American Journal of Entomology
2025, Vol. 9, No. 1, pp. 1-5
https://doi.org/10.11648/j.aje.20250901.11

Research Article

Investigating the Defensive Mechanisms of Stingless Bees, *Meliponula beccarii L.*, Against Ants *(Dorylus fulvus)*

Etenesh Mekonnen*, Alemayehu Gela

Oromia Agricultural Research Institute, Holeta Bee Research Center, Bee Health Department, Holeta, Ethiopia

Abstract

Stingless bees (*M. beccarii*) have developed many approaches to control nests from their enemies/pest and predators/. Defensive behavior of *M. beccarii* was not conducted by physical body. Despite lacking a sting, stingless bees are active in defending their enemies possess numerous defensive mechanisms. The study was conducted at Holeta Bee Research Center, stingless bee (*M. beccarii*) apiary site to investigate three defensive mechanisms (dyadic (one to one), Group interaction and colony interaction or defensive behavior). The objective of study was to conduct the defensive mechanism of stingless bees (*M. beccarii*) against ants (*D. fulvus*). Defensive behavior between *D. fulvus* and *M. beccarii* was observed by different numbers of workers of ants and stingless bees in each group. Dyadic encounter a defensive between single worker of *D. fulvus* and *M. beccarii*, Group Interaction: Defensive between thirty two workers from each group and Colony interaction between a mass of colonies defensive were observed. In Colony interaction defensive behavior aggressive interaction between the *D. fulvus* and *M. beccarii* was freely observed when a part of stingless bee nest with brood and adults were placed near the ground close to the *D. fulvus* nest. The interaction between ants and stingless bees in dyadic and group interaction were overpowered by ants where as in colony interaction deter by stingless bees. This is may explain why stingless bees living in free environment without attack of ants though they share the same ecology. Therefore, identifying these ant-deterrent and exploring for the development of ant protection for other is suggested.

Keywords

Ants, Defensive, *Meliponula beccarii*, Interaction

1. Introduction

Stingless bees (Meliponini) are a significant social attained insects widely active in the transfer of pollen grains crops in non –closed farms and closed [4, 22]. Stingless bees have developed many approaches to control their home from their preys and pests. Numerous *M. beccarii* place where they live resisting attack are summarized by [21]. Workers of some social insects involve self-suicidal defense and other insects were seal their nest entrances from the external to protect against their enemies and during while others seal their nest entrances from the outside to protect against their enemies and during harsh seasons.

In honey bees (*Apis Mellifera L.*), sting autonomy is well known that contains the individual defense of the sting apparatus from their parts. Venom delivery increases pheromone release and also the device be able to go on with expand much time later the capable of wounding occurrence [10, 5].

*Corresponding author: etenumekonnen@gmail.com (Etenesh Mekonnen)

Received: 13 December 2024; **Accepted:** 27 December 2024; **Published:** 17 January 2025

Animals destroy their self via internal rupturing or explosion of an organ which ruptures the skin and the ants defend by the chemical known in some of them species [6] and termites [3]. Aphids use a defending mechanism by producing sticky secretion causing attack the aphids' predator, there by immobilizing it [23]. All those mechanisms together social factor and biological variation certainly cause mortality in the guarding workers.

Many species of stingless (*Meliponinae)* were distributed Worldwide, around equator tropics and sub -equator. Stingless bees be strong resemblance associated *A. melifera*, and reside live permanent cooperate of insects [16, 20]. Because of their sting is vestigial *M. beccarii* be cannot swindle [17]. Even though defense is important for colony survival, non-stinging particularly in stingless bees is an important phenomenon to protect them from self-scarify unlike body rupture in stinging *A. mellifera* workers. But, stingless bees front on to attacking at home starting numerous origin vary beginning warm blooded vertebrates near home over charge bees [24, 22, 20]. without talking any notice absent a swindle, *M. beccarii* are active in defending their enemies own scores of self-justifying process as well as freezing, harrying, corrosive additive drug, frighten chemicals capable of acting hormones and be suspended watch over [25]. As a result, stingless bees (*Meliponinae)* are less likely attacked by their a natural enemies like safari ants, wasps, spiders and small hive beetle (personal observations). Rather, they are highly affected by anthropogenic effects like deforestation and habitat fragmentations with poor management.

