The Determination of Mosquito Females (Culicidae) by Microscopic Preparations of the Head.[1/]

III. A Key to Species (excluding *Aedes*)

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ABSTRACT. A key to species (excluding the genus *Aedes*), as well as supplementary notes and basic quantitative indices for each of the 34 species are given.

In preceding works, the general nature of taxonomic characteristics and tables for determining genera and subgenera of the fauna of the Soviet Union were given (Gutsevich 1972, 1973). Below is presented a key to species, excluding the genus *Aedes*, which will be discussed exclusively in the next paper. Species of the four genera having only one species each in the Soviet Union are not included in the present key, since they can be determined by the key to genera and subgenera which has already been published. Brief notes concerning each of the 34 species, as well as basic quantitative indices (see Table) are supplementarily included. I would like to thank K. G. Fedorov for making the preparations and for organizing the collections of species.

KEY TO DETERMINING SPECIES
Genus *Anopheles*

The palps are approximately equal in length to the proboscis.

1 (12) The frons is moderately wide (1-3 facets). The oral cavity is not armed (without teeth). The pharynx is not enlarged in the anterior half or else is enlarged barely noticeably. . .Subgenus *Anopheles*

2 (5) The 1st segment of the palps has a bundle of scales. The scales of the palps are mainly narrow and upright, especially in the proximal part of the palps.

3 (4) The cheeks have numerous scales. . . . . *An. hyrcanus*

4 (3) The cheeks have no scales. . . . . *An. lindesayi*

5 (2) The 1st segment of the palps has no scales. The scales of the palps are on the whole adherent or semi-adherent.

6 (11) The frons is wider (2-3 facets); there are no less than 8-10 relatively large hairs on the frons.

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7(8) On the upper surface of the 2nd segment of the antennae there are numerous scales and hairs (6-10 or more), developed not only on the interior side, but also on the exterior side of the segment . . . . . .*An. maculipennis*

8(7) On the upper surface of the 2nd segment of the antennae there are only isolated (2-4) hairs and scales, located on the interior side of the segment

9(10) The hairs of the antennal whorl are relatively short. The index of Pa/A is greater than two; sometimes it is approximately two (see Table). . . . . .*An. claviger*

Basic Quantitative Indices

Species	Pa/Pr	Pa/A	A/Pr	Number of Preparations
An. maculipennis	0.96—1.03	2.32—2.56	0.08—0.09	7
An. claviger	0.93—1.04	2.0 —2.38	0.08—0.09	9
An. plumbeus.	0.95—1.02	1.51—1.74	0.09—0.1	6
An. algeriensis	0.89—0.95	1.96—2.49	0.08—0.09	5
An. hyrcanus	0.91—1.05	1.76—2.22	0.09—0.1	5
An. lindesayi	0.98	2.03	0.13	1
An. superpictus	0.96—0.99	3.21—3.69	0.07	6
An. pulcherrimus	0.93—0.99	2.23—2.55	0.09—0.1	6
T. christophi	0.23	1.64	0.08	1
U. unguiculata	0.11—0.15	0.53—0.71	0.14—0.17	6
O. pulchripalpis	0.41—0.45	1.29—1.59	0.17—0.18	3
M. richiardii	0.23—0.27	0.94—1.04	0.12—0.14	8
Cx. vorax	0.28	1.06—1.2	0.15	2
Cx. fuscanus	0.26	1.21	0.14	2
Cx. modestus	0.17—0.2	0.52—0.62	0.15—0.17	14
Cx. pusillus	0.19—0.23	0.54	0.14	4
Cx. martinii	0.18—0.2	0.49—0.65	0.15—0.16	2
Cx. territans	0.18—0.21	0.57—0.71	0.14—0.17	7
Cx. hortensis	0.19—0.23	0.65—0.86	0.14—0.15	7
Cx. pipiens	0.16—0.2	0.5—0.75	0.14—0.17	14
Cx. vagans	0.18—0.23	0.69—0.9	0.13—0.15	11
Cx. theileri	0.17—0.21	0.69—0.85	0.11—0.13	11
Cx. univittatus	0.19—0.21	0.64—0.7	0.14—0.15	4
Cx. tritaeniorhynchus	0.19—0.21	0.66—0.91	0.11—0.15	10
Cx. orientalis	0.23—0.26	0.68—0.8	0.17—0.19	6
Cx. mimeticus	0.21—0.23	0.76—0.9	0.15—0.17	7
Cx. bitaeniorhynchus	0.21—0.25	0.7—0.91	0.16—0.18	9
Cu. longiareolata	0.27—0.32	1.28—1.51	0.11—0.12	7
Cu. alaskaensis	0.19—0.22	0.69—0.99	0.11—0.13	7
Cu. annulata	0.19—0.25	0.76—1.12	0.11—0.13	10
Cu. bergrothi	0.18—0.22	0.76—1.07	0.11—0.12	6
Cu. morsitans	0.22—0.25	0.81—0.88	0.16	4
Cu. ochroptera	0.25—0.26	0.72—0.89	0.16—0.18	5
Cu. setivalva	0.23—0.26	0.87—0.99	0.15—0.17	7
Total				219

