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ORIGINAL RESEARCH ARTICLE

# Diversity and community composition of click beetles (Coleoptera: Elateridae) in forest patches of Iligan City, Mindanao, Philippines

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**A B S T R A C T**

Click beetles (Family Elateridae) are among the most diverse groups within the Elateroidea superfamily of beetles. These insects are often used as indicators of ecosystem diversity, as their presence reflects environmental health. Moreover, many beetle species also depend on forests for survival, highlighting their interconnected relationship with the ecosystem. In this context, this study surveyed click beetles in various forest patches in Iligan City using Malaise traps and active collection methods. Over six months of collection, 27 individuals representing 13 morphospecies and eight subfamilies were documented. Species richness and diversity were highest in Sikyop (*H'*=1.67; *D'*=0.76; *J'*=0.86), followed by Tinago (*H'*=1.32), while the most abundant species include *Melanotus* sp., *Cryptalaus* sp., *Csikia* sp., and *Agrypnus* species. However, most identifications remain provisional due to distinct morphological traits among taxa and require molecular confirmation. These findings offer preliminary insight into species composition and local diversity, providing baseline data that is imperative for inventory, ecological studies, and future management strategies, as well as valuable information for local communities.

**Keywords:** *Elateridae, Mindanao, Malaise trap, morphology, Philippines*

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## INTRODUCTION

Forests are home to a wide variety of species, and beetles are frequently employed to indicate the diversity within these ecosystems (Spina et al., 2023; Verma et al., 2023). Multiple factors affect the diversity of beetles, including the amount of energy in decaying wood, the variety of the forest, and how the forest is managed (Rappa et al., 2022). Consequently, the overall health of the forest and biodiversity can be assessed through the intricate interactions between beetles and forest ecosystems, underscoring their importance as bioindicators (Chowdhury et al., 2023; Medhi et al., 2020). Moreover, landscape diversity is a key factor in determining the range of insect species in a given area (Ali et al., 2022), and ongoing studies continue to uncover new insect species across various ecosystems (Stork et al., 2024; Sharma et al., 2023; Gleason, 2022).

On the other hand, Elateridae, also known as click beetles, is one of the most immense families within the superfamily Elateroidea (Huang et al., 2023; Nasserzadeh et al., 2023). These beetles are recognized for their sturdy, compressed bodies and unique clicking mechanism in the middle section of their thorax (Zhang et al., 2023; Song et al., 2023; Ruan et al., 2022). They are actively involved in various ecological processes that contribute to the environment, which play a crucial role in maintaining the equilibrium of forest ecosystems (Hume et al., 2024; Bârdan et al., 2024). In particular, members of the family Elateridae exhibit diverse ecological functions — some species act as predators and biological control agents (e.g., *Cryptalaus* sp.), others serve as pollinators, while many feed on decomposing organic matter during their larval stage, thereby enhancing soil quality (Kundrata et al., 2020; Liu and Zhang, 2022). These multiple ecological roles underscore their importance as contributors to ecosystem functioning and biodiversity maintenance (Hume et al., 2024; Verma et al., 2023).

On the contrary, they are economically important pests in numerous regions, including Europe, North America, and Asia, as some click beetle species are notorious for causing extensive crop damage (Van Herk et al., 2021; Leung et al., 2020). They damage the below-ground plant tissue of many crops, such as potatoes, carrots, rutabaga, and sugar beets (Leung et al., 2020), rendering them unmarketable. Additionally, controlling click beetles becomes particularly challenging once they latch onto crops (Poggi et al., 2021). The larvae of click beetles can navigate through soil by following existing burrows, leveraging their unique body and natural inclinations (Joshi and Wang-Pruski, 2024). This behavior consequently leads to rapid damage to plant roots within a short period of time (N'Tsoukpoe, 2023). Therefore, it is vital to acquire a comprehensive understanding of their diversity, even though there is currently no concrete evidence of an infestation in the Philippines. Furthermore, this knowledge will enable us to take proactive measures and establish preventive strategies (Lemke et al., 2023; Ramesha et al., 2024). Such approaches include monitoring or risk assessments based on crop, landscape factors, soil, and climate for proactive measures, as well as strategies involving prophylactic practices such as low-risk rotation, irrigation, tilling, and attractants to control the larval populations and utilize the other species as biocontrol (van Herk, 2023; Poggi et al., 2021).

The present findings contribute to understanding the occurrence of click beetles in Iligan City and provide baseline data for ecological assessments and conservation initiatives. Click beetles serve as indicators of sustainable forest management (Chowdhury et al., 2023). Understanding their biology and ecology is essential for developing control strategies on agricultural lands and for highlighting their potential as bioindicators of environmental pollution and as assemblages for assessing ecological status in response to anthropogenic land-use changes (Sangwan et al., 2024; Guseva et al., 2020).

This study aims to document the diversity and species composition of click beetles in the forest patches of Iligan City. It also seeks to describe the morphological characteristics of collected species to inform future conservation or pest management efforts by establishing a foundational body of information to ensure the welfare of those beneficial organisms while minimizing the likelihood of future infestations.

## MATERIALS AND METHODS

### Description of the study area

Geographically, the city of Iligan, Lanao del Norte Province, is located on the northern coast of Mindanao, overlooking Iligan Bay, and encompasses a diverse landscape. Within this setting, the present research was conducted at four forested locations within Iligan City (Figure 1). Sikyop Agri-tourism Adventure Park in Barangay Rogongon is a karst secondary forest situated at approximately 8°14.8230' N and 124°25.3770 ' E with an elevation of 365.6 m asl, characterized by limestone outcrops with cave and rock compartments. The topography of the area is mountainous to rolling slopes. Eco-Tourism Park-Tinago Falls in Barangay Ditucalan lies at 238.6 m asl (8°9.6670'N and 124°11.1200'E) and consists of a mono-plantation of mahogany interspersed with regenerative riparian forest. National Power Corporation (NPC) - Agus 6, also in Barangay Ditucalan, is a secondary regenerative forest near a hydroelectric power facility at 185.1 m asl (8°10.9580' N and 124°11.6140' E), representing a disturbed forest edge environment. Dodiongan Falls in Barangay Kabacsanan is the lowest site at 74.9 m asl (8°16.2740'N and 124°18.8100'E), characterized by secondary riparian forest adjacent to agricultural land. These four locations were selected to represent a range of habitat types, elevation and land cover.

