

MOSQUITOES OF TASMANIA AND BASS STRAIT ISLANDS

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(Plates iv-v)

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Synopsis

Twenty-nine species have been recorded from Tasmania, twenty-two from Flinders Island, ten from King Island and four from other small islands of Bass Strait. A new species, *Anopheles tasmaniensis*, and the life history of *Culiseta weindorferi* (Edw.) are described.

The Tasmanian mosquito fauna is closely related to that of southern Victoria. All Tasmanian species either occur in Victoria or have close relatives there. The endemic *Culiseta weindorferi* is closely related to *C. otwayensis* Dobr., and *Aedes cunabulanus* Edw. belongs to a group of the subgenus *Ochlerotatus* which is well represented in Victoria.

Two main elements are represented in the Tasmanian fauna: the southern-Bassian and the northern. The Bassian element is represented by eleven species of *Ochlerotatus*, three species of *Culiseta* and one of the *apiculis* complex of *Neoculex*. The Bassian element may have originated in the tropics and subsequently spread to the northern and the southern temperate regions, being progressively displaced further from the tropics by later evolving groups. The northern element is represented in Tasmania by fourteen species. Species well adapted to cool conditions are widespread but others are confined to the warmer coastal areas or to warmer habitats.

The majority of Tasmanian species are forest mosquitoes and since these have only a restricted ability to disperse across open spaces, it seems that Tasmania received most of the mosquito fauna before separation from the mainland. However, the species which breed in the coastal regions or in the open country may have dispersed to Tasmania, after separation, by the chain of the Bass Strait islands.

The distribution of the two forms of *Ae. andersoni* Edw. suggests that the Grampians form dispersed from the mainland into Tasmania where the typical form evolved and subsequently migrated to the mainland.

The main differences of the Flinders Island fauna from that of Tasmania are (1) the absence from Flinders Island of the two endemic Tasmanian species and also those species which are restricted to special habitats not available on Flinders Island, and (2) the presence of two northern species, *Ae. macmillani* Marks and *M. linealis* Skuse which do not occur in Tasmania, and of two species which are restricted to the coastal regions and the islands with a mild climate (*Ae. clelandi* Taylor and *Ae. stricklandi* Edw.).

The small fauna of King Island reflects the lack of variety of habitats.

INTRODUCTION

Erichson described the first mosquito from Tasmania, *Aedes australis*, in 1842. The description was based on two males and one female sent to him from Van Diemen's Land by A. Schayer. This was followed by Macquart's description of *Aedes nigrithorax* in 1847 and *Aedes rubrithorax* in 1850. Walker described *Anopheles annulipes* and *Aedes crucians* in 1856, but the latter is conspecific with *Aedes australis* Erichson.

In 1911 Strickland described six species which he found in collections sent to F. V. Theobald by T. L. Bancroft. However, four of these had been already described and only *Tripteroides tasmaniensis* and *Aedes andersoni* (*tasmaniensis* Strickland) were new species. Taylor described *Culiseta littleri* in 1914 and Edwards a further four species in 1926: *Culiseta weindorferi*, *Aedes cunabulanus*, *Aedes luteifemur* and *Aedes purpuriventris*.

Thus during the period 1842-1926 fourteen species were described or recorded from Tasmania. There were no new records until 1948 when D. Lee recorded two more species.

Since 1951 collections from Tasmania and Bass Strait Islands have been made by officers of the Wildlife Survey Section of C.S.I.R.O. (J. H. Calaby, A. L. Dyce, D. L. McIntosh, M. D. Murray and F. N. Ratcliffe) and other entomologists (E. N. Marks, I. Rowley, T. E. Woodward and E. G. Connah). These collections added four species and two subspecies to the Tasmanian fauna (Dobrotworsky, 1953, 1954, 1957 and 1960). By 1960 a total of twenty species and two subspecies had been recorded from Tasmania, four from Flinders Island and two from King Island.

This contribution also incorporated the results of collecting trips by the author to Tasmania (October–November 1961, November–December 1962 and October 1963), to Flinders Island (November 1962 and February 1963) and King Island (November 1963). During these studies 255 breeding places were investigated and larvae collected; almost 2500 adults were collected or reared. In addition to this material I was able to study mosquitoes collected in Tasmania by Dr. M. Littlejohn, and on Bass Strait Islands by Dr. J. A. Thomson, Messrs. S. Murray-Smith and E. Zoski.

The island of Tasmania is largely covered with hills and mountains which are particularly rugged in the western part. Forests cover 47% of the island. The temperate marine climate with rainfall throughout the year creates excellent conditions for the breeding of forest mosquitoes. However, the eastern parts of the island are drier with an average yearly rainfall of below 40 inches, and most of the rain water pools usually become dry during November. The western region of the island has an annual rainfall ranging from 50 to 150 inches, and rain water pools do not dry out throughout the year and provide all year round breeding sites for mosquitoes. However, at higher altitudes the development of larvae would cease during winter where snow may lie for some months.

The low-lying areas are restricted and mostly confined to the north and north-east; they are covered with sclerophyll forest, heath, marshes or tea-tree swamps. Open swamps are rare. Here again in shaded swamps the forest mosquitoes prevail.

A description of the physical features, climate and vegetation is given in Atlas of Tasmania 1965.

The breeding sites of mosquitoes on Flinders Island are less variable than in Tasmania because the mountains are not high and the island does not experience the cold winter conditions such as exist in Tasmania. Frosts are rare and no snow falls occur even on the highest mountains (the highest Strzelecki Peaks are 2,550 feet). The rainfall does not exceed 35 inches per annum, approximately as high as in the eastern part of Tasmania.

The extensive plains with shallow lagoons and swamps provide more habitats for mosquitoes breeding in plain country than in Tasmania.

The major features of King Island are the plateau country, the plains, the swamps and lagoons, and dune formations. The highest hills reach only 600 feet. The island provides a very limited variety of habitats for mosquitoes, and only ten species are recorded there as against twenty-two for Flinders Island.

A full description of Flinders Island is given by Dimmock (1957) and by Guiler *et al.* (1958), and of King Island by Stephens and Hosking (1932) and by Jennings (1959). There is a brief review, of both islands, by Littlejohn and Martin (1965).

DISTRIBUTION AND COMPOSITION OF THE MOSQUITO FAUNA

Five genera of mosquitoes are represented in Tasmania: (1) *Anopheles*—four species, (2) *Tripteroides*—two species, (3) *Aedes*—seventeen species, (4) *Culiseta*—three species and (5) *Culex*—three species (Table 3). The genus *Mansonia* is not recorded from Tasmania but is represented by one species on Flinders Island. Their distribution and abundance are determined by various

environmental factors but particularly by the availability of suitable breeding sites. As would be expected, species which breed in open swamps e.g. *Culex globocoxitus*, *C.p. australicus* and *An. annulipes* are not numerous in Tasmania; they are restricted to low land areas. In contrast to these, species which are associated with forests are numerous and widely distributed. However, forest mosquito species with special requirements are not evenly distributed: *Ae. nigrithorax* and *Ae. silvestris* breed in temporary ground pools in sparse sclerophyll forest; *Tripteroides* and *Ae. notoscriptus* are tree hole breeders.

TABLE 1

Distribution according to habitat of larvae in Tasmania

Species	Number of breeding sites						
	Total	Ground pools		Swamps		Rock pools	Discarded tyres and tins
		More or less exposed to sun	Completely shaded	Grassy	Tea tree		
<i>An. stigmaticus</i>	1		1				
<i>An. annulipes</i>	2		1		1		
<i>An. tasmaniensis</i>	2				2		
<i>T. tasmaniensis</i>	2						2
<i>Ae. (O.) nigrithorax</i>	4	3	1				
<i>Ae. (O.) flavifrons</i>	4		3		1		
<i>Ae. (O.) calcariae</i>	1		1				
<i>Ae. (O.) purpuriventris</i>	3	1	2				
<i>Ae. (O.) luteifemur</i>	17	7	6	2	2		
<i>Ae. (O.) silvestris</i>	6	4	2				
<i>Ae. (O.) nivalis</i>	11	5	5	1			
<i>Ae. (O.) cunabulanus</i>	35	15	17	3			
<i>Ae. (O.) andersoni</i>	37	18	15	2	2		
<i>Ae. (O.) continentalis</i>	5		3		2		
<i>Ae. (F.) alboannulatus</i>	9	7	2				
<i>Ae. (F.) rubrithorax</i>	47	13	31		1	1	1
<i>Ae. (F.) rupestris</i>	4	2				2	
<i>Ae. (P.) postspiraculosis</i>	2		2				
<i>Ae. (H.) australis</i>	1					1	
<i>C. inconspicua</i>	31	6	20	1	4		
<i>C. weindorferi</i>	2		2				
<i>C. fergusoni</i>	26	7	15		4		
<i>C. globocoxitus</i>	2			2			
<i>C. p. australicus</i>	1			1			
	255	88	129	12	19	4	3

Species with a greater capacity for adaptation to cold conditions are able to penetrate to higher altitudes where they breed in moorland and sedgeland country; their larvae are mostly confined there to shallow pools exposed to the sun. These high-altitude species are *Ae. nivalis*, *Ae. cunabulanus* and *Ae. andersoni* (Table 2).

However, for many species which breed in cool ground water, the range of breeding sites is greater than in Victoria. Thus, species such as *C. fergusoni*, *Ae. rubrithorax* and *C. inconspicua* are not restricted to completely shaded pools; because of the lower temperatures prevailing during spring and early summer in Tasmania they are also able to breed freely in pools more or less exposed to the sun (Table 1).

