

## Contributions to the systematics of the family Buprestidae (Coleoptera) by the first description of male external genital organ and illustrations of six species from Ankara province

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**Abstract:** The main aim of this study is to contribute to the systematics relating to the family Buprestidae, by studying the male external genital organs (aedeagi) of six species belonging to the genera *Acmaeodera*, *Acmaeoderella*, *Anthaxia*, *Capnodis*, and *Perotis*, none of which had been illustrated previously. Samples of these species were collected from the province of Ankara, Turkey, and the aedeagus of each was described and illustrated in detail for the first time. The findings were then compared with the current literature.

**Key words:** Jewel beetles, systematics, male external genitalia, aedeagus, first descriptions, drawings

### 1. Introduction

Buprestidae is one of the largest Coleopteran families in the world. According to various researchers, it contains between 11,500 and 16,000 species (Tozlu and Özbek, 2000a). Like in many insect groups, the richness of insect biodiversity makes differentiation between species difficult. As a result, aedeagi are inevitably used in species identification. The aedeagus of Buprestidae species take a modified trilobate form unique to that family. Aedeagus consists of the parameres, which are median lobe and phallobase. The principal components of the median lobe are two flat plates: one ventral and one dorsal. It is almost parallel basally, is deeply grooved on the ventral side, and apex acute to transverse. Parameres, which are generally symmetrical (but occasionally asymmetrical), sometimes bear membranous lateral lobes and sensory setae distally, and have a highly modified structure. The phallobase is fused to form a plate (Bellamy and Volkovitsh, 2016). Buprestids are different from all other elateroids in which the phallobase is fused with the parameres (Crowson, 1967). The main aim of this study is examining and drawing male aedeagi of six Buprestid species for the first time in order to make contributions to Buprestidae systematics.

### 2. Materials and methods

Male species examined were collected in Ankara province in 2018 (May–October) and 2019 (April–October).

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The locations from which specimens were collected are shown in Figure 1. Species were identified using literature including diagnostic keys and species descriptions (Bílý, 1980; Tezcan, 1990; Lodos and Tezcan, 1995; Tozlu, 1997; Tozlu and Özbek, 2000a, 2000b; Çağlar, 2009; Volkovitsh, Sakalian, and Georgiev, 2015). The aedeagi of the samples examined were prepared using standard methods. Their morphology was described in detail, photographs of them were taken, and detailed drawings were made from both dorsal and lateral views. The aedeagi were compared with those of closely related species, samples of which were collected during the field study (with others acquired from present literature). Diagnostic characteristics of aedeagi for differential diagnosis are also given briefly in Table 1.

### 3. Results

Specimens were collected from the following species: *Acmaeodera* (s.str.) *flavolineata*, *Acmaeoderella* (*Euacmaeoderella*) *villosula*, A. (E.) *gibbulosa*, *Capnodis carbonaria*, *Perotis cuprata*, and *Anthaxia* (*Cratomerus*) *eugeniae*. The localities from where they were collected, aedeagus descriptions, habitus photographs, aedeagus drawings and photographs, distribution maps, and character table are given below.

Subfamily: Polycestinae Lacordaire, 1857

*Acmaeodera* (s.str.) *flavolineata* Laporte & Gory, 1835 (Figure 2.)

