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A THESIS
FOR THE DEGREE OF MASTER OF SCIENCE

**Systematic Study of Family Eucnemidae (Coleoptera:
Elateroidea) in Korea**

어리방아벌레과(딱정벌레목: 방아벌레상과)의 계통분류학적 연구

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February, 2017

Abstract

Systematic Study of Family Eucnemidae (Coleoptera: Elateroidea) in Korea

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This thesis consisted of two main themes: i) taxonomic review of the Korean Eucnemidae; ii) molecular phylogeny of Eucnemidae.

In the first chapter, the Korean Eucnemidae was reviewed for the first time. A total of 22 species and 14 genera belonging to two subfamilies of family Eucnemidae were recognized in Korean Peninsula, including two new species and 15 unrecorded species. Among previously recorded species, we couldn't examine *Dromaeolus marginatus* Hisamatsu, 1965, because of absence of specimen. All Korean species and genera were redescribed with keys to subfamilies, tribes, genera, and species.

In the second part, phylogenetic study of family Eucnemidae was conducted for estimating a monophyly based on molecular fragments of mitochondrial protein coding gene (cytochrome c oxidase subunit I gene, COI) and two nuclear ribosomal RNA genes (18S rRNA and 28S rRNA) by Bayesian Inference (BI) and Maximum Likelihood (ML) analysis. The phylogenetic analyses indicated that Eucnemidae is a monophyletic group in Elateroidea but mostly paraphyletic in subfamily level. Anischiinae, which is distinct in morphology, was independent group in both molecular analyses. Three tribes of subfamily Melasinae, Dirhagini, Epiphanini, and Hylocharini, appeared as an independent clade in both phylogeny trees, respectively. Also, the tribe Euryptychini, which is classified as Macraulacinae, distinctly separated from main clade of Macraulacinae.

Keywords: Eucnemidae, false click beetle, New records, Korea, taxonomy, systematics, molecular phylogeny.

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PART I. Taxonomic review of the family Eucnemidae (Coleoptera: Elateroidea) from Korea

Abstract

The family Eucnemidae is reviewed with 22 species and 14 genera from Korea, including two new species, *Dirrhagofarsus* sp. nov. and *Microrhagus* sp. nov., and 15 unrecorded species, *Bioxylus natsumiae* Watanabe, 2009, *B. personatus* Mamaev, 1976, *B. pilosellus* Hisamatsu, 1959, *Dirrhagofarsus lewisi* (Fleutiaux, 1900), *D. modestus* (Fleutiaux, 1923), *Euryptychus vicinus* Fleutiaux, 1923, *Fornax nipponicus* Fleutiaux, 1923, *Heterotaxis nipparensis* Hisamatsu, 1957, *Hylis harmandi* (Fleutiaux, 1923), *Hylochaes harmandi* Fleutiaux, 1900, *Microrhagus mystagogus* (Fleutiaux, 1923), *M. foveolatus* (Fleutiaux, 1923), *Otho sphondyloides* (Germar, 1818), *Proxylobius helleri* Fleutiaux, 1900, and *P. longicornis* Hisamatsu, 1958.

In this thesis, All Korean species are redescribed with keys to subfamilies, tribes, genera, and species. Photographs of characteristic structures of adult are also provided.

Keywords: Eucnemidae, taxonomy, revision, new records, Korea

1. Introduction

1.1. General introduction of the family Eucnemidae

The family Eucnemidae (Coleoptera: Elateroidea) is a cosmopolitan group, especially tend to be more abundant and diverse in tropical areas (Muona, 2010). The family consists of approximately 1,900 species and 200 genera in the world (Otto, 2016). They have been called ‘false click beetles’ as common name to differentiate from ‘click beetles’, Elateridae. There was some belief that eucnemids lack ability of ‘clicking’, but several observations of click-mechanism in eucnemids were reported (Ahrens, 1812; Kirk, 1922; Burakowski, 1989; Muona, 1993). Click-mechanism of Eucnemidae is related to well-developed prosternal process and cavity of mesosternum. Prosternal process, produced from posterior margin of prosternum, is hooked to mesosternal cavity by contraction of prothoracic muscle, then eucnemids can jump by releasing connection (Otto, 2016). Click-mechanism is utilized as defensive strategy, not only escape from dangers, but also making some audible sounds for startle their enemies (Muona, 1993). However, they usually drop off to ground or pretended to be dead when disturbed, because click-mechanism is obviously excessive in energy efficiency (Kaschek, 1984; Muona, 1993).

The adults of eucnemids are very similar to elaterids in morphology, but can be distinguished by following features: body mostly more convex and cylindrical; second antennomere attached subterminally to first; labrum hidden underneath

clypeus; abdominal ventrite strongly connate (Laterille, 1834; Bonvouloir, 1871; Fleutiaux, 1935; Muona, 1993; Otto, 2016). Most of them are known as nocturnal and excellent fliers. They are also very active, rarely encountered running on trunk, especially broken surface (Muona, 2010). Chemical communication is certainly important in their behavior, for instance, swarming of *Melasis buprestoides* (Linnaeus, 1761) and mating behavior of other species, such as species belonging *Hylochares*, *Hylis*, *Microrhagus* (Palmqvist, 1952; Muona, 2010). It is unclear whether they feed or not, however, some eucnemid groups were identified that destitute of functional gut altogether (Dodelin et al., 2005).

The larvae are diverse in body form, more or less sclerotized, elateriform or buprestiform to fusiform (Otto, 2016). They have diagnostic morphological features as following: legs absent, close to immobile; microtrichial patches and areoles well-developed on most segments of body (Mamaev, 1976; Lucht, 1981; Burakowski, 1989; Muona and Teräväinen, 2008). They were observed to penetrate into rotten wood using their wedge-like head and microtrichial patches, with help of fluid pressure (Lucht, 1981). Another characteristic organ, areole, was regarded as enlargement of membranes (Mamaev, 1976; Lucht, 1981), or organs for nutrition (Gardner, 1935). However, function of areole is clearly verified to remove excessive water from their body (Muona and Teräväinen, 2008). The eucnemid larvae are mostly known as mycetophagous, feeding fungal hyphae on rotten wood as main food rather than wood particles (Muona and Teräväinen, 2008). They feed mycelium by extra-oral digestion, breaking down their food with secreted digestive

fluid through mouthparts, and ingesting nutrition in liquid form (Burakowski and Buchholz, 1991; Muona and Teräväinen, 2008). Van Horn (1909) reported wood particles in guts of *Melasis pectinicornis* (Melsheimer, 1846), but following studies never found any solid materials in intestine (Ford and Spilman, 1979; Dodelin et al., 2005; Muona and Teräväinen, 2008). Ford and Spilman (1979) reported that first instar of *Dirrhagofarsus* may work in linear-form until oval chamber is constructed in sapwood, finally live in U-form in last stage.

1.2. Historical review

1.2.1. Taxonomic transition of the family Eucnemidae

The oldest genus of Eucnemidae is *Melasis*, established by Oliver (1790) based on type species *Melasis buprestoides* (Linnaeus, 1761). Ahrens (1812) founded the genus *Eucnemis* and described their ability to jump. Fleming (1821) firstly placed eucnemid beetles in separate group, Melasides, but most subsequent authors ignored this view. Later, Eschscholtz (1829) erected the tribe Eucnemides. Mannerheim (1823) published the first revision of the genus *Eucnemids* with 10 species and described new one genus, *Xylophilus*. Latreille (1824) supported Mannerheim's work (1823) and designated as the genus *Eucnemis*. Latreille (1834) suggested a new classification of the family Serricornes that divided in five tribes: Buprestides, Eucnemides, Cerophytides, Elaterides, and Cebrionides. Lacordaire (1857) divided the Eucnemides in three groups: Melasides, Eucnemides vrais, and Perothopides.

Duval (1863) mostly shared Lacordaire's view, but placed Cerophytides in Eucnemides. Bonvouloir (1871, 1872, 1875) followed Duval's work and published monographs that treat all genera and species of Eucnemides with well-defined illustrations. Horn (1890) revised Eucnemidae from Central American fauna, regarding eucnemids as an independent family. Lameere (1900) separate the *Balgus* type genera into Elateridae based on adult structure. Fleutiaux (1923) revised Japanese eucnemids and founded the subfamily Macraulacinae. Fleutiaux (1935) classified species and genera of Eucnemidae from Palaearctic region. Crowson (1955) classified Eucnemidae as an independent group in modern view and separated separated the genus *Perothops* as a family, Perothopidae. Cobos (1964) replaced Perothopidae in Eucnemidae as a subfamily and divided Eucnemidae in five subfamilies: Gastraulacinae, Eucneminae, Melasinae, Dirhaginae, and Perothopinae. Lawrence (1988) shared Cobos's view and classified the families of Elateroidea, including Eucnemidae, with morphological features. Most recently, Muona (1993) proposed a classification with eight subfamilies, considering morphological characters of adults: Eucneminae, Macraulacinae, Melasinae, Perothopinae, Phyllocerinae, Pseudomeninae, Palaeoxeninae, and Phlegoninae. Lawrence et al. (2007) followed Muona's classification (1993) and replaced a controversial Elateroidea group (Anischiidae or Anischiinae of Elateridae) in Eucnemidae as a separate subfamily, Anischiinae.

Eucnemidae was used as family name in company with Melasidae, however, Muona and Alaruikka (2007) purposed to conserve usage of Eucnemidae over the

older name for reasons of stability.

1.2.2. History of Korean records

Studies on the family Eucnemidae from Korea have been barely conducted. Previously, only five species of Eucnemidae have been recorded from Korea (Table 1). Since *Xylophilus ainu* (Fleutiaux) was firstly recognized by ESK/KSAE (1994), Suzuki (2012) reported *Isorhipis foveata* Hisamatsu, sooner than after, Suzuki (2014) added three species, *Dromaeolus marginatus* Hisamatsu, *Microrhagus ramosus* (Fleutiaux), and *Farsus ainu* Fleutiaux. However, all previous recorded species were reported with only distributional information. Additionally, several original descriptions for species are also insufficient and limited. For this reason, we tried to conduct first taxonomic review of the family Eucnemidae from Korean Peninsula with specific taxonomic information in the present study.

In this chapter, a total of 22 species and 14 genera of the family Eucnemidae, including two new species and 15 unrecorded species, are reviewed. Diagnoses, redescriptions, identification keys, and photographs of characteristic structures of adult are provided. Newly reported species from Korea, including two new species, are listed as follows:

- *Bioxylus natsumiae* Watanabe
- *Bioxylus personatus* Mamaev
- *Bioxylus pilosellus* Hisamatsu
- *Dirrhagofarsus lewisi* (Fleutiaux)

- *Dirrhagofarsus modestus* (Fleutiaux)
- *Dirrhagofarsus* sp. nov. Seung and Lee
- *Euryptychus vicinus* Fleutiaux
- *Fornax nipponicus* Fleutiaux
- *Heterotaxis nipparensis* Hisamatsu
- *Hylis harmandi* (Fleutiaux)
- *Hylochares harmandi* Fleutiaux
- *Microrhagus fovealatus* (Fleutiaux)
- *Microrhagus mystagogus* (Fleutiaux)
- *Microrhagus* sp. nov. Seung and Lee
- *Otho sphondyloides* (Germar)
- *Proxylobius helleri* Fleutiaux
- *Proxylobius longicornis* Hisamatsu

Table 1. History of records of Korean Eucnemidae

No.	Author	Year	Scientific name	Korean name
1	ESK/KSAE	1994	<i>Xylophilus ainu</i> (Fleutiaux)	어리방아벌레
2	Suzuki	2012	<i>Isorhipis foveata</i> Hisamatsu,	-
3	Suzuki	2014	<i>Dromaeolus marginatus</i> Hisamatsu	-
4	Suzuki	2014	<i>Farsus ainu</i> Fleutiaux	-
5	Suzuki	2014	<i>Microrhagus ramosus</i> (Fleutiaux)	-

2. Materials and methods

2.1. Material examined

Collection of false click beetles

Materials for the present study were mostly collected from 2015 to 2016. The

collection was mainly performed by flight intercept traps (FIT, window traps) installed in the mixed forest. Light trap, malaise trap, and collecting with naked eye were also used for collection. All specimens are deposited in the insect collection of Seoul National University (SNU, Korea). Additional materials were based on specimens in the following institutions: Korea National Arboretum (KNA, Pocheon, Korea); National Institute of Agricultural Sciences (NIAS, Wanju, Korea).

Specimen preparation

Collected samples were preserved in 95% ethyl alcohol (ETOH) and made into dried specimens for exact identifications. They were pinned with the micro-pins of no. A1–A2 and B1–B2 pin (Watkins and Doncaster, England) by double-mounted method. Dissection of antennae, hind legs, and aedeagus was conducted as follows: i) Antennae dissection: The dried specimens were softened in boiling water for 30~60 minutes and dissected the antennae with forceps. The separated antennae were mounted on a slide glass with glycerin and covered with cover glass. ii) Hind legs dissection: The dried specimens were intenerated in boiling water for 30~60 minutes and dissected the structures with forceps. The separated samples were mounted on a slide glass with glycerin and covered with cover glass. iii) Aedeagus dissection: The dried specimens were macerated in water at room temperature for a day and occasionally pierced the side of terminal tergite with micro-pin to catalyze softening. After that, broke terminal tergite, and took out the aedeagal pouch with

micro-tools and forceps. Then samples were transferred to 5ml tube with 10% potassium-hydroxide (KOH) and boiled for a hour at 50–60°C. The dissolved samples were mounted on double cavity microscope slide with glycerin and covered with cover glass. After examination, samples were stored in polyethylene genitalia vials with glycerin.

Examinations

The dried specimens were examined under a microscope (S8APO, Leica, Germany). Photographs of characteristic structures were taken by a digital camera (EOS-600D, CANON, Japan) through MP-E 65mm Lens. Several taken layers of pictures were stacked by the software (Zerene Stacker 1.04, Zerene Systems, USA) for improving the resolution. Compensation of images and plates were finished with the software (Photoshop CC 2014, Adobe system, USA). The slide mounted samples were examined under a microscope (DM4000B, Leica, Germany) and the digital images were taken by the software (Active measure ver. 3.0.3, Mitani Co. Ltd, Japan) for measurement.

2.2. Terminology

The terminology for morphological characters of Eucnemidae was followed that of Muona (1993, 2010) and indicated with pictures as below.

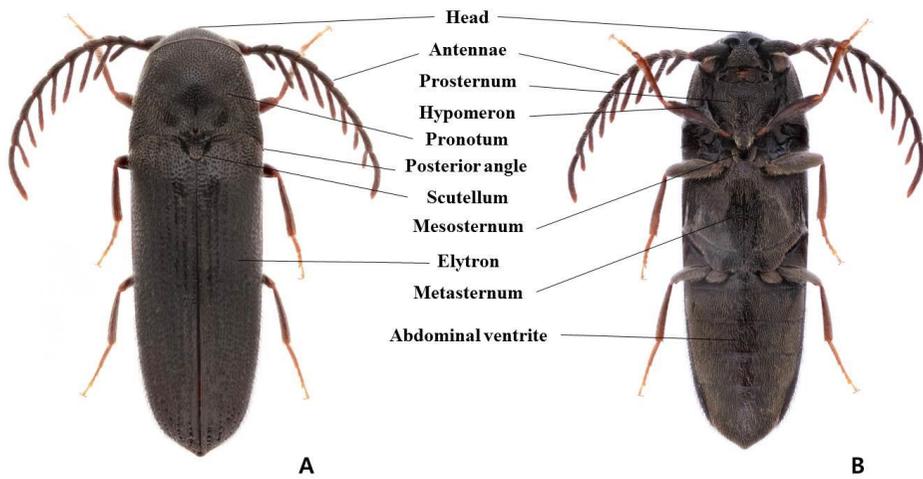


Fig. 1. The dorsal and ventral habitus of *Microrhagus foveolatus* (Fleutiaux). Male. A, dorsal; B, ventral.

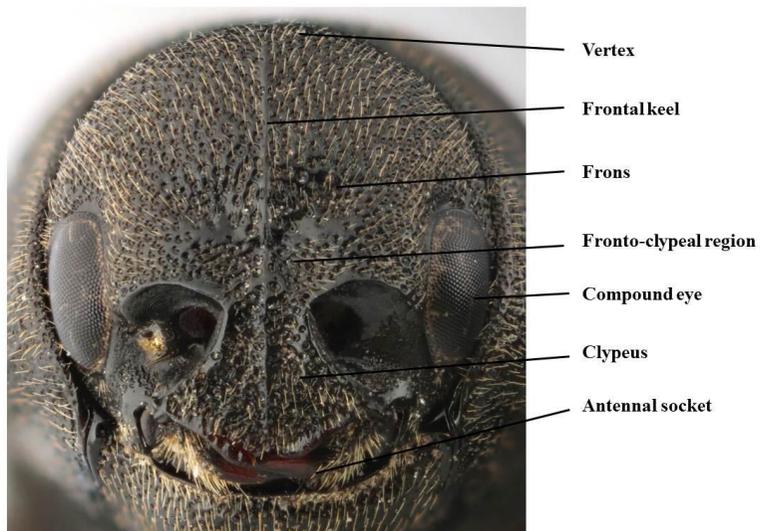


Fig. 2. The frontal view of *Otho sphondyloides* (Germar). Female.

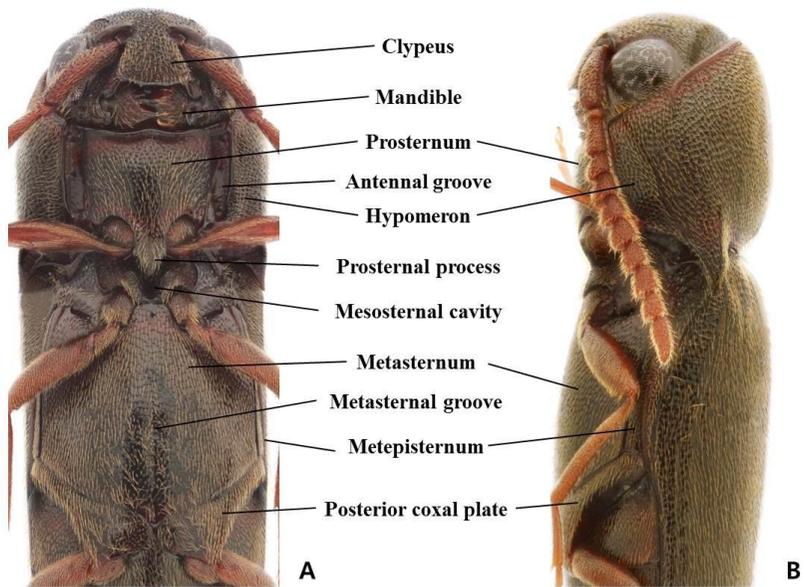


Fig. 3. The ventral and lateral view of *Dirrhagofarsus modestus* (Fleutiaux). Female. A, ventral; B, lateral.

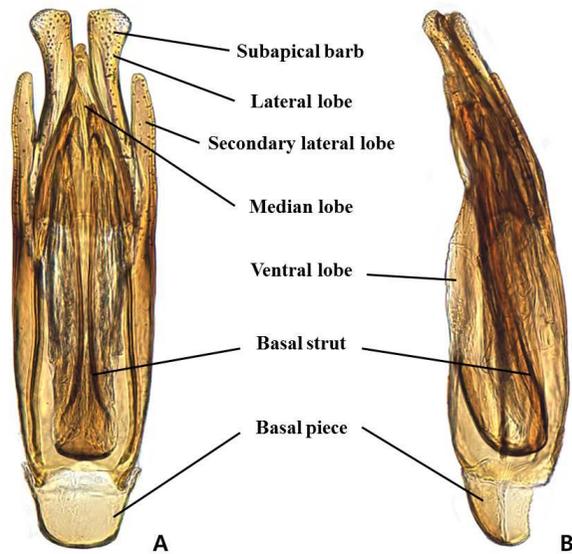


Fig. 4. The genitalia structure of *Proxyllobius helleri* (Fleutiaux). Male. A, dorsal; B, lateral.

2.3. Abbreviations of localities in the Korean Peninsula

The province abbreviations are as follows: SL, Seoul-si; GG, Gyeonggi-do; GW, Gangwon-do; CB, Chungcheongbuk-do; CN, Chungcheongnam-do; JB, Jeollabuk-do; JN, Jeollanam-do; GB, Gyeongsangbuk-do; GN, Gyeongsangnam-do; JJ, Jeju-do (Is.).

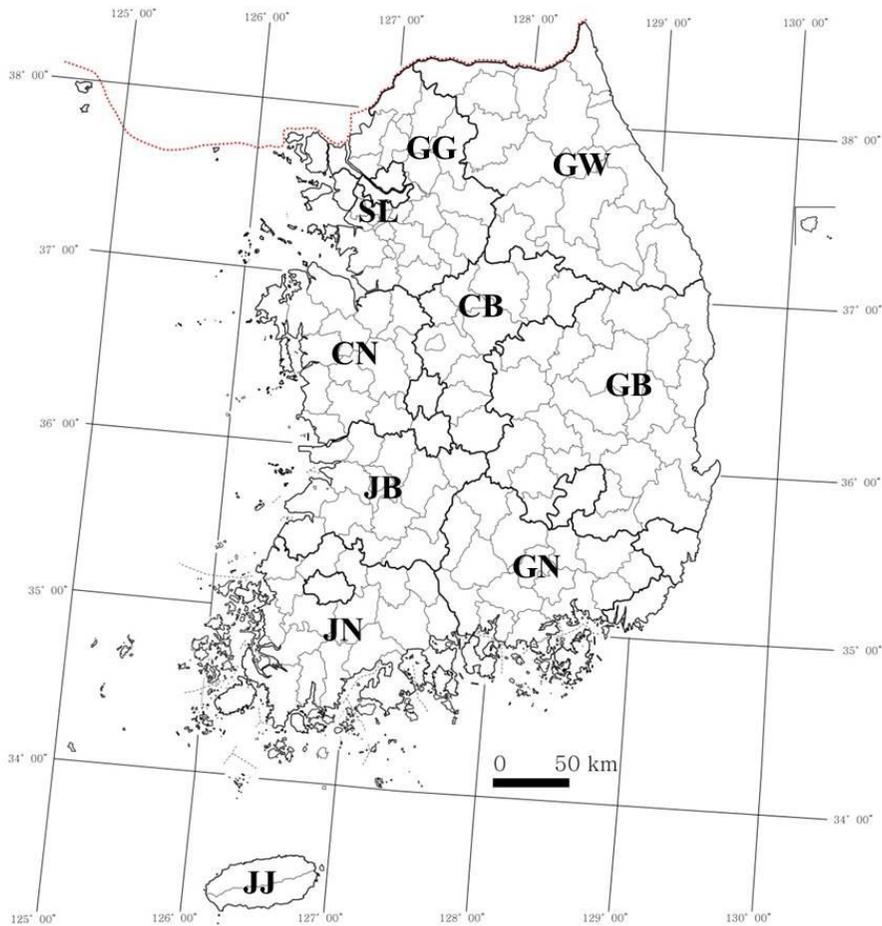


Fig. 5. A map for abbreviations of localities in the Korean peninsula.

3. Results

Systematic accounts

Order Coleoptera

Suborder Polyphaga

Superfamily Elateroidea

Family Eucnemidae Eschscholtz, 1829

Type genus: *Eucnemis* Ahrens, 1812.

Diagnosis. Body small to large sized, length of 1.5~40 mm; form elongate to strongly elongate and moderately to strongly convex; head mostly strongly deflexed and deeply inserted into prothorax; labrum attached underneath clypeus, mostly hidden; antennae consist of 11 segments, with various form, filiform, moniliform, serrate, or pectinate; mostly with sexual dimorphic antennal structure, usually more delicate in male; antennal scape mostly long; pedicel small and attached to scape subterminally; pronotum with well-developed posterior angles; elytra 1.2 to 4 times as long as wide; prosternal process more or less developed between coxae of foreleg, click mechanism well-developed; abdominal ventrite mostly strongly connate; aedeagus mostly trilobate type, variable (Muona, 1993, 2010).

Key to the subfamilies of Korean Eucnemidae

- 1. Hypomeron with lateral antennal groove or simple; meso- and metatibiae with row of spines on lateral surface **Macraulacinae**
- Hypomeron with notosternal antennal groove or simple; meso- and metatibiae without row of spines on lateral surface **Melasinae**

Subfamily Melasinae Fleming, 1821

Melasidae Fleming, 1821: 49. Type genus: *Melasis* A. G. Oliver, 1790.

Diagnosis. Body usually small sized; labrum attached underneath frontoclypeal region; hypomeron with notosternal antennal groove or simple; mesepimeron fused with mesepisternum; tibiae of forelegs with one apical spur; fourth tarsomere usually bilobate; claws simple; abdominal ventrites connate; aedeagus originally bulbous, wide, and with basal struts (Muona, 1993, 2000).

Key to the tribes of Korean Melasinae

- 1. Hypomeron with parallel sides **Melasini**
- Hypomeron with unparallel sides, more or less narrowed anteriorly **2**
- 2. Posterior coxal plate with parallel sides or gradually expanded laterally **3**

- Posterior coxal plate gradually expanded medially 5
- 3. Antennae moniliform; third antennomere obviously longer than fourth; pronotum always with a conspicuous medio-longitudinal groove and transverse lateral impressions **Hylocharini**
- Antennae filiform, serrate, or pectinate; third antennomere distinctly shorter than fourth; pronotum often with a medio-longitudinal groove partly or transverse lateral impressions 4
- 4. Body mostly small sized; antennae filiform or serrate; lateral lobe of aedeagus usually bilobate at apex **Xylobiini**
- Body mostly moderate to large sized; antennae strongly serrate or pectinate; lateral lobes of aedeagus simply narrow at apex **Calyptocerini**
- 5. Pronotal lateral ridge sinuate or divided; hypomeron often with notosternal antennal groove **Dirhagini**
- Pronotal lateral ridge smooth and undivided; hypomeron simple **Epiphanini**

Tribe Calyptocerini Muona, 1993

Calyptocerini Muona, 1993: 43. Type genus: *Calyptocerus* Guérin-Ménéville, 1843.

Diagnosis. Body elongate and cylindrical; clypeus weakly trifurcated at apical margin; antennae strongly serrate or pectinate; third antennomere small, obviously

shorter than fourth; pronotal lateral ridge complete; hypomeron narrowed anteriorly; hypomeral antennal grooves absent; posterior coxal plate subparallel-sided; first tarsomere of foreleg without sex comb in male; fifth abdominal ventrite narrowly rounded or produced at apical margin; seventh tergite keeled medially; aedeagus bulbous (Muona, 1993; Otto, 2015).

Genus *Otho* Lacordaire, 1857

Otho Lacordaire, 1857: 113. Type species: *Melasis sphondyloides* Germar, 1818.

Diagnosis. Body elongate, robust, and cylindrical; frons with a distinct medio-longitudinal keel; clypeus slightly sinuate at apical margin; antennae serrate or pectinate; third antennomere short, subequal to second; antennomeres 4~10 strongly toothed or branched; pronotum strongly convex, significantly wider than long, and with a distinct medio-longitudinal groove; pronotal lateral ridge simple; elytra distinctly striated; hypomeral antennal grooves absent; metepimeron invisible; metepisternum widened posteriorly; posterior coxal plate subparallel-sided, slightly expanded outward; legs slightly slender; first tarsomere of hind leg significantly long; abdominal ventrites strongly connate and convex, fifth ventrite narrowly rounded or produced at apex; aedeagus bulbous; median lobe of aedeagus triangular; lateral lobes of aedeagus simple at apex, non-bilobed; (Bonvouloir 1875; Fleutiaux, 1935; Hisamatsu, 1985).

***Otho sphondyloides* (Germar, 1818)**

Melasis sphondyloides Germar, 1818: 235.

Hypocoelus sibiricus Motschulsky, 1845: 34.

Diagnosis. Body mostly black with ferruginous elytral humeri; frons with an entire median keel; antennae pectinate in male, strongly serrate in female; third antennomere shortest, subequal to second; pronotum transverse, significantly wider than long, and with a distinct median groove in its full length; scutellum triangular, non-punctate, and glabrous; metasternum with a medio-longitudinal groove; metepisternum widened posteriad; posterior coxal plate slightly expanded outward; fifth abdominal ventrite dully produced at apical margin.

Redescription. Female (Fig. 12, A~C) 6.1~8.5 mm long and 2.0~2.8 mm wide. **Body** elongate, cylindrical, and strongly convex; mostly black; antennae, mouthparts, clypeus, elytral humeri, femur, and tibiae ferruginous; tarsi chestnut to yellowish brown; with fairly glossy surface; covered with yellowish gray pubescence. **Head** strongly inserted into prothorax, barely visible in dorsal view; mostly with circular and dense punctures, rougher and more irregular near clypeus; with a medio-longitudinal keel from vertex to clypeal apex, more or less indistinct near vertex; frontoclypeal region transversely depressed; clypeus weakly bifurcated at apical margin, width of clypeal apex about 2.3 times wider than distance between antennal sockets (Fig. 34, A2). **Antennae** (Fig. 33, A2) serrate, not reaching posterior coxal plate, covered with yellowish brown pubescence; first antennomere

oblong and robust; second antennomere obconical and short, about 1.8 times longer than third; third antennomere shortest and transverse; fourth antennomere widened toward apex, about 1.5 times longer than wide, approximately 1.4 times longer than antennomeres 2~3 combined, and about 1.4 times longer than fifth; antennomeres 5~10 subequal, strongly toothed; apical antennomere oblong, about 2.5 times longer than wide, and about 1.9 times longer than tenth. **Pronotum** strongly convex, about 1.25 times wider than long, subparallel-sided near base, abruptly narrowed anteriorly from basal half, and arcuate at anterior margin; mostly with fine, dense, and rough punctures, larger and sparser at lateral and posterior regions; with a distinct medio-longitudinal groove in full length of pronotum; with symmetrical, transverse depressions at middle; a pair of deep dimples presented at base; antiscutellar area broadly truncated; pronotal posterior angles short, sharply produced, and barely exceeding posterior margin of antiscutellar area. **Scutellum** triangular, about 1.5 times wider than long; gradually narrowed posteriorly, and slightly rounded at apex; barely punctate and pubescent, fairly glabrous. **Elytra** conjointly with width to length as about 1 to 2.4, parallel-sided, gradually attenuated near apices; strongly striated, with rough and deep punctures; interstriae strongly convex; with several large and deep punctures near apices; simply rounded at apices. **Prosternum** strongly transverse, gradually widened anteriorly; mostly with fine and sparse punctures, sparser at lateral region; prosternal process stout, gradually narrowed and slanted posteriorly; hypomeron mostly with large, irregular, and rough punctures, gradually larger and sparser posteriorly; with coarse surface at posterior fossae; hypomeral antennal groove absent. **Mesosternum** with fine and irregular punctures;

mesepimeron fused with mesepisternum, with sparse punctures, especially at anterior region. **Metasternum** with fine, regular, and dense punctures; with a medio-longitudinal groove in full length of metasternum; metepisternum (Fig. 35, A2) gradually widened posteriad, widest width about 1.3 times wider than outside of posterior coxal plate; posterior coxal plate (Fig. 36, A2) gradually expanded outward, laterally about 1.5 times wider than medially. **Legs** (Fig. 37, A2) moderate in length, fairly slender; first tarsomere of hind leg about 1.4 times longer than tarsomeres 2~4 combined; second tarsomere about 1.3 times longer than third; fifth tarsomere about 1.4 times longer than second; claws simple. **Abdomen** strongly connate; with punctures as metasternum; each ventrite convex medially; fifth ventrite gradually narrowed posteriad, dully produced at apical margin (Fig. 38, K2).