Driver ants (*Dorylus fulvous*) are the most damaging pests familiar to pounce *A. mellifera* in several territory in sub -tropical countries of Africa [1, 9]. It is announced to be nearly all consequence and wide spread existing foe of honey bees in Sudan [8], in Uganda [14, 2, 7]. Ants cause serious damage to honey bees and their products and as a result many productive bee colonies have been killed due to ants attack. Furthermore, tenacious strike along *Dorylus fulvous* announced just key source for runaway *A. mellifera*. [9, 7]. According to [7] has approximate once-a year economic dropping of *A. mellifera* and their products due to ants attack in the two areas of Ethiopia is exceed $ 250,00 per year.

Interaction between driver ants (*D. fulvus*) and stingless bees (*M. beccarii*) is yet not investigated despite their living environment is similar (both harboring underground). Even though stingless bees are much vulnerable to ants attack due to their nesting nature, it is not common to observe that stingless bees are attacked by ants as that of the honey bees (personal observation). This indicates that the stingless bees may involve different and effective strategies of the stingless bees against their enemies was a paramount important to co-manage them with honey bees and I turn prevent against ants. Therefore, confirmation of our observation and understanding the defensive mechanisms of the stingless bees against ant is paramount important. Hence, the objective of the project was to confirm stingless bees protect themselves from ants and identify the defensive mechanism of stingless bees against ants.

2. Methodology

The activity was conducted at Holeta Bee Research Center (HBRC) of stingless bee apiary site. Twenty well established stingless bee colonies in pot hives were used for the experiment. An observation platform, with circular dimension was prepared as a media to easily observe behavioral and interaction between the two species during the experiments.

2.1. Study on Defensive Mechanisms

To describe and quantify the behavioral defensive mechanisms and inter specific encounters between *M. beccarii* and *D. fulvus*, three different tests were used: Dyadic encounters, Interaction between groups of workers and interaction between colonies.

2.1.1. Dyadic Encounters

Dyadic (one-to-one) encounters was used to determine the fighting ability of individuals. An observation platform with a perforated cover that allowed circular dimension (diameter 5 cm, height 7 cm) with a cover that allowed air circulation was made as a media. Single workers from each species was randomly picked and then placed simultaneously in an observation platform. A total of 20 fighting reactions were accomplished. Defend /fight/initiators, means of contact (physical fighting) the successful and the minimum hourly requirements to win were observed and recorded. In addition to physical fighting, the incidence of a strong abdominal gaster flexation as an indicator of chemical defense was observed.

2.1.2. Group Interaction

The test using interaction between group of workers *M. beccarii* and *D. fulvus* aimed to assess the fighting abilities of both species in such encounters and to determine the level of workers aggressiveness. Thirty two worker from each species were randomly selected and kept in separate observation platforms according to procedure of [19]. For *D. fulvus*, equal proportions of the major, median and minor morphs were used. Both set of workers were tipped gently into a single plastic container (30 x 20 x 8 cm) with a transparent cover. The workers of each species were placed in opposite sides of the box separated by piece of wooden board before the start of observation. Combat durations of 10,20,30,40 and 50 min were tested, using fresh groups each time. Each duration were repeated three times. The mean number of ants and stingless bees that died was recorded. In addition to physical combat, gaster flexation by *M. beccarii* was observed.

2.1.3. Colony Interaction

The fighting or contact between massive number of individual ants species was used in accordance with the producers described by [11, 12, 25], with some variations. The luring of driver ants into *M. beccarii* domestic sites by providing them with raw or rotten meat is common in rural areas of Ethiopia to eradicate pests, cockroaches, house bugs, spiders, and others. In our first set of experiments, ant colonies was attracted by providing them with honey bee comb containing different stages of broods according to [19]. Initially, the comb was placed close to the ants bivouac until the worker swarm moved on to it. After approximately 30 min, the comb was gradually dragged along the ground, with an additional brood dropped to motivate foraging along the way, until it was very close to the stingless bee nest. In this way, it was easy to induce large numbers of *D. fulvus* workers into the *M. beccarii* territory and bring the two species into contact. In the second set of experiments, a portion of *M. beccarii* nest with brood and adults was removed from its original nest and placed near the ground close to a *D. fulvus* bivouac from where the latter was marching on honeybee brood combs. To assess how territorial defense was affecting the levels of combat, the experiment was repeated four times in *M. beccarii* territory and four times in *D. fulvus* territory.

