

## Four Kinds of Anopheline Mosquitoes in Chosen.

By

Manabu YAMADA.

Department of Hygiene and Preventive Medicine, Medical Faculty,  
Keijo Imperial University, Japan  
(Director: Prof. Dr. H. MIYASHIMA.)

With Plates VII—XVI.

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### 1. Introduction.

After the Russo-Japanese War (1904—05) anopheline mosquitoes of Chosen were widely examined by several surgeons [18—20] and were reported to be the same as *Anopheles yesoensis*, which had been first found in Hokkaido (北海道) and named by J. TSUZUKI (都築其之助) [16], 1901. But K. MIYAJIMA (宮島賢之助) [17] suggested in 1903 that *A. yesoensis* might be identical with *Anopheles hyrcanus* var. *sinensis* WIEDEMANN, and in 1924 S. YAMADA (山田 一郎) [1] confirmed MIYAJIMA'S opinion and concluded that TSUZUKI'S specimens of anopheles might have been that of *A. sinensis*. Hence the sole and widely prevalent anopheline mosquito in Chosen were surely *A. sinensis*.

In 1916 Surgeon Colonel S. WATANABE (渡邊修) [22] collected many specimens of anopheles from various places in Chosen and examined them with S. YAMADA [21]. Among these specimens they found a new species caught at Heisho (江界道 平昌) and named it *Anopheles koreicus* YAMADA & WATANABE, 1918.

In 1921 F. W. EDWARDS [12, 13] described a new species *Anopheles punctithasis* caught at Nagasaki (長崎), Japan, but this was found later by S. YAMADA to be entirely identical with *A. koreicus*.

In 1928 H. KOBAYASHI (小林晴吉郎) [5, 23] examined many specimens of mosquitoes collected from various places in Chosen, but could not find any other anopheles than *A. sinensis*.

In 1932 the writer found *Anopheles sineroides* at Seiryori (京畿道 清涼里), near Keijo, and also in 1935 *A. koreicus* and *A. edwardsi* in the vicinity of Taiden (忠清南道 大田). Thus both *A. sineroides* and *A. edwardsi* were first discovered by the writer in Chosen and the species of anopheline mosquitoes in Chosen has amounted to four. Of these four species *A. sinensis* is the most common and the other three are extremely rare.

As *A. koreicus*, *A. sineroides* and *A. edwardsi* are so rare not only in Chosen, but also in Japan Proper, no morphological description of the eggs, larvae and pupae of these species has ever been reported.

Since 1932 the writer has been able to observe the development of these anopheles from the eggs laid by the captured female imagines to the adult ones by rearing the larvae artificially in the laboratory. I believe it may be of significance to make a comparative description of morphology of the eggs, larvae and pupae of these four kinds of anopholes.

### 2. Examination and preservation of specimens.

As eggs of mosquitoes float on the surface of water, and larvae and pupae move very quickly, it is not an easy task to observe precisely the minute structure of their bodies in their natural position. If larvae or pupae are killed by chemicals or heat, their bodies become deformed and appendages distorted. Floats of eggs may easily be damaged by heating. Larvae or pupae can be made motionless by cooling with ice water, but to keep the temperature of the water below 5 C is not so easy. It is absolutely necessary to keep eggs, larvae or pupae always moist, or they may entirely be crumpled and disfigured.

The simple practical method of examination is following:

Larvae or pupae are narcotized with chloroform water (alcohol 10 c.c., chloroform 0.2 c.c., water 96.0 c.c.) and made motionless. Then they are put on a slide-glass with a drop of water, covered with a cover-glass, the edge of it being smeared with vaseline. After the position of the object is ascertained to be correct for the microscopic examination, the cover-glass is fixed with melted parafine. Eggs can be examined by a similar method.

*Preservation of specimens.* Eggs can be preserved alive in a bottle for quite a long time, if they are kept moist and the temperature below 12 C. To keep eggs moist they are laid on a sheet of filter-paper made moist from beneath by water soaked cotton.

Eggs can also be preserved without much damage by floating them on a small quantity of water in a bottle, and in order to prevent the eggs adhering to the wall of bottle, petroleum benzin is poured on the water surface.

Specimens of larvae or pupae can be preserved in a solution of acetic acid (5 gr. of 30% acetic acid, sterile aqu. dest. 100 c.c.) in a refrigerator. Mosquitoes imagines can safely be preserved in a closed bottle by enclosing them with cotton soaked with formalin water.

### 3. Special morphological descriptions.

#### (a) *Anopheles hyrcanus* (PAULIAN) var. *sinensis* (WIEDERMASS)

##### I. Egg

(in mm.)

	Minimum	Maximum	Average
Length of eggs	0.61	0.71	0.66
Length of floats	0.34	0.41	0.36
Breadth of eggs	0.18	0.21	0.20

By using a hand lens, two types of eggs can be distinguished.

Type I. The whole grey upper surface is surrounded by a mill which is on lateral sides contiguous to floats and leaves no space between them. (Pl. VI, Fig. 1a.) In some specimens the lateral parts of the mill contiguous to floats are very thin or disappear entirely, and in some others the mill is an evenly ring all around the upper surface. (Pl. VII, Fig. 1a.)

Type II. The mill is not contiguous to the lateral parts of floats, but on both sides a narrow silver-greyish space between them. The mill is a wide

consisting of numerous small air-cells, is more distinct in *A. sinensis* than in those of the other three species. 6-12 white warts can be seen at both ends of the upper surface. The float is made up of 25-30 air chambers on each side.

I observed another type of ova laid by *A. sinensis* which were generally more blackish than the usual ones. This kind of ova resembles closely that of *A. sineroides* and possesses on the upper surface a black longitudinal median band surrounded by a thin frill. This black band is, however, broader than that of *A. sineroides*, and its average breadth is 0.086 mm. Whether this kind of ova indicates a different subspecies or not, is at present still problematical.

## II. Fourth Stage Larva.

- (1) **General appearance.** The average length is about 6 mm. (Pl. VII 1.) According to the environment, the colour is varied, green, grey, reddish or dark brown and some are spotted.
- (2) **Head.** (Pl. VII 2.)
  - (a) The pattern on the dorsal surface has four pigmented bands, whose position and size are varied.
  - (b) Outer clypeal hairs. Split into 35-50 branches, form a flat, fan-shaped tuft. (Pl. IX 1 a, b.)
  - (c) Inner clypeal hairs. Long, slender and single and set close together. (Pl. VII 7.)
  - (d) Posterior clypeal hair. Branched (2-4) in the shape of young grass. (Pl. IX 6 a, 6 b, 7 a, 7 b.)
  - (e) Frontal hairs. The tips of all three pairs are almost the same length. (Pl. VII 7.)
  - (f) Antenna. Spinens scattered on the surface of the antenna are rather slender. At the tip of the antenna, there are a long branched hair and two (rarely three) long, large spines. (Pl. IX 13. Plate X 1 a, b 2 a, b.)
  - (g) Antennal hair. Branched (3-6) near the base. (Pl. X 3 a, b, c, d.)
  - (h) Triangular plate. The crest of the plate is rather narrow and long, tapering bluntly. (Pl. VII 11.)
- (3) **Thorax.**
  - (a) Inner shoulder hair (or Inner anterior submedian thoracic hair). Tips are single or branched (3-4). (Pl. X 8 a-d.)
  - (b) Outer mesothoracic hair (or median lateral thoracic hair). Single or branched into 5. (Pl. X 12, 13.)