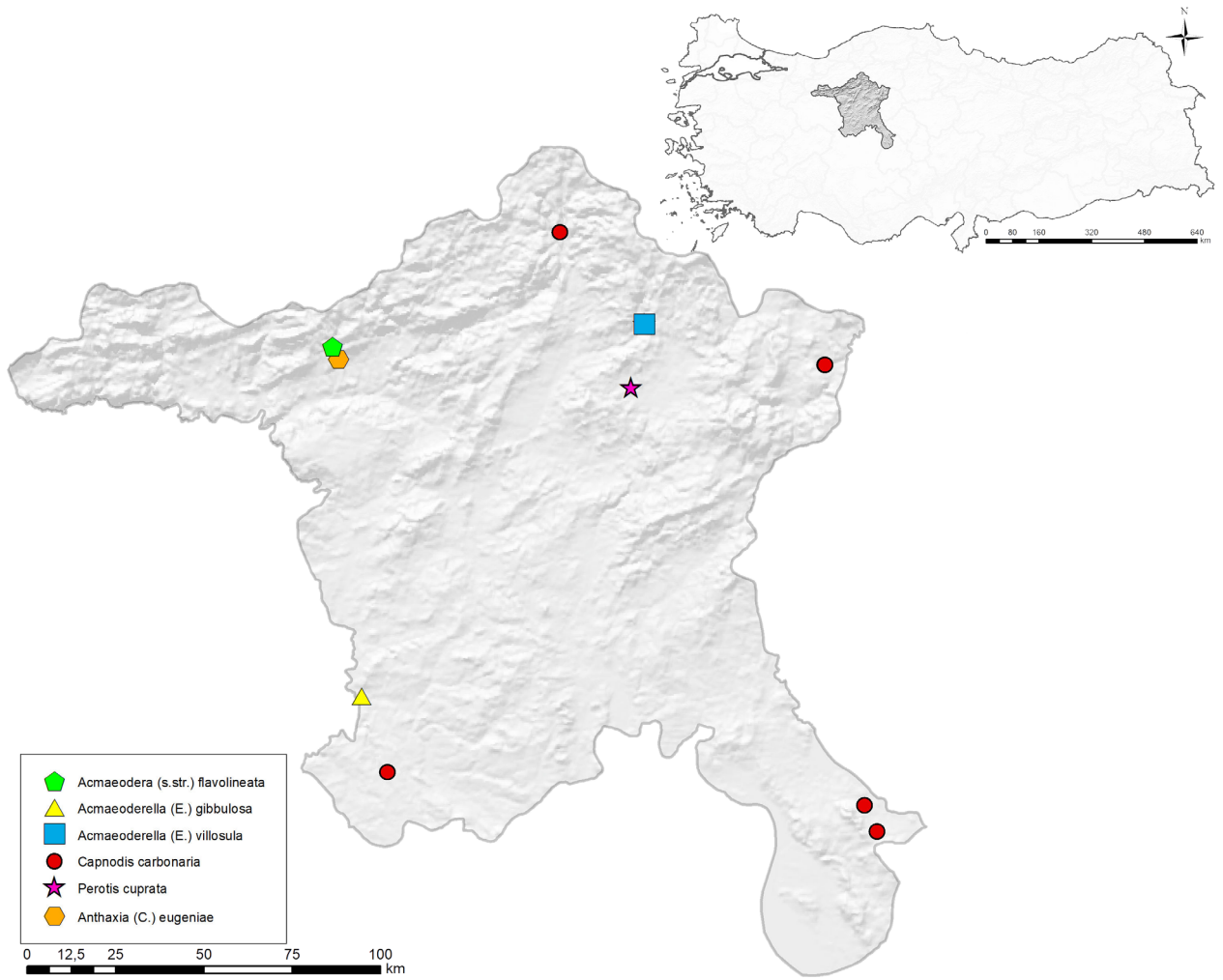


Figure 1. The localities of the examined species collected in Ankara province (the map designed with ArcGIS Pro v.2.2).

Table 1. Diagnostic characters of aedeagi of examined species.

