A MEANS OF IDENTIFYING THE COMMON MOSQUITOES OF THE PERTH METROPOLITAN AREA

IRVING-BELL AND LIEHNE

REVISED BY
ANDREW BLAIR
with keys to adult and larval mosquitoes in South-Western Australia by Peter Liehne

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Department of CONSERVATION & ENVIRONMENT Western Australia

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1. INTRODUCTION

1.1 NEED FOR IDENTIFICATION

There are about 50 species of mosquitoes known to occur in Western Australia. Ten of these are found throughout the whole State, wherever conditions are suitable for them to breed. A further 16 species are restricted to areas north of Geraldton and 23 species occur only in southern areas. Only 11 of the 23 species found in the southern parts of the State are common around Perth.

While mosquitoes are regarded as pests in the Perth area because they cause discomfort and annoyance rather than because they transmit diseases, it is still necessary to take measures to control them in many places. If appropriate control measures are to be taken it is best to know what species of mosquito is causing the nuisance because different species have different responses to weather conditions and different swarming and biting behavior, and thus have different vulnerable points in their life histories. A good understanding of these vulnerable points enhances the development of economical strategies to combat the problem. The purpose of this guide, or key, is to enable that ready identification of adult mosquitoes as a first step towards the implementation of effective control programmes.

1.2 NAMES AND TECHNICAL TERMINOLOGY

1.2.1 Names Used in Classifying Mosquitoes

Throughout the guide use is made of technical names for the kinds, or species, of mosquitoes, and for the parts of the mosquito body. It is hoped that this won't deter the lay person from using the key. The procedures employed for naming living organisms by biologists may appear unduly complicated but in fact there is a good reason for having an established set of rules and regulations governing the names used. Use of the name *Culex fatigans*, for instances, tells a worker, in the business of controlling the beast, a great deal about the animal, whether it occurs in Australia, Africa or Europe. Biological terminology is a kind of universal language. The complexities of the naming procedure need not worry us here but a few details are included at this point.

Insects are classified into a number of orders: the beetles are placed together in an order, the moths

and butterflies in another order, the grasshoppers and crickets in another, and so on. The mosquitoes, together with the midges, bush-flies, blowflies and the many other kinds of flies, are classified in the order DIPTERA. The word literally means 'two wings' and describes a characteristic of the flies which distinguishes them from the other insects, all of which have either four wings or no wings at all.

The DIPTERA is made up of a number of "families". All the mosquitoes are grouped together in a single family, the Culicidae, which comprises three sub-families, the Anophelinae, the Culicinae and the Toxorhynchitinae. As all the mosquitoes known to occur in Western Australia belong to the Anophelinae and the Culicinae, only these two subfamilies will be considered here. Subfamilies are further broken up into genera (singular-genus). Each genus consists of one or more species. A species can be regarded as a biological entity with its members having structure and behavior distinct from other species. In fact the concept of species is a difficult one but lets take a straight-forward view here. The name of a species (eg. *Culex fatigans*) consists of (at least) two parts, the generic name (eg. *Culex*) and the trivial name (eg. *fatigans*).

1.2.2 Names Applied to Structures and Body Parts

The various mosquito species are distinguished from each other by differences in the shape and relative size of certain parts of the body, by the patterns formed by the veins in the wings, and by the patterns formed by scales on the legs, abdomen and other parts of the body. The parts of the insect body have a special set of terms applied to them and these names are used in the guide for convenience and brevity. Figures 3, 4, 5 and 6 have been included to illustrate the meanings of these terms. (see page)

1.2.3 Sources of Further Information

Users of this Bulletin who would like to read about the natural history of insects are directed to Hughes (1974)[3]. A CSIRO publication entitled The Insects of Australia[1] provides a more detailed technical account of insect biology and classification.

1.3 EQUIPMENT AND MATERIALS FOR HANDLING AND PRESERVING MOSQUITOES

Identification of adult mosquitoes requires careful examination of the insects with a hand lens (x 10 magnification) or, if possible, with a low-

power binocular microscope. It is helpful to have a lamp which can be directed onto the specimen.

Fresh adult specimens are more easily handled with a pair of fine dissecting forceps.

It is often convenient to drive a fine pin through the underside of the thorax between the mid-legs, and to then hold the pin with the mosquito fixed firmly on the pin shaft.

Once mosquito specimens dry out, they become brittle and must be handled with care. It is therefore necessary to preserve the specimens. Two methods are available: Dry preservation is preferable and involves the mounting or pinning of specimens; Wet preservation entails placing specimens in preserving alcohol. For further information on wet preservation see Norris and Upton (1974)[6]

For pinning of mosquitoes, a fine steel pin (specifically for insect mounting) is inserted through a piece of polyporous pith mounted on a large pin. The mosquito should be laid on its back and the pin inserted between the mid-legs through the thorax. For further information on this method see Dobrotworsky (1965)[3].

1.4 THE KEY: ITS BACKGROUND, USE AND LIMITATIONS

1.4.1 Background to the Key

The guide is a revised and illustrated version of a key produced in 1975 by two graduate students of the Zoology Department of the University of Western Australia - Rosemary Irving-Bell and Peter Liehne[4]. The key relies heavily on work published elsewhere, particularly in books by Dobrotworsky[3] and Marks[5], and the illustrations used here are reproduced from those books with the permission of the publishers.

1.4.2 Use of a Dichotomous Key

The guide is in the form of a dichotomous (two-branching) key, so-called because at each step in the key it is necessary to choose between two alternative descriptions. If you are uncertain how a dichotomous key works, perhaps the following, rather simple-minded example will demonstrate:

A Guide to Vehicles

1. Moves over surface of ground on metal tracks.....2

   Moves over surface of ground on wheels with rubber tyres.....3

2.(1) Driver seated in open or within cabin with glass windows.....caterpillar tractor

   Driver seated within armour-plated turret .....military tank

3.(1) Number of wheels bearing rubber tyres: two 4

   Number of wheels bearing rubber tyres: more than two 5

4.(3) Equipped with internal combustion engine and fuel tank.....motor bike

   Not equipped with internal combustion engine and fuel tank.....push bike

5.(3) Would go on to key out vehicles with four wheels vs. those with more than four wheels etc..

1.4.3 Limitation to the Key

This guide permits the identification of adult female mosquitoes only. In most species the female must take a meal of blood before she can lay fertile eggs. The male, on the other hand, feeds only on nectar or other plant juices. Thus it is the female which makes its presence felt by biting and it is usually the female which is captured in houses and in baited traps. The water-dwelling larvae and pupae of mosquitoes can be identified too but this is more difficult than the identification of the adults and may require higher magnification and better lighting. When it is necessary to identify mosquitoes captured as larvae or pupae, it is usually more convenient to keep them until they emerge as adults than to attempt to identify the juvenile stages. Larvae can usually be kept successfully in some water from the place in which they were captured, in a small, covered container protected from severe changes in temperature. As a rule they will obtain enough food from the water to enable them to mature but a little yeast powder may be added to the water if necessary.

2. STRUCTURE (MORPHOLOGY) OF MOSQUITOES

2.1 MORPHOLOGY OF IMMATURE STAGES

Morphology of the immature stages of the mosquito shall not be discussed, except for the inclusion of Figure 1 which illustrates their form and indicates the differences between the two subfamilies Anophelinae and Culicinae. Figure 2 illustrates the form of the pupal stage, from which the adult directly matures.

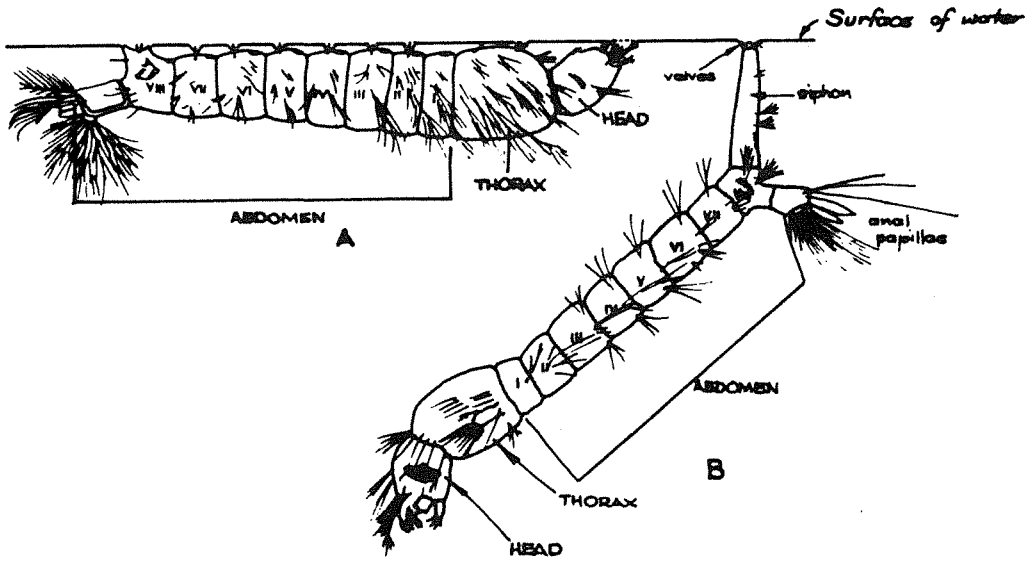


Figure 1 : Anopheline and Culicine larvae.

A. lateral view of Anopheline larva;

B. lateral view of Culicine larva.

Note resting position of larvae relative to the water surface.

(From Dobrotworsky, M V "The Mosquitoes of Victoria", 1965. Melb. Uni. Press, courtesy of the publishers).

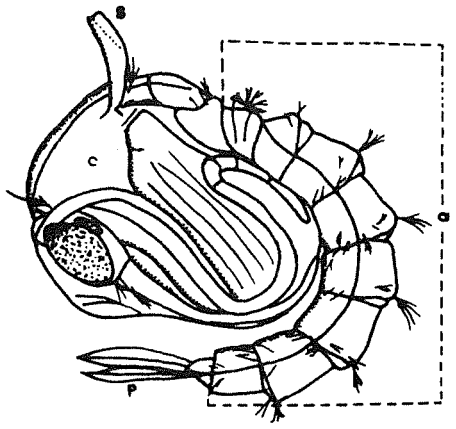


Figure 2 : Lateral view of pupa.

a. abdomen;

c. cephalothorax;

p. anal papillae;

s. siphon.

(From Dobrotworsky, 1965).

2.2 MORPHOLOGY OF THE ADULT

Figures 3, 4, 5 and 6 are included to illustrate some of the important morphological characteristics required in the identification of adult mosquitoes.

