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Heterotrigona itama cockerell's nest exit activity (Hymenoptera: Apidae: Meliponinae) in Pocut Merah Intan Forest Park, Aceh Besar Regency

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Abstract

Background: The study conducted in the Pocut Meurah Intan Forest Park (TAHURA PMI) area aimed to analyze the outgoing activity of *Heterotrigona itama* worker beehives and their relationship with environmental and physical factors such as temperature, humidity, and light intensity. **Methods:** *H. itama* activity is observed from 06.00 to 18.00 WIB. Bees exiting the hive are counted using manual counting to determine the number of individuals that exit the hive for 10 minutes every hour. Observation of activities outside the nest consists of foraging, throwing garbage, and drones guarding the nest. **Results** showed that the peak of activity out of *H. itama* nests occurred at 09.00 - 10.00 WIB and 13.30 - 14.30 WIB. Results: Foraging activity was the highest nest exit activity. The relationship between light intensity factor and activity outside the foraging nest is moderate (R2 = 0.651), while temperature and humidity are weak (R2 = 0.052 and 0.091). The activity of exiting the nest to throw garbage has a moderate relationship with light intensity (R2 = 0.439) compared to temperature (R2 = 0.253) and humidity (R2 = 0.296). Furthermore, physical factors of light intensity (R2 = 0.6217) had a greater relationship with drone activity out of the nest than factors of temperature (R2 = 0.4385) and humidity (R2 = 0.4063). Activity outside the nest is positively correlated with temperature and light intensity and negatively correlated with humidity. **Conclusions:** Thus, it can be concluded that light intensity has the greatest influence on the activity out of the nest.

Keywords: *Heterotrigona itama*; out of nest activity; stingless bee; TAHURA PMI

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Introduction

Stingless bees (Meliponinae) are social insects (Sadam et al., 2016), which has different names in each region, such as kelulut (Riau and South Sumatra), galo-galo (Minang), linoet (Aceh), teuweul (West Java and Banten), and klanceng (Java) (Zuriana & Suwarno, 2020). Hornets live in groups to form colonies of one queen, several males, and hundreds to thousands of worker bees (Salatnaya et al., 2020). Worker bees care for larvae and eggs, build eggs, care for queens, clean hives, guard hives, and forage (Huang, 2010). Foraging worker kelulut bees collect nectar, pollen (pollen), and resins from various plant species (Salatnaya et al., 2020; Zuriana & Suwarno, 2020). Worker hornets start foraging at dawn and stop when the sun sets (Nugroho & Soesilohadi, 2015). Kelulut foraging activities are influenced by environmental abiotic factors such as temperature, light intensity, relative humidity, and rain (Samsudin et al., 2018). and the distance of plants from the nest also affects the foraging activities of kelulut (Nuraini et al., 2020). In addition, colony conditions and feed availability correlate with food (pollen and nectar) and nest-making materials (resin) brought to the nest (Yustia et al., 2017).

Kelulut is often found in tropical forest areas with many flowering plants (Putra and Jasmin, 2021). The Pocut Meurah Intan (PMI) Forest Park (Tahura) area is one of the nature conservation areas, has a purpose as a natural or artificial plant and animal collection area (Vianti et al., 2018), which is used for the interests of research, science, education, supporting cultivation, tourism and recreation culture in the tropics (Erwin et al., 2017), and also plays a role in reducing carbon in the air (Fadhli et al., 2021). Tahura PMI has also been used as a location for the Aceh kelulut breeding center through collaboration between the Aceh Environment and Forestry Service (DLHK), the Aceh Manpower and Population Mobilization Service, and the Bee Foundation since March 2021 (Zuriana & Suwarno, 2020).

Information about kelulut cultivation results was limited to a lack of development of kelulut cultivation. One behavior closely related to the production of honey and bee pollen is leaving the hive, which consists of foraging activities, throwing garbage, and drones that guard the hive. Activity out of the nest by kelulut, especially foraging activities, is strongly influenced by physical factors, the environment, and the availability of feed around it. Based on the description above, studying the exit activity of Trigona beehives *(Heterotrigona) itama* Cockerell and the relationship of activity patterns out of the hive with physical environmental factors is necessary. Research is expected to provide information and knowledge to develop *Heterotrigona itama* cultivation and its preservation.

