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Mosquitoes of Otago

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APART FROM the monograph by J. N. Belkin on the mosquitoes of the South Pacific (1962) the only readily available publication dealing with the identification of New Zealand's mosquitoes as a whole is that of Miller and Phillipps (1952) which gives few details of the distribution of the ten species described and does not include *Aëdes (Ochlerotatus) subalbirostris* Klein and Marks or other more recently discovered species. *Aëdes subalbirostris* was redescribed from a specimen taken in Invercargill in 1906 and erroneously identified as *Aëdes albirostris* (Macquart) by Edwards (1924). Klein and Marks (1960) showed that the specimen differed from *A. albirostris* and described it as a new species. In 1958 further females of *A. subalbirostris* were taken near Invercargill (Dumbleton, L. J., in press). Males and larval stages of the species were not known until recently, when they were found on the Otago Peninsula and have since been described (Marks, E. N. and Nye, E. R., 1963). Dumbleton (1962) added a new subgenus and species to the New Zealand faunal list with the description of *Aëdes (Nothoskusea) chathamicus* Dumbleton from the Chatham Islands. Another recent addition to the New Zealand list followed the discovery of the Australian mosquito *Aëdes (Halaëdes) australis* (Erichson) on Stewart Island and Otago Peninsula (Nye, E. R., 1962).

Collection of mosquitoes by the authors in the region of Dunedin, and to a minor extent in Central Otago has revealed the existence of five species to which may be added three others, recorded from Otago but not found by us. Five genera are represented as follows:

Culex pervigilans Bergroth
Opifex fuscus Hutton
Aëdes (Halaëdes) australis (Erichson)
Aëdes (Ochlerotatus) antipodeus (Edwards)
Aëdes (Ochlerotatus) subalbirostris Klein and Marks
Culiseta (Climacura) tonnoiri (Edwards)
Mansonia (Coquillettidia) tenuipalpis (Edwards)
Mansonia (Coquillettidia) iracunda (Walker)

The following keys have been designed, as far as possible, to allow identification of the above five species without the likelihood of misidentifying other species recorded from New Zealand, but not yet known from Otago. It should be noted that the larvae of the *Mansonia* species have not yet been described and are therefore not included in the key to larvae. In common with other members of the genus it is expected that these will show the siphonal adaptation associated with the piercing of underwater vegetation. Brief descriptions of the points of value in distinguishing the species are given but for full descriptions reference should be made to the authorities quoted. The ecological details provided summarize our experiences in the province of Otago, with the exceptions of *Culiseta tonnoiri*, *Mansonia tenuipalpis* and *M. iracunda*.

KEY TO ADULT FEMALES

1. (a) Pulvilli on fifth tarsal segment expanded and easily seen (Fig. 1 a), claws simple — Genus *Culex*
   (b) No easily seen pulvilli, claws simple, toothed or bearing hair-like basal spine — 2
2. (a) Clusters of wing scales forming dark patches with some darkening of the wing membrane anteriorly, femora with preapical pale ring — *Culiseta (Climacura) tonnoiri* (Edwards)
   (b) Wings without dark patches — 3
3. (a) Claws simple, large, postspiracular bristles (Fig. 2) absent — 4
   (b) Claws toothed or with hair-like basal spine (Fig. 1 b & c) — 5
4. (a) Ventral aspect of base of vein Sc bearing scales and bristles — *Mansonia (Coquillettidia) tenuipalpis* (Edwards)
   (b) Ventral aspect of base of vein Sc bearing bristles only — *Mansonia (Coquillettidia) iracunda* (Walker)
5. (a) Claws bearing hair-like basal spine (Fig. 1 c) — *Opifex fuscus* Hutton
   (b) Claws toothed, postspiracular bristles present — 6
6. (a) Tarsal banding present — 7
   (b) Tarsal banding absent — *Aëdes (Halaëdes) australis* (Erichson)
7. (a) White mesonotal scales forming a pattern (Fig. 12), proboscis entirely dark scaled — *Aëdes (Ochlerotatus) antipodeus* (Edwards)
   (b) No patterning of white mesonotal scales, golden scales and hairs only — *Aëdes (Ochlerotatus) subalbirostris* Klein and Marks

KEY TO FOURTH INSTAR LARVAE

1. (a) Siphon with four or more pairs of sub-ventral hairs, single or branched — 2
   (b) Siphon with only one sub-ventral tuft — 3
2. (a) Siphon with more than four pairs of single or bifid, minute hairs — *Culiseta tonnoiri* (Edwards)
   (b) Siphon with four pairs of sub-ventral hair tufts — Gen. *Culex*

Fig. 1. Fifth tarsal segments, seen from different aspects. a, *Culex* sp. b, *Aëdes* sp. c, *Opifex fuscus*. *e*, empodium; *p*, pulvillus.

3. (a) Pecten composed of two to three widely separated spines
Opifex fuscus Hutton

(b) Pecten composed of more than three spines 4

4. (a) Pecten composed of about 14-25 spines, the distal ones very closely spaced but becoming separated proximally, not extending beyond proximal half of siphon
Aëdes (Halaëdes) australis (Erichson)

(b) Pecten otherwise 5

5. (a) Pecten composed of 14-16 spines with last spine more or less separated from the rest and often close to the siphonal tuft *Aëdes (Ochlerotatus) subalbirostris* Klein and Marks

(b) No separated pecten spine. Siphonal index (length of siphon/width of siphon at base) about 3.0
Aëdes (Ochlerotatus) antipodeus (Edwards)

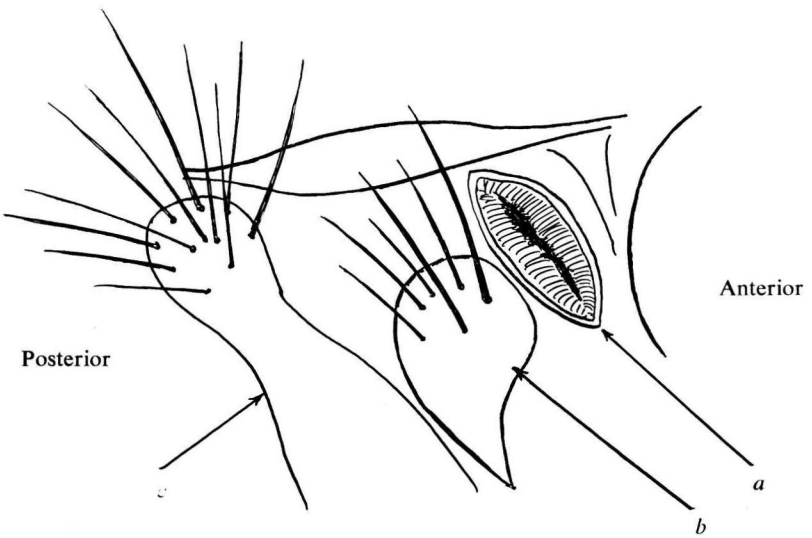

Fig. 2. Diagram of right lateral aspect of thorax. *a*, anterior spiracle; *b*, pleurite bearing postspiracular bristles; *c*, mesopleuron.

