

To Prof. J. S. Needham

Compliments of
Yin-chi Hsu 9

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THE MAYFLIES OF CHINA

(ORDER EPHEMEROPTERA)

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INTRODUCTION

Ephemeroptera is comparatively a small order of insects which are commonly called mayflies by the English speaking people. In the old Chinese classics they were called 蜉蝣. In spite of their small size and insignificance, they have long been recorded in the old Chinese literature. The shortness of their adult life has long been observed by the old Chinese amateur naturalists. They were frequently mentioned in poetical writings.

"Mayflies are fragile insects of singularly elegant form and of very peculiar and interesting habits. In their immature stages they are all aquatic, and the adults are to be met with only near the water. As a group they have received scant attention from collectors of insects. They are well known to all fisherman, and even philosophers have heard of them.

"Certain mayflies appear on the wing but once a year, and vanish again completely after a few hours flight. These have served the moralists as examples of the brevity of earthly existence. Many of them hover over the surface of the water, where fishes leap to catch them. These are the ones that have chiefly interested the fishman.

"Some mayflies suddenly appear in flight in countless numbers and form vast swarms along the waterside. Such swarms compel the notice of everyone. They are harmless, of course, but they settle all over one's clothing, and get into one's mouth and ears, and are sadly indifferent to the blow that threatens to crush them." *

So far very little work has been done on the taxonomy of the Chinese mayflies. Most of the workers on Chinese mayflies in the past have limited themselves to the descriptions of a few species collected from restricted localities. The present work is the first attempt to make a monographic study of the Chinese species and to summarize our knowledge of this group to date, and will be published in parts in the present and subsequent numbers of this Bulletin.

HISTORICAL

Prior to this time, reports on mayflies from China have been very few, and have been related mainly to small collections at restricted regions. The earliest description of the Chinese species is on *Cloëon dipterum*, described by Linné in 1761 in Fauna Suecica, ed. II. The earliest records of the species from China were made by Eaton in his monograph "Recent Ephemeridae", published in 1883-'87, in which he recorded the following Chinese species :

* From Needham, Traver, & Hsu, The Biology of Mayflies, p. 1 (1935)

Ephemera lineata, *E. serica*, *Cloëon bimaculatum*, *C. dipterum*, *C. sinense*, and *Paegnooides cupulatus*. Since then, more than a dozen papers have been published on the Ephemeropterous fauna of China by Eaton, McLachlan, Klapálek, Ulmer, Navás, Wu, and Hsü. Of these, two catalogues, one by Wu in 1935¹, and the other by Ulmer in 1936², gave a complete list of Chinese species known up to the early part of 1936.

Up to the present sixty four species have been described and these are distributed in three families, ten subfamilies, and twenty genera. This number, however, does not include the new species which are described in this paper.

The describers of the Chinese mayflies and the number of species described in each of the papers chronologically arranged are set forth in Table I.

SOURCE OF MATERIALS

The material upon which the present study was based, was derived from the following sources.

1. A small collection from Szechuan by Graham in the Smithsonian Institution, U. S. A.
2. A small collection in Cornell University Collection made by Professor James G. Needham, while he was in China during 1927-'28.
3. A large collection from Kiangsi Province collected by Dr. Wei-I Yang, while he was the Director of the Bureau of Entomology at Nanchang.
4. A collection of Peiping species made by Dr. Chenfu F. Wu and Dr. Shao-wen Ling in the Entomological Collection of Yenching University.
5. A collection of Kwangsi species collected by Mr. H. C. Tao, formerly of Kwangsi University.
6. A small collection of Hongkong species sent by Mr. Ng Ching-sum of Hongkong University.
7. A small collection of Chekiang forms collected by Prof. Chi-ying Liu of National Chekiang University.
8. A small collection from Nanking made by Prof. Tsong-ling Tsou of National Central University.
9. A collection of Fukien species sent by Prof. C. R. Kellogg of Fukien Christian University.
10. A small collection of Kirin species collected by Dr. H. T. Feng of the National Agricultural Institute.
11. The author's own collection made at Soochow and Peiping.

Grateful acknowledgements are due to the above mentioned institutions and friends of the author for the privilege of studying the interesting collections.

¹ Wu, Cat. Ins. Sin., I, p. 247-253 (1935)

² Ulmer, Peking Nat. Hist. Bull. 10:212 (1936)

TABLE I. DESCRIBERS OF CHINESE MAYFLIES

Families		Ephemeridae			Baetidae				Heptageniidae				Number of Species									
Subfamilies		Palingeninae	Polymitarcinae	Ephemerinae	Potamanthinae	Leptophlebiinae	Ephemerellinae	Caeninae	Baetinae	Siphonurinae	Heptageninae											
Genera		Anagenesia	Chromarcys	Ephemera	Potamanthodes	Potamanthellus	Rhoënanthopsis	Leptophlebia	Ephemerella	Teloganodes	Caenis	Baetis		Cloëon	Isonychia	Siphuriscus	Ecdyonurus	Heptagenia	Iron	Paegniodes	Thalerosphyrus	Anepeorus
Years	Describers																					
1761	Linné												1									1
1853	Walker												1									1
1858	Hagen												1									1
1870	Eaton			1																		1
1871	Eaton			1																		2
1875	Mclachlan							1														1
1885	Eaton												1									1
1892	Eaton			1	1	1																3
1904	Mclachlan			1																		1
1905	Klapálek									1			1									2
1912	Ulmer			1																		1
1919	Ulmer			2			1							1	1		1					6
1922	Navás																1					1
1924	Ulmer			1																		1
1925	Ulmer																	1		1		2
1930	Navás			1																		1
1931	Hsü			1																		1
1931	Navás											1	1									2
1932	Navás			1											1							2
1933	Navás									1			2							1		4
1934	Navás			2													2	1				5
1936	Ulmer			1				1	1			2					2	1				6
1936	Hsü	1			1	1			1					1		1	1	1				8
1936	Navás			1				2								3	2	2				10
Total		1	1	14	2	2	1	3	3	1	1	3	8	2	2	6	6	4	1	2	1	64**

** This number does not include the new species and a new genus described in this paper.

TAXONOMIC CHARACTERS

The adult mayfly has a long and soft body, usually with ten abdominal segments and two or three long setae-like tails at the posterior end.

The head is distinct and free, with a pair of large compound eyes, three ocelli, a pair of short setaceous antennae and the degenerated mouthparts. The compound eyes of the males are always larger than those of the females.

The thorax consists of three segments, bearing three pairs of long and slender legs and one or two pairs of wings. The wings are held upright when the animal is at rest. The forewing is usually triangular in shape with rounded angles. The costal margin is straight and long, the outer margin is slightly arched, and the inner margin is slightly incurved

and very short. The hind wings when present may be small, long and lanceolate in shape with a few veins or may be prominent, triangular and ovate in shape with complicated veins.

