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N. Hamilton Farley

COMMONWEALTH OF AUSTRALIA

Department of Health

**SERVICE PUBLICATION (SCHOOL OF PUBLIC
HEALTH AND TROPICAL MEDICINE)**

NUMBER 5

**THE INTERMEDIARY HOSTS OF MALARIA
IN THE NETHERLANDS INDIES**

By

FRANK H. TAYLOR, F.R.E.S., F.Z.S.

Issued by

**THE SCHOOL OF PUBLIC HEALTH AND TROPICAL MEDICINE
(UNIVERSITY OF SYDNEY)
COMMONWEALTH DEPARTMENT OF HEALTH**

**UNDER THE AUTHORITY OF
THE MINISTER FOR HEALTH**

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FOREWORD.

QUITE apart from war-time conditions which have abruptly abolished international boundaries, peace-time relationships between such close neighbours as Australia and the Netherlands Indies compel a close study of the disease-bearing agents in adjacent countries.

While traffic between the islands adjacent to Australia and the Commonwealth itself was slow and intermittent, these matters had not so great an importance as they now have when traffic is speedy and almost continuous.

Mr. Taylor has assembled all available information relating to the "Intermediary Hosts of Malaria in the Netherlands Indies", and this compilation should prove of very great value to all those whose interests and duties require a knowledge of these important facts.

J. H. L. CUMPSTON,
Director-General of Health.

Canberra, A.C.T.
18th October, 1943.



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PREFACE.

THE information contained in the following pages has been gathered from the following sources: Christophers, Gater, Swellengrebel and Rodenwaldt, and Taylor.

Gater's work, a classic, on the larvæ and imagines of the genus *Anopheles* as represented in Malaya, has long been out of print. I have not hesitated to make use of his descriptions and illustrations. His descriptions are brief, but contain all that is required for the accurate determination of a species.

Christophers' descriptions of the two varieties of *Anopheles hyrcanus* Pallas have been substituted for Gater's descriptions of this variable species.

The use of already published descriptions and illustrations has saved the time and trouble that it would have taken in drawing up descriptions from the actual specimens. Due acknowledgment is gratefully made to the various authors.

I have included some species where the evidence as to their efficiency as intermediary hosts is perhaps not clear-cut.

There are three Anophelines in the Netherlands East Indies which are extremely efficient intermediary hosts of malaria wherever they are found: *A. maculatus* Theobald, *A. minimus* Theobald, and *A. ludlowi* var. *sundaicus* Rodenwaldt. Of the remainder two, *A. barbirostris* v. d. Wulp and *A. bancrofti* Giles (the latter found in Netherlands New Guinea, while the former extends to India), must not be overlooked as potentially important species. *A. barbirostris* has been proved to be important both in the Netherlands East Indies and in Malaya as being capable of originating epidemics of malaria, while *A. bancrofti* has been found to be heavily infected in nature.

My thanks are extended to Dr. A. B. Walkom, Director, The Australian Museum, for the use of the block of the wing of *A. bancrofti*. I desire to tender sincere thanks to Colonel Howard F. Smith, United States Army, for valuable suggestions and material assistance. I also wish to extend my thanks to Mrs. Garrard, Dr. van Leent and Mr. Perndt for assistance cheerfully given.

Control measures and other cognate matters have not been touched upon as they are to be found in Service Publication (School of Public Health and Tropical Medicine) No. 4, Mosquito Intermediary Hosts of Disease in Australia and New Guinea.

FRANK H. TAYLOR.

22nd September, 1943.

INDEX TO SPECIES AND VARIETIES.

Names printed in bold type are species recorded from the Netherlands Indies. Those in roman type do not belong to the area under consideration. Synonyms are in italics.

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KEY TO SPECIES.

Keys of the adult females and fourth instar larvæ of the Anophelines of the Malayan Region, as defined below, and of the Australian Region have been taken *in toto* from Russell, Rozeboom and Stone (1943) and are here duly acknowledged. All systematists will see the wisdom of taking in the whole of the Malayan Region, since several species from Malaya are to be found in the Netherlands Indies and extend into the Australian Region, e.g. *A. barbirostris*, *A. subpictus*, etc.

MALAYAN REGION, INCLUDING SIAM, FRENCH INDO-CHINA, MALAYA, SUMATRA, JAVA AND BORNEO.

The keys are based on those published by Gater (1934, 1935). Information concerning species from regions near Malaya was obtained from Borel (1930), Swellengrebel and Rodenwaldt (1932), Christophers (1933) and Causey (1937). Species from the neighbouring areas not included in Gater's keys have been inserted. *A. bulkleyi*, described from a single male, is not included in this key to females, and *bancrofti barbiventris* is not sufficiently described to include.

Key to Adult Females.

- | | |
|---|--|
| 1. Wing not spotted | 2 |
| Wing spotted | 4 |
| 2. Wing brown, dark | 3 |
| Wing yellow, light | <i>A. vagus</i> (in part)
(= <i>immaculatus</i>) |
| 3. Palpus about three-fourths as long as labium; vertical scales broad; about 5 mm. in length; wing 4.0 to 5.0 mm. in length; large species | <i>A. brevipalpis</i> |
| Palpus as long as labium; vertical scales very narrow; about 3.5 mm. in length; wing 2.5 to 3.5 mm. in length; small species | <i>A. aitkeni aitkeni</i>
<i>A. aitkeni bengalensis</i>
<i>A. aitkeni palmatus</i>
<i>A. insulæflorum</i> |
| 4. Wing with less than four dark areas involving both costa and vein 1 | 5 |
| Wing with at least four dark areas involving both costa and vein 1 | 20 |
| 5. Femur of hind leg with a prominent tuft of scales distally | 6 |
| Hind leg without such tuft of scales on femur, although sometimes rough apically | 8 |
| 6. Hind femur with tuft of scales black basally and white apically | 7 |
| Hind femur with tuft of scales black; with a broad pale basal band | <i>A. wellingtonianus</i> |
| 7. Abdominal segment 8 with conspicuous yellow scales; palpus unbanded or with a few light scales between segments 3 and 4; thorax with mesonotum scaled only on anterior portion | <i>A. asiaticus</i> |
| Abdominal segment 8 without yellow scales; palpus with pale bands; thorax with mesonotum completely scaled | <i>A. annandalei annandalei</i> |
| 8. Wing with costa on basal third entirely dark or with only scattered pale scales | 9 |
| Wing with a broad pale interruption on basal third of costa | <i>A. gigas sumatrana</i> |
| 9. Hind femur without a broad pale band | 10 |
| Hind femur with a broad pale band | <i>A. lindesayi cameronensis</i> |
| 10. Palpus with distinct pale bands or markings | 11 |
| Palpus without distinct pale bands or markings although sometimes with a few pale scattered scales | 15 |
| 11. Abdominal segment 7 ventrally with a tuft of scales; clypeus with lateral scale tufts | 12 |
| Abdominal segment 7 and clypeus without tufts of scales | 14 |
| 12. Hind tarsal segments 4 and 5 not both completely white | 13 |
| Hind tarsal segments 4 and 5 completely white | <i>A. hyrcanus nigerrimus</i> (form <i>argyropus</i>) |

13. Hind tarsal segment 4 only pale apically; wing with subcostal pale spot equally involving vein 1 .. *A. hyrcanus sinensis*
Hind tarsal segment 4 pale both basally and apically; subcostal pale spot only partially or not involving vein 1 .. *A. hyrcanus nigerrimus*
14. Hind tarsal segment 5 completely white; any pale scales on palpus restricted to narrow areas .. 16
Hind tarsal segment 5 not completely white; palpus with pale scales forming broad pale bands .. *A. separatus*
A. hunteri
15. Hind tarsal segment 5 completely white .. 16
Hind tarsal segment 5 not completely white .. 17
16. Hind tarsal segments 3 and 4 each at least half white .. *A. alboteniatus*
Hind tarsal segments 3 and 4 each only tipped with white at base and apex .. *A. montanus*
17. Abdominal segment 7 with a tuft of scales ventrally; wing with basal third of costa with some scattered pale scales .. 18
Abdominal segment 7 and costa not so .. 19
18. Wing with small pale fringe spot at apex of vein 3, sometimes one at 2.1; abdomen ventrally with some pale scales .. *A. barbirostris barbirostris*
Wing with a large pale fringe spot which extends from apex of vein 2.2 or vein 3 to apex of vein 4.1; abdomen ventrally without pale scales .. *A. barbumbrosus*
19. Hind tarsal segments without pale markings .. *A. baezai*
Hind tarsal segments with minute, apical, pale markings .. *A. umbrosus*
A. novumbrosus
A. similissimus
20. Hind tarsal segment 5 partially or entirely white, some other tarsal segments white or with conspicuous pale bands .. 21
Hind tarsal segment 5 entirely or mainly dark, other tarsal segments dark or with only rather narrow pale bands .. 35
21. Legs with speckled femora and tibiae .. 22
Legs with femora and tibiae not speckled .. 26
22. Hind tarsal segments 4 and 5 entirely white .. 23
Hind tarsal segment 4 only partially white, segment 5 partially or entirely white .. 31
23. Hind tarsal segment 2 partially white, segment 3 completely white; palpus with three pale bands, the apical one broad .. 24
Hind tarsal segment 3 dark at base; palpus with four narrow pale bands .. *A. watsonii*
24. Palpus with a single broad apical pale band, segments 2 and 3 not speckled .. 25
Palpus with two broad apical pale bands of more or less equal width, these separated by a narrower dark band, segments 2 and 3 distinctly speckled .. *A. splendidus*
25. Dorsum of last two abdominal segments clothed with golden hairs and scales; inner one-fourth and outer one-third of costa chiefly pale .. *A. jamesi*
Dorsum of last two abdominal segments not so; inner one-fourth and outer one-third of costa chiefly dark .. *A. ramsayi*
26. Hind tarsal segments 4 and 5 white, apex of segment 3 sometimes white; palpus with three pale bands .. 27
Hind tarsal segment 4 with black band; palpus with four pale bands .. *A. karwari*
27. Vein 5 with stem and lower branch mostly pale, without any dark spot at origin of 5.1 .. 28
Vein 5 with stem and lower branch mostly dark, or at least with dark area at origin of 5.1 .. *A. annularis*
28. Hind tarsal segments 3, 4 and 5 white, sometimes segment 2 white apically; palpus with pale apical band not more than half as wide as dark preapical band .. 29
Hind tarsal segment 3 only half white; palpus with pale band more than half as wide as preapical dark band, involving half or more of segment 4 .. *A. schüffneri*
29. Abdomen with scattered scales ventrally on most segments, and dorsally on segments 5 and 6; sternopleura with defined clusters of pale scales; hind tarsal segment 1 with or without an apical pale area .. 30

- Abdomen with few or no pale scales except apically on venter and dorsum; sternopleura without defined clusters of pale scales; hind tarsal segment 1 usually with an apical area of pale scales. *A. philippinensis*
30. Abdomen laterally with prominent tufts of dark scales which are visible from above on segments 2 to 7; palpus with scattered pale scales on dark areas of segments 3 and 4; hind tarsal segment 1 with a pale apical spot *A. errabundus*
(=*philippinensis*?)
- Abdomen without prominent lateral tufts of dark scales visible from above; palpus without scattered pale scales on dark areas of segments 3 and 4; hind tarsal segment 1 never with an apical pale area *A. pallidus*
31. Abdomen without conspicuous ventral tufts of scales except perhaps on segments 5 to 7 where they are not prominent 32
- Abdomen with conspicuous tufts of dark scales ventrally on segments 2 to 7, which are visible from the side *A. kochi*
32. Vein 6 with more than three dark spots 33
- Vein 6 with two or three dark spots *A. maculatus maculatus*
33. Hind leg with a broad white spot involving both sides of the tibio-tarsal joint 34
- Hind leg without such a broad white spot *A. tessellatus* (in part)
34. Palpus and proboscis of nearly same length
A. leucosphyrus leucosphyrus (in part)
- Palpus much shorter than proboscis *A. leucosphyrus hackeri* (in part)
35. Front tarsal segments with broad pale bands at joints 36
- Front tarsal segments with narrow or no pale bands at joints 44
36. Femora and tibiae speckled 37
- Femora and tibiae not speckled 42
37. Vein 6 with two or three dark spots 38
- Vein 6 with more than three dark spots 40
38. Wing fringe with nine to ten larger light spots not only at tip of the vein, but also between veins 5.1 and 5.2, and between 5.2 and 6 *A. parangensis*
- Wing fringe with seven to eight smaller light spots, at the tips of the vein and at most also between vein 5.2 and 6 39
39. Wing with two dark spots on vein 1 below median dark area on costa, and fringe without pale spot between vein 6 and vein 5.2 *A. sundaicus*
- Wing with three dark spots on vein 1 below median dark area on costa, and fringe with pale spot between vein 6 and vein 5.2 *A. ludlowii*
40. Hind leg with a broad white area at the tibio-tarsal joint 41
- Hind leg without a broad white area at the tibio-tarsal joint *A. tessellatus* (in part)
41. Palpus and proboscis of about same length
A. leucosphyrus leucosphyrus (in part)
- Palpus much shorter than proboscis *A. leucosphyrus hackeri* (in part)
42. Palpus with width of apical pale band not exceeding twice the width of preapical dark band; costa between humeral cross vein and base of wing dark, or with pale spots 43
- Palpus with width of apical pale band three or more times width of preapical dark band; costa between humeral vein and base of wing entirely dark *A. vagus* (in part)
43. Palpus with apical pale band as wide as preapical dark band; wing with costa at base (between humeral cross vein and base of wing) spotted black and white, wing base pale *A. subpictus subpictus*
- Palpus with apical pale band about twice as wide as preapical dark band; wing with costa at base (between humeral cross vein and base of wing) dark, extreme base of wing mostly dark *A. subpictus malayensis*
44. Palpus with three pale bands; vein 4 of wing with distinct pale areas before fork, and with fringe spots at least at apex of either vein 4.2 or 5.1 45
- Palpus with four pale bands; vein 4 of wing dark to fork, except for a few pale scales opposite origin of vein 3; without fringe spots except at apex of vein 1 *A. aurostris*
45. Palpus with apical and subapical pale bands as wide as or wider than intervening dark band 46

- Palpus with subapical pale band much narrower than preapical dark band 48
46. Wing usually without pale fringe spot at apex of vein 6; labium entirely dark or apical half appearing pale in certain lights . . 47
 Wing with pale fringe spot at apex of vein 6; labium pale on apical half *A. aconitus*
47. Wing with costa entirely dark on basal third; labium pale on apical half *A. varuna*
 Wing with costa on basal third marked by a pale interruption which may be very small; labium uniformly dark, or sometimes with small pale ventral area *A. minimus*
48. Wing with pale fringe spots at apex of all veins except vein 6; vein 1 pale at base up to basal dark area; anterior promontory with some erect pale scales *A. fluvialis*
 Wing with pale fringe spots only at apex of veins 4.1 or 5.1 or both; vein 1 with dark spot opposite humeral white spot; anterior promontory without, or with very few erect pale scales *A. culicifacies*

Key to Fourth Instar Larvæ.

The larvæ of *A. bancrofti barbiventris*, *bulkleyi*, and *errabundus* have not been described; that of *alongensis*, described from larvæ only, has not been included because of lack of information.

1. Inner clypeal hairs approximated, the distance between their bases not more (usually much less) than the distance between the bases of the inner and outer clypeal hairs on one side; antennal hair usually branched* 2
 Inner clypeal hairs placed far apart, the distance between their bases twice or more the distance between the bases of the inner and outer clypeal hairs on one side; antennal hair simple 26
2. Frontal hairs well developed; subantennal hair with numerous branches; antennal hair branched 3
 Frontal hairs poorly developed; subantennal hair simple or with only a few branches distally; antennal hair simple or branched 5
3. Some abdominal palmate hairs well developed, with leaflets 4
 Abdominal palmate hairs without leaflets, the latter represented by filamentous branches 6
4. Abdominal palmate hairs with leaflets on at least segments 3 to 7 . . 12
 Abdominal palmate hairs with leaflets only on segments 4 and 5 or 4 to 6 *A. novumbrosus*
5. Thorax and abdomen clothed with innumerable minute spines; subantennal hair branched distally *A. annandalei annandalei*
 Thorax and abdomen not clothed with such spines; subantennal hair simple *A. asiaticus*
6. Outer clypeal hair with not more than twenty-three branches, not forming a tuft 7
 Outer clypeal hair with numerous branches, forming a broom-like tuft with thirty-seven or more thick branches *A. similissimus*
7. Inner clypeal hair simple or divided into several fine branches at extreme tip 8
 Inner clypeal hair with numerous short side hairs on the distal half, appearing like test-tube brush *A. umbrosus* (in part)
8. Posterior clypeal hairs simple or divided into two to four branches at the base 9
 Posterior clypeal hair with a distinct stem carrying four to seven branches *A. brevipalpis*
9. Lateral hair on abdominal segment 4 with not more than 5 branches . . 10
 Lateral hair on abdominal segment 4 with seven to ten branches *A. baezai*
10. Posterior clypeal hairs simple 11
 Posterior clypeal hairs with two to four branches arising from near the base *A. umbrosus* (in part)
11. Outer clypeal hair with six to ten branches; antennal hair with seven to thirteen branches; outer occipital hair with two or three branches *A. hunteri*
 Outer clypeal hairs with eleven to sixteen branches; antennal hair with seventeen to thirty-six branches; outer occipital hair with five or six branches *A. separatus*

* In *aurirostris* the clypeal hairs are all close together, but it is keyed out in the second part of this couplet, because of the minute, simple, antennal hair.

12. Anterior tergal plates very large, occupying nearly half or more of the dorsum of each segment *A. aitkeni palmatus*
Anterior tergal plates small except on segment 8 13
13. Antennal hair small, less than half the length of shaft, the branches reaching nowhere near end of shaft; outer clypeal hairs simple or with not more than five branches, not bushy 14
Antennal hair large, half or more the length of shaft, the branches reaching nearly to end of shaft or beyond; outer clypeal hairs bushy, with at least six, usually many more branches.. .. 22
14. Inner clypeal hair with two to six long branches 15
Inner clypeal hair unbranched 17
15. Inner clypeal hair with two branches 16
Inner clypeal hair with three to six branches *A. aitkeni bengalensis*
16. Inner clypeal hair with fine side hairs on middle third *A. aitkeni aitkeni*
(in part—"Malayan type")
Inner clypeal hair without fine side hairs on middle third.. ..
A. aitkeni aitkeni (in part—"Indian type")
17. Inner clypeal hairs approximated, their bases nearly touching; no side hairs 18
Inner clypeal hairs placed about the same distance apart as the distance between outer and inner hairs on one side; with fine side hairs on middle third.. .. *A. aitkeni aitkeni* (in part)
18. Lateral hair on abdominal segment 3 with more than eight branches 19
Lateral hair on abdominal segment 3 with only five to eight branches
A. insulaeflorum
19. Outer and posterior clypeal hairs branched 20
Outer and posterior clypeal hairs simple, or with two or three branches distally on posterior hairs only 21
20. Palmate hairs on metathorax and abdominal segment 2 with leaflets
A. aitkeni aitkeni (in part)
Palmate hairs on metathorax and abdominal segment 2 with filamentous or at most slightly flattened branches *A. gigas sumatrana*
21. Prothoracic hair 2 with fifteen to twenty-two branches; lateral hair on abdominal segments 4 and 5 with two branches ..
A. wellingtonianus
Prothoracic hair 2 with twelve to fifteen branches; lateral hair on abdominal segments 4 and 5 with three branches
A. lindesayi cameronensis
22. Inner clypeal hairs approximated, their bases nearly touching .. 23
Inner clypeal hairs placed nearly as far apart as the distance between the inner and outer hairs on one side *A. alboteniatus*
23. Prothoracic hair 1 with branches nearly as long as the whole hair.. 24
Prothoracic hair 1 simple or with a few short branches at the tip .. 25
24. Outer clypeal hairs with twenty-seven to fifty or more branches, forming a strong, broom-like tuft *A. barbirostris barbirostris*
Outer clypeal hairs with twelve to twenty branches, not forming a broom-like tuft *A. barbumbrosus*
25. Outer clypeal hair with thirty-seven or more thick branches.. ..
A. hyrcanus sinensis; *A. hyrcanus nigerrimus*
Outer clypeal hair with not more than fifteen fine branches *A. montanus*
26. Anterior tergal plates on abdominal segments 2 to 7 small, not involving the small median posterior plate 27
Anterior tergal plates on abdominal segments 2 to 7 very large, involving the small median posterior plate 28
27. Outer clypeal hair simple, or with short side hairs 29
Outer clypeal hair with long brush-like branches 42
28. Clypeal hairs with side hairs; posterior clypeal hair branched ..
A. aconitus (in part)
All clypeal hairs simple *A. minimus*; *A. varuna*; *A. fluviatilis*;
A. aconitus (in part)
29. Prothoracic hair 1 with large, darkly pigmented root; the hair tending to stoutness, with numerous branches 30
Prothoracic hair 1 with small, unpigmented or lightly pigmented root; the hair tending to slenderness, or with few branches .. 37
30. Abdominal palmate hair 2 fully developed with well differentiated filaments 31
Abdominal palmate hair 2 with filamentous branches, lanceolate leaflets or at most with very poorly differentiated filaments .. 34

31. One of the long mesothoracic pleural hairs with lateral branches... *A. parangensis*
 Long mesothoracic pleural hairs simple ... 32
32. Filaments of abdominal palmate hairs less than half as long as blade ;
 anterior tergal plates not much more than twice as broad as
 long, saddle-shaped ... 33
 Filaments of abdominal palmate hairs more than half as long as
 blade ; anterior tergal plates three or four times as broad as
 long, oval ... *A. culicifacies*
33. Bases of inner, outer, and posterior clypeal hairs on one side forming
 an approximate equilateral triangle ... *A. watsonii*
 Bases of inner, outer, and posterior clypeal hairs on one side forming
 a scalene or isosceles triangle ... *A. leucosphyrus hackeri*
34. Outer clypeal hairs with side hairs ; abdominal palmate hair 2
 with lanceolate leaflets or with a poorly differentiated filament... 35
 Outer clypeal hairs simple ; abdominal palmate hair 2 with
 filamentous or only slightly flattened branches... *A. leucosphyrus leucosphyrus*
35. Lateral hair on abdominal segment 5 with two to six branches, on
 segment 6 with three to six branches ... 36
 Lateral hair on abdominal segment 5 with six to fourteen branches,
 on segment 6 with seven to sixteen branches ... *A. karwari*
36. Filaments of abdominal palmate hairs with narrow bases and sharp
 points ; metathoracic palmate hair often with a few, narrow,
 lanceolate leaflets ... *A. maculatus maculatus*
 Filaments of abdominal palmate hairs with broad bases and blunt
 points ; metathoracic palmate hair always with filamentous
 branches ... *A. splendidus*
37. Inner clypeal hairs placed far apart, the distance between them
 twice or thrice the distance between inner and outer ... 38
 Inner clypeal hairs approximate, the distance between them less
 than twice that between inner and outer ... *A. aurirostris*
38. Posterior clypeal hair long, placed in line with or external to inner
 hairs and some distance from them ... 39
 Posterior clypeal hair short, placed close and internal to the inner
 hairs ... *A. vagus*
39. Filament of leaflet of abdominal palmate hair poorly differentiated,
 not more than about one-third as long as blade ... 40
 Filament of leaflet of abdominal palmate hairs sharply differentiated,
 nearly as long as blade ... *A. sundaicus*
A. ludlowi
A. subpictus subpictus
A. subpictus malayensis
40. Outer clypeal hair simple or forked at tip ; about one-fourth as long
 as inner ; metathoracic palmate hair well developed, with
 lanceolate leaflets ... 41
 Outer clypeal hair with thick side hairs, one-half or more as long
 as inner ; metathoracic palmate hair undeveloped, with three
 or four filamentous branches ... *A. ramsayi*
41. Abdominal palmate hairs 1 and 2 with lanceolate leaflets ; antennæ
 lightly pigmented ... *A. kochi*
 Abdominal palmate hairs 1 and 2 with the branches filamentous
 or only slightly flattened ; antennæ heavily pigmented ... *A. tessellatus*
42. Posterior clypeal hairs with two to nine branches from near the base 43
 Posterior clypeal hairs simple or forked only at tip... *A. annularis* ; *A. schüffneri*
43. Inner occipital hairs with two to nine branches from near base ... 45
 Inner occipital hairs simple or forked only at tip ... 44
44. Abdominal segment 1 with well developed palmate hairs ; usually
 dark grey larva, with two or three silvery spots on dorsum ... *A. annularis*
 Abdominal segment 1 without differentiated palmate hairs ; usually
 pale, dirty yellow larva, without conspicuous spots ... *A. jamesii*
45. Posterior clypeal hairs with five to nine branches ; filament of
 leaflet of palmate hair less than half as long as blade *A. philippinensis*
 Posterior clypeal hairs with two to five branches, usually three ;
 filament of leaflet of palmate hair at least half as long as blade... *A. pallidus*

ANOPHELINES OF THE AUSTRALIAN REGION.

Anopheles and malaria are believed to occur in nearly all the Pacific islands between the equator and 20° S. from New Guinea eastwards to 170° E. Belep, north-west of New Caledonia, is free from malaria, as are a few small islands such as Tucopia. Outside the area Aneitym, a few minutes south of 20° S., is malarious. New Caledonia is apparently free, although there has been a little doubt about this (Mumford, 1942).

There are anophelines throughout Australia and Tasmania, but malaria is not endemic in Tasmania or in Australia, as a rule, south of 20° S. North of this approximate line malaria is faintly to moderately endemic and occasionally epidemic in Australia. It is hyperendemic in such areas as New Guinea, the Solomons, and the New Hebrides.

The list of species in the Australian area has been compiled from Taylor (1927, 1934), Edwards (1924), Swellengrebel and Rodenwaldt (1932), and a mimeographed article by J. M. Mackerras. The keys to adults and larvæ are taken from Mackerras, with some modifications.

Key to Adult Females.

The adults of *A. incognitus*, and *B. walchi* are unknown.

1. Stem of vein 4 and vein 5.1 distinctly sinuous (*Bironella*) .. 2
These veins not sinuous (*Anopheles*) .. 4
2. First fork-cell very short (about one-third the length of the stem) or absent .. 3
First fork-cell of normal length .. *B. travestitus*; *B. hollandi* (= *walchi* ?)
3. First fork-cell present .. *B. gracilis*
First fork-cell not developed; only the apical portion of vein 2.2 present .. *B. papuæ*; *B. derooki*; *B. soesiloi*
4. Brown or black species; costa with at most one or two white spots .. 5
Brightly marked species; costa with at least four conspicuous white spots .. 10
5. Small, brown, concolorous species; wing scales uniform .. 6
Larger, blackish species; wings with patches of dark scales .. 8
6. Basal four-fifths of hind femora creamy to yellow anteriorly .. 7
Hind femora uniformly brown anteriorly .. *A. insulæflorum*
7. Hind femur pale yellow on about basal three-fourths without a dark dorsal line; wing scales (except those on costa and fringe) slightly pale on apical half of wing; a slight grey cloud on membrane towards costa in middle .. *A. stigmaticus stigmaticus*
Hind femur pale yellow on about basal three-fourths with a dark dorsal line nearly to base; wing scales uniformly dark and wing membrane uniformly clear .. *A. stigmaticus corethroides*
8. Palpi normal; costa without a white spot beyond middle; hind tarsi entirely dark .. *A. atratipes*
Palpi with bushy outstanding scales; wing with a white spot beyond the middle of the costa; hind tarsi with narrow white rings .. 9
9. Hind femora with scattered pale scales; fringe scales of wing with white patches at the ends of 4.1, 4.2, 5.1 and 5.2 .. *A. bancrofti*
Hind femora entirely dark; fringe scales of wing with white patches only at the apices of veins 2.1, 2.2, 3 and 5.2 .. *A. barbirostris*
10. Femora and tibiae without rings or spots; palpus with apical segment and apical part of fourth segment entirely white, forming a broad white tip to the palpus .. *A. subpictus*
Femora and tibiae conspicuously ringed or spotted with pale scales; palpi not as above .. 11
11. Proboscis one-fifth longer than the palpi, black on basal half, brown to golden on distal half; palpus with three broad pale bands on distal half .. *A. longirostris*
Proboscis but little longer than the palpi .. 12
12. All abdominal tergites with numerous conspicuous yellow scales, sternites with scales .. 13
Abdominal tergites with at most scattered creamy scales, increasing posteriorly, sternites bare .. 14
13. Tarsal segments banded apically only .. *A. amictus* (in part)
Tarsal segments with apical and basal bands, forming relatively broad white ring across the joints .. *A. amictus* (in part)
14. Last three segments of palpus with broad white apical bands, that on the third (antepenultimate) segment covering one-third to one-half of the segment and never interrupted by dark scales .. 15

- Palpus similar, but pale apical band on third (antepenultimate) segment always obscured by dark scales which often form a ring subdividing the pale ring into two parts 16
15. Proboscis pale on at least a portion of apical half .. *A. annulipes mastersi*
 Proboscis almost entirely dark except for labella *A. annulipes annulipes*
16. Proboscis dark except for labella .. *A. punctulatus moluccensis*
 Proboscis pale on apical half *A. punctulatus punctulatus*

KEY TO FOURTH INSTAR LARVÆ.

- The larvæ of *A. stigmaticus corethroides* and *B. hollandi* are unknown.
1. Thorax with both mesothoracic and metathoracic palmate hairs (*Bironella*) 2
 Thorax with metathoracic palmate hairs only, or none (*Anopheles*) .. 5
2. Antennal hair small, with few branches, and situated near the base of the antenna; outer clypeal hairs very short .. *B. papuæ*
B. derooki
B. soesiloi
- Antennal hair large, plumose, with many branches, and situated about the middle of the shaft (except in *walchi*); outer clypeal hairs long, as long as, or about half as long as, the inner clypeals .. 3
3. Outer clypeal hairs with four to six branches, about half the length of the inner hairs .. *B. gracilis*
 Outer clypeal hairs simple or forked near the tip, more than half as long as the inner clypeals .. 4
4. Prothoracic hair 1 larger, with thirteen to sixteen branches .. *B. travestitus*
 Prothoracic hair 1 small, with four to five branches .. *B. walchi*
5. Inner clypeal hairs close together, much nearer to one another than to the outer clypeal hairs .. 6
 Inner clypeal hairs widely separated, much nearer to the outer clypeal hairs than to each other .. 10
6. Outer clypeal hair strongly and conspicuously branched .. 7
 Outer clypeal hair single .. 8
7. Inner clypeal hairs with minute lateral branches .. *A. bancrofti*
 Inner clypeal hairs simple .. *A. barbirostris*
8. Outer clypeal hairs very stout and spine-like, about one-third the length of the inner clypeals .. *A. insulæflorum*
 Outer clypeal hairs more than one-half the length of the inner clypeals .. 9
9. Larger, black larvæ, with the antennal hair large and strongly branched .. *A. atratipes*
 Smaller, brown larvæ, with the antennal hair very small and finely branched .. *A. stigmaticus stigmaticus*
10. Posterior clypeal hairs very long, and projecting well beyond the head .. 11
 Posterior clypeal hairs short, never reaching to the anterior margin of the head .. 12
11. Outer and posterior clypeal hairs strongly branched .. *A. incognitus*
 Outer clypeal hairs single, posterior clypeals single or bifid .. *A. amictus*; *A. subpictus*
12. Outer clypeal hairs simple or very finely plumose; posterior clypeals very short, single or occasionally bifid .. 13
 Outer clypeal hairs definitely plumose or branched; posterior clypeals larger, with five or six branches .. 15
13. Inner surface of antenna with short but stout spines; prothoracic hair 1 with short, stout base and radiating branches somewhat resembling a palmate hair .. *A. longirostris*
 Inner surface of antenna without these stout spines; prothoracic hair 1 with a long main stem with lateral branches arising along its length .. 14
14. Inner and outer clypeal hairs very sparsely frayed, outer about one-half the length of inner; prothoracic hair 1 with main stem slender .. *A. punctulatus punctulatus*
 Inner and outer clypeal hairs distinctly frayed, the outer about two-thirds the length of inner; prothoracic hair 1 with swollen main stem .. *A. punctulatus moluccensis*
A. annulipes mastersi
A. annulipes annulipes
15. Outer clypeals plumose
 Outer clypeal hairs strongly and conspicuously branched .. *A. annulipes subsp.*
A. meraukensis

Genus *Anopheles* Meigen.

Anopheles Meigen, *Syst. Besch.*, I, 1818, 10.

