

First report on the invasion of vermicelli by *Lasioderma serricorne*

RD Dodiya¹, NP Pathan^{2*}, SM Goswami¹, BA Chachpara¹ and PM Sondarava³



Summary

Lasioderma serricorne F. causes significant losses to grain that is kept in storage. They can also spoil a lot more food than they actually consume. An empirical experiment was carried out to ascertain the level of insect infestation in the vermicelli at Anand, Gujarat, India. Also, per cent weight loss of vermicelli due to infestation of *L. serricorne* and apparent parasitism of *Anisopteromalus calandrae* (Howard) on grub of *L. serricorne* were calculated. The percentage of weight lost due to its infestation ranged from 18.00 to 68.00 per cent. Notably, the grub of *L. serricorne* was parasitized by *A. calandrae* and the apparent parasitism ranged from 48.00 to 85.00 percent. It was the first report of *Lasioderma serricorne* an infestation in vermicelli from India.

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Introduction

From the farm gate to industrial products, insects stored products infest a variety of agricultural goods. Numerous authors have documented the threat of insect pest infestation on harvested crop produce or processed goods (Parkin 2008; Babarinde et al. 2013; Dodiya et al. 2022; Haldhar et al. 2023a). In a particular brand of digestible biscuit, *Lasioderma serricorne* was discovered by Babarinde et al. (2008). Additionally, Odeyemi et al. (2005) reported finding *Tribolium castaneum* in several cookie brands. These are signs that insect pests like *Lasioderma*, which are the main pests of cereals, may target processed goods produced from grains. As a worldwide pest of stored products, the cigarette beetle (*Lasioderma serricorne* Fab.) of the Coleopteran order causes significant financial harm to grain that is kept in storage. The beetle's preferred food source is dried tobacco, which includes cigars, chewing tobacco, and leaves. The cigarette beetle damages a wide range of items that are kept in storage, including cereal, dates, dried fish, ginger, grain, pepper, pharmaceuticals, raisins, and seeds. They may consume medicines, leaves, and book bindings in addition to common crops like wheat and grain. They are a common source of annoyance in museums and historical buildings. They can also spoil a lot more food than they consume. Bamboo, beans, biscuits, cassava, chickpea, cocoa, coffee beans, copra,

coriander, cotton seed before and after harvesting, cotton seed meal, atta, cumin, dates, dried banana, dried cabbage, dried carrot, ginger, grain, groundnut, nutmeg, raisins, rice, tobacco, dried fish, fish meal, and leather are all part of the wide host range of *L. serricorne* (Howe 1957). This pest was also noted by Retief (1988) on plant specimens on exhibit in the National Herbarium in Pretoria. For the first time, Dodiya et al. (2023), reported this pest in domestically stored garlic from Gujarat. The larva excavates the material and consumes its contents (Dodiya et al. 2024a). Although adult feeding is limited, it manages to get away via holes in packaged goods. According to Powell (1931), quality loss is caused by dead beetles, excreta, and other waste products. An annual loss due to the cigarette beetle reported by Kant et al. (2013) in several seed spice crops, including dill (39.5%), ajawan (47.75%), cumin (51.02%), fennel (58.02%), and coriander (49.58%). A classic pasta shape that resembles spaghetti and is circular in section is called vermicelli. It is referred to as "vermicelle" in English-speaking areas and is thinner than spaghetti, while it is thicker in Italy. Refined wheat flour milled from durum wheats is used to make it. The suitability of many Indian durum wheat cultivars for the making of vermicelli has been investigated. Vermicelli may be found throughout the Indian subcontinent's countries either as long strands or broken into pieces. The term "vermicelli" has several regional variations: *sewiyun* in Sindhi; *semya* in Telugu; *semya* in Tamil when made with wheat, and *sevai* when made with rice; *semya* in Malayalam; *shavige* in Kannada; *sewoi* in Assamese; *shemai* in Bengali; *seviyan* in Hindi, Urdu, and Punjabi; *shevaya* in Marathi; *simiei* in Odia; *sev* in Gujarati and *semige* in Tulu. The noodles are used in several recipes, such as a rice pudding-like sweet treat called *kheer*. In several regions