Male unavailable specimen in this study.

Specimens examined. <GW> 3 ♀, Osaek-ri, Seo-myeon, Yangyang-gun, 20. vi. 2015, leg. S. H. Lee; 1 ♀, Wangsan-ri, Wangsan-myeon, Gangneung-si, 05 ~ 29. vi. 2016, leg. Seung and Jung by FIT; 1 ♀ Suha-ri, Daegwanryeong-myeon, Pyeongchang-gun, 05 ~ 29. vi. 2016, leg. Seung and Jung by FIT.

Distribution. Korea (New record), Japan, Europe (Austria, Bulgaria, Belarus, Croatia, Russia, Germany, Hungary, Latvia, Romania, Ukraine).

Remarks. *Otho sphondyloides* show individual variation in coloration of elytral humeri and clypeus, blackish brown to ferruginous.

Tribe Dirhagini Reitter, 1911

Dirrhagini Reitter, 1911: 202. Type genus: *Dirhagus* Latreille, 1834.

Microrhaginae Fleutiaux, 1919: 112. Type genus: *Microrhagus* Dejean, 1833.

Arhipini Cobos, 1965: 396. Type genus: *Arrhipis* Bonvouloir, 1871.

Diagnosis. Body oblong, oval; antennae serrate or pectinate; pronotal lateral ridge serrate or divided; hypomeron narrowed anteriorly, with excretory pore close to coxa of foreleg, and with notosternal antennal groove; posterior coxal plate usually expanded medially; tibia of foreleg with one apical spur; first tarsomere of foreleg with sex comb in male; median lobe of aedeagus bifurcated at apex (Reitter, 1911; Fleutiaux, 1919; Muona, 1993, 2000).

Key to the genera of Korean Dirhagini

1. Elytra simply rounded at apices in lateral view; clypeal base strongly narrow, width of clypeal apex more than 3.5 times wider than distance between antennal sockets *Microrhagus*
- Elytra distinctly compressed or protruded at apices in lateral view; clypeal base moderately narrow, width of clypeal apex less than three times wider than distance between antennal sockets **2**
2. Frons without keel; antennal grooves triangular, strongly expanded posteriorly;

second antennomere as long as fourth; fifth abdominal ventrite distinctly depressed and densely pubescent at middle *Farsus*

- Frons with a pair of longitudinal keels near compound eye; antennal grooves parallel-sided; second antennomere shorter than fourth; fifth abdominal ventrite simple at middle *Dirrhagofarsus*

Genus *Dirrhagofarsus* Fleutiaux, 1935

Dirrhagofarsus Fleutiaux, 1935: 15. Type species: *Microrhagus lewisi* Fleutiaux, 1900.

Attenuorhagus Olexa, 1975: 161. Type species: *Hypocoelus attenuates* Mäklin, 1845.

Diagnosis. Body elongate, subcylindrical; vertex with transverse row of vestiture; frons with a pair of latero-longitudinal keels near compound eyes; compound eyes well-developed, large, reniform; antennae filiform or serrate; second antennomere significantly shorter than fourth; antennomeres 3~10 at least twice longer than wide; pronotum parallel-sided, almost quadrate, convex, rounded at anterior margin; elytra elongate and significantly compressed or protruded at apices in lateral view; hypomerall antennal grooves well-developed, notosternal, parallel-sided, and with outer marginal keel; metepimeron invisible; metepisternum narrow and subparallel-sided; posterior coxal plate strongly expanded medially; legs slender; fourth tarsomere dilated; abdominal ventrites connate; fifth ventrite sharply produced at apex; aedeagus elongate, dorsoventrally compressed; median lobe of aedeagus

bifurcated at apex; lateral lobes of aedeagus slender and narrowed toward apex (Fleutiaux, 1935; Muona 2000, 2011; Otto et al., 2014).

Key to the species of Korean *Dirrhagofarsus*

1. Third antennomere of male more than 1.5 times longer than fourth; elytra conjointly with width to length as about 1 to 2.5 *Dirrhagofarsus* sp. nov.

- Third antennomere of male less than 1.5 times longer than fourth; elytra conjointly with width to length as about 1 to 2.7 2

2. Frons with a weak medio-longitudinal keel; elytral apices simply roundly compressed in lateral view *D. modestus*

- Frons without medio-longitudinal keel; elytral apices distinctly protruded in lateral view *D. lewisi*

***Dirrhagofarsus* sp. nov. Seung and Lee**

Diagnosis. Body mostly chestnut; antennae weakly serrate in both sexes, more stubby in female; third antennomere of male more than 1.5 times longer than fourth; pronotum slightly depressed at middle; elytra conjointly with width to length as about 1 to 2.5; elytral apices simply rounded in lateral view; hypomer al antennal grooves well developed, notosternal, and fairly glabrous; metepisternum narrow,

subparallel-sided, and wider than outer margin of posterior coxal plate; posterior plate strongly expanded inward; fifth abdominal ventrite sharply produced at apex.

Description. Male (Fig 13, A, C~D) 4.3~5.3 mm long and 1.2~1.5 mm wide. **Body** elongate, oblong, subcylindrical, and fairly convex; mostly chestnut with yellowish brown tarsi; with moderately glossy surface; covered with golden pubescence. **Head** moderately inserted into prothorax; mostly with circular and regular punctures, denser and rougher near clypeus; compound eyes large, well-developed, reniform; a pair of latero-longitudinal keels well-developed near eyes; frontoclypeal region weakly depressed; clypeus feebly trilobate at apical margin, length of clypeal apex about three times wider than distance between antennal sockets (Fig. 34, B1). **Antennae** (Fig. 33, B1) serrate, almost reaching posterior coxal plate, covered with yellowish brown pubescent; first antennomere elongate; second antennomere obconical and shortest; third antennomere rectangular, about 2.3 times longer than wide, about twice longer than second, and about 1.5 times longer than fourth; antennomeres 4~10 subequal, gradually slenderized toward apex; apical antennomere elongate, about 3.8 times longer than wide, and about 1.7 times longer than previous. **Pronotum** fairly convex, parallel-sided, quadrate, as long as wide, and arcuate at anterior margin; with rougher and coarser punctures than head, especially at middle and posterior regions, with strongly rough punctures at anterior and lateral regions; weakly depressed at middle; with a short median keel at base; pronotal lateral ridge divided; anterolateral ridge very shortly extended, almost one-

sixth of length of pronotum; posterolateral ridge long, about four-fifth of length of pronotum; antiscutellar area fairly compressed, almost straight; pronotal posterior angles sharply produced, exceeding posterior margin of antiscutellar area. **Scutellum** triangular, about 1.3 times wider than long, gradually narrowed posteriad, and slightly rounded at apex; roughly punctate; densely pubescent. **Elytra** conjointly with width to length as about 1 to 2.5; parallel-sided, and gradually attenuated near apices; weakly striated, with regular punctures; interstriae slightly convex; with several large and deep punctures near apices; weakly compressed and simply rounded at apices in lateral view (Fig. 38, U1). **Prosternum** transverse, parallel-sided; mostly with punctures as head, slightly larger and rougher at lateral region; prosternal process subparallel-sided, gradually tapered and declined posteriad; hypomeron with larger and rougher punctures than prosternum; with wrinkled surface and deep excretory pore at posterior fossae; hypomeral antennal grooves (Fig. 38, A1) well-developed, notosternal, parallel-sided, with outer marginal keel, barely punctate, and strongly glabrous. **Mesosternum** with rough and irregular punctures; mesepimeron fused with mesepisternum, with coarse and irregular punctures. **Metasternum** mostly with punctures as prosternum, slightly larger and denser at lateral region; with a medio-longitudinal groove, not reaching anterior margin; metepisternum (Fig. 35, B1) narrow, subparallel-sided, slightly widened posteriad, and widest width about 1.5 times longer than outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, B1) strongly expanded inward, medially about four times wider than laterally. **Legs** (Fig. 37, B1) moderate in length; tibiae and tarsi slender; first tarsomere of hindleg about 1.5 times longer

than tarsomeres 2~4 together; second tarsomere about 1.3 times longer than third; fifth tarsomere about 1.2 times longer second tarsomere; claws simple. **Abdomen** strongly connate; with denser punctures than metasternum; fifth ventrite gradually narrowed posteriad and sharply produced at apical margin. **Aedeagus** (Fig. 39, A1~2) elongate, dorsoventrally compressed, about 4.5 times longer than wide; median lobe almost straight, gradually narrowed distally, deeply and narrowly bifurcated at apex; basal struts reaching basal piece; lateral lobes slightly longer than median lobe, slightly curved ventrally, with basally attached secondary lateral lobes; secondary projections well-developed, elongate, subparallel-sided, weakly pointed at apex; basal piece rectangular, about 1.25 times longer than wide, almost one-fifth of length of aedeagus. **Female** (Fig. 13, B) similar to male, but can be distinguished by the following characters: 4.5~5.7 mm long and 1.3~1.7 mm wide; clypeal base slightly more wide than those of male, width of clypeal apex about 2.8 times wider than distance between antennal sockets (Fig. 34, B2); third antennomere about 1.75 times longer than fourth; antennomeres 4~10 more stubby than male (Fig. 33, B2).

Specimens examined. <SL> 5 ♂, Mt. Gwanak, Daehak-dong, Gwanak-gu, Seoul-si, 18. i. 2016, J. B. Seung (03. iv. 2016, adult emergence). <GG> 4 ♂, Mt. Bara, Hagui-dong, Uiwang-si, 22. vi. 2015, leg. J. B. Seung by LT; 1 ♂, Mt. Bara, Hagui-dong, Uiwang-si, 01. vi. 2016, leg. J. B. Seung by LT; 1 ♂, Mt. Bara, Hagui-dong, Uiwang-si, 04. vi. 2016, leg. M. S. Oh by LT; 3 ♀, Baekgok-ri, Mado-myeon, Hwaseong-si, 06 ~ 28. vi. 2016, leg. Seung and Yeom by FIT.

Distribution. Korea (Central).

Remarks. *Dirrhagofarsus* sp. nov. can be distinguished from *D. modestus* by chestnut body color, antennal structure, relatively short elytra, and tarsal characters. Larvae in last stage were collected in standing dead tree of *Alnus japonica* in January. They retain U-formed in ovale larval cell. Adults emerged with another eucnemids, *Dirrhagofarsus modestus* and *Hylis* sp. in April. Most of them collected by light trap, occasionally by flight intercept traps. They showed ability of clicking, frequent flying, and active running.

***Dirrhagofarsus lewisi* (Fleutiaux, 1900)**

Microrhagus lewisi Fleutiaux, 1900: 358.

Dirrhagus lewisi Fleutiaux, 1923: 308.

Dirrhagofarsus lewisi Fleutiaux, 1935: 16.

Diagnosis. Mostly dark chestnut; antennae weakly serrate; third antennomere less than 1.5 times longer than fourth; pronotum fairly convex, with dull surface; elytra conjointly with width to length as about 1 to 2.7; elytral apices distinctly protruded in lateral view; hypomeral antennal grooves well-developed, notosternal, and glabrous; metepisternum narrow, subparallel-sided, slightly widened posteriad, and widest width wider than outer margin of posterior coxal plate; posterior coxal plate strongly expanded inward; fifth abdominal ventrite sharply produced at apex.

Redescription. Female (Fig. 14, A~C) 6.1~7.7 mm long and 1.7~2.2 mm wide. **Body** elongate, cylindrical, and convex; mostly chestnut to dark brown with ferruginous antennae and legs; mostly with dull surface; covered with yellowish pubescence. **Head** deeply inserted into prothorax, barely visible in dorsal view; with circular, irregular, and rough punctures, finer and coarser near clypeus and occiput area; compound eyes large, well-developed, and weakly reniform; frons with a pair of latero-longitudinal keels near compound eyes; frontoclypeal region slightly depressed; clypeus broadly trilobed at apical margin, width of clypeal apex about 2.7 times wider than distance between antennal sockets (Fig. 34, C2). **Antennae** (Fig. 33, C2) weakly serrate, almost reaching second abdominal ventrite, covered with yellowish grey pubescence; first antennomere elongate; second antennomere obconical and shortest; third antennomere elongate, about 2.5 times longer than second, and about 1.3 times longer than fourth; antennomeres 4~10 subequal, slightly shortened distally; apical antennomere oblong, about 2.9 times longer than wide, and approximately 1.5 times longer than tenth. **Pronotum** moderately convex, as long as wide, quadrate, parallel-sided, and broadly arcuate at anterior margin; with finer, rougher, and more regular punctures than head, especially at anterior region; with a medio-longitudinal keel at basal half; pronotal lateral ridge divided; anterolateral ridge very shortly extended, about one-fifth of length of pronotum; posterolateral ridge long, approximately four-fifth of length of pronotum; antiscutellar area broadly notched; pronotal posterior angles sharply produced, exceeding posterior margin of antiscutellar area. **Scutellum** trapezoidal, tongue-like, about 1.1 times wider than long, gradually narrowed posteriad, and rounded at apex;

roughly punctate; rarely pubescent. **Elytra** conjointly with width to length as about 1 to 2.65, parallel-sided, and gradually attenuated near apices; weakly striated, with fairly shallow and irregular punctures; interstriae weakly convex; with several large and deep punctures near apices; strongly compressed and distinctly protruded at apices in lateral view (Fig. 38, V2). **Prosternum** transverse, subparallel-sided, slightly widened anteriorly; with finer and regular punctures than head; prosternal process subparallel-sided, gradually tapered, and declined posteriorly; hypomeron with larger and rougher punctures than prosternum; hypomeral antennal grooves (Fig. 38, B2) well-developed, notosternal, parallel-sided, keeled marginally, non-punctate, and strongly glabrous. **Mesosternum** with coarse punctures; mesepimeron and mesepisternum fused, with more sparse and irregular punctures than mesosternum, especially at anterior region. **Metasternum** mostly with denser punctures than prosternum, slightly sparser at lateral region; with a weak medio-longitudinal groove in full length of metasternum, more or less indistinct at anterior margin; metepisternum (Fig. 35, C2) narrow, subparallel-sided, slightly widened posteriorly, and widest width about 1.7 times wider than outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, C2) strongly expanded inward, medially about four times wider than laterally. **Legs** (Fig. 37, C2) moderate in length; tibiae and tarsi slender; first tarsomere of hind leg about 1.5 times longer than tarsomeres 2~4 combined; second tarsomere about 1.6 times longer than third, as long as fifth tarsomere; claws simple. **Abdomen** strongly connate; with denser punctures than metasternum, granulated; fifth ventrite gradually narrowed posteriorly, sharply pointed at apical margin. **Male** unavailable specimen in this study.

Specimens examined. <GG> 1 ♀, Mt. Bara, Hagui-dong, Uiwang-si, 22. vi. 2015, leg. J. B. Seung by LT. <GW> 1 ♀, Beopheung-ri, Suju-myeon, Yeongwol-gun, 02 ~ 16. vii. 2015, leg. Seung and Lee by FIT; 2 ♀, Micheon-ri, Seo-myeon, Yangyang-gun, 09. vii. 2016, leg. S. H. Lee. <JN> 3 ♀, Jungdae-ri, Ganjeon-myeon, Gurye-gun, 04 ~ 15. vii. 2016, leg. Seung and Lee by FIT.

Distribution. Korea (New record), Japan, Nearctic Region.

Remarks. *Dirrhagofarsus lewisi* is differentiated from other *Dirrhagofarsus* species by dull surface of body, antennal structures, simple frons, distinct protrusion of elytral apices, and tarsal structure. This species were rarely attracted to light trap.

***Dirrhagofarsus modestus* (Fleutiaux, 1923)**

Dirrhagus modestus Fleutiaux, 1923: 308.

Dirrhagus modestus Hisamatsu, 1960: 101.

Rhacopus modestus Hisamatsu, 1985: 50.

Dirrhagofarsus modestus Muona, 1993: 46.

Diagnosis. Body mostly dull black; antennae weakly serrate in both sexes, more stubby in female; third antennomere of male less than 1.5 times longer than fourth; pronotum with fairly shiny surface; elytra conjointly with width to length as about 1 to 2.7; elytral apices simply rounded in lateral view; hypomeral antennal grooves

well-developed, notosternal, and glabrous; metepisternum narrow, parallel-sided, width of posterior margin as wide as outer margin of posterior coxal plate; posterior coxal plate strongly expanded inward; fifth abdominal ventrite sharply produced at apical margin.

Redescription. Male (Fig. 15, A, C~D) 4.5~5.9 mm long and 1.2~1.5 mm wide. **Body** elongate, cylindrical, and fairly convex; mostly black; antennae, mouthparts, anterior and posterior margin of pronotum reddish brown; tibiae and tarsi chestnut to ferruginous; with fairly shiny surface; covered with yellowish brown pubescence. **Head** deeply inserted into prothorax; mostly with circular, irregular, and rough punctures, rougher and more irregular near clypeus; compound eyes large, well-developed, and weakly reniform; with a pair of distinct latero-longitudinal keels near compound eyes; frontoclypeal region weakly depressed; clypeus broadly rounded at apical margin, width of clypeal apex about 2.9 times wider than distance between antennal sockets (Fig. 34, D1). **Antennae** (Fig. 33, D1) weakly serrate, almost reaching second abdominal ventrite, and covered with yellowish vestiture; first antennomere elongate; second antennomere obconical and shortest; third antennomere rectangular, about 2.5 times longer than wide, approximately twice wider than second, and about 1.35 times longer than fourth; antennomeres 4~10 gradually lengthened and slenderized toward apex; apical antennomere elongate, about 5.5 times longer than wide, and approximately 1.7 times longer than previous. **Pronotum** fairly convex, as long as wide, quadrate, parallel-sided, and rounded at anterior margin; mostly with finer, rougher, and denser punctures than head,

gradually more rugose at lateral region; with a medio-longitudinal keel at basal half; pronotal lateral ridge divided; anterolateral ridge very shortly extended, about one-sixth of length of pronotum; posterolateral ridge long, approximately four-fifth of length of pronotum; antiscutellar area weakly compressed, almost straight; pronotal posterior angles sharply produced, exceeding posterior margin of antiscutellar area.

Scutellum subtriangular, tongue-like, as long as wide, gradually narrowed posteriad, and rounded at apex; roughly punctate; rarely pubescent. **Elytra** conjointly with width to length as about 1 to 2.7, parallel-sided, gradually attenuated near apices; weakly striated with shallow and scattered punctures; interstriae weakly convex; with several large and deep punctures near apices; fairly compressed and simply rounded at apices in lateral view (Fig. 38, W2). **Prosternum** slightly transverse, parallel-sided; mostly with more regular punctures than head, gradually finer and denser at anterior and posterior regions; prosternal process subparallel-sided, gradually tapered, and oblique posteriad; hypomeron with rougher punctures than prosternum; hypomeral antennal grooves well-developed, notosternal, parallel-sided, with outer marginal keel, barely punctate, and glabrous (Fig. 38, C1). **Mesosternum** with rough and coarse punctures; mesepimeron fused mesepisternum, with rugose surface. **Metasternum** mostly with finer, sparser, and more regular punctures than prosternum, especially at middle; metepisternum (Fig. 35, D1) narrow, parallel-sided, and width of posterior margin as long as outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, D1) strongly expanded inward, medially about four times wider than laterally. **Legs** (Fig. 37, D1) moderate in length; tibiae and tarsi slender; first tarsomere of hind leg about 1.5 times longer than tarsomeres 2~4

combined; second tarsomere about 1.6 times longer than third, as long as fifth; claws simple. **Abdomen** strongly connate; with finer punctures than metasternum; fifth ventrite gradually narrowed posteriad, sharply produced at apex. **Aedeagus** (Fig. 34, B1~2) elongate, slightly compressed dorsoventrally, about 5.3 times longer than wide; median lobe almost straight, gradually narrowed distally, deeply bifurcated at apex; basal struts reaching basal piece; lateral lobes as long as median lobe, almost convergent medially near apex, with basally attached secondary lateral lobes; secondary lateral lobes elongate, slender, subparallel-sided, weakly pointed apex; basal piece trapezoidal, about 1.25 times longer than wide, almost one-sixth of length of aedeagus. **Female** (Fig. 15, B) similar to male, but can be distinguished by following characters: body larger and stouter, 5.2~6.8 mm long, 1.4~1.9 mm wide; clypeal base (Fig. 34, D2) more wide than those of male, width of clypeal apex about 2.7 times wider than distance between antennal sockets; antennae (Fig. 33, C1) relatively shorter, almost reaching posterior coxal plate; third antennomere about 1.7 times longer than fourth; antennomeres 4~10 more stubby; apical antennomere about 3.3 time longer than wide.

Specimens examined. <SL> 11 ♂, 10 ♀, Mt. Gwanak, Daehak-dong, Gwanak-gu, Seoul-si, 18. i. 2016, leg. J. B. Seung (03. iv. 2016, adult emergence). <GG> 1 ♀, Mt. Bara, Hagui-dong, Uiwang-si, 22. vi. 2015, leg. J. B. Seung by LT; 2 ♂, 1 ♀, Mt. Bara, Hagui-dong, Uiwang-si, 01. vi. 2016, leg. J. B. Seung by LT. <GW> 1 ♂, Beopheung-ri, Suju-myeon, Yeongwol-gun, 19. vi ~ 02. vii. 2015, leg. Seung and Lee by FIT; 1 ♀, Deokgu-ri, Sangdong-eup, Yeongwol-gun, 19. vi ~ 02. vii. 2015,

leg. Seung and Lee by FIT; 1 ♀, Beopheung-ri, Suju-myeon, Yeongwol-gun, 02 ~ 16. vii. 2015, leg. Seung and Lee by FIT; 1 ♀, Wangsan-ri, Wangsan-myeon, Gangneung-si, 05 ~ 29. vi. 2016, leg. Seung and Jung by FIT; 3 ♀, Suha-ri, Daegwanryeong-myeon, Pyeongchang-gun, 05 ~ 29. vi. 2016, leg. Seung and Jung by FIT. <JN> 2 ♀, Jungdae-ri, Ganjeon-myeon, Gurye-gun, 04 ~ 15. vii. 2016, Seung and Lee by FIT. <JJ> 2 ♂, Gyorae gotjawal, Gyorae-ri, Jocheon-eup, Jeju-si, 10. vi – 21. vii. 2016, leg. Seung and Jung by FIT.

Distribution. Korea (New record), Japan, Russia (Far East).

Remarks. Larvae in last stage of *D. modestus* were observed in standing dead tree of *Alnus japonica* in January. They retained U-formed in small larval cell. Adults emerged with another eucnemids, *Dirrhagofarsus* sp. nov. and *Hylis* sp. in April. They were commonly attracted to light trap. They showed ability of clicking, frequent flying, and active running.

Genus *Farsus* Jacquelin du Val, 1860

Farsus Jacquelin du Val, 1860: 116. Type species: *Hylochaes unicolor* Latreille, 1834.

Rhagomerus Iablokoff-Khnzorian, 1964: 162. Type species: *Rhagomerus obesus* Iablokoff-Khnzorian, 1964.

Diagnosis. Body oblong and subcylindrical; head convex, strongly inserted into prothorax; clypeus broadly rounded or trilobed at apex; antennae subfiliform or

serrate; second antennomere slightly shorter or as long as fourth; third antennomere about twice longer than fourth; antennomeres 4~10 strongly toothed; pronotum convex, quadrate, and parallel-sided; elytral apices distinctly produced at apices; hypomerall antennal grooves well-developed, notosternal, triangular, and gradually expanded posteriad; metepimeron invisible; metepisternum narrow and subparallel-sided; posterior coxal plate expanded inward; first tarsomere as long as tarsomeres 2~4 combined; abdominal ventrites strongly connate; fifth ventrite with transverse crest with dense hairy; aedeagus elongate, slender; lateral lobes of aedeagus slightly enlarged and curved at apex (Jacquelin du Val, 1860; Fleutiaux, 1935; Hisamatsu, 1985; Muona, 2010).

***Farsus ainu* Fleutiaux, 1923**

Farsus ainu Fleutiaux, 1923: 306.

Diagnosis. Body mostly dull chestnut; clypeus broadly trifurcated at apical margin; antennae serrate; third antennomere elongate, about 1.7 times longer than fourth; pronotum fairly convex, quadrate, and parallel-sided; elytral apices distinctly protruded; hypomerall antennal grooves well-developed, notosternal, triangular, and strongly expanded posteriad; metepisternum parallel-sided, width of posterior margin narrower than outer margin of posterior coxal plate; posterior coxal plate expanded inward; fifth abdominal ventrite with transverse and distinct crest with dense hairs at middle, simply rounded at apical margin.

Redescription. Male (Fig. 20, A~C) 5.7~6.2 mm long and 1.9~2.0 mm wide. **Body** oblong, subcylindrical, and fairly convex; mostly chestnut; antennae, tibiae and tarsi orange brown; with dull surface at dorsum, fairly glossy ventrally; covered with yellowish brown pubescence. **Head** strongly inserted into prothorax, barely visible in dorsal view; mostly with circular, irregular, and rough punctures, finer and denser at frontoclypeal region; frons slightly depressed; clypeus feebly trilobed at apical margin, width of clypeal apex about 2.4 times wider than distance between antennal sockets (Fig. 34, II). **Antennae** (Fig. 33, II) weakly serrate, obviously reaching metepisternum, covered with golden vestiture; first antennomere elongate; second antennomere obconical and shortest; third antennomere elongate, about 2.2 times longer than wide, about 1.9 times longer than second, and about 1.7 times longer than fourth; antennomeres 4~6 subequal; antennomeres 7~10 gradually slenderized distally; apical antennomere oblong, about 2.5 times longer than wide, and about 1.4 times longer than tenth. **Pronotum** convex, as long as wide, quadrate, parallel-sided, abruptly narrowed from basal four-fifth, and truncated at anterior margin; with finer and rougher punctures than head; pronotal lateral ridge divided; anterolateral ridge shortly extended, about one-fourth of length of pronotum; posterolateral ridge almost two-third of length of pronotum; antiscutellar area slightly notched; pronotal posterior angles sharply produced, exceeding posterior margin of antiscutellar area. **Scutellum** trapezoidal, about 1.15 times longer than wide, gradually narrowed posteriad, and weakly rounded at apex; roughly punctate; rarely pubescent. **Elytra** conjointly with width to length as about 1 to 2.3, parallel-sided, and gradually attenuated near apices; slightly striated, with shallow and

irregular punctures; interstriae slightly convex; with large and deep punctures near apices; distinctly compressed and protruded at apices. **Prosternum** transverse, gradually expanded anteriorly; mostly with sparser and more regular punctures than pronotum, slightly more large and disperse laterally; prosternal process stout, gradually narrowed posteriorly, declined near apex; with a medio-longitudinal keel; hypomeron with denser and more rough punctures than prosternum; with wrinkled surface at posterior fossae; hypomeran antennal grooves (Fig. 38, H1) well-developed, notosternal, triangular, shallow, and with scattered punctures, especially at posterior region. **Mesosternum** roughly punctate; mesepimeron fused with mesepisternum, glabrous at posterior region. **Metasternum** with finer, denser, and more regular punctures than prosternum, especially at middle; with a weak medio-longitudinal groove at middle, not reaching anterior margin; metepisternum (Fig. 35, I1) parallel-sided, width of posterior margin about four-fifth of outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, I1) strongly expanded inward, medially about 2.7 times wider than laterally. **Legs** (Fig. 37, I1) slightly short; tibiae and tarsi slender; first tarsomere of hind leg about 1.1 times longer than tarsomeres 2~4 combined; second tarsomere about 1.2 times longer than third; fifth tarsomere about 1.2 times longer than second; claws simple. **Abdomen** strongly connate; with finer and denser punctures than metasternum; fifth ventrite with transverse crest with dense hairs at middle and rounded at apical margin (Fig. 38, O1). **Aedeagus** (Fig. 39, G1~2) elongate, laterally compressed near base, and about 5.6 times longer than wide; median lobe straight in lateral view, gradually widened distally, deeply bifurcated at apex; basal strut not reaching basal piece; lateral lobes straight as

median lobe, weak apical tooth extended inward near apex, apex densely setose on inner margin; basal piece rectangular, about 1.5 times longer than wide, almost one-fourth of length of aedeagus. **Female** unavailable specimen in this study.

Specimens examined. <GW> 1 ♂, Osaek-ri, Seo-myeon, Yangyang-gun, 20. vi. 2015, leg. S. H. Lee; 1 ♂, Micheon-ri, Seo-myeon, Yangyang-gun, 09. vii. 2015, leg. S. H. Lee.

Distribution. Korea, Japan.

Remarks. *Farsus ainu* can be easily distinguished from other Korean eucnemids by crest with dense hairs at fifth abdominal ventrite. Male individuals were observed under bark of dead tree.

Genus *Microrhagus* Dejean, 1833

Arhagus Méquignon, 1925a: 187. Type species: *Microrhagus pyrenaeus* Bonvouloir, 1872.

Dichodirhagus Méquignon, 1925b: 240. Type species: *Microrhagus pyrenaeus* Bonvouloir, 1872.

Microrhagus Dejean, 1833: 85. Type species: *Elater pygmaeus* Fabricius, 1792.

Dirhagus Latreille, 1834: 130. Type species: *Elater pygmaeus* Fabricius, 1792.

Aulacostenus Motschulsky, 1870: 117. Type species: *Aulacostenus pavidus* Motschulsky, 1870.

Emyirhagus Olexa, 1975. Type species: *Microrhagus emyi* Rouget, 1856.

Diagnosis. Body elongate, oblong, and weakly convex; head moderately inserted into prothorax; with excretory pits between eyes and antennal sockets; clypeus strongly narrowed at base; antennae serrate or pectinate, mostly more delicate in male; third antennomere shorter or as long as antennomeres 4~5 combined; pronotum subquadrate to trapezoidal; pronotal lateral ridge divided; hypomerall antennal grooves well-developed, notosternal, with excretory pits; metepimeron invisible; metepisternum subparallel-sided or widened posteriorly; posterior coxal plate expanded inward; legs short, fairly slender; first tarsomere of hind leg longer or as long as 2~3 combined; fourth tarsomere slightly dilated; fifth abdominal ventrite dully produced or simply rounded at apex; aedeagus with apically bifurcated median lobe (Lacordaire, 1857; Bonvouloir, 1872; Reitter, 1921; Fleutiaux, 1935; Hisamatsu, 1960, 1985; Muona, 2000).

Key to the species of Korean *Microrhagus*

1. Frons shortly keeled or grooved at middle; antennae of male pectinate from third antennomere; pronotum narrowing anteriorly, with a pair of dimples at middle ... **2**
- Frons simple; antennae of male pectinate from fourth antennomere; pronotum quadrate, without dimples at middle *M. mystagogus*
2. Antennae of male branched near base in third antennomere, near middle in fourth,

- near apex in antennomeres 5~10; pronotum without groove at middle; lateral lobes of aedeagus narrowly produced at apex **3**
- Antennae of male branched near apex in antennomeres 3~10; pronotum with a distinct longitudinal groove at middle; lateral lobes of aedeagus truncated at apex ***Microrhagus* sp. nov.**
3. Third antennal branch as long as length of third antennomere; pronotum less densely punctate, distance between punctures more than its diameter; ventral lobe of aedeagus distinctly broadened toward apex ***M. foveolatus***
- Third antennal branch about 1.4 times longer than length of third antennomere; pronotum very densely punctate, distance between punctures less than its diameter; ventral lobe of aedeagus subparallel-sided, barely broadened ***M. ramosus***

***Microrhagus* sp. nov.**

Diagnosis. Body mostly shiny black; frons with a distinct longitudinal groove at middle; antennae pectinate from third antennomere in male, serrate in female; pronotum with a pair of dimples and a distinct longitudinal groove at middle; scutellum slightly elevated in lateral view; elytra conjointly with width to length as about 1 to 2.65; hypomeral antennal grooves well-developed, notosternal, slightly widened posteriad, and with outer marginal keel; metepisternum narrow, slightly widened posteriad, as long as outer margin of posterior coxal plate; posterior coxal

plate expanded inward; fifth abdominal ventrite narrowly rounded at apical margin.