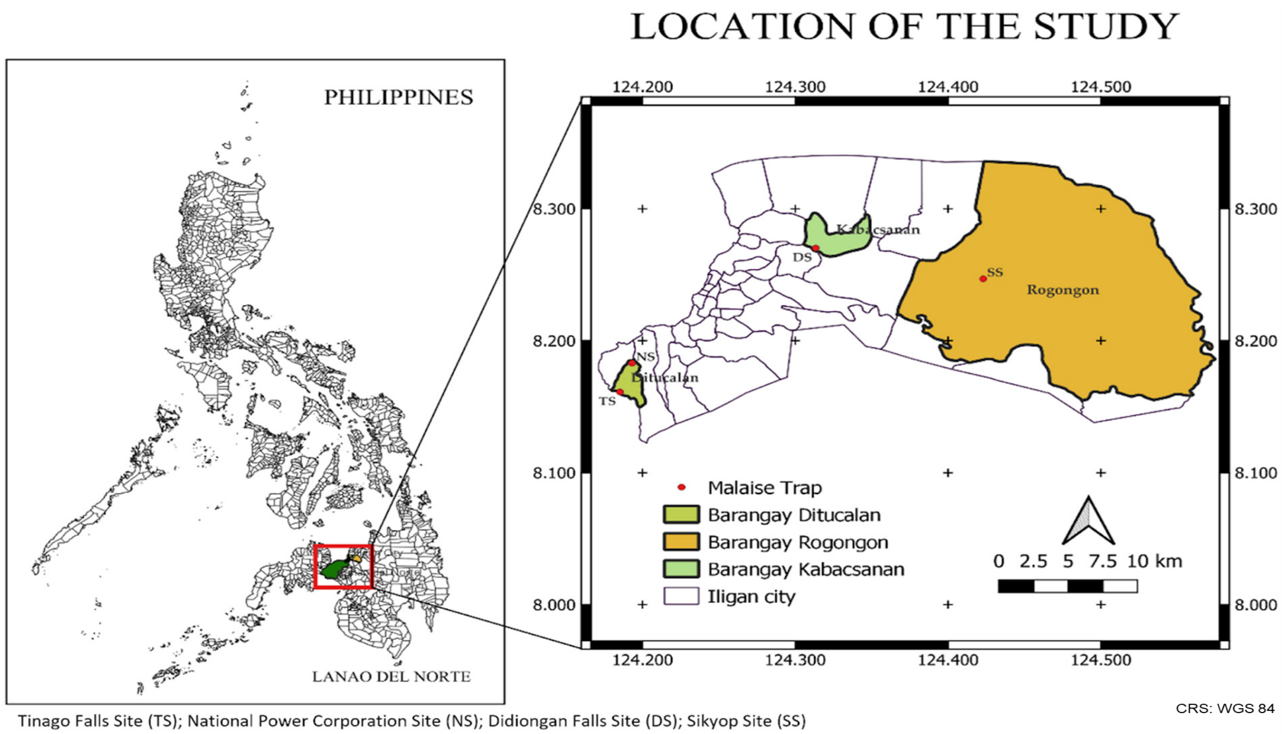


**Figure 1.** Map showing the study sites in Iligan City, Lanao del Norte.

### Sampling methods and identification of click beetles

Malaise traps (passive) were deployed at ground level in each forest patch to capture specimens (Chimeno et al., 2023; Welti et al., 2021). They were left in place from May to October 2023 to ensure sufficient sampling. The collected samples were transferred into another empty container with 96% ethanol and brought to the laboratory for further sorting and identification. Active sampling was also conducted as supplemental data. This involved five days of field observation at every site, utilizing sweep nets and white cloth (active) to capture the insects. The identification of elaterid beetles was accomplished by taking the image of every specimen with a high-resolution camera and Leica microscope in the laboratory of Ecology and Evolutionary Genomics and Bioinformatics, Department of Biomedical Science and Environmental Biology, Kaohsiung Medical University, Taiwan, and recorded using standard entomological methods. Specimens were sorted into morphospecies, defined as distinct morphological unit that differ in the external characteristics (color patter, antenna and pronotal shape) following Pik et al. (1999). Each sample was examined based on key morphological traits using the dichotomous key from the 2005 7th edition of Borror and Delong's book Introduction to the Study of Insects, which was especially useful during the initial sorting stage to separate beetles from other insect groups. For species-identification, the Barcode of Life Data

System (BOLD) digital platform was also utilized by comparing the images of our specimens with available reference photographs of Elateridae. The final taxonomic description was guided by the diagnostic characters on the literature of Bi et al. (2019) and Chang and Ren, (2010). Due to unique traits and morphological overlap among taxa and the limitations of available regional keys, identifications were primarily limited to the genus level or designated as provisional morphospecies.

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**Data analysis**

The tabulated data were analyzed using the Kruskal-Wallis test for both abundance and species richness in R version 4.4.2. Before this, a Shapiro–Wilk normality test was conducted to assess whether the data were normally distributed. The results indicated that the data did not meet the normality assumption, justifying the use of a non-parametric test. Meanwhile, because this study has sparse data, the researcher also used alternative visualization indices to provide an additional perspective on the results. To illustrate the trends, a bar plot was used to highlight species richness across the four study locations quickly. Additionally, to explore faunal patterns, the Bray-Curtis Dissimilarity Index was computed to visualize community similarity or dissimilarity among sites, represented through a heatmap, and the Shannon–Wiener diversity index (*H'*), Simpson (*D'*), and Evenness (*J'*) were calculated to provide a descriptive assessment of diversity and relative species distribution. These analyses were not intended for inferential generalization but instead offer a multi-metric assessment of diversity and species composition, consistent with the study's objectives.

## RESULTS

Table 1 shows the number of individuals of each specimen, the collection method (Malaise vs. Active), and the collection site. A total of 27 individuals of click beetles, belonging to 8 subfamilies and 13 morphospecies, were collected at four collection sites in Iligan City. Among them, Sikyop has the most samples (14 individuals) in the forest, followed by Tinago (8 individuals), and the fewest in Dodiongan (2 individuals).

**Table 1.** List of click beetles morphospecies recorded from four location in Iligan City, showing the number of individuals collected per site and their perspective capture method.

| Site | Morphospecies | No. of Individuals | Collection method |
|---|---|---|---|
| Sikyop | *Cryptalaus* sp. | 2 | Active |
| | *Spilus* sp. | 1 | Active |
| | *Oestodes* sp. | 1 | Active |
| | *Csikia* sp. | 1 | Active |
| | *Melanotus* sp. 1 | 6 | Active |
| | *Melanotus* sp. 2 | 2 | Malaise |
| | *Idolus* sp. | 1 | Malaise |
| Tinago | Unidentified species 1 | 1 | Active |
| | *Agrypnus* sp. | 2 | Malaise |
| | *Cryptalaus* sp. | 2 | Active |
| | *Csikia* sp. | 3 | Active |
| NPC | *Oxynopterus* sp. | 3 | Active |
| Dodiongan | *Agrypnus* sp. | 2 | Malaise |
| Total | 13 | 27 | |

A morphological comparison (Table 2) is created to facilitate clearer differentiation by summarizing the key features among the identified morphospecies. The table highlights the unique elytral patterns of the species and emphasizes the significant size differences among them. *Oxynopterus* sp. was the largest, while *Idolus* sp. was the smallest. Additionally, the majority of the samples were collected from the Sikyop site.

**Table 2.** Summary of Morphological Traits per Morphospecies.

| Morphospecies | Body length (mm) | Elytral pattern | Antennae type | Collection sites |
|---|---|---|---|---|
| *Cryptalaus* sp. | 25.9 | Arrow shape pattern | Serrate | Sikyop, Tinago |
| *Spilus* sp. | 11.4 | Smooth, shiny | Serrate | Sikyop |
| *Oestodes* sp. | 11.3 | Sparse pale setae, black | Serrate | Sikyop |
| *Csikia* sp. | 6.0 | Uniform, dark brown | Filiform | Sikyop, Tinago |
| *Melanotus* sp. 1 | 5.1 | pale dense setae | Filiform | Sikyop |
| *Melanotus* sp. 2 | 4.3 | Dark band center | Filiform | Sikyop |
| *Idolus* sp. | 3.8 | Cross-like band | Filiform | Sikyop |
| Unknown | 14.4 | Semi-circle, dark pattern | Serrate | Tinago |
| *Agrypnus* sp. | 12.7 | dense setae, brown | Serrate | Tinago, Dodiongan |
| *Oxynopterus* sp. | 64.8 | Reddish-brown, tapered | Lamellate | NPC |

The bar plot shows that Sikyop has the highest species richness among the four study sites, with seven unique species, followed by Tinago with four. In contrast, NPC and Dodiongan recorded the fewest unique species, each with only one (Figure 2). This suggests that Sikyop and Tinago harbour more diverse click beetle species than NPC and Dodiongan. However, the Kruskal-Wallis test for abundance and species richness showed no significant differences among sites. Since the p-value exceeds 0.05, the non-parametric test indicates that the variation in species numbers among the four sites is not statistically significant.

