THE DRAGONFLIES (ODONATA) OF NEW CALEDONIA AND THE LOYALTY ISLANDS

PART 2. IMMATURE STAGES

MAURITS A. LIEFTINCK
"Kallisle", Rhenen 2780, the Netherlands

ABSTRACT

Of the 40 species of Odonata hitherto known to occur in New Caledonia (18 Zygoptera and 22 Anisoptera), the larval stages of 9 belonging to the first and 12 to the second suborder are represented in the material studied, 10 of them being here characterized for the first time. Special attention has been paid to the endemic Argiolestinae, *the* Isostictidae, *and* Synthemis, *whose salient characteristics are described and illustrated in some detail. The first category comprises 4 species, viz.* Argiolestes ochraceus, *the supposed* Caledargiolestes uniseries, Caledopteryx sarasini *and, inevitably, also the mysterious terrestrial kind, of which the imago still remains to be discovered. All are isolated, dissimilar forms showing specializations of their own, which are probably largely adaptive by nature, being nonapparent in the adult dragonfly. For three species the generalized structure of the proventriculus is also described and figured. Comparisons are made with some Papuan relatives and, more especially, with* Austroargiolestes icteromelas. *The most noticeable characters of this Australian zygopteron are described and figured, with notes on the ethology of its larva based on field observations, and comments on the function of its caudal lamellae as respiratory and locomotion organs.*

As to Isosticta, *keys are supplied for the distinction of 3 of the 5 known species, followed by a brief characterization of a very young individual. The diagnosis of* I. robustior *is mainly based on the exuviae of one specimen which is, in fact, the only New Caledonian dragonfly ever obtained in the act of transformation and preserved with its larval skin.*

Of the conspicuous corduliid genus Synthemis, *only 6 insular species have so far been described, but 7 are recognized in the material on hand. The distinguishing features of these are illustrated and arranged in a key, though only* S. fenella *and* miranda *could be identified with reasonable certainty.*

The only aeshnid represented in the collections is Aeshna brevistyla, *of which some structural peculiarities are figured.*

The introduction ends with an appeal to local students of the aquatic insect fauna to study the autochthonous Odonata in the field, collect their larvae selectively, and rear them in small aquaria in order to match them against the perfect insect.

RÉSUMÉ

Parmi les 40 espèces d'Odonates connues pour le moment de Nouvelle Calédonie (18 Zygoptères et 22 Anisoptères) 21 sont représentées par leur stade larvaire dans le matériel étudié, soit 9 Zygoptères et 12 Anisoptères. Dix d'entre eux sont décrits ici pour la première fois. Les Argiolestinae *endémiques, les* Isostictidae *et* Synthemis, *ont été plus spécialement étudiés et leurs caractères les plus marquants sont donnés et illustrés en détail. La première catégorie comprend 4 espèces, soit* Argiolestes ochraceus, *la supposée* Caledargiolestes uniseries, Caledopteryx sarasini *et, évidemment, l'espèce terrestre mystérieuse dont l'imago reste encore à trouver. Toutes sont des formes isolées et dissemblables montrant des spécialisations propres, qui sont très probablement de nature adaptative pour l'essentiel puisqu'elles ne sont plus décelables chez les libellules adultes. Pour 3 espèces la structure générale du proventriculus est décrite et représentée. Des comparaisons sont faites avec des espèces voisines de Nouvelle Guinée et, plus particulièrement, avec* Austroargiolestes icteromelas. *Les caractères les plus marquants de ces Zygoptères australiens sont décrits et dessinés, avec des notes sur le comportement larvaire basées sur des observations in situ, et des commentaires sur le fonctionnement des lamelles caudales comme organes de respiration et de locomotion.*

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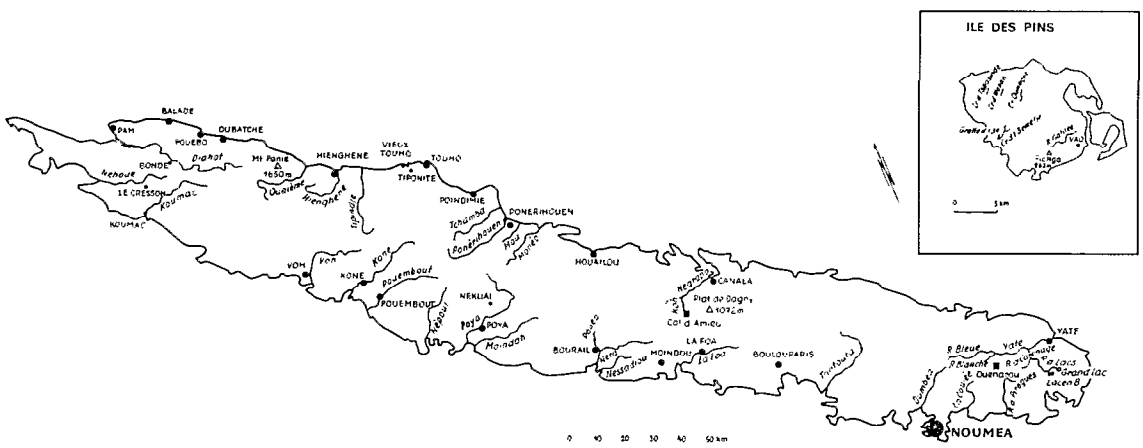
En ce qui concerne Isosticta, *des clés suivies d'une brève caractérisation de très jeunes individus, permettent d'identifier 3 des 5 espèces connues. La diagnose de* I. robustior *est basée principalement sur l'exuvie d'un individu qui est, en fait, la seule libellule néo-calédonienne jamais obtenue par métamorphose et conservée avec sa dépouille larvaire.*

A l'intérieur du remarquable genre corduliide de Synthemis *6 espèces insulaires seulement ont été décrites jusqu'à présent, mais 7 espèces différentes peuvent être distinguées à partir du matériel larvaire. Une clé permet de les séparer bien que* S. fenella *et* miranda *aient seules pu être identifiées avec une probabilité raisonnable.*

La seule Aeshnide présente dans les collections est Aeshna brevistyla ; *certaines de ses particularités structurales sont mises en évidences.*

Enfin, les étudiants locaux intéressés par l'entomofaune aquatique sont encouragés à étudier les odonates autochtones sur le terrain, ce qui permettra de ramasser les larves sélectivement puis de les élever en aquariums de façon à pouvoir mettre en relation le stade larvaire et l'imago de chaque espèce.



Carte. — Nouvelle Calédonie

INTRODUCTION

The present account is the second part of my survey of the Odonata of New Caledonia and concludes it with a discussion of the immature stages. These larval forms were collected almost exclusively by the participants of the two hydrobiological expeditions mentioned already in the first article and also in the next chapter of the present instalment of this work. Nearly all individuals came from New Caledonia; the larvae of two common Zygoptera, viz. *Ischnura heterosticta* (Burm.) and *Agriocnemis e. exsudans* Selys, can now be recorded for the first time from the Loyalties as well. I have attempted to discuss them in such a manner as to stress their salient characters and as far as possible to show relationships.

In the previous part (huj. op., 1975), 40 taxa in the adult state (species and subspecies) were recorded as occurring in the New Caledonian archipelago. This total can be left unchanged since *Ischnura torresiana* Till. has now proved to be conspecific with the common Australian *I. heterosticta* (teste J. A. L. Watson, in litt.), while one enigmatic taxon should be added to the list. In spite of much careful consideration it has been found impossible to associate the much-discussed terrestrial megapodagrionid described by Lippitt Willey (1955) with any of the other members of the family so that this insect, for the time being, must complement our list as a *species inquirenda.*

As to the larvae, we can say that about half of them have become known, all samples together comprising 22 recognizable species, some of the latter being, however, represented by very few individuals only. Two species are known to me only from the descriptions, viz. the aforementioned terrestrial larva, and the equally unnamed *Synthemis* described by Campion (1921).

In the following pages descriptions and fully illustrated keys are given for 10 previously unknown and 6 earlier described and redefined forms. All of them are of more than usual interest. Unfortunately, only 5 species in the first category could be definitely associated with their imagines, while one other was named with reasonable certainty. The 4 that remain are all species of *Synthemis*, which, though strikingly alike in general appearance, exhibit well-marked structural differences. To guarantee their recognition in future, I have arranged them together with the others in a key, with sketches of their most noticeable characters.

The second group is equally interesting inasmuch as it includes the terrestrial larva of unknown status, of which a full account is therefore given. The 6

remaining taxa are commented upon more briefly, or simply illustrated and put on record.

This leaves us with about 20 species whose larvae were not yet found in the island. With the exception of three or four puzzling *Megapodagrionidae* (including, of course, the unknown terrestrial kind), and the peculiar corduliid *Metaphya elongata* Campion as well, the discovery in New Caledonia of the others is of lesser importance as they belong to mostly common and widely distributed species which are either known already from other parts of Melanesia and Australia, or presumably resemble congeneric species so much as to be easily recognized when found.

For purposes of comparison with the insular forms, I have included also notes and illustrations of some extralimital species of interest. First of all the argiolestine *Austroargiolestes icteromelas* (Selys) from Australia, which is re-characterized; and sketches are given of *Argiolestes pectitus* Lieft., *A. fontinalis* Lieft. and *Selysioneura cornelia* Lieft. (a near ally of *Isosticta*), all of them from New Guinea. Notes on the behaviour and habitation of these forms are copied from the author's previous publications or from information kindly supplied by Mr. Roderick DOBSON, who studied the habits of many Odonata in New South Wales and elsewhere in Australia.

With regard to literature bearing on the subject not cited in the present paper, the reader is invited to consult the bibliography at the end of the first part of this work.

Lastly, it will be remembered that only once a New Caledonian dragonfly (a single male of the endemic *Isosticta robustior* Ris) has been caught in the act of transformation and preserved with its exuviae. I hope, therefore, that this survey may serve to stimulate those who have the opportunity of collecting and observing Odonata in the field, and to raise as many of the species to the adult stage as possible!

MATERIAL AND COLLECTING STATIONS

All vials containing specimens recorded in this paper include full locality labels, with the original field numbers mentioned on each. As to the Florida University (FAMU) expedition, collectors' initial names are added to the locality labels by a suffix to the field numbers, but these have been omitted from the list, because each person collected various groups of insects at each locality.

To avoid undue length of the paragraphs "Material" preceding the taxonomic discussions in this paper, nearly all samples are listed by their original field numbers only. This applies to both the Austrian (FNK) and American (FAMU) Expeditions. Detailed information on the localities visited by the first-mentioned expedition, with a numerical list of the collecting stations (prefixed FNK), is to be found in the report published by Prof. STARMÜHLNER in this journal (1968, see my previous reference list). A similar list, which gives descriptions of all field stations where Odonata have been collected by members of the FAMU expedition, was kindly provided by Dr. W. L. PETERS. These stations (prefixed N), are the following:

N 12 - S branch, Dumbéa River, 12 km NE of Dumbéa, 31 m, 6.9.1972; 21° C.
N 13 - Nondoué River, 12 km NW of Dumbéa, 31 m, 6-8.9. 1972; 18° C.
N 14 - Stream, Val de l'Hermitage, 1 km NE of Terr. Route 1, 76 m, 7.9. 1972; 18° C.
N 15 - Tributary of Karionan River, 5 km NNW of Paita, 122 m, 10.9.1972; 18° C.
N 16 - Ouen Koh River, Col d'Amieu Forest Station, 366 m, 13.9.1972; 18° C.
N 17 - Stream, headwaters of Fonwhary River, 1.3 km SE of Col d'Amieu on Terr. Route 5, 412 m, 14-15.9.1972; 16.5° C.
N 18 - Stream, headwaters of Fonwhary River, 4 km SE of Col d'Amieu on Terr. Route 5, 183 m, 15.9.1972; 17° C.
N 19 - Ba Quinoré River, 3 km NE of Col d'Amieu Forest Station on Terr. Route 5, 259 m, 15.9.1972; 18° C.
N 20 - Sarraméa River, Sarraméa, 31 m, 16.9.1972.
N 21 - Stream on Eaux et Forêts, NW of Col d'Amieu, 412 m, 16.9.1972.
N 22 - Stream on Mt. Pouédihi, 17 km W of Ouénarou Forest Station on Eaux et Forêts road, 153 m, 21.9.1972; 19° C.
N 23 - Stream, Ouénarou Forest Station, 137 m, 21-22.9.1972.
N 24 - Roadside ditch, 6.4 km NW of Ouénarou Forest Station, on Eaux et Forêts road, 137 m, 22.9.1972.
N 25 - Stream on Mt. Pouédihi, Bon Secours, 7 km NW of Ouénarou Forest Station, on Eaux et Forêts road, 153 m, 22.9.1972; 20.5° C.
N 26 - Rivière des Pirogues, 2.5 km SW of Col de Ouénarou, on Terr. Route 2, 23.9.1972; 20.5° C.
N 27 - Stream on Pic Mouirange, Camp des Travaux Publics on Terr. Route 2, 24-29.9.1972; 20° C.
N 28 - Nondoué River, 12 km NW of Dumbéa, 31 m, 28.9.1972.
N 31 - Ile des Pins: Grotte d'Oumagne, 15 m, 3-6.9.1972; 20.5° C.
N 34 - Stream, Val de l'Hermitage, 1 km NE of Terr. Route 1, 76 m, 10.10.1972; 19° C.
N 35 - Tributary of Karionan River, 5 km NNW of Paita, 122 m, 11-12.10.1972; 19° C.
N 37 - Stream on Mt. Aoupinié, 22 km SW of bridge at Ponérihouen on Goa road, 458 m, 17-21.10.1972; 18-19° C.
N 38 - Stream, 21 km W of junction of Tchamba River road & Terr. Route 3, on Tchamba River road, 61 m, 18.10. 1972; 28° C.
N 41 - Poema River, Kavatch-Hienghène Forest Station Castex, 46 m, 23-29.10.1972; 24.5° C.
N 42 - Stream on Mt. Gaata, 4.3 km NW of Station Castex, 76 m, 22-29.20.1972; 19° C.
N 43 - Hienghène River, Tindo, 122 m, 25.10.1972; 24° C.
N 45 - Ouen Koh River, Col d'Amieu Forest Station, 366 m, 31.10.1972; 21° C.
N 46 - Stream on Eaux et Forêts road, NW of Col d'Amieu, 412 m, 31.10.1972; 18° C.
N 47 - Stream, headwaters of Fonwhary River, 1.3 km SE of Col d'Amieu on Terr. Route 5, 412 m, 31.10.1972; 18° C.

N 50 - Stream on Mt. Pouédihi, 15 km W of Ouénarou Forest Station, on Eaux et Forêts road, 153 m, 5.11.1972; 19.5° C.

N 51 - Rivière Bleue, at bridge on Eaux et Forêts road, 21 km NW of Ouénarou Forest Station, 183 m, 6-7.11.1972; 19° C.

N 52 - Stream on Mt. Pouédihi, Bon Secours, 7 km NW of Ouénarou Forest Station on Eaux et Forêts road, 153 m, 8-10.11.1972.

N 53 - Stream on Mt. Pouédihi, 16.5 km W of Ouénarou Forest Station, on Eaux et Forêts road, 153 m,8-10.11. 1972.

N 54 - Tributary of Karionan River, 5 km NW of Paita, 122 m, 14.11.1972; 20.5° C.

N 55 - Stream on Pic Mouirange, Camp des Travaux Publics on Terr. Route 2, 153 m, 15.11.1972; 23° C.

Odonata from Ile des Pins

Larvae of the following species can be recorded from freshwater habitats on Ile des Pins, a small island about 50 km SE off the southern extremity of New Caledonia.

1. Creek of the second cave Wouintureu, temp. (exposed) 20.5 °C (FNK 113):
   Aeshna brevistyla Ramb.; *Hemicordulia fidelis* Macl. (supposition); *Orthetrum caledonicum* (Br.); and *Diplacodes haematodes* (Burm.)
2. Grotte d'Oumagne, 15 m alt., temp. 20.5 °C (N 31): *Isosticta* cf. *tillyardi* Campion.

Acknowledgements

I wish to express my best thanks to Mrs. Ruth Lippitt Willey, of the University of Illinois, Chicago, for the loan of some important photographs and drawings published by her earlier and the permission to reproduce these for inclusion in the present article as fig. 43 and 44-53. I am also grateful to Mr. Chr. Hoorn, of the Rijksmuseum van Natuurlijke Historie, Leiden, for having photographed a few other larvae of interest, which are rendered in fig. 14-16, 42 and 60 of this paper.

ZYGOPTERA

Fam. Lestidae

Lestes (Indolestes) cheesmanae Kimmins

Material. — Österr. Neukaledonien Exp. 1965: 2 young ex., FNK 44/2, 28.7.1965 (NMW).

Two conspecific specimens of the same age, but unfortunately not nearly half grown. Almost certainly *cheesmanae*, originally described from the New Hebrides and subsequently recorded also from New Caledonia (huj. op., 1: 1975). The characteristic shape of the labial palpus will serve to distinguish this species from other *Indolestes*. As pointed out earlier (Lieftinck, 1960 b), the serrated median process of the palpus is not found in any other of the described species of *Indolestes* but resembles instead the form it has in *Austrolestes analis* (Ramb.), figured by Ris (1910: 445, fig. 21, sub *Lestes* Larve B) and Watson (1962). In the present young larvae the broadened median projection is more regularly toothed, rather comb-like, than in the full-grown specimen.

Fam. Megapodagrionidae

Subfam. Argioleslinae

Throughout the Australo-Papuan region the constituents of this subfamily exhibit great diversity of structure in almost every detail of their organization. The five New Caledonian representatives form no exception to this, all except *Argiolestes ochraceus* having with some justification been segregated into three small genera. As has been pointed out in the first part of this work (Lieftinck, 1975), the imagines of the insular taxa are not much alike, all having a different 'facies' by which they are fairly easily recognized. Further to my comments on the adults, I may add that this interspecific variation is even more pronounced than in the various species-groups occurring in Australia and the Papuan region. All the same I believe that, until the subfamily can be treated upon the whole, these groups can be split up most conveniently only into three genera, viz. *Argiolestes* (type species *A. australis* Ramb.), *Austroargiolestes* Kennedy (type species *A. icteromelas* Selys), and *Podopleryx* Selys (type species *P. roseonotata* Selys); see also Lieftinck, 1935 and 1956. I prefer to leave *A. ochraceus* (Montr.), from New Caledonia, in *Argiolestes* s. str., although this species in several respects seems to bridge the gap between the two first-mentioned genera. Some isolated Asiatic relatives inhabiting countries further to the west, which are of no concern in this context, take a position of their own though showing characters indicating nearest relationship with the Papuan group.

It is generally understood that larval characters are of great assistance in determining the affinities of the major systematic groups of the Zygoptera. However, there is every reason to doubt whether this applies also to some aberrant and strictly isolated forms that were dispersed and placed, rather arbitrarily, in one or other of the superfamilies. These higher taxa now contain several puzzling genera and have become a veritable reservoir of heterogeneous elements.

