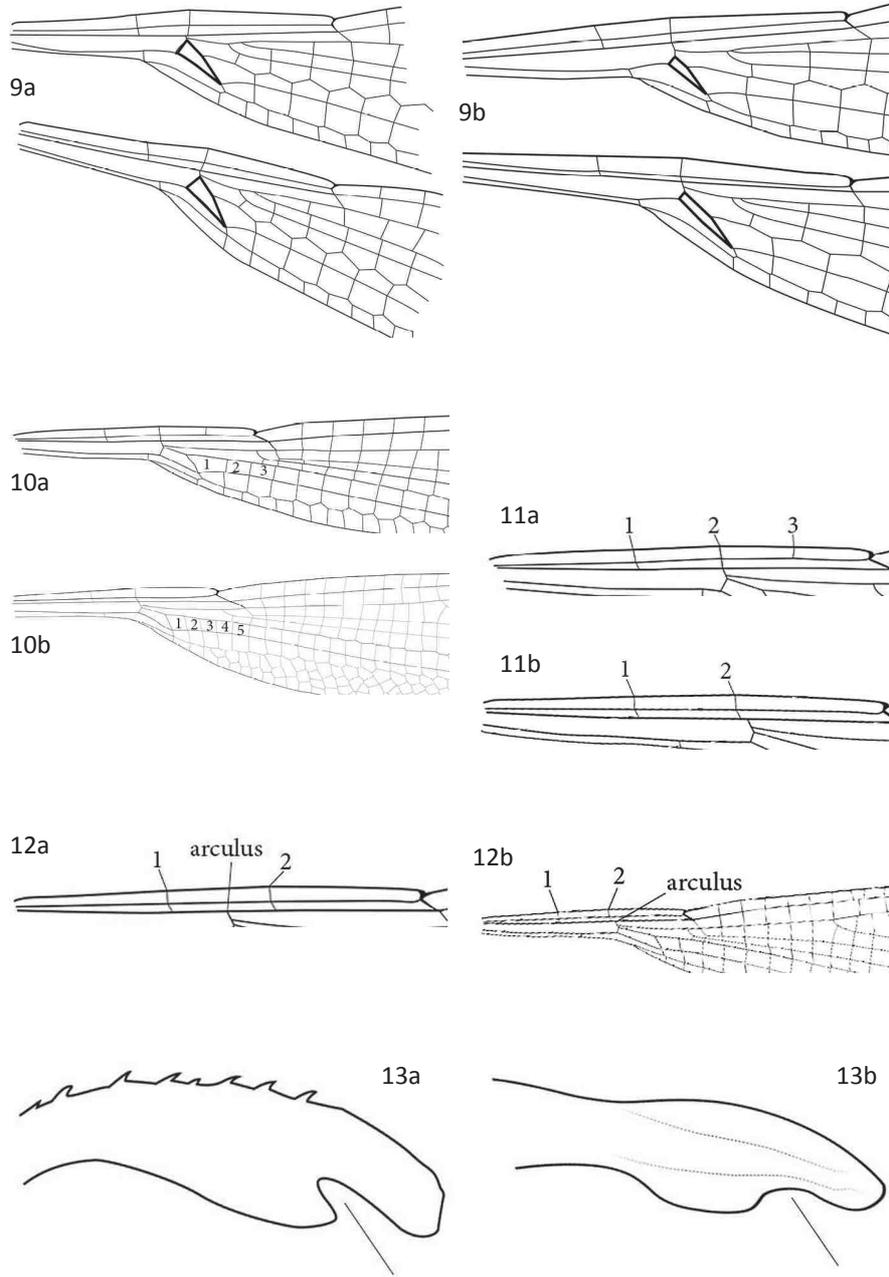


**I: Key to Lestidae**

- 1a – Quadrilateral cells of fore and hind wing similar in size and shape, that of hind wing less than 1.10 times length of fore wing quadrilateral (Fig. 9a) ..... *Lestes concinnus* (GT)
- 1b – Quadrilateral cell of fore and hind wing dissimilar in size and shape, that of hind wing more than 1.15 times, usually 1.3 to 1.5 times as long as that of fore wing (Fig. 9b) . *Indolestes cheesmanae* (GT)

