University of Queensland Papers

DEPARTMENT OF ENTOMOLOGY

Volume I. 1957 Number 5

The Subgenus *Ochlerotatus* in the Australian Region (Diptera: Culicidae)

I. Notes on classification, with the description of a new species.

BY

ELIZABETH N. MARKS, M.Sc., Ph.D.

Price: Two Shillings

THE UNIVERSITY OF QUEENSLAND PRESS
BRISBANE

24th SEPTEMBER, 1957

DEPARTMENT OF ENTOMOLOGY

VOL. I 1957 NUMBER 5

The Subgenus *Ochlerotatus* in the Australian Region (Diptera: Culicidae)

I. Notes on classification, with the description of a new species.

BY

ELIZABETH N. MARKS, M.Sc., Ph.D.

National Mosquito Control Committee
Department of Entomology
University of Queensland

THE UNIVERSITY OF QUEENSLAND PRESS
BRISBANE
24th SEPTEMBER, 1957

Wholly set up and printed in Australia by
WATSON, FERGUSON AND COMPANY
Brisbane, Q.
1957

The Subgenus *Ochlerotatus* in the Australian Region (Diptera: Culicidae)

I. Notes on classification, with the description of a new species.

By ELIZABETH N. MARKS

Twenty-seven species of *Aedes* (*Ochlerotatus*) have been described from the Australian region, including one in the present paper. Larvae of eleven of these have been described. Recent field studies by various workers in Australia have revealed additional life histories and undescribed species.

Similarities of the male terminalia and the larvae give a truer indication of the affinities of species than the presence or absence of tarsal bands. On this basis the Australian species are arranged in nine sections, the distinguishing characters of which are given.

The male, female, larva and pupa of a new species, *Aedes* (*Ochlerotatus*) *calcariae*, are described from specimens from South Australia, where it breeds in flooded rabbit burrows. It occurs also in Victoria. Notes are given on its biology and its affinities discussed.

Introduction

The present paper is planned to be the first of a series by several authors in various journals, dealing with the systematics, distribution and ecology of mosquitoes of the subgenus *Ochlerotatus* in the Australian region. From this region, Mackerras (1927) recognised 22 species, one of which was later removed from the subgenus. Edwards (1932) listed the remaining 21. The number of described species is now 27, including one described below, and at least a dozen species are as yet undescribed. Of the total, one, *A. vigilax*, has a wide distribution, one occurs in Tahiti only, one (undescribed) in Solomon Is. only, two in New Guinea only, two in New Zealand only, and the remainder are confined to Australia and Tasmania.

Mackerras (1927) gave the most recent general review of the subgenus, and at that time larvae of two species had been described. Lee (1944) added two, Marks (1949) four, Stone and Rosen (1952) one, and Miller and Phillips (undated) one, while another is described in the present paper, bringing the total to eleven. Others are now known and await description.

Most species of this subgenus breed in temporary pools, resulting from heavy rain, floods, melting snow, or high tides, or in permanent pools subject to considerable fluctuation in water level due to these agencies. Their eggs are believed to be laid in soil or on vegetation of a drying-out pool, can withstand desiccation, and hatch when the breeding place is filled again. The larval and pupal periods are usually short, and in hot climates adults may emerge less than a week after the breeding place is filled. The adults of one generation appear suddenly in large numbers, males soon disappear, and females are a pest for a limited period only. Because of this, and the difficulty of reaching known localities when the breeding places are newly filled, many species have for long been known only from females taken biting, and often from few specimens. In recent years, the nature of the work of C.S.I.R.O. Wild Life Survey Section has meant that trained personnel were located in the field at the time of *Ochlerotatus*

breeding. The present papers are based to a large extent on collections made by these officers in the south and west of Australia though workers in other institutions have made considerable contributions from the states with which they are concerned.

Classification

Edwards (1924) and Mackerras (1927) recognised two distinct faunal elements, Neotropical and Holarctic, among Australian *Ochlerotatus*. It is not proposed at this stage to make any further general comparisons between the Australian species and those of other regions, beyond pointing out that two species which differ little from certain Australian species with Holarctic affinities, have since been described from South Africa (Muspratt, 1953). Edwards (1932) divided the subgenus *Ochlerotatus* into eight groups, placing the Australian species with Neotropical affinities in Group A, and dividing the remainder, on the basis of presence or absence of tarsal rings, between Group B (in which he doubtfully placed three species) and Group G. Accumulated information on all stages of Australian species endorses the comment of Mackerras (1927) that groupings based on tarsal banding are unnatural. Many species differ in detail from the diagnostic characters of Edwards' groups, which will not be considered further at present.

With the discovery of males and larvae of species hitherto known only from females, it has become apparent that the Australian species may be divided on male terminalia into several distinct groups, some of which are also distinguished on larval characters. In some cases two species which closely resemble one another in other adult characters fall into different groups. As knowledge of some species is incomplete, the following is in the nature of a preliminary classification but should be of general use to workers on *Ochlerotatus* in indicating affinities which may not be obvious from a study of females only. The general term "section" is used to avoid confusion with Edwards' groups. Some sections are the equivalent of the subgroups into which Edwards' groups of the subgenus *Finlaya* were divided by Knight and Marks (1952), but this term has not been used since this regional study concerns only a small proportion of the total species in the subgenus *Ochlerotatus*. All species described from the Australian region are listed; many are placed in sections on information still unpublished. Some additional sections will need to be added for species not yet described. Keys to the species will be included in a subsequent paper.

VIGILAX SECTION. Male Terminalia: Coxite—apical lobe undeveloped or weakly developed with one or two strong setae or fine hairs only; basal lobe rounded, hairy, sometimes with a few broadened setae apically, or produced into a curved arm with expanded knob bearing stout setae; no rows of long mesially directed setae sternally. Harpago slender, without thumb; appendage bristle-like, straight or slightly curving at tip.

Larva: Lateral comb 20–40 scales or fringed spines. Siphon normal, index 1.5–3.0; pecten without detached teeth; seta 1 arising beyond pecten.

Included species: *antipodeus* Edwards, *edgari* Stone and Rosen, *inexpectatus* Bonne-Wepster, *rubrithorax* (Macquart), *vigilax* (Skuse).