Species	Median lobe apex	Paramere lateral sides	Paramere apical setae	Paramere apex
<i>Acmaeodera flavolineata</i>	Obtuse	Expanded from posterior to middle, narrowed from middle to anterior	None	Obtuse
<i>Acmaeoderella gibbulosa</i>	Obtuse	Parallel-sided, narrowed in apical part	None	Pointed
<i>Acmaeoderella villosula</i>	Obtuse	Expanded from posterior to anterior, narrowed in apical part	None	Pointed
<i>Capnodis carbonaria</i>	Pointed	Expanded in posterior half to anterior, widened in anterior half, narrowed in apical part	Long, dense	Pointed
<i>Perotis cuprata</i>	Pointed	Parallel in posterior third, expanded to anterior in medial third part, almost parallel in anterior third part	Long, dense	Obliquely truncated
<i>Anthaxia eugeniae</i>	Obtuse	Expanded from posterior to almost middle, gradually narrowed from middle to apical part, expanded in apical part and then narrowed to apex	Long, sparse	Lobe-like expanded

Material examined: Ankara (Beyazarı), 40°13'21.60'' N, 31°53'31.90'' E, 833.8m, 1♂, 18.6.2019.

Aedeagus (Figure 3. A–D): In the dorsal view, phallobase hyaline, lateral margins narrowed posteriorly, triangle-like, posterior margin rounded; parameres hyaline, stronger sclerotized in the apical part, lateral margins slightly widened from the posterior to middle, and gradually narrowed from the middle to the apices, obtuse at apex; median lobe hyaline, apex hyaline, and rounded. In lateral view, the phallobase slightly sclerotized, posterior margin raised upwards; parameres straight in the dorsal fourth, then gradually narrowed to the apical part, suddenly curved near the apex, then continued almost straight to the tip, rounded at apex.

*Acmaeoderella* (*Euacmaeoderella*) *villosula* (Steven, 1830) (Figure 4.)

Material examined: Ankara (Çubuk), 40°18'13.67'' N, 32°55'39.64'' E, 1163 m, 2♂♂, 11.6.2018.

Aedeagus (Figure 5. A–D): In the dorsal view, phallobase hyaline, lateral margins narrowed posteriorly, triangle-like, posterior margin slightly rounded; parameres hyaline in posterior half, sclerotized in the anterior half, lateral margins slightly widened from the posterior to the anterior, gradually narrowed towards apex in apical part, the inner margins slightly bowed towards the apex in the apical part, parameres covered with campaniform sensillae, with narrowly rounded apex; median lobe hyaline, its tip more hyaline, with rounded apex. In lateral view, phallobase slightly sclerotized, posterior margin raised upwards; parameres dorsally convex in posterior third, the rest gradually narrowed towards the end, ventral part of parameres arcuate in posterior third, medial third almost straight, narrowed gradually towards tip in anterior third, apex rounded.

*Acmaeoderella* (*Euacmaeoderella*) *gibbulosa* (Ménétriés, 1832) (Figure 6.)

Material examined: Ankara (Polatlı), 39°20'00.00'' N, 32°01'35.80'' E, 728m, 2♂♂, 27.7.2019.

Aedeagus (Figure 7. A–D): In the dorsal view, phallobase hyaline, anterior corners curved downward and pointed, lateral margins narrowed from anterior to posterior, posterior margin rounded; parameres sclerotized, lateral margins slightly expanded towards anterior in posterior third, then continued parallel to the apical part, gradually narrowed to the tip in the apical part, inner edges of the apical part directed outwards, expanded, the parameres covered with campaniform sensillae in anterior third, with rounded apex; median lobe hyaline, with rounded apex. In lateral view, phallobase sclerotized, posterior margin raised upwards; parameres inclined towards ventral in posterior fourth, then dorsal part of parameres gradually narrowed to the tip, almost straight in ventral, apex rounded.

Subfamily Chrysochroinae Laporte, 1835

*Capnodis carbonaria* (Klug, 1829) (Figure 8.)

Material examined: Ankara (Evren), 39°05'06.54'' N, 33°40'58.56'' E, 930 m, 1♂, 18.5.2018; Ankara (Kızılcahamam), 40°31'55.72'' N, 32°38'20.81'' E, 1329 m, 1♂, 13.7.2018; Ankara (Evren), 39°01'08.00'' N, 33°43'30.30'' E, 1013 m, 2♂♂, 19.VII.2018; Ankara (Kalecik), 40°12'30.40'' N, 33°31'50.00'' E, 665 m, 18♂♂, 22.7.2018; Ankara (Kalecik), 40°12'29.70'' N, 33°31'51.10'' E, 671.6m, 3♂♂, 21.6.2019; Ankara (Polatlı), 39°08'34.70'' N, 32°07'08.80'' E, 912m, 1♂, 27.7.2019.