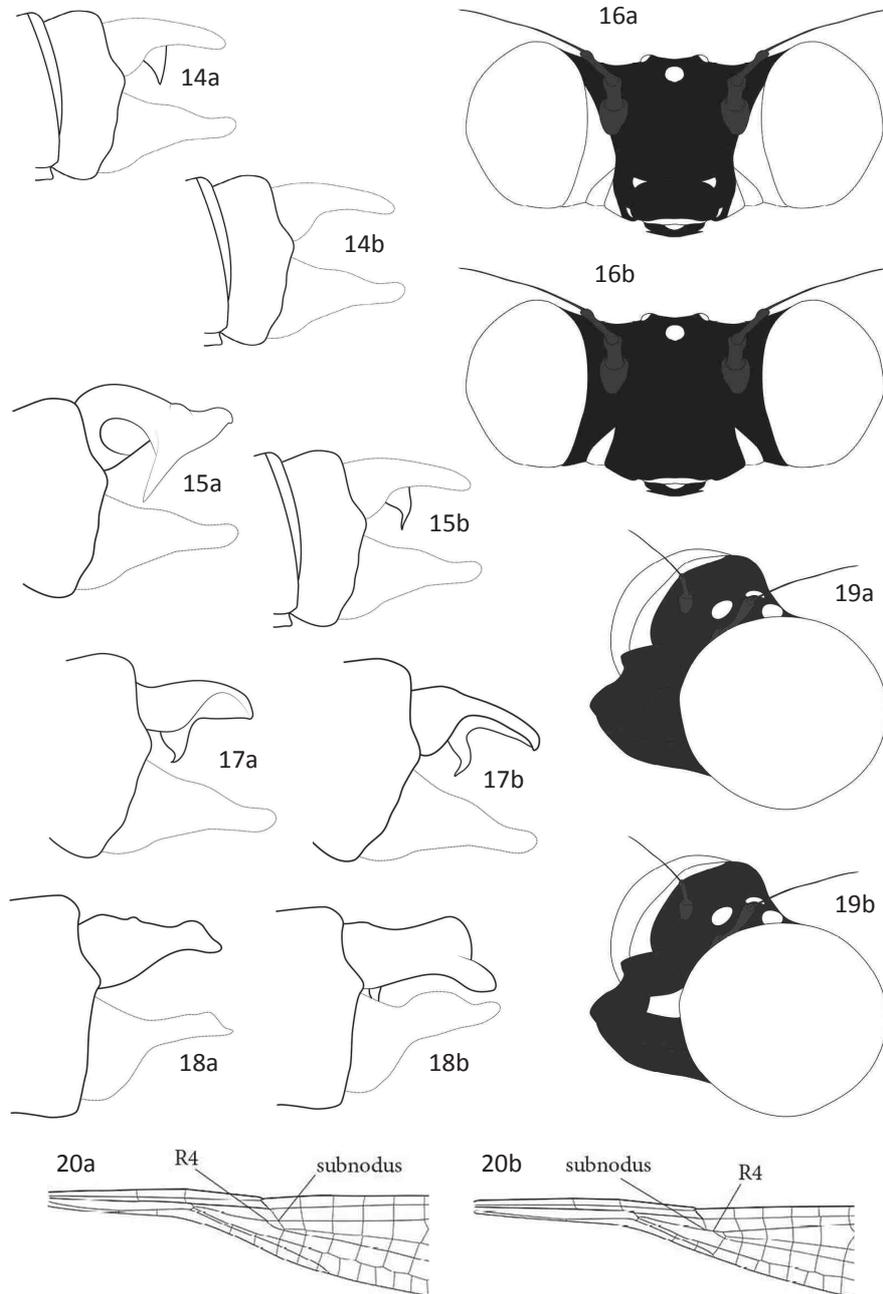
**II: Key to Argiolestidae**

- 1a – Up to three cells in discoidal field between discoidal cell and level of subnodus (Fig. 10a) ..... (2)
- 1b – More than three cells in discoidal field, between discoidal cell and level of subnodus (Fig. 10b) ..... (4)
- 2a – Three antenodal cross-veins, the 3<sup>rd</sup> incomplete (check all wings as the 3<sup>rd</sup> vein may be lacking on one or two of the wings) (Fig. 11a) ..... *Trineuragrion percostale* (GT)
- 2b – Two antenodal cross-veins (Fig. 11b) ..... *Caledargiolestes* (3)
- 3a – Arculus midway between Ax1 and Ax2 (Fig. 12a). Male superior anal appendages with a deep angled notch toward the tip (Fig. 13a) ..... *Caledargiolestes uniseriis* (GT)
- 3b – Arculus slightly distal to Ax2 (Fig. 12b). Male superior anal appendages with a knob-like process (not notch!) toward the tip (Fig. 13b) ..... *C. janiceae* (GT)
- 4a – Labrum black. Hind wing shorter than 31 mm; fewer than 22 postnodals; females and immature males with yellow to white pterostigma with light brown frame ..... *Eoargiolestes ochraceus* (GT)
- 4b – Labrum pale blue. Hind wing longer than 33 mm; more than 23 postnodals; both sexes with dark pterostigma in all imaginal stages ..... *Caledopteryx* (5)
- 5a – Abdominal segments 2–8 with paired light spots on the dorsum ..... *Caledopteryx maculata* (GT)
- 5b – Abdominal segments 2–8 without paired light spots on the dorsum ..... *C. sarasini* (GT)

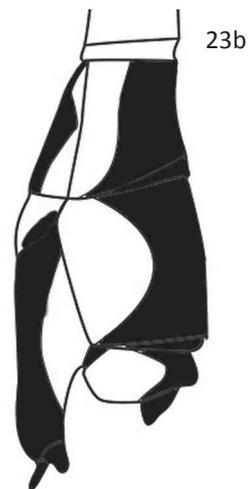
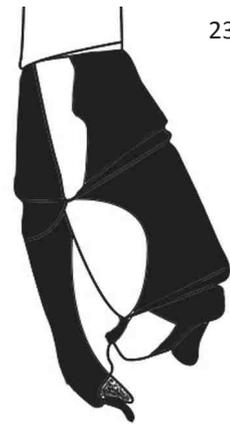
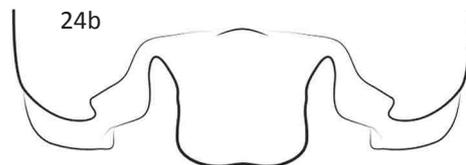
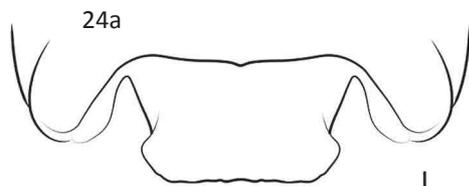
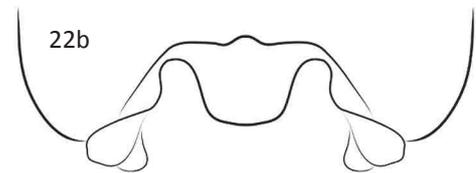
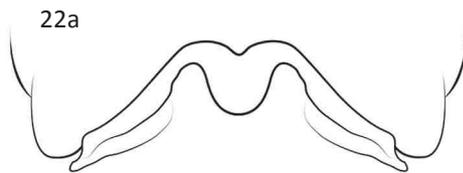
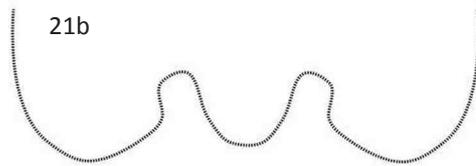
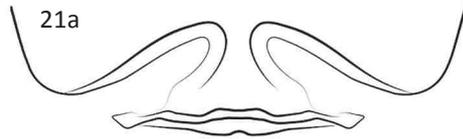


**III: Key to Isostictidae**

- 1a – Male ..... (2)
- 1b – Female ..... (6)
- 2a – Superior anal appendages with spine projecting ventrally  
(Fig. 14a) ..... (3)
- 2b – Superior anal appendages without spine projecting ventrally  
(Fig. 14b) ..... (5)
- 3a – Spine on the anal appendages straight; its outer lateral margin  
reaching the tip of the appendages as the spine is situated in the  
distal portion of the appendages (Fig. 15a) ..... *Isosticta humilior* (GT)
- 3b – Spine of superior anal appendages curved; its outer margin does  
not reach the tip of the appendages as the spine is situated in the  
proximal portion of the appendages (Fig. 15b) ..... (4)
- 4a – Genal area with bright yellow-green stripe (Fig. 16a); superior  
appendages tapering rapidly toward apex (Fig. 17a); abdomen +  
anal appendages longer than 35 mm ..... *I. robustior* (GT, LI)
- 4b – Genal area black (Fig. 16b); superior anal appendages gradually  
tapering toward the apex (Fig. 17b); abdomen + appendages  
shorter than 35 mm ..... *I. gracilior* (GT)
- 5a – Superior anal appendages generally tapering toward apex and  
with small subapical tubercle (Fig. 18a); lateral base of mandible  
glossy black (Fig. 19a); 14–18 postnodal cross-veins in fore wing  
and 12–14 in the hind wing ..... *I. spinipes* (GT, LI)
- 5b – Superior appendages do not appear to be tapering towards the  
apex, having near parallel sided for about  $\frac{2}{3}$  of their length and  
with large subapical tubercle (Fig. 18b); lateral base of mandible  
with a lemon yellow spot (Fig. 19b); 12–14 postnodal cross-veins  
in fore wing and 10–12 in hind wing ..... *I. tillyardi* (GT, IP)
- 6a – Wings with R4 forking before the subnodus; its basal portion  
distinctly curved (Fig. 20a) ..... (7)
- 6b – Wings with R4 forking after subnodus; its basal portion slightly  
curved (Fig. 20b) ..... (9)