2.2. Statistical Analysis

The collected data were analyzed using descriptive statistics and presented by table and graph.

3. Results and Discussions

3.1. Dyadic Encounters

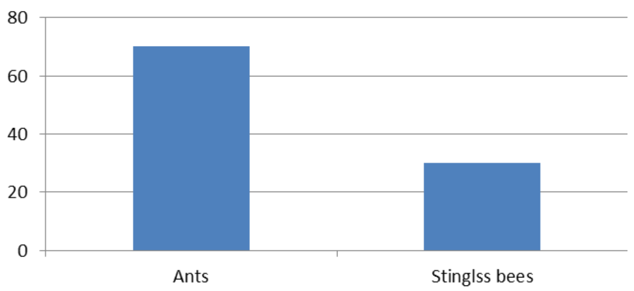

Figure 1. *Percent of fight initiators.*

Single workers of stingless bee (*M. beccarii*) and *D. fulvus* were fight each other. During the fight observation the action of stingless bees and ants were recorded in different minutes in percentage (Figure 1). From all 20 tests, the 14 fight initiators (70%) were *D. fulvus* and 6 fight initiators (30%) were *M. beccarii*. *D. fulvus* worker fighters were imperative to start fight and *M. beccarii* worker fighters slow to join fight. *M. beccarii* were more exposed to die before *D. fulvus.* Physical interactions lead with the *D. fulvus* attacking, biting stretching the legs and wings of *M. beccarii* were observed.

70% fights were initiated by ant where as 10% of the stingless bees were died in 20 minutes and the rest 90% of them in 30 min of fighting while only 10 of the ants were died until 40 minutes (Table 1). The physical fighting was controlled by ants mainly by attacking the stingless from back by biting and pulling their legs.

This suggests that stingless bees were not defending ants through physical interaction (fighting).

Table 1. *Percent of deaths recorded in different times.*

Time (minutes)	Stingless bees' death (%)	Ant death (%)
10	0	0
20	10	0
30	90	0
40	0	10

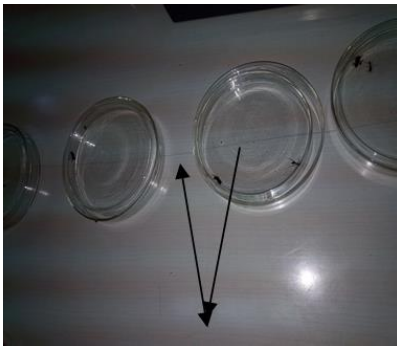

Figure 2. *When Single workers of M. beccarii and D. fulvus join each other in prepared media.*

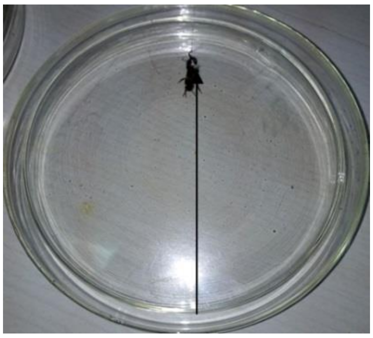

Figure 3. *M. beccarii and D. fulvus fight each other.*

3.2. Group Interaction

In group interaction, it was observed that ants were fighting in group against stingless bees. While, stingless bees fight in individual. Latter *D. fulvus* was in group or individually stretched legs of *M. beccarii/* their challengers/ in variation ways until they became stretched eagled and unmoving. In *M. beccarii*, the assistance of a fight worker was rare and of short duration. In 30 min fighting, 100% of stingless bees were died (Table 2). During fight, stingless bees were physically injured and lost their legs and wings. As the time of fighting increased the numbers of dead *M. beccarii* workers were observed to increase. As indicated by [13, 17, 18] there is less evidence for cooperative fighting in eusocial bees.