- (c) Thoracic palmate. Small and rudimentary on the metathorax. (Pl. XI 9, 10.)
- (4) **Abdomen.**
  - (a) Palmate hairs (or float hairs). The tip of each leaflet is thin and long, tapering sharply and irregularly with staircase-shaped notches on the lateral margins of the apical half. (Pl. XI 3 a, b.)
  - (b) Pecten. Any spine is unrecognizable on the teeth. Long teeth are darker brown than short ones. (Pl. X 17 a, b.)

## III. Pupae.

- (1) Palmate hair (or balancing pupal bristle). Thickly branched at the base, tuft-shaped, each bristle branched dichotomously or fork-shaped. This hair of *A. sinensis* resembles closely that of *A. edwardsi*, but the former has more branches at base than the latter. (Pl. XII 1, 4, 5.)
- (2) **Seventh segment.**
  - Seta A. Stout and short, tip tapering. (Pl. XV 1 a.)
  - Seta B. Branched into 3 or 4. (Pl. VI 9, XIII 1.)
  - Seta C. Single or branched dichotomously. (Pl. XII 9, XIII 1.)
- (3) **Paddle.** (Pl. XIII 1.)
  - Terminal paddle hair. Split near the tip into 2, 3 or 6 branches. (Pl. XIV 1-6.)
  - Subterminal hair. (It was first given the above name by the writer.) A slender hair arising about 0.05 mm apart from the terminal hair and split into 2 or 3 branches.

## (b) *Anopheles sineroides* (YAMADA).

### I. Egg.

(in mm.)

	Minimum.	Maximum.	Average
Length of eggs	0.54	0.59	0.56
Length of floats.	0.34	0.41	0.37
Breadth of eggs.	0.19	0.21	0.20

On the upper surface a dark stripe of the breadth of 0.023-0.047 mm runs straight from one end to the other, both lateral margins having white frills.

At each end of the dark stripe 4-8 white warts can microscopically be recognized. The float consists of 22-30 air chambers. (Pl. VII 2 a, b & 3 a, b.)

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P. sineroides

## II. Fourth Stage Larva.

- (1) General appearance. Yellowish brown. (Pl. VIII 2.)
- (2) Head.
- Pattern on the dorsal surface is more or less distinct. No distinct transversal band as in the case of *A. sinensis*. (Pl. VII 8.)
  - Outer clypeal hair. Fan-shaped, branching near the tip dichotomously or in fork-shape, branches being short and usually 11-15 in number. (Pl. IX 2 a-c.)
  - Inner clypeal hair. Long, slender and single and set close together. (Pl. VII 8.)
  - Posterior clypeal hair. Split into 2-6 branches in the shape of young grass. (Pl. IX 9, 10.)
  - Frontal hair. Outer two pairs are obviously shorter than the inner one pair. (Pl. VII 8.)
  - Antenna. Spines scattered over the surface of the antenna resembles those of *A. sinensis*, relatively more slender than those of the other two species. (Pl. IX 14, 15.)
  - Antennal hair. Split into 4-7 branches. (Pl. IX 14, 15.)
  - Triangular plate. Crest relatively wide and blunt. (Pl. VII 12.)
- (3) Thorax.
- Inner shoulder hair. Splitting near the tip into 2 or 3 branches. (Pl. X 9 a c.)
  - Outer mesothoracic hair. Splitting near the tip into 3 branches. (Pl. X 14.)
  - Thoracic palmate on metathoracic. Resembling *A. sinensis* in its shape. (Pl. XI 11, 15.)
- (4) Abdomen.
- Palmate hairs. The tip of each leaflet appears to be cut off. Near the tip both edges are notched in the shape of a stair-case. In the middle of the leaflet numerous pigmented longitudinal striae are seen. (Pl. XI 4.)
  - Pecten. Spines on short teeth are stout and conspicuous. Long teeth are deeper in colour than short ones. (Pl. X 18.)

## III. Pupa.

- Palmate hair. Branched at the base in flat tuft shape, bristles branching dichotomously. (Pl. XII 2, 6.)

- (2) Seventh segment.
- Seta A. Stout and short, tip blunt. (Pl. XV 2 a.)
- Seta B. Split into 2 branches. (Pl. XII 10.)
- Seta C. Single. (Pl. XII 10.)
- (3) Paddle.
- Terminal paddle hair. Split near the tip into 2 or 3 branches. (Pl. XIV 7, 8.)
- Subterminal hair. Split into 2 branches. (Pl. XIV 7, 8.)

(c) *Anopheles koreicus* YAMADA & WATANABE.

## I. Egg.

(in mm.)

	Minimum.	Maximum.	Average
Length of eggs.	0.43	0.52	0.50
Length of floats.	0.34	0.40	0.36
Breadth of eggs.	0.11	0.19	0.16

On the upper surface of the egg, two dark olive-shaped specks are clearly observed.

The anterior speckle (0.193×0.050 mm.) is a little larger than the posterior one (0.169×0.045 mm.). These black speckles, tapering at the interior ends, are surrounded by a white frill.

At each end of an egg there are 3 or 4 white warts. The float consists of 26-33 air-chambers. (Pl. VII 4.)

## II. Fourth Stage Larva.

- (1) General appearance. The colour is generally dark; dark spots never change throughout those four stages according to the conditions of the breeding places.
- A white spot is seen on the dorsal surface of the third segment of the abdomen. (Pl. VIII 2.)
2. Head.
- The dorsal surface is more or less irregularly patterned. (Pl. VII 8.)
  - Outer anterior clypeal hair. Branched laterally into 4-6 hairs. (Pl. IX 3 a, b & 5 a.)

