**Dinomyrmex gigas** (Latreille, 1802): A Potential Icon for Taman Negara Johor Endau Rompin

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**Abstract.** *Dinomyrmex gigas* (Latreille, 1802) is one of the largest ants in the world and the largest in Southeast Asia. It is also more commonly known as the giant forest ant. This large charismatic ant can be found in the forests of Southeast Asia, however it is not often sighted by the public due to its predominant nocturnal nature. Despite being considerably well studied compared to its smaller counterparts, most people know little about the giant forest ant beyond its large size. Most studies on this species focus on the populations found in Malaysia and Brunei characterizing many aspects of the natural history and biology of this species including its foraging behaviour, diet, territoriality, reproduction and colony structure. While much is known about the biology of this species, fragmented forest habitats may have an impact on the viability and behaviour of this majestic giant ant of the forest. This study involved insects’ viability observation and sampling of ant specimens. The results of observations showed that *D. gigas* is viable in Endau Rompin Johor National Park (TNJER). Then, various ecological aspects of *D. gigas* was investigated through field studies and secondary information. Due to its size and uniqueness this species has a potential to be developed into a nature tourism product for Malaysia. The present study elaborated to further discover its daily activity, nesting and defence behaviour which could be useful in developing it into a nature tourism product. As the species is also limited in distribution to undisturbed forest, the issue of its survival is discussed with relation to conservation of the tropical rainforest.

1. **Introduction**

1.1. **Background**

Endau Rompin Johor National Park (TNJER) was chosen as the site of study because of its well-known location among nature lovers and tourists since its first scientific expedition in 1985 [1]. The beauty of the world's oldest rainforest flora and fauna and tropical rainforest ecosystems [1, 2], makes the Endau Rompin Johor National Park an ideal nature tourism destination. In addition to its fully equipped hospitality facilities, there is also the Endau Rompin Nature Education and Research Center (NERC) dedicated to researchers who wish to conduct scientific studies related to TNJER.

Giant forest ants or *Dinomyrmex gigas* can be found here at TNJER. This ant species is the largest in term of size in Southeast Asia [3, 4, 5] and have interesting characteristics and behaviors. *D. gigas* is found especially in the virgin and secondary forests in the Southeast Asian region ranging from Borneo, Sumatra to Thailand. Its habitat ranges from mangrove swamps to elevations above 1,500 m above sea...
level [6, 7]. Several researchers have reported several ecological and behavioral aspects of this species [8, 6, 4].

Among the uniqueness of *D. gigas* is the ritual of fighting that takes place between different colonies in an open area. The behavior of defending regions by these giant ants can persist for months [4]. This condition could be observed at night and may take several hours [4]. Usually a certain place is selected, and one could see hundreds of them fighting and dying.

According to Pfeiffer’s years of study, a colony of *D. gigas* could inhabit up to 0.8 hectare of hive area with an average of 7,000 worker ants spread across 11 different nests. The bimorphic worker ants have an average weight of 372 mg for the major and 135 mg for the minor. As a nocturnal species, *D. gigas* often go out for food in large groups at night. However, there are also individuals who come out during the day but in small groups. Honey is a major source of food in addition to insects and bird feces [4]. No studies have been conducted in TNJER on *D. gigas*, and the presence of these ants is high due to uninterrupted forest conditions and is suitable for *D. gigas* habitat.

Being common in the park, this ant species has a potential to be promoted as a nature tourism product. In addition, characteristics of this ant are in accordance with the criteria of a nature tourism product. The eight criteria are endemism, rarity, reliability of sightings, morphological attractiveness, behavioural enticement, safety, link to local cultures and ecological importance. These criteria are the governing factors behind the success of the advanced nature tourism attractions [9]. Enhancing the potential of the ant species as tourism product, the park as a tourist destination could prosper and sustain itself as it is facilitated by the comprehensive factors of five ‘A’s of tourism which are accessibility, accommodation, amenities, attractions and activities [10].

2. Methodology

Ant from the species *Dinomyrmex gigas* (Latreille, 1802) was selected as an insect tourism icon at TNJER based on criteria suitable for a good nature tourism product. It is huge, being one of the largest ants in the world, thus easily visible. Besides, *D. gigas* could only be found in prime forests condition [3] making it valuable item for tourism, in line with current demand to promote conservation.