Culex pervigilans Bergroth, 1889

Three species in the genus *Culex* are recorded from New Zealand, *C. pervigilans*, *C. fatigans* Wiedemann and *C. annulirostris* Skuse. Because of the close similarity between *pervigilans* and *fatigans* many of the descriptive points given below apply to both species. As far as is known *fatigans* does not occur in the South Island but this possibility should be borne in mind and some distinguishing features between this species and *pervigilans* are given.

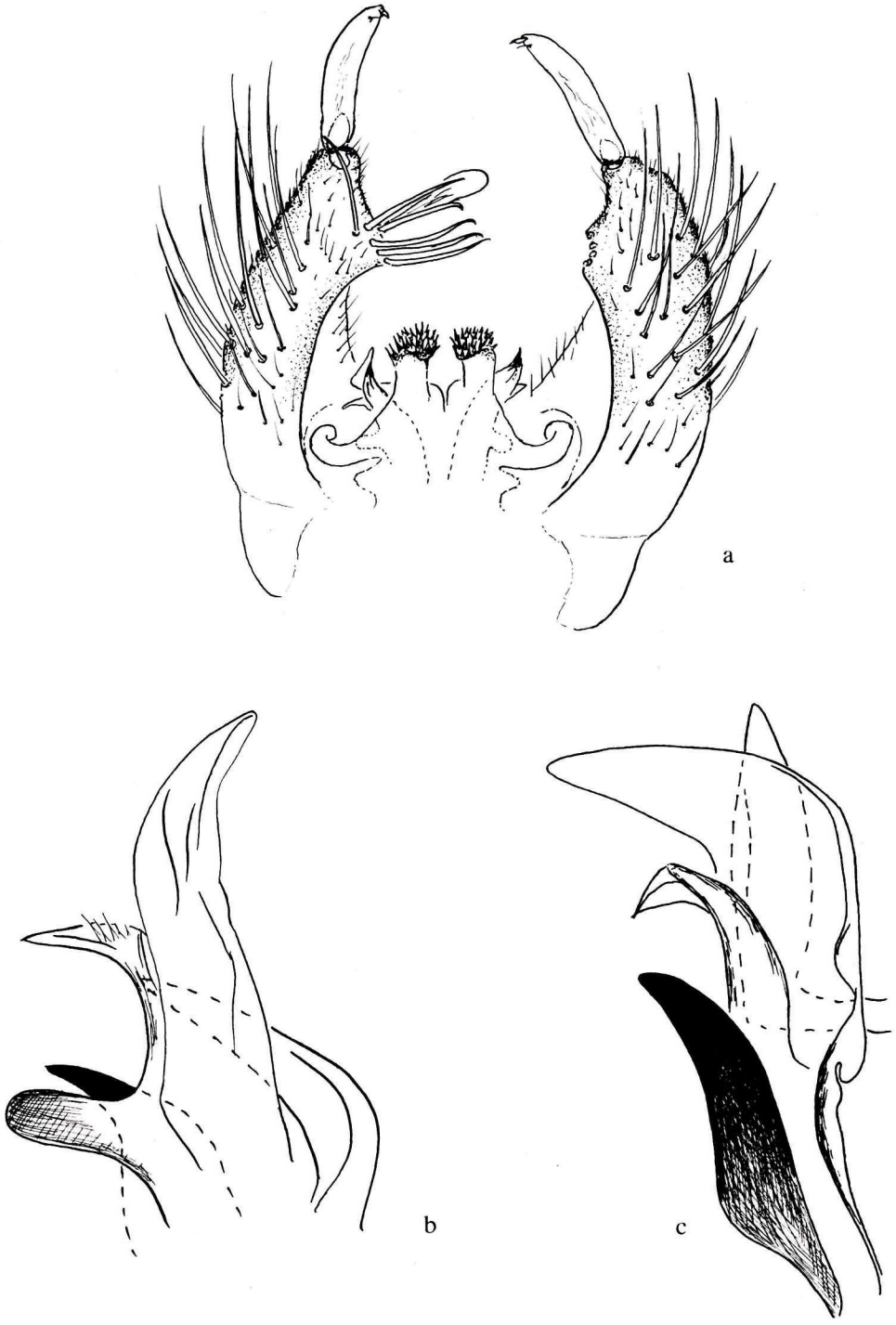

Fig. 3. a, Male terminalia of *Culex pervigilans*, apical lobe structures on one side not shown. b, aedeagus of *C. pervigilans*. c, aedeagus of *C. fatigans*.

Adult

Female: A medium sized brownish mosquito, readily placed in the genus on the basis of two negative features, the absence of toothed claws on the forelegs (Fig. 1 a) and of postspiracular bristles, and on the presence of pulvilli. Fine golden scales cover the mesonotum, tending to white posteriorly and on the scutellum. The abdominal tergites have broad, white, basal scaling, tending to broaden centrally on the first four segments. According to Edwards (1923) the females of *pervigilans* are distinguished from *fatigans* by the presence, in the former species, of a row of dark spots on the abdominal tergites. *Culex annulirostris* is readily separated from *pervigilans* and *fatigans* by having a pale band in the middle of the proboscis, pale dots anteriorly placed on the front tibiae and tarsal banding.

Male: Similar to the female apart from head structure.

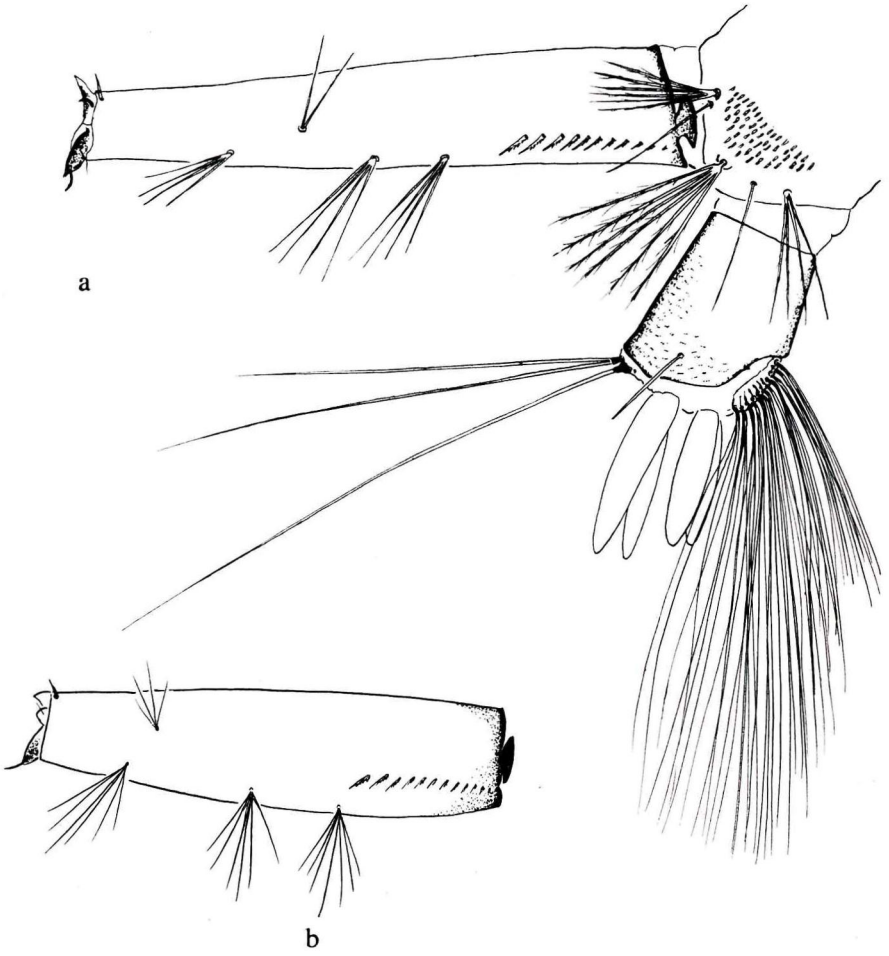

Fig. 4. a, Terminal larval segments of *Culex pervigilans*. b, siphon of *C. fatigans*.