Aedeagus (Figure 9. A–D): In the dorsal view, phallobase slightly sclerotized, the lateral margins slightly expanded to the anterior; parameres highly sclerotized, lateral margins slightly widened towards the anterior in posterior half, clearly widened in anterior half and gradually narrowed to the apex in the apical part, margins of narrowed area slightly less sclerotized than the other parts, and this area longly setose almost in anterior half, apex pointed; median lobe less sclerotized than parameres, gradually narrowed in apical part then more markedly, apex pointed. In lateral view, the phallobase inclined towards ventral, posterior margin raised; parameres dorsally straight, parameres ventrally almost straight in posterior half, gradually narrowed towards the tip in anterior half, pointed at apex.

*Perotis cuprata* (Klug, 1829) (Figure 10.)

Material examined: Ankara (Pursaklar), 40°08'29.14'' N, 32°53'21.52'' E, 1039.43m, 1♂, 11.6.2018; Ankara (Çubuk), 40°18'13.67'' N, 32°55'39.64'' E, 1163m, 1♂, 11.6.2018.

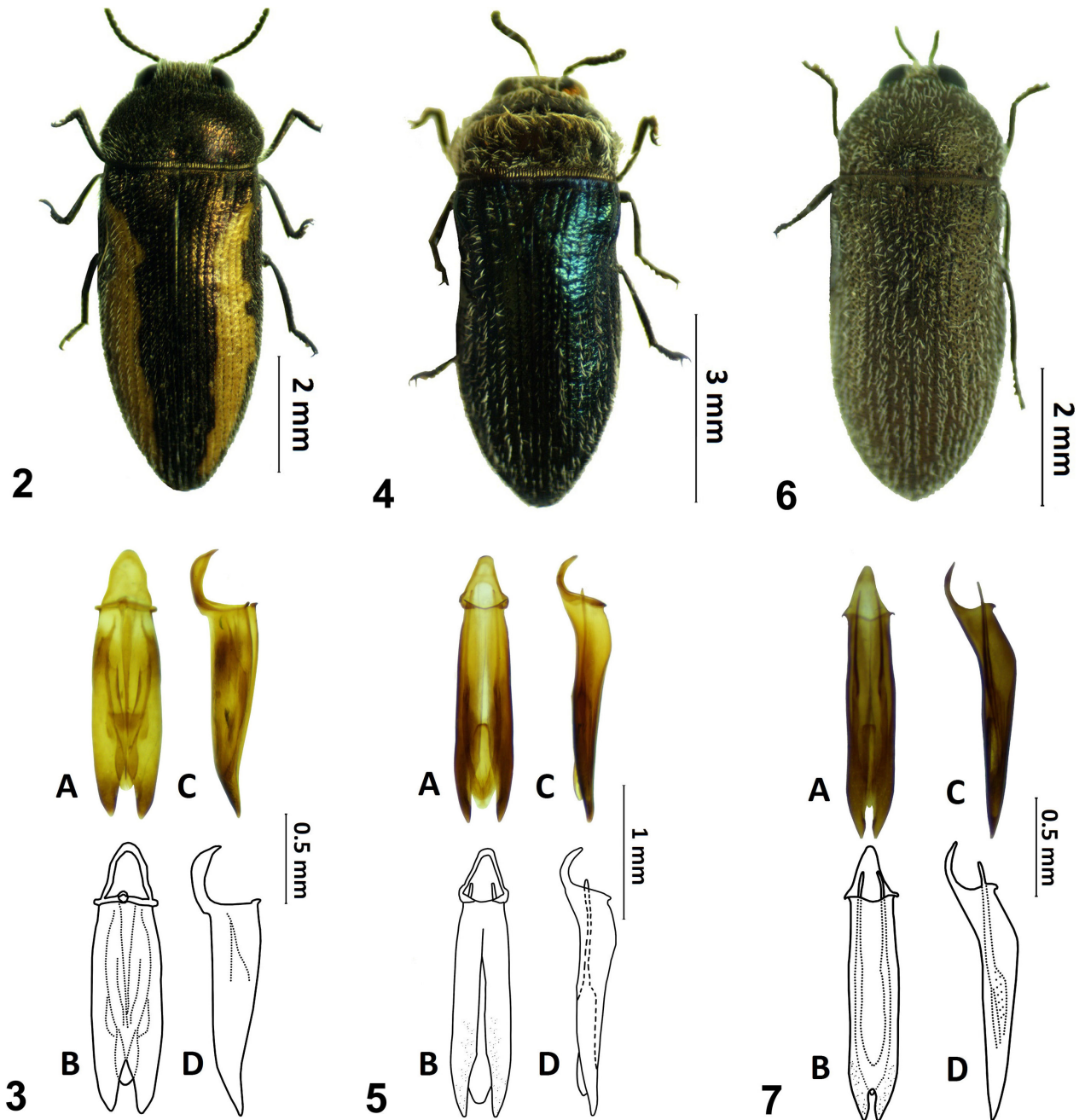
Aedeagus (Figure 11. A–D): In the dorsal view, phallobase slightly sclerotized, its lateral margins almost parallel, narrowing in the posterior, with a slightly pointed posterior margin; parameres quite sclerotized, and covered with campaniform sensilla in anterior two thirds, lateral margins almost parallel in the posterior third, then expanded in the medial third, and again almost parallel in the anterior third; apex slightly sclerotized, yellowish-white, obliquely truncated, and blunt, yellowish-white area densely long setose; median lobe sclerotized, gradually narrowing in the apical part, increasingly pointed towards the apex, and obtuse at the apex; in the lateral view, the phallobase sclerotized, lateral margins dorsally and ventrally narrowing towards the apex, and apex pointed.