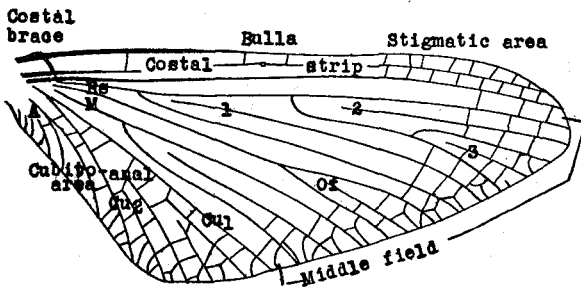


Fig. 1. Fore wing of *Heptagenia flavata* Navás showing the main topographic features of a mayfly wing, cross veins of the middle field mostly omitted. The numerals 1, 2 and 3 designate successive forks in the triple triad of the radial sector; forks 2 and 3 are not present in the hind wing of recent mayflies. Of, outer fork of Rs. (Adapted from Needham, Traver, and Hsu).

The wing venation (Figs. 1 & 2). —“The costa forms the anterior margin of the wing and extends from base to tip. The Subcosta is a low-lying, weaker vein that generally parallels the Costa almost to the apex. Midway in its length it is interrupted by a Bulla—a weakly chitinized dilation. The Radius is unique and remarkable for the depth of its forks, for the great development of its sector, Rs, and for the basal detachment of the sector

from the main stem, R_1 . In the generalized wings of *Siphonurus* and its near allies, the wide-spreading anterior division of the radial sector is twice subdivided by a fork within a fork. The first added fork springs from the rear of vein R_2 ; the second from the front of the first. All these are separated by intercalaries as shown in Fig. 1. With specialization, these extra branches tend to become detached. They then appear as intercalaries. The median vein has a single deep fork that lies proximal to or nearly at the level of the first fork of the radial sector. This is typically a complete and symmetrical fork, but in the Ephemeroidea it lies close to the wing base and is sagged to rearward, becoming strongly unsymmetrical. In the Baetinae and in others with reduced venation the posterior branch becomes detached and appears as an independent vein. The cubital vein is divided almost or quite to the wing base and into two very unequal and unlike parts. The anterior branch, Cu_1 , is smoothly curved and often bears short branches or long marginal veinlets on its posterior side. It ends on the outer margin of the wing near the hind angle and is a high vein. The other branch, Cu_2 , is generally much shorter, ends on the inner margin and is a

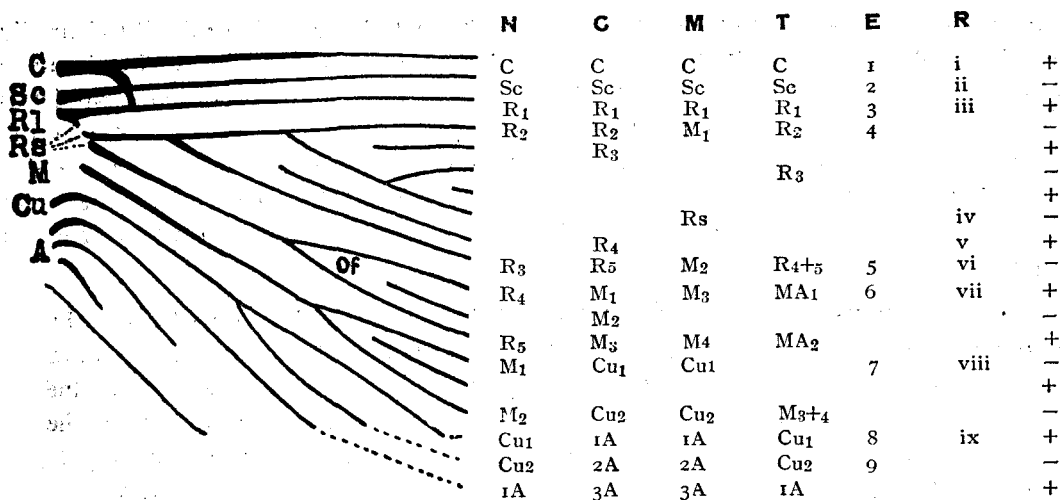


Fig. 2. Diagram showing the system of vein designations used in this paper as expressed in the column headed N which is Needham's system of mayfly wing venation. In parallel columns are shown their equivalents in other systems. The column headed C is that of Comstock and Needham (1899), used hitherto by many writers on mayflies. The M column shows that of Morgan (1912). The T column shows Tillyard's latest system. The E column shows Eaton's system in Arabic numerals; and the R column, that of Redtenbacher in Roman numerals. The plus and minus signs in the last column indicate high and low veins respectively. (From Needham, Traver, and Hsu).

low vein. The anal veins are weak and rather irregular. They are crowded into the little remaining inner corner of wing that is bounded externally by vein Cu₂. In the hind wing the costal border is dilated just beyond the costal brace into a thin flat lobe or angulation of very variable form, that lies beneath the anal area of the fore-wing. Beyond this the Costa and Subcosta are often fused. In generalized forms the radial sector is attached normally to R₁, and only twice forked, both divisions of it with their single intercalaries being simple triads. Media is often forked farther out in the wing. The cubital fork is extended to the wing base. Its intercalary is extended to the base also, so that the cubital triad has come to appear as three complete, subparallel, independent veins. The weak anal veins when present are even more variable than in the fore-wing. There is no stigma in the mayfly wing, but there is in the fore-wing a corresponding stigmatic area in which the cross veins are generally heavier, more numerous, more irregular, and more aslant than elsewhere.”³

The legs.—There are three pairs of legs which are quite different in length in the different sexes, the first pair is usually the longest and is longer in the male than in the female. The hind pair is usually the shortest. The increase in length is due to the prolongation of the tibia and tarsus. The legs are longer in the imago than in the subimago. The middle and hinder pairs of legs do not differ greatly in length. In the

3. From Needham, Traver, & Hsu, *The Biology of Mayflies*, p. 118-121 (1935).

male the tarsus is generally longer than its tibia, but not always. A peculiarity of mayfly tarsi is their tendency to eliminate the ankle joint by fusion with tibia. In the more generalized mayflies all tarsi are five-jointed, but in others one or two basal joints may be more or less completely fused with the tibia. This occurs less frequently in the fore-legs. Each tarsus bears at the tip a pair of claws which in the great majority are dissimilar with one of them degenerated, blunt, quite as large as the other but not claw-like at all. In certain other groups they are similar either both claw-like or both degenerated and blunt.

