

SPECIES COMPOSITION AND AN IDENTIFICATION KEY TO SPECIES OF THE TRIBE *Coprini* Kolbe, 1805 IN PU HOAT NATURE RESERVE

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SUMMARY

Dung beetle species belong to three families: Scarabaeidae, Aphodiidae and Geotrupidae (Coleoptera: Scarabaeoidea), varying greatly in larval and adult ecologies. Dung beetles fulfill important functional roles in terrestrial ecosystems by burying and consuming animal dung and rotten fruits and fungi. This study investigates the species composition and community structure of dung beetles of the tribe *Coprini* Kolbe, 1805 (Scarabaeidae: Scarabaeinae) in the Pu Hoat Nature Reserve, an area belonging to the Western Nghe An Biosphere Reserve (Nghe An Province). So far, 35 species of the tribe *Coprini* have been recorded in Vietnam, most of them are large-bodied dung beetles. The trapping sites were deployed across a broad range of terrestrial habitats, being representative of the variety of agricultural and forestry environments present on the Pu Hoat Nature Reserve. Baited-pitfall traps and light traps were used to collect the *Coprini* dung beetles. In total, 12 *Coprini* species of three genera: *Catharsius* Hope, 1837, *Synapsis* Bates, 1868 and *Copris* Geoffroy, 1762 have been recorded for the first time in Pu Hoat Nature Reserve. In this study, we provide a thoroughly illustrated key to all recorded species of the tribe *Coprini* in Pu Hoat Nature Reserve. The key with a photographic guide would be broadly useful for both specialists and non-specialists in the identification of the *Coprini* species.

Keywords: community structure, *Coprini*, identification key, Pu Hoat Nature Reserve, species composition.

1. INTRODUCTION

The tribe *Coprini* Kolbe, 1805 comprises more than 900 species of 21 genera worldwide. Most *Coprini* species are black and medium-to large-bodied dung-beetles with a body length ranging from 9 mm to 30 mm (Scholtz *et al.*, 2009). The *Coprini* species possess a strongly convex shape. The head of the males bears horns, ridges and humps. The pronotum is often punctate. The highly developed sexual dimorphism in this group manifests primarily in the shape of the head and the pronotum. The species antenna consists of 9 segments. The meso- and meta- tibiae are short and strong. The elytron bears 8 to 10 distinct striae. The *Coprini* is primarily coprophagous, although some species are necrophagous, particularly related to carrion. Most *Coprini* species show predominantly nocturnal flight activity, although some species of the genus *Copris* are known as diurnal species. This tribe is classed as fast-burying tunnellers, as dung is first rapidly removed into tunnel, following which it is relocated into one or more deeper tunnels for their nest construction.

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The tribe *Coprini* in Vietnam currently includes 35 species and is taxonomically challenging (Bui Van Bac, 2019). The names of some taxa of the tribe *Coprini* have been often changed. There are important reasons leading to erroneous and inconsistent species identifications. First, the identification key of the *Coprini* species in Vietnam is lacking. Second, the existing keys of the *Coprini* species in specific areas are not easily accessible as there are huge differences in species composition of *Coprini* species among spatially separated ecosystems. Finally, accurate taxonomy is hampered by the lack of detailed illustrations of the main morphological characters, posing major problems for the practical identification of *Coprini* spp.

Pu Hoat Nature Reserve has a total area of 67,934 ha in Que Phong district (Nghe An province), and are parts of the Western Nghe An Biosphere Reserve. Pu Hoat Nature Reserve hosts various ecosystems and landscapes, of which four main formations include closed forests, sparse forests, scrubs and grass vegetation. More than 750 plant

species are recorded in Pu Hoat, of which 30 species are listed in the Vietnam Redbook (2007). Forty five mammal species, 131 bird species and eight reptile species are also found in this area. During the course of our examination on the insect fauna of Pu Hoat Nature Reserve, 12 *Coprini* species have been found for the first time. In the following, the first identification key of these species is provided. The community structure of Coprinid communities was also examined.

2. RESEARCH METHODS

2.1. Dung beetle sampling and identification

The *Coprini* dung beetles were sampled over three consecutive collection trips in 2020, mainly using baited pitfall traps. The trapping sites encompassed a broad range of forest and agricultural habitats, being representative of the variety of habitats in the core and buffer

zones of Pu Hoat Nature Reserve. The traps were placed at intervals of at least 150 m to minimize trap interference. At each trapping site, three pitfall traps with three different baits, including fresh animal dung of pigs and buffalos and rotten fish were arranged in a fixed order in a 30 m diameter triangle. Each trap consisted of a plastic bucket buried to its rim in the soil, filled with 0.5 L 70% ethanol, and baited. In addition, three light traps were deployed at each habitat type to collect dung beetles. All trapped beetles were removed from the traps after 72 h of trap exposure and were preserved in ethanol until examination in the laboratory (Bui *et al.*, 2019).

