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# Diversity of insects in Ciliwung Riverbank condet region (Rindam Jaya), South Jakarta, Indonesia

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**Abstract**
Insects are animal with the highest diversity in the world and is one of the fauna that can live in various habitats and plays as important role in maintaining the stability of ecosystems both on land and water. The great role of insects for environment leads to research by using insects as polluted environment bioindicator. One of the polluted environment in Jakarta is Ciliwung River. Ciliwung River is one of polluted river caused by many society and industrial activity around the river. Previous research of insects has been done in Srengseng Sawah and Manggarai Water Gate when Ciliwung River are not yet restored into sustainable condition. A preliminary research has been conducted in the Ciliwung River, Condet Region (Rindam Jaya), South Jakarta which aims to determine the diversity of insects in the area. This study conducted as preliminary data for the further insect's research of the Ciliwung River. The result showed that 390 individual insects were found with Formicidae family most widely found (227 individuals). This study also measured diversity values using frequency of attendance. The highest frequency of attendance score is in groups of Formicidae family insects (58.2%).

**Keywords:** Insects, Ciliwung River, pollution, diversity

## Introduction
Indonesia is a country with high biodiversity, as it has ecosystems, species within ecosystems and genetic traits in each species are very diverse. Therefore, Indonesia is known as mega biodiversity [1, 2]. This is because Indonesia is located in the tropics with a stable climate, and is an archipelagic country geographically located between the continents of Asia and Australia [3].
Insects are one of the animal group with the highest diversity in the world with a 58% percentage in biodiversity globally. Insects can live in a variety of habitats and play an important role in maintaining the stability of ecosystems, both on land and water. Insects have modified and adaptable bodies capable of producing a variety of diversity capable of living in land and water environments. The diversity includes: the state and stability of the basic pattern is long-lasting also the variety is high (there are 29 orders found today). The number of insects individual reaches one quintillion (1018). [4, 5] The current number of insects species found reached 1.004.898 species. [6, 7, 8] Insects are known to have evolved beyond the evolution of land plants in the Silurian and Devonian periods of more than 400 million years ago. Collembola and apterygota insects show evidence of their relics in the Devonian period, while the flying insects in the Carbon period. [9, 10, 11]
Attention to environmental issues has increased the demand for bioindicators that can determine the conditions of the environment. [12, 13] Insects are the organism that can contribute as a general appraiser of an environmental sustainability level. Insect indicators are especially useful because more than half of all species and their diversity are able to assess differences in habitat on an acceptable scale. [14, 15, 16] One of the insects used as bioindicators is Formicidae family (ants).
Research about the diversity of insects in the Ciliwung River was first conducted by Ruslan (2008) on the diversity of ground insects in the Ciliwung River region at two locations (Srengseng Sawah and Manggarai Water Gate) in Jakarta. [17] Ciliwung River is one of the rivers that play an important role in the life of the people of Jakarta. This river comes from Mount Pangrango, which flows through the Bogor Regency, Bogor City, Depok City and then to Jakarta. The condition of the Ciliwung River is now polluted due to the large number of community activities and industry around the river. [18, 19, 20] This causes a decline in the quality of Ciliwung River water, both used for human daily needs, and wildlife life in the habitat. This polluted condition is thought to affect the diversity of fauna, one of which is the diversity of insects. [21, 22]
This study was conducted prior to the massive cleanup of Ciliwung River which was led by Jakarta Military Command (Kodam Jaya). Further research is needed on the diversity of insects after Ciliwung River is cleaned.

## Material and Methods
### 1. Research sites
This study was conducted on May – July 2017. The study consisted of sampling at 30 points along the Ciliwung River in Condet (Rindam Jaya) South Jakarta area and the sample analysis was conducted at the Biology Laboratory of Al Azhar University Indonesia and Cibinong Indonesian Academy of Science (LIPI Cibinong). Research procedure includes location survey, insect collection, sample identification, sample confirmation and diversity calculation using frequency of attendance.