Pa = Palps Pr = Proboscis A = Antenna

10(9) The hairs of the antennal whorl are long. The index of Pa/A is significantly less than two. . . . . *An. plumbeus*

11(6) The frons is narrower (1-1.5 facets); there are no more than 6-8 large hairs on the frons. . . . . *An. algeriensis*

12(1) The frons is very wide (4-7 facets). The oral cavity is armed (with teeth). The pharynx is greatly enlarged in the anterior part . . . . . Subgenus *Cellia*

13(14) The width of the frons is 4-5 facets. The scales of the palps are on the whole adherent. Pa/A is greater than three. .*An. superpictus*

14(13) The width of the frons is 6-7 facets. The scales of the palps are mainly narrow and upright. Pa/A is less than three. . *An. pulcherrimus*

Genus *Culex*

The oral cavity is armed. The posterior section of the pharynx is usually slightly thickened and is shorter than the anterior part. The palps, as a rule, have 4 segments. The space between the eyes is narrow. In the majority of cases, the 3rd segment of the antennae has 2 colors: the proximal part is light and the distal part is dark.

1(4) The palps are long (Pa/Pr = 0.26-0.28), especially the 4th segment; Pa/A is greater than one. . . . . Subgenus *Lutzia*

2(3) The 4th segment of the palp has a relatively slender base (on a short "little stem"). . . . . *Cx. vorax*

3(2) The 4th segment of the palp is relatively thick at the base, without a "little stem". . . . . *Cx. fuscanus*

4(1) The palps are relatively short (Pa/Pr = 0.16-0.25); Pa/A is less than one

5(10) The frons either has no scales or they exist only at its posterior edge. The palps are short: Pa/A = 0.5-0.6. . . . . .Subgenus *Barraudius* and *Cx. (Neoculex) martinii*

6(7) The length of the 3rd and 4th segments of the palps is approximately the same. A very small mosquito, the length of the 4th segment of the palps is not greater than 120 mk. . . . . .*Cx. pusillus*

7(6) The 4th segment of the palps is 1½ to 2 times longer than the 3rd segment. The mosquitoes are small, but nonetheless they have relatively large dimensions: the length of the 4th segment of the palps is not less than 130 mk.

8(9) The 4th segment of the palps is usually darkened and is about 1½ times longer than the 3rd segment. The 5th segment of the antennae has microtrichia. . . . . .*Cx. modestus*

9(8) The 4th segment of the palps is slightly sclerotized and is twice as long as the 3rd segment. The 5th segment of the antennae has no microtrichia. . . . . .*Cx. martinii*

10(5) The frons has scales which are scattered at least along the length of the entire posterior half. The palps are usually of average length; Pa/A = 0.7 or more; now and then it is around 0.6; as an exception it is 0.5.