The *Coprini* species were identified according to the keys of Bui *et al.* (2018), Bui & Bonkowski (2018) and Bui *et al.* (2019).



A.



B.

Fig. 1. Dung beetle sampling with baited pitfall traps (A) and light traps (B)

2.2. Examined specimens

All examined specimens are deposited in the Vietnam National University of Forestry (VNUF) (Xuan Mai, Chuong My, Hanoi, Vietnam).

2.3. Designing an identification key of *Coprini* species

The key to *Coprini* species in Pu Hoat Nature Reserve was based on the specimens examined by us in VNUF. The morphological traits of *Coprini* species in this key were followed by Bui *et al.* (2018) and Vaz-de-Mello *et al.* (2011).

2.4. Data analysis

In order to visualize the dung beetle community structure between habitat types, a non-metric multidimensional scaling (NMDS) based on Bray-Curtis dissimilarities using relative abundances from a species matrix was computed. Analysis of Permutational multivariate analysis of variance (PERMANOVA) was used to test for differences among dung beetle communities. All tests and ordination plots were performed using the vegan package v. 2.4–5 (Oksanen *et al.*, 2017), and each test was based on 999 permutations.

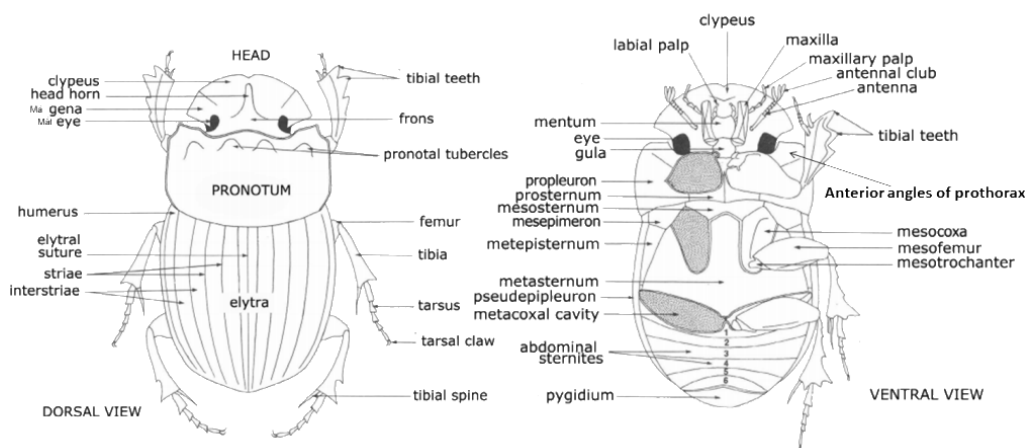


Fig. 2. Morphological traits used in the identification key of *Coprini* species in Pu Hoat Nature Reserve (modified from Vaz-de-Mello *et al.*, 2011)

3. RESULTS

3.1. Species composition of *Coprini* species in Pu Hoat Nature Reserve

In total, 12 *Coprini* species were sampled and identified in Pu Hoat Nature Reserve. The dung beetles were distributed across three genera: *Copris* (10 species), *Catharsius* (1 spe.) and *Synapsis* (1 spe.) (Table 1). Primary forests hosted the highest number of *Coprini* species (10 species), while *Acacia* plantations

showed a very low level of dung beetle diversity with four collected *Coprini* species. Seven, eight and nine *Coprini* species were found in meadows, secondary forests and arable land, respectively.

The community structure of *Coprini* beetles varied significantly between habitat types. The species ordination in NMDS clearly separated the forest dung-beetle communities from the remaining dung beetle communities.

