

Analysis Of Insect Fauna Biodiversity On Reclamation Land From Former Nickel Mining In Konawe Regency

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ABSTRACT

Nickel mining activities have been identified as a factor in insect biodiversity degradation. This study aimed to evaluate insect community parameters, including species, diversity, abundance, and evenness, by comparing post-mining and natural land in Amonggedo District, Konawe Regency. Sampling was conducted using sweep net, pitfall trap, and light trap methods. The findings showed a significant decrease in species richness in the post-mining land (4 orders, 6 families, 11 individuals) compared to the control land (6 orders, 11 families, 104 individuals). Although both locations had a moderate diversity index (H') (1.55 vs. 1.72), the post-mining land recorded a higher evenness index (E) (0.86), indicating a more balanced distribution between families but with a much lower population. Dominance shifted from Ectobiidae in the natural land to Crambidae and Scoliidae in the post-mining area, confirming a transformation in community structure due to the impact of nickel mining.

Keywords: *Light Trap, Pitfall Trap, Sweep Net, Abundance, Evenness*

INTRODUCTION

In addition to its productive agricultural sector, with leading commodities such as rice, corn, and cocoa, Konawe Regency also plays a vital role in the mining industry in Southeast Sulawesi. This region has massive nickel potential, reaching a total of 529.9 million tons, divided into resources of 460.57 million tons and reserves of 69.3 million tons. With nickel content ranging from 0.6% to 2%, mining activity is concentrated in strategic areas such as Rounta, Puriala, and Puriala Districts. This geological wealth positions Konawe as one of the main nickel extraction centers in the region (Nursahan et al. 2013).

Nickel exploitation places significant ecological pressure on entomofaunal biodiversity. Land clearing and topsoil removal lead to habitat fragmentation, leading to the loss of numerous insect species. This has a direct impact on the degradation of ecosystem function, particularly for functional insect groups such as pollinators and decomposers. (Handayani et al. 2021). The drastic decline in insect biodiversity in post-nickel mining areas is a logical consequence of the transformation of vegetation structure, the food crisis, and extreme microclimate fluctuations.

This phenomenon stands in stark contrast to the biological nature of insects, the most successful class of arthropods, encompassing approximately 675,000 global species. Although insects are highly adaptable thanks to their drought-resistant chitinous exoskeletons, tracheal systems for aerial respiration, and the ability to fly for mobility, environmental pressures in post-mining areas appear to exceed the tolerance thresholds of many species. Flight, typically effective for mate search and predator avoidance, becomes suboptimal when the supporting habitat has undergone massive degradation (Humphreys dan Ruxton 2019). Given the limited data on entomofaunal biodiversity in post-nickel mining areas in Southeast Sulawesi, particularly in Konawe Regency, this research is crucial. The study aims to identify the composition of insect species colonizing post-mining areas and conduct a comparative analysis of their diversity compared to undisturbed areas.

METHODS

This research took place from May to June 2025 in a post-nickel mining area in Amonggedo District, Konawe Regency, Southeast Sulawesi. The observation site covered approximately 1 hectare of land that had been abandoned for 6–12 months. Sampling was

Awaluddin, Ibnu Fajar, Muhammad Boteq, Waode Siti Anima Hisein, Nuriadi, Siska Efendi, *Analysis Of Insect Fauna Biodiversity On Reclamation Land From Former Nickel Mining In Konawe Regency*

conducted in five observation plots determined using purposive sampling techniques, taking into account similarities in vegetation characteristics and land topography.

Insect specimen collection was conducted comprehensively using three sampling techniques: sweep nets, pitfall traps, and light traps. The sweep net procedure was carried out in the morning, using three sweeps at each point. This process was repeated for three consecutive days, both in the ex-mining area and the control area. All insects collected in the collection bottles were then further analyzed in the Plant Protection Laboratory for identification.

Pitfall trap sampling was conducted in five observation plots in the post-mining area. Traps were set simultaneously in the morning between 7:00 and 9:00 a.m. WITA (Central Indonesian Time) to minimize specimen damage due to increased ambient temperature. The sampling cycle took place three times over a three-day period. All trapped insects were then transferred to collection bottles for identification in the Plant Protection Laboratory. Identical methods were also applied to the control area for comparison.