THEOBALDI SECTION. Male Terminalia: Coxite—apical lobe elongate, fairly well developed, hairy; basal lobe prominent, densely hairy often with some modified setae; no rows of long mesially directed setae sternally. Harpago slender, without thumb; appendage bristle-like, angled near tip and may have retrorse projection.

Larva: Lateral comb 12–25 spines with denticles or fringe at base. Siphon not sclerotised to base dorsally; pecten without detached teeth; seta 1 long, arising beyond pecten; seta 9 a stout hook.

Included species: *normanensis* (Taylor), *pseudonormanensis* Marks, *theobaldi* (Taylor).

ACULEATUS SECTION. Male Terminalia: Coxite—apical lobe undeveloped, with a strong bristle; basal lobe slightly developed, hairy; several rows of long mesially directed setae sternally. Harpago long, with swelling or slight thumb with bristle; appendage broad, curved, with long fimbriations.

Larva: Head and body studded with sclerotized tubercles. Head seta 4 strongly developed. Lateral comb 10–15 spines with denticles at base. Pecten without detached teeth; siphonal seta 1 arising beyond pecten.

Included species: *aculeatus* (Theobald), *purpuraceus* Brug (larva unknown).

BURPENGARYENSIS SECTION. Male Terminalia: Coxite—apical lobe slightly developed, with 1–2 strong setae; basal lobe moderately developed with numerous setae on inner fold and one long seta at apex; no rows of long mesially directed setae sternally. Harpago with prominent thumb with apical bristle; appendage broad, fimbriated.

Larva: Lateral comb 6–10 spines. Pecten with detached teeth beyond siphonal seta 1.

Included species: *burpengaryensis* (Theobald), *macleayanus* Mackerras, *nigrithorax* (Macquart), *sagax* (Skuse), *vittiger* (Skuse).

Distinguishing larval characters have not been found for the following five sections. The larvae have lateral comb 20–50 fringed scales or pointed spines; pecten without detached teeth; siphonal seta 1 arising beyond pecten.

FLAVIFRONS SECTION. Male Terminalia: Coxite—apical lobe a moderate swelling, bearing short setae; basal lobe slightly developed with a patch of fine setae on inner fold; several rows of long mesially directed setae on apical half sternally. Harpago with or without a distinct thumb; appendage broad, fimbriated.

Included species: *calcariae* sp.n., *clelandi* (Taylor), *flavifrons* (Skuse), *purpuriventris* Edwards.

PERKINSI SECTION. Male Terminalia: Coxite—apical lobe prominent, with fine hairs; basal lobe prominent with a short stout seta near base, and a row of long recurved setae at apex, the most tergal of which is thickened; several rows of long mesially directed setae sternally. Harpago without thumb; appendage broad, blade-like.

Included species: *luteifemur* Edwards, *perkinsi* Marks.

CUNABULANUS SECTION. Male Terminalia: As in Perkinsi Section, but apical lobe is slightly less prominent, and there are no rows of long mesially directed setae sternally on coxite.

Included species: *andersoni* Edwards (larva unknown), *cunabulanus* Edwards.

CAMPTORHYNCHUS SECTION. Male Terminalia: Coxite—apical lobe prominent, with fine hairs; basal lobe moderate, rounded, with a short stout seta

near base, a long stout seta, and a row of shorter setae, not recurved; several rows of long mesially directed setae sternally. Harpago without thumb; appendage broad, blade-like.

Included species: *camptorhynchus* (Thomson), *nivalis* Edwards.

Larvae of the following section are still unknown.

STRICKLANDI SECTION. Male Terminalia: Coxite—apical lobe prominent with short broad setae; basal lobe scarcely developed, with six shortish setae; no rows of long mesially directed setae sternally. Harpago with bristle but no distinct thumb; appendage short, broad, curved.

Included species: *stricklandi* (Edwards).

Not included in the above sections is *albirostris* (Macquart), known from females only.

Male terminalia of the type species of 7 sections are figured in Mackerras (1927) (*vigilax, theobaldi, flavifrons, camptorhynchus*) or Marks (1949) (*theobaldi, aculeatus, perkinsi, stricklandi*). Terminalia of the Burpengaryensis Section are illustrated by Mackerras' (1927) figures of *vittiger* and *sagax*. No figures of species in the Cunabulanus Section have been published.

Aedes (Ochlerotatus) calcariae sp.n.*

Distinctive Characters: A medium to large sized species, this is the only known Australian *Ochlerotatus* in which hind tarsal segment V is all white. In addition, it is distinguished from the few others that have bands on the hind tarsi extending onto the apices of the preceding segments, by its unmottled femora and tibiae, or entirely dark scaled wings, or small kneespots.

Male Terminalia—Coxite with more numerous setae than other species of the Flavifrons Section, which lack the group of long fine setae tergally near base of coxite.

Larva—From other species with normal siphon, pecten with not less than 15 spines, none detached, lateral comb of 20–50 fringed scales and saddle not a complete ring, it is distinguished by having head seta 6 (B) usually single, or not divided before mid length, prothoracic seta 3 usually single, and seta 1 of Segment VIII single to trifid.

Holotype Male.

Wing length, 4.0 m.m. *Head:* Integument dark; clothed with creamy scales, large narrow curved mesially, broad flat laterally and numerous upright forked. A pair of long pale vertical bristles, a row of 7 long mesially directed ocular bristles, the median pair pale, the rest dark, and finer bristles laterally. Torus large, dark; flagellar segments of antenna brown with long black verticillate hairs lying mainly in a vertical plane, the two apical segments dark with short dark hairs. Clypeus dark. Palps slightly longer than proboscis (excluding labella), purplish black scaled with dorsal white basal patches covering ⅓ segment IV and ⅓ V; IV and V slightly down turned; long purplish hairs ventrally at apex of III and along IV, also along inner side of IV, shorter scattered dark hairs on V. Proboscis almost 1½ times length of fore femur, purplish black scaled, labella dark.

