

CHECKLIST OF *ANOPHELES* OF THAILAND

- Anopheles (Anopheles) argyropus* (Swellengrebel), 1914
An. (Anopheles) asiaticus (Leicester), 1904
An. (Anopheles) baezai Gater, 1933
An. (Anopheles) barbirostris Van der Wulp, 1884
An. (Anopheles) barbumbrosus Strickland & Choudhury, 1927
An. (Anopheles) bengalensis Puri, 1930
An. (Anopheles) bulkleyi Causey*, 1937
An. (Anopheles) campestris Reid, 1962
An. (Anopheles) crawfordi Reid, 1953
An. (Anopheles) donaldi Reid, 1962
An. (Anopheles) fragilis (Theobald), 1903
An. (Anopheles) hodgkini Reid, 1962
An. (Anopheles) indiensis Theobald, 1903
An. (Anopheles) insulaeflorum (Swellengrebel & Swellengrebel de Graaf), 1919
An. (Anopheles) interruptus Puri, 1929
An. (Anopheles) kyondawensis Abraham, 1947
An. (Anopheles) lesteri paraliae Sandosham, 1959
An. (Anopheles) letifer Sandosham, 1944
An. (Anopheles) montanus Stanton & Hacker, 1917
An. (Anopheles) nigerrimus Giles, 1900
An. (Anopheles) palmatus (Rodenwaldt), 1926
An. (Anopheles) peditaeniatus (Leicester), 1908
An. (Anopheles) pollicaris Reid, 1962
An. (Anopheles) pursati Laveran, 1902

* *Anopheles (Anopheles) bulkleyi* was described from 1 male, which has since been lost or destroyed.

An. (Anopheles) roperi Reid, 1950
An. (Anopheles) separatus (Leicester), 1908
An. (Anopheles) sinensis Wiedemann, 1828
An. (Anopheles) sintonoides Ho, 1938
An. (Anopheles) stricklandi Reid, 1965
An. (Anopheles) tigertti Scanlon & Peyton, 1967
An. (Anopheles) umbrosus (Theobald), 1903
An. (Anopheles) whartoni Reid, 1963
An. (Cellia) aconitus Donitz, 1902
An. (Cellia) annularis Van der Wulp, 1884
An. (Cellia) balabacensis Baisas, 1936
An. (Cellia) balabacensis introlatus Colless, 1957
An. (Cellia) culicifacies Giles, 1901
An. (Cellia) hackeri Edwards, 1921
An. (Cellia) indefinitus (Ludlow), 1904
An. (Cellia) jamesii Theobald, 1901
An. (Cellia) jeyporiensis James*, 1902
An. (Cellia) karwari (James), 1903
An. (Cellia) kochi Donitz, 1901
An. (Cellia) maculatus Theobald, 1901
An. (Cellia) minimus Theobald, 1901
An. (Cellia) nivipes Theobald, 1903
An. (Cellia) pampanai Buttiker & Beales, 1959
An. (Cellia) philippinensis Ludlow, 1902
An. (Cellia) pujutensis Colless, 1948
An. (Cellia) ramsayi Covell, 1927

* Recent research has turned up specimens of *jeyporiensis* from northern Thailand which conform to both subspecies and intermediates. Consequently, we will call all of these *jeyporiensis*, until the infraspecific taxonomy of this species is reviewed.

An. (Cellia) riparis macarthuri Colless, 1956

An. (Cellia) splendidus Koizumi, 1920

An. (Cellia) stephensi Liston, 1901

An. (Cellia) subpictus Grassi, 1899

An. (Cellia) sundaicus (Rodenwaldt), 1925

An. (Cellia) tessellatus Theobald, 1901

An. (Cellia) vagus Donitz, 1902

DOUBTFUL RECORDS

The following species have been reported from Thailand, but the records are considered doubtful and these species have not been included in this key. Persons collecting specimens in Thailand suspected as being one of these species should seek confirmatory identifications.

Anopheles (Anopheles) aithenii James, 1903

An. (Anopheles) albotaeniatus (Theobald), 1903

An. (Anopheles) gigas formosus Ludlow, 1909

An. (Anopheles) gigas sumatrana Swellengrebel & Rodenwaldt, 1932

An. (Cellia) filipinae Manalang, 1930

An. (Cellia) fluviatilis James, 1902

An. (Cellia) maculatus willmorei James, 1903

An. (Cellia) majidi Young & Majid, 1928

An. (Cellia) pallidus Theobald, 1901

An. (Cellia) varuna Iyengar, 1924

**KEY TO THE FOURTH INSTAR LARVAE OF THE ANOPHELES
MOSQUITOES OF THAILAND**

1. Distance between bases of setae 2-C approximately equal to or less than distance between bases of setae 2-C and 3-C on one side; seta 1-A often large and branched, if simple or small then some or all of setae 5, 6 and 7-C short with few branches or simple (fig. 3a)
.....Subgenus *Anopheles*.....2
- Distance between bases of setae 2-C wider than distance between bases of setae 2-C and 3-C on one side; seta 1-A small and simple, rarely bifid or trifid; setae 5, 6 and 7-C long, plumose (fig. 3b)
.....Subgenus *Cellia*.....32
2. (1) Some or all of setae 5, 6 and 7-C simple or short with few branches (figs. 4-7)
.....3
- Setae 5, 6 and 7-C well developed and plumose.....6
3. (2) Setae 5, 6 and 7-C very short, sparsely branched; seta 4-C approximately equal length of seta 3-C (figs. 4 & 5)
.....*culiciformis* complex.....4
- Seta 5-C long and simple, setae 6 & 7-C short, sparsely branched; seta 4-C 1/2 or less length of seta 3-C (figs. 6 & 7)
.....*asiaticus* complex.....5
4. (3) Antennal shaft markedly curved; integument of thorax and abdomen smooth (fig. 4)
.....*kyondawensis*
- Antennal shaft straight or only slightly curved; integument of thorax and abdomen with numerous spicules (fig. 5)
.....*sintonoides*
5. (3) Seta 11-C long, with few branches on distal half; integument of thorax and abdomen usually with numerous lateral and ventral spicules (fig. 6)
.....*interruptus*

	Seta 11-C long, simple; integument of thorax and abdomen smooth (fig. 7)	
		<i>asiaticus*</i>
6. (2)	Seta 1-A small, inserted on basal 1/3 of antenna, less than half the length of antennal shaft (figs. 8-13)	<i>aitkenii</i> complex 7
	Seta 1-A large, inserted on middle 1/3 of antenna, half or more the length of antennal shaft (figs. 14-22)	12
7. (6)	Abdominal segments with large anterior tergal plates, 1/2 to 3/4 the width of segment (fig. 8)	<i>palmatius</i>
	Abdominal segments with anterior tergal plates not more than 1/2 width of segment (figs. 9-13)	8
8. (7)	Median area of seta 2-C with fine barbs (fig. 9a, b)	<i>fragilis</i>
	Median area of seta 2-C forked or simple, but without barbs (figs. 10-13)	9
9. (8)	Abdominal seta 6-III with more than 15 branches; seta 2-C with 2-9 branches arising 1/3 to 1/2 way along stem (fig. 10)	<i>bengalensis</i>
	Abdominal seta 6-III with less than 15 branches; seta 2-C simple or with branches arising on distal half of stem (figs. 11-13)	10
10. (9)	Seta 2-C with 2-5 branches on distal half, bases about as far apart as distance between 2-C and 3-C on one side (fig. 11)	<i>tigertti</i>
	Seta 2-C simple, bases nearly touching (figs. 12 & 13)	11
11. (10)	Abdominal seta 1-I with flattened leaflets; seta 3-C simple, rarely bifid (fig. 12)	<i>insulaeflorum</i>
	Abdominal seta 1-I with filamentous branches; seta 3-C with 2-4 branches (fig. 13)	<i>stricklandi</i>
12. (6)	Seta 1-P simple or with few short branches on distal half (figs. 14, 16-20)	13

* Dark marks on thorax and abdominal segment IV, are usually seen in living larva

	Seta 1-P with branches arising near base (figs. 21 & 22).....	
 <i>barbirostris</i> complex.....	27
13. (12)	Seta 3-C with 40 or more branches (fig. 14).....	
 <i>hyrcanus</i> complex.....	14
	Seta 3-C with less than 25 branches (figs. 16-20).....	22
14. (13)	Seta 4-M small, with sinuate, horizontally spreading branches arising close together at base (figs. 14 & 15a).....	<i>peditaeniatus</i>
	Seta 4-M with stiff more erect and straight branches, usually arising along central stem (figs. 14 & 15b).....	15
15. (14)	Seta 6-III usually with more than 20 branches; seta 6-I usually with more than 21 branches; seta 5-C with 17 or more branches (figs. 14 & 15c).....	<i>sinensis</i>
	Seta 6-III seldom with more than 20 branches; seta 6-I usually with less than 21 branches; seta 5-C with 11-18 branches.....	16
16. (15)	Seta 8-C with 12-24 branches (fig. 14).....	17
	Seta 8-C with 5-11 branches.....	20
17. (16)	Seta 14-P with 3-5, usually 3-4 branches; seta 1-M with 26-38 branches, rarely less than 28 (fig. 14).....	<i>pursati</i>
	Seta 14-P with 5 or more (rarely 5) branches; seta 1-M usually with less than 28 branches.....	18
18. (17)	Seta 5-IV with 2-4, usually 3 branches; seta 5-III with 4-8 branches (fig. 15c).....	<i>nigerrimus</i>
	Seta 5-IV seldom with less than 5 branches; seta 5-III with 7-17 branches (fig. 15c).....	19

19. (18) Seta 2-II with 8-14 branches; seta 9-VI with 5-9 branches; pecten seldom with more than 6 long teeth (figs. 14 & 15c, d).....
..... *indiensis* (in part)
- Seta 2-II with 6-9 branches; seta 9-VI with 4-5 branches; pecten usually with 7-8 long teeth (figs. 14 & 15c, d)..... *argyropus*
20. (16) Seta 9-III with 10-16 branches; pecten seldom with more than 6 long teeth; seta 13-IV with 6-12 short branches, approximately half the length of seta 10-IV (fig. 15c, d)..... *indiensis* (in part)
- Seta 9-III with less than 10 branches; pecten seldom with less than 7 long teeth; seta 13-IV with 4-9 long branches, approximately equal or slightly less the length of seta 10-IV (fig. 15c, d)..... 21
21. (20) Seta 5-II with 6-10 branches; saddle seta (1-X) strong, longer than saddle (fig. 15c, d)..... *lesteri paraliae*
- Seta 5-II seldom with less than 12 branches; saddle seta (1-X) usually weak and shorter than saddle (fig. 15c, d)..... *crawfordi*
22. (13) Seta 1 fully developed on abdominal segments III-VII (fig. 16).....
..... *montanus*
- Seta 1 on abdominal segments without distinct flattened leaflets or fully developed only on segments IV-V (figs. 17-20).....
..... *umbrosus* complex..... 23
23. (22) Spiracular area with long stigmal filament; seta 1 fully developed on abdominal segments IV-V (fig. 17)..... *umbrosus*
- Spiracular area without stigmal filament; seta 1 on abdominal segments without distinct flattened leaflets (figs. 18-20)..... 24
24. (23) Seta 6-IV with 7 or more branches; seta 2-C usually with fine barbs at tip (fig. 18)..... *baezai*
- Seta 6-IV with less than 7 branches; seta 2-C usually simple..... 25

25. (24) Seta 1-A with 25 or more branches; seta 4-A with all branches filamentous (fig. 19)..... *separatus*
- Seta 1-A with less than 25 branches; seta 4-A with 1 or 2 branches rather stout and hooked (fig. 20)..... 26
26. (25) Seta 0-III with 5 or more branches (fig. 20a)..... *roperi**
- Seta 0-III usually with less than 5 branches at least on one side (fig. 20b)..... *letifer**
- *whartoni***
27. (12) Spiracular area with thumb-like stigmal club arising between spiracles; seta 9-C usually with 10-17 branches (fig. 21)..... *pollicaris*
- Spiracular area without stigmal club; seta 9-C with 5-11 branches (fig. 22)..... 28
28. (27) Seta 3-C with 12-36 thin attenuated branches, usually lax and spreadout (fig. 23a)..... *barbumbrosus*
- Seta 3-C with thick branches, usually stiff and crowded together (broom-like), and usually more numerous (figs. 22-23b, c)..... 29 ***
29. (28) Seta 3-C with 19-44 branches, rarely more than 40; sum of branches on both setae 5-III plus those on both setae 13-IV usually total 25-38 (figs. 22 & 23b, d)..... *hodgkini*

* An examination of the types of *letifer* and *roperi* revealed the seta 6-III character used by Reid (4, 8) is not valid.

** *letifer* and *whartoni* larvae are currently not separable.

*** The remaining species in the *barbirostris* complex, i.e., *hodgkini*, *barbirostris*, *campestris* and *donaldi* are not always identifiable in the larval stage. Studies requiring specific identification should rely on individually reared specimens and use the pupal skin for precise identification.

	Seta 3-C with 30-95 branches, rarely less than 40; sum of branches on both setae 5-III plus those on both setae 13-IV rarely more than 24 (figs. 22 & 23c, d).....	30
30. (29)	Difference between the sum of branches on both setae 13-III and that of both setae 5-VII is 0-10 (figs. 22 & 23c, d).....	<i>barbirostris</i>
	Difference between the sum of branches on both setae 13-III and that of both setae 5-VII is 9-23.....	31
31. (30)	Sum of branches on both setae 13-I is 27-45 (figs. 22 & 23 c, d).....	<i>campestris</i>
	Sum of branches on both setae 13-I is 18-27 (figs. 22 & 23 c, d).....	<i>donaldi</i>
32. (1)	Abdominal segments III-VII with large anterior tergal plates, enclosing small posterior plates (figs. 24-26).....	<i>minimus</i> complex..... 33
	Abdominal segments III-VII with small anterior tergal plates, or if large, not enclosing small posterior plates (figs. 27-28, 30-42).....	35
33. (32)	Seta 2-C barbed; seta 4-C with 2-5 branches (fig. 24).....	<i>aconitus</i>
	Seta 2-C simple; seta 4-C simple.....	34
34. (33)	Seta 0-III to VII arising from anterior tergal plate, approximately 1/3 to 1/2 of distance between lateral margin and center of plate (fig. 25).....	<i>pampanai</i>
	Seta 0-III to VII arising external and posterior lateral to anterior tergal plate, rarely arising on posterior-lateral margin of anterior tergal plates VI and VII (fig. 26).....	<i>minimus</i> *

* In the original description of *pampanai*, Buttiker and Beales (1959) used the bases of the shoulder setae and the anterior tergal plate on abdominal segment II as also distinct from *minimus*, but these distinctions do not hold in Thailand specimens.

35. (32)	Seta 3-C barbed* or branched (figs. 27-33).....	36
	Seta 3-C simple (figs. 34-42).....	44
36. (35)	Seta 3-C with brush-like branches (figs. 27-29).....	37
	Seta 3-C barbed, not brush-like (figs. 30-33).....	40
37. (36)	Seta 8-C simple, or bifid at tip (figs. 27-28).....	38
	Seta 8-C split near base into 2-8 branches (fig. 29).....	39
38. (37)	Seta 1-I with distinct flattened leaflets (fig. 27).....	<i>annularis</i>
	Seta 1-I with filamentous branches (fig. 28).....	<i>jamesii</i>
39. (37)	Sum of branches on both setae 8-C plus both setae 9-C minus sum of both setae 4-C usually less than 15; blades of abdominal seta 1 often with mottled pattern and filaments about 1/3 as long as blades (fig. 29a).....	<i>philippinensis**</i>
	Sum of branches on both setae 8-C plus both setae 9-C minus sum of both setae 4-C usually 15 or more; blades of abdominal seta 1 usually lightly pigmented and filaments about 1/2 as long as blades (fig. 29b).....	<i>nivipes</i>
40. (36)	Seta 1-I with well developed leaflets; seta 4-C with 2-4 branches from base; seta 2-C with strong barbs along entire length; anterior tergal plates large (fig. 30).....	<i>jeyporiensis</i>
	Seta 1-I lacking well developed leaflets; seta 4-C simple, or bifid near tip; seta 2-C slightly barbed (may appear simple under low magnification); anterior tergal plates small to medium (figs. 31-33).....	41

* This character is frequently minute, proceed with caution and always use high magnification.

** Differences between *nivipes* and *philippinensis* are clearest in the pupal stage. Only about 80% of the larvae can be identified by the above characters, unless accompanied by pupal skins.

41. (40)	Seta 1-P with less than 15 branches; shortest seta in prothoracic pleural group stout, with short blunt barbs (fig. 31).....	<i>ramsayi</i>
	Seta 1-P with more than 15 branches; shortest seta in prothoracic pleural group slender, with fine branches (figs. 32-33).....	42
42. (41)	Setae 6-V and VI with 6-16 branches; filaments of abdominal setae 1 with blunt points (fig. 32).....	<i>karwari</i>
	Setae 6-V and VI with 3-6 branches; filaments of abdominal setae 1 with round or sharp points (fig. 33).....	43
43. (42)	Filaments of abdominal setae 1 with round points; seta 6-III usually with 15-19 branches rarely 20-21 (fig. 33a).....	<i>splendidus</i>
	Filaments of abdominal setae 1 with sharp attenuated points; seta 6-III with 20 or more branches (fig. 33b).....	<i>maculatus*</i>
44. (35)	Setae 4-C short, arising near setae 2-C and with bases closer together than bases of setae 2-C (fig. 34).....	<i>vagus</i>
	Setae 4-C usually long, arising far back from setae 2-C, with bases wide apart.....	45
45. (44)	Abdominal segments with pair of small submedian oval plates posterior-lateral to posterior tergal plates; setae 9, 10-T, one with few branches, the other simple (fig. 35).....	<i>culicifacies</i>
	Abdominal segments with only anterior and posterior tergal plates, without submedian plates; setae 9, 10-T both branched or both simple.....	46
46. (45)	Setae 9, 10-T both branched (figs. 36-38).....	47
	Setae 9, 10-T both simple (figs. 39-42).....	50

* The sharp pointed filaments are easily seen, but some may be broken off, thus several palmate setae should be examined.

47. (46) Seta 1-I with filamentous branches (fig. 36).....*stephensi*
 Seta 1-I with flattened leaflets.....48
48. (47) Seta 4-M split into 3-4 branches from near base (fig. 37).....*sundaicus*
 Seta 4-M with 1-2 branches, if third branch present this usually arises
 about half way along one of other branches (fig. 38).....49
49. (48) Seta 1-I usually with 6 or fewer leaflets and without differentiated
 filaments; seta 1-P usually with less than 13 branches (fig. 38a)
 *subpictus**
 Seta 1-I seldom with less than 7 leaflets and with well differentiated
 filaments; seta 1-P usually with 14 or more branches (fig. 38b)
 *indefinitus**
50. (46) Seta 1-P usually with 2-10 branches, arising from small, lightly pigmented
 basal tubercle (figs. 39-40).....51
 Seta 1-P with more than 10 branches, arising from large, darkly pigmented
 basal tubercle (figs. 41-42).....
 *leucosphyrus* complex.....52
51. (50) Seta 1-II with flattened leaflets; seta 1-P usually with 7-10 branches
 (fig. 39).....*kochi*
 Seta 1-II with filamentous branches; seta 1-P with 2-5 branches (fig. 40)
 *tessellatus*
52. (50) Seta 1-II fully developed, with clearly differentiated filaments (fig. 41)
 *hackeri*
 Seta 1-II not fully developed, with at most lanceolate leaflets without
 filaments (fig. 42).....53

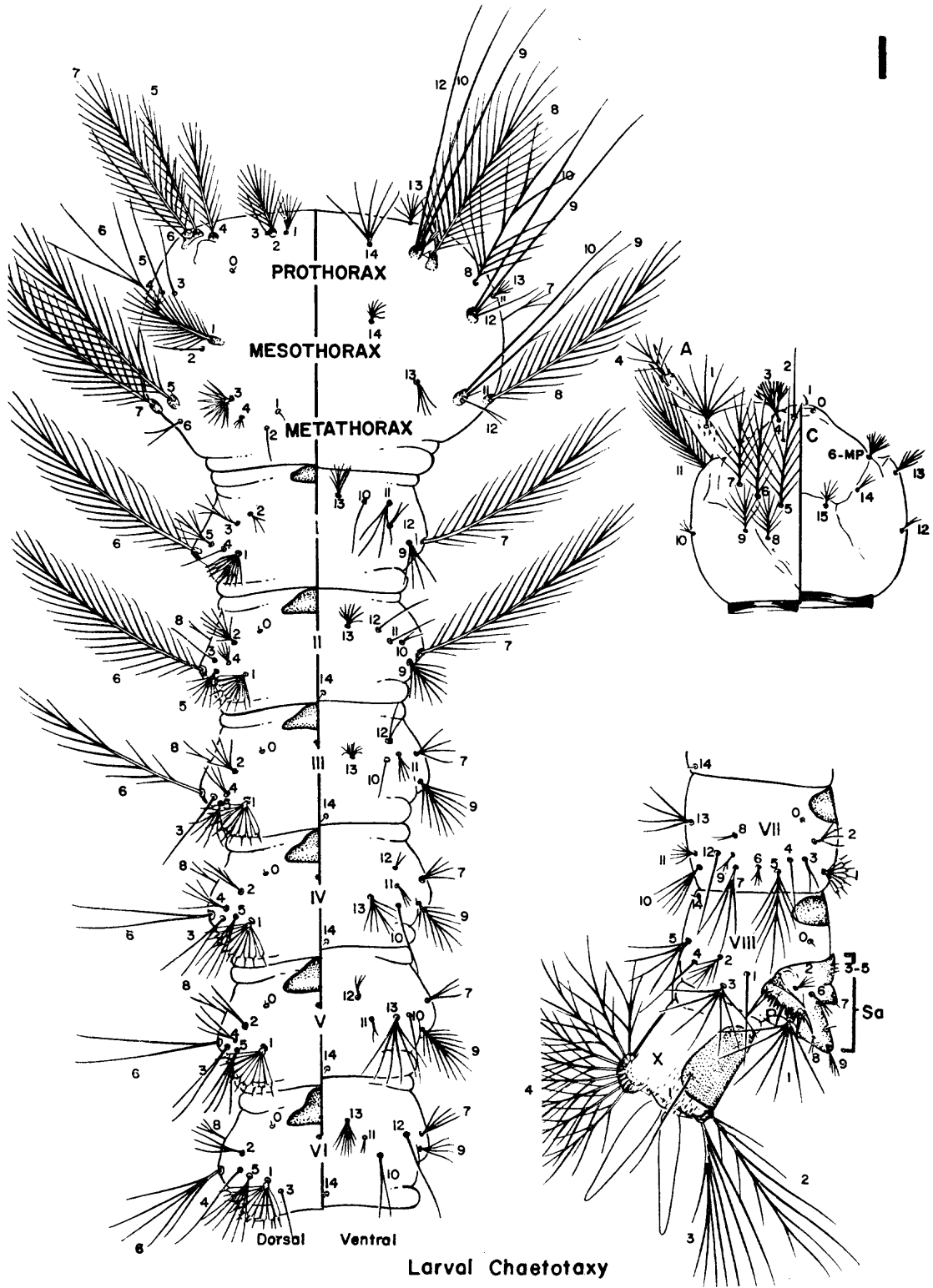
* *subpictus* and *indefinitus* are very closely related and a few larvae may require other associated life stages for positive identification.