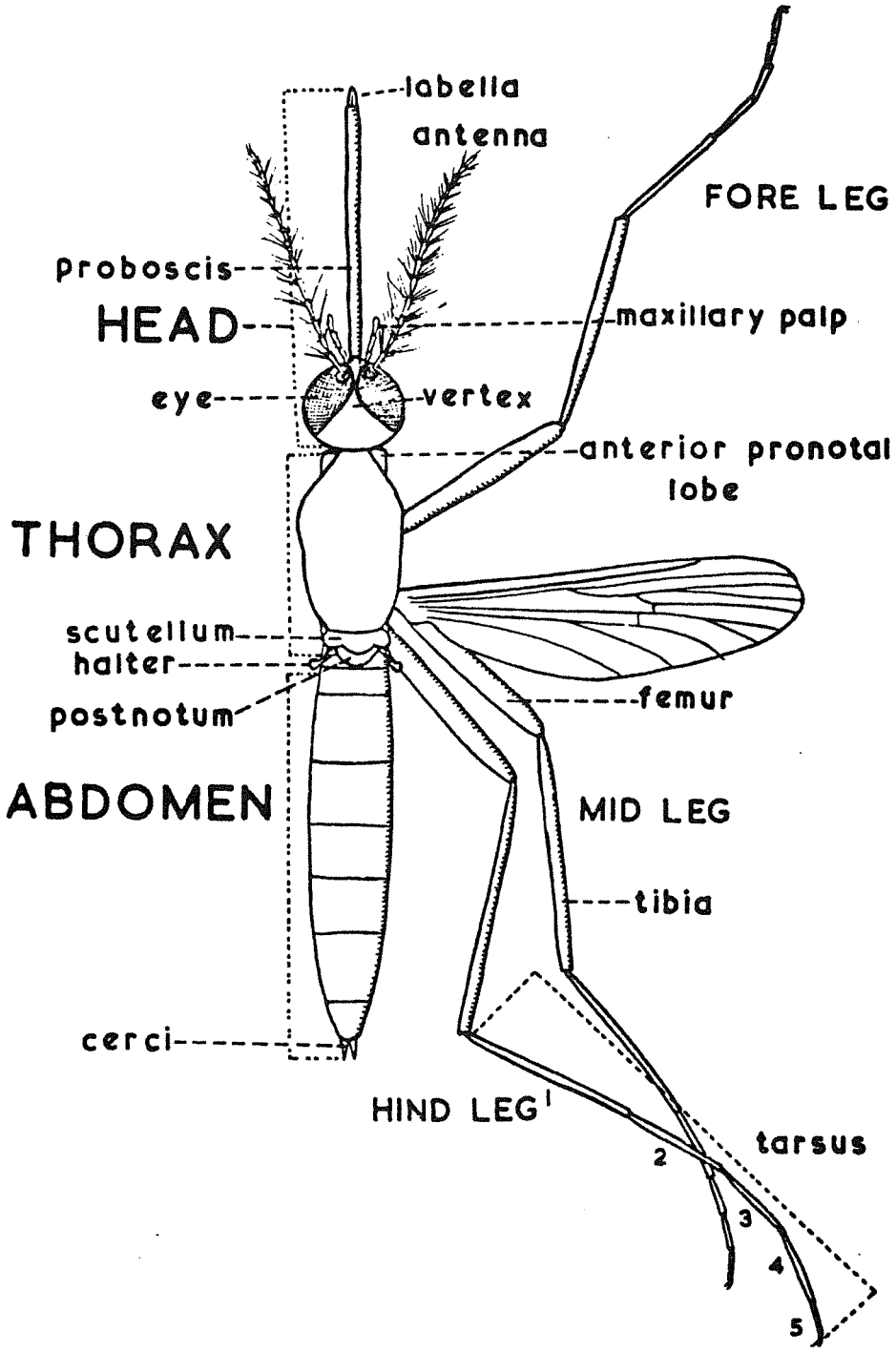


Figure 3 : Diagram of a female mosquito (from Dobrotworsky, 1965).

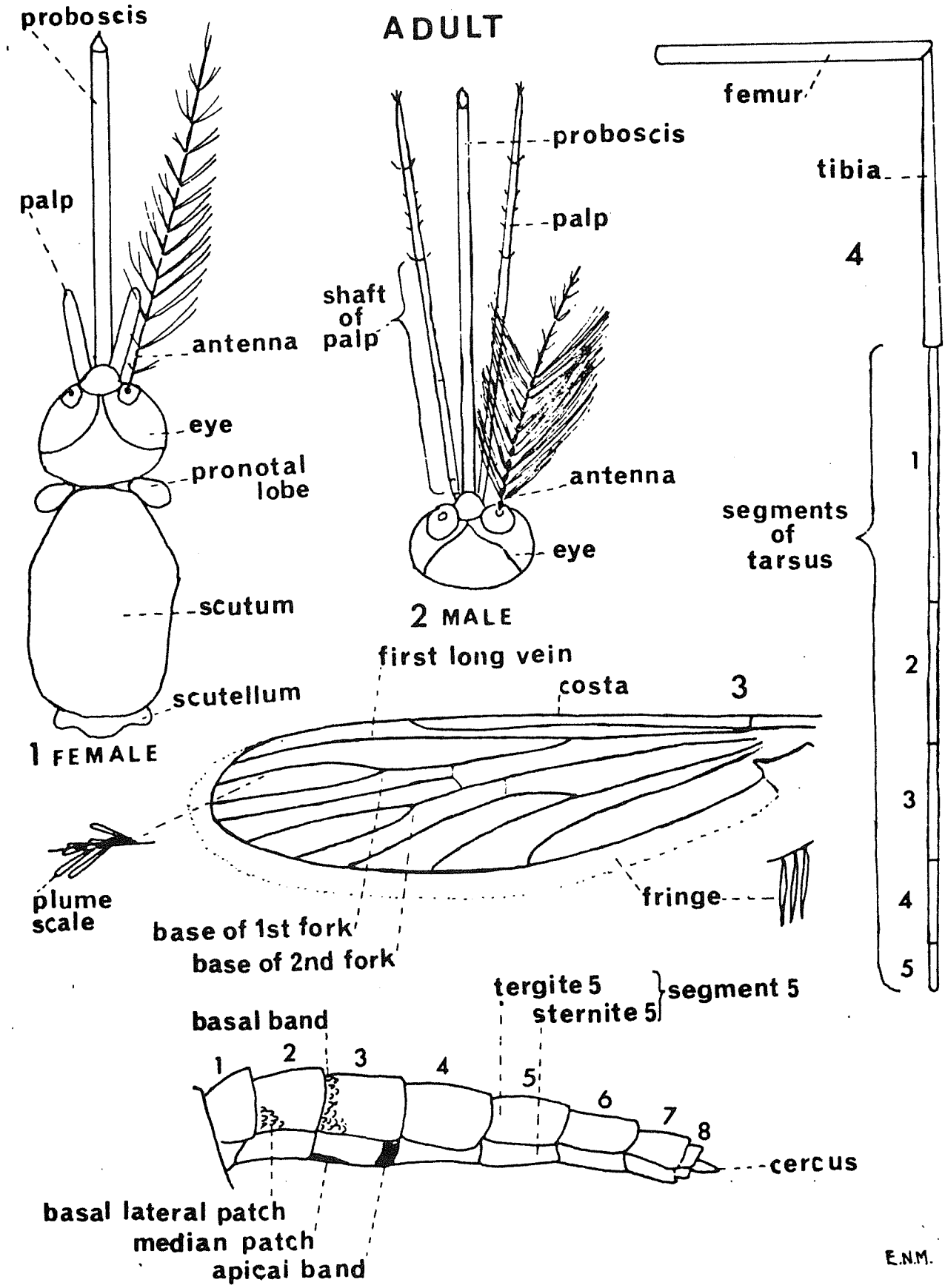


Figure 4 : Aspects of the morphology of the male and female mosquito.

(from Marks, E N An Atlas of Common Queensland Mosquitoes, 1973. Courtesy of the author).

HEAD

The Antennae: Males have very numerous long hairs which give a bushy appearance. Females usually have a few hairs radiating from the base of each segment, (see Figure 5). The segments are roughly cylindrical and equal in length.

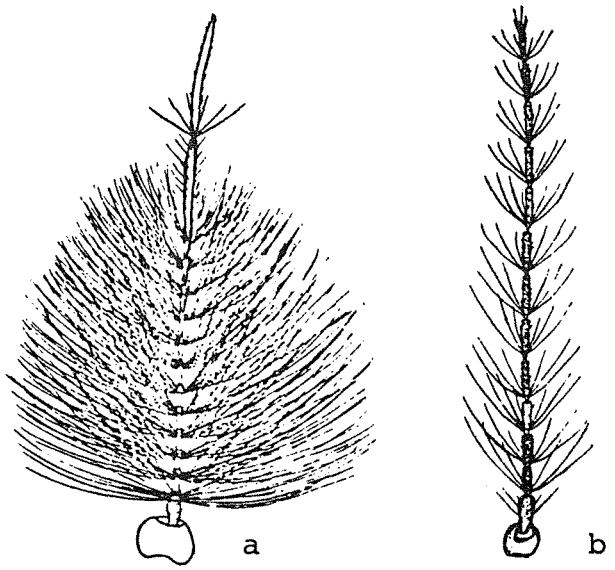


Figure 5 : a. Antenna of male mosquito with typical bushy appearance.

b. Antenna of female mosquito

(from Dobrotworsky, 1965).

The Palps: The palps consist of five segments. In males they are as long as the proboscis and usually hairy at the tip. In females the palps are less than half the length of the proboscis, except in the subfamily Anophelinae where they are about as long as the proboscis.

The Proboscis: The Proboscis is an elongate structure which acts as a sheath for the piercing and sucking mouth-parts. The proboscis consists of the labella and the labium and is straight in almost all West Australian mosquitoes.

THORAX

The upper surface of the thorax is the scutum. In front on both sides lie the pronotal lobes and at the back is the scutellum. The side of the thorax is divided into a number of distinct areas as shown in Figure 6. Three pairs of legs (fore, mid and hind) are attached to the thorax. Each leg has three long sections, the femur, tibia and tarsus. The five segments of the tarsus are important because the colour and pattern of scaling are used in identification.

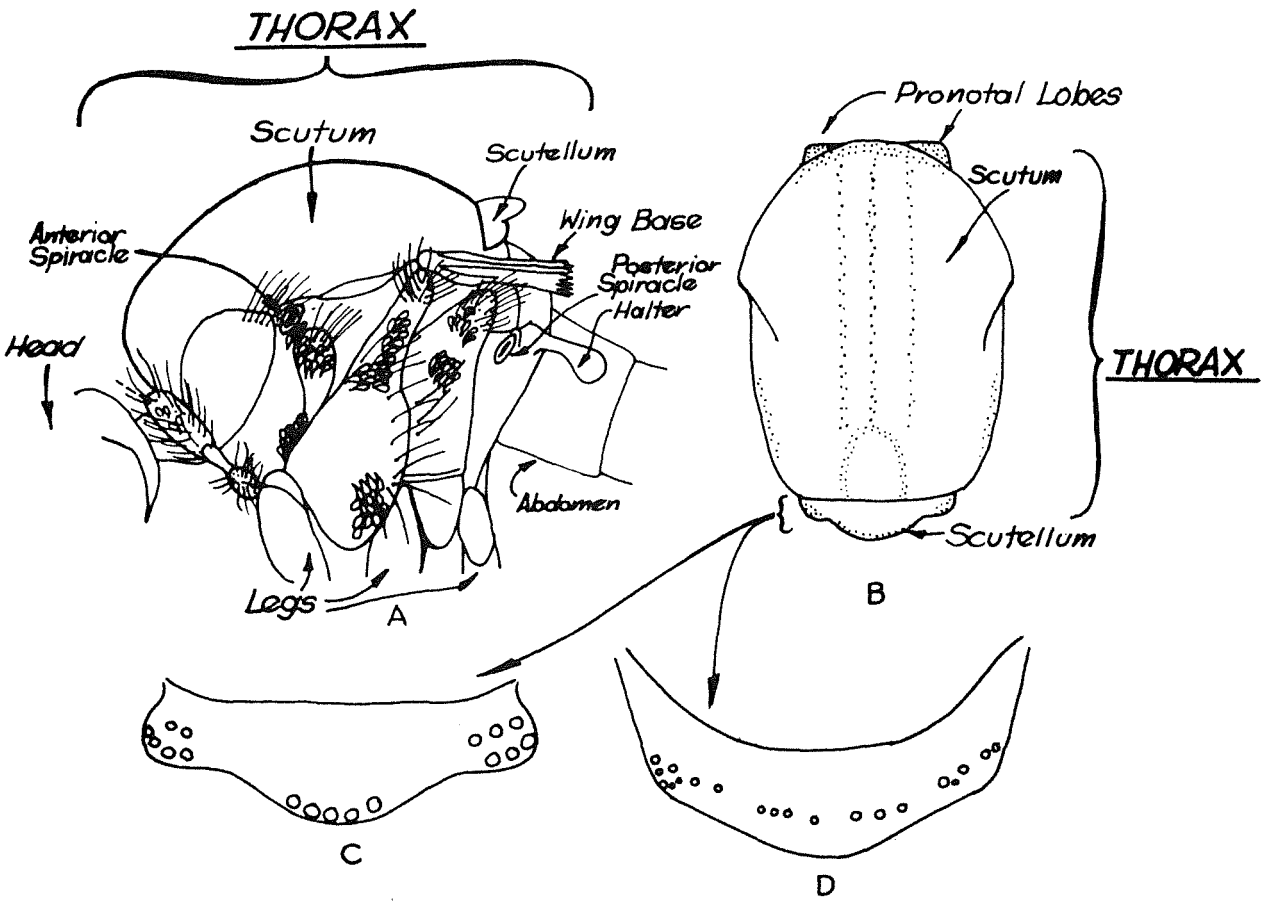


Figure 6 : Parts of the mosquito thorax.