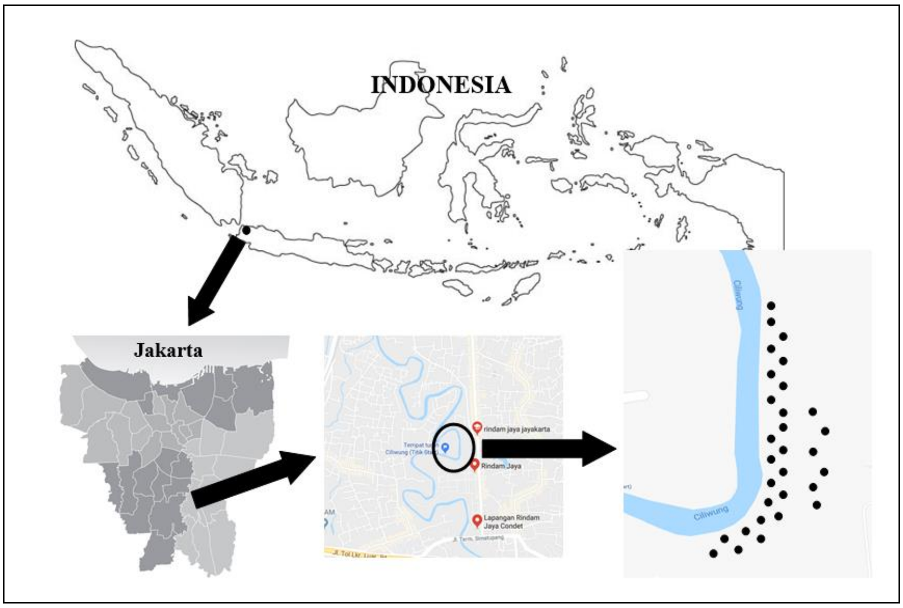


**Fig 1:** The insects sampling location with 30 dots of trap placement

## 2. Material

The material used three types of traps, Pitfall Trap, Yellow Pan Trap (YPT) and insect net, samples inside plastic seals, the sample bottle

## 3. Procedures

### 3.1 Location survey

Location survey are conducted from Rindam Jaya, Condet, South Jakarta to Bidara Cina using LCR (Landing Craft Rubber) boat along the Ciliwung River to determine the location where the traps are installed. Location were obtained at Rindam Jaya, Condet, South Jakarta.

### 3.2 Insect collecting

The installation of insect trap is done after determining the location of trap placement. We used three types of traps, Pitfall Trap to capture the ground insect, Yellow Pan Trap (YPT) to capture small flying insect and insect net to catch large flying insect.

### 3.3 Sample identification

All samples were taken to Biology Laboratory of Al Azhar University Indonesia for identification. Before samples were identified, samples inside plastic seals was transferred first to the sample bottle. Subsequently all insects were identified to the level of the Order. The identified samples are then recorded by number, type of Order, sample location, sampling time and sample size.

### 3.4 Sample confirmation

The identified samples were then taken to Indonesian Institut of Science or Lembaga Ilmu Pengetahuan Indonesia (LIPI) Cibinong for confirmation until Order level that had previously been done and further identification up to the Family level.

## 4. Data analysis

The samples that have been identified then calculated using Frequency of Attendance with the following formula:

$$FK = \frac{a}{n} x\ 100\%$$

Note:
a= the number of collected family
n= total samples

Description of results:
0-25% = very rare
25-50% = uncommon
50-75% = common
>75% = very common

## Result and Discussion

The total number of individuals collected in this study were 390 specimens consisting of 7 orders, 1 Lepidoptera sample, 2 Blattodea samples, 19 Orthoptera samples, 16 Hemiptera samples, 55 Coleoptera samples, 235 Hymenoptera samples and 53 Diptera samples (Table 1).

**Table 1:** Data of insect samples collected (order and family) and Frequency of Attendance of each family

| No. | Order | Family | Number of individuals | Frequency of attendance (FoA) (%) |
|---|---|---|---|---|
| 1 | Lepidoptera | Hesperidae | 1 | 0.26 |
| 2 | Blattodea | Blattidae | 2 | 0.51 |
| 3 | Orthoptera | Acrididae | 7 | 1.79 |
| | | Gryllidae | 12 | 3.07 |
| 4 | Hemiptera | Membracidae | 16 | 4.2 |
| 5 | Coleoptera | Carabidae | 4 | 1.02 |
| | | Staphylinidae | 51 | 13.1 |
| 6 | Hymenoptera | Formicidae | 227 | 58.2 |

| | | | | |
|---|---|---|---|---|
| | | Crabronidae | 1 | 0.26 |
| | | Figitidae | 1 | 0.26 |
| | | Sphecidae | 1 | 0.26 |
| | | Collitidae | 1 | 0.26 |
| | | Icheumonidae | 2 | 0.51 |
| | | Apidae | 2 | 0.51 |
| 7 | Diptera | Dolicophodidae | 43 | 11.02 |
| | | Ephydridae | 5 | 1.28 |
| | | Calliphoridae | 1 | 0.26 |
| | | Tachinidae | 4 | 1.02 |
| 8 | Odonata | Libellulidae | 7 | 1.79 |
| | | Coenagrionidae | 2 | 0.51 |
| Total individual | | | 390 | 100 |