Description. Male (Fig. 16, A, C~D) 4.9~5.2 mm long and 1.4~1.5 mm wide. **Body** strongly elongate, subcylindrical and weakly convex; mostly black; second antennomere, antennal branches, mandible, and tibiae ferruginous; maxillary palpi and tarsi yellowish brown; with fairly shiny surface; covered with golden pubescence. **Head** large, moderately inserted into prothorax; mostly with circular, irregular and rough punctures, especially at clypeus; compound eyes well-developed, undivided; with a distinct short median groove at frons; frontoclypeal region slightly depressed; clypeus feebly concave at middle of apical margin, broadly bifurcated, width of clypeal apex about 3.9 times wider than distance between antennal sockets (Fig. 34, E1). **Antennae** (Fig. 33, E1) pectinate from third antennomere; third, fourth, and fifth ramose about 1.05, 1.65, and 1.75 times longer than length of each antennomeres, respectively; almost exceeding first abdominal ventrite, covered with yellowish brown hairs; first antennomere oblong and robust; second antennomere obconical and shortest; third antennomere about 1.65 times longer than second, as long as fourth; antennomeres 3~10 branched near apex, gradually lengthened toward apex; apical antennomere elongate, curved, about 7.3 times longer than wide, and about 1.9 times longer than tenth. **Pronotum** weakly convex, about 1.3 times wider than long, subparallel-sided near base, gradually narrowed anteriorly from basal two-third, and broadly arcuate at anterior margin; mostly with finer, sparser, and more regular punctures than head, gradually largely and densely punctate at lateral region; with a pair of prominent dimples at middle;

with a distinct longitudinal groove at middle; weakly impressed at base; pronotal lateral ridge divided; anterolateral ridge shortly extended, about one-third of length of pronotum; posterolateral ridge almost three-fifth of length of pronotum; antiscutellar area almost straight, weakly sinuate; pronotal posterior angles sharply produced, slightly extended outwardly, and distinctly exceeding posterior margin of antiscutellar area. **Scutellum** slightly raised in lateral view; trapezoidal, about 1.15 times longer than wide, gradually narrowed posteriad, and rounded at apex; roughly punctate; densely pubescent. **Elytra** conjointly with width to length as about 1 to 2.65, parallel-sided, gradually attenuated near apices; fairly striated, with irregular punctures; interstriae weakly convex; with several large and deep punctures near apices; simply rounded at apices. **Prosternum** transverse, with curved sides, slightly widened anteriorly, and anterior margin weakly trilobed; mostly with larger, sparse, and more regular punctures than head, especially at medial region; prosternal process robust, gradually tapered and oblique posteriad; hypomeron with larger, denser, and rougher punctures than prosternum; with rugose surface at posterior fossae; hypomeral antennal grooves (Fig. 38, D1) well-developed, notosternal, slightly widened posteriad, with outer marginal keel, with several rough punctures at posterior region, fairly glossy, and with excretory pores. **Mesosternum** with shallow and rough punctures; mesepimeron fused with mesepisternum, with rough punctures, especially at anterior region. **Metasternum** mostly with finer and denser punctures than prosternum; with a medio-longitudinal groove, not reaching anterior margin; metepisternum (Fig. 35, E1) narrow, gradually widened posteriad, widest width as long as outer margin of posterior coxal plate; posterior coxal plate

(Fig. 36, E1) expanded inward, medially about 1.6 times wider than laterally. **Legs** (Fig. 37, E1) moderate in length, fairly slender; first tarsomere of hind leg about 1.5 times longer than tarsomeres 2~4 combined; second tarsomere about 1.3 times longer than third; fifth tarsomere about 1.2 times longer than second; claws simple. **Abdomen** strongly connate; with finer and denser punctures than metasternum; first ventrite with excretory pit at anterolateral margin; fifth ventrite narrowly rounded at apical margin (Fig. 38, L1). **Aedeagus** (Fig. 39, C1~2) elongate, about 4.3 times longer than wide, slightly compressed dorsoventrally; median lobe elongate, slightly curved near apex in lateral view, broadly bifurcated basally, slightly widened toward apex, broadly notched and setose at apex; lateral lobes slender, almost straight in lateral view, with apical tooth inwardly, truncated at apex, pubescent with dense hairs near apex; ventral lobe shorter and broader than median lobe, almost truncated at apical margin; basal piece gourd-shaped, curved sided, about 1.45 times longer than wide, approximately one-third of length of aedeagus. **Female** (Fig. 16, B) can be distinguished from male by sexual dimorphism: 4.8~6.1 mm long and 1.4~1.8 mm wide; clypeus slightly more wide at base than those of male, width of clypeal apex about 3.7 times wider than distance between antennal sockets (Fig. 34, E2); antennae (Fig. 33, E2) serrate, relatively shorter than male, not exceeding posterior coxal plate; first antennomere oblong and stout; second antennomere obconical, shortest; third antennomere elongate, rectangular, approximately twice as long as wide, about 1.7 times longer than second, and about 1.3 times longer than fourth; antennomere 4~10 slightly lengthened and slenderized toward apex; apical antennomere elongate, about 5.3 times longer than wide, and about 1.8 times longer

than tenth.

Specimens examined. <JJ> 1 ♀, Donnaeko, Sanghyo-dong, Seogwipo-si, Seogwipo-si, 12. v. 2016, leg. J. B. Seung; 1 ♀, Hwasun gotjawal, Hwasun-ri, Andeok-myeon, Seogwipo-si, 12. v. 2016, leg. J. B. Seung; 5 ♀, Gyoraе gotjawal, Gyoraе-ri, Jocheon-eup, Jeju-si, 12. v ~ 10. vi. 2016, leg. Seung and Jung by FIT; 4 ♂, 2 ♀, Hwasun gotjawal, Hwasun-ri, Andeok-myeon, Seogwipo-si, 12. v ~ 10. vi. 2016, leg. Seung and Jung by FIT; 1 ♂, 2 ♀, Seongpanak, Gyoraе-ri, Jocheon-eup, Jeju-si, 12. v ~ 10. vi. 2016, leg. Seung and Jung by FIT.

Distribution. Korea (Jeju Island).

Remarks. *Microrhagus* sp. nov. similar to *M. foveolatus*, but can be distinguished by following characters: frons significantly grooved at middle; pronotum with a distinct medio-longitudinal groove at middle; elytra relatively elongate, width to length ratio about 1 to 2.65; lateral lobes of aedeagus short and truncated at apex. The structure of aedeagus closely resembles those of *M. pectinicornis*, but differ in antennal branches. Antennae of male of *M. pectinicornis* branched near base in third and fourth antennomere.

***Microrhagus foveolatus* (Fleutiaux, 1923)**

Dirhagus foveolatus Fleutiaux, 1923: 308.

Dirrhagus foveolatus Fleutiaux, 1935: 17.

Diagnosis. Body mostly shiny black; frons with a weak longitudinal keel at middle; antennae pectinate from third antennomere in male, serrate in female; pronotum with fairly sparse punctures, distance between punctures more than its diameter, with a pair of distinct dimples at middle; scutellum raised in lateral view; elytra conjointly with width to length as about 1 to 2.45; hypomer al antennal grooves well-developed, notosternal, and slightly expanded posteriad; metepisternum gradually widened posteriad, widest width narrower than outer margin of posterior coxal plate; posterior coxal plate expanded inward; fifth abdominal ventrite weakly compressed and narrowly rounded at apical margin.

Redescription. Male (Fig. 17, A, C~D) 5.1~6.0 mm long and 1.6~1.9 mm wide. **Body** elongate, subcylindrical, and fairly convex; mostly black with yellowish brown tarsi; with strongly glossy surface; covered with golden pubescence. **Head** moderately inserted into prothorax; mostly with circular and regular punctures, denser at frontoclypeal region; frons with a weak medio-longitudinal keel at middle; frontoclypeal region slightly depressed; clypeus broadly rounded and slightly sinuate at apical margin, width of clypeal apex about 3.7 times wider than distance between antennal sockets (Fig. 34, F1). **Antennae** (Fig. 33, F1) pectinate from third antennomere; third, fourth, and fifth ramose about 1.05, 2.1 and 2.1 times longer than length of each antennomeres, respectively; almost exceeding posterior coxal plate, covered with yellowish brown pubescent; first antennomere oblong and robust; second antennomere obconical, shortest; third antennomere branched near base, about 1.65 times longer than second, and about 1.3 times longer than fourth;

fourth antennomere branched near middle; antennomeres 5~10 branched near apex; apical antennomere strongly elongate, curved, about 9.5 times longer than wide, and about 2.5 times longer than previous. **Pronotum** fairly convex, about 1.15 times wider than long, subparallel-sided near base, gradually narrowed anteriorly, and broadly arcuate at anterior margin; with punctures as head, slightly larger at lateral region, distance between punctures more than its diameter; with a pair of distinct dimples at middle; with a short medio-longitudinal keel at base, depressed symmetrically at base and near posterior angles; pronotal lateral ridge divided; anterolateral ridge exceeding half of length of pronotum; posterolateral ridge almost reaching half of length of pronotum, sometime fused with anterolateral ridge; antiscutellar area almost straight; pronotal posterior angles sharply produced, distinctly exceeding posterior margin of antiscutellar area. **Scutellum** slightly raised in lateral view; trapezoidal, about 1.1 times longer than wide, gradually narrowed posteriorly, and rounded at apex; roughly and densely punctate; pubescent with dense hairs, especially at apex. **Elytra** conjointly with width to length as about 1 to 2.45, subparallel-sided, gradually attenuated posteriorly; fairly striated, with rough and irregular punctures; interstriae convex; with large and deep punctures near apices; simply rounded at apices. **Prosternum** transverse, with curved sides, anterior margin weakly trilobed; almost with punctures as head, more denser at anterior and posterior regions; prosternal process stout, gradually tapered and declined posteriorly; hypomeron with more scattered punctures than prosternum; hypomeral antennal grooves (Fig. 38, E1) well-developed, notosternal, slightly expanded posteriorly, rarely punctate, glabrous, and with excretory pores. **Mesosternum** roughly punctate;

mesepimeron and mesepisternum fused, with rough punctures, especially at anterior region. **Metasternum** with finer and denser punctures than prosternum, especially at middle; with a weak median groove, not reaching anterior margin; metepisternum (Fig. 35, F1) gradually widened posteriad, widest width about four-fifth of outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, F1) expanded inward, medially about 2.3 times wider than laterally. **Legs** (Fig. 37, F1) moderately in length; tibiae and tarsi slender; first tarsomere of hind leg about 1.2 times longer than tarsomeres 2~4 combined; second tarsomere about 1.25 times longer than third; fifth tarsomere about 1.7 times longer than second; claws simple. **Abdomen** strongly connate; with finer punctures than metasternum; fifth ventrite slightly compressed and narrowly rounded at apical margin. **Aedeagus** (Fig. 39, D1~2) elongate, about 4.3 times longer than wide, strongly compressed dorsoventrally; median lobe slightly curved ventrally in lateral view, distinctly bifurcated at apex; lateral lobes as long as median lobe; feebly curved ventrally as median lobe, slightly convergent medially, dully pointed at apex, and with basally attached secondary lateral lobes; secondary lateral lobes shorter than lateral lobes; strongly bent ventrally, parallel-sided, pointed at apex, and covered with long hairs; ventral lobe as long as median lobe, gradually expanded toward apex, broadly truncated at apex, and densely pubescent; basal piece rectangular, about 1.75 times longer than wide, about one-third of length of aedeagus. **Female** (Fig. 17, B) can be distinguished from male by following characters: clypeal base slightly more wide than those of male, width of clypeal apex about 3.5 times wider than distance between antennal sockets (Fig. 34, F2); antennae (Fig. 33, F2) serrate, relatively shorter than those of

male, not reaching posterior coxal plate; first antennomere oblong and stout; second antennomere obconical and short, as long as fourth; third antennomere elongate, about 1.9 times longer than wide, about 1.7 times longer than second and fourth antennomeres; antennomere 4~10 gradually lengthened, slenderized, and more strongly toothed toward apex; apical antennomere elongate, about 3.5 times longer than wide, about 2.2 times longer than previous.

Specimens examined. <SL> 1 ♀, Gil-dong Natural Ecology Park, Gildong, Gangdong-gu, Seoul-si, 16. v. 2016, leg. B. H. Jung. <GG> 1 ♀, Deoksu-ri, Danwol-myeon, Yangpyeong-gun, 08 ~ 22. v. 2016, leg. Seung and Jung by FIT. <GW> 1 ♂, 1 ♀, Suha-ri, Daegwanryeong-myeon, Pyeongchang-gun, 05 ~ 29. vi. 2016, leg. Seung and Jung by FIT; 1 ♀, Wangsan-ri, Wangsan-myeon, Gangneung-si, 05 ~ 29. vi. 2016, leg. Seung and Jung by FIT. <JJ> 1 ♂, 1 ♀, Gyoraegotjawal, Gyoraegotjawal-ri, Jocheon-eup, Jeju-si, 10. vi. 2016, leg. J. B. Seung; 3 ♂, Gyoraegotjawal, Gyoraegotjawal-ri, Jocheon-eup, Jeju-si, 13. v ~ 10. vi. 2016, leg. Seung and Jung by FIT; 1 ♂, Seongpanak, Gyoraegotjawal-ri, Jocheon-eup, Jeju-si, 13. v ~ 10. vi. 2016, leg. Seung and Jung by FIT.

Distribution. Korea (New record), Japan, Russia (Far East).

Remarks. *Microrhagus foveolatus* is differentiated from *M. ramosus* by following characters: ratio of antennal branches, relatively shorter; pronotum with sparser punctures, distance between punctures more than its diameter; elytra relatively more elongate; ventral lobe of aedeagus gradually expanded toward apex. Adults were

observed at standing dead tree covered with hypae.

***Microrhagus mystagogus* (Fleutiaux, 1923)**

Dirrhagus mystagogus Fleutiaux, 1923: 309.

Dirrhagus mystagogus Fleutiaux, 1935: 17.

Diagnosis. Body mostly dull black; antennae pectinate from fourth antennomere in male, serrate in female; third antennomere elongate, about 1.75 times longer than fourth; pronotum fairly convex, quadrate, parallel-sided; elytra conjointly with width to length as about 1 to 2.3; hypomer al antennal grooves well-developed, notosternal, parallel-sided, barely punctate, and glabrous; metepisternum narrow, slightly widened posteriad, widest width narrower than outer margin of posterior coxal plate; posterior coxal plate expanded inward; fifth abdominal ventrite simply rounded at apical margin.

Redescription. Male (Fig. 18, A, C~D) 3.2~3.9 mm long and 1.0~1.2 mm wide. **Body** oblong, subcylindrical, and fairly convex; mostly black; antennae and femur chestnut; tibiae, and tarsi yellowish brown; with weakly glossy surface; covered with yellowish pubescence. **Head** moderately inserted into prothorax; mostly with circular and rough punctures, denser and coarser near clypeal base; frontoclypeal region slightly depressed; clypeus rounded and weakly sinuate at apical margin, width of clypeal apex about 3.9 times wider than distance between antennal sockets

(Fig. 34, G1). **Antennae** (Fig. 33, G1) pectinate from fourth antennomere; fourth, fifth and sixth ramose about 1.4, 2.3 and 2.6 times longer than length of each antennomeres, respectively; almost exceeding posterior coxal plate, covered with yellowish brown pubescent; first antennomere oblong and stout; second antennomere obconical, shortest; third antennomere elongate, gradually expanded toward apex, about 1.9 times longer than wide, about three times longer than second, and about 1.75 times longer than fourth; antennomeres 4~10 branched near apex, gradually lengthened toward apex; apical antennomere strongly elongate, curved, about 11.5 times longer than wide, and about 2.9 times longer than tenth. **Pronotum** fairly convex, as long as wide, quadrate, parallel-sided, and broadly arcuate at anterior margin; mostly with more regular punctures than head, slightly larger and sparser at posterior region; with a short median keel at base; pronotal lateral ridge divided; anterolateral keel shortly extended, not reaching anterior one-third; posterolateral keel exceeding posterior two-third; antiscutellar area almost straight; pronotal posterior angles sharply produced, and distinctly exceeding posterior margin of antiscutellar area. **Scutellum** subtriangular, about 1.1 times wider than wide, gradually narrowed posteriad, and rounded at apex; roughly punctate; barely pubescent. **Elytra** conjointly with width to length as about 1 to 2.3, parallel-sided, gradually narrowed near apices; indistinctly striated, with shallow and irregular punctures; interstriae slightly convex; with several large and deep punctures near apices; simply rounded at apices. **Prosternum** transverse, parallel-sided, anterior margin weakly trifurcated; mostly with punctures as pronotum, slightly larger at lateral margin; prosternal process robust at base, abruptly tapered and declined

posteriad; hypomerion mostly with punctures as prosternum, slightly rougher at posterior region; with wrinkled surface at posterior fossae; hypomeral antennal grooves (Fig. 38, F1) well-developed, notosternal, subparallel-sided, keeled marginally, rarely punctate, glabrous, with excretory pits. **Mesosternum** roughly punctate; mesepimeron fused with mesepisternum, with coarse and irregular punctures, especially at anterior region. **Metasternum** mostly with finer punctures than prosternum, slightly larger at lateral region; with a medio-longitudinal groove, not reaching anterior margin; metepisternum (Fig. 35, G1) significantly widened posteriad, widest width about four-fifth of outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, G1) expanded inward, medially about 1.8 times wider than laterally. **Legs** (Fig. 37, G1) moderate in length; tibiae and tarsi slender; first tarsomere of hind leg about 1.3 times longer than tarsomeres 2~4 combined; second tarsomere about 1.3 times longer than third; fifth tarsomere about 1.2 times longer than second; claws simple. **Abdomen** strongly connate; with slightly finer and denser punctures than metasternum; fifth ventrite rounded at apical margin (Fig. 38, M1). **Aedeagus** (Fig. 39, E1~2) elongate, about 3.85 times longer than wide, compressed dorsoventrally; median lobe slightly bent ventrally in lateral view, distinctly sloped, fused with lateral lobes; lateral lobes strongly curved ventrally, enlarged near apex, densely setose; basal piece strongly bifurcated basally, about 1.62 times longer than wide, approximately one-fifth of length of aedeagus. **Female** (Fig. 18, B) can be distinguished from male by following characters: body more stout than male, 3.4~3.9 mm long and 1.1~1.3 mm wide; clypeus (Fig. 34, G2) slightly more wide at base than those of male, width of clypeal apex about 3.7 times

wider than distance between antennal sockets; antennae (Fig. 33, G2) serrate, not reaching posterior coxal plate; first antennomere elongate; second antennomere obconical, shortest; third antennomere rectangular, elongate, about 3.1 times longer than wide, about 2.25 times longer than second, and about 1.6 times longer than fourth; antennomeres 4~10 gradually more strongly toothed; apical antennomere elongate, about 3.5 times longer than wide, and approximately twice longer than previous.

Specimens examined. <GG> 1 ♀, Deoksu-ri, Danwol-myeon, Yangpyeong-gun, 29. vi ~ 16. vii. 2016, leg. Seung and Jung by FIT. <GW> 1 ♂, 1 ♀, Yeongheung-ri, Yeongwol-eup, Yeongwol-gun, 19. vi ~ 02. vii. 2015, leg. Seung and Lee by FIT; 1 ♂, Beopheung-ri, Suju-myeon, Yeongwol-gun, 03 ~ 16. vii. 2015, leg. Seung and Lee by FIT; 1 ♂, 4 ♀, Beopheung-ri, Suju-myeon, Yeongwol-gun, 05 ~ 29. vi. 2016, leg. Seung and Jung by FIT.

Distribution. Korea (New record), Japan, Russia (Far East).

Remarks. *Microrhagus mystagogus* can be easily distinguished from other Korean *Microrhagus* species by its antennal structure, pronotum quadrate with parallel sides, hypomerall antennal grooves, and structure of aedeagus.

***Microrhagus ramosus* (Fleutiaux, 1902)**

Dirhagus ramosus Fleutiaux, 1923: 308.

Dirrhagus ramosus Fleutiaux, 1935: 17.

Diagnosis. Body mostly dull black; frons with a weak longitudinal keel at middle; antennae pectinate from third antennomere in male, serrate in female; pronotum with dense punctures, distance between punctures less than its diameter, with a pair of weak dimples at middle; hypomer al antennal grooves well-developed, notosternal, slightly expanded posteriad, and barely punctate; metepisternum gradually widened posteriad, widest width wider than outer margin of posterior coxal plate; posterior coxal plate expanded inward; fifth abdominal ventrite weakly compressed and narrowly rounded at apical margin.

Redescription. Male (Fig. 19, A, C~D) 3.3~4.8 mm long and 1.0~1.5 mm wide. **Body** elongate, subcylindrical, and fairly convex; mostly black; antennal branches and tibiae orange brown; tarsi yellowish brown; with dull surface; covered with yellowish pubescence. **Head** weakly inserted into prothorax; mostly with circular and regular punctures, finer and denser at frontoclypeal region, rougher at clypeus; frons with a weak longitudinal keel at middle; frontoclypeal region slightly depressed; clypeus (Fig. 34, H1) feebly bifurcated at apical margin, width of clypeal apex about 4.2 times wider than distance between antennal sockets. **Antennae** (Fig. 33, H1) pectinate from third antennomere; third, fourth, and fifth ramose about 1.35, 2.5, and 2.4 times longer than length of each antennomeres, respectively; almost exceeding posterior coxal plate, covered with yellowish brown vestiture; first antennomere oblong and robust; second antennomere obconical, shortest; third antennomere branched near base, 1.7 times longer than second, and about 1.3 times

longer than fourth; fourth antennomere branched near middle; antennomeres 5~10 branched near apex, gradually lengthened and slenderized toward apex; apical antennomere strongly elongate, curved, about 9.4 times longer than wide, and about 2.2 times longer than tenth. **Pronotum** fairly convex, about 1.1 times wider than wide, subparallel-sided near base, gradually narrowed anteriorly from basal two-third, and broadly rounded at anterior margin; mostly with denser punctures than head, slightly larger at lateral region, distance between punctures less than its diameter; with a pair of indistinct dimples at middle, with a short medio-longitudinal keel at base, depressed symmetrically at base and near posterior angles; pronotal lateral ridge divided; anterolateral ridge extended almost half of length of pronotum; posterolateral ridge almost exceeding half of length of pronotum, sometimes fused with anterolateral ridge; antiscutellar area weakly notched; pronotal posterior angles sharply produced, distinctly exceeding posterior margin of antiscutellar area. **Scutellum** distinctly raised in lateral view; triangular, about 1.3 times longer than wide, gradually narrowed posteriorly, and rounded at apex; roughly punctate; densely pubescent, especially near apex. **Elytra** conjointly with width to length as about 1 to 2.2, subparallel-sided, gradually narrowed posteriorly; weakly striated, with rough and irregular punctures; interstriae slightly convex, with several large and deep punctures near apices; simply rounded at apices. **Prosternum** transverse, with curved sides, anterior margin slightly trifurcated; with more scattered and regular punctures than pronotum; prosternal process stout, gradually tapered and declined posteriorly; hypomeron with rougher, denser, and larger punctures than prosternum; hypomeral antennal grooves (Fig. 38, G1) well-developed, notosternal, slightly

widened posteriad, barely punctate, glabrous, with excretory pits. **Mesosternum** roughly and irregularly punctate; mesepimeron fused with mesepisternum, with rough punctures, especially at anterior region. **Metasternum** with finer and sparser punctures than prosternum at middle, especially at middle; with a weak medio-longitudinal groove, not reaching anterior margin; metepisternum (Fig. 34, H1) gradually widened posteriad, widest width about 1.2 times wider outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, H1) expanded inward, medially about 2.3 times wider than laterally. **Legs** (Fig. 37, H1) moderate in length; tibiae and tarsi slender; first tarsomere of hind leg about 1.3 times longer than tarsomeres 2~4 combined; second tarsomere about 1.3 times longer than third; fifth tarsomere about 1.5 times longer than second tarsomere; claws simple. **Abdomen** strongly connate; punctate as metasternum; fifth ventrite weakly compressed and narrowly rounded at apical margin (Fig. 38, N1). **Aedeagus** (Fig. 39, F1~2) elongate, about five times longer than wide, strongly compressed dorsoventrally; median lobe slightly curved apically in lateral view, distinctly sloped and deeply bifurcated at apex; lateral lobes as long as median lobe, subparallel-sided curved ventrally as median lobe, fairly bifurcated at apex, with basally attached secondary lateral lobes; secondary lateral lobes parallel-sided strongly bent ventrally, pointed apically; ventral lobe shorter than median lobe, parallel-sided, truncated at apex, and densely pubescent; basal piece rectangular, about 1.6 times longer than wide, almost one-third of length of aedeagus. **Female** (Fig. 19, B) can be distinguished from male by following characters: clypeus (Fig. 34, H2) slightly more wide at base than those of male, width of clypeal apex about four times wider than distance between antennal

sockets; antennae (Fig. 33, H2) serrate, relatively shorter than male, not reaching posterior coxal plate; first antennomere oblong and stout; second antennomere obconical, short, as long as fourth; third antennomere elongate, about 1.9 times longer than wide, about 1.7 times longer than fourth; antennomere 4~10 gradually lengthened, slenderized and more strongly toothed toward apex; apical antennomere elongate, about 3.5 times longer than wide, about 2.2 times longer than previous.

Specimens examined. <GW> 5 ♂, 1 ♀, Beopheung-ri, Suju-myeon, Yeongwol-gun, 19. vi ~ 02. vii. 2015, leg. Seung and Lee by FIT; 2 ♂, 2 ♀, Deokgu-ri, Sangdong-eup, Yeongwol-gun, 19. vi ~ 02. vii. 2015, leg. Seung and Lee by FIT; 5 ♂, Deokgu-ri, Sangdong-eup, Yeongwol-gun, 02 ~ 16. vii. 2015 leg. Seung and Lee by FIT; 9 ♂, Wangsan-ri, Wangsan-myeon, Gangneung-si, 05 ~ 29. vi. 2016, leg. Seung and Jung by FIT; 1 ♂, Jindong-ri, Girin-myeon, Inje-gun, 13. vii. 2016, leg. M. S. Oh. <JN> 1 ♂, Jungdae-ri, Ganjeon-myeon, Gurye-gun, 04 ~ 15. vii. 2016, leg. Seung and Lee by FIT. <JJ> 1 ♂, Gyorae gotjawal, Gyorae-ri, Jocheon-eup, Jeju-si, 13. v ~ 10. vi. 2016, leg. Seung and Jung by FIT; 1 ♂, Seongpanak, Gyorae-ri, Jocheon-eup, Jeju-si, 13. v – 10. vi. 2016, leg. Seung and Jung by FIT.

Distribution. Korea (New record), Japan.

Remarks. *Microrhagus ramosus* show individual morphological variation as below: anterolateral ridge and posterolateral ridge of pronotum occasionally fused; ventral lobe of aedeagus sometimes slightly widened near apex.

Tribe Epiphanini Muona, 1993

Epiphanini Muona, 1993: 45. Type genus: *Epiphanis* Eschscholtz, 1829.

Diagnosis. Body oblong and subcylindrical; pronotal lateral ridge complete; hypomeron gradually narrowed anteriorly; hypomerol antennal grooves absent; mesepimeron fused with mesepisternum; posterior coxal plate expanded inward; tibia of foreleg with one spur; first tarsomere of foreleg without sex comb in male; abdominal ventrites connate; median lobe of aedeagus deeply bifurcated at apex, fused with lateral lobes (Muona 1993, 2000).

Genus *Hylis* Gozis, 1886

Hylis Gozis, 1886: 21. Type species: *Eucnemis procerulus* Mannerheim, 1823.

Etatocoelus Hyslop, 1921: 644. Type species: *Hypocaelus matthiesseni* Reitter, 1906.

Hypohylis Reitter: 1911: 203. Type species: *Hypocaelus matthiesseni* Reitter, 1906.

Hypocoelus auct.

Diagnosis. Body oblong, oval, and slightly convex; head often with a medio-longitudinal keel at frons; clypeal mostly rounded at apical margin; antennae more or less serrate, mostly more slender in male than those of female; antennomeres mostly keeled medially; fourth antennomere shorter than antennomeres 2~3 combined; pronotal lateral ridge simple; elytra indistinctly striated, with irregular

punctures; hypomeron gradually narrowed anteriorly and without excretory pits; hypomeral antennal grooves mostly absent; metepimeron invisible; metepisternum subparallel-sided; posterior coxal plate expanded inward; tarsi slender; fourth tarsomere obliquely truncated; fifth abdominal ventrite simply rounded or distinctly pointed; median lobe of aedeagus deeply bifurcated at apex, fused with lateral lobes (Bonvouloir, 1875; Fleutiaux, 1923, 1935; Hisamatsu, 1985; Muona 2000, 2011).

***Hylis harmandi* (Fleutiaux, 1923)**

Hypocoelus harmandi Fleutiaux, 1923: 326.

Diagnosis. Body mostly dull black; frons with a distinct crest with dense hairs near clypeal base in male; antennae weakly serrate in male, almost moniliform in female; third antennomere shorter than antennomeres 4~5 combined; pronotum with a indistinct median groove at basal half; hypomeral antennal grooves absent; metepisternum subparallel-sided, slightly widened posteriorly, widest width as long as outer margin of posterior coxal plate; posterior coxal plate expanded inward; fifth abdominal ventrite almost truncated or weakly concave at apical margin.