Thorax: Integument dark; 2 distinct submedian bare patches on anterior margin; scutal scales narrow curved, bronzy brown, with an indistinct pattern of creamy to pale golden scales which form a border to the scutum, a broad median stripe along the acrostichal bristles (with a few dark scales

* Since its discovery, this species has been referred to as "white-foot" in correspondence between Australian workers on mosquitoes.

scattered along the midline) forking round the prescutellar bare area, a pair of narrow submedian stripes, mesial to the dorsocentral bristles on anterior half and lateral to them on posterior half of scutum, and a pair of broad horizontal patches extending from these stripes to the scutal angles. The pale scales on the border and round the prescutellar bare area are larger than the rest. Scutal bristles dark, about 15 acrostichal, 9 dorsocentral, 7 prescutellar, 3–4 on fossa, and a row of long dark bristles and a patch of shorter pale ones above wingroot. Scutellum dark, clothed with large narrow curved creamy scales, 6 long bristles to mid lobe and 5 to lateral lobes, as well as a few shorter bristles. Metapostnotum dark brown. *Apn.* with elongate broad creamy scales; *ppn.* with large narrow curved and elongate broad creamy scales. Propleuron with numerous pale bristles and some elongate white scales, one pale scale on postspiracular area on one side, subspiracular area with a few white scales (some narrow) along margin with *ppn.* and a larger patch of broad scales on margin with *stp.*; patches of broad white scales on paratergite, preala below knob, a large upper and smaller lower posterior patch on *stp.*, upper and median patches on *msp.* Metameron bare. *Ppn.* with 5–7 bristles and a couple of shorter bristles in front of them, the longest bristles brown; pleural bristles pale, 5 postspiracular, 13–14 prealar, about 15–19 upper and no lower *msp.* bristles.

Legs: Coxae and trochanters pale scaled. Femora, tibiae and tarsi unmottled, purplish black scaled with white or creamy markings. Foreleg: femur with pale band at base, extending anteriorly as a patch and then a few scattered pale scales for $\frac{2}{3}$ length, and posteriorly as a pale streak for $\frac{3}{4}$ length, and with small pale kneespot; tibia with small pale patches dorsally at base and posteriorly at apex; tarsal segments I and II with small basal pale patches, III with a couple of pale scales at base. Midleg: femur dark anteriorly except for basal pale band and small pale kneespot, pale posteriorly on basal $\frac{3}{4}$ with a few scattered pale scales beyond; tibia and tarsus as on foreleg, tarsal segment III with small basal pale patch. Hindleg: femur pale on basal half except for broad dark dorsal line not reaching to base and with pale kneespot; tibia with small pale patches at base and anteriorly at apex; tarsal segments I–IV with basal pale bands, very narrow on I, and covering $\frac{1}{8}$ II, $\frac{1}{4}$ III, $\frac{1}{4}$ IV; and also with apical dorsal pale patches; V all white. Claws (Fig. 1, a–c): Fore tarsal claws curved, unequal, anterior longer with slender pointed tooth laterally near base, and large, stout, apically rounded tooth ventrally at mid length; posterior with large stout pointed tooth ventrally near base. Mid tarsal claws markedly unequal, anterior long, simple, curved on basal half, slightly sinuous on apical half with ventral swelling beyond midlength; posterior curved, with stout curved pointed tooth ventrally at $\frac{1}{3}$ length. Hind tarsal claws equal, curved, with a long straight bristle-like tooth arising ventrally near base.

Wings: Entirely purplish black scaled. Cell R_2 1.3 x its stem, cell M_1 0.8 x its stem, its base slightly proximal to that of cell R_2; r–m its own length distal to base of M_{3+4}. Halteres pale; knob pale scaled with a few dark scales mesially.

Abdomen: Tergites purplish black scaled, with dark bristles along apical border and numerous long bristles laterally; I with a median patch of dark scales and pale scaled lateral border; II–VII with basal bands, straight mesially, widening laterally, about $\frac{1}{4}$ length II–VI, $\frac{1}{3}$ VII; true tergite VIII pale scaled, bristly. Sternites with numerous scattered bristles; II pale scaled, III–VII dark with large basal lateral white patches, III–V also with some scattered white scales mesially near apex; true sternite VIII pale scaled with large median apical dark patch.

Terminalia (Fig. 1, *f-i*): Described from holotype and 7 paratypes. Coxite dark scaled laterally, about 4 times as long as broad at midlength, with moderately developed apical and basal lobes. On the tergal aspect of coxite, mesially, 5–7 rows of short setae run from below the apical lobe to the basal lobe merging with a group of about 20 longer fine setae at base of coxite. Laterally, both tergally and sternally, there are long strong setae. On the sternal aspect of coxite, mesially, there are about 6 rows of long, golden, mesially directed setae on apical half with fewer shorter ones on basal half, and some short setae basally. The apical lobe bears about 10–16 short setae on its tergal aspect, 2–4 at apex being slightly longer and stouter ($\frac{1}{3}$ longer than appendage of style). The basal lobe extends as a rounded plate within the fold of the coxite, and bears numerous fine

setae with slightly curved tips, those toward the tergal aspect being longer, with 2–3 long setae arising at the tergal angle of the lobe. Style slightly more than ⅓ length of coxite, curved, basal ⅔ swollen, pilose, apical ⅓ slender, with 2–4 fine setae; appendage terminal, about ⅛ length of style, tapering, with rounded tip. Harpago about ⅓ length of coxite, stout, curved, pilose on basal ½, with 1 strong