TABLE 2
Distribution of mosquitoes according to altitudes

Localities	Altitude in feet	<i>Aedes</i>														
		<i>cunabulanus</i>	<i>andersoni</i>	<i>continentalis</i>	<i>nivalis</i>	<i>silvestris</i>	<i>luteifemur</i>	<i>camporhynchus</i>	<i>purpuriventris</i>	<i>flavifrons</i>	<i>nigrithorax</i>	<i>rubrithorax</i>	<i>alboannulatus</i>	<i>Culiseta inconspicua</i>	<i>Culex fergusoni</i>	<i>Anopheles tasmaniensis</i>
Bridport	10	+	+	+	-	-	+	-	+	+	-	+	-	+	+	-
Sassafras	50	-	+	-	-	-	+	-	-	+	-	+	+	+	+	-
Birralee	50	-	+	-	-	-	+	-	-	+	-	+	+	+	+	+
Lake Leake	2·300	+	+	-	+	+	-	+	-	-	+	+	+	-	-	-
Storey's Creek ..	3·000	+	+	-	-	-	-	-	+	-	-	+	-	+	-	-
Breona	3·400	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-

TABLE 3
Distribution of mosquitoes in southern Victoria, Tasmania and Bass Strait Islands

Species	Victoria			Bass Strait Islands			
	East Gippsland	Eastern Highlands and West Gippsland	Otway-Portland area	Erith, Deal, Great Dog	King	Flinders	Tasmania
ANOPHELINAE							
<i>Anopheles</i>							
<i>stigmaticus</i>	+	+	+	-	-	+	+
<i>pseudostigmaticus</i>	-	+	-	-	-	-	-
<i>atrripes</i>	+	+	+	-	+	+	+
<i>tasmaniensis</i>	+	-	+	-	-	-	+
<i>annulipes</i>	+	+	+	-	-	+	+
CULICINAE							
<i>Tripteroides</i>							
<i>atrripes</i>							
(Southern form)	-	+	+	-	-	-	+
<i>tasmaniensis</i>	+	+	+	-	-	+	+
<i>marksi</i>	+	-	-	-	-	-	-
<i>Mansonia</i>							
<i>linealis</i>	+	+	+	-	-	+	-
<i>aurata</i>	+	-	-	-	-	-	-
<i>variegata</i>	+	-	-	-	-	-	-
<i>Aedeomyia</i>							
<i>venustipes</i>	+	+	-	-	-	-	-
<i>Aedes</i>							
<i>procox</i>	+	-	-	-	-	-	-
<i>theobaldi</i>	+	-	-	-	-	-	-
<i>nigrithorax</i>	+	+	+	-	-	+	+
<i>imperfectus</i>	+	+	-	-	-	-	-
<i>flavifrons</i>	+	+	+	-	+	+	+
<i>calcariae</i>	+	+	+	-	-	-	+

TABLE 3—continued

Distribution of mosquitoes in southern Victoria, Tasmania and Bass Strait Islands

Species	Victoria			Bass Strait Islands			Tasmania
	East Gippsland	Eastern Highlands and West Gippsland	Otway-Portland area	Erith, Deal, Great Dog	King	Flinders	
<i>purpuriventris</i>	..	—	+	—	—	—	+
<i>clelandi</i>	..	—	+	—	—	+	—
<i>perkinsi</i>	..	+	—	—	—	—	—
<i>luteifemur</i>	..	+	+	+	+	+	+
<i>silvestris</i>	..	+	+	+	—	—	+
<i>nivalis</i>	..	—	+	—	—	—	+
<i>camptorhynchus</i>	..	+	+	+	+	+	+
<i>cunabulanus</i>	..	—	—	—	—	—	+
<i>andersoni</i>	..	—	+	+	+	+	+
<i>continentalis</i>	..	+	+	+	—	+	+
<i>stricklandi</i>	..	—	—	+	—	+	—
<i>dobrotworskyi</i>	..	+	+	+	—	—	—
<i>notoscriptus</i>	..	+	+	+	—	+	+
<i>alboannulatus</i>	..	+	+	+	+	+	+
<i>rubrithorax</i>	..	+	+	+	+	+	+
<i>rupestris</i>	..	+	+	+	—	—	+
<i>tubbutiensis</i>	..	+	—	—	—	—	—
<i>subbasalis</i>	..	+	—	—	—	—	—
<i>milsoni</i>	..	+	—	—	—	—	—
<i>subauridorsum</i>	..	+	+	—	—	—	—
<i>macmillani</i>	..	+	+	—	—	+	—
<i>multiplex</i>	..	+	—	—	—	—	—
<i>postspiraculosus</i>	..	+	+	+	—	—	+
<i>australis</i>	..	+	+	+	+	+	+
<i>Culiseta</i>							
<i>victoriensis</i>	..	—	+	—	—	—	—
<i>drummondii</i>	..	—	+	—	—	—	—
<i>sylvanensis</i>	..	—	+	—	—	—	—
<i>hilli</i>	..	+	+	—	—	—	—
<i>frenchii</i>	..	+	+	—	—	—	—
<i>otwayensis</i>	..	—	—	+	—	—	—
<i>inconspicua</i>	..	+	+	+	+	+	+
<i>weindorferi</i>	..	—	—	—	—	—	+
<i>littleri</i>	..	—	+	+	—	—	+
<i>antipodea</i>	..	+	+	—	—	—	—
<i>Culex</i>							
<i>fergusoni</i>	..	+	+	+	—	+	+
<i>douglasi</i>	..	+	+	—	—	—	—
<i>postspiraculosus</i>	..	+	+	—	—	—	—
<i>pseudomelanoconia</i>	..	+	—	—	—	—	—
<i>orbostiensis</i>	..	+	+	—	—	—	—
<i>annulirostris</i>	..	+	—	—	—	—	—
<i>globocoxitus</i>	..	+	+	+	—	+	+
<i>pipiens australicus</i>	..	+	+	+	—	+	+
<i>pipiens molestus</i>	..	+	+	+	—	—	+
		47	43	31	4	10	22
							30

Although most species are well adapted to cool climatic conditions and non-seasonal rainfall, some are distributed in areas with a warmer climate or are confined to habitats with a warmer microclimate e.g. exposed rock pools.

A comparison of the fauna of Tasmania and Bass Strait Islands with that of southern Victoria shows that all Tasmanian species either occur in Victoria or have a close relationship to Victorian species (Table 3). A striking fact emerging from Table 3 is that the mosquito fauna of Tasmania is almost identical with that of the Otway-Portland area of Victoria.

In Tasmania, as in Victoria, the mosquito fauna comprises two major elements, (1) the more ancient southern or Bassian element consisting of the genus *Culiseta*, one group of the subgenus *Ochlerotatus* and the subgenus *Neoculex* (*apicalis* complex) and (2) the northern which is a part of the Indo-Malayan element. This element, which includes a great assemblage of relatively recent successful insects, is represented by *Anopheles*, *Tripteroides*, *Mansonia*, *Culex* and subgenera *Finlaya* and *Pseudoscusea*, and on Flinders Island *Chaetocruomyia*, of the genus *Aedes*.

Previously (Dobrotworsky, 1965) the concept of a southern entry via an Antarctic landmass of the Bassian element in the Australian mosquito fauna was rejected. The detailed study of Tasmanian mosquitoes has not led to any modification of the view that this element entered Australia from the north and was progressively displaced away from the tropics by later-evolving elements.

The migration route of mosquitoes in eastern Australia was probably along the coast and ranges, a route which for the migration of plants has been extremely important and of great antiquity (Burbidge, 1960).

The successful southern dispersal of mosquitoes on the mainland has depended on climate tolerance and adaptability. Some species of *Ochlerotatus* e.g. *Ae. procax* (Skuse) have penetrated just across the Victorian border into East Gippsland, *Ae. perkinsi* Marks has dispersed throughout East Gippsland, while *Ae. imperfectus* Dobr. has penetrated into the Western Highlands as far as Beaufort.

Such pattern of migration can also be observed among mosquitoes of the northern or Indo-Malayan element.

Dispersal to Tasmania raises other problems. Tasmania was joined to Australia, and Port Phillip Bay and Bass Strait were formerly portions of a continuous land surface (Keble, 1946). A land connection between Australia and Tasmania remained until late Tertiary times; Tillyard (1926) believes that the land connection was broken and joined several times. This land bridge has been regarded as the main route for the migration of flora and fauna

Paramonow (1959), however, has questioned the importance of this land bridge. "The ability of an insect to fly or to be carried by wind for very long distances, the presence of a group of islands between Tasmania and Australia forming a bridge between them, are factors nullifying the presence of the strait between Tasmania and Australia." It seems to me that this cannot be applied to all winged insects in spite of many reports of the ability for long distance flights of many of them and the importance of wind in their dispersal. For example, in Canada the adults of tent caterpillar moth (*Malacosma disstrigata* Hübner) were carried by the turbulent air associated with cold front for a distance of at least 300 miles in 12 hours (Brown, 1965). Trapping of airborne insects from ships and airplanes has yielded large numbers of insects (Glick, 1939; Gressitt *et al.*, 1960, 1961; Yashimoto and Gressitt, 1960, 1961; Harrell and Yashimoto, 1963; Madison, 1964). The mosquitoes were collected only on few occasions, but there are reports of their being taken at altitudes up to 5,000 feet, and at sea as far as 110 kilometres from nearest land.

It should be kept in mind that the occurrence of active or passive dispersal of insects depends largely on their behaviour and ecology. Insects living in open country or in the upper strata of the forest may be easily carried by winds or may be able to fly long distances. Insects of this type include the southern Victorian mosquitoes: *Ae. camptorhynchus*, *Ae. australis*, *Ae. notoscriptus*, *Ae. macmillani*, *Tripteroides*, *An. annulipes*, *C. globocoxitus* and *C.p. australicus*. These species are potentially able to cross Bass Strait particularly by "jumping" from island to island. The ability of some of these species to breed in salt or brackish water is a further favourable factor helping dispersal across sea barriers. However, the majority of Tasmanian and southern Victorian mosquitoes are ecologically confined to forests and even during swarming they do not fly in

the upper strata. Such mosquitoes usually do not fly out of the forests where they have their breeding sites and are not exposed to strong winds which could carry them for long distances and across water gaps. The unfavourable ecological conditions associated with open and dry land constitute another barrier to the dispersal of many forest mosquitoes. Several common species