Characters.—Adult: Head with the neck projecting directly forwards and supported by long lateral cervical plates. Antennae of ♂ plumose; of ♀ with whorls of hairs at bases of segments, the hairs evenly spread all round. Palpi normally about as long as proboscis in both sexes, rarely somewhat shorter, never much less than three-quarters as long as proboscis, even in ♀. Palpi of ♂ with the last two segments rather conspicuously swollen (somewhat flattened in section), usually turned outwards in repose. Thorax always distinctly longer than broad, not much arched dorsally. Anterior pronotal lobes more or less prominent in front. Posterior pronotal lobes quite bare, without hairs or scales. Scutellum evenly rounded, with a regular row of bristles on posterior margin. Middle part of sternopleura without bristles, those of the upper and lower series short. Hypopygium without basal lobe on coxite, but with from one to five spines or stout bristles in this position. Legs variously ornamented or unmarked, rarely with white bands at bases of tarsal segments. Fifth tarsal segment of front legs of ♂ longer than or subequal to fourth, with a bristly swelling at base and bearing only one claw which has basal and median teeth. Fifth tarsal segment of middle legs in both sexes somewhat longer than fourth, without bristly swelling at base, and bearing two rather small, equal and simple claws. Wings with or without markings. Upper fork never much shorter than its stem (sometimes longer). Stem of lower (median) fork always straight; terminal section of Cu_1 rarely slightly concave above. All veins rather densely scaly, including *An*.

Larva.—Head without spines near front margin of clypeus. Clypeal hairs variously formed, but the three pairs usually dissimilar and never with a fan-like tuft at the end of a long stalk. A transverse row of six pinnate frontal hairs. Apical hair of antenna (between spines) with few branches, usually from near base, or at most slightly pinnate. Thorax with the middle hair of the anterior submedian group simply pinnate. Pleural hairs various, but only two long ones on metathorax. Abdomen with a long feathered lateral hair on segment 3, rarely also on segments 4–7. Anterior median flap of spiracular apparatus somewhat triangular, without apical filament; posterior pair of flaps without lateral hairs. Float-hairs normally present on segments 3–7, their component filaments usually elliptical, with or without “shoulder”, but never racquet-shaped. Dorsal hairs of anal segment and hairs of ventral brush irregularly pinnate. Skin of thorax and abdomen rarely pubescent.

Eggs.—Very varied in form in the different species, usually with lateral or dorsal “floats” formed by a corrugated membrane.

KEYS TO SUBGENERA.

Adults.

- | | |
|--|-------------------------------------|
| 1. Thorax blackish, with a broad grey line from neck to scutellum .. | |
| | Subgenus <i>Stethomyia</i> Theobald |
| Thoracic ornamentation quite otherwise | 2 |

scaled ; eyes deep blue black ; antennæ blackish brown, clothed with short white pile, basal lobe with a few flat pale scales at its apex, second segment about twice the length of the third, light brown at the base, densely clothed with brown scales, third short and pale at the apex ; plumes of ♂ black.

Thorax dark brown to black, covered with rather long dense pale golden hairs, anterior margin with pale narrow curved scales in the centre with broad brown upright ones on the edges above the prothoracic lobes, the latter brown and prominent, clothed with pale golden hairs and broad upright brown scales on their inner edges ; scutellum with the sides creamy yellow with pale yellowish hair-like scales, centre black, nude, fringed with pale brown hairs ; metanotum brown ; pleuræ mottled black and brown, with a few scattered white scales.

Wing.—Densely covered with black scales for the most part. Creamy coloured spot at junction of subcosta with costa. Five small creamy-white spots on 1 terminating about the distance between spots 4 and 5 from the costal spot ; fringe spot at apex of 1 ; a pale apical spot involving the fringe on 2.1, also a sub-basal one on 2.2, middle and apex black, area between mottled ; base of 3 black, rest mottled ; fringe spot at apex of 4.1 and 4.2 both mottled ; basal two-thirds of 5.2 creamy-white, a small sub-basal and apical black spot on 5.1, remainder mottled, a light fringe spot on 5.1 and 5.2, 5 with a distinct basal spot, then a small creamy one, rest mottled ; basal half of 6 mottled, then a distinct black spot, apex with a black spot, intervening area creamy-white.

Abdomen black, clothed with golden brown hairs ; venter brown, black towards the apex, clothed with flat white scales and brown hairs, the apical half of the seventh segment tufted with dark scales.

♂.—Terminalia : Leaflets, about six in number, very small and short, the longest about half as long as phallosome, remainder much shorter. Basal spines of coxite on a large prominence, each with a well marked tubercle at its base, spines about equal in length, stout, apex narrowed and curved. Club very slender, somewhat like a blunt edged spine. Harpago appears split.

Legs : Coxæ and trochanters brown with patches of white scales ; fore, mid and hind femora pale beneath, brown scaled above, with the pale ground colour showing through, the fore femora with the basal half club-shaped ; tibiæ dark brown, with the apex dilated and with a white spot, a fairly dense line of white scales above ; first tarsi black with creamy white apical banding, second tarsi brown with creamy apical banding, remaining tarsi brown ; second tarsi of mid legs black with a white apical spot, third and fourth black, fifth brown. the second to fourth tarsi of hind legs black with creamy white apical banding, the fourth with basal banding also fifth tarsi ; first tarsi of hind legs slightly longer than the tibiæ.

Larva.—Inner clypeal bristles closely approximated, about twice as long as the outer clypeal bristles, abraded, outer clypeal bristles much branched, main stem divided, close to base, into two branches which again are multibranched, the branches carry many tufts of hair. Antennæ covered with many short spines, basal fourth slightly swollen, antennal plume sub-

median, composed of a stout stem with about seventeen branches, sabres weakly chitinized, terminal hair finely plumed, medio-frontal bristles situated slightly anterior to base of antennæ, plumes fairly long, outer forked twice at apex, with thirty-two plumes; middle with seventeen plumes with a long apical shaft; inner bifurcated at apex, with sixteen plumes, the two apical shafts very long and extending beyond the clypeus. Palmate hairs on segments three to seven each with twenty-two leaflets, latter blackish-brown, filaments pale, serrations at point of origin of filament about three on either side. Pecten with about ten teeth, eight about the same length.

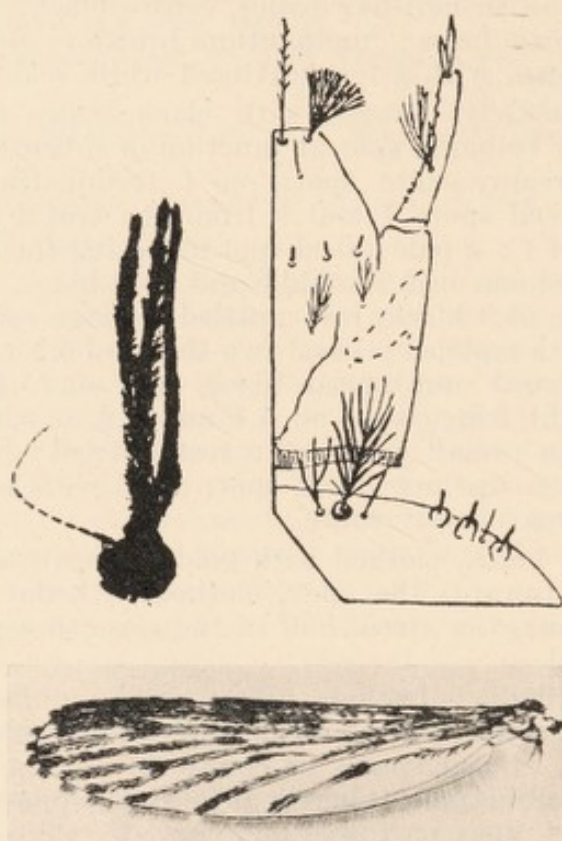


Fig. 1.—*A. bancrofti* Giles. Left, ♀ head; right, right-hand side of larval head; bottom, wing. After Swellengrebel and Rodenwaldt, and Taylor.

Distribution.—Northern Australia. This species was abundant in Sherwood, a suburb of Brisbane, in 1913; it is still fairly common in the outlying districts of Brisbane. It has never been taken in northern New South Wales, possibly because it has not been searched for. Papua and New Guinea.

Bionomics.—The larvæ of this species are found in shaded pools, along the grass grown banks of slowly running creeks and rivers, also in pot-holes in creeks and rivers. In fact this species, like *A. amictus*, *A. annulipes*, *A. punctulatus* and *A. punctulatus* var. *moluccensis*, breeds in any clear or muddy ground water. I have not found any of the above species breeding in polluted water.

A. bancrofti will, like the abovenamed species, feed at any hour of the day, in the shade or when the sun is obscured. It also feeds at night time. I have found engorged specimens of

A. bancrofti in tents during the day, morning and afternoon, when the front and back flaps of the tents have been fastened back, allowing a strong breeze to pass through. *A. amictus* and *A. punctulatus* var. *moluccensis* were taken at the same time in the above tents.

Relation to Disease.—Overbeek and Stoker (1938) state that De Rook found a natural infection index at Tanah Merah in Netherlands New Guinea of 4.3 per cent. The type of malaria found is not stated. No information is available in regard to the ability of this mosquito to transmit malaria in Australia.

Swellengrebel and Rodenwaldt (1932) consider *A. bancrofti* "a very dangerous malaria carrier, contrary to *A. barbirostris*. Walch (1932) ascertained that this . . . is feeding only on human blood."

There is considerable literature from authors in the Netherlands East Indies which points to this mosquito being an efficient intermediary host of *Wuchereria bancrofti* in Netherlands New Guinea.

Anopheles (Anopheles) barbirostris Van der Wulp.

Notes Leyden Museum, VI, 1884, 248.

Large, dark, palpi conspicuously shaggy; hind legs spread outwards when at rest.

Labium (Fig. 2).—Slightly shorter than palpi, shaggy, especially in basal half or two-thirds, unornamented; antennæ with some dark scales on segment 2, and a tuft on 3; clypeus without scales.

Palpi (Fig. 2).—Very shaggy, scales at base very long; unornamented, without any pale scales.

Thorax.—Mesonotum dark with some darker stripes, sparsely covered with narrow, hair-like scales; pleura dark with lighter markings. Anterior pronotum with a thick tuft of scales. Propleural setæ 4 to 6; spiracular setæ numerous;

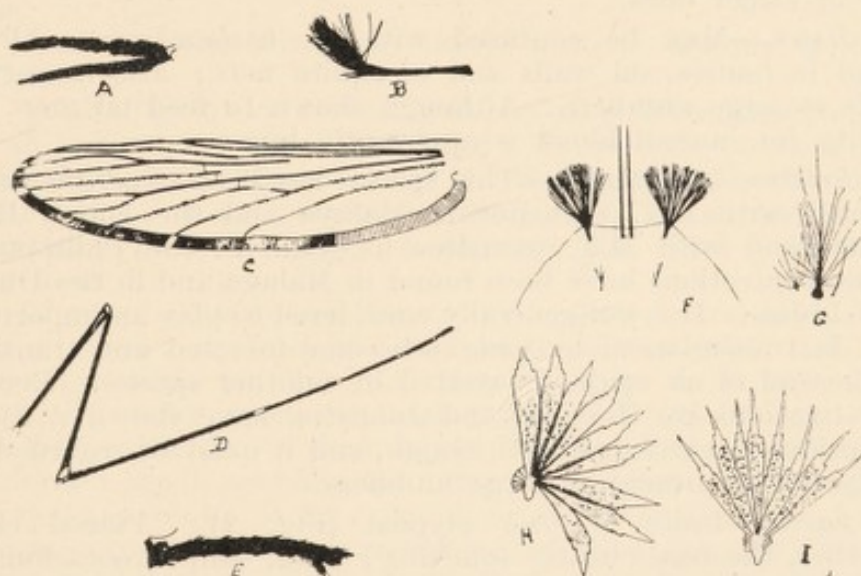


Fig. 2.—*A. barbirostris* v. d. Wulp. A, ♀ labium and palp; B, ♂ palp; C, wing; D, hind leg; E, abdomen, side view; F, clypeal hairs; G, right sub-median prothoracic; H, part of abdominal palmate II, I, alternate form. After Gater.

mesepimeral setæ present; a few scales associated with the following thoracic pleural setæ: propleural, upper and lower sternopleural, mesepimeral.

Wings (Fig. 2).—Predominantly speckled owing to mixture of broad dark and pale scales on most veins. *C* dark, but with a varying number of scattered pale scales in the basal half, often forming distinct patches; subcostal pale area small, variable, not or only just involving R_1 ; apical pale area small, involving R_1 , which is mainly dark beyond *Sc* pale area; R_2 with a sub-apical or apical, R_3 with two, palish areas; *M* dark; *Cu* speckled or dark, tips of Cu_1 and Cu_2 dark; *An* speckled in basal half, the distal half with two dark spots; fringe with narrow pale areas at R_{4+5} , usually at Cu_2 , sometimes at R_2 (if so, the posterior pale area on fringe at apex of wing narrow).

Legs (Fig. 2).—Femora dark or narrowly pale at base and apex; femur I pale below basally, II and III with pale longitudinal stripes; tibiæ narrowly pale at base and apex; tarsus of leg I with narrow terminal pale bands on segments 1 and 2; tarsus of leg II with exceedingly narrow bands in same positions or unbanded; tarsus of leg III with narrow apical bands on segments 1 to 4, tending to extend on to base of succeeding segments; coxæ dark with tufts of scales.

Abdomen (Fig. 2).—Dark, mostly with setæ only; a few narrow scales on VIII dorsally, some scattered pale scales on most segments ventrally; a prominent tuft of dark scales on median posterior region of sternum VII. Cerci without scales.

♂.—Wing more extensively pale; antennæ pale between whorls; palpi (Fig. 2) dark, unornamented, sometimes with a few pale scales, longer than labium; legs more broadly banded; tuft of scales on sternum of abdominal segment VII absent.

Terminalia.—Ninth tergite with rounded processes, shorter than the space between them; claspettes with two fine setæ on ventral lobe, one not much longer than spatulate process, one shorter; leaflets of phallosome large, serrated, on both edges in case of larger ones.

Notes.—May be confused with *A. barbumbrosus*. Often found in houses, on walls and mosquito nets; also in cattle-sheds in large numbers. Although shown to feed on man, its avidity for human blood is apparently low.

Relation to Malaria.—This species has been experimentally infected with B.T. parasites in Malaya and the Dutch East Indies, and with M.T. parasites (oocysts) in the Philippines. Natural infections have been found in Malaya and in the Dutch East Indies. It is not generally considered to play an important part in transmission, but might become infected and transmit at the end of an epidemic started by another species. Recent investigations by Hodgkin and Johnston have shown it to be the principal carrier at Batu Gajah, and it must be regarded as dangerous if present in large numbers.

Larva.—Inner anterior clypeal (Fig. 2): Placed close together, the bases nearly touching; long, simple, occasionally forked at tip. Outer anterior clypeal: Half to two-thirds the length of inner; branching in the form of a flat broom, the branches stiff and thick, 27 to 50 or more in number. Posterior clypeal: Short, not reaching bases of anterior hairs; internal

to outer anterior, with 2 to 5 branches arising from near the base. Sutural: Much longer than posterior clypeal, nearly reaching bases of frontal hairs; stout, with 8 to 10 branches. Trans-sutural: Smaller than sutural and in advance of them; with 6 to 9 branches. Antennal: On dorso-internal surface, nearly half the length of shaft from the base; long, reaching beyond end of shaft, with 8 to 14 branches. Sub-median prothoracic (Fig. 2): Inner with a short stem and 6 to 14 branches from near the base; central stout, with 10 to 16 branches and a fairly prominent root; outer sometimes as long as inner. Metathoracic palmate: Fairly well developed with 16 to 23 long, lanceolate leaflets. Pleural: Prothoracic with 3 long simple, 1 short with 2 to 5 stout branches from near the base. Mesothoracic with 2 long, 1 short and 1 very short, all simple. Metathoracic with 2 long simple, 1 short with 2 or 3 branches, 1 very short simple (occasionally bifid). Abdominal palmate: I with 9 to 13 lanceolate leaflets, some of which may show signs of indentations; II to VII (Fig. 2) fully developed, the points sharp but the filaments poorly differentiated; pigmentation patchy, appearing as if scaled, heavier in the basal two-thirds, the apical third of leaflet being more or less clear. On segment II (Fig. 2) the leaflets are often narrower than on the other segments, with the filaments comparatively longer and the indentations sometimes lacking.

Habitat.—Rice-fields, pools, drains, swamps, ponds, streams, wells, miscellaneous, "artificial". Typically an open swamp breeder and common in rice-fields, where it appears in large numbers, in some localities, in November, when the crop is just under half-grown. May be said to show a preference for deep over shallow water. It has been recorded from brackish water.

Anopheles (Anopheles) hunteri Strickland.

Ind. J. Med. Res., IV, 1916, 263.

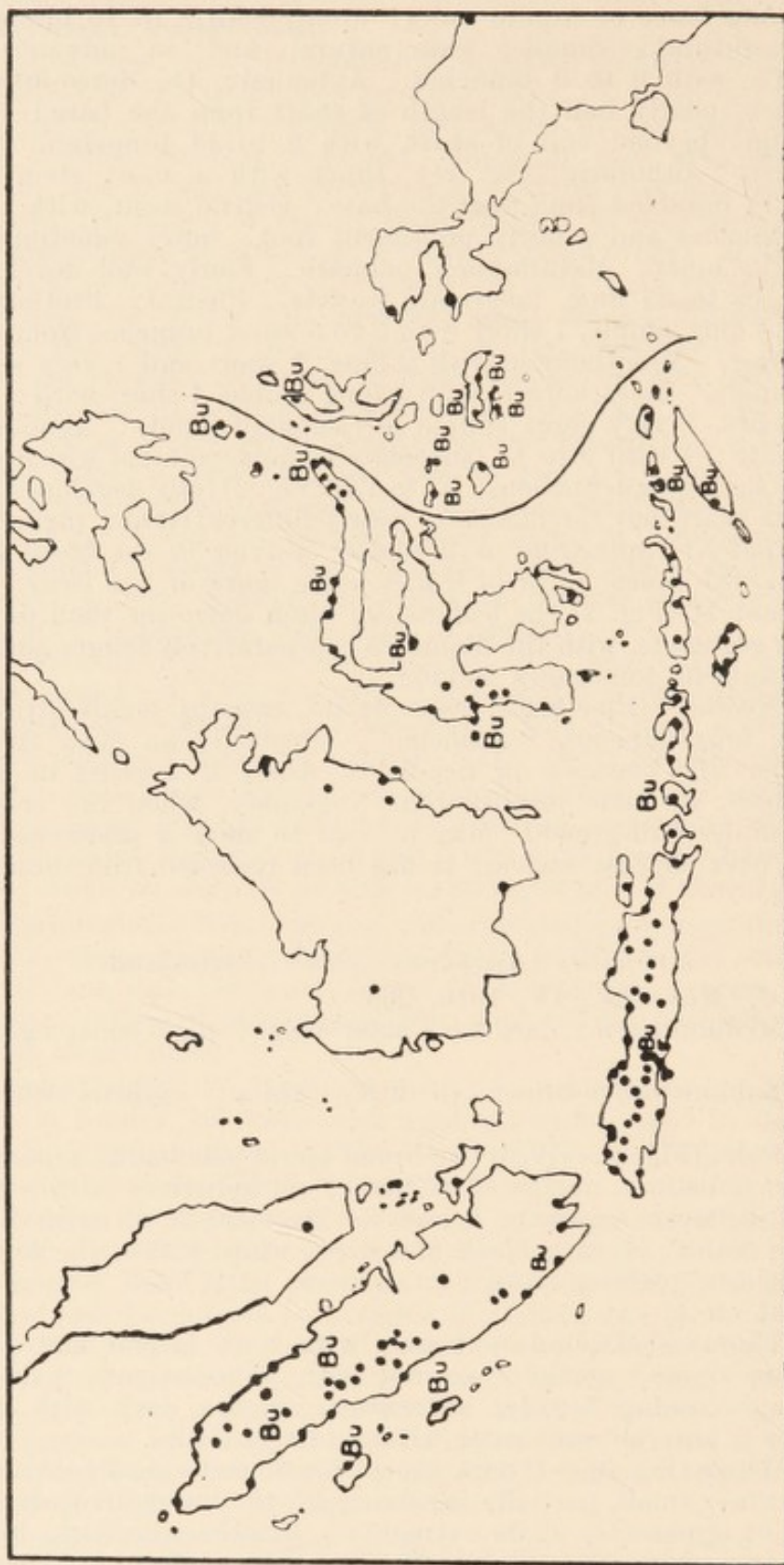
Medium sized; dark with paler wings; palpi conspicuously pale.

Labium olive-brown to dirty white; clypeus without scales.

Palpi (Fig. 3).—With two broad apical pale bands, separated by an indistinct, narrow dark band; an indistinct narrow pale band between segments 2 and 3. Segment 5 all with dirty white scales; 4 with black and dirty white scales, the former sometimes predominating; a narrow pale band present or absent on 1.

Thorax.—Mesonotum brown with dark lateral and paler median lines; sparsely covered with pale, narrow, hair-like scales becoming broader anteriorly; pleura dark with grey stripes; anterior pronotum with a tuft of scales.

Wings (Fig. 3).—*C* dark except for *Sc* and apical pale areas, the former small, partially involving R_1 , the latter involving R_1 , but not apparently at its extremity; *Rf* otherwise dark, but a pale area may occur proximally to origin of *Rs*; *Rs* dark at origin and bifurcation; R_2 mostly dark, a sub-apical pale area; R_3 mostly pale, dark basally and apically; R_{4+5} pale, small dark spots at base and apex; *M* dark basally, then pale or mixed; M_1 dark at base and apex, M_2 at apex only; *Cu* dark at base;



MAP 1.—DISTRIBUTION OF *ANOPHELES BARBIROSTRIS* AND ITS
VARIETY *BARBUMBROSA*.
Bu.=*barbumbrosa*.

Cu_1 with small dark spots near origin, in basal third, and a longer spot at apex; Cu_2 dark at apex; An with median and apical dark spots; fringe pale from between R_2 and R_3 to R_{4+5} , sometimes a pale area at Cu_2 .

Legs.—A “knee-spot” generally present; narrow pale bands at tibio-tarsal and tarsal joints, extreme apex of tarsus 5 of hind leg pale.

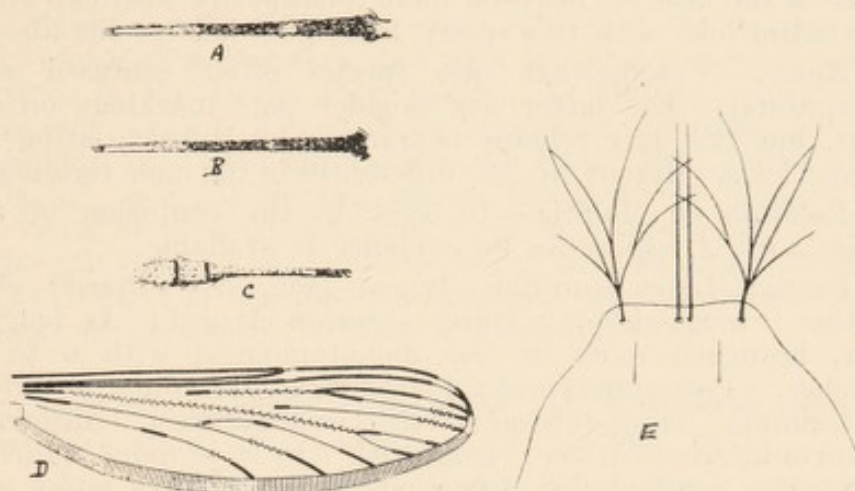


Fig. 3.—*A. hunteri* Strickland. A-B, ♀ palp; C, ♂ palp; D, wing; E, clypeal hairs. After Gater.

JAVA.

West Java: Westbantam, Sudbantam, Nordbantam, Binnenland Bantam, Batavia, Buitenzorg, Tandjong Priok, Tjibodas, Poentjak, Tjiteureup, Djampang, Sindangbarang, Soekaboemi, Bandoeng, Tjiheha-Ebene, Nord-Soemedang, Kepetakan, Cheribon, Tegal Wangi, Tji kadoe, Bandjar.

Middle Java: Tjilatjap, Noesa kambangan, Gombong Bu., Babakan, Maos, Banjoemas, Poerworedjo, Margaredjo, Tegal, Semarang, Rembang, Magelang, Djogja, Solo, Ambarawa.

East Java: Toeban, Soerabaja, Lamongan, Djatirogo, Modjowarno, Wonosari, Madioen, Pasoeroean, Probolinggo, Sud-Loemadjang, Malang, Banjoewangi, Insel Madoera.

SUMATRA.

Atjeh (Achin): Kotaradja, Takengon, Belangkedjeren, Kotatjane, Sigli, Tapatoean, Lho Soekon, Bireuen, Lokop, Langsa, Meulaboh, Lho Seumawe, Singkel, Talang akar.

East Sumatra: Deli-Ebene, Deli-Kuste, Kisaran, Moeara Tebo.

West Sumatra: Sidikalang Bu., Sibolga, Silindoeng-Ebene, Pahahi-Ebene, Padang-Sidempoean, Gross-Mandailing Bu., Klein-Mandailing Bu., Rao, Soendatar, Fort de Kock, Fort v. d. Capellen, Singkarak, Solok, Sawah loento, Padangpandjang, Naras, Kajoetanam, Moeara laboeh, Angoli, Andkola djoeloe.

South Sumatra: Benkoelen, Kepahiang, Tjoeroep, Ketahoen-Ebene, Moeara aman, Kroe Bu., Lampongs.

NEW GUINEA.

Kloof Biwouak, Fakfak, Sorong Bu., Noeseroe.

BORNEO.

Tandjong Redeb, Sanggau, Meliau, Samarinda, Tenggarong, Boeloengan, Bandjermasin, Rantau pandjang.

CELEBES.

Makassar, Mamoejoe, Toradja-Lander, Pampanoea, Parepare, Paloe, Pinrang, Madjene Bu., Rapang, Leok, Paleleh Bu., Tolitoli, Boeol, Kotamobagoe, Menado Bu., Sonder, Motoling, Werot, Likoe pang, Palopo, Posso Bu.

ISLANDS.

Nias Bu., Mentawai, Siberoet, Banka, Riouw, Bali, Lombok Bu., Moena (Raha), Sanana Bu., Boeroe Bu., Sangihe, Talaud Bu., Salajar, Halmahera Bu., Ambon Bu., Soela-Inseln Bu., Ceram Bu., Saparoea Bu., Haroekoe Bu., Timor Bu., Wetar, Kisar, Flores, Pantar Bu., Alor, Soembawa, Soemba.

Abdomen.—Dark, without scales; no tuft on sternum of segment VII.

♂.—Palpi (Fig. 3): Broadly banded with dirty white scales on segments 4 and 5, segment 3 and a portion of 2 nearly all pale-scaled. The pale scales may be less predominant; dark bands occur between segments 3/4 and 4/5.

Terminalia: Processes of ninth tergite long, over half the length of the interval between them; claspettes with two lobes, the ventral lobe with two setæ; leaflets of phallosome absent.

Notes.—A somewhat rare species often confused with *A. separatus*. The latter has broader pale markings on the wings, but the only reliable characters for differentiating the two species, at present, are the differences in the male terminalia.

Relation to Malaria.—In view of the confusion of this species with *A. separatus*, no evidence is available.

Larva.—Inner anterior clypeal (Fig. 3): Placed close together; long, simple. Outer anterior clypeal: As long as inner, branched more or less dichotomously, with 6 to 10 branches. Posterior clypeal: Placed internal to outer anterior; short, simple. Trans-sutural: With 2 or 3 branches. Antennal: On dorso-internal surface; long, with 7 to 13 or more branches. Sub-median prothoracic: Inner much shorter than outer with about 5 branches or less distally; central with about 11 branches and a small root. Abdominal palmate: Undeveloped on any segment, the leaflets represented by 16 or 17 filamentous branches.

Habitat.—Pools, swamps and stream beds in jungle.

Anopheles (Anopheles) hyrcanus var. *sinensis* Wied.
Auss. zweifl. Ins., I, 1828, 547.

Hind tarsi with narrow pale rings at apices of segments only. The dark areas on wings (Fig. 4) variable and sometimes suffused, dark spot at base of fifth vein short, usually dot-like. The subcostal pale area involves the costa and first vein. Bases of second and fourth veins lighter, a fringe spot usually at 5.2.

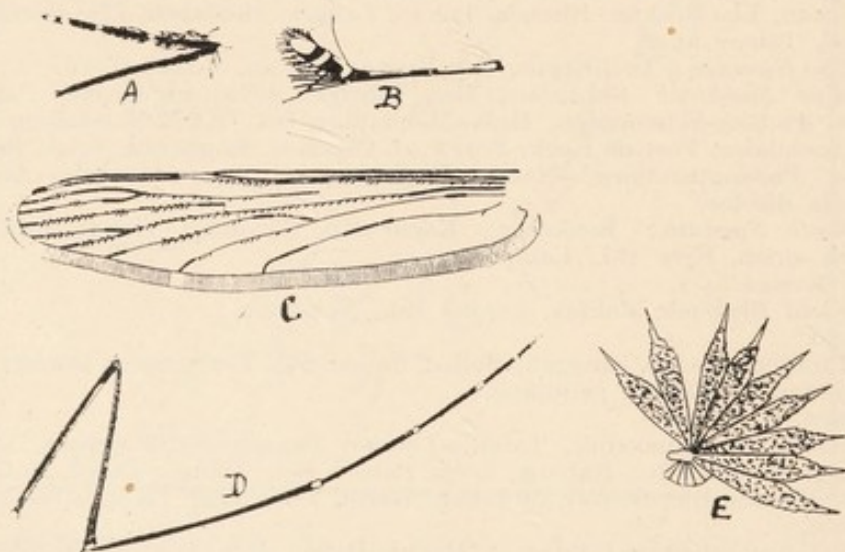


Fig. 4.—*A. hyrcanus* var. *sinensis* Wiedemann. A, ♀ labium and palp; B, ♂ palp; C, wing; D, hind leg; E, part of abdominal palmate IV. After Gater.

Larva.—This sub-species can sometimes be distinguished from *nigerrimus* by the pigmentation on the leaflets of the palmate hairs on segments III to VI, which is less dense and more evenly distributed, leaving only the tips of the leaflets clear (Fig. 4).

Relation to Malaria.—The two sub-species have not always been distinguished in reports of investigations on this species. The following remarks therefore apply to one or both forms.

Experimental infections with B.T. and Q. malaria have been obtained in Formosa, and with all three species of malaria parasite in the Dutch East Indies. In Malaya, experimental infections with M.T. and B.T. have been obtained. Natural infections have been observed in the Dutch East Indies and in Malaya. In Sumatra, this species is considered to have been the cause of several epidemics, while in Formosa and Korea it is thought to be an important carrier of B.T. malaria. Recently, it has come to be considered a carrier of some importance under certain circumstances, in Malaya (Hodgkin, 1933).

Anopheles (Anopheles) hyrcanus var. *nigerrimus* Giles.

Handbook Gnats or Mosquitoes, Ed. 1, 1900, 161.

Adult ♀.—Large (length of wing 3.5–5 mm.), anopheline attitude very marked.

Head: Scales on occiput of normal type, extending low down on postgenæ; a well-marked white vertical spot; vertical chætæ forming a single line extending to front of vertex; white chætæ very slightly modified, forming a conspicuous tuft; ocular scales well developed and long. Antennæ with some small pale scales on torus and numerous broad white scales, usually on the first five or more flagellar segments. Palp with index 0.6, covered throughout whole length with long erect scales, giving markedly shaggy effect; black, with a white apical band and narrowish pale bands at 2–3, 3–4, and 4–5; some scales on membrane at base. Clypeus with a large tuft of black scales laterally towards base. Mandible with about 40 teeth; maxilla 16.

Thorax: Prothoracic lobes furnished with dense tuft of outstanding black scales; propleural hairs 4 or more. Mesonotum dark, almost black, median area not markedly lighter than fossæ and lateral areas; median area covered with rather numerous light curved hairs, becoming scales in the middle of anterior promontory, where a tuft of white scales is formed; very marked tufts of scales on lateral areas of promontory, often somewhat palish above; fossæ with scantier hairs. Scutellum with the large hairs dark. Pleuræ dark, marked with the usual pale horizontal lines; spiracular hairs present, usually about 5; prealar numerous (about 15); upper mesepimeral about 10; sternopleural with the upper and lower groups numbering about 4 and 10 respectively, latter usually with a scale or two.

Wings large (three times length of thorax); anterior fork cell about one-quarter length of wing; index 1.5; petiole about half length of cell. Ornamentation of wing as shown in Fig. 5; pattern often somewhat confused, owing to dark and pale scales both being present on the veins together; often pale

scales present in middle of vein, and laterally extended scales dark; in some places dark scales present on lower surface of wing, and are seen through wing-membrane when upper scales are pale.