Redescription. Male (Fig. 21, A, C~D) 3.4~3.9 mm long and 1.25~1.3 mm wide. **Body** oblong, subcylindrical and slightly convex; mostly black; antennae, tibiae, and tarsi chestnut; mostly with dull surface, fairly glossy at elytra and hypomera; covered with yellowish brown pubescence. **Head** large, weakly inserted into prothorax; mostly with circular, irregular, and rough punctures, slightly larger and

rougher at clypeus; compound eyes undivided; frontoclypeal region with a deep crest with dense hairs; clypeus broadly rounded at apical margin, width of clypeal apex about 2.5 times wider than distance between antennal sockets (Fig. 34, J1). **Antennae** (Fig. 33, J1) weakly serrate, almost reaching first abdominal ventrite, covered with short yellowish brown vestiture; first antennomere stout and robust; second antennomere obconical, shortest; third antennomere gradually widened toward apex, about 1.45 times longer than wide, about 1.85 times longer than second, and approximately 1.2 times longer than fourth; antennomeres 4~10 gradually lengthened toward apex; apical antennomere oblong, about 2.9 times longer than wide, approximately 1.65 times longer than previous. **Pronotum** trapezoidal, fairly convex, about 1.2 times wider than wide, subparallel-sided, abruptly narrowed from basal two-third, almost truncated at anterior margin; with larger, denser, and more regular punctures than head; with a indistinct medio-longitudinal groove at basal half; antiscutellar area almost straight; pronotal posterior angles sharply produced, slightly extended outward, and distinctly exceeding posterior margin of antiscutellar area. **Scutellum** trapezoidal, as long as wide, gradually narrowed posteriad, and rounded at apex; roughly punctate; densely pubescent near apex. **Elytra** conjointly with width to length as about 1 to 2.3, subparallel-sided, gradually attenuated posteriad; fairly striated, with rough and irregular punctures; interstriae slightly convex; with several large and deep punctures near apices; simply rounded at apices. **Prosternum** trapezoidal, gradually widened anteriorly, anterior margin straight; with finer and denser punctures than head; prosternal process robust, parallel-sided, abruptly narrowed and declined near

apex; hypomeron mostly with larger and more scattered punctures, especially at anterior region; with rugose surface at posterior fossae; hypomeral antennal grooves absent. **Mesosternum** densely and coarsely punctate; mesepimeron fused with metepisternum, with rough punctures, especially at anterior region. **Metasternum** punctate as prosternum; with a medio-longitudinal groove, not reaching anterior margin; metepisternum (Fig. 35, J1) subparallel-sided, gradually widened posteriad, and widest width as wide as outer margin of posterior coxal; posterior coxal plate (Fig. 36, J1) expanded inward, medially about 2.3 times wider than laterally. **Legs** (Fig. 37, J1) slender; first tarsomere of hind leg about 1.4 times longer than tarsomeres 2~4 combined; second tarsomere about 1.4 times longer than third; fifth tarsomere about 1.1 times longer than second; claws simple. **Abdomen** strongly connate; punctate as metasternum; first ventrite with a pair of pits at anterolateral margin; fifth ventrite almost truncated at apical margin (Fig. 38, P1). **Aedeagus** (Fig. 39, H1~2) elongate, about 4.6 times longer than wide, strongly compressed dorsoventrally, setose at dorsal surface; median lobe elongate, straight in lateral view, extended outward apically, and deeply bifurcated at apex; basal strut absent; lateral lobes slender, almost straight in lateral view, and with apical tooth inwardly; basal piece quadrate, as long as wide, and approximately one-fifth of length of aedeagus. **Female** (Fig. 21, B) similar to male, but can be distinguished from male by following characters: Body more large and stout, 3.95~4.7 mm long and 1.3~1.65 mm wide; frontoclypeal region weakly depressed and simply pubescent than those of male; clypeus (Fig. 34, J2) more wide at base, width of clypeal apex about 2.2 times wider than distance between antennal sockets; antennae (Fig. 33, J2)

almost moniliform, relatively shorter than male, not reaching posterior coxal plate; third antennomere more elongate, about 1.7 times longer than wide, about 1.7 times longer than second and fourth antennomeres; antennomeres 4~10 more stubby, slightly lengthened and slenderized toward apex; apical antennomere oblong, approximately twice wider than long.

Specimens examined. <GW> 2 ♂, 1 ♀, Yeongheung-ri, Yeongwol-eup, Yeongwol-gun, 19. vi ~ 02. vii. 2015, leg. Seung and Lee by FIT; 1 ♀, Yeongheung-ri, Yeongwol-eup, Yeongwol-gun, 02 ~ 16. vii. 2015, leg. Seung and Lee by FIT; 2 ♂, Yeongheung-ri, Yeongwol-eup, Yeongwol-gun, 16 ~ 30. vii. 2015, leg. Seung and Lee by FIT.

Distribution. Korea (New record), China (Northeast), Japan, Russia (Far East).

Remarks. *Hylis harmandi* is characteristic by a distinct crest with dense hairs at frons in male. S. Hisamatsu (1985) said that length of antennomeres 4~5 combined is about 1.7~1.9 times longer than third. As a result of the present study, ratio of 1.7 is corresponded to male and 1.9 for female.

Tribe Hylocharini Jacquelin du Val, 1859

Hylocharites Jacquelin du Val, 1859: 119. Type genus: Hylochaes Latreille, 1834.

Hylocharini Cobos, 1965: 369. Type genus: Hylochaes Latreille, 1834.

Diagnosis. Body oblong and cylindrical; antennae weakly serrate or miniliform;

pronotum with transverse impression; pronotal lateral ridge complete; hypomeral antennal grooves absent; posterior coxal plate subparallel-sided; tibia of foreleg with one apical spur; first tarsomere of foreleg without sex comb in male; seventh tergite keeled at middle; aedeagus bulbous (Muona, 1993, 2000).

Genus *Hylochaes* Latreille, 1834

Hylochaes Latreille, 1834: 127. Type species: *Elater cruentatus* Gyllenhal, 1808.

Diagnosis. Body oblong and cylindrical, rarely pubescent with short hairs; antennae weakly serrate or miniliform; pronotum with transverse impression medio-laterally; pronotal lateral ridge complete; hypomeron narrowed anteriorly; hypomeral antennal grooves absent; mesepimeron fused with mesepisternum; posterior coxal plate subparallel-sided; tibia of foreleg with one spur; first tarsomere of foreleg without sex comb in male; abdominal ventrites connate; seventh tergite keeled at middle; aedeagus bulbous (Muona, 1993, 2000).

***Hylochaes harmandi* Fleutiaux, 1900**

Hylochaes harmandi Fleutiaux, 1900: 360.

Diagnosis. Body mostly shiny black; frons with a distinct longitudinal depression; clypeus distinctly trifurcated at apical margin; antennae moniliform, almost reaching metepisternum; pronotum with lateral impressions and medio-longitudinal

depression at middle; elytra distinctly striated, with deep and regular punctures; hypomer al antennal grooves absent; metepisternum gradually widened posteriad, widest width wider than outer margin of posterior coxal plate; posterior coxal plate subparallel-sided; fifth abdominal ventrite strongly compressed and beaked at apical margin.

Redescription. Male (Fig. 22, A, C~D) 4.8~6.6 mm long and 1.5~2.2 mm wide. **Body** oblong, cylindrical, and strongly convex; mostly black; antennae dark ferruginous to dull black; tibiae, femur, and tarsi chestnut; with strongly glossy surface; rarely covered with short yellowish brown hairs. **Head** deeply inserted into prothorax, barely visible in dorsal view; mostly with circular and irregular punctures, rougher and denser at clypeus; with a distinct longitudinal depression at frons; clypeus rounded at middle of apical margin, distinctly trifurcated at apical margin, width of clypeal apex about 2.3 times wider than distance between antennal sockets (Fig. 34, K1). **Antennae** (Fig. 33, K1) moniliform, almost reaching metepisternum, covered with golden pubescence; first antennomere elongate and robust; second antennomere obconical, shortest; third antennomere elongate, about 1.65 times longer than wide, about 1.6 times longer than second, and about 1.4 times longer than fourth; antennomeres 4~10 subequal, as long as wide; apical antennomere oblong, truncated at apex, about 1.7 times longer than wide, about 1.5 times longer than previous. **Pronotum** strongly convex, about 1.1 times wider than wide, parallel-sided near base, abruptly narrowed anteriorly from basal half, and

almost truncated at anterior margin; mostly with rougher punctures than head, slightly larger and more scattered laterally, rarely punctate at posterior margin; with transverse depressions longitudinally and laterally at middle, strongly impressed at middle of base; antiscutellar area almost truncated; pronotal posterior angles short, dully produced, and almost exceeding posterior margin of antiscutellar area. **Scutellum** quadrate, as long as wide, subparallel-sided, weakly narrowed posteriad, and slightly rounded at apical margin; rarely punctate; barely pubescent. **Elytra** conjointly with width to length as about 1 to 2.3, parallel-sided, gradually attenuated near apices; strongly striated, with deep and regular punctures; interstriae strongly convex; with several strong and large punctures near apices; simply rounded at apices. **Prosternum** transverse, subparallel-sided, slightly widened anteriorly, and anterior margin distinctly trilobed; with more scattered punctures than pronotum, finer and denser at anterior and posterior regions, larger laterally; prosternal process robust, gradually tapered and declined posteriad; hypomeron punctate with larger and more irregular punctures than prosternum; with rough surface at posterior fossae; hypomeral antennal grooves absent. **Mesosternum** finely and coarsely punctate; mesepimeron fused with mesepisternum, mostly with rough and coarse punctures. **Metasternum** with finer, denser, and more regular punctures than prosternum; with a medio-longitudinal groove, not reaching anterior margin; metepisternum (Fig. 35, K2) gradually widened posteriad, widest width about 1.4 times wider than outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, K2) slightly expanded inward, weakly concave at middle, medially about 1.2 times wider than laterally. **Legs** (Fig. 37, K1) moderate in length and fairly slender; length

of tarsomeres 2~4 combined of hind leg about 1.2 times longer than first; second tarsomere about 1.3 times longer than third; fifth tarsomere about 1.8 times longer than fifth; claws simple. **Abdomen** connate; mostly with punctures as metasternum, strongly rougher and denser at fifth ventrite near apex; each ventrites convex; fifth ventrite abruptly narrowed, compressed and distinctly beaked at apical margin (Fig. 38, Q1). **Aedeagus** (Fig. 39, I1~2) bulbous, dorsoventrally flattened, about 3.5 times longer than wide; median lobe stout, with weakly biconcave-sided near apex, simply rounded at apical margin, and fused with lateral lobes; lateral lobes distinctly shorter than median lobe, parallel-sided, rounded at apex, and rarely setose apically; basal piece quadrate, as long as wide, almost one-fourth of length of aedeagus. **Female** (Fig. 22, B) very similar to male, but can be distinguished by the following characters: body more large and stout, 6.3~8.8 mm long and 2.1~3.0 mm wide; third antennomere more elongate than those of male, about 1.9 times longer than wide, about 1.7 times longer than fourth; apical antennomere about twice longer than wide, about 1.7 times longer than tenth (Fig. 33, K2); first tarsomere of hind leg as long as tarsomeres 2~4 combined; second tarsomere about 1.6 times longer than third.

Specimens examined. <GG> 2 ♂, Mt. Kalbong, Seungan-ri, Gapyeong-eup, Gapyeong-gun, 08. vi. 2009, leg. H. C. Park; 1 ♂, 1 ♀, Samhoe-ri, Cheongpyeong-myeon, Gapyeong-gun, 27. v. 2016, leg. S. H. Lee. <GW> 1 ♀, Beopheung-ri, Suju-myeon, Yeongwol-gun, 19. vi ~ 02. vii. 2015, leg. Seung and Lee by FIT; 1 ♀, Wangsan-ri, Wangsan-myeon, Gangneung-si, 05 ~ 29. vi. 2016, leg. Seung and Jung by FIT. <CN> 1 ♂, Bunam-ri, Sindoan-myeon, Gyeryong-si, 30. v. 1987, leg.

U. H. Baek; 1 ♂, Mt. Manin, Haso-dong, Dong-gu, Daejeon-si, 06. vi. 2016, leg. M. S. Oh. <JJ> 1 ♂, Gyoraegotjawal, Gyoraeri, Jocheon-eup, Jeju-si, 12. v ~ 10. vi. 2016, leg. Seung and Jung by FIT.

Distribution. Korea (New record), Japan, Russia (Far East).

Remarks. *Hylocharis harmandi* can be easily distinguished from other eucnemids by characteristic frons, antennae, pronotum, elytral striae, and apical margin of fifth abdominal ventrite. Adults were observed wandering at felling timbers in May and June. Individual variation was appeared in body size between male and female (smallest male: 4.8 mm; largest female: 8.8 mm).

Tribe Melasini Fleming, 1821

Melasidae Fleming, 1821: 49. Type genus: *Melasis* A. G. Olivier, 1790.

Melasini Bonvouloir, 1870: 19. Type genus: *Melasis* A. G. Olivier, 1790.

Diagnosis. Body elongate and cylindrical; labrum partly visible; antennae pectinate or flabellate in male, serrate in female; pronotal lateral ridge complete; hypomeron parallel-sided; hypomeran antennal grooves absent; prosternal process high, strongly convex; metepimeron partly exposed; legs distinctly slender or robust; first tarsomere of foreleg without sex comb in male; fifth abdominal ventrite narrowly pointed or beaked at apical margin; seventh abdominal tergite keeled medially; aedeagus bulbous, median lobe narrowly pointed at apical margin.

(Muona 1993, 2000, 2010).

Genus *Isorhipis* Lacordaire, 1835

Isorhipis Lacordaire, 1835: 622. Type species: *Isorhipis lepaigei* Lacordaire, 1835.

Tharops Laporte, 1835: 168. Type species: *Tharops melasoides* Laporte, 1835.

Diagnosis. Body strongly elongate and cylindrical; clypeus mostly trapezoidal, broadly rounded at apical margin; antennae flabellate in male, serrate in female; pronotum quadrate, parallel-sided, without anterior marginal keel; hypomeron mostly parallel-sided; hypomeran antennal grooves absent; mesepimeron fused with mesepisternum; metepimeron partly visible; metepisternum gradually widened posteriad; posterior coxal plate strongly expanded inward; legs long and slender; tibia of foreleg with one spur at apex; abdominal ventrites connate, convex; fourth and fifth ventrites keeled apically; aedeagus bulbous; median lobe of aedeagus sharply produced, lateral lobes of aedeagus with apical tooth (Bonvouloir, 1870; Fleutiaux, 1935; Hisamatsu, 1985; Muona, 1995, 2000, 2011).

***Isorhipis foveata* Hisamatsu, 1955**

Isorhipis foveata Hisamatsu, 1955: 96.

Diagnosis. Body elongate and fairly flattened; mostly dull black with yellowish

tinged elytra; antennae distinctly flabellate in male, serrate in female; pronotum strongly declined laterally, depressed at middle; elytra tinged with yellow at basal half; hypomerical antennal grooves absent; metasternum with a medio-longitudinal groove; metepisternum subparallel-sided; posterior coxal plate strongly expanded inward; fourth and fifth abdominal ventrite shortly keeled at apical margin; fifth tergite keeled medially, invisible in lateral view.

Redescription. Male (Fig. 23, A, C~D) 3.4~5.6 mm long and 0.8~1.4 mm wide. **Body** elongate, subcylindrical, and fairly flattened; mostly black; antennomeres 3~11, maxillary palpi and trochanters yellowish brown; second antennomere, basal half of elytra and tarsi yellow to bright yellowish brown; mostly with dull surface, slightly glossy at pronotum, hypomeron, and abdominal ventrites; covered with yellowish gray pubescence. **Head** large, moderately inserted into prothorax; mostly with circular, rough, and irregular punctures, slightly larger at clypeus; compound eyes undivided; frontoclypeal region slightly depressed; clypeus (Fig. 34, L1) broadly rounded at middle of apical margin, slightly trifurcated, width of clypeal apex about 1.85 times wider than distance between antennal sockets. **Antennae** (Fig. 33, L1) flabellate from fourth antennomere, almost exceeding mesosternum, and covered with yellowish grey pubescent; first antennomere oblong and robust; second antennomere obconical, about 1.5 times longer than fourth; third antennomere trapezoidal, gradually widened toward apex, approximately 1.7 times longer than wide, about 1.4 times longer than second; antennomeres 4~10 subequal, branched near apex; apical antennomere strongly elongate. **Pronotum** weakly

convex, quadrate, parallel-sided, about 1.15 times wider than wider, and weakly concave at anterior margin; mostly with sparser and more regular punctures than head, slightly denser and rougher at lateral and posterior regions; strongly compressed and declined laterally at each side, obviously depressed at middle, with a weak and short medio-longitudinal groove at base; antiscutellar area notched; pronotal posterior angles short, dully produced, slightly extended outward, and almost exceeding posterior margin of antiscutellar area. **Scutellum** trapezoidal, about 1.1 times longer than wide, anterior margin rounded, gradually narrowed posteriad, and weakly bifurcated at apex; roughly punctate; densely pubescent. **Elytra** conjointly with width to length as about 1 to 3.05, parallel-sided, gradually attenuated near apices; fairly striated, with regular punctures; intervals slightly convex; with several irregular and rough punctures near apices; simply rounded at apices. **Prosternum** rectangular, parallel-sided, and distinctly keeled at anterior margin; mostly with sparser and more regular punctures than head, especially at middle, slightly more denser at anterior and lateral regions; prosternal process slender, parallel-sided from coxae of foreleg, gradually oblique posteriad; hypomeron with denser and more regular punctures than prosternum at anterior region, gradually more rare posteriad; with wrinkled surface at posterior fossae; hypomerall antennal grooves absent. **Mesosternum** densely and coarsely punctate; mesepimeron fused with metepisternum, with rugose surface. **Metasternum** mostly with finer, denser, and more regular punctures than prosternum, gradually more scattered laterally; with a medio-longitudinal groove, not reaching anterior margin; metepisternum (Fig. 35, L1) narrow, subparallel-sided, about 1.5 times wider than

outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, L1) strongly expanded inward, medially approximately 4.6 times wider than laterally. **Legs** (Fig. 37, L1) long and slender; first tarsomere of hind leg about 1.1 times longer than tarsomeres 2~4 combined; second tarsomere about 1.6 times longer than third; fifth tarsomere about 1.4 times longer than second; claws simple. **Abdomen** connate; punctate as metasternum; ventrites 1~5 obviously elevated medially, fourth and fifth ventrites distinctly keeled at middle of apical margin, fifth tergite weakly and longitudinally keeled, barely visible at lateral view. **Aedeagus** (Fig. 39, J1~2) bulbous, about 3.2 times longer than wide; median lobe elongate, spindle-formed, strongly curved near apex in lateral view, and dully pointed at apex; basal struts reaching basal piece; lateral lobes slender, slightly extended outward, with apical tooth, slightly curved at lateral view, and dully pointed at apex; basal piece semicircular, as long as wide, approximately one-third of length of aedeagus. **Female** (Fig. 23, B) can be easily distinguished from male by sexual dimorphism: Body more elongate and large, 6.7~7.9 mm long and 1.5~1.8 mm wide; antennae (Fig. 33, L2) serrate, almost exceeding mesosternum; first antennomere oblong and stout; second antennomere obconical, shortest; third antennomere elongate, about twice longer than wide, approximately 2.1 times longer than second, and about 1.65 times longer than fourth; antennomere 4~10 subequal, gradually more strongly dentate toward apex; apical antennomere oblong, about 1.6 times longer than wide, and about 1.7 times longer than previous.

Specimens examined. <SL> 1 ♂, Cheongnyangni-dong, Dongdaemun-gu, Seoul-

si, 03. v. 2016, leg. J. K. Jung. <GG> 1 ♀, Gwangnung Arboretum, Sohol-eup, Pocheon-si, 21. v. 1992, leg. G. J. Weon; 1 ♀, Gwangnung Arboretum, Sohol-eup, Pocheon-si, 29. v. 1992, leg. G. J. Weon; 1 ♀, Gwangnung Arboretum, Sohol-eup, Pocheon-si, 21. v. 1995, leg. G. J. Weon; 1 ♂, 1 ♀, Deoksu-ri, Danwol-myeon, Yangpyeong-gun, 08. ~ 22. v. 2016, leg. Seung and Jung by FIT. <GW> 2 ♀, Cheonmi-ri, Bangsan-myeon, Yanggu-gun, 16. v. 2015, leg. S. H. Lee.

Distribution. Korea, Japan.

Remarks. *Isorhipis foveata* can be distinguished from other *Isorhipis* species by weakly serrated antennae of female, yellowish-tinged elytra, low median keel at seventh tergite. A female individual was observed wandering at felling timbers in May. Individual variation was observed in coloration of elytra, tinged with yellow wholly or basal half. Also, lateral lobes of male genitalia were observed which more or less extended laterally. Samples of male genitalia were very deficient, so additional examination should be needed.

Tribe Xylobiini Reitter, 1911

Xylobiini Reitter, 1911: 203. Type genus: *Xylobius Latreille*, 1834.

Diagnosis. Form oblong and subcylindrical; third antennomere mostly small; pronotal lateral ridge complete; hypomeron narrowed anteriorly; hypomeral antennal grooves mostly absent; posterior coxal plate subparallel-sided; tibia of foreleg with

one apical spur; first tarsomere of foreleg without sex comb in male; abdominal ventrites connate; seventh tergite keeled medially; aedeagus bulbous; median lobes of aedeagus fused with lateral lobes (Reitter, 1911; Muona, 1993, 2000).

Key to the genera of the tribe Xylobiini in Korea

1. antennomeres 4~11 with medio-longitudinal keel; hypomeral antennal grooves more or less developed *Proxylobius*
- antennomeres 4~11 without medio-longitudinal keel; hypomeral antennal grooves absent **2**
2. Body with strongly glossy surface; antennae moniliform; pronotum sparsely and regularly punctate; scutellum non-punctate, glabrous *Xylophilus*
- Body mostly with dull surface; antennae filiform or serrate; pronotum and scutellum densely and roughly punctate with pubescence *Bioxylus*

Genus *Bioxylus* Fleutiaux, 1923

Bioxylus Fleutiaux, 1923: 320. Type species *Xylobius japonensis* Fleutiaux, 1900.

Diagnosis. Body oblong and cylindrical; head convex; antennae filiform or serrate; second antennomere short, as long as or shorter than third; fourth antennomere as long as antennomeres 2~3 combined; pronotum fairly convex, often with a median

groove; hypomeron gradually narrowed anteriorly; hypomeral antennal grooves absent; metepisternum usually subparallel-sided; posterior coxal plate subparallel-sided; fourth tarsomere weakly dilated; abdominal ventrites connate; fifth ventrite simply rounded or pointed at apical margin; median lobe of aedeagus fused with lateral lobes; lateral lobes of aedeagus with basally attached secondary lateral lobes (Fleutiaux, 1923, 1935; Hismatsu, 1959, 1985; Muona, 2011).

Key to the species of the genus *Bioxylus* in Korea

1. Metepisternum strongly widened posteriorly; fifth abdominal ventrite distinctly produced at apical margin *Bioxylus personatus*
- Metepisternum subparallel-sided; fifth abdominal ventrite simply rounded at apical margin **2**
2. Body covered with dense hairs; elytra wholly unicolor, dark brown to black; fifth abdominal ventrite narrowly rounded at apical margin *Bioxylus pilosellus*
- Body covered with moderately dense hairs; elytral base ferruginous; fifth abdominal ventrite serrate at apical margin in male *Bioxylus natsumiae*

***Bioxylus natsumiae* Watanabe, 2009**

Bioxylus natsumiae Watanabe, 2009: 135.

Diagnosis. Body mostly dull black with reddish elytra base; head with a distinct keel medio-longitudinally from occiput to clypeal apex, more or less indistinct near apical margin; clypeus bifurcated at apical margin; antennae weakly serrate, distinctly long in male; first antennomere relatively short and stout; antennomeres 4~10 gradually slenderized toward apex; apical antennomere strongly elongate; pronotum strongly convex; scutellum triangular; metepisternum slightly widened posteriad; posterior coxal plate subparallel-sided, medially slightly wider than laterally; fifth abdominal ventrite distinctly serrate at apical margin in male.

Redescription. Male (Fig. 24, A, C~D) 3.3~4.3 mm long and 1.1~1.4 mm wide. **Body** oblong, cylindrical, and strongly convex; mostly black; mandibles, antennae, pronotal margin, posterior angles, scutellum, elytral base, and femur ferruginous; tibiae and tarsi orange-brown; mostly with dull surface; covered with fairly dense yellowish pubescence. **Head** deeply inserted into prothorax, barely visible in dorsal view; mostly with circular and rough punctures, slightly finer and denser at fronto-clypeal region; compound eyes undivided; with a medio-longitudinal keel from vertex to clypeal apex, indistinct at apical margin; frontoclypeal region weakly depressed; clypeus (Fig. 34, M1) concave at middle of apical margin, bifurcated, width of clypeal apex about 2.35 times wider than distance between antennal sockets. **Antennae** (Fig. 33, M1) weakly serrate, almost reaching fourth abdominal ventrite, and covered with yellowish brown pubescence; first antennomere oblong and stout; second antennomere obconical, short, and about 1.5 times longer than third; third antennomere shortest, closely connected to fourth; fourth antennomere

rectangular, about 1.2 times longer than wide, and approximately 1.2 times longer than antennomeres 2~3 combined; fifth antennomere about 1.1 times longer than fourth; antennomeres 5~10 gradually lengthened and slenderized toward apex; apical antennomere distinctly elongate, about five times longer than wide, and about 1.6 times longer than tenth. **Pronotum** strongly convex, about 1.2 times wider than wide, subparallel-sided, abruptly narrowed anteriorly from basal three-fifth, and arcuate at anterior margin; mostly with finer, denser, and rougher punctures than head, slightly larger and sparser at posterior region; antiscutellar area weakly notched; pronotal posterior angles sharply produced, and distinctly exceeding posterior margin of antiscutellar area. **Scutellum** triangular, about 1.25 times longer than wide, gradually narrowed posteriorly, and dully pointed at apex; sparsely punctate; rarely pubescent. **Elytra** conjointly with width to length as about 1 to 2.1, parallel-sided, gradually attenuated posteriorly near apices; fairly striated with rough and fine punctures; interstriae weakly convex; with several large and deep punctures near apices; simply rounded at apices. **Prosternum** transverse, gradually widened anteriorly, and weakly trifurcated at anterior margin; with punctures as head; prosternal process parallel-sided, abruptly narrowed and declined near apex; hypomeron mostly with larger and sparser punctures than prosternum, gradually more scattered posteriorly; with rugose and wrinkled surface at posterior fossae; hypomeral antennal grooves absent. **Mesosternum** finely and roughly punctate; mesepimeron fused with metepisternum, mostly non-punctate, with glabrous surface, especially at posterior region. **Metasternum** with finer, sparser and more regular than prosternum; with a weak medio-longitudinal groove, more or less

indistinct near anterior margin; metepisternum (Fig. 35, M1) subparallel-sided, slightly widened posteriad, widest width about 1.5 times wider than outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, M1) slightly expanded inward, medially about 1.5 times wider than laterally. **Legs** (Fig. 37, M1) moderate in length; tibiae and tarsi slender; first tarsomere of hind leg about 1.3 times longer than tarsomeres 2~4 combined; second tarsomere about 1.15 times longer than third; fifth tarsomere about 1.5 times longer than second; claws simple. **Abdomen** strongly connate; punctate as metasternum; fifth ventrite distinctly serrated at apical margin (Fig. 38, R1). **Aedeagus** (Fig. 39, K1~2) about 3.2 times longer than wide; median lobe elongate, about 4.6 times longer than wide, gradually narrowed distally from basal two-third, slightly bent ventrally in lateral view, fused with lateral lobes; basal strut short, not reaching basal piece; lateral lobes convergent medially, slightly longer than median lobe, strongly curved ventrally in lateral view, with basally attached secondary lateral lobes; secondary lateral lobes subparallel-sided, stout, as long as lateral lobes, shortly setose; basal piece about 1.25 times wider than long, almost one-fifth of length of aedeagus. **Female** (Fig. 24, B) similar to male, but can be distinguished by the following characters: body slightly more stout, 3.4~4.7 mm long and 1.1~1.7 mm wide; clypeal base slightly more wide than those of male, width of clypeal apex about 2.15 times wider than distance between antennal sockets (Fig. 34, M2); antennae (Fig. 33, M2) relatively shorter, almost exceeding posterior coxal plate; second antennomere obconical, as long as third; fourth antennomere shorter than antennomeres 2~3 combined; antennomeres 5~10 subequal; apical antennomere about 3.7 times longer than wide; pronotum more

strongly narrowed anteriorly than male; elytra conjointly with width to length as about 1 to 2.2; fifth abdominal ventrite barely serrate at apical margin, almost rounded (Fig. 38, R2).

Specimens examined. <GG> 5 ♂, Deoksu-ri, Danwol-myeon, Yangpyeong-gun, 16 ~ 26. vii. 2015, leg. Seung and Jung by FIT; 2 ♂, Deoksu-ri, Danwol-myeon, Yangpyeong-gun, 26. vii ~ 03. viii. 2015, leg. Seung and Jung by FIT; 2 ♂, Deoksu-ri, Danwol-myeon, Yangpyeong-gun, 29. vi ~ 16. vii. 2016, leg. Seung and Jung by FIT; 9 ♀, Gwangnung Arboretum, Sohol-eup, Pocheon-si, 09. vii. 2007, leg. T. S. Kwon.; 4 ♀, Gwangnung Arboretum, Sohol-eup, Pocheon-si, 26. vii. 2007, leg. T. S. Kwon. <GW> 2 ♂, Yeongheung-ri, Yeongwol-eup, Yeongwol-gun, 19. vi ~ 02. vii. 2015, leg. Seung et Lee by FIT; 1 ♂, Yeongheung-ri, Yeongwol-eup, Yeongwol-gun, 02 ~ 16. vii. 2015, leg. Seung et Lee by FIT; 3 ♂, Beopheung-ri, Suju-myeon, Yeongwol-gun, 16 ~ 30. vii. 2015, leg. Seung et Lee by FIT; 1 ♂, Yeongheung-ri, Yeongwol-eup, Yeongwol-gun, 16 ~ 30. vii. 2015, leg. Seung et Lee by FIT; 1 ♂ Suha-ri, Daegwanryeong-myeon, Pyeongchang-gun, 05 ~ 29. vi. 2016, Seung and Jung by FIT.

Distribution. Korea (New record), Japan.

Remarks. All examined specimens of *B. natsumiae*, collected by author, are male. We couldn't available any description or illustration for female, but some female specimens of the genus *Bioxylus*, collected from Gwangnung Arboretum, were identified as female of *B. natsumiae* by Dr. Suzuki. The further study would be need

for exact identification.

***Bioxylus personatus* Mamaev, 1976**

Bioxylus personatus Mamaev, 1976: 149.

Diagnosis. Body mostly dull black with reddish brown antennae and elytra; head with a distinct medio-longitudinal keel from vertex to clypeus; clypeus weakly bifurcated at apical margin; antennae weakly serrate or moniliform; antennomeres 4~10 trapezoidal to rectangular; apical antennomere oblong; pronotum fairly large and convex; elytra reddish brown; metepisternum triangular, strongly widened posteriad; posterior coxal plate subparallel-sided; fifth abdominal ventrite distinctly beaked at apical margin.

