

A New Species of *Anopheles* in Chosen (Korea).

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With Plates III-VII.

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I. Introduction.

The species of anopheline mosquitoes which have been found hitherto in Chosen (Korea) are as follows [1] [2]:

1. *A. (A.) hyrcanus* var. *sinensis* WIEDEMANN (1828),
2. *A. (A.) sineroides* YAMADA (1924),
3. *A. (A.) koreicus* YAMADA and WATANABE (1918),
4. *A. (A.) edwardsi* YAMADA (1924).

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Since 1933 I have occasionally captured at some places in Keiki-do and South Tyusei-do in Chosen anopheline mosquitoes which are different clearly in morphology and breeding habits from those of the known four species. I examined these mosquitoes minutely and compared with the descriptions of known similar anopheles of various regions of the world. Finally I am convinced that this form of anopheles has never been described till today and is, beyond doubt, a new species. The late Dr. S. YAMADA, whom I showed some specimens of this mosquito last year, agreed to regard it as a new species. So in accordance with the orthodox classification of anopheles [3] [4] [5] I want to name it *Anopheles (Anopheles) pullus* M. YAMADA.

II. Methods of Examination and Number of Mosquitoes Examined.

The technic of examination of various stages of mosquitoes should be referred to my previous paper [3]. The materials were treated as follows:

1. Typical living female adults caught in the fields were kept in the laboratory. Some of the eggs laid from these adults were examined morphologically, and some others were kept on water in dishes. The larvae which hatched from these eggs were fed with scum of ponds or streams. The pupae and adults which developed from these larvae were examined minutely.
2. Living larvae collected in the fields were fed separately in dishes in the similar way. The casts of larvae and pupae and the adults thus obtained were examined morphologically.

During four years from 1933 to 1937, 317 adults in total were collected, of which 98 (σ 56, φ 42) were reared from the eggs, 176 (σ 94, φ 82) developed from the larvae collected in the fields, and 43 (σ 1, φ 42) were captured in the fields. Almost all casts of larvae and pupae were examined microscopically.

III. Morphological Descriptions.

(A) Egg. (Plate III, 1.)

The result of measurement of eggs of *A. pullus* is tabulated as follows:

	Maximum	Minimum	Average
Length of eggs	0.64	0.49	0.56
Length of floats	0.33	0.23	0.28
Breadth of eggs	0.22	0.18	0.21
Breadth of decks	0.056	0.033	0.045

The eggs were measured previous to the hatching at the middle of eggs, including floats. The breadth of black deck running longitudinally on the upper surface of the egg is about one fifth of that of the egg. The deck is surrounded by white opaque frill. At both ends of the deck several bosses (or warts in my previous paper) can be distinguished. No spine on these bosses (Plate III, 2).

(B) **Larva.** (IV Stage.)

1. **General appearance.** The length of fully grown larvae is 5.98-6.40 mm (average 6.1 mm). The colour is yellowish brown, not changeable according to the breeding environment.

2. **Head.**

- (a) Marking on the dorsal surface is shown in Plate III, 3, three brown bands can be observed.
- (b) Inner anterior clypeal hairs (Plate III, 4). Set closely, long and slender. In some cases towards the tip dichotomously branched and occasionally one or two lateral branchlets.
- (c) Outer anterior clypeal hairs (Plate III, 5). Splitting in many branchlets (36-61) forming fan-shaped tufts.
- (d) Posterior clypeal hair (Plate III, 6a-6c). Very slender 2-4 (occasionally 5-7) branches visible under high magnification.
- (e) Frontal hairs. Easily visible with a hand lens. Apices of all three hairs almost of the same height.
- (f) Antenna (Plate III, 7). Comparatively large spines scattered densely over the surface of the antenna. Under low magnification the antennae look grey.
- (g) Antennal hair. Long, well developed.
- (h) Triangular plate (Plate III, 8a, 8b). Crest rather blunt and flat.

3. **Thorax.**

- (a) Thoracic hairs (Plate III, 9, Plate IV, 2a, 2b, 3a, 3b).
- (b) Inner shoulder hair (Plate III, 10). Splitting usually in 2, occasionally in 3 branches at the middle. In some instances simple or splitting near the tip.
- (c) Mesothoracic hair 2 (Plate IV, 1a, 1b). Splitting into 2 or 3 branches at the middle or near the tip.
- (d) Thoracic palmate on metathorax (Plate III, 9). Poorly developed, recognizable only under high magnification.