Methods

H. itama bee colony activity was observed in the Pocut Meurah Intan Forest Park (TAHURA) area, Seulawah Valley District, Aceh Besar Regency. The method used is an observation by observing the activity of *H. itama* worker bees.

The nest exit activity was observed every hour for 10 minutes starting from 06.00 - 18.00 WIB. The activity of kelulut out of the nest was divided into three categories: foraging activities, garbage disposal activities (cleaning the nest), and drones (guarding the nest). Foraging was observed in bees that fly out of the entrance to the hive quickly and instantly disappear. More trash removal activity was observed in bees exiting the hive and carrying material in the mandibular section. Activity in and out of the hive (drone) to guard the hive is observed in bees that come out of the hive door at low speed, fly around the hive, and then return to the nest entrance.

Environmental factors were measured during hourly observations of activity outside the hive, consisting of light intensity measured using a lux meter, relative humidity of air measured by a hygrometer, and air temperature measured by a thermometer. Environmental factors were measured around the nest at one meter from the observation nest. Data on the foraging activity of *T. itama* was analyzed using quadratic polynomial regression analysis to determine the relationship between environmental factors in the foraging activity of *T. itama*. Bees.

Result

H. itama nest exit activities consist of foraging, garbage disposal, and drones that guard the nest. The activity of the first worker bees out of the hive generally begins at 06.15 - 06.20 WIB.

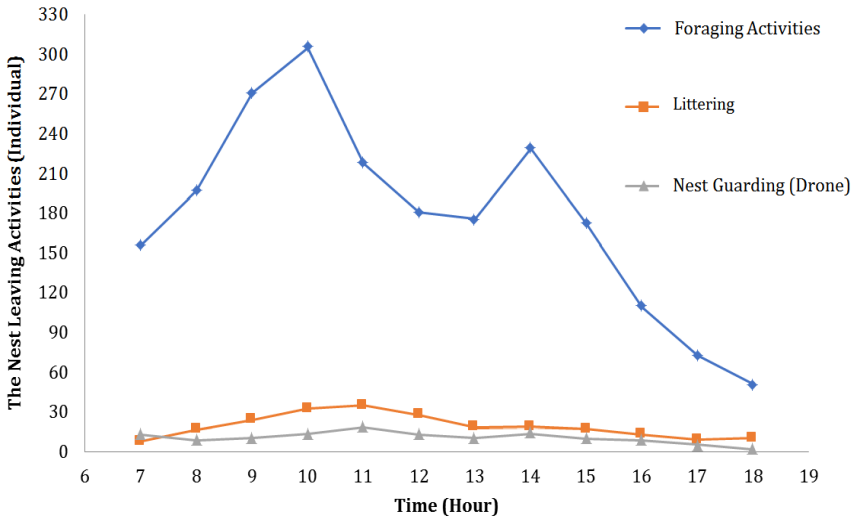


Figure 1. Nest activity

The activity of *H. itama* workers out of the nest fluctuates, morning at 07.00 WIB until afternoon at 18.00 WIB. The highest activity of *H. itama* out of the nest occurs in the morning (09.00 - 10.00 WIB) and afternoon (13.30 - 14.30 WIB) in the morning.