53. (52) Basal tubercle of seta 1-P with prominent apical tooth or spine (fig. 42a)
 *balabacensis* *
- Throughout Thailand - *b. balabacensis**
 - Extreme southern Thailand - *b. introlatus**
- Basal tubercle of seta 1-P without apical tooth or with small round flange
 (fig. 42b, c).....54
54. (53) Seta 9-I with not more than 4 branches; setae 4-C usually not reaching
 bases of setae 2-C (fig. 42b).....*pujutensis*
- Seta 9-I with 5 or more branches; setae 4-C usually reaching to bases of
 setae 2-C (fig. 42c).....*riparis macarthuri*

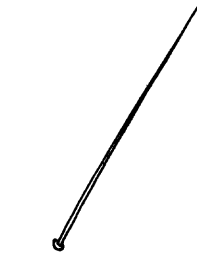
* Distinctive larval features separating the 2 subspecies of *balabacensis* in Malaya (Reid, 1968), apparently do not hold in Thailand. Persons working in extreme southern Thailand should try to rear a sample of larvae and be alert for the more distinctive characters assigned to the adults of *b. introlatus*.

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SETA TYPES



simple



single ,barbed



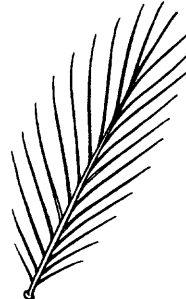
brush



branched

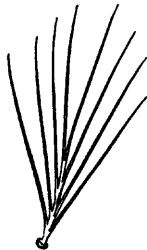


pectinate

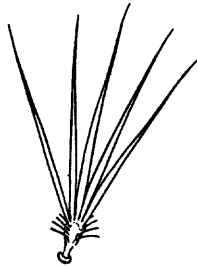


plumose

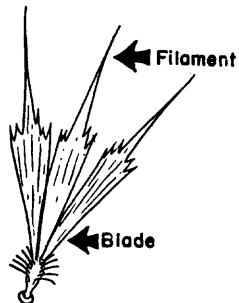
Seta I. on abdominal segment



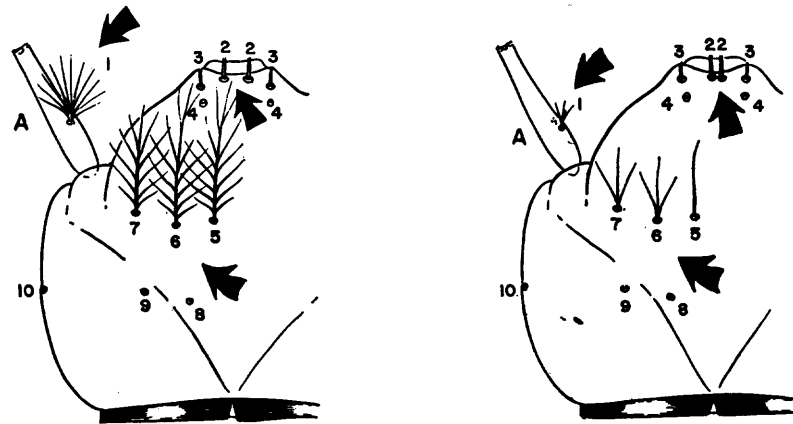
branches filamentous.



flattened leaflets
or lanceolate leaflets.

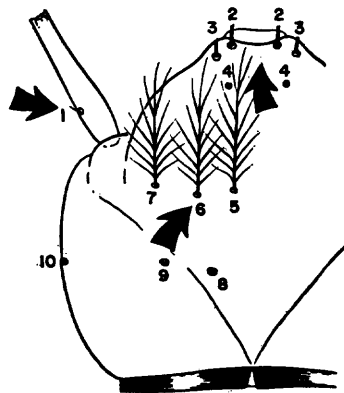


flattened leaflets,
fully developed, with
clearly differentiated
filaments.



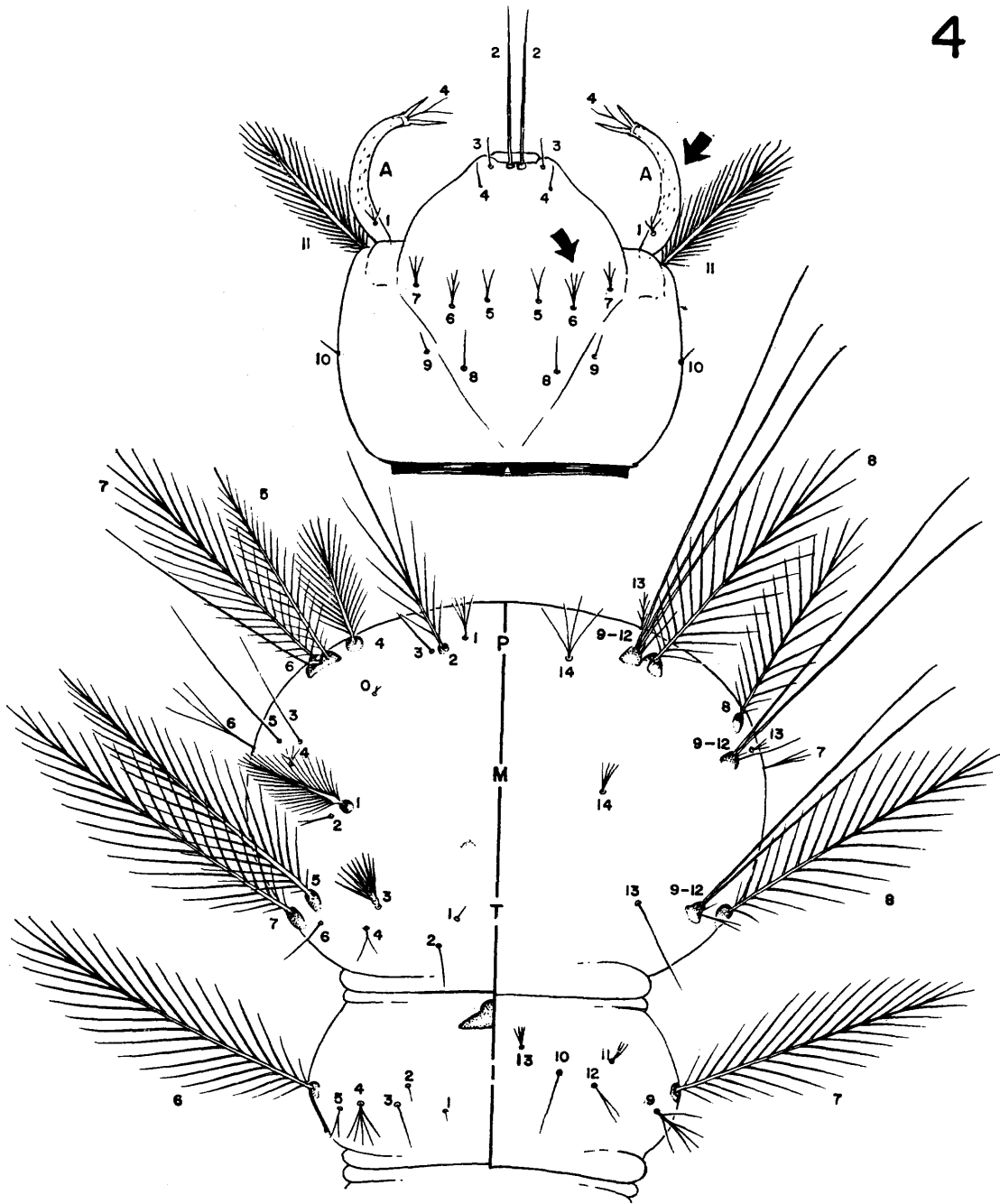
Anopheles (Anopheles)

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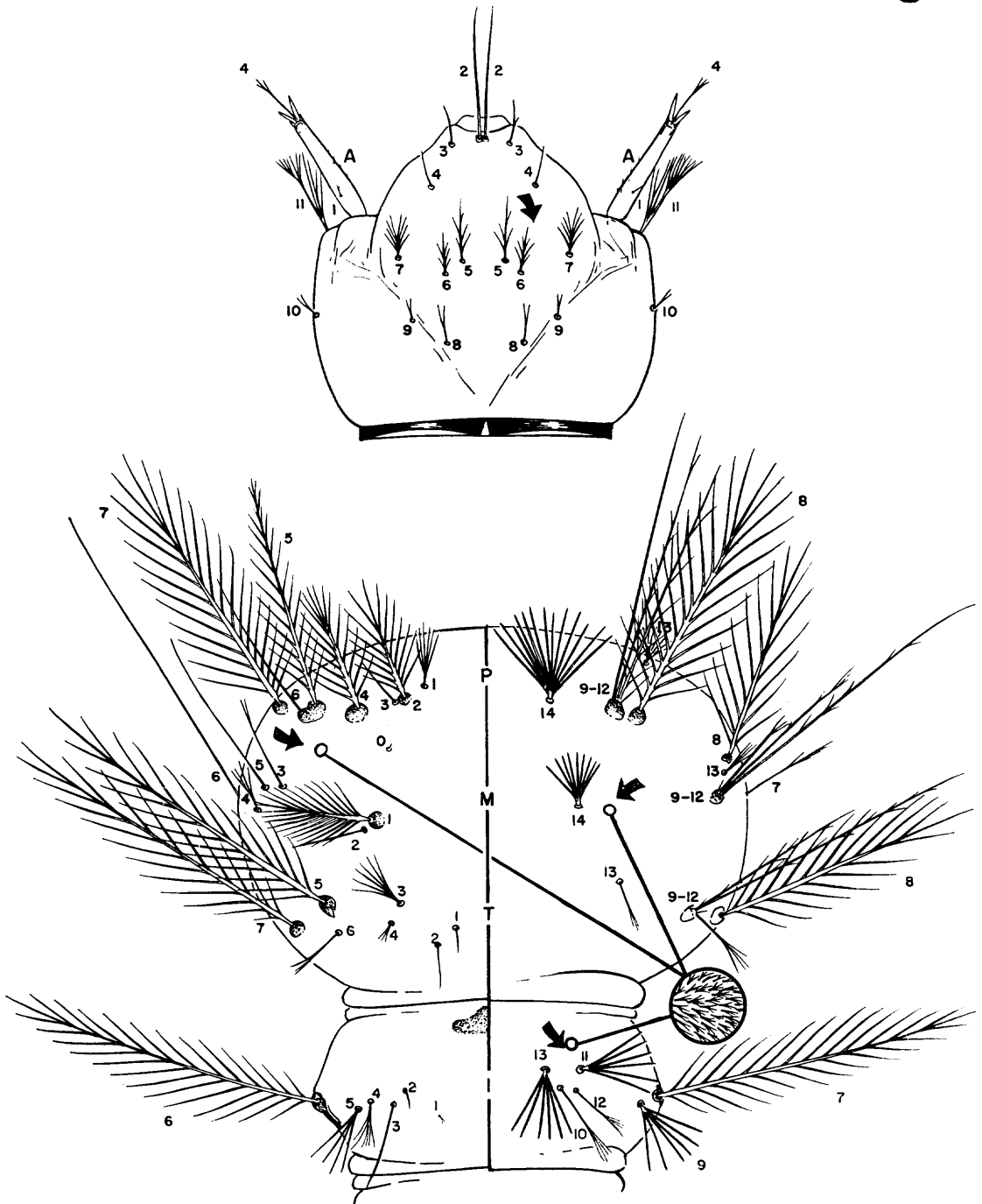


Anopheles (Cellia)