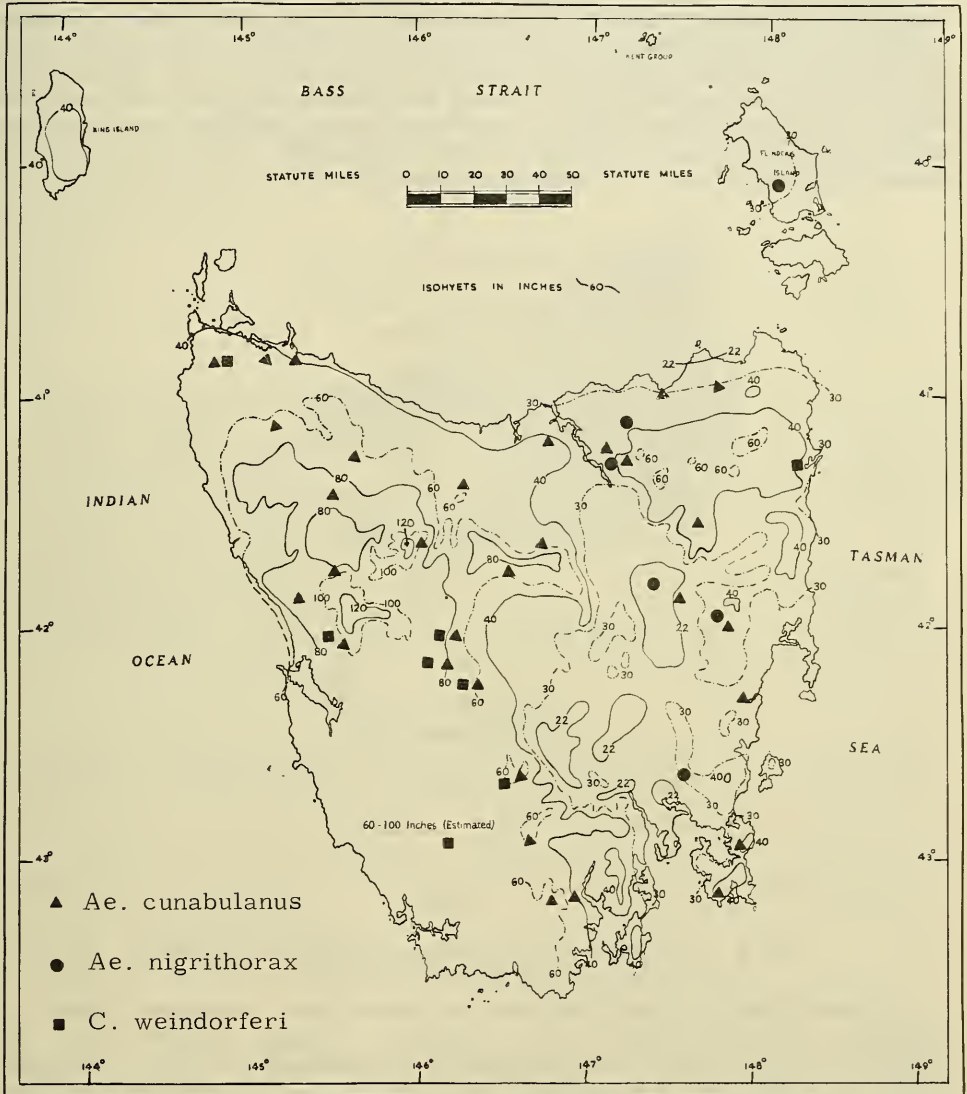


Fig. 1. Distribution of some species of mosquitoes in Tasmania and Bass Strait Islands.

of *Culiseta* widely distributed in the Eastern Highlands of Victoria have not dispersed across the intervening plain into the ecologically favourable Grampians and Otway Ranges.

Quite short stretches of ocean have apparently prevented the dispersal of the common Tasmanian species *Ae. cunabulanus* through the chain of islands to the ecologically suitable Flinders Island, itself only some 35 miles off the Tasmanian coast (Fig. 1). *Ae. cunabulanus* presumably evolved in Tasmania

before the Pleistocene but did not cross the land bridge which joined Tasmania to the mainland during the glacial period. It is difficult to imagine the cause of this failure but it is possible that this species evolved in remote or secluded parts of Tasmania and did not disperse until the disappearance of the land bridge.

While Bass Strait would seem to constitute an impassable barrier to the spread of some mosquitoes, the distribution of others seems to confirm Paramonov's (1959) claim that the main obstacles to the spread of some Victorian insects to Tasmania are climatic and ecological. This may be the explanation of the absence from Tasmania of Victorian species such as *Ae. dobrotworskyi* Marks which occurs in southern Victoria from Genoa to Apollo Bay, and *M. linealis* and *Ae. macmillani* which have reached Flinders Island but are apparently absent from Tasmania. The absence of *C. weindorferi* from the Bass Strait Islands may also be due to climatic factors (Fig. 2).



Fig. 2. Distribution of some species of mosquitoes in Victoria, Bass Strait Islands and Tasmania.

It seems therefore that the main migration route was from Victoria to Tasmania. The distribution of *Ae. andersoni* suggests however, that the migration of this species has occurred in both directions. The Grampians form of *Ae. andersoni* is common in the Grampians and is recorded also from a few localities along the Dividing Range to Kiandra in New South Wales. It is likely that this form migrated to Tasmania where the typical form evolved. In Tasmania this form is highly adapted to cold conditions and often breeds at high altitudes (3,000–3,500 feet). On the mainland its distribution is coastal.

The most important differences between the mosquito fauna of Tasmania and the Bass Strait Islands and that of southern Victoria are: (1) absence from Tasmania of the group of northern species which in Victoria are almost entirely confined to East Gippsland. (2) The absence from Tasmania of *Culiseta* species breeding in subterranean waters in tunnels of land crayfishes. These species are common throughout Gippsland. (3) The occurrence in Tasmania

of two endemic species: *Culiseta weindorferi* and *Aedes cunabulannus*. (4) Distribution of *Aedes andersoni* in Tasmanian highlands up to 3,500 feet. (5) The mosquito fauna of Bass Strait Islands is impoverished Victorian fauna.

Paramonov (1959) described the Tasmanian insect fauna as impoverished by comparison with that of Victoria and attributed this condition to the elimination of many species during the Pleistocene glaciation. However, it would seem that the impact of glaciation on the Tasmanian flora and fauna has been exaggerated, for Jennings and Banks (1958) assert that "an ice sheet occurred only in the Central Plateau with cirque and walley glaciers elsewhere". There is no doubt that certain endemic genera of plants became extinct during the most severe phase of glaciation (Burbidge, 1960) and it is possible that some endemic species of mosquitoes suffered the same fate. However, there is no evidence that the Tasmanian mosquito fauna was ever substantially richer than at the present time.

TAXONOMIC ACCOUNT

Family CULICIDAE

Key to genera

Adults

1. Scutellum trilobed, each lobe bearing bristles. Palps in female much shorter than proboscis 2
 Scutellum evenly rounded with marginal setae along it. Palps of females as long as proboscis *Anopheles*
2. (1) Pulvilli present *Culex*
 Pulvilli absent 3
3. (2) Spiracular bristles absent 4
 Spiracular bristles present 5
4. (3) Postspiracular bristles present *Aedes*
 Postspiracular bristles absent *Mansonia*
5. (3) Uniformly brown; base of subcostal vein hairy beneath *Culiseta*
 Black with patches of broad white scales on thorax and abdomen; base of subcostal vein bare beneath *Tripteroides*

Larval (fourth stage)

1. VIIIth abdominal segment without respiratory siphon *Anopheles*
 VIIIth abdominal segment with elongate respiratory siphon 2
2. (1) Distal half of siphon modified for piercing roots of aquatic plants *Mansonia*
 Siphon not modified, normal in shape 3
3. (2) Anal segment with ventral brush (seta 4) reduced to one pair of setae *Tripteroides*
 Anal segment with ventral brush of several tufts 4
4. (3) Siphon with pair of basal setae *Culiseta* (in part)
 Siphon without basal setae 5
5. (4) Siphon with several pairs of ventral tufts *Culex*
 Siphon with a pair of median tufts or setae 6
6. (5) Some of setae plumose; anal segment usually not completely ringed by saddle *Aedes*
 All setae non-plumose; anal segment completely ringed by saddle .. *Culiseta* (in part)

Subfamily ANOPHELINAE

Genus ANOPHELES Meigen

Key to Tasmanian species of the genus ANOPHELES

Adults

1. Wings and legs profusely marked with white scales *annulipes*
 Legs dark scaled 2
2. Wings with some silvery or pale sections of veins. Hind femur entirely dark scaled 3
 Wings entirely dark scaled. Basal four-fifths of hind femur creamy scaled *stigmaticus*
3. Fringe of wings with distinct white section at tip *atratipes*
 Fringe of wings entirely dark *tasmaniensis*

Subgenus ANOPHELES Meigen

ANOPHELES (ANOPHELES) STIGMATICUS Skuse

Anopheles stigmaticus Skuse, 1889, PROC. LINN. SOC. N.S.W., 3: 1758.

This is a small brown species. The basal four-fifths of the hind femora are clothed with creamy scales. It has been recorded from Hobart (Dobrotworsky, 1957). Additional record is: Flinders Island. It also occurs in the mountainous areas of Victoria and New South Wales.

Material examined: 2♂.

ANOPHELES (ANOPHELES) ATRATIPES Skuse

Anopheles atratipes Skuse, 1889, PROC. LINN. SOC. N.S.W., 3: 1755.

This also is a dark brown mosquito. However, the hind legs are entirely dark and the wings have white sections along some veins; the fringe scales at the tip of the wing are white. A single upper sternopleural bristle. The palpi are black and the two basal segments have a rather shaggy appearance (Plate 1).

It is a coastal species not previously recorded from Tasmania or Bass Strait Islands. It has been collected by A. L. Dyce and M. D. Murray at Bridgewater, and by the author at St. Helens and Detention River in Tasmania, and on King and Flinders Islands. It also occurs in all mainland states.

Material examined: 1♂, 14♀.

ANOPHELES (ANOPHELES) TASMANIENSIS n. sp.

Types: The holotype male and three paratype females were bred from larvae collected 29/11/62 at Birralee, Tasmania, and have their associated larval and pupal skins; the allotype and one paratype female were collected at the same locality and date, and eight paratype females were also collected there (27/10/61). The holotype male, allotype female and seven paratype females are in the National Insect Collection, C.S.I.R.O., Canberra. One female paratype is in each of the following collections: National Museum, Melbourne; School of Public Health and Tropical Medicine, Sydney; University of Queensland, Brisbane; British Museum (Natural History), London; U.S. National Museum, Washington.