Terminalia: Both *pervigilans* and *fatigans* are immediately distinguished from those of other New Zealand species by the possession of a subapical lobe on the coxite bearing spines and other processes. Careful study of the aedeagus of *pervigilans* and *fatigans* reveals differences which may be used in separating males of the two species (Fig. 3 a, b, c).

Larva (Fig. 4 a): No New Zealand species other than *pervigilans* and *fatigans* has the siphon bearing four pairs of subventral siphonal tufts; the closest approach to this condition is seen in *Culiseta tonnoiri* (Edwards) but in this species there are only single or bifid hairs and not tufts in the corresponding positions. The larva of *Culex annulirostris* differs in having six pairs of tufts. Separation of *pervigilans* and *fatigans* larvae is not an easy task; Miller and Phillipps (1952) note that the penultimate siphonal hair tuft is more laterally placed in *fatigans* than in *pervigilans* but the present authors note that in locally collected material of *pervigilans*, identified on the basis of male terminalia, the siphonal hair tuft in question is also laterally placed and question the value of this character. Hopkins (1952) draws attention to the fact that the siphon of *fatigans* is widest at about 1/3 its length from the base (Fig. 4 b) whereas it is noted that local material of *pervigilans* has an evenly tapering siphon. The siphonal index (length/width at base) for 20 fourth instar larvae of *pervigilans* collected in Dunedin gave a mean value of 5.1 (range 4.1-5.8) which implies a more slender siphon than found in *fatigans* (Hopkins *loc cit*) although there is undoubtedly an overlapping of values.

Ecology and distribution: Of the mosquitoes in Otago *C. pervigilans* has been found in the widest variety of habitats. Larvae have been collected from a coastal swamp, a brackish ditch, a flooded paddock, a water drum and a large pond. Dense populations of *pervigilans* larvae were sometimes found but in some pools only scattered individuals were obtained. The maximum salinity recorded from water supporting larvae was 0.8% NaCl from a roadside ditch near Allan's Beach, Otago Peninsula.

The flora and fauna associated with *C. pervigilans* varied greatly. Several of the breeding sites were temporary. Tubificid worms were usually numerous in bottom mud and species of Ostracoda were almost always present. Dragon fly nymphs, chironomid larvae and stratiomyid larvae were also common.

Culex pervigilans larvae were found at Doctor's Point, near Victory Beach and Hooper's Inlet on the Otago Peninsula. Larvae were also found in the grounds of the Otago Museum, Dunedin, on the Taieri Plain, at Frankton, Central Otago, and in the waters of the Taieri River near Middlemarch. Professor J. A. R. Miles has also kindly provided a record of larvae found in the Catlins district.

Culiseta (Climacura) tonnoiri (Edwards, 1925)

Adult

Female: The presence of spotted wings and pale preapical femoral bands is a combination of characters not present in any other New Zealand species. Other features are the presence of pale scaling on the undersides of the femora and patches of pale scales at the apices of the tibiae. Mesonotal markings and abdominal banding are not seen in this species.

Male: The male of this species has not been described.

Larva (Fig. 5): In common with the larvae of members of this genus, *Culex (Culiseta) tonnoiri* has the siphon bearing several pairs of hair tufts. In this species, however, there are more than four pairs of tufts and in all of them the hairs are short, fine and either single or, at the most bifid, with the exception of a small basal tuft which is 3-4 branched.

Ecology and distribution: This species has not been encountered in eastern Otago but has been recorded from Westland and west Otago. Miller and Phillipps (1952) note that larvae have been found in heavily sheltered, slow flowing streams rich in decaying matter.

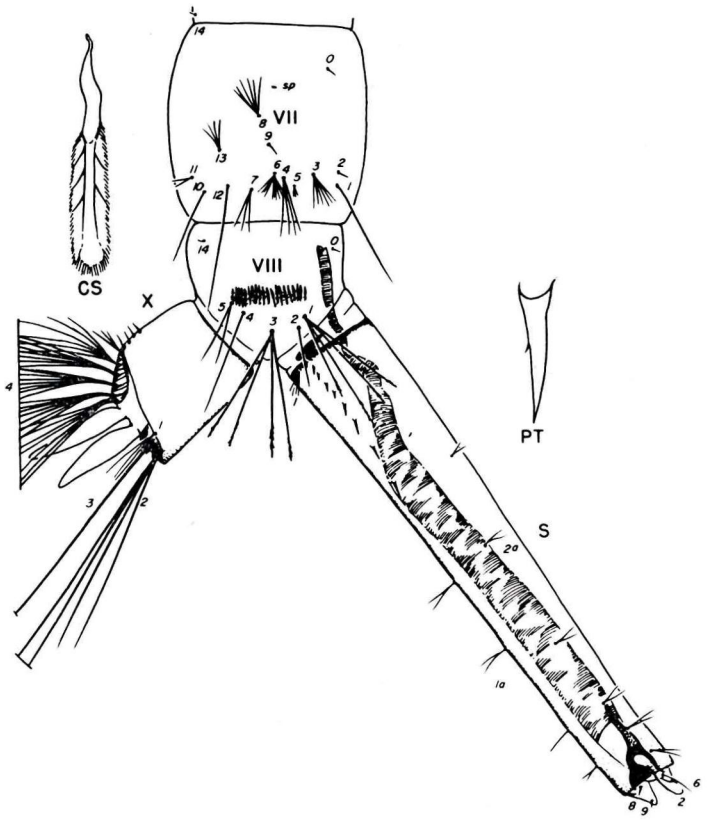

Fig. 5. Terminal larval segments of *Culiseta tonnoiri* (Belkin, 1962). *cs*, comb scale; *pt*, pecten spine.

Mansonia (Coquillettidia) tenuipalpis (Edwards, 1924)

Adult

Female: Naked-eye appearances of the females of the species and of *M. iracunda* are similar to *Culex* and *Aëdes* species (Belkin, 1962). Examination of the tarsal segments shows, however, that pulvilli are absent, which distinguishes from *Culex* spp. and that the claws are simple, unlike the condition in *Aëdes* females. The

mesonotal background colouration in *M. tenuipalpis* is dark brown with golden mesonotal and scutellar scales. The wings are dark scaled with the ventral aspect of the vein Sc bearing bristles and a few scales, a feature which distinguishes the species from *M. iracunda.*

Male: Similar to the female.

Terminalia (Fig. 6): Both *M. tenuipalpis* and *M. iracunda* are easily separated from other New Zealand species by the presence of a heavily sclerotized, blade-like process arising from the claspette approximately one third the length of the coxite.

