

The Classification of Heptageniidae (Ephemeroptera) in Korea

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韓國產 꼬리하루살이科 (하루살이目)의 分類

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摘 要

韓國產 Heptageniidae (꼬리하루살이科)의 하루살이類에 대하여 Imanishi (1940)는 6屬 11種의 幼虫을 記錄한 바 있다. 그 중 확인되지 않은 北韓產 3種을 제외하고, 새로이 6種이 추가되어 總 6屬 2亞屬 14種으로 정리하였다. 또한 이 중 6種의 成虫을 확인하여 새로이 記錄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

14. *Heptagenia kyotoensis* Gose, 1963

* Newly recorded species from Korea.

INTRODUCTION

The eleven Korean species of Heptageniid mayflies were recorded on their nymphal stage by Imanishi (1940): *Bleptus fasciatus* Eaton (1885); *Epeorus latifolium* Ueno (1928); *Epeorus curvatulus* 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 *Cinygmula* and *Cinygma* on their Asiatic species (Imanishi (1940), Bajkova (1975), etc.). We place our species in *Cinygmula* 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; *Cinygmula* KUa; *Cinygmula* 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 *Cinygmula*.

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: Kangwön-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; MP_1 and MP_2 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 than gill lamellae at abdominal segment 1 (Pl. I: a,f,g).Gen. *Bleptus*

-*Bleptus fasciatus*
- 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) aesculus*
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).....
-Gen. *Rithrogena*
-*Rithrogena na*
- Gill lamellae of segment 1 not meeting beneath the body.6
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. *Cinygmula*...7
- Anterior margin of head weakly convex or level along median line. Caudal filaments with spines or setae or both.....8
7. Abdominal terga without distinct pale markings. Body length 5.5~6.5 (Pl. VI: a).....
-*Cinygmula* KUa
- Abdominal terga with distinct pale markings. Body length 10.0~15.0 (Pl. VII: a).....
-*Cinygmula* 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. *Ecdyonurus*...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
9. Legs relatively short. Only plate-like gill lamellae present (Pl. XI: a,i,j).
-*Ecdyonurus* KUa
- Legs relatively long. Plate-like gill lamellae and fibrilliform gill tufts present10
10. Caudal filaments with spines at each segment and long setae at each side (Pl. XII: a,i)
-*Ecdyonurus* KUb
- Caudal filaments with only spines at each segment.....11
11. Anterior margin of head without pale round markings (Pl. X: a)....*Ecdyonurus dracon*
- Anterior margin of head with pale round markings.12
12. Anterior margin of head with two pale round markings. Body length 5.0~6.0 (Pl. IX: a).*Ecdyonurus kibunensis*
- Anterior margin of head with four pale round markings. Body length 12.0~15.0 (Pl.

- VIII: a).....*Ecdyonurus yoshidae*
 13. Plate-like gill lamellae longer than fibrilliform gill tufts (Pl. XIII: a,h).
 *Heptagenia kihada*
 — Fibrilliform gill tufts very strongly developed. Gill lamellae rudimentary (Pl. XIV: a,i)
 *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)

Bleptus fasciatus Eaton, 1885 : 243; Ueno, 1931 : 194; Horasawa, 1931 : 29; Imanishi, 1940 : 252.

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 ADULT: KN: Yangsan Kajisan (1 ♂ imago, 26 V 1982, J.U. Byun); Pusan Pömösa (1 ♂ imago, 1 VI 1982, J.U. Byun); Hamyang P'iagol (1 ♂ imago, 22 VI 1982, J.U. Byun)

NYMPHS: Length: Body 15.0. Caudal filaments 10.0. General color brownish. Body robust and stumpy (Pl. I: a). Mouthparts illustrated in Pl. I: b-e; labrum, maxillae, and labium very characteristic. Legs relatively short and stout. Fibrilliform gill tufts of abdominal segment 1 very strongly developed; their basal part forming a flat plate of tufts (Pl. I: f). Caudal filaments shorter than body; without both of spines and setae.

COLLECTING LOCALITIES OF NYMPH: KG: P'och'ön Paegunsan (9 VIII 1984); Kap'y-öng Ch'önggyesan (24 V 1981), KW: Hongch'ön Kyebangsang (5 VI 1983); Wonsöng Ch'ia-ksan (25 V 1982), CCN: Yesan Sudögsa (2 X 1983); Kümsan Taedunsan (24 IX 1982), KB: Yöngch'ön Pohyönsan (25 IX 1984), KN: Hamyang P'iagol (22 VI 1982), CLB: Muju Tög-

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).

NYMPHS: 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).

NYMPHS: 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; 0.7; 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: Hongchŏn Kyebangsan (10 ♂ imagos, 20 ♀ imagos, 5 VI 1983, Y.J. Bae), KB: Yŏngp'ung Sobaeksan (1 ♂ imago, 6 ♀ imagos, 17 V 1983, Y.J. Bae), CLB: Muju Tŏgyusan (50 ♂ imagos, 20~22 V 1983, Y.J. Bae, among them 1 ♂ imago obtained by rearing in laboratory at 27 V 1983), CLN: Kurye Hwaŏmsa (2 ♀ imagos, 1 ♂ subimago, 2 ♀ subimagos, 30 V 1983, Y.J. Bae); Sŏngju Songgwangsa

(3 ♀ subimago, 29 V 1983, Y.J. Bae)

NYMPHS: Length: Body 11.0~17.0. Caudal filaments 13.0~19.0. General color light brownish or brownish. Head with dense marginal setae; two pairs of light markings at frontal margin (Pl. II: a). Mouthparts illustrated in Pl. II: b-d. Each abdominal terga with one pair of dark submedian markings (Pl. II: a). Plate-like gill lamellae large; with numerous reddish brown round spots (Pl. II: a, e). Caudal filaments longer than body; without both of spines and setae.

COLLECTING LOCALITIES OF NYMPH: SL: Tobong-gu Tobongsan (6 V 1981), KG: P'och'ŏn Paegunsan (9 VIII 1984); Kap'yŏng Hwaaksan (20 VII 1978, 1 X 1982); Kap'yŏng Myŏngjisan (30 VIII 1981, 26 III 1982, 23 IV 1982, 3 VII 1982); Kap'yŏng Unaksan (29 IX 1971); Kapyŏng Chojongch'ŏn (22 IV 1974, 13~14 X 1974, 24 IX 1978); Kap'yŏng Chŏngp'yŏng (12 VI 1983); Kap'yŏng Yumyŏngsan (8 V 1983, 14 V 1983); Yangju Pogwangsa (12 IV 1983); Yangju Iryŏng (25 IV 1982); Namyangju Kwangnŭng (13 IV 1981, 19 V 1983); Namyangju Wangsukch'ŏn (13 V 1983); Namyangju Ch'ŏnmasan (14 VIII 1977); Yangp'yŏng Yongmunsan (8 X 1965, 28 V 1982), KW: Yanggu Ch'ŏnmi-ri (19 VI 1983); Inje Paektamsa (4 VI 1979, 11 X 1982); Inje Ch'ŏndo-ri (10 X 1982); Inje Changsudae (25 V 1966); Inje Pangdaesan (30 VII 1981); Yangyang Osaek (2 X 1983); Yangyang Yangyangch'ŏn (13 X 1982); Yangyang Namdaech'ŏn (14 X 1982); Hongch'ŏn Sogyebangsan (22 VII 1981); Hongch'ŏn Kyebangsan (6 VI 1983); Hongch'ŏn Kach'ilbong (23 VI 1984); P'yŏngch'ang Odaesan (20 VII 1981, 14 X 1982); T'aebaek T'aebaeksan (13 VIII 1983); Wonsŏng Ch'iaksan (17 VIII 1984), CCB: Chech'ŏn Yongdusan (10 VII 1983); Poŭn Songnisan (10 VIII 1983); Okch'ŏn Sŏdaesan (9 IX 1972, 14 X 1972); Koesan Hwayang-ri (15 IX 1984); Koesan Kwanp'yong-ri (16 IX 1984), CCN: Kongju Magoksa (26 IX 1982); Yesan Sudŏksa (2 X 1983); Ch'ŏngyang Ch'ilgapsan (27 IX 1982, 3 X 1983), KB: Yŏngp'ung Sobaeksan (7 VI 1981, 27 I 1983); Mungyŏng Mungyŏngsaejae (11 VIII 1983); Yŏngch'ŏn Pohyŏnsan (25 IX 1984), KN: Hapch'ŏn Haeinsa (13 I 1983); Yangsan T'ongdosa (29 V 1982); Yangsan Naewŏnsa (27 V 1981, 27 V 1982, 29 V 1982, 1 VI 1982); Yangsan Hoeyach'ŏn (23 IX 1984); Hamyang P'iagol (22~23 VI 1982, 19 IX 1982); Kŏje Yongjusa (22 VII 1972), CLB: Muju Tŏgyusan (20~21 V 1983); Muju Kuch'ŏndong (16 VIII 1970, 9 X 1970), CLN: Changsŏng Paegyangsa (29 V 1983); Kurye Hwaŏmsa (31 V 1983); Sŭngju Songgwangsa (9 VIII 1976, 30 V 1983); Sunch'ŏn Ponggangch'ŏn (11 VI 1983); Kwangyang Tongch'ŏn (18 VI 1983); Yŏngam Wŏlch'ulsan (15 IV 1982), CJ: Namjeju Kangjŏngch'ŏn (4 VII 1982)

DISTRIBUTION: Korea, Japan, Sakhalin, Amur, Tom'

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.

