The Classification of Ephemeroidea (Ephemeroptera) in Korea

Yoon, Il Byong and Yeon Jae Bae
(Dept. of Biology, Korea University, Seoul 132, Korea)

摘 要

(韩语) 河蚌科的作者是 Imanishi (1940) 和 Potamanthus rb (=Potamanthus coreanus sp. n.) 以及 Ephemera strigata 韩国伊寿记是马故而, 离外, 国内的生态学的文献指出 Potamanthus kamonis (=Potamanthus coreanus), Ephorion shigae, Ephemera orientalis 等有增加的报告。本著者在上记的韩国内河蚌科的河蚌类的分类上 3属 4属 5 种的再整理后, 各种的成虫和幼虫的发现而记述的。

Family Potamanthidac Jacobson & Bianchi, 1905 (강하류하늘:新科)
Genus Potamanthodes Ulmer, 1919 (강하류하늘:新属)
1. Potamanthodes kamonis (Imanishi), 1940 (강하류하늘:新属)
Genus Potamanthus Pictet, 1848 (강하류하늘:新属)
2. Potamanthus coreanus sp. n. (강하류하늘:新属)
Family Polymitarcyidae Banks, 1900 (환하류하늘:新科)
Genus Ephorion Williamson, 1802 (환하류하늘:新属)
3. Ephorion shigae Takahashi, 1924 (환하류하늘:新属)
Family Ephemeridae Leach, 1815 (하류하늘:新科)
Genus Ephemera Linneaus, 1758 (하류하늘:属)
4. Ephemera strigata Eaton, 1892 (무늬하류하늘)
5. Ephemera orientalis McLachlan, 1875 (동양하류하늘)

INTRODUCTION

As to Korean Ephemeroidea, Imanishi (1940) described the nymphal stages of Potamanthus rb and Ephemera strigata from Korea for the first time. Since then several species of Ephemeroidea were recorded on their collecting localities of nymph in some ecological literatures of Korea: Potamanthus kamonis; Potamanthus rb; Potamanthus naa; Ephorion shigae; Ephemera lineata; Ephemera orientalis and Ephemera japonica. Among them, we

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have confirmed the five species of Korean Ephemeroidea from our studied area and describe
the adults and nymphs in this paper: *Potamanthus kamonis; Potamanthus nb; Ephoron
shigae; Ephemera strigata* and *Ephemera orientalis*.

As to Imanishi’s (1940) *Potamanthus (Potamanthodes) kamonis*, we place the species to
genus *Potamanthodes* by its distinct characteristics of adult. And we newly give a name
*Potamanthus nb*, recorded by Imanishi (1940) as species native to Korea, to *Potamanthus
coreanus*.

All the examined materials are based on the specimens that have been collected by the
authors or the other Korean scientists during the period of 1964~1985 at about 120 localities
in Korea. All of them are preserved in alcohol and deposited at Korean Entomological
Institute, Korea University, Seoul.

**SYSTEMATICS**

Family **POTAMANTHIDAE** Jacobson & Bianchi, 1905 (강하무살이科：新稱)
Type genus: *Potamanthus* Pictet

ADULTS: Base of veins MP₁ and CuA of fore wing strongly divergent from base of vein
MP₁; vein A₁ forked near wing margin. Forceps 3 jointed, first joint longest.

NYMPHS: Mandibular tusks projecting forward and visible from above. Abdominal gills
held laterally; gills on segment 1 rudimentary and unbranched; gills on segment 2~7
paired, margins with long fringes.

Genus *Potamanthodes* Ulmer, 1919 (강하무살이붙이属：新稱)
*Potamanthodes* Ulmer, 1919 : 11; Ulmer, 1932~33 : 200; Hsu, 1937~38 : 124
Type species: *Potamanthodes formosus* (Eaton)
Type locality: Taiwan

ADULTS: Veins MP₁ and MP₂ of fore wing not connected at base.

NYMPHS: Mandibular tusks more or less developed,

1. *Potamanthodes kamonis* (Imanishi), 1940 (강하무살이붙이：新稱) (Fig. 1~7)