In Fraser's Reclassification (1957), the author admits that his grouping includes a number of discordant elements, and adds that the exact relationships of several genera to each other and the rest of the order can only be worked out when we have a fuller knowledge of their early nymphal stages. Generally speaking this is true enough, but I would like to emphasize the point that in recent years

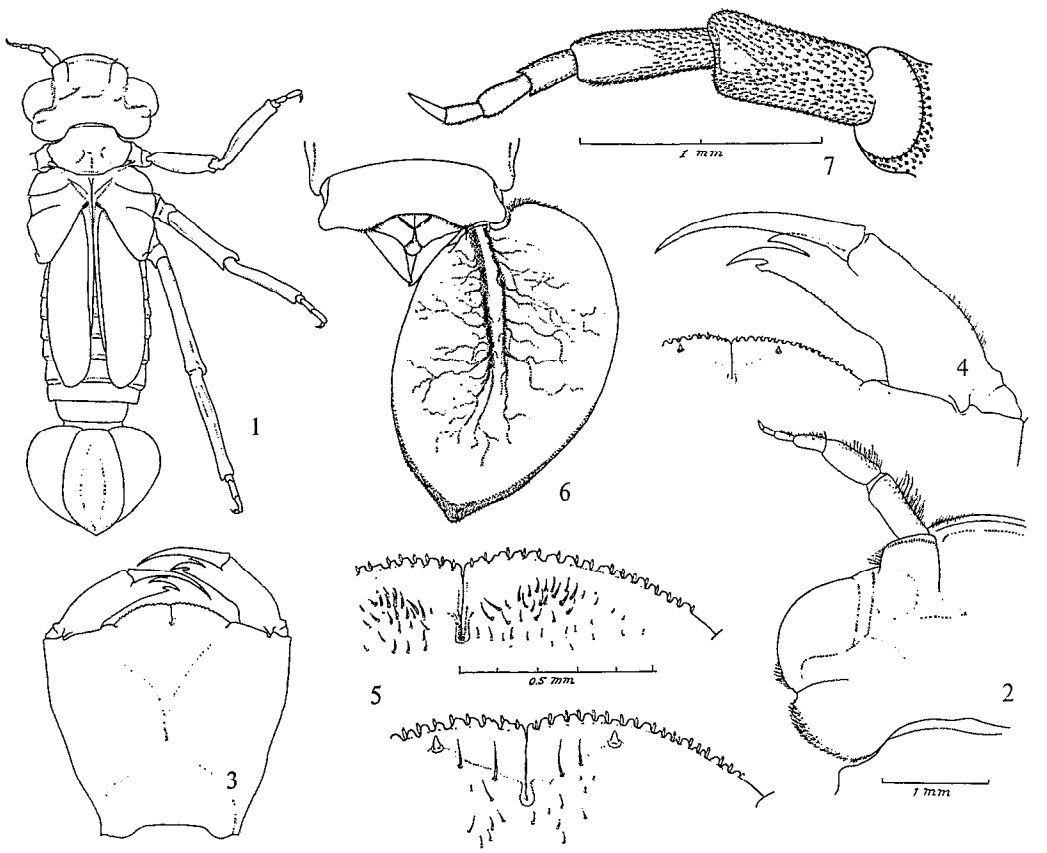


Fig. 1-6. — *Argiolestes pectitus* Lieft., ult ♂ larva, Central New Guinea. General aspect (1), part of head with antenna (2), labium (3) and distal portion of same, viewed from within (4), outer and inner view of median lobe, greatly enlarged (5), apex of abdomen, ventral view, showing tracheae of left lateral lamella (6).
Fig. 7. — Antenna of *A. fontinalis* Lieft., ult larva, Central New Guinea, showing microsetae. After LIEFTINCK (1956).

striking examples have become known of forms belonging to non-related families which nevertheless show surprisingly similar specializations of corresponding organs, so as to conceal their true identity. Unsuspected similarities of structure, e.g. in body form, labial and antennal structure, or shape and posture of the caudal gills, may therefore be regarded as secondarily developed specializations. Consequently, with regard to the more remotely allied systematic units, there is much evidence that a number of features they share have evolved along parallel lines as adaptations to a similar environment and mode of life.

All *Argiolestinae* so far known have stream-dwelling larvae which either cling to the underside of pebbles and large stones or else, conceal themselves in clefts of rocks; others, like *Caledopteryx*, may live among trash or the mossy coating of boulders lying in the stream-bed. It is clear from what will be said of the Australian *A. icteromelas*, that this type of larva is very different from the one described by me for the Papuan *Argiolestes pectitus* and *fontinalis* (*loc. cit.*, 1956), the convex roof-shaped gills of which probably serve to anchor the insect to rocks or, less likely, are used for suction. Evolution of them has been considerable, as much in fact as the imagines, but it is evident that both stages evolved in entirely different directions.

Turning our attention again to the New Caledonian taxa, we see that the four larval forms presently distinguished—including the supposed terrestrial species—are rather different from one another. Each exhibits its own specializations to some degree, either recalling the Australian species, or suggestive of the Papuan forms.

Wing venation and species recognition

As a rule, the more important venational characteristics employed to separate the adult dragonfly are most distinctive, laid out already plainly in fully developed wings of the mature larva. In spite of

that, these features in zygopterous larvae are frequently not clearly brought to light. Especially the position of the antenodal and anal nervures in the stalked basal portion of the wing, which otherwise would have provided the key to specific identification, either failed to show up clearly enough or remained invisible in mounted slide preparations of unsheathed wings that were passed into water, or various concentrations of alcohol and glycerin. A further disadvantage was the circumstance that conspecific imagines and larvae were only rarely met with in one and the same locality; and, unfortunately, no specimens were found with their exuviae during the process of transformation. With a single exception for each, our series of *Argiolestes ochraceus* and *Caledopteryx sarasini*, came from places where apparently no adults of the group were observed or captured while on the wing: the former only once at N 55, the other at N 50. As a result, only the two last-mentioned forms could be definitely associated with their proper species, the third being far more difficult to place than I had anticipated. It is the species here referred to *Caledargiolestes uniseries*; a characterization of the latter will be given in the next pages.

Speciation and divergency of characters

Comparative studies of larval morphology frequently entice to investigate the finer structures with a view to disclose the affinities between species. It is tempting, therefore, to speculate on the origin and speciation of the faunal elements in New Caledonia. In the present instance we meet with a cluster of undeniably interrelated taxa, all inhabiting the same island, whose larval and imaginal stages are, nevertheless, very dissimilar specifically. I have suggested earlier (LIEFTINCK, 1975) that the immediate ancestors of each of the present-day species may have reached the island from geographically remote continents and from various directions, at different intervals; thereafter the descendants of these immigrants could develop under varying circumstances, each in its own way. Thus it may be inferred from the above that the broad differentiation between the larval forms is the result of selective influences and can, perhaps, be explained by the different microhabitats in which they came to live, each adapting itself to a special environment.

Austroargiolestes icteromelas (Selys). *Fig. 8-14*

Argiolestes icteromelas: TILLYARD, 1917: 38, 47, 71, 100-103, text-fig. 1 (anatomy lat. caudal lamella), 28 (transverse sections of same), 29 (position of same), pl. 1 fig. 8-11 (lam. of *A. icteromelas* and *griseus*), pl. 6 fig. 40-45 (transverse sections through lamellae); TILLYARD, 1917a, fig. 23C (larval wing tracheation), 42A (whole larva); TILLYARD, 1926: 77 fig. F11D (whole larva and labial palpus). LIEFTINCK, 1956: 113-116 (notes on caudal lamellae; see below).

Extralimital material. — Australia: 1 ♀ ult, New South Wales, Wahroonga, 2.XII.1956, R. DOBSON (ML).

This is a common Australian species, which is here included for comparison with other members of the subfamily occurring in Papua and New Caledonia.

As far as I know, the larva has never been fully described, but as the species is well-known in Australia, the picture of a female (fig. 14) may give a sufficiently good impression of its general appearance and colour pattern. This was taken from the same specimen as the one discussed hereafter, which was examined further and dissected to reveal its more important characters, illustrated in the accompanying sketches (fig. 8-13).

Before pointing out some details of structure, I wish to correct an unfortunate error committed by me in an attempt to correlate the shape and usage of the caudal lamellae of Papuan *Argiolestes* with those described for certain Australian relatives of the same group, which are different (LIEFTINCK, 1956: 115-116). The position and adaptive function of these organs had been already commented upon and illustrated by TILLYARD (1917: 100-103) for *Austroargiolestes icteromelas* and allied species. Starting from the principle that the attitude of these gill lamellae should be more or less alike and serve the same purpose in the two allied—yet morphologically divergent species-groups, it was asserted that they should have the same function in both. This would imply that TILLYARD's diagram showing transverse sections across the gill system of Australian *icteromelas*, had been placed accidentally in inverted position. This assumption proved to be entirely unjustified and needs rectification. The error was kindly brought to my attention by Mr. R. DOBSON (now in Jersey, C. I.), whose own observations and arguments served to disclose the real facts, which are in full harmony with TILLYARD's earlier conclusions and can be explained as follows.

On numerous occasions during his long stay at Wahroonga, in New South Wales, Mr. DOBSON found living larvae and exuviae of *A. icteromelas* and three allied species in various suitable streams. On examining these, he noticed that all agreed in showing a *concave* appearance of the upper surface of the lamellae. He observed *icteromelas* clinging tightly to the underside of stones when the latter were lifted out from the water. Though stressing the difficulty of observing underwater behaviour of these insects in the field, Mr. DOBSON opines that the force of water in a strong current acting on the top of the concave gills would tend to keep the larva more firmly attached to the rock surface than a convex one, as suggested

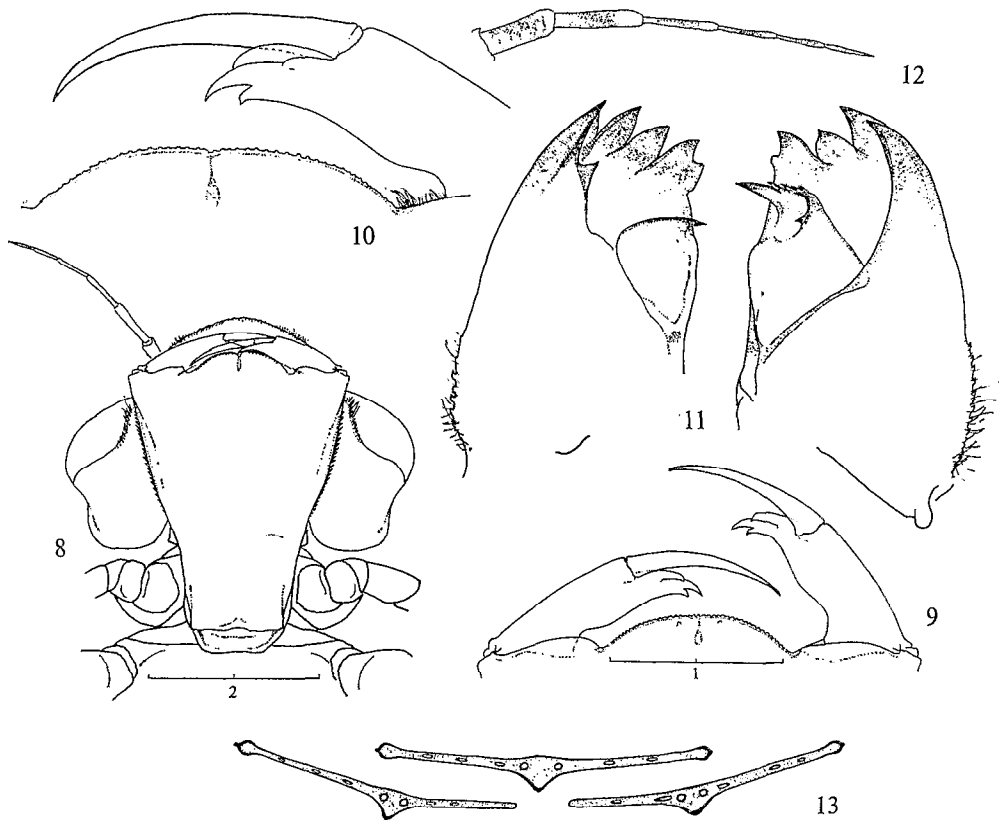


Fig. 8-13. — *Austroargiolestes icteromelas* (Selys), ult ♀ larva, Wahroonga, N.S.W. Ventral aspect of head showing natural position of labium (8), distal portion of labium (9) and right palpus (10), 9 viewed from within; right and left mandible, ventral view (11), antenna (12), and transverse section through caudal lamellae in natural position showing tracheae, semidiagrammatic (13). Fig. 13 after TILLYARD (1917), slightly generalized.

also by TILLYARD. I must admit that this is most likely the case providing, of course, the larva is facing the stream. In the same letter, dated Nov. 29, 1956, Mr. DOBSON draws the following interesting parallel when he writes: "Further to this argument is the case of the bird *Cinclus* (i.e. *C. cinclus*, the Dipper), which feeds on the bottom of running streams and uses the current against its wings and back surfaces to keep itself submerged". In a second communication, enclosed with the larva of *A. icteromelas* freshly taken by him on Dec. 2, 1956 at Wahroonga, Mr. DOBSON adds the following observations: "The nymphs of this species are perfectly happy in still water, if transferred there, though the imagines always oviposit in running streams. I have bred many out in my pond. I must confess to putting the enclosed specimen through several different sorts of unpleasantness, including prodding, etc., in the hope that it might do something out of the ordinary with its caudal gills. However, even in running water, its almost horizontal gills remained in the fanned position, the median gill just overlapping at the basal edges, this central gill being at a raised angle of about 20 degrees above the lateral ones."

Description of ultimate instar

Total length of body (from anterior border of labrum to apex of median caudal lamella), 23.0 mm, without lamellae (but incl. valves), 15.5 mm, length of median caudal lamella, 7.7 mm, greatest breadth of same, 2.9 mm.

General body colour yellow-brown, mottled, banded and striped with darker brown, as shown in the photograph. Legs long and very slender, all femora and tibiae distinctly ringed with brown. Caudal lamellae rather more ochreous brown, richly decorated with partly confluent transverse brown bands. Genital valves projecting a little (0.3 mm) beyond apex of 10th segment. Pubescence inconspicuous,very short, thin and sparsely distributed, consisting of minute hairs. Lamellae minutely serrulate and

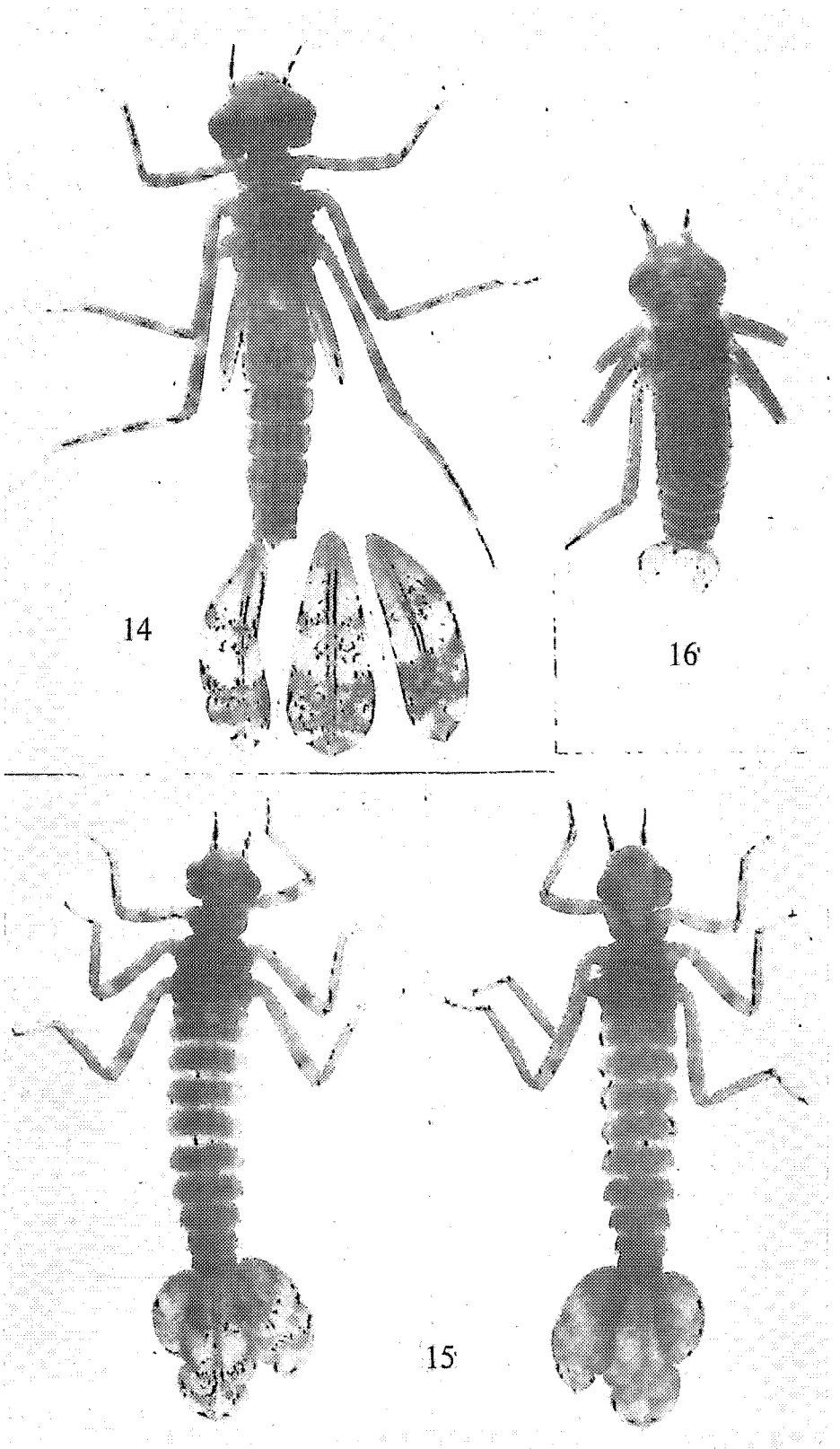


Fig. 14. — *Austroargiolestes icteromelas* (Selys), ult ♀ larva, Wahroonga, N.S.W.; total length (incl. lamellae), 23.0 mm.
Fig. 15. — *Argiolestes ochraceus* (Montr.), penult larva FNK 105/1, dorsal and ventral view; total length (incl. lamellae), 19.0 mm (abdomen extended!).
Fig. 16. — *Caledargiolestes uniseries* (Ris) supposition, ult ♂ larva FNK 59 (median lamella wanting); total length (incl. lamellae) 13.0 mm (abdomen contracted!).

fringed with short fine hairs all along lateral borders.

The dentition of the mandibles and proventriculus were not studied.

As will appear from the illustrations, the Australian *icteromelas* larva differs conspicuously from that of the dominant Papuan group exemplified by *A. pectilus* Lieft. (fig. 1-6) (1). The latter is a much more stoutly built insect, its antennae as well as the labium and legs being markedly shorter and of more compact form. The entirely differently shaped gill lamellae, discussed above, may of course serve to distinguish them at first glance. On the other hand, the structure of the labium is very similar in these species, the tridentate apex of the palpus being much alike, while both agree also in that the midlobe of the labium lacks the prominently convex apical lobes and deep median cleft, which are so notable in several New Caledonian larvae of the group.

Argiolestes ochraceus (Montrouzier). *Fig. 15, 17-24, 39*

Material. — 7 ♂ 1 ♀ (various stages), FNK 105/1; N 15-16, 19-20, 35, 37, and 55; for details, see LIEFTINCK (1975).

Stature of *Austroargiolestes icteromelas* and resembling that species in many respects, especially by its slender forms and the enormous size of the caudal gills. All specimens except the full-grown male, are intact, the lamellae of the young individuals being already of great size and of the same form as those of the older larvae. They are of the same horizontal lamellar type, but differ in being much broader. Colour and mottled pattern similar to *icteromelas*, but marginal denticles stronger ; disk covered more abundantly with microsetae and fine hairs. The main tracheae stand out clearly.

The illustrations of the most distinctive details of structure (including fig. 39 of the proventriculus) were all taken from the only mature specimen (N 16b), whose forms are rather distorted, so that only the penultimate instar larva could be photographed (fig. 15). The measurements of this are : total length 19.0 mm, of body+gills, 14.0+5.0 mm.

The body cuticle and gills of all specimens are covered throughout with a thin layer of silt and particles of fine sand adhering to the pubescence, so as to conceal most of the colour design. It is evident, therefore, that *A. ochraceus* lives in slow flowing water with a silty bottom.

Description of ultimate instar (after 1 ♂ N 16).

Total length of body (from anterior border of labrum to apex of median caudal lamella), 20.5 mm, without lamellae 14.2 mm ; caudal lamellae, greatest breadth of triplet united in natural position (fig. 23-24), 7.0 mm approx. ; length of median gill 6.5 mm, greatest breadth of same 4.3 mm.

A fairly large, very slender larva, with a small head, long and slim spidery legs, and flat, greatly expanded, plate-shaped caudal lamellae of enormous size. A good impression of this larva can be obtained from fig. 15, which shows a specimen in the penultimate instar.

Body elongate, longer than the preceding species, widest across eyes, almost parallel-sided from end of mesothorax to about midway abdomen, then slightly tapering to the end; more hairy than previously described species. Occipital area and dorsal thoracic sclerites dull, covered with microscopical warts; labrum anteriorly, thoracic carinae, legs and sides of abdominal segments, tufted and fringed with longish fine hairs especially conspicuous laterally at dorsum and sides of abdominal tergites. Antennae and occipital lobes postero-dorsally beset with more or less club-shaped setae. Integument of normal consistency, not heavily sclerotised; colour mainly pale brown; ocellar area with a rather X-shaped darker brown spot, and basal three-fourths of second antennal segment likewise more obscured; disks of dorsal thoracic sclerites, small spots on each side of the median line of abdominal tergites, and rather larger (though indistinct) dots to the inside of the lateral expansions of all abdominal segments, also dark brown. Legs pale brown, but bases of all femora and tibiae, as well as additional broad subapical rings at the femora, distinctly darker brown. Abdominal segments marked lengthwise with two pairs of dark brown spots, two on each side of the median line, and with a large, elongate or subtriangular dark spot on each side placed well distant from the side margin, the expanded portions of the tergites remaining unmarked. Caudal lamellae delicately banded with more or less coalescent dark brown spots, as shown in fig. 23.

Head relatively small, width across eyes about equal to greatest breadth of mesothorax; eyes very large and globular, subcircular in dorsal view, much longer than postocular part of head, and transverse diameter of each equal to the shortest distance separating them at halfway length of head; ventral aspect of head as in fig. 17. Antennae 6-segmented, longer and much slenderer than in *Caledopteryx* and *Caledargiolestes*; first two segments thicker than the next and fringed anteriorly with swollen (club-shaped) setae; 2 a little longer than 1, 3 shorter than 4, which is subequal in length to 5+6. Mandi-

(1) See also CORBET, 1962 : 81, with more illustrations of this species.