The Genitalia.—The genitalia of the male is composed of two parts, namely, the genital forceps, and the penis. The genital forceps are jointed and leg-like appendages at the caudo-ventral border of the ninth abdominal segment. The number of segments and the length of the different segments vary in the different species. Above and in between the genital forceps there is a median copulatory process, the penis, which is in most species quite large, prominent, and two-lobed which are referred to as penial lobes. The penial lobes vary in shape, size, and structure in the different species.

The Tails.—In both sexes there are two or three tails projecting behind the tenth abdominal segment. When three are present, the median one is either longer or shorter than the lateral ones or sometimes it may be only rudimentary. All the tails are many jointed and are usually longer than the body. Their length varies in the different species. They may be naked or provided with whorls of short hairs, and may be armed with bands of various colors.

ORDER EPHEMEROPTERA

“These are winged insects of moderate size and incomplete metamorphosis whose immature stages are aquatic, whose adult life is very brief, and whose characteristics are more fully set forth in the preceding paragraphs. They are found in fresh water in all parts of China, and are among the most important aquatic herbivorous invertebrates.

They may be grouped in three main families⁴ which are distinguished as follows⁵

KEY TO THE FAMILIES OF CHINESE EPHEMEROPTERA⁶

- 1 — Veins M and Cu₁ of fore-wing diverging very strongly at base, with M₂ strongly bent toward Cu basally (Fig. 8). Hind tarsi with four freely movable joints..... **Ephemeridae**
- Veins M and Cu₁ of fore-wing little divergent or running parallel to each other at base. (Fig. 1). Hind tarsi four or five jointed..... 2

4. According to the system of classification adopted in Needham, Traver & Hsu, *The Biology of Mayflies*.
 5. From Needham, Traver, & Hsu, *The Biology of Mayflies*, p. 239 (1935).
 6. Adapted from Needham, Traver, & Hsu, *The Biology of Mayflies*, p. 239 (1935).

- 2 — Hind tarsi with five freely movable joints. Intercalaries between Cu_1 and Cu_2 arranged in two parallel pairs, first pair short and second pair long. Venation never greatly reduced. Eyes of the male simple.....**Heptageniidae**
- Hind tarsi with three or four freely movable joints. Intercalaries between Cu_1 and Cu_2 not as above. Venation sometimes greatly reduced. Eyes of the male often divided.
.....**Baetidae**

FAMILY EPHEMERIDAE

"Mostly large mayflies, the wings with abundant cross veins. Median vein and anterior branch of cubitus of fore wing strongly divergent at the base. Posterior fork of media very deep, its basal portion strongly sagging toward cubitus. Outer fork (Of) in hind wing wanting, R_4 and R_5 being fused. Stigmatic area of the fore wing never widened, often becoming somewhat narrowed; no sagging in the costal margin. Male fore tarsus five-jointed, the basal joint very short. Middle and hind tarsi four-jointed, the additional basal joint being fused with the tibia. Among the members of this family there is a very great diversity of form and structure."

KEY TO THE SUBFAMILIES OF EPHEMERIDAE⁸

- 1 — Sc of fore wing hidden in a fold of the membrane under R, being invisible at apex and visible only at base. Branches of R approaching each other in pairs. Legs of female short and of male strong. Forceps 3-jointed, basal joint long.....**Palingeniinae**
- Sc of fore wing visible throughout, fully developed.....2
- 2 — Both wings translucent, in male dull glistening, in female quite dull. No free intercalaries at hind margin of the wings. Legs feeble, fore legs of male sometimes long, hind legs always short and feeble.....**Polymitarcinae**
- Both wings transparent and glistening. Numerous short free intercalaries at hind margin, especially of the hind wing. Legs strong, always functional.....3
- 3 — Ist A of fore wing forked once, no cross veins here on the margin of the wing. Forceps without short basal joint, first joint the longest.....**Potamanthinae**
- Ist A of fore wing not forked, but united with margin of the wing by several to numerous cross veins. Forceps with short basal joint, second joint the longest.....**Ephemerinae**

7. From Needham, Traver, & Hsu, *The Biology of Mayflies*, p. 240 (1935).

8. Adapted from Ulmer, *Revised Key to the Genera of Ephemeroptera*, *Peking Nat. Hist. Bull.* Vol. 7, p. 195-196 (1932).

LIST OF SPECIES IN FAMILY EPHEMERIDAE

Species	Year	Distribution	Type Collections
FAMILY EPHEMERIDAE			
Subfamily Palingeninae			
Genus ANAGENESIA Etn.			
1. yangi Hsu	1936	Po-yang Lake, Kiangsi	1♂, 2♀ & 3♀ Subim. Author's Coll.
Subfamily Polymitarcinae			
Genus CHROMARCYS Navás			
2. magnifica Navás	1933	Yunnan	Navás' Coll.
Genus POLYMITARCYS Etn.			
3. nanchangi n. sp.	1936	Nanchang, Kiangsi	13♀ Author's Coll.
Subfamily Ephemerinae			
Genus EPHEMERA			
4. axillaris Navás	1930	Houy-Tchéou	Paris Museum
5. formosana Ulmer	1919	Lo fau shan, Canton	12♂, 4♀, 12 subim. Berlin & Dahlem Museums, Ulmer & Mell's Coll.
6. kirinensis Hsu	1931	Kirin, Peiping	19♂, 7♀ subim. Author's Coll. Many subim. Ulmer's Coll.
7. lineata Etn.	1870	Peiping, Soochow, Hunan, Kiangsi.	Many ♂, ♀, subim. Ulmer & Author's Coll.
8. lota Navás	1934	Loubou, Kuling	Musée Heude
9. media Ulmer	1936	Lo fau shan, Canton; Peiping	2♂, 5♀, 7 subim. Ulmer's Coll.
10. pictipennis Ulmer	1924	Shanghai, Kuling, Mokanshan	2♂ Ulmer's Coll.
11. pictiventris Mclan.	1904	Siao Lou, Ta-chien-lu, Szechuan	1♂, 1♀, 4 subim. Mclachlan's Coll.
12. pieli Navás	1934	Loubou	Musée Heude
13. pulcherrima Etn.	1892	Mahntsishan, Fukien, Lo fau shan, Kwangtung	1♂, 5♀, 5 subim. Mell's Coll. 1♂, many subim. Hamburg Museum
14. purpurata	1919	Houy-Tchéou	3♂, 1 subim. Paris Museum
15. sauteri Ulmer	1912	Lo fau shan, Canton	24♂, 14♀, 1♀ subim. Deutsch. Ent. Museum & Ulmer's Coll.
16. serica Etn.	1871	North China, Kwangtung, Hongkong	2♂, 3♀, 29 im. & subim. British, Paris & Berlin Museums.
17. shengmi n. sp.	1936	Sheng-mi, Nanchang, Kiangsi	1♂, 6♂ subim. Author's Coll.
18. spilosa Navás	1936	Kuling	Musée Heude
19. wuchowensis n. sp.	1936	Wuchow, Kwangsi	1♂ subim., 5♀ subim. Author's Coll.
20. yaoshani n. sp.	1936	Yao-shan, Wuchow, Kwangsi	3♂ subim., 4♀ subim. Author's Coll.