¹Department of Entomology, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar, Gujarat, India – 385 506

²Department of Plant Protection, College of Horticulture, S. D. Agricultural University, Jagudan, Gujarat, India – 384 460

³Department of Genetics and Plant Breeding, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, India – 388 001

*Corresponding author: NP Pathan, E-mail: naziya.p.pathan@gmail.com

of India, vermicelli is also used to prepare the well-known meal upma. It is made by cooking dried oil-roasted vermicelli with enough water to absorb it, along with pre-sauteed veggies such as onions, carrots, French beans, peas, etc. (Vetrimani et al. 2005; Mogra & Midha 2013; Haldhar et al. 2023b). Given the increasing demand for these items in the majority of developing-nation homes, research on the impact of insect infestation on product quality is necessary to help manufacturers, merchants, and consumers handle these products properly. Consequently, determining the pest infestation in the vermicelli was the objective of this experiment.

Material and Methods

Survey

An empirical investigation was conducted on locally produced vermicelli in Anand, Gujarat, India (Latitude: 22.5645° N, Longitude: 72.9289° E, Altitude: 39 m above MSL). Thirty households' worth of homemade vermicelli was used to gather the damaged samples. To find out whether there were any insect pests on the vermicelli that had been stored in plastic jars with tiny holes for air to circulate through. The samples were routinely checked for the presence of pests. Within the plastic jar, beetles became apparent after three months of storage, and little parasitic wasps were discovered after the fourth week. Using a mouth aspirator, the beetles and wasps were removed from the plastic container and then preserved in 70% high-grade alcohol.

Rearing of *L. serricorne* and *A. calandrae*

The initial culture of *L. serricorne* was obtained from the infested vermicelli, and adult insects were reared on it at 28±2 °C and 75 ± 5% relative humidity. The vermicelli was first stored at 20 °C for one week to remove previous natural pest infestations. Twenty adult *L. serricorne* of mixed sexes were placed in glass 250 ml jars with 500 g of vermicelli, and the jars were covered with a net to allow for air circulation. The adults were removed from the jars after one week of infestation, and these jars were kept for 30 days, after which grub were used in the following experiments. *Anisopteromalus calandrae* (Howard) were reared in accordance with the methodology proposed by Guo et al. (2019), as briefly described below. The adult *A. calandrae* was raised on 6-week-old mature larvae and pupae of *L. serricorne* at 28 ± 2 °C, 75 ± 5% RH after being naturally infected in vermicelli. After two weeks, newly emerging adults of *A. calandrae* were made accessible and utilized in the experimental investigations.

Damage potential of *L. serricorne* grub

To determine the amount of damage and weight loss caused by the insect infestation on vermicelli experiment was conducted in a completely randomized design (CRD) with thirty treatments and three replications. To make the vermicelli clean, sieving was done. In this experiment, 25 gm vermicelli was put in each of 30 petri plates and 10 grubs of *L. serricorne* were released into each of petri dish. After two weeks of released weight of infested vermicelli was measured. According to Chakma (2014) per cent weight loss due to infestation of *L. serricorne* was calculated as below formula.

% Weight loss due to infestation

$$= \frac{\text{Total weight of vermicelli} - \text{Weight of infested vermicelli}}{\text{Total weight of vermicelli}} \times 100$$

Apparent parasitism of *A. calandrae* on grub of *L. serricorne*

The parasitism percentage of wasps on grub was recorded in terms of apparent parasitism in CRD design with ten treatments and three repetitions. For that thirty grubs of *L. serricorne* were put in Petri plate and there after 1-2 days old mated female of *A. calandrae* released in each of petri plate with the help of mouth aspirator. After 24 hours parasitoid was evacuated from them and the observations were taken after two weeks as number offspring of host and parasitoid which were emerged from it. Apparent parasitism was calculated as formula given by Zilch et al. (2017).