Nocturnal insect samples were collected by placing light traps at central points in each observation area. The devices were installed in the afternoon between 6:00 PM and 6:30 PM WITA, with sampling frequency three times over three consecutive days. This procedure was applied consistently in both post-mining and natural areas. The collected specimens were then secured in collection bottles for identification at the Entomology and Toxicology Laboratory of the Plant Protection Department, Faculty of Agriculture, Halu Oleo University.

Observation Variables

The variables observed in this study are as follows:

Insect diversity

The method for estimating species diversity parameters is determined through the integration of species richness and population evenness. This analysis is calculated using the Shannon-Wiener Diversity Index, referring to a modified study by Awaluddin *et al.* (2024).

$$H' = - \sum_{i=1}^s P_i (\ln P_i)$$

Description:

H' = diversity index.

ni = number of species or families in a plot or number of i-th individuals.

N = total number of individuals obtained.

Pi = proportion of the first species in the community.

The diversity index category values are determined by referring to the Shannon-Wiener index criteria as stated in Table 1.

Table 1. Diversity Index Category Criteria (%)

H' value	Diversity Category
$H' < 1$	Low
$1 \leq H' \leq 3$	Medium
$H' > 3$	High

Abundance of Insects

Species abundance is measured quantitatively to determine the number of individuals in a community. Methodologically, this value is obtained by calculating the percentage ratio between the number of each species and the total number of individuals using the formula:

$$KRi = \sum \frac{Ni}{N} \times 100\%$$

Description:

KRi = Relative abundance (%)

Ni = Total number of individuals

N = Total number of individuals obtained

Insect Evenness Index

To describe how evenly distributed individuals of each species are in an environment, a parameter called the Index of Evenness or Evenness Index is used.

$$E = \frac{H'}{\ln(s)}$$

E = Evenness index (value between 0 – 1)

H' = Shannon-Wiener species diversity index

In = Natural logarithm

S = Number of species found

A community's evenness is considered high if the proportion of individuals between species tends to be balanced. Conversely, dominance by one or more species indicates a low

evenness value. This parameter has a range of values between 0 and 1, where values closer to 1 reflect an even distribution of individuals, while values closer to 0 indicate population imbalance due to species dominance.

Data analysis

Observation data were identified and analyzed descriptively based on the type, diversity, abundance and evenness of insects found in Amonggedo District, Konawe Regency.

RESULTS AND DISCUSSION

Taxonomic arrangement of insects that inhabit a habitat

There were significant differences in the insect community structure at the two sites; the mined area contained only 11 individuals from 4 orders and 5 families. In contrast, the unmined area exhibited significantly higher species richness, with a total of 104 individuals from 7 orders and 11 families. Coleoptera, Hymenoptera, Lepidoptera, and Diptera dominated the mined area, but the undisturbed area also contained additional orders such as Blattodea, Hemiptera, Odonata, and Orthoptera, demonstrating broader diversity (Figure 1).