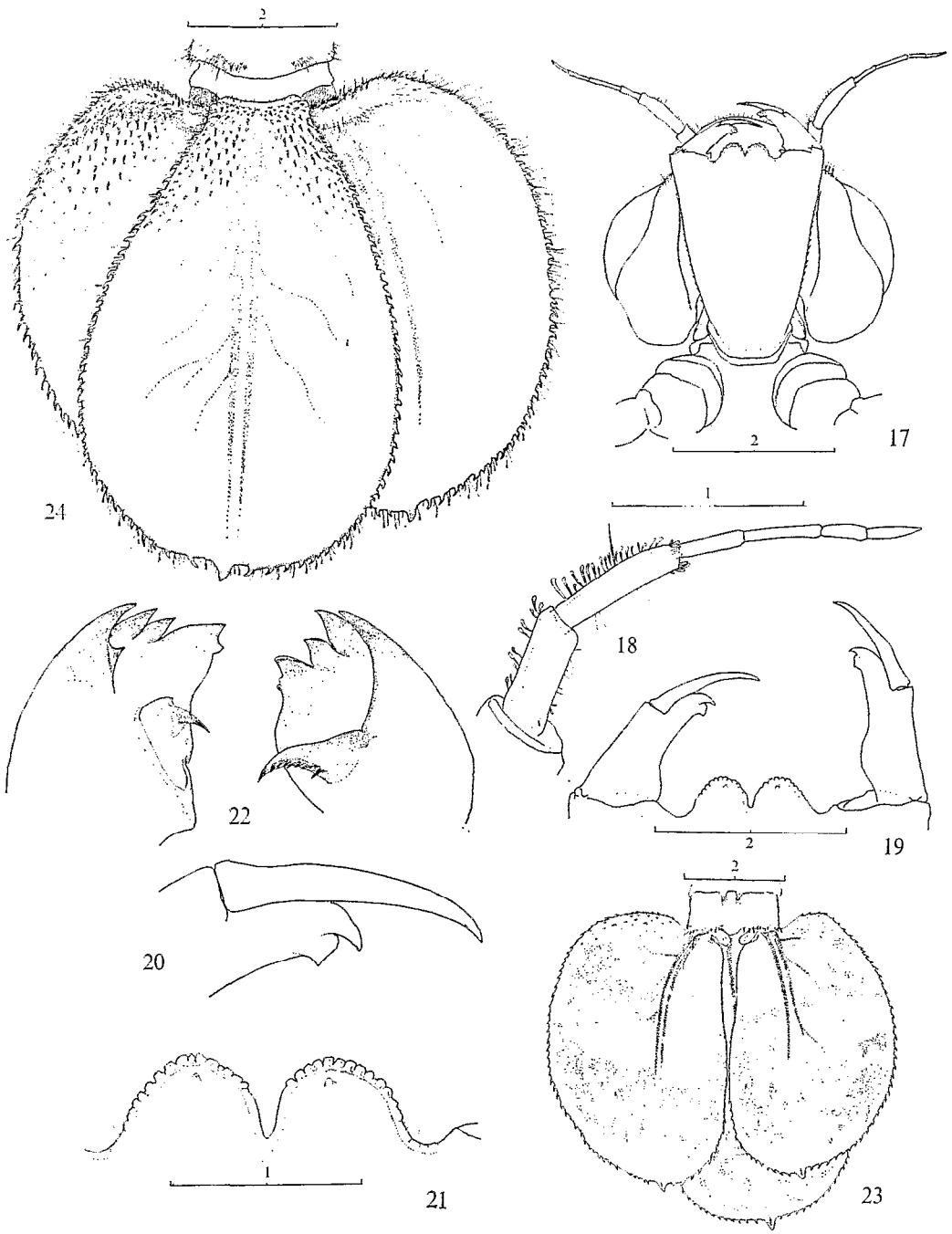


Fig. 17-24. — *Argiolestes ochraceus* (Montr.), ult ♂ larva N 16b. Ventral aspect of head showing natural position of labium (17), right antenna (18), distal portion of labium (19), apex of left palpus (20), both viewed from within, apex of median lobe (21), right and left mandible, ventral view (22), apex of abdomen with lamellae *in situ*, showing tracheae and colour design, ventral view (23), and dorsal view of caudal lamellae more enlarged, showing tracheae, rims, dentition and pilosity (24).

bles (fig. 22) shaped much as in the allied regional species but less differentiated into incisor and molar regions. Right mandible with four incisors and an additional rudiment of a fifth (innermost) tooth, the outermost one longest, carrying a secondary tooth at some distance from apex and a second, sharply acute spine low down at extreme base, representing the molar region. Left mandible lacking a well defined comb-like molar row of teeth, which is replaced by a long outcurved tooth carrying a small triangular point at its base and an equally long tooth at the opposite side of the gap, which forms part of the incisor tooth-row, being the first and longest of the group. Ocelli of normal size, smooth, light brown. Compound eyes on the inside not bounded by a sulcus, and a ridge is entirely lacking, but on the ventral side there is a short anterior series of minute warts terminating in a tuft of longish hairs. Occipital lobes prominent, beset with setiferous warts. Labium (fig. 17) flat, shorter and narrower than in *C. uniseries*, reaching back only as far as anterior margin of procoxae; median lobe of mentum still more produced and deeply emarginate, the marginal crenulations lacking the short setae of the other regional species. Palpus ending in a short robust hook preceded by a still shorter recurved tooth; inner border of the basal portion convex, not crenulated; movable hook robust and strong (fig. 19-20).

Mesothoracic wing pads long, straight, perfectly flat and parallel-sided, extending back to a little beyond posterior border of segment 5. Prothorax much narrower than head, propleural divisions broader than pronotum; anterior lobe rounded, collar-like, pronotal tubercles distinct, hind margin of posterior lobe a little projecting and straight-lined in the middle, the sides obtuse-angulate; dorsal mesothoracic sclerites consisting of a raised and triangular median part and depressed lateral portions, the latter subequal in size to the metathoracic shields, all sclerites dull, rugose, almost bare, except the lateral edges, which are fringed with fine hairs.

Legs very long and slender, femora and tibiae parallel-sided, neither expanded nor flattened, triquetral in cross-section.

Abdomen tapering gradually from base to apex, segments elongate-oval in cross-section but tergites more convex than sternites; side portions of all segments (except 10) prominent with sharply pronounced carinae, the expansions of 1-4 rounded off, those of 6-8 successively more distinct and terminating in a short spine, which is most conspicuous at 8. All tergites clothed with raised hairs, the lateral expanded parts and posterior margins fringed with curly pile, the apical segments moreover with row of dark marginal teeth on either side of the median line. Paraprocts very small, converging, bluntly triangular and rather flattened dorsally (male).

Caudal lamellae in the form of broad and very flat overlapping leaves, differing in shape and size, as shown in fig. 23-24; in transverse section they appear somewhat similar to those of the allied species but are still thinner and more depressed, especially the median lamella, the surface of which is only slightly hollowed out above and a little convex underneath; median ribs unapparent dorsally and only weakly developed ventrally, except at extreme bases and apices of all. Cuticle rather thick, leaving little room for the ventrally removed tracheae, the finer branches of which are not easily made out. Swollen basal rims of all lamellae tuberculate, the tubercles carrying short, acute, spike-like microsetae decreasing gradually in size posteriorly; surface otherwise dull; side margins of all with continuous row of sharp curved spines, and fringed sparsely with longish hairs; midribs ending in a short nipple-shaped process (fig. 23-24).

Caledargiolestes uniseries (Ris), supposition. *Fig. 16, 25-32, 40*

Material. — 12 ex. (both sexes, various stages), FNK 59; and N 15, 22, 25, 27, 34, 46, and 47; for details, see LIEFTINCK (1975).

Description of ullimate instar (after 1 ♂ FNK 59, 1 ♀ N 34, and 2 ♂ 1 ♀ N 47).

Total length of body (from anterior border of labrum to apex of median caudal lamella) 15.3-15.8 mm, without lamellae 10.8-11.4 mm; caudal lamellae (measured in 1 ♂ and 1 ♀): greatest breadth of triplet united in natural position (fig. 31) 3.1-3.3 mm; length of median gill 4.3-4.4 mm, greatest breadth of same 3.1-3.3 mm.

Much smaller, more slender, less sclerotized and lighter coloured than *Caledopteryx*. Body compactly built, widest across eyes, tapering gradually toward apex of abdomen; clothed sparsely with minute setiferous warts and short curved hairs, those at carinae and at margin of almost all segments longest. Fringes of longer hairs at anterior border of labrum, antennae, dorsal carinae of femora, and at sides of pro- and mesonota. Integument brownish yellow, marked with brown, darkest posteriorly on thoracic sclerites and on distal portions of abdominal segments, all of the latter with fairly distinct yellowish triangular spots filling out antero-lateral edges of segments, the lateral borders themselves brown, these spots being also distinct on the abdomen ventrally. Faintly indicated spots and stripes of brown also on sternites of thorax and abdomen in addition to the former. Coxae, trochanters and tarsi of legs pale yellow, legs otherwise brown, not banded, the carinae darkest.

Head large and rather flattened dorsally, shape of

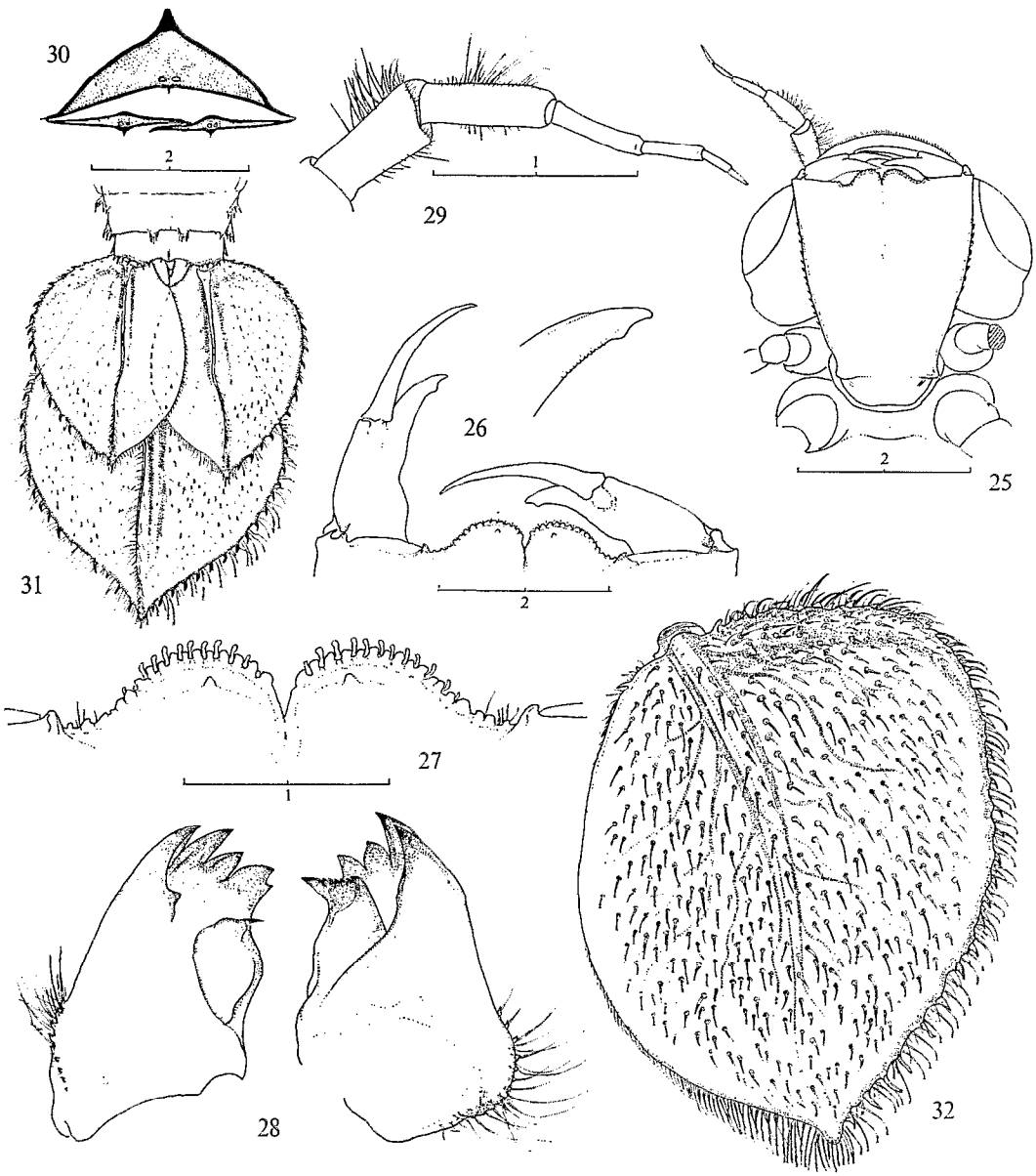


Fig. 25-32. — *Caledargiolestes uniseries* (Ris) supposition, ult ♂ and ♀ larvae. Ventral aspect of head of ♂ N 22, showing natural position of labium (25), distal portion of labium ♂ N 22 and ♀ FNK 59, viewed from within (26), apex of median lobe of FNK 59 (27), right and left mandible of N 47, ventral view (28), antenna of N 22 (29), transverse section through caudal lamellae of N 47 at some distance from base, semidiagrammatic (30), apex of ♂ N 47 abdomen with lamellae *in situ*, showing midribs and tracheae (stippled), ventral view (31), and right lateral lamella of N 22, dorsal view, showing tracheae, rims, dentition and pilosity (32).

labium, mandibles, and antennae as in fig. 25-29, the latter 6-segmented, the first two segments thicker than the next and fringed densely with long fine hairs which are longest on the inner faces; segments decreasing gradually in length, the last segment of minute size. Mandibles short and strong, much as in *Caledopteryx*, divided into well developed incisor and molar regions. Incisor ridge of right mandible consisting of four strong triangular teeth, decreasing in size gradually inward but all of them pointed, with rudiment of the fifth (innermost) tooth; molar region strongly raised, forming a broad triangular plate which terminates in a slender acuminate tooth; ridge between outer incisor and molar projection

with additional small triangular tooth. Left mandible armed with four robust incisors similar to those of the right, but outermost one almost twice as large as the others ; molar ridge terminating in a conspicuous comb-like cutting edge, the comb consisting of 4-5 small pointed teeth of equal length, which are flanked on either side by a robust tooth of larger size, one prominent and oblique, the other smaller and more slender (fig. 28). Ocelli of large size, standing out clearly as smooth, transparent pale yellow spots. Compound eyes bounded on the inside by a low tuberculate ridge separated from the eye by a sulcus, less pronounced than in *Caledopteryx*; no antero-lateral ridge. Labium (fig. 25) robust, flat, reaching back as far as a little beyond posterior border of precoxae; median lobe of mentum more prominently bilobate than in *Caledopteryx*, with a wider median cleft and higher setiferous marginal crenulations, but each carrying a similar, premarginal tubercle. Palpus ending in a single subacute spine which is armed on the inside with a vestigial subapical tubercle; inner border slightly convex, not crenulated; movable hook strong, sickle-shaped (fig. 26).

Mesothoracic wing pads long, straight, perfectly flat and parallel-sided, extending back to the end of tergite 6 or to about midway between 6 and 7. Prothorax broad and shield-like, divided into a short collar-like anterior portion and a much broader posterior plate whose hind border projects caudad, all sides of prothoracic shield rounded; dorsal meso and metathoracic sclerites rather deeply impressed in the middle, their surfaces smooth, but the surrounding darker coloured rims covered with wart-like tubercles.

Legs long and slender, femora and tibiae almost parallel-sided but all laterally compressed, especially the femora; dorsal carinae of the latter clothed sparsely with fine longish hairs.

Abdomen short and compact, segments lacking a dorsal crest; postero-lateral angles distinct, subrectangular but not at all produced; posterior border of two last segments beset with a row of sharp denticles, especially evident ventrally. Paraprocts converging, cylindrical with bluntly pointed apices (male); gonapophyses short, projecting but slightly beyond apex of tenth segment, the outer pair acute; paraprocts triangularly pointed (female).

Caudal lamella of large size and characteristic form, in transverse section shaped as in fig. 30. Cuticle thick, but much less than in *Caledopteryx*; colour yellow brown, the tubercles darker. Median lamella considerably larger and also longer than lateral pair; dorsal surface roof-shaped with high longitudinal crest extending from base to apex, sides on either side of the crest concave, but lateral margins slightly curved down; ventral surface concave though carrying also a median carina which is much finer and less elevated than the dorsal one. Lateral lamella leaf-like, strongly swollen and rimmed at its base, disk rather hollowed out above but forming a low triangle in cross-section, ventral surface of each with well developed median ridge, highest basally. Dorsal surface of all lamellae covered all over with setiferous warts, on each side of the crest moreover with coarser and more crowded warts and long, fine, raised hairs; lateral margins armed with conspicuous, curved, acute teeth and fringed with long erect hairs, all increasing gradually in strength and length towards the end. Ventral surface of lamellae smooth, only the crests clothed with longish raised hairs. Tracheal system situated ventrad, shining through the integument; directly before entering the lamella, the stem already divides into two finely branched main tracheae. No darkly pigmented pattern.

As will appear from the above description and photograph (fig. 16), this species in general appearance and size approaches the forms described from West New Guinea (*Argiolestes* s. str., fig. 1 and 6) more closely than any of the others. The caudal gills are relatively short and of the same vaulted type, that is to say, here only the much inflated median lamella is hollowed out beneath, while the lateral ones are more flattened (fig. 30-31). In details of structure, the *C. uniseries* larva exhibits a mixture of features found also in one or more of the other species discussed.

The wings of three full-grown examples were carefully studied, but in none of them (from FNK 59, N 22 and N 47), the basal veins could be traced; in the female from N 34 the wings were crumpled. The remaining venational characters are in accordance with those of adult *C. uniseries*, though it must be said that the position of the veins and number of postnodals correspond with *Trineuragrion* as well. I have chosen for *Caledargiolestes* on account of the length-breadth ratio of the wings and the shape of the pterostigma, two details agreeing with the imago.

Caledopteryx sarasini (Ris). *Fig. 33-38, 41-42*

Material. — About 65 ex. (both sexes, various stages), FNK 8b, 26, 29, 39, 97, and 104; N 22, 25, 27, 50, and 52; for details, see LIEFTINCK (1975).

Description of ultimate instar

Total length of body (from anterior border of labrum to apex of median caudal lamella) 22.5-23.5 mm, without lamellae 16.5-17.5 mm; caudal lamellae (measured in one ♀): greatest breadth of triplet united (when fully expanded, approximately as shown in fig. 38) 6.5 mm; length of median gill 5.8 mm, greatest breadth of same 4.0 mm.