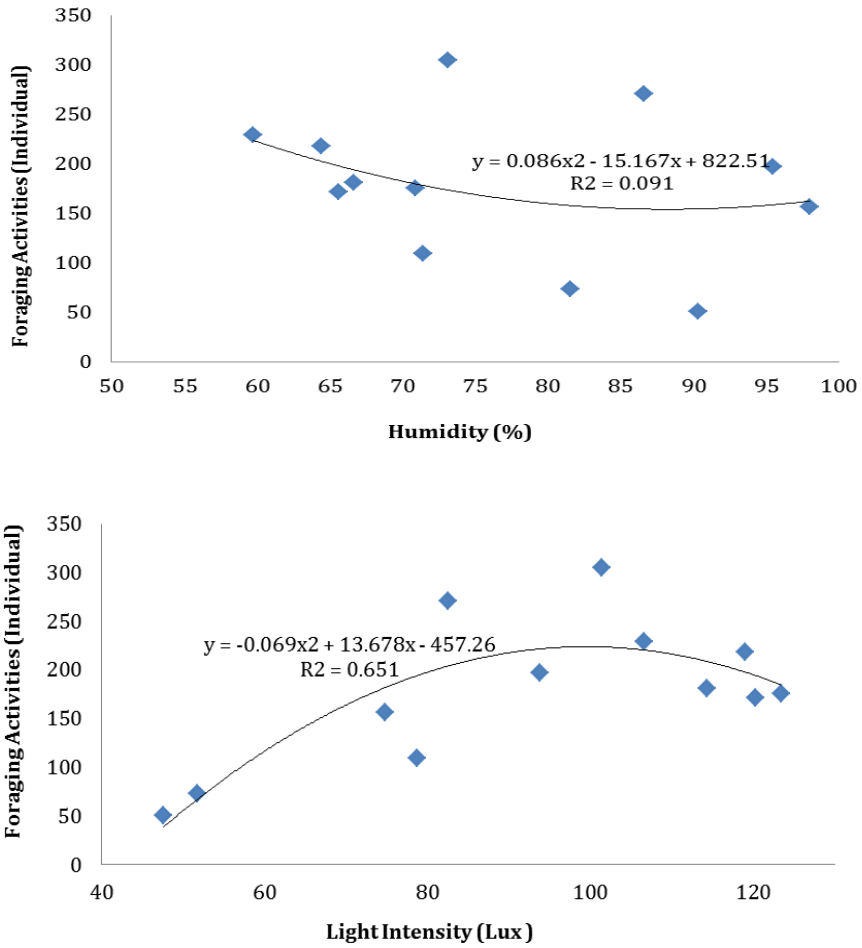


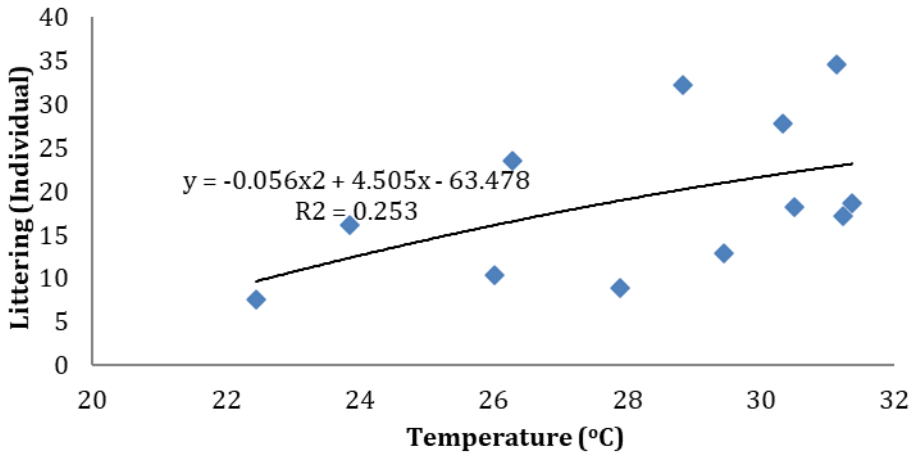
Figure 2. The relationship of foraging activity with environmental and physical factors. (a) air temperature; (b) air humidity; (c) sunlight intensity