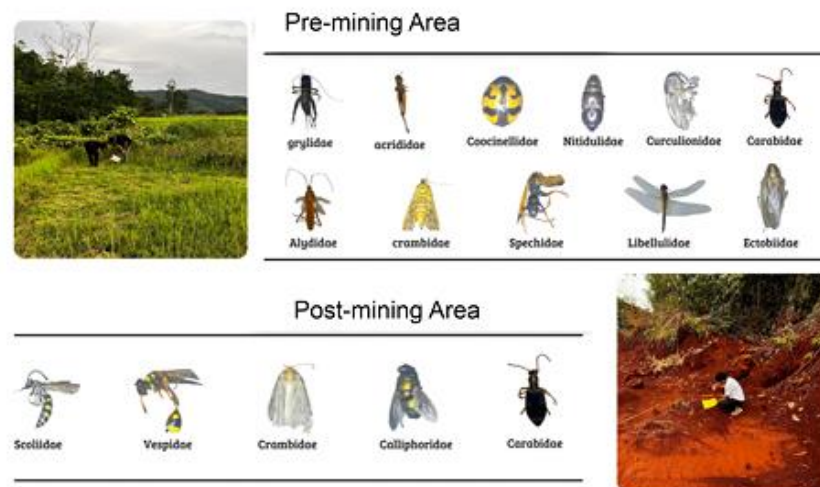


Figure 1. Initial land conditions (before mining) and post-nickel mining land

The ecological conditions in the pre-mining area indicated significant biodiversity, with 104 individuals found. However, after nickel extraction, the insect population in the area decreased drastically to just 11 individuals, indicating habitat loss and a significant shift in community structure. The transformation of natural forest into former nickel mining areas has resulted in the loss of insect order diversity. While pre-mining areas were inhabited by a variety of groups, from Blattodea to Orthoptera, post-mining areas retain only four dominant orders

with very limited numbers of individuals (Aronson dan Le Floc'h 1996).

Diversity Index

Insect community characteristics at both research sites were measured using the Shannon-Wiener metric (H') and the evenness index (E). The distribution of individuals at each site is also presented through an abundance analysis, as shown in (Figure 2).

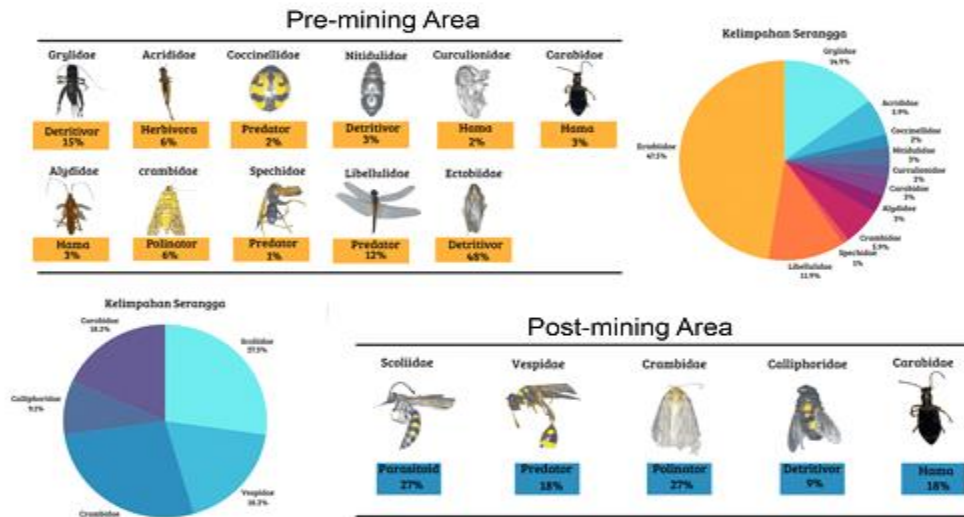


Figure 2. Diversity of insect species found before and after nickel mining

Biodiversity analysis at the two research sites revealed a relatively small difference in H' scores, namely 1.55 for the former mining area and 1.72 for the undisturbed area. The inclusion of both locations in the moderate category indicates that the insect community structure there still maintains a relatively equal population balance in terms of quality index (Semy dan Singh 2023).

Although the initial soil profile had a higher abundance of individuals, the evenness index (E) in the post-mining area was higher (0.86) than in the unmined area (0.71). This indicates the dominance of certain families in the undisturbed area, while in the post-mining area, individuals were more evenly distributed across families (Řehouňková et al. 2016). Overall, mining activities have altered the insect community structure by reducing abundance and shifting species distribution patterns, although diversity categories remain relatively similar. In the post-mining area, only six families were recorded with relative abundances ranging from 8% to 25%, with Megachilidae and Crambidae being the most dominant groups. In contrast, the initial shaded area showed higher diversity, with eight families and significantly

Awaluddin, Ibnu Fajar, Muhammad Boteq, Waode Siti Anima Hisein, Nuriadi, Siska Efendi, *Analysis Of Insect Fauna Biodiversity On Reclamation Land From Former Nickel Mining In Konawe Regency*

larger populations (Beneduci et al. 2023). Ectobiidae (49%) was the most dominant family in the unmined area, followed by Gryllidae (16%) and Libellulidae (12%).

