

The Potential of Arboreal Tiger Beetle (*Derocrania scitiscabra* Walker) as a Natural Enemy for the Control of Fall Armyworm (*Spodoptera frugiperda* JE Smith)

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ABSTRACT

Purpose: The fall armyworm, *Spodoptera frugiperda*, is a serious pest of maize, sugarcane, and other crops in Sri Lanka. Natural predators and parasitoids are considered the best methods to control this insect pest. The present study investigates the possibility of using an endemic tiger beetle, *Derocrania scitiscabra*, as a natural predator for the larval stages of *S. frugiperda*.

Research Method: The feeding preferences of *D. scitiscabra* to live prey versus dead prey, live prey types including different instar stages of *S. frugiperda* were investigated in the laboratory using choice tests. Fresh minced meat was used as dead prey, while red ants, earthworms and the six larval instar stages of *S. frugiperda* were used as live prey.

Findings: Red ants were the most preferred prey type of *D. scitiscabra*, and dead prey, earthworms and mature *S. frugiperda* larvae were not consumed. Early larval instar stages of *S. frugiperda* were selected as prey, and the beetle showed a high feeding preference for the second larval instar stage. This feeding preference was observed irrespective of whether red ants were present or absent in the same environment. *D. scitiscabra* may have selected the second larval instars of *S. frugiperda* due to their small size, high prey density, mobility, and being devoid of injury.

Research Limitations: The tests were conducted under laboratory conditions in insectary facilities. However, field investigations are essential to understand the ecological dynamics that affect insect behavior and survival.

Originality/value: An endemic beetle is introduced to control *S. frugiperda* infestations in their early stages of development. The finding may provide an environmentally safe and economically beneficial method to control *S. frugiperda*.

Keywords: Natural predator, Pest control, Red ants, Second larval instar, Sri Lanka.

INTRODUCTION

The Fall armyworm, *Spodoptera frugiperda* (J.E. Smith), is a serious crop pest in Sri Lanka that was first reported in August 2018 (Perera *et al.*, 2019). It has caused massive damage to large-scale corn monocropping systems, and the total estimated damage to the crop is about 20% (Dissanayake, 2019). In the first emergence, it has been recorded from the Uva, Eastern, and North-Central provinces of the island and has been recently reported as a caterpillar menace in Dambana of the Uva province. In addition to corn, *S. frugiperda*

has been reported from the sugar plantations of the country (Wanasinghe *et al.*, 2019) and on vegetable crops (Wijerathna *et al.*, 2021).

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According to Perera *et al.* (2019), the pest can be devastating to paddy cultivation in the future. The government of Sri Lanka has allocated millions of rupees for preventive and control measures, mainly for pesticides and special chemicals used to control the pest in the United States (Dissanayake, 2019). However, it is suggested that control of the pest will be best achieved through switching from industrial-type mono-cropping to ecological agriculture technologies with the promotion of natural predators and parasitoids (Perera *et al.*, 2019).

Spodoptera frugiperda is known from many other countries in addition to Sri Lanka, and has been considered as a serious pest of cultivated crops from early times (Luginbill, 1928). Therefore, control measures have also been adopted from early times, such as mechanical measures (construction of deep furrows as barriers, crushing of larvae by steel lawn rollers), chemical measures (sprays, baits, and dust), cultural measures (keeping clean fields, flooding, shallow cultivation), and biological measures (Luginbill, 1928). In biological control measures, many insects have been used as predators and parasites, particularly in the orders Hymenoptera, Diptera, Hemiptera, and Coleoptera (Luginbill, 1928). Amongst the Coleopterans, *Calosoma* larvae (Carabidae) have been used as predators of fall armyworms, the most common being *Calosoma calidum* (Luginbill, 1928). However, much later *Calosoma sayi* has been recorded as a predator of fall armyworm pupae in sorghum fields of South Georgia (Gross and Pair, 1986). Ground beetles such as *Lebia analis*, *Galerita bicolor*, and *Callida punctata* also feed on the fall armyworm (Luginbill, 1928), and the ground beetle, *Onypterygia faminia*, has been recorded as a predator of fall armyworm larvae in Guatemala (Gross and Pair, 1986). The tiger beetle, *Megacephala (Tetracha) carolina*, of tribe Megacephalini has been used as a predator for bio-control of fall armyworm larvae as far back as 1928 (Luginbill, 1928). In addition, much later in 2006, the same tiger beetle species was recorded as a predator that can be used to control the fourth instar larval stage of fall armyworm (Nachappa *et al.*, 2006). Further, tiger beetles have been recorded as predators of young larvae of fall armyworms that harm turf grass in Kentucky (Terry *et al.*, 1993). Young (2005), who compared the predatory and scavenging efficiency of three carabid species on *S. frugiperda*, revealed the tiger beetle *Cicindela punctulata* (tribe: Cicindelini) as the most efficient predator and scavenger. The study demonstrated that the tiger beetles had a highly energetic hunting strategy and less energy storage capacity, which demands the species to consume more food, more frequently. Further, tiger beetles