4. Abdomen.

- (a) Hairs on segment 1 and 2 shown in Plate IV, 4 and 5.
- (b) Palmate hairs (Plate V, 1a, 1b, 2a, 2b). Well developed except on segment 1 and 2. Edge serrated in the shape of stair-case and maple-leaf. Surface of the leaflets dark brown, marked irregularly with longitudinal stripes of light and dark colour.
- (c) Pecten (Plate IV, 7). The maximum length of long teeth 0.13-0.16 mm, the minimum length of short teeth 0.04 mm. The long teeth are darker in color than the short ones. Conspicuous spines on both kinds of teeth extending till the apices.

(C) Pupa.

- (a) No special characteristics in size or in respiratory trumpet (Plate V, 4).
- (b) Palmate hairs (Plate V, 5). Resembling those of *A. edwardsi*, branched near the base into 6-9 thick petioles which split dichotomously or in fork-shape into numerous slender hairs.
- (c) Thorax, abdomen and tail shown in Plate V, 3.
- (d) Seventh segment. Seta A (Plate VI, 2a). Stout and short, the tip blunt in the shape of duck-bill.
Seta B (Plate V, 6). Splitting into 2-8 branches.
Seta C (Plate V, 6). Splitting into 2-6 branches.
- (e) Paddle hairs or terminal hairs (Plate VI, 1a, 1b). Tips splitted dichotomously. One or two lateral branches.
- (f) Accessory paddle hair (designated as subterminal hair in my previous paper) (Plate VI, 1a, 1b). Splitting towards the apex or at the middle into two branchlets.

(D) Female Adult.

1. **General Appearance.** Median or fairly large sized, with anopheline attitude at rest. The most marked characteristic of this species is that the adults look in general very dark and the white spots are indistinct. The surface of the body and wing is covered diffusely with dark scales. Pale scales appear lightish dark under weak illumination.

2. Head. (Plate VI, 3).

- (a) Palpi. Almost of the same length as proboscis, covered with dark scales. A narrow white band at the apex and at each joint. The scales on the basal one third are long and large, mixed with a few white ones.

- (b) Proboscis. Covered with black scales.
- (c) Labellum. Blackish brown.
- (d) Antenna. Covered with black hairs. On the basal one third, upper sides of torus scattered with white lingulate scales.
- (e) Clypeus. On each side a group of black lingulate scales.
- (f) Vertex. Covered with darkish cuneiform scales, of which the apices seemingly whitish.

3. Thorax.

- (a) Anterior pronotum and mesonotum. Darkish grey, covered sparsely with black hairs, which reflect rays strongly and appear mostly whitish.
- (b) Mesoscutellum. Dark bristles on the posterior edge.
- (c) Halter. Covered densely with small dark scales.

4. Abdomen. (Plate VII, 1.)

Dorsal as well as ventral side is dark, covered sparsely with dark bristles. On the ventral side of each segment a pair of silvery white cuneiform speckles. A group of dark lingulate scales on the posterior median half of the ventral side of the seventh segment.

5. Wing. (Plate VI, 4 a, 4 b).

- (a) Length of wing; minimum 4.40 mm, maximum 5.95 mm, average 5.30 mm.
- (b) Costa. One or two white spots. Sc-spot is, usually smaller, occasionally larger than P-spot. In case of one white spot, Sc-spot is always large, measuring on the average 0.24 mm. The sizes of these spots are as follows:

		Min.	Max.	Average
One spot	Sc	0.14	0.35	0.24
	P	0.13	0.28	0.17
Two spots	Sc	0.14	0.19	0.18
	P			

These costal spots shall be discussed later in detail.

- (c) Subcosta. Dark except the joint Sc, but occasionally a few white scales on the outer half.
- (d) Vein 1 or Radius. A white spot near Sc-spot of the similar size. But this spot is very variable; in some cases only one side opposite Sc is white, but the another side dark scaled, and occasionally disappearing