Previous study on two locations in Ciliwung River (Srengseng Sawah and Manggarai) showed that in Srengseng Sawah captured 561 Hymenoptera samples, 21 Orthoptera samples, 68 Coleoptera samples, and 15 Diptera samples. In Manggarai insect captured were 168 Hymenoptera samples, 5 Orthoptera samples, 37 Coleoptera samples and 20 Diptera samples. [17]

The most commonly found family is the ant (Formicidae family). This is due to the high survival of ants. Ants can be found all over the world except Iceland, Greenland, Antarctica, parts of Polynesia, and some remote islands in the Atlantic Ocean and India. Ants can also live in almost all habitats and terrestrial environments including deserts, beaches, inside walls and unused waterways. Some species are even able to live in the water for 14 days by turning into a sleeping state (dormant) that causes the reduction of oxygen required by ants twentyfold. [23, 24] The number of individuals found was 227 (FoA 58.2%).

**Table 2:** Collected insect data comparison between Rindam Jaya and study by Ruslan (2008) in Srengseng Sawah and Manggarai.

| No. | Order | Rindam Jaya | | Srengseng Sawah | | Manggarai | |
|---|---|---|---|---|---|---|---|
| | | ∑ F | ∑ I | ∑ F | ∑ I | ∑ F | ∑ I |
| 1 | Lepidoptera | 1 | 1 | 0 | 0 | 0 | 0 |
| 2 | Blattodea | 1 | 2 | 0 | 0 | 0 | 0 |
| 3 | Orthoptera | 2 | 19 | 3 | 21 | 2 | 5 |
| 4 | Hemiptera | 1 | 16 | 1 | 1 | 1 | 1 |
| 5 | Coleoptera | 2 | 55 | 7 | 68 | 4 | 37 |
| 6 | Hymenoptera | 7 | 235 | 4 | 561 | 4 | 168 |
| 7 | Diptera | 4 | 53 | 6 | 15 | 6 | 20 |
| 8 | Odonata | 2 | 9 | 0 | 0 | 0 | 0 |
| 9 | Homoptera | 0 | 0 | 1 | 2 | 0 | 0 |
| 10 | Psocoptera | 0 | 0 | 1 | 1 | 1 | 1 |
| 11 | Isoptera | 0 | 0 | 1 | 1 | 0 | 0 |
| Total | | 20 | 390 | 24 | 670 | 18 | 232 |

**Note:** ∑F is total number of Family and ∑I is total number of Individuals.

Formicidae family (ants) are generally used for soil quality bioindicators and have an important role in the improvement of degraded areas and forests under reforestation. This group of insects is very sensitive to human influences, and can be used as an environmental indicator in different ecosystems. [25, 26, 27] Many species of ants may become extinct somewhere depending on how much the environment is changing. This may lead to superior dominant species that can be used as indicators in an impaired environment. [28, 29] Until now there has been no research conducted to see the benefits of ants on the Ciliwung River.

The highest number of family collected from Hymenoptera order is from Rindam Jaya, while the highest number of family collected from Coleoptera order is from Srengseng Sawah. In the Srengseng Sawah area, 561 individuals of the Hymenoptera Order were found higher than the other two locations, but the Lepidoptera, Blattodea and Odonata Order were not found in Srengseng Sawah and Manggarai (Table 2). This can be caused by several factors, one of which is the abiotic factor. One of the abiotic factors affecting dragonflies (Odonata order) is water pH although it does not affect significantly. [30, 31, 32]

Based on research conducted by Elfidasari *et al* (2020) the pH of Ciliwung River's water is 6.9. [33] The existence of dragonfly is quite tolerant where in water with a very acidic pH (<4.00) there are still certain types of dragonflies, although in very small quantities, which the dragonfly can not develop in neutral waters. However, waters with a pH below 3.00 can cause damage to dragonflies. [34, 35] It can be explained that dragonflies can be found in the Ciliwung River due to the dragonfly is quite tolerant even at very low pH, while the pH of Ciliwung River is neutral.

For the Hesperiidae Family (Lepidoptera order) only one specimen was obtained because the method of catching using insect net was less efficient (only one to two people who capturing with insect net). Crabronidae family, Figitidae family, Sphecidae family, Colletidae family (Hymenoptera order) and Calliphoridae family (Diptera order) also get only one specimen from each family because the method used is not specific to the insects family. The Frequency of Presence (FoA) of this family is only 0.2% (Table 1). The method used is Yellow Pan Trap (YPT), which is a common method used to capture parasitoid insects. [36, 37] Based on the recommendation of an insect researcher at LIPI Cibinong, trap was filled with water and was given a drop of dish soap, and trap was placed for only few hours (8 am – 12 pm). This short term trap placement was to prevent the insect for being damaged and may cause only a few insects to be caught.