have been described as natural enemies that are not negatively affected by consuming *S. frugiperda* infesting genetically modified Bt (bacterial toxin) maize, and thus very effective as natural enemies (Fernandes *et al.*, 2007).

However, the possibility of using arboreal tiger beetles (tribe: Collyridini) as predators in controlling *S. frugiperda* or any other insect pest of crop cultivation has not yet been investigated. This is very surprising as species of Collyridini have several advantages as natural enemies of crop pests when compared with species of other tiger beetle tribes. In Sri Lanka, crop cultivations are the most preferred habitat type of arboreal tiger beetles (Abeywardhana *et al.*, 2021a), and species of Collyridini occur naturally in cultivated lands elsewhere in the world (Cabras and Wiesner, 2016; Toki *et al.*, 2017). In contrast, tiger beetle species of the tribe Cicindelini mostly prefer locations near water that are sparsely vegetated such as beaches, river banks, and edges of reservoirs (Abeywardhana *et al.*, 2020), and Megacephalini resides in floodplain habitats and salt marshes (Adis *et al.*, 1998; Šekeroğlu and Aydin, 2002). Further, arboreal tiger beetles are found associated with the leaves, branches, and stems of a plant, coinciding with the occurrence of insect pests on crops, whereas other tiger beetles are mostly ground-dwelling. According to Sinu *et al.* (2006), the Cicindelini species *Cicindela whitelli* and *C. flavomaculata* are unlikely to be efficient natural enemies of rice paddy pests as they are ground dwellers restricted to feeding on the muddy substratum of rice paddy fields and are not active climbers. Additionally, most species of Collyridini are diurnal and forage for prey when pests are actively feeding on crop plants. Megacephalini are nocturnal and during the day seek shelter under rocks, in dry cracks of desiccated lakes, and under flotsam washed ashore (Carter, 1989).

Therefore, investigating the potential of arboreal tiger beetle species of the tribe Collyridini as a natural enemy for the control of *Spodoptera frugiperda* is quite logical. In the present study, *Derocrania scitiscabra* Walker was selected as the species for investigation as it has been known to be the most common species from crop cultivations in Sri Lanka (Abeywardhana *et al.*, 2021a). Further, the species has been recently recorded from the Uva, Eastern, North-Central, and Northwestern provinces (Abeywardhana *et al.*, 2021b), where *Spodoptera frugiperda* infestations are also prevalent. With all the above-described background, the present study intends to investigate the possibility of using the adult tiger beetle species, *D. scitiscabra*, as a natural enemy to control *S. frugiperda*. The findings of the study will be of immense importance to the

country and provide a novel approach to managing the devastating *S. frugiperda* within Sri Lanka.

MATERIALS AND METHODS

Collection and Characterization of the Predatory Organism Derocrania scitiscabra

Derocrania scitiscabra is found in several locations of the country and was collected from coconut cultivation in Dambadeniya, Kurunegala district, Northwestern province. Adult beetles were handpicked from coconut tree trunks when foraging at levels of 1–2 feet above the ground. They were characterized using morphological and morphometric features.

Choice Tests

The choice tests aimed to identify the specific feeding preferences of *D. scitiscabra* across various prey types and conditions. Choice tests were conducted to determine the feeding preferences of *D. scitiscabra* for living versus dead prey to determine the beetle's preference for active prey. Earthworms versus red ants were used to assess the predator's preference between different prey species. Preferred living prey versus different instar stages of *S. frugiperda* were tested to identify if certain developmental stages of this pest are more attractive or vulnerable to *D. scitiscabra*. All tests were conducted at the insectary facilities of the University of Colombo under a temperature of $28 \pm 2^\circ\text{C}$ and $80 \pm 10\%$ relative humidity, with a 12 h:12 h light: dark natural photoperiod.

