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Diversity of Beautiful Beetles in the Suranadi Nature Tourism Park Area

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Abstract: Beetles exhibit unique shapes and color variations and play important ecological roles in the environment. Suranadi Nature Tourism Park (TWA Suranadi), a nature-based tourism area, has the potential presence of beautiful beetles. This study aims to examine the diversity of beautiful beetles in TWA Suranadi to support its tourism appeal. Sampling was conducted in May 2024 by surveying predetermined paths. The beetles collected were identified using identification books, relevant articles, and taxonomic name verification through websites. Thirteen species were identified, belonging to six families (*Cerambycidae; Chrysomelidae*, *Erotylidae*, *Eucnemidae*, *Hydrophilidae*, *Scarabaeidae*). The Chrysomelidae and Scarabaeidae families were species-rich and exhibited diverse shapes and colors. Beetles found along the forest edge path showed greater diversity (H'=2.3842) compared to the other two paths, namely the water path (H'=2.2893) and the middle path (H'=1.9804). The diversity (H') of beautiful beetles in TWA Suranadi was 2.3532.

Keywords: Beautiful; Beetles; Diversity; Suranadi; Tourism.

Introduction

Suranadi Nature Tourism Park (TWA Suranadi) is a popular forest area located in Suranadi Village, covering an area of 52 hectares. The management of TWA Suranadi is carried out using a block system, which includes a protection block (39 ha), a limited utilisation block (5 ha), an intensive utilisation block (7 ha), and a rehabilitation block (10 ares) [1]. The high diversity of flora and fauna and the relatively well-preserved natural conditions make TWA Suranadi an attractive forest to visit [2]. The beetle species is one of the fascinating and diverse fauna inhabiting TWA Suranadi.

Beetles (Coleoptera) are characterized by the presence of thick and hard elytra (forewings) that protect the body and hind wings [3]. Most beetles are highly attracted to light and can survive in various types of ecosystems [4]. The number of beetle species in Indonesia is not clearly known, but conservative estimates range between 25,000 to 40,000 species out of more than 380,000 described worldwide [5]. At the Zoologicum Bogoriense Museum (MZB), there are 30 species of stag beetles stored, originating from various islands in Java.

Beetles are large creatures with attractive colours, and these colours are significant in determining their appearance [6]. For instance, stag beetles (Coleoptera: Lucanidae) are a group of insects primarily associated with woody plants in forests. The beauty of beetle morphology, such as that of stag beetles, has made them a commodity traded domestically and internationally, often exported alive [7]. Most of the beetles' color pigments are derived from the plants they consume during the larval stage. These pigments accumulate in the beetle larvae's system and, through the process of metamorphosis, contribute to the beautiful colors in adult beetles. Additionally, the beautiful colors of beetles are often a result of light refraction caused by their translucent chitin.

The presence of certain beetle species with beautiful and exotic colors is intriguing to study because, in addition to their important ecological roles, beetles also have an economic role in promoting local economic activity through tourism, such as ecotourism. Beautiful beetles are defined as those with attractive shapes and colours, including colourful beetles and those that refract light, which has the potential to become an additional attraction for tourists, especially at TWA Suranadi. However, scientific information on beetle species and ecology, particularly regarding the diversity and distribution of beautiful beetles in TWA Suranadi, is still incomplete. Therefore, research on the diversity of beautiful beetles in TWA Suranadi is essential to identify the species and locations where beetles are commonly found, supporting their potential as a tourism attraction.

Research Methods

Data collection on the diversity of beautiful beetle species in the TWA Suranadi area was conducted using a survey method. This involved capturing and directly documenting the beetles encountered during forest exploration in TWA Suranadi. The inventory was carried out along predetermined paths, including the forest edge, middle, and water paths. The inventory activities took place in May 2024, from 08:00 to 12:00 WITA.

The beetle samples collected were brought to the laboratory for further observation and identification down to the lowest possible taxonomic level. The dry beetle specimens were stored in papillote paper with codes consisting of letters or numbers to differentiate between species. Identified beetles were then stored in collection boxes to prevent damage. Beetle identification was based on morphological characteristics using species identification books [8] and related articles, followed by [9]- [13]

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taxonomic verification on the Catalogue of Life website (https://www.catalogueoflife.org/)[14]. The diversity of beautiful beetle species obtained was calculated using the Shannon-Weiner diversity index (H') [15].