Apparent parasitism

$$= \frac{\text{No. of emerged parasitoids}}{\text{No. of emerged parasitoids} + \text{No. of emerged host}} \times 100$$

Statistical analysis

The experiment on quantitative deterioration of the vermicelli and apparent parasitism was set up in a completely randomized design and data were subjected to analysis of variance (ANOVA). All the data were statistically analyzed by using software R version 4.3.2 and doe bioresearch package.

Results and Discussion

Morphological traits of beetle and wasp

Based on morphological traits by Halstead (1986), Dodiya et al. (2023), the insects were recognized as the Cigarette beetle, *Lasioderma serricorne* (Fabricius) (Coleoptera: Anobiidae). The body of *L. serricorne* grub has a C shape, and its creamy white in color and encircled by yellowish brown hairs, while its head and mouthparts are yellow (Figure 1A). Additionally, exarate type pupae were seen (Figure 1B). The adult beetle has a characteristic "humpbacked" appearance with serrated antennae (Figure 1C). It is tiny, reddish brown in colour, and has very few hairs on its elytra. (Figure 1D, E, F). The collected wasp was identified as *Anisopteromalus calandrae* Howard (Hymenoptera: Pteromalidae) which was the larval pupal parasitoid of *L. serricorne* (Dodiya et al. 2022). Wasp was brownish black with a green metallic shine in appearance. The head capsule was oval in shape and resembled a chickpea. It features three ocelli eyes in addition to a pair of dark-reddish compound eyes. Geniculate antennae were present. The antennae's terminal segments were dark brown colour. The other segments were yellow or yellowish-brown, starting with the scape, pedicel, and other four flagellum segments. The mouthparts have evolved from the chewing type and are yellow in colour. The femur, coxa, and trochanter of each being black or blackish-brown. The tibia and tarsus had golden color. The short, splitted ovipositor was located near the end of the oval-shaped abdomen. It has a dark color with some bright green patches strewn around. Adult of *A. calandrae* first foraging around grub of *L. serricorne*. Once they confirmed that host was suitable and free from any disease infection. It climb on grub body and find out

suitable place for laying egg and at the end it laid two to three eggs on lower abdominal region of host grub and then leave the host (Figure 2). After 3 to 4 days larvae of

