The Classification of Heptageniidae (Ephemeroptera) in Korea

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摘 要

韩国内産 Heptageniidae (꼬리하루살이科)의 하루살이目에 대하여 Imanishi (1940)는 6属 11種의 幼虫を 記録한 바 있다. 그 중 확인되지 않은 北韓內 3種을 제외하고, 세로이 6種이 추가되 어總 6屬 2亞属 14種으로 정리하였다. 또한 이 중 6種의 成虫を 확인하여 세로이 記録하였다. 그 내용은 다음과 같다.

Family Heptageniidae Needham, 1901
Genus Bleptus Eaton, 1885
1. Bleptus fasciatus Eaton, 1885
Genus Epeorus Eaton, 1881
Subgenus Epeorus Eaton, 1881
2. Epeorus (Epeorus) latifolium Ueno, 1928
3. Epeorus (Epeorus) curvatulus Matsumura, 1931
Subgenus Iron Eaton, 1883
4. Epeorus (Iron) aesculus Imanishi, 1934
Genus Rithrogena Eaton, 1881
5. Rithrogena na
Genus Cinygmula McDunnough, 1933
*6. Cinygmula KUa
*7. Cinygmula KUb
Genus Ecdyonurus Eaton, 1868
8. Ecdyonurus yoshidae Takahashi, 1924
9. Ecdyonurus kibunensis Imanishi, 1936
*10. Ecdyonurus dracon Kluge, 1983
*11. Ecdyonurus KUa
*12. Ecdyonurus KUb
Genus Heptagenia Walsh, 1863
*13. Heptagenia kihada Matsumura, 1931

* Newly recorded species from Korea.
INTRODUCTION

The eleven Korean species of Heptageniidae mayflies were recorded on their nymphal stage by Imanishi (1940): *Bleptus fasciatus* Eaton (1885); *Epeorus latifolium* Ueno (1928); *Epeorus curvatus* Matsumura (1931); *Epeorus aesculus* Imanishi (1934); *Rithrogena* na; *Cinygma hirasana* Imanishi (1935); *Cinygma* na; *Ecdyonurus yoshidae* Takahashi (1924); *Ecdyonurus kibunensis* Imanishi (1936); *Ecdyonurus* na; and *Heptagenia kyotoensis* Gose (1963) (=*Heptagenia* nb). But, among them, we never met three species of North Korean: *Cinygma hirasana*; *Cinygma* na; and *Ecdyonurus* na in any localities that we examined.

Some ephemeropterists discussed the separation of *Cinygma* and *Cinygma* on their Asiatic species (Imanishi (1940), Bajkova (1975), etc.). We place our species in *Cinygma* by their distinct characteristics of nymph. As to the separation of *Ecdyonurus* and *Heptagenia* on their nymphal stage, we follow Imanishi (1936), Bogoescu & Tabacaru (1962), Chernova (1976), Flowers (1980), and Kluge (1980), etc.

We have 5 undetermined species in the present paper: *Rithrogena* na; *Cinygma* KUa; *Cinygma* KUb; *Ecdyonurus* KUa; and *Ecdyonurus* KUb. We couldn’t obtain their adults so far. In fact, there remain many systematic problems, especially in *Rithrogena* and *Cinygma*.

All the examined materials are based on the specimens that have been collected by us or the other Korean scientists during the period of 1965~1984 at nearly 120 localities in Korea. All of them are preserved in alcohol and deposited at Korean Entomological Institute, Korea University, Seoul.

In the following description, all the measuring unit are mm. Terminology is based on Edmunds et al (1976). We didn’t record the number and collector on the numerous nymphs. The initials of collecting locality are as follows. SL: Seoul; KG: Kyönggi-do; KW: Kangwôn-do; CCB: C’ungch’öngbuk-do; CCN: Ch’ungch’öngnam-do; KB: Kyöngsangbuk-do; KN: Kyöngsangnam-do; CLB: Chöllabuk-do; CLN: Chöllanam-do; CJ: Cheju-do. The Romanization of Korean localities is based on “Korean Gazetteer” (Ministry of Education, 1984).

SYSTEMATICS

Family HEPTAGENIIDAE Needham, 1901

ADULTS: Forewings with two pairs of cubital intercalaries; MP₁ and MP₂ forming a more or less symmetrical fork. Hind tarsi five segmented. Two caudal filaments.

NYMPHS: Body distinctly depressed or flattened. Eyes and antennae dorsal. Abdominal gills present on segments 1~7; gill lamellae plate-like; with or without fibrilliform tufts at or near the base. Two or three caudal filaments.

Nymphal identification key to Korean species of Heptageniidae.

1. Two caudal filaments present. ..........................................................2
   — Three caudal filaments present.....................................................5
2. Fibrilliform gill tufts very strongly developed; especially longer then gill lamellae at abdominal segment 1 (Pl. I: a,f,g). ..............................................Gen. *Bleptus*
Fibrilliform gill tufts weakly developed. Plate-like gill lamellae large. —Gen. _Epeorus_ —3

3. Gill lamellae of segment 1 smaller than that on segment 3; not meeting beneath the body. —Subgen. _Epeorus_ —4

— Gill lamellae of segment 1 larger than the following ones; meeting beneath the body (Pl. IV: a,d,f). —Subgen. _Iron_

— _Epeorus_ (Iron) _aesulus_

4. Gill lamellae with reddish brown or brown spots (Pl. II: a,e). —

— _Epeorus_ (Epeorus) _latifolium_

— Gill lamellae without such spots (Pl. III: a,e). —_Epeorus_ (Epeorus) _curvatulus_