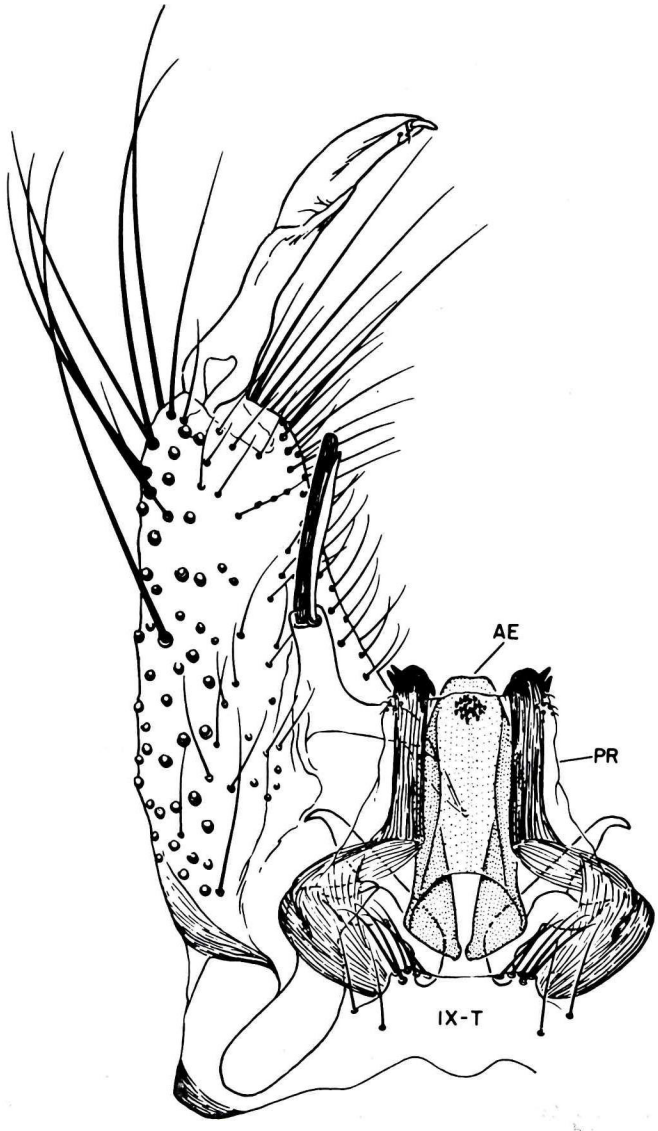

Fig. 6. Male terminalia of *Mansonia tenuipalpis* (Belkin, 1962). *pr,* paraproct; *ae,* aedeagus.

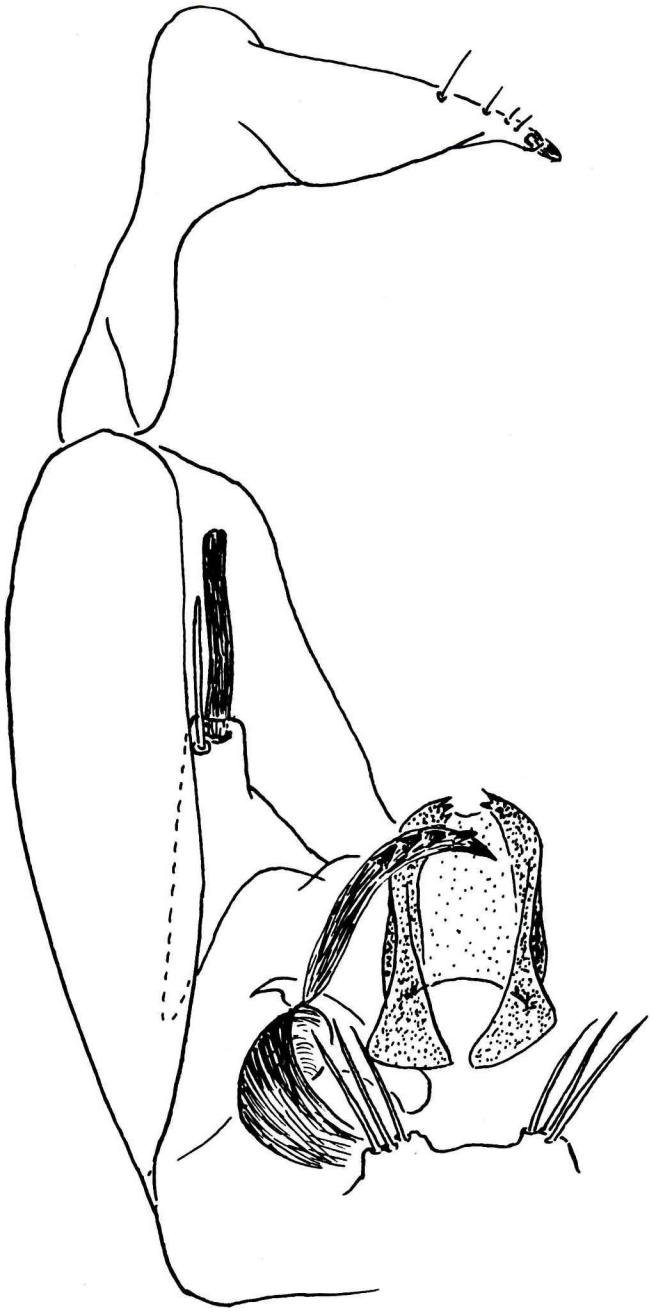

Fig. 7. Male terminalia of *Mansonia iracunda* (redrawn after Belkin, 1962 and E. N. Marks, pers. comm.), hairs and scales not shown.

The basistyle of *tenuipalpis* is almost straight and only moderately lobed which contrasts with the markedly angled and lobed basistyle of *M. iracunda*. A number of unique features present in the species are considered by Belkin (1962) possibly to justify the erection of a new subgenus or genus to contain it.

Larva: Not known.

Distribution: The only records of this species and *M. iracunda* from Otago so far known are from Martin's Bay, collected by R. R. Forster in 1955 (Belkin, J. N., personal communication).

Mansonia (Coquillettidia) iracunda (Walker, 1848)

Adult

Female: In spite of a similarity between the adults of *M. iracunda* and *M. tenuipalpis*, Belkin (1962) notes a number of important differences, notably the presence of scales only on the ventral aspect of the base of wing vein Sc, the presence, in *iracunda*, of a membranous area on the inner aspect of the male coxite and other features.

Male: Similar to the female.

Terminalia (Fig. 7): See under *M. tenuipalpis*.

Larva: Not known.

Distribution: See under *M. tenuipalpis*.

Opifex fuscus Hutton, 1902

Adult

Female: To the naked eye this is a dark, medium-sized mosquito which is seen on close examination to have no tarsal banding or thoracic markings of note. The feature which distinguishes *O. fuscus* from all other New Zealand species is the presence of a fine hair-like spine arising from near the base of each claw (Fig. 1 c), this feature is present on all legs. The palps are noticeably clubbed distally and are mainly dark with a few, pale scales on the penultimate segment. The mesonotum is predominantly dark with a covering of mixed, fine, black and golden scales. The abdominal tergites are mainly dark-scaled with lateral patches of off-white scales which extend basally towards the middle of the segment.