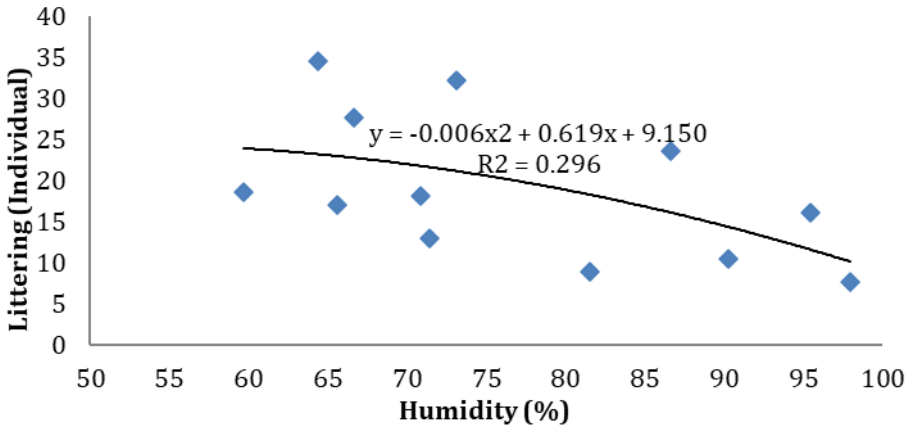
Foraging Activities

The activity of exiting the hive in search of food is characterized by worker bees that come out of the hive flying quickly and do not carry any material. Foraging activity is the highest nest exit activity in *H. itama*. Based on the analysis results, light intensity has a greater influence than air temperature and humidity on the foraging activity of kelulut bees. The relationship between foraging activity and three physical factors, namely air temperature, air humidity and light intensity, respectively, was shown through a quadratic polynomial regression model, namely Y = 1.498X2 - 77.386X + 1155.38 (R2 = 0.052), Y = 0.086X2 - 15.167X + 822.51 (R2 = 0.091), and Y = -0.0687X2 + 13.678X - 457.26 (R2 = 0.651). R-square (R2) is categorized as strong if it is more >0.67, medium if 0.33< R2<0.67, and weak if R2 <0.33.

Garbage Disposal Activities

The activity of exiting the hive to throw garbage is characterized by the presence of material carried by worker bees in the mouth. The relationship between the activity of exiting the hive to air temperature, air humidity and light intensity, respectively, was shown through a quadratic polynomial regression model (Figure 3), Y = -0.0562 - 4.505X + 63.478 (R2 = 0.253), Y = -0.006X2 + 0.619X + 9.150 (R2 = 0.296), and Y = -0.002X2 + 0.473X - 11.628 (R2 = 0.439). Based on the analysis, the intensity of light has a greater influence than the temperature and humidity of the air on the activity of disposing of *H. itama* garbage if the air temperature and light intensity increase and humidity decreases, the activity of *H. itama* out of the nest to dispose of garbage will increase.





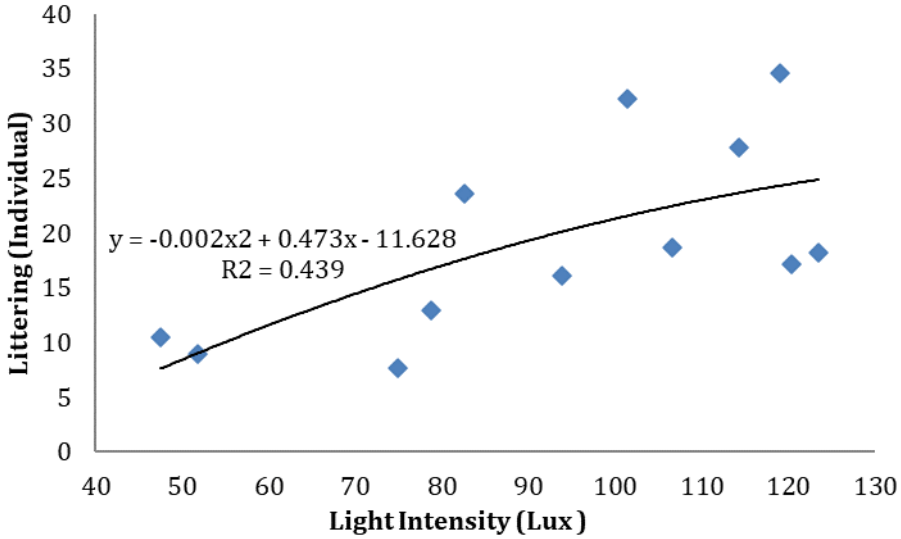
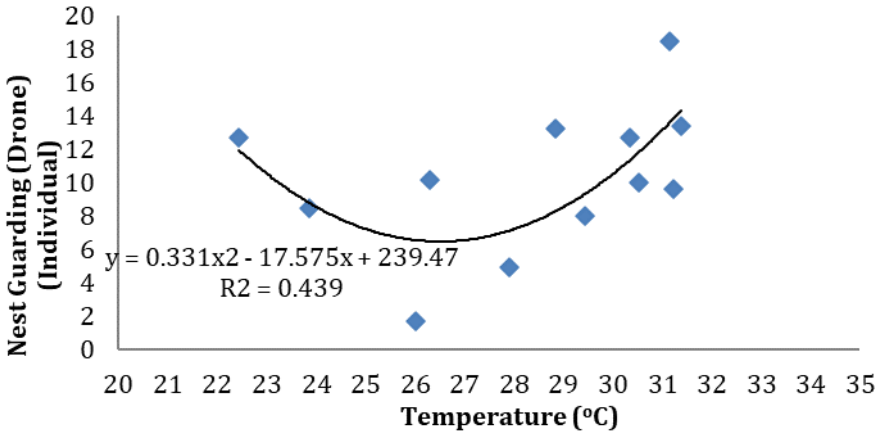