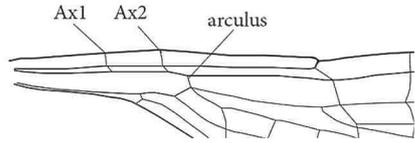
- 7a – Posterior lobe of prothorax with median lobe strongly constricted basally, then suddenly broadened, forming a triangular plate in dorsal view (Fig. 21a), its distal half in lateral view raised almost perpendicularly; lateral lobes reduced to mere swollen ridges; 13 postnodal cross-veins in fore wing; hind wing shorter than 20 mm ..... *I. humilior* (GT)
- 7b – Posterior lobe of prothorax deeply trifid, the median lobe neither abruptly raised nor constricted basally, shorter than the lateral lobes (Fig. 21b); more than 13 postnodal cross-veins in fore wing; hind wing longer than 20 mm ..... (8)
- 8a – Posterior lobe of prothorax with median lobe small, bluntly triangular in outline and directed obliquely upward and backward, markedly shorter than the lateral lobes, the latter diverging, somewhat raised, triangular and of moderate size (Fig. 22a); abdomen + appendages longer than 33 mm ..... *I. robustior* (GT, LI)
- 8b – Posterior lobe of prothorax with median lobe larger, subrectangular in outline and more depressed, not much shorter than lateral lobes, the latter similar to *I. robustior*, but more pronounced and of larger size (Fig. 22b); abdomen + appendages shorter than 33 mm ..... *I. gracilior* (GT)
- 9a – Ovipositor (including styles) projecting beyond the tip of abdomen for about the length of the anal appendages (Fig. 23a). Posterior lobe of prothorax with median lobe distinctly broader than long, exceeding lateral lobes, its swollen margin with long fringe of stiff, raised, radiating bristles; distance separating mid-lobe from lateral rims much less than its own diameter (Fig. 24a) ..... *I. spinipes* (GT, LI)
- 9b – Ovipositor (including styles) projecting beyond the tip of abdomen for more than twice the length of the appendages (Fig. 23b). Posterior lobe of prothorax with median lobe narrower, a little longer than broad, not exceeding lateral lobes, its swollen margin more distinctly upturned and fringed with long raised bristles similar to *I. spinipes*; distance separating mid-lobe from lateral lobes only little smaller than its own diameter (Fig. 24b) ..... *I. tillyardi* (GT)



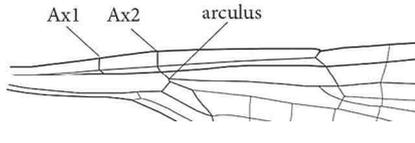
**IV: Key to Coenagrionidae**

- 1a – Arculus in hind wing situated distal to Ax2 by at least the length of subcostal part of antenodal (Fig. 25a); hind wing shorter than 14 mm ..... *Agriocnemis* (2)
- 1b – Arculus in hind wing situated at or slightly distal to Ax2 (Fig. 25b); hind wing longer than 14 mm ..... (3)
- 2a – Male superior anal appendages in dorsal view undulate and with very prominent dorso- apical tooth visible in lateral view (Fig. 26a); middle part of posterior lobe of female pronotum with small emargination thus appearing bilobed (Fig. 27a) ..... *Agriocnemis exsudans* (GT, OU, LI, WA, FU)
- 2b – Male superior anal appendages in dorsal view straight and with very small dorso-apical tooth visible in lateral view (Fig. 26b); middle part of posterior lobe of female pronotum variable in shape (may not be differentiated from the lateral portions), but does not appear bilobed (Fig. 27b) ..... *A. argentea* (WA)
- 3a – Anal vein leaving wing margin well basal to the level of Ac in both wings, so that there is a basal segment of anal vein about the same length as Ac (Fig. 28a) ..... *Ischnura* (4)
- 3b – Anal vein leaving wing margin nearer to or beyond level of Ac; basal segment of hind wing anal vein, if present, not more than half as long as Ac (Fig. 28b) ..... (9)
- 4a – Male ..... (5)
- 4b – Female ..... (7)
- 5a – Abdominal segments 2–6 red-orange . *Ischnura aurora* (GT, WA, FU)
- 5b – Abdominal segments 2–5 dark brown to black ..... (6)

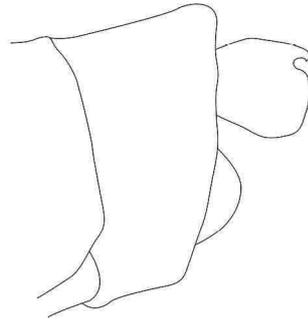
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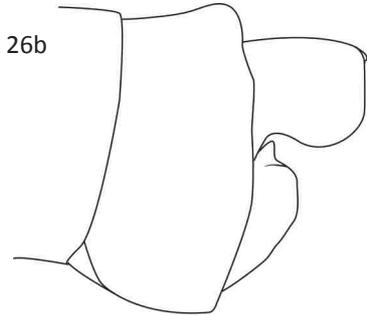
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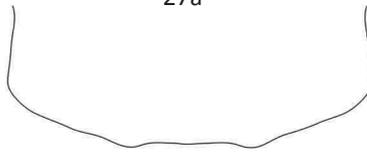
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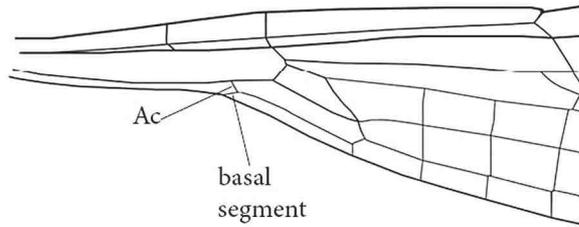
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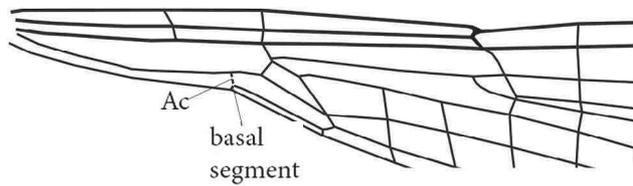
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28a