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- (c) Inner anterior clypeal hair. Long, slender, single and set closely together. (Pl. VII 9, IX 5 a.)
  - (d) Posterior clypeal hair. Single, no branch. (Pl. XI 11.)
  - (e) Frontal hairs. Outer two pairs are notably shorter than the inner one pair. (Pl. VII 9.)
  - (f) Antenna. Spines on the surface of antenna are very sparsely scattered. (Pl. IX 16, IV 4.)
  - (g) Antennal hair. Short, dichotomously branched (6 or 7). (Pl. IX 16, IV 5.)
  - (h) Triangular plate. Crest blunt. (Pl. VII 13.)
- (3) Thorax.
- (a) Inner shoulder hair. Branched near its base into 2 or 3 hairs. (Pl. X 10.)
  - (b) Outer mesothoracic hair. Single or splitting near the tip into 2 branches. (Pl. X 15.)
  - (c) Thoracic palmate on metathorax. Small or rudimentary, resembling that of *A. sineroides*. (Pl. XI 16.)
- (4) Abdomen.
- (a) Leaflets of palmate hairs. Edges of the outer half are notched like maple leaves, and the middle part is patterned irregularly. (Pl. XI 5.)
  - (b) Pecten. No difference of colour between long and short teeth. Spines on short teeth are very thin and numerous. Rarely a few spines at the base of long teeth. (Pl. XI 1.)

### III. Pupa.

- (1) Palmate hairs. Very characteristic tuft-shape, profusely branched near the base into very thin hairs. (Pl. XII 3.)
- (2) Seventh segment. (Pl. XIII 3.)
  - Seta A. Relatively thin and long, tapering rather sharply.
  - Seta B. Split near the tip into 3 branches.
  - Seta C. Single.
- (3) Paddle. (Pl. XIII 3.)
  - Terminal paddle hair. Single.
  - Subterminal hair. Single.

### (d) *Anopheles edwardsi* (YAMADA).

#### I. Egg.

(in mm.)

	Minimum	Maximum	Average
Length of eggs.	0.47	0.51	0.50
Length of floats.	0.31	0.40	0.35
Breadth of eggs.	0.16	0.21	0.20

On the upper surface two black speckles similar to those of *A. koreicus* are present. The inner ends of the speckles are not tapering, but blunt.

The anterior speckles (av.  $0.189 \times 0.068$  mm.) are a little larger than the posterior ones (av.  $0.157 \times 0.060$  mm.). At each end of an egg 3 or 4 white warts. (Pl. I 6 a, b, c.)

Floats is made up of 31-37 air chambers. (Pl. VII 5.)

#### II. Fourth Stage Larva.

- (1) General appearance. Yellowish brown; more yellowish than *A. sineroides*.
- (2) Head.
  - (a) Dorsal surface is more or less irregularly patterned. (Pl. VII 10.)
  - (b) Outer clypeal hair. Laterally branched in 6 hairs. (Pl. IX 4.)
  - (c) Inner clypeal hairs. Long, slender, single and set close together. (Pl. IX 5 b.)
  - (d) Posterior clypeal hair. Near the tip split into 3 branches. (Pl. IX 12, 5 b.)
  - (e) Frontal hairs. Inner one pair are a little longer than the outer two pairs. (Pl. VII 10.)
  - (f) Antenna. Spines on the antenna are comparatively stout and short. (Pl. IX 17, X 6.)
  - (g) Antennal hair. Long and slender, branching near the base into 7-8 hairs. (Pl. X 7, IX 17.)
  - (h) Triangular plate. Crest very blunt and flat. (Pl. VII 14.)
- (3) Thorax.
  - (a) Inner shoulder hair. Single or split near the tip into 2 or 3 short branches. (Pl. X 11 a-c.)
  - (b) Outer mesothoracic hair. Single or branching at the middle and near the tip (1-3). (Pl. X 16 a, b.)

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- (c) Thoracic palmate on the metathorax. Small or rudimentary and being broader and shorter than the other three species. (Pl. XI 12 and 17.)
- (4) Abdomen.
- (a) Palmate hairs. Notches on the edges are few and shallow. In the middle three transversal light coloured bands can be distinguished. (Pl. XI 6 a, b.)
- (b) Pecten. No difference of colour is seen between long and short teeth. Spines on short teeth are small and numerous. Some spines are rarely found at the bases of long teeth. (Pl. XI 2.)

### III. Pupa.

- (1) Palmate hair. Branched near the base into 5-8 thick stems which split dichotomously or in fork-shape into numerous slender hairs. (Pl. XII 7, 8.)
- (2) Seventh segment.
- Seta A. Comparatively more slender than that of other species; tip tapering. (Pl. XV 3 a, b.)
- Seta B. Split near the tip into 2 branches. (Pl. XII 11.)
- Seta C. Single. (Pl. XII 11.)
- (3) Paddle. (Pl. XIV f.)
- Terminal paddle hair. Single.
- Subterminal hair. Single.

### 4. Comparative description.

(1) During 1931-35 the writer examined more than ten thousand anopheline larvae and imagoes captured in the vicinities of Keijo and Taiden. Most of them were *A. sinensis*, but imagoes of three other different species were discovered. They were *A. sineroides* (64 in number), *A. koreicus* (21) and *A. edwardsi* (13), all being female. I was also able to observe numerous larvae, pupae and imagoes reared from the eggs which were laid by these captured female imagoes.

As breeding places of the anopheline mosquitoes are peculiar to each species, the geographical distribution of the mosquitoes is not uniform, but may be different according to the local characteristics. *A. sinensis* is ubiquitous in Chosen and can be captured almost everywhere. But the other three kinds of anophelids breed preferably in cool water, and their distribution is more restricted to hilly places.

As the morphological examinations of these eggs, larvae and pupae have

been described above in detail, their characteristics are compared in the following chapters.

### (2) Egg.

#### (a) Black stripe and black speckles.

Examined with a hand lens, on the upper surface of an egg a broad black stripe running from one end to the other can be seen. Examined microscopically, this black stripe is, like the gunwale in a boat, surrounded by a white opaque frill which keeps the black area from wetting.

The silvery grey surface between the frill and side floats is covered with a thin flat epithelium which extends over the air cells of the frill. This construction can easily be ascertained by staining eggs in Malpighian tubes of adult female mosquitoes.

The frill is not straight, but winding, and consists of a row of small air cells, which are very frail and, if heated, they are ruptured easily.

In the case of *A. koreicus* or *A. edwardsi*, the black stripe observed in *A. sineroides* seems to disappear in the middle part, leaving anterior and posterior black speckles.

The frill of *A. sinensis* is thick, conspicuous and runs near the floats. Hence its upper surface appears almost entirely grey and two silver-greyish parts outside the frill become narrow stripes or disappear totally. (Pl. VII a, b.)

(b) White warts. At both ends of each anopheline egg several white warts are present. Magnified highly, these warts resemble molar teeth, and in some specimens a few short spines are present. (Pl. VII 6.) These warts are the most numerous in *A. sinensis*, next in *A. sineroides*, and *A. koreicus* and *A. edwardsi* are the least of all.

#### (c) Size of eggs.

The minimum, maximum and average sizes for each species are shown above. Eggs of *A. sinensis* are the largest and those of *A. sineroides*, *A. koreicus* and *A. edwardsi* are smaller in the order mentioned. Compared with the size of anopheline ova shown in Boyd's [6] "Introduction to Malariology" i.e. 0.6-0.8 mm in length, those of *A. koreicus* and *A. edwardsi* are distinctly shorter in length.