Male: A unique feature which immediately distinguishes *O. fuscus* from other New Zealand species is the absence of whorls of antennal hairs and the presence of a single dorsal spine on each of the second, third and fourth flagellar segments. The palps do not bear brush-like hairs and the claws on the forelegs are extremely long, more than twice the length of the fifth tarsal segment. This combination of features makes the male of *O. fuscus* readily recognizable.

Terminalia (Fig. 8): Although the hypopygium of *O. fuscus* is not necessary for the identification of males of this species it is figured for comparison with those of other species; noteworthy features are the densely hairy coxites, with relatively few long hairs, the massive, heavily sclerotized basistyle and stout dististyle.

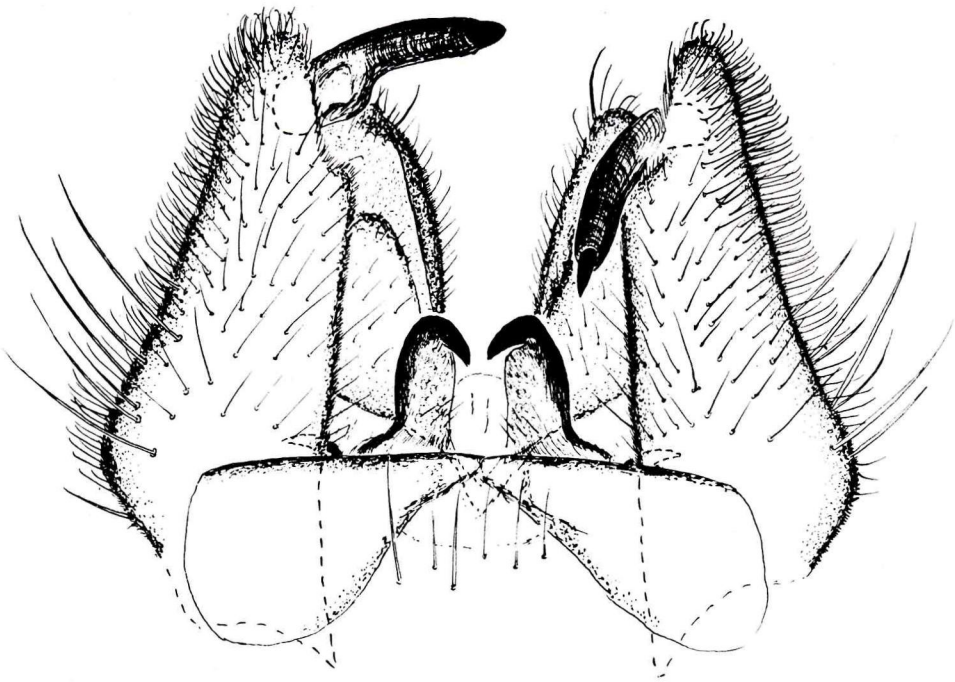

Fig. 8. Male terminalia of *Opifex fuscus*.

Larva (Fig. 9): A feature which readily distinguishes this species from *Aëdes australis*, which is also a coastal brackish water breeder, is the great reduction in number of pecten spines; two or three widely separate spines are seen variably spaced within the proximal third of the siphon. *O. fuscus* shares with *A. australis* the possession of a smooth antennal shaft, although the former species has one or two spines distally spaced which may be overlooked; a point of difference from *australis* is the appearance in *fuscus* of a very short antennal tuft, less than the width of the antennal shaft, placed at its mid-point and consisting of an unbranched hair. The same structure in *australis* is frayed, about half the length of the antennal shaft and placed slightly before its mid-point.

Ecology and distribution: The only previous record of *O. fuscus* in Otago has been from near Cape Saunders (Marks, 1958). We found *O. fuscus* breeding in pools above high water level at Sandfly Bay and at Cape Saunders. In autumn adult numbers decline from the peak reached in summer months. The latest adults have been captured is late in April in Otago and May in Canterbury. Kirk (1923) described the peculiar mating habits of this species. During the summer the surfaces of some pools are almost covered by swarms of adults, predominantly males, snatching at pupae. Physical conditions in supralittoral pools fluctuate irregularly and at times rapidly (McGregor, 1964) and larvae appear well adapted to this variable environment.

Larvae have been taken from a fresh water stream (Dumbleton, 1962), a horse trough near Akaroa lighthouse, Banks Peninsula (collected by Dr R. L. C. Pilgrim) and hyperhaline pools with salinities up to 9.0% NaCl (McGregor, 1963).

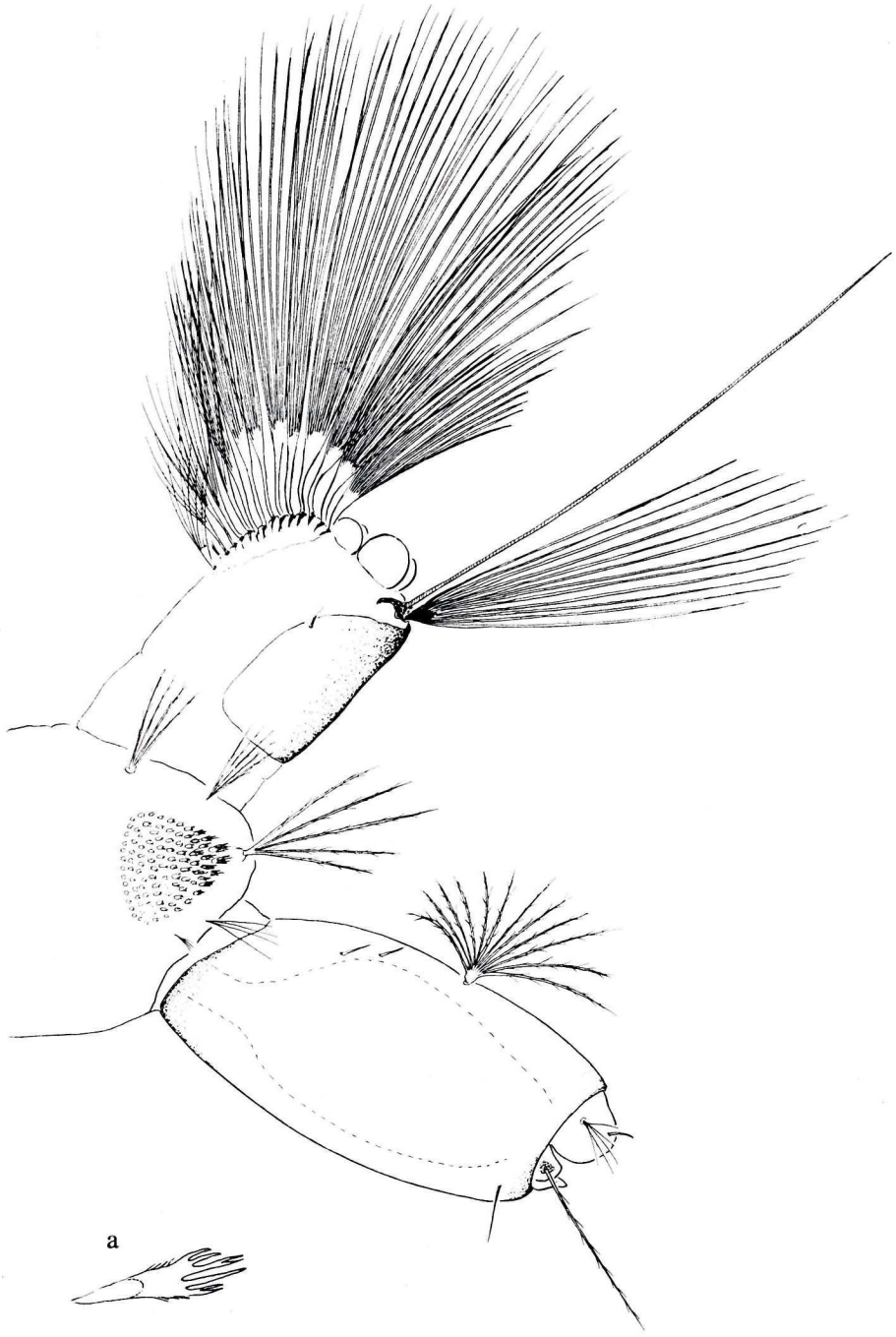

Fig. 9. Terminal larval segments of *Opifex fuscus*. a, comb scale.