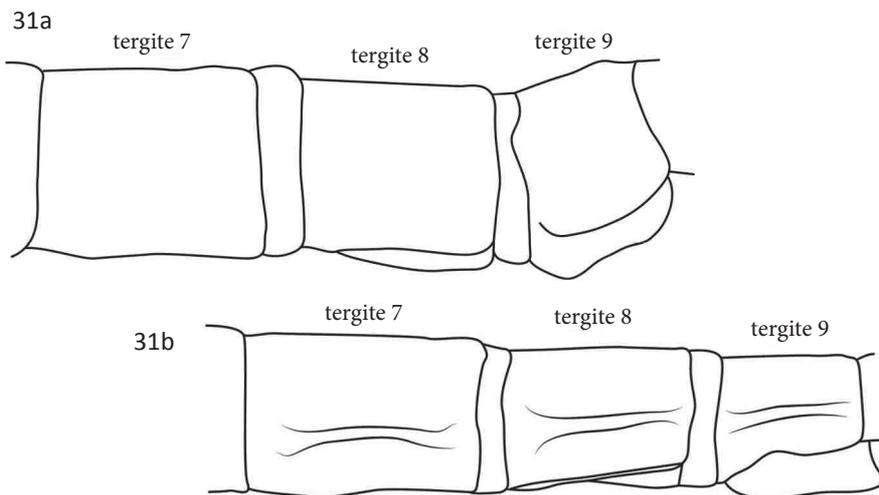
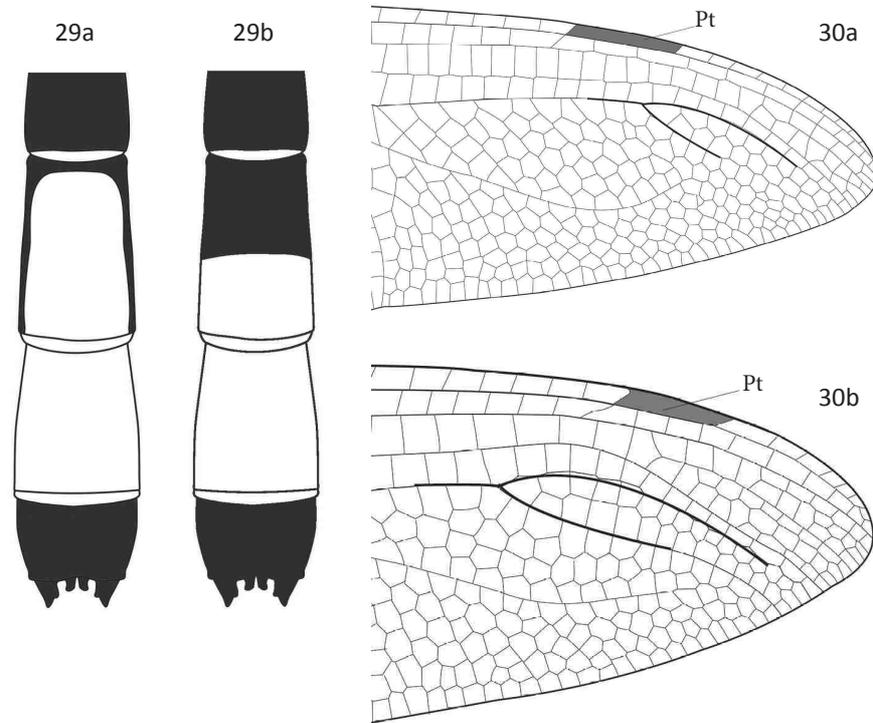
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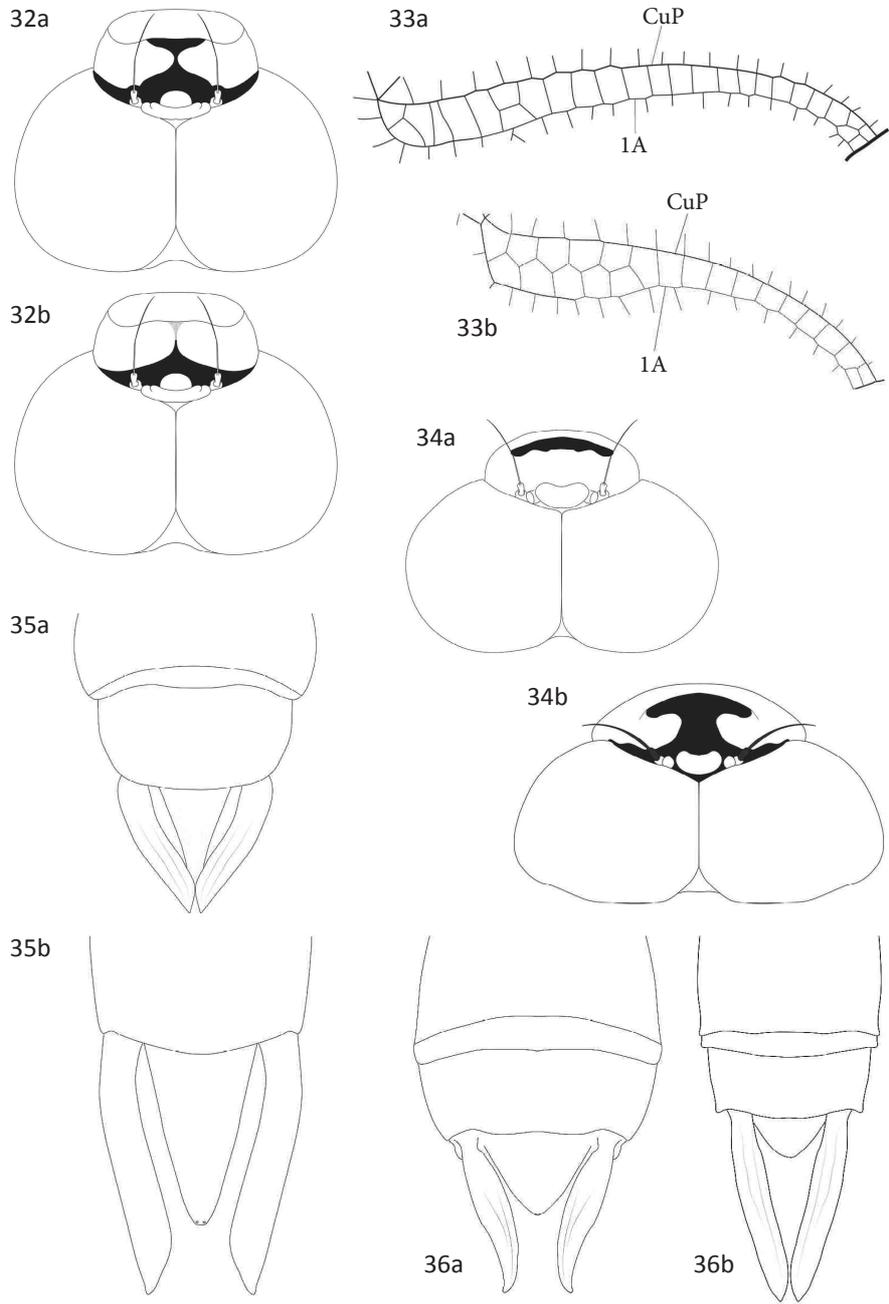
- 6a – In dorsal view the abdominal segments 8 and 9 entirely blue (Fig. 29a) ..... *I. heterosticta* (GT, OU)
- 6b – In dorsal view only abdominal segment 9 entirely blue; segment 8 blue only in the posterior half (Fig. 29b) ..... *I. pamela* (GT)
- 7a – Post-ocular spots irregularly shaped and non-circular .....  
..... *I. aurora* (GT, WA, FU)
- 7b – Post-ocular spots regularly shaped and circular ..... (8)
- 8a – Post-ocular spots large, with diameter about equal to distance between lateral ocelli; Pt in all wings forming an almost perfect rhombus; abdomen + anal appendices longer than 25 mm .....  
..... *I. heterosticta* (GT, OU)
- 8b – Post-ocular spots very small, with diameter about one half that of the distance between lateral ocelli; Pt in all wings strongly kite-shaped, with length of two sides nearest base of wing about  $\frac{3}{4}$  length of two sides nearest apex of wing; abdomen + anal appendices shorter than 24 mm ..... *I. pamela* (GT)
- 9a – Legs pale orange-red (males) or dull yellow (females), without black on the outer surface ..... *Xanthagrion erythroneurum* (GT)
- 9b – Legs blue (males) or green-yellow (females), extensively black on the outer surface ..... *Austroagrion watsoni* (GT)