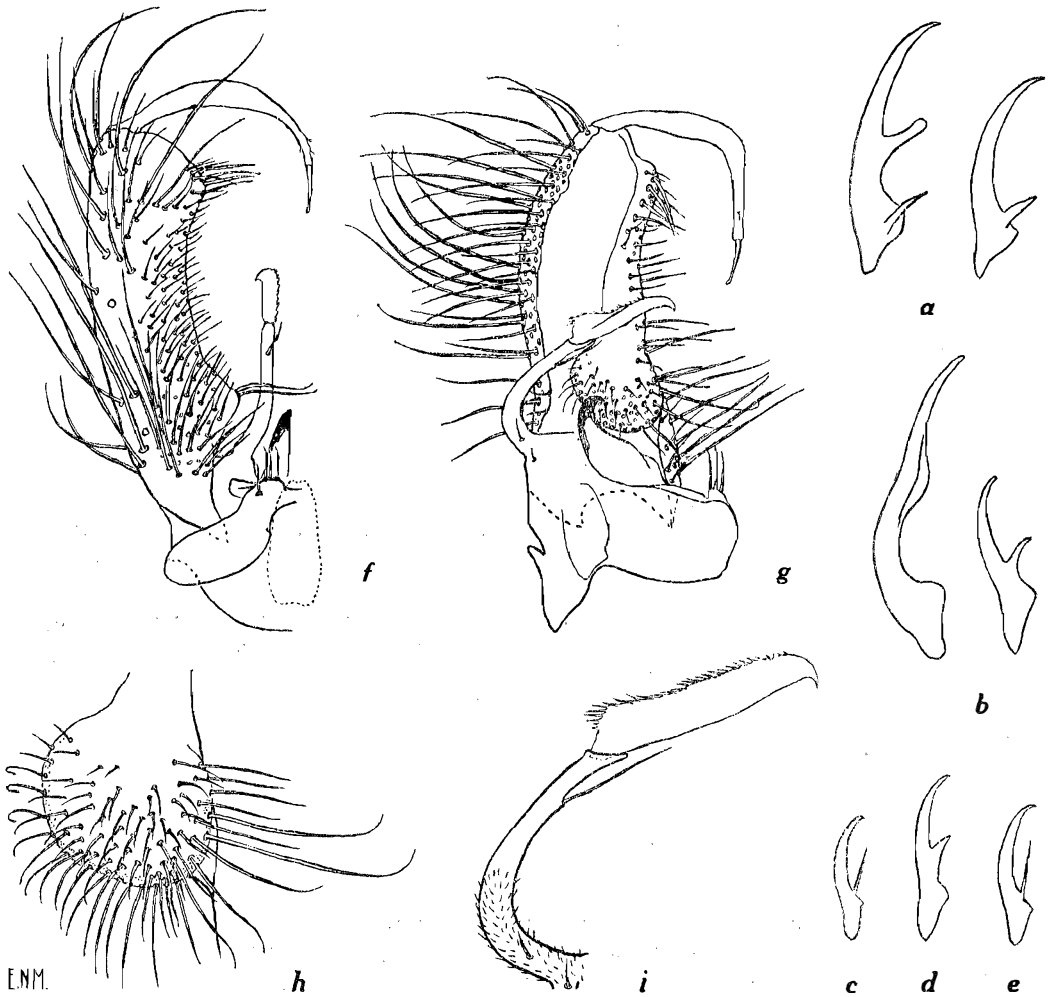

FIG. 1—*Aedes calcariae* sp. n. *a-e*, tarsal claws; *a*, ♂ fore tarsal claws; *b*, ♂ mid tarsal claws; *c*, ♂ hind tarsal claw; *d*, ♀ fore tarsal claw; *e*, ♀ hind tarsal claw. *f-i*, ♂ terminalia; *f*, left half, tergal aspect (scales omitted); *g*, right half, inner lateral aspect; *h*, basal lobe, inner lateral aspect; *i*, harpago, inner lateral aspect; *a-e*, x 200; *f*, *g* x 94; *h*, *i*, x 188.

preapical seta ½ length of appendage, and 2–5 short setae near base; appendage almost as long as harpago, expanded abruptly from base, with short fimbriations almost to apex, and short curved pointed tip. Paraproct with 1 strong and 1–2 inconspicuous teeth. Phallosome simple, oval. Lobes of IXth tergite with 2–5 short strong setae. IXth sternite with 5–6 setae.

Among 35 paratype males the following differences from the holotype occur: Wing length 3.4–4.7mm. *Head:* Integument brown; pale patches on palps pale-reflecting rather than white, ⅛–⅓ IV and ⅛–⅛ V, or inconspicuous on IV; a few pale scales at apex of III and IV; palps practically straight; rarely a few pale reflecting scales under the proboscis at midlength. *Thorax:* Integument

medium or reddish brown; pale scaling on scutum reduced leaving little trace of the median and submedian pale stripes on anterior half, but a distinct horizontal patch in front of prescutellar bare area, or pale scales increased, almost completely covering fossae; 6 long bristles on lateral lobe of scutellum. *Apn.* with narrow curved as well as broad scales; *ppn.* with a few dark scales among the pale; a few pale scales on postspiracular area, or none; anterior scales on subspiracular area all broad; 5–8 long *ppn.* bristles, with 2–6 shorter bristles anterior to them; 4–9 postspiracular bristles. Foreleg with a few dark scales on coxa, a patch of dark scales on trochanter, femur with pale scales anteriorly not extending beyond the basal band, or extending up to ½ length, posteriorly extending over basal ½ or to apex, the distal portion often of scattered pale scales; basal pale patches on tarsal segments pale reflecting or white, often represented by only 1 or 2 scales, usually on I–II or I–III, sometimes I–IV and rarely on I only or on I–V. Midleg: femur pale posteriorly on basal ½–⅔, sometimes with scattered scales beyond or with a posteroventral line continuing to apex; tarsus with basal patches on at least I–II, otherwise as on foreleg. Hindleg: femur pale on basal ½–⅔ anteriorly, sometimes with a few pale scales beyond, and on basal ½–⅔ posteriorly, sometimes with apical dark scaling extending slightly towards base ventrally; basal tarsal bands covering ⅛–⅕ II, 1/7–¼ III, ⅛–⅓ IV. Wings: Cell R_2 1.0–1.4 x stem, cell M_1 0.5–0.8 x stem, its base level with or distinctly proximal to that of cell R_2; r–m ½–⅔ its own length distal to base of M_{3+4}. Knob of halteres entirely pale scaled. *Abdomen:* Tergal bands ⅛ length II–VI, ¼ VII or ⅓ II–VII; tergite VIII with some dark scales. Sternites without white scales mesially at apex; or mainly pale scaled with large basal median and apical lateral dark patches.

Female.