11(14) The narrowest width of the frons is equal in diameter to a facet or is slightly greater. The space between the eyes on the lower side of the head is equal to 1-2 facets. . . . . Subgenus *Neoculex*

12(13) Besides the scales on the frons there are a few hairs; the point of their attachment is larger than the point of the scales' attachment . . . . . *Cx. territans*

13(12) The frons has scales but no hairs, not counting 2 large hairs which are located on the level of the posterior edge of the eyes. . . . . *Cx. hortensis*

14(11) The narrowest width of the frons is less than the diameter of a facet. On the lower side of the head, the eyes, as a rule, almost adjoin, or else the space between them does not exceed the diameter of a facet . . . . . .Subgenus *Culex*

15(22) The proboscis does not have a light ring.

16(17) The segments of the antenna, in comparison with the length of the proboscis, are short: A/Pr = 0.11-0.13. The length of the clypeus, as a rule, is almost equal to its width. . . . . *Cx. theileri*

17(16) The segments of the antenna, in comparison to the length of the proboscis, are longer: A/Pr = 0.13-0.17. The length of the clypeus in most cases is less than its width.

18(21) The dark part of the 3rd segment of the antennae is clearly distinguished from its light part.

19(20) There are microtrichia on the 4th segment of the antennae; sometimes there are just a few of them; now and then they don't exist at all. From below, the eyes are more often separated by a space which is 0.5-1 times greater than a facet. . . . . *Cx. pipiens*
(distributed everywhere)

20(19) There are no microtrichia on the 4th segment of the antennae; sometimes there are isolated ones. From below, the eyes are as a rule approximated up to the point of touching along the length of 2-3 facets. . . . . .*Cx. vagans*
(Far East, Eastern Siberia)

21(18) The dark apical part of the 3rd segment of the antennae is not clearly distinguished from the light part. . . . . .*Cx. univittatus*
(only in the south of Central Asia, rare)

22(15) The proboscis has a light ring in the middle.

23(24) A small mosquito. The palps are short; the length of the 4th segment is, as a rule, not greater than 220-230 mk. There is no clear border between the darkened apex of the 3rd segment of the antennae and its light part. A/Pr = 0.11-0.15. . . . . .*Cx. tritaeniorhynchus*

24(23) The mosquitoes are of medium size; more rarely they are large. The length of the 4th segment of the palps is not less than 220 mk. The dark apical part of the 3rd segment of the antennae is clearly distinguished from the light part (if the preparation is not too faded). A/Pr = 0.15-0.19.

25(26) In some specimens (but not in all), the palps have 5 segments; the 5th segment is approximately equal in size to a facet. The scales of the palps are "ordinary" (relatively narrow). . . .*Cx. orientalis*

26(25) The palps have 4 segments; it is sometimes possible to distinguish a 5th segment in the form of an inconspicuous rudiment. In addition to the narrow scales on the palps, there are usually wider ones too.

27(28) The 4th segment of the palps is thinner; the 3rd segment is moderately thickened; its length is obviously greater than its width. . . . . *Cx. mimeticus*

28(27) The palps are thicker; the length of the 3rd segment is almost equal to its width. . . . . .*Cx. bitaeniorhynchus*

Genus *Culiseta*

The palps have 5 segments; more often they are long. In most species the antennae have microtrichia on the 4th segment; in one species there are scales on the 1st segment. The anterior portion of the frons is not wider than 1-1.5 facets; it does not have a longitudinal suture, but if there is one, then it is thin and sometimes incomplete. The oral cavity is unarmed. The posterior section of the pharynx is greatly enlarged.

1(2) The 1st segment of the antennae has a bundle of scales. The palps are very long: Pa/Pr = 0.27-0.32; Pr/A is greater than one. The scales are scattered along the entire frons (subgenus *Allotheobaldia*, one species - *Cu. (Al.) longiareolata)*.

2(1) The 1st segment of the antenna has no scales. The palps are more often of average length: Pa/Pr = 0.18-0.26; Pa/A is less than one; rarely it is approximately one. There are no scales in the anterior part of the frons.