#### V: Key to Aeshnidae

- 1a – Last prominent fork of IR3 at or near level of distal end of pterostigma in both wings (Fig. 30a); anal margin of hind wing rounded in both sexes, male lacking anal triangle and auricle . *Anax* (2)
- 1b – Prominent fork of IR3 near or proximal to level of basal end of pterostigma in both wings (Fig. 30b); anal margin of hind wing rounded in female, angulated in male, forming anal triangle; male with auricle ..... (4)
- 2a – Sides of abdominal tergite evenly rounded in male (Fig. 31a), strongly ridged on tergite 7–8 or 7–9 in female . *Anax papuensis* (GT)
- 2b – Sides of abdominal tergite 7–9 in male, 4–9 or 5–9 in female, with strong supplementary longitudinal ridge (Fig. 31b) ..... (3)

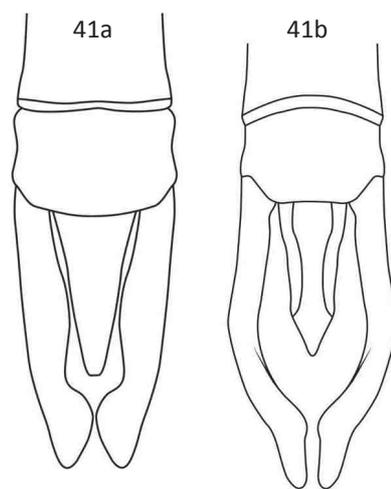
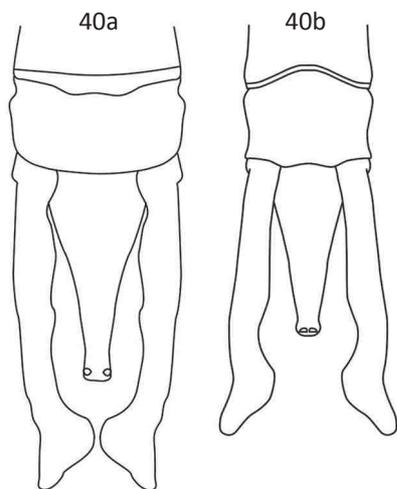
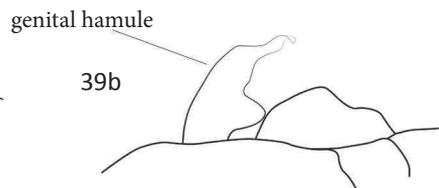
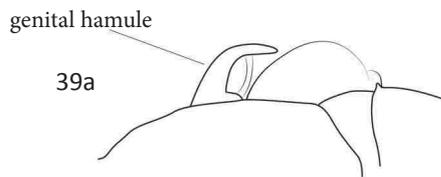
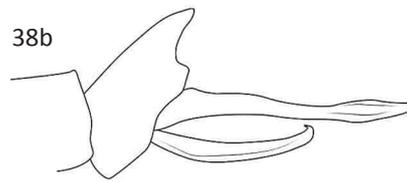
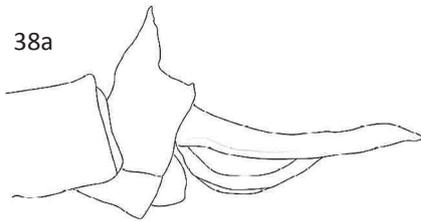
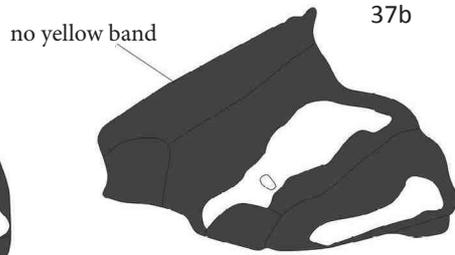
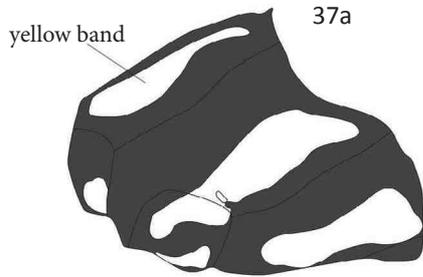


- 3a – Top of frons: subtriangular dark area in front of eyes and ocelli projects as a T-shaped mark (Fig. 32a) ..... *A. gibbosulus* (GT)
- 3b – Top of frons: subtriangular dark area in front of eyes and ocelli does not project as a T-shaped mark (Fig. 32b) .....  
..... *A. guttatus* (GT, WA, FU)
- 4a – Space between CuP and 1A of hind wing one, occasionally two cells wide, slightly and continuously tapering from proximal to distal (Fig. 33a) ..... (5)
- 4b – Space between CuP and 1A of hind wing two to three cells wide proximally and abruptly constricted about midway of its length, narrowing to half or less in width (Fig. 33b) ..... (6)
- 5a – Front of synthorax with long, slanting pale stripe on each side; abdominal segments 4–7 with prominent basal, central and apical pale, yellowish spots ..... *Austrogynacantha heterogena* (GT)
- 5b – Front of synthorax dull brown or green, pale or dark, with or without an ill-defined pale patch in lower, outer corner; abdominal segment 4–7 with, at most, small pale spots, often almost unpatterned ..... *Gynacantha rosenbergi* (GT)
- 6a – Top of frons without conspicuous T-mark, only a transverse bar along the crest (Fig. 34a) ..... *Anaciaeschna jaspidea* (GT, FU)
- 6b – Top of frons with a conspicuous T-mark (Fig. 34b) ..... (7)
- 7a – Sides of abdominal segment 10 in dorsal view oblique, width of segment at least twice the length; male superior anal appendages strongly convergent (Fig. 35a); female anal appendages turned outward at the tips (Fig. 36a) ..... *Oreaeschna dominatrix* (GT, LI)
- 7b – Sides of abdominal segment 10 in dorsal view parallel, width of segment much less than twice the length; male superior anal appendages slightly convergent (Fig. 35b); female anal appendages straight (Fig. 36b) ..... *Aeshna brevistyla caledonica* (GT, IP)