Live versus Dead Prey: To test the feeding preference of *D. scitiscabra* for live versus dead prey, fresh minced meat was taken as dead prey, while earthworms (*Eudrilus euginea*, body length 50–60 mm) and red ants (*Anoplolepis gracilipes*, body length 2–3 mm) were considered as live prey. One adult *D. scitiscabra* that was held without food for four days was exposed to 1 g of fresh minced meat (dead prey) and 15 live red ants within a glass tank of 4 cm height \times 15 cm width \times 21 cm length. The feeding behavior of *D. scitiscabra* was observed for 15 minutes, and the amount of minced meat consumed or the number of red ants consumed was recorded. The experiment was repeated five times.

To test the feeding preference of *D. scitiscabra* for earthworms, the above experiment was repeated by changing the live prey type to three earthworms instead of the 15 red ants. Five replications of the experiment were conducted.

Earthworms versus Red Ants: To test the feeding preference of *D. scitiscabra* for two different types of live prey, one adult *D. scitiscabra* was exposed to three earthworms and 15 red ants within the glass tank. The feeding behavior of *D. scitiscabra* was observed for 15 minutes, and the number of earthworms and red ants consumed was recorded. The experiment was repeated five times.

Preferred Live Prey versus S. frugiperda Larval Stages: The preferred live prey type determined from the above choice test and different instar stages of *S. frugiperda* larvae were presented to *D. scitiscabra*. Fifteen red ants and 15 larvae of *S. frugiperda* of a particular instar stage were offered to one adult *D. scitiscabra* per trial. Five trials were performed for each larval instar stage of *S. frugiperda*. The feeding behavior of *D. scitiscabra* was observed for 15 minutes, and the number of red ants and *S. frugiperda* larvae consumed was recorded. Morphological and morphometric data of *S. frugiperda* larvae were used in separating them into their respective instar stages.

Feeding Preference of D. scitiscabra to Selected S. frugiperda Instar Stage in the Presence and Absence of the Most Preferred Prey Type: *Derocrania scitiscabra* was provided with the most preferred *S. frugiperda* instar stage determined from the above experiment, in the absence and presence of the most preferred prey type (red ants). The experiment was carried out in two components: in the first component, *D. scitiscabra* was provided with 15 red ants and 15 *S. frugiperda* second instar larvae, and in the second component, *D. scitiscabra* was only provided with the larvae. After providing the prey, the feeding behavior of *D. scitiscabra* was observed for 15 minutes, and the number of prey consumed was recorded. Fifteen replications of the experiment were conducted for each component.

Data Analysis and Statistical Tests

Data analysis using statistical tests was performed to determine the significant variations between the amount of dead prey and live prey consumed; the amount of the different types of live prey consumed; the number of the different larval instar stages of *S. frugiperda* consumed; and the number of the second larval instar consumed in the presence and absence of red ants. The parametric One-way Analysis of Variance (ANOVA) was used to determine significant variations among the numbers, and the significance was assessed with a 95% confidence interval. Statistical analysis was performed using Minitab version 1.9 statistical software.



Figure 1: The predatory beetle *Derocrania scitiscabra*.



Figure 2: The six larval instar stages of *S. frugiperda* ; a First instar stage, b Second instar stage, c Third instar stage, d Fourth instar stage, e Fifth instar stage, f Sixth instar stage.

RESULTS AND DISCUSSION

Characterization of Derocrania scitiscabra

D. scitiscabra has a uniformly black-colored body with a large head, prominent eyes, significantly long and thin antennae, long and narrow pronotum, and widened elytra. Species could be distinguished by the entirely sculptured elytra that has polygonal dimples in the first half that are stretched lengthwise and grouped into sinuous wrinkles in the second half. The males and

females were morphologically similar in coloration and other features, but females were larger in body size (Body length: female 16.18 – 19.80 mm [n = 9]; male 15.49 – 18.52 mm [n = 15]). (Figure 01).