- entirely. Ps-spot is usually a mixture of white and dark scales, but this dark spot and Md-spot may occasionally be absent.
- (e) Vein 2 or Radius sector. Base of petiole always dark, the remaining part of the petiole covered with white and dark scales mixed, occasionally one more dark spot on the petiole.
Anterior branch (R_1). Mainly dark with one white spot, which sometimes incomplete or divided into two spots by black scales.
Posterior branch (R_2). Also mainly dark with one white spot, which sometimes absent or divided into two parts.
- (f) Vein 3. Except basal and apical dark spots, the middle covered with a mixture of dark and white scales. In some instances entirely dark or a few white scales mixed.
- (g) Vein 4. White and dark scales mixed on the stem, occasionally white scales more abundant or entirely dark. Complete or incomplete three dark spots on anterior and posterior branch.
- (h) Vein 5 or Cubitus. Stem mainly white, a few dark scales sparsely scattered. Near the base dark spot. On anterior branch usually two white spots, which occasionally incomplete or divided into three spots by dark scales. An apical dark spot on posterior branch.
- (i) Vein 6 or Analis. Two dark spots, the one a little distal from the middle, the other at the apex.
- (j) Fringe. Entirely dark, no any pale spot.
- (k) Humeral cross-vein. No scale.
- (l) Remigium. Covered with tiny pale scales, no dark ones.

6. Leg.

All legs entirely dark, covered with dark scales, tarsal segments especially dark, ventral side of femoral segment lightly colored. Presence or absence of narrow white bands of pale scales at the apical ends of segments is tabulated as follows:

	Femur	Tibia	Tarsus I	Tarsus II	Tarsus III	Tarsus IV	Tarsus V
Fore leg	±	+	##	#	+	-	-
Middle leg	±	+	##	#	+	-	-
Hind leg	±	##	###	#	+	±	-

+ white band present, # distinctly, ## very distinctly.

- white band absent.

± white band inconstant.

Although some white scales may be present at the basal ends of segments, the white bands owe almost entirely to the pale scales existing at the apical ends.

(E) Male Adult.

- (a) Palpi. Covered with white and dark scales; brownish dark hair groups at the apices.
- (b) Wing. In general less dark than that of female, and the dark area are somewhat less distinct. But in some instances the male wings resemble entirely the female ones.
- (c) Dorsal and lateral sides of hypogium (or terminalia) and coxites (or side pieces) are covered with numerous white scales and a few dark hairs (Plate VII, 2).
- (d) Style (or claspers), parabasal spines, harpags, ninth tergite, lobe or anal or tenth segment and spines are shown in Plate VII, 3-4, 5a, 5b.
- (e) Leaflets of phallosome or mesosome usually 6 on each side, but sometimes 5 or 4 on one side only.

IV. Breeding Habits.

A. pullus breeds in rather cool water of about 19° C and wherein *Potamogeton crispus* L., *Najas graminea* Del., *Ceratophyllum demersum* L. etc. grow. The larvae begin to develop in April and May. In July and August larvae of *A. sinensis* breed abundantly in warm water of rice-fields, but *A. pullus* can not be found in such places, but only in cool springs or ponds in the shade of trees on highland. When it becomes cool in September, *A. sinensis* decreases rapidly, but *A. pullus* increases contrariwise and can be found till late in November [6] [7] [8].

V. Collection Record.

Place	Date	Adults with				Larvae			
		one white costal spot		two white costal spots		one spot		two spots	
		♂	♀	♂	♀	♂	♀	♂	♀
Seiryori, Keiki-do 京畿道清涼里	April, 1933						1		1
Keijo University 京城帝大	October, 1934					1	1	2	

Place	Date	Adults with				Larvae			
		one white costal spot		two white costal spots		one spot		two spots	
		♂	♀	♂	♀	♂	♀	♂	♀
Ronsan, South Tyusei-do 忠南麓山	August, 1935		1						
Sintosen, South Tyusei-do 忠南新郷村	August, 1935		7		4	2	4		2
Saisen, South Tyusei-do 忠南瀬川	Aug.-Sept. 1935		4		25	3	3	32	26
Keijo University 京城帝大	Oct.-Nov. 1936			1	1	4	6	52	36
Total			12	1	30	9	15	85	67
			12		31		24		152

VI. Two Forms of *A. pullus*.

Judging from the costal spots on wing we can distinguish two forms of *A. pullus*; the one has a distinct white spot, and the other, two spots. For the sake of brevity we may call the first *one spotted*, and the latter *two spotted*. From the beginning of this study, paying deep attention to this marked difference, I supposed these two forms might be different species and have endeavoured to find other constant differentials. A female of *one spotted* form caught at Sintosen, South Tyusei-do, in 1935, laid 64 eggs, of which a part was kept as specimens, and from the rest 35 adults emerged (♂ 20, ♀ 15). Of these 35 adults 25 were distinctly *one spotted*, but the remaining 10 adults possessed two spots either on both wings or on one wing only. In another case, a female adult of *two spotted* form, which had been caught at Saisen, South Tyusei-do, laid 77 eggs, and from these eggs 63 adults emerged (♂ 36, ♀ 27). All of them were *two spotted*, no *one spotted* appeared.