The apparent apical pale spot is really sub-apical, being proximal to the junction of vein 1 with the costa, and not continuous with the pale apical fringe-area; apex of wing is very characteristically widely and continuously pale to beyond vein 3. In this variety the subcostal spot does not usually completely, if at all, involve vein 1 and is very commonly small and fleck-like; stems of veins 2 and 4 usually all dark, but not invariably so; usually no fringe-spot at 5.2, but one is occasionally present; border-scales often conspicuously pale or creamy, but may be darkish, especially in middle portion of wing. Scaling heavy and profuse; scales broadly fusiform and laterals widely spread, in anterior portion of wing meeting, or nearly meeting, scales of contiguous veins; max. str. about 12.

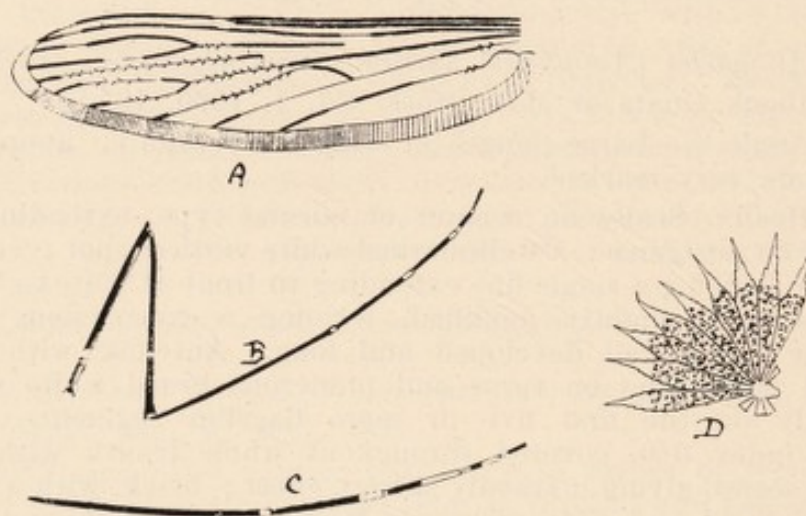


Fig. 5.—*A. hyrcanus* var. *nigerrimus* Giles. A, wing; B, hind leg; C, tarsus of hind leg enlarged; D, part of abdominal palmate IV.
After Gater.

Legs (Fig. 5): Anterior femora markedly swollen in basal half. Femora dark to base or nearly so; front pair dark beneath, often with a pale area towards apex posteriorly, others usually more or less pale beneath; dark or narrowly pale apically. Tibiæ usually pale on one aspect for whole length, and also usually pale at base and more or less apically. Tarsi very variable in extent of marking; usually with pale apical bands of moderate extent on segments 1-3 on fore and mid-legs and segments 1-4 on the hind legs, very commonly with the joint 3-4 on the hind legs with banding also; in many series the extent of paling is much greater, involving half the segment on the front legs and a large part of the more distal segments on the hind legs, these being sometimes almost entirely pale (argyropus form). Front coxæ with dark and often pale scales anteriorly, the mid and hind with a conspicuous tuft of erect pale scales externally towards apices. Trochanters with scales on fore and mid legs, those of the hind legs with hairs only.

Abdomen dark, devoid of scales, except a few towards posterior border of tergite VIII and a tuft of black scales centrally towards the apex on segment VII. Cerci with hairs only.

Adult ♂.—In general as in ♀. Antenna without scales on first flagellar segment. Palpi clubbed, the last two segments clearly articulated and constricted somewhat at joint. Marginal hairs on segment 5 few and inconspicuous; forming a row 4-5 deep on either border of segment 4; numerous hairs arising from apex of 3. Scaling rather profuse and inclined to form tufts, with black and white ornamentation; apical segment white apically and usually over greater part of outer surface, dark at base and edges, some white scales along inner dorsal margin; preceding segment pale at apex and over greater part of median area; segment 3 pale at apex and usually with pale line of conspicuous scales along dorsum; a well-marked white area at pseudo-joint and often some pale scales on segment 2. Ungues with basal spur. Abdomen devoid of scales (and lacking ventral tuft shown by female), but with numerous scales on coxites.

♂ terminalia: Parabasal spines 2; inner about one-quarter length of coxite, stouter than, but about half length only of outer; end flattened, sharply pointed and shortly recurved; outer nearly straight, tapering, and not recurved at end. A well-marked internal spine about half-way down coxite. Harpago with a flattened club on dorsal lobe and two simple spines on inner lobe. Phallosome approaching half length of coxite; usually with about 5 leaflets, but sometimes as few as 2; leaflets small, delicate, the largest lanceolate, serrated, and often with subterminal tooth, giving it a very characteristic bifid appearance. Ninth tergite with long processes, about as long as the interval between them, distinctly clubbed.

Pupa.—Paddle: Index 1; external border in middle third with small, appressed spines, replaced in posterior third by delicate hairs; paddle-hair short, straight, or nearly so, simple; accessory hair two-thirds paddle hair. Spine: VIII poorly developed, with 2-3 fine lateral branches and 2 fine terminal branches; accessory hair as long as spine, simple; II-VII short, blunt, thick, reduced in size on more anterior segments. Hair B: VII half length segment, 6-7 branches; III-VI half length of segment, 15-16 branches. Hair C: VII two-thirds length of segment, 2-3 branches; III-VI about half length segment, 3-6 branches on 5 and 6, more numerous branches on 3 and 4; II reduced, 7-8 branches. Hair 5 bifurcate on segments III-VI, simple on VII. Most of the other hairs simple or bifurcate, except hairs 3 and 4 on segments 2-4, which may have several branches.

Larva.—Clypeal hairs: Inner clypeal hair simple, outer clypeal hair dendritically branched, with 50-60 terminal branches; posterior clypeal hair with 2-3 branches or rarely 4-5. Frontal hairs normal, long. Antennae very stout, uniformly pigmented, small spines well developed on inner aspect; hair arising from internal aspect about middle of antenna, with 8-12 branches; terminal hairs 6-10 branches; sabres relatively long, a little less than half length antenna. Long setae forming cluster on dorso-external surface about middle of mandible, markedly plumose, not simple as in other

larvæ. Mentum very small, with four teeth on each side of median tooth, last of series often very small. Shoulder hairs: Inner without conspicuous basal tubercle, short, simple, or sometimes split into 2 or 3; middle stout, feathered; outer simple, arising independently. Metathoracic hair No. 1 developed as palmate hair. Pleural hairs as in subgroup, dorsal posterior 1 having 3-4 stiff branches. Palmate hairs (Fig. 5) well developed on III-VII; hair No. 1 on I and II poorly developed, with 9-13 leaflets. Leaflets lanceolate, with shallow indentations scattered along distal third; length of leaflet on mid-abdominal segment 0.126 mm. Lateral hairs on I-III long, stout, feathered; on IV-V long and split near base into 2-3 branches; on VI-VII very short, with 4-6 branches. Tergal plates not very long, but fairly broad. Spiracular chitinization poorly developed and widely separated from median plate, which is not very broad anteriorly. Pecten with 6-9 long and 12-17 short projections, which are without serrations along their dorsal borders, the two outermost projections somewhat longer than the other long ones. Post-spiracular hair with 3-4 branches. Outer submedian caudal with 5-6 long branches, with stout ends, but not very sharply curved, and forming poorly developed hooks. Hair No. 0 very short and split near its middle into 3 branches on II-VIII.

Anopheles (Anopheles) separatus Leicester.

Culicidæ Malaya, 1908, 36.

Large, dark; wing-veins with numerous pale scales.

Clypeus without a tuft of scales; labium (Fig. 6) rough, slightly shaggy towards base, unornamented; antennæ with some scales on segment 2 and a cluster of pale scales on 3.

Palpi (Fig. 6).—Rough, shaggy on segment 2; segment 5 entirely pale; segment 4 variable, pale with an admixture of dark scales in central area, or showing a definite dark central band, up to three-quarters the length of segment, or dark basally with only the apex pale; segments 1 to 3 dark, occasionally with a few pale scales at apex of 2 and 3.

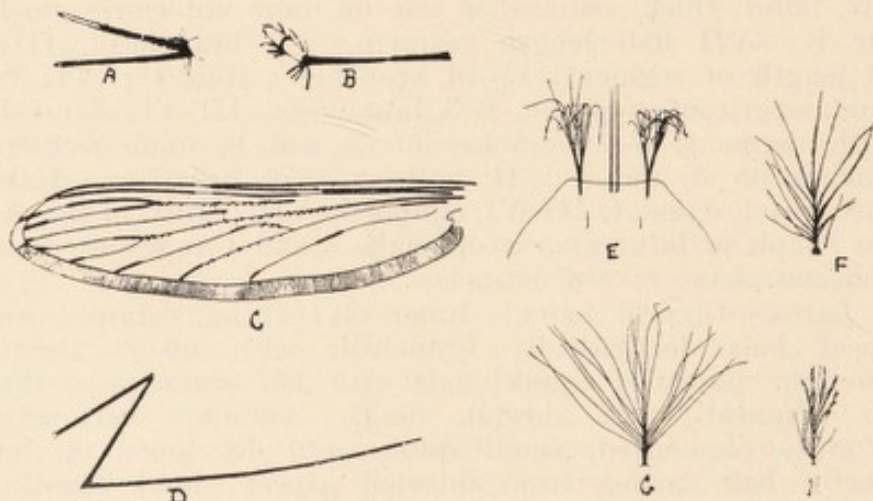


Fig. 6.—*A. separatus* Leicester. A, ♀ labium and palp; B, ♂ palp; C, wing; D, hind leg; E, clypeal hairs; F, right sub-median prothoracic; G, abdominal palmate IV; H, hair No. 1 on mesothorax. After Gater.

Thorax.—Mesonotum usually with pale median area and dark stripes, a few scattered narrow, curved hair-like scales. Anterior pronotum with a tuft of scales. Propleural setæ 3, or 2; spiracular setæ 2 or 3; no scales on pleura.

Wings (Fig. 6).—*C* dark except at subcostal and apical pale areas, both of which are fairly broad, the subcostal involving R_1 ; R_1 with an area of pale or mixed scales in accessory sector region, pale at apex; *Rs* pale, with a dark spot at base, R_2 dark, pale subapically; R_3 pale with dark spots at base and apex, or with a median pale area equal to basal and apical dark spots; bifurcation of R_2 and R_3 dark; R_{4+5} pale with dark spots at base and apex; *M* pale or mixed, with a dark spot at base, M_1 with dark spots at base and apex, M_2 dark at apex only; *Cu* dark at base, otherwise pale, Cu_1 with a few dark scales near origin and dark spots before middle and at apex; Cu_2 pale, dark apically; *An* pale basally, with dark spots at middle and apex; fringe pale at apex of wing from before R_1 to termination of R_2 , and from between R_2 to R_3 to the termination of R_{4+5} or just beyond.

Legs (Fig. 6).—Femora somewhat paler below; tibiæ minutely pale apically; tarsi 1 to 4 on all legs with narrow apical pale bands, fifth tarsi often with some pale scales at extreme tip. Coxæ without scales.

Abdomen.—Entirely without scales.

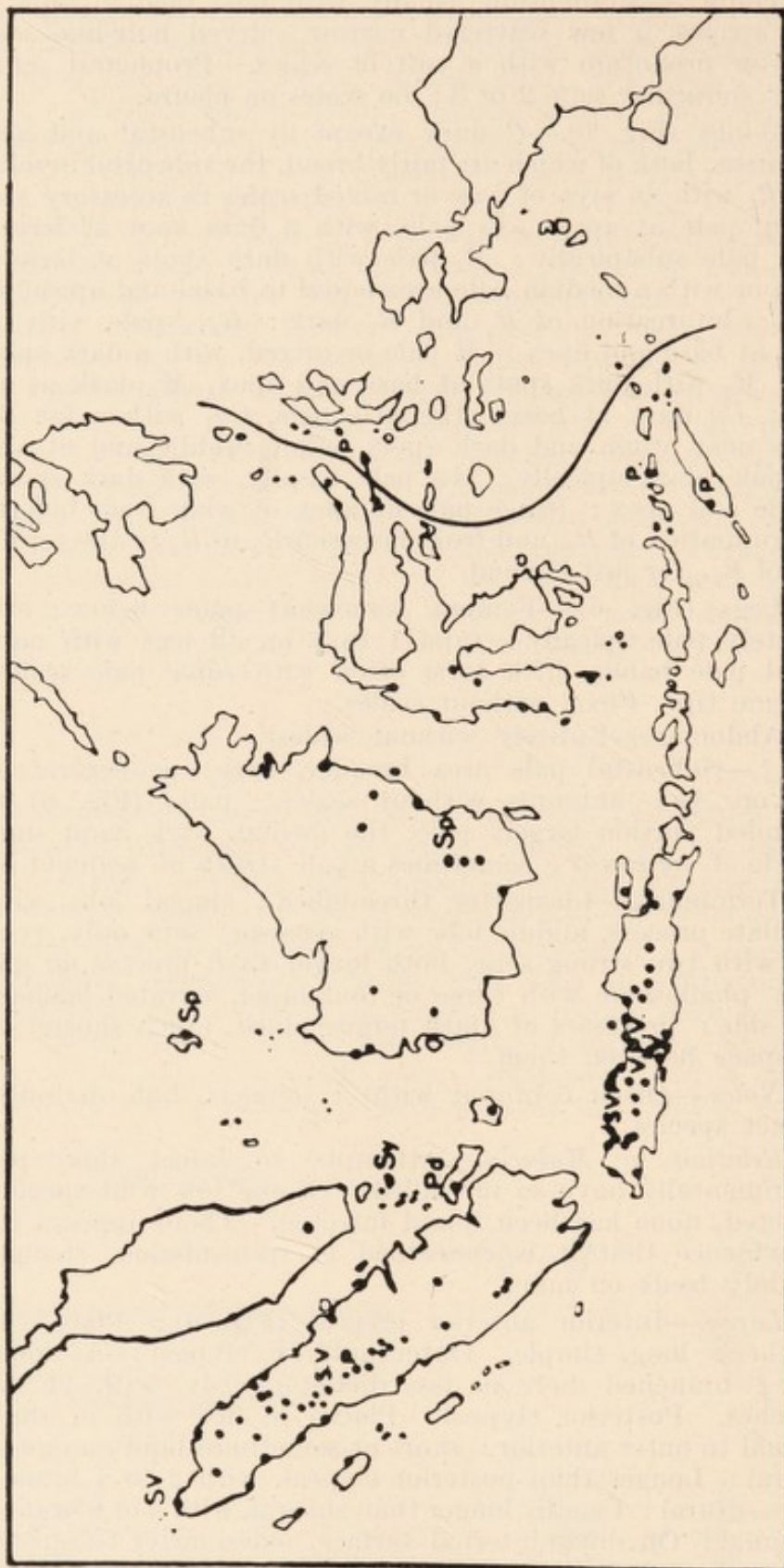
♂.—Subcostal pale area broader, only one central dark spot on *An*; antennæ without scales; palpi (Fig. 6) with expanded portion largely pale, the median dark band smaller than in *A. hyrcanus*; sometimes a pale streak on segment 3.

Terminalia.—Claspettes three-lobed; dorsal lobe with a spatulate process, middle lobe with accessory setæ only, ventral lobe with two strong setæ, both longer than process on dorsal lobe; phallosome with three or four large, serrated leaflets on each side; processes of ninth tergite short, much shorter than the space between them.

Notes.—Often confused with *A. hunteri*, but obviously a distinct species.

Relation to Malaria.—Attempts to infect this species experimentally have so far failed. Of the few wild specimens dissected, none has been found infected. There appears to be no evidence that it is concerned in transmission, though it certainly feeds on man.

Larva.—Interior anterior clypeal (Fig. 6): Placed close together; long, simple. Outer anterior clypeal: As long as inner; branched more or less dichotomously, with 11 to 16 branches. Posterior clypeal: Placed in line with or slightly internal to outer anterior; short or sometimes bifid on one side. Sutural: Longer than posterior clypeal, with 2 to 4 branches. Trans-sutural: Usually longer than sutural, with 5 or 6 branches. Antennal: On dorso-internal surface, one-quarter to one-third the length of shaft from the base; reaching beyond end of shaft, with 25 to 36 branches, occasionally less, from 17 upwards. Sub-median prothoracic (Fig. 6): Inner much shorter than outer, dividing into 4 or 5 branches at the tip; central with 9 to 14 branches and a small root. Metathoracic palmate: Undeveloped, small, with 4 or 5 filamentous branches. Pleural:



MAP 2.—DISTRIBUTION OF *ANOPHELES HYRCANUS*, ITS VARIETIES, ALSO OF *A. HUNTERI* AND *A. SEPARATUS*.

S.=var. *sinensis*.

V.=var. *nigerrimus*.

P.=var. *pseudopictus*.

Sp.=*separatis*.

Pd.=*peditæniatus*.

H.=*hunteri*.

Prothoracic with 3 long simple, 1 very short with 3 to 6 stout branches, brush-like. Mesothoracic with 2 long simple, 1 short simple or bifid, 1 very short simple. Metathoracic with 2 long simple, 1 short with 2 to 4 branches, 1 very short simple, sometimes bifid. Abdominal palmate: Undeveloped on any segment, the leaflets represented by filamentous branches; I larger than II, with 12 to 16 branches; II small, with 11 to 15 branches; III to VI (Fig. 6) larger, with 18 to 25 branches; VII smaller, with 12 to 18 branches.

Notes.—Hair No. 1 on mesothorax (Fig. 6) poorly developed; lateral hair on segment IV with 3 or 4 branches.

Habitat.—Drains, pools, swamps, streams, ponds, wells. Usually found under shade in somewhat restricted localities.

Anopheles (Anopheles) umbrosus Theobald.

Mon. Culicidae, III, 1903, 87.

Fairly large, dark, little ornamented.

Clypeus without a tuft of scales; labium (Fig. 7) rough, somewhat shaggy near base; antennæ with scales on segments 2 and 3.

Palpi (Fig. 7).—Rough, shaggy near base, unornamented.

Thorax.—Mesonotum with a pale median area, varying in extent, and a few scattered, very narrow, curved hair-like scales. Anterior pronotum with a tuft of scales. Propleural setæ absent; no scales on pleura.

Wings (Fig. 7).—C dark except at the small subcostal pale area, which is usually present, and at the small apical pale area, which extends from just before R_1 to just beyond it; R_1 dark,

JAVA.

West Java: Westbantam, Ostbantam, Sudbantam, Batavia S.V.P., Tandjong Priok P., Buitenzorg, Tjitjoeroeg, Soekaboemi, Tjiheha-Ebene, Bandoeng-Ebene, Nordsoemedang, Tjikadoe, Tegal Wangi, Bandjar, Kepetakan V.P., Cheribon V.P.

Middle Java: Tjilatap V., Babakan, Gombong, Poerworedjo, Tegal V., Pekalongan, Semarang, Magelang, Ambarawa P., Banjoebiroe, Solo.

East Java: Residenz Madioen, Lamongan, Modjowarno, Soerabaja, Probolinggo, Sudloemadjang, Insel Madoera.

SUMATRA.

Atjeh (Achin): Kotaradja S.V., Lho Soekon P., Lho Seumawe, Belang Pidie, Belang Kedjeren, Talang akar, Takengon, Langsa, Meulaboh, Tapatoean, Kota Tjane, Lokop, Bireuen, Singkel Sp.

East Sumatra: Deli-Ebene, Deli-Kuste, Kisaran, Karoo-Hochebene, Tandjong Morawa, Bagan Siapiapi Sp., Rengat, Moeara Tebo, Laobalang.

West Sumatra: Sidikalang, Toba-Ebene, Sibolga, Padang Sidempoean, Angkola djoeloe, Silindoeng-Ebene, Pahahi-Ebene, Gross-und Klein-Mandailing S.V., Soendatar, Rao P., Fort de Kock Sp. Pd., Fort v. d. Capellen, Singkarak, Solok, Sawah Loento, Naras, Angoli, Moeara laboeh, Padang Pd., Pangoeroeran.

South Sumatra: Ketahoen-Ebene, Kepahiang, Tjoeroep, Moeara aman, Aerprioekan Sp., Lampongs P., Kota agoeng.

BORNEO.

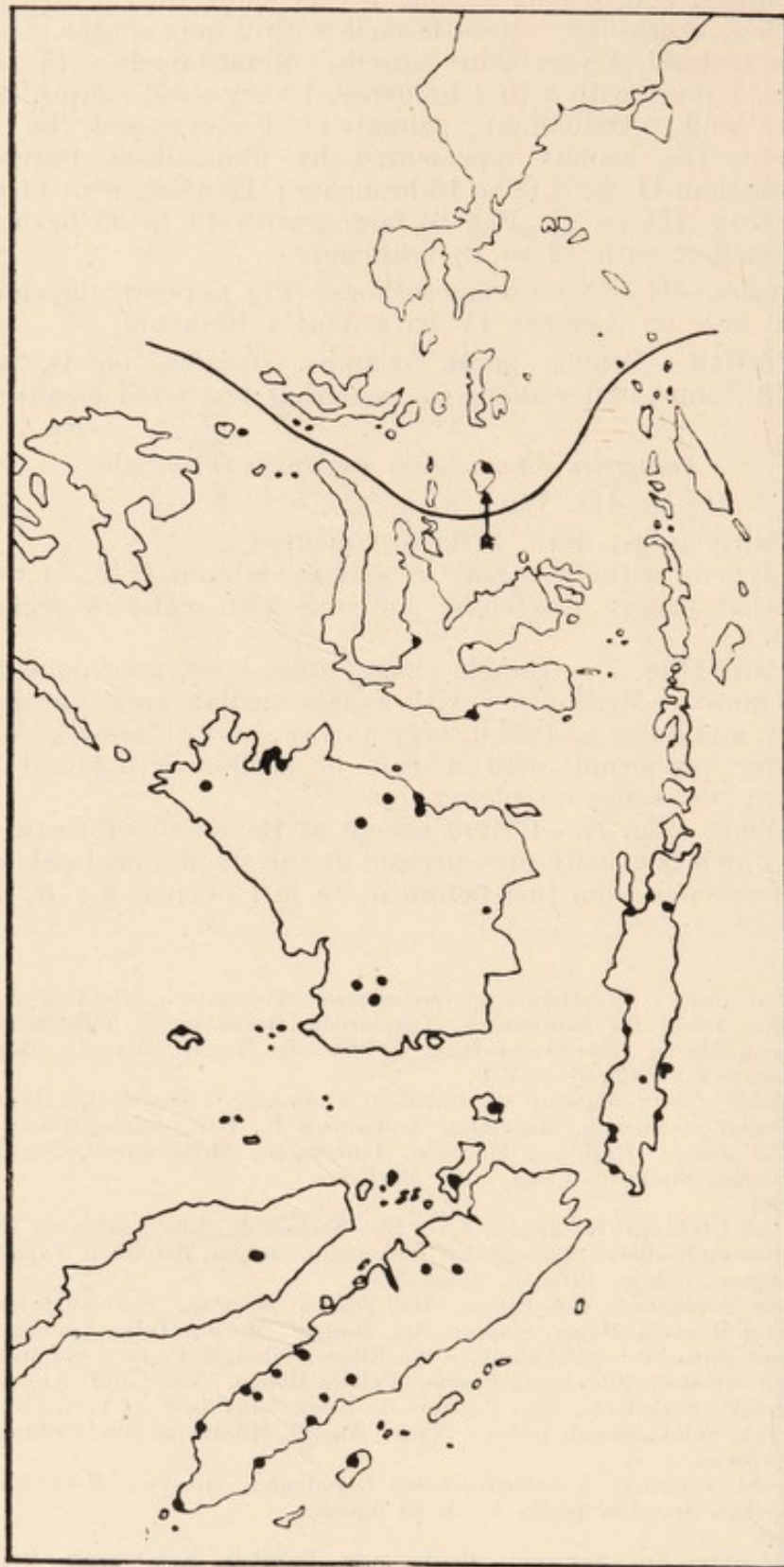
Amoentai Sp., Sanggau, Singkawang, Barabai, Kendangan, Bandjermasin, Tajan, Tenggara, Tandjong Redeb, Sankoeirang, Balikpapan, Tarakan, Obere Mahakam, Nangatajap.

CELEBES.

Macassar V., Mamoedjoe, Palopo, Pampanoea, Pare pare, Barroe, Paloe, Kotamobagoe, Sonder.

ISLANDS.

Nias, Enggano, Riouw H., Natoena Sp., Banka Pd., Billiton, Krakatau, Karimoendjawa, Salajar, Timor P., Alor P., Ternate P.



MAP 3.—DISTRIBUTION OF *ANOPHELES UMBROSUS*.

JAVA.

West Java : West-Bantam, Batavia, Tandjong Priok, Sindangbarang, Bandjar.

Middle Java : Noesa kambangan, Tegal, Semarang.

East Java : Soerabaja, Pasoeroean, Tambaksari.

a small pale area in accessory sector region and at apex, sometimes partially involved with subcostal pale area; R_s with mixed scales and two dark spots, or largely dark; R_2 with a subapical pale area, R_3 with a pale area before or about the middle; R_{4+5} mainly pale, a dark spot at base; M dark at base, followed by mixed or pale scales, M_1 with a dark spot at base, M_2 dark basally and apically; Cu dark at base, then pale, Cu_1 with dark spots before middle and at apex, Cu_2 dark apically; An with two dark spots; fringe pale at terminations of R_2 and R_{4+5} in addition to apical pale area.

Legs (Fig. 7).—Femora paler beneath, no or only just perceptible banding at joints of fore- and mid-tarsi. Femur of hind leg minutely pale apically, as are the tibia, and tarsi 1 to 3; tarsi 2 to 5 banded basally to a varying extent. Coxæ without scales.

Abdomen.—Entirely without scales.

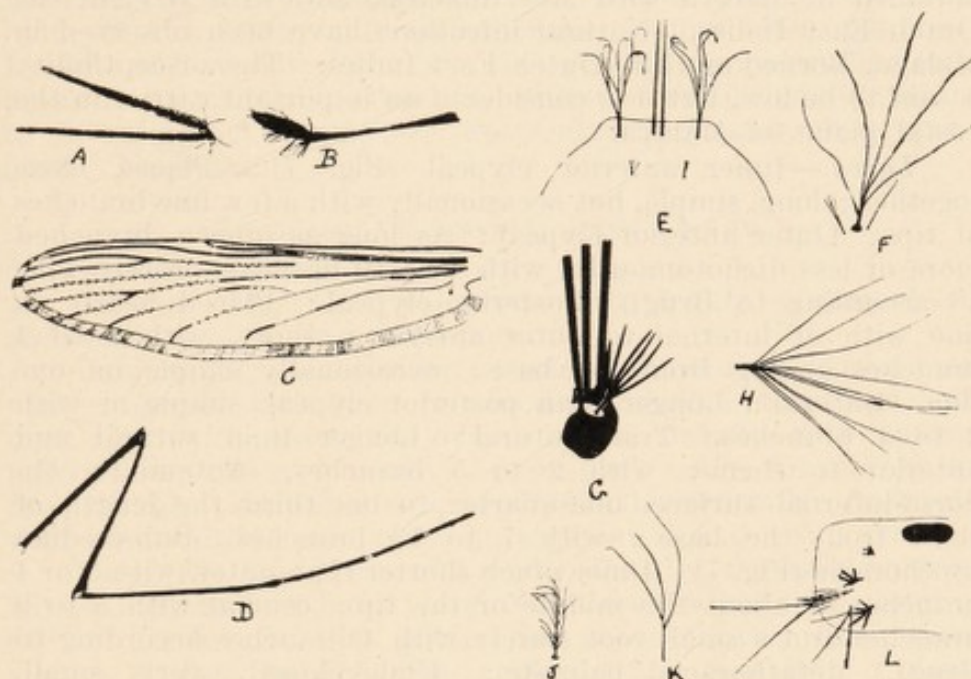


Fig. 7.—*A. umbrosus* Theobald. A, ♀ labium and palp; B, ♂ palp; C, wing; D, hind leg; E, clypeal hairs; F, right sub-median prothoracic; G, basal portion of prothoracic pleural hairs (after Puri); H, abdominal palmate IV; J, hair No. 1 on mesothorax; K, lateral hair (No. 6) on segment IV; L, left-hand portion of abdominal segment IV showing hairs Nos. 1 to 6 and hair No. 0 anteriorly. After Gater.

SUMATRA.

Atjeh (Achin): Takengon, Singkel, Meulaboh, Lho Seumawe, Lho Soekon, Kroengradja, Olehleh.

East Sumatra: Kisaran, Deli-Kuste, Deli-Ebene, Kateman, Rengat, Tandjong balai, Mocara Tebo.

West Sumatra: Sibolga, Padang Sidempoean, Mocara laboeh, Gross-Mandailing, Aerprioekan.

BORNEO.

Sanggau, Simpang, Nangatajap, Balikpapan, Koeala Sambodja, Sekadau, Tandjong Redeb, Tenggara, Tarakan, Obere Mahakam, Tini, Tandjong Selor, Sekajam.

CELEBES.

Madjene, Posso.

ISLANDS.

Nias, Riouw, Banka, Billiton, Natoena, Boeroe.

♂.—Subcostal pale area wider; *M*, *Cu* and their branches largely pale except at base; *An* with one dark spot; tarsal banding on hind leg not so evident; palpi (Fig. 7) entirely dark with numerous setae on expanded portion.

Terminalia.—Claspettes two-lobed, dorsal lobe with a spatulate process, ventral lobe with a strong seta, much longer than process, and a minute seta external to it; leaflets present on phallosome; ninth tergite somewhat curved posteriorly, the processes broad, stumpy, much shorter than the space between them. Coxites with some scales.

Notes.—The above description refers to what is usually taken to be *A. umbrosus* in Malaya. It is uncertain, however, if the form described conforms to Theobald's type, and there are other forms which differ from it. The group requires revision.

Relation to Malaria.—Experimental infections have been obtained in Malaya with M.T. malaria, and with B.T. in the Dutch East Indies. Natural infections have been observed in Malaya, Borneo and the Dutch East Indies. The susceptibility is said to be low, but it is considered an important carrier in the costal plains of Malaya.

Larva.—Inner anterior clypeal (Fig. 7): Placed close together; long, simple, but occasionally with a few fine branches at tips. Outer anterior clypeal: As long as inner; branched more or less dichotomously, with 4 to 10 branches (rarely with 13 according to Brug). Posterior clypeal: Placed nearly in line with or internal to outer anterior; short, with 2 to 4 branches arising from the base; occasionally simple on one side. Sutural: Longer than posterior clypeal, simple or with 2 to 4 branches. Trans-sutural: Longer than sutural and anterior to them; with 2 to 5 branches. Antennal: On dorso-internal surface, one-quarter to one-third the length of shaft from the base; with 7 to 13 branches. Sub-median prothoracic (Fig. 7): Inner much shorter than outer, with 3 or 4 branches at about the middle or the tip; central with 5 to 9 branches and a small root (rarely with 4 branches according to Brug). Metathoracic palmate: Undeveloped, very small, with 3 or 4 filamentous branches. Pleural: Prothoracic with 3 long simple, 1 very short with 4 to 6 stout branches, brush-like (Fig. 7). Mesothoracic with 2 long, 1 short and 1 very short, all simple. Metathoracic with 2 long simple, 1 short with 2 or 3 branches, 1 very short simple. Abdominal palmate: Undeveloped on any segment, the leaflets represented by filamentous branches; I to VI (Fig. 7) with 5 to 12 branches; VII with 7 to 10 branches.

Notes.—Hair No. 1 on mesothorax (Fig. 7) poorly developed. Lateral hair on segment IV (Fig. 7) with only 2 or 3 branches. Hair "0" fairly conspicuous on abdominal segments II to VII, with 3 to 10 branches (Fig. 7).

Habitat.—Pools, drains, swamps, streams, miscellaneous, wells, ponds. Usually found under shade, but also in the open. Common in water discoloured by decaying vegetation and peat.

Subgenus *Myzomyia* Blanchard.

C.R. Soc. Biol., LIV, 1902, 795.

Characters.—Adult: Propleural and spiracular hairs variable, often reduced in number or absent. Buccopharyngeal

armature of ♀ always present but of various types. Hypopygium with a group of 4–6 spines at base of coxite; these spines usually more slender than in *Anopheles* s.str., and not set on tubercles or lobe; no additional spine on inner margin of coxite near middle. Wings nearly always with distinct pale markings, including a series of four spots along costa; bases of fork-cells and areas adjacent to cross-veins almost always with pale scales.

Pupa.—Lateral apical hairs of abdominal segments usually longer than in subgenus *Anopheles* and sharply pointed; terminal hair of paddle usually long and hooked; hair *C* (admedian hairs of posterior margin) of segments 5–7 usually as long as the following segment or longer, simple or bifurcate.