**VI: Key to Synthemistidae**

- 1a – Abdomen + appendices shorter than 35 mm; hind wing shorter than 30 mm ..... (2)
- 1b – Abdomen + appendices longer than 40 mm; hind wing longer than 33 mm ..... (3)
- 2a – Yellow ante-humeral bands (Fig. 37a) ..... *Synthemis fenella* (GT)
- 2b – Without yellow ante-humeral bands (Fig. 37b) ..... *S. ariadne* (GT)
- 3a – Male ..... (4)
- 3b – Female ..... (9)
- 4a – Long dorsal spine on the dorsum of abdominal segment 10 ..... (5)
- 4b – Without long dorsal spine on the dorsum of abdominal segment 10. (6)
- 5a – Tip of the tenth segment's abdominal spine in lateral view acute and pointing almost straight upward (Fig. 38a) ..... *S. miranda* (GT)
- 5b – Tip of the tenth segment's abdominal spine in lateral view rounded and curved posteriorly (Fig. 38b) ..... *S. pamela* (GT)
- 6a – Superior anal appendages brown ..... (7)
- 6b – Superior anal appendages at least partly yellow or whitish ..... (8)
- 7a – Genital hamule non-undulate (Fig. 39a); anal appendages as in Fig. 40a ..... *S. serendipita* (GT)
- 7b – Genital hamule undulate (Fig. 39b); anal appendages as in Fig. 40b ..... *S. campioni* (GT)
- 8a – Synthorax with narrow yellowish line at the first (intersegmental) suture separated from a pale spot at the spiracle; anal appendages as in Fig. 41a ..... *S. montaguei* (GT)
- 8b – Synthorax with two broad uninterrupted cream stripes or bands, one at the first (intersegmental) suture enclosing spiracle, the second crossing the metepimeron; anal appendages as in Fig. 41b ..... *S. flexicauda* (GT)
- 9a – Hind wing coloured distally of discoidal cell, or colouration reaching nodus ..... *S. miranda* (part) (GT)
- 9b – Hind wing not coloured distally of discoidal cell ..... (10)

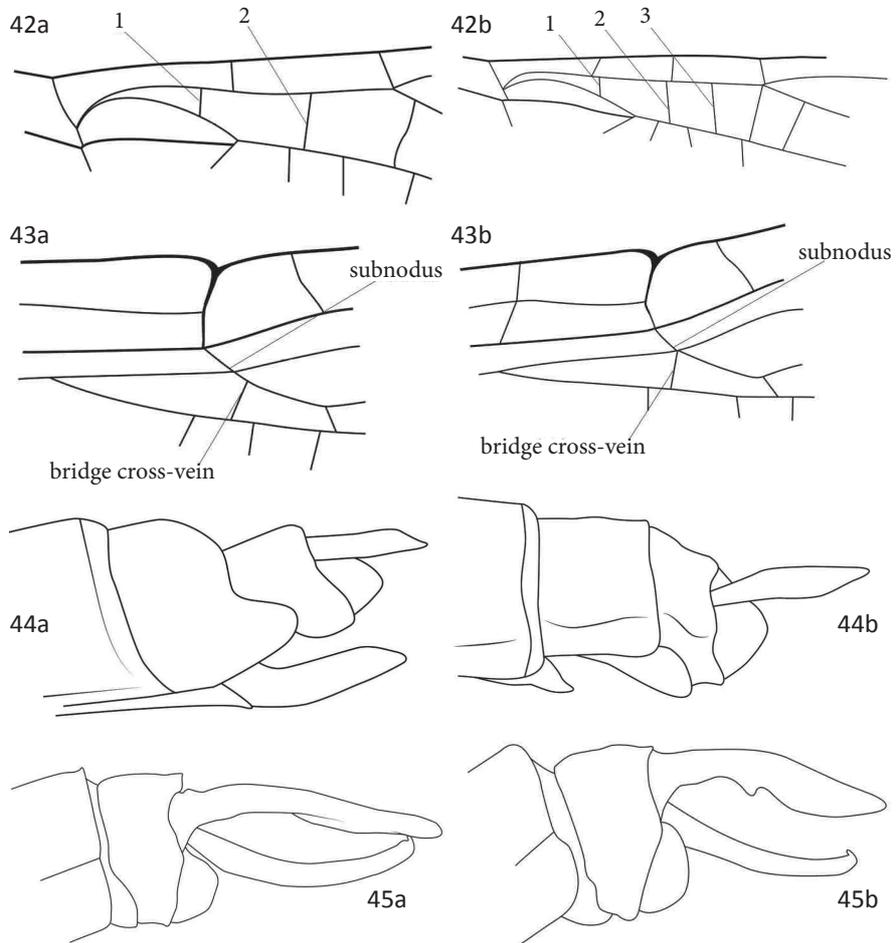


- 10a – Synthorax laterally with large triangular bright green stripe tapering ventrally toward the coxae ..... *S. pamela* (GT)
- 10b – Synthorax laterally with small traces of yellow or without any bright spots at all ..... (11)
- 11a – Anal appendages shorter than abdominal segment 10 (wings may lack colouration) ..... *S. miranda* (part) (GT)
- 11b – Anal appendages longer than abdominal segment 10 ..... (12)
- 12a – Sides of thorax and anal appendages uniformly brown ..... (13)
- 12b – Sides of thorax with one or two yellow stripes or bands; anal appendages at least partly yellow or whitish ..... (14)
- 13a – Wings with translucent brown between nodus and pterostigma; distance between anal appendages smaller than half the width of abdominal segment 10; hind wing shorter than 45 mm ..... *S. campioni* (GT)
- 13b – Wings without translucent brown between nodus and pterostigma; distance between appendages equals half the width of abdominal segment 10; hind wing longer than 45 mm ..... *S. serendipita* (GT)
- 14a – Synthorax with narrow yellowish line at intersegmental suture separated from a pale spot at the spiracle ..... *S. montaguei* (GT)
- 14b – Synthorax with two broad uninterrupted cream stripes or bands, one at intersegmental suture enclosing spiracle, the other across metepimeron ..... *S. flexicauda* (GT)