3(8) The segments of the antennae are relatively short: A/Pr = 0.11-0.13. The frons is wider and has scales in the posterior third and in the middle part. On the lower side of the head the space between the eyes is wider: 1.5-4 facets. . . . . .Subgenus *Culiseta*

4(5) In most cases there are many microtrichia on the 4th segment of the antennae. The frons is equal to or wider than the diameter of a facet. . . . . .*Cu. alaskaensis*

5(4) There are few microtrichia or none at all on the 4th segment of the antennae. The frons is approximately equal in width to the diameter of a facet; frequently it is narrower.

6(7) As a rule, there are microtrichia on the 4th segment of the antennae. The space between the eyes on the lower side of the head is relatively wider: 2-4 facets. . . . . .*Cu. annulata*

7(6) As a rule, there are no microtrichia on the 4th segment of the antennae; now and then there are isolated ones. The space between the eyes on the lower side of the head is narrower: 1.5-2.5 facets . . . . . *Cu. bergrothi*

8(3) The segments of the antennae are longer: A/Pr = 0.15-0.18. The frons is narrower - usually narrower than a facet - and has no scales, or else they exist only in the posterior third. The space between the eyes on the lower side of the head is narrower: 0.5-2 facets . . . . . .Subgenus *Culicella*

9(12) The 4th segment of the antennae has isolated microtrichia or else it has none at all. The space between the eyes on the lower side of the head is usually equal to 1-2 facets. Large hairs, which stand out rather clearly, are located behind the eyes on the occiput.

10(11) As a rule, the 4th segment of the antennae has isolated microtrichia . . . . . *Cu. morsitans*
(a widely distributed species)

11(10) As a rule, the 4th segment of the antennae has no microtrichia. . . . . *Cu. setivalva*
(Crimea, Caucasus)

12(9) There are a good number of microtrichia on the 4th segment of the antennae. On the lower side of the head, the eyes are approximated almost to the point of touching. The relatively larger hairs behind the eyes do not stand out clearly because of their dimensions. . . . . .*Cu. ochroptera*

Brief Notes on Individual Species

1. *Anopheles maculipennis* Mg. This species is distinguished from similar species by the large number of hairs and scales on the upper side of the 2nd segment of its antennae. The scales of the palps are mainly adherent, and only in the basal fourth of the 2nd segment are the scales arranged at a 45-70° angle to the surface. The frons has a width of 2-3 facets; it has numerous hairs and scales; there are no less than 8-10 relatively large hairs among them.

2. *An. claviger* Mg. This species is distinguished from the preceding one by the weak development of the hairs and scales on the upper side of the 2nd segment of its antennae. It is distinguished from *An. algeriensis* by the greater width of its frons, and from *An. plumbeus* by the relatively short length of the hairs of its antenna and - more reliably - by its higher index of Pa/A, which is not less than two.

3. *An. plumbeus* Steph. This species is distinguished from *An. claviger*, which outwardly resembles it, by the greater length of the hairs of its antennal whorls. The antennae somewhat resemble the antennae of the male. The index of Pa/A is less than two.

4. *An. algeriensis* Theob. This species is distinguished from the above species by a narrower frons with relatively few hairs and scales. There are about ten hairs and scales on the 2nd segment of the antennae, a characteristic by which *An. algeriensis* distinguishes itself from two other species having wings with no spots.

5. *An. hyrcanus* Pall. This species is distinguished from all other species of the mosquito fauna of the Soviet Union by the presence of scales on the cheeks, which form 2 thick bundles along the sides of the clypeus. Another feature which it has in common with the next species is the presence of scales on the 1st segment of the palps. The scales of the palps are mainly semi-adherent, and on the 2nd segment they are narrow and upright. The palps therefore appear thick and "shaggy".

6. *An. lindesayi* Giles. This species is distinguished from all other species of the native fauna except *An. hyrcanus* by the presence of scales on the 1st segment of the palps. It is distinguished from *An. hyrcanus* by the absence of scales on the cheeks.

7. *An. superpictus* Grassi. The frons is wide. The light ringlets on the palps are clearly enough visible, as they are in *An. pulcherrimus*, too.