Redescription. Female (Fig. 25, A~C) 4.8~5.1 mm long and 1.5~1.6 mm wide. **Body** oblong, subcylindrical, and fairly convex; mostly black; antennae, pronotal anterior margin, elytra, tibiae, and tarsi reddish brown to chestnut; mostly with dull surface; covered with short yellowish brown pubescence. **Head** deeply inserted into prothorax; mostly with circular, dense, and rough punctures, slightly finer and closer at frontoclypeal region; compound eyes undivided; with a medio-longitudinal keel from vertex to clypeal base; frontoclypeal region weakly depressed; clypeus (Fig. 34, N2) slightly concave at apical margin, bifurcated, width of clypeal apex about 2.6 times wider than distance between antennal sockets. **Antennae** (Fig. 33, N2) weakly serrate, almost reaching posterior coxal plate, covered with golden-

pubescence; first antennomere elongate and stout; second antennomere obconical, short, about 1.8 times longer than third; third antennomere shortest, closely connected to second; fourth antennomere quadrate, about 1.1 times longer than wide, as long as antennomeres 2~3 combined, about 1.1 times longer than fifth; antennomeres 5~10 subequal, slightly slenderized toward apex; apical antennomere oblong, about 1.7 times longer than wide, and about 1.8 times longer than previous. **Pronotum** moderately convex, as long as wide, parallel-sided, abruptly narrowed from basal two-third, and arcuate at anterior margin; mostly with finer, denser, and rougher punctures than head; a pair of dimples presented symmetrically at middle; with a medio-longitudinal groove at anterior half, indistinct at anterior margin; shortly impressed medio-longitudinally at base; antiscutellar area almost straight; pronotal posterior angles sharply produced, slightly extended outward, exceeding posterior margin of antiscutellar area. **Scutellum** trapezoidal, as long as wide, gradually narrowed posteriad, and truncated at apex; densely punctate; irregularly pubescent. **Elytra** conjointly with width to length as about 1 to 2.2, parallel-sided, gradually attenuated posteriad near apices; fairly striated, with rough and irregular punctures; interstriae weakly convex; with several large and deep punctures near apices; simply rounded at apices. **Prosternum** slightly transverse, subparallel-sided, slightly widened anteriorly; with sparser and more regular punctures than head; prosternal process robust, slightly tapered posteriad, and strongly oblique near apex; hypomerion mostly with larger, rougher and more irregular punctures than prosternum; with rugose surface at posterior fossae; hypomerion antennal grooves absent. **Mesosternum** sparsely and roughly punctate; mesepimeron fused with

mesepisternum, with rough surface, especially at anterior region. **Metasternum** with finer and denser punctures than prosternum; with a medio-longitudinal groove, not reaching anterior margin; metepisternum (Fig. 35, N2) strongly widened posteriad, widest width about 1.55 times wider than outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, N2) subparallel-sided, slightly concave at middle, medially about 1.1 times wider than medially. **Legs** (Fig. 37, N2) moderately in length; tarsi fairly slender; first tarsomere of hind leg about 1.15 times longer than tarsomeres 2~4 combined; second tarsomere about 1.5 times longer than third; fifth tarsomere about 1.2 times longer than second; claws simple. **Abdomen** strongly connate; punctate as metasternum; fifth ventrite distinctly pointed at apical margin, strongly depressed at each side near apex (Fig. 38, S2). **Male** unavailable specimen in this study.

Specimens examined. <GW> 1 ♀, Wangsan-ri, Wangsan-myeon, Gangneung-si, 03 ~ 29. vi. 2016, leg. Seung and Jung by FIT. <JJ> 1 ♀, Gyorae gotjawal, Gyorae-ri, Jocheon-eup, Jeju-si, 12. v ~ 10. vi. 2016, Seung and Jung by FIT.

Distribution. Korea (New record), Russia (Far East).

Remarks. *Bioxylus personatus* is very similar to *B. galloisi* Fleutiaux, 1923, but can be distinguished by fifth abdominal ventrite which distinctly beaked. Individual variation is observed with elytra color, more or less brown, occasionally tinged with black.

***Bioxylus pilosellus* Hisamatsu, 1959**

Bioxylus pilosellus Hisamatsu, 1959: 23.

Diagnosis. Body mostly dull black, covered with strongly dense hairs; head with medio-longitudinal keel from vertex to frontoclypeal region; clypeus bifurcated at apical margin; antennae weakly serrate; third antennomere short, slightly longer than second; hypomerall antennal grooves absent; metepisternum slightly widened posteriad; posterior coxal plate subparallel-sided; fifth abdominal ventrite simply rounded at apical margin.

Redescription. Male (Fig. 26, A, C~D) 4.7~5.1 mm long and 1.5~1.6 mm wide. **Body** oblong, cylindrical, and fairly convex; mostly black to dark brown; tibiae and tarsi reddish brown; with fairly glossy surface; covered with strongly dense yellowish pubescence. **Head** deeply inserted into prothorax, barely visible in dorsal view; mostly with circular and dense punctures, closer and rougher at clypeus; compound eyes undivided; with a medio-longitudinal keel from vertex to clypeal base; frontoclypeal region slightly depressed; clypeus (Fig. 34, O1) bifurcated at apical margin, width of clypeal apex about 2.3 times wider than distance between antennal sockets. **Antennae** (Fig. 33, O1) serrate, almost exceeding posterior coxal plate, and pubescent with golden hairs; first antennomere cylindrical and stout; second antennomere obconical, short, and about 1.5 times longer than third; third antennomere shortest, closely connected to second; fourth antennomere rectangular, about 1.7 times longer than wide, about 1.3 times longer than antennomeres 2~3

combined, about 1.15 times longer than fifth; antennomeres 5~10 subequal, slightly slenderized toward apex; apical antennomere oblong, about 3.2 times longer than wide, and about 1.7 times longer than tenth. **Pronotum** fairly convex, as long as wide, narrowed anteriorly from basal two-third, and arcuate at anterior margin; with denser and rougher punctures than head; antiscutellar area weakly notched; pronotal posterior angles sharply produced, exceeding posterior margin of antiscutellar area. **Scutellum** subtriangular, about 1.2 times longer than wide, gradually narrowed posteriorly, and narrowly rounded at apex; roughly punctate; densely pubescent. **Elytra** conjointly with width to length as about 1 to 2.3, subparallel-sided, gradually attenuated posteriorly; fairly striated, with rough and deep punctures; interstriae fairly convex; with several large and deep punctures near apices; simply rounded at apices. **Prosternum** transverse; weakly widened anteriorly; mostly with finer and sparser punctures than head, slightly closer at lateral region; prosternal process robust, gradually tapered and declined posteriorly; hypomeron punctate as prosternum, gradually scattered and glabrous posteriorly; with glossy surface at posterior fossae; hypomeral antennal grooves absent. **Mesosternum** densely and roughly punctate; mesepimeron fused with mesepisternum, with rugose surface. **Metasternum** with finer and denser punctures than prosternum; with a medio-longitudinal groove, not reaching anterior margin; metepisternum (Fig. 35, O1) subparallel-sided, widest width about two-third of outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, O1) slightly expanded inward, medially about 1.5 times wider than laterally. **Legs** (Fig. 37, O1) moderate in length; tibiae and tarsi fairly slender; first tarsomere of hind leg about nine-tenth of tarsomeres 2~4 combined; second

tarsomere about 1.25 times longer than third; fifth tarsomere about 1.5 times longer than second; claws simple. **Abdomen** strongly connate; punctate as metasternum; fifth ventrite slightly compressed and rounded at apical margin. **Aedeagus** (Fig. 34, L1~2) about 3.55 times longer than wide; median lobe stout, about 2.8 times longer than wide, strongly curved ventrally in lateral view, gradually widened from base and abruptly narrowed toward apex from basal two-third, fused with lateral lobes; basal strut not reaching basal piece; lateral lobes obviously longer than median lobe, distinctly bent ventrally in lateral view, convergent medially, with basally attached secondary lateral lobes; secondary lateral lobes as long as lateral lobes, stout, convergent medially near apex, truncated at apex, and with several long hairs from basal two-third toward apex; basal piece subcircular, about 1.1 times wider than wide, almost one-fourth of length of aedeagus. **Female** (Fig. 26, B) very similar to male, but can be distinguished by the following characters: more large and stout, 4.9~6.1 mm long, 1.5~2.0 mm wide; clypeal base more wide than those of male, width of clypeal apex about 1.9 times wider than distance between antennal sockets (Fig. 34, O2); antennae (Fig. 33, O2) relatively shorter, almost reaching posterior coxal plate; antennomeres 5~10 more stubby.

Specimens examined. <GG> 3 ♀, Gwangnung Arboretum, Sohol-eup, Pocheon-si, 09. vii. 2007, leg. T. S. Kwon; 6 ♀, Gwangnung Arboretum, Sohol-eup, Pocheon-si, 26. vii. 2007, leg. T. S. Kwon. <GW> 2 ♂, Suha-ri, Daegwanryeong-myeon, Pyeongchang-gun, 05 ~ 29. vi. 2016, leg. Seung and Jung by FIT. <JN> 1 ♂, Jungdae-ri, Ganjeon-myeon, Gurye-gun, 04 ~ 15. vii. 2016, leg. Seung and Lee by

FIT; 1 ♀, Mt. Duryun, Pyeonghwal-ri, Samsan-myeon, Haenam-gun, 22. viii. 2009, leg. T. S. Kwon. <JJ> 1 ♂, Seogwipo Natural Forest, Daepo-dong, Seogwipo-si, 22. vii. 2016, leg. J. B. Seung.

Distribution. Korea (New record), Japan.

Remarks. *Bioxylus pilosellus* can be easily distinguished from other *Bioxylus* species by their strongly dense hairs, especially on dorsal surface. A male individual was observed wandering on dead barkless tree with mycelium in July. Individual variation was observed in body coloration, dark brown to dull black.

Genus *Proxylobius* Fleutiaux, 1900

Proxylobius Fleutiaux, 1900: 360. Type species: *Proxylobius helleri* Fleutiaux, 1900.

Phizoschilus Fleutiaux, 1930: 273. Type species: *Phizoschilus gardneri* Fleutiaux, 1930.

Diagnosis. Body oblong, cylindrical, and strongly convex; head strongly inserted into prothorax; frons with a distinct medio-longitudinal keel from vertex to clypeal apex; antennae serrate in both sexes; antennomeres 4~11 keeled medio-longitudinally; second and third antennomere short, subequal, and very closely connected; pronotum strongly convex; pronotal lateral ridge simple; elytra fairly striated; hypomer al antennal grooves well-defined or indistinct; metepisternum widened posteriad; posterior coxal plate subparallel-sided; tarsi of hind legs shorter than tibiae; abdominal ventrites connate, fifth ventrite simply rounded at apical

margin; aedeagus bulbous; median lobes of aedeagus fused with lateral lobes; lateral lobes of aedeagus with basally attached secondary lateral lobes (Fleutiaux, 1900, 1923, 1935; Hisamatsu, 1958, 1985; Muona, 2011).

Key to the species of Korean *Proxylobius*

1. Antennae moderate in length, almost reaching posterior coxal plate; hypomerall antennal grooves well-developed, with outer marginal keel; secondary lateral lobes of aedeagus relatively elongate *Proxylobius helleri*
- Antennae long, distinctly exceeding third abdominal ventrite; hypomerall antennal grooves indistinct, without outer marginal keel; secondary lateral lobes of aedeagus short and stubby *Proxylobius longicornis*

***Proxylobius helleri* Fleutiaux, 1900**

Proxylobius helleri Fleutiaux, 1900: 361.

Diagnosis. Body mostly dull black with reddish elytral humeri; head with a distinct medio-longitudinal keel from vertex to clypeal apex; antennae serrate, almost reaching posterior coxal plate; third antennomere shortest; clypeus weakly bifurcated at apex; pronotum strongly convex; elytra fairly striated; hypomerall antennal grooves well-developed, with outer marginal keel; prosternal process with a medio-longitudinal keel; metepisternum slightly widened posteriad; posterior

coxal plate subparallel-sided; fifth abdominal ventrite rounded at apical margin.

Redescription. Male (Fig. 27, A, C~D) 2.6~4.3 mm long and 0.9~1.5 mm wide.

Body oblong, cylindrical, and convex; mostly black; mouthparts, antennomeres 2~3, and elytral humeri ferruginous; tibiae and tarsi chestnut to yellowish brown; with dull surface; covered with yellowish brown pubescence. **Head** deeply inserted into prothorax, barely visible in dorsal view; mostly with circular, dense, and irregular punctures, slightly larger near vertex; compound eyes undivided; with a distinct medio-longitudinal keel from vertex to clypeal apex; clypeus (Fig. 34, P1) weakly bifurcated at apical margin, width of clypeal apex about 2.7 times wider than distance between antennal sockets. **Antennae** (Fig. 33, P1) serrate, almost reaching posterior coxal plate, covered with golden-pubescence; first antennomere oblong and stout; second antennomere obconical, short, and about 1.5 times longer than third; third antennomere shortest, closely connected to fourth; fourth antennomere quadrate, about 1.5 times longer than wide, about 1.3 times longer than antennomeres 2~3 combined, and about 1.2 times longer than fifth; antennomeres 5~8 gradually lengthened and slenderized; ninth and tenth antennomeres subequal, slightly shorter than eighth; apical antennomere oblong, about 3.4 times longer than wide, and about 1.5 times longer than tenth. **Pronotum** strongly convex, about 1.15 times wider than wide, slightly narrowed from basal half to anterior margin, abruptly declined posteriad from basal one-fourth, and almost truncated at anterior margin; mostly with finer, rougher, and more irregular punctures than head, slightly larger at lateral region; with a pair of small and deep dimples at middle of base;

antiscutellar area slightly notched; pronotal posterior angles short, sharply produced, and barely exceeding posterior margin of antiscutellar area. **Scutellum** trapezoidal, about 1.1 times longer than wide, weakly narrowed posteriad, and almost cut-like at apex; densely and regularly punctate; evenly pubescent near apex. **Elytra** conjointly with width to length as about 1 to 2.1, subparallel-sided, gradually attenuated posteriad; fairly striated, with rough and fine punctures; interstriae weakly convex; with several large and deep punctures near apices; simply rounded at apices. **Prosternum** transverse, parallel-sided, and truncated at anterior margin; mostly with more regular and scattered punctures than head, slightly larger and denser at lateral region; prosternal process stout, gradually tapered and declined posteriad, with a medio-longitudinal keel near base; hypomeron with larger and more irregular punctures than prosternum, gradually enlarge and roughen posteriad; with wrinkled surface at posterior fossae; hypomeral antennal grooves (Fig. 34, II) well-developed, notosternal, wide, slightly expanded posteriad, with outer marginal keel, barely punctate, and glabrous. **Mesosternum** mostly finely and regularly punctate; mesepimeron fused with mesepisternum, with rough punctures, especially at anterior region. **Metasternum** mostly with finer and denser punctures than prosternum, gradually enlarged laterally; with a medio-longitudinal groove at middle, not reaching anterior margin; metepisternum (Fig. 35, P1) slightly widened posteriad, widest width about 1.35 times wider than outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, P1) subparallel-sided, medially about 1.1 time wider than laterally. **Legs** (Fig. 37, P1) moderate in length; tibiae and tarsi slender; first tarsomere of hind leg about 1.2 times longer than tarsomeres 2~4 combined;

second tarsomere about 1.1 times longer than third; fifth tarsomere about 1.5 times longer than second; claws simple. **Abdomen** strongly connate; with denser punctures than metasternum; fifth ventrite simply rounded at apical margin. **Aedeagus** (Fig. 39, M1~2) about 3.2 times longer than wide; median lobe stout, about 3.95 times longer than wide, gradually narrowed toward apex, slightly curved ventrally in lateral view, and fused with lateral lobes; basal strut not reaching basal piece; lateral lobes subparallel-sided, slightly bent ventrally as median lobe in lateral view, distinctly longer than median lobe, with dull apical tooth, and with basally attached secondary lateral lobes; secondary lateral lobes shorter than median lobe, parallel-sided, slender, rounded at apex; basal piece trapezoidal, about 1.35 times wider than long, almost one-sixth of length of aedeagus. **Female** (Fig. 27, B) very similar to male, but can be distinguished by the following characters: more large and stout, 4.8~5.9 mm long and 1.6~1.9 mm wide; clypeal base more wide than those of male, width of clypeal apex about 2.15 times wider than distance between antennal sockets (Fig. 34, P2); antennae (Fig. 33, P2) relatively shorter, not reaching posterior coxal plate; antennomeres 5~10 more stubby; apical antennomere about 2.9 times longer than wide.

Specimens examined. <GG> 2 ♀, Gwangnung Arboretum, Sohol-eup, Pocheon-si, 29. vi. 2007, leg. T. S. Kwon; 8 ♀, Gwangnung Arboretum, Sohol-eup, Pocheon-si, 09. vii. 2007, leg. T. S. Kwon; 5 ♀, Gwangnung Arboretum, Sohol-eup, Pocheon-si, 26. vii. 2007, leg. T. S. Kwon. <GW> 3 ♂, Deokgu-ri, Sangdong-eup, Yeongwol-gun, 19. vi ~ 02. vii. 2015, Seung and Lee by FIT; 3 ♂, Deokgu-ri, Sangdong-eup,

Yeongwol-gun, 03 ~ 16. vii. 2015, leg. Seung and Lee by FIT; 3 ♂, Beopheung-ri, Suju-myeon, Yeongwol-gun, 03 ~ 16. vii. 2015, leg. Seung and Lee by FIT; 2 ♂, Beopheung-ri, Suju-myeon, Yeongwol-gun, 16 ~ 30. vii. 2015, leg. Seung and Lee by FIT <JJ> Gyorae gotjawal, Gyorae-ri, Jocheon-eup, Jeju-si, 12. v ~ 10. vi. 2016, leg. Seung and Jung by FIT.

Distribution. Korea (New record), Japan, Russia (Far East).

Remarks. Individual variation is observed in coloration of elytral humeri, ferruginous to blackish brown.

***Proxylobius longicornis* Hisamatsu, 1958**

Proxylobius longicornis Hisamatsu, 1958: 118.

Diagnosis. Body mostly dull black with reddish elytral humeri; head with a distinct medio-longitudinal keel from vertex to clypeal apex; antennae weakly serrate; antennomeres 4~10 gradually lengthened and slenderized; apical antennomere strongly elongate; clypeus distinctly bifurcated at apex; pronotum strongly convex; hypomeral antennal grooves indistinct, without outer marginal keel; metepisternum gradually widened posteriad; posterior coxal plate subparallel-sided; fifth abdominal ventrite simply rounded at apical margin.

Redescription. Male (Fig. 28, A~C) 4.5 mm long and 1.5 mm wide. **Body** oblong, cylindrical, and strongly convex; mostly black; antennomeres 2~3, elytral humeri,

and apex of fifth abdominal ventrite ferruginous; tibiae and tarsi chestnut to yellowish brown; with mostly dull surface; covered with yellowish brown hairs. **Head** deeply inserted into prothorax, barely visible in dorsal view; with circular, dense, and irregular punctures, rougher and closer near clypeus; compound eyes undivided; with a distinct medio-longitudinal keel from vertex to clypeal apex; clypeus (Fig. 34, Q1) distinctly bifurcated at apical margin, width of clypeal apex about 2.7 times wider than distance between antennal sockets. **Antennae** (Fig. 33, Q1) weakly serrate, almost reaching third abdominal ventrite, covered with golden pubescence; first antennomere oblong and robust; second antennomere obconical, short, and about 1.6 times longer than third; third antennomere shortest, closely connected to fourth; fourth antennomere quadrate, about 1.8 times longer than wide, about twice longer than antennomeres 2~3 combined, about 1.1 times longer than fifth; antennomeres 5~8 gradually lengthened and slenderized toward apex; ninth and tenth antennomeres subequal, slightly shorter than eighth; apical antennomere elongate, about six times longer than wide, and about 1.7 times longer than tenth. **Pronotum** strongly convex, about 1.15 times wider than wide, slightly narrowed anteriorly from basal half, and almost truncated at anterior margin; mostly with closer and rougher punctures than head, gradually enlarged laterally; antiscutellar area notched; pronotal posterior angles short, sharply produced, and exceeding posterior margin of antiscutellar area. **Scutellum** trapezoidal, about 1.2 times wider than wide, gradually narrowed posteriorly, and truncated at apex; roughly punctate; rarely pubescent. **Elytra** conjointly with width to length as about 1 to 2.2, subparallel-sided, gradually attenuated posteriorly; fairly striated, with fine, deep, and rough

punctures; intervals weakly convex; with several large and deep punctures near apices; simply rounded at apices. **Prosternum** transverse, subparallel-sided, slightly widened anteriorly; mostly with more regular punctures than head, slightly larger at lateral region; prosternal process stout, with parallel sides near base, gradually tapered and declined posteriorly, and with a distinct medio-longitudinal keel; hypomeron punctate as prosternum, slightly more scattered at posterior region, non-punctate and glabrous near notosternal suture; with wrinkled surface at posterior fossae; hypomeran antennal grooves indistinct. **Mesosternum** roughly and sparsely punctate; mesepimeron fused with mesepisternum, roughly punctate, especially at anterior region. **Metasternum** with finer and denser punctures than prosternum, slightly larger at lateral region; with a medio-longitudinal groove at middle, not reaching anterior margin; metepisternum (Fig. 35, Q1) gradually widened posteriorly, widest width about 1.3 times wider than outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, Q1) parallel-sided, slightly concave near midline. **Legs** (Fig. 37, Q1) moderate in length; tibiae and tarsi slender; first tarsomere of hind leg about 1.45 times longer than tarsomeres 2~4 combined; second tarsomere about 1.3 times longer than third; fifth tarsomere about 1.7 times longer than second; claws simple. **Abdomen** strongly connate; punctate as metasternum; fifth ventrite simply rounded at apical margin. **Aedeagus** (Fig. 39, N1~2) about 3.45 times longer than wide; median lobe stout, about 3.6 times longer than wide, gradually narrowed toward apex, slightly bent ventrally in lateral view, and fused with lateral lobes; basal strut not reaching basal piece; lateral lobes slightly bent ventrally as median lobe in lateral view, distinctly longer than median lobe, with dull apical tooth, with

basally attached secondary lateral lobes; secondary lateral lobes stout, shorter than median lobe, parallel-sided, rounded at apex, and shortly setose; basal piece quadrate, as long as wide, almost one-sixth of length of aedeagus. **Female** unavailable specimen in this study.

Specimens examined. <JN> 1 ♂, Jungdae-ri, Ganjeon-myeon, Gurye-gun, 04 ~ 15. vii. 2016, leg. Seung and Lee by FIT.

Distribution. Korea (New record), Japan.

Remarks. *Proxylobius longicornis* is very similar to *P. helleri*, but can be distinguished by its relatively long antennae, absence of hypomeral antennal grooves, and structure of secondary lateral lobes of aedeagus.

Genus *Xylophilus* Mannerheim, 1823

Xylophilus Mannerheim, 1823: 14. Type species: *Elater alni* Fabricius, 1801.

Xylobius Latreille, 1834: 124. Type species: *Elater alni* Fabricius, 1801.

Xyloecus Dejean, 1833: 85. Type species: *Elater alni* Fabricius, 1801.

Diagnosis. Body elongate, subcylindrical, sparsely punctate, and with strongly glossy surface; clypeus slightly trifurcated or sinuate at apex; antennae moniliform; second antennomere subequal or slightly shorter than third; antennomeres 2~3 combined longer than fourth; antennomeres 4~10 almost quadrate; apical

antennomere oblong; pronotum fairly convex; pronotal lateral ridge simple; scutellum glabrous; elytra indistinctly striated; hypomeral antennal grooves absent; metepisternum subparallel-sided; posterior coxal plate subparallel-sided; tibiae slightly thickened toward apex; tarsi subcompressed or subcylindrical; abdominal ventrites connate; fifth ventrite simply rounded at apical margin; median lobe of aedeagus fused with lateral lobes (Mannerheim, 1823; Bonvouloir, 1875; Hisamatsu, 1985; Muona, 2000, 2011).

***Xylophilus ainu* (Fleutiaux, 1923)**

Xylobius ainu Fleutiaux, 1923: 321.

Diagnosis. Body mostly black with reddish elytral humeri, with strongly glossy surface; head weakly keeled from vertex to frons; clypeal bifurcated at apex; antennae moniliform; second antennomere slightly shorter than fourth, as long as third; scutellum non-punctate and glabrous; hypomeral antennal grooves absent; metepisternum parallel-sided, same width with elytral epipleuron; posterior coxal plate gradually expanded inward; fifth abdominal ventrite narrowly rounded at apical margin.

Redescription. Male (Fig. 29, A, C~D) 3.5~4.7 mm long and 1.1~1.5 mm wide. **Body** oblong, subcylindrical, and fairly convex; mostly black; mouthparts, antennae, elytral humeri, femur, and tibiae reddish brown; tarsi gradually tinged yellowish brown toward apex; wholly with strongly shiny surface; rarely covered with

yellowish brown pubescence. **Head** moderately inserted into prothorax; mostly with circular and regular punctures, slightly denser and coarser near clypeus; compound eyes undivided; with a weak medio-longitudinal keel from vertex to middle of frons; frontoclypeal region slightly depressed; clypeus (Fig. 34, R1) distinctly bifurcated at apical margin; width of clypeal apex about 2.5 times wider than distance between antennal sockets. **Antennae** (Fig. 33, R1) moniliform, almost reaching first abdominal ventrite, covered with yellowish brown pubescence; first antennomere oblong and stout; second antennomere obconical and subequal to third; third antennomere quadrate, as long as wide; antennomeres 4~10 rectangular, slightly lengthened toward apex; apical antennomere oblong, about twice longer than wide, and about 1.75 times longer than tenth. **Pronotum** weakly convex, about 1.15 times wider than wide, abruptly narrowed anteriorly from basal two-third, and almost truncated at anterior margin; mostly with sparser and more regular punctures than head; antiscutellar area notched; pronotal posterior angles sharply produced, exceeding posterior margin of antiscutellar area. **Scutellum** trapezoidal, tongue-like, about 1.1 times wider than long, slightly narrowed posteriorly, rounded at apex; non-punctate and glabrous. **Elytra** conjointly with width to length as about 1 to 2.4; parallel-sided, gradually attenuated posteriorly near apices; indistinctly striated, with fine and regular punctures; interstriae almost flattened; with several large and deep punctures near apices; simply rounded at apices. **Prosternum** transverse, subparallel-sided, slightly widened anteriorly, and broadly arcuate at anterior margin; mostly with punctures as head, slightly denser at lateral region; prosternal process robust, gradually narrowed and oblique posteriorly; hypomeron mostly with larger

and rougher punctures than prosternum, gradually more scattered posteriad; with wrinkled surface at posterior fossae; hypomerall antennal grooves absent. **Mesosternum** roughly punctate; mesepimeron fused with mesepisternum, with rough surface, especially at anterior region. **Metasternum** with finer and closer punctures than prosternum; with a weak medio-longitudinal groove, indistinct at anterior half; metepisternum (Fig. 35, R1) parallel-sided, same width with elytral epipleuron, posterior width about 1.1 times wider than outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, R1) gradually expanded inward, medially about 1.5 times wider than laterally. **Legs** (Fig. 37, R1) moderate in length, slender; first tarsomere of hind leg as long as tarsomeres 2~4 combined; second tarsomere about 1.1 times longer than third; fifth tarsomere about twice longer than second; claws simple. **Abdomen** strongly connate; mostly punctate as metasternum; fifth ventrite narrowly rounded at apical margin. **Aedeagus** (Fig. 39, O1~2) 3.85 times longer than wide; median lobe elongate, about 3.6 times as long as wide, gradually narrowed toward apex, strongly bent ventrally in lateral view, and fused with lateral lobes; basal strut not reaching basal piece; lateral lobes distinctly longer than median lobe, with subapical tooth, inner margins almost parallel-sided, lateral margins arched near apex; basal piece semicircular, about 1.15 times wider than long, almost one-third of length of aedeagus. **Female** (Fig. 29, B) very similar to male, but can be distinguished by the following characters: body more large and stout, 3.7~5.8 mm long and 1.1~1.8 mm wide; antennae (Fig. 33, R2) relatively shorter than those of male, almost reaching middle of metepisternum; second antennomere approximately 1.3 times longer than third; antennomeres 4~10 more

stubby and transverse; apical antennomere about 1.7 times longer than wide.

Specimens examined. <GG> 2 ♀, Gwangnung Arboretum, Sohol-eup, Pocheon-si, 29. vi. 2007, leg. T. S. Kwon. <GW> 1 ♂, Osaek-ri, Seo-myeon, Yangyang-gun, 20. vi. 2015, leg. S. H. Lee; 1 ♀, Osaek-ri, Seo-myeon, Yangyang-gun, 22. vi. 2015, leg. S. H. Lee; 1 ♀, Beopheung-ri, Suju-myeon, Yeongwol-gun, 02 ~ 16. vii. 2015, leg. Seung and Lee by FIT. <JB> 1 ♂, Bongdeok-ri, Bokheung-myeon, Sunchang-gun, Jeollabuk-do, 27. v ~ 13. vi. 2016, leg. Seung and Jung by FIT. <JJ> 1 ♂, 2 ♀, Seongpanak, Gyorae-ri, Jocheon-eup, Jeju-si, 10. vi. 2016, leg. J. B. Seung; 4 ♂, 2 ♀, Gyorae gotjawal, Gyorae-ri, Jocheon-eup, Jeju-si, 10. vi. 2016, leg. J. B. Seung; 4 ♂, 7 ♀, Seogwipo Natural Forest, Daepo-dong, Seogwipo-si, 11. vi. 2016, leg. J. B. Seung; 1 ♂, Gyorae gotjawal, Gyorae-ri, Jocheon-eup, Jeju-si, 13. v ~ 10. vi. 2015, leg. Seung and Jung by FIT; 1 ♀, Hwasun Gotjawal, Hwasun-ri, Andeok-myeon, Seogwipo-si, 13. v ~ 10. vi. 2015, leg. Seung and Jung by FIT.

Distribution. Korea, Japan, Russia (Far East).

Remarks. *Xylophilus ainu* very similar to Japanese species, *X. rufomarginatus*, but can be distinguished by following characters: fourth antennomere as long as third antennomere, while about twice longer in *X. rufomarginatus*; metepisternum as wide as elytral epipleuron, while wider in *X. rufomarginatus*. Several individuals were observed wandering and mating at dead or dying barklees trees of *Styrax*, *Fraxinus*, *Quercus*, *Mallotus* and *Torreya*.

Subfamily Macraulacinae Fleutiaux, 1923

Macraulacinae Fleutiaux, 1923: 304. Type genus: *Macraulacus* Bonvouloir, 1872.

Diagnosis. Body usually elongate; labrum attached underneath frontoclypeal region; pronotal lateral ridges complete; hypomeron with lateral antennal groove or simple; mesepimeron fused with mesepisternum; tibia of foreleg with one apical spur; meso- and metatibiae with row of spines; median lobe of aedeagus fused with lateral lobes (Muona, 1993, 2000).

Key to the tribes of Korean Macraulacinae

- 1. Antennomeres 9~11 enlarged; hypomeron without antennal groove
..... **Euryptychini**
- Antennomeres 9~11 simple; hypomeron with lateral antennal groove
..... **Macraulacini**

Tribe Euryptychini Mamaev, 1976

Euryptychini Mamaev, 1976: 154. Type genus: *Euryptychus* LeConte, 1852.

Diagnosis. Body elongate, slightly convex; antennomeres 9~11 enlarged, mostly longer in male than those of female; mandible slender, without secondary teeth; hypomerol antennal grooves absent; posterior coxal plate first tarsomere of foreleg

with sex comb in male; fourth tarsomere simple; abdominal ventrites connate; median lobe of aedeagus bifurcated at apex (Muona, 1993, 2000).

Genus *Euryptychus* Leconte, 1852

Euryptychus LeConte, 1852: 46. Type species: *Eucnemis heterocerus* Say, 1836.

Dyscolocerus Bonvouloir, 1871: 73. Type species: *Dyscolocerus subnitidus* Bonvouloir, 1872.

Diagnosis. Body elongate and slightly convex; clypeus rounded at apical margin; third antennomere elongate; antennomeres 4~8 subequal and wider than long; antennomeres 9~11 enlarged; pronotum slightly convex, strongly narrowed anteriorly; pronotal posterior angles sharply produced posteriorly; hypomeral antennal grooves absent; metepisternum subparallel-sided; posterior coxal plate strongly expanded inward; fourth tarsomere slightly oblique; aedeagus elongate and slender; median lobe of aedeagus deeply bifurcated at apex (Leconte, 1852; Bonvouloir, 1875; Hisamatsu, 1985; Muona 2000).

***Euryptychus vicinus* Fleutiaux, 1923**

Euryptychus vicinus Fleutiaux, 1923: 324.