Morphological and Morphometric Differentiation of the Larval Instar Stages of S. frugiperda

The larval lengths and morphological characters of the different instar stages of *S. frugiperda* were recorded. The first instar stage was distinguished by a length of

1.68 ± 0.42 mm [$n = 98$], and a large prominent black head with a transparent body. Black-colored markings were evident in the thoracic and abdominal segments of the body. The second instar stage denoted a length of 3.31 ± 0.56 mm [$n = 85$] and was characterized by a green transparent body with a conspicuous band on the first thoracic segment. The third instar stage was defined by a length of 6.77 ± 0.34 mm [$n = 77$], with light brown dorsal coloration marked with white vertical bands. The fourth instar stage had a length of 11.68 ± 0.65 mm [$n = 93$], with a greenish-brown body and reddish-brown head. The head was mottled by white markings. The fifth instar stage was defined by a length of 17.23 ± 0.97 mm [$n = 71$], and characterized by a browner body with an inverted Y mark on the head between the eyes. The final or sixth larval instar stage was 29.27 ± 1.96 mm [$n = 83$] in length, with a mid-line arising from the base of the inverted “Y” mark on the head extending towards the last abdominal segment.

Feeding Preference of *D. scitiscabra* to Living versus Dead Prey

The choice test conducted to investigate the feeding preference of *D. scitiscabra* revealed that the arboreal tiger beetle preferred live prey to dead prey. A significant difference (Sig. 0.000, $p < 0.05$) prevailed between the amount of dead prey and live prey consumed by the beetle. Dead prey given in the form of fresh minced meat were not consumed at all while red ants were consumed in all five trials with an average of 11 red ants per trial. However, the predator did not prefer earthworms as live prey and did not consume them in any of the trials (Table 01). Tiger beetles are ambush predators that hunt and feed mainly on active approaching prey such as ants, other insects, spiders, and small crustaceans, and only occasionally scavenge on dead organisms (Pearson, 1988; Sinu *et al.*, 2006; Satoh and Hayaishi, 2007; Rewicz and Jaskula, 2018). The prey type that *D. scitiscabra* may select and consume relies on one or more characteristics of the prey, such as prey size, prey density, mobility, fitness, nutritional quality, color, odor, and taste. When considering prey size, visual predators such as tiger beetles that locate prey by sight (Rewicz and Jaskula, 2018) are known to prefer larger prey compared to smaller prey (Cogni *et al.*, 2002). However, pursuing prey that is too large can be harmful or energetically costly to predators, while pursuing prey that is too small may not provide adequate energetic returns (Schmitz, 2017). In the present experiment, *D. scitiscabra* did not consume dead prey, nor did it pursue or consume earthworms that were comparably larger than the predator and less active. *D. scitiscabra* preferred to consume red ants

that were comparatively small and highly mobile, as observed in the choice test investigating its feeding preference between earthworms and red ants.

Feeding Preference of *D. scitiscabra* to Earthworms versus Red Ants

When presented with only live prey, red ants were preferred over earthworms in all trials. In all trials, earthworms were not consumed, while an average of 11 red ants were consumed per trial (Sig. 0.000, $p < 0.05$) (Table 02.). However, when red ants were provided with *S. frugiperda* larvae, the beetles consumed larval forms of certain instar stages.

Feeding Preference of *D. scitiscabra* to Different Instar Stages of *S. frugiperda*

When presented with both prey types—red ants and *S. frugiperda* larvae—*D. scitiscabra* showed a higher preference for red ants than for the *S. frugiperda* larval stages (Sig. 0.001, $p < 0.05$). The mature larval instar stages (fourth, fifth, sixth) were not attacked or consumed at all, while the early larval instar stages (first, second, third) were consumed alongside the red ants. However, *D. scitiscabra* consumed the first and third larval stages in very low amounts compared with the second larval instar stage (Sig. 0.003, $p < 0.05$) (Figure 03.). Further, the feeding preference of *D. scitiscabra* for the second larval instar stage did not seem to be affected by the presence or absence of the red ants (preferred prey type), as a similar amount of second instar larvae were consumed when red ants were present and when they were absent ($p < 0.05$) (Figure 04.). The feeding preference of *D. scitiscabra* to second larval instar stages of *S. frugiperda* may be attributed to many factors of prey selection. For instance, the second larval instar stage of *S. frugiperda* was more or less similar in body length (3.31 mm) to that of the red ants (2–3 mm) and may suffice the criteria for preferable prey size as has been vaguely shown by several previous studies. The assassin bug, *Zelus longipes*, has been known to attack small caterpillars of *S. frugiperda* more often than the medium and large ones, as successful attacks are more frequent on small larvae and the risk of injury to the predator is low (Cogni *et al.*, 2002). Further, adult male and female predators of the plant bug, *Engytatus varians*, are known to consume significantly more second-instar prey of *S. frugiperda* when compared with the other instar stages (Pineda *et al.*, 2020).