The sizes of these spots were measured and their variability was compared. The result was as follows:

	Sc-spot	P-spot
Average	0.17 mm	0.18 mm
Difference between the maximum and minimum	0.15 mm	0.05 mm

From this result Sc-spot seems to be more variable than P-spot. So it is rather irrational to consider that P-spot disappears to become *one spotted*.

In order to decide whether these two forms of *A. pullus* are different species or not, it was necessary to examine precisely other characters. No distinct difference, however, was observed in male genitalia; the eggs, larvae and pupae are almost alike morphologically and no marked difference was recognized.

Some larvae collected from a pond in the yard of the University were fed individually in dishes, and these larvae and the pupae which developed from them were examined minutely. But no differential characteristic of the two forms was discovered.

The difference of number and position of spots on wings is generally regarded as an important differential characteristic. In our case, however, I could not ascertain any other definite difference in morphology of the eggs, larvae, pupae and adults. Also in regard to breeding habits both forms of *A. pullus* are entirely similar. So instead of separating them into two different species, we want for the time being to regard them as belonging to a single species, *A. pullus*.

I think it is very interesting that RUSSEL and BAISAS [9] describe that *A. hyrcanus* var. *nigerrimus* has one or two costal spots on wings. In this case, contrary to *A. pullus*, P-spot is present constantly and Sc-spot is occasionally wanting. During my studies of *A. sineroides*, *A. koreicus* and *A. edwardsi*, which were fed in the laboratory, I myself observed frequently that some of costal spots, which are so characteristic of these species, disappear partly or entirely. Judging from these facts it must be born in mind that occasionally the spots on wings, which are usually regarded as important differentials, may vary markedly. In connection with this point I shall briefly refer to the views of some authors with regard to the criteria in differentiating anopheline mosquitoes.

Investigating 48 species of anopheles of India, CHRISTPHERS (1915) [10] described male genitalia as a differential characteristic. STRICKLAND (1924) [11] also studied anopheles of India and is of opinion that, if adults differ morphologically and the larvae do not, they are of varietal ranks, and if adults as well as larvae differ definitely, they are of different species.

ROOT (1922-1924) studied extensively the anopheline larvae of America and mentioned various characteristics of them [12] [13]. Then he (1923-1924) recognized that male genitalia is very important for the differentiation [14] [15].

Further he says (1926), "All the adults of the *Nyssorhynchus* group are quite similar in general appearance and exhibit considerable variation within the species, so that it is often difficult to find any satisfactory differentials for the females of closely related species. I have taken the position that where well-marked and constant differences existed in larval structure and male genitalia, it was proper to consider the two forms as distinct species, though no satisfactory characters for the separation of adult females could be presented. This is reason for describing *A. strodei* as a new species. Conversely, in the case of *A. brasiliensis*, where male genitalia and larvae are identical or practically so, I have considered the small, but definite differences in adult markings as deserving only a varietal status." [16].

Concerning subspecies of *A. maculipennis*, which have been widely studied in Europe, SWELLENGREBELL [17] [18] says that, even though adults are very difficult to distinguish morphologically, they can be separated by taking into consideration the conditions of breeding places. Moreover, he and other authors in Holland consider that various biological behaviors are important as differentials.

HACKET [19] [20] [21] claims that, though the structures of adults and larvae of *A. maculipennis* are more or less unstable and may be considerably modified by the conditions of the breeding environment, the morphology of eggs are very valuable for the distinction of subspecies. BAISAS [22] observed, however, that "the eggs of certain varieties and some species are so very much alike that it seems impossible to differentiate such eggs when mixed together or when they are obtained from unknown or indetermined adults. The eggs of var. *nigerrimus* and the eggs of one type of *sinensis* (narrow decked) may be cited as examples." RUSSEL and BAISAS [9] say that male terminalia can hardly be relied on as differential owing to its variability and technical difficulty of its examination.