But the floats of these two species are comparatively large.

### (3) Larva.

(a) Size. There is no specific difference among the sizes of the full grown fourth stage larvae. The average length from the top to the tail is about 6.3 mm. If the food is not sufficient, the breadth of the larva diminishes conspicuously, the length remaining unchanged.

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(b) Palmate hair. The writer found a pair of palmate hair on each dorsal surface of the metathorax of the larvae of these four species and on the 1st to 7th abdominal segments. These hairs on the first and second abdominal segments are, not always, but usually very small or rudimentary. Occasionally **fully-developed palmate hairs are seen on the 2nd segment, and rarely quite developed ones on the 1st segment.**

(4) Pupa.

No specific difference among the sizes of pupae of the four species. Their average length is 5.2 mm. If the food is deficient, pupae are generally small. Trumpets of pupae are almost all the same in these four species. They are **short, stumpy, funnel-shaped, and the openings are large. Concerning several parts of paddles shown in Pl. XIV a c, no difference among these four species was seen.**

(5) Adults.

S. YAMADA described in 1924 the morphology of adults of *A. sinensis* and *A. boreicus* in Chosen and those of *A. sineroides* and *A. edwardsi* in Japan Proper.

The writer examined precisely the adults of these four species caught in Chosen and compared them with the descriptions reported by S. YAMADA and could identify them respectively.

I compared *A. sineroides* and *A. edwardsi*, which were discovered by me for the first time in Chosen, with specimens of these anopheline adults caught in Japan and could ascertain that these two species discovered in Chosen are quite identical with those caught in Japan Proper. It may not be necessary to describe here in detail the morphology of the adults of these four species. But the differential characteristics and keys for the four anopheline mosquitoes are shown in the following table.

Synoptic Table of the adult female anopheline mosquitoes in Chosen.

	<i>A. sinensis.</i>	<i>A. sineroides.</i>	<i>A. boreicus.</i>	<i>A. edwardsi.</i>
Pulpi.	Four white bands.	Four white bands.	No white band.	No white band.
Costa.	Two white patches on the apical half.	Four white patches, small ones at the base and humeral cross vein, and two other long ones on the apical half.	Four white patches, similar to <i>A. sineroides</i> .	Five white patches, two small ones at the base and humeral cross vein, a long one on the middle part, and two other long ones on the apical half.

	<i>A. sinensis.</i>	<i>A. sineroides.</i>	<i>A. boreicus.</i>	<i>A. edwardsi.</i>
Analus.	Two black patches, one on the middle part and the other on the apical half.	Three black patches, two patches on the middle part and the other at the apex.	Three black patches, at the base, smallest on the middle part, largest at the apex.	Three black patches, similar to <i>A. boreicus</i> .
Clypeus.	A patch of broad linguulate brownish black scales on both sides.	Similar to <i>A. sinensis</i> .	No patch of brownish black scales on both sides.	No patch on both sides.
Seventh dorsal abdominal tergum.	A patch of erect linguulate scales is in the posterior part, and in some cases a whitish grey patch in the middle of the segment.	A patch of white scale in the middle and behind it, a patch of black scales.	Similar to <i>A. sinensis</i> . The tips of scales are bent down and seem as if cut off.	Similar to <i>A. sinensis</i> .
White bands of legs.	Base of tibia of hind leg.	Base of the first and second tarsus of fore leg.	Tips of third and fourth tarsus of fore leg.	

Key to the adult female anopheline mosquitoes of Chosen.

- I. Costa with two white patches ..... *A. sinensis*.
  - II. Costa with four patches ..... *A. sineroides*.
    - 1) Palpus with four white bands ..... *A. sineroides*.
    - 2) Palpus without white bands ..... *A. boreicus*.
  - III. Costa with five white patches ..... *A. edwardsi*.
- These characteristics are lost in some cases.  
The details are to be discussed in other paper.

Key to eggs of anopheline mosquitoes of Chosen.

- I. Upper surface with broad greyish-black zone surrounded by frill ..... *A. sinensis*.

- II. Upper surface with a longitudinal narrow coal-black stripe... *A. sineroides*.  
 III. Upper surface with an anterior and a posterior coal-black oval patch.  
 (1) Coal-black patches tapering inward ..... *A. koreicus*.  
 (2) Coal-black patch with blunt ends ..... *A. edwardsi*.

Key to larvae of anopheline mosquitoes of Chosen.

- I. Outer (anterior) clypeal hairs, flat fan-shaped, splitting in numerous fine branches (33-50)..... *A. sinensis*.

II. Frontal hairs.

Inner one pair are longer than the other two pairs.

- (1) Outer (anterior) clypeal hair splitting in fork-shape near the tip into less numerous branches (11-15) ... *A. sineroides*.  
 (2) Outer (anterior) clypeal hair branching dichotomously into 4-6 hairs.  
 (a) Inner shoulder hair splitting near the base into two or three branches..... *A. koreicus*.  
 (b) Inner shoulder hair splitting near the tip into two or three branches..... *A. edwardsi*.

Key to pupae of anopheline mosquitoes of Chosen.

The following Seta A, B and C are presented on the dorsal surface of the seventh abdominal segment as illustrated in Plate VI 9-11, VII 1-4.

I. Seta C, single or splitting into two branches.

Seta B, splitting into three or four branches.

Seta A, stout with tapering tip ..... *A. sinensis*.

II. Seta C, simple.

(1) Seta B, splitting into three branches.

Palmaria hairs of the first abdominal segment, long

and slender, branched in two places..... *A. koreicus*.

(2) Seta B, splitting into two branches.

(a) Seta A, stout with tapering tip ..... *A. sinensis*.

(b) Seta A, slender without tip ..... *A. edwardsi*.

According to SIMON & HANSEN [1-5] there are two pairs of legs of *A. sinensis* and *A. edwardsi* in Philippine. One pair resembles that of *A. sinensis* or *A. edwardsi*.

*edwardsi*, and the other looks like that of *A. sineroides*. But their larvae are morphologically entirely different.

*A. (Myzomia) palloni* [8, 15] of North China breeds in hilly regions and its larvae are abundant with black pigment which does not change according to the conditions of the breeding place. These characteristics resemble *A. koreicus*, but morphologically they are quite different. If the larvae of four species of anopheline mosquitoes of Chosen are compared, *A. sinensis* possesses the most developed and complicated structure and *A. sineroides*, *A. koreicus* and *A. edwardsi* are less developed in the order mentioned.

Record.

*A. sinensis*.

Raman (羅南). (S. SAKAI. 1911.)

Kwainai (會寧). (Z. NISHYAMA. 1911.)

Kanko (咸興). (—, 1911.)

Ryuzan (龍山). (Y. HASEGAWA. 1913.)