Moreover, larger aggregates or densities of *S. frugiperda* larvae are known to be more frequently

Table 1: Feeding preference of *D. scitiscabra* to live versus dead prey.

Trial Number	Predator	Dead Prey	Live Prey	Amount of Dead Prey Consumed (1g)	Number of Live Prey Consumed
01	<i>D. scitiscabra</i> (1)	Fresh minced meat (1g)	Red ants (15)	0	8
02	<i>D. scitiscabra</i> (1)	Fresh minced meat (1g)	Red ants (15)	0	10
03	<i>D. scitiscabra</i> (1)	Fresh minced meat (1g)	Red ants (15)	0	13
04	<i>D. scitiscabra</i> (1)	Fresh minced meat (1g)	Red ants (15)	0	14
05	<i>D. scitiscabra</i> (1)	Fresh minced meat (1g)	Red ants (15)	0	10
Average				0 ± 0	11 ± 2.45*
01	<i>D. scitiscabra</i> (1)	Fresh minced meat (1g)	Earthworms (3)	0	0
02	<i>D. scitiscabra</i> (1)	Fresh minced meat (1g)	Earthworms (3)	0	0
03	<i>D. scitiscabra</i> (1)	Fresh minced meat (1g)	Earthworms (3)	0	0
04	<i>D. scitiscabra</i> (1)	Fresh minced meat (1g)	Earthworms (3)	0	0
05	<i>D. scitiscabra</i> (1)	Fresh minced meat (1g)	Earthworms (3)	0	0
Average				0 ± 0	0 ± 0

* Significant difference between the amount of prey consumed.

attacked by predators than smaller aggregates. This has been attributed to volatiles released from patches of high prey density that attract increased numbers of predators and parasitoids, semiochemicals released from herbivore-damaged plants, and defoliation of host plant by large densities of larvae, likely to further expose the prey to the predator (Chapman *et al.*, 2000). High larval density occurs in the early larval stages of *S. frugiperda*, while usually, only one caterpillar of the fifth and sixth instar stages infest a plant part (Kuate *et al.*, 2019). Hence, the second larval instar stage of *S. frugiperda* characterized by high larval density may be preferred by *D. scitiscabra*.

Thirdly, the feeding preference of *D. scitiscabra* for the

second larval instar stage of *S. frugiperda* may depend upon the mobility of the prey. This fact was also evident in the present study, as *D. scitiscabra* did not consume any dead matter given in the form of fresh minced meat while showing a preference for live prey. The early instar stages of *S. frugiperda* are very active when compared with the late larval stages and dispersion for resources and refugia is observed (Pannuti *et al.*, 2015). Larvae migrate from plant to plant with neonates using silk threads and more mature larvae by crawling (Njuguna *et al.*, 2021). *Derocrania scitiscabra* may prefer these moving early instar larvae, especially as their movement is slow. Rewicz and Jaskula (2018) have reported that certain tiger beetle species of the tribe Cicindelini strongly prefer slow-moving prey that cannot escape from the pursuing beetle.

Table 2: Feeding preference of *D. scitiscabra* to two different types of live prey.

Trial Number	Predator	Live Prey 1	Live Prey 2	Number of Live Prey 1 Consumed	Number of Live Prey 2 Consumed
01	<i>D. scitiscabra</i> (1)	Earthworms (3)	Red ants (15)	0	15
02	<i>D. scitiscabra</i> (1)	Earthworms (3)	Red ants (15)	0	10
03	<i>D. scitiscabra</i> (1)	Earthworms (3)	Red ants (15)	0	11
04	<i>D. scitiscabra</i> (1)	Earthworms (3)	Red ants (15)	0	9
05	<i>D. scitiscabra</i> (1)	Earthworms (3)	Red ants (15)	0	10
Average				0 ± 0	11 ± 2.34*

* Significant difference between the amounts of prey consumed.