Thus we do not at present know any simple and reliable differential criteria which are applicable to all species of anopheles of various regions. We have to examine as many characters as possible which have been claimed to be valuable differentials by authors.

VII. Coloration of Anopheles.

ROOR [16] observed that in the great majority of specimens of anopheles (*Nyssorhynchus*) of Brazil (*alb tarsis* var. *brasiliensis*, *argyritarsis*, *darlingi*,

tarsimaculatus and *strodei*) the farther their locality was from the Equator, the greater (on the average) was the extent of the black area of the second hind tarsal. According to DAVIS [23], this geographical correlation is undoubtedly due to climate; probably progressively lower temperature, and even in the same area (e. g. Northern Argentina) the specimens secured in winter are usually more melanotic than those taken in summer.

CHRISTPHERS [4] says that "coloration in the group varies from a lightish grey or fawn to shades of brown practically amounting to black, and, though subject to some variation in the species, is often very helpful in identification, sometimes specimens may show more pigmentation than is usual with the species (*melanism*). A contrary effect is seen where the dark markings are abnormally restricted and spots normally present obliterated, or pigmentation may be defective in a capricious manner or almost entirely absent (*hypomelanism*)."

A similar description may be encountered with in RUSSELL'S paper [9].

In the case of *A. pullus* I observed also that the color varies from lightish dark to blackish. But even those lightish dark ones are much darker than usual *A. sinensis* and can easily be distinguished from it at a glance. Concerning the seasonal variation of color of *A. pullus* the observation is still very scanty. During October last year the specimens of *A. pullus* secured from the pond in the yard of the University showed no marked increase of the color as it became colder.

VIII. Comparison with the other Four Known Species of Anopheline Mosquitoes of Chosen.

1. *A. hyrcanus* var. *sinensis*.

By the following characteristics of *A. pullus*, *A. hyrcanus* var. *sinensis* can be distinguished from it:

- (1) Adult [1] [24] [25] [26].
 - (a) Macroscopically very dark, white spots generally small.
 - (b) One or two white costal spots on the wing. In *two-spotted* forms Sc-spot is very small.
 - (c) Neither fringe spot, nor apical pale area of wing.
 - (d) Dorsal and lateral sides of male coxites covered with numerous white scales.
- (2) Larvae [2] [7] [27] [28] [24].

- (a) Palmate hairs of abdominal segments black. Under high magnification peculiar crepe-like markings on each leaflets.
 - (b) Pecten. Conspicuous spines on long teeth extending till the tips.
 - (c) Triangular plate. Crest blunt or flat.
- (3) Pupa [2] [7] [28] [29].
Apex of Seta A of the seventh abdominal segment bill-shaped.
- (4) Egg.
Breadth of deck narrower than that of *A. hyrcanus* var. *sinensis*.
2. *A. sineroides*, *A. koreicus* and *A. edwardsi*.
- (1) Adult [1] [30].
By above (a) (b) (c) distinguishable.
 - (2) Larvae [2].
By above (a) and (b) distinguishable.
 - (3) Pupa [2].
By above (a) and (b) distinguishable.
 - (4) Egg [2].
Breadth of deck of *A. pullus* broader than that of *A. sineroides*.
Deck of *A. koreicus* and *edwardsi* separated into double area.

IX. Comparison with other Resembling Species.

1. *A. hyrcanus* var. *mesopotamiae* CHRISTOPHERS and KHAZAN CHAND.

This species was first reported (1915) by CHRISTOPHERS and KHAZAN CHAND [31] as a new species on account of a slight difference in the shape of the processes of the ninth tergite of the male hypopygium and was named *A. sinensis* var. *mesopotamiae*, but later its name was changed as above by EDWARDS [3]. According to EDWARDS' description [32], *A. hyrcanus* inhabiting Japan and Eastern Siberia has the wing-markings blurred somewhat as in the var. *mesopotamiae*, but the general coloration is much darker. S. YAMADA [1] differentiated *A. sinensis* from *A. hyrcanus* and ascertained that the form inhabiting predominantly Japan and Chosen belongs to *A. sinensis*.

As described above, *A. pullus* is much darker than *A. sinensis*, and *A. hyrcanus* is darker than *A. mesopotamiae*, so *A. pullus* must be inferred to be darker than *A. mesopotamiae*. Besides the coloration, possessing the following characteristics, *A. mesopotamiae* can easily be distinguished from *A. pullus* [31].