A robust, stockily built, rather flat and almost

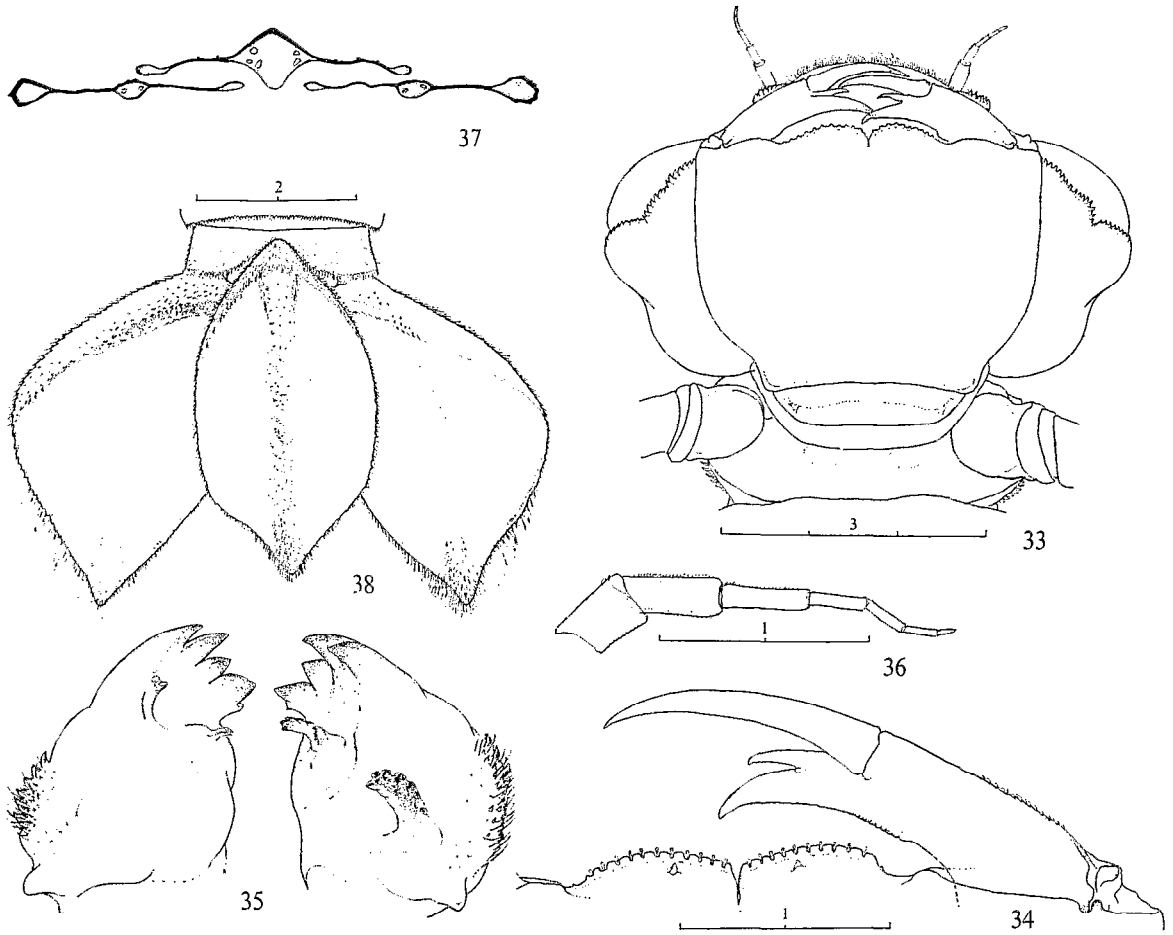


Fig. 33-38. — *Caledopteryx sarasini* (Ris), ult ♂ larva N 25. Ventral aspect of head showing natural position of labium (33), distal portion of labium viewed from within (34), right and left mandible, ventral view (35), antenna (36), transverse section through caudal lamellae in natural position showing tracheae, semidiagrammatic (37), apex of abdomen with lamellae *in situ*, showing rims and apical fringes, semidiagrammatic, details partly omitted (median lamella regenerated) (38).

hairless larva with a large head, long wings, a short abdomen and conspicuous, fan-like caudal lamellae. Body heavily sclerotized, cuticle of most dorsal and lateral parts covered with microscopical, shortly setiferous, warts, especially at the carinae and ends of abdominal segments; several small areas (e.g. on vertex, epicranium, pronotum, wing-sheaths, femora) are smooth and completely bare; there is a dense fringe of short hairs at the anterior border of labrum and dorsal carinae of femora, and on either side of the middorsal line of all abdominal tergites. Integument brown, frequently very dark above, especially on the abdomen; femora with poorly defined dark basal and subapical rings. Ventral surface of body lighter brown, the impressions to the inside of the foliaceous expansions of abdominal segments 2-7 darkest. All thoracic sterna as well as abdominal sternites 2-3 each with deep black central spots, the prosternal spot single, cordiform and largest, the mesosternal spot twofold, subtriangular or crescentic, only slightly smaller but quite conspicuous, the remaining spots small and often indistinct.

Head rather flattened dorsally, much broader than long, width across eyes only little less than twice median length of head (100: 53 approx.); eyes protuberant, inner orbits at first subparallel and slightly inward convex, then diverging with deeply concave margin, the posterior portion of eye extending caudad, the apex narrowly rounded; postocular lobes large and bulging, rounded and projecting posteriorly well beyond occipital crest, which is almost straight-lined. Labrum declivous with rounded side-edges, shallowly emarginate, only about one-fourth as long as broad; clypeus also short and broad;

frontal ridge straight, obtuse-angulate. Antenna (fig. 36) slender, inserted slightly in advance of eyes behind the somewhat raised upper margin of the sockets, 7-segmented, the first two segments more robust than the next ones, 2 and 3 the longest, subequal in length. Mandibles (fig. 35) short and strong, with well developed incisor and molar regions; incisor ridge of both left and right mandible consisting of four robust teeth, the two lower (outermost) ones longest, curved, pyramidal and pointed, the two upper (inner) teeth more flattened and blunt; molar regions at the inside very small, well separated from incisor ridge, each forming a slender raised pyramid which ends in a tiny two-pronged spine (right), or an equally small, acute quadridentate cutting edge (left). Ocelli distinct, of moderate size. Compound eyes bounded in front and aside by a slightly swollen undulated ridge separated from the eye margin by a deep sulcus, the ridge itself carrying a row of subacute tubercles, which are largest at antero-lateral margin. Labium (fig. 33) very broad, short and flat, reaching back as far as a little beyond middle of prosternum and posterior margin of procoxae; apical portion of median lobe of mentum forming two protuberant convex lobes separated by a partly closed deep median cleft, each of the lobes carrying a minute tubercular seta just before margin, the margin itself with row of setiferous molar-like crenulations. Palpus ending in a two-pronged spine, innermost spine the longer, acuminate, the outer one less curved, subacute; inner border of main spine feebly undulated; movable hook strong, sickle-shaped (fig. 34).

Mesothoracic wing pads very long, divergent, extending back to a little beyond posterior border of tergite 6, or almost as far as apex of 7. Prothorax broad and shield-like, anterior and posterior margins simple and straight, antero-lateral border little prominent, obtuse-angulate, rather swollen and covered with warts, behind this at first straight-lined, then again much swollen and likewise beset with wart-like tubercles; dorsal mesopleural sclerites subrectangular, the metapleural ones subtriangular in outline, lateral margins of the former finely tuberculate.

Legs strong, femora and tibiae almost straight, placed in a vertical plane, femora greatly compressed and flattened but only little expanded, dorsal crest subacute, with continuous, double row of small backward directed denticles, ventral crest less distinct and more finely denticulate; tibiae parallel-sided with dorsal, ventral and incomplete external median carinae.

Abdomen short, tapering gradually from base to apex; dorsal carina of separate segments poorly developed and postero-lateral angles subrectangulate, not projecting; posterior border of three last segments finely denticulate, fringed with very short hairs.

Caudal lamellae of the horizontal lamellar type, in transverse section (at about one-third of their length from base) shaped as in fig. 37. Median lamella invariably a little longer than lateral pair, as shown in fig. 42. (In the specimen shown in fig. 38 the median lamella is shorter and narrower than usual and probably regenerated). Cuticle thick, surface undulated and minutely tuberculate all over but devoid of hairs, except along the finely serrulated margins, which carry a dense fringe of soft pubescence, the hairs becoming progressively longer towards the apices of the gills. Hypodermis strongly pigmented, blackish brown to purplish black in very mature larvae, with subcircular specks of lighter colour irregularly distributed over most of the surface of the lateral pair, the apices of the latter carrying a pair of pale ochreous spots on either side of the midrib. In freshly moulted larvae the gills are lighter, especially at their bases and apices, showing a more or less banded pattern of dark pigment somewhat similar to that of certain *Argiolestes*.

By its dark, almost hairless body, stocky build and grotesquely formed labium and gills, this is certainly the most striking and easily recognized larva of the argiolestine group. The species attracts the attention also by the short antennae, flattened femora, the curiously black-spotted thoracic sternites, and the light-tipped lamellae.

No less than 65 specimens in all stages of maturity were contained in the samples from a great many localities, but in only two places (viz. N 22 and N 27), *C. sarasini* kept company with other members of the group. Evidently the commonest and most widely distributed of all rheophilous Zygoptera occurring in the island.

There are half a dozen very young individuals in the collection (N 50-52). In them the wing buds are hardly apparent as vestigial crescents, but in other respects they are closely similar to mature examples. The mentum and palpus are devoid of setae, the antennae are 6-segmented, and the lamellae also are much alike those of the full-grown larva. The measurements are: total length (excl. gills), 6.5-7.0 mm.

The proventriculus of larval Argiolestinae

In fig. 39-41 the complete proventriculi are shown of the ultimate instar larvae of three New Caledonian species, viz. *Argiolestes ochraceus* (no. N 16), *Caledargiolestes uniseries* (no. N 47), and *Caledopteryx sarasini* (no. N 50). All drawings are on the same scale. It will be seen that in the first two species the gizzard shows a pattern far more regular than the

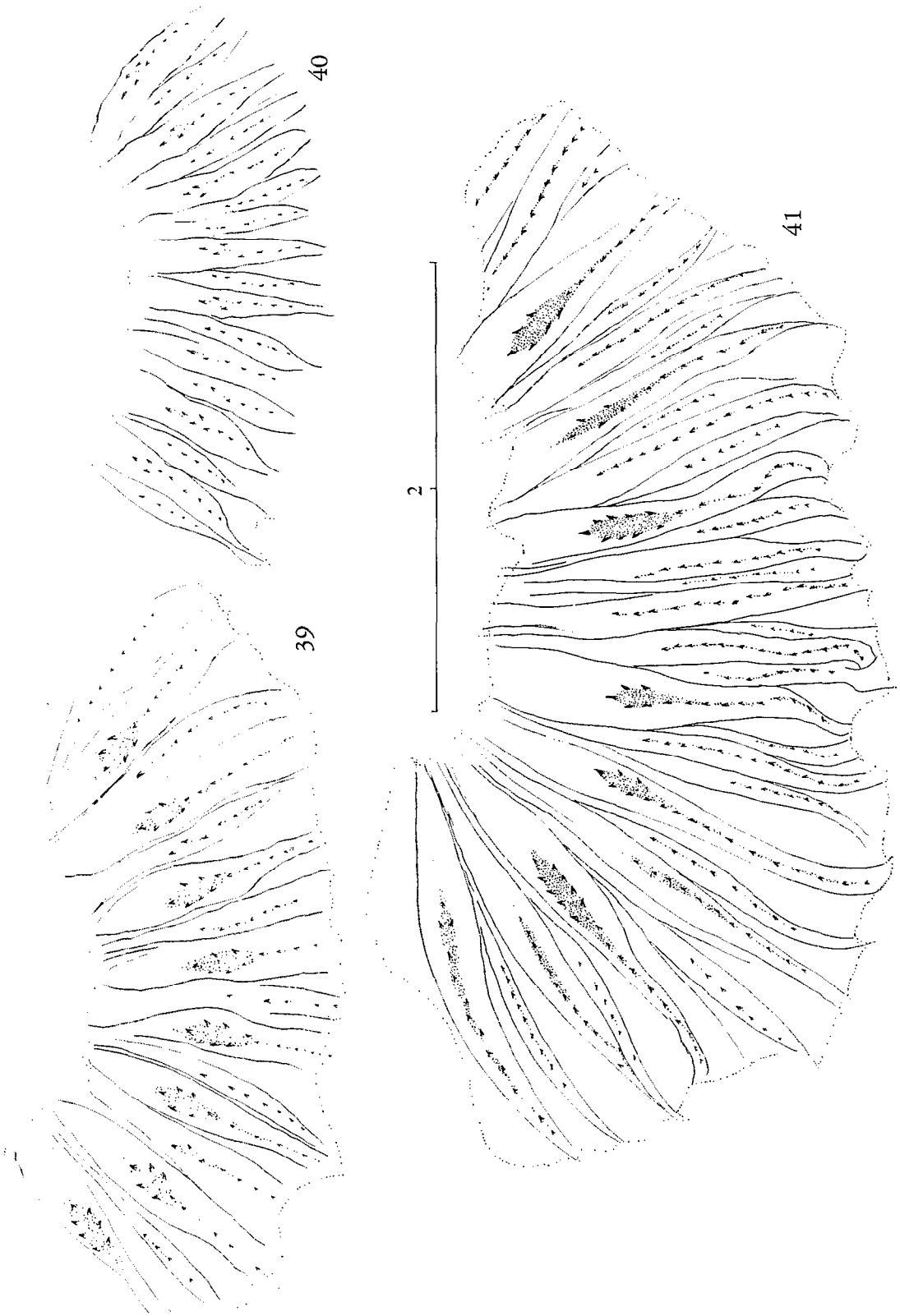


Fig. 39-41. — Proventriculi of New Caledonian Argiolestinae. *Argiolestes ochraceus* (Montr.) (39), *Caledargiolestes uniseries* (Ris) supposition (40), and *Caledopteryx sarasini* (Ris), N 50 (41). All on the same scale.

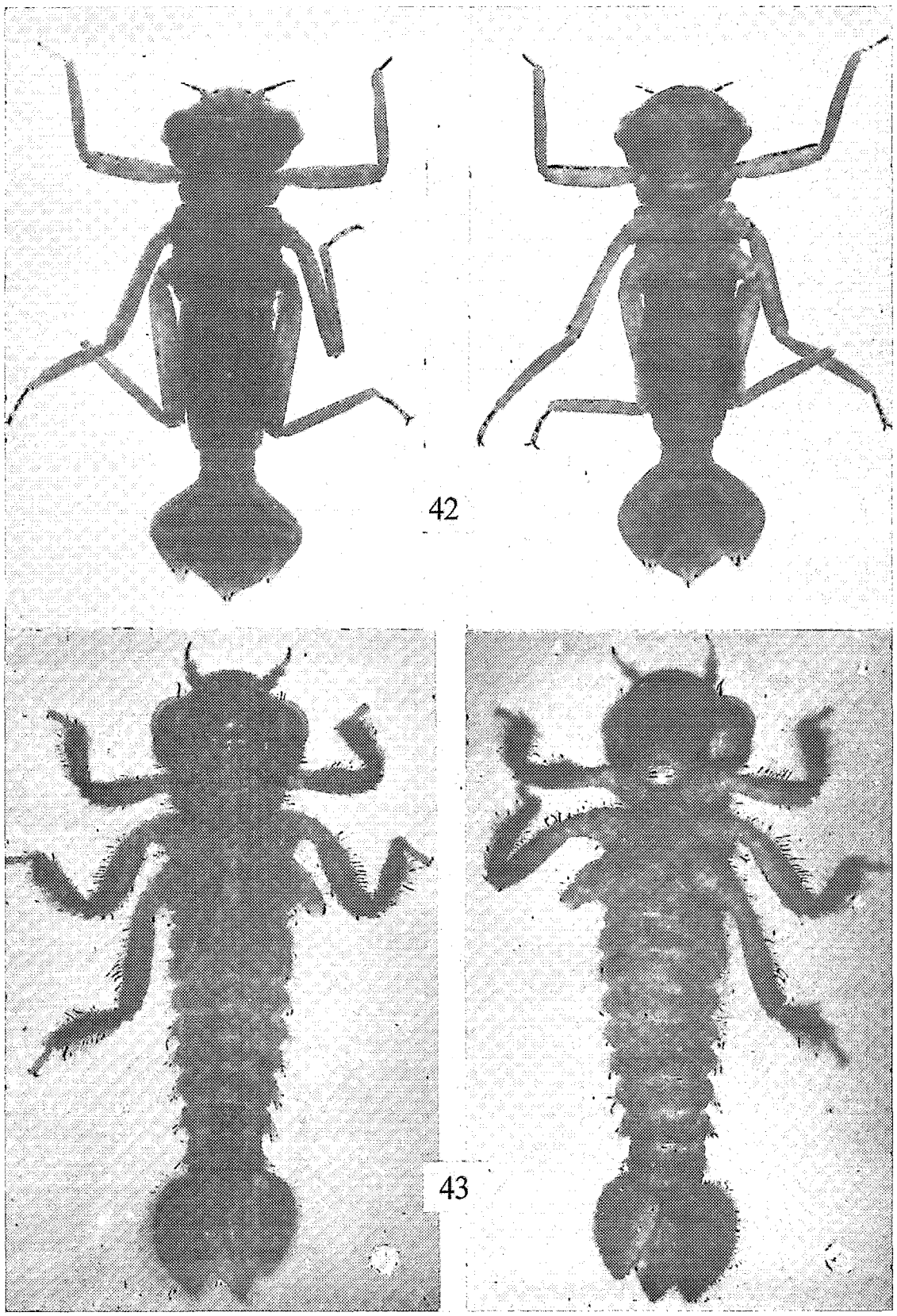


Fig. 42. — *Caledopteryx sarasini* (Ris), ult ♂ larva, FNK 29, dorsal and ventral view, total length 23.0 mm.
Fig. 43. — Unknown terrestrial Megapodagrionid, dorsal and ventral view of unique young specimen from Ciu, N.C., total length (incl. lamellae) 11.2 mm. Fig. 43 after LIPPITT WILLEY (1955).

one described and figured for *Argiolestes pectitus*, a Papuan species of the mountains in western New Guinea (LIEFTINCK, 1956). In one specimen of the latter, the proventriculus consisted of 20 folds which are only weakly differentiated into larger and smaller ones, the teeth on the folds at the same time being undifferentiated, irregularly arranged and their number variable. In *Argiolestes ochraceus*, on the other hand, there are eight fairly well defined major folds, each carrying 7-13 teeth, which alternate with eight minor folds with 4-8 teeth. The dentition on all folds is placed on slightly raised, weakly sclerotised areas of a pale yellow colour. The posterior (anal) portions of these raised and pigmented cuticular areas on the major folds are expanded, carrying 3-7 diverging teeth of slightly larger size, while the teeth on the anterior (oral) portions of the large plates and those occupying the whole length of the smaller ones are single-lined. In *Caledargiolestes uniseries* the differentiation into larger and smaller fields (and also into the posteriorly expanded and pigmented teeth-bearing ridges) is less pronounced than in *A. ochraceus*, in which species there are occasionally one or two minor fields intercalated.

These generalized forms of larval gizzard conform with those described for the more primitive Zygoptera (e.g. *Calopterygoidea* and *Amphipterygidae*), in which the teeth—though more differentiated posteriorly than anteriorly—are all of one kind and placed in a continuous row on a single cuticular plate.

Lastly, *Caledopteryx sarasini* differs from the other species in that the dental folds have increased considerably in number, there being no less than 32 teeth-carrying fields in one of the specimens examined (fig. 41), apart from a few intercalated toothless "fields" of doubtful consistency. Apart from this, the development into major and minor folds is irregular and ill-pronounced, in so far that there are six or seven well-differentiated major fields (each with 14-21 teeth and showing at least two to three duplicated teeth at their posterior ends). These alternate with about an equal number of slenderer fields of medium size whose 11-14 teeth are placed in a single row on less raised and pigmented plates; finally, between the latter and the major folds there are about 11-12 much shorter folds, which have only 2-8 small teeth placed on a still narrower ridge; the last-mentioned ones are intercalated farthest anterad and may be considered as the true minor folds.

Genus et species incert. (nov.?). *Fig. 43-53*

This is the unnamed terrestrial zygopterid larva mentioned already in the first part of this survey. It is no doubt the most intriguing of all immature forms so far known from New Caledonia. The specimen is unique and was described and portrayed in great detail by Mrs. LIPPITT WILLEY (1955), who kindly permitted me to make full use of her information on it.

In the opening chapter of the *Argiolestinae* I have touched upon the diffcult problem of explaining morphological conformities notable in larvae of non-related taxa, and the influence of the environment on the insect's organization. Experience has learnt that, with species whose early stages are still unknown, it is often quite impossible to foretell anything about the physiognomy of their larvae, not to mention structural peculiarities so frequently displayed by them. Good examples of that kind are found among the *Platycnemididae*, and also the *Argiinae* of both Hemispheres. But it is with the heterogeneous *Megapodagrionidae* and the so-called "annectent" non-calopterygoid families *Amphipterygidae* and FRASER's "*Pseudolestidae*", that we meet with the greatest diversity of structure (1).

When measuring the present insect's characters with those of some argiolestine, lestoidine, or amphipterygid larvae, we come across such a medley of characters that any effort to classify it had to be given up as mere guess-work. I prefer, therefore, to leave any conclusion about its status to someone having the opportunity of examining the wing venation of a full-grown example.

With a slight departure from one of TILLYARD's reconciliations, we may say that even if the larval form does not fit in with our preconceived notions and expectations, we must accept the facts as they are, and try still to solve the problems which our knowledge has only rendered more difficult.

The insect was found in the Berlese funnel material of soil and leaf litter, near the village Ciu, and has never turned up again since its discovery, now more than 20 years ago. In general appearance and structure this larva is equally remarkable as the insular *Argiolestinae* dealt with in the previous pages, and yet is quite unique by its hairiness, almost all parts of the body being covered with long, mostly strong, setae. When the larva was received, it was

(1) Incidentally, mention may be made of a number of genera that were omitted by FRASER, or whose larvae have only recently become known, e.g. *Amphipteryx, Devadatta, Heteragrion, Oxystigma, Rhinagrion,* and *Rhipidolestes*. I hope before long to publish a more detailed study of the archaic Amphipterygidae, a family partly investigated already earlier. See LIEFTINCK (1971a, 1972), and WATSON (1966).

