

## COMMENTS ON THE SPECIES CONCEPT IN SOME AUSTRALIAN *ANISOPS* SPINOLA (HEMIPTERA: NOTONECTIDAE)

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### Introduction

Twenty-five species of *Anisops* are recorded from Australia and Tasmania, 16 are endemic. A few species are taxonomically confusing as they occur in more than one form. *Anisops* is compared with *Buenoa* Kirkaldy which replaces *Anisops* in the New World.

The species concept is discussed, especially of those with an extra-Australian distribution which tend to be superficially distinct at the periphery of their range.

Figures and short descriptions are given of little known species from New Guinea which may eventually be found in Australia. Finally a new species is described from Lihir, Bismarek Archipelago.

### Species Concept

#### *Alpha taxonomy*

To understand the problems posed by various species of *Anisops*, it is necessary to consider the species concept in the genus. With few exceptions, only the males can be named with reasonable certainty.

Attempts by Sweeney (1965) and Lansbury (1969) to devise reasonably easy keys to the Australian *Anisops* have not been completely successful. The occasional failure of my 1969 key is caused by trying to key out forms of species which were not available to me when the key was prepared. The key couplet referring to the comparative width of the head to the pronotum has proved unreliable when dealing with species which vary in the degree of development of the flight musculature.

There are over one hundred described and seemingly valid species of *Anisops*, some of them with a widespread distribution. The characters used to divide up the genus into manageable proportions vary greatly in their reliability. Structural peculiarities of the head and rarely the pronotum easily distinguish a small number from most of the genus. Aus-

tralian species with reliable 'spot' characters are *stali* Kirkaldy; *calcaratus* Hale; *nasuta* Fieber; *semita* Brooks; and *tahitiensis* Lundblad. Of the remainder, *thienemauui* Lundblad; *nodulata* and *canaliculata* Brooks are easily recognized by abnormally shaped rostral prongs.

The characters used by Brooks (1951) to separate species fall into two categories (1) morphometrics of the head capsule and the pronotum; (2) presence of grooves, ridges or prolongations of the head capsule especially the facial tubercle. Secondary sexual characters with combinations of the primary features are reworked to enable species to be keyed out. The measurements of the head and pronotum are not easy to make as the structures are nearly all convex. The chaetotaxy of the male front leg, number of pegs in the stridulatory row and distribution of spines and setae on the front tibia and tarsus are used. The rostral prongs which are projections borne either side of the third rostral segment are also important.

#### *Wing polymorphism*

The terminology used to indicate if an *Anisops* can fly or not is rather confusing. No problem arises over the term macropterous, but brachypterous can be misleading. All Australian *Anisops* have fully developed fore wings and hind or metathoracic wings. Despite the presence of wings, most species produce forms with the wing musculature undeveloped, in its place parenchymatous tissue. Young (1962) uses the term 'normal' for individuals capable of flight and 'flightless' for those which although possessing full sized wings, have not developed flight muscle.

The term 'brachyclytrous' has been suggested, although possibly quite suitable, some confusion may arise as this term is also applied to the Staphylinidae and Dermaptera with their characteristic short elytra, a condition not oc-

curing in *Anisops*. To avoid confusion, the terminology of Young (1962) is followed in these notes.

The normal forms with fully developed flight musculature are easily recognized by the pigmented scutellum, the clavus and corium also coloured, most commonly black, brown, red or yellow, usually a subtle combination of two or three colours. The metanotum is black or dark brown. Flightless forms (always with fully developed metathoracic wings in Australian species) have hyaline scutellums, the dorsal pigmentation showing through, likewise the clavus and corium. The metanotum is not pigmented, but occasionally dark brown at the wing bases. The following descriptions are taken from Young (1962) and refer to *assimilis* and *wakefieldi* White, both endemic to New Zealand. The macropterous form of both sexes have the lateral margins of the pronotum divergent. The males of the brachypterous forms have more-or-less parallel sided pronotums and females with slightly divergent pronotums. A check of Brooks (1951) and Lansbury (1964) shows that they often described two colour forms of a species but did not comment on the shape of the pronotum. A further complication has been found in a number of species which are isolated from the rest because the head is as wide or wider than the pronotal humeral width, these are: *evansi* Brooks (Tasmania) *robusta* Hutchinson (E. Africa) *leucothea* Esaki (Samoa and elsewhere) *doris* Kirkaldy (Australia) *tasmaniaensis* Brooks (Tasmania) *philippinensis* Brooks (Philippines and elsewhere) and *assimilis*. Young's (1962) description of *assimilis* differs from Brooks, the head irrespective of the form is always narrower than the pronotal humeral width. It seems to be a general rule in *Anisops* that the lateral margins of the pronotum of flightless males are more-or-less parallel sided, therefore the taxonomic value of the head-pronotal width is of limited use in those species which have more voluminous eyes. Series of *evansi* from Tasmania and the mainland show both forms to be present, where females can safely be associated with males, the head is always narrower than the humeral width.

In *B. limnocastris* Hungerford and other species, both sexes of the flightless forms have the head as wide or wider than the pronotal humeral width, normal forms of both sexes have the head narrower than the humeral width. Truxal (1953) describing the wing polymorphic forms of *limnocastris* found that the scutellum of the normal form was longer than the median length of the pronotum, that of the flightless form clearly shorter. These differences have not been found so far in *Anisops*.

### Colour

It is not known how much the colour of *Anisops* species can vary. Young (1962) found a direct correlation between colour and flight musculature. There is some evidence that in some circumstances *Anisops* exhibit a phenomenon rather better known in the Corixidae (see *deanei*). Specimens from turbid water with a peaty or dark substrate frequently have a much larger area of the hemelytra with dark brown transverse markings, the pronotum is often more heavily pigmented. The same species of corixid from a sandy or gravel substrate are much paler. The significance of colour in *Anisops* where it impinges on food gathering and its role in enabling *Anisops* to merge with the background are poorly documented. The differences noted by Young (1962) refer almost exclusively to the colour of the scutellum. The pale flightless *Anisops* with little dorsal pigmentation may be difficult for a predator to locate visually, the normal form with a pigmented scutellum and intensified colouring of the hemelytra may be easier for a predator to see. Both forms would be equally at risk viewed from any position sub-surface when ascending to the surface to renew their gas supply or at risk from predators which use other senses than sight to locate their prey. Bayly, Ebsworth and Wan (1975) present data from which it can be inferred that within closed systems such as exist on Fraser Island, Qld., that fish and water-bugs are mutually exclusive. They postulate that either the fish eliminate the bugs by feeding on them, or the fish out-compete the bugs for the available food supply. Young's (1962) data on *assimilis* shows that both forms were found in almost equal numbers. The num-



ber of habitats where only the normal form were found was almost the same as the flightless form. The total number of habitats with both forms present being just over double the number of those where only one form was present. *Anisops wakefieldi* differed, the normal form was ten times more common than the flightless and four times as many habitats were populated by the normal form compared with the flightless form. Both species were found together in 'swarms', *assimilis* having a greater tolerance of habitat types. In the more stable weedy habitats with little open water *wakefieldi* was the dominant species.