- (a) Costa. More or less numerous white scales along its posterior border.
In about half the specimens these are present along the whole length

of the costa, while in the remaining half they are present only on the outer half of the vein.

- (b) Sixth Vein. Two conspicuous dark spots occupying most of the outer half of the vein, the more distal including the termination of the vein.
- (c) Apex of wing. Pale from junction of third to junction of upper branch of second with margin.
- (d) Penultimate Segment. A few pale scales forming a more or less developed ventral tuft.
- (e) Femora and Tibiae. Dark scaled above, light below; apices of both pale, especially in the hind legs.

2. *A. lindesayi* GILES [4] [33] [34] [35] [45] [46] [47].

This species can be distinguished by possession of the following characteristics.

(1) Adult.

- (a) Palpi. Entirely devoid of pale markings.
- (b) Costa, first and sixth vein. Only apices white scaled.
- (c) Hind femora. A broad white band occupying about 1/5 before distal 1/5 of femur, also white beneath for about its inner 1.3.
- (d) Tarsi. Entirely dark.

Larva, Pupa, Egg of *A. lindesayi* [4] [7] [36] [37] [46] are so distinctly different in numerous points from those of *A. pullus* that the detailed description may not be necessary.

3. *A. lindesayi* var. *japonicus* YAMADA [1].

(1) Adult.

- (a)–(c) in the previous species are entirely same with this species.
- (d) Vein 1. A few yellowish scales at the junction of the humeral cross-vein.
- (e) Three fringe spots.

(2) Larva, pupa [7].

Easily distinguishable.

4. *A. lindesayi* var. *benguelensis*, *nigericus* and *cameronensis* are distinctly different from *A. pullus* [4] [9] [38].

5. *A. hyrcanus* var. *nigerrimus* GILES [4] [9] [25] [26].

(1) Adult.

- (a) Costa. P-spot constant, Sc-spot occasionally wanting. With *A. pullus*, Sc-spot constant.

- (b) Fringe of wing. A pale spot at apex.
 - (c) Hind tarsi. White ring very broad, the fourth segment more or less conspicuously white at base as well as tip.
 - (d) Phallosome. Leaflets serrated.
- (2) Larva [22] [28] [35].
- (a) Mesothoracic hair. Peculiarly shaped, splitting into 5 branches. With *A. pullus*, 3-4 branches.
 - (b) Pecton. Spines of long teeth absent towards the tips.
 - (c) Abdominal palmate hairs. Marking on leaflets clearly different from those of *A. pullus*, strêpe fine.
- (3) Pupa [22] [28] [29].
- Seta A-VIII. Very few, short sharp-pointed, branches located laterally towards the base.
- (4) Egg [37]. Deck narrower.
6. *A. hyrcanus* var. *pseudosinensis* BAISAS 1935.

This species has not yet been described systematically in detail. But so far as described, this mosquito has the following distinguishable characteristics. If the characters of *pseudosinensis* which has not been described coincide with these of *sinensis*, the differences between that species and *pullus* are fairly marked.

- (1) Adults [22].
- (a) Costa. P- and Sc-spots large.
 - (b) Remigium. Usually dark with some pale scales at the middle.
 - (c) Humeral Vein. Usually with 2 or 3 dark scales.
 - (d) Fringe. Pale spot at apex of wing involving area opposite Vein 1 to opposite Vein 4.1.
 - (e) Process of Segment IX of male terminalia. Apices not enlarged, blunt.
- (2) Larva [28].
- (a) Very light yellowish.
 - (b) Inner anterior clypeals. Very variable, usually splitting into two towards the apex.
 - (c) Posterior clypeals. Readily seen.
 - (d) Inner and middle shoulder hairs. Average length and ratios between the inner and the middle shoulder hairs are all smaller than those of *A. pullus* as the following table shows:

	Shoulder hairs	Average length	Ratio (%)
<i>A. pseudosinensis</i>	inner	0.0874	33
	middle	0.2670	
<i>A. lesteri</i>	inner	0.0657	24
	middle	0.2787	
<i>A. pullus</i>	inner	0.1468	43
	middle	0.3407	

(3) Pupa [28].

- (a) Most of dorsal hairs of metathorax and abdomen differ more or less from those of *A. pullus*.
 (b) Seta A-VI. Apex tapering sharply, that of *A. pullus* blunt.
 (c) Terminale and accessory hairs. Normally simple, rarely 2.