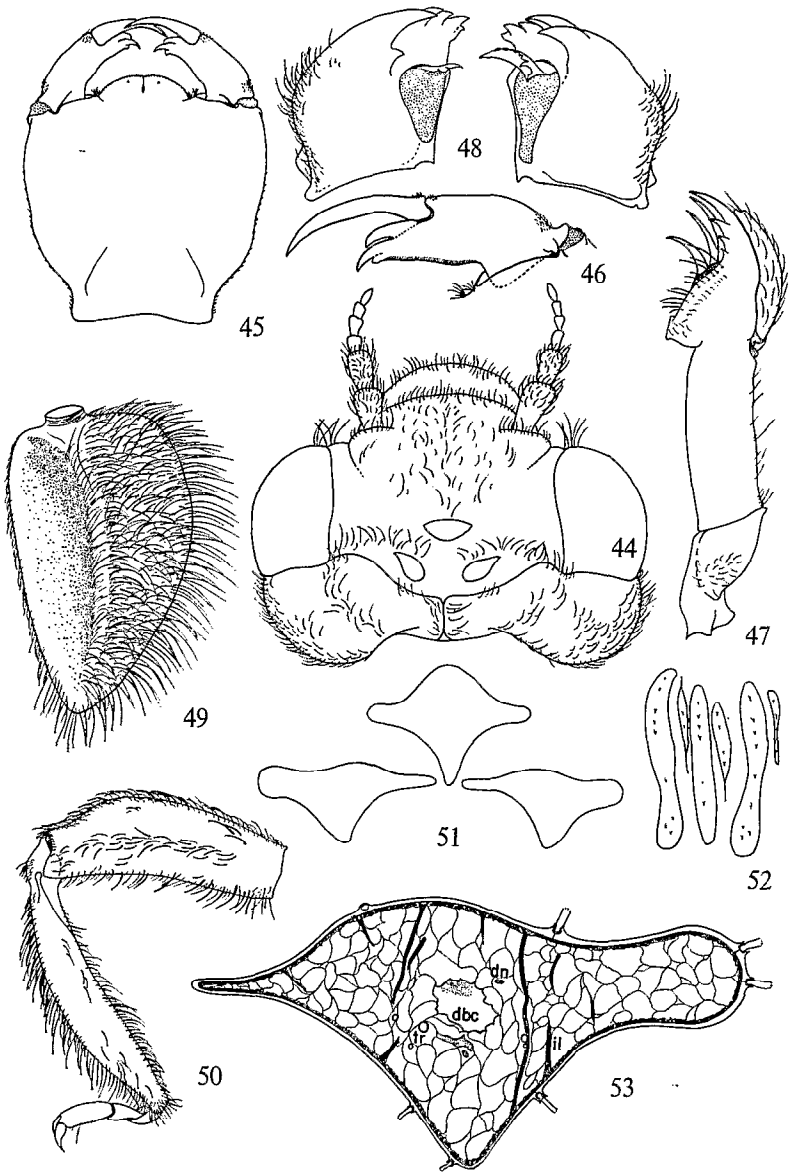


Fig. 44-53. — Unknown terrestrial Megapodagrionid, young specimen from Ciu, N.C. Dorsal view of head (44), labium viewed from within (45), right labial palpus (46), right maxilla (47), right and left mandible, ventral view (48), left lateral caudal lamella, ventral view (49), right mid leg (50), outline diagram of cross section through caudal lamellae showing relative shape and positions (51), diagram of several dental folds of proventriculus to show generalized pattern (52), reconstruction of cross-section through middle of left lateral lamella; dbc, dorsal blood channel; dn, dorsal longitudinal nerve; il, vertical internal lamina; tr, tracheal trunk (53). After LIPPITT WILLEY (1955).

heavily coated with debris caught among the long hairs.

The following additional observations are extracted from a letter received by Mrs. LIPPITT from Dr. E. O. WILSON, of the Museum of Comparative Zoology at Harvard University, who discovered the insect. "All soil and leaf litter samples were collected in dry to moderately moist (but never wet) spots on the forest floor, never less than 200 feet from the river and 75-100 feet above it on a fairly steep slope. There were no lesser streams or other standing bodies of water in the part of the forest I worked. Most of the samples were taken in a level area with numerous small rocks and moist leaf litter several inches

deep." (*loc. cit.*: 137-138). Mrs. LIPPITT adds to her description that the morphology of the insect would suggest either a burrowing or terrestrial habitat. She also argues that, in consequence of the locality, in which it was collected, it seems reasonable to consider it terrestrial, because the increased number of setae would serve to maintain a cover of damp debris which keeps the cuticle moist, a necessity for gas exchange.

It would be most helpful and of considerable interest, if local scientists would keep a sharp lookout for this forest-dwelling insect. In order to recognize it, I have included in the present account copies of the original photographs and illustrations published by its describer (fig. 43 and 44-53).

FAM. ISOSTICTIDAE

Since publication of my general survey of the immature stages of the *Protoneuridae* (LIEFTINCK, 1953), which still included the isostictine group of genera, the larvae of two others, both from Australia, have become known. These are *Oristicta filicicola* Till. (FRASER, 1956) and *Eurysticta coolawanyah* Watson (WATSON, 1969). which, in respect of the caudal gills, agree with *Isosticta*, *Neosticta* and *Selysioneura* in that the organs are of the constricted—lamellate or saccoid—type, a characteristic feature of the whole group and one of the reasons why the isostictines were removed from the *Protoneuridae* as a subfamily which was later given family rank. See WATSON (1969) and LIEFTINCK (1975).

According to TILLYARD (1917), the difference between the constricted gills of *Neosticta canescens* and those of *Isosticta simplex* is, that those of *Neosticta* are of the saccoid type, whereas *Isosticta* possesses laterally compressed blades. Of *Neosticta*, TILLYARD aptly writes: "The shape of the gill may be roughly described as that of a rather short candle surmounted by a flame, the basal joint representing the candle, the distal joint the flame. The constriction between the two joints is very strongly marked, and is only just sufficiently wide to allow of the passage of the main tracheae and the blood-canals. The cuticle is everywhere covered with small, scattered hairs, which become longer and more abundant upon the distal end of the basal joint, and also over the whole of the distal joint." And further: "The cuticle is quite clear and unpigmented. The hypodermal pigment... is not distributed equally all over the gill, but is chiefly confined to three transverse zones, viz., around the base of the gill, around distal third of the basal joint, and upon all except the extreme base and tip of the distal joint." This description, and TILLYARD's illustrations as well, conform fairly closely to the form we observe in the New Caledonian *Isosticta*, whose gills are obviously unlike those of the Australian *Isosticta simplex*. The latter are described as being intermediate in form between the constricted saccus of *Neosticta* and the nodate vertical lamellae found in many *Coenagrionidae*. TILLYARD writes: "Our original simile of the 'candle and flame', used to describe the appearance of the gills of *Neosticta*, would hold fairly well for *Isosticta*, if we add that, in this case, the flame is as big as the candle, and both it and the candle itself have become flattened... The gill is opaque throughout, deeply pigmented in brown or black. Consequently the tracheal system is very difficult to follow; but it can be seen, in specimens fresh from ecdysis, to be very similar to that of *Neosticta*, except that there are always only two main tracheae in each gill. The cuticle is covered with short, shaggy hairs, especially upon the distal joint. The length of the median gill is 4.5 mm, that of the laterals 5 mm; the former is slightly wider, and its tip more rounded than in the latter. These gills are held well apart from one another, the angle between the two laterals being from 20° to 30°, while the median gill projects above them at an angle of from 30° to 40°." The change in the form of gill is said by TILLYARD to be correlated with a change in the habits of these larvae. *Neosticta*, though often found on the sides of larger rocks in deep still pools, is a rock-dweller in running water, "whereas *Isosticta* dwells in trash, twigs, or matted roots, on the bottoms of slowly-moving streams."

It will be shown that apparently all New Caledonian *Isosticta* possess gills of the saccoid type, thus differing markedly from those of *I. simplex*, and although the basal joint is more tensely swollen than the distal one they are of quite the same kind as those of *Neosticta* and the allied *Selysioneura* (two species), a genus which has its distribution centre in New Guinea. Other salient characters shared alike by *Selysioneura* and the insular (non-Australian) *Isosticta*, are found in the dentition of the mandibles, the general form of the labium with its prominent ligula (unknown still in *Neosticta*) and, more especially, the absence of setae on the inside of the palpus, which are so conspicuously present in *Isosticta simplex* (mental setae 1.1, palpal setae 3.3), *Oristicta* (mental setae 2.2, palpal setae 5.5), and *Eurysticta* (mental setae 2.2, palpal setae 2.2). To illustrate these similarities, I have included reproductions of my sketches of *S. cornelia* (fig. 55-59) for comparison with those of New Caledonian *Isosticta*.

Lastly, I would suggest that the absence of palpal setae in mature isostictid larvae, is probably not a primitive feature. At the end of the specific key that follows, I have added a note on the morphology of a very young larva which clearly shows a pair of setae on each of its palpi. Their existence at an early stage of development and subsequent disappearance may

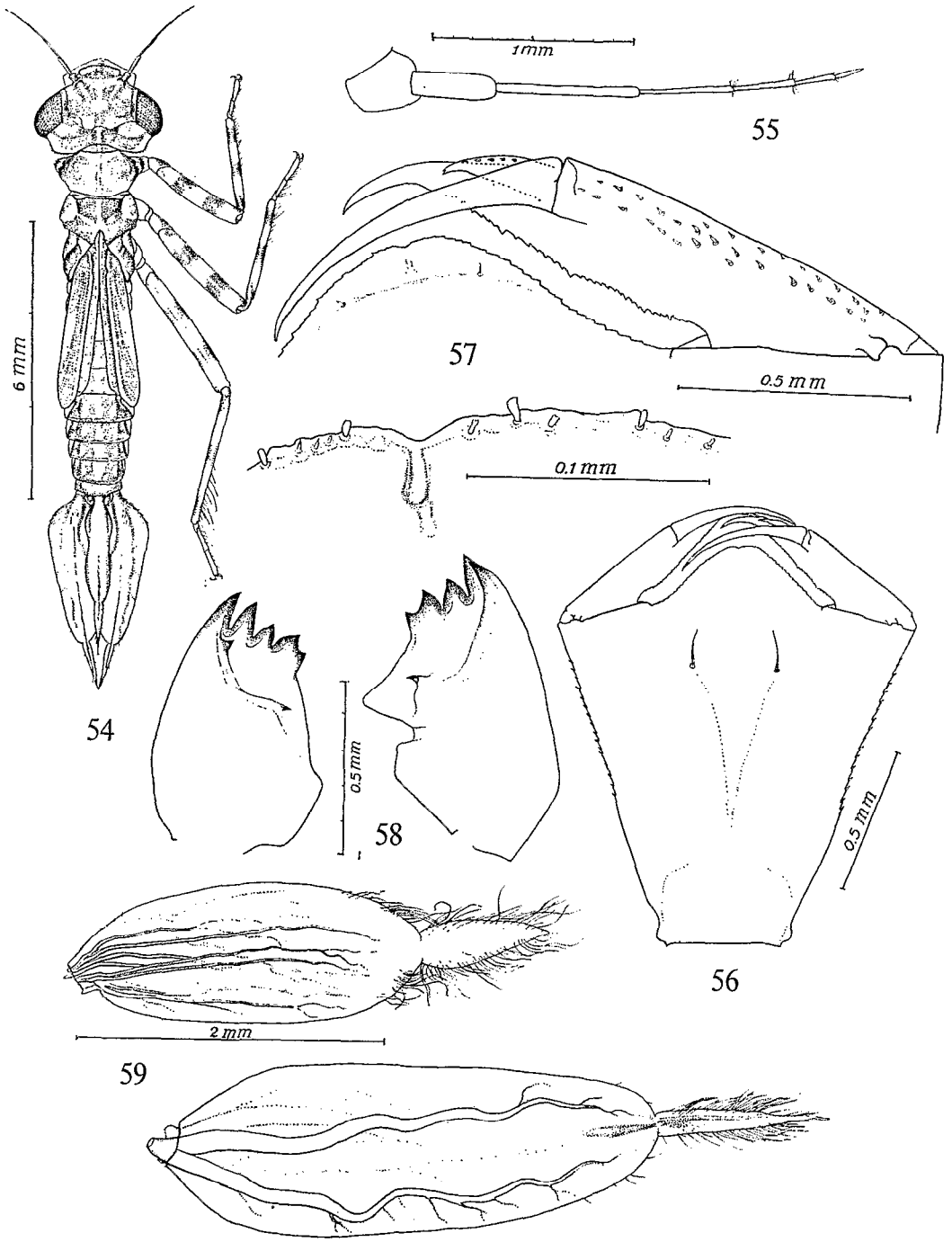


Fig. 54-59. — *Selysioneura cornelia* Lieft., ult ♂ larva, West New Guinea. Full-grown larva, spirit specimen (54), antenna (55), labium viewed from within (56), distal portion of labium with right palpus and apex of median lobe, showing closed cleft, greatly enlarged (57), right and left mandible, ventral view (58), left side view of median caudal lamella (upper) and interior view of right lateral lamella (bottom), showing tracheae and pubescence (59). After LIEFTINCK (1953).

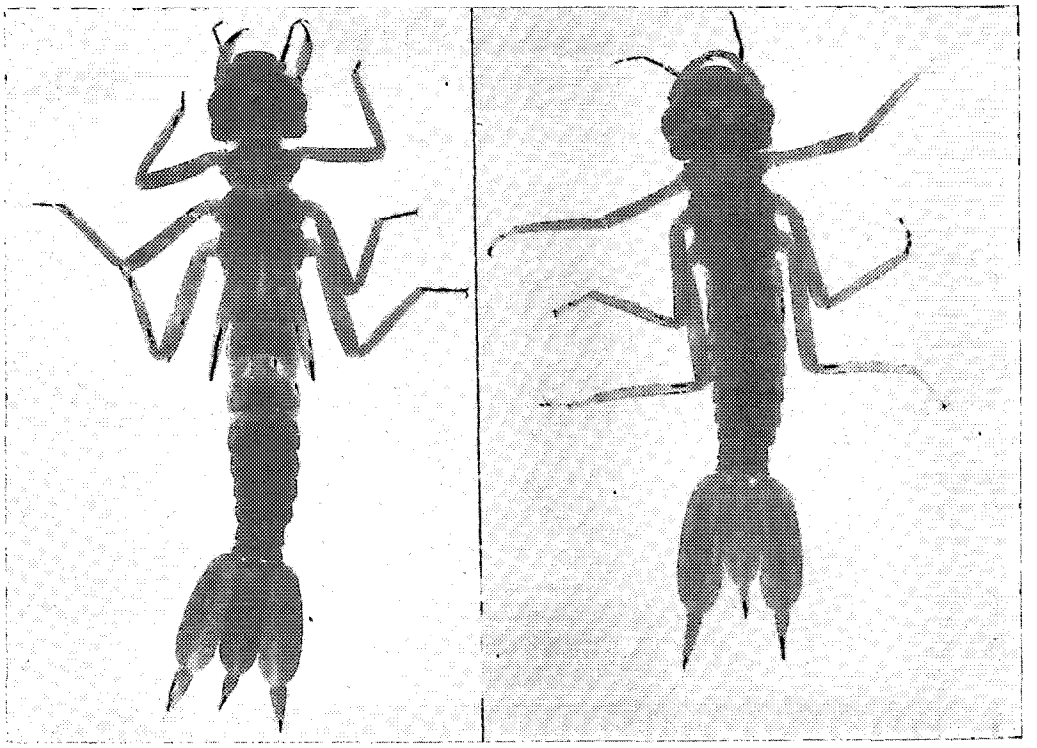


Fig. 60. — *Isosticta robustior* Ris, two ult ♀ larvae from New Caledonia, FNK 94/1 and FNK 37 (right), total lengths (incl. gill lamellae), 22.0 and 20.5, respectively.

indicate that the loss of setae is a secondary phenomenon peculiar to the insular forms and not yet manifest in the more primitive allies occurring in Australia.

Does it mean that the wealth of excessive features of New Caledonian Odonata, larva and imagines, are all adaptive in nature; and that the autochthonous elements in this island are derivatives of an ancient Australian fauna?

The insular species have the following characters in common.

General appearance of *Selysioneura*, facies as shown in fig. 60 of *I. robustior*. Apart from the slender body form and long antennae, distinguished from other coenagrionoid larvae by the great size of the labium and the two-jointed, sausage-shaped gills. Body (except gills) almost bare, legs sparsely fringed with very fine longish hairs. Ocelli of large size, clearly visible as almost circular whitish spots. Occipital lobes prominently bulging, nearly semicircular in outline, densely covered posteriorly with short, acute microsetae. Labium extending back from a little beyond posterior border of precoxae (*robustior*) to as far as base of mesocoxae (*spinipes* group). Wings lying parallel on the dorsum, reaching about as far as halfway length of segment 6. Caudal lamellae as in fig. 66 and 70-71; swollen basal portion clothed at extreme base with short spinulose setae, the apical division with fine longish hairs increasing in length toward end of lamella; dorsal and ventral ridges of second part with dense fringe of still longer, hyaline pubescence.

Of the five *Isosticta* species presently known from New Caledonia, at least three are well represented in our material. They can be divided into two groups characterized in the same way as the imagines, the salient points of distinction being found in the developing wing venation, which are clearly discernible in full-grown specimens of each. In the *I. robustior* group, three species have now been described, while of the other group apparently only *spinipes* and its near ally *tillyardi* occur in the island As to their identity, I have chosen for the three best known species, viz. *robustior* on the one hand, and *tillyardi* and *spinipes* on the other, the first two having been collected in plenty. *I. robustior* is easily known by its slightly larger size and uniform colouring. *I. tillyardi* and the rarer *spinipes* are so much alike that full descriptions of each have little meaning. The majority are evidently *tillyardi*, but not all specimens could be named as such, only the female of that species, readily known by its long

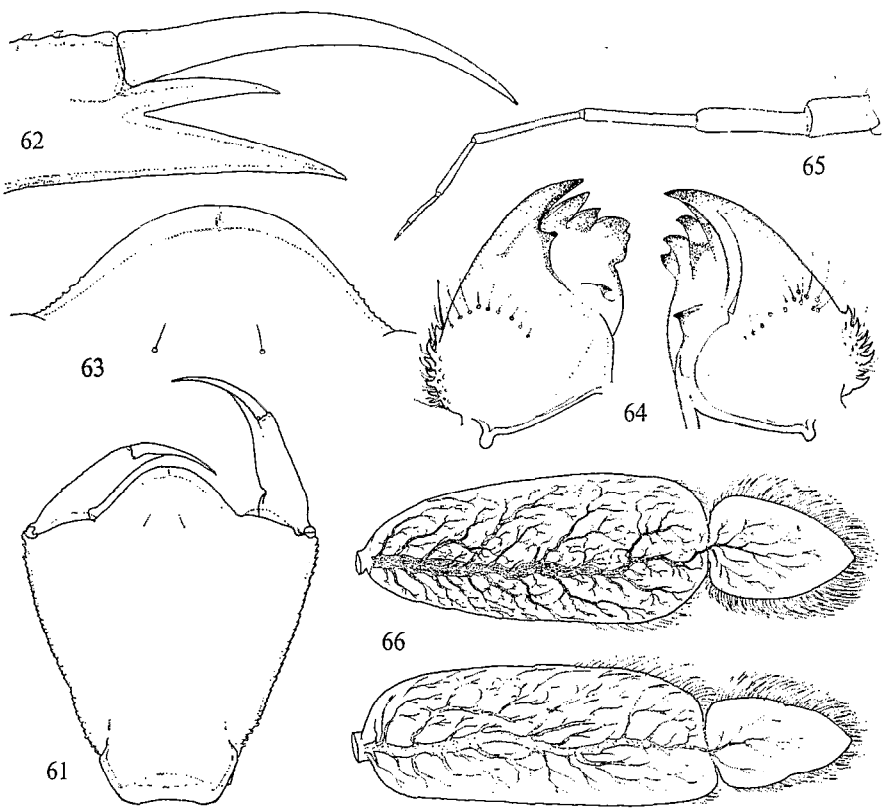


Fig. 61-66. — *Isosticta robustior* Ris, larval structures of exuviae from Thi River valley. Dorsal view of labium showing natural position of palpus (61), apex of left palpus viewed obliquely from within (62), apex of median lobe (63), right and left mandible, ventral view (64), right antenna (65). — Fig. 66. *I. robustior* Ris, ult larva, FNK 94/1, left side view of median (upper) and left lateral caudal lamella, showing outermost main trachea and marginal fringes (same specimen as fig. 60, left).

ovipositor, has been segregated from the rest under the heading "Material". The sketches of the labium and key characters given for *spinipes* are based on females and two or three males, all of them full-grown.

Isosticta robustior Ris. *Fig. 60-66*

Material. — Apart from the unique cast skin of the specimen bred out by the late F. X. WILLIAMS, mentioned in my previous report (huj. op., 1975), the following can be recorded. Österr. Neukaledonien Exp. 1965: ca 58 ex. (both sexes, about 30 ex. ult-penult, the remainder younger instars), FNK 5/1, 9, 11/1, 26, 29, 29/1-2, 37 (fig. 60), 55, 63, 64/2, 70/2, 71/2-3, 77, 79/3, 84/2, 94/1-2 (fig. 60 and 66), 95, and 104 (NMW, ML). New Caledonia FAMU Exp. 1972: ca 68 ex. (both sexes, about 50 ex. ult-penult, the rest younger stages), N 15, 18-24, 26-27, 35, 37, 42, 46, 50-51, and 54 (CFT, ML).