Community Structure and Dominance Analysis. A striking difference between the two locations lies in the evenness of individuals. **Unmined Land:** Despite having higher family richness (8 families) and a greater number of individuals, this ecosystem exhibits population imbalance. The dominance of the Ectobiidae family (49%) indicates a population "explosion" of one species group. According to Pielou's Evenness Criteria, this condition is often found in stable lands where resources are abundant for generalist species. **Post-Mining Land:** In contrast, in post-mining land, the distribution of individuals is more even (range 8–25%) (Maczkowiack et al. 2012). This explains the higher Evenness Index (E) value (0.86) here, despite the significantly lower number of individuals (Antwi et al. 2008). The absence of highly dominant families indicates that the site is in the early stages of colonization, where interspecific competition is not yet particularly intense (Hale dan Swearer 2017).

Relationship between Habitat Conditions and Found Families. Presence of Ectobiidae, Gryllidae, and Libellulidae: The dominance of Ectobiidae (forest cockroaches) and Gryllidae (crickets) in unmined areas is closely related to the availability of abundant litter and organic material as food sources. The presence of Libellulidae (dragonflies) at 12% is an important indicator of water sources or high humidity in the initial soil conditions, considering that dragonflies are bioindicators of clean waters according to the National Institute of Sciences (BRIN) Biosystematics Research Center (Gradict Semiun et al. 2023).

Dominance of Megachilidae and Crambidae: In post-mining areas, the presence of Megachilidae (leafcutter bees) and Crambidae (moths) indicates that the area may have begun to be colonized by pioneer plants or open vegetation that supports pollinating insects and flying herbivores active in warm areas. **Impact of Nickel Mining on Entomofauna.** Ecologically, nickel mining causes the loss of topsoil (Kamal et al. 2025). Your data analysis shows that: There was a drastic decrease in the number of individuals (from 104 to 11). The loss of sensitive families such as Libellulidae in post-mining areas indicates the loss of aquatic habitat or moist microhabitats due to land clearing (University dan Vicentini 2022). Post-mining areas have lower stability despite high evenness, as small populations are highly susceptible to local extinction.

CONCLUSION AND IMPLICATIONS

Based on the results of research and analysis of insect diversity in two different locations, it can be concluded that:

- a. Nickel mining activities significantly reduced the number of individual insects. This is evident in the drastic decline in the number of individuals, from 104 in the initial (unmined) area to just 11 in the former mined area.
- b. Despite the significant differences in the number of individuals, the Shannon-Wiener diversity index (H') values at both locations were still in the moderate category (Unmined Land $H' = 1.72$; Former Mined Land $H' = 1.55$). This indicates that categorically, species diversity has not been completely lost, but the stability of the ecosystem has been disrupted.
- c. There are contrasting distribution patterns. The ex-mining land has a higher evenness index (E) (0.86) due to the relatively equal distribution of individuals across families (no one is highly dominant). In contrast, the initial shaded land has a lower evenness index (0.71) due to the strong dominance of the Ectobiidae family (49%), indicating an abundance of organic resources in the natural forest.
- d. Mining has led to the loss of sensitive families and indicators of healthy environments, such as Libellulidae (dragonflies) and Gryllidae (crickets). In former mined areas, communities have shifted to simpler ones, with the Megachilidae and Crambidae families dominating, which are better adapted to open areas.
- e. Overall, nickel mining degrades insect community structure through vegetation removal and microclimate changes. Restoring ecological function in post-mining areas requires reclamation efforts focused on restoring native soil structure and vegetation to allow lost families to recolonize.

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Awaluddin, Ibnu Fajar, Muhammad Boteq, Waode Siti Anima Hisein, Nuriadi, Siska Efendi, *Analysis Of Insect Fauna Biodiversity On Reclamation Land From Former Nickel Mining In Konawe Regency*

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Awaluddin, Ibnu Fajar, Muhammad Boteq, Waode Siti Anima Hisein, Nuriadi, Siska Efendi, *Analysis Of Insect Fauna Biodiversity On Reclamation Land From Former Nickel Mining In Konawe Regency*

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