Distinctive Characters. Adult: A dark species which has pale scales along only some sections of the wing veins. It can be distinguished from *An. atratipes* by the narrower squama scales of the veins, the entirely dark fringe of the wing, the presence of 3-5 upper sternopleural bristles. The two basal segments of the palpi are not shaggy (Plate 1).

Larva: Brown with white dorsal longitudinal stripe on the thorax and abdomen.

Holotype Male. Head: Vertex with pale upright forked scales, becoming black laterally. Frontal tuft white. Tori dark, flagellar segments of antennae pale, but two terminal segments dark; verticillate hairs silver grey. Palps dark scaled; long hairs on segments IV and V, pale. Proboscis black. Thorax: Scutum brown, margins lighter; anterior margin with median and lateral white scale-tufts. Bristles dark. One strong and three weaker upper sternopleural bristles and four lower sternopleural bristles; seven-eight upper mesepimeral bristles. Numerous pale setae in front of wing roots and along lateral edge of scutum. Scutellum light brown with 16 long black setae, and several small pale ones. Legs black, hind femora paler ventrally. Wings: Fringe dark without white section at tip of wings (wing scales partly rubbed, see description of wing venation in allotype female). Knob of haltere brown scaled, with pale stem. Abdomen: Dark brown, almost black, clothed with

numerous pale hairs; scales absent. Terminalia (Fig. 3 *a, b*): Coxite short, blunt, tapering, with long setae and a few scales laterally; inner side of coxite with a long subapical seta curved at its tip. A single stout parabasal spine curved at its tip, arising from an elongate base; ventral lobe of harpago with two short and two longer setae; dorsal lobe with fine broadened setae, four of them in close set row, and one shorter seta arising distally between them and ventral lobe. Style long and slender with minute setae along it; terminal appendage small. Lobes of tergite widely separated, with numerous short setae.

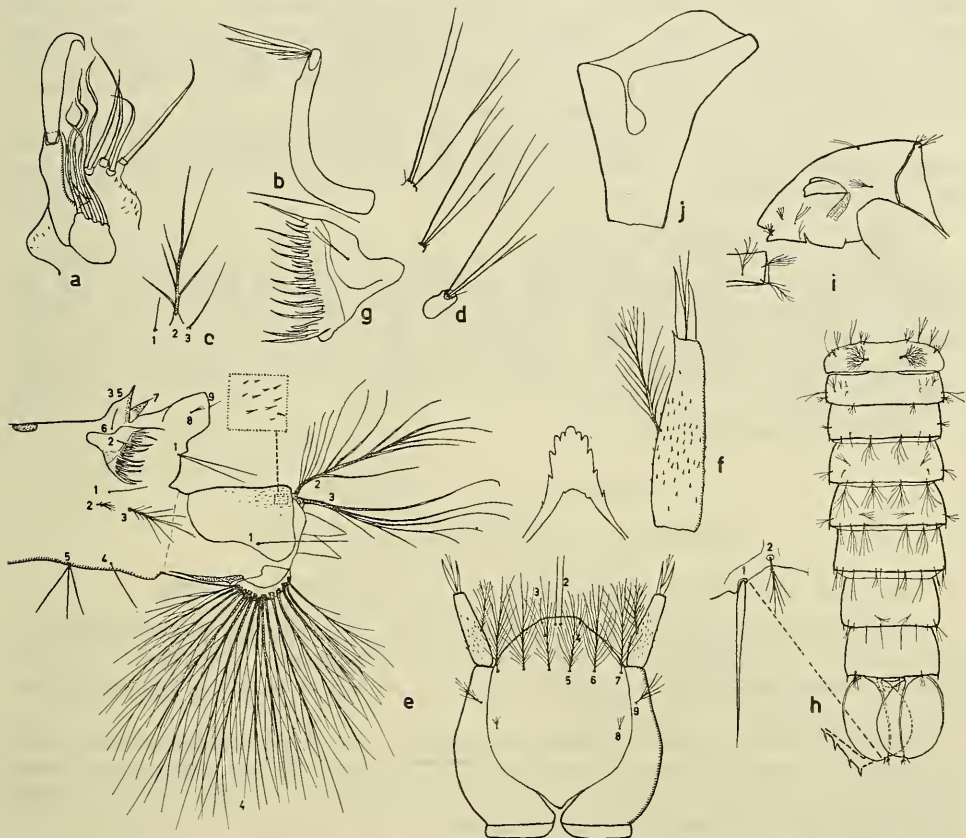


Fig. 3. *Anopheles tasmaniensis* n.sp., *a-b*, adult: *a*, harpago; *b*, phallosome; *c-g*, larva: *c*, prothoracic setae 1-3; *d*, pro-, meso- and metathoracic pleural setae; *e*, head, mentum and terminal segments; *f*, antenna; *g*, pecten; *h-j*, pupa: *h*, abdomen; *i*, cephalothorax and metanotum; *j*, trumpet.

Allotype Female. This differs from the holotype as follows: Tori and first flagellar segment pale, other flagellar segments black. Palps as long as proboscis without labella, black scaled. Scutum dark brown between dorso-central bristles; fossa and lateral area light brown sparsely clothed with small narrow curved pale scales; bristles black, but pale in front of wing roots and along border with pleura. Scutellum with a row of 25 strong black and several smaller pale bristles. 5-6 lower sternopleural bristles; 3 bristles on prealar knob; 10-14 upper mesepimeral bristles. Wings: C, Sc, R₁, R₂, R_s and M₃₊₄, uniformly clothed with dark scales; apical three-quarters of R₃, pale scaled; R₄₊₅ with some pale scales, particularly distally; Cu, pale scaled on basal three-quarters, dark apically; M and An, pale scaled, some black scales basally. Patches of black scales at base of fork R₂ and R₃, and M₁ and M₂, at base R₄₊₅, and M-Cu where it joins Cu.

Paratype Females. The series of 12 paratypes do not show significant variations.

Larva (Fig. 3 *c-g*): Brown with white dorsal longitudinal stripe on thorax and abdomen. Head: setae 2, arising close together, long, stout, single and simple; 3, single, simple; 4, fine, single, simple; 5, 6 and 7 plumose almost equal in length; 8, small, about 4 branched; 9, larger, about 7 branched. Antennae spiculated; seta 1, arising at about mid-length, about three-quarters as long as antenna, plumose. Thorax: Prothoracic setae 1 and 3, single, simple; 2, about 6 branched. Metathoracic palmate setae (1) reduced to branched hair. Abdomen: Segments I-VIII with narrow transverse tergal plate. Pecten with about 24 spines. Anal segment: Saddle covered with fine spicules; seta 1, long, single; 2, about 13 branched; 3, about 7 branched; 4 (ventral brush) of 14-16 plumose setae.

Pupa (Fig. 3 *h, i*): Trumpet broad with almost quadrangle opening, with deep incision. Paddle: without fringe; seta 1, single, stout; seta 2, small, fine, 5-6 branched.

Eggs are illustrated in Plate 2.

Biology: The adults were common in a tea-tree swamp near Birralee, northern Tasmania 27/10/61, but no larvae were found at that date. On the second occasion (29/11/62), this swamp was very shallow and dry in places; several larvae and pupae were collected in the deeper parts.

Distribution. Tasmania: Birralee and Redpa. It also occurs in a coastal belt of Victoria.

Material examined: 1♂, 20♀.

Subgenus CELLIA Theobald

ANOPHELES (CELLIA) ANNULIPES Walker*

Anopheles annulipes Walker, 1846, *Ins. Saund. Dipt.*, 1: 433.

Mackerras (1927), Lee and Woodhill (1944) pointed out the variability of this species in Tasmania as well as on the mainland. Specimens with an entirely black proboscis and others with the proboscis pale on the apical half have been collected in Tasmania.

It has been recorded from Launceston and Low Head (Lee, 1948). Additional records: Bridgewater (A. L. Dyce and M. D. Murray). Little Swanport, St. Patrick's River; King and Flinders Islands. It is widely distributed on the mainland of Australia.

Material examined: 4♂, 1♀.

Subfamily CULICINAE

Tribe SABETHINI

Genus TRIPTEROIDES Giles

Subgenus RACHIONOTOMYIA Theobald

Atripes Group

TRIPTEROIDES (RACHIONOTOMYIA) ATRIPES Skuse

Culex atripes Skuse, 1889, *Proc. Linn. Soc. N.S.W.*, 3: 1750.

A small black mosquito without a white pattern on the scutum; the pleura are densely clothed with white scales.

*For synonymy of this and other species, see Dobrotworsky (1965).

This is a first record of this species from Tasmania. All four specimens examined belong to the southern form of *T. atripes* which have small lateral patches on the tergites visible from above only on segments VI and VII. The females have been taken biting at Lisdillon and Ferntree.

T. atripes also occurs in South Australia, Victoria, New South Wales and Queensland.

Material examined : 4♀.

Caledonicus Group

TRIPTEROIDES (RACHIONOTOMYIA) TASMANIENSIS (Strickland)

Stegomyia tasmaniensis Strickland, 1911, *Entom.*, 44 : 249.

This can be distinguished from *T. atripes* by having a band of white scales across the pleuron, and by the pale scaling of the terminal segments of the hind legs.

It is distributed mainly in areas with an annual rainfall higher than 30 inches.

This species has been recorded from : Advent Bay, Bridport, Cradle Valley, Devonport, Eaglehawk, Geeveston, Hartz Mt., King River, Launceston, Mole Creek, Mt. Arthur, Mt. Farrel, Mt. Wellington, New River, St. Patrick's River, Springfield (Edwards, 1924, 1926); Ferntree, Low Head (Lee, 1946, 1948); additional records are : Maydena (D. L. Dyce and M. D. Murray); Derwent Bridge, Renison Bell and Flinders Island. It also occurs in Victoria, South Australia and New South Wales.

Material examined : 6♂, 20♀.

Tribe CULICINI

Genus MANSONIA Blanchard

Subgenus COQUILLETIDIA Dyar

MANSONIA (COQUILLETIDIA) LINEALIS (Skuse)

Culex linealis Skuse, 1899, *PROC. LINN. SOC. N.S.W.*, 3 : 1747.

Distinguished by the light-golden longitudinal lines on the dark-bronze scaled scutum and by the white scaled venter with median black patches and black apical border on the sternites.