Isosticta tillyardi Campion. *Fig. 67-72*

Material. — Österr. Neukaledonien Exp. 1965: 7 ♀ ult, FNK 47/2, 67/1, 79/1, 85/1, 94/1, and 105/1 (NMW, ML). New Caledonia FAMU Exp. 1972: 1 ♀ ult, N 17 (ML).

The above specimens, all females, are at once recognizable by the great length of the genital valves and hence are unmistakable *tillyardi*.

Isosticta tillyardi Campion and **spinipes** Selys (mixed). *Fig. 73-75*

Material. — Österr. Neukaledonien Exp. 1965: ca 65 ex. (both sexes, about 45 ex. ult-penult, the remainder various younger stages), FNK 10, 20, 35, 37, 32-42/2, 44, 47/2, 52, 64/1, 67/1, 79/1, 80, 82, 85/1-2, 94/1, 105/1, 110, 115 (both species, fig. 67-75), and 120 (NMW, ML). New Caledonia FAMU Exp. 1972: ca 30 ex. (both sexes, about 10 ex. ult-penult, the rest younger instars), N 16, 17, 31, 37, 42, and 51 (CFT, ML).

Key to the known species of Isosticta

1. Legs unicoloured brown, femora becoming slightly darker toward the bases and apices, the tibiae also a little obscured at extreme base. Antennal segment 3 not much longer than 2 or 4 (fig. 65). Ligula of mentum protruding, strongly convex (fig. 63); labial palpus bifid, the prongs unequal but almost straight and evenly

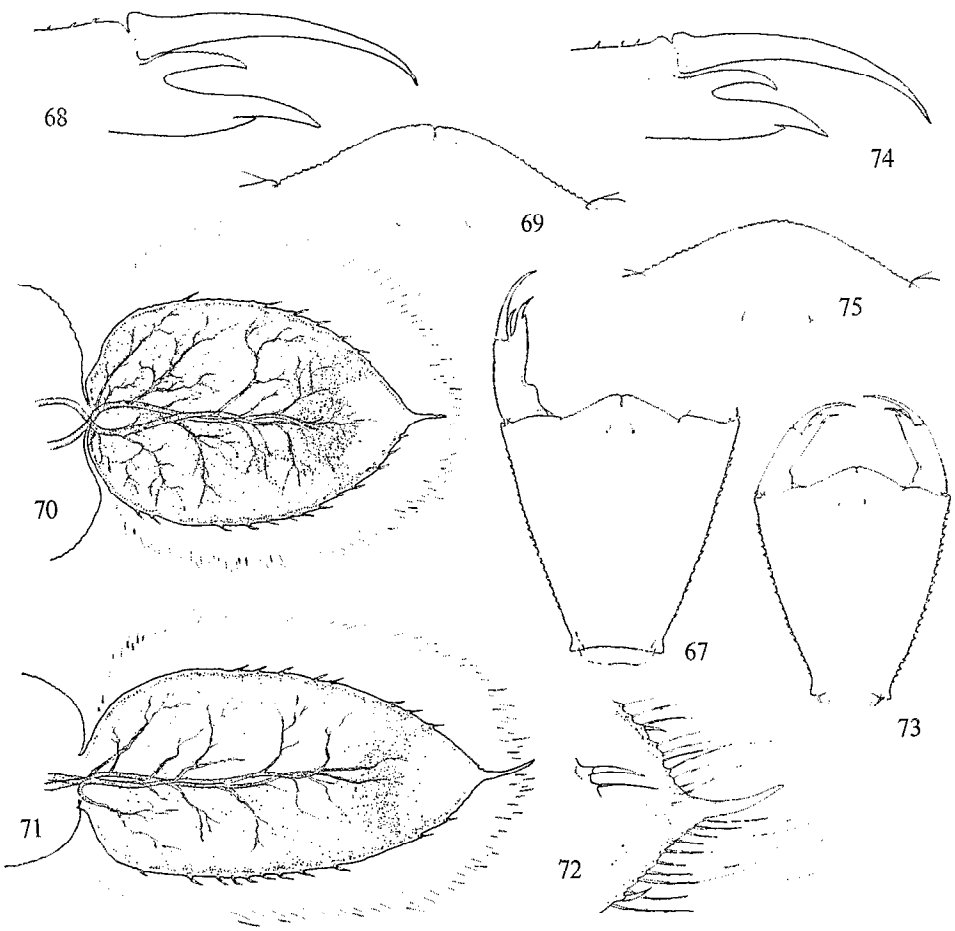


Fig. 67-75. — *Isosticta spinipes* Selys and *tillyardi* Campion, supposition, ult larval structures, N 115; labium of *I. tillyardi*, viewed from within (67), apex of left palpus (68), apex of median lobe, more enlarged (69); fig. 70-72, left side wiew of distal joint of median (70) and left lateral (71) caudal gills showing pattern, tracheae and marginal fringes, with apex of lateral lamella more enlarged (72). Fig. 73-75, *Isosticta spinipes* Selys, supposition, same labial structures as before, all on the same scale.

pointed (fig. 62). Abdomen brown, growing darker posteriorly, dorsum with narrow, continuous median stripe and all segments apically with transverse dark bands which gradually become broader from before backward, leaving large, suboval, yellowish side spots at each segment. Length ratio of basal and distal parts of caudal lamellae approx. as 26 : 10; colour light to dark brown, basal part slightly paler near base, distal one unicoloured, pubescence hyaline, as shown in fig. 66. Ovipositor valves subequal in length to segm. 9+10, tips projecting but slightly beyond posterior border of 10th segment. Total length (incl. gills) 20.5-22,0 mm, length of median gill about 5.5 mm..... *robustior*

–. Legs banded: all femora and tibiae with well defined dark brown basal, median and apical rings, the apical femoral rings broadest and the tibial annules equidistant; tarsi pale. Antennal segment 3 markedly longer than 2 or 4 (e.g., length ratios of separate segments of *tillyardi* as 8 : 14 : 25 : 16 : 10 : 7 : 3), bases and apices of 2-6 pale. Ligula of mentum less projecting, obtuse-angulate (fig. 69 and 75); labial palpus bifid, the prongs unequal, slightly curved inward, the innermost spine with additional subapical tooth (fig. 68 and 74). Body with variegated pattern of yellow- and dark brown; posterior lobe of prothorax with pair of transverse dark spots, meso-metanotum with dark median band. Abdomen brown, growing darker posteriorly, the continuous pale median band broader, and dark transverse apical bands more sharply defined on all segments and hardly prolonged basad, occupying about one-third of the segment's length. Length ratios of basal and distal parts of caudal lamellae as 22 : 10, the basal part unicoloured brown, the distal one broader and more flattened than in *robustior*, terminating abruptly in a fine point, margins with row of spinulose setae and densely fringed roundabout with very fine long hairs; colour dark, except the tips, which are conspicuously whitish (fig. 70-71) Length of ovipositor valves variable. Size smaller, e.g. total length (incl. gills), 16.0-16.8 mm (11.2-11.8+4.8-5.0 mm, *tillyardi*), and 18.7 mm (13.3+5.4 mm, *spinipes*) 2

2. Pale middorsal band of abdomen relatively broad; dark transverse apical bands well defined, the posterior ones occupying about distal one-third of the segment's length, all interrupted on middorsum by the pale median band. Brown rings at femora almost equidistant, the apical one only little broader than the others. Ovipositor valves of great length, about twice as long as segm. 9, surpassing 10th segment for about one and one-third or more of its length..... *tillyardi*
–. Pale middorsal and dark transverse apical bands of abdomen all narrower, the latter ill-defined anteriorly. Brown rings at femora of unequal breadth, the basal ring narrow, the median one broader, but only half as long as the apical ring. Ovipositor valves shorter, not projecting beyond apex of 10th segment for more than its length..... *spinipes*

Description of an early instar larva of Isosticta

The following notes are taken from a very young *Isosticta* larva, the smallest among the many immature individuals brought home by the two expeditions. Though the specimen was discovered too late for having structural drawings included in this paper, a brief discussion of some features of interest may not be out of place: (1) the antennae are distinctly 7-segmented, which is very unusual for such a young larva; (2) the labial palpus still possesses a pair of setae, which have become lost in older instar larvae. which is also worthy of note in connection with what has been said before about the specific differences between full-grown *Isosticta* larvae from Australia and New Caledonia; (3) the initial *Isosticta* palpus is surprisingly similar in shape and marginal dentition to that of other primitive forms, more especially the calopterygoid genera *Euphaea* and *Vestalis*, figured by LIEFTINCK (1962a), and others discussed by ASAHINA (1954) and Hortense BUTLER (1904), whose comments are worth reading but hardly necessary here to repeat. Of course, the question whether some phylogenetical importance can be placed on a comparative study of the labial structure of the earliest instar larvae, remains to be answered. Anyhow, it seems to me that published observations, however few in number, indicate that the described form of palpus represents a truly primitive type of the zygopterid labium.

Material. — 1 ex., possibly 3rd post-prolarval instar, N 43, Hienghène River, Tindo, 25.10.1972, W.L. & J.G. PETERS, FAMU Exp. (ML).

Total length (incl. filiform caudal gills), 4.0 mm; length of body without gills, 2.4 mm; median and lateral gill of equal length, 1.6 mm.

Body very slender, colourless and almost bare, including antennae and legs, only posterior abdominal segments laterally minutely pubescent. Labium broad-triangular, median length, 0.56 mm, greatest anterior breadth, 0.5 mm. Mental setae distinct, one each side, median lobe obtuse-angulate, less projecting than in full-grown *I. tillyardi* (fig. 67), without indication of a median cleft, its free border carrying 8-9 minute blunt tubercles on either side. Palpus much broader than in full-grown larva, outer border strongly convex, inner border straight, carrying 5-6 distinct recurved teeth, apex oblique, finely serrulate, the end-hook longer than the exterior teeth; palpal setae well developed, two on either side, the distal one longest and attaining apex of movable hook. Antenna short, 0.6 mm, slightly exceeding mid-length of head, 7-segmented, length-ratios of separate segments 2 : 6 : 4 : 4 : 4 : 4 : 3; segm. 1 short and square, 2 somewhat expanded, three times as long as broad, 3-7 more slender. No trace yet of developing wings. Caudal gills slim and slender, distinctly two-jointed. Basal joint cylindrical, vermiform, 0.9 mm long, broadest slightly beyond halfway length, a little more than six times as long as greatest diameter; two straight, parallel, unbranched main tracheae uniting at the constriction; in dorsal view each gill bears a row of 4 or 5 widely spaced, short and robust spinulose setae on either side. Distal joint 0.7 mm long, filiform, tapering gradually to a fine point and clothed sparsely with very fine, long hairs.

A conjectural note on some biological specialities

Unfortunately, nothing definite seems to be known of the biology of New Caledonian *Isosticta*. In my article on larval *Protoneuridae*, I have summarized TILLYARD's observations on the curious behaviour and site-selection of adult Australian *Isosticta simplex* Martin and *Oristicta filicicola* Till. (LIEFTINCK, 1953: 664). In the same paper a detailed account has been given of the extraordinary egg-laying process of the allied *Selysioneura cornelia* Lieft., in western New Guinea. The unattended female of that species was watched for a long time while ovipositing in the midribs of broad leaves on a branch overshadowing a forest brook, high up in a tree. The larvae of these *Selysioneura* (fig. 54) were found singly under pebbles in the shoals of small rivers and streams. I should not be surprised to learn that our insular *Isosticta* have similar arboreal habits and a mode of oviposition corresponding to that observed in *Selysioneura*.

FAM. COENAGRIONIDAE

Ischnura heterosticta (Burm.)

Material. — Österr. Neukaledonien Exp. 1965: 37 ex. (12 ult, rest younger stages, both sexes), FNK 16 (1 ♀ ult, 1 penult), 27 (1 juv.), 46 (2 ♂ ult, 1 juv.), 48 (1 ♀ ult, 21 ex. younger stages), and 49 (8 ult, 1 juv.) (NMW). New Caledonia FAMU Exp. 1972: 2 ex. ult, 9 younger stages N 41 (CFT, ML).

New Caledonia: 1 ♀ ult, Nouméa, Anse Vata, 21.11.1952, ponded ditch, no. P5, Marshall Laird (ML). — Loyalty Is.: 1 ex. ult, Uvea, Faiaoué, 22.3.1953, small semi-permanent pond, no. AA6, Marshall Laird (ML).

The early stages of this common species have been described and illustrated in some detail by Tillyard (1917a: 97, figs.) and Watson (1962: 28-29, pl. 4 figs.). I am not quite sure whether the many young larvae are correctly identified as some of the samples may include also individuals of the somewhat smaller *I. aurora* Brauer.

Agriocnemis e. exsudans Selys

Material. — Österr. Neukaledonien Exp. 1965: 15 ex. (6 ult, 9 younger stages, both sexes), FNK 16, 27, 36 (3 ♂ 1 ♀, ult, 2 juv.), 44 (1 ♀ ult, 2 juv.), 48/2, 80 (1 ♀ ult, 3 juv.), and 94 (2 juv.) (NMW). New Caledonia FAMU Exp. 1972: 32 ex. (few ult, mostly younger stages, both sexes), N 24, N 34, and N 41 (CFT and ML). — Loyalty Is.: 1 ex. ult, Lekin, Uvea, 21.3.1953, large permanent swamp, no. AA1, Marshall Laird (ML). A number of young specimens are from Uvea, St. Joseph village (no. BB2, CC4-5), brackwater and pond, 23.3. 1953, same collector, possibly also belong here, though some may be *Xiphiagrion cyanomelas* Selys.

The larvae of this little species are so similar to those of *A. femina* (Brauer), that it will, I believe, suffice to copy a picture of the latter with one of its caudal lamellae (fig. 100), published on an earlier occasion (Lieftinck, 1962). Several individuals have lost their gills so that a number of them, particularly the immature stages, could be determined only tentatively.

ANISOPTERA

Fam. Aeshnidae

Subfam. Aeshninae

Aeshna brevistyla Rambur. *Fig. 76-81*

Material. — Österr. Neukaledonien Exp. 1965: 1 ♀ ult and 1 ♀ 4-ult, FNK 113 (NMW). New Caledonia FAMU Exp. 1972: 1 ex., very young, N 24 (ML).

The mature larva is a female in perfect condition with the characteristic wing venation fully developed and clearly discernible. For details of the morphology and anatomy of *A. brevistyla*, the reader is referred to Tillyard's works (1916, 1917). Both publications contain abundantly illustrated information on the characters of larva and imago. See also Watson (1962: 13, key and pl. 6 fig. 26).

The following details of structure and drawings are taken from the mature and very young New Caledonian examples, now before me.

Full-grown larva. — Total length of body 34.0 mm, breadth of head across eyes 8.3 mm, median length of head 6.4 mm. Structure of labium, anal appendages and ovipositor valves, as in fig. 76-79. Antenna 7-segmented, 1-2 subequal in length, each approximately also equalling 4 and 5, which together are a little shorter than 3. Submentum reaching back to end of coxa 3. Supra-coxal process of prothorax small, trapezoidal in outline, divided into two almost equilateral triangles, the posterior one a trifle larger and broader than the anterior, the interspace rectangulate. Lateral spines of abdomen present on segm. 6-9. Anal pyramid subequal in length to segm. 9+10.

The very young larva (N 24) measures only 13.5 mm (abdomen greatly extended!); antenna already 7-segmented; shape and armature of labium as in fig. 80-81; wing buds vestigial, visible as minute triangles.

This species can be distinguished from the larvae of *Anaciaeschna* most conveniently by the longer and more slender form of the labium, the much shorter cerci (i.e. the "app. sup." of Schmidt, 1950), and the female, moreover, by the small size of the genital valves. Comparisons were made with larvae of the Oriental *Anaciaeschna jaspidea* (Burm.), *montivagans* Lieft., and *megalopis* Martin, all of these being approximately of the same size as the present species of *Aeshna*.

Fam. Corduliidae

Subfam. Corduliinae

Hemicordulia fidelis MacLachlan (supposition)

Material. — Österr. Neukaledonien Exp. 1965: 1 ex. ult, FNK 113; 2 ex. ult, FNK 36; 1 ex. ult, FNK 46/1; several ex., younger stages, FNK 16, FNK 44/1 (NMW & ML). New Caledonia FAMU Exp. 1972: 1 ex. ult, N 37; several younger stages, N 17, N 34, and N 45 (ML).

These larvae probably all belong to a single species which resemble each other closely. The following is a brief characterization of N 37, the neuration of which agrees with that of regional *Hemicordulia*.

Total length 19.0 mm, length of abdomen 11.5 mm, greatest breadth of same at end of 6th segment 7.5 mm; breadth across eyes 5.3 mm; length of hind femur 6.2 mm.

Antenna long and slender, 7-segmented. Mental setae 10-11, arranged in a curved row, decreasing gradually in size toward either end of the row; distal border of palpus with 7-8 distinct setiferous teeth, the outermost tooth divided; palpal setae 6 (left) and 7 (right). Wings lying parallel on the back, venation as for genus; fore wing with 7 Ax and 6-7 Px. Prominent dorsal hooks of abdomen present on 3-9,

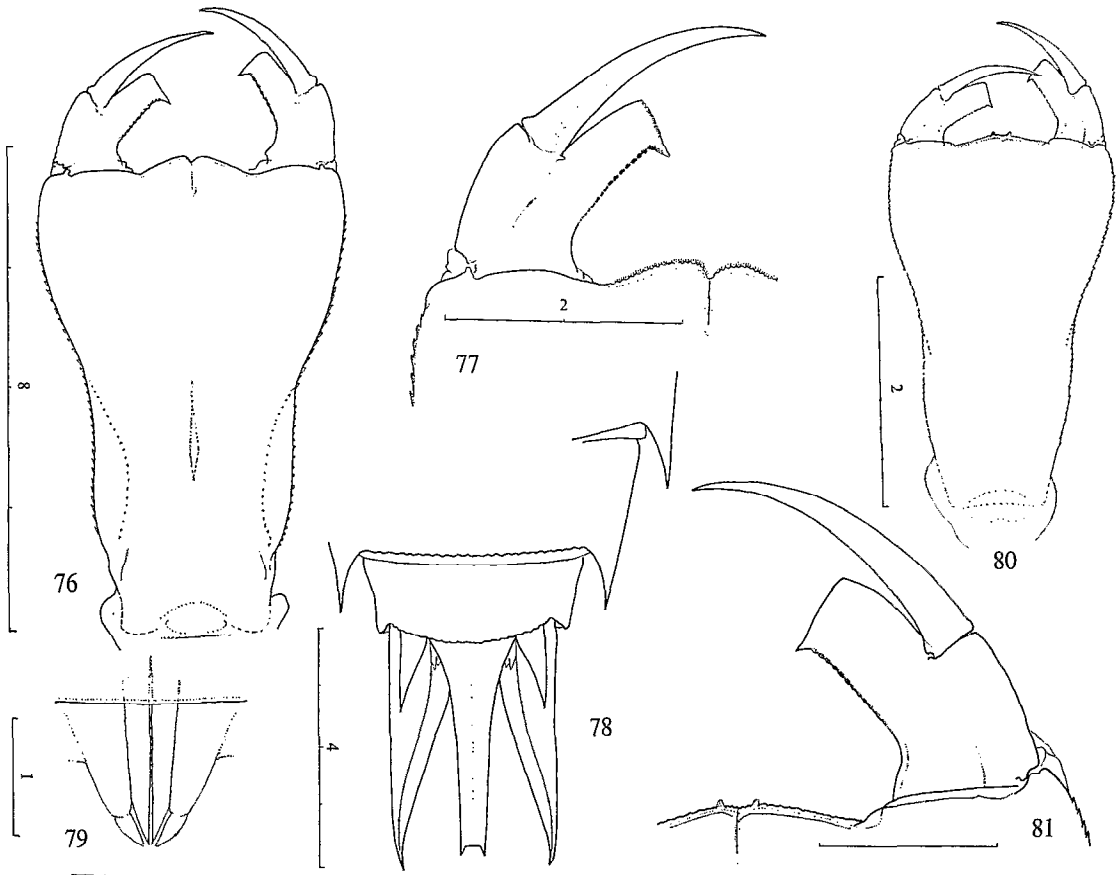


Fig. 76-79. — *Aeshna brevistyla* Ramb., ult ♀ larval structures, FNK 113. Labium viewed from within (76), internal view of left palpus and apical portion of median lobe (77), apex of abdomen (78), ventral view of ovipositor valves (79). — Fig. 80-81. *A. brevistyla* Ramb., early instar larva N 24. Internal view of labium (80) and the same of right palpus with apical portion of median lobe, showing rudiments of glossa; scale-line 0.5 mm (81).

of moderate size, straight-lined dorsally in profile, bluntly pointed and directed caudad, the one on 7 largest. Lateral spines present on 8-9 only, small, of equal size and moderate length, acuminate, on 8 straight, the one on 9 very slightly incurved.