A. calandrae hatched out and enter in to body of *L. serricorne* grub and feed inside.

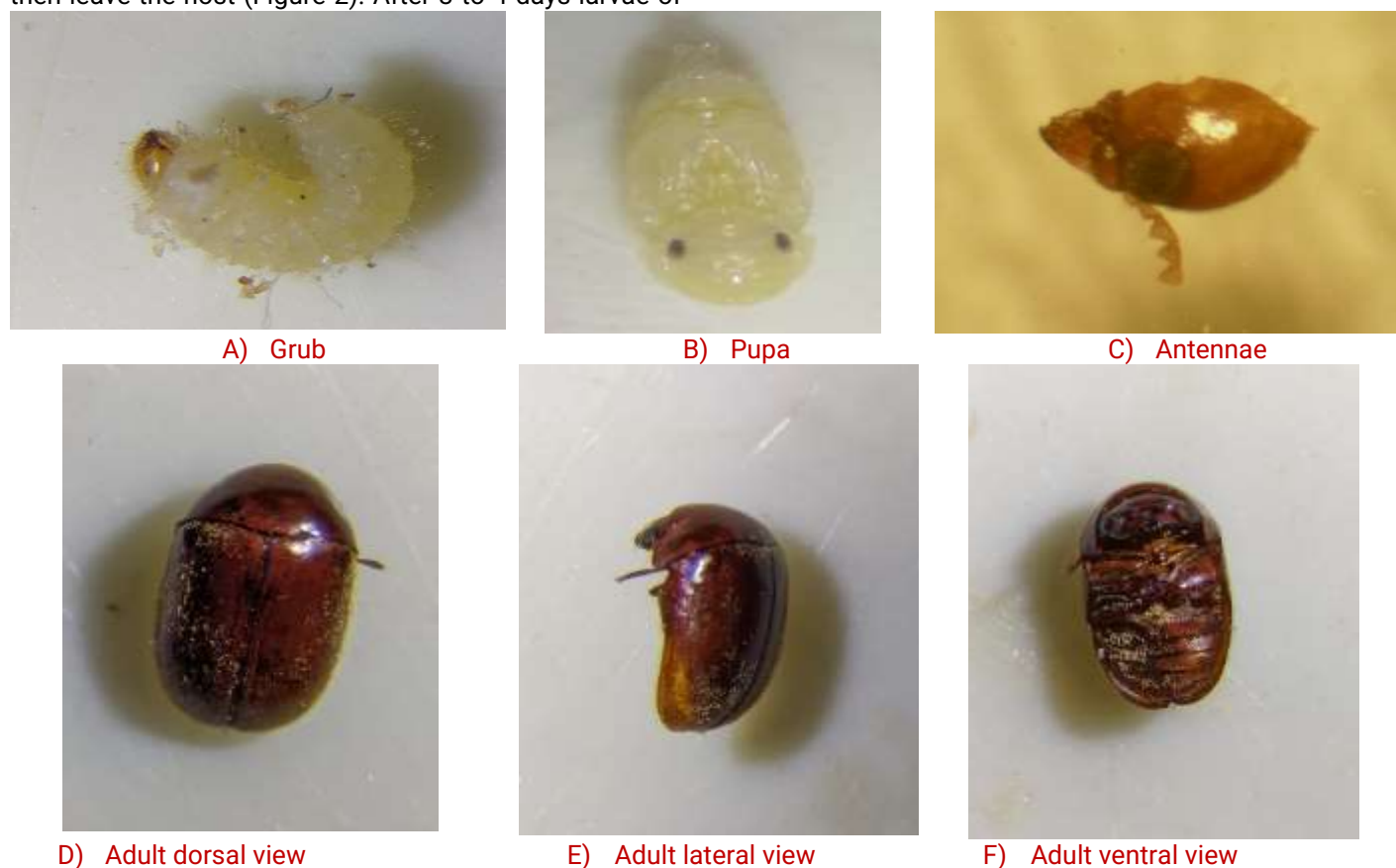


Figure 1. Morphology of *L. serricorne*

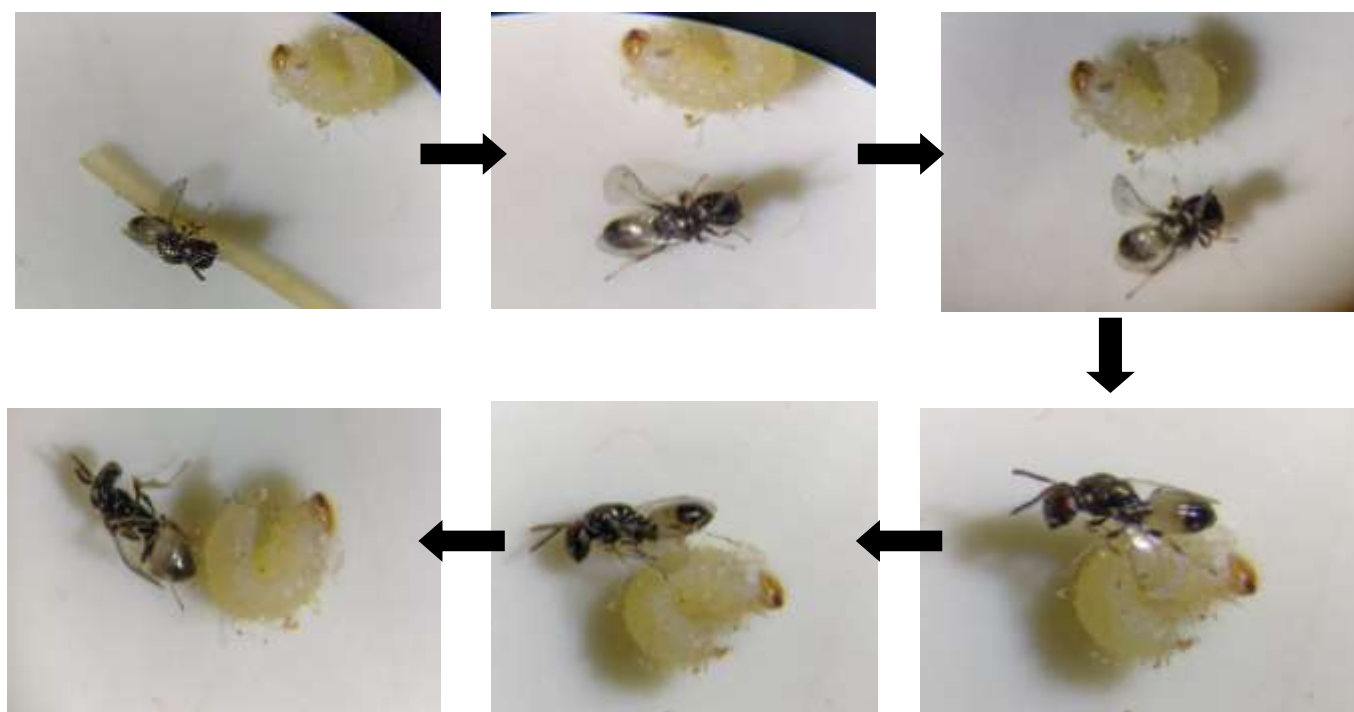


Figure 2. Parasitizing pattern of *Anisopteromalus calandrae*

Damage potential of *L. serricorne* grub

The adult, pupa and grub of *L. serricorne* were obtained from infested vermicelli. Grubs of *L. serricorne* damaged the vermicelli by feeding on it, clumping the material together during feeding, and a powdery substance appeared at the bottom of the product (Figure 3). The

findings shown in Table 1 demonstrate a notable range in the percentage weight reduction of vermicelli due to *L. serricorne* infestation reaching from 18.35% to 68.91%. Among the examined samples, the maximum weight loss was 68.91%, while the minimum was 18.35%. This broad range implies that the weight and quality of vermicelli

were significantly impacted by *L. serricorne* infestation. The p-value suggests that the observed differences are unlikely to be the result of chance, whereas the recorded F value shows the variability between the samples. Based on statistical analysis we concluded that the percent weight loss is indeed influenced by the infestation of *L. serricorne*. The relative variability of the data set is reflected in the coefficient of variation. This