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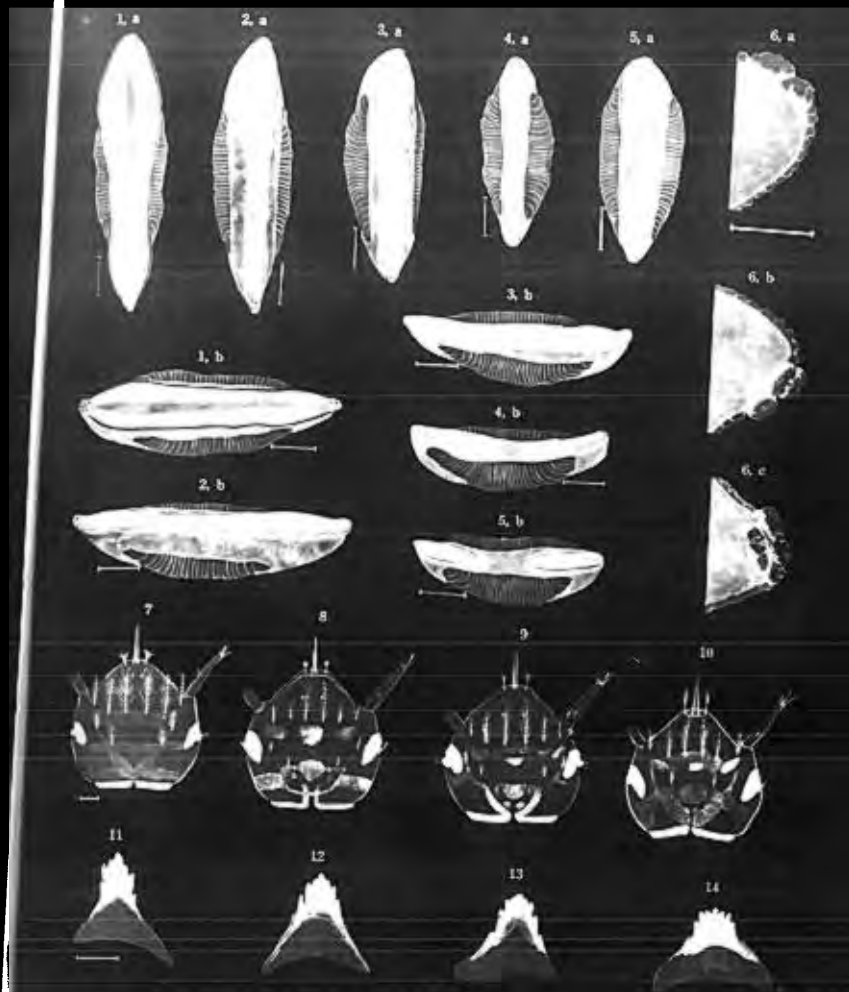
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### Explanations of Plates VII XVI.

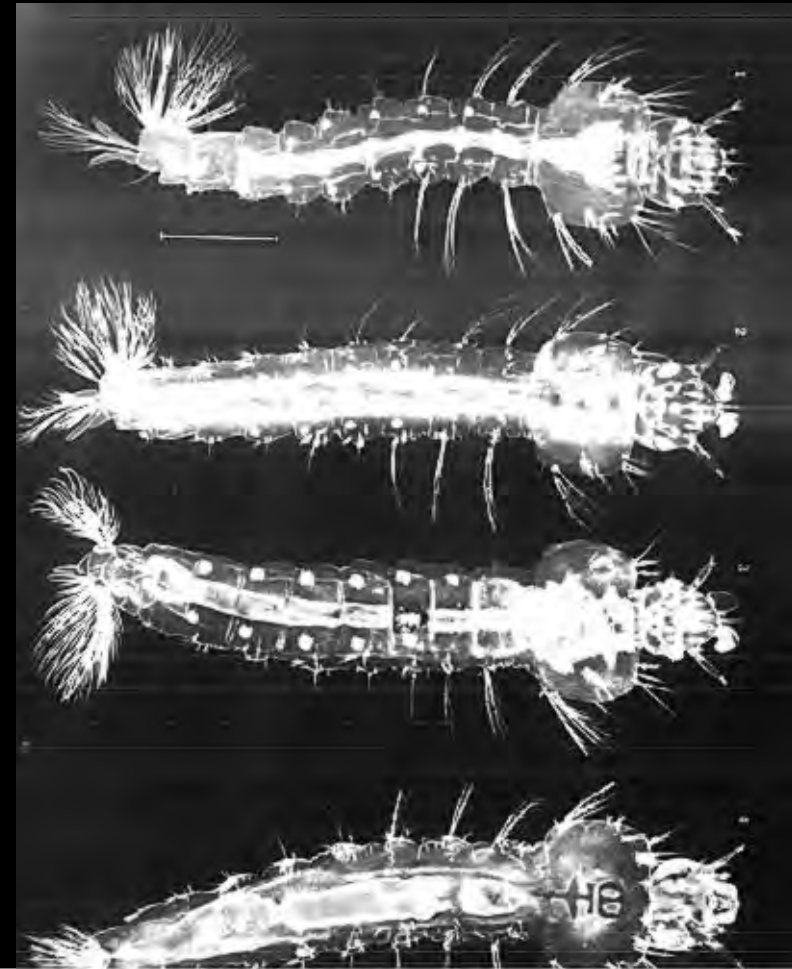
Of the following figures which are not specially remarked the scale of magnification corresponds to 0.05 mm.

Plate VII. Eggs. Larvae; heads and triangular plates.

- |   |            |
|---|------------|
| 1a. Upper surface of an egg of <i>A. sinensis</i> .                       | } 0.01 mm  |
| 1b. Dorsolateral view of an egg of <i>A. sinensis</i> .                   |            |
| 2a, 3a. Upper surface of an egg of <i>A. sineroides</i> .                 |            |
| 2b, 3b. Dorsolateral view of an egg of <i>A. sineroides</i> .             |            |
| 4a. Upper surface of an egg of <i>A. korcicus</i> .                       |            |
| 4b. Dorsolateral view of an egg of <i>A. korcicus</i> .                   |            |
| 5a. Upper surface of an egg of <i>A. edwardsi</i> .                       | } 0.025 mm |
| 5b. Dorsolateral view of an egg of <i>A. edwardsi</i> .                   |            |
| 6a. White warts at the anterior end of an egg of <i>A. edwardsi</i> .     |            |
| 6b, c. White warts at the posterior end of an egg of <i>A. edwardsi</i> . | } 0.1 mm   |
| 7. Dorsal head of larva of <i>A. sinensis</i> .                           |            |
| 8. Dorsal head of larva of <i>A. sineroides</i> .                         |            |
| 9. Dorsal head of larva of <i>A. korcicus</i> .                           |            |
| 10. Dorsal head of larva of <i>A. edwardsi</i> .                          |            |
| 11. Triangular plate of <i>A. sinensis</i> .                              |            |
| 12. Triangular plate of <i>A. sineroides</i> .                            |            |
| 13. Triangular plate of <i>A. korcicus</i> .                              |            |
| 14. Triangular plate of <i>A. edwardsi</i> .                              |            |



- Plate VIII Larva 10 mm  
1. Dorsal surface of larva of *A. sinensis*.  
2. Dorsal surface of larva of *A. sineroides*.  
3. Dorsal surface of larva of *A. koreicus*.  
4. Abdominal surface of larva of *A. sineroides*.