Table 1. Species composition and distribution of *Coprini* species collected in different habitats in Pu Hoat Nature Reserve

No.	Genus/ Subgenus/ Species	Habitats					Trap types
		PF	SF	AP	AL	M	
I.	<i>Synapsis</i> Bates, 1868						
1.	<i>S. tridens</i> Sharp, 1881	x	x				L, P, B
II.	<i>Catharsius</i> Hope, 1837						
2.	<i>C. molossus</i> (Linnaeus), 1758	x	x	x	x	x	L, P, B
III.	<i>Copris</i> Geoffroy, 1762						
III.1	Subgenus <i>Copris</i> (<i>copris</i>)						
3.	<i>C. (C.) carinicus</i> Gillet, 1910		x		x		P, B
4.	<i>C. (C.) confucius</i> Harold, 1877	x	x		x	x	L, P, B
5.	<i>C. (C.) corpulentus</i> Gillet, 1910	x					P, B
6.	<i>C. (C.) magicus</i> Harold, 1881				x	x	P, B
7.	<i>C. (C.) numa</i> Lansberge, 1886	x			x	x	L, P, B, F
8.	<i>C. (C.) repertus</i> Walker, 1858	x	x	x			P, B
9.	<i>C. (C.) sinicus</i> Hope, 1842	x			x	x	L, P, B
10.	<i>C. (C.) szechouanicus</i> Balharsar, 1958	x	x		x		P, B
III.2	Subgenus <i>Paracopris</i>						
11.	<i>C. (P.) cariniceps</i> Felsche, 1910	x	x	x	x	x	P, B
III.3	Subgenus <i>Microcopris</i>						
12.	<i>C. (M.) reflexus</i> Fabricius, 1787	x	x	x	x	x	L, P, B, F

PF: Primary forests, SF: Secondary forests, AP: Acacia Plantations, AL: Arable land and M: Meadows) with light traps (L) and baited-pitfall traps (P: pig dung-baited traps, B: buffalo dung-baited traps, F: rotten fish-baited traps).

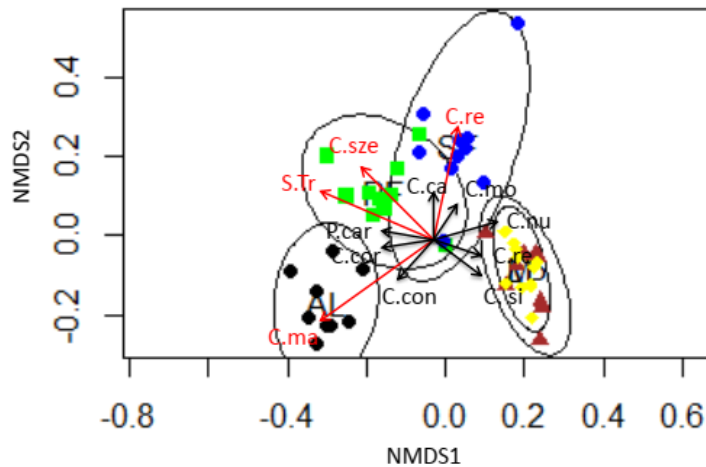


Fig. 3. NMSD ordination visualized the community structures of dung beetles between habitat types (Primary forests=PF, green; Secondary forest =SF, blue; Acacia Plantations=AP, brown; Meadows=M, yellow; arable land=AL, black) in Pu Hoat Nature Reserve

(Ellipsoids represent 95% confidence intervals surrounding centroids of each habitat types. The fitted vectors of *Coprini* species were displayed only for the significant variables ($p < 0.05$) (S.Tr = *S. tridens*, C.mo = *C. molossus*, C.ca = *C. (C.) carinicus*, C.con = *C. (C.) confucius*, C.cor = *C. (C.) corpulentus*, C.ma = *C. (C.) magicus*, C.nu = *C. (C.) numa*, C.re = *C. (C.) repertus*, C.si = *C. (C.) sinicus*, C.sze = *C. (C.) szechouanicus*, P.car = *C. (P.) cariniceps* and C.re = *C. (M.) reflexus*)

3.2. A key to species of all *Coprini* species found in Pu Hoat Nature Reserve

- 1. Genae expanded (Fig. 4A).....*S. tridens*
- Genae unexpanded (Fig. 4B).....2

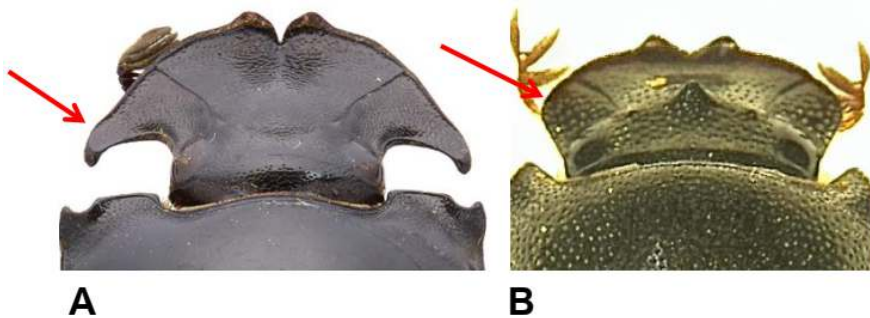


Fig. 4. Head structure with genae expanded (A) and unexpanded (B)