### Genitalia

The genitalia of *Anisops* are of very limited value at the species level. Brooks (1951) figured the left and right parameres but made no reference to them. Young (1962) did not figure or comment on the New Zealand species. Truxal (1953) figured the parameres of seven *Buenoa* species which closely resemble *Anisops* in general plan. The female genitalia of *Anisops* are of less taxonomic value than the male, the same seems to apply to *Buenoa* although *hungerfordi* Truxal differs from the others in the shape and distribution of large setae on the first gonapophysis, *hungerfordi* oviposits in rock crevices rather than plant tissue as do most other species of *Buenoa* and, as far as is known, all *Anisops*. The figures of the male genitalia (Figs. 43-58) are slightly misleading as they tend to show differences which do not exist, this is because some difficulty was experienced in placing the parameres on identical planes on the slides leading to some distortion. The apex of the left paramere is rather variable, the tip sometimes being curved inwardly, thus when viewed from the side, the tip is not visible. The right paramere is a simple flat plate.

### Isolating mechanisms

As it seems that the genitalia and the distinctions contrived by the taxonomists using the morphometrics of the head and pronotum are of limited value, the problem arises of what in certain circumstances constitutes a species in *Anisops*. Since *Buenoa* are so very much

alike *Anisops*, one of the main differences being that the male *Buenoa* has two segmented front tarsi, whereas *Anisops* males have one-segmented tarsus. It is felt that the behaviour of *Buenoa* and *Anisops* are probably rather similar. In laboratory experiments it has been found that *B. limnocastris* males will pair with *macrotibialis* Hungerford females, the F<sub>1</sub> generation are sterile, males morphologically intermediate, their acoustical behaviour similar to that of their male parents. Stimson Wilcox (n.d.) (1975). Truxal (1953) descriptions of the stridulatory apparatus of *Buenoa* species, especially the number of stridulatory pegs shows that within a species, the variation found is less than in *Anisops*. Young (1962) found that in *assimilis* males, the shape and number of stridulatory pegs was fairly constant; the size and arrangement in *wakefieldi* could be variable (28 and 15 pegs respectively). The short peg row of *wakefieldi*, rostral prong and expanded facial tubercle would produce a different sound than the longer peg row of *assimilis* drawn across a larger rostral prong. The expanded facial tubercle of *wakefieldi* would greatly hinder their attempts to pair with *assimilis* females. Presumably in New Zealand where *Anisops* has been geographically isolated for a long period and the number of species small, stable populations would develop. Sound production in *Buenoa* is assisted by the body which in whole or part acts as a frequency generator. Experimental work with *Buenoa* shows that acoustical behaviour is important in reproductive isolation amongst coexistent species, Stimson Wilcox (n.d.), (1975). No information is available on *Anisops*. Acoustical behaviour as an isolating mechanism in mixed populations is well known in other groups. Ragge (1965) describing British Acrididae (*Orthoptera*) likely to be found in the same general habitat states that *Chorthippus brunneus* (Thunberg) has 50-90 stridulatory pegs on each hind femora; *C. parallelus* (Zetterstedt) 70-130 and *Myrmeleotettix maculatus* (Thunberg) 130-180 pegs etc. Ragge's diagrams of the songs of these and other species shows that irrespective of the number of pegs, the songs of the males of each species remain consistent in volume

and duration. It is reasonable to assume from this that *Anisops* males only utilize sufficient pegs to produce a consistent species signal. This factor also tends to reduce the taxonomic value of minor variations in the number, size and arrangement of the stridulatory comb. This variation seems to be a feature of a number of nondescript species with an extensive geographical distribution.

Assuming that part of any population of an *Anisops* species living in ponds, dams and ephemeral pools contains a percentage of individuals with fully developed musculature, it is essential that should conditions deteriorate sufficiently to induce flight, the migrant population should produce and recognize acoustic signals from the same species in the habitat emigrated to, otherwise discrete populations would form in the same habitat. Exceptional habitats such as Lake Tengano, Rennell Island only seem to produce flightless forms see '*capitata*'.

*Anisops elstoni, deanei* and *philippinensis*  
Brooks

Under *elstoni* material from various localities in different countries is compared. With one or two exceptions nothing is known about the type of habitat, population density, species diversity or basic chemical and physical properties of the habitats where *elstoni* was collected. The genetic aspects remain totally unknown. As more material becomes available it has become increasingly difficult to confine the species to its original concept which, lacking secondary sexual characters, reproductive organs indistinguishable from other species and where the morphometrics are complicated by structural changes caused by wing polymorphism. The discontinuous distribution of *elstoni* and other species suggest that the species concept is not fully understood or the term 'super species' might be appropriate.

In Tasmania which has five species of *Anisops*, unpublished data shows that where two or more species are found in the same habitat, one at least is easily recognized by its larger size and/or secondary sexual characters leaving the remaining species to be easily recognized by their lack of secondary features. Con-

ditions in Tasmania tend to be rather different from those on the mainland with its greater diversity of species. The carrying capacity of habitats, especially species diversity rather than the total population of water-bugs etc. is not too well known. In Tasmania, out of 175 samples, only one habitat had eight species of water-bug present (Blackmans Lagoon). Three habitats with six species and six with five. The great majority of samples composed of two-three species. These figures may reflect vagaries of sampling rather than an accurate reflection of these habitats. There are 24 species of water-bugs in Tasmania, 28 if the Saldidae, Ochteridae and Gelastocoridae are included.