This species has not been found in Tasmania but occurs on Flinders Island (J. H. Calaby and D. L. Dyce, 2/12/51; N. V. Dobrotworsky, 10/2/63). This is the most southern record of *M. linealis* which occurs in South Australia, Victoria, New South Wales and Queensland.

Material examined : 8♀.

Genus AEADES Meigen

Key to species of the genus AEADES

Adults, female

- 1. Tarsal segments with broad white bands 2
- Tarsi dark scaled, without white bands 10
- 2. (1) Wings mottled with white scales *flavifrons*
- Wings dark scaled or with a few slightly paler scales 3
- 3. (2) Wings with a few slightly paler scales form A
- Wings completely dark scaled 4
- 4. (3) Scutum with longitudinal lines and lyre-shaped pattern *notoscriptus*
- Scutum without such pattern 5

5. (4)	Scutum with patches of white scales ; femora with ochreous preapical ring	<i>alboannulatus</i>	6
	No patches of white scales on scutum ; femora without preapical ring		6
6. (5)	Fifth tarsal segment of hind legs black		7
	Fifth tarsal segment more or less white scaled		8
7. (6)	Venter more or less ochreous, usually with scattered black scales	<i>rubrithorax</i>	
	Venter either black with white lateral patches on sternites, or white with apical black band on sternites	<i>rupestris</i>	
8. (6)	Fifth tarsal segment of hind legs all white ; legs unmottled ; proboscis black scaled		9
	Fifth tarsal segment of hind legs dark scaled apically ; legs and proboscis intensively mottled	<i>campторhynchus</i>	
9. (8)	Vertex with broad scales ; proboscis short ; anterior half of scutum pale scaled	<i>macmillani</i>	
	Vertex with narrow scales ; proboscis of normal length ; scutum in general dark scaled	<i>calcariae</i>	
10. (1)	Wings mottled, scutum dark, contrasting with white scaled pleura	<i>stricklandi</i>	
	Wings with pale scales only along distal part of vein C and usually also R ; tergites unbanded, IV-VII mottled ; venter with some ochreous scales apically	<i>luteifemur</i>	
	Wings entirely dark scaled		11
11. (10)	Vertex with broad scales	<i>postspiraculosus</i>	
	Vertex with narrow scales		12
12. (11)	Scutum with broad margin of pale scales contrasting with dark scales medially		13
	Scutal scaling otherwise		14
13. (12)	Tergites unbanded ; hind femora mottled ; usually patch of broad scales in front of wing roots	<i>andersoni</i>	
	Tergites banded ; hind femora pale scaled on basal three-quarters ; no patch of broad scales in front of wing roots	<i>nigrithorax</i>	
14. (12)	All femora unmottled		15
	At least fore and mid femora mottled		17
15. (14)	Cerci long and narrow	<i>australis</i>	
	Cerci short and broad		
16. (15)	Tergites unbanded ; venter more or less purplish	<i>purpuriventris</i>	
	Tergites banded, venter ochreous scaled with some black scales	<i>clelandi</i>	
17. (14)	All femora mottled		18
	Hind femora pale on basal half or two-thirds		19
18. (17)	Proboscis black scaled	<i>cunabulanus</i>	
	Proboscis mottled	<i>continentalis</i>	
19. (18)	Scutal scales medially small, dark bronze ; tergites with white basal bands constricted laterally	<i>silvestris</i>	
	Scutal scales rather large, golden ; tergal bands on segments II-VI straight	<i>nivalis</i>	

Larvae (fourth stage)

1.	Head seta 5, single (rarely 2 branchiae on one side)	2
	Head seta 5 with two or more branches	6
2. (1)	Lateral comb teeth in irregular or triangular patch	3
	Lateral comb teeth in a single row	5
3. (2)	Siphon long slender with index 4·7-5·3 ; seta 1, longer than half length of siphon	<i>postspiraculosus</i>
	Siphon short, seta 1, small	4
4. (3)	Lateral comb teeth of distal row larger than those in basal rows ; saddle covering three-quarters of dorsal part of segment ; upper pair of anal papillae about as long as saddle	<i>notoscriptus</i>
	Lateral comb teeth of equal size ; saddle reduced ; anal papillae very small	<i>australis</i>
5. (2)	Pecten with 1-2 detached spines above seta 1 ; lateral comb of 8-14 spines	<i>nigrithorax</i>
	Pecten without detached spines ; lateral comb usually of 4 spines	<i>stricklandi</i>
6. (1)	Head seta 6, single	7
	Head seta 6, multibranchied	9
7. (6)	Scales of lateral comb fringed, with central long spine ; ventral brush without precratal tufts ; anal papillae short, less than half as long as saddle	<i>clelandi</i>
	Scales of lateral comb fringed, without long central spine	8
8. (7)	Lateral comb patch of less than 36 scales ; siphon index less than 3 ; pecten of thick spines with pale tip	<i>calcariae</i>
	Lateral comb patch of 35-53 scales ; siphon index more than 3 ; pecten spines slender, tip black	<i>flavifrons</i>

9. (6) Antennae at least as long as head or longer; scales of lateral comb fringed, without long central spine; spines of pecten with pale tip; anal papillae unequal, shorter than saddle *purpuriventris*
10. (9) Antennae shorter than head 10
10. (9) Anal papillae small globular; scales of lateral comb coarsely fringed, without central long spine *camptorhynchus*
- Anal papillae elongate, pointed 11
11. (10) Lateral comb scales finely fringed 12
- Lateral comb scales with 1-4 longer central spines, coarsely fringed basally 14
12. (11) Head setae 4, 5 and 6, almost in straight line; prothoracic seta 4 single; 5, 2-3 branched *rupestris*
- Head setae 4, 5 and 6, forming triangle; prothoracic seta 5 single 13
13. (12) Head setae 4, 5 and 6, forming almost a right-angle with seta 4 well in front of seta 5; prothoracic seta 4, single *alboannulatus*
- Head setae 4, 5 and 6, forming obtuse angle, with seta 4 slightly in front of or behind seta 5; prothoracic seta 4, 2-3 branched *rubrithorax*
14. (11) Siphon index exceeds 3; pecten of 24-37 close-set, strong, dark spines with paler tip 15
- Siphon index usually less than 3; pecten of 16-25 evenly spaced spines with dark tip 16
15. (14) Prothoracic setae 1, 2 and 6, single; 3, 4 and 5, 2-branched *andersoni*
- Prothoracic setae 1, 2, 4, 5 and 6, single; 3, 2-branched *continentalis*
16. (14) Scales of lateral comb with central spine at least twice as long as nearest lateral 17
- Scales of lateral comb with 2-4 longer spines of almost equal length *cunabulanus*
17. (16) Anal papillae less than half length of saddle *luteifemur*
- Anal papillae almost as long as saddle or longer *nivalis*
or *silvestris*

Subgenus OCHLEROTATUS Lynch Arribalzaga

Burpengariensis Section

AEDES (OCHLEROTATUS) NIGRITHORAX (Macquart)

Culex nigrithorax Macquart, 1847, *Dipt. Exot. Supp.*, 2: 9.

This species was originally described from Tasmania and was known only from the type specimen until F. N. Ratcliffe rediscovered it in 1952. Dr. E. N. Marks redescribed the species in 1960.

Ae. nigrithorax is closely related to *Ae. sagax* (Skuse) and can only be distinguished from the latter by the scale pattern on the scutum which is dark bronze medially and creamy, or white, laterally and the hind femora which are pale almost to the apex. Both these traits vary a great deal, particularly the scutal pattern, and in some areas, where the distributions of the two species overlap, it is difficult to separate them. *Ae. sagax* is absent from Tasmania and because of this it is possible to study the range of variation in *Ae. nigrithorax*. For these studies 280 specimens have been collected and examined.

The scutal pattern in *nigrithorax* from Tasmania varies a great deal. Among specimens bred from one pool at Epping, there were some with lateral areas of the scutum clothed with creamy scales and others with almost an entirely dark scutum. The pattern of the hind femora is more constant; all examined specimens had the femora white anteriorly with dark scaling only at the apex (Plate 2 *a, b*).

Particular attention was paid to the presence of tooth on the claws of hind tarsi; in the *Ae. sagax* from Northern Victoria these are simple. The study of the claws of the hind legs in two Tasmanian populations revealed high variability of this trait. There are specimens with or without tooth on all four claws or with three or two or only one claw toothed (Table 4).

TABLE 4
Variability of the hind claws in Ae. nigrithorax

Locality	Specimens examined	Percentage of specimens showing various distribution of teeth										
		1/1	1/1	1/1	1/0	1/0	1/0	1/1	0/0	0/1	0/0	0/0
Epping.. ..	222	45.5		15.7		7.7		3.6		10.4		17.1
Runnymede ..	58	56.9		12.1		5.2		3.4		10.6		12.1
	280	47.8		15.0		7.1		3.6		10.4		16.1

Description of fourth stage larva (from Epping): Head broad, seta 4, very small, 2-4 branched; 5, 6 and 8, single; 7, 3-6 branched; 9, 2-branched. Antenna short, about half length of head; seta 1, 3-7 branched. Mentum with 11-13 lateral teeth on each side. Prothoracic setae 1, 2, 4 and 6, single; 3 and 5, single or 2 branched; 7, 3-5 branched. Abdomen. VIIIth segment: lateral comb row of 9-13 spines coarsely fringed basally; seta 1, 4-7 branched; 2 and 4, single; 3, 8-13 branched; 5, 5-8 branched. Siphon index 2.6-3.7, mean 3.1; pecten of 22-29 spines, 1 or 2 detached spines beyond seta 1; seta 1, 3-6 branched. Anal segment: setae 1 and 3, single; 2, 6-10 branched; 4 (ventral tuft) of 16 tufts, 1-2 precratal. Anal papillae lanceolate, about as long as the saddle or longer.

Distribution. It has been found in the dryer eastern part of Tasmania at lower altitudes where it is confined to sclerophyll forests. It has been recorded from Epping (Marks, 1960) and Launceston (Mackerras, 1927). Additional records are: Tasmania: Nunamara, Runnymede, Golconda and Lake Leake; Flinders Island. It occurs also in Victoria, South Australia and New South Wales.

Material examined: 39♂, 275♀.

Flavifrons Section

Aedes (Ochlerotatus) flavifrons (Skuse)

Culex flavifrons Skuse, 1889, PROC. LINN. SOC. N.S.W., (2) 3: 1735.