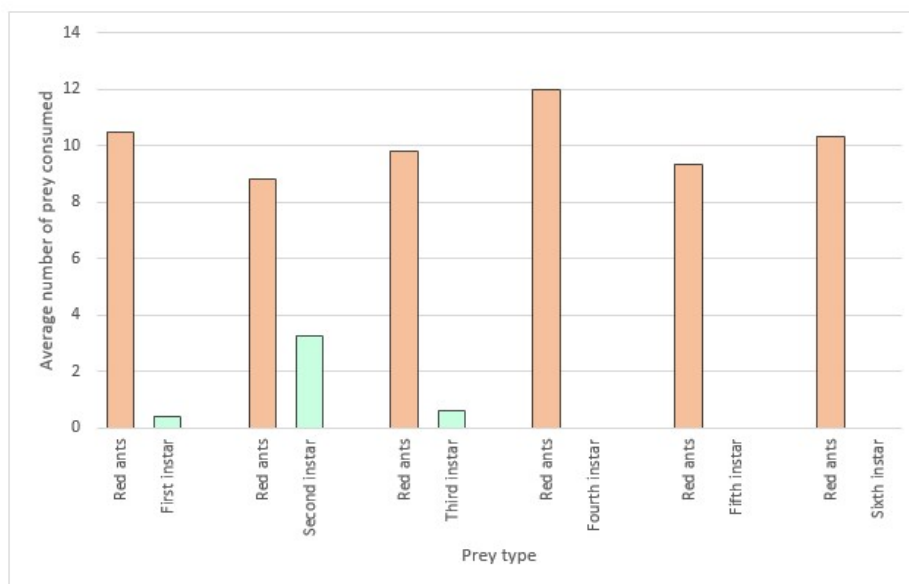


Figure 3: Feeding preference of *D. scitiscabra* to red ants and different instar stages of *S. frugiperda* larvae.

Another factor that may affect the prey selection process of *D. scitiscabra* is the fitness or absence of injury in the *S. frugiperda* larval stages. Tiger beetles are known to refrain from attacking wounded prey, in the sense that they will produce noxious chemicals. Further, these predators prefer attacking the middle or front part of the prey, as the main muscles responsible for walking are placed in the insect’s thorax, as well as the main part of the insect nervous system (Rewicz and Jaskula, 2018). An attack on these body parts usually allows immobilizing and killing the prey quickly, hence, especially prey with damaged anterior portions will not be preferred. Injury to the *S. frugiperda*

larvae may occur due to various reasons including farming practices, invertebrate and vertebrate predators and cannibalism. Cannibalism is quite common in *S. frugiperda* larvae and may occur between the same-aged instar stages or different-age instar stages in which the more mature larval stage attacks the more immature larval stage. When considering cannibalism amongst same-aged larval instars, Kasige *et al.* (2022) have demonstrated that cannibalism is not evident amongst second larval instar stages, and an increasing trend occurs amongst the same-age conspecifics from the third to the fifth instar stage. This may also explain and may be an additional reason for the preference of *D.*