- 2. Elytra with two lateral carinre (Fig. 5A)..... *C. molossus*
- Elytra with one carina (Fig. 5B).....3

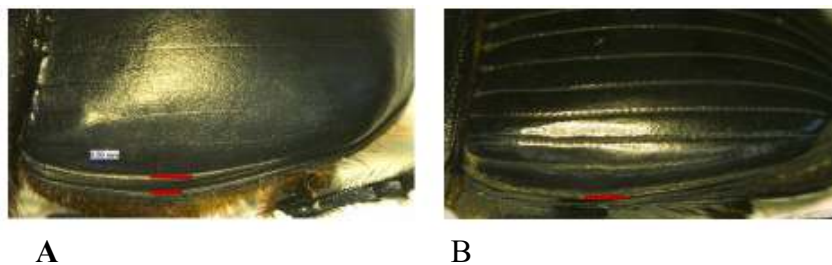


Fig. 5. Elytra structure with two lateral carinre (A) and one carina (B)

- 3. Anterior angles of prothorax with deep excavation on ventral side..... *C. (M.) reflexus*
- Anterior angles of prothorax flat, without excavation on ventral side.....4
- 4. Elytral interstriae deeply punctate (Fig.6A)..... *C. (P.) cariniceps*
- Elytral interstriae shallowly or indistinctly punctate (Fig. 6B).....5

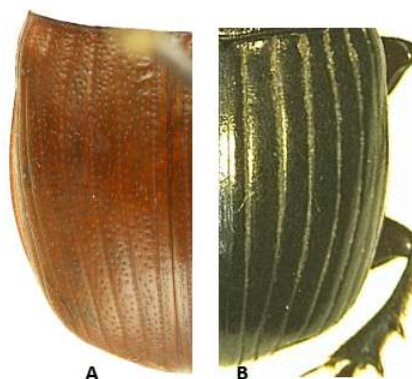


Fig. 6. Elytra structure with interstriae deeply punctate (A) and indistinctly punctate (B)

5. Clypeus and anterior part of genae rugose or deeply punctate (Fig. 7A).....6
 - Clypeus and anterior part of genae smooth, almost impunctate Fig. 7B).....9

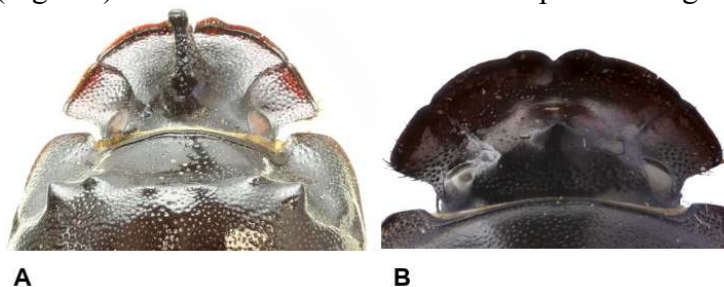


Fig.7. Head structure with clypeus deeply punctate (A) and indistinctly punctate (B)

6. Protibial spur curved inwards near apex.....7
 - Protibial spur straight or curved outwards near apex.....8
 7. Pygidium sparsely, weakly and unevenly punctate..... *C. (C.) sinicus*
 - Pygidium densely, deeply and evenly punctate..... *C. (C.) carinicus*
 8. Elytra strongly striate. Mesofemora and metafemora indistinctly punctate.....
*C. (C.) magicus*
 - Elytra weakly striate. Mesofemora and metafemora shallowly but distinctly punctate...
 *C. (C.) repertus*
 9. Pronotum with sharp frontal declivity....10
 - Pronotum without sharp frontal declivity...
11
 10. Anterior part of pronotum with pair of protuberances..... *C. (C.) corpulentus*
 - Pronotum with transverse carina on upper part of anterior declivity...*C. (C.) szechouanicus*
 11. Vertex with deep and adjoining punctures. Punctures on genae deep, dense and surround eyes. Clypeal apex with narrow and deep emargination..... *C. (C.) confucius*
 - Vertex with separate punctures. Punctures on genae shallow and do not surround eyes. Clypeal apex with wide and shallow emargination.....*C. (C.) numa*