The allotype and 22 paratype females differ from males as follows:

Wing length: 3.6–5.7mm. (4.6mm. in allotype). *Head:* A few dark narrow curved scales may form a submedian patch behind the pale scaled eye margin; there are a few dark upright forked scales laterally and some of the posterior ones may be brownish, or all dark except a few creamy at vertex. Torus dark below, ochraceous above with numerous flat pale scales mesially and about 6 short hairs; first flagellar segment ochraceous on basal ½ and with a patch of white scales and sometimes a few dark scales mesially; remainder of flagellum dark with pale clothing hairs and long dark bristles. Palps ⅛ length of proboscis, purplish black scaled with a patch of pale scales at tip, occasionally inconspicuous, and sometimes a few pale scales preapically, or at midlength, or laterally at base. Proboscis 1⅛ times length of fore femur, entirely dark scaled.

Thorax: Scutal scale pattern showing same variation as in male; the median and submedian stripes anteriorly may be ill-defined, forming a rather broad pale area with some dark scales through it, but a pattern with reduced pale scaling is more usual; scutellum with 7–9 long bristles to mid lobe and 6–10 to lateral lobes. Scales on *apn.* and *ppn.* may be almost all narrow curved, there may be a couple of dark scales on *apn.*, and usually a few on *ppn.*, but sometimes as much as ½ or ⅔ *ppn.* scales are dark. The 2 subspiracular scale patches may be fused, likewise the 2 *msp.* patches; there may be a large patch of pale scales on postspiracular area and it is seldom unscaled; 5–10 long *ppn.* bristles, plus a varying number of shorter ones; 6–12 postspiracular bristles. On *msp.* there may be 2 strong bristles placed one above the other near the middle of the anterior margin; 5 specimens, including the allotype, have 2 bristles on each side, others have 1 on one side and 0–2 on the other, and 5 have none on either side. Legs: On fore femur pale scaling anteriorly may extend to ⅜ length and posteriorly extends almost or quite to apex; tibia may have a line of pale scales posteriorly; basal pale patches on at least fore tarsal segments I–III, and frequently on IV and V; there may be a complete basal band on II. Mid femur occasionally with a discontinuous ventral white line on basal ½ which may show anteriorly; posteriorly pale on basal ⅔–¾ with scattered pale scales beyond and with a posteroventral line to apex, or pale to apex, without distinct lines. Mid tarsal segments I–III with basal pale bands or patches, usually a few scales or small patch at base of IV and V, sometimes a few pale scales at apex of I. Hind femur pale anteriorly on basal ⅔–¾ sometimes with 1 or 2 scattered scales beyond, posteriorly on basal ½–⅔ and frequently with a more or less continuous line of pale scales ventrally almost to apex; hind tarsal bands covering basal 1/7–⅕ II, ⅛–¼ III and ¼–⅓ IV. Claws (Fig. 1, *d–e*) equal, fore

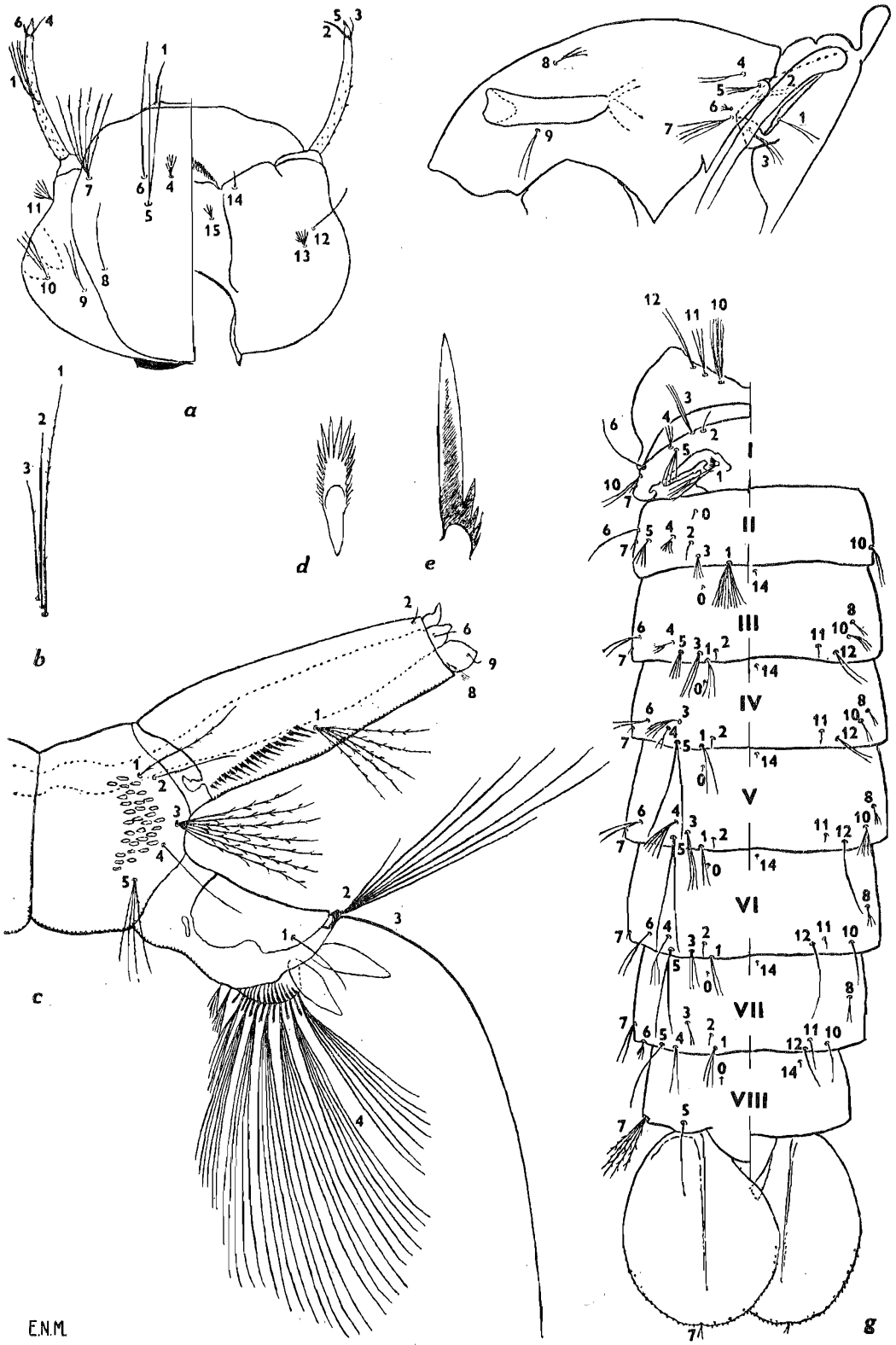

FIG. 2—*Aedes calcariae* sp. n. *a-e*, larva; *a*, head; *b*, prothoracic setae 1-3 (left side); *c*, terminal segments; *d*, lateral comb tooth; *e*, pecten tooth; *f-g*, pupa; *f*, cephalothorax; *g*, metanotum and abdomen (dorsal setae on left, ventral on right). *a*, and *c*, x 38; *b*, x 47; *d*, and *e*, x 300; *f*, and *g*, x 25.