Fraser Is., Qld. has been studied in some detail (Bayly *et al.*, 1975). Four species is the maximum recorded from Boomerang South Lake, 13 lakes sampled. Bensink and Burton (1975) on the littoral fauna of Blue and Brown Lakes on Stradbroke Is., Qld. found five and nine species respectively. Brown Lake being sampled more often than Blue Lake. Some of the *Anisops* listed in Bayly *et al.* (1975) and Bensink and Burton (1975) are discussed in the taxonomic section of these notes.

The problem arises of deciding whether the material from Tasmania is conspecific with those from mainland localities in Australia and further north in New Guinea etc.

The data can be interpreted in one of two ways, *elstoni* may be a complex of races which because of geographical isolation are in the process of evolving into distinct species or it may be a widespread 'plastic' species which has spread from south east Asia into Australasia, each population still linked by common genetic factors.

*Anisops deanei* is confined to Australia and a closely allied form or species is rather common in Tasmania, much more so than *elstoni*. Non-Tasmanian *deanei* varies rather more than *elstoni*. In Tasmania they are both sometimes found in the same habitat, but do not seem to be so on the mainland.

Where two or more species occur in the same habitat, acoustic behaviour, phased life



cycles and a subtle niche preference not so far revealed by sampling seem to enable *Anisops* species to coexist and avoid competition for the available food supply.

#### *Habitat and distribution*

Lack of data makes it difficult to be precise about the habitat preferences of Australian *Anisops* species. Sweeney (1965) describes *elstoni* as rare and confined to the south east, the most westerly record being Narrandera, N.S.W. Most Australian *Anisops* are found along the eastern coastal zone, a few are confined to the more arid interior. Some species typified by *thienemanni*, *stali* and *hyperion Kirkaldy* are found across the continent. The coastal zone from Brisbane northwards has a number of species with prominent secondary sexual characters and not related to the New Guinea fauna. Species of the more temperate areas are less well endowed with such features. *Anisops philippinensis* appears to be a relative newcomer to the Queensland fauna rather like *tahitiensis* Sweeney (1965).

#### *Taxonomy*

##### **Anisops elstoni** Brooks, 1951

Figures 1-15, 43-50 and 59-61

This species was described from Myponga, South Australia; The Dorrigo, 3,000', New South Wales; Brisbane, Queensland and Szechuan, Suifu, China. Brooks compared *elstoni* with *exigera* Horvath (New Guinea). His figures of the male front leg are misleading as he omits to include the large spine on the inner proximal margin of the front tarsus (Figs. 1, 4, 7, 10 and 13) and he overlooked it in his description. Fortunately, he mentioned it in the key to species. He does mention the pronotal depression which is helpful in isolating *elstoni* from related species (Figs. 3, 6, 9, 11 and 14). The material studied has been found to vary from various localities in Tasmania, Australia, New Guinea, Vietnam and possibly Rennell Island.

A male from Charters Towers Qld., Coll. Sedlacek (Bishop Museum) has a bright red scutellum. Eyes orange-brown and pronotum straw yellow. The hemelytra are hyaline except for the inner claval margin adjacent to the



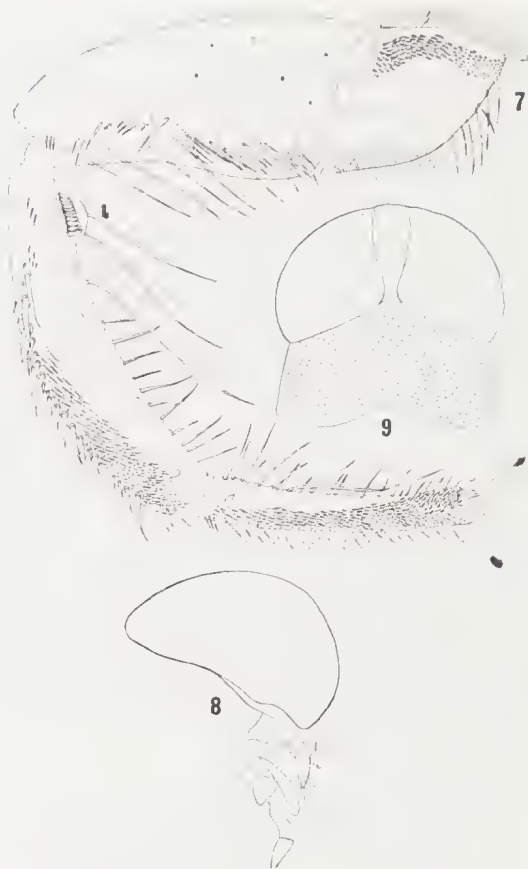
Figures 1-3—*Anisops elstoni* Brooks ♂, Myponga, S.A.: 1, front leg. 2, head from side. 3, head and pronotum from above.

scutellum which is carmine. Metanotum dark reddish brown, tergites black, posteriorly margined with yellow. Sternites other than keel black.

A small series mostly females from Caddies Creek, N.S.W. vary between the colour of the Charters Towers male through to the pale yellowish form. The hemelytra are hyaline, metanotum pale yellow. Pronotal shape the same regardless of colouration. A series from Valley Heights near Katoomba are a uniform greyish black. The lack of pigment may be because they were kept in alcohol for an unknown period. The eyes appear to be rather more elongate than usual and give the impression of being wider than the humeral width, they are consistently narrower, a ratio of 41:43. A similar phenomenon is found in the Fraser Island population from Lake 'AB' (Fig. 9). The rostral prong of the Fraser Is-



Figures 4-6—*A. elstoni* ♂, upper reaches of Sorrel River, Tasmania: 4, front leg. 5, head from side. 6, head and pronotum from above.



Figures 7-9—*A. elstoni* ♂, Fraser Island, Qd.: 7, front leg. 8, head from side. 9, head and pronotum from above.

land males is much more sharply separated from the third rostral segment as it is differentially coloured (Fig. 8). A male from North Stradbroke Island, Qld. Brown Lake, 7.iv.1974, Macfarlane and Sweeney (Site 9c) closely resembles the highly coloured form from Charters Towers (Figs. 10-12) and is clearly the macropterous form. The male from Vietnam does not differ much from the Australian form (Figs. 13-15). It is now certain that *A. depressa* Lansbury (1962) described from Dutch New Guinea is a synonym of *elstoni*. The differences outlined in Lansbury (1964) are not sufficient to justify the separation of *depressa* from *elstoni*. The presence of *elstoni* in New Guinea is a useful link between Vietnam, China and Australia.