Diagnosis. Body mostly dull black with more densely pubescent ventral surface;

antennae enlarged apically; antennomeres 4~8 short, subequal; clypeus broadly rounded at apex; pronotum slightly convex, abruptly narrowed anteriorly; hypomeral antennal grooves absent; metepisternum subparallel-sided; posterior coxal plate strongly expanded inward; fifth abdominal ventrite simply rounded at apical margin.

Redescription. Female (Fig. 30, A~C) 7.7~9.4 mm long and 2.2~2.8 mm wide; **Body** elongate, slightly convex; mostly black with orange brownish tarsi; fairly glossy and covered with yellowish gray hairs on dorsum; dull and densely covered with golden pubescence on ventral surface. **Head** transverse, moderately inserted into prothorax; mostly with circular and regular punctures, denser at frontoclypeal region; compound eyes undivided; frons with a short longitudinal groove at middle; clypeus (Fig. 34, S2) simply rounded at apical margin, width of clypeal apex approximately twice wider than distance between antennal sockets. **Antennae** (Fig. 33, S2) enlarged apically, almost exceeding hypomeron, and covered with yellowish brown pubescence; first antennomere elongate and stout; second antennomere obconical, about 1.5 times longer than fourth; third antennomere elongate, rectangular, and as long as antennomeres 4~5 combined; antennomeres 4~8 subequal, wider than long; antennomeres 9~11 enlarged; ninth antennomere about 1.6 times longer than wide, about 1.1 times longer than tenth; apical antennomere oblong, about 1.2 times longer than previous. **Pronotum** slightly convex, as long as wide, subparallel-sided, abruptly narrowed anteriorly from basal three-fifth, and arcuate at anterior margin; with finer and sparser punctures than head; with a weak medio-longitudinal groove at basal half; a pair of indistinct dimples presented at

middle of basal two-third; antiscutellar area slightly impressed and notched; pronotal posterior angles sharply produced posteriad, obviously exceeding antiscutellar area. **Scutellum** trapezoidal, as long as wide, gradually narrowed posteriad, and slightly rounded at apex; sparsely punctate; rarely pubescent. **Elytra** conjointly with width to length as about 1 to 2.3; parallel-sided, gradually narrowed near apices; fairly striated, with deep punctures; interstriae moderately convex; with several large and deep punctures near apices; simply rounded at apices. **Prosternum** rectangular, with curved sides, and slightly widened anteriorly; mostly with finer punctures than head, slightly rougher and denser at anterior and lateral regions; prosternal process narrow, gradually tapered and oblique posteriad; hypomeron punctate as prosternum; with rugose surface at posterior fossae; hypomeral antennal grooves absent. **Mesosternum** with rough and dense punctures; mesepimeron fused with mesepisternum, coarsely punctate, especially at posterior region. **Metasternum** with dense punctures than prosternum; metepisternum (Fig. 35, S2) subparallel-sided, slightly widened posteriad, and widest width about 2.5 times wider than outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, S2) strongly expanded inward, medially about five times wider than laterally. **Legs** (Fig. 37, S2) fairly stout, tarsi slender; first tarsomere of hind leg about 1.2 times longer than tarsomeres 2~4 combined; second tarsomere about 1.2 times longer than third; fifth tarsomere about 1.1 times longer than second; claws simple. **Abdomen** strongly connate; punctate as metasternum; fifth ventrite simply rounded at apical margin. **Male** unavailable specimen in this study.

Specimens examined. <GG> 1 ♀, Gwangnung National Arboretum, Sohol-eup, Pocheon-si, 29. vi. 2007, leg. T. S. Kwon; 1 ♀, Gwangnung National Arboretum, Sohol-eup, Pocheon-si, 06. viii. 2008, leg. T. S. Kwon. <GW> 1 ♀, Cheonmi-ri, Bangsan-myeon, Yanggu-gun, 16. v. 2015, leg. S. H. Lee; 1 ♀, Beopheung-ri, Sujumyeon, Yeongwol-gun, 02 ~ 16. vii. 2015, leg. Seung and Lee by FIT.

Distribution. Korea (New record), Japan, Russia (Far East).

Remarks. *Euryptychus vicinus* is differentiated from *E. lewisi* by length of third antennomere: third antennomere as long as antennomeres 4~5 combined in *E. vicinus*, shorter in *E. lewisi*. A female individual was observed wandering at surface of dead tree in May.

Tribe Macraulacini (Fleutiaux, 1923)

Macraulacinae Fleutiaux, 1923: 304. Type genus: *Macraulacus* Bonvouloir, 1872.

Fornaxini Cobos, 1965: 294. Type genus: *Fornax* Laporte, 1835.

Dromaeolini Leiler, 1976: 48. Type genus: *Dromaeolus* Kiesenwetter, 1858.

Diagnosis. Body elongate and slightly convex; antennomeres 4~10 subequal; mandibles short, with secondary teeth; hypomer al antennal grooves well-developed laterally, basally open; mesepisternum fused with mesepisternum; meso- and meta tibiae with row of spines; first tarsomere of foreleg with sex comb in male; fourth tarsomere dilated and bilobed; abdominal ventrites mostly strongly connate; median

lobe mostly fused with lateral lobes (Muona, 1993, 2000).

Key to the genera of Korean Macraulacini

1. Posterior coxal plate strongly widened inward; apical margin of fifth abdominal ventrite more or less narrowly rounded in both sexes **2**
 - Posterior coxal plate subparallel-sided; apical margin of fifth abdominal ventrite sharply pointed in male, truncated or slightly concave in female ***Heterotaxis***
2. Body mostly chestnut to dark brown; basal width of metepisternum narrower than outer margin of posterior coxal plate ***Fornax***
 - Body mostly black; basal width of metepisternum wider than outer margin of posterior coxal plate ***Dromaeolus***

Genus *Dromaeolus* Kiesenwetter, 1858

Dromaeolus Kiesenwetter, 1858: 197. Type species: *Eucnemis barnabita* A. Villa and J. B. Villa, 1838.

Megathambus Reitter, 1911: 201. Type species: *Dromaeolus moronita* Bonvouloir, 1871.

Melanus Broun, 1881: 676. Type species: *Melanus sculptus* Broun, 1881.

Diagnosis. Body oblong or elongate, fairly convex; antennae various in form, filiform to serrate; second antennomere shortest or as long as fourth; antennomeres 3~10 weakly toothed at least in male; apical antennomere oblong; pronotum slightly wider than long and strongly sinuated at base; hypomer al antennal grooves well-developed laterally or simple; basal width of metepisternum wider than outer margin of posterior coxal plate; posterior coxal plate strongly expanded inward; fourth tarsomere dilated, slightly shorter than third, and about twice wider than fifth; fifth abdominal ventrite simply rounded or pointed at apical margin (Bonvouloir, 1871; Fleutiaux, 1923; Hisamatsu, 1985; Muona, 2000).

***Dromaeolus marginatus* Hisamatsu, 1965**

Dromaeolus marginatus Hisamatsu, 1965: 134.

Diagnosis. Body mostly black with brown antennae and ferruginous legs; head moderately convex, without longitudinal keel at frons; antennae feebly serrate or filiform; third antennomere about 1.8 times longer than fourth; antennomeres 4~10 slightly lengthened toward apex; apical antennomere elongate, about four times longer than wide, and approximately 2.3 times longer than tenth; pronotum gradually narrowed anteriorly; posterior angles sharply produced; elytra conjointly with width to length as about 1 to 2.2; hypomer al antennal grooves well-developed, lateral, deep, and smooth; metepisternum narrow, subparallel-sided, slightly widened posteriorly, and widest width slightly narrower than outer margin of

posterior coxal plate; posterior coxal plate strongly expanded inward; fifth abdominal ventrite narrowly rounded or obtusely pointed at apical margin (Hisamatsu, 1965).

Specimens examined. Unavailable Korean specimen in this study.

Distribution. Korea (Mt. Seorak, Ganwon-do), Japan (Hachijo Island), Taiwan.

Remarks. Suzuki (2014) reported *D. marginatus* for distributional information from Korea. We couldn't identify this species in the present study.

Genus *Fornax* Laporte, 1835

Fornax Laporte, 1835: 172. Type species: *Fornax ruficollis* Laporte, 1835.

Filifornax Fleutiaux, 1945: 188. Type species: *Fornax leseleuci* Fleutiaux, 1899.

Monilifornax Fleutiaux, 1945: 189. Type species: *Fornax lambertoni* Fleutiaux, 1926.

Diagnosis. Body elongate, slightly convex, narrowed anteriorly and posteriorly; clypeus simply rounded or sinuate at apical margin; antennae filiform; second antennomere shortest; third antennomere elongate; antennomeres 4-10 gradually slenderized toward apex; apical antennomere strongly elongate; hypomerall antennal grooves well-developed laterally; basal width of metepisternum narrower than outer margin of posterior coxal plate; posterior coxal plate strongly expanded inward; fourth tarsomere short, bilobed; median lobe of aedeagus fused with lateral lobes;

lateral lobes with basally attached secondary lateral lobes (Laporte, 1835; Bonvouloir, 1872; Hisamatsu, 1985; Muona 2000).

***Fornax nipponicus* Fleutiaux, 1923**

Fornax nipponicus Fleutiaux, 1923: 295.

Diagnosis. Body wholly chestnut with fairly shiny surface; antennae almost filiform or slightly serrate in both sexes; antennomeres 4~10 gradually lengthened and slenderized toward apex; clypeus broadly rounded at apex; pronotum gradually narrowed anteriorly; elytra elongate, more or less striated; hypomerical antennal grooves well-developed, lateral, deep, and basally open; metasternum with two pair of longitudinal grooves at anterolateral margin; metepisternum subparallel-sided; posterior coxal plate strongly expanded inward; fifth abdominal ventrite narrowly rounded.

Redescription. **Male** (Fig. 31, A, C~D) 7.1~8.9 mm long and 2.0~2.3 mm wide; **Body** elongate, subcylindrical, and slightly convex; wholly castaneous; with fairly glossy surface; covered with dense golden pubescence. **Head** transverse, moderately inserted into prothorax; mostly with circular and regular punctures, finer at frontoclypeal region; compound eyes large, well-developed, and undivided; clypeus (Fig. 34, T1) broadly rounded at apical margin, width of clypeal apex about 2.6 times wider than distance between antennal sockets. **Antennae** (Fig. 33, T1) filiform, almost exceeding posterior margin of metepisternum, covered with short

yellowish pubescence; first antennomere elongate and stout; second antennomere obconical, shortest; third antennomere elongate, about twice longer than wide, approximately 1.5 times longer than second, and about 1.3 times longer than fourth; antennomeres 4~10 gradually lengthened and slenderized toward apex; apical antennomere strongly elongate, about five times longer than wide, and approximately 1.85 times longer than tenth. **Pronotum** slightly convex, as long as wide, gradually narrowed anteriorly, and weakly arcuate at anterior margin; mostly punctate as head, finer and denser at anterior and posterior regions; antiscutellar area slightly impressed and straight; pronotal posterior angles sharply produced, distinctly exceeding posterior margin of antiscutellar area. **Scutellum** trapezoidal, about 1.2 times wider than long, gradually narrowed posteriorly, and almost truncated at apex; roughly punctate; densely pubescent. **Elytra** conjointly with width to length as about 1 to 2.5; subparallel-sided, gradually narrowed posteriorly; weakly striated, with irregular and shallow punctures; interstriae almost flattened; with several large and deep punctures near apices; simply rounded at apices. **Prosternum** quadrate, subparallel-sided, and slightly widened anteriorly; with regular and sparse punctures; prosternal process stout, parallel-sided, gradually tapered and declined near apex; hypomeron with more shallow and irregular punctures than prosternum; with wrinkled surface at posterior fossae; hypomeral antennal grooves well-developed laterally, open at posterior margin, with slightly wrinkled surface, and fairly glabrous. **Mesosternum** roughly punctate; mesepimeron fused with mesepisternum, sparsely punctate, especially at posterior region. **Metasternum** with punctures as prosternum; with two pairs of longitudinal grooves at both sides

of anterior margin; with a weak medio-longitudinal groove at middle, not reaching anterior margin; metepisternum (Fig. 35, T1) subparallel-sided, gradually widened posteriad, and widest width about 1.3 times wider than outer margin of posterior coxal plate; posterior coxal plate (Fig. 36, T1) strongly expanded inward, medially approximately eight times wider than laterally. **Legs** (Fig. 37, T1) moderate in length, femur robust, tibiae and tarsi fairly slender; first tarsomere of hind leg about 1.2 times longer than tarsomeres 2~4 combined; second tarsomere about 1.5 times longer than third, approximately 1.7 times longer than fifth; claws simple. **Abdomen** strongly connate; mostly punctate as metasternum, with coarser and denser punctures at posterior region of fifth ventrite; fifth ventrite narrowly rounded at apical margin. **Aedeagus** (Fig. 39, P1~2) elongate, about 3.75 times longer than wide; median lobe elongate, strongly compressed dorsoventrally, gradually expanded distally, deeply and narrowly bifurcated at apex; lateral lobes obviously shorter than median lobe, with apical tooth, with laterally attached secondary lateral lobes; secondary lateral lobes foliated; basal strut reaching basal piece; basal piece rectangular, about 1.28 times longer than wide, and almost one-fourth of length of aedeagus. **Female** (Fig. 31, B) very similar to male, but can be distinguished by the following characters: clypeus (Fig. 34, T2) more wide at base than those of male, width of clypeal apex about 2.2 times wider than distance between antennal sockets; antennae (Fig. 33, T2) relatively shorter, almost reaching metasternum; third antennomere about 1.45 times longer than fourth; antennomeres 4~10 more stubby; apical antennomere less elongate, about 4.1 times longer than wide, and approximately 1.7 time longer than previous (Fig. 33, T2).

Specimens examined. <SL> 1 ♂, Mt. Gwanak, Daehak-dong, Gwanak-gu, Seoul-si, 19. vi. 2015, leg. J. B. Seung; 4 ♂, 7 ♀, Mt. Gwanak, Daehak-dong, Gwanak-gu, Seoul-si, 11. iv. 2016, leg. J. B. Seung (09. v. 2016, adult emergence).

Distribution. Korea (New record), Japan, Russia (Far East).

Remarks. *Fornax nipponicus* is differentiated from Japanese species, *F. victor*, by its simple claws. Straight-formed larvae in last stage were collected between sapwoods of dead *Robinia pseudoacacia* in April and emerged as adults in May. Adults were observed clicking, well-flying, and active-running.

Genus *Heterotaxis* Bonvouloir, 1871

Heterotaxis Bonvouloir, 1871: 75. Type species: *Heterotaxis myrmidon* Bonvouloir, 1875.

Diagnosis. Body oblong, cylindrical, and strongly convex; clypeus trapezoidal, feebly trilobed or simply rounded at apical margin; antennae serrate or filiform, not exceeding pronotum; second antennomere slightly shorter than third; pronotum strongly convex, as long as wide; elytra strongly striated; hypomer al antennal grooves well-developed laterally; metepimeron invisible; metepisternum strongly expanded posteriad; posterior coxal plate subparallel-sided; first tarsomere as long as tarsomeres 2~3 combined; fifth ventrite truncated or beaked at apical margin (Bonvouloir, 1875; Hisamatsu, 1957, 1985; Muona, 2011).

***Heterotaxis nipparensis* Hisamatsu, 1957**

Heterotaxis nipparensis Hisamatsu, 1957: 45.

Diagnosis. Body mostly dull black with ferruginous antennae and elytral base; antennae strongly serrate in female; antennomeres 4~10 subequal in length, gradually more strongly toothed; clypeus trapezoidal; pronotum strongly convex, with an entire medio-longitudinal groove; scutellum tongue-like, non-punctate, and glabrous; elytra strongly striated; hypomer al antennal grooves well-developed laterally, deep, and basally open; metepisternum strongly widened posteriad; posterior coxal plate parallel-sided; fifth abdominal ventrite truncated at apical margin.

Redescription. Female (Fig. 32, A~C) 5.7~6.2 mm long and 1.9~2.1 mm wide; **Body** oblong, cylindrical, and strongly convex; mostly black; antennae dark brown; mouthparts, pronotal anterior margin, pronotal posterior angles, prosternal process, elytral base, and fifth abdominal ventrite tinged with ferruginous; tibiae yellowish brown; with dull surface; covered with golden pubescence. **Head** strongly inserted into prothorax, barely visible in dorsal view; mostly with circular and irregular punctures, finer and coarser near clypeus; frontoclypeal region slightly depressed; clypeus (Fig. 34, U2) trapezoidal, sinuate and rounded at apical margin, width of clypeal apex about 1.6 times wider than distance between antennal sockets. **Antennae** (Fig. 33, U2) strongly serrate, almost reaching anterior margin of metepisternum, covered with yellowish brown pubescence; first antennomere

oblong, robust, and produced at apex; second antennomere obconical, shortest; third antennomere quadrate, as long as wide, and about 1.3 times longer than second; fourth antennomere about 1.1 times longer than third; antennomeres 4~10 subequal in length, gradually strongly toothed toward apex; apical antennomere oblong, about 2.3 times longer than wide, and about 1.7 times longer than tenth. **Pronotum** strongly convex, as long as wide, abruptly narrowed anteriorly from basal half, and arcuate at anterior margin; mostly with rougher and coarser punctures than head, slightly larger at lateral and posterior regions; with a medio-longitudinal groove in full length of pronotum, more or less indistinct near anterior margin; antiscutellar area straight; pronotal posterior angles dully produced, exceeding posterior margin of antiscutellar area. **Scutellum** tongue-like, about 1.2 times longer than wide, parallel-sided, narrowed posteriorly near apex, and broadly rounded at apex; non-punctures and glabrous. **Elytra** conjointly with width to length as about 1 to 2.1, subparallel-sided, gradually narrowed posteriorly; strongly striated, with deep and large punctures; interstriae strongly convex; simply rounded at apices. **Prosternum** strongly transverse, with curved sides, and widened anteriorly; mostly with larger, sparser, and more regular punctures than head; prosternal process narrow, parallel-sided, and gradually declined and pointed near apex; hypomeron with larger and rougher punctures than prosternum; with rugose surface at posterior fossae; hypomeral antennal grooves (Fig. 38, J2) well-developed laterally, open at posterior margin, barely punctate, and glabrous. **Mesosternum** with regular and dense punctures; mesepimeron fused with mesepisternum, coarsely punctate, especially at posterior region. **Metasternum** mostly with finer, denser, and more regular

punctures than prosternum, gradually sparser at lateral region; with a medio-longitudinal groove in full length of metasternum; metepisternum (Fig. 35, U2) triangular, distinctly widened posteriad, and widest width about three-fifth of outside of posterior coxal plate; posterior coxal plate (Fig. 36, U2) parallel-sided, slightly concave at middle. **Legs** (Fig. 37, U2) moderate in length, slender; first tarsomere of hind leg as long as tarsomeres 2~4 combined; second tarsomere about 1.3 times longer than third, as long as fifth; claws simple. **Abdomen** strongly connate; with fine punctures than metasternum; each ventrites distinctly convex at middle; fifth ventrite truncated at apical margin (Fig. 34, T2). **Male** unavailable specimen in this study.

Specimens examined. <GW> 2 ♀, Suha-ri, Daegwanryeong-myeon, Pyeongchang-gun, 14. vii. 2015, leg. J. B. Seung.

Distribution. Korea (New record), Japan.

Remarks. *Heterotaxis nipparensis* can be distinguished from other *Heterotaxis* species by its strongly serrate antennae in female. Adults and cadavers were observed under bark of dead *Betula davurica*.

4. Discussion

In the present study, the family Eucnemidae was reviewed as 22 species of 14 genera from Korean Peninsula, including two new species, *Dirrhagofarsus* sp. nov. and *Microrhagus* sp. nov., and 15 unrecorded species, *Bioxylus natsumiae* Watanabe, *B. personatus* Mamaev, *B. pilosellus* Hisamatsu, *Dirrhagofarsus lewisi* (Fleutiaux), *D. modestus* (Fleutiaux), *Euryptychus vicinus* Fleutiaux, *Fornax nipponicus* Fleutiaux, *Heterotaxis nipparensis* Hisamatsu, *Hylis harmandi* (Fleutiaux), *Hylochaes harmandi* Fleutiaux, *Microrhagus mystagogus* (Fleutiaux), *M. fovealatus* (Fleutiaux), *Otho spondyloides* (Germar), *Proxyllobius helleri* Fleutiaux, and *P. longicornis* Hisamatsu.

Unfortunately, among five previously recorded species from Korea, we couldn't available *Dromaeolus marginatus* Hisamatsu which reported by Suzuki (2014). In regard of *D. marginatus*, further study should be needed for securing positive proof specimens and verifying taxonomically.

Since *Xyophilus ainu* (Fleutiaux) was reported (ESK/KSAE, 1994), as a first record of Eucnemidae from Korea, a total of five species had been reported with only distributional information. So, Eucnemidae have remained as an unfamiliar group in Korea and available deposited specimens were severely insufficient as well. Most samples, which were studied in the present study, were collected during two years, from 2015 to 2016, using traps. Therefore, their biology still remained as secret, in both of adults and larvae. However, Eucnemidae seems to play important

role as decomposer in life cycle of forest, because they live in wood-abundant habitat and feed dead woody materials in larval stage. It would be investigated for their detailed biology and exact role in forest ecosystem in the further study.

Table 2. Checklist of the family Eucnemidae from Korea. Asterisk symbols (*) with species indicate new records to the fauna from the present study.

No.	Subfamily	Tribe	Scientific name	Korean name
1	Melasinae	Calyptricerini	<i>Otho sphondyloides</i> (Germar, 1818)*	-
2		Dirrhagini	<i>Dirrhagofarsus</i> sp. nov.*	-
3			<i>Dirrhagofarsus lewisi</i> (Fleutiaux, 1900)*	-
4			<i>Dirrhagofarsus modestus</i> (Fleutiaux, 1923)*	-
5			<i>Microrhagus</i> sp. nov.*	-
6			<i>Microrhagus foveolatus</i> (Fleutiaux, 1923)*	-
7			<i>Microrhagus mystagogus</i> (Fleutiaux, 1923)*	-
8			<i>Microrhagus ramosus</i> (Fleutiaux, 1902)	-
9			<i>Farsus ainu</i> Fleutiaux, 1923	-
10		Epiphanini	<i>Hylis harmandi</i> (Fleutiaux, 1923)*	-
11		Hylocharini	<i>Hylochaeres harmandi</i> Fleutiaux, 1900*	-
12		Melasini	<i>Isorhipis foveata</i> Hisamatsu, 1955	-
13		Xylobiini	<i>Bioxylus natsumiae</i> Watanabe, 2009*	-
14			<i>Bioxylus personatus</i> Mamaev, 1976*	-
15			<i>Bioxylus pilosellus</i> Hisamatsu, 1959*	-
16			<i>Proxyllobius helleri</i> Fleutiaux, 1900*	-
17			<i>Proxyllobius longicornis</i> Hisamatsu, 1958*	-
18			<i>Xylophilus ainu</i> (Fleutiaux, 1923)	어리방아벌레
19	Macraulacinae	Euryptychini	<i>Euryptychus vicinus</i> Fleutiaux, 1923*	-
20		Macraulacini	<i>Dromaeolus marginatus</i> Hisamatsu, 1965	-
21			<i>Fornax nipponicus</i> Fleutiaux, 1923*	-
22			<i>Heterotaxis nipparensis</i> Hisamatsu, 1957*	-

PART II. Molecular phylogeny of the family Eucnemidae (Coleoptera: Elateroidea)

Abstract

The family Eucnemidae (Coleoptera: Elateroidea) is saprophagous beetles, at least in larval stage, and expected to play important role in life cycle of forest as decomposer. Their phylogenetic work which based on molecular analysis has been never conducted in family level, even some cladistic analysis was proposed with morphological characters.

In this chapter, we performed preliminary phylogenetic analysis of Eucnemidae based on DNA partitions of three gene regions: mitochondrial protein coding gene (cytochrome c oxidase subunit I gene, COI) and two nuclear ribosomal RNA genes (18S rRNA and 28S rRNA). A total of 72 taxa of Elateroidea, including 48 eucnemid species, were analyzed using Bayesian Inference (BI) and Maximum Likelihood (ML). Our results of molecular analysis represent that Macraulacinae and Melasinae is paraphyletic group, respectively.

Keywords: Eucnemidae, Elateroidea, molecular phylogeny, COI, 18S, 28S

1. Introduction

The family Eucnemidae (Coleoptera: Elateroidea) is a fairly large group, consists of approximately 1,900 species and 200 genera worldwide (Otto, 2016). They tend to more abundant and diverse in tropical regions and considerable number of diversity remains undescribed in tropics. So the real number of species is expected to exceed 3,000 in the world (Muona, 2010). Eucnemidae is regarded as one of primitive groups, forming a monophyletic clade in Elateroidea as Fig. 7. (Bocakova *et al.*, 2007; Kunderata *et al.*, 2011; Kunderata *et al.*, 2013; Kunderata *et al.*, 2014).

Historically, the classification of Eucnemidae had been inconsistent for a long time. Since Eschscholtz (1829) erected tribe Eucnemides, several authors proposed various classification based on divergente morphological characters (Lacordaire, 1857; du Val, 1863; Bonvouloir, 1872, 1872, 1875; Lameere, 1900; Fleutiaux, 1902b, 1920, 1921a, 1921b, 1935; Crowson, 1955; Cobos, 1961, 1964; Lawrence, 1988). The latest work for relationships within Eucnemidae was suggested by Muona (1993) who classified Eucnemidae as eight subfamilies based on 51 morphological characters (Fig. 6). According to cladistics analysis of Muona (1993), Perothopinae and Pseudomeninae were most primitive groups of Eucnemidae. In case of most diverse groups, Eucneminae, Macraulacinae, and Melasinae, were relatively lately diverged than other groups. Also, the monophyly of Eucnemidae was well-supported. Lawrence *et al.* (2007) suggested that Anischiinae of Elateridae (or Anischiidae as independent family), should be replaced in Eucnemidae as subfamily based on adult and larval morphology, as well as molecular analysis.

Although Muona (1993) provided comprehensive cladistics hypothesis based on morphological characters, however, any studies on molecular phylogeny of the family Eucnemidae have not been performed. For this reason, we tried to perform molecular work to estimate for monophyly of Eucnemidae and implicate the preliminary hypotheses for the phylogenetic relations within Eucnemidae based on molecular analysis.

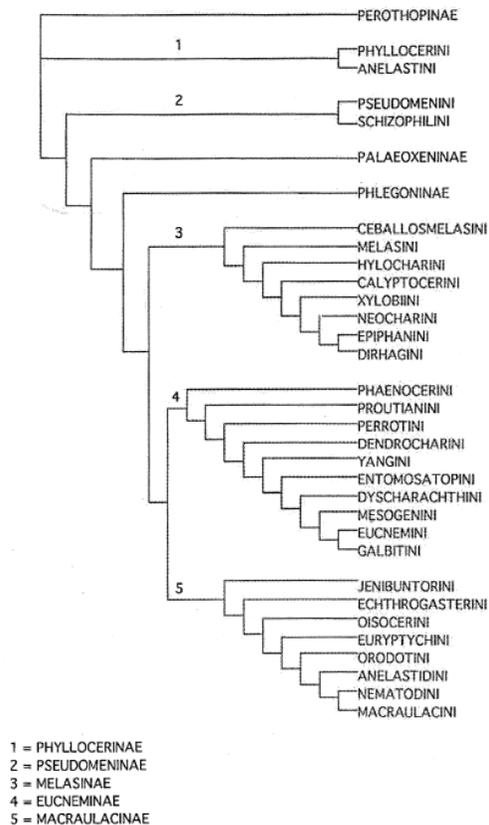
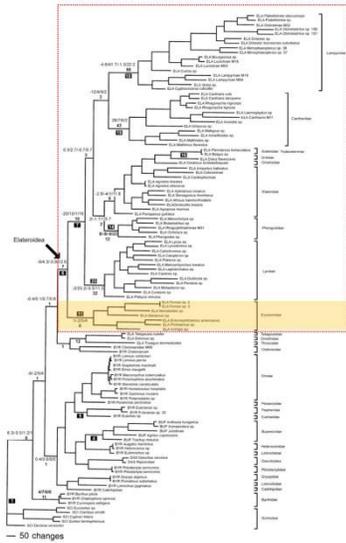
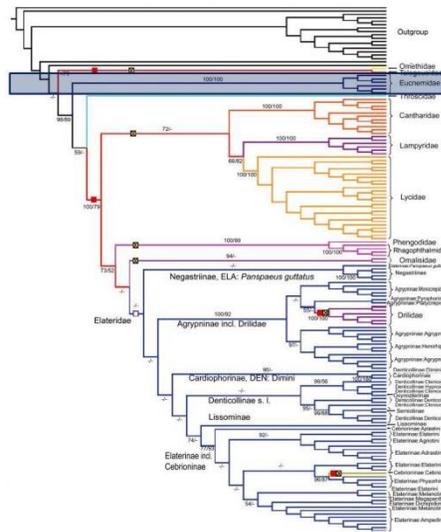


Fig. 6. Cladogram of Phylogenetic relationships within Eucnemidae. Based on 51 morphological characters (Muona, 1993).

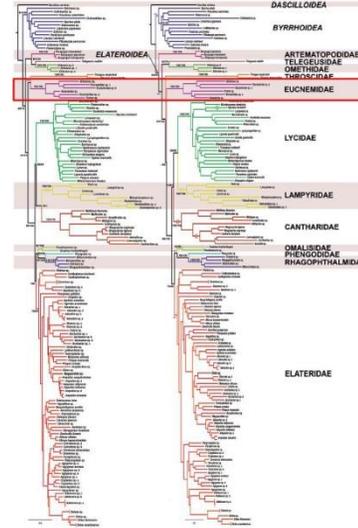
(a) Bocakova et al., 2007



(b) Kunderata and Bocak(2011)



(c) Kunderata et al., 2013



(d) Kunderata et al., 2014

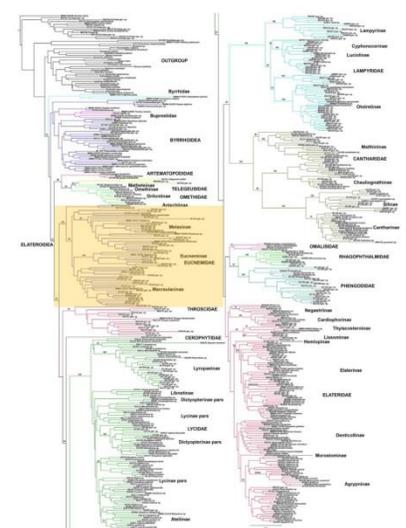


Fig. 7. The taxonomic position and monophyly of Eucnemidae within Elateroidea.

(a) Molecular phylogenetics of Elateriformia based on partial nuclear genes (18S rRNA, 28S rRNA) and mitochondrial genes (16S rDNA, COI); (b) Phylogenetic relationships in Elateroidea using partial nuclear genes (18S rDNA, 28S rDNA) and mitochondrial genes (*rrnL* gene, COI); (c) Contentious relationships to elateroid families using nuclear genes (18S rRNA, 28S rRNA) and mitochondrial genes (*rrnL* gene, COI) ; (d) Comprehensive phylogeny of Elateroidea based on partial nuclear genes (18S rRNA, 28S rRNA) and mitochondrial genes (*rrnL* gene, COI).