A. lateral view;

B. dorsal view with positions of bristles indicated;

C. scutellum of a Culicine;

D. scutellum of an Anopheline.

(Dobrotworsky, 1965).

ABDOMEN

The upper plates of the abdomen are tergites and the lower ones are sternites. There are eight distinct segments which are numbered from the thorax outwards. The eighth segment is sometimes completely withdrawn into the seventh in some species. Protruding beyond the eighth segment is a pair of valves, the cerci - between which the eggs pass when they are laid. The shape of the tip of the abdomen is characteristic of certain groups.

Sharply defined bands of scales on the proboscis, thorax, legs and abdomen are useful in identification, and care must be taken when handling specimens not to rub these scales off the insect.

2.3 FAMILY AND SUBFAMILY IDENTIFICATION

Mosquitoes (family Culicidae) are distinguished from midges and other Dipterans (flies) by the following adult characteristics:

1. Both sexes have a proboscis. 2. Wing veins have scales on them.

The distinguishing features of the two Subfamilies of the Culicidae which occur in Western Australia, the Anophelinae and Culicinae, are as listed in Table 1.

Table 1 : The Characteristics Distinguishing the Culicinae from the Anophelinae

	Anophelinae	Culicinae
Larvae	No respiratory siphon Rest parallel to water surface (see Figure 2)	Respiratory siphon present Rest at an angle to surface of water (see Figure 5)
Adults	Palps of female as long as proboscis. Resting position with abdomen at an angle to surface of sub-strate	Palps of female shorter than half the length of proboscis. Resting position with abdomen parallel to surface of substrate

3. IDENTIFICATION OF MOSQUITO SPECIES

1. Palps as long as proboscis (see Figure 7.1)
   Abdominal tergites bare of scales.....*Anopheles annulipes*
   (Figure 7.)

   Palps shorter than half length of proboscis;
   Abdominal tergites with conspicuous scaling
   .....(Subfamily Culicinae) 2

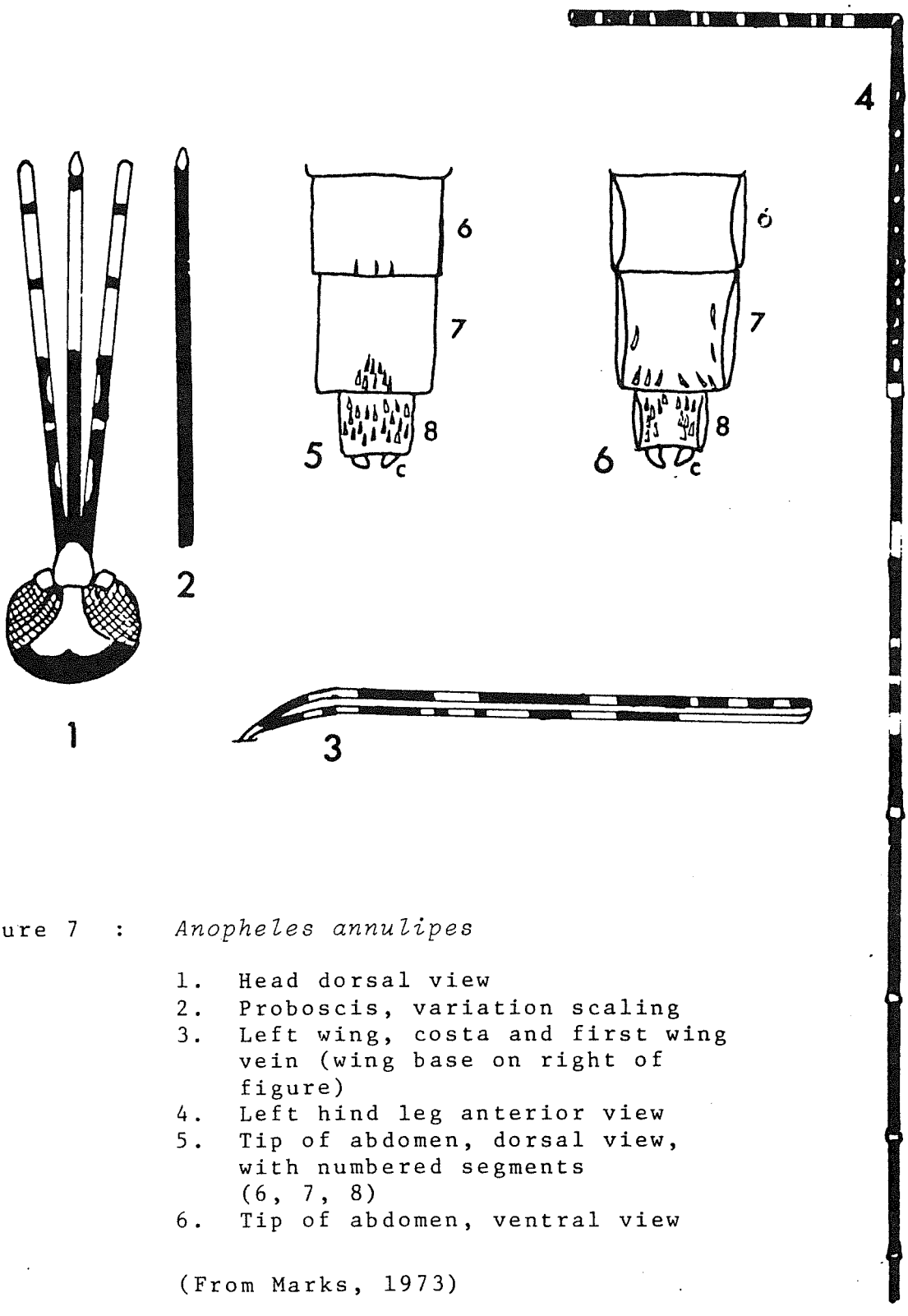


Figure 7 : *Anopheles annulipes*

1. Head dorsal view
2. Proboscis, variation scaling
3. Left wing, costa and first wing vein (wing base on right of figure)
4. Left hind leg anterior view
5. Tip of abdomen, dorsal view, with numbered segments (6, 7, 8)
6. Tip of abdomen, ventral view

(From Marks, 1973)

2. (1) Proboscis with sharply defined white band around middle (not more than 1/3 length of proboscis).....3

Proboscis otherwise 4

3. (2) Scutum with lyre-shaped pattern of narrow white lines; hind leg with longitudinal white lines on femur and tibia, wide white basal bands on tarsal segments 2 - 4. Bases of forked cells of wing not equal in distance from base of wing.
.....*Aedes notoscriptus* (Figure 8)

Scutum otherwise, legs mottled, tarsi with narrow bands, pale basal tergal bands extended in the middle of some segments. Bases of forked cells of wing equal in distance from base of wing.
.....*Culex annulirostris* (Figure 9)

4. (2) Tarsi with distinct basal white bands 5

Tarsi all dark or with inconspicuous basal bands on segments 2 and 4 7

5. (4) Hind femur with distinct pre-apical white ring; ocherous knee spot...*Aedes alboannulatus* (Figure 10)

Hind femur without pre-apical white ring 6

6. (5) Wing scales all dark..*Aedes camptorhynchus* (Figure 11)

Wing with some mottling of pale scales
.....*Aedes vigilax* (Figure 12)

7. Basal tergal bands present 8

Basal tergal bands absent but distinct white (very bright) lateral tergal patches present.
.....*Coquillettidia linealis* (Figure 13

8. (7) Basal tergal bands of abdomen are constricted at the sides and separated from the white lateral spots on at least segments 4 and 5 9

Basal tergal bands are continuous and not separated from lateral white spots on at least segments 4 and 5
.....10

9. (8) Dark species, abdominal sternites with medium elongate and lateral apical patches of dark scales
.....*Culex australicus* (Figure 14)

Lighter species, black central patches on sternites are absent, or if present, are small and inconspicuous .....*Culex fatigans* (Figure 15)

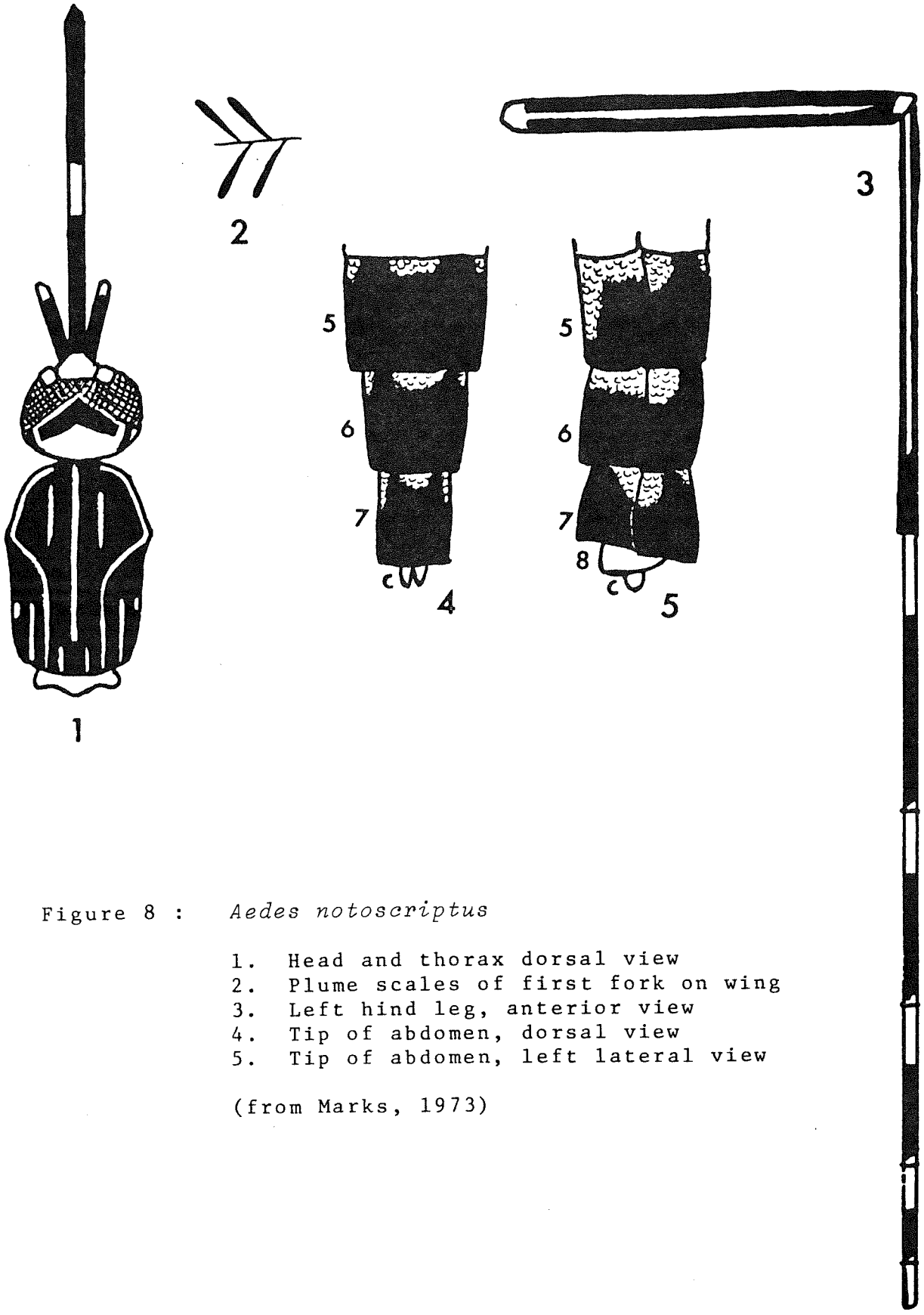


Figure 8 : *Aedes notoscriptus*

1. Head and thorax dorsal view
2. Plume scales of first fork on wing
3. Left hind leg, anterior view
4. Tip of abdomen, dorsal view
5. Tip of abdomen, left lateral view