and mid tarsal claws similar, curved distally, with short stout pointed tooth ventrally at mid-length; hind claws similar to male. Wings: Cell R_2 1.7–2.6 times its stem, cell M_1 0.8–1.5 times its stem, its base well distal to, level with, or slightly proximal to that of cell R_2.

Abdomen: Tergal bristles pale; tergite I with white scaled lateral border and with a median patch, which may be dark, or partly or entirely pale (in the allotype the patch is dark with a few narrow curved as well as broad pale scales in midline at apex); II–VII with large basal lateral pale patches extending about $\frac{2}{3}$ length of segment and with complete basal pale bands, narrow or $\frac{1}{4}$–$\frac{1}{3}$ length of segments, or II–VI with a line of pale scales at base discontinuous with lateral patches; or IV–VII with only scattered scales at base, or VI with lateral patches only; VII may have some mottling of pale scales in midline and there may be a few pale scales at apex of IV–VI and a pale apical border on VII; VIII narrow, pale or dark, bare of scales. Sternite II pale scaled, III–VI pale scaled with basal median and apical lateral dark patches, the basal patches may be represented by only a few scattered dark scales, may be absent on III and VI or may be large and contiguous with apical patches; VI and VII may be dark scaled except for basal lateral pale patches and some pale scales mesially at apex, or VII may have apical lateral dark patches only or be entirely pale; VIII narrow, bare; cerci long, dark.

Specimens (3 males, 2 females) from other localities in South Australia resemble the type series; one female from Dismal Swamp has 2–3 lower *msp.* bristles. Victorian specimens (8 males, 12 females) are generally larger (wing length, males 3.6–5.0mm., females 4.2–5.8mm.) and the majority have extensive golden scaling on the anterior half of the scutum, obscuring any pattern; a Ballan male has 10 setae on IXth sternite; 2 Lyonville females have a slight mottling of pale scales on proboscis; on hind tarsi basal bands may be $\frac{1}{3}$ III, $\frac{2}{3}$ IV.

Larva (Fig. 2, *a–e.* Nomenclature of setae as in Belkin (1950).)

Length 8.5–9.8mm. Head, siphon and saddle brown.

Head: $\frac{4}{5}$ as long as broad. Antennae almost $\frac{1}{2}$ length of head, about 10 times as long as broad, slightly tapering, with small scattered spicules; seta 1 arising at about midlength, 3–6 branched, frayed; terminal and subterminal setae arising close together, 2 long, stout, 3 and 4 shorter, slender, 4 longer than 3, 5 broad, subovoid on basal $\frac{1}{2}$, narrower and tapering on apical $\frac{1}{2}$, 6 short, stout. Head seta 1 single, slender, curved, frayed, occasionally bifid at tip. Base of 7 slightly behind base of antenna, 6 level with 7 and a little more than $\frac{1}{2}$ way between it and midline, 4 level with 6 and $\frac{1}{2}$ way between it and midline, 5 almost directly behind 6; 4 4–7 branched; 5 single to trifid; 6 single or rarely bifid or trifid near midlength, about $\frac{1}{2}$ length of head; 5 and 6 simple or frayed; 7 6–8 branched, frayed; 8 long, single, rarely bifid or trifid; 9 long, fine, 2–4 branched (usually 2); 10 2–3 branched, 11 6–8 branched, 12 single or bifid 13 4–9 branched, 14 single, 15 2–6 branched. Setae of mouth brushes pectinate. Mentum triangular with median tooth and 12–15 fairly even lateral teeth.

Thorax: Prothoracic setae 1, 2 and 3 without sclerotized bases, finely frayed, or 2 and 3 simple; 1 long, single; 2 shorter, single; 3 shorter than 2, usually single, occasionally one of the pair is bifid.

Abdomen: Seta 6 on segments I–VI and 7 on I long, frayed; on I, 6 bifid, rarely trifid, 7 single; 6 on II bifid or trifid, on III and IV single or bifid, on V single or rarely bifid, on VI single. VIIIth segment: Lateral comb a triangular patch of 27–36 broad, coarsely fringed, apically rounded scales, in 3–4 rows; seta 1 single to trifid, frayed; 2 and 4 single, simple; 3 5–9 branched, sparsely plumose; 5 3–6 branched, frayed. Siphon cylindrical, tapering slightly towards apex, with well developed acus; index 2.6–2.8; pecten extending over basal $\frac{2}{5}$, of 15–21 even, close-set, rather broad dark spines, each distinctly paler towards tip and with 1 large stout and 3–5 smaller denticles at base, one of which may be distal to the stout denticle; a few of the proximal pecten spines are smaller; seta 1 arising at about $\frac{1}{2}$ length of siphon, 5–7 branched, sparsely plumose; seta 8 4–7 branched. Anal segment: Saddle covering dorsal $\frac{3}{5}$–$\frac{4}{5}$ segment, without apical spines; a small separate elongate sclerotized plate lies at the lower proximal angle of the saddle.

REFERENCES

BELKIN, J. N., 1950. A revised nomenclature for the chaetotaxy of the mosquito larva (Diptera: Culicidae). *Amer. Midl. Nat.* **44**: 678-698.

————————, 1952. The homology of the chaetotaxy of immature mosquitoes and a revised nomenclature for the chaetotaxy of the pupa (Diptera, Culicidae). *Proc. ent. Soc. Wash.* **54**: 115-130.