- Plate IX. Outer, inner & posterior clypeal hairs of larvae. Antennae of larvae.
- 1a, b. Outer clypeal hair (left) of *A. sinensis*. b, a rare example.
  - 2a, b. Outer clypeal hair of *A. sineroides*. a left, b right of the same larva.
  - 2c. Outer clypeal hair of *A. sineroides*, showing many branches.
  - 3a, b. Outer clypeal hair of *A. koreicus*. a left, b right of the same larva.
  - 4a, b. Outer clypeal hair of *A. edwardsi*. a left, b right of the same larva.
  - 5a. Outer and inner clypeal hairs of *A. koreicus*.
  - 5b. Outer, inner and posterior clypeal hairs of *A. edwardsi*.
  - 6a, b. Posterior clypeal hairs of *A. sinensis*. a left, b right.
  - 7a, b. Posterior clypeal hairs of *A. sinensis*. a left, b right.
  8. Posterior clypeal hairs of *A. sinensis* (variation). a left, b right.
  - 9a, b. Posterior clypeal hair of *A. sineroides*. a, left. |—| 0.01 mm. b, right.
  - 10a, b. Posterior clypeal hair of *A. sineroides*. a left, b right.
  11. Posterior clypeal hair of *A. koreicus*.
  12. Posterior clypeal hair of *A. edwardsi*. |—| 0.01 mm.
  13. Antenna of the larva of *A. sinensis*, showing the left dorsal surface.
  14. Antenna of the larva of *A. sineroides*, showing the left dorsal surface.
  15. Antenna of the larva of *A. sineroides*, showing the left dorsal surface.
  16. Antenna of the larva of *A. koreicus*, showing the left dorsal surface.
  17. Antenna of the larva of *A. edwardsi*, showing the right dorsal surface.



Plate X. Antenna, shoulder hair, mesothoracic hair and pecten of larvae.

- 1 a. Antenna of the larva of *A. sinensis*, showing the left dorsal surface.
- 1 b. Antenna of the larva of *A. sinensis* (variation), showing the right dorsal surface.
- 2 a, b. Hair at the end of dorsal surface of left larval antenna of *A. sinensis*.
- 3 a. Right antennal hair on the dorsal surface of larva of *A. sinensis*.
- 3 b, c, d. Left antennal hair on the dorsal surface of larva of *A. sinensis*.
4. Hair at the end of dorsal surface of right larval antenna of *A. koreicus*.
5. Right antennal hair on the dorsal surface of larva of *A. koreicus*.
6. Hair at the end of dorsal surface of the left larval antenna of *A. edwardsi*.
7. Antennal hair on dorsal surface of the left larval antenna of *A. edwardsi*.
- 8 a. Left shoulder hair of *A. sinensis*.
- 8 b, c. Right shoulder hair of *A. sinensis*.
- 8 d. Inner shoulder hair (variation) of *A. sinensis*.
- 9 a. Left shoulder hair of *A. sineroides*.
- 9 b. Right shoulder hair of *A. sineroides*.
- 9 c. Right shoulder hair of *A. sineroides*. The left is of the same form.
- 10 a, b, c. Left shoulder hair of *A. koreicus*.
- 11 a. Left shoulder hair of *A. edwardsi*.
- 11 b. Right shoulder hair of *A. edwardsi*.
- 11 c. Left shoulder hair of *A. edwardsi*.
12. Outer mesothoracic hair (left) of *A. sinensis*.
13. Outer mesothoracic hair (right) of *A. sinensis* (variation).
14. Outer mesothoracic hair (right) of *A. sineroides*.
- 15 a, b. Outer mesothoracic hair (left) of *A. koreicus*.
- 16 a, b. Outer mesothoracic hair (left) of *A. edwardsi*.
- 17 a, b. Pecten (or comb) of *A. sinensis*. b, showing its hair.
- 18 a, b, d. Pecten of *A. sineroides*. b its hair, d small tooth.



## Plate XI. Pecten and palmate hair.

- 1 a, b. Pecten of *A. koreicus*. b, its hair.
- 2 a, b. Pecten of *A. edwardsi*. b, its hair.
- 3 a, b. Palmate hair on the 5th or 6th abdominal segment of larvae of *A. sinensis*. b, a middle leaflet.
- 4 a, b. Palmate hair on the 5th or 6th abdominal segment of larvae of *A. sinensis*. b, a middle leaflet.
- 5 a, b. Palmate hair on the 5th or 6th abdominal segment of larvae of *A. koreicus*. b, a middle leaflet.
- 6 a, b. Palmate hair on the 5th or 6th abdominal segment of larvae of *A. edwardsi*. b, a middle leaflet.
7. Variation(?) in palmate hair of *A. sinensis*, showing no pattern.
8. Base of palmate hair of *A. sinensis*.
- 9, 10. Thoracic palmate of *A. sinensis*.
11. Thoracic palmate of *A. sinensis*.
12. Thoracic palmate of *A. edwardsi*.
- 13, 14. Hairs around the thoracic palmate of *A. sinensis*.
15. Hairs around the thoracic palmate of *A. sinensis*.
16. Hairs around the thoracic palmate of *A. koreicus*.
17. Hairs around the thoracic palmate of *A. edwardsi*.