(from Marks, 1973)

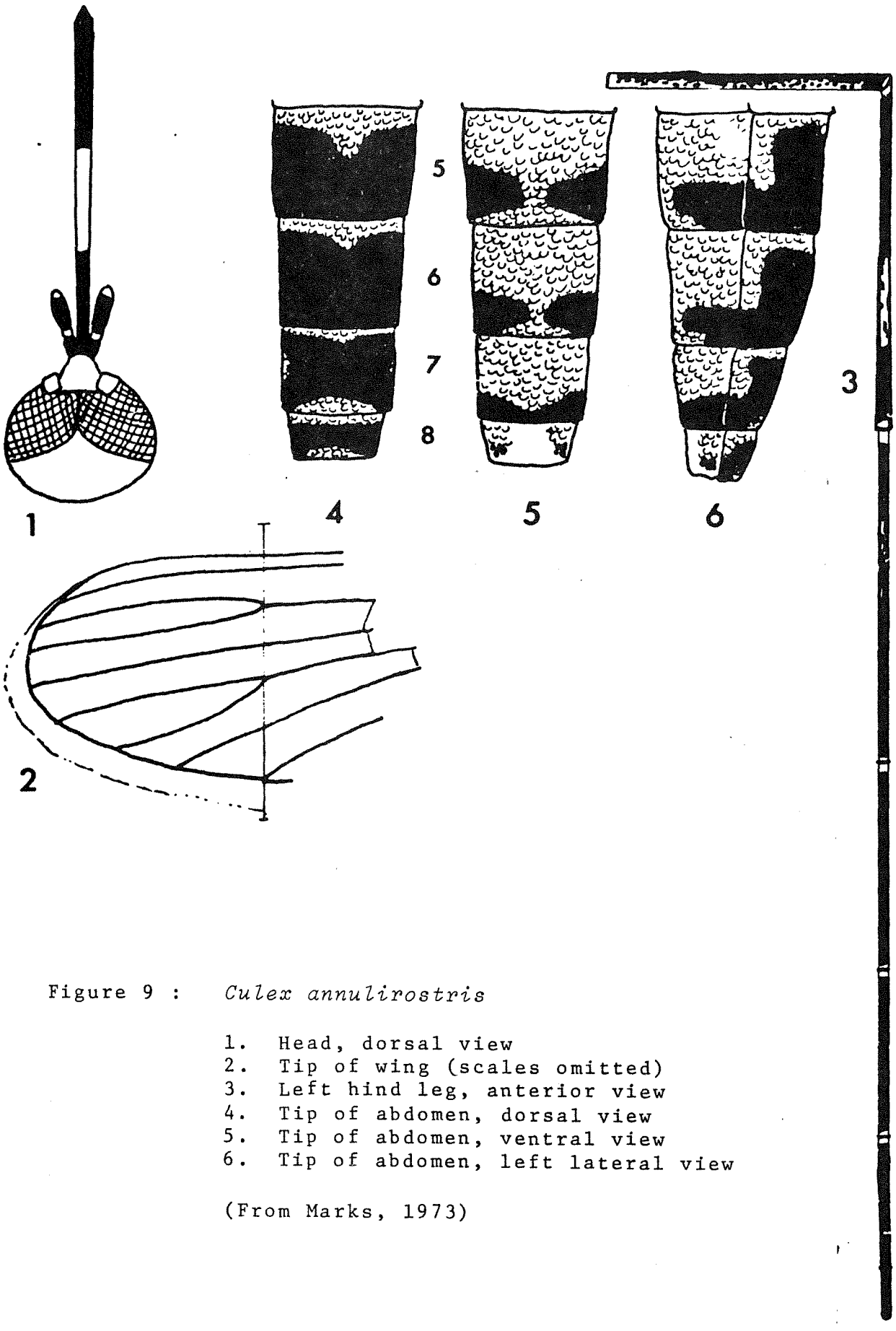


Figure 9 : *Culex annulirostris*

1. Head, dorsal view
2. Tip of wing (scales omitted)
3. Left hind leg, anterior view
4. Tip of abdomen, dorsal view
5. Tip of abdomen, ventral view
6. Tip of abdomen, left lateral view

(From Marks, 1973)

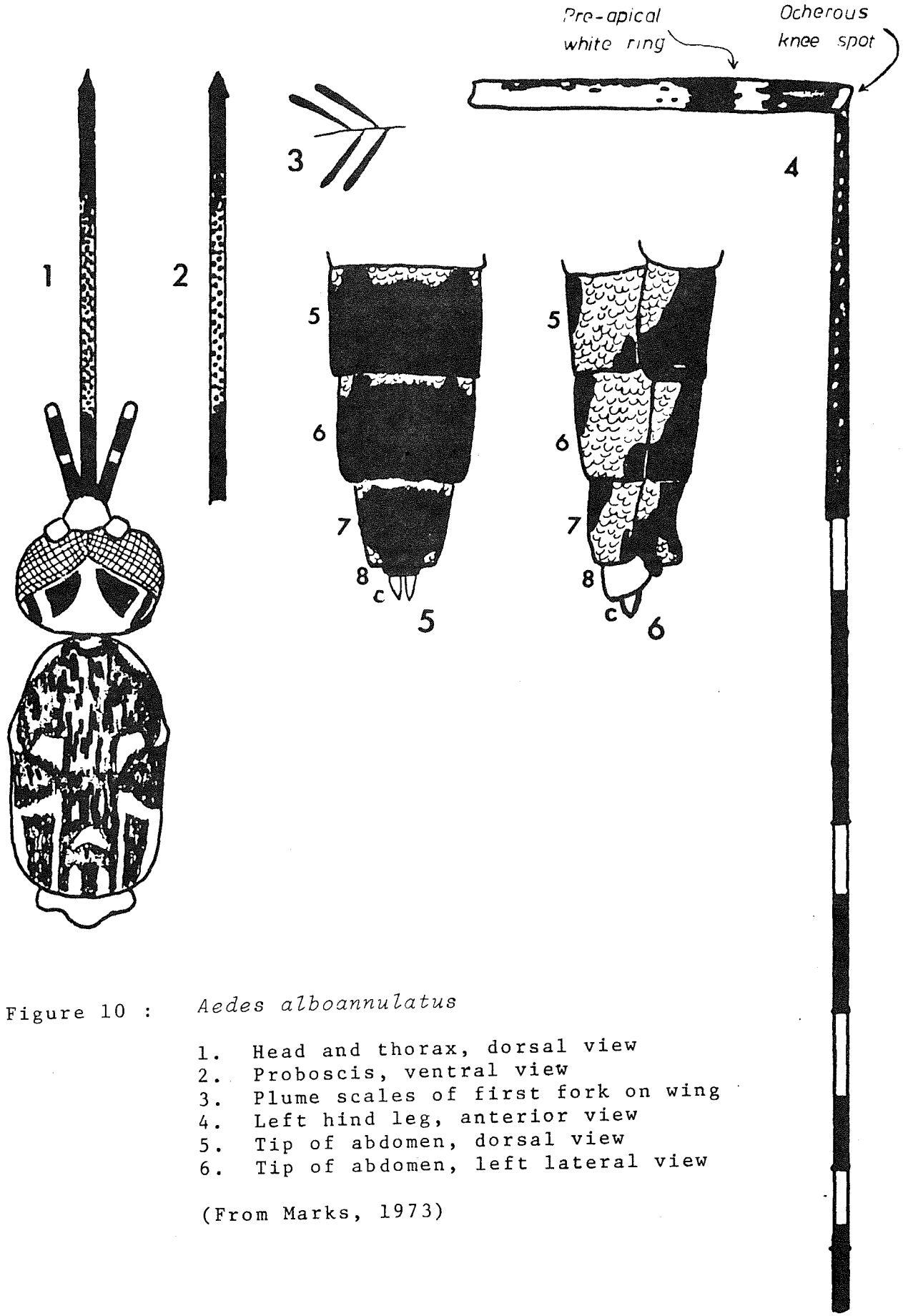


Figure 10 : *Aedes alboannulatus*

1. Head and thorax, dorsal view
2. Proboscis, ventral view
3. Plume scales of first fork on wing
4. Left hind leg, anterior view
5. Tip of abdomen, dorsal view
6. Tip of abdomen, left lateral view

(From Marks, 1973)

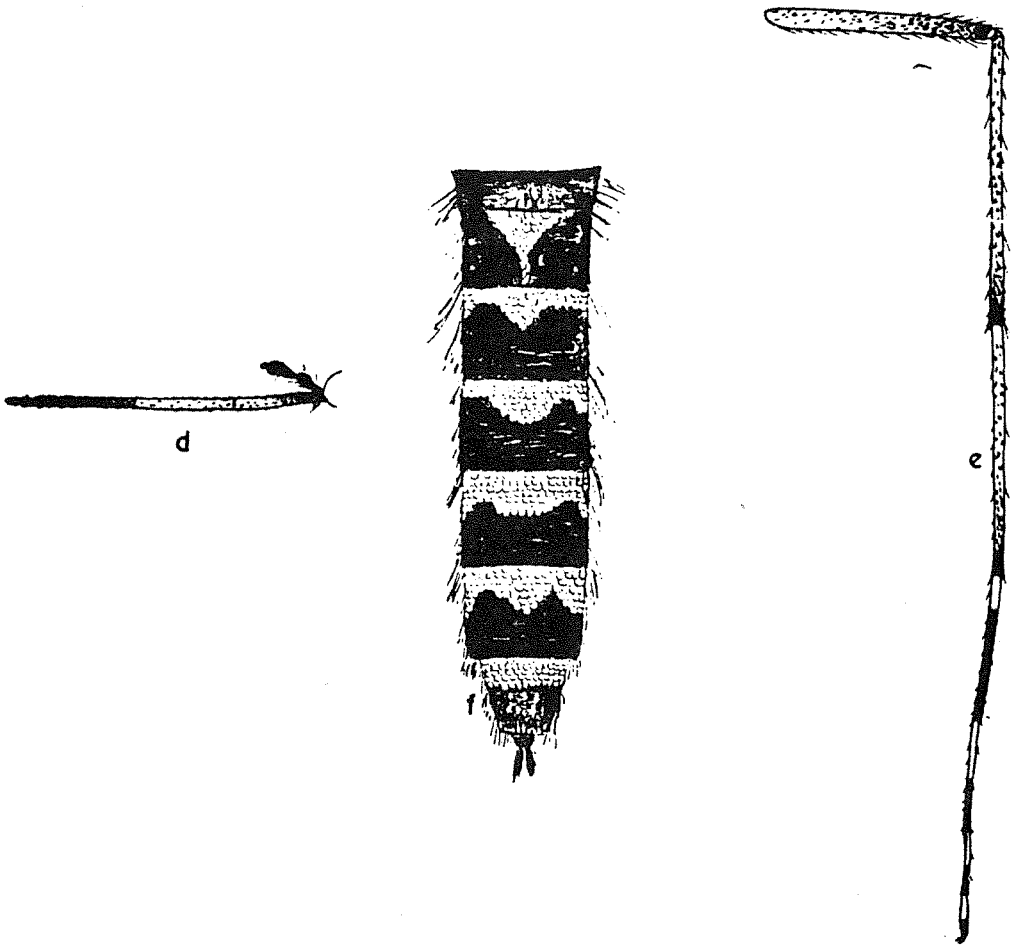


Figure 11 : *Aedes camptorhynchus*

d. Proboscis and palp of female
e. Left hind leg, anterior view
f. Abdomen, dorsal view

(From Dobrotworsky, 1965)