Some larvae have only simple hairs in their mouth-brushes, others contain pectinate bristles (Marks, 1958). This dimorphism is environmentally controlled, probably by available food (McGregor, 1963).

The red cosmopolitan copepod *Tigriopus fulvus* (Fischer) is almost always present with *O. fuscus* in pools. Also commonly associated are Amphipoda, the dipteran *Ephydrella novae zealandiae* Tonnoir and Malloch and the green alga *Enteromorpha*.

Fig. 10. Male terminalia of *Aëdes australis* (Belkin, 1962). *pr*, paraproct; *cl*, claspette; *ae*, aedeagus.

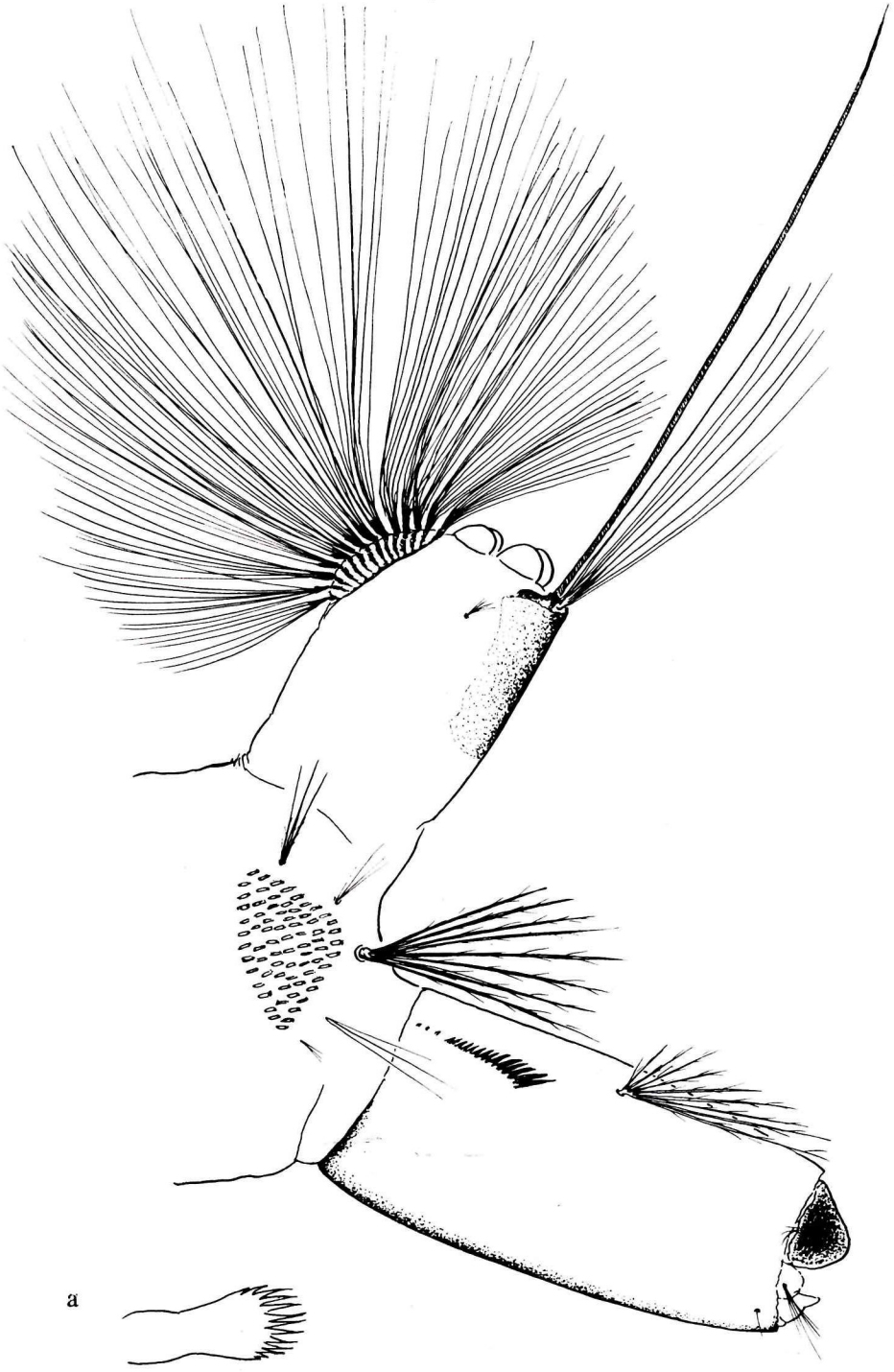

Fig. 11. Terminal larval segments of *Aëdes australis*.
a, comb scale.

Aedes (Halaedes) australis (Erichson, 1842)

Adult

Female: Of the representatives of the genus *Aëdes* so far recorded in New Zealand this is the only species in which no tarsal banding is evident; an additional feature which will distinguish it from the North Island species *A. notoscriptus*, and also from *A. antipodeus* is the presence of an unpatterned mesonotum. *Aëdes subalbirostris* shares with *australis* the absence of pale golden scales forming a mesonotal pattern but differs in having tarsal banding. There is a certain amount of ground colour variation in the species, from brownish to blackish-brown with white or creamy-white scales forming broad, basal bands which show some constriction centrally in the distal abdominal segments.

Male: Similar to the female but in locally collected material the abdominal bands appear somewhat broader and do not show the central constriction.

Terminalia (Fig. 10): Although devoid of conspicuous features making for easy recognition the following negative features should be noted; absence of a subapical lobe on the coxite (cf. gen. *Culex* and *A. subalbirostris*) and absence of a conspicuous basal lobe (cf. *A. antipodeus*). Positive features include the presence of foliate setae on the inner edge of the tergal flap of the coxite towards the base and the presence of a long seta basal to a row of long, unmodified setae on the sternal flap of the coxite (Mattingly and Marks, 1955).

Larva (Fig. 11): In its fourth instar the larva of this species has a pecten composed of 19-25 spines, closely spaced and placed within the proximal half of the siphon; this feature makes for ready distinction from *O. fuscus* with its two or three spines, and incidentally from the short-siphoned, smooth-antennaed *A. notoscriptus* which has about 18 spines reaching well beyond the mid-point of the siphon. It should be noted that the earlier instars have the pecten extending further along the siphon, as far as or slightly beyond its mid-point, but with the distal spines still closely placed together and the proximal more widely spaced.