*Potamanthus (Potamanthodes) kamonis* Imanishi, 1940 : 178

*Potamanthus formosus*: Ueno, 1969 : 232

ADULTS: MALE IMAGO. Body 14.0 mm. Caudal filaments 30.0 mm. General color yellow.
Eyes green; intersected by a brown band; basal part of each ocellus with a brown band.
Distance between eyes: width of head ≈ 1 : 5. Pronotum with a pair of sublateral stripes
and one median stripe (Fig. 3). MP₁ and MP₂ of fore wing not connected at base; base of
MP₂ meet CuA (Fig. 4). Crossveins brown, distinct. In the fore legs apical half of femur
and basal part of tibia brown; apical ends of tibia and 1~4 tarsal joints brown (Fig. 6).
Ratio of each fore leg segment 70 : 138 : 6 : 50 : 46 : 30 : 20(Fig. 6). Ratio of each hind leg
segment 65 : 62 : 7 : 6 : 3 : 15(Fig. 7). Abdomen yellow; 1~6 abdominal terga with a pair
of obscure markings on each lateral portion (Fig. 3). Penis Y-shaped; about 0.5 times length of first joint of forceps (Fig. 5). Cerci and terminal filament pale yellow. FEMALE IMAGO. General color and body shape similar to male imago. Eyes small; hinder margin of sternite 9 swallowly notched.

COLLECTING LOCALITIES OF ADULT: KG: Kap'yŏng Ch'ŏngp'yŏng (11 ♂ imagos, 130 ♀ imagos, 11 VI 1983, Y.J. Bae); Namyangju Wangsukch'ŏn (1 ♂ imago, 27 V 1983, Y.J. Bae, Obtained by rearing).

NYMPHS: Body 10.0mm, Caudal filaments 7.0 mm. General color brown, with, light markings (Fig. 1). Mandibular tusks more or less developed (Fig. 2). 1~10 abdominal terga with 3 longitudinal light stripes (Fig. 1).


DISTRIBUTION: Korea, Japan

Genus Potamanthus Pictet, 1843 (강하물살생물：新種)

Potamanthus Pictet, 1843 : 111, 197; Eaton, 1871 : 36; Eaton, 1884 : 78

Type species: Potamanthus luteus Linnaeus

Type locality: Europe

ADULTS: Vein MP₁ and MP₂ of fore wing connected at base.

NYMPHS: Mandibular tusks very strongly developed.

2. Potamanthus coreanus sp. n. (강하물살생물：新種) (Fig. 8~21)

Potamanthus nb: Imanishi, 1940 : 182

ADULTS: MALE IMAGO. Body 18.5 mm, Cerci 43.0 mm. Terminal filament 4.5 mm. General color brown, with reddish brown markings. Eyes orange; intersected dark grey band on the basal portion. Distance between eyes: width of head ≈ 1 : 22. Each ocellus with dark band at basal part. Thorax dark brown; pleural area somewhat light color. Fore legs brown; middle and hind legs white. Claws brown; fore leg claws similar, middle and hind leg claws dissimilar. Ratio of each fore leg segment 114 : 150 : 6 : 50 : 33 : 27 : 20(Fig. 14). Ratio of each hind leg segment 102 : 80 : 8 : 6 : 4 : 15 (Fig. 15). Wings hyaline; veins brown. Fore wings with reddish brown markings on the middle portion; with reddish brown stripes along basal and apical part of subcostal area. Basal part of MP₂ of fore wing curved and connected with MP₁. Apical half of hind wing reddish brown; costal projection
Acute. Abdomen light brown; 2–9 abdominal terga with a pair of reddish brown sublateral stripes (Fig. 18). 1–9 abdominal sterna with a pair of dark spots on each lateral portion and with two pairs of obscure submedian markings. Genital forceps white, 3 jointed; 1st joint longest. Penis illustrated in Fig. 12. Cerci reddish brown; with white bands at every two or three segments. Terminal filament very short; about 1/10 times length of cerci (Fig. 18). FEMALE IMAGO. Body 17.0 mm, Cerci 27.0 mm. Terminal filament 11.5 mm. General color white, with reddish brown markings. Eyes black. Distance between eyes: width of head = 1 : 2. Each ocellus with dark brown band at basal part. Thorax white, with reddish brown markings: pronotum with a pair of sublateral stripes and one median stripe (Fig. 20). Fore legs reddish brown; basal part of tibia and 1–4 tarsal joints white. Middle and hind legs white. Claws light brown, dissimilar. Ratio of each fore leg segment 125 : 155 : 4 : 17 : 12 : 8 : 20 (Fig. 16). Ratio of each hind leg segment 125 : 165 : 10 : 7 : 5 : 22 (Fig. 17). Wings similar to male imago (Fig. 21); marginal stripe of hind wing more narrow. Abdomen white; sublateral stripes of abdominal terga more narrow and distinct (Fig. 19, 20). Subanal plate swallowly notched (Fig. 13). Cerci reddish brown; with white bands every one or two segments. Terminal filament about 2/5 times length of cerci. MALE and FEMALE SUBIMAGO. Similar to male and female imago: dull in color.