Results and Discussion

Composition of beetle species

The number of families and species found along the three research paths did not differ significantly. A total of 13 species were identified in this study, belonging to 6 families (Table 1; Figure 1). The number of families identified was lower, but the number of species was higher compared to beetle studies that used pitfall traps [16] for sample collection. These studies found more families, but fewer species [17] compared to the previous year's arboreal beetle study at the same location. The beetles found in TWA Suranadi were much fewer compared to those in the Jeruk Manis Protected Forest in East Lombok [18], the tropical rainforests of Sulawesi [19], and the land-use systems in Jambi, Sumatra [20].

The forest edge path had a higher composition compared to the other two paths, based on the number of species and individual beetles found (Figure 1). In contrast, more species were found on the water path than the other two. The family category showed the same number for forest and water paths. The middle path had the lowest composition in terms of the number of families, species, and individuals found (Figure 1). This is likely due to the characteristics of the middle path, which tends to have large, dense vegetation and a canopy that is distant from the forest floor, limiting light penetration, which in turn resulted in fewer beetles being found during the survey.

Certain biotic and abiotic factors influence the presence of beetles. For example, three abiotic factors that affect the species richness of ambrosia beetles are temperature, rainfall, and elevation [21]. Elevation is indicated to influence the number of individuals but not the number of beetle species [22]. [19] It was found that species composition was higher in forests where the canopy size tends to decrease towards the forest floor. Tree composition also affects the presence of beetles. Certain beetle groups utilize specific tree species to support their survival. Ambrosia beetles use six types of trees as their hosts: Tectona grandis (Teak), Syzygium Aromatum (Clove), Swietenia mahagoni (Mahogany), Pinus merkusii (Sumatran Pine), Paraserianthes falcataria (Maluku Albizia), and Mangifera indica (Mango) [23]. The number of individuals and species in beetle groups like ambrosia beetles (Curculionidae: Platypodinae and Scolytinae) can also be significantly influenced by the age of the tree stands, humidity, and temperature. Furthermore, the presence of beetles is also affected by land conversion, such as the conversion of forests into agroforestry areas. Only 12.5% of the beetle species found in forest areas were also recorded in agroforestry areas [24].

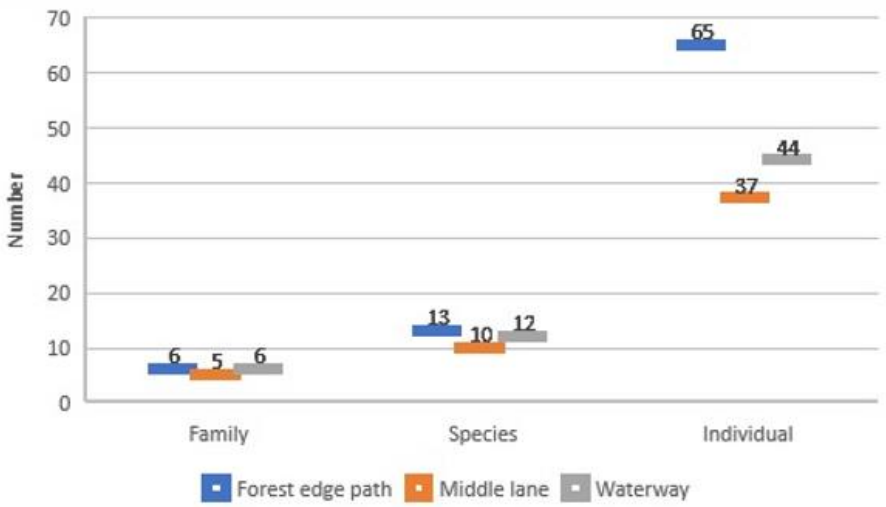

Figure 1. Composition of beautiful beetles in the three observation paths at TWA Suranadi