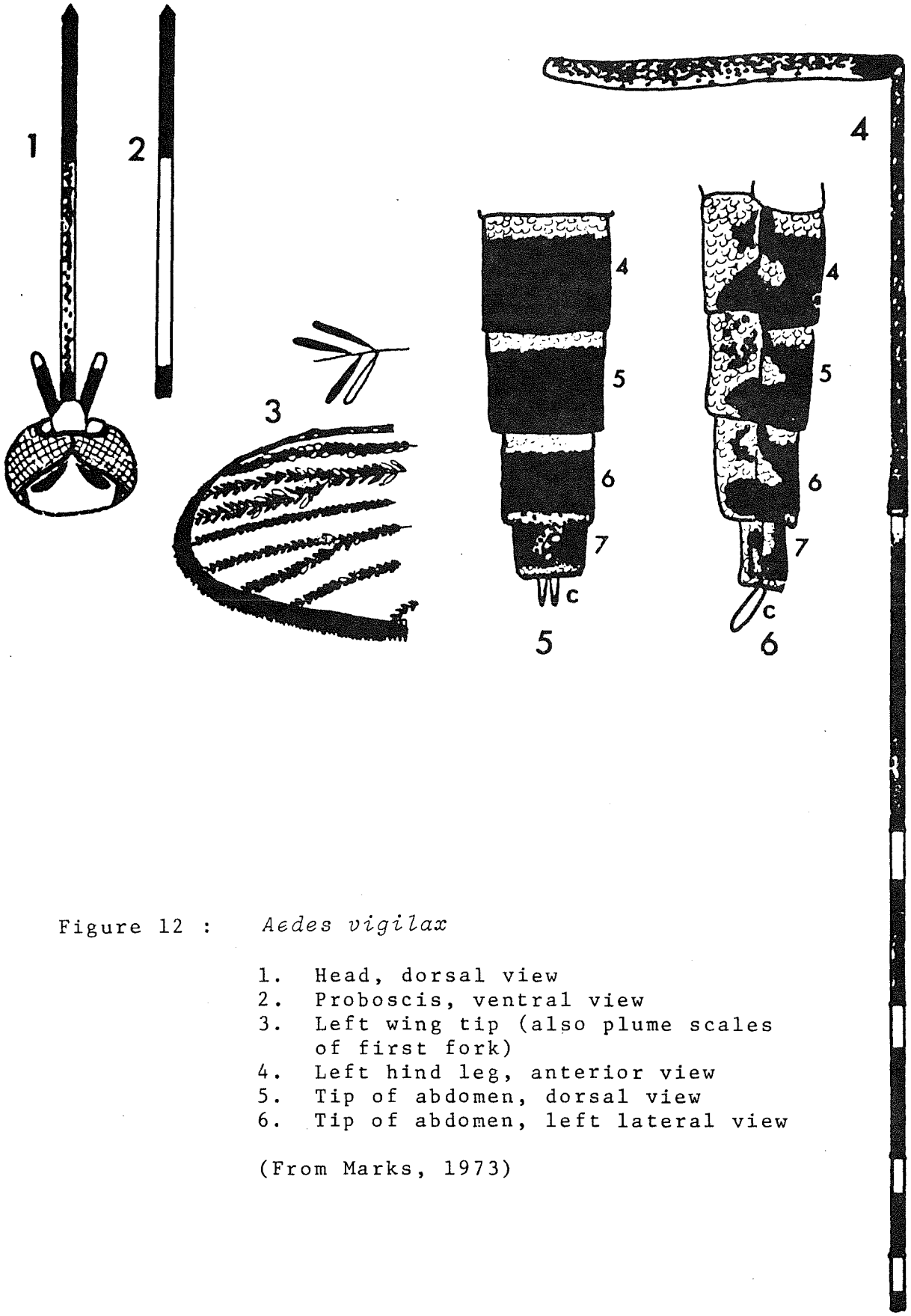


Figure 12 : *Aedes vigilax*

1. Head, dorsal view
2. Proboscis, ventral view
3. Left wing tip (also plume scales of first fork)
4. Left hind leg, anterior view
5. Tip of abdomen, dorsal view
6. Tip of abdomen, left lateral view

(From Marks, 1973)

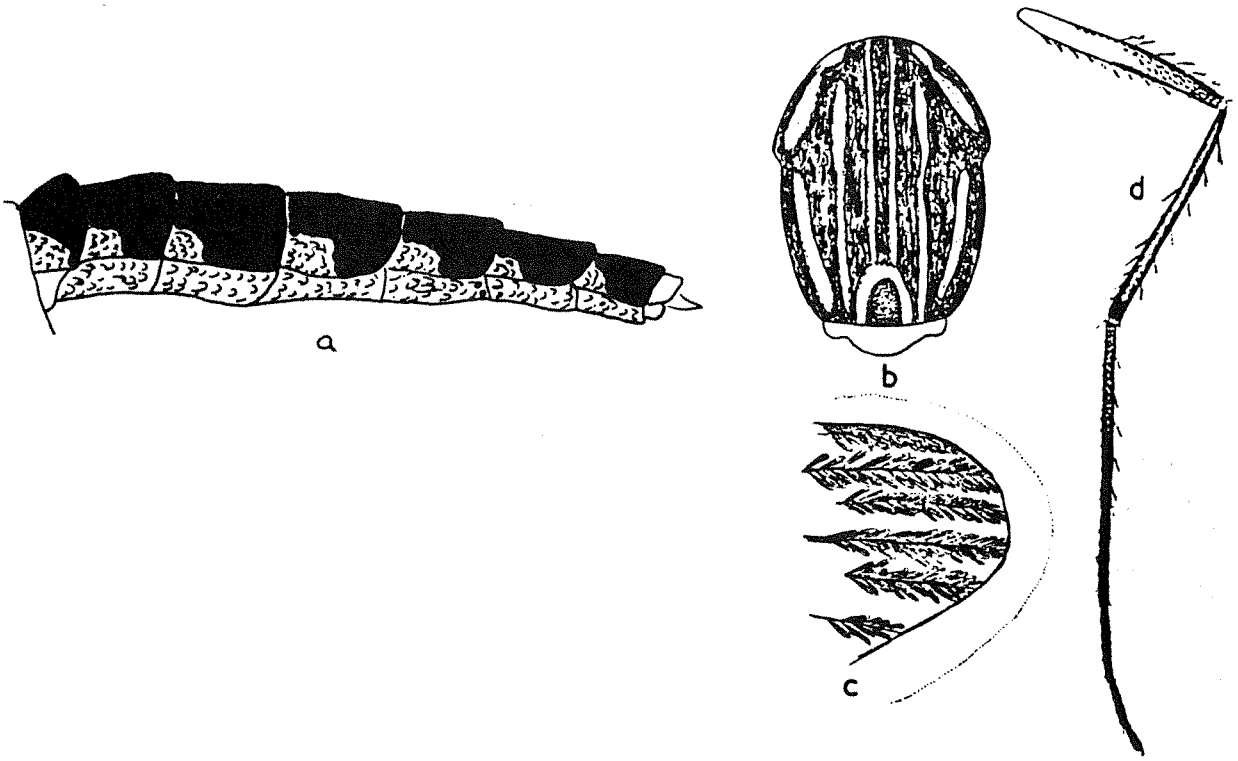


Figure 13 : *Coquillettidia linealis*

a. Abdomen, left lateral view
b. Thorax, dorsal view
c. Portion of wing
d. Left, hind leg, anterior view

(b, c, d from Dobrotworsky, 1965)

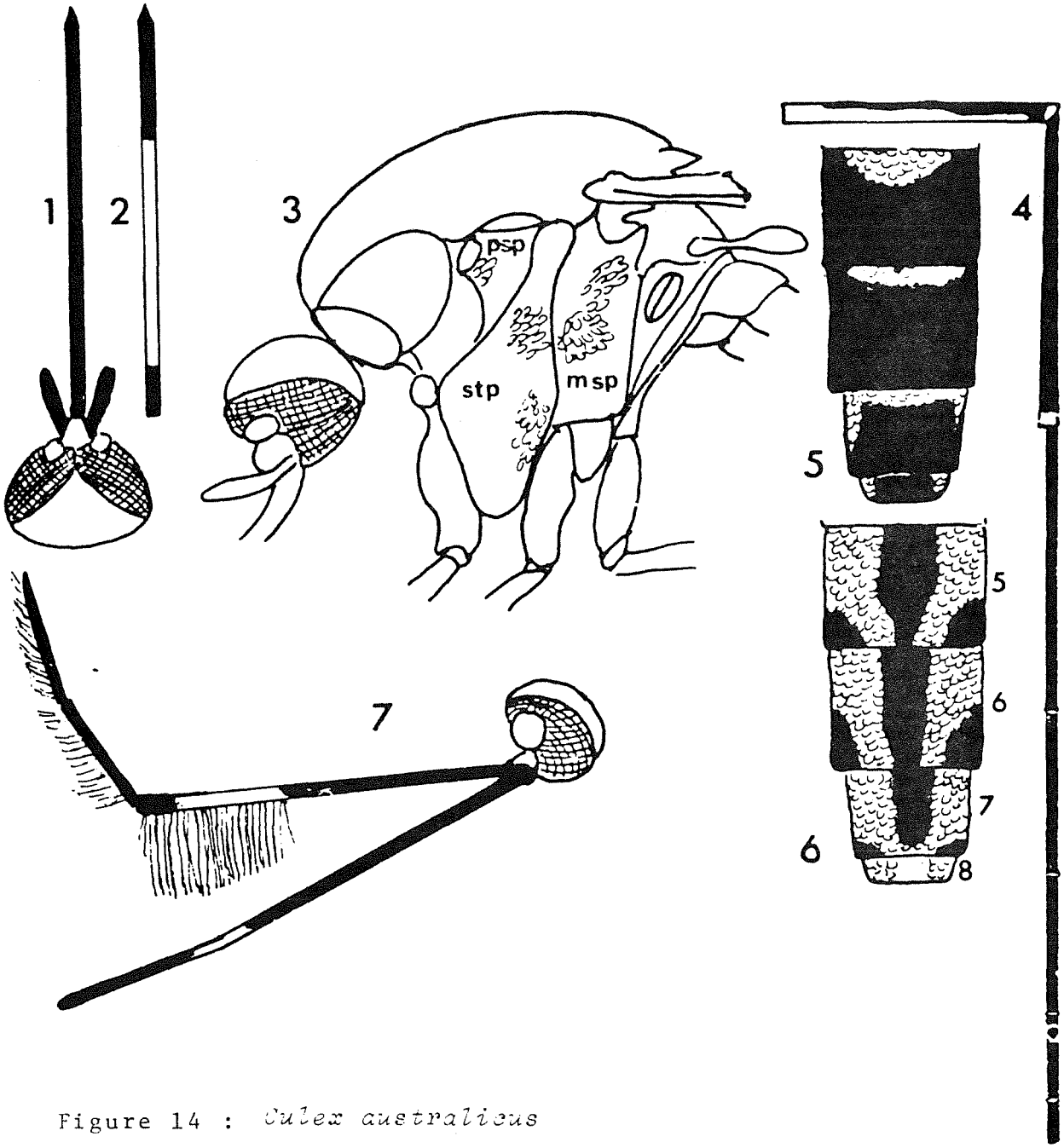


Figure 14 : *Culex australicus*

1. Head dorsal view
2. Proboscis, ventral view
3. Thorax, left lateral view. Showing white scale patches. (psp. - post-spiracular area; stp. - sterno-pleuron; msp. - mesepimeron)
4. Left hind leg, anterior view
5. Tip of abdomen, dorsal view
6. Tip of abdomen, ventral view
7. Male head, lateral view

(From Marks, 1973)