#### VII: Key to Corduliidae

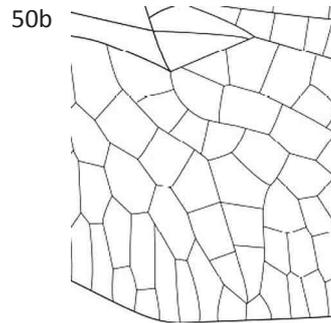
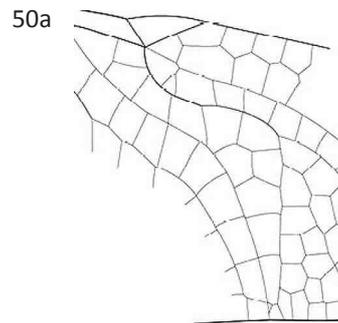
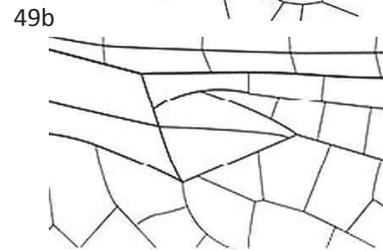
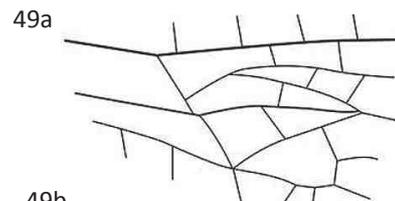
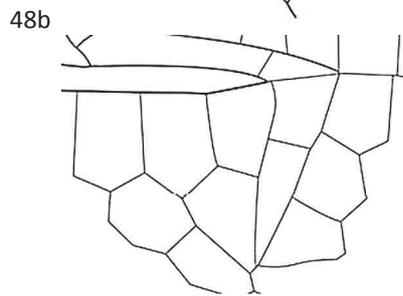
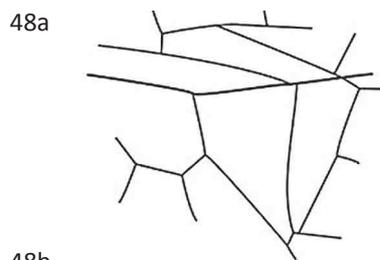
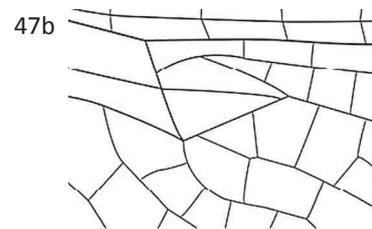
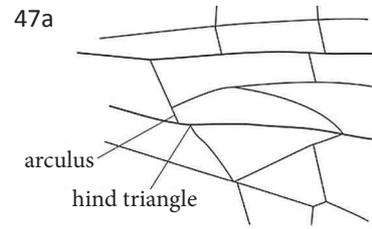
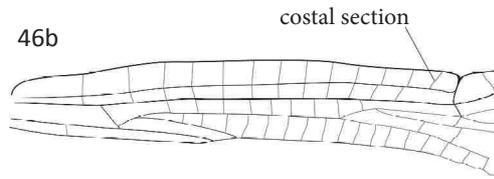
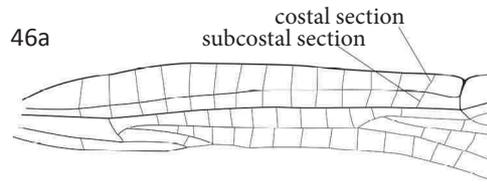
- 1a – Two cross-veins between sectors of arculus basal to fork of Rs in hind wing (Fig. 42a); bridge cross-vein between subnodus and oblique vein (Fig. 43a); female with ovipositor long, spoon-like, extending beyond end of abdomen (Fig. 44a) . *Metaphya elongata* (GT)
- 1b – Three cross-veins between sectors of arculus basal to fork of Rs in hind wing (Fig. 42b); bridge cross-vein at subnodus (Fig. 43b); ovipositor short, less than half as long as tergite 9 (Fig. 44b) ..... *Hemicordulia* (2)

- 2a – Abdomen brown-green with metallic sheen and obscure spots.  
 Male superior anal appendages without a median tooth (Fig. 45a).  
 Female fore wing without diffuse yellow or light orange spot  
 ..... *Hemicordulia hilaris* (GT, IP)
- 2b – Abdomen green-brown with metallic sheen and bright yellow spots on segments 4–7. Male superior anal appendages with a median tooth (Fig. 45b). Female fore wing with diffuse yellow or light orange spot in distal area ..... *H. fidelis* (GT, OU, LI, IP)



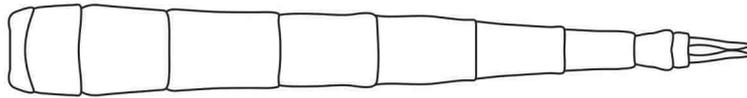
**VIII: Key to Libellulidae**

- 1a – Distal antenodal cross-vein in fore wing complete, both costal and subcostal sections present (Fig. 46a) ..... (2)
- 1b – Distal antenodal cross-vein in fore wing incomplete, only the costal section present (Fig. 46b) ..... (6)
- 2a – Basal side of hind wing triangle just distal to well distal to arculus (Fig. 47a) ..... *Agrionoptera insignis* (GT, OU, LI, MA)
- 2b – Basal side of hind wing triangle at or proximal to arculus (Fig. 47b) ..... (3)
- 3a – Fore wing triangle free (Fig. 48a); hind wing with 5 antenodal cross-veins ..... *Macrodiplax cora* (GT, WA)
- 3b – Fore wing triangle crossed (Fig. 48b); hind wing with more than 5 antenodal cross-veins ..... *Orthetrum* (4)
- 4a – Hind wing clear at base ..... *Orthetrum caledonicum* (GT, LI, IP)
- 4b – Small reddish brown to yellowish brown spot at base of hind wing ..... (5)
- 5a – Sides of synthorax striped black and yellow ..... *O. sabina* (GT, WA, FU)
- 5b – Sides of synthorax unicolorously yellowish brown ..... *O. villosovittatum* (GT)
- 6a – Hind wing triangle crossed (Fig. 49a) .. *Neurothemis stigmatizans* (GT)
- 6b – Hind wing triangle free (Fig. 49b) ..... (7)
- 7a – Tip of anal loop usually open on one or both sides of mid-vein, the bounding veins of loop extending to wing margin, occasionally closed, the bounding veins meeting mid-vein at wing margin (Fig. 50a) ..... (8)
- 7b – Tip of anal loop closed, the bounding veins meeting mid-vein one row of cells before wing margin (Fig. 50b) ..... (9)

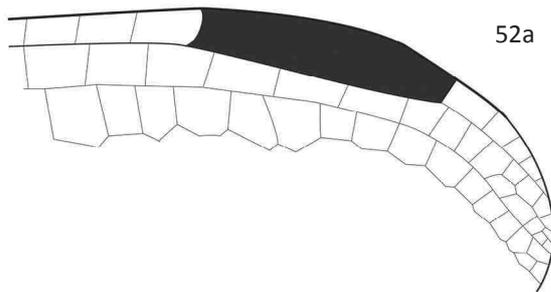
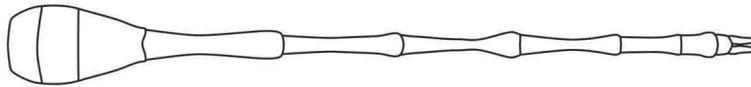