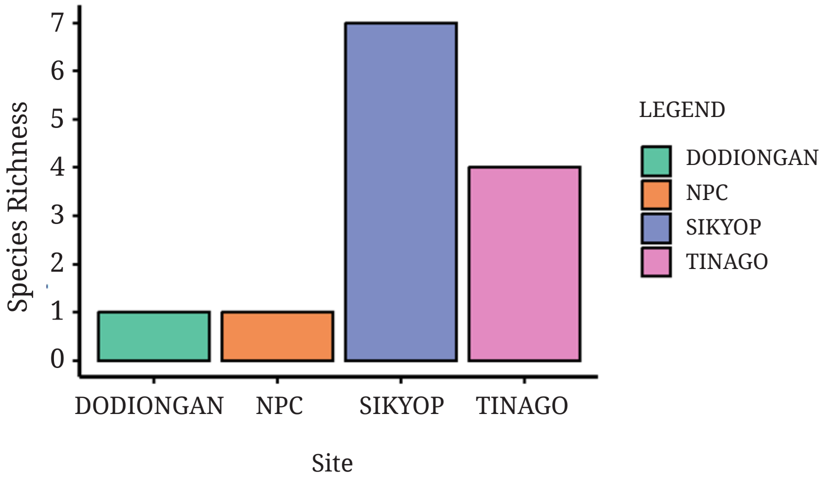


**Figure 2.** Species richness across four forested sites, highlighting the variation in the number of unique species observed at each site.

In figure 3. The heatmap shows Bray-Curtis Dissimilarity on a scale of 0 to 1, with a colour gradient from blue (low dissimilarity) to red (high dissimilarity) for the four study sites, visualizing dissimilarity between pairs based on species composition. Sikyop is highly dissimilar from the NPC and Dodiongan (red). This suggests that Sikyop has a distinct species composition compared to other sites. In contrast, Tinago is moderately dissimilar to Sikyop, with a dissimilarity value of 0.5. This implies that they may share some species, but there are still notable differences. Meanwhile, Tinago is highly dissimilar from NPC, which represents the color gradient red, whereas Dodiongan has a value close to 1.

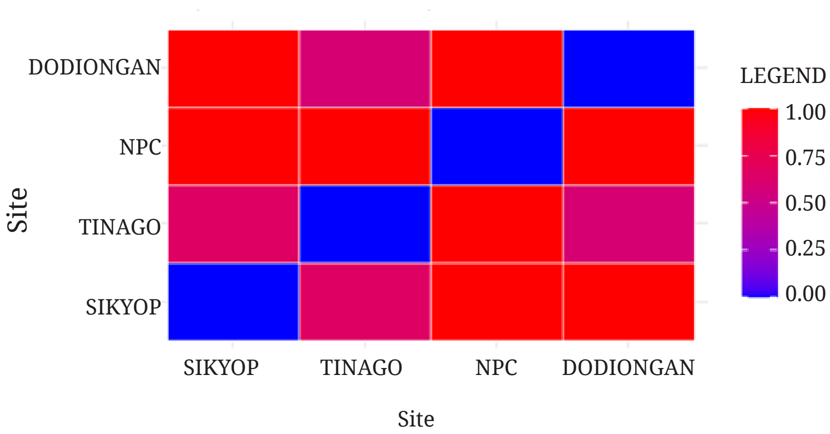


**Figure 3**. Illustrates the dissimilarity in species composition among the study sites using Heatmap visualization based on the Bray-Curtis Dissimilarity Index.

Across four study sites, click beetle diversity was categorized as low to moderate (Table 3). Sikyop has the highest diversity index (*H'*=1.67; *D'*=0.76), followed by Tinago (*H'*=1.32; *D'*=0.72), reflecting a relatively even distribution of species in these two sites (*J'*=0.86 and 0.95, respectively). In contrast, NPC and Dodiongan yielded *H'*=0, indicating the presence of only a single species in each site, which prevented the computation of evenness. These values align with the earlier species richness patterns, in which Sikyop and Tinago supported more species than NPC and Dodiongan.

**Table 3.** The value of Shannon-Wiener diversity index, Simpson index, and Evenness index for click beetles at the four study sites.

| Site | Shannon-Wiener (*H'*) | Simpson's Index (*D'*) | Evenness (*J'*) |
|---|---|---|---|
| Sikyop | 1.67 | 0.76 | 0.86 |
| Tinago | 1.32 | 0.72 | 0.95 |
| NPC | 0 | 0 | NaN |
| Dodiongan | 0 | 0 | NaN |

**Taxonomy**

Elaterinae; Leach, 1815

Genus *Spilus* sp.

Diagnosis: The coloration of the body is dark brown to reddish-brown, shiny, with some portion of the prothorax. The head is visible, eyes visible from dorsal view (Figure 4A). Antennae serrate; short, not reaching the posterior angle of the pronotum, with 11 visible segments (Fig.ure 4C). Prothorax slightly convex from dorsal view, with pointy spines in the posterior edge. The median line of the pronotal disc has no visible ridges but is coarsely punctated, covered with fine, small suberect brown setae along the body and legs (Fig. 4B). The surface of the elytra has visible parallel longitudinal striae with a truncate apex and slender legs.

Body length: 11.4 mm

Remarks: The classification of this genus within the subfamily of Elaterinae is currently uncertain and requires further research.

Locality record: No previous records from the Philippines are listed in GBIF; the present study provides the first occurrence from Iligan City, Mindanao.

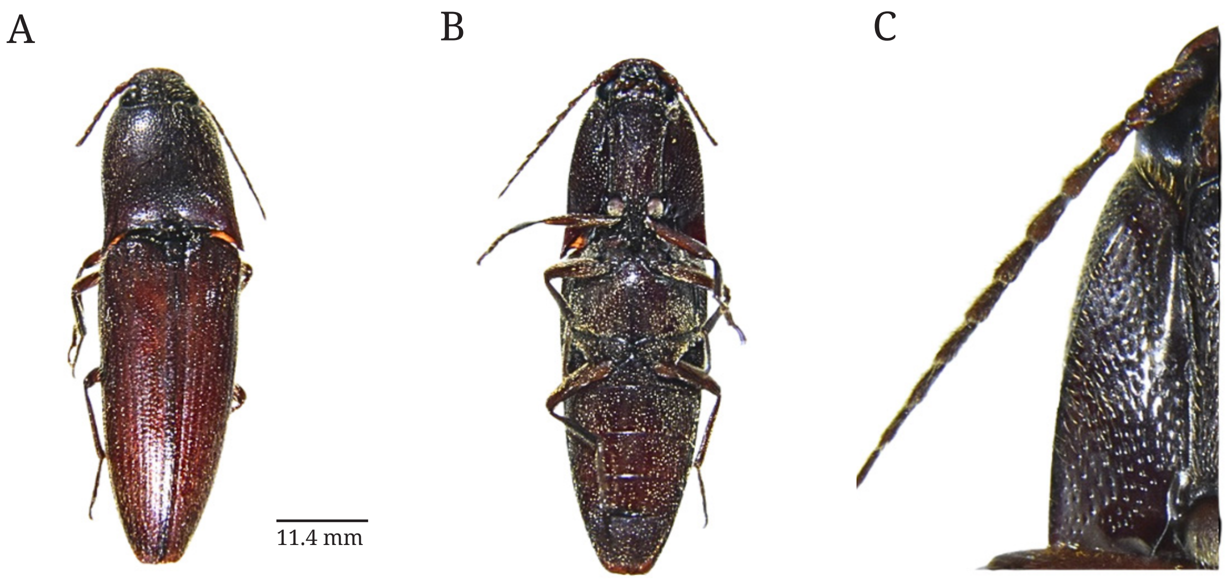


**Figure 4.** Habitus of *Spilus* sp.: (A) dorsal view; (B) ventral view; (C) antennae.

Oestidinae; Hyslop, 1917

Genus *Oestodes* sp.