5. Gill lamellae of segment 1 very large; meeting beneath the body (Pl. V: a,i). —

— _Rithrogena_ na

— Gill lamellae of segment 1 not meeting beneath the body. —

6. Anterior margin of head more or less concave along median line (Pl. VI: a, Pl. VII: a). Caudal filaments without both of spines and setae. —Gen. _Cingymula_ —7

— Anterior margin of head weakly convex or level along median line. Caudal filaments with spines or setae or both. —

7. Abdominal terga without distinct pale markings. Body length 5.5~6.5 (Pl. VI: a). —

— Abdominal terga with distinct pale markings. Body length 10.0~15.0 (Pl. VII: a). —

— _Cingymula_ KUa

— _Cingymula_ KUb

8. Maxillae with ventral setae of galea-lacinia scattered; palpi with segments 2 and 3 fused, length of segments 3 about 1/5 length of segments 2 (Pl. VIII: f,g; Pl. IX: f,g; Pl. X: d,e; Pl. XI: d,e; Pl. XII: d,e). Labium with broad U-shaped separation of glossae; glossae oval, stalked (Pl. VIII: d; Pl. IX: d; Pl. X: f; Pl. XI: g; Pl. XII: f). —

— Gen. _Ecydonurus_ —9

— Maxillae with ventral setae of galea-lacinia in a sub-median row; palpi with segment 2 and 3 fused, length of segment 3 below 1/10 length of segment 2 (Pl. XIII: f,g; Pl. XIV: g,h). Glossae of labium near each other or curved at middle; not oval; not stalked (Pl. XIII: d; Pl. XIV: e). —Gen. _Heptagenia_ —13


— _Ecydonurus_ KUa

— Legs relatively long. Plate-like gill lamellae and fibrilliform gill tufts present —

10. Caudal filaments with spines at each segment and long setae at each side (Pl. XII: a,i) — 

— _Ecydonurus_ KUb

— Caudal filaments with only spines at each segment. —

11. Anterior margin of head without pale round markings (Pl. X: a) — _Ecydonurus dracon_

— Anterior margin of head with pale round markings. —

12. Anterior margin of head with two pale round markings. Body length 5.0~6.0 (Pl. IX: a). — _Ecydonurus kibunensis_

— Anterior margin of head with four pale round markings. Body length 12.0~15.0 (Pl.
Ecdyonurus yoshidae

13. Plate-like gill lamellae longer than fibrilliform gill tufts (Pl. XIII: a, h).

.............................. Heptagenia kihada

.............................. Heptagenia kyotoensis

Genus Bleptus Eaton, 1885

Bleptus Eaton, 1885: 243

Type species: Bleptus fasciatus Eaton

Type locality: Yagohora, Japan

ADULTS: Brown stripes present at the apex margin of fore and hind wings and across the middle portion of fore wings. Penis lobes narrow; V-shaped; without titillators (Pl. I: h).

NYMPHS: Galea-lacinia of maxillae with long hairs on crown (Pl. I: c). Abdominal terga 1~9 with median spines at each posterior margin (Pl. I: a). Fibrilliform gill tufts very strongly developed, especially at abdominal segment 1 (Pl. I: a,f,g). Two caudal filaments present.

1. Bleptus fasciatus Eaton 1885

(Pl. I: a-h; Pl. XV: a)


ADULTS: MALE IMAGOS. Length: Body 9.3. Caudal filaments 31.3. Fore wings length 10.5; width 3.4. Hind wings length 2.5; width 1.2. Fore legs femur 2.5; tibia 3.8; tarsus 4.9. Each tarsal segment of fore leg 1.3; 1.3; 1.2; 0.8; 0.3. Middle legs femur 2.4; tibia 3.5; tarsus 1.3. Hind legs femur 2.5; tibia 3.5; tarsus 1.1. Eyes dark reddish brown. Thorax light yellowish brown; with a dark brownish spot on each pleural region of prothorax. Hind wings relatively short and narrow; with weakly developed cubital and anal regions. Legs light yellowish; with brownish bands at apex margin of each femur and tibia. Claws dissimilar. Abdominal segments 1~7 translucent; 8~10 reddish brown; each tergum with brownish median line and brownish posterior transverse line. Base of caudal filaments darker. Genitalia illustrated in Pl. I: h, Pl. XV: a.


COLLECTING LOCALITIES OF NYMPH: KG: P'oče'ën Paegunsan (9 VIII 1984); Kap'yŏng Ch'onggyesan (24 V 1981), KW: Hongch'ŏn Kyebangsan (5 VI 1983); Wonsŏng Ch'iaksan (25 V 1982), CCN: Yesan Sudŏgsa (2 X 1983); Kūmsan Taedunsan (24 IX 1982), KB: Yŏngch'ŏn Pohyŏnsan (25 IX 1984), KN: Hamyang P'iągol (22 VI 1982), CLB: Muju Tŏg-
yusan (21 V 1983)

DISTRIBUTION: Korea, Japan

Genus Epeorus Eaton, 1881

Epeorus Eaton, 1881 : 26; Eaton, 1885 : 237

Type species: Epeorus torrentium Eaton

Type locality: Tarascon, France

ADULTS: Fore legs of tarsal segment 1 as long as or slightly longer than tarsal segment 2. Penis lobes with or without titillators (Pl. II: f; Pl. IV: f).

NYMPHES: Galea-lacinia of maxillae without both of spines and hairs on crown; with triad of stout spines at inner apical margin (Pl. III: d). Gill lamellae of abdominal segments 1 well developed; meeting or not meeting beneath the body. Two caudal filament present.

Subgenus Epeorus s.s. Eaton, 1881

Epeorus Eaton, 1881 : 26

Type species: Epeorus (E.) torrentium Eaton

Type locality: Tarascon, France

ADULTS: Penis lobes of male genitalia without titillators (Pl. II: f).