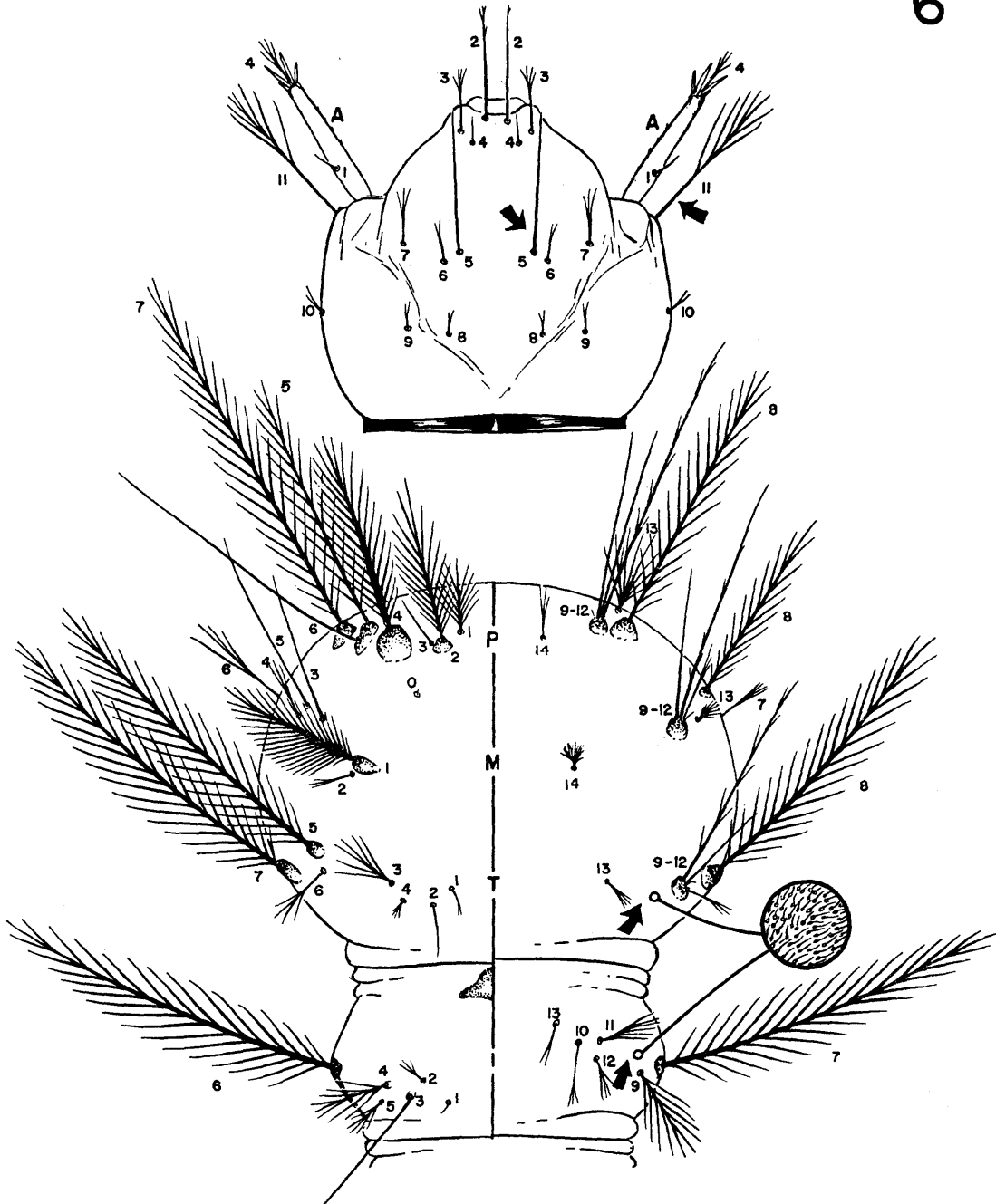
b



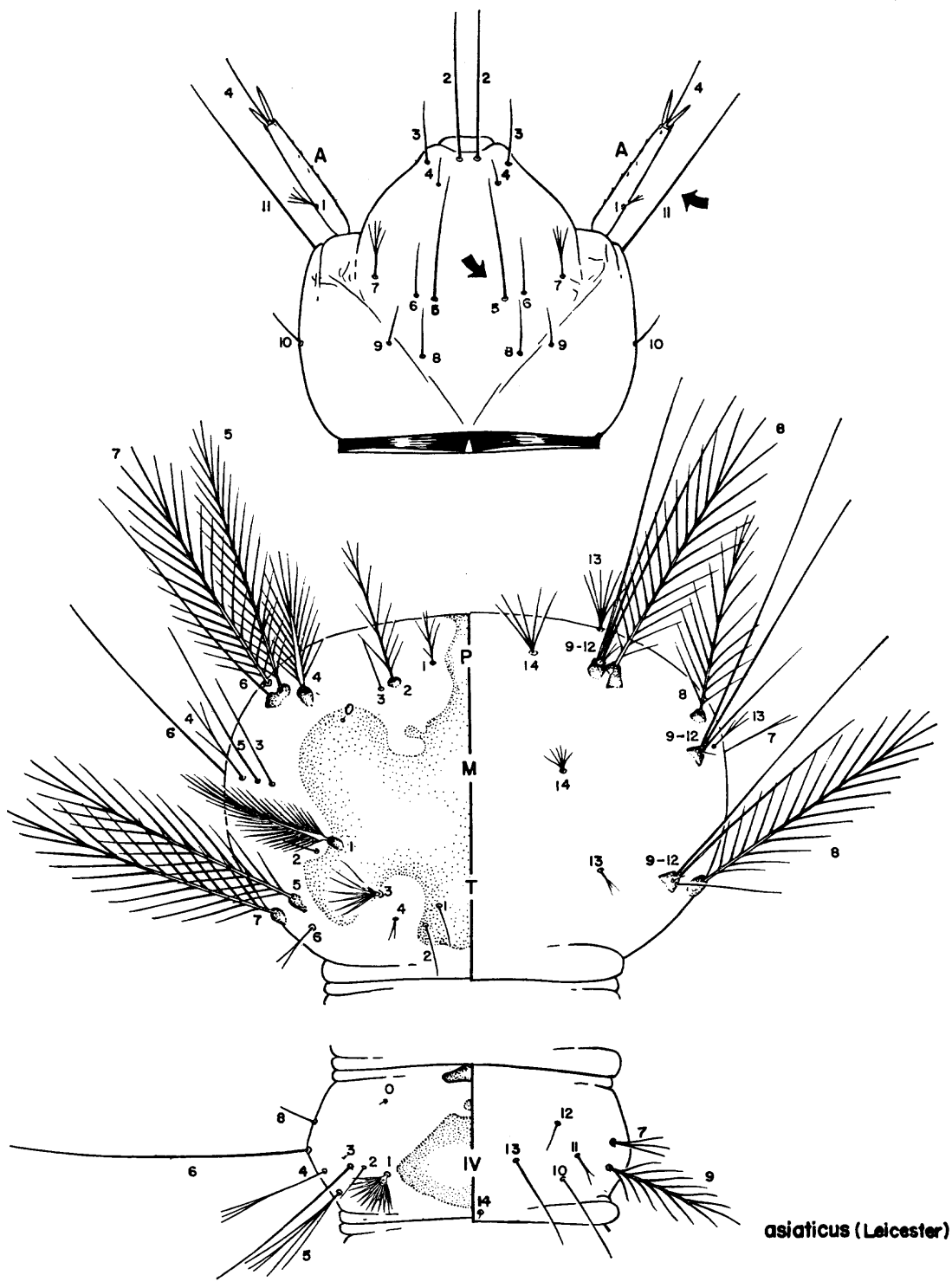
kyondawensis Abraham



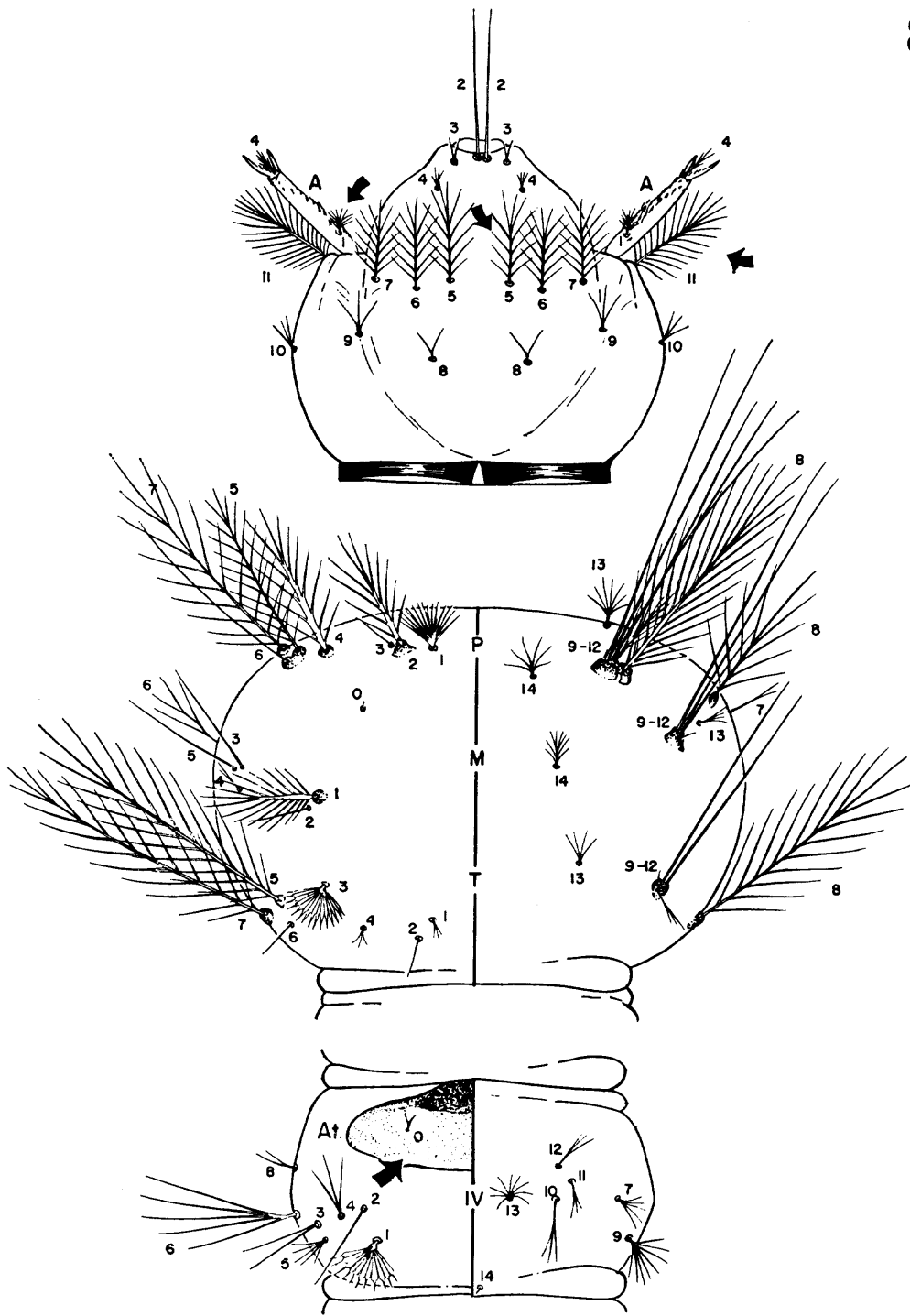
sintonoides Ho



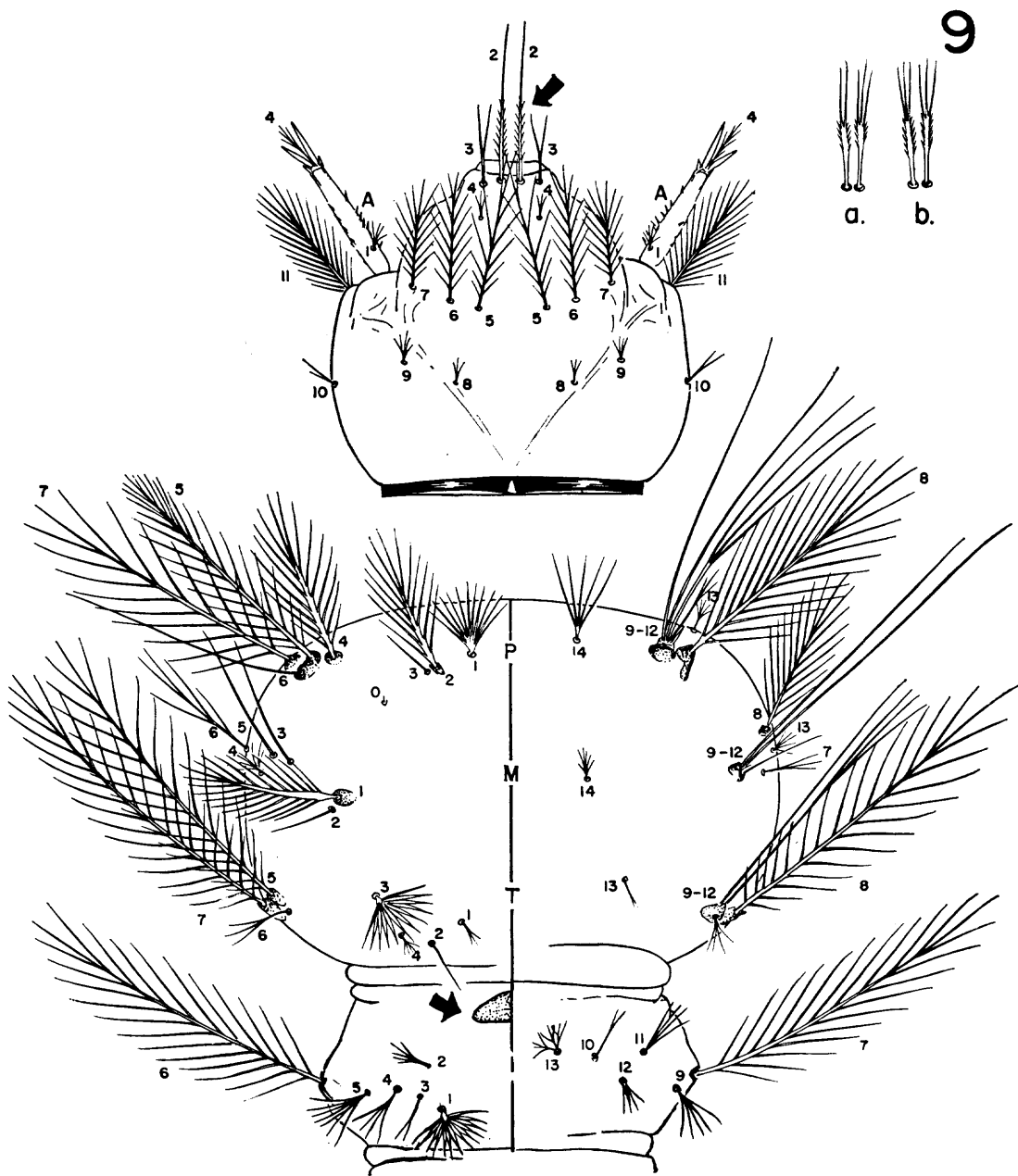
interruptus Puri



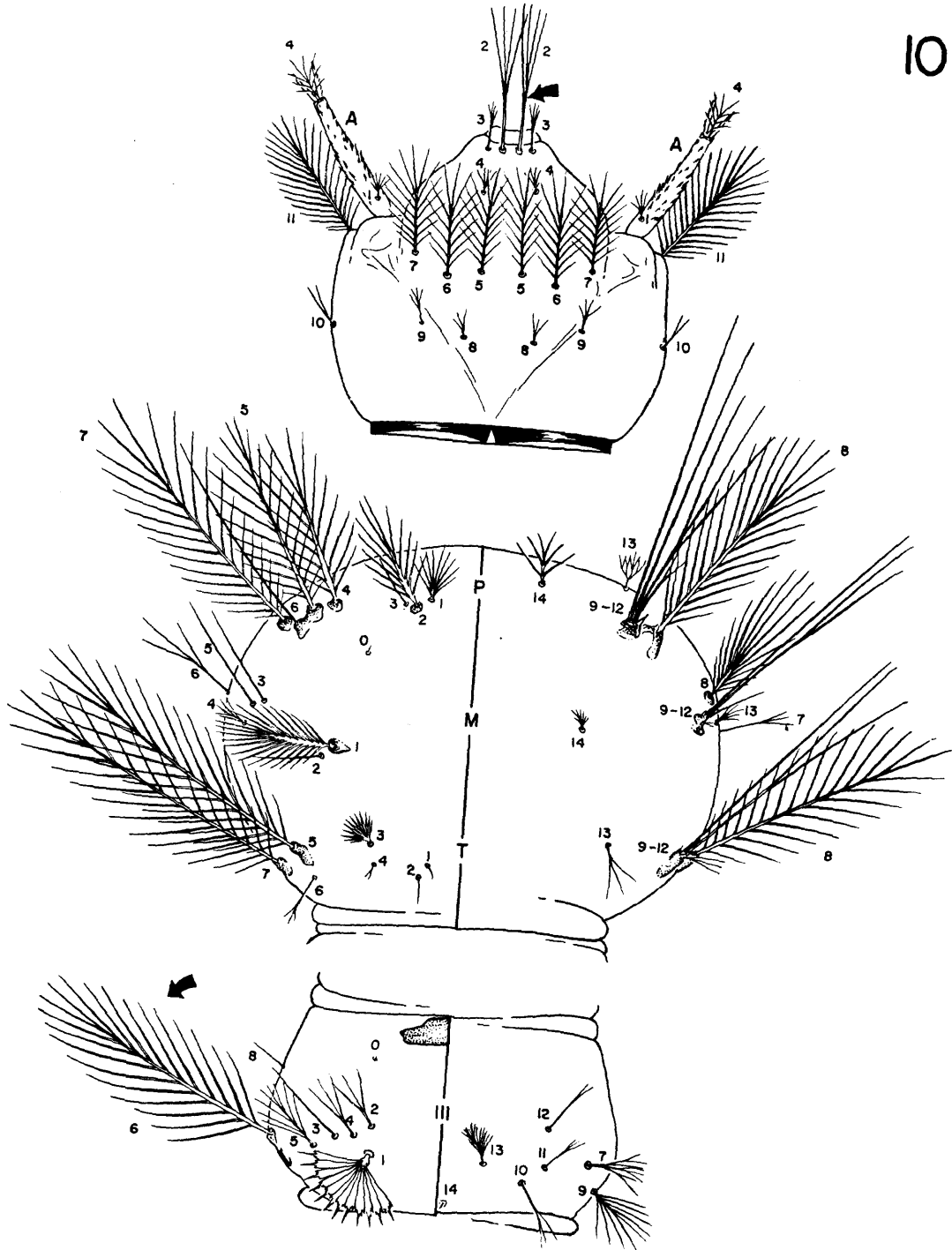
asiaticus (Leicester)



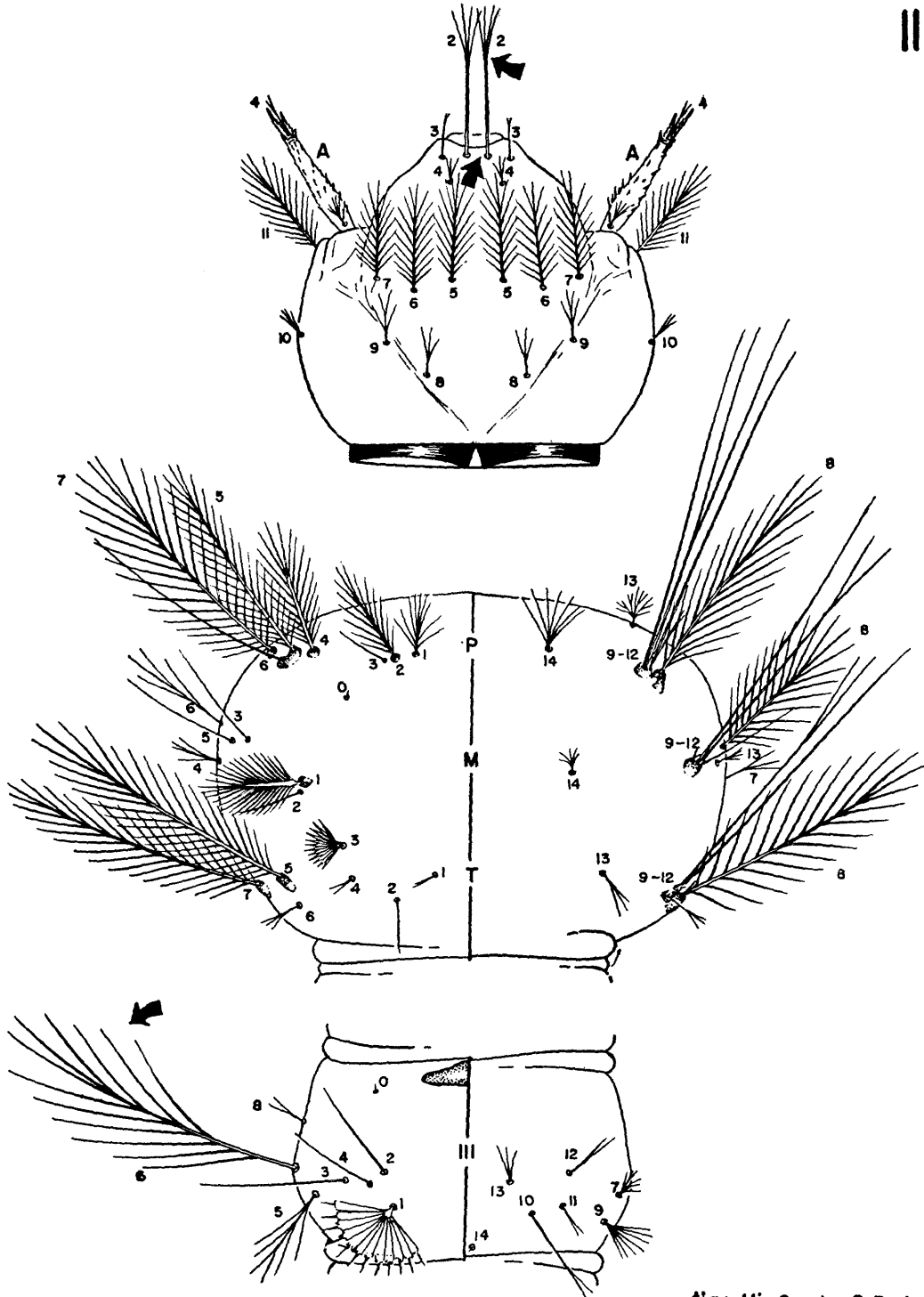
palmatus (Rodewaldt)



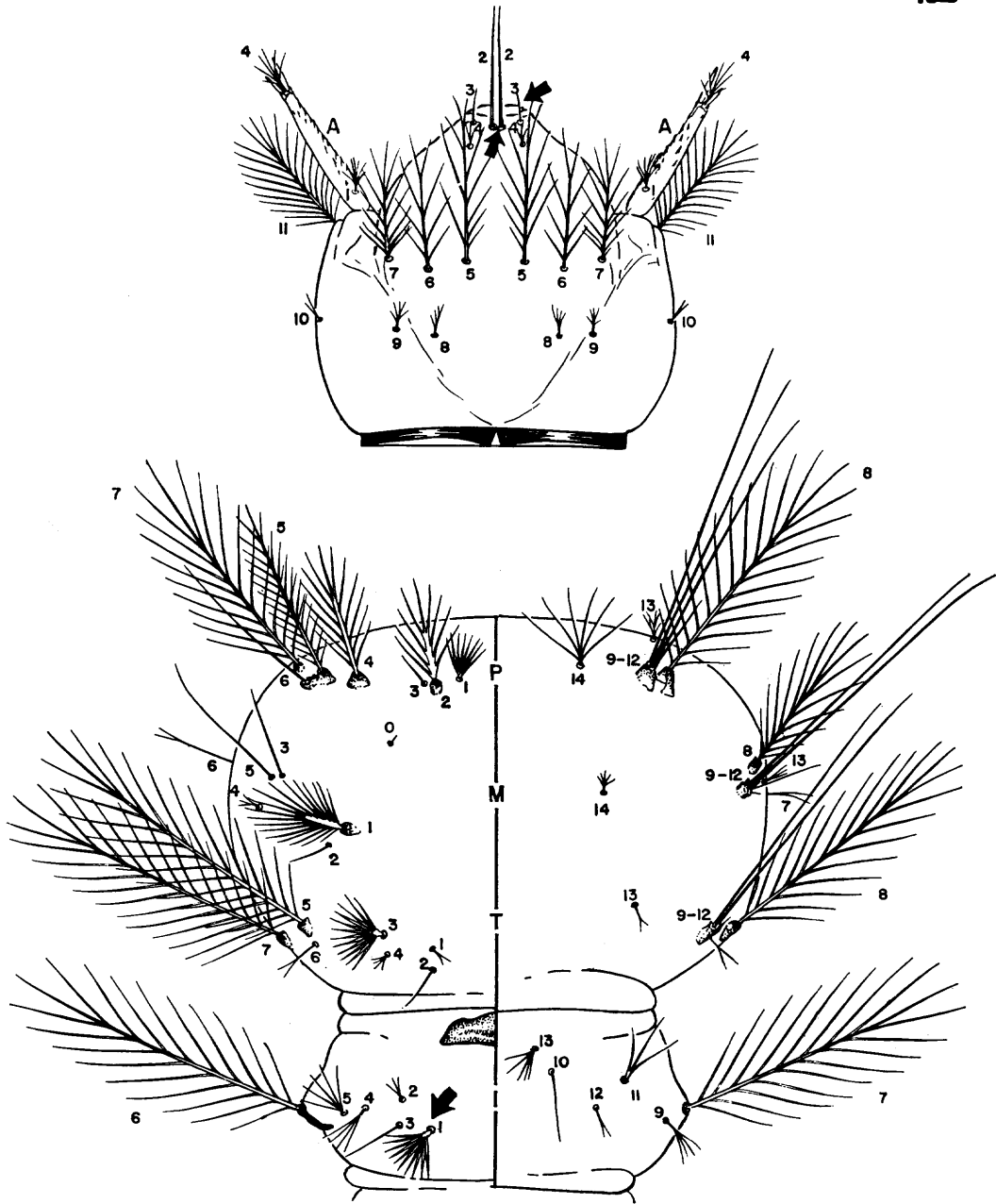
fragilis (Theobald)