3. *Epeorus (Epeorus) curvatulus* Matsumura, 1931

(Pl. III: a-e)

Epeorus curvatulus 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

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'ön Paegunsan (9 VIII 1984); P'och'ön Wangbangsan (8 IX 1984); Kap'yöng Myöngjisan (30 VI 1981, 17 IV 1982); Kap'yöng Hwaaksan (1 X 1982); Yangju Pogwangsa (12 VIII 1981); Yangju Songch'u (12 VI 1971); Namyangju Kwangnūng (13 VI 1981, 27 I 1983); Namyangju Ch'önmasan (14 VIII 1977); Yangp'yöng Yongmunsan (28 V 1982), KW: Yanggu Ch'önmi-ri (19 VI 1983); Inje Paektamsa (17 VIII 1971, 11 X 1982); Inje Tut'ayön (19 VI 1983); Inje Ch'öndo-ri (10 X 1982); Inje Changsudae (25 V 1966); Inje Chinbu (27 IX 1972); Hongch'ön Sogyebangsan (22 VI 1981); Wonsöng Ch'iaksan (31 VI 1975, 2~3 IX 1982, 15 VIII 1984, 17 VIII 1984); P'yöngch'ang Odaesan (20 VI 1981, 14 X 1984); Myöngju Sogūmgangsan (19 IX 1971), CCB: Chech'ön Yongdusan (10 VI 1983); Poūn Songnisan (10 VIII 1983); Koesan Hwayang-ri (15 IX 1984); Koesan Kwangp'yöng-ri (16 IX 1984), CCN: Kongju Magoksa (26 IX 1982); Kongju Kapsa (23 IX 1982); Ch'öngyang Ch'ilgapsan (27 IX 1982); Kūmsan Taedunsan (24 IX 1982), KB: Ponghwa Naesöngch'ön (28 I 1983); Mungyöng Mungyöngsaejae (12 VIII 1983); Yöngch'ön Pohyönsan (25 IX 1984); Talsöng Pisūlsan (24 IX 1984); Ch'öngsong Chuwangsan (29 I 1983); Ullūng Chödong (2 VIII 1982), KN: Yangsan Naewönsa (27 V 1982); Yangsan T'ongdosa (29 V 1982); Yangsan Hoeyach'ön (23 IX 1984); Pusan Pömösa (4 X 1983); Hamyang P'iagol (22 VI 1982, 19 IX 1982); Sanch'öng Chungsan-ri (30 VI 1981), CLN: Changsöng Paegyangsa (29 V 1983); Kurye Hwaömsa (30~31 V 1983); Sūngju 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)

4. *Epeorus (Iron) aesculus* Imanishi, 1934

(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)

NYMPHS: Length: Body 10.0~12.0. Caudal filaments 10.0~13.0. General color light brownish or brownish. Anterior margin of head pale; with a dark median stripe (Pl. IV: a). Mouthparts illustrated in Pl. IV: b-c. Each femur with a dark round marking on the middle portion (Pl. IV: a). Plate-like gill lamellae very strongly developed; gill lamellae of abdominal segment 1 and 7 meeting beneath the body (Pl. IV: a,d,e). Caudal filaments longer than body; without both of spines and setae.

COLLECTING LOCALITIES OF NYMPH: KW: Inje Pangdaesan (30 VII 1981); Hongch'ön Kyebangsang (24 VII 1981); Hongch'ön Kach'ilbong (6 VI 1983, 23 VI 1984); P'yöngch'ang Odaesan (20 VI 1981); T'aebaek T'aebaeksan (13 VIII 1983), CLB: Muju Togyusan (21 V 1983)

DISTRIBUTION: Korea, Japan, China, Amur, Ussuri

REMARKS: Imanishi (1934) discussed the separation of *Epeorus* (*I.*) *aesculus* and *Epeorus* (*I.*) *uenoi* Matsumura on their nymphal stage.

Genus ***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

NYMPHS: Length. Body 7.0~10.5. Caudal filaments 6.0~10.0. General color light yellowish or light yellow brownish; without markings. Body weak and frail. Mouthparts illustrated in Pl. V: b-g. Abdominal gills illustrated in Pl. V: a,h,i.

COLLECTING LOCALITIES OF NYMPH: KG: P'och'ön Paegunsan (9 VIII 1984); Kap'yöng Hwaaksan (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 P'aldang (14 X 1972); Yöju Yöju (14 X 1972), KW: Inje Ch'öndo-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-söng Kangch'ön (15 X 1972); P'yöngch'ang Odaesan (14 X 1982); Wönsöng Ch'iaksan (31

VIII 1975, 2~3 IX 1982, 8 VIII 1984), CCB: Poŭn Songnisan (10 VII 1983); Okch'ŏn Sŏd-aesan (9 IV 1972, 14 X 1972); Koesan Hwayang-ri (15 IX 1984); Koesan Kwang'yŏng-ri (16 IX 1984), KB: Mungyŏng Mungyŏngsaejae (11~12 VIII 1983); Ch'ŏngsong Chuwangsan (29 I 1983); Yŏngil Pog'yŏngsa (30 I 1983), KN: Hamyang P'iajol (22~23 VI 1982, 18~19 IX 1982); Yangsan Naewŏnsa (1 VI 1982), CLB: Muju Tŏgyusan (20 V 1983)

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 Palaearctic 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 *Cinygmula* McDunnough, 1933

Cinygmula McDunnough, 1933 : 75

Type species: *Cinygmula ramaleyi* Dodds

Type locality: Tollando, 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. Clossveins 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 *Cinygmula* is separated from *Cinygma* and *Rithrogena* by the shape of genitalia. The nymph of *Cinygmula* 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 *Cinygmula* have exceptions (Imanishi (1940), Bajkova (1974), Kustareva (1978), etc.). We dare to suppose that *Cinygma* and *Cinygmula* are closely related each other. We place our species provisionally in *Cinygmula* by their distinct characteristics of nymph.

6. *Cinygmula* 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 tergum. Gill lamellae of abdominal segment 1~7 whitish; trachea obscure or absent; without fibrilliform gill tufts (Pl. VI: a,i).

COLLECTING LOCALITIES OF NYMPH: KG: Kap'yŏng Ch'ŏnggyesan (24 V 1981); Kap'yŏng Myŏngjisan (31 III 1982), KW: Inje Tut'ayŏn (15 III 1968); Sokch'o Sŏrakdong (21 I 1984); Hongch'ŏn Kyebangsang (21 VII 1981, 5 VI 1983); Hongch'ŏn Kach'ilbong (23 VI 1984), KB: Yŏngp'ung Sobaeksan (6~7 VI 1981, 27 I 1983), KN: Hapch'ŏn Haeinsa (31 V 1983), CLB: Muju Tŏgyusan (21 V 1983)

DISTRIBUTION: Korea

7. *Cinygmula* KU_b

(Pl. VII: a-h)

NYMPHS: Length: 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 *Cinygmula* KU_a. 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); Namyangju Kwangnŭng (27 I 1983), KB: Ch'ŏngyang Chuwangsan (29 I 1983); Yŏngil Pogyŏngsa (30 I 1983); Taegu Tonghwasa (30 I 1983)

DISTRIBUTION: Korea

REMARKS: Like *Rithrogena*, the separation of *Cinygmula* nymphs is very difficult too. *Cinygmula* KU_a and *Cinygmula* KU_b 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 *Cinygmula* specimens lacking fibrilliform gill tufts. But we suppose that they are very closely related. According to body length, *Cinygmula* KU_a is similar to *Cinygma hirasana*, *Cinygmula* KU_b is close to *Cinygma na*. Besides, we suppose that *Cinygmula* KU_a and *Cinygmula* KU_b are closely associated with some Japanese *Cinygma*: *Cinygma hirasana* Imanishi (1935); *Cinygma dorsalis* Imanishi (1935) and some Eastern Siberian species: *Cinygma kurenzovi* Bajkova (1965); *Cinygmula grandifolia* Chernova (1952); *Cinygmula altaica* Chernova (1949); *Cinygmula oreophila* Kustareva (1978); and *Cinygmula 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

Ecdyurus 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: i). Genitalia illustrated in Pl. VIII: j, Pl. XV: c. FEMALE IMAGOS. Length: Body 11.3. Caudal filaments 22.0. Fore wings length 13.0; 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 ♂ subimago, 2 ♀ subimagos, 1 IV 1984, Y.J. Bae, all of them obtained by rearing in laboratory during 30 IV 1984~9 V 1984), KG: Namyangju Kwangnŭng (1 ♂ imago, 17 IV 1983, Y.J. Bae, obtained by rearing in laboratory); Namyangju Wangsukch'ŏn (2 ♀ imagos, 3 V 1983, Y.J. Bae, obtained by rearing in laboratory at 26 V 1983), CLN: Kurye Hwaŏmsa (1 ♀ subimago, 30 V 1983, Y.J. Bae); Sŭngju Songgwangsa (1 ♂ subimago, 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).

COLLECTING LOCALITIES OF NYMPHS: SL: Tobong-gu Tobongsan (6 V 1981), KG: P'och'ön Paegunsan (9 VIII 1984); Kap'yöng Hwaaksan (1 IV 1982, 20 VII 1982); Kap'yöng Myöngjisan (2 IX 1981, 3 VII 1982, 4 IX 1982, 22 I 1983); Kap'yöng Namisöm (20 VII 1982); Kap'yöng Ch'öngp'yöng (12 VI 1983); Kap'yöng Taesöng-ri (24 X 1982); Kap'yöng Yumyöngsan (14 V 1983); Namyangju Kwangnüng (13 VI 1981, 31 III 1983, 19 V 1983); Namyangju P'aldang (23 V 1982); Kwangju Kyönganch'ön (31 VII 1981), KW: Inje Ch'öndo-ri (10 X 1982); Inje Paektamsa (17 VIII 1971); Inje Pangdaesan (30 VII 1981); Hongch'ön Sogyebangsan (22 VII 1981); Wonsöng Ch'iaksan (31 VII 1972, 2 IX 1982, 10 IX 1983, 17 VIII 1984), CCB: Chech'ön Yongdusan (10 VII 1983); Okch'ön Södaesan (25 IX 1982); Koesan Kwang'yöng-ri (16 IX 1984), CCN: Kongju Magoksa (26 IX 1982); Ch'öngyang Ch'ilgapsan (21 VIII 1982, 27 IX 1982); Kümsan Taedunsan (24 IX 1982), KB: Ponghwa Naesöngch'ön (28 I 1983); Mungyöng Mungyöngsaejae (12 VIII 1983); Ch'öngsong Chuwangsan (29 I 1983); Kumi Kümosan (31 I 1983), CLN: Söngju Songgwangsa (9 VIII 1976); Kwangyang Paegunsan (29 V 1981); Kwangyang Ogryongch'ön (18 VI 1983); Sunch'ön Ponggang (11 VI 1983); Yöch'ön Tolsando (11 IV 1982)

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

NYMPHS: Length: Body 5.0~6.0. Caudal filaments 5.0~6.0. General color brownish; with light markings. Anterior margin of head with one pair of light round markings (Pl. IX: a). Mouthparts illustrated in Pl. IX: b-g. Abdominal terga with light markings; segments 1~2, 7~8 remarkable (Pl. IX: a). Abdominal segments 1~7 with plate like gill lamellae; trachea well developed; segments 1~6 with fibrilliform gill tufts (Pl. IX: a). Caudal filaments with spines.