Species	Year	Distribution	Type Collections
Subfamily Patamanthinae			
Genus POTAMANTHODES Ulmer			
21. formosus Etn.	1892	Mahn tsi shan, Yunnanfu; Houy-Tschéou	3♂, 7 ♀, many subim, Paris, Berlin, Hamburg Museums, Mell's Coll.
22. kwangsiensis n. sp.	1936	Yao-san, Kwangsi; Shang Jao, Fon Chen, Chin Tseng, Jao chow, Kiangsi	14♂ subim, & 17 ♀ subim. Author's Collection
Genus NEOPOTAMANTHODES gen. nov.			
23. lanchi n. sp.	1936	Lanchi, Chekiang; Wuchow; Kwangsi	2 ♀, 1♂ subim., 1 ♀ subim. Author's Coll.
24. nanchangi Hsu	1936	Nanchang, Kiangsi	1♂ Author's Coll.
Genus POTAMANTHELLUS Lest.			
25. amabilis Etn.	1892	Kwangtung	1♂ & 1 ♀ subim. Paris & Berlin Museums.
26. chinensis Hsu	1936	Shang Jao, Kiangsi; Pei shan, Kirin	3♂ Author's Coll.
Genus RHOËNANTHOPSIS Ulmer			
27. magnificus Ulmer	1919	Shan Chouen, Chenghu	4♂, 1 ♀, 2♂ subim. Wein, Paris, & Berlin Museums

Subfamily Palingeninae

Eyes of ♂ large, oval, narrowly separated from each other. Median ocellus much smaller than the lateral ones. Pronotum large, transverse, broader than head, tumescent, arched behind.

Subcosta of the fore wing, when developed, retired within a fold of the membrane somewhat beneath the radius. Wing venation complete and plentiful, cubital vein of the fore wing either sinuous, or else nearly straight from the wing base to its fork, and afterwards gently arched. Branches of radius approaching each other in pairs. Wing membrane translucent and dull.

Legs of adult ♀ when not functional short in proportion to the body, and feeble through atrophy of the tibia and tarsus; the fore legs in both sexes of the subimago extremely short, and transversely rugose; hind legs of adult ♀ the longest pair. Fore tibia and tarsus densely rugose transversely; claws in each tarsus unequal, and not quite alike.

Tails pubescent or minutely pilose, short in ♀, very long and divaricate in ♂. Proximal joint of forcep the longest, penial lobes unarmed.

KEY TO THE GENERA OF PALINGENINAE⁹

- 1 — Outer fork (Of) of fore wing forked behind the middle; at least three long intercalaries in the first cubital area; fore tarsus of male about 2½ times as long as femur; tails of ♀ about as long as the body; forceps slender, consisting of 6 to 7 joints, the first very long, the last 5 to 6 joints short..... **Palingenia**^{9a}
- Outer fork (Of) of fore wing forked before the sector or at most at the same time with it; (Fig. 3); fore tarsus of ♂ only about as long as femur; tails of ♀ about ½ as long as the body..... **Anagenesia**

Genus **Anagenesia** Eaton

- 1883 — Eaton — Revis. Monogr. p. 25.
- 1920 — Ulmer — Stettin. Ent. Zeitung 81:102.
- 1923 — Lestage — Ann. Soc. Ent. Belgique 63:108,109.
- 1932 — Ulmer — Peking Nat. Hist. Bull. 7:196.

SIZE : Mayflies of large and heavy species.

HEAD : Broad and somewhat depressed.

PRONOTUM : Broader than long and broader than head.

LEGS : Short, fore leg shortest and hind leg longest; fore tarsus of male shorter than femur.

WINGS : With outer fork (Of) forked before the middle; three conspicuous sets of longitudinal veins proceed in pairs to the outer margin of the wing. (Fig. 3).

TAILS : Two in number; in male more than three times as long as the body; in female about half as long as the body.

GENITALIA : Forceps three-jointed, basal joint very long, two terminal joints short.

GENOTYPE : *Anagenesia (Palingenia) lata* Walk.

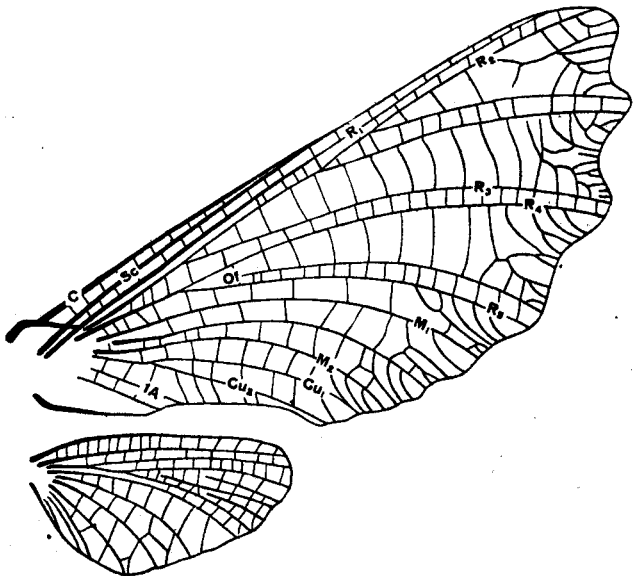


Fig. 3. *Anagenesia yangi* Hsu. Fore and hind wings. (Original)

⁹ Adapted from Ulmer, Revised Key to the Genera of Ephemeroptera, Peking Nat. Hist. Bull., Vol. 7, p. 196 (1932).

^{9a} Not recorded in China.

Anagenesia yangi Hsu

1936—Hsu—Peking Nat. Hist. Bulletin 10:319.

MEASUREMENTS: Length of body: Holotype ♂ imago 25 mm., Allotype ♀ sub-imago 22 mm., other males measure from 26 to 27 mm., and other females measure from 17 to 18 mm. Length of wing: Holotype ♂ imago 19 mm. Length of tails 48 mm.

♂ Imago (In alcohol)

FORM: A very large and heavy species.

GENERAL COLORATION: Light brown to brown above and pale to pale creamy below.

HEAD: Broad and somewhat depressed. Vertex broad and light brown. Front pale. Compound eyes grayish and widely separated. Ocelli with black ring at base and pale at tip. Antennae whitish with two large basal segments and a terminal filament.