implies that there was a significant amount of variation in the amount of weight loss among the samples. All things considered, our findings highlight the importance of *L. serricorne* infestation in vermicelli, highlighting its consequences for both quality and economy. This information is perhaps best illustrated by the graphical depiction in Figure 4, which shows the per cent weight loss varied across the samples.

Table 1. Per cent Weight loss of vermicelli due to infestation of *L. serricorne*

Sample no.	Weight of infested vermicelli out of total weight of vermicelli (25 gm)	% Weight loss due to infestation
1	13.48	46.08
2	17.71	29.17
3	17.94	28.23
4	18.60	25.59
5	17.19	31.23
6	7.77	68.91
7	18.28	26.89
8	17.37	30.51
9	17.95	28.21
10	13.08	47.67
11	12.44	50.23
12	15.88	36.49
13	12.29	50.84
14	17.11	31.56
15	9.72	61.13
16	17.35	30.60
17	17.96	28.17
18	12.36	50.57
19	12.11	51.55
20	20.41	18.35
21	9.99	60.03
22	16.32	34.72
23	16.89	32.44
24	11.50	54.00
25	16.12	35.52
26	13.05	47.80
27	16.43	34.27
28	18.63	25.47
29	16.87	32.53
30	14.23	43.08
S. Em. $\pm$		9.66
F value		1.72
P value		0.54
C. V. %		42.08