————————, 1953. Corrected interpretations of some elements of the abdominal chaetotaxy of the mosquito larva and pupa (Diptera, Culicidae). *Proc. ent. Soc. Wash.* **55**: 318-324.

EDWARDS, F. W., 1924. A synopsis of the adult mosquitoes of the Australasian region. *Bull. ent. Res.* **14**: 351-401.

————————, 1932. Diptera. Family Culicidae. *Genera Insect.* **194**: 1-258.

KNIGHT, K. L. AND MARKS, E. N., 1952. An annotated checklist of the mosquitoes of the subgenus *Finlaya*, genus *Aedes*. *Proc. U.S. nat. Mus.* **101**: 513-574.

LEE, D. J., 1944. An atlas of the mosquito larvae of the Australasian region, pp. 119. Australian Military Forces (Restricted).

MACKERRAS, I. M., 1927. Notes on Australian mosquitoes (Diptera, Culicidae). Part ii. The zoogeography of the subgenus *Ochlerotatus* with notes on the species. *Proc. Linn. Soc. N.S.W.* **52**: 284-298.

MARKS, E. N., 1949. Studies of Queensland Mosquitoes. Part IV.—Some species of *Aedes* (subgenus *Ochlerotatus*). *Pap. Dep. Biol. Univ. Qd.* **2** (11): 1-41.

MILLER, D. AND PHILLIPPS, W. J., undated—?1952. Identification of New Zealand Mosquitoes, pp. 28. Nelson: Cawthron Institute. Issued by N.Z. Dept. of Health.

MUSPRATT, J., 1953. Research on South African Culicini (Diptera, Culicidae). 1. Descriptions of two new *Aedes* (*Ochlerotatus*) Lynch Arribalzaga. *J. ent. Soc. S. Afr.* **16**: 51-58.

STONE, A. AND ROSEN, L., 1952. A new species of *Aedes* from Tahiti (Diptera: Culicidae). *Proc. Hawaii. ent. Soc.* **14**: 425-428.

VOCKEROTH, J. R., 1954. Notes on the identities and distributions of *Aedes* species of Northern Canada, with a key to the females (Diptera: Culicidae). *Canad. Ent.* **86**: 241-255.

Seta 1 single, simple, about ½ length of saddle, seta 2 5–9 branched, 3 single, 4 (ventral brush) of 16 5–9 branched tufts, 2 or rarely 3 of which are precratal, the rest arising from a grid which may be incomplete laterally. Anal papillae equal, pointed, slightly less than ½ length of saddle.

Description based on 4 larval skins (1 associated with allotype, 2 with paratypes and 1 with a pupa), and on 8 morphotype larvae. One additional larva from Robe agrees with this series except that the lateral comb has 48–50 scales; it may be an atypical specimen of *calcariae* or belong to another species. Two whole larvae and one correlated skin from Dismal Swamp agree well, but head seta 7 may be 5–10 branched, 9 single and on segment VIII, seta 3 may be 10 branched, seta 5 7 branched.

In a series of 8 skins from Maroondah, Vic., the siphonal length indicates that the larvae were about ¼ larger than South Australian specimens. These differ from the series described in having head seta 4 5–9 branched, 5 3–5 branched, 6 4 branched at midlength in one specimen, 7 8–13 branched, 11 5–10 branched, siphonal index may be 2.9; on anal segment, seta 4 may have 15 cratal and 1 precratal tuft and in one specimen has 17 tufts, 2 precratal; anal papillae equal in length to saddle.

Pupa (Fig. 2, *f–g*. Nomenclature of setae as in Belkin (1952, 1953).)

Cephalothorax: Trumpet evenly pigmented, 3½–4 times as long as greatest width, with oblique opening; ratio of meatus to whole 1 : 1.3–1.5, apical notch shallow. Seta 1 1–3 branched; seta 2 2–4 branched; seta 3 1–4 branched; seta 4 1–3 branched; seta 5 2–4 branched; seta 6 short, 2–4 branched; seta 7 1–6 branched; seta 8 2–5 branched; seta 9 1–3 branched; seta 10 4–9 branched; seta 11 2–3 branched; seta 12 1–3 branched.

Abdomen: Seta 2 on segments I–VII and seta 7 on I–VI are single. *Segment I.* Seta 1 strongly developed, dendritic; seta 3 2–4 branched; seta 4 2–5 branched; seta 5 2–6 branched; seta 6 1–3 branched; seta 10 2–4 branched. *Segment II.* Seta 1 6–24 branched; seta 3 2–7 branched; seta 4 4–9 branched; seta 5 2–4 branched; seta 6 1–2 branched; seta 10 1–3 branched. *Segment III.* Seta 1 2–6 branched; seta 3 2–4 branched; seta 4 2–6 branched; seta 5 3–7 branched; seta 6 1–4 branched; seta 8 1–5 branched; seta 10 2–6 branched; seta 11 single; seta 12 2–3 branched. *Segment IV.* Seta 1 2–5 branched; seta 3 3–7 branched; seta 4 1–4 branched; seta 5 1–2 branched; seta 6 1–4 branched; setae 8, 10 and 12 1–3 branched; seta 11 single. *Segment V.* Seta 1 1–4 branched; seta 3 2–4 branched; seta 4 3–7 branched; seta 5 1–2 branched; seta 6 2–3 branched; seta 8 1–4 branched; seta 10 3–7 branched; setae 11 and 12 single. *Segment VI.* Seta 1 2–3 branched; setae 3 and 4 2–4 branched; setae 5 and 6 1–2 branched; seta 8 1–5 branched; setae 10, 11 and 12 single. *Segment VII.* Seta 1 1–4 branched; seta 3 2–4 branched; setae 4 and 5 1–2 branched; seta 6 2–7 branched; seta 7 1–3 branched; seta 8 1–4 branched; seta 10 single; setae 11 and 12 1–2 branched. *Segment VIII.* Seta 5 1–2 branched; seta 7 2–8 branched, plumose, ¼–⅓ length of paddle. *Paddles* with apex broadly rounded in South Australian specimens (which have index 1.2–1.3), tending more to be oval in Victorian specimens (which have index 1.3–1.5); buttress and midrib moderately developed; a border of fine denticles round apex; seta 7 2–3 branched.