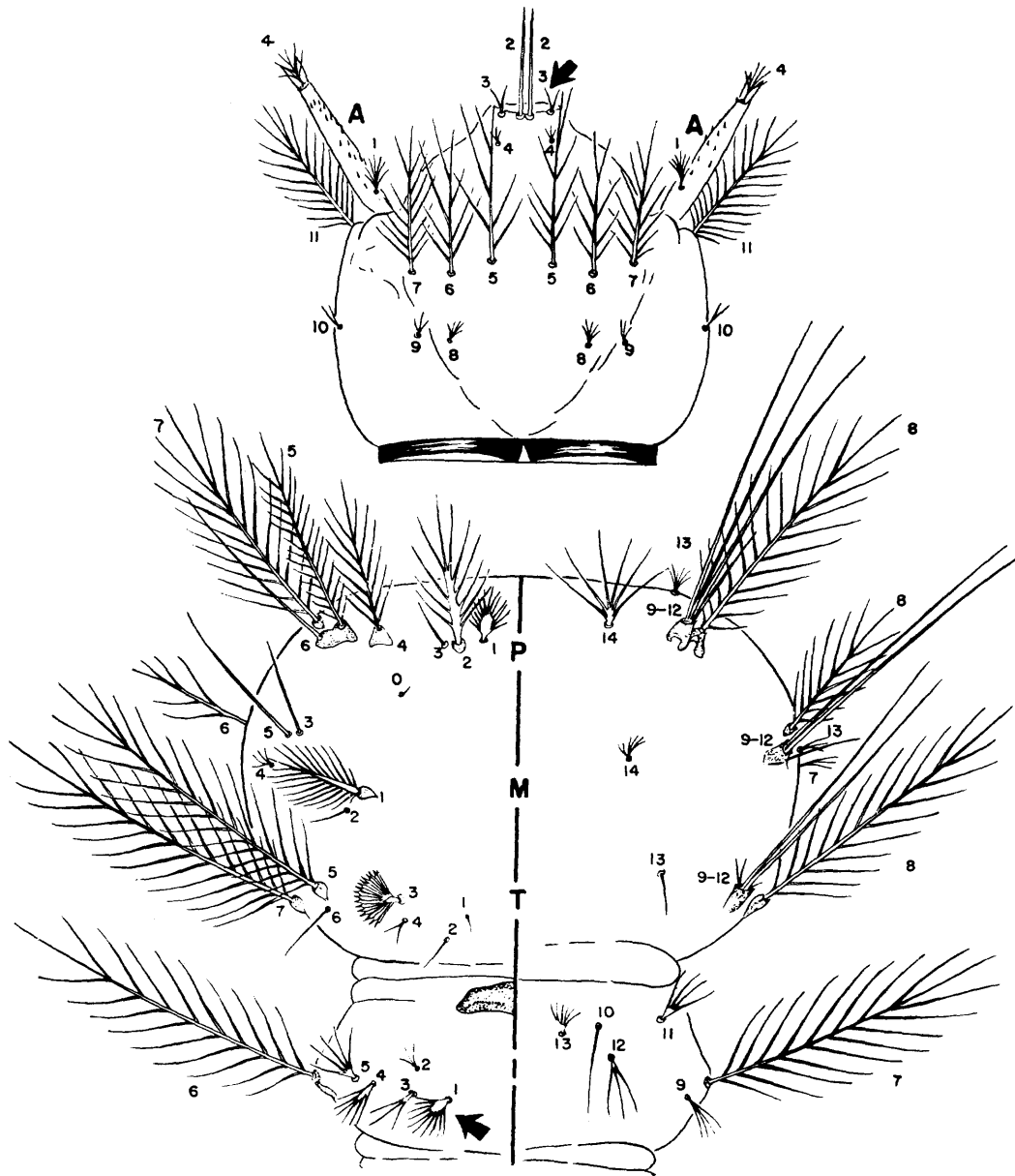
bengalensis Puri



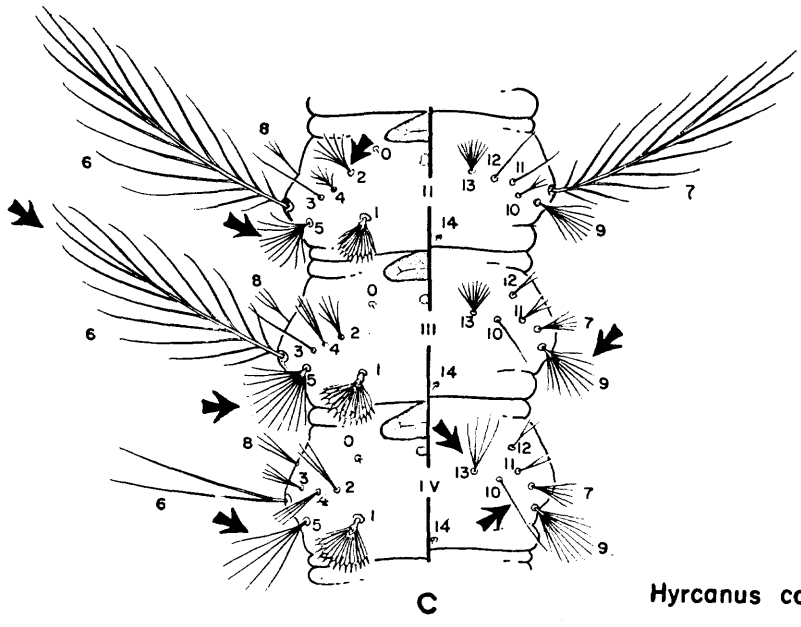
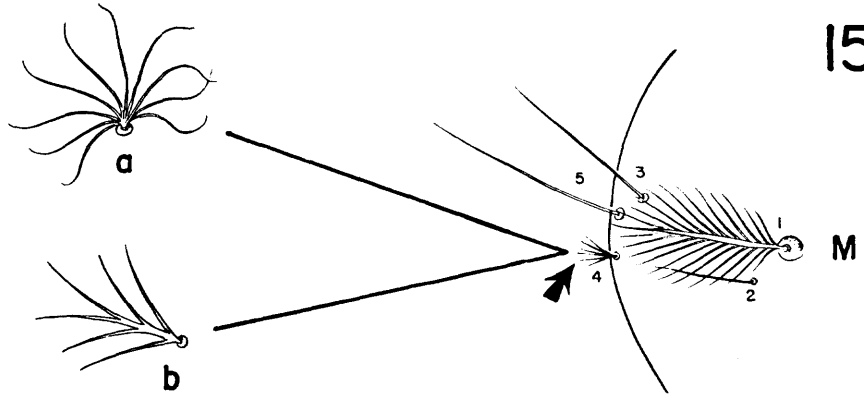
figertii Scanlon & Peyton



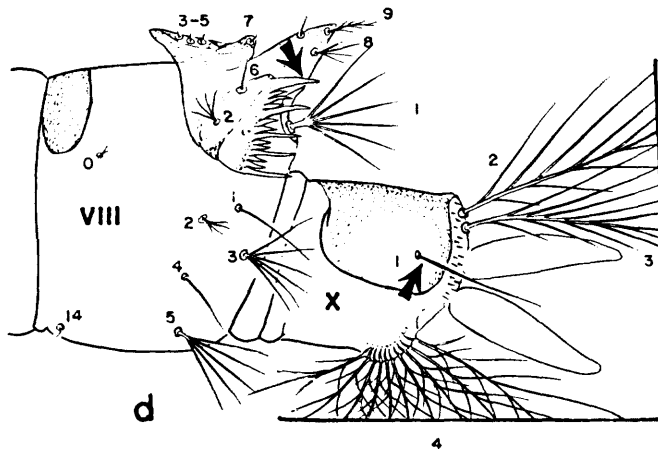
insulaeflorum (Swellengrebel & Swellengrebel de Graaf)