This species can be recognized fairly easily from others. It has a dark blotch on the wing membrane, mottled wings, mottled femora and tibiae and banded tarsi; the tergites are unbanded. However, *Ae. flavifrons* is a very variable species. The proboscis may be intensively mottled or have only a few pale scales. The scutum may be clothed with light golden scales or clothed mainly with dark bronze, almost black scales with only a few pale golden ones mostly around the bare prescutellar area. Usually all the hind tarsal segments have only basal white bands. However, sometimes there may also be pale scales apically or almost complete apical ring on segments I and II. The mottling of the tergites also varies considerably. Ranging from a scattering of a few pale scales on the terminal segments to an intensive mottling of all tergites; some specimens have tergites VI and VII creamy scaled. The venter may be creamy scaled with a few scattered black scales, or the mottling may be so intensive that the venter appears almost black.

Distribution. This species is particularly common in the northern part of Tasmania. It has been recorded from: Wedge Bay and Mt. Arthur (Edwards, 1924); Eaglehawk Neck, Geeveston, Low Head (Lee, 1948); Advent Bay, Russell Falls, Strahan (Marks, 1964); King Island (Mackerras, 1927). Additional records are: Birrallee, Liapootah, Little Swanport, Marrawah, Montumana,

Mt. Field Nat. Pk., Mt. Hartz Nat. Pk., Oonah, Port Arthur, Powranna, Pt. Sorell, Redpa, Sassafras; Flinders Island. It also occurs in Victoria, South Australia and New South Wales.

Material examined: 5♂, 251♀.

AEDES (OCHLEROTATUS) CALCARIAE Marks

Aedes calcariae Marks, 1957, *Pap. Dep. Ent. Univ. Qd.*, 1 (5): 74.

This species has dark scaled wings. The legs are unmottled, the tarsi banded and the terminal segment of the hind tarsus is entirely white. The sternites are pale scaled with basal median and apical lateral black patches.

This is the first record of this species from Tasmania. It has been collected at Carrick, Little Swanport and Nunamara. It also occurs in Victoria and South Australia.

Material examined: 3♂, 4♀.

AEDES (OCHLEROTATUS) PURPURIVENTRIS Edwards

Aedes purpuriventris Edwards, 1926, *Bull. ent. Res.*, 17: 13.

This can be readily distinguished by the black scaled wings and legs, unbanded tarsi, the presence of a dark blotch in the middle of the wing membrane and the partly or wholly purple-scaled venter.

Ae. purpuriventris was originally described from a single female collected at Eaglehawk Neck and rediscovered during the present studies in several localities: Bridport, Liapootah, Little Swanport, Mt. Hartz Nat. Pk., Storey's Creek. It also occurs in Victoria.

Material examined: 16♂, 19♀.

AEDES (OCHLEROTATUS) CLELANDI (Taylor)

Culicada clelandi Taylor, 1914, *Trans. ent. Soc. Lond.*, 1913: 690.

The main distinctive characters are: The scutum uniformly clothed with golden scales; unmottled femora, the unbanded tarsi, the narrow creamy tergal bands and the ochreous venter with some black scales.

This species was originally described by Taylor (1913) from Flinders Island, and later recorded from King Island (Mackerras, 1927), but is not recorded from Tasmania. It also occurs in coastal areas of Western Australia, South Australia and Victoria.

Material examined: 11♀.

Perkinsi Section

AEDES (OCHLEROTATUS) LUTEIFEMUR Edwards

Aedes luteifemur Edwards, 1926, *Bull. ent. Res.*, 17: 112.

A rather light coloured species which can be distinguished by the pale scaling of apical part of the costal vein and at R₁. The hind femora are more or less ochreous with only a few dark scales apically; the tarsi are dark. The tergites are unbanded with scattered, more or less ochreous, scales, particularly on the apical segments.

Most of the specimens collected in Tasmania and King Island are typical. However, some have the distal part of the hind femur mottled with dark scales. A few specimens have all the tergites extensively mottled with ochreous scales. Many specimens collected at Flinders Island are much darker than the typical

ones. Males often have all the scales on the wings dark and the apical half or one-third of the hind femora dark scaled anteriorly. In the dark females the wings have pale scales only on the apex of the subcosta; the hind femora are as in the males but there are always some ochreous scales.

This is a very common species recorded from: Advent Bay, Mt. Farrel, Strahan (Edwards, 1926); Georgetown (Mackerras, 1927); Lake St. Clair (Dobrotworsky, 1960). Additional records are: Birrallee, Blackwood, Bridport, Buttlers Gorge, Deloraine, Dundas, Florentine Valley, Frankford, Geeveston, Golconda, Granton, King River, Kamona, Marrawah, Montana, Nunamara, Port Arthur, Pt. Sorell, Queenstown, Redpa, Sassafra, Smithton, Tullah, Zeehan; King and Flinders Islands. It also occurs in Victoria.

Material examined: 10♂, 156♀.

AEDES (OCHLEROTATUS) SILVESTRIS Dobrotworsky

Aedes waterhousei Dobrotworsky, 1960, PROC. LINN. SOC. N.S.W., 85: 57.

A large dark species with unbanded tarsi. The tergites are black with convex bands. The sternites are white scaled with prominent median and apical black patches. It has been recorded from Hobart (Dobrotworsky, 1960). Additional records are: Blackwood, Epping, Lake Leake, Little Swanport, Montana, Powrana. It also occurs in Victoria, South Australia and New South Wales.

Material examined: 11♂, 18♀.

AEDES (OCHLEROTATUS) NIVALIS Edwards

Culex australis Theobald, 1911 (*non* Erichson, 1842), *Mon. Cul.*, 2: 91.

The female is similar to that of *Ae. silvestris* but the scutal scales are golden and larger than in *silvestris*; the tergal basal bands are almost straight. The males are readily distinguished from all other species by having hairy tergites; the only scales present form lateral white patches. In some specimens the basal abdominal bands are reduced to a narrow line.

It has been recorded from: Mt. Wellington (Edwards, 1926), Great Lake (Lee, 1948). Additional records are: Battler's Gorge, Blackwood, Breona, Campbell Town, Derwent Bridge, Granton, Lake Leake, Little Swanport, Poatina, Powrana, Waldheim. It also occurs along the Great Dividing Range in Victoria and New South Wales.

AEDES (OCHLEROTATUS) CAMPTORHYNCHUS (Thomson)

Culex camptorhynchus Thomson, 1868, *Eugenie's Resta Dipt.*, p. 443.

Easily recognized by the uniformly clothing of golden scales on the scutum, the extensive mottling of the proboscis and legs with pale scales, the dark scaled wings and the banded tarsi. The tergal basal bands are convex and the white sternites have median and lateral patches of black scales. It is common in the coastal areas where it breeds usually in brackish waters, but it has also been recorded on occasions breeding in fresh water pools and swamps.

It has been recorded from: Cataract Gorge, Georgetown, Launceston, St. Helens (Edwards, 1924); Burnie, Coles Bay, Ferntree, Fort Direction, Hobart, King River, Sandford, Sassafra (Lee, 1948). Additional records are: Bridgewater (A. L. Dyce and M. D. Murray); Lake Leake, Little Swanport, Port Arthur, Swan Sea; St. Margarets, Sunday (D. L. McIntosh), King and Flinders Islands. It also occurs in Victoria, South Australia, Western Australia and New South Wales.

Material examined: 20♀.

Cunabulanus Section

AEDES (OCHLEROTATUS) CUNABULANUS Edwards

Aedes cunabulanus Edwards, 1924, *Bull. ent. Res.*, 14 : 378.

It has an entirely black proboscis and black tarsi, the scutum uniformly clothed with golden scales and mottled hind femora.

Ae. cunabulanus is a variable species. Two main forms may be recognized :

1. Specimens with broad tergal bands. This form usually has white curved scales on the vertex ; the upright scales are light brown or pale medially, black laterally ; behind the eyes there are two dark patches. The posterior pronotum with elongate white scales below and also in the middle among the narrow curved black ones. The venter is usually entirely white but may have more or less conspicuous dark median, and apical lateral, patches.
2. Specimens without basal tergal bands. The vertex has narrow, curved creamy scales with the upright scales light golden medially, dark laterally ; there may be no dark patch behind the eyes. The elongate white scales on the posterior pronotum are restricted to its lower part. The venter has prominent black patches ; the lateral ones in some specimens joining in the middle, forming apical black bands.

Both these forms often occur together, and the intermediates are common.

This species has been recorded from : Cradle Valley, Ferntree, Mt. Farrel, Mt. Field, Mt. Wellington, St. Patrick, Strahan (Edwards, 1924, 1926) ; Mt. Arthur (Mackerras, 1927) ; Ben Lomond, Great Lake, Lake St. Clair, Ragged Jack Saddle, Upper Blessington, Walls of Jerusalem (Lee, 1948), Gormanston, Moth Creek (Dobrotorsky, 1960). Additional records are : Bridgewater (A. L. Dyce and M. D. Murray) ; Breona, Bridport, Buttler's Gorge, Campbell Town, Derwent Bridge, Eaglehawk Neck, Florentine Valley, Forth Falls, Geeveston, Golden Valley, Granton, Hartz Nat. Pk., Kamona, King River, King William Saddle, Lake Leake, Liapootah, Lilydale, Little Swanport, Mt. Arthur, Nunamara, Parrawe, Patersonia, Port Arthur, Queenstown, Redpa, Renison Bell, Rocherlea, Rosebery, Storey's Creek, Tunel Mt., Waldheim, Wandobe Riv., Waratah, Zeehan. *Ae. cunabulanus* has not been recorded outside Tasmania.

Material examined : 56♂, 330♀.

AEDES (OCHLEROTATUS) CONTINENTALIS Dobrotorsky

Aedes continentalis Dobrotorsky, 1960, *PROC. LINN. SOC. N.S.W.*, 85 : 71.

Rather similar to *Ae. cunabulanus* but can be separated from it by the presence of pale mottling on the proboscis.

This is a coastal species which occurs mainly in the northern part of Tasmania : Birrallee, Bridport, Lake Leake, Redpa. It has been also recorded from Flinders Island (Dobrotorsky, 1960) and occurs in Victoria.