Described from 13 pupal skins from Robe (3, 1 associated with allotype, 2 with paratypes) and Dismal Swamp (1), S. Australia; Grassdale (3) and Maroondah (6), Vic., also one whole pupa correlated with larval skin from Robe.

Types: Holotype male, allotype female, "Calcaria", near Lake Eliza, about 7m. S. of Robe, S. Australia, 10.viii.1953, reared from flooded rabbit burrows, E. W. L. Lines. Paratypes: 7 males, 2 females, 18.ix.1952, 17 males, 13 females, 10.viii.1953, 6 males, 2 females, 24.ix.1953, and 5 males, 5 females, 3.viii.1956, all from type locality. The allotype, and 1 male and 1 female paratype have associated larval and pupal skins and 1 female paratype an associated larval skin; 8 morphotype larvae 10.viii.1953, 3 2.viii.1956, 3 3.viii.1956, and 1 larval skin associated with pupa, 11.viii.1953, all from the type locality.

All the foregoing material, except as under, is deposited in the collection of the C.S.I.R.O. Division of Entomology, Canberra. The remaining paratypes and

morphotypes are distributed as follows:—University of Queensland, 6 males (1 with correlated skins), 4 females, 1 larva; Queensland Museum, 1 male, 1 female; School of Public Health and Tropical Medicine, Sydney, 2 males, 1 female, 1 larva; Macleay Museum, Sydney, National Museum of Victoria, South Australian Museum, and U.S. National Museum, each 1 male and 1 female; British Museum (Natural History), 2 males, 1 female, 1 larva.

This species is named from "Calcaria", Mr. Lines' property on which he collected the type series.

Biology: The following is an abstract of Mr. Lines' observations on *A. calcariae* in South Australia:

"Breeding Sites: All those found have been in or associated with flooded rabbit burrows. Often the water surface was up to 2 ft. below ground level and almost in the dark, here larvae of *A. clelandi* were frequently associated. Where water had risen to form a pool at the mouth of the burrow, larvae of *A. purpuriventris* and *A. camptorhynchus* were associated. The water in burrows is fresh and very often tea-coloured from dissolved organic matter, apparently arising largely from rabbit faeces; there is no actively growing vegetation in these sites. At the type locality where numerous larvae were collected from burrows spread over a few acres, the soil was largely calcium carbonate sands derived from seashells.

Breeding Season: Water, accessible to examination, is present in these sites from winter until mid-spring, but may be present at deeper levels until early summer. The main concentrations of larvae have been found in August and September.

Distribution: The larvae have been found most widely distributed in the wetter parts of the S.E. of the State, viz., within 30 miles of the coast S. of lat. 36° S. One adult specimen was collected on Yorke's Peninsula where flooded burrows would be rather rare. It may be significant that either old or inhabited warrens of the wombat occur throughout the districts where *A. calcariae* has been found. These warrens are very deep, and it is suspected that they will hold free water each winter and often well into the summer.

Biting Habits: Occasionally attracted to man in cloudy weather or at late dusk in spring. It does not bite man readily or aggressively as does *A. camptorhynchus* which is usually present at these times. Adults of *A. calcariae* have been disturbed from inhabited—and therefore dry—rabbit burrows at Dismal Swamp."

In Victoria, *A. calcariae* has been found breeding in a flooded rabbit burrow, almost dried out (Grassdale), in a pit under the roots of a fallen tree (Lyonville), in a large pit in forest (Foster), in a small pit, 7 in. in diameter, connected with crayfish holes and filled by underground water, in forested hill country (Maroondah) and in a shaded pit 3 ft. deep, with clear water (Ballan). The earliest larval collection is in July and the latest record a female taken biting at dusk in the bush at Lyonville, in December.

Distribution: The south-east of South Australia and southern Victoria. In addition to the type series, specimens have been examined from the following localities—SOUTH AUSTRALIA: Dismal Swamp (28.ix.1953), Ashmore (11.viii.1953), all coll. E. W. L. Lines. VICTORIA: Lyonville (14.xii.1954, 18.x.1955), Ballan (11.x.1956), Maroondah (26.vii.1955, 6.ix.1955, 25.x.1955), Tarwin Lower (21.xi.1956), Foster (5.viii.1955), all coll. N. V. Dobrotworsky; Skipton (11.viii.1952, G. W. Douglas); Grassdale (17.ix.1953, A. Neboiss). Grassdale is 220 m. W. and the other localities within a 90 m. radius of Melbourne.

Discussion: Although, at first sight, the tarsal markings suggest that *A. calcariae* is very distinct from other Australian species of *Ochlerotatus,* this is not borne out by examination of the male terminalia and the larva, which clearly show that it is allied to *A. flavifrons, A. clelandi* and *A. purpuriventris.* Claws of Australian species have not so far been studied in detail. Vockeroth (1954) pointed out that the shape of the tarsal claws is an excellent specific character in many species of *Ochlerotatus.* He found that in the majority of species from northern Canada the claws of all legs of the females are of the same shape, and those of the hind legs of the male are of the same shape as those of the female of the species. In *A. calcariae* the claws of the hindlegs of the female differ from those of the fore and midlegs, but resemble those of the hindlegs of the male.

Acknowledgments

The classification of Australian *Ochlerotatus* could not have been attempted without the gift or loan of specimens from many sources, and the field work of many collectors, whose contributions cannot be individually acknowledged here. I am particularly indebted to Mr. N. V. Dobrotworsky, University of Melbourne, for helpful discussions and for providing specimens and life histories of Victorian species and to Mr. E. W. L. Lines, C.S.I.R.O. Wild Life Survey Section, Adelaide, for his lengthy series of *A. calcariae* and for permitting inclusion in this paper of his field observations on this species. A special tribute should be paid to Mr. F. N. Ratcliffe, Officer-in-Charge, C.S.I.R.O. Wild Life Survey Section, who has not only made numerous collections himself but has done much to stimulate the enthusiasm and co-operation of the various persons working on different problems concerning mosquitoes of the subgenus *Ochlerotatus.*