NYMPHS: Body 30.0 mm. Caudal filaments 13.0 mm. General color light brown or brown. Mandibular tusks very strongly developed; about 2 times length of head (Fig. 2). Fore tibiae long; about 1.5 times length of fore femur (Fig. 11). 1–9 abdominal terga with two pairs of light submedian markings (Fig. 8). Gills lateral; Gill 1 luidimentary, gill 2–8 bisect and pullinously (Fig. 9, 10). Caudal filaments reddish brown; with white bands every one or two segments.


DISTRIBUTION: Korea
Family POLYMITARCYIDAE Banks, 1900 (흰하루살이科: 新稱)

Type genus: Ephoron Williamson

ADULTS: Base of veins MP₃ and CuA strongly divergent from base of vein MP₁. Middle and hind legs of male and all legs of female feeble, nonfunctional. Color usually pale; wings somewhat translucent.

NYMPHS: Mandibular tusks curved downward apically as viewed laterally; with numerous tubercles and setae. Ventral apex of hind tibiae rounded. Gills dorsal; gills on abdominal segment 1 vestigial.

Genus Ephoron Williamson, 1802 (흰하루살이属: 新稱)

Ephoron Williamson, 1802: 71; Eaton, 1883: 43

Polymitarcy Eaton, 1868: 84

Type species: Ephoron leukon Williamson

Type locality: New Jersey

ADULTS: Wings of female (subimago) distinctly translucent; wings of male slightly translucent. Wings with numerous crossveins and net-like marginal intercalaries. Genital forceps four segemented.

NYMPHS: Mandibular tusks with numerous tubercles on upper and lateral surface. Head with round median frontal process. Gills on abdominal segment 1 single; segment 2~7 forked, each lamella with short fringes.

3. Ephoron shigae Takahashi, 1924 (흰하루살이: 新稱) (Fig. 22~29)

Polymitarcys shigae Takahashi, 1924: 379

Polymitarcy shigae: Ueno, 1931: 189

ADULTS: MALE IMAGO. Body 12.0 mm. Cerci 38.0 mm. Terminal filament 0.5 mm. General color white. Eyes black. Distance between eyes: width of head ≈ 1 : 1.6. Basal area of ocelli dark brown; with black band. Thorax white. Fore legs femur brown; tibiae light brown. Ratio of each segment of fore leg 40 : 65 : 70 : 70 : 48 : 48 : 22 (Fig. 27). Middle and hind legs short and feeble (Fig. 28). Wings slightly translucent; with numerous crossveins and net-like marginal intercalaries. Costal projection of hind wing moderate. Abdominal terga with light brown obscure markings. Cerci long; about 4 times length of body. Terminal filament rudimentary. Forceps four segmented; penis V-shaped, divergent laterally (Fig. 25). FEMALE SUBIMAGO. General color and body shape similar to male imago (Fig. 26). Distance between eyes: width of head ≈ 1 : 1.6. All legs short and feeble. Wings similar to male imago; translucent (Fig. 29). Three long caudal filaments; with numerous hairs (Fig. 26).

NYMPHS: Length 17.5 mm, Caudal filaments 9.0 mm. General color white; with light brown markings. Anterior half of head brown (Fig. 22). Mandibular tusks with numerous tubercles and setae (Fig. 22, 23). Pronotum with V-shaped brown marking (Fig. 22). Gill on abdominal segment 1 single; segment 2～7 forked, with short fringes (Fig. 24). Abdominal terga with light brown obscure markings.

COLLECTING LOCALITIES OF NYMPH: KG: Kap'yŏng Ch'ŏngp'yŏng (12 VI 1983); Kwangju Kyŏnganch'ŏn (31 VII 1981), KW: P'yŏngch'ang Noeun-ri (9 VII 1983), CCB: Ch'ungju Talch'ŏn (12 VI 1983)

DISTRIBUTION: Korea, Japan

Family EPHEMERIDAE Leach, 1815 (하루살이과)
Type genus: Ephemerida Linnaeus

ADULTS: Base of veins MP₂ and CuA strongly divergent from base of vein MP₁. Vein A₁ unforked, attached to hind margin by three or more veinlets. Abdomen of most species with striking dark pattern on terga and sterna. Genital forceps four segmented.

NYMPHS: Mandibular tusks curved upward apically as viewed laterally. Ventral apex of hind tibiae projected into distinct acute point. Gills dorsal; gills on abdominal segments 1 reduced, segments 2～7 forked with margins long fringed.