Larva.—Hair on shaft of antennæ always short and simple, and usually on outer surface. Inner anterior clypeal hairs well separated, their distance apart at least equal to one-fourth of their length. Pleural hairs variable, one or both of the long hairs of the meso- and metathoracic groups often plumose. Leaflets of float-hairs usually with jagged edges and ending in a filament (occasionally elliptical, without shoulder or filament, as in subgenus *Anopheles*). Spiracular apparatus as in subgenus *Anopheles*.

Anopheles (Myzomyia) kochi Dönitz.

Insektenbörse, XVIII, 1901, 1.

Medium size, light coloured, very highly ornamented; abdominal scale-tufts conspicuous.

Labium (Fig. 8).—Golden in apical half or more, sometimes with a narrow dark band proximal to labella; the basal half dark, but with scattered golden scales, usually with golden patches, especially ventrally; some dark scales may occur in the pale apical area; at base, a tuft of scales ventrally. Antennæ with some minute pale scales on segment 2, and a tuft on 3.

Palpi (Fig. 8).—Segment 5 golden apically, the basal portion with a narrow dark band; segment 4 dark basally for about a fifth of its length, then golden for about another fifth, then white; 3 dark basally, then golden, white apically; 2 dark with some pale scales and a white band at apex.

Thorax.—Mesonotum with prominent “eye-spots” and frosty markings, covered with pale scales becoming broader in fossæ and along lateral margins. Anterior pronotum with a tuft of scales. Propleural setæ 2 or 3; spiracular setæ absent, but with one or two pale scales in this region; some scales associated with prealar, sternopleural and subalar groups.

Wings (Fig. 8).—Predominantly pale, the spots small, often dot-like; fringe mainly pale.

Legs.—Femora, tibiæ and first tarsus (except on leg I) speckled; tibiæ may be minutely pale apically; tarsi 1 to 4 pale at apex on all legs, very narrow on leg II, sometimes hardly perceptible on segment 4 of legs I and II; segments 3 to 5 of leg III (Fig. 8) with basal bands, the banding on this leg broad at joints 2/3, 3/4 and 4/5; apex of segment 5 on leg III pale. Coxæ with scales. Speckling sometimes extends to tarsus 2 on all legs.

Abdomen (Fig. 8).—Dorsum with golden scales on posterior border of segments II to VIII; venter with prominent tufts of



MAP 4.—DISTRIBUTION OF *ANOPHELES KOCHI*.

JAVA.

West Java : Westbantam, Sudbantam, Serang, Batavia, Tandjong Priok, Buitenzorg, Soekaboemi, Poentjak, Tjimahi, Bandoeng, Bandjar, Tjiheha-Ebene, Tji kadoe, Tegal Wangi, Kepetakan, Cheribon, Nord-Soemedang.

dark scales, submedianly towards the posterior border, of segments II to VII, some yellow scales on VIII; large, round pale spots sub-medianly on venter of segments III to VI or more. Cerci with scales.

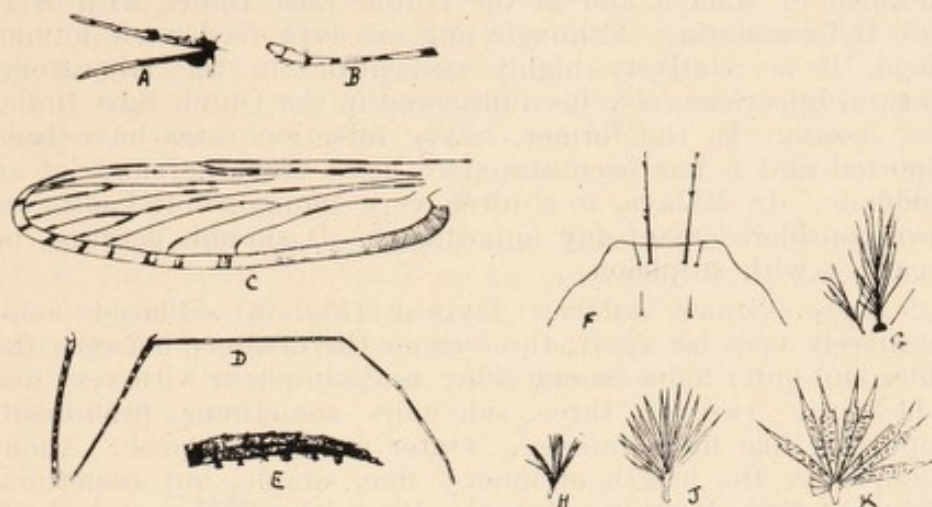


Fig. 8.—*A. kochi* Dönitz. A, labium and palp; B, palp; C, wing; D, hind leg; E, side view of abdomen. After Gater.

♂.—Labium with more extensive pale areas in proximal portion, sometimes appearing almost entirely pale from above; antennæ with some scales on segment 3; palpi as in Fig. 8, largely pale.

Terminalia.—Terminal seta on claspettes as long as or slightly longer than spatulate process, two or three shorter setæ placed internally and numerous accessory setæ. Phallosome short, stumpy, with about six leaflets on each side; two parabaasal spines separated somewhat from the other three of the group.

Notes.—An unmistakable species, very common near human habitations and frequently found in houses. It appears to bite

Middle Java: Tegal, Semarang, Magelang, Ambarawa, Tjilatjap, Noesa kambangan, Gombong, Solo.

East Java: Residenz Madioen, Modjowarno, Soerabaja, Sud-Leomadjang, Bondowoso, Insel Madoera.

SUMATRA.

Atjeh (Achin): Lho Seumawe, Lho Soekon, Meulaboh, Tapatoean, Lokop, Takengon, Kotatjane, Langsa.

East Sumatra: Deli-Ebene, Deli-Kuste, Kisaran, Laobalang, Moeara Tebo.

West Sumatra: Sidikalang, Sibolga, Silindoeng-Ebene, Pahahi-Ebene, Palang Sidempoean, Gross-Mandailing, Klein-Mandailing, Rao, Soendatar, Fort de Kock, Pajakombo, Padang pandjang, Fort v. d. Capellen, Angoli, Kajoetanam, Naras, Emmahaven, Angkola djoeloe, Moeara laboeh.

South Sumatra: Doerian, Martapoera, Moeara aman, Ketahoen-Ebene, Tjoeroep, Aer prioekan, Kepahiang, Lampongs.

BORNEO.

Singkawang, Sanggau, Sintang, Kendangan, Balikpapan, Moeara Tewe, Samarinda, Tenggarong, Tarakan, Tandjong Redeb.

CELEBES.

Paloe, Toli-Toli, Boeol, Menado, Posso, Kotamobagoe, Palpo, Watampone.

ISLANDS.

Nias, Poelau telo, Enggano, Simaloer, Riouw, Banks, Billiton, Batoe-Inseln, Bali, Lombok, Soembawa, Soemba, Flores, Poelau laoet, Soela-Inseln, Boeroe, Ambon, Ceram, Halmahera, Ternate, Aroe-Inseln (?).

man with some reluctance, not more than about 48 per cent. feeding on human blood when offered to starved specimens in captivity.

Relation to Malaria.—Experimental infections have been obtained in Malaya and in the Dutch East Indies with M.T. and B.T. malaria. Although not an avid feeder on human blood, it is relatively highly susceptible in the laboratory. Natural infections have been observed in the Dutch East Indies and Assam. In the former, heavy infection rates have been reported and it has been stated to have been the cause of an epidemic. In Malaya, it is often very common but has never been considered as of any importance. It should, perhaps, be regarded with suspicion.

Larva.—Inner anterior clypeal (Fig. 8).—Placed comparatively very far apart, three times the distance between the inner and outer hairs on one side; fine, simple or with very fine side-hairs; two or three side-hairs sometimes prominent, appearing like fine branches. Outer anterior clypeal: About one-quarter the length of inner; fine, simple, but sometimes forked at tip. Posterior clypeal: Placed far back, nearly halfway between frontal and anterior clypeal hairs; external to inner anterior but in line with, external, or internal to outer anterior. Sutural: Longer (sometimes two or three times) than posterior clypeal; simple or forked at tip. Trans-sutural: As long as sutural and in line with or slightly in advance of them; simple or with 2 or 3 branches distally. Antennal: On dorso-external surface, one-quarter to one-third the length of shaft from the base; fine, very short. Sub-median prothoracic (Fig. 8): Inner longer than outer; weak, with 7 to 10 branches or less; central with 11 to 15 branches and a fairly prominent root. Metathoracic palmate: Fairly well developed, with 9 to 12 lanceolate leaflets. Pleural: Prothoracic with 3 long simple, 1 short simple or bifid. Mesothoracic with 2 long, 1 short and 1 minute, all simple. Metathoracic with 2 long simple, 1 short with 2 or 3 branches, 1 minute simple. Abdominal palmate: I (Fig. 8) small, with narrow lanceolate leaflets or filamentous branches; II (Fig. 8) larger, with lanceolate leaflets or leaflets showing a few indentations; III to VI (Fig. 8) fully developed, the filament with broad base and very fine tip, the latter often broken off, giving the appearance of a blunt filament; pigmentation heavier proximally, the tips of leaflets clear.

Notes.—Antenna very lightly pigmented.

Habitat.—Drains, pools, swamps, miscellaneous, rice-fields, wells, "artificial", seepages, streams, ponds. Often found in small collections of muddy water in roads and near houses. In rice-fields it is found in the small, muddy pools after the water is drained off for harvest.

Anopheles (Myzomyia) leucosphyrus Dönitz.

Insektenbörse, XVIII, 1901, 37.

Medium size, highly ornamented, the hind tibio-tarsal joint conspicuously white.

Labium (Fig. 9).—Slightly longer than palpi, smooth distally, shaggy basally, especially ventrally, unornamented; antennæ with scales on segment 3.

Palpi (Fig. 9).—Rough, shaggy towards base; four narrow pale bands, apex pale; apical and subapical pale bands about equal, broader than preapical dark band, or these three bands may be equal; apices of segments 2 and 3 pale, the former sometimes with only a few pale scales.

Thorax.—Mesonotum dark with some frosty markings often showing "eye-spots" on fossæ; some narrow curved scales, more numerous on anterior half and laterally over wings. Anterior pronotum with a tuft of scales. Propleural setæ 2 or 3; spiracular setæ fine, small, 1 or 2. Halteres with conspicuous, pearly white scales.

Wings (Fig. 9).—Scaling on most veins broken into numerous short dark spots and pale areas, especially noticeable on *Cu* and its branches and on *An*, which has 5 to 7 dark spots; pattern very variable, differing on two wings of the same specimen; fringe spot usually present at termination of *Cu*₁ and often between *Cu*₂ and *An*.

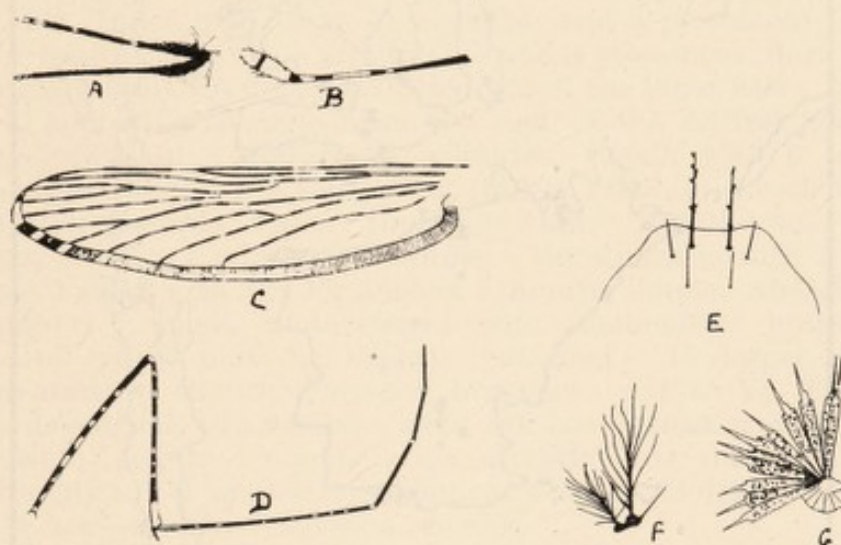


Fig. 9.—*A. leucosphyrus* Dönitz. A, ♀ labium and palp; B, ♂ palp; C, wing; D, hind leg; E, clypeal hairs; F, right sub-median prothoracic; G, part of abdominal palmate IV. After Gater.

Legs.—Femora, tibiae and tarsus 1 speckled on all legs, tarsus 2 on leg III in addition; tarsi 1 to 4 on all legs with apical pale bands; basal pale bands on segments 2 to 4 of leg I, forming broad bands at these joints; tips of fifth tarsus usually dark, more rarely pale; hind leg (Fig. 9) with a conspicuous broad pale cream or white band at the tibio-tarsal joint, involving about one-fifth of the length of tibia and basal portion of tarsus 1. Coxæ without scales.

Abdomen.—Without scales dorsally except on segment VIII, on which numerous golden scales occur; ventrally with a few scales on segment VI, a tuft of dark scales and a few pale scales on VII and some golden scales on VIII. Cerci with scales.

♂.—Similar to female, palpi as in Fig. 9; scaling on venter of abdomen absent.

Terminalia.—Claspettes with terminal seta as long as spatulate process; an internal, sub-terminal seta half as long; a minute seta situated proximally between the other two;



MAP 5.—DISTRIBUTION OF *ANOPHELES LEUCOSPHYRUS*.
H.=var. *hackeri*.

JAVA.

Westbantam, Tambaksari, Sud Malang.

SUMATRA.

Atjeh (*Achin*): Langsa, Takengon.

numerous accessory setæ on inner face. Phallosome with 7 or 8 leaflets on each side.

Notes.—Usually associated with jungle.

Relation to Malaria.—This species has been infected experimentally with B.T. malaria and has also been observed naturally infected in the Dutch East Indies. It is not generally considered, however, to be of much importance as a carrier.

Larva.—Inner anterior clypeal (Fig. 9): Placed far apart, simple or with a few fine side-hairs. Outer anterior clypeal: Placed rather far back, one-third to one-half the length of inner; simple. Posterior clypeal: Placed external to inner, internal to outer anterior clypeal hairs; fine, extending to bases of inner anterior hairs; simple, or bifid at the tip in some. Sutural: As long as posterior clypeal; simple or bifid distally. Trans-sutural: Slightly longer than sutural and slightly anterior to them; with 3 to 6 branches, occasionally simple or bifid. Antennal: On dorso-external surface, one-third the length of shaft from the base; minute, simple. Submedian prothoracic (Fig. 9): Inner with 13 to 21 branches and a prominent, dark root; central with 11 or 12 branches and a prominent, dark root which is usually confluent with the root of the inner hair; outer short, appearing to arise from the root of the central hair or very close to it. Methoracic palmate: Small, with 6 to 12 lanceolate leaflets on a fairly long stalk. Pleural: Prothoracic with 3 long simple, 1 short simple or bifid. Mesothoracic with 2 long, 1 short, 1 minute, all simple. Metathoracic with 2 long simple, 1 short with 2 or 3 branches, 1 minute, simple. Abdominal palmate: I small, undeveloped with filamentous branches, some of which may be slightly flattened; II larger, with filamentous or slightly flattened branches; III to VI (Fig. 9) fully developed, the filament with the base broad and the tip somewhat coarse; pigmentation slightly less distally than proximally; VII smaller, the filament not so well differentiated.

Notes.—Shaft of antenna slender.

Habitat.—Pools, swamps, miscellaneous, streams, "artificial", drains, ponds, wells. Water often stagnant; usually found under shade.

Anopheles (Myzomyia) punctulatus Dönitz.

Insektenbörse, XVIII, 1901, 372.

♀.—Head with apical half of proboscis creamy-white to yellowish with a brownish ring immediately before the base of the labella; palpi of female with a dorsal patch of pale scales

East Sumatra: Deli-Ebene, Deli-Kuste, Tandjong Balai, Kisaran, Moeara Tebo H.

West Sumatra: Gross-Mandailing, Soendatar, Kajoetanam, Sawah loento, Moeara laboeh, Angoli, Limau manis.

South Sumatra: Benkoelen, Moeara aman, Aerprioekan, Doerian, Lampongs.

BORNEO.

Sanggau, Balikpapan, Samarinda H., Tenggarong H., Tandjong Redeb, Tandjong Selor, Tandjong Palas, Tandjong Djoetar, Moeara Tewe, Ober-Mahakam, Sekajam, Tajan, Meliau, Tarakan, Sekadau, Nangatajap.

CELEBES.

Madjene H., Mamoedjoe H., Toradjagebiet H., Tolitoli H., Paleleh, Posso H.

ISLANDS.

Nias, Poelau laoet, Boeton, Sangihe H., Talaud.

toward the base of the second segment, apex with a narrow pale band, apical half of third segment pale with a discoloured spot subapically, rest dusky-brown with a small sub-basal pale spot, fourth segment with a narrow brownish-black band as also the fifth segment, remainder creamy-white.

Thorax: Scales on the anterior prothoracic lobes are sparse, those on the mesonotum appear to be narrower than in var. *moluccensis*.

Wings and legs are similar to those of var. *moluccensis*; tarsal V of fore leg may be dark, or there may be pale scales mixed with dark ones; the basal banding on III-IV of mid legs may be absent, tarsal III and sometimes IV of hind legs may also be spotted.

Abdomen similar to that of var. *moluccensis*, scales only on segments VII and VIII, coxites also covered with scales; all segments covered with pale hairs.

♂.—Head with palpi as figured. Terminalia as figured.

Larva.—Shoulder hair small, unpigmented, not on a "plate" as in var. *moluccensis* as in figure. Inner and outer anterior clypeal hairs not frayed, the outer about half the length of the inner; inner occipital hair not branched; leaflets of palmate bristles pigmented, smaller than in var. *moluccensis*, filament one-third the length of the blade, shoulder well marked.

Distribution.—As for var. *moluccensis*. Type localities were Bogadjim (Stephansort) near Madang and Kokopo (Herbertshoe) on Blanche Bay, New Britain.

Bionomics.—As for var. *moluccensis* and like it in feeding habits—both the typical form and the variety will feed at any time of the day, provided the sky is overcast.

Both are small, grey mosquitoes and do not attract much attention when feeding because their bite is not severe, neither do they make any noise. The typical form, like the variety, enters houses and remains there if undisturbed. It often happens that the typical form is less abundant than the variety *moluccensis*.

There are occasions when both the typical form and the variety appear to be present in almost negligible numbers and yet the malaria may be high. This is also accentuated by the fact that when larvæ are abundant the adults are not at their peak. It is after the larvæ have matured, pupated and the adults emerged when the peak period comes, approximately three to four weeks from the time when the larvæ are seen to be abundant. This is the period that marks the onset of malaria in a district.

Again there is a pre-wet season rise in malaria in New Guinea which subsides at the onset of the wet, remaining in this condition until the end of the wet season, when there is another definite rise, the post-wet season malaria rise, which, like the pre-wet season rise, may assume epidemic form if there be an influx of new arrivals such as takes place in wartime.

Relation to Disease.—Heydon in 1923 demonstrated that this mosquito and its variety were intermediary hosts of malaria, the former of M.T., and the latter of B.T., M.T., and possibly Quartan.

De Rook in 1924 proved that this species was a carrier of malaria in north New Guinea, finding a natural infection rate

of 1.5-5 per cent. in different months with an abundance of cysts in the stomach.

Many workers have since confirmed that this species and var. *moluccensis* are efficient intermediary hosts.

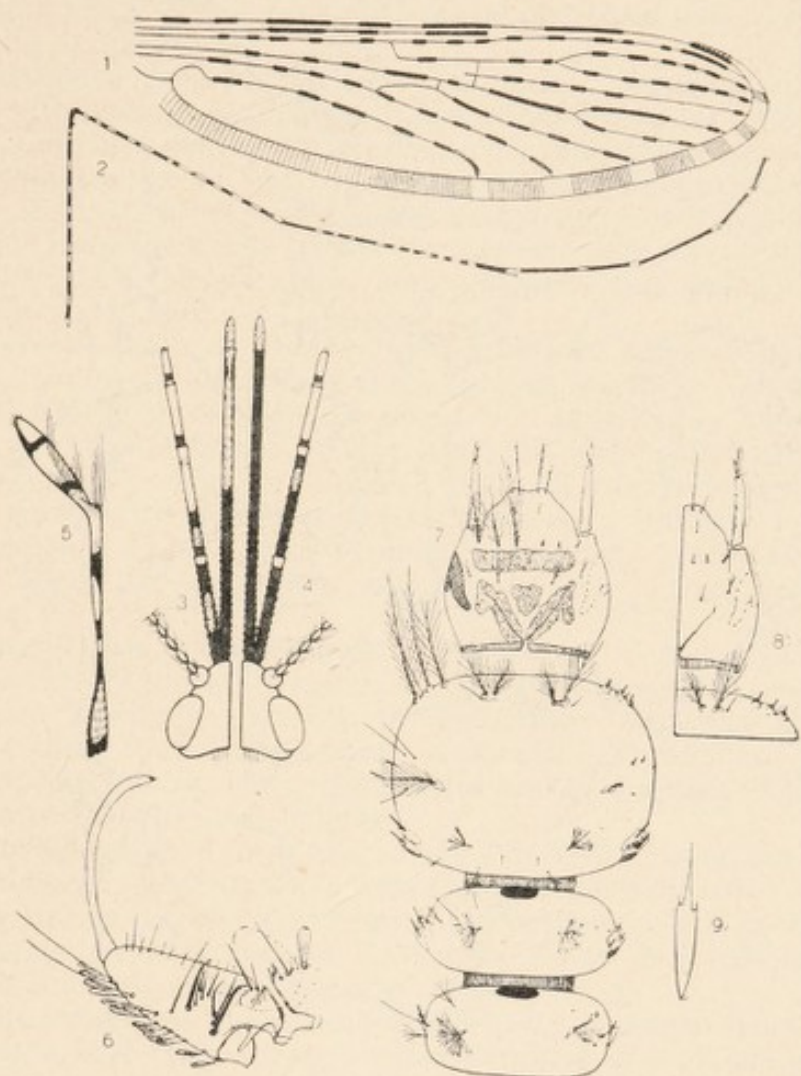


Fig. 10.—*A. punctulatus* Dönitz, also var. *moluccensis* Swell. and Sw. de Graaf. 1, wing; 2, hind leg; 3, ♀ head; 5, ♂ palp; 6, ♂ terminalia; 8, larva; 9, leaf of float hair. Var. *moluccensis*, 4, ♀ head; 7, larva. After Swellengrebel and Rodenwaldt.

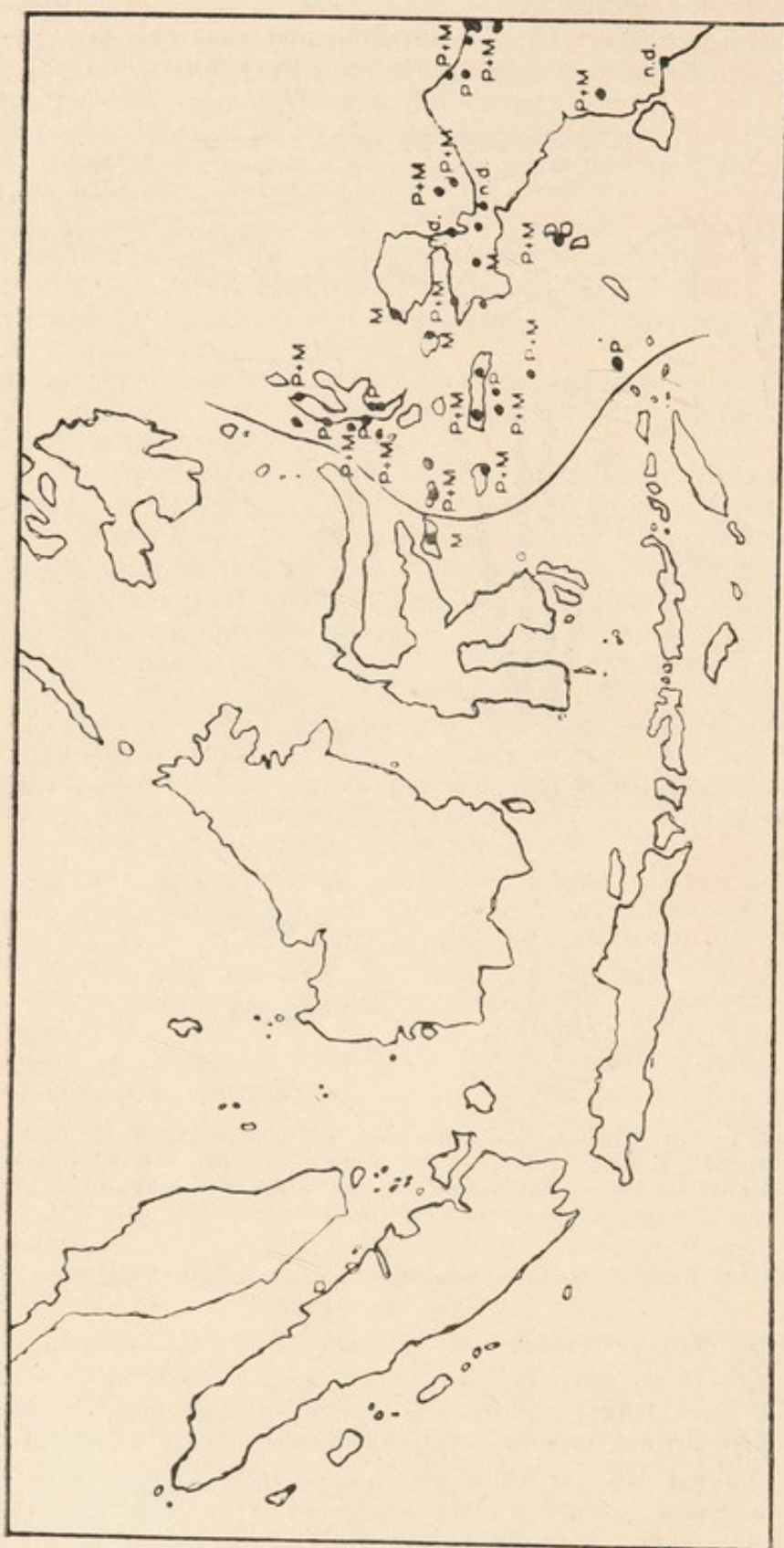
Anopheles (Myzomyia) punctulatus var. *moluccensis* Swell. and Swell. de Graaf.

Meded. Burger. Genesck. Dienst, Deel IX, 1919, Addenda 1.

♀.—Head covered with white scales, base of head with black ones; antennae brown, whorls of hair pale; proboscis blackish-brown, labella yellowish-brown; palpi as in figure.

Thorax with anterior prothoracic lobe covered with small black scales; scutum with scattered white semi-erect scales and pale hairs; scutellum with white semi-erect scales; a dark brown spot on either side of thorax about one-third the distance from the anterior margin, and a median one just behind the scutellum.

Wings as in figure.



MAP 6.—DISTRIBUTION OF *ANOPHELES PUNCTULATUS* AND VAR. *MOLUCCENSIS*.

P.=*punctulatus*. M.=*moluccensis*. n.d.=not differentiated.

Legs.—Dusky-brown, very distinctly spotted, the spots forming more or less complete rings; fore leg: femur, tibia and tarsus I spotted, apex of tarsus with broad apical band; tarsi II–IV with broad, pale base and apex; femur, tibia and first tarsal of mid leg with numerous pale bands, second tarsus with a median band, tarsi I–IV with apical and basal pale banding; hind leg is figured.

Abdomen dark brown, with pale hairs; segments six and seven with narrow, semi-erect, yellowish-golden scales; sternites seven and eight similar to tergites seven and eight; terminalia somewhat similar to var. *tessellatus* but between the parbasal spines there is rather coarse short hair instead of it being fine. Inwards from the apical hair of the harpago only one short hair, half the length of the apical one; between this and the club are two small hairs.

Larva.—Inner and outer anterior clypeal bristles distinctly frayed, the outer about half the length of the inner; posterior clypeal bristle inconspicuous, about one-quarter the length of the inner clypeal bristle. Outer occipital hair with four small branches, inner with two to three; mid and inner shoulder hairs dark, stout, with numerous lateral branches; palmate bristles on segments II–VII with leaflets pigmented, blade slightly longer than filament, latter tapering to a fine point, shoulder distinct.

Distribution.—Queensland: Townsville, Cairns, Charters Towers (K. J. Clinton), Hughenden, Mt. Isa, Mareeba, Atherton; Northern Territory: Darwin to Katherine. Probably also in the northern part of Western Australia. Throughout New Guinea, particularly along the coastal areas; Papua: Molucca Islands to the 170° east longitude.

The Queensland localities, except Charters Towers, are from specimens taken by myself. There is no doubt that this variety is very widely distributed in north Queensland. It is probably the commonest mosquito in Katherine, where it breeds in the lagoons and pot-holes along the river banks.

The female freely enters houses to feed; engorged specimens may often be found in considerable numbers in such situations during the daytime.

It will feed at any time of the day if the sky be overcast. I found at Keravat and Pondo in New Britain that it fed freely indoors from the mid afternoon until late at night.

Relation to Malaria.—An important intermediary host of B.T., M.T., and (?) Quartan.

It is also an efficient intermediary host of *Wuchereria bancrofti*.

NEW GUINEA.

Kokas M., Kaimana M., Fakfak P.+M., Albatrosbiwak P.+M., Meer-Ebene P.+M., Batavia Biwak P.+M., Motor Biwak P.+M., Pionier Biwak P., Prauw Biwak M., Manokwari n.d., Merauke n.d., Tanah merah (Digoel) P.+M., Idora P., Schouten-Insel P.+M., Sorong M., Hollandia P.+M., Hinterland der Geelvinkbai n.d.

OTHER ISLANDS.

Halmahera: Sidangoli P., Tobelo P.+M., Weda P.+M., Maidi P., Gita P., Batjan-Archipel P.+M., Poelau Salawati M., Misool M., Poleau Larat P.+M., Japen-Gruppe P.+M., Ceram (Piroe) P.+M., Ambon P.+M., Boeroe P.+M., Ternate P.+M., Aroe P.+M., Soela-Inseln P.+M., Banggai-Inseln M., Banda P.+M., Saparoea P., Damar P.

Bionomics.—Sunlit natural and artificial water, e.g. banks of rivers and creeks, with or without vegetation, drains, trenches, swamps, hoof prints of cattle and horses, puddle holes, and occasionally brackish water pools.

This mosquito follows man when he cuts down and clears away the scrub, thus admitting the sun to ground water which was previously unsuitable to it for lack of sunlight.

Anopheles (Myzomyia) tessellatus Theobald.

Mon. Culicida, I, 1901, 175.

Medium size, highly ornamented.

Labium (Fig. 11).—Golden in apical half with a dark spot proximal to labella, base dark, somewhat shaggy ventrally; antennæ with some scales on segments 2 and 3, sometimes on 4.

Palpi (Fig. 11).—Rough, somewhat shaggy at base; four white bands, three broad, one narrow; apical pale band narrower than sub-apical, which is about the same width or slightly narrower than the preceding pale band, the intervening black bands narrow, about the same width or narrower than the pale band at apex of segment 2; some pale scales on dorsum of segments 2 and 3.

Thorax.—Mesonotum dark with some frosty markings and a tendency to form "eye-spots"; some narrow pale scales along median line and laterally. Anterior pronotum with some scales. A single propleural seta, spiracular setæ absent.

Wings (Fig. 11).—Scaling on veins broken into a number of dot-like dark spots (as in *A. hackeri* and *A. leucosphyrus*) similar to *A. leucosphyrus* but with fringe-spots at terminations of Cu_2 and An ; very variable, differing on two wings of same specimen; An with at least four dark spots, usually more.

Legs.—Femora, tibiæ and tarsus 1 on all legs speckled; leg I with apical pale bands on tibia and tarsi 1 to 5, tarsi 2 to 4 with basal bands as well, forming broad bands at these joints; leg II with narrow apical bands on tarsi 1 to 3, bands at apex of 4 and 5 hardly perceptible; hind leg (Fig. 11) with the tibia minutely pale apically and narrow terminal bands on tarsi 1 to 4; tarsus 5 usually dark at apex, more rarely pale. Coxæ without scales.

Abdomen.—Without scales except on cerci.

♂.—Labium dark throughout its length; antennæ with a few dark scales on segment 3; wing not showing the marked spotting to the same extent, especially on An , which may have only two dark spots; palpi as in Fig. 11.

Terminalia.—Apical seta of claspette longer than spatulate process, two short setæ internally and numerous accessory setæ. Phallosome with about seven leaflets on each side.

Notes.—Often taken in human-bait traps; has been shown to feed on man.