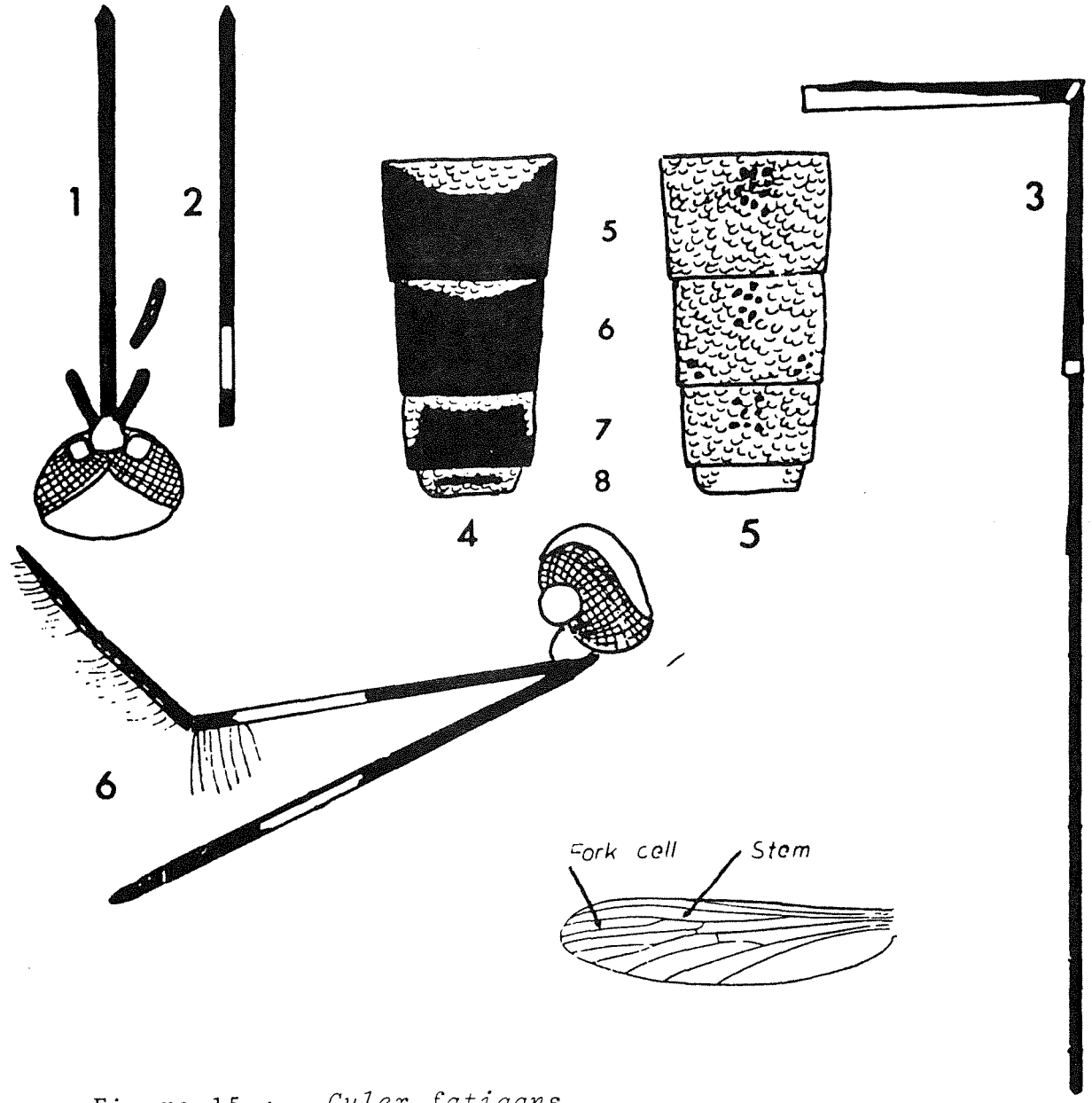


Figure 15 : *Culex fatigans*

1. Head dorsal view (also a palp showing variation in scaling)
2. Proboscis, ventral view
3. Left hind leg, anterior view
4. Tip of abdomen, dorsal view
5. Tip of abdomen, ventral view
6. Male head, left lateral view
7. Female wing

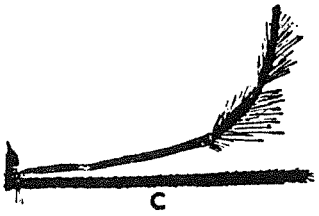
(From Marks, 1973)

10. (8) Tergites almost black with broad creamy bands. Underside of proboscis with pale scales over whole length.....*Culex globocoxitus* (Figure 16)

Tergites brown, bands pale. Ventral surface of proboscis with dark scales at tip .....*Culex molestus* (Figure 17)

Postcript

Two features which serve to distinguish *Culex molestus* from *Culex fatigans* and *Culex australicus* are the straight tergal bands and the short stem of the upper fork cell (Figures 15 (7) and 17 (d)). In *Culex molestus*, the stem is only about one-fifth of the length of the cell, in *Culex fatigans* it is about one-third of the length of the cell.



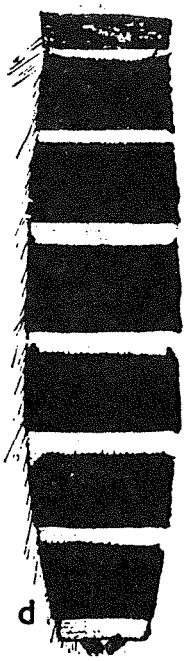
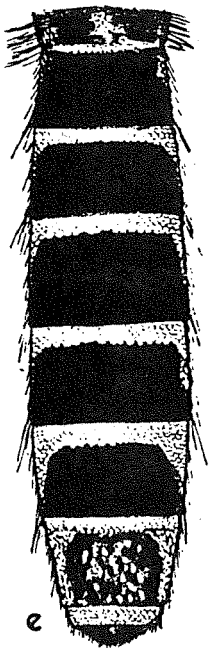


Figure 16 : *Culex globocoxitus*

c. Male proboscis and palp

d. Female abdomen, dorsal view

(From Dobrotworsky, 1965)



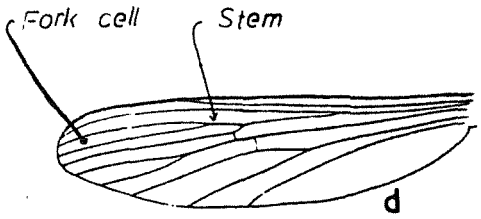


Figure 17 : *Culex molestus*

d. Left wing

e. Female abdomen, dorsal view

(From Dobrotworsky, 1965)

4. DESCRIPTION OF SPECIES

4.1 ANOPHELES ANNULIPES COMPLEX (see Figure 7)

Distinctive Characters

Speckled grey mosquito with extensive spotting of wings and legs. Three white and two black bands on apical half of palp. Radius vein of wing with 5 - 10 black patches or spots. Abdominal sternites and tergites without scales.

Distribution

The commonest of the Australian anophelines, found throughout Australia.

Breeding Places

Ground pools and swamps, sunlit or shaded and the character of the water may vary from clear to brackish to polluted.

Adult Habits

Only rarely bites man indoors and in the open, usually at dusk and dawn. It is known to attack a wide variety of mammals and birds.

This complex is the only group with speckled wings in the south of the State. At the extreme north of the State there are other species with which it may be confused.

4.2 AEDES NOTOSCRIPTUS (see Figure 8)

Distinctive Characters

Black mosquito with a distinctive scale pattern of white lines. Proboscis with median white band. Palps with small white patch at tip. Scutum with lyre-shaped pattern of scales (see Figure 8.1). Abdominal tergites with median and lateral basal patches. Tip of abdomen slightly tapering. Cerci large. Hind femur and tibia with white strips anteriorly. Hind tarsal segments banded, except segment 5 which is all white.

Distribution

Australia-wide.

Breeding Sites

Breeds in tree holes and rock holes and also in a variety of domestic and artificial containers. The eggs can withstand drying.

Adult Habits

Bites day (in shade) and night, attacks both man and animals and has been taken biting birds.

4.3 CULEX ANNULIROSTRIS (see Figure 9)

Distinctive Characters

Square-tipped abdomen, segment VIII large, proboscis with conspicuous white band on the middle third. Femora mottled; tarsi with very small white basal bands. Bases of forks of wing level (see Figure 9.2 - line joining bases of wing forks is at right angles to costa). White basal tergal bands join lateral patches. Tergites 2 - 5 with the white basal band produced backwards in the midline. Sternites with apical bands sometimes divided medially with black stripe.

Distribution

All Australia, very common both north and south.

Breeding Places

Fresh water swamps, pools, etc.. Sometimes in temporary waters.

Adult Habits

Bites man, mammals and birds - especially at dusk.

4.4 AEDES ALBOANNULATUS (see Figure 10)

Distinctive Characters

Proboscis mottled, wing scales dark. Abdominal tergites with incomplete narrow white basal bands and basal lateral patches. Sternite eight large and prominent. Hind Femora and tibiae mottled; hind femur with distinct white ring at about 3/4 length. Hind tarsal segments 1 - 4 basally banded. Scutum clothed with bronze scales and has some pale patches. Sternites white scaled with median black patches.

Distribution

Typically southern - is a common mosquito in WA, SA, Victoria and New South Wales.

Breeding Sites

Breeds usually in clear, grassy, open ground pools. Eggs can withstand drying.

Adult Habits

Day and evening biting. Feeds on man, mammals and birds.

4.5 AEDES CAMPTORHYNCHUS (see Figure 11)

Distinctive Characters

Proboscis and palps extensively mottled, often almost completely pale-scaled. Scutum with golden scales with 1 or 2 white patches, about mid-length. Femora, tibiae

and first tarsal segments mottled. (Hind tarsal segments 1 - 5 with wide basal bands). Wings dark scaled. Tergites with basal pale bands extended posteriorly in the middle and continuous with lateral patches. Tip of abdomen tapering; segment 8 hidden; cerci long.

Distribution

Occurs wherever brackish water occurs and is restricted to the southern states (south WA, SA, Vic., Tas., south NSW).

Breeding Places

Breeds in brackish swamps in open country and also in fresh water.

Adult Habits

Attacks man and domestic animals - is a vicious biter, attacking during the day and particularly after sunset.

4.6 AEDES VIGILAX (see Figure 12)

Distinctive characters

Proboscis pale beneath on basal 2/3. Palps with white tips. Wing scales with some pale mottling, plume scales narrow. Abdominal tergites with basal white bands not reaching lateral margin, with lateral spots rarely touching base. Tip of abdomen tapering. Segment eight hidden; cerci long; femora and tibiae mottled; hind tarsal segments 1 - 5 with wide basal bands.

Distribution

Coastal distribution almost all around Australia.

Breeding Sites

Temporary brackish marshes - tidal marshes; also found in freshwater in some instances. Eggs resist drying.

Adult Habits

Bites man, mammals, birds at all times. Can travel great distances from breeding sites.

4.7 COQUILLETTIDIA LINEALIS (see Figure 13)

Distinctive Characters

The scutum is clothed with dark bronze scales except light golden longitudinal lines; the tarsi have inconspicuous basal bands on 2 - 3 segments; the sternites are white scaled with a median black patch and a black apical border.

Distribution

Widely distributed throughout Victoria and recorded from Queensland, New South Wales, South Australia and Western Australia.

Breeding Places

The larvae of this species are unknown. It is a characteristic of the genus that the larvae have siphonal valves modified into piercing apparatus. Using this modified siphon larvae attach themselves to aquatic vascular plants, from which they derive their air supply.

Adult Habits

This species is a vicious day-biting mosquito which attacks man as well as domestic animals. It is particularly active just after sunset.

4.8 CULEX AUSTRALICUS (see Figure 14)

Distinctive Characters

Similar to *Culex fatigans* but underside of proboscis always pale on middle third, often on basal 2/3. Post spiracular area (psp) may have a few scales. Adbominal sternites with elongate median patches and lateral apical patches.

Distribution

Australia.

Breeding Places

A variety of ground pools and artificial containers - water sometimes brackish or slightly polluted.

Adult Habits

Bites birds and small mammals by night. (Rarely man - but may be attracted to lights).

4.9 CULEX FATIGANS (see Figure 15)

Distinctive Characters

Brown colour, square-tipped abdomen. Cerci inconspicuous, tarsi unbanded, tibia pale at apex. Abdominal tergites with basal pale bands. Abdominal sternites pale scaled, with a few median dark scales. Palps dark, femora not mottled, proboscis with some pale scaling on underside. No scales on post spiracular area.

Distribution

Australia-wide (an introduced species).

Breeding Places

Polluted water near human habitation (ground pools, drains, sumps, tins, septic tanks, drums, etc.). Very common in the autumn.

Adult Habits

Bites man and birds by night - a common domestic mosquito.

4.10 CULEX GLOBOCOXITUS (see Figure 16)

Distinctive Characters

Square-tipped abdomen, legs dark, abdominal tergites with basal creamy bands not separated from lateral spots on segments 2 - 5.