Diagnosis: Shiny, coloration is predominantly black; fore- and mid-femur legs paler than body. Head strongly protruding to prothorax, big rounded prominent eyes (Figure 5A). Antennae serrate and long, reaching the second half of elytra length, covered with fine distinct setae; 11 visible segments (Figure 5C). Slightly convex prothorax in dorsal view, distinct spines in the posterior edge on the lateral sides. Carina absent in pronotal disc, but coarsely punctated in the prosternum (Figure 5B). Fine, long, suberect paler setae are present posteriorly along the legs and become denser on the abdominal segments, with sparse patches occurring medially on the elytra. The dorsal view of elytra slightly traced with parallel longitudinal striae and a slightly obtuse apex. Slender and narrow legs, elongated body shape.

Body length: 11.3 mm

Remarks: The classification of this genus within the subfamily of Oestidinae is currently uncertain and requires further research.

Locality record: GBIF data show no records of this taxon from the Philippines.

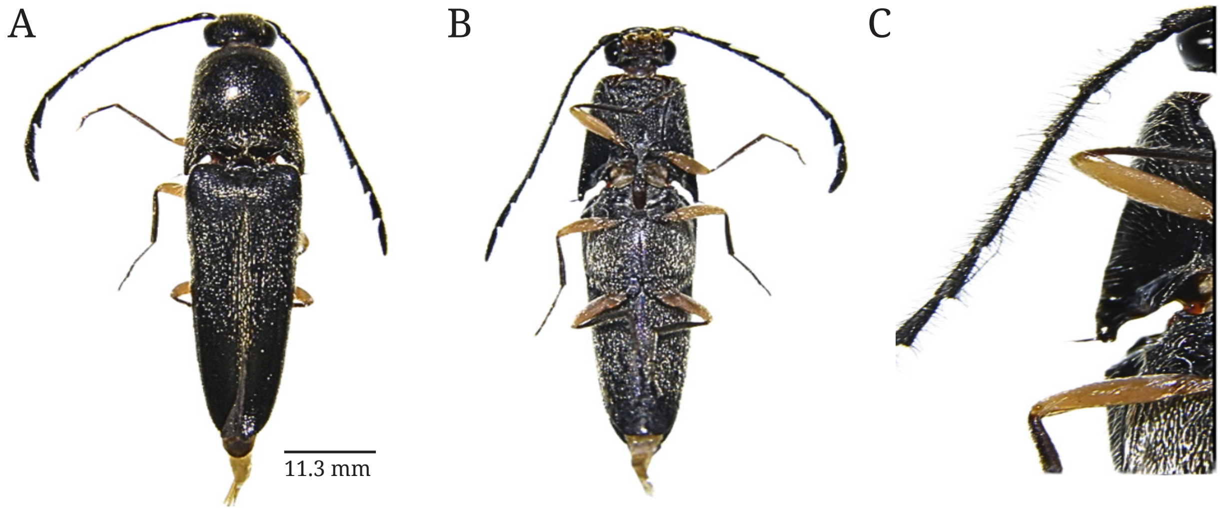


**Figure 5.** Habitus of *Oestodes* sp.: (A) dorsal view; (B) ventral view; (C) antennae.

Dendrometrinae; Gistel, 1848

Genus *Csikia* sp.

Diagnosis: Dark brown, paler on the posterior edge of the prothorax with a distinct spine, short striae somewhat visible parallel on the lateral sides, and a darker portion on the median pronotal disc, shiny and slightly elevated. Ridges in lateral margins visible from ventral view (Figure 6B). Carina absent, headvisible along with mandible, and small eyes. Antennae filiform, short, and do not extend to the posterior angle of the pronotum, with 11 visible segments (Figure 6C). Elytra slightly obtuse, the apex has parallel longitudinal striae and slender legs. In the ventral view, the half of the upper right abdomen has more pigment: subcylindrical body shape, body covered with fine, small brown setae (Figure 5A).

Body length: 6.0 mm

Remarks: The classification of this genus within the subfamily of Dendrometrinae is currently uncertain and requires further research

Locality record: No occurrence in the Philippines is currently documented in GBIF.

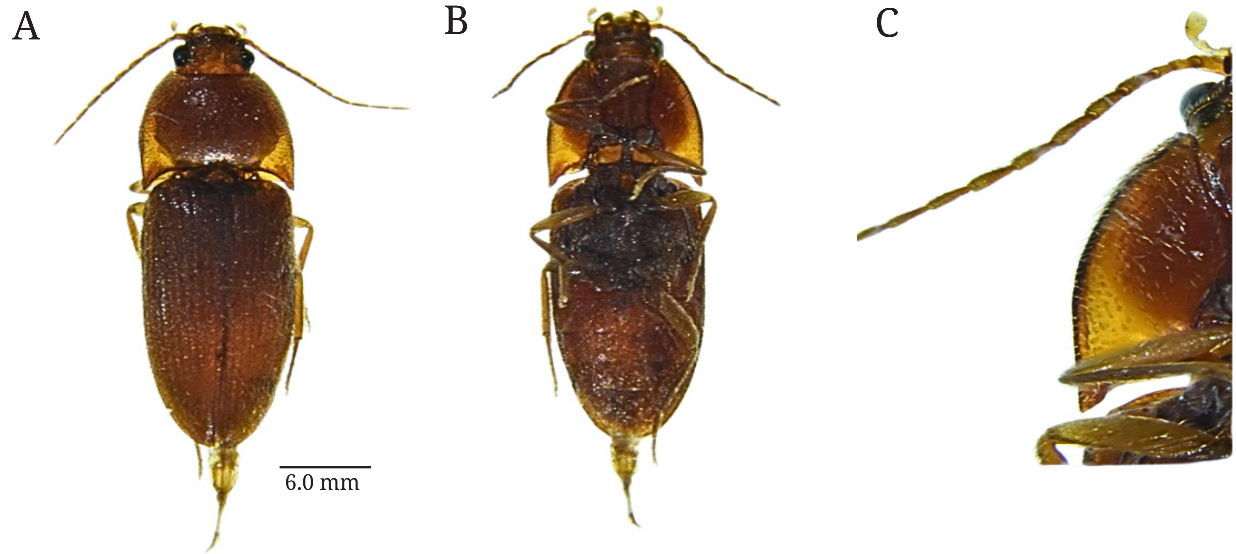


**Figure 6.** Habitus of *Csikia* sp.: (A) dorsal view; (B) ventral view; (6) antennae.

Elaterinae; Leach, 1815

Genus *Melanotus* sp. 1

Diagnosis: Body is shiny and black, subcylindrical. Head is deeply sunk into the pronotum, with the eyes remaining visible in dorsal view (Figure 7A). Antennae filiform, short, brown, and 11-segmented (Figure 7C). Prothorax bell-shaped, smooth and covered with a dense, distinct pattern, pale setae, arranged in a spirally twisted pattern on the pronotal disc. No ridges are found in the median area, which is more coarsely punctated in the prosternum (Figure 5B). Elytra has longitudinal striae covered with pale setae but denser in the lower part of the elytra, with lesser setae in the abdomen, a slightly obtuse apex, and a visible scutellum. Legs are slender and brown.