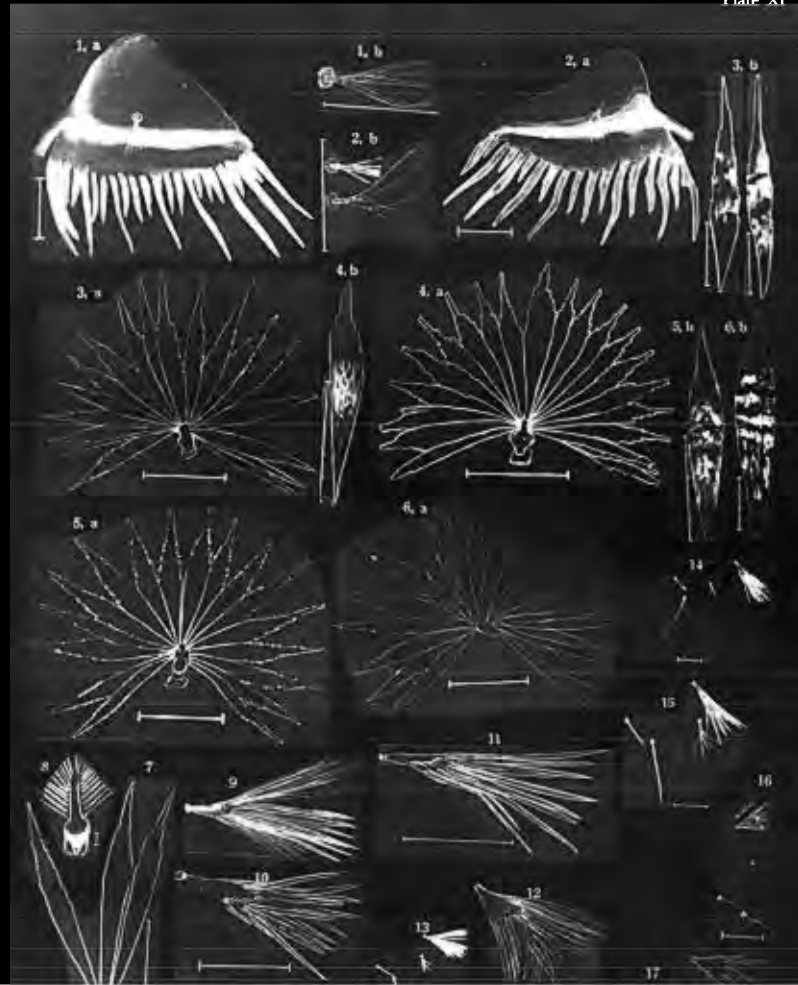
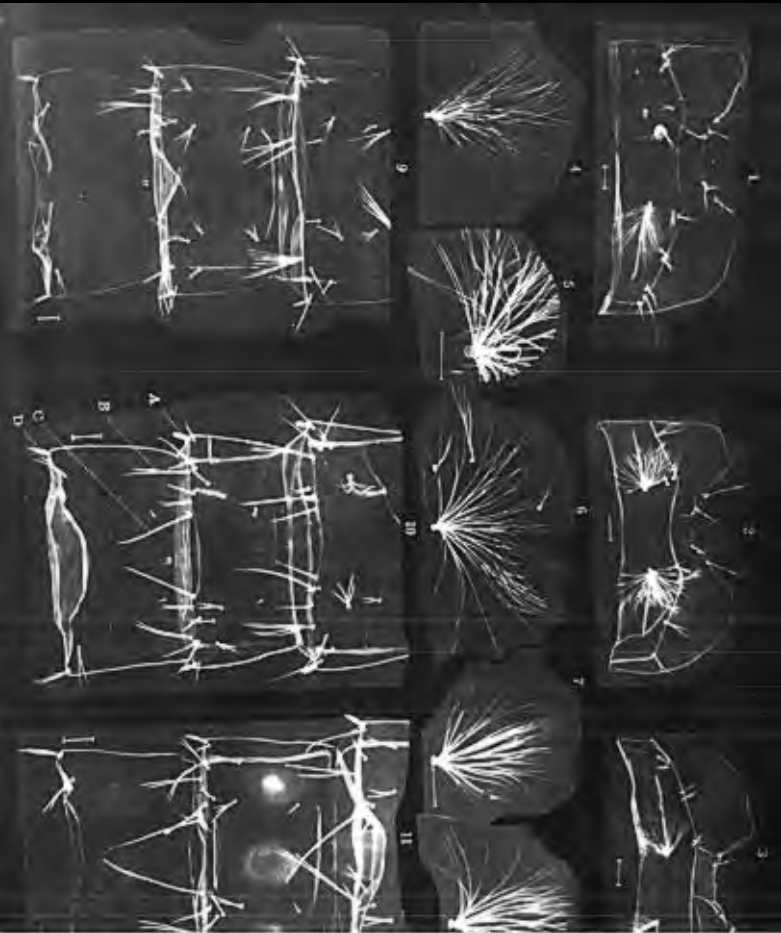
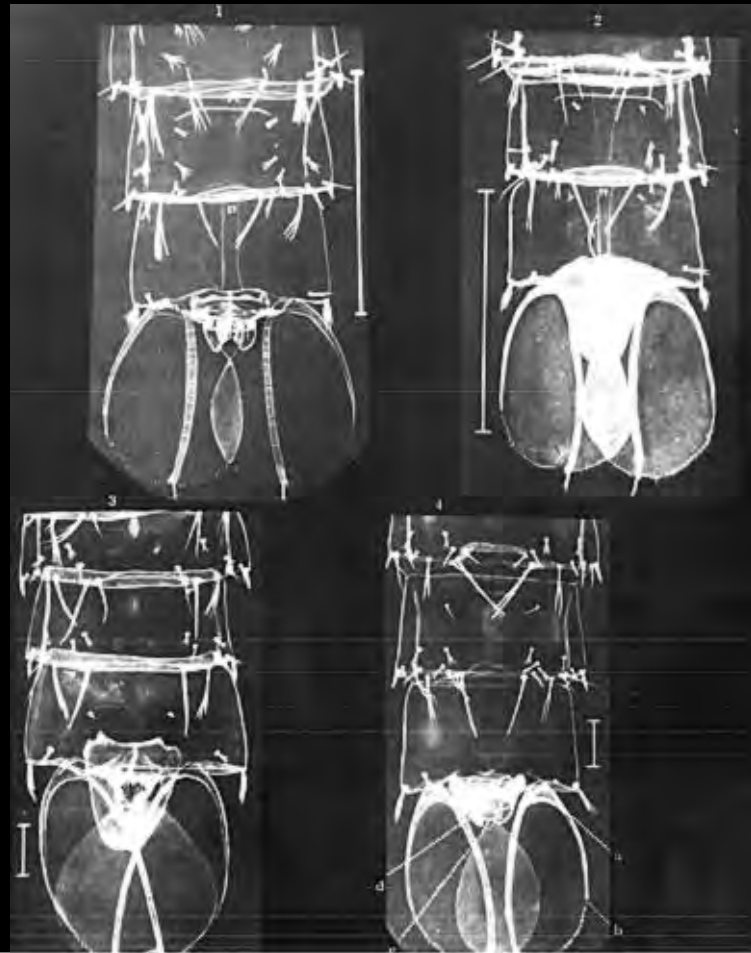


Plate XII. Pupae.