Relation to Malaria.—Experimental infections have been obtained with M.T. malaria in Formosa and in the Dutch East Indies, where a natural infection was also observed. It is not considered to play any important part in transmission.

Larva.—Inner anterior clypeal (Fig. 11): Placed far apart but comparatively closer together than in *A. kochi*; short,

stout, with a few fine side-hairs or simple; occasionally the side-hairs are comparatively thick. Outer anterior clypeal: About one-quarter the length of inner anterior; fine, simple. Posterior clypeal: About the same length as outer anterior; placed far back, nearly half-way to bases of frontal hairs, in line with or slightly external to inner anterior; fine, simple. Sutural: Slightly longer than posterior clypeal; with 2 to 4 branches. Trans-sutural: As long as sutural and anterior to them, with 2 to 4 branches. Antennal: On dorso-external surface, one-quarter to one-third the length of shaft from the

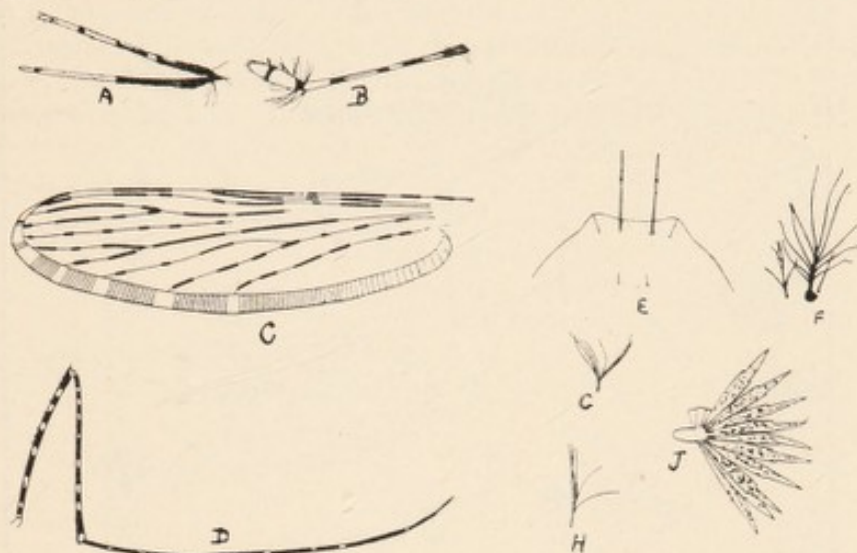


Fig. 11.—*A. tessellatus* Theobald. A, ♀ labium and palp; B, ♂ palp; C, wing; D, hind leg; E, clypeal hairs; F, right sub-median prothoracic; G, abdominal palmate I; H, abdominal palmate II; J, part of abdominal palmate IV. After Gater.

base; fine, very short, simple. Sub-median prothoracic (Fig. 11): Inner slightly longer than outer, very weak, with 2 to 5 branches; central with 6 to 13 branches and a fairly prominent root. Metathoracic palmate: Less developed than in *A. kochi*; with lanceolate leaflets, the tips fine. Pleural: Prothoracic with 3 long simple, 1 short simple or bifid. Mesothoracic with 2 long, 1 short and 1 minute, all simple. Metathoracic with 2 long simple, 1 short forked and 1 minute simple. Abdominal palmate: I (Fig. 11) small, with filamentous or slightly flattened branches, or very narrow, lanceolate leaflets; II (Fig. 11) slightly larger, with filamentous or flattened branches, or very narrow, lanceolate leaflets; III to VI (Fig. 11) fully developed, but the filament very poorly differentiated, very few indentations being present, some leaflets even lanceolate; pigmentation even; VII smaller, often only with lanceolate leaflets.

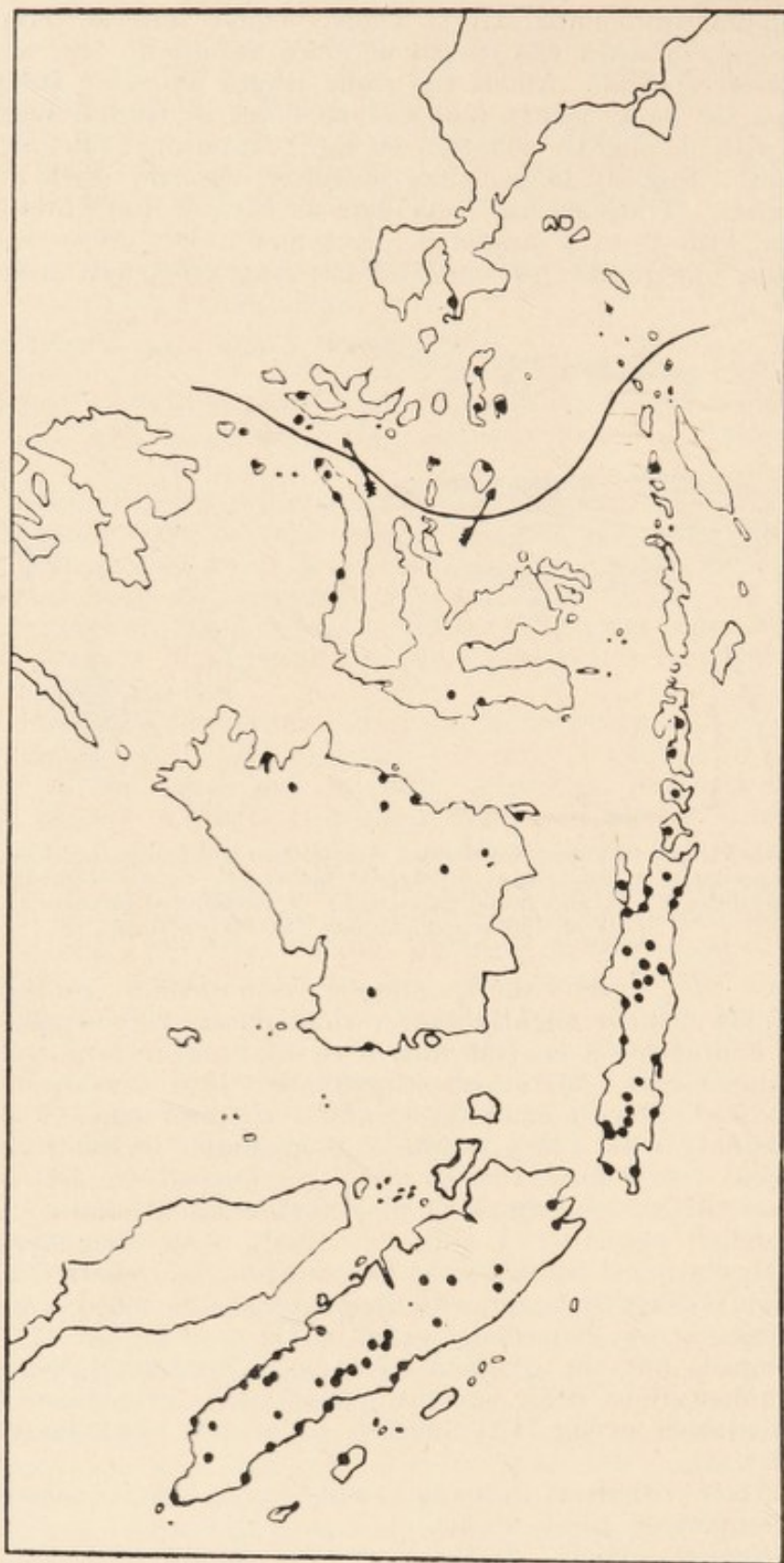
Notes.—Shaft of antenna usually fairly heavily pigmented (in comparison to *A. kochi*).

Habitat.—Pools, drains, swamps, ponds, miscellaneous, streams, rice-fields, "artificial". Under shade or in the open; often in dirty, stagnant water.

Anopheles (Myzomyia) aconitus Dönitz.

Zeitschr. f. Hyg. Infectiösk., XLI, 1902, 70.

Small; labium pale in apical half; legs dark.



MAP 7.—DISTRIBUTION OF *ANOPHELES TESSELATUS*.

JAVA.

West Java: Westbantam, Sudbantam, Batavia, Tandjong Priok, Buitenzorg, Soekaboemi, Sindangbarang, Tjiheha-Ebene, Bandoeng, Bandjar Tji kadoe, Tegal wangi, Kepetakan.

Middle Java: Tjilatjap, Tegal, Semarang, Magelang, Ambarawa, Solo.

Labium (Fig. 12).—Pale (golden) in apical half, dorsally as well as ventrally, sometimes with some dark scales, or a narrow dark ring, just proximal to labella; antennæ with one or two minute pale scales on segment 2, some larger scales on 3.

Palpi (Fig. 12).—Three pale bands, two broad one narrow, or two, one very broad and one narrow; segment 5 entirely pale, 4 entirely pale or with a narrow dark band centrally, 3 and 2 pale apically, 3 usually basally as well; apical pale band much broader than pre-apical dark band when present, the sub-apical pale band from half to as broad as the apical when a pre-apical dark band occurs.

Thorax.—Mesonotum with a paler median area and some narrow, hair-like scales. Anterior pronotum without scales. Propleural setæ 1 or 2; spiracular setæ 1 or absent, very small.

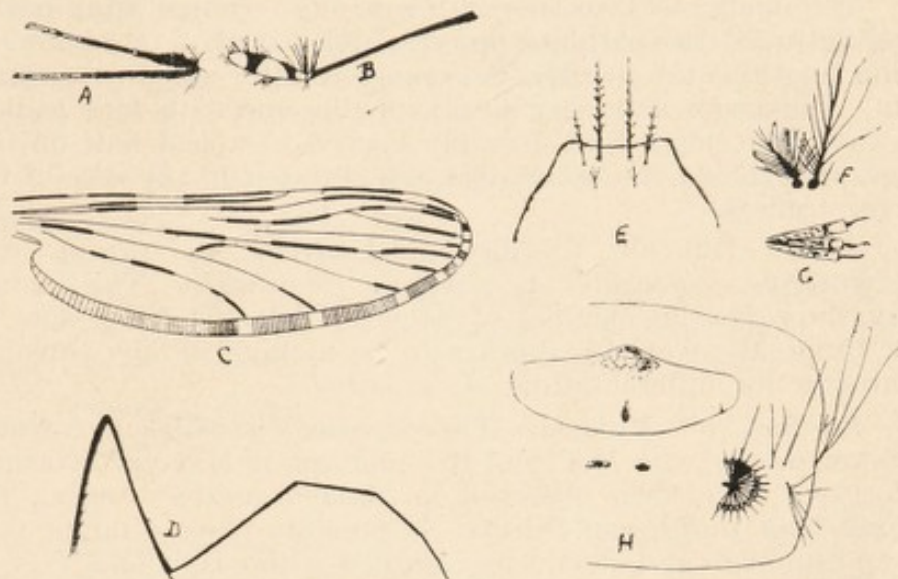


Fig. 12.—*A. aconitus* Dönitz. A, ♀ labium and palp; B, ♂ palp; C, wing; D, hind leg; E, clypeal hairs; F, right sub-median prothoracic; G, leaflets from abdominal palmate IV; H, showing tergal plates, hair No. 0 and hairs 1 to 6 and 8. After Gater.

East Java: Residenz Madioen, Djatirogo, Modjowarno, Soerabaja, Pasoeroean, Probolinggo, Sud-Loemadjang, Kali Rawaan, Bondowoso, Insel Madoera.

SUMATRA.

Atjeh (Achin): Kota Radja, Lho Seumawe, Lokop, Lho Soekon, Meulaboh, Belang Kedjeren, Kota Tjane, Takengon, Tapatoean, Singkel.

East Sumatra: Deli-Ebene, Deli-Kuste, Tandjong Morawa, Kisaran, Inland Djambi, Tandjong Balai, Moeara Tebo, Tandjong Poera.

West Sumatra: Sibolga, Sidikalang, Angkola djoeloe, Padang Sidempoean, Gross-Mandailing, Rao, Angoli, Soendatar, Pajakombo, Emmahaven, Kajoe tanam, Fort de Kock, Fort v. d. Capellen, Naras, Moeara laboeh.

South Sumatra: Moeara aman, Tjoeroep, Aer prioekan, Pager alam, Lampongs.

BORNEO.

Sanggau, Singkawang, Kendangan, Samarinda, Tenggarong, Boeloengan, Balikpapan, Moeara Tewe, Tandjong redeb.

CELEBES.

Polewali, Toradja-Gebiet, Boeol, Paleleh, Kotamobagoe, Menado, Sonder.

ISLANDS.

Nias, Krakatau, Bali, Lombok, Poelau laoet, Sangihe, Sanana, Boeroe, Ambon, Ceram, Ternate, Halmahera, Soembawa, Alor.

NEW GUINEA.

Fakfak ???

Wings (Fig. 12).—Fairly light ; pre-humeral, humeral and pre-sector dark spots on *C* often continuous, or the pre-sector pale area may be present ; *R*₁ usually pale from base to pre-sector dark spot, middle spot on *R*₁ distinctly shorter than on *C* ; *R*₄₊₅ mainly pale, a basal dark spot present or absent ; *An* usually with three, but sometimes with only two dark spots ; fringe pale at terminations of all veins, including *An*, at apex of wing extensively pale from *R*₁ to *R*₄₊₅, or broken up by dark areas. A variable wing.

Legs (Fig. 12).—Uniformly dark except for occasional minute pale areas at base of fore- and mid-femora and tibiae ; tarsi sometimes with a suggestion of banding, but indefinite.

Abdomen.—Entirely without scales.

♂.—Labium entirely dark ; palpi as in Fig. 12.

Terminalia.—Claspettes with a strong terminal seta, half as long again as the spatulate process, and a stout seta, about the same length as the process, between the latter and the terminal seta ; numerous accessory setae ; phallosome with four leaflets on each side, blade-like, strongly curved in apical half on one edge, straight on the other edge and serrated in the case of the larger leaflets.

Notes.—Difficult to distinguish from *A. varuna* and *A. minimus*, especially *A. minimus flavirostris*. The labium may show varying degrees of paleness, but the fringe-spot at the termination of *An* appears to be a more or less constant character for differentiating *A. aconitus*.

Relation to Malaria.—This species has been infected experimentally with M.T. and B.T. malaria in Malaya. Natural infections have been observed in Malaya (mid-gut only), the Dutch East Indies and Burma. It possibly plays a minor part in transmission and should be regarded with suspicion.

Larva.—Inner anterior clypeal (Fig. 12) : Placed far apart ; short, stout, with a few fine or prominent but short side-hairs, some of which may be bifid. Outer anterior clypeal : Half or more the length of inner ; stout, with a few prominent but short side-hairs, which are sometimes stout and spine-like. Posterior clypeal : Placed slightly external to inner anterior ; short, not extending to bases of inner anterior ; with 2 to 5 branches. Sutural : Longer than posterior clypeal, with 2 to 4 branches. Trans-sutural : As long as sutural and anterior to them ; with 3 to 7 branches. Antennal : On dorso-external surface, about one-fifth the length of shaft from the base ; very short, simple. Sub-median prothoracic (Fig. 12) : Inner stout, with 17 to 24 branches and a fairly prominent, dark root ; central stout, with 10 to 13 branches and a fairly prominent, dark root, which is sometimes confluent with the root of the inner hair. Metathoracic palmate : Fairly well developed, with 11 to 18 narrow, lanceolate leaflets, the points very fine and drawn out. Pleural : Prothoracic with 2 long simple, 1 long with 7 to 9 branches, 1 short with 2 or 3 branches. Mesothoracic with 2 long simple, 1 short forked, 1 minute simple. Metathoracic with 1 long simple, 1 long with 4 to 7 branches, 1 very short with 3 to 5 branches, 1 minute simple. Abdominal palmate : I fairly well developed, with lanceolate leaflets, or narrow leaflets with the filaments poorly differentiated in

comparison with those on posterior segments; pigmented; II to VII (Fig. 12) fully developed, the leaflets on II narrower than on succeeding segments; filament sharply differentiated, fine with narrow base, one-third to one-half the length of blade. The pigmentation is uneven, there being a clear cone-shaped area, below the filament, which is separated from the rest of the leaflet by a narrow band of darker pigmentation.

Notes.—Anterior tergal plates (Fig. 12) very large, the posterior border convex, involving the small posterior plate. Anteriorly there is an area of darker pigmentation and posteriorly, beyond the border of the plate, are two small oval plates. Hair "0" on abdominal segments II to VII prominent, simple or with 2 or 3 branches; it is situated either just outside the edge of the anterior plate or just within the posterior lateral borders (Fig. 12).

Habitat.—Rice-fields, streams, pools, drains, swamps, ponds, seepages, wells, miscellaneous, "artificial". Usually in the open, with a preference for clear, slowly flowing water.

Anopheles (Myzomyia) minimus Theobald.

Mon. Culicidæ, I, 1901, 186.

Small; lighter facies, legs dark.

Labium (Fig. 13).—Mostly dark; but often with a pale area ventrally in apical half; antennæ with one or two minute pale scales on segment 2, and some larger scales on 3.

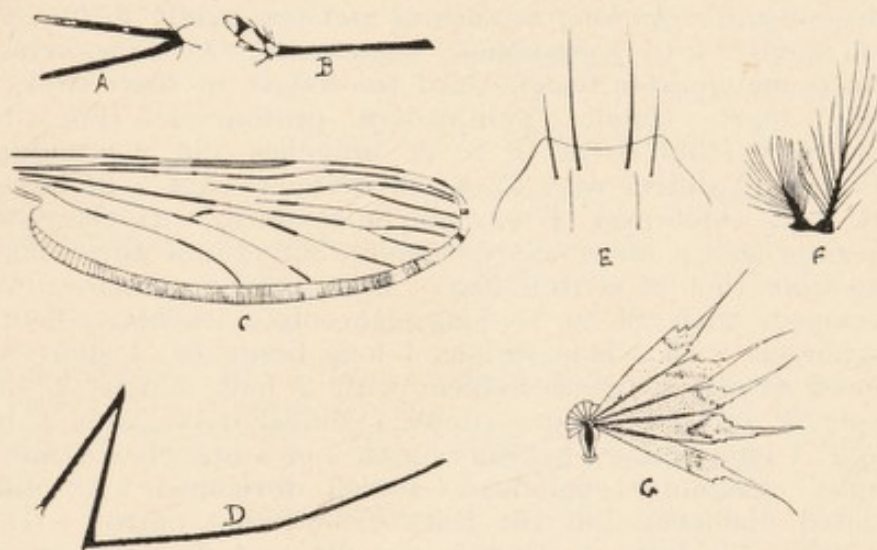


Fig. 13.—*A. minimus* Theobald. A, ♀ labium and palp; B, ♂ palp; C, wing; D, hind leg; E, clypeal hairs; F, right sub-median prothoracic; G, part of abdominal palmate IV. After Gater.

Palpi (Fig. 13).—Three pale bands, two fairly broad, one narrow; segment 5 entirely pale, 4 pale apically and basally, 3 and 2 pale apically; apical pale band, pre-apical dark band and sub-apical pale band all about equal in width. The pale bands variable in extent and apparently not to be taken as a reliable criterion for differentiating this species from *A. aconitus*.

Thorax.—Mesonotum with a paler median area and some narrow, hair-like scales. Anterior pronotum without scales. Propleural setæ 1 or 2; spiracular setæ 1 or absent, small.

Wings (Fig. 13).—Fairly dark ; pre-humeral and humeral dark spots on *C* continuous, but a minute pale area (pre-sector) separating dark base of *C* from pre-sector dark spot ; *R*₁ pale from base to pre-sector dark spot, middle dark spot shorter on *R*₁ than on *C* ; *R*₄₊₅ mainly pale with a dark spot at base ; *An* with two dark spots, the outer long ; fringe with a pale area from *R*₁ to *R*₂, and fringe-spots at terminations of most other veins except *An*.

Legs (Fig. 13).—Uniformly dark, coxæ without scales.

Abdomen.—Entirely without scales.

♂.—Palpi (Fig. 13) : With expanded portion mostly pale.

Terminalia.—Practically the same as in *A. fluviatilis*.

Notes.—Described by Gater from specimens kindly supplied by the Central Malaria Bureau (India) and Dr. Paul F. Russell (Philippine Islands). Recorded in India and the Philippines as a house-loving species, but this habit appears to be not so evident in French Cochin-China.

Relation to Malaria.—This species is regarded as a most important natural carrier wherever it occurs.

Larva.—Inner anterior clypeal (Fig. 13) : Placed far apart ; stout, simple. Outer anterior clypeal : Over half the length of inner ; stout, simple. Posterior clypeal : Placed in line with inner anterior, reaching as far as bases of anterior hairs ; simple. Sutural : As long as posterior clypeal ; with 4 to 7 branches. Trans-sutural : As long as sutural and practically in line with them ; with 4 to 7 branches. Antennal : On dorso-external surface, one-quarter to one-third the length of shaft from the base ; short, simple. Sub-median prothoracic (Fig. 13) : Inner very stout, with 19 to 26 branches and a prominent, dark root ; central with 12 to 18 branches and a prominent, dark root, which may or may not be confluent with the root of the inner hair ; outer short, slender, sometimes appearing to arise from root of central hair. Metathoracic palmate : Well developed, with 12 to 17 long, lanceolate leaflets. Pleural : Prothoracic with 2 long simple, 1 long branched, 1 short with 3 or 4 branches. Mesothoracic with 2 long simple, 1 short simple or bifid, 1 minute simple. Metathoracic with 1 long simple, 1 long branched, 1 short with 2 or 3 branches, 1 minute simple. Abdominal palmate : I well developed with differentiated filaments, but the leaflets somewhat narrow ; II to VII (Fig. 13) fully developed, the filament fine and sharply differentiated, but with a somewhat broad base, one-half to two-thirds the length of blade ; distal portion of leaflets clear, proximal portion pigmented, an area of deeper pigmentation between the two portions.

Notes.—Posterior to hair No. 1 on the mesothorax there is a small median brown plate, and a little posterior to this is a pair of similar plates. Tergal plates very large, posterior border rounded and including the posterior plate. A little posterior to the large plate is a pair of small, sub-median oval plates. Hair "0" prominent, arising a little behind the posterior border of the anterior tergal plates on each side, but not as large as in *A. fluviatilis*. Exceptionally it may just touch the edge of the plate on III and IV, but never arises directly from it.

It is simple or with 2 branches on II, with 2 branches on III to V, with 2 or 3 on VI and simple on VII.

Habitat.—Small pools at the edges of streams; grassy streams, springs, irrigation channels, rice-fields; usually in "clean" water.

Anopheles (Myzomyia) varuna Iyengar.

Ind. J. Med. Res., XII, 1924, 24.

The palps of the female have two broad white bands apically. The intervening black area is never broader than the middle white band, though it is often equal to it. The apical white band is somewhat smaller than the next white band. The base of the costa is uninterruptedly dark-scaled for one-third of its length. The small white basal spot of *A. minimus* is never found in this form. The third longitudinal vein has some black scaling apically and basally and the central white region varies from three-quarters to two-thirds of the length of the vein. The fifth vein is as in *A. listoni*; but its anterior branch has either only one white spot along its course near cross-vein *m-cu*, or with an additional spot.

The main differences between *minimus*, *varuna* and *listoni* are with regard to the bands on the female palpi, the basal costal black spot and the fifth vein. They may be summarized as follows:

	<i>A. minimus</i> Theo.	<i>A. varuna</i> Iyengar.	<i>A. listoni</i> Liston.
1. Apical bands of female palpi.	Broad.	Broad.	Narrow.
2. Basal $\frac{1}{3}$ rd of costa	Not continuously dark; interrupted by a small white spot.	Continuously dark.	Continuously dark.
3. Middle white area of the 3rd vein.	$\frac{1}{3}$ ths to $\frac{2}{3}$ ths of length of vein.	$\frac{1}{3}$ ths to $\frac{2}{3}$ ths.	$\frac{1}{3}$ ths to $\frac{2}{3}$ ths or even less.
4. Anterior branch of 5th vein.	Mostly white-scaled with three small black spots.	Black - scaled with one or two white spots.	Black with one small white spot.

Gater's description is also given with his illustrations, as it is fuller.

Small; very similar to *A. minimus*.

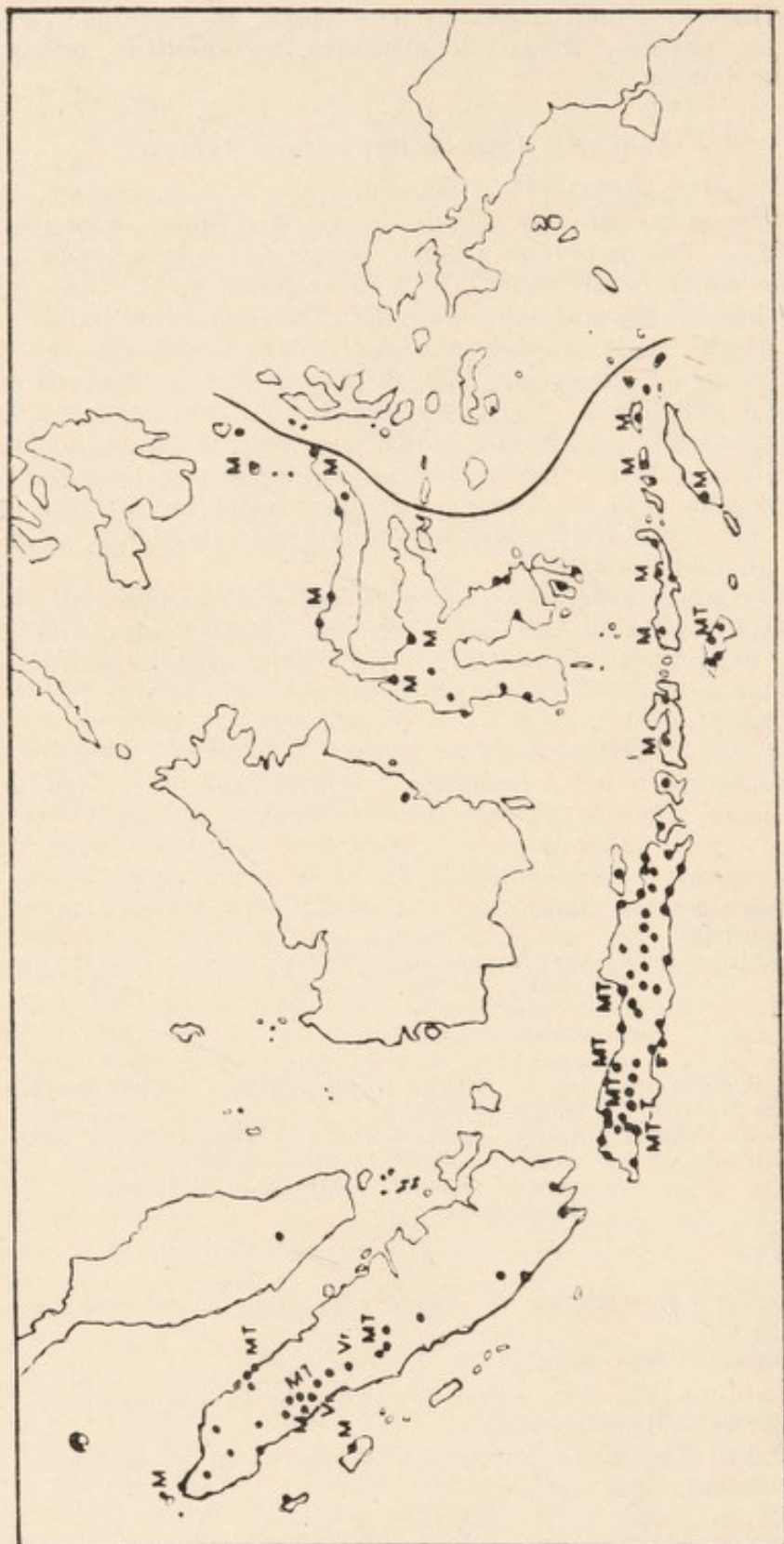
Labium (Fig. 14).—Pale to a varying extent in apical half, dorsally as well as ventrally.

Palpi (Fig. 14).—Three pale bands as in *A. minimus*, two fairly broad, one narrow.

Thorax.—As in *A. minimus*.

Wings (Fig. 14).—Similar to *A. minimus* but darker, more like *A. fluviatilis*, pre-humeral, humeral and presector dark spots continuous, no pale area before sector.

Legs.—Uniformly dark, coxæ without scales, as in *A. minimus*.



MAP 8.—DISTRIBUTION OF *ANOPHELES ACONITUS*,
A. MINIMUS AND *A. VARUNA*.

T.=*aconitus*. M.=*minimus*. Vr.=*varuna*.

Abdomen.—As in *A. minimus*.

♂.—Similar to *A. minimus* except for characters given. Palpi (Fig. 14) with smaller pale areas.

Terminalia.—Similar to those of *A. fluvialis*, but 4 or more leaflets on each side (Christophers).

Notes.—Liable to be mistaken for *A. aconitus*, especially when the labium is markedly pale.

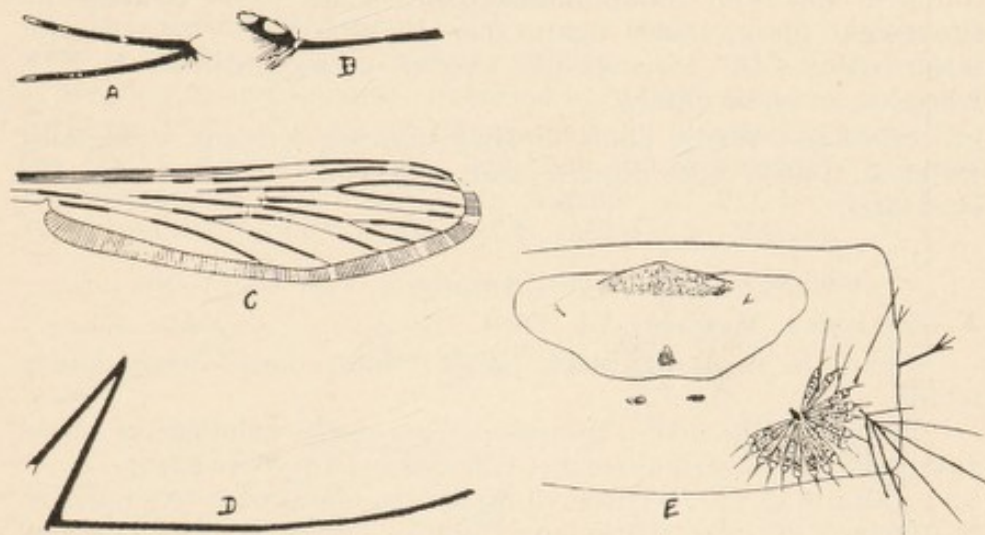


Fig. 14.—*A. varuna* Iyengar. A, ♀ labium and palp; B, ♂ palp; C, wing; D, hind leg; E, right-hand portion of abdominal segment V, showing tergal plates, hair No. 0, hairs 1 to 6 (6 cut off short), and 8. After Gater.

JAVA.

West Java: Westbantam, Sudbantam, Ostbantam, Tegal wangi, Tjikadoe, Serang, Batavia, Tandjong Priok, Buitenzorg, Soekaboemi, Wijnkoopsbai (T.M.), Djampang (T.M.), Tjiheha-Ebene (T.M.), Bandoeng, Soemadang, Nord-Soemedang (T.M.), Bandjar.

Middle Java: Tjilatjap, Noesa kambangan, Babakan, Gombong, Tegal, Batoer, Semarang (T.M.), Oengaran, Kedong Kebo, Willem I., Magelang, Solo.

East Java: Inland und Kuste der Residenz Madioen, Modjowarno, Modjokerto, Kediri, Djatirogo, Soerabaja, Malang, Tambaksari, Nordkuste von Ostjava langs Madoerastrasse, Sudkuste von ganz Ostjava, Sud-Loemadjang, Sitoebondo, Banjoewangi, Insel Madoera.

SUMATRA.

Atjeh (Achin): Kotaradja (T.M.), Lokop, Belang kedjeren, Bireuen, Seulimeum, Tapatoean, Kroengradja (M.), Takengon, Kotatjane, Seroewai.

East Sumatra: Kuste von Deli, Ebene von Deli, Kisaran (M.T.), Lao Balang (M.T.).

West Sumatra: Angkola djoeloe (T.M.), Padang Sidempoean (M.T.), Gross-Mandailing (M.T.), Moeara laboeh (T.M.), Batang toroe (Vr.), Loeboek Sikaping (T.M.Vr.), Soendatar (T.M.Vr.), Angoli (T.M.), Rao, Pahahi-Ebene, Kajoetanam, Sidikalang, Fort de Kock, Padang Pandjang, Fort v. d. Capellen (T.M.).

South Sumatra: Benkoelen, Ketahoen-Ebene, Moeara aman, Tjoeroep, Lampongs.