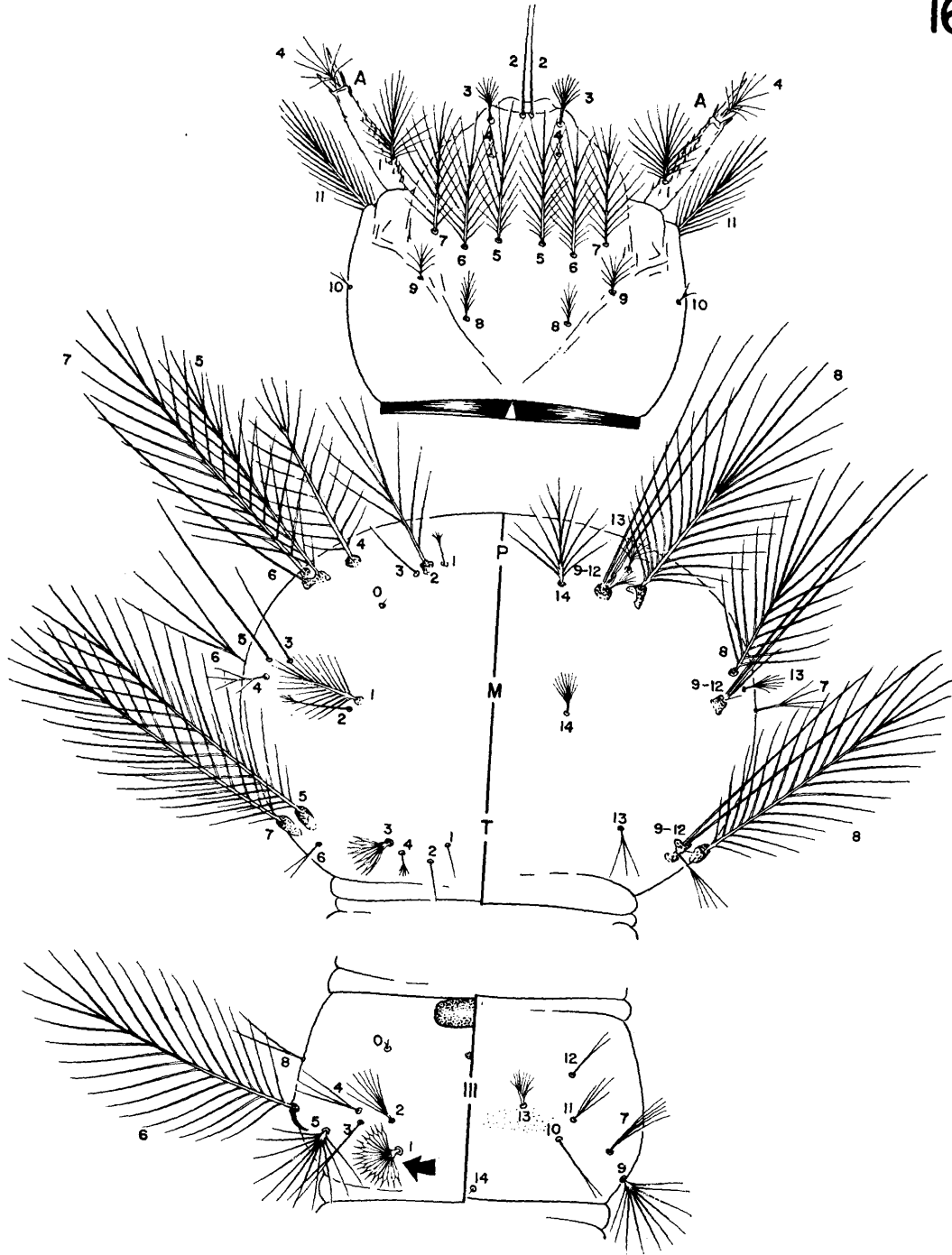


stricklandi Reid

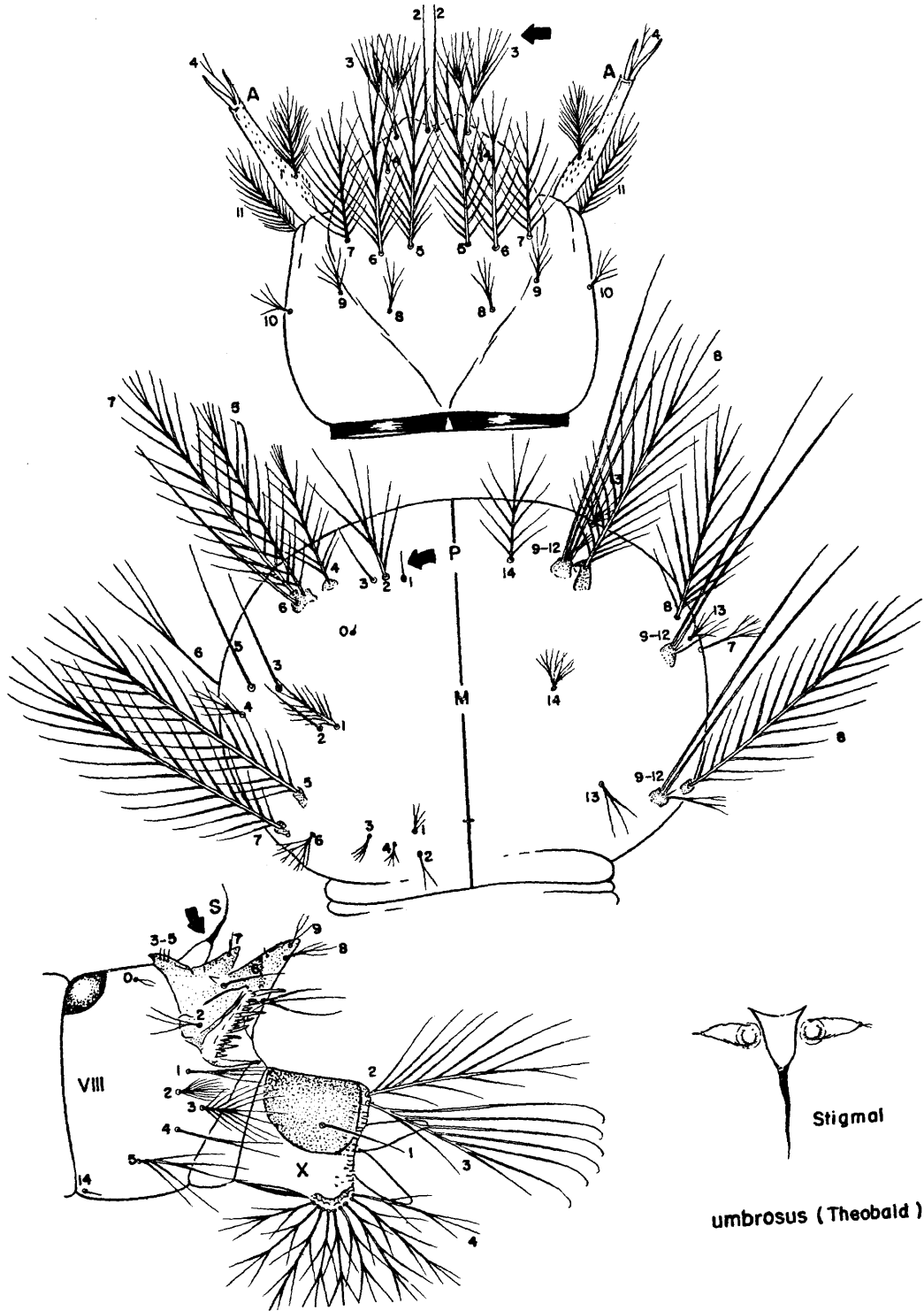


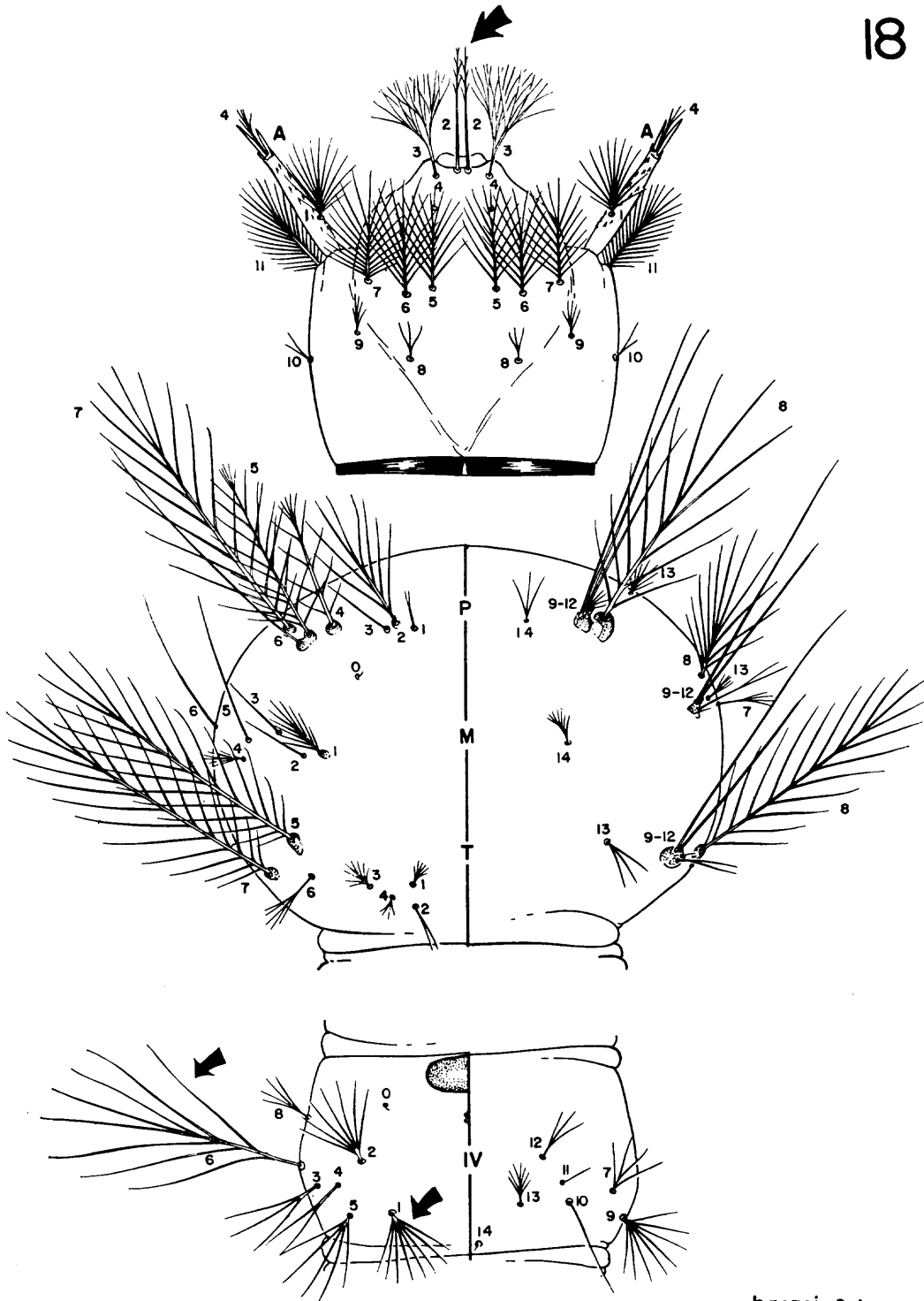
Hyrcanus complex



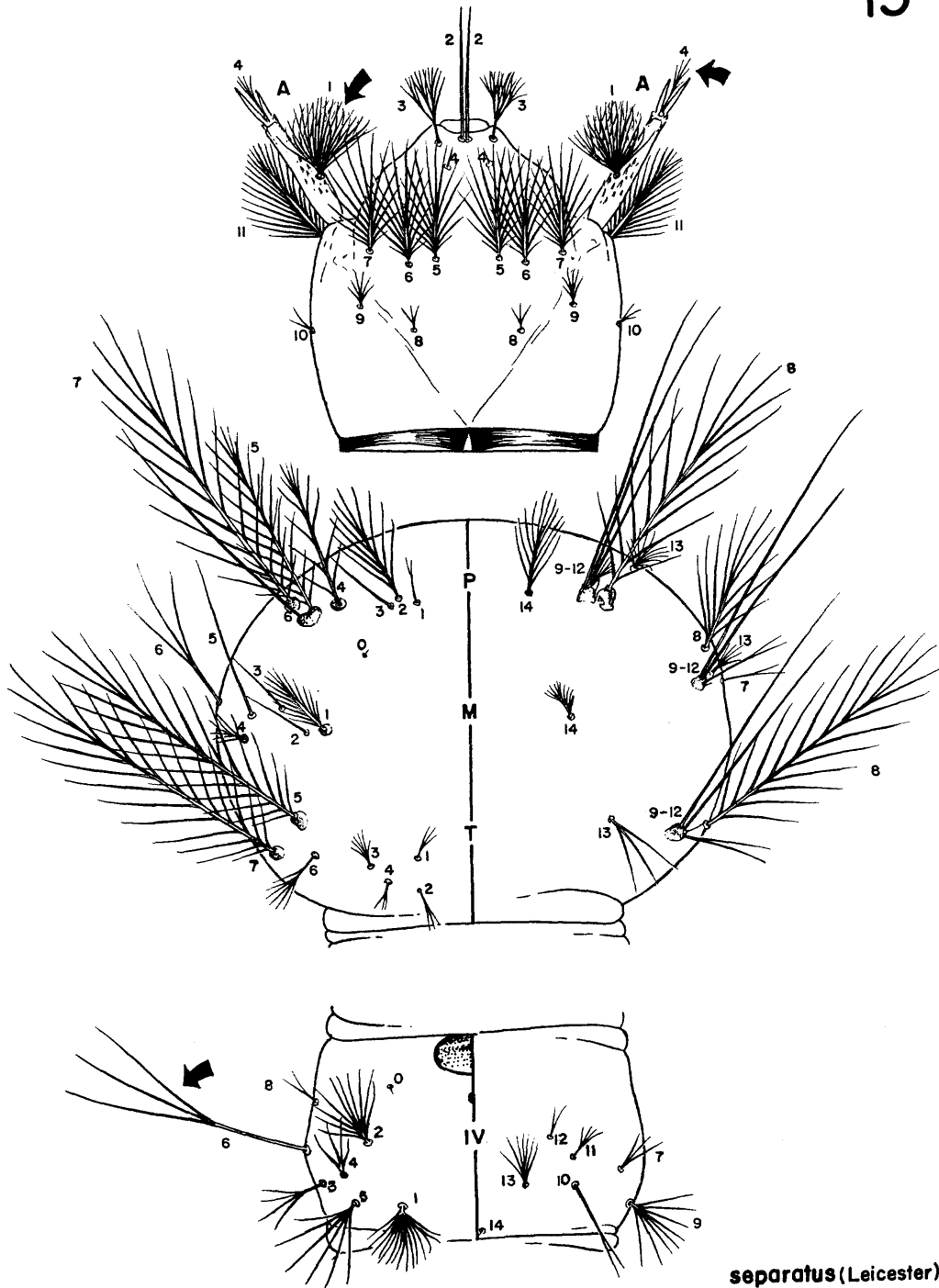


montanus Stanton & Hacker

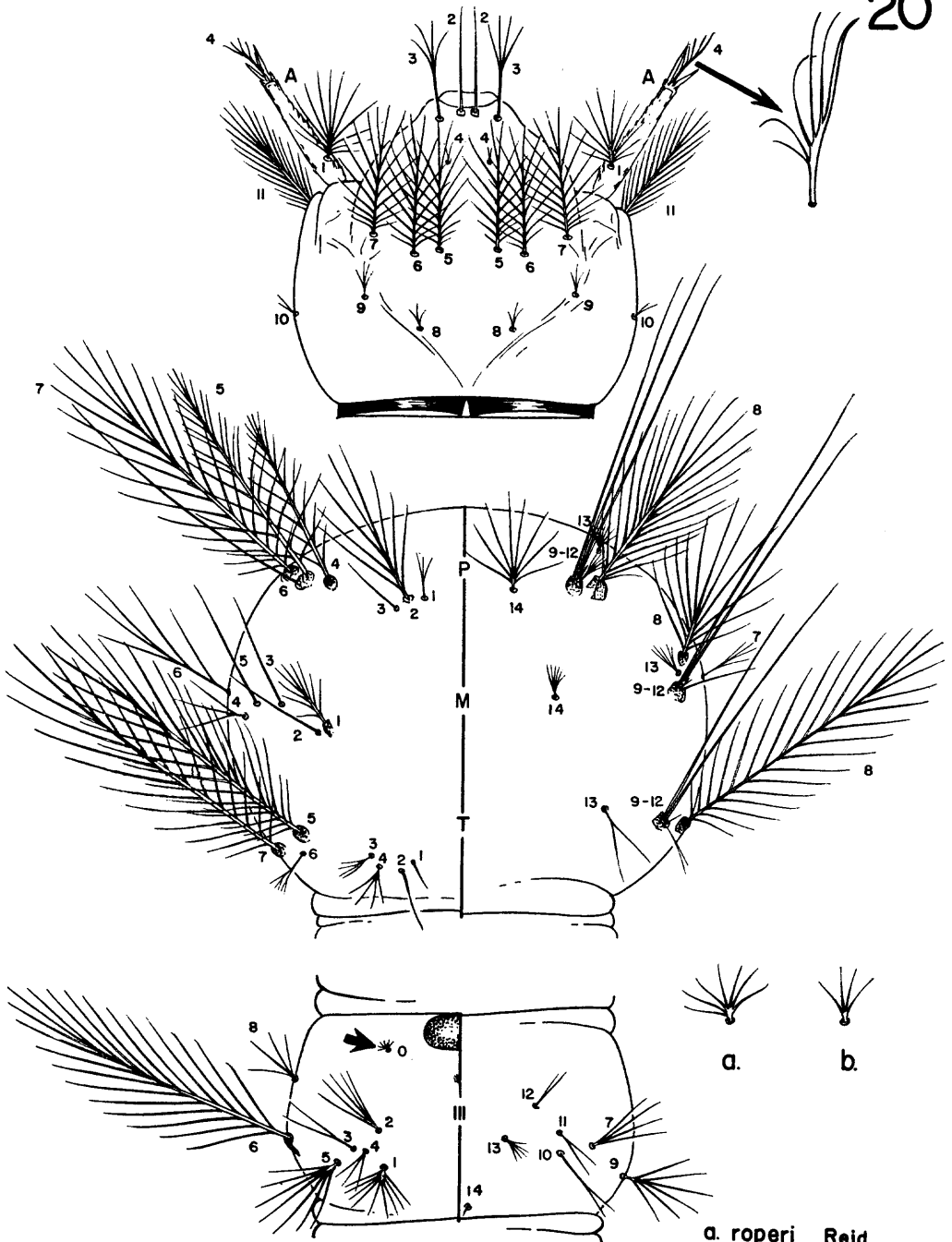




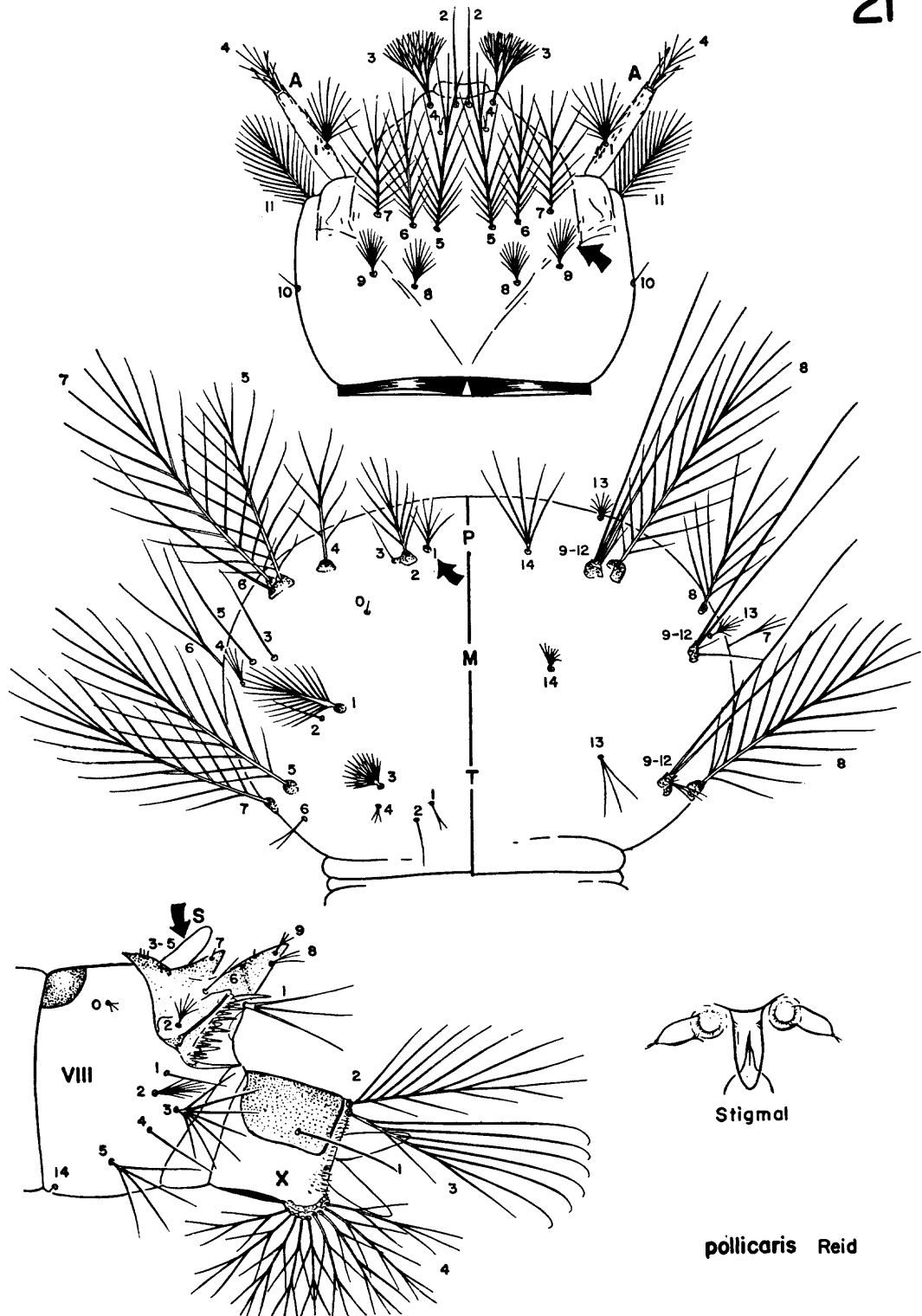
baezai Gater



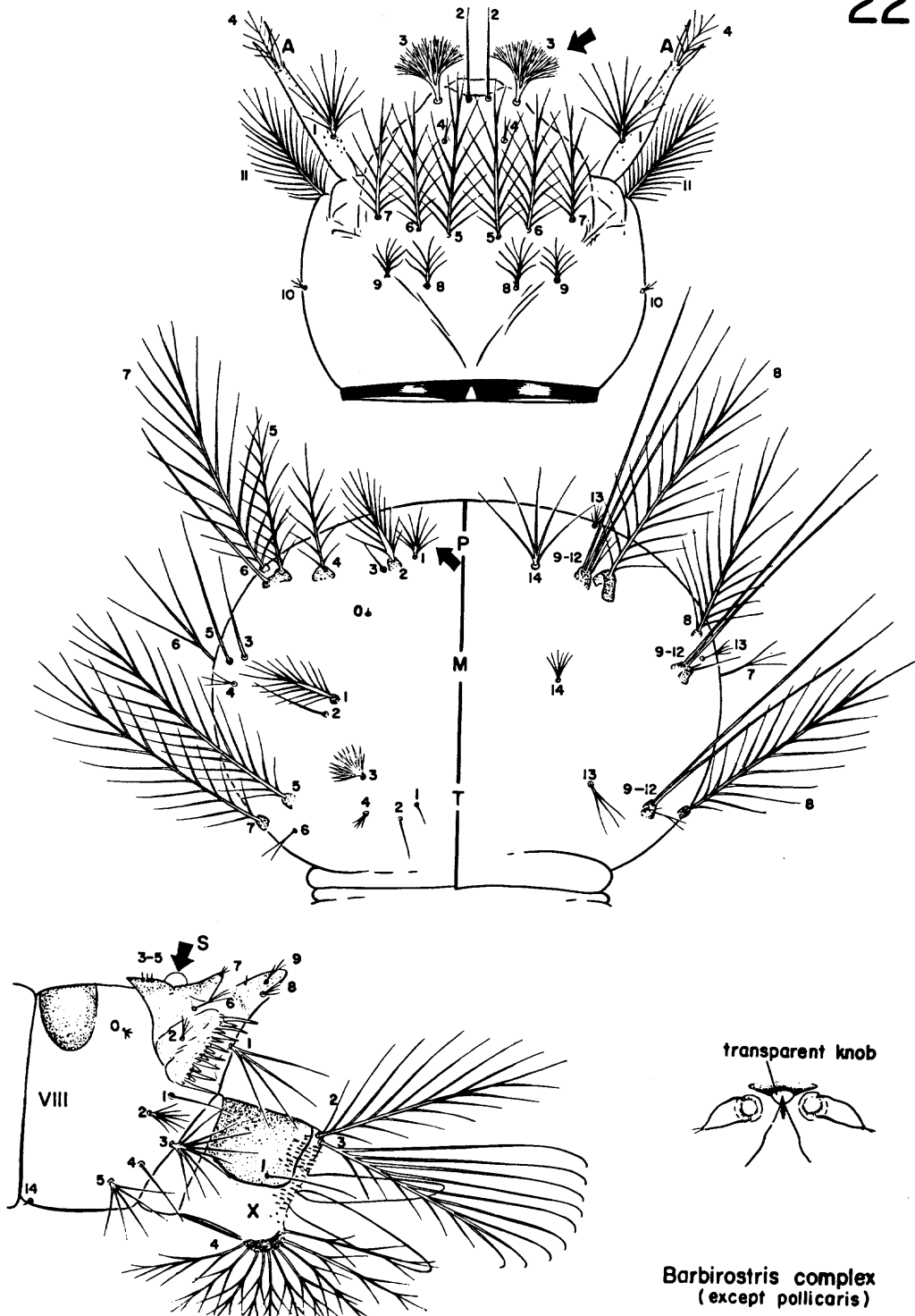
separatus (Leicester)



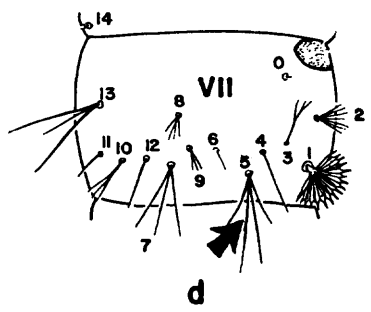
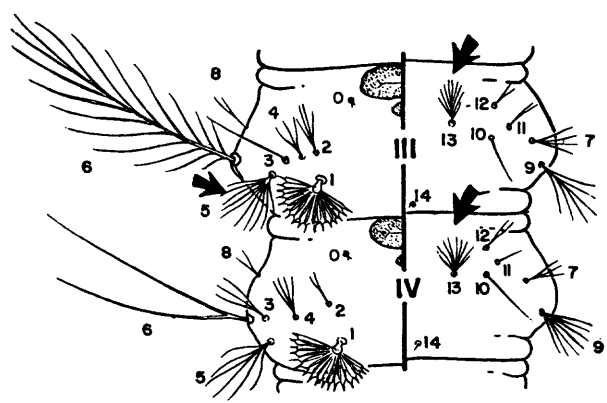
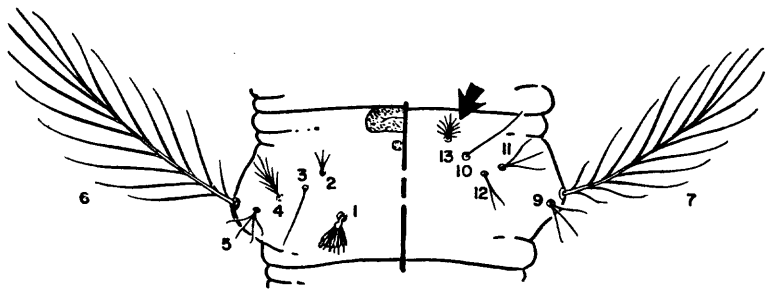
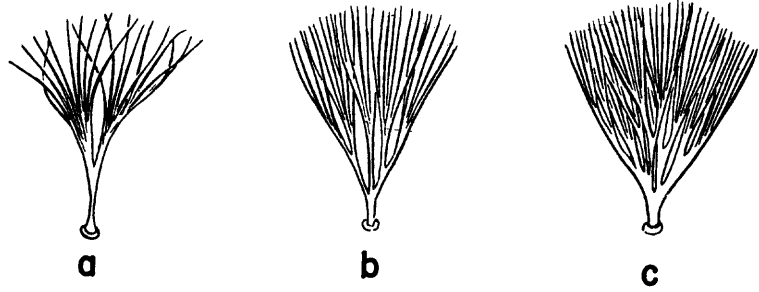
a. roperi Reid
b. letifer Sandosham
whartoni Reid



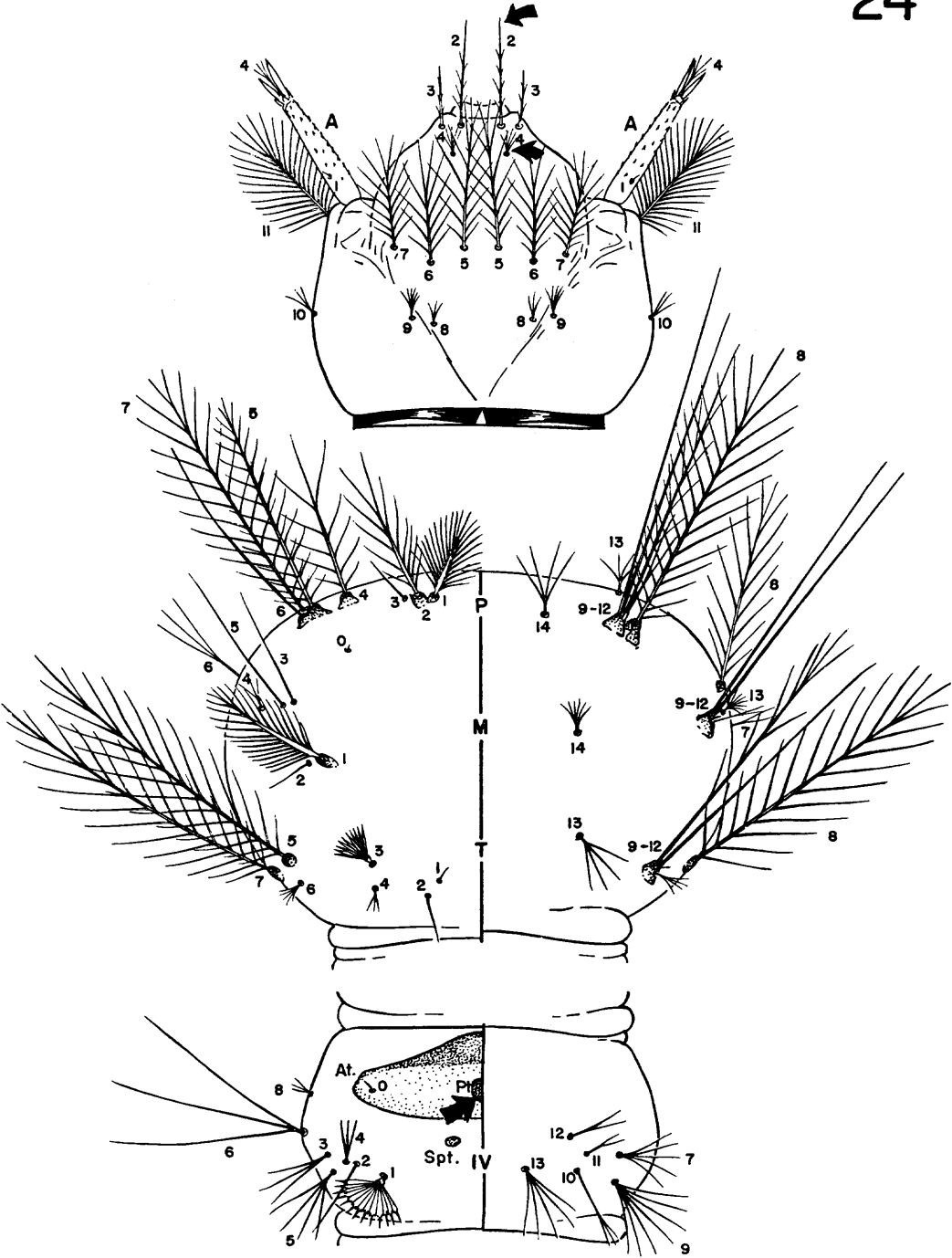
pollicaris Reid



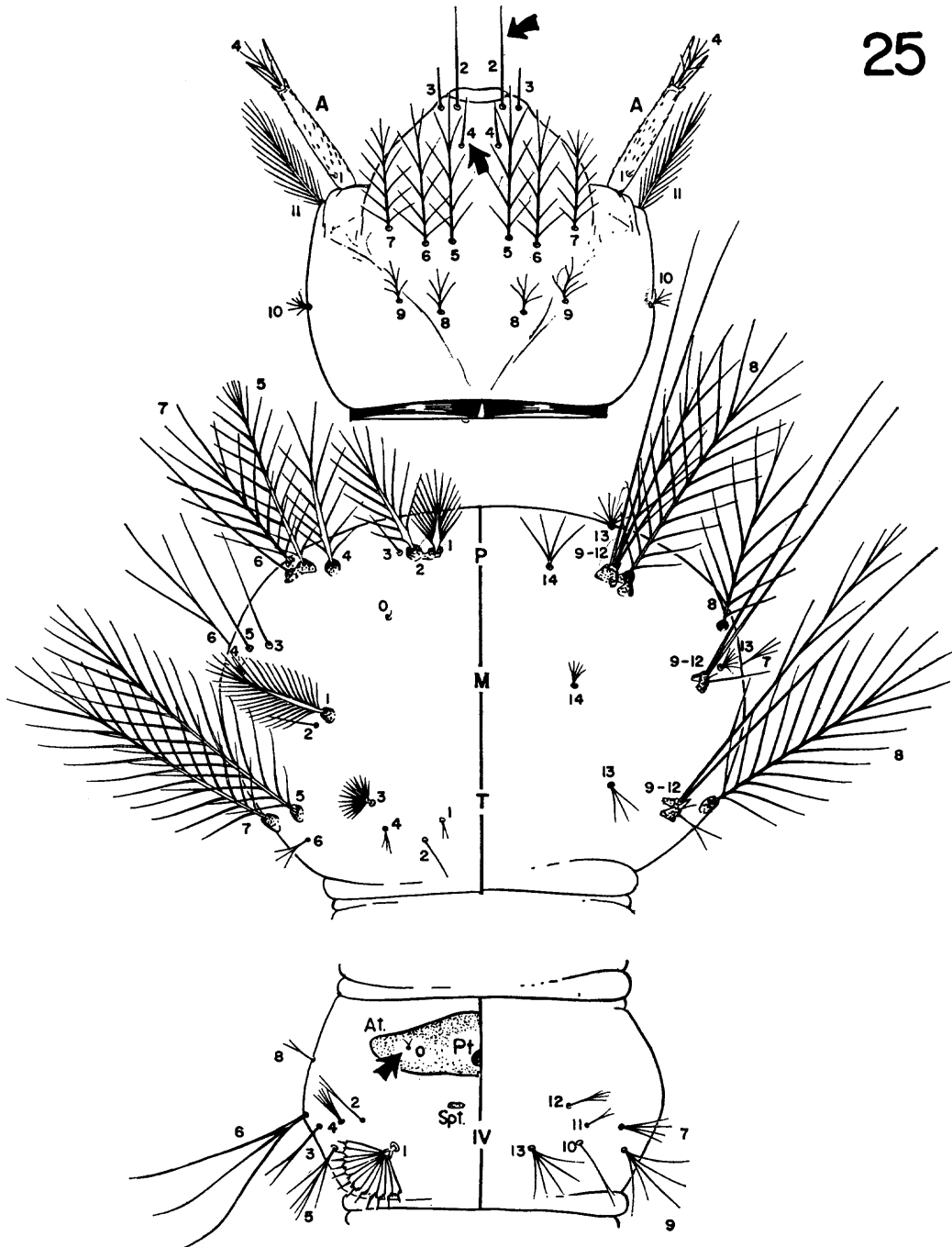
Barbirostris complex
(except *pollicaris*)