Subfamily Buprestinae Leach, 1815

*Anthaxia* (*Cratomerus*) *eugeniae* Ganglbauer, 1885 (Figure 12.)

Material examined: Ankara (Beyazarı), 40°11'27.72'' N, 31°54'51.36'' E, 748 m, 1♂, 19.5.2018.

Aedeagus (Figure 13. A–D): In the dorsal view, phallobase hyaline, posterior and lateral margins slightly sclerotized, rectangular-like, lateral margins almost

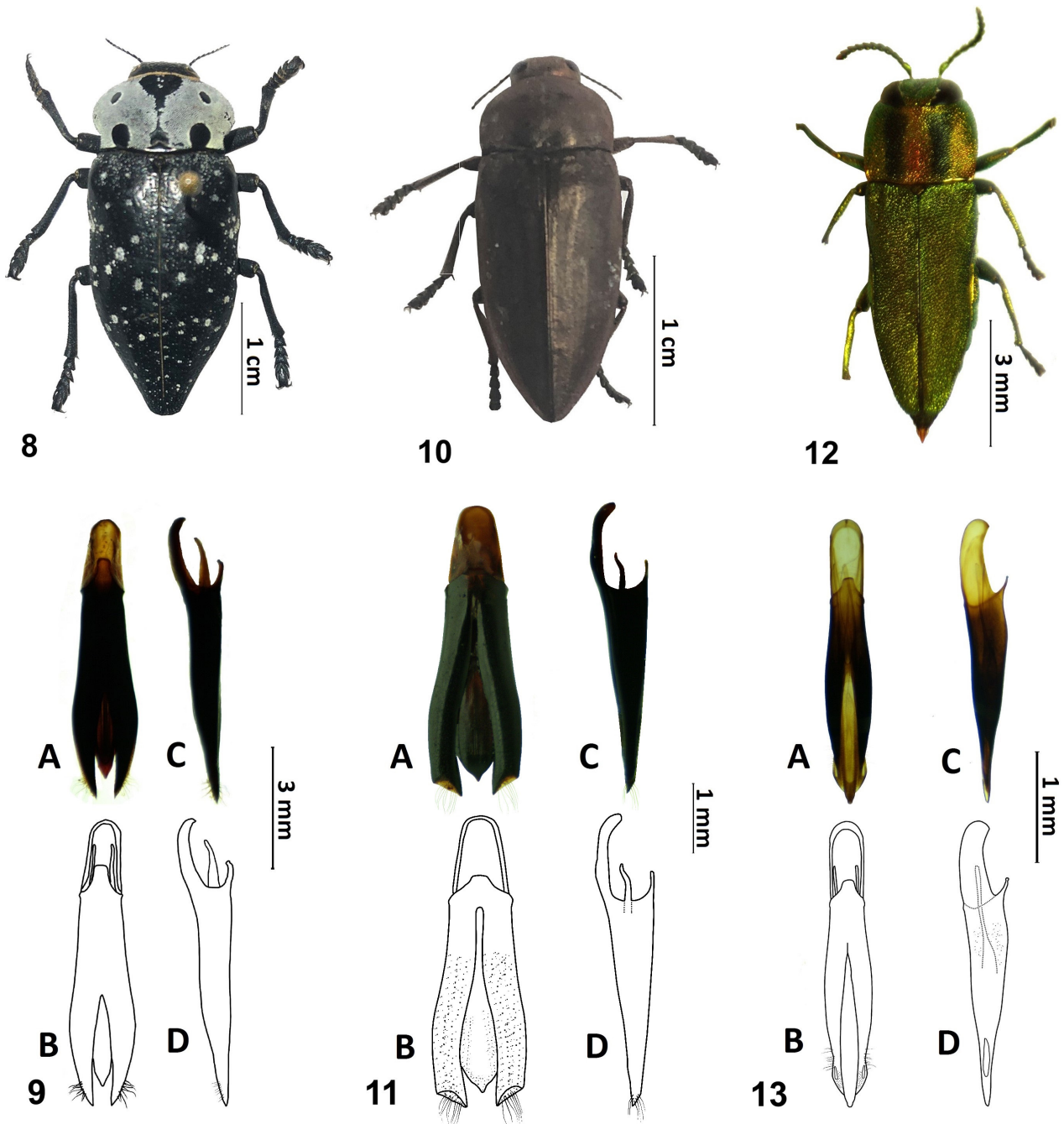


**Figures 2–7.** Habitus and aedeagi. 2–3. *Acmaeodera* (s.str.) *flavolineata*, 4–5. *Acmaeoderella* (*Euacmaeoderella*) *villosula*, 6–7. *A. (E.) gibbulosa*. A–B) Dorsal photograph and drawing of aedeagus. C–D) Lateral photograph and drawing of aedeagus.

parallel, posterior margin rounded; parameres sclerotized, less sclerotized in the apical part, the lateral margins gradually widened from the posterior to almost middle, gradually narrowed from middle to apical part, expanded in apical part, and then narrowed towards apex, long, sparsely setose before apical part, parameres bearing long oval, less sclerotized, yellowish area where they expand in the apical part, with campaniform sensillae from this

area to the tip, apex pointed; median lobe hyaline, slightly sclerotized in apical part and gradually narrowing to the tip, suddenly narrowing just before the apex, the apex pointed. In lateral view, phallobase hyaline, posterior margin not raised, slightly rounded; parameres dorsally and ventrally narrowed towards anterior in posterior two thirds, clearly narrowed in the last third, with a longly oval, less sclerotized zone in this area, apex blunt.