The male genitalia (Figs. 43-50) show minor variations in the shape of the parameres. The first gonapophysis of the females (Figs. 59-61) are all remarkably similar. One feature of *elstoni* is the increase in size of the front tarsal spine from north to south, the Vietnam male having the least conspicuous (Fig. 13). The Myponga (Fig. 1) and Tasmanian, Sorrel River (Fig. 4) the largest. *Anisops elstoni* is rare in Tasmania, besides the Sorrel River, material has been studied from a creek 6 miles from Interlaken on the Bothwell Road; Blackmans Lagoon; Flinders Island. All the material pale yellowish brown and preserved in alcohol.

***Anisops 'capitata'* Lansbury, 1968**  
(Figures 16-18)

This species has very close affinities with



Figures 10-12—*A. elstoni* ♂, N. Stradbroke Island, Qd.: 10, front leg. 11, head and pronotum from above. 12, head from side.



Figures 13-15—*A. elstoni* ♂, Vietnam, 19 km N.W. of Dalat, 1300 m., May, 1960: 13, front leg. 14, head and pronotum from above. 15, head from side.

*elstoni*, especially the form from Fraser Island. In Brooks (1951) key it keys out with *rigoensis* and *biroi* Brooks, but does not seem to be related to them. In Lansbury (1969) it keys out with *evansi* and *doris* because the head is wider than the pronotal humeral width. Like *elstoni*, the pronotal disk is depressed. The specimens collected by E. S. Brown from Lake Tengano are rather more yellowish than those obtained by Torben Wolff from the same general habitat which are relatively paler, the hemelytra are hyaline, the costal margin near the pronotum being infuscated smokey brown. The colour approaches that of the *deanei* population from North Stradbroke Island.

Although treated as a distinct species, it is very probable that *capitata* is a brachypterous form of *elstoni*. Andersen (1975) relegated

*Limnogonus rennellensis* Brown (Gerridae) to a subspecies of *L. fossarum* F. a widespread Indo-Australian and Pacific species, *capitata* is almost certainly at least in the same category.

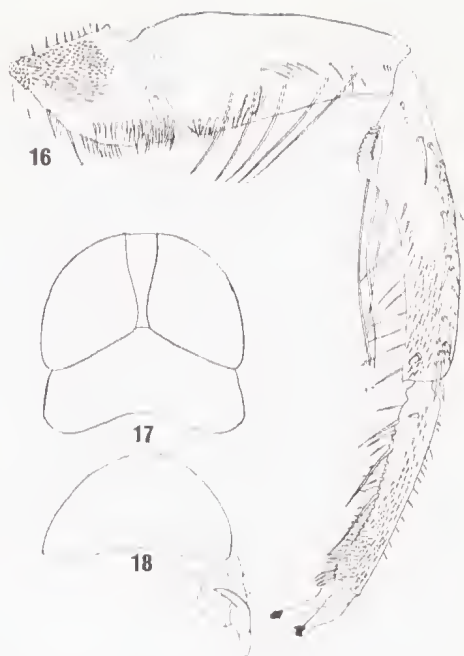
#### **Anisops philippinensis** Brooks, 1951

Figures 19-29, 53 and 54

Described from a series of 90 specimens from the Philippine Islands, Mindanao, Lake Linao, North Slope, Mt Apo Davao Province, 7800'. H. Hoogstraal and F. G. Werner. Most of type series in Field Museum, Chicago.

Brooks compared *philippinensis* with *tahitiensis*, the latter is easily recognized by the carinate frons. Brooks commented that the scutellum was either testaceous or black with anterior margin testaceous. Because of the varia-





Figures 16-18—*A. 'capitata'* Lansbury ♂, Rennell Island: 16, front leg. 17, head and pronotum from above. 18, head from side.

tion in the morphometries of the head and pronotum, Brooks found it necessary to key *philippinensis* out in three separate couplets. Like *elstoni*, *philippinensis* is a nondescript species with no obvious secondary sexual characters to distinguish it from other similar size species. The Australian material referred to this species constitutes a new record for Australia.

Figures 19-21 are based on a study of two male paratypes and differ in several details from Brooks' figures, especially the chaetotaxy of the front tarsus and shape of the rostral prong. Comparing these figures with those of a single male (Figs. 25-29) from Fraser Island, Boomerang South Lake (No. 5) I. A. E. Bayly (Bayly *et al.*, 1975) shows a remarkable similarity between the two forms. The Fraser Island male differs by having the head about 9x wider than the anterior width of the vertex and fractionally wider than the pronotal humeral width. The pronotum is pale yellow,

hemelytra hyaline. There seems no doubt that this male is a flightless form of *philippinensis*. The minor variations in the chaetotaxy of the front leg are not considered significant, especially as the paratype(s) do not agree with the figure by Brooks.

A pair from N.E. New Guinea, Wau, Morobe District, 1100 m., 9.ix.1961, J. Sedlacek (Bishop Museum) (Figs. 22-24) are rather more like the form from the Philippines although the chaetotaxy of the front tarsus is dissimilar. The head is 7.5x anterior width of the vertex, Brooks gives the head width as 10x anterior width of vertex.