THORAX: Pronotum light yellowish brown, somewhat lighter on the margins and the middle portion. Mesonotum brownish with a light longitudinal stripe along the median line. Metanotum light yellowish brown. Ventral surface of thorax pale.

LEGS: Pale. Foreleg short and stout, shorter than the hind leg. Fore tarsus slightly shorter than the femur and five segmented. Mid-femur very short only half the length of tibia. Mid-tarsus four segmented. Hind leg the longest. Hind tibia very long, twice the length of the femur. Hind tarsus four segmented. Last tarsal segment bearing only one claw. (Fig. 4).

WINGS: Uniformly white, Subcosta of fore wing hidden in a fold of the membrane under radius, being invisible at apex and visible only at base. Branches of radius approaching each other in pairs. Three con-

spicuous sets of longitudinal veins proceed in pairs to the outer margin which is sinuate. Outer fork (Of) forked before the middle at the same place as the first forking of Rs. (Fig. 3).

ABDOMEN: Brownish above and pale below. Segments 3-9 each bearing a dusty brown patch at the middle of the tergum. Posterior margin of tenth tergite straight at middle and with two deep triangular lateral notches at the bases of the two lateral tails. Posterior margin of tenth sternite roundly notched.

TAILS: Pale. Two lateral tails very long, and pubescent all over. Median tail very short and rudimentary, consisting of only four or five segments.

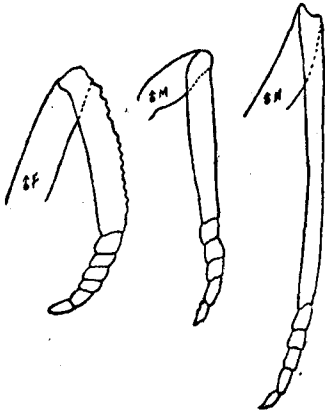


Fig. 4. *Anagenesia yangi* Hsu
♂ Legs.

GENITALIA: Forceps each consisting of three segments. Basal segment very long, last two segments very short. The last two segments together being about $\frac{1}{2}$ the length of the basal segment. Pineal lobes of imago narrow, separated, and each with a sharp incurved distal tooth. Pineal lobes of subimago broad and fused at base. (Fig. 5 & 6).

♀ **Subimago (In alcohol).**

GENERAL COLORATION: Brown to chocolate above. Light brown to brown below.

HEAD: Vertex brown, armed with two reddish brown transverse patches behind the two lateral ocelli. Epicranial suture chocolate. Front light brown. Lateral ocelli same as in male. Median ocellus not elevated.

PRONOTUM: Deep brown with a chocolate median longitudinal line.

MESONOTUM: Chocolate with a pale median longitudinal stripe. Metanotum deep brown.

VENTRAL SURFACE: Of thorax brown to deep brown.

LEGS: Pale for the most part. Coxae deep brown.

ABDOMEN: Brownish above with dusty brown patches on the tergum of all abdominal segments. Posterior margin of tenth tergite with the middle roundly extended posteriorly. Ventral surface of abdomen light brown. Posterior margin of tenth sternite more or less straight.

TAILS: Shorter than those of the male, measuring only 14 mm. in length.

HOLOTYPE: One male imago from Hsieh Shan, Po-yang Lake (鄱陽湖口鞋山) Collected by Dr. Wei-I Yang on April 14, 1930. In Yin-chi Hsu's collection.

ALLOTYPE: One female subimago of same locality, date, and collector. In Yin-chi Hsu's collection.

PARATYPES: Two male and two female subimagos of same locality, date and collector.

Subfamily Polymitarcinae

Pronotum tumid and its hinder border straight. The subcosta of fore wing visible throughout, and fully developed. Both fore and hind wings translucent, in male dull glistening and in female quite dull. There are no free intercalaries at the hind margin of the wing. The legs are feeble, fore legs of male are sometimes long, and hind legs are always short and feeble. Posterior margin of the 9th sternite in the female is not extended into a lobe.

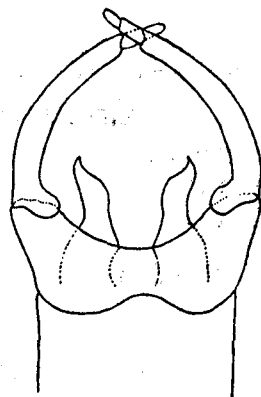


Fig. 5. *Anagenesia yangi*
Hsu. ♂ imago
Genitalia, ventral

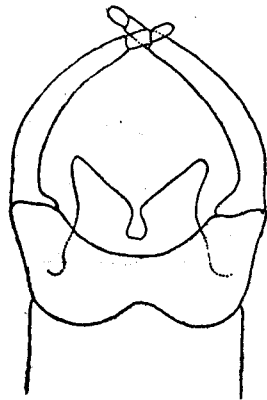


Fig. 6. *Anagenesia yangi*
Hsu, ♂ subimago
Genitalia, ventral

KEY TO THE GENERA OF POLYMITARCINAE

- 1 — Fore wing (Fig. 7) with an additional branch to Cu₁, this vein therefore forked; the intercalaries lying in the area between these two branches of Cu₁; eyes of male small, only half as broad as their distance from each other.....**Polymitarcys** Eaton
- Fore wing with 1A extending to the outer margin, sending out many branches posteriorly; 2A and 3A simple. Hind wing with radial sector branched, anal veins sending out many branches posteriorly.....**Chromarcys** Navás

Genus **CHROMARCYS** Navás¹⁰

1932—Navás—Memorie della Pont. Accademia della Scienze-I Nuovi Lincei, Serie II, Vol. XVI, p. 927.

FORM : Similar to genus *Polymitarcys* Eaton.

HEAD : Vertex carinated, anterior part of carina diverge into Y-shaped fork.

WINGS : Membranous, veins colored, reticulation dense. Fore wing with radial sector two branched, the anterior branch either forked successively or branched externally; to lie along the procubitus (media) beyond the division of the radial sector fork; media two branched, anterior one branching successively to the outer posterior part; 1st A (first axillary) extending to the outer margin, sending out many branches posteriorly; 2nd and 3rd A (2nd and 3rd axillaries) simple. Hind wing with radial sector branched; dividing before the middle of the wing; anal veins (axillaries) sending out many branches posteriorly.

TAILS : Three in ♀, middle one much shorter than the lateral ones.

GENOTYPE : *Chromarcys magnifica* Navás.

Chromarcys magnifica Navás¹¹

1932—Navás—Memorie della Pont. Accademia delle Scienze-I Nuovi Lincei, Serie II, Vol. XVI, p. 928.

1935—Wu—Cat. Ins. Sin. I: 247.

MEASUREMENTS : Length of body 20 mm., length of fore wing 28 mm., length of hind wing 12 mm., length of tail 9 mm.