Genus Ephemerida Linnaeus, 1758 (하루살이목)

Ephemerida Linnaeus, 1758 : 546; Eaton, 1868 : 85; Eaton, 1883 : 58
Type species: Ephemerida vulgata Linnaeus
Type locality: Europe

ADULTS: Wings with distinct pattern of dark markings; crossveins crowded together near bullae; vein A₁ attached to hind margin by three to many veinlets. Genital forceps four segmented. Terminal filament as long as cerci.

NYMPHS: Head with frontal process bifid. Gills on abdominal segment 1 bifid near base.

4. Ephemerida strigata Eaton, 1982 (두색하루살이) (Fig. 30～36)


ADULTS: MALE IMAGO. Body 15.0 mm. Cerci 35.5 mm. Terminal filament 33.0 mm. General color white. Eyes black; basal area of ocelli dark brown. Distance between eyes: width of head ≃ 1 : 2.9. Thorax yellow; with dark brown markings. Pronotum with a pair of sublateral stripes. Fore legs dark brown; middle and hind legs white. Ratio of each segment of fore legs 72 : 198 : 9 : 75 : 60 : 42 : 24 (Fig. 35). Wings hyaline; veins brown. Fore wings with 2～3 crossveins crowded together near bullae; with distinct dark brown markings on the portion (Fig. 34). Costal projection of hind wing round; outer margin of hind wing brown. 1～10 abdominal terga with a pair of dark brown stripes (Fig. 33); 1～9 abdominal sterna with a pair of slender dark brown stripes. Genital forceps four segmented,
2nd joint longest; penis V-shaped, small (Fig. 32). Caudal filaments brown; basal parts darker. Terminal filament nearly as long as cerci. FEMALE IMAGO. Body 23.5 mm. Cerci 32.0 mm. Terminal filament 29.0 mm. General color and body shape similar to male imago. Distance between eyes: width of head ≈ 1 : 1.8.


NYMPHS: Body 22.5 mm, Caudal filaments 8.5 mm. General color white or light brown; 1–10 abdominal terga with a pair of dark brown stripes (Fig. 30).


DISTRIBUTION: Korea, Japan, Siberia.

REMARKS: In some specimens of nymph, color variation is shown: the stripes of abdominal terga, especially on segments 7–9, more narrow and completely separated each other (Fig. 31).

5. _Ephemera orientalis_ McLachlan, 1875 (동양하루살이) (Fig. 37–43)

_Ephemera orientalis_ McLachlan, 1875 : 167; Ulmer, 1925 : 98; Tshernova, 1973 : 326

_Ephemera lineata_: Imanishi, 1940 : 176
ADULTS: MALE IMAGO. Body 19.0 mm. Cerci 37.0 mm. Terminal filament 33.0 mm. General color white. Eyes black; upper portion light brown with orange ring (Fig. 40). Distance between eyes: width of head = 1 : 2.9. Basal part of ocelli with dark spots. Thorax white, with brown markings; pronotum with a pair of dark brown sublateral stripes (Fig. 40). Fore legs brown; each jointing area dark. Ratio of each segment of fore leg 72 : 174 : 6 : 75 : 68 : 43 : 27 (Fig. 42). Middle and hind legs white. Fore wings with 2~3 crossveins crowded together near bullae; with dark markings on the portion; with dark spot at the base of IMP (Fig. 41). Costal projection of hind wing round; outer margin of hind wing brown. 3~9 abdominal terga with 2~3 pairs of dark submedian stripes and with a pair of sublateral stripes; stripes on abdominal terga 7~9 each ends meet (Fig. 40). 2~9 abdominal sterna with a pair of dark submedian stripes, Genital forceps 4 segmented; 2nd segment longest. Penis with a pair of ventral spines (Fig. 39). Caudal filaments white; each joint with dark band, with dark hairs. Terminal filament nearly as long as cerci.

FEMALE IMAGO. Body 18.0 mm. Cerci 20.0 mm. Terminal filament 19.5 mm. General color and body shape similar to male imago. Distance between eyes: width of head = 1 : 2.


NYMPHS: Body 23.5 mm. Caudal filaments 8.5 mm. General color white or light brown. 3~9 abdominal terga with 2~3 pairs of submedian stripes; stripes on 7~9 abdominal terga each ends meet (Fig. 38).