**Figures 8–13.** Habitus and aedeagi. 8–9. *Capnodis carbonaria*, 10–11. *Perotis cuprata*, 12–13. *Anthaxia (Cratomerus) eugeniae*. A–B) Dorsal photograph and drawing of aedeagus. C–D) Lateral photograph and drawing of aedeagus.

#### 4. Discussion

In the scope of contributing to the systematics of the family Buprestidae, we examined male external genital organs, aedeagi, of six species belonging to the genera *Acmaeodera* (1 species), *Acmaeoderella* (2 species), *Anthaxia* (1 species), *Capnodis* (1 species) and *Perotis* (1 species). Photographs were taken, drawings and detailed descriptions were made.

*Acmaeodera flavolineata* is one of the species, whose aedeagus structure was not studied in details in the present literature. Description, dorsal and lateral photographs and drawings of the aedeagus of this species, are given in this study for the first time in detail.

The aedeagi of two species in the genus *Acmaeoderella* were examined for the first time in detail. These are *A. gibbulosa* and *A. villosula*.

Aedeagi of *A. gibbulosa* and *A. villosula* species were compared. The aedeagus of *A. villosula* is more robust than that of *A. gibbulosa*. In the dorsal view, the lateral margins of the parameres of *A. gibbulosa* are more parallel-sided than those of *A. villosula*. The lateral margins of the parameres are expanded gradually from the posterior to the anterior in *A. villosula*. In addition, in the lateral view, almost posterior fourth of parameres of *A. gibbulosa* are clearly inclined towards ventral.

The genus *Capnodis* is also one of the well known genera of this family. On the other hand, we could not find any data about detailed examination of aedeagus structure of *C. carbonaria*. The aedeagus of this species was examined and compared with the aedeagus drawing of *C. miliaris*, which is a closely related species in Kalashian (1983). The lateral margins of the parameres of *C. miliaris* are more straight in the anterior half than in *C. carbonaria*. Apical part is more densely setose than in *C. carbonaria*. In this study, photograph and drawing of the aedeagus structure of *C. carbonaria* is given together for the first time in detail.

The aedeagus of *Perotis cuprata* was examined in detail and compared with aedeagus of closely related *P. lugubris* in Izzillo and Sparacio (2011). Detailed description, photographs, and drawings of the aedeagus of *P. cuprata* is given for the first time. In *P. cuprata*, parameres are almost parallel-sided in the posterior half and then expanding clearly and continuing parallelly in the anterior half. In addition, the apex of the parameres seem to be obliquely truncate and setose. When the photograph of aedeagus of *P. lugubris* is examined in Izzillo and Sparacio (2011), it is seen that parameres gradually expanding from anterior

to median and then gradually narrowing towards apex. Apical part is also setose and apex pointed.

In this study, dorsal and lateral photographs, drawings and description of aedeagus structure of *Anthaxia eugeniae* are given together for the first time in detail. The aedeagus of this species has been compared with these of closely related species in the literature. Comparing to aedeagi of *A. diadema diadema* (Fischer 1823) and *A. paphia* Novak & Makris, 2002 (Novak and Makris, 2002), parameres of *A. eugeniae* are seem to be wider in the apical part than these of two other species. It is more parallel-sided in *A. paphia* and *A. diadema*. Also, apex of the median lobe is more rounded. When looking at the photographs of aedeagi of *A. sponsa* Kiesenwetter, 1857 and *A. scorzonerae* (Fivaldszky, 1838) in Ruicanescu (2015), it is seen that the aedeagus of *A. sponsa* is more robust, parameres of *A. eugeniae* are wider in apical part than both *A. sponsa* and *A. scorzonerae*. In *A. sponsa* and *A. scorzonerae*, lateral margins of the parameres are more parallel in the apical part.

Diagnostic characters which may be useful for the species discrimination, such as apex of the median lobe, lateral margins of parameres, presence of setae in the apical part, and the apex of parameres, are summarized for examined species in Table 1.

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