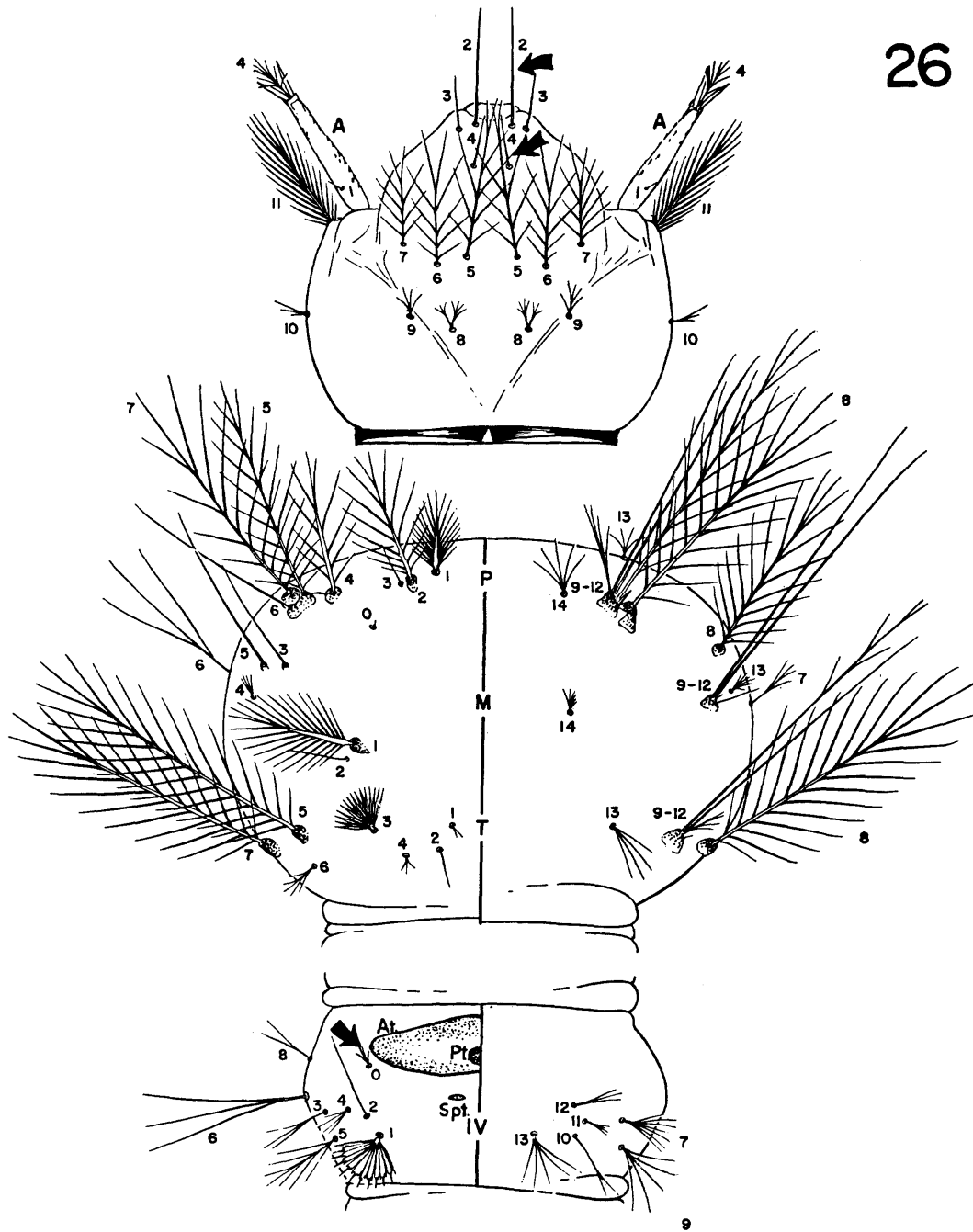


Barbirostris complex
(except pollicaris)