Leaf beetles (Chrysomelidae) were the family with the most species (5 species) in this study, followed by the Scarabaeidae family (4 species) (Table 1). Chrysomelidae were also very abundant in the forest areas of Sabah, Malaysia, along with Curculionidae [25]. The abundance and diversity of leaf beetles are not influenced by different landscapes but by the type of land use. Leaf beetles found in natural forests and rubber forests had higher numbers of individuals and species compared to oil palm plantations and rubber plantations [26]. Most Chrysomelidae can be distinguished by their elongated bodies, short legs, and antennae that are half the length of their bodies. They have protective wing covers (elytra) that meet along a line beneath the abdomen. Their colors vary, typically bright or metallic, with the dorsal part usually having two colors with distinct patterns. Examples from this study include *Aulacophora indica* (Gmelin, 1790) and *Phyllocharis undulata* (Linnaeus, 1763), which have metallic colors (Figure 2 c; d).

Scarabaeidae, often referred to as scarab beetles, play important roles in forest ecosystems, such as nutrient recycling, seed dispersal, forest regeneration, parasite population control, and reducing carbon emissions [27]. This group has varying and highly diverse body shapes, typically robust, oval, or elongated, and ranges in length from 2 to 60 mm. They have distinctive antennae with 8 to 11 segments. Sexual dimorphism and polymorphism are common in

Scarabaeidae beetles. Males often have horns and are more conspicuous, while females do not have as striking an appearance. For example, the male *Oryctes rhinoceros* (Linnaeus, 1758) has a horn on its head (Figure 2 a). *O. rhinoceros* belongs to the subfamily Dinastinae, which has a phytophagous feeding habit (plant-eating) [28]. Despite their beautiful shapes and colors, groups like *O. rhinoceros* are pests and a threat to coconut, oil palm, and date palm agriculture[29]-[30]. Globally, *O. rhinoceros* is found in Africa, Asia, Oceania, South America, and North America. In Southeast Asia, areas highly suitable for the growth of *O. rhinoceros* include Myanmar, Thailand, Vietnam, Laos, Cambodia, Singapore, Indonesia, Brunei, and the Philippines[31]. Another species within this family, the dung beetle, plays a crucial ecological role and is quite vulnerable to changes in ecosystem conditions, making it a common bioindicator[32]. One of the scarab beetle species found with attractive colors in TWA Suranadi is *Gametis plagiata*. This species has a combination of two or three colors, including greenish-black, creamy white, and reddish-orange. *G. plagiata* is reported to be found only in Indonesia, specifically in East Java, Bali, Lombok, and Sumbawa. There are few articles related to the ecological role and specific distribution of this species. However, another species from the same genus, *G. versicolor* (Fabricius, 1775) (Syn. *Oxycetonia versicolor*), which has similar colors to *G. plagiata*, is known as a pest of cotton plants in Central India [33]. Generally, , this group is a good environmental health indicator, playing roles in pollination and nutrient cycling [34].