Body length: 5.1 mm

Remarks: The placement of *Melanotus* sp. 1 remains tentative and needs to be further studied to confirm that it belongs to the Elateridae and not to the Eucnemidae family. Several diagnostic structures required for confident separation were not fully visible in the available images.

Locality record: GBIF records confirm the presence of this taxon in Visayas, Philippines

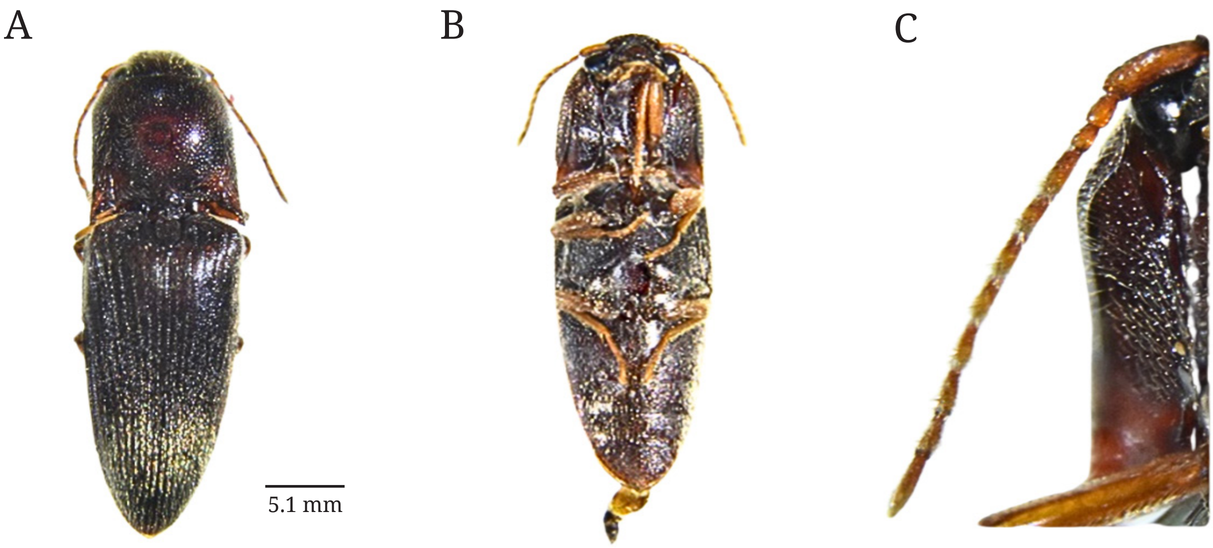


**Figure 7.** Habitus of *Melanotus* sp. 1: (A) dorsal view; (B) ventral view; (C) antennae.

Elaterinae; Leach, 1815

Genus *Melanotus* sp. 2

Diagnosis: Color is dark brown and shiny. The head is deeply sunk into the pronotum. Eyes not visible from dorsal view (Figure 8A). Antennae short, brown, and not reaching the posterior angle of pronotum; filiform, and 11-segmented (Figure 8C). Prothorax bell-shaped, smooth, covered with dense, distinct pattern, pale setae; spirally twisted pattern on the pronotal disc as well as the prosternum, no ridges found in the median area. Elytra with dark-colored band medially; rounded anteriorly, zigzagged posteriorly in dorsal view. The surface is subapically denser with fine suberect paler setae, but less in the abdomen (Figure 8A). Elytra with longitudinal striae; slightly obtuse apex. Legs are slender and brown.

Body length: 4.3 mm

Remarks: *Melanotus* sp. 1 and *Melanotus* sp. 2 are morphologically similar, but some features are notably distinct, such as the elytral patterns, which suggest that *Melanotus* sp. two might be a different species.

Locality record: GBIF records confirm the presence of this taxon in Visayas, Philippines.

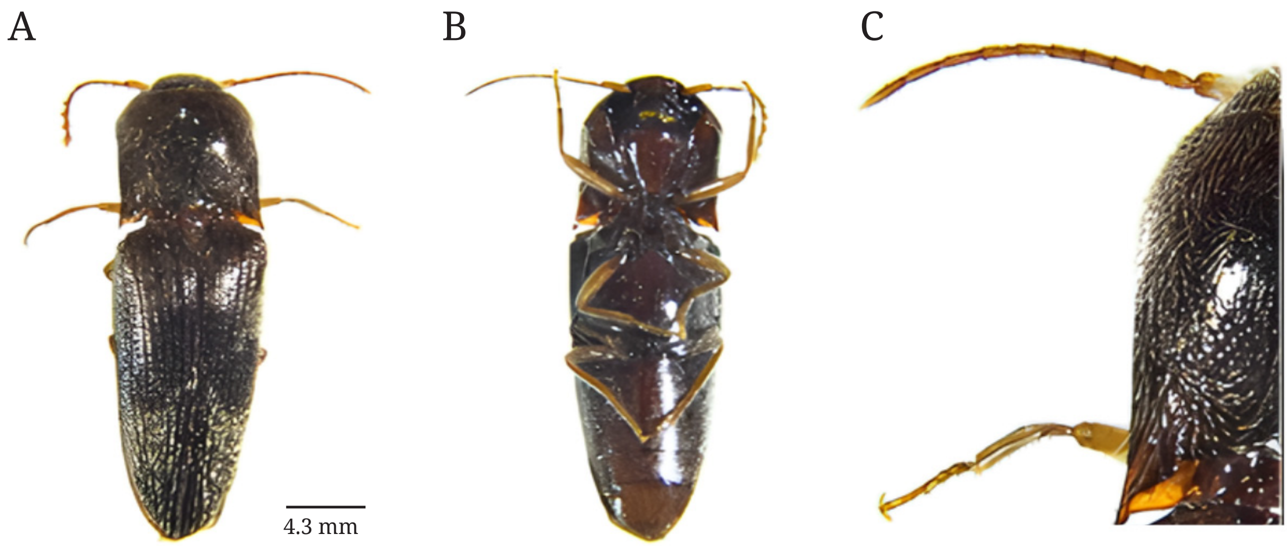


**Figure 8.** Habitus of *Melanotus* sp. 2: (A) dorsal view; (B) ventral view, (C) antennae.

Elaterinae; Leach, 1815

Genus *Idolus* sp.

Diagnosis: Coloration dark-brown to brown, paler in legs. The body is slightly arcuated from the lateral view. The head and eyes are hardly visible and deeply sunk into the pronotum from a dorsal view. Antennae filiform, short, brown, 11-segmented (Figure 9C), not reaching the posterior angle of the pronotum with fine setae. Prothorax striking dark brown but pale on the ventral side (Figure 9B); paler pointy spine narrowed posteriorly on the lateral sides of the pronotum. Carina is absent in the median part of the pronotal disc, but has a slightly punctated short line posteriorly near the scutellum. Elytra with dark-colored band; cross-shaped at mid-length (Figure 9A). The anterior half of the elytra bears prominent, parallel-sided dark lines; whereas the posterior half shows fewer to no dark lines, with only the longitudinal striae remaining visible; Slightly obtuse apex. The majority of the body is covered with fine, pale setae.

Body length: 3.8 mm

Remarks: The classification of this genus within the subfamily of Elaterinae is currently uncertain and requires further research.