BORNEO.

Balikpapan.

CELEBES.

Makassar, Rapang, Madjene, Toradja-Gebiet, Mandar, Paloe (M.), Boeol (M.), Paleleh (M.), Menado, Posso (M.), Palopo- und Toma-Ebene, Kotamobagoe, Kolaka, Moeara-Bai, Kendari.

ISLANDS.

Sabang (M.), Simaloer, Nias (M.), Bali, Lombok, Soembawa, Flores (M.), Soemba (M.T.), Alor (M.), Wetar (M.), Pantar, Timor-Koepang (M.), Roma, Babar, Kisar, Sangihe (M.), Talisai (M.), Boeton, Moena.

Relation to Malaria.—This species has been found infected in nature and is possibly just as important a carrier as *A. minimus*, to which it is closely related.

Larva.—Closely resembles the larva of *A. minimus*, differing as follows: (1) Leaflets of metathoracic palmate hair longer (0.083 mm. as against 0.071 mm.) (2) Leaflets of abdominal palmate hairs larger. (3) The most important difference is found in hair 0 on abdominal segments II to VII. It arises on the tergal plate, much nearer the middle than the posterior border (Fig. 14). It is simple, except on segments IV to VII, where it may be bifid.

Habitat.—Wells, pools in slow-running streams; stagnant water in ponds and ditches and collections of water by the roadside.

Anopheles (Myzomyia) annularis Van der Wulp.

Notes Leyden Museum, VI, 1884, 249.

Small to medium, black facies; hind tarsi conspicuously white.

Labium (Fig. 15).—Unornamented, rather shaggy at base; antennae with scales on segment 2, and on 3 to 5 or more.

Palpi (Fig. 15).—Three white bands, one broad, two narrow. Segment 5 entirely white, apex of 4, 3 and 2 white; apical white band three-quarters to as wide as pre-apical black band. Shaggy.

Thorax.—Mesonotum dark, without pale median area, covered with short, broad pale scales extending to fossae. Anterior pronotum usually with one or two scales. Propleural setae absent; spiracular setae 2 or 3; one or more pale scales associated with pre-alar and sternopleural groups, but not forming clusters.

Wings (Fig. 15).—Predominantly dark; pre-humeral dark accessory spot long, undivided, narrowly separated from the broad humeral dark spot; all veins mainly dark, with narrow pale areas; *Sc* pale area not involving *R*₁, or only partly; *Cu* and *Cu*₂ mainly dark, dark at origin of *Cu*₁.

Legs.—Femora and tibiae pale on inner face, both minutely pale apically; hind-leg (Fig. 15) with a distinct white band at apex of tarsus 1; tarsus 2 white apically for about one-quarter of its length; 3 to 5 entirely white; a pale patch on femur, similar to leg II, may occur; leg I with fairly broad terminal white bands on tarsi 1 to 3. Leg II with a prominent white patch near apex of femur and fairly broad white terminal bands on tarsi 1 and 2. Coxae with some pale scales.

Abdomen.—Some dark scales on posterior and lateral regions of segments VI or VII to VIII dorsally; some pale scales on lateral regions of same segments ventrally, rather more numerous than on dorsum. Cerci with prominent scales.

♂.—Palpi (Fig. 15): Mainly dark except for white areas on expanded portion; a few pale scales, sometimes extensive, on dorsum of segments 2 and 3.

Terminalia.—Claspettes with a stout apical seta, not much longer than spatulate process; a fine, short seta between apical seta and process; two similar setae internal to apical. Leaflets 4 or 5 on each side, long; largest fairly strongly convex on

one edge, straight on the other, the others less convex ; serrations on straight edge of all leaflets for nearly their whole length. Coxites with scales.

Notes.—This species should not be confused with *A. philippinensis* or *A. pallidus*, especially on the character of veins *Cu* and *Cu*₂. In India it is stated to be mainly a cattle-feeder, but is also found in houses. Walch has stated that it feeds readily on man in the Netherlands Indies.

Relation to Malaria.—Owing to the confusion of this species with *A. philippinensis* and *A. pallidus*, the earlier records of experimental and natural infections in Malaya must be accepted with caution. It has been experimentally infected in India and the Dutch East Indies, and has been found naturally infected in these countries as well as in Burma. It has recently been experimentally infected with M.T. malaria in Malaya.

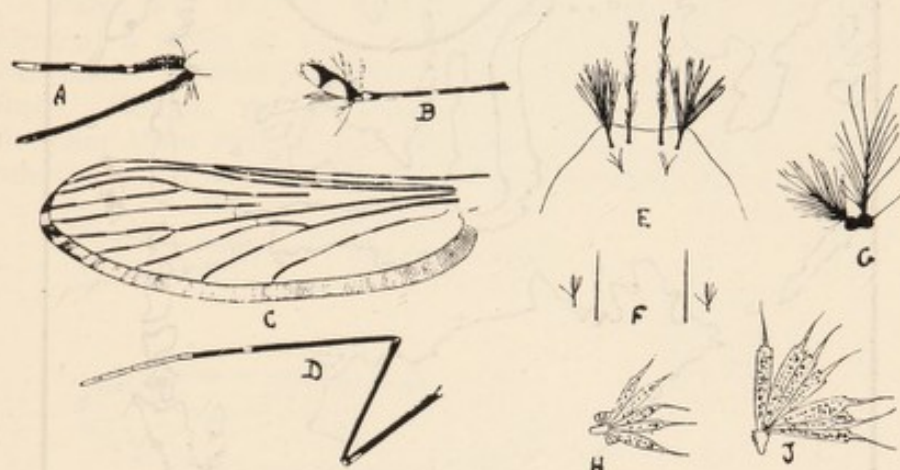


Fig. 15.—*A. annularis* v. d. Wulp. A, ♀ labium and palp ; B, ♂ palp ; C, wing ; D, hind leg ; E, clypeal hairs ; F, sutural and trans-sutural hairs ; G, right sub-median prothoracic ; H, part of abdominal palmate I ; J, part of abdominal palmate IV. After Gater.

Larva.—Inner anterior clypeal (Fig. 15) : Placed far apart ; stout, with numerous long, conspicuous side-hairs. Outer anterior clypeal : Two-thirds to three-quarters the length of inner ; with 12 to 27 long, thin branches, giving the hair the appearance of a brush ; the main stem may be divided. Posterior clypeal : Placed external to inner anterior ; short, not reaching the bases of the latter ; with 2 to 5 branches or simple. Sutural (Fig. 15) : Longer than posterior clypeal, almost reaching the bases of frontal hairs ; simple or bifid at tip. Trans-sutural : Shorter than sutural and slightly anterior to them ; with 3 to 5 branches. Antennal : On dorso-external surface, one-third the length of shaft from the base ; small, simple, but occasionally bifid at the tip. Sub-median prothoracic (Fig. 15) : Inner stout, with 12 to 21 closely set branches and a prominent, dark root ; central stout, with 10 to 15 branches and a prominent, dark root, which is confluent with the root of the inner hair ; outer sometimes apparently arising from the root of the central hair. Metathoracic palmate : Fairly well developed with 6 to 12 lanceolate leaflets, the tips fine. Pleural : Prothoracic with 2 long simple, 1 long branched and 1 short with 2 or 3 branches. Mesothoracic with 1 long simple, 1 long branched, 1 short simple



MAP 9.—DISTRIBUTION OF *ANOPHELES ANNULARIS*.

JAVA.

West Java: Westbantam, Ostbantam, Sudbantam, Tegal wangi, Tjikadoe, Serang, Batavia, Tandjong Priok, Buitenzorg, Soekaboemi, Tjiheha-Ebene, Cheribon, Kepetakan, Nord-Soemedang, Bandjar.

Middle Java: Tjilatjap, Noesa kambangan, Babakan, Gombong, Semarang, Ambarawa, Magelang, Tegal, Solo.

or forked and 1 minute simple. Metathoracic with 2 long branched, stout; 1 very short with 2 to 4 branches and 1 minute simple. Abdominal palmate: I (Fig. 15) small, the filament usually partially differentiated, but sometimes with lanceolate leaflets; II to VII (Fig. 15) fully developed, the filament fine, nearly three-fifths the length of blade, with the base fairly broad; pigmentation even or slightly deeper distally.

Habitat.—See remarks under *A. philippinensis*.

Anopheles (Myzomyia) karwari James, in Theobald.

Mon. Culicidæ, III, 1903, 102.

Small to medium, ornamented; hind tarsi tipped with white.

Labium (Fig. 16).—Unornamented, rather shaggy at base; antennæ with scales on 2 and 3.

Palpi (Fig. 16).—Four white bands, two broad, two narrow. Segment 5 white at base and apex, with a narrow black band near base; 4 white distally, black at base; apex of 3 and 2 white. Rough, rather shaggy at base. Apical white band narrower than sub-apical; pre-apical dark band very narrow, sometimes partially obscured by overhanging white scales.

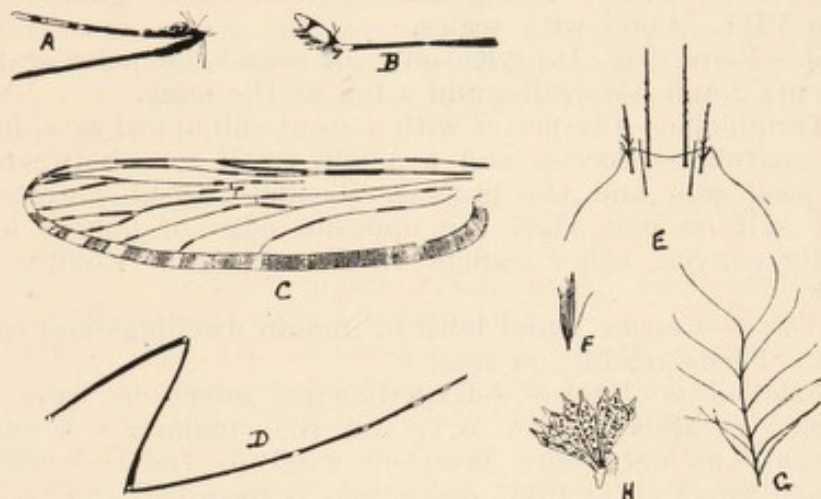


Fig. 16.—*A. karwari* James. A, ♀ labium and palp; B, ♂ palp; C, wing; D, hind leg; E, clypeal hairs; F, metathoracic palmate; G, lateral hair (No. 6) on segment V; H, part of abdominal palmate IV. After Gater.

East Java: Residenz Madioen Inland und Kuste, Modjowarjno, Toeban, Soerabaja, Sud-Loemadjang, Insel Madoera: Bangkalan.

SUMATRA.

Atjeh (Achin): Kotaradja, Lho Seumawe, Tapatoean, Sigli, Belang kedjeren, Seulimeum, Lokop.

East Sumatra: Kisaran, Moeara Tebo, Laobalang.

West Sumatra: Sidikalang, Sibolga, Padang Sidempoean, Gross-Mandailing, Klein-Mandailing, Rao, Soendatar, Loeboek Sikaping, Fort de Kock, Pajakombo, Fort v. d. Capellen, Singkarak, Sawah Loento, Solok, Angoli, Angkola djoeloe, Moeara laboeh, Limau manis, Kajoetanam, Naras, Padang, Emmahaven, Sandaran agoeng, Padang Pandjang.

South Sumatra: Pager alam, Tjoeroep, Benkoelen, Doerian, Ketahoen-Ebene, Lampongs.

BORNEO.

Tajan (Bv. Kapoeas).

ISLANDS.

Nias, Banka, Bali, Soemba, Roti, Timor.

Thorax.—Mesonotum without pale median area, covered with fairly broad scales extending into fossæ; an "eye-spot" sometimes visible anteriorly at sides of median line. Anterior pronotum usually without scales, sometimes with a single scale. Propleural setæ absent; spiracular setæ 2 to 4; an occasional scale associated with pre-alar and lower sternopleural groups.

Wings (Fig. 16).—Predominantly pale, pattern generally as in figure but somewhat variable; inner and outer pre-humeral dark accessory spots undivided; R_1 pale at base; An with two dark spots, the distal spot long; fringe spots usually at terminations of all veins, but that at termination of An may be absent; a fringe-spot between Cu_2 and An .

Legs.—Dark with white bands, femora and tibiæ minutely pale apically, femora pale ventrally in varying degrees. Hind leg (Fig. 16) with apex of tarsi 1, 2 and 3 white in increasing widths; tarsus 4 white with a central black band; 5 entirely white. Leg I with fairly broad apical white bands on tarsi 1 to 3; II with narrow white bands at apex of tarsi 1 and 2. A white area on outer face of base of tibiæ II and III. Coxæ with a few scales or bare.

Abdomen.—Scaling on dorsum restricted to a few on VII and VIII; ventrally a few scattered scales on segments V or VI to VIII. Cerci with scales.

♂.—Palpi (Fig. 16) with only an occasional paler scale on segments 2 and 3 dorsally, and a few at the joint.

Terminalia.—Claspettes with a stout sub-apical seta, longer than spatulate process, and a single small seta between the sub-apical seta and the process. Leaflets broad, serrated in distal half on one edge, the opposite edge of largest leaflet broadly convex, other leaflets more lanceolate. Coxites with scales.

Notes.—Can be found both in human dwellings and cattle-sheds. Feeds readily on man.

Relation to Malaria.—Experimental infections have been obtained in Malaya with M.T. and B.T. malaria. A natural infection has only once been observed in India, when one stomach infection in 1,697 dissections is recorded, and twice in Malaya (one stomach infection in 1,216 and two glands in 2,217 dissections). It is at present doubtful if it plays an important part in transmission.

Larva.—Inner anterior clypeal (Fig. 16): Placed far apart, with a few or numerous short, fine side-hairs, which are always clearly visible. Outer anterior clypeal: Half or more than half the length of inner; with 3 to 10 short side-hairs, which are rather more conspicuous than those on the inner anterior. Posterior clypeal: Placed in line with, or slightly external to inner anterior; reaching the bases of the latter or well beyond; simple, occasionally forked on one side. Sutural: As long as posterior clypeal; simple or with 2 or 3 branches arising about half-way or more from the base. Trans-sutural: Shorter than sutural and anterior to them; with 3 to 7 branches. Antennæ: On dorso-external surface, one-quarter to two-fifths the length of shaft from the base; short but fairly prominent, simple. Sub-median prothoracic: Inner with 18 to 33 branches and a prominent, dark root; central with 18 to 29 branches, the main stem sometimes divided, and a prominent, dark root. Meta-

thoracic palmate (Fig. 16): Undeveloped, with 3 to 10 filamentous branches; never with lanceolate leaflets. Pleural: Prothoracic with 2 long simple, 1 long branched, 1 short with 3 to 7 branches. Mesothoracic with 1 long simple, 1 long branched, 1 short with 2 to 4 branches, 1 minute simple. Metathoracic with 2 long branched, 1 short with 3 to 6 branches, 1 minute simple. Abdominal palmate: I undeveloped with filamentous or slightly flattened branches, never with narrow lanceolate leaflets; II small, with 8 to 16 lanceolate leaflets; III to VII (Fig. 16) fully developed, the filament fairly well differentiated, one-fifth to one-quarter the length of blade, bluntly pointed with a fairly broad base; pigmentation even or somewhat irregularly distributed, especially distally.

Notes.—Lateral hair on segment V (Fig. 16) with 6 to 14 branches, on VI with 7 to 16 branches. Hair No. 5 on abdominal segment II with 6 to 10 branches. These characters, together with the invariable absence of lanceolate leaflets on the metathoracic palmate hairs, can be relied upon to distinguish this species from *A. maculatus*. In the latter, slightly damaged filaments on the abdominal palmate hairs may give the appearance of those found in *A. karwari*.

Habitat.—Pools, drains, swamps, seepages, streams, miscellaneous, ponds, rice-fields, wells. Usually found in grassy pools in the open and more commonly in hilly than in flat country. Frequently associated with *A. maculatus* in the same breeding-place.

Anopheles (Myzomyia) maculatus Theobald.

Mon. Culicidae, I, 1901, 171.

Small to medium, highly ornamented; legs conspicuous, speckled, hind tarsi tipped with white.

Labium (Fig. 17).—Unornamented, rather shaggy at base; antennae with scales on segments 2 and 3 and 4 or 5.

Palpi (Fig. 17).—Three white bands, two broad, one narrow. Segment 5 entirely white, 4 mainly so with a narrow black band centrally, 3 and 2 white apically; apical white band rather broader than sub-apical, pre-apical black band narrower than

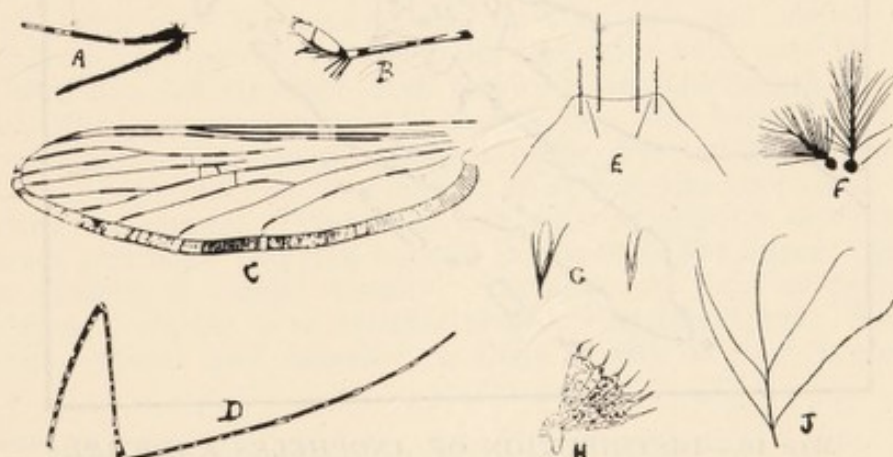
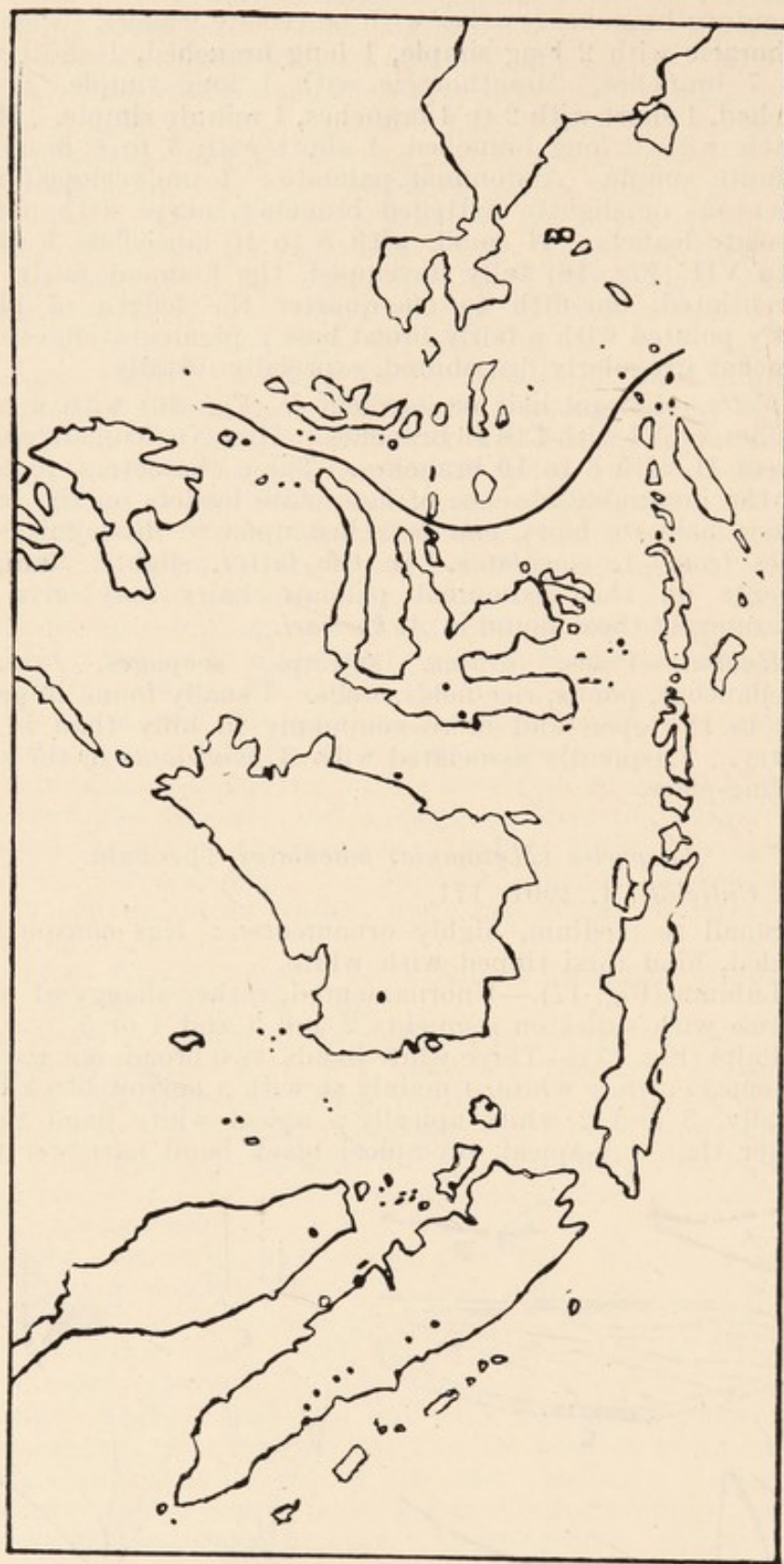


Fig. 17.—*A. maculatus* Theobald. A, ♀ labium and palp; B, ♂ palp; C, wing; D, hind leg; E, clypeal hairs; F, right sub-median prothoracic; G, two forms of metathoracic palmate hair; H, part of abdominal palmate IV; J, lateral hair (No. 6) on segment V. After Gater.



MAP 10.—DISTRIBUTION OF *ANOPHELES KARWARI*.

SUMATRA.

West Sumatra : Sibolga, Padang Sidempoean, Gross-Mandailing, Loeboek Sikaping, Soendatar, Naras, Kajoe tanam, Angoli, Moeara laboeh, Aer prioekan.

either. Rough, shaggy at base; sometimes some scattered pale scales on dorsal surfaces of segments 2 and 3.

Thorax.—Mesonotum with very slightly paler median area, covered with rather broad pale scales narrowing along centre and anteriorly; scales extending into fossæ and somewhat thicker along lateral areas. Anterior pronotum with a scale or two. Propleural setæ absent; spiracular setæ 4 to 6; pale scales associated with pre-alar and sternopleural groups.

Wings (Fig. 17).—Predominantly pale, pattern generally as in figure but variable; inner and outer pre-humeral dark accessory spots separate or only partly joined; R_1 pale at base; An with three, sometimes two, dark spots, the distal spot short; fringe-spots at termination of all veins.

Legs.—Femora and tibiæ speckled, speckling extended to tarsus 1 or 2. Hind leg (Fig. 17) with pale stripe on inner face of femur which is minutely white apically; tibia minutely white apically; tarsi 1 and 2 white apically, 3 and 4 white basally and apically, 5 entirely white. Leg I with white spots on tarsus 1 and fairly broad white bands at all joints except 4/5; II with pale stripe on inner face of femur, and apical white bands on tarsi 1 to 3. Coxæ II and III with scales.

Abdomen.—Scaling on dorsum very variable; scales may be confined to segment VIII only, or extend from II to VIII, increasing in numbers from before backwards, the latter fairly common, as is also scaling from IV to VIII. Ventrally, some scattered scales usually present posteriorly from V to VIII or less; laterally some scales at posterior angles, sometimes forming tufts on VIII, more rarely on VII as well. Cerci with numerous scales.

♂.—Palpi (Fig. 17) mostly white, usually with pale stripes along dorsal surface of segments 2 and 3. Abdomen with fairly heavy scaling on ventral surface (rotated) of segment VIII. Coxites with numerous scales.

Terminalia.—Claspettes with an apical seta longer than spatulate process; two short sub-apical setæ internal to apical. Leaflets broad, broadly convex in apical half on one edge, a few serrations in apical half on the opposite, concave edge.

Larva.—Inner anterior clypeal (Fig. 17): Placed far apart; stout, with short side-hairs on the distal two-thirds. The side-hairs may be conspicuous, or very fine and visible only under a high power; occasionally some side-hairs may be bifid. Outer anterior clypeal: Half to two-thirds the length of inner anterior; stout, with side-hairs. The side-hairs are more conspicuous than on the inner anterior, but not so numerous; sometimes stout and long enough to appear like short branches. Posterior clypeal: Placed in line with or slightly external to inner anterior; reaching beyond the bases of the latter; simple or sometimes forked distally. Sutural: As long as posterior clypeal; simple or sometimes forked. Trans-sutural: Shorter than sutural and anterior to them; with 2 to 5 branches.

BORNEO.

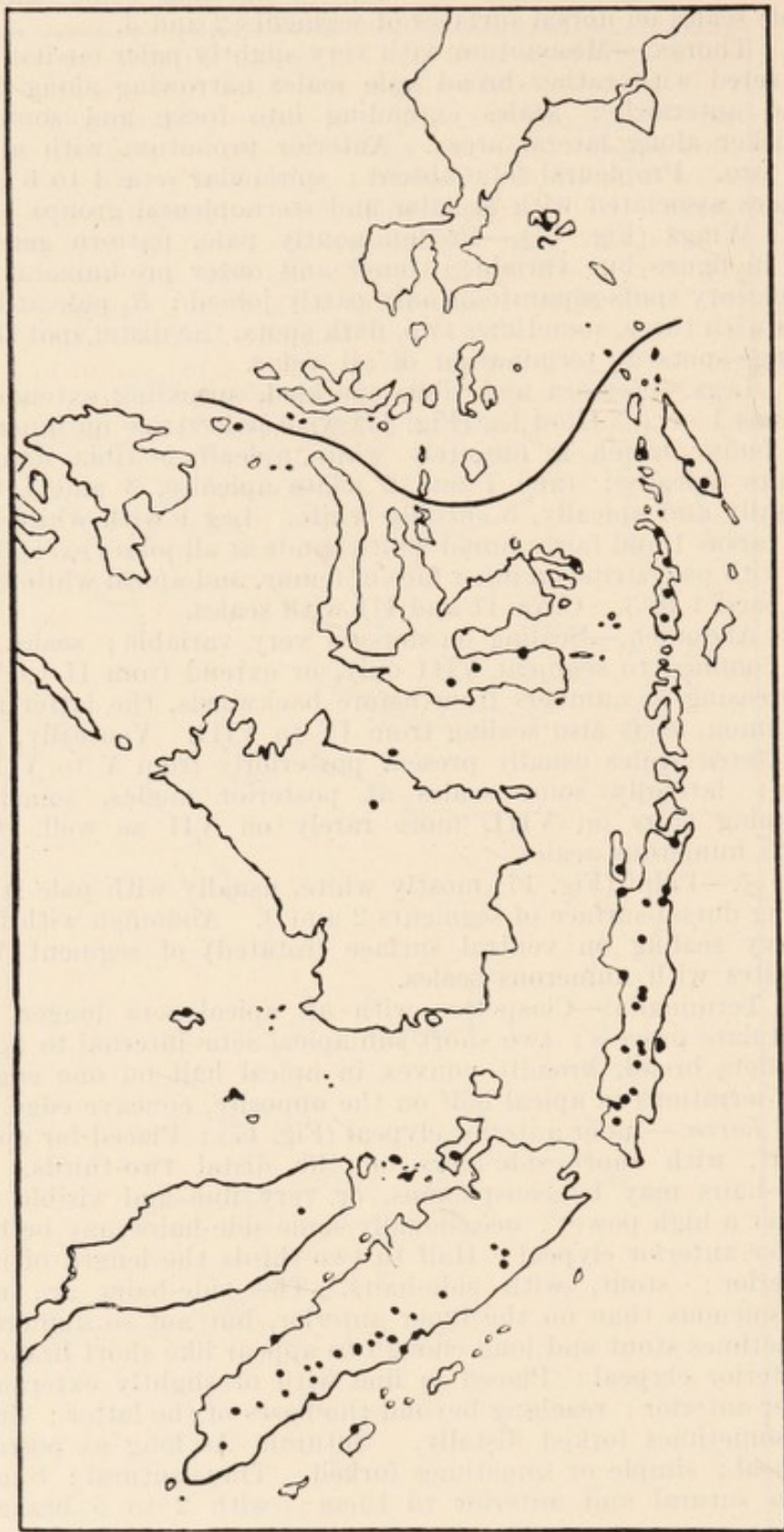
Meliau.

CELEBES.

Madjene, Mandar, Toradja-Lander.

ISLANDS.

Riouw, Banka, Billiton.



MAP 11.—DISTRIBUTION OF *ANOPHELES MACULATUS*.

JAVA.

West Java: Ostbantam, Tjikadoe, Soekaboemi, Djampang-Gegeng, Buitenzorg, Poentjak, Tasikmalaja, Nord-Soemedang, Sud-Soemedang, Bandjar.

Antennal: On dorso-external surface, one-quarter to two-fifths the length of shaft from the base; short but prominent, simple. Sub-median prothoracic (Fig. 17): Inner stout, with 18 to 25 closely set branches and a prominent, dark root; central stout, with 14 to 24 branches and a prominent, dark root; outer sometimes appearing to arise from the root of the central hair. Metathoracic palmate: Variable, even on the two sides of the same larva. Undeveloped, with 2 to 6 filamentous branches (Fig. 17), or with some of the branches slightly flattened; or partially developed, with 1 to 4 narrow, lanceolate leaflets (Fig. 17). Pleural: Prothoracic with 2 long simple, 1 long branched, 1 short with 3 to 5 branches. Mesothoracic with 1 long simple, 1 long sparsely branched, 1 short simple or forked at tip, 1 minute simple. Metathoracic with 2 long sparsely branched, 1 short with 2 to 5 branches at the tip, 1 minute simple. Abdominal palmate: I small, the leaflets filamentous, slightly flattened, or very narrow lanceolate; II small, with 6 to 18 leaflets, lanceolate or with poorly differentiated filaments; III to VII (Fig. 17) fully developed, the pigmentation of the leaflets tending to be patchy, but heavier at the distal end; filament well differentiated, one-third to two-thirds the length of blade, sharply pointed, the base narrow or moderately broad.

Notes.—Lateral hairs on segments V and VI (Fig. 17) with 3 to 6 branches. Hair No. 5 on abdominal segment II with 4 to 6 branches. The tips of the filaments of the palmate hairs are easily broken off, giving the filaments a blunt appearance.

Habitat.—Drains, pools, streams, swamps, seepages, miscellaneous, ponds, wells, "artificial". Typical of cleared hill jungle, but usually under very light shade. Those found in ponds and swamps were probably at the edges, where fresh water was flowing in. Although normally a pure water breeder, in the absence of its preferred breeding places it can adapt itself to a large number of other types of water.

Notes.—*A. maculatus dravidicus* Christophers has scaling on the dorsum of the abdomen extending over several segments; it is now considered merely as a variant of the typical form. *A. maculatus* is a shy species, usually difficult to find in buildings in Malaya, although apparently often taken in them elsewhere;

Middle Java: Batoer, Wonosobo, Bandjarnegara, Noesa kambangan, Semarang, Banjoe biroe.

East Java: Residenz Madioen, Soerabaja, Malang, Sud-Malang, Kali Rawaan, Sud-Banjoewangi, Insel Madoera.

SUMATRA.

Atjeh (Achin): Takengon, Belang kedjeren.

East Sumatra: Kisaran, Karoo-Hochebene.

West Sumatra: Sidikalang, Sibolga, Padang Sidempoean, Gross-Mandailing, Soendatar, Angkola Djoeloe, Limau manis, Loeboek soelasih, Fort de Kock, Padangpandjang, Kajoetanam, Naras, Emmahaven, Angoli, Sawah Loento, Sandaran agoeng, Moeara laboeh.

South Sumatra: Moera aman, Ketahoen-Ebene, Pager alam, Doerian.

BORNEO.

Ober-Mahakam.

CELEBES.

Toradja-Lander, Watampone, Balangnipa.

ISLANDS.

Nias, Enggano, Riouw, Banka, Natoena, Anambas, Boeton, Flores, Timor: Koepang, Atamboea; Alor, (Aroe ???).

it is readily taken in human-bait traps and feeds most avidly on man. Essed states that it is attracted to light.

Relation to Malaria.—This species has repeatedly been shown to be one of the most important natural carriers in Malaya.

Anopheles (Myzomyia) pallidus Theobald.

Mon. Culicidæ, I, 1901, 134.

Brown facies ; very similar to *A. philippinensis*, from which it can be distinguished on the following points :

Thorax.—Meskatopisternum with pale scales in clusters associated with sternopleural setæ, those associated with upper group extending beyond it upwards and downwards towards lower group.