NYMPHES: Gill lamellae of abdominal segment 1 not meeting beneath the body.

2. Epeorus (Epeorus) latifolium Ueno, 1928

(Pl. II: a-f; Pl. XV: b)

Epeorus latifolium Ueno, 1928 : 34; Horasawa, 1929 : 253; Ueno, 1931 : 192; Imanishi, 1940 : 248; Chernova, 1949 : 146; Chernova, 1952 : 251

ADULT: MALE IMAGOS. Length: Body 12.0. Caudal filaments 26.0. Fore wings length 11.0; width 4.0. Hind wings length 4.0; width 2.3. Fore legs femur 2.8; tibia 2.8; tarsus 5.2. Each tarsal segment of fore legs 1.4; 1.3; 1.2; 0.8; 0.5. Middle legs femur 2.8; tibia 2.2; tarsus 1.5. Each tarsal segment of middle legs 0.4; 0.4; 0.3; 0.1; 0.3. Head light yellowish; eyes dark greyish. Thorax light yellowish; with two pairs of brownish bands on pro-tergum. Fore wings hyaline; stigmatic area whitish; with dark brownish spot at basal area. Each femur with dark brownish spot at the middle and apex surface. Claws dissimilar. Abdominal segments 3~7 translucent; whitish. Abdominal segments 1~2, 8~10 light yellowish. Genitalia illustrated in Pl. II: f, Pl. XV: b. FEMALE IMAGOS. Length: Body 11.0. Caudal filaments 25.7. Fore wings length 13.0; width 5.3. Hind wings length 4.5; width 2.6. Fore legs femur 3.0; tibia 2.5; tarsus 2.8. Each tarsal segment of fore legs 0.7; 0.7; 0.3; 0.4. Middle legs femur 3.1; tibia 2.5; tarsus 1.5. Hind legs femur 3.0; tibia 2.1; tarsus 1.4. General color and body form similar to male imagos. MALE and FEMALE SUBIMAGOS. Similar to male and female imagos but duller. 

COLLECTING LOCALITIES OF ADULT: KW: Hongch'on Kyebangsan (1 ♂ imagos, 20 ♀ imagos, 5 VI 1983, Y.J. Bae), KB: Yongp'un Sobaeksan (1 ♂ imago, 6 ♀ imagos, 17 V 1983, Y.J. Bae), CLB: Muju Togyusan (50 ♂ imagos, 20~22 V 1983, Y.J. Bae, among them 1 ♂ imago obtained by rearing in laboratory at 27 V 1983), CLN: Kurye Hwaomsa (2 ♀ imagos, 1 ♂ subimagos, 30 V 1983, Y.J. Bae); Sungi Songgwangsa
3. Epeorus (Epeorus) curvatus Matsumura, 1931

(Pl. III: a-e)

Epeorus curvatus Matsumura, 1931: 1477; Imanishi, 1934: 392; Imanishi, 1940: 250

NYMPHS: Length: Body 10.0~14.0. Caudal filaments 13.0~17.0. Head with dense marginal setae; one pair of light C-shaped marking at frontal margin (Pl. III: a). Mouthparts illustrated in Pl. III: b-d. Each abdominal tergum with dark median line and one pair of round

REMARKS: This species is widely distributed from Japan to western Siberia, Tom' R. basin (Chernova, 1958). Also this species is one of the most abundant species in Korea.
submedian spots (Pl. III: a). Plate-like gill lamellae whitish or light brownish; without numerous spots (Pl. III: a, e). Caudal filaments without both of spines and setae.

COLLECTING LOCALITIES OF NYMPH: KG: P'och'ŏn Paegunsan (9 VIII 1984); P'och'ŏn Wangbangsan (8 IX 1984); Kap'yŏng Myŏngjisan (30 VI 1981, 17 IV 1982); Kap'yŏng Hwa-aksan (1 X 1982); Yangju Pogwangsa (12 VIII 1981); Yangju Songch'u (12 VI 1971); Namyangju Kwangnung (13 VI 1981, 27 I 1983); Namyangju Ch'ŏnmasan (14 VIII 1977); Yangpyŏng Yongmunsan (28 V 1982), KW: Yanggu Ch'ŏn-mi-ri (19 VI 1983); Inje Paktamhsa (17 VIII 1971, 11 X 1982); Inje T'ut'ayŏn (19 VI 1983); Inje Ch'ŏndo-ri (10 X 1982); Inje Chungsudae (25 V 1966); Inje Chine (27 IX 1972); Hongch'ŏn Sogyebangsan (22 VI 1981); Wonsŏng Ch'iaksan (31 VI 1975, 2-3 IX 1982, 15 VIII 1984, 17 VIII 1984); P'yŏngch'ang Odae- san (20 VI 1981, 14 X 1984); Myŏngju Sog'umgangsan (19 IX 1971), CCB: Chech'ŏn Yongdusan (10 VI 1983); Po'-n Songnisan (10 VIII 1983); Koesan Hwayang-ri (15 IX 1984); Koesan Kwanpyŏng-ri (16 IX 1984), CCN: Kongju Magoks (26 IX 1982); Kongju Kapsa (23 IX 1982); Ch'ŏngyang Ch'ilgapsan (27 IX 1982); Kumsan Taedunsan (24 IX 1982), KB: Ponghwa Naesŏngch'ŏn (28 I 1983); Mungyŏng Mungyŏngsaejai (12 VIII 1983); Yŏngch'ŏn Pohyŏnsan (25 IX 1984); Talsŏng Pisŭlsan (24 IX 1984); Ch'ŏngsong Chuwan-gsan (29 I 1983); Ullŭng Chŏdong (2 VIII 1982), KN: Yangsan Naewoŏnsa (27 V 1982); Yangsan Tongdosa (29 V 1 982); Yangsan Hoe'yach'ŏn (23 IX 1984); Pusan Pŏmsa (4 X 1983); Hamyang P'iagol (22 VI 1982, 19 IX 1982); Sanch'ŏng Chungsan-ri (30 VI 1981), CLN: Changsŏng Paegyangsa (29 V 1983); Kurye Hwaŏmsa (30-31 V 1983); Sŏngju Songgwangsa (9 VIII 1976, 30 V 1983); Kwangyang Paegunsan (29 V 1981)