HEAD : Testaceous, vertex dusky, anterior part of face produced into a compressed beak; carina with its axis twice as long as its branches; eyes fuscus dusky; ocelli dark, with a circular black ring.

THORAX : Testaceous reddish yellow; pronotum strongly transverse, underneath fuscus dusky.

LEGS : Reddish yellow.

WINGS : Wing membrane with antero-lateral and outer borders violet colored, reticulation beneath fuscus-violet. Fore wing triangular, apex parabolic, membrane hyaline from behind cubitus continuously to the outer margin, yellow colored at the base and behind 2A (2nd axillary); radial sector sending out two branches in the internal fifth, externally

10 Adapted from Navás, Mem. Acc. Sci Nuovi Lincei, (2), XVI, p. 927 (1932).

11 Adapted from Navás, Mem. Acc. Sci Nuovi Lincei, (2), XVI, p. 928 (1932)

often successively branched; extending and forking beyond the middle of the wing, branches undivided; media forked near the base, posterior branch undivided, anterior one usually 5 branched posteriorly; 1A (first axillary) giving off 4-5 branches, some forked; veinlets of 3A (3rd axillary) nearly yellow. Hind wing with outer fork (Of) greatly dilated, membrane beneath violet colored, behind the inner anal (axillary) area olive green up to the broad border; costal area at the basal third with yellow reticulation; radial sector many branched; extending and forking before the middle of the wing; 1A (first axillary) sending out many branches posteriorly.

ABDOMEN: Reddish yellow, upper part partly fuscus.

TAILS: Fuscus black; lateral ones heavy; middle one slender, much shorter.

TYPE: Collected by D. Alberto Bris from Yunnan. In Navàs' Collection.

Genus *Polymitarcys* Eaton

1868—Eaton—Ent. Mo. Mag. Vol. 84.

1883—Eaton—Revis. Monogr. p. 43.

1932—Ulmer—Peking Nat. Hist. Bull. 7:197.

HEAD: Eyes of male relatively small, oval, mutually remote; median ocellus much smaller than the lateral ones, which are unusually large in comparison with the eyes.

PRONOTUM: Somewhat broader than long.

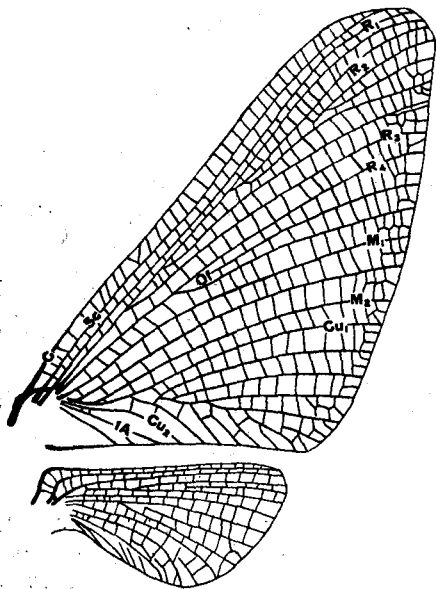


Fig. 7. *Polymitarcys nanchangi* n. sp.
Fore and hind wings. (Original).

WINGS: Outer fork (Of) of fore wing forked at most at the end of the first fourth and behind (or at the same time with) the sector; fore wing with an additional branch to Cu_1 , this vein therefore forked; there are intercalaries lying in the area between these two branches of Cu_1 . (Fig. 7).

LEGS: Fore legs of male about as long as the body, the other legs short and feeble. In the female the legs are all short and weak, about $1/3$ the length of the body, hind leg slightly longer.

TAILS: In ♂ 2, in ♀ 3, equal; in ♂ about three times as long as the body, glabrous from the base nearly to the tip; in ♀ about $3/4$ as long as the body, and pubescent.

GENITALIA: Forceps four-jointed, proximal joint short, somewhat compressed; second joint the longest. Penial lobes exposed, straight, unarmed.

GENOTYPE: *Polymitarcys virgo* Ol.

Polymitarcys nanchangi n. sp.

MEASUREMENTS: Length of body: Allotype ♀ imago 15.5 mm., other females 14-17 mm.

♀ Imago (In alcohol)

FORM: Large.

GENERAL COLORATION: Light.

HEAD: Vertex transverse much broader than long; eyes dark, small. Ocelli large, all three similar in size, separated.

THORAX: Light yellowish, pronotum somewhat broader than long, mesonotum with two closely parallel median brown lines.

LEGS: Short and weak, light yellowish.

WINGS: White and transparent; outer fork (Of) forked at the same time with the second forking of Rs; Cu₁ forked with an additional branch; there are intercalaries lying in the area between these two branches of Cu₁. (Fig. 7).

ABDOMEN: Light yellowish, posterior margin of 7-9th tergites slightly dusty, posterior margin of 10th sternite truncate.

TAILS: Three in number, white, hairy; lateral ones large, slightly longer than body; median one slender, shorter.

ALLOTYPE: One ♀ imago from Nanchang, Kiangsi. Collected by Dr. Wei-I Yang in August, 1930. In Yin-chi Hsu's Collection.

PARATYPES: 12 ♀ from same locality and date. In Yin-chi Hsu's Collection.

Subfamily Ephemerinae

"Eyes of male of moderate to large size, more or less approximated apically. Wings hyaline. Marginal intercalaries irregular. Costal cross veins well developed. Cubital intercalaries somewhat resembling marginal veinlets, consisting of two to four forks decurrent from anterior branch of cubitus. Costal angulation of hind wing low. Legs normally developed. Claws on fore leg of male similar, blunt; on middle and hind legs of male and all legs of female, dissimilar on each tarsus. Forceps four-jointed."¹²

KEY TO THE GENERA OF EPHEMERINAE

- 1 — Three long tails. Fore leg of male long, tibia $2\frac{1}{2}$ to 3 times as long as the femur, tarsus about 4 times as long as the femur; a series of cross veins between 1st A and wing margin **Ephemera**
- Only two long tails..... 2
- 2 — Penial lobes hooked, broader at base than at apex..... **Hexagenia**¹³
- Penial lobes tube-like, almost straight..... **Pentagenia**¹⁸

¹² From Needham, Traver, & Hsu, The Biology of Mayflies, p. 245 (1935).

¹³ Not recorded from China.

Genus **Ephemera** Linné

- 1758—Linné—Syst. Nat. ed. 10:546.
- 1815—Leach—Brewst. Edinb. Encycl. 9:137 (restricted)
- 1883—Eaton—Revis. Monogr. p 58.
- 1920—Ulmer—Stett. Ent. Zeit. 81:283.
- 1920—Needham—Bull. Bur. Fish. 36:283.
- 1932—Ulmer—Peking Nat. Hist. Bull. 7:195.
- 1933—Spieth—J. N. Y. Ent. Soc. 41:347.
- 1935—Wu—Cat. Ins. Sin., I, p. 247.