Table 2. *Percent death of fighters in different times.*

Time (minute)	Stingless bee death (%)	Ant death (%)
10	10.7	0
20	66.7	0
30	22.6	0
40		0
50		0

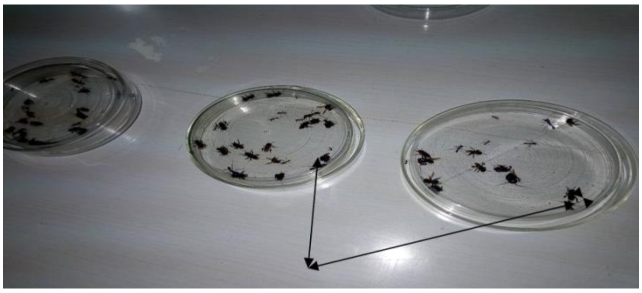

Figure 4. *Group of D. fulvus and M. beccarii test.*

3.3. Interaction Between Colonies

Aggressive interaction between the *D. Fulvus and M. beccarii* was freely observed when a part of *M. beccarii* nest with brood and adults were placed near the ground close to the *D. fulvus* nest. The ants were run away aggressively when introduced to stingless bees**,** the *D. Fulvus* were able to travel round the *M. beccarii* nest. *M. beccarii* were not participated in fight during ants attracted by combs were join their territory. Reversing direction of *D. Fulvus* workers was seen.

Simultaneously, a portion of *M. beccarii* nest content was cut and placed near the nest of ants (*D. fluvus*). Similarly, the colony of ants were disturbed and run out of their nests to the surrounding environment when portion of stingless bee nest introduced to the nest of Ants. This suggests that the nest of stingless bees deter ants, this result agrees with report of [15].

Figure 5. *Interaction between colonies of ants and stingless bees.*

4. Conclusions and Recommendation

Ants were the fight initiators, and defeated stingless bees in Dyadic and group interactions through physical fighting and biting. The most evident reasons for the success of *D. fulvus* were biting and group combat. However, in colony interaction at natural nest sites stingless bee colony deters ant colony. This is may explain why stingless bees living in free environment without attack of ants though they share the same ecology. Therefore, identifying these ant-deterrent and exploring for the development of ant protection for other is suggested.

Abbreviations

A. mellifera	Apis Mellifera
D. fulvus	Dorylus Fulvus
M. beccarii	Meliponula Beccarii
Hbrc	Holeta Bee Research Center

Acknowledgements

The authors would like to acknowledge the Holeta Bee Research Center for material and financial supports.

Authors Contributions

Etenesh Mekonnen: Formal Analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing

Alemayehu Gela: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Adjare, S. O. (1990) Beekeeping in Africa, Agricultural Service Bulletin, Vol. 68/6. Food and Agriculture Organization of the United Nations (FAO), Italy.

[2] Amssalu Bezabeh, (2012) "Apiculture research achievements, challenges, and prospects in Ethiopia," inAgricultural Research for Ethiopian Renaissance, Challenges-and-Future-Directions, pp. 265–272, Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia.

[3] Bordereau C, Robert A, Tuyen VV, Peppuy A (1997) Suicidal defensive behaviour by frontal gland dehiscence in Globitermes sulphureus Haviland soldiers (Isoptera). Insect Soc 44: 289–297.

[4] Buchmann, S. L. (1983). Buzz pollination in angiosperms. In: Jones CE, Little RJ (Eds) Handbook of experimental pollination biology, Van Nostrand.

[5] Burrell BD, Smith BH (1995) Modulation of the honey bee (Apis mellifera) sting response by octopamine. J Insect Physiol 41: 671–680.

[6] Davidson DW, Salim KA, Billen J (2012) Histology of structures used in territorial combat by Borneo's "exploding ants". Acta Zool 93: 487–491.