Figure 3. The relationship of garbage disposal activities with physical environmental factors. (a) air temperature; (b) air humidity; (c) sunlight intensity

Drone Activities

Drone activity out of the nest aims to guard the nest. The relationship of drone activity out of the nest with environmental physical factors, namely air temperature (Y = 0.3314X2 - 17.575X + 239.47 (R2 = 0.4385)), air humidity (Y = 0.015X2 - 2.5354X + 114.42 (R2 = 0.4063)), and light intensity (Y = -0.0024X2 + 0.5312X - 17.183 (R2 = 0.6217)) can be seen in Figure 4, respectively. Based on the analysis results, physical environmental factors such as sunlight intensity have a greater influence than air temperature and humidity on drone activity out of the nest. If the air temperature and light intensity increase and humidity decrease, drone activity H. The first exit from the nest will increase.



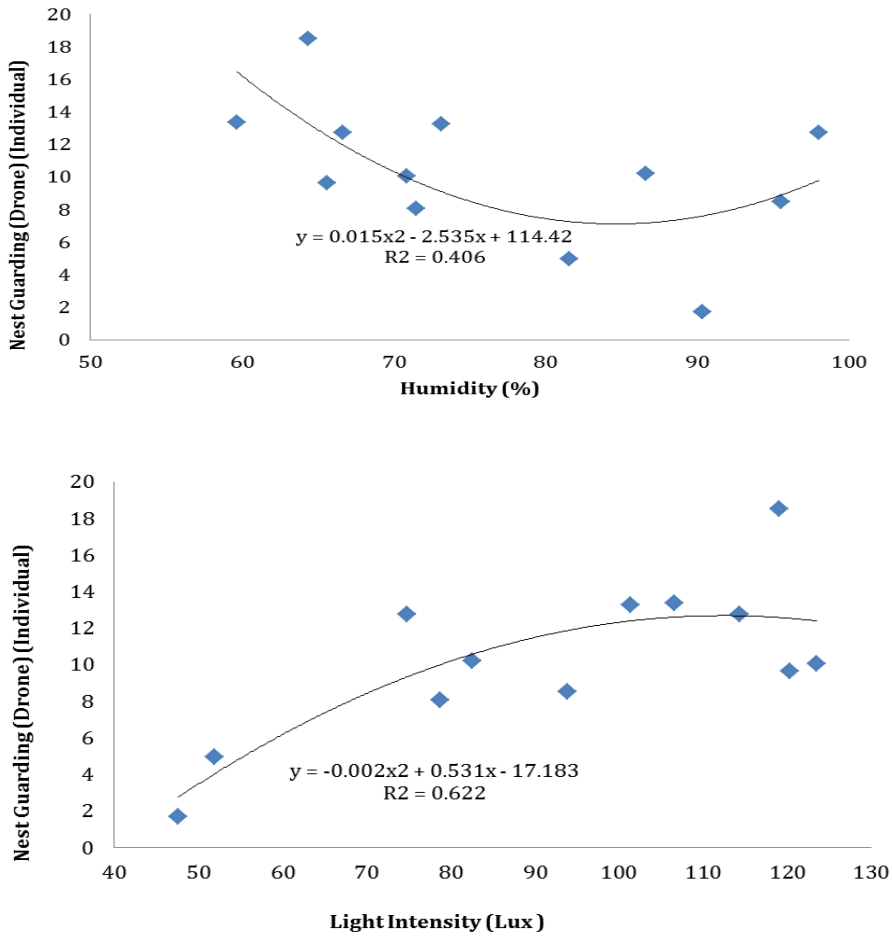


Figure 4. The relationship between drone activity and environmental, physical factors. (a) air temperature; (b) air humidity; (c) intensity of sunlight

Discussion

The activity of the first worker bees out of the hive generally begins at 06.15 - 06.20 A.M. Harjanto et al. (2020) stated that activities outside the nest were carried out from morning to late evening. The highest activity of workers out of the nest (morning-evening) is foraging activity. This phenomenon is to the statement of Saufi & Thevan (2015): the highest nest exit activity is foraging activity, and the lowest is throwing garbage. In general, the model is shown in Figure 1.