DISTRIBUTION: Korea, Japan, Manchuria

Subgenus **Iron** Eaton, 1883

**Iron** Eaton, 1883 : 244

Type species: *Epeorus (I.) longimanus* Eaton

Type locality: Manitou, Colorado

ADULTS: Penis lobes of male genitalia with titillators (Pl. IV: g).

NYMPHS: Gill lamellae of abdominal segment 1 meeting beneath the body (Pl. IV: f)


(Pl. IV: a-g)

**Epeorus aesculus** Imanishi, 1934 : 384; Imanishi, 1940 : 250; Chernova, 1952 : 251

ADULTS: MALE IMAGOS. Length: Body 13.0. Caudal filaments 33.0. Fore wings length 13.0; width 5.0. Hind wings length 5.0; width 2.5. Fore legs femur 3.0; tibia 4.5; tarsus 7.2. Each tarsal segment of fore legs 1.9; 1.9; 1.7; 1.2; 0.5. Middle legs femur 2.5; tibia 2.5; tarsus 1.5. Hind legs femur 2.5; tibia 2.3 tarsus 1.4. Head light yellowish; eyes dark greyish or grey brownish. Thorax light yellowish; with dark brown spot on each pleural region of prothorax. Stigmatic area of fore wings whitish. Veins light brownish. Legs whitish; each femur with dark brown markings on the middle portion. Tibia and tarsus of fore legs brownish. Abdominal segments 2-5 translucent; segments 1, 6-10 light yellowish; segments 1-7 with dark brownish posterior transverse line. Genitalia illustrated in
Pl. IV: g.

COLLECTING LOCALITIES OF ADULT: KB: Yöngp'ung Sobaeksan (1 imago, 18 V 1984, Y.J. Bae)


DISTRIBUTION: Korea, Japan, China, Amur, Ussuri

REMARKS: Imanishi (1934) discussed the separation of Epeorus (I.) aesculus and Epeorus (I.) unoi Matsumura on their nympha1 stage.

Gerus **Rithrogena** Eaton, 1881

**Rithrogena** Eaton 1881: 23; Eaton, 1885: 250

Type species: **Rithrogena semicolata** Curtis

Type locality: Europe

ADULTS: Penis lobes of male genitalia separated, narrow, rod-shaped, divergent laterally; titillators broad, closely adhering to the lobes, crenate or pointed apically (From Chernova (1974), Ulmer (1932~1933), etc.).

NYMPHS: Galea-lacinia of maxillae with comb-like spines on crown (Pl. V: e). Maxillary palpi two segmented; with numerous comb-like spinules on segment 2 (Pl. V: e,f). Plate-like gill lamellae very strongly developed; gill lamellae of segment 1 meeting beneath the body (Pl. V: i). Three caudal filaments present; without both of spines and setae.

5. **Rithrogena na**

(Pl. V: a-i)

**Rithrogena na**: Imanishi, 1940: 246


COLLECTING LOCALITIES OF NYMPH: KG: P'och'ön Paegunsan (9 VIII 1984); Kap'yöng Hwaksan (20 VII 1982, 1 X 1982); Kap'yöng Myöngjisan (27 IV 1982, 3 VII 1982); Kap'yöng Chojongch'ön (29 IV 1973, 27 V 1973, 31 VI 1973, 22 VI 1974); Kap'yöng Yum-yöngsan (14 V 1983); Namyangju Paldang (14 X 1972); Yöju Yöju (14 X 1972), KW: Inje Ch'ondo-ri (10 X 1982); Inje Paektamsa (17 VIII 1971, 11 X 1982); Yangyang Osaek (2 X 1983); Yangyang Yangyangch'ön (13 X 1982); Yangyang Namdaech'ön (14 X 1982); Ch'u-nsöng Kangch'on (15 X 1972); P'yöngch'ang Odaesan (14 X 1982); Wönsöng Ch'liaksan (31

DISTRIBUTION: Korea

REMARKS: In some specimens of Rithrogena na, the body color appearing purple brownish and abdominal terga 4,8,9 paler. However, It is very difficult to separate Rithrogena nymphs (Imanishi, 1940). Also, Sinichenkova (1973, 1973) provided the identification key to Palaeartic species of Rithrogena. We suppose Rithrogena na closely related to some Japanese or Eastern Siberian species of Rithrogena. But we couldn’t obtain the adults of Rithrogena na.

Genus Cinygmul a McDunnough, 1933

Cinygmul a McDunnough, 1933: 75

Type species: Cinygmul a ramaleyi Dodds

Type locality: Tolland, Colorado

ADULTS: Penis lobes of Male genitalia very deeply separated and in the apical parts sometimes divergent laterally. Titillators usually present or sometimes absent; a pair of processes situated below the titillators and on the outer side. Crossveins of stigmatic area usually not Anastomosed. Subanal plate of female with deep V-shaped median emargination (From Chernova (1974) and Edmunds et al. (1976)).