COLLECTING LOCALITIES OF NYMPH: SL: Tobong-gu Tobongsan (15 VI 1983), KG: P'och'ön Paegunsan (9 VIII 1984); P'och'ön Wangbangsan (1 V 1982); Kap'yöng Myöngjisan (29 III 1982); Kap'yöng Unaksan (29 IX 1971); Kap'yöng Chojongch'ön (27 V 1973, 16 VIII 1978); Kap'yöng Yumyöngsan (14 V 1983); Yangju Pogwangsa (4 IV 1981, 12 VIII 1981); Namyangju Kwangnüng (13 VI 1981); Yangp'yöng Yongmunsan (28 V 1982), KW: Yanggu Omi-ri (19 VI 1983); Inje Paektamsa (17 VIII 1971, 11 X 1982); Yangyang Osaek (2 X 1983); Yangyang Yangyangch'ön (13 X 1982); Hongch'ön Kyebangsan (6 VI 1983); Hongch'ön Kach'ilbong (24 VII 1981, 23 VI 1984); Sokch'o Sörakdong (21 I 1984); Wonsöng Ch'iaksan (31 VII 1975, 2~3 IX 1982, 15 VIII 1984, 17 VIII 1984); P'yöngch'ang Odaesan (14 X 1982); T'aebaek T'aebaeksan (13 VIII 1983), CCB: Chech'ön

Yongdusan (26 I 1983, 10 VII 1983); Poŭn Songnisan (10~11 VIII 1983); Okch'ŏn Sŏdaesan (17 VI 1972, 25 IX 1982); Koesan Hwayang-ri (15 IX 1984); Koesan Kwŏnp'yŏng-ri (16 IX 1984), CCN: Kŭmsan Taedunsan (24 IX 1982); Kongju Kapsa (23 IX 1982); Kongju Tonghaksa (18 VI 1982, 30 I 1983, 3 IV 1983); Ch'ŏngyang Ch'ilgapsan (27 IX 1982, 3 X 1983), KB: Yŏngp'ung Sobaeksan (7 VI 1981, 27 I 1983); Mungyŏng Mungyŏngsaejae (11 VIII 1983); Yŏngch'ŏn Pohyŏnsan (25 IX 1984); Talsŏng Pisŭlsan (24 IX 1984); Ch'ŏngsŏng Chuwangsan (29 I 1983), KN: Yangsan Naewŏnsa (27 V 1982, 1 VI 1982); Yangsan T'ongdosa (29 V 1982); Yangsan Hoeyach'ŏn (23 IX 1984); Hapch'ŏn Haeinsa (31 I 1983); Hamyang P'iagol (22~23 VI 1982, 18~19 IX 1982), CLB: Muju Tŏgyusan (20~21 V 1983), CLN: Changsŏng Paegyangsa (29 V 1983); Sŭngju Songgwangsa (30 V 1983); Kwangyang Paegunsan (29 V 1981); Kwangyang Ogryongch'ŏn (18 VI 1983); Sunch'ŏn Ponggang (11 VI 1983), CJ: Namjeju Andŏkkyegok (8 V 1983)

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 imagos. FEMALE SUBIMAGOS. Similar to female imagos but duller.

COLLECTING LOCALITIES OF ADULT: SL: Tobong-gu Puk'ansan (4 ♂ imagos, 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 8 IV 1984~15 IV 1984), KB: Yŏngp'ung Sobaeksan (2 ♂ imagos, 19 V 1984, Y.J. Bae).

NYMPHS: Length: Body 13.0~15.0. Caudal filaments 15.0~16.0. General color brownish or dark brownish. Mouthparts illustrated in Pl. X: b-g. Anterior margin of head without markings (Pl. X: a). Abdominal terga with light marking; terga 4~5, 8~9 with U-shaped

light markings (Pl. X: a). Abdominal segments 1~7 with gill lamellae; segments 1~6 with fibrilliform gill tufts. Caudal filaments with spines.

COLLECTING LOCALITIES OF NYMPH: SL: Tobong-gu Tobongsan (6 V 1981, 11 III 1982), KG: P'och'ön Paegunsan (9 VIII 1984); Kap'yöng Hwaaksan (1 IV 1982), Kap'yöng Myöngjisan (15 I 1982, 27 IV 1982); Yangju Pogwangsa (25 III 1984); Namyangju Suraksan (21 XI 1982), KW: Yanggu Taeamsan (18 VI 1983), Sokch'o Sörakdong (15 I 1983, 21 I 1984); P'yöngch'ang Odaesan (14 X 1982); Wonsöng Ch'iaksan (10 IV 1983), CCB: Chech'ön Yongdusan (26 I 1983), CCN: Kongju Kapsa (23 IX 1983), KB: Yöngp'ung Sobaeksan (27 I 1983); Yöngch'ön Pohyönsan (25 IX 1984); Ch'öngsong Chuwangsan (29 I 1983); Kumi Kūmosan (31 I 1983), KN: Pusan Pömsa (4 I 1983); Pusan Paegyongsan (5 I 1983); Hamyang P'iagol (18 IX 1982), CLN: Kurye Hwaömsa (30 V 1983); Kwangyang Paegunsan (29 V 1981); Yöch'ön Tolsando (11 II 1982)

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,j). Caudal filaments shorter than body; with long setae (Pl. XI: a,k).

COLLECTING LOCALITIES OF NYMPHS: KG: P'och'ön Wangbangsan (1 V 1982); Kap'yöng Myöngjisan (22 I 1983); Kap'yöng Yumyöngsan (14 V 1983); Yangju Iryöng (25 III 1981), KW: Wonsöng Ch'iaksan (31 VII 1975), CCB: Okch'ön Södaesan (25 IX 1982); Kosan Hwayang-ri (15 IX 1984), KB: Yöngp'ung Sobaeksan (27 I 1983); Ponghwa Nae-söngch'ön (28 I 1983); Taegu Tonghwasa (30 I 1983); Ch'öngsong Chuwangsan (29 I 1983), KN: Hapch'ön Haeinsa (31 I 1983), CLN: Söngju Songgwangsa (30 V 1983)

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,j).

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

REMARKS: *Ecdyonurus* KU_b 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, 25 III 1984, Y.J. Bae, all of them obtained by rearing in laboratory during 21 IV 1984~26 IV 1984), KB: Yöngp'ung Sobaeksen (2 ♂ imagos, 19 V 1984, Y.J. Bae), CLN: Kurye Hwaömsa (1 ♂ imago, 30 V 1984, Y.J. Bae).

NYMPHS: Length: Body 9.0~12.0. Caudal filaments 10.0~15.0. General color brownish. Anterior margin of head without markings. Mouthparts illustrated in Pl. XIII: b-g. Each abdominal terga with a pair of sub-median markings (Pl. XIII: a). Plate-like gill lamellae of abdominal segments 1~7 pointed; trachea well developed (Pl. XIII: a,h). Caudal filaments with both of spines and setae (Pl. XIII: a,i).

COLLECTING LOCALITIES OF NYMPH: SL: Tobong-gu Tobongsan (6 V 1981, 15 V 1983), KG: Yangju Pogwangsa (4 IV 1981), KW: Yanggu Taeamsan (5 X 1972, 24 IX 1982), KB: Yöngp'ung Sobaeksan (6 VI 1981)

DISTRIBUTION: Korea, Japan

14. *Heptagenia kyotoensis* Gose, 1963

(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. Genral 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).

COLLECTING LOCALITIES OF NYMPH: KG: P'och'ön Paegunsan (9 VIII 1984), KW: Wonsöng Ch'iaksan (31 VII 1975), KN: Hamyang P'iagol (23 VI 1982); Kōje Yongjusa (4 VII 1983), CLN: Söngju Songgwangsa (9 VIII 1976); Sunch'ön Ponggang (11 VI 1983); Kwangyang Paegunsan (29 V 1981); Kwangyang Ogryongch'ön (18 VI 1983)

DISTRIBUTION: Korea, Japan

SUMMARY

The eleven Korean species of Heptageniid 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 Heptageniid 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.

ACKNOWLEDGEMENTS

We sincerely thank Dr. R.W. Flowers, Florida A & M University, for his helpful advices

and for his offering of Dr. N. Yu. Kluge's papers. We also thank Dr. D. Braasch, Potsdam (DDR), for his useful suggestions.

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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.*) *curvatulus* (a-e: nymph)

- a. dorsal view b. labrum c. hypopharynx d. right maxilla e. gill 3

Pl. IV: *Epeorus* (*I.*) *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. comb-like spinule 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 kibunensis* (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: *Ecdyonourus 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

a. *Bleptus fasciatus* b. *Epeorus* (E.) *latifolium* c. *Ecdyonurus yoshidae* d. *Ecdyonurus dracon* e. *Heptagenia kihada*