Figure 3 *Lasioderma serricorne* infestation in/on Vermicelli

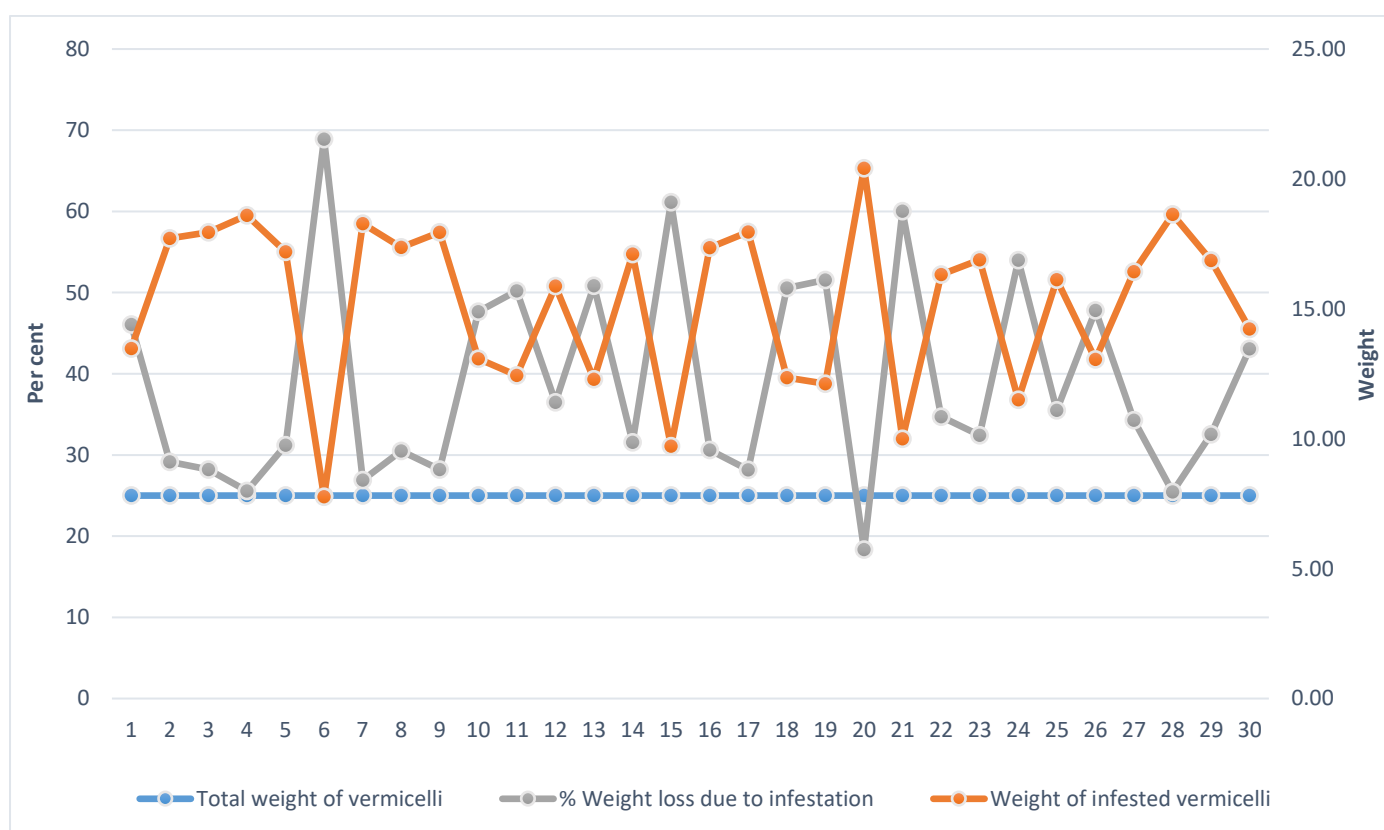


Figure 4. Per cent weight loss of vermicelli due to infestation of *L. serricorne* ($p < 0.05$)