[7] Desalegn Begna (2007). Assessment on the effect of ant (Dorylus fulvus) on honeybee colony (*A. mellifera*) and their products in West and South West Shewa Zone: Ethiopia Ethiopian journal of animal production. 7(1): 12- 26, Addis Ababa, Ethiopia. https://doi.org/10.1080/00218839.2008.11101418

[8] El-Niweiri, M. A. A., El-Sarrag, M. S. A. & Satti, A. A. (2004) Detection, Distribution and Incidences of Insect Pests and Predators of Honeybees (Apis mellifera L.) in Sudan. Environment and Natural Resources Research Institute, National Center for Research, Khartoum [WWW document] URL. http://saudibi.com/files/image/pdf/conf4/3.pdf [accessed on 5 May 2012].

[9] Hepburn, H. R. and S. E. Radloff, 1998. Honeybees of Africa. Springer, Berlin, Germanyvan Zweden JS, Grüter C, Jones SM, Ratnieks FLW (2011) Hovering guards of the stingless bee Tetragonisca angustula increase colony defensive perimeter as shown by intra and inter-specific comparisons. Behav Ecol Sociobiol 65: 1277–1282.

[10] Hermann HR (1971) Sting autotomy, a defensive mechanism in certain social Hymenoptera. Insect Soc 18: 111–120.

[11] Human, K. G. & Gordon, D. M. (1996) Exploitation and interference competition between the invasive Argentine ant Linepithema humile, and native ant species. Oecologia, 105, 405–412.

[12] Human, K. G. & Gordon, D. M. (1999) Behavioral interactions of the invasive Argentine ant with native ant species. Insectes Sociaux, 46, 159–163.

[13] Johnson L. K. and Hubbell S. P. 1974. Aggression and competition among stingless bees: field studies. Ecology 55: 120-127.

[14] Kajobe, R., Agea, J. G., Kugonza, D. R., Alioni, V., Otim, A. S., Rureba, T. & Marris, G. (2009) National Beekeeping Calendar, Honeybee Pest and Disease Control Methods from Improved Production of Honey and other Hive Products in Uganda.

[15] Lehmberg L., Dworschak K and Bluethgen N. 2008. Defensive behavior and chemical deterrence against ants in the stingless bee genus Trigona (Apidae, Meliponini). Journal of Apiculture Research 47(1):-17-21.

[16] Michener CD (2000) The bees of the world. Johns Hopkins University Press, Baltimore.

[17] Nagamitsu T. and Inoue T. 1997. Aggressive foraging of social bees as a mechanism of floral resource partitioning in an Asian tropical rainforest. Oecologia 110: 432-439.

[18] Nieh, J. C., K. Kruizinga, L. S. Barreto, F. A. L. Contrera, and V. L. Imperatriz-Fonseca. 2005. Effect of group size on the aggressionstrategy of an extirpating stingless bee, Trigona spinipes. InsectesSociaux 52: 147–154.

[19] Nuru A, Awraris G, Shenkute, Ahmed A, Al-Ghamdi, Amenay Assefa, Mohammad J, Ansari, Brian Taylor, Sarah Radloff (2014) Crematogaster chiarinii ants as a potential biological control agent for protecting honeybee colonies from attack by Dorylus quadratus driver ants in Ethiopia (Hymenoptera: Formicidae).

[20] Roubik DW (2006) Stingless bee nesting biology. Apidologie 37: 124–143.

[21] Sommeijer M. J., Ruijter A. de (2000) Insect pollination in greenhouses, Proc. specialists' meeting held in Soesterberg, The Netherlands.

[22] Suka T, Inoue T (1993) Nestmate recognition of the stingless bee Trigona (Tetragonula) minangkabau (Apidae: Meliponinae). J Ethol 11: 141–147.

[23] Uematsu K, Kutsukake M, Fukatsu T, Shimada M, Shibao H (2010) Altruistic colony defense by menopausal female insects. Curr Biol 20: 1182–1186.

[24] Wille A (1983) Biology of the stingless bees. Annu Rev Entomol 28: 41–64.

[25] Zee, J. & Holway, D. (2006) Nest raiding by the invasive Argentine ant on colonies of the harvester ant, Pogonomyrmex subnitidus. Insectes Sociaux, 53, 161–167.