PLATE I

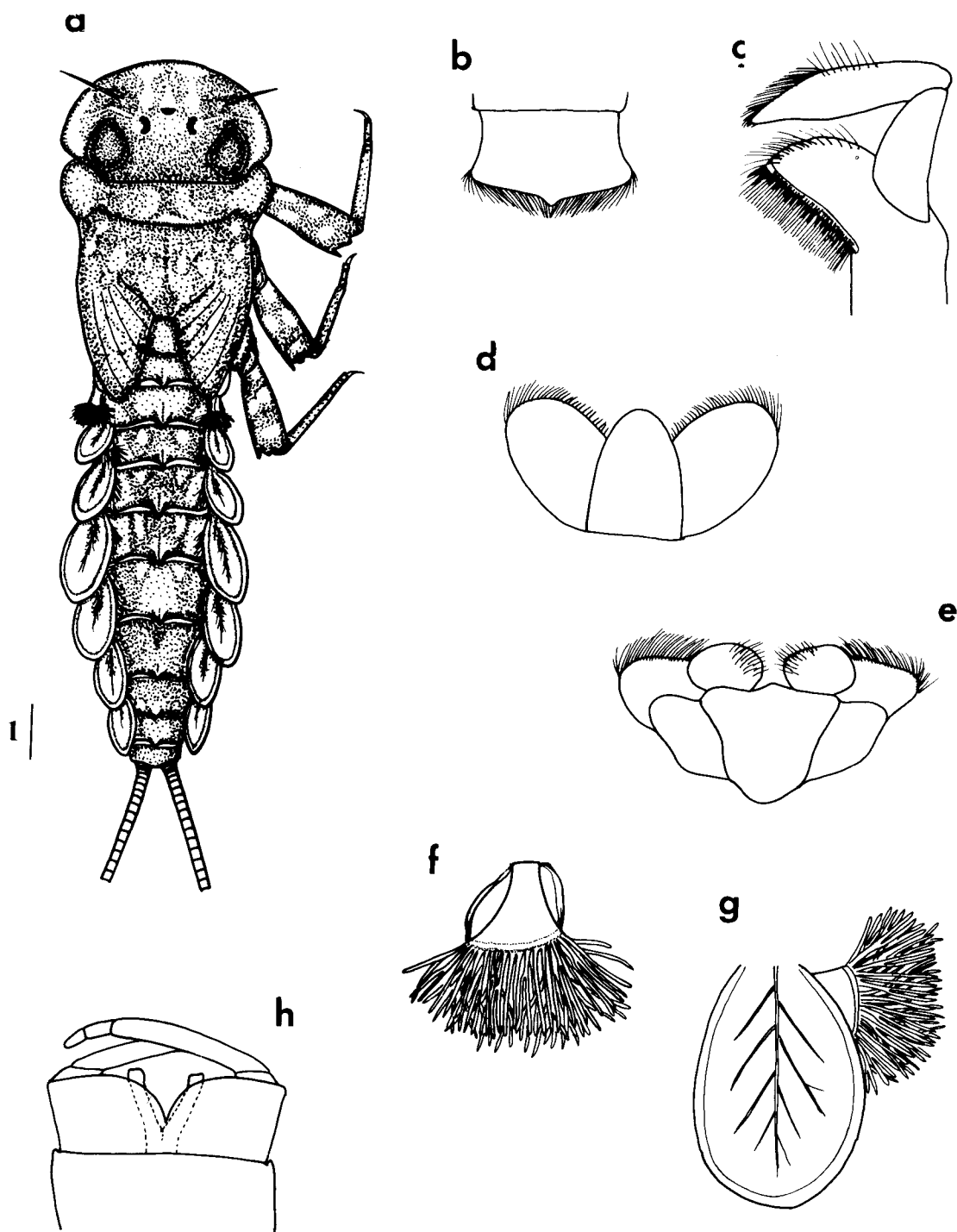
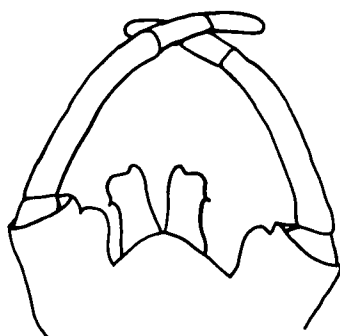
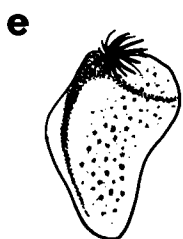
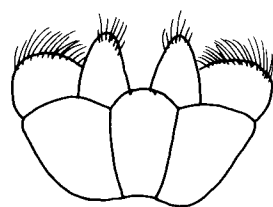
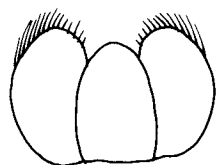
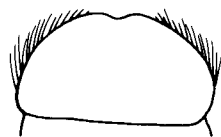
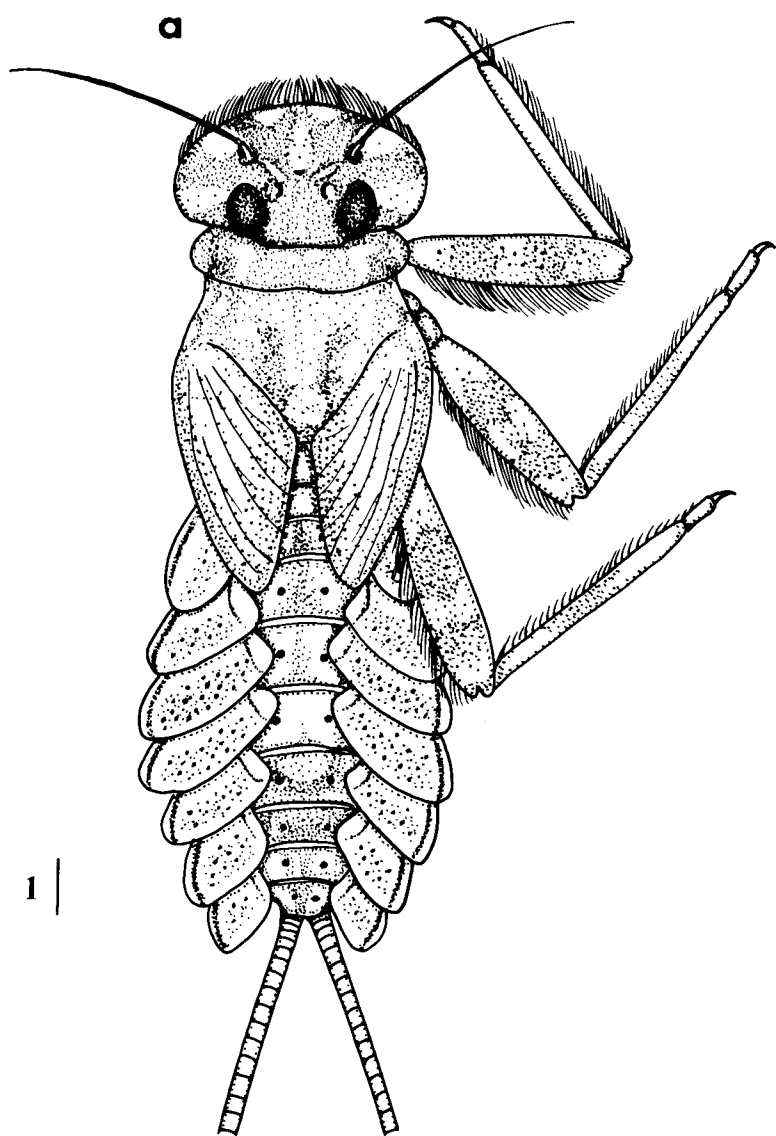
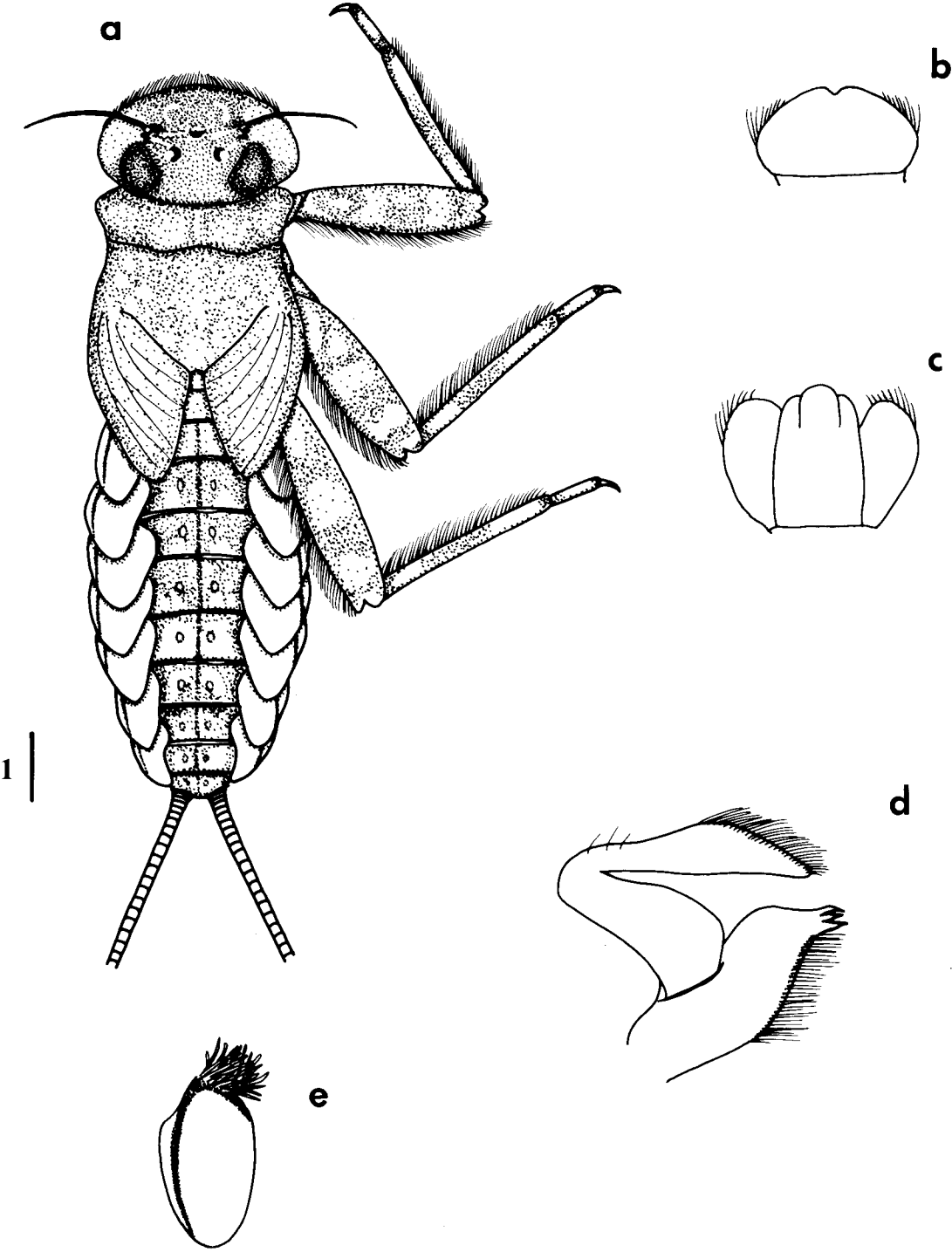