Field studies were designed to look at the communication, defense, foraging and feeding behaviour of *D. gigas*. The first step is to find a nest of *D. gigas* ants in the park. The nests found were marked and their coordinates taken as records. Pictures of the nests were also taken as evidence. The trails used are tourist-focused areas. Firstly, the Ethnobotany Park near the Visitor Complex, which serves as a visitor counter besides providing accommodation and cafes. Secondly, the Temekong trail at NERC which is suitable for environmental education purposes and the next one is Pacau, Kuala Jasin also a main route for tracking activity. These trails are the most frequented used by visitors.

A monitoring experiment was performed to see the circadian pattern of *D. gigas*. This continuous observation is important to study peak active times for *D. gigas* exiting and entering the nest for food foraging activity. This 24-hour observation required an additional field assistant to record data of individual survey conducted every 30 minutes. The results of the census were recorded in a prepared form. In addition, during the monitoring experiment food items brought back to the nest by the ants were sampled. The amount and type of food were recorded. The monitoring experiments were repeated three times.

In order to study mode of communication between *D. gigas* individuals, observations were made on the physical communication behavior between ants in the same colony. Photographs of ants interacting with each other were taken as records. In addition, notes on physical reaction like tapping the antenna between two individual were made during the observation.

Finally, a brief experiment to record responses of *D. gigas* when defending themselves was conducted. So called introduced “enemies” were ants of the same species from a different colony. The reactions from the defending ants were observed during the excavation of nest activity. When excavating ant individual would bring out soil from inside the nest to deposit just outside the entrance opening. During excavating process, a few of enemy ants were introduced. In addition, enemy ants individual
were thrust directly to the excavating host ants. Notes are taken based on the defensive behavior of the ants against the enemy as well as if any other methods were employed to defend the nest.

3. Result and Discussion

3.1. Ecological studies on D. gigas
During the monitoring experiment activities of *D. gigas* individuals were observed and recorded to study circadian patterns of feeding and nesting behaviour. The selected nest was designated as PetaNERC001 with coordinates of N 02º31.771’, E 103º24.045’. The nest is located in the ground and has one main entrance and two other smaller entrances (lightly covered with soil at the opening) at the base of the tree. It was found that the main entrance of the nest faced northwest (Figure 1).

![Figure 1. Position (A) of the nest entrance facing northwest. The other smaller entrance opening (B) was loosely covered with soil by worker ants.](image)

Data obtained were averaged out. Based on the three days observation, the average active period was from 1830h to 2330h (Figure 2). From 1900h to 2300h, four to ten individuals could be seen in groups coming out of the nest. When returning to the nest, the ants move in a row or group of four to ten individuals. This activity is called mass-gathering. This collective movement will be led by one minor worker ant and followed by another adult or juvenile worker ant.

This pattern indicated that *D. gigas* is nocturnal or night active ant (Figure 3). Associations between circadian patterns and ecological parameters such as temperature, humidity and light intensity may affect ant ecological function [11]. The least active time for *D. gigas* is around 0630h to 0930h.
Figure 2. Circadian pattern of *D. gigas*. Data are averaged for three consecutive days.

Figure 3. *D. gigas* appearing during night time in groups

3.1.1. *D. gigas* communication. In the same colony, the communication behavior between ant individuals was observed (Figure 4). Communication to pass or share information could be seen between ant individuals prior to permission given by a major worker presumably acting as soldier stationed at the nest entrance, allowed entry into the nest to the communicating ants. It is noted that when a burning stick that emit smoke was positioned near the nest entrance, the major worker ant acting as gatekeeper would enter the nest perhaps to pass information the colony of what is happening outside their nest. Ants coming from inside the nest would initially waved their antennae to ensure there is no danger outside, before exiting the nest entrance. If there was a drastic change, example increased in humidity caused by in coming rain, the ants would re-enter the nest. Once ants were outside the nest
entrance, they would come into contact perhaps for the purpose of determination as to whether the individual ants were from the same colony or maybe to inform something like distance between food source to the nest. Communication has shown that individual ants are always in contact with their antennas for the purpose of informing food sources and warning of enemy threats.

### 3.1.2. The defense systems

The mechanisms of defense vary between ant species. In addition, being large, D. gigas defend themselves by biting their opponents with their strong jaws. Major worker ants have a larger head than their body size, which is useful in protecting the nest entrance from intruders while also being able to bite the prey out from the nest. Its brown black body coloration serves as a warning to the enemy or as a disguise among vegetation in the environment. D. gigas has reddish brown coloration of their abdomen that could be easily seen by the enemies and keep themselves away. It’s generally dark color also protects the ants from being detected by enemies while looking for food during night time.