8. *An. pulcherrimus* Theob. The frons is very wide; it has scales and numerous hairs. The palps are "shaggy".

9. *Toxorhynchites christophi* Portsch. The proboscis is very long, about 7 mm, and it is bent; at the base it is 2-3 times wider than it is at the apex. The base of the proboscis on the lower side is notable for its large spine-shaped hairs. The palps are relatively long; the 4th segment is slightly bent and is not thickened. The eyes are approximated on

the upper as well as on the lower side of the head. The frons is narrower than one facet and longer than 300 mk. This amounts to almost 20 times the diameter of a facet, which in the given species is smaller than in other mosquitoes.

10. *Uranotaenia unguiculata* Edw. This species is easily distinguished by the structure of its palps and frons. The palps consist of a total of two sections. The microtrichia on the antennae go up to the 8th segment. The lobes of the eyes, which are turned towards one another on the upper side of the head, are narrow. They are joined by a diametrical suture, from which the longitudinal suture stems.

11. *Orthopodomyia pulchripalpis* Rond. This species is distinguished by its long, very thin palps; the proximal part of the 4th segment is not thicker than the closest segments of the antenna. The proboscis has a narrow light ring in the middle. The frons is narrow and long, with scales and hairs.

12. *Mansonia richiardii* Fic. The light ring on the proboscis is wide and not clearly marked. The scales of the proboscis and palps are mainly wide; many have 10 and more longitudinal lines ("little ribs"). The palps have 5 segments; the 4th segment is not thickened; it has the characteristic slightly double flexure; the large hairs on the 3rd segment are concentrated mainly in its exterior distal corner. The frons is narrow, with scales only in the posterior half.

13. *Culex vorax* Edw. This species is distinguished from all other species of the genus except *Cx. fuscanus* by its long palps. The eyes are approximated almost to the point of touching on the upper as well as the lower side of the head.

14. *Cx. fuscanus* Wied. This species is similar to the preceding one. The palps are somewhat shorter; the 4th segment is not tapered at the base.

15. *Cx. modestus* Fic. This species is distinguished by its short palps and very narrow frons; there is a relatively large space between the eyes on the lower side of the head (2-3 facets). The palps have 4 segments; the 4th segment does not have large hairs. The segments of the antennae are long and dark; there are microtrichia on the 3rd through the 5th segments.

16. *Cx. pusillus* Macq. This species is similar to the preceding one. It is distinguished by its very small dimensions (the length of the proboscis is only 1.0-1.3 mm), as well as by the ratio of the length of the distal segments of the palps.

17. *Cx. martinii* Med. This species is similar to the subgenus *Barraudius* in head structure. It is distinguished by the weak sclerotization of its palps, and by its dimensions. There are isolated microtrichia on the 4th segment of the antennae; they are lacking altogether on the 5th segment.

18. *Cx. territans* Walk. The frons has scales and a few (larger) hairs. The palps are relatively short.

19. *Cx. hortensis* Fic. This species is similar to the preceding one. It is distinguished by the lack of hairs in the middle part of the frons and by its longer palps.

20. *Cx. pipiens* L. As in other species of the subgenus *Culex*, the narrowest space between the eyes on the upper and lower sides of the head is, as a rule, less than the diameter of a facet. The palps have 4 segments; the 4th segment has microtrichia; those specimens which are occasionally found without microtrichia on this segment can be distinguished only with difficulty or else not at all from *C. vagans*.

21. *Cx. vagans* Wied. This species is very similar to the preceding one. It is distinguished by the lack of microtrichia on the 4th segment of its antennae. In other respects, the distinctions have a quantitative character: the palps are somewhat longer; the eyes on the lower side of the head are more approximated, and there are more hairs on the occiput behind each eye - 5 to 8.

22. *Cx. theileri* Theob. This species is reliably distinguished by its low index for A/Pr, which depends mainly on the significant length of the proboscis. Other distinctions are less clear: the 4th segment of the palps is more often thick; the number of large hairs on the occiput behind each eye is relatively greater - 5 to 10 hairs on each side; sometimes they form 2 incomplete rows.