Distribution

Widespread in southern half of Australia.

Breeding Sites

Breeds in open swamps; grassy open pools.

Adult Habits

Not a man-biting mosquito.

4.11 CULEX MOLESTUS (see Figure 17)

Distinctive Characters

Similar to *Culex globocoxitus* but differs in that proboscis has dark scales on underside towards the tip.

Distribution

Souther parts of Australia, in association with man. (An introduced species).

Breeding Sites

Found in heavily polluted, artificial containers such as septic tanks and leach drains, as well as any other pools of water. Very common in the spring.

Adult Habits

The females are autogenous, ie. they can produce one egg batch without taking a blood meal by using reserves of protein, etc., stored during larval development. This means that this species can breed for generation after generation in sealed, underground water masses and so long as the septic tank/leach drains remain sealed, the mosquitoes obviously cannot be a biting nuisance. If the female is to lay a second batch of eggs, she must take a blood meal. Attacks humans and domestic birds.

5. REFERENCES

1. CSIRO (Division of Entomology) (1970), Insects of Australia. Melbourne University Press, Melbourne.

2. Dobrotworsky, M. V. (1965), The Mosquitoes of Victoria. Melbourne University Press, Melbourne.

3. Hughes, R. D. (1974), Living Insects. The Australian Naturalist Library, Collins, Sydney.

4. Liehne, P. and Irving-Bell, R. (1975). Original "Key to Common Mosquitoes of the Perth Area". Typescript.

5. Marks, E. N. (1973), An Atlas of Common Queensland Mosquitoes. University of Queensland Bookshop, St. Lucia.

6. Norris, K. R. and Upton, M. S. (1974). Collection and Preservation of Insects. Aust. Ent. Soc. Miscellaneous Publication No. 3.

6. KEYS TO THE MOSQUITOES OF SOUTH-WESTERN AUSTRALIA

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THE MOSQUITOES OF SOUTH-WEST AUSTRALIA[1]

Species	Distribution[2]	Status	Preferred breeding habitat	Other comments
Anopheles (Anopheles) atratipes	C D	Locally common	Permanent shady fresh water	
An. (Cellia) annulipes[4]	A B C D	Very common	Permanent and semi permanent open	Often in association with *Culex annulirostris, Cx. australicus*
Aedes (Chaetocruiomyia) calabyi	C D	Rare		Larva unknown
Ae. (Finlaya) alboannulatus	A B C D	Very common	Temporary ground water	
Ae. (Fin). notoscriptus	A B C D	Common	Tree holes, artificial containers	Often in domestic situations
Ae. (Fin). occidentalis	B C D	Locally common	Rain-filled rock holes, on granite outcrops	
Ae. (Halaedes) ashworthi	B C D	Common on south coast	Sea water in rock holes in splash zones	
Ae. (Macleaya) tremulus[4]	A B C D	Uncommon local flushes	Tree holes, artificial containers	Northern populations are sometimes in domestic situations
Ae. (Mucidus) alternans	A	Uncommon	Temporary ground water	Larvae are predatory Arid zone species
Ae. (Ochlerotatus) cacozelus	C D	Rare		Larva unknown
Ae. (Och). camptorhynchus	B C D	Common	Fresh to brackish water in tidal marshes	Major nuisance pest
Ae. (Och). clelandi	C D	Locally common	Fresh water pools	
Ae. (Och). eidsvoldensis	D	Rare	Clear fresh ground pools with grassy edges	Mainly a northern species One record from the South-west
Ae. (Och). hesperontius	C D	Rare		Larva unknown
Ae. (Och). hodgkini	C D	Rare	Fresh, clear grassy pools	
Ae. (Och). nignithorax	D	Rare	Shallow fresh water with rotting vegetation	
Ae. (Och). mackintoshi	C D	Rare	Fresh clear open water. Shallow with reeds and grass	
Ae. (Och). purpureifemur	C	Rare		Larva unknown
Ae. (Och). ratcliffe	C D	Uncommon	Temporary ground pools	
Ae. (Och). sagax	A B C D	Very common on occasions	Temporary ground pools, flood water	
Ae. (Och). stricklandi	D	Uncommon to rare	Temporary ground pools	
Ae. (Och). turneri	C D	Uncommon		Larva unknown
Ae. (Och). vigilax	A B C	Very common	Tidal salt marshes	Potential vector of disease Major nuisance species
Ae. (Och). E.N.M's Koorda Sp.[3]	B	Uncommon	Temporary ground pools	Dry/arid zone species
Ae. (Och). E.N.M's Sp. No. 71[3]	A B	Uncommon	Temporary ground pools	Arid zone species
Ae. (Pseudoskusea) bancroftianus	A B C	Common	Ground pools and flood water	May be seen in plagues
Coquillettidia linealis	B C D	Locally common		Larva unknown
Culex (Culex) annulirostris[4]	A B C D	Fresh water pools and swamps	Common	Major vector of diseases
Cx. (Cux) australicus	A B C D	Fresh water swamps	Very common	
Cx. (Cux) fatigans	A B C D	Very common	Fresh and polluted water	Domestic species often in septic tanks
Cx. (Cux) globocoxitus	A B C D	Locally common	Brackish swamps and flood waters	
Cx. (Cux) molestus	B C D	Common	Heavily polluted water	Domestic species in septic tanks
Cx. (Neoculex) latus	B C D	Uncommon	Clear fresh water pools & swamps	
Culiseta (Culicella) atra	B C D	Locally common	Clear fresh grassy pools	
Tripteroides (Rachinonotomyia) atripes	A B C D	Locally common	Tree holes, artificial containers	Often in domestic situations

[1]The South-west of Australia is defined as that area of the state which received an average annual rainfall in excess of 250 mm.

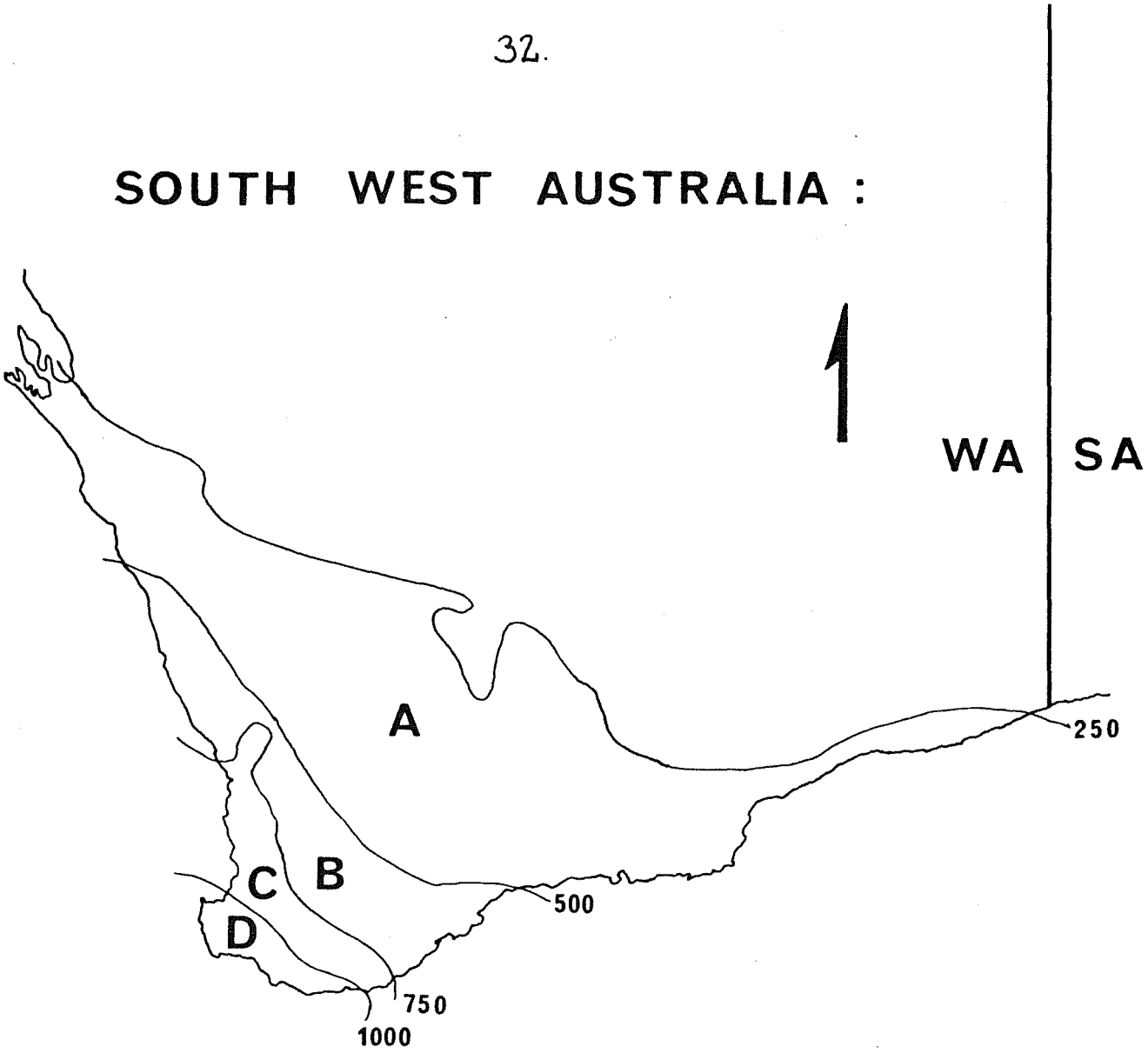
[2]The distribution zones are taken from the average rainfall data (see accompanying map)

Zone A = 250 - 500 mm
Zone B = 500 - 750 mm
Zone C = 750 -1000 mm
Zone D = more than 1000 mm

[3]New species which are as yet undescribed are allotted a title or number according to its position in Dr. Elizabeth Marks' list of new or undescribed species. This has become a standard coding for new species in Australia.

[4]These "species" consist of a number of distinct species which are morphologically difficult to separate. One or more members of each species complex occur in South-West Australia.

SOUTH WEST AUSTRALIA :



The distribution zones are taken from the average rainfall data

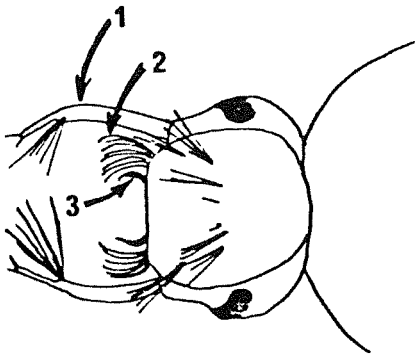
Zone A = 250-500 mm

Zone B = 500-750 mm

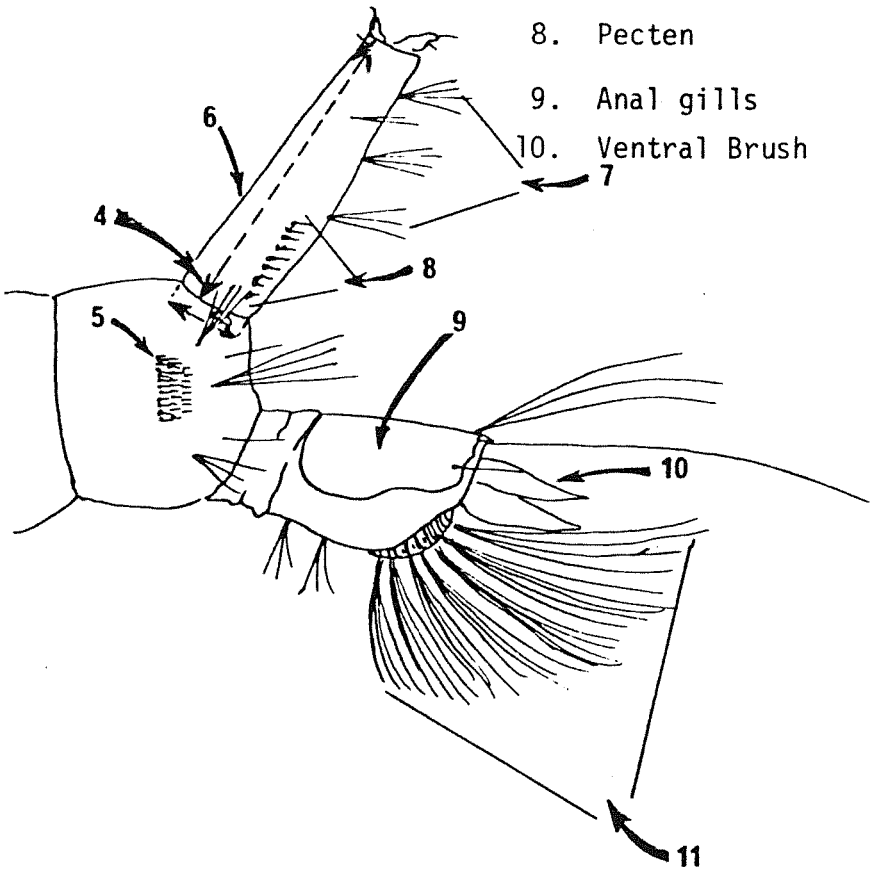
Zone C = 750-1000 mm

Zone D = more than 1000 mm.