Butterflies and moths (Lepidoptera order) live in temperate and tropical climates and very sensitive to environmental changes. [38, 39] Several groups of Lepidoptera are used as indicators of environmental pollution of heavy metals and carbon dioxide at locations adjacent to industrial and residential areas. The presence of bronze, iron, nickel, cadmium, sulfuric acid ions and other substances used in fertilizers were studied with pupae of different species from Geometridae and Noctuidae family. [24]

**Fig 1:** Environmental condition of sampling location

The Coleoptera order represents about 20% of the total arthropod diversity and plays a role in maintaining soil quality, regulation of invertebrate populations, and contributes to soil physical and chemical content. [40] Beetles from the Coleoptera Order and the Carabidae Family are important predators participating in biological control and biological monitoring of pollution from oil, sulfur, herbicide, CO2, insecticides and radioactive phosphorus. [41, 42] The beetle family (Coleoptera: Scarabidae) has a high potential as an environmental indicator in forest and agricultural areas. [43]

**Table 3:** Bioindicator insect groups in aquatic and terrestrial environments and their role in environmental biomonitoring. [44]

| Group | General Name | Biomonitoring | Habitat |
|---|---|---|---|
| Odonata Order | Anisoptera & Zygoptera | Water quality | Aquatic |
| Grynidae Dysticidae Hydrophilidae Notonectidae Famili Velllidae | Whirligig beetles Predaceous diving beetles - Backswimmer - | Highly adaptable | Aquatic |
| Ephemeroptera Plecoptera Order | Mayflies Stoneflies | Highly adaptable | Aquatic |
| Halobates | Ocean-skaters | Cadmium and lead | Aquatic |
| Coleoptera order Scarabaeidae family | Beetle | Forest and agriculture | Land |
| Ordo Coleoptera Famili Carabidae | Beetle | Biological oil control, sulfur, herbicide, CO2, insecticide pollution | Land |
| Lepidoptera order | Moth and butterfly | More sensitive with envidomental change with heavy metal and CO2 pollution | Land |
| Collembola order | Springtails | Heavy metal pollution, pesticide and water acidity | Land |
| Formicidae family | Ants | Reforestation | Land |
| Diptera order Sarcophagidae family | Flies and mosquito | Heavy metal | Land |
| Diptera order Syrphidae family | Flies and mosquito | Affected by decreased diversity | Land |
| Apis melifera | Domestic bees | Chemical environmental change | Land |

The Frequency of Attendance (FoA) of the Staphylinidae family (Coleoptera order) is quite large compared to other families (13%) (Table 1). This is presumably because Staphylinidae can live in various environments such as under rocks and other objects on the ground, and can live on fungi and leaf remains. [45] (Borror *et al*. 1992), in which the majority of sampling environment location is soil mixed with rocks and many other objects on the ground (Figure 1).

Diptera order is a very heterogeneous insect group but is still limited in its use as a bioindicator due to the lack of ecological knowledge of many flies. The fly species from the Sarcophagidae family have potential as indicators of environmental pollution such as heavy metals, asbestos fibers and chemical wastes. [41, 46] It is recommended that the use of flies (Diptera order) as a chemical indicator of contaminated soil should be careful because of the variability of flies sensitivity to insecticides and herbicides. [41, 47, 48] In this order, the Dolicophodidae family has a highest number on study location (11%) (Table 1). The Dolicophodidae family (Diptera order) is a family of flies that can live in many places, especially near swamps, waterways, forests and grasslands, but many of these flies can only live in certain environments. The larvae are present in mud or water, on decomposed wood, under bark and on grass stems. [45, 49] (Borror *et al*. 1992).

Many of the samples obtained at the study location were bioindicator insects such as Odonata, Coleoptera, Lepidoptera and Diptera, as well as the Carabidae (Ordo Coleoptera) family and the Formicidae Family (Hymenoptera order). [21, 24, 41] This is appropriate as presented in the research of da Rocha *et al* (2010) that the insect groups collected are included in environmental bioindicators (Table 3). [44]

**Conclusion**

The result showed that 390 individual insects were found with Formicidae family most widely found (227 individuals). The highest frequency of attendance score is in groups of Formicidae family insects (58.2%).

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