SIZE: Mayflies of moderate size, body from 11-25 mm. in length.

HEAD: Eyes of ♂ oval, rather small, their inner orbits curved, separated apically by a distance at least as great as diameter of one eye. Posterior margin of head of ♀ almost straight between the eyes.

PRONOTUM: In ♀ somewhat transverse, tumescent above, about as wide as the head behind but narrow in front; the anteriorly convergent lateral borders slightly constricted at about the first 1/3, and suddenly rounded off at the angles in front and behind; the arched and sinuous hind margin slightly emarginate in the middle, and a little everted at the lateral angles.

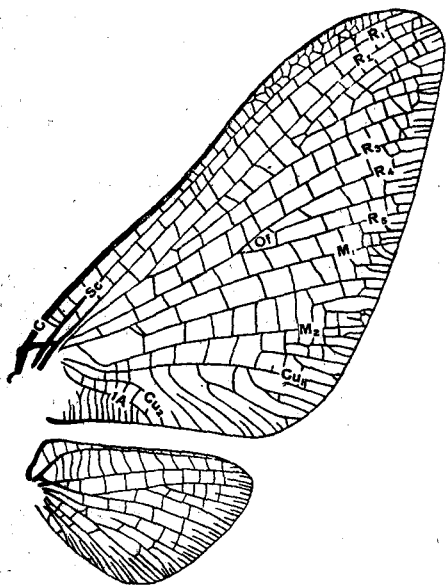


Fig. 8. *Ephemera kirinensis* Hsu
Fore and hind wings. (Original)

LEGS: Fore leg of male almost as long as the body, tibia $2\frac{1}{2}$ or 3 times as long as the femur, the tarsus about 4 times as long as the femur; ♀ fore femur about $\frac{3}{4}$ as long as the tibia and subequal in length to the tarsus. Both claws of fore leg blunt.

WINGS: Fore wing with a series of cross veins at the anal angle between the first anal vein and the wing margin. (Fig. 8).

TAILS: Middle tail about as long as the lateral ones in both sexes; lateral tails in ♂ about twice as long as the body, in ♀ subimago and in ♀ imago nearly of the same length as the body.

GENITALIA: Forceps 4-jointed, second joint long and strongly bowed. Penial lobes varying in length, short and some very long; tittulators present or absent.

GENOTYPE: *Ephemera vulgata* Linn.

KEY TO THE SPECIES OF EPHEMERA

- 1—First abdominal segment light and without any color patterns on all sides..... 2
- First abdominal segment with distinct color patterns at least on the tergite..... 9

- 2—Tenth abdominal segment without any dark spots nor streaks on dorsal and lateral sides 3
- Tenth abdominal segment with either dark spots or streaks on dorsal and lateral sides 7
- 3—Second abdominal tergite with one pair of round dark spots on the sides 5
- Second abdominal tergite without such dark spots 4
- 4—Second tergite with a pair of median dark longitudinal streaks; 7th to 9th tergites each with only one pair of longitudinal streaks **spilosa** Navás
- Second tergite without a pair of median dark longitudinal streaks; 7th to 9th tergites each with two pairs of longitudinal streaks **media** Ulmer
- 5—Dorsal surface of 8th and 9th abdominal segments each with three pairs of curved dark longitudinal streaks of varying length 6
- Dorsal surface of 8th and 9th abdominal segments each with only one pair of curved dark longitudinal streaks **serica** Eaton
- 6—Second abdominal tergite with a median pair of very small dark spots, sternites of 6-9th abdominal segments each with two pairs of dark longitudinal streaks **formosana** Ulmer
- Second abdominal tergite without such a median pair of dark spots, sternites of 6-9th abdominal segments each with only one pair of dark longitudinal streaks **pulcherrima** Eaton
- 7—Dorsal surface of second abdominal segment with one pair of parallel dark longitudinal streaks and without dark spots **lota** Navás
- Dorsal surface of second abdominal segment without parallel dark longitudinal streaks, but with paired dark spots 8
- 8—7-9th tergites each with three pairs of median curved longitudinal streaks of varying lengths, forceps with dark patches, penial lobes small without titillators **shengmi** n. sp.
- 7-9th tergites each with only one pair of median curved longitudinal streaks; forceps without dark patches; penial lobes large, triangular, with two stout titillators **yaoshani** n. sp.
- 9—Penial lobes long and narrow 10
- Penial lobes not long 12
- 10—Second segment of forceps more than twice the length of the third segment 11
- Second segment of forceps slightly longer than the third segment, abdomen with "V"-shaped dark pattern on each tergite **pictiventris** MacLachlan
- 11—Penial lobes with a lateral tooth at tip, abdominal tergites without paired parallel dark longitudinal streaks **pictipennis** Ulmer

- Penial lobes sharply pointed at tip without a lateral tooth, abdominal tergites each with three pairs of parallel dark longitudinal streaks.....**purpurata** Ulmer
- 12—6-9th abdominal tergites in ♂ each with three pairs of median curved dark longitudinal streaks13
- 6-9th abdominal tergites in ♂ each with one or two pairs of median curved dark longitudinal streaks.....14
- 13—First abdominal tergite light, with two oblique dark streaks close to the median posterior margin, second tergite in ♂ with one pair of curved dark longitudinal streaks and one pair of dark spots.....**wuchowensis** n. sp.
- First abdominal tergite dark, with two dark spots at middle, second tergite with one pair of curved dark longitudinal streaks and without a pair of dark spots.....**kirinensis** Hsu
- 14—3rd-5th abdominal tergites each with a median inverted "V"-shaped dark pattern and two short lateral dark longitudinal streaks.....**axillaris** Navás
- 3rd-5th abdominal tergites without such dark pattern.....15
- 15—Anterior segments of abdomen each with one pair of curved dark longitudinal streaks at middle on the back, posterior segments each with two pairs of such dark streaks....**lineata** Eaton
- Abdominal coloration not as above.....16
- 16—3rd-7th abdominal tergites each with one pair of long, curved, dark, longitudinal streaks, 8th and 9th tergites each with two pairs of curved, dark, longitudinal streaks of different lengths, the outer pair shorter, and a single median dark longitudinal streak between the two longest dark streaks.....**piell** Navás
- 2nd-8th abdominal tergites each with at most one pair of dark curved longitudinal streaks, 9th tergite with two pairs, inner pair shorter.....**sauteri** Ulmer

Ephemera axillaris Navás¹⁴

1930—Navás—Broteria XXVI, p. 133.

1935—Wu—Cat. Ins. Sin. I:247.