PLATE II





PLATE

IV

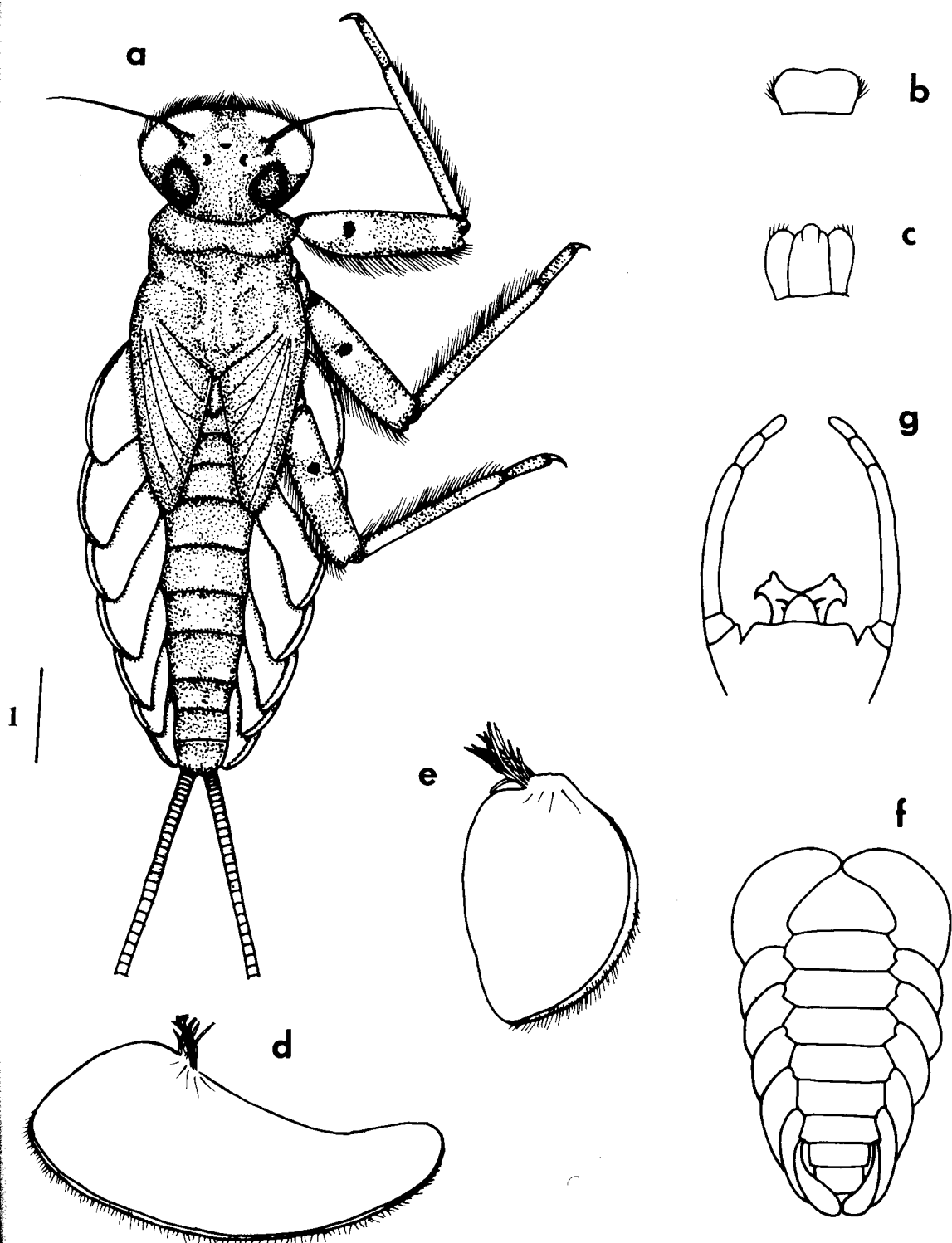


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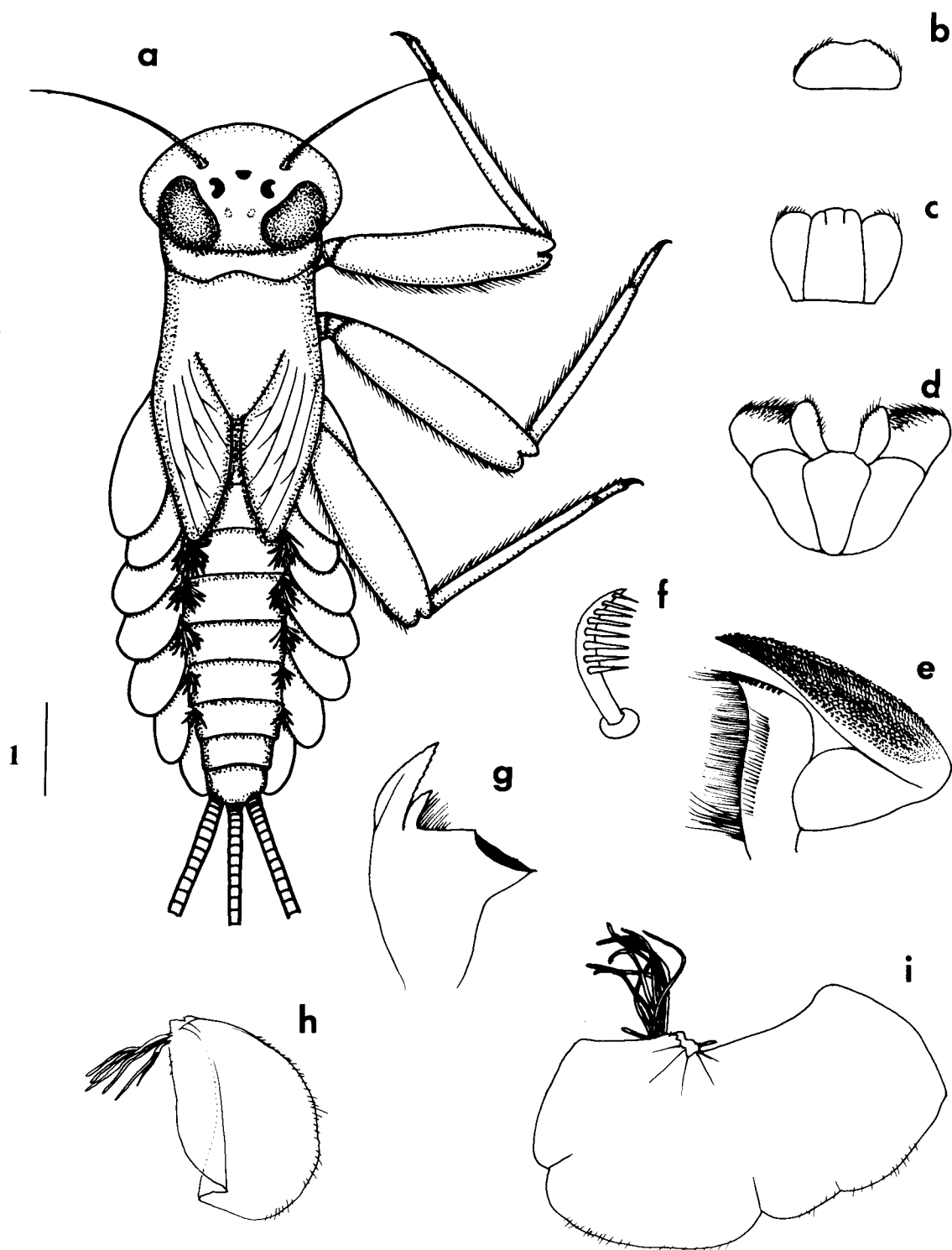


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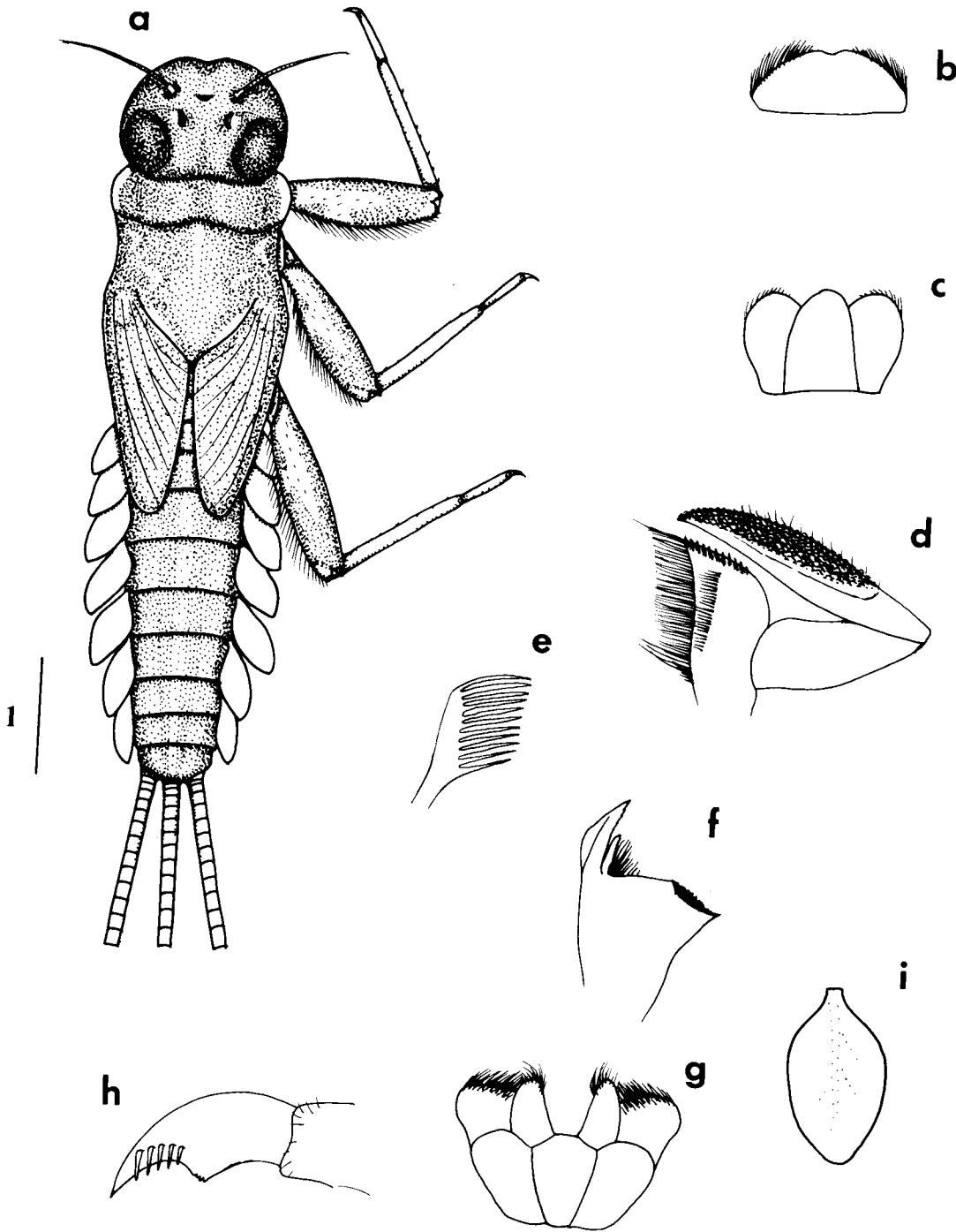