NYMPHS: Anterior margin of head more or less concave along median line (Pl. VII: a). Galea-lacinia of maxillae with comb-like spines on crown (Pl. VI: d, Pl. VII: f). Maxillary palpi two segmented; with numerous spicules (Pl. VI: d, Pl. VII: f). (similar to Rithrogena). Fibrilliform gill tufts of abdominal segment 1–7 reduced to two or three filaments or absent (Pl. VI: i, Pl. VII: h). Three caudal filaments present; without both of spines and setae.

REMARKS: The adult of Cinygmul a is separated from Cinygma and Rithrogena by the shape of genitalia. The nymph of Cinygmul a is separated from them by the anterior margin of head, mouthparts, and the shape of gills (Imanishi (1940), Chernova (1976), Edmunds et al (1976), etc.). But many Asiatic nymphs of Cinygma and Cinygmul a have exceptions (Imanishi (1940), Bajkova (1974), Kustareva (1978), etc.). We dare to suppose that Cinygma and Cinygmul a are closely related each other. We place our species provisionally in Cinygmul a by their distinct characteristics of nymph.

6. Cinygmul a KUa

(Pl. VI: a-i)

NYMPHS: Length: Body 6.5. Caudal filaments 9.8. General color light brownish. Anterior margin of head more or less concave along median line; without markings (Pl. VI: a). Mouthparts illustrated in Pl. VI: b-g; galea-lacinia of maxilla with about eleven comb-like spines; maxillae with ventral setae in a sub-median row; maxillary palpi with numerous comb-like spicules. Claw with five denticles (Pl. VI: h). Abdominal terga without markings; in some
specimen with a pair of small round sub-median markings on each tegum. Gill lamellae of abdominal segment 1~7 whitish; trachea obscure or absent; without fibrilliform gill tufts (Pl. VI: a.i).


DISTRIBUTION: Korea

7. Cinygmulua KUb
(Pl. VII: a-h)

NYMPHs: Lenght: Body 10.0~15.0. Caudal filaments 11.0~16.0. General color light brownish or brownish. Anterior margin of head more or less concave along median line; with one pair of pale round markings (Pl. VII: a). Mouthparts illustrated in Pl. VII: b-f; similar to Cinygmulua KUb. Abdominal terga with distinct light markings (Pl. VII: a). Gill lamellae of abdominal segments 1~7 whitish; trachea more or less distinct or obscure; without fibrilliform gill tufts (Pl. VII: a, h).

COLLECTING LOCALITIES OF NYMPH: KG: Kap’yŏng Myŏngjisan (31 III 1982); Nam-yangju Kwangnung (27 I 1983), KB: Ch’ŏngyang Chuwangsan (29 I 1983); Yongil Pogyŏngsa (30 I 1983); Taegu Tonghwasa (30 I 1983)

DISTRIBUTION: Korea

REMARKS: Like Rithrogena, the separation of Cinygmulua nymphs is very difficult too. Cinygmulua KUb and Cinygmulua KUb are divided by body length, the markings of head and abdominal terga, and the shape of gills. Also these two species are separated from Cinygma hirasana Imanishi and Cinygma na which were recorded from several localities of North Korea (Imanishi, 1940) by the shape of gills. All of our Cinygmulua specimens lacking fibrilliform gill tufts. But we suppose that they are very closely related. According to body length, Cinygmulua KUb is similar to Cinygma hirasana, Cinygmulua KUb is close to Cinygma na. Besides, we suppose that Cinygmulua KUb and Cinygmulua KUb are closely associated with some Japanese Cinygma: Cinygma hirasana Imanishi (1935); Cinygma dorsalis Imanishi (1935) and some Eastern Siberian species: Cinygma kurenzovi Bajkova (1965); Cinygmulua grandifolia Chernova (1952); Cinygmulua altaica Chernova (1949); Cinygmulua oreophila Kustareva (1978); and Cinygmulua putranica Kluge (1980) etc. These two species need to reexamine when their adults get obtained.

Genus Ecdyonurus Eaton, 1868

Ecdyonurus Eaton, 1868 : 142

Ecdyurus Eaton, 1871: 25

Type species: Ecdyonurus venosus Fabricius

Type locality: Europe

ADULTS: Hind tarsal segments 1 as long as or slightly longer than segments 2. Penis lobes
of male genitalia strongly extended laterally: with titillators (Pl. VIII: j; Pl. X: h).

NYMPHS: Galea-lacinia of maxillae with 12~17 comb-like spines on crown; ventral setae scattered; maxillary palpi with segments 2 and 3 fused, length of segments 3 about 1/5 length of segments 2 (Pl. VIII: f,g; Pl. IX: f,g; Pl. X: d,e; Pl. XI: d,e; Pl. XII: d,e). Labium with broad U-shaped separation of glossae; glossae oval, stalked (Pl. VIII: d; Pl. IX: d; Pl. X: f; Pl. XI: g; Pl. XII: f). Three caudal filaments present; with spines or setae or both.