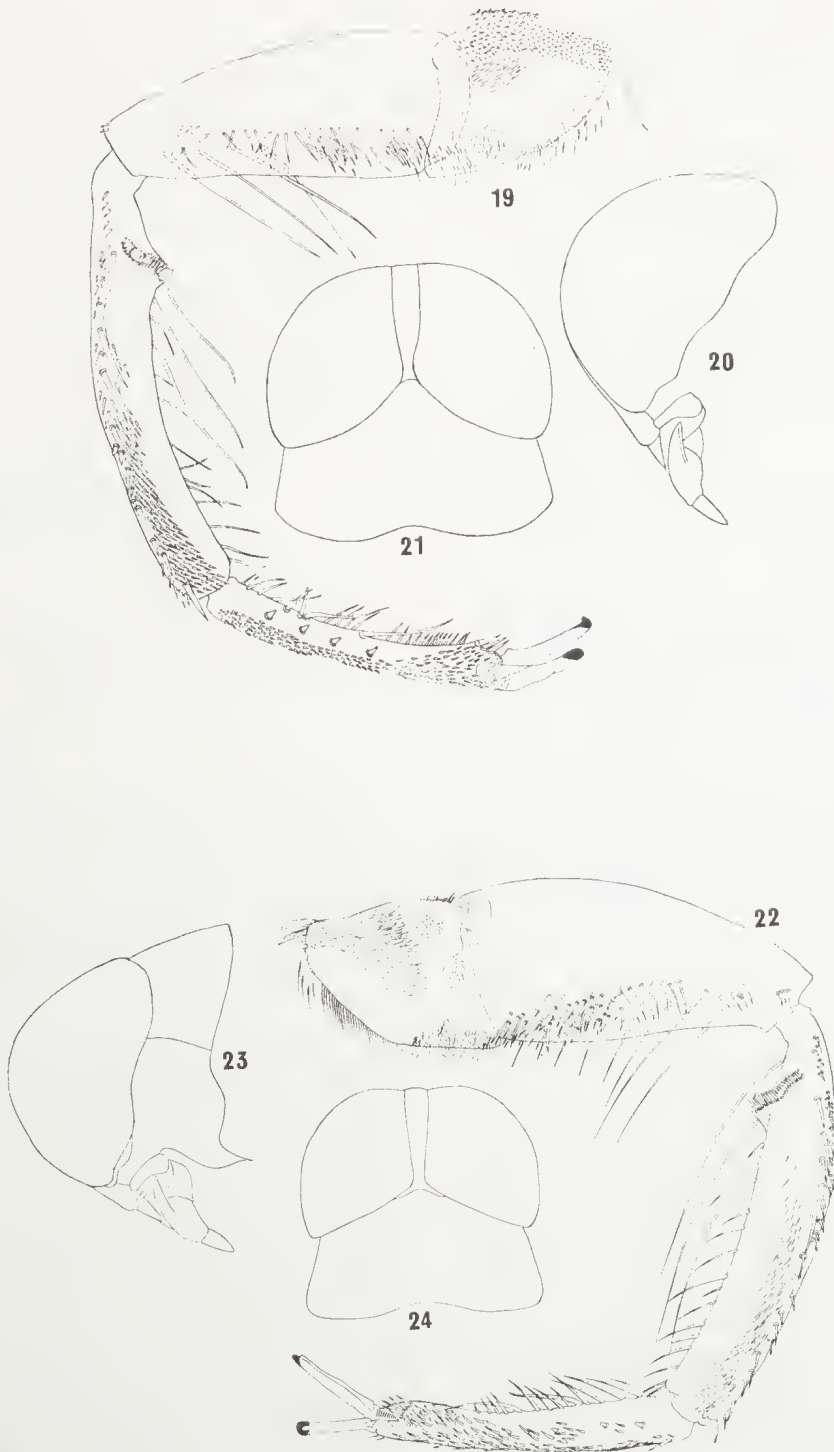
#### *Anisops deanei* Brooks, 1951 Figures 30-32

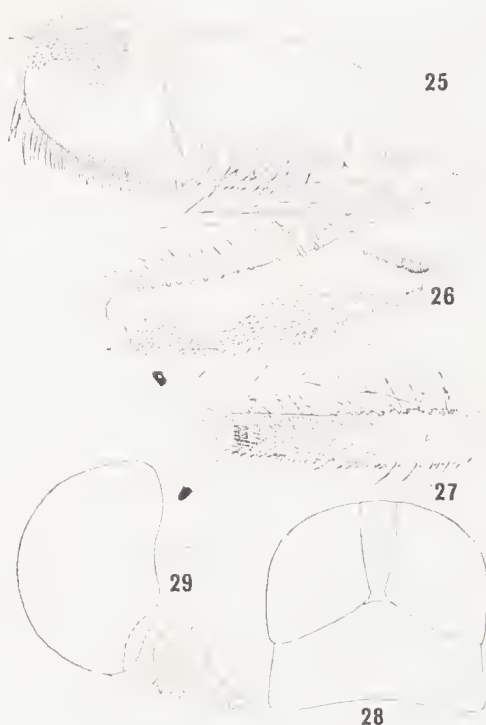
A small series from North Stradbroke Island, Brown Lake, September, 1972, G. Monteith are quite unlike the usual form of *deanei* (Lansbury, 1964). The eyes are dark brown-black. The head between the eyes, facial tubercle and labrum black. Pronotum and scutellum almost hyaline, pale yellow of thorax showing through. Pronotal fovea dark brown and tomentose. Hemelytra hyaline, infuscated along the costal margin. Abdomen black, legs dark brown—black and shining. Because of its unusual appearance this population puzzled me. The eyes are large and the head is as wide or wider than the pronotum and 11x the anterior width of the vertex; *deanei* normally always has the head narrower than the pronotum and the head width 6-7x anterior width of the vertex. The synthlipsis is wide, half the anterior width of vertex. Lateral margins of pronotum almost parallel and slightly concave in some specimens (Fig. 31). The rostral prong is rather more sinuate than usual and the base of the third segment is not much wider than the apex of the fourth (Fig. 32). The chaetotaxy of the male front leg (Fig. 30) is similar to

Figures 19-21—*A. philippinensis* Brooks ♂ paratype.: 19, front leg. 20, head from side. 21, head and pronotum from above.

Figures 22-24—*A. philippinensis* ♂ New Guinea: 22, front leg. 23, head from side. 24, head and pronotum from above.