Legs.—Tarsus of hind leg (Fig. 18) with no trace of pale marking at apex.

Abdomen.—Scaling on dorsum heavier ; ventrally a number of scattered pale scales on III to VIII, the cluster of dark scales on VII not so large.

Male terminalia.—Leaflets about 5 on each side (Christophers).

Notes.—Only one example of this species has as yet been seen from Malaya. The differences from *A. philippinensis* agreed with those noted by Christophers for the Indian form. Nothing is known of its habits in Malaya ; it is found in houses and cow-sheds in India.

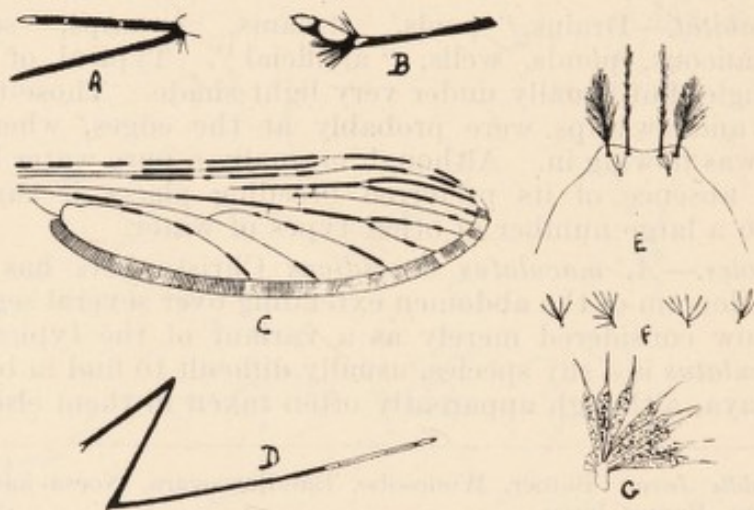


Fig. 18.—*A. pallidus* Theobald. A, ♀ labium and palp ; B, ♂ palp ; C, wing ; D, hind leg ; E, clypeal hairs ; F, sutural and trans-sutural hairs ; G, part of abdominal palmate IV. After Gater.

Relation to Malaria.—Experimental as well as natural infections are recorded from India, but this species is not generally considered to be an important carrier. There are no reliable records for Malaya.

Roy and Biswas (*J. Malar. Inst. India*, IV, 1942, 417) have shown on gland dissection of 854 specimens caught in houses of *Anopheles pallidus* Theobald a sporozoite rate of 0.7 per cent., indicating that this species is an intermediary host of major importance.

Larva.—Inner anterior clypeal (Fig. 18): Placed far apart; stout, with numerous, prominent side-hairs. Outer anterior clypeal: Half to two-thirds the length of inner; with 15 to 37 long branches, giving the hair the appearance of a brush; the main stem often divides into 2 or 3 branches. Posterior clypeal: Placed external to inner anterior; short, only just reaching bases of inner anterior hairs, with 2 to 5 branches, usually 3. Sutural (Fig. 18): With 3 to 8 branches, usually 5; in Indian specimens the main stem usually divides into two diverging branches near the base, each branch again subdividing. Trans-sutural: About the same length or slightly shorter than sutural and approximately in line with them; with 4 to 7 branches. Antennal: On dorso-external surface, one-quarter to one-third the length of shaft from the base; fine, short, simple. Sub-median prothoracic: Inner stout, with 16 to 26 branches and a prominent, dark root; central fairly stout, with 11 to 15 branches and a prominent, dark root, which is confluent with the root of the inner hair; outer sometimes appearing to arise from the root of the central hair. Metathoracic palmate: Better developed than in *A. annularis*, with 11 to 15 lanceolate leaflets. Pleural: Prothoracic with 2 long simple, 1 long stout branched, 1 short with 2 to 5 branches. Mesothoracic with 1 long simple, 1 long stout branched, 1 short simple, 1 minute simple. Metathoracic with 2 long stout branched, 1 short with 2 or 3 branches, 1 minute simple. Abdominal palmate: I small, with the leaflets lanceolate, or with very poorly differentiated filaments; II to VII (Fig. 18) fully developed; pigmentation heavier distally; the filament sharply pointed but not very fine, half or more the length of blade.

Notes.—See under *A. philippinensis*.

Habitat.—Sumatra: Sarolangoe, Solok.

Anopheles (Myzomyia) philippinensis Ludlow.

J. Amer. Med. Assn., 1902, 426.

Small to medium; hind tarsi conspicuously white; dark brown facies.

Labium (Fig. 19).—Unornamented, rather shaggy at base; antennæ with scales on 2, and on 3 to 5 or 6 or more.

Palpi (Fig. 19).—Three white bands, one broad, two narrow. Segment 5 entirely white, apex of 4, 3 and 2 white; apical white band three-quarters to as broad as pre-apical dark band. Shaggy.

Thorax.—Mesonotum without paler median area, covered with short, broad pale scales extending to fossæ. Anterior pronotum usually with one or two scales. Propleural setæ absent; spiracular setæ 2 or 3; some scales associated with pre-alar and sternopleural groups; an occasional scale on other areas of meskatepisternum, but not in clusters.

Wings (Fig. 19).—Moderately pale; inner and outer pre-humeral dark accessory spots usually divided, the areas of dark and pale scaling in this region very variable; *C*, *R*₁ and other anterior veins with narrow pale areas; *Sc* pale area involves *R*₁; *R*₄₊₅ mainly pale; *Cu* and *Cu*₂ mainly pale, no dark spot at origin of *Cu*₁; *An* with 2 or 3 dark spots.

Legs.—Femora and tibiae pale on inner face, a few white scales at apex or dark. Hind leg (Fig. 19) with a terminal pale patch or band, which may be small or (rarely) absent, on tarsus 1; tarsus 2 white distally for one-third to one-half its length; 3 to 5 entirely white. Leg I with fairly broad white bands at apex of tarsi 1 to 3. Leg II with a linear patch of white scales near apex of femur and fairly broad white bands at apex of tarsi 1 and 2. Coxæ with scales.

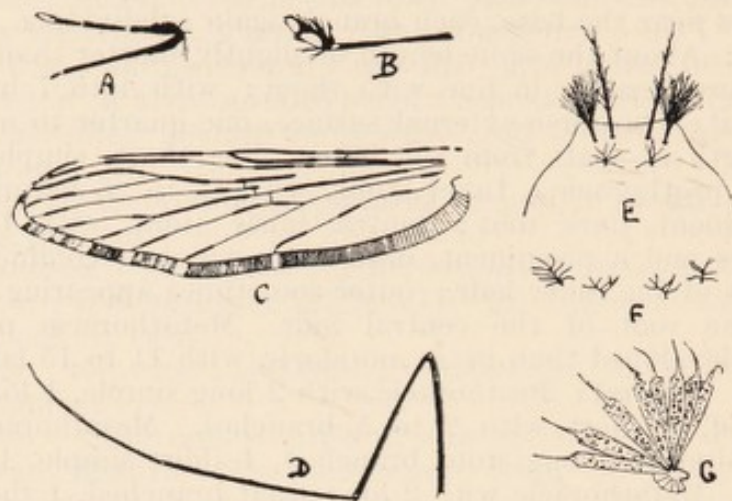


Fig. 19.—*A. philippinensis* Ludlow. A, ♀ labium and palp; B, ♂ palp; C, wing; D, hind leg; E, clypeal hairs; F, sutural and trans-sutural hairs; G, part of abdominal palmate IV. After Gater.

Abdomen.—A few scales on IV and V dorsally, increasing on VI and VII along posterior borders, more numerous on VIII; ventrally very few or no pale scales except on VI to VIII, a small cluster of dark scales centrally on VII, dark scales at posterior angles of VIII (sometimes VII as well) tending to form tufts.

♂.—Palpi (Fig. 19): Mainly dark with white areas on expanded portion.

Terminalia.—Claspettes with stout apical seta not much longer than spatulate process; a short, fine seta between apical seta and process, and two similar setae internal to apical seta. Leaflets long, about 6 on each side, broader ones curved on one edge in distal half, serrated for most of their length on the opposite, straight edge; smaller leaflets with few serrations.

Notes.—Very easily confused with *A. pallidus* and with *A. annularis* on superficial examination. Found in houses and cattle-sheds, and occasionally taken in enormous numbers in human-bait traps. Feeds on man, but not very readily.

Relation to Malaria.—Malayan records for *A. annularis* (*A. fuliginosus*) almost certainly apply to this species in the majority of cases. Records for "*A. fuliginosus*" show that both experimental and natural infections have been obtained, and the true *A. philippinensis* has been experimentally infected with M.T. and B.T. malaria. In India and Burma *A. philippinensis* has been found naturally infected. Dissections of 562 specimens taken in a malarious district in Malaya were negative. It often occurs in enormous numbers and although

there is not at present any reliable evidence that it plays any important part in transmission, it should not entirely be neglected as a possible carrier.

Larva.—Inner anterior clypeal (Fig. 19): Placed far apart; stout, with numerous, conspicuous side-hairs, longer than in *A. pallidus*; some may be bifid. Outer anterior clypeal: About two-thirds the length of inner; with 25 to 38 long branches, giving the hair the appearance of a brush; the main stem often divides into two or three branches. Posterior clypeal: Placed external to inner anterior; short, not reaching the bases of the latter; with 5 to 9 branches from near the base. Sutural (Fig. 19): Longer than posterior clypeal, not reaching the bases of frontal hairs; with 3 to 9 branches, the hair usually dividing into two diverging branches near the base. Trans-sutural: About as long as sutural and anterior to them; with 4 to 9 branches. Antennal: On dorso-external surface, one-quarter to one-third the length of shaft from the base; base rather stout and tending to split into 2 or 3 branches at the tip. Sub-median prothoracic: Inner stout, with 18 to 28 branches and a prominent, dark root; central stout, with 13 to 22 branches and a prominent, dark root, which is confluent with the root of the inner hair; outer arises apart from the root of the central hair. Metathoracic palmate: Well developed, with 11 to 15 lanceolate leaflets. Pleural: Prothoracic with 2 long simple, 1 long stout branched, 1 short with 2 to 4 branches. Mesothoracic with 1 long simple, 1 long branched, 1 short simple or forked, 1 very short simple. Metathoracic with 2 long branched, 1 short with 2 or 3 branches, 1 minute simple. Abdominal palmate: I fairly well developed, with lanceolate leaflets, or leaflets with poorly differentiated filaments; II fully developed, but smaller than on succeeding segments; III to VII (Fig. 19) fully developed; filament under half the length of blade, the base fairly broad, tapering abruptly to a very fine tip; pigmentation even or rather heavier distally.

Notes.—Descriptions of this species differ, especially in regard to the branching of the sutural hairs. Malayan specimens do not appear to agree with descriptions published by workers in India; but *A. pallidus* and *A. philippinensis* have so recently been recognized as occurring together in Malaya that the above description must at present be accepted with caution, and discrimination between the two species will remain uncertain until more specimens can be examined.

Habitat.—Rice-fields, pools, drains, swamps, ponds, wells, streams, miscellaneous, "artificial". An open swamp breeder, common in rice-fields, especially not long after the crop is planted out. The three species, *A. philippinensis*, *A. pallidus* and *A. annularis* have been confused in Malaya, so that the above records refer to all three. The common species in Malaya appears to be *A. philippinensis*.

Distribution.—Java; Sumatra; New Guinea: Merauke.

Anopheles (Myzomyia) ramsayi Covell.

Ind. J. Med. Res., XIV, 1927, 1020.

Small, highly ornamented; legs conspicuous, speckled, hind tarsi largely white.

Labium (Fig. 20).—Unornamented, smooth; antennæ with white scales on segments 2, 3 and 4.

Palpi (Fig. 20).—Three white bands, one broad, two narrow; segment 5 entirely white, 4 white in distal half, apex of 3 and 2 white; apical white band equal to twice the width of pre-apical dark band.

Thorax.—Mesonotum with broad pale scales, especially anteriorly and extending into fossæ, and narrow pale scales. Anterior pronotum without scales. Propleural setæ absent; spiracular setæ 2; a scale or two associated with the spiracular group.

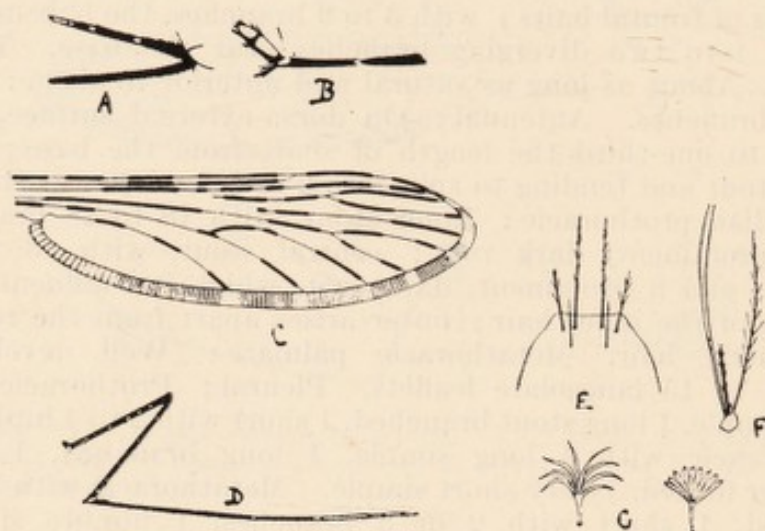


Fig. 20.—*A. ramsayi* Covell. A, ♀ labium and palp; B, ♂ palp; C, wing; D, hind leg; E, clypeal hairs; F, prothoracic pleural hairs; G, two forms of abdominal palmate II. After Gater.

Wings (Fig. 20).—Fairly dark, pattern generally as in figure; humeral and pre-humeral accessory dark spots broad; pre-apical dark spot on *C* much broader than the pale area on either side; *Cu-Cu₂* with three or four dark spots, a small spot at the origin of *Cu₁*; *An* with three dark spots.

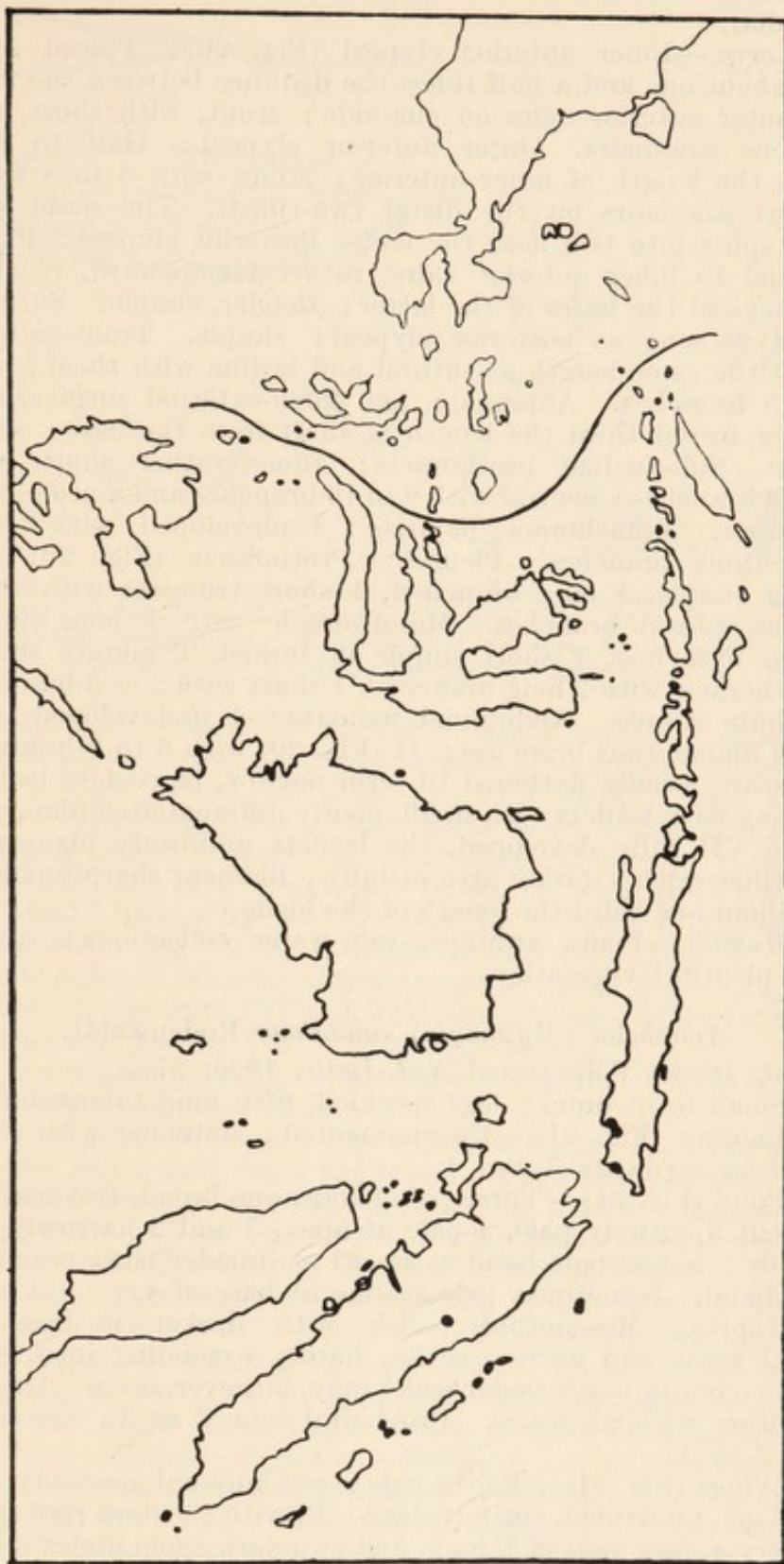
Legs.—Femora and tibiae speckled, pale below, tibiae minutely pale apically; tarsus 1 also paler below, sometimes with some speckling. Leg I with tarsi 1 to 3 pale apically; leg II with the femur and tarsi 1 and 2 pale apically. Hind leg (Fig. 20) with apex of tarsi 1 and 2 pale, segments 3, 4 and 5 uninterruptedly white.

Abdomen.—With brownish hairs, scales confined to a few on the dorsum of segments VII and VIII, and the venter of VII. Cerci with scales.

♂.—Similar to female; palpi as in Fig. 20.

Terminalia.—Claspettes with a short seta on each side of the apical seta, the latter slightly longer than the spatulate process. Leaflets of phallosome short, the broader ones with one edge convex in the distal half, the other edge straight with a few serrations about the middle.

Notes.—Described from Indian specimens kindly supplied by the Central Malaria Bureau. Ramsay reports taking this species in houses and cattle-sheds.



MAP 12.—DISTRIBUTION OF *ANOPHELES RAMSAYI*.

JAVA.

West Java : Westbantam, Batavia, Tandjong Priok, Tegal sangi.

SUMATRA.

East Sumatra : Moeara Tebo.

Relation to Malaria.—Natural infections have been observed in India.

Larva.—Inner anterior clypeal (Fig. 20): Placed apart only about one and a half times the distance between the inner and outer anterior hairs on one side; stout, with short, conspicuous side-hairs. Outer anterior clypeal: Half to two-thirds the length of inner anterior; stout, with 3 to 8 thick, spinous side-hairs on the distal two-thirds. The main stem often splits into two near the end. Posterior clypeal: Placed external to inner anterior hairs, rather far forward, reaching well beyond the bases of the latter; slender, simple. Sutural: About as long as posterior clypeal; simple. Trans-sutural: About the same length as sutural and in line with them; with 2 or 3 branches. Antennal: On dorso-external surface, one-quarter to one-third the length of shaft from the base; short, simple. Sub-median prothoracic: Inner rather short, with 7 to 10 branches; central with 9 to 16 branches and a prominent, dark root. Metathoracic palmate: Undeveloped, with 3 or 4 filamentous branches. Pleural: Prothoracic (Fig. 20) with 2 long simple, 1 long branched, 1 short truncate with short, spinous lateral branches. Mesothoracic with 1 long simple, 1 long branched, 1 short simple or forked, 1 minute simple. Metathoracic with 2 long branched, 1 short with 2 or 3 branches, 1 minute simple. Abdominal palmate: I undeveloped, with 4 to 6 filamentous branches; II (Fig. 20) with 6 to 9 branches, which are usually flattened to form narrow, lanceolate leaflets, but may have leaflets with small, poorly differentiated filaments; III to VII fully developed, the leaflets uniformly pigmented, sometimes with a darker area distally; filament sharply pointed and about one-third the length of the blade.

Habitat.—Pools, swamps, rain-water collections; always with plentiful vegetation.

Anopheles (Myzomyia) sundaicus Rodenwaldt.

Meded. Dienst Volksgezond Ned.-Indie, 1926, 87.

Small to medium; legs speckled, fifth hind tarsus dark.

Labium (Fig. 21).—Unornamented; antennæ with a few scales on segments 3 and 4.

Palpi (Fig. 21).—Three pale bands, one broad, two narrow; segment 5 entirely pale, 4 pale at apex, 3 and 2 narrowly pale apically; apical pale band as broad or broader than pre-apical dark band. Sometimes pale scaling at base of 4.

Thorax.—Mesonotum palish with darker median and lateral areas and narrow scales, hardly extending into fossæ, in which one or two broader scales may, however, occur. Anterior pronotum without scales. Propleural setæ 2 or 3; spiracular setæ 2 or 3.

Wings (Fig. 21).—Fairly pale; pre-humeral accessory dark spot long, undivided, entirely dark; R_1 with the dark spot below pre-sector dark spot of C long, and two dark spots under middle dark spot of costa; pre-apical dark spot on C longer than the pale areas on either side; petiole of cell R_2 short, shorter than cell, a dark spot often at the bifurcation; sector pale area entirely pale, no dark scales encroaching from either side; An with two dark spots; fringe without a pale area between termination of Cu_2 and An .

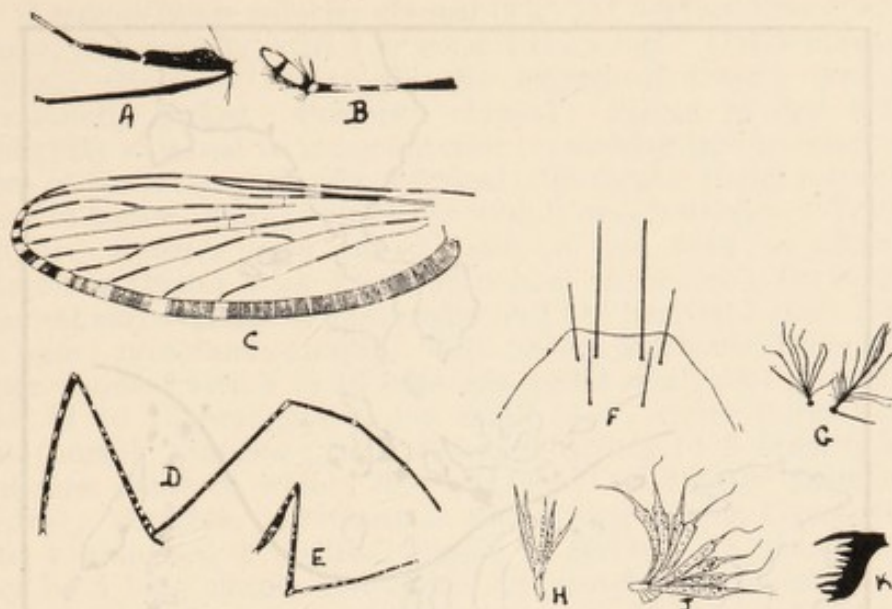


Fig. 21.—*A. sundaicus* Rodenwaldt. A, ♀ labium and palp; B, ♂ palp; C, wing; D, hind leg; E, fore leg; F, clypeal hairs; G, right posterior sub-median prothoracic; H, abdominal palmate I; J, abdominal palmate IV; K, spiracular pecten. After Gater.

Legs.—Femora, tibiae and first tarsal segments speckled, the pale patches often large and appearing as bands; fifth tarsi entirely dark. Hind leg (Fig. 21) with distinct pale bands apically on all segments except tarsus 4, on which it may be indistinct, and 5; speckling sometimes extends to tarsus 2. Leg I (Fig. 21) with apical pale bands on tibia and tarsus 1, tarsi 2 and 3 banded apically and basally, 4 basally only. Leg II similar to fore leg, the basal bands on tarsi very small.

Abdomen.—Without scales except at apex, where they are confined to segments VII and VIII dorsally and VIII ventrally, sometimes a few on VII. Cerci with scales.

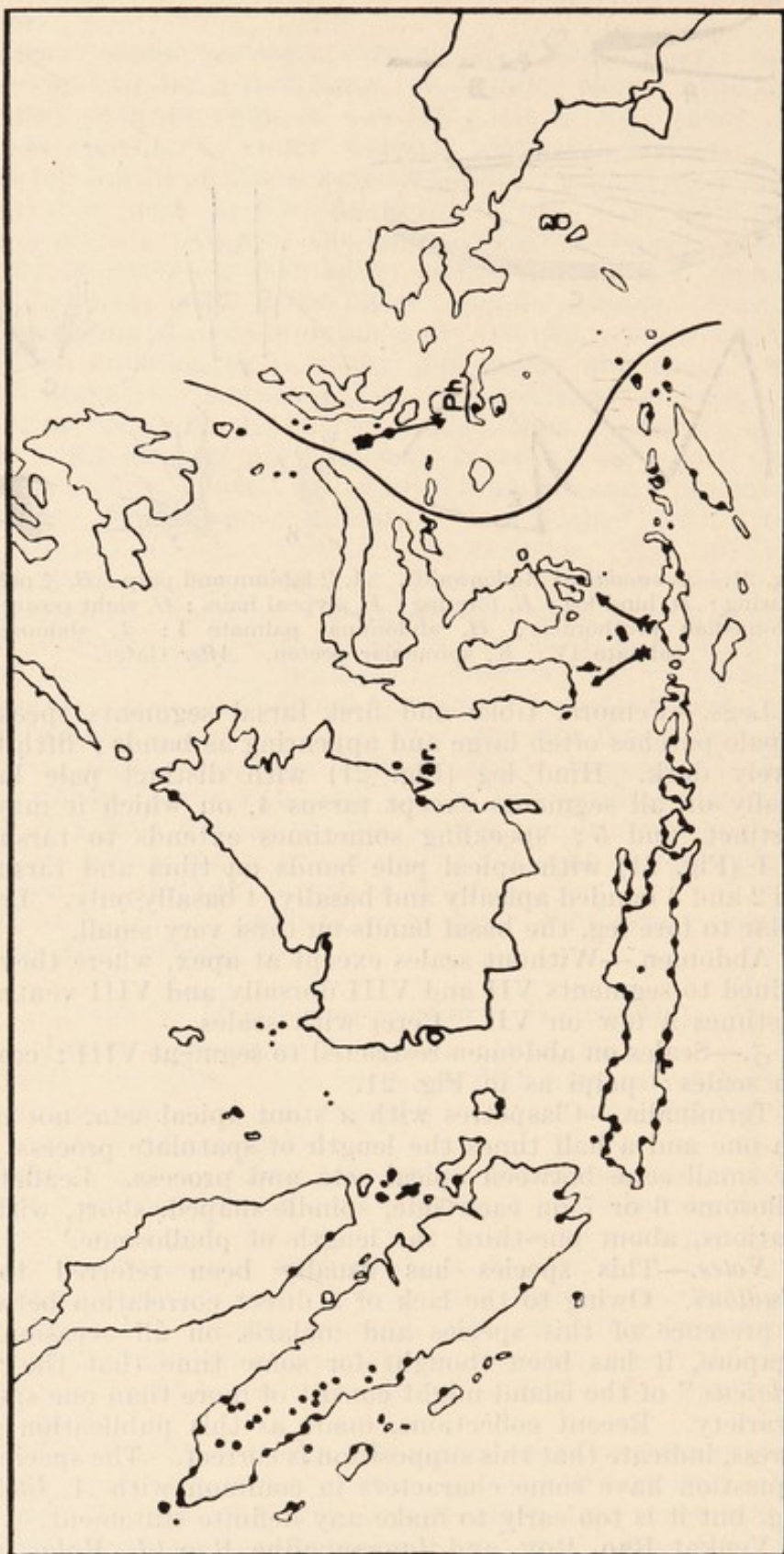
♂.—Scales on abdomen restricted to segment VIII; coxites with scales; palpi as in Fig. 21.

Terminalia.—Claspettes with a stout apical seta, not more than one and a half times the length of spatulate process, two very small setae between apical seta and process. Leaflets of phallosome 6 or 7 on each side, spindle-shaped, short, without serrations, about one-third the length of phallosome.

Notes.—This species has usually been referred to as *A. ludlowi*. Owing to the lack of a direct correlation between the presence of this species and malaria on all occasions in Singapore, it has been thought for some time that the "*A. sundaicus*" of the island might consist of more than one species or variety. Recent collections, made as this publication goes to press, indicate that this supposition is correct. The specimens in question have some characters in common with *A. litoralis* King, but it is too early to make any definite statement.

Venkat Rao, Roy, and Jaggannadha Rao (*J. Malar. Inst. India*, IV, 1942, 405) have shown that the flight range of both sexes of *Anopheles sundaicus* Rodenwaldt is at least two miles.

Relation to Malaria.—This species is regarded as one of the most important natural carriers in the coastal regions of all countries where it occurs.



MAP 13.—DISTRIBUTION OF *ANOPHELES SUNDAICUS*.

JAVA.

West Java : Westbantam, Sudbantam, Nordbantam, Batavia, Tandjong Priok, Serang, Wijnkoopshai, Sindangbarang, Genteng, Kepetakan, Cheribon.

Middle Java : Tjilatjap, Babakan, Noesa kambangan, Gombong, Tegal, Semarang, Demal, Solo, Margaredjo.

Larva.—Inner anterior clypeal (Fig. 21).—Placed far apart; simple, occasionally with 2 or even 3 branches. Outer anterior clypeal: Half to two-thirds the length of inner; simple, occasionally forked. Posterior clypeal: Placed in line with, or slightly external to inner anterior; reaching just beyond the bases of the latter; simple or forked. Sutural: Long, reaching bases of frontal hairs; simple or with 2 or 3 branches. Trans-sutural: Shorter than sutural and in line with or slightly anterior to them; with 3 to 6 branches. Antennal: On dorso-external surface, half or just under half the length of shaft from the base; prominent, simple. Sub-median prothoracic (Fig. 21): Inner slender, with 8 to 16 branches and a small root; central with 11 to 16 branches and a small root; outer fairly long. Metathoracic palmate: Undeveloped, with 2 to 5 filamentous branches, some of which, however, may be slightly flattened. Pleural: Variable. Prothoracic with 2 long simple, 1 long with 2 to 4 branches, 1 medium simple or forked. In some there may be 3 long simple and 1 medium simple, and occasionally all four may be of approximately equal length and simple. Mesothoracic with 2 long, 1 short and 1 minute, all simple; or one of the long hairs may have 2 or 3 branches. Metathoracic with 2 long branched, 1 short simple or with 2 or 3 branches, 1 minute simple. Abdominal palmate: I (Fig. 21) small, with 4 to 12 leaflets; variable, leaflets sometimes lanceolate with long drawn-out points, or with fairly well differentiated filaments; II fully developed, leaflets somewhat narrower than on succeeding segments, occasionally the filament poorly differentiated; III to VII (Fig. 21) fully developed, the pigmentation even or with some darker spots; filament nearly as long as blade, the base fairly broad, tapering rather abruptly to a very fine tip.

Notes.—Indistinguishable, in the majority of cases, from *A. subpictus malayensis*. Walch (1929) was able to distinguish it from specimens of *A. subpictus*, taken in brackish water, by the form of the spiracular pecten (Fig. 21).

East Java: Toeban, Kuste der Residenz Madioen, Kuste Kediri, Soerabaja, Kuste langs Madoerastrasse, Pasoeroean, Probolinggo, Kraksaan, Besoeki, Panaroekan, Sudkuste von Loemadjang, Sudkuste von Djember, Banjoewangi, Kuste von Insel Madoera.

SUMATRA.

Atjeh (Achin): Kotaradja, Meulaboh, Singkel, Tapatoean, Lho Soekon, Olehleh, Sigli, Lho Seumawe, Tjalang, Bireuen, Kroengradja.

East Sumatra: Kuste von Deli, Nordkuste von Tobasee, Lao Balang, Belawan (Deli), Samosir.

West Sumatra: Sibolga, Padang Sidempoean, Gross-Mandailing, Klein-Mandailing, Pangoeroeran, Pahahi-Ebene, Rao, Angkola djoeloe, Fort v. d. Capellen, See von Manindjau, Emmahaven, Naras.

South Sumatra: Benkoelen, Lampongs.