Colour light brown, the eyes dark brown; meso-metapleurae also distinctly darker. Legs pale, trochanters obscured, all femora marked with two well defined median brown rings placed at equal distances from base and apex and almost equal in length to the light-coloured areas. Abdomen yellow-brown, 4-9 each with pair of small brown spots placed in two rows, the innermost spots vestigial.

It is impossible to identify this larva with any amount of certainty as *Hemicordulia* or *Procordulia*, as both genera possess species with or without dorsal hooks and lateral spines on the abdomen, the two forms being very much alike in general appearance and size. As to its proper name I have, however, selected *H. fidelis* as the most likely possibility, this being the commonest representative in the island.

Whole pictures of *Hemicordulia* larvae are found in NEEDHAM (1932: 113, fig. 34), of the allied *H. mumfordi* Needham (sub *H. assimilis* Hagen), from the Marquesas Is. A portrait of the Australian *H. tau* Selys was published by WATSON (1962, pl. 11 fig. 61), of *H. olympica* Lieft., from central New Guinea by LIEFTINCK (1962: 46, fig. 14), and of *H. ogasawarensis* Oguma, from the Bonin Is., by UBUKATA & IGA (1974: 22, fig. 1). None of these possess dorsal processes on the abdominal segments. A species apparently very similar to the present one, is *H. australiae* (Ramb.), which also possesses dorsal spines and looks very similar to the present species (see WATSON, 1962: 25, pl. 2 fig. 1).

Subfam. Synthemistinae

The immature stages of the *Synthemistinae* have been investigated by several authors, the most advanced studies of the life history being embodied in a well known article published by TILLYARD (1910), and two others by J. A. L. WATSON (1962, 1967), all on Australian species. TILLYARD described and illustrated the larvae of the following five: *Synthemis eustalacta* (Burm.), *S. macrostigma orientalis* Till., *S. regina* Selys. *Eusynthemis guttata* Selys, and *Choristhemis flavoterminata* (Martin), from southeast Australia. WATSON published excellent whole pictures of larvae and their structure of four others, viz. *S. cyanilincta* Till., *S. macrostigma occidentalis* Till., *S. leachii* Selys, and *S. spinifer* Till., all from southwest Australia. The same author supplied keys to the identification of the latter.

The early stages of a fairly substantial species-group occurring in New Guinea and some of the neighbouring islands, are still unknown.

CAMPION (1921) was the first to describe a larva from New Caledonia but, unfortunately, the venation of this was too undeveloped to afford a guide to specific recognition. Next to this came my own paper on eastern *Corduliidae* (LIEFTINCK, 1971), in which the larvae of two others from the same island were described, viz. the supposed *S. miranda* Selys, and the aberrant *S. fenella* Campion, both collected by the Austrian expedition. In the following pages the most striking features exhibited by another four members of the genus are discussed in some detail, which brings the number of New Caledonian taxa up to seven. Their salient characters are illustrated and summarized in a key. Unfortunately, only one of them, i.e. the peculiar *S. fenella*, could be identified with absolute certainty, the specific name of all others (including the supposed *miranda*) remaining uncertain. In order to disclose their identity in future and to facilitate comparisons, the latter are here merely recorded as "spec. indet. A-E". All characters given are based on full-grown specimens. It is worthy of note that, again with the exception of *S. fenella*, the material presently available to this purpose is very limited. I am quite unable to explain why it is that so very few of the larger-sized species were discovered by members of the two expeditions.

All synthemistine larvae, so far known, have the following characters in common by which they can be distinguished from other *Corduliidae*:

(1) Body form elongate-oval; (2) Wing cases strongly divergent; (3) Head large, transverse, subrectangular, prominent outer part of compound eye small, slightly projecting laterad, posterior angles rounded; a well-developed, transverse, dorsally flattened frontal plate with convex or straight anterior margin fringed densely with thick, often swollen bristles or papillae; (4) Legs relatively short and strong, unmodified; (5) Labium of huge size, subtriangular, deeply cupped; mental setae divided into primaries and secondaries placed at an angle; ligula of midlobe conspicuously present as a more or less advanced triangular tubercle; labial palpus nearly always strongly dentate, but distal border lacking setae, their free margin instead minutely crenulated; (6) Antenna short, typically 7-segmented (occasionally only 6 or even 5 joints), the basal one shorter than broad, the second larger and swollen, the remainder elongate, with third segment the longest; (7) Abdominal segments—with the exception only of CAMPION's unknown New Caledonian species—without postero-lateral spines or teeth; apical middorsal projections ("dorsal hooks") often wanting, but when present, apparently never acute and in the form of rounded tubercles.

Key to the larvae of New Caledonian species of Synthemis

1. Body elongate, almost hairless, total length not exceeding 18 mm. Head broadest anteriorly across eyes (4.0 mm), which are not protuberant; sides little convergent, convex; frontal plate strongly projecting anterad, surface flat, anterior border biconvex, shallowly emarginate; antenna short, with 6-7 (occasionally only 4) segments in about equal proportion (fig. 86). Labium narrow, submentum reaching back to end of coxa 2 or slightly beyond; 2 primary mental setae and 2 palpal setae each side; palpus subtriangular, distal border entire, lacking advanced teeth, free margin finely crenulated. Abdomen more than twice as long as broad, segments apically without any indication of middorsal protuberances, postero-lateral angles obtuse-angulate, only those of 9 slightly projecting caudad, obtuse. Anal pyramid subequal in length to segm. 9, elements pointed, straight, only apex of epiproct down-curved, cerci finely acuminate. Venation open. Not more than 14 Ax (first series) and 11 Px in fore wing, 11 Ax and 10 Px in hinder pair. All triangles and subtriangles free, hypertriangle with 1 cross vein; discoidal field of fore wing commencing with a single row of cells. Total length of body 16.3-17.8 mm; abdomen more than twice as long as broad, 10.5-11.0 mm, greatest breadth at base of 6th segment 4.5-4.7 mm ..... *fenella*

–. Body broader, oval, moderately to strongly pubescent, total length exceeding 20 mm. Head larger and broader; abdomen at most twice as long as broad, usually shorter, greatest breadth at segments 5-6, which are subparallel-sided. Labium at least with 3 primary mental and 4 palpal setae each side; palpus of normal shape, distal border invariably denticulate, usually bearing large jagged teeth, free margin finely crenulated. Venation denser with higher nodal index; triangles and subtriangles with 1 or more cross veins, at least so in fore wing 2

2. Total length of body 28 mm; greatest breadth of head 7 mm. Abdomen elongate-oval, 16 mm long, unicoloured

dark reddish brown, smooth, except a few hairs on lateral margins of the more anterior segments; 2-9 with postero-lateral spine on each side, curved and rather large on three more proximal segments, straighter and smaller on the five more distal segments. The two lateral anal appendages [paraprocts] but slightly curved the other three more decidedly so. Labium reaching back to a point between bases of mid and hind coxae; primary mental setae 7-8, secondary setae 4, each side; distal border of palpus fringed with 5-6 distinct teeth, palpal setae 4 on right, 3 on left side. Frontal plate conspicuous, projecting forward with semicircular anterior border fringed with coarse yellow hairs. Eyes rather prominent (considerably larger than in *S. eustalacta*). (Description after CAMPION, 1921)... *spec. indet. A*

–. Size smaller, total length of body not exceeding 24.5 mm (20.5-24.5 mm), greatest breadth of head across slightly prominent eyes, 5.5-6.9 mm. Frontal plate less conspicuously projecting, anterior border slightly convex, or nearly straight. Abdomen with postero-lateral angles obtuse-angulate, devoid of spines; at least traces of blunt apical middorsal tubercles upon intermediate segments. Pubescence variable. Distal border of labial palpus deeply indented, bearing 4-6 finely crenulated jagged teeth, the intervals U- or V-shaped (fig. 91); primary mental setae 3.3 or 4.4, secondaries invariably more numerous, distal portion of median lobe moreover covered with numerous microsetae; palpal setae invariably 4.4. Fore wing with 21-27 Ax (first series) and 13-17 Px. Anal pyramid about as long as middorsal length of segm. 9+10, the paraprocts longest..... 3

3. Paraprocts in profile distinctly downcurved and epiproct rather S-shaped: upper margin of the latter at first concave, then convex; cerci short and slender, dorsal surface not flattened (fig. 94). Anterior border of frontal plate with dense fringe of long thick pale hairs and a row of much shorter hyaline papillae. Distal border of labial palpus carrying 5 robust teeth; primary mental setae 4.4. Femora with two fairly distinct though incomplete brown bands, one subbasal and a second, much broader, subapical one. Abdomen above brownish yellow variegated with a mottled pattern of small dark brown spots, the largest of these forming two broken bands running lengthwise on each side of the median line. Dorsal tubercles (fig. 94) low, transverse, the one on 5 most distinct and on 9 vestigial. Body moderately pubescent: most carinae fringed and tufted rather densely with pale hairs. ♂ Total length 23.2 mm, breadth across eyes 6.2 mm..... *spec. indet. C*

–. Paraprocts in profile pricker-shaped, straight or nearly so, epiproct also straighter, not definitely S-shaped; cerci longer and broader. Other characters combined not as above..... 4

4. Dorsal tubercles of abdomen of large size, raised and slightly nodded, those on intermediate segments in profile distinctly longer than their basal breadth, the one on 9 only small, knob-like (fig. 92). Frontal plate as in previous species, but anterior border lacking dense fringe of long thick hairs, with row of short hyaline papillae. Distal border of labial palpus carrying 5 (left) or 4 (right) robust teeth; primary mental setae 4.4. Femora not banded, brown, growing darker toward apex. Abdomen yellow-brown, becoming darker posteriorly, pattern not very distinct, except on 6-8 a middorsal dark brown patch centred with a U-shaped light spot just in front of the darkish tubercles; no dark lateral dots. Body rather sparsely pubescent, less hairy than in previous species. ♂ Total length 22.5 mm, breadth across eyes 5.7 mm, abdomen broadest at nearly parallel-sided segm. 5-6. For further details, see LIEFTINCK (1971). ..... *miranda* (supposition)

–. Dorsal tubercles of abdomen shorter and lower, directed obliquely caudad (fig. 95-99). Femora yellow-brown, not definitely banded, either unicoloured or with broad apical obscuration..... 5

5. Smaller species, total length 20.5-21.5 mm. Abdominal markings well defined, contrastingly coloured: middorsum of 3-9 brown growing darker posteriorly, each with pair of minute light specks on a dark ground and a much larger, roundish, yellow spot on either side of the dark median band, side-portions lighter brown with indistinct oval light dot. Body and legs conspicuously hairy, especially at lateral carinae of abdominal segments, and with long apical tufts at posterior angles... 6

–. Slightly larger, total length 23.8-24.5 mm. Abdominal markings less distinct, mottled with brown, middorsum of 3-8 or 3-9 with yellow V-shaped twin-spot, the limbs of which terminate in a short triangular hook pointing obliquely backward, so as to form a winged marking. Body sparsely pubescent, lateral carinae of abdomen fringed with fine pale hairs, lacking conspicuous long apical tufts at posterior angles. Head larger and broader than in allied regional species, breadth across eyes 6.7-6.9 mm. Anterior border of frontal plate nearly straight, fringed with short, thick, pale hairs curving toward middle from either side. Primary mental setae 3.3, secondaries 6; palpal teeth robust, 4 (left) and 5 (right), the outermost pair deeply divided. Dorsal tubercles of abdomen very broad, moderately raised, but hardly visible in dorsal view (fig. 96, ♂). Paraprocts rather broad and convex dorsally, apices abruptly and finely pointed, those of ♀ distinctly shorter than in ♂ (♂ fig. 96, ♀ fig. 97)..... *spec. indet. B*

6. Head broadest across eyes: sides a little converging. Antenna, fig. 99. Dorsal tubercles of abdomen more prominent, those on 6-9 projecting a little beyond posterior border of tergites and well visible in dorsal aspect, largest on 7 (fig. 99). Cerci slender, slightly incurved, dorsal surface convex and covered with wart-like papillae; paraprocts acuminate (fig. 98). Distal border of labial palpi carrying 5 robust teeth, the innermost indentation of right palpus very small; primary mental setae 4.3, secondaries 5-6. Total length 20.5 mm, breadth across eyes 6.0 mm..... *spec. indet. D*

–. Head broadest across postocular lobes: sides nearly parallel. Dorsal tubercles of abdomen lower and slightly broader, not projecting beyond posterior border of tergites and hardly visible in dorsal view, largest on 7-8 (fig. 95). Cerci a little more expanded and morei ncurved, dorsal surface less convex and with fewer papillae; paraprocts bluntly pointed (fig. 95). Distal border of labial palpus carrying 3 large and 1 irregularly indented teeth (left), and 3 large and 1 more deeply split teeth (right); primary mental setae 3.3, secondaries 7. Total length 21.5 mm, breadth across postocular lobes 5.7 mm (across eyes 5.5 mm)..... *spec. indet. E*

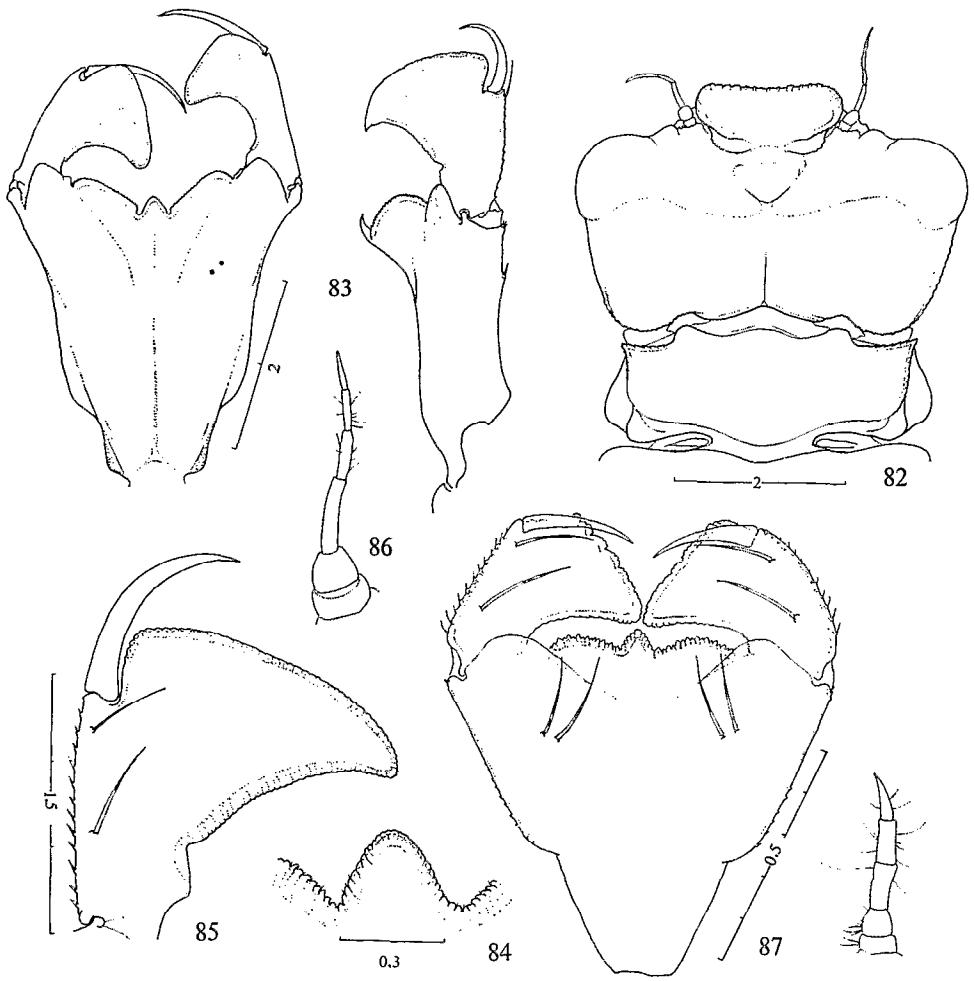


Fig. 82-87. — *Synthemis fenella* Campion, ult larval structures. Dorsal view of head and prothorax (82), external (ventral) and left lateral view of labium, the pair of spots indicating origin of two mental setae (83), apical portion of median lobe (ligula), more enlarged (84), internal view of left palpus (85), left antenna (86). — Fig. 87. *S. fenella* Campion, 4th instar larva, labium viewed from within and antenna of same.

Synthemis fenella Campion. *Fig. 82-87*

Synthemis fenella (supposition) : Lieftinck, 1971: 53-54, fig. 31 (proventriculus), 44-49 (? penult & younger larvae, struct.).

Material. — Österr. Neukaledonien Exp. 1965: many larvae (all stages), FNK 9, 15, 26, 63, and 97 (see Lieftinck, 1971); about 36 additional specimens, both sexes (mostly young stages), FNK 25, 43, 46/2, 59/2, 62/1, 63-64, 67/2, 77-78 (24 ex.), and 89 (NMW, ML). New Caledonia FAMU Exp. 1972: ca. 235 ex. (both sexes, 55 full-grown, the rest younger stages), N 13-21, 25-28, 34-35, 37, 42-43, 46-47, and 50-54 (CFT, ML).

The very aberrant gomphid-like larva of this little corduliid, so different in general appearance from its congeners, is the smallest species of the insular group. Details of its structure are shown in fig. 82-87.

Contrary to expectation, there is no evidence of more than one taxon being contained in the material on hand. All specimens are approximately equal in size, as indicated previously, and show no differences except in colour. A great many larvae were examined upon their wing venation but no variation pointing to specific differentiation could be found. Though in my former sketch of the antenna the annular first joint was omitted (now replaced by fig. 86), several full-grown examples have only 6- or (rarely) even 5-segmented antennae; however, in the great majority these organs are, as in all other species, normally 7-segmented, one being here figured for another species (fig. 99). They vary in colour from light to dark brown, the abdomen usually marked with a pair of continuous dark brown bands, one on each

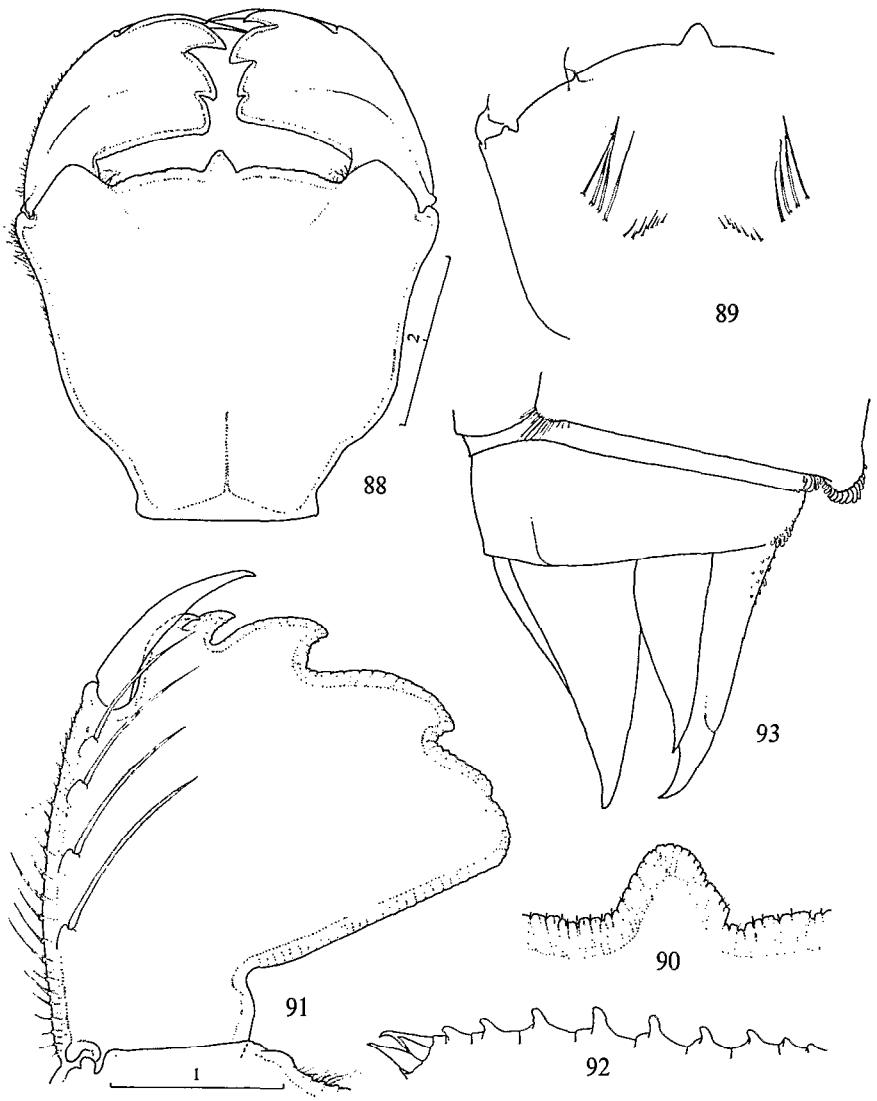


Fig. 88-93. — *Synthemis miranda* Selys, supposition, ult ♂ larva FNK 105/1. External (ventral) view of labium (88), partial internal (dorsal) view of mentum, showing setae (89), apical portion (ligula) of same, more enlarged (90), internal view of left palpus (91), right side view of abdomen, showing dorsal tubercles (92), and tip of abdomen with appendages, left side view (93).

side of a somewhat narrower median band of much lighter colour. Other specimens are lighter and unicoloured. Most larvae are smooth and quite clean, but some (from N 16) are covered all over with a greyish loamy encrustation, while in still others the cuticle is encrusted with a definitely reddish substance, suggesting iron-rust.