Zuriana & Suwarno (2020) reported that the first worker hornets left the hive at 06.10 - 06.20 WIB and finally entered the hive at 6.20 - 6.35 P.M. Basari et al. (2018) showed similar results that nest exit activity slowly increased since 07.00 WIB and peaked at 11.00 WIB; activity then slowly decreased at midday until it peaked again at 14.00 to 15.00 WIB before finally decreasing and stopping at dusk. as reported by Price et al. (2021) that several types of stingless bees such as *Tetragonisca angustula, Tetragona elongate, Scaptotrigona bipunctata, Trigona braueri,* and *Trigona hypogea* also experienced increased activity in the morning and decreased in the afternoon around four o'clock in the afternoon local time.

The difference in the time of activity out of the nest is thought to be caused by several factors, such as the availability of resources and the distance of the nest to the feed source. Asrianny et al. (2019) stated that the existence of feed sources around the kelulut hive is an important factor that affects the activity of kelulut bees in finding feed. Ramadani et al. (2021), added that environmental physical factors include air temperature and light intensity. Physical factors or microclimate that can affect the flight activity of hornets are air temperature, humidity, light intensity, and wind speed.

Nugroho & Soesilohadi (2015) said that the relationship between temperature and light intensity is inversely proportional to humidity, where air humidity tends to fall if light intensity and air temperature increase. During observation, the average air temperature and humidity at the peak of *H. itama* activity was 26.3 - 31.3 °C and 60 - 86%. The range of these physical factors (temperature and humidity) is wider than the report of Riendriasari & Krisnawati (2017), which states that the normal range of humidity preferred by Trigona ranges from 60.5 - 71% and the normal temperature is 27-29 °C. Kapitanhitu et al. (2018), reported the ideal temperature for active bees is 16-26 °C, where generally activity begins when the temperature ranges from 22-23 °C with humidity 70 - 88%, and sunlight intensity 183 - 4344 lux.

Based on Figure 2, the activity of exits of the foraging hive of *H. itama* bees is positively (unidirectional) with air temperature and light intensity and negatively correlated (inversely) with air humidity. If the air temperature and light intensity increase and the humidity decreases, the activity of the nest to find food will increase. The activity out of the nest of *H. itama* tends to decrease when the humidity increases and the temperature and light intensity are too low. The results are similar to Ramadani et al.'s (2021) study. The activity out of the nest of *H. itama*, *Tetragonula fuscobalteata*, and T. *testaceitarsis* is directly proportional to the level of air temperature and light intensity but inversely proportional to humidity. Based on Kiew et al. (2010), an important factor affecting the activity of exiting Trigona beehives in foraging is the light intensity because sunlight is a guide to feed sources by Trigona bees. Benedick et al. (2021) added that the foraging activity of the result can also be influenced by the presence, quality, and material of floral or non-floral in the environment and varies depending on time. Kwapong et al. (2010) state that an important factor that affects the activity of exiting the Trigona beehive in foraging is the intensity of sunlight. This is because Trigona bees use sunlight as a guide to feed sources.

Garbage disposal activities are hive cleaning work carried out by bees. Hidayat (2019) stated that nest-cleaning workers leave the nest with food waste, nest fragments, and dead insects. Vossler (2019) explained that waste pellets are hive residues derived from stem cell cerumen pollen granules from feces, cocoons, parents, or adult bees. This residue is collected on certain hive parts, which are then formed into pellets by special garbage workers. Generally, kelulut will throw garbage at a distance that varies from the nest, which is one to 35 m. Garbage is thrown away from the nest to avoid nest detection by enemies such as phorid flies, parasites, and predators. In addition to throwing garbage, these bees also carry out drone activities to protect the hive from predators. Hidayat (2019) explained drones are male bees that have the second largest number after worker bees in the hive. In addition to fertilizing, the queen is tasked with guarding the hive from interference. This study shows the influence of drone activity on temperature, air humidity, and light intensity.

Conclusions

The activity of exiting the nest of *H. itama* begins at sunrise and continues until evening. The peak of activity occurs in the morning before noon (09.00 - 10.00 WIB) and in the afternoon before evening (13.30 - 14.30 WIB). The highest activity out of the nest is the activity of foraging, then throwing garbage and drones out of the nest. *H. itama* nest exit activity is positively correlated with air temperature and light intensity while negatively correlated with air humidity. Light intensity has the greatest influence on the activity of the nest exit. This is indicated by the R-square (R2) value of light intensity greater than the R2 value of air temperature and humidity.

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Declaration statement

The authors reported no potential conflict of interest.

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