8. Ecdyonurus yoshidae Takahashi, 1924
(Pl. VIII: a-j; Pl. XV: c)

Ecdyonurus yoshidae Takahashi, 1924; Imanishi 1940: 252
Heptagenia yoshidae: Chernova, 1952: 251
Ecdyonurus japonicus Ueno, 1928: 30; Ueno, 1931: 197; Chernova, 1949: 141
Ecdyonurus japonica: Horasawa, 1931: 30

ADULTS: MALE IMagos. Length: Body 10.5. Caudal filaments 29.0. Fore wings length 11.3; width 4.0. Hind wings length 3.8; width 2.2. Fore legs femur 2.8; tibia 3.4; tarsus 5.0. Each tarsal segment of fore legs 1.1; 1.4; 1.3; 0.8; 0.4. Middle legs femur 2.7; tibia 2.0; tarsus 1.2. Hind legs femur 3.0; tibia 2.0; tarsus 1.0. Hind tarsal segments in order of descending length: 1, 5, 2, 3, 4. Eyes dark greyish. Thorax pale yellowish; with two pairs of dark spots on prothorax tergum; with one pair of dark brownish strips on mesothorax tergum. Legs whitish; with dark brownish spots on the middle portion of each femur and at the apex of each femur and tibia. Stigmatic area of fore wing translucent, whitish. Cross veins dark brownish; the basal part of C, Sc of fore wings remarkable. Abdominal segments 1~6 translucent, whitish; segment 7~10 pale yellowish. Each abdominal tergum with dark brownish spots; forming a stripe (Pl. VIII: j). Genitalia illustrated in Pl. VIII: j, Pl. XV: c. FEMALE IMagos. Length: Body 11.3. Caudal filaments 22.0. Fore wings length 13.9; width 4.6. Hind wings length 4.0; width 2.3. Fore legs femur 3.0; tibia 2.3; tarsus 2.0. Middle legs femur 3.0; tibia 2.2; tarsus 1.1. Hind legs femur 3.5; tibia 2.4; tarsus 1.1. General color similar to male imagos. MALE and FEMALE SUBIMagos. Similar to male and female imagos, but duller.

COLLECTING LOCALITIES OF ADULT: SL: Tobong-gu Puk’ansan (2 ♂ imagos, 1 ♀ imago, 1 ♀ subimagos, 2 ♂ subimagos, 1IV 1984, Y. J. Bae, all of them obtained by rearing in laboratory during 30 IV 1984~9 V 1984), KG: Namyangju Kwangnung (1 ♂ imago, 17 IV 1983, Y. J. Bae, obtained by rearing in laboratory); Namyangju Wangsukch’on (2 ♀ imagos, 3 V 1983, Y. J. Bae, obtained by rearing in laboratory at 26 V 1983), CLN: Kurye Hwaomsa (1 ♀ subimagos, 30 V 1983, Y. J. Bae); Sungi Songgwangsa (1 ♀ subimagos, 29 V 1983, Y. J. Bae)

NYMPHS: Length: Body 12.0~15.0. Caudal filaments 17.0~20.0. General color brownish or dark brownish; with distinct light markings. Anterior margin of head with two pairs of distinct light round markings (Pl. VIII: a). Mouthparts illustrated in Pl. VIII: b-g. Abdominal terga with distinct light markings; segment 4, 8, 9 remarkable (Pl. VIII: a). Abdominal segments 1~7 with gill lamellae; trachea well developed; segments 1~6 with fibrilliform
gill tufts. Caudal filaments with spines (Pl. VIII: a,h).


DISTRIBUTION: Korea, Japan, Manchuria, Amur, Ussuri, Tom'

REMARKS: As Epeorus (E.) latifolium, this species widely distributed from Japan to western Siberia, Tom' R. basin (Chernova, 1958). Also, this species is one of the most abundant species in Korea. The nymph of Ecdyonurus yoshidae is similar to Ecdyonurus abracadabrus Kluge (1983).

9. Ecdyonurus kibunensis Imanishi, 1936

(Pl. IX: a-g)

Ecdyonurus kibunensis Imanishi, 1936 : 540; Imanishi, 1940 : 253

Heptagenia kibunensis: Chernova, 1952 : 253


DISTRIBUTION: Korea, Japan, China, Manchuria, Ussuri, Amur

REMARKS: This species is similar to Ecdyonurus scalaris Kluge (1983). It needs reexamine when the adults get obtained.

10. Ecdyonurus dracon Kluge, 1983

(Pl. X: a, i, Pl. XV: d)

Ecdyonurus dracon Kluge, 1983: 27

ADULTS: MALE IMagos. Length: Body 12.5. Caudal filaments 30.3. Fore wings length 10.5; width 3.8. Hind wings length 3.9; width 2.3. Fore legs femur 3.1; tibia 2.6; tarsus 4.4. Each tarsal segment of fore legs 0.8; 1.2; 1.1; 0.9; 0.4. Middle legs femur 3.0; tibia 2.5; tarsus 1.2. Hind legs femur 3.3; tibia 2.6; tarsus 1.1. Hind tarsal segments in order of descending length 1, 5, 2, 3, 4. Eyes dark greyish. Thorax dark brownish. Legs pale yellowish; femur with dark brown band on the middle portion and at the apex. Veins of wing dark brownish; cross veins of C, Sc, R very remarkable. Abdominal terga 1, 8～10 brownish; 2～7 whitish; each tergum with characteristic brownish posterior transverse stripe (Pl. X: i). Abdominal sterna 1, 7～10 light brownish; 2～7 pale yellowish. Genitalia illustrated in Pl. X: h, Pl. XV: d. Caudal filaments pale yellowish. FEMALE IMagos. Length: Body 12.0. Caudal filaments 19.0. Fore wings length 11.5; width 4.0. Hind wings length 4.5; width 2.3. Fore legs femur 3.1; tibia 2.7; tarsus 1.7. Middle legs femur 3.4; tibia 2.7; tarsus 1.2. Hind legs femur 3.6; tibia 2.7; tarsus 1.0. General color and body form similar to male imagoes. FEMALE SUBIMagos. Similar to female imagoes but duller.