- 8a – Abdomen tapering progressively from segment 3 to tip (Fig. 51a); variable, yellowish brown patch between triangle and nodus of hind wing, sometimes very faint; male abdomen orange brown ..... *Tholymis tillarga* (GT, WA, FU)
- 8b – Abdomen narrowing abruptly within the length of segment 3 (Fig. 51b); wing tips variably darkened, sometimes hyaline, rest of wing membrane hyaline except for dark flecks at extreme base and, in some, a dark costal band, or with general, yellowish brown suffusion; male abdomen dull brown to blackish brown ..... *Zyxomma petiolatum* (GT)
- 9a – Hind wing shorter than 30 mm ..... *Diplacodes* (10)
- 9b – Hind wing longer than 30 mm ..... (12)
- 10a – Costal vein entirely pale to the level of pterostigma ..... *Diplacodes haematodes* (GT, IP)
- 10b – Costal vein with black longitudinal lines, thus appearing completely dark to the level of pterostigma ..... (11)
- 11a – Anal appendages partly or entirely creamy white .... *D. trivialis* (OU)
- 11b – Anal appendages not creamy white ..... *D. bipunctata* (GT, WA, FU)
- 12a – Wings with more than two cross-veins below the pterostigma (Fig. 52a) ..... *Lathrecista asiatica* (*asiatica*: GT, LI; *festae*: WA, FU)
- 12b – Wings with two or fewer cross-veins below the pterostigma (Fig. 52b) ..... (13)
- 13a – Hind wing without dark mark at the base ..... *Pantala flavescens* (GT, OU, WA, FU)
- 13b – Hind wing with dark mark at the base ..... (14)
- 14a – Wing membrane hyaline except for narrow to broad, dark reddish brown patch at base of hind wing and variable, small reddish brown patch at base of fore wing, often lacking; male abdomen orange red or reddish brown, the last few segments marked with black ..... *Tramea* (15)
- 14b – Both fore and hind wing with dark brown to black markings; male abdomen black ..... *Rhyothemis* (17)

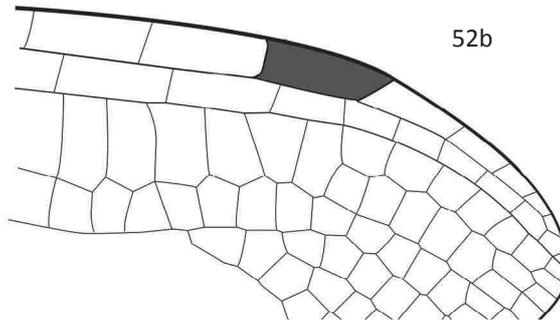
51a



51b



52a



52b

- 15a – Coloration along synthoracic sutures darker than areas between them, giving impression of two dull yellowish to brown stripes on dark purplish background ..... *Tramea loewii* (GT)
- 15b – Synthorax almost uniformly red, top of pleural sutures darkened ..... (16)
- 16a – Anal appendages as long as abdominal segments 9 + 10 .....  
..... *T. liberata* (GT)
- 16b – Anal appendages longer than abdominal segments 9 + 10 .....  
... *Tramea transmarina* (*intersecta*: GT, LI, IP; *transmarina*: WA, FU)
- 17a – Wings with dark marks without traces of yellow .....  
..... *Rhyothemis regia chalcoptilon* (WA, FU)
- 17b – Wings with dark marks and yellow patches (or traces of yellow) . (18)
- 18a – Wings with dark marks and pale tips; wing membrane brownish yellow with darker brown mottling ..... *R. graphiptera* (GT)
- 18b – Wing tips dark; wing membrane colourless or tinged yellow, and marked with brownish black patches, including major brownish black area traversed by yellow cross band at base of hind wing ..... *R. phyllis* (*apicalis*: GT; *dispar*: WA)

### Acknowledgments

This key is dedicated to the memory of Daniel Grand, the first and primary author of this paper. His long-time studies of New Caledonian Odonata resulted in a final species checklist and a key to local species. In order to keep his original intentions, we publish his original version of the key with only small modifications and additions. In the preparation of the key we received important advice and verification details from Graham S. Vick. We also thank other researchers who supported us with advice, literature and copyrights permission: John Marris, Richard Seidenbusch, Martin Schorr, Paul Smith, and Günther Theischinger.

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## References

- CAMPION H. 1921. Odonata collected in New Caledonia by the late Mr Paul D. Montague. *The Annals and Magazine of natural History* (IX) 8: 33-67
- DAVIES D.A.L. 2002. The odonate fauna of New Caledonia, including the description of a new species and a new subspecies. *Odonatologica* 31: 229-344
- KALKMAN V.J. & THEISCHINGER G. 2013. Generic revision of Argiolestidae (Odonata), with four new genera. *International Journal of Odonatology* 16: 1-52
- LIEFTINCK M.A. 1971. Study in oriental Corduliidae (Odonata). *Tijdschrift voor Entomologie* 114: 1-63
- LIEFTINCK M.A. 1975. The dragonflies (Odonata) of New Caledonia and the Loyalty Islands, 1: Imagines. *Cahiers de l'Office de la Recherche scientifique et technique d'Outre-mer* (Hydrobiologie) 9 (2): 127-176
- MEURGEY F. 2004. Contribution à la connaissance de la faune odonatologique des Départements et Territoires d'Outre-mer français III. Annexe V, Nouvelle-Calédonie. *Martinia* 20: 98-101
- PAPAZIAN M., DUMONT H.J. & MARY-SASAL N.J. 2007. The Odonata of the Pacific Ocean Islands of Wallis and Futuna, with special reference to speciation in *Ischnura aurora* (Brauer). *Odonatologica* 36: 53-62
- THEISCHINGER G. & HAWKING J. 2006. The complete guide to dragonflies of Australia. CSIRO Publishing, Collingwood, VIC.
- VICK G.S. & DAVIES D.A.L. 1988. A new species of *Ischnura* from New Caledonia (Zygoptera: Coenagrionidae). *Odonatologica* 17: 281-287
- VICK G.S. & DAVIES D.A.L. 1990. A new species of *Oreaeschna* from New Caledonia (Anisoptera: Aeshnidae). *Odonatologica* 19: 187-194
- WATSON J.A.L., THEISCHINGER G. & ABBEY H.M. 1991. The Australian dragonflies. A guide to the identification, distribution and habitats of Australian Odonata. CSIRO, Canberra and Melbourne
- WINSTANLEY W.J. 1984. *Synthemis serendipita* sp. nov. (Odonata: Synthemistidae) from New Caledonia. *New Zealand Journal of Zoology* 11: 9-12
- WINSTANLEY W.J. & DAVIES D.A.L. 1982. *Caledopteryx maculata* sp. nov. (Odonata: Megapodagrionidae) from New Caledonia. *Odonatologica* 11: 339-346