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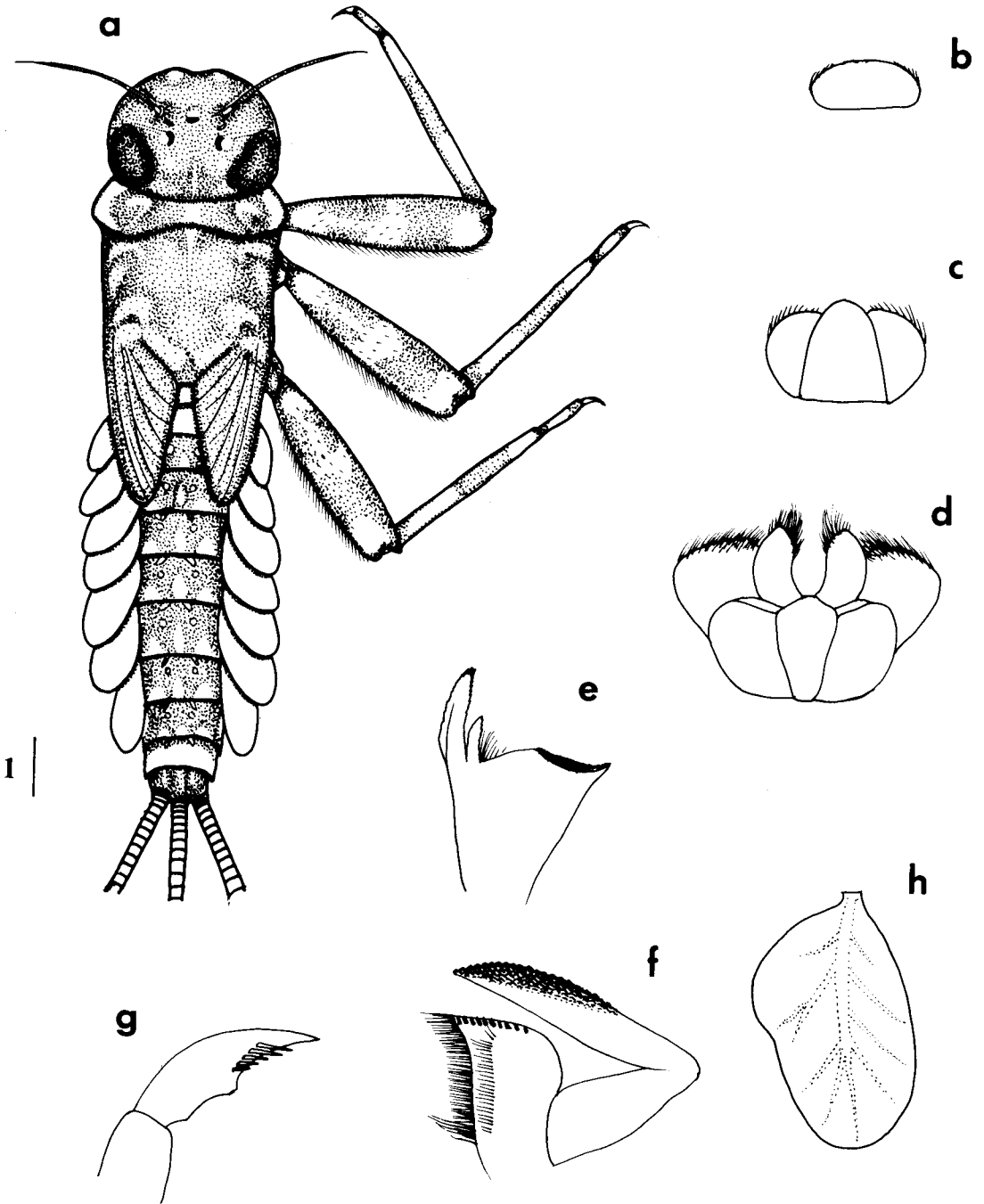
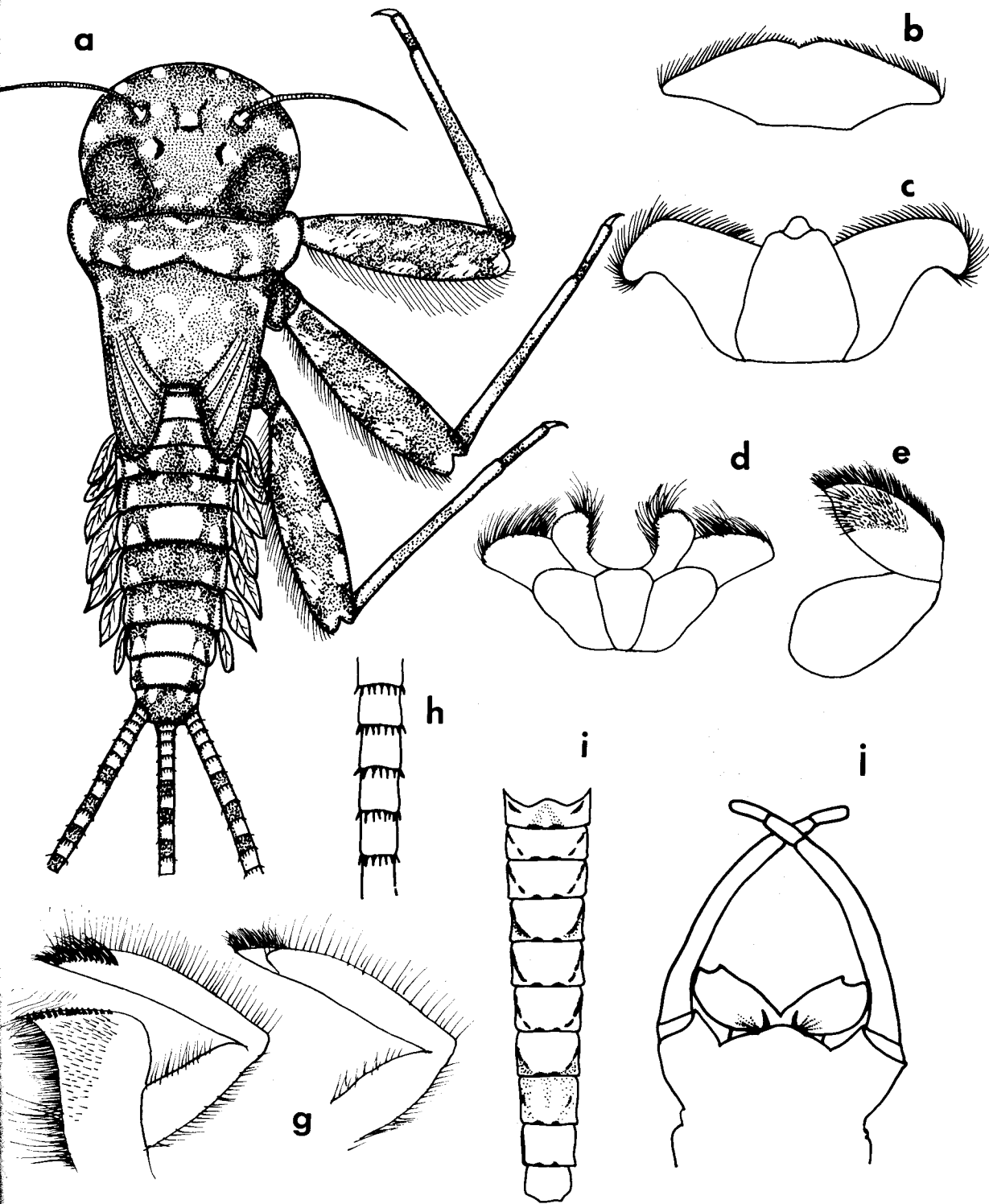


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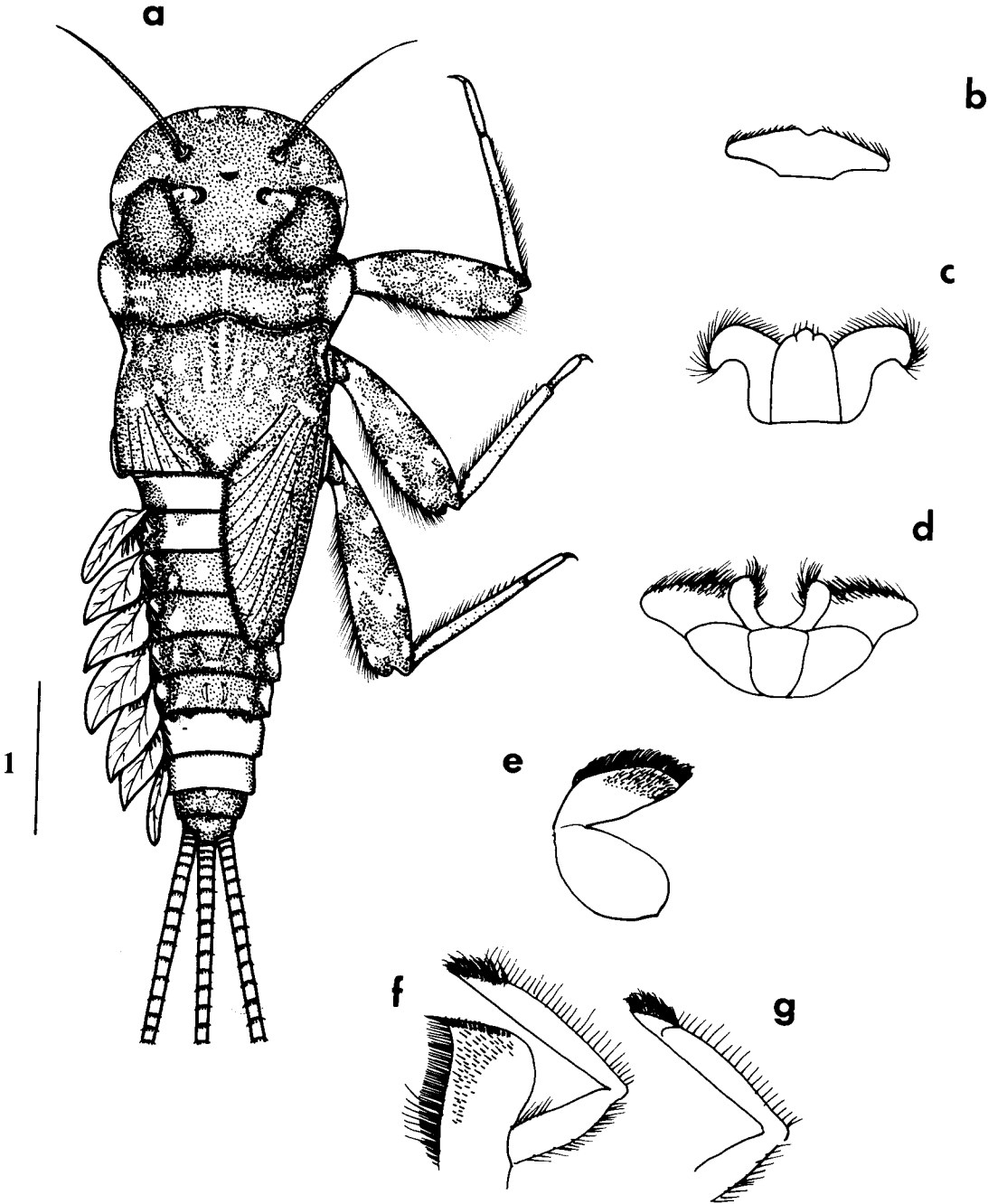