Locality record: GBIF data show no records of this taxon from the Philippines.

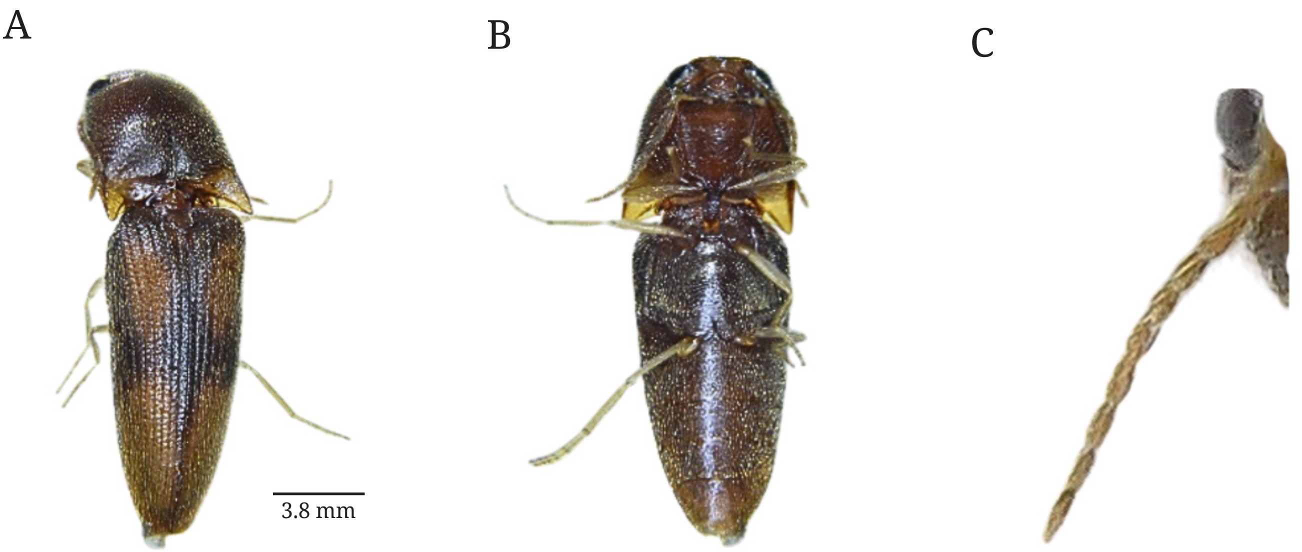


**Figure 9.** Habitus of *Idolus* sp.: (A) dorsal view; (B) ventral view; (C) antennae.

Agrypninae; Candèzè, 1857

Genus *Cryptalaus* sp.

Diagnosis: Body coloration light brown to dark-brown, with some portions of white spots giving a mottled appearance; covered with thick, dense, short setae. Body flat, elongated and deeply arcuated from lateral view. Head deeply sunk into the pronotum. Shorter antennae, serrate; darker color, and 11 visible segments (Figure 10C). Prothorax wide; pointy spines on posterior angle, no visible ridges medially but with darker longitudinal band connecting pronotum to elytra, along with semi-circle dark spot on each parallel sides anteriorly; dispersed, coarse and dark spot covering the pronotal disc (Figure 10A). From the ventral view, prosternal process inflexed; narrowed and strongly attached to mesosternal cavity (Fig. 10B). The scutellum is narrowed posteriorly and moderately elevated. Elytra with a dark-colored band, arrow-shaped, in the mid-anterior, with a distinct, short, and dark parallel line medially and a semi-rounded pattern on each of the elytron; the posterior angle bears some dark patterning at the apex; slightly obtuse apex and visible longitudinal striae. Abdomen covered with dense, short brown setae, becoming lesser medially. Legs slender.

Body length: 25.9 mm

Remarks: The classification of this genus within the subfamily of Agrypninae is confirmed but still requires further research.

Locality record: GBIF records confirm the presence of this taxon in Luzon, Philippines.

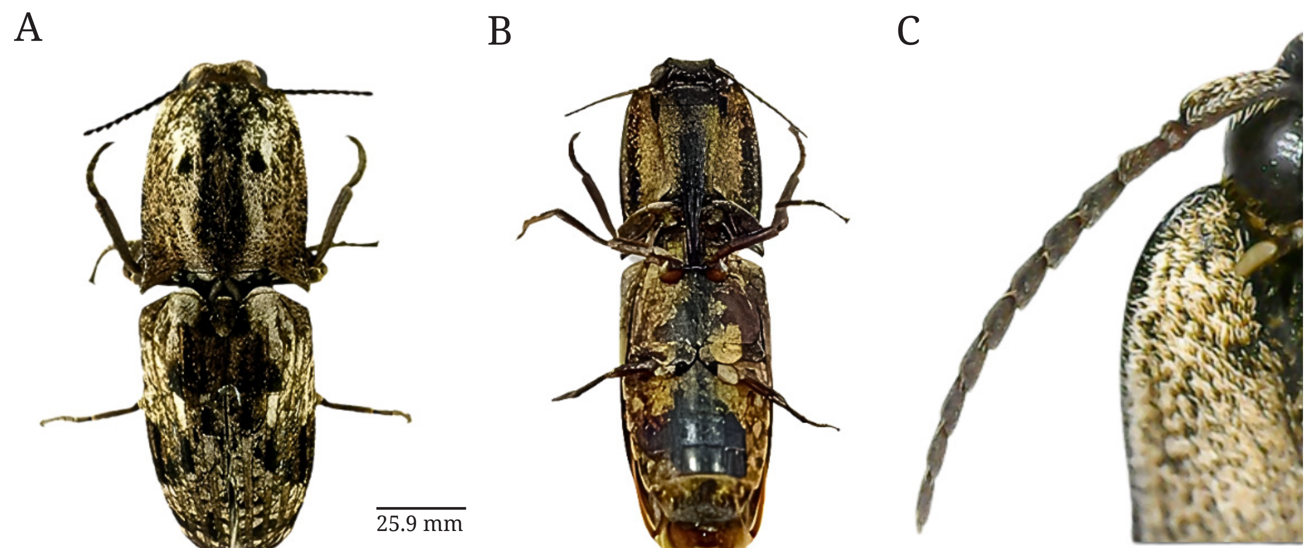


**Figure 10.** Habitus of *Cryptalaus* sp.: (A) dorsal view; (B) ventral view; (C) antennae.

Agrypninae; Candèze, 1857

Genus *Agrypnus* sp.

Diagnosis: Overall body coloration uniformly brown, covered with white, densely short setae along the abdomen (Figure 11B). Prothorax wide, curved inwardly in the anterior angle, with a slight dent on the posterior angle. Head and eyes visible but deeply sunk into pronotum. Antennae serrate, 11-segmented, shorter (Figure 11C), extending only to about half of the anterior prothoracic length. Scutellum semi-circle. Elytra with longitudinal striae, apex slightly obtuse; legs slender (Figure 11A).

Body length: 12.7 mm

Remarks: *Agrypnus* species is one of the most well-studied species and known for its fetid-smell as its defense mechanism. Genus confirmed but still requires further research.

Locality record: GBIF records confirm the presence of this taxon in Visayas, Philippines.