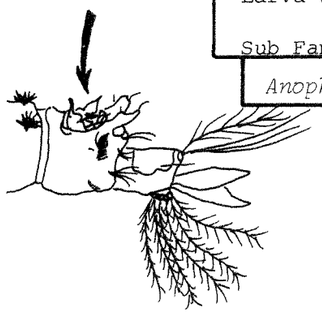
TAXONOMIC TERMINOLOGY OF MOSQUITO LARVAE



1. Antenna
2. Mouth Brushes
3. Clypeal Spines
4. Siphon Index - $\frac{\text{length}}{\text{width at base}}$
5. Lateral Comb
6. Siphon
7. Ventral Tufts on Siphon
8. Pecten
9. Anal gills
10. Ventral Brush

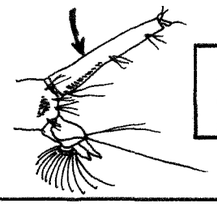


A SIMPLIFIED KEY TO THE COMMON MOSQUITOES OF SOUTH WEST W.A.: LARVAE

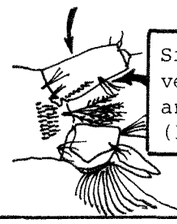


Larva without distinct syphon
Sub Fam. ANOPHELINI

Anopheles annulipes



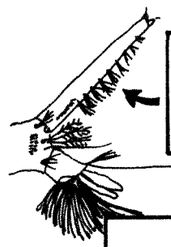
Larva with distinct siphon on segment VIII
Sub Fam. CULICINI



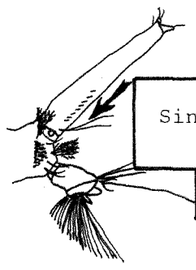
Siphon with single pair of ventral tufts, values small and unmodified, siphon stout (less than 2x Anal segment)

Siphon with single pair of tufts ventrally. Value modified to serrated piercing & cutting structure for peircing plant stems.

Coquillettidia linealis

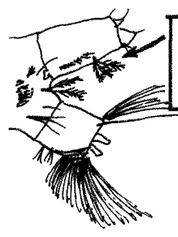


Siphon with more than 1 pr. of tufts. Siphon usually long and slender, more than 3x Anal segment. GENUS CULEX



Single pair of tufts arise at base of siphon

Culiseta atra



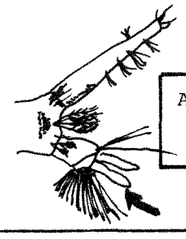
Single pair tufts arise at least ¼ length of siphon from base

GENUS AEDES

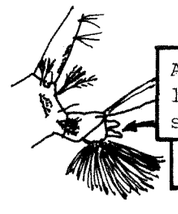
Antennae entirely brown Siphon with 3-4 pairs of tufts.

Antennae white on basal ½, dark brown siphon with 6 pr. tufts.

Cx. annulirostris



Anal gills as long as saddle



Anal gills ½ to 1/3 length of saddle

Cx. globocoxitus

Antenna dark brown (3/4 length of head)
Siphon index >5.0

Cx. australicus

Antenna grey 0.55 length of head. Siphon index 3.5 - 4.5

Cx. molestus

Cx. fatigans

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NOTES ON "A SIMPLIFIED KEY TO THE COMMON MOSQUITOES OF SOUTH-WEST WESTERN AUSTRALIA : LARVAE"

This key is obviously not intended as a rigorous guide to all the species in South-West Australia. Indeed, the genus *Tripteroides* is not mentioned at all and *Aedes* is keyed only to genus level. However, if this key is used in conjunction with the accompanying adult key, and with the notes presented in the tables and below, it should offer a reasonable guide as to species.

A. The genus *Tripteroides* has larvae with a siphon. These larvae can be distinguished from all other mosquito larvae by the following characteristics: (1) there is only one pair of tufts in the ventral brush; (2) the tufts of hairs on the body are very thick and stout.

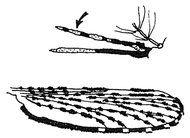
B. Tidal salt marsh *Aedes* species (*Aedes camptorhynchus; Aedes vigilax*) may be separated as follows:

Ae. camptorhynchus - saddle covers only dorsal half of the anal segment

Ae. vigilax - saddle extends around whole anal segment.

C. Fresh water breeding *Aedes:* it is difficult to decide which species larvae to include, as, depending on local conditions, relatively uncommon species may have large populations. Accordingly, it is suggested that adults are identified using the accompanying key. The preferred breeding sites may then be determined from the notes in the table.

AN ILLUSTRATED KEY TO THE COMMON MOSQUITOES OF SOUTH WEST AUSTRALIA : ADULT FEMALES



Palpi as long as proboscis wings spotted black and white
Sub. Fam. ANOPHELINI

Anopheles annulipes

Palpi up to 2/3 length proboscis usually much shorter; wings dark or mottled.
Sub. Fam. CULICINI

Proboscis without distinct white band

Proboscis with sharply defined white band around middle (not more than 1/3 length proboscis)

Hind tarsi with distinct basal white bands

Hind tarsi without distinct bands

Scutum dark; legs mottled; tarsi with narrow bands; bases of forked cells equal distance from base of wing.

Culex annulirostris

Scutum with lyre-shaped pattern of narrow white lines

Aedes notoscriptus

Hind femur without pre-apial pale ring

Hind femur with distinct pre-apical white ring and with ochreous knee spot

Aedes alboannulatus

Basal tergal bands present

No basal tergal bands, but distinct white lateral patches on tergites.

Wing scales all dark
Basal tegal bands extended in midline

Aedes camptorhynchus

Wing scales with some mottling with pale scales; basal tergal bands with straight posterior margin; lateral tergal patches are narrower near base than at mid length of segment

Aedes vigilax

Tip of abdomen distinctly rounded

Tip of abdomen pointed

Basal tergal bands constricted. Laterally and separated from lateral patches on tergites IV and V

Basal tergal bands continuous on Tergites IV and V

Head with narrow scales dorsally

Aedes sagax

Head with broad flat scales dorsally

Aedes bancroftianus

Lateral patches basal; scutum with a pattern of longitudinal lines of pale scales

Coquillettidia linealis

Lateral patches apical; scutum clothed in bronzy scales

Tripteroides atripes

Dark species; sternites with median elongate & lateral apical patches of dark scales

Culex australicus

Lighter; central black patches on sternites absent or inconspicuous

Culex fatigans

Tergites dark (almost black) with broad creamy bands. Underside of proboscis with pale scales over whole length.

Culex globocoxitus

Tergites brown, bands pale
Ventral surface of proboscis with dark scales at tip

Culex molestus

DEPARTMENT OF MICROBIOLOGY
THE UNIVERSITY OF WESTERN AUSTRALIA

NOTES ON "AN ILLUSTRATED KEY TO THE COMMON MOSQUITOES OF SOUTH-WEST AUSTRALIA : ADULT FEMALES"

The species listed in the key are those which occur most commonly through the South-west. They include the major domestic species, those which form the major nuisance pests, and those most commonly encountered in rural situations.

Three main points must be remembered in relation to this key:

(A) The key is an artificial means of separating certain species and is based on convenient morphological characters. As such, many of the minor species conform to the characters used in the key and this may lead to some confusion, particularly before the user becomes familiar with the common species.

(B) Under favourable local conditions, such minor species may in fact form the greatest proportion of mosquitoes present.

(C) The key is valid only for the South-west of Australia. The mosquitoes in the Pilbara and Kimberley region are covered by "An atlas of common Queensland mosquitoes" by Dr. E.N. Marks (available from the Department of Entomology, University of Queensland).

The following notes attempt to overcome some of these confusions and to give some simple characters which distinguish the common species in the key from those other species which share the morphological characters as used in the key.

Format:

These notes refer to divisions in the key which use a simple character to separate the mosquitoes into two groups. For example, the first division separates the Anophelines (which have palps as long as the proboscis) from the Culicines (which have palps less than 2/3 length of the proboscis). All the Anophelines will key out with *Anopheles annulipes*. In fact, only one other Anopheline occurs in South-west Australia. *Anopheles atratipes* has dark wings whilst *Anopheles annulipes* wings are spotted.

The other divisions in the key are treated similarly. (Common species - i.e. those in the key - are underlined).

A. Palps as long as proboscis:

An. annulipes - wings spotted

An. atratipes - wings dark

B. Proboscis with pale ring on middle 1/3:

Aedes alternans has a broad ill-defined pale ring over basal 2/3 proboscis, palps are 2/3 length of proboscis, very large species.

C. Proboscis without band; banded tarsi on hind leg; hind femur without pre-apical pale ring:

Aedes calabyi - no basal tergal band, only lateral and median patches. A small hunched mosquito with pale scutum.

C.1. with wing scales dark:

Aedes camptorhynchus : proboscis and legs mottled; scutum with golden scales and one or two white patches.

Aedes mackintoshi : scutum red brown with broad pale bands along lateral border.

Aedes tremulus : dorsal head scales broad and flat; proboscis and legs uniformly dark scaled; tarsus IV all dark and V all white.

Aedes ENMs Koorda sp. : white bands overlap both segments on junction of tibia/femur; tibia/tarsis.

Aedes occidentalis : scutum dark with bronzy patches; proboscis dark scaled.

C.2. with some mottling on wings:

Aedes vigilax : lateral patches on tergal bands broadest at mid length of segment.

Aedes eidsvoldensis : wing scales large and prominent, lateral tergal bands broadest at base.

Aedes ENMs Sp. No. 71 : lateral tergal bands broadest at base.

Aedes alternans : (see B above). A very large species, with alternating light and dark bands on legs, shaggy appearance.

D. Species with unbanded proboscis; unbanded tarsi; no basal tergal bands:

Culiseta atra : dark species, tergites completely black.

D.1. Species with lateral tergal patches basal

Coquillettidia linealis : scutum with pronounced pattern of longitudinal pale and dark lines, proboscis dark scaled

Aedes turneri : extensive mottling of legs and proboscis, dark, species

Aedes stricklandi : white apical border on some tergites

Aedes purpureifemur : scutum dark

Culex latus : broad golden streak runs from dorsal head along mid line of scutum

E. Species with unbanded proboscis; basal tergal bands; pointed abdomen and with narrow scales on dorsal surface of head:

Aedes sagax : scutal scaling bronzy; femora and tibiae mottled; tergal bands extended in mid line

Aedes nigrithorax; scutum dark bronze medially, creamy white margins

Aedes hesperontius : scutum dark, mid femur unmottled

Aedes clelandi : basal tergal bands straight in midline

Aedes cacozelus : tergal bands not joined in mid line or segment V. Wings, legs and proboscis mottled.

Aedes ratcliffei : scutum red brown with broad pale lateral margin

Aedes hodgkini : scutum red brown with broad pale lateral margin, tergal bands extended in mid line to produce a white stripe.

Aedes ashworthi : tergal bands sometimes restricted in mid line; femora and tibiae all dark (femora with pale streak).

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