MEASUREMENTS: Length of fore wing 27.5 mm., length of hind wing 21 mm.

BODY: Reddish yellow, weakly golden colored, furrows fuscus.

HEAD: Eyes fuscus; antennae with basal segment fuscus, the rest yellowish.

THORAX: Upper surface with two black longitudinal lines, lower surface with fuscus black longitudinal ridges to the sides.

LEGS: Yellow, tibia yellow, the apex of fore femur, base of tibia fuscus.

WINGS: Hyaline, base of reticulation golden yellow, the remaining greater part fuscus black. Fore wing yellow, with numerous cross veins, about 5 black ones between Cu_1 and

14. Adapted from Navás, Broteria XXVI, p. 133. (1930.)

Cu₂, those between Cu₂ and 1A yellow, those near Cu₂ black, those behind 1A numerous and yellow. Hind wing with reticulation pale; many discal veinlets fuscus. (Fig. 9)

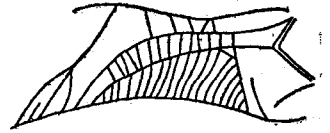


Fig. 9. *Ephemera axillaris* Navás. Cubito-anal area of the fore wing. (After Navás)



ABDOMEN: Upper surface ornamented with fuscus lines, second tergite with a sub-semicircular line except the posterior and lateral margins, 3rd to 7th tergites each with two lines extending from the anterior to the middle, diverging posteriorly; lines on 7th tergite subparallel, inner ones elliptical and closed; another pair of lines parallel on both sides in tergites 3rd to 7th and the longitudinal ridge near the conjunctiva; lower surface with two median longitudinal stripes, slightly diverging posteriorly, fuscus. (Fig 10).

TYPE: Collected by Père Cavalerie from Houy-Tchéou in 1908. In Paris Museum.

***Ephemera formosana* Ulmer¹⁵**

Fig. 10. *Ephemera axillaris* Navás. Abdomen dorsal. (After Navás)

- 1919—Ulmer—Arch. f. Naturg. 85, A (11), p. 6, f. 5.
- 1925—Ulmer—Arch. f. Naturg. 91, A (5), p. 92.
- 1935—Wu—Cat. Ins. Sin, 1:247.

MEASUREMENTS: Length of body ♂ imago 14-16 mm., ♀ 19-21 mm.; length of wing ♂ imago 14-17 mm., ♀ imago 19-20 mm.; wing expanse ♂ imago 29-36 mm., ♀ imago 40-42 mm.; length of tails ♂ imago 50 mm., ♀ imago 25 mm.

♂ Imago (dried)

HEAD: Above light ochraceous yellow to brown yellow; eyes and ocelli black.

PRONOTUM: Clear yellow (chrome-yellow), sides brown yellow, with brown black short longitudinal stripes on each side.

MESONOTUM: Yellow, with brown spots in the middle, posterior end light yellow.

METANOTUM: Entirely light yellow.

LEGS: Fore leg with coxa and trochanter yellow, the former with black longitudinal stripe and the latter with apex blackish; femur, tibia, and tarsus pitch brown (lighter or darker), all the joints black; the first tarsal segment and claws entirely black (brown black); hind leg yellow (light yellow); the mid coxa black brown; the hind coxa with black round spots; on the fore leg the femur nearly as long as the second tarsal segment, the tibia shorter than the tarsus, but much longer than the second and third tarsal segments together, 4th tarsal segment twice as long as the 5th, 3rd tarsal segment three times as long as the 5th.

WINGS: Transparent, colorless, without spotted pattern; only the costal area, especially the pterostigmatic region and the subcostal area of the fore wing are light gray brown; veins leather brown, only the cross veins of the basal half of the costal and subcostal areas blackish and somewhat thickened; the surroundings at the bulla on the Sc and sector in the fore wing brown; the cross veins there somewhat thickened and black, so that this part appears to have one or two spots.

15 Adapted from Ulmer, Archiv. f. Naturg. 85, A (11), p. 6, f. 5 (1919).

ABDOMEN: Above and below light grayish yellow; the three last segments more or less brown; the upper surface of the abdomen bearing the following coloration: second tergite with a roundish small spot on each side, sometimes prolonged into a short point at the anterior end above the side line, and two small black dots at the middle; 3rd to 9th tergites each with a pair of curved black longitudinal streaks, shorter in anterior segments and longer in posterior segments; 5th to 9th tergites each with another lighter and shorter pair of longitudinal streaks in between the first pair; 7th to 9th tergites each with a third pair on sides of the first pair; the lateral sides of 3rd to 9th segments each with one longitudinal black streak above the side line and another similar one below the side line; second to 9th sternites each with a pair of median, black, longitudinal streaks. (Fig. 11).

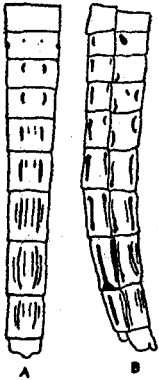


Fig. 11. *Ephemera formosana* Ulmer
♂ Abdomen A. dorsal, B. ventral.
(After Ulmer)

TAILS: Yellowish brown, middle tail lighter and shorter; lateral tails ringed with black, the basal half of the tails with only 4th or 5th joints ringed, the distal half with all joints ringed.

GENITALIA: Forceps and penial lobes grayish brown, the basal segments of the forceps darker, not different in form from *Ephemera sauteri* Ulmer.

♀ Imago (dried)

FORM: Very similar to that of the male.

MESONOTUM: Entirely yellow.

LEGS: Fore legs yellow, only the two ends of tibia and the claws dark, coxa with black spots which are larger on hind coxa.

WINGS: Very light greenish yellow.

TAILS: Yellow, more grayish yellow to the tip, all the joints finely ringed with black brown.

♂ and ♀ Subimago (dried)

GENERAL COLORATION: Color pattern of thorax and abdomen similar to the imago.

LEGS: Fore leg of ♂ and ♀ subimago evenly colored with light ochraceous yellow, the apex of of the femur and two ends of tibia gray black, tarsal segments with dark rings, claws dark, dark spots on hind coxa distinct.

WINGS: Fore wing with two black brown spots on the bulla. Wings of ♀ subimago more gray yellow, likewise each with two dark spots. Costal and subcostal areas somewhat clear and deep yellow, the cross veins in these two areas and the basal cross veins in the following area black.

TYPES: 3♂, 1♀ in Berlin Museum; 5♂, 1♀, and 12 subimago in Ulmer's Collection; 1♂, 1♀ in Dahlem Museum. All collected by H. Sauter from Formosa. 1♀ from Lo fau shan, 4 subimagos from Canton in Mell's Collection; 3♂, 1♂ subimago from Canton in Berlin Museum. All collected by H. Sauter.

(To be continued)