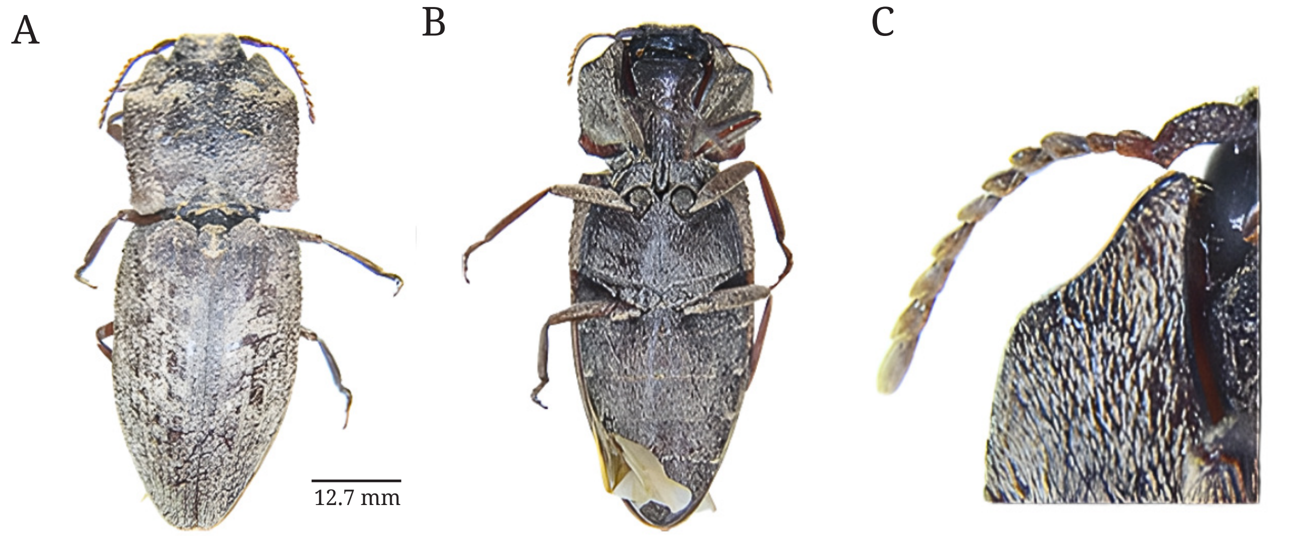


**Figure 11.** Habitus of *Agrypnus* sp.: (A) dorsal view; (B) ventral view; (C) antennae.

Agrypninae; Candèze, 1857

Genus Unknown

Diagnosis: Body color generally brown, covered with short, thick, and densely white setae, giving a likely white appearance. Head protruding, eyes large, clearly visible from dorsal view (Figure 12A). Antennae serrate, 11-segmented, shorter (Figure 12C). Prothorax is distinctly narrowed posteriorly where it meets the elytra, convex dorsally; visible lateral carinae, marked by dark-colored longitudinal band and a semi-rounded dark patch laterally on the median pronotal area; pointy spines on posterior angle at each side. The overall body shape is usually slender compared with that of typical Elateridae, giving the specimen a more elongated appearance. Pronotosternal suture visible from ventral view with narrowed prosternal process, and slightly straight from dorsal view (Figure 12B). Scutellum strongly elevated—semi-rounded, dark-colored pattern in each elytron with longitudinal striae present. Elytra slightly truncated, each elytron not closely attached at the apex. Abdomen densely covered with white short setae along its slender legs, becoming fewer medially.

Body length: 14.4 mm

Remarks: In the current study, this species can be identified only to the subfamily level.

Locality record: No previous records from the Philippines are listed in GBIF; the present study provides the first occurrence from Iligan City, Mindanao.

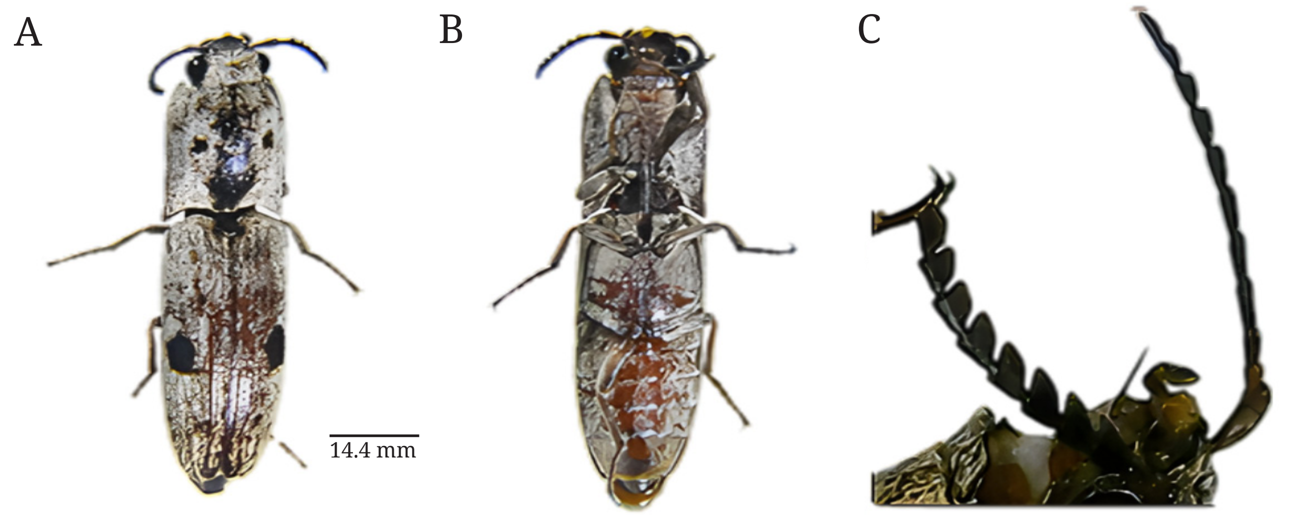


**Figure 12.** Habitus of unknown elaterid species: (A) dorsal view; (B) ventral view; (C) antennae.

Dendrometrinae; Gistel, 1848

Genus *Oxynopterus* sp.

Diagnosis: Body generally hard, smooth body texture, predominantly reddish-brown coloration. Sharp, pointy lateral margins of prothorax and elytra. Protruding big eyes and head from dorsal view (Figure 13A). Antennae lamellate, long, extending from the segments (Figure 13C). Prothorax wide and flat. No visible carina medially, with some pigmented portion from the ventral view (Figure 13B). Scutellum circular-shaped, slightly elevated. Elytra with a visible longitudinal light dark-colored pattern, a darker portion posteriorly at the apex, with each elytron tapering in the lateral margins. Legs slender.

Body length: 64.8 mm

Remarks: A common species often called a giant click beetle. Genus confirmed but still requires further research.

Locality record: GBIF records confirm the presence of this taxon in Luzon, Visayas, Philippines.