Material examined : 11♂, 39♀.

AEDES (OCHLEROTATUS) ANDERSONI Edwards

Andersonia tasmaniensis Strickland, 1911, *Entom.*, 44 : 250.

Easily distinguished by the scutal pattern and the presence of a patch of broad, flat, white scales in front of the root of each wing (the typical form). The hind femora are mottled, the tarsi dark and the tergites unbanded.

Among the typical form collected in Tasmania, a few specimens have a patch of elongate and rather narrow scales in place of the broad scales at the wing roots.

This species has been recorded from : Cradle Valley, Eaglehawk, Geeveston, Mt. Farrel, Mt. Field, St. Patrick (Edwards, 1926); Great Lake, Upper Blessington (Lee, 1948); Boystown Res., Lake St. Clair, Port Davey (Dobrotworsky, 1960) and Flinders Island (Dobrotworsky, 1960). Additional records are : Birrale, Breona, Bridport, Buckland, Campbell Town, Derwent Bridge, Frankford, Golconda, Granton, King William Saddle, Lake Leake, Lebrina, Lilydale, Lisdolon, Montana, Mt. Cameron, Mt. Arthur, Nunamara, Patersonia, Port Arthur, Pt. Sorell, Redpa, Rocherlea, Ross, Sassafras, St. Patrick's River, Storey's Creek, Swan Sea, Wayatinah, Zeehan; King Island. It also occurs in Victoria.

Material examined : 33♂, 107♀.

Stricklandi Section

AEDES (OCHLEROTATUS) STRICKLANDI (Edwards)

Grabhamia australis Strickland, 1911, *Entom.*, 44 : 133.

Easily recognized by the dark-bronze scutum contrasting with the white scaled pleura, the dark scaled wings mottled with broad white scales and the dark scaled tarsi.

It was originally described from Flinders Island by Strickland (1911) and later collected frequently there (J. B. Cleland, J. H. Calaby, D. L. McIntosh). It also occurs on King Island, but has not been recorded from Tasmania. *Ae. stricklandi* has a coastal distribution in Victoria, South Australia and Western Australia.

Material examined : 14♀.

Group undetermined

AEDES (OCHLEROTATUS) form A

A female reared from a pupa collected in a ground pool at Flinders Island (8/2/63) is probably an undescribed species, but as the male and the larva are unknown its taxonomic status remains uncertain. The main morphological traits of this female are :

Vertex with pale forked and curved scales; palps with pale scales at tip; proboscis dark scaled with admixture of some pale scales on basal three-quarters. Scutum uniformly clothed with pale-golden scales with admixture of some dark scales in fossae and laterally on anterior half. Posterior pronotum with broad dark scales medially and narrow, curved, pale scales below and above. Pleura with broad pale scales; two strong pale lower mesepimeral bristles (on one side). Wing membrane with faint blotch in middle; dark scaled with a few scattered pale scales. Femora dark scaled to base, anteriorly with admixture of a few pale scales, posteriorly more intensively mottled with pale scales, particularly on basal one-third. Tibia dark scaled with some mottling. All tarsal segments with basal white bands. Tergites dark scaled, unbanded with white basal lateral patches; 6th and 7th mottled. Sternites pale scaled with dark apical bands.

Subgenus FINLAYA Theobald

Mediovittatus Group

AEDES (FINLAYA) NOTOSCRIPATUS (Skuse)

Culex notoscriptus Skuse, 1889, *PROC. LINN. SOC. N.S.W.*, 3 : 1738.

A small black species with banded tarsi. It is easily recognized by a re-shaped pattern on the scutum and the banded proboscis.

It has been recorded from Low Head (Lee, 1948). Additional records are: Maydena (A. L. Dyce and M. D. Murray); Epping, Hobart; Flinders Island. It is widespread on the mainland of Australia.

Material examined: 4♀.

Alboannulatus Group

AEDES (FINLAYA) ALBOANNULATUS (Macquart)

Culex alboannulatus Macquart, 1849, *Dipt. exot. Suppl.*, 4: 10.

A dark species with a mottled proboscis, banded tarsi and a preapical white band or patch on the femora; the venter is white with black median patches.

It has been recorded from: Strahan (Edwards, 1926). Additional records are: Bridgewater, Sandfly (A. L. Dyce and M. D. Murray); Birrallee, Carrick, Christmas Hills, Deloraine, Little Swanport, Marawah, Powranna and Bass Strait Islands: Deal (Zosky), King and Flinders. It also occurs in Western Australia, South Australia and in all the eastern states of Australia.

Material examined: 37♂, 52♀.

AEDES (FINLAYA) RUBRITHORAX (Macquart)

Culex rubrithorax Macquart, 1850, *Dipt. exot. Suppl.*, 4: 9.

Rather similar to *Ae. alboannulatus* but the proboscis is unmottled, there is no preapical white band on the femora, and the venter has an ochreous tint with a mottling of black scales.

One female from Flinders Island differs from all other specimens in having the hind femora dark scaled dorsally almost to base and anteriorly with only a few pale scales.

It has been recorded from: Hillwood, Lindisfarne, Westmoreland (Edwards, 1924), and Flinders Island (Dobrotworsky, 1960). Additional records are: Lake St. Clair, Maydena (A. L. Dyce and M. D. Murray); Orford, Geeveston (E. G. Connah); Bicheno, Birrallee, Bridport, Blackwood, Bronte, Buckland, Buttler's Gorge, Carrick, Deloraine, Dunnorlan, Elizabeth Town, Ferntree, Florentine Valley, Frankford, Hobart, King River, Lake Leake, Lebrina, Lilydale, Little Swanport, Myrtle Bank, Mt. Arthur, Mt. Field Nat. Pk., Mt. Hartz Nat. Pk., Mt. Wellington, Nunamara, Oonah, Osterley, Parrawe, Patersonia, Port Arthur, Powranna, Queenstown, Rocherlea, Rosebery, Sassafras, St. Clair, St. Helens, St. Marys, Storey's Creek, Waldheim, Waratah, Weldborough; North Bruny Island (E. G. Connah), Deal Island (E. Zosky) and King Island. It also occurs in South Australia and all eastern states of Australia.

Material examined: 36♂, 157♀.

AEDES (FINLAYA) RUPESTRIS Dobrotworsky

Aedes rupestris Dobrotworsky, 1959, *PROC. LINN. SOC. N.S.W.*, 84: 136.

This is similar to *Ae. rubrithorax*, but may be easily separated from it by the pattern on the venter: the sternites are black scaled with basal lateral white patches, or are white scaled with a median patch and an apical black band. This species has not previously been recorded from Tasmania. It has been collected at: North Bruny Island (E. G. Connah); Forth Falls, Huonville, Little Swanport, Rosebery. It also occurs in Victoria and Queensland, and presumably in New South Wales, but it has not been recorded there.

Material examined: 5♂, 12♀.

Subgenus CHAETOCRUIOMYIA Theobald

Aedes (CHAETOCRUIOMYIA) MACMILLANI Marks

Aedes macmillani Marks, 1964, *Proc. Linn. Soc. N.S.W.*, 89 : 131.

A very small stoutly-built species with short proboscis and legs. The anterior half of the scutum is pale, the posterior half dark. The tarsi are banded.

One female was collected by the author at Flinders Island 8/2/63, and this is the most southern record of this species. It also occurs in Victoria and New South Wales.

Subgenus PSEUDOSKUSEA Theobald

Aedes (PSEUDOSKUSEA) POSTSPIRACULOSIS Dobrotworsky

Aedes postspiraculosis Dobrotworsky, 1960, *Proc. Linn. Soc. N.S.W.*, 85 : 261.

A rather small blackish mosquito with banded abdomen and unbanded tarsi. It is easily distinguished from all others by the broad flat scales on the vertex.

This is the first record of this species from Tasmania: Epping, Little Swanport, Powanna, St. Marys. It also occurs in South Australia, Victoria and New South Wales.

Material examined : 19♂, 10♀.

Subgenus HALAEDES Belkin

Aedes (HALAEDES) AUSTRALIS (Erichson)

Culex australis Erichson, 1842, *Arch. Naturgesch.*, 8 : 270.

This is a rather inconspicuous brown species with unbanded tarsi, broad creamy basal bands on the tergites and pale sternites with apical lateral black patches.

At Killiecrankie Bay, Flinders Island, *Ae. australis* behaved as a domestic species, invading houses near the shore; it fed during the night.

It has been recorded from: Eaglehawk Neck (Edwards, 1926), Low Heads (Lee, 1948), Port Davey (Marshall Laird, 1956). Additional records are: Bicheno, Black River, Hobart, Port Arthur, Randalls Bay, and Bass Strait Islands: Deal (E. Zosky), Fisher (J. H. Calaby), Great Dog (J. Thomson), Erith (S. Murray-Smith), King and Flinders. It also occurs along the coast of the Australian mainland from the southern border of Queensland to South Australia and along the southern part of Western Australia.

Material examined : 5♂, 16♀.

Genus CULISETA Felt

Subgenus AUSTROTROTHEOBALDIA Dobrotworsky

CULISETA (AUSTROTROTHEOBALDIA) LITTLERI (Taylor)

Chrysoconops littleri Taylor, 1914, *Trans. ent. Soc. Lond.*, (4) : 702.

It can be distinguished from other species by the pale upright scales on the vertex and by the presence of narrow curved scales on the posterior pronotum.

This species was originally described from a single female from Mt. Arthur, Tasmania. No specimens were collected during the present studies. Apparently it is very rare in Tasmania.

C. littleri also occurs in Victoria and New South Wales.

Subgenus CULICELLA Felt

CULISETA (CULICELLA) INCONSPICUA (Lee)

Theobaldia inconspicua Lee, 1937, PROC. LINN. SOC. N.S.W., 42: 294.

This can be recognized by the dark upright scales on the vertex, the pale scaling of the underside of the proboscis and the bare posterior pronotum.

The swarming of *C. inconspicua* has been observed on Flinders Island (8/2/63). It occurred in a forest glade close to a bush. The swarm appeared just after sunset and consisted of some hundred males, which moved rhythmically in a vertical direction some three to six feet above the ground.