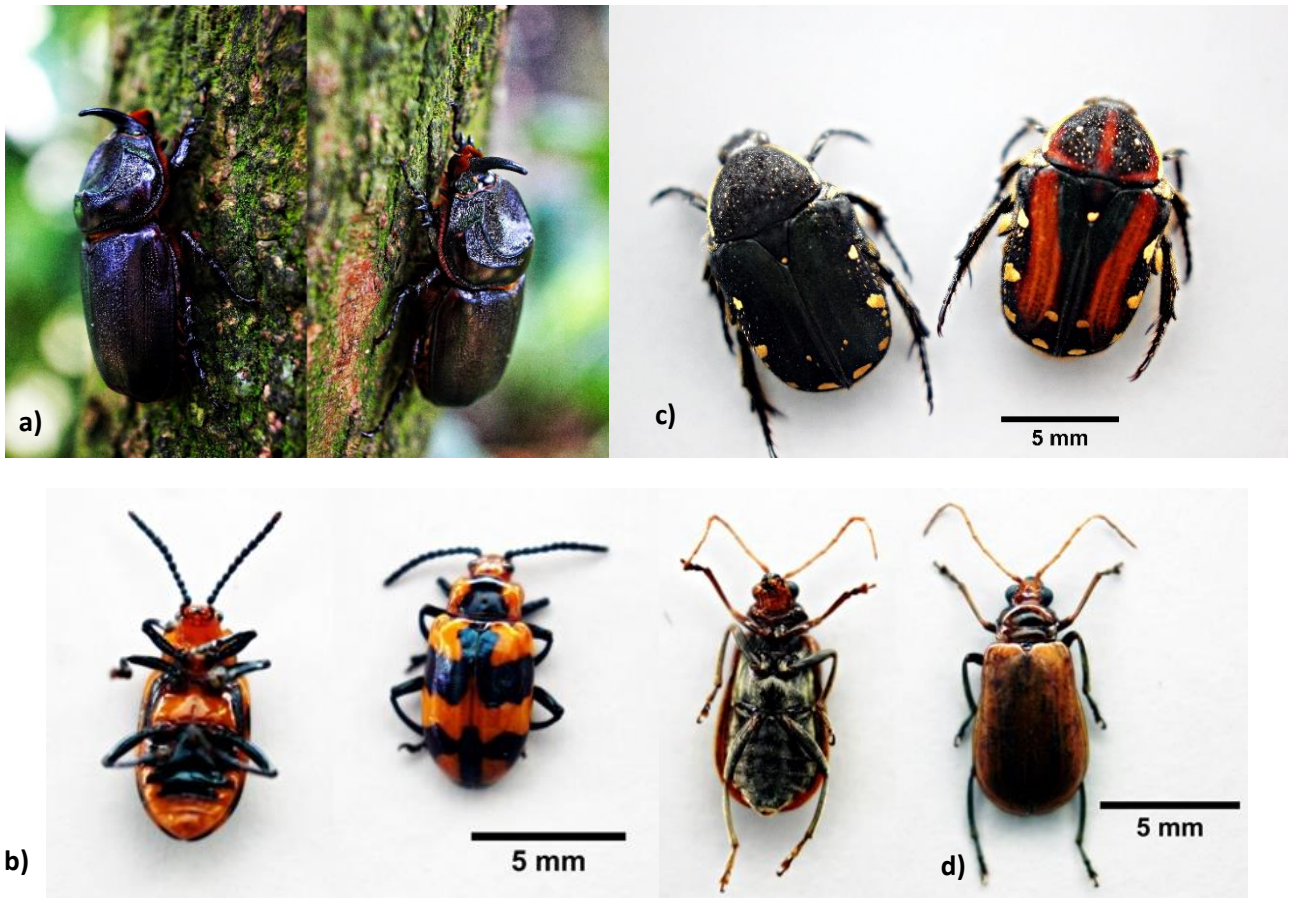

Figure 2. Examples of beautiful beetle species found in TWA Suranadi**,** a) *Oryctes rhinoceros* (Linnaeus, 1758); b) *Gametis plagiata* (Schaum, 1848); c) *Aulacophora indica* (Gmelin, 1790); d) *Phyllocharis undulata* (Linnaeus, 1763).

Diversity of Beetles

Overall, the beetle diversity (H') in TWA Suranadi is 2.3532, with the highest diversity found along the forest edge path (Table 1). This diversity is lower compared to a study [35] focused on Cerambycidae beetles, where H' values were 3.23 (rubber forest), 2.67 (rubber plantation), and 2.38 in logged rubber forests. However, it is higher when compared to oil palm plantation sites (2.01). A similar pattern is seen when compared with a study on leaf beetles (Chrysomelidae), which had diversity values of 3.83 (forest), 3.33 (rubber forest), 2.55 (rubber plantation), and 1.97 (oil palm plantation). However, it shows a difference when compared to Cerambycid beetles in the Pangandaran Nature Reserve, where diversity tends to be lower across all areas compared to TWA Suranadi, with values of TWA 1 (H': 2.01), nature reserve 2 (1.75), TWA 2 (1.70), and nature reserve 1 (1.52) [36].