DISTRIBUTION: Korea, Japan, Manchuria, Siberia.
Adult identification key to Korean species of Ephemeroidea

1. Middle and hind legs of male and all legs of female feeble, nonfunctional; color usually pale; wings somewhat translucent and colorless (Fig. 29). ........................................Fam. Polymitarcyidae
   ....................................................................................Gen. Ephoron
   ....................................................................................---Ephoron shigae
   
   -- All legs of both sexes well developed, functional; color variable........................................2

2. Vein A1 of forewing forked near wing margin (Fig. 4, 21); genital forceps 3 jointed (Fig. 5, 12); abdomen usually yellow, in some species with reddish lateral stripes. ........Fam. Potamanthidae
   .....................................................................................---Gen. Ephemeridae
   .....................................................................................---Potamanthodes kamonis

-- Vein A1 of forewing unforked, attached to hind margin by several to numerous veinlets (Fig. 34, 41); genital forceps 4 jointed (Fig. 32, 39); abdomen of most species with striking dark pattern on terga and sterna. ........................................Gen. Ephemeridae
   .....................................................................................---Potamanthodes coreanus sp. n.

3. Vein MP1 and MP2 of forewing not connected at base (Fig. 4). ........Gen. Potamanthodes
   .....................................................................................---Potamanthodes kamonis

-- Vein MP1 and MP2 of forewing connected at base (Fig. 21). ........Gen. Potamanthus

...............................................................................---Potamanthus coreanus sp. n.

4. 7～9 abdominal terga with a pair of dark submedian stripes (Fig. 33). ..............................
   .....................................................................................---Ephemera strigata

-- 7～9 abdominal terga with 3 pairs of slender submedian stripes, each ends meet (Fig. 40). .....................................................................................---Ephemera orientalis

Nymphal identification key to Korean species of Ephemeroidea

1. Abdominal gills held laterally (Fig. 1). ........................................Fam. Potamanthidae
   -- Abdominal gills held dorsally (Fig. 38). ..................................................3

2. Mandibular tusks slightly to moderately developed (Fig. 1); mature nymph about 10 mm. ....................................................Gen. Potamanthodes
   .....................................................................................---Potamanthodes kamonis

-- Mandibular tusks very strongly developed (Fig. 11); mature nymph about 30 mm. ......Gen. Potamanthus
   .....................................................................................---Potamanthus coreanus sp. n.

3. Mandibular tusks curved upward; with numerous tubercles and setae on upper and lateral surface (Fig. 22, 23); head with round median frontal process (Fig. 22). .....Fam. Polymitarcyidae
   .....................................................................................---Gen. Ephoron
   .....................................................................................---Ephoron shigae

-- Mandibular tusks curved upward; frontal process of head bifid (Fig. 37). ....................Fam. Ephemeridae
   .....................................................................................---Gen. Ephemeridae

4. 7～9 abdominal terga with a pair of thick submedian stripes (Fig. 30) or somewhat slender sublateral stripes (Fig. 31). .............................................---Ephemera strigata
7～9 abdominal terga with 3 pairs of slender submedian stripes, each ends meet (Fig. 38). Ephemera orientalis

SUMMARY

We reviewed the five species of Korean Ephemeroidea, including 4 genera and 3 families, which were recorded by Imanishi (1940) and some ecological literatures of Korea in the present paper. All the adults and nymphs were described with illustrations and adult and nymphal identification key was provided. As to Potamanthus nb, we newly give a name as Potamanthus coreanus.

LITERATURE CITED


---, 1969. Mayflies (Ephemeroptera) from various regions of Southeast Asia. Orient. Insects, 3(3) : 221~238.


EXPLANATION OF FIGURES

Fig. 1~7. *Potamanthodes kamonis* (1~2: nymph, 3~7: adult) 1. dorsal view 2. mandible 3. dorsal view (♂ imago) 4. fore wing (♂ imago) 5. genitalia (♂ imago) 6. fore leg (♂ imago) 7. hind leg (♂ imago)


Fig. 22~29. *Ephoron shigae* (22~24: nymph, 25~29: adult) 22. dorsal view of head and prothorax 23. lateral view of mandible 24. abdominal gill (3rd) 25. genitalia (♂ imago) 26. dorsal view (♀ imago) 27. fore leg (♂ imago) 28. hind leg (♂ imago) 29. fore wing (♀ subimago)

Fig. 30~36. *Ephemera strigata* (30~31: nymph, 32~36: adult) 30. stripes on abdominal terga 31. stripes on abdominal terga (variation) 32. genitalia (♂ imago) 33. dorsal view (♂ imago) 34. fore wing (♂ imago) 35. fore leg (♂ imago) 36. hind leg (♂ imago)

Fig. 37~43. *Ephemera orientalis* (37~38: nymph, 39~43: adult) 37. dorsal view of head and prothorax 38. dorsal view of abdomen 39. genitalia (♂ imago) 40. dorsal view (♂ imago) 41. fore wing (♂ imago) 42. fore leg (♂ imago) 43. hind leg (♂ imago)