23. *Cx. univittatus* Theob. Very similar to *C. pipiens*. The palps are more often thicker, are blunt at the apex, and sometimes have an inconspicuous rudiment of the 5th segment. The length of the clypeus is obviously less than its width. There are 4-5 large hairs on the occiput behind each eye.

24. *Cx. tritaeniorhynchus* Giles. This species is similar to the three following. It is characterized by the presence of a light ring in the middle of the proboscis, which is easily discernable on the preparations. It is also distinguished by its relatively small dimensions. The palps have 4 segments and are short; the 4th segment is symmetrically attached to the 3rd segment; that is, it is attached approximately in the middle of the 3rd segment.

25. *Cx. orientalis* Edw. As in the two following species, the 4th segment of the palps is attached to the 3rd segment more or less asymetrically - it is closer to the exterior side of the apex of the 3rd segment. The 3rd segment of the palps is thick and usually has a conspicuous interior apical angle.

26. *Cx. mimeticus* Noé. In comparison to similar species, the frons is somewhat wider, especially in its posterior part; an incomplete longitudinal suture is sometimes outlined.

27. *Cx. bitaeniorhynchus* Giles. The frons is very narrow; the eyes are approximated almost to the point of touching along a significant length. It is distinguished by the relatively wide, mainly semi-adherent, scales of its palps, which therefore appear "shaggy".

28. *Culiseta longiareolata* Macq. It is distinguished by the presence of a bundle of scales on the 1st segment of the antennae, which is located closer to the exterior side of the segment. The 4th segment of the palps has short, thick, spine-shaped hairs on the exterior side.

29. *Cu. alaskaensis* Ludl. The 4th segment of the palps has numerous microtrichia, but sometimes there are few of them. It is not always possible to distinguish mosquitoes of the southern subspecies *C. a. indica* from *C. annulata* by preparations of the head.

30. *Cu. annulata* Sehr. In most cases there are few microtrichia on the 4th segment of the antennae. The 5th segment of the palps often has an irregular or double form.

31. *Cu. bergrothi* Edw. This species is similar in head structure to the 2 preceding ones. It is distinguished by the lack of microtrichia on the 4th segment of the antenna (a similarity with mosquitoes of the genus *Aedes*); occasionally there may be isolated microtrichia there.

32. *Cu. morsitans* Theob. As in the two following species, the frons is narrow and the index of A/Pr is high.

33. *Cu. setivalva* Masl. It is very similar to the preceding species. It is distinguished by the lack of microtrichia on the 4th segment of the antennae (isolated ones can exist) and by the weak development of large hairs on the 4th segment of the palps.

34. *Cu. ochroptera* Peus. It is distinguished by the large number of microtrichia on the 4th segment of the antennae. The relatively large hairs on the occiput are separated from the edge of the eye by a rather wide space, where smaller hairs, as well as scales, are located.

The given materials show that it is possible to determine with complete reliability the majority of mosquito species according to preparations of the head, but still not all species can be determined in this way. We regard our method as a supplement to the usual methods of determination. In some cases, species which are easily determined by outward appearance (by color) are difficult to determine by head structure, for example: *Cu. alaskaensis* and *Cu. annulata*, *Cu. bergrothi* and *Cu. annulata*. In other cases, the females of the species which can not always be distinguished with certainty according to the usual characteristics, are clearly distinguishable according to head structure (*An. claviger* and *An. plumbeus*, *Cx. modestus* and *Cx. pusillus* and others). Therefore both methods as it were supplement each other, especially in determining "shabby" specimens (i.e., those which are not in good condition.). With some skill in the practice of determining species, it does not appear to be mandatory in most cases to measure with the help of an ocularmicrometer and to find out indices. These methods are mainly indispensible in studying some little-researched species which are determined with difficulty and "doubtful" specimens.

It is obvious that females of every species of mosquito are characterized by definite peculiarities of the structure of the head and its appendages. Further research will probably reveal other diagnostic characteristics as well, which will ensure great reliability in determining mosquito species.

Literature

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