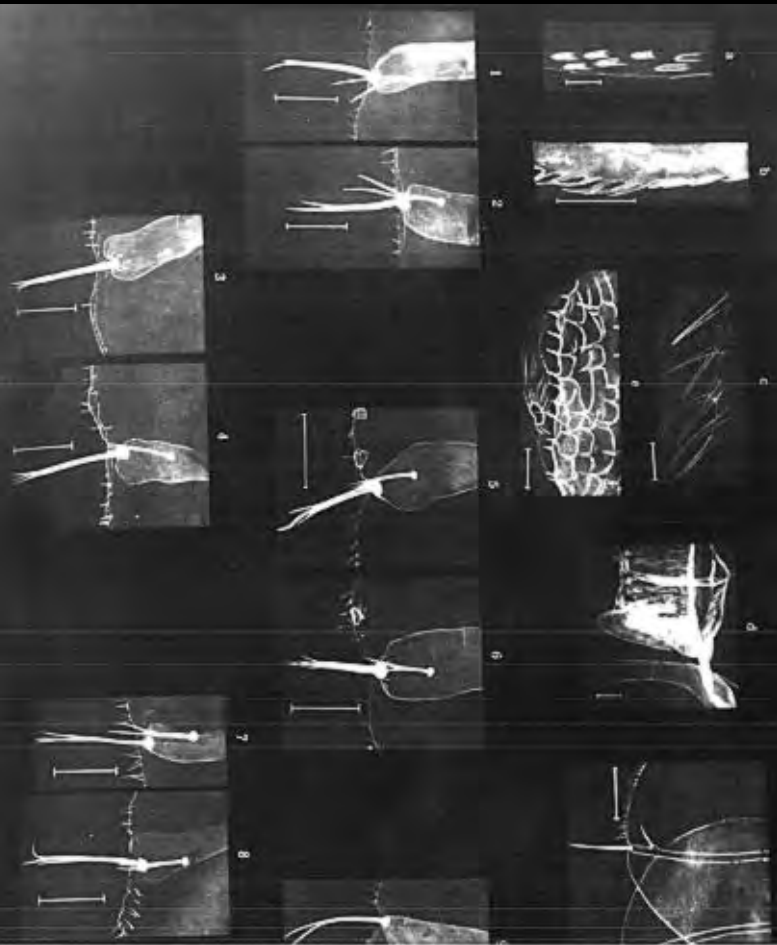
1. Dorsal surface of abdominal segment I of *A. sinensis*.
2. Dorsal surface of abdominal segment I of *A. sinensis*.
3. Dorsal surface of abdominal segment I of *A. leucosticta*.
- 4, 5. Palmate hair on the 1st segment of *A. sinensis*.
6. Right palmate hair on the 1st segment of *A. sinensis*.
- 7, 8. Palmate hair on the 1st segment of *A. leucosticta*, right, & left.
9. Dorsal surface of abdominal segments VII, VIII of *A. sinensis*.
10. Dorsal surface of abdominal segments VII, VIII of *A. leucosticta*.



- Plate XIII. Abdominal segments and appendages of pupae
1. Dorsal surface of pupa (♂) of *A. sinensis*.
  2. Dorsal surface of pupa (♀) of *A. sinensis*.
  3. Dorsal surface of pupa (♂) of *A. leucurus*, showing the last part.
  4. Dorsal surface of pupa (♂) of *A. edwardsi*, showing the last part.



- Plate XIV. Paddle and appendage of pupae.  
a, b, c, e, f. Several parts of Paddle of *A. edwardsi* (cf. Pl. VII 4)  
a, b, c, e - 0.01 mm. f - 0.1 mm.  
d. Genitalia in female of *A. sinensis*. - 0.01 mm.  
1, 2. Terminal hair of *A. sinensis* (♂). 1 right, 2 left.  
3, 4. Terminal hair of *A. sinensis* (♀). 3 right, 4 left.  
5, 6. Terminal hair of *A. sinensis*.  
7, 8. Terminal hair of *A. sinensis* (♂). 7 right, 8 left.  
9. Terminal hair of *A. sinerodes* (♂).



- Plate XV. Seta on the dorsal surface of abdominal segment VII & VIII of pupa.
- 1 a. Seta A on the 7th segment of *A. sinensis* (♀).
  - 1 b. Seta D on the 8th segment of *A. sinensis* (♀).
  - 2 a. Seta A on the 7th segment of *A. sinensis* (♂).
  - 2 b. Seta D on the 8th segment of *A. sinensis* (♂).
  - 3 a, b. Seta A on the 7th segment of *A. edwardsi*. a left, b right.
  - 3 c. Seta D on the 8th segment of *A. edwardsi*.

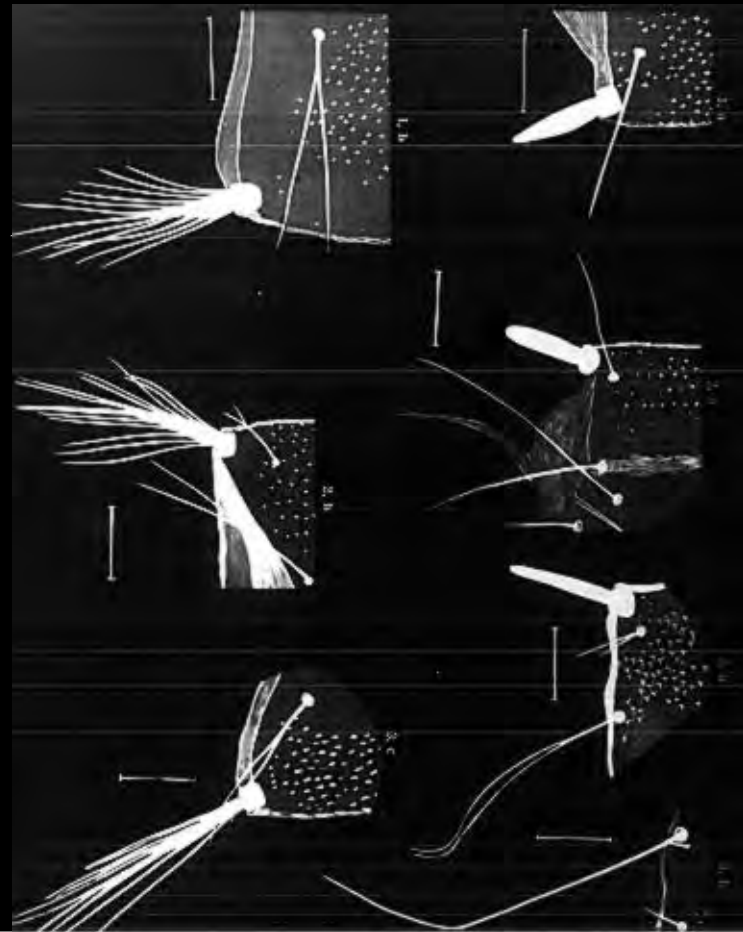


Plate XVI. Imagoes (♀).

- 1, 2. Wing of *A. sineroides*.
3. Wing of *A. koreicus*.
4. Wing of *A. edwardsi*.
5. Seventh sternite of *A. sineroides*.
6. Seventh sternite of *A. edwardsi*.
7. Anterior part of the head of *A. sineroides*.
8. Anterior part of the head of *A. edwardsi*.