Apparent parasitism of *A. calandrae* on grubs of *L. serricorne*

Analysing the apparent parasitism of *A. calandrae* on *L. serricorne* grubs, the results depicted in Table 2 showed that *A. calandrae* has a significant effect on *L. serricorne* grubs, with observed apparent parasitism rates ranging from 48.89% to 85.56%. A highly significant difference ($p < 0.001$) is revealed by the statistical analysis with a degree of freedom, highlighting the major impact of *A. calandrae* in parasitizing *L. serricorne* grub. The samples show variation in *A. calandrae* capacity to parasitize *L. serricorne* grub, with the maximum recorded parasitism rate of 85.56% and the lowest of 48.89%. While the p-

value indicates that the observed differences are not statistically significant at the traditional significance threshold of 0.05, the F value shows variability between the samples. It is important to remember that even if the p-value is somewhat above the cut off, the outcome nonetheless points to a significant trend in the data. In comparison to the weight loss data, the coefficient of variation indicates a comparatively reduced variability, pointing to a more consistent pattern in the apparent parasitism rates. The findings indicate that *A. calandrae* appears to be rather parasitic on the grub of *L. serricorne*, although there are differences in the degree of effectiveness, it was in different samples. Figure 5

graphical depiction is probably going to shed more light on the patterns in apparent parasitism rates that have been noticed.

Table 2. Apparent parasitism of *A. calandrae* on *L. serricorne*

S. No.	<i>L. serricorne</i> grubs	Number of emerged <i>A. calandrae</i>	Number of emerged <i>L. serricorne</i>	Apparent parasitism Write the measurement unit. It may be in % or any other form.
1	30.00	25.00	5.00	83.33
2	30.00	14.67	15.33	48.89
3	30.00	20.33	9.67	67.78
4	30.00	15.00	15.00	50.00
5	30.00	15.00	15.00	50.00
6	30.00	17.00	13.00	56.67
7	30.00	23.00	7.00	76.67
8	30.00	15.67	14.33	52.22
9	30.00	25.67	4.33	85.56
10	30.00	19.67	10.33	65.56
S. Em $\pm$				8.88
F value				2.31
P value				0.07
C. V. %				24.18