2. Materials and methods

2.1. Taxon sampling

A total of 72 taxa of Elateroidea, comprising 48 eucnemid species and 24 outgroup species of two families, were used in the present analyses. Among them, sequenced data for 46 species were downloaded from NCBI (Bocakova *et al.*, 2007; Sagegami-Oba *et al.*, 2007; Brüstle and Muona, 2009; Brüstle *et al.*, 2010; Kunderata and Bocak, 2011; Kunderata *et al.*, 2014). Most collected samples were preserved in 95% ethyl alcohol (ETOH) at -24°C . The eucnemid taxa consisted of three subfamilies (Anischiinae, Macraulacinae, and Melasinae) and eight tribes (Calyptocerini, Dirhagini, Epiphanini, Euryptychini, Hylocharini, Macraulacini, Melasini, and Xylobiini; in case of Anischiinae, not classified in tribal level). The outgroup taxa, Elateridae comprised 10 species belonging to four subfamilies (Agrypninae, Cardiophorinae, Denticollinae, and Elaterinae) and Throscidae with 14 species which were mostly undetermined.

2.2. Laboratory work

DNA extraction

Genomic DNA was extracted by grinding up from abdominal tissue or legs of vouchers, using DNeasy Blood & Tissue kit (QIAGEN, Inc., Dusseldorf, Germany) and according to manufacturer's protocol. The remaining vouchers made into dried

specimens by double-mounted method. All voucher specimens are deposited in the insect collection of College for Agriculture and Life Science, Seoul National University (CALS, SNU).

PCR amplification and Sequencing

In PCR amplification, one mitochondrial protein coding gene (cytochrome c oxidase subunit I gene, COI) and two nuclear ribosomal RNA genes (18S rRNA and 28S rRNA) were selected. Meanwhile, we tried to use another nuclear protein coding gene, elongation factor-1 α (EF-1 α), for analysis but failed to obtain adequate sequence. Perhaps, EF-1 α may not appropriate for Eucnemidae. The primers for amplifying each gene are listed in Table 2. PCR was performed using AccuPower[®] PCR Premix (BIONEER, Corp., Daejeon, Korea) in 20 μ l-volumed mixtures containing 0.4 μ M of each primer, 250 μ M of dNTPs, 1.5 mM of MgCl₂, and 0.05 μ g of genomic DNA template. The thermal cycling program was performed according to protocols as follow: 1) COI marker: initial denaturation at 94 $^{\circ}$ C for 5 min; 40 cycles of denaturation at 94 $^{\circ}$ C for 30 s, annealing at 47 $^{\circ}$ C for 30 s, and extension at 72 $^{\circ}$ C for 2 min; final extension at 72 $^{\circ}$ C for 10 min. 2) 18S and 28S markers: initial denaturation at 94 $^{\circ}$ C for 5 min; 40 cycles of denaturation at 94 $^{\circ}$ C for 30 s, annealing at 52 $^{\circ}$ C for 30 s, extension at 72 $^{\circ}$ C for 2 min; final extension at 72 $^{\circ}$ C for 10 min. 3) EF-1 α marker: 94 $^{\circ}$ C for 5 min; 42 cycles of denaturation at 94 $^{\circ}$ C for 30 s, annealing temperature decreasing from 58 $^{\circ}$ C to 42 $^{\circ}$ C by 2 $^{\circ}$ C every

third cycle and final 18 cycles at 42°C for 1 min, extension at 72°C for 10 min. PCR products were assessed by 0.7 % agarose gel electrophoresis. After identification of single band, PCR products were purified and sequenced at MACROGEN, Inc. (Seoul, Korea).

Table 3. Primers used in the present study.

Gene	Primer Name	Sequence (5'-3')	Reference
18S	18S5	GAC-AAC-CTG-GTT-GAT-CCT-GCC-AGT	Shull <i>et al.</i> (2001)
	18Sb5.0	TAA-CCG-CAA-CAA-CTT-TAA-T	Shull <i>et al.</i> (2001)
28S	28SFF	TTA-CAC-ACT-CCT-TAG-CGG-AT	Inward (2003)
	28SDD	GGG-ACC-CGT-CTT-GAA-ACA-C	Inward (2003)
COI	SPat	GCA-CTA-WTC-TGC-CAT-ATT-AGA	Simon <i>et al.</i> (1994)
	SJerry	CAA-CAT-YTA-TTY-TGA-TTY-TTT-GG	Simon <i>et al.</i> (1994)
EF-1 α (failed)	efs372	CTG-GTG-AAT-TTG-AAG-CYG-GTA	Nomark <i>et al.</i> (1999)
	efa747	CCA-CCA-ATT-TTG-TAG-ACA-TC	Nomark <i>et al.</i> (1999)

Sequencing alignment

The obtained sequences of each gene were assembled using SeqMan pro ver. 7.1.0 (DNASTAR, Inc., Madison, USA) and checked for error manually with Chromas 2.6.2 (Technelysium Pty Ltd, Brisbane, Australia). The identified sequences were aligned and trimmed ambiguous anterior and posterior regions using MEGA 5.10 (Tamura *et al.*, 2011). Finally, aligned sequences of each gene were combined with SequenceMatrix 1.7.8 (Vaidya *et al.*, 2010).

2.3. Phylogenetic analyses

The combined data set was analyzed in two phylogenetic analyses, Bayesian Inference (BI) and Maximum Likelihood (ML). Each analysis was rooted using two families of Elateroidea as out groups. The combined data set was comprised of DNA partitions of three gene regions.

Bayesian Inference analysis

Bayesian Inference analysis was performed with GTR+I+G model using MrBayes ver. 3.1.2 (Ronquist and Huelsenbeck, 2003). The BI analyses ran for 2 million Markov chain Monte Carlo (MCMC) generations. The burninfrac was set at 0.5 (50%) of the sampled number of trees. Tracer ver. 1.4 (Rambaut and Drummond, 2007) was used to view the graphical representation of MCMC chain mixing to ensure that distribution had stabilized. A 50% majority rule consensus tree was constructed from the remaining trees to estimate posterior probabilities.

Maximum Likelihood analysis

Maximum Likelihood analysis was conducted with PhyML ver. 3.0 (Lanave et al., 1984). Each node was estimated with 1,000 bootstrap replications.

Table 4. Taxa used in the present study with GenBank accession numbers

Family	Subfamily	Tribe	Scientific name	Localities	GenBank accession number		
					18S	28S	COI
Eucnemidae	Anischiinae	-	<i>Anischia</i> sp.2	New Caledonia	KF625545	KF626145	KF625246
Eucnemidae	Anischiinae	-	<i>Anischia</i> sp.3	New Caledonia	KF625546	KF626146	KF625247
Eucnemidae	Melasiinae	Calyptocerini	<i>Otho sphondyloides</i>	Korea (Gangwon)	-	-	-
Eucnemidae	Melasiinae	Dirhagini	<i>Arrhipis elegans</i>	South America	FJ868692	x	FJ868702
Eucnemidae	Melasiinae	Dirhagini	<i>Arrhipis gaillardi</i>	Africa	FJ868684	x	FJ868718
Eucnemidae	Melasiinae	Dirhagini	<i>Arrhipis senegalensis</i>	South Africa	FJ868683	x	FJ868698
Eucnemidae	Melasiinae	Dirhagini	<i>Arrhipis</i> sp.1		x	DQ198745	DQ198577
Eucnemidae	Melasiinae	Dirhagini	<i>Arrhipis subacuta</i>	Central America	FJ868693	x	FJ868703
Eucnemidae	Melasiinae	Dirhagini	<i>Arrhipis vassei</i>	Africa	FJ868688	x	FJ868700
Eucnemidae	Melasiinae	Dirhagini	Dirhagini sp.1	Korea (Gyeonggi)	-	-	-
Eucnemidae	Melasiinae	Dirhagini	Dirhagini sp.2	Korea (Gyeonggi)	-	-	-
Eucnemidae	Melasiinae	Dirhagini	<i>Dirrhagofarsus lewisi</i>	Korea (South Jeolla)	-	-	-
Eucnemidae	Melasiinae	Dirhagini	<i>Dirrhagofarsus modestus</i>	Korea (Gyeonggi)	-	-	-
Eucnemidae	Melasiinae	Dirhagini	<i>Dirrhagofarsus</i> sp.1	Korea (Gyeonggi)	-	-	-
Eucnemidae	Melasiinae	Dirhagini	<i>Entomophthalmus americanus</i>		DQ100491	DQ198727	x
Eucnemidae	Melasiinae	Dirhagini	<i>Farsus ainu</i>	Korea (Gangwon)	-	-	-
Eucnemidae	Melasiinae	Dirhagini	<i>Microrhagus foveolatus</i>	Korea (Gangwon)	-	-	-
Eucnemidae	Melasiinae	Dirhagini	<i>Microrhagus mystagogus</i>	Korea (Gangwon)	-	-	-
Eucnemidae	Melasiinae	Dirhagini	<i>Microrhagus pygmaeus</i>	Czech Republic	KF625570	KF626170	KF625271
Eucnemidae	Melasiinae	Dirhagini	<i>Microrhagus ramosus</i>	Korea (Gangwon)	-	-	-
Eucnemidae	Melasiinae	Dirhagini	<i>Microrhagus</i> sp.1	Korea (Jeju)	-	-	-
Eucnemidae	Melasiinae	Dirhagini	<i>Microrhagus</i> sp.10	Slovakia	KF625569	KF626169	KF625270

Eucnemidae	Melasinae	Dirhagini	<i>Protofarsus convexus</i>	Central-North America	FJ868694	x	x
Eucnemidae	Melasinae	Dirhagini	<i>Protofarsus</i> sp.1		DQ100496	DQ198732	DQ198565
Eucnemidae	Melasinae	Epiphanini	<i>Hylis olexai</i>		EF363007	x	HQ164971
Eucnemidae	Melasinae	Epiphanini	<i>Hylis harmandi</i>	Korea (Gangwon)	-	-	-
Eucnemidae	Melasinae	Epiphanini	<i>Hylis</i> sp.1	Korea (Seoul)	-	-	-
Eucnemidae	Melasinae	Epiphanini	<i>Hylis</i> sp.2	Korea (Gyeonggi)	-	-	-
Eucnemidae	Melasinae	Epiphanini	<i>Hylis</i> sp.3	Korea (Gangwon)	-	-	-
Eucnemidae	Melasinae	Epiphanini	<i>Hylis yanoi</i>	Korea (Gangwon)	-	-	-
Eucnemidae	Melasinae	Hylocharini	<i>Hylochaes cruentatus</i>	Finland	FJ462387	FJ462401	x
Eucnemidae	Melasinae	Hylocharini	<i>Hylochaes harmandi</i>	Korea (Gyeonggi)	-	-	-
Eucnemidae	Melasinae	Hylocharini	<i>Hylochaes</i> sp.1	Russia	FJ462397	FJ462413	x
Eucnemidae	Melasinae	Melasini	<i>Isorhipis foveata</i>	Korea (Gyeonggi)	-	-	-
Eucnemidae	Melasinae	Melasini	<i>Isorhipis marmottani</i>	Czech Republic	x	KF626183	KF625281
Eucnemidae	Melasinae	Melasini	<i>Isorhipis</i> sp.1	Korea (Gangwon)	-	-	-
Eucnemidae	Melasinae	Melasini	<i>Melasis buprestoides</i>	Greece	KF625558	KF626158	KF625259
Eucnemidae	Melasinae	Xylobiini	<i>Bioxylus natsumiae</i>	Korea (Gyeonggi)	-	-	-
Eucnemidae	Melasinae	Xylobiini	<i>Bioxylus personatus</i>	Korea (Gangwon)	-	-	-
Eucnemidae	Melasinae	Xylobiini	<i>Bioxylus pilosellus</i>	Korea (Gangwon)	-	-	-
Eucnemidae	Melasinae	Xylobiini	<i>Proxylobius helleri</i>	Korea (Gangwon)	-	-	-
Eucnemidae	Melasinae	Xylobiini	<i>Proxylobius longicornis</i>	Korea (South Jeolla)	-	-	-
Eucnemidae	Melasinae	Xylobiini	<i>Xylophilus ainu</i>	Korea (Jeju)	-	-	-
Eucnemidae	Macraulacinae	Euryptychini	<i>Euryptychus vicinus</i>	Korea (Gangwon)	-	-	-
Eucnemidae	Macraulacinae	Macraulacini	<i>Fornax nipponicus</i>	Korea (Seoul)	-	-	-
Eucnemidae	Macraulacinae	Macraulacini	<i>Fornax</i> sp.2		x	DQ198728	DQ198561
Eucnemidae	Macraulacinae	Macraulacini	<i>Fornax</i> sp.3		DQ100492	DQ198729	DQ198562
Eucnemidae	Macraulacinae	Macraulacini	<i>Heterotaxis nipparensis</i>	Korea (Gangwon)	-	-	-

Elateridae	Elaterinae	Adrastini	Adrastini sp.1	Japan	HQ333780	HQ333875	HQ333963
Elateridae	Elaterinae	Agriotini	<i>Agriotes obscurus</i>	Czech Republic	HQ333805	HQ333900	KF625441
Elateridae	Elaterinae	Ampedini	<i>Ampedus gracilips</i>	Korea (Gyeonggi)	-	-	-
Elateridae	Elaterinae	Ampedini	<i>Ampedus puniceus</i>	Korea (Gangwon)	-	-	-
Elateridae	Denticollinae	Denticollini	<i>Denticollis</i> sp.1	Japan	HQ333759	HQ333854	HQ333943
Elateridae	Cardiophorinae	Cardiophorini	<i>Dicronychus cinereus</i>	Czech Republic	HQ333776	HQ333871	HQ333959
Elateridae	Cardiophorinae	Cardiophorini	<i>Dicronychus rubripes</i>	Slovakia	HQ333764	HQ333859	HQ333947
Elateridae	Agrypninae	Drilini	<i>Drilus concolor</i>	Hungary	HQ333827	KF626322	HQ334007
Elateridae	Agrypninae	Drilini	<i>Malacogaster passerinii</i>	Italy	KF625741	KF626321	KF625432
Elateridae	Agrypninae	Hemirhipini	<i>Tetrigus cyprius</i>	Greece	KF625744	KF626327	KF625438
Throscidae	Throscinae	Throscini	<i>Aulonothroscus longulus</i>	Korea (Gyeonggi)	-	-	-
Throscidae	Indet.	Indet.	Throscidae sp.1	Malaysia	KF625542	KF626142	KF625242
Throscidae	Indet.	Indet.	Throscidae sp.2	Indonesia	KF625541	KF626141	KF625241
Throscidae	Indet.	Indet.	Throscidae sp.3	Cameroon	KF625540	KF626140	KF625240
Throscidae	Indet.	Indet.	Throscidae sp.4	Cameroon	KF625539	KF626139	KF625239
Throscidae	Indet.	Indet.	Throscidae sp.5	Cameroon	KF625538	x	KF625238
Throscidae	Indet.	Indet.	Throscidae sp.6	Cameroon	KF625537	KF626138	KF625237
Throscidae	Indet.	Indet.	Throscidae sp.7	Cameroon	KF625536	KF626137	KF625236
Throscidae	Indet.	Indet.	Throscidae sp.8	Japan	KF625535	KF626136	KF625235
Throscidae	Indet.	Indet.	Throscidae sp.9	Indonesia	KF625534	KF626135	KF625234
Throscidae	Indet.	Indet.	Throscidae sp.10	Indonesia	KF625533	KF626134	KF625233
Throscidae	Indet.	Indet.	Throscidae sp.11	Malaysia	KF625532	KF626133	KF625232
Throscidae	Indet.	Indet.	Throscidae sp.12	Japan	KF625544	KF626144	KF625244
Throscidae	Indet.	Indet.	Throscidae sp.13	Indonesia	KF625543	KF626143	KF625243

* Indet, indeterminate; -, unpublished; x, unavailable.

3. Results

The phylogenetic trees from Bayesian Inference (BI) and Maximum Likelihood (ML) based on the combined data set of mitochondrial protein coding gene and nuclear ribosomal RNA genes were presented in Fig. 8. The clade of Eucnemidae which consisted of 48 taxa was monophyletic from outgroup, Throscidae and Elateridae, including 24 taxa in both BI and ML trees. In level of subfamily, Anischiinae formed the monophyletic clade within Eucnemidae, although it didn't have sufficient exemplars, and Macraulacinae and Melasinae were confirmed as paraphyletic groups in both trees (Fig. 9). In case of Melasinae, several tribes, such as Dirhagini, Hylocharini, and Epiphanini, formed independent clade from the major one, comprising Melasini and Xylobiini. Also, Macraulacinae was paraphyletic because Euryptychini was distinctly separated from the major clade of other Macraulacinae. In tribal level, most tribes were well-supported monophyly except the clade of Xylobiini + Calyptocerini in both phylogenetic analyses. Calyptocerini was nested within the clade of Xylobiini which was one of major clades of Melasinae (Fig. 10).

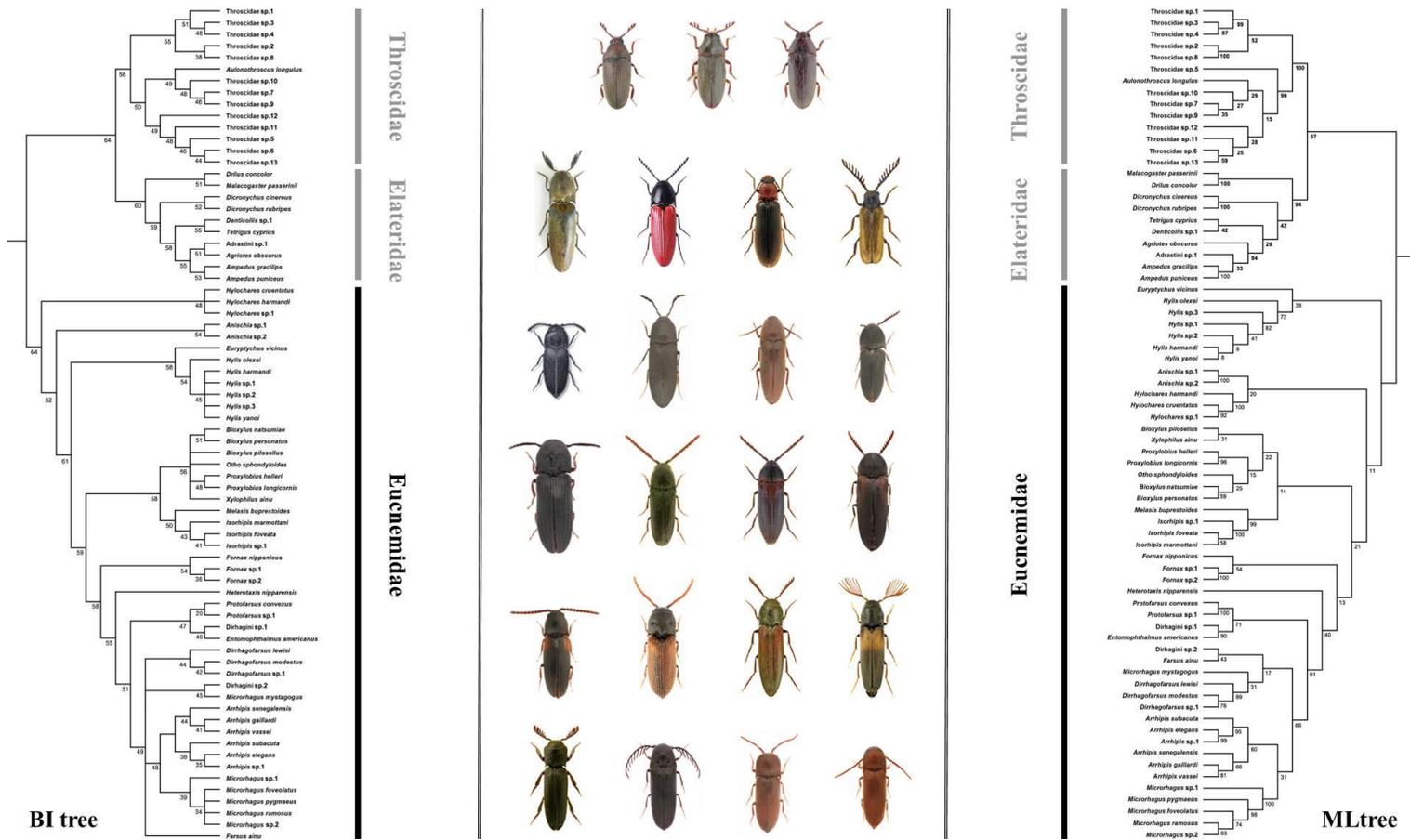


Fig. 8. Phylogenetic trees (BI, ML) resulting from the present study. Bayesian inference tree and Maximum likelihood tree from the combined data set of all nuclear and mitochondrial partitions. Numbers on nodes indicate Bayesian posterior probability values and bootstrap values for each node.

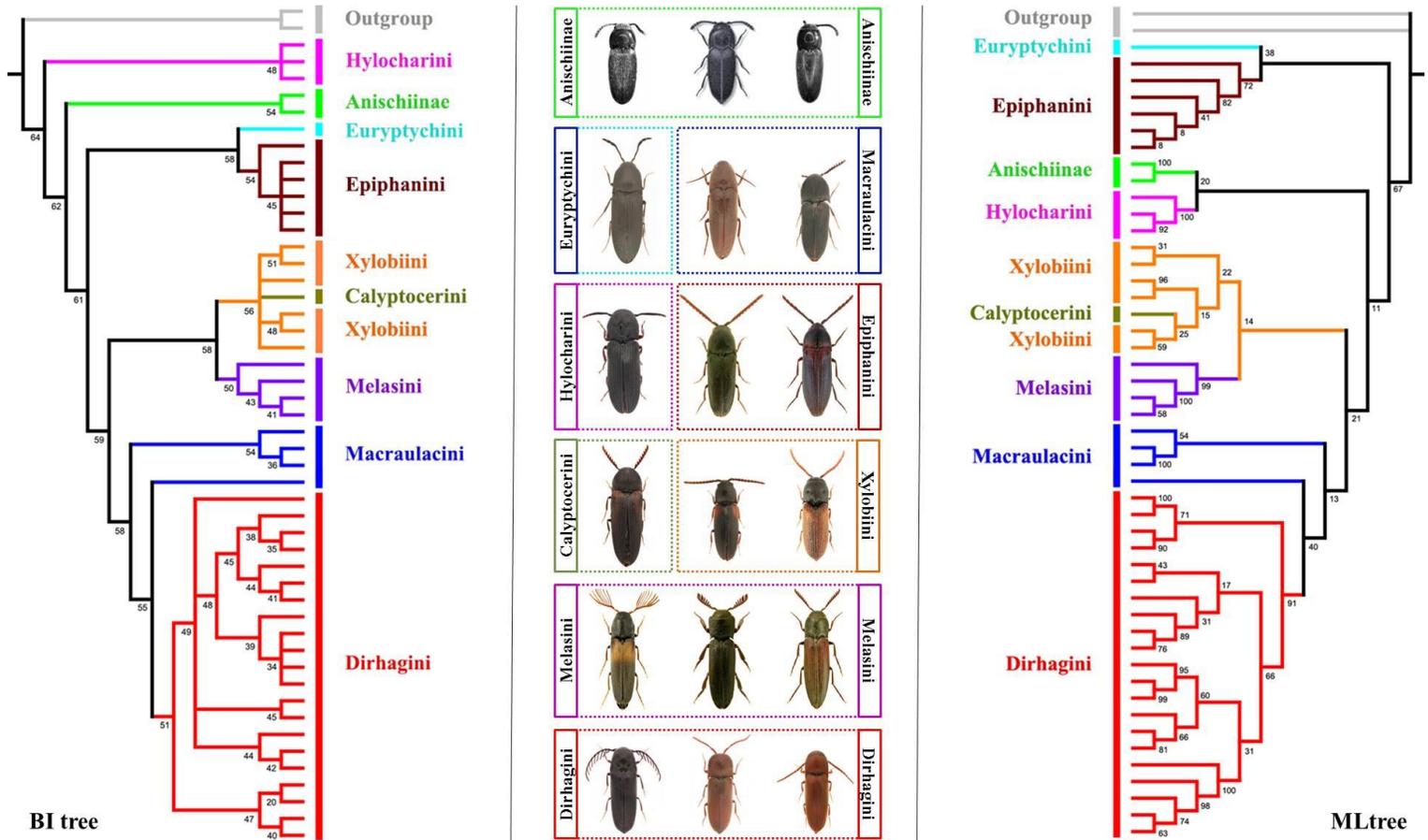


Fig. 10. Phylogenetic trees (BI, ML) indicating in tribe level based on previous classification. Bayesian inference tree and Maximum likelihood tree from the combined data set of all nuclear and mitochondrial partitions. Branches are colored by the tribes of Eucnemidae. Numbers on nodes indicate Bayesian posterior probability values and bootstrap values for each node.

4. Discussion

The family Eucnemidae was confirmed as the monophyletic group which was identical to previous molecular works (Bocakova et al., 2007; Kunderata et al., 2014) in two phylogenetic analyses, Bayesian Inference (BI) and Maximum Likelihood (ML). Most recently, Muona (1993) classified Eucnemidae based on morphological characters, focusing on subfamilies and tribes. Although we were able to use only few samples to define the correct relationships within Eucnemidae, however, our results were considerably disaccorded with previous cladistic analysis (Muona, 1993), especially in the subfamily Melasinae. Resulting from the present study, phylogenetic trees from BI and ML analyses displayed that Melasinae is paraphyletic group. Detailed phylogenetic relationships of subfamilies and tribes were mentioned as below.

4.1. Anischiinae

The subfamily Anischiinae was monophyletic in both phylogenetic trees, BI and ML in the present study (Fig. 9, Fig. 10). Anischiinae was classified as independent family or one of subfamily of Elateridae (Lawrence and Newton, 1995; Muona, 1995; Lawrence *et al.*, 1999) based on its distinct morphological characters. However, Lawrence et al. (2007) conducted molecular analysis including *Anischia* and confirmed that Anischiinae should be reclassified as a subfamily of Eucnemidae.

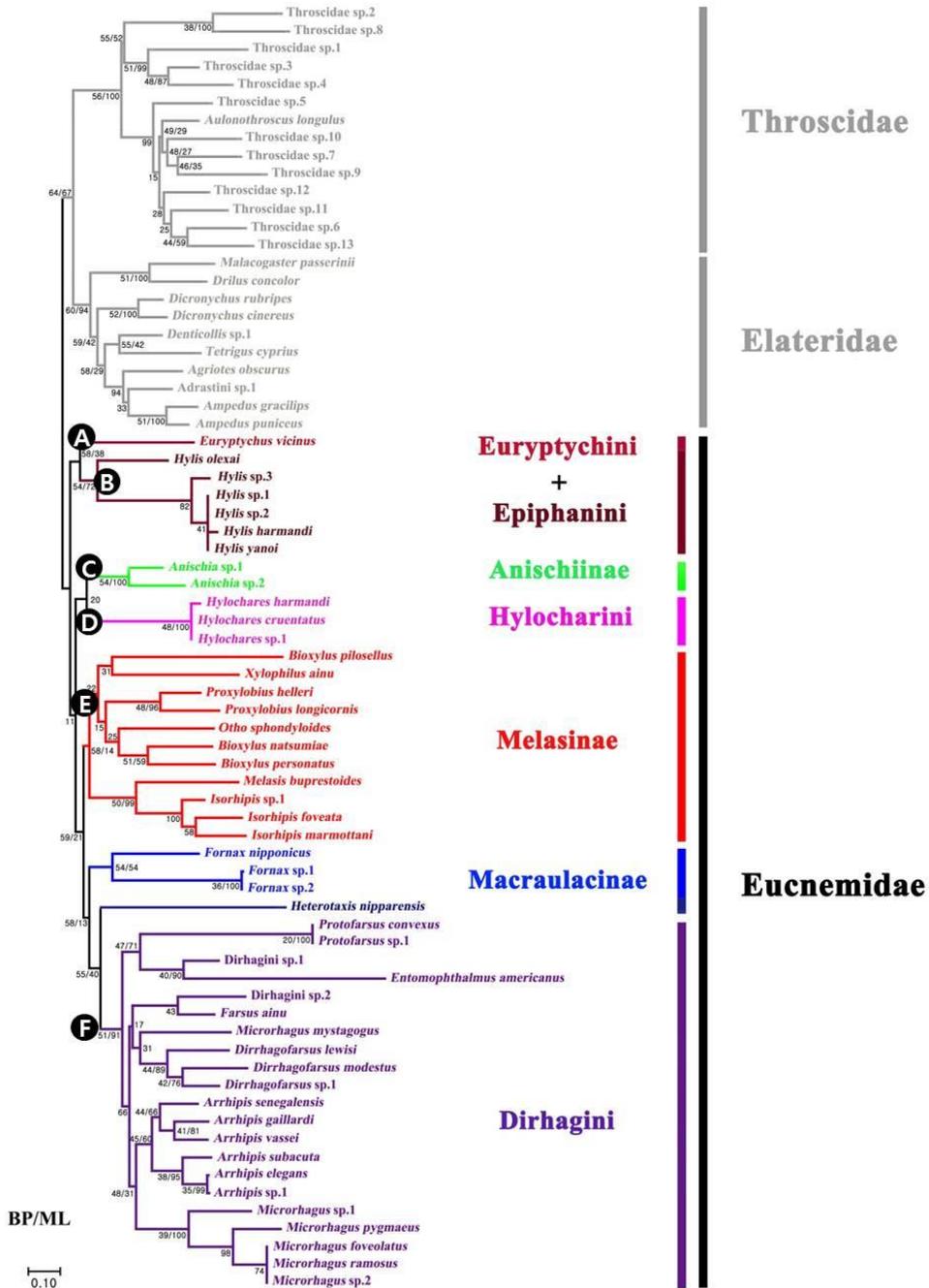


Fig. 11. Reclassification of Eucnemidae inferred from phylogenetic results. Branches and group names are colored by independent groups. Numbers on the branches indicate Bayesian posterior probability values (BP) and bootstrap values (ML) of each analysis. Capital letters on the nodes refer to groups which were discussed in the text.

Morphologically, Anischiinae is distinct as follows: body mostly small, length of 1.7~3.5 mm; antennae clavate, apical 2~5 segments enlarged; pronotum with two pairs of longitudinal keel; hypomer al antennal grooves absent; posterior coxal plate absent; trochanter strongly long, almost half of femur; aedeagus with asymmetrical, laterally compressed phallobase.

In the present study, Anischiinae was included in clade of Eucnemidae and clearly separated from other subfamilies (node C in Fig. 11). Correct taxonomic position of Anischiinae within Eucnemidae was unclear, therefore further studies will be needed to solve.

4.2. Melasinae

Muona (1993) classified the subfamily Melasinae by following morphological characters: hypomeron with notosternal antennal groove or simple; mesepimeron fused with mesepisternum; abdominal ventrite connate; protibia with one apical spur; mese- and metatibia without spines; first tarsomere of foreleg without basal sex comb in male; aedeagus bulbous and wide.

Phylogenetic results of the present study, however, showed that Melasinae is paraphyletic group (Fig. 9, Fig. 10). Each independent tribe was discussed as below.

4.2.1. Hylocharini

In the present study, the clade of Hylocharini was monophyletic and separated from main clade of Melasinae in both phylogenetic trees (Fig. 9, Fig. 10). The tribe Hylocharini is comprised of one genus, *Hylochares*, including eight species (Brüstle and Muona, 2009; Muona, 2011). Hylocharini was grouped by following characters: Form cylindrical; mandible short, with secondary ventral tooth; pronotum with lateral and median depressions; pronotal lateral ridge simple; hypomeral antennal grooves absent; metepisternum partly exposed; posterior coxal plate parallel-sided; protibia with one apical spur; first tarsomere of foreleg without sex comb in male; median lobe of aedeagus broad and round at apex. Among these characters, pronotal depressions and structure of aedeagus was specific. Additionally, elytra with deep and distinct striae punctures and tarsomeres 3~4 with ventral membranous lobe.