Differences in forest types and categories seem to impact the diversity and abundance of beetles. Plantation forests negatively affect the richness and abundance of Coleoptera species compared to natural forests. Species richness and beetle abundance significantly increase as local plantations age without invasive species but decrease in exotic plantations. Small plantations near native forests have higher beetle species richness and abundance compared to those located far from native forests [37]. For instance, ambrosia beetles have diversity values of 1.03 (Malang City)

and 1.01 (Batu City) [38], and beetles found in rice storage warehouses in Mataram City and Central Lombok have a diversity of 1.60 [39]. This diversity is lower compared to the beetle diversity in TWA Suranadi. In primary forests, beetle diversity as scavengers, fungivores, and herbivores is relatively similar but lower compared to predators. In secondary forests, functional beetle groups have diversity that can be categorized into three classes: predators (relatively high), fungivores and herbivores (relatively low), and in between (scavengers).

All species in this study were found in all research paths, except for *Phyllocharis undulata* (Linnaeus, 1763), which was found on the forest edge and water paths, followed by *Languria* sp. on the same paths, and *G. plagiata*, which was only found on the forest edge path (Table 1). The presence of certain tree species that serve as hosts for beetles likely determines the distribution of beetles. *P. undulata* in TWA Suranadi is generally found on the leaves of *Clerodendron* sp., along with the group *Aulacophora* sp. (*A. indica*; *A. hilaris hilaris* (Boisduval, 1835); *A. lewisii* Baly, 1886). Groups like *Gametis* sp. are more attracted to flowering plants, such as *G. bealiae* (Gory & Percheron, 1833), which was observed feeding on the flowers of *Ligustrum sinense* Lour, and *Gametis jucunda* (Faldermann, 1835) feeding on *Ligustrum sinense*, *Clausena lansium*, *Toddalia asiatica*, *Guilandina bonduc*, *Rhus chinensis*, and *Schima superba*. Erotylidae are known as stem borers and agricultural pests [40].

Table 1. Diversity index of beautiful beetles in TWA Suranadi

Family	Species	Forest edge path	Midle Path	Water path
1. Cerambycidae	1. *Chlorophorus* sp.	+	+	+
2. Chrysomelidae	2. *Aulacophora indica* (Gmelin, 1790)	+	+	+
	3. *Aulacophora hilaris* (Boisduval, 1835)	+	+	+
	4. *Aulacophora lewisii* Baly, 1886	+	+	+
	5. *Lema* sp.	+	+	+
	6. *Phyllocharis undulata* (Linnaeus, 1763)	+	-	+
3. Erotylidae	7. *Languria* sp.	+	-	+
4. Eucnemidae	8. *Galbites* sp	+	+	+
5. Hydrophilidae	9. *Dactylosternum* sp.	+	+	+
6. Scarabaeidae	10. *Gametis plagiata* (Schaum, 1848)	+	-	-
	11. *Onthophagus* sp.	+	+	+
	12. *Oryctes rhinoceros* (Linnaeus, 1758)	+	+	+
	13. *Anomala cupripes* (Hope, 1839)	+	+	+
Diversity Indeks(H')		2.3842	1.9804	2.2893
Overall H' of TWA Suranadi				2.3532

The presence of *Languria* sp. (Erotylidae) as a stem borer prefers herbaceous and woody plants or bamboo. For example, *Languria mozardi* Latreille attacks various plant families, including canola (*Brassica napus* L.; Brassicaceae) [41], and the genus *Tetraphala* sp., such as *T. collaris*, bores into the live petioles and stems of dicotyledonous herbs, *Sambucus chinensis* (Adoxaceae), using its mandibles to lay its eggs. The presence of predators also affects the distribution of beetles. *Aulacophora indica*, which plays a role as a pollinator, is also a leaf pest on watermelon, cucumber, and pumpkin, and has been reported as prey for *Perillus bioculatus* (Fabricius) [42].

Conclusion

The beetles found in TWA Suranadi consist of 6 families (13 species). Chrysomelidae and Scarabaeidae are the two families with the most species, including beetles with beautiful shapes and colors. The forest edge path was where the most unique and beautiful beetles were found, compared to the other two paths. The presence of these beautiful beetles has the potential to enhance the attractiveness of TWA Suranadi for ecotourism.

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