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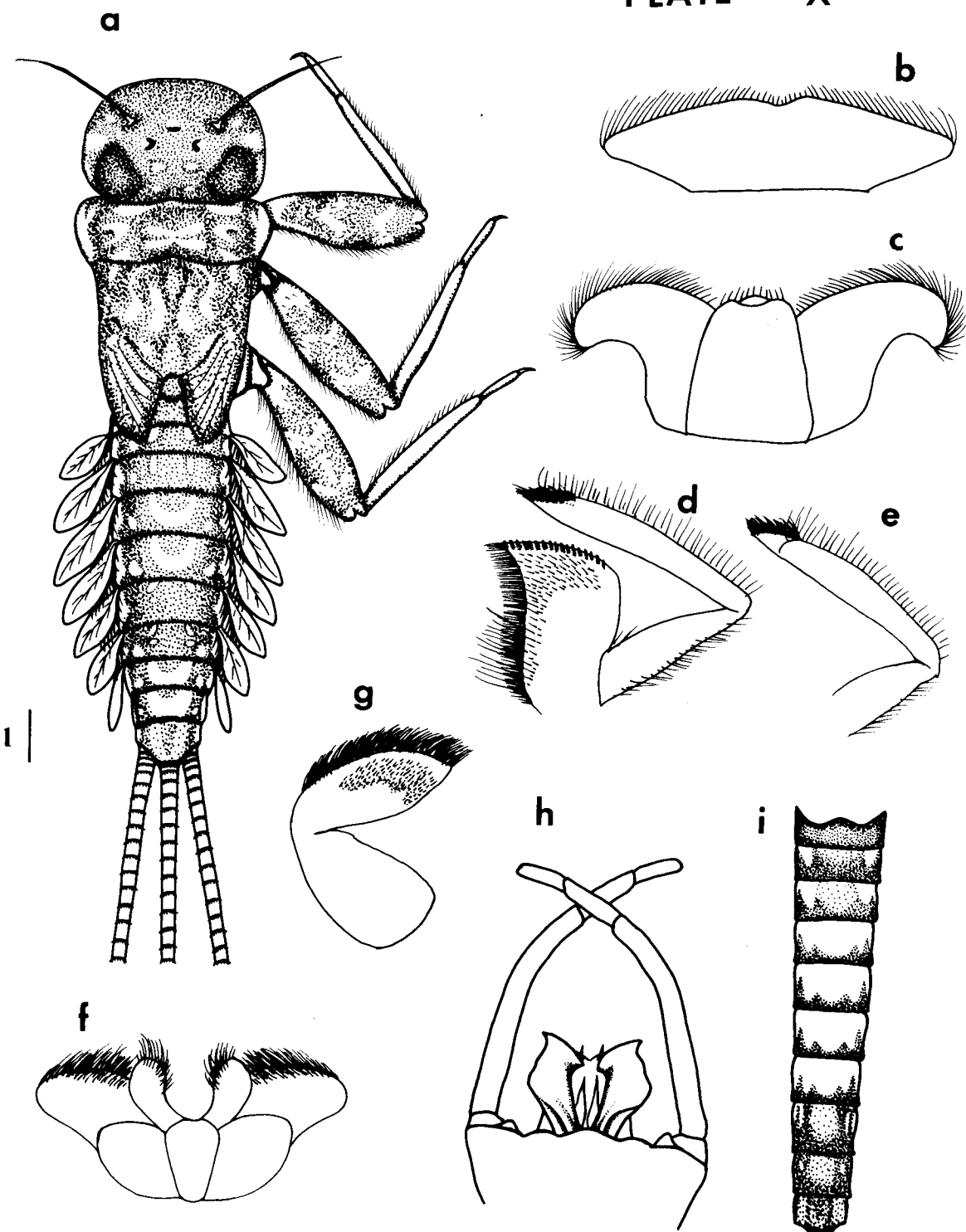


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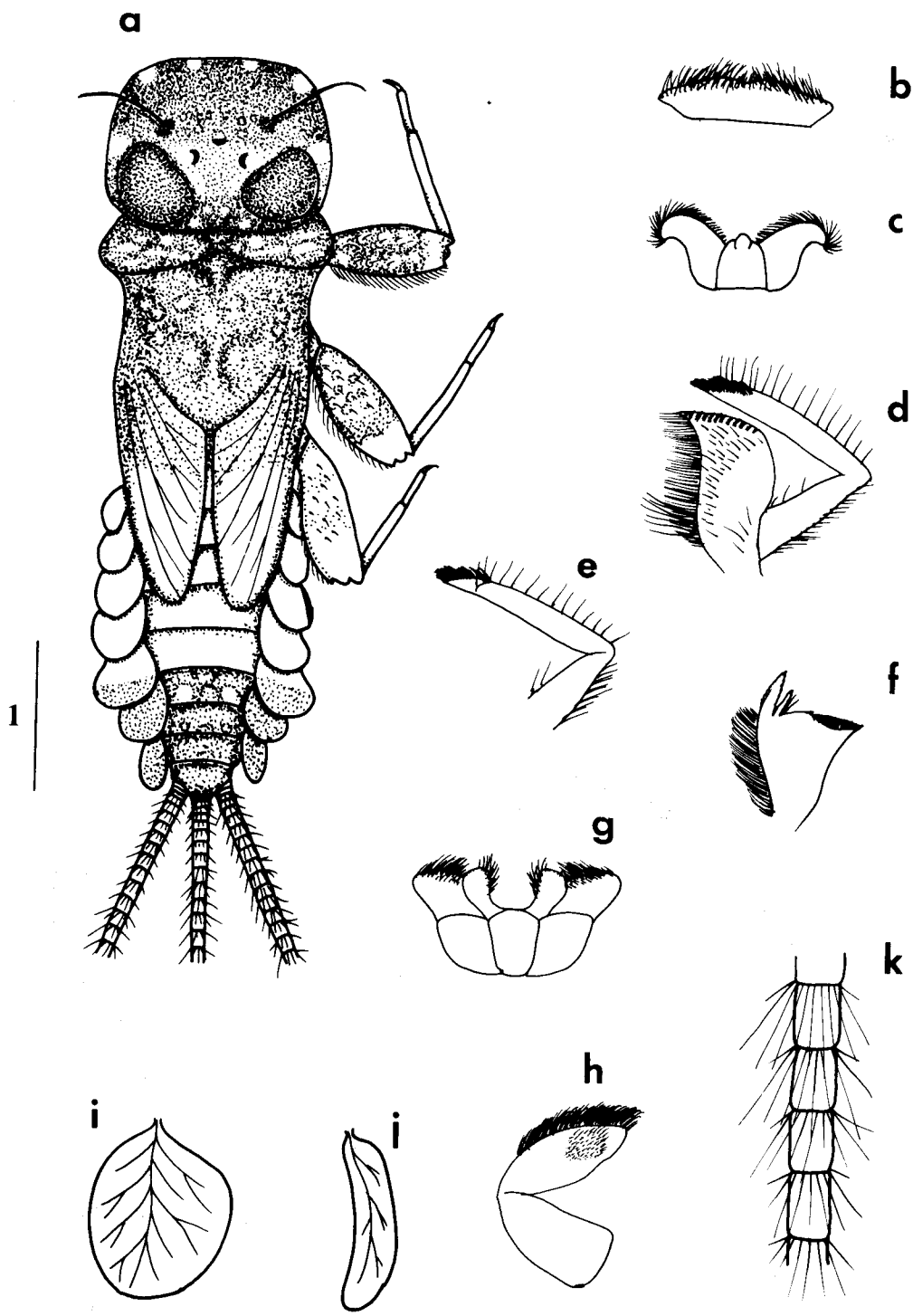


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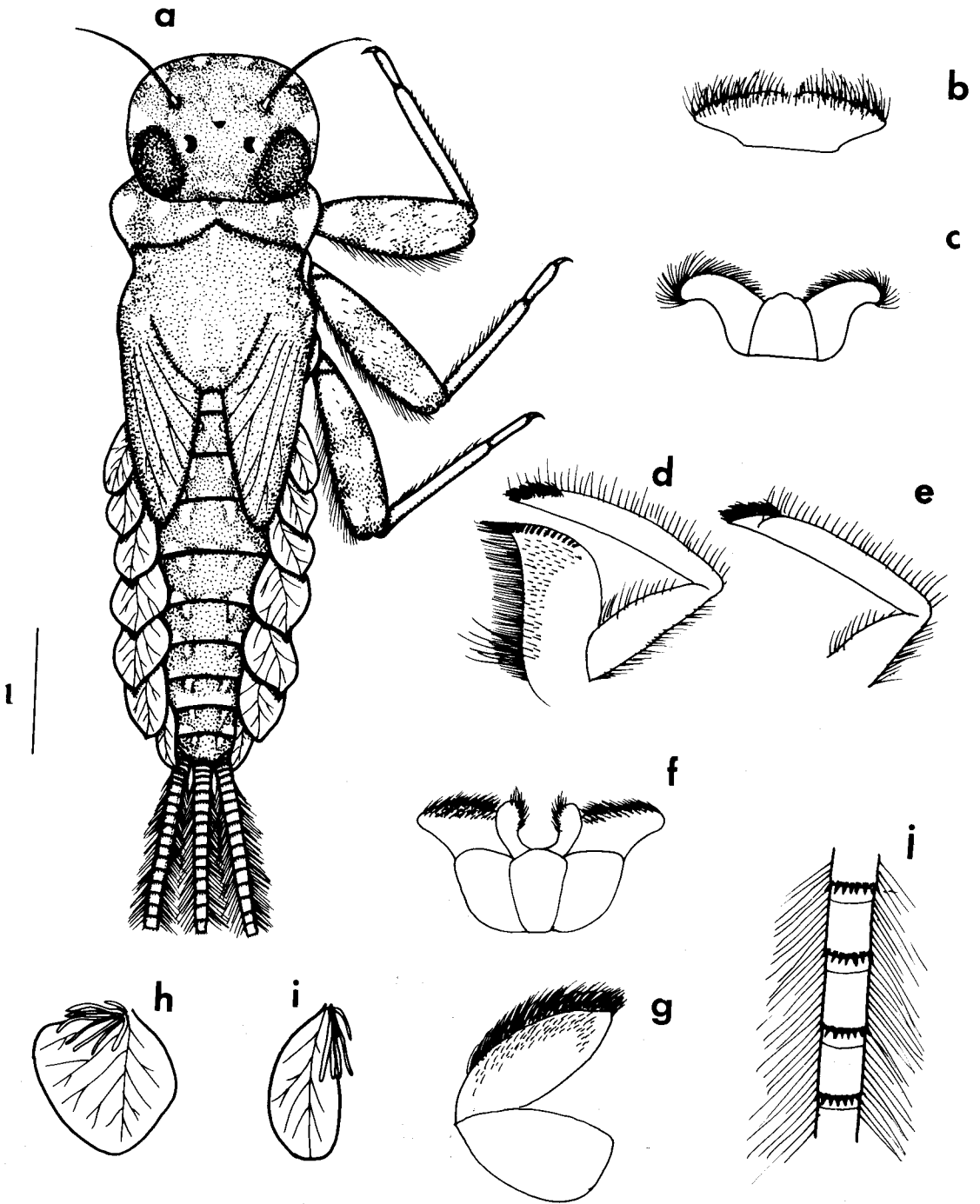