It has been recorded from Sulfur Creek (Dobrotworsky, 1954). Additional records in Tasmania are: Birralee, Bridport, Bronte, Buckland, Carrick, Deloraine, Dunnorlan, Frankford, Geeveston, King River, Lilydale, Montana, Montumana, Moorina, Mt. Field Nat. Pk., Mt. Hartz Nat. Pk., Port Arthur, Pt. Sorell, Myrtle Bank, Redpa, Renison Bell, Rocherlea, Sassafras, Smithton, St. Marys, St. Patrick's Riv., Storey's Creek, Swansea, Waratah and Zeehan; Flinders, King and Great Dog Islands.

C. inconspicua also occurs in Victoria, South Australia and New South Wales.

Material examined: 47♂, 28♀.

CULISETA (CULICELLA) WEINDORFERI (Edwards)

Theobaldia weindorferi Edwards, 1926, *Bull. ent. Res.*, 17: 111.

This species was described in 1926 and has not been collected again until present studies. The discovery of a breeding place in Redpa has made possible the description of the life history of the species.

Edwards in his description stated that the type female differs from the male "in having the upright scales of the head dark". An examination of the types in the National Insect Collection, Canberra, has shown that the female with dark scales on the vertex is actually a different species: *C. inconspicua* described by Lee in 1937.

Distinctive Characters. *The females:* Upright and narrow curved scales on vertex pale; lateral broad scales, white; ocular setae dark. Proboscis and palps black scaled; torus light brown with black setae, scales absent; flagellar segments dark with black setae. Scutum with very narrow dark bronze scales, setae black; scutellum with fine narrow pale scales and seven black border bristles on each lobe. Anterior pronotum with bristles only. Posterior pronotum with a few hair-like scales. Two dark spiracular bristles. Mesepimeron with two dark, strong lower bristles, a patch of fine hairs, very few narrow scales near middle and several bristles on upper part. Tergites clothed with dark scales with violet reflections. Venter with lighter scales. Wings dark scaled. Legs, including tarsi, dark; femora of all legs dark anteriorly to the base.

The male: Palps slightly shorter than proboscis with labella; terminal segment parallel to proboscis. Terminalia (Fig. 4 a, b): Coxites more than twice as long as broad, tapering on distal one-third; basal lobe with a tuft of rather long, curved thick setae. Phallosome simple, oval in shape. Paraproct with three teeth. Lobes of tergite IX distinct, each with 6-8 setae.

Larva (Fig. 4 c, d): Brownish. Head about two-thirds as long as broad. Antennae slightly shorter than length of head; seta 1 arising about three-quarters of length from base, about 19-22 branched. Head setae: 4, moderately long, single; 5, 4-5 branched; 6, single; 7, 3-4 branched; 8 and 9, 2 branched. Mentum with 10-12 lateral teeth. Prothoracic setae 1, 2, 3, 5, 6 and 7, single; 4, 2 branched. Abdomen. VIIIth segment: lateral comb patch of 42-50

fringed scales; seta 1, plumose, 8-12 branched; 2 and 4, single; 3, plumose, 3-5 branched; 5, 2-4 branched. Siphon long, slightly tapering, with index 6.0-7.1; basal seta single; pecten of 3-7 spines. Anal segment: saddle complete ring; seta 1, 1-2 branched; 2, 7-9 branched; 3, 3 branched; 4 (ventral brush) of 15-16 tufts. Anal papillae narrow, pointed, about as long as saddle or slightly longer.

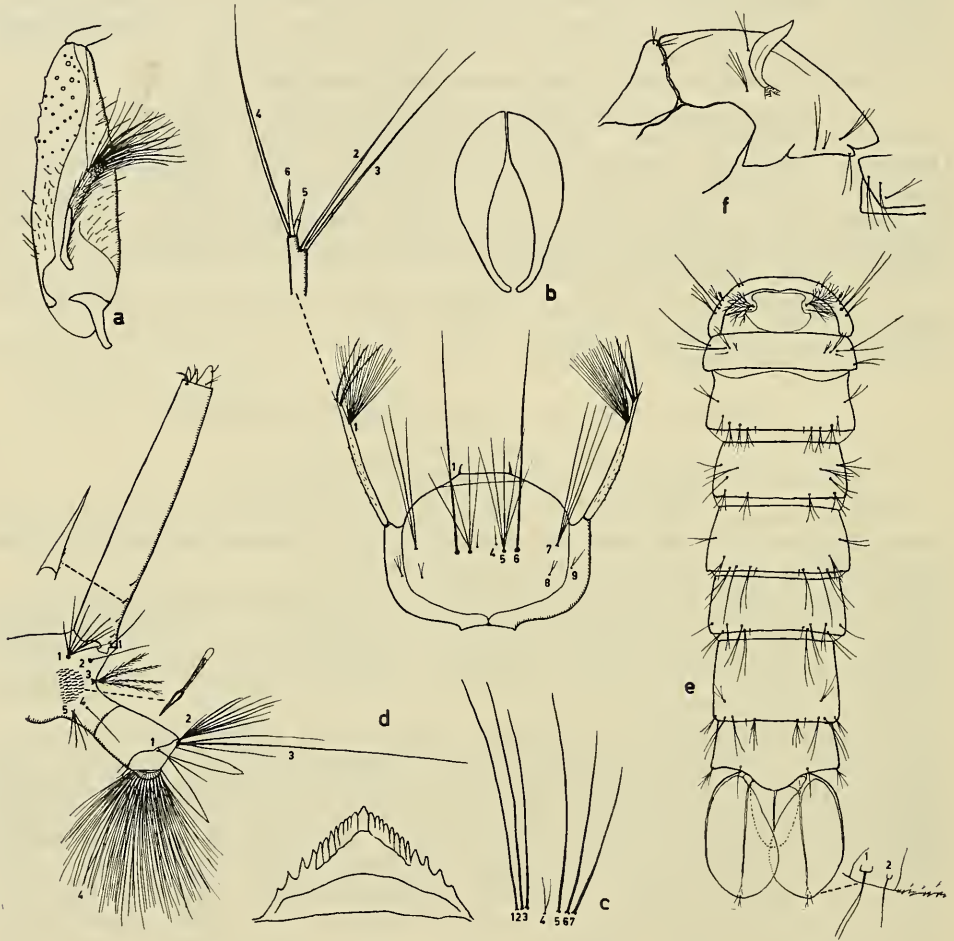


Fig. 4. *Cutiseta weindorferi* Edw., a-b, adult: a, coxite, inner aspect; b, phallosome; c-d, larva: c, prothoracic setae; d, head, mentum and terminal segments: e-f, pupa: e, abdomen; f, cephalothorax and metanotum.

Pupa: Details shown in Fig. 4 e, f.

Biology. This is a day-biting species which attacks man. It is well adapted to a cold climate and continues biting activity at temperatures as low as 11°C.

Its mating behaviour is similar to that of *C. hilli* Edw.; it occurs during the day and the males have been observed in small numbers flying about close to ground. Coupling is usually initiated while both sexes are in flight, and is completed on the grass. Larvae have been found in a pit under an uprooted tree in dense bush.

Distribution. It occurs only in Tasmania, and has been collected at : Lake St. Clair, Maydena (A. L. Dyce and M. D. Murray), Arthur Plains (A. Neboiss); Florentine Valley (M. Littlejohn); Buttler's Gorge, six miles west of King Saddle, Queenstown, Redpa, St. Helens.

Material examined : 63♂, 58♀.

Discussion. *C. weindorferi* is closely related to *C. otwayensis* Dobr. The adults of both species are very similar but the males of *C. weindorferi* have 6-8 setae on each lobe of tergite IX. The larva also are similar, but may be separated by the following traits : in *weindorferi* the mentum has 10-12 lateral teeth (*otwayensis* 13-14); seta 3 of abdominal segment VIII, 3-4 branched (*otwayensis* 5-6), and siphonal index is 6.0-7.1 (*otwayensis* 4.8-5.6). It is likely that *C. otwayensis* differs also in mating habits, and it is not recorded yet as a man-biting species.

Genus CULEX Linnaeus

Pipiens Group

CULEX (CULEX) GLOBOCOXITUS Dobrotworsky

Culex globocoxitus Dobrotworsky, 1953, PROC. LINN. SOC. N.S.W., 77 : 357.

This species has the proboscis pale scaled beneath to the tip; the tergites are black scaled with creamy bands unconstricted laterally.

It has been recorded from Bothell, Launceston and Middleton (Dobrotworsky, 1953). Additional records are : Bridgewater (A. L. Dyce and M. D. Murray), Cremorne, Granton; Flinders Island. It also occurs in south-western Queensland, New South Wales, South Australia, Victoria and Western Australia.

Material examined : 6♂, 10♀.

CULEX (CULEX) PIPIENS AUSTRALICUS Dobrotworsky and Drummond

Culex pipiens australicus Dobrotworsky and Drummond, 1953, PROC. LINN. SOC. N.S.W., 78 : 143.

It can be recognized by : the presence of a few broad white scales on the postspiracular area. The tergal bands are constricted laterally, and there are conspicuous median and apical lateral black patches on the sternites.

It has been recorded from : Bothell, Launceston (Dobrotworsky and Drummond, 1953). Additional records are : Bridgewater, Sandfly and St. Clair (A. L. Dyce and M. D. Murray), Cremorne; King and Flinders Islands. It is widely distributed on the Australian mainland, and has also been recorded from New Caledonia.

Material examined : 22♂, 32♀.

CULEX (CULEX) PIPIENS MOLESTUS Forskal

Culex molestus Forskal, 1775, *Descr. Animalium*, p. 85.

It resembles *C. globocoxitus* but may be distinguished from it by the dark brown scaled tergites and by the fact that the posterior margins of the tergal bands are not sharply defined. The ventral side of the proboscis is dark scaled apically.

It has been recorded from Tasmania (Dobrotworsky and Drummond, 1953).

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EXPLANATION OF PLATES IV-V

Plate iv

Anopheles atratipes Skuse. *a*, head; *b*, wing. *Anopheles tasmaniensis* Dobrotworsky. *c*, head; *d*, wing.

Plate v

Anopheles tasmaniensis Dobrotworsky. *a*, eggs (from Dobrotworsky, 1965, by permission of the Melbourne University Press). *Aedes nigrithorax* Macquart, Epping, Tasmania. Scutum, hind femur and tibia. *b*, typical form; *c*, dark form.