Ecology and distribution: The breeding sites of *A. australis* so far examined in Otago and Stewart Island appeared similar to those of *O. fuscus*.

At Cape Saunders *A. australis* and *O. fuscus* larvae were taken from the same pool. All the sites, whether rocky pools or roadside ditches in Otago, or a boat hull on Stewart Island, were within splashing distance or seepage distance of the shore. Salinities ranging from 0.3% NaCl to 3.6% NaCl have been recorded for *A. australis* larval habitats in Otago and observations on one roadside pool showed that surface salinity fell from 2.6% NaCl to 1.3% NaCl in seven days.

Enteromorpha, Tigriopus fulvus, Melaraphe cincta and *Ephydrella novaezealandiae* were commonly associated with *A. australis* as with *Opifex fuscus*. Larvae of *Eristalis tenax L.* (Diptera, Syrphidae) were found in one pool.

In the Otago Province *A. australis* has now been recorded from Shag Point, Karitane and from Purakanui, Potato Point, Penguin Beach, Pipikaretu Beach, Papanui Inlet and Cape Saunders on the Otago Peninsula. A further noteworthy record for this species was the finding of a male by Dr M. Pillai (personal communication) at Whataroa in Westland on 25 April 1963. The only other published New Zealand record for the species has been from Stewart Island (Nye, 1962). From Southland the species has been recorded from Bluff by one of the authors (D.D. McG.).

Aedes (Ochlerotatus) antipodeus (Edwards, 1919)

Adult

Female: The markings on the mesonotum of this species are characteristic and in an unrubbed specimen almost adequate for identification (Fig. 12). In case of doubt, or a damaged specimen, reference should be made to the fact that the proboscis of *antipodeus* is uniformly dark (cf. *notoscriptus* which has a patch of

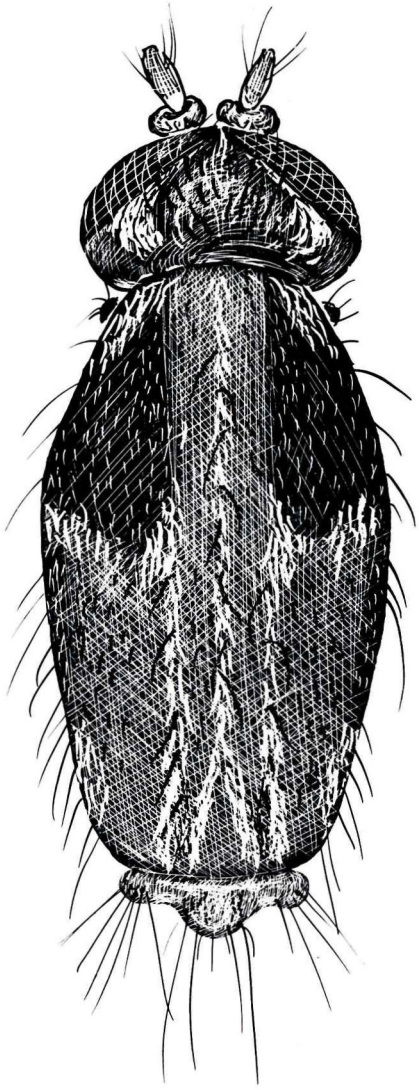

Fig. 12. *Aëdes antipodeus.*

white scales in the centre of the proboscis) and the presence of tarsal banding which is absent in *A. australis*. Apart from the thoracic marking *antipodeus* differs from *subalbirostris* in having darker femora, a character which can be appreciated by the unaided eye.

Male: Similar to the female apart from head structures; the male of *antipodeus* differs from *subalbirostris* in mesonotal markings.

Fig. 13. Male terminalia of *Aëdes antipodeus*.

Terminalia (Fig. 13): An obvious feature of the coxite of *antipodeus* is its distal expansion and well marked basal lobe. The claspette is a relatively simpler structure than that of the other member of the subgenus, *subalbirostris*.

Larva (Fig. 14): In Otago the authors have found *antipodeus* breeding in the same situations as *subalbirostris*. A satisfactory feature for the separation of the two species, the larvae of which are broadly similar in appearance, is found in the structure of the pecten which, in *antipodeus*, has no separated distal spine. The number of pecten spines tends to be greater in *antipodeus*, 17-22, than in *subalbirostris*, 14-16. The siphonal index is, however, similar in the two species.