4. DISCUSSION

For the first time, this study provided species composition and community structure of *Coprini* dung beetles in various habitats of Pu Hoat Nature Reserve. It was not surprising to find significant differences in community structures of dung beetles among habitat types, as dung beetles are known to be sensitive to environmental change, such as ambient temperatures (Halffter & Arellano, 2002) and soil textures (Beiroz *et al.*, 2017). However, a particularly remarkable result from the current study was that the changes in dung beetle communities were also seen in a small functional group such as the tribe *Coprini*. The species *Synapsis tridens* were found exclusively in primary forests, and thus may be considered as indicator species for undisturbed forests, while the arable land was the preference habitat of *Copris magicus*. The species *C. (M.) reflexus* was dominant in secondary forests. This suggested the potential use of these dung-beetle species as bio-indicator species in tropical habitat change.

5. CONCLUSION

Twelve *Coprini* species were recorded during our intensive surveys of insect fauna in Pu Hoat Nature Reserve. The first identification key of *Coprini* species with a

photographic guide would help both specialists and non-specialists in the identification of the *Coprini* species. Changes in community structure of a small functional group of dung beetles along a gradient of habitat changes in Pu Hoat Nature Reserve suggested that dung beetles are a high-performance indicator group in monitoring and evaluating the ecological consequences of habitat change in this area.

Acknowledgment

The results of this research are among outputs of the following projects (1) Designing an illustrated key of species of the genus *Coprini* Geoffroy, 1762 (Coleoptera: Scarabaeidae) in Vietnam with the code LN.QM-2020.3 under the Decision 158/QĐ-ĐHLN-KHCN (on 20th Jan. 2020) of the Rectorate of the Vietnam National University of Forestry and (2) Examining the insect diversity and reviewing solutions for insect conservation in Pu Hoat Nature Reserve according to the Decision 118/QĐ-SNN.QLKTKHCN dated on 06/3/2020 of the Nghe An Department of Agriculture and Rural Development.

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THÀNH PHẦN LOÀI VÀ KHÓA PHÂN LOẠI CÁC LOÀI THUỘC TỘC *Coprini* Kolbe, 1805 TẠI KHU BẢO TỒN THIÊN NHIÊN PÙ HOẠT

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TÓM TẮT

Các loài bọ hung ăn phân thuộc 3 họ: Scarabaeidae, Aphodiidae và Geotrupidae (Coleoptera: Scarabaeoidea) có đặc điểm hình thái và sinh học rất khác nhau cả ở giai đoạn ấu trùng và trưởng thành. Bọ hung đóng vai trò quan trọng trong các hệ sinh thái trên cạn thông qua quá trình chôn vùi và tiêu thụ phân động vật, trái cây thối và nấm. Nghiên cứu đã điều tra thành phần loài và cấu trúc quần xã bọ hung thuộc Tộc *Coprini* Kolbe, 1805 (họ Scarabaeidae: Scarabaeinae) tại Khu Bảo tồn thiên nhiên Pù Hoạt, một khu vực thuộc Khu dự trữ sinh quyển miền Tây Nghệ An (tỉnh Nghệ An). Cho đến nay, 35 loài thuộc Tộc *Coprini* đã được ghi nhận ở Việt Nam, hầu hết là những loài bọ hung có kích thước lớn. Các điểm đặt bẫy đã được triển khai ở các sinh cảnh đại diện tại khu vực canh tác nông nghiệp và rừng nhiệt đới tại Khu Bảo tồn thiên nhiên Pù Hoạt. Bẫy hố có mồi nhử và bẫy đèn được sử dụng để thu thập bọ hung *Coprini*. Nghiên cứu đã ghi nhận được 12 loài bọ hung *Coprini* thuộc ba giống: *Catharsius* Hope, 1837, *Synopsis* Bates, 1868 và *Coprini* Geoffroy, 1762. Trong nghiên cứu này, chúng tôi xây dựng một khóa nhận dạng cho tất cả các loài đã được ghi nhận thuộc Tộc *Coprini* tại Khu Bảo tồn thiên nhiên Pù Hoạt. Khóa phân loại với các hướng dẫn hình ảnh sẽ giúp cho việc nhận dạng dễ dàng các loài *Coprini* trên thực tế.

Từ khóa: cấu trúc quần xã, *Coprini*, khóa phân loại, Khu Bảo tồn thiên nhiên Pù Hoạt, thành phần loài.

Received : 04/10/2020

Revised : 15/11/2020

Accepted : 21/11/2020