BORNEO.

Standortsvarietat: in Koeala Sambodja bei Balikpapan.

CELEBES.

Bonthain.

ISLANDS.

Poelau We, Simaloer, Nias, Siberoet, Enggano, Banjak Inseln, Anambas Inseln, Riouw-Archipel, Banka, Billiton, Edam, Bali, Lombok, Soembawa, Salajar, Flores, Alor, Pantar, Timor: Koepang, Wini, Atapoepoe; Wetar, Roma, Leti, Laboehan marege (Djampea-Gruppe), Boeton.

Habitat.—Pools, drains, swamps, wells, "artificial", rice-fields, miscellaneous. Small, open pools containing brackish water along the coast. It is also said to be capable of breeding in fresh water.

Anopheles (Myzomyia) subpictus Grassi.

Atti d. R. Acad. Lincei, (5), VIII, 1899, 101.

♀.—Head: Frontal tuft well marked, ocular scales narrow; second, or basal, segment (torus) occasionally with a few small minute scales, inner side of third segment (flagellar) with white scales. Palpi somewhat shaggy, apical segment about half the length of the penultimate, segments two, three and four with narrow pale apical bands, fifth segment wholly pale, about the same length as the pre-apical dark area; labium uniformly dark.

Thorax: Pale with darker median and lateral areas; two to three propleural hairs; median area covered with short, golden, curved hairs, median and lateral tufts of narrow white scales on the anterior promontory of mesonotum, below latter there are numerous erect black scales.

Wings: Pale, costa with the two pre-humeral dark spots sometimes joined, middle dark spot about twice the length of the pre-apical, dark area on first vein shorter than that on costa, sometimes a small dark spot present on first vein basal to the dark area. Pale areas much more prominent than dark areas, as shown in Fig. 22.

Legs: Fore femora distinctly swollen basally, with a narrow, dark, basal ring, ventral surface often dark or pale basally; mid and hind femora markedly pale beneath except at base and apex; all femora with a double pale spot toward apex dorsally, apices dark; fore tibiae broadly pale beneath, with a thin pale line on outer surface; mid and hind tibiae similar with a thin pale line expanding at apex. Fore tarsi with broad apical and basal banding, involving the joints, of tarsi one and two, two and three, three and four, fifth of fore and mid legs with narrow basal banding, fifth unbanded in the hind legs.

Abdomen pale, covered with dense golden hairs and some narrow yellowish scales; occasionally dark ones may be present, on posterior margins of VII and VIII; ventral surface of VII with scattered pale scales laterally and numerous dark hairs, usually some dark scales in the mid line apically.

♂.—As female. Palpi as in figure. Abdomen covered with hairs, except dorsum of VIII, which is clothed with numerous fairly broad scales; coxites with numerous dark and pale scales. Harpago of terminalia with very long apical spine, more than twice length of club; a small spine, less than one-quarter length of apical spine between the latter and the club. Phallosome rather strongly bent; about one-third length of coxite with about six to seven leaflets on each side, largest leaflet about half the length of the phallosome, leaflets blade-like, some shallow serrations at the base of the larger ones.

Larva.—Clypeal hairs slender, simple; *oc* slightly more than half the length of *ic*; *pc* slightly shorter than *oc*. Antennae rather slender; hair arising about middle of antenna; terminal

hair with three to four branches. Maxillary palp with the cone bifid from about its middle. Mentum with four teeth on either side of median tooth, all adequal and equidistant except last in row, latter tooth somewhat smaller.

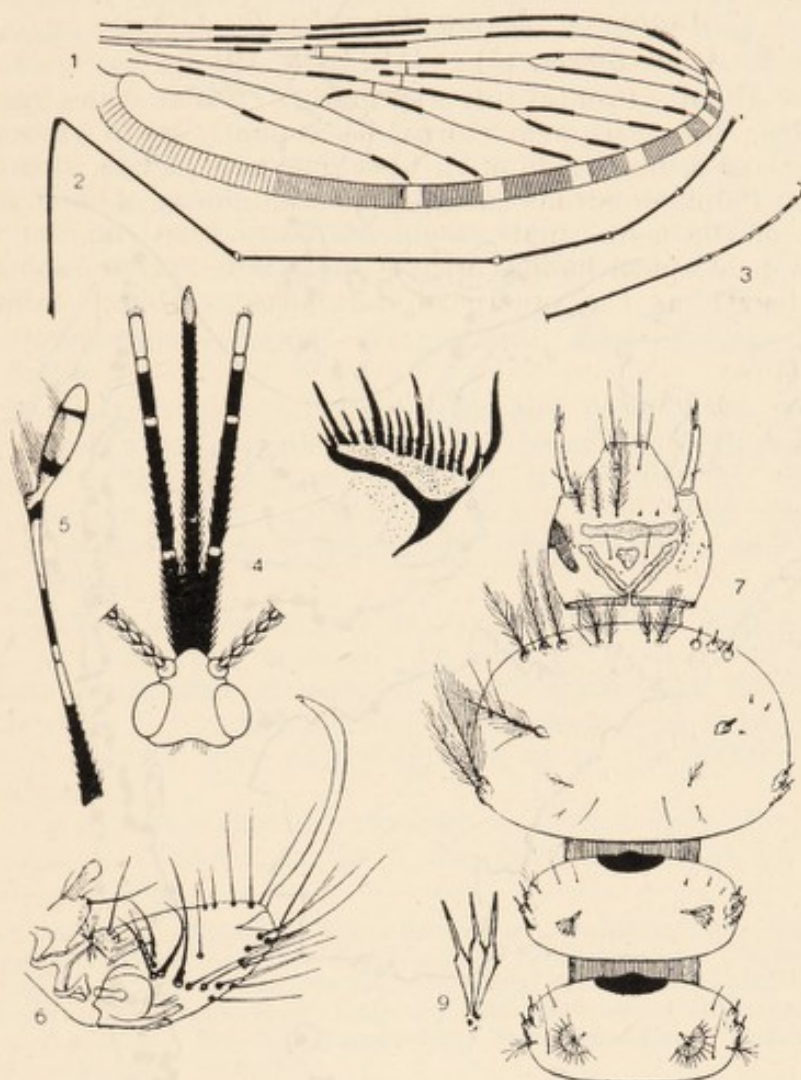


Fig. 22.—*A. subpictus* Grassi. 1, wing; 2, ♀ hind leg; 3, ♂ tarsus of hind leg; 4, ♀ head; 5, ♂ palp; 6, ♂ terminalia; 7, larva; 8, pecten; 9, part of float hair. After Swellengrebel and Rodenwaldt, and Barraud.

Inner shoulder hair without conspicuous basal tubercle, slender, sparsely feathered; middle with poorly formed tubercle, about one and a half times the length of the inner. Metathoracic hair I resembling ordinary hair, short, simple, or split into two to five branches. Palmate hairs well developed on II–VII; hair No. 1 on I with six to nine poorly developed filaments. Leaflets uniformly but scarcely pigmented; filament nearly as long as blade, shoulder well defined. Lateral hairs on IV–VI long, splitting near base into three slender branches; on VII very short, split into two to three branches. Tergal plates very small and narrow. Spiracular chitinization (*spc*) well developed, with projecting spur. Pecten with four to five long, and ten to eleven short processes. Post-spiracular hair (*ps*) long, with five to six branches, arising near base; outer sub-



MAP 14.—DISTRIBUTION OF *ANOPHELES SUBPICTUS*.

JAVA.

West Java : Westbantam, Ostbantam, Nordbantam, Sudbantam, Tegalwangi, Tjikadoe, Serang, Batavia, Tandjong Priok, Soekaboemi, Tjiheha-Ebene, Djampang-Gegend, Bandoeng-Ebene, Soemedang, Cheribon, Kepetakan Bandjar.

median caudal hair with six to eight long branches forming poorly-developed hooks with very shallow curves; anal papillæ rather stout, twice as long as anal segment.

Pupa.—Paddle with external border bare on anterior quarter, followed by some short denticles, becoming rather short stout spines posteriorly, replaced abruptly by hairs decreasing in size, not reaching paddle-hair, latter long, hooked; accessory hair simple. Spine on VIII somewhat less than half segment, and on V-VII curved, pointed, those on VI and VII somewhat more, that of V slightly less than half length of segment. III-IV short, blunt. Hair *B* branched on III-VII; *C* on V-VII, simple, somewhat longer than segment; on IV with two to three branches, about length of segment, on III with four to six branches, shorter than segment. *C'* on VI simple. *T* on I simple.

Distribution.—Papua, Netherlands East Indies, Malaya and India.

Bionomics.—Breeds in brackish and fresh water swamps, often muddy rain water pools, and pools contaminated with sewage. "This mosquito, although it prefers the blood of cattle, enters houses and behaves as a typical house mosquito, remaining also during the daytime" (Swellengrebel and Rodenwaldt, 1932).

Relation to Disease.—It is an intermediary host of B.T., M.T., and Quartan malaria. It has not been considered an efficient transmitter of malaria. Swellengrebel and Rodenwaldt (1932) state: "As far as Java is concerned, one must, indeed, be very careful with any judgment as to the significance of *A. subpictus* . . ."

It is probable that *A. subpictus*, in Java, is only of moderate importance. Indeed, in Java the most important part of a

Middle Java: Tjilatjap, Noesa kambangan, Babakan, Gombong, Tegal, Semarang, Margaredjo, Kuste der Residenz Rembang, Solo, Magelang.

East Java: Kuste der Residenz Madioen, Kuste der Residenz Kediri, Modjowarno, Soerabaja, Kuste langs der Madoerastrasse, Pasoeroean, Probolinggo, Kraksaan, Besoeki, Panaroekan, Sud-Loemadjang, Sud-Djember, Banjoewangi, Insel Madoera.

SUMATRA.

Atjeh (Achin): Kotaradja, Lho Seumawe, Lokop, Bireuen, Olehleh, Kroengradja.

East Sumatra: Nordkuste des Tobasees.

West Sumatra: Sidikalang.

South Sumatra: Lampongs.

Kroe

Singkarak

Solok

Pahahi-Ebene

Insel Mentawai

} Sumatra.

BORNEO.

Balikpapan.

CELEBES.

Boeloekoemba, Balang Nipa, Kolaka, Bonthain, Makassar, Barroe, Parepare, Polewali, Madjene, Mamoedjoe, Boeol, Tolitoli, Leok, Kotamobagoe, Kendari.

ISLANDS.

Nias, Siberoet, Poelau We, Banka, Billiton, Bali, Lombok, Soembawa, Flores, Soemba, Timor-Koepang, Alor, Pantar, Wetar, Roma, Poelau laeet, Djampea, Boeton, Moena, Bonerate, Salajar, Boeroe, Ambon, Haroekoe, Ceram, Geser, Soela-Inseln, Halmahera, Ternate, Batjan, Misool, Goram-Inseln.

campaign against an epidemic has been done after the suppression of *A. ludlowi*, even if *A. subpictus* can still be found, but, as mentioned above, this is not always the case.

The position is different in Celebes. There *A. ludlowi* is absent in wide stretches of the west and south coast, whereas *A. subpictus* is abundant because of the large brackish water swamps, and lagoons. There, despite its relatively low natural infection (Rodenwaldt, Makassar 0.5 ; Kundig 0.3) *A. subpictus* without any doubt is the sole source of infection. That is to say that so far there are no indications that *A. parangensis* is of any importance. This is proved quite clearly by the reclamation by drainage of the lagoons and brackish water swamps at Boeloekoemba, Baroe and Makassar (Swellengrebel and Rodenwaldt, 1932).

According to Soewadji Prawirohardjo (1939), this mosquito is an efficient intermediary host of *Filaria bancrofti*.

Anopheles (Myzomyia) subpictus var. *malayensis* Hacker.

Malaria Bur. Rept., F.M.S., II, 1921, 1.

Sufficient numbers of specimens have not been obtainable to investigate the sub-specific forms of *A. subpictus*. *A. subpictus malayensis* is usually distinguished from the type form by the length of the apical pale band on the female palpi, which is twice that of the pre-apical dark band (Fig. 23). The pre-humeral accessory dark spot is usually undivided, or only partially so (Fig. 23). Christophers states that the pre-apical dark spot on *C* appears to be usually rather short, as in the type form.

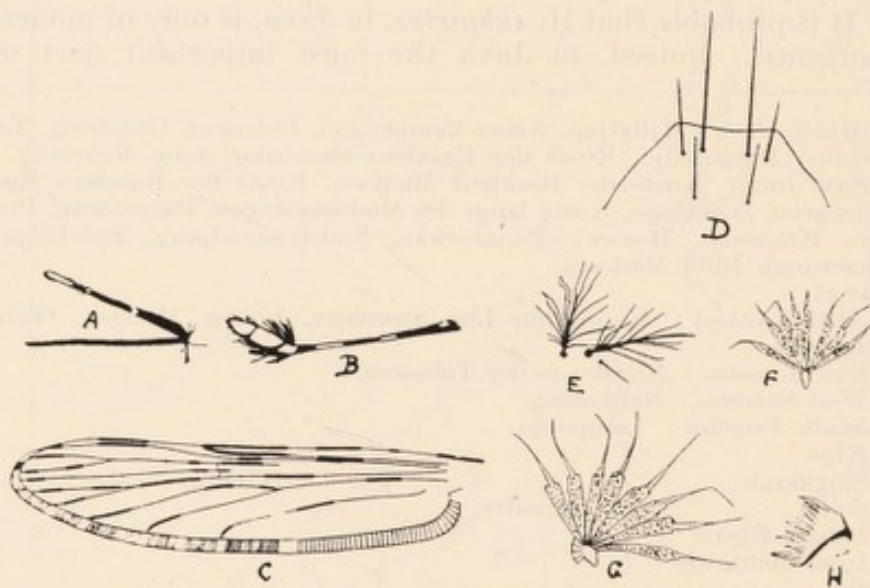


Fig. 23.—*A. subpictus* var. *malayensis* Hacker. A, ♀ labium and palp; B, ♂ palp; C, wing; D, clypeal hairs; E, right sub-median prothoracic; F, abdominal palmate I; G, abdominal palmate IV; H, spiracular pecten of specimen from brackish water. After Gater.

King has recently applied the name *indefinitus* to a form of *A. subpictus* occurring in the Philippines. In this form the pre-apical dark spot is as long as, or longer than the pale areas on each side, otherwise it differs from the type form much as does *malayensis*. It is uncertain if the two forms are distinct,

and *indefinitus*, to the description of which many Malayan specimens appear to conform (Fig. 23), has priority over *malayensis*. Should the two forms turn out to be the same, *indefinitus*, which in the past has unfortunately been used to designate both *A. vagus* and *A. subpictus*, will replace *malayensis*.

The males are indistinguishable, for practical purposes, from those of *A. vagus*.

Relation to Malaria.—Except for experimental infections with M.T. and B.T. parasites, there is no evidence in regard to the Malayan sub-species. In 147 specimens offered human blood by Green, 31 per cent. fed.

Larva.—Inner anterior clypeal (Fig. 23): Placed far apart; simple or forked. Outer anterior clypeal: Half to two-thirds the length of inner; simple or forked. Posterior clypeal: Placed in line with or slightly external to inner anterior; reaching just beyond the bases of the latter; simple or forked. Sutural: Long, reaching bases of frontal hairs; simple or forked. Trans-sutural: As long as sutural and in line with or slightly anterior to them; with 3 to 6 branches. Antennal: On dorso-external surface, half, or just under half, the length of shaft from the base; prominent, rather stout, simple. Sub-median prothoracic (Fig. 23): Inner slender, with 11 to 21 branches and a small root; central with 11 to 20 branches and a small root. Metathoracic palmate: Rather larger in some specimens than in *A. sundaius*; undeveloped, with 3 to 6 filamentous branches. Pleural: Prothoracic with 2 long simple, 1 long with 2 or 3 branches, 1 short simple or forked. Mesothoracic with 1 long simple, 1 long with 2 to 4 branches (sometimes simple), 1 short simple or bifid, 1 minute simple. Metathoracic with 2 long branches, 1 short forked, 1 minute simple. Abdominal palmate: I (Fig. 23) small, the filament partially or fairly well differentiated; II fully developed, but the leaflets somewhat narrower than on succeeding segments; III to VII (Fig. 23) fully developed, filament well differentiated, the base broad, tapering abruptly to a very fine tip, nearly as long as the blade; pigmentation slight but even.

Notes.—Lateral hairs on segments IV, V and VI more often with 3 than with 2 branches. In specimens from brackish water, Walch (1929) was able to distinguish this species from *A. sundaius*, in a large number of cases, by the form of the spiracular pecten (Fig. 23), but this was not possible with specimens from fresh water. The character does not appear to be reliable, however, and for practical purposes the larvæ of *A. subpictus malayensis* and *A. sundaius* cannot be differentiated with certainty.

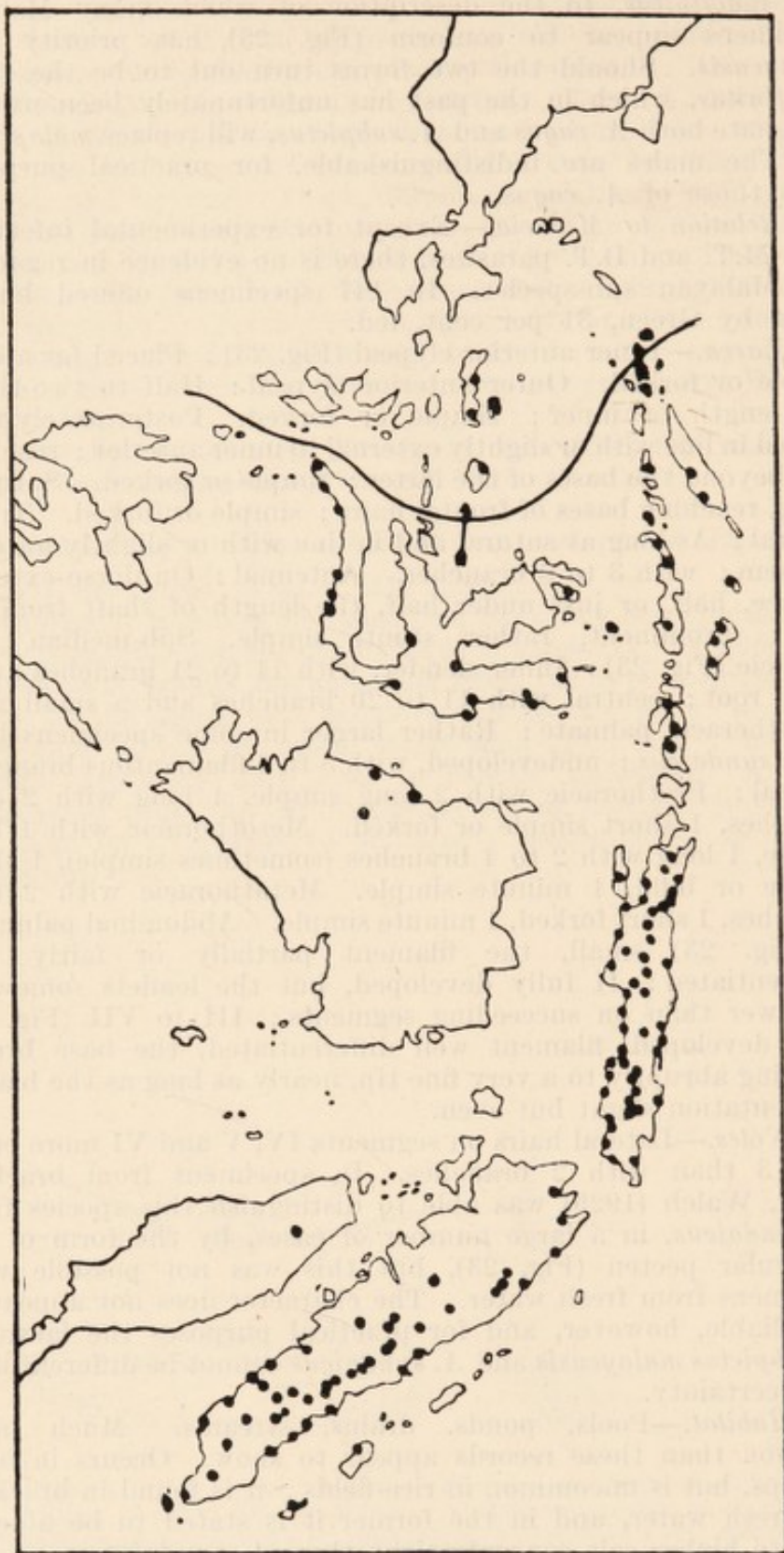
Habitat.—Pools, ponds, drains, streams. Much more common than these records appear to show. Occurs in open swamps, but is uncommon in rice-fields; it is found in brackish and fresh water, and in the former it is stated to be able to tolerate higher salt concentrations than *A. sundaius*.

Anopheles (Myzomyia) vagus Dönitz.

Zeitschr. f. Hyg. Infectiösk., XLI, 1902, 80.

Very similar to *A. subpictus*, differing as follows:

Labium (Fig. 24).—With a pale streak or patch proximal to labella ventrally, sometimes extending to sides and dorsum.



MAP 15.—DISTRIBUTION OF *ANOPHELES VAGUS*.

JAVA.

West Java : Bantam, Batavia, Tandjong Priok, Indramajoe, Tji kadoe, Soekaboemi, Djampanggegend, Tjiandjoer, Sindangbarang, Tjimahi, Bandoeng, Tjiheha-Ebene, Bandjar, Soemedang, Tegal wangi, Cheribon, Kepetakan.

Palpi (Fig. 24).—Apical pale band much broader, three to five times the width of pre-apical dark band, which is about the same width or not much broader than the sub-apical pale band.

Thorax.—Propleural setæ 3 or 4; spiracular setæ 3 to 5.

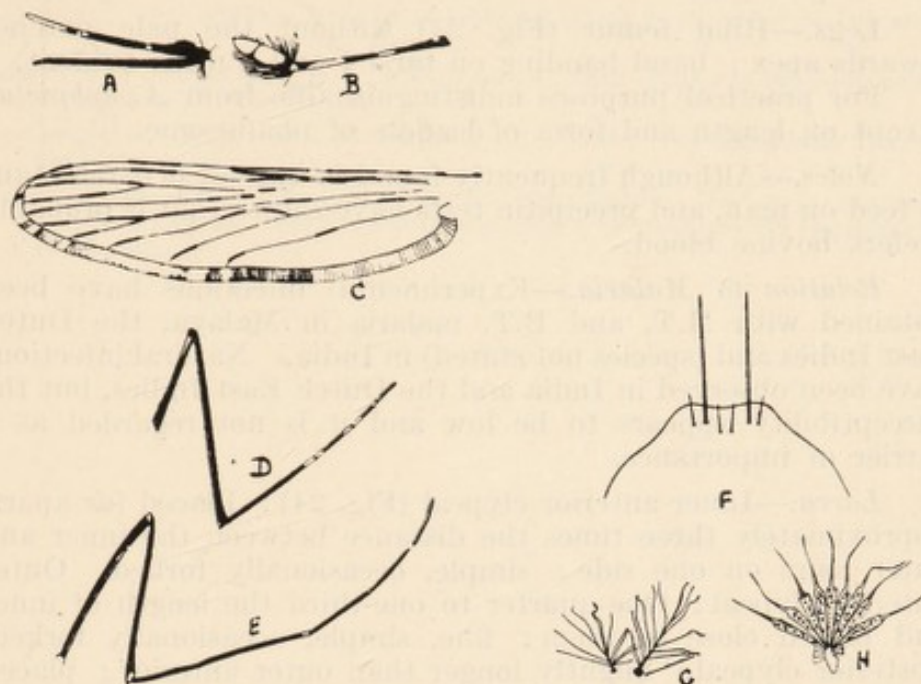


Fig. 24.—*A. vagus* Dönitz. A, ♀ labium and palp; B, ♂ palp; C, wing; D, fore leg; E, hind leg; F, clypeal hairs; G, right sub-median prothoracic; H, part of abdominal palmate IV. After Gater.

Middle Java: Tjilatjap, Babakan, Gombong, Banjoemas, Tegal, Pekalongan, Semarang, Magelang, Solo, Ambarawa, Margaredjo.

East Java: Inland und Kuste der Residenz Madioen, Djatirogo, Toeban, Kediri, Modjowarno, Soerabaja, Malang, Poenten, Tambaksari, Pasoeroean, Probolinggo, Kali rawaan, Sud-Loemadjang, Bondowoso, Sud-Djember, Banjoewangi, Insel Madoera.

SUMATRA.

Atjek (Achin): Kotaradja, Meulaboh, Lho Seumawe, Langsa, Tapatoean, Lho Soekon, Kota Tjane, Takengon, Lokop, Bireuen, Singkel, Belang kedjeren, Kroengradja, Seulimeum, Sigli, Belang Pidie.

East Sumatra: Deli-Ebene, Deli-Kuste, Kisaran, Lao Balang, Tandjong balai, Inland von Djambi, Moeara Tebo.

West Sumatra: Balige, Toba-Ebene, Pangoeroeran, Silindoeng-Ebene, Sidikalang, Sibolga, Padang Sidempoean, Gross-Mandailing, Klein-Mandailing, Rao, Soendatar, Loeboek Sikaping, Fort de Kock, Padang pandjang, Pad. Kotabalaroe, Kotabaroe, Kajoetanam, Fort v. d. Capellen, Singkarak, Sawah loento, Soengei penoeh, Naras, Emmahaven, Angoli, Moeara laboeh.

South Sumatra: Pager alam, Benkoelen, Ranau-See, Ketahoen-Ebene, Moeara aman, Tjoeroep, Kroe, Semangka-Ebene, Lampongs.

BORNEO.

Balikpapan, Samarinda, Ober-Mahakam.

CELEBES.

Makassar, Boeloekoemba, Maros, Pare Pare, Madjene, Paloe, Poigar, Leok, Paleleh, Tolitoli, Boeol, Kotamobagoe, Amoerang, Menado, Posso, Pampanoea.

ISLANDS.

Nias, Poelau We, Poelau babi, Simaloer, Enggano, Poelau laeet, Moena (Raha), Djampea, Soembawa, Soemba, Flores, Timor, Alor, Adonara, Roti, Kisar, Boeroe, Ambon, Ceram, Babar.

Wings (Fig. 24).—Pale; *C* with the pre-humeral dark accessory spot incompletely divided, with pale scales anteriorly, sometimes undivided; extreme base of wing dark; pre-apical dark spot on *C* often narrower than the subcostal pale area as well as pre-apical.

Legs.—Hind femur (Fig. 24) without the pale patches towards apex; basal banding on tarsi 4 and 5 more evident.

For practical purposes indistinguishable from *A. subpictus* except on length and form of leaflets of phallosome.

Notes.—Although frequently found in houses, it is reluctant to feed on man, and precipitin tests have shown that it probably prefers bovine blood.

Relation to Malaria.—Experimental infections have been obtained with M.T. and B.T. malaria in Malaya, the Dutch East Indies and (species not stated) in India. Natural infections have been observed in India and the Dutch East Indies, but the susceptibility appears to be low and it is not regarded as a carrier of importance.

Larva.—Inner anterior clypeal (Fig. 24): Placed far apart, approximately three times the distance between the inner and outer hairs on one side; simple, occasionally forked. Outer anterior clypeal: One-quarter to one-third the length of inner and placed close to them; fine, simple, occasionally forked. Posterior clypeal: Slightly longer than outer anterior; placed internal to inner anterior and close to them; fine, simple. Sutural: Very long, usually reaching beyond bases of frontal hairs; simple or forked. Trans-sutural: Nearly as long as sutural and more or less in line with them; with 4 to 7 branches. Antennal: On dorso-external surface, one-third to nearly half the length of shaft from the base; prominent, simple. Sub-median prothoracic (Fig. 24): Inner slender, with 12 to 21 branches and a small root; central with 11 to 20 branches and a small, but more prominent root; outer long, simple. Meta-thoracic palmate: Variable; with filamentous or slightly flattened branches, or with 2 to 6 narrow, lanceolate leaflets, the tips fine and drawn out. Pleural: Prothoracic with 3 long and 1 medium, all simple. Mesothoracic with 2 long (1 occasionally forked), 1 short and 1 minute, all simple. Meta-thoracic with 2 long branched (1 only sparsely branched), 1 short forked, 1 minute simple. Abdominal palmate: I small, with lanceolate leaflets, the tips fine, or with partially differentiated filaments; II fully developed, the leaflets narrower than on succeeding segments, or with only partially differentiated filaments; III to VII (Fig. 24) fully developed, the filament with a broad base, tapering abruptly to a very fine tip, from four-fifths as long to as long as the blade; pigmentation rather patchy, somewhat heavier distally from a point below the origin of the filament.

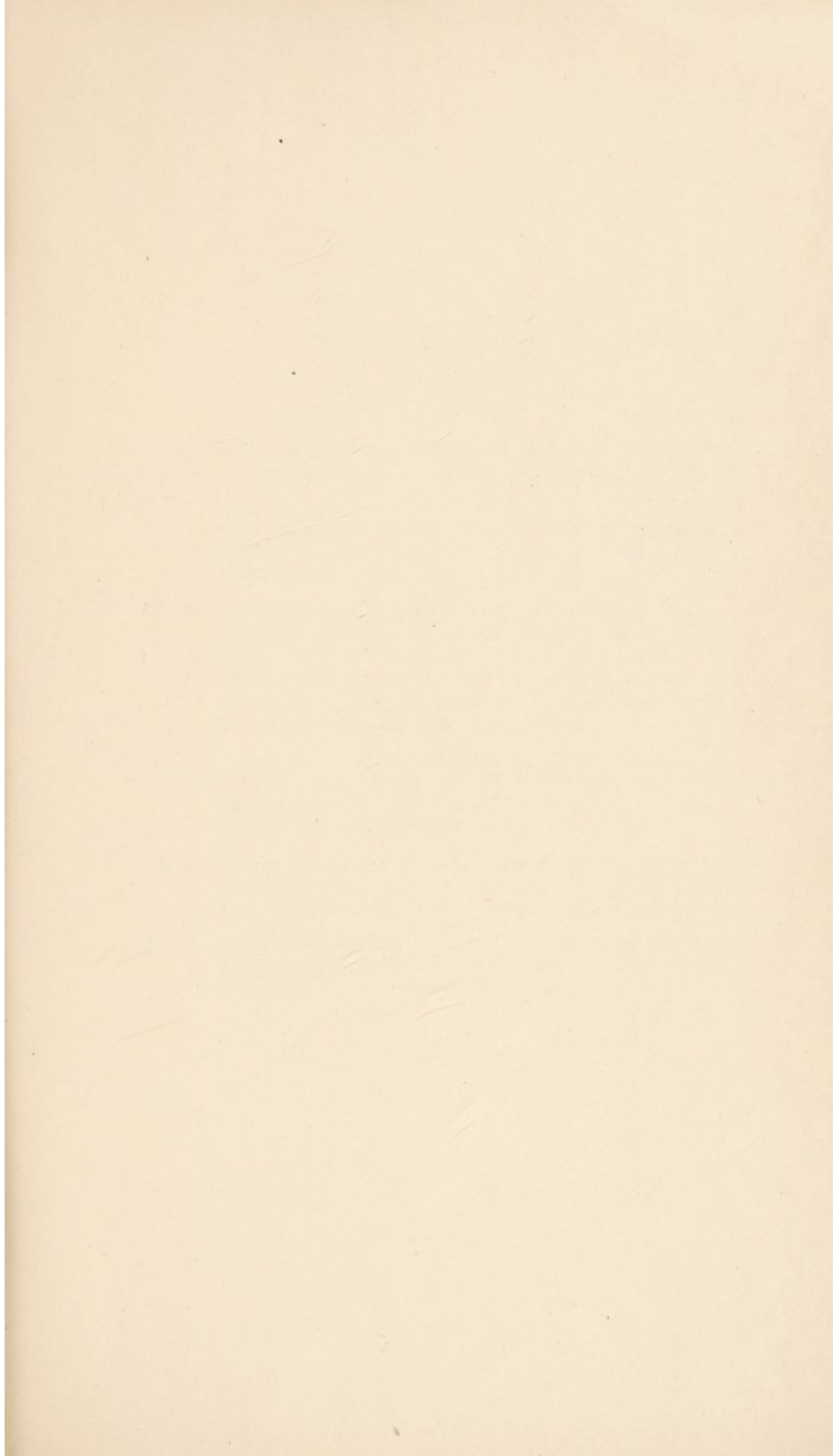
Notes.—Lateral hairs on segments IV, V and VI more often with 2 than with 3 branches.

Habitat.—Pools, drains, miscellaneous, swamps, ponds, rice-fields, streams, "artificial", seepages, wells. Small, open muddy pools, often containing foul water. Recorded from brackish water, alternating with *A. sundaicus*.

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