(4) Egg [12].

Eggs of *A. pseudosinensis* resemble those of *A. pullus*, but floats of the former are generally longer than those of the latter as shown in the following table:

	Length of egg			Length of float			Length of float Length of egg (average) × 100
	min.	max.	average	min.	max.	average	
<i>A. pseudosinensis</i>	.46	.51	.49	.30	.42	.35	65-80 (71)
<i>A. pullus</i>	.49	.63	.56	.22	.33	.28	47-52 (50)

BAISAS [22] [28] reported two other new species, namely *A. hyrcanus* var. *lesteri* and *A. hyrcanus* var. *williamsoni*. Deck of egg of *A. lesteri* is narrower than that of *A. pullus*. Egg of *A. williamsoni* is unknown, but the larva and pupa differ so clearly from those of *A. pullus* that comparative description may be unnecessary.

7. *A. barbirostris* VAN DER WULP [9] [26] [35] [38].

(1) Adult.

- (a) Palpi. Entirely dark.
 (b) Fringe. A pale fringe spot opposite apices of 2.1 and 3 and usually 5.2.
 (c) Process of abdominal segment IX and harpages. Shape peculiar.

(2) Larva.

Antennal hairs, shoulder hairs and pecten differ distinctly from those of *A. pullus*.

8. *A. jessae* GATER [4] [9] [38].

(1) Adult.

- (a) Palpi. Shaggy and entirely dark.
- (b) Fringe. With an apical white spot.
- (c) Abdomen. Without scales even on cerci, but coxites with long scales along the external borders.
- (d) Process of abdominal segment IX. Peculiarly shaped.

(2) Larva.

Obvious distinctions in inner and outer clypeal hairs, antennal hairs and pecten.

A. umbrosus THEO. [4] [26] and other anopheles of dark coloration can easily be distinguished from *A. pullus* by the morphology of adults and larvae [4] [41-47].

X. Remarks.

Blood sucking habit of adult *A. pullus* is very vigorous. At Saisen, South Tyusei-do, I found many blood engorged adults at night in stables and dwelling houses. But the epidemiological significance as vector of malaria transmission is at present entirely unknown. Further investigations on this problem are urgently required.

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XII. Explanation of Plates III-VII. *A. pullus*.

Of all the following figures except specially remarked the scale of magnification corresponds to $\frac{1}{20}$ mm.



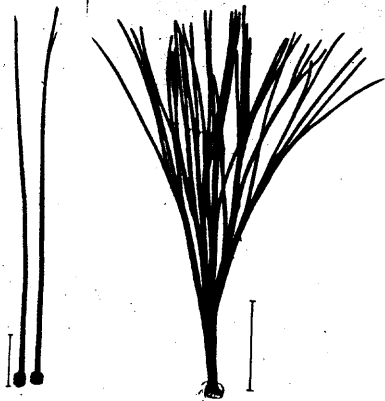
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4

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6a



6b



6c



6d



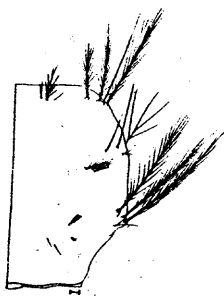
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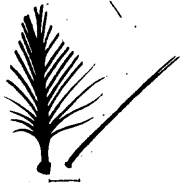
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9



7



1a



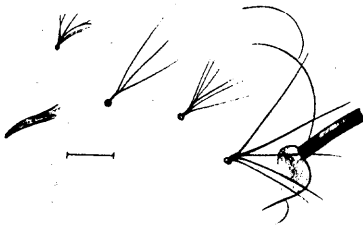
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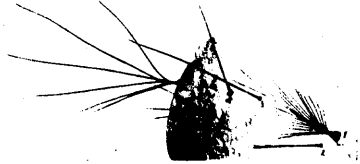
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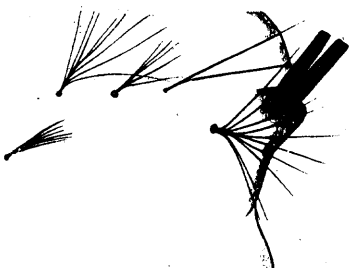
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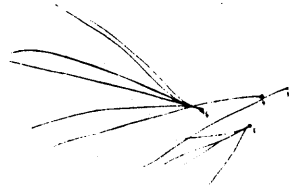
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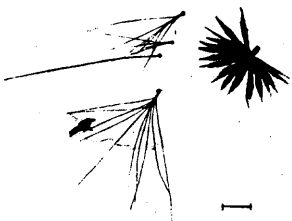
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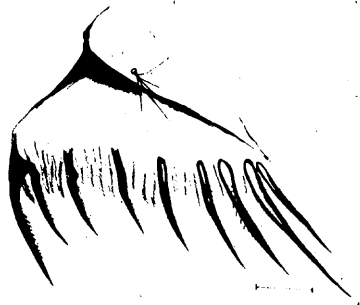
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1a