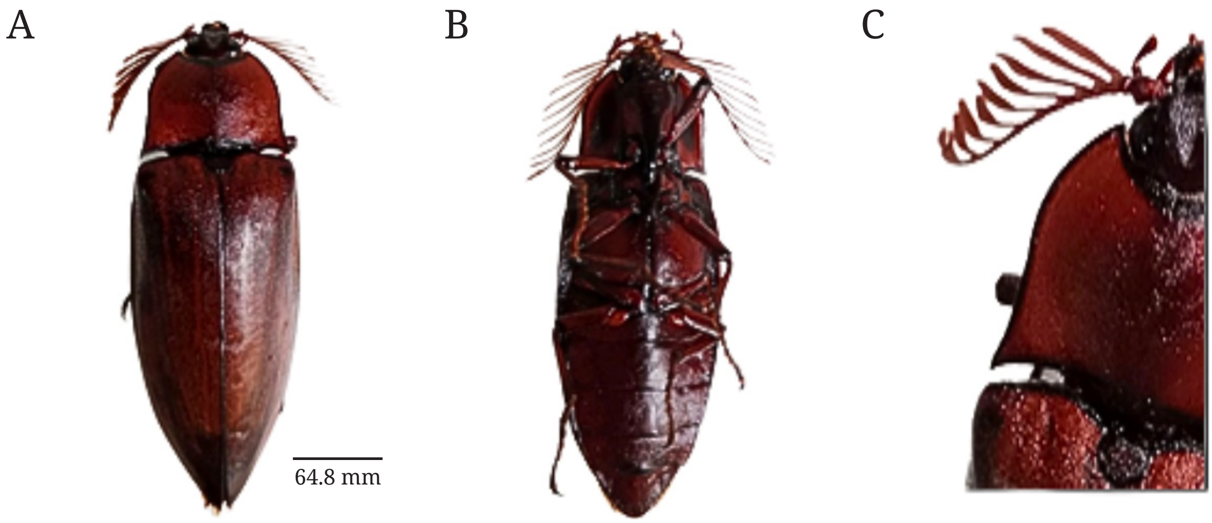


**Figure 13.** *Oxynopterus* sp.: (A) dorsal view; (B) ventral view; (C)antennae.

## DISCUSSION

### Indices in the presence of the Elateridae and sampling efforts

The species list, per site and capture method, offers an exploratory ecological view of click beetle diversity in Iligan City. The most abundant species found in the four sampling sites were *Melanotus* sp. 1 (6 individuals), *Cryptalaus* sp., *Csikia* sp., *Agrypnus* sp. (4 individuals), and *Oxynopterus* sp. (3 individuals). While the results of the nonparametric test show no significant difference ($p > 0.05$), they suggest that the abundance and species richness of click beetles do not vary between Sikyop, Tinago, NPC, and Dodiongan. It can also result from other factors, such as habitat characteristics and environmental conditions that may influence click beetle populations rather than the site itself (Iamandei and Rujescu, 2023; Nakládal et al., 2022; Park et al., 2021). Another factor may be the small sample size and uneven distribution, which make it difficult to detect differences (Hoffmannova and Kundrata, 2022; Koval and Guseva, 2019). With the aid of other indices, such as bar plots, it still provided a straightforward comparison of species richness, showing that site A has the highest species diversity (Gülsoy and Özkan, 2019). As mentioned, the overall trends indicate that Sikyop exhibits the highest species richness among the four sites. This area is characterized by a mountainous karst landscape with cave openings and rock compartments, even though it is just a secondary forest. In contrast, other areas are classified as mono-plantations of mahogany trees, secondary riparian forests, and secondary regenerative forests.

As a result, the bar plot visually summarizes discernible ecological patterns in the dataset. This pattern suggests that Sikyop has a greater variety of habitats for click beetles than other sites. This is similar to the finding of Kasmiatun et al. (2020) that there is a significant difference in the species composition of click beetles across four different land-use types in the Harapan rainforest, located in Jambi Province. Meanwhile, the illustration of the dissimilarity matrix shows that sites with higher species richness are more distinct from those with lower species richness, as they contain more unique species, which aligns with the above observations.

The Shannon-Wiener, Simpson and Evenness indices further support the observed patterns across the study sites. Sikyop and Tinago exhibited the highest diversity values and more balanced species distributions, whereas NPC and Dodiongan yielded no measurable diversity due to single-species records. This reflects a complete absence of community heterogeneity and indicates total dominance by a single morphospecies in these sites. Beyond confirming these patterns, incorporating $H'$ and $D'$ complements the bar plot and Bray–Curtis results by accounting for both species richness and relative abundance, reinforcing that Sikyop and Tinago harbor more structured click beetle assemblages than the other sites. Likewise, the study's findings support the idea, as proposed by Guseva et al. (2020), that variations in biotopes can contribute to species composition across sites.

Furthermore, given the limited sample size and reliance on morphospecies-level identification, we emphasize that these results are preliminary and should be interpreted cautiously. However, variation in species captured across methods offers valuable insights into sampling approaches. Active sampling proved more efficient for larger species such as *Oxynopterus* sp., while Malaise traps were more effective for the passive collection of smaller-bodied beetles. These findings highlight the importance of combining multiple sampling techniques to obtain more collected samples. Future research should employ stratified sampling methods and prioritize molecular validation to address taxonomic uncertainties.

Placement of Elateridae

The provisional classification of the Philippines elaterid genera reflects fundamental challenges in click beetle systematics rather than taxonomic uncertainty unique to this study (Motyka et al., 2025; Kusy et al., 2020). Half of the morphospecies lack published Philippine occurrence records, primarily because of the group's cryptic diversity and incomplete regional surveys (Ghahari et al., 2024). This knowledge gap is particularly pronounced in the Oriental region, where Elateridae diversity remains poorly documented compared to European and North American faunas (Anichtchenko and Wiesner, 2024; Berba and Matias, 2022; Freitag et al., 2016).

On the other hand, the morphological approach used here, based on the diagnostic characters including the prosternal process, mesoventrite modifications, and thoracic morphology (Ruan et al., 2022), successfully delineated three genera. However, this approach has inherent limitations. Ontogenetic modifications and convergent evolution across distantly related lineages can produce similar phenotypes, complicating morphology-based classification (Kusy et al., 2023). Specifically, in our captured images, the pretarsal claws are not sufficiently visible to allow confident separation of *Melanotus* sp. 1 and sp. 2. This necessitates molecular validation to confirm their placement within Elateridae versus related eucnemid lineages, as previous literature also acknowledges this difficulty (Song et al., 2023). Notably, an unknown species within Agrypninae was identified only to the subfamily level due to unique characteristics. This species is slightly morphologically similar to *Cryptalaus* sp., but it still possesses distinct features, specifically in the elytral pattern, where the unknown species exhibits a narrower body and prothorax. These distinctive features are crucial for differentiation and underscore the need for molecular confirmation, as phylogenomic studies have revealed extensive cryptic diversity and the necessity of reclassifying within Elateridae (Douglas et al., 2021). Recent genomic analysis demonstrated that classification based solely on morphology can obscure phylogenetic relationships, particularly among soft-bodied or ontogenetically modified groups (Kundrata and Boc, 2011). For the Philippines, elaterid work, this means the presented classification provides a functional interim framework pending DNA barcode analysis.

## CONCLUSIONS

This study provides a preliminary checklist of click beetles and requires further refinement through detailed morphological descriptions and molecular analysis, such as DNA barcoding, to ensure accurate identification. This initial assessment may also open the door to the discovery of new species. While the number of individuals collected was limited, the results highlight that Sikyop has a potentially high diversity area and emphasize the complementary utility of both passive and active sampling methods. Moreover, the provisional classification of species underscores the need for future taxonomic confirmation via molecular tools. Despite its limitations, these findings provide valuable baseline data to inform biodiversity monitoring, ecological research, forest management, and future entomological research in the region. Overall, Iligan City has promising biodiversity, but further studies are needed to understand its entomofauna fully.

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## AUTHOR CONTRIBUTIONS

A. P.: Field sampling, laboratory work, morphological analysis, data analysis, conceptualization, writing of the manuscript drafts, and revisions. E. P. M., R. F. A., and O. A. A: Supervision, guidance throughout the study, and critical review of the manuscript.

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## DECLARATION

### Informed consent statement

This study involved only the collection of insect specimens and did not include any procedures requiring institutional ethical approval. Sampling was conducted in accordance with local regulations, and necessary permissions for specimen collection were obtained from the respective barangay and site management authorities.

### Conflict of interest

The authors declare that there are no conflicts of interest associated with this publication.

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