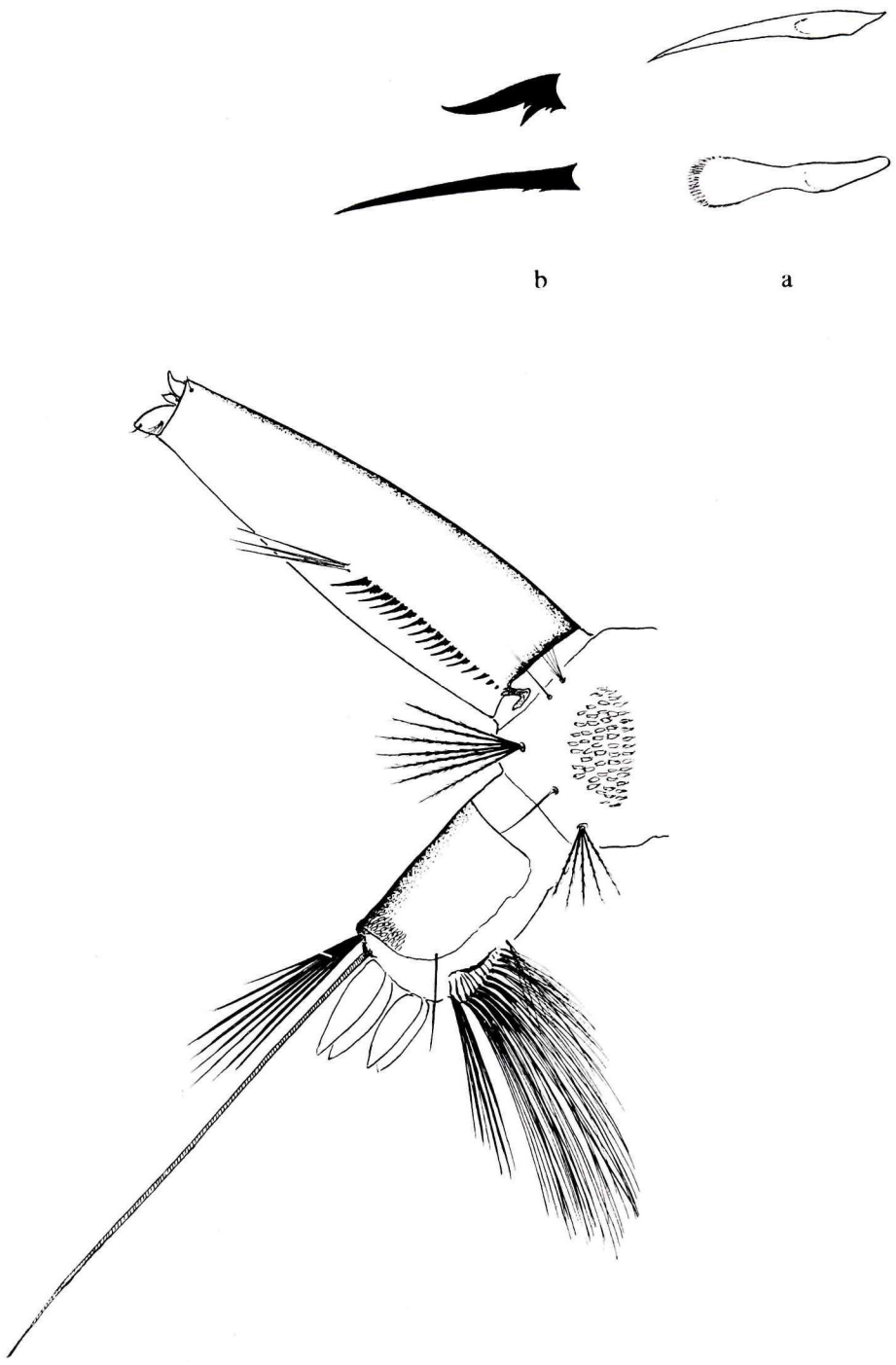

Fig. 14. Terminal larval segments of *Aëdes antipodeus*. a, central and lateral comb scales. b, distal and proximal pecten spines.

Ecology and distribution: The species *A. antipodeus* and *A. subalbirostris* are discussed together as these species were usually found associated in our records to date. Although only *subalbirostris* was found in a horse trough on the Taieri Plain, other localities yielded both species with a numerical preponderance in favour of *subalbirostris*. Several ponds in which both species were found had a diameter greater than 15 metres and one had a maximum diameter of nearly 50 metres. Unlike *O. fuscus, A. australis* and *C. pervigilans* which were sometimes found in stagnant or even foul water, *A. subalbirostris* and *antipodeus* favoured clean water. Measurements from ponds near the coast from which larvae were collected showed the water to be fresh.

The large ponds were notable for the diversity of their fauna, which ranged from the ubiquitous ostracods, the cladoceran *Daphnia* sp., numerous insect larvae and the predatory notonectid *Anisops assimilis* Buchanan-White to the frog *Hyla aurea* Lesson and several species of water fowl.

Records for both *A. antipodeus* and *subalbirostris* come from near Taiaroa Head, Pipikaretu Beach, near Victory Beach and Papanui Inlet on the Otago Peninsula, also from the Taieri Plain.

Aedes (Ochlerotatus) subalbirostris Klein and Marks, 1960

Adult

Female: The three New Zealand species in the genus *Aëdes* having tarsal bands of pale scales are *A. subalbirostris, antipodeus* and *notoscriptus*. Both the last two species have in addition dorsal thoracic markings formed by golden scales which is a feature absent in *subalbirostris*. *A. subalbirostris* has the thoracic integument

Fig. 15. Male terminalia of *Aëdes subalbirostris*. a, claspette, enlarged.

reddish-brown in colour which contrasts with the more blackish scaling of the abdominal segments. The abdominal segments have narrow, inconspicuous, basal bands of pale scales and, in the terminal four segments, a fringing of pale apical scales on each segment. The femora are mainly pale-scaled becoming dark apically with extension of the dark area on to the dorsal and ventral surfaces grading to scattered, dark scales.

Male: Similar to the female with the exception that the femora bear more dark scales than the female's and appear uniformly mottled along their lengths. The palpi are dark-scaled except for a band of cream scales in the centre of the second segment, and at the base of the fourth segment.

Terminalia (Fig. 15): The presence of a subapical lobe on the coxite is a feature not seen in any other New Zealand species except for those in the genus *Culex* where the lobe bears several differently modified processes. The subapical lobe in *subalbirostris* bears hairs only. There is also a basal lobe on the coxite bearing hairs. Two conspicuous claspettes (Fig. 15 a) are also seen.

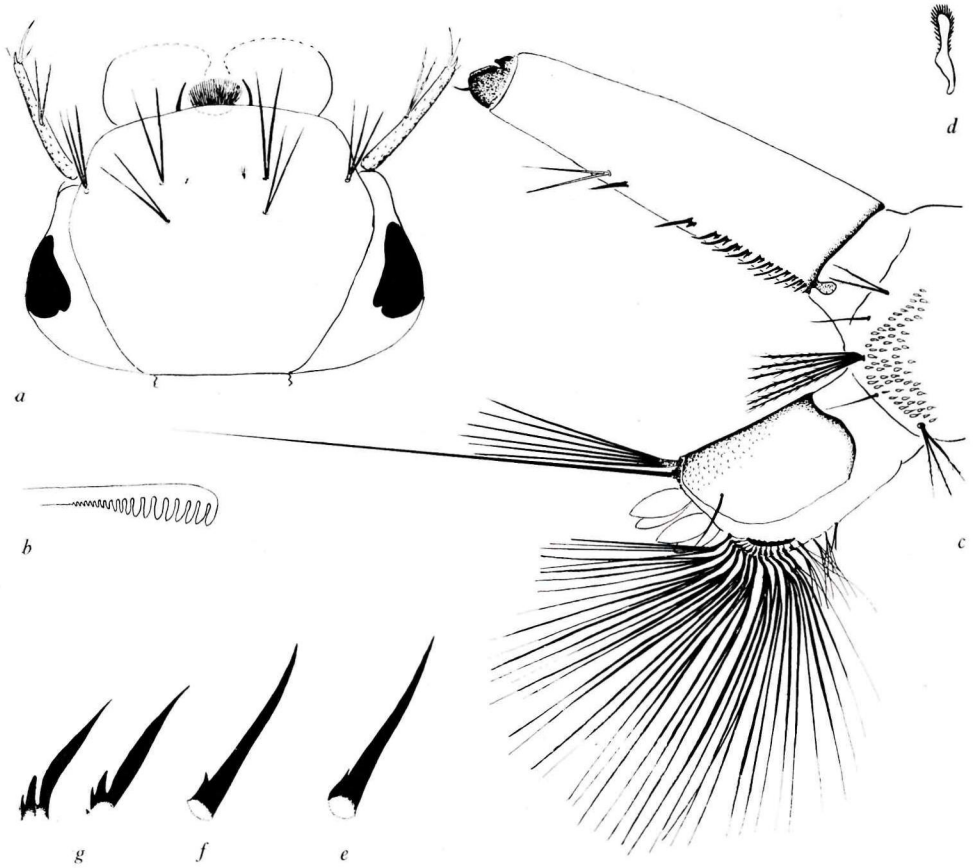

Fig. 16. Larval features of *Aëdes subalbirostris* (Marks and Nye, 1963). *a*, dorsum of head; *b*, inner mouth-brush hair; *c*, terminal larval segments; *d*, comb scale; *e*, terminal pecten spine; *f*, sub-terminal pecten spine; *g*, proximal pecten spines.

Larva (Fig. 16): Many of the features of the larva of *subalbirostris* are shared by *A. antipodeus* but separation of the fourth instar larvae of the two species is readily accomplished by examination of the pecten. In *subalbirostris* the distal pecten spine is variably separated from the remainder and close to the siphonal tuft; no such separation of the last spine is seen in *antipodeus*. An additional feature which may be noted is the marked separation between the primary denticle and the first secondary denticle of the pecten spines; this feature is not seen in *antipodeus*.

Ecology and distribution: The ecology and distribution of this species is dealt with along with that of *A. antipodeus*.

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