These characters were well-supported phylogenetic results that Hylocharini should be separated from Melasinae (node D in Fig.11). Further study will be needed to solve whether Hylocharini is placed as independent subfamily or combined with other eucnemids group.

4.2.2. Epiphanini

We used the genus *Hylis* for representing the tribe Epiphanini in the present study, and the clade of Epiphanini came out that was monophyly and separate from main clade of Melasinae in both phylogenetic trees (Fig. 9, Fig. 10). The tribe Epiphanini was erected by Muona (1993) including two genera, *Epiphanis* and *Hylis*.

Epiphanini was characteristic by following characters: form narrowed anteriorly and posteriorly; frontoclypeal region mostly expanded; mandible short, with secondary ventral tooth; pronotal lateral ridge simple; hypomer al antennal grooves absent; posterior coxal plate expanded medially; protibia with one apical spur; first tarsomere of foreleg without sex comb in male; median lobe of aedeagus deeply bifurcated. Especially, their elaterid-like form, protruded frons, and distinctly bifurcated median lobe of aedeagus were diagnostic characters.

Based on molecular analyses and morphological character, Epiphanini should be separated from Melasinae (node B in Fig. 11). Further study will be needed to locate them in right taxonomic position.

4.2.3. Calyptocerini + Melasini + Xylobiini

The genus *Otho* was used for exemplar of the tribe Calyptocerini in the present study. Our results showed that the clade of Calyptocerini was nested within Xylobiini and sister to Melasini in both phylogenetic trees (Fig. 9, Fig. 10). Muona (1993) classified Calyptocerini with two genera, *Calyptocerus* and *Otho*, including three and seven species, respectively. Calyptocerini was grouped by following characters: Form cylindrical; mandible short, with secondary ventral tooth; antennae pectinate or flabellate; third antennomere small; pronotal lateral ridge simple; hypomer al antennal grooves absent; metepisternum partly exposed; posterior coxal plate parallel-sided; seventh tergite with median keel; protibia with one apical spur;

first tarsomere of foreleg without sex comb in male; aedeagus bulbous; median lobe of aedeagus entire; lateral lobes of aedeagus with subapical tooth. Calyptocerini was closely related with other tribes of Melasinae, Melasini and Xylobiini, in morphology. Calyptocerini and Melasini shared common morphological characters as follow: Form cylindrical; antennae pectinate or flabellate; pronotal lateral ridge simple; hypomeron simple; metepisternum partly exposed; seventh tergite with median keel; protibia with one apical spur; first tarsomere of foreleg without sex comb in male; aedeagus bulbous; median lobe of aedeagus entire; lateral lobes of aedeagus with subapical tooth. Also, Calyptocerini and Xylobiini shared following common characters: mandible short, with secondary ventral tooth; pronotal lateral ridge simple; third antennomere small; hypomeran antennal grooves absent; posterior coxal plate parallel-sided; seventh tergite with median keel; protibia with one apical spur; first tarsomere of foreleg without sex comb in male; aedeagus bulbous; median lobe of aedeagus entire.

Morphological characters of above three tribes were well-corresponded with diagnostic features of Melasinae. Also, Calyptocerini seemed like an intermediate group between Melasini and Xylobiini based on morphological characters. According to our results, Calyptocerini would be incorporated into Xylobiini (node E in Fig. 11). However, several morphological differences were existed between them. Although there was no problem to place Calyptocerini, Melasini, and Xylobiini within Melasinae, further study should be conducted to solve the exact taxonomic position of Calyptocerini.

4.2.4. Dirhagini

The tribe Dirhagini is a diverse group which comprising of 25 genera with 291 described species (Muona, 1993; Muona, 2011). Among them, six genera and two undetermined Dirhagini species were used for representing the tribe and appeared as a monophyletic group. Also, Dirhagini was separated from Melasinae and formed independent clade in both phylogenetic trees in the present study (Fig. 9, Fig. 10). Muona (1993) classified Dirhagini as following characters: Form narrowed anteriorly and posteriorly; Mandible short, with secondary ventral tooth; pronotal lateral ridge serrate or divided; hypomeron with notosternal antennal grooves and deep excretory pits; posterior coxal plate mostly widened medially; protibia with one apical spur; first tarsomere of foreleg with apical sex comb in male; median lobe of aedeagus deeply or widely bifurcated. Morphologically, Dirhagini was clearly differ from other Melasinae species by apical sex comb of foreleg in male, serrate or divided pronotal lateral ridge, and structure of aedeagus. In contrast, Cobos (1964) classified Dirhagini as a independent subfamily, Dirhaginae, based on pronotal lateral ridge and hypomeral antennal grooves.

To add to Cobos's view, apical sex comb of foreleg in male and structure of aedeagus can be obvious morphological characters to separate Dirhagini from Melasinae. Dirhagini should be separated from Melasinae and reclassified as independent subfamily, Dirhaginae, based on its specific morphological characters and molecular analysis (node F in Fig. 11).

4.3. Macraulacinae

The subfamily Macraulacinae was grouped by Muona (1993) with following characters: hypomeron with lateral antennal groove or simple; mesepimeron fused with mesepisternum; abdominal ventrite connate; protibia with one apical spurs; meso- and metatibia with row of spines; first tarsomere of foreleg simple or with sex comb in male.

Although few samples were used for the present study, our results showed that Macraulacinae is paraphyletic group (Fig. 9, Fig. 10). In case of the tribe Macraulacini, two sister clade appeared, however, phylogenetic relationships within the tribe were unclear. Further study with more diverse taxa will be needed to cover in subfamily level.

4.3.1. Euryptychini

In the present study, the clade of the tribe Euryptychini was separated from other Macruacinae clade, and contained the tribe Epiphanini in both trees in the present analysis (Fig. 9, Fig. 10). Euryptychini consists of one genus, *Euryptychus*, with 20 species (Muona, 1993; Muona, 2011). Muona (1993) grouped Euryptychini by following characters: mandible slender, without secondary tooth; antennae clavate, antennomeres 9~11 enlarged; hypomeral antennal grooves absent; protibia with one apical spur; first tarsomere of foreleg with complete or apical sex comb in male; fourth tarsomere simple; aedeagus with bifurcated apex. In our results, Euryptychini

was tied to Epiphanini in both phylogenetic trees. Morphologically, Euryptychini and Epiphanini shared similar body form, elaterid-like, and apically bifurcated median lobe of aedeagus. In addition, both of them had clavate antennae. In case of the genus *Epiphanis*, belonging to Epiphanini, with antennae which enlarged in antennomeres 8~12.

These similar morphological characters would be closely related to our results that both groups were included same or sister clade (node A and node B in Fig. 11). Further study will be needed to clarify phylogenetic relationships between them.

5. Conclusion

Phylogenetic analysis of the present study was performed by Bayesian Inference and Maximum Likelihood analysis using mitochondrial protein coding gene (COI) and nuclear ribosomal RNA genes (18S rRNA and 28S rRNA, failed in case of EF-1 α) to implicate preliminary hypotheses for phylogenetic relationships within the family Eucnemidae. Although the present results were not included diverse taxa and not enough to cover in family level, several aspects were not corresponded to previous classification (Muona, 1993). Significant hypotheses based on present analysis were suggested as follow: 1) Anischiinae is independent subfamily of Eucnemidae 2) Hylocharini may be separated from Melasinae. 3) Epiphanini may be segregated from Melasinae. 4) Calyptocerini seems intermediate group between Melasini and Xylobiini, and may be transfer into Xylobiini. 5) Dirhagini should be elevated to the subfamily like 'Dirhaginae'. 6) Euryptychini would be separated from Macraulacinae. In order to clarify ambiguous and unresolved phylogenetic relationships and understand the comprehensive phylogeny of Eucnemidae, additional taxa and informative genes should be included in the further study.

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Appendix I. Adult habitus

Plate 1.



Fig. 12. The habitus of *Otho sphondyloides* (Germar, 1818). A~C: female. A: dorsal; B: ventral; C: lateral. Scale bar: 1 mm.



Fig. 13. The habitus of *Dirrhagofarsus* sp.nov. Seung and Lee. A, C~D: male; B: female. A~B: dorsal; C: ventral; D: lateral. Scale bar: 1 mm.

Appendix I. Adult habitus

Plate 2.



Fig. 14. The habitus of *Dirrhagofarsus lewisi* (Fleutiaux, 1900). A~C: female. A: dorsal; B: ventral; C: lateral. Scale bar: 1 mm.



Fig. 15. The habitus of *Dirrhagofarsus modestus* (Fleutiaux, 1923). A, C~D: male; B: female. A~B: dorsal; C: ventral; D: lateral. Scale bar: 1 mm.

Appendix I. Adult habitus

Plate 3.



Fig. 16. The habitus of *Microrhagus* sp. nov. Seung and Lee. A, C~D: male; B: female. A~B: dorsal; C: ventral; D: lateral. Scale bar: 1 mm.



Fig. 17. The habitus of *Microrhagus foveolatus* (Fleutiaux, 1923). A, C~D: male; B: female. A~B: dorsal; C: ventral; D: lateral. Scale bar: 1 mm.

Appendix I. Adult habitus

Plate 4.



Fig. 18. The habitus of *Microrhagus mystagogus* (Fleutiaux, 1923). A, C~D: male; B: female. A~B: dorsal; C: ventral; D: lateral. Scale bar: 1 mm.



Fig. 19. The habitus of *Microrhagus ramosus* (Fleutiaux, 1902). A, C~D: male; B: female. A~B: dorsal; C: ventral; D: lateral. Scale bar: 1 mm.

Appendix I. Adult habitus

Plate 5.



Fig. 20. The habitus of *Farsus ainu* Fleutiaux, 1923. A~C: male. A: dorsal; B: ventral; C: lateral. Scale bar: 1 mm.



Fig. 21. The habitus of *Hylis harmandi* (Fleutiaux, 1923). A, C~D: male; B: female. A~B: dorsal; C: ventral; D: lateral. Scale bar: 1 mm.

Appendix I. Adult habitus

Plate 6.



Fig. 22. The habitus of *Hylochaeres harmandi* Fleutiaux, 1900. A, C~D: male; B: female. A~B: dorsal; C: ventral; D: lateral. Scale bar: 1 mm.



Fig. 23. The habitus of *Isorhipis foveata* Hisamatsu, 1955. A, C~D: male; B: female. A~B: dorsal; C: ventral; D: lateral. Scale bar: 1 mm.

Appendix I. Adult habitus

Plate 7.



Fig. 24. The habitus of *Bioxylus natsumiae* Watanabe, 2009. A, C~D: male; B: female. A~B: dorsal; C: ventral; D: lateral. Scale bar: 1 mm.



Fig. 25. The habitus of *Bioxylus personatus* Mamaev, 1976. A~C: female. A: dorsal; B: ventral; C: lateral. Scale bar: 1 mm.

Appendix I. Adult habitus

Plate 8.



Fig. 26. The habitus of *Bioxylylus pilosellus* Hisamatsu, 1959. A, C~D: Male; B: female. A~B: Dorsal; C: ventral; D: lateral. Scale bar: 1 mm.



Fig. 27. The habitus of *Proxylobius helleri* Fleutiaux, 1900. A, C~D: male; B: female. A~B: dorsal; C: ventral; D: lateral. Scale bar: 1 mm.

Appendix I. Adult habitus

Plate 9.



Fig. 28. The habitus of *Proxylobius longicornis* Hisamatsu, 1958. A~C: male. A: dorsal; B: ventral; C: lateral. Scale bar: 1 mm.



Fig. 29. The habitus of *Xylophilus ainu* (Fleutiaux, 1923). A, C~D: male; B: female. A~B: dorsal; C: ventral; D: lateral. Scale bar: 1 mm.

Appendix I. Adult habitus

Plate 10.



Fig. 30. The habitus of *Euryptychus vicinus* Fleutiaux, 1923. A~C: female. A: dorsal; B: ventral; C: lateral. Scale bar: 1 mm.



Fig. 31. The habitus of *Fornax nipponicus* Fleutiaux, 1923. A, C~D: male; B: female. A~B: dorsal; C: ventral; D: lateral. Scale bar: 1 mm.

Appendix I. Adult habitus

Plate 11.



Fig. 32. The habitus of *Heterotaxis nipparensis* Hisamatsu, 1957. A~C: female. A: dorsal; B: ventral; C: lateral. Scale bar: 1 mm.

Appendix II. Structures of adult

Plate 12.

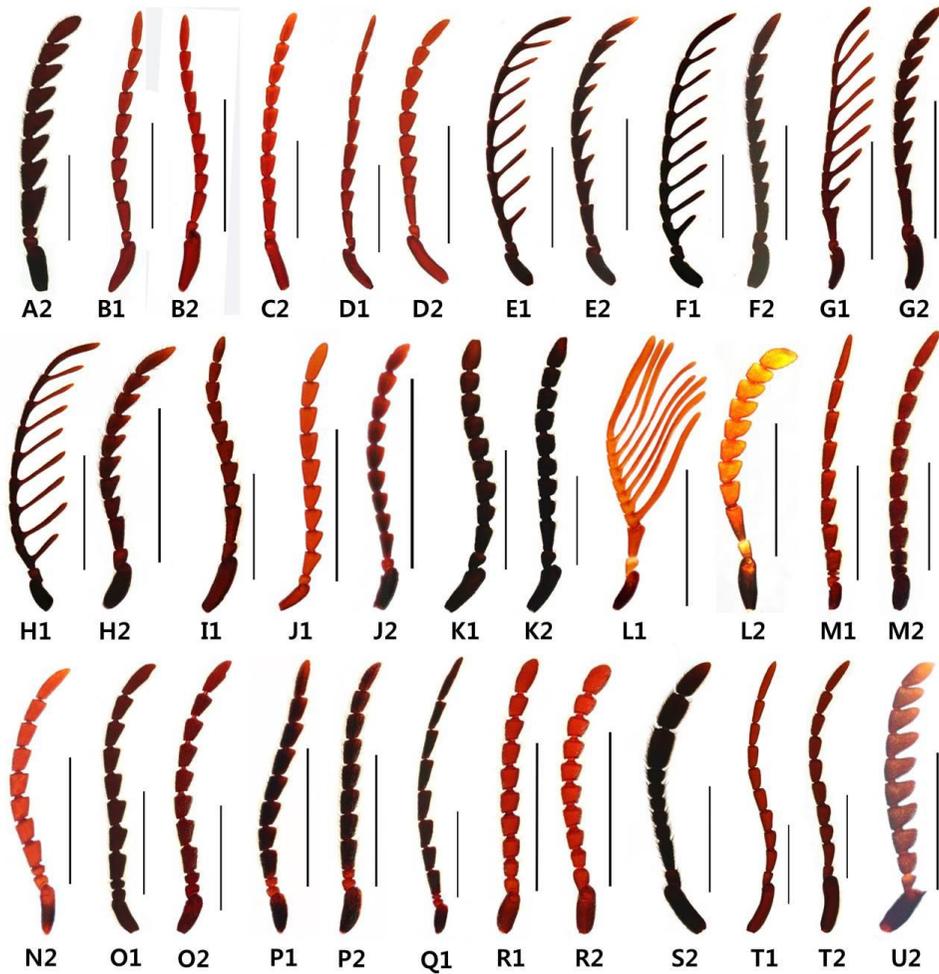


Fig. 33. The structures of antennae in Korean Eucnemidae. A: *Otho sphondyloides*; B: *Dirrhagofarsus* sp. nov.; C: *D. lewisi*; D: *D. modestus*; E: *Microrhagus* sp. nov; F: *M. foveolatus*; G: *M. mystagogus*; H: *M. ramosus*; I: *Farsus. ainu*; J: *Hylis harmandi*; K: *Hylochaes harmandi*; L: *Isorhipis foveata*; M: *Bioxylus natusmiae*; N: *B. personatus*; O: *B. pilosellus*; P: *Proxyllobius helleri*; Q: *P. longicornis*; R: *Xylophilus ainu*; S: *Euryptychus vicinus*; T: *Fornax nipponicus*; U: *Heterotaxis nipparensis*. 1: male; 2: female. Scale bar: 1 mm.

Appendix II. Structures of adult

Plate 13.



Fig. 34. The structures of head in Korean Eucnemidae. A: *Otho sphondyloides*; B: *Dirrhagofarsus* sp. nov.; C: *D. lewisi*; D: *D. modestus*; E: *Microrhagus* sp. nov.; F: *M. foveolatus*; G: *M. mystagogus*; H: *M. ramosus*; I: *Farsus. ainu*; J: *Hylis harmandi*; K: *Hylochaes harmandi*; L: *Isorhipis foveata*; M: *Bioxylus natusmiae*; N: *B. personatus*; O: *B. pilosellus*; P: *Proxylobius helleri*; Q: *P. longicornis*; R: *Xylophilus ainu*; S: *Euryptychus vicinus*; T: *Fornax nipponicus*; U: *Heterotaxis nipparensis*. 1: male; 2: female. Scale bar: 0.5 mm.

Appendix II. Structures of adult

Plate 14.



Fig. 35. The structures of metepisternum in Korean Eucnemidae. A: *Otho sphondyloides*; B: *Dirrhagofarsus* sp. nov.; C: *D. lewisi*; D: *D. modestus*; E: *Microrhagus* sp. nov; F: *M. foveolatus*; G: *M. mystagogus*; H: *M. ramosus*; I: *Farsus. ainu*; J: *Hylis harmandi*; K: *Hylochaes harmandi*; L: *Isorhipis foveata*; M: *Bioxylus natusmiae*; N: *B. personatus*; O: *B. pilosellus*; P: *Proxyllobius helleri*; Q: *P. longicornis*; R: *Xylophilus ainu*; S: *Euryptychus vicinus*; T: *Fornax nipponicus*; U: *Heterotaxis nipparensis*. 1: male; 2: female. Scale bar: 0.5 mm.

Appendix II. Structures of adult

Plate 15.

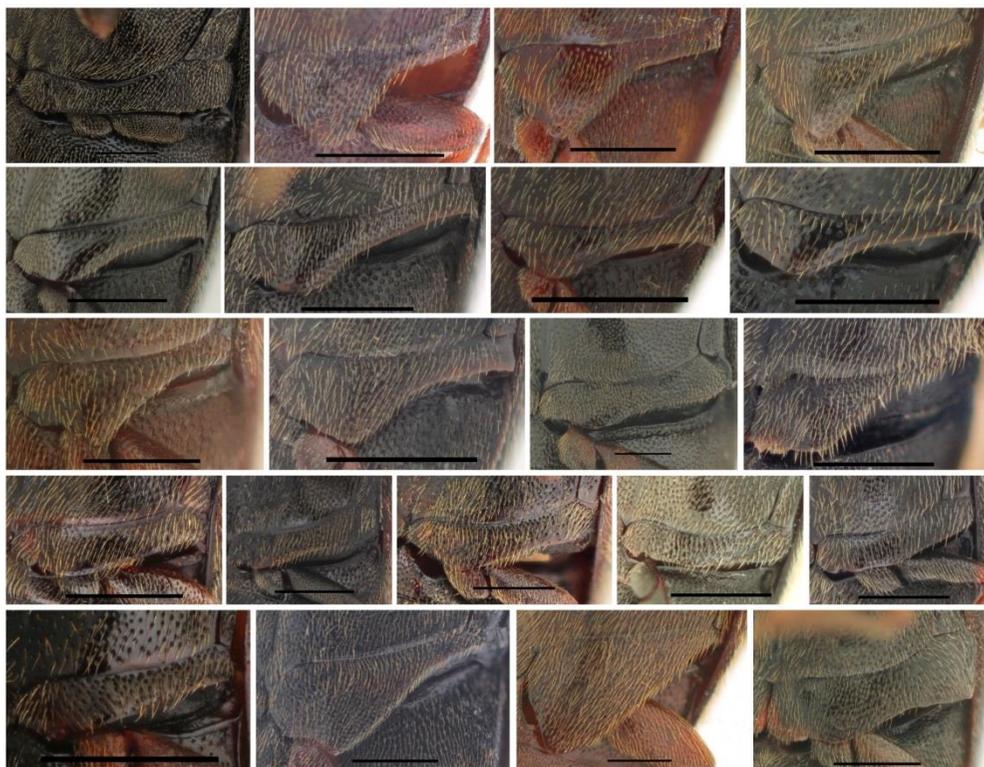


Fig. 36. The structures of posterior coxal plate in Korean Eucnemidae. A: *Otho sphondyloides*; B: *Dirrhagofarsus* sp. nov.; C: *D. lewisi*; D: *D. modestus*; E: *Microrhagus* sp. nov; F: *M. foveolatus*; G: *M. mystagogus*; H: *M. ramosus*; I: *Farsus. ainu*; J: *Hylis harmandi*; K: *Hylochaes harmandi*; L: *Isorhipis foveata*; M: *Bioxylus natusmiae*; N: *B. personatus*; O: *B. pilosellus*; P: *Proxyllobius helleri*; Q: *P. longicornis*; R: *Xylophilus ainu*; S: *Euryptychus vicinus*; T: *Fornax nipponicus*; U: *Heterotaxis nipparensis*. 1: male; 2: female. Scale bar: 0.5 mm.

Appendix II. Structures of adult

Plate 16.

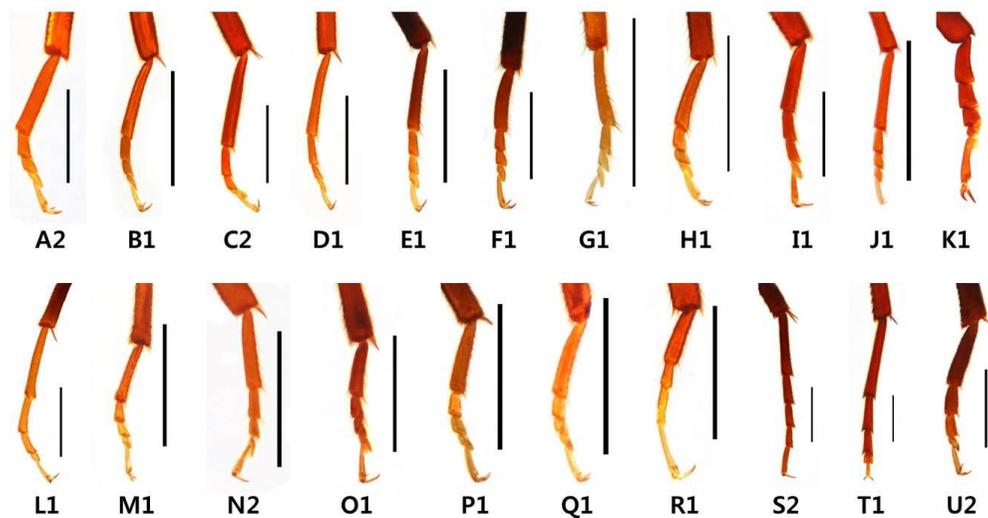


Fig. 37. The structures of hind-tarsi in Korean Eucnemidae. A: *Otho sphondyloides*; B: *Dirrhagofarsus* sp. nov.; C: *D. lewisi*; D: *D. modestus*; E: *Microrhagus* sp. nov.; F: *M. foveolatus*; G: *M. mystagogus*; H: *M. ramosus*; I: *Farsus. ainu*; J: *Hylis harmandi*; K: *Hylochaes harmandi*; L: *Isorhipis foveata*; M: *Bioxylus natusmiae*; N: *B. personatus*; O: *B. pilosellus*; P: *Proxylobius helleri*; Q: *P. longicornis*; R: *Xylophilus ainu*; S: *Euryptychus vicinus*; T: *Fornax nipponicus*; U: *Heterotaxis nipparensis*. 1: male; 2: female. Scale bar: 0.5 mm.

Appendix II. Structures of adult

Plate 17.

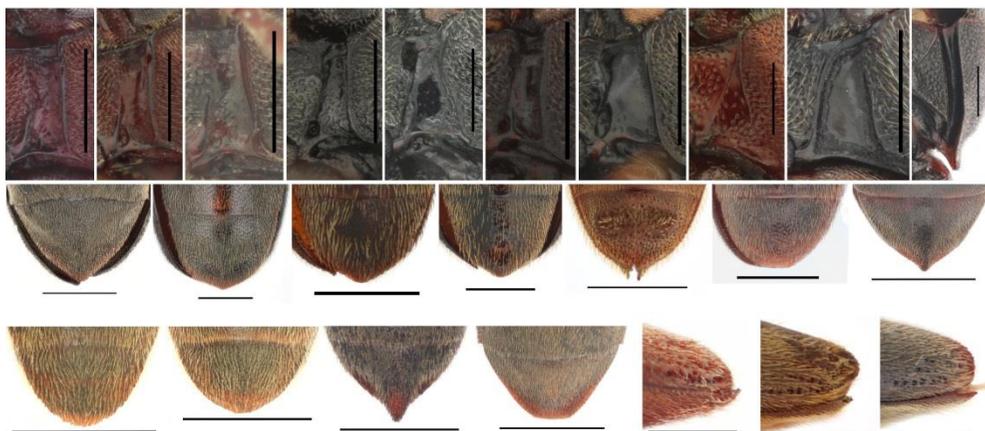


Fig. 38. Additional morphological characters of Korean Eucnemidae. A~J: Hypomerall antennal grooves; K~T: Fifth abdominal ventrite; U~W: Elytral apices. A, U: *Dirrhagofarsus* sp. nov.; B, V: *D. lewisi*; C, W: *D. modestus*; D, L: *Microrhagus* sp. nov.; E: *M. foveolatus*; F, M: *M. mystagogus*; G, N: *M. ramosus*; H, O: *Farsus. ainu*; I: *Proxylobius helleri*; J, T: *Heterotaxis nipparensis*; K: *Otho sphondyloides*; P: *Hylis harmandi*; Q: *Hylochaes harmandi*; R: *Bioxylus natusmiae*; S: *B. personatus*. 1: male; 2: female. Scale bar: 0.5 mm.

Appendix II. Structures of adult

Plate 18.

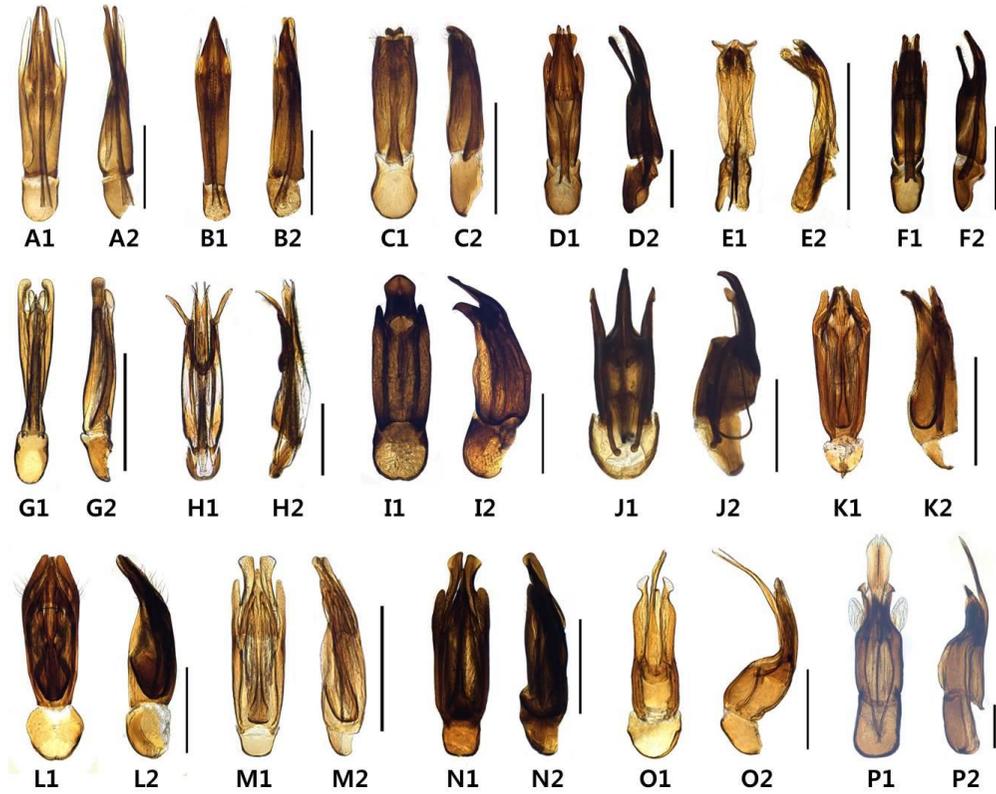


Fig. 39. The structures of aedeagus in Korean Eucnemidae. A: *Dirrhagofarsus* sp. nov.; B: *D. modestus*; C: *Microrhagus* sp. nov.; D: *M. foveolatus*; E: *M. mystagogus*; F: *M. ramosus*; G: *Farsus. ainu*; H: *Hylis harmandi*; I: *Hylochaes harmandi*; J: *Isorhipis foveata*; K: *Bioxylus natusmiae*; L: *B. pilosellus*; M: *Proxylobius helleri*; N: *P. longicornis*; O: *Xylophilus ainu*; P: *Fornax nipponicus*. 1: dorsal; 2: lateral. Scale bar: 0.5 mm.

국문초록

어리방아벌레과(딱정벌레목: 방아벌레상과)의 계통분류학적 연구

서울대학교 대학원
농생명공학부 곤충학 전공
승진배

본 연구는 방아벌레상과에 속하는 어리방아벌레과에 대한 계통분류학적 연구로, 크게 두 가지의 주제로 구성되어 있다. 첫 번째 주제는 한반도에 서식하는 어리방아벌레과에 대한 분류학적 재검토이며, 두 번째는 분자마커를 이용한 어리방아벌레과의 계통에 대한 연구이다.

첫 번째 장에서 다룬 한국산 어리방아벌레과의 분류학적 재검토에서는, 총 2개 아과, 14속에 속하는 22종의 어리방아벌레류가 확인되었다. 이 중에는 2종의 신종과 15종의 미기록종이 포함되어 있으며, 2014년 보고된 *Dromaeolus marginatus*의 경우, 표본의 부재로 인해 본 연구에서 확인하지 못하였다. 모든 한국산 어리방아벌레류는 재기술했으며, 각 분류단계에 대한 검색표를 포함하였다.

두 번째 연구에서는, 분자마커를 이용하여 어리방아벌레과에 대한 계통학적 연구를 수행하였다. 베이저안 추론(Bayesian Inference), 최대공산(Maximum Likelihood) 분석에 의한 결과에서, 어리방아벌레과는 방아벌레상과 내에서 단계통성을 보이는 무리인 것으로 확인되었다. 하지만 아과 단위에서 기존 분류체제와 비교해 볼 때, 어리방아벌레과는 상당한 측계통성을 보이는 것으로 확인되었다. Melasinae에 속하는 Dirhagini, Epiphanini, Hylocharini는 Calyptocerini, Melasini, Xylobiini가 포함된 Melasinae의 주요 분기점에서 각각 분리되어 독립된 무리로 나타났다. 또한, Macraulacinae에 속하는 Euryptychini는 Macraulacinae의 계통군에서 분리되어 나타났다.

검색어; 어리방아벌레과, 분류학적 검토, 한반도, 계통분류학, 분자계통학