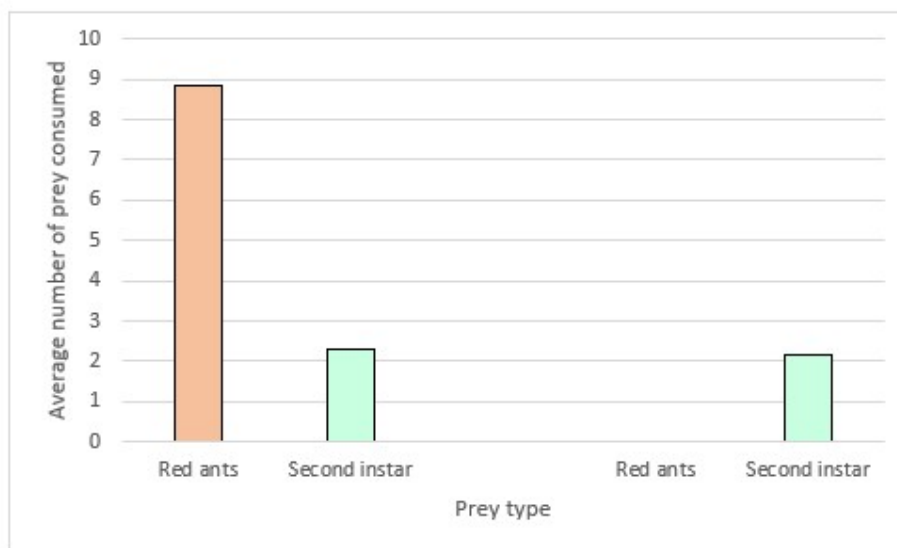


Figure 4: Feeding preference of *D. scitiscabra* to the second instar stages of *S. frugiperda* in the presence and absence of red ants.

scitiscabra for the second larval stages of *S. frugiperda*.

Thus, the second larval instar stage of *S. frugiperda* may have the appropriate prey size, prey density, mobility and less injury for *D. scitiscabra*, when compared with the other larval stages of *S. frugiperda* and other potential prey of the crop cultivation habitats. Hence, there is a high possibility that this larval stage be selected by the tiger beetle and strongly preyed upon and thus controlled largely.

However, conducting future studies on field sites in *S. frugiperda*-infested areas of the country are advisable. Further, more investigations on arboreal tiger beetles naturally occurring in crop cultivation habitats, especially nocturnal species that hunt at night may be beneficial as *S. frugiperda* larvae feed and are also active at night.

The tiger beetle's preference for early-stage larvae may be strategically important for pest control and crop protection in agricultural systems, as it targets pest populations before they can mature and cause significant damage to crops. Mature instar stages of the fall armyworm are known to consume a greater quantity of food than the early instar stages, moreover causing greater damage by targeting the fruiting structures of crops (Luttrell and Mink, 1999; Hardke *et al.*, 2015; Matova *et al.*, 2020). In contrast, smaller larvae of *S. frugiperda* feed on the leaves of plants causing chlorophyll degradation, which will lead to a reduction in photosynthetic productivity and plant vigor. Therefore, it has been shown that fall armyworm control measures should be instituted when the larvae are young and immature, so that crop damage may not

pass the economic injury level (EIL) (Anjorin *et al.*, 2022).

The findings of this study underscore the potential role of tiger beetles as natural pest control agents within integrated pest management (IPM) frameworks. By targeting *S. frugiperda* larvae at early developmental stages, tiger beetles can help reduce pest populations before they cause significant crop damage, aligning with ecological approaches to pest management that emphasize the use of biological controls over chemical pesticides.

Moreover, the study highlights the importance of conserving natural habitats within agricultural landscapes to support tiger beetle populations and other beneficial predators. Incorporating such conservation practices into farming systems could enhance pest control efficacy while reducing dependency on synthetic inputs, thereby contributing to more sustainable and resilient agricultural practices.

Future research should explore the scalability of using tiger beetles in IPM strategies across different crops and regions, particularly under field conditions that reflect real-world agricultural challenges. This work aligns with global efforts to implement ecologically sound pest management approaches that protect crop yields, safeguard biodiversity, and support environmental health.

CONCLUSION

The present study on the characterization of *Derocrania scitiscabra* and its feeding preferences highlighted

the strong preference of the beetles to live prey such as red ants and early instar larvae of *S. frugiperda*. It avoids consuming larger, less mobile prey (e.g., earthworms) and dead matter, aligning with the predator's natural ambush-hunting strategy. The beetle's selective predation on the second instar larvae of *S. frugiperda* underscores its potential as a biological control agent. Early-stage larvae are targeted before they inflict significant agricultural damage, suggesting strategic benefits in integrated pest management (IPM) frameworks. Preserving natural habitats to sustain

tiger beetle populations can enhance their role in crop protection. Further research is recommended to assess their efficacy in field conditions, focusing on diverse crop systems and nocturnal beetle species that might complement pest control during *S. frugiperda*'s peak activity periods. In conclusion, *D. scitiscabra* demonstrates significant potential as a natural ally in sustainable agriculture, emphasizing the value of ecological pest control approaches that reduce reliance on chemical interventions.

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