![Image of ants communicating](image1.jpg)

**Figure 4.** Left; vibrating antenna to detect changes in the environment outside the nest. Right; two individuals ant communicate through contacted antenna

### 3.1.3. Foods and foraging behaviour

Observations on the circadian pattern found that D. gigas went out at dusk starting 1830 and returned to the nest early dawn in small groups of five to ten individuals. There were also individuals that went out on their own or return to the nest, bringing home food. Almost 70% of ants entering the nest without bringing any food in their mandibles. However, when something is brought home it is usually a small dead insect. Ants would also likely to suck nectar of flowers or liquids and then store them in the mouth [12]. The liquid would be regurgitated and shared by giving to the larva or queen.

### 3.2. D. gigas an icon for Taman Negara Johor Endau Rompin

Comparison between the various species of ants found that D. gigas is better suited to be an icon because of its distinctively large size and colour that are different from other ants that could be seen in the park. Also known as forest giant ants, D. gigas is active at night after 11 pm [4]. To make D. gigas as a tourism icon it must meet the criteria of nature tourism products [13, 14].

Elegance is often an effective attraction for a nature tourism product. The elegance of an organism assists in the marketing of the product and guarantees its viability due to the certainty of the discovering the species [13]. D. gigas is native to Southeast Asian countries such as Indonesia, Malaysia, Borneo, Singapore, South Thailand and the Philippines, it could be promoted to be a major tourist attraction for Southeast Asia nature tourism [4]. As these ants are also found in lowland rainforest [15], visitors could easily find them on the forest floor without having to climb hills or mountains. Compared to mudskippers, tourists need to visit areas that still have high populations such as mangroves [16]. Tourists also need boat service to take them to the affected areas.
D. gigas are not found in highly disturbed forests and development areas [17, 18]. As in Singapore, this species is not found except in forested areas [19]. The rarity of D. gigas species requires tourists to visit the national forests and national parks to discover these giant ants.

The third criterion which is safety is critical to ensure that tourists are not exposed to the dangers of what they want to see. D. gigas only attack when threatened and to protect their territory from enemy. Although 20 to 30 mm in size, D. gigas are non-stinging and their mandible bites are non-lethal [4].

As for the further criterion which is visibility or reliability of sighting, D. gigas are more likely to be found at night because the humidity is higher and temperature lower. During the day, they are also prone to predators such as birds [15]. However, some individual ants could still be seen during the day, especially in areas with high humidity and low temperatures [4].

The uniqueness of the behavior of D. gigas could be elaborated for tourists and visitors alike. These ants have an inherent tendency to perform battle rituals in an open field [4]. This ritual of warfare takes place between different colonies and can last for weeks. This ritual warfare is followed by death of the enemy whose limbs could be ripped off by D gigas using its front foot and powerful jaw [3].

Morphological attraction is another important criterion for nature tourism products. This physical attraction not only attracts natural tourists but ensures their acceptance of a product effectively [14]. Undeniably, D. gigas has a great physical attraction to be showcased to tourists. D. gigas morphological attraction is in terms of its large body size; being the largest ant in Southeast Asia, in addition to their prominent gaster colour [3].

In addition, in terms of cultural values, D. gigas is also associated with native such as the Jakun communities that use it as a flavour enhancer in cooking [20]. D. gigas is also used for medical and recreational purposes [20].

3.2.1. Aspects of ecology. There are some differences in communication methods between ants and other insects. Communication between ants is important because ants are eusocial insects that cannot live alone and need each other [21, 22]. Ants have the ability to use various defence methods and attacks against predators and victims. Like other insects, ants are protected by the hard-outer shell of the exoskeleton. This outer protector protects ants from predatory threats in addition to having water-resistant particles [23]. Small, but physically powerful that is beyond human expectations is a unique subject to study. To sum it up, this uniqueness aspects of ant ecology should tally and focus on what tourists want to know as the principle of "market demand" also makes a product marketable.

4. Conclusion and Suggestion
Recommendations for future studies should include other potential insects to be featured in tourism. Although insects such as butterflies have become well-known as a tourism product, their ecological aspects are normally not emphasized for nature tourists’ attention. The ecological uniqueness of an insect should be shared with the purpose of attracting tourists and making their observational activities useful at the same time inculcating and increasing a sense of appreciation and conservation.

The second proposal is that, in the future, aspects of the social perspective can be conducted to assess the level of awareness and acceptance of nature tourism among tourists. These developments have led to improvements in the conservation efforts of NGOs and universities. Finally, the university needs to work with government agencies such as the Department of Tourism and tourism players to help promote the huge biodiversity available in Malaysia to enhance tourism industry. As D. gigas is available in pristine forests, similar study could be done to show its feasibility to enhance other parks and protected forests in Malaysia.

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