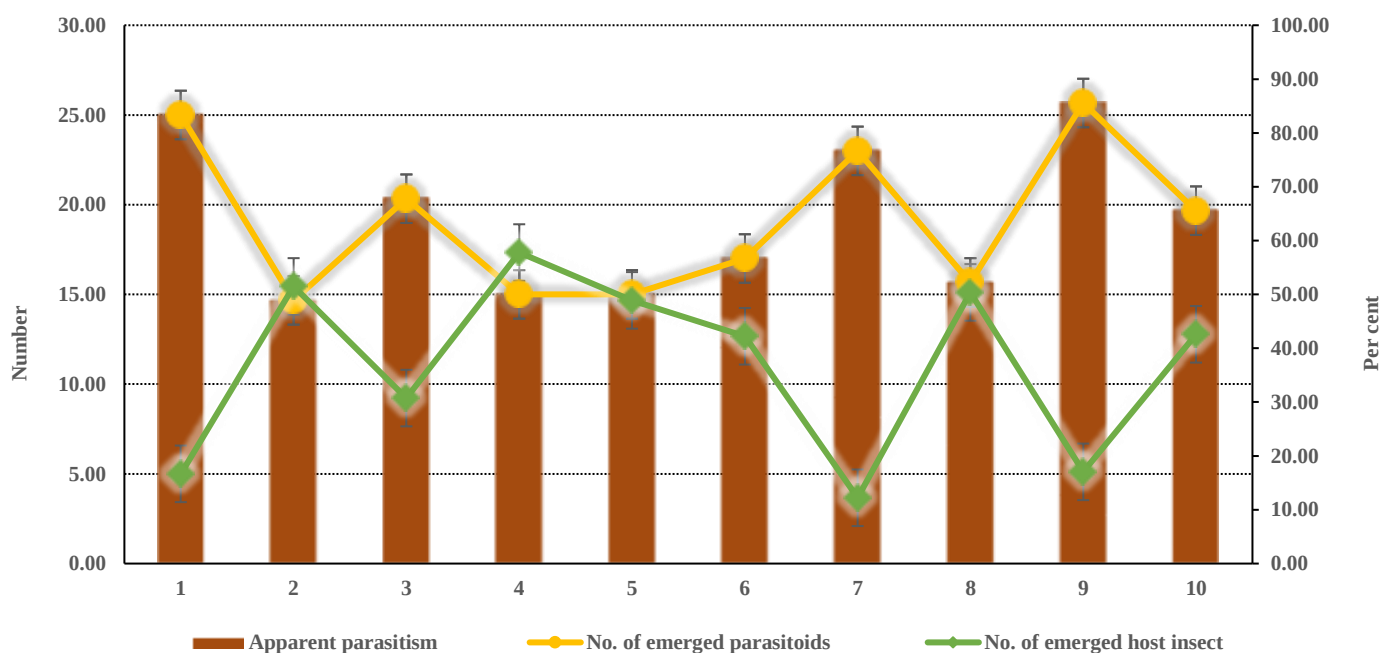


Figure 5. Apparent parasitism of *A. calandrae* on grubs of *L. serricorne* ($p < 0.001$)

The apparent parasitism of *A. calandrae* on *L. serricorne* was recorded at 92-96% by Zilch et al. (2017). According to Guo et al. (2021), the parasitism rate of *A. calandrae* against *L. serricorne* grubs increases with both larval age and the host-to-prey ratio. Yang et al. (2022) found that *A. calandrae* can effectively parasitize *L. serricorne* grubs

and use them as hosts for long-term refrigeration at 10 °C for up to 45 days without significantly affecting the suitability of the progeny. Dodiya et al. (2024b) reported that the most preferred parasitism stage for *A. calandrae* was the 6th instar grub and pupa of *T. castaneum*, noting 87.5% parasitism of 6th instar grubs placed closest to the

surface of the storage structure. Parasitism decreased as storage depth increased. Several studies have indicated that stored grain pests can become serious threats to processed foodstuffs. For example, Latha et al. (2015) found that vermicelli stored in a cotton bag had 3.25 fewer *Sitophilus oryzae* insects and no *T. castaneum* insects after 60 days. After 180 days, there were approximately 43.00 *S. oryzae* and 22.00 *T. castaneum* insects, respectively. Murata et al. (2008) noted that mature *S. zeamais* infestations can occur in pasta. According to Babarinde et al. (2010), *T. castaneum* infestation of plantain chips also affected the chips' proximate composition. Zhang et al. (2010) stated that the two most significant factors influencing changes in noodle texture parameters produced by wet gluten content in wheat are infection time and population density of the lesser grain borer. The present findings demonstrate that *L. serricorne* poses a serious risk to the storage of vermicelli, resulting in both qualitative and quantitative degradation, as this product is a by-product of wheat grain. To date, no scientists have reported *L. serricorne* infestation in vermicelli in India.

Conclusion

Lasioderma serricorne is a known pest of stored grain as well as food products. It causes more damage than it consumes, making it a particularly economical pest. The percentage of weight loss caused by *L. serricorne* in vermicelli ranged from 18.00% to 68.00%. In nature, there is always an enemy of an enemy. Here, the apparent parasitism of *Anisopteromalus calandrae* on the grubs of *L. serricorne* was reported to range from 48.00% to 85.00%. This is the first report of *L. serricorne* infestation in vermicelli from India.

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