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2b



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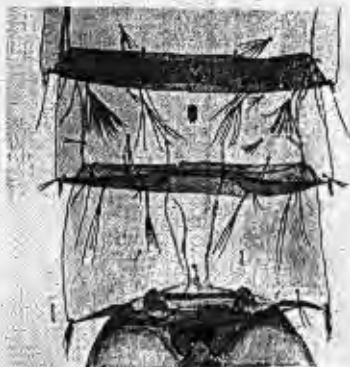
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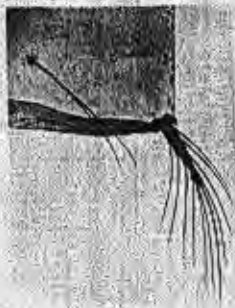
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1b



2a



2b



3



4a



4b

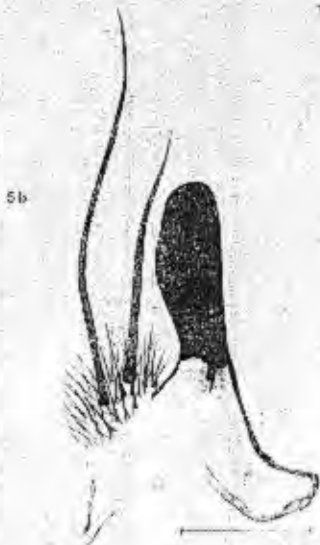
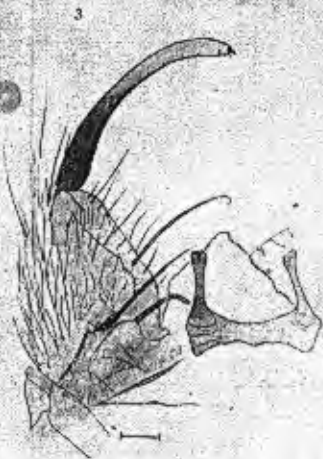


Plate III.

1. Egg.
 2. Bosses of the egg.
 3. Dorsum of head
 4. Inner anterior clypeal hair
 5. Outer anterior clypeal hair
 - 6 a-c. Posterior clypeal hairs
 7. Antenna
 - 8 a, 8 b. Triangular plates
 9. Thoracic hairs
 10. Shoulder hairs
- } of larvae.

Plate IV.

- 1 a. Outer mesothoracic hairs (r.)
 - 1 b. do. (l.)
 - 2 a. Prothoracic hair (l.)
 - 2 b. do. (r.)
 - 3 a. Dorsum of mesothorax (l.)
 - 3 b. Mesothoracic hairs
 4. Hairs of r. abdominal segment I
 5. Hairs of r. abdominal segment II
 6. Hairs of l. abdominal segment III
 7. Pecten
- } of larvae.

Plate V.

- 1 a, 1 b. Palmate hairs of abdominal segment VI
 - 2 a, 2 b. Leaflets of the palmate hairs
 3. Dorsum of metathorax and abdominal segments
 4. Trumpet
 5. Palmate hair of abdominal segment I
 6. Dorsum of abdominal segment VII-VIII
- } of pupae.

Plate VI.

- 1 a, 1 b. Terminal hairs and accessory hairs
 - 2 a. Seta A-VII
 - 2 b. Seta A-VIII
 3. Anterior part of head of a female adult.
 - 4 a. Wing (two costal spots)
 - 4 b. Wing (one costal spot)
- } of pupae.
- } 1.0 mm

Plate V.

1. Seventh sternite of a female adult.
2. Dorsum of coxite.
3. Side piece of male hypopygium.
4. Tip and leaflets of phallosome showing no serration of leaflets.
- 5 a. Harpagos of male hypopygium.
- 5 b. do.