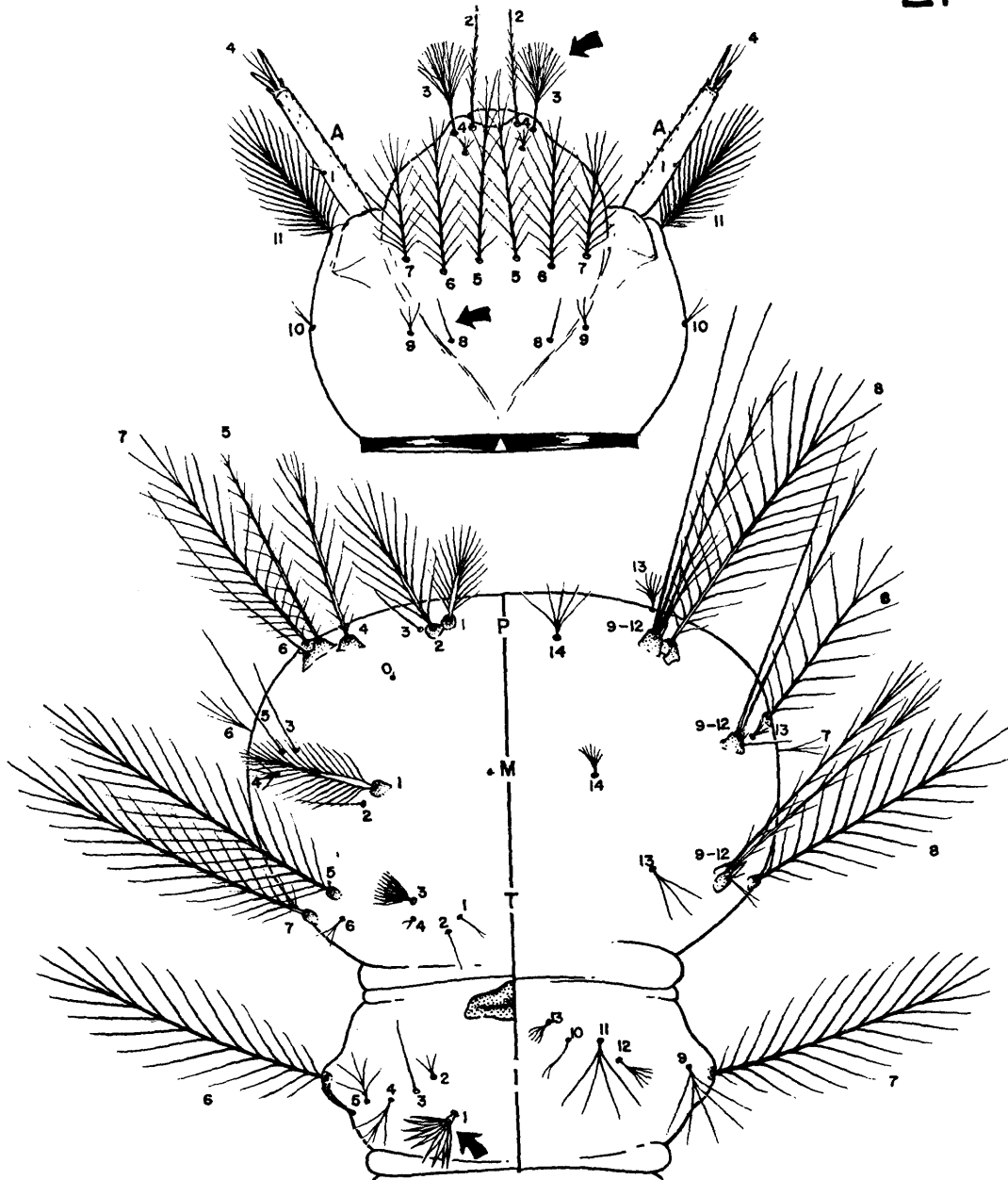


aconitum Donitz

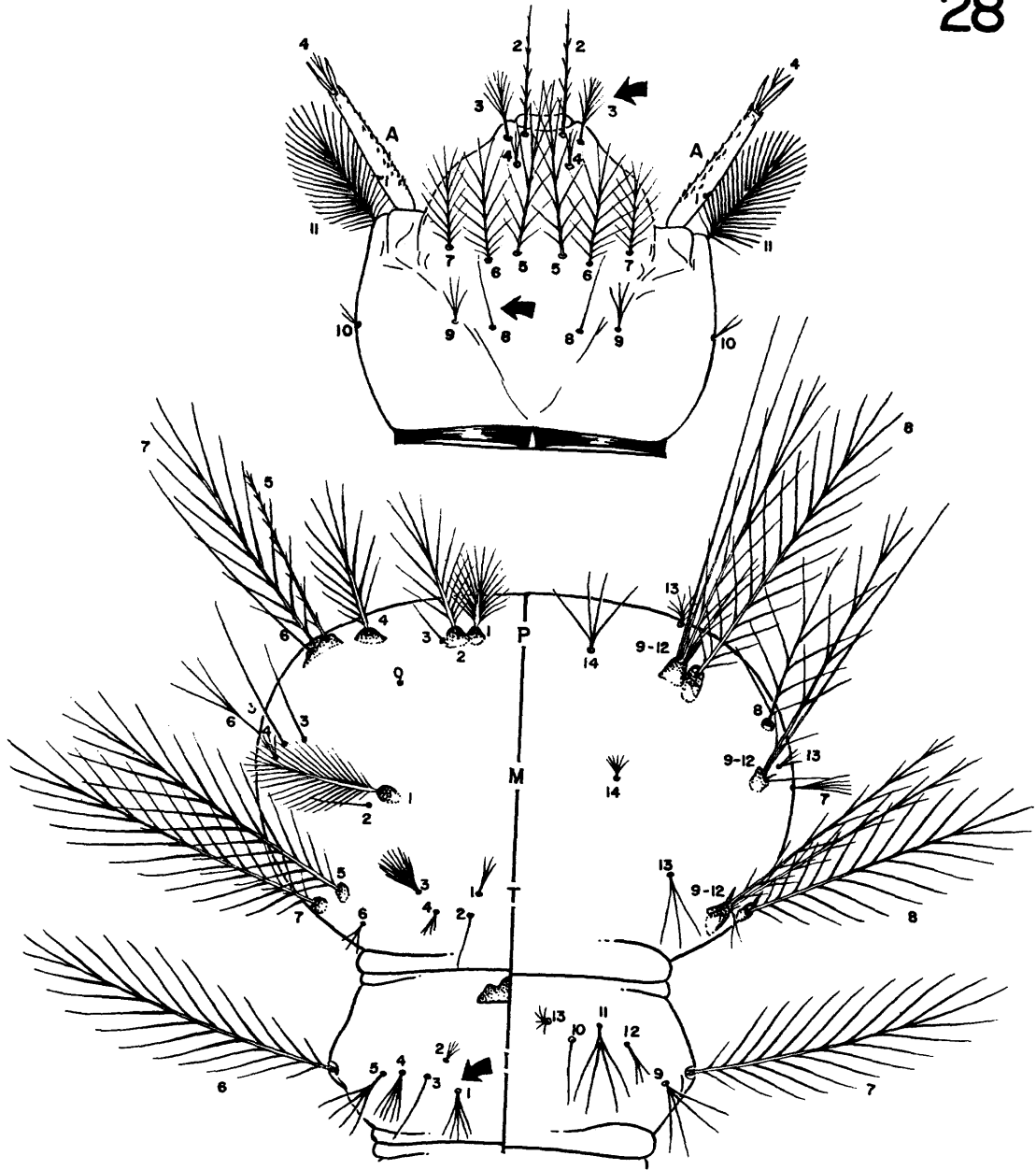




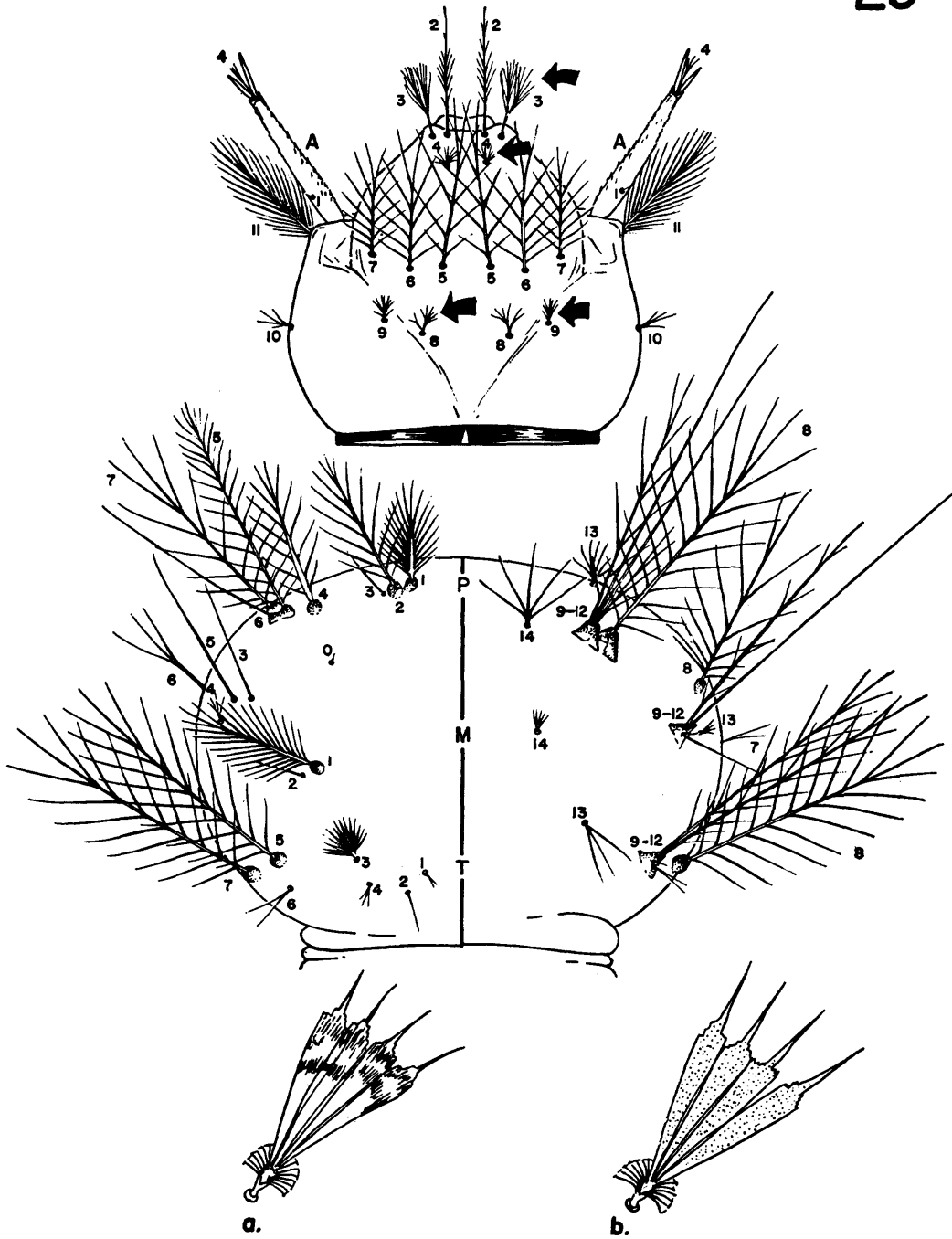
minimus Theobald



annularis Van der Wulp

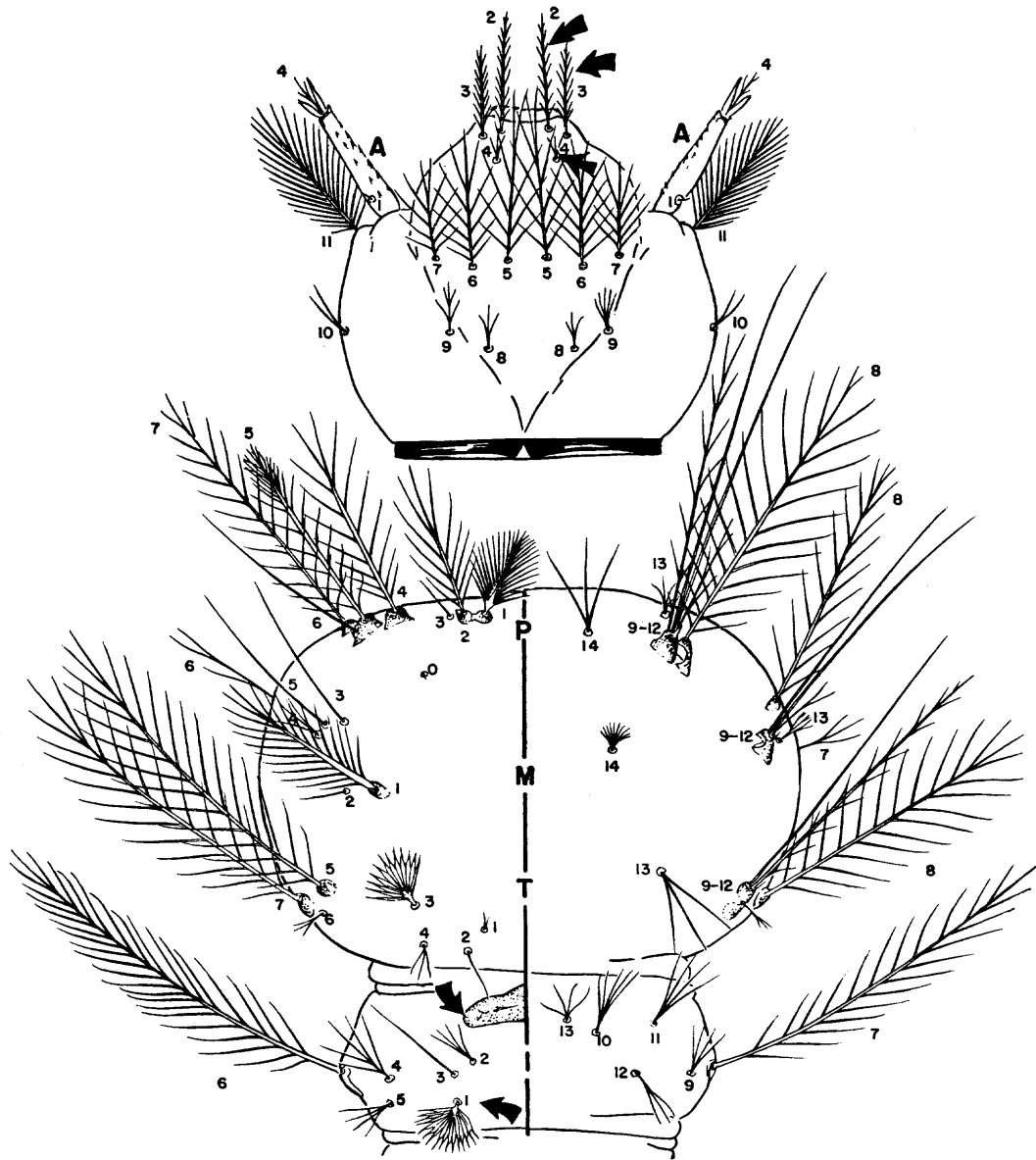


jamesii Theobald

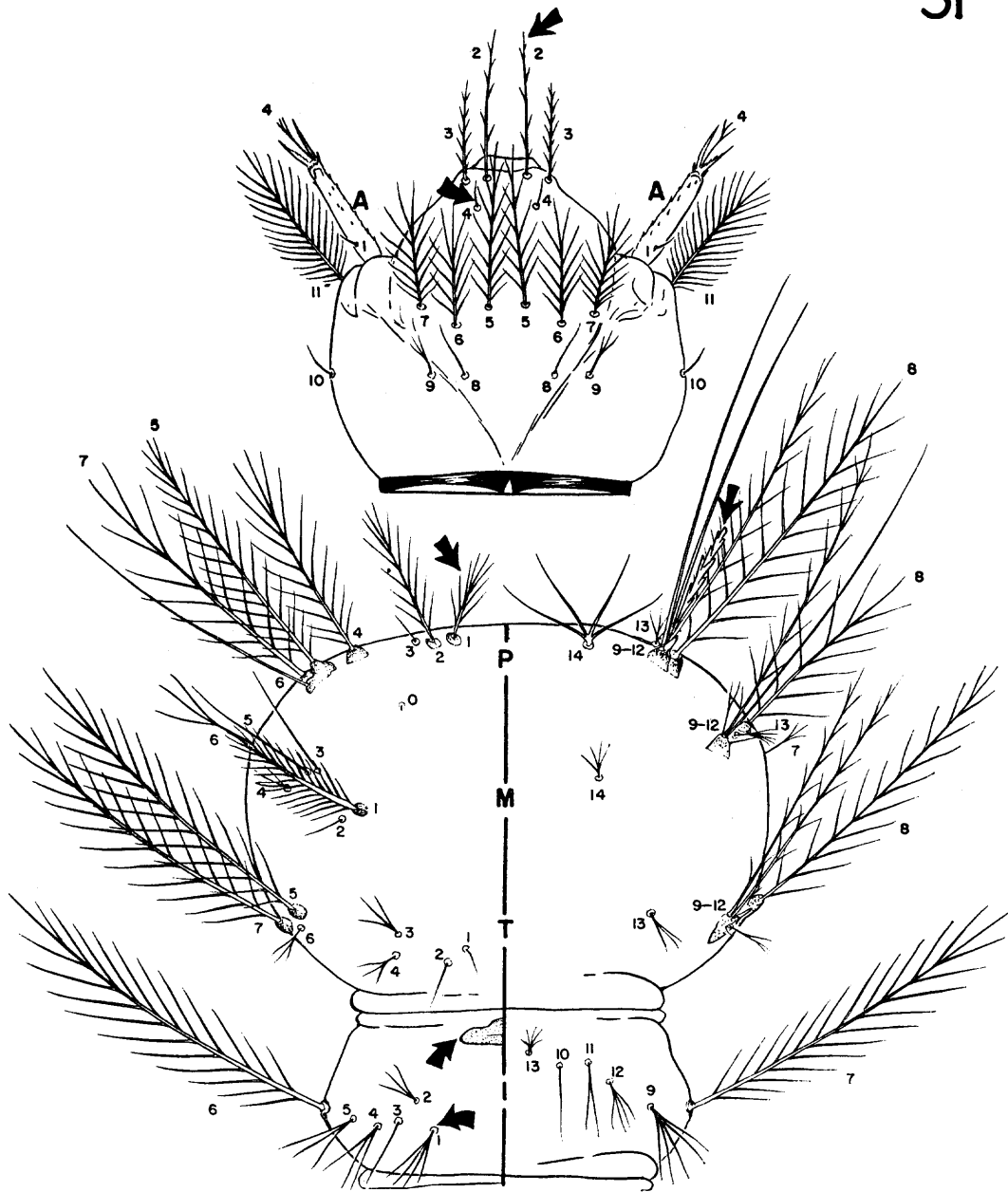


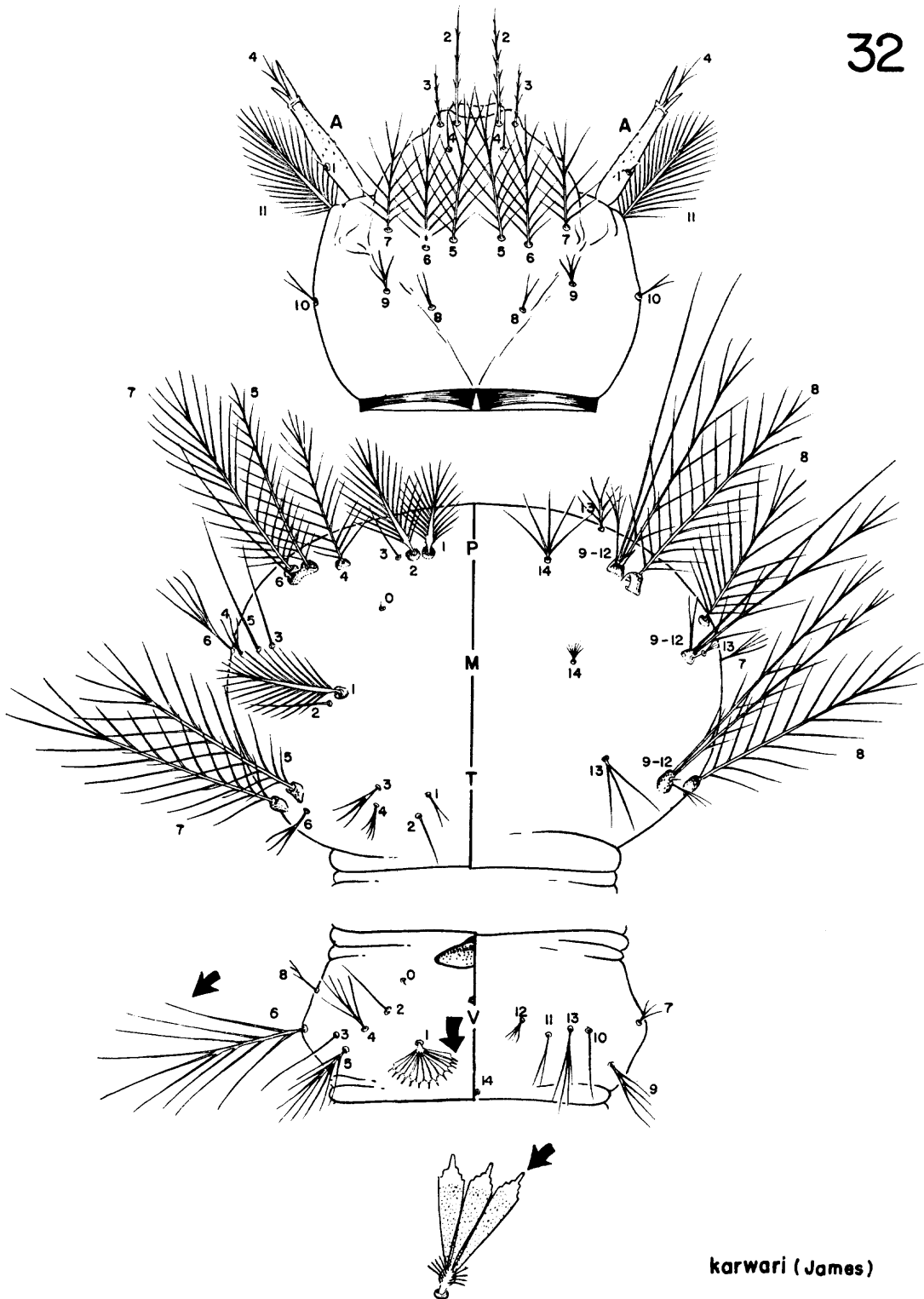
philippinensis Ludlow

nivipes Theobald

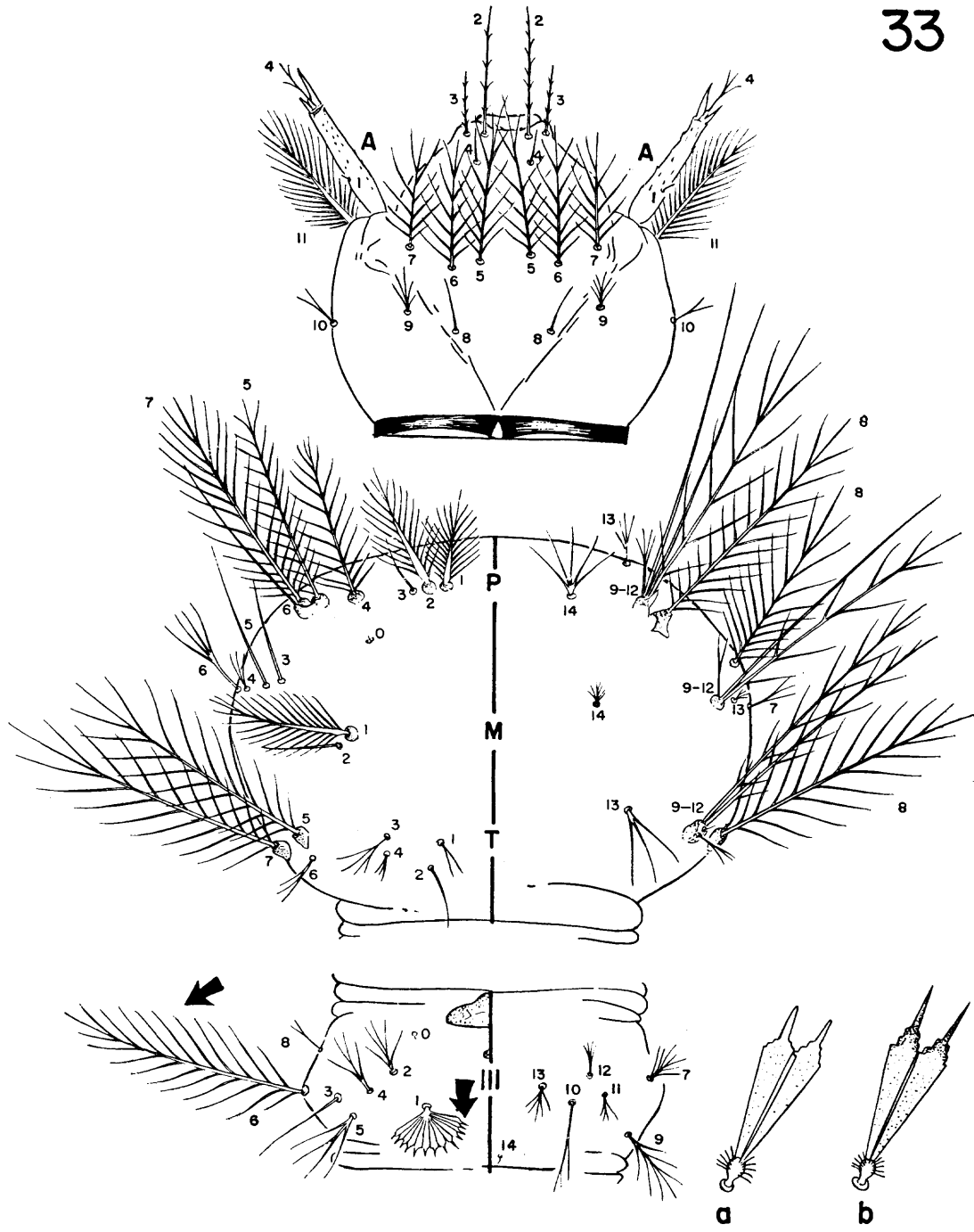


jeyporiensis James

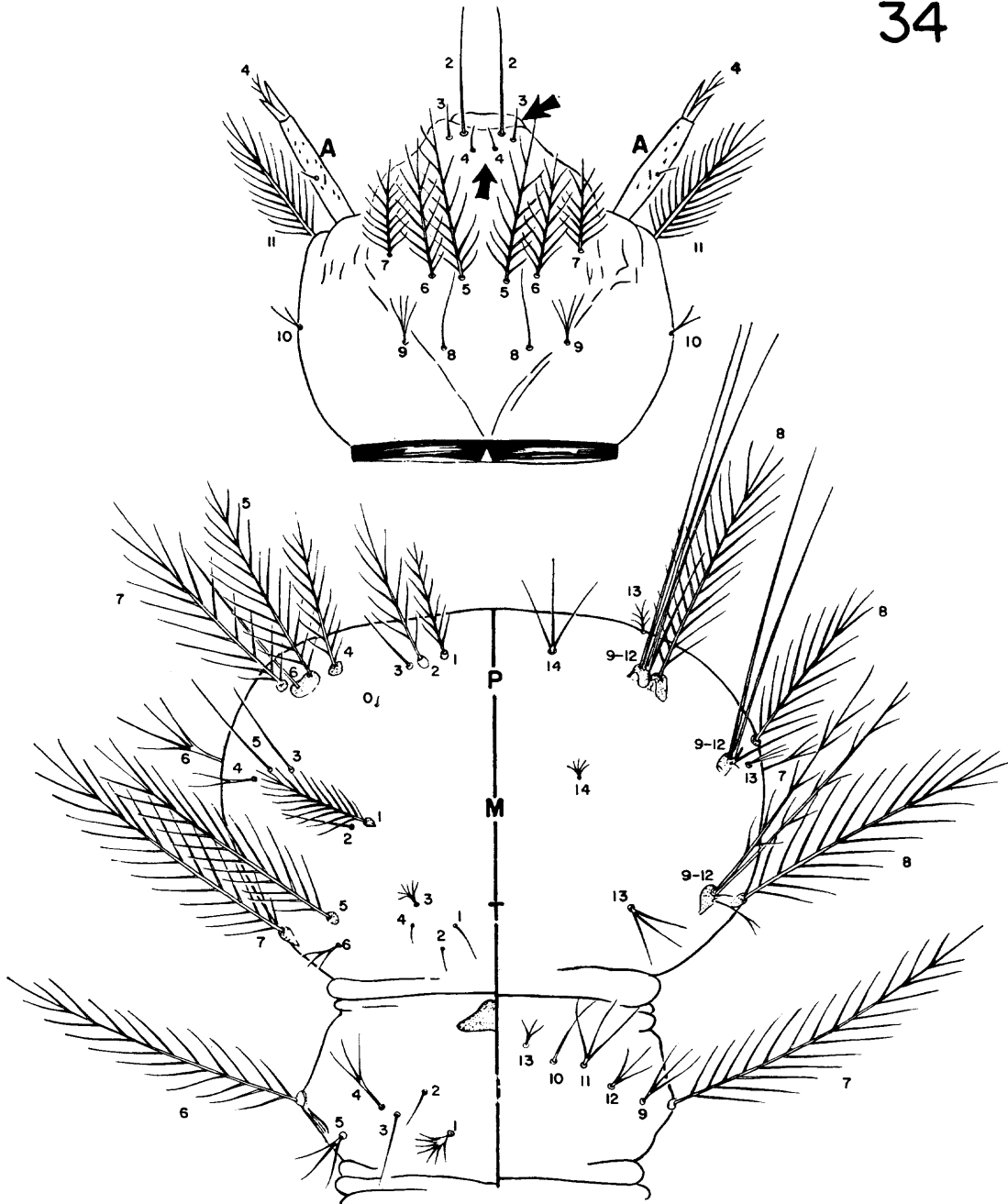




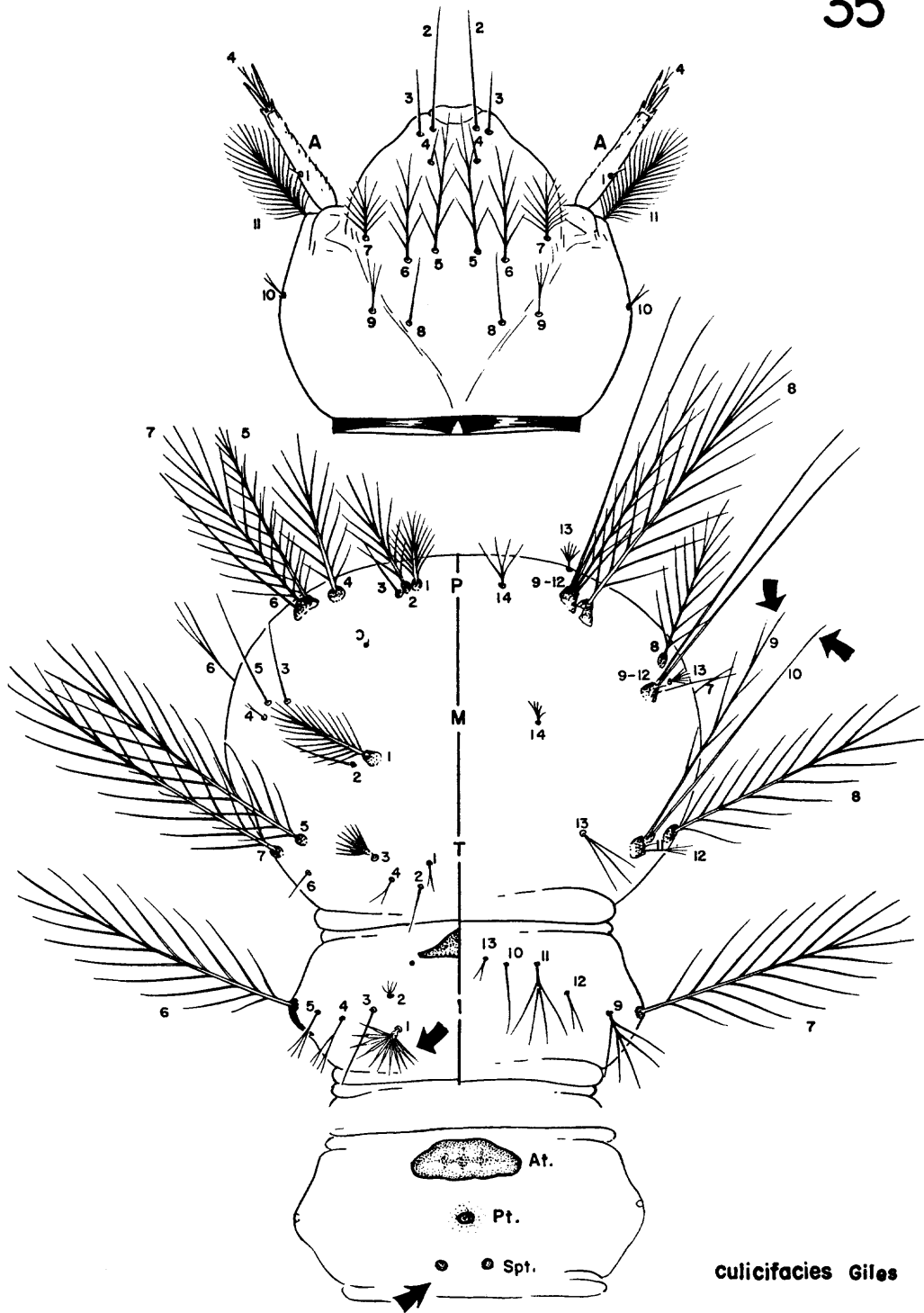
karwari (James)