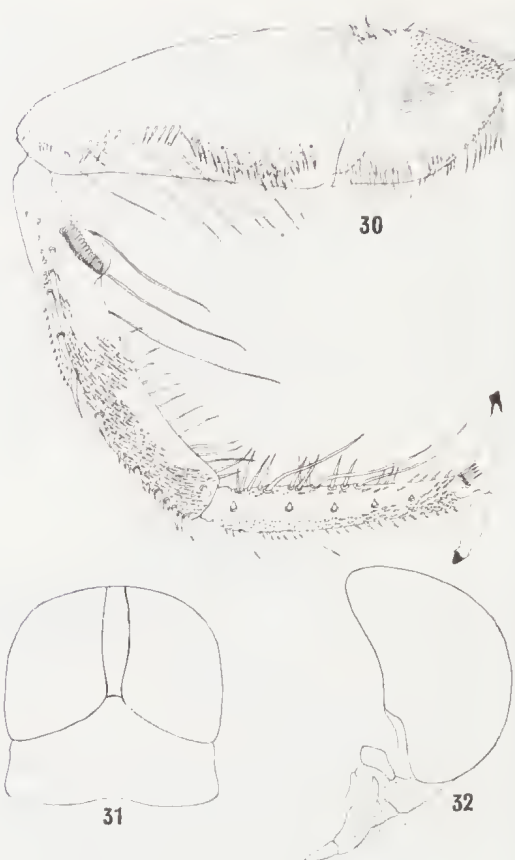






Figures 25-29—*A. philippinensis* ♂, Fraser Island, Qd., Boomerang South: 25, front femur. 26, tibia. 27, tarsus. 28, head and pronotum from above. 29, head from side.

typical *deanei*. In Brooks (1951) this form keys out to couplet 53 (*philippinensis* and *windi* Brooks) the latter is distinguished by having the synthlipsis almost the same width as the anterior width of the vertex. In Lansbury (1969) it keys out as either *deanei* or *nabilla* Lansbury. The rostral prong of *nabilla* is smaller, rather slender, apically acuminate and the front femur is broader distally than in *deanei*. Bensink and Burton (1975) refer to a species 'near *philippinensis*' Det. Lansbury from Blue and Brown Lakes on North Stradbroke Island. This is the brachypterous form of *deanei* and forms an interesting parallel with those described by Young (1962) for New Zealand species. Bensink and Burton (1975) found as on Fraser Island (Bayly *et al.*, 1975) that no fish were present in the lake with the more diverse water-bug fauna (nine species) Brown Lake;



Figures 30-32—*A. deanei* Brooks ♂, N. Stradbroke Island, Qd: 30, front leg. 31, head and pronotum from above. 32, head from side.

whereas Blue Lake with fish present had five species present including *deanei*. Almost three times as many collections were made from Brown Lake therefore Bensink and Burton's data is not conclusive.

The water-bug fauna of Brown Lake is of interest as it shows the low species diversity in a lake with a surface area of c. 25 ha and a maximum depth of 6.4 m. The pH varying between 3.95 and 5.4. Bensink and Burton (1975) distinguish two groups of aquatic invertebrates: Zooplankton, one water-bug, *deanei* and the littoral fauna; *deanei*, *elstoni* corixidae *Micronecta* sp.\*; Nepidae *Ranatra diminuta*, *R. dispar* Montandon and *Laccotrephes tristis* Stål; Naucoridae *Naucoris australicus*

\* *Micronecta lansburgi* Wroblewski

Stål; Gerridae *Rhagodotarsus* sp., *Limnogonus fossarum* (Fabr.). With the exception of *Micronecta*, all the water bugs listed are entirely predatory. Bensink and Burton (1975) comment that *deanei* readily fed on *Chaoborus* in the laboratory as do the fish in Blue Lake which has a low species diversity.

The colour of *deanei* from Brown Lake which is described as humic brown due to accumulated dissolved organic matter does support the suggestion that the colour of the water and substrate influences the colouration of the *Anisops* species present although fish predators were absent. Potential predators of *Anisops* would include nepids, other notonectids, Coleoptera and Odonata nymphs.

### *Anisops rigoensis* Brooks, 1951

Figures 33-36

Small species 4.4-5 mm long, maximum width 1.1-1.3 mm.

Originally, description based on specimens from New Guinea: N.G., Rigo, Luglio [July], 1889, L. Loria; N.G., Lemian Berlinhafen 1896, Biro and N.G. Friedrich-Wilh.-hafen, 1896, Biro in the Snow Entomological Collections, Lawrence Kansas.

*Material examined.* 1♂ 1♀ paratype N.G. Rigo, Luglio, 1889 and 11♂ 1♀ New Guinea: Neth. Genjam 40 km west of Hollandia, 100-200 m; 1-10.iii. T.C. Maa by courtesy of the Snow Ent. Coll. and Bishop Museum respectively.

The description given by Brooks is rather confusing. The two paratypes do not agree with the original description. The synthlipsis of the male is not 1/5-1/3 anterior width of vertex as stated by Brooks, but 1/9-1/12 anterior width of vertex. The vertex is feebly carinate, commencing at the synthlipsis and extending about 1/3 median head length between the eyes. The development of the carina is rather variable and difficult to see. Brooks gives a muddled description of the morphometrics of the head and pronotum. The ratios in the series examined have the head length about the same as the median pronotal length, pronotal humeral width just under twice the median length. Brooks comparing *biroi* with *rigoensis* states that *rigoensis* has three small setae on the inner surface of the male front tarsus, they are not shown in his figure and in his key, couplet 93 he

specifically excludes *biroi* and *rigoensis* from the remaining species by the absence of setae on the front tarsus. The rostral prong of *rigoensis* is rather variable (Figs. 34, 36). Chaetotaxy of the male front leg (Fig. 33).

### *Anisops biroi* Brooks, 1951

Figures 37-39

Small species (Brooks states males 4.2-4.3 mm long, maximum width 1.2-1.3 mm).

Original description based on 3♂ 2♀ from New Guinea, Seleo Berlinhafen. '96 (Biro). Type series in the Snow Entomological Collections, Lawrence Kansas.

*Material examined:* 1♂ 1♀ paratype; male 5 mm long, female 4.9 mm long. By courtesy of the Snow Ent. Coll.

Brook's description is brief but adequate to distinguish *biroi* from *rigoensis*. The synthlipsis of *biroi* is wider than that of *rigoensis* and the male examined lacks a carinate vertex. The chaetotaxy of the front leg (Fig. 37) hardly differs from *rigoensis*. The rostral prong is a little longer, Brooks states that the prong of *biroi* is at least as long as the third segment whereas in *rigoensis* the prong is shorter than the third rostral segment. Comparison of figure 38 with figures 34 and 36 do not wholly support Brooks diagnosis. The eyes of *rigoensis* are larger (Figures 34-36) than those of *biroi* (Figs. 38, 39).