COLLECTING LOCALITIES OF ADULT: SL: Tobong-gu Pu’ksans (4 ♂ imagoes, 1 ♀ imago, 1 ♀ subimago, 1 IV 1984, Y.J. Bae, all of them obtained by rearing in laboratory during 11 IV 1984～22 IV 1984), KG: Yangju Pogwangsa (1 ♂ imago, 1 ♀ imago, 1 ♀ subimago, 25 III 1984, Y.J. Bae, all of them obtained by rearing in laboratory during 4 IV 1984～15 IV 1984), KB: Yŏng’ung Sobaeksan (2 ♂ imagoes, 19 V 1984, Y.J. Bae).


DISTRIBUTION: Korea, Far Eastern Siberia

REMARKS: This species is similar to Ecdyonurus tobiironis Takahashi (1929) and Ecdyonurus aurarius Kluge (1983), but they are separated by genitalia, color of cross veins of wing, markings of abdomen, and color of caudal filaments, etc. (Kluge, 1983).

11. Ecdyonurus KUa

(Pl. XI: a-k)

NYMPHS: Length: Body 5.0~5.5. Caudal filaments 2.5~3.0. General color brownish or dark brownish or black; with small pale markings. Middle portion of head, the posterior half of wing pads, hind legs, and abdominal terga 1~6 pale color (Pl. XI: a). Head nearly square. Anterior margin of head nearly level along the median line; with two pairs of pale markings (Pl. XI: a). Mouthparts illustrated in Pl. XI: b-h. Legs very short; with spines on the upper portion of femur (Pl. XI: a). Abdominal segments 1~7 with plate-like gill lamellae only (Pl. XI: a,i,i). Caudal filaments shorter than body; with long setae (PL XI: a,k).


DISTRIBUTION: Korea

REMARKS: In some specimens of Ecdyonurus KUa, the body length comes to 9.0. Ecdyonurus KUa is very characteristic. This species is separated from the other species of Ecdyonurus by general body form, relative length of legs and caudal filaments, shape of gills and caudal filaments, markings, etc. But mouthparts are Ecdyonurus form.

12. Ecdyonurus KUb

(Pl. XII: a-j)

NYMPHS: Length: Body 5.8~6.7. Caudal filaments 4.0~5.0. General color brownish or pale brownish; with light markings. Anterior margin of head with two pairs of small light
markings (Pl. XII: a). Mouthparts illustrated in Pl. XII: b-g. Each abdominal terga with one pair of submedian light markings (Pl. XII: a). Abdominal segments 1~7 with plate-like gill lamellae; trachea well developed; segment 1~6 with fibrilliform gill tufts (Pl. XII: a,h, i). Caudal filaments with spines on each segment and long intersegmental setae on both side (Pl. XII: a,i).

COLLECTING LOCALITIES OF NYMPH: KG: Kap’yŏng Yumyŏngsan (14 V 1983); Kap’yŏng Ch’ŏngp’yŏng (12 VI 1983).

REMARKS: Ecdyonurus KUb is similar to Ecdyonurus kibunensis, but separated by markings of head and abdomen, shape of caudal filaments, etc.

Genus **Heptagenia** Walsh, 1863

**Heptagenia** Walsh, 1863 : 179

Type species: **Heptagenia flavescens** Walsh

Type locality: Rock Island

**ADULTS:** Hind tarsal segments 1 shorter than segments 2. Penis lobes of male genitalia broad; with titillators (Pl. XIII: k).

**NYMPHS:** Galea-lacinia of maxillae with 9~11 comb-like spines on crown; with ventral setae in a sub-median row; maxillary palpi with segments 2 and 3 fused, length of segments 3 below 1/10 length of segments 2 (Pl. XIII: f,g; Pl. XIV: g,h). Glossae of labium near each other or curved at middle; not oval; not stalked (Pl. XIII: d; Pl. XIV: e). Three caudal filaments present; with both of spines and setae.

13. **Heptagenia kihada** Matsumura, 1931

(Pl. XIII: a-k)

**Heptagenia kihada** Matsumura, 1931 : 1478; Imanishi, 1935 : 220; Imanishi, 1940 : 255

**ADULTS:** MALE IMAGOS. Length: Body 12.0. Caudal filaments 34.7. Fore wings length 10.8; width 3.8. Hind wings length 4.0; width 1.9. Fore legs femur 2.3; tibia 2.5; tarsus 4.7. Each tarsal segments of fore legs 0.5; 1.3; 1.3; 1.1; 0.5. Middle legs femur 2.5; tibia 2.1; tarsus 1.5. Hind legs femur 2.7; tibia 2.3; tarsus 1.4. Hind tarsal segments in order of descending length 2, 1, 3~5, 4. Head dark brownish; eyes black. Thoracic tergum and sternum dark brownish; pleura pale yellowish. Fore femur basal half pale brownish; apical half brownish. Fore tibiae brownish; tarsus pale brownish. Middle and hind femur whitish; tibiae and tarsus pale brownish. Veins of wing brownish. Abdominal segments brownish; each segment with triangular white marking on each side; with one pair of sub-median spots on each tergum (Pl. XIII: j). Caudal filaments pale brownish; basal part brownish. Genitalia illustrated in Pl. XIII: k. FEMALE IMAGOS. Length: Body 13.2. Caudal filaments 26.3. Fore wings length 12.5; width 4.8. Hind wings length 4.0; width 1.9. Fore legs femur 2.7; tibia 2.2; tarsus 2.4. Middle legs femur 2.7; tibia 2.1 tarsus 1.5. Hind legs femur 3.0; tibia 2.4. General color similar to male imagos, but paler. Pleural region of thorax and each abdominal segment pale yellowish. MALE and FEMALE SUBIMAGOS. Similar to male and female imagos, but duller.