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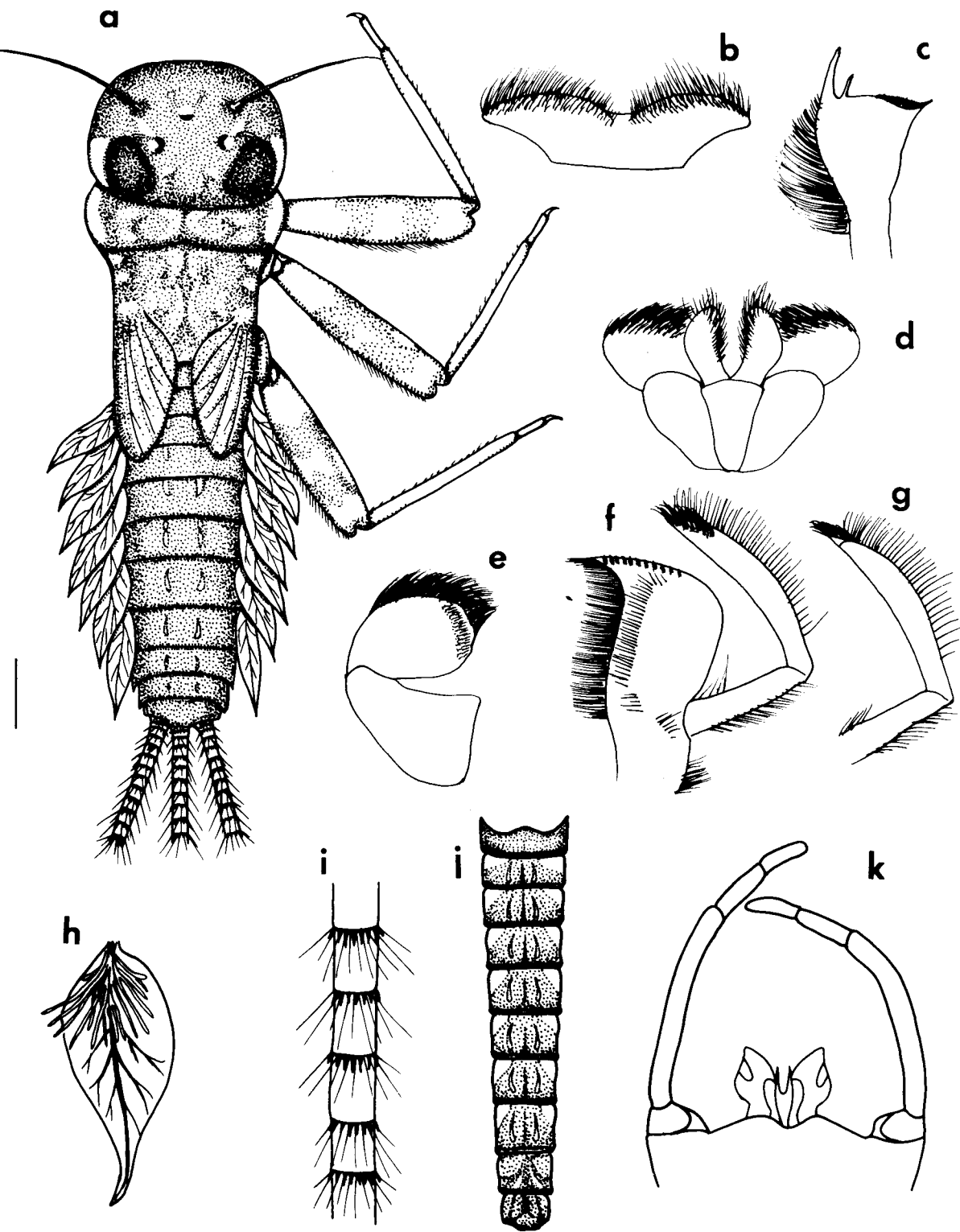


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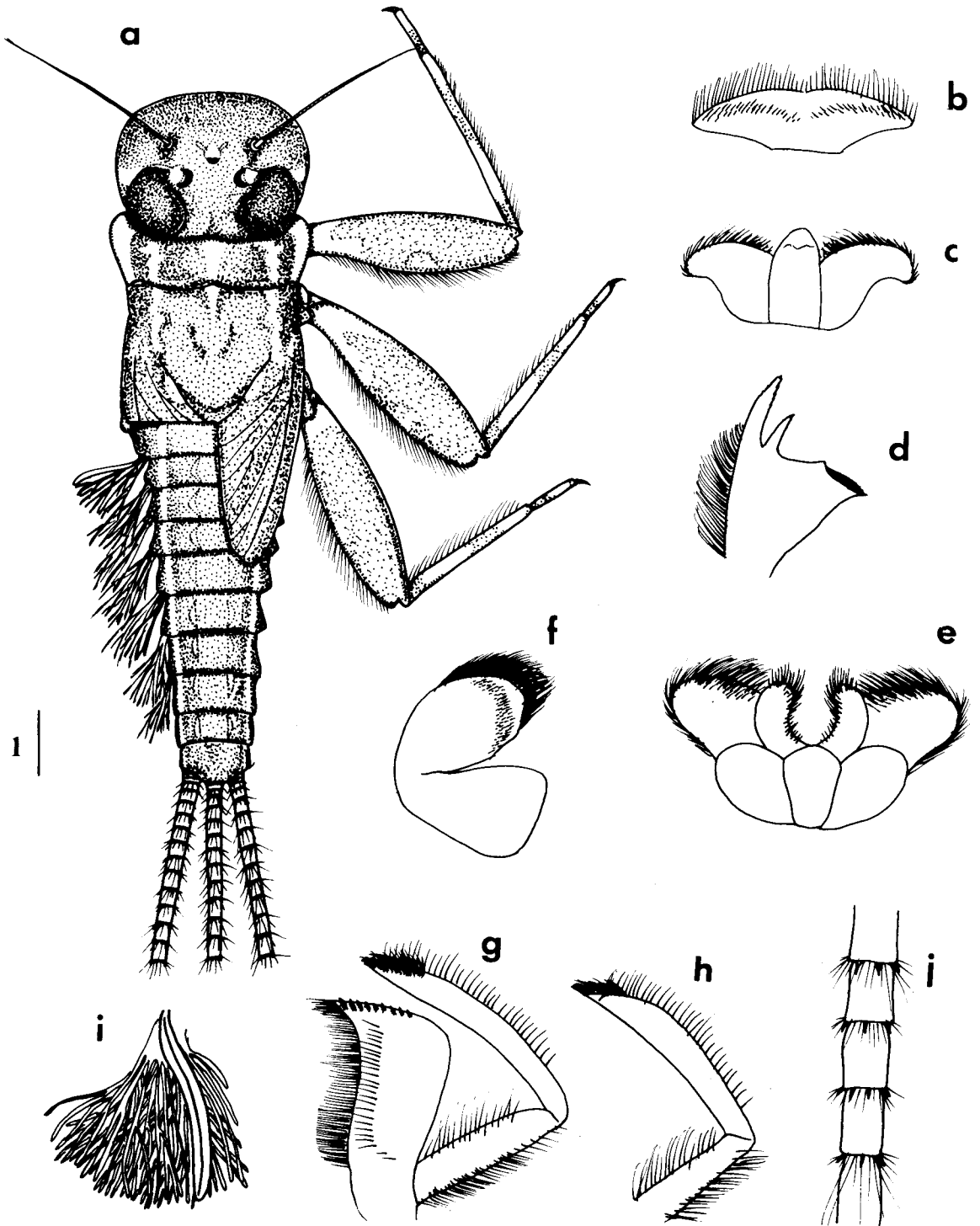
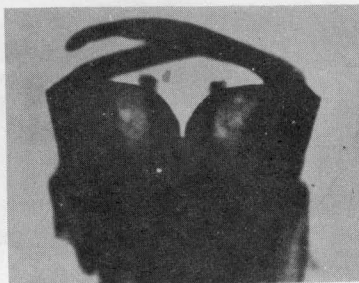
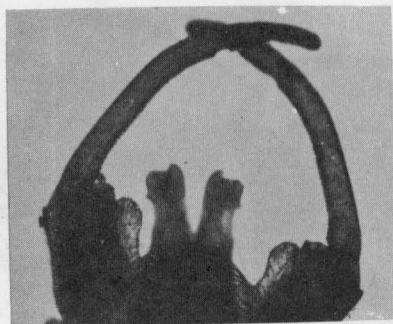
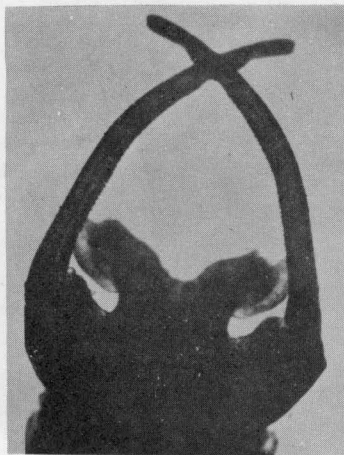
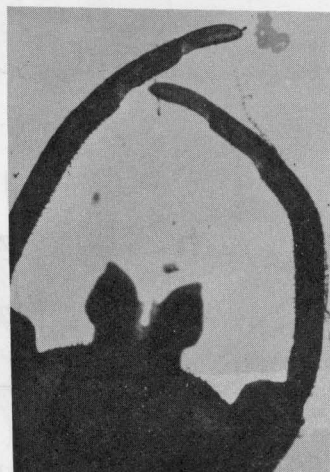


PLATE XV

a**b****c****d****e**

(40 x)