*Anisops rigoensis* and *biroi* are similar in general appearance, chaetotaxy of the front legs and shape of the rostral prong. The only real difference is that *rigoensis* has a feebly carinate vertex and a very narrow synthlipsis. Because of a lack of data on other species, it is not possible to comment on the differences in eye size between these two species.

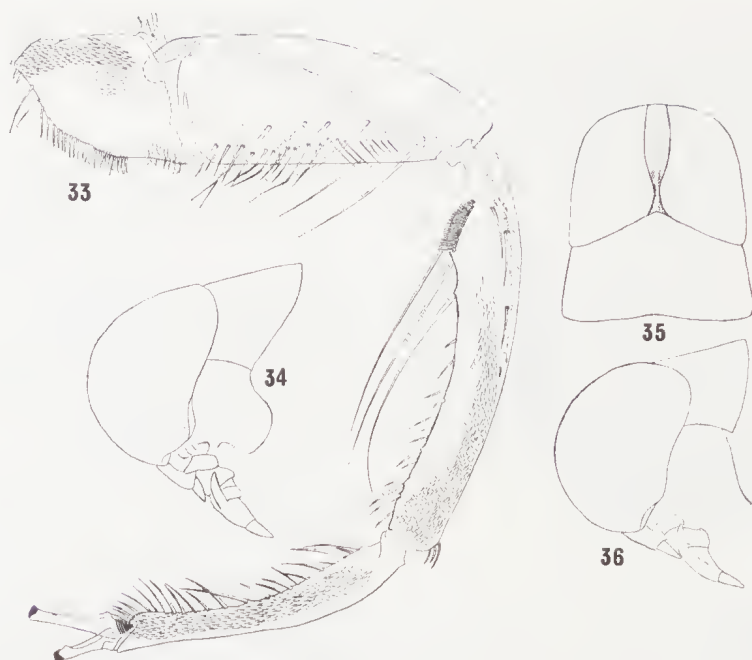
### *Anisops lihiriensis* sp. n.

(Figures 40-42 and 51, 52)

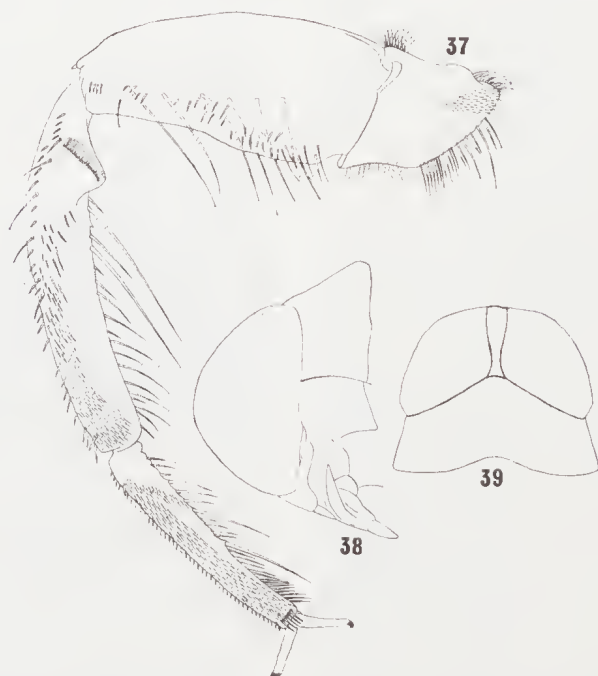
Males, 5.5 mm long, maximum width 1.75 mm.

Colour, eyes grey, vertex, pronotal fovea and pronotum yellowish white. Scutellum basally broadly brown, apex yellowish white. Hemelytra hyaline, claval margins and hemelytral com-

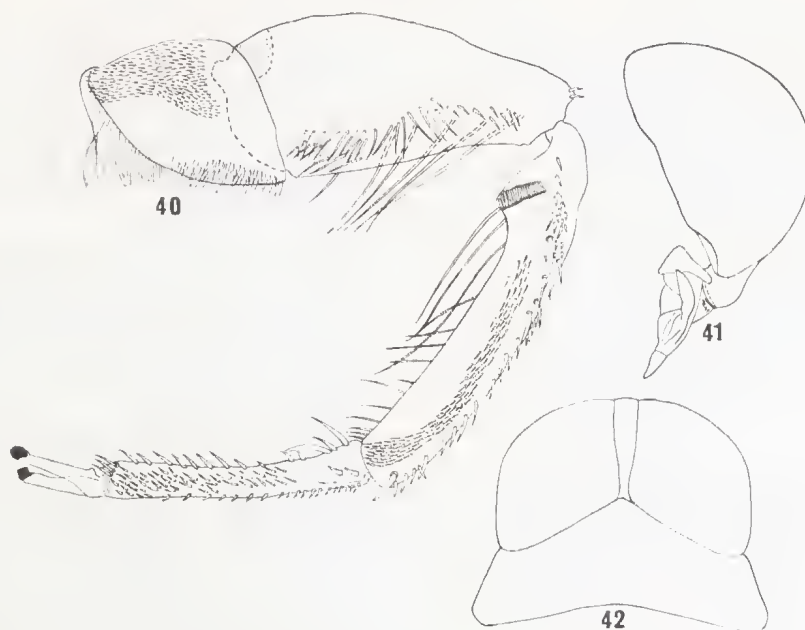




Figures 33-36—*A. rigoensis* Brooks ♂, 33-35, paratype. 36, Genjam, N.G.: 33, front leg. 34, head from side. 35 and 36, head and pronotum from above.



Figures 37-39—*A. biroi* Brooks ♂, paratype: 37, front leg. 38, head from side. 39, head and pronotum from above.



Figures 40-42—*A. lihiriensis* sp. n. ♂ paratype, Lihir: 40, front leg. 41, head from side. 42, head and pronotum from above.

missure pale red. Abdomen dark brown to black, legs pale yellow. Originally preserved in alcohol.

Structure, greatest width of head between ten and twelve times the anterior width of the vertex, narrower than pronotal humeral width. Synthlipsis about half the anterior width of vertex. Median head length slightly shorter than the pronotum. Humeral width about two and a half times median pronotal length. Facial tubercle prominent.