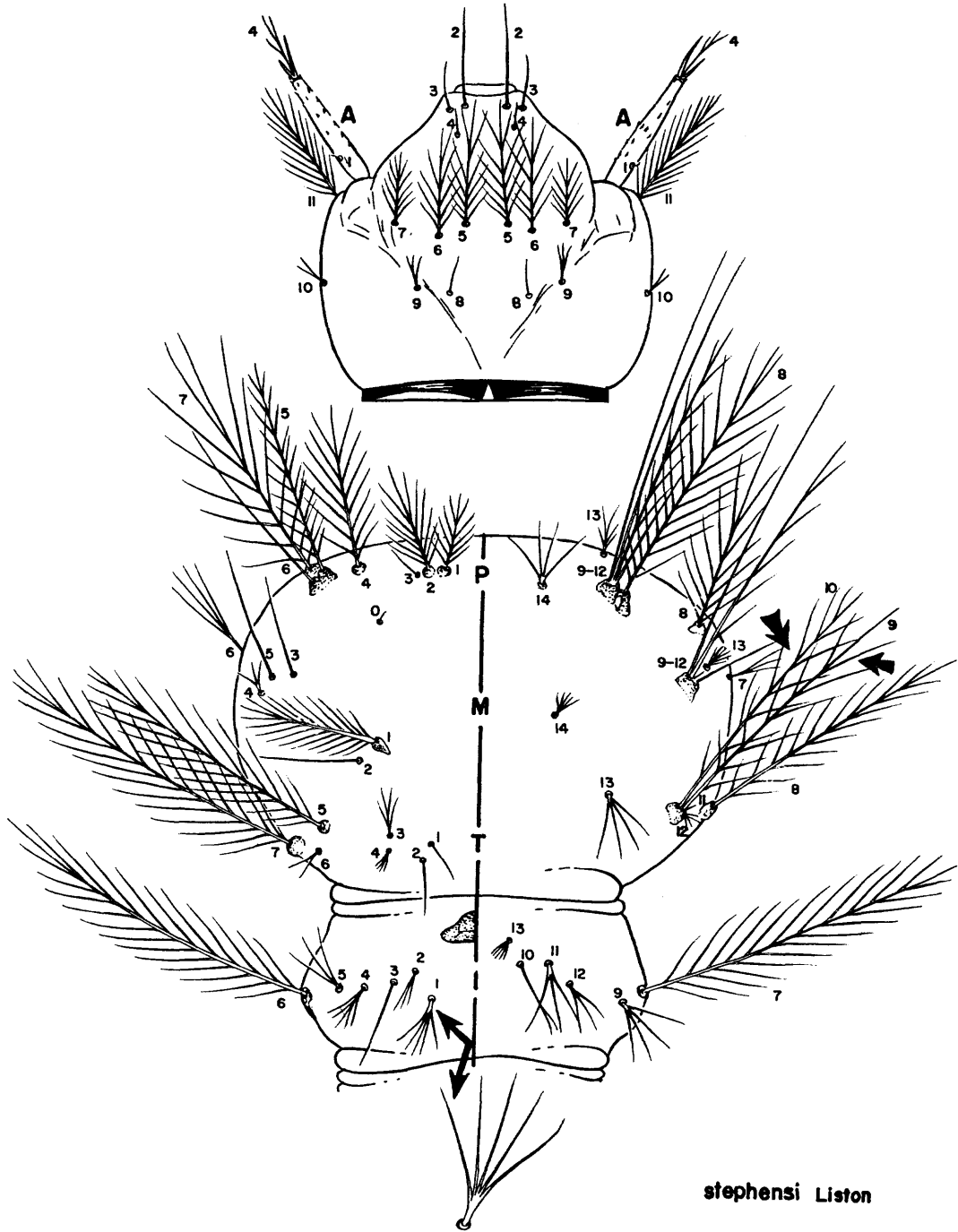


a. splendidus Koizumi **b. maculatus** Theobald

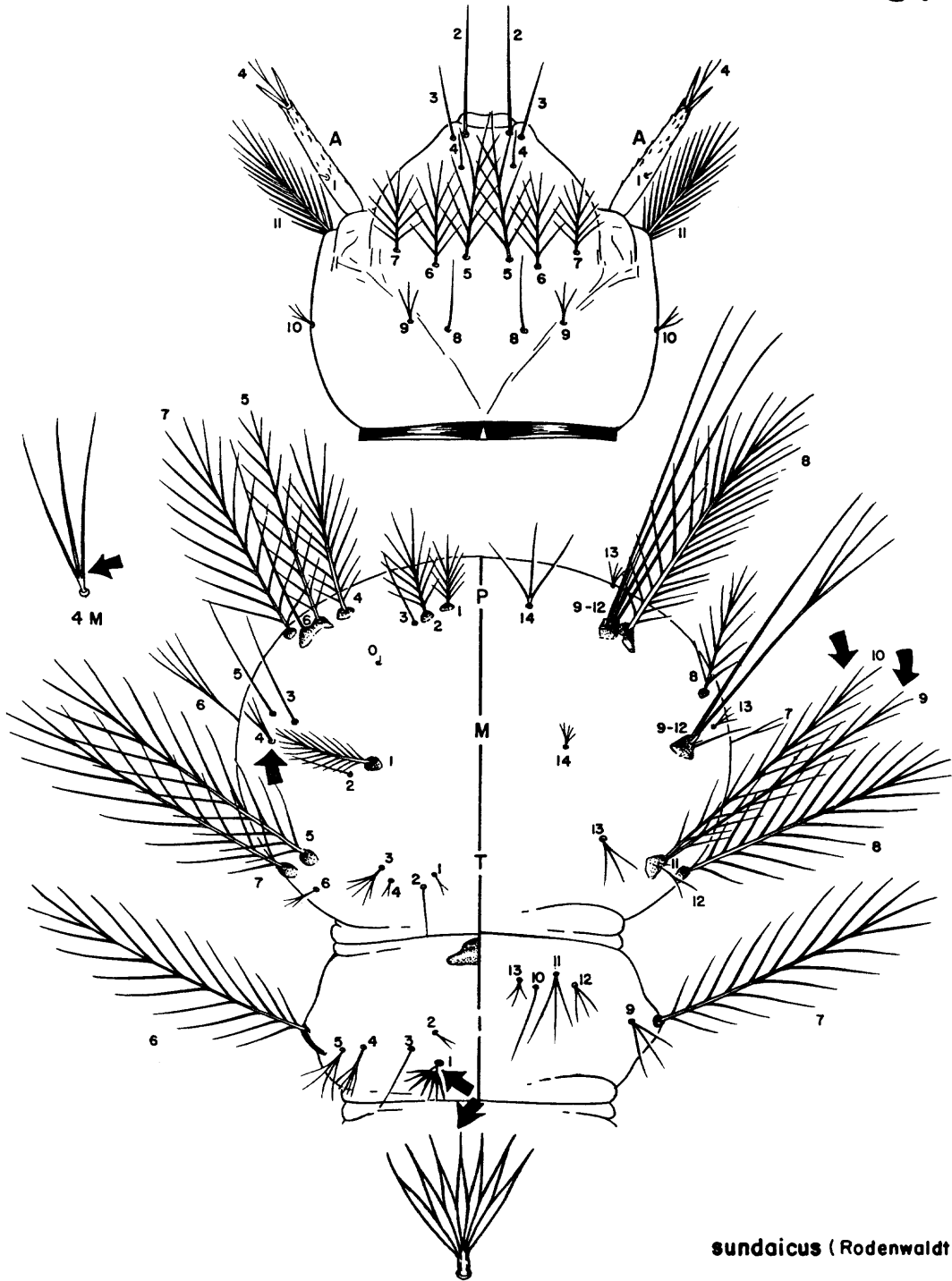


vagus Donitz

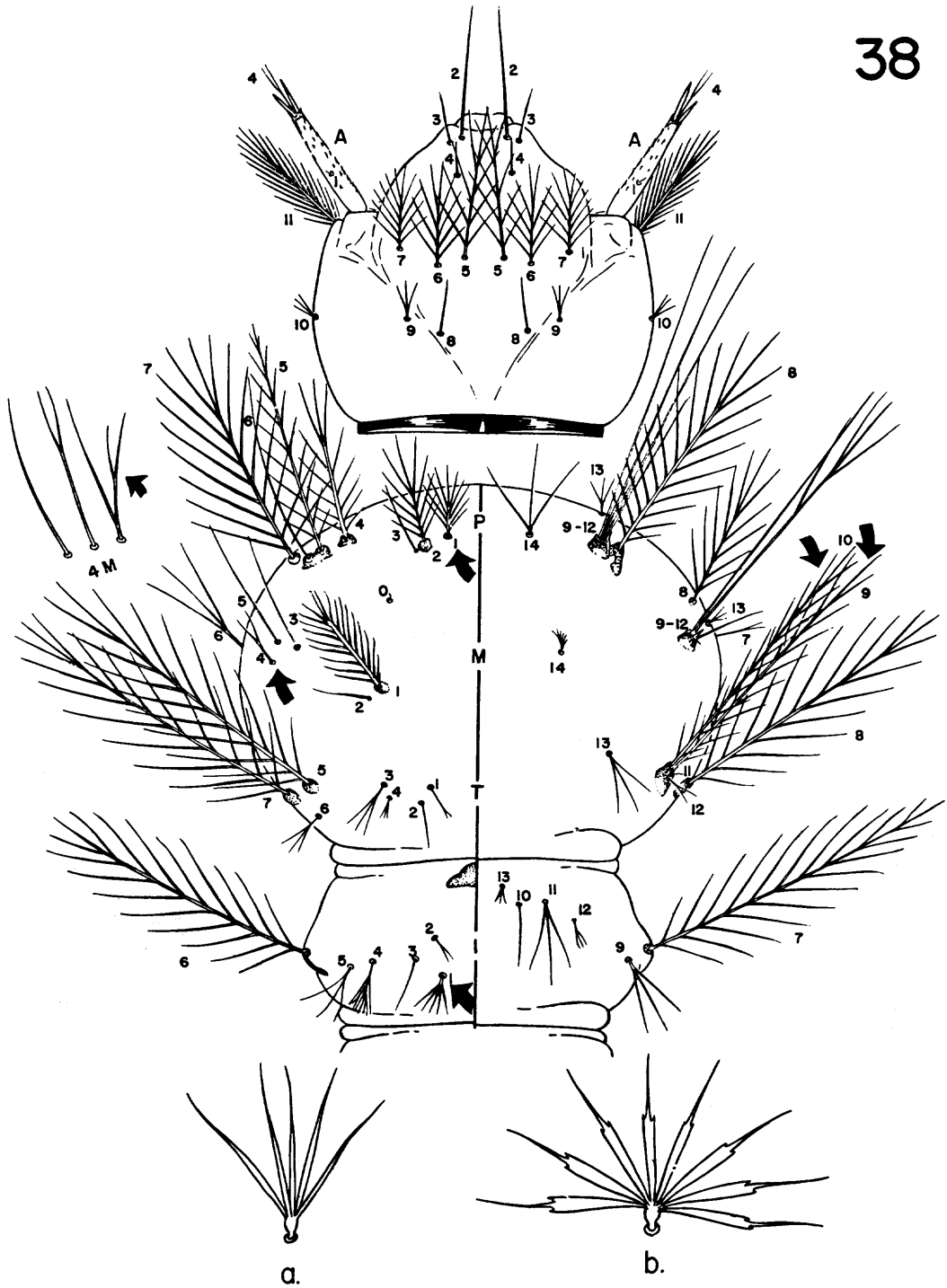




stephensi Liston

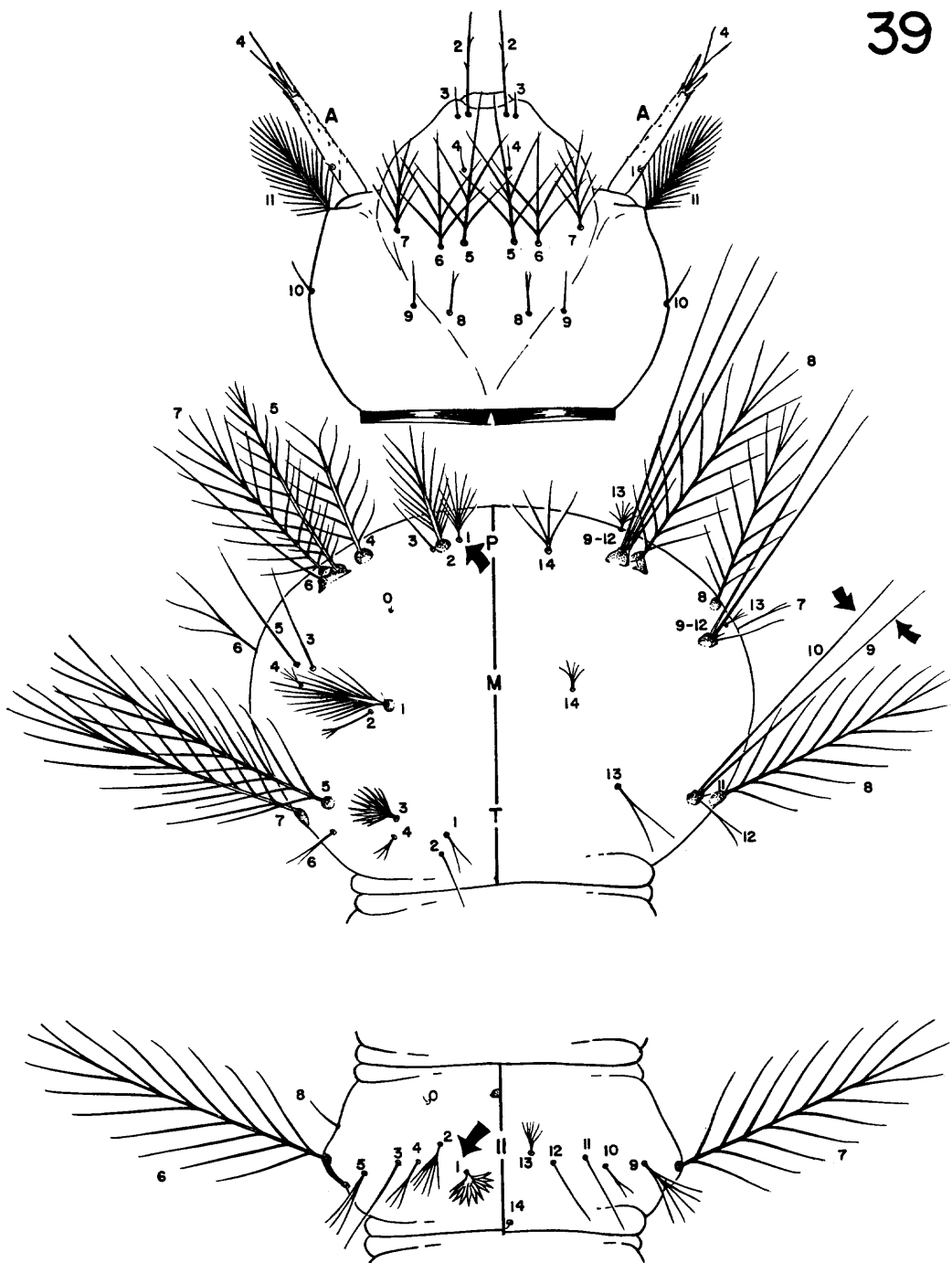


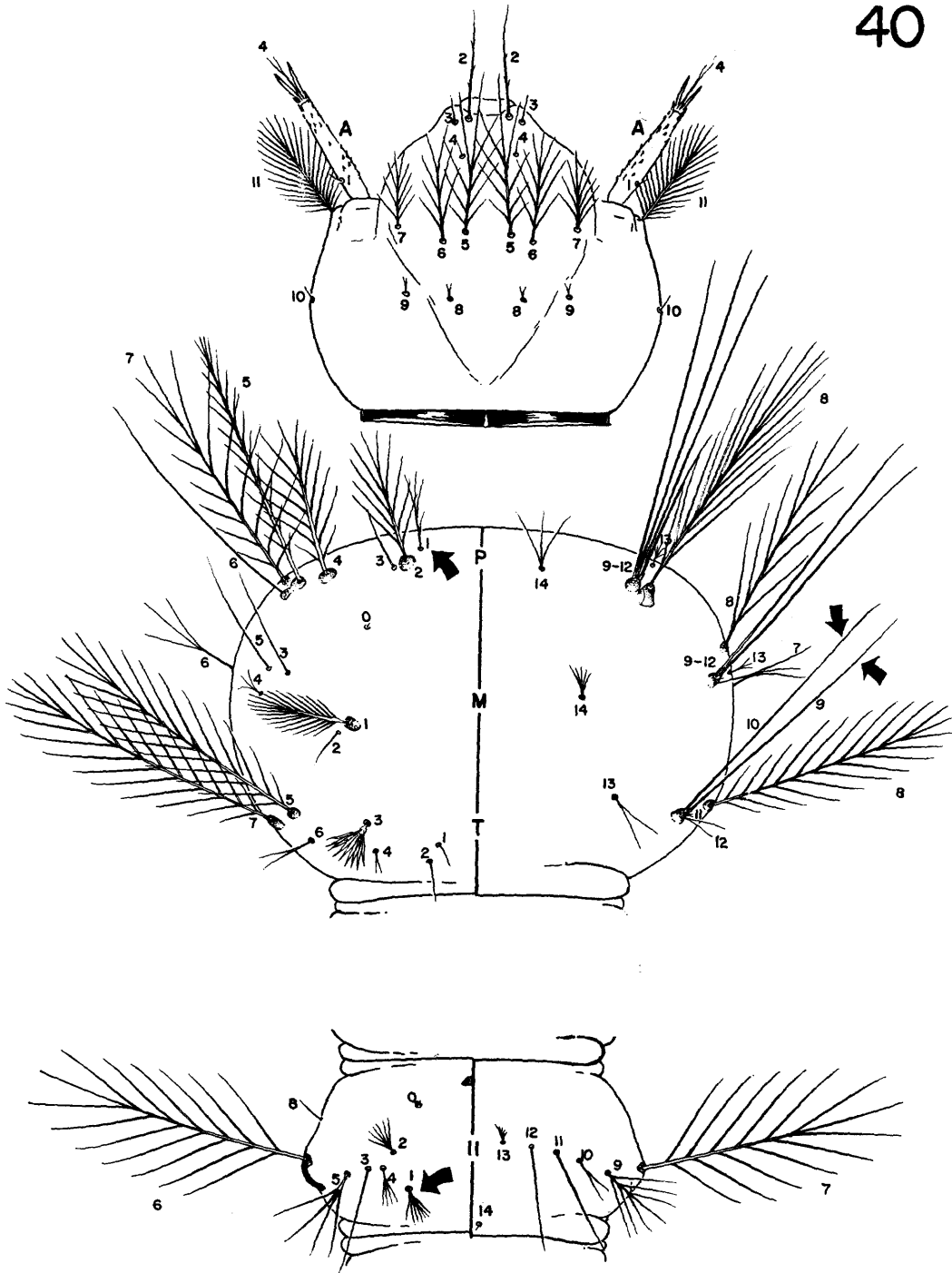
sundaicus (Rodenwaldt)



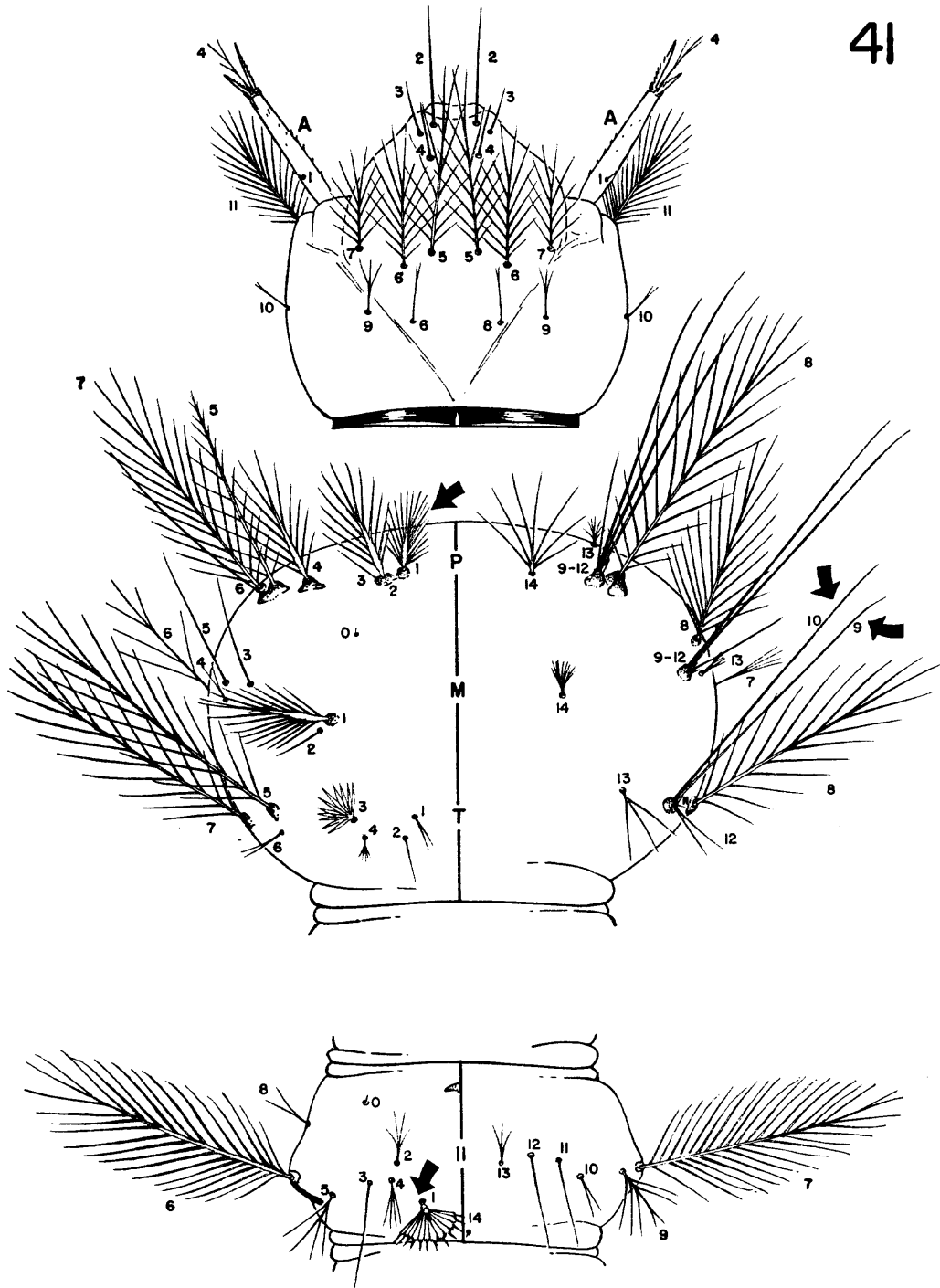
subpictus Grassi

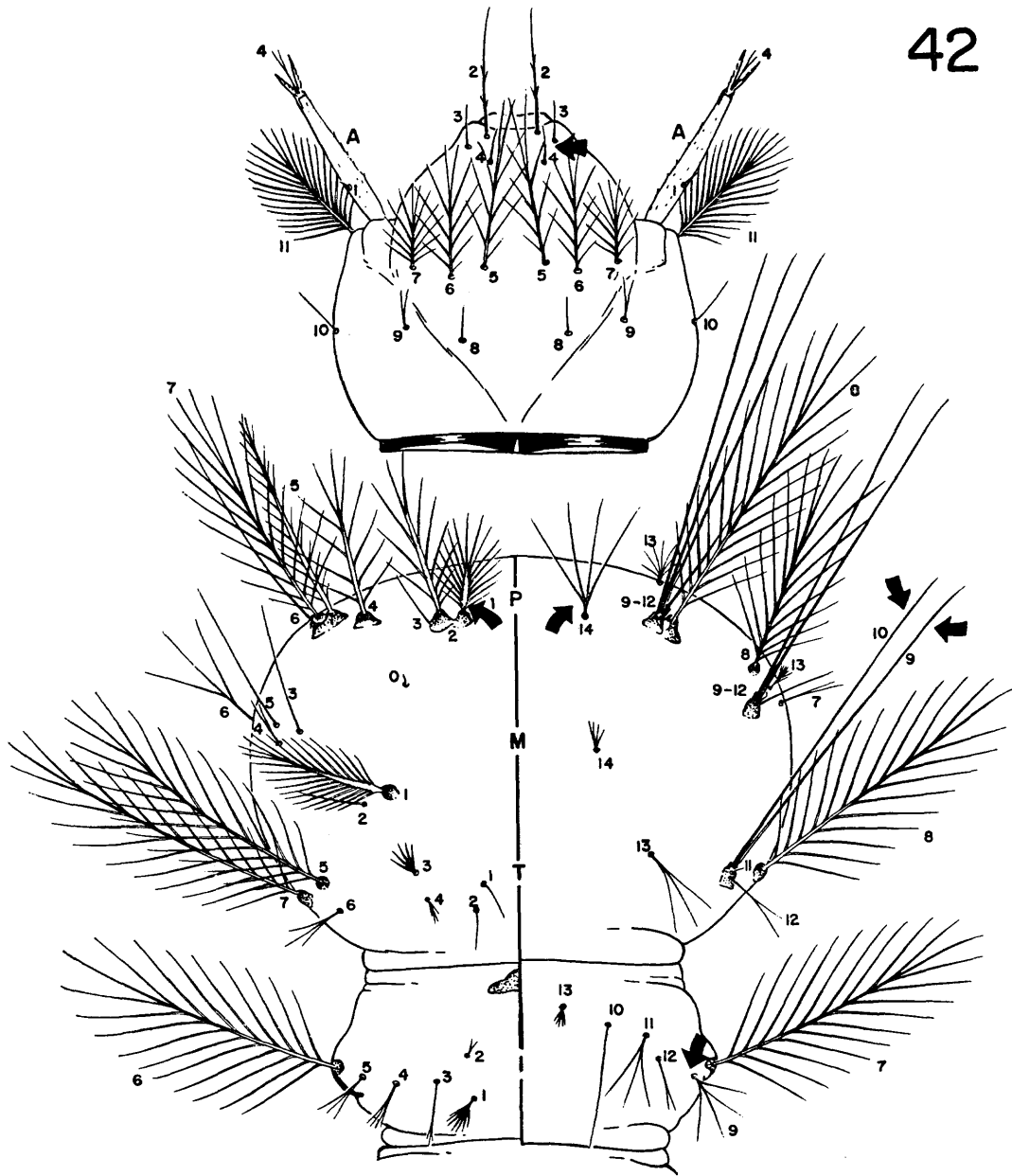
indefinitus (Ludlow)





tessellatus Theobald





a

balabacensis
Baisas



b

pujutensis
Colless



c

riparis macarthuri
Colless