Judging by the great quantity of specimens, in all stages of development, accumulated by both expedition parties, *fenella* is evidently a very common and widely distributed dragonfly in New Caledonia. Whereas larvae were found plentifully in numerous localities, both sexes of the dragonfly itself were captured by Dr. and Mrs. PETERS only in one locality, at which place the insect abounded, probably flyingin swarms. It is evident, however, that the imago is a very inconspicuous and easily overlooked insect that may have arboreal habits.

Synthemis miranda Selys (supposition). *Fig. 88-93*

Synthemis miranda (supposition) : LIEFTINCK, 1971: 55 fig. 32 (proventriculus), 39-43 (ult ♂ larva, struct.).

Material. — Österr. Neukaledonien Exp. 1965: 1 ♂ (ult), FNK 105/1 (see LIEFTINCK, 1971). New Caledonia FAMU Exped. 1972: 1 ex. (3-ult), N 46 (ML).

This species was identified mainly on the basis of the wing venation, the only mature ♂ having less than 20 but more than 15 antenodals in the fore wing, and 12-13 in the hind wing, which precludes the other large-sized congeners, *S. campioni* and *montaguei*, although it could also be *flexicauda*, which is a much scarcer insect than *miranda*.

I have copied my earlier published illustrations of the labial structure (fig. 88-91), but the figure of the antenna was discarded because it does not show the overlooked short first segment, the species in point of fact having the usual number of 7 antennal segments. For a full description, see my former paper. If the two specimens are correctly referred to *miranda*, its larva should be easily recognized by the relatively long and erect dorsal tubercles on the abdomen (fig. 92), which in all other known species are markedly shorter.

Synthemis spec. indet. A

Synthemis spec., CAMPION, 1921: 63-64 (descr., New Caledonia, 1914, *sine loc.*).

No material. Differs from all regional species by its large size, the presence of postero-lateral abdominal spines, and the more numerous mental setae.

Synthemis spec. indet. B. *Fig. 96-97*

Material. — New Caledonia FAMU Exped. 1972: 1 ♀ ult, N 15 and 1 ♂ ult, N 22 (ML).

A rather large-sized larva with open neuration. Venational details: Fore wing with 22-23 Ax (first series) and 13 Px (♀ only); median space with 5 (♀) and 3 (♂), cubital space with 9 (♀) and 11 (♂) cross veins; triangles with 1 cross vein, internal triangle 3-celled, hypertriangle with 2 cross veins (♀); discoidal field with 1 ×3 cells followed by 7-9 ×2 antenodal cell rows; 1 row of cells Cu_1-Cu_2. Hind wing with 16-17 Ax; median space with 5, cubital space with 9 cross veins (♀); triangle with 1 (♀) and 2 (♂) cross veins; 14 (♀) and 9 (♂) cells in anal loop; field between Cu_1-Cu_2 commencing with 3 ×2 cells, followed by 6 ×1 cell.

Although the sexual differences in the venation of adult *Synthemis* are well-known and manifest also in the larvae of the present species, I am not entirely convinced that these two individuals are conspecific: some slight differences existing in the degree of hairiness and abundance of tubercular papillae which cover most parts of the body, the female being less hairy and more finely papillate dorsally than the male. Hence the identity of both must remain unknown.

Synthemis spec. indet. C. *Fig. 94*

Material. — New Caledonia FAMU Exped. 1972: 1 ♂ ult, 1 ex. (sex?) penult, N 21 (ML).

In addition to the key characters, the following venational peculiarities were observed on the right pair of wings: Fore wings with 21-22 Ax (first series) and 11 Px; median space with 5, cubital space with 8 cross veins; triangle and internal triangle each with 1 cross vein; discoidal field with 1 ×3 cells, followed by 8 ×1 antenodal cell row. Hind wing with 15 Ax and 13 Px; median space with 6, cubital space with 8 cross veins; triangle free; 17 cells in anal loop; 2 cell rows between Cu_1 and Cu_2.

Easily distinguished from other species by the downcurved paraprocts (fig. 94). Identity unknown, but possibly the larva of *S. flexicauda*. Although the nodal index corresponds with that of the adult, details in the venation do not agree with the unique type male of that species.

Synthemis spec. indet. D. *Fig. 98-99*

Material. — New Caledonia FAMU Exped. 1972: 1 ♀ ult, N 15 (ML).

Like the next, this species is somewhat smaller and more hairy than species B (see previous key). Some clearly discernible venational characters are: Fore wing with 26-27 Ax (first series) and 13 Px; median space with 5, cubital space with 10 cross veins; triangle with 1 cross vein, internal triangle 3-celled, hypertriangle with 3 cross veins; 1 row of cells Cu_1-Cu_2. Hind wing with 15 Ax and 17 Px; median space with 5, cubital space with 8 cross veins; 13 cells in anal loop; cells included between Cu_1-Cu_2 indistinct, but both veins more strongly curved than in the supposed *S. montaguei* (i.e. spec. indet. B).

Synthemis spec. indet. E. *Fig. 95*

Material. — New Caledonia FAMU Exped. 1972: 1 ♂ ult, 1 ex. (sex?) juv., N 42 (ML).

Details of the venation (both pairs of wings): Fore wing with 22-25 Ax (first series) and 15 Px; median space with 5, cubital space with 10-11 cross veins; triangle with 1 cross vein, internal triangle 3-celled; discoidal field commencing with several rows of 2 cells *(sic)*. Hind wing with 14-15 Ax; median space with 4, cubital space with 7-8 cross veins; 9 cells in anal loop; triangle with 1 cross vein *(sic)*.

Considering the high nodal indices of this and the previous species D, we shall have to await material of both stages collected during the act of transformation to decide upon their identity: they may either belong to *S. campioni*, *montaguei*, or to a species still undescribed.

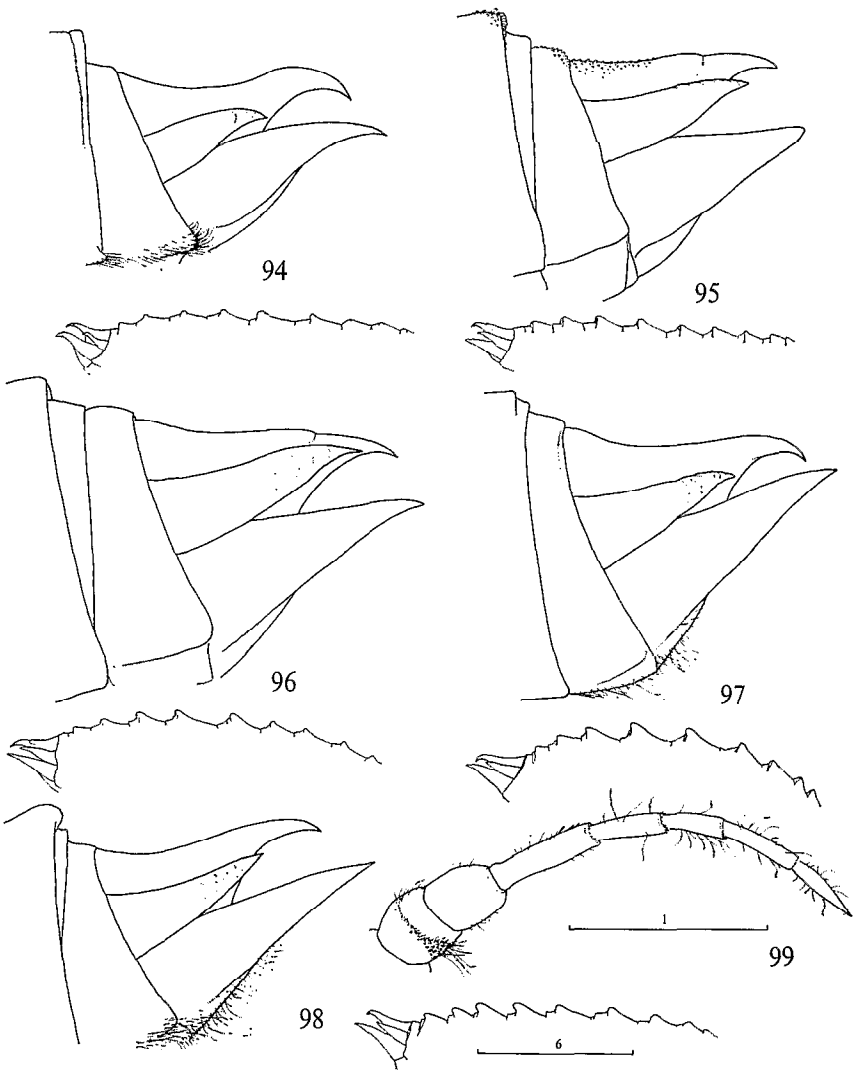


Fig. 94-99. — Four different species of the *Synthemis miranda* group, showing left side of tips of abdomen with appendages and dorsal tubercles on abdominal segements. ♂ N 21 spec. C (94), ♂ N 42 spec. E (95), ♂ N 22 spec. B (96), ♀ N 15 same spec. B (97), ♀ N 15 spec. D (98), right antenna of same ♀ spec. D (99). Corresponding figures on the same scale.

Field notes on the coexistence of Synthemis *larvae and adults*

It is generally understood that larval dwelling-places of a given species do not necessarily coincide with the habitations frequented by the adult dragonfly of the same kind. Soon after emergence most strong-flying Anisoptera leave their parental lake or stream to spend a long time away from water during the maturation and feeding period. It is not until after several days, at the beginning of the reproduction period, that individuals return to their breeding places to mate and oviposit. Thus mixed populations of congeneric species may often assemble and abound in places where the immature stages are nowhere to be found. Contrarily, one may look in vain for a single dragonfly flying over its favourite stream, in spite of the fact that mixed populations of larvae obviously belonging to congeneric yet different species can be obtained in plenty from the same stream. As to *Synthemis*, it seems that we are confronted with the same situation. Therefore, all I can do at present is to summarize the known facts concerning the habitations of the insular species, both larvae and adults.

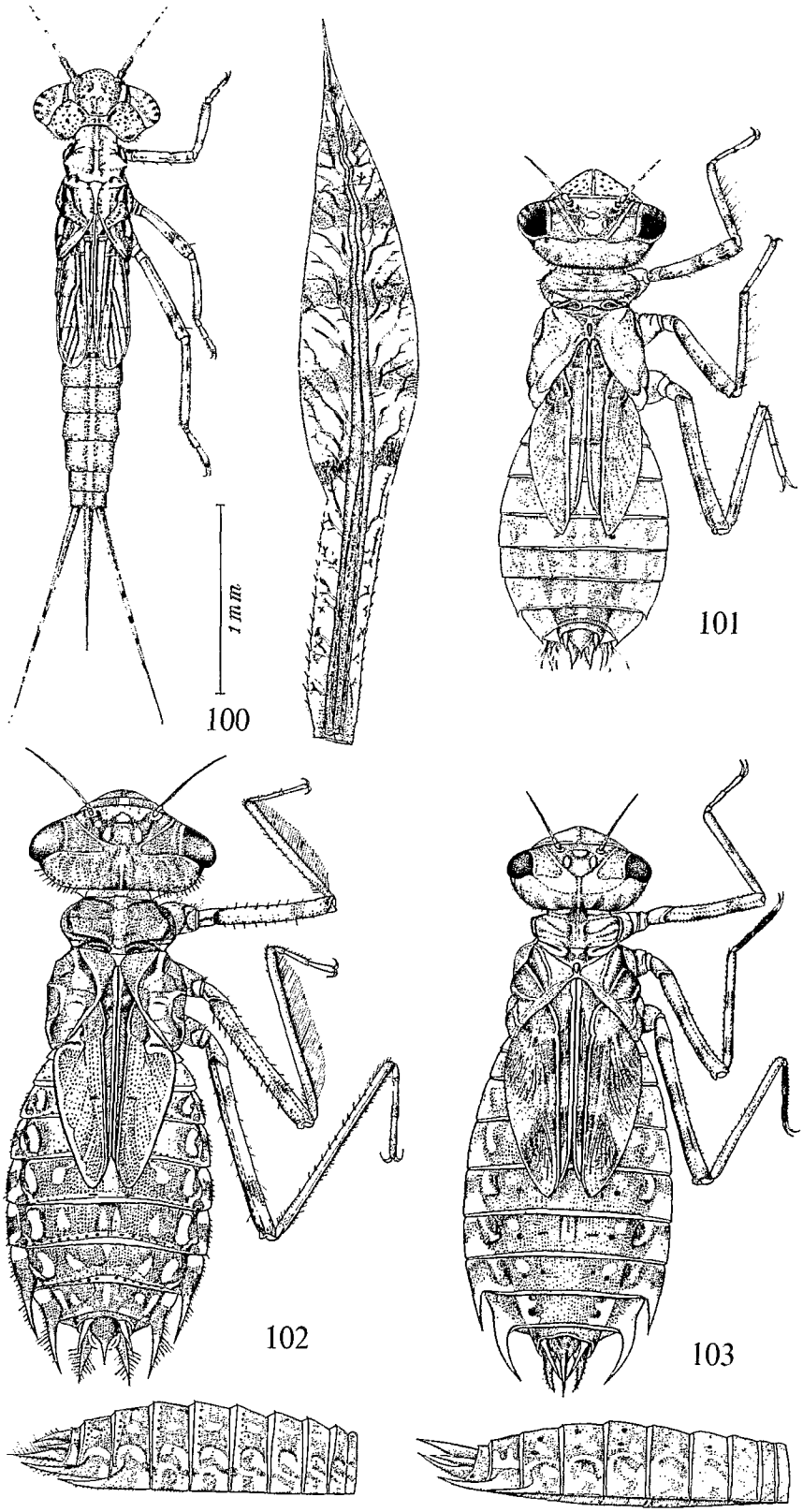


Fig. 100. — *Agriocnemis f. femina* (Brauer), ult instar larva, W. Java, live specimen, and median caudal lamella of same, more enlarged.
Fig. 101. — *Diplacodes bipunctata* (Brauer), ult instar larva, Central West New Guinea, length 11.5 mm.
Fig. 102. — *Tramea transmarina propinqua* Lieft., ult instar larva, North New Guinea, length 25.9 mm.
Fig. 103. — *Pantala flavescens* (F.), ult instar larva, North Sumatra, length 24.0 mm.

Larvae. — The expeditions' locality lists indicate that the little *S. fenella* may be found in any stream practically all over the island, from near sea level to about 460 m altitude in the hills. Specimens were taken from a tributary of the Karionan River near Paita (N 15, ca. 120 m) along with examples of spec. B and D. In a stream on the Eaux et Forêts road, NW of Col d'Amieu, 412 m, it kept company with spec. C (at N 21) and with the supposed *S. miranda* (at N 46) as well, apparently all being collected simultaneously in the same stream-bed. Lastly, *fenella* was dredged up from a stream on Mt. Gaata along with a fifth species (spec. E), near Station Castex, at 76 m, a place which at the same time yielded a good series of imagines of the former.

Imagines. — Remarkably enough, apart from the common *S. fenella*, nearly all individuals of the five other described species came from places where no larvae were collected. Examples of these have now become known from the following localities (arranged alphabetically):

S. ariadne — Yiambe

S. campioni — La Crouen; Mt. Mou; Pouébo, 200-250 m

S. flexicauda — Mt. Nekando

S. miranda — Bourai-Houailou Rd.; Canala; Col de Pirogue; Col de Roussettes; Dogny; Forêt de Thi(r); La Crouen; La Foa; Mokoué-Dothio; Mt. Koghi(s), 300-600 m; Mt. Mou; Mt. des Sources; Nakety, 400 m; Nouméa; Pouébo and environs, ca. 400 m.

S. montaguei — Col d'Amieu; Mt. Mou; Pouébo, 200-250 m; St. Louis Valley.

It will be seen from the above that in two localities (Mt. Mou and the environs of Pouébo) *S. campioni*, *miranda* and *montaguei* occurred together, while at La Crouen *campioni* kept company with *miranda* only.

Though fragmentary, these records may prove useful to students who wish to match the two stages in the development of these conspicuous insects.

FAM. LIBELLULIDAE

Orthetrum caledonicum (Brauer)

Material. — Österr. Neukaledonien Exp. 1965: 1 ex. ult, FNK 46/1; 1 ex., young specimen, FNK 36; 1 ex. ult, 5 younger stages, FNK 113 (NMW). New Caledonia: 1 ex. ult, Grand Lac, 3.1.1967, no. 23, W. L. PETERS; FAMU Exp. 1972: 2 ex. juv, N 41 (ML). New Caledonia: 2 ex., penult, Nouméa, Anse Vata, 21.11.1951, ponded ditch, no. P5, Marshall LAIRD (ML).

This species in general appearance is much like other members of the genus, such as *O. villosovittatum* (Brauer). A hairy larva, lacking dorsal abdominal hooks but with small, finely pointed lateral spines at segments 8 and 9. Easily known by the subrectangular shape of the head, small eyes and long, acuminate anal appendages. For a good picture of the whole insect, see WATSON (1962: 44, pl. 12 fig. 66).

Diplacodes haematodes (Burm.)

Material. — Österr. Neukaledonien Exp. 1965: 11 ex. ult, FNK 34/1 (1 ex.), 44/1 (1 ex.), 46/1 (3 ex.), 47/2 (1 ex.), 48 (2 ex.), 49 (2 ex.), and 113 (1 ex.) with several young individuals (NMW). New Caledonia FAMU Exp. 1972: 7 ex. ult, N 14, 5 ex. young specimens, N 38, 4 ex. ult and some younger stages, N 41, 2 ex. ult and 4 younger ex., N 45 (CFT and ML).

The small body size, short legs and banded femora of *Diplacodes* will serve to distinguish its members fom other regional libellulid larvae. The labium of *D. haematodes* has been figured by WATSON (1962: 46, pl. 13 fig. 73). Our specimens differ but little from those of *D. bipunctata* (Brauer), of which a picture is here included (fig. 101). The abdomen is usually less extended than in the spirit specimen shown, the wings reaching back to a little beyond the hind margin of the 7th segment.

Tramea transmarina intersecta Lieft. (supposition).

Tramea transmarina intersecta Lieftinck, 1975: 162-164, fig. 58-59 (♂ ♀ New Caledonia; ♀ New Hebrides).

Material. — Österr. Neukaledonien Exp. 1965: 1 exuviae, FNK 62, Nekliai, 150 m, 10.8.1965, « unter Niaouli Rinde » *(sic)* (NMW). New Caledonia: 2 ex. ult, 1 very young, Grand Lac, 4.1.1967, N 23, W. L. PETERS (ML). — N.B.: Three imagines recorded from the island in my previous article (*loc. cit.*: 162) were accidentally placed in the paragraph "larvae".

The two full-grown larvae are indistinguishable from specimens in our collection of the subspecies *propinqua* Lieft., from New Guinea and elsewhere in the Papuan region. One of the latter is here figured (fig. 102) to show the beautiful colour design of these conspicuous insects. *Tramea* larvae live freely among the aquatic shore vegetation of lakes, ponds and marshes. They are easily distinguished from those of *Pantala flavescens* (F.) (fig. 103), among other characters by the larger head, differently shaped abdomen, and the closely set long and fine hairs fringing the outer ridges of the fore and mid tibiae. *Pantala*, also, can be recognized by its black tarsi, which are pale-coloured in *Tramea*.

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Errata

In Part 1. Imagines, of this publication (*Cah. O.R.S.T.O.M., sér. Hydrobiol.*, vol. IX, n° 3, 1975 : 127-166), the following corrections should be made :

— Page 136, second column, the last line of the last sentence (continued on p. 137) should read : — « moreover, the shape of the ligula of male *Caledopteryx* is entirely different from that of *P. selysi* Foerster (fig. 1), figured also by KENNEDY (1920) for *P. roseonotata* (Selys), the form of this organ resembling that of the remaining New Caledonian species... », etc.

— Page 162, second column, part of the caption « *Material* (imagines) » of *Tramea transmarina intersecta* has been unintentionally listed under the heading « *Material* (larvae) », only the exuviae belonging here.