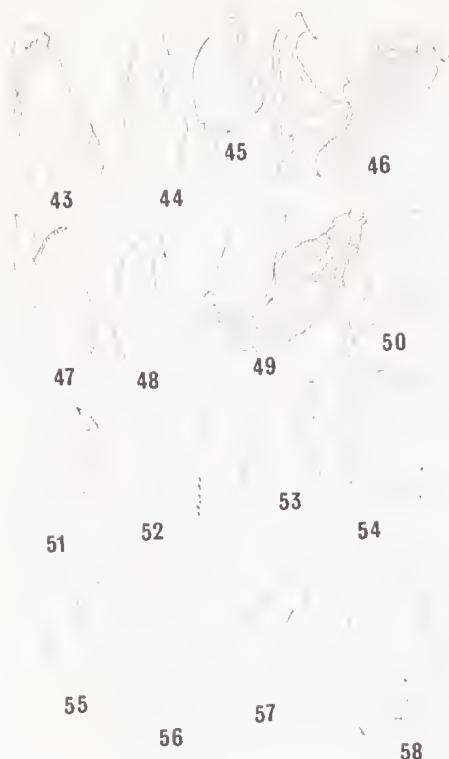
Keys out to couplet 53 in Brooks (1951) similar to *philippinensis* and *windi*, *lihiriensis* differs from them by having an inflated facial tubercle, the rostral prong is rather stouter and the front tibia does not have the setae characteristic of these species. In Lansbury (1969) *lihiriensis* keys out with *deanei*, the same differences apply. Parameres (Figs. 51, 52).

Holotype ♂, 2 ♂ paratypes: Bismarck Archipelago, Lihir, Put Put, pig wallows, 10' diameter, bottom muddy, water opaque 3" deep, 30.vi.1965, A. W. Sweeney (Oxford).

On the same island on the 13.vi.1965, A. W. Sweeney collected a long series of *tahitiensis*. This species has spread over much of the Indo-Australian Pacific region. Originally described from Tahiti. It is common in the New Hebrides, New Guinea, Solomons, Malaya etc. Sweeney (1965) recorded *tahitiensis* from Queensland. *Anisops nasuta* Fieber has a similar distribution although it does not extend so far across the Pacific. Known from Tonga Is. (Nova Pou Is.) New Hebrides, New Caledonia, New Guinea, Solomons, Malaya, Java, Bismarck Archipelago and northern Australia. The first gonapophysis of the female (Fig. 62) drawn to the same scale as figures 59-61 shows that although *nasuta* is larger than *elstoni* 6-7.5 mm compared with 5 mm, the gonapophysis is not significantly larger.

#### Acknowledgements

I wish to thank Dr P. S. Lake, Zoology Department, Monash University, Victoria for the loan of many samples of water bugs from Tas-



Figures 43-58 *Anisops* parameres. Figures 43-50 *elstoni*; 43-44 myponga; 45-46 Sorrell River; 47-48 Stradbroke Island; 49-50 Fraser Island. Figures 51-52 *lihirlensis*. Figures 53-54 *philippinensis*, Fraser Island. Figures 55-56 *deanei*, Stradbroke Island. Figures 57-58 *Nasuta*, Fraser Island.

mania. Dr A. Neboiss for the loan of material from Blackmans Lagoon, Tasmania. The Bernice P. Bishop Museum, Honolulu for the loan of important material. Dr G. Byers of the Snow Entomological Collections, Lawrence, Kansas for the loan of specimens from the type series of species described by G. T. Brooks. Lastly Mr A. W. Sweeney for the gift of material from the Bismarck Archipelago.

## References

- ANDERSEN, N. M., 1975. The *Limnognathus* and *Neogerris* of the Old World. *Entomologica Scandinavica*, Supplementum 7: 1-93.
- BAYLY, I. A. E., E. P. EBSWORTH and HANG FONG WAN, 1975. Studies on the lakes of Fraser Island, Queensland. *Aust. J. Mar. Freshwat. Res.*, 26: 1-13.
- BENSINK, A. H. A. and H. BURTON, 1975. North Stradbroke Island a place for freshwater invertebrates. *Proc. R. Soc. Qd.* 86(7): 29-45.
- BROOKS, G. T., 1951. A revision of the genus *Anisops* (Notonectidae, Hemiptera). *Kans. Univ. Sci. Bull.* 34: 301-519.
- LANSBURY, I., 1962. Notes on the genus *Anisops* in Bishop Museum. *Pacific Insects*. 4: 141-151.
- , 1964. The genus *Anisops* in Australia (Hemiptera: Notonectidae). *J. ent. Soc. Qd.* 3: 52-65.
- , 1968. Notonectidae (Hemiptera-Heteroptera) of Rennell Island. The Natural History of Rennell Island 5 (Zoology), pp. 95-98.
- , 1969. The genus *Anisops* in Australia (Hemiptera-Heteroptera Notonectidae). *J. nat. Hist.* 3: 433-458.
- RAGGE, D. R., 1965. Grasshoppers, Crickets and Cockroaches of the British Isles, F. Warne, London.
- STIMSON WILCOX, R. (not dated). Abstract 'Acoustical behaviour, sound producing-structures and biology of *Buenoa* (Hemiptera, Notonectidae).' Thesis, Department of Zoology, University of Michigan, Ann Arbor, Michigan, 271 pages.
- , 1975. Sound producing mechanisms of *Buenoa macrotibialis* Hungerford (Hemiptera: Notonectidae), *Int. J. Insect Morphol. & Embriol.* 4(2): 169-182.
- SWEENEY, A. W., 1965. The distribution of the Notonectidae (Hemiptera) in south-eastern Australia. *Proc. Linn. Soc. N.S.W.* 90(1): 87-94.
- TRUXAL, F. S., 1953. A revision of the genus *Buenoa* (Hemiptera Notonectidae). *Kans. Univ. Sci. Bull.* 35: 1351-1523.
- YOUNG, E. C., 1962. The Corixidae and Notonectidae (Hemiptera-Heteroptera) of New Zealand. *Rec. Canterbury Mus.* 7(V): 327-374.





Figures 59-62—*Anisops* gonapophyses. Figure 59, *elstoni*, Myponga. Figure 60, *elstoni*, Sorrel River. Figure 61, *elstoni*, Fraser Island. Figure 62, *nasuta*, Fraser Island.