COLLECTING LOCALITIES OF ADULT: SL: Tobong-gu Puk’ansan (3 ♀ imagos, 3 ♂ im-
agos, 1 IV 1984, Y.J. Bae, all of them obtained by rearing in laboratory during 20 IV 1984 ∼30 IV 1984), KG: Yangju Pogwangsa (4 ♂ imagos, 1 ♀ imago, 1♂ subimago, 2 ♀ subimagos, 23 III 1984, Y.J. Bae, all of them obtained by rearing in laboratory during 21 IV 1984 ∼26 IV 1984), KB: Yongp’ung Sobaeksan (2 ♂ imagos, 19 V 1984, Y.J. Bae), CLN: Kurye Hwaômsa (1 ♂ imago, 30 V 1984, Y.J. Bae).


DISTRIBUTION: Korea, Japan


(Pl. XIV: a-j)

Heptagenia kyotoensis Gose, 1963: 143

Heptagenia nb: Imanishi, 1940: 257

NYMPHS: Length: Body 13.0 ∼14.0. Caudal filaments 15.0 ∼20.0. General color brownish with pale markings. Anterior margin of head without markings. Mouthparts illustrated in Pl. XIV: b-h. Pro and mesothoracic terga with a pair of pale longitudinal stripes (Pl. XIV: a). Abdominal terga with a pair of longitudinal pale stripes on both side; a pair of sub-median markings on each segment (Pl. XIV: a). Abdominal segments 1 ∼7 fibrilliform gill tufts very strongly developed; gill lamellae rudimentary (Pl. XIV: a,i). Caudal filaments longer than body; with both of spines and setae (Pl. XIV: a,j).


DISTRIBUTION: Korea, Japan

SUMMARY

The eleven Korean species of Heptageniidae mayflies were recorded on their nymphal stage by Imanishi (1940). Among them, we except 3 species of North Korean in this paper which we never met in any localities that we examined, and we add 6 Korean species of Heptageniidae newly. Therefore 14 Korean Heptageniidae mayflies, including 2 subgenera and 6 genera, are reviewed in the present paper. Also, their nymphal identification key is provided, and some adult stages are recorded.

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**LITERATURE CITED**


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Matsumura, S., 1931. 6000 illustrated insects of Japanese Empire. Tokyo


EXPLANATION OF PLATES

Pl. I: Bleptus fasciatus (a-g: nymph, h: adult)
   a. dorsal view b. labrum c. left maxilla d. hypopharynx e. labium f. gill 1 g. gill 3 h. male genitalia

Pl. II: Epeorus (E.) latifolium (a-e: nymph, f: adult)
   a. dorsal view b. labrum c. hypopharynx d. labium e. gill 3 f. male genitalia

Pl. III: Epeorus (E.) euripus (a-e: nymph)
   a. dorsal view b. labrum c. hypopharynx d. right maxilla e. gill 3

Pl. IV: Epeorus (L.) aesculus (a-f: nymph, g: adult)
   a. dorsal view b. labrum c. hypopharynx d. gill 1 e. gill 3 f. ventral view of abdomen g. male genitalia
Pl. V: *Rithrogena* na (a-i: nymph)
  a. dorsal view b. labrum c. hypopharynx d. labium e. left maxilla f. come-like spine of maxillary palp g. right mandible h. gill 7 i. gill 1

Pl. VI: *Cinygmula* KUa (a-i: nymph)
  a. dorsal view b. labrum c. hypopharynx d. left maxilla e. comb-like spines of galea-lacinia of maxillae f. right mandible g. labium h. claw of fore legs i. gill 3

Pl. VII: *Cinygmula* KUb (a-h: nymph)
  a. dorsal view b. labrum c. hypopharynx d. labium e. right mandible f. left maxilla g. claw of fore legs h. gill 3

Pl. VIII: *Ecdyonurus yoshidae* (a-h: nymph, i-j: adult)
  a. dorsal view b. labrum c. hypopharynx d. labium e. labial palp (opposite view) f. left maxilla g. maxillary palp (opposite view) h. caudal filament i. dorsal view of abdomen j. male genitalia

Pl. IX: *Ecdyonurus kubunensis* (a-g: nymph)
  a. dorsal view b. labrum c. hypopharynx d. labium e. labial palp (opposite view) f. left maxilla g. maxillary palp (opposite view)

Pl. X: *Ecdyonurus dracon* (a-g: nymph, h-i: adult)
  a. dorsal view b. labrum c. hypopharynx d. left maxilla e. maxillary palp (opposite view) f. labium g. labial palp h. male genitalia i. dorsal view of abdomen

Pl. XI: *Ecdyonurus* KUa (a-k: nymph)
  a. dorsal view b. labrum c. hypopharynx d. left maxilla e. maxillary palp (opposite view) f. right mandible g. labium h. labial palp (opposite view) i. gill 5 j. gill 1 k. caudal filament

Pl. XII: *Ecdyonurus* KUb (a-j: nymph)
  a. dorsal view b. labrum c. hypopharynx d. left maxilla e. maxillary palp (opposite view) f. labium g. labial palp (opposite view) h. gill 3 i. gill 1 j. caudal filament

Pl. XIII: *Heptagenia kihada* (a-i: nymph, j-k: adult)
  a. dorsal view b. labrum c. right mandible d. labium e. labial palp (opposite view) f. left maxilla g. maxillary palp (opposite view) h. gill 3 i. caudal filament j. dorsal view of abdomen k. male genitalia

Pl. XIV: *Heptagenia kyotoensis* (a-j: nymph)
  a. dorsal view b. labrum c. hypopharynx d. right mandible e. labium f. labial palp (opposite view) g. left maxilla h. maxillary palp (opposite view) i. gill 3 